



HP 75000 SERIES B and C

Eight-Channel Strain Completion & Excitation Signal Conditioning Plug-on HP E1506A/E1507A

User's Manual

The HP E1506/E1507 manual also applies to HP E1413Bs as HP E1413 Options 16/17.

Enclosed is the User's Manual for the HP E1506/E1507 Signal Conditioning Plug-ons. Insert this manual in your HP E1413/E1313, or HP E1415 manual behind the "Signal Conditioning Plug-ons" divider.



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E1506-90003

HP E1506/E1507

Eight-Channel Strain Completion and Excitation Signal Conditioning Plug-on

Introduction

HP E1506 and HP E1507 are Signal Conditioning Plug-ons (SCPs) that provide the Strain Completion and Excitation Voltages for strain measurements. HP E1506 is for 120Ω bridges and HP E1507 for 350Ω bridges. The SCPs provide Strain Completion and Excitation Voltages for a total of 8 channels.

About This Manual

Except where noted, all references to the HP E1413 apply to the HP E1313 and HP E1415. This manual shows how to connect to the Terminal Module for strain measurements, and also shows how to control the Signal Conditioning Plug-on (SCP) using SCPI commands and Register-Based commands. The following also explains the capabilities of the SCP and gives the specifications. The manual contents consist of:

- How The HP E1413A Makes Strain Measurements 4
- Selecting The 1/4 Bridge Jumper 6
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Installation

Notice that the HP E1506A/E1507A has several jumpers that must be set before installing it in its VXI module. See Figures 4, 14, and 15 for jumper location and function.

How The HP E1413 Makes Strain Measurements

The HP E1413 requires two SCPs to make strain gage measurements. One SCP provides the Excitation Signals and Bridge Connections (i.e., the HP E1506/E1507 SCP) and the other SCP, the sense SCP, makes the measurement connections to the HP E1413 (e.g., HP E1501, Direct Input SCP).

Figures 1, 2, and 3 show examples of a typical 1/4 Bridge, 1/2 Bridge, and Full Bridge strain gage measurement, respectively. In the figures, the Strain Completion and Excitation SCP supplies the strain completion circuitry for the 1/4 and 1/2 Bridge configurations and the excitation voltage for all the bridge configurations.

The 1/4 Bridge Jumper *must be installed* for 1/4 Bridge measurements and *removed* for 1/2 and Full Bridge measurements (see “Selecting The 1/4 Bridge Jumper” on page 6).

The 29.4kΩ Shunt resistor checks for correct bridge operation by adding it across one leg of the bridge (see “Using the Shunt Resistor” on page 20).

The Excitation Jumper allows the selection of an internal or external Excitation Voltage (see “Using External Excitation Voltages” on page 18).

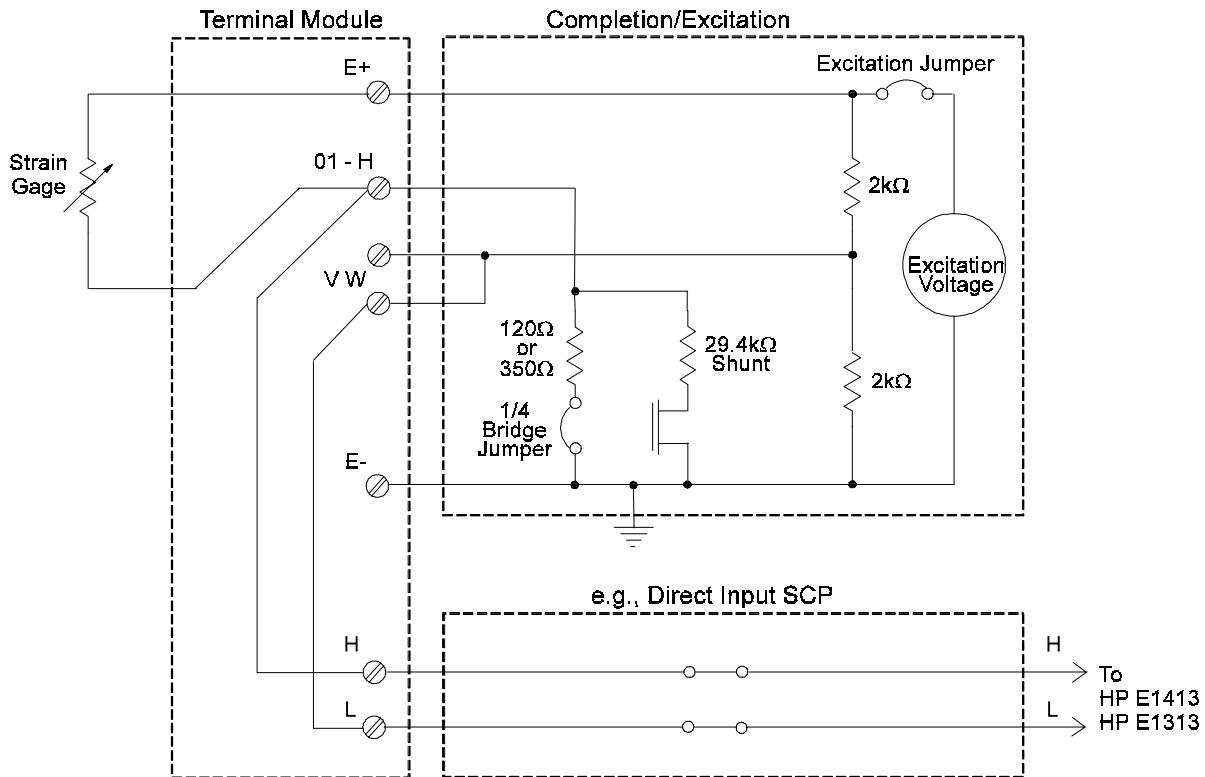


Figure 1 Typical 1/4 Bridge Strain Gage Measurement

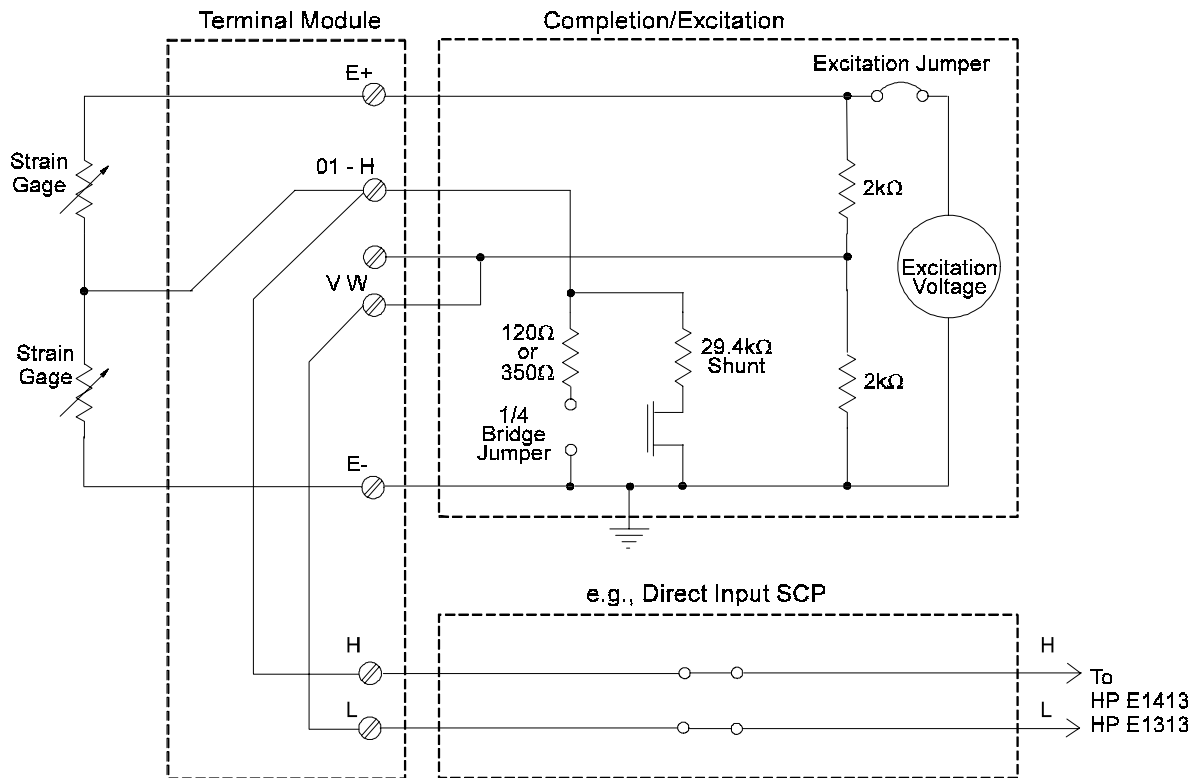


Figure 2 Typical 1/2 Bridge Strain Gage Measurement

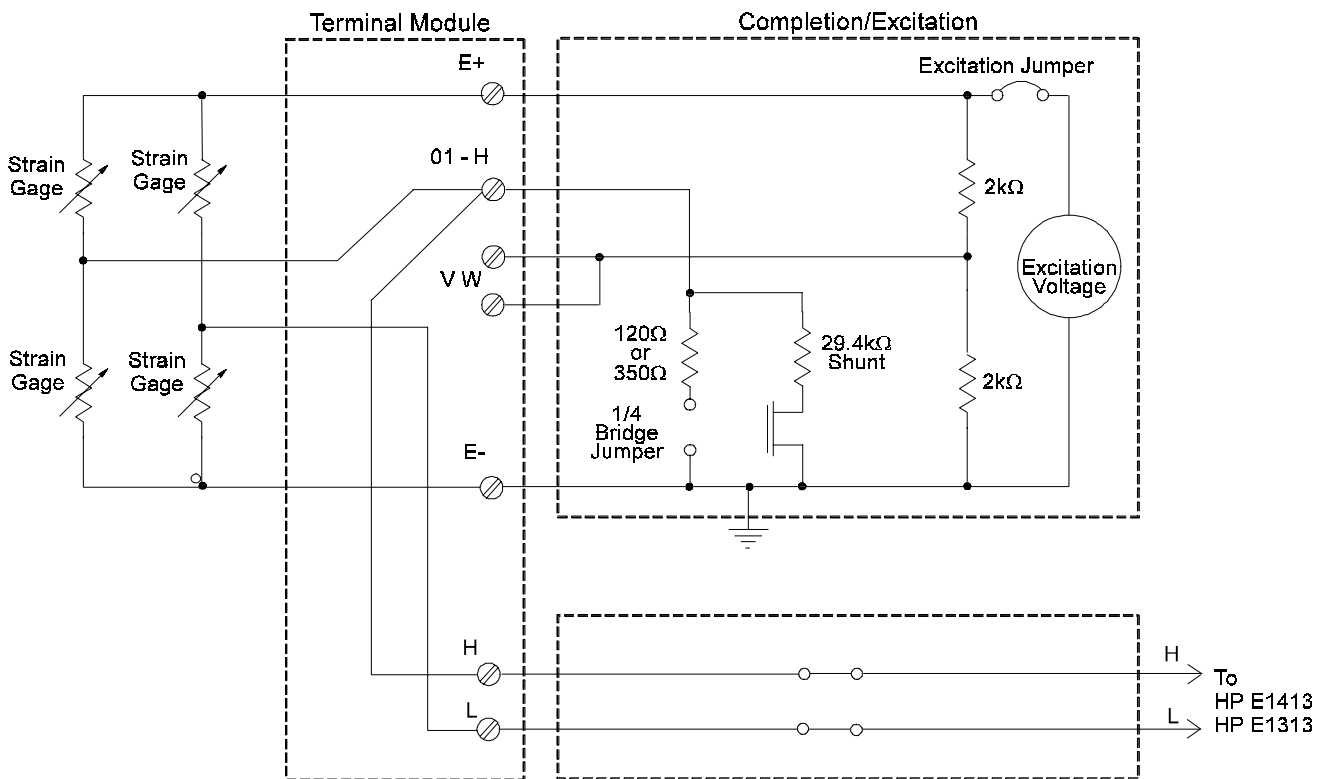


Figure 3 Typical Full Bridge Strain Gage Measurement

Selecting The 1/4 Bridge Jumper

Remove the 1/4 Bridge Jumper of any channel that is to make a 1/2 Bridge or a Full Bridge measurement. Figure 4 shows the location of the jumpers (on the connector side of the board). The figure shows a removed jumper on channel 7 for a 1/2 or Full Bridge measurement and installed jumpers on channels 0 through 6 for 1/4 Bridge measurements (default setting).

Note Be sure to keep any removed jumpers for future use, in case 1/4 Bridge measurements are to be made later.

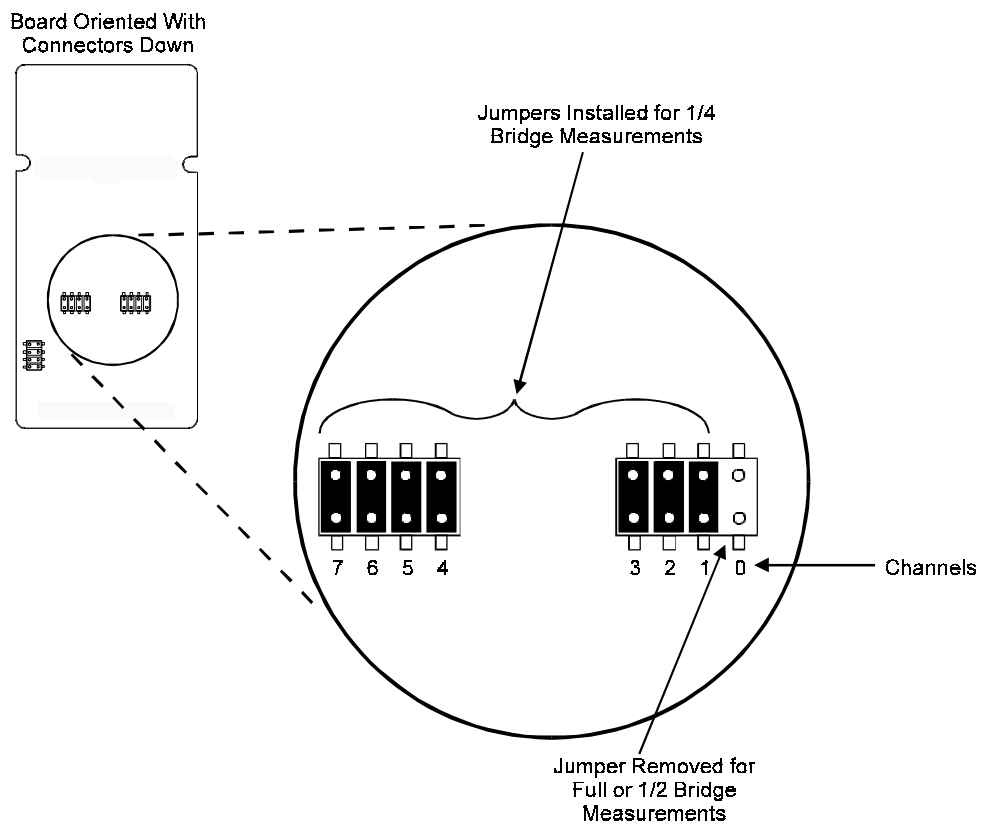


Figure 4 Location of the 1/4 Bridge Jumper

Connecting To The Terminal Module

This section shows how to make 1/4, 1/2, and Full Bridge strain gage connections to the Terminal Module. The Terminal Module supplies the connections between the external strain gages, and both the Strain Completion/Excitation SCP and the sense SCP (e.g., Direct Input SCP).

Connections on the Terminal Module

The SCP connections for the the Terminal Modules are shown on the stick-on labels that came with the SCP. Use the appropriate label for the type of Terminal Module you have. The connections and appropriate stickers for the different Terminal Modukes are as follows:

- For HP E1413C and above Terminal Modules, use stickers for HP E1506/07 SCPs. The connections are shown in Figure 5.
- For HP E1313 Terminal Modules, use stickers for HP E1506/07 SCPs. The connections are shown in Figure 6 and 7.
- For HP E1413B and below Terminal Modules, use stickers for HP E1413 Option 15/16 SCPs. The connections are shown in Figure 8.

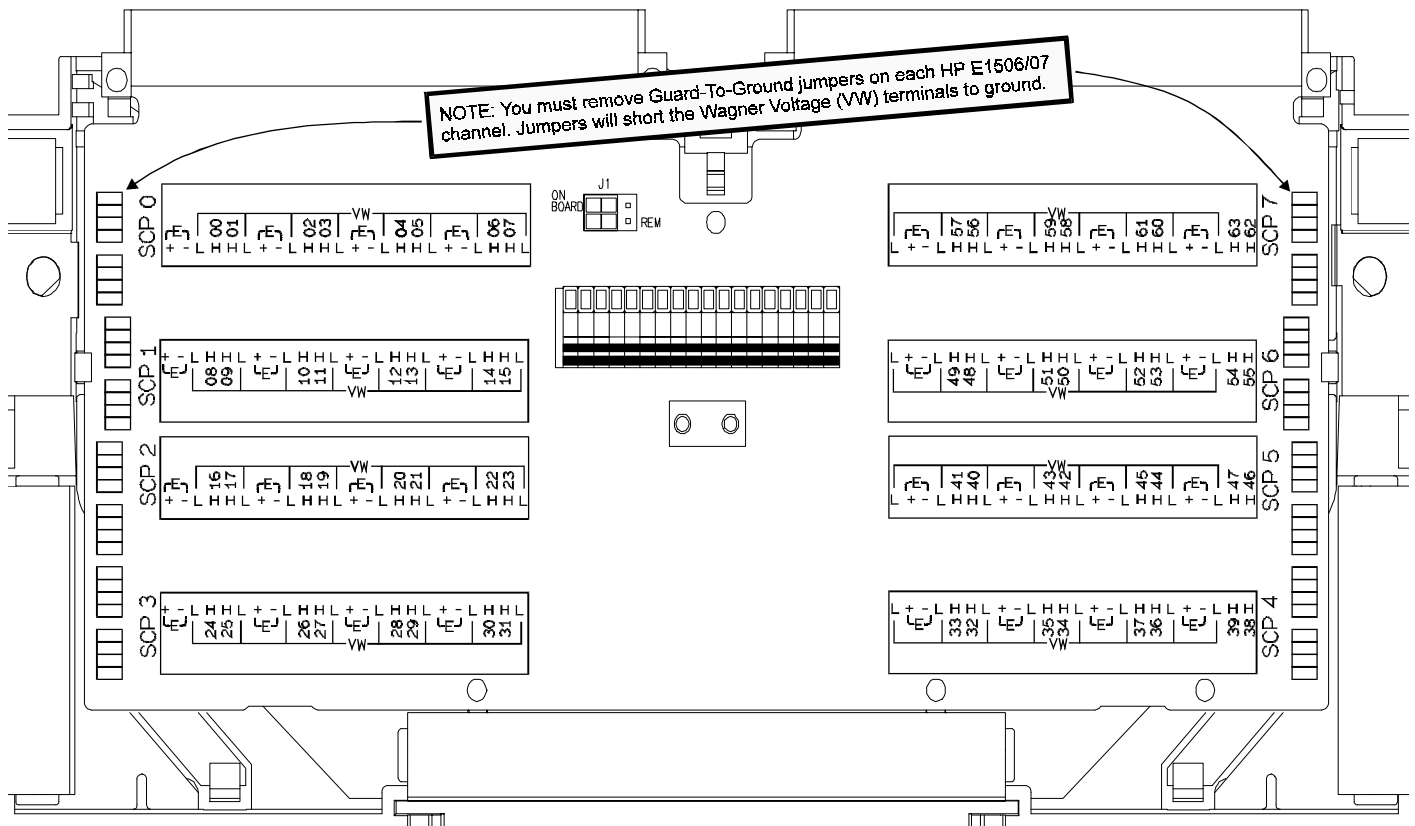


Figure 5 HP E1506/07 C-Size Terminal Module Connections

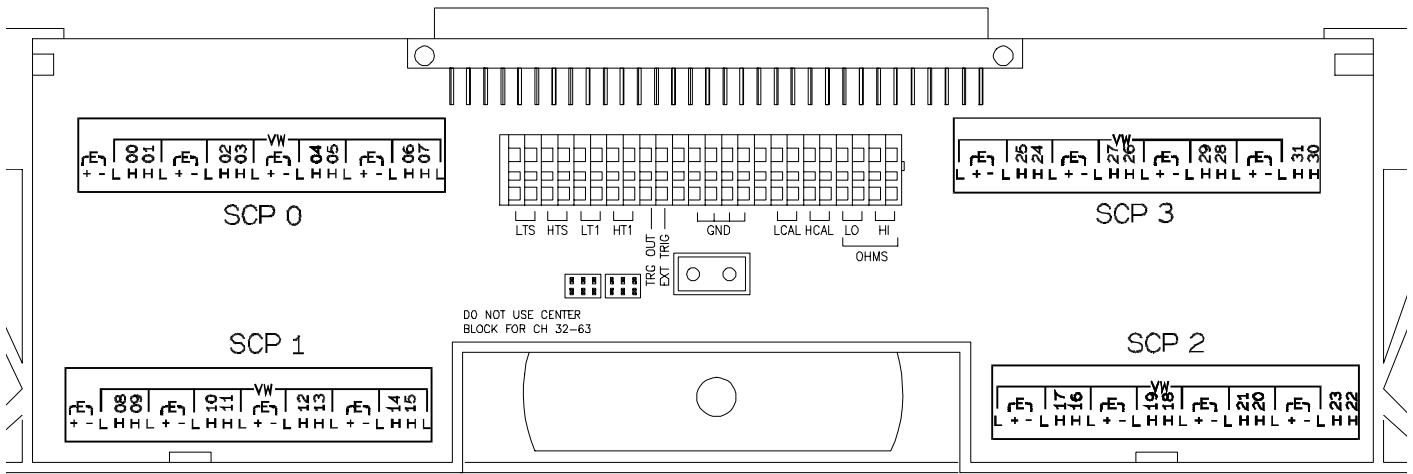


Figure 6 HP E1506/07 B-size Terminal Module Connections (Ch 00-31)

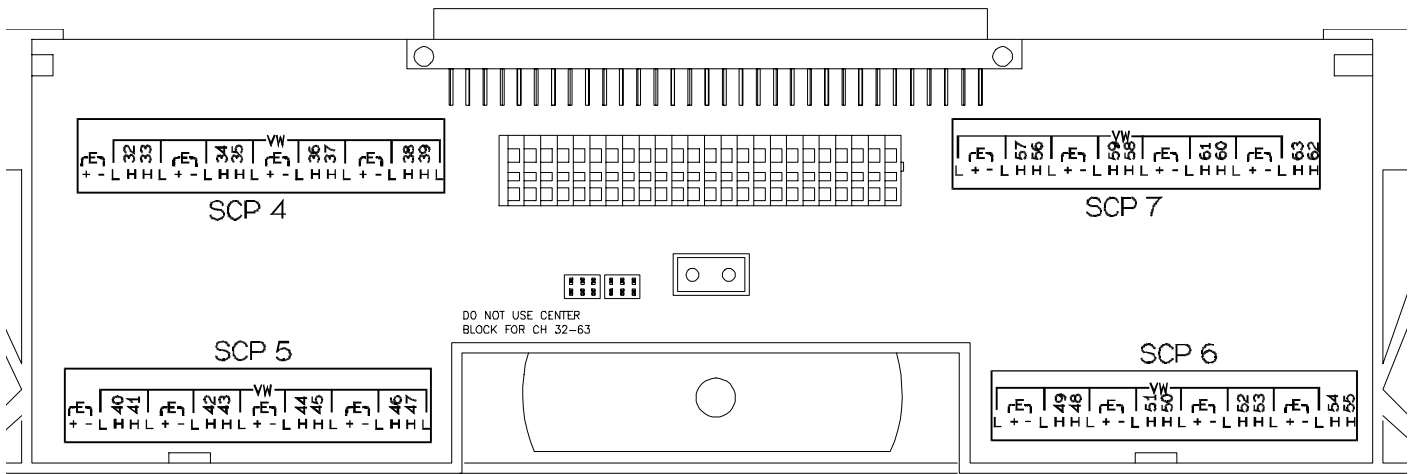


Figure 7 HP E1506/07 B-size Terminal Module Connections (Ch 32-63)

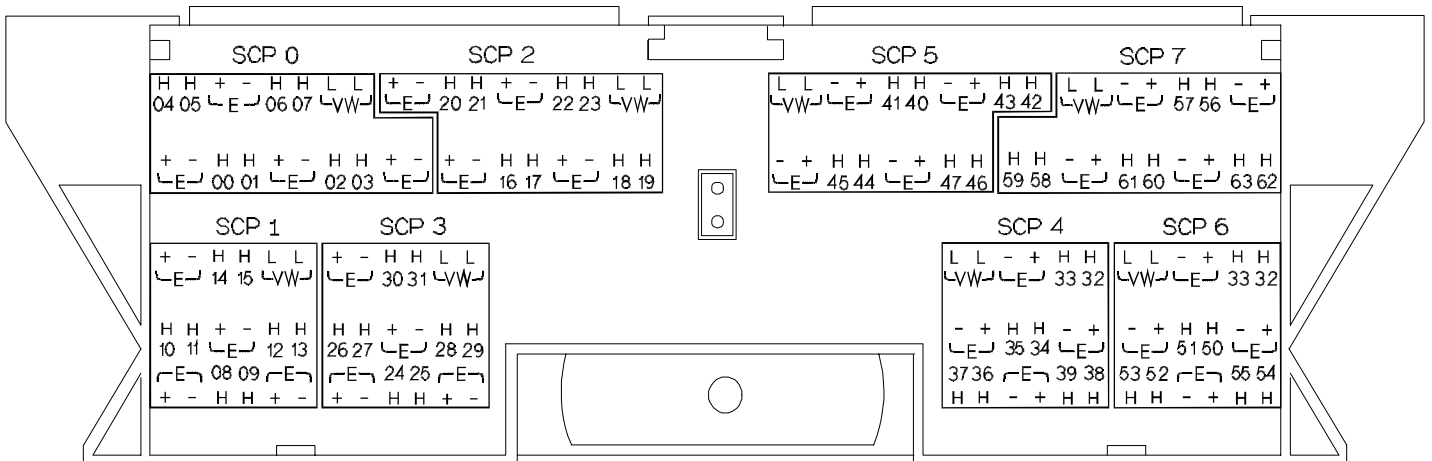


Figure 8 HP E1413 Option 16/17 Terminal Module Connections

Typical Location of Terminal Module Connections

Figure 9 shows where to connect the strain gages to the Terminal Module. The figure assumes that the Strain Completion and Excitation SCP is the first SCP (i.e., SCP 0) and the Direct Input SCP is the second SCP (i.e., SCP 1).

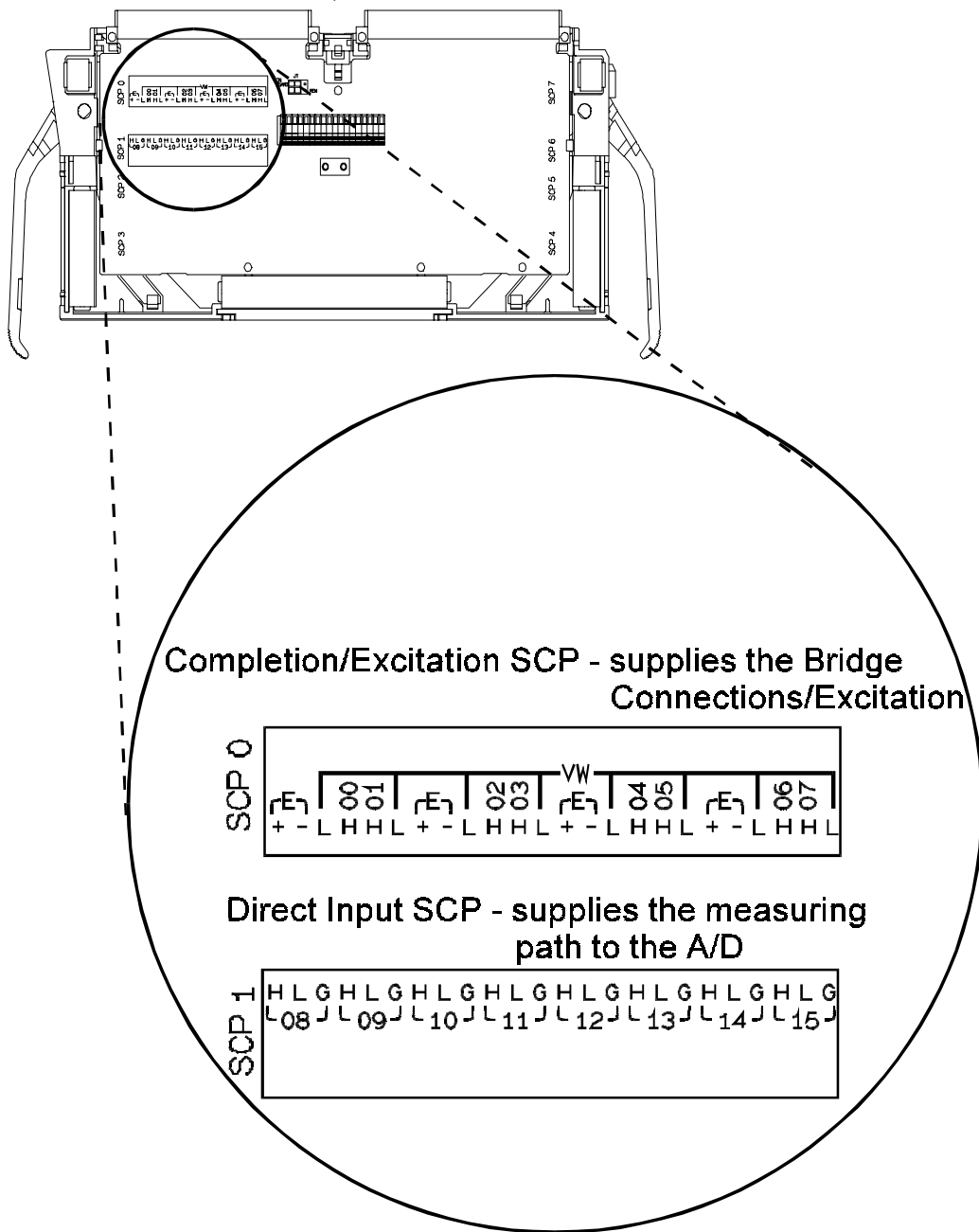


Figure 9 Typical Locations of Terminal Module Connections

Wiring the Terminal Module

- See “Attaching and Wiring the Terminal Module” in the HP E1413 User’s Manual to wire the strain gages to the Terminal Module.
- For accurate measurements, use a twisted shielded cable for the strain gage connections. Connect the shield to the specimen and to the guard (G) terminal on the Terminal Module.

Note The following figures in this section show the connections using SCP 0 as the Strain SCP and SCP 1 as the Direct Input SCP. Use the same technique using other SCPs and other channel numbers.

For example, for a Channel 00 H and L connection on SCP 0, connect to H and L on Channel 57 for SCP 7.

1/4 Bridge Connections

Use Figure 10 for 1/4 Bridge connections to the Terminal Module. *Install* the 1/4 Bridge Jumper(s) for all channels that are to make 1/4 Bridge measurements, if jumper(s) is removed (see Figure 4).

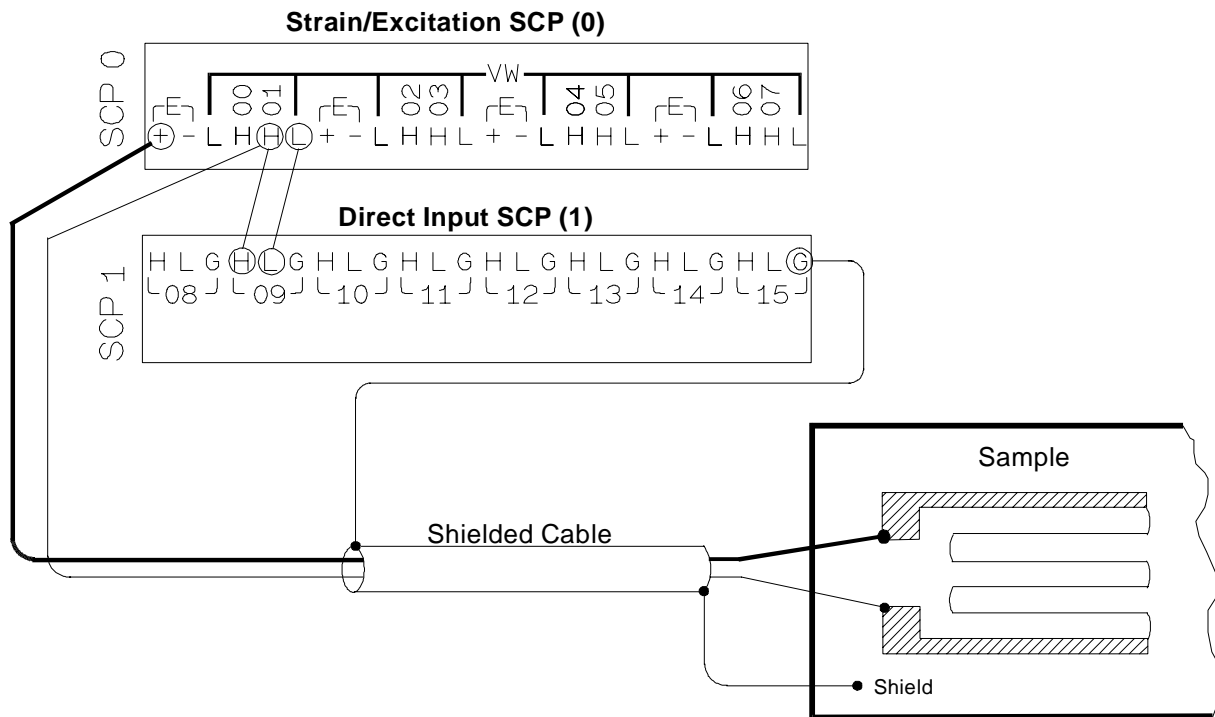


Figure 10 Typical 1/4 Bridge Connections

1/2 Bridge Connections

Use Figure 11 for 1/2 Bridge connections to the Terminal Module.
 Remove the 1/4 Bridge Jumper(s) for all channels that are to make 1/2 Bridge measurements, if jumper(s) is installed (see Figure 4).

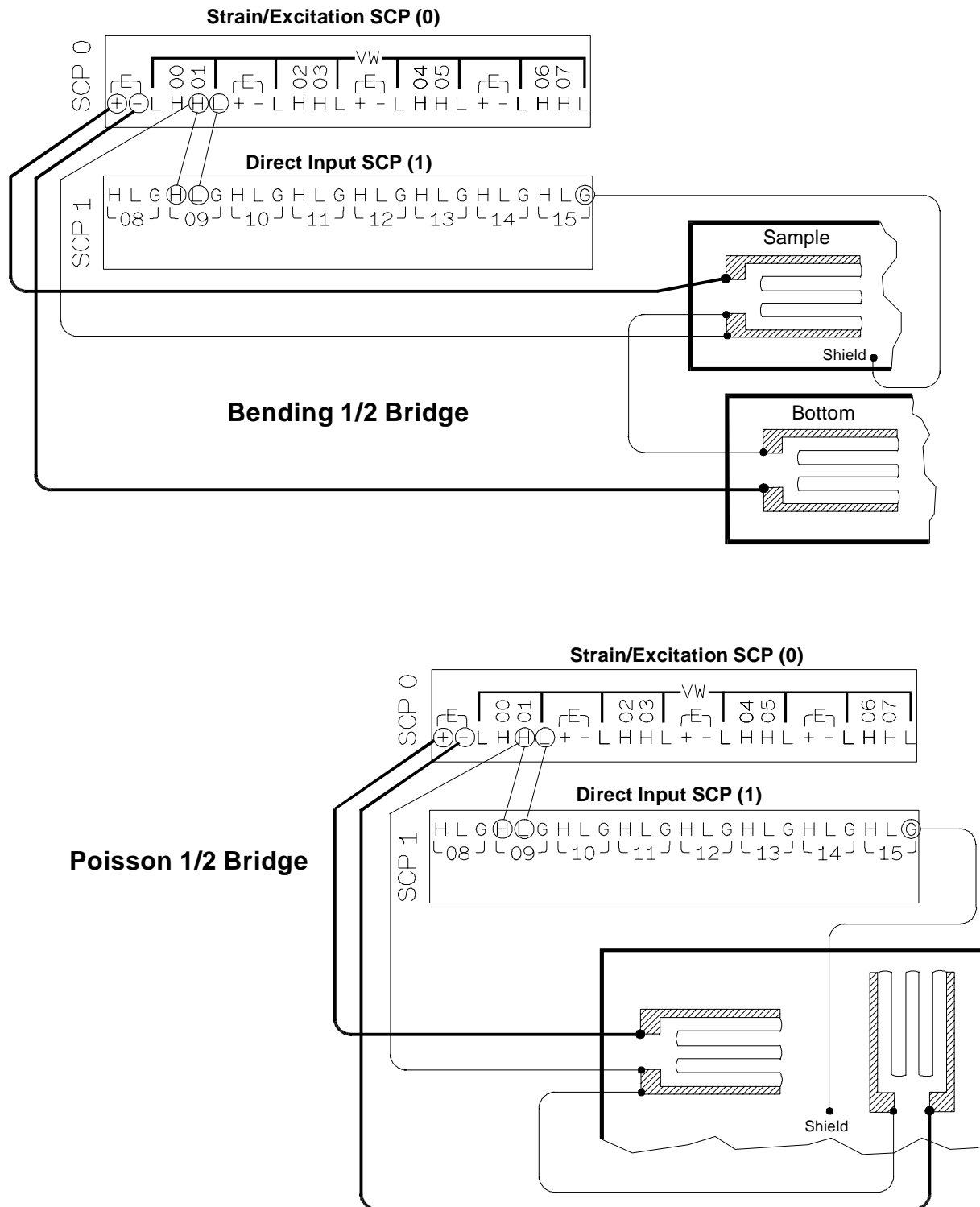


Figure 11 Typical 1/2 Bridge Connections

Full Bridge Connections

Use Figure 12 and 13 for Full Bridge connections to the Terminal Module. *Remove* the 1/4 Bridge Jumper(s) for all channels that are to make Full Bridge measurements, if jumper(s) is installed (see Figure 4).

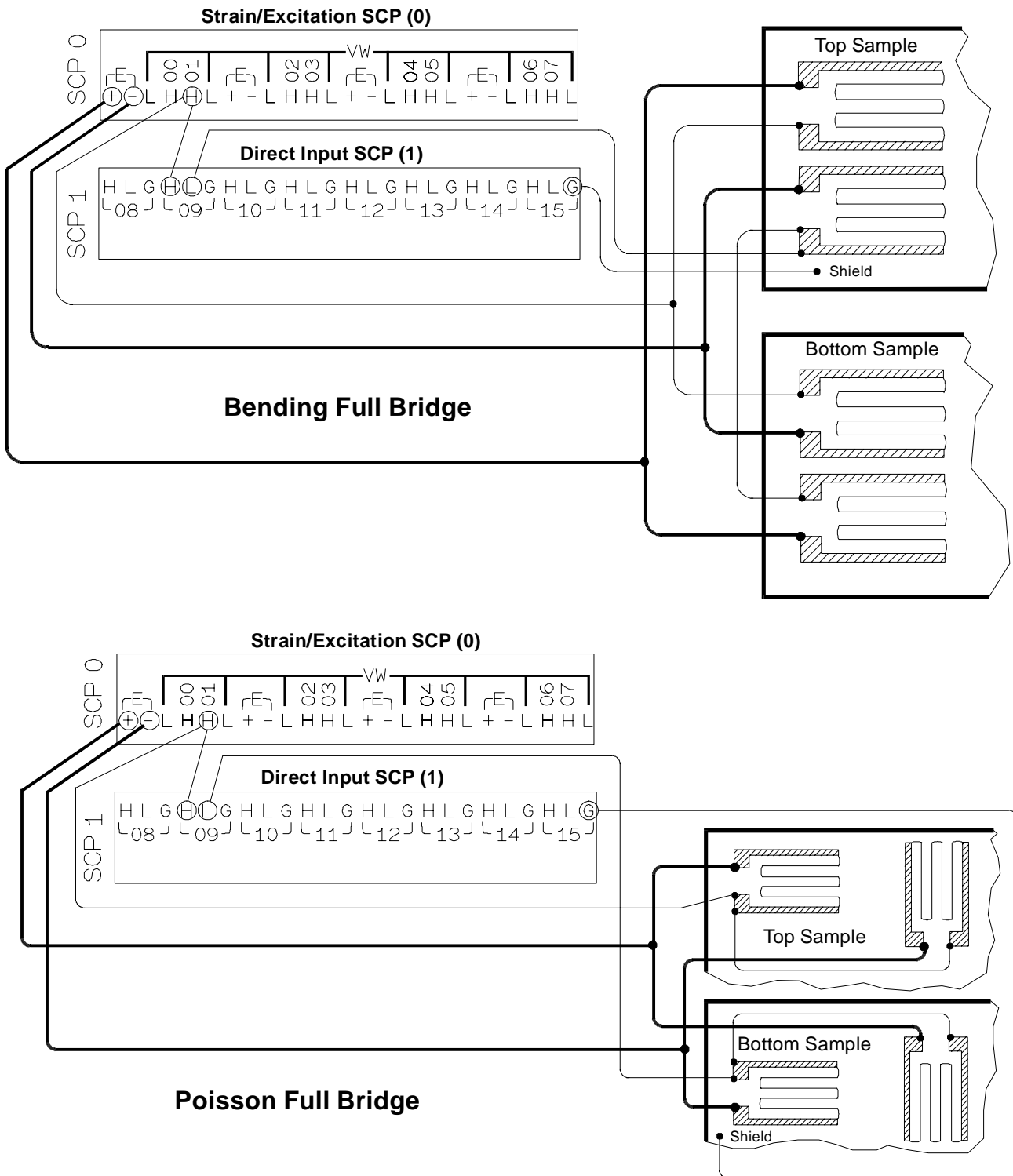


Figure 12 Full Bridge Connections

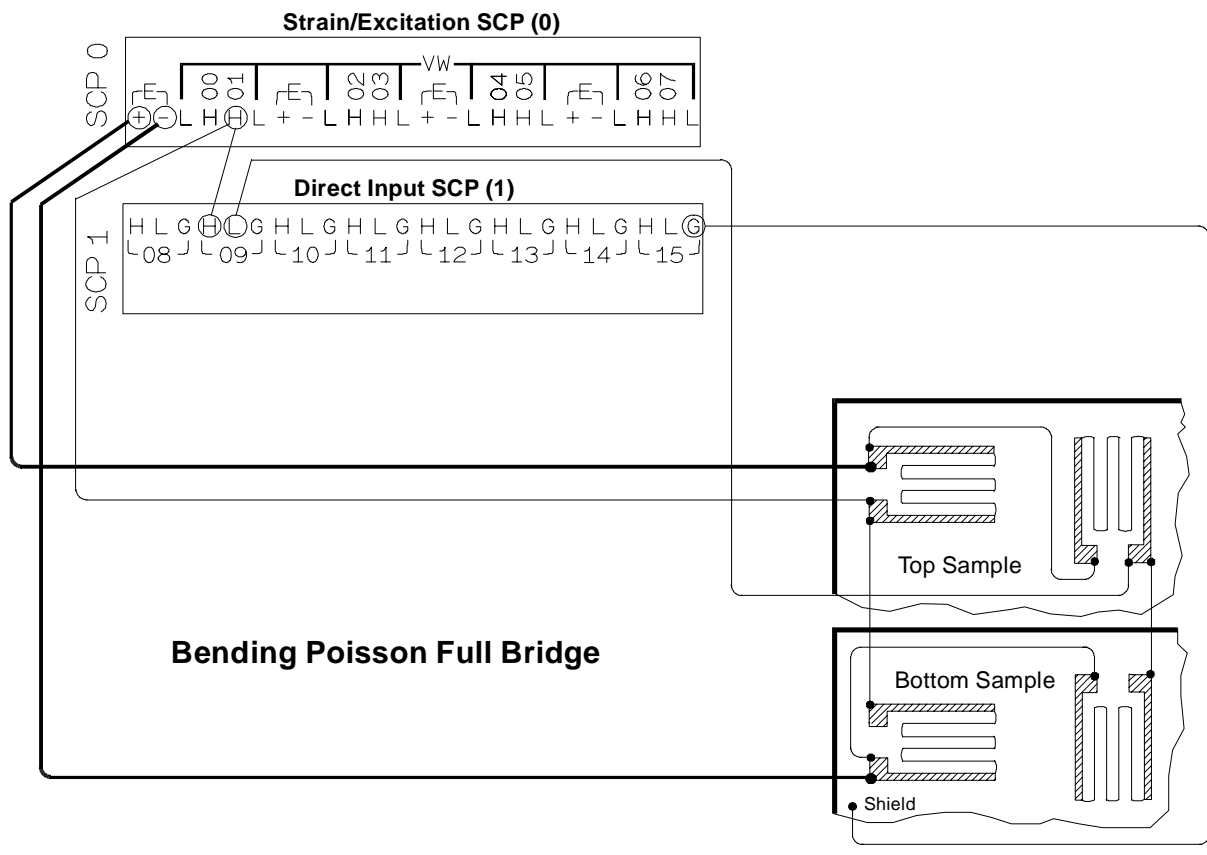


Figure 13 Full Bridge Connections (Cont.)

Programming With SCPI Commands

The following SCPI commands verify the SCP types installed in the HP E1413 and how to program the HP E1413 for strain measurements using the HP E1506/E1507 SCPs. The commands listed in this section are also shown in Chapter 5 of the HP E1413 User's Manual.

Configuring the ID of the SCP

A configuration jumper must be installed when the HP E1506/07 is to be used in HP E1413A/B Scanning A/D modules. This jumper must be removed when the HP E1506/07 is to be used in HP E1413C, and HP E1313A Scanning A/D modules or in HP E1415A Algorithmic Controller modules. See Figure 14 for jumper location.

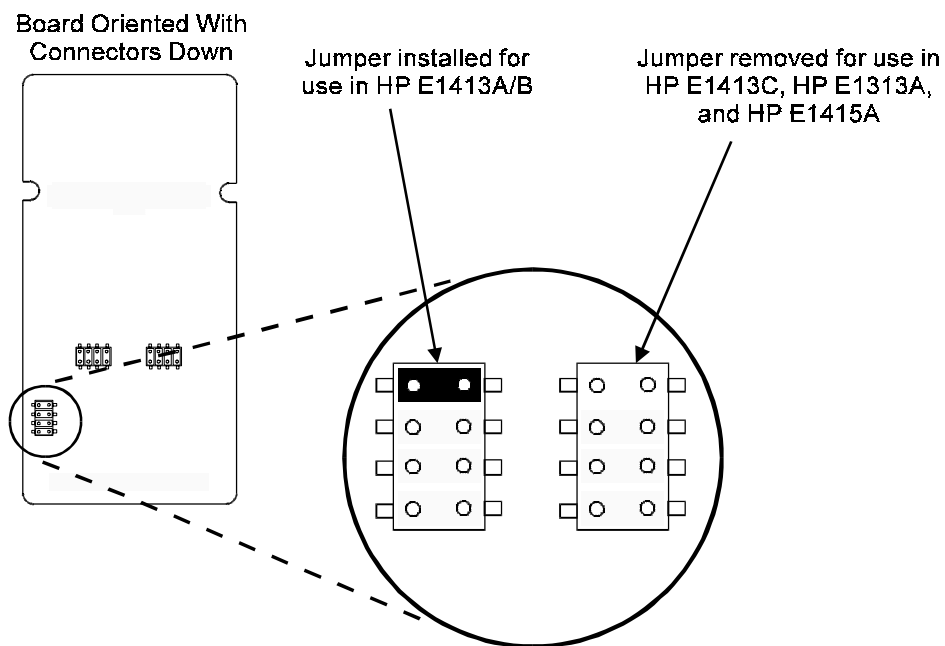


Figure 14 SCP ID Select Jumper

Checking the ID of the SCP

After configuring the ID Select jumper, use the “SYSTem:CTYPe? (@< channel>)” command to verify the SCP type(s) in the HP E1413.

- The *channel* parameter specifies a single channel in the channel range covered by the SCP of interest. The first channel numbers for each of the eight SCP positions are: 0, 8, 16, 24, 32, 40, 48, and 56.

The value returned for the HP E1506 SCP in an HP E1413A/B is:
HEWLETT-PACKARD, E1413 Opt 16 120-Ohm Strain Bridge Completion
SCP,0,0

The value returned for the HP E1506 SCP in an HP E1413C/E1313A/E1415A is:
HEWLETT-PACKARD, E1506 120-Ohm Strain Bridge Completion SCP,0,0

The value returned for the HP E1507 SCP in an HP E1413A/B is:
HEWLETT-PACKARD, E1413 Opt 17 350-Ohm Strain Bridge Completion SCP,0,0

The value returned for the HP E1507 SCP in an HP E1413C/E1313A/E1415A is:
HEWLETT-PACKARD, E1507 350-Ohm Strain Bridge Completion SCP,0,0

To determine the type of SCP installed on channels 0 through 7, send:

SYST:CTYP? (@100)	<i>query SCP type @ ch 0</i>
enter statement here	<i>enter response string</i>

Making 1/4 Bridge Measurements

The following example shows how to make 1/4 Bridge measurements. The example uses a Strain Completion and Excitation SCP (HP E1506 or E1507) for the source and a Direct Input SCP (HP E1501) for the sense. The source channels (0 through 7) are set for 1/4 Bridge configuration (1/4 Bridge Jumper installed). The sense channels are 8 through 15.

Bridge is *Unstrained*

The following specifies the parameters to convert strain gage readings for the specified sense channels. Do the following when the bridge is in the *Unstrained* configuration:

CAL:TARE (@108:115)	<i>measure the unstrained voltage on sense channels 8-15</i>
CAL:TARE?	<i>to return the success flag from the CAL:TARE operation</i>
enter CAL:TARE query	<i>wait until success flag from CAL:TARE operation is returned</i>
STR:GFAC 2,(@108:115)	<i>specifies the gage factor on sense channels 8-15; selected factor is 2 (default value)</i>
FUNC:STR:QUAR 1,(@108:115)	<i>link channel 8-15 to EU conversion for strain measurement; selected voltage range is 1V</i>

Bridge is *Strained*

When the bridge is in the *Strained* configuration and measurement are to be made, use the HP E1413's INITiate and TRIGger commands to make the strain measurements. You must define what triggers, etc., to use to make the measurements (see the "HP E1413 User's Manual" for information).

Making Full Bending Poisson Bridge Measurements

The following example shows how to make Full Bridge Bending Poisson Bridge measurements. The example uses a Strain Completion and Excitation SCP (HP E1506 or E1507) for the source and a Direct Input SCP (HP E1501) for the sense. The source channels (0 through 7) are set for Full Bridge configuration (1/4 Bridge Jumper removed). The sense channels are 8 through 15.

Bridge is *Unstrained*

The following specifies the parameters to convert strain gage readings for the specified sense channels. Do the following when the bridge is in the *Unstrained* configuration:

CAL:TARE (@108:115)	<i>measure the unstrained voltage on sense channels 8-15</i>
CAL:TARE?	<i>to return the success flag from the CAL:TARE operation</i>
enter CAL:TARE query	<i>wait until success flag from CAL:TARE operation is returned</i>
STR:GFAC 2,(@108:115)	<i>specifies the gage factor on sense channels 8-15; selected factor is 2 (default value)</i>
STR:POIS .3,(@108:115)	<i>set Poisson ratio for EU conversion; selected value is .3 (default value)</i>
FUNC:STR:FBP 1,(@108:115)	<i>link channel 8-15 to EU conversion for strain measurement; selected voltage range is 1V</i>

Bridge is *Strained*

When the bridge is in the *Strained* configuration and measurement are to be made, use the HP E1413's INITiate and TRIGger commands to make the strain measurements. You must define what triggers, etc., to use to make the measurements (see the "HP E1413 User's Manual" for information).

Comments

The following explains the commands used in strain measurements.

How to Link EU Conversions to Channels

The following explains the commands that link the strain EU conversion with the specified channels. The commands tell the HP E1413 to use the EU conversion for strain measurements. The HP E1413 performs the appropriate EU conversion (e.g., 1/4 Bridge measurements) depending on the command used. Thus, each bridge configuration has its own command with the command used for the 1/4 Bridge configuration as the default value. (See "Linking Channels with EU Conversion" in Chapter 3 of the HP E1413 User's Manual.)

The syntax of a typical command is:

```
[SENse:]FUNCTion:STRain:HBending [< range> ,](@< ch_list> )
```

where < range> > is the voltage range of the HP E1413 (default value or

no specified parameter is AUTO) and *< ch_list >* specifies the channels of the sense SCP (e.g., HP E1501, Direct Input) that connects to the bridge (not the Strain Completion and Excitation SCP).

The different bridge types and corresponding EU to Channels Linking commands are in the following table.

Bridge Type	Command
Full Bending Bridge	[SENse:]FUNction:STRain:FBENding
Full Bending Poisson Bridge	[SENse:]FUNction:STRain:FBPoisson
Full Poisson Bridge	[SENse:]FUNction:STRain:FPOisson
1/2 Bending Bridge	[SENse:]FUNction:STRain:HBENding
1/2 Poisson Bridge	[SENse:]FUNction:STRain:HPOisson
1/4 Bridge	[SENse:]FUNction:STRain[:QUARter]

Purpose of Channel Tare Calibration (CAL:TARE)

The CALibration:TARE command measures the voltage across the bridge to determine the unstrained voltage value of the bridge. This corrects for the offset voltage across the bridge when in the *Unstrained* configuration.

The command automatically executes the CAL? command and thus calibrates the internal excitation supply of the Bridge Completion and Excitation SCP.

The HP E1413 uses the unstrained reading (i.e., offset voltage) in conjunction with the strain gage factor (see “Purpose of the Strain Gage Factor Command (STR:GFAC)” below) to calculate the strain measurements. You normally perform both operations before making the actual strain measurements.

Instead of using CAL:TARE, you can use the [SENse:]STRain:UNSTrained command to enter the unstrained voltage. In this case you must measure and enter the offset voltage of the bridge, when the bridge is *Unstrained*. The command syntax is:

```
[SENse:]STRain:UNSTrained < unstrained_v > ,( @ < ch_list > )
```

where *< unstrained_v >* is the voltage value of the bridge in the unstrained position (default is 0V) and *< ch_list >* specifies the channels of the sense SCP (e.g., HP E1501, Direct Input) that connects to the bridge (not the Strain Completion and Excitation SCP).

Purpose of the Strain Gage Factor Command (STR:GFAC)

The [SENse:]STRain:GFACtor command specifies the gage factor to be used by the HP E1413 to calculate the strain measurements. The default value of the command is a factor of 2. The command syntax is:

```
[SENse:]STRain:GFACtor < gage_factor > ,( @ < ch_list > )
```

where *< gage_factor >* is the gage factor value (default is 2) and *< ch_list >* specifies the channels of the sense SCP (e.g., HP E1501, Direct Input) that connects to the bridge (not the Strain Completion and Excitation SCP).

Purpose of the Poisson Ratio Command (STR:POIS)

The [SENse:]STRain:POISson command sets the Poisson ratio to be used by the HP E1413 for EU conversion of strain values measured (see “Linking Channels with EU Conversion” in Chapter 3 of the HP E1413 User’s Manual). This command is only needed if making Poisson strain measurements. It is not needed for making 1/4 Bridge, or 1/2 or Full Bridge Bending measurements. The default value of the command is .3. The command syntax is:

```
[SENse:]STRain:POISson < poisson_ratio > ,(@< ch_list > )
```

where *< poisson_ratio >* is the Poisson ratio (default is 2) and *< ch_list >* specifies the channels of the sense SCP (e.g., HP E1501, Direct Input) that connects to the bridge (not the Strain Completion and Excitation SCP).

NOTE

Because of the number of possible strain gage configurations, the driver must generate any Strain EU conversion tables and download them to the instrument when INITiate is executed. This can cause the time to complete the INIT command to exceed 1 minute.

Using External Excitation Voltages

You can use your own external excitation voltage instead of using the internal voltage of the Bridge Completion and Excitation SCP. If using an external voltage, you must:

- isolate the internal excitation supply that is on the SCP
- connect the external voltage to the Terminal Module
- enter the value of the excitation voltage into the HP E1413 so it can make the correct EU conversions for strain measurements

Isolating the Internal Excitation Supply

To use an external excitation voltage, isolate the internal excitation supply from the bridge. To do this, remove the “Excitation Jumpers” from the Bridge Completion and Excitation SCP as shown in Figure 15.

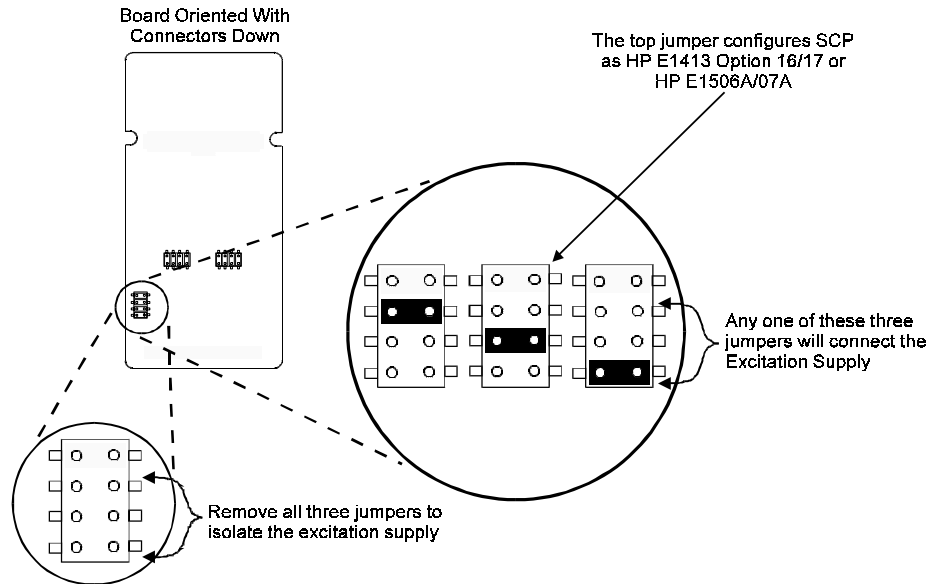


Figure 15 Isolating the Internal Excitation Supply

Connecting the External Supply

Use Figure 16 to connect to external supply to the Terminal Module. Be sure the “Excitation Jumper” is removed from the Strain Completion and Excitation SCP before connecting the external supply (see “Isolating the Internal Excitation Supply” above).

Note

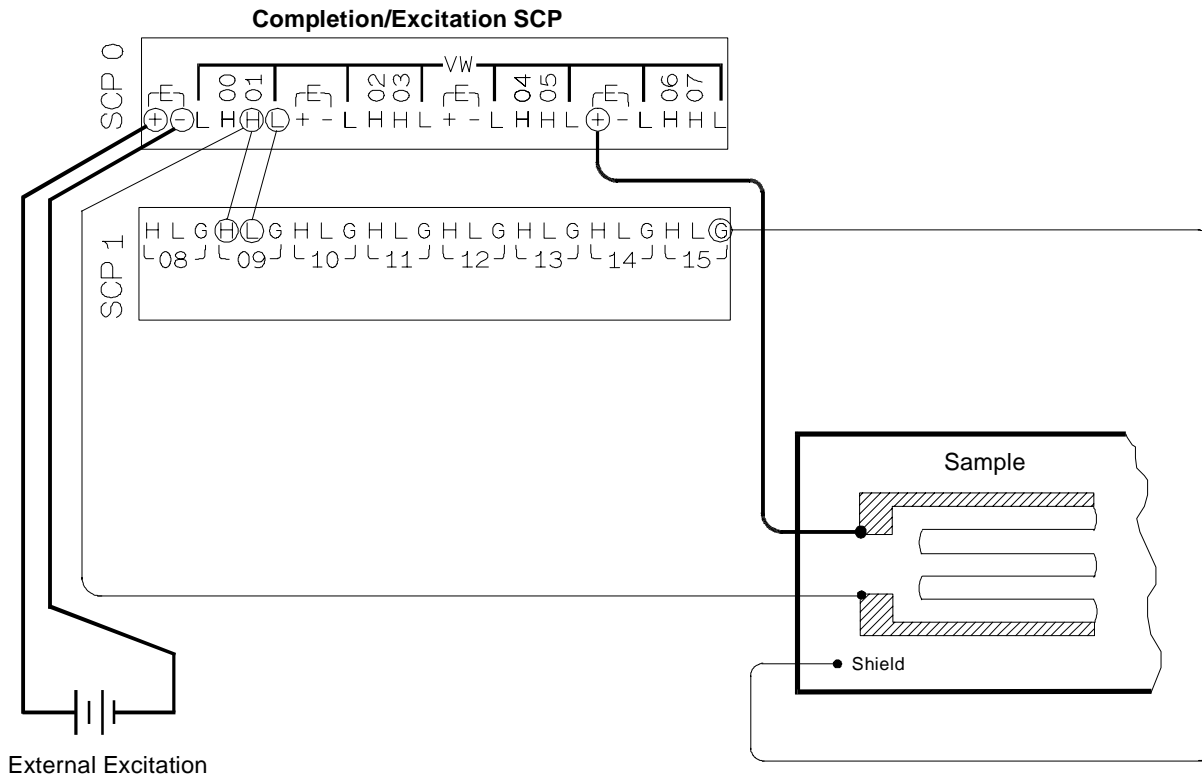
Be sure to keep the removed jumper for future use, in case the internal Excitation Supply is to be used later.

Enter Excitation Voltage Value

Use the [SENSe:]STRain:EXCitation command to enter the value of the external excitation voltage. The syntax of the command is:

```
[SENSe:]STRain:EXCitation < excite_v> ,( @ < ch_list> )
```

where < excite_v> is the value of the external excitation voltage and < ch_list> specifies the channels of the sense SCP (e.g., HP E1501, Direct Input) that connects to the bridge (not the Strain Completion and Excitation SCP).



Connect the External Excitation Supply to any "+" and "-" terminal pair.

Shown is a 1/4 Bridge configuration; connections to other configurations is the same.

Figure 16 Connecting the External Excitation Supply

The default value of the excitation voltage is 3.9V, which is also the value of the internal excitation supply. The minimum allowable voltage value that can be entered is .01V and the maximum value is 42V.

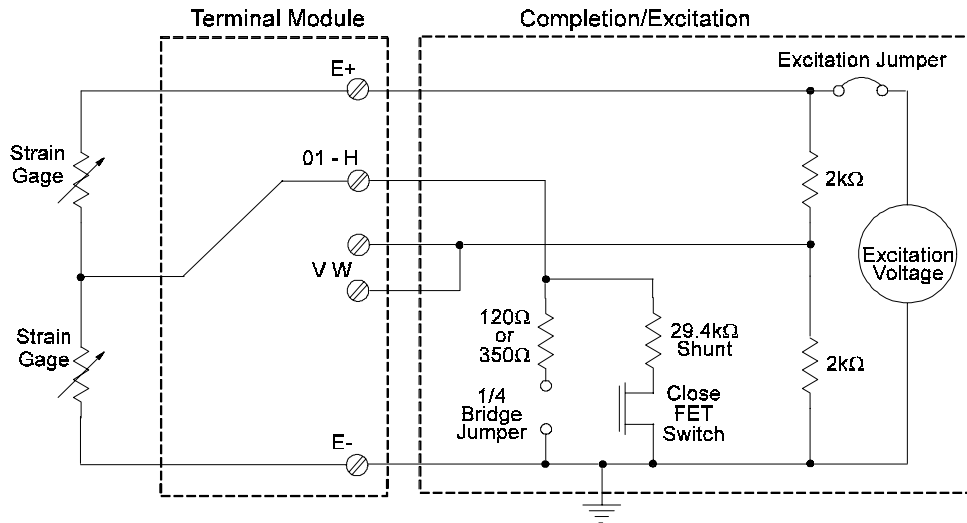
Using The Shunt Resistor

To check if the bridge is operational, you can add a 29.4kΩ Shunt resistor across one leg of the bridge, as illustrated in Figure 17. A FET switch adds or removes the resistor. When the resistor is added, it changes the unstrained offset voltage on the bridge.

The resistor can only affect the bridge balance as long as you follow the connections shown in Figures 1, 2, and 3. Use the OUTPUT:SHUNT command to add or remove the resistor from the bridge. The syntax of the command is:

```
OUTPUT:SHUNT 1 | 0 | ON | OFF
```

where 1 or ON adds the shunt resistor and 0 or OFF (default value) removes the resistor.



Shown is a 1/2 Bridge configuration; the function for the shunt resistor is the same for other bridges

Figure 17 Adding the Shunt Resistor

Register-Based Programming

Chapter 6 of the HP E1413 User's Manual cover the Register-Based commands shown below. You should read that chapter to become familiar with accessing registers and executing Register-Based commands. This section relates those commands to the parameter values that are specified for this SCP.

When Register Programming an SCP, most communication is through the Signal Conditioning Bus. For that you will use the Register Commands:

SCPWRITE < regaddr> < regvalue>

and

SCPREAD? < regaddr>

Read (returned value)	Write (< regvalue>)	SCP Register	< regaddr> Value
SCP ID - Opt 16: (C0C0 ₁₆) - Opt 17: (C040 ₁₆) - E1506: (C0B0 ₁₆) - E1507: (C030 ₁₆)		Whole SCP Reg 0	00ppp000000 ₂
SCP Gain Scale (XXX0 ₁₆)		Whole SCP Reg 1	00ppp000001 ₂
	SCP Excitation Activation (XXX1 ₁₆)	Whole SCP Reg 2	00ppp000002 ₂
Channel Gain (XXX0 ₁₆)		Channel Reg 1	01ppppcc001 ₂
	Calibration (Xnnn ₁₆) where nnn= Cal Value	Whole SCP Reg 3	01ppp000003 ₂

XXX= don't care

ppp= Plug-on
ccc= SCP channel

Checking the ID of the SCP

To query an SCP for its ID value, write the following value to Parameter Register 0:

$$(SCP\ number) \times 40_{16}$$

Then write the opcode for SCPREAD? (0800₁₆) to the Command Register. The ID value will be written to the Response Register. Read the Response Register for the value.

Excitation Voltage Activation (HP E1506/07 Only)

After the HP E1506/E1507 is reset or after a power-on condition, the SCP's excitation voltage is not enabled. (This is only for the HP E1506/E1507 and not the HP E1413 Options 16/17.) To enable the excitation voltage, write a 1 to Register 2.

Excitation Calibration Register

The excitation calibration register controls a DAC that adjusts the SCP's internal excitation voltage for 3.9V. The Register-Based command CARDCAL? (1000₁₆) controls this register and the user should not write to them.

Specifications

General Specification

SCP Current Requirements:(Amps)

	5Vtyp	5Vmax	24typ	24Vmax	-24Vtyp	-24Vmax
E1506A	0.28	0.28	.026	.032	.023	.027
E1507A	0.09	0.09	.026	.032	.023	.027

Excitation Voltage (measured with HP E1501, Direct Input)

Accuracy: (90 day) 23°C, ±1°C with *CAL done after 1 hr. warmup
3.9000 V nominal ±512µV

Noise: (3 sigma) (350Ω completion, one channel, 3.90V)

A/D Filter Off: 450µV

A/D Filter On: 366µV

Tempco: 39µV/°C (difference between factory calibration and *CAL temp)

Completion Resistors

Power: 0.125W @ 125°C

Tolerance: 0.05%

TCR: ±5 ppm/°C

Bridge Offsets: (±1°C of tare cal, 1/4 Bridge)

Offset: ±40µV Note: Offset may vary depending on the stability of the attached strain gage

Strain Accuracies for System

Gain + Offset Error: 40µe

Noise Error: 27µe - A/D Filter Off

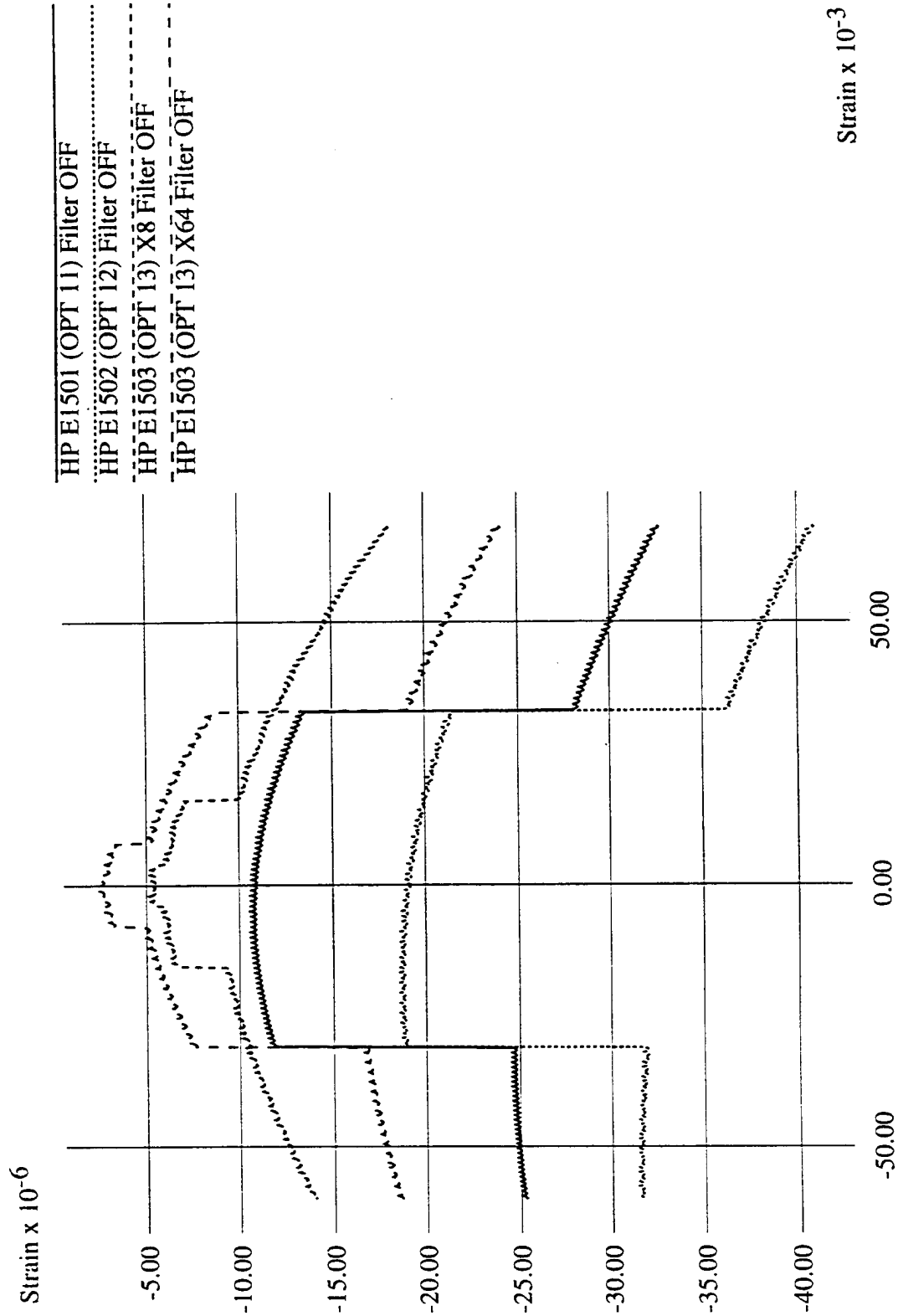
20µe - A/D Filter On

Strain Measurement Accuracies

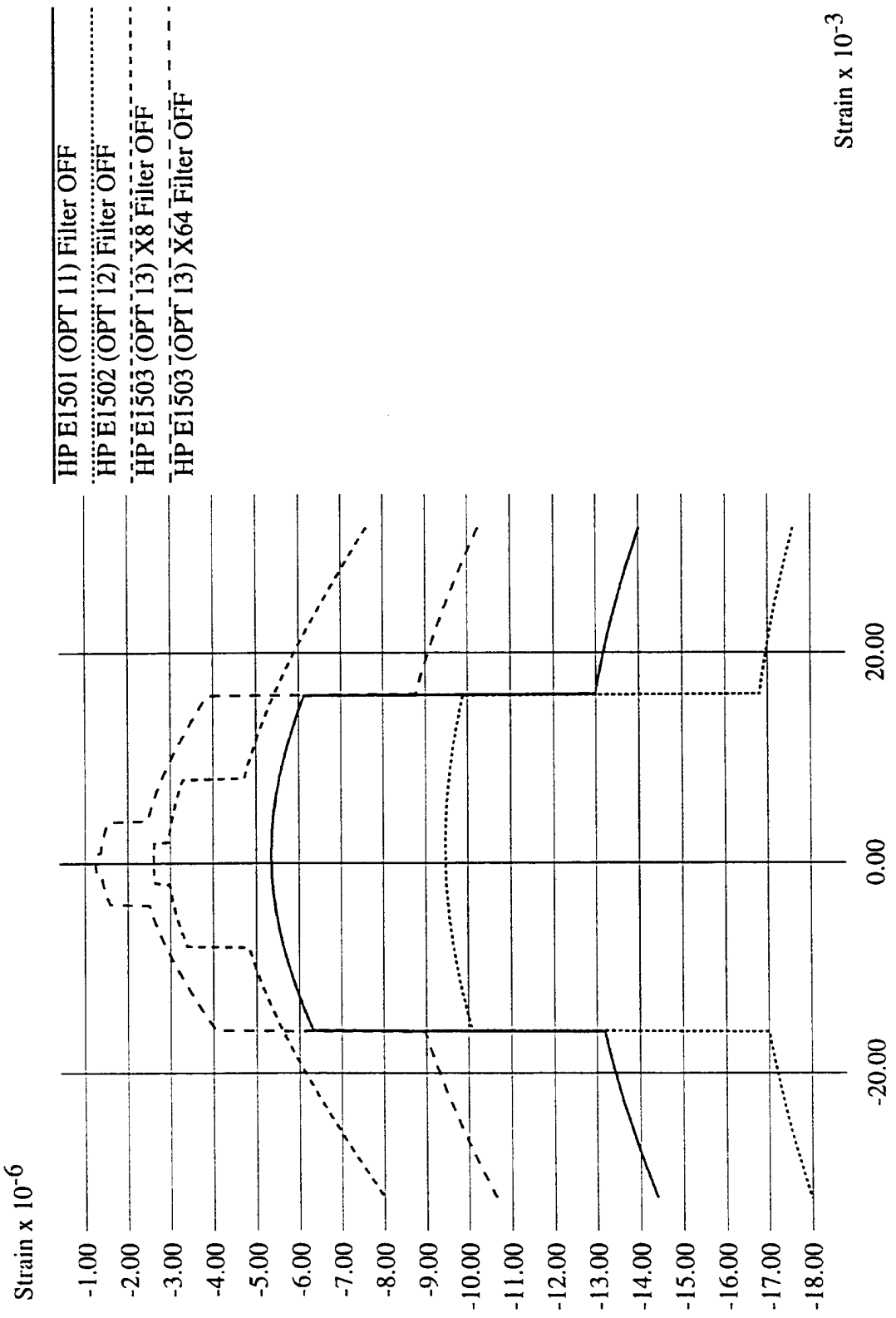
The graphs on the following pages shows the following strain accuracies:

- Quarter Bridge (1/4 Bridge)
- Half Bridge (1/2 Bridge) Bending
- Half Bridge (1/2 Bridge) Poisson
- Full Bridge Bending
- Full Bridge Poisson
- Full Bridge Bending Poisson

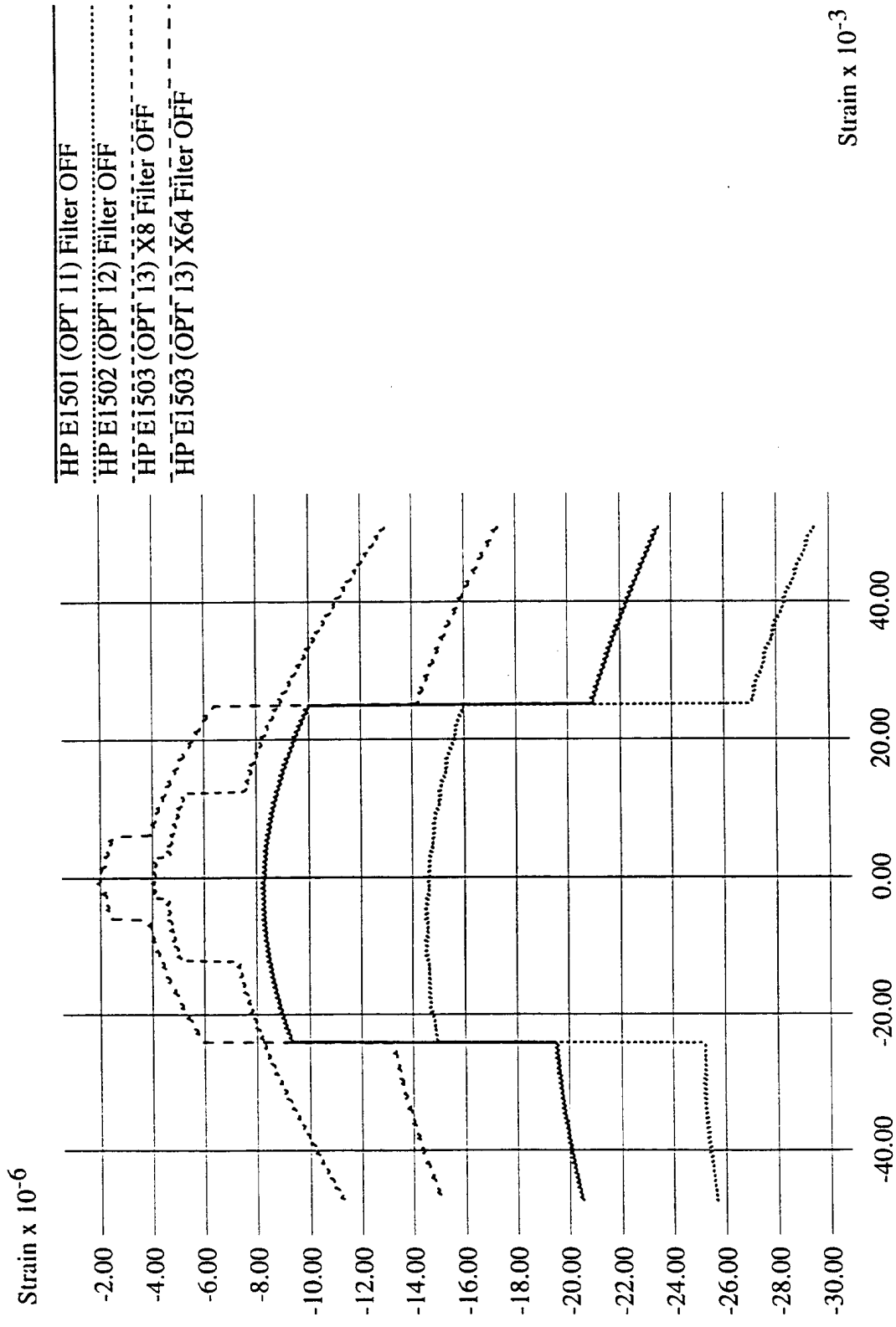
Quarter Bridge



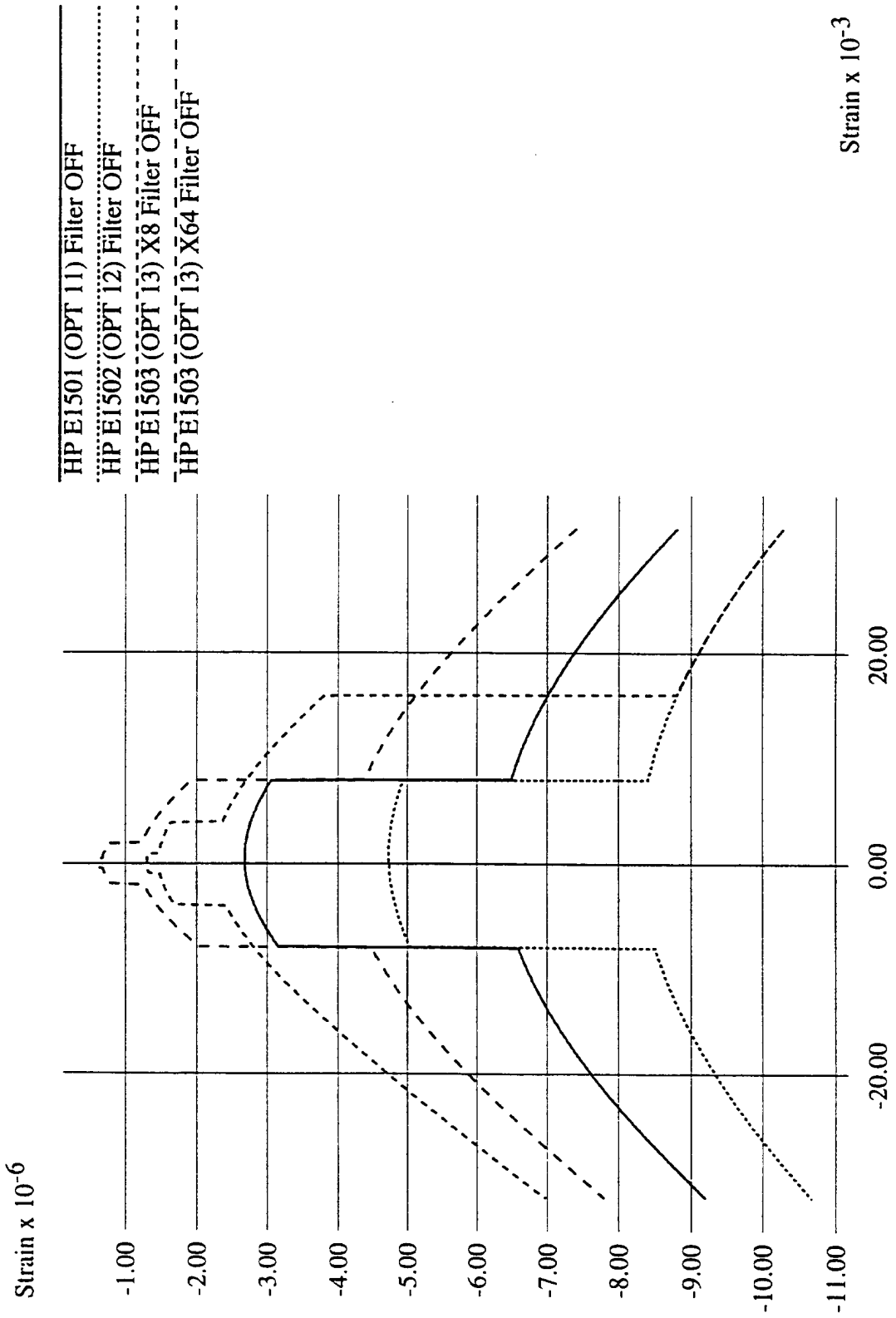
Half Bridge Bending



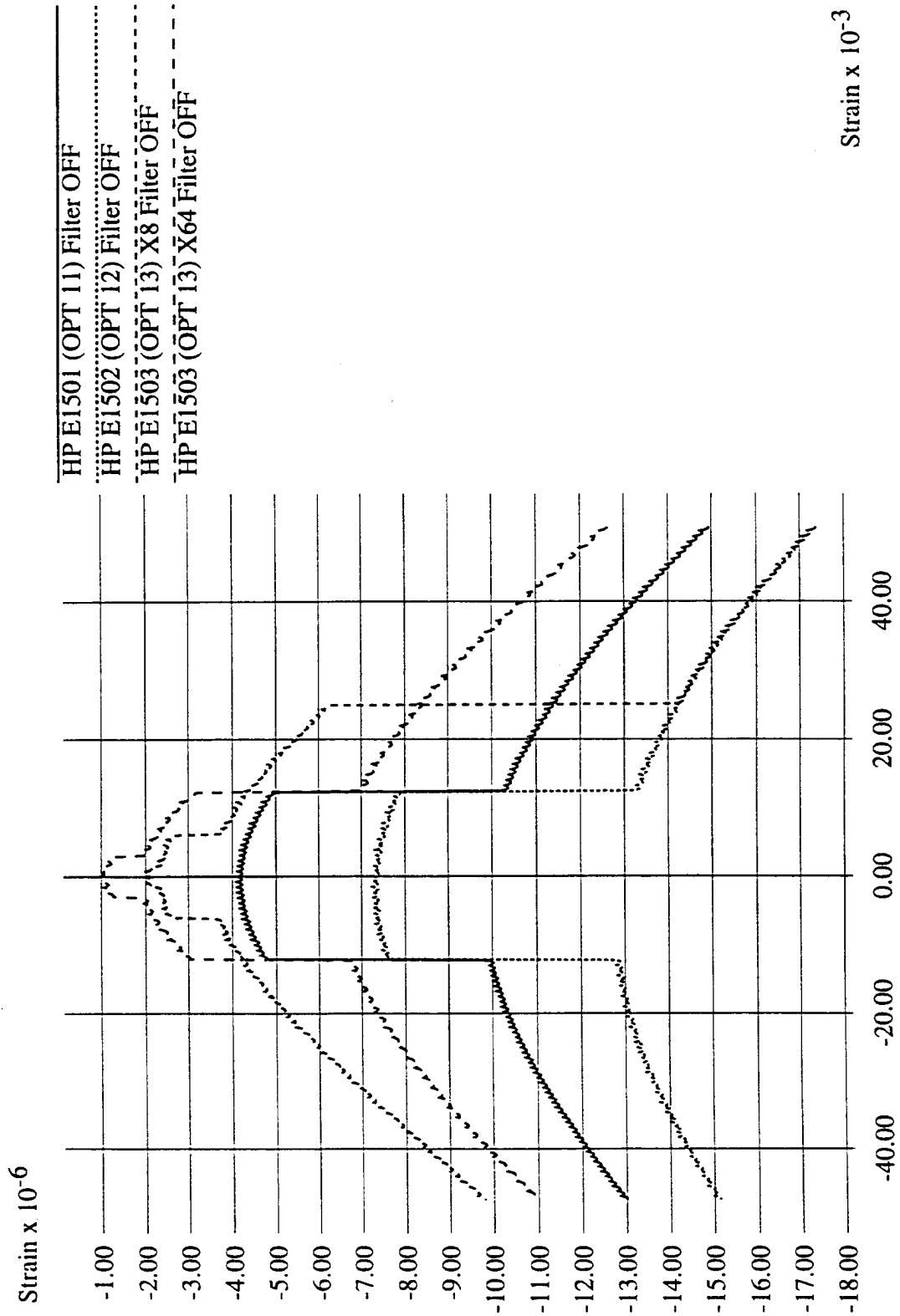
Half Bridge Poisson



Full Bridge Bending



Full Bridge Poisson



Full Bridge Bending Poisson

