Contents

HP E1333A Universal Counter Service Manual

Edition 4

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Notes

Certification

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

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HP E1333A 3-Channel Universal Counter Service Manual
Edition 4

Documentation History

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

Edition 1 (Part Number E1333-90010). . . . . April 1991

Edition 2 (Part Number E1333-90011). . . . . March 1992

Edition 3 (Part Number E1333-90012). . . . . June 1996

Edition 4 (Part Number E1333-90013). . . . . December 1996

Safety Symbols

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

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

or

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

Alternating current (AC).

Direct current (DC).

Indicates hazardous voltages.

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

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

WARNINGS

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

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

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

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

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

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

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

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

Declaration of Conformity

according to ISO/IEC Guide 22 and EN 45014

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

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

declares, that the product:

Product Name: 3-Channel Universal Counter

Model Number(s): HP E1333A

Product Options: All

conforms to the following Product Specifications:

Safety: IEC 348:1978/HD 401 S1:1981
CSA 556B
UL 1244

EMC: CISPR 11:1990/EN55011 (1991): Group1 Class A
EN50082-1:1992
IEC 801-2:1991: 4kVCD, 8kVAD
IEC 801-3:1984: 3 V/m
IEC 801-4:1988: 1kV Power Line
0.5kV Signal Lines

Supplementary Information: The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the "CE" marking accordingly.

Safety qualification performed February, 1989.
Tested in a typical HP B-size VXI configuration.

September 5, 1996 **Jim White, QA Manager**

European contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department HQ-TRE, Herrenberger Straße 130, D-71034 Böblingen, Germany (FAX +49-7031-143143).

Notes

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HP E1333A 3-Channel Universal Counter Service Manual
Edition 4

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Please pencil-in one circle for each statement below:

	Disagree				Agree
• The documentation is well organized.	O	O	O	O	O
• Instructions are easy to understand.	O	O	O	O	O
• The documentation is clearly written.	O	O	O	O	O
• Examples are clear and useful.	O	O	O	O	O
• Illustrations are clear and helpful.	O	O	O	O	O
• The documentation meets my overall expectations.	O	O	O	O	O

Please write any comments or suggestions below--be specific.

What's in This Manual

Manual Overview

This manual shows how to service the HP E1333A 3-Channel Universal Counter. Additional manuals which may be required for servicing the counter include the *HP E1333A User's Manual* which contains counter operation, installation, and configuration information, and the appropriate mainframe user's manual(s) for mainframe operation, installation and configuration information.

Manual Content

Chapter	Title	Content
1	General Information	Provides a basic description, and lists available options and accessories. Also lists the tools and test equipment required for service.
2	Installation	Procedures to install the counter, perform initial inspection, prepare for use, and store and ship the counter.
3	Operating Instructions	Procedures to operate the counter, perform scheduled preventive maintenance, and perform operator's check.
4	Verification Tests	Functional verification, operation verification, and performance verification tests to test the counter.
5	Adjustments	Procedures to adjust the counter to within its rated specifications.
6	Replaceable Parts	Lists part numbers for user replaceable parts in the counter. Provides information on ordering spare parts and module/assembly exchange.
7	Service	Procedures to aid in fault isolation and repair of the counter.
Appx A	Calculating Multimeter Accuracy	Shows how counter accuracy is defined and calculated.
Appx B	Verification Tests - C Programs	Gives C Program Examples to do the Verification Tests in Chapter 3 and Chapter 4.

Notes

Chapter 1
General Information

Introduction

This HP E1333A Service Manual contains information required to test, adjust, troubleshoot, and repair the HP E1333A B-Size VXI 3-Channel Universal Counter. See the *HP E1333A User's Manual* for additional information. Figure 1-1 shows the HP E1333A counter.

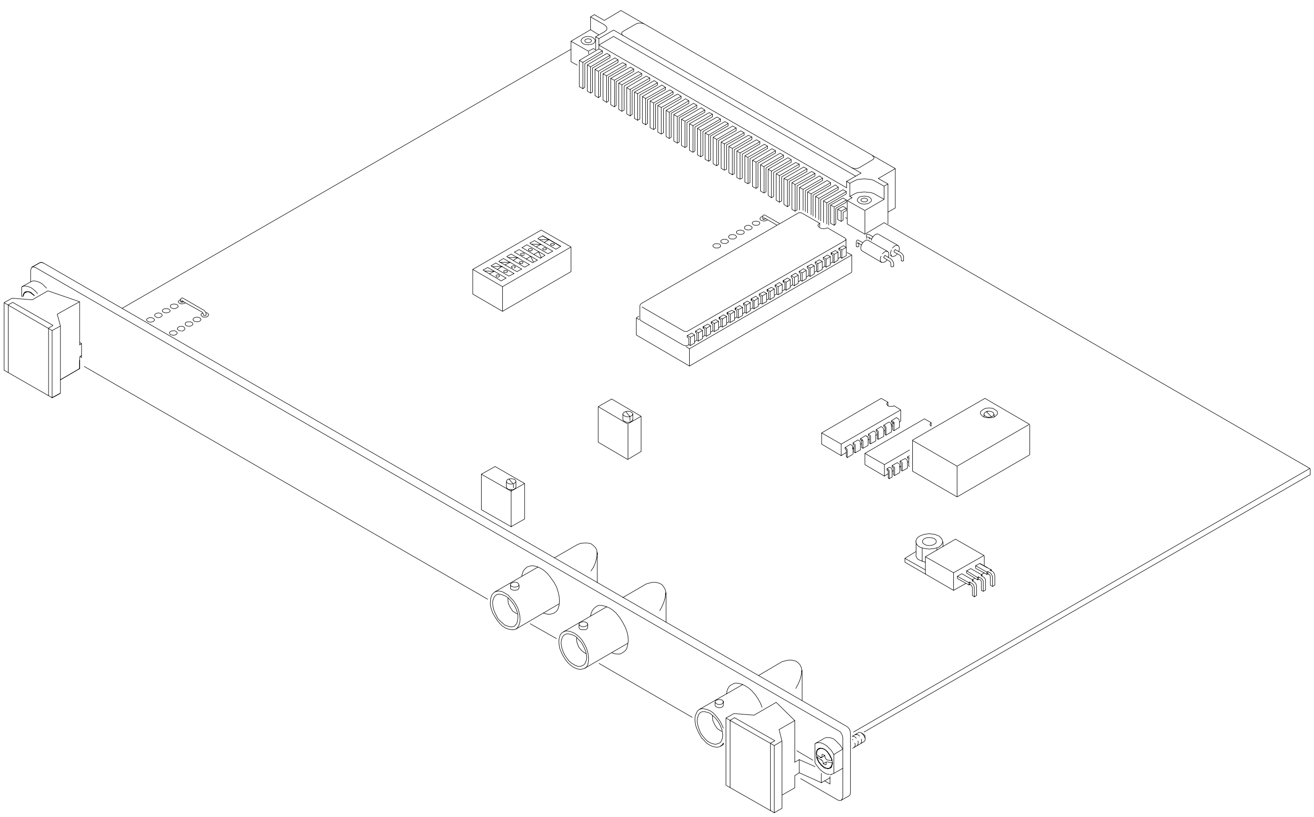


Figure 1-1. HP E1333A 3-Channel Counter

Safety Considerations

This product is a Safety Class I instrument that is provided with a protective earth terminal when installed in the mainframe. The mainframe, counter, and all related documentation should be reviewed for familiarization with safety markings and instructions before operation or service.

Refer to the WARNINGS on page 3 in this manual for a summary of safety information. Safety information for preventive maintenance, testing, adjusting, and service follows and is also found throughout this manual.

WARNINGS and CAUTIONS

This section contains WARNINGS which must be followed for your protection and CAUTIONS which must be followed to avoid damage to the equipment when performing instrument maintenance or repair.

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 mainframe input wiring terminals, power cord, or 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.)

COMMON GROUND. Verify that a common ground exists between the unit under test and the counter (via the mainframe) prior to energizing either unit.

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 maintenance can be performed without power applied, the power should be removed.)

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).

WARNING

CAPACITOR VOLTAGES. Capacitors inside the mainframe may remain charged even when the mainframe has been disconnected from its source of 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.

CAUTION

MAXIMUM VOLTAGE. Maximum voltage that may be applied between any BNC connector is 42 V for the 1 MΩ input impedance (Channels 1 and 2) and 5 V for the 50 Ω input impedance (Channels 1, 2, and 3). In general, the limiting factor is the maximum power which cannot exceed 0.5 W.

STATIC ELECTRICITY. Static electricity is a major cause of component failure. To prevent damage to the electrical components in the counter, observe anti-static techniques when removing a counter from the mainframe or when working on the counter.

Counter Description

The HP E1333A counter is an "instrument" in the slots of a VXIbus mainframe. As such, it is assigned an error queue, input and output buffers, status registers, and is allocated a portion of mainframe memory for reading storage.

NOTE Instruments are based on the logical addresses of the plug-in modules. Refer to the configuration guide provided with your system for information on setting the addresses to create an instrument.

There are six HP E1333A counter functions (see Table 1-1):

- Frequency Measurements
- Period Average
- Pulse Width/Pulse Width Average
- Time Interval/Time Interval Average
- Totalize
- Frequency Ratio

Table 1-1. HP E1333A 3-Channel Universal Counter Functions

Function/ Feature	Chs	Description
Frequency Measurements	1,2,3	Measure frequency from DC to 100 MHz on Channels 1 and 2. Measure frequency from 75 MHz to 1 GHz on Channel 3
Period Average	1,2	Average from 2 to 65,536 periods of the input signal. Period range is 1 µsec to 6,871 seconds.
Pulse Width	1,2	Measure positive or negative pulse width of the input signal. Pulse width range is 200 nsec to 6,871 sec.
Time Interval	1,2	Measure the time interval between transitions from one channel to another channel. Range is 200 nsec to 6,871 seconds.
Totalizing	1,2	Count the number of transitions on Channels 1 and 2. Minimum pulse width is 5 nsec. Range is 1 to 2^{36}-1.
Frequency Ratio	1,2	Measure frequency ratio between Channel 1 and 2 or between Channel 2 and 1. Min pulse width is 5 nsec.
Input Capabilities	1,2	Programmable input coupling, termination, attenuation, low pass filter, and trigger levels.

Counter Specifications

Counter specifications are listed in Appendix A of the *HP E1333A User's Manual*. These specifications are the performance standards or limits against which the instrument may be tested.

Counter Serial Numbers

Counters covered by this manual are identified by a serial number prefix listed on the title page. Hewlett-Packard uses a two-part serial number in the form XXXXAYYYYY, where XXXX is the serial prefix, A is the country of origin (A = USA), and YYYYY is the serial suffix. The serial number suffix is assigned sequentially to each instrument.

If the serial number prefix of your instrument is greater than the one listed on the title page, a Manual Update (as required) will explain how to adapt this manual to your instrument. If the serial number prefix is lower than the one listed on the title page, information contained in Chapter 7, "Manual Changes," explains how to adapt this manual to your instrument.

Counter Options

There are no electrical or mechanical options available for the HP E1333A counter. However, you can order Option 1BN which provides a MIL-STD-45662A Calibration Certificate, or Option 1BP which provides the Calibration Certificate and measurement data. Contact your nearest Hewlett-Packard Sales and Service Office for information on Options 1BN and 1BP.

Recommended Test Equipment

Table 1-2 lists the test equipment recommended for testing, adjusting and servicing the HP E1333A counter. Essential requirements for each piece of test equipment are described in the Requirements column.

Table 1-2. Recommended Test Equipment

Instrument	Requirements	Recommended Model	Use*
Controller, HP-IB	HP-IB compatibility as defined by IEEE Standard 488-1978 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TEO, L2, LE0, SR0, RL0, PP0, DC0, DT0, and Cl, 2, 3, 4, 5	HP 9000 Series 300 or IBM compatible PC with HP BASIC	A,F,O, P,T
Mainframe	Compatible with counter	HP E1300A, E1301A, E1302A, or E1401B/T, E1421A (requires E1405A/B or E1406A)	A,F,O, P,T
Function Generator	0.1 Hz to 10 MHz	HP 3325A	F,O,P
Signal Generator	100 kHz to 1 GHz	HP 8663A	F,O,P
DC Standard	Voltage Range -3.0 V to 30.0 V	Datron 4708 with Option 10	F, O,P
Universal Counter	Frequency Range: 0.1 Hz to 1 GHz Accuracy: At least equal to HP 5334B	HP 5334B with (1.3 GHz) C Channel	O,P
Oscilloscope	Frequency Range: 1 kHz to 100 kHz	HP 54111D	A
Digital Multimeter	General Purpose Voltage and Resistance	HP 3458A	T

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

Chapter 2
Installation

Introduction

This chapter provides information to install the HP E1333A counter, including initial inspection, preparation for use, environment, storage and shipment.

Initial Inspection

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, keep the container until the shipment contents have been checked and the instrument has been checked mechanically and electrically. See Chapter 1 (Figure 1-1) for shipment contents. See Chapter 4 for procedures to check electrical performance.

WARNING **To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).**

If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify your nearest Hewlett-Packard Sales and Service Office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as Hewlett-Packard, and keep the shipping materials for the carrier's inspection.

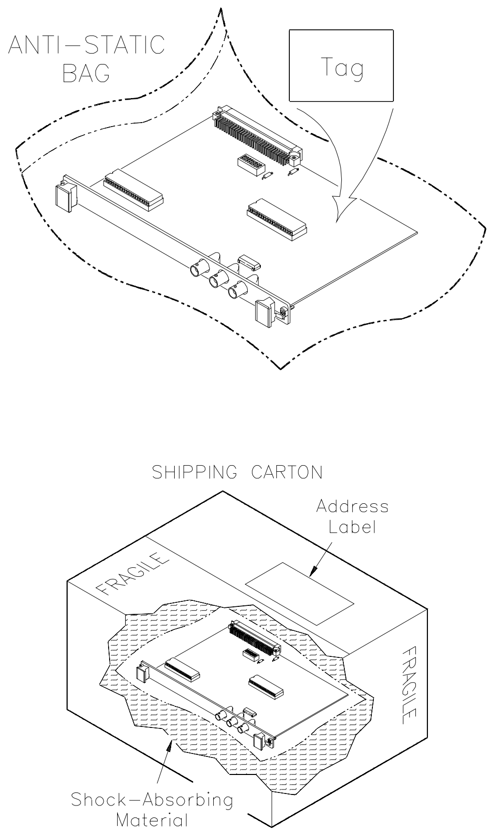
Preparation for Use

See Chapter 2 of the *HP E1333A User's Manual* to prepare the HP E1333A counter for use. See the appropriate mainframe user's manual(s) to prepare your mainframe. If your mainframe is not manufactured by Hewlett-Packard, consult the manufacturer for a list of available manual(s).

Recommended operating environment for the HP E1333A counter is 0^{o}C to $+55^{o}$C with humidity <65% relative (0^{o}C to $+40^{o}$C). The instrument should be stored in a clean, dry environment. For storage and shipment, the temperature range is -40^{o}C to $+75^{o}$C with humidity <65% relative (0^{o}C to $+40^{o}$C).

Shipping Guidelines

Follow the steps in Figure 2-1 to return the HP E1333A counter to a Hewlett-Packard Sales and Support Office or Service Center.



1. Prepare the Counter

+ Remove user wiring from the module
+ Attach tag to ,module/pod that identifies
  - Owner
  - Model Number/Serial Number
  - Service required
+ Place tagged device in approved anti-static bag

2. Package the Counter

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

3. Ship the Counter to Hewlett-Packard

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

Figure 2-1. Packaging/Shipping Guidelines

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

Chapter 3
Operating Instructions

Introduction

This chapter lists operating information for the HP E1333A counter, including:

- Counter operation
- Preventive maintenance
- Operator's check (self-test)

Counter Operation

See the *HP E1333A 3-Channel Universal Counter User's Manual* for counter operation, including:

- Getting started
- Configuring the counter
- Using the counter
- Understanding the counter

- Counter command reference
- Counter specifications
- Counter error messages

Preventive Maintenance

Preventive Maintenance for the HP E1333A counter consists of periodically cleaning the counter and then running the Operator's Check (*TST? command). For best results, you should clean the counter once a year or more often if the counter is used in a very dusty or very humid area. See Table 3-1 for recommended cleaning equipment and supplies.

Description	Recommended Use
Soft-bristle brush Mild soap solution Lint-free cloth	Remove dust from printed circuit board Clean faceplate panel Clean faceplate panel

WARNINGS and CAUTIONS

WARNING **To eliminate possible electrical shock, disconnect AC power from the mainframe and disconnect all inputs to the counter before removing the counter from the mainframe.**

CAUTION **Use static control devices (wrist straps, static mats, etc.) when handling the printed circuit assembly. Also, do not use a vacuum cleaner to remove dust from the printer circuit assembly. See Chapter 8, "Service," for electrostatic discharge (ESD) precautions.**

Cleaning Procedure

Use the following steps to clean the counter:

1. Disconnect any user wiring connected to the input terminals.
2. Remove dust from the printed circuit surface.
3. Clean all contacts indicated in Figure 3-1.
4. Clean the faceplate panel using a lint-free cloth.
5. Reconnect user wiring to the counter input connectors.

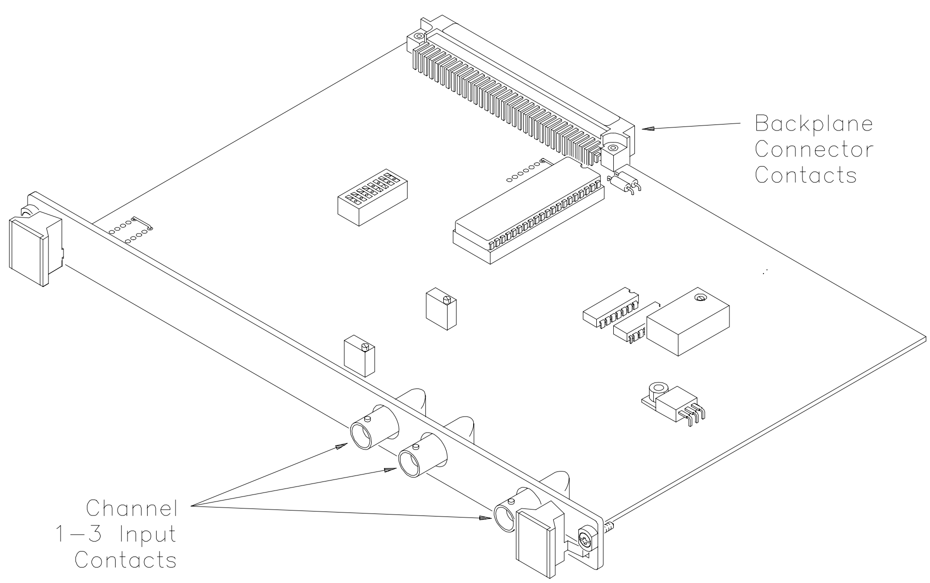


Figure 3-1. Cleaning the HP E1333A Counter

Operator's Check

The Operator's Check for the HP E1333A counter consists of sending the self-test (*TST?) command and checking the return. The operator's check can be used at any time to verify the counter is connected properly and is responding to the self-test command. See Chapter 8, "Service," for a list of counter self-test errors.

As required, see the mainframe user's manual for information on address selection. See the *HP E1333A User's Manual* for information on counter SCPI commands.

Self-Test Procedure

1. Verify the counter is properly installed in the mainframe and the mainframe has passed its power-on sequence test.
2. Execute the counter self-test using the *TST? command (see example following).
3. A "0" returned means no self-test failure, while "1" through "7" returned means a failure was detected. See Chapter 8, "Service," for troubleshooting information (see NOTE below).

NOTE Test failures can be caused by improper cabling, improper selection of the interface select code, primary, and/or secondary address setting. Verify proper connection and address selection before troubleshooting.

Example: Counter Self-Test

An example follows which uses an HP 9000 Series 300 computer with HP BASIC and a counter address of 70906.

```
10  OUTPUT 70906;"*TST?"              !Send the self-test command
20  ENTER 70906;A                     !Enter self-test result
30  PRINT A
40  END
```

Notes

Chapter 4
Verification Tests

Introduction

The three levels of test procedures described in this chapter are used to verify that the HP E1333A counter:

- is fully functional (Functional Verification)
- meets selected testable specifications (Operation Verification)
- meets all testable specifications (Performance Verification)

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

Test Conditions and Procedures

For valid tests, all test equipment and the counter must have a one hour warm-up, and the line voltage must be 115/230 Vac ± 10%. See Table 1-2, "Recommended Test Equipment," for test equipment requirements.

For best test accuracy, the ambient temperature of the test area should be between 18°C and 28°C and stable to within ± 1°C. You should perform the Performance Verification tests at least once a year. For heavy use or severe operating environments, perform the tests more often.

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

Performance Test Record

Table 4-8, "Performance Test Record for the HP E1333A Counter," at the end of this chapter provides space to enter the results of each Performance Verification test and allows you to compare the results with the upper and lower limits for the test. You may make a copy of this form, if desired.

NOTE The Performance Verification tests assume the test equipment used is calibrated and is operating at peak performance. If this is not the case, problems can occur.

For example, an uncalibrated source may cause what seems to be an inaccurate measurement. This condition must be considered when observed measurements do not agree with the performance test limits.

The value in the "Measurement Uncertainty" column of Table 4-8 is derived from the specifications for the source used for the test, and represents the expected accuracy of the source. The values in Table 4-8 assume the source is externally locked to a "house standard" with accuracy = $\pm (3 \times 10^{-11}) \times$ measurement, so the measurement uncertainty is that of the house standard.

The value in the Test Accuracy Ratio (TAR) column of Table 4-8 is the ratio of counter accuracy to measurement uncertainty, rounded to the nearest integer for TARs <10:1, or shown as ">10:1" for TARs >10:1. For example, if counter accuracy = $\pm 6.0 \times 10^{-6}$ Hz and measurement uncertainty = $\pm 3.0 \times 10^{-7}$ Hz, TAR = $\pm (6.0 \times 10^{-6}/3.0 \times 10^{-7}) = \pm 20:1$. Since this is >10:1, the entry in Table 4-8 is ">10:1".

Verification Test Examples

Each performance verification test includes an example program to perform the test. Each example uses address 70906 for the counter, and an HP 9000 Series 200/300 computer running HP BASIC and SCPI (Standard Commands for Programmable Instruments) commands. You may need to change the counter address and/or command syntax to perform the examples for your setup.

As required, see the mainframe user’s manual for information on address selection and cabling guidelines. See the *HP E1333A User’s Manual* for information on counter SCPI commands.

Functional Verification Tests

The functional verification tests for the HP E1333A can be performed at any time to verify the counter is functional and is communicating with the mainframe, external computer and/or external terminal. The functional tests for the HP E1333A counter are:

- Counter Self-Test
- Totalizing Measurements Test (Optional)
- Ratio Measurements Test (Optional)
- Trigger Level Test (Optional)

Counter Self-Test

This test verifies the counter is communicating with the mainframe, external controller, and/or external terminal by performing a counter self-test (*TST? command). See "Operator's Checks" in Chapter 3 for a description of the counter self-test.

Totalizing Measurement Test

This test verifies the totalize measurement functions on Channels 1 and 2 at 1 Hz and 4 MHz. The test passes if the count increments on each channel. The test fails if the count remains at 0 for either or both channels.

Equipment Setup

Connect an HP 3325A function generator to Channel 1 and Channel 2 as shown in Figure 4-1. Then, set the HP 3325A output to 1 Hz sine wave at 50 mV rms.

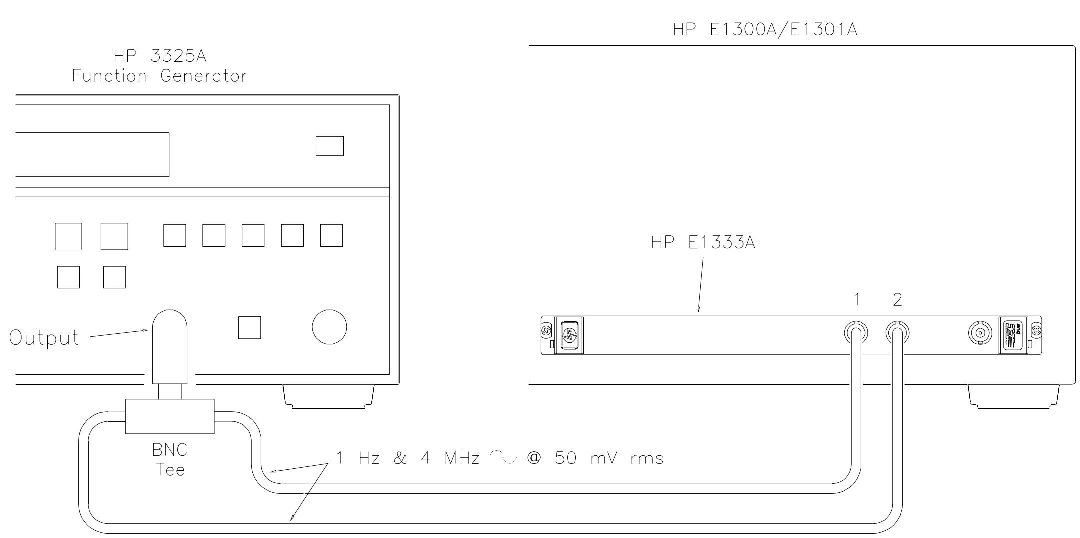


Figure 4-1. Totalizing Measurements Test Connections

Test Procedure

1. Set HP E1333A input conditions

   - Reset counter . . . . *RST
   - Set DC coupling . . . . INP:COUP DC
   - Set 50Ω input impedance . . . . INP:IMP MIN

2. Totalize counts for 1 Hz input

   - Channel 1 to TOTalize CONF1:TOT
   - Channel 2 to TOTalize CONF2:TOT
   - Initiate measurement on Ch 1 . . . . INIT1
   - Return Ch 1 results . . . . FETC1?
   - Initiate measurement on Ch 2 . . . . INIT2
   - Return Ch 2 results . . . . FETC2?
   - Verify count increments on both channels

3. Totalize count for 4 MHz input

   - After 10-15 counts, set source to . . . . 4 MHz output
   - Repeat Step 2 for 4 MHz output

4. Remove power and disconnect test equipment

Example: Totalizing Measurements Functional Test

```
10    PRINT "Totalize counts for the following inputs:"
20    PRINT
30    PRINT "1 Hz, 50 mV rms sinewave"
40    PRINT "4 MHz, 50 mV rms sinewave"
50    DISP " Press any key to stop the program"
60    ON KBD GOTO Quit
70    OUTPUT 70906;"*RST"
80    OUTPUT 70906;"INP:COUP DC"
90    OUTPUT 70906;"INP:IMP MIN"
100  FOR Chan= 1 TO 2
110   OUTPUT 70906;"CONF"&VAL$(Chan)&":TOT"
120   OUTPUT 70906;"INIT"&VAL$(Chan)
130  NEXT Chan
140 Start: !
150  FOR Chan = 1 TO 2
160   OUTPUT 70906;"FETC"&VAL$(Chan)&"?"
170   ENTER 70906;Reading(Chan)
180   PRINT TABXY(1,7+Chan);"Channel ";Chan;" total counts =
";Reading(Chan)
190  NEXT Chan
200  GOTO Start
210 Quit: !
220  CLEAR SCREEN
230  END
```

Ratio Measurements Test

This test checks the ratio measurements function of the HP E1333A for Channel 1/Channel 2, using Channel 1 and Channel 2 frequencies and ratios shown in Table 4-1.

Table 4-1. Ch 1/Ch 2 Ratio Measurements

Ch 1 Freq	Ch 2 Freq	Ch 1/Ch 2 Ratio
1 MHz	100 Hz	10000
1 MHz	1 kHz	1000
1 MHz	10 kHz	100
1 MHz	100 kHz	10
1 MHz	1 MHz	1

Equipment Setup

Connect the equipment as shown in Figure 4-2. Then, set the Channel 1 and Channel 2 sources to output sine waves at 50 mV rms. Set Channel 1 frequency to 1 MHz

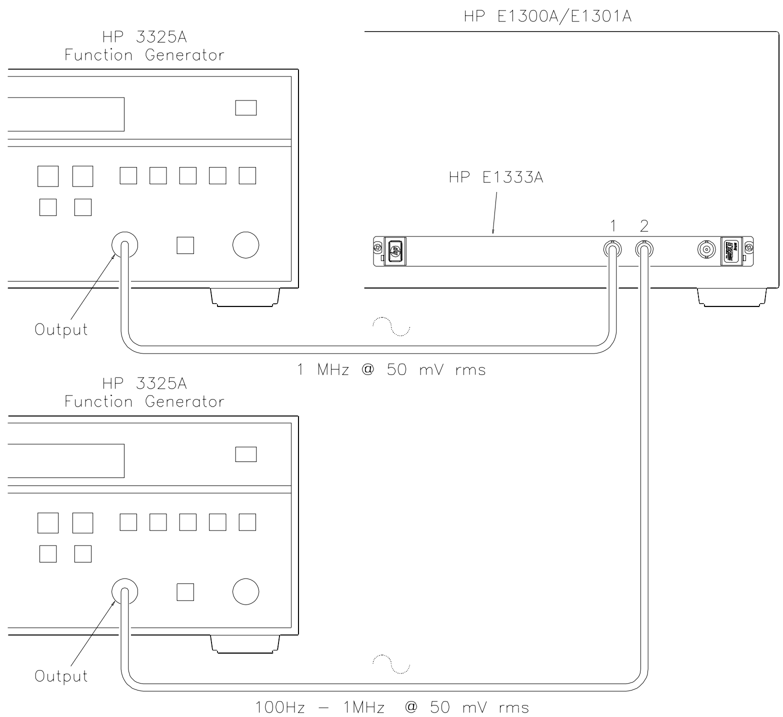


Figure 4-2. Ratio Measurements Test Connections

Test Procedure

1. Set the HP E1333A input conditions

- Reset Counter . . . . *RST
- Coupling to DC . . . . INP:COUP DC
- Input impedance to 50Ω. . . . . INP:IMP MIN

2. Measure Ch 1/Ch 2 ratio at 100 Hz on Ch 2

- Set Ch 1 source output . . . . 1 MHz
- Set Ch 2 source output . . . . 100 Hz
- Set Ch 1 function, range, resolution . CONF1:RAT 1E6,1E3
- Initiate Ch 1/Ch 2 ratio meas INIT1
- Return Ch 1/Ch 2 ratio results . . . . FETC1?
- Verify returned result 10000

3. Repeat Step 2 for each Ch 2 frequency in Table 4-1.

4. Remove power and disconnect test equipment

Example: Ratio Measurements Functional Test

```
10   PRINT "Ch 1/Ch 2 ratio measurement"
20   PRINT
30   PRINT "Procedure:"
40   PRINT
50   PRINT " 1. Set Ch 1 source to 50 mV rms sine wave at 1 MHz "
60   PRINT " 2. Set Ch 2 source to 50 mV rms sine wave."
70   PRINT " 3. Vary Ch 2 freq from 100 Hz to 1 MHz (5 steps)."
80   PRINT " 4. Check Ch 1/Ch 2 ratio at each frequency step."
90   DISP " Press any key to stop the program "
100  ON KBD GOTO Quit
110  OUTPUT 70906;"*RST"
120  OUTPUT 70906;"INP:COUP DC"
130  OUTPUT 70906;"INP:IMP MIN"
140 Start: !
150  OUTPUT 70906;"CONF1:RAT 1E6,1E3"
160  OUTPUT 70906;"INIT1"
170  WAIT 1
180  OUTPUT 70906;"FETC1?"
190  ENTER 70906;Rdg
200  OUTPUT 70906;"MEAS2:FREQ?"
210  ENTER 70906;Ch2_freq
220  Ch2_freq = PROUND(Ch2_freq,2)
230  PRINT TABXY(1,12);"Results:"
240  PRINT TABXY(5,14);"Ch 2 frequency = ";Ch2_freq;"Hz        "
250  PRINT TABXY(5,15);"Ch 1/Ch 2 ratio = ";Rdg;"         "
260  GOTO Start
270 Quit: !
280  CLEAR SCREEN
290  END
```

Trigger Level Test

This test checks the trigger level accuracy on Channel 1 for the -2.56V, 0V, +2.54V and +25.4V trigger levels. Table 4-2 shows the trigger levels measured, the input attenuation level in dB, and the below-level and above-level voltage values for each trigger level.

Table 4-2. Trigger Level Tests

Trigger Level (V)	Input Attenuation (dB)	Below-Level Value (V)	Above-Level Value (V)
-2.56	0	-2.836	-2.284
+0.00	0	-0.02	+0.02
+2.54	0	+2.266	+2.814
+25.4	20	+22.66	+28.14

For this test, the HP E1333A is set to TOTalize mode and the desired trigger level is set. Next, a DC voltage is input which is less than the specified trigger level value and the count is measured (should be 0). The voltage is then set above the trigger level value and the totalized count is measured again (should be at least 1). If the increased count is >0, the test passes. The below-level and above-level values in Table 4-2 are derived from:

Below-Level Value (0 dB) = Trig Lvl - |.02 + |Trig Lvl/10||
Above-Level Value (0 dB) = Trig Lvl + |.02 + |Trig Lvl/10||
Below-Level Value (20 dB) = Trig Lvl - |.20 + |Trig Lvl/10||
Above-Level Value (20 dB) = Trig Lvl + |.20 + |Trig Lvl/10||

Equipment Setup

Connect the equipment as shown in Figure 4-3. Then, set the DC Standard for DC output.

Test Procedure

1. Set HP E1333A input conditions

- Reset Counter . . . . *RST
- Coupling to DC . . . . INP:COUP DC
- Input filter to ON . . . . INP:FILT ON

2. Test Low-Level Trigger Levels (Below-Level Value Setting)

- Set the DC Standard output . . . . -2.836 Vdc
- Channel 1 to TOTalize. SENS1:FUNC:TOT
- Ch 1 trig lvl to -2.56V . . . . SENS1:EVEN:LEV -2.56
- Initiate Ch 1 measurement INIT1
- Return Ch l results . . . . FETC1?
- Verify returned result. . . . . 0 counts

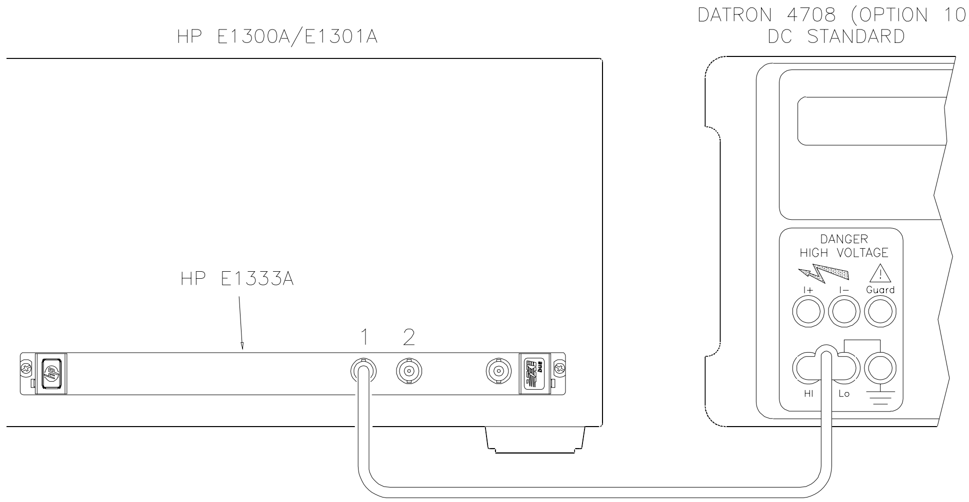


Figure 4-3. Trigger Level Tests Connections

3. Test Low-Level Trigger Levels (Above-Level Value Setting)

- Set DC Standard output . . . . -2.284 Vdc
- Initiate Ch 1 measurment INIT1
- Return Ch 1 results. . . . . FETC1?
- Verify returned result . . . . at least 1 count

4. Repeat Steps 2 and 3 for the 0 V and +2.54 V trigger levels, using the Below-Level and Above-Level Values in Table 4-2.

5. Test High-Level Trigger Level

NOTE When the input attenuation is 20 dB, you must divide the desired trigger level by 10, and then enter the result using SENS:EVEN:LEV value.

- Set 20 dB input atten . . . . INP:ATT MAX
- Set DC Standard output . . . . +22.66 Vdc
- Ch 1 trig lvl to +25.4V SENS1:EVEN:LEV 2.54
- Initiate Ch 1 measurement INIT1
- Return Ch 1 results. . . . . FETC1?
- Verify returned result . . . . 0 counts

- Set DC Standard output . . . . +28.14 Vdc
- Initiate Ch 1 measurement INIT1
- Return Ch 1 results. . . . . FETC1?
- Verify returned result . . . . at least 1 count

6. Remove power and disconnect test equipment

Example: Trigger Level Functional Test

```
10     OPTION BASE 1
20     DIM Trig_ lev(4),Low(4),High(4),Lvl(4)
30     DATA -2.56,0,2.54,25.4
40     DATA -2.836,-.02,2.266,22.66
50     DATA -2.284,.02,2.814,28.14
60     READ Trig_ lev(*)
70     READ Low(*)
80     READ High(*)
90     !
100  OUTPUT 70906;"*RST"
110  OUTPUT 70906;"INP:COUP DC"
120  OUTPUT 70906;"INP:FILT ON"
130  OUTPUT 70906;"CONF1:TOT"
140  FOR I = 1 TO 4
150  IF I = 4 THEN
160          OUTPUT 70906;"1NP:ATT MAX"
170          Lvl(I) = Trig_lev(I)/10
180        ELSE
190          OUTPUT 70906;"INP:ATT MIN"
200          Lvl(I) = Trig_Lvl(I)
210        END IF
220  OUTPUT 70906;"SENS1:EVEN:LEV";Lvl(I)
230  PRINT TABXY(1,1);"Trigger level= ";Trig_lev(I);"V"
240  PRINT TABXY(1,4);"Procedure:"
250   !
260   PRINT TABXY(5,6);"1. Set source to ";Low(I);"Volts.   "
270   PRINT TABXY(5,7);"2. Increase source to ";High(I);"Volts.   "
280   PRINT TABXY(5,8);"3. Verify that Channel 1 count increases."
290   OUTPUT 70906;"INIT1"
300   DISP "For next trigger level, press any key."
310   ON KBD GOTO Next_lvl
320 Start: !
330   OUTPUT 70906;"FETC1?"
340   ENTER 70906;Reading
350   PRINT TABXY(10,12);"Channel 1 count = ";Reading;"        "
360   GOTO Start
370 Next_lvl: !
380  NEXT I
390  OUTPUT 70906;"INP:ATT MIN"
400  DISP "Test completed."
410  STOP
420  END
```

Operation Verification Tests

Operation verification test objectives are to instill a high degree of confidence that the HP E1333A 3-Channel Universal Counter is meeting selected specifications from those listed in Appendix A, "Specifications," in the *HP E1333A User's manual*.

Operation verification tests can be used in applications such as incoming inspection and after HP E1333A repair. To perform operation verification tests, do the parts of the performance verification tests shown in Table 4-3.

NOTE For best results, the HP E1333A 10 MHz reference oscillator should be adjusted to 10 MHz ± 10Hz. Before using the operation verification tests, you may want to perform the Reference Oscillator Adjustment procedure in Chapter 5, "Adjustments."

Table 4-3. Operation Verification Tests

Test	Test These Specifications
Frequency	Chan 1: 1 kHz, 8.192 sec gate Chan 1: 1 MHz, 1.024 sec gate Chan 2: 100 MHz, 0.002 sec gate Chan 3: 400 MHz, 0.016 sec gate
Period average	Chan 1: 1 msec period, average 16 periods Chan 1: 1 µsec period, average 1024 periods
Pulse Width	Chan 1: 1 msec pulse width, POS pulse Chan 2: 1 msec pulse width, POS pulse
Time Interval	Chan 1: 500 nsec interval, Ch 1 POS to Ch 2 NEG edge Chan 2: 500 nsec Interval, Ch 2 POS to Ch 1 NEG edge

Performance Verification Tests

Performance verification test objectives are to instill a high degree of confidence that the HP E1333A 3-Channel Universal Counter is meeting the specifications listed in Appendix A, "Specifications," of the *HP E1333A User's Manual*. Performance verification tests are required whenever a calibration is required. The HP E1333A counter performance verification tests are:

- Frequency Measurements
- Period Average Measurements
- Pulse Width Measurements
- Time Interval Measurements

NOTE For best results, the HP E1333A 10 MHz reference oscillator should be adjusted to 10 MHz ± 10 Hz. Before beginning the performance verification tests, you may want to perform the Reference Oscillator Adjustment procedure in Chapter 5 - "Adjustments."

Frequency Measurements Test

This test checks frequency measurement accuracy on Channels 1, 2, and 3. Input level sensitivity is tested indirectly by using input signals with amplitudes equal to the sensitivity limits.

Table 4-4. Frequency Measurements Performance Tests

Ch	Source	Source Ampl (mV rms)	Source Freq	Aperture Time (sec)
1	HP 3325A	25 mV rms	10 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 4 MHz 10 MHz	32.768 16.384 8.192 4.096 2.048 1.024 .512 .256
1	HP 8663A	25 mV rms	20 MHz 50 MHz 100 MHz 100 MHz 100 MHz 100 MHz 100 MHz 100 MHz	.128 .064 .032 .016 .008 .004 .002 65.536
2	HP 8663A	25 mV rms	100 MHz	.002
3	HP 8663A	10 mV 10 mV 10 mV 10 mV 10 mV 30 mV 40 mV	75 MHz 100 MHz 200 MHz 400 MHz 600 MHz 900 MHz 1 GHz	.128 .064 .032 .016 .008 .004 .002

Equipment Setup

Connect the equipment as shown in Figure 4-4. For measurements from 10 Hz through 10 MHz, connect the HP 3325A Function Generator to Channel 1. For measurements above 10 MHz, connect the HP 8663A Signal Generator to Channel 1, 2 or 3. Set outputs for sine wave.

NOTE

If a frequency test fails, measure the ACTUAL input to the HP E1333A to ensure that the input is the appropriate value (25 mV, 10 mV, 30 mV, or 40 mV rms). If the input is less than the specified value, increase the source output as required.

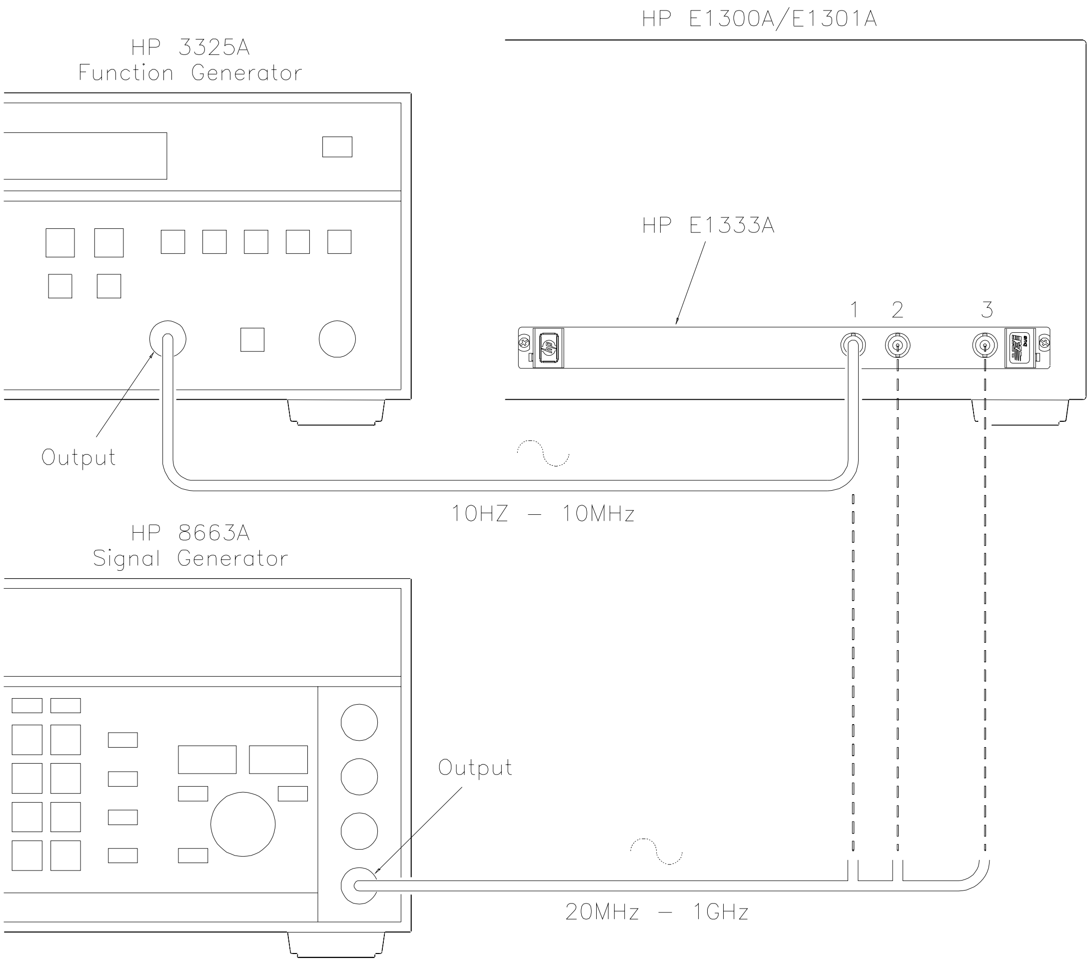


Figure 4-4. Frequency Measurements Test Connections

Test Procedure

1. Set HP E1333A input conditions:

- Reset counter . . . . *RST
- Set DC coupling . . . . INP:COUP DC
- Set 50Ω input impedance . . . . INP:IMP MIN

2. Measure Channel 1 frequencies (HP 3325A Source)

- Connect HP 3325A to Channel 1
- Set HP 3325A output . . . . 10 Hz at 25 mV rms
- Set FREQ function on Ch 1 . . . . SENS1:FUNC:FREQ
- Set 32.768 sec aperture SENS1:FREQ:APER 32.768
- Read measurement result . . . . READ1?
- Verify result within limits . . . . Table 4-8
- Repeat steps for each HP 3325A Channe1 source frequency, source amplitude and aperture time entry in Table 4-4.

3. Measure Channel 1 frequencies (HP 8663A Source)

- Connect HP 8663A to Channel 1
- Set HP 8663A output . . . . 20 MHz at 25 mV rms
- Set .128 sec aperture . . . . SENS1 :FREQ:APER .128
- Read measurement result . . . . READ1?
- Verify result within limits . . . . Table 4-8
- Repeat steps for each HP 8663A Channel 1 source frequency, source amplitude and aperture time entry in Table 4-4

4. Measure Channel 2 frequency (HP 8663A Source)

- Connect HP 8663A to Channel 2
- Set HP 8663A output . . . . 100 MHz at 25 mV rms
- Set .002 sec aperture . . . . SENS2:FREQ:APER .002
- Read measurement result . . . . READ2?
- Verify result within limits . . . . Table 4-8

5. Measure Channel 3 frequencies (HP 8663A Source)

- Connect HP 8663A to Channel 3
- Set HP 8663A output . . . . 75 MHz at 10 mV rms
- Set .128 sec aperture . . . . SENS3:FREQ:APER .128
- Read measurement result . . . . READ3?
- Verify result within limits . . . . Table 4-8
- Repeat steps for each HP 8663A Channel 3 source frequency, source amplitude and aperture time entry in Table 4-4

6. Remove power and disconnect test equipment

Example: Frequency Measurements Test

This program measures frequency on Channels 1, 2, and 3 for the frequencies and aperture times shown in Table 4-4.

NOTE Some measurements take up to 65 seconds to complete. If a measurement appears to take too long, check connections and/or code you entered.

```
10    OPTION BASE 1
20    DIM Aper(24),Ampl$(24)[10],Freq(24),Freq$(24)[10], Chan(24),Read(24)
30    DATA 32.768, 16.384, 8.192, 4.096, 2.048, 1.024, .512, .256
40    DATA .128, .064, .032, .016, .008, .004, .002, 65.536
50    DATA.002,.128,.064,.032,.016,.008,.004,.002
60    READ Aper(*)
70    DATA 25 mV, 25 mV, 25 mV, 25 mV, 25 mV, 25 mV, 25 mV, 25 mV
80    DATA 25 mV, 25 mV, 25 mV, 25 mV, 25 mV, 25 mV, 25 mV, 25 mV
90    DATA 25 mV, 10 mV, 10 mV, 10 mV, 10 mV, 10 mV, 30 mV, 40 mV
100  READ Ampl$(*)
110  DATA 1.E1,1.E2,1.E3,1.E4,1.E5,1.E6,4.E6,1.E7
120  DATA 2.E7,5.E7,1.E8,1.E8,1.E8,1.E8,1.E8,1.E8
130  DATA 1.E8,7.5E7,1.E8,2.E8,4.E8,6.E8,9.E8,1.E9
140  READ Freq(*)
150  DATA 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, 4 MHz, 10 MHz
160  DATA 20 MHz, 50 MHz, 100 MHz, 100 MHz, 100 MHz, 100 MHz, 100
MHz, 100 MHz
170  DATA 100 MHz, 75 MHz, 100 MHz, 200 MHz, 400 MHz, 600 MHz, 900
MHz, 1 GHz
180  READ Freq$(*)
190  OUTPUT 70906;"*RST"
200  OUTPUT 70906;"INP:COUP DC"
210  OUTPUT 70906;"INP:IMP MIN"
220  FOR I = 1 TO 24
230    IF I < 17 THEN Chan(I) = 1
240    IF I = 17 THEN Chan(I) = 2
250    IF I > 17 THEN Chan(I) = 3
260   OUTPUT CRT;"Frequency Measurernents on Channel";Chan(I)
270   OUTPUT CRT;"Frequency = ";Freq$(I)
280   OUTPUT CRT;"Aperture time = ";Aper(I);" sec"
290   OUTPUT CRT;" "
300   OUTPUT CRT;" Set source frequency to ";Freq$(I)
310   OUTPUT CRT;" Set source output to ";Ampl$(I);" rms"
320   DISP " Press Continue when ready "
330   PAUSE
340   CLEAR SCREEN
350   OUTPUT 70906;"SENS"&VAL$(Chan(I))&":FUNC:FREQ"
360   OUTPUT 70906;"SENS"&VAL$(Chan(I))&":FREQ:APER ";Aper(I)
370   OUTPUT 70906;"READ"&VAL$(Chan(I))&"?"
380   ENTER 70906;Read(I)
390  NEXT I
400  PRINT "Frequency Measurments Performance Test Completed."
410  PRINT "Press Continue to display the results."
420  PAUSE
430  CLEAR SCREEN
440  PRINT " HP E1333A counter Frequency Measurements"
450  PRINT
460 Format:IMAGE 4X,2A,4X,9A,5X,9A,8X,9A
470  PRINT USING Format;"Ch";"Frequency";"Aper Time";"Measured"
480  PRINT USING Format;" ";"(Hz)";"(sec)";"Freq (Hz)"
490  PRINT
500 Format1:1MAGE 4X,D,5X,7A,6X,2D.3D,7X,10D.3D
510  FOR I = 1 TO 24
520   PRINT USING Format1;Chan(I);Freq$(I);Aper(I);Read(I)
530  NEXT I
540  END
```

A typical return is:

```
HP E1333A Counter Frequency Measurements

    Ch    Frequency       Aper Time     Measured
          (Hz)              (sec)       Freq (HZ)

    1      10 Hz          32.768           9.979
    1      100 Hz         16.384          99.976
    1      1 kHz           8.192         999.878
                .
                .
                .
    3      1 GHz           0.002     1000003001.000
```

Period Average Measurements Test

This test measures period averages on Channel 1 only. Period average measurements are made with the frequencies, periods and number of periods averaged shown in Table 4-5. (Channel 2 is not tested since the same circuitry is used for Channels 1 and 2.)

Table 4-5. Period Measurements Performance Tests

Chan	Source Frequency	Source Period	Periods Averaged
1	1 Hz	1 sec	2
	10 Hz	100 msec	4
	100 Hz	10 msec	8
	1 kHz	1 msec	16
	5 kHz	200 usec	32
	10 kHz	100 usec	64
	50 kHz	20 usec	128
	100 kHz	10 usec	256
	500 kHz	2 usec	512
	1 MHz	1 usec	1024
	2 MHz	500 nsec	2048
	5 MHz	200 nsec	4096
	10 MHz	100 nsec	8192

Equipment Setup

Connect an HP 3325A Function Generator to Channel 1 as shown in Figure 4-5. Then, set HP 3325A to output sine waves at 50 mV rms.

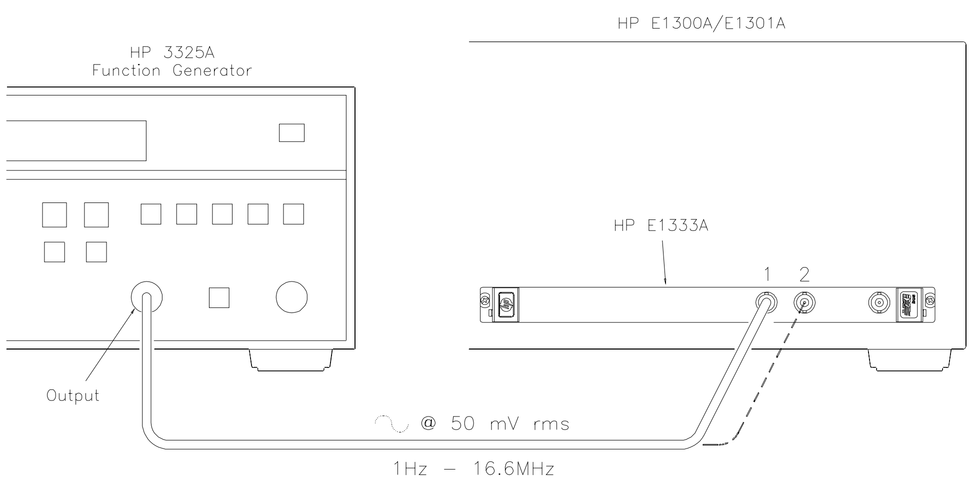


Figure 4-5. Period Measurements Test Connections

Test Procedure

1. Set HP E1333A Input conditions

- Reset counter . . . . *RST
- Set DC coupling . . . . INP:COUP DC
- Set 50Ω Input Impedance . . . . INP:IMP MIN

2. Measure Channel 1 periods

- Connect HP 3325A to Channel 1
- Set HP 3325A output . . . . 1 Hz at 50 mV rms
- Set PER function on Ch 1 . . . . SENS1:FUNC:PER
- Set 2 periods avgd SENS1:PER:NPER 2
- Read measurement result . . . . READ1?
- Verify result within limits . . . . Table 4-8
- Repeat steps for each HP 3325A Channel 1 source frequency and periods averaged entry in Table 4-5.

3. Remove power and disconnect test equipment

Example: Period Average Measurements

This program measures period averages on Channel 1 for the periods and number of periods averaged shown in Table 4-5.

```
10   OPTION BASE 1
20   DIM Nper(13),Per$(13)[10],Freq$(13)[10],Read(13)
30   DATA 2,4,8,16,32,64,128,256,512
40   DATA 1024,2048,4096,8192
50   READ Nper(*)
60   DATA 1 sec, 100 msec, 10 msec, 1 msec, 200 usec, 100 usec, 20 usec
70   DATA 10 usec, 2 usec, 1 usec, 500 nsec, 200 nsec, 100 nsec
80   READ Per$(*)
90   DATA 1 Hz, 10 Hz, 100 Hz, 1 kHz, 5 kHz, 10 kHz, 50 kHz
100  DATA 100 kHz, 500 kHz, 1 MHz, 2 MHz, 5 MHz, 10 MHz
110  READ Freq$(*)
120  OUTPUT 70906;"*RST"
130  OUTPUT 70906;"INP:COUP DC"
140  OUTPUT 70906;"INP:IMP MIN"
150  FOR I = 1 TO 13
160   OUTPUT CRT;"Period Average Measurements on Channel 1"
170   OUTPUT CRT;"Period = ";Per$(I)
180   OUTPUT CRT;"Periods averaged = ";Nper(I)
190   OUTPUT CRT;" "
200   OUTPUT CRT;" Set source frequency to ";Freq$(I);" sine wave"
210   OUTPUT CRT;" Set source output to 50 mV rms"
220   DISP " Press Continue when ready "
230   PAUSE
240   CLEAR SCREEN
250   OUTPUT 70906;"SENS1:FUNC:PER"
260   OUTPUT 70906;"SENS1:PER:NPER ";Nper(I)
270   OUTPUT 70906;"READ1?"
280   ENTER 70906;Read(I)
290  NEXT I
300  PRINT "Period Measurements Performance Test Completed."
310  PRINT "Press Continue to display the results."
320  PAUSE
330  CLEAR SCREEN
340  PRINT " HP E1333A Counter Period Measurements"
350  PRINT
```

(Continued on Next Page)

```
360 Fomat:IMAGE 4X,2A,4X,9A,5X,9A,4X,13A
370  PRINT USING Fomat;"Ch";"Period";"Periods";"Measured"
380  PRINT USING Format;" ";"(sec)";"Averaged";"Period (sec)"
390  PRINT
400 Format1:IMAGE 4X,A,5X,8A,6X,5D,7X,D.7DE
410  FOR I = 1 TO 13
420   PRINT USING Forrnat1;"1";Per$(I);Nper(I);Read(I)
430  NEXT I
440  END
```

A typical return is:

```
HP E1333A Counter Period Measurements

 Ch   Period     Periods       Measured
      (sec)      Averaged      Period (sec)

 1    1 sec         2         9.9999155E-01
 1    100 msec      4         9.9999724E-02
 1    10 msec       8         1.0000020E-02
               .
               .
               .
 1    100 nsec     8192       1.0000000E-07
```

Pulse Width Measurements Test

This test measures positive and negative pulse width averages on Channels 1and 2 at 0.5 Hz and 500Hz. Table 4-6 shows the pulse widths and pulse polarities measured.

Table 4-6. Pulse Width Measurements Tests

Ch	Pulse Width	Pulse Polarity
1	1 sec 1 sec 1 msec 1 msec	POS NEG POS NEG
2	1 sec 1 sec 1 msec 1 msec	POS NEG POS NEG

Equipment Setup

Connect the HP 3325A Function Generator to Channel 1 as shown in Figure 4-6. Then, set the HP 3325A to output a square wave at 50 mV rms.

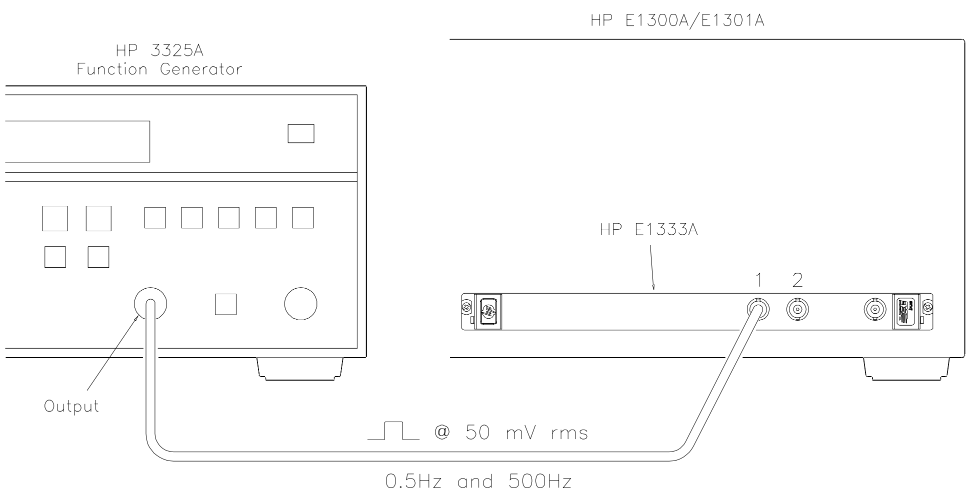


Figure 4-6. Pulse Width Measurements Connections

Test Procedure

1. Set HP E1333A input conditions

- Reset counter . . . . *RST
- Set DC coupling . . . . INP:COUP DC
- Set 50Ω input impedance . . . . INP:IMP MIN

2. Measure Channel 1 positive pulse widths

- Connect HP 3325A to Channel 1
- Set HP 3325A output . . . . 0.5 Hz
- Set pos pulse width on Ch 1. . . . . SENS1:FUNC:PWID
- Average 2 periods SENS1:TINT:NPER 2
- Read measurement result . . . . READ1?
- Verify result within limits . . . . Table 4-8
- Repeat steps for 500 Hz

3. Measure Channel 1 negative pulse widths

- Set HP 3325A output 0.5Hz
- Set neg pulse width on Ch 1 . . . . SENS1:FUNC:NWID
- Read measurement result . . . . READ1?
- Verify result within limits . . . . Table 4-8
- Repeat steps for 500 Hz

4. Measure Channel 2 positve pulse widths

- Connect HP 3325A to Channel 2
- Set HP 3325A output . . . . 0.5 Hz
- Set pos pulse width on Ch 2. . . . . SENS2:FUNC:PWID
- Average 2 periods SENS2:TINT:NPER 2
- Read measurement result . . . . READ2?
- Verify result within limits . . . . Table 4-8
- Repeat steps for 500 Hz

5. Measure Channel 2 negative pulse widths

- Set HP 3325A output . . . . 0.5 Hz
- Set neg pulse width on Ch 2 . . . . SENS2:FUNC:NWID
- Read measurement result . . . . READ2?
- Verify result within limits . . . . Table 4-8
- Repeat steps for 500 Hz

6. Remove power and disconnect test equipment

Example: Pulse Width Measurements

This program measures positive and negative pulse widths on Channels 1 and 2 for 0.5 Hz and 500 Hz

```
10   OPTION BASE 1
20   DIM Freq$(8)[10],Read(8),Pulse(8),Pol$(8)[10],Chan(8),Pulse$(8)[10],
Type$(8)[10]
30   DATA 1.,.001,1.,.001,1.,.001,1.,.001
40   READ Pulse(*)
50   DATA 1 sec, 1 sec, 1 msec, 1 msec
60   DATA 1 sec, 1 sec, 1 msec, 1 msec
70   READ Pulse$(*)
80   DATA POS,NEG,POS,NEG,POS,NEG,POS,NEG
90   READ Type$(*)
100  DATA PWID,NWID,PWID,NWID,PWID,NWID,PWID,NWID
110  READ Pol$(*)
120  DATA 0.5 Hz, 0.5 Hz, 500 Hz, 500 Hz
130  DATA 0.5 Hz, 0.5 Hz, 500 Hz, 500 Hz
140  READ Freq$(*)
150  OUTPUT 70906;"*RST"
160  OUTPUT 70906;"INP:COUP DC"
170  OUTPUT 70906;"INP:IMP MIN"
180  FOR I = 1 TO 8
190    IF I <= 4 THEN Chan(I) = 1
200    IF I > 4 THEN Chan(I) =2
210    OUTPUT CRT;"Pulse Width Measurements on Channel";Chan(I)
220    OUTPUT CRT;""
230    OUTPUT CRT;"Measure ";Type$(I);" Pulse Width"
240    OUTPUT CRT;"Pulse Width = ";Pulse$(I)
250    OUTPUT CRT;"Periods averaged = 2"
260    OUTPUT CRT;" "
270    OUTPUT CRT;" Set source frequency to ";Freq$(I);" square wave"
280    OUTPUT CRT;" Set source output to 50 mV rms"
290    DISP " Press Continue when ready "
300    PAUSE
310    CLEAR SCREEN
320    OUTPUT 70906;"SENS"&VAL$(Chan(I))&":FUNC:";Pol$(I)
330    OUTPUT 70906;"SENS"&VAL$(Chan(I))&":PER:NPER 2"
340    OUTPUT 70906;"READ"&VAL$(Chan(I))&"?"
350    ENTER 70906;Read(I)
360  NEXT I
370  PRINT "Pulse Width Measurements Performance Test Completed."
380  PRINT "Press Continue to display the results."
390  PAUSE
400  CLEAR SCREEN
410  PRINT " HP E1333A Counter Pulse Width Measurements"
420  PRINT
430 Format:IMAGE 4X,2A,4X,9A,4X,9A,5X,12A
440  PRINT USING Format;"Ch";"Pulse";"Pulse";"Measured"
450  PRINT USING Format;" ";"Width";"Polarity";"Width (msec)"
460  PRINT
470 Format1:IMAGE 4X,D,5X,8A,5X,8A,6X,4D.5D
480  FOR I = 1 TO 8
490    PRINT USING Format1;Chan(I);Pulse$(I);Type$(I);Read(I)*1000
500  NEXT I
510  END
```

A typical return is:

```
HP E1333A Counter Pulse Width Measurements

 Ch    Pulse    Pulse      Measured
       Width    Polarity   Width (msec)

  1    1 sec    POS         999.99706
  1    1 sec    NEG        1000.00666
  1    1 msec   POS           1.00006
  1    1 msec   NEG            .99976
  2    1 sec    POS        1000.02296
  2    1 sec    NEG        1000.05296
  2    1 msec   POS           1.00026
  2    1 msec   NEG            .99966
```

Time Interval Measurements Test

This test checks time interval accuracy on Channels 1 and 2 for the time interval and edges shown in Table 4-7, where POS = rising edge and NEG = falling edge of channel input.

Table 4-7. Time Interval Measurements Tests

Ch	Time Inverval	Ch 1 Edge	Ch 2 Edge
1	500 nsec	POS	NEG
2	500 nsec	NEG	POS

Equipment Setup

Connect the HP 3325A Function Generator to Channels 1 and 2 (tee connection) as shown in Figure 4-7. Then, set the HP 3325A to output 1 MHz square waves at 50 mV rms.

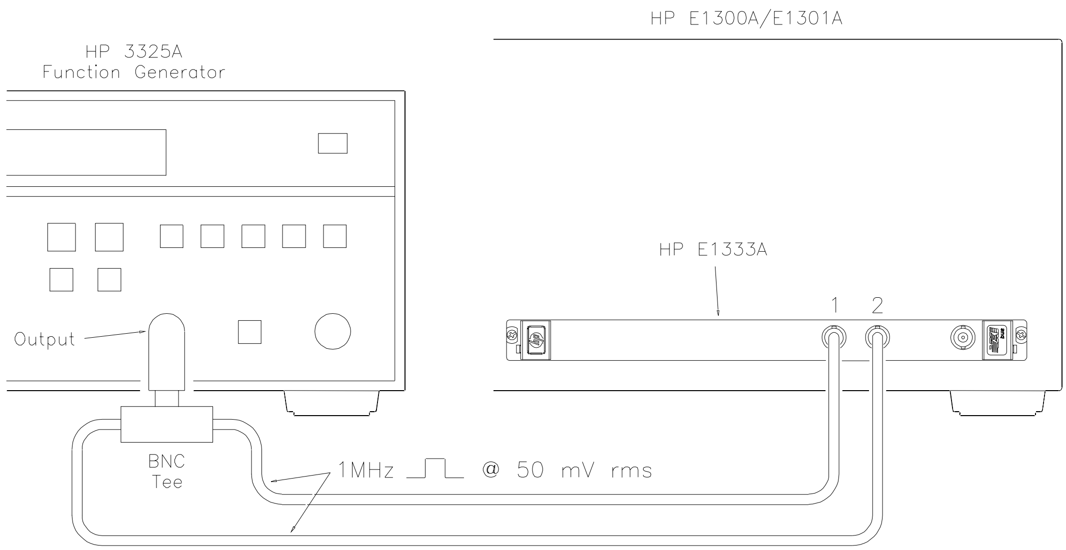


Figure 4-7. Time Interval Measurments Connections

Test Procedure

1. Set HP E1333A input conditions

- Reset counter . . . . *RST
- Set DC coupling . . . . INP:COUP DC
- Set 50Ω input Impedance . . . . INP:IMP MIN

2. Measure Channel 1 time interval

- Set time interval on Ch 1 . . . . SENS1:FUNC:TINT
- Set Ch 1 POS edge . . . . SENS1:EVEN:SLOP POS
- Set Ch 2 NEG edge . . . . SENS2:EVEN:SLOP NEG
- Read measurement result . . . . READ1?
- Verify result within limits . . . . Table 4-8

3. Measure Channel 2 time interval

- Set time interval on Ch 2 . . . . SENS1:FUNC:TINT
- Set Ch 1 NEG edge . . . . SENS1:EVEN:SLOP NEG
- Set Ch 2 POS edge . . . . SENS2:EVEN:SLOP POS
- Read measement result. . . . . READ2?
- Verify result within limits . . . . Table 4-8

4. Remove power and disconnect test equipment.

Example: Time Interval Measurements

This program measures time intervals for a 1 MHz signal input to Channels 1 and 2.

```
10    OPTION BASE 1
20    DIM Chan(2),Read(2),Slope1$(2)[10],Slope2$(2)[10]
30    DATA 1,2
40    READ Chan(*)
50    DATA POS,NEG
60    READ Slope1$(*)
70    DATA NEG,POS
80    READ Slope2$(*)
90    OUTPUT 70906;"*RST"
100  OUTPUT 70906;"INP:COUP DC "
110  OUTPUT 70906;"INP:IMP MIN"
120  FOR I = 1 TO 2
130    OUTPUT CRT;"Time Interval Measurements on channel";Chan(I)
140    OUTPUT CRT;"From Channel 1 ";Slope1$(I);" edge to Channel 2 ";
Slope2$(I);" edge"
150    OUTPUT CRT;" "
160    OUTPUT CRT;" Set output to 1 MHz square wave @ 50 mV rms"
170    DISP " Press Continue when ready "
180    PAUSE
190    CLEAR SCREEN
200    IF I = 1 THEN Ch1_meas
210    IF I = 2 THEN Ch2_meas
220 Ch1_meas: !
230    OUTPUT 70906;"SENS1:FUNC:TINT"
240    OUTPUT 70906;"SENS1:EVEN:SLOP POS"
250    OUTPUT 70906;"SENS2:EVEN:SLOP NEG"
260    OUTPUT 70906;"READ1?"
270    ENTER 70906;Read(I)
280    GOTO Continue
290 Ch2_meas:
300    OUTPUT 70906;"SENS2:FUNC:TINT"
310    OUTPUT 70906;"SENS1:EVEN:SLOP NEG"
320    OUTPUT 70906;"SENS2:EVEN:SLOP POS"
330    OUTPUT 70906;"READ2?"
340    ENTER 70906;Read(I)
350 Continue: !
360  NEXT I
370  PRINT "Time Interval Measurement Performance Test Completed."
380  PRINT "Press Continue to display the results."
390  PAUSE
400  CLEAR SCREEN
410  PRINT " HP E1333A Counter Time Interval Measurements"
420  PRINT
430 Format:IMAGE 4X,2A,6X,10A,3X,5A,3X,5A,5X,9A
440  PRINT USING Format;"Ch";"Time";"Ch 1";"Ch 2";"Measured"
450  PRINT USING Format;" ";"Interval";"Edge";"Edge";"Interval"
460  PRINT USING Format;" ";"(nsec)";" ";" ";"(nsec)"
470  PRINT
480 Format1:IMAGE 4X,D,8X,4A,8X,3A,5X,3A,5X,4D.3D
490  FOR I = 1 TO 2
500    PRINT USING Format1;Chan(I);"500’;Slope1$(I);Slope2$(I); Read(I)*1.E
+9
510  NEXT I
520  END
```

A typical return is:

```
HP E1333A Counter Time Interval Measurements

Ch      Time       Ch 1     Ch2      Measured
      Interval     Edge     Edge     Interval
       (nsec)                         (sec)

 1      500        POS      NEG      456.348
 2      500        NEG      NEG      556.931
```

Performance Test Record

Table 4-8, "Performance Test Record for the HP E1333A Counter," can be used to record the results of each Operation Verification and Performance Verification test for the HP E1333A counter (this record can be copied if desired). The record includes the upper and lower limits, the measurement uncertainty, and the Test Accuracy Ratio (TAR) for the test.

NOTE The values for counter accuracy, measurement uncertainty and TAR in Table 4-8 assume the following conditions. If your test conditions differ from these conditions, you will need to compute the appropriate values.

- Input noise (e_n) = 1 mV rms
- Slew rate = 0.5 x freq (V/sec) = 0.5/period (V/sec)
- Timebase error = 6.0 x 10^{-6} x measurement
- Measurement uncertainty = 3 x 10^{-11} x measurement

Table 4-8. Performance Test Record for the HP E1333A Counter (Page 1 of 4)

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:

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Table 4-8. Performance Test Record for the HP E1333A Counter (Page 2 of 4)

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 4-8. Performance Test Record for the HP E1333A Counter (Page 3 of 4)

Model ______________________	Report No. ________________	Date _______________

Source Freq	Aper Time (sec)	Low Limit (Hz)	Measured Frequency (Hz)	High Limit (Hz)	Measurement Uncertainty (Hz)	Test Acc Ratio
Channel 1						
10 Hz	32.768	9.969	________________	10.031	3.00000E-10	>10:1
100 Hz	16.384	99.94	________________	100.06	3.00000E-09	>10:1
1 kHz	8.192	999.87	________________	1000.13	3.00000E-08	>10:1
10kHz	4.096	9999.7	________________	10000.3	3.00000E-07	>10:1
100 kHz	2.048	99999	________________	100001	3.00000E-06	>10:1
1MHz	1.024	999993	________________	1000007	3.00000E-05	>10:1
4MHz	.512	3999974	________________	4000026	1.20000E-04	>10:1
10MHz	.256	9999936	________________	10000064	3.00000E-04	>10:1
20MHz	.128	19999872	________________	20000128	6.00000E-04	>10:1
50MHz	.064	49999684	________________	50000316	1.50000E-03	>10:1
100MHz	.032	99999369	________________	100000631	3.00000E-03	>10:1
100MHz	.016	99999337	________________	100000663	3.00000E-03	>10:1
100MHz	.008	99999275	________________	100000725	3.00000E-03	>10:1
100MHz	.004	99999149	________________	100000851	3.00000E-03	>10:1
100MHz	.002	99998899	________________	100001101	3.00000E-03	>10:1
100MHz	65.536	99999400	________________	100000600	3.00000E-03	>10:1
Channel 2						
100 MHz	.002	99998899	________________	100001101	3.00000E-03	>10:1
Channel 3						
75 MHz	.128	74999050	________________	75000950	2.25000E-03	>10:1
100 MHz	.064	99998400	________________	100001600	3.00000E-03	>10:1
200 MHz	.032	199996800	________________	200003200	6.00000E-03	>10:1
400 MHz	.016	399993600	________________	400006400	1.20000E-02	>10:1
600 MHz	.008	599988400	________________	600011600	1.80000E-02	>10:1
900 MHz	.004	899978600	________________	900021400	2.70000E-02	>10:1
1 GHz	.002	999962000	________________	1000038000	3.00000E-02	>10:1

Table 4-8. Performance Test Record for the HP E1333A Counter (Page 4 of 4)

Model ____________________	Report No. ____________________	Date ______________

Period Measurements (Channel 1)

Source Period	Period Avgd	Low Limit (sec)	Measured Period (sec)	High Limit (sec)	Meas Uncert (sec)	Test Acc Ratio
1 sec	2	9.9858948E-01	______________	1.0014105E+0	3.00000E-11	>10:1
100 msec	4	9.9929151E-02	______________	1.0007085E-01	3.00000E-12	>10:1
10 msec	8	9.9964163E-03	______________	1.0003584E-02	3.00000E-13	>10:1
1 msec	16	9.9981219E-04	______________	1.0001878E-03	3.00000E-14	>10:1
200 usec	32	1.9997812E05	______________	2.0002188E-04	6.00000E-15	>10:1
100 usec	64	9.9993449E-05	______________	1.0000655E-04	3.00000E-15	>10:1
20 usec	128	1.9998660E-05	______________	2.0001340E-05	6.00000E-16	>10:1
10 usec	256	9.9994397E-06	______________	1.0000560E-05	3.00000E-16	>10:1
2 usec	512	1.9997817E-06	______________	2.0002183E-06	6.00000E-17	>10:1
1 usec	1024	9.9989360E-07	______________	1.0001064E-06	3.00000E-17	>10:1
500 nsec	2048	4.9994749E-07	______________	5.0005251E-07	1.50000E-17	>10:1
200 nsec	4096	1.9997425E-07	______________	2.0002575E-07	6.00000E-18	>10:1
100 nsec	8192	9.9987159E-08	______________	1.0001284E-07	3.00000E-18	>10:1

Pulse Width Measurements (Channel 1: 2 Periods Averaged)

Pulse Width	Pulse Polarity	Low Limit (msec)	Measured Width (msec)	High Limit (msec)	Meas Uncert (sec)	Test Acc Ratio
1 sec	POS	997.18500	______________	1002.81500	3.00000E-11	>10:1
1 sec	NEG	997.18500	______________	1002.81500	3.00000E-11	>10:1
1 msec	POS	.99714	______________	1.00286	3.00000E-14	>10:1
1 msec	NEG	.99714	______________	1.00286	3.00000E-14	>10:1
						>10:1
1 sec	POS	997.18500	______________	1002.81500	3.00000E-11	>10:1
1 sec	NEG	997.18500	______________	1002.81500	3.00000E-11	>10:1
1 msec	POS	.99714	______________	1.00286	3.00000E-14	>10:1
1 msec	NEG	.99714	______________	1.00286	3.00000E-14	>10:1

Time Interval Measurements (Channels 1 and 2: 1 Period Averaged)

Ch	Ch 1 Edge	Ch 2 Edge	Time Interval (nsec)	Low Limit (nsec)	Measured Interval (nsec)	High Limit (nsec)	Meas Uncert (sec)	Test Acc Ratio
1	POS	NEG	500	397.191	______________	602.809	1.500000E-17	>10:1
2	NEG	POS	500	397.191	______________	602.809	1.500000E-17	>10:1

Notes

Chapter 5
Adjustments

Introduction

This chapter contains procedures to adjust the HP E1333A Counter, including the 10 MHz reference oscillator frequency, Channel 1 trigger level zero, and channel 2 trigger level zero.

Adjustment Requirements

The counter should be adjusted after repair to ensure peak performance. Equipment required for the adjustment procedures is listed in Table 1-2, "Recommended Test Equipment." In addition, you will need a small slotted screwdriver, a Phillips (or Pozidriv) screwdriver, and a T10 torx key.

Before performing adjustments, the counter must have a minimum 60-minute warm up and the line voltage must be 115/230 Vac ±10%. For best accuracy, the test area temperature should be between 18°C and 28°C, and stable to ±1°C.

WARNING **Remove the power cord and all other sources of power supplied (via other plug-in modules) to the mainframe. When installation is complete, cover all unused slots and ensure that all module faceplates are secured tightly against the mainframe.**

Only qualified, service-trained personnel should install or change the location of the HP E1333A (or any other plug-in module) inside the HP 75000 Series B mainframe.

Adjustment Access

To perform the reference oscillator and trigger level zero adjustments, ensure that the components to be adjusted (R10, R11, and U7) are accessible. There are two main ways to do this (you can also install the counter in an HP E1400T mainframe):

- One way is to remove all other modules in the mainframe and place the counter in a slot that allows access to the components.
- The other way is to remove the mainframe top cover and/or any internal covers required to access the components. See the appropriate mainframe service manual and/or configuration guide for instructions.

Reference Oscillator Adjustment

This adjustment sets the 10 MHz reference oscillator output to 10 MHz ± 10 Hz (± 1 ppm). The procedure is:

1. Connect Channel A of the HP 5334B Universal Counter to the output of the 10 MHz reference oscillator (U53 pin 13) (see Figure 5-1).
2. Set the HP 5334B counter to measure frequency on Channel A.
3. Reset the HP E1333A with *RST.
4. Use a slotted screwdriver to adjust the U7 potentiometer until the HP 5334B shows 10 MHz ± 10 Hz.

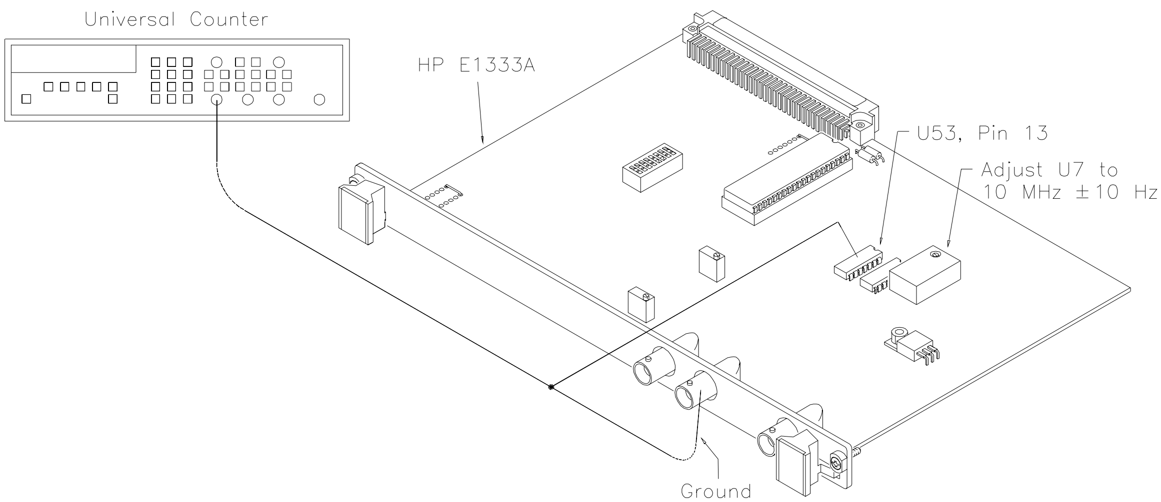

Figure 5-1. Reference Oscillator Adjustments

Trigger Level Zero Adjustments

This procedure adjusts the crossing point for 0V level triggering on Channels 1 and 2. The procedure is:

1. For Channel 1 trigger level zero adjustments, connect an oscilloscope between U2 pin 5 and the HP E1333A input Common, and connect the HP 3325A output to Channel 1 (see Figure 5-2).
2. Output a 1 Vac PP triangle wave at 10 kHz from the HP 3325A to Channel 1 of the HP E1333A. You should see a square wave.
3. Adjust potentiometer R11 until the positive and negative pulses of the square wave are equal in width.
4. Repeat steps 2 and 3 with triangle waves of amplitudes of 250 mV PP and 50 mV PP. The adjustment becomes more accurate as the input amplitude becomes smaller.
5. For Channel 2 adjustments, repeat steps 1 through 4 except connect the HP 3325A output to Channel 2, connect the oscilloscope to U2 pin 12 and the input Common, and adjust R10.

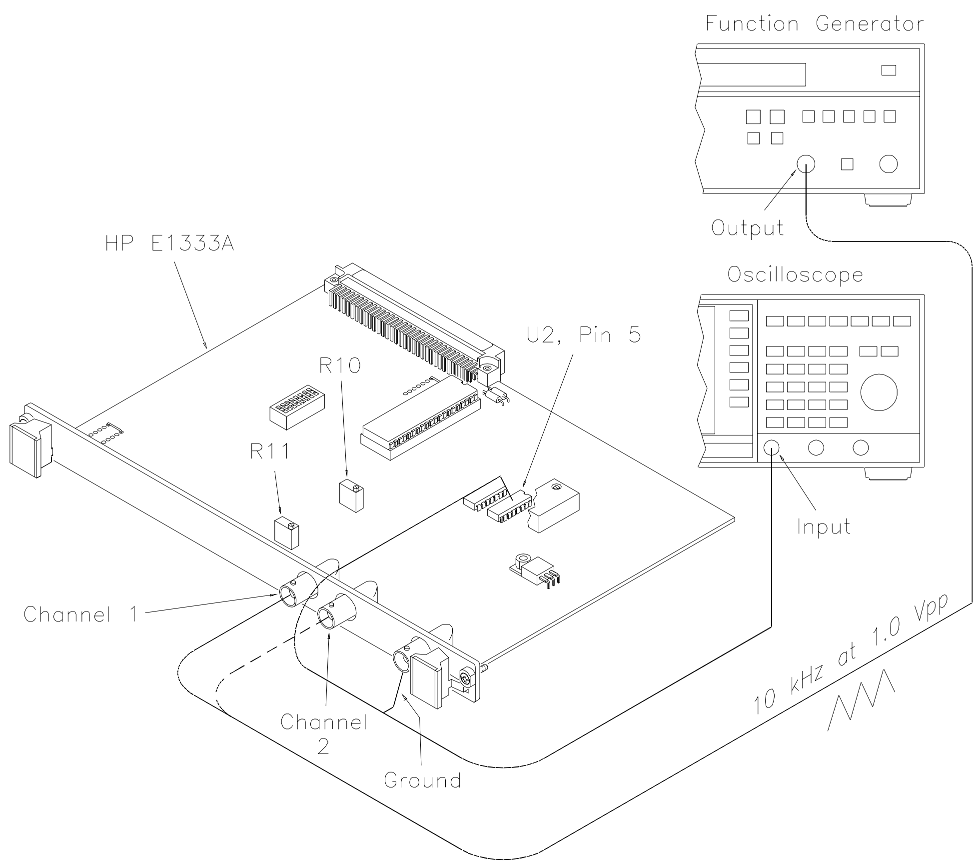

Figure 5-2. Trigger Level Zero Adjustments

Notes

Chapter 6
Replaceable Parts

Introduction

This chapter contains information to order replaceable parts for the HP E1333A counter.

Exchange Assemblies

Table 6-1 lists assemblies that may be replaced on an exchange basis (EXCHANGE ASSEMBLIES). Exchange, factory-repaired, and tested assemblies are available only on a trade-in basis. Defective assemblies must be returned for credit. Assemblies required for spare parts stock must be ordered by the new assembly part number. Contact your nearest Hewlett-Packard Sales and Service Office for details.

Ordering Information

To order a part listed in Table 6-1, specify the Hewlett-Packard part number, the check digit (CD), and the quantity required. Send the order to your nearest Hewlett-Packard Sales and Service Office. (Using the check digit will help ensure accurate processing of your order.)

Replaceable Parts List

Tables 6-1 lists the replaceable parts for the HP E1333A counter. See Figure 6-1 for locations of parts listed in Table 6-1.

Table 6-1. HP E1333A Replaceable Parts

Reference* Designator	HP Part Number	CD	Qty	Description
				EXCHANGE ASSEMBLIES
	E1333-66201	8	1	3-CHAN UNIVERSAL COUNTER (NEW)
	E1333-69201	4	1	3-CHAN UNIVERSAL COUNTER (EXCH)
A1	E1333-66501	0	1	**PRINTED CIRCUIT ASSY [a]**
A1BRK1	0500-2183	1	2	BRACKET-RIGHT ANGLE,MTG;PNL-PCB
	0361-1295	3	2	RIVET-SEMITUBULAR .095 DIA .406 LNG
A1BRK2	0500-2183	1		BRACKET-RIGHT ANGLE,MTG;PNL-PCB
	0361-1295	3		RIVET-SEMITUBULAR .095 DIA .406 LNG
A1F1	2110-0712	8	3	FUSE-SUBMINIATURE 4A 125V NTD AX
A1F2	2110-0712	8		FUSE-SUBMINIATURE 4A 125V NTD AX
A1F2	2110-0712	8		FUSE-SUBMINIATURE 4A 125V NTD AX
A1J1	1250-1846	6	3	CONNECTOR-RF BNC FEM PC 50-OHM
A1J2	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM
A1J3	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM
A1JM1	7175-0057	5	2	RESISTOR-ZERO OHMS TND COPPER
A1JM2	7175-0057	5		RESISTOR-ZERO OHMS TND COPPER
A1MP1	0570-1295	6	1	STUD-PRSN M3.0 X .56 MM LONG
A1MP2	0535-0004	9	1	NUT-HEX DBL-CHAN M3X0.5 2.9 MM THK
A1MP3	2190-0584	0	1	WASHER-LK HLCL 3.0 MM 3.1-MM-ID
A1P1	1252-1596	7	1	CONN-POST-TYPE;2.54-PIN-SPCG96-CONT
	0361-1294	2	2	RIVET-SEMITUBULAR .095 DIA .328 LNG
A1SW1	3101-3066	3	1	SWITCH-DIP RKR SPST 0.1A 5VDC
A1XU14	1200-0817	4	1	SOCKET-IC 40-CONT DIP DIP-SLDR
				MECHANICAL PARTS
MP1	E1300-45101†		1	HNDL-KIT TOP, HP†
MP2	E1300-45102†		1	HNDL-KIT BTM, VXI†
PNL1	E1333-00202†		1	PNL-RR CENTER 4 CH†
SCR1-SCR2	0515-2140		2	SCR-THD-RLG M2.5 X0.45 14mm
SCR5-SCR6	0515-2743		2	SCR-FH M2.5 X 8 THREAD ROLLING

* See Table 6-2 for Reference Designator definitions.

[a] Repair limited to replacement of parts listed - see Introduction for ordering information

† These parts are not compatible with older version fixed handles and their corresponding front panels. To replace one or more of these older parts, you must order all three new parts (Top and Bottom Handle Kits AND Front Panel).

Table 6-2. HP E1333A Reference Designators

HP E1333A Reference Designators	
A .... assembly BRK .... bracket F .... fuse J .... electrical connector (jack) JM .... electrical connector (jumper) MP .... misc. mechanical part	P .... electrical connector (plug) PNL .... panel SCR .... screw SW .... switch XU ....socket, integrated circuit

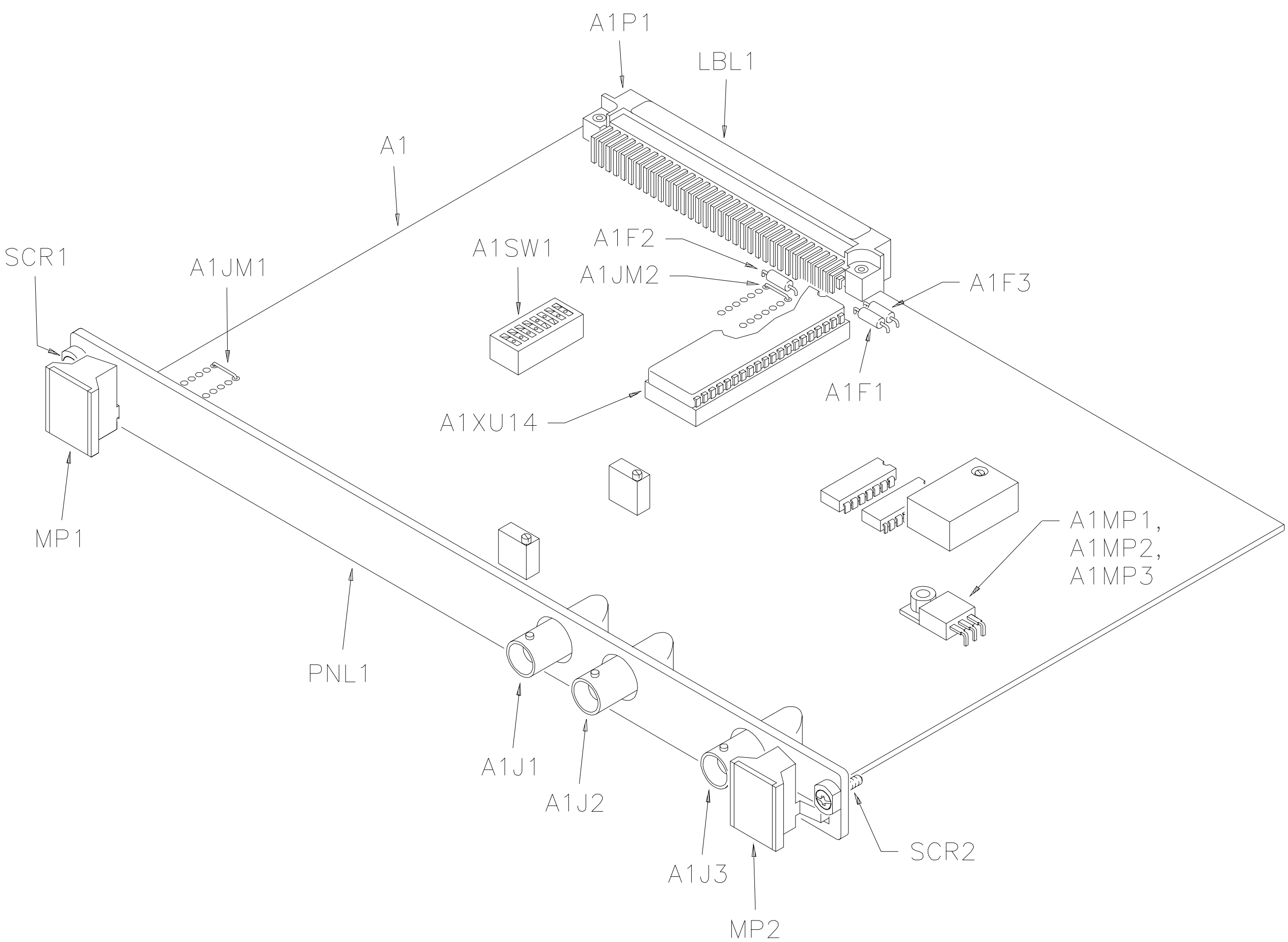

Figure 6-1. HP E1333A Counter - Replaceable Parts

Chapter 7
Service

Introduction

This chapter contains information to service the HP E1333A counter, including troubleshooting guidelines and repair/maintenance 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 counter troubleshooting and repair is listed in Table 1-2, "Recommended Test Equipment." To avoid damage to the screw head slots, use Pozidrive or Torx drivers as required. You may need Torx size T-8 (8710-1673), size T-10 (8710-1284), and size T-15 (8710-1816) screwdrivers. For adjustments to R10 and R11 (see Chapter 5, "Adjustments"), use a blade tuning tool (8710-0033) or JFD Model 5284 (8710-1010) hex tuning tool.

Service Aids

Service aids on printed circuit boards include pin numbers, some reference designations, and assembly part numbers. See Chapter 6, "Replaceable Parts," for descriptions and location of HP E1333A replaceable parts.

Service notes, manual updates, and service literature for the HP E1333A counter may be available through Hewlett-Packard. For information, contact your nearest Hewlett-Packard Sales and Service Office.

Troubleshooting Techniques

There are two main steps to troubleshoot an HP E1333A counter problem: (1) identify the problem, and (2) test assemblies to isolate the cause to a user-replaceable component.

Identifying the Problem

Counter problems can be divided into four general categories:

- Self-test errors
- Operator errors
- Catastrophic failures
- Performance out of specification

Self-Test Errors

An error number (1 through 7) is returned when the counter self-test fails. If a self-test error occurs, recycle power and repeat the self-test. If the error repeats, see the following section "Testing the Counter" to troubleshoot the counter. Table 7-1 shows some typical causes of self-test errors.

Table 7-1. Self-Test Errors

Error	Description	Typical Causes
0	Self-Test Passed	
1	Counter did not power up properly	-Bad connections/settings -A1F1, F2, or F3 open -Hardware failure (exchange)
2	Problem with digital portion of trigger level	-Hardware failure (exchange)
3	Counter did not properly measure frequency	-Hardware failure (exchange)
4	Counter did not properly measure period	-Hardware failure (exchange)
5	Counter did not properly totalize	-Hardware failure (exchange)
6	Problem with analog portion of trigger level	-Hardware failure (exchange)
7	Counter is not in proper state after being reset	-Incorrect operation -Hardware failure (exchange)

Operator Errors

Apparent failures may result from operator errors. See Appendix B, "Error Messages," in the *HP E1333A User's Manual* for information on operator errors.

Catastrophic Failure

If a catastrophic failure occurs, see "Testing the Counter" below to troubleshoot the counter.

Performance Out of Specification

If the counter performance is out of specification limits, use the adjustment procedures in Chapter 5, "Adjustments," to correct the problem.
If the condition repeats, see "Testing the Counter" below to troubleshoot the counter.

Testing the Counter

You can use the tests and checks in Table 7-2 to isolate the problem to a user-replaceable part on the counter front panel or to the A1 PCA. See Figure 6-1 in Chapter 6, "Replaceable Parts," for locations of user-replaceable parts.

NOTE If the problem cannot be traced to a user-replaceable part listed in Table 6-1, return the counter to Hewlett-Packard for exchange. See Chapter 6, "Replaceable Parts," for procedures.

Table 7-2. HP E1333A Tests/Checks

Test/Check	Reference Designator	Check:
Heat Damage	- - - - - - - - - -	Discolored PC boards Damaged insulation Evidence of arcing
Switch/Jumper Settings	JM1, JM3 SW1	IRQ Level setting LADDR setting
A1 Assembly	F1, F2, F3 J1, J2, J3 P1 XU14	Fuse continuity Mating connector contacts Connector contacts IC contact/connections

Checking Heat Damage

Inspect the counter for signs of abnormal internally generated heat such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. If there is damage, do not operate the counter until you correct the problem.

Checking Switches/Jumpers

Verify the logical address setting is set correctly (factory set at 48). Verify the interrupt priority jumpers are set correctly (factory set at level 1). See the *HP E1333A User's Manual* for information.

Testing the A1 Assembly

To test the A1 Assembly, remove mainframe power and remove the counter from the mainframe. Then, see table 7-2 for guidelines to isolate the problem to a user-replaceable part.

Repair/Maintenance Guidelines

This section gives guidelines to repair and maintain the HP E1333A counter, including:

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

ESD Precautions

Electrostatic discharge (ESD) may damage MOS, CMOS and other static sensitive devices in the HP E1333A counter. This damage can range from slight parameter degradation to catastrophic failure. When handling counter assemblies, follow these guidelines to avoid damaging counter components:

- Always use a static-free work station with a pad of conductive rubber or similar material when handling counter components.

- After you remove the counter from the mainframe, place the counter on a conductive surface to guard against ESD damage.

- Do not use pliers to remove a MOS or 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 MOS or CMOS device from an assembly, place the device onto a pad of conductive foam or other suitable holding material.
- If a device requires soldering, be sure the assembly is placed on a pad of conductive material. Also, be sure you, the pad, and the soldering iron tip are grounded to the assembly. Apply as little heat as possible when soldering.
- When you replace a MOS or CMOS device, ground the foam to the counter before removing the device from the foam.

The etched circuit boards in the counter 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 (a 38-watt soldering iron is recommended), 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 the HP E1333A counter, inspect the counter 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 self-test (*TST? command) to verify that the counter is functional.

Notes

Appendix A
Counter Accuracy Calculations

Introduction

This appendix shows how counter accuracy is defined and calculated for the HP E1333A 3-Channel Counter. See Table 4-8, "Performance Test Record," for the HP E1333A Counter, for values of counter accuracy.

Counter accuracy is defined as the expected accuracy of the measurement due ONLY to the HP E1333A counter. The "Low Limit" entry in Table 4-8 corresponds to the lower (-) value of counter accuracy, while the "High Limit" entry in Table 4-8 corresponds to the upper (+) value of counter accuracy.

For further information on counter accuracy specifications, see Application Note 200, "Fundamentals of Electronic Counters" (HP part number 02-5952-7506) and Application Note 200-4, "Understanding Frequency Counter Specifications" (HP part number 02-5952-7522).

Calculating Counter Accuracy

For the HP E1333A counter, accuracy is defined for Frequency Measurements, Period Average Measurements, Pulse Width Measurements, and Time Interval Measurements by the following equation:

accuracy = ± [resolution + timebase error + trigger noise error]

Resolution is defined as the smallest change in the measurement that can be detected. For frequency measurements, resolution is in Hz. For period average, pulse width, and time interval measurements, resolution is in seconds (see Table A-1).

NOTE For Channel 3 frequency accuracy calculations, frequency resolution = 64/aper time.

Table A-1. HP E1333A Counter Resolution Equations

Measurement	Resolution	Range/values
Frequency	1* / *aper time* (Hz)	.002, .004,...,65.536 sec
Period Average	100 / *# periods avgd* (nsec)	2, 4, 8,..., 65536 periods
Pulse Width/ Time Interval	100 / *# periods avgd* (nsec)	1, 2, 4,..., 128 periods

*For Channel 3 only, frequency resolution (Hz) = 64/aper time

Timebase error is defined as the maximum fractional change in the 10 MHz reference timebase frequency due to all error sources, which we will call the **timebase** (initial accuracy, aging, and temperature drift), multiplied by the measurement result. That is:

timebase error = ± [initial accuracy + aging rate + temperature drift] x measurement result.

For the HP E1333A, the *worst-case* timebase values are initial accuracy = ± 2 ppm, aging rate = ± 2 ppm/year, and temperature drift = ± 5 ppm, 0°C to 50°C. However, typical maximum temperature drift is about 2 ppm (see Figure A-1), and calibration is usually performed at 1-year intervals. Thus, a typical timebase error = ± (2 x 10^{-6} + 2 x 10^{-6} + 2 x 10^{-6}) = ± (6 x 10^{-6}) x measurement result.

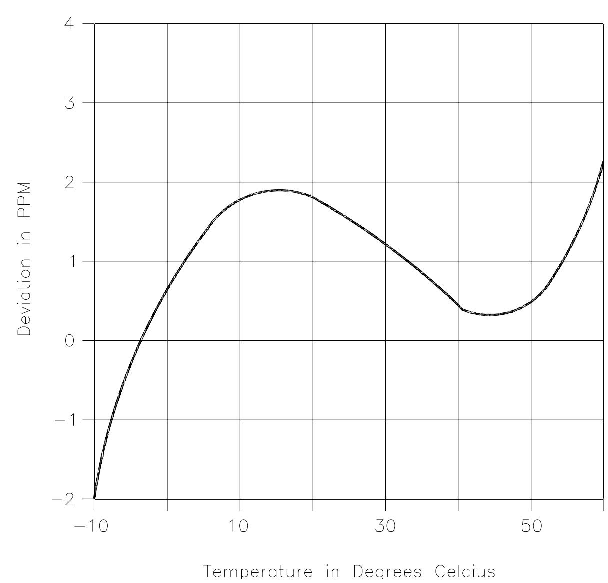

Figure A-1. Typical Temperature Drift

Trigger Noise Error

Trigger noise error is defined as the additional error caused by counter input noise (80 μV for the HP E1333A) and by noise on the input signal. The *input slew rate at trigger point* (in μV/sec) is the rate at which the input voltage is changing when the input is triggered. That is:

$$\textbf{slew rate} = \frac{\Delta V}{\Delta t}$$

For example, for a 50 mV ramp wave input with a 10 μsec rise time,

$$\textbf{slew rate} = \frac{0.8 \times 50 \times 10^{-3}}{10 \times 10^{-6}} = 4{\times}10^{3} V/sec = 4{\times}10^{9} \mu V/sec$$

Typically, however, the slew rate is not a constant, but varies linearly with the input frequency, according to the **slew rate factor**. That is, **slew rate = slew rate factor x frequency = slew rate factor/period**. For example, a typical slew rate factor for a 50 mV input signal is 0.5 (for slew rate in V/sec). Thus, for a 50 mV input at 10 kHz, a typical **slew rate** = 0.5 x 10^4 V/sec = 5000 V/sec = 5 x 10^9 μV/sec.

Frequency Measurements Trigger Noise Error

From Appendix A, "Specifications," of the *HP E1333A User's Manual,* for frequency measurements:

Trigger Noise Error (RMS) = T, where:

$$T = \frac{\sqrt{(80\mu V)^2 + (e_n)^2}}{\textit{input slew rate at trigger point}}$$

e_n = rms noise (in μV) on the input signal for a 150 MHz bandwidth.

However, T is NOT the "trigger noise error" term for frequency measurements accuracy, but is only part of the equation. From Application Note 200-4, for frequency measurements:

trigger noise error (Hz)

= [(1.4 x T)/aper time] x frequency

$$= 1.4 \text{ x } \frac{\sqrt{(80\mu V)^2 + (e_n)^2}}{\textit{input slew rate at trigger point}} \text{ x frequency}$$

Period Measurements Trigger Noise Error

From Appendix A, "Specifications," of the *HP E1333A User's Manual*, for period, pulse width, and time interval measurements:

Trigger Noise Error (RMS) = T, where T is:

$$T = \frac{\sqrt{(80\mu V)^2 + (e_n)^2}}{\textit{input slew rate at trigger point}}$$

However as with frequency measurements, T is NOT the "trigger noise error" term for period measurements, but is only part of the equation. For period average, pulse width, and time interval measurements, **trigger noise error** = (1.4 x T)/nper, where nper = number of periods averaged. Therefore:

trigger noise error (sec) =

$$1.4 \text{ x } \frac{\sqrt{(80\mu V)^2 + (e_n)^2}}{nper \times \textit{ input slew rate at trigger point}}$$

Counter Accuracy Equations Table

Table A-2 summarizes counter accuracy equations for frequency, period average, pulse width, and time interval measurements. For any listed measurement, **accuracy** = ±[resolution + timebase error + trigger noise error] .

Table A-2. HP E1333A Counter Accuracy Equations

Measurement	± resolution	± timebase error*	± trigger noise error**
Frequency	$\frac{1}{\textit{aper time}}$ (Hz) (.002, .004, ..., 65.536 sec)	timebase x frequency (Hz)	$\frac{1.4 \times T}{\textit{aper time}} \times \textit{frequency}$ (Hz)
Period Average	$\frac{100}{\textit{\# periods avgd}}$ (nsec) (2, 4, 8,..., 65536 periods)	timebase x period (sec)	$\frac{1.4 \times T}{\textit{\# periods avgd}}$ (sec)
Pulse Width	$\frac{100}{\textit{\# periods avgd}}$ (nsec) (1, 2, 4,..., 128 periods)	timebase x pulse width (sec)	Same as Period
Time Interval	Same as Pulse Width	timebase x interval (sec)	Same as Period

* timebase = ± [initial accuracy + aging rate + temp drift] = 6.0 x 10^{-6} (typical)

$$** \; T = \frac{\sqrt{(80\mu V)^2 + (e_n)^2}}{\textit{input slew rate at trigger point}}$$

Accuracy Calculations Examples

Two examples follow to calculate HP E1333A counter accuracy. The first example calculates frequency measurement accuracy, while the second example calculates period measurement accuracy.

Example: Calculating Frequency Accuracy

For this example, assume the following values/conditions:

Input frequency: 10 kHz sine wave
Input amplitude: 50 mV rms
Aper time: 4.096 sec
Timebase: 6.0 x 10^{-6}
Source noise (e_n): 1 mV rms
Slew rate: 0.5 x frequency (V/sec)

NOTE The source noise of 1 mV is a typical value. You will need to measure the noise of your source for most accurate calculations.

Frequency Measurement Accuracy Equation

For frequency measurements: **accuracy** (Hz) = ± [resolution + timebase error + trigger noise error].

Calculate Resolution

For an aperture time of 4096 msec, **resolution** = ± 1/aper time = ± 1/(4.096)= ± 0.2441 Hz

Calculate Timebase Error

For frequency measurements, **timebase error** = timebase x frequency = ± [initial accuracy + aging rate + temp drift] x frequency = ± (6.0 x 10^{-6}) x 10^4 Hz = ± 0.06 Hz

Calculate Trigger Noise Error

From Table A-2, for frequency measurements:

trigger noise error (Hz) $= \pm \frac{1.4 \times T}{aper\ time} \times frequency$

$$\text{where } T = \frac{\sqrt{(80\mu V)^2 + (e_n)^2}}{\textit{input slew rate at trigger point}}$$

e_n = rms noise (in µV) on the input signal

Thus, for input noise e_n = 1 mV, aper time = 4.096 sec, and slew rate = 0.5 x 10^4 V/sec (5 x 10^9 µV/sec), the trigger noise error for a 10 kHz input is:

trigger noise error (Hz)

$$= \pm 1.4 \times \frac{\sqrt{(80\mu V)^2 + (1000\mu V)^2}}{4.096\ sec \times 5 \times 10^9\ {}^{\mu V}\!/_{sec}} \times 10^4\ Hz$$

$= \pm 1.686 \times 10^{-3}$ Hz = ± 0.000686 Hz

Calculate Frequency Measurement Accuracy

Since **accuracy** (frequency measurements) = ± [resolution + timebase error + trigger noise error]

accuracy = ± (0.2441 Hz + 0.06 Hz + 0.000686 Hz)
= ± 0.3048 Hz

Effects of Varying Signal Conditions

Although this example showed resolution as the primary contributor to counter accuracy, timebase errors can also be a major contributor, as shown in Table A-3. For Case 1, the resolution error contributes about 79% of the error. However, for Case 2 the timebase error contributes about 99% of the error. For Case 3, triggering is assumed to NOT be at the midpoint of the sine wave, and a slew rate of 1 V/sec is assumed. However, even with a very slow slew rate, the trigger noise error is only about 0.14%.

Table A-3. Effects on Frequency Accuracy of Varying Input Conditions

Case	Freq	Aper Time (sec)	Slew Rate (V/sec)	Resolution (Hz)	Timebase Error (Hz)	Trigger Error (Hz)	Counter Acc (Hz)
1	10 kHz	4.096	10^3	0.2441 (79%)	0.06	3.43×10^{-3}	0.3076
2	10 MHz	32.768	10^6	0.0305	60.0 (99%)	4.29×10^{-4}	60.0309
3	1 Hz	4.096	1	0.2441 (99%)	6×10^{-6}	3.43×10^{-4}	0.2445

NOTE Although the combinations shown in TableA-3 do not necessarily reflect actual test conditions, the numbers do indicate that a careful analysis of the input signal and triggering points is required to determine the accuracy of your measurements.

Example: Calculating Period Average Accuracy

For this example, assume the following values/conditions:

Input period: 200 µsec (5 kHz sine wave)
Number periods averaged: 32
Timebase: 6.0×10^{-6}
Source amplitude: 50 mV rms
Source Noise (e_n): 1 mV rms
Slew rate: 0.5/period (V/sec)

NOTE The source noise of 1 mV is a typical value. You will need to measure the noise of your source for most accurate calculations. You can use this example for time interval and pulse width measurements by substituting the appropriate equations shown in Table A-2.

Period Measurement Accuracy Equation

For period measurements, **accuracy** (sec) = ± [resolution + timebase error + trigger noise error].

Calculate Resolution

For 32 periods to be averaged, **resolution** = ± (100/nper) = ± (l00/32) = ± 3.125 nsec

Calculate Timebase Error

For period measurements, **timebase error** (sec) = timebase x period = ± [initial accuracy + aging rate + temp drift] x period. For this example, timebase error = $\pm (6.0 \times 10^{-6}) \times (200 \times 10^{-6}) = \pm 1.2$ nsec.

Calculate Trigger Noise Error

From Table A-1, **trigger noise error** (sec) = 1.4 x T/*nper*, where:

$$T = \frac{\sqrt{(80\mu V)^2 + (e_n)^2}}{\textit{input slew rate at trigger point}}$$

For a 1 mV rms input noise, 32 periods averaged, and slew rate = 0.5/200 x 10^{-6} = 2500 V/sec (2.5 x 10^9 µV/sec):

trigger noise error (sec) =

$$\pm 1.4 \times \frac{\sqrt{(80\mu V)^2 + (1000\mu V)^2}}{32 \times 2.5 \times 10^9\ ^{\mu V}\!/_{sec}} = \pm 17.556 \text{ nsec}$$

Calculate Period Average Measurement Accuracy

accuracy (period average measurements)
= ± [resolution + timebase error + trig noise error]
= ± (3.125 nsec + 1.2 nsec + 17.556 nsec) = ± 21.881 nsec

Effects of Varying Signal Conditions

Although this example showed trigger noise error as the primary contributor to counter accuracy, resolution errors and timebase errors can also be major contributors, as shown in Table A-4. For Case 1, the resolution error contributes about 88% of the error. However, for Case 2 the timebase error contributes about 86% of the error. For Case 3, triggering is assumed to NOT be at the midpoint of the sine wave. With a (slow) slew rate of 100 V/sec, the trigger noise error is about 99% of the total error.

Table A-4. Effects on Period Accuracy of Varying Input Conditions

Case	Period (sec)	Periods Avgd	Slew Rate (V/sec)	Resolution (nsec)	Timebase Error (nsec)	Trigger Error (nsec)	Counter Acc (nsec)
1	1 x 10^{-3}	2	10^6	50.000 (88%)	6.000	0.7022	56.702
2	2 x 10^{-3}	128	10^4	.7813	12.000 (86%)	1.0972	13.879
3	5 x 10^{-7}	2048	10^2	.0488	.0030	6.8578 (99%)	6.909

Counter Accuracy Programs

Two programs follow to calculate counter accuracies. After you enter the parameter values, the program computes the appropriate measurement accuracies and prints the results. The programs are designed for HP 9000 Series 200/300 computers using HP BASIC.

Frequency Measurement Accuracy

To make frequency measurement accuracy calculations, first enter the desired number of accuracy calculations you want to make (up to 100 sets of calculations). Then, for each calculation enter the desired values for:

- Frequency (Hz)
- Aper time (sec)
- Timebase
- Source noise (V rms)
- Slew rate (V/sec)

The program calculates frequency measurement accuracy for each set of input values and prints or displays the results. A typical display follows the program listing.

NOTE

If you want to make more than 100 calculations, change the DIM statement (line 40) for the number of calculations required. Also, if your printer address is not 701, change line 30 PRINTER IS 701 to your printer address. If you do not want to use a printer, change line 30 to 30 PRINTER IS 1.

Program Listing

```
10    Calc_no = 0
20    OPTION BASE 1
30    PRINTER IS 701
40    DIM Freq (100),Aper(100),Timebase(100),Noise(100),
Slewrate(100),Accuracy(100)
50    INPUT " Select number of calculations (1 to 100) ",Calc_no
60    FOR I = 1 TO Calc_no
70      CLEAR SCREEN
80      OUTPUT CRT;"Select values for frequency accuracy calculation
number";I
90      INPUT " Frequency (Hz) = ",Freq(I)
100     INPUT " Aper time (sec) = ",Aper(I)
110     INPUT " Timebase = ",Timebase(I)
120     INPUT " Source noise (V rms) = ",Noise(I)
```

Continued on Next Page

```
130    INPUT " Slew rate (V/sec) = ",Slewrate(I)
140    Accuracy(I)=1/Aper(I)+Timebase(I)*Freq(I) + 1.4*Freq(I) *
(SQRT((8.0E-5 ^ 2 + Noise(I) ^ 2))/(Slewrate(I) *Aper(I)))
150  NEXT I
160  CLEAR SCREEN
170  PRINT "Frequency Measurement Accuracy (Hz)"
180  PRINT
190  PRINT
200 Format:IMAGE 10A,4X,10A,2X,12A,X,14A,2X,12A,3X,8A
210  PRINT USING Format;"Frequency";"AperTime"; "Timebase"; "Source
Noise";"Slew Rate";"Accuracy"
220  PRINT USING Format;"(Hz)";"(sec)";"";"(V rms)";"(V/sec)";"(Hz)"
230  PRINT
240  FOR I = 1 TO Calc_ no
250 Format1:IMAGE D.5DE,3X,2D.3D,3X,D.5DE,3X,D.5DE,
4X,D.5DE,3X,2A,D.5DE
260    PRINT USING Format1;Freq(I);Aper(I);Timebase(I);
Noise(I);Slewrate(I);CHR$(254);Accuracy(I)
270  NEXT I
280  END
```

Typical display

```
 Frequency Measurement Accuracy (Hz)

Frequency     Aper Time    Timebase      Source Noise      Slew Rate     Accuracy
(Hz)          (sec)                      (v rms)           V/sec)        (Hz)


1.00000E+04    4.096       6.00000E-6    1.00000E-03       1.00000E+03   ±3.07570E-01
```

Period Measurements Accuracy

To make period/pulse width/time interval accuracy calculations, enter the number of accuracy calculations you want to make (up to 100 sets of calculations). Then, for each calculation enter the desired values for:

- Period/pulse width/time interval (sec)
- Number of periods averaged
- Timebase
- Source noise (V rms)
- Slew rate (V/sec)

The program calculates period, pulse width, or time interval measurement accuracy for each set of input values and displays the results. A typical display follows the program listing.

NOTE If you want to make more than 100 calculations, change the DIM statement (line 40) for the number of calculations required. Also, if your printer address is not 701, change line 30 PRINTER IS 701 to your printer address. If you do not want to use a printer, change line 30 to 30 PRINTER IS 1.

Program Listing

```
10   Calc_no=0
20   OPTION BASE 1
30   PRINTER IS 701
40   DIM Period(100),Nper(100),Timebase(100),Noise(100),
Slewrate(100),Accuracy(100)
50   INPUT " Select number of calculations (1 to 100) ",Calc_no
60   FOR I = 1 TO Calc_no
70    CLEAR SCREEN
80     OUTPUT CRT;"Select values for period/PW/TI calculation number";I
90      INPUT " Period/pulse width/time interval (sec) = ",Period(I)
100     INPUT " Number periods averaged = ",Nper(I)
110     INPUT " Timebase = ",Timebase(I)
120     INPUT " Source noise (V rms) = ",Noise(I)
130     INPUT " Slew rate (V/sec) = ",Slewrate(I)
140    Accuracy(I) = 1.E-7/Nper(I) +Timebase(I)*Period(I) +
1.4*(SQRT((8.0E-5 ^ 2 + Noise(I) ^ 2))/(Nper(I)*Slewrate(I)))
150  NEXT I
160  CLEAR SCREEN
170  PRINT "Period /Pulse Width/Time Interval Measurement Accuracy
(sec)"
180  PRINT
190  PRINT
200 Format:IMAGE 12A,3X,8A,2X,11A,2X,12A,3X,9A,6X,8A
210  PRINT USING Format;"Period/P.W./";"Periods";"Timebase";"Source
Noise";"Slew Rate";"Accuracy"
220  PRINT USING Format;"T.I.(sec)";"Averaged";""; "(V rms)";"( V/sec)";
"(sec)"
230  PRINT
240  FOR I = 1 TO Calc_ no
250 Format1:IMAGE D.5DE,3X,5D,3X,D.5DE,3X,D.5DE,
3X,D.5DE,3X,2A,D.5DE
260    PRINT USING Format1;Period(I);Nper(I);Timebase(I);Noise(I);
Slewrate(I);CHR$(254);Accuracy(I)
270  NEXT I
280  END
```

Typical Display

Period/Pulse Width/Time Interval Measurement Accuracy (sec)

Period/P.W./ T.I.(sec)	Periods Averaged	Timebase (sec)	Source Noise (V rms)	Slew Rate (V/sec)	Accuracy (sec)
2.00000E-03	128	6.00000E-6	1.00000E-03	1.00000E+04	±1.38785E-08

Appendix B
Verification Tests - C Programs

Functional Verification Tests

These programs are designed to do the Functional Verification Tests found in Chapter 3, "Operating Instructions," and Chapter 4 , "Verification Tests."

Operator's Check

The Operator's Check for the HP E1333A counter consists of sending the self-test (*TST?) command and checking the return. The operator's check can be used at any time to verify the counter is connected properly and is responding to the self-test command. See Chapter 7, "Service," for a list of counter self-test errors.

As required, see the mainframe user's manual for information on address selection. See the *HP E1333A User's Manual* for information on counter SCPI commands.

```
#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,6"                    /* Address of Device */

void main ()
{
  INST id;                                  /* Define id as an instrument */
  char a[256] = {0};                        /* Result variable */
  id = iopen (ADDR);                        /* Open instrument session */

  itimeout (id, 10000);                     /* Set instrument timeout to 10 seconds */

  ipromptf (id, "*TST?\n", "%t", a);        /* Self test command */

  printf ("\n %s", a);                      /* Print result */

  getchar ();                               /* Pause */

  iclose (id);                              /* Close instrument session */
}
```

Totalizing Measurement Test

This test verifies the totalize measurement functions on Channels 1 and 2 at 1 Hz and 4 MHz. The test passes if the count increments on each channel. The test fails if the count remains at 0 for either or both channels.

```
/*  Totalizing Measurements Functional Test                E1333A  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,06"                    /* Address of device */

void main ()
{
  INST id;                                   /* Define id as an instrument */
  char *freq;
  int chan, i, timer;
  float reading, counter;
  char cr[256];

  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);                    /* Exit on error */

  id = iopen (ADDR);                         /* Open instrument session */

  iprintf (id, "*RST\n");
  iprintf (id, "INP:COUP DC\n");
  iprintf (id, "INP:IMP MIN\n");
  printf ("\n\nTotalize Counts");

  for (i = 0;i <= 1;i ++)
  {
    if (i == 0) freq = "1 Hz";
    else        freq = "4 MHz";

    for (chan = 1;chan <= 2;chan ++)
    {
      printf ("\n\n 1. Set input to channel %u to %s, 50 mV rms sine wave", chan, freq);
      printf ("\n 2. Press ENTER when connections are complete");
      getchar ();

      counter = 0;
      timer = 0;
      printf ("\n\nTotalizing counts for channel %u", chan);
      printf ("\n This will take about 15 seconds");

      iprintf (id, "CONF%u:TOT\n", chan);
      iprintf (id, "INIT%u\n", chan);
      while (counter < 15)
```

```
      {
        timer++;
        iprintf (id, "FETC%u?\n", chan);
        iscanf (id, "%f", &reading);
        if (reading > counter)
        {
          counter = reading;
          printf (".");
          timer = 0;
        }
        if (timer > 200)
        {
          printf ("\n\n  *** Channel %u FAILED to count ***", chan);
          goto FAIL;
        }
      }

      printf ("\n\nChannel %u PASSED Totalizing Measurements Functional Test for %s",
chan, freq);
      FAIL:
      }
    }

    iclose (id);                                    /* Close instrument session */
}
```

Ratio Measurements Test

This test checks the ratio measurements function of the HP E1333A for Channel 1/Channel 2, using Channel 1 and Channel 2 frequencies and ratios shown in Table 4-1.

```
/*  Ratio Measurements Functional Test                E1333A  */

#include <stdio.h>
#include <sicl.h>
#include <math.h>

#define ADDR "hpib7,9,06"                   /* Address of device */

void main ()
{
  INST id;                                  /* Define id as an instrument */
  int i;
  float reading[5], freq1[5], freq2[5];
  double freq;
```

```
  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);                  /* Exit on error */

  id = iopen (ADDR);                       /* Open instrument session */

  iprintf (id, "*RST\n");
  iprintf (id, "INP:COUP DC\n");
  iprintf (id, "INP:IMP MIN\n");

  for (i = 2;i <= 6;i ++)
  {
    iprintf (id, "CONF1:RAT 1E6,1E3\n");
    iprintf (id, "INIT1\n");
    freq = pow (10,i);

    printf ("\n\n 1. Set input to channel 1 to 1 MHz, 50 mV rms sine wave");
    printf ("\n 2. Set input to channel 2 to %lf Hz, 50 mV rms sine wave", freq);
    printf ("\nPress ENTER when connection is complete");
    getchar ();
    iprintf (id, "INIT1\n");
    iprintf (id, "FETC1?\n");
    iscanf (id, "%f", &reading[i-2]);

    iprintf (id, "MEAS1:FREQ?\n");
    iscanf (id, "%f", &freq1[i-2]);
    iprintf (id, "MEAS2:FREQ?\n");
    iscanf (id, "%f", &freq2[i-2]);

  }

  printf ("\n\n-----------------------------------------------------------");
  printf ("\nCh 1 Freq    Ch2 Freq    Ch1/Ch2 Ratio    Ch1/Ch2 Ratio");
  printf ("\n                                  should be           measured\n");

  for (i = 0; i <= 4; i++)
    printf ("\n%.0f Hz  %7.0f Hz    %5.0f           %5.0f", freq1[i], freq2[i], freq1[i]/freq2[i],
reading[i]);

  iclose (id);                             /*close instrument session */
}
```

Trigger Level Test

This test checks the trigger level accuracy on Channel 1 for the -2.56V, 0V, +2.54V and +25.4V trigger levels. Table 4-2 shows the trigger levels measured, the input attenuation level in dB, and the below-level and above-level voltage values for each trigger level.

```
/*  Trigger Level Functional Test                E1333A  */

#include <stdio.h>
#include <sicl.h>
#include <math.h>

#define ADDR "hpib7,9,06"                        /* Address of device */

void main ()
{
 INST id;                                        /* Define id as an instrument */
 int i, fail = 0;
 float trig_lev[4] = {-2.56, 0, 2.54, 25.4};
 float low[4] = {-2.836, -.02, 2.266, 22.66};
 float high[4] = {-2.284, .02, 2.814, 28.14};
 float reading, level[4];

 #if defined(__BORLANDC__) && !defined(__WIN32__)
  _InitEasyWin();
 #endif

 ionerror(I_ERROR_EXIT);                         /* Exit on error */

 id = iopen (ADDR);                              /* Open instrument session */

 iprintf (id, "*RST\n");
 iprintf (id, "INP:COUP DC\n");
 iprintf (id, "INP:FILT ON\n");
 iprintf (id, "CONF1:TOT\n");
 printf ("\n\nTrigger Level Measurements");

 for (i = 0;i <= 3;i ++)
 {
  if (i == 3)
  {
   iprintf (id, "INP:ATT MAX\n");
   level[i] = trig_lev[i] / 10;
  }
  else
  {
   iprintf (id, "INP:ATT MIN\n");
   level[i] = trig_lev[i];
  }
  iprintf (id, "SENS1:EVEN:LEV %f\n",level[i]);

  printf ("\n\nTrigger Level = %f", trig_lev[i]);
```

```
    printf ("\n\n 1. Set input to channel 1 to %f Volts", low[i]);
    printf ("\nPress ENTER when connection is complete");
    getchar ();
    iprintf (id, "INIT1\n");
    iprintf (id, "FETC1?\n");
    iscanf (id, "%f", &reading);

    if (reading > 0)
    {
      printf ("\n\n *** Test FAILED for trigger level = %f", trig_lev[i]);
      fail = 1;
    }

    printf ("\n 2. Increase input to channel 1 to %f Volts", high[i]);
    printf ("\nPress ENTER when connection is complete");
    getchar ();

    iprintf (id, "FETC1?\n");
    iscanf (id, "%f", &reading);

    if (reading <= 0)
    {
      printf ("\n\n *** Test FAILED for trigger level = %f", trig_lev[i]);
      fail = 1;
    }
  }

  if (fail == 0)    printf ("\n\nAll Trigger Level tests PASSED");
  else              printf ("\n\nOne or more Trigger Level tests FAILED");

  iclose (id);                                  /* Close instrument session */
}
```

Performance Verification Tests

These programs are designed to do the Performance Verification Tests found in Chapter 4, "Verification Tests."

Frequency Measurements Test

This test checks frequency measurement accuracy on Channels 1, 2, and 3. Input level sensitivity is tested indirectly by using input signals with amplitudes equal to the sensitivity limits.

```
/*  Frequency Measurements Test                  E1333A  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,06"                          /* Address of device */

void main ()
{
  INST id;                                         /* Define id as an instrument */
  int chan[24], i;
  float reading[24];
  float aper[24] = {32.768, 16.384, 8.192, 4.096, 2.048, 1.024, .512, .256, .128, .064,
.032, .016, .008, .004, .002, 65.536, .002, .128, .064, .032, .016, .008, .004, .002};
  float ampl[24] = {.025, .025, .025, .025, .025, .025, .025, .025, .025, .025, .025, .025,
.025, .025, .025, .025, .025, .01, .01, .01, .01, .01, .03, .04};
  float freq[24] = {1.E1, 1.E2, 1.E3, 1.E4, 1.E5, 1.E6, 4.E6, 1.E7, 2.E7, 5.E7, 1.E8, 1.E8,
1.E8, 1.E8, 1.E8, 1.E8, 1.E8, 7.5E7, 1.E8, 2.E8, 4.E8, 6.E8, 9.E8, 1.E9};

  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);                          /* Exit on error */

  id = iopen (ADDR);                               /* Open instrument session */

  iprintf (id, "*RST\n");
  iprintf (id, "INP:COUP DC\n");
  iprintf (id, "INP:IMP MIN\n");
  printf ("\n\nFrequency Measurements");

  for (i = 0;i <= 23;i ++)
  {
    if (i < 16)   chan[i] = 1;
    if (i == 16) chan[i] = 2;
    if (i > 16)   chan[i] = 3;
```

```
    printf ("\n\nFrequency Measurements of channel %u", chan[i]);
    printf ("\n  Frequency = %f Hz", freq[i]);
    printf ("\n  Aperture time = %f sec", aper[i]);

    printf ("\n\n 1. Set source frequency to %f Hz", freq[i]);
    printf ("\n 2. Set source output to %f Volts", ampl[i]);
    printf ("\nPress ENTER when ready");
    getchar ();

    iprintf (id, "SENS%u:FUNC:FREQ\n", chan[i]);
    iprintf (id, "SENS%u:FREQ:APER %.3f\n", chan[i], aper[i]);
    iprintf (id, "READ%u?\n", chan[i]);
    iscanf (id, "%f", &reading[i]);
  }

  printf ("\n\nFrequency Measurements Performance Test Completed");
  printf ("\nPress ENTER to display the results");
  getchar ();

  printf ("\n\n-------------------------------------------------");
  printf ("\nCh    Frequency    Aper Time    Measured");
  printf ("\n         (Hz)             (sec)          Freq (Hz)\n");
  for (i = 0; i <= 23; i++)
    printf ("\n%u      %4f Hz      %6f       %f", chan[i], freq[i], aper[i], reading[i]);

  iclose (id);                                    /* Close instrument session */
}
```

Period Average Measurements

This test measures period averages on Channel 1 only. Period average measurements are made with the frequencies, periods and number of periods averaged shown in Table 4-5. (Channel 2 is not tested since the same circuitry is used for Channels 1 and 2.)

```
/*  Period Average Measurements Test                  E1333A  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,06"                         /* Address of device */

void main ()
{
  INST id;                                        /* Define id as an instrument */
  int i;
  float reading[13];
  int nper[13] = {2, 4, 8, 15, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192};
```

```
  char *per[13] = {"1 sec", "100 msec", "10 msec", "1 ms", "200 usec", "100 usec", "20
usec", "10 usec", "2 usec", "1 usec", "500 nsec", "200 nsec", "100 nsec"};
  char *freq[13] = {"1 Hz", "10 Hz", "100 Hz", "1 kHz", "5 kHz", "10 kHz", "50 kHz", "100
kHz", "500 kHz", "1 MHz", "2 MHz", "5 MHz", "10 MHz"};

  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);                          /* Exit on error */

  id = iopen (ADDR);                               /* Open instrument session */

  iprintf (id, "*RST\n");
  iprintf (id, "INP:COUP DC\n");
  iprintf (id, "INP:IMP MIN\n");
  printf ("\n\nPeriod Average Measurements");

  for (i = 0;i <= 12;i ++)
  {
    printf ("\n\nPeriod Average Measurements of channel 1");
    printf ("\n  Period = %s", per[i]);
    printf ("\n  Periods Averaged = %u", nper[i]);

    printf ("\n\n 1. Set source frequency to %s, 50 mV rms sine wave", freq[i]);
    printf ("\nPress ENTER when ready");
    getchar ();

    iprintf (id, "SENS1:FUNC:PER\n");
    iprintf (id, "SENS1:PER:NPER %u\n", nper[i]);
    iprintf (id, "READ1?\n");
    iscanf (id, "%f", &reading[i]);
  }
  printf ("\n\nPeriod Measurements Performance Test Completed");
  printf ("\nPress ENTER to display the results");
  getchar ();

  printf ("\n\n-------------------------------------------------");
  printf ("\nCh    Period    Periods      Measured");
  printf ("\n        (sec)      Averaged   Period (sec)\n");
  for (i = 0; i <= 12; i++)
    printf ("\n1     %8s    %4u     %f", per[i], nper[i], reading[i]);

  iclose (id);                                 /* Close instrument session */
}
```

Pulse Width Measurements Test

This test measures positive and negative pulse width averages on Channels 1 and 2 at 0.5 Hz and 500Hz. Table 4-6 shows the pulse widths and pulse polarities measured.

```
/*  Pulse Width Measurements Test                E1333A  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,06"                        /* Address of device */

void main ()
{
  INST id;                                       /* Define id as an instrument */
  int i, chan[8];
  float reading[8];
  float pulse[8] = {1., .001, 1., .001, 1., .001, 1., .001};
  char *pulse_wid[8] = {"1 sec","1 sec","1 msec","1 msec","1 sec","1 sec","1 msec","1
msec"};
  char *type[8] = {"POS","NEG","POS","NEG","POS","NEG","POS","NEG"};
  char *freq[8] = {"0.5 Hz","0.5 Hz","500 Hz","500 Hz","0.5 Hz","0.5 Hz","500 Hz","500
Hz"};
  char *pol[8] = {"PWID","NWID","PWID","NWID","PWID","NWID","PWID","NWID"};

  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);                        /* Exit on error */

  id = iopen (ADDR);                             /* Open instrument session */

  iprintf (id, "*RST\n");
  iprintf (id, "INP:COUP DC\n");
  iprintf (id, "INP:IMP MIN\n");
  printf ("\n\nPulse Width Measurements");

  for (i = 0;i <= 7;i ++)
  {
    if (i <= 3) chan[i] = 1;
    if (i >  3)  chan[i] = 2;

    printf ("\n\nPulse Width Measurements of channel %u", chan[i]);
    printf ("\n  Measure %s Pulse Width", type[i]);
    printf ("\n  Pulse Width = %s", pulse_wid[i]);
    printf ("\n  Periods Averaged = 2");

    printf ("\n\n 1. Set source frequency to %s, 50 mV rms square wave", freq[i]);
    printf ("\nPress ENTER when ready");
    getchar ();
```

```
    iprintf (id, "SENS%u:FUNC:%s\n", chan[i], pol[i]);
    iprintf (id, "SENS%u:PER:NPER 2\n", chan[i]);
    iprintf (id, "READ%u?\n", chan[i]);
    iscanf (id, "%f", &reading[i]);
  }

  printf ("\n\nPulse Width Measurements Performance Test Completed");
  printf ("\nPress ENTER to display the results");
  getchar ();

  printf ("\n\n-------------------------------------------------");
  printf ("\nCh    Pulse     Pulse      Measured");
  printf ("\n        Width    Polarity    Width (msec)\n");
  for (i = 0; i <= 7; i++)
    printf ("\n%u     %6s   %3s        %f", chan[i], pulse_wid[i], pol[i], reading[i]);

  iclose (id);                                   /* Close instrument session */
}
```

Time Interval Measurements Test

This test checks time interval accuracy on Channels 1 and 2 for the time interval and edges shown in Table 4-7, where POS = rising edge and NEG = falling edge of channel input.

```
/*  Time Interval Measurements Test                E1333A  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,06"                        /* Address of device */

void main ()
{
  INST id;                                       /* Define id as an instrument */
  int i, chan[2];
  float reading[2];
  char *slope1[2] = {"POS","NEG"};
  char *slope2[2] = {"NEG","POS"};

  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);                        /* Exit on error */
```

```
 id = iopen (ADDR);                               /* Open instrument session */

  iprintf (id, "*RST\n");
  iprintf (id, "INP:COUP DC\n");
  iprintf (id, "INP:IMP MIN\n");
  printf ("\n\nTime Interval Measurements");

  for (i = 0;i <= 1;i ++)
  {
    if (i == 0) chan[i] = 1;
    if (i == 1) chan[i] = 2;

    printf ("\n\nTime Interval Measurements of channel %u", chan[i]);
    printf ("\n  From Channel 1 %s edge to Channel 2 %s edge", slope1[i], slope2[i]);
    printf ("\n\n 1. Set source frequency to 1 MHz, 50 mV rms square wave");
    printf ("\nPress ENTER when ready");
    getchar ();

    if (i == 0)
    {
      iprintf (id, "SENS1:FUNC:TINT\n");
      iprintf (id, "SENS1:EVEN:SLOP POS\n");
      iprintf (id, "SENS2:EVEN:SLOP NEG\n");
      iprintf (id, "READ1?\n");
      iscanf (id, "%f", &reading[i]);
    }
    if (i == 1)
    {
      iprintf (id, "SENS2:FUNC:TINT\n");
      iprintf (id, "SENS1:EVEN:SLOP NEG\n");
      iprintf (id, "SENS2:EVEN:SLOP POS\n");
      iprintf (id, "READ2?\n");
      iscanf (id, "%f", &reading[i]);
    }
  }

  printf ("\n\nTime Interval Measurements Performance Test Completed");
  printf ("\nPress ENTER to display the results");
  getchar ();

  printf ("\n\n-----------------------------------------------");
  printf ("\nCh     Time       Ch 1    Ch 2    Measured");
  printf ("\n       Interval     Edge    Edge   Interval");
  printf ("\n       (nsec)                      (nsec)\n");
  for (i = 0; i <= 1; i++)
    printf ("\n%u     500        %3s     %3s     %f", chan[i], slope1[i], slope2[i],
reading[i]*(1.E9));

  iclose (id);                                  /* Close instrument session */
}
```

Counter Accuracy Programs

These programs are designed to calculate counter accuracies as described in Appendix A, "Counter Accuracy Calculations."

Frequency Measurement Accuracy

To make frequency measurement accuracy calculations, first enter the desired number of accuracy calculations you want to make (up to 100 sets of calculations). Then, for each calculation enter the desired values for:

- Frequency (Hz)
- Aper time (sec)
- Timebase
- Source noise (V rms)
- Slew rate (V/sec)

The program calculates frequency measurement accuracy for each set of input values and displays the results.

```
/*  Frequency Measurement Accuracy            E1333A  */

#include <stdio.h>
#include <math.h>

void main (void)
{
  float freq[100], aper[100], timebase[100], noise[100], slewrate[100], accuracy[100];
  int i;
  float calc = 0;

  printf ("\nSelect number of calculations (1 to 100) ");
  scanf ("%f", &calc);

  for (i = 0;i < calc;i ++)
  {
    printf ("\n\nSelect values for frequency accuracy calculation %u", i+1);
    printf ("\n\n  Frequency (Hz) = ");
    scanf("%f", &freq[i]);
    printf ("\n  Aper time (sec) = ");
    scanf("%f", &aper[i]);
    printf ("\n  Timebase = ");
    scanf("%f", &timebase[i]);
    printf ("\n  Source noise (V rms) = ");
    scanf("%f", &noise[i]);
    printf ("\n  Slew rate (V/sec) = ");
    scanf("%f", &slewrate[i]);

    accuracy[i] = 1/aper[i] + timebase[i]*freq[i] + 1.4*freq[i]*(sqrt((pow (8.0E-5,2) + pow
(noise[i],2)))/(slewrate[i]*aper[i]));
  }
```

```
  printf ("\n\n\nFrequency Measurement Accuracy\n\n");
  printf ("\nFrequency   Aper Time   Timebase   Source Noise   Slew Rate   Accuracy");
  printf ("\n(Hz)           (sec)                          (V rms)           (V/sec)       (Hz)\n");
  for (i = 0;i < calc;i ++)
    printf ("\n%e  %e  %e %e %e %e", freq[i], aper[i], timebase[i], noise[i], slewrate[i],
accuracy[i]);

}
```

Period Measurements Accuracy

To make period/pulse width/time interval accuracy calculations, enter the number of accuracy calculations you want to make (up to 100 sets of calculations). Then, for each calculation enter the desired values for:

- Period/pulse width/time interval (sec)
- Number of periods averaged
- Timebase
- Source noise (V rms)
- Slew rate (V/sec)

The program calculates period, pulse width, or time interval measurement accuracy for each set of input values and displays the results.

```
/*  Period Measurement Accuracy            E1333A  */

#include <stdio.h>
#include <math.h>

void main (void)
{
  float period[100], nper[100], timebase[100], noise[100], slewrate[100], accuracy[100];
  int i, calc = 0;

  printf ("\nSelect number of calculations (1 to 100) ");
  scanf ("%u", &calc);

  for (i = 0;i < calc;i ++)
  {
    printf ("\n\nSelect values for period/PW/TI accuracy calculation %u", i+1);
    printf ("\n\n  Period/pulse width/Time interval (sec) = ");
    scanf("%f", &period[i]);
    printf ("\n  Number of periods averaged = ");
    scanf("%f", &nper[i]);
    printf ("\n  Timebase = ");
```

```
    scanf("%f", &timebase[i]);
    printf ("\n  Source noise (V rms) = ");
    scanf("%f", &noise[i]);
    printf ("\n  Slew rate (V/sec) = ");
    scanf("%f", &slewrate[i]);

    accuracy[i] = 1.E-7 / nper[i] + timebase[i]*period[i] + 1.4*(sqrt((pow(8.0E-5,2) +
pow(noise[i],2)))/(nper[i]*slewrate[i]));
  }

  printf ("\n\n\nPeriod/Pulse width/Time interval Measurement Accuracy\n\n");
  printf ("\nPeriod/PW/    Periods     Timebase   Source Noise   Slew Rate   Accuracy");
  printf ("\nTI (Hz)           (sec)                          (V rms)           (V/sec)        (sec)\n");
  for (i = 0;i < calc;i ++)
    printf ("\n%e  %e  %e %e %e %e", period[i], nper[i], timebase[i], noise[i], slewrate[i],
accuracy[i]);

}
```

Notes