



## *SF Series*

### **IEEE-488.2/RS-232 Option Programming Manual**

**Sorensen** Power Supplies  
Elgar Electronics Corporation  
9250 Brown Deer Road  
San Diego, CA 92121-2294  
1-800-73ELGAR (1-800-733-5427)  
Tel: (858) 450-0085  
Fax: (858) 458-0267  
Email: [sales@elgar.com](mailto:sales@elgar.com)  
[www.elgar.com](http://www.elgar.com)

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# SAFETY NOTICE

Before applying power to the system, verify that the SF Series supply is configured properly for the user's particular application.



## WARNING!

**HAZARDOUS VOLTAGES IN EXCESS OF 280 VRMS, 600V PEAK MAY BE PRESENT WHEN COVERS ARE REMOVED. QUALIFIED PERSONNEL MUST USE EXTREME CAUTION WHEN SERVICING THIS EQUIPMENT. CIRCUIT BOARDS, TEST POINTS, AND OUTPUT VOLTAGES MAY BE FLOATING ABOVE (BELOW) CHASSIS GROUND.**

Installation and service must be performed by qualified personnel who are aware of dealing with attendant hazards. This includes such simple tasks as fuse verification.

**Ensure that the AC power line ground is connected properly to the SFI Series unit input connector or chassis. Similarly, other power ground lines including those to application and maintenance equipment must be grounded properly for both personnel and equipment safety.**

Always ensure that facility AC input power is de-energized prior to connecting or disconnecting the input/output power cables.



During normal operation, the operator does not have access to hazardous voltages within the chassis. However, depending on the user's application configuration, HIGH VOLTAGES HAZARDOUS TO HUMAN SAFETY may be generated normally on the output terminals.

Ensure that the output power lines are labeled properly as to the safety hazards and that any inadvertent contact with hazardous voltages is eliminated. To guard against risk of electrical shock during open cover checks, do not touch any portion of the electrical circuits. Even when the power is off, capacitors can retain an electrical charge. Use safety glasses during open cover checks to avoid personal injury by any sudden failure of a component.

Due to filtering, the unit has high leakage current to the chassis. Therefore, it is essential to operate this unit with a safety ground.

**Some circuits are live even with the front panel switch turned off. Service, fuse verification, and connection of wiring to the chassis must be accomplished at least five minutes after power has been removed via external means; all circuits and/or terminals to be touched must be safety grounded to the chassis.**

After the unit has been operating for some time, the metal near the rear of the unit may be hot enough to cause injury. Let the unit cool before handling.

Qualified service personnel need to be aware that some heat sinks are not at ground, but at high potential.

These operating instructions form an integral part of the equipment and must be available to the operating personnel at all times. All the safety instructions and advice notes are to be followed.

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## SAFETY SYMBOLS



CAUTION  
Risk of Electrical Shock



CAUTION  
Refer to Accompanying Documents



Off (Supply)



Direct Current (DC)



Standby (Supply)



Alternating Current (AC)



On (Supply)



Three-Phase Alternating Current



Protective Conductor Terminal



Earth (Ground) Terminal



Fuse



Chassis Ground

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# SECTION 1

## FEATURES, FUNCTIONS, AND SPECIFICATIONS

### 1.1 Introduction

This manual covers the Digital Interface Adapter (DIA) for SF Series supplies. The DIA interface card enables the user to operate from a computer via the IEEE-488.2 GPIB or RS-232 interface, allowing full remote programming control and monitoring of the SF Series supply.

### 1.2 Features and Functions

#### **Features**

- 16-bit programming and 16-bit readback of voltage and current
- IEEE-488.2 and SCPI compliant command set
- Current Ramp functions
- Field-upgradable firmware via RS-232
- Soft calibration
- Rear panel IEEE-488.2 and RS-232 control interface
- Rear panel configuration switch

#### **Programmable Functions**

- Output current
- Soft limits for current
- Output enable/disable
- Maskable fault interrupt
- Hold and trigger
- Full calibration

**Readback Functions**

- Actual measured voltage and current
- Current settings
- Soft current limit
- Status and Accumulated Status registers
- Programming error codes
- Fault codes
- Manufacturer, power supply model, and firmware version identification

## 1.3 Specifications

**Programming Resolution**

Current: 0.002% of full scale

**Programming Accuracy**

Current:  $\pm$  ( 0.4% of maximum output current)\*

**Readback Resolution**

Voltage:  $\pm$  0.002% of full scale

Current:  $\pm$  0.002% of full scale

**Readback Accuracy**

Voltage:  $\pm$  ( 0.15% of full scale output voltage)

Current:  $\pm$  ( 0.4% of full scale output current)\*

\* After 30 minutes operation with fixed line, load, and temperature.

**Note:** Refer to the SFA or SFI power supply Operation manual for effects of line regulation, load regulation, and temperature on accuracy specifications.

Specifications subject to change without notice.

## SECTION 2 CONFIGURATION

The DIA is installed into the supply at the factory. Use the Setup Procedure described below to configure the DIA for your system and application.

### 2.1 Setup Procedure

This procedure is a quick reference for the configuration requirements. Refer to Section 2.2 for detailed information on the rear panel switches.

1. Set the rear panel Remote/Local switch to Remote (On or 1).
2. Set the rear panel Power On Service Request switch to No Service Request (Off or 0).
3. *SFA* - Set the GPIB address switches to the desired address.  
**Note:** *Valid GPIB addresses are 1-30.*

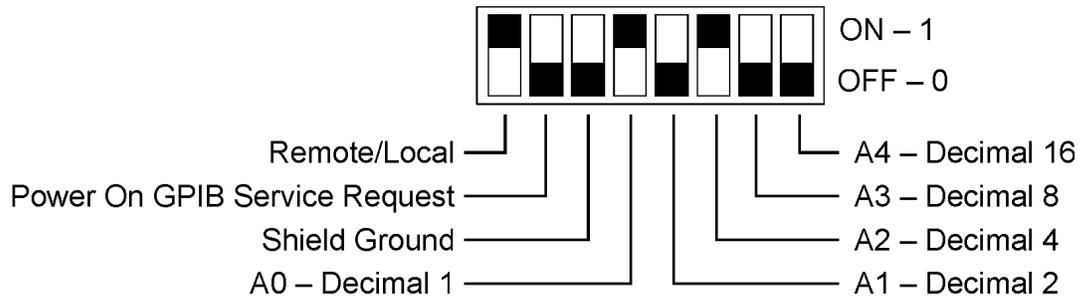
*SFI* – From the Home menu page 3, press (F1) to enter the Remote menu. Select the IEEE488 address for GPIB programming or baud rate for RS232.

4. Connect the GPIB or RS232 Interface Cable to the supply.
5. Connect power to the unit and turn on the unit.
6. Configure the controller to match the supply identification and configuration. Use one of the available programs such as IBCONF from National Instruments for GPIB, or set the RS232 baud rate to 19200 for SFA or selected rate for SFI, 8 data bits, no parity, and 1 stop bit.
7. Test the communication interface by issuing a \*IDN? Command. This returns the supply's model and firmware versions and does not affect the output of the supply.

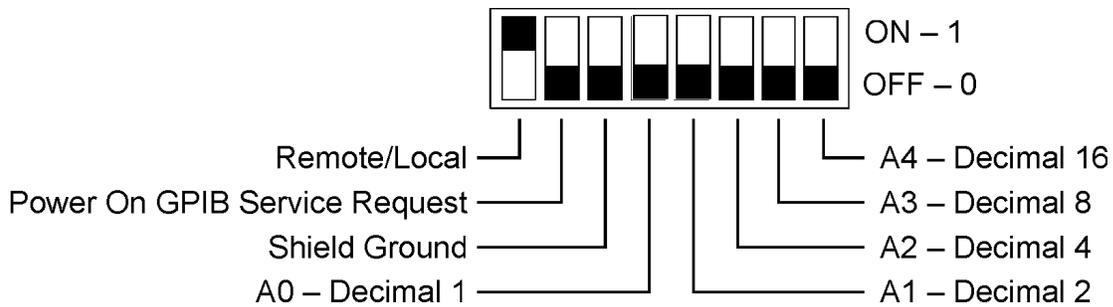
## 2.2 Rear Panel Configuration Switch

The DIP switch is accessible from the rear panel to allow configuration of the supply with the installed DIA for the user's particular system and application. The following figures show the configuration, as set up in Section 2.1, and with GPIB address set to five (5) for the SFA.

**Note:** Two types of DIP switches are utilized; toggle and rocker. For toggle switches, the shading indicates the position of the toggle switch. For rocker switches, the shading indicates the depressed side.



**Figure 2-1. SFA Configuration Switch**



**Figure 2-2. SFI Configuration Switch**

### 2.2.1 Remote/Local Selection

Set the rear panel Remote/Local switch to select remote or local operation.

#### REMOTE/LOCAL SWITCH

Switch Position	Description
ON	Remote operation selected. *
OFF	Local operation selected. Front panel control is enabled. Unit will switch to remote operation upon the first GPIB or RS-232 command.

\* In the ON position, the power hardware and GPIB card initialize to the remote state on power turn on. In addition, front panel control remains disabled regardless of the state of the GPIB interface REN line or the GTL command. The special command SYST:LOCAL <on/off> is permitted as a means to revert to front panel control if desired.

Powering up in remote mode will result in the following operating conditions:

#### REMOTE MODE POWER-ON CONDITIONS

Condition	Default
Current	Initial power-on current. Default value = OA. See CAL:INIT:CURR
Soft Current Limit	Model maximum current
Delay	0.5 seconds
Foldback Protection	OFF
Output	ON
Hold	OFF
Unmask	NONE
Service Request Capability	OFF

#### 2.2.2 Power-On GPIB Service Request (PON SRQ) Selection

Set the rear panel PON SRQ switch to ON to cause a GPIB service request to be sent to the computer controller when the supply is turned on.

#### POWER-ON GPIB SERVICE REQUEST (PON SRQ) SWITCH

Switch Position	Description
ON	Power-On SRQ selected
OFF	No Power-On SRQ selected

Refer to your specific GPIB controller card manual for further details on serial polling.

#### 2.2.3 Shield Ground

Connects GPIB cable shield to chassis ground.

#### 2.2.4 Address Selection

The SFA address selection is binary with switch A0 as the LSB and A4 as the MSB. The rear panel switch illustration in Section 2.2 shows the address selection 00101 in binary (5 decimal).

The SFI address is selected and enabled from a list in the Remote menu. See SFI Operation manual for more details on Remote menu, Navigation and Editing.

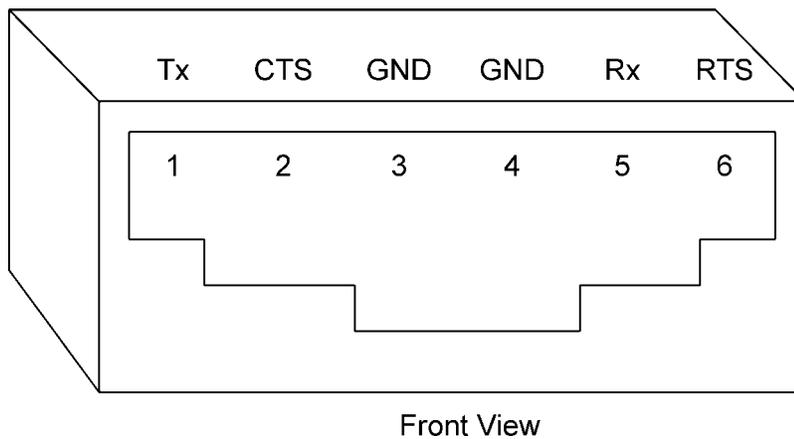
The address selection for a unit is the GPIB address of that device (1-30). SCPI reserves channel 0 as the global channel to address all channels.

ADDRESS SWITCHES

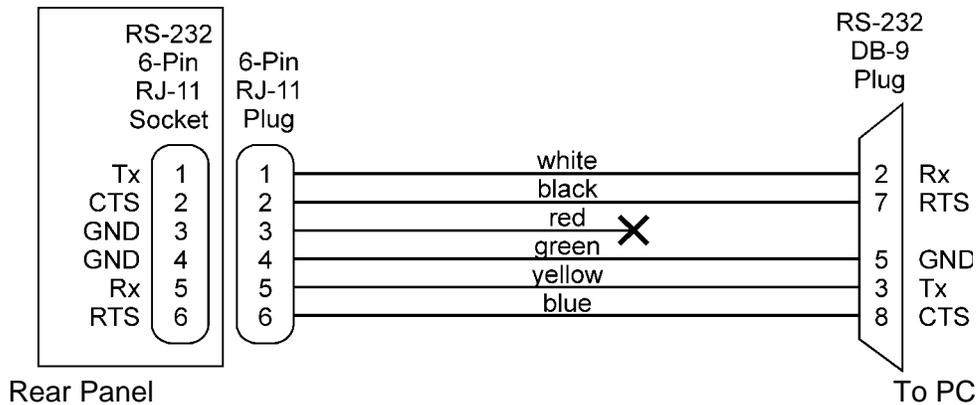
Switch Position	Description
ON	1
OFF	0

### 2.3 Remote Programming Via RS-232

The DIA's RS-232 interface operates at fixed 19.2Kbaud for SFA and is selectable from 2400 to 19.2Kbaud for the SFI, with 8 data bits, no parity, and 1 stop bit. All DIA commands are supported at the RS-232 interface with the exception of the Service Request (SRQ) function which is a GPIB-specific function requiring the dedicated Service Request line of the IEEE-488.2 interface. In this case, the SRQ function has no effect. The RS-232 interface is accessible through the rear panel 6-pin RJ-11 connector. The connector is labeled RS232.



**Figure 2-2. RS-232 Rear Panel RJ-11 Connector Pinout**



**Figure 2-3. SF to PC RS-232 Connection (RJ-11 to DB-9)**

## SECTION 3

# IEEE 488.2 AND SCPI COMMAND OPERATION

### 3.1 Introduction

The following sections describe the operation of the DIA by remote programming using the DIA IEEE-488.2 and SCPI command sets. The DIA IEEE488.2 and SCPI command sets provide programming, query, and status commands that facilitate remote control of the power supply.

### 3.2 IEEE-488.2 Register Definitions

The DIA supports the IEEE-488.2 and SCPI 1995.0 status reporting data structures. These structures are comprised of status registers and status register enable mask pairs. The following sections describe these pairs.

#### 3.2.1 SCPI Status Byte

The SCPI Status Byte status register can be read by the \*STB? command or by issuing a GPIB serial poll. The Status Byte status register can be cleared by the use of the \*CLS command.

The DIA can be configured to request service from the GPIB controller by setting the appropriate bits in the Service Request Enable Register (SRE). The SRE register has the same bit pattern as the Status Byte. It is modified using the \*SRE <mask> command and read with the \*SRE? command. For example, if the SRE register is set to 0x10 (MAV), when the DIA unit has a message available, the Status Byte register will contain 0x50 (RQS and MAV) and the SRQ line of the GPIB will be asserted to indicate a request for service. See table below, and refer to Section 5 for further information.

## SCPI STATUS BYTE

Bit	Hex Value	Description
0	0x01	Not used.
1	0x02	Protection Event Status flag. Indicates the selected protection event occurred.
2	0x04	Error/event queue message available. Set when any error/event is entered in the System Error Queue. It is read using the SYSTem:ERRor? query.
3	0x08	Questionable Status flag. Indicates the quality of the current data being acquired. This bit is not used.
4	0x10	Message available (MAV). Indicates a message is available in the GPIB output queue. Cleared after the GPIB output buffer is read.
5	0x20	Standard Event Status Register (ESR). Summary bit for the ESR. Set when any of the ESR bits are set and cleared when the ESR is read.
6	0x40	Request Service flag (RQS) for serial polling or Master Summary Status (MSS) in response to *STB?. If service requests are enabled (with the *SRE command), this bit represents the RQS and will be sent in response to a serial poll, then cleared. If RQS is not enabled, the bit represents the MSS bit and indicates the device has at least one reason to request service. Even though the device sends the MSS bit in response to a status query (*STB?), it is not sent in response to a serial poll. It is not considered part of the IEEE-488.1 Status Byte.
7	0x80	Operation Status flag. Indicates the current operational state of the unit. This bit is not used.

## 3.2.2 Standard Event Status Register (ESR)

The Standard Event Status Register (ESR) can be read by the \*ESR? command. Reading this register or issuing a \*CLS command will clear the ESR. Use the \*ESE (Standard Event Status Enable Register) to enable corresponding ESR bits to be summarized in the summary bit of the SCPI Status byte. To configure the DIA to generate GPIB service requests based on the ESR, both the Standard Event Status Enable Register and the Service Request Enable Register must be programmed. See table below, and refer to Section 5 for further information.

## STANDARD EVENT STATUS REGISTER

Bit	Hex Value	Description
0	0x01	Operation Complete
1	0x02	Request Control - not used
2	0x04	Query Error
3	0x08	Device Dependent Error
4	0x10	Execution Error (e.g., range error)
5	0x20	Command Error (e.g., syntax error)
6	0x40	User Request - not used
7	0x80	Power On

### 3.2.3 Protection Condition and Protection Event Status Register

These two registers have the same bit meanings, but they differ in regards to how they function.

The Protection Condition Register can be read using the STAT:PROT:COND? command. This command gives the *present status condition* of the power hardware, so the data is not latched. It is meant to be used as a polling register.

The Protection Event Status Register can be read by the STATus:PROTEction:EVENT? command. Reading this register, issuing a \*CLS command, or issuing a \*RST command will clear the Protection Event Status Register. Bits in the Protection Event Status Register will be set only when the corresponding bit in the Protection Event Status Enable Register is set and the corresponding event occurs. The status is then latched and will remain in that state until it is read or cleared due to some command action. (Use the STATus:PROTEction:ENABLE <mask> command to set the Enable Register and the STATus:PROTEction:ENABLE? query to read the Enable Register.) To configure the DIA to generate GPIB service requests based on the Protection Event Status Register, both the Protection Event Status Enable Register and the Service Request Enable Register (\*SRE) must be programmed. For further information, refer to the table below, and to Section 5.

#### PROTECTION CONDITION AND EVENT STATUS REGISTERS

Bit	Hex Value	Description
0	0x01	Not used
1	0x02	Constant current operation
2	0x04	Not used
3	0x08	Overvoltage protection tripped (not applicable for SFA)
4	0x10	Overtemperature protection tripped
5	0x20	Supply external shutdown active
6	0x40	Foldback mode operation
7	0x80	Remote programming error

### 3.2.4 Operation Status and Questionable Status Registers

The Operation Status and Questionable Status Registers will always return 0 when queried. The Operation Status Enable and Questionable Status Enable Registers can be programmed and queried to allow SCPI compatibility but have no effect on the Operation Status and Questionable Status Registers.

### 3.2.5 Error/Event Queue

The DIA maintains an Error/Event Queue as defined by SCPI. The queue holds up to 10 error events. It is queried using the SYSTem:ERRor? command which reads in a First In/First Out (FIFO) manner. The read operation removes the entry from the queue. The \*CLS command will clear all entries from the queue.

The following error codes are defined in the SCPI 1995.0 specification and are supported by the DIA. Error codes are in the range of [-32768, 32767]. SCPI reserves the negative error codes and 0, while error codes greater than 0 are device specific errors.

## SCPI ERROR CODES

<b>Error Code</b>	<b>Description</b>
206	<b>No channels setup to trigger</b> This means that an attempt was made to trigger the DIA using the TRIG:TYPE <1 2 3> command when there are no armed trigger settings. This error is <i>not</i> generated when the GET is received, even when there are no armed trigger settings.
205	<b>GPIB GET not allowed during message</b> This error means that the GPIB G(roup) E(xecute) T(ripper) multiline command was errantly generated by the system computer while or very shortly after a message is or was sent. Give a few milliseconds after a message was sent before attempting a GET; and never send a GET during the midst of a message transfer over the GPIB.
204	<b>GPIB IFC caused warm boot</b> This error relates to the GPIB IFC signal, and is available only in association with a proprietary command.
203	<b>Hardware watchdog warm boot</b> This error is caused by a hardware fault either in the power supply proper, or on the DIA. One possible explanation might be that the mains power to the supply was interrupted for a short but sufficient time to cause the DIA processor to reset and re-boot. Also, it might be possible to generate this error by a very momentary off action of the front panel power switch.
202	<b>Foreground watchdog warm boot</b> This error means that the internal firmware on the DIA found an internal error condition that halted processing; to force resumption of processing, a warm boot was required.
201	<b>Unexpected warm boot</b> This error means that the DIA GPIB-side processor experienced a warm boot that was unexpected, and it may indicate an internal crash of the DIA processor.
102	<b>Incompatible unit type</b> This error is not used. It cannot occur.
100	<b>Incompatibility error</b> This error is not used. It cannot occur.
0	<b>No error</b> The error queue is empty.
-102	<b>Syntax error</b> An unrecognized command or data type was encountered.
-108	<b>Parameter not allowed</b> More arguments than expected were received.
-151	<b>Invalid string data</b> Incorrect password. Manufacturer, model, or serial number string was more than 16 characters. Invalid mnemonic.
-161	<b>Invalid block data</b> The expected number of data values was not received.

<b>Error Code</b>	<b>Description</b>
-200	<p><b>Execution error</b></p> <p>An error/event number in the range [-299,-200] indicates that an error has been detected by the instruments execution control block. The occurrence of any error in this class shall cause the execution error bit (bit 4) in the Event Status Register to be set. An execution error can be the result of:</p> <ul style="list-style-type: none"> <li>• A &lt;program data&gt; element out of range, such as programming 35 volts in a 33 volt device.</li> <li>• A command could not be executed due to the current condition of the device.</li> </ul>
-203	<p><b>Command protected</b></p> <p>Attempted to store calibration values to EEPROM without unlocking.</p>
-221	<p><b>Settings conflict</b></p> <p>Attempted to set output greater than soft limits or to set soft limits less than output.</p>
-222	<p><b>Data out of range</b></p> <p>Parameter exceeded range of valid values.</p>
-225	<p><b>Out of memory</b></p> <p>There is not enough memory to perform the requested operation.</p>
-241	<p><b>Hardware missing</b></p> <p>A legal command or query could not be executed because of a hardware fault.</p>
-284	<p><b>Program currently running</b></p> <p>A legal command or query could not be executed because a function is currently running.</p>
-292	<p><b>Referenced name does not exist</b></p>
-293	<p><b>Referenced name already exists</b></p>
-316	<p><b>Checksum error</b></p>
-330	<p><b>Self-test failed</b></p> <p>A self-test failure has occurred.</p>
-340	<p><b>Calibration failed</b></p> <p>Error during calculation of calibration values occurred.</p>
-350	<p><b>Queue overflow</b></p> <p>The error queue can contain up to 10 entries. If more than 10 error/event conditions are logged before the SYSTem:ERRor? query, an overflow will occur; the last queue entry will be overwritten with error -350. When the queue overflows, the least recent error/events remain in the queue and the most recent error/events are discarded.</p>
-360	<p><b>Communication error</b></p> <p>Communications to a channel was disrupted.</p>

### 3.2.6 Serial Poll Operation

Performing a serial poll will not modify the Status Byte other than to clear the RQS (bit 6) for an DIA requesting service. Queries affecting the Status Registers and subsequent serial poll are described below:

- \*STB? clears the Status Byte
- \*ESR? clears the ESR and bit 5 of the Status Register
- SYSTem:ERRor? clears bit 2 of the Status Register if the queue is empty

## 3.3 IEEE-488.2 and SCPI Conformance Information

The DIA conforms to most of the specifications for devices as defined in IEEE-488.2 and SCPI Version 1995.0. Confirmed Commands are those that are approved in the SCPI 1995 Specification, Volume 2: Command Reference. They are denoted by a “C” in the “SCPI” column. Any commands that are not Confirmed Commands are labeled as Not Approved denoted by an “N.”

### 3.3.1 Parameter Definitions

PARAMETER DEFINITIONS	
Type	Valid Arguments
<boolean>	“ON” or 1. “OFF” or 0.
<NR1>	The data format <NR1> is defined in IEEE-488.2 for integers. Zero, positive and negative integer numeric values are valid data.
<0+NR1>	Zero and positive integer numeric values.
<-NR1>	Negative integer numeric values.
<NRf>	The data format <NRf> is defined in IEEE-488.2 for flexible Numeric Representation. Zero, positive and negative floating point numeric values are some examples of valid data.
<0+NRf>	Zero and positive floating point numeric values.
<-NRf>	Negative floating point numeric values.
<string>	Characters enclosed by single or double quotes.

### 3.3.2 Units

The Series DIA will accept the following units as suffixes to numeric values:

UNITS	
Type of Unit	Valid Suffix
Voltage	"VOLTS" or "volts", "V" or "v", "MV" or "mv" or "mV"
Current	"AMPS" or "amps", "A" or "a", "MA" or "ma" or "mA"
Time	"SEC" or "sec", "S" or "s", "MS" or "ms", "MIN" or "min"
Frequency	"HZ" or "hz"

The default units are VOLTS, AMPS, SEC, and HZ. For example, "SOUR:VOLT 1" programs 1 volt. To program in units of millivolts, type "SOUR:VOLT 1mV".

### 3.3.3 Conventions

SCPI uses the conventions where optional commands and parameters are enclosed by "[ ]". Additionally the shorthand version of a command is indicated by capital letters. The DIA supports Channel 1 only.

For example,

```
Source: CURRENT[:LEVEL][:IMMEDIATE][:AMPLITUDE] 120.0
```

can be written as

```
SOURCE:CURRENT 120.0
```

or

```
SOUR:CURR 120.0
```

### 3.3.4 Queries

The query syntax is identical to the command syntax with a "?" appended. For example, to query the programmed voltage, send the string: `SOURCE:CURRENT?`. A subsequent device read will return a value such as "33.000". All queries are terminated with a carriage return and line feed (0x0D 0x0A) for those GPIB controllers that require termination characters. When the DIA has nothing to report, its output buffer will contain two ASCII characters: a carriage return and linefeed (in decimal the values are: <13><10>).

**Note:** Commands with associated queries are noted with a "Q" in the **Q?** column of the SCPI documentation tables.

### 3.4 IEEE-488.2 Common Command Subsystem

The following commands are common to all SCPI instruments and declared mandatory by IEEE-488.2. In the following table, the DIA is defined as the “device” on the GPIB bus. A “C” in the **SCPI** column indicates that a command is SCPI-compliant.

Command	Description	SCPI
*CLS	Clears all status reporting data structures including the Status Byte, Standard Event Status Register, and Error Queue. The STAT:PROT:ENAB (protection event enable register) is cleared by this command; other enable registers are not cleared by this command.	C
*ESE <0+NR1>	Sets the value of the Standard Event Status Enable Register that determines which bits can be set in the Standard Event Status Register. See section 3.2.2 for valid values.	C
*ESE?	Returns the integer value of the Standard Event Status Enable Register. See section 3.2.2 for valid values.  <b>Response:</b> <0+NR1>	C
*ESR?	Returns the integer value of the Standard Event Status Register. The ESR and the Status Byte ESR bit are cleared. See section 3.2.2 for valid values.  <b>Response:</b> <0+NR1>	C
*IDN?	Returns the device identification as an ASCII string.  <b>Response:</b> <Manufacturer>, <model>, <serial number>, <DCI firmware version> <AI firmware version>  <b>Example:</b> Sorensen, SFA 100/150C-1AAA, YYWWC#####, 1.00,1.00	C
*OPC	Enables the Operation Complete bit of the Standard Event Status Register to be set when all pending operations are complete. See section 3.2.2.	C
*OPC?	Returns the integer value “1” when all pending operations are complete. See section 3.2.2.  <b>Response:</b> <0+NR1>	C
*RST	Resets the supply to its Power ON (PON) state. Clears all status reporting data structures including the Status Byte, Standard Event Status Register, and Error Queue. The STAT:PROT:ENAB (protection event enable register) is cleared by this command; other enable registers are not cleared by this command.	C
*SRE <0+NR1>	Sets the value of the Service Request Enable Register, which determines which bits in the Status Byte will cause a service request from the device. See section on Status Byte for valid values.	C
*SRE?	Returns the integer value of the Service Request Enable Register. See section on Status Byte for valid values. Values range from 0-63 or 128-191.  <b>Response:</b> <0+NR1>	C

Command	Description	SCPI
*STB?	Returns the integer value of the Status Byte with bit 6 representing the Master Summary Status (MSS) instead of RQS. The MSS bit acts as a summary bit for the Status Byte and indicates whether the device has at least one reason to request service based on the MAV and the ESR bits. The Status Byte is cleared. See section on Status Byte for valid values. Values range from 0-255.  <b>Response:</b> <0+NR1>	C
*TST?	Sets the device to execute an internal self-test and return the integer value of the results. Value of "0" indicates no errors.  <b>Response:</b> <0+NR1>	C
*WAI	Sets the device to wait until all previous commands and queries are complete before executing commands following the *WAI command.	C

## 3.5 SOURCE SCPI Command Subsystem

### 3.5.1 SOURCE SCPI Command Summary

SOURce

```

:CURRent
:CURRent?
  [:LEVel]
  [:LEVel?]
    [:IMMediate]
    [:IMMediate?]
      [:AMPLitude] <0+NRf>
      [:AMPLitude?]
    :TRIGgered
    :TRIGgered?
      :CLEar
      [:AMPLitude] <0+NRf>
      [:AMPLitude?]
  :LIMit
  :LIMit?
    [:AMPLitude] <0+NRf>
    [:AMPLitude?]
  :RAMP <0+NRf> <0+NRf>
  :RAMP?
    :ABORt
    :ALL?
    :TRIGgered <0+NRf> <0+NRf>
    :TRIGgered?
:ONLine?

:STATus
  :BLOCk?
  :REGister?
:TIMEout?

```

## 3.5.2 SOURCE SCPI Command Reference

In the following table a "C" in the **SCPI** column indicates that the command is SCPI-compliant. The **Q?** column indicates whether the command can also be used for querying.

Command	Description	SCPI	Q?
SOURce	Source subsystem.	C	
:CURRent	Sets the output current in amps (default) or in milliamps.	C	Q
[ :LEVel ]	Sets the output current in amps (default) or in milliamps.	C	Q
[ :IMMediate ]	Sets the output current in amps (default) or in milliamps.	C	Q
[ :AMPLitude ] <0+NRf>	Sets the output current in amps (default) or in milliamps.	C	Q
:TRIGgered	Sets the value of the output current to be implemented by the trigger.	C	Q
:CLEar	Clears the trigger mode.		
[ :AMPLitude ] <0+NRf>	Sets the value of the output current to be implemented by the trigger.	C	Q
:LIMit	Sets an upper soft limit on the programmed output current for the supply. The soft limit prevents the supply from being inadvertently programmed above the soft limit, thus providing a method for protecting the load against damaging currents.	C	Q
[ :AMPLitude ] <0+NRf>	Sets an upper soft limit on the programmed output current for the supply.	C	Q
:RAMP <0+NRf> <0+NRf>	Sets the output current to ramp from the present value to the specified value (first argument) in the specified time (second argument). See Ramp Function description below.	N	Q
:ABORt	Aborts ramping and clears trigger mode.		
:ALL?	Returns the ramping status of all channels.		
:TRIGgered <0+NRf> <0+NRf>	Sets the output current to ramp from the present value to the specified value (first argument) in the specified time (second argument) upon the trigger command. See Ramp description below.	N	Q
:ONLine?	Returns the integer value 1(ONLINE) or 0 (OFFLINE) of the channel online status.	N	

Command	Description	SCPI	Q?
:STATus			
:BLOCk?	<p>Returns the block of data critical to the status of the channel:</p> <ol style="list-style-type: none"> <li>1) channel number</li> <li>2) online status</li> <li>3) status flags register (see table below)</li> <li>4) status register</li> <li>5) accumulated status</li> <li>6) fault mask register</li> <li>7) fault register</li> <li>8) error register</li> <li>9) model serial number</li> <li>10) model voltage</li> <li>11) model current</li> <li>12) model over-voltage</li> <li>13) output voltage DAC gain</li> <li>14) output voltage DAC offset</li> <li>15) output current DAC gain</li> <li>16) output current DAC offset</li> <li>17) output voltage protection DAC gain</li> <li>18) output voltage protection DAC offset</li> <li>19) voltage measurement ADC gain</li> <li>20) voltage measurement ADC offset</li> <li>21) current measurement ADC gain</li> <li>22) current measurement ADC offset</li> <li>23) model string</li> <li>24) OVP calibrated</li> </ol> <hr/> <p>Each value is separated by commas.</p>	N	
:REGister?	Returns the integer value of the status register. See Section_5.	N	
:TIMEout?	Returns the integer value 1 (timeout since last query) or 0 (no timeout) of the timeout status of the channel.	N	

## THE RAMP FUNCTION

The ramp function allows the user to transition from one current to another linearly in a specified time period (100 ms - 99 sec with 100 ms programming resolution). A unit may ramp only current.

Current ramping requires an appropriate resistive load.

### SOURce[n]:STATus:BLOCK? "Status Flags" REGISTER

Bit	Hex Value	Name	Description
0	0x001	remote mode	Remote mode was selected.
1	0x002		Not used.
2	0x004	PON SRQ	PON Service Request selected by rear panel switch.
3	0x008	SRQ sent	GPIB Service Request issued and the serial poll has not been received.
4	0x010	EEPROM	The EEPROM is locked.
5	0x020	trip occurred	Either an OV or OT trip occurred.
6	0x040	sense signal	Not used.
7	0x080	isolation signal	Not used.
8	0x100	hold	Current output waiting for trigger.
9	0x200	fold	Foldback protection is enabled.
10	0x400	SRQ enabled	Service Request generation is enabled.
11	0x800	output	Output is on.

## 3.6 MEASURE SCPI Command Subsystem

### 3.6.1 MEASURE SCPI Command Summary

```

MEASure
  :CURRent?
  :CURRent
    :AVERage <value>
    :AVERage?
  :VOLTage?
  :VOLTage
    :AVERage <value>
    :AVERage?

```

### 3.6.2 MEASURE SCPI Command Reference

In the following table a "C" in the **SCPI** column indicates that the command is SCPI-compliant.

Command	Description	SCPI
MEASure	Measure subsystem.	C
:CURRent?	Returns the floating point value of the DC output current in amps.	C
:CURRent		
:AVERage <value>	Enter a value of 1 to 5 to set the number of readings to average together when returning the current value from the MEAS:CURR? command. This function reduces noise in the readback readings. The (default) value of 1 provides the fastest response time, but the noisiest readings.	N
:AVERage?	Returns the number 1 to 5 to indicate the last set number of readings to average together when taking a current reading.	N
:VOLTage?	Returns the floating point value of the DC output voltage in volts.	C
:VOLTage		
:AVERage <value>	Enter a value of 1 to 5 to set the number of readings to average together when returning the voltage value from the MEAS:VOLT? command. This function reduces noise in the readback readings. The (default) value of 1 provides the fastest response time, but the noisiest readings.	N
:AVERage?	Returns the number 1 to 5 to indicate the last set number of readings to average together when taking a voltage reading.	N

## 3.7 OUTPUT SCPI Command Subsystem

### 3.7.1 OUTPUT SCPI Command Summary

OUTPut

```

:PROTection
    :DELaY <0+NRf>
    :DELaY?
    :FOLD <0|1|2>
    :FOLD?
:STATe <boolean>
:STATe?
:TRIPped?

```

### 3.7.2 OUTPUT SCPI Command Reference

In the following table a "C" in the **SCPI** column indicates that the command is SCPI-compliant. The **Q?** column indicates whether the command can also be used for querying.

Command	Description	SCPI	Q?
OUTPut	Output subsystem.	C	
:PROTection		N	
:DELaY <0+NRf>	Sets the programmable time delay executed by the supply before reporting output protection conditions after a new output current is specified.	N	Q
:FOLD <0 1 2>	Sets the foldback (program down) mode of the supply. Valid arguments are 0 (OFF or do nothing, do not program down to zero), 1 (Not used), or 2 (program down to zero upon entering constant-current mode).	N	Q
:STATe <boolean>	Sets the output to zero or the programmed value. Valid arguments are 1/ON or 0/OFF. *RST state value is ON.	C	Q
:TRIPped?	Returns the integer value 1 (TRIPPED) or 0 (UNTRIPPED) state of the output.	N	

## 3.8 STATUS SCPI Command Subsystem

**Note:** See Section 5 for further information.

### 3.8.1 STATUS SCPI Command Summary

```

STATus
  :OPERation
    :CONDition?
    :ENABle <0+NR1>
    :ENABle?
    :EVENT?
  :PRESet
  :PROTection
    :CONDition?
    :ENABle <0+NR1>
    :ENABle?
    :EVENT?
    :SELEct <0+NR1>
  :QUEStionable
    :CONDition?
    :ENABle <0+NR1>
    :ENABle?
    :EVENT?

```

### 3.8.2 STATUS SCPI Command Reference

In the following table a "C" in the **SCPI** column indicates that the command is SCPI-compliant. The **Q?** column indicates whether the command can also be used for querying.

Command	Description	SCPI	Q?
STATus	Status subsystem.	C	
:OPERation		C	
:CONDition?	Returns the integer value of the Operation Condition Register. The query is supported but will always return "0" indicating operational condition.	C	
:ENABle <0+NR1>	Sets the enable mask of the Operation Event Register allowing true conditions to be reported in the summary bit of the Operation Condition Register. Values are written and queried but have no effect on the Operation Condition Register.	C	Q
:EVENT?	Returns the integer value of the Operation Event Register. This query is supported but always returns a value of "0" indicating operational condition.	C	
:PRESet	Sets the enable mask of the Operation Event Register and the Questionable Event Register to all 1's.	C	

Command	Description	SCPI	Q?
:PROTection		C	
:CONDection?	Returns the integer value of the Protection Condition Register. Used to read the status of the power hardware. See section 3.2.3 for a detailed table of the various bits that make up this register.	C	
:ENABle <0+NR1>	Sets the enable mask of the Protection Event Register which allows true conditions to be reported in the summary bit of the Protection Condition Register.	C	Q
:EVENt?	Returns the integer value of the Protection Event Register.	C	
:SELEct <0+NR1>	This command provides a means for selecting which fault bits from the protection event register (also called the fault register and readable using the STAT:PROT:EVEN? command) are able to set the protection event flag bit in the SCPI status byte (readable using the *STB? command). It defaults to value 255 at power-on time, and never changes unless intentionally programmed to a new value.	N	
:SELEct?	Queries the last selection value programmed.	N	
:QUEStionable		C	
:CONDection?	Returns the integer value of the Questionable Condition Register. The query is supported but will always return "0" indicating operational condition.	C	
:ENABle <0+NR1>	Sets the enable mask of the Questionable Event Register allowing true conditions to be reported in the summary bit of the Questionable Condition Register. Values are written and queried but have no effect on the Questionable Condition Register.	C	Q
:EVENt?	Returns the integer value of the Questionable Event Register. This query is supported but always returns a value of "0", indicating operational condition.	C	

## 3.9 SYSTEM SCPI Command Subsystem

### 3.9.1 SYSTEM SCPI Command Summary

SYSTem

```
:ERRor?
:FAULt?
:VERsion?
:LOCAL <boolean>
:LOCAL?
:LOCLOUT <boolean>
```

### 3.9.2 SYSTEM SCPI Command Reference

In the following table a "C" in the **SCPI** column indicates that the command is SCPI-compliant. The **Q?** column indicates whether the command can also be used for querying.

Command	Description	SCPI	Q?
SYSTem	System subsystem.	C	
:ERRor?	Queries Error Queue for next error/event entry (first in, first out). Entries contain an error number and descriptive text. A 0 return value indicates no error occurred; negative numbers are reserved by SCPI. The maximum return string length is 255 characters. The queue holds up to 10 error/entries. All entries are cleared by the *CLS command.	C	
:FAULt?	Returns four numeric values separated by commas for the four system fault registers. See System Fault Registers below. Valid response is 128, 0, 0, 0 or 0, 0, 0, 0. <b>Response:</b> <Fault1–8>, <Fault9–16>, <Fault17–24>, <Fault25–31>	N	
:VERsion?	Returns a numeric value corresponding to the SCPI version number for which the instrument complies. The response is in the format YYYY.V where the Y's represent the year and V represents the approved version number for that year (e.g., 1995.0)	C	

Command	Description	SCPI	Q?
SYST:LOCAL	SYST:LOCAL <ON OFF> is a special purpose programming command that may be used to cause source to be set to the local state or to the remote state. This command has two noteworthy circumstances under which it may prove necessary. The first case involves using RS232 to communicate with the supply, since the normal GPIB mechanisms for transition between local and remote and back again do not exist when using RS232. The other case is when the REMOTE/LOCAL switch S1-1 is placed in the ON position—thereby disabling the GPIB mechanism for transition from remote to local. The SYST:LOCAL ON command provides a means for the system computer to force the source to the local state. Also, the SYST:LOCAL? query command is available to examine the local-remote state of the supply. And the command SYST:LOCAL OFF may be used to force supply to the remote state.	N	Q
SYST:LOCAL:LOCKOUT	The SYST:LOCAL:LOCKOUT <0 1 OFF ON> command provides a means of controlling the local lockout functionality that is an alternative to the low level GPIB LLO command.  In contrast, using the GPIB LLO low level command causes the supply to be placed into the local lockout state. To place the supply into the local lockout state, use the SYST:LOCAL:LOCKOUT command.	N	

## SYSTEM FAULT REGISTERS

Bit Position	Bit Weight	Fault1–8	Fault9–16	Fault17–24	Fault25–31
7	128	Channel 1	not used	not used	not used
6	64	not used	not used	not used	not used
5	32	not used	not used	not used	not used
4	16	not used	not used	not used	not used
3	8	not used	not used	not used	not used
2	4	not used	not used	not used	not used
1	2	not used	not used	not used	not used
0	1	not used	not used	not used	not used

The SYSTem:FAULT? query returns 4 numeric values separated by commas. Each value is the decimal equivalent of the total bit weights for that System Fault Register as described in the table above.

## 3.10 TRIGGER SCPI Command Subsystem

### 3.10.1 TRIGGER SCPI Command Summary

TRIGger

:ABORt  
:RAMP  
:TYPE <1|2|3>

### 3.10.2 TRIGGER SCPI Command Reference

Command	Description	SCPI
TRIGger	Trigger subsystem.	C
:ABORt	Clears all settings of voltage and current upon trigger.	N
:RAMP	Implements current ramping function previously programmed by the SOURce:CURRent:RAMP commands.	N
:TYPE<1 2 3>	Implements current values previously programmed by the SOURce:CURRent:LEVel:TRIGger commands. Valid arguments are 1 (Not Used), 2 (Current), or 3 (Both).	N

## 3.11 CALIBRATION SCPI Command Subsystem

See Section 4 for calibration procedures.



#### WARNING

Please refer to the power supply manual for further information before performing calibration procedures. Calibration must be performed by qualified personnel who appropriately deal with attendant hazards. If calibration is not performed properly, functional problems could arise, requiring that the supply be returned to the factory.

### 3.11.1 CALIBRATION SCPI Command Summary

#### CALibrate

```

:DATA <NRf><NRf><NRf><NRf><NRf><NRf><NRf><NRf><NRf><NRf>
:INITial
  :CURRent <0+NRf>
  :CURRent?
    :PROTection <NRf>
    :PROTection?
:LOCK
:MEASure
  :CURRent
    :ADC?
    :CALCulate
    :GAIN <NRf>
    :GAIN?
    :OFFSet <NRf>
    :OFFSet?
    :POINT <1|2> <0+NRf>
  :VOLTage
    :ADC?
    :CALCulate
    :GAIN <NRf>
    :GAIN?
    :OFFSet <NRf>
    :OFFSet?
    :POINT <1|2> <NRf>
:OUTPut
  :CURRent
    :CALCulate
    :DAC <0+NR1>
    :GAIN <NRf>
    :GAIN?
    :OFFSet <NRf>
    :OFFSet?
    :POINT <1|2> <NRf>

:STORE
:UNLock <string>

```

## 3.11.2 CALIBRATION SCPI Command Reference

In the following table a "C" in the **SCPI** column indicates that the command is SCPI-compliant. The **Q?** column indicates whether the command can also be used for querying.

Command	Description	SCPI	Q?
CALibrate	Calibration subsystem.	C	
:DATA <Nrf><Nrf><Nrf> <Nrf><Nrf><Nrf> <Nrf><Nrf><Nrf> <Nrf>	Sets the values of the ten floating point calibration constants: 1) not used 2) not used 3) output current DAC gain 4) output current DAC offset 5) output current protection DAC gain 6) output current protection DAC offset 7) voltage measurement ADC gain 8) voltage measurement ADC offset 9) current measurement ADC gain 10) current measurement ADC offset Values are separated by space or comma.	N	
:INITial		N	
:CURRent	Sets the power-on default value of current.	N	Q
:PROTection <Nrf>	Sets the power-on default value of the overcurrent protection.	N	Q
:LOCK	Disables access to the non-volatile memory. Prevents attempts to store calibration values.	N	
:MEASure		N	
:CURRent			
:ADC?	Returns the integer value of the A/D for the current measurement.	N	
:CALCulate	Calculates the value of the gain and offset for current measurements.	N	
:GAIN <Nrf>	Sets the value of the gain for current measurements.	N	Q
:OFFSet <Nrf>	Sets the value of the offset for current measurements.	N	Q
:POINT <1 2> <0+Nrf>	Sets the current measurement calibration point (1 or 2). The actual output current is measured with an external meter.	N	
:VOLTage		N	
:ADC?	Returns the integer value of the A/D for the voltage measurement.	N	
:CALCulate	Calculates the value of the gain and offset for voltage measurements.	N	
:GAIN <Nrf>	Sets the value of the gain for voltage measurements.	N	Q
:OFFSet <Nrf>	Sets the value of the offset for voltage measurements.	N	Q

Command	Description	SCPI	Q?
<NRf> :POINT <1 2>	Sets the voltage measurement calibration point (1 or 2). The actual output voltage is measured with an external meter.	N	
:OUTPut		N	
:CURRent		N	
:CALCulate	Calculates the value of the gain and offset for output current.	N	
:DAC <0+NR1>	Sets the output of the output current D/A converter.	N	
:GAIN <NRf>	Sets the value of the gain for the output current.	N	Q
:OFFSet <NRf>	Sets the value of the offset for the output current.	N	Q
<0+NRf> :POINT <1 2>	Sets the current output calibration point (1 or 2). The actual output current is measured with an external meter.	N	
:STORe	Stores the calibration constants in non-volatile memory.	N	
:UNLock <string>	Sets the non-volatile memory available to store calibration constants. The access string is "6867".	N	

### 3.12 Examples of Using the SCPI Commands

The following examples demonstrate programming a power supply to control and to readback the output using the SCPI commands. The maximum voltage and current output is dependent on the particular model. The examples list only the SCPI commands; the code required to send the commands is dependent on the type of language you are using (e.g., C or BASIC) and GPIB hardware (e.g., National Instruments).

**EXAMPLE:** Program a unit 1A, and verify the output.

```
// Use SYST:ERR? after each command to verify no programming errors.
// turn on the unit.
*CLS // clear the unit to its power-on default settings.
*RST // reset the unit.
SOUR:CURR 1.0 // program output current to 1.0 A.
SOUR:CURR? // confirm the output current setting (response: 1.0).
MEAS:CURR? // measure the actual output current (response: ~ 1.0 with appropriate
load on output).
MEAS:VOLT? // measure the actual output voltage (response: ~ depends on load).
```

**EXAMPLE:** Program a unit with the output shorted to ramp its output current from 5A to 25A in 30 seconds.

```
// Use SYST:ERR? after each command to verify no programming errors.
```

```
// turn on with no load at the output.
*CLS // clear the unit to its power-on default settings.
*RST // reset the unit.
// short the output.
SOUR:CURREN 5.0 // program output current to 5.0 A.
SOUR:CURREN:RAMP 25.0 30.0 // program current to ramp from the present
// value (5.0 A) to 25.0 A in 30 seconds.
```

**EXAMPLE:** Program a unit with a load at the output, to ramp its output current from 5 ADC to 25 ADC in 30 seconds upon the trigger command.

```
// Use SYST:ERR? after each command to verify no programming errors.
// turn on the unit.
*CLS // clear the unit to its power-on default settings.
*RST // reset the unit.
SOUR:CURREN 5.0 // program output current to 5.0 ADC.
SOUR:CURREN:RAMP:TRIG 25.0 30.0 // program current to ramp from the present
// value (5.0 ADC) to 25.0 ADC in 30 secs.
// upon the trigger command.
TRIG:RAMP // start ramp execution.
TRIG:ABORT // turn off trigger mode.
```

**EXAMPLE:** Program a unit to power-on and initialize 1A. Verify proper power-on initialization.

```
// Use SYST:ERR? after each command to verify no programming errors.
// turn on the unit.
*CLS // clear the unit to its power on default settings.
*RST // reset the unit.
CAL:INIT:CURREN 1.0 // set power-on initial current to 1.0 A.
CAL:INIT:CURREN? // confirm power-on initial current setting.
CAL:UNLOCK "6867" // unlock nonvolatile memory for calibration value storage.
CAL:STORE // store the calibration values in nonvolatile memory.
CAL:LOCK // lock nonvolatile memory for calibration value protection.
// cycle power to the unit.
SOUR:CURREN? // confirm power-on initial current setting.
```

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# SECTION 4 CALIBRATION



## WARNING

Please refer to the power supply manual for further information before performing calibration procedures. Calibration must be performed by qualified personnel who appropriately deal with attendant hazards. If calibration is not performed properly, functional problems could arise, requiring that the supply be returned to the factory.

## 4.1 Introduction

The DIA is calibrated to adjust internal signal levels to correspond to the expected supply output signal levels. You must perform the calibration procedures if the power supply's programming or readback performance falls out of specification due to component aging drifts. Refer to your power supply manual to find the required calibration interval. The DIA is calibrated for output current programming, output overcurrent protection programming, voltage readback, and current readback. There are 10 calibration factors (four measurement and six output).

The calibration procedures in the following sections are designed to be performed at ambient temperature of  $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ , after the unit has had a stable output and a stable load for at least 30 minutes.

The following test equipment is required in addition to the computer system to complete the following calibration:

- 6-digit digital voltmeter (DVM)
- current shunt rated for 110% of full output current

## 4.2 Setup for Calibration

### **STEP DESCRIPTION**

1. Disconnect the power supply's AC input power.
2. Disconnect the load from the power supply you want to calibrate.

3. Connect the power supply for sensing at the required load point. Refer to the power supply manual for further information.
4. Connect a current shunt rated for the full output current of the supply and the DVM for current and overcurrent calibration.
5. Assure the correct GPIB primary address has been set by the rear panel switch.
6. Set the power supply to REMOTE mode by the rear panel switch.
7. Connect the GPIB controller to the power supply at the rear panel connector.
8. Reconnect the AC input power. Turn the unit ON and allow the unit to warm up for at least 30 minutes.
9. The unit is ready for all calibration procedures.

**WARNING**

Exercise caution when using and servicing power supplies. High energy levels can be stored at the output voltage terminals on all power supplies in normal operation. In addition, potentially lethal voltages exist in the power circuit and the output connector on power supplies that are rated at 60V and over. Filter capacitors store potentially dangerous energy for some time after power is removed.

### 4.3 Voltage Measurement/Readback Calibration

**STEP DESCRIPTION**

1. Program the overcurrent protection to maximum to prevent nuisance trips:  
`CAL:OUTP:CURR:PROT:DAC 65535`
2. Apply a resistive load to the output equivalent to  $V_{max}$  (maximum compliance voltage)/ $I_{max}$
3. Program the output of the first calibration point to approximately 15% of full scale current by sending the following command string from the computer:

```
CAL:OUTP:CURR:DAC 9830
```

4. Let the output settle and measure the voltage with the meter.
5. Enter the actual voltage readback corresponding to the DAC value 9830 of the first calibration point:

```
CAL:MEAS:VOLT:POINT 1 <voltage>
```

6. Program the output of the second calibration point to approximately 85% of full scale voltage by sending the following command string from the computer:  

```
CAL:OUTP:CURR:DAC 55700
```
7. Let the output settle and measure the voltage with the meter.
8. Enter the actual voltage readback corresponding to the DAC value 5570 of the second calibration point:  

```
CAL:MEAS:VOLT:POINT 2 <voltage>
```
9. Reset the output voltage to 0 volts by programming the current to 0 amps.  

```
CAL:OUTP:CURR:DAC 0
```
10. Program the DIA to calculate the voltage readback calibration gain and offset values:  

```
CAL:MEAS:VOLT:CALC
```
11. Program the DIA to unlock the non-volatile memory for calibration value storage:  

```
CAL:UNLOCK "6867"
```
12. Program the DIA to store the calibration values in non-volatile memory:  

```
CAL:STORE
```
13. Program the DIA to lock the non-volatile memory for calibration value protection  

```
CAL:LOCK
```
14. The voltage readback calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

## 4.4 Current Programming Calibration

### **STEP DESCRIPTION**

1. Program the overcurrent protection to maximum to prevent nuisance trips:  

```
CAL:OUTP:CURR:PROT:DAC 65535
```
3. Program the output of the first calibration point to approximately 15% of full scale current by sending the following command string from the computer:  

```
CAL:OUTP:CURR:DAC 9830
```

4. Let the output settle and measure the current with the current shunt and the meter.
5. Enter the actual output current corresponding to the DAC value 9830 of the first calibration point:

```
CAL:OUTP:CURR:POINT 1 <current>
```

6. Program the output of the second calibration point to approximately 85% of full scale current by sending the following command string from the computer:

```
CAL:OUTP:CURR:DAC 55700
```

7. Let the output settle and measure the current with the current shunt and the meter.
8. Enter the actual output current corresponding to the DAC value 55700 of the second calibration point:

```
CAL:OUTP:CURR:POINT 2 <current>
```

9. Reset the output current to 0 amps.

```
CAL:OUTP:CURR:DAC 0
```

10. Program the DIA to calculate the output current calibration gain and offset values:

```
CAL:OUTP:CURR:CALC
```

11. Program the DIA to unlock the non-volatile memory for calibration value storage:

```
CAL:UNLOCK "6867"
```

12. Program the DIA to store the calibration values in non-volatile memory:

```
CAL:STORE
```

13. Program the DIA to lock the non-volatile memory for calibration value protection

```
CAL:LOCK
```

14. The output current calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

## 4.5 Current Measurement/Readback Calibration

### **STEP DESCRIPTION**

1. Program the overcurrent protection to maximum to prevent nuisance trips:

```
CAL:OUTP:CURR:PROT:DAC 65535
```

3. Program the output of the first calibration point to approximately 15% of full scale current by sending the following command string from the computer:

```
CAL:OUTP:CURR:DAC 9830
```

4. Let the output settle and measure the current with the current shunt and the meter.
5. Enter the actual current readback corresponding to the DAC value 9830 of the first calibration point:  

```
CAL:MEAS:CURR:POINT 1 <current>
```
6. Program the output of the second calibration point to approximately 85% of full scale current by sending the following command string from the computer:  

```
CAL:OUTP:CURR:DAC 55700
```
7. Let the output settle and measure the current with the current shunt and the meter.
8. Enter the actual current readback corresponding to the DAC value 55700 of the second calibration point:  

```
CAL:MEAS:CURR:POINT 2 <current>
```
9. Reset the output current to 0 amps.  

```
CAL:OUTP:CURR:DAC 0
```
10. Program the DIA to calculate the current readback calibration gain and offset values:  

```
CAL:MEAS:CURR:CALC
```
11. Program the DIA to unlock the non-volatile memory for calibration value storage:  

```
CAL:UNLOCK "6867"
```
12. Program the DIA to store the calibration values in non-volatile memory:  

```
CAL:STORE
```
13. Program the DIA to lock the non-volatile memory for calibration value protection  

```
CAL:LOCK
```
14. The current readback calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

## 4.6 Current Programming and Readback Calibration

This procedure may be used to save time if both the output and readback require calibration.

### **STEP DESCRIPTION**

1. Program the overcurrent protection to maximum to prevent nuisance trips:  

```
CAL:OUTP:CURR:PROT:DAC 65535
```
3. Program the output of the first calibration point to approximately 15% of full scale current by sending the following command string from the computer:  

```
CAL:OUTP:CURR:DAC 7830
```

4. Let the output settle and measure the current with the current shunt and the meter.
5. Enter the actual output current corresponding to the DAC value 7830 of the first calibration point:

```
CAL:OUTP:CURR:POINT 1 <current>
```

```
CAL:MEAS:CURR:POINT 1 <current>
```

6. Program the output of the second calibration point to approximately 85% of full scale current by sending the following command string from the computer:

```
CAL:OUTP:CURR:DAC 55700
```

7. Let the output settle and measure the current with the current shunt and the meter.
8. Enter the actual output current corresponding to the DAC value 55700 of the second calibration point:

```
CAL:OUTP:CURR:POINT 2 <current>
```

```
CAL:MEAS:CURR:POINT 2 <current>
```

9. Reset the output current to 0 amps.

```
CAL:OUTP:CURR:DAC 0
```

10. Program the DIA to calculate the output current and current measurement calibration gain and offset values:

```
CAL:OUTP:CURR:CALC
```

```
CAL:MEAS:CURR:CALC
```

11. Program the DIA to unlock the non-volatile memory for calibration value storage:

```
CAL:UNLOCK "6867"
```

12. Program the DIA to store the calibration values in non-volatile memory:

```
CAL:STORE
```

13. Program the DIA to lock the non-volatile memory for calibration value protection

```
CAL:LOCK
```

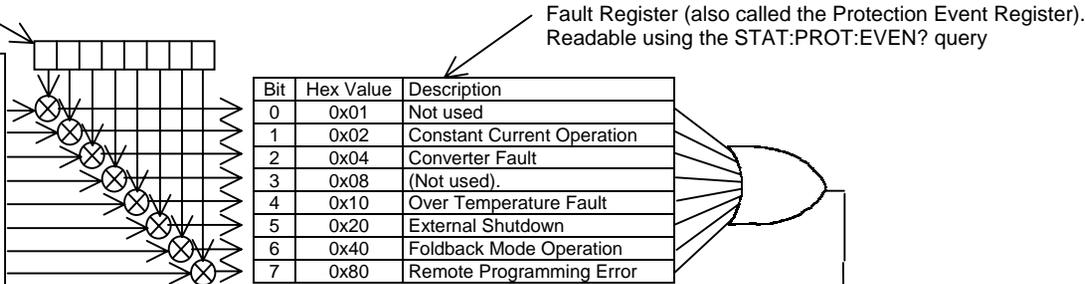
The output current and current measurement calibrations are completed at the same time. The unit may be turned OFF or other calibration procedures may be performed.

SECTION 5  
SCPI STATUS IMPLEMENTATION

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The Protection Enable Register. Readable using the STAT:PROT:ENAB? query command. Write-able using the STAT:PROT:ENAB <value> command. Used to select what fault events may set a bit in the Fault Register. Certain faults can occur even if they are not enabled. This is because the Protection Enable Register merely filters which events are allowed to affect the Fault Register, not whether those events can occur or not. An exception to this rule involves the Constant Voltage Operation, Constant Current Operation, and Foldback Mode Operation bits. If these bits are not enabled, then mode changes shall not cause a shutdown. Read about these bits further in the manual.

Various fault events must be enabled by the protection enable register before they are recorded in the fault register.



The SESER (Standard Event Status Enable Register). This register is read using the \*ESE? SCPI query command. This register is written to using the \*ESE <value> command. A "1" in the appropriate bit location enables that corresponding bit from the SESR to pass through to the input of the OR gate to be included in the SESR summary bit (bit 5) in the SCPI Status Byte.

Various events set the SESR bits directly.

Bit	Hex Value	Description
0	0x01	Operation Complete
1	0x02	Request Control (Not Used)
2	0x04	Query Error (Not Used)
3	0x08	Device Dependent Error
4	0x10	Execution Error (e.g., range error)
5	0x20	Command Error (e.g., syntax error)
6	0x40	User Request (Not Used)
7	0x80	Power On

The SESR (Standard Event Service Register). Masking does *not* prevent events from setting bits in the SESR. This facilitates polling as one means of detecting these events since the SESR can be polled (read) using the \*ESR? command, irrespective of the bits set or not set in the Standard Event Status Enable Register.

The SCPI Status Byte. Read using either the \*STB? command, or the GPIB serial poll operation.

Seven bit wise logical AND operations

Bit	Hex Value	Description
0	0x01	Not Used
1	0x02	Protection Event Flag
2	0x04	Error/Event Queue Message Avail.
3	0x08	Questionable Status (Not Used)
4	0x10	Message Available
5	0x20	Standard Event Status Register
6	0x40	RQS/MSS Service Request Bit
7	0x80	Operation Status Flag (Not Used)

Eight bit wise logical AND operations

The Service Request Enable Register (SRE). Used to enable which Status Byte bits can affect the service request bit. \*SRE? reads. \*SRE <value> writes.

## SCPI STATUS IMPLEMENTATION



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