

***Programming Guide***  
**HP-IB DC Power Supplies**  
**Series 664xA, 665xA, 667xA**  
**and 668xA**

HP Part No. 5960-5597



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## SAFETY GUIDELINES

The beginning of the power supply Operating Manual has a Safety Summary page. Be sure you are familiar with the information on that page before programming the power supply for operation from a controller.

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**Warning**      **ENERGY HAZARD.** Power supplies with high output currents (such as the Series 668xA) can provide more than 240 VA at more than 2 V. If the output connections touch, severe arcing may occur resulting in burns, ignition or welding of parts. Take proper precautions before remotely programming the output circuits.

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## PRINTING HISTORY

The edition and current revision of this guide are indicated below. Reprints of this guide 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 guide occurring between revisions are covered by change sheets shipped with the guide.

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# INTRODUCTION

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## ABOUT THIS GUIDE

This guide provides remote programming information for the following series of HP-IB programmable power supplies:

- HP 664xA
- HP 665xA
- HP 667xA
- HP 668xA

You will find the following information in the rest of this guide:

- Chapter 2 Introduction to SCPI messages structure, syntax, and data formats. Examples of SCPI programs.
- Chapter 3 Dictionary of SCPI commands. Table of programming parameters.
- Chapter 4 Description of the status registers
- Chapter 5 Error messages
- Appendix A SCPI conformance information.
- Appendix B Use of the alternate Compatibility programming language.

## DOCUMENTATION SUMMARY

### User's Guide

The Operating Guide, shipped with the power supply, has information helpful to programming the power supply and explains the SCPI commands used for remote calibration. Sample calibration and verification programs are included.

### External Documents

#### SCPI References

The following document will assist you with programming in SCPI:

- <sup>1</sup>*Beginner's Guide to SCPI*. HP Part No. H2325-90001.
  - Highly recommended for anyone who has not had previous experience programming with SCPI or TMSL.

#### HP-IB References

For a basic introduction to the HP-IB, see the following:

- <sup>1</sup>*Tutorial Description of the Hewlett-Packard Interface Bus*. HP Part No. 5952-0156.
  - Highly recommended for those not familiar with the IEEE 488.1 and 488.2 standards.

<sup>1</sup>To obtain a copy, contact your local HP Sales and Support Office.

The most important HP-IB documents are your controller programming manuals - HP BASIC, HP-IB Command Library for MS DOS, etc. Refer to these for all non-SCPI commands (e.g., Local Lockout).

The following are two formal documents concerning the HP-IB interface:

- <sup>2</sup>*ANSI/IEEE Std. 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation*. This defines the technical details of the HP-IB interface. While much of the information is beyond the need of most programmers, it can serve to clarify terms used in this guide and in related documents.
- <sup>2</sup>*ANSI/IEEE Std. 488.2-1987 IEEE Standard Codes, Formats, Protocols, and Common Commands*. Recommended as a reference only if you intend to do fairly sophisticated programming. It is helpful for finding the precise definitions of certain types of SCPI message formats, data types, or common commands.

<sup>2</sup>Available from the IEEE (Institute of Electrical and Electronics Engineers), 345 East 47th Street, New York, NY 10017, USA.

### **PREREQUISITES FOR USING THIS GUIDE**

The organization of this guide assumes that you know or can learn the following information:

1. How program in your controller language (HP BASIC, QUICKBASIC, C, etc.).
2. The basics of the HP-IB (IEEE 488).
3. How to program I/O statements for an IEEE 488 bus instrument. From a programming aspect, the power supply is simply a bus instrument.
4. How to format ASCII statements within your I/O programming statements. SCPI commands are nothing more than ASCII data strings incorporated within those I/O statements.
5. The basic operating principles of the power supply as explained in "Chapter 5 - Front Panel Operation" of the Operating Guide.
6. How to set the HP-IB address of the power supply. This cannot be done remotely, but only from the supply's front panel (see **System Considerations** in "Chapter 2 - Remote Programming").

## Remote Programming

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### HP-IB CAPABILITIES OF THE POWER SUPPLY

All power supply functions except for setting the HP-IB address are programmable over the IEEE 488 bus (also known as the Hewlett-Packard Interface Bus or "HP-IB"). The IEEE 488.1 capabilities of the power supply are listed in the Supplemental Characteristics of the Operating Guide. The power supply operates from an HP-IB address that is set from the front panel (see **System Considerations** at the end of this chapter).

### INTRODUCTION TO SCPI

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**Important!** Learn the basics of power supply operation (see "Chapter 5 - Front Panel Operation" in the power supply Operating Guide) before using SCPI.

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SCPI (Standard Commands for Programmable Instruments) is a programming language for controlling instrument functions over the HP-IB (IEEE 488) instrument bus. SCPI is intended to function with *standard* HP-IB hardware and conforms to the IEEE Standard Digital Interface for Programmable Instrumentation. SCPI is layered on top of the hardware portion of IEEE 488.2. The same SCPI commands and parameters control the same functions in different classes of instruments. For example, you would use the same DISPLAY command to control the power supply display state and the display state of a SCPI-compatible multimeter.

**Note** HPSL (Hewlett-Packard System Language) and TMSL (Test and Measurement System Language) were earlier versions of SCPI. If you have programmed in either, then you probably can go directly to "Chapter 3 - Language Dictionary".

---

### Conventions

The following conventions are used throughout this chapter:

- |                 |     |  |
|-----------------|-----|--|
| Angle brackets  | < > | Items within angle brackets are parameter abbreviations. For example, <NR1> indicates a specific form of numerical data.   |
| Vertical bar    |     | Vertical bars separate one of two or more alternative parameters. For example, 0 OFF indicates that you may enter either "0" or "OFF" for the required parameter.  |
| Square Brackets | [ ] | Items within square brackets are optional. The representation [SOURce]:CURRent means that SOURCce may be omitted.  |
| Braces          | { } | Braces indicate parameters that may be repeated zero or more times. It is used especially for showing arrays. The notation <A>{<,B>} shows that "A" is a required parameter, while "B" may be omitted or may be entered one or more times. |

<b>Boldface font</b>	Boldface font is used to emphasize syntax in command definitions. <b>TRIGger:DELay</b> <NRf> shows a command syntax.
<b>Computer font</b>	Computer font is used to show program text within normal text. TRIGger:DELay .5 represents program text.

## SCPI Messages

There are two types of SCPI messages, program and response.

- A *program message* consists of one or more properly formatted SCPI commands sent from the controller to the power supply. The message, which may be sent at any time, requests the power supply to perform some action.
- A *response message* consists of data in a specific SCPI format sent from the power supply to the controller. The power supply sends the message only when commanded by a special program message called a “query.”

## Types of SCPI Commands

SCPI has two types of commands, common and subsystem.

### Common Commands

*Common* commands (see Figure 3-1) generally are not related to specific operation but to controlling overall power supply functions, such as reset, status, and synchronization. All common commands consist of a three-letter mnemonic preceded by an asterisk:

```
*RST *IDN? *SRE 8
```

### Subsystem Commands

Subsystem commands (see Figure 3-2) perform specific power supply functions. They are organized into an inverted tree structure with the “root” at the top. Some are single commands while others are grouped under other subsystems.

## Structure of a SCPI Message

SCPI messages consist of one or more message units ending in a message terminator. The terminator is not part of the syntax, but implicit in the way your programming language indicates the end of a line (such as a newline or end-of-line character).

### The Message Unit

The simplest SCPI command is a single message unit consisting of a command header (or keyword) followed by a message terminator.

```
ABOR
VOLT?
```

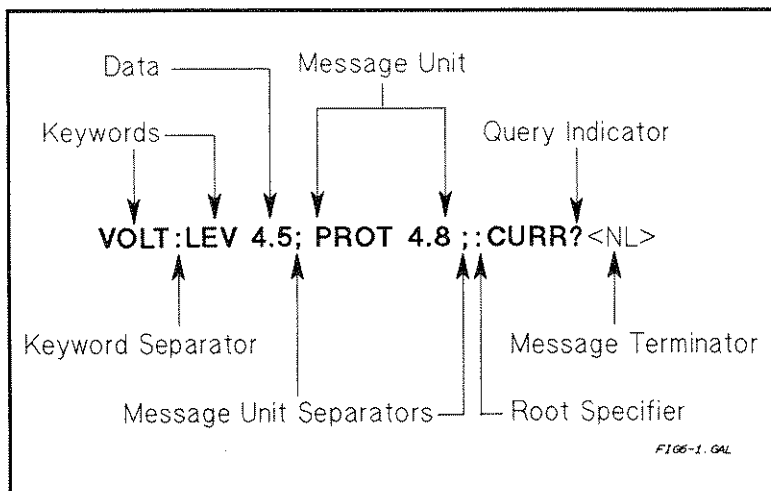
The message unit may include a parameter after the header. The parameter usually is numeric, but it can be a string:

```
VOLT 20
VOLT MAX
```

### Combining Message Units

The following command message (see Figure 2-1) is briefly described here, with more details in subsequent paragraphs.

```
VOLT:LEV 4.5;PROT 4.8;;CURR?<NL>
```



**Figure 2-1. Command Message Structure**

The basic parts of the message in Figure 2-1 are:

Message Component	Example
Headers	VOLT LEV PROT CURR
Header Separator	The <i>colon</i> in VOLT:LEV
Data	4.5 4.8
Data Separator	The <i>space</i> in VOLT 4.5 and in PROT 4.8
Message Units	VOLT:LEV 4.5 PROT 4.8 CURR?
Message Unit Separator	The <i>semicolons</i> in VOLT:LEV 4.5; and PROT 4.8;
Root Specifier	The <i>colon</i> in PROT 4.8::CURR?
Query Indicator	The <i>question mark</i> in CURR?
Message Terminator	The <NL> (newline) indicator. Terminators are not part of the SCPI syntax

## Parts of a SCPI Message

### Headers

*Headers* (which are sometimes known as “keywords”) are instructions recognized by the power supply interface. Headers may be either in the long form or the short form.

**Long Form** The header is completely spelled out, such as **VOLTAGE STATUS DELAY**

**Short Form** The header has only the first three or four letters, such as **VOLT STAT DEL.**

Short form headers are constructed according to the following rules:

- If the header consists of *four or fewer* letters, use all the letters. (DFI DATA)
- If the header consists of *five or more* letters and the fourth letter *is not* a vowel (a,e,i,o,u), use the first four letters. (VOLTage STATus)
- If the header consists of *five or more* letters and the fourth letter *is* a vowel (a,e,i,o,u), use the first three letters. (DELay CLEar)

You must follow the above rules when entering headers. Creating an arbitrary form, such as QUEST for QUESTIONABLE, will result in an error. The SCPI interface is *not* sensitive to case. It will recognize any case mixture, such as VOLTAGE, Voltage, Volt, volt.

---

**Note** Shortform headers result in faster program execution.

---

**Header Convention.** In this manual, headers are emphasized with **boldface** type. The proper short form is shown in upper-case letters, such as **DELay**.

**Header Separator.** If a command has more than one header, you must separate them with a colon (**VOLT:PROT OUTPUT:PROTection:CLEar**).

**Optional Headers.** The use of some headers is optional. Optional headers are shown in brackets, such as **OUTPut[:STATe] ON**. However, if you combine two or more message units into a compound message, you may need to enter the optional header. This is explained under “Traversing the Command Tree.”

#### **Query Indicator**

Following a header with a question mark turns it into a query (**VOLT? VOLT:PROT?**). If a query contains a parameter, place the query indicator at the end of the *last header* (**VOLT:PROT? MAX**).

#### **Message Unit Separator**

When two or more message units are combined into a compound message, separate the units with a semicolon (**STATus:OPERation?;QUEStionable?**).

---

**Important** You can combine message units only at the current path of the command tree (see “Traversing the Command Tree”).

---

#### **Root Specifier**

When it precedes the first header of a message unit, the colon becomes a “root specifier”. This indicates that the command path is at the root or top node of the command tree. Note the difference between root specifiers and header separators in the following examples:

<b>OUTP:PROT:DEL .1</b>	All colons are header separators
<b>:OUTP:PROT:DEL .1</b>	The first colon is a root specifier
<b>OUTP:PROT:DEL .1;VOLT 12.5</b>	The third colon is a root specifier

#### **Message Terminator**

A terminator informs SCPI that it has reached the end of a message. Three permitted messages terminators are:

- newline (<NL>), which is ASCII decimal 10 or hex 0A.
- end or identify (<END>)
- both of the above (<NL><END>).

In the examples of this manual, there is an assumed message terminator at the end of each message. If the terminator needs to be shown, it is indicated as <NL> regardless of the actual terminator character.

### **Traversing the Command Tree**

Figure 2-2 shows a portion of the subsystem command tree (you can see the complete tree in Figure 3-2). Note the location of the *ROOT* node at the top of the tree. The SCPI interface is at this location when:

- the power supply is powered on
- a device clear (DCL) is sent to the power supply



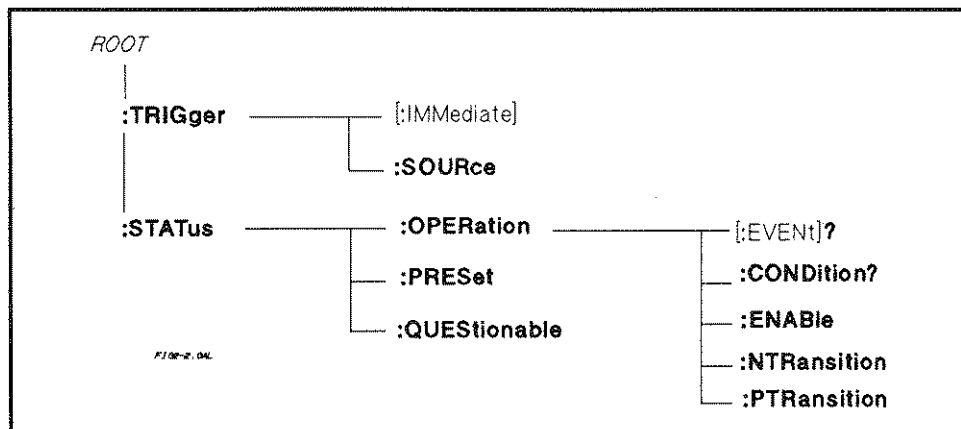


Figure 2-2. Partial Command Tree

- the interface encounters a message terminator
- the interface encounters a root specifier

#### Active Header Path

In order to properly traverse the command tree, you must understand the concept of the active header path. When the power supply is turned on (or under any of the other conditions listed above), the active path is at the root. That means the interface is ready to accept any command at the root level, such as **TRIGger** or **STATus** in Figure 2-2. Note that you do not have to precede either command with a colon; there is an implied colon in front of every root-level command.

If you enter **STATUS**, the active header path moves one colon to the right. The interface is now ready to accept **:OPERATION**, **:PRESET**, or **QUESTIONABLE** as the next header. Note that you must include the colon, because it is required between headers.

If you next enter **:OPERATION**, the active path again moves one colon to the right. The interface is now ready to accept **:EVENT?**, **CONDITON?**, **ENABLE**, **NTRANSITION**, or **PTRANSITION** as the next header.

If you now enter **:ENABLE**, you have reached the end of the command string. The active header path remains at **:ENABLE**. If you wished, you could have entered **:ENABLE 18;PTRANSITION 18** and it would be accepted. The entire message would be **STATUS:OPERATION:ENABLE 18;PTRANSITION 18**. The message terminator after **PTRANSITION 18** returns the path to the root.

#### The Effect of Optional Headers

If a command includes optional headers, the interface assumes they are there. For example, if you enter **STATUS:OPERATION?**, the interface recognizes it as **STATUS:OPERATION:EVENT?** (see Figure 2-2). This returns the active path to the root (**:STATUS**). But if you enter **STATUS:OPERATION:EVENT?**, then the active path remains at **:EVENT**. This allows you to send **STATUS:OPERATION:EVENT?;CONDITION?** in one message. If you tried to send **STATUS:OPERATION?;CONDITION?** the command path would send **STATUS:OPERATION:EVENT?** and then return to **:STATUS** instead of to **:CONDITION**.

The optional header **SOURCE** precedes the current, digital, and voltage subsystems (see Figure 3-2). This effectively makes **:CURRENT**, **:DIGITAL**, and **:VOLTAGE** root-level commands.

### Moving Among Subsystems

In order to combine commands from different subsystems, you need to be able to restore the active path to the root. You do this with the root specifier (:). For example, you could clear the output protection and check the status of the Operation Condition register as follows (see Figure 3-2):

```
OUTPUT:PROTECTION:CLEAR
STATUS:OPERATION:CONDITION?
```

By using the root specifier, you could do the same thing in one message:

```
OUTPUT:PROTECTION:CLEAR;:STATUS:OPERATION:CONDITION?
```

---

**Note** The SCPI parser traverses the command tree as described in Appendix A of the IEEE 488.2 standard. The “Enhanced Tree Walking Implementation” given in that appendix is *not* implemented in the power supply.

---

The following message shows how to combine commands from different subsystems as well as within the same subsystem (see Figure 3-2):

```
VOLTAGE:LEVEL 7;PROTECTION 8;:CURRENT:LEVEL 150;PROTECTION ON
```

Note the use of the optional header LEVEL to maintain the correct path within the voltage and current subsystems and the use of the root specifier to move between subsystems.

### Including Common Commands

You can combine common commands with system commands in the same message. Treat the common command as a message unit by separating it with the message unit separator. Common commands *do not affect the active header path*; you may insert them anywhere in the message.

```
VOLT:TRIG 7.5;INIT;*TRG
OUTP OFF;*RCL 2;OUTP ON
```

### SCPI Queries

Observe the following precautions with queries:

- Remember to set up the proper number of variables for the returned data.
- Set the program to read back all the results of a query before sending another command to the power supply. Otherwise, a *Query Interrupted* error will occur and the unreturned data will be lost.

### Value Coupling

Value coupling results when a command directed to send one parameter also changes the value of a second parameter. There is no direct coupling among any power supply SCPI commands. However, be aware that until they are programmed, uninitialized trigger levels will assume their corresponding immediate levels. For example, if a power supply is powered up and VOLT:LEV is programmed to 6, then VOLT:LEV:TRIG will also be 6 until you program it to another value. Once you program VOLT:LEV:TRIG to another value, it will remain at that value regardless of how you subsequently reprogram VOLT:LEVEL.

### SCPI Data Formats

All data programmed to or returned from the power supply is ASCII. The data may be *numerical* or *character string*.

## Numerical Data

Table 2-1 and Table 2-2 summarize the numerical formats.

**Table 2-1. Numerical Data Formats**

Symbol	Data Form
	<b>Talking Formats</b>
<NR1>	Digits with an implied decimal point assumed at the right of the least-significant digit. Examples: 273 0273
<NR2>	Digits with an explicit decimal point. Example: 273. .0273
<NR3>	Digits with an explicit decimal point and an exponent. Example: 2.73E+2 273.0E-2
	<b>Listening Formats</b>
<NRf>	Extended format that includes <NR1>, <NR2> and <NR3>. Examples: 273 273. 2.73E2
<NRf+>	Expanded decimal format that includes <NRf>, MIN, and MAX. Examples: 273 273. 2.73E2 MAX. MIN and MAX are the minimum and maximum limit values that are implicit in the range specification for the parameter.

**Table 2-2. Suffixes and Multipliers**

Class	Suffix	Unit	Unit with Multiplier
Current	A	Ampere	MA (milliamperere)
Amplitude	V	Volt	MV (millivolt)
Time	S	second	MS (millisecond)
<b>Common Multipliers</b>			
	1E3	K	kilo
	1E-3	M	milli
	1E-6	U	micro

## Boolean Data

Either form {1|0} or {ON|OFF} may be sent with commands. Queries always return 1 or 0.

**OUTPut OFF**

**CURRent:PROTection 1**

## Character Data

For query statements, character strings may be returned in either of the forms shown in Table 2-3, depending on the length of the returned string.

**Table 2-3. Character Data Formats**

<CRD>	<u>Character Response Data</u> . Permits the return of character strings.
<AARD>	<u>Arbitrary ASCII Response Data</u> . Permits the return of undelimited 7-bit ASCII. This data type has an implied message terminator.
Note:	The IEEE 488.2 format for a string parameter requires that the string be enclosed within either single ( ' ') or double ( " ") quotes. Be certain that your program statements comply with this requirement.

## EXAMPLES

The examples given here are generic, without regard to the programming language or type of HP-IB interface. Because SCPI commands are sent as ASCII output strings within the programming language statements, the SCPI syntax is independent of both programming language and interface.

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**Note** The examples are followed by sample program code written for three popular types of BASIC-controlled HP-IB interfaces.

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## Controlling Output

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**Important** The power supply responds simultaneously to both digital and analog programming inputs. If it is receiving an input over the HP-IB and a corresponding input from the front panel (and/or from the analog programming port), the power supply output will be the algebraic sum of the inputs.

---

### Programming Voltage and Current

The following statements program both voltage and current and return the actual output from the sense terminals:

OUTP OFF	<i>Disable the output</i>
VOLT 4.5;CURR 255	<i>Program the voltage and current</i>
VOLT?;CURR?	<i>Read back the programmed levels</i>
OUTP ON	<i>Enable the output</i>
MEAS:VOLT?;MEAS:CURR?	<i>Read back the outputs from the sense terminals</i>

### Programming Protection Circuits

This example programs the voltage and current, programs an overvoltage protection value, and turns on the overcurrent protection. It then reads back all the programmed values.

VOLT:LEV 4.5;PROT 4.75	<i>Program the voltage and overvoltage protection</i>
CURR:LEV 255;PROT:STAT ON	<i>Program the current and overcurrent protection</i>
VOLT:LEV?;PROT?;:CURR:LEV?;PROT:STAT?	<i>Read back the programmed values</i>

Note the required use of the optional **LEVel** header in the above example (see “The Effect of Optional Headers”, given previously).

### Changing Outputs by Trigger

If you do not program pending triggered levels, they default to the programmed (immediate) output levels. The following statements shows some basic trigger commands.

OUTP OFF	<i>Disable the output.</i>
VOLT:LEV:IMM 2.2;TRIG 2.5	<i>Program the (immediate) voltage level to 2.2 V and the pending triggered level to 2.5 V.</i>
CURR:LEV:IMM 150;TRIG 250	<i>Program the (immediate) current level to 150 A and the pending triggered level to 250 A.</i>

VOLT:LEV:IMM?;TRIG?;:CURR:LEV:IMM?;TRIG?	<i>Check all the programmed values.</i>
OUTP ON	<i>Enable the output.</i>
MEAS:VOLT?;CURR?	<i>Read back the immediate levels from the sense terminals.</i>
INTIT;TRIG	<i>Arm the trigger circuit and send a single trigger.</i>
INIT;*TRG	<i>Same as above, except using a common command.</i>
MEAS:VOLT?;CURR?	<i>Read back the triggered levels from the sense terminals.</i>

If you need to send two or more triggers, program the trigger circuit for continuous arming.

OUTP OFF	<i>Disable the output.</i>
VOLT:LEV:IMM 5.0;TRIG 2.5	<i>Program the (immediate) voltage level to 5 V and the pending triggered level to 2.5 V.</i>
INTIT:CONT ON	<i>Program the trigger circuit for continuous arming.</i>
OUTP ON	<i>Enable the output to 5 V.</i>
TRIG	<i>Trigger the output voltage to 2.5 V.</i>
VOLT:TRIG 5;:TRIG	<i>Set the pending trigger level to 5 V and trigger the output voltage back to 5 V.</i>
INTIT:CONT OFF	<i>Remove the continuous trigger arming.</i>

### **Saving and Recalling States**

You can remotely save and recall operating states. See \*SAV and \*RCL in “Chapter 3 - Language Dictionary” for the parameters that are saved and recalled.

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<b>Note</b>	When you turn the power supply on, it automatically retrieves the state stored in location 0. When a power supply is delivered, this location contains the factory defaults (see *RST in “Chapter 3 - Language Dictionary”).
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OUTP OFF;VOLT:LEV 6.5;PROT 6.8	<i>Program a desired operating state</i>
CURR:LEV 335;PROT:STAT ON	
*SAV 2	<i>Save this state to location 2</i>
*RCL 2	<i>(Later) recall this same state</i>

### **Writing to the Display**

You can include messages to the front panel LCD in your programs. The description of **DISP:TEXT** in “Chapter 3 - Language Dictionary” shows the number and types of permitted display characters. In order to write to the display, you must first change it to text mode as shown in the following example:

DIS:MODE TEXT	<i>Switch display to text mode</i>
RECALLED 2	<i>Write “Recalled 2” to the display</i>
DIS:MODE NORM	<i>Return display to its normal mode</i>

## Programming Status

You can use status programming to make your program react to events within the power supply. "Chapter 4 - Status Reporting" explains the functions and bit configurations of all status registers. Refer to Figure 4-1 in that chapter while examining the examples given here.

### Detecting Events via SRQ

Usually you will want the power supply to generate interrupts (assert SRQ) upon particular events. For this you must selectively enable the appropriate status register bits. The following examples allow the power supply to assert SRQ under selected conditions.

1. STAT:OPER:ENAB 1280;PTR 1280;\*SRE 128     *Assert SRQ when the supply switches between CV and CC modes*
2. STAT:OPER:ENAB 1;PTR 1;NTR 1;\*SRE 128     *Assert SRQ when the supply enters or leaves calibration mode*
3. STAT:QUES 3;PTR 3;\*SRE 128                 *Assert SRQ when the supply goes into overvoltage or overcurrent condition*
4. STAT:OPER:ENAB 1280;PTR 1280;  
   STAT:QUES 3;PTR 3;\*SRE 136                 *Assert SRQ under any event occurring in 1. or 3., above*

### Reading Specific Registers

You can exercise program control without interrupts by reading specific registers.

- STAT:OPER:1280;EVEN?                             *Enable only the CV and CC events and read their status*
- STAT:OPER:ENAB 1313;PTR 1313;EVEN?            *Enable all conditions of the Operation Status register and read any events*
- STAT:OPER:ENAB?;EVENT?;:STAT:QUES:ENAB?;EVEN?;:\*ESE?;\*ESR?             *Read which events are active and which events are enabled in the Operation, Questionable, and Standard Event status registers*

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**Note**            The last query string can be handled without difficulty. However, you should request too many queries, the system may return a "Query DEADLOCKED" error (-430). In that case, break the long string into smaller parts.

---

### Programming the Digital I/O Port

Digital control ports 1 and 2 are TTL outputs that can be programmed either high or low. Control port 3 can be programmed to be either a TTL input or a TTL output. Send a decimal parameter that translates into the desired straight binary code for these ports. (See DIG:DATA[:VAL] in "Chapter 3 - Language Dictionary" for the port bit configurations.)

- DIG:DATA 3        *Set ports 1 and 2 high and make 3 another output port*
- DIG:DATA 7        *Set ports 1 and 2 high and make 3 an input port*
- DIG:DATA?        *Read back the present port configuration*

## SYSTEM CONSIDERATIONS

The remainder of this chapter addresses some system issues concerning programming. These are power supply addressing and the use of the following types of HP-IB system interfaces:

1. HP Vectra PC controller with HP 82335A HP-IB Interface Command Library
2. IBM PC controller with National Instruments GPIB-PCII Interface/Handler
3. HP controller with HP BASIC Language System

### The HP-IB Address

The power supply address cannot be set remotely; it must be set from the front panel. Once the address is set, you can assign it inside programs.

### Setting the HP-IB Address

Figure 4-6 in the power supply Operating Guide shows the ways the power supply can be connected to the HP-IB bus. You can set up the HP-IB address in one of three ways:

1. As a stand-alone supply (the only supply at the address). It has a primary address in the range of 0 to 30. For example:  
5 or 7
2. As the direct supply in a serial link. It is the only supply connected directly to the HP-IB bus. The primary address is unique and can be from 0 to 30. It is entered as an integer followed by a decimal separator. The secondary address always is 0, which may be added after the primary address. If the secondary address is omitted, it is assumed to be 0. For example:  
5.0 or 7.
3. As a linked supply in serial link. It gets its primary address from the direct supply. It has a unique secondary address that can be from 1 to 15. It is entered as an integer preceded by a decimal separator. For example:  
.1 or .12

When you enter a secondary address, leading zeros between the decimal separator and the first digit are ignored. For example, .1, .01, and .001 are accepted as secondary address 1 and displayed as 0.01. Zeros following a digit are not ignored. Thus, .10 and .010 are both accepted as secondary address 10 and displayed as 0.10.

### Changing the Power Supply HP-IB Address

Use the **Address** key and numerical keypad for entering addresses. The power supply is shipped with a 5 stand-alone address as the default. The general procedure for setting an address is:

Action	Display Shows
Press <b>Address</b>	Current address
Press new address keys	New address replaces numbers on the display
Press <b>Enter</b>	Display returns to meter mode

If you try to enter a forbidden number, ADDR ERROR is displayed.

The following examples show how to set addresses:

To set stand-alone primary address 6, press **Address** **6** **Enter**

To set direct supply primary address 6, press **Address** **6** **.** **Enter**

To set linked secondary address 1, press **Address** **.** **1** **Enter**

To set linked secondary address 12, press **Address** **.** **1** **2** **Enter**

---

**Note**

The power supply display will reset (recall the state in location 0) whenever you change between the following types of HP-IB addresses:

- a stand-alone primary address and a direct primary address.
  - a direct primary address and a secondary address.
- 

**Assigning the HP-IB Address in Programs**

The following examples assume that the HP-IB select code is 7, the the power supply is 6, and that the power supply address will be assigned to the variable *@PS*.

```
1000 !Stand-alone address. The power supply will respond it is set to 6
1010 PS=706                                !Statement for HP82335A Interface
1010 ASSIGN @PS TO 706                      ! Statement for HP BASIC Interface
1020 !Direct address. The power supply will respond if it is set to 6. or
      6.0
1030 PS=70600                              !Statement for HP82335A Interface
1030 ASSIGN @PS TO 70600                    ! Statement for HP BASIC Interface
1040 !Linked address 1. The power supply will respond if it is set to address
      .1 and is serially connected to a supply at direct
      address 6.0
1050 PS=706.01                             !HP82335A Interface
1090 ASSIGN @PS TO 706.01                   !HP BASIC Interface
```

For systems using the National Instruments DOS driver, the address is specified in the software configuration program (IBCONFIG.EXE) and assigned a symbolic name. The address then is referenced only by this name within the application program (see the National Instruments GP-IB documentation).

**DOS Drivers****Types of Drivers**

The HP 82335A and National Instruments GP-IB are two popular DOS drivers. Each is briefly described here. See the software documentation supplied with the driver for more details.

**HP 82335A Driver.** For GW-BASIC programming, the HP-IB library is implemented as a series of subroutine calls. To access these subroutines, your application program must include the header file SETUP.BAS, which is part of the DOS driver software.

SETUP.BAS starts at program line 5 and can run up to line 999. Your application programs must begin at line 1000. SETUP.BAS has built-in error checking routines that provide a method to check for HP-IB errors during program execution. You can use the error-trapping code in these routines or write your own code using the same variables as used by SETUP.BAS.

**National Instruments GP-IB Driver.** Your program must include the National Instruments header file DECL.BAS. This contains the initialization code for the interface. Prior to running any applications programs, you must set up the interface with the configuration program (IBCONF.EXE).



Your application program will not include the power supply symbolic name and HP-IB address. These must be specified during configuration (when you run IBCONF.EXE). Note that the primary address range is from 0 to 30 but any secondary address must be specified in the address range of 96 to 126. The power supply expects a message termination on EOI or line feed, so set *EOI w/last byte of Write*. It is also recommended that you set *Disable Auto Serial Polling*.

All function calls return the status word *IBSTA%*, which contains a bit (ERR) that is set if the call results in an error. When ERR is set, an appropriate code is placed in variable *IBERR%*. Be sure to check *IBSTA%* after every function call. If it is not equal to zero, branch to an error handler that reads *IBERR%* to extract the specific error.

### **Error Handling**

If there is no error-handling code in your program, undetected errors can cause unpredictable results. This includes “hanging up” the controller and forcing you to reset the system. Both of the above DOS drivers have routines for detecting program execution errors.

---

**Important** Use error detection after every call to a subroutine.

---

### **HP BASIC Controllers**

The HP BASIC Programming Language provides access to HP-IB functions at the operating system level. This makes it unnecessary to have the header files required in front of DOS applications programs. Also, you do not have to be concerned about controller “hangups” as long as your program includes a timeout statement. Because the power supply can be programmed to generate SRQ on errors, your program can use an SRQ service routine for decoding detected errors. The detectable errors are listed in Table 5-1 of “Chapter 5 - Error Messages”.

### **Sample Program Code**

The following programs are intended only to show how some of the same power supply functions can be programmed to each of the three previously mentioned HP-IB interfaces. The first two are for the DOS interfaces and the third for the HP BASIC interface.

SAMPLE FOR POWER SUPPLY AT STAND-ALONE ADDRESS 6. SEQUENCE SETS UP CV MODE OPERATION, FORCES SUPPLY TO SWITCH TO CC MODE, AND DETECTS AND REPORTS MODE CHANGE.

\*\*\*\*\*

HP Vectra PC Controller Using HP 82335A Interface

\*\*\*\*\*

```
5      ' <----- Merge SETUP.BAS here ----->
1000  MAX.ELEMENTS=2 :ACTUAL.ELEMENTS=0 :MAX.LENGTH=80 :ACT.LENGTH=0
1005  DIM OUTPUTS(2) :CODES$=SPACE$(40)
1010  ISC=7 :PS=706
1015  '
1020  'Set up the Power Supply Interface for DOS driver
1025  CALL IORESET (ISC)                      'Reset the interface
1030  IF PCIB.ERR <> NOERR THEN ERROR PCIB.BASERR
1035  TIMEOUT=3
1040  CALL IOTIMEOUT (ISC, TIMEOUT)          'Set timeout to 3 seconds
1045  IF PCIB.ERR <> NOERR THEN ERROR PCIB.BASERR
1050  CALL IOCLEAR (ISC)                     'Clear the interface
1055  IF PCIB.ERR <> NOERR THEN ERROR PCIB.BASERR
1060  CALL IOREMOTE (ISC)                   'Set Power Supply to remote mode
1065  IF PCIB.ERR <> NOERR THEN ERROR PCIB.BASERR
1070  '
1075  'Program power supply to CV mode with following voltage and current
1080  CODES$ = "VOLTAGE 7.8;CURRENT 480"      :GOSUB 2000
1085  '
1090  'Query power supply outputs & print to screen
1095  CODES$ = "MEASURE:VOLTAGE?;CURRENT?"    :GOSUB 2000 :GOSUB 3000
1100  VOUT = OUTPUTS(1)
1105  IOUT = OUTPUTS(2)
1110  PRINT "The output levels are "VOUT" Volts and "IOUT" Amps"
1115  '
1120  'Program triggered current level to value insufficient to maintain
1125  'supply within its CV operating characteristic
1130  CODES$ = "CURR:TRIG 50"                :GOSUB 2000
1135  '
1140  'Set operation status mask to detect mode change from CV to CC
1145  CODES$ = "STAT:OPER:ENAB 1024;PTR 1024" :GOSUB 2000
1150  '
1155  'Enable Status Byte OPER summary bit
1160  CODES$ = "*SRE 128"                   :GOSUB 2000
1165  '
1170  'Arm trigger circuit and send trigger to power supply
1175  CODES$ = "INITIATE;TRIGGER"           :GOSUB 2000
1180  '
1185  'Wait for supply to respond to trigger
1190  FOR I= 1 to 100 :NEXT I
1195  '
1200  'Poll for interrupt caused by change to CC mode and print to screen
1205  CALL IOSPOLL (PS,RESPONSE)
1210  IF (RESPONSE AND 128)<>128 THEN GOTO 1240 'No OPER event to report
1215  CODES$ = "STATUS:OPER:EVEN?"          :GOSUB 2000 'Query status oper register
1220  CALL IOENTER (PS,OEVENT)              'Read back event bit
1225  IF PCIB.ERR <> NOERR THEN ERROR PCIB.BASERR
1230  IF (OEVENT AND 1024) = 1024 THEN PRINT "Supply switched to CC mode."
```

```

1240 'Clear the status circuit
1245 CODES$ = "*CLS" :GOSUB 2000
1250 FOR I = 1 TO 100 :NEXT I 'Wait for supply to clear
1255 '
1260 'Disable output and save present state in location 2
1265 CODES$ = "OUTPUT OFF;*SAV 2" :GOSUB 2000
1270 END
1275 '
2000 'Send command to power supply
2005 LENGTH = LEN(CODES$)
2010 CALL IOOUTPUTS (PS,CODES$,LENGTH) 'Send command to interface
2015 IF PCIB.ERR <> NOERR THEN ERROR PCIB.BASERR 'SETUP.BAS error trap
2020 RETURN
2025 '
3000 'Get data from power supply
3005 CALL IOENTERA (PS,OUTPUTS(1),MAX.ELEMENTS,ACTUAL.ELEMENTS)
3010 IF PCIB.ERR <> NOERR THEN ERROR PCIB.BASERR
3015 RETURN
*****
IBM Controller Using National Interface
*****
990 ' ----- Merge DECL.BAS here -----
1000 'Power Supply Variable = PS% ; Stand-Alone Address = 706
1005 CODES$=SPACE$(50):MODE$=SPACE$(5):OEVENT$=SPACE$(20)
1010 D$=SPACE$(60):OUTPUT$=SPACE$(40):BDNAME$="PS%"
1015 DIM OUTPUT(2)
1020 '
1025 'Set up power supply interface for DOS driver
1030 CALL IBFIND(BDNAME$,PS%)
1035 IF PS%<0 THEN PRINT "IBFIND Failed."
1040 CALL IBCLR(PS%)
1045 '
1050 'Program power supply to CV mode with following voltage and current
1055 CODES$ = "VOLTAGE 7.8;CURRENT 480" :GOSUB 2000
1060 '
1065 'Query power supply outputs and print to screen
1070 CODES$ = "MEASURE:VOLTAGE?;CURRENT?" :GOSUB 2000 :GOSUB 3000
1075 VOUT = OUTPUT(1)
1080 IOUT = OUTPUT(2)
1085 PRINT"The programmed levels are "VOUT" Volts and "IOUT" Amps"
1090 '
1095 'Program triggered current level to value insufficient to maintain
1100 'supply within its CV operating characteristic
1105 CODES$ = "CURR:TRIG 50" :GOSUB 2000
1110 '
1115 'Set operation status mask to detect mode change from CV to CC
1120 CODES$ = "STAT:OPER:ENAB 1024;PTR 1024" :GOSUB 2000
1125 '
1130 'Enable Status Byte OPER summary bit
1135 CODES$ = "*SRE 128" :GOSUB 2000
1140 '
1145 'Arm trigger circuit and send trigger to power supply
1150 CODES$ = "INITIATE;TRIGGER" :GOSUB 2000

```

```

1160 'Wait for supply to respond to trigger
1165 FOR I= 1 to 100 :NEXT I
1170 '
1175 'Poll for interrupt caused by change to CC mode and print to screen
1180 SPOL%=0
1185 CALL IBRSP(PS%,SPOL%)
1190 IF (SPOL% AND 128) = 128 THEN POLL = 1 'Set interrupt flag on OPER bit
1195 IF POLL <> 1 THEN GOTO 1230 'No interrupt to service
1200 "CODES$ = "STAT:OPER:EVEN?" :GOSUB 2000 'Query status oper register
1205 CALL IBRD(PS%,OEVENT$) 'Read back event bit
1210 IF IBSTA% < 0 THEN GOTO 2100
1215 OEVENT=VAL(OEVENT$)
1220 IF (OEVENT AND 1024) = 1024 THEN PRINT "Supply switched to CC mode."
1225 '
1230 'Clear status circuit
1235 CODES$="*CLS" :GOSUB 2000
1240 FOR I=1 TO 50 :NEXT I 'Wait for supply to clear
1245 '
1250 'Disable output and save present state to location 2
1255 CODES$ = "OUTPUT OFF;*SAV 2" :GOSUB 2000
1260 END
1265 '
2000 'Send command to power supply
2005 CALL IBWRT(PS%,CODES$)
2010 IF IBSTAT% < 0 THEN GOTO 2100 'Error detected
2015 RETURN
1250 'Disable output and save present state to location 2
1255 CODES$ = "OUTPUT OFF;*SAV 2" :GOSUB 2000
1260 END
1265 '
2000 'Send command to power supply
2005 CALL IBWRT(PS%,CODES$)
2010 IF IBSTAT% < 0 THEN GOTO 2100 'Error detected
2015 RETURN
2020 '
2100 'Error detection routine
2105 PRINT "GPIB error. IBSTAT% = &H";HEX$(IBSTAT%)
2110 PRINT " IBERR% = ";IBERR%" in line ";ERL
2115 STOP
2120 '
3000 'Get data from power supply
3005 CALL IBRD(PS%,OUTPUT$)
3010 IF IBSTA% < 0 THEN GOTO 2100
3015 I=1 'Parse data string
3020 X=1
3025 C=INSTR(I,OUTPUT$,";")
3030 WHILE C<>0
3035 D$=MID$(OUTPUT$,I,C-I)
3040 OUTPUT(X)=VAL(D$) 'Get values
3045 I=C+1
3050 C=INSTR(I,OUTPUT$,";")
3055 X=X+1
3060 WEND

```

Programming Some Power Supply Functions (continued)

```

3065 D$=RIGHT$(OUTPUT$,LEN(OUTPUT$)-(I-1))
3070 OUTPUT(X)=VAL(D$)
3075 OUTPUT$=SPACE$(40) 'Clear string
3080 RETURN

*****
          Controller Using HP BASIC
*****
1000 !Power supply at stand-alone address = 706
1005 OPTION BASE 1
1010 DIM Codes$(80),Response$(80),Mode$(32)
1015 !
1020 !Program power supply to CV mode with following voltage and current
1025 OUTPUT 706;"VOLTAGE 7.8;CURRENT 480"
1030 !
1035 !Query power supply outputs and print to screen
1040 OUTPUT 706;"MEASURE:VOLTAGE?;CURRENT?" !Query output levels
1045 ENTER 706;Vout,Iout
1050 PRINT "The output levels are ";Vout;" Volts and ";Iout" Amps"
1055 !
1060 !Program current triggered level to a value insufficient to maintain
1065 !supply within its CV operating characteristic
1070 OUTPUT 706;"CURR:TRIG 50"
1075 !
1080 !Set operation status mask to detect mode change from CV to CC
1085 OUTPUT 706;"STAT:OPER:ENAB 1280;PTR 1280"
1090 !
1095 !Enable Status Byte OPER summary bit
1100 OUTPUT 706;"*SRE 128"
1105 !
1110 !Arm trigger circuit and send trigger to power supply
1115 OUTPUT 706;"INITIATE;TRIGGER"
1130 !Poll for interrupt caused by change to CC mode and print to screen
1135 Response=SPOLL(706)
1140 IF NOT BIT (Response,7) THEN GOTO 1130 !No OPER event to report
1145 OUTPUT 706;"STAT:OPER:EVEN?" !Query status operation register
1150 ENTER 706;Oevent !Read back event bit
1155 IF BIT(Oevent,10) THEN PRINT "Supply switched to CC mode."
1160 !
1165 !Clear status
1170 OUTPUT 706;"*CLS"
1175 !
1180 !Disable output and save present state in location 2
1185 OUTPUT 706;"OUTPUT OFF;*SAV 2"
1190 END

```

**Programming Some Power Supply Functions (continued)**

## Language Dictionary

---

### INTRODUCTION

This section gives the syntax and parameters for all the IEEE 488.2 SCPI commands and the Common commands used by the power supply. It is assumed that you are familiar with the material in “Chapter 2 - Remote Programming”. That chapter explains the terms, symbols, and syntactical structures used here and gives an introduction to programming. You should also be familiar with “Chapter 5 - Front Panel Operation” (in the Operating Guide) in order to understand how the power supply functions.

The programming examples are simple applications of SCPI commands. Since SCPI syntax remains the same for all programming languages, the examples are generic.

Syntax definitions use the long form, but only short form headers (or “keywords”) appear in the examples. If you have any concern that the meaning of a header in your program listing will not be obvious at some later time, then use the long form to help make your program self-documenting.

### Parameters

Most commands require a parameter and all queries will return a parameter. The range for a parameter may vary according to the model of power supply. Parameters for all current models are listed in Table 3-1 at the end of this chapter.

### Related Commands

Where appropriate, related commands or queries are included. These are listed either because they are directly related by function or because reading about them will clarify or enhance your understanding of the original command or query.

### Order of Presentation

The dictionary is organized as follows:

- IEEE 488.2 common commands, in alphabetical order
- Subsystem commands

### Common Commands

Common commands begin with an \* and consist of three letters (command) or three letters and a ? (query). *Common* commands are defined by the IEEE 488.2 standard to perform some common interface functions. The power supply responds to the 13 required common commands that control status reporting, synchronization, and internal operations. The power supply also responds to five optional common commands controlling triggers, power-on conditions, and stored operating parameters.

### Subsystem Commands

Subsystem commands are specific to power supply functions. They can be a single command or a group of commands. The groups are comprised of commands that extend one or more levels below the root. The description of subsystem commands follows the listing of the common commands.

### DESCRIPTION OF COMMON COMMANDS

Figure 3-1 shows the common commands and queries. These commands are listed alphabetically in the dictionary. If a command has a corresponding query that simply returns the data or status specified by the command, then both command and query are included under the explanation for the command. If a query does not have a corresponding command or is functionally different from the command, then the query is listed separately. The description of each common command or query specifies any status registers affected. In order to make use of this information, you must refer to “Chapter 4 - Status Reporting”, which explains how to read specific register bits and use the information that they return.

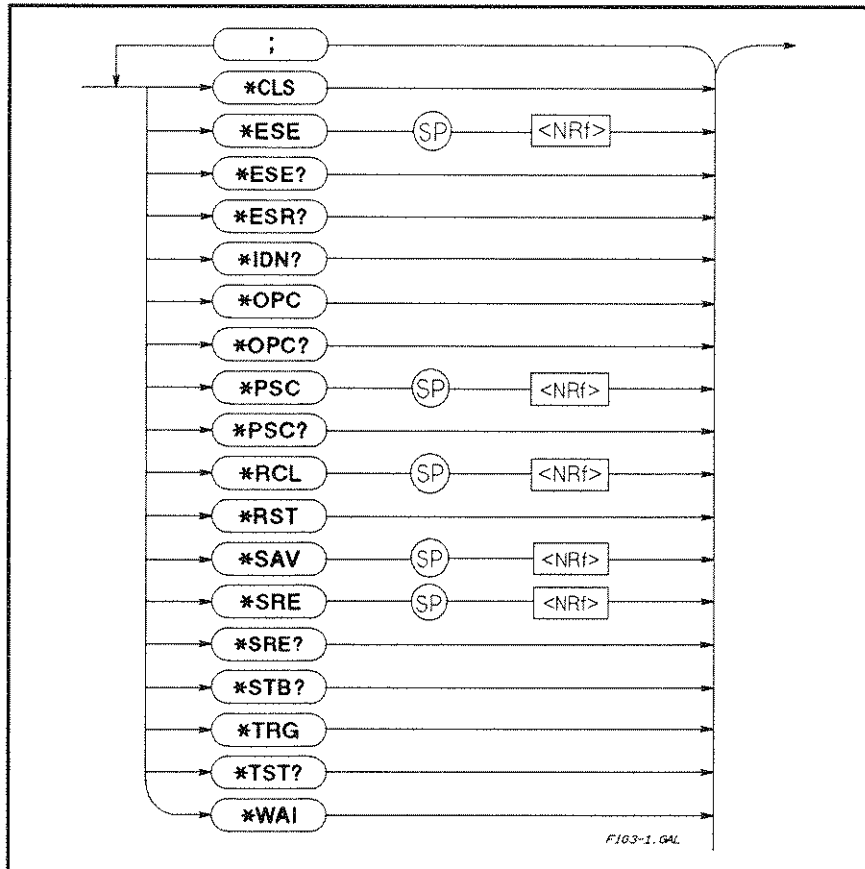


Figure 3-1. Common Commands Syntax Diagram

**\*CLS**

**\*ESE**

**\*CLS**

**Meaning and Type**

*Clear Status* Device Status

**Description**

This command causes the following actions (see “Chapter 4 - Status Reporting” for descriptions of all registers):

- Clears the following registers:
  - Standard Event Status
  - Operation Status Event
  - Questionable Status Event
  - Status Byte
- Clears the Error Queue
- If **\*CLS** immediately follows a program message terminator (<NL>), then the output queue and the MAV bit are also cleared.

<b>Command Syntax</b>	<b>*CLS</b>
<b>Parameters</b>	(None)
<b>Query Syntax</b>	(None)

**\*ESE**

**Meaning and Type**

*Event Status Enable* Device Status

**Description**

This command programs the Standard Event Status Enable register bits. The programming determines which events of the Standard Event Status Event register (see **\*ESR?**) are allowed to set the ESB (Event Summary Bit) of the Status Byte register. A “1” in the bit position enables the corresponding event. All of the enabled events of the Standard Event Status Event Register are logically ORed to cause the Event Summary Bit (ESB) of the Status Byte Register to be set. See “Chapter 4 - Status Reporting” for descriptions of all three registers.

**Bit Configuration of Standard Event Status Enable Register**

<b>Bit Position</b>	7	6	5	4	3	2	1	0
<b>Bit Name</b>	PON	0	CME	EXE	DDE	QYE	0	OPC
<b>Bit Weight</b>	128	64	32	16	8	4	2	1
	CME = Command error; DDE = Device-dependent error; EXE = Execution error; OPC = Operation complete; PON = Power-on; QYE = Query error							



**\*ESE****\*ESR?****\*IDN?**

Command Syntax	<b>*ESE</b> <NRf>
Parameters	0 to 255
Power On Value	(See <b>*PSC</b> )
Suffix	(None)
Example	<b>*ESE</b> 129
Query Syntax	<b>*ESE?</b>
Returned Parameters	<NR1> (Register value)
Related Commands	<b>*ESR?</b> <b>*PSC</b> <b>*STB?</b>

---

**Caution** If **PSC** is programmed to 0, then the **\*ESE** command causes a write cycle to nonvolatile memory. The nonvolatile memory has a finite maximum number of write cycles (see Supplemental Characteristics in Chapter 1 of the power supply Operating Guide). Programs that repeatedly cause write cycles to nonvolatile memory can eventually exceed the maximum number of write cycles and may cause the memory to fail.

---

**\*ESR?****Meaning and Type**

*Event Status Register* Device Status

**Description**

This query reads the Standard Event Status Event register. Reading the register clears it. The bit configuration of this register is the same as the Standard Event Status Enable register (**\*ESE**). See “Chapter 4 - Status Reporting” for a detailed explanation of this register.

Query Syntax	<b>*ESR?</b>
Parameters	(None)
Returned Parameters	<NR1> (Register binary value)
Related Commands	<b>*CLS</b> <b>*ESE</b> <b>*ESE?</b> <b>*OPC</b>

**\*IDN?**

*Identification Query*

**Meaning and Type**

*Identification* System Interface

**Description**

This query requests the power supply to identify itself. It returns a string composed of four fields separated by commas.

Query Syntax	<b>*IDN?</b>										
Returned Parameters	<AARD>										
	<table> <thead> <tr> <th>Field</th> <th>Information</th> </tr> </thead> <tbody> <tr> <td><i>Hewlett-Packard</i></td> <td>Manufacturer</td> </tr> <tr> <td><i>xxxxA</i></td> <td>4-digit model number followed by a letter suffix</td> </tr> <tr> <td><i>nnnnA-nnnnn</i></td> <td>10-character serial number or 0</td> </tr> <tr> <td>&lt;R&gt;.xx.xx</td> <td>Revision levels of firmware</td> </tr> </tbody> </table>	Field	Information	<i>Hewlett-Packard</i>	Manufacturer	<i>xxxxA</i>	4-digit model number followed by a letter suffix	<i>nnnnA-nnnnn</i>	10-character serial number or 0	<R>.xx.xx	Revision levels of firmware
Field	Information										
<i>Hewlett-Packard</i>	Manufacturer										
<i>xxxxA</i>	4-digit model number followed by a letter suffix										
<i>nnnnA-nnnnn</i>	10-character serial number or 0										
<R>.xx.xx	Revision levels of firmware										
Example	HEWLETT-PACKARD, 6681, 0, A.00.01										
Related Commands	(None)										

**\*OPC**

**\*ESR?**

**\*OPC?**

**\*OPC**

**Meaning and Type**

*Operation Complete*    Device Status

**Description**

This command causes the interface to set the OPC bit (bit 0) of the Standard Event Status register when the power supply has completed all pending operations. (See **\*ESE** for the bit configuration of the Standard Event Status register.) *Pending operations* are complete when:

- all commands sent before **\*OPC** have been executed. This includes overlapped commands. Most commands are sequential and are completed before the next command is executed. Overlapped commands are executed in parallel with other commands. Commands that affect output voltage, current or state, relays, and trigger actions are overlapped with subsequent commands sent to the power supply. The **\*OPC** command provides notification that all overlapped commands have been completed.
- any change in the output level caused by previous commands has been completed (completion of settling time, relay bounce, etc.)
- all triggered actions are completed

**\*OPC** does not prevent processing of subsequent commands but Bit 0 will not be set until all pending operations are completed.

<b>Command Syntax</b>	<b>*OPC</b>
<b>Parameters</b>	(None)
<b>Related Commands</b>	<b>*OPC?    *WAI</b>

**\*OPC?**

**Meaning and Type**

*Operation Complete*    Device Status

**Description**

This query causes the interface to place an ASCII "1" in the Output Queue when all pending operations are completed. *Pending operations* are as defined for the **\*OPC** command. Unlike **\*OPC**, **\*OPC?** prevents processing of all subsequent commands. **\*OPC?** is intended to be used at the end of a command line so that the application program can then monitor the bus for data until it receives the "1" from the power supply Output Queue.

---

**Caution**    Do not follow **\*OPC?** with **\*TRG** or HP-IB bus triggers. Such triggers sent after **\*OPC?** will be prevented from executing and will prevent the power supply from accepting further commands. If this occurs, the only programmable way to restore operation is by sending the power supply a HP-IB DCL (Device Clear) command.

---

<b>Query Syntax</b>	<b>*OPC?</b>
<b>Returned Parameters</b>	<NR1>            ASCII 1 is placed in the Output Queue when the power supply has completed operations.
<b>Related Commands</b>	<b>*OPC    *TRIG    *WAI</b>

**\*OPT?**

**\*PSC**

**\*RCL**

**\*OPT?**

**Meaning and Type**

*Option Identification Query*

**Description**

This query requests the power supply to identify any options that are installed. Options are identified by number A 0 indicates no options are installed.

Query Syntax	<b>*OPT?</b>
Returned Parameters	<AARD>

**\*PSC**

**Meaning and Type**

*Power-on Status Clear* Device Initialization

**Description**

This command controls the automatic clearing at power turn-on of:

- the Service Request Enable register
- the Standard Event Status Enable register

If the command parameter = 1, then the above registers are cleared at power turn on. If the command parameter = 0, then the above registers are not cleared at power turn on but are programmed to their last state prior to power turn on. This is the most common application for \*PSC and enables the power supply to generate an SRQ (Request for Service) at power on.

Command Syntax	<b>*PSC &lt;bool&gt;</b>
Parameters	0 1 OFF ON
Example	<b>*PSC 0 *PSC 1</b>
Query Syntax	<b>*PSC?</b>
Returned Parameters	<NR1> 0 1
Related Commands	<b>*ESE *SRE</b>

**Caution**

\*PSC causes a write cycle to nonvolatile memory. If \*PSC is programmed to 0, then the \*ESE and \*SRE commands also cause a write cycle to nonvolatile memory. The nonvolatile memory has a finite number of write cycles (see "Table 1-2, Supplementary Characteristics"). Programs that repeatedly write to nonvolatile memory can eventually exceed the maximum number of write cycles and may cause the memory to fail

**\*RCL**

**Meaning and Type**

*Recall* Device State

**Warning**

Recalling a previously stored state may place hazardous voltage at the power supply output.

**Description**

This command restores the power supply to a state that was previously stored in memory with the \*SAV command to the specified location. The following states are recalled:

**\*RCL****\*RST**

CURR[LEV][:IMM]  
 CURR:PROT:STAT  
 DIG:DATA[:VAL]

OUTP[:STAT]  
 OUTP:PROT:DEL  
 OUTP:REL[:STAT]

OUTP:REL:POL  
 VOLT[:LEV][:IMM]  
 VOLT:PROT[:LEV]

Sending **\*RCL** also does the following:

- forces an **ABORt** command before resetting any parameters (this cancels any uncompleted trigger actions)
- disables the calibration function by setting **CAL:STATe** to **OFF**
- sets display functions as follows:
  - **DISP[:WIND][:STATe]** to **ON**
  - **DISP[:WIND]:MODE** to **NORMAl**
  - **DISP[:WIND]:TEXT** to ' '
- sets **INIT:CONT** to **OFF**
- sets **TRIG:SOUR** to **BUS**

At power turnon, the power supply normally is returned to the factory defined turn-on state (see **\*RST**). However, it also may turn on to the state stored in location 0 (see *Turn-On Condition* under "Chapter 5 - Front Panel Operation" of the power supply Operating Guide).

Command Syntax	<b>*RCL &lt;NRf&gt;</b>
Parameters	0 1 2 3
Example	<b>*RCL 3</b>
Query Syntax	(None)
Related Commands	<b>*PSC *RST *SAV</b>

**\*RST****Meaning and Type**

*Reset* Device State

**Description**

This command resets the power supply to a factory-defined state as defined below. **\*RST** also forces an **ABORt** command.

Command	State
<b>CAL:STAT</b> <i>OFF</i>	<b>OUTP[:STAT]</b> <i>OFF</i>
<b>CURR[:LEV][:IMM]</b> *	<b>OUTP:PROT:DEL</b> *
<b>CURR[:LEV]:TRIG</b> *	<b>OUTP:REL[:STAT]</b> <i>OFF</i>
<b>CURR:PROT:STAT</b> <i>OFF</i>	<b>OUTP:REL:POL</b> <i>NORM</i>
<b>DIG:DATA</b> 0	<b>TRIG:SOUR</b> <i>BUS</i>
<b>DISP[:WIND]:STAT</b> <i>ON</i>	<b>VOLT[:LEV][:IMM]</b> *
<b>DISP[:WIND]:MODE</b> <i>NORM</i>	<b>VOLT[:LEV][:TRIG]</b> *
<b>DISP[:WIND]:TEXT</b> ' '	<b>VOLT:PROT[:LEV]</b> *
<b>INIT:CONT</b> <i>OFF</i>	

\* Model-dependent value. See Table 3-1.

Command Syntax	<b>*RST</b>
Parameters	(None)
Query Syntax	(None)
Related Commands	<b>*PSC *SAV</b>

**\*SAV**

**\*SRE**

**\*SAV**

**Meaning and Type**

*SAVE* Device State

**Description**

This command stores the present state of the power supply to the specified location in memory. Up to four states can be stored. Under certain conditions (see “Turn-On Conditions” in “Chapter 5 - Front Panel Operation” of the Operating Guide), location 0 may hold the device state that is automatically recalled at power turn-on.

The following power supply parameters are stored by **\*SAV**:

<b>CURR[:LEV][:IMM]</b>	<b>OUTP[:STAT]</b>	<b>OUTP:REL:POL</b>
<b>CURR:PROT:STAT</b>	<b>OUTP:PROT:DEL</b>	<b>VOLT[:LEV][:IMM]</b>
<b>DIG:DATA[:VAL]</b>	<b>OUTP:REL[:STAT]</b>	<b>VOLT:PROT[:LEV]</b>

<b>Command Syntax</b>	<b>*SAV &lt;NRf&gt;</b>
<b>Parameters</b>	<b>0 1 2 3</b>
<b>Example</b>	<b>SAV 3</b>
<b>Query Syntax</b>	<b>(None)</b>
<b>Related Commands</b>	<b>*RCL *RST</b>

**Caution**

The power supply uses nonvolatile memory for recording register states. Programs that repeatedly use **\*SAV** for recalling states cause frequent write cycles to the memory and can eventually exceed the maximum number of write cycles for the memory (see in the power supply Operating Guide).

**\*SRE**

**Meaning and Type**

*Service Request Enable* Device Interface

**Description**

This command sets the condition of the Service Request Enable Register. This register determines which bits from the Status Byte Register (see **\*STB** for its bit configuration) are allowed to set the Master Status Summary (MSS) bit and the Request for Service (RQS) summary bit. A 1 in any Service Request Enable Register bit position enables the corresponding Status Byte Register bit and all such enabled bits then are logically ORed to cause Bit 6 of the Status Byte Register to be set. See “Chapter 4 - Status Reporting” for more details concerning this process.

When the controller conducts a serial poll in response to SRQ, the RQS bit is cleared, but the MSS bit is not. When **\*SRE** is cleared (by programming it with 0), the power supply cannot generate an SRQ to the controller.

**\*SRE****\*STB?**

Command Syntax	<b>*SRE</b> <NRf>
Parameters	0 to 255
Default Value	(See <b>*PSC</b> )
Example	<b>*SRE</b> 20
Query Syntax	<b>*SRE?</b>
Returned Parameters	<NR1> (Register binary value)
Related Commands	<b>*ESE</b> <b>*ESR</b> <b>*PSC</b>

---

**Caution** If **\*PSC** is programmed to 0, then the **\*SRE** command causes a write cycle to nonvolatile memory. The nonvolatile memory has a finite number of write cycles (see Supplemental Characteristics in the power supply Operating Guide). Programs that repeatedly write to nonvolatile memory can eventually exceed the maximum number of write cycles and may cause the memory to fail

---

**\*STB?****Meaning and Type**

*Status Byte* Device Status

**Description**

This query reads the Status Byte register, which contains the status summary bits and the Output Queue MAV bit. Reading the Status Byte register does not clear it. The input summary bits are cleared when the appropriate event registers are read (see "Chapter 4 - Status Reporting" for more information). The MAV bit is cleared at power on or by **\*CLS**.

A serial poll also returns the value of the Status Byte register, except that bit 6 returns Request for Service (RQS) instead of Master Status Summary (MSS). A serial poll clears RQS, but not MSS. When MSS is set, it indicates that the power supply has one or more reasons for requesting service.

**Bit Configuration of Status Byte Register**

Bit Position	7	6	5	4	3	2	1	0
Condition	OPER	MSS <sup>1</sup> (RQS)	ESB	MAV	QUES	<sup>2</sup>	<sup>2</sup>	<sup>2</sup>
Bit Weight	128	64	32	16	8	4	2	1
ESB = Event status byte summary; MAV = Message available								
MSS = Master status summary; OPER = Operation status summary;								
QUES = Questionable status summary; RQS = Request for service								
<sup>1</sup> Also represents RQS. <sup>2</sup> These bits are always zero.								

Query Syntax	<b>*STB?</b>
Returned Parameters	<NR1> (Register binary value)
Related Commands	(None)

**\*TRG**

**\*TST?**

**\*WAI**

**\*TRG**

**Meaning and Type**

*Trigger* Device Trigger

**Description**

This command generates a trigger when the trigger subsystem has **BUS** selected as its source. The command has the same affect as the Group Execute Trigger (<GET>) command.

Command Syntax	<b>*TRG</b>
Parameters	(None)
Query Syntax	(None)
Related Commands	<b>ABOR CURR:TRIG INIT TRIG[:IMM] VOLT:TRIG &lt;GET&gt;</b>

**\*TST?**

**Meaning and Type**

*Test* Device Test

**Description**

This query causes the power supply to do a self-test and report any errors (see "Selftest Error Messages" in "Chapter 3 - Turn-On Checkout" of the power supply Operating Guide).

Query Syntax	<b>*TST?</b>
Returned Parameters	<NR1>
	0 Indicates power supply passed self-test.
	Nonzero Indicates an error code.
Related Commands	(None)

**\*WAI**

**Meaning and Type**

*Wait to Continue* Device Status

**Description**

This command instructs the power supply not to process any further commands until all pending operations are completed. "Pending operations" are as defined under the **\*OPC** command. **\*WAI** can be aborted only by sending the power supply an HP-IB **DCL** (Device Clear) command.

Command Syntax	<b>*WAI</b>
Parameters	(None)
Query Syntax	(None)
Related Commands	<b>*OPC *OPC?</b>

**DESCRIPTION OF SUBSYSTEM COMMANDS**

Figure 3-2 is a tree diagram of the subsystem commands. Commands followed by a question mark (?) take only the query form. Except as noted in the syntax descriptions, all other commands take both the command and query form. The commands are listed in alphabetical order and the commands within each subsystem are grouped alphabetically under the subsystem.

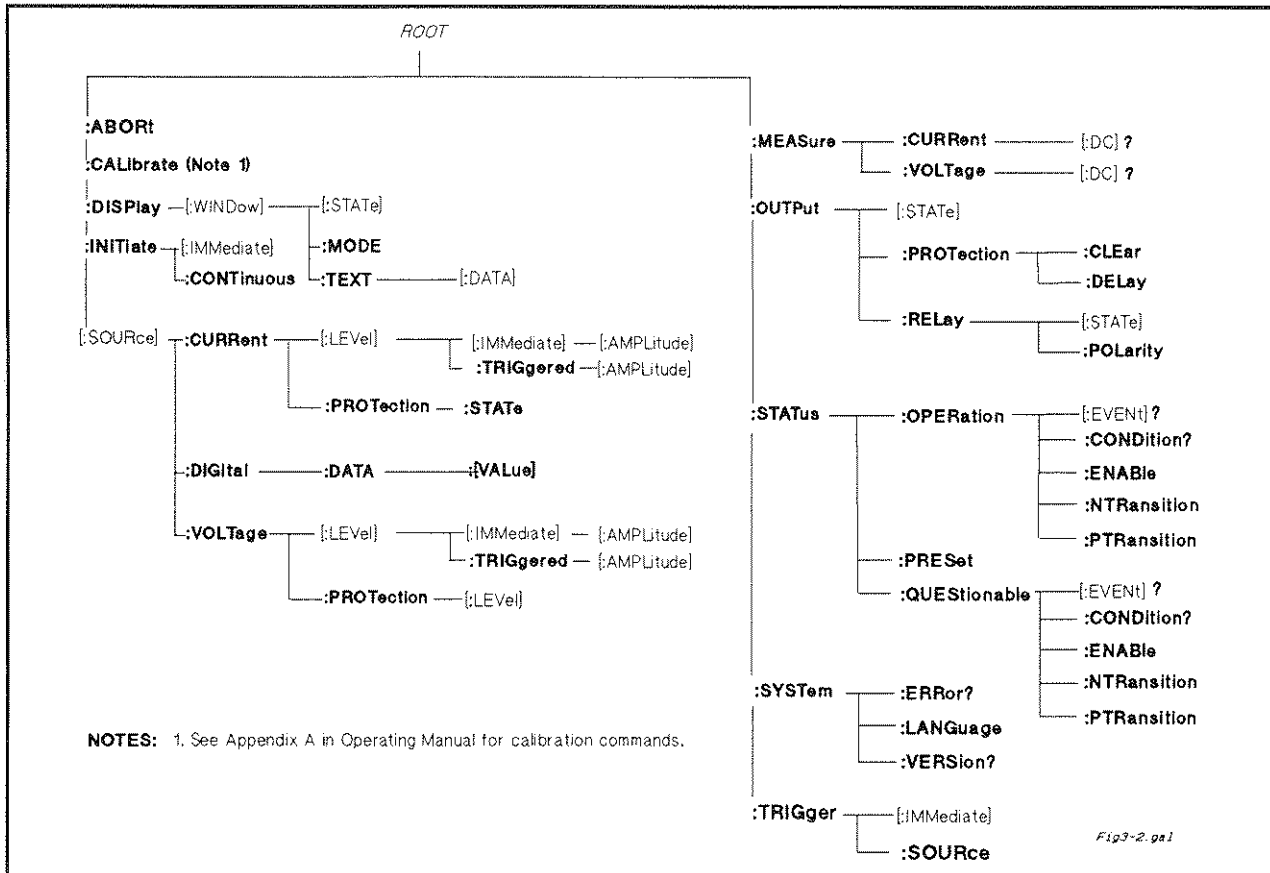


Figure 3-2. Subsystem Commands Tree Diagram

**ABOR**

This command cancels any trigger actions presently in process. Pending trigger levels are reset equal to their corresponding immediate values. **ABOR** also resets the WTG bit in the Operation Condition Status register (see “Chapter 4 - Status Reporting”). If **INIT:CONT ON** has been programmed, the trigger subsystem initiates itself immediately after **ABORt**, thereby setting WTG. **ABOR** is executed at power turn on and upon execution of **\*RCL** or **RST**.

Command Syntax	<b>ABORt</b>
Parameters	(None)
Examples	<b>ABOR</b>
Query Syntax	(None)
Related Commands	<b>INIT *RST *TRG TRIG</b>

**Calibration Commands**

See Appendix A in the power supply Operating Guide



## Current Subsystem

This subsystem programs the output current of the power supply.

### CURR

#### CURR:TRIG

These commands set the immediate current level or the pending triggered current level of the power supply. The immediate level is the current programmed for the output terminals. The pending triggered level is a stored current value that is transferred to the output terminals when a trigger occurs. A pending triggered level is unaffected by subsequent **CURR** commands and remains in effect until the trigger subsystem receives a trigger or an **ABORT** command is given. If there is no pending **CURR:TRIG** level, then the query form returns the **CURR** level. In order for **CURR:TRIG** to be executed, the trigger subsystem must be initiated (see **INITiate**).

Command Syntax	[SOURce]:CURRent[:LEVel] [:IMMediate][:AMPLitude] <NRf+> [SOURce][:CURRent[:LEVel]:TRIGgered [:AMPLitude] <NRf+>
Parameters	Table 3-1
Default Suffix	A
*RST Value	Table 3-1
Examples	CURR 200 MA            CURRENT:LEVEL 200 MA CURRENT:LEVEL:IMMEDIATE:AMPLITUDE 2.5 CURR:TRIG 20            CURRENT:LEVEL:TRIGGERED 20
Query Syntax	[SOURce]:CURRent[:LEVel] [:IMMediate][:AMPLitude]? [SOURce]:CURRent[:LEVel] [:IMMediate][:AMPLitude]? MAX [SOURce]:CURRent[:LEVel] [:IMMediate][:AMPLitude]? MIN [SOURce]:CURRent[LEVel]:TRIGgered [:AMPLitude]? [SOURce]:CURRent[LEVel]:TRIGgered [:AMPLitude]? MAX [SOURce]:CURRent[:LEVel]:TRIGgered [:AMPLitude]? MIN
Returned Parameters	<NR3>    CURR? and CURR:TRIG? return presently programmed immediate and triggered levels. If not triggered level is programmed, both returned values are the same. CURR? MAX and CURR? MIN return the maximum and minimum programmable immediate current levels. CURR:TRIG? MAX and CURR:TRIG? MIN return the maximum and minimum programmable triggered current levels.
Related Commands	For CURR    *SAV   *RCL   *RST For CURR:TRIG    ABOR   CURR   *RST

#### CURR:PROT:STAT

This command enables or disables the power supply overcurrent protection (OCP) function. If the overcurrent protection function is enabled and the power supply goes into constant-current operation, then the output is disabled and the Questionable Condition status register OC bit is set (see "Chapter 4 - Status Reporting"). An overcurrent condition can be cleared with the **OUTP:PROT:CLE** command after the cause of the condition is removed.

Command Syntax	[SOURce]:CURRent:PROTection:STATe <bool>
Parameters	0   1   OFF   ON
*RST Value	OFF
Examples	CURR:PROT:STAT 0    CURRENT:PROTECTION:STATE OFF CURR:PROT:STAT 1    CURRENT:PROTECTION:STATE ON
Query Syntax	[SOURce]:CURRent:PROTection:STATe?
Returned Parameters	<NR1>    0 or 1
Related Commands	OUTP:PROT:CLE    *RST

**DIG:DATA**

This command sets and reads the power supply digital control port when that port is configured for Digital I/O operation. Configuring of the port is done via an internal jumper (see Appendix D in the Operating Guide). The port has three signal pins and a digital ground pin. Pins 1 and 2 are output pins controlled by bits 0 and 1. Pin 3 is controlled by bit 3 and can be programmed to serve either as an input or an output. Pin 4 is the digital ground.

Bit position 2 normally serves as an output. To change it to an input, it must first be programmed high. The **DIG:DATA?** query returns the last programmed value in bits 0 and 1 and the value read at pin 3 in bit 2. The bits are turned on and off in straight binary code as follows:

**Digital I/O Port Programming Chart**

	Bit Configuration			Pin Configuration <sup>1</sup>					Bit Configuration			Pin Configuration <sup>1</sup>			
Value	0	1	2	1	2	3	4	Value	0	1	2	1	2	3	4
0	0	0	0	Lo	Lo	Output	Gnd	4	0	0	1	Lo	Lo	Input	Gnd
1	1	0	0	Hi	Lo	Output	Gnd	5	1	0	1	Hi	Lo	Input	Gnd
2	0	1	0	Lo	Hi	Output	Gnd	6	0	1	1	Lo	Hi	Input	Gnd
3	1	1	0	Hi	Hi	Output	Gnd	7	1	1	1	Hi	Hi	Input	Gnd

<sup>1</sup>Pins 1 and 2 are always outputs

**Command Syntax** [SOURCE]:DIGital:DATA[:VALue] <NRf>  
**Parameters** 0 to 7  
**Suffix** (None)  
**\*RST Value** 0  
**Examples** DIG:DATA 7 DIGITAL:DATA:VALUE 7  
**Query Syntax** [SOURCE]:DIGital:DATA?  
**Returned Parameters** <NR1> Values from 0 to 7  
**Related Commands** \*RST \*RCL \*SAV

**Display Subsystem**

This subsystem controls the state and output of the alphanumeric portion of the display.

**DISP**

Enables or disables the display. When disabled, the display characters are blank. The annunciators are not affected by this command.

**Command Syntax** DISPlay[:WINDow][:STATe] <bool>  
**Parameters** 0 | 1 | OFF | ON  
**Suffix** (None)  
**\*RST Value** ON  
**Examples** DISP ON DISPLAY:STATE ON  
**Query Syntax** DISPlay[:WINDow][STATe]?  
**Returned Parameters** <NR1> 0 or 1  
**Related Commands** DISP:MODE DISP:TEXT \*RST

**DISP:MODE**

Switches the display between its normal metering mode and a mode in which it displays text sent by the user. The command uses the character data <CRD> format.

**DISP:MODE****DISP:TEXT****Initiate Subsystem**

Command Syntax	DISPlay[:WINDow]:MODE NORMAl TEXT
Parameters	<CRD> NORMAl   TEXT
*RST Value	NORM
Examples	DISP:MODE NORM    DISPLAY:MODE NORMAL DISPLAY:WINDOW:MODE TEXT
Query Syntax	DISPlay[:WINDow]:MODE?
Returned Parameters	<CRD>    NORMAL or TEXT
Related Commands	DISP    DISP:TEXT    *RST

**DISP:TEXT**

Allows character strings to be sent to display. The characters will be displayed when the display mode is **TEXT**. The LCD has the following character set:

**LCD Character Set**

uppercase letters	A through Z (Case-sensitive entry)
digits	0 through 9
punctuation	-   " \$ < > + - / = ? . : ,
blank space	

A display is capable of showing up to 12 characters. However, the three punctuation characters [(.)(:)(,)] do not count toward the 12-character limit when they are preceded by an alphanumeric character. When punctuation characters are included, then the maximum number of characters (alphanumeric + punctuation) that can be displayed is 15. If it exceeds the display capacity, a message will be truncated to fit and no error message will be generated. If any character in the message is not a member of the above character set, the character will not be rejected but will be displayed as a "starburst" (all 16 segments of the character will light).

Command Syntax	DISPlay[:WINDow]:TEXT [:DATA] <STR>
Parameters	(See LCD character set)
*RST Value	' '
Examples	DISP:TEXT "DEFAULT_MODE" DISPLAY:WINDOW:TEXT:DATA '533.2E-1VOLTS'
Query Syntax	DISPlay[:WINDow]:TEXT?
Returned Parameters	<STR>    (Last programmed text string)
Related Commands	DISP    DISP:MODE    *RST

---

**Note**            *IEEE Standard Digital Interface for Programmable Instrumentation* requires that a string be enclosed in either single (') or double (") quotes.

---

**Initiate Subsystem**

This subsystem enables the trigger system. When a trigger is enabled, an event on a selected trigger source causes the specified triggering action to occur. If the trigger subsystem is not enabled, all trigger commands are ignored. If **INIT:CONT** is **OFF**, then **INIT** enables the trigger subsystem only for a single trigger action. The subsystem must be enabled prior to each subsequent trigger action. If **INIT:CONT** is **ON**, then the trigger subsystem is continuously enabled and **INIT** is redundant.

**INIT****MEAS****OUTP**

<b>Command Syntax</b>	INITiate[:IMMediate]
	INITiate:CONTinuous <bool>
<b>Parameters</b>	For INIT[:IMM] (None)
	For INIT:CONT 0 1 OFF ON
<b>*RST Value</b>	OFF
<b>Examples</b>	INIT INITIATE:IMMEDIATE
	INIT:CONT 1 INITIATE:CONTINUOUS 1
<b>Query Syntax</b>	For INIT[:IMM] (None)
	For INIT:CONT INIT:CONT?
<b>Returned Parameters</b>	<NR1> 0 1
<b>Related Commands</b>	ABOR <GET> *RST TRIG *TRG

**Measure Subsystem**

This query subsystem returns the voltage and current measured at the power supply's sense terminals.

<b>Query Syntax</b>	MEASure:CURRent[:DC]? MEASure:VOLTage[:DC]?
<b>Parameters</b>	(None)
<b>Default Suffix</b>	A for MEAS:CURR? V for MEAS:VOLT?
<b>Examples</b>	MEAS:CURR? MEAS:VOLT? MEASURE:VOLTAGE:DC? MV
<b>Returned Parameters</b>	<NR3>

**Output Subsystem**

This subsystem controls the power supply's voltage and current outputs and an optional output relay.

---

**Caution** Do not install or program the HP Relay Accessories if the power supply maximum output current rating (see Table 3-1) exceeds the contact ratings of the relay.

---

**OUTP**

This command enables or disables the power supply output. The state of a disabled output is a condition of zero output voltage and a model-dependent minimum source current (see Table 3-1). The query form returns the output state.

<b>Command Syntax</b>	OUTPut[:STATe] <bool>
<b>Parameters</b>	0   OFF   1   ON
<b>Suffix</b>	(None)
<b>*RST Value</b>	0
<b>Examples</b>	OUTP 1 OUTPUT:STATE ON
<b>Query Syntax</b>	OUTPut[:STATe]?
<b>Returned Parameters</b>	<NR1> 0 or 1
<b>Related Commands</b>	*RST *RCL *SAV

**OUTP:PROT**

There are two output protection commands that do the following:

**OUTP:PROT:CLE** Clears any OV (overvoltage), OC (overcurrent, unless set via external voltage control), OT (overtemperature), or RI (remote inhibit) protection features. After this command, the output is restored to the state it was in before the protection feature occurred.

**OUTP:PROT****OUTP:REL****OUTP:REL:POL**

**OUTP:PROT:DEL** Sets the time between the programming of an output change that produces a CV, CC, or UNREG condition and the recording of that condition by the Status Operation Condition register. The delay prevents the momentary changes in power supply status that can occur during reprogramming from being registered as events by the status subsystem. Since the delay applies to CC status, it also delays the OCP (overcurrent protection) feature. The OVP (overvoltage protection) feature is not affected by this delay.

<b>Examples</b>	<code>OUTP:PROT:CLE</code> <code>OUTPUT:PROTECTION:CLEAR</code> <code>OUTPUT:PROTECTION:DELAY 75E-1</code> <code>OUTP:PROT:DEL MIN</code> <code>OUTPUT:PROT:DELAY MAX</code>
<b>Query Syntax</b>	<code>OUTP:PROT:CLE</code> (None) <code>OUTPut:PROTection:DELAy?</code> <code>OUTPut:PROTection:DELAy? MIN</code> <code>OUTPup:PROTection:DELAy?</code> <code>MAX</code>
<b>Returned Parameters</b>	<NR3> <code>OUTP:PROT:DEL?</code> returns value of programmed delay. <code>OUTP:PROT:DEL? MIN</code> and <code>OUTP:PROT:DEL? MAX</code> return the minimum and maximum programmable delays.
<b>Related Commands</b>	<code>OUTP:PROT:CLE</code> (None) <code>OUTP:PROT:DEL</code> <code>*RST</code> <code>*RCL</code> <code>*SAV</code>

**OUTP:REL**


---

**Caution** Do not install or program the HP Relay Accessories if the power supply maximum output current rating (see Table 3-1) exceeds the contact ratings of the relay.

---

This command is valid only if the power supply is configured for the optional relay connector. Programming **ON** closes the relay contacts; programming **OFF** opens them. The relay is controlled independently of the output state. If the power supply is supplying power to a load, that power will appear at the relay contacts during switching. If the power supply is not configured for the relay option, sending either relay command generates an error.

<b>Command Syntax</b>	<code>OUTPut:RELAy[:STATe]</code> <bool>
<b>Parameters</b>	0   1   OFF   ON
<b>*RST Value</b>	0
<b>Examples</b>	<code>OUTP:REL 1</code> <code>OUTP:REL OFF</code>
<b>Query Syntax</b>	<code>OUTPput:RELAy?</code>
<b>Returned Parameters</b>	0   1
<b>Related Commands</b>	<code>OUTP[:STAT]</code> <code>*RCL</code> <code>*SAV</code>

**OUTP:REL:POL**


---

**Caution** Do not install or program the HP Relay Accessories if the power supply maximum output current rating (see Table 3-1) exceeds the contact ratings of the relay.

---

This command is valid only if the power supply is configured for the optional relay connector. Programming **NORMAl** causes the relay output polarity to be the same as the power supply output. Programming **REVerse** causes the relay output polarity to be opposite to that of the power supply output. If `OUTP[:STAT] = ON` when either relay command is sent, the power supply output voltage is set to 0 during the time that the relays are changing polarity.

If the power supply is not configured for the relay option, sending either relay command generates an error.

Command Syntax	OUTP <u>ut</u> :REL <u>ay</u> :POL <u>arity</u> <CRD>
Parameters	NORM <u>al</u>   RE <u>verse</u>
*RST Value	NORM
Examples	OUTP:REL:POL NORM
Query Syntax	OUTP <u>put</u> :REL <u>ay</u> :POL <u>arity</u> ?
Returned Parameters	NORM   REV
Related Commands	OUTP[:STAT] *RCL *SAV

## Status Subsystem

This subsystem programs the power supply status registers. The power supply has three groups of status registers; **Operation**, **Questionable**, and **Standard Event**. The Standard Event group is programmed with Common commands as described in "Chapter 4 - Status Reporting". The Operation and Questionable status groups each consist of the Condition, Enable, and Event registers and the NTR and PTR filters.

## Status Operation Registers

The bit configuration of all Status Operation registers is shown in the following table:

**Bit Configuration of Operation Registers**

Bit Position	15-12	11	10	9	8	7	6	5	4	3	2	1	0
Bit Name	NU	NU	CC	NU	CV	NU	NU	WTG	NU	NU	NU	NU	CAL
Bit Weight		2048	1024	512	256	128	64	32	16	8	4	2	1
CAL = Interface is computing new calibration constants; CC = The power supply is in constant-current mode.													
CV = The power supply is in constant voltage mode; NU = (Not used); WTG = The interface is waiting for a trigger.													

**Note** See "Chapter 4 - Status Reporting" for more explanation of these registers.

## STAT:OPER?

This query returns the value of the Operation Event register. The Event register is a read-only register which holds (latches) all events that are passed by the Operation NTR and/or PTR filter. Reading the Operation Event register clears it.

Query Syntax	STAT <u>us</u> :OPER <u>tion</u> [:EVENT]?
Parameters	(None)
Returned Parameters	<NR1> (Register Value)
Examples	STAT:OPER? STATUS:OPERATIONAL:EVENT?
Related Commands	*CLS STAT:OPER:NTR STAT:OPER:PTR

**STAT:OPER:COND?**

This query returns the value of the Operation Condition register. That is a read-only register which holds the real-time (unlatched) operational status of the power supply.

Query Syntax	STATus:OPERation:CONDition?
Parameters	(None)
Examples	STAT:OPER:COND?    STATUS:OPERATION:CONDITION?
Returned Parameters	<NR1>    (Register value)
Related Commands	(None)

**STAT:OPER:ENAB**

This command and its query set and read the value of the Operational Enable register. This register is a mask for enabling specific bits from the Operation Event register to set the operation summary bit (OPER) of the Status Byte register. This bit (bit 7) is the logical OR of all the Operational Event register bits that are enabled by the Status Operation Enable register.

Command Syntax	STATus:OPERation:ENABle <NRf>
Parameters	0 to 32727
Suffix	(None)
Default Value	0
Examples	STAT:OPER:ENAB 1312    STAT:OPER:ENAB 1 STATUS:OPERATION:ENABLE?
Query Syntax	STATus:OPERation:ENABle?
Returned Parameters	<NR1>    (Register value)
Related Commands	STAT:OPER:EVEN

**STAT:OPER NTR/PTR Commands**

These commands set or read the value of the Operation NTR (Negative-Transition) and PTR (Positive-Transition) registers. These registers serve as polarity filters between the Operation Enable and Operation Event registers to cause the following actions:

- When a bit in the Operation NTR register is set to 1, then a 1-to-0 transition of the corresponding bit in the Operation Condition register causes that bit in the Operation Event register to be set.
- When a bit of the Operation PTR register is set to 1, then a 0-to-1 transition of the corresponding bit in the Operation Condition register causes that bit in the Operation Event register to be set.
- If the same bits in both NTR and PTR registers are set to 1, then *any transition* of that bit at the Operation Condition register sets the corresponding bit in the Operation Event register.
- If the same bits in both NTR and PTR registers are set to 0, then *no transition* of that bit at the Operation Condition register can set the corresponding bit in the Operation Event register.

---

**Note**                    Setting a bit in the value of the PTR or NTR filter can of itself generate positive or negative events in the corresponding Operation Event register.

---

**STAT:OPER:NTR/PTR****STAT:PRES****STAT:QUES?**

Command Syntax	STATus:OPERtion:NTRansition <NRf> STATus:OPERtion:PTRansition <NRf>
Parameters	0 to 32727
Suffix	(None)
Default Value	0
Examples	STAT:OPER:NTR 32 STAT:OPER:PTR 1312
Query Syntax	STAT:OPER:NTR? STAT:OPER:PTR?
Returned Parameters	<NR1> (Register value)
Related Commands	STAT:OPER:ENAB

**STAT:PRES**

This command sets all defined bits in the Status Subsystem PTR registers and clears all bits in the subsystem NTR and Enable registers. STAT:OPER:PTR is set to 1313 and STAT:QUES:PTR is set to 1555.

Command Syntax	STATus:PRESet
Parameters	(None)
Examples	STAT:PRES STATUS:PRESET
Query Syntax	(None)
Related Commands	(None)

**Status Questionable Registers**

The bit configuration of all Status Questionable registers is as follows:

**Bit Configuration of Questionable Registers**

Bit Position	15-11	10	9	8	7	6	5	4	3	2	1	0
Bit Name	NU	UNR	RI	NU	NU	NU	NU	OT	NU	NU	OC	OV
Bit Weight		1024	512	256	128	64	32	16	8	4	2	1
NU = (Not used); OC = Overcurrent protection circuit has tripped.												
OT = Overtemperature status condition exists; OV = Overvoltage protection circuit has tripped												
RI = Remote inhibit is active UNR = Power supply output is unregulated.												
Note: See "Chapter 4 - Status Reporting" for more explanation of these registers.												

**STAT:QUES?**

This query returns the value of the Questionable Event register. The Event register is a read-only register which holds (latches) all events that are passed by the Questionable NTR and/or PTR filter. Reading the Questionable Event register clears it.

Query Syntax	STATus:QUESTIONable[:EVENT]?
Parameters	(None)
Returned Parameters	<NR1> (Register Value)
Examples	STAT:QUES? STATUS:QUESTIONABLE:EVENT?
Related Commands	*CLS STAT:QUES:ENAB STAT:QUES:NTR STAT:QUES:PTR



**STAT:QUES:COND?**

This query returns the value of the Questionable Condition register. That is a read-only register which holds the real-time (unlatched) questionable status of the power supply.

Query Syntax	STATus:QUESTIONable:CONDition?
Parameters	(None)
Examples	STAT:QUES:COND? STATUS:QUESTIONABLE:CONDITION?
Returned Parameters	<NR1> (Register value)
Related Commands	(None)

**STAT:QUES:ENAB**

This command and its query set and read the value of the Questionable Enable register. This register is a mask for enabling specific bits from the Questionable Event register to set the questionable summary bit (QUES) of the Status Byte register. This bit (bit 3) is the logical OR of all the Questionable Event register bits that are enabled by the Questionable Status Enable register.

Command Syntax	STATus:QUESTIONable:ENABle <NRf>
Parameters	0 to 32727
Suffix	(None)
Default Value	0
Examples	STAT:QUES:ENAB 20 STAT:QUES:ENAB 16
Query Syntax	STATus:QUESTIONable:ENABle?
Returned Parameters	<NR1> (Register value)
Related Commands	STAT:QUES?

**STAT:QUES NTR/PTR Commands**

These commands allow you to set or read the value of the Questionable NTR (Negative-Transition) and PTR (Positive-Transition) registers. These registers serve as polarity filters between the Questionable Enable and Questionable Event registers to cause the following actions:

- When a bit of the Questionable NTR register is set to 1, then a 1-to-0 transition of the corresponding bit of the Questionable Condition register causes that bit in the Questionable Event register to be set.
- When a bit of the Questionable PTR register is set to 1, then a 0-to-1 transition of the corresponding bit in the Questionable Condition register causes that bit in the Questionable Event register to be set.
- If the same bits in both NTR and PTR registers are set to 1, then *any transition* of that bit at the Questionable Condition register sets the corresponding bit in the Questionable Event register.
- If the same bits in both NTR and PTR registers are set to 0, then *no transition* of that bit at the Questionable Condition register can set the corresponding bit in the Questionable Event register.

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**Note**            Setting a bit in the PTR or NTR filter can of itself generate positive or negative events in the corresponding Questionable Event register.

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<b>STAT:QUES:NTR/PTR</b>	<b>SYST:ERR?</b>	<b>SYS:LANG</b>	<b>SYST:VERS?</b>
Command Syntax	STATus:QUEStionable:NTRansition <NRf> STATus:QUEStionable:PTRansition <NRf>		
Parameters	0 to 32727		
Suffix	(None)		
Default Value	0		
Examples	STAT:QUES:NTR 16    STATUS:QUESTIONABLE:PTR 512		
Query Syntax	STAT:QUES:NTR?    STAT:QUES:PTR?		
Returned Parameters	<NR1>    (Register value)		
Related Commands	STAT:QUES:ENAB		

### SYST:ERR?

This query returns the next error number followed by its corresponding error message string from the remote programming error queue. The queue is a FIFO (first-in, first-out) buffer that stores errors as they occur. As it is read, each error is removed from the queue. When all errors have been read, the query returns 0,NO ERROR. If more errors are accumulated than the queue can hold, the last error in the queue will be -350,TOO MANY ERRORS (see Table 5-1 in "Chapter 5 - Error Messages" for other error codes).

You can use the power supply front panel **Error** key to read errors from the queue. Errors generated at the front panel are not put into the queue but appear immediately on the display.

Query Syntax	SYSTEM:ERRor?
Parameters	(None)
Returned Parameters	<NR1>,<SRD>
Examples	SYST:ERR?    SYSTEM:ERROR?
Related Commands	(None)

### SYST:LANG

This command switches the interface between its SCPI (TMSL) command language and its compatibility language. The compatibility language is provided for emulation of older power supply systems and is described in Appendix B. Sending the command causes:

- The alternate language to become active and to be stored in nonvolatile memory.
- The power supply to reset to the state stored in Location 0.

If the power supply is shut off, it will resume operation in the last-selected language when power is restored.

Command Syntax	SYSTEM:LANGuage <string> <i>Syntax is the same, regardless of the present language</i>
Parameters	TMSL   COMPatibility <i>Note: Parameter TMSL must be used in place of SCPI.</i>
Default Value	TMSL or last selected language
Examples	SYST:LANG TMSL    SYSTEM:LANGUAGE COMPATIBILITY
Query Syntax	SYSTEM:LANGuage?
Returned Parameters	<CRD>    TMSL   COMP
Related Commands	(None)

### SYST:VERS?

This query returns the SCPI version number to which the power supply complies. The returned value is of the form YYYY.V, where YYYY represents the year and V is the revision number for that year.

**TRIG****TRIG:SOUR****Voltage Subsystem**

Query Syntax	SYSTEM:VERSion?
Parameters	(none)
Returned Paramters	<NR2>
Examples	SYST:VERS?    SYSTEM:VERSION?
Related Commands	(None)

**Trigger Subsystem**

This subsystem controls remote triggering of the power supply.

**TRIG**

When the trigger subsystem is enabled, **TRIG** generates a trigger signal. The trigger will then:

1. Initiate a pending level change as specified by **CURR[:LEV]:TRIG** or **VOLT[:LEV]:TRIG**.
2. Clear the WTG bit in the Status Operation Condition register.
3. If **INIT:CONT** has been given, the trigger subsystem is immediately re-enabled for subsequent triggers. As soon as it is cleared, the WTG bit is again set to 1.

Command Syntax	TRIGger[:IMMediate]
Parameters	(None)
Examples	TRIG TRIGGER:IMMEDIATE
Query Syntax	(None)
Related Commands	ABOR    CURR:TRIG    INIT    *TRG    VOLT:TRIG

**TRIG:SOUR**

This command selects the trigger source. Since the power supply has no other trigger source than the HP-IB bus, this command need not be used. It is included in the command set to provide programming compatibility with other instruments (such as the HP Electronic Load family) that may have more than one trigger source.

Command Syntax	TRIGger:SOURce <CRD>
Parameters	BUS
*RST Value	BUS
Examples	TRIG:SOUR BUS    TRIGGER:SOURCE BUS
Query Syntax	TRIGger:SOURce?
Returned Parameters	BUS
Related Commands	*RST    *TRG    TRIG[:IMM]

**Voltage Subsystem**

This subsystem programs the output voltage of the power supply.

**VOLT****VOLT:TRIG**

These commands set the immediate voltage level or the pending triggered voltage level of the power supply. The immediate level is the voltage programmed for the output terminals. The pending triggered level is a stored voltage value that is transferred to the output terminals when a trigger occurs. A pending triggered level is unaffected by subsequent **VOLT** commands and remains in effect until the trigger subsystem receives a trigger or an **ABORT** command is given. If there is no pending **VOLT:TRIG** level, then the query form returns the **VOLT** level. In order for **VOLT:TRIG** to be executed, the trigger subsystem must be initiated (see **INITiate**).

**VOLT****VOLT:TRIG****VOLT:PROT**

<b>Command Syntax</b>	[SOURce]:VOLTage[:LEVel][:IMMediate][AMPLitude] <NRf+> [SOURce][:VOLTage[:LEVel]:TRIGgered[:AMPLitude] <NRf+>
<b>Parameters</b>	Table 3-1
<b>Default Suffix</b>	V
<b>*RST Value</b>	Table 3-1
<b>Examples</b>	VOLT 200 MA            VOLTAGE:LEVEL 200 MA VOLTAGE:LEVEL:IMMEDIATE:AMPLITUDE 2.5 VOLT:TRIG 20            VOLTAGE:LEVEL:TRIGGERED 20
<b>Query Syntax</b>	[SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]? [SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]? MAX [SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]? MIN [SOURce]:VOLTage[LEVel]:TRIGgered[:AMPLitude]? [SOURce]:VOLTage[LEVel]:TRIGgered[:AMPLitude]? MAX [SOURce]:VOLTage[:LEVel]:TRIGgered[:AMPLitude]? MIN
<b>Returned Parameters</b>	<NR3>    VOLT? and VOLT:TRIG? return presently programmed immediate and triggered levels. If not triggered level is programmed, both returned values are the same. VOLT? MAX and VOLT? MIN return the maximum and minimum programmable immediate voltage levels. VOLT:TRIG? MAX and VOLT:TRIG? MIN return the maximum and minimum programmable triggered voltage levels.
<b>Related Commands</b>	For VOLT    *SAV   *RCL   *RST For VOLT:TRIG    ABOR   VOLT   *RST

**VOLT:PROT**

This command sets the overvoltage protection (OVP) level of the power supply. If the output voltage exceeds the OVP level, then the power supply output is disabled and the Questionable Condition status register OV bit is set (see "Chapter 4 - Status Reporting"). An overvoltage condition can be cleared with the **OUTP:PROT:CLE** command after the condition that caused the OVP trip is removed. The OVP always trips with zero delay and is unaffected by the **OUTP:PROT:DEL** command.

<b>Command Syntax</b>	[SOURce]:VOLTage:PROTection[:LEVel] <NRf+>
<b>*Alternate Syntax</b>	[SOURce]:VOLTage:PROTection:AMPLitude <NRf+>
<b>Parameters</b>	Table 3-1
<b>Default Suffix</b>	V
<b>*RST Value</b>	MAX
<b>Examples</b>	VOLT:PROT 21.5    VOLT:PROT:LEV MAX VOLTAGE:PROTECTION:LEVEL 145E-1
<b>Query Syntax</b>	[SOURce]:VOLTage:PROTection[:LEVel]? [SOURce]:VOLTage:PROTection [:LEVel]? MIN [SOURce]:VOLTage:PROTection [:LEVel]? MAX
<b>Returned Parameters</b>	<NR3>    VOLT:PROT? returns presently programmed OVP level. VOLT:PROT? MAX and VOLT:PROT? MIN return the maximum and minimum programmable OVP levels.
<b>Related Commands</b>	OUTP:PROT:CLE   *RST   *SAV   *RCL * Available to accommodate earlier power supply programs.

## COMMAND SUMMARY

This summary lists all power supply subsystem commands in alphabetical order, followed by all common commands in alphabetical order. See Table 3-1 for the command parameters accepted by each power supply model.

**Command Summary**

<i>Command</i>	<i>Parameters</i>
<b>Subsystem Commands</b>	
ABOR	(none)
CAL	(See Appendix A in the Operating Manual)
[SOUR]:CURR[:LEV][:IMM][:AMPL]	<NRf+>[suffix]
[SOUR]:CURR[:LEV][:IMM][:AMPL]?	(none)  MIN MAX
[SOUR]:CURR[:LEV]:TRIG[:AMPL]	<NRf+>[suffix]
[SOUR]:CURR[:LEV]:TRIG[:AMPL]?	(none)  MIN MAX
[SOUR]:CURR:PROT:STAT	0 1   ON OFF
[SOUR]:CURR:PROT:STAT?	(none)
[SOUR]:DIG:DATA[:VAL]	<NRf>
[SOUR]:DIG:DATA[:VAL]?	(none)
DISP[WIND]:MODE	NORM TEXT
DISP[WIND]:MODE?	(none)
DISP[:WIND][:STAT]	0 1   OFF ON
DISP[:WIND][:STAT]?	(none)
DISP[:WIND]:TEXT[:DATA]	<STR>
DISP[:WIND]:TEXT[:DATA]?	(none)
INIT[:IMM]	(none)
INIT:CONT	0 1   OFF ON
INIT:CONT?	(none)
MEAS:CURR[:DC]?	(none)
MEAS:VOLT[:DC]?	(none)
OUTP[:STAT]	0 1 OFF ON
OUTP[:STAT]?	(none)
OUTP:PROT:CLE	(none)
OUTP:PROT:DEL	0 to 32.767 MIN MAX
OUTP:PROT:DEL?	(none)  MIN MAX
OUTP:REL[:STAT]	0 1 2OFF ON+
OUTP:REL[:STAT]?	(none)
OUTP:REL:POL	NORM REV
OUTP:REL:POL?	(none)

**Command Summary (continued)**

<i>Command</i>	<i>Parameters</i>
<b>Subsystem Commands (cont)</b>	
STAT:OPER:COND?	(none)
STAT:OPER:ENAB	<NRf>
STAT:OPER:ENAB?	(none)
STAT:OPER[:EVEN]?	(none)
STAT:OPER:NTR	<NRf>
STAT:OPER:NTR?	(none)
STAT:OPER:PTR	<NRf>
STAT:OPER:PTR?	(none)
STAT:PRES	(none)
STAT:QUES:COND?	(none)
STAT:QUES:ENAB	<NRf>
STAT:QUES:ENAB?	(none)
STAT:QUES[:EVEN]?	(none)
SYST:ERR?	(none)
SYST:LANG	TMSL COMP
SYST:LANG?	(none)
SYST:VERS?	(none)
TRIG[:IMM]	(none)
TRIG:SOUR	BUS
TRIG:SOUR?	(none)
[SOUR]:VOLT[:LEV][:IMM][:AMPL]	<NRf+>[suffix]
[SOUR]:VOLT[:LEV][:IMM][:AMPL]?	(none)  MIN MAX
[SOUR]:VOLT[:LEV]:TRIG[:AMPL]	<NRf+>[suffix]
[SOUR]:VOLT[:LEV]:TRIG[:AMPL]?	(none)  MIN MAX
[SOUR]:VOLT:PROT[:LEV]	<NRf+>[suffix]
[SOUR]:VOLT:PROT[:LEV]?	<NRf+>[suffix]

**Common Commands**

<i>Command</i>	<i>Parameters</i>	<i>Command</i>	<i>Parameters</i>	<i>Command</i>	<i>Parameters</i>
*CLS	(None)	*OPC?	(None)	*SRE	<NRf>
*ESE	<NRf>	*PSC	<bool>	*SRE?	(None)
*ESE?	(None)	*PSC?	(None)	*STB?	(None)
*ESR?	(None)	*RCL	<NRf>	*TRG	(None)
*IDN?	(None)	*RST	(None)	*TST?	(None)
*OPC	(None)	*SAV	<NRf>	*WAI	(None)

**PROGRAMMING PARAMETERS**

Table 3-1 list the programming parameters for each of the models.

**Table 3-1. Power Supply Programming Parameters (see note)**

Parameter	HP Model and Value					
CURR[:LEV] MAX and CURR[:LEV]:TRIG MAX (Programming range is 0 to MAX)	6641A	6642A	6643A	6644A	6645A	
	20.475 A	10.237 A	6.142 A	3.583 A	1.535 A	
	6651A	6652A	6653A	6654A	6655A	
	51.188 A	25.594 A	15.356 A	9.214 A	4.095 A	
	6671A	6672A	6673A	6674A	6675A	
	225.23 A	102.37 A	61.43 A	35.83 A	18.43 A	
	6680A	6681A	6682A	6683A	6684A	
	875 A	580 A	240 A	160 A	128 A	
*RST Current Value	6641A	6642A	6643A	6644A	6645A	
	0.08 A	0.04 A	0.024 A	0.014 A	0.006 A	
	6651A	6652A	6653A	6654A	6655A	
	0.205 A	0.100 A	0.060 A	0.036 A	0.016 A	
	6671A	6672A	6673A	6674A	6675A	
	0.88 A	0.40 A	0.24 A	0.14 A	0.07 A	
	6680A	6681A	6682A	6683A	6684A	
	73.71 A	48.75 A	20.26 A	13.51 A	10.79 A	
OUTP:PROT:DEL	0 to 32.727 s (MAX) for all models					
*RST Value	200 ms for all models					
VOLT[:LEV] MAX and VOLT[:LEV]:TRIG MAX (Programming range is 0 to MAX)	6641A	6642A	6643A	6644A	6645A	
	6651A	6652A	6653A	6654A	6655A	
	6671A	6672A	6673A	6674A	6675A	
	8.190 V	20.475 V	35.831 V	61.425 V	122.85 V	
	6680A	6681A	6682A	6683A	6684A	
	5.145 V	8.190 V	21.50 V	32.75 V	41.0 V	
	*RST Voltage Value	0 V for all models				
	VOLT:PROT MAX (Programming range is 0 to MAX)	6641A	6642A	6643A	6644A	6645A
6651A		6652A	6653A	6654A	6655A	
8.8 V		22.0 V	38.5 V	66.0 V	132.0 V	
6671A		6672A	6673A	6674A	6675A	
10.0 V		24.0 V	42.0 V	72.0 V	144.0 V	
6680A		6681A	6682A	6683A	6684A	
6.25 V		10.0 V	25.2 V	38.4 V	48.0 V	
*RST OVP value		MAX for all models				

**Note** For programming accuracy and resolution, see the Specifications and Supplemental Characteristics in the Operating Guide.