Contents

HP E1429A/B 2-Channel Digitizer Service Manual

Edition 1

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What's in this Manual

Manual Overview

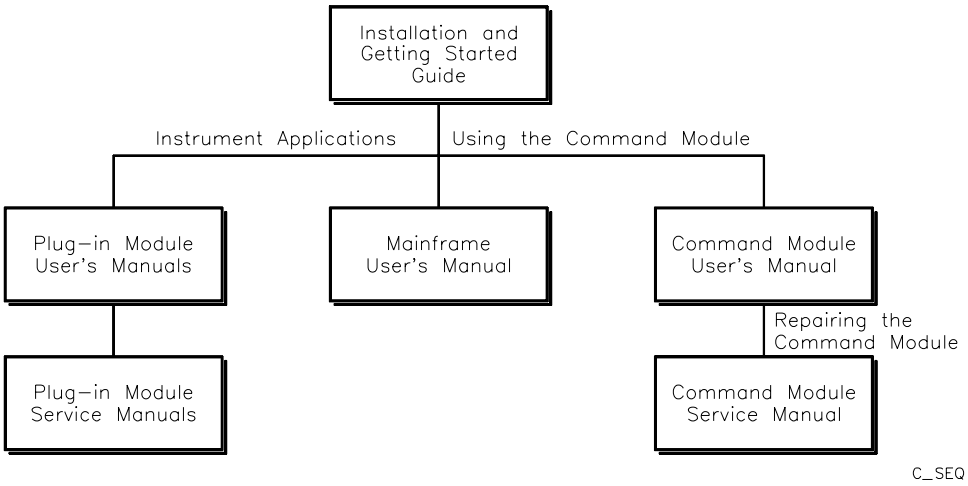
This manual shows how to service the HP E1429A/B 20 MSa/s Digitizers. See the *HP E1429A/B User's Manual* for additional information on installing, configuring, and operating the instrument. Consult the appropriate mainframe manual for information on configuring and operating the mainframe.

Manual Content

Chap	Title	Content
1	General Information	Lists basic instrument descriptions, tools and test equipment required for service, and procedures to inspect and ship the instruments.
2	Setting Calibration Values	Shows how to read/enter calibration constants and protected user data, and how to enter a new calibration security code.
3	Verification Tests	Describes self-tests and functional verification tests for the instruments.
4	Adjustments	Shows how to perform adjustments for the instruments.
5	Replaceable Parts	Lists part numbers of replaceable parts for the instruments. Also includes information to order spare parts and to exchange/replace instruments.
6	Service	Procedures to aid in fault isolation and repair of the instruments.
A	CALibration Commands	Summarizes the CALibration subsystem commands for the instruments.
B	Calculating Digitizer Accuracy	Shows how to calculate digitizer accuracy, source measurement uncertainty, and test accuracy ratio (TAR) for the digitizers.
C	Error Messages	Lists error messages associated with performance verification tests and adjustments.

HP 75000 Series C Service Documentation

Suggested Sequence to Use Manuals



Manual Descriptions

Title	Description
Series C Installation and Getting Started Guide	Step-by-step instructions for all aspects of plug-in module, mainframe, and command module installation. Also contains programming information and examples.
Mainframe User's Manual	Information to prepare the mainframe and to install plug-in modules.
Command Module User's Manual	Programming information for the command module and general programming information for instruments installed in the mainframe.
Command Module Service Manual	Command module service information. Includes information and procedures for functional verification, operation verification, performance verification, troubleshooting, and repair.
Plug-In Module User's Manuals	Plug-in module programming and configuration information. Contains programming examples and SCPI command reference for the module.
Plug-In Module Service Manuals	Plug-in module service information. Depending on the module, includes information and procedures for functional verification, operation verification, performance verification, adjustment, troubleshooting, and repair.

Manual Comment Sheet

HP E1429A/B 2-Channel 20 MSa/s Digitizers Service Manual
Manual Part Number E1429-90010
Edition 1 (September 1993)

You can help us improve our manuals by sharing your comments and suggestions. Please complete this questionnaire after becoming familiar with the manual and then return it to us. **In appreciation of your time, we will enter your name in a quarterly drawing for a Hewlett-Packard calculator.**

Please describe the system configuration, programming language, and plug-in modules you are using with this product.

_____
_____
_____
_____
_____
_____
_____

Please pencil-in one circle for each statement below as it applies to this documentation:

	Disagree				**Agree**
☐ The manual is well organized	O	O	O	O	O
☐ Instructions are easy to understand	O	O	O	O	O
☐ The manual is clearly written	O	O	O	O	O
☐ Examples are clear and useful	O	O	O	O	O
☐ Manual contains enough examples	O	O	O	O	O
☐ Illustrations are clear and helpful	O	O	O	O	O
☐ Manual meets my expectations	O	O	O	O	O

Please write any comments and/or suggestions in the space provided below. Use additional pages if you wish. The more specific your comments, the more useful they are to us.

_____
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_____
_____

Your Name: _____ **Company:** _____

Address: _____ **Job Title:** _____

City/State: _____ **Telephone:** _____

Zip/Postal Code: _____ **Country:** _____

Chapter 1
General Information

Introduction

This service manual contains information to test, troubleshoot, and repair the HP E1429A/B 2-Channel 20 MSa/s Digitizers (digitizers). The HP E1429A/B digitizers are identical, except that the HP E1429B adds a Local Bus capability not available in the HP E1429A. Figure 1-1 shows a typical HP E1429A/B digitizer.

NOTE

See "Inspection/Shipping" if you need to perform incoming (initial) inspection of your digitizer. Before you use the digitizer, see Chapter 2 - Setting Calibration Values for guidelines to record initial calibration data values.

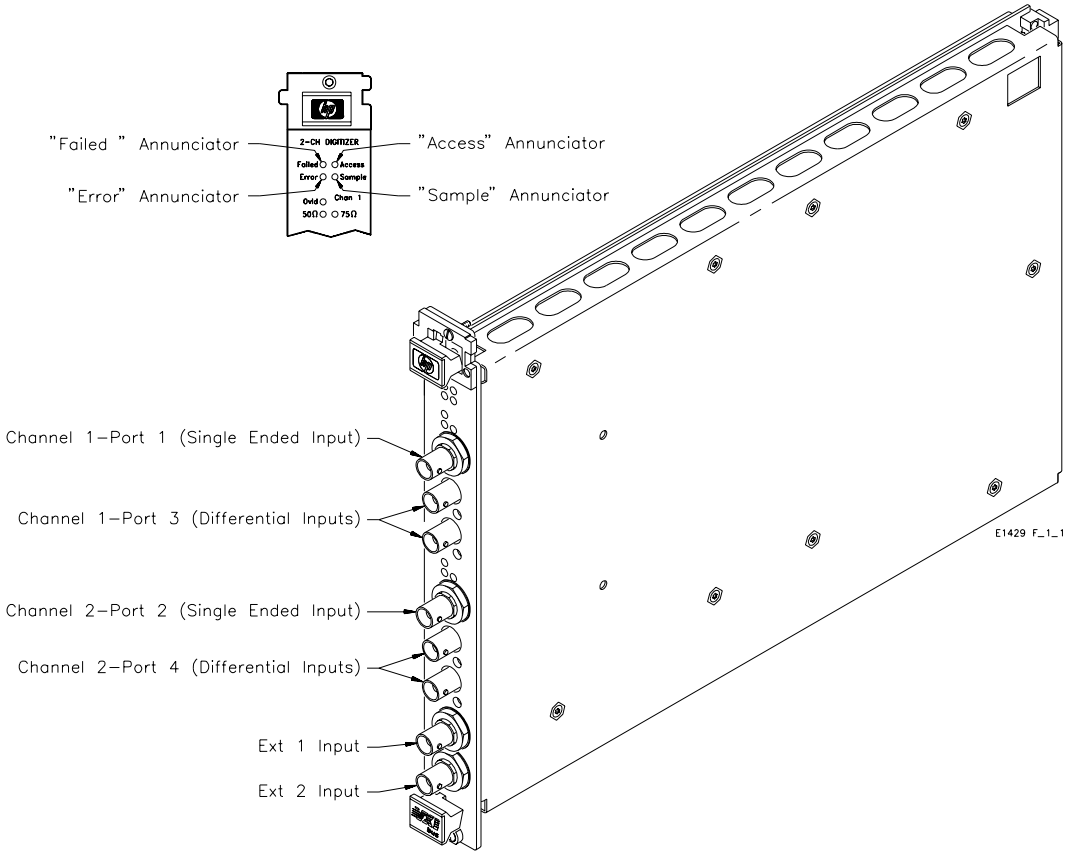

Figure 1-1. HP E1429A/B Digitizers

Safety Information

The HP E1429A/B digitizers are Safety Class I instruments that are 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 digitizer.

See the WARNINGS page (page iii) for a summary of safety information. Safety information to test and service the HP E1429A/B digitizers 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 digitizer.

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 fuseholders.

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 (terminal to terminal and terminal to chassis) is ± 42 V peak.

STATIC ELECTRICITY. Static electricity is a major cause of component failure. To prevent damage to the electrical components in the digitizers, observe anti-static techniques when removing a digitizer from the mainframe or when handling a digitizer. Also, be sure to tighten the front panel screws when installing an HP E1429A/B in a mainframe slot.

Product Information

This section summarizes information for the HP E1429A/B digitizers in the following areas:

- digitizer description
- digitizer specifications
- digitizer serial number information
- digitizer options
- digitizer environmental limits
- service programs disk

Description

The HP E1429A/B digitizers are VXIbus C-Size, message-based servant and register-based (A24) slaves, with A16/A24, D8/D16, and D32 read capability. The digitizers can operate in a C-Size VXIbus mainframe using an HP E1406A Command Module and Standard Commands for Programmable Instruments (SCPI). The digitizers also support register-based programming.

The digitizers can sample input transient waveforms at sample rates of 0.05 to 20 MSa/s in 1-2-5 sequence. Each of the two channels includes a differential and single-ended input. The single-ended inputs can be programmed for 50 Ω or 75 Ω. Battery-backed memory allows 512 K readings per channel. Arm and trigger signals can be generated internally or received from a variety of sources on the VXI backplane or the faceplate BNCs. Self-tests (power-on and *TST?) are available to verify digitizer operation.

Specifications

See *Appendix A - Specifications* in the *HP E1429A/B User's Manual* for HP E1429A/B digitizer specifications. These specifications are the performance standards or limits against which the instrument may be tested.

Serial Numbers

Figure 1-2 shows Hewlett-Packard serial number structure. HP E1429A/B digitizers covered by this manual are identified by the serial number prefixes listed on the title page.

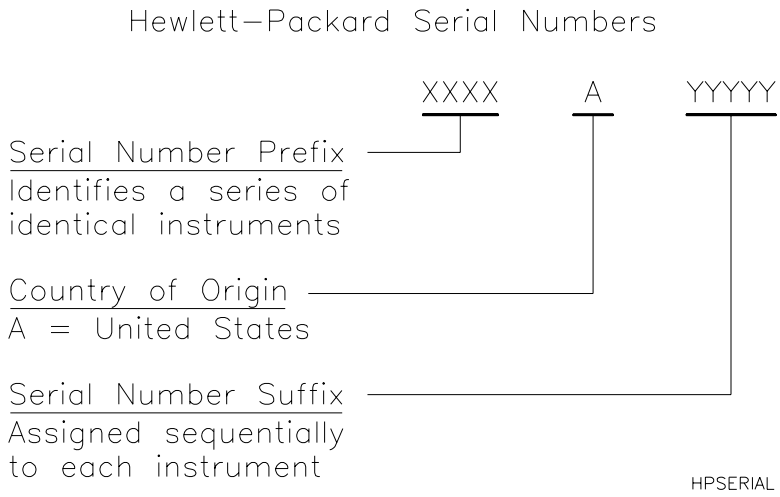

Figure 1-2. Hewlett-Packard Serial Numbers

Options

There are no options for the HP E1429A/B digitizers. However, the HP E1429B digitizer includes a Local Bus that is not available in the HP E1429A digitizer.

Operating/Storage Environments

The HP E1429A/B digitizers should be stored in a clean, dry environment. The following table shows recommended operating/shipping environments for the digitizers.

Operating/Shipping Environments

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

Service Programs Disk

An *HP E1429A/B Service Programs* disk is shipped with this manual. The programs on the disk are in LIF format, with the program filename shown in line 10 of each program. To run a program, load the disk in the disk drive, select the disk drive as the primary drive, type LOAD "*filename*" and press RUN. For example, to run the HP E1429A/B Self-Test (Test F-1 in Chapter 3), load the disk and type LOAD "SELFTEST". Then, press RUN to run the program. The following table summarizes *Service Programs* disk contents.

HP E1429A/B Service Programs

Chap	Category	*filename*	Description
2	Calibration Security	CAL_CODE	Allows user to set new calibration code.
	Calibration Constants	READ_CAL	Reads the existing calibration count and constants.
		LOAD_CAL	Allows user to enter new calibration constants.
	Protected User Data	PRO_DATA	Allows user to enter data into protected user data memory.
3	Functional Verification Tests	SELFTEST	Performs a digitizer self-test.
		DC_CMRR	Checks DC common mode rejection ratio for 10 Vdc input.
		AC_CMRR	Checks AC common mode rejection ratio for 20 Vac input.
	Performance Verification Test	PERFTEST	Measures DCV inputs for all channels, and checks inputs against specification limits.
4	Electronic Adjustments	ADJUST	Performs A/D converter delay constant adjustment, zero offset adjustment, and channel gain adjustments for chan 1 and 2.
	Mechanical Adjustments	AC_ADJS	Allows user to minimize the differential channel voltage offset by adjusting the AC CMRR to maximum.
		FLATNESS	Allows user to adjust each channel for maximum flat frequency response (maximum flatness).

Recommended Test Equipment

See Table 1-1 for test equipment recommended to test and service the HP E1429A/B digitizers. Essential requirements for each piece of test equipment are listed in the *Requirements* column. You may substitute other equipment if it meets the requirements in Table 1-1.

Table 1-1. 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	F,P
Mainframe	Compatible with HP E1405B or HP E1406A	HP E1400B, HP E1400T, or HP E1401A (each mainframe requires HP E1405B or E1406A Command Module)	F,P
DC Source	Voltage range: ± 100 Vdc	Datron 4708, Option 10	F,P,A
Tools	Alignment Tool Adjustment Tool	HP P/N 8710-0630 (Supplied) HP P/N 8710-2106 (Supplied)	A

*A = Adjustments, F = Functional Verification Tests, P = Performance Verification Tests, T = Troubleshooting

Inspection / Shipping

This section shows initial (incoming) inspection and shipping guidelines for the HP E1429A/B digitizers.

Initial Inspection

Use the steps in Figure 1-3 as guidelines to perform initial (incoming) inspection of the HP E1429A/B digitizers. After the digitizer passes its initial inspection, see *Chapter 2 - Setting Calibration Values* to set a new calibration security code and record initial calibration constants.

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.

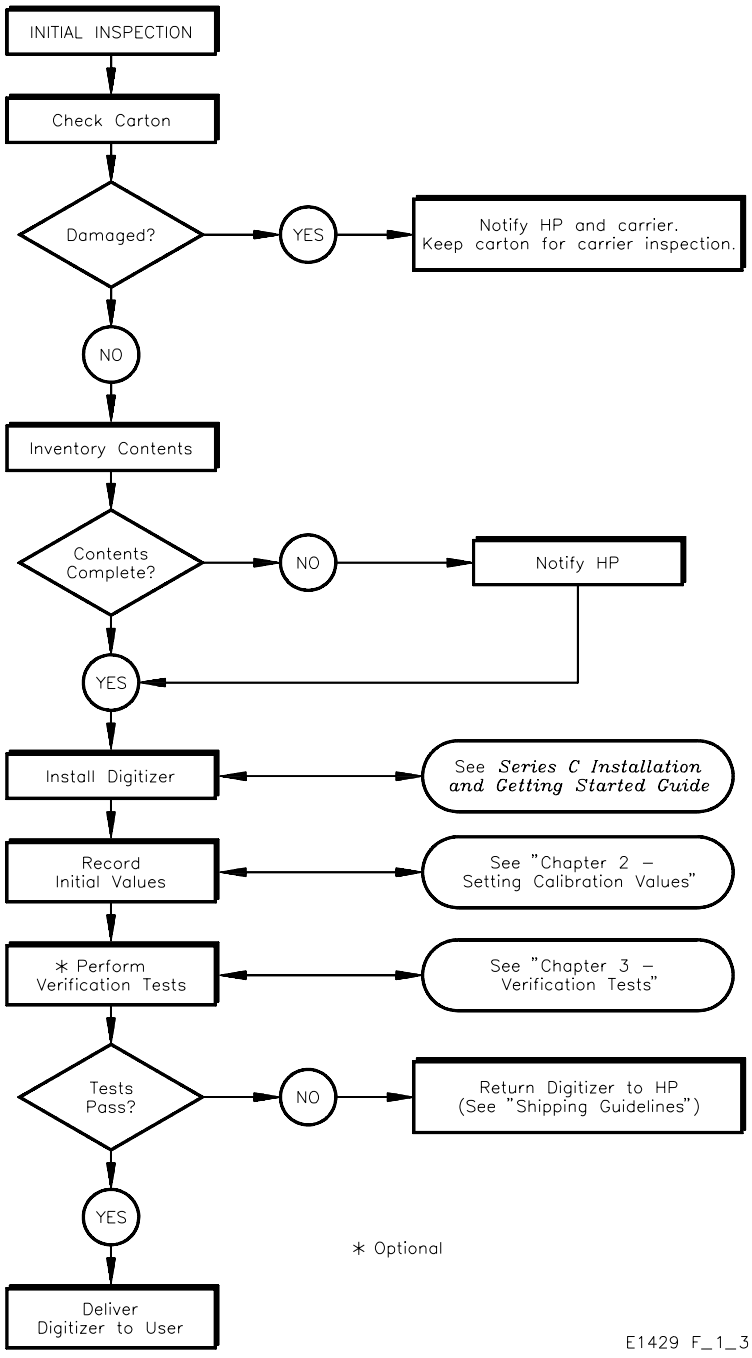

Figure 1-3. Initial (Incoming) Inspection Guidelines

Shipping Guidelines

Follow the steps in Figure 1-4 to return an HP E1429A/B digitizer to a Hewlett-Packard Sales and Support Office or to a Service Center.

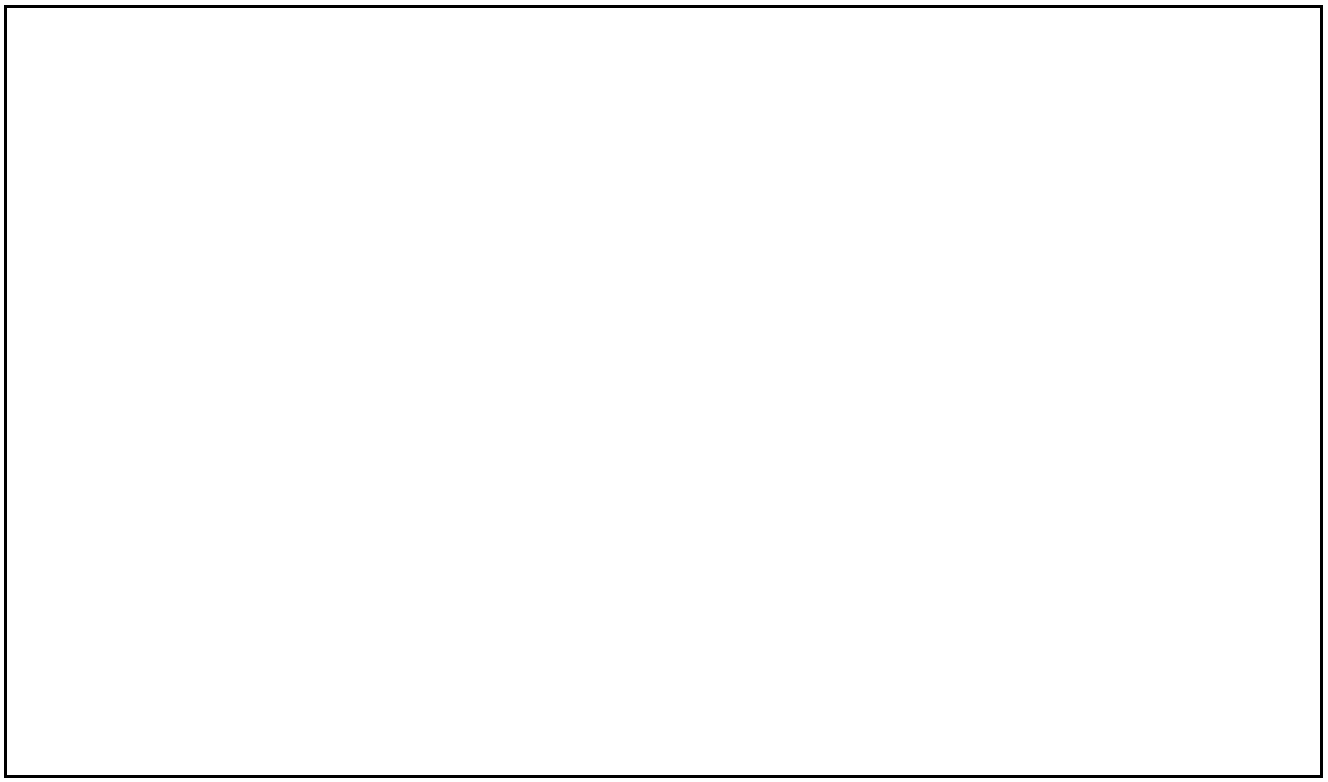

Figure 1-4. Recommended Shipping Guidelines

Chapter 2
Setting Calibration Values

Introduction

This chapter shows how to read existing calibration values for your digitizer and how to change these values as required. It includes:

- setting/defeating calibration security
- reading/setting calibration constants
- reading/setting protected user data

Before You Recalibrate...

Before you recalibrate your digitizer, you may want to set a new calibration security code and record the initial calibration count and calibration constants. See "Setting Calibration Security Code" to set a new calibration security code. See "Reading Calibration Constants" to read the initial calibration count and constants.

Calibration Information Table

Table 2-1, *HP E1429A/B Digitizers Calibration Information*, on the following page, is a form you can copy and use to record the current value of the calibration count, calibration constants for each channel, and your current calibration security code. We recommend that you use this form to record the initial values before you use the digitizer, and whenever you change values.

Table 2-1. HP E1429A/B Digitizers Calibration Information Table

General Information

Digitizer Serial Number:_____

Calibration Security Code: _____

Date/Time: _____

Calibration Count: _____

Calibration Constants Values

Index	Contents	Ch1	Ch2	Index	Contents	Ch1	Ch2
0	offset for 1.0230V range	____	____	31	gain lsb: s/e .5115V range	____	____
1	A to D chip internal setting	____	____	32	offset: diff .10230V range	____	____
2	A to D chip internal setting	____	____	33	gain msb: diff .10230V range	____	____
3	A to D chip internal setting	____	____	34	gain lsb: diff .10230V range	____	____
4	A to D chip internal setting	____	____	35	offset: diff .2046V range	____	____
5	A to D chip internal setting	____	____	36	gain msb: diff .2046V range	____	____
6	linearity bit 5 right	____	____	37	gain lsb: diff .2046V range	____	____
7	linearity bit 5 left	____	____	38	offset: diff .51175V range	____	____
8	linearity bit 6 right	____	____	39	gain msb: diff .5115V range	____	____
9	linearity bit 6 left	____	____	40	gain lsb: diff .5115V range	____	____
10	linearity bit 7 right	____	____	41	offset: diff 1.0230V range	____	____
11	linearity bit 7 left	____	____	42	gain msb: diff 1.0230V range	____	____
12	linearity bit 8 right	____	____	43	gain lsb: diff 1.0230V range	____	____
13	linearity bit 8 leftt	____	____	44	offset: diff 2.046V range	____	____
14	linearity bit 9 right	____	____	45	gain msb: diff 2.046V range	____	____
15	linearity bit 9 left	____	____	46	gain lsb: diff 2.046V range	____	____
16	linearity bit 10 right	____	____	47	offset: diff 5.115V range	____	____
17	linearity bit 10 left	____	____	48	gain msb: diff 5.115V range	____	____
18	gain msb	____	____	49	gain lsb: diff 5.115V range	____	____
19	gain lsb	____	____	50	offset: diff 10.230V range	____	____
20	conversion delay adjust	____	____	51	gain msb: diff 10.230V range	____	____
21	trigger level negative	____	____	52	gain lsb: diff 10.230V range	____	____
22	trigger level positive	____	____	53	offset: diff 20.46V range	____	____
23	offset: s/e .10230V range	____	____	54	gain msb: diff 20.46V range	____	____
24	gain msb: s/e .10230V range	____	____	55	gain lsb: diff 20.46V range	____	____
25	gain lsb: s/e .10230V range	____	____	56	offset: diff 51.15V range	____	____
26	offset: s/e .2046V range	____	____	57	gain msb: diff 51.15V range	____	____
27	gain msb: s/e .2046V range	____	____	58	gain lsb: diff 51.15V range	____	____
28	gain lsb: s/e .2046V range	____	____	59	offset: diff 102.30V range	____	____
29	offset: s/e .5115V range	____	____	60	gain msb: diff 102.30V range	____	____
30	gain msb: s/e .5115V range	____	____	61	gain lsb: diff 102.30V range	____	____

s/e = single-ended input (Ports 1 and 2), diff = differential ports (Ports 3 and 4)

Calibration Security

This section shows how to set a calibration security code for your digitizer and how to defeat calibration security, if required.

Setting Calibration Security Code

When the HP E1429A/B digitizer was shipped from the factory, the calibration security code was set to E1429. Before using the digitizer and, as necessary, we recommend you change the calibration security code to prevent unauthorized or accidental calibration. Record the new security code (on Table 2-1, if desired) and store the result in a secure place.

NOTE

If you do not know the current calibration code but want to disable calibration security, you must disassemble the instrument and reset jumpers. See "Defeating Calibration Security" for procedures if this is required.

Example: Setting New Calibration Security Code

An example program follows to allow you to set a new calibration security code. Note that the new calibration security code applies to both channel 1 and channel 2. If the existing calibration security code is not E1429, change line 40 to reflect the new code. For example, if the desired new code is "NEW_CODE", change line 40 to: 40 OUTPUT @Dig;"CAL:SEC:STAT OFF,NEW_CODE".

```
10!   RE-STORE "CAL_CODE"
20    !
30    ASSIGN @Dig TO 70905                          !Assign @Dig to 70905
40    OUTPUT @Dig;"CAL:SEC:STAT OFF,E1429"          !Disable cal security on both channels,
                                                    assuming factory-set security code
50  Retry:  !
60    CLEAR SCREEN
70    INPUT " Enter new  calibration security code ",New_code$   !User enters new security code
80    PRINT "New calibration code = ";New_code$     !Display new code
90    INPUT " Is this code correct (Y/N)? ",Ans$    !User verification of new code
100   IF Ans$="Y" OR Ans$="y" THEN
110     GOTO Correct
120   ELSE
130     GOTO Retry                                  !Reenter security code if incorrect
140   END IF
150 Correct:  !
160     OUTPUT @Dig;"CAL:SEC:CODE ";New_code$       !New security code stored
170     OUTPUT @Dig;"CAL:SEC:STAT ON"               !Reenable cal security on both channels
180   END
```

Defeating Calibration Security

If you do not know the current calibration security code, you can defeat the calibration security feature by disassembling the digitizer and moving the jumper on connector J201 (see Figure 2-1) to the unsecured position (left-most pins). See *Chapter 6 - Service* for disassembly instructions.

To prevent accidental or unauthorized calibration, move the jumper back to the secured position (right-most pins) as soon as the security code has been set to the desired value. To do this, you will need to move the jumper to the unsecured position, reassemble the instrument, enter the new <*code*> value, disassemble the instrument again, set the jumper back to the secured position, and reassemble the instrument.

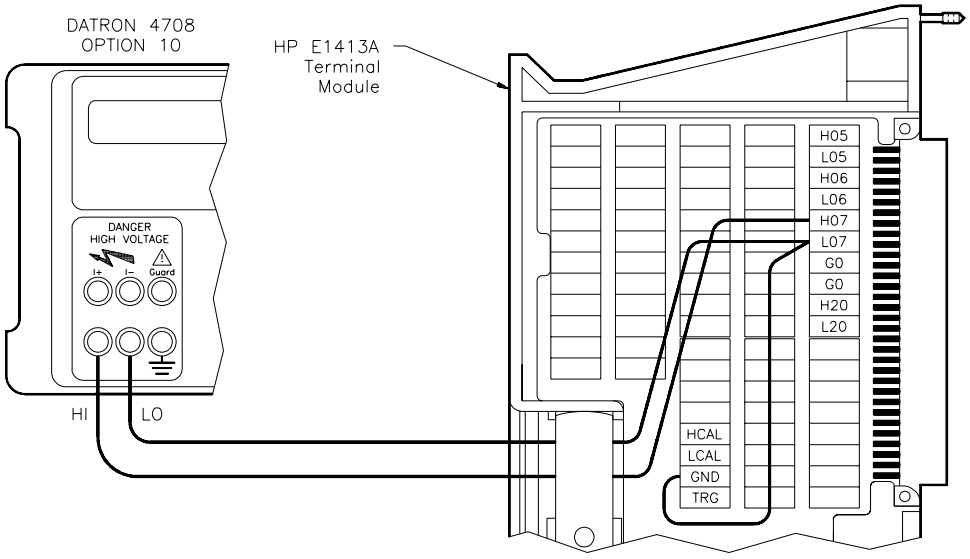

Figure 2-1. Defeating Calibration Security

Calibration Constants

This section shows how to read existing calibration constants and calibration count, and how to enter new calibration constants as required.

Reading Calibration Constants

Before using the digitizer, we suggest you record the initial calibration count and calibration constants on Table 2-1 and store the results in a secure place. Note that the calibration count applies to both channels 1 and 2, so a single count is returned for the digitizer. The calibration constants, however, are unique to each channel.

Example: Reading Calibration Count and Constants

An example program follows to read the existing calibration count and calibration constants for channels 1 and 2.

```
10   !RE-STORE "READ_CAL"
20   ASSIGN @Dig TO 70905                                    !Assign @Dig to 70905
30   !
40   ! ---------- Read calibration count ----------
50   !
60   OUTPUT @Dig;"CAL:COUN?"                                 !Query calibration count
70   ENTER @Dig;Cal_count                                    !Enter calibration count
80    !
90    ! ---------- Read channel 1 calibration constants ------------
100  !
110  DIM Ndig$[1],Count$[9]                                  !Dimension parameters for header
120  ASSIGN @Digu TO 70905;FORMAT OFF                        !Turn FORMAT OFF for array data
130  OUTPUT @Dig;"FORM PACK"                                 !Set PACKed format
140  OUTPUT @Dig;"CAL1:DATA?"                                !Query calibration data
150  ENTER @Digu USING "#,X,K,K";Ndig$;Count$[1;VAL(Ndig$)]  !Strip off header preceeding data
160  ALLOCATE INTEGER Cal1_data(1:VAL(Count$)/2)             !Allocate array to hold channel 1 data
170  ENTER @Digu;Cal1_data(*)                                !Read channel 1 calibration constants
180  ENTER @Dig USING "B";Line_feed                          !Strip off leftover line feed
190  !
200  ! ------ Read channel 2 calibration constants ----------
210  !
220  OUTPUT @Dig;"CAL2:DATA?"                                !Query calibration data
230  ENTER @Digu USING "#,X,K,K";Ndig$;Count$[1;VAL(Ndig$)]  !Strip off header preceeding data
240  ALLOCATE INTEGER Cal2_data(1:VAL(Count$)/2)             !Allocate array to hold channel 2 data
250  ENTER @Digu;Cal2_data(*)                                !Read channel 2 calibration constants
260  ENTER @Dig USING "B";Line_feed                          !Strip off leftover line feed
```

(continued on next page)

```
270  !
280  ! ------- Display calibration count/constants ----------
290  !
300  CLEAR SCREEN
310   PRINT "HP E1429A/B Digitizer Calibration Count/Constants"
320   PRINT
330   PRINT "Date:";DATE$(TIMEDATE)
340   PRINT "Time:";TIME$(TIMEDATE)
350   PRINT "Calibration Count:";Cal_count
360   PRINT
370   PRINT "Channel 1 Calibration Constants"
380   PRINT
390   PRINT Cal1_data(*)
400   PRINT
410   PRINT "Channel 2 Calibration Constants"
420   PRINT
430   PRINT Cal2_data(*)
440   END
```

A typical result follows, where channel 1 index 0 in Table 2-1 = -147, index 1 = 939,..., index 61 = -307,
and channel 2 index 0 = -248, index 1 = 939,..., index 61 = -310.

```
HP E1429A/B Digitizer Calibration Count/Constants

Date: 24 Sep 1993
Time: 10:15:23
Calibration Count: 3

Channel 1 Calibration Constants

 -147   939   533   336  -819  -450   -21    59
  -30    58    21    88   -15    57    21    99
  -42    43   387  -310   117  2047 -2048  -328
  397  -300  -306   407  -290  -290   413  -284
 -343   385  -312  -310   387  -310  -293   391
 -306  -277   390  -307  -279   393  -304  -279
  397  -300  -281   391  -306  -280   392  -305
 -281   395  -302  -281   390  -307

Channel 2 Calibration Constants

 -248   939   533   336  -819  -450   -21    59
  -30    58    21    88   -15    57    21    99
  -42    43   387  -310   117  2047 -2048  -328
  397  -300  -306   407  -290  -290   413  -284
 -343   385  -312  -310   387  -310  -293   391
 -306  -277   390  -307  -279   393  -304  -279
  397  -300  -281   391  -306  -280   392  -305
 -281   395  -302  -281   390  -310
```

Setting New Calibration Constants

If you need to set new calibration constants (or reset existing calibration constants), you can use the following program. The new calibration constants take effect immediately, but are not saved to nonvolatile calibration memory unless the CAL:STOR command is executed.

Example: Setting New Calibration Constants

The following program loads 62 calibration constants into the digitizer, and then stores the new constants to nonvolatile calibration RAM. If you want to verify that the new constants are stored, you can run the "READ_CAL" program in "Reading Calibration Constants". Substitute the values of your calibration constants for the example values listed in lines 120 - 160.

```
10   !RE-STORE "LOAD_CAL"
20   !
30   ! ---------- Initial Setup ----------
40   !
50   ASSIGN @Dig TO 70905                                    !Assign @Dig to 70905
60   ASSIGN @Digu TO 70905;FORMAT OFF                        !Turn FORMAT OFF for array data
70   INTEGER Array(0:61)                                     !Dimension array for cal constants
80   INPUT " Enter channel number (1 or 2) for constants  ",Chan
90   !
100  ! ---------- Input  new calibration constants ----------
110  !
120  DATA -147,939,533,336,-819,-450,-21,59,-30,58,21,88,-15,57,21
130  DATA 99,-42,43,387,-310,117,2047,-2048,-328,397,-300,-306,407
140  DATA -290,-290,413,-284,-343,385,-312,-310,387,-310,-293,391
150  DATA -306,-277,390,-307,-279,393,-304,-279,397,-300,-281,391
160  DATA -306,-280,392,-305,-281,395,-302,-281,390,-307
170  READ Array(*)                                           !Read new calibration constants
180  !
190  ! --------- Enter/store calibration constants ----------
200  !
210  OUTPUT @Dig;"FORM PACK"                                 !Set PACKed format
220  OUTPUT @Dig;"CAL"&VAL$(Chan)&":SEC:STAT OFF,E1429"      !Turn calibration security OFF,
                                                             assuming factory-set code of E1429
230  OUTPUT @Dig;"CAL"&VAL$(Chan)&":STOR:AUTO OFF"           !Disable  storage of cal constants
240  OUTPUT @Dig USING "#,K";"CAL"&VAL$(Chan)&":DATA #3124"  !Specify 124 bytes (62 constants)
250  OUTPUT @Digu;Array(*),CHR$(10),END                      !Send array of calibration constants
260  OUTPUT @Dig;"CAL"&VAL$(Chan)&":STOR"                    !Store new calibration constants
270  OUTPUT @Dig;"CAL:SEC:STAT ON"                           !Turn calibration security ON
280  END
```

Protected User Data

This section shows how to read existing protected user data, and how to enter new protected user data into memory as required. As desired, you can enter and read information in "protected user data" memory.

Since calibration security must be OFF to write to this memory area, you can use *PUD to store sensitive information such as date of last calibration, the number of the last calibration, etc. *PUD? reads the current protected user data in IEEE-488.2 definite length block format. *PUD? returns the information regardless of the state of calibration security.

Example: Reading/Entering Protected User Data

An example program follows to enter data into protected user data memory and to read the result. In this program, you must enter the proper header and the header must account for all characters and spaces. For example, in line 90 "Last Calibration: 17 Feb 1994" has 29 spaces and characters, so the header is #229. Use the current calibration security code in line 80.

```
10   !RE-STORE "PRO_DATA"
20   !
30   ASSIGN @Dig TO 70905                          !Assign @Dig to 70905
40   DIM Pro_data$[256]
50   !
60   !------------------Enter/read  protected user data ----------------------
70   !
80   OUTPUT @Dig;"CAL:SEC:STAT OFF,E1429"          !Turn calibration security OFF
90   OUTPUT @Dig;"*PUD #229Last Calibration: 17 Feb 1994"   !Enter desired message/information
100  OUTPUT @Dig;"CAL:SEC:STAT ON"                 !Turn calibration security ON
110  OUTPUT @Dig;"*PUD?"                           !Read protected user data
120  ENTER @Dig;Pro_data$                          !Enter data (includes header)
130  !
140  !----------------------Display results/-----------------------------------
150  !
160  CLEAR SCREEN
170  PRINT "HP E1429A/B Digitizers - Protected User Data"
180  PRINT
190  PRINT Pro_data$[POS(Pro_data$,CHR$(32));LEN(Pro_data$)]
200  END
```

A typical return follows.

HP E1429A/B Digitizers - Protected User Data

Last Calibration: 17 Feb 1994

Chapter 3
Verification Tests

Introduction

The three levels of test procedures described in this chapter are used to verify that the HP E1429A/B digitizers:

- 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 1-1 for test equipment requirements. You should complete the performance verification tests at least once a year. For heavy use or severe operating environments, perform the tests more often. The temperature should be between 18^{o}C and 28^{o}C.

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

PerformanceTest Record

The results of each performance verification test may be recorded in Table 3-1, *HP E1429A/B Digitizers Performance Test Record.* This form can be copied, if desired.

Verification Test Examples

Each verification test procedure includes an example program that performs the test. All example programs assume the following:

- Controller is an HP 9000 Series 200/300 computer
- Programming language is HP BASIC
- Digitizer address is 70905 (logical address is 40)

Functional Verification Tests

The purpose of the functional verification tests is to verify that the HP E1429A/B digitizer is functioning properly. The following table lists functional verification tests for the HP E1429A/B digitizers.

NOTE

For a quick functional verification test of the HP E1429A/B digitizers, do only Test F-1: Self-Test.

HP E1429A/B Digitizers Functional Verification Tests

Test	Descripton	Test Passes if:
F-1: Self-Test	Test module functions using *TST?	*TST? returns "0"
F2: DC Common Mode Rejection Ratio (DC CMRR)	Check DC CMRR for 10 Vdc input	DC CMRR ≥ 68 dB
F3: AC Common Mode Rejection Ratio (AC CMRR)	Check AC CMRR for 20 Vac PP input @ 1MHz	AC CMRR ≥ 60 dB

Test F-1: Self-Test

Description

The self-test provides a high degree of confidence that the HP E1429A/B digitizer is functional. The test uses *TST? to self-test the digitizer and takes about 30 seconds to complete. During the test sequence:

- First, all front panel LEDs should turn ON
- Next, the relays should activate
- Then, the 50 Ω LEDs should turn ON

Test Procedure

1. Execute the self-test:

   *TST? *Self-test command*

2. Read the result. A "0" indicates that the test passed. If a failure occurs, the instrument returns a "1" and generates an error message that identifies the cause of the failure.

NOTE *If self-test fails, do the Electronic Adjustments in Chapter 4 - Adjustments and rerun the self-test. If the test still fails, replace the instrument.*

Example Program

This program performs a self-test on the digitizer.

```
10   !RE-STORE "SELFTEST"
20   DIM Err_msg$[255]
30   ASSIGN @Dig TO 70905                    !Assign @Dig to digitizer
40   OUTPUT @Dig;"*TST?"                     !Send self-test command
50   ENTER @Dig;Result
60   IF Result <>0 THEN
70     PRINT "SELF-TEST FAILED"
80     PRINT
90     REPEAT
100      OUTPUT @Dig;"SYST:ERR?"
110      ENTER @Dig;Code,Err_msg$
120      PRINT Code,Err_msg$
130    UNTIL Code=0
140  ELSE
150    PRINT "SELF-TEST PASSED"
160  END IF
170  END
```

Test F-2: DC CMRR Test

Description

This test checks the DC common mode rejection ratio (DC CMRR) for the differential inputs of the digitizer. There are two steps to this test.

First, an input of 0.0 Vdc is applied simultaneously to the HI and LO inputs of (differential) port 3 or port 4, with the digitizer set to the 0.1V range. The differential input value (difference between the HI and LO port readings) is measured by the digitizer (we'll call this value Vos).

Next, an input of 10.0 Vdc is applied simultaneously to the HI and LO inputs of (differential) port 3 or port 4, with the digitizer set to the 0.1V range. The differential input value (difference between the HI and LO port readings) is measured by the digitizer (we'll call this value Vavg).

The DC CMRR is then computed using the following formula. The result should be a DC CMRR >68 dB.

$$dc\_cmrr = 20 \log_{10} \frac{10.0}{| V_{avg} - V_{os} |}$$

NOTE

If the DC CMRR test fails (CMRR ≤ 68 dB), perform the Electronic Adjustments in Chapter 4 - Adjustments and rerun the test. If the test still fails, replace the digitizer.

Equipment Setup

- Set up the equipment as shown in Figure 3-1
- Set DC source output to 0.0 Vdc

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.

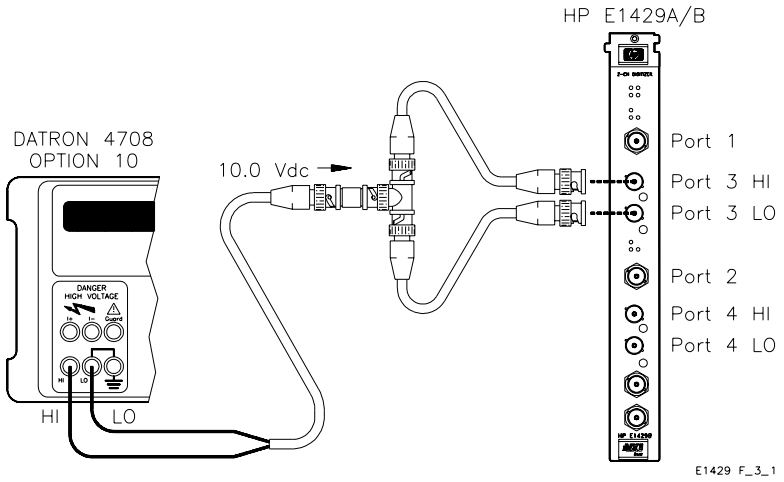

Figure 3-1. DC CMRR Test Setup

Test Procedure

1. Make Channel 1 measurements for 0 Vdc input:

   Set Datron output to 0.0 Vdc.

MEAS1:ARR:VOLT? (100),0.1,DEF,(@3)	*Set digitizer for ch 1 meas, 100 readings, 0.1V range, input on port 3*
ENTER statement;A	*Store 100 readings in data array A*
Vos = SUM(A)/100	*Compute average value for 0.0 Vdc input (Vos)*

2. Make Channel 1 measurements for 10.0 Vdc input:

   Set Datron output to 10.0 Vdc.

MEAS1:ARR:VOLT? (100),0.1,DEF,(@3)	*Set digitizer for ch 1 meas, 100 readings, 0.1V range, input on port 3*
ENTER statement;B	*Store 100 readings in data array B*
Vavg = SUM(B)/100	*Compute average value for 10V input (Vavg)*

3. Compute DC CMRR

Cmrr = 20*LOG$_{10}$ (10.0/(| Vavg_Vos |))	*Calculate DC CMRR*

4. Repeat the test for Channel 2 Vdc input

   Make connections to port 4 HI and LO

MEAS2:ARR:VOLT? (100),0.1,DEF,(@4)	*Set digitizer for ch 2 meas, 100 readings, 0.1V range, input on port 4*

Example Program This program makes 100 readings of the offset voltage on channels 1 and 2 and displays the DC Common Mode Rejection Ratio (DC CMRR) for each channel.

```
10!   RE-STORE "DC_CMRR"
20    !
30    ! ---------- Initial Setup ----------
40    !
50    ASSIGN @Dig TO 70905                                    !Assign @Dig to digitizer address
60    DIM A(1:100), B(1:100)                                  !Dimension arrays for measured values
70    FOR Chan=1 TO 2                                         !Loop for channels 1 and 2
80      PRINT "Channel";Chan;"DC Common Mode Rejection Ratio Test"
90      PRINT
100     PRINT "1. Connect DC source to Port";Chan+2;"HI and LO"
110     PRINT "2. Set DC source output to 10.0 Vdc"
120     DISP " Press Continue when ready "
130     PAUSE
140     CLEAR SCREEN
150   !
160   ! ----------  Compute Avg Value for 0V Input (Vos)  ----------
170   !
180   OUTPUT @Dig;"MEAS"&VAL$(Chan)&":ARR:VOLT? (100),      !Measure differential input on channel
0.1,DEF,(@"&VAL$(Chan+2)&")"                                  1 or 2
190   ENTER @Dig;A(*)                                         !Enter results
200   Vos=ABS(SUM(A)/100)                                     !Find avg value of 100 (0V) inputs
210     PRINT "Set DC source output to 10.0 Vdc"
220     DISP " Press Continue when ready "
230     PAUSE
240     CLEAR SCREEN
250   !
260   ! ----------  Compute Avg Value for 10V Input (Vavg)  ----------
270   !
280   OUTPUT @Dig;"MEAS"&VAL$(Chan)&":ARR:VOLT? (100),      !Measure differential input on channel
0.1,DEF,(@"&VAL$(Chan+2)&")"                                  1 or 2
290   ENTER @Dig;B(*)                                         !Enter results
300   Vavg=ABS(SUM(B)/100)                                    !Find avg value of 100 (10V) inputs
310   !
320   ! ----------  Compute DC CMRR  ----------
330   !
340   Cmrr=20*LGT(10.0/(ABS(Vavg-Vos)))                       !Compute CMRR, based on 10 Vdc and
                                                              0Vdc inputs
350   IF Chan=1 THEN Cmrr1=Cmrr                               !Store channel 1 results
360   IF Chan=2 THEN Cmrr2=Cmrr                               !Store channel 2 results
370 NEXT Chan
380 !
```

(continued on next page)

```
390  !---------- Display Results ----------
400  !
410  PRINT "DC Common Mode Rejection Ratio (CMRR) Test"
420  PRINT
430  PRINT "Channel 1 DC CMRR:";DROUND(Cmrr1,3);" dB"        !Display channel 1 results
440  PRINT "Channel 2 DC CMRR:";DROUND(Cmrr2,3);" dB"        !Display channel 2 results
450  END
```

A typical result is:

DC Common Mode Rejection Ratio (CMRR) Test

Channel 1 DC CMRR: 84.8 dB
Channel 2 DC CMRR: 82.9 dB

Test F-3: AC CMRR Test

This test checks the AC common mode rejection ratio (AC CMRR) for the differential inputs of the digitizer. An input of 20.0 Vac PP @ 1 MHz is applied simultaneously to the HI and LO inputs of (differential) port 3 or port 4, with the digitizer set to the 0.1V range. The differential input value (difference between the HI and LO port readings) is then measured by the digitizer.

NOTE

Do not run the AC CMMR test before doing the DC CMRR test (Test F-2). If the DC CMRR test fails, do NOT run the AC CMRR test. If the DC CMRR test passes, but the AC CMRR test fails, perform the electronic adjustments (A/D converter delay constant, zero offset, and gain) shown in Chapter 4 - Adjustments and rerun the test. If the test still fails, replace the digitizer.

To calculate the AC CMRR, we will compare the rms value of the input (20 Vac PP = 10 Vac Pk = 7.0714356 Vrms) with the measured rms voltage. The rms value is the standard deviation of the measured voltage, as calculated from the following formula, with n = 1000 readings and v_i = measured voltages.

$$std\_dev = \left[\frac{n \sum_{i=1}^{n} (v_i)^2 - (\sum_{i=1}^{n} v_i)^2}{n(n-1)} \right]^{1/2}$$

From this, the AC CMRR is calculated from the following formula. The result should be an AC CMRR >60 dB.

$$ac\_cmrr = 20 \log_{10} \frac{Vrms\ input}{Vrms\ detected} = 20 \log_{10} \frac{7.0714356}{std\_dev}$$

Equipment Setup

- Set up the equipment as shown in Figure 3-2
- Set DC source output to 20.0 Vac PP @ 999990 Hz

WARNING

The DC Standard (Datron 4708, Option 20) 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.

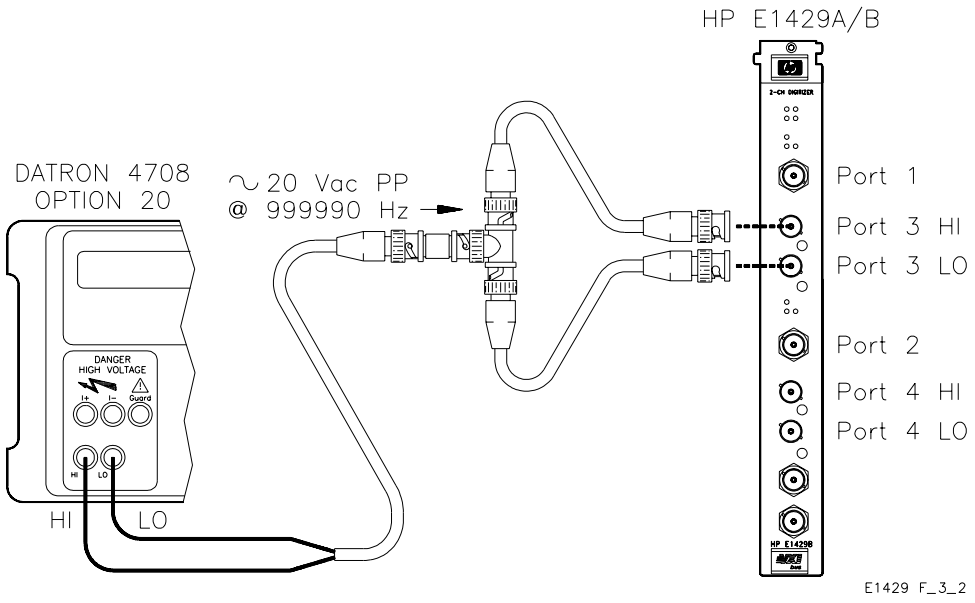

Figure 3-2. AC CMRR Test Setup

Test Procedure

1. Make Channel 1 measurements:

MEAS1:ARR:VOLT? (1000),0.1,DEF,(@3)	*Set digitizer for ch 1 meas, 1000 readings, 0.1V range, input on port 3*
ENTER statement;A	*Store readings in array A*

2. Compute AC CMRR

Std_dev = see formula on page 3-8	*Calculate standard deviation of measurements*
Cmrr = 20*LGT(7.0714356/std_dev)	*Calculate AC CMRR for 20.0 Vac PP @ 1 MHz*

3. Repeat the test for Channel 2 input

Make connections to port 4 HI and LO

MEAS2:ARR:VOLT? (1000),0.1,DEF,(@4)	*Set digitizer for ch 2 meas, 1000 readings, 0.1V range, input on port 4*

Repeat steps 1 through 3 for channel 2

Example Program

This program takes 1000 readings of the voltage on channels 1 and 2 and displays the AC Common Mode Rejection Ratio (AC CMRR).

```
10   ! RE-STORE "AC_CMRR"
20   !
30   ! ---------------------------- Initial Setup --------------------------------
40   !
50   Addr=70905                                                    !Factory-set address
60   INPUT " Enter digitizer Logical Address (default = 70905) ",Addr   !User selects Logical Address
70   ASSIGN @Dig TO Addr                                           !Assign @Dig to digitizer address
80   DIM A(1:1000)                                                 !Dimension array to hold readings
90   FOR Chan=1 TO 2                                               !Loop for both channels
100    CLEAR SCREEN
110    PRINT "Channel";Chan;"AC Common Mode Rejection Ratio Test"
120    PRINT
130    PRINT "1. Connect AC source to Port";Chan+2;"HI and LO"
140    PRINT "2. Set AC source output to 20.0 Vac PP @ 999990 Hz"
150    DISP " Press Continue when ready to start "
160    PAUSE
170    CLEAR SCREEN
180    !
190    ! ---------------------- Make measurements ---------------------------
```

(continued on next page)

```
200   !
210   OUTPUT @Dig;"MEAS"&VAL$(Chan)&":ARR:VOLT? (1000),
0.1,DEF,(@"&VAL$(Chan+2)&")"                    !Take 1000 readings on specified port
                                                with digitizer set to 0.1V range
220   ENTER @Dig;Value(*)                       !Enter 1000 readings
230   !
240   ! ---------- Compute AC CMRR ----------
250   !
260   FOR I=1 TO 1000
270       A(I)=Value(I)^2
280   NEXT I
290   Std_dev=SQR(((1000.0*SUM(A)-SUM(Value)^2))/9.9999E+5)   !Compute standard deviation
300   Cmrr=20.0*LGT(7.0714356/Std_dev)          !Compute AC CMRR
310   IF Chan=1 THEN Cmrr1=Cmrr
320   IF Chan=2 THEN Cmrr2=Cmrr
330 NEXT Chan
340 !
350 !---------- Display Results ----------
360 !
370 PRINT "AC Common Mode Rejection Ratio (CMRR) Test"
380 PRINT
390 PRINT "Channel 1 AC CMMR = ";DROUND(Cmrr1,3);" dB"
400 PRINT "Channel 2 AC CMMR = ";DROUND(Cmrr2,3);" dB"
410 END
```

Typical Result A typical result follows.

```
AC Common Mode Rejection Ratio (CMRR) Test

Channel 1 AC CMMR = 84.1 dB
Channel 2 AC CMMR = 82.4 dB
```

Operation Verification Test

The operation verification test for the HP E1429A/B digitizers is the same as the performance verification test, except that only one measurement per range for each port is made, as listed in the following table.

HP E1429A/B Digitizers - Operation Verification Test Values

Ports	Range (Vdc)	Input (Vdc)
1 and 2	-0.10225V to 0.10230V -0.2045V to 0.2046V -0.51125V to 0.5115V -1.0225V to 1.0230V	0.07 0.15 0.35 0.70
3 and 4	-0.10225V to 0.10230V -0.2045V to 0.2046V -0.51125V to 0.5115V -1.0225V to 1.0230V -2.045V to 2.046V -5.1125V to 5.115V -10.225V to 10.230V -20.45V to 20.46V -51.125V to 51.15V -102.25V to 102.30V	0.07 0.15 0.35 0.70 1.40 3.50 7.00 14.0 35.0 70.0

Performance Verification Test

Performance verification tests are used to test the HP E1429A/B digitizer's electrical performance using the specifications in *Appendix A - Specifications* of the *HP E1429A/B User's Manual* as the performance standards. These tests are suitable for incoming inspection and troubleshooting.

The results of the performance verification tests should be recorded in Table 3-1, *HP E1429A/B Digitizers Performance Test Record*, at the end of this chapter. HP E1429A/B performance verification includes the following test.

HP E1429A/B Digitizers - Performance Verification Test

Test #	Test Name	Measures:
3-1	DC Voltage Accuracy	DC voltage accuracy for single-ended ports 1 and 2 and for differential ports 3 and 4

Test 3-1: DC Voltage Accuracy

Description

The purpose of this test is to verify that the HP E1429A/B digitizer meets its specifications for DC Voltage Accuracy on all ports.

NOTE

If the digitizer fails the DC voltage accuracy test, perform the electronic adjustments in Chapter 4 - Adjustments and rerun the test. If the test then fails, do the mechanical adjustments in Chapter 4 and rerun the test. If the test still fails, replace the instrument.

Equipment Setup

- Set up the equipment as shown in Figure 3-3
- Set the source output for -0.07 Vdc

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.

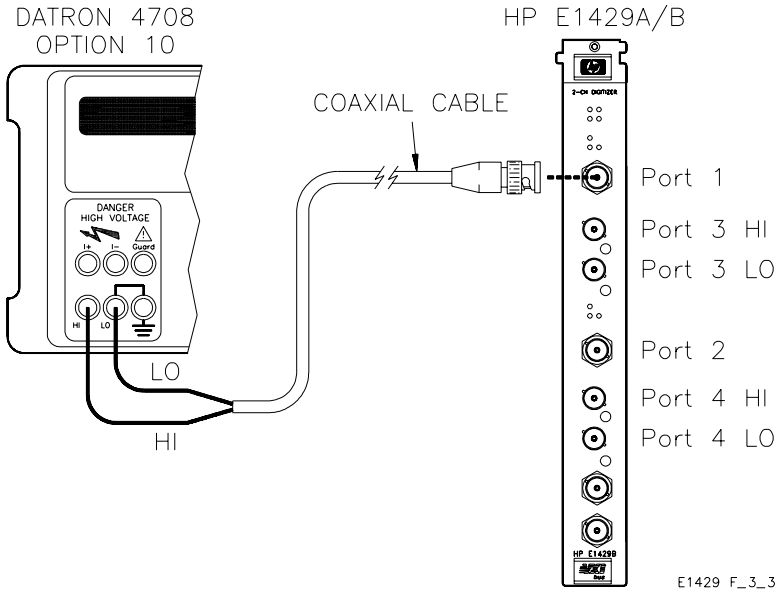

Figure 3-3. DCV Accuracy Test Setup

Test Procedure

1. Set Port 1 to measure DCV input:

   MEAS1:ARR:VOLT? (100), .1,DEF,(@1) *Set digitizer for 100 readings on port 1*

2. Input specified voltage from Datron 4708:

   Use values in following table

3. Read measurement and record the reading in Table 3-1:

   ENTER statement *Returns reading*

Perform steps 1 - 3 for each port, range and input in the following table:

DC Voltage Accuracy Test Ranges/Inputs (Vdc)

Range	.1023V	.2046V	.5115V	1.023V	2.046V	5.115V	10.23V	20.46V	51.15V	102.3V
Port 1 Inputs	-0.07 -0.03 0.03 0.07	-0.15 -0.06 0.06 0.15	-0.35 -0.15 0.15 0.35	-0.7 -0.3 0.3 0.7	N/A	N/A	N/A	N/A	N/A	N/A
Port 2 Inputs	-0.07 -0.03 0.03 0.07	-0.15 -0.06 0.06 0.15	-0.35 -0.15 0.15 0.35	-0.7 -0.3 0.3 0.7	N/A	N/A	N/A	N/A	N/A	N/A
Port 3 Inputs	-0.07 -0.03 0.03 0.07	-0.15 -0.06 0.06 0.15	-0.35 -0.15 0.15 0.35	-0.7 -0.3 0.3 0.7	-1.4 -0.6 0.6 1.4	-3.5 -1.5 1.5 3.5	-7 -3 3 7	-14 -6 6 14	-35 -15 15 35	-70 -30 30 70
Port 4 Inputs	-0.07 -0.03 0.03 0.07	-0.15 -0.06 0.06 0.15	-0.35 -0.15 0.15 0.35	-0.7 -0.3 0.3 0.7	-1.4 -0.6 0.6 1.4	-3.5 -1.5 1.5 3.5	-7 -3 3 7	-14 -6 6 14	-35 -15 15 35	-70 -30 30 70

Example Program This program measures the DC input voltage for each value in the preceeding table and displays the results.

```
10!   RE-STORE "PERFTEST"
20    !
30    !------------------ Enter input values and digitizer ranges --------------------
40    !
50    Addr=70905
60    INPUT " Enter digitizer logical address (default = 70905) ",Addr
70    ASSIGN @Dig TO Addr
80    DISP CHR$(129)
90    DIM Input(1:40),Range(1:10),Reading(1:100),Result(1:4,1:10,1:112)
100   DIM Lower(1:4,1:10,1:112),Delta(1:4,1:10,1:112)
110   DIM Upper(1:4,1:10,1:112),Flag$(1:4,1:10,1:112)[4]
120   DATA .1023,.2046,.5115,1.023,2.046
130   DATA 5.115,10.23,20.46,51.15,102.3
140   READ Range(*)
150   DATA -.07,-.03,.03,.07,-.15,-.06,.06,.15,-.35,-.15,.15,.35
160   DATA -.7,-.3,.3,.7,-1.4,-.6,.6,1.4,-3.5,-1.5,1.5,3.5
170   DATA -7,-3,3,7,-14,-6,6,14,-35,-15,15,35,-70,-30,30,70
180   READ Input(*)
190   !
200   ! ------------ Make DCV measurements for ports 1 - 4 -----------------
210   !
220   FOR I=1 TO 4                  !ports
230     IF I=1 OR I=3 THEN Chan=1
240     IF I=2 OR I=4 THEN Chan=2
250     IF I=1 OR I=2 THEN Nbr=4
260     IF I=3 OR I=4 THEN Nbr=10
270     FOR J=1 TO Nbr               !ranges
280       FOR K=4*J-3 TO 4*J         !inputs
290 Retry:      !
300         CLEAR SCREEN
310         PRINT "DC Voltage Accuracy Measurements"
320         PRINT
330         PRINT "  Port:        ";I
340         PRINT "  Range (Vdc):  ";Range(J)
350         PRINT "  Input (Vdc):  ";Input(K)
360         PRINT
370         PRINT "1. Connect DC source output to Port";I
380         PRINT "2. Set DC source output to ";Input(K);"Vdc"
```

(continued on next page)

```
390         IF ABS(Input(K))=70 THEN
400           BEEP
410           PRINT
420           PRINT "WARNING: HIGH VOLTAGE OUTPUT FROM SOURCE"
430         END IF
440         DISP " Press Continue when voltage is input "
450         PAUSE
460         OUTPUT @Dig;"MEAS"&VAL$(Chan)&":ARR:VOLT?
(100),"&VAL$(Range(J))&",DEF,(@"&VAL$(I)&")"
470         ENTER @Dig;Reading(*)
480         Result(I,J,K)=SUM(Reading)/100
490         IF I=1 OR I=2 THEN
500           Delta(I,J,K)=ABS(.004*Input(K))+.005*Range(J)
510         ELSE
520           Delta(I,J,K)=ABS(.005*Input(K))+.02*Range(J)
530         END IF
540         Upper(I,J,K)=Input(K)+Delta(I,J,K)
550         Lower(I,J,K)=Input(K)-Delta(I,J,K)
560         IF Result(I,J,K)< (I,J,K) OR Result(I,J,K)>Upper(I,J,K) THEN
570           Flag$(I,J,K)="FAIL"
580           GOTO Test_fail
590         END IF
600 Next_meas:        !
610       NEXT K
620     NEXT J
630   NEXT I
640   !
650   !------------------------------ Print Results ----------------------------------------
660   !
670 Print_res:   !
680   CLEAR SCREEN
690   INPUT " Do you want to print (P) or display (D) the results? ",Ans$
700   IF Ans$="P" OR Ans$="p" THEN
710     Ptr_addr=701
720     INPUT " Enter printer address (701 is default) ",Ptr_addr
730     PRINTER IS Ptr_addr
740   ELSE
750     PRINTER IS 1
760   END IF
770   PRINT "HP E1429A/B Digitizers - DCV Accuracy Test"
780   PRINT
```

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```
790   PRINT "Date: ";DATE$(TIMEDATE)
800   PRINT "Time: ";TIME$(TIMEDATE)
810   PRINT
820   PRINT "Port   Range     Input    Minimum     Measured      Maximum     Pass/Fail"
830   PRINT "       (Vdc)     (Vdc)      (Vdc)       (Vdc)        (Vdc)"
840   PRINT
850 Fmt:IMAGE D,3X,3D.5D,3X,S3D.2D,3X,S3D.5D,3X,S3D.5D,3X,S3D.5D,4X,4A
860   FOR I=1 TO 4
870     IF I=1 OR I=2 THEN Nbr_print=4
880     IF I=3 OR I=4 THEN Nbr_print=10
890     FOR J=1 TO Nbr_print
900       FOR K=4*J-3 TO 4*J
910         PRINT USING Fmt;I,Range(J),Input(K),Lower(I,J,K),Result(I,J,K),Upper(I,J,K),Flag$(I,J,K)
920         IF Next$(K)="E" OR Next$(K)="e" THEN End_print
930       NEXT K
940     NEXT J
950   NEXT I
960 End_print:   !
970   GOTO End_prog
980   !
990   !--------------------------- Test Failure Indication ---------------------------------
1000  !
1010 Test_fail: !
1020  CLEAR SCREEN
1030  Flag$(I,J,K)="FAIL"
1040 BEEP
1050  PRINT "              NOTE"
1060  PRINT
1070  PRINT "The measurement test FAILED for the ";Input(K);"V input"
1080  PRINT "on the ";Range(J);"V range"
1090  PRINT
1100  PRINT "Measured voltage = ";DROUND(Result(I,J,K),4);"V"
1110  PRINT "Expected voltage = ";DROUND(Input(K),4);"V"
1120  PRINT "Maximum Limit    = ";DROUND(Upper(I,J,K),4)
1130  PRINT "Minimum Limit    = ";DROUND(Lower(I,J,K),4)
1140  PRINT
1150  PRINT "Be sure the DC Standard OUTPUT is set to ";Input(K);"V"
1160  PRINT "and the DC Standard OUTPUT switch is set to ON"
1170  PRINT
1180 Reenter:    !
1190  INPUT " End this test (E), retry this measurement (R), or do next measurement (N)? ",Next$(K)
```

(continued on next page)

```
1200  CLEAR SCREEN
1210  IF Next$(K)="E" OR Next$(K)="e" THEN GOTO Print_res
1220  IF Next$(K)="R" OR Next$(K)="r" THEN
1230    Flag$(I,J,K)=""
1240    GOTO Retry
1250  END IF
1260  IF Next$(K)="N" OR Next$(K)="n" THEN
1270    GOTO Next_meas
1280  ELSE
1290    DISP " You entered an incorrect letter. Please reenter desired action. "
1300    GOTO Reenter
1310  END IF
1320  !
1330  ! ------------------------------ Error Messages ----------------------------------------
1340  !
1350 Err_msg:  !
1360  CLEAR SCREEN
1370  BEEP
1380  PRINT "Error messages"
1390  PRINT "Correct errors listed and then rerun this program"
1400  PRINT
1410  REPEAT
1420    OUTPUT @Dig;"SYST:ERR?"
1430    ENTER @Dig;Err_msg$
1440    PRINT Err_msg$
1450  UNTIL Err_msg$="+0,""No error"""
1460  STOP
1470 End_prog:  !
1480  END
```

Typical Result

HP E1429A/B Digitizers DC Accuracy Test

Date: 11 Feb 1994
Time: 14:30:01

Port	Range (Vdc)	Input (Vdc)	Minimum (Vdc)	Measurement (Vdc)	Maximum (Vdc)	Pass/Fail
1	.10230	-.07	-.07079	-.07001	-.06921	
.	.	.	.	.	.	
.	.	.	.	.	.	
4	102.30000	+70.00	+67.60400	+69.91	+72.39600	

Performance Test Record

Table 3-1, *HP E1429A/B Digitizers Performance Test Record*, is a form you can copy and use to record performance verification test results for the digitizers. This table shows digitizer instrument accuracy, Datron 4708 (source) measurement uncertainty, and test accuracy ratio (TAR) values. See *Appendix B - Calculating Digitizer Accuracy* for information on accuracy, measurement uncertainty, and TAR calculations.

Digitizer Test Limits

Test limits are defined using the 1-year specifications in *Appendix A-Specifications* of the *HP E1429A/B User's Manual*. See *Appendix B - Calculating Digitizer Accuracy* in this manual for sample calculations of digitizer 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 B - Calculating Digitizer Accuracy* in this manual for sample calculations of measurement uncertainty.

Test Accuracy Ratio (TAR)

Test Accuracy Ratio (TAR) for the HP E1429A/B digitizers is defined as Digitizer Accuracy divided by Measurement Uncertainty, where accuracy = maximum allowable value - expected reading (input). That is:

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

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

Table 3-1. HP E1429A/B Digitizers Performance Test Record (Page 1 of 5)

Test Facility:

Name _____ Report No. _____

Address _____ Date _____

City/State _____ Customer _____

Phone _____ Tested by _____

Model _____ Ambient temperature _____ ^{o}C

Serial No. _____ Relative humidity _____%

Options _____ Line frequency _____ Hz (nominal)

Firmware Rev. _____

Special Notes:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Table 3-1. HP E1429A/B Digitizers Performance Test Record (Page 2 of 5)

Model _____ **Report No.** _____ **Date** _____

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 3-1. HP E1429A/B Digitizers Performance Test Record (Page 3 of 5)

Test 3-1: DC Voltage Measurement Accuracy - Port 1 Measurements (All values in Vdc)

Range	Input	Minimum	Measured	Maximum	M.U.*	TAR**
-0.10225	-0.07	-0.0708	_____	-0.0692	1.1E-6	>10:1
to	-0.03	-0.0306	_____	-0.0294	9.2E-7	>10:1
+0.10230	+0.03	+0.0294	_____	+0.0306	9.2E-7	>10:1
	+0.07	+0.0692	_____	+0.0708	1.1E-6	>10:1
-0.2045	-0.15	-0.1516	_____	-0.1484	1.4E-6	>10:1
to	-0.06	-0.0613	_____	-0.0587	1.0E-6	>10:1
+0.2046	+0.06	+0.0587	_____	+0.0613	1.0E-6	>10:1
	+0.15	+0.1484	_____	+0.1516	1.4E-6	>10:1
-0.51125	-0.35	-0.3540	_____	-0.3460	2.2E-6	>10:1
to	-0.15	-0.1532	_____	-0.1468	1.4E-6	>10:1
+0.5115	+0.15	+0.1468	_____	+0.1532	1.4E-6	>10:1
	+0.35	+0.3460	_____	+0.3540	2.2E-6	>10:1
-1.0225	-0.7	-0.7079	_____	-0.6921	4.8E-6	>10:1
to	-0.3	-0.3063	_____	-0.2937	3.8E-6	>10:1
+1.0230	+0.3	+0.2937	_____	+0.3063	3.8E-6	>10:1
	+0.7	+0.6921	_____	+0.7079	4.8E-6	>10:1

Test 3-1: DC Voltage Measurement Accuracy - Port 2 Measurements (All values in Vdc)

Range	Input	Minimum	Measured	Maximum	M.U.*	TAR**
-0.10225	-0.07	-0.0708	_____	-0.0692	1.1E-6	>10:1
to	-0.03	-0.0306	_____	-0.0294	9.2E-7	>10:1
+0.10230	+0.03	+0.0294	_____	+0.0306	9.2E-7	>10:1
	+0.07	+0.0692	_____	+0.0708	1.1E-6	>10:1
-0.2045	-0.15	-0.1516	_____	-0.1484	1.4E-6	>10:1
to	-0.06	-0.0613	_____	-0.0587	1.0E-6	>10:1
+0.2046	+0.06	+0.0587	_____	+0.0613	1.0E-6	>10:1
	+0.15	+0.1484	_____	+0.1516	1.4E-6	>10:1
-0.51125	-0.35	-0.3540	_____	-0.3460	2.2E-6	>10:1
to	-0.15	-0.1532	_____	-0.1468	1.4E-6	>10:1
+0.5115	+0.15	+0.1468	_____	+0.1532	1.4E-6	>10:1
	+0.35	+0.3460	_____	+0.3540	2.2E-6	>10:1
-1.0225	-0.7	-0.7079	_____	-0.6921	4.8E-6	>10:1
to	-0.3	-0.3063	_____	-0.2937	3.8E-6	>10:1
+1.0230	+0.3	+0.2937	_____	+0.3063	3.8E-6	>10:1
	+0.7	+0.6921	_____	+0.7079	4.8E-6	>10:1

* M.U. = 90-day accuracy of the Datron 4708 @ 23^0C $\pm 1^0$C

** TAR = Test Accuracy Ratio = Digitizer Accuracy/Source M.U., shown

Table 3-1. HP E1429A/B Digitizers Performance Test Record (Page 4 of 5)

Test 3-1: DC Voltage Measurement Accuracy - Port 3 Measurements (All values in Vdc)

Range	Input	Minimum	Measured	Maximum	M.U.	TAR
-0.10225	-0.07	-0.0724	_____	-0.0676	1.1E-6	>10:1
to	-0.03	-0.0322	_____	-0.0278	9.2E-7	>10:1
+0.10230	+0.03	+0.0278	_____	+0.0322	9.2E-7	>10:1
	+0.07	+0.0676	_____	+0.0724	1.1E-6	>10:1
-0.2045	-0.15	-0.1548	_____	-0.1452	1.4E-6	>10:1
to	-0.06	-0.0644	_____	-0.0556	1.0E-6	>10:1
+0.2046	+0.06	+0.0556	_____	+0.0644	1.0E-6	>10:1
	+0.15	+0.1452	_____	+0.1548	1.4E-6	>10:1
-0.51125	-0.35	-0.362	_____	-0.338	2.2E-6	>10:1
to	-0.15	-0.161	_____	-0.139	1.4E-6	>10:1
+0.5115	+0.15	+0.139	_____	+0.161	1.4E-6	>10:1
	+0.35	+0.338	_____	+0.362	2.2E-6	>10:1
-1.0225	-0.7	-0.724	_____	-0.676	4.8E-6	>10:1
to	-0.3	-0.322	_____	-0.278	3.8E-6	>10:1
+1.0230	+0.3	+0.278	_____	+0.322	3.8E-6	>10:1
	+0.7	+0.676	_____	+0.724	4.8E-6	>10:1
-2.045	-1.4	-1.448	_____	-1.352	6.5E-6	>10:1
to	-0.6	-0.644	_____	-0.556	4.5E-6	>10:1
+2.046	+0.6	+0.556	_____	+0.644	4.5E-6	>10:1
	+1.4	+1.352	_____	+1.352	6.5E-6	>10:1
-5.1125	-3.5	-3.62	_____	-3.38	1.2E-5	>10:1
to	-1.5	-1.61	_____	-1.39	6.8E-6	>10:1
+5.115	+1.5	+1.39	_____	+1.61	6.8E-6	>10:1
	+3.5	+3.38	_____	+3.62	1.2E-5	>10:1
-10.225	-7	-7.24	_____	-6.76	7.8E-5	>10:1
to	-3	-3.22	_____	-2.78	6.2E-5	>10:1
+10.230	+3	+2.78	_____	+3.22	6.2E-5	>10:1
	+7	+6.76	_____	+7.24	7.8E-5	>10:1
-20.45	-14	-14.48	_____	-13.32	1.1E-4	>10:1
to	-6	-6.44	_____	-5.56	7.4E-5	>10:1
+20.46	+6	+5.56	_____	+6.44	7.4E-5	>10:1
	+14	+13.52	_____	+14.48	1.1E-4	>10:1
-51.125	-35	-36.2	_____	-33.8	1.9E-4	>10:1
to	-15	-16.1	_____	-13.9	1.1E-4	>10:1
+51.15	+15	+13.9	_____	+16.1	1.1E-4	>10:1
	+35	+33.8	_____	+36.2	1.9E-4	>10:1
-102.25	-70	-72.4	_____	-67.6	3.3E-4	>10:1
to	-30	-32.2	_____	-27.8	1.7E-4	>10:1
102.30	+30	+27.8	_____	+32.2	1.7E-5	>10:1
	+70	+67.6	_____	+72.4	3.3E-4	>10:1

Table 3-1. HP E1429A/B Digitizers Performance Test Record (Page 5 of 5)

Test 3-1: DC Voltage Measurement Accuracy - Port 4 Measurements (All values in Vdc)

Range	Input	Minimum	Measured	Maximum	M.U.*	TAR**
-0.10225	-0.07	-0.0724	_____	-0.0676	1.1E-6	>10:1
to	-0.03	-0.0322	_____	-0.0278	9.2E-7	>10:1
+0.10230	+0.03	+0.0278	_____	+0.0322	9.2E-7	>10:1
	+0.07	+0.0676	_____	+0.0724	1.1E-6	>10:1
-0.2045	-0.15	-0.1548	_____	-0.1452	1.4E-6	>10:1
to	-0.06	-0.0644	_____	-0.0556	1.0E-6	>10:1
+0.2046	+0.06	+0.0556	_____	+0.0644	1.0E-6	>10:1
	+0.15	+0.1452	_____	+0.1548	1.4E-6	>10:1
-0.51125	-0.35	-0.362	_____	-0.338	2.2E-6	>10:1
to	-0.15	-0.161	_____	-0.139	1.4E-6	>10:1
+0.5115	+0.15	+0.139	_____	+0.161	1.4E-6	>10:1
	+0.35	+0.338	_____	+0.362	2.2E-6	>10:1
-1.0225	-0.7	-0.724	_____	-0.676	4.8E-6	>10:1
to	-0.3	-0.322	_____	-0.278	3.8E-6	>10:1
+1.0230	+0.3	+0.278	_____	+0.322	3.8E-6	>10:1
	+0.7	+0.676	_____	+0.724	4.8E-6	>10:1
-2.045	-1.4	-1.448	_____	-1.352	6.5E-6	>10:1
to	-0.6	-0.644	_____	-0.556	4.5E-6	>10:1
+2.046	+0.6	+0.556	_____	+0.644	4.5E-6	>10:1
	+1.4	+1.352	_____	+1.352	6.5E-6	>10:1
-5.1125	-3.5	-3.62	_____	-3.38	1.2E-5	>10:1
to	-1.5	-1.61	_____	-1.39	6.8E-6	>10:1
+5.115	+1.5	+1.39	_____	+1.61	6.8E-6	>10:1
	+3.5	+3.38	_____	+3.62	1.2E-5	>10:1
-10.225	-7	-7.24	_____	-6.76	7.8E-5	>10:1
to	-3	-3.22	_____	-2.78	6.2E-5	>10:1
+10.230	+3	+2.78	_____	+3.22	6.2E-5	>10:1
	+7	+6.76	_____	+7.24	7.8E-5	>10:1
-20.45	-14	-14.48	_____	-13.32	1.1E-4	>10:1
to	-6	-6.44	_____	-5.56	7.4E-5	>10:1
+20.46	+6	+5.56	_____	+6.44	7.4E-5	>10:1
	+14	+13.52	_____	+14.48	1.1E-4	>10:1
-51.125	-35	-36.2	_____	-33.8	1.9E-4	>10:1
to	-15	-16.1	_____	-13.9	1.1E-4	>10:1
+51.15	+15	+13.9	_____	+16.1	1.1E-4	>10:1
	+35	+33.8	_____	+36.2	1.9E-4	>10:1
-102.25	-70	-72.4	_____	-67.6	3.3E-4	>10:1
to	-30	-32.2	_____	-27.8	1.7E-4	>10:1
102.30	+30	+27.8	_____	+32.2	1.7E-5	>10:1
	+70	+67.6	_____	+72.4	3.3E-4	>10:1

Notes

Chapter 4
Adjustments

Introduction

The procedures in this chapter show how to perform electronic and mechanical adjustments for the HP E1429A/B digitizers, including:

- Electronic Adjustments
  - A/D converter delay constant
  - zero offset adjustments
  - channel gain adjustments

- Mechanical Adjustments
  - AC common mode rejection ratio (AC CMRR)
  - Flatness adjustments

Adjustments Guidelines

Table 4-1 summarizes suggested adjustments procedures for the HP E1429A/B digitizers. Note that the adjustments MUST be done in the order listed above (electronic adjustments followed by mechanical adjustments).

Table 4-1. HP E1429A/B Digitizers Adjustment Guidelines

If this test fails:	Do these adjustments:	After you do the adjustments:
Test F-1: Self-Test	Electronic Adjustments	Rerun the self-test. If the test still fails, replace the instrument.
Test F-2: DC CMRR	Electronic Adjustments	Rerun the DC CMRR test. If the test still fails, replace the instrument.
Test F-3: AC CMRR	Electronic Adjustments	Rerun the AC CMRR test. If the test still fails, replace the instrument.
Test 3-1: DC Accuracy	Electronic Adjustments followed by Mechanical Adjustments	After doing the Electronic Adjustments, rerun the DC Accuracy Test. If the test then fails, do the Mechanical Adjustments and rerun the test. If the test still fails, replace the instrument.

Adjustments Environment

See Table 1-1 in *Chapter 1 - General Information* for test equipment required for the procedures described in this chapter. Before performing adjustments, allow the HP E1429A/B digitizer to warm up for at least one hour. The temperature should be within $\pm 5^{o}C$ of the temperature of the most recent adjustments and between $18^{o}C$ and $28^{o}C$.

Making Electronic Adjustments

This section shows how to make electronic adjustments for the HP E1429A/B digitizers, including adjustments for:

- A/D converter delay constant
- Zero offset
- Channel gain

NOTE

Perform electronic adjustments if the self-test, DC CMRR, AC CMRR, or DC Accuracy test in Chapter 3 - Verification Tests fails. Electronic adjustments must be done in the order shown above.

Description

This procedure adjusts each range for ports 1 through 4 on the digitizer. This procedure uses default settings for the zero offset and gain adjustments. See *Appendix A - CALibration Commands* to change settings as required.

Equipment Setup

- Connect the equipment as shown in Figure 4-1
- Set the DC source output to 1.0 Vdc

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.

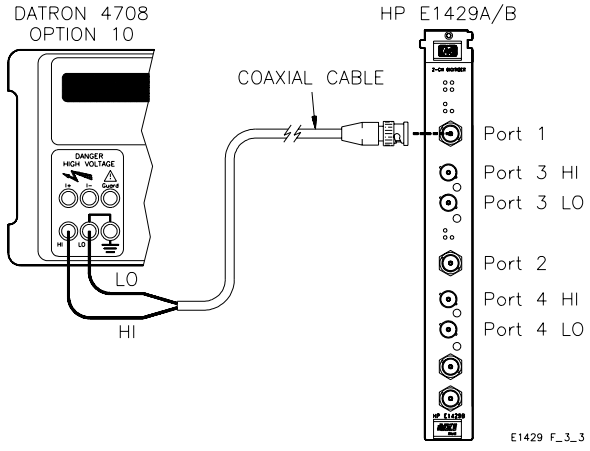


Figure 4-1. Electronic Adjustments Setup

Adjustment Procedure

1. Reset the digitizer:

```
*RST;*CLS                    Reset digitizer
```

2. Read starting number of calibrations:

```
CAL:COUN?                    Query calibration count
```

3. Adjust A/D converter delay constant:

```
CAL:STOR:AUTO OFF            Do not store cal constants
CAL:SEC:STAT OFF,E1429       Turn cal security OFF
CAL:DEL                      Calibrate delay constant
                             for A/D converter
```

4. Make zero offset adjustments for channels 1 and 2:

```
CAL1:ZERO DEF,DEF,ALL        Zero offset cal on channel 1
CAL2:ZERO DEF,DEF,ALL        Zero offset cal on channel 2
```

5. Make gain adjustments for all ranges on ports 1-4:

```
CONF <chan>:ARR:VOLT (1000),<input>,DEF,<port>
                             Configure each channel
                             for 1000 readings for the
                             input and port specified
CAL <chan>:VAL <input>       Specify voltage level to be
                             applied to port
```

Repeat Step 5 for all ranges and ports in the order shown in the following table:

Ports	Range (Vdc)	Input (Vdc)	Ports	Range (Vdc)	Input (Vdc)
1/2	1.0230	1.0	3/4	1.0230	1.0
	0.1023	0.1		0.1023	0.1
	0.2046	0.2		0.2046	0.2
	0.5115	0.5		0.5115	0.5
				2.046	2.0
				5.1125	5.0
				10.23	10.0
				20.46	20.0
				51.15	50.0
				102.30	50.0*

*Do NOT exceed 50 Vdc for the 102 Vdc range

6. Store cal constants/read ending cal number:

```
CAL1:STOR                    Store chan 1 cal const
CAL2: STOR                   Store chan 2 cal const
CAL:COUN?                    Query  calibration number
```

7. Turn calibration security ON:

```
CAL:SEC:STAT ON              Turn calibration security
                             ON for both channels
```

Example Program

An example program follows to perform an A/D converter delay constant adjustment, zero offset adjustment, and channel gain adjustments for channels 1 and 2. This program performs all adjustments using default settings. If you do not want to use the default settings, see *Appendix A - CALibration Commands* for guidelines to set changes.

```
10!  RE-STORE "ADJUST"
20   !
30   ! ---------- Initial Setup ----------
40   !
50   CLEAR SCREEN
60   Addr=70905                                          !Factory-set logical address
70   INPUT " Enter digitizer logical address (default = 70905) ",Addr
80   ASSIGN @Dig TO Addr                                 !Assign @Dig to digitizer address
90   OUTPUT @Dig;"*RST;*CLS"                             !Reset instrument
100  !
110  ! -------- Read starting calibration count ----------
120  !
130  OUTPUT @Dig;"CAL:COUN?"                             !Query calibration count (shared by
                                                         both channels)
140  ENTER @Dig;Cal_ct_orig                              !Enter calibration count
150  !
160  !--------- Adjust A/D converter delay constant ----------
170  !
180  OUTPUT @Dig;"CAL:SEC:STAT OFF,E1429"                !Turn cal security OFF (both channels)
190  OUTPUT @Dig;"CAL:STOR:AUTO OFF"                     !Turn off  storage of  cal constants
200  OUTPUT @Dig;"CAL:DEL"                               !Adjust A/D converter delay constant
                                                         (both channels)
210  !
220  !------ Zero offset adjustments for Channels 1 and 2 ------
230  !
240  OUTPUT @Dig;"CAL1:ZERO DEF,DEF,ALL"                 !Zero offset adjustment for channel 1
250  OUTPUT @Dig;"CAL2:ZERO DEF,DEF,ALL"                 !Zero offset adjustment for channel 2
260  !
270  !---- Gain adjustments for all ranges on ports 1-4 -------
280  !
290  DIM Input(1:10),Range(1:10)
300  DATA 1.0,0.1,0.2,0.5,2.0,5.0,10.0,20.0,50.0,50.0
310  READ Input(*)                                       !Enter voltage source input values
320  DATA 1.0,0.1,0.2,0.5,2.0,5.0,10.0,20.0,50.0,100.0
330  READ Range(*)                                       !Enter digitizer voltage ranges
340  FOR Port=1 TO 4                                     !Gain adjustments for all four ports
350    IF Port=1 OR Port=3 THEN Chan=1
```

(continued on next page)

```
360    IF Port=2 OR Port=4 THEN Chan=2
370    IF Port=1 OR Port=2 THEN Nbr=4
380    IF Port=3 OR Port=4 THEN Nbr=10
390    FOR I=1 TO Nbr
400 Retry:    !
410      CLEAR SCREEN
420      PRINT "HP E1429A/B Digitizer Gain Adjustments"
430      PRINT
440      PRINT "Port:";Port;"  Range:";Range(I);"Vdc"
450      PRINT
460      IF Port=1 OR Port=2 THEN
470      PRINT "1. Connect DC source output to Port";Port
480      PRINT "2. Set DC source output to ";Input(I);"Vdc"
490     ELSE
500      PRINT "1. Connect DC source output to Port";Port;"HI"
510      PRINT "2. Set DC source output to ";Input(I);"Vdc"
520     END IF
530      IF I=10 THEN
540        PRINT
550        PRINT "              WARNING"
560        PRINT
570        PRINT "The input for the 100V range is 50 Vdc, NOT"
580        PRINT "100 Vdc. To avoid possible shock hazard, do NOT"
590        PRINT "input more than 50 Vdc for this adjustment. "
600      END IF
610      DISP " Press Continue when voltage is input "
620      PAUSE
630      OUTPUT @Dig;"CONF"&VAL$(Chan)&":ARR:VOLT (1000),    !CONFigure digitizer to known state
"&VAL$(Input(I))&",DEF,(@"&VAL$(Port)&")"
640      OUTPUT @Dig;"CAL"&VAL$(Chan)&":VAL ";Input(I)       !Specify input voltage
650      OUTPUT @Dig;"CAL"&VAL$(Chan)&":GAIN DEF,DEF"        !Perform channel gain on specified port
660      DIM Err_msg$[256]
670      OUTPUT 70905;"SYST:ERR?"                            !Check for gain adjustment errors
680      ENTER 70905;Code,Err_msg$
690      IF Code<>0 THEN GOTO Err_chk                        !Call error routine on error
700     NEXT I                                               !Next adjustment
710   NEXT Port                                              !Next port
720   !
730   ! ------- Read new calibration constants ----------
740   !
750   DIM Ndig$[1],Count$[9]                                 !Dimension header parameters
760   ASSIGN @Digu TO Addr;FORMAT OFF                        !Turn FORMAT OFF for array data
770   OUTPUT @Dig;"FORM PACK"                                !Set PACKed format
```

(continued on next page)

```
780  FOR J=1 TO 2
790    OUTPUT @Dig;"CAL"&VAL$(J)&":DATA?"                    !Query channel calibration constants
800    ENTER @Digu USING "#,X,K,K";Ndig$;Count$[1;VAL(Ndig$)] !Strip off header
810    IF J=1 THEN
820      ALLOCATE INTEGER Cal1_data(1:VAL(Count$)/2)          !Allocate array for channel 1 data
830      ENTER @Digu;Cal1_data(*)                             !Enter channel 1 data
840      ENTER @Dig USING "B";Line_feed                       !Strip off leftover line feed
850    ELSE
860      ALLOCATE INTEGER Cal2_data(1:VAL(Count$)/2)          !Allocate array for channel 2 data
870      ENTER @Digu;Cal2_data(*)                             !Enter channel 2 data
880      ENTER @Dig USING "B";Line_feed                       !Strip off leftover line feed
890    END IF
900  NEXT J
910  !
920  !------------ Store cal constants/read cal count ------
930  !
940  OUTPUT @Dig;"CAL1:STOR"
950  OUTPUT @Dig;"CAL2:STOR"
960  OUTPUT @Dig;"CAL:COUN?"
970  ENTER @Dig;Cal_count
980  !
990  !------------ Display results ----------------------
1000 !
1010 CLEAR SCREEN
1020 PRINT "HP E1429A/B Digitizer Calibration Constants"
1030 PRINT
1040 PRINT "Date: ";DATE$(TIMEDATE)
1050 PRINT "Time: ";TIME$(TIMEDATE)
1060 PRINT "Starting calibration count =";Cal_ct_orig
1070 PRINT "Ending calibration count   =";Cal_count
1080  PRINT
1090  PRINT "Channel 1 Calibration Constants"
1100  PRINT
1110  PRINT Cal1_data(*)
1120  PRINT
1130 PRINT "Channel 2 Calibration Constants"
1140 PRINT
1150 PRINT Cal2_data(*)
1160 GOTO No_err
1170 !
1180 !---------------On error, display error message ---------------
1190 !
```

(continued on next page)

```
1200 Err_chk:!
1210  CLEAR SCREEN
1220  PRINT
1230  PRINT "Gain Adjustment Error"
1240  PRINT
1250  PRINT "Port:    ";Port
1260  PRINT "Range:  ";Range(I);"Vdc"
1270  PRINT "Input:  ";Value(I);"Vdc"
1280  BEEP
1290  PRINT
1300  PRINT Code,Err_msg$                                  !Display error message
1310  PRINT
1320  PRINT "1. Check input value/port connections"
1330  PRINT "2. Correct as necessary and rerun this adjustment"
1340  DISP " Press Continue to rerun this adjustment "
1350  PAUSE
1360  GOTO Retry
1370 No_err:  !
1380  OUTPUT @Dig;"CAL:SEC:STAT ON"                        !Turn cal security ON (both channels)
1390  END
```

Typical Result

A typical result follows. In the following display for channel 1, index 0 in Table 2-1 = -147, index 1 = 939,..., index 61 = -307. For channel 2, index 0 = -150, index 1 = 939,..., index 61 = -310.

Since this program generates 30 adjustments (2 for zero offset adjustments, 8 for channel gain adjustments on Ports 1 and 2, and 20 for channel gain adjustments on Ports 3 and 4), the difference between the starting and ending calibration count should be 30 counts.

HP E1429A/B Digitizer Calibration Constants

Date: 17 Feb 1994
Time: 10:15:23
Starting calibration count = 189
Ending calibration count = 219

Channel 1 Calibration Constants

-147	939	533	336	-819	-450	-21	59
-30	58	21	88	-15	57	21	99
-42	43	387	-310	117	2047	-2048	-328
397	-300	-306	407	-290	-290	413	-284
-343	385	-312	-310	387	-310	-293	391
-306	-277	390	-307	-279	393	-304	-279
397	-300	-281	391	-306	-280	392	-305
-281	395	-302	-281	390	-307		

Channel 2 Calibration Constants

-150	939	533	336	-819	-450	-21	59
-30	58	21	88	-15	57	21	99
-42	43	387	-310	117	2047	-2048	-328
397	-300	-306	407	-290	-290	413	-284
-343	385	-312	-310	387	-310	-293	391
-306	-277	390	-307	-279	393	-304	-279
397	-300	-281	391	-306	-280	392	-305
-281	395	-302	-281	390	-310		

Making Mechanical Adjustments

This section shows how to make mechanical adjustments for the HP E1429A/B digitizers, including:

- AC Common Mode Rejection Ratio (AC CMRR) Adjustments
- Flat Frequency Response (Flatness) Adjustments

NOTE

The electronic adjustments shown in "Making Electronic Adjustments" MUST be done before doing any of the mechanical adjustments. Also, the AC CMRR adjustment must be done before the Flatness adjustment.

AC Common Mode Rejection Ratio Adjustments

This procedure allows the user to minimize the differential voltage by adjusting AC CMRR to maximum.

Description

This procedure adjusts the digitizer so that AC Common Mode Rejection Ratio (AC CMRR) for the differential input ports is maximized. This, in turn, minimizes the differential voltage for the digitizer.

As shown in Figure 4-2, to perform AC CMRR adjustments an input of 20.0 Vac PP @ 999990 Hz is applied simultaneously to the HI and LO inputs of (differential) port 3 or port 4, with the digitizer set to the 0.1V range. Capacitor C306 (for channel 1) or C406 (for channel 2) is then adjusted until the differential voltage is minimized.

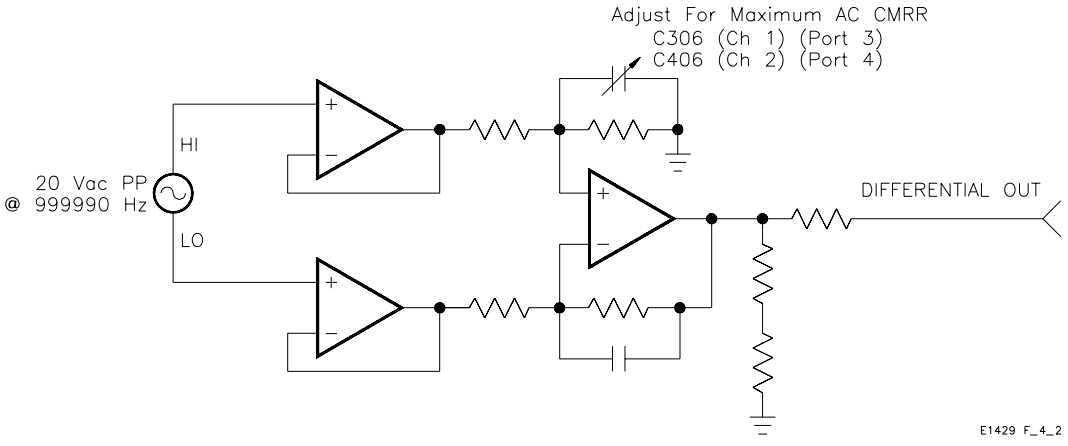


Figure 4-2. AC CMRR Adjustments

Equipment Setup

- Set up the equipment as shown in Figure 4-3
- Set DC source output to 20.0 Vac PP @ 999990 Hz

WARNING

The DC Standard (Datron 4708, Option 20) 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.

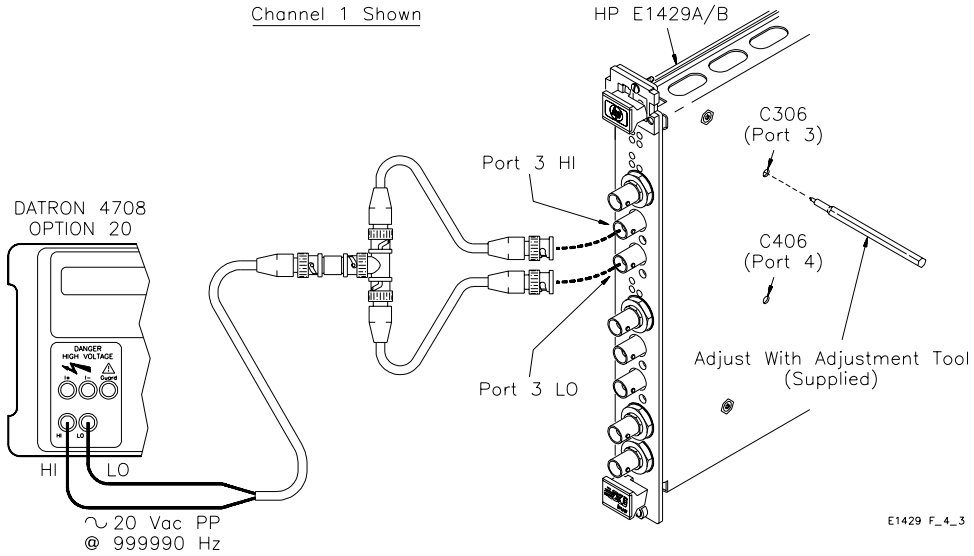


Figure 4-3. AC CMRR Adjustments Setup

Test Procedure

1. Make Channel 1 measurements:

MEAS1:ARR:VOLT? (1000),0.1,DEF,(@3)	*Set digitizer for ch 1 meas, 1000 readings, 0.1V range, input on port 3*
ENTER statement;Values	*Store 1000 readings in data array A*

2. Compute AC CMRR

Cmrr=20*LGT(7.0714356/Std_dev)	*(Calculate AC CMRR for 20.0 Vac input (see Test F-3 in Chap 3)*

3. Repeat the test for Channel 2 input

Make connections to port 4 HI and LO

MEAS2:ARR:VOLT? (1000),0.1,DEF,(@4)	*Set digitizer for ch 2 meas, 1000 readings, 0.1V range, input on port 4*

Example Program This program allows you to adjust C306 (channel 1) or C406 (channel 2) for maximum AC CMRR. The display is similar to the following. Adjust C306 or C406 until the AC CMRR value is maximized.

AC Common Mode Rejection Ratio = 84.3 dB

70 dB 75 dB 80 dB 85 dB 90 dB

```
10    ! RE-STORE "AC_ADJS"
20    !
30    ! ---------------------------- Initial Setup --------------------------------
40    !
50    Addr=70905                                                    !Factory-set address
60    INPUT " Enter digitizer logical address (default = 70905) ",Addr   !Enter digitizer address
70    ASSIGN @Dig TO Addr                                           !Assign @Dig to digitizer address
80    DIM A(1:1000),Value(1:1000)                                   !Dimension arrays for values
90    FOR Chan=1 TO 2                                               !Loop for both channels
100     CLEAR SCREEN
110     PRINT "AC Common Mode Rejection Ratio Adjustments - Channel";Chan
120     PRINT
130     PRINT "1. Connect AC source to Port";Chan+2;"HI and LO"
140     PRINT "2. Set AC source output to 20.0 Vac PP @ 1 MHz"
150     DISP " Press Continue when ready to start adjustments "
160     PAUSE
170    CLEAR SCREEN
180   !
190   ! ------------------- Make measurements --------------------------
200   !
210 Read:   !
220   OUTPUT @Dig;"MEAS"&VAL$(Chan)&":ARR:VOLT? (1000),
0.1,DEF,(@"&VAL$(Chan+2)&")"                                        !Take 1000 readings on specified port
                                                                    with digitizer set to 0.1V range
230   ENTER @Dig;Value(*)                                           !Enter 1000 readings
240   !
250   ! ---------------- Compute AC CMRR --------------------------------
260   !
270   FOR I=1 TO 1000                                               !Loop to calculate error values
280     A(I)=Value(I)^2                                             !Calculate error values
290   NEXT I
300   Std_dev=SQR(((1000.0*SUN(A)-SUM(Value)^2))/9.9999E+5)         !Calculate std deviation of errors
310   Cmrr=20.0*LGT(7.0714356/Std_dev)                              !Compute AC CMRR
320   !
```

(continued on next page)

```
330   !---------------------- Display CMRR values -------------------------
340   !
350   PRINT TABXY(1,1),"AC CMRR Adjustments for Channel";Chan
360   IF Chan=1 THEN
370      PRINT TABXY(1,4),"1. Adjust C306 for maximum CMRR value"      !Channel 1 user adjustments
380      PRINT TABXY(1,5),"2. Press Return key for Channel 2 adjustments"
390   END IF
400   IF Chan=2 THEN
410     PRINT TABXY(1,4),"1. Adjust C406 for maximum CMRR value"  !Channel 2 user adjustments
420     PRINT TABXY(1,5),"2. Press Return key to end this program"
430   END IF
440   PRINT TABXY(1,8),"AC Common Mode Rejection Ratio =";DROUND(Cmrr,3);"dB    "
450   PRINT TABXY(1.5*(Cmrr-65),10),CHR$(252),CHR$(32)
460   PRINT TABXY(1,11),"70 dB   75 dB    80 dB    85 dB    90 dB"
470   ON KBD GOTO Compl                                    !Go to next channel or end program
                                                           when user presses keyboard key
480   GOTO Read                                            !Loop until user presses keyboard key
490 Compl:   !
500   NEXT Chan
510   CLEAR SCREEN
520   END
```

Typical Result A typical result for Channel 1 follows.

AC CMMR Adjustments for Channel 1

1. Adjust C306 for maximum CMRR value
2. Press Return key for Channel 2 adjustments

AC Common Mode Rejection Ratio = 84.3 dB

70 dB 75 dB 80 dB 85 dB 90 dB

Flatness Adjustments

This adjustment measures the voltage at 1 kHz (reference value) and the voltage at 100 kHz, and allows the user to adjust the digitizer so that the two values are as nearly as possible equal (flat frequency response).

NOTE

Do NOT perform flatness adjustments unless the electronic adjustments (A/D converter delay constant, zero offset, and gain) for channels 1 and 2 have been performed, the digitizer has passed the DC CMRR test, and the AC CMRR adjustments have been performed.

Description

As shown in Figure 4-4, for flatness adjustments a 16.0 Vac PP signal @ 990 Hz is input to Port 3 HI and is measured to form a reference value. The input is then changed to 99990 Hz and the value is again measured. The user adjusts the front-panel Port 3 HI "Svc Only" adjustment until the value at 100 kHz matches the 1 kHz reference value. This procedure is repeated for Port 3 LO, Port 4 HI, and Port 4 LO.

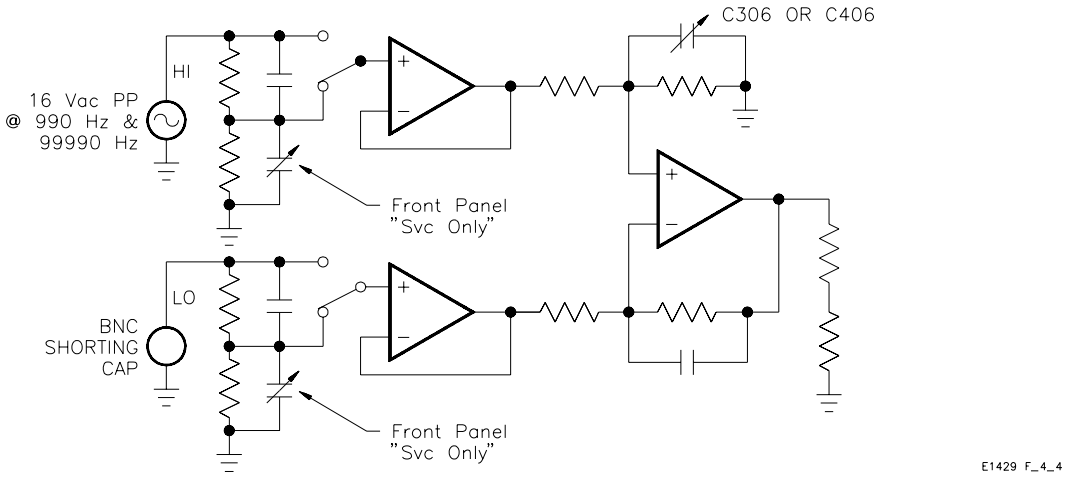


Figure 4-4. Flatness Adjustments

Equipment Setup

- Set up the equipment as shown in Figure 4-5
- Set DC source output to 16.0 Vac @ 990 Hz

WARNING

The DC Standard (Datron 4708, Option 20) 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.

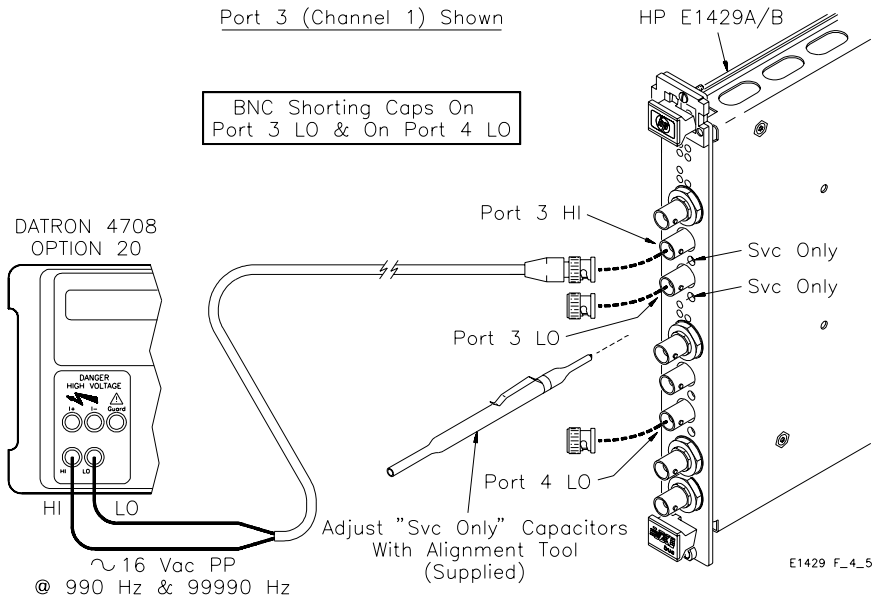


Figure 4-5. Flatness Adjustments Setup

Test Procedure

1. Make Port 3 HI measurements:

```
MEAS1:ARR:VOLT?  (1000),10.0,DEF,(@3)   Set digitizer for ch 1 meas,
                                        1000 readings, 10.0V
                                        range,  input on port 3 HI
ENTER statement;A                       Store 1000 readings in A
```

2. Compute CMRR

```
Rms1 = ABS(MAX(A(*)))/SQRT(2)           RMS value at 1 kHz
Rms2 = ABS(MAX(A(*)))/SQRT(2)           RMS value at 100 kHz
Db=20*LGT(Rms2/Rms1)                    Calculate relative gain
```

3. Repeat test for Port 3 LO

   Make connections to port 3 LO

Repeat steps 1 through 3 for channel 2 (port 4 HI and LO)

Example Program

This program allows you to adjust each channel for maximum flatness. The display is similar to the following. Adjust the appropriate front-panel "Svc Only" capacitor until the difference between the measured values at 1 kHz and 100 kHz (relative gain) is minimized (ideally 0 dB).

Relative Gain = 1.3 dB

```
10!   RE-STORE "FLATNESS"
20    !
30    ! ---------- Initial Setup ----------
40    !
50     CLEAR SCREEN
60     Addr=70905                                                    !Factory-set address
70     DIM A(1:1000)                                                 !Dimension array to store 1000 readings
80     INPUT " Enter digitizer logical address (default = 70905) ",Addr  !User enters digitizer address
90    ASSIGN @Dig TO Addr                                           !Assign @Dig to digitizer address
100   FOR Chan=1 TO 2                                              !Loop for channels 1 and 2
110    FOR Input=1 TO 2                                             !Loop for 1 kHz and 100 kHz inputs
120      CLEAR SCREEN
130      IF Input=1 THEN
140        PRINT "Flatness Adjustments - Port";Chan+2;"HI"
150        PRINT
160        PRINT "1. Connect AC source to Port";Chan+2;"HI"
170        PRINT "2. Connect BNC shorting cap to Port";Chan+2;"LO"
180        PRINT "3. Set AC source output to 16.0 Vac PP"
190      ELSE
200        PRINT "Flatness Adjustments - Port";Chan+2;"LO"
210        PRINT
220        PRINT "1. Connect AC source to Port";Chan+2;"LO"
230        PRINT "2. Connect BNC shorting cap to Port";Chan+2;"HI"
240        PRINT "3. Set AC source output to 16.0 Vac PP"
250      END IF
260      DISP " Press Continue when ready "
270      PAUSE
280 Retry:       !
290      CLEAR SCREEN
300      FOR Freq=1 TO 2
310        IF Freq=1 THEN PRINT "Set AC source output to 990 Hz"
320        IF Freq=2 THEN PRINT "Set AC source output to 99990 Hz"
330        DISP " Press Continue when ready "
340        PAUSE
350        CLEAR SCREEN
360   !
370   ! ---------- Make measurements ----------
380   !
```

```
390       OUTPUT @Dig;"MEAS"&VAL$(Chan)&":ARR:VOLT? (1000), !Make 1000 measurements on the
10.0,DEF,(@"&VAL$(Chan+2)&")"                                specified port with the digitizer set to
                                                             10.0V range
400       ENTER @Dig;A(*)                                    !Store 1000 readings
410       IF Freq=1 THEN Rms1=ABS(MAX(A(*)))/SQRT(2)         !Compute rms value at 1 kHz
420       IF Freq=2 THEN Rms2=ABS(MAX(A(*)))/SQRT(2)         !Compute rms value at 100 kHz
430     NEXT Freq
440     IF Rms2=Rms1 THEN GOTO Compl                         !Avoid potential divide by zero error
450     Db=20*LGT(Rms2/Rms1)                                 !Compute relative gain (in dB)
460   !
470   !------------------- Display difference value ----------------------
480   !
490     IF Db<.1 THEN GOTO Compl
500     IF Input=1 THEN
510       PRINT "Flatness Adjustments for Port";Chan+2;"HI"
520       PRINT
530       PRINT "Relative Gain (dB) = ";DROUND(Db,3);"dB"
540       PRINT
550       PRINT "1. Adjust port";Chan+2;"HI ""Svc Only"" capacitor"
560     ELSE
570       PRINT "Flatness Adjustments for Port";Chan+2;"LO"
580       PRINT
590       PRINT "Relative Gain (dB) = ";DROUND(Db,3);"dB"
600       PRINT
610       PRINT "1. Adjust port";Chan+2;"LO ""Svc Only"" capacitor"
620     END IF
630     PRINT "2. Press Continue to check new  value"
640     ON KBD GOTO Compl                                    !User presses keyboard key to go to next
                                                             channel or to end program
650     PAUSE
660     GOTO Retry
670 Compl:      !
680     IF Input=1 THEN PRINT "Relative Gain for Port";Chan+2;"HI = 0 dB"
690     IF Input=2 THEN PRINT "Relative Gain for Port";Chan+2;"LO = 0 dB"
700     IF Chan=2 AND Input=2 THEN
710       GOTO End_of_test
720     ELSE
730       PRINT "Press Continue for next adjustment"
740     END IF
750     PAUSE
760   NEXT Input
770   NEXT Chan
780 End_of_test:     !
790   PRINT "Flatness Adjustments Completed"
800   END
```

Chapter 5
Replaceable Parts

Introduction

This chapter contains information to order replaceable parts and/or exchange modules for the HP E1429A/B digitizers. 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 5-1 lists modules 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 5-1. HP E1429A/B Digitizers - Exchange/New Modules

Model	Description	Exchange Part Number	New Part Number
HP E1429A HP E1429B	2-Channel 20 MSa/s Digitizer w/Memory 2-Channel 20 MSa/s Digitizer w/Memory and Local Bus	E1429-69201 E1429-69202	E1429-66201 E1429-66202

NOTE

If an HP E1429A/B digitizer 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. Individual printed circuit assemblies (PCA A1 through A4) cannot be returned for replacement or exchange.

Replaceable Parts Lists

Table 5-2 lists replaceable parts for the HP E1429A/B digitizers. See "Component Locators" (Figures 5-1 and 5-2) for locations of parts in Table 5-2. Table 5-3 shows reference designators for parts in Table 5-2, and Table 5-4 shows the manufacturer code list for the parts.

Table 5-2. HP E1429A/B Digitizers Replaceable Parts

Reference Designator	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			HP E1429A/B HARDWARE PARTS (FIG 5-1)		
HDL1	E1400-84105	1	EXT HANDLE KIT-BOTTOM	28480	E1400-84105
HDL2	E1400-84106	1	EXT HANDLE KIT-TOP	28480	E1400-84106
HDW11-HDW14	2950-0054	4	NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	28480	2950-0054
HDW15-HDW18	3050-0604	4	WASHER-FL 7/16 IN .5-IN-ID .75-IN-OD	86928	5710-94-16
PNL1	E1429-00201	1	FRONT COVER (E1429A)	28480	E1429-00201
PNL1	E1429-00211	1	FRONT COVER (E1429B)	28480	E1429-00211
SCR1-SCR8	0515-1135	9	SCREW M3 X 0.5 25MM-LG FLAT-HD	28480	0515-1135
SCR9	0515-0430	1	SCREW M3 X 0.5 6MM-LG PAN-HD	28480	0515-0430
SCR10	0515-1135		SCREW M3 X 0.5 25MM-LG FLAT-HD	28480	0515-1135
SCR11-SCR12	0515-1968	2	SCREW M2.5 X 0.45 11MM-LG PAN-HD	28480	0515-1968
SCR13-SCR14	0515-0368	2	SCREW M2.5 X 0.45 12MM-LG PAN-HD	28480	0515-0368
SCR15-SCR16	0515-1375	2	SCREW M2.5 X 0.45 6MM-LG FLAT-HD	83486	343-300-02506
SHD1	E1429-00601	1	TOP SHIELD (E1429A)	28480	E1429-00601
SHD1	E1429-00604	1	TOP SHIELD (E1429B)	28480	E1429-00604
SHD2	E1429-00602	1	BOTTOM SHIELD	28480	E1429-00602
SHD3	E1429-00603	1	SHIELD	28480	E1429-00603
SHD4	E1429-00605	1	SHIELD RFI/BNC (E1429B)	28480	E1429-00605
			A1 PCA REPLACEABLE PARTS (FIG 5-2)		
A1J101	1252-4857	1	CONN-POST TYPE 120-CONTACT	06776	P50L-120S-RR1-TG3022
A1J201- J202	1250-2012	4	CONN-RF BNC RCPT 50-OHM	00779	27676-1
A1J601- J602	1250-2012		CONN-RF BNC RCPT 50-OHM	00779	2227676-1
A1P101,P201,P301	1252-5406	3	CONN-POST TYPE 20-CONTACT	00779	104549-2
			A2 PCA REPLACEABLE PARTS (FIG 5-2)		
A2 F401-F407	2110-0699	7	FUSE-SUBMINIATURE 5A 125V NTD	75915	R251005T1
A2 J2 - J3	1251-5150	2	CONN-POST TYPE 12-CONTACT	18873	67996-612
A2 J101- J103	1252-4568	5	CONN-POST TYPE 3-CONTACT	18873	89602-603
A2 J201- J202	1252-4568		CONN-POST TYPE 3-CONTACT	18873	89602-603
A2 P1-P2	1252-1596	2	CONN-POST TYPE 96-CONTACT	06776	DIN-96CPC-SRI-TR
A2 P110-P111	1252-4481	2	CONN-POST TYPE 80-CONTACT	00779	104549-9
A2 P112	1252-4859	1	CONN-POST TYPE 120-CONTACT	06776	P50L-120P-RR1-TG3076
A2 SP601-SP602	3101-2243	2	SWITCH-DIP ROCKER 8-1A 0.05A 30VDC	81073	YY22318ST
			A3 PCA REPLACEABLE PARTS (FIG 5-2)		
A3J101,J201,J301	1252-5404	3	CONN-POST TYPE 20-CONTACT	00779	104550-2
A3 J302,J305	1250-1846	4	CONN-RF BNC RCPT 50-OHM	24931	28JR342-1
A3 J402,J405	1250-1846		CONN-RF BNC RCPT 50-OHM	24931	28JR342-1
			A4 PCA REPLACEABLE PARTS (FIG 5-2)		
A4 J110-J111	1252-4572	2	CONN-POST TYPE 80-CONTACT	00779	104550-8

Table 5-3. HP E1429A/B Digitizers Reference Designators

Reference Designators	
A ..... assembly	P ..... electrical conn (plug)
F ..... fuse	PNL ..... panel
HD ..... handle	SCR ..... screw
J .....electrical connector (jack)	SHD ..... shield
MP ..... misc mech part	SP ..... switch (push-button)

Table 5-4. HP E1429A/B Digitizers Code List of Manufacturers

Mfr Code	Manufacturer Name	Manufacturer Address			Zip Code
00779	AMP INC	HARRISBURG	PA	US	17111
	ROBINSON NUGENT INC	NEW ALBANY	IN	US	47150
06776	DUPONT E I DE NEMOURS & CO	WILMINGTON	DE	US	19801
	SPECIALTY CONNECTOR CO	FRANKLIN	IN	US	46131
18873	HEWLETT-PACKARD CO - CORPORATE	PALO ALTO	CA	US	94304
24931	LITTELFUSE INC	DES PLAINES	IL	US	60016
28480	GRAYHILL INC	LA GRANGE	IL	US	60525
	ELCO INDUSTRIES INC	ROCKFORD	IL	US	61125
	SEASTROM MFG INC	GLENDALE	CA	US	91201
75915					
81073					
83486					
86928					

Component Locators

Figures 5-1 and 5-2 show locations of selected replaceable parts for the HP E1429A/B digitizers.

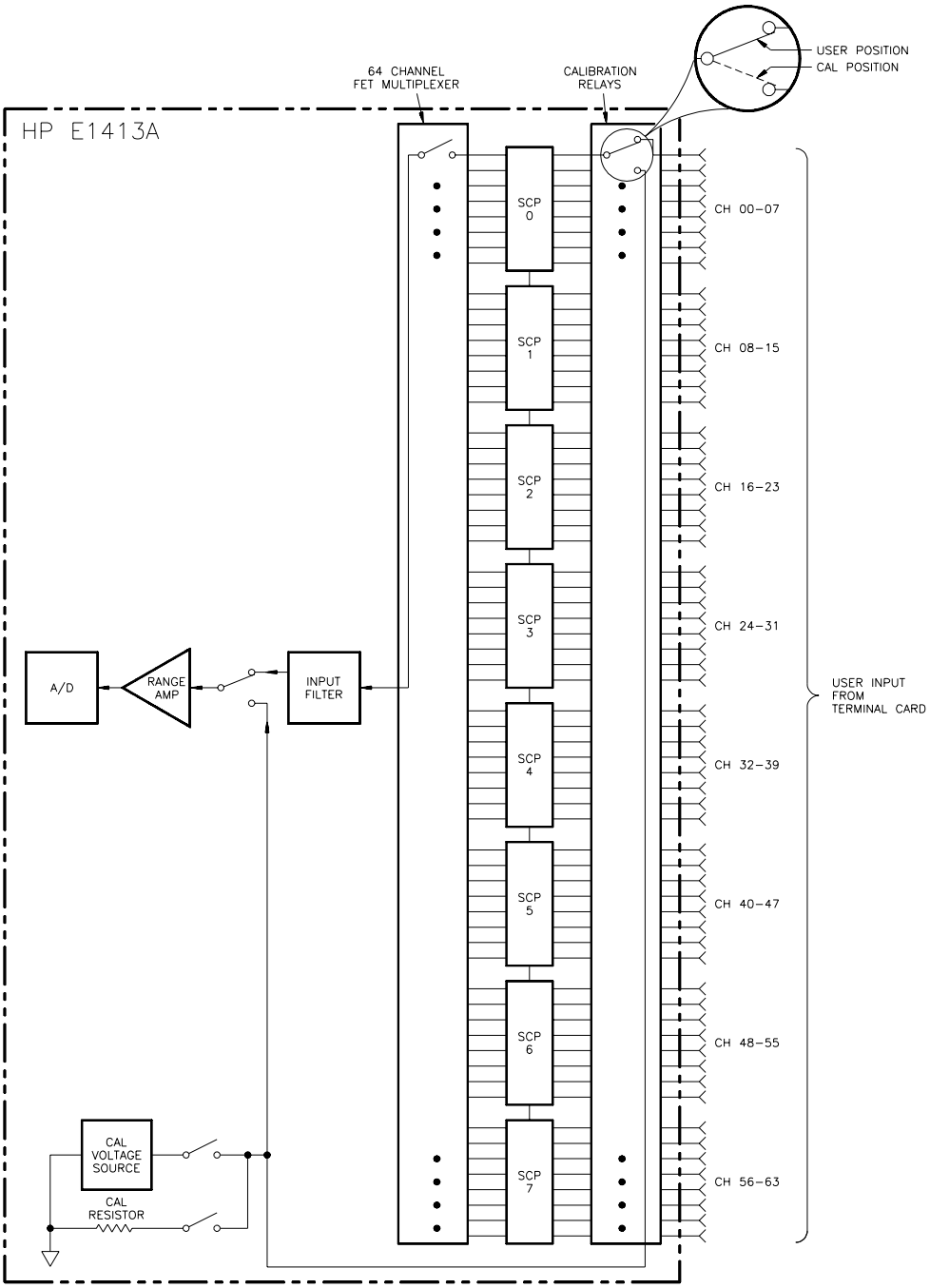


Figure 5-1. Replaceable Mechanical Parts

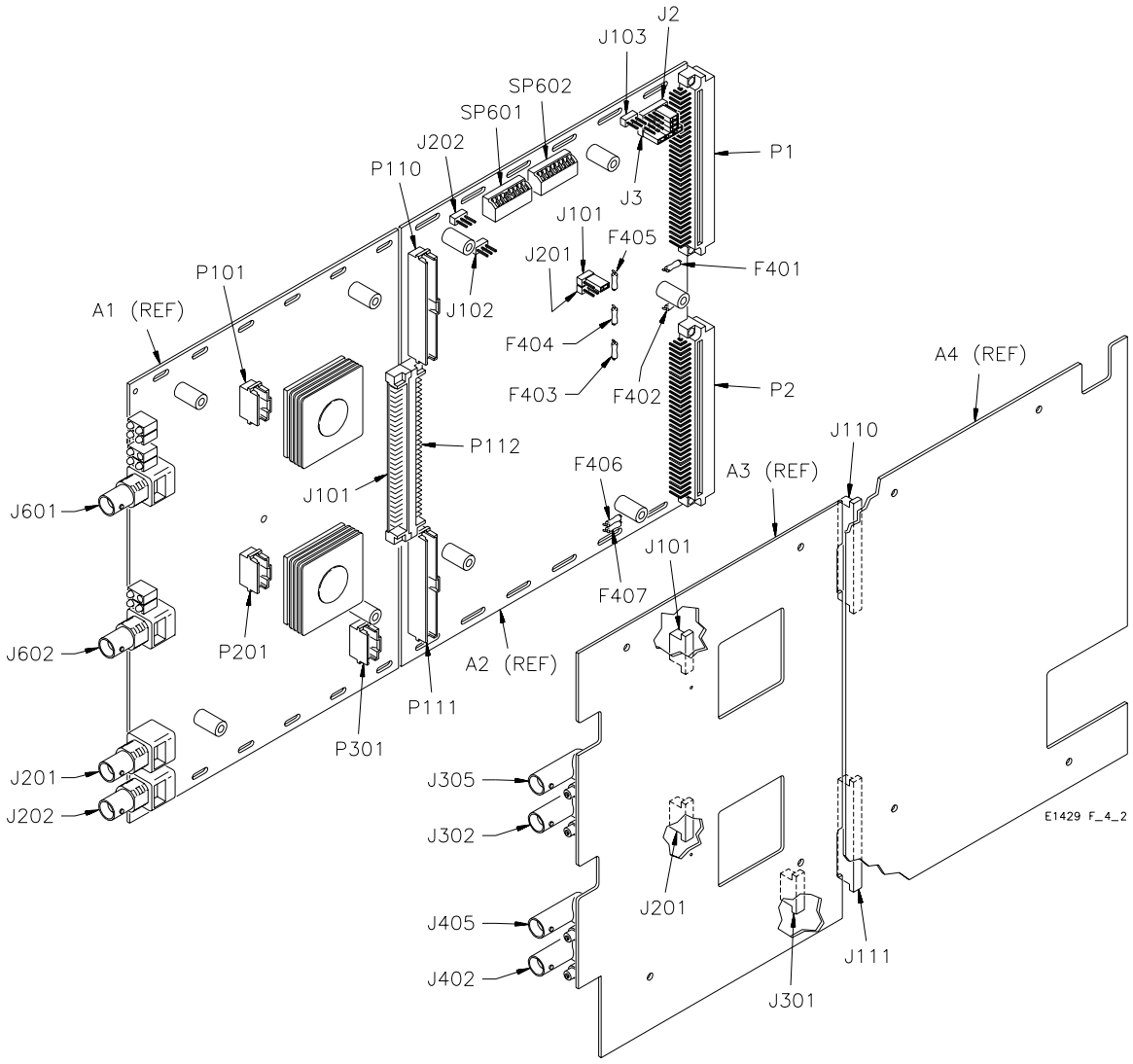


Figure 5-2. A1 - A4 PCAs Replaceable Parts

Notes

Chapter 6
Service

Introduction

This chapter contains information to service the HP E1429A/B digitizers, 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 HP E1429A/B digitizers troubleshooting and repair is listed in Table 1-1, *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 5 - Replaceable Parts* for descriptions and locations of HP E1429A/B replaceable parts. Service notes and service literature for the digitizers 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 HP E1429A/B digitizers is module replacement.

- Before replacing an HP E1429A/B digitizer, check fuses F401 through F407 on the A2 Printed Circuit Assembly (PCA) and check other replaceable parts listed in Table 5-2.
- If the fault can be traced to a part listed in Table 5-2, repair the fault and retest the instrument. If not, exchange or replace the entire HP E1429A/B. (Individual PCAs cannot be exchanged or replaced).
- See "Shipping Guidelines" in *Chapter 1 - General Information* to return an HP E1429A/B digitizer to Hewlett-Packard.

Troubleshooting Guidelines

To troubleshoot an HP E1429A/B digitizer problem, you should first identify the problem, and then isolate the cause to a replaceable part. See *Chapter 5 - Replaceable Parts* for digitizer replaceable parts

NOTE

If the problem cannot be isolated to a replaceable part listed in Table 5-2, exchange or replace the entire instrument. Individual PCAs cannot be exchanged or replaced. See Table 5-1 for exchange part numbers.

Identifying the Problem

Table 6-1 lists some common problems for the HP E1429A/B digitizers, along with symptoms and possible solutions. If a problem cannot be identified using these steps, replace or exchange the entire module.

Table 6-1. HP E1429A/B Digitizers Typical Problems

Symptom	Recommended Action
Non-zero error code in response to SYST:ERR?	See *Appendix C - Error Messages*
Module not responding to commands.	See "Making Visual Checks"
Module fails verification test (Chapter 3 - Verification Tests)	See "Testing the Module"

Making Visual Checks

Visual checks for the digitizers include the following. See Table 6-2 for typical checks.

- Check for heat damage
- Check fuses/switches/jumpers
- Check connector contacts

NOTE

See the HP E1429A/B User's Manual for information on logical address and IRQ settings. If there are no apparent problems following the visual checks, run the verification tests in Chapter 3 to see if the module is defective.

Table 6-2. HP E1429A/B Digitizers Visual Checks

Test/Check	Reference Designator	Check:	Action/Notes
Heat Damage	- - - - - - - -	Discolored PC board Damaged insulation Evidence of arcing	If there is damage, do not operate the module until you have corrected the problem.
Fuses/Jumpers/ Switches (A2 PCA)	A2F401 - F407 A2J2 A2J201 A2SP601 A2SP602	Fuse continuity Jumper position Jumper position Logical address setting Servant area switch	Replace fuses(s) as required Factory set at IRQ Level 3 Factory set to SECURITY Factory set to 40 Factory set to 255
Replaceable Parts	See Table 5-2 for replaceable parts	Bent, damaged connectors	Repair/replace as required

Testing the Module

You can use the tests and checks in *Chapter 3 - Verification Tests* to identify a problem with the instrument. See *Chapter 5 - Replaceable Parts* for locations of mechanical parts.

Disassembly

To perform digitizer disassembly, you will need a:

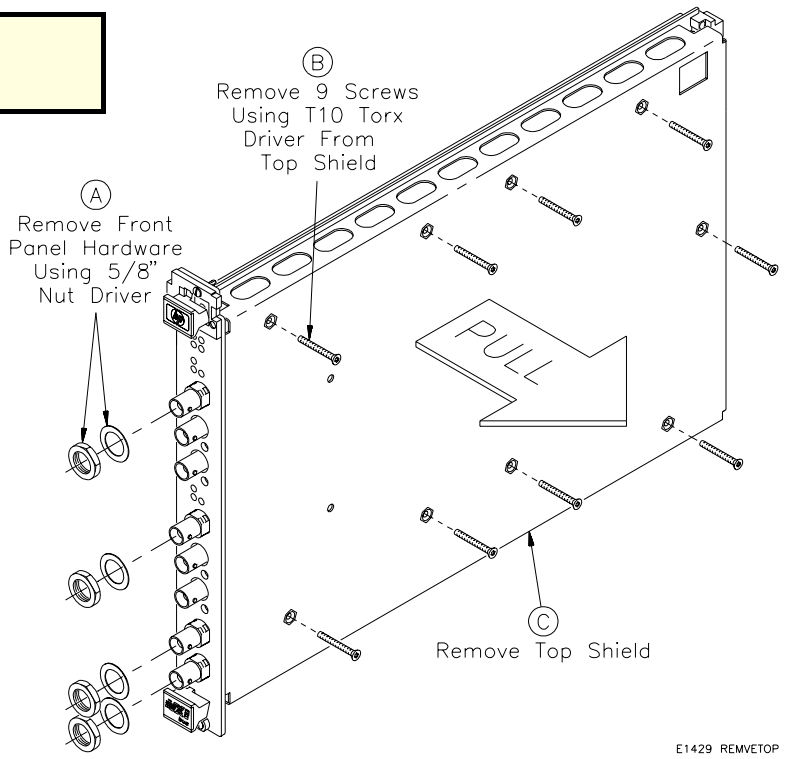
- 5/8" (15.875 mm) nut driver
- T-8 TORX driver
- T-10 TORX driver

See the following figures for steps to disassemble a digitizer. Reverse the steps to reassemble the digitizer.

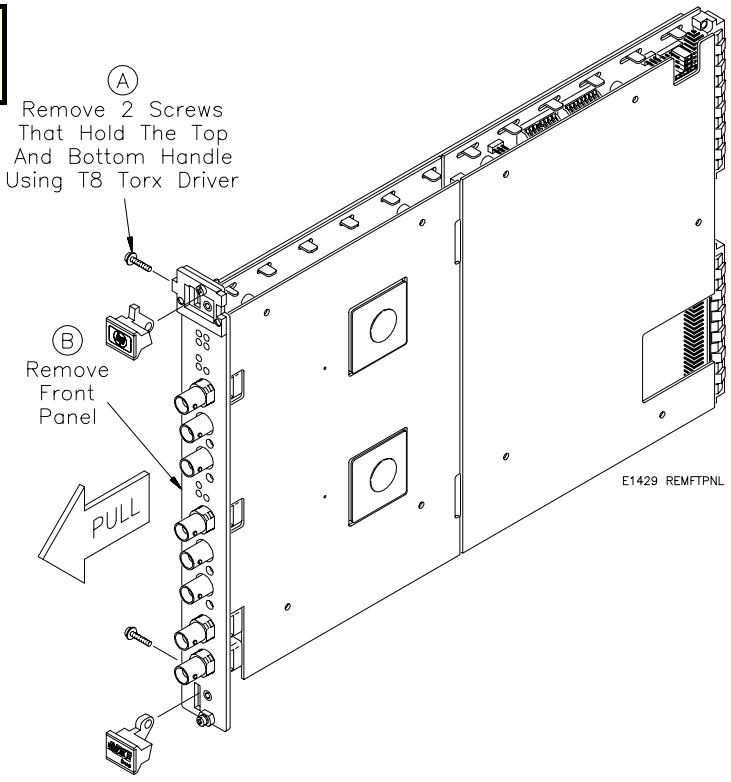
CAUTION

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

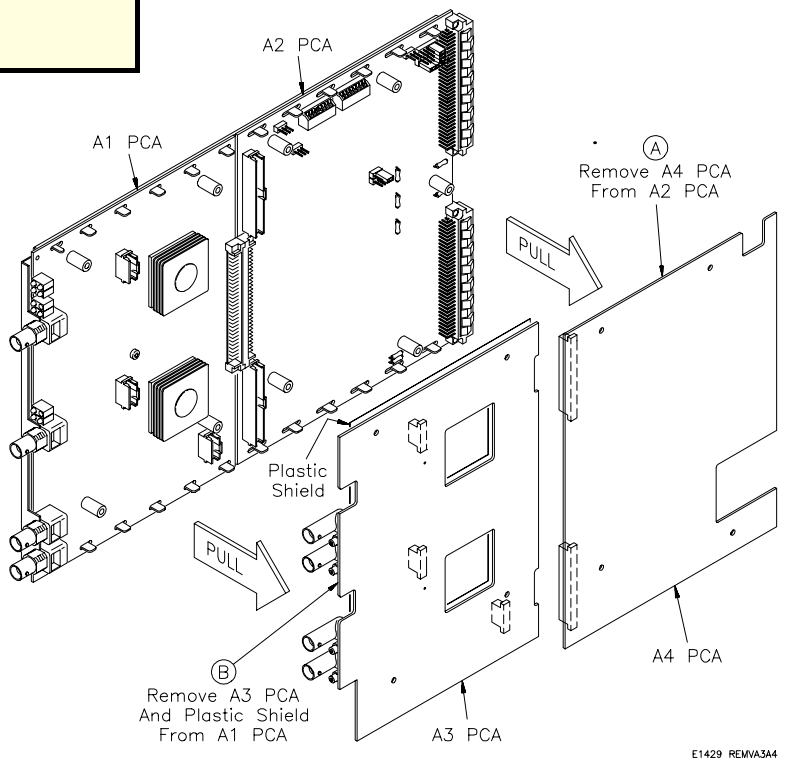
1 Remove Top Shield



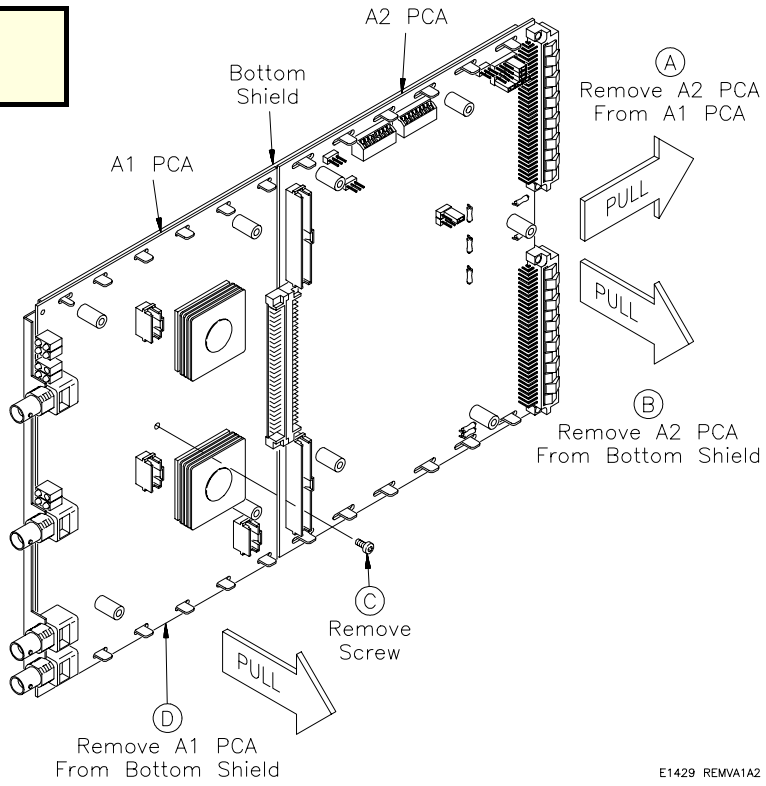
2 Remove Front Panel



3 Remove A3/A4 PCAs



4 Remove A1/A2 PCAs



Repair / Maintenance Guidelines

Guidelines to repair and maintain an HP E1429A/B digitizer follow, including:

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

CAUTION

Do not touch the digitizer 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 digitizers such as ROM or RAM ICs. This damage can range from slight parameter degradation to catastrophic failure. When handling digitizer 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 digitizer 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 digitizer 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 digitizer module is operational.

NOTE

As desired, you may want to run the functional and/or performance verification tests in Chapter 3 - Verification Tests.

Notes

Appendix A
CALibration Commands

Command Summary

This appendix describes the CALibration subsystem commands used for the HP E1429A/B digitizers. Table A-1 summarizes CALibration commands for the digitizers.

Table A-1. HP E1429A/B Digitizers CALibration Commands

Command	Description	Page
CALibration [< *chan* >]:COUNt?	Returns the number of times the digitizer has been calibrated.	A-2
CALibration [< *chan* >]:DATA < *block data* >	Use to set or query current calibration constants	A-3
CALibration [< *chan* >]:DELay	Adjusts delay constant for the A/D converter.	A-5
CALibration [< *chan* >]:GAIN [< *readings* > [,< *period* > [,*flag*]]]	Performs gain adjustment using specified number of readings and sample rate.	A-6
CALibration [< *chan* >] :SECure:CODE < *code* >	Sets code to disable calibration security. Factory set to E1429.	A-9
CALibration [< *chan* >] :SECure:STATe < *mode* > ,[< *code* >]	Enables or disables calibration security.	A-10
CALibration [< *chan* >]:STORe	Stores current calibration constants into nonvolatile RAM.	A-11
CALibration [< *chan* >]:STORe:AUTO [< *mode* >]	Selects whether calibration constants will be automatically stored when commands such as CAL:GAIN and CAL:ZERO complete.	A-12
CALibration [< *chan* >]:VALue < *number* >	Specifies voltage level to be supplied at input. Value is then used in subsequent CAL:GAIN or CAL:ZERO commands.	A-13
CALibration [< *chan* >]:ZERO [< *readings* > [,< *period* > , [< *mode* >]]]	Performs a zero offset adjustment using the specified number of readings and sample rate.	A-14
*PUD <mask>	Store/retrieve data in nonvolatile protected user data area.	A-16

CALibration:COUNt?

Description

CALibration[< *chan* >]:COUNt? returns the number of times the digitizer has been calibrated. Executing CAL:GAIN, CAL:ZERO, or CAL:STORe increments the count, so CALibration:COUNt? can be used to detect accidental or unauthorized HP E1429A/B calibrations.

Executable When Initiated?	yes	**Query Command?**	query only
Coupled Command?	no	***RST Condition:**	unaffected

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none

Comments

- Before using your digitizer, query the calibration count to determine the initial value. You may want to record and store the initial count value. The digitizer stores the calibration count in nonvolatile calibration RAM that remains even when power if turned OFF. Both channels share the same counter, so channel 1 and channel 2 return the same result.
- The count increments whenever either channel stores calibration data to memory. Maximum count value is 2,147,483,647 after which the count returns to 0.
- Executing CALibration:GAIN or CALibration:ZERO with calibration security disabled (CALibration:SECure:STATe OFF) and with CALibration:STORe:AUTO ON increments the calibration count.
- With CALibration:STORe:AUTO ON, a complete calibration of all input ranges increments the number by several counts. By setting CALibration:STORe:AUTO to OFF, you can defer storing calibration constants until CALibration:STORe is sent.

Related Commands

CALibration:GAIN
CALibration:SECure:STATe
CALibration:STORe
CALibration:STORe:AUTO
CALibration:ZERO

Example

Query Calibration Count

```
CAL:COUN?                    Query calibration count
```

CALibration:DATA

Description

CALibration[< *chan* >]:DATA <*block data*> sets/queries calibration constants. CAL:DATA sends calibration constants to the digitizer in indefinite or definite length arbitrary block format. CAL:DATA? returns current calibration constant values in definite length arbitrary block format.

Executable When Initiated?	no	**Query Command?**	yes
Coupled Command?	no	***RST Condition:**	none

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none
block data	IEEE 488.2 block data	-2048 to 2047	none

Comments

- Sending calibration constants with this command causes the digitizer to calibrate to the new constants. Error -222; "Data out of range" results if the constants are not within valid ranges.
- The new calibration constants take effect immediately, but are not saved to nonvolatile calibration RAM until CALibration:STORe is executed.
- As desired, you can prepare calibration constants tables to be downloaded whenever the characteristics of the device connected to the digitizer change. Storage and retrieval from memory of these tables is then under control of the host controller, external to the digitizer.
- CAL:DATA? returns the current calibration constants for the digitizer. These may not be the same values stored in nonvolatile calibration RAM unless CALibration:STORe has previously been executed on these constants.
- Each channel contains 62 calibration constants, as shown in the following table. Note that the array index starts with 0.

Index	Contents	Index	Contents
0	offset for 1.0235V range	31	gain lsb for single-ended .5115 V range
1	A to D chip internal setting	32	offset for differential .10230 V range
2	A to D chip internal setting	33	gain msb for differential .10230 V range
3	A to D chip internal setting	34	gain lsb for differential .10230 V range
4	A to D chip internal setting	35	offset for differential .2046 V range
5	A to D chip internal setting	36	gain msb for differential .2046 V range
6	linearity bit 5 left	37	gain lsb for differential .2046 V range
7	linearity bit 5 right	38	offset for differential .5115 V range
8	linearity bit 6 left	39	gain msb for differential .5115 V range
9	linearity bit 6 right	40	gain lsb for differential .5115 V range
10	linearity bit 7 left	41	offset for differential 1.0230 V range
11	linearity bit 7 right	42	gain msb for differential 1.0230 V range
12	linearity bit 8 left	43	gain lsb for differential 1.0230 V range
13	linearity bit 8 right	44	offset for differential 2.046 V range
14	linearity bit 9 left	45	gain msb for differential 2.046 V range
15	linearity bit 9 right	46	gain lsb for differential 2.046 V range
16	linearity bit 10 left	47	offset for differential 5.115 V range
17	linearity bit 10 right	48	gain msb for differential 5.115 V range
18	gain msb	49	gain lsb for differential 5.115 V range
19	gain lsb	50	offset for differential 10.230 V range
20	conversion delay adjust	51	gain msb for differential 10.230 V range
21	trigger level negative	52	gain lsb for differential 10.230 V range
22	trigger level positive	53	offset for differential 20.46 V range
23	offset for single-ended .10230 V range	54	gain msb for differential 20.46 V range
24	gain msb for single-ended .10230 V range	55	gain lsb for differential 20.46 V range
25	gain lsb for single-ended .10230 V range	56	offset for differential 51.15 V range
26	offset for single-ended .2046V range	57	gain msb for differential 51.15 V range
27	gain msb for single-ended .2046 V range	58	gain lsb for differential 51.15 V range
28	gain lsb for single-ended .2046 V range	59	offset for differential 102.30 V range
29	offset for single-ended .5115 V range	60	gain msb for differential 102.30 V range
30	gain msb for single-ended .5115 V range	61	gain lsb for differential 102.30 V range

Related Commands

CALibration:STORe

Example 1 Sending array of new calibration constants

```
ASSIGN @Dig TO 70905                          !Assign I/O path to 70905
ASSIGN @Digu TO 70905;FORMAT OFF              !Turn FORMAT OFF for
                                               array data
OUTPUT @Dig;"FORM PACK"                       !Set PACKed format
CAL1:SEC:STAT OFF,E1429                       !Turn calibration security
                                               OFF, assuming factory-set
                                               code of E1429
OUTPUT @Dig USING "#,K";"CAL1:DATA #3124"!Specify 124 bytes
                                               coming (62 constants)
OUTPUT @Digu;Array(*),CHR$(10),END            !Send array of calibration
                                               constants
```

Example 2 Query calibration constants on channel 2

```
DIM Ndig$[1],Count$[9]                          !Dimension parameters for header
ASSIGN @To TO 70905                             !I/O path to digitizer
ASSIGN @From TO 70905;FORMAT OFF                !I/O Path from digitizer. Turn FORMAT OFF for array data
OUTPUT @To;"FORM PACK"                          !Set PACKed format
 OUTPUT @To;"CAL2:DATA?"                        !Query calibration data
ENTER @From USING "#,X,K,K";Ndig$;Count$[1;VAL(Ndig$)]!Strip the header preceeding data
ALLOCATE INTEGER Cal_data(1:VAL(Count$)/2)!Allocate an array to hold the data
ENTER @From;Cal_data(*)                         !Read the calibration constants
ENTER @To USING "B";Line_feed                   !Strip off leftover line feed
```

CALibration:DELay

Description

CALibration[***< chan >*** **]:DELay** calibrates the delay constant for both channels of the A/D converter. Since this calibration determines a nominal value for 25^{o} C, the CAL:DELay command should be executed at an ambient temperature as close to 25^{o} C as possible.

Executable When Initiated?	no	**Query Command?**	no
Coupled Command?	no	***RST Condition:**	unaffected

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none

Comments

- Before executing this command, set both channels to the single-ended setting and 1.0235 volt range using *RST or CONF1:ARR:VOLT (1),1.0,(@1) followed by CONF2:ARR:VOLT (1),1.0,(@2).
- This setting was calibrated at the factory. Under normal conditions, it is not necessary to execute this command again. You may need to do this calibration is if the fastest sample rate appears to be 10 MHz instead of 20 MHz, especially at higher ambient operating temperatures (such as 50 to 60 degrees C).
- This command calibrates the delay constants for the A/D converters on both channels of the digitizer.

- If CALibration:STORe:AUTO is ON the new settings will be stored to nonvolatile calibration RAM. Calibration security must be OFF (CAL:SEC:STAT OFF) for the new constants to be permanently stored in nonvolatile calibration RAM. CALibration:COUNt is incremented with this command when the values are stored to calibration RAM.

Related Commands

CALibration:SECure:STATe
CALibration:STORe
CALibration:STORe:AUTO

Example: **Adjust calibration delay**

```
CAL:SEC:STAT OFF,E1429      Set calibration security OFF, assuming factory code of E1429
CAL:DEL                     Adjust calibration delay for both channels
```

CALibration:GAIN

Description

CALibration[< *chan* >]:GAIN [< *readings* > [, < *period* > [, < *flag* >]]] performs a gain calibration using a specified number of readings and sample rate. A linearity calibration is also done on the 1V measurement range with the single-ended port (port 0 or 2). This linearity calibration may be disabled by setting the *flag* parameter to OFF. Omitting the optional *flag* parameter will cause linearity calibration to be performed.

Executable When Initiated?	no	**Query Command?**	no
Coupled Command?	no	***RST Condition:**	none

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none
readings	numeric	100 to 32767 |DEFault (= 1000)	none
period	numeric	reference period to reference period * 4E8 |DEFault (= 1.0E-4)	seconds
flag	boolean	ON | OFF | defaults to ON	none

Comments

- CALibration:VALue specifies the voltage to be used as the full scale value for calibration. This voltage must be between 85.0% and 99.5% of the full scale reading for the current configuration. The 99.5% upper limit ensures that noise will not cause erroneous full scale (overload) readings.

- Before executing CALibration:GAIN do the following steps. If you use CONFigure, it must be sent first. Otherwise, several settings such as CALibration:SECure:STATe and CALibration:VALue are reset to their *RST values.

  1. Disable calibration security with CALibration:SECure:STATe OFF.

  2. Use CONFigure or use SENSe:VOLTage:RANGe and SENSe:FUNCtion to place the digitizer to the desired range and port.

  3. As applicable, set the input filter and impedance to the desired settings with INPut:FILTer and INPut:IMPedance, respectively.

  4. Use CALibration:VALue to set the voltage value to be applied. This value must be 85% to 99.5% of the full scale input for the range being calibrated. Since CONFigure resets this setting, do this after using the CONFigure command.

  5. Connect a standard DC voltage input to the port to be calibrated, with the input value the same as specified with the CALibration:VALue command.

- MINimum and MAXimum are not allowed with this command. Optional parameters left blank are filled from left to right. Therefore, you may need to use the DEFault syntax to note that a parameter has been defaulted. For example, to default the number of readings and specify a sample rate, the command would appear as:

  CAL:GAIN DEF,.05,one

- CALibration:GAIN forces the internal reference (20 MHz) oscillator to be used. Sample rates are attained using that reference.

- The default number of readings is 1000, and the default period is 1.0E-4 seconds. These values were selected so that the product of the two is a period that is an integral multiple of both 50 Hz and 60 Hz line cycles (.1 second).

- The product of the period and number of readings is checked to see if it exceeds 10 seconds. If so, Error -221; "Settings conflict; Calibration time too long" occurs.

- When calibrating gain on differential ports, the error "All readings have same value in cal_mean routine" could occur. The most likely cause of this error is that the two differential inputs on the port are not grounded properly, and a common mode overload is occurring.

- Normally, new gain values are automatically stored in nonvolatile calibration RAM. However, if CALibration:STORe:AUTO OFF is set, the new gain values are stored to calibration RAM only when CALibration:STORe is executed.

Related Commands

CALibration:SECure:STATe
CALibration:STORe
CALibration:STORe:AUTO
CALibration:VALue

Example

Performing gain calibration

CONF:ARR:VOLT (100),4.8,DEF,(@1)	*Configure for 100 readings on the 5V range.*
CAL:SEC:STAT OFF,E1429	*Disable calibration security, assuming security code E1429*
CAL:STOR:AUTO OFF	*Disable automatic storage of calibration constants*
CAL1:VAL 4.8	*Set value to > 85% of positive full scale on 5 V range*
CAL1:GAIN DEF,DEF	*Calibrate channel 1 for gain using default sample rate and number of points. Linearity is not done since this is not the 1V range.*
CAL1:STOR	*Store new gain settings into calibration RAM.*

CALibration:SECure:CODE

Description

CALibration[< ***chan*** >**]:SECure:CODE** < ***code*** > sets the code required to disable calibration security. Calibration security must be previously disabled to use this command.

Executable When Initiated?	yes	**Query Command?**	no
Coupled Command?	no	***RST Condition:**	unaffected

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none
code	character data	1 to 12 characters	none

Comments

- Valid calibration security codes must begin with a letter and can contain letters, digits, and underscores. Lower case letters are automatically converted to upper case.
- The calibration code is shared by both channels. The digitizer stores the security code in its nonvolatile calibration RAM, and the code remains in RAM even with power off.
- If calibration security has not been previously disabled (with CALibration:SECure:STATe OFF), Error 311, "Calibration security on" is generated. You must know the current security code to disable calibration security.
- The factory-set calibration security code is E1429. Before using your digitizer, you should change the code to prevent unauthorized calibration. Record the new security code and store in a secure place. If you forget the new code, defeating security requires instrument disassembly.

Related Commands

CALibration:SECure:STATe

Example

Changing the calibration security code

```
CAL:SEC:STAT OFF,E1429          Disable security for both channels
CAL:SEC:CODE NEW_CODE           Set new security code for both channels
CAL:SEC ON                      Reenable security on both channels
```

CALibration:SECure:STATe

Description

CALibration[< *chan* >]:SECure:STATe < *mode* >,[< *code* >] enables or disables calibration security. Disable calibration security to calibrate the digitizer, change the security code, or to change protected user data.

Executable When Initiated?	yes	**Query Command?**	yes
Coupled Command?	no	***RST Condition:**	unaffected

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none
mode	boolean	OFF|0|ON|1	none
code	character data	1 to 12 characters	none

Comments

- This command enables/disables calibration security for both channels simultaneously. The *code* parameter must be present to disable the security, or Error -109,"Missing parameter" is generated.
- The *code* value must match the currently programmed code or Error -224,"Illegal parameter value" is generated. A 1 second delay occurs before the digitizer executes any subsequent commands.
- To enable calibration security, the *code* parameter is *not* required, but is checked if it is present. If an incorrect code is supplied, Error -224, "Illegal parameter value" is generated.
- Security must be disabled to calibrate the digitizer, or to use the *PUD command.

Related Commands

CALibration:GAIN
CALibration:SECure:CODE
CALibration:STORe
CALibration:ZERO
*PUD

Example

Disabling calibration security

```
CAL:SEC:STAT OFF,E1429        Disable security, assuming factory-set security code
```

CALibration:STORe

Description

CALibration[< ***chan*** >**]:STORe** stores current calibration constants into nonvolatile calibration RAM.

Executable When Initiated?	no	**Query Command?**	no
Coupled Command?	no	***RST Condition:**	none

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none

Comments

- CALibration:SECure:STATe must be OFF before executing this command.

Related Commands

CALibration:COUNt?
CALibration:DATA
CALibration:SECure:STATe
CALibration:STORe:AUTO

Example

Sending and storing new calibration constants

```
ASSIGN @Dig TO 70905                              Assign I/O path to 70905
ASSIGN @Digu TO 70905;FORMAT OFF                  Turn FORMAT OFF for
                                                  array data
OUTPUT @Dig;"FORM PACK"                           Set PACKed format
CAL1:SEC:STAT OFF,E1429                           Turn calibration security
                                                  OFF, assuming factory
                                                  code of E1429
OUTPUT @Dig USING "#,K";"CAL1:DATA #3124"         Specify 124 bytes
                                                  coming (62 constants)
OUTPUT @Digu;Array(*),CHR$(10),END                Send array of calibration
                                                  constants
OUTPUT @Dig;"CAL:STOR"                            Store calibration constants
                                                  in nonvolatile RAM
```

CALibration:STORe:AUTO

Description

CALibration[< ***chan*** >**]:STORe:AUTO** ***<mode>*** selects whether calibration constants will be stored when commands such as CALibration:GAIN and CALibration:ZERO complete.

Executable When Initiated?	yes	**Query Command?**	yes
Coupled Command?	no	***RST Condition:**	*mode* = ON

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none
mode	boolean	ON|1|OFF|0	none

Comments

- Enabling CAL:STOR:AUTO for either channel enables storage for both channels.

Related Commands

CALibration:GAIN
CALibration:SECure:STATe
CALibration:STORe
CALibration:ZERO

Example

Turn automatic storage of calibration constants OFF

```
CAL:STOR:AUTO OFF          Disable automatic storage of calibration constants
```

CALibration:VALue

Description

CALibration[< *chan* >]:VALue < *number* > specifies the voltage level to be supplied at the input. This voltage value is then used in subsequent CALibration:GAIN or CALibration:ZERO commands.

Executable When Initiated?	no	**Query Command?**	yes
Coupled Command?	no	***RST Condition:**	*number* = 1.0185

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none
number	numeric	-101.80 to 101.85	volts

Comments

- The following table shows allowable CALibration:VALues closest to full scale for the specified voltage range.

Maximum Gain Calibration Values (V)	Voltage Range (Volts)	Allowable Ports
-.10180 and .10185	0.1023	1,2,3,4
-.2036 and .2037	0.2046	1,2,3,4
-.5090 and .50925	0.5115	1,2,3,4
-1.0180 and 1.0185	1.023	1,2,3,4
-2.036 and 2.037	2.046	3,4
-5.090 and 5.0925	5.115	3,4
-10.180 and 10.185	10.23	3,4
-20.360 and 20.370	20.46	3,4
-50.900 and 50.925	51.15	3,4
-101.80 and 101.85	102.3	3,4
< -48.925 and > 48.975	102.3	3,4

- The digitizer cannot distinguish between a value which is exactly full scale and an overload - both cases generate the same measured value. Therefore, the voltage specified for CALibration:VALue must be at least 85% of full scale and cannot be closer than 10 counts from absolute full scale (approximately 99.5% of full scale)

- Calibration values on the 102.35 volt range have a special low end allowed, so that voltages much less than full scale may be used to calibrate gain on this range. Values < -48.975 and > 48.975 are accepted as legal values for calibrating the 102.35 volt range.

Related Commands CALibration:GAIN

Example **Setting calibration value**

CAL2:VAL 5.00 *Specified value to be input to Channel 2 is 5.00 V*

CALibration:ZERO

Description **CALibration[< *chan* >]:ZERO [< *readings* >[,< *period* >,[< *mode* >]]]** performs a zero offset calibration using a specified number of readings and sample rate on the specified range(s).

Executable When Initiated?	no	**Query Command?**	no
Coupled Command?	no	***RST Condition:**	none

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
chan	numeric	1 or 2	none
readings	numeric	100 to 32767 |DEFault (= 1000)	none
period	numeric	reference period to reference period * 4E8 |DEFault (= 1.0E-4)	seconds
mode	discrete	ALL |ONE	none

Comments

- When this command completes, the new calibration constants are automatically stored to nonvolatile calibration RAM unless CALibration:STORe:AUTO OFF is set.

- Before executing CALibration:ZERO, do the following steps:

  1. If *mode* is not ALL, use CONFigure or SENSe:VOLTage:RANGe and SENSe:FUNCtion to place the digitizer to the desired range and port.

  2. Program the input filter and impedance (if applicable) to the desired settings with INPut:FILTer and INPut:IMPedance, respectively.

  3. To automatically store the new constants in nonvolatile calibration RAM when CAL:ZERO completes, set CALibration:STORe:AUTO ON, and turn calibration security OFF.

  4. To store new constants only after a complete calibration, set CALibration:STORe:AUTO OFF and use CALibration:STORe to store the constants.

- MINimum and MAXimum are not allowed with this command.

- Optional parameters left blank are filled from left to right. Therefore, you may need to use the DEFault syntax to show that a parameter has been defaulted. For example, to default the number of readings and specify a sample rate, the command would appear as:

  CAL:ZERO DEF, .05, ONE

- CALibration:ZERO forces the internal reference (20 MHz) oscillator to be used. Sample rates are attained using that reference.

- The default number of readings is 1000 and the default period is 1.0E-4 seconds, so that the product of the two is a period is an integral multiple of both 50 Hz and 60 Hz line cycles (0.1 second).

- The product of the period and number of readings is checked. If it exceeds 10 seconds, Error -221; "Settings conflict; Calibration time too long" occurs.

- The default <*mode*> is ONE, which calibrates using the current settings of SENSe:VOLTage:RANGe and SENSe:FUNCtion. Specifying <*mode*> ALL performs a zero calibration on all voltage range settings for *both* ports on the specified channel.

Related Commands

CALibration:GAIN
CALibration:SECure:STATe
CALibration:VALue

Example Performing a zero calibration

```
CAL:SEC:STAT OFF,E1429          Disable security, assuming factory-set security code
CAL1:ZERO DEF,DEF,ALL           Calibrate channel 1 using default sample rate and number of points, and calibrate all gain ranges on ports 1 and 3.
```

*PUD

Description

***PUD < *mask* >** stores specified data in digitizer nonvolatile calibration RAM. The data must be sent in IEEE-488.2 definite or indefinite block format. Calibration security must have previously been disabled.

The query form returns the current protected user data in IEEE-488.2 definite block format. The query form can be executed regardless of the state of calibration security.

NOTE

When shipped from the factory, the protected user data area contains the date of the digitizer's last calibration.

Executable When Initiated?	yes	**Query Command?**	yes
Coupled Command?	no	***RST Condition:**	unaffected

Parameters

Parameter Name	Parameter Type	Range of Values	Default Units
mask	block data *or* string	0 through 63 characters	none

Comments

- Calibration security must have previously been disabled to send data to the protected user data area.
- If there is no data in protected user memory, Error -312,"PUD memory lost" occurs.

Related Commands

CALibration:SECure:STATe

Example Sending protected user data

```
*PUD#229Last Calibration: 27 May 1993     Send information to protected user data area
```

Appendix B
Calculating Digitizer Accuracy

Introduction

This appendix shows how HP E1429A/B digitizer accuracy, source equipment measurement uncertainty, and test accuracy ratio (TAR) values are defined and calculated for the performance verification tests for the digitizers.

See Table 3-1, " *HP E1429A/B Digitizers Performance Test Record* " for 1-year specification values of digitizer accuracy, 90-day specification values for the Datron 4708 measurement uncertainty, and test accuracy ratios (TARs).

NOTE

Digitizer accuracy, measurement uncertainty, and test accuracy ratios in Table 3-1 are valid ONLY for the specified test conditions and assumptions described in this manual.

Digitizer Accuracy Definition

Digitizer accuracy is the expected accuracy of the measurement due ONLY to the digitizer. The "Minimum" entry in Table 3-1 is the lower value of digitizer accuracy, while the "Maximum" entry is the upper value of digitizer accuracy. If a measured reading is between the Minimum and Maximum values in Table 3-1, the test passes for this input.

Measurement Uncertainty Definition

Measurement Uncertainty is the expected accuracy of the source used to input signals to the multimeter. Since the Datron 4708 Autocal Multifunction Standard is the source used for inputs, the measurement uncertainty is that of the Datron 4708.

Test Accuracy Ratio (TAR) Definition

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

$$\text{TAR} = \frac{\text{Maximum Value} - \text{Input}}{\text{Measurement Uncertainty}}$$

where *Maximum* = largest amount of variation from the expected reading (the *input*), and *measurement uncertainty* is that of the test equipment (Datron Standard). If a TAR exceeds 10:1, the entry in Table 3-1 is ">10:1".

Digitizer Accuracy Calculations

For the HP E1429A/B digitizers performance verification tests, DC voltage accuracy is defined using the 1-year specifications in *Appendix A - Specifications* of the *HP E1429A/B User's Manual*. The *assumed* test conditions are:

- 1 year since the last adjustment
- Operating temperature $23^{o}C \pm 5^{o}C$
- At least one hour warmup for the source

DC Voltage Accuracy Equations

From *Appendix A - Specifications* of the *HP E1429A/B User's Manual*, for single-ended inputs (ports 1 and 2), DC voltage 1-year accuracy = ± 0.4% of reading ± 0.25% of peak-to-peak full-scale. For differential inputs (ports 3 and 4), DC voltage 1-year accuracy = ± 0.5% of reading ± 1.0% of peak-to-peak full-scale.

NOTE

For single-ended port inputs, DC Accuracy is specified for the average of 100 readings, with CAL:ZERO performed within 24 hours prior to reading in a stable environment. For differential port inputs, DC Accuracy is specified for the average of 100 readings with inputs terminated in <1 kΩ, with CAL:ZERO performed within 24 hours prior to reading in a stable environment.

Example: Calculate Single-Ended Port DCV Accuracy

For this example, assume a 0.5 Vdc input to Port 1 or 2, with the digitizer set to the -0.51125V to +0.5115V range. From *Appendix A - Specifications* of the *HP E1429A/B Digitizers User's Manual*, DCV Accuracy = ± 0.4% of reading ± 0.25% of peak-to-peak full scale.

For a 0.5 Vdc input, DC Accuracy = ± [(0.004 x 0.5) + 0.0025 x (0.5115 - (-0.51125)] = ± 0.00456 Vdc. Thus, in Table 3-1 Maximum = 0.5 + 0.00456 = 0.50456 Vdc and Minimum = 0.5 - 0.00456 = 0.49544 Vdc.

Example: Calculate Differential Port DCV Accuracy

For this example, assume a 5.0 Vdc input to Port 3 or 4, with the digitizer set to the -5.1125V to +5.115V range. From *Appendix A - Specifications* of the *HP E1429A/B Digitizers User's Manual*, DC Accuracy = ± 0.5% of reading ± 1.0% of peak-to-peak full scale.

For a 5.0 Vdc input, DCV Accuracy = ± [(0.005 x 5.0) + 0.01 x (5.115 - (-5.1125)] = ± 0.127 Vdc. Thus, in Table 3-1 Maximum = 5.0 + 0.127 = 5.127 Vdc and Minimum = 5.0 - 0.127 = 4.873 Vdc.

Measurement Uncertainty Calculations

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. The *assumed* test conditions are:

- Temperature of $23^{o}C \pm 1^{o}C$
- Maximum of 90 days since calibration

Calculate DCV Measurement Uncertainty

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

Datron Range (Volts)	Datron Accuracy (ppm)	Calibration Uncertainty (ppm)	Measurement Uncertainty Equation (in μ V)
1.0000000 V	2 + 0.4	2	4.0 x Input (in V) + 0.8
10.000000 V	1 + 0.15	1.5	2.5 x Input (in V) + 3.0
100.00000 V	2 + 0.25	2	4.0 x Input (in V) + 50.0

Example: Calculate DC Voltage Measurement Uncertainty

Since Measurement Uncertainty = Datron Accuracy + Calibration Uncertainty, for a 5.0 Vdc OUTPUT and 10.000000 V range, the Measurement Uncertainty (μV) = ± [(1.0 x 5.0) + (2 x 0.15 x 10) + (1.5 x 5.0)] = ± 15.5 μV = ± 1.55 E-5 V.

Test Accuracy Ratio (TAR) Calculations

For the HP E1429A/B digitizers, Test Accuracy Ratio (TAR) is:

$$TAR = \frac{\text{Maximum} - \text{Input}}{\text{Measurement Uncertainty}}$$

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

Example: Calculate Single-Ended Port TAR

For this example, assume a 0.5 Vdc input to Port 1 or 2 with the digitizer set to the -0.51125V to +0.5115V range. From Table 3-1 Maximum = 0.50546 Vdc. If the Datron is set to the 1.0 Vdc range, Measurement Uncertainty (μV) = ± [(2.0 x 0.5) + (2 x 0.4 x 1) + (2 x 0.5)] = ± 2.8 μV = ± 2.8E-6 Vdc. Thus:

TAR = (0.50546 - 0.50000)/2.8E-6 = 1950:1

Since this value is >10:1, the entry in Table 3-1 is ">10:1".

Example: Calculate Differential Port TAR

For this example, assume a 5.0 Vdc input to Port 3 or 4, with the digitizer set to the -5.1125V to +5.115V range. Then, from Table 3-1 the Maximum value = 5.127 Vdc. If the Datron is set to the 10.0 Vdc range, Measurement Uncertainty (μV) = ± [(1.0 x 5.0) + (2 x 0.15 x 10) + (1.5 x 5.0)] = ± 15.5 μV = ± 1.55E-5 Vdc. Thus:

TAR = (5.127 - 5.000)/1.55E-5 = 8193:1

Since this value is >10:1, the entry in Table 3-1 is ">10:1".

Appendix C
Error Messages

Introduction

This appendix lists HP E1429A/B digitizers error messages.

Digitizer Error Messages

Table C-1 lists HP E1429A/B digitizers error messages.

Table C-1. HP E1429A/B Error Messages

Code	Message	Description
-101	Invalid character	Unrecognized character in parameter.
-102	Syntax error	Command missing a space or comma between parameters.
-103	Invalid separator	Parameter is separated by a character other than a comma.
-104	Data type error	The wrong data type (number, character, string, expression) was used when specifying the parameter.
-105	GET not allowed	An HP-IB Group Execute Trigger was included in a command string sent to the digitizer.
-108	Parameter not allowed	More parameters were received than expected for the command header.
-109	Missing parameter	Command requires a parameter or parameters.
-112	Program mnemonic too long	Command keyword >12 characters.
-113	Undefined header	Command header (keyword) was incorrectly specified.
-121	Invalid character in number	A character other than a comma or number is in the middle of a number.
-123	Exponent too large	Then magnitude of the exponent is larger than 32000.
-124	Too many digits	More than 255 digits were used to specify a number.
-128	Numeric data not allowed	A number was specified when one is not allowed.
-131	Invalid suffix	Parameter suffix was incorrectly specified (e.g., 10 MZ rather than 10 MHz).

Table C-1. HP E1429A/B Error Messages (cont'd)		
-138	Suffix not allowed	Parameter suffix is specified when one is not allowed.
-141	Invalid character data	Discrete parameter specified is not a valid choice.
-144	Character data too long	A character data type parameter is >12 characters.
-148	Character data not allowed	Discrete parameter was specified when another type (e.g., numeric, boolean) is required.
-151	Invalid string data	The string data specified (such as for the OUTPut:ECLTrg:FEED <source> command) is not a valid choice.
-158	String data not allowed	A string was specified when another parameter type (i.e., discrete, numeric, boolean) is required.
-161	Invalid block data	The number of bytes in a definite length data block does not equal the number of bytes indicated by the block header.
-168	Block data not allowed	Block data was specified when another parameter type (i.e., discreter, numberic, boolean) is required.
-171	Invalid expression	The expression used to calculate a parameter value is invalid.
-178	Expression data not allowed	An expression cannot be used to calculate a parameter value.
-181	Invalid outside macro def	A macro parameter placeholder ($< number) was encountered outside of a macro definition.
-183	Invalid inside macro def	A command was encountered that is not allowed inside a macro.
-184	Macro parameter error	A command inside the macro definition had the wrong number or wrong type of parameters.
-211	Trigger ignored	A trigger was received and the digitizer was not in the wait-for-trigger state. Or, a trigger was received from a source other than the specifiied source.
-212	Arm ignored	An arm was received and the digitizer was not in the wait-for-arm state. Or, an arm was received from a source other than the specified source.
-213	Init ignored	INITiate:IMMediate received while the digitizer was initiated.
-214	Trigger deadlock	Readings cannot be retrieved using FETCh? or READ? because TRIGger:STARt:COUNt INFinite is set. Also occurs with READ? and TRIGger:STARt:SOURce HOLD or TRIGger:STARt:SOURce BUS set.
-215	Arm deadlock	Readings cannot be retrieved using FETCh? or READ? because ARM:STARt:COUNt INFinite is set. Also occurs with READ? and ARM:STARt:SOURce BUS, or ARM:STARt:SOURce OFF set.

Table C-1. HP E1429A/B Error Messages (cont'd)		
-221	Settings conflict	Refer to the statement appended to the "Settings conflict" message for a description of the conflict and how it was resolved.
-222	Data out of range	Parameter value is out of range for any digitizer configuration.
-224	Illegal parameter value	An exact value, from a list of possible choices, was expected.
-230	Data corrupt or stale	Attempting to FETch? data from the digitizer following a reset or other digitizer configuration change.
-231	Data questionable	Reading accuracy is questionable. An example is when the expected value and resolution parameters of the CONFigure or MEASure command are specified. If the resolution is too fine for the expected value, this error occurs.
-240	Hardware error	The command could not be executed due to a hardware failure.
-270	Macro error	*RMC <name> was executed but the name is not defined.
-271	Macro syntax error	A syntax error occurred among the commands within the macro.
-272	Macro execution error	Macro program data sequence could not be executed due to a syntax error within the macro definition.
-273	Illegal macro label	The macro label defined in the *DMC command was too long, the same as a common command keyword, or contained invalid header syntax .
-274	Macro parameter error	The macro definition improperly used a macro parameter placeholder.
-275	Macro definition too long	The commands within the macro could not be executed because the string or block contents were too long.
-276	Macro recursion error	A macro program data sequence could not be executed because the sequence leads to the execution of a macro being defined.
-277	Macro redefinition not allowed	A macro label in the *DMC command could not be executed because the macro label was already defined.
-278	Macro header not found	A legal macro label in the *GMC? query could not be executed because the header was not previously defined.
-312	PUD memory lost	The protected user data saved by the *PUD command has been lost.
-313	Calibration memory lost	The nonvolatile calibration data used by the *CAL command has been lost.
-330	Self-test failed	Note the information associated with the message for a description of the failure.
-350	Queue overflow	The digitizer error queue is full and additional errors have occurred.

Table C-1. HP E1429A/B Error Messages (cont'd)		
-410	Ouery INTERRUPTED	The digitizer was sent a command before it was finished responding to a query command.
-420	Query UNTERMINATED	The controller (computer) attempted to read a query response from the digitizer without having first sent a complete query command.
-430	Query DEADLOCKED	The digitizer's input and output buffers are full and the digitizer cannot continue.
-440	Query UNTERMINATED after indefinite response	Occurs when the *IDN? query is not the last query executed in a command string.
1002	Cal security enabled	Calibration security must be disabled to calibrate the digitizer, to read or write calibration data, to change the security code, or to change protected user data.
1004	Cal write fail	Writing calibration or protected user data (*PUD) to nonvolatile memory failed.
1005	Error during CAL	An error occurred during calibration. Refer to the statement appended to this message for a description of the error.
1007	Cal security defeated	A jumper was moved to defeat calibration security.
1008	Error during zero cal	An error occurred during calibration of the zero offset. Refer to the statement appended to this message for a description of the error.
1009	Error during gain cal	An error occurred during gain calibration. Refer to the statement appended to this message for a description of the error.
1010	Error during linearity cal	An error occurred during linearity calibration. Refer to the statement appended to this message for a description of the error.
1015	A/D control reg not resp	The serial interface register was not working properly at power-on.
1016	Illegal during LBUS or VME memory transfer	The command cannot be executed while a VME bus or Local bus data transfer is in progress.
1017	Battery too low, data may be lost	Battery does not have sufficient charge to maintain memory over an extended period. Error occurs when readings are taken, when the battery is enabled/disabled, or during the self-test.
1018	Battery-backed data corrupt	Error is due to low battery charge, or if the battery is enabled after readings are in memory.
1213	Illegal when initiated	Command cannot be initiated while digitizer is INITiated.
2003	Memory addres incorrect	Address specified by DIAG:POKE or DIAG:PEEK? is not valid.
2004	Invalid address for 32-bit access	Attempting a 32-bit read from an odd-numbered address.
2007	Bus error	Error during DIAG:POKE or DIAG:PEEK?