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HP E1313A, E1413A/B, & E1413C) 32/64 Channel Scanning A/D

Service Manual

Where to Find it - Online and Printed Information:

System installation (hardware/software)	VXIbus Configuration Guide* HP VIC (VXI installation software)*
Module configuration and wiring	This Manual
SCPI programming	User's & SCPI Programming Manual
SCPI example programs	User's & SCPI Programming Manual, Driver Disk
SCPI command reference	User's & SCPI Programming Manual
Register-Based Programming	User's & SCPI Programming Manual
VXI*plug&play* programming	VXI*plug&play* Online Help
VXI*plug&play* example programs	VXI*plug&play* Online Help
VXI*plug&play* function reference	VXI*plug&play* Online Help
Soft Front Panel information	VXI*plug&play* Online Help
VISA language information	HP VISA User's Guide
HP VEE programming information	HP VEE User's Manual

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Manual Part Number: E1413-90032
Printed in U.S.A. E0497

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HP E1313A, E1413A/B, & E1413C 32/64 Channel Scanning A/D Service Manual
Edition 4
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Documentation History

All Editions and Updates of this manual and their creation date are listed below. The first Edition of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct or add additional information to the current Edition of the manual. Whenever a new Edition is created, it will contain all of the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this documentation history page.

Edition 1 . . . . . January 1994

Edition 2 . . . . . August 1995

Edition 3 . . . . . April 1996

Edition 4 . . . . . April 1997

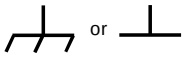
Safety Symbols



Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.



Indicates the field wiring terminal that must be connected to earth ground before operating the equipmentÅprotects against electrical shock in case of fault.



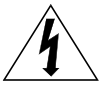
Frame or chassis ground terminal—typically connects to the equipment's metal frame.



Alternating current (AC)



Direct current (DC).



Indicates hazardous voltages.

WARNING Calls attention to a procedure, practice, or condition that could cause bodily injury or death.

CAUTION Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

WARNINGS

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

Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), an uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

For continued protection against fire, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type. DO NOT use repaired fuses or short-circuited fuse holders.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DO NOT service or adjust alone: Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT substitute parts or modify equipment: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

Declaration of Conformity
according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Hewlett-Packard Company
Loveland Manufacturing Center

Manufacturer's Address: 815 14th Street S.W.
Loveland, Colorado 80537

declares, that the product:

Product Name: 32 Channel Scanning A/D, 64 Channel Scanning A/D

Model Number: HP E1313A, E1313A Opt 001, E1413A/B, E1413C

Product Options: All

conforms to the following Product Specifications:

Safety: IEC 1010-1 (1990) Incl. Amend 1 (1992)/EN61010-1 (1993)
CSA C22.2 #1010.1 (1992)
UL 3111-1 (1994)

EMC: CISPR 11:1990/EN55011 (1991): Group1 Class A
IEC 801-2:1991/EN50082-1 (1992): 4kVCD, 8kVAD
IEC 801-3:1984/EN50082-1 (1992): 3 V/m
IEC 801-4:1988/EN50082-1 (1992): 1kV Power Line
.5kV Signal Lines

Supplementary Information: The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (inclusive 93/68/EEC) and carries the "CE" mark accordingly.

Tested in a typical configuration in an HP C-Size VXI mainframe.

April, 1996

Jim White, QA Manager

European contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department HQ-TRE, Herrenberger Straße 130, D-71034 Böblingen, Germany (FAX +49-7031-14-3143)

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Edition 4

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• Instructions are easy to understand.	O	O	O	O	O
• The documentation is clearly written.	O	O	O	O	O
• Examples are clear and useful.	O	O	O	O	O
• Illustrations are clear and helpful.	O	O	O	O	O
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Chapter 1
General Information

Introduction

This service manual contains information to test, troubleshoot, and repair the HP E1413A/B/C 64-Channel Scanning A/D, the HP E1313A 32-Channel Scanning A/D, the HP E1313A Option 001 64-Channel Scanning A/D, and the associated Signal Conditioning Plug-Ons (SCPs). Unless otherwise noted, references to the HP E1413C also apply to the HP 1413A/B and the HP E1313A (and its option 001). Figure 1-1, "HP E1313A Scanning A/D Converter," shows a typical E1313A Scanning A/D and the SCPs described in this manual. Figure 1-2, "HP E1413A/B Scanning A/D Converter," on page 16 shows the E1413A/B and Figure 1-3, "HP E1413C Scanning A/D Converter," on page 17 shows the E1413C.

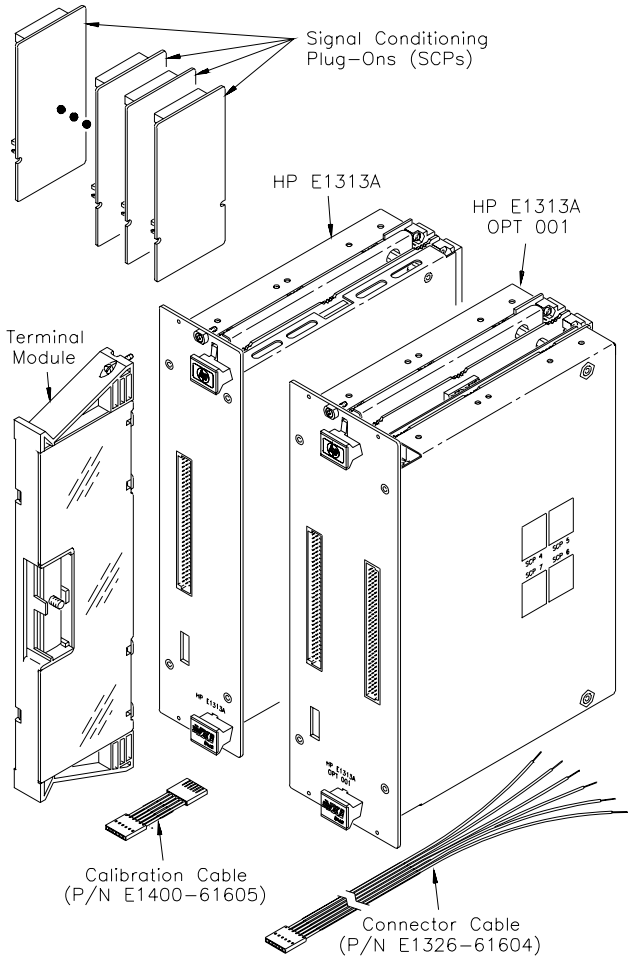


Figure 1-1. HP E1313A Scanning A/D Converter

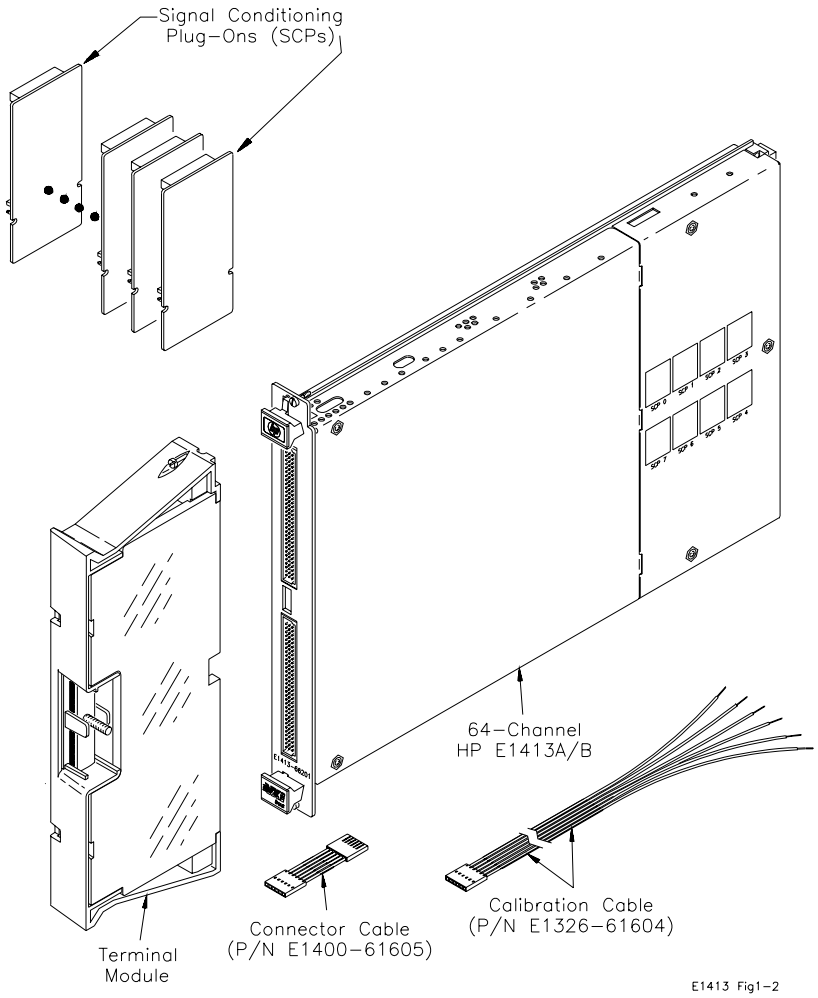


Figure 1-2. HP E1413A/B Scanning A/D Converter

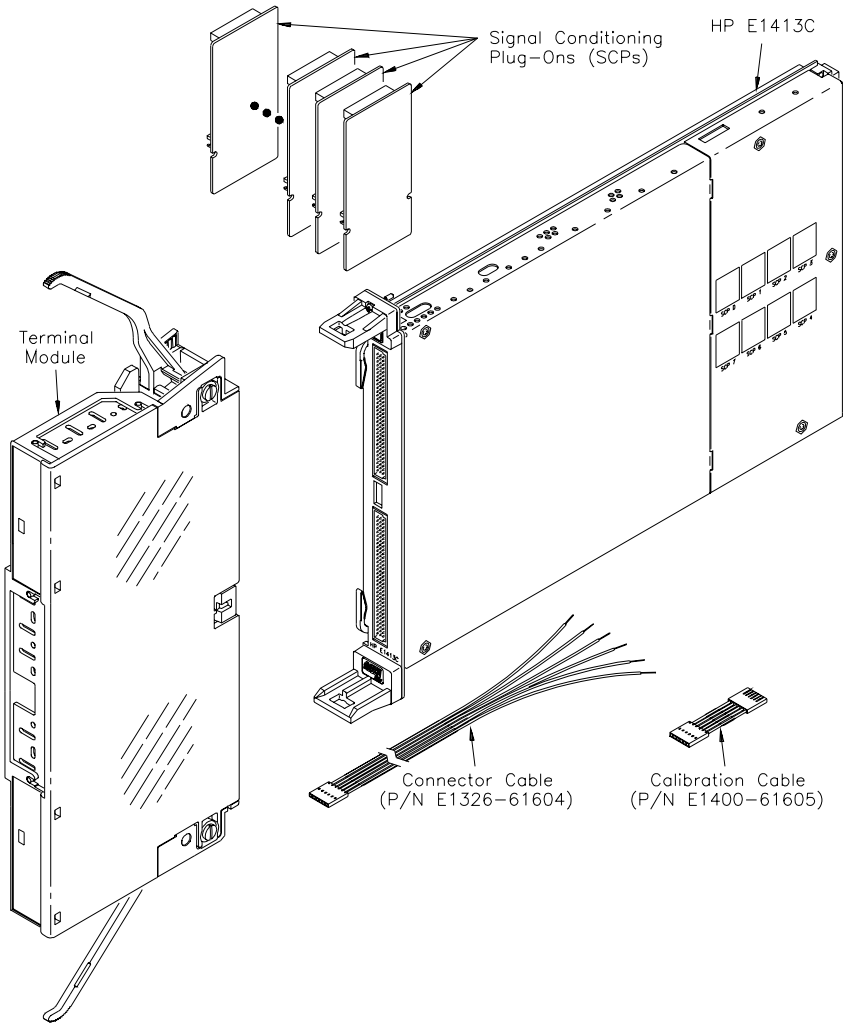


Figure 1-3. HP E1413C Scanning A/D Converter

Safety Information

The HP E1413C Scanning A/D is a Safety Class I instrument that is provided with a protective earth terminal when installed in the mainframe. Check the mainframe and all related documentation for safety markings and instructions before operating or servicing a Scanning A/D.

See the WARNINGS on page 4 for a summary of safety information. Safety information to test and service the HP E1413C Scanning A/D follows and is also found throughout this manual.

WARNINGS

Follow the WARNINGS listed to avoid possible injury to yourself or others when operating, repairing, or servicing a Scanning A/D.

WARNING

SERVICE-TRAINED PERSONNEL ONLY. The information in this manual is for service-trained personnel who are familiar with electronic circuitry and are aware of the hazards involved. To avoid personal injury or damage to the instrument, do not perform procedures in this manual or do any servicing unless you are qualified to do so.

CHECK MAINFRAME POWER SETTINGS. Before applying power, verify that the mainframe setting matches the line voltage and the correct fuse is installed. An uninterruptible safety earth ground must be provided from the main power source to the supplied power cord set.

GROUNDING REQUIREMENTS. Interruption of the protective (grounding) conductor (inside or outside the mainframe) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two-conductor outlet is not sufficient protection.)

IMPAIRED PROTECTION. Whenever it is likely that instrument protection has been impaired, the mainframe must be made inoperative and be secured against any unintended operation.

REMOVE POWER IF POSSIBLE. Some procedures in this manual may be performed with power supplied to the mainframe while protective covers are removed. Energy available at many points may, if contacted, result in personal injury. (If service can be performed without power applied, remove the power.)

WARNING **USING AUTOTRANSFORMERS. If the mainframe is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the main's supply).**

USE PROPER FUSES. For continued protection against fire hazard, replace the line fuse(s) only with fuses of the same current rating and type (such as normal blow, time delay, etc.). Do not use repaired fuses or short-circuited fuse holders.

CAUTIONS

Follow the CAUTIONS listed to avoid possible damage to the equipment when performing instrument operation, service, or repair.

Caution **MAXIMUM INPUT VOLTAGE/CURRENT. To avoid possible damage to the instrument, maximum input voltage (normal mode plus common mode) is ± 42 Vpeak. Maximum operating voltage is ± 16 Vpeak. Maximum current per channel or common: 100 mA DC or AC RMS.**

STATIC ELECTRICITY. Static electricity is a major cause of component failure. To prevent damage to the electrical components in the Scanning A/D or SCPs, observe anti-static techniques when removing an HP E1413C from the mainframe or when handling an HP E1413C or SCP. Also, be sure to tighten the front panel screws when installing an HP E1413C in a mainframe slot.

Scanning A/D Description

The HP E1413C Scanning A/D Converter is a VXIbus C-Size, register-based instrument. The E1313A is a VXIbus B-Size, register-based instrument. The Scanning A/D operates in a VXIbus mainframe using a Command Module and Standard Commands for Programmable Instruments (SCPI).

The instrument can measure DC voltage, resistance, temperature, and strain when appropriate Signal Conditioning Plug-Ons (SCPs) are installed on the instrument (see "Scanning A/D (SCPs)"). The Scanning A/D has 100 kHz scanning rate up to 100,000 readings/sec with full autozeroing and autocalibration.

Scanning A/D Specifications

See *Appendix A - Specifications* in the *HP E1413C User's Manual* for HP E1413C Scanning A/D specifications. These specifications are the performance standards or limits against which the instrument may be tested.

Scanning A/D Environment

The HP E1413C Scanning A/D and SCPs should be stored in a clean, dry environment. Recommended operating/storage environments for the HP E1413C Scanning A/D and SCPs are:

Table 1-1. Environmental Specifications

	Temperature	Relative Humidity
Operating Environment	0^{o}C to +55^{o}C	<65% (0^{o}C to +40^{o}C)
Storage/Shipment	-40^{o}C to +75^{o}C	<65% (0^{o}C to +40^{o}C)

Scanning A/D (SCPs)

When introduced, SCPs were sold as options to the E1313A and E1413A/B. These options are obsolete and replaced by an SCP model number. For your convenience, the option numbers and model numbers are both listed in Table 1-2.

Table 1-2. Signal Conditioning Plug-Ons

SCP Model Number	E1313A E1413A/B Option	Description	SCP Model Number	E1313A E1413A/B Option	Description
E1501A	011	Direct Input SCP	E1510A	020	4 Channel Sample & Hold
E1502A	012	Low Pass Filter Input SCP	E1511A	021	4 Channel Transient Strain
E1503A	013	Gain/Filter Input SCP	E1512A	None	8 Channel 25Hz Low Pass
E1504A	014	Breadboard (no tests)	E1513A	None	Attenuator Input / 16
E1505A	015	Current Source SCP	E1514A	None	Iso x1, 4 Channel 10Hz LP
E1506A	016	120 Ω Strain Gage SCP	E1515A	None	Iso x1, 4 Channel 100Hz LP
E1507A	017	350 Ω Strain Gage SCP	E1516A	None	Iso x64, 4 Channel 10Hz LP
E1508A	018	Fixed Gain/Filter Input SCP	E1517A	None	Iso x64, 4 Channel 100Hz LP
E1509A	019	Fixed Gain/Filter Input SCP	E1518A	None	Resistance Measurement

Service Programs Disk

An *HP E1413C Service Programs* disk is shipped with this manual. The programs on the disk are in ANSI C language using HP VISA.The disk is DOS formatted, the programs were written in Microsoft® Visual C++ but the programs should compile under any standard ANSI C compiler. *The files on the disk can be read by any standard ASCII editor*.

To run the programs you must have the HP I/O Library, SCPI Drivers, and an HP 82340 or 82341 HP-IB module installed and properly configured in your computer.

The following table lists the programs on the disk.

Table 1-3. HP E1413C Service Programs

Chap	Category	*filename*	Test Description
2 & 5	Functional Verification Tests	SELFTEST.C	Performs self-test of the Scanning A/D
		OVERRANG.C	Tests Scanning A/D overrange detection function
		OPENTRAN.C	Tests Scanning A/D open transducer detection (OTD) function
	Performance Verification Tests	PERF01.C	Tests DC voltage accuracy using E1501A SCP
		PERF02_12.C	Tests DC voltage accuracy using E1502A or E1512A SCP
		PERF0301.C	Tests DC voltage accuracy using E1503A SCP @ Gain X1
		PERF0308.C	Tests DC voltage accuracy using E1503A SCP @ Gain X8
		PERF0364.C	Tests DC voltage accuracy using E1503A SCP @ Gain X64
		PERF05.C	Tests current accuracy using E1505A SCP
		PERF06_07.C	Tests excitation voltage accuracy using E1506A SCP or E1507A SCP
		PERF08.C	Tests DC voltage accuracy using E1508A SCP
		PERF09.C	Tests DC voltage accuracy using E1509A SCP
		PERF10SH.C	Tests 4 Sample & Hold Channels DC voltage accuracy using E1510A SCP
		PERF10ST.C	Tests 4 Straight-Through Channels DC voltage accuracy using E1510A SCP
		PERF11.C	Tests DC voltage accuracy and Excitation voltage using E1511A SCP
		PERF13.C	Tests DC voltage accuracy using E1513A SCP
		PERF14_15.C	Tests DC voltage accuracy using E1514A or E1515A SCP
		PERF16_17.C	Tests DC voltage accuracy using E1516A or E1517A SCP
		PERF18V.C	Tests DC voltage accuracy using E1518A SCP (4 channels)
		PERF18i.C	Tests DC current accuracy using E1518A SCP (4 channels)
3	Adjustments	ADJSPROC.C	Performs internal A/D adjustments for the Scanning A/D

Inspection/Shipping

This section shows initial (incoming) inspection and shipping guidelines for the HP E1413C Scanning A/D and associated SCPs.

Initial Inspection

Use the steps in Figure 1-4, “Initial (Incoming) Inspection Guidelines,” on page 22 as guidelines to perform initial (incoming) inspection of the HP E1413C Scanning A/D.

WARNING **To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to the shipping container or to the instrument.**

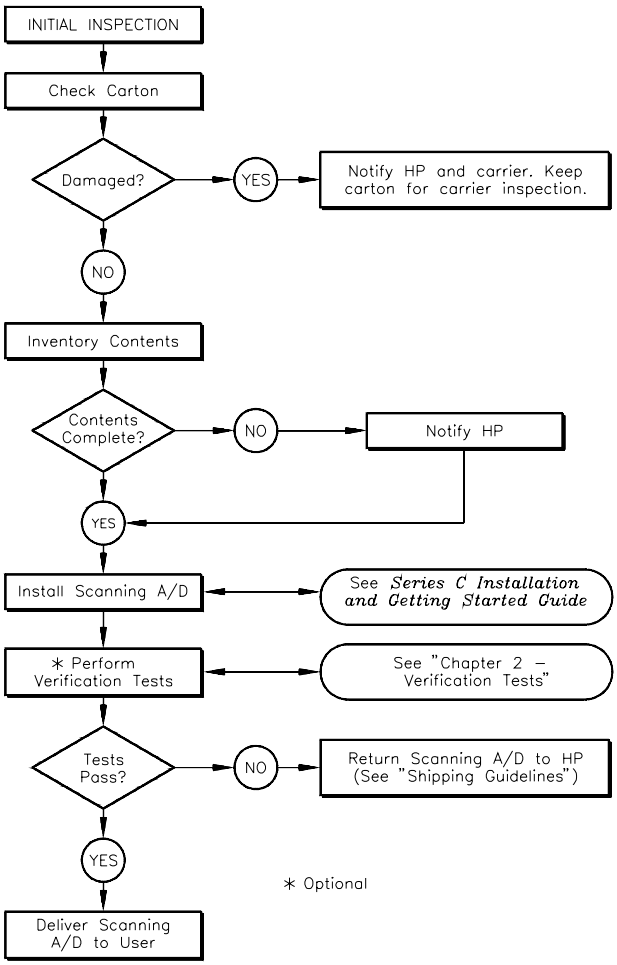
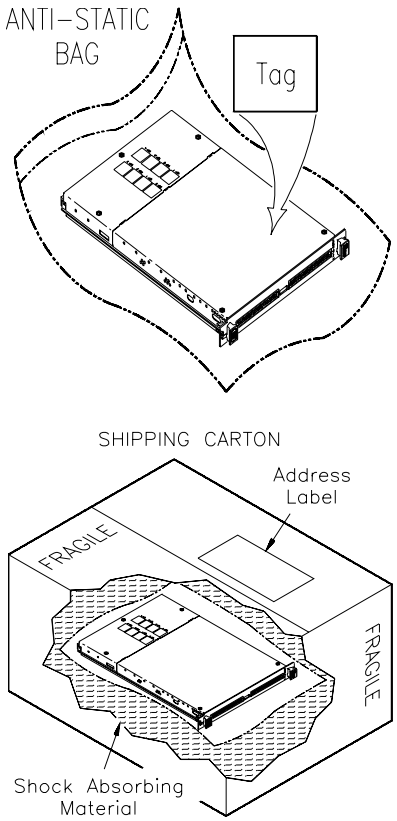


Figure 1-4. Initial (Incoming) Inspection Guidelines

Shipping Guidelines

Follow the steps in Figure 1-5, “Packaging/Shipping Guidelines,” on page 23 to return an HP E1413C Scanning A/D and/or SCPs to a Hewlett-Packard Sales and Support Office or to a Service Center.



1 Remove Terminal Block/SCPs

- Remove SCP(s) from instrument*
- Remove terminal block from instrument

2 Prepare Instrument/SCP

- Attach tag to instrument that identifies
  - -- Owner
  - -- Model Number/Serial Number
  - -- Service Required
- Place tagged device in anti-static bag

3 Package Instrument/SCP

- Place packaged instrument in shipping carton**
- Place 75 to 100 mm (3 to 4 inches) of shock-absorbing material around the device
- Seal the shipping carton securely
- Mark the shipping carton FRAGILE

4 Ship Instrument to Hewlett-Packard

- Place address label on shipping carton
- Send carton to Hewlett-Packard

* When returning an HP E1413C, first remove and save all installed SCPs. See *Chapter 5 - Service* for procedures to remove SCPs from the HP E1413C Scanning A/D.

** We recommend you use the same shipping materials as those used in factory packaging (available from Hewlett-Packard). For other (commercially-available) shipping materials, use a double-wall carton with minimum 2.4 MPa (350 psi) test.

Figure 1-5. Packaging/Shipping Guidelines

Recommended Test Equipment

See Table 1-4 for test equipment recommended to test and service the HP E1413A/B Scanning A/D and SCPs. Essential requirements for each piece of test equipment are listed in the *Requirements* column. You may substitute other equipment if it meets the requirements listed in the table.

Table 1-4. Recommended Test Equipment

Instrument	Requirements	Recommended Model	Use
Controller, HP-IB	HP-IB compatibility as defined by IEEE Standard 488-1987 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5	HP 9000 Series 300 or IBM Compatible PC with HP 82340 or 82341 HP-IB module	F,P
Mainframe	Compatible with HP E1405B or HP E1406A Command Module	HP E1401B/T or E1421B (requires HP E1405B or E1406A)	F,P
Digital Multimeter	Voltage Range: ±20 Vdc Resistance Range: 1 MΩ Current Range: 100µA to 1 mA DC	HP 3458A	A,T
Voltage Source	Voltage Range: ± 20 Vdc	Datron 4708 Option 10	F,P
*A = Adjustments, F = Functional Verification Tests, P = Performance Verification Tests, T = Troubleshooting			

Chapter 2
Verification Tests

Introduction

Unless otherwise noted, references to the HP E1413C also apply to the HP E1313A (and its option 001) and the HP E1413A/B. The three levels of test procedures described in this chapter are used to verify that the HP E1413C Scanning A/Ds and associated Signal Conditioning Plug-Ons (SCPs):

- are functional (Functional Verification)
- meet selected testable specifications (Operation Verification)
- meet all testable specifications (Performance Verification)

WARNING **Do not perform any of the following verification tests unless you are a qualified, service-trained technician and have read the WARNINGS and CAUTIONS in Chapter 1.**

Test Conditions/ Procedures

See Table 1-4 for test equipment requirements. You should complete the performance verification tests on a periodic basis, as required. For best results, the test environment temperature should be $23^{o}C \pm 1^{o}C$.

The verification tests assume that the person performing the tests understands how to operate the mainframe, the Scanning A/D, and specified test equipment. The test procedures do not specify equipment settings for test equipment, except in general terms. It is assumed a qualified, service-trained technician will select and connect any cables, adapters, and probes required for the test.

Performance Test Record

Record the results of each performance verification test in Table 2-1, *HP E1313A, E1413A/B/C Performance Test Record*. Copy the form as needed.

Verification Test Examples

Each verification test includes an example program, and all example programs are on the *HP E1413C Service Programs* disk sent with this manual. All example programs assume the following:

- Controller is a PC
- Programming language is ANSI C
- Scanning A/D address is 70903 (logical address is 24)
- DMM is an HP 3458A at address 722

Functional Verification Tests

The purpose of the functional verification tests is to verify that the Scanning A/D is functioning properly. No attempt is made to verify that the instrument is meeting specifications. Functional verification tests for the HP E1413C Scanning A/Ds include:

- Test F-1: Scanning A/D Self-Test
- Test F-2: A/D Overrange Detection
- Test F-3: Open Transducer Detection

Note For a quick functional check of the A/D, perform only the Self-Test.

Test F-1: Scanning A/D Self-Test

Description

The self-test provides a high degree of confidence that the HP E1413C Scanning A/D is functional. The self-test may take several minutes.

Note During the first 5 minutes after power-on, the self-test may fail. Allow the Scanning A/D to warm up before running the self-test.

Test Procedure

1 Execute the self-test

*TST?	*Self-test command*

2 Read the result

ENTER statement	*"0" = test passed. Any other number = self-test failure.*

Example Program

Run the "SELFTEST" program to perform a self-test of the Scanning A/D. The test also identifies installed SCPs and tests for system errors. If the self-test passes, the display is: **Self-test PASSED**.

If the self-test fails, it will display the error number:

Self Test Error: 3052

Test F-2: A/D Overrange Detection

Description

This test checks the DCV overrange detection function of the A/D. An input of ±17 Vdc is applied with the Scanning A/D set to the 16V range. The result should be an overrange indication (± 9.9E+37). *This test applies to only the E1501A through E1503A, E1508A through E1512A, E1514A, and E1515A SCPs.*

Test Procedure

1 Make Equipment Connections

- Set up the equipment as shown in Figure 2-1. Connections are shown to channel 07. You can connect inputs to any channel.
- Be sure the desired SCP is installed for the channel(s) tested.

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

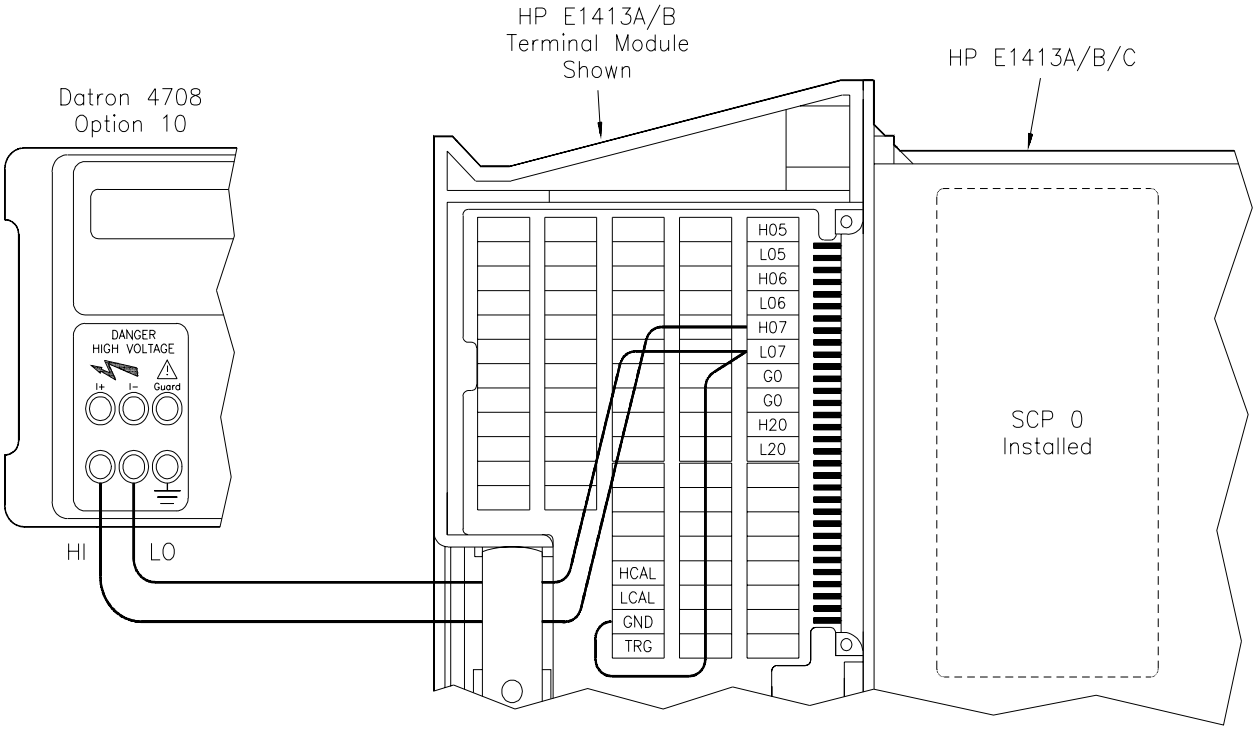


Figure 2-1. A/D Overrange Detection Test Connections

2 Set up the Scanning A/D

Test with +17 Vdc applied (Input to channel 07 illustrated)

*RST;*CLS;*OPC?	*Reset Scan A/D and clear status register*
ENTER statement	**OPC? response*
FUNC:VOLT 16, (@107,107)	*Set voltage meas, 16V range on ch 07*

3 Trigger the Scanning A/D

INIT	*Set Wait For Trigger state*
TRIG	*Trigger the instrument*

4 Read measurement from Current Value Table

DATA:CVT? (@107)	*Reads channel 07 voltage from CVT*
ENTER statement	*Returns reading - should be 9.9E+37*

5 Repeat Steps 3 and 4 for -17 Vdc input

Example Program

Run the "OVERRANG" program to perform an overrange check for +17 Vdc and -17 Vdc input to the Scanning A/D. Typical results when the test passes are:

+17 Vdc overrange indication = 9.9E+37
-17 Vdc overrange indication = -9.9E+37

Test F-3: Open Transducer Detection

Description

This test checks the HP E1413C "Open Transducer Detection (OTD)" capability. To do this test, an input short is applied and the channel voltage is measured. Then, the input is opened and the channel voltage is again measured. The short should return <1 Vdc and the open should return 9.9E+37 (overrange). *This test applies to only the E1501A through E1503A, E1508A through E1512A, and E1518A (Channels 4 - 7 only) SCPs.*

Note

Enabling any SCP channel for OTD selects all eight channels on that SCP. Thus, an open transducer on any channel to an enabled SCP results in an OTD indication for the SCP. You will need to determine which channel(s) have open transducers. See Chapter 5 - Service for guidelines.

Test Procedure

1 Make Equipment Connections

- Set up the equipment as shown in Figure 2-2. Connections are shown for channel 07 - modify as required.
- Be sure the desired SCP is installed for the channel tested.

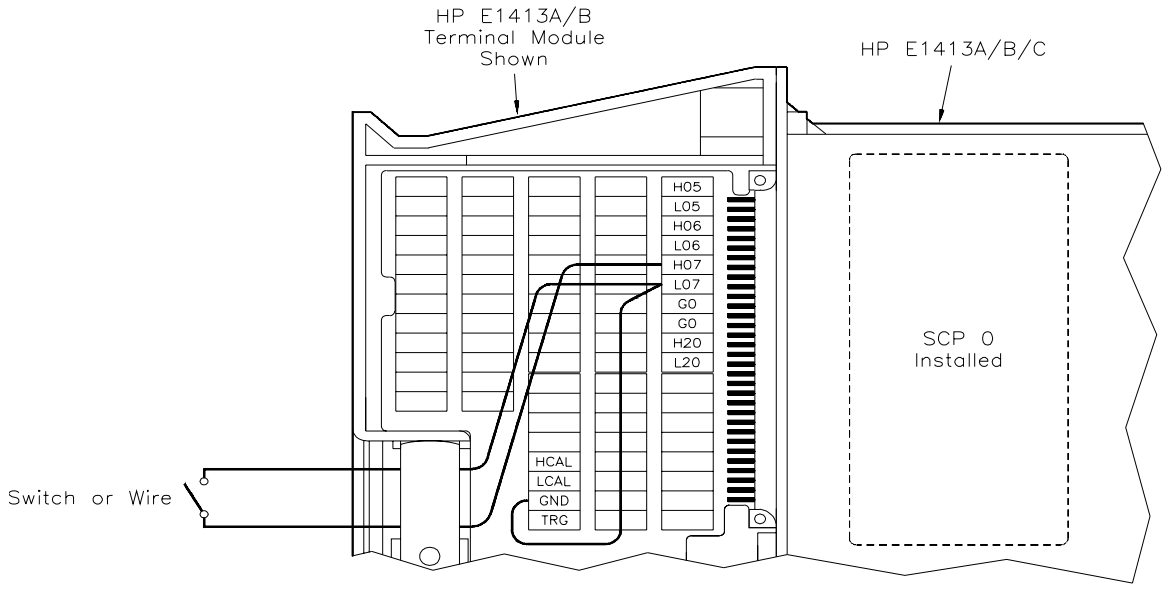


Figure 2-2. Open Transducer Detection Connections

2 Set up the Scanning A/D

Test with short applied to Scanning A/D (channel 07 illustrated)

```
*RST;*CLS;*OPC?
```

Reset Scanning A/D and clear status register

ENTER statement	**OPC? response*
FUNC:VOLT 4, (@107,107)	*Set for voltage meas, 4V range on channel 07*
DIAG:OTD ON, (@107)	*Enable OTD on channels 00 - 07 (SCP 0)*

3 Trigger the Scanning A/D

INIT	*Set Wait For Trigger state*
WAIT 15	*Filter settling time*
TRIG	*Trigger the Scanning A/D*

4 Read measurement from Current Value Table

DATA:CVT? (@107)	*Read channel 07 voltage from CVT*
ENTER statement	*Return reading - should be <1 Vdc*

5 Repeat Steps 3 and 4 for open input. Reading for this test should be 9.9E+37 (overrange).

Example Program

Run the "OPENTRAN" program to perform an open transducer check. A typical result for this test is:

Shorted input value = 0.002929 Vdc
Open input value = 9.9E+37 Vdc

Performance Verification Tests

The procedures in this section are used to test the Scanning A/D's DC voltage accuracy using the 90-day specifications in the *HP E1313A and E1413C User's Manual* as the performance standards. The results of each performance verification test can be recorded on the *HP E1313A, E1413A/B/C Performance Test Record* (Table 2-1 at the end of this chapter).

Note

For the HP E1413C Scanning A/D, Operation Verification tests are the same as the Performance Verification tests. If the Scanning A/D fails a performance verification test, adjust the instrument using the procedures in Chapter 3 - Adjustments and then rerun the test. If the test fails again, replace the instrument.

Performance Verification Test Conditions

The assumed conditions for the HP E1413C performance verification tests are based on the following specifications/conditions:

- Minimum 1 hour warm-up for the Scanning A/D and DC Standard
- Test environment temperature $23^{o}C \pm 1^{o}C$
- Linearity = ± % of reading (90-day specifications)

- *CAL? command executed before measurements
- CAL:ZERO? executed within 5 minutes after *CAL?
- [SENSe:]FILTer[:LPASs][:STATe] ON set

Performance Verification Test Programs

The table on the next page summarizes Scanning A/D performance verification tests. The *filename* in the table refers to the name of the verification test program on the *HP E1413C Service Programs* disk.

The programs on the disk are in standard ANSI C language using the HP I/O Library (SICL/VISA). The disk is DOS formatted and the programs can be opened into any standard DOS editor. The programs were written and verified in Microsoft® Visual C++, on an HP Vectra computer, with an HP 82341 HP-IB interface installed in the computer. The programs should compile under any standard ANSI C compiler.

To run the programs you must have the HP I/O Library (SICL/VISA), SCPI Drivers, and an HP 82340 or 82341 HP-IB module installed and properly configured in your computer.

HP E1413C Scanning A/D
Performance Verification Tests
Example Programs List

Test	Test Name	Test Description	SCP/Gain	Filename
2-1	DCV Accuracy - E1501A	DC voltage accuracy for the .0625V, .25V, 1.0V, 4.0V, and 16.0V ranges	E1501A Gain X1	PERF01.C
2-2	DCV Accuracy - E1502A and E1512A	DC voltage accuracy for the .0625V, .25V, 1.0V, 4.0V, and 16.0V ranges	E1502A & E1512A Gain X1	PERF02_12.C
2-3	DCV Accuracy - E1503A (Gain X1)	DC voltage accuracy for the .0625V, .25V, 1.0V, 4.0V, and 16.0V ranges and 2Hz, 10Hz, 100Hz filters or filter OFF	E1503A Gain X1	PERF0301.C
2-4	DCV Accuracy - E1503A (Gain X8)	DC voltage accuracy for the .0625V, .25V, 1.0V, 4.0V, and 16.0V ranges and 2Hz, 10Hz, 100Hz filters or filter OFF	E1503A Gain X8	PERF0308.C
2-5	DCV Accuracy - E1503A (Gain X64)	DC voltage accuracy for the .0625V, .25V, 1.0V, 4.0V, and 16.0V ranges and 2Hz, 10Hz, 100Hz filters or filter OFF	E1503A Gain X64	PERF0364.C
2-6	DCI Accuracy - E1505A	DC current accuracy for the 30µA and 488µA ranges	E1505A	PERF05.C
2-7	Excitation Voltage Accuracy - E1506A	3.9 Vdc excitation voltage accuracy	E1506A	PERF06_07.C
2-8	Excitation Voltage Accuracy - E1507A	3.9 Vdc excitation voltage accuracy	E1507A	PERF06_07.C
2-9	DCV Accuracy -E1508A	DC voltage accuracy for the .0625V, .250V, 1.0V, 4.0V, and 16.0V ranges	E1508A Gain X16	PERF08.C
2-10	DCV Accuracy - E1509A	DC voltage accuracy for the .0039V, .0156V, .0625V, and .25V ranges	E1509A Gain X64	PERF09.C
2-11	DCV Accuracy - E1510A S&H channels.	DC voltage accuracy and sample & hold droop for the 4 sample & hold channels	E1510A all gains	PERF10SH.C
2-12	DCV Accuracy - E1511A	DC voltage accuracy and sample & hold droop for the 4 Bridge Sense (Sample & Hold) channels	E1511A all gains	PERF11.C
2-13	DCV Accuracy - E1510A Straight- Through channels	DC voltage accuracy for the .0625V, .250V, 1.0V, 4.0V, and 16.0V ranges	E1510A Gain X1	PERF10ST.C
2-14	Excitation Voltage - E1511A	1, 2, 5, and 10 volt Excitation Voltage measurement	E1511A	PERF11.C
2-15	DCV Accuracy - E1512A	DC voltage accuracy for the .0625V, .25V, 1.0V, 4.0V, and 16.0V ranges	E1512A Gain X1	PERF02_12.C
2-16	DCV Accuracy - E1513A	DC voltage accuracy for the 1.0V and 4.0V ranges	E1513A Gain ÷ 16	PERF13.C
2-17	DCV Accuracy - E1514A and E1515A	DC voltage accuracy for the 16V range	E1514A & E1515A Gain X1	PERF14_15.C

Test	Test Name	Test Description	SCP/Gain	Filename
2-18	DCV Accuracy - E1516A and E1517A	DC voltage accuracy for the 4V range	E1516A & E1517A Gain X64	PERF16_17.C
2-19	DCI Accuracy - E1518A (ch 00-03)	DC current accuracy for the 30µA and 488µA ranges	E1518A	PERF18i.C
2-20	DCV Accuracy - E1518A (ch 04-07)	DC voltage accuracy for the .0625V, .25V, 1.0V, 4.0V, and 16.0V ranges	E1518A Gain X1	PERF18V.C

Test 2-1: DCV Accuracy - E1501A
Test 2-2: DCV Accuracy - E1502A & E1512A

Description

Test 2-1 checks HP E1413C Scanning A/D DC voltage measurement accuracy when an E1501A Straight-Through SCP is used. Test 2-2 checks DCV accuracy when an E1502A or E1512A Fixed Filter SCP is used.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to terminal block (see Figure 2-3)

[b] Connect terminal block to installed Scanning A/D

Note

The procedure shown uses channel 07. Substitute the appropriate channel number and SCP number if you use another channel.

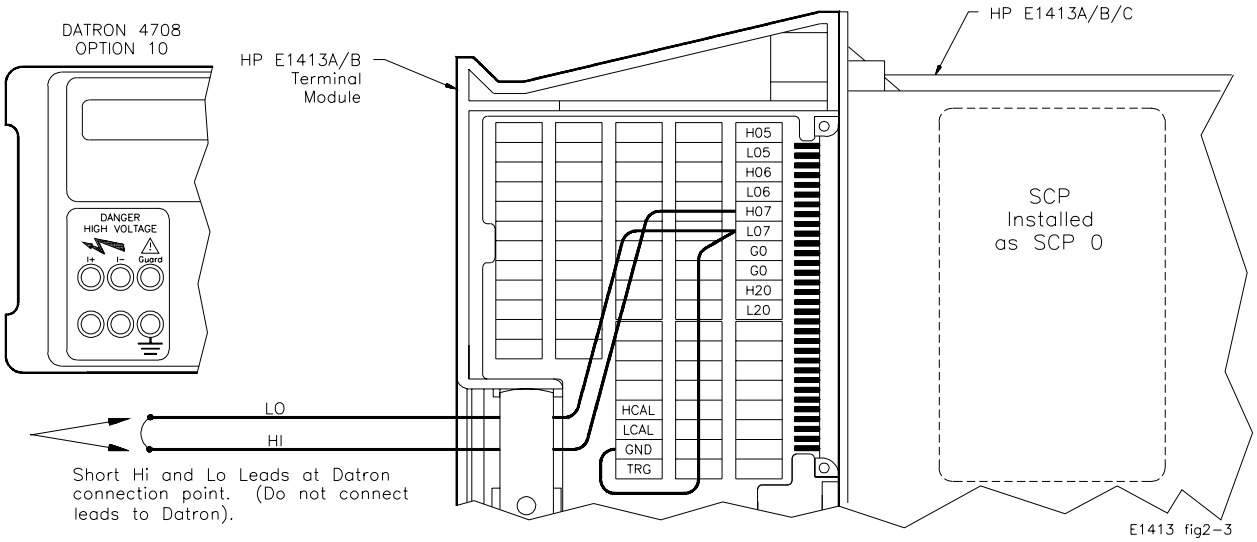


Figure 2-3. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1501A, E1502A or E1512A)

```
SYST:CTYP? (@107)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform Channel Calibrations

```
CAL:TARE:RESET             Erase all previous tares
CAL:STOR TARE              Store tare in FLASH ROM
*CAL?                      Perform channel calibration
CAL:STORE ADC              Store *CAL? results
```

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-4)

[b] Set DC Standard OUTPUT to -50 mV

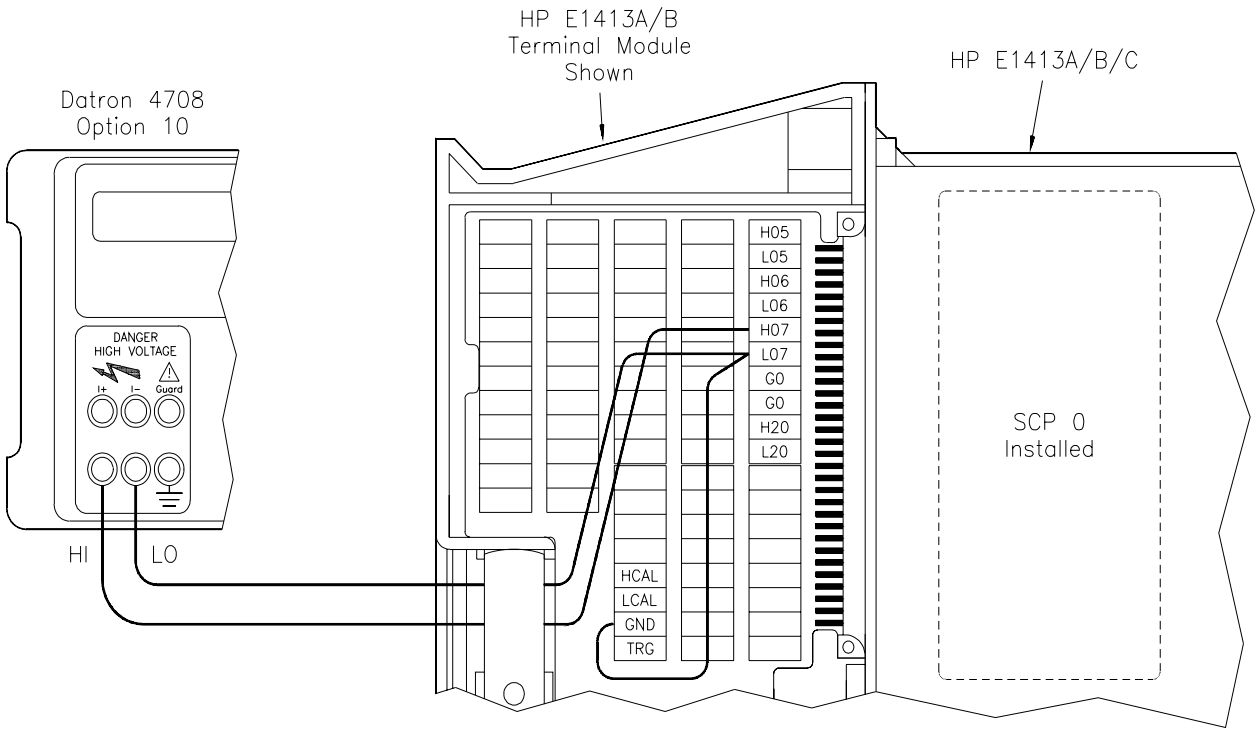


Figure 2-4. DC Standard Connections

5 Make DCV Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	**OPC? return*
FUNC:VOLT .0625, (@107,107)	*Set DCV meas, .0625V range on ch 07*
ROUT:SEQ:DEF LIST1, (@107,107,107)	*Defines ch 07 as scan list for LIST1*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*
TRIG:SOUR IMM	*Sets continuous triggering*
SAMP:TIM LIST1, 1E-3	*Pace measurements at 1 msec intervals*
SENS:FILT ON	*Enables A/D filter*
CAL:ZERO?	*Auto zero measurement*
ENTER statement	*Wait for CAL:ZERO to complete*
INIT:CONT ON	*Sets continuous Wait for Trigger*

	state
DATA:FIFO:PART? 400	*Returns 400 readings from FIFO buffer*
ENTER statement	*Enters 400 readings*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Result)/400.0	*Result is average of 400 readings*

6 Repeat Measurements for each Input and Range

[a] Set DC Standard OUTPUT to -37 mV and repeat Step 5 (except for *RST;*CLS;*OPC?)

[b] Repeat [a] for the inputs and ranges in the following table

A/D Range	.0625 V	.25 V	1.0 V	4.0 V	16.0 V
Input (Vdc)	-0.050	-0.20	-0.80	-3.2	-12.8
	-0.037	-0.15	-0.60	-2.4	- 9.6
	-0.025	-0.10	-0.40	-1.6	- 6.4
	-0.012	-0.05	-0.20	-0.8	- 3.2
	0.000	0.00	0.00	0.0	0.0
	0.012	0.05	0.20	0.8	3.2
	0.025	0.10	0.40	1.6	6.4
	0.037	0.15	0.60	2.4	9.6
	0.050	0.20	0.80	3.2	12.8

Example Programs

To test the E1501A run the "PERF01" program. To test the E1502A or E1512A run the "PERF02_12" program. Typical results for Tests 2-1 and 2-2 follow.

Test 2-1: DCV Accuracy - E1501A (PERF01) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1501A Straight-Through SCP

Range	Input	Minimum	Reading	Maximum
.0625 V	-50.0000 mV	-50.0103 mV	-50.0071 mV	-49.9897 mV
.0625 V	-37.0000 mV	-37.0090 mV	-37.0063 mV	-36.9910 mV
.	.	.	.	.
.	.	.	.	.
16.0 V	+12.8000 V	+12.7982 V	+12.8001 V	+12.8018 V

Test 2-2: DCV Accuracy - E1502A or E1512A (PERF02_12) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1502A or E1512A Fixed Filter SCP

Range	Input	Minimum	Reading	Maximum
.0625 V	-50.0000 mV	-50.0122 mV	-50.0046 mV	-49.9878 mV
.0625 V	-37.0000 mV	-37.0109 mV	-37.0049 mV	-36.9891 mV
.	.	.	.	.
.	.	.	.	.
16.0 V	+12.8000 V	+12.7982 V	+12.8001 V	+12.8018 V

Test 2-3: DCV Accuracy - E1503A (Gain X1)
Test 2-4: DCV Accuracy - E1503A (Gain X8)
Test 2-5: DCV Accuracy - E1503A (Gain X64)

Description

These three tests check DC Voltage measurement accuracy when an E1503A Amplifier+Filter SCP is used. Test 2-3 uses gain X1, Test 2-4 uses gain X8, and Test 2-5 uses gain X64.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to terminal block (see Figure 2-5)

[b] Connect terminal block to installed Scanning A/D

Note

The procedure shown uses channel 07, gain X1, and 100 Hz filter cutoff frequency. Substitute the appropriate channel number, gain, and filter cutoff frequency as required for your application.

.

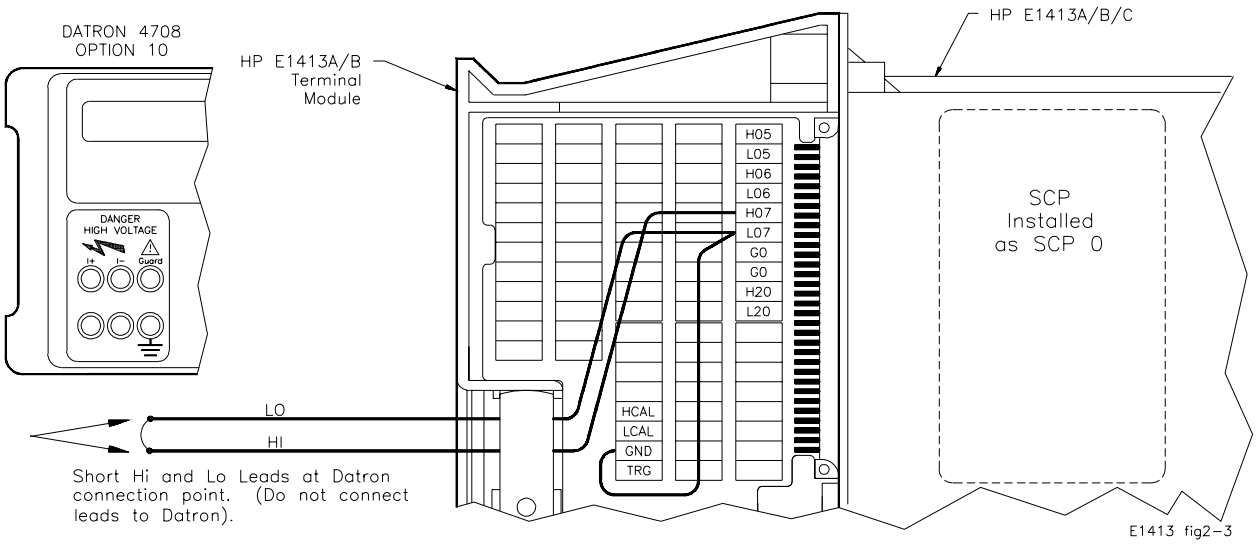


Figure 2-5. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1503A)

```
SYST:CTYP? (@107)        Check SCP 0 type
ENTER statement          Returns SCP type
```

3 Perform Channel Calibrations

```
CAL:TARE:RESET           Erase all previous tares
CAL:STOR TARE            Store tare in FLASH ROM
*CAL?                    Perform channel calibration
CAL:STORE ADC            Store *CAL? results
```

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-6)

[b] Set DC Standard OUTPUT to -50 mV

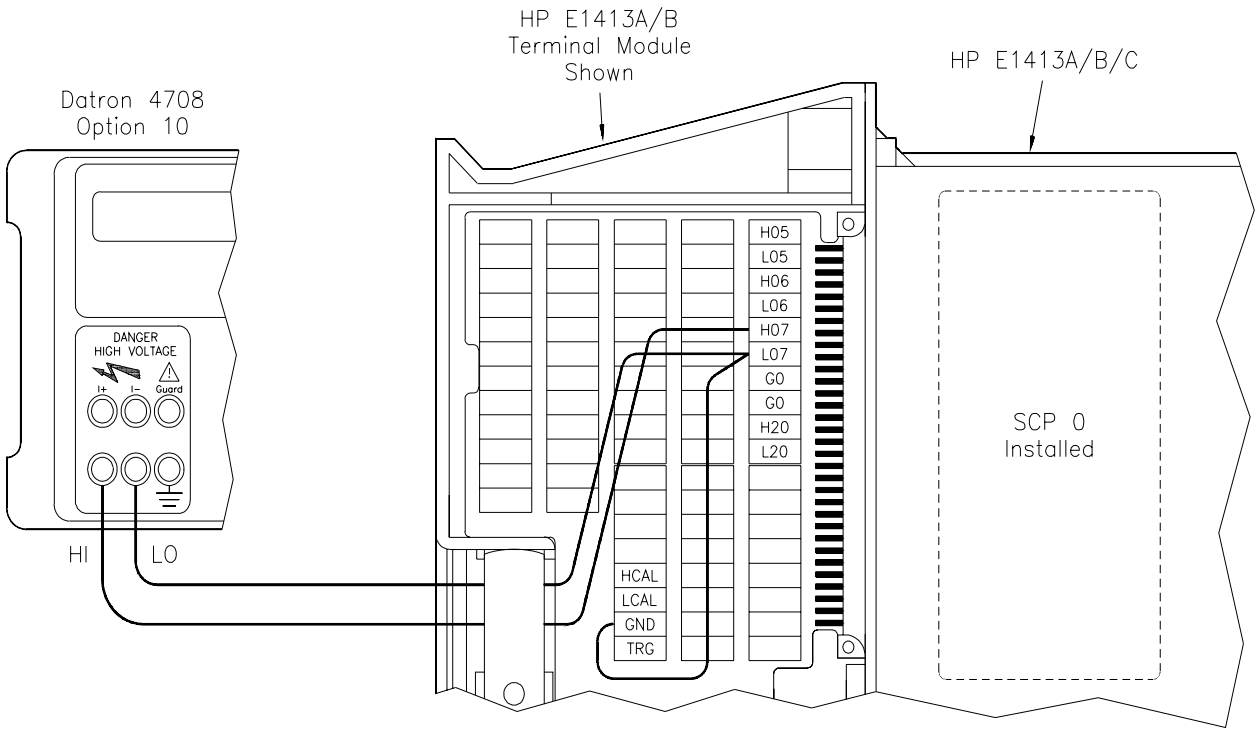


Figure 2-6. DC Standard Connections

5 Make DCV Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	*Verify *OPC? completion*
INP:GAIN 1, (@107)	*Set SCP gain X1*
INP:FILT:FREQ 100, (@107)	*Set 100 Hz as filter cutoff freq*
FUNC:VOLT .0625, (@107,107)	*Set DCV meas, .0625V range on ch 07*
ROUT:SEQ:DEF LIST1, (@107,107,107)	*Defines ch 07 as scan list for LIST1*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*
TRIG:SOUR IMM	*Sets continuous triggering*
SAMP:TIM LIST1, 1E-3	*Pace measurements at 1 msec intervals*
SENS:FILT ON	*Enables A/D filter*
CAL:ZERO?	*Auto zero measurement*

ENTER statement	*Wait for CAL:ZERO to complete*
INIT:CONT ON	*Sets continuous Wait for Trigger state*
DATA:FIFO:PART? 400	*Returns 400 readings from FIFO buffer*
ENTER Statement	*Enters 400 readings*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Result)/400.0	*Result is average of 400 readings*

6 Repeat measurements for each input and range

[a] Set DC Standard OUTPUT to -37 mV and repeat Step 5 (except for *RST;*CLS;*OPC?)

[b] Repeat [a] for the inputs and ranges in the following table

A/D Range	.0625V	.25V	1.0V	4.0V	16.0V
SCP Gain X1 (Test 2-3)	-50 mV -37 mV -25 mV -12 mV 0 mV 12 mV 25 mV 37 mV 50 mV	-0.20 V -0.15 V -0.10 V -0.05 V 0.00 V 0.05 V 0.10 V 0.15 V 0.20 V	-0.80 V -0.60 V -0.40 V -0.20 V 0.00 V 0.20 V 0.40 V 0.60 V 0.80 V	-3.2 V -2.4 V -1.6 V -0.8 V 0.0 V 0.8 V 1.6 V 2.4 V 3.2 V	-12.8 V - 9.6 V - 6.4 V - 3.2 V 0.0 V 3.2 V 6.4 V 9.6 V 12.8 V
SCP Gain X8 (Test 2-4)	-6.0 mV -4.5 mV -3.0 mV -1.5 mV 0.0 mV 1.5 mV 3.0 mV 4.5 mV 6.0 mV	-25 mV -18 mV -12 mV - 6 mV 0 mV 6 mV 12 mV 18 mV 25 mV	-100 mV - 75 mV - 50 mV - 25 mV 0 mV 25 mV 50 mV 75 mV 100 mV	-0.4 V -0.3 V -0.2 V -0.1 V 0.0 V 0.1 V 0.2 V 0.3 V 0.4 V	-1.6 V -1.2 V -0.8 V -0.4 V 0.0 V 0.4 V 0.8 V 1.2 V 1.6 V
SCP Gain X64 (Test 2-5)	N/A	-3.0 mV -2.5 mV -1.5 mV -0.8 mV 0.0 mV 0.8 mV 1.5 mV 2.5 mV 3.0 mV	-12.8 mV - 9.6 mV - 6.4 mV - 3.2 mV 0.0 mV 3.2 mV 6.4 mV 9.6 mV 12.8 mV	-50.0 mV -37.5 mV -25.0 mV -12.5 mV 0.0 mV 12.5 mV 25.0 mV 37.5 mV 50.0 mV	-200 V -150 V -100 V - 50 V 0 V 50 V 100 V 150 V 200 V

Example Programs

To perform Test 2-3, run the "PERF0301" program. To perform Test 2-4, run the "PERF0308" program. To perform Test 2-5, run the "PERF0364" program. Typical results for the "PERF0301","PERF0308" and "PERF0364" programs (all with 100 Hz filter) follow.

Note There are 14 performance verification tests available for the E1503A SCP. You may do any or all tests, depending on your specific application requirements. The E1503A SCP was factory-tested at 2 Hz, 10 Hz, 100 Hz and filter OFF for gain X1; at 100 Hz for gain X8; and at 100 Hz for gain X64.

Test 2-3: DCV Accuracy - E1503A (Gain X1) (PERF0301) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1503A Amplifier+Filter SCP
Gain X1 and 100 Hz Filter

Range	Input	Minimum	Reading	Maximum
.0625 V	-50.0000 mV	-50.0118 mV	-50.0032 mV	-49.9882 mV
.0625 V	-37.0000 mV	-37.0105 mV	-37.0035 mV	-36.9895 mV
.	.	.	.	.
.	.	.	.	.
16.0 V	+12.8000 V	+12.7982 V	+12.7997 V	+12.8018 V

Test 2-4: DCV Accuracy - E1503A (Gain X8) (PERF0308) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1503A Amplifier+Filter SCP
Gain X8 and 100 Hz Filter

Range	Input	Minimum	Reading	Maximum
.0625 V	-6.0000 mV	-6.0044 mV	-6.0010 mV	-5.9956 mV
.0625 V	-4.5000 mV	-4.5043 mV	-4.5029 mV	-4.4953 mV
.	.	.	.	.
.	.	.	.	.
16.0 V	+1.6000 V	+1.5998 V	+1.6001 V	+1.6002 V

Test 2-5: DCV Accuracy - E1503A (Gain X64) (PERF0364) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1503A Amplifier+Filter SCP
Gain X64 and 100 Hz Filter

Range	Input	Minimum	Reading	Maximum
.25 V	-3.0000 mV	-3.0024 mV	-3.0019 mV	-2.9976 mV
.25 V	-2.5000 mV	-2.5024 mV	-2.5016 mV	-2.4977 mV
.	.	.	.	.
.	.	.	.	.
16 V	+200.0000 mV	+199.972 mV	+200.0024 mV	+200.028 mV

Test 2-6: DCI Accuracy - E1505A

Description This test checks DC current output accuracy when an E1505A Current Source SCP is used.

Test Procedure

1 Make Channel Connections

[a] Connect wiring to terminal block and DMM (see Figure 2-7)

[b] Connect the terminal block to the installed Scanning A/D

[c] Connect an HP-IB cable from the DMM to the computer

Note The procedure shown uses channel 00. Substitute the appropriate channel number as required for your application. Using shielded, teflon-coated cable for connections is highly recommended.

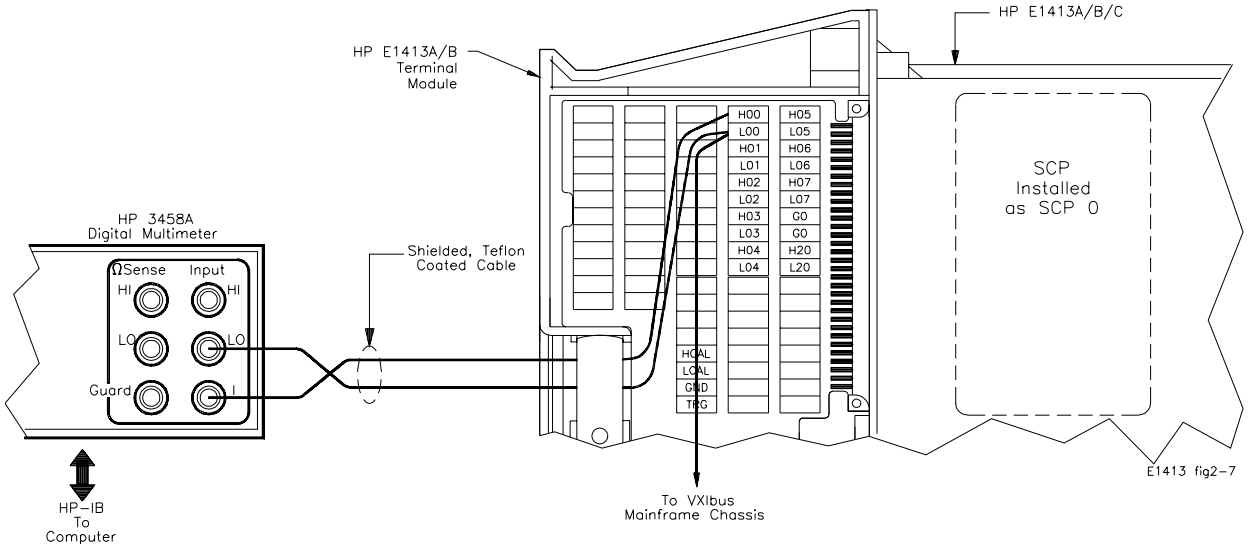


Figure 2-7. Typical Wiring Configurations

2 Check SCP 0 type (must be E1505A)

```
SYST:CTYP? (@100)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform HP 3458A DMM Autocalibration (Optional)

For most accurate results, an autocalibration (ACAL) of the HP 3458A DMM is recommended every 24 hours. (The autocalibration takes about 12 minutes.) As required, perform an autocalibration with the following command. If autocalibration is not required, go to step 4.

```
OUTPUT 722; "ACAL ALL"     Performs HP 3458A DMM autocalibration
```

4 Perform Channel Calibration (30 µA range)

Note It is essential to perform a channel calibration (*CAL?) for each current range before measuring the current output on the range. For example, you must set the scanning A/D for DCI operation on the 30µA range and perform *CAL? for the 30µA range before measuring the 30µA output. The same procedure is required for the 488µA range.

```
OUTP:CURR:STAT ON, (@100)          Enable current output on channel 00
OUTP:CURR:AMPL 30E-6, (@100)       Set output current on ch 00 to 30 uA
*CAL?                              Perform *CAL?
CAL:ZERO?                          Perform A/D Zero
```

5 Make DCI Measurement (30µA range)

```
OUTPUT 722;"PRESET NORM"           Set HP 3458A DMM @ address 722 to known state
OUTPUT 722;"NPLC 100"              Set HP 3458A DMM to NPLC 100
OUTPUT 722;"DCI 100E-6"            Set DMM range to DCI @ 100 uA
WAIT 5                             Wait 5 sec for settling
ENTER statement                    Return DCI reading (~30.518 uA)
```

6 Perform Channel Calibration (488 µA range)

```
OUTP:CURR:STAT ON, (@100)          Enable current output on channel 00
OUTP:CURR:AMPL 488E-6, (@100)      Set output current on ch 00 to 488 uA
*CAL?                              Perform *CAL?
CAL:ZERO?                          Perform A/D Zero
```

7 Make DCI Measurement (488 µA range)

```
OUTPUT 722;"PRESET NORM"           Set HP 3458A DMM @ address 722 to known state
OUTPUT 722;"NPLC 100"              Set HP 3458A DMM to NPLC 100
OUTPUT 722;"DCI 1E-3"              Set DMM range to DCI @ 1 mA
WAIT 5                             Wait 5 sec for settling
ENTER statement                    Return DCI reading ( ~488.28 uA)
```

Example Program

To perform Test 2-6, run the "PERF05" program. Typical results for the "PERF05" program follow.

Test 2-6: DCI Accuracy - E1505A (PERF05) Typical Results

HP E1413C Scanning A/D
DC Current Accuracy Test
E1505A Current Source SCP

Current (µA)	Minimum (µA)	Reading (µA)	Maximum (µ)A
30.518	30.509	30.521	30.527
488.28	488.22	488.29	488.34

Test 2-7: Excitation Voltage Accuracy - E1506A
Test 2-8: Excitation Voltage Accuracy - E1507A

Description

These two tests check SCP excitation voltage accuracy. Test 2-7 uses an E1506A 120Ω Strain Gage SCP and Test 2-8 uses an E1507A 350Ω Strain Gage SCP. An HP 3458A DMM is used to measure the excitation voltage for each SCP.

Test Procedure

1 Make Channel Connections

[a] Connect wiring to terminal block and DMM (see Figure 2-8)

[b] Connect the terminal block to the installed Scanning A/D

[c] Connect an HP-IB cable from the DMM to the computer

Note

This procedure shown uses channel 06. Substitute the appropriate channel number as required for your application. Connections are shown to channel 06 (+E and -E for SCP 0). Modify the connections as required for the channel you use.

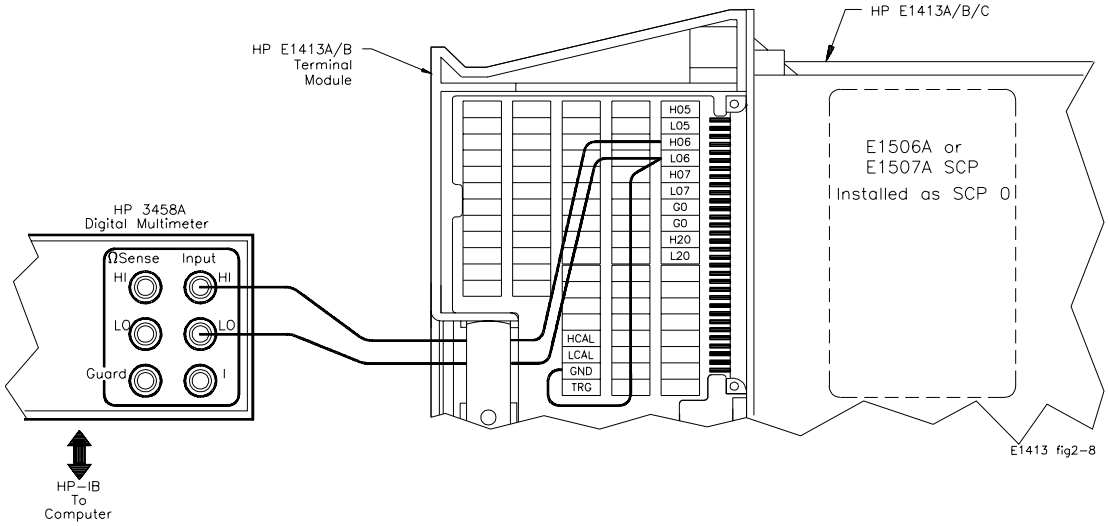


Figure 2-8. Typical Wiring Configuration

2 Check SCP 0 Type (must be E1506A or E1507A)

SYST:CTYP? (@106)	*Check SCP 0 type*
ENTER statement	*Returns SCP type*

3 Perform HP 3458A DMM Autocalibration (Optional)

For most accurate results, an autocalibration (ACAL) of the HP 3458A DMM is recommended every 24 hours. (The autocalibration takes about 12 minutes.) As required, perform an autocalibration with the following command. If autocalibration is not required, go to Step 4.

```
OUTPUT 722; "ACAL ALL"          HP 3458A DMM autocalibration
```

4 Perform Channel Calibration

```
*RST;*CLS;*OPC?                 Reset Scanning A/D, clear status registers, wait for completion
ENTER statement                 Return *OPC? completion
*CAL?                           Perform *CAL?
CAL:ZERO?                       Perform A/D Zero
```

5 Measure Excitation Voltage

```
OUTPUT 722;"PRESET NORM"        Set HP 3458A DMM @ address 722 to known state
OUTPUT 722;"NPLC 100"           Set HP 3458A DMM to NPLC 100
ENTER statement                 Return Excitation Voltage (~3.9 Vdc)
```

Example Programs

To perform Test 2-7 or Test 2-8, run the "PERF06" program. Typical results for the "PERF06" program follows.

Test 2-7: Excitation Voltage Accuracy - E1506A (PERF06) Typical Results

```
HP E1413C Scanning A/D
Excitation Voltage Accuracy Test
E1506A Strain Gage SCP

Minimum          Measured          Maximum

3.899488 Vdc     3.900027 Vdc      3.900512 Vdc
```

Test 2-8: Excitation Voltage Accuracy - E1507A (PERF06) Typical Results

```
HP E1413C Scanning A/D
Excitation Voltage Accuracy Test
E1507A Strain Gage SCP

Minimum          Measured          Maximum

3.899488 Vdc     3.900068 Vdc      3.900512 Vdc
```

Test 2-9: DCV Accuracy - E1508A
Test 2-10: DCV Accuracy - E1509A

Description

Test 2-9 checks DC voltage measurement accuracy when an E1508A Fixed Filter+Amplifier SCP is used. Test 2-10 checks DC voltage measurement accuracy when an E1509A Fixed Filter+Amplifier SCP is used.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to terminal block (see Figure 2-9)

[b] Connect terminal block to installed Scanning A/D

Note

The procedure shown uses channel 07. Substitute the appropriate channel number and SCP number if you use another channel.

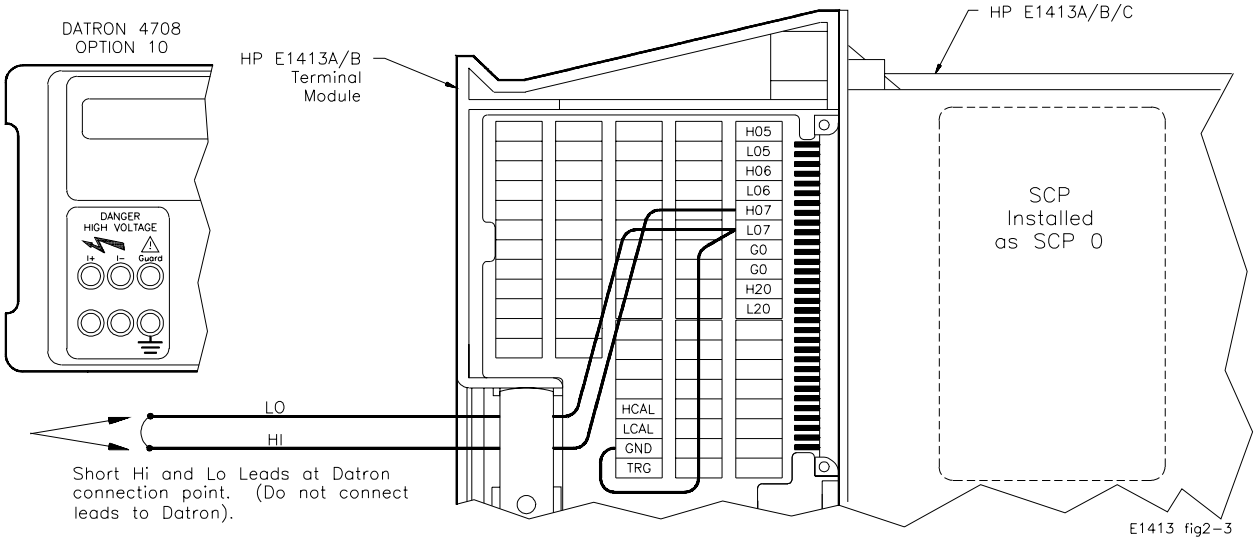


Figure 2-9. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1508A or E1509A)

```
SYST:CTYP? (@107)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform Channel Calibrations

```
CAL:TARE:RESET             Erase all previous tares
CAL:STOR TARE              Store tare in FLASH ROM
*CAL?                      Perform channel calibration
CAL:STORE ADC              Store *CAL? results
```

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-10)

[b] Set DC Standard OUTPUT to -3 mV

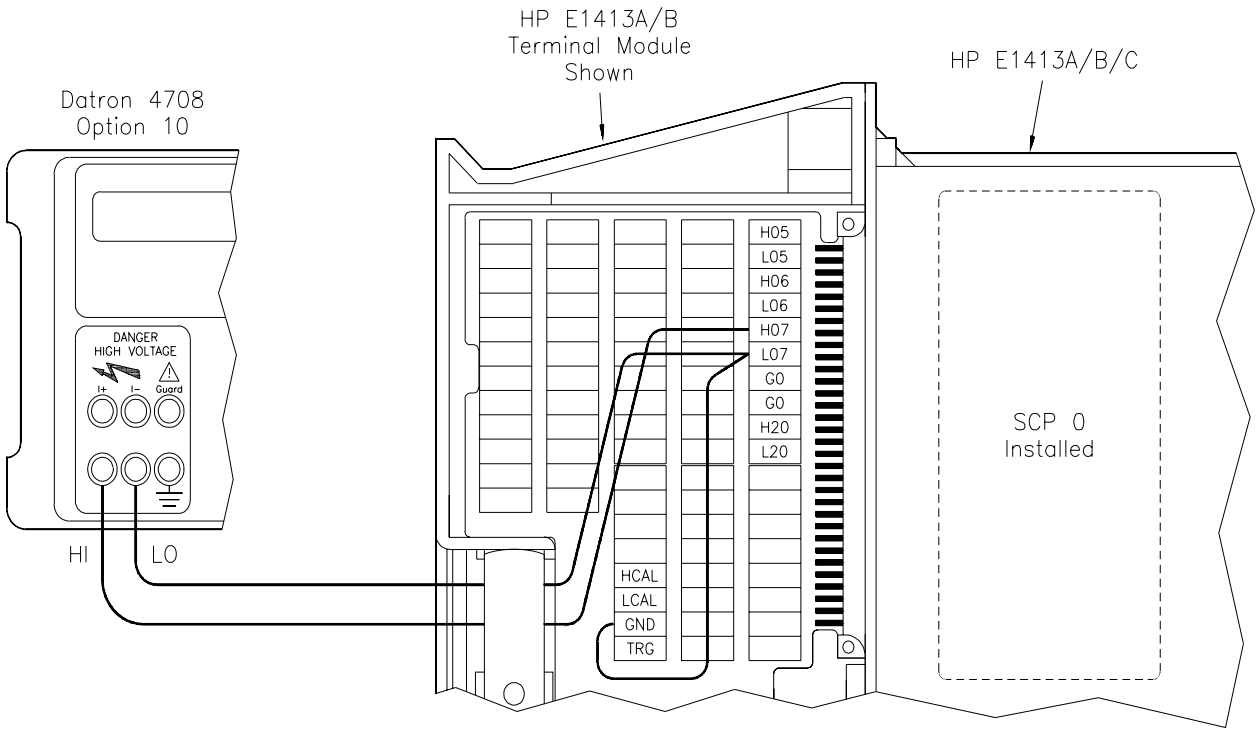


Figure 2-10. DC Standard Connections

5 Make DCV Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	**OPC? return*
FUNC:VOLT .0625, (@107,107)	*Set DCV meas, .0625V range on ch 07*
ROUT:SEQ:DEF LIST1, (@107,107,107)	*Defines ch 07 as scan list for LIST1*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*
TRIG:SOUR IMM	*Sets continuous triggering*
SAMP:TIM LIST1, 1E-3	*Pace measurements at 1 msec intervals*
SENS:FILT ON	*Enables A/D filter*
CAL:ZERO?	*Auto zero measurement*
ENTER statement	*Wait for CAL:ZERO to complete*
INIT:CONT ON	*Sets continuous Wait for Trigger*

	state
DATA:FIFO:PART? 400	*Returns 400 readings from FIFO buffer*
ENTER Statement	*Enters 400 readings*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Result)/400.0	*Result is average of 400 readings*

6 Repeat Measurements for each input and range

[a] Set DC Standard OUTPUT to -2.3 mV and repeat Step 5 (except for *RST;*CLS;*OPC?)

[b] Repeat [a] for the inputs and ranges in the following table

Range	.0625 V	.25 V	1.0 V	4.0 V	16.0 V*
Input (mV)	-3.0	-13	-50	-200	-800
	-2.3	- 9	-38	-150	-600
	-1.5	- 6	-25	-100	-400
	-0.8	- 3	-13	- 50	-200
	0	0	0	0	0
	0.8	3	13	50	200
	1.5	6	25	100	400
	2.3	9	38	150	600
	3.0	13	50	200	800

* Range applies to Test 2-9 (E1508A SCP) ONLY

Example Programs

To perform Test 2-9, run the "PERF08" program. To perform Test 2-10, run the "PERF09" program. Typical results for Test 2-9 and Test 2-10 follow.

Test 2-9: DCV Accuracy - E1508A (PERF08) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1508A Fixed Filter+Amplifier SCP

Range	Input	Minimum	Reading	Maximum
.0625 V	-3.0 mV	-3.0041 mV	-3.0028 mV	-2.9959 mV
.0625 V	-2.3 mV	-2.3040 mV	-2.3034 mV	-2.2960 mV
.	.	.	.	.
.	.	.	.	.
16.0 V	+800.0 mV	+799.889 mV	+800.0083 mV	+800.111 mV

Test 2-10: DCV Accuracy - E1509A (PERF09) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1509A Fixed Filter+Amplifier SCP

Range	Input	Minimum	Reading	Maximum
.25 V	-3.0 mV	-3.0026 mV	-2.9980 mV	-2.9974 mV
.25 V	-2.3 mV	-2.3025 mV	-2.3001 mV	-2.2975 mV
.	.	.	.	.
.	.	.	.	.
16 V	+200.0 mV	+199.972mV	+200.0287 mV	+200.028 mV

Test 2-11: Sample&Hold DCV Accuracy and Droop - E1510A
Test 2-12: Sample&Hold DCV Accuracy and Droop - E1511A

Description

Test 2-11 checks the DC Voltage accuracy and Sample & Hold Droop for the four Sample & Hold channels (00 - 03; 08 - 11; etc) on the E1510A 4-Channel Sample & Hold Signal Conditioning SCP. Test 2-12 checks the DC Voltage accuracy and Sample & Hold Droop for the four Bridge Sense channels on an E1511A Transient Strain SCP.

Note

The E1511A Transient Strain SCP should have all four channels configured for full-bridge measurements for proper calibration.

To test the 4 Straight-Through channels on the E1510A 4-Channel Sample & Hold Signal Conditioning SCP, use Test 2-13. To test the Excitation voltages on an E1511A Transient Strain SCP, use Test 2-14.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to Terminal Module (see Figure 2-11).

[b] Connect Terminal Module to installed Scanning A/D.

Note

The example shown uses channel 02. Substitute the appropriate channel number and SCP number if you use another channel.

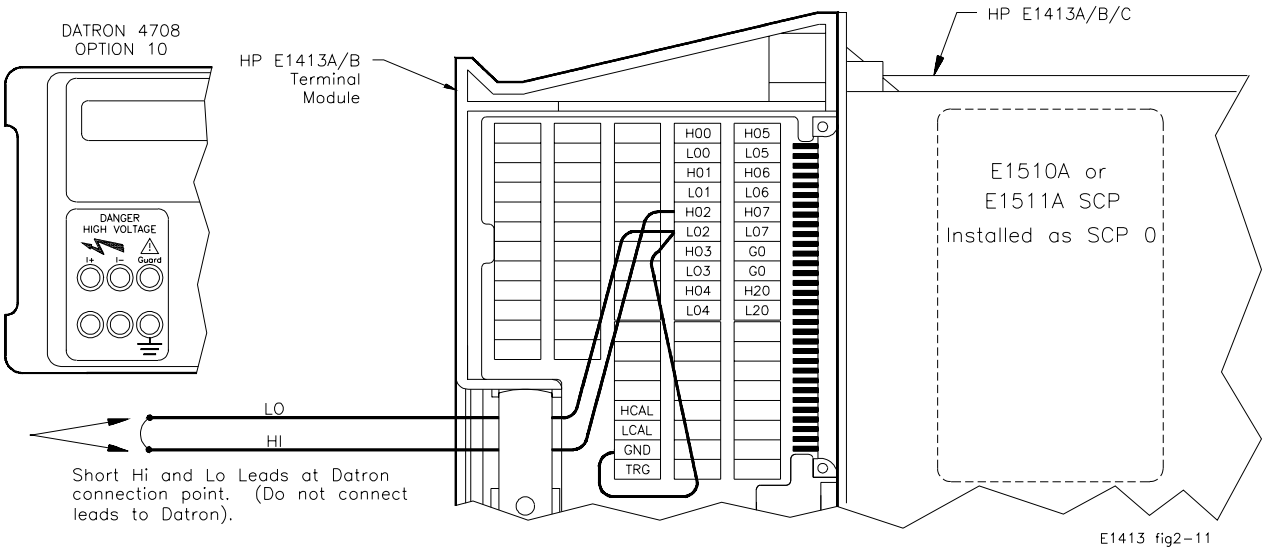


Figure 2-11. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1510A)

SYST:CTYP? (@102)	*Check SCP 0 type*
ENTER statement	*Returns SCP type*

3 Perform Channel Calibrations

CAL:TARE:RESET	*Erase all previous tares*
CAL:STOR TARE	*Store tare in FLASH ROM*
*CAL?	*Perform channel calibration*
CAL:STORE ADC	*Store *CAL? results*

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-12). (This test is only for the 4 Sample & Hold channels on an E1510A or E1511A.)

[b] Set DC Standard OUTPUT to -100 mV (first gain tested is X0.5).

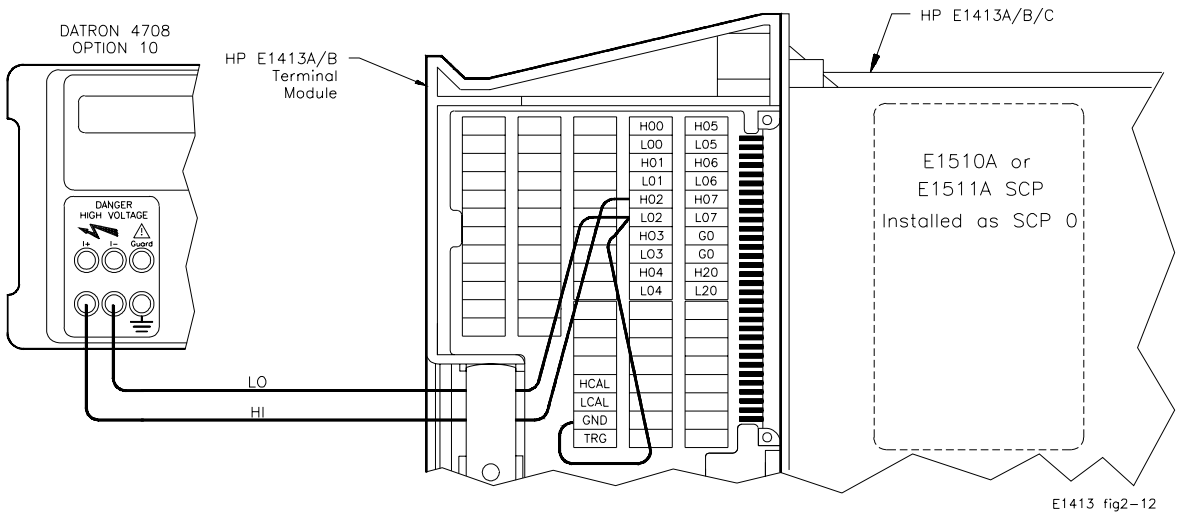


Figure 2-12. DC Standard Connections

5 Make DC Voltage Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	*OPC? return*
FUNC:VOLT .125, (@102)	*Set DCV meas, .125V range on ch 102*
ROUT:SEQ:DEF LIST1, (@102,102,102)	*Defines ch 102 as scan list for LIST1 (min. of 3 channels in list)*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*

TRIG:SOUR TIM	*Sets trig source as internal timer*
TRIG:TIM:MODE SYNC	*Synchronous Trigger timer*
SAMP:TIM LIST1, 1.5E-5	*Pace measurements at 15 µS*
TRIG:TIM 1E-3	*Pacer time of 1 mS*
SENS:FILT OFF	*Disables A/D filter*
INP:FILT:FREQ 15,(@102)	*Enables 15 Hz filter on S&H channels*
INP:GAIN 0.5,(@102)	*Sets gain to 0.5 on S&H channels*
CAL:ZERO?	*Auto zero measurement*
ENTER statement	*Wait for CAL:ZERO to complete*
INIT:CONT ON	*Sets continuous Wait for Trigger state*
DATA:FIFO:PART? 1600	*Returns 1600 readings from FIFO buffer*
ENTER Statement	*Enters 1600 readings (400 per ch)*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Readings)/400.0	*Result is average of 400 rdgs/channel*

6 Repeat Measurements for each gain, input, and range

[a] Set DC Standard OUTPUT to 0.0 V and repeat Step 5 (except reset)

[b] Repeat [a] for the inputs and ranges in the following table

Sample&Hold Channels Gain = X0.5	A/D Range	.0625	.25	1.0	4.0	
	Input (V)	-0.1 0.0 0.1	-0.4 0.0 0.4	-1.6 0.0 1.6	-6.4 0.0 6.4	
Sample&Hold Channels Gain = X8	A/D Range	.0625	.25	1.0	4.0	
	Input (V)	-0.00624 0.0 0.00624	-0.025 0.0 0.025	-0.1 0.0 0.1	-0.4 0.0 0.4	
Sample&Hold Channels Gain = X64	A/D Range		.25	1.0	4.0	
	Input (V)		-0.00312 0.0 0.00312	-0.0125 0.0 0.0125	-0.05 0.0 0.05	
Sample&Hold Channels Gain = X512	A/D Range				4.0	
	Input (V)				-0.00625 0.0 0.00625	

Straight-Through Channels	A/D RANGE	0.0625	0.25	1.0	4.0	16.0
	Input (V)	-0.05	-0.2	-0.8	-3.2	-12.8
		-0.037	-0.15	-0.6	-2.4	-9.6
		-0.025	-0.1	-0.4	-1.6	-6.4
		-0.012	-0.05	-0.2	0.8	-3.2
		0.00	0.0	0.0	0.0	0.0
		0.012	0.05	0.2	0.8	3.2
		0.025	0.1	0.4	1.6	6.4
		0.037	0.15	0.6	2.4	9.6
		0.05	0.2	0.8	3.2	12.8

7 Set Up Scanning A/D for Sample & Hold Droop Test

```
INP:GAIN .5,(@108,111)                  Set gain to X0.5
INP:FILT:LPAS:STATE ON,(@108,111)       Filter on
INP:FILT:FREQ 100,(@108,111)            Filter Freq 100 Hz
CAL:ZERO                                Do Cal Zero on SCP
INP:FILT:LPAS:STATE OFF                 Turn filter off
FUNC:VOLT 4,(@108,111)                  DCV meas, 4 V range
ROUT:SEQ:DEF:LIST1,(@108,111)           Define Scan List
ROUT:SCAN LIST1                         Set scan list
TRIG:SOUR IMM                           Sets continuous triggering
SAMP:TIM LIST1, 30E-3                   Sets sample rate at .03 sec
DATA:FIFO:RESET                         Clear FIFO buffer
FORMAT ASCII                            Readings are ASCII format
INIT:CONT ON                            Trigger the Scanning A/D
DATA:FIFO:PART? 100                     Read back 100 readings
ENTER statement                         Enters 100 readings
INIT:CONT OFF                           Stop Triggering
Droop = ( Max-Min )/1                   Droop in Volts/Sec = (Start V -
                                        End V)/(Tsamp * NRDGS).
                                        Note: Tsamp * NRDGS = 1 Sec
```

Example Program

To perform Test 2-11 on an E1510A Sample & Hold SCP, run the "PERF10SH" program. To perform Test 2-12 on an E1511A Transient Strain SCP, run the "PERF11" program. Typical Results for the program follow.

Test 2-11: DCV Accuracy and Sample&Hold Droop - E1510A (PERF10SH) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1510A 4-Channel Sample & Hold SCP
Channel 102 set at gain = 64.0

Range	Input	Minimum	Reading	Maximum
0.25000	-.003120	-0.003136	-0.003125	-0.003104
0.25000	0.000000	-0.000015	-0.000014	0.000015
0.25000	0.003120	0.003104	0.003122	0.003136
1.0000	-0.012500	-0.012518	-0.012503	-0.012483
1.0000	0.000000	-0.000015	-0.000014	0.000015
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
4.0000	0.000000	-0.000015	-0.000013	0.000015
4.0000	0.050000	0.049975	0.050007	0.050025

Test 2-13: DCV Accuracy, Straight-Through Channels -- E1510A

Description

This test is functionally identical to Test 2-1 for the E1501A SCP. Refer to that test earlier in this chapter for more information. Figure 2-13 shows how to connect the equipment for testing; channel 07 is shown as an example.

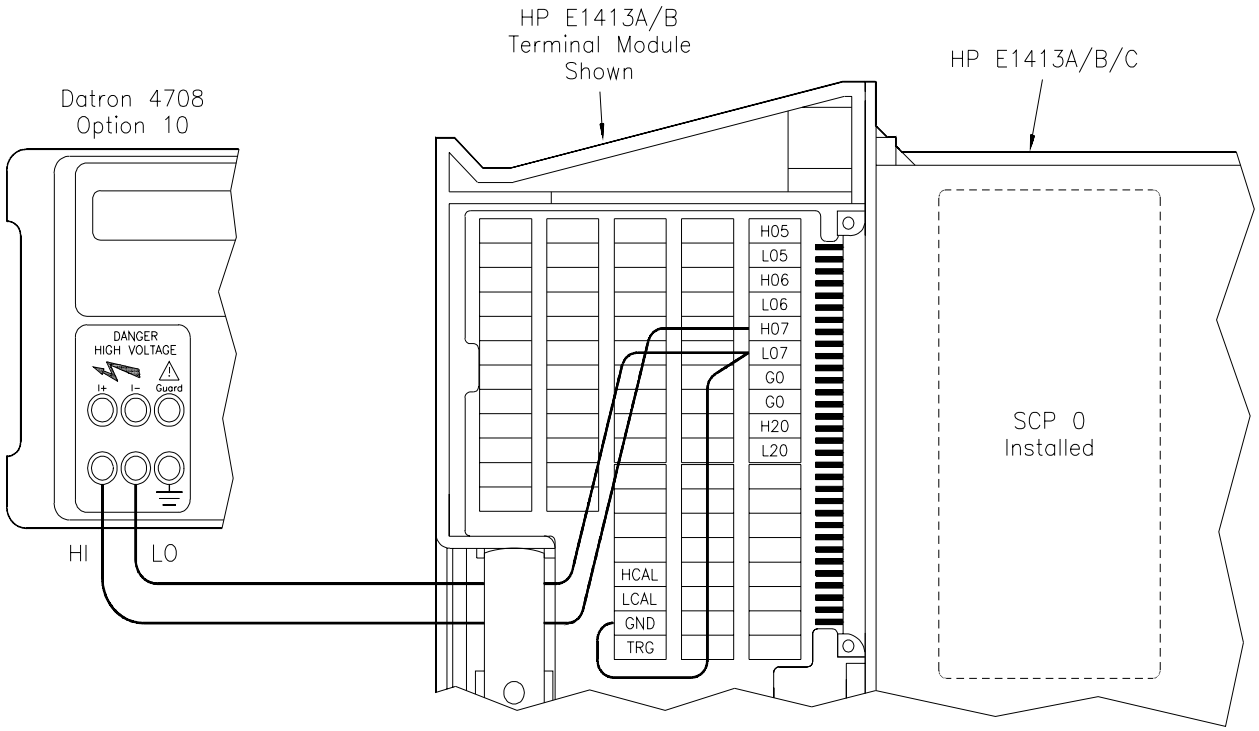


Figure 2-13. DC Standard Connections for the Straight-Through Channels

Example Program

To perform Test 2-13 on the 4 straight-through channels (04 - 08; 12 - 15; etc.) of an E1510A Sample & Hold SCP, run the "PERF10ST" program. Use the program "PERF10SH" (Test 2-11) to test the 4 Sample & Hold channels.

Test 2-14: Excitation Voltage Measurement -- E1511A

Description

This test checks the E1511A SCP excitation voltages. Voltage values are: 0 (off), 1, 2, 5, and 10 volts. There are no specifications for these voltages; the test uses an HP 3458A DMM to measure the excitation voltage.

Test Procedure

1 Make Channel Connections

[a] Connect wiring to terminal module and DMM (see Figure 2-14)

[b] Connect the terminal module to the installed Scanning A/D

[c] Connect an HP-IB cable from the DMM to the computer

Note

This example shown uses channel 102. Substitute the appropriate channel number as required for your application. Connections are shown to channel 02 (E2+ and E2- for SCP 0/1). Modify the connections as required for the channel you use.

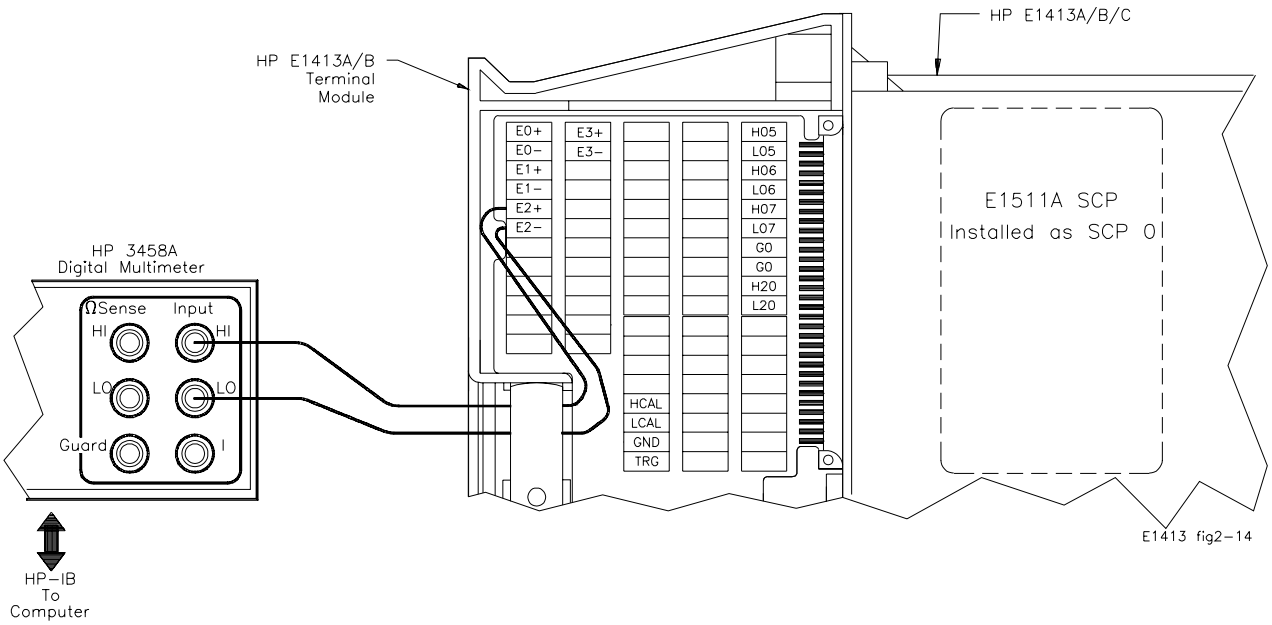


Figure 2-14. Typical Wiring Configuration

2 Check SCP 0 Type (must be E1511A)

```
SYST:CTYP? (@102)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform HP 3458A DMM Autocalibration (Optional)

For most accurate results, an autocalibration (ACAL) of the HP 3458A DMM is recommended every 24 hours. (The autocalibration takes about 12

minutes.) As required, perform an autocalibration with the following command. If autocalibration is not required, go to Step 4.

```
OUTPUT 722; "ACAL ALL"          HP 3458A DMM autocalibration
```

4 Set Excitation Voltages

```
OUTP:VOLT:AMPL 1,(@102,102,102)   Set excitation voltage to 1 volt on channel 102
```

5 Measure Excitation Voltages

```
OUTPUT 722;"PRESET NORM"          Set HP 3458A DMM @ address 722 to known state
OUTPUT 722;"NPLC 10"              Set HP 3458A DMM to NPLC 10
ENTER statement                   Return Excitation Voltage (~1.0 Vdc)
```

6 Repeat Measurements for each excitation voltage

[a] Set the excitation voltage to 2, 5, and 10 volts and repeat Step 5

Example Program

To perform Test 2-14 on an E1511A, run the program "PERF11". This program also tests the DCV accuracy and Sample&Hold droop on the Bridge Sense channels.

Test 2-15: DCV Accuracy -- E1512A

Description This test is functionally identical to Test 2-2 for the E1502A SCP. Refer to Test 2-2 earlier in this chapter for more information.

Example Program To perform Test 2-15 on the E1512A SCP, run the "PERF02_12" program.

Test 2-16: DCV Accuracy - E1513A

Description Test 2-15 checks HP E1413C Scanning A/D DC voltage measurement accuracy when an E1513A Divide by 16 SCP is used.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to terminal block (see Figure 2-15)

[b] Connect terminal block to installed Scanning A/D

Note The procedure shown uses channel 07. Substitute the appropriate channel number and SCP number if you use another channel.

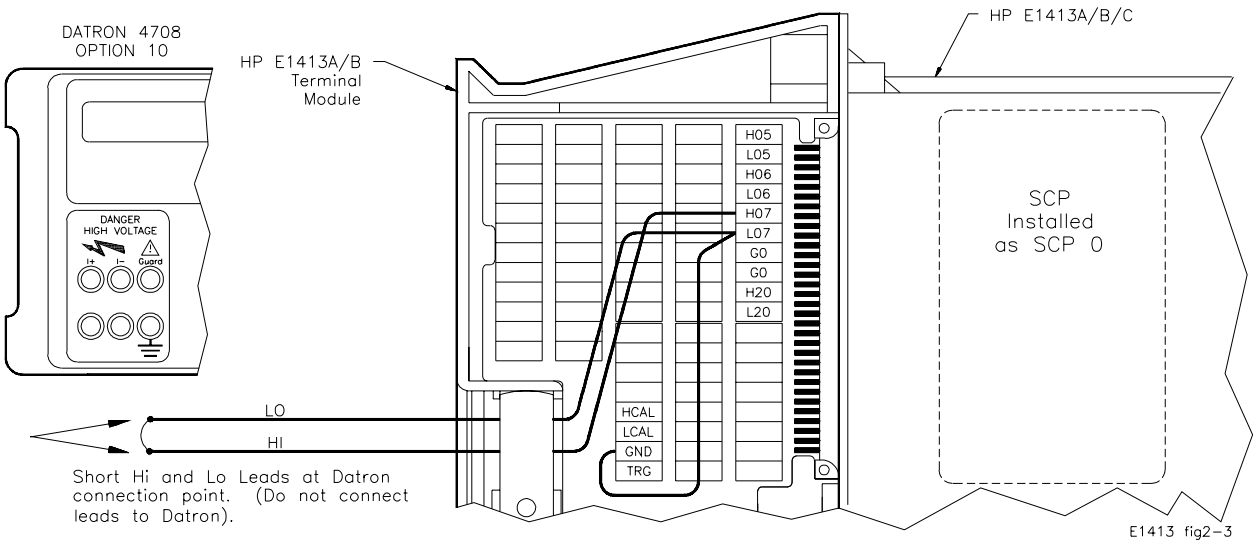


Figure 2-15. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1513A)

```
SYST:CTYP? (@107)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform Channel Calibrations

```
CAL:TARE:RESET             Erase all previous tares
CAL:STOR TARE              Store tare in FLASH ROM
*CAL?                      Perform channel calibration
CAL:STORE ADC              Store *CAL? results
```

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-16)

[b] Set DC Standard OUTPUT to -12.8 V

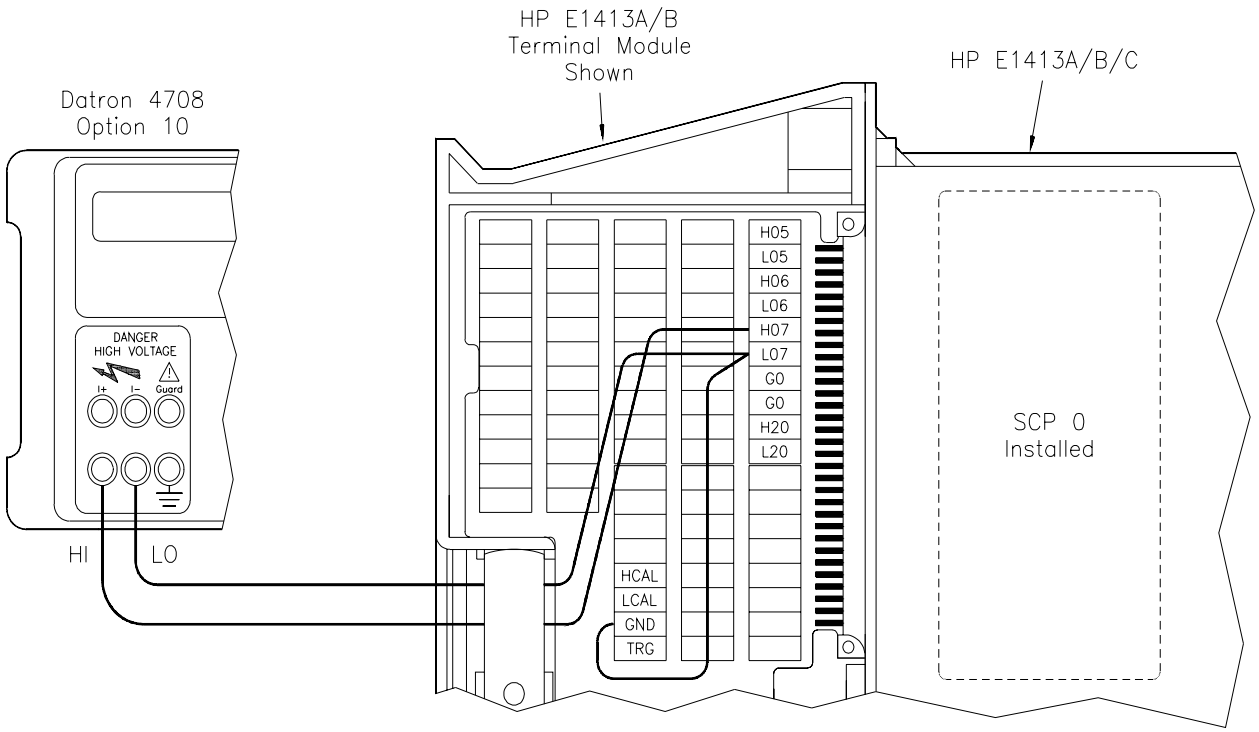


Figure 2-16. DC Standard Connections

5 Make DCV Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	**OPC? return*
FUNC:VOLT 1, (@107,107)	*Set DCV meas, 1V range on ch 07*
ROUT:SEQ:DEF LIST1, (@107,107,107)	*Defines ch 07 as scan list for LIST1*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*
TRIG:SOUR IMM	*Sets continuous triggering*
SAMP:TIM LIST1, 1E-3	*Pace measurements at 1 msec intervals*
SENS:FILT ON	*Enables A/D filter*
CAL:ZERO?	*Auto zero measurement*
ENTER statement	*Wait for CAL:ZERO to complete*
INIT:CONT ON	*Sets continuous Wait for Trigger*

	state
DATA:FIFO:PART? 400	*Returns 400 readings from FIFO buffer*
ENTER statement	*Enters 400 readings*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Result)/400.0	*Result is average of 400 readings*

6 Repeat Measurements for each Input and Range

[a] Set DC Standard OUTPUT to -9.6 V and repeat Step 5 (except for *RST;*CLS;*OPC?)

[b] Repeat [a] for the inputs and ranges in the following table

A/D Range	1.0 V	4.0 V
Inputs (Vdc)	-12.8	-51.2
	-9.6	-38.4
	-6.4	-25.6
	-3.2	-12.8
	0.0	0.0
	3.2	12.8
	6.4	25.6
	9.6	38.4
	12.8	51.2

Example Programs

To test the E1513A run the "PERF13" program. Typical results for Test 2-16 follows.

Test 2-16: DCV Accuracy - E1513A (PERF13) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1513A Divide by 16 SCP

Range	Input	Minimum	Reading	Maximum
1.0 V	-12.8 V	-12.8031 V	-12.8011 mV	-12.7969 V
1.0 V	- 9.6 V	- 9.6024 V	- 9.6002 mV	- 9.5976 V
.	.	.	.	.
.	.	.	.	.
4.0 V	+51.2 V	+51.1878 V	+51.2073 V	+51.2122 V

Test 2-17: DCV Accuracy - E1514A and E1515A

Description

Test 2-17 checks HP E1413C Scanning A/D DC voltage measurement accuracy when an E1514A or E1515A Fixed Filter and Amplifier SCP is used.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to terminal block (see Figure 2-17)

[b] Connect terminal block to installed Scanning A/D

Note

The procedure shown uses channel 07. Substitute the appropriate channel number and SCP number if you use another channel.

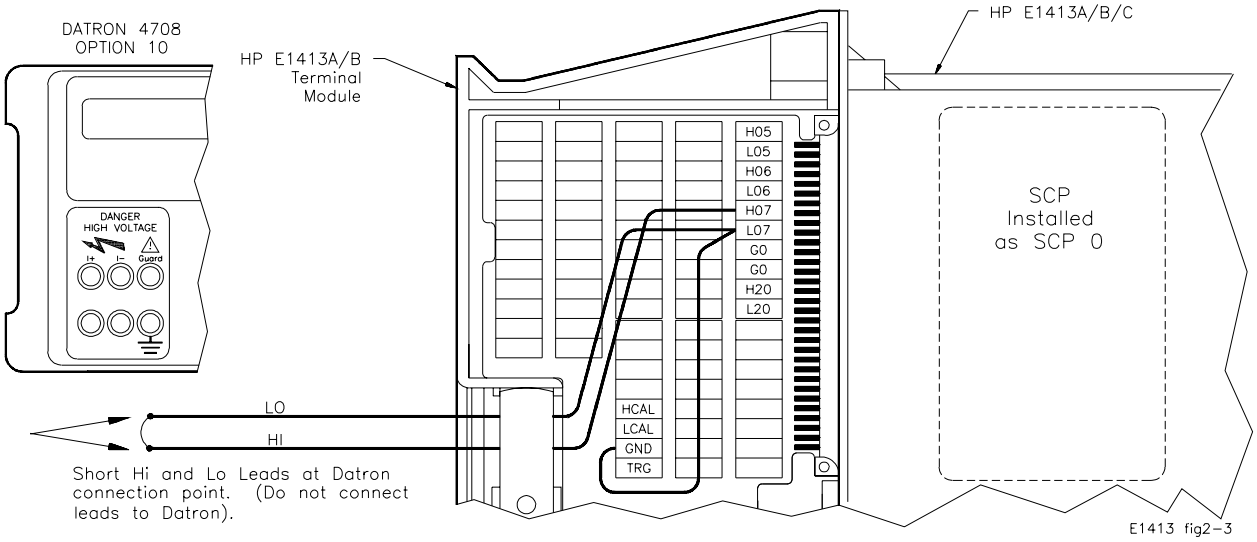


Figure 2-17. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1514A or E1515A)

```
SYST:CTYP? (@107)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform Channel Calibrations

```
CAL:TARE:RESET             Erase all previous tares
CAL:STOR TARE              Store tare in FLASH ROM
*CAL?                      Perform channel calibration
CAL:STORE ADC              Store *CAL? results
```

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-18)

[b] Set DC Standard OUTPUT to -12.8 V

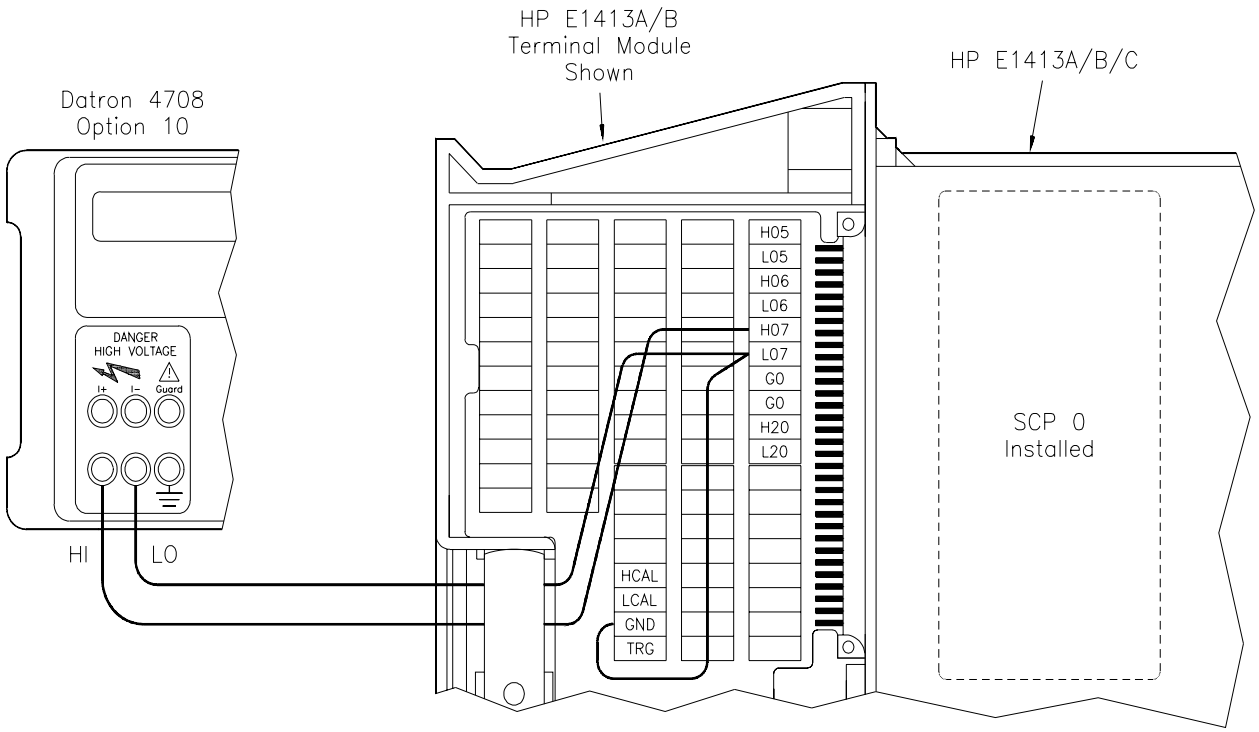


Figure 2-18. DC Standard Connections

5 Make DCV Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	**OPC? return*
FUNC:VOLT 16, (@107,107)	*Set DCV meas, 16V range on ch 07*
ROUT:SEQ:DEF LIST1, (@107,107,107)	*Defines ch 07 as scan list for LIST1*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*
TRIG:SOUR IMM	*Sets continuous triggering*
SAMP:TIM LIST1, 1E-3	*Pace measurements at 1 msec intervals*
SENS:FILT ON	*Enables A/D filter*
CAL:ZERO?	*Auto zero measurement*
ENTER statement	*Wait for CAL:ZERO to complete*
INIT:CONT ON	*Sets continuous Wait for Trigger*

	state
DATA:FIFO:PART? 400	*Returns 400 readings from FIFO buffer*
ENTER statement	*Enters 400 readings*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Result)/400.0	*Result is average of 400 readings*

6 Repeat Measurements for each Input on the 16V Range

[a] Set DC Standard OUTPUT to -9.6 V and repeat Step 5 (except for *RST;*CLS;*OPC?)

[b] Repeat [a] for the inputs in the following table

A/D Range	16.0 V
Inputs (Vdc)	-12.8
	-9.6
	-6.4
	-3.2
	0.0
	3.2
	6.4
	9.6
	12.8

Example Programs

To test the E1514A or E1515A run the "PERF14_15" program. Typical results for Test 2-17 follows.

Test 2-17: DCV Accuracy - E1514A or E1515A (PERF14_15) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1514A or E1515A SCP

Range	Input	Minimum	Reading	Maximum
16.0 V	-12.8 V	-12.8029 V	-12.8007 mV	-12.7971 V
16.0 V	- 9.6 V	- 9.6024 V	- 9.6007mV	- 9.5976 V
.	.	.	.	.
.	.	.	.	.
16.0 V	+12.8 V	+12.7971 V	+12.8019 V	+12.8029 V

Test 2-18: DCV Accuracy - E1516A and E1517A

Description

Test 2-18 checks HP E1413C Scanning A/D DC voltage measurement accuracy when an E1516A or E1517A Iso. Fixed Filter and Amplifier SCP is used.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to terminal block (see Figure 2-19)

[b] Connect terminal block to installed Scanning A/D

Note

The procedure shown uses channel 07. Substitute the appropriate channel number and SCP number if you use another channel.

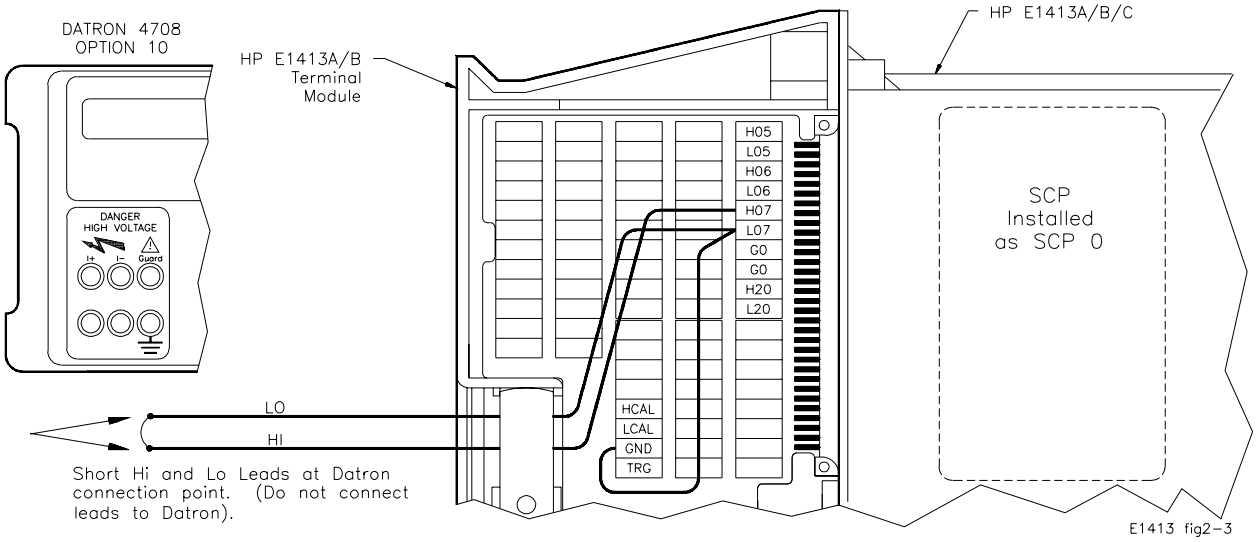


Figure 2-19. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1516A or E1517A)

```
SYST:CTYP? (@107)        Check SCP 0 type
ENTER statement          Returns SCP type
```

3 Perform Channel Calibrations

```
CAL:TARE:RESET           Erase all previous tares
CAL:STOR TARE            Store tare in FLASH ROM
*CAL?                    Perform channel calibration
CAL:STORE ADC            Store *CAL? results
```

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-20)

[b] Set DC Standard OUTPUT to -0.050 V

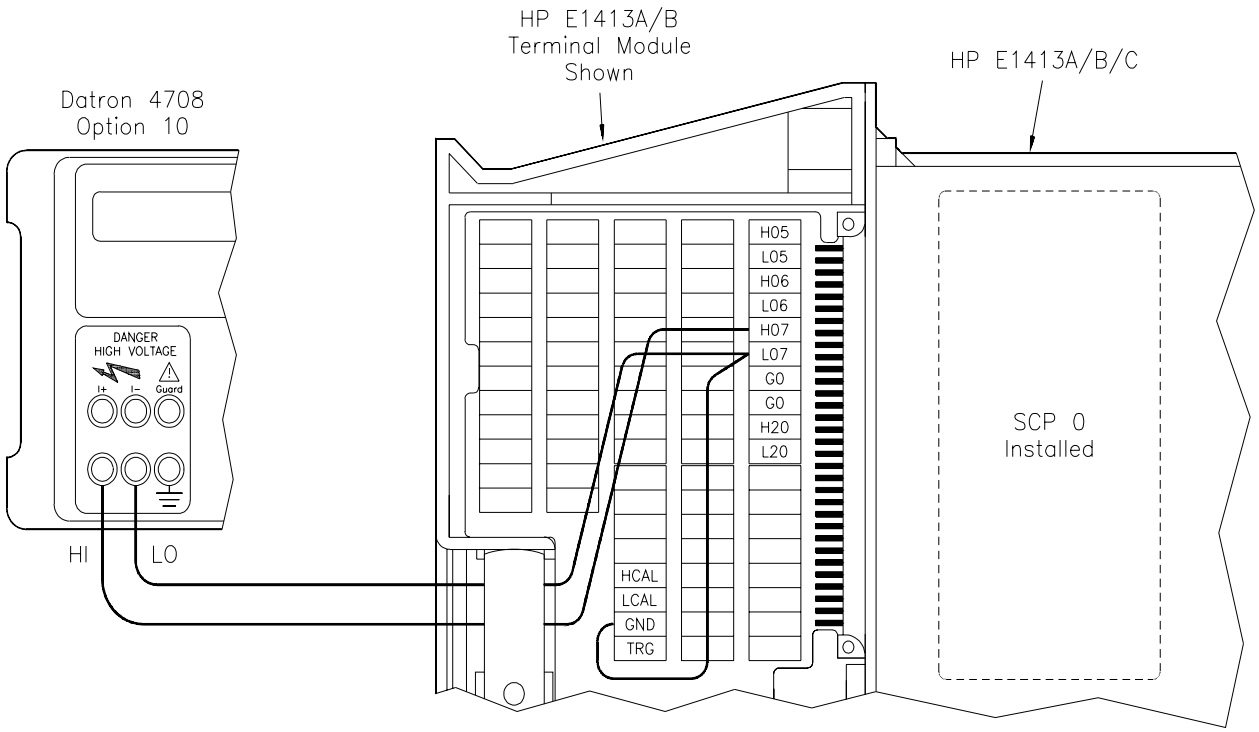


Figure 2-20. DC Standard Connections

5 Make DCV Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	**OPC? return*
FUNC:VOLT 4, (@107,107)	*Set DCV meas, 4V range on ch 07*
ROUT:SEQ:DEF LIST1, (@107,107,107)	*Defines ch 07 as scan list for LIST1*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*
TRIG:SOUR IMM	*Sets continuous triggering*
SAMP:TIM LIST1, 1E-3	*Pace measurements at 1 msec intervals*
SENS:FILT ON	*Enables A/D filter*
CAL:ZERO?	*Auto zero measurement*
ENTER statement	*Wait for CAL:ZERO to complete*
INIT:CONT ON	*Sets continuous Wait for Trigger*

	state
DATA:FIFO:PART? 400	*Returns 400 readings from FIFO buffer*
ENTER statement	*Enters 400 readings*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Result)/400.0	*Result is average of 400 readings*

6 Repeat Measurements for each Input on the 4V Range

[a] Set DC Standard OUTPUT to -0.037 V and repeat Step 5 (except for *RST;*CLS;*OPC?)

[b] Repeat [a] for the inputs in the following table

A/D Range	4.0 V
Inputs (Vdc)	-0.050 -0.037 -0.025 -0.012 0.000 +0.012 +0.025 +0.037 +0.050

Example Programs

To test the E1516A or E1517A run the "PERF16_17" program. Typical results for Test 2-18 follows.

Test 2-18: DCV Accuracy - E1516A or E1517A (PERF16_17) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1516A or E1517A SCP

Range	Input	Minimum	Reading	Maximum
4.0 V	-0.050 V	-0.050011 V	-0.049992 V	-0.049989 V
4.0 V	-0.037 V	-0.037009 V	-0.037003 V	-0.036991 V
.	.	.	.	.
.	.	.	.	.
4.0 V	+0.050 V	+0.049989 V	+0.049995 V	+0.050011 V

Test 2-19: DCI Accuracy - E1518A

Description This test checks DC current output accuracy when an E1518A Current Source SCP is used.

Test Procedure

1 Make Channel Connections

[a] Connect wiring to terminal block and DMM (see Figure 2-21)

[b] Connect the terminal block to the installed Scanning A/D

[c] Connect an HP-IB cable from the DMM to the computer

Note The procedure shown uses channel 00. Substitute the appropriate channel number as required for your application. Using shielded, teflon-coated cable for connections is highly recommended.

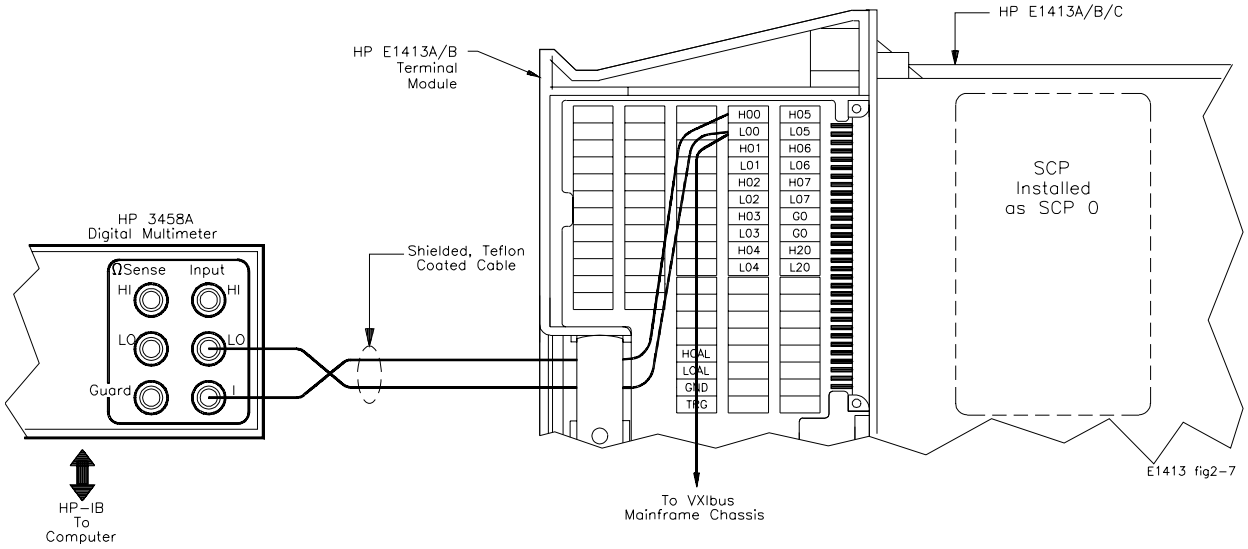


Figure 2-21. Typical Wiring Configurations

2 Check SCP 0 type (must be E1518A)

```
SYST:CTYP? (@100)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform HP 3458A DMM Autocalibration (Optional)

For most accurate results, an autocalibration (ACAL) of the HP 3458A DMM is recommended every 24 hours. (The autocalibration takes about 12 minutes.) As required, perform an autocalibration with the following command. If autocalibration is not required, go to step 4.

```
OUTPUT 722; "ACAL ALL"     Performs HP 3458A DMM autocalibration
```

4 Perform Channel Calibration (30 µA range)

Note It is essential to perform a channel calibration (*CAL?) for each current range before measuring the current output on the range. For example, you must set the scanning A/D for DCI operation on the 30µA range and perform *CAL? for the 30µA range before measuring the 30µA output. The same procedure is required for the 488µA range.

```
OUTP:CURR:STAT ON, (@100)          Enable current output on channel 00
OUTP:CURR:AMPL 30E-6, (@100)       Set output current on ch 00 to 30 uA
*CAL?                              Perform *CAL?
CAL:ZERO?                          Perform A/D Zero
```

5 Make DCI Measurement (30µA range)

```
OUTPUT 722;"PRESET NORM"           Set HP 3458A DMM @ address 722 to known state
OUTPUT 722;"NPLC 100"              Set HP 3458A DMM to NPLC 100
OUTPUT 722;"DCI 100E-6"            Set DMM range to DCI @ 100 uA
WAIT 5                             Wait 5 sec for settling
ENTER statement                    Return DCI reading (~30.518 uA)
```

6 Perform Channel Calibration (488 µA range)

```
OUTP:CURR:STAT ON, (@100)          Enable current output on channel 00
OUTP:CURR:AMPL 488E-6, (@100)      Set output current on ch 00 to 488 uA
*CAL?                              Perform *CAL?
CAL:ZERO?                          Perform A/D Zero
```

7 Make DCI Measurement (488 µA range)

```
OUTPUT 722;"PRESET NORM"           Set HP 3458A DMM @ address 722 to known state
OUTPUT 722;"NPLC 100"              Set HP 3458A DMM to NPLC 100
OUTPUT 722;"DCI 1E-3"              Set DMM range to DCI @ 1 mA
WAIT 5                             Wait 5 sec for settling
ENTER statement                    Return DCI reading ( ~488.28 uA)
```

Example Program

To perform Test 2-19, run the "PERF18i" program. Typical results for the "PERF18i" program follow.

Test 2-19: DCI Accuracy - E1518A (PERF18i) Typical Results

HP E1413C Scanning A/D
DC Current Accuracy Test
E1518A Current Source SCP

Current (µA)	Minimum (µA)	Reading (µA)	Maximum (µ)A
30.518	30.509	30.521	30.527
488.28	488.22	488.29	488.34

Test 2-20: DCV Accuracy - E1518A

Description

Test 2-20 checks DC voltage measurement accuracy when an E1518A Resistance Measurement SCP is used.

Test Procedure

1 Make Channel Tare/Calibration Connections

[a] Connect wiring to terminal block (see Figure 2-22)

[b] Connect terminal block to installed Scanning A/D

Note

The procedure shown uses channel 07. Substitute the appropriate channel number and SCP number if you use another channel.

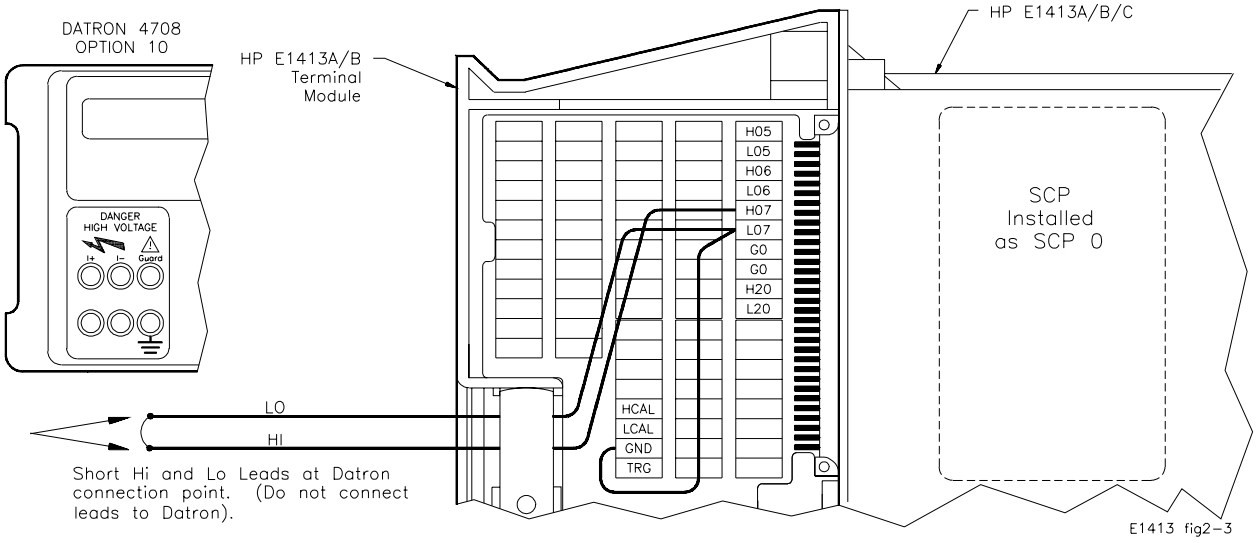


Figure 2-22. Channel Tare/Calibration Connections

2 Check SCP 0 type (must be E1518A)

```
SYST:CTYP? (@107)          Check SCP 0 type
ENTER statement            Returns SCP type
```

3 Perform Channel Calibrations

```
CAL:TARE:RESET             Erase all previous tares
CAL:STOR TARE              Store tare in FLASH ROM
*CAL?                      Perform channel calibration
CAL:STORE ADC              Store *CAL? results
```

4 Make Connections to DC Standard

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages that are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

[a] Connect HI and LO leads to DC Standard (see Figure 2-23)

[b] Set DC Standard OUTPUT to -3 mV

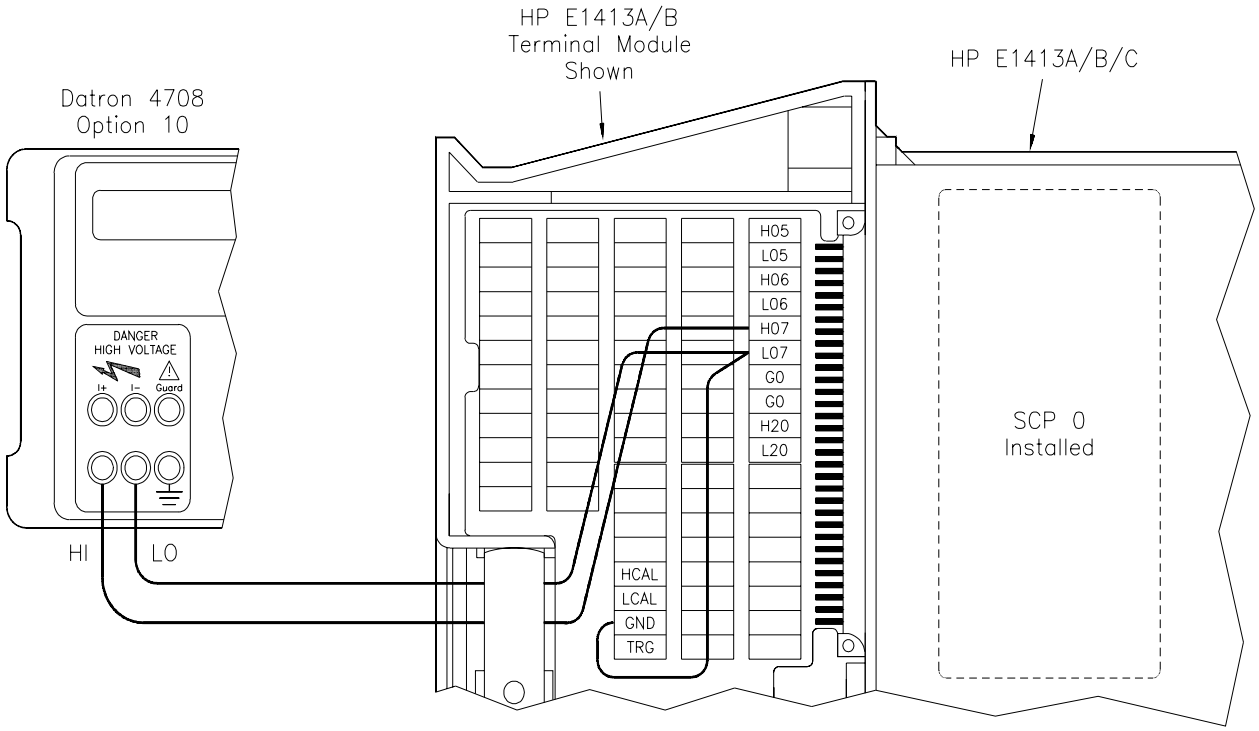


Figure 2-23. DC Standard Connections

5 Make DCV Measurements

*RST;*CLS;*OPC?	*Reset Scanning A/D, clear status register*
ENTER statement	**OPC? return*
FUNC:VOLT .0625, (@107,107)	*Set DCV meas, .0625V range on ch 07*
ROUT:SEQ:DEF LIST1, (@107,107,107)	*Defines ch 07 as scan list for LIST1*
ROUT:SCAN LIST1	*Sets LIST1 as Scan List*
TRIG:SOUR IMM	*Sets continuous triggering*
SAMP:TIM LIST1, 1E-3	*Pace measurements at 1 msec intervals*
SENS:FILT ON	*Enables A/D filter*
CAL:ZERO?	*Auto zero measurement*
ENTER statement	*Wait for CAL:ZERO to complete*

INIT:CONT ON	*Sets continuous Wait for Trigger state*
DATA:FIFO:PART? 400	*Returns 400 readings from FIFO buffer*
ENTER Statement	*Enters 400 readings*
INIT:CONT OFF	*Finish scan, return to Trigger Idle state*
Average = SUM(Result)/400.0	*Result is average of 400 readings*

6 Repeat Measurements for each input and range

[a] Set DC Standard OUTPUT to -2.3 mV and repeat Step 5 (except for *RST;*CLS;*OPC?)

[b] Repeat [a] for the inputs and ranges in the following table

A/D Range	.0625 V	.25 V	1.0 V	4.0 V	16.0 V
Input (mV)	-3.0	-13	-50	-200	-800
	-2.3	- 9	-38	-150	-600
	-1.5	- 6	-25	-100	-400
	-0.8	- 3	-13	- 50	-200
	0	0	0	0	0
	0.8	3	13	50	200
	1.5	6	25	100	400
	2.3	9	38	150	600
	3.0	13	50	200	800

Example Programs

To perform Test 2-20, run the "PERF18V" program. Typical results for Test 2-20 follow.

Test 2-20: DCV Accuracy - E1518A (PERF18V) Typical Results

HP E1413C Scanning A/D
DC Voltage Accuracy Test
E1518A Fixed Filter+Amplifier SCP

Range	Input	Minimum	Reading	Maximum
.0625 V	-3.0 mV	-3.0041 mV	-3.0028 mV	-2.9959 mV
.0625 V	-2.3 mV	-2.3040 mV	-2.3034 mV	-2.2960 mV
.	.	.	.	.
.	.	.	.	.
16.0 V	+800.0 mV	+799.889 mV	+800.0083 mV	+800.111 mV

Performance Test Record

Table 2-1, *HP E1313A, E1413A/B/C Performance Test Record*, is a form you can copy and use to record performance verification test results for the HP E1313A and E1413A/B/C Scanning A/Ds. This table shows HP E1313A, E1413A/B/C Scanning A/D instrument accuracy, Datron 4708 Option 10 measurement uncertainty, and test accuracy ratio (TAR) values. See *Appendix A - Calculating Scanning A/D Accuracy* for information on accuracy, measurement uncertainty, and TAR calculations.

Scanning A/D Test Limits

Test limits are defined using the 90 day specifications in *Appendix A - Specifications* of the *HP E1313A and E1413A/B/C User's Manual*. See *Appendix A - Calculating Scanning A/D Accuracy* in this manual for sample calculations of Scanning A/D test limits.

Measurement Uncertainty

For the performance verification tests in this manual, the measurement uncertainties are based on the 90-day accuracy specifications for the Datron 4708 Source. See *Appendix A - Calculating Scanning A/D Accuracy* in this manual for sample calculations of measurement uncertainty.

Test Accuracy Ratio (TAR)

Test Accuracy Ratio (TAR) for the scanning A/D is defined as Scanning A/D Accuracy divided by Measurement Uncertainty, where accuracy = maximum allowable value - expected reading. That is:

$$TAR = \frac{MaximumValue - ExpectedReading}{MeasurementUncertainty}$$

For TARs that exceed 10:1, the entry is ">10:1".

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 1 of 29)

Test Facility:

Name _____ Report No. _____

Address _____ Date _____

City/State _____ Customer _____

Phone _____ Tested by _____

Model _____ Ambient temperature _____ °C

Serial No. _____ Relative humidity _____ %

Options _____ Line frequency _____ Hz (nominal)

Firmware Rev. _____

Special Notes:

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 2 of 29)

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 3 of 29)

Test 2-1: DCV Measurement Accuracy - E1501A Straight-Through SCP

A/D Range	Input	Minimum	Measured	Maximum	M.U.*	TAR**
.0625 V	- 50.0000 mV	- 50.0103 mV	_____	- 49.9897 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0090 mV	_____	- 36.9910 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0078 mV	_____	- 24.9922 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0065 mV	_____	- 11.9935 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0053 mV	_____	+ 0.0053 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9935 mV	_____	+ 12.0065 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9922 mV	_____	+ 25.0078 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9910 mV	_____	+ 37.0090 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9897 mV	_____	+ 50.0103 mV	7.5E-7 V	>10:1
.25 V	- 200.0000 mV	- 200.0303 mV	_____	- 199.9697 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0253 mV	_____	- 149.9747 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0203 mV	_____	- 99.9797 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0153 mV	_____	- 49.9847 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0103 mV	_____	+ 0.0103 mV	8.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.9847 mV	_____	+ 50.0153 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9797 mV	_____	+100.0203 mV	1.2E-6 V	>10:1
	+150.0000 mV	+149.9747 mV	_____	+150.0253 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9697 mV	_____	+200.0303 mV	1.6E-6 V	>10:1
1.0V	- 800.000 mV	- 800.111 mV	_____	- 799.889 mV	4.0E-6 V	>10:1
	- 600.000 mV	- 600.091 mV	_____	- 599.909 mV	3.2E-6 V	>10:1
	- 400.000 mV	- 400.071 mV	_____	- 399.929 mV	2.4E-6 V	>10:1
	- 200.000 mV	- 200.051 mV	_____	- 199.949 mV	1.6E-6 V	>10:1
	0.000 mV	- 0.031 mV	_____	+ 0.031 mV	0.8E-6 V	>10:1
	+200.000 mV	+199.949 mV	_____	+200.051 mV	1.6E-6 V	>10:1
	+400.000 mV	+399.929 mV	_____	+400.071 mV	2.4E-6 V	>10:1
	+600.000 mV	+599.909 mV	_____	+600.091 mV	3.2E-6 V	>10:1
	+800.000 mV	+799.889 mV	_____	+800.111 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4 V	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5 V	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5 V	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5 V	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5 V	10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5 V	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5 V	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5 V	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 4 of 29)

Test 2-2: DCV Measurement Accuracy - E1502A 7 Hz Low Pass Filter SCP

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.0625 V	- 50.0000 mV	- 50.0122 mV	_____	- 49.9878 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0109 mV	_____	- 36.9891 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0097 mV	_____	- 24.9903 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0084 mV	_____	- 11.9916 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0072 mV	_____	+ 0.0072 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9916 mV	_____	+ 12.0084 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9903 mV	_____	+ 25.0097 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9891 mV	_____	+ 37.0109 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9878 mV	_____	+ 50.0122 mV	7.5E-7 V	>10:1
.25 V	- 200.0000 mV	- 200.0322 mV	_____	- 199.9678 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0272 mV	_____	- 149.9728 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0222 mV	_____	- 99.9778 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0172 mV	_____	- 49.9828 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0122 mV	_____	+ 0.0122 mV	8.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.9828 mV	_____	+ 50.0172 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9778 mV	_____	+100.0222 mV	1.2E-6 V	>10:1
	+150.0000 mV	+149.9728 mV	_____	+150.0272 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9678 mV	_____	+200.0322 mV	1.6E-6 V	>10:1
1.0V	- 800.000 mV	- 800.113 mV	_____	- 799.887 mV	4.0E-6 V	>10:1
	- 600.000 mV	- 600.093 mV	_____	- 599.907 mV	3.2E-6 V	>10:1
	- 400.000 mV	- 400.073 mV	_____	- 399.927 mV	2.4E-6 V	>10:1
	- 200.000 mV	- 200.053 mV	_____	- 199.947 mV	1.6E-6 V	>10:1
	0.000 mV	- .033 mV	_____	+ .033 mV	0.8E-6 V	>10:1
	+200.000 mV	+199.947 mV	_____	+200.053 mV	1.6E-6 V	>10:1
	+400.000 mV	+399.927 mV	_____	+400.073 mV	2.4E-6 V	>10:1
	+600.000 mV	+599.907 mV	_____	+600.093 mV	3.2E-6 V	>10:1
	+800.000 mV	+799.887 mV	_____	+800.113 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4 V	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5 V	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5 V	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5 V	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5 V	10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5 V	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5 V	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5 V	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 5 of 29)

Test 2-3: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X1, 2 Hz Filter)						
A/D Range	**Input**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
.0625 V	- 50.0000 mV	- 50.0180 mV	_____	- 49.9820 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0167 mV	_____	- 36.9833 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0155 mV	_____	- 24.9845 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0142 mV	_____	- 11.9858 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0130 mV	_____	+ 0.0130 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9858 mV	_____	+ 12.0142 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9845 mV	_____	+ 25.0155 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9833 mV	_____	+ 37.0167 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9820 mV	_____	+ 50.0180 mV	7.5E-7 V	>10:1
.25 V	- 200.000 mV	- 200.035 mV	_____	- 199.965 mV	1.6E-6 V	>10:1
	- 150.000 mV	- 150.030 mV	_____	- 149.970 mV	1.4E-6 V	>10:1
	- 100.000 mV	- 100.025 mV	_____	- 99.975 mV	1.2E-6 V	>10:1
	- 50.000 mV	- 50.020 mV	_____	- 49.980 mV	1.0E-6 V	>10:1
	0.000 mV	- 0.015 mV	_____	+ 0.015 mV	8.0E-7 V	>10:1
	+ 50.000 mV	+ 49.980 mV	_____	+ 50.020 mV	1.0E-6 V	>10:1
	+100.000 mV	+ 99.975 mV	_____	+100.025 mV	1.2E-6 V	>10:1
	+150.000 mV	+149.970 mV	_____	+150.030 mV	1.4E-6 V	>10:1
	+200.000 mV	+199.965 mV	_____	+200.035 mV	1.6E-6 V	>10:1
1.0V	- 800.000 mV	- 800.113 mV	_____	- 799.887 mV	4.0E-6 V	>10:1
	- 600.000 mV	- 600.093 mV	_____	- 599.907 mV	3.2E-6 V	>10:1
	- 400.000 mV	- 400.073 mV	_____	- 399.927 mV	2.4E-6 V	>10:1
	- 200.000 mV	- 200.053 mV	_____	- 199.947 mV	1.6E-6 V	>10:1
	0.000 mV	- 0.033 mV	_____	- 0.033 mV	0.8E-6 V	>10:1
	+200.000 mV	+199.947 mV	_____	+200.053 mV	1.6E-6 V	>10:1
	+400.000 mV	+399.927 mV	_____	+400.073 mV	2.4E-6 V	>10:1
	+600.000 mV	+599.907 mV	_____	+600.093 mV	3.2E-6 V	>10:1
	+800.000 mV	+799.887 mV	_____	+800.113 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4 V	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5 V	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5 V	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5 V	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5 V	>10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5 V	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5 V	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5 V	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 6 of 29)

Test 2-3: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X1, 10 Hz Filter)						
A/D Range	**Input**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
.0625 V	- 50.0000 mV	- 50.0145 mV	_____	- 49.9855 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0132 mV	_____	- 36.9868 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0120 mV	_____	- 24.9880 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0107 mV	_____	- 11.9893 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0095 mV	_____	+ 0.0095 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9893 mV	_____	+ 12.0107 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9880 mV	_____	+ 25.0120 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9868 mV	_____	+ 37.0132 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9855 mV	_____	+ 50.0145 mV	7.5E-7 V	>10:1
.25 V	- 200.0000 mV	- 200.0325 mV	_____	- 199.9675 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0275 mV	_____	- 149.9725 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0225 mV	_____	- 99.9775 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0175 mV	_____	- 49.9825 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0125 mV	_____	+ 0.0125 mV	8.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.9825 mV	_____	+ 50.0175 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9775 mV	_____	+100.0225 mV	1.2E-6 V	>10:1
	+150.0000 mV	+149.9725 mV	_____	+150.0275 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9675 mV	_____	+200.0325 mV	1.6E-6 V	>10:1
1.0V	- 800.0000 mV	- 800.1118 mV	_____	- 799.8882 mV	4.0E-6 V	>10:1
	- 600.0000 mV	- 600.0918 mV	_____	- 599.9082 mV	3.2E-6V	>10:1
	- 400.0000 mV	- 400.0718 mV	_____	- 399.9282 mV	2.4E-6 V	>10:1
	- 200.0000 mV	- 200.0518 mV	_____	- 199.9482 mV	1.6E-6 V	>10:1
	0.0000 mV	- 0.0318 mV	_____	+ 0.0318 mV	0.8E-6 V	>10:1
	+200.0000 mV	+199.9482 mV	_____	+200.0518 mV	1.6E-6 V	>10:1
	+400.0000 mV	+399.9282 mV	_____	+400.0718 mV	2.4E-6 V	>10:1
	+600.0000 mV	+599.9082 mV	_____	+600.0918 mV	3.2E-6 V	>10:1
	+800.0000 mV	+799.8882 mV	_____	+800.1118 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4 V	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5 V	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5 V	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5 V	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5 V	10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5 V	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5 V	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5 V	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 7 of 29)

Test 2-3: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X1 and 100 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.0625 V	- 50.0000 mV	- 50.0118 mV	_____	- 49.9882 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0105 mV	_____	- 36.9895 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0093 mV	_____	- 24.9907 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0080 mV	_____	- 11.9920 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0068 mV	_____	+ 0.0068 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9920 mV	_____	+ 12.0080 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9907 mV	_____	+ 25.0093 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9895 mV	_____	+ 37.0105 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9882 mV	_____	+ 50.0118 mV	7.5E-7 V	>10:1
.25 V	- 200.0000 mV	- 200.0312 mV	_____	- 199.9688 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0262 mV	_____	- 149.9738 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0212 mV	_____	- 99.9788 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0162 mV	_____	- 49.9838 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0112 mV	_____	+ 0.0112 mV	8.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.9838 mV	_____	+ 50.0162 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9788 mV	_____	+100.0212 mV	1.2E-6 V	>10:1
	+150.0000 mV	+149.9738 mV	_____	+150.0262 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9688 mV	_____	+200.0312 mV	1.6E-6 V	>10:1
1.0V	- 800.0000 mV	- 800.1113 mV	_____	- 799.8887 mV	4.0E-6 V	>10:1
	- 600.0000 mV	- 600.0913 mV	_____	- 599.9087 mV	3.2E-6 V	>10:1
	- 400.0000 mV	- 400.0713 mV	_____	- 399.9287 mV	2.4E-6 V	>10:1
	- 200.0000 mV	- 200.0513 mV	_____	- 199.9487 mV	1.6E-6 V	>10:1
	0.0000 mV	- 0.0313 mV	_____	+ 0.0313 mV	0.8E-6 V	>10:1
	+200.0000 mV	+199.9487 mV	_____	+200.0513 mV	1.6E-6 V	>10:1
	+400.0000 mV	+399.9287 mV	_____	+400.0713 mV	2.4E-6 V	>10:1
	+600.0000 mV	+599.9087 mV	_____	+600.0913 mV	3.2E-6 V	>10:1
	+800.0000 mV	+799.8887 mV	_____	+800.1113 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5	>10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 8 of 29)

Test 2-3: DCV Measurement Accuracy - E1503A Amplifier+Filter Input SCP (Gain X1, Filter OFF)						
A/D Range	**Input**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
.0625 V	- 50.0000 mV	- 50.0113 mV	_____	- 49.9887 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0100 mV	_____	- 36.9900 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0088 mV	_____	- 24.9912 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0075 mV	_____	- 11.9925 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0063 mV	_____	+ 0.0063 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9925 mV	_____	+ 12.0075 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9912 mV	_____	+ 25.0088 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9900 mV	_____	+ 37.0100 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9887 mV	_____	+ 50.0113 mV	7.5E-7 V	>10:1
.25 V	- 200.0000 mV	- 200.0308 mV	_____	- 199.9692 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0258 mV	_____	- 149.9742 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0208 mV	_____	- 99.9792 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0158 mV	_____	- 49.9842 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0108 mV	_____	+ 0.0108 mV	8.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.9842 mV	_____	+ 50.0158 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9792 mV	_____	+100.0208 mV	1.2E-6 V	>10:1
	+150.0000 mV	+149.9742 mV	_____	+150.0258 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9692 mV	_____	+200.0308 mV	1.6E-6 V	>10:1
1.0V	- 800.0000 mV	- 800.1112 mV	_____	- 799.8888 mV	4.0E-6 V	>10:1
	- 600.0000 mV	- 600.0912 mV	_____	- 599.9088 mV	3.2E-6 V	>10:1
	- 400.0000 mV	- 400.0712 mV	_____	- 399.9288 mV	2.4E-6 V	>10:1
	- 200.0000 mV	- 200.0512 mV	_____	- 199.9488 mV	1.6E-6 V	>10:1
	0.0000 mV	- 0.0312 mV	_____	+ 0.0312 mV	0.8E-6 V	>10:1
	+200.0000 mV	+199.9488 mV	_____	+200.0512 mV	1.6E-6 V	>10:1
	+400.0000 mV	+399.9288 mV	_____	+400.0712 mV	2.4E-6 V	>10:1
	+600.0000 mV	+599.9088 mV	_____	+600.0912 mV	3.2E-6 V	>10:1
	+800.0000 mV	+799.8888 mV	_____	+800.1112 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5	10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 9 of 29)

Test 2-4: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X8 and 2 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.0625 V	- 6.0000 mV	- 6.0052 mV	_____	- 5.9948 mV	4.4E-7 V	>10:1
	- 4.5000 mV	- 4.5051 mV	_____	- 4.4950 mV	4.3E-7 V	>10:1
	- 3.0000 mV	- 3.0049 mV	_____	- 2.9951 mV	4.2E-7 V	>10:1
	- 1.5000 mV	- 1.5048 mV	_____	- 1.4953 mV	4.1E-7 V	>10:1
	0.0000 mV	- 0.0046 mV	_____	+ 0.0046 mV	4.0E-7 V	>10:1
	+ 1.5000 mV	+ 1.4953 mV	_____	+ 1.5048 mV	4.1E-7 V	>10:1
	+ 3.0000 mV	+ 2.9951 mV	_____	+ 3.0049 mV	4.2E-7 V	>10:1
	+ 4.5000 mV	+ 4.4950 mV	_____	+ 4.5051 mV	4.3E-7 V	>10:1
	+ 6.0000 mV	+ 5.9948 mV	_____	+ 6.0052 mV	4.4E-7 V	>10:1
.25 V	- 25.0000 mV	- 25.0073 mV	_____	- 24.9927 mV	5.8E-7 V	>10:1
	- 18.0000 mV	- 18.0066 mV	_____	- 17.9934 mV	5.3E-7 V	>10:1
	- 12.0000 mV	- 12.0060 mV	_____	- 11.9940 mV	4.8E-7 V	>10:1
	- 6.0000 mV	- 6.0054 mV	_____	- 5.9946 mV	4.4E-7 V	>10:1
	0.0000 mV	- 0.0048 mV	_____	+ 0.0048 mV	4.0E-7 V	>10:1
	+ 6.0000 mV	+ 5.9946 mV	_____	+ 6.0054 mV	4.4E-7 V	>10:1
	+12.0000 mV	+ 11.9940 mV	_____	+ 12.0060 mV	4.8E-7 V	>10:1
	+18.0000 mV	+ 17.9934 mV	_____	+ 18.0066 mV	5.3E-7 V	>10:1
	+25.0000 mV	+ 24.9927 mV	_____	+ 25.0073 mV	5.8E-7 V	>10:1
1.0V	- 100.000 mV	- 100.016 mV	_____	- 99.984 mV	1.2E-6 V	>10:1
	- 75.000 mV	- 75.014 mV	_____	- 74.987 mV	1.1E-6 V	>10:1
	- 50.000 mV	- 50.011 mV	_____	- 49.989 mV	1.0E-6 V	>10:1
	- 25.000 mV	- 25.009 mV	_____	- 24.992 mV	9.0E-7 V	9:1
	0.000 mV	- 0.006 mV	_____	+ 0.006 mV	8.0E-7 V	8:1
	+ 25.000 mV	+ 24.992 mV	_____	+ 25.009 mV	9.0E-7 V	9:1
	+ 50.000 mV	+ 49.989 mV	_____	+ 50.011 mV	1.0E-6 V	>10:1
	+ 75.000 mV	+ 74.987 mV	_____	+ 75.014 mV	1.1E-6 V	>10:1
	+100.000 mV	+ 99.984 mV	_____	+100.016 mV	1.2E-6 V	>10:1
4.0V	- 400.000 mV	- 400.056 mV	_____	- 399.944 mV	2.4E-6 V	>10:1
	- 300.000 mV	- 300.046 mV	_____	- 299.954 mV	2.0E-6 V	>10:1
	- 200.000 mV	- 200.036 mV	_____	- 199.964 mV	1.6E-6 V	>10:1
	- 100.000 mV	- 100.026 mV	_____	- 99.974 mV	1.2E-6 V	>10:1
	0.000 mV	- 0.016 mV	_____	+ 0.016 mV	8.0E-7 V	>10:1
	+100.000 mV	+ 99.974 mV	_____	+100.026 mV	1.2E-6 V	>10:1
	+200.000 mV	+199.964 mV	_____	+200.036 mV	1.6E-6 V	>10:1
	+300.000 mV	+299.954 mV	_____	+300.046 mV	2.0E-6 V	>10:1
	+400.000 mV	+399.944 mV	_____	+400.056 mV	2.4E-6 V	>10:1
16.0V	- 1.6000 V	- 1.6002 V	_____	- 1.5998 V	7.0E-6 V	>10:1
	- 1.2000 V	- 1.2002 V	_____	- 1.1998 V	6.0E-6 V	>10:1
	- 0.8000 V	- 0.8001 V	_____	- 0.7999 V	5.0E-6 V	>10:1
	- 0.4000 V	- 0.4001 V	_____	- 0.3999 V	4.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.4000 V	+0.3999 V	_____	+0.4001 V	4.0E-6 V	>10:1
	+0.8000 V	+0.7999 V	_____	+0.8001 V	5.0E-6 V	>10:1
	+1.2000 V	+1.1998 V	_____	+1.2002 V	6.0E-6 V	>10:1
	+1.6000 V	+1.5998 V	_____	+1.6002 V	7.0E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 10 of 29)

Test 2-4: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X8 and 10 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.0625 V	- 6.0000 mV	- 6.0048 mV	_____	- 5.9952 mV	4.4E-7 V	>10:1
	- 4.5000 mV	- 4.5047 mV	_____	- 4.4954 mV	4.3E-7 V	>10:1
	- 3.0000 mV	- 3.0045 mV	_____	- 2.9955 mV	4.2E-7 V	>10:1
	- 1.5000 mV	- 1.5044 mV	_____	- 1.4957 mV	4.1E-7 V	>10:1
	0.0000 mV	- 0.0042 mV	_____	+ 0.0042 mV	4.0E-7 V	>10:1
	+ 1.5000 mV	+ 1.4957 mV	_____	+ 1.5044 mV	4.1E-7 V	>10:1
	+ 3.0000 mV	+ 2.9955 mV	_____	+ 3.0045 mV	4.2E-7 V	>10:1
	+ 4.5000 mV	+ 4.4954 mV	_____	+ 4.5047 mV	4.3E-7 V	>10:1
	+ 6.0000 mV	+ 5.9952 mV	_____	+ 6.0048 mV	4.4E-7 V	>10:1
.25 V	- 25.0000 mV	- 25.0071 mV	_____	- 24.9929 mV	5.8E-7 V	>10:1
	- 18.0000 mV	- 18.0064 mV	_____	- 17.9936 mV	5.3E-7 V	>10:1
	- 12.0000 mV	- 12.0058 mV	_____	- 11.9942 mV	4.8E-7 V	>10:1
	- 6.0000 mV	- 6.0052 mV	_____	- 5.9948 mV	4.4E-7 V	>10:1
	0.0000 mV	- 0.0046 mV	_____	+ 0.0046 mV	4.0E-7 V	>10:1
	+ 6.0000 mV	+ 5.9948 mV	_____	+ 6.0052 mV	4.4E-7 V	>10:1
	+12.0000 mV	+ 11.9942 mV	_____	+ 12.0058 mV	4.8E-7 V	>10:1
	+18.0000 mV	+ 17.9936 mV	_____	+ 18.0064 mV	5.3E-7 V	>10:1
	+25.0000 mV	+ 24.9929 mV	_____	+ 25.0071 mV	5.8E-7 V	>10:1
1.0V	- 100.800 mV	- 100.015 mV	_____	- 99.985 mV	1.2E-6 V	>10:1
	- 75.000 mV	- 75.013 mV	_____	- 74.987 mV	1.1E-6 V	>10:1
	- 50.000 mV	- 50.010 mV	_____	- 49.990 mV	1.0E-6 V	10:1
	- 25.000 mV	- 25.008 mV	_____	- 24.992 mV	9.0E-7 V	9:1
	0.000 mV	- 0.005 mV	_____	+ 0.005 mV	8.0E-7 V	7:1
	+ 25.000 mV	+ 24.992 mV	_____	+ 25.008 mV	9.0E-7 V	9:1
	+ 50.000 mV	+ 49.990 mV	_____	+ 50.010 mV	1.0E-6 V	10:1
	+ 75.000 mV	+ 74.987 mV	_____	+ 75.013 mV	1.1E-6 V	>10:1
	+100.000 mV	+ 99.985 mV	_____	+100.015 mV	1.2E-6 V	>10:1
4.0V	- 400.000 mV	- 400.056 mV	_____	- 399.944 mV	2.4E-6 V	>10:1
	- 300.000 mV	- 300.046 mV	_____	- 299.954 mV	2.0E-6 V	>10:1
	- 200.000 mV	- 200.036 mV	_____	- 199.964 mV	1.6E-6 V	>10:1
	- 100.000 mV	- 100.026 mV	_____	- 99.974 mV	1.2E-6 V	>10:1
	0.000 mV	- 0.016 mV	_____	+ 0.016 mV	8.0E-7 V	>10:1
	+100.000 mV	+ 99.974 mV	_____	+100.026 mV	1.2E-6 V	>10:1
	+200.000 mV	+199.964 mV	_____	+200.036 mV	1.6E-6 V	>10:1
	+300.000 mV	+299.954 mV	_____	+300.046 mV	2.0E-6 V	>10:1
	+400.000 mV	+399.944 mV	_____	+400.056 mV	2.4E-6 V	>10:1
16.0V	- 1.6000 V	- 1.6002 V	_____	- 1.5998 V	7.0E-6 V	>10:1
	- 1.2000 V	- 1.2002 V	_____	- 1.1998 V	6.0E-6 V	>10:1
	- 0.8000 V	- 0.8001 V	_____	- 0.7999 V	5.0E-6 V	>10:1
	- 0.4000 V	- 0.4001 V	_____	- 0.3999 V	4.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.4000 V	+0.3999 V	_____	+0.4001 V	4.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8001 V	5.0E-6 V	>10:1
	+1.2000 V	+1.1998 V	_____	+1.2002 V	6.0E-6 V	>10:1
	+1.6000 V	+1.5998 V	_____	+1.6002 V	7.0E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 11 of 29)

Test 2-4: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X8 and 100 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.0625 V	- 6.0000 mV	- 6.0044 mV	_____	- 5.9956 mV	4.4E-7 V	10:1
	- 4.5000 mV	- 4.5043 mV	_____	- 4.4958 mV	4.3E-7 V	10:1
	- 3.0000 mV	- 3.0041 mV	_____	- 2.9959 mV	4.2E-7 V	10:1
	- 1.5000 mV	- 1.5040 mV	_____	- 1.4961 mV	4.1E-7 V	10:1
	0.0000 mV	- 0.0038 mV	_____	+ 0.0038 mV	4.0E-7 V	10:1
	+ 1.5000 mV	+ 1.4961 mV	_____	+ 1.5040 mV	4.1E-7 V	10:1
	+ 3.0000 mV	+ 2.9959 mV	_____	+ 3.0041 mV	4.2E-7 V	10:1
	+ 4.5000 mV	+ 4.4958 mV	_____	+ 4.5043 mV	4.3E-7 V	10:1
	+ 6.0000 mV	+ 5.9956 mV	_____	+ 6.0044 mV	4.4E-7 V	10:1
.25 V	- 25.0000 mV	- 25.0069 mV	_____	- 24.9931 mV	5.8E-7 V	>10:1
	- 18.0000 mV	- 18.0062 mV	_____	- 17.9938 mV	5.3E-7 V	>10:1
	- 12.0000 mV	- 12.0056 mV	_____	- 11.9944 mV	4.8E-7 V	>10:1
	- 6.0000 mV	- 6.0050 mV	_____	- 5.9950 mV	4.4E-7 V	>10:1
	0.0000 mV	- 0.0044 mV	_____	+ 0.0044 mV	4.0E-7 V	>10:1
	+ 6.0000 mV	+ 5.9950 mV	_____	+ 6.0050 mV	4.4E-7 V	>10:1
	+12.0000 mV	+ 11.9944 mV	_____	+ 12.0056 mV	4.8E-7 V	>10:1
	+18.0000 mV	+ 17.9938 mV	_____	+ 18.0062 mV	5.3E-7 V	>10:1
	+25.0000 mV	+ 24.9931 mV	_____	+ 25.0069 mV	5.8E-7 V	>10:1
1.0V	- 100.000 mV	- 100.015 mV	_____	- 99.985 mV	1.2E-6 V	>10:1
	- 75.000 mV	- 75.013 mV	_____	- 74.988 mV	1.1E-6 V	>10:1
	- 50.000 mV	- 50.010 mV	_____	- 49.990 mV	1.0E-6 V	10:1
	- 25.000 mV	- 25.008 mV	_____	- 24.993 mV	9.0E-7 V	8:1
	0.000 mV	- 0.005 mV	_____	+ 0.005 mV	8.0E-7 V	6:1
	+ 25.000 mV	+ 24.993 mV	_____	+ 25.008 mV	9.0E-7 V	8:1
	+ 50.000 mV	+ 49.990 mV	_____	+ 50.010 mV	1.0E-6 V	10:1
	+ 75.000 mV	+ 74.988 mV	_____	+ 75.013 mV	1.1E-6 V	>10:1
	+100.000 mV	+ 99.985 mV	_____	+100.015 mV	1.2E-6 V	>10:1
4.0V	- 400.000 mV	- 400.056 mV	_____	- 399.944 mV	2.4E-6 V	>10:1
	- 300.000 mV	- 300.046 mV	_____	- 299.954 mV	2.0E-6 V	>10:1
	- 200.000 mV	- 200.036 mV	_____	- 199.964 mV	1.6E-6 V	>10:1
	- 100.000 mV	- 100.026 mV	_____	- 99.974 mV	1.2E-6 V	>10:1
	0.000 mV	- 0.016 mV	_____	+ 0.016 mV	8.0E-7 V	>10:1
	+100.000 mV	+ 99.974 mV	_____	+100.026 mV	1.2E-6 V	>10:1
	+200.000 mV	+199.964 mV	_____	+200.036 mV	1.6E-6 V	>10:1
	+300.000 mV	+299.954 mV	_____	+300.046 mV	2.0E-6 V	>10:1
	+400.000 mV	+399.944 mV	_____	+400.056 mV	2.4E-6 V	>10:1
16.0V	- 1.6000 V	- 1.6002 V	_____	- 1.5998 V	7.0E-6 V	>10:1
	- 1.2000 V	- 1.2002 V	_____	- 1.1998 V	6.0E-6 V	>10:1
	- 0.8000 V	- 0.8001 V	_____	- 0.7999 V	5.0E-6 V	>10:1
	- 0.4000 V	- 0.4001 V	_____	- 0.3999 V	4.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.4000 V	+0.3999 V	_____	+0.4001 V	4.0E-6 V	>10:1
	+0.8000 V	+0.7999 V	_____	+0.8001 V	5.0E-6 V	>10:1
	+1.2000 V	+1.1998 V	_____	+1.2002 V	6.0E-6 V	>10:1
	+1.6000 V	+1.5998 V	_____	+1.6002 V	7.0E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 12 of 29)

Test 2-4: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X8 and Filter OFF)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.0625 V	- 6.0000 mV	- 6.0043 mV	_____	- 5.9957 mV	4.4E-7 V	10:1
	- 4.5000 mV	- 4.5042 mV	_____	- 4.4959 mV	4.3E-7 V	10:1
	- 3.0000 mV	- 3.0040 mV	_____	- 2.9960 mV	4.2E-7 V	10:1
	- 1.5000 mV	- 1.5039 mV	_____	- 1.4962 mV	4.1E-7 V	9:1
	0.0000 mV	- 0.0037 mV	_____	+ 0.0037 mV	4.0E-7 V	9:1
	+ 1.5000 mV	+ 1.4962 mV	_____	+ 1.5039 mV	4.1E-7 V	9:1
	+ 3.0000 mV	+ 2.9960 mV	_____	+ 3.0040 mV	4.2E-7 V	10:1
	+ 4.5000 mV	+ 4.4959 mV	_____	+ 4.5042 mV	4.3E-7 V	10:1
	+ 6.0000 mV	+ 5.9957 mV	_____	+ 6.0043 mV	4.4E-7 V	10:1
.25 V	- 25.0000 mV	- 25.0068 mV	_____	- 24.9932 mV	5.8E-7 V	>10:1
	- 18.0000 mV	- 18.0061 mV	_____	- 17.9939 mV	5.3E-7 V	>10:1
	- 12.0000 mV	- 12.0055 mV	_____	- 11.9945 mV	4.8E-7 V	>10:1
	- 6.0000 mV	- 6.0049 mV	_____	- 5.9951 mV	4.4E-7 V	>10:1
	0.0000 mV	- 0.0043 mV	_____	+ 0.0043 mV	4.0E-7 V	>10:1
	+ 6.0000 mV	+ 5.9951 mV	_____	+ 6.0049 mV	4.4E-7 V	>10:1
	+12.0000 mV	+ 11.9945 mV	_____	+ 12.0055 mV	4.8E-7 V	>10:1
	+18.0000 mV	+ 17.9939 mV	_____	+ 18.0061 mV	5.3E-7 V	>10:1
	+25.0000 mV	+ 24.9932 mV	_____	+ 25.0068 mV	5.8E-7 V	>10:1
1.0V	- 100.000 mV	- 100.015 mV	_____	- 99.985 mV	1.2E-6 V	>10:1
	- 75.000 mV	- 75.012 mV	_____	- 74.988 mV	1.1E-6 V	>10:1
	- 50.000 mV	- 50.010 mV	_____	- 49.990 mV	1.0E-6 V	10:1
	- 25.000 mV	- 25.007 mV	_____	- 24.993 mV	9.0E-7 V	8:1
	0.000 mV	- 0.005 mV	_____	+ 0.005 mV	8.0E-7 V	6:1
	+ 25.000 mV	+ 24.993 mV	_____	+ 25.007 mV	9.0E-7 V	8:1
	+ 50.000 mV	+ 49.990 mV	_____	+ 50.010 mV	1.0E-6 V	10:1
	+ 75.000 mV	+ 74.988 mV	_____	+ 75.012 mV	1.1E-6 V	>10:1
	+100.000 mV	+ 99.985 mV	_____	+100.015 mV	1.2E-6 V	>10:1
4.0V	- 400.000 mV	- 400.056 mV	_____	- 399.944 mV	2.4E-6 V	>10:1
	- 300.000 mV	- 300.046 mV	_____	- 299.954 mV	2.0E-6 V	>10:1
	- 200.000 mV	- 200.036 mV	_____	- 199.964 mV	1.6E-6 V	>10:1
	- 100.000 mV	- 100.026 mV	_____	- 99.974 mV	1.2E-6 V	>10:1
	0.000 mV	- 0.016 mV	_____	+ 0.016 mV	8.0E-7 V	>10:1
	+100.000 mV	+ 99.974 mV	_____	+100.026 mV	1.2E-6 V	>10:1
	+200.000 mV	+199.964 mV	_____	+200.036 mV	1.6E-6 V	>10:1
	+300.000 mV	+299.954 mV	_____	+300.046 mV	2.0E-6 V	>10:1
	+400.000 mV	+399.944 mV	_____	+400.056 mV	2.4E-6 V	>10:1
16.0V	- 1.6000 V	- 1.6002 V	_____	- 1.5998 V	7.0E-6 V	>10:1
	- 1.2000 V	- 1.2002 V	_____	- 1.1998 V	6.0E-6 V	>10:1
	- 0.8000 V	- 0.8001 V	_____	- 0.7999 V	5.0E-6 V	>10:1
	- 0.4000 V	- 0.4001 V	_____	- 0.3999 V	4.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.4000 V	+0.3999 V	_____	+0.4001 V	4.0E-6 V	>10:1
	+0.8000 V	+0.7999 V	_____	+0.8001 V	5.0E-6 V	>10:1
	+1.2000 V	+1.1998 V	_____	+1.2002 V	6.0E-6 V	>10:1
	+1.6000 V	+1.5998 V	_____	+1.6002 V	7.0E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 13 of 29)

Test 2-5: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X64 and 2 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.25 V	- 3.0000 mV	- 3.0032 mV	_____	- 2.9968 mV	4.2E-7 V	8:1
	- 2.5000 mV	- 2.5032 mV	_____	- 2.4969 mV	4.2E-7 V	8:1
	- 1.5000 mV	- 1.5031 mV	_____	- 1.4970 mV	4.1E-7 V	7:1
	- 0.8000 mV	- 0.8030 mV	_____	- 0.7970 mV	4.1E-7 V	7:1
	0.0000 mV	- 0.0029 mV	_____	+0.0029 mV	4.0E-7 V	7:1
	+0.8000 mV	+0.7970 mV	_____	+0.8030 mV	4.1E-7 V	7:1
	+1.5000 mV	+1.4970 mV	_____	+1.5031 mV	4.1E-7 V	7:1
	+2.5000 mV	+2.4969 mV	_____	+2.5032 mV	4.2E-7 V	8:1
	+3.0000 mV	+2.9968 mV	_____	+3.0032 mV	4.2E-7 V	8:1
1.0V	- 12.8000 mV	- 12.8043 mV	_____	- 12.7957 mV	4.9E-7 V	9:1
	- 9.6000 mV	- 9.6040 mV	_____	- 9.5960 mV	4.7E-7 V	8:1
	- 6.4000 mV	- 6.4036 mV	_____	- 6.3964 mV	4.4E-7 V	8:1
	- 3.2000 mV	- 3.2033 mV	_____	- 3.1967 mV	4.2E-7 V	8:1
	0.0000 mV	- 0.0030 mV	_____	+ 0.0030 mV	4.0E-7 V	8:1
	+ 3.2000 mV	+ 3.1967 mV	_____	+ 3.2033 mV	4.2E-7 V	8:1
	+ 6.4000 mV	+ 6.3964 mV	_____	+ 6.4036 mV	4.4E-7 V	8:1
	+ 9.6000 mV	+ 9.5960 mV	_____	+ 9.6040 mV	4.7E-7 V	8:1
	+12.8000 mV	+12.7957 mV	_____	+12.8043 mV	4.9E-7 V	9:1
4.0V	- 50.0000 mV	- 50.0085 mV	_____	- 49.9915 mV	7.5E-7 V	>10:1
	- 37.5000 mV	- 37.5073 mV	_____	- 37.4928 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0060 mV	_____	- 24.9940 mV	5.8E-7 V	10:1
	- 12.5000 mV	- 12.5048 mV	_____	- 12.4953 mV	4.9E-7 V	10:1
	0.0000 mV	- 0.0035 mV	_____	+ 0.0035 mV	4.0E-7 V	9:1
	+12.5000 mV	+12.4953 mV	_____	+12.5048 mV	4.9E-7 V	10:1
	+25.0000 mV	+24.9940 mV	_____	+25.0060 mV	5.8E-7 V	10:1
	+37.5000 mV	+37.4928 mV	_____	+37.5073 mV	6.6E-7 V	>10:1
	+50.0000 mV	+49.9915 mV	_____	+50.0085 mV	7.5E-7 V	>10:1
16.0V	- 200.0000 mV	- 200.0282 mV	_____	- 199.9718 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0282 mV	_____	- 149.9768 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0182 mV	_____	- 99.9818 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0132 mV	_____	- 49.9868 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0082 mV	_____	+ 0.0082 mV	0.8E-6 V	10:1
	+ 50.0000 mV	+ 49.9868 mV	_____	+ 50.0132 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9818 mV	_____	+100.0182 mV	1.2E-6V	>10:1
	+150.0000 mV	+149.9768 mV	_____	+150.0232 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9718 mV	_____	+200.0282 mV	1.6E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 14 of 29)

Test 2-5: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X64 and 10 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.25 V	- 3.0000 mV	- 3.0026 mV	_____	- 2.9974 mV	4.2E-7 V	6:1
	- 2.5000 mV	- 2.5026 mV	_____	- 2.4975 mV	4.2E-7 V	6:1
	- 1.5000 mV	- 1.5025 mV	_____	- 1.4976 mV	4.1E-7 V	6:1
	- 0.8000 mV	- 0.8024 mV	_____	- 0.7976 mV	4.1E-7 V	6:1
	0.0000 mV	- 0.0023 mV	_____	+0.0023 mV	4.0E-7 V	6:1
	+0.8000 mV	+0.7976 mV	_____	+0.8024 mV	4.1E-7 V	6:1
	+1.5000 mV	+1.4976 mV	_____	+1.5025 mV	4.1E-7 V	6:1
	+2.5000 mV	+2.4975 mV	_____	+2.5026 mV	4.2E-7 V	6:1
	+3.0000 mV	+2.9974 mV	_____	+3.0026 mV	4.2E-7 V	6:1
1.0V	- 12.8000 mV	- 12.8037 mV	_____	- 12.7963 mV	4.9E-7 V	8:1
	- 9.6000 mV	- 9.6034 mV	_____	- 9.5966 mV	4.7E-7 V	7:1
	- 6.4000 mV	- 6.4030 mV	_____	- 6.3970 mV	4.4E-7 V	7:1
	- 3.2000 mV	- 3.2027 mV	_____	- 3.1973 mV	4.2E-7 V	6:1
	0.0000 mV	- 0.0024 mV	_____	+ 0.0024 mV	4.0E-7 V	6:1
	+ 3.2000 mV	+ 3.1973 mV	_____	+ 3.2027 mV	4.2E-7 V	6:1
	+ 6.4000 mV	+ 6.3970 mV	_____	+ 6.4030 mV	4.4E-7 V	7:1
	+ 9.6000 mV	+ 9.5966 mV	_____	+ 9.6034 mV	4.7E-7 V	7:1
	+12.8000 mV	+12.7963 mV	_____	+12.8037 mV	4.9E-7 V	8:1
4.0V	- 50.0000 mV	- 50.0080 mV	_____	- 49.9920 mV	7.5E-7 V	>10:1
	- 37.5000 mV	- 37.5068 mV	_____	- 37.4934 mV	6.6E-7 V	10:1
	- 25.0000 mV	- 25.0055 mV	_____	- 24.9945 mV	5.8E-7 V	10:1
	- 12.5000 mV	- 12.5043 mV	_____	- 12.4958 mV	4.9E-7 V	9:1
	0.0000 mV	- 0.0030 mV	_____	+ 0.0030 mV	4.0E-7 V	8:1
	+12.5000 mV	+12.4958 mV	_____	+12.5043 mV	4.9E-7 V	9:1
	+25.0000 mV	+24.9945 mV	_____	+25.0055 mV	5.8E-7 V	10:1
	+37.5000 mV	+37.4933 mV	_____	+37.5068 mV	6.6E-7 V	10:1
	+50.0000 mV	+49.9920 mV	_____	+50.0080 mV	7.5E-7 V	>10:1
16.0V	- 200.0000 mV	- 200.028 mV	_____	- 199.972 mV	1.2E-6 V	>10:1
	- 150.0000 mV	- 150.023 mV	_____	- 149.977 mV	1.0E-6 V	>10:1
	- 100.0000 mV	- 100.018 mV	_____	- 99.982 mV	8.0E-7 V	>10:1
	- 50.0000 mV	- 50.013 mV	_____	- 49.987 mV	6.0E-7 V	>10:1
	0.0000 mV	- 0.008 mV	_____	+ 0.008 mV	4.0E-7 V	10:1
	+ 50.0000 mV	+ 49.987 mV	_____	+ 50.013 mV	6.0E-7 V	>10:1
	+100.0000 mV	+ 99.982 mV	_____	+100.018 mV	8.0E-7 V	>10:1
	+150.0000 mV	+149.977 mV	_____	+150.023 mV	1.0E-6 V	>10:1
	+200.0000 mV	+199.972 mV	_____	+200.028 mV	1.2E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 15 of 29)

Test 2-5: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X64 and 100 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.25 V	- 3.0000 mV	- 3.0024 mV	_____	- 2.9976 mV	4.2E-7 V	6:1
	- 2.5000 mV	- 2.5024 mV	_____	- 2.4977 mV	4.2E-7 V	6:1
	- 1.5000 mV	- 1.5023 mV	_____	- 1.4978 mV	4.1E-7 V	5:1
	- 0.8000 mV	- 0.8022 mV	_____	- 0.7978 mV	4.1E-7 V	5:1
	0.0000 mV	- 0.0021 mV	_____	+0.0021 mV	4.0E-7 V	5:1
	+0.8000 mV	+0.7978 mV	_____	+0.8022 mV	4.1E-7 V	5:1
	+1.5000 mV	+1.4978 mV	_____	+1.5023 mV	4.1E-7 V	5:1
	+2.5000 mV	+2.4977 mV	_____	+2.5024 mV	4.2E-7 V	6:1
	+3.0000 mV	+2.9976 mV	_____	+3.0024 mV	4.2E-7 V	6:1
1.0V	- 12.8000 mV	- 12.8035 mV	_____	- 12.7965 mV	4.9E-7 V	7:1
	- 9.6000 mV	- 9.6032 mV	_____	- 9.5968 mV	4.7E-7 V	7:1
	- 6.4000 mV	- 6.4028 mV	_____	- 6.3972 mV	4.4E-7 V	6:1
	- 3.2000 mV	- 3.2025 mV	_____	- 3.1975 mV	4.2E-7 V	6:1
	0.0000 mV	- 0.0022 mV	_____	+ 0.0022 mV	4.0E-7 V	6:1
	+ 3.2000 mV	+ 3.1975 mV	_____	+ 3.2025 mV	4.2E-7 V	6:1
	+ 6.4000 mV	+ 6.3972 mV	_____	+ 6.4028 mV	4.4E-7 V	6:1
	+ 9.6000 mV	+ 9.5968 mV	_____	+ 9.6032 mV	4.7E-7 V	7:1
	+12.8000 mV	+12.7965 mV	_____	+12.8035 mV	4.9E-7 V	7:1
4.0V	- 50.0000 mV	- 50.0079 mV	_____	- 49.9921 mV	7.5E-7 V	>10:1
	- 37.5000 mV	- 37.5067 mV	_____	- 37.4934 mV	6.6E-7 V	10:1
	- 25.0000 mV	- 25.0054 mV	_____	- 24.9946 mV	5.8E-7 V	9:1
	- 12.5000 mV	- 12.5042 mV	_____	- 12.4959 mV	4.9E-7 V	9:1
	0.0000 mV	- 0.0029 mV	_____	+ 0.0029 mV	4.0E-7 V	7:1
	+12.5000 mV	+12.4959 mV	_____	+12.5042 mV	4.9E-7 V	9:1
	+25.0000 mV	+24.9946 mV	_____	+25.0054 mV	5.8E-7 V	9:1
	+37.5000 mV	+37.4934 mV	_____	+37.5067 mV	6.6E-7 V	10:1
	+50.0000 mV	+49.9921 mV	_____	+50.0079 mV	7.5E-7 V	>10:1
16.0V	- 200.0000 mV	- 200.028 mV	_____	- 199.972 mV	1.2E-6 V	>10:1
	- 150.0000 mV	- 150.023 mV	_____	- 149.977 mV	1.0E-6 V	>10:1
	- 100.0000 mV	- 100.018 mV	_____	- 99.982 mV	8.0E-7 V	>10:1
	- 50.0000 mV	- 50.013 mV	_____	- 49.987 mV	6.0E-7 V	>10:1
	0.0000 mV	- 0.008 mV	_____	+ 0.008 mV	4.0E-7 V	10:1
	+ 50.0000 mV	+ 49.987 mV	_____	+ 50.013 mV	6.0E-7 V	>10:1
	+100.0000 mV	+ 99.982 mV	_____	+100.018 mV	8.0E-7 V	>10:1
	+150.0000 mV	+149.977 mV	_____	+150.023 mV	1.0E-6 V	>10:1
	+200.0000 mV	+199.972 mV	_____	+200.028 mV	1.2E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 16 of 29)

Test 2-5: DCV Measurement Accuracy - E1503A Amplifier+Filter SCP (Gain X64 and Filter OFF)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.25 V	- 3.0000 mV	- 3.0024 mV	_____	- 2.9976 mV	4.2E-7 V	6:1
	- 2.5000 mV	- 2.5024 mV	_____	- 2.4977 mV	4.2E-7 V	6:1
	- 1.5000 mV	- 1.5023 mV	_____	- 1.4978 mV	4.1E-7 V	5:1
	- 0.8000 mV	- 0.8022 mV	_____	- 0.7978 mV	4.1E-7 V	5:1
	0.0000 mV	- 0.0021 mV	_____	+0.0021 mV	4.0E-7 V	5:1
	+0.8000 mV	+0.7978 mV	_____	+0.8022 mV	4.1E-7 V	5:1
	+1.5000 mV	+1.4978 mV	_____	+1.5023 mV	4.1E-7 V	5:1
	+2.5000 mV	+2.4977 mV	_____	+2.5024 mV	4.2E-7 V	6:1
	+3.0000 mV	+2.9976 mV	_____	+3.0024 mV	4.2E-7 V	6:1
1.0V	- 12.8000 mV	- 12.8035 mV	_____	- 12.7965 mV	4.9E-7 V	7:1
	- 9.6000 mV	- 9.6032 mV	_____	- 9.5968 mV	4.7E-7 V	7:1
	- 6.4000 mV	- 6.4028 mV	_____	- 6.3972 mV	4.4E-7 V	6:1
	- 3.2000 mV	- 3.2025 mV	_____	- 3.1975 mV	4.2E-7 V	6:1
	0.0000 mV	- 0.0022 mV	_____	+ 0.0022 mV	4.0E-7 V	6:1
	+ 3.2000 mV	+ 3.1975 mV	_____	+ 3.2025 mV	4.2E-7 V	6:1
	+ 6.4000 mV	+ 6.3972 mV	_____	+ 6.4028 mV	4.4E-7 V	6:1
	+ 9.6000 mV	+ 9.5968 mV	_____	+ 9.6032 mV	4.7E-7 V	7:1
	+12.8000 mV	+12.7965 mV	_____	+12.8035 mV	4.9E-7 V	7:1
4.0V	- 50.0000 mV	- 50.0079 mV	_____	- 49.9921 mV	7.5E-7 V	>10:1
	- 37.5000 mV	- 37.5067 mV	_____	- 37.4934 mV	6.6E-7 V	10:1
	- 25.0000 mV	- 25.0054 mV	_____	- 24.9946 mV	5.8E-7 V	9:1
	- 12.5000 mV	- 12.5042 mV	_____	- 12.4959 mV	4.9E-7 V	9:1
	0.0000 mV	- 0.0029 mV	_____	+ 0.0029 mV	4.0E-7 V	7:1
	+12.5000 mV	+12.4959 mV	_____	+12.5042 mV	4.9E-7 V	9:1
	+25.0000 mV	+24.9946 mV	_____	+25.0054 mV	5.8E-7 V	9:1
	+37.5000 mV	+37.4934 mV	_____	+37.5067 mV	6.6E-7 V	10:1
	+50.0000 mV	+49.9921 mV	_____	+50.0079 mV	7.5E-7 V	>10:1
16.0V	- 200.0000 mV	- 200.028 mV	_____	- 199.972 mV	1.2E-6 V	>10:1
	- 150.0000 mV	- 150.023 mV	_____	- 149.977 mV	1.0E-6 V	>10:1
	- 100.0000 mV	- 100.018 mV	_____	- 99.982 mV	8.0E-7 V	>10:1
	- 50.0000 mV	- 50.013 mV	_____	- 49.987 mV	6.0E-7 V	>10:1
	0.0000 mV	- 0.008 mV	_____	+ 0.008 mV	4.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.987 mV	_____	+ 50.013 mV	6.0E-7 V	>10:1
	+100.0000 mV	+ 99.982 mV	_____	+100.018 mV	8.0E-7 V	>10:1
	+150.0000 mV	+149.977 mV	_____	+150.023 mV	1.0E-6 V	>10:1
	+200.0000 mV	+199.972 mV	_____	+200.028 mV	1.2E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 17 of 29)

Test 2-6: DCI Measurement Accuracy - E1505A Current Source SCP						
A/D Range	**Output**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
30µA	30.518 µA	30.509 µA	_____	30.527 µA	1.26E-9	7:1
488µA	488.28 µA	488.22 µA	_____	488.34 µA	1.28E-8	5:1
Test 2-7: Excitation Voltage Measurement Accuracy - E1506A 120Ω Strain Gage SCP						
A/D Range	**Output**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
3.9 Vdc	3.9 Vdc	3.899488 Vdc	_____	3.900512 Vdc	1.65E-5	31:1
Test 2-8: Excitation Voltage Measurement Accuracy - E1507A 350Ω Strain Gage SCP						
A/D Range	**Output**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
3.9 Vdc	3.9 Vdc	3.899488 Vdc	_____	3.900512 Vdc	1.65E-5	31:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 18 of 29)

Test 2-9: DCV Measurement Accuracy - E1508A Fixed Filter + Amplifier SCP

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.0625V	- 3.0000 mV	- 3.0041 mV	_____	- 2.9959 mV	4.2E-7 V	10:1
	- 2.3000 mV	- 2.3040 mV	_____	- 2.2960 mV	4.2E-7 V	10:1
	- 1.5000 mV	- 1.5040 mV	_____	- 1.4961 mV	4.1E-7 V	10:1
	- 0.8000 mV	- 0.8039 mV	_____	- 0.7961 mV	4.1E-7 V	10:1
	0.0000 mV	- 0.0038 mV	_____	+0.0038 mV	4.0E-7 V	10:1
	+0.8000 mV	+0.7961 mV	_____	+0.8039 mV	4.1E-7 V	10:1
	+1.5000 mV	+1.4961 mV	_____	+1.5040 mV	4.1E-7 V	10:1
	+2.3000 mV	+2.2960 mV	_____	+2.3040 mV	4.2E-7 V	10:1
	+3.0000 mV	+2.9959 mV	_____	+3.0041 mV	4.2E-7 V	10:1
.25V	- 13.0000 mV	- 13.0055 mV	_____	- 12.9945 mV	4.9E-7 V	>10:1
	- 9.0000 mV	- 9.0051 mV	_____	- 8.9949 mV	4.7E-7 V	>10:1
	- 6.0000 mV	- 6.0048 mV	_____	- 5.9952 mV	4.4E-7 V	>10:1
	- 3.0000 mV	- 3.0045 mV	_____	- 2.9955 mV	4.2E-7 V	>10:1
	0.0000 mV	- 0.0042 mV	_____	+ 0.0042 mV	4.0E-7 V	>10:1
	+ 3.0000 mV	+ 2.9955 mV	_____	+ 3.0045 mV	4.2E-7 V	>10:1
	+ 6.0000 mV	+ 5.9952 mV	_____	+ 6.0048 mV	4.4E-7 V	>10:1
	+ 9.0000 mV	+ 8.9949 mV	_____	+ 9.0051 mV	4.7E-7 V	>10:1
	+13.0000 mV	+12.9945 mV	_____	+13.0055 mV	4.9E-7 V	>10:1
1.0V	- 50.0000 mV	- 50.0099 mV	_____	- 49.9901 mV	7.5E-7 V	>10:1
	- 37.5000 mV	- 37.5087 mV	_____	- 37.4914 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0074 mV	_____	- 24.9926 mV	5.8E-7 V	>10:1
	- 13.0000 mV	- 13.0062 mV	_____	- 12.9938 mV	4.9E-7 V	>10:1
	0.0000 mV	- 0.0049 mV	_____	+ 0.0049 mV	4.0E-7 V	>10:1
	+13.0000 mV	+12.9938 mV	_____	+13.0062 mV	4.9E-7 V	>10:1
	+25.0000 mV	+24.9926 mV	_____	+25.0074 mV	5.8E-7 V	>10:1
	+37.5000 mV	+37.4914 mV	_____	+37.5087 mV	6.6E-7 V	>10:1
	+50.0000 mV	+49.9901 mV	_____	+50.0099 mV	7.5E-7 V	>10:1
4.0V	- 200.000 mV	- 200.028 mV	_____	- 199.972 mV	1.6E-6 V	>10:1
	- 150.000 mV	- 150.023 mV	_____	- 149.977 mV	1.4E-6 V	>10:1
	- 100.000 mV	- 100.018 mV	_____	- 99.982 mV	1.2E-6 V	>10:1
	- 50.000 mV	- 50.013 mV	_____	- 49.987 mV	1.0E-6 V	>10:1
	0.000 mV	- 0.008 mV	_____	+ 0.008 mV	0.8E-6 V	10:1
	+ 50.000 mV	+ 49.987 mV	_____	+ 50.013 mV	1.0E-6 V	>10:1
	+100.000 mV	+ 99.982 mV	_____	+100.018 mV	1.2E-6 V	>10:1
	+150.000 mV	+149.977 mV	_____	+150.023 mV	1.4E-6 V	>10:1
	+200.000 mV	+199.972 mV	_____	+200.028 mV	1.6E-6 V	>10:1
16.0V	- 800.000 mV	- 800.111 mV	_____	- 799.889 mV	4.0E-6 V	>10:1
	- 600.000 mV	- 600.091 mV	_____	- 599.909 mV	3.2E-6 V	>10:1
	- 400.000 mV	- 400.071 mV	_____	- 399.929 mV	2.4E-6 V	>10:1
	- 200.000 mV	- 200.051 mV	_____	- 199.949 mV	1.6E-6 V	>10:1
	0.000 mV	- 0.031 mV	_____	+ 0.031 mV	0.8E-6 V	>10:1
	+200.000 mV	+199.949 mV	_____	+200.051 mV	1.6E-6 V	>10:1
	+400.000 mV	+399.929 mV	_____	+400.071 mV	2.4E-6 V	>10:1
	+600.000 mV	+599.909 mV	_____	+600.091 mV	3.2E-6 V	>10:1
	+800.000 mV	+799.889 mV	_____	+800.111 mV	4.0E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 19 of 29)

Test 2-10: DCV Measurement Accuracy - E1509A Fixed Filter + Amplifier SCP

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
.25V	- 3.0000 mV	- 3.0026 mV	_____	- 2.9974 mV	4.2E-7 V	6:1
	- 2.3000 mV	- 2.3025 mV	_____	- 2.2975 mV	4.2E-7 V	6:1
	- 1.5000 mV	- 1.5025 mV	_____	- 1.4976 mV	4.1E-7 V	6:1
	- 0.8000 mV	- 0.8024 mV	_____	- 0.7976 mV	4.1E-7 V	6:1
	0.0000 mV	- 0.0023 mV	_____	+0.0023 mV	4.0E-7 V	6:1
	+0.8000 mV	+0.7976 mV	_____	+0.8024 mV	4.1E-7 V	6:1
	+1.5000 mV	+1.4976 mV	_____	+1.5025 mV	4.1E-7 V	6:1
	+2.3000 mV	+2.2975 mV	_____	+2.3025 mV	4.2E-7 V	6:1
	+3.0000 mV	+2.9974 mV	_____	+3.0026 mV	4.2E-7 V	6:1
1.0V	- 13.0000 mV	- 13.0037 mV	_____	- 12.9963 mV	4.9E-7 V	8:1
	- 9.0000 mV	- 9.0033 mV	_____	- 8.9967 mV	4.7E-7 V	7:1
	- 6.0000 mV	- 6.0030 mV	_____	- 5.9970 mV	4.4E-7 V	7:1
	- 3.0000 mV	- 3.0027 mV	_____	- 2.9973 mV	4.2E-7 V	6:1
	0.0000 mV	- 0.0024 mV	_____	+ 0.0024 mV	4.0E-7 V	6:1
	+ 3.0000 mV	+ 2.9973 mV	_____	+ 3.2027 mV	4.2E-7 V	6:1
	+ 6.0000 mV	+ 5.9970 mV	_____	+ 6.0030 mV	4.4E-7 V	7:1
	+ 9.0000 mV	+ 8.9967 mV	_____	+ 9.6033 mV	4.7E-7 V	7:1
	+13.0000 mV	+12.9963 mV	_____	+13.3037 mV	4.9E-7 V	8:1
4.0V	- 50.0000 mV	- 50.0080 mV	_____	- 49.9920 mV	7.5E-7 V	>10:1
	- 37.5000 mV	- 37.5068 mV	_____	- 37.4933 mV	6.6E-7 V	10:1
	- 25.0000 mV	- 25.0055 mV	_____	- 24.9945 mV	5.8E-7 V	10:1
	- 13.0000 mV	- 13.0043 mV	_____	- 12.9957 mV	4.9E-7 V	9:1
	0.0000 mV	- 0.0030 mV	_____	+ 0.0030 mV	4.0E-7 V	8:1
	+13.0000 mV	+12.9957 mV	_____	+13.0043 mV	4.9E-7 V	9:1
	+25.0000 mV	+24.9945 mV	_____	+25.0055 mV	5.8E-7 V	10:1
	+37.5000 mV	+37.4933 mV	_____	+37.5068 mV	6.6E-7 V	10:1
	+50.0000 mV	+49.9920 mV	_____	+50.0080 mV	7.5E-7 V	>10:1
16V	- 200.0000 mV	- 200.028 mV	_____	- 199.972 mV	1.2E-6 V	>10:1
	- 150.0000 mV	- 150.023 mV	_____	- 149.977 mV	1.0E-6 V	>10:1
	- 100.0000 mV	- 100.018 mV	_____	- 99.982 mV	8.0E-7 V	>10:1
	- 50.0000 mV	- 50.013 mV	_____	- 49.987 mV	6.0E-7 V	>10:1
	0.0000 mV	- 0.008 mV	_____	+ 0.008 mV	4.0E-7 V	10:1
	+ 50.0000 mV	+ 49.987 mV	_____	+ 50.013 mV	6.0E-7 V	>10:1
	+100.0000 mV	+ 99.982 mV	_____	+100.018 mV	8.0E-7 V	>10:1
	+150.0000 mV	+149.977 mV	_____	+150.023 mV	1.0E-6 V	>10:1
	+200.0000 mV	+199.972 mV	_____	+200.028 mV	1.2E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 20 of 29)

Test 2-11: DCV Measurement Accuracy, Sample, & Hold Channels - E1510A Sample & Hold SCP						
Gain / A/D Range	**Input**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
Gain X0.5:						
0.0625VDC	- 0.1 VDC	-0.100508 VDC	_____	-0.099492 VDC	1.20E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+0.1 VDC	+0.099492 VDC	_____	+0.100508 VDC	1.20E-6 V	>10:1
0.25 VDC	- 0.4 VDC	-0.400568 VDC	_____	-0.399432 VDC	2.40E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+0.4 VDC	+0.399432 VDC	_____	+0.400568 VDC	2.40E-6 V	>10:1
1.0 VDC	- 1.6 VDC	-1.600808 VDC	_____	-1.599192 VDC	7.00E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+1.6 VDC	+1.599192 VDC	_____	+1.600808 VDC	7.00E-6 V	>10:1
4.0 VDC	- 6.4 VDC	-6.401768 VDC	_____	-6.398232 VDC	19.0E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+6.4 VDC	+6.398232 VDC	_____	+6.401768 VDC	19.0E-6 V	>10:1
Gain X8:						
0.0625 VDC	- 0.00624	-0.006272 VDC	_____	-0.006208 VDC	0.44E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.40E-6 V	>10:1
	+0.00624	+0.006208 VDC	_____	+0.006272 VDC	0.44E-6 V	>10:1
0.25 VDC	- 0.025	-0.025036 VDC	_____	-0.024965 VDC	0.57E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.40E-6 V	>10:1
	+0.025	+0.024965 VDC	_____	+0.025036 VDC	0.57E-6 V	>10:1
1.0 VDC	- 0.1	-0.100051 VDC	_____	-0.099950 VDC	1.20E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.80E-6 V	>10:1
	+0.1	+0.099950 VDC	_____	+0.100051 VDC	1.20E-6 V	>10:1
4.0 VDC	- 0.4	-0.400111 VDC	_____	-0.399890 VDC	2.40E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.80E-6 V	>10:1
	+0.4	+0.399890 VDC	_____	+0.400111 VDC	2.40E-6 V	>10:1
Gain X64:						
0.25 VDC	- 0.00312	-0.003136 VDC	_____	-0.003104 VDC	0.42E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.00312	+0.003104 VDC	_____	+0.003136 VDC	0.42E-6 V	>10:1
1.0 VDC	- 0.0125	-0.012518 VDC	_____	-0.012483 VDC	0.49E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.0125	+0.012483 VDC	_____	+0.012518 VDC	0.49E-6 V	>10:1
4.0 VDC	- 0.05	-0.050025 VDC	_____	-0.049975 VDC	0.75E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.05	+0.049975 VDC	_____	+0.050025 VDC	0.75E-6 V	>10:1
Gain X512:						
4.0VDC	- 0.00625	-0.006268 VDC	_____	-0.006234 VDC	0.44E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.00625	+0.006234 VDC	_____	+0.006268 VDC	0.44E-6 V	>10:1
Sample & Hold Droop	4 V Range, X0.5 Gain, 7.5 VDC Input	----	_____	1 V/S	----	----

Test 2-13: DCV Measurement Accuracy, Straight-Through Channels - E1510A Sample & Hold SCP

A/D Range	Input	Minimum	Measured	Maximum	M.U.*	TAR**
.0625 V	- 50.0000 mV	- 50.0103 mV	_____	- 49.9897 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0090 mV	_____	- 36.9910 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0078 mV	_____	- 24.9922 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0065 mV	_____	- 11.9935 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0053 mV	_____	+ 0.0053 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9935 mV	_____	+ 12.0065 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9922 mV	_____	+ 25.0078 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9910 mV	_____	+ 37.0090 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9897 mV	_____	+ 50.0103 mV	7.5E-7 V	>10:1
.25 V	- 200.0000 mV	- 200.0303 mV	_____	- 199.9697 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0253 mV	_____	- 149.9747 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0203 mV	_____	- 99.9797 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0153 mV	_____	- 49.9847 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0103 mV	_____	+ 0.0103 mV	8.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.9847 mV	_____	+ 50.0153 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9797 mV	_____	+100.0203 mV	1.2E-6 V	>10:1
	+150.0000 mV	+149.9747 mV	_____	+150.0253 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9697 mV	_____	+200.0303 mV	1.6E-6 V	>10:1
1.0V	- 800.000 mV	- 800.111 mV	_____	- 799.889 mV	4.0E-6 V	>10:1
	- 600.000 mV	- 600.091 mV	_____	- 599.909 mV	3.2E-6 V	>10:1
	- 400.000 mV	- 400.071 mV	_____	- 399.929 mV	2.4E-6 V	>10:1
	- 200.000 mV	- 200.051 mV	_____	- 199.949 mV	1.6E-6 V	>10:1
	0.000 mV	- 0.031 mV	_____	+ 0.031 mV	0.8E-6 V	>10:1
	+200.000 mV	+199.949 mV	_____	+200.051 mV	1.6E-6 V	>10:1
	+400.000 mV	+399.929 mV	_____	+400.071 mV	2.4E-6 V	>10:1
	+600.000 mV	+599.909 mV	_____	+600.091 mV	3.2E-6 V	>10:1
	+800.000 mV	+799.889 mV	_____	+800.111 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4 V	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5 V	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5 V	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5 V	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5 V	10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5 V	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5 V	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5 V	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 22 of 29)

Test 2-12: DCV Measurement Accuracy, Bridge Sense Channels - E1511A Transient Strain SCP						
Gain / A/D Range	**Input**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
Gain X0.5:						
0.0625VDC	- 0.1 VDC	-0.100508 VDC	_____	-0.099492 VDC	1.20E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+0.1 VDC	+0.099492 VDC	_____	+0.100508 VDC	1.20E-6 V	>10:1
0.25 VDC	- 0.4 VDC	-0.400568 VDC	_____	-0.399432 VDC	2.40E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+0.4 VDC	+0.399432 VDC	_____	+0.400568 VDC	2.40E-6 V	>10:1
1.0 VDC	- 1.6 VDC	-1.600808 VDC	_____	-1.599192 VDC	7.00E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+1.6 VDC	+1.599192 VDC	_____	+1.600808 VDC	7.00E-6 V	>10:1
4.0 VDC	- 6.4 VDC	-6.401768 VDC	_____	-6.398232 VDC	19.0E-6 V	>10:1
	0.0 VDC	-0.000488 VDC	_____	+0.000488 VDC	0.80E-6 V	>10:1
	+6.4 VDC	+6.398232 VDC	_____	+6.401768 VDC	19.0E-6 V	>10:1
Gain X8:						
0.0625 VDC	- 0.00624	-0.006272 VDC	_____	-0.006208 VDC	0.44E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.40E-6 V	>10:1
	+0.00624	+0.006208 VDC	_____	+0.006272 VDC	0.44E-6 V	>10:1
0.25 VDC	- 0.025	-0.025036 VDC	_____	-0.024965 VDC	0.57E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.40E-6 V	>10:1
	+0.025	+0.024965 VDC	_____	+0.025036 VDC	0.57E-6 V	>10:1
1.0 VDC	- 0.1	-0.100051 VDC	_____	-0.099950 VDC	1.20E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.80E-6 V	>10:1
	+0.1	+0.099950 VDC	_____	+0.100051 VDC	1.20E-6 V	>10:1
4.0 VDC	- 0.4	-0.400111 VDC	_____	-0.399890 VDC	2.40E-6 V	>10:1
	0.0	-0.000031 VDC	_____	+0.000031 VDC	0.80E-6 V	>10:1
	+0.4	+0.399890 VDC	_____	+0.400111 VDC	2.40E-6 V	>10:1
Gain X64:						
0.25 VDC	- 0.00312	-0.003136 VDC	_____	-0.003104 VDC	0.42E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.00312	+0.003104 VDC	_____	+0.003136 VDC	0.42E-6 V	>10:1
1.0 VDC	- 0.0125	-0.012518 VDC	_____	-0.012483 VDC	0.49E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.0125	+0.012483 VDC	_____	+0.012518 VDC	0.49E-6 V	>10:1
4.0 VDC	- 0.05	-0.050025 VDC	_____	-0.049975 VDC	0.75E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.05	+0.049975 VDC	_____	+0.050025 VDC	0.75E-6 V	>10:1
Gain X512:						
4.0VDC	- 0.00625	-0.006268 VDC	_____	-0.006234 VDC	0.44E-6 V	>10:1
	0.0	-0.000015 VDC	_____	+0.000015 VDC	0.40E-6 V	>10:1
	+0.00625	+0.006234 VDC	_____	+0.006268 VDC	0.44E-6 V	>10:1
Sample & Hold Droop	4 V Range, X0.5 Gain, 7.5 VDC Input	----	_____	1 V/S	----	----

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 23 of 29)

Test 2-14: Excitation Voltage Measurement - E1511A Transient Strain SCP						
A/D Range	**Output**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
1 VDC	1 VDC	---	_____	---	1.65E-5	31:1
2 VDC	2 VDC	---	_____	---	1.65E-5	31:1
5 VDC	5 VDC	---	_____	---	1.65E-5	31:1
10 VDC	10 VDC	---	_____	---	1.65E-5	31:1

Test 2-15: DCV Measurement Accuracy - E1512A 25 Hz Low Pass Filter

A/D Range	Input	Minimum	Measured	Maximum	M.U.*	TAR**
.0625 V	- 50.0000 mV	- 50.0122 mV	_____	- 49.9878 mV	7.5E-7 V	>10:1
	- 37.0000 mV	- 37.0109 mV	_____	- 36.9891 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0097 mV	_____	- 24.9903 mV	5.8E-7 V	>10:1
	- 12.0000 mV	- 12.0084 mV	_____	- 11.9916 mV	4.8E-7 V	>10:1
	0.0000 mV	- 0.0072 mV	_____	+ 0.0072 mV	4.0E-7 V	>10:1
	+ 12.0000 mV	+ 11.9916 mV	_____	+ 12.0084 mV	4.8E-7 V	>10:1
	+ 25.0000 mV	+ 24.9903 mV	_____	+ 25.0097 mV	5.8E-7 V	>10:1
	+ 37.0000 mV	+ 36.9891 mV	_____	+ 37.0109 mV	6.6E-7 V	>10:1
	+ 50.0000 mV	+ 49.9878 mV	_____	+ 50.0122 mV	7.5E-7 V	>10:1
.25 V	- 200.0000 mV	- 200.0322 mV	_____	- 199.9678 mV	1.6E-6 V	>10:1
	- 150.0000 mV	- 150.0272 mV	_____	- 149.9728 mV	1.4E-6 V	>10:1
	- 100.0000 mV	- 100.0222 mV	_____	- 99.9778 mV	1.2E-6 V	>10:1
	- 50.0000 mV	- 50.0172 mV	_____	- 49.9828 mV	1.0E-6 V	>10:1
	0.0000 mV	- 0.0122 mV	_____	+ 0.0122 mV	8.0E-7 V	>10:1
	+ 50.0000 mV	+ 49.9828 mV	_____	+ 50.0172 mV	1.0E-6 V	>10:1
	+100.0000 mV	+ 99.9778 mV	_____	+100.0222 mV	1.2E-6 V	>10:1
	+150.0000 mV	+149.9728 mV	_____	+150.0272 mV	1.4E-6 V	>10:1
	+200.0000 mV	+199.9678 mV	_____	+200.0322 mV	1.6E-6 V	>10:1
1.0V	- 800.000 mV	- 800.113 mV	_____	- 799.887 mV	4.0E-6 V	>10:1
	- 600.000 mV	- 600.093 mV	_____	- 599.907 mV	3.2E-6 V	>10:1
	- 400.000 mV	- 400.073 mV	_____	- 399.927 mV	2.4E-6 V	>10:1
	- 200.000 mV	- 200.053 mV	_____	- 199.947 mV	1.6E-6 V	>10:1
	0.000 mV	- .033 mV	_____	+ .033 mV	0.8E-6 V	>10:1
	+200.000 mV	+199.947 mV	_____	+200.053 mV	1.6E-6 V	>10:1
	+400.000 mV	+399.927 mV	_____	+400.073 mV	2.4E-6 V	>10:1
	+600.000 mV	+599.907 mV	_____	+600.093 mV	3.2E-6 V	>10:1
	+800.000 mV	+799.887 mV	_____	+800.113 mV	4.0E-6 V	>10:1
4.0V	- 3.2000 V	- 3.2004 V	_____	- 3.1996 V	1.1E-5 V	>10:1
	- 2.4000 V	- 2.4004 V	_____	- 2.3996 V	9.0E-6 V	>10:1
	- 1.6000 V	- 1.6003 V	_____	- 1.5997 V	7.0E-6 V	>10:1
	- 0.8000 V	- 0.8002 V	_____	- 0.7998 V	5.0E-6 V	>10:1
	0.0000 V	- 0.0001 V	_____	+0.0001 V	3.0E-6 V	>10:1
	+0.8000 V	+0.7998 V	_____	+0.8002 V	5.0E-6 V	>10:1
	+1.6000 V	+1.5997 V	_____	+1.6003 V	7.0E-6 V	>10:1
	+2.4000 V	+2.3996 V	_____	+2.4004 V	9.0E-6 V	>10:1
	+3.2000 V	+3.1996 V	_____	+3.2004 V	1.1E-5 V	>10:1
16.0V	- 12.8000 V	- 12.8018 V	_____	- 12.7982 V	1.0E-4 V	>10:1
	- 9.6000 V	- 9.6014 V	_____	- 9.5986 V	8.8E-5 V	>10:1
	- 6.4000 V	- 6.4011 V	_____	- 6.3989 V	7.6E-5 V	>10:1
	- 3.2000 V	- 3.2008 V	_____	- 3.1992 V	6.3E-5 V	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-5 V	10:1
	+ 3.2000 V	+ 3.1992 V	_____	+ 3.2008 V	6.3E-5 V	>10:1
	+ 6.4000 V	+ 6.3989 V	_____	+ 6.4011 V	7.6E-5 V	>10:1
	+ 9.6000 V	+ 9.5986 V	_____	+ 9.6014 V	8.8E-5 V	>10:1
	+12.8000 V	+12.7982 V	_____	+12.8018 V	1.0E-4 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 25 of 29)

Test 2-16: DCV Measurement Accuracy - E1513A Divide by 16 Attenuator SCP						
A/D Range	**Input**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
1 V	-12.8000 V	-12.8031 V	_____	-12.7969 V	56E-6 V	>10:1
	- 9.6000 V	- 9.6024 V	_____	- 9.5976 V	43E-6 V	>10:1
	- 6.4000 V	- 6.4018 V	_____	- 6.3982 V	31E-6 V	>10:1
	- 3.2000 V	- 3.2011 V	_____	- 3.1989 V	18E-6 V	>10:1
	0.0000 V	- 0.0005 V	_____	+ 0.0005 V	5.0E-6 V	>10:1
	+ 3.2000 V	+ 3.1989 V	_____	+ 3.2011 V	18E-6 V	>10:1
	+ 6.4000 V	+ 6.3982 V	_____	+ 6.4018 V	31E-6 V	>10:1
	+ 9.6000 V	+ 9.5976 V	_____	+ 9.6024 V	43E-6 V	>10:1
	+12.8000 V	+12.7969 V	_____	+12.8031 V	56E-6 V	>10:1
4 V	-51.2000 V	- 51.2122 V	_____	- 51.1878 V	210E-6 V	>10:1
	-38.4000 V	- 38.4096 V	_____	- 38.3904 V	159E-6 V	>10:1
	-25.6000 V	- 25.6071 V	_____	- 25.5929 V	107E-6 V	>10:1
	-12.8000 V	- 12.8045 V	_____	- 12.7955 V	56E-6 V	>10:1
	0.0000 V	- 0.0020 V	_____	+ 0.0020 V	5.0E-6 V	>10:1
	+12.8000 V	+12.7955 V	_____	+12.8045 V	56E-6 V	>10:1
	+25.6000 V	+25.5929 V	_____	+25.6071 V	107E-6 V	>10:1
	+38.4000 V	+38.3904 V	_____	+38.4096 V	159E-6 V	>10:1
	+51.2000 V	+51.1878 V	_____	+51.2122 V	210E-6 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 26 of 29)

Test 2-17: DCV Measurement Accuracy - E1514A Fixed Filter and Amplifier SCP (Gain X1, 10 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
16 V	-12.8000 V	-12.8029 V	_____	-12.7971 V	1.0E-04 V	>10:1
	- 9.6000 V	- 9.6024 V	_____	- 9.5976 V	8.8E-05 V	>10:1
	- 6.4000 V	- 6.4019 V	_____	- 6.3981 V	7.6E-05 V	>10:1
	- 3.2000 V	- 3.2015 V	_____	- 3.1985 V	6.3E-05 V	>10:1
	0.0000 V	- 0.0010 V	_____	0.0010 V	5.0E-05 V	>10:1
	+ 3.2000 V	+ 3.1985 V	_____	+ 3.2015 V	6.3E-05 V	>10:1
	+ 6.4000 V	+ 6.3981 V	_____	+ 6.4019 V	7.6E-05 V	>10:1
	+ 9.6000 V	+ 9.5976 V	_____	+ 9.6024 V	8.8E-05 V	>10:1
	+12.8000 V	+12.7971 V	_____	+12.8029 V	1.0E-04 V	>10:1

Test 2-17: DCV Measurement Accuracy - E1515A Fixed Filter and Amplifier SCP (Gain X1, 100Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
16 V	-12.8000 V	-12.8029 V	_____	-12.7971 V	1.0E-04 V	>10:1
	- 9.6000 V	- 9.6024 V	_____	- 9.5976 V	8.8E-05 V	>10:1
	- 6.4000 V	- 6.4019 V	_____	- 6.3981 V	7.6E-05 V	>10:1
	- 3.2000 V	- 3.2015 V	_____	- 3.1985 V	6.3E-05 V	>10:1
	0.0000 V	- 0.0010 V	_____	0.0010 V	5.0E-05 V	>10:1
	+ 3.2000 V	+ 3.1985 V	_____	+ 3.2015 V	6.3E-05 V	>10:1
	+ 6.4000 V	+ 6.3981 V	_____	+ 6.4019 V	7.6E-05 V	>10:1
	+ 9.6000 V	+ 9.5976 V	_____	+ 9.6024 V	8.8E-05 V	>10:1
	+12.8000 V	+12.7971 V	_____	+12.8029 V	1.0E-04 V	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 27 of 29)

Test 2-18: DCV Measurement Accuracy - E1516A Iso. Filter and Amplifier SCP (Gain X64, 10 Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
4.0 V	-0.0500 V	-0.050011 V	_____	-0.049989 V	0.75E-6	>10:1
	-0.0370 V	-0.037009 V	_____	-0.036991 V	0.66E-6	>10:1
	-0.0250 V	-0.025008 V	_____	-0.024992 V	0.57E-6	>10:1
	-0.0120 V	-0.012006 V	_____	-0.011994 V	0.48E-6	>10:1
	0.0000 V	-0.000004 V	_____	+0.000004 V	0.40E-6	10:1
	+0.0120 V	+0.011994 V	_____	+0.012006 V	0.48E-6	>10:1
	+0.0250 V	+0.024992 V	_____	+0.025008 V	0.57E-6	>10:1
	+0.0370 V	+0.036991 V	_____	+0.037009 V	0.66E-6	>10:1
	+0.0500 V	+0.049989 V	_____	+0.050011 V	0.75E-6	>10:1

Test 2-18: DCV Measurement Accuracy - E1517A Iso. Filter and Amplifier SCP (Gain X64, 100Hz Filter)

A/D Range	Input	Minimum	Measured	Maximum	M.U.	TAR
4.0 V	-0.0500 V	-0.050011 V	_____	-0.049989 V	0.75E-6	>10:1
	-0.0370 V	-0.037009 V	_____	-0.036991 V	0.66E-6	>10:1
	-0.0250 V	-0.025008 V	_____	-0.024992 V	0.57E-6	>10:1
	-0.0120 V	-0.012006 V	_____	-0.011994 V	0.48E-6	>10:1
	0.0000 V	-0.000004 V	_____	+0.000004 V	0.40E-6	10:1
	+0.0120 V	+0.011994 V	_____	+0.012006 V	0.48E-6	>10:1
	+0.0250 V	+0.024992 V	_____	+0.025008 V	0.57E-6	>10:1
	+0.0370 V	+0.036991 V	_____	+0.037009 V	0.66E-6	>10:1
	+0.0500 V	+0.049989 V	_____	+0.050011 V	0.75E-6	>10:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 28 of 29)

Test 2-19: DCI Measurement Accuracy - E1518A Resistance Measurement SCP						
A/D Range	**Output**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
30µA	30.518 µA	30.509 µA	_____	30.527 µA	1.26E-9	7:1
488µA	488.28 µA	488.22 µA	_____	488.34 µA	1.28E-8	5:1

Table 2-1. Performance Test Record for the HP E1313A, E1413A/B/C Scanning A/D (Page 29 of 29)

Test 2-20: DCV Measurement Accuracy - E1518A Resistance Measurement SCP						
A/D Range	**Input**	**Minimum**	**Measured**	**Maximum**	**M.U.**	**TAR**
.0625V	- 3.0000 mV	- 3.0041 mV	_____	- 2.9959 mV	4.2E-7 V	10:1
	- 2.3000 mV	- 2.3040 mV	_____	- 2.2960 mV	4.2E-7 V	10:1
	- 1.5000 mV	- 1.5040 mV	_____	- 1.4961 mV	4.1E-7 V	10:1
	- 0.8000 mV	- 0.8039 mV	_____	- 0.7961 mV	4.1E-7 V	10:1
	0.0000 mV	- 0.0038 mV	_____	+0.0038 mV	4.0E-7 V	10:1
	+0.8000 mV	+0.7961 mV	_____	+0.8039 mV	4.1E-7 V	10:1
	+1.5000 mV	+1.4961 mV	_____	+1.5040 mV	4.1E-7 V	10:1
	+2.3000 mV	+2.2960 mV	_____	+2.3040 mV	4.2E-7 V	10:1
	+3.0000 mV	+2.9959 mV	_____	+3.0041 mV	4.2E-7 V	10:1
.25V	- 13.0000 mV	- 13.0055 mV	_____	- 12.9945 mV	4.9E-7 V	>10:1
	- 9.0000 mV	- 9.0051 mV	_____	- 8.9949 mV	4.7E-7 V	>10:1
	- 6.0000 mV	- 6.0048 mV	_____	- 5.9952 mV	4.4E-7 V	>10:1
	- 3.0000 mV	- 3.0045 mV	_____	- 2.9955 mV	4.2E-7 V	>10:1
	0.0000 mV	- 0.0042 mV	_____	+ 0.0042 mV	4.0E-7 V	>10:1
	+ 3.0000 mV	+ 2.9955 mV	_____	+ 3.0045 mV	4.2E-7 V	>10:1
	+ 6.0000 mV	+ 5.9952 mV	_____	+ 6.0048 mV	4.4E-7 V	>10:1
	+ 9.0000 mV	+ 8.9949 mV	_____	+ 9.0051 mV	4.7E-7 V	>10:1
	+13.0000 mV	+12.9945 mV	_____	+13.0055 mV	4.9E-7 V	>10:1
1.0V	- 50.0000 mV	- 50.0099 mV	_____	- 49.9901 mV	7.5E-7 V	>10:1
	- 37.5000 mV	- 37.5087 mV	_____	- 37.4914 mV	6.6E-7 V	>10:1
	- 25.0000 mV	- 25.0074 mV	_____	- 24.9926 mV	5.8E-7 V	>10:1
	- 13.0000 mV	- 13.0062 mV	_____	- 12.9938 mV	4.9E-7 V	>10:1
	0.0000 mV	- 0.0049 mV	_____	+ 0.0049 mV	4.0E-7 V	>10:1
	+13.0000 mV	+12.9938 mV	_____	+13.0062 mV	4.9E-7 V	>10:1
	+25.0000 mV	+24.9926 mV	_____	+25.0074 mV	5.8E-7 V	>10:1
	+37.5000 mV	+37.4914 mV	_____	+37.5087 mV	6.6E-7 V	>10:1
	+50.0000 mV	+49.9901 mV	_____	+50.0099 mV	7.5E-7 V	>10:1
4.0V	- 200.000 mV	- 200.028 mV	_____	- 199.972 mV	1.6E-6 V	>10:1
	- 150.000 mV	- 150.023 mV	_____	- 149.977 mV	1.4E-6 V	>10:1
	- 100.000 mV	- 100.018 mV	_____	- 99.982 mV	1.2E-6 V	>10:1
	- 50.000 mV	- 50.013 mV	_____	- 49.987 mV	1.0E-6 V	>10:1
	0.000 mV	- 0.008 mV	_____	+ 0.008 mV	0.8E-6 V	10:1
	+ 50.000 mV	+ 49.987 mV	_____	+ 50.013 mV	1.0E-6 V	>10:1
	+100.000 mV	+ 99.982 mV	_____	+100.018 mV	1.2E-6 V	>10:1
	+150.000 mV	+149.977 mV	_____	+150.023 mV	1.4E-6 V	>10:1
	+200.000 mV	+199.972 mV	_____	+200.028 mV	1.6E-6 V	>10:1
16.0V	- 800.000 mV	- 800.111 mV	_____	- 799.889 mV	4.0E-6 V	>10:1
	- 600.000 mV	- 600.091 mV	_____	- 599.909 mV	3.2E-6 V	>10:1
	- 400.000 mV	- 400.071 mV	_____	- 399.929 mV	2.4E-6 V	>10:1
	- 200.000 mV	- 200.051 mV	_____	- 199.949 mV	1.6E-6 V	>10:1
	0.000 mV	- 0.031 mV	_____	+ 0.031 mV	0.8E-6 V	>10:1
	+200.000 mV	+199.949 mV	_____	+200.051 mV	1.6E-6 V	>10:1
	+400.000 mV	+399.929 mV	_____	+400.071 mV	2.4E-6 V	>10:1
	+600.000 mV	+599.909 mV	_____	+600.091 mV	3.2E-6 V	>10:1
	+800.000 mV	+799.889 mV	_____	+800.111 mV	4.0E-6 V	>10:1

Chapter 3
Adjustments

Introduction

The procedures in this chapter show how to electronically adjust the HP E1413C Scanning A/D to compensate for A/D source voltage and reference resistor offsets. Unless otherwise noted, references to the HP E1413C also apply to the HP E1413A/B and the HP E1313A (and its option 001).

Recommended Equipment/ Environment

A digital multimeter (DMM) is required for the procedures in this chapter. The HP 3458A is the recommended DMM. Before performing these procedures, allow the HP E1413C to warm up for at least one hour. The temperature should be within ± 1°C of the temperature of the most recent calibration.

Flash Memory Access

The Flash Memory Protect Jumper (JM 2201) (see Figure 3-1 for location) is shipped in the "PROG" position. If the jumper is changed to the "PROTect" position, you will not be able to store new calibration constants into Flash Memory (Electrically Erasable Programmable Read Only Memory or EEPROM). If the adjustment program shown in this chapter displays an error message, you may need to change the jumper to the PROG position and rerun the program.

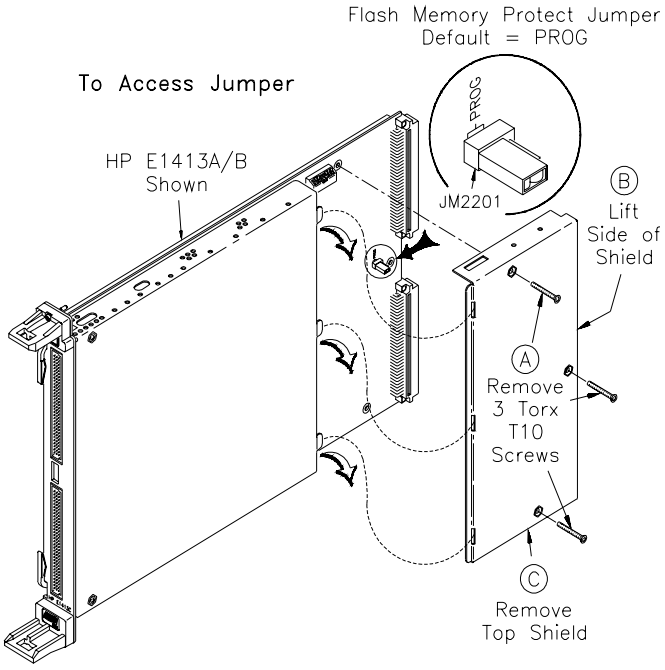


Figure 3-1. Flash Memory Protect Jumper

A/D Adjustment Procedure

This adjustment performs internal A/D adjustments using the CAL:CONF, CAL:VAL, and CAL:STOR commands. (See *Appendix C - Command Reference* for command descriptions.)

Description

The adjustment procedure consists of measuring the values of the 7.5 kΩ reference resistor and voltage source with an external DMM and then entering the values into Scanning A/D RAM. After the new values have been entered into RAM, they can be stored in Flash Memory (Electrically Erasable Programmable Read Only Memory or EEPROM). See Figure 3-2 for commands and steps. You can perform these adjustments using either the Cal Bus connectors on the Scanning A/D or the HOHM, LOHM, HCAL, and LCAL connectors on the terminal block.

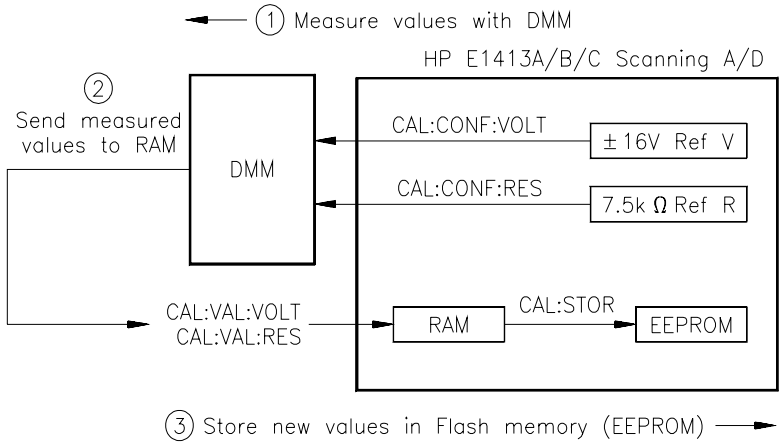


Figure 3-2. Scanning A/D Adjustments

Equipment Setup

- Perform an autocalibration on the HP 3458A DMM (unless an autocal has been performed within the last 24 hours).
- Connect the equipment as shown in Figures 3-3 through 3-6, using the connections on the terminal module or the Cal Bus connections on the Scanning A/D.
- If you use the Cal Bus connections, remove the terminal module and make connections between the DMM and Scanning A/D #1. You can use the 555 mm (22 inch) calibration cable supplied.
- To adjust two or more Scanning A/Ds (one at a time), connect additional HP E1413As (in adjacent mainframe slots) using the 60 mm (2.4 inch) connecting cable supplied.

DC Voltage and Resistance Measurements - HP 3458A or E1410A Multimeters to Cal Bus Connections

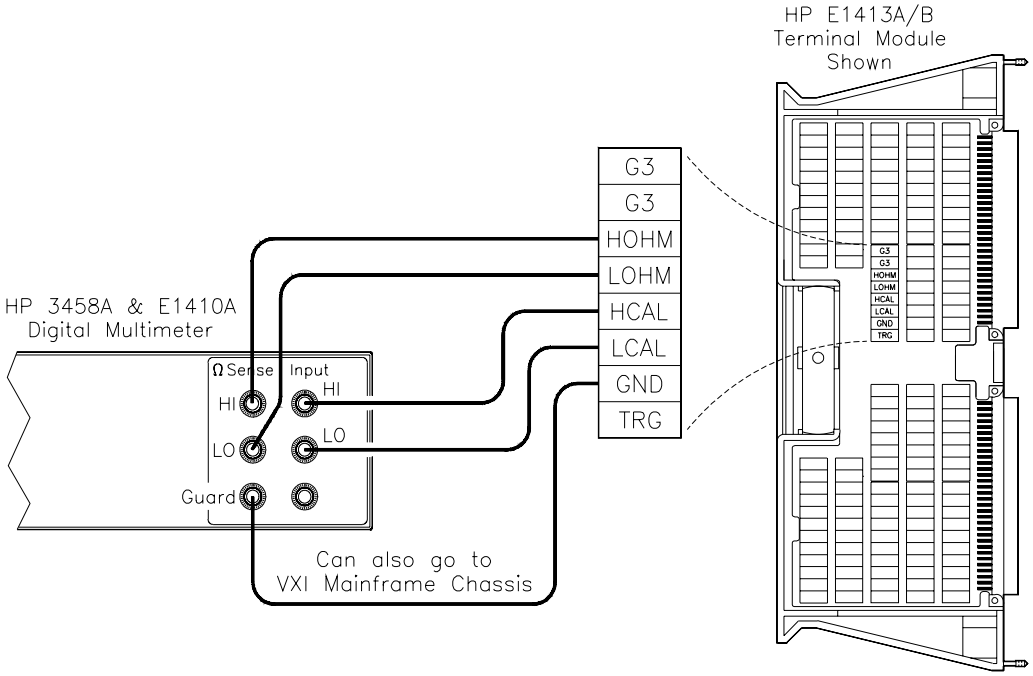


Figure 3-3. Terminal Module Connections

DC Voltage and Resistance Measurements - HP 3458A or E1410A Multimeters to Cal Bus Connections

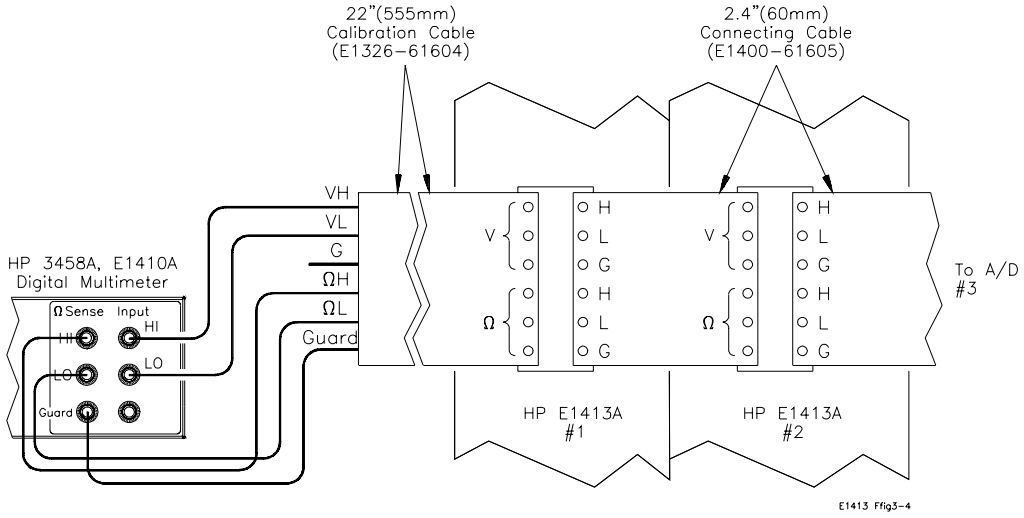


Figure 3-4. Cal Bus Connections

DC Voltage and Resistance Measurements - HP 3457A or 34401A Multimeters to Terminal Module

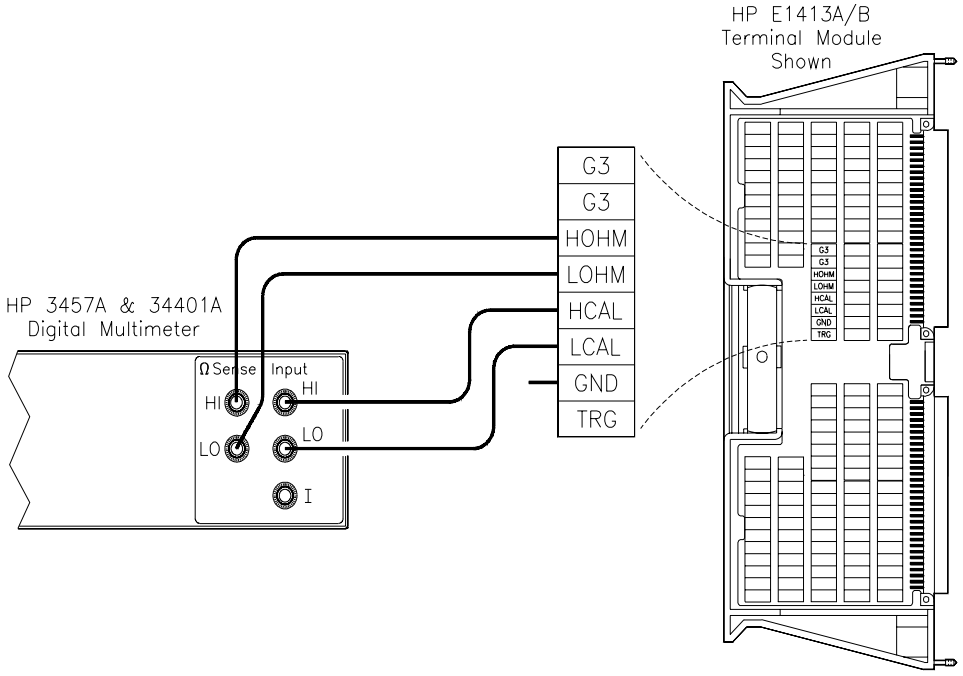


Figure 3-5. Terminal Module Connections

DC Voltage and Resistance Measurements - HP 3457A or 34401A Multimeters to Cal Bus Connections

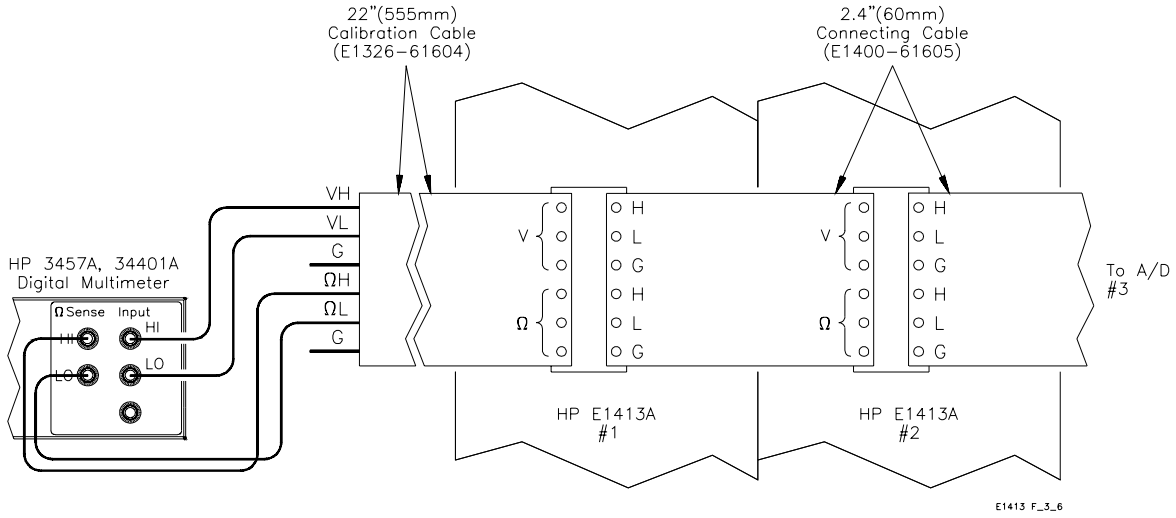


Figure 3-6. Cal Bus Connections

DC Voltage and Resistance Measurements - HP E1326A or E1411A Multimeters to Terminal Module

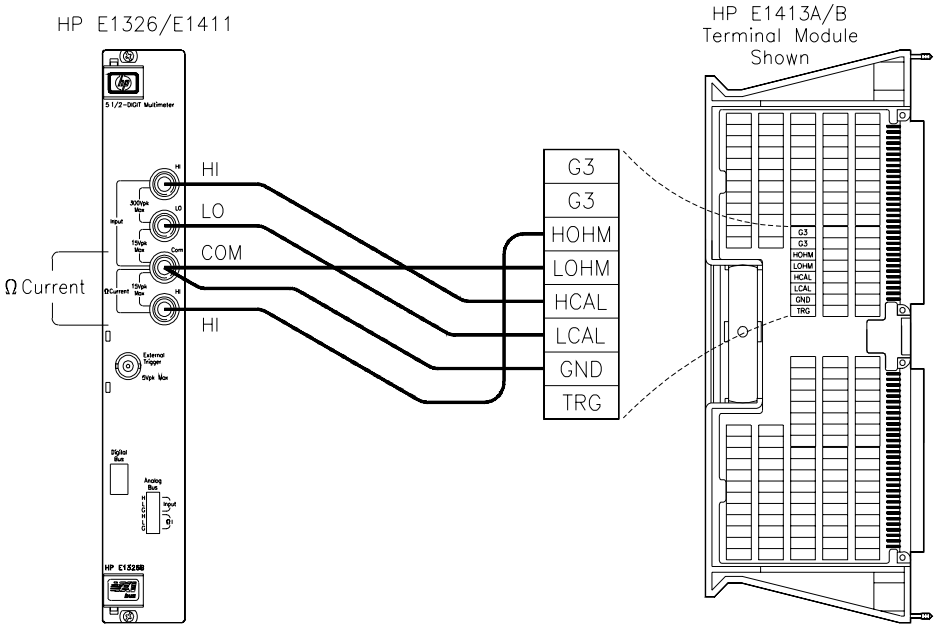


Figure 3-7. Terminal Module Connections

DC Voltage and Resistance Measurements - HP E1326A or E1411A Multimeters to Cal Bus Connections

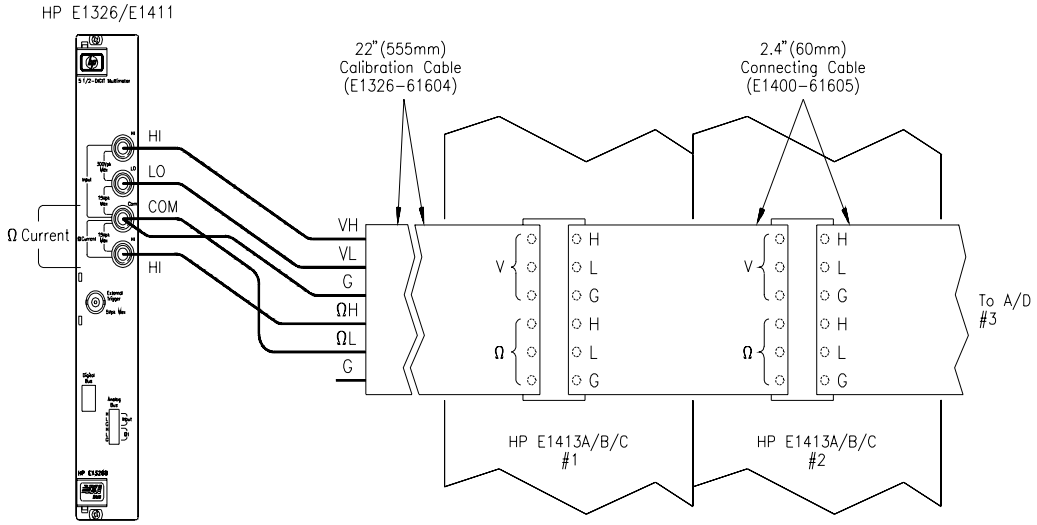


Figure 3-8. Cal Bus Connections

Adjustment Procedure

This procedure adjusts the Scanning A/D using the HP 3458A DMM for external measurements.

Note As shipped from the factory, the Flash Memory Protect Jumper (JM 2201) is set to the "PROG" position. If the jumper is NOT set to the PROG position, values cannot be loaded into Flash memory and the following error messages are displayed. If required, change the jumper setting to the PROG position (see Figure 3-1) and then rerun the adjustment procedure.

Error Messages

+3034,"0x4: DSP-Flash ROM erase failure"
+3035,"0x8: DSP-Programming voltage not present"
"+0, No error"

1 Perform DMM Autocalibration

[a] As required, perform an autocalibration on the HP 3458A DMM

ACAL ALL	*Perform DMM autocalibration*

[b] If autocal is not required, go to Step 2

2 Measure Reference Resistance

[a] Make 4-wire resistance connections (see Figures 3-3 through 3-8)

[b] Set Scanning A/D to measure resistance

*RST;*CLS;*OPC?	*Reset Scanning A/D and clear status register*
CAL:CONF:RES;*OPC?	*Set for resistance measurements. Use *OPC? and ENTER to ensure Scanning A/D setup is complete*
ENTER statement	

[c] Set and Trigger DMM

RESET	*Reset DMM*
FUNC OHMF	*Set 4-wire ohms*
OCOMP ON	*Set offset compensation*
NPLC 20	*Set NPLC 20*
WAIT 1	*Wait 1 second*
TRIG SGL	*Trigger DMM*
ENTER <*ref_ohms*>	*Measure value of reference resistor*

[d] Send measured value to Scanning A/D

CAL:VAL:RES <ref_ohms>	*Send ref resistor value to E1413C RAM*

3 Source Voltage Measurements

[a] Make DCV connections (see Figures 3-3 through 3-8)

[b] Reset Scanning A/D

```
*RST;*CLS;*OPC?          Reset Scanning A/D and clear status register
```

[c] Set DMM

```
RESET                    Set DMM for DCV, autorange
NPLC 20                  Set NPLC 20
```

Note When measuring with the HP 3458A on the 16 V range, the E1413's source is ~10 V. Ensure the HP 3458A is on its 10V range, the 100V range loads the source.

[d] Set Scanning A/D for first voltage measurement

```
CAL:CONF:VOLT .0625, ZERO    Connect DMM to source voltage, set .0625V range and ZERO source output.
*OPC?                        Use *OPC? to ensure setup completed
ENTER statement
```

[e] Trigger DMM and Send Voltage Value to RAM

```
TRIG SGL                 Measure source voltage and store result in ref_volts
WAIT 1
ENTER <ref_volts>
```

[f] Send measured value to Scanning A/D

```
CAL:VAL:VOLT <ref_volts>     Send meas value to E1413C RAM
```

Note CAL:VAL:VOLT <*ref_volts*> value may need adjusting for improved accuracy. For example, the E1413 source impedance is 470Ω. Placing the 10MΩ impedance of the HP 3457A or E1410A DMM across the source (see Figure 3-9) when measuring the 4V or 16V A/D range reduces the reading accuracy. For this example, multiply the DMM reading by 1.000047 to get the true <ref_volts> value to send to the E1413's RAM.

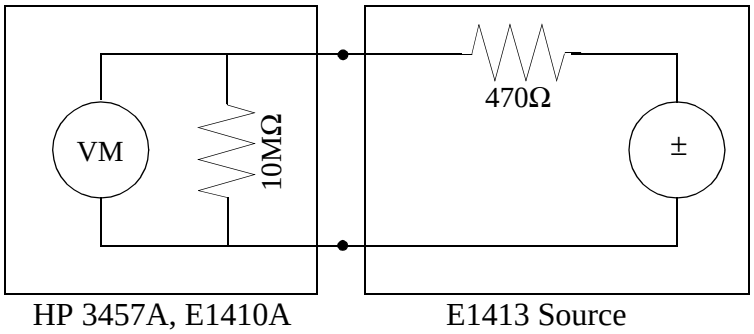


Figure 3-9. Cal Value Voltage Adjustment

Perform voltage measurements for all ranges/levels in order shown below:

Range	Level	Range	Level
.0625V	ZERO	4.0V	ZERO
.0625V	FULL-SCALE	4.0V	FULL-SCALE
.25V	ZERO	16.0V	ZERO
.25V	FULL-SCALE	16.0V	FULL-SCALE
1.0V	ZERO		
1.0V	FULL-SCALE		

4 Store Results in Flash Memory

CAL:STOR ADC

Store new resistance and voltage calibration constants in Flash memory

Example Program

Run the "ADJSPROC" program to perform A/D adjustments for an HP E1413C Scanning A/D. For this program, an HP 3458A DMM is used to measure the reference resistor and reference voltage values. A typical display for the ADJSPROC program follows.

A/D Adjustments (ADJSPROC) Typical Results

Measured Voltage Values

1. Voltage should be ~90% FULL-SCALE range (except 16V range).
2. For the 16V range, voltage value should be ~10.0V.

Range (V)	Level	Measured (V)	% of Full-Scale
.0625	ZERO	.0001	
.0625	FSC	.0564	90.3
.2500	ZERO	.0001	
.2500	FSC	.2253	90.1
1.0000	ZERO	.0001	
1.0000	FSC	.8941	89.4
4.0000	ZERO	.0001	
4.0000	FSC	3.5988	90.0
16.0000	ZERO	.0001	
16.0000	FSC	10.0035	62.5

Resistance Value: 7.4981 Kohms

Chapter 4
Replaceable Parts

Introduction

This chapter contains information to order replaceable parts and/or exchange modules for the HP E1313A 32 Channel Scanning A/D, E1313A Option 001 64 Channel Scanning A/D, HP E1413A/B Scanning A/D, HP E1413C Scanning A/D, and the Signal Conditioning Plug-Ons (SCPs). To order a part or exchange assembly listed in this chapter, specify the Hewlett-Packard part number and the quantity required. Send the order to your nearest Hewlett-Packard Sales and Support Office.

Exchange Modules

Table 4-1 lists modules described in this manual that may be replaced on an exchange basis (Exchange Modules). Exchange modules are available only on a trade-in basis. Defective modules must be returned for credit. Order modules for spare parts stock by the new module part number.

Table 4-1. E1313A and E1413A/B/C Scanning A/D - Exchange/New Modules

Scanning A/D Module	Exchange Part Number	New Part Number
E1313A	E1313-69201	E1313-66201
E1313A Option 001	E1313-69202	E1313-66202
E1413A/B	E1413-69211	E1413-66211
E1413C	E1413-69221	E1413-66221

Replaceable Parts Lists

Table 4-4 lists replaceable parts for the HP E1313A Scanning A/D and Table 4-5 lists replaceable parts for the HP E1313A/Opt. 001 Scanning A/D. Table 4-6 lists replaceable parts for the HP E1413A/B Scanning A/D. Table 4-7 lists replaceable parts for the HP E1413C Scanning A/D. See "Component Locators" (Figures 4-1 through 4-8) for locations of parts. Table 4-2 shows reference designators for parts in Tables 4-4 through 4-7 and Table 4-3 shows the manufacturer code list for these parts.

Table 4-8 lists replacement part numbers for the Signal Conditioning Plug-Ons (SCPs).

Note If a Scanning A/D defect can be traced to a fuse or replaceable mechanical part, replace the fuse and/or part and retest the module. If the defect cannot be traced to a fuse or replaceable mechanical part, replace the entire module.

Table 4-2. HP E1413C Scanning A/D Reference Designators

Reference Designators		
A ..... assembly	J .....electrical connector (jack)	S ..... switch (rotary)
CBL ..... cable	JM .....jumper	SCR ..... screw
F ..... fuse	MP ..... misc. mech part	SHD ..... shield
HD .....misc hardware	P ..... electrical conn (plug)	SP ..... switch (push-button)
	PNL ..... panel	TP ..... test connector

Table 4-3. HP E1413C Scanning A/D Code List of Manufacturers

Mfr Code	Manufacturer Name	Manufacturer Address			Zip Code
00779	Amp Inc	Harrisburg	PA	US	17111
05791	Lyn-Tron Inc	Burbank	CA	US	91505
26742	Methode Electronics Inc	Chicago	IL	US	60656
28480	Hewlett-Packard Co - Corporate	Palo Alto	CA	US	94304
30817	Instrument Specialties Co Inc	Del Water Gap	PA	US	18327
75915	Littelfuse Inc	Des Plaines	IL	US	60016
81073	Grayhill Inc	La Grange	IL	US	60525
83486	Elco Industries Inc	Rockford	IL	US	61125
91662	Elco Corp	Newport Beach	CA	US	92660

Component Locators

Figures 4-1 through 4-4 show locations of selected replaceable parts for the E1313A Scanning A/D. Figures 4-5 through 4-7 show locations of selected replaceable parts for the E1413A/B Scanning A/D. Figures 4-8 through 4-10 show locations of selected replaceable parts for the E1413C Scanning A/D. For the Signal Conditioning Plug-Ons (SCPs), replace the complete SCP

assembly.

Table 4-4. HP E1313A Scanning A/D Replaceable Parts

Reference Designator	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			HP E1313A HARDWARE PARTS (FIG 4-1)		
CBL1	E1326-61604	1	CONNECTOR CABLE	28480	E1326-61604
CBL2	E1400-61605	1	CALIBRATION CABLE	28480	E1400-61605
MP1	E1300-45101	1	HANDLE KIT- TOP, HP	28480	E1300-45101
MP2	E1300-45102	1	HANDLE KIT- BOTTOM, VXI	28480	E1300-45102
PNL1	E1313-00201	1	FRONT PANEL	28480	E1313-01201
SH1	E1313-00601	1	SHIELD RIGHT	28480	E1313-00601
SH2	E1313-00602	1	SHIELD LEFT	28480	E1313-00602
SH3	E1313-00603	1	SHIELD - INNER, TOP, 02 PCA	28480	E1313-00603
SH4	E1313-00604	1	SHIELD - INNER, BOTTOM, 02 PCA	28480	E1313-00604
	E1450-01202	1	RFI SHIELD	28480	E1450-01202
	0380-4352	2	STANDOFF - HEX 11.44mm, M3X0.5 THD	28480	0380-4352
	0515-0372	8	SCREW - 8mm, M3.0X0.50 PAN HEAD	28480	0515-0372
	2190-0584	2	WASHER - 3.0mm 3.1mm ID, 6.2m OD	28480	2190-0584
	0380-1362	2	STANDOFF - HEX 12mm, M3.0X0.5 THD	28480	0380-1362
	0515-0664	1	SCREW - 12mm, M3.0X0.50 PAN HEAD	28480	0515-0664
	0515-1135	2	SCREW - 25mm, M3.0X0.50 90 DEG FLAT HEAD	28480	0515-1135
	0515-1227	6	SCREW - 6mm, M3.0X0.50 90 DEG FLAT HEAD	28480	0515-1227
	0380-4353	4	STANDOFF - HEX 18.68mm, M3.0X0.5 THD	28480	0380-4353
	0515-1968	2	SCREW - MACH M2.5X0.45 11mm, PAN HEAD	28480	0515-1968
	0535-0008	2	NUT - M2.5X0.45 2mm THICK 5mm A/F	28480	0535-0008
	0515-0368	2	SCREW - 12mm, M2.5X0.45 PAN HEAD	28480	0515-0368
	0515-0430	2	SCREW - 6mm, M3.0000X0.5 PAN HEAD	28480	0515-0430
	3050-0891	4	WASHER - 3.0mm 3.3mm ID, 6.85mm OD	28480	3050-0891
	0515-1108	2	SCREW - 12mm, M2.5X0.45 PAN HEAD	28480	0515-1108
			A1 PCA REPLACEABLE PARTS		
A1	E1313-66501	1	PC ASSY, DIGITAL & POWER SUPPLY	28480	E1313-66501
F170-F172	2110-0863	3	FUSE-SUBMINIATURE 5A 125V NTD BI UL CSA	28480	2110-0863
			A2 PCA REPLACEABLE PARTS		
A2	E1313-66502	1	PC ASSY, ANALOG/DIGITAL & CHANNEL	28480	E1313-66502
K4100-K4231	0490-1937	35	RELAY - 2C 3VDC COIL, 1A, 125VAC	28480	0490-1937
			TERMINAL CASE ASSEMBLY PARTS		
A1	E1300-84401	1	CASE TERMINAL BLOCK ASSEMBLY	28480	E1300-84401
MP1	03852-01201	1	CLAMP	28480	03852-01201
MP2	03852-86701	1	PAD-CLAMP	28480	03852-86701
MP3	0515-2109	1	SCREW-MACH 10-24 .625-IN-LG PAN-HD-SLT	28480	0515-2109
MP4	1390-0846	2	FASTENER-CAPTIVE SCREW M2.5 X 0.45	28480	1390-0846
MP5	E1300-01202	1	CLAMP STRAIN RELIEF	28480	E1300-01202
MP6	E1300-44104	1	TERMINAL HOUSING-BOTTOM	28480	E1300-44104
MP7	E1300-44105	1	TERMINAL HOUSING-TOP	28480	E1300-44105
			TERMINAL BLOCK PARTS		
A1	E1313-66510	1	TERMINAL CARD ASSEMBLY	28480	E1413-66510
JM1	1251-6001	1	CONNECTOR POST TP 2 X 3P	28480	1251-6001
J6-J10	0360-2582	5	TERMINAL BLOCK 24 POS	28480	0360-2582
P1	1252-1593	1	CONNECTOR-RA RCPT, 96P	28480	1252-1593

a. Includes J4100, J4110, J4220, J4230, J4340, J4350, J4460, and J4470
b. Includes J4101, J4111, J4221, J4231, J4341, J4351, J4461, and J4471
c. Includes K4100-K4115, K4190-K4192, K4216-K4231, K4332-K4347, and K4448-K4463

Table 4-5 lists the parts for the HP E1313A Option 001 - 64 Channel Scanning A/D. Parts not listed are identical to the parts on the standard HP E1313A (Table 4-4).

Table 4-5. HP E1313A Option 001 Parts List

Reference Designator	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
PNL 1	E1313-00202	1	FRONT PANEL, 4 SLOT	28480	E1313-00202
SH2	E1313-00602	1	SHIELD LEFT	28480	E1313-00602
SH3	E1313-00603	1	SHIELD, INNER TOP, 02 PCA	28480	E1313-00603
SH4	E1313-00604	1	SHIELD, INNER BOTTOM, 02 PCA	28480	E1313-00604
SH5	E1313-00605	1	SHIELD RIGHT, 4 SLOT	28480	E1313-00605
SH6	E1313-00607	1	SHIELD, INNER BOTTOM, 03 PCA	28480	E1313-00607
CBL1	E1313-61604	1	CABLE 80 PIN 64 CH MUX INTERFACE	28480	E1313-61604
	0380-4352	2	STANDOFF - HEX 11.44mm, M3X0.5 THD	28480	0380-4352
	2190-0584	2	WASHER - 3.0mm, 3.1mm ID, 6.2mm OD	28480	2190-0584
	0380-1362	2	STANDOFF - HEX 12mm, M3.0X0.5 THD	28480	0380-1362
	0515-0664	1	SCREW - 12mm, M3.0X0.5 PAN HEAD	28480	0515-0664
	0515-1135	2	SCREW - 25mm, M3.0X0.5 90 DEG FH	28480	0515-1135
	0515-0372	2	SCREW - 8mm, M3.0X0.5 PAN HEAD	28480	0515-0372
A3	E1313-66503	1	PCA, CHANNEL 32 TO 63	28480	E1313-66503

Table 4-6. HP E1413A/B Scanning A/D Replaceable Parts

Reference Designator	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			HP E1413A/B HARDWARE PARTS (FIG 4-3)		
CBL1	E1326-61604	1	CALIBRATION CABLE	28480	E1326-61604
CBL2	E1400-61605	1	CONNECTORCABLE	28480	E1400-61605
HDL1	E1400-84105	1	EXT HANDLE KIT-BOTTOM	28480	E1400-84105
HDL2	E1400-84106	1	EXT HANDLE KIT-TOP	28480	E1400-84106
PNL1	E1405-00201	1	FRONT PANEL	28480	E1405-01201
SCR5-SCR9	0515-1135	5	SCREW-M3 X 0.5 25MM-LG FLAT-HEAD	28480	0515-1135
SCR10-SCR11	0515-0368	2	SCREW-M2.5 X 0.45 12MM-LG PAN-HEAD	28480	0515-0368
SCR12-SCR13	0515-1375	2	SCREW-M2.5 X 0.45 6MM-LG FLAT-HEAD	83486	343-300-02506
SHD1	E1413-00601	1	TOP SHIELD	28480	E1413-00601
SHD2	E1413-00602	1	BOTTOM SHIELD	28480	E1413-00602
SHD3	E1413-00603	1	COVER SCP	28480	E1413-00603
SHD4	E1413-00604	1	INNER SHIELD	28480	E1413-00604
			A1 PCA REPLACEABLE PARTS (FIG 4-4)		
PCA1	E1413-66501	1	PRINTED CIRCUIT ASSEMBLY	28480	E1413-66501
F101-F105	2110-0712	5	FUSE-SUBMINIATURE 4A 125V NTD AX	75915	R251004T1
J1-J2	1251-7799	4	CONN-POST TYPE 2.54-PIN-SPCG 96-CONTACT	91662	10-8457-096-002-037
J3	1252-0776	1	CONN-POST TYPE .100-PIN-SPCG 12-CONTACT	00779	102979-6
J4100-J4470[a]	1252-4618	8	50-PIN CONNECTOR 104549-7	00779	104549-7
J4101-J4471[b]	1252-5357	8	50-PIN RECEPTACLE 104550-6	00779	104550-6
JM2201	1251-4682	1	CONN-POST TYPE .100-PIN-SPCG 3-CONTACT	26742	1102-1-103-02
K4100-K4463[c]	0490-1937	67	RELAY 2C 3VDC COIL 1A 125VAC	28480	0490-1937
P1-P2	1251-7799		CONN-POST TYPE 2.54-PIN-SPCG 96-CONTACT	91662	10-8457-096-002-037
SP1	3101-2243	1	SWITCH-DIP ROCKER 8-1A 0.05A 30VDC	81073	76YY22318S
			TERMINAL CASE ASSEMBLY PARTS (FIG 4-5)		
	E1413-80001	1	COMPLETE TERMINAL BLOCK with CASE	28480	E1413-80001
A1	E1400-84401	1	CASE TERMINAL BLOCK ASSEMBLY	28480	E1400-84401
MP1	03852-01201	1	CLAMP	28480	03852-01201
MP2	03852-86701	1	PAD-CLAMP	28480	03852-86701
MP3	0515-2109	1	SCREW-MACH 10-24 .625-IN-LG PAN-HD-SLT	28480	0515-2109
MP4	1390-0846	2	FASTENER-CAPTIVE SCREW M2.5 X 0.45	28480	1390-0846
MP5	E1300-01202	1	CLAMP STRAIN RELIEF	28480	E1300-01202
MP6	E1400-44104	1	TERMINAL HOUSING-BOTTOM	28480	E1400-44104
MP7	E1400-44105	1	TERMINAL HOUSING-TOP	28480	E1400-44105
			TERMINAL BLOCK PARTS (FIG 4-6)		
A1	E1413-66510	1	TERMINAL CARD ASSEMBLY	28480	E1413-66510
JM1	1251-6001	1	CONNECTOR POST TP 2 X 3P	28480	1251-6001
P1-P2	1252-1593	2	CONNECTOR-RA RCPT, 96P	28480	1252-1593
TB1-TB2	0360-2391	4	TERMINAL BLOCK 12 POS	28480	0360-2391
TB3-TB5	0360-2501	6	TERMINAL BLOCK 10 POS	28480	0360-2501
TB6-TB11	0360-2502	6	TERMINAL BLOCK 8 POS	28480	0360-2502
TB12-TB13	0360-2391		TERMINAL BLOCK 12 POS	28480	0360-2391
TB14-TB16	0360-2501		TERMINAL BLOCK 10 POS	28480	0360-2501

a. Includes J4100, J4110, J4220, J4230, J4340, J4350, J4460, and J4470
b. Includes J4101, J4111, J4221, J4231, J4341, J4351, J4461, and J4471
c. Includes K4100-K4115, K4190-K4192, K4216-K4231, K4332-K4347, and K4448-K4463

Table 4-7. HP E1413C Scanning A/D Replaceable Parts

Reference Designator	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			HP E1413C HARDWARE PARTS (FIG 4-7)		
CBL1	E1326-61604	1	CALIBRATION CABLE	28480	E1326-61604
CBL2	E1400-61605	1	CONNECTOR CABLE	28480	E1400-61605
HDL1	E1400-45102	1	HANDLE BOTTOM	28480	E1400-45102
HDL2	E1400-45101	1	HANDLE TOP	28480	E1400-45101
PNL1	E1413-00212	1	FRONT PANEL	28480	E1413-00212
SCR5-SCR9	0515-1135	5	SCREW-M3 X 0.5 25MM-LG FLAT-HEAD	28480	0515-1135
SCR10-SCR11	0515-0664	2	SCREW-M3.0 X 12MM	28480	0515-0664
SCR12-SCR13	0515-0430	2	SCREW-M3.0 X 6MM	28480	0515-0430
SHD1	E1413-00607	1	TOP SHIELD	28480	E1413-00607
SHD2	E1413-00602	1	BOTTOM SHIELD	28480	E1413-00602
SHD3	E1415-00603	1	COVER SCP	28480	E1415-00603
SHD4	E1415-00604	1	INNER SHIELD	28480	E1415-00604
			A1 PCA REPLACEABLE PARTS (FIG 4-8)		
PCA1	E1413-66502	1	PRINTED CIRCUIT ASSEMBLY	28480	E1413-66502
F103,F106	2110-0932	2	FUSE-SUBMINIATURE 5A 125V	75915	R251004T1
F101,102,104,105	2110-0936	4	FUSE-SUBMINIATURE 4A 125V	28480	2110-0936
J1-J2,P1-P2	1251-7799	4	CONN-POST TYPE 2.54-PIN-SPCG 96-CONTACT	91662	10-8457-096-002-037
J3	1252-0776	1	CONN-POST TYPE .100-PIN-SPCG 12-CONTACT	00779	102979-6
J4100-J4470[a]	1252-4618	8	50-PIN CONNECTOR 104549-7	00779	104549-7
J4101-J4471[b]	1252-5357	8	50-PIN RECEPTACLE 104550-6	00779	104550-6
JM2201	1251-4682	1	CONN-POST TYPE .100-PIN-SPCG 3-CONTACT	26742	1102-1-103-02
K4100-K4463[c]	0490-1937	67	RELAY 2C 3VDC COIL 1A 125VAC	28480	0490-1937
SP1	3101-2243	1	SWITCH-DIP ROCKER 8-1A 0.05A 30VDC	81073	76YY22318S
			TERMINAL CASE ASSEMBLY PARTS (FIG 4-9)		
	E1413-80011	1	COMPLETE TERMINAL BLOCK with CASE	28480	E1413-80011
A1	E1400-84405	1	CASE TERMINAL BLOCK ASSEMBLY	28480	E1400-84405
MP1	E1400-45103	1	TOP LEVER	28480	E1400-45103
MP2	E1400-45104	1	BOTTOM LEVER	28480	E1400-45104
MP3	1460-2552	1	TORSION SPRING LEFT WOUND	28480	1460-2552
MP4	1460-2553	1	TORSION SPRING RIGHT WOUND	28480	1460-2553
MP5	E1400-44109	1	CVR-BTM TRM HSG	28480	E1400-44109
MP6	1390-1026	2	STUD QUICK FASTENER	28480	1390-1026
MP7	1390-1027	2	RECEPTICAL QUICK FASTENER	28480	1390-1027
MP8	E1400-04117	1	CVR KIT TERMINAL BLOCK	28480	E1400-04117
MP9	E1400-04116	1	TOP COVER	28480	E1400-04116
			TERMINAL BLOCK PARTS (FIG 4-10)		
A1	E1413-66510	1	TERMINAL CARD ASSEMBLY	28480	E1413-66510
JM1	1251-6001	1	CONNECTOR POST TP 2 X 3P	28480	1251-6001
P1-P2	1252-1593	2	CONNECTOR-RA RCPT, 96P	28480	1252-1593
TB1	0360-2574	1	TERMINAL BLOCK 18 POS	28480	0360-2574
TB2-TB9	0360-2577	8	TERMINAL BLOCK 24 POS	28480	0360-2577

a. Includes J4100, J4110, J4220, J4230, J4340, J4350, J4460, and J4470
b. Includes J4101, J4111, J4221, J4231, J4341, J4351, J4461, and J4471
c. Includes K4100-K4115, K4190-K4192, K4216-K4231, K4332-K4347, and K4448-K4463

Table 4-8. Signal Conditioning Plug-Ons Replacement Assembly

Model Number	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
E1501A	E1413-66511	1	Direct Input SCP	28480	E1413-66511
E1502A	E1413-66512	1	Low Pass Filter Input SCP	28480	E1413-66512
E1503A	E1413-66513	1	Gain/Filter Input SCP	28480	E1413-66513
E1504A	E1413-66514	1	Breadboard (no tests)	28480	E1413-66514
E1505A	E1413-66515	1	Current Source SCP	28480	E1413-66515
E1506A	E1413-66516	1	120 Ω Strain Gage SCP	28480	E1413-66516
E1507A	E1413-66517	1	350 Ω Strain Gage SCP	28480	E1413-66517
E1508A	E1413-66518	1	Fixed Gain/Filter Input SCP	28480	E1413-66518
E1509A	E1413-66519	1	Fixed Gain/Filter Input SCP	28480	E1413-66519
E1510A	E1413-66520	1	4 Channel Sample & Hold	28480	E1413-66520
E1511A	E1413-66521	1	4 Channel Transient Strain	28480	E1413-66521
E1512A	E1512-66501	1	8 Channel 25Hz Low Pass	28480	E1512-66501
E1513A	E1513-66501	1	Attenuator Input / 16	28480	E1513-66501
E1514A	E1514-66501	1	Iso x1, 4 Channel 10Hz LP	28480	E1514-66501
E1515A	E1515-66501	1	Iso x1, 4 Channel 100Hz LP	28480	E1515-66501
E1516A	E1516-66501	1	Iso x64, 4 Channel 10Hz LP	28480	E1516-66501
E1517A	E1517-66501	1	Iso x64, 4 Channel 100Hz LP	28480	E1517-66501
E1518A	E1518-66501	1	Resistance Measurement	28480	E1518-66501

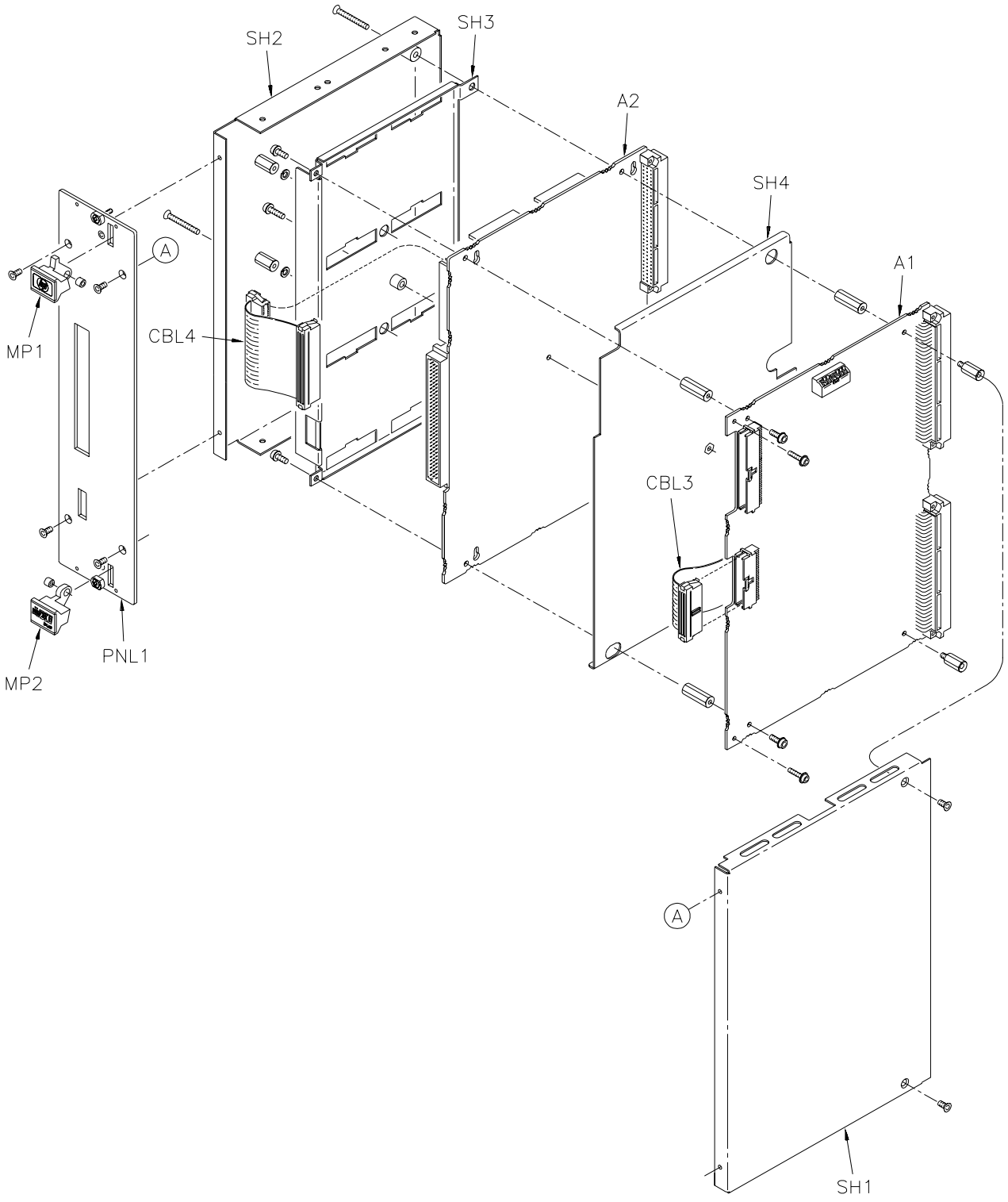


Figure 4-1. HP E1313A Mechanical Parts

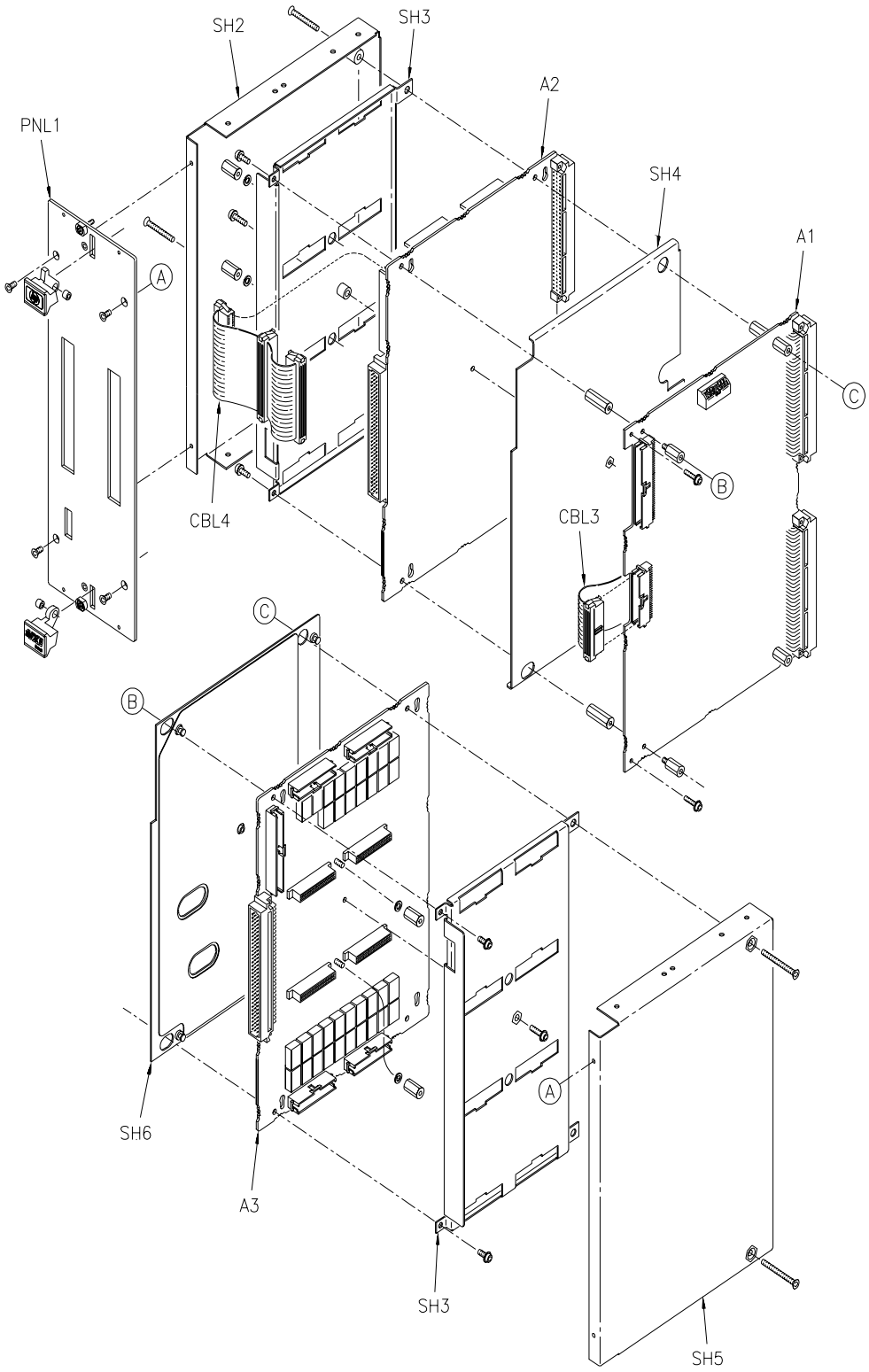


Figure 4-2. HP E1313A Option 001 Mechanical Parts

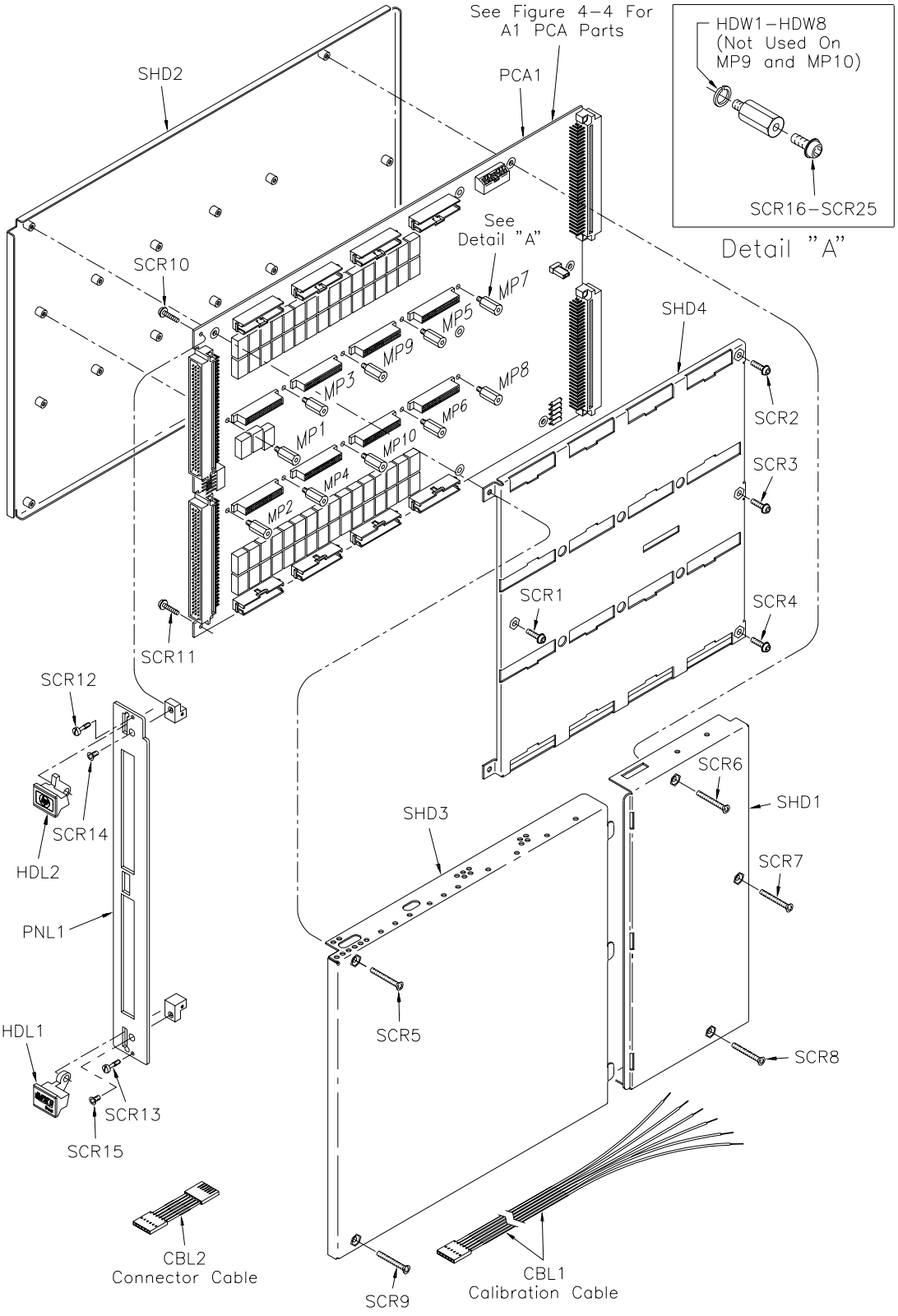


Figure 4-3. HP E1413A/B Mechanical Parts

A1 PCA Relay Number Legend

Ch	Relay	Ch	Relay	Ch	Relay	Ch	Relay	Ch	Relay	Ch	Relay
0	K4100	11	K4111	22	K4222	33	K4333	44	K4344	55	K4455
1	K4101	12	K4112	23	K4223	34	K4334	45	K4345	56	K4456
2	K4102	13	K4113	24	K4224	35	K4335	46	K4346	57	K4457
3	K4103	14	K4114	25	K4225	36	K4336	47	K4347	58	K4458
4	K4104	15	K4115	26	K4226	37	K4337	48	K4448	59	K4459
5	K4105	16	K4216	27	K4227	38	K4338	49	K4449	60	K4460
6	K4106	17	K4217	28	K4228	39	K4339	50	K4450	61	K4461
7	K4107	18	K4218	29	K4229	40	K4340	51	K4451	62	K4462
8	K4108	19	K4219	30	K4230	41	K4341	52	K4452	63	K4463
9	K4109	20	K4220	31	K4231	42	K4342	53	K4453	90	K4190
10	K4110	21	K4221	32	K4332	43	K4343	54	K4454	91	K4191
										92	K4192

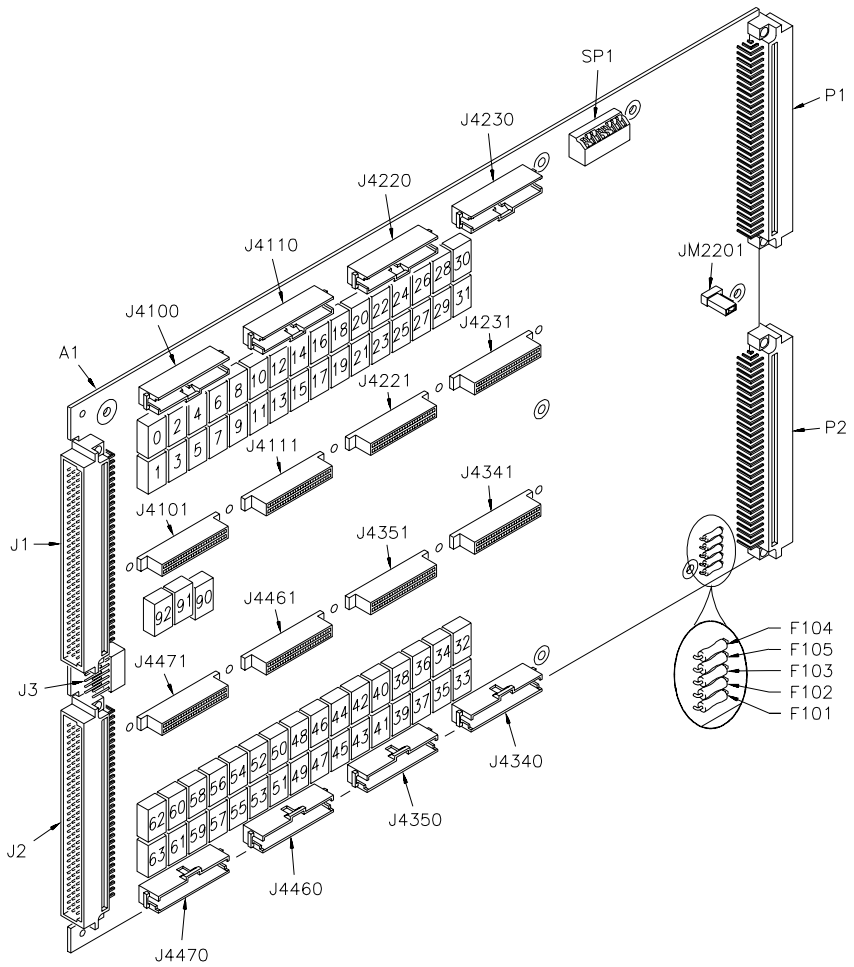


Figure 4-4. HP E1413A/B A1 PCA Replaceable Parts

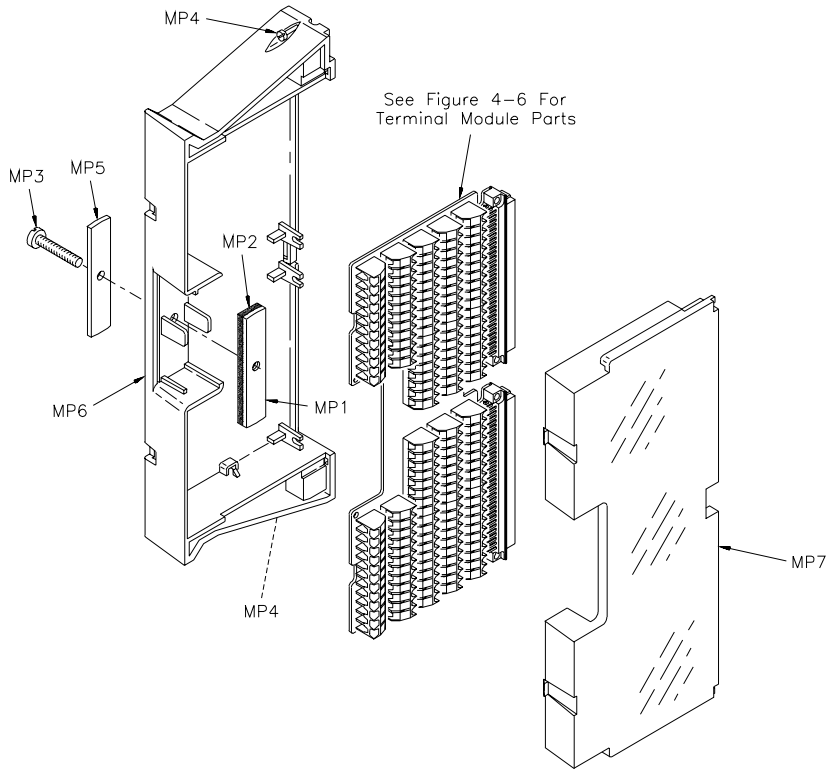


Figure 4-5. HP E1413A/B Terminal Case Parts

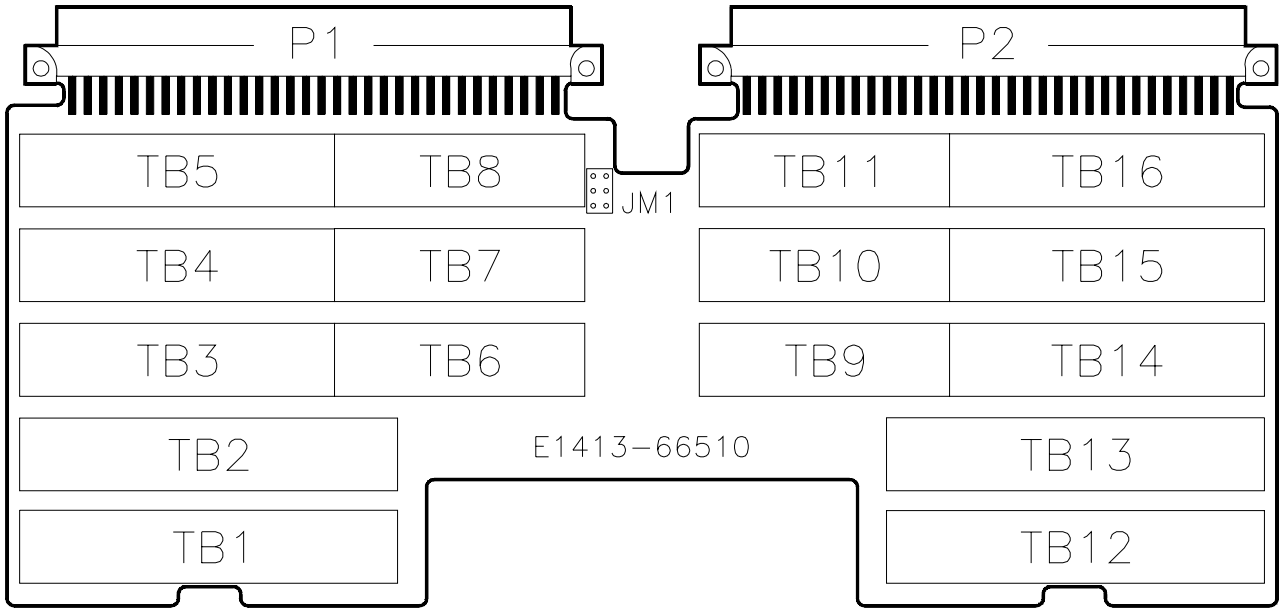


Figure 4-6. HP E1413A/B Terminal Block Parts

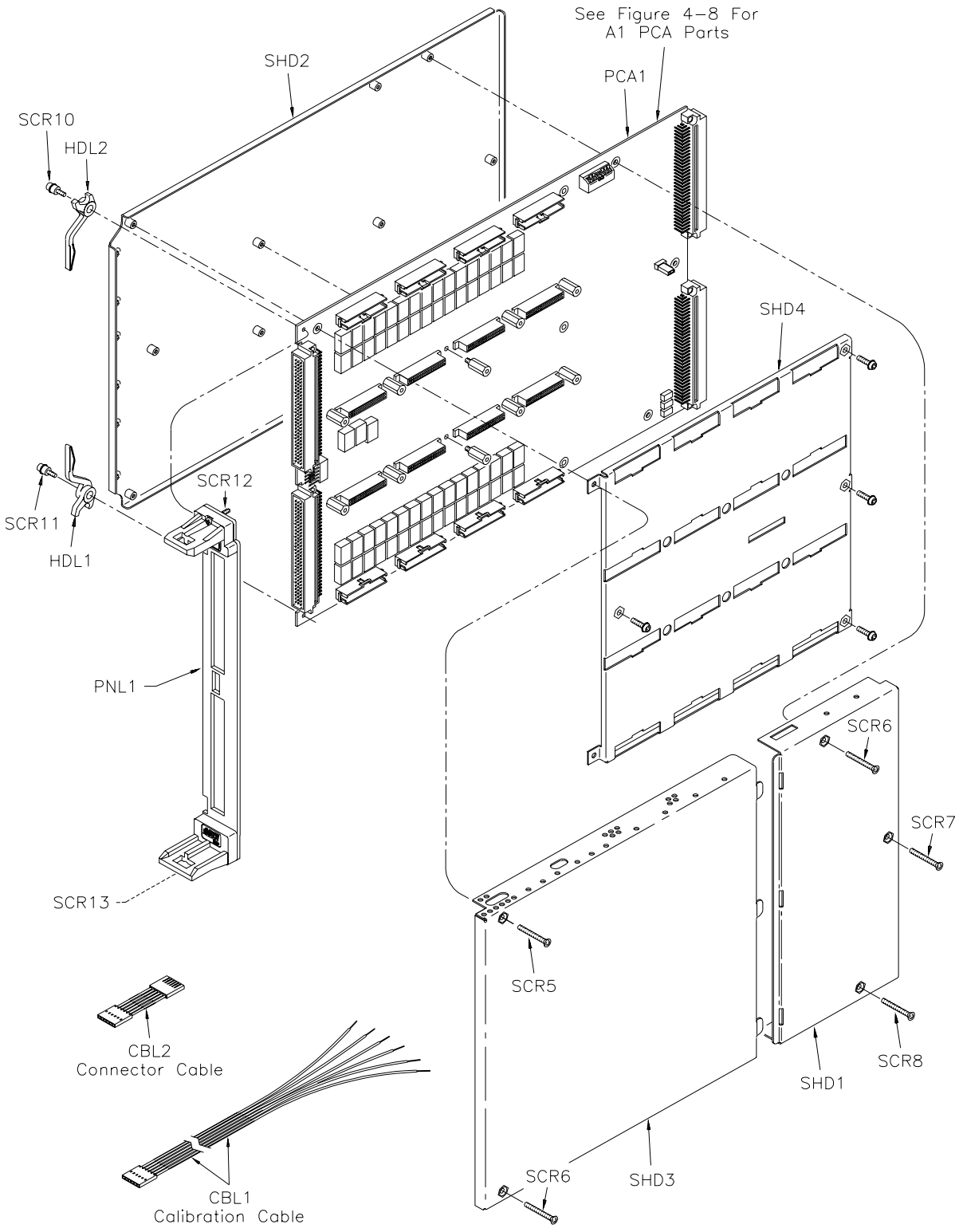


Figure 4-7. HP E1413C Mechanical Parts

A1 PCA Relay Number Legend

Ch	Relay	Ch	Relay	Ch	Relay	Ch	Relay	Ch	Relay	Ch	Relay
0	K4100	11	K4111	22	K4222	33	K4333	44	K4344	55	K4455
1	K4101	12	K4112	23	K4223	34	K4334	45	K4345	56	K4456
2	K4102	13	K4113	24	K4224	35	K4335	46	K4346	57	K4457
3	K4103	14	K4114	25	K4225	36	K4336	47	K4347	58	K4458
4	K4104	15	K4115	26	K4226	37	K4337	48	K4448	59	K4459
5	K4105	16	K4216	27	K4227	38	K4338	49	K4449	60	K4460
6	K4106	17	K4217	28	K4228	39	K4339	50	K4450	61	K4461
7	K4107	18	K4218	29	K4229	40	K4340	51	K4451	62	K4462
8	K4108	19	K4219	30	K4230	41	K4341	52	K4452	63	K4463
9	K4109	20	K4220	31	K4231	42	K4342	53	K4453	90	K4190
10	K4110	21	K4221	32	K4332	43	K4343	54	K4454	91	K4191
										92	K4192

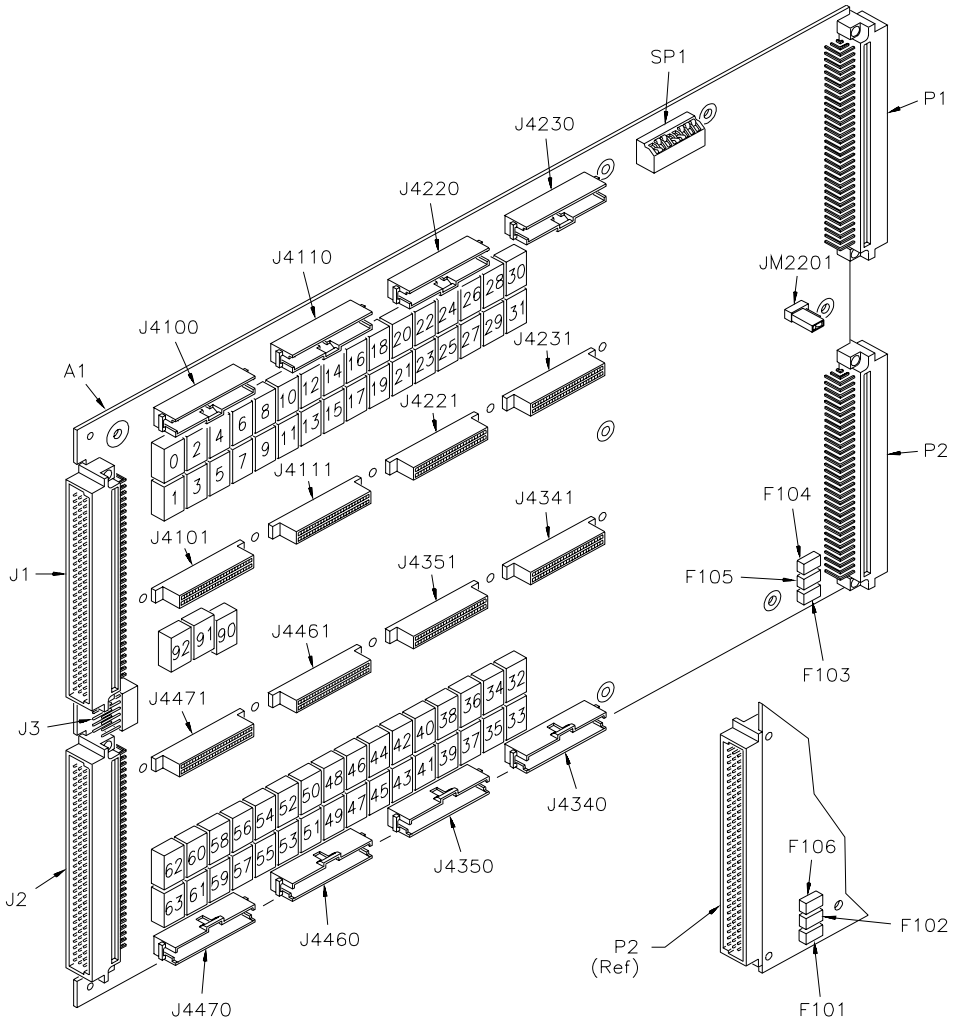


Figure 4-8. HP E1413C A1 PCA Replaceable Parts

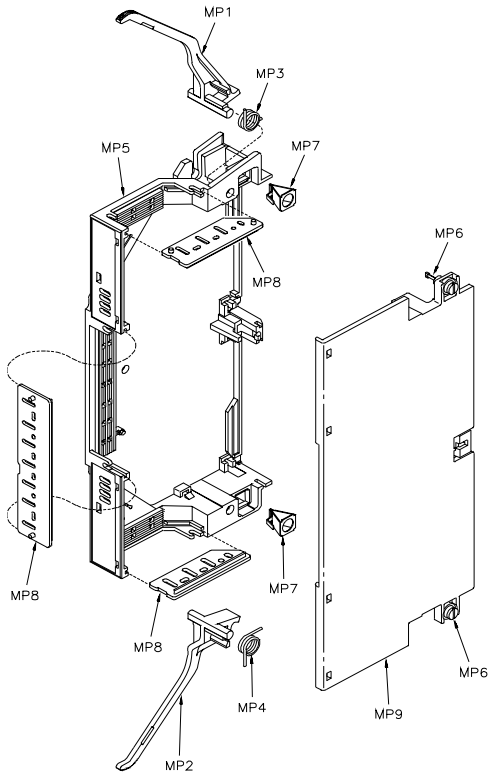


Figure 4-9. HP E1413C Terminal Case Parts

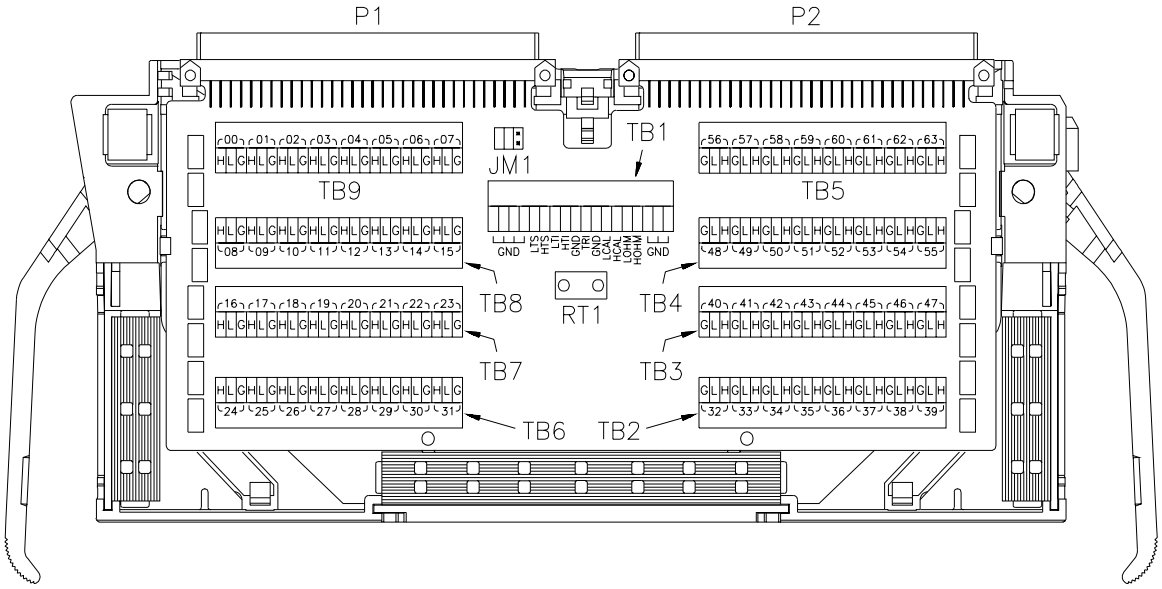


Figure 4-10. HP E1413C Terminal Block Parts

Chapter 5
Service

Introduction

This chapter contains information to service the 64-Channel Scanning A/D Converter, including recommended repair strategy, troubleshooting guidelines, and disassembly/repair guidelines.

WARNING **Do not perform any of the service procedures shown unless you are a qualified, service-trained person, and have read the WARNINGS and CAUTIONS in Chapter 1.**

Equipment Required

Equipment required for Scanning A/D troubleshooting and repair is listed in Table 1-4, *Recommended Test Equipment.* To avoid damage to the screw head slots, use T8 and T10 Torx drivers as described in the "Disassembly" section in this chapter.

Service Aids

See *Chapter 4 - Replaceable Parts* for descriptions and locations of replaceable parts. Service notes and service literature for the Scanning A/D may be available through Hewlett-Packard. For information, contact your nearest Hewlett-Packard Sales and Support Office.

Recommended Repair Strategy

The recommended repair strategy for the Scanning A/D and associated SCPs follows:

- Before replacing an HP E1413C Scanning A/D, check fuses F101 through F106 (F101 through F105 for the HP E1413A/B and F170 through F172 for the HP E1313A) on the A1 Printed Circuit Assembly (PCA) and check other replaceable parts listed in *Chapter 4 - Replaceable Parts*.
- If the fault can be traced to a part listed in Chapter 4, repair the fault and retest the instrument. If not, exchange or replace the entire Scanning A/D or SCP.
- See "Shipping Guidelines" in *Chapter 1 - General Information* to return a Scanning A/D to Hewlett-Packard.

Troubleshooting Guidelines

This section shows suggested steps to troubleshoot Scanning A/D faults to a replaceable part listed in *Chapter 4 - Replaceable Parts*. If the fault cannot be isolated to a replaceable part, do not attempt further repairs. Instead, replace the instrument. The first step in troubleshooting the Scanning A/D is to run the self test (SELFTEST.C) program.

Running Service Test Program

To begin troubleshooting, run the SELFTEST program to test the Scanning A/D. If the self-test passes, "Self-test (*TST?) PASSED" is displayed. If the self-test fails, error messages are displayed. Table 5-1 shows suggested actions, depending on the program results.

Note During the first 5 minutes after power is applied, the self-test (*TST?) may fail. Allow the Scanning A/D to warm up before running the SELFTEST program.

Table 5-1. Scanning A/D Troubleshooting Steps

If the SELFTEST program result is:	The most likely cause is:	See this section:
No return	Mechanical part failure	"Checking Mechanical Parts"
+3052, "Self test failed. Check info in FIFO"	SCP is not properly seated or is defective	"Checking SCPs"

For example, the following result for the SELFTEST program indicates test #72 (SCP continuity) failed and channel 100 is the failed channel. See *Appendix C - Command Reference* for a description of the *TST? and SYST:ERR? error messages.

System Error Messages
+3052,"Self test failed. Test info in FIFO"
+0,"No error"
FIFO Error Messages
1 - 99 = Failed test number
100 - 163 = Failed channel number
200 - 204 = Range for failed test

+7.200000E+001,+1.000000E+002

Checking Mechanical Parts

If the self-test service (SELFTEST) program does not respond, remove the Scanning A/D from the mainframe and check the mechanical parts listed in *Chapter 4 - Replaceable Parts* (see Figures 4-1 through 4-10 for component locations).

Change/repair/replace components as required and then retest the instrument using the SELFTEST program. If the SELFTEST still does not return a response, replace the instrument.

Table 5-2. Scanning A/D Mechanical Checks

Test/Check	Reference Designator	Check	Comments
Heat Damage	- - - - - - - -	Discolored PC board Damaged insulation Evidence of arcing	If there is damage, do not operate the instrument until you have corrected the problem.
Logical Address	SP1	LADDR setting (factory set to 24)	See the *HP E1413C User's Manual* for information on switch settings.
A1 PCA	F101 - F105 J1 - J3, J1203, J4100 - J4471 P1 - P2	Fuse continuity Damaged connectors	See "Repair/Maintenance Guidelines" before replacing fuse(s)/connectors. See "Disassembly" to remove covers/shields.
Terminal Module	JM1 MP1 - MP7 P1 - P2 TB1 - TB16	Damaged connectors	See Figures 4-5 and 4-6 for HP E1413A/B terminal block parts locations. See Figures 4-9 and 4-10 for HP E1413C terminal block parts locations.

Checking SCPs

If there are no apparent mechanical problems but the instrument does not pass the test (SELFTEST) program, check all installed SCPs. Table 5-3 gives some guidelines to check/replace SCPs.

Table 5-3. Guidelines to Check/Replace SCPs

If the SELFTEST shows failure for test number(s):	Do This:
20 or 30 through 37	Remove all SCPs and rerun the SELFTEST program. If *TST? then passes, replace SCPs one at a time until you find the one causing the problem. Then, replace the SCP causing the problem.
72 or 74 through 76	Try to reseat the SCP that the channel number(s) point to and then rerun SELFTEST. Or, move the SCP and see if the problems follow the SCP. If so, replace the SCP and rerun SELFTEST.
Other test numbers	Replace the instrument.

Disassembly

To perform Scanning A/D disassembly, you will need a T-8 and T-10 Torx driver. See Figure 5-1 for steps to disassemble a Scanning A/D. Reverse the steps to reassemble the Scanning A/D.

Caution **Do not handle or disassemble the Scanning A/D module unless you are familiar with the precautions listed in the "Repair/Maintenance Guidelines" section of this chapter.**

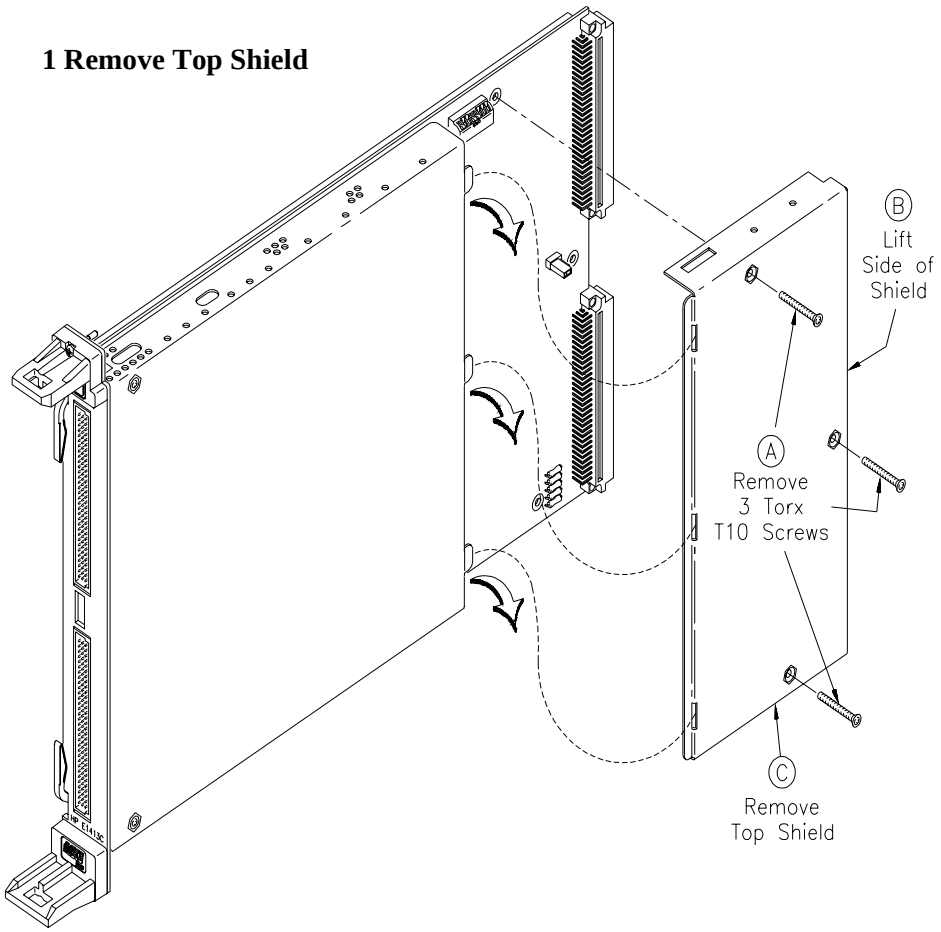
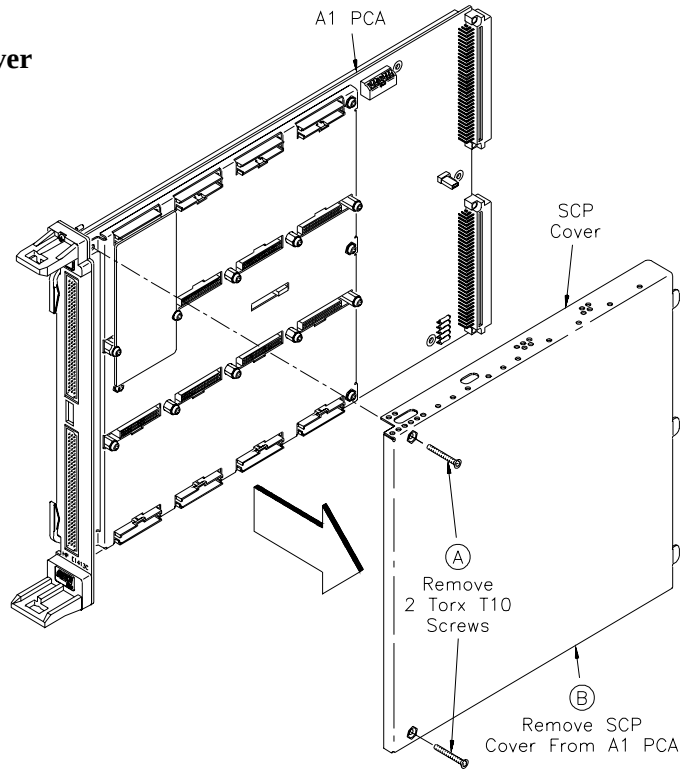
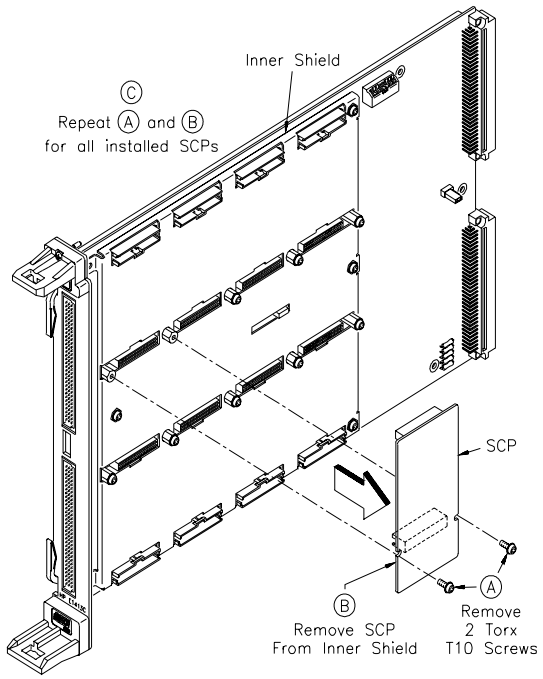


Figure 5-1. Scanning A/D Disassembly

2 Remove SCP Cover

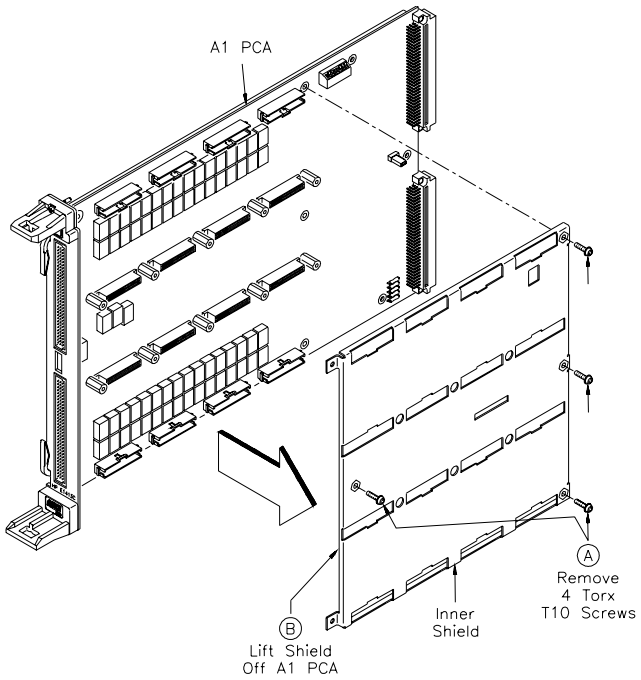


3 Remove SCP(s)



Scanning A/D Disassembly (Cont'd)

4 Remove Inner Shield



5 Remove A1 PCA

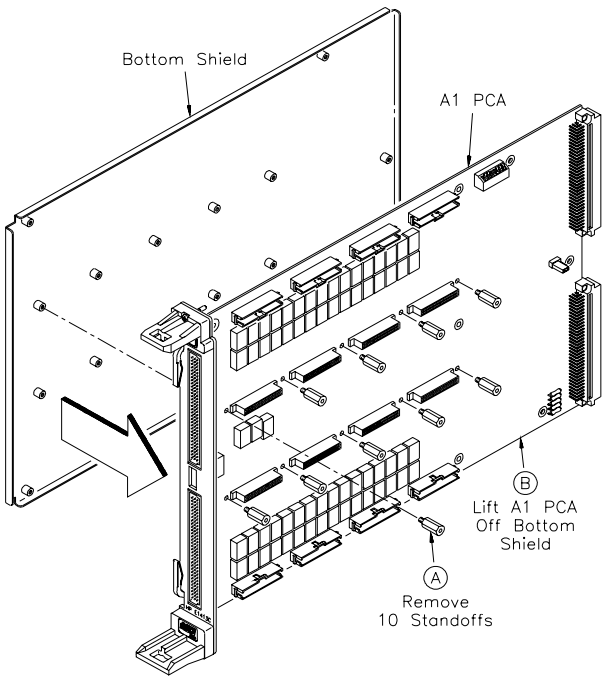


Figure 5-1. Scanning A/D Disassembly (cont'd)

Repair/Maintenance Guidelines

Guidelines to repair and maintain a Scanning A/D follow, including:

- ESD precautions
- Soldering printed circuit boards
- Post-repair safety checks

Caution **Do not touch the Scanning A/D or SCP edge connector pins at any time unless you are actively using a static-free workstation.**

ESD Precautions

Electrostatic discharge (ESD) may damage CMOS and other static-sensitive devices in the Scanning A/D such as ROM or RAM ICs. This damage can range from slight parameter degradation to catastrophic failure. When working on Scanning A/D or SCP modules, follow these guidelines to avoid damaging components:

- Always use a static-free work station with a pad of conductive rubber or similar material when handling module components.
- After you remove a module from the frame, place the module on a conductive surface to guard against ESD damage.
- Do not use pliers to remove a CMOS device from a high-grip socket. Instead, use a small screwdriver to pry the device up from one end. Slowly lift the device up, one pair of pins at a time.
- After you remove a CMOS device from a module, place the device onto a pad of conductive foam or other suitable holding material.
- If a device requires soldering, be sure the device is placed on a pad of conductive material. Also, be sure you, the pad, and the soldering iron tip are grounded to the device. Apply as little heat as possible when soldering.

Soldering Printed Circuit Boards

The etched circuit boards on Scanning A/D module printed circuit assemblies (PCAs) have plated-through holes that allow a solder path to both sides of the insulating material. Soldering can be done from either side of the board with equally good results. When soldering to any circuit board, keep in mind the following guidelines:

Caution **Do not use a sharp metal object such as an awl or twist drill, since sharp objects may damage the plated-through conductor.**

- Avoid unnecessary component unsoldering and soldering. Excessive replacement can result in damage to the circuit board and/or adjacent components.
- Do not use a high power soldering iron on etched circuit boards, as excessive heat may lift a conductor or damage the board.
- Use a suction device or wooden toothpick to remove solder from component mounting holes. When using a suction device, be sure the equipment is properly grounded to prevent electrostatic discharge from damaging CMOS devices.

Post-Repair Safety Checks

After making repairs to Scanning A/D module components, inspect the device for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and correct the cause of the condition. Then, run the power-on self-test to verify that the Scanning A/D module is operational.

Note As desired, you may want to run the functional and/or performance verification tests in Chapter 2 - Verification Tests.

Appendix A
Calculating Scanning A/D Accuracy

Introduction

This appendix shows how scanning A/D accuracy, source equipment measurement uncertainty, and test accuracy ratio (TAR) values are defined and calculated for the performance verification tests for the HP E1413C Scanning A/D.

See Table 2-1, "*HP E1413C Performance Test Record* " for 90-day specification values of Scanning A/D accuracy, for Datron 4708 and HP 3458A DMM measurement uncertainties, and for test accuracy ratios (TARs).

Note

Scanning A/D accuracy, measurement uncertainty, and test accuracy ratios in Table 2-1 are valid ONLY for the specified test conditions and assumptions described in this manual.

Scanning A/D Accuracy Definition

Scanning A/D accuracy is the expected accuracy of the measurement due ONLY to the Scanning A/D. The Minimum entry in Table 2-1 "*HP E1413C Performance Test Record* " is the lower value of Scanning A/D accuracy, while the Maximum entry is the upper value of Scanning A/D accuracy. If a measured reading is between the Minimum and Maximum values in Table 2-1, the test passes for this reading.

Measurement Uncertainty Definition

Measurement Uncertainty is the expected accuracy of the source used to input signals to the Scanning A/D or the instrument used to measure outputs from the Scanning A/D. A Datron 4708 Autocal Multifunction Standard Option 10 is the source used for inputs and an HP 3458A DMM is the measuring device for outputs, so the measurement uncertainty is that of a Datron 4708 or an HP 3458A DMM.

Test Accuracy Ratio (TAR) Definition

Test Accuracy Ratio (TAR) for the HP E1413C is defined by:

$$TAR = \frac{MaximumValue - ExpectedReading}{MeasurementUncertainty}$$

where MaximumValue = largest amount of variation from the expected reading (the input or output), and MeasurementUncertainty is that of the test equipment (Datron Standard or HP 3458A DMM). If a TAR exceeds 10:1, the entry in Table 2-1 "*HP E1413C Performance Test Record* " is ">10:1".

Scanning A/D Accuracy Calculations

For HP E1413C Scanning A/D performance verification tests, accuracy is defined for DC voltage measurements using the specifications in the *HP E1413C User's Manual*. The assumed test conditions are:

- 90 days since the last adjustment
- Operating temperature $23^{o}C \pm 1^{o}C$
- At least one hour warm-up time

DCV Accuracy Equations

DC voltage specifications in the *HP E1413C User's Manual* are defined for 90 days @ $23^{o}C \pm 1^{o}C$. Since 400 readings are averaged for each measurement, the 3 sigma noise values listed in the *HP E1413C User's Manual* are not used. Tables A-1 through A-19 list accuracy values used for the SCP performance verification test limits.

For example (see Table A-1), with a 3.2 Vdc input and the 4.0V range, DCV accuracy (90-day) for the E1501A SCP = ± (.01% of reading + 122 µV offset error) = ± (.0001 x 3.2 + 122 x 10^{-6}) = ± 0.0004 Vdc. Thus, for a 3.2 Vdc input the Minimum value for the E1501A SCP test in Table 2-1 "*HP E1413C Performance Test Record* " = 3.1996 Vdc and the Maximum value = 3.2004 Vdc.

Table A-1. DCV Accuracy - E1501A SCP (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0625V	± .01%	5.3 µV	± [.0001*rdg + 5.3 µV]
.25V	± .01%	10.3 µV	± [.0001*rdg + 10.3 µV]
1.0V	± .01%	31 µV	± [.0001*rdg + 31 µV]
4.0V	± .01%	122 µV	± [.0001*rdg + 122 µV]
16.0V	± .01%	488 µV	± [.0001*rdg + 488 µV]

Test Conditions:

$23^{o}C \pm 1^{o}C$ with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 10ppm/^{o}C after *CAL?. (0-40^{o}C) 0.14 µV/^{o}C, (40-55^{o}C) 0.8 µV + 0.38 µV/^{o}C

Table A-2. DCV Accuracy - E1502A SCP (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0625V	± .01%	7.2 µV	± [.0001*rdg + 7.2 µV]
.25V	± .01%	12.2 µV	± [.0001*rdg + 12.2 µV]
1.0V	± .01%	33 µV	± [.0001*rdg + 33.0 µV]
4.0V	± .01%	122 µV	± [.0001*rdg + 122.0 µV]
16.0V	± .01%	488 µV	± [.0001*rdg + 488.0 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 10ppm/°C after *CAL?. Offset (0-30°C) no additional error, (30-40°C) 0.1 µV/°C, (40-55°C) 2.4 µV + 0.27 µV/°C.

Table A-3. DCV Accuracy - E1503A SCP @ Gain X1 (90-day)

Range ± FS	Linearity % of rdg	Offset Error 2 Hz	10 Hz	100 Hz	Filter OFF
.0625V	± .01%	13 µV	9.5 µV	6.8 µV	6.3 µV
.25V	± .01%	15 µV	12.5 µV	11.2 µV	10.8 µV
1.0V	± .01%	33 µV	31.8 µV	31.3 µV	31.2 µV
4.0V	± .01%	123 µV	122 µV	122 µV	122 µV
16.0V	± .01%	488 µV	488 µV	488 µV	488 µV

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 15 ppm/°C after *CAL?. Offset - Add tempco + fixed offset to offset above.

Temp	Tempco	2 Hz	10 Hz	100 Hz	Filter OFF
0-30°C	0.16 µV/°C	0 µV	0 µV	0 µV	0 µV
30-40°C	0.18 µV/°C	13 µV	9 µV	1.1 µV	0.2 µV
40-55°C	0.39 µV/°C	31 µV	22 µV	6.4 µV	1.1 µV

Table A-4. DCV Accuracy - E1503A SCP @ Gain X8 (90-day)

Range ± FS	Linearity % of rdg	Offset Error 2 Hz	10 Hz	100 Hz	Filter OFF
.0078V	± .01%	4.6 µV	4.2 µV	3.8 µV	3.7 µV
.031V	± .01%	4.8 µV	4.6 µV	4.4 µV	4.3 µV
.125V	± .01%	6 µV	5.3 µV	5 µV	4.9 µV
0.5V	± .01%	16 µV	16 µV	16 µV	16 µV
2.0V	± .01%	61µV	61 µV	61 µV	61 µV

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 15 ppm/°C after *CAL?. Offset - Add tempco + fixed offset to offset above.

Temp	Tempco	2 Hz	10 Hz	100 Hz	Filter OFF
0-30°C	0.16 µV/°C	0 µV	0 µV	0 µV	0 µV
30-40°C	0.18 µV/°C	4.3 µV	2.7 µV	1.0 µV	0.2 µV
40-55°C	0.39 µV/°C	13 µV	10 µV	6.2 µV	0.8 µV

Table A-5. DCV Accuracy - E1503A SCP @ Gain X64 (90-day)

Range ± FS	Linearity % of rdg	Offset Error 2 Hz	10 Hz	100 Hz	Filter OFF
.0039V	± .01%	2.9 µV	2.3 µV	2.1 µV	2.1 µV
.0156V	± .01%	3 µV	2.4 µV	2.2 µV	2.2 µV
.0625V	± .01%	3.5 µV	3 µV	2.9 µV	2.9 µV
.25V	± .01%	8.2 µV	8 µV	8 µV	8 µV

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 15 ppm/°C after *CAL?. Offset - Add tempco + fixed offset to offset above.

Temp	Tempco	2 Hz	10 Hz	100 Hz	Filter OFF
0-30 °C	0.16 µV/°C	0 µV	0 µV	0 µV	0 µV
30-40°C	0.18 µV/°C	1.1µV	0.2 µV	0.1 µV	0.1 µV
40-55°C	0.39 µV/°C	6 µV	1.4 µV	0.6 µV	0.6 µV

Table A-6. Excitation Voltage Accuracy - E1506A/E1507A SCPs (90-day)

Nominal Value	Accuracy
3.9000 Vdc	± 512 µV

Test Conditions:

- 23°C ± 1°C with *CAL? done after a one-hour warm-up.
- CAL:ZERO? done within 5 minutes before the measurement.
- Temperature coefficient: 39 µV/°C.

Table A-7. DCV Accuracy - E1508A SCP (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0039V	± .01%	3.8 µV	± [.0001*rdg + 3.8 µV]
.0156V	± .01%	4.2 µV	± [.0001*rdg + 4.2 µV]
.0625V	± .01%	4.9 µV	± [.0001*rdg + 4.9 µV]
0.25V	± .01%	8.0 µV	± [.0001*rdg + 8.0 µV]
1.0V	± .01%	31.0 µV	± [.0001*rdg + 31 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 15 ppm/°C after *CAL?. Offset (0-30°C) 0.16 µV/°C, (30-40°C) 0.18 µV/°C, (40-55°C) 0.39 µV/°C.

Table A-8. DCV Accuracy - E1509A SCP (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0039V	± .01%	2.3 µV	± [.0001*rdg + 2.3 µV]
.0156V	± .01%	2.4 µV	± [.0001*rdg + 2.4 µV]
.0625V	± .01%	3.0 µV	± [.0001*rdg + 3.0 µV]
.25V	± .01%	8.0 µV	± [.0001*rdg + 8.0 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 15 ppm/°C after *CAL?. Offset (0-30°C) 0.16 µV/°C, (30-40°C) 0.18 µV/°C, (40-55°C) 0.39 µV/°C.

Table A-9. DCV Accuracy - E1510A and E1511A SCPs @ Gain X0.5 (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.125V	± .02%	488 µV	± [.0002*rdg + 488 µV]
0.5V	± .02%	488 µV	± [.0002*rdg + 488 µV]
2V	± .02%	488 µV	± [.0002*rdg + 488 µV]
8V	± .02%	488 µV	± [.0002*rdg + 488 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON. Temperature coefficients: Gain - 10 ppm/°C after *CAL?. Offset (0-30°C) 0 µV/°C, (30-55°C) 0.75 µV/°C.

Table A-10. DCV Accuracy - E1510A and E1511A SCPs @ Gain X8 (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
7.8 mV	± .02%	30.5 µV	± [.0002*rdg + 30.5 µV]
31.25 mV	± .02%	30.5 µV	± [.0002*rdg + 30.5 µV]
125 mV	± .02%	30.5 µV	± [.0002*rdg + 30.5 µV]
0.5 V	± .02%	30.5 µV	± [.0002*rdg + 30.5 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON. Temperature coefficients: Gain - 10 ppm/°C after *CAL?. Offset (0-30°C) 0 µV/°C, (30-55°C) 0.75 µV/°C.

Table A-11. DCV Accuracy - E1510A and E1511A SCPs @ Gain X64 (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
3.9 mV	± .02%	15.0 µV	± [.0002*rdg + 15.0 µV]
15.6 mV	± .02%	15.0 µV	± [.0002*rdg + 15.0 µV]
62.5 mV	± .02%	15.0 µV	± [.0002*rdg + 15.0 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON. Temperature coefficients: Gain - 10 ppm/°C after *CAL?. Offset (0-40°C) 0.14 µV/°C, (40-55°C) 0.38 µV/°C.

Table A-12. DCV Accuracy - E1510A and E1511A SCPs @ Gain X512 (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
7.81 mV	± .04%	15.0 µV	± [.0002*rdg + 15.0 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 10 ppm/°C after *CAL?. Offset (0-40°C) 0.14 µV/°C, (40-55°C) 0.38 µV/°C.

Table A-13. DCV Accuracy - E1510A SCP Straight Through Channels (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0625V	± .01%	5.3 µV	± [.0001*rdg + 5.3 µV]
.25V	± .01%	10.3 µV	± [.0001*rdg + 10.3 µV]
1.0V	± .01%	31 µV	± [.0001*rdg + 31 µV]
4.0V	± .01%	122 µV	± [.0001*rdg + 122 µV]
16.0V	± .01%	488 µV	± [.0001*rdg + 488 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 10ppm/°C after *CAL?. (0-40°C) 0.14 µV/°C, (40-55°C) 0.8 µV + 0.38 µV/°C.

Table A-14. DCV Accuracy - E1512A SCP (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0625V	± .01%	7.2 µV	± [.0001*rdg + 7.2 µV]
.25V	± .01%	12.2 µV	± [.0001*rdg + 12.2 µV]
1.0V	± .01%	33 µV	± [.0001*rdg + 33.0 µV]
4.0V	± .01%	122 µV	± [.0001*rdg + 122.0 µV]
16.0V	± .01%	488 µV	± [.0001*rdg + 488.0 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 10ppm/°C after *CAL?. Offset (0-30°C) no additional error, (30-40°C) 0.1 µV/°C, (40-55°C) 2.4 µV + 0.27 µV/°C.

Table A-15. DCV Accuracy - E1513A SCP (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
1.0V	± .02%	500 µV	± [.0002*rdg + 500 µV]
4.0V	± .02%	1.95 mV	± [.0002*rdg + 1.95 mV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain -.001/°C after *CAL?. Offset (0-40°C) 0.14 µV/°C, (40-55°C) 0.8 µV + 0.38 µV/°C.

Table A-16. DCV Accuracy - E1514A and E1515A SCPs (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
16 V	± .015%	976 µV	± [.00015*rdg + 976 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 10ppm/°C after *CAL?. Offset (0-40°C) 0.14 µV/°C, (40-55°C) 0.8 µV/.°C

Table A-17. DCV Accuracy - E1516A and E1517A SCPs (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0625 V	± .015%	3.8 µV	± [.00015*rdg + 3.8 µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 10ppm/°C after *CAL?. Offset (0-40°C) 0.14 µV/°C, (40-55°C) 0.8 µV/.°C

Table A-18. DCV Accuracy - E1518A SCP (90-day)

Range ± FS	Linearity % of rdg	Offset error	Total offset
.0039 V	± .01%	3.8 µV	± [.0001*rdg + 3.8 µV]
.0156 V	± .01%	4.2 µV	± [.0001*rdg + 4.2 µV]
.0625 V	± .01%	4.9 µV	± [.0001*rdg + 4.9 µV]
.25 V	± .01%	8.0 µV	± [.0001*rdg + 8.0 µV]
1.0 V	± .01%	31.0 µV	± [.0001*rdg + 31. µV]

Test Conditions:

23°C ± 1°C with *CAL? done after a one-hour warm-up. CAL:ZERO? done within 5 minutes before the measurement. Autoranging OFF and A/D Filter ON.
Temperature coefficients: Gain - 15ppm/°C after *CAL?. Offset (0-30°C) 0.16 µV/°C, (30-40°C) 0.18 µV/°C, (40-55°C) 0.39 µV/.°C.

DCI Accuracy Equations

Table A-19 shows DC current accuracy limits for the E1505A and E1518A SCPs.

Table A-19. DCI Accuracy - E1505A and E1518A SCPs (90-day)

Current Amplitude	Output Accuracy
30.518µA 488.28µA	± 9 nA ± 60 nA
Test Conditions: - 23°C ± 1°C with *CAL? done after a one-hour warm-up. - CAL:ZERO? done within 5 minutes before the measurement.	

Measurement Uncertainty Calculations

This section shows how measurement uncertainties are calculated for the Datron 4708 Source and the HP 3458A DMM. The Datron 4708 source is used for DCV inputs for the SCP performance verification tests.

The HP 3458A DMM is used to measure the DC current output for E1505A and E1518A SCP tests and to measure the excitation voltage value for the E1506A and E1507A SCP tests. Assumed test conditions for both instruments are:

- Temperature of $23^{o}C \pm 1^{o}C$
- 90 days since calibration
- At least one hour warm-up time

DC Source Measurement Uncertainty

Measurement uncertainties for the Datron 4708 source are calculated using the 90-day accuracy specifications in the *Datron 4708 User's Handbook*. Measurement Uncertainty = Datron Accuracy + Calibration Uncertainty, where Datron Accuracy (ppm) = Accuracy Relative to Calibration Standards = ± (ppm OUTPUT + ppm FS) and FS = 2 x range for all ranges.

From *Section 6 - Specifications* of the *Datron 4708 User's Handbook*, DC Voltage (Option 10) Measurement Accuracy follows, where Datron Accuracy = ± (ppm OUTPUT + ppm FS).

Table A-20. Datron 4708 DC Voltage Specifications (Option 10, 90-day)

Datron Range (Volts)	Datron Accuracy (ppm)	Calibration Uncertainty (ppm)	Total Measurement Uncertainty (µV)
100.00000 mV	3 + 0.4 µV	4	± [7.0 * |OUTPUT| + 0.4]
1.0000000 V	2 + 0.4	2	± [4.0 * |OUTPUT| + 0.8]
10.000000 V	1 + 0.15	1.5	± [2.5 * |OUTPUT| + 3.0]
100.00000 V	2 + 0.25	2	± [4.0 * |OUTPUT| + 50.0]

For example, for a 3.2 Vdc OUTPUT and 10.000000 V range the Measurement Uncertainty (µV) = ± [(1.0 x 3.2) + (2 x 0.15 x 10) + (1.5 x 3.2)] = ± 11 µV = ± 1.1E-5 V. Or, from Table A-20, Measurement Uncertainty (µV) = ± [(2.5 x 3.2) + 3.0] = ± 11 µV = ± 1.1E-5 V.

DMM Measurement Uncertainty

The HP 3458A DMM is used to measure the current output from the E1505A and E1518A SCPs and to measure the excitation voltage for the E1506A and E1507A Strain Gage SCPs. Table A-21 shows measurement uncertainty for the DCV and DCI ranges used for these SCPs. All accuracy readings are for PRESET;NPLC 100. In Table A-21:

DMM Accuracy = ppm of Reading + ppm of Range

Table A-21. HP 3458A DMM DCV/DCI Accuracy (90-day)

SCP	SCP Output	DMM Range	DMM Accuracy	Measurement Uncertainty
E1505A/E1518A	30.518 µA	100 µA	15 + 8	1.26E-3 µA
E1505A/E1518A	488.28 µA	1 mA	15 + 5	12.3E-3 µA
E1506A/E1507A	3.9 Vdc	10 Vdc	4.1 + 0.05	1.65E-5 Vdc

For example, for an E1505A SCP and the 30.518 µA range, DCI measurement uncertainty = $\pm [(15 \times 10^{-6} \times 30.518 \times 10^{-6)} + (8 \times 10^{-6} \times 100 \times 10^{-6})] = \pm 1.26 \times 10^{-9}$ A = $\pm 1.26 \times 10^{-3}$ µA. Or, for an E1506A SCP with 3.9000 Vdc excitation voltage, DCV measurement uncertainty = $\pm (4.1 \times 10^{-6} \times 3.9 + .05 \times 10^{-6} \times 10) = \pm 1.65 \times 10^{-5}$ Vdc.

Test Accuracy Ratio (TAR) Calculations

For the HP E1413C Scanning A/D, DCV Test Accuracy Ratio (TAR) is:

$$TAR = \frac{Maximum - Input}{MeasurementUncertainty}$$

where Maximum, Input, and Measurement Uncertainty are all in Vdc.

For example, for a 3.2 Vdc measurement (Input) to an E1501A SCP, Maximum value = 3.2008 Vdc and Datron 4708 Measurement Uncertainty = 1.1E-5 Vdc, so:

$$TAR = \frac{3.2008 - 3.2000}{1.1 \times 10^{-5}} = 73.1$$

Since this value is >10:1, the entry in Table 2-1 "*HP E1413C Performance Test Record* " is ">10:1".

Appendix B
Error Messages

This appendix contains both the Self Test Error Messages (Table B-1) and the general error messages (Table B-2). Self Test error messages are those errors that result from a failed Self Test. General error messages are those errors that result from programming errors, calibration errors, etc.

Self Test Error Messages

During the first five minutes after power is applied, *TST? may fail. Allow the module to warm up before executing *TST?. If the self test error code number is between 100 and 163, subtract 100 to find the failed channel. If the error number is between 200 and 204, subtract 200 to find the A/D range (0 to 4) that failed.

Table B-1. HP E1413C Self Test Error Messages

Self Test Error Code	Description
1	Digital Failure. Writes and reads patterns failed via A16.
2	Digital Failure. Writes and reads patterns failed via A16 and A24.
3	Digital Failure. Writes and reads patterns failed via A16 and A24.
4	Digital Failure. Writes data to FIFO and CVT through A24. Reads data from FIFO through A16, reads data from CVT through A24.
5	Digital Failure. DSP sends count to FIFO. Reads count from FIFO via A16.
6	Digital Failure. Checks operation of Measurement Complete status bit by toggling initiated line in scan status register.
7	Digital Failure. Checks operation of FIFO half and FIFO full IRQ generation. Note: This test will fail on models with serial number 100 and lower.
8	Digital Failure. Checks trigger operation by using trigger timer and trigger count.
9	Digital Failure. Checks operation of trigger sources.
10 - 19	Reserved for future use.
20	SCMs and MUX. An SCM had an ID of 0000h. Only first channel of SCP is listed next.
21	SCMs and MUX. Neither the HP E1313-66502 or the E1313-66505 PCA is connected. *TST? aborts after this failure. Check ribbon cable connections. Only tested on HP E1313A.
22	SCMs and MUX. The E1313-66502 PCA is not connected. The E1313-66503 PCA is connected but cannot run without the E1313-66502. *TST? aborts after this failure. Check ribbon cable connections. Only tested on HP E1313A.
23	MUX & A/D. Digital Readback of Shift Registers. U4506 and U4508 on E1313-66503 PCA failed. This is only tested on E1313A Option 001 (64 channel version).
24	MUX & A/D. Digital Readback of Shift Registers. U4500 and U4502 on E1313-66503 PCA failed. This is only tested on E1313A Option 001 (64 channel version).
25	MUX & A/D. Checks digital self test mux on E1313-66503 PCA. [E1313 Option 001 (64 ch. version) only]
26	MUX & A/D. Digital Readback of Hi-speed MUX control FA0 on E1313-66503. Checks A/D (U3535) and ROM (U3536) on E1313-66502. Checks 50 pin ribbon cable. [E1313 Option 001 (64 ch. version) only]

Table B-1. HP E1413C Self Test Error Messages

Self Test Error Code	Description
27	MUX & A/D. Digital Readback of Hi-speed MUX control FA1. Checks A/D (U3535), ROM (U3536) on E1313-66502. Checks 50 pin ribbon cable. [E1313 Option 001 (64 ch. version) only]
28	MUX & A/D. Digital Readback of Hi-speed MUX control FA2 & FA3. Checks A/D (U3535), ROM (U3536) on E1313-66502. Checks 50 pin ribbon cable. [E1313 Option 001 (64 ch. version) only]
29	MUX & A/D. Digital Readback of Hi-speed MUX control FA4 & FA5. Checks A/D (U3535), ROM (U3536) on E1313-66502. Checks 50 pin ribbon cable. [E1313 Option 001 (64 ch. version) only]
30	MUX & A/D. Digital Readback of shift registers U4501 and U4504.
31	MUX & A/D. Digital Readback of shift registers U4506 and U4508.
32	MUX & A/D. Digital Readback of shift registers U4600 and U4602.
33	MUX & A/D. Checks SAFEn Monostable (U4507).
34	MUX & A/D. Digital Readback of Hi-speed MUX control FA0. Checks A/D (U3535), ROM (U3536).
35	MUX & A/D. Digital Readback of Hi-speed MUX control FA1. Checks A/D (U3535), ROM (U3536).
36	MUX & A/D. Digital Readback of Hi-speed MUX control FA2 & FA3. Checks A/D (U3535), ROM (U3536).
37	MUX & A/D. Digital Readback of Hi-speed MUX control FA4 & FA5. Checks A/D (U3535), ROM (U3536).
38	Not Used on E1413 or E1313.
39	Not Used on E1413 or E1313.
40	A/D. Checks 4.5 Vref > 4.35V and SelfTestMux U3135. U3135 or U3128 may have large leakage current.
41	A/D. Puts 0.25 V from Cal_src R1 to SelfTestMux U3135. Should read between 0.2 and 0.3 V but reads between 2 to 2.5 V. Checks Ref. Divider RP3101.
42	A/D. Puts 0.25 V from Cal_src R1 to SelfTestMux U3135. Should read between 0.2 and 0.3 V but reads between -4.5 to 0.2, 0.3 to 2.0, or 2.5 to 4.5 V.
43	A/D. TST_RD at the input to the A/D SelfTestMux U3135 is not within ± 0.1 V with all Relay drives off.
44	A/D. CAL_SRC at the input to the A/D SelfTestMux U3135 is not within ± 0.1 V with the CAL SOURCE DAC centered on R1 or within ± .05 V with the CAL SOURCE DAC centered on R0.
45	A/D. OFS_ADJ at the input to the A/D SelfTestMux U3135 is not within ± 0.02 V with the FINE OFST ADJUST dac code = 0.
46	A/D. OFS_ADJ at the input to the A/D SelfTestMux U3135 is not within -4.5 ± 0.1 V with the FINE OFST ADJUST dac code = 3685.
47	A/D. Problems with the COARSE OFST ADJUST DAC U3331. With input amp shorted, it could not zero out the offset. It could not adjust the offset by the following percent of ranges (Ex: ± 24% of 1V for R2) R0: 79%, R1: 35%, R2: 24%, R3: 21%, R4: 20%.
48	A/D. With the input amp shorted and the COARSE OFST ADJUST DAC zeroed, could not zero out the offset and/or converge with the FINE OFST ADJUST DAC.
49	A/D. CHK ± 15V at the input to the A/D SelfTestMux U3135 is within -0.4 V to -3.2 V. Check ± 15V supplies ± 15 V ± 5%.
50	A/D. CAL_SRC R0 at the input to the A/D SelfTestMux U3135 is not within ± 0.35V ± 5% with ± 0.35V output from CAL_SRC.
51	A/D. CAL_SRC R1 at the input to the A/D SelfTestMux U3135 is not within ± 14V ± 5% with ± 14V output from CAL_SRC.

Table B-1. HP E1413C Self Test Error Messages

Self Test Error Code	Description
52	A/D. CAL_SRC R0 through the normal measurement path is not within ± 0.35V ± 5% with ± 0.35V output from CAL_SRC.
53	A/D. CAL_SRC R1 through the normal measurement path is not within ± 15V ± 5% with ± 15V output from CAL_SRC.
54	A/D. Rough check of the Gain Cal Dac. GCAL_OUT at the input to the A/D SelfTestMux U3135. The input amp input is at ± 85% of FS. The limit varies from 15% on R0 to 3% on R4.
55	A/D. Tight err check on Gain Cal Dac. Uses normal measurement path. With -90% of full scale input, sets gain dac to 0, 2048, & 4095. Checks change between mid and extremes is 3.9% to 4.4% on all ranges.
56	A/D. Checks A/D autoranges correctly. Applies input of ± 90% ± 7% of FS and checks range A/D took reading on. The reference voltages for the autorange circuitry are the ± 15V supplies. Verify the ± 15V supplies are ± 15.1V ± 5%
57	A/D. Checks reading returned by A/D autorange is correct. Applies input of ± 90% ± 7% of FS and checks reading returned is ± 10% of input.
58	A/D. Checks Isource OFF <= 10nA. With Isource on & I dac @ 2048, checks Isource 122.1 µA ± 1.5%.
59	A/D. Checks range of the I dac. Changes I dac from 2048 to 0 and 4095, checks Isource changes from 1.8% to 1.96%.
60	A/D. Checks front end & A/D noise with A/D filter ON. The limits are 1.7CTSms R0 and 1.2CTSms R1 to R4.
61	A/D. Checks front end & A/D noise with A/D filter OFF. The limits are 2.7CTSms R0 and 1.5CTSms R1 to R4.
62	A/D. Checks offset between A/D filter ON and OFF. The limits in CTS are R0: 2.5, R1: 1.5, R2 to R4: 1.
63	Not used on HP E1313 or E1413.
64	MUX. Zeroing of coarse and/or fine offset dacs failed before starting to test MUXs.
65	MUX. Could not verify Isource relay Open or Calbus positioned to SCMs with Isource.
66	MUX. Coil voltage on CAL_BUS relay is incorrect when positioning relay.
67	MUX. Could not reposition CAL_BUS relay contacts.
68	MUX. Coil voltage on Isource relay is incorrect when positioning relay.
69	MUX. Could not reposition Isource relay contacts.
70	MUX. Coil voltage on OHM relay is incorrect when positioning relay.
71	MUX. Checks timing of SAFEn MONOSTABLE U4507.
72	MUX. Could not reposition one or more channel relay contacts. Blows relays open with SAFEn and verifies one bank & I & CALBUS relays open. Also checks the continuity through the SCPs. Make sure SCPs are completely seated. Swap and/or move SCPs and see if channel failures follow the moved SCP. With Strain completion and I source cards, uses SCP sources and Rs.
73	MUX. Coil voltage on channel relay coils is incorrect when positioning bank relays. Although all 8 relays in a bank have the same voltage, only the first relay in bank is listed.
74	MUX. Open transducer detect for a channel does not work correctly. The A/D senses the current through the 7.5k Ohm resistor. Either the total offset voltage is too large with OTD on or the difference between OTD on and off is too small. The limits for this test change with SCP types. Swap and/or move SCPs and see if channel failures follow the moved SCP.
75	MUX. There was excessive current leakage. OTD is OFF. The A/D senses the current through the 7.5k Ohm. The limits for this test change with different SCP types. Swap and/or remove SCPs and see if the channel failures follow the moved SCP.
76	MUX. There was excessive voltage offset for a channel. OTD if OFF. The limits for this test change with different SCP types. Swap and/or remove SCPs and see if the channel failures follow the moved SCP.

Table B-1. HP E1413C Self Test Error Messages

Self Test Error Code	Description
77-79	Not used on HP E1313 or E1413.
80	MUX. The mid-scale Strain dac output is incorrect for a channel. Error only reported for 1st channel of SCP. Only tested on E1506A and E1507A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
81	MUX. The range of the Strain E dac is incorrect for a channel. Error only reported for the 1st channel of the SCP. Only tested on E1506A & E1507A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
82	MUX. The noise of the Strain E dac is high for a channel. Error only reported for 1st channel of SCP. Only tested on E1506A & E1507A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
83	MUX. With S_CAL? open, the R_leg resistance was incorrect for a channel. Different specs with dip switch open and shut. Tests only STRAIN channels 0, 2, 4, & 6 of SCP. Only tested on E1506A & E1507A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
84	MUX. When closing the S_CAL switch, the resistance change was incorrect. Different specs with dip switch open and shut. Tests only STRAIN channels 0, 2, 4, & 6 of SCP. Only tested on E1506A & E1507A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
85	Not used on HP E1313 or E1413.
86	MUX. Checks SCP Isource OFF <= 10 nA. Checks both SCP Isource ranges. Only tested on E1505A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
87	MUX. Checks SCP Isource dac mid-scale. Checks both SCP Isource ranges. Only tested on E1505A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
88	MUX. Checks SCP Isource dac range. Checks both SCP Isource ranges. Only tested on E1505A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
89	MUX. MUX(Analog): Checks SCP Isource compliance > 10V. Checks both SCP Isource ranges. Only tested on E1505A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
90	MUX. Checks Strain Gage SCP Wagner voltage control. Sets excitation voltage to 5 volts. Makes a measurement with the Wagner voltage off, then on. The difference between the two is checked for the expected change. Only tested on E1510A and E1511A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
91	MUX. Checks the range of operation of the autobalance DAC with the input shorted. The DAC is set to minimum, center, and maximum. The change in results is checked against expected changes. Only tested on E1510A and E1511A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
92	MUX. The sample/hold channels are checked to see that they indeed do hold a value even though the input is changed. The internal short is sampled and held, then OTD is turned on changing the input. The results are checked to see that they are not affected by the input change over a long period. Only tested on E1510A and E1511A. Swap and/or move SCPs and see if channel failure follows the moved SCP.
93	MUX. The sample/hold channels are checked to see that the droop of the held value is within tolerance. The cal source set at 4V is sampled and held. Measurements are checked over a long period to verify that droop is within tolerance. Only tested on E1510A and E1511A. Swap and/or move SCPs and see if channel failure follows the moved SCP.

Table B-2. HP E1413C Error Messages

Code	Description	Comments
-108	Parameter not allowed.	
-160	Block data error.	
-211	Trigger ignored.	
-212	Arm ignored.	
-213	INIT ignored.	
-221	Settings conflict.	
-222	Data out of range.	
-224	Illegal parameter value.	
-240	Hardware error. Execute *TST?.	
-253	Corrupt media.	
-281	Cannot create program.	
-282	Illegal program name.	
-310	System error.	
-410	Query INTERRUPTED.	
2001	Invalid channel number.	
2003	Invalid word address.	
2007	Bus error.	
2008	Scan list not initialized.	
2009	Too many channels in channel list.	
2016	Byte count is not a multiple of two.	
3000	Illegal while initiated.	
3001	Illegal while continuous.	
3004	Illegal command. CAL:CONF not sent.	Incorrect sequence of calibration commands. Send CAL:CONF command before CAL:VAL command.
3005	Illegal command. Send CAL:VAL:RES.	The only command accepted after a CAL:CONF: RES is a CAL:VAL:RES command.
3006	Illegal command. Send CAL:VAL:VOLT.	The only command accepted after a CAL:CONF:VOLT is a CAL:VAL:VOLT command.
3007	Invalid signal conditioning module.	The command sent to an SCP was illegal for its type.
3008	Too few channels in scan list.	A Scan List must have at least two channels.
3012	Trigger too fast.	Scan List not completed before another trigger event occurs.
3015	Channel modifier not permitted here.	
3019	TRIG:TIM interval too small for SAMP:TIM interval and scan list size.	TRIG:TIM interval must allow for completion of entire scan list at currently set SAMP:TIM interval.

Table B-2. HP E1413C Error Messages

Code	Description	Comments
3020	Input overvoltage.	Calibration relays opened (if JM2202 not cut) to protect module inputs, and Questionable Data Status bit 11 set. Execute *RST to close relays and/or reset status bit.
3021	FIFO overflow.	
3026	Calibration failed.	
3027	Unable to map A24 VXI memory.	
3028	Incorrect range value.	Range value sent is not supported by instrument.
3030	Command not yet implemented.	
3032	0x1: DSP-Unrecognized command code.	
3033	0x2: DSP-Parameter out of range.	
3034	0x4: DSP-Flash ROM erase failure.	
3035	0x8: DSP-Programming voltage not present.	
3036	0x10: DSP-Invalid SCP gain value.	Check that SCP is seated or replace SCP. Channel numbers are in FIFO.
3037	0x20: DSP-Invalid *CAL? constant or checksum. *CAL? required.	
3038	0x40: DSP- Could not cal some channels.	Check that SCP is seated or replace SCP. Channel numbers are in FIFO.
3039	0x80: DSP-Re-Zero of ADC failed.	
3040	0x100: DSP-Invalid Tare CAL constant or checksum.	Perform CAL:TARE - CAL:TARE? procedure.
3041	0x200: DSP-Invalid Factory CAL constant or checksum.	Perform A/D Cal procedure.
3042	0x400: DSP-DAC adjustment went to limit.	Execute *TST?
3043	0x800: DSP Status--Do *CAL?	
3044	0x1000: DSP-Overvoltage on input.	
3045	0x2000: DSP-reserved error condition.	
3046	0x4000: DSP-ADC hardware failure.	
3047	0x8000: DSP-reserved error condition.	
3048	Calibration or Test in Process.	
3049	Calibration not in Process.	
3050	ZERO must be sent before FSCale.	Perform A/D Cal sequence as shown in CAL:CONF:VOLT
3051	Memory size must be multiple of 4.	From MEM:VME:SIZE. Each HP E1413 reading requires 4 bytes.

Table B-2. HP E1413C Error Messages

Code	Description	Comments
3052	Self test failed. Test info in FIFO.	A value of 1 through 99 is a failed test number. A value of 100 through 163 is a channel number for the failed test. A value of 200 through 204 is an A/D range number for the failed test where 200 =.0625V, 201 =.25V, 202 = 1V, 203 = 4V, and 204 = 16V range. For example, if DATA:FIFO? returns the values 72 and 108, this indicates that test number 72 failed on channel 8. Test numbers 20, 30-37, 72, 74-76 may indicate a problem with a Signal Conditioning Plug-on. For tests 20 and 30-37, remove all SCPs and see if *TST? passes. If so, replace SCPs one at a time until you find the one causing the problem. For tests 72, and 74-76, try to re-seat the SCP that the channel number(s) points to, or move the SCP and see if the failure(s) follow the SCP. If the problems move with the SCP, replace the SCP. Refer to the *TST? command for a list of module functions tested. NOTE During the first 5 minutes after power is applied, *TST? may fail. Allow the module to warm up before executing *TST?.
3053	Corrupt on board Flash memory.	
3056	Custom EU not loaded.	May have erased custom EU conversion table with *RST. May have linked channel with standard EU after loading custom EU, this erases the custom EU for this channel. Reload custom EU table using DIAG:CUST:LIN or DIAG:CUST:PIEC.

Appendix C
Command Reference

Introduction

This appendix describes the Standard Commands for Programmable Instruments (SCPI) CALibration commands and IEEE-488.2 Common Commands for the HP E1413C. Commands are listed alphabetically within each subsystem. See *Chapter 5 - Command Reference* in the *HP E1413C User's Manual* for command fundamentals.

CALibration Commands

The CALibration subsystem commands provide two major categories of calibration: A/D Calibration and Working Calibration.

A/D Calibration

For this procedure, an external multimeter is used to determine the actual voltage and resistance values of the Scanning A/D's internal calibration sources. The known values are then sent to the Scanning A/D where they are stored and used to perform internal A/D calibration.

A/D calibration requires a series of CALibration commands (**CAL:CONF..., CAL:VAL..., and CAL:STORE ADC**). See *Chapter 3 - Adjustments* for the procedure. Always execute ***CAL? or a CAL:TARE** operation after A/D calibration.

Working Calibration

As shown in Figure C-1, there are three levels of "working calibration": A/D Zero, Channel Calibration, and Channel Tare.

A/D Zero (CAL:ZERO?): This function quickly compensates for any short term A/D converter offset drift (the autozero function in a conventional voltmeter).

Channel Calibration (*CAL? or CAL:SETup): This function corrects for offset and gain errors, thermal offsets, and component drift for each channel out to the input side of the SCP.

Channel Tare (CAL:TARE): This function corrects for voltage offsets in external (user) system wiring. The user places a short across the transducer wiring and the voltage that the Scanning A/D measures is now considered the new "zero" value for that channel. The new offset can be stored in non-volatile calibration memory (with **CAL:STOR TARE**) but is in effect whether stored or not. **CAL:TARE** automatically executes a ***CAL?**

command.

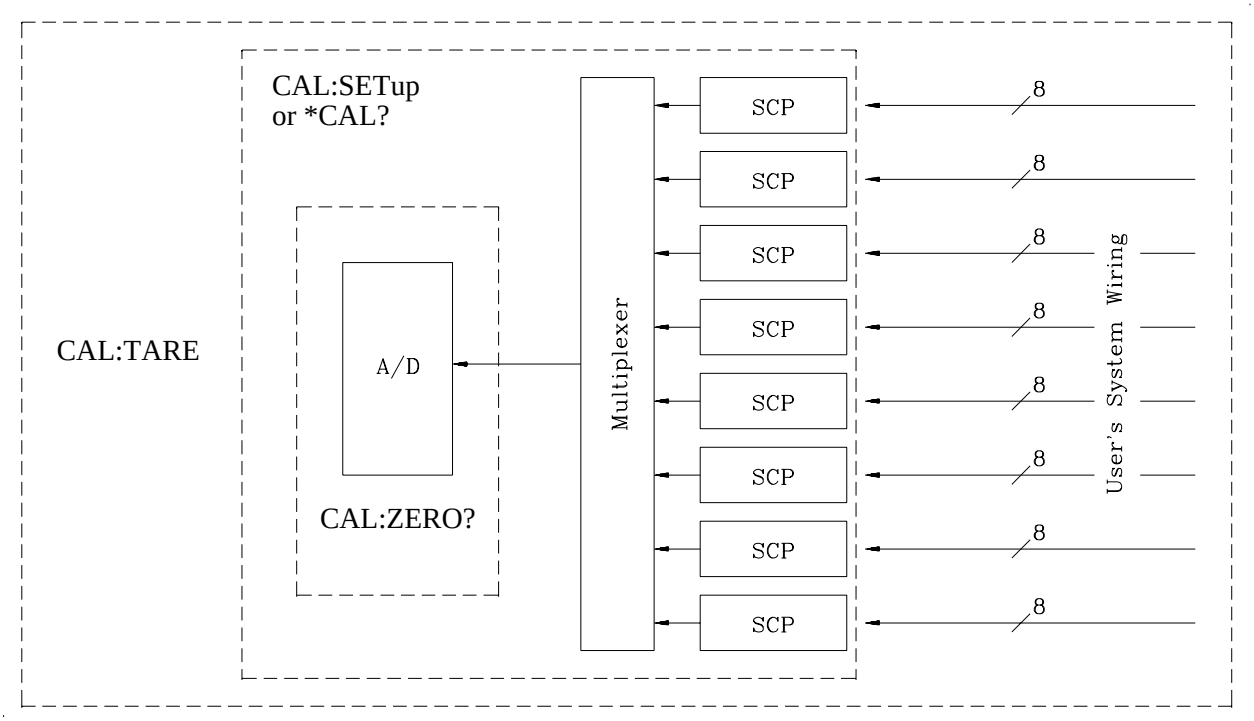


Figure C-1. HP E1413A/B Working Calibration Levels

CALibration Command Syntax

```
CALibration
    :CONFigure
        :RESistance
        :VOLTage <range>, ZERO | FS
    :SETup
    :SETup?
    :STORe ADC | TARE
    :TARE (@<ch_list>)
        :RESet
    :TARE?
    :VALue
        :RESistance <ref_ohms>
        :VOLTage <ref_volts>
    :ZERO?
```

CALibration: CONFigure: RESistance

CALibration:CONFigure:RESistance connects the on-board reference resistor to the Calibration Bus. A four-wire measurement of the resistor can be made with an external multimeter connected to the **HCAL, LCAL, HOHM,** and **LOHM** terminals on the terminal module or to the **VH, VL, Ω H,** and **Ω L** terminals on the Cal Bus connector.

Comments

- **Related Commands:** CAL:VAL:RES, CAL:STOR ADC

Command Sequence

```
CAL:CONF:RES                          connect reference resistor to
                                      Calibration Bus
*OPC? or SYST:ERR?                    must wait for CAL:CONF:RES
                                      to complete
(now measure ref resistor with external DMM)
CAL:VAL:RES <measured value>          Send measured value to module
CAL:STORE ADC                         Store cal constants in
                                      non-volatile memory (used only
                                      at end of complete cal sequence)
```

CALibration: CONFigure: VOLTage

CALibration:CONFigure:VOLTage <range>,<zero_fs> connects the on-board voltage reference to the Calibration Bus. A measurement of the source voltage can be made with an external multimeter connected to the **HCAL** and **LCAL** terminals on the terminal module or to the **VH** and **VL** terminals on the Cal Bus connector. The *range* parameter controls the voltage level available when the *zero_fs* parameter is FSCale (full scale).

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
range	numeric (float32)	see comments	volts
zero_fs	discrete (string)	ZERO | FSCale	none

Comments

- The *range* parameter must be within 5% of one of the 5 following values: .0625VDC, .25VDC, 1VDC, 4VDC, 16VDC. Range may be specified in millivolts (mV).
- The FSCALE output voltage of the calibration source should be greater than 90% of the nominal value for each range, except the 16V range where the output is 10V.
- **Related Commands:** CAL:VAL:VOLT, CAL:STOR ADC

Usage

```
CAL:CONF:VOLT .25, ZERO               Voltage reference set to .25V
                                      range and zero output
CAL:CONF:VOLT .25, FSCALE             Set same range but full-scale
                                      output
```

Command Sequence

```
CAL:CONF:VOLTAGE .0625, ZERO          connect voltage reference to
                                      Calibration Bus
*OPC? or SYST:ERR?                    Wait for CAL:CONF: VOLT to
                                      complete
(now measure voltage with external DMM)
CAL:VAL:VOLT <measured value>         Send measured value to module
repeat above sequence for full-scale
repeat zero and full-scale for remaining ranges (.25, 1, 4, 16)
CAL:STORE ADC                         Store cal constants in
```

non-volatile memory (used only at end of cal seq)

CALibration:SETup

CALibration:SETup causes the Channel Calibration function to be performed for every module channel. The Channel Calibration function calibrates the A/D Offset and the Gain/Offset for all 64 channels. This calibration is accomplished using internal calibration references. Since this is time-consuming, you may want to run many at once rather than one at a time.

CAL:SET performs the same operation as the *CAL? command except that since it is not a query command it does not tie up the C-SCPI driver waiting for response data from the instrument. If you have multiple HP E1413s in your system, you can start a CAL:SET operation on each and then execute a CAL:SET? command to complete the operation on each instrument.

- **Related Commands:** CAL:SETup?, *CAL?

Usage

CAL:SET	*start SCP Calibration on 1st HP E1413*
:	*start SCP Calibration on more HP E1413s*
CAL:SET	*start SCP Calibration on last HP E1413*
CAL:SET?	*query for results from 1st HP E1413*
:	*query for results from more HP E1413s*
CAL:SET?	*query for results from last HP E1413*

CALibration:SETup?

CALibration:SETup? returns a value to indicate the success of the last CAL:SETup or *CAL? operation. CAL:SETup? returns the value only after the CAL:SETup operation is complete.

Comments

- **Returned Value:**

Value	Meaning	Further Action
0	Cal OK	None
-1	Cal Error	Query the Error Queue (SYST:ERR?) See Appendix B. Also run *TST?
-2	No results available	No *CAL? or CAL:SETUP done

The C-SCPI type for this returned value is **int16**.

- **Related Commands:** CAL:SETup, *CAL?

Usage

see CAL:SETup

CALibration:STORe

CALibration:STORe <type> stores the most recently measured calibration constants into Flash Memory (Electrically Erasable Programmable Read Only Memory). When *type* = ADC, the module sets its Analog-to-Digital Converter calibration using the most recently measured CAL:VALues for voltage and resistance, and stores these to Flash Memory. When *type* = TARE, the module stores the most recently measured CAL:TARE channel offsets into Flash Memory.

Note

The HP E1413's Flash Memory has a finite lifetime of approximately ten thousand write cycles (unlimited read cycles). While executing CAL:STOR once every day would not exceed the lifetime of the Flash Memory for approximately 27 years, an application that stored constants many times each day would unnecessarily shorten the Flash Memory's lifetime. See Comments below.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
type	discrete (string)	ADC|TARE	none

Comments

- The Flash Memory Enable jumper (JM 2201) must be set to the enable position before executing this command (See *Chapter 3 - Adjustments*).
- Channel offsets are compensated by the CAL:TARE command even when not stored in the Flash Memory. There is no need to use the CAL:STORE TARE command for channels which are re-calibrated frequently.
- **Related Commands:** CAL:VAL:RES, CAL:VAL:VOLT
- ***RST Condition:** Stored calibration constants are unchanged.

Usage

```
CAL:STORE ADC          Store cal constants in non-volatile memory after A/D calibration
CAL:STORE TARE         Store channel offsets in non-volatile memory after channel tare
```

Command Sequence

Storing A/D cal constants

```
perform complete A/D calibration, then...
CAL:STORE ADC
```

Storing channel tare (offset) values

CAL:TARE <*ch_list*>	*to correct channel offsets*
CAL:STORE TARE	*Optional - depends on long term storage req*

CALibration:TARE

CALibration:TARE (@<ch_list>) measures the voltage present on the channels specified and stores the value in on-board RAM as a calibration constant for those channels. Future measurements made with the channels will be compensated by the amount of the tare value.

Use CAL:TARE to compensate for voltage offsets in transducer wiring. Where tare values need to be retained for long periods, they can be stored in the module's Flash Memory (Electrically Erasable Programmable Read Only Memory) by executing the CAL:STORe TARE command.

Note The HP E1413's Flash Memory has a finite lifetime of approximately ten thousand write cycles (unlimited read cycles). While executing CAL:STOR once every day would not exceed the lifetime of the Flash Memory for approximately 27 years, an application that stored constants many times each day would unnecessarily shorten the Flash Memory's lifetime.

Note If Open Transducer Detect (OTD) is enabled when CAL:TARE is executed, the module will disable OTD, wait 1 minute to allow channels to settle, perform the calibration, and then re-enable OTD. If your program turns off OTD before executing CAL:TARE, it should also wait 1 minute for settling.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
ch_list	channel list (string)	100 - 163	none

Comments

- Channel offsets are compensated by the CAL:TARE command even when not stored in the Flash Memory. There is no need to use the CAL:STORE TARE command for channels which are re-calibrated frequently.
- Set Amplifier/Filter SCP gain before CAL:TARE. For best accuracy, choose the gain that will be used during measurements.
- Executing CAL:TARE sets the Calibrating bit (bit 0) in Operation Status Group. Executing CAL:TARE? resets the bit.

- **Related Commands:** CAL:TARE?, CAL:STOR TARE

- ***RST Condition:** Channel offsets are not affected by *RST.

Command Sequence

```
CAL:TARE <ch_list>          to correct channel offsets
CAL:TARE?                   to return the success flag from
                            the CAL:TARE operation
CAL:STORE TARE              Optional - depends on long
                            term storage req
```

CALibration: TARE:RESet

CALibration:TARE:RESet resets the tare calibration constants to zero for all 64 channels. Executing CAL:TARE:RES affects the tare cal constants in RAM only. To reset the tare cal constants in Flash Memory, execute CAL:TARE:RES and then execute CAL:STORE TARE.

Command Sequence

```
CAL:TARE:RESET              to reset channel offsets
CAL:STORE TARE              Optional if necessary to reset
                            tare cal constants in Flash
                            Memory.
```

CALibration:TARE?

CALibration:TARE? Returns a value to indicate the success of the last CAL:TARE operation. CAL:TARE? returns the value only after the CAL:TARE operation is complete.

- **Returned Value:**

Value	Meaning	Further Action
0	Cal OK	None
-1	Cal Error	Query the Error Queue (SYST:ERR?) See Error Messages in *Appendix B - Error Messages*. Also run *TST?
-2	No results available	No CAL:TARE done

The C-SCPI type for this returned value is **int16**.

- Executing CAL:TARE sets the Calibrating bit (bit 0) in Operation Status Group. Executing CAL:TARE? resets the bit.

- **Related Commands:** CAL:STOR TARE

Command Sequence

```
CAL:TARE <ch_list>          to correct channel offsets
CAL:TARE?                   to return the success flag from
                            the CAL:TARE operation
CAL:STORE TARE              Optional depending on necessity
                            of long term storage
```

CALibration: VALue:RESistance

CALibration:VALue:RESistance <ref_ohms> sends the value of the on-board reference resistor to the module for A/D calibration.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
ref_ohms	numeric (float 32)	5%	ohms

Comments

- *ref_ohms* must be within 5% of the nominal resistor value and may be specified in Kohm.
- A four-wire measurement of the resistor can be made with an external multimeter connected to the **HCAL, LCAL, HOHM,** and **LOHM** terminals on the terminal module or to the **VH, VL,Ω H,** and **Ω L** terminals on the Cal Bus connector.
- Use the CAL:CONF:RES command to configure the reference resistor for measurement at the Calibration Bus connector.
- **Related Commands:** CAL:CONF:RES, CAL:STORE ADC

Usage

CAL:VALUE:RESISTANCE <measured value>

Command Sequence

CAL:CONF:RES
(*now measure ref resistor with external DMM*)
CAL:VAL:RES <measured value> *Send measured value to module*

CALibration: VALue:VOLTage

CALibration:VALue:VOLTage <ref_volts> sends the value of the DC reference source to the module for A/D calibration.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
ref_volts	numeric (float 32)	must be withing 10% of range nominal	volts

Comments

- *ref_volts* may be specified in millivolts (mV).
- A measurement of the source voltage can be made with an external multimeter connected to the **HCAL** and **LCAL** terminals on the

terminal module or to the **VH** and **VL** terminals on the Cal Bus connector.

- Use the CAL:CONF:VOLT command to configure the on-board voltage source for measurement at the Calibration Bus connector.
- The value sent must be for the currently configured range and output (zero or full scale) as set by the previous CAL:CONF:VOLT <*range*>, ZERO | FSCale command.
- **Related Commands:** CAL:CONF:VOLT, CAL:STORE ADC

Usage

CAL:VALUE:VOLTAGE <measured value>

Command Sequence

```
CAL:CONF:VOLTAGE 4,FSCALE
*OPC?                                   Wait for operation to complete
ENTER statement
(now measure voltage with external DMM)
CAL:VAL:VOLT <measured value>           Send measured value to module
```

CALibration:ZERO?

CALibration:ZERO? corrects Analog to Digital converter offset for any drift since the last *CAL? or CAL:ZERO? command was executed.

Comments

- The CAL:ZERO? command only corrects for A/D offset drift (zero). Use the *CAL? common command to perform on-line calibration of channels as well as A/D offset. *CAL? performs gain and offset correction of the A/D and each channel out to the field wiring connector.
- **Returned Value:**

Value	Meaning	Further Action
0	Cal OK	None
-1	Cal Error	Query the Error Queue (SYST:ERR?) See Error Messages in *Appendix B - Error Messages*

The C-SCPI type for this returned value is **int16**.

- Executing this command **does not** alter the module's programmed state (function, range, etc.).
- **Related Commands:** *CAL?

- ***RST Condition:** A/D offset performed

Usage

```
CAL:ZERO?
enter statement here                    returns 0 or -1
```

Common Commands

This section describes IEEE-488.2 Common commands. See *Chapter 5 - HP E1413 Command Reference* in the *HP E1413C User's Manual* for Common Command fundamentals.

*CAL?

Calibration Command. The calibration command causes the Channel Calibration function to be performed for every module channel. The Channel Calibration function includes calibration of A/D Offset, and Gain and Offset for all 64 channels. This calibration is accomplished using internal calibration references.

- **Returned Value:**

Value	Meaning	Further Action
0	Cal OK	None
-1	Cal Error	Query the Error Queue (SYST?ERR?). See Error Messages in A*ppendix B - Error Messages*

The C-SCPI type for this returned value is **int16**.

- **Related Commands:** CALibration:SETup, CALibration:SETup?

- Executing this command **does not** alter the module's programmed state (function, range etc.).

Note If Open Transducer Detect (OTD) is enabled when *CAL? is executed, the module will disable OTD, wait 1 minute to allow channels to settle, perform the calibration, and then re-enable OTD. If your program turns off OTD before executing *CAL?, it should also wait 1 minute for settling.

*CLS

Clear Status Command. The *CLS command clears all status event registers (Standard Event Status Event Register, Standard Operation Status Event Register, Questionable Data Event Register) and the instrument's error queue. This clears the corresponding summary bits (bits 3, 5, & 7) in the Status Byte Register.

*CLS does not affect the enable bits in any of the status register groups. (The SCPI command STATus:PRESet *does* clear the Operation Status Enable and Questionable Data Enable registers.) *CLS disables the Operation Complete function (*OPC command) and the Operation Complete Query function (*OPC? command).

*ESE <mask>

Standard Event Status Enable Register Command. Enables one or more events in the Standard Event Status Register to be reported in bit 5 (the Standard Event Status Summary Bit) of the Status Byte Register. You enable an event by specifying its decimal weight for <*mask*>. To enable more than one event (bit), specify the sum of the decimal weights. The C-SCPI type for <*mask*> is **int16**.

Bit #	7	6	5	4	3	2	1	0
Weighted Value	128	64	32	16	8	4	2	1
Event	Power-On	User Request	Command Error	Execution Error	Device Dependent Error	Query Error	Request Control	Operation Complete

*ESE?

Standard Event Status Enable Query. Returns the weighted sum of all enabled (unmasked) bits in the Standard Event Status Register. The C-SCPI type for this returned value is **int16**.

*ESR?

Standard Event Status Register Query. Returns the weighted sum of all set bits in the Standard Event Status Register. After reading the register, *ESR? clears the register. The events recorded in the Standard Event Status Register are independent of whether or not those events are enabled with the *ESE command to set the Standard Event Summary Bit in the Status Byte Register. The Standard Event bits are described in the *ESE command. The C-SCPI type for this returned value is **int16**.

*IDN?

Identity. Returns the device identity. The response consists of the following four fields (fields are separated by commas):

- Manufacturer
- Model Number
- Serial Number (returns 0 if not available)
- Firmware Revision (returns 0 if not available)

The *IDN? command returns the following command string for the HP E1413:

HEWLETT-PACKARD,E1413,<*serial number*>,<*revision number*>
The C-SCPI type for this returned value is **string**.

Note The revision will vary with the revision of the firmware installed in the instrument. This is the only indication of which version of the firmware is installed.

*OPC

Operation Complete. Causes an instrument to set bit 0 (Operation Complete Message) in the Standard Event Status Register when all pending operations have been completed. By enabling this bit to be reflected in the Status Byte Register (*ESE 1 command), you can ensure synchronization between the instrument and an external computer or between multiple instruments.

Note Do not use *OPC to determine when the CAL:SETUP or CAL:TARE commands have completed. Instead, use their query forms CAL:SETUP? or CAL:TARE?

*OPC?

Operation Complete Query. Causes an instrument to place a 1 into the instrument's output queue when all pending instrument operations are finished. By requiring your computer to read this response before continuing program execution, you can ensure synchronization between one or more instruments and the computer. The C-SCPI type for this returned value is **int16**.

Note Do not use *OPC? to determine when the CAL:SETUP or CAL:TARE commands have completed. Instead, use their query forms CAL:SETUP? or CAL:TARE?

*RST

Reset Command. Resets the HP E1413 as follows:

- Sets all four scan lists to their default states:
  -- Scan List 1 = ROUT:SEQ:DEF (@100:163)
  -- Scan List 2 through 4 are zero length *(undefined)*
  -- SENSE:FUNC:VOLT AUTO,(@100:163)
  (all channels DCV, autorange)

- Sets the trigger system as follows:
  -- TRIGGER:SOURCE HOLD
  -- TRIGGER:TIMER 1E-4
  -- TRIGGER:COUNT 1
  -- ARM:SOURCE IMMEDIATE

- SAMPLE:TIMER 10E-6
- Aborts all pending operations, returns to Trigger Idle state
- Disables the *OPC and *OPC? modes
- MEMORY:VME:ADDRESS 240000;
  MEMORY:VME:STATE OFF; MEMORY:VME:SIZE 0

*RST does not affect:

- Calibration data
- The output queue

- The Service Request Enable (SRE) register
- The Event Status Enable (ESE) register

*SRE <mask>

Service Request Enable. When a service request event occurs, it sets a corresponding bit in the Status Byte Register (this happens whether or not the event has been enabled (unmasked) by *SRE). The *SRE command allows you to identify which of these events will assert an HP-IB service request (SRQ).

When an event is enabled by *SRE and that event occurs, it sets a bit in the Status Byte Register and issues an SRQ to the computer (sets the HP-IB SRQ line true). You enable an event by specifying its decimal weight for <*mask*>. To enable more than one event, specify the sum of the decimal weights. The C-SCPI type for <*mask*> is **int16**.

Bit #	7	6	5	4	3	2	1	0
Weighted Value	128	64	32	16	8	4	2	1
Event	Operation Status	Request Service	Standard Event	Message Available	Questionable Status	not used	not used	not used

*SRE?

Status Register Enable Query. Returns the weighted sum of all enabled (unmasked) events (those enabled to assert SRQ) in the Status Byte Register. The C-SCPI type for this returned value is **int16**.

*STB?

Status Byte Register Query. Returns the weighted sum of all set bits in the Status Byte Register. Refer to the *ESE command earlier in this chapter for a table showing the contents of the Status Byte Register. *STB? does not clear bit 6 (Service Request). The Message Available bit (bit 4) may be cleared as a result of reading the response to *STB?. The C-SCPI type for this returned value is **int16**.

*TRG

Trigger. Triggers an instrument when the trigger source is set to bus (TRIG:SOUR BUS command) and the instrument is in the Wait for Trigger state.

*TST?

Self-Test. Causes an instrument to execute extensive internal self-tests and returns a response showing the results of the self-test.

Note During the first 5 minutes after power is applied, *TST? may fail. Allow the module to warm-up before executing *TST?

Comments

- **Returned Value:**

The C-SCPI type for this returned value is **int16**.

- Following *TST?, the module is placed in the *RST state.
- *TST? performs the following tests on the HP E1413 and installed Signal Conditioning Plug-ons (SCPs):

DIGITAL TESTS:

Test# Description

1-3: Writes and reads patterns to registers via A16 & A24
4-5: Checks FIFO and CVT
6: Checks measurement complete (Measuring) status bit
7: Checks operation of FIFO half and FIFO full IRQ generation
8-9: Checks trigger operation

ANALOG FRONT END DIGITAL TESTS:

Test# Description

20: Checks that SCP ID makes sense
30-32: Checks relay driver and fet mux interface with EU CPU
33,71: Checks opening of all relays on power down or input overvoltage
34-37: Check fet mux interface with A/D digital

ANALOG TESTS:

Test# Description

40-42: Checks internal voltage reference
43-44: Checks zero of A/D, internal cal source and relay drives
45-46: Checks fine offset calibration DAC
47-48: Checks coarse offset calibration DAC
49: Checks internal + and -15V supplies
50-53: Checks internal calibration source
54-55: Checks gain calibration DAC
56-57: Checks that autorange works
58-58: Checks internal current source
60-63: Checks front end and A/D noise and A/D filter
64: Checks zeroing of coarse and fine offset calibration DACs
65-70: Checks current source and CAL BUS relay and relay drives and OHM relay drive
71: See 33
72-73: Checks continuity through SCPs, bank relays and relay drivers
74: Checks open transducer detect
75: Checks current leakage of the SCPs
76: Checks voltage offset of the SCPs

***WAI** **Wait-to-Continue**. Prevents an instrument from executing another command until the operation begun by the previous command is finished (sequential operation).

Note Do not use *WAI to determine when the CAL:SETUP or CAL:TARE commands have completed. Instead, use their query forms CAL:SETUP? or CAL:TARE?. CAL:SETUP? and CAL:TARE? return a value only after the CAL:SETUP or CAL:TARE operations are complete.

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