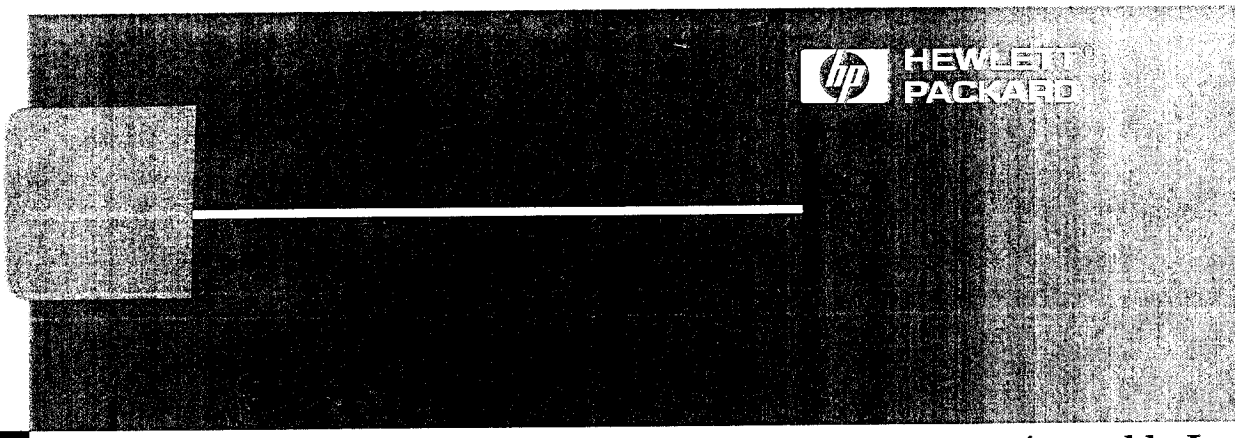

Assembly-Le
Service Guid

HP 53131A/132A/181A
225 MHz Counter

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Assembly-Level Service Guide

This guide describes how to service the HP 53131A and HP 53132A Universal Counters, and the HP 53181A Frequency Counter. The information in this guide applies to instruments having the number prefix listed below, unless accompanied by a "Manual Updating Changes" package indicating otherwise.

SERIAL PREFIX NUMBER:

3547 and above (HP 53131A)
3547 and above (HP 53132A)
3548 and above (HP 53181A)

HP 53131A/132A/181A 225 MHz Counter

Printed: October 1995

Printed in USA

Manual part number 53131-90023

Certification and Warranty

Certification

Hewlett-Packard Company certifies that this product met its published specification 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 the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of three years from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For detailed warranty information, see back matter.

Safety Considerations

General

This product and related documentation must be reviewed for familiarization with this safety markings and instructions before operation.

This product is a safety Class I instrument (provided with a protective earth terminal).

Before Applying Power

Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to instructions in Chapter 1 of the Operating Guide.

Safety Earth Ground

An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

Warning Symbols That May Be Used In This Book

Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

Indicates hazardous voltages.

Safety Considerations (contd)

Indicates earth (ground) terminal.

or

Indicated terminal is connected to chassis when such connection is not apparent.

Indicates Alternating current.

Indicates Direct current.

WARNING

BODILY INJURY OR DEATH MAY RESULT FROM FAILURE TO HEED A WARNING. DO NOT PROCEED BEYOND A WARNING SIGN UNTIL THE INDICATED CONDITIONS ARE FULLY UNDERSTOOD AND MET.

CAUTION

Damage to equipment, or incorrect measurement data, may result from failure to heed a caution. Do not proceed beyond a *CAUTION* sign until the indicated conditions are fully understood and met.

For additional safety and acoustic noise information, see back matter.

Hewlett-Packard Company
Santa Clara Division
5301 Stevens Creek Boulevard
Santa Clara, California 95052-8059

Contents

2 Service

Preface

This guide provides assembly-level service information for the HP 53131A and HP 53132A Universal Counters, and the HP 53181A Frequency Counter.

How to Use This Guide

Repair Strategy

This service guide is designed to isolate failures to the assembly level only.

The HP 53131A/132A/181A Counter can be returned to Hewlett-Packard (HP) for all service work, including troubleshooting, and verifying specifications. Contact your nearest HP Sales and Service Office for more details.

Note: there is an Express Repair / Performance Calibration Service for USA customers if downtime is critical. You can receive your repaired Counter via overnight shipment. Just call 303-649-5512 and ask for Express Repair / Performance Calibration Service. When your Counter is repaired, it will be returned via overnight shipment at no extra charge.

If you decide to service the Counter yourself, use the troubleshooting procedures in Chapter 2 (Service) and the disassembly and reassembly procedures in Chapter 3 (Replacing Assemblies). Then use the calibration instructions in Chapter 2 to calibrate the Counter for peak-performance operation, and finally perform the complete performance tests in Chapter 1 to verify the Counter's specifications.

Instrument Identification

Instrument identification is made from the serial number on the rear panel of the Counter. HP uses a two-part serial number with the first part (prefix) identifying a series of instruments and the second part (suffix) identifying a particular instrument within a series. An HP-assigned alpha character between the prefix and suffix identifies the country in which the instrument was manufactured.

Instruments Covered by this Guide

This guide applies directly to HP 53131A, HP 53132A, and HP 53181A Counters that have the same serial number prefix(es) shown on the title page. If the serial number prefix of your Counter differs from that listed

on the title page of this guide, then there may be differences between this guide and your instrument.

Instruments having a higher serial prefix are covered when required by one or more manual-change sheets included with this guide. If a required change sheet is missing, contact your nearest HP Sales Office listed at the back of this guide. Instruments having a serial prefix lower than that listed on the title page are covered in Chapter 6, "Backdating."

Assembly-Level Service Guide Organization

This assembly-level service guide consists of a table of contents, preface, eight chapters and an index. The page running headers identify the chapters and sections of this manual. The chapter contents are summarized as follows:

Chapter 1, "Performance Tests," provides procedures that verify the Counter operates properly and meets the HP 53131A/132A or HP 53181A specifications given in Chapter 7, "HP 53131A/132A Specifications," or Chapter 8, "HP 53181A Specifications," in this guide.

Chapter 2, "Service," is divided into seven main sections that provide instructions for returning the Counter to HP for service, calibrating the Counter, and troubleshooting the assemblies in the Counter.

Chapter 3, "Replacing Assemblies," provides procedures for replacing defective assemblies and/or modules in the Counter.

Chapter 4, "Retrofitting Options," provides field-installation procedures that help you install options into the Counter.

Chapter 5, "Replaceable Parts," lists the replaceable parts contained in the Counter, and explains how to order replacement parts for your Counter.

Chapter 6, "Backdating," contains information required to adapt this manual for older instruments.

Chapter 7, "HP 53131A/132A Specifications," lists all the specifications and operating characteristics for the HP 53131A/132A Universal Counter.

Chapter 8, "HP 53181A Specifications," lists all the specifications and operating characteristics for the HP 53181A Frequency Counter.

How to Order Guides

The part number for this guide is listed in the *Certification and Warranty* page (located on the back of the title page) and on the rear cover of this guide.

Description of the 225 MHz Counters

The **HP 53131A** and **HP 53132A** are universal counters capable of measuring frequencies to 225 MHz on Channels 1 and 2. With an optional Channel 3 Option 030, this capability extends to 3.0 GHz.

For the HP 53131A, frequency and time interval resolutions are 10 digits in one second and 500 picoseconds, respectively. The HP 53131A provides users with an HP-IB measuring speed of 200 measurements per second, and is suitable for bench-top operation and lower-volume ATE operation. The frequency and time interval resolutions for the HP 53132A are up to 12 digits in one second and 150 picoseconds, respectively. The HP 53132A provides users with exceptional resolution, and is ideal for ATE systems operation.

The HP 53131A/132A basic measurement functions include Frequency, Period, Pulse Width, Duty Cycle, Rise/Fall Time, Time Interval, Frequency Ratio, Totalize, Phase, and Peak Voltage.

The **HP 53181A** is a frequency counter capable of measuring frequencies to 225 MHz on Channel 1. Depending on which optional Channel 2 the counter contains, this capability is extended to 1.5 GHz (Option 015) or 3.0 GHz (Option 030). The HP 53181A has a frequency resolution of 10 digits in one second.

The HP 53181A provides users with an HP-IB measuring speed of 200 measurements per second, and is suitable for bench-top and ATE operation.

The HP 53181A basic measurement functions include Frequency, Period, Peak Voltage, and Frequency Ratio (if Channel 2 is installed).

The HP 53131A/132A/181A include additional measurement functions and features that are designed specifically for manufacturing and service applications:

- 1, 5, 10 MHz external reference capability—to match customer's house standard (however, the HP 53132A's external reference capability is 10 MHz only),
- optional ultra-high stability , high stability, or medium stability oven oscillators for high accuracy needs,
- external gating,
- statistics,
- automatic limit testing,
- SCPI programming capability, and
- analog display mode limit testing

Programmable control is performed via an HP-IB. The HP-IB and a talk-only RS-232C serial port are standard for the HP 53131A/132A/181A. The serial port is for printing measured and analyzed data on serial printers, or for outputting an out-of-limit signal.

Options

The options available for the HP 53131A/132A/181A Counter are listed following this paragraph. Specifications for the options are listed in Chapter 7, "HP 53131A/132A Specifications," and Chapter 8, "HP 53181A Specifications." If you've purchased an option with the initial order, it will be installed at the factory and ready for operation at delivery. Refer to the "Retrofitting Options" chapter in this guide for instructions on field installation of the options.

NOTE

The "0's" and "1's" in the following option numbers are numeric characters (that is, they are not letters).

Hardware

- Medium Stability Oven Timebase, Option 001
- DC Power Input, Option 002

- High Stability Oven Timebase, Option 010
- Ultra-High Stability Oven Timebase, Option 012 (HP 53132A and HP 53181A Only)
- 1.5 GHz RF Input Channel (Channel 2), Option 015 (HP 53181A Only)
- 3.0 GHz RF Input Channel (Channel 3), Option 030
- 5.0 GHz RF Input Channel (Channel 3), Option 050
- *Rear Terminals, Option 060
- Rack Mount Kit, Option 1CM (HP part number 5062-3972)

Support

- 5-year Return to HP for Repair, Option W50
- 5-year Return to HP for Calibration, Option W52

Accessories Supplied and Available

Accessories Supplied

- Power cord, 2.3 meters

Accessories Available

- HP 34161A Accessory Pouch
- Printer RS-232 Interface cables, HP 24542G or HP 24542H
- HP-IB cables, HP 10833A/B/C/D

*For the HP 53131A/132A Option 030, front and rear terminals can exist for Channel 1 and 2. The optional Channel 3 can be configured as rear terminals only or front terminals only. For the HP 53181A, front and rear terminals can exist for Channel 1. The optional Channel 2 can be configured as rear terminals only or front terminals only. Option 050 can be configured only as front terminals.

1

Performance Tests

Verifying Specifications

Introduction

This chapter provides procedures to test the electrical performance of the HP 53131A/132A Universal Counter and HP 53181A Frequency Counter, using the specifications listed in Chapter 7, "HP 53131A/132A Specifications," and Chapter 8, "HP 53181A Specifications," of this guide.

Three types of testing are provided:

- Operational Verification
- Complete Performance Tests
- Optional HP-IB Verification

This chapter is organized as follows:

Operational Verification

The operational verification is an abbreviated series of checks that may be performed to give a high degree of confidence that the instrument is operating properly without performing the complete performance tests. An operational verification is useful for incoming inspection, routine maintenance, and after instrument repair.

Complete Performance Tests

The complete performance tests verify the specifications listed in Chapter 7, "HP 53131A/132A Specifications," and Chapter 8, "HP 53181A Specifications." All tests can be performed without accessing the inside of the instrument.

Optional HP-IB Verification

The HP-IB verification program, described on page 1-38 (HP 53131A/132A) or page 1-66 (HP 53181A), exercises the Counter via the HP-IB interface. The program is written for an HP 9000 series 200 or 300 Desktop Computer as the controller. If the instrument successfully completes all phases of the verification program, there is a very high probability that the HP-IB interface is working properly.

The HP-IB program is available on disks as indicated in the following listing:

- **For HP 53131A/132A Counters** — HP part number 53131-13501 (3 1/2-inch LIF disk) and HP part number 53131-13502 (5 1/4-inch LIF disk).
- **For HP 53181A Counters** — HP part number 53181-13501 (3 1/2-inch LIF disk) and HP part number 53131-13502 (5 1/4-inch LIF disk).

Recommended Calibration Cycle

The Counter requires periodic verification of operation. Depending on the use and environmental conditions, aging, and measurement accuracy required, the Counter should be checked using the operational verification procedure *at least* once every year.

Test Record

The results of the operational verification, complete performance tests, and HP-IB verification test should be recorded on a copy of the Performance Test Record, located at the end of each (i.e., HP 53131A/132A and HP 53181A) complete performance tests section in this chapter.

Equipment Required

Table 1-1. Recommended Test Equipment

Instrument	Required Characteristics	Recommended Model	Use
Synthesizer	DC to 13 MHz	HP 3325B	OV, P, T
Synthesized Signal Generator	100 kHz to 2560 MHz	HP 8663A	OV, P,T
Pulse Generator	5 ns pulse width	HP 8130A or equivalent	OV, C
Sweep Oscillator	3.0 GHz	HP 8340B	P, T
Primary Frequency Standard (10 MHz House Standard)	Absolute accuracy >1 x 10^{-10}	HP 5071A	C
DC Power Supply	Adjustable to 5.000V	HP 6234A	C
Digital Voltmeter	Microvolt accuracy	HP 3458A	OV, C
Type N-to-BNC Connector	_____	HP 1250-0780	OV, P
BNC-to-Dual Banana Plug	BNC(m) to banana plug	HP 11001-60001	OV, P, C T
50Ω Feedthrough (3)	_____	HP 10100C	GV, P, C
50Ω Coaxial Cable with BNC connectors (5)	BNC(m) to BNC(m), 48 inches	HP 10503A	OV, P, C, T
Coaxial BNC Tee Connector	_____	1250-0781	P, C

P = Performance Tests
OV = Operational Verification
C = Calibration
T = Troubleshooting

HP 53131A/132A/181A Operational Verification

The operational verification is an abbreviated series of checks that may be performed to give a high degree of confidence that the instrument is operating properly without performing the complete performance tests.

If you are unfamiliar with the operation of the Counter, you should review the Chapter 1, "Getting Started," in the Operating Guide. However, the procedures in this chapter are written so that little experience is necessary. The procedures should be followed in the order in which they appear.

Power-On Self Tests

1 **Inspect the Counter for any damage.**

2 **Make sure no cables are connected to the input channels (rear and front panels) of the Counter.**

NOTE

It is normal for the fan in the Counter to continue to run after the Counter is placed in Standby mode. Power to the timebase is continuous to maintain long term measurement reliability, and the fan helps maintain timebase temperature stability.

NOTE

The power supply will automatically sense the input voltage; thus, there is no need to change the ac voltage setting.

3 **Connect the power cord to the Counter, and connect the other end of the power cord to the primary power source.**

4 **Press *POWER* key to turn on the Counter.**

5 **Verify that the following happens:**

- All segments of the front-panel display light up,
- ***SELFTST: PASS*** is displayed,

- ***HP-IB AT n*** is quickly displayed — where "n" represents the HP-IB address (Note that some earlier versions of the Counter's firmware did not display the HP-IB address at power-up.), and
- dashes are displayed.

The Counter is now ready to measure frequency of a signal applied to CHANNEL 1 input as indicated by illumination of the **Freq** and **Ch1** annunciators.

If a fail message is displayed, refer to the troubleshooting section in Chapter 2, "Service," of this guide.

6 For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 1.

6′ For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 1.

7 Connect the Counter's rear-panel *10 MHz Out* as shown in Figure 1-1A or Figure 1-1B, depending on which Counter you are testing.

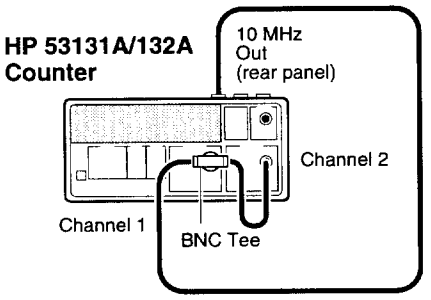


Figure 1-1A. Operational Verification Setup for HP 53131A/132A

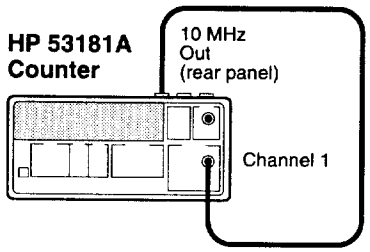


Figure 1-1B. Operational Verification Setup for HP 53181A

8 **Depending on which Counter you are testing, verify the appropriate reading as shown below:**

For HP 53131A and HP 53181A, verify a reading of 10.000,000,00 MHz.

For the HP 53132A, verify a reading of 10.000,000,000 MHz.

9 **For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 2.**

9′ **For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 2.**

NOTE

The remaining steps apply to the HP 53131A and HP 53132A only since the HP 53181A does not have a standard Channel 2 input. For the HP 53181A, proceed to the following "Run Self Test" section.

10 **Press *Freq & Ratio* key until *FREQUENCY 2* is displayed to select Channel 2 for frequency measurements.**

For the HP 53131A, verify a reading of 10.000,000,00 MHz.

For the HP 53132A, verify a reading of 10.000,000,000 MHz.

11 **For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 3.**

Run Self Test

1 **Disconnect the input signals from the Counter.**

2 **Power down (turn off the Counter), press and hold *Recall (Utility)* key, then press *POWER* key.**

3 **Press *Recall* key until *TEST: ALL ?* is displayed.**

4 **Press *Enter* key.**

Observe that ***ALL: PASS*** is displayed after the self test is completed.

If ***ALL: FAIL*** is displayed or a failure is indicated, refer to the troubleshooting section in Chapter 2, "Service," of this guide.

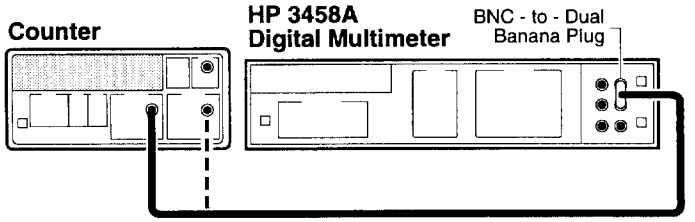
5 **For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 4.**

5′ **For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 3.**

Termination Check

1 **Cycle the *POWER* key to preset the Counter.**

2 **Connect a digital voltmeter (DVM) to CHANNEL 1 as shown in Figure 1-2, and set it to measure ohms (set DVM to appropriate Ω range).**



HP 53131A/132A is shown in above figure. This setup for the HP 53181A requires a connection to Channel 1 only.

Figure 1-2. Termination Check Setup

3 **Press Channel 1 *50Ω/1MΩ* key.**

The LED turns on, indicating a 50Ω input impedance for Channel 1.

4 **Press Channel 1 *DC/AC* key.**

The LED turns on, indicating DC input coupling for Channel 1.

5 **Verify the DVM reads** 51.1Ω ± 3Ω.

6 **For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 5a.**

6′ **For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 4a.**

7 **Press Channel 1 *50Ω/1MΩ* key.**

The LED turns off, indicating a 1 MΩ input impedance for Channel 1.

8 **Verify the DVM reads approximately** 1.0000000 MOHM.

9 **For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 5b.**

9′ **For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 4b.**

10 **Repeat steps 3 through 9 for Channel 2 for the HP 53131A/132A Counter ONLY since the HP 53181A Counter does not have a standard Channel 2.**

11 **For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Tests 6a and 6b.**

12 **Disconnect the test setup.**

External Arm Test (HP 53131A/132A Only)

This test verifies the External Arm port of the HP 53131A and HP 53132A Counter is operational.

Equipment

HP 8663A Synthesized Signal Generator
HP 8130A Pulse Generator (or equivalent)
HP 10100C 50Ω Feedthrough
HP 10503A BNC Cables (2)
HP 1250-0780 N-to-BNC Connector

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set the Counter as follows:**

Other Meas, ***TOTALIZE 1***
Gate & ExtArm, ***GATE: EXTERNL (ENTER)***

3 **Set CHANNEL 1 input conditions to:**

Trigger/Sensitivity, ***AUTO TRG: ON***
Trigger/Sensitivity, ***LEVEL: 50 PCT***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuator, Off
100kHz Filter, Off

Procedure

1 **Set the Pulse Generator to the following:**

PERIOD: 20 μs
WIDTH: 5 μs
High: 3.00 V Low : 1.50 V
Trailing/Leading : 1.0 ns
Input Mode: TRIG

2 **Connect the equipment as shown in Figure 1-3.**

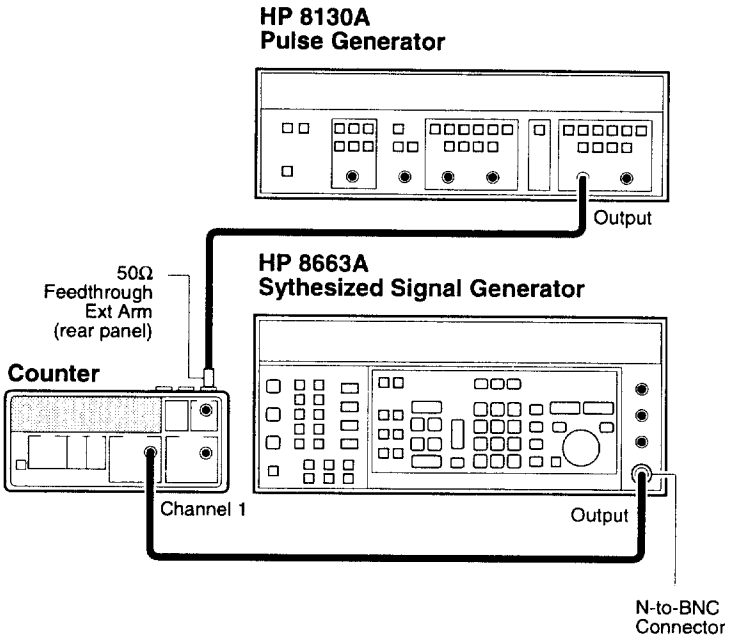


Figure 1-3. External Arm Test Setup (HP 53131A/132A Only)

3 **Set the HP 8663A to output a 200 MHz, 100 mV sine wave signal to Channel 1.**

4 **On the Counter, Press *Run* key.**

5 **Send a single pulse by pressing the MAN key on the HP 8130A, and observe that with each press the *Gate* annunciator flashes.**

The Counter should display approximately 1000.

6 **For HP 53131A/132A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 7.**

7 **Disconnect the test setup.**

External Timebase Tests

These tests verify the External Timebase 1, 5, 10 MHz specifications of the HP 53131A and HP 53181A Counters by checking that TIMEBASE AUTO allows the Counter to be synchronized to the external reference.

Note that the HP 53132A only operates with the 10 MHz external timebase; therefore, perform the procedure in the section titled "10 MHz External Timebase Input for the HP 53132A," on page 1-14 to verify that TIMEBASE AUTO allows the Counter to be synchronized to the external reference.

Equipment

HP 3325B Synthesizers (2)
HP 10100C 50Ω Feedthrough
HP 10503 BNC Cables (2)

1 MHz External Timebase Input (HP 53131A and HP 53181A Only)

1 **Connect the equipment as shown in Figure 1-4.**

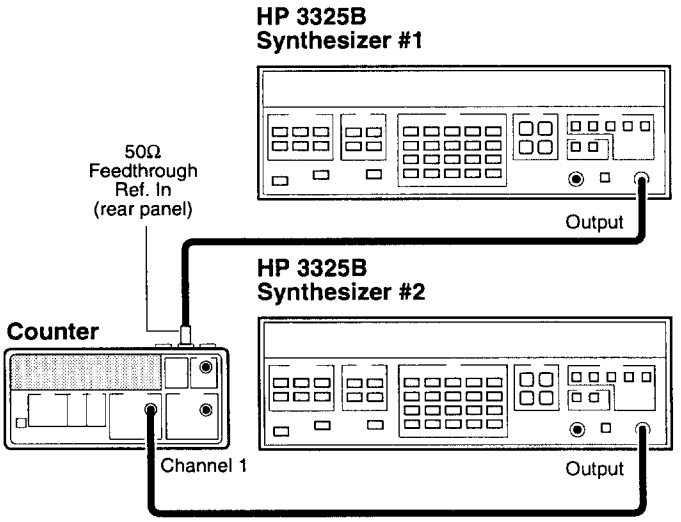


Figure 1-4. External Timebase Test Setup

2 **Cycle the *POWER* key to preset the Counter.**

3 **Set Synthesizer #1 (i.e., the HP 3325B connected to the rear-panel *Ref In* input of the Counter via a 50Ω feedthrough) to output a 1 MHz, 200 mV rms sine wave signal.**

4 **Set Synthesizer #2 (i.e., the HP 3325B connected to Channel 1) to output a 2 MHz, 100 mV rms square wave signal.**

Verify the Counter displays a reading of approximately 2 MHz and the **ExtRef** annunciator is lit.

5 **For HP 53131A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 8a.**

5′ **For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 5a.**

5 MHz External Timebase Input (HP 53131A and HP 53181A Only)

1 **Change the frequency of Synthesizer # 1, which is connected to the Counter's rear-panel *Ref In* input to 5 MHz.**

2 **On the Counter, press *Run* key.**

Verify the Counter displays a reading of approximately 2 MHz and the **ExtRef** annunciator is lit.

3 **For HP 53131A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 8b.**

3′ **For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 5b.**

10 MHz External Timebase Input (HP 53131A and HP 53181A Only)

1 **Change the frequency of Synthesizer #1, which is connected to the Counter's rear-panel *Ref In* input to 10 MHz.**

2 **On the Counter, press *Run* key.**

Verify the Counter displays a reading of approximately 2 MHz and the **ExtRef** annunciator is lit.

3 **For HP 53131A, mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 8c.**

3′ **For HP 53181A, mark Pass or Fail in the HP 53181A Performance Test Record on page 1-67, Test 5c.**

4 **Disconnect the test setup.**

This completes the Operational Verification for the HP 53131A and HP 53181A.

10 MHz External Timebase Input for the HP 53132A

1 **Connect the equipment as shown in Figure 1-4.**

2 **Set Synthesizer #1 (i.e., the HP 3325B that is connected to the rear-panel *Ref In* input of the Counter via a 50Ω feedthrough) to output a 10 MHz, 200 mV rms sine wave signal.**

3 **Set Synthesizer #2 (i.e., the HP 3325B that is connected to Channel 1) to output a 2 MHz, 100 mV rms square wave signal.**

Verify the Counter displays a reading of approximately 2 MHz and the ExtRef annunciator is lit.

4 **Mark Pass or Fail in the HP 53131A/132A Performance Test Record on page 1-39, Test 8d.**

5 **Disconnect the test setup.**

This completes the Operational Verification for the HP 53132A.

HP 53131A/132A Complete Performance Tests

The specifications of the **HP 53131A/132A Universal Counter** can be verified by performing the performance tests provided in this section. Table 1-2 lists a summary of the HP 53131A/132A performance tests.

Record the results of the performance tests in the appropriate place on HP 53131A/132A Performance Test Record, which starts on page 1-39.

(Note: the complete performance tests for the HP 53181A Frequency Counter begin on page 1-45 of this chapter.)

NOTE

To perform valid testing of the specifications, warm up the Counter and test equipment for 30 minutes.

Table 1-2. The HP 53131A/132A Performance Tests

Page Number	*Test Description
1-16	Test 1: Time Interval
1-18	Test 2: Trigger Level
1-21	Test 3: Channels 1 and 2 Frequency Sensitivity
1-26	Test 4: Channels 1 and 2 Frequency Accuracy
1-29	Test 5: Option 030/ 050 Channel 3 Frequency Sensitivity
1-32	Test 6: Option 030/ 050 Channel 3 Frequency Accuracy
1-35	Test 7: Peak Volts, Channels 1 and 2
1-38	HP 53131A/132A HP-IB Verification

*Other Counter measurement functions (e.g., Period) are mathematically derived by the microprocessor from the parameters verified by these performance tests. If the Counter passes the performance tests, the other measurement functions are functioning to specifications.

Test 1: Time Interval (HP 53131A/132A Only)

This test verifies the Time Interval specifications between Channels 1 and 2.

Equipment

HP 8130A Pulse Generator (or equivalent)
HP 10503A BNC Cable

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Press *Time & Period* key until *TI 1 TO 2* is displayed.**

3 **Set CHANNEL 1 input conditions to:**
Trigger/Sensitivity, *AUTO TRG: OFF*
Trigger/Sensitivity, *LEVEL: .500V (Enter)*
Trigger/Sensitivity, *COMMON 1: ON*
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

4 **Set CHANNEL 2 input conditions to:**
Trigger/Sensitivity, *AUTO TRG: OFF*
Trigger/Sensitivity, *LEVEL: .500V (Enter)*
Trigger/Sensitivity, *SLOPE: NEG*
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

Procedure

1 **Connect the pulse generator signal to Channel 1 of the Counter as shown in Figure 1-5.**

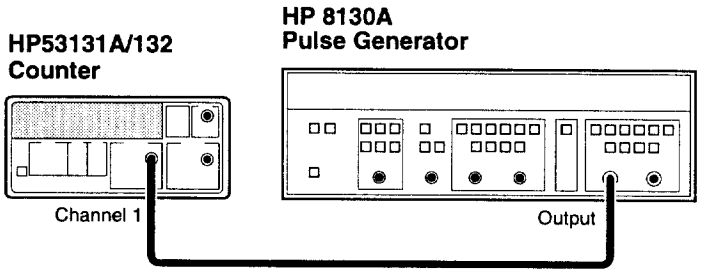


Figure 1-5. Time Interval (Channel 1 TO 2) Test Setup

2 **Set the Pulse Generator to the following:**

PERIOD: 10 µs
WIDTH: 150 ns
High: 1.00 V Low : 0.00 V
Input Mode: Normal

3 **On the Counter, Press *Single/Stop* key.**

The HP 53131A Counter should display 0.1500 µs ±0.0040 µs.

The HP 53132A Counter should display 0.1500 µs ±0.0025 µs.

4 **Record this value in the appropriate place in the Performance Test Record (Test 1, Line 1 for HP 53131A or Test 1, Line 2 for HP 53132A).**

5 **Disconnect the test setup.**

Test 2: Trigger Level (HP 53131A/132A Only)

This test verifies the Trigger Level accuracy of the HP 53131A and HP 53132A Universal Counters.

Equipment

HP 3325B Synthesizer
HP 10503A BNC Cable

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set CHANNEL 1 input conditions to:**
Trigger/Sensitivity, *AUTO TRG: OFF*
Trigger/Sensitivity, *LEVEL: 0.000V*
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

3 **Set CHANNEL 2 input conditions to:**
Trigger/Sensitivity, *AUTO TRG: OFF*
Trigger/Sensitivity, *LEVEL: 0.000V*
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

Procedure

1 **Connect the output of the HP 3325B to Channel 1 of the Counter as shown in Figure 1-6.**

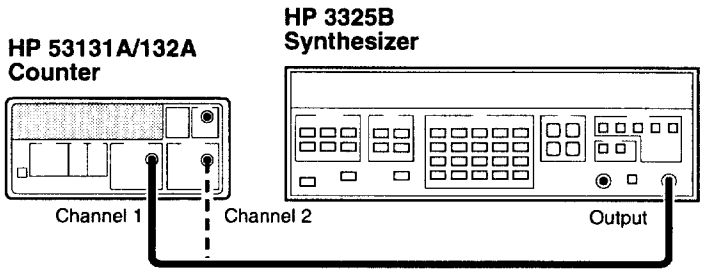


Figure 1-6. Trigger Level Test Setup

2 **Set the HP 3325B to output a 1 MHz, 80 mVp-p square wave signal.**

3 **Set the HP 3325B DC OFFSET to –60 mV.**

4 **On the Counter, press *Run* key.**

5 **Now, increment the dc offset on the HP 3325B by +1 mV until the Counter's *Gate* annunciator flashes and continue incrementing until the Counter displays a *stable* reading of approximately 1 MHz.**

Observe the offset value on the display of the HP 3325B.

Record the dc offset value_____ mV.

6 **Add the upper peak voltage (40 mV) of the 80 mV p-p signal to the offset value in step 5** (For example, –24 mV + 40 mV = 16 mV).

This is the upper hysteresis level.

Record the upper hysteresis level_____ mV.

7 **In the Counter's Channel 1 Trigger/Sensitivity menu, change the SLOPE to NEG.**

8 **Set the HP 3325B DC OFFSET to +60 mV.**

9 **On the Counter, press *Run* key.**

10 **Now, decrement the offset on the HP 3325B by –1 mV until the Counter's *Gate* annunciator flashes and continue decrementing until the Counter displays a *stable* reading of approximately 1 MHz.**

Observe the offset value on the display of the HP 3325B.

Record the value_____ mV.

11 **Add the lower peak voltage (-40mV) of the 80 mVp-p signal to the offset value in step 10 (For example, 21 mV – 40 mV = –19 mv.)**

This result is the lower hysteresis level.

Record the lower hysteresis level _____ mV.

12 **Now, add the upper hysteresis value (recorded in step 6)and lower hysteresis value (recorded in step 11).**

This is the trigger level; it should be 0.0 V ±15 mV.

13 **Record the trigger level value in the appropriate place in the Performance Test Record (Test 2, Line 1).**

14 **Repeat steps 1 through 13 for Channel 2.**

15 **Record the trigger level value in the appropriate place in the Performance Test Record (Test 2, Line 2).**

16 **Disconnect the test setup.**

Test 3: Channels 1 and 2 Frequency Sensitivity (HP 53131A/132A Only)

This set of tests verifies frequency sensitivity specifications of the HP 53131A and 53132A Universal Counters.

Equipment

HP 8663A Synthesized Signal Generator
HP 1250-0780 Type N-to-BNC Connector
HP 10100C 50Ω Feedthrough
HP 10503A BNC Cables (2)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set CHANNEL 1 input conditions to:**

Trigger/Sensitivity, ***AUTO TRG: OFF***
Trigger/Sensitivity, ***LEVEL: 0.000 V***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

3 **Set CHANNEL 2 input conditions to:**

Trigger/Sensitivity, ***AUTO TRG: OFF***
Trigger/Sensitivity, ***LEVEL: 0.000 V***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

100 kHz to 100 MHz Sensitivity for HP 53131A/132A

1 **Connect the equipment as shown in Figure 1-7, with the signal generator connected to Channel 1 of the Counter.**

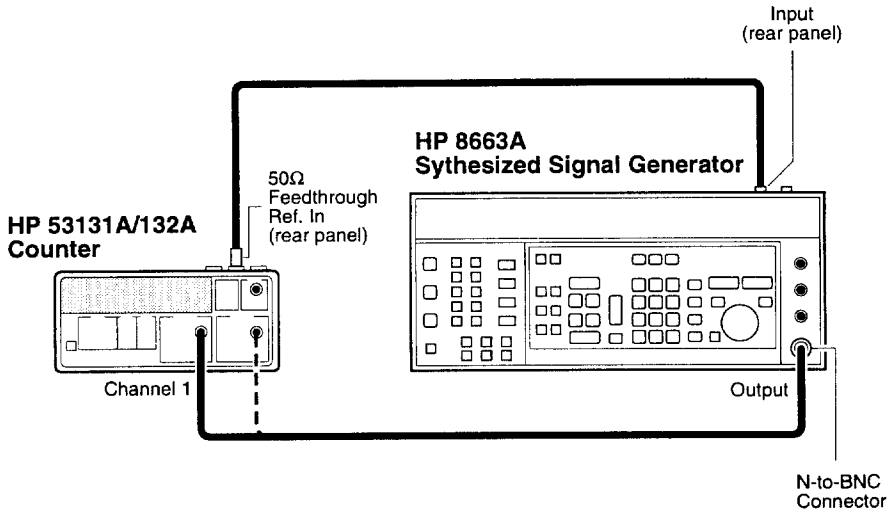


Figure 1-7. Channels 1 and 2 Frequency Sensitivity Test Setup

2 **Set the HP 8663A Signal Generator to output a 100 MHz, – 35.0 dBm sine wave signal (–20.0 dBm for Option 060 Rear Terminals) to the Counter's Channel 1 input.**

3 **On the Counter, press *Run* key.**

4 **In 0.1 dB steps, increase the power level until the Counter displays a *stable* reading of 100 MHz.**

The Counter should display 100 MHz when the signal generator level is ≤ –21.0 dBm (20 mVrms). **Counters with Option 060 should display 100 MHz when the signal generator level is ≤ –9.5 dBm (75 mVrms).**

5 **Sweep the frequency from 100 MHz to 100 kHz. *For Option 060, sweep frequencies from 225 MHz to 100 kHz.***

The Counter should read frequencies from 100 MHz to 100 kHz at an input power level of ≤ –21.0 dBm (20 mVrms). **Counters with**

Option 060 should read frequencies from 225 MHz to 100 kHz at ≤ –9.5 dBm (75 mVrms).

6 **Record the actual reading in the appropriate place in the Performance Test Record (Test 3, Line 1).**

If you are testing a Counter with front-panel terminals (Standard), record the reading on Line 1 of the **Standard** portion of the test record.

If you are testing a Counter with rear terminals (Option 060), record the reading on Line 1 of the **Option 060** portion of the test record.

NOTE DO NOT test the front terminals if rear terminals are installed. The front terminal performance is not specified when the rear terminals are installed.

7 **Connect the HP 8663A to Channel 2 of the Counter.**

8 **On the Counter, press *Freq & Ratio* key until *FREQUENCY 2* is displayed.**

9 **Repeat steps 2 through 5 for Channel 2.**

10 **Record the actual reading in the appropriate place in the Performance Test Record (Test 3, Line 2).**

If you are testing a Counter with front-panel terminals (Standard), record the reading on Line 2 of the **Standard** portion of the test record.

If you are testing a Counter with rear terminals (Option 060), record the reading on Line 2 of the **Option 060** portion of the test record.

NOTE The remaining sensitivity procedures are NOT required for Counters that contain Option 060 Rear Terminals; thus, this completes the sensitivity portion of the Frequency Performance Test. Go to the Frequency Accuracy Test on page 1-26.

100 MHz to 200 MHz Sensitivity for HP 53131A/132A

1 **Leave the signal generator connected to Channel 2. Change the signal generator settings to 200 MHz at –30 dBm.**

2 **On the Counter, press *Run* key.**

3 **Increase the power level by 0.1 dB steps until the Counter displays a *stable* 200 MHz reading.**

The Counter should display 200 MHz when the input signal level is ≤ –17.5 dBm (30 mVrms).

4 **Sweep the signal generator frequency from 200 MHz to 100 MHz.**

The Counter should read frequencies from 200 MHz to 100 MHz when the input signal level is ≤ –17.5 dBm (30 mVrms).

5 **Record the actual reading in the Performance Test Record (Test 3, Line 3).**

6 **Connect the signal generator to Channel 1.**

7 **On the Counter, press *Freq & Ratio* key until *Frequency 1* is displayed.**

8 **Repeat steps 1 through 4 for Channel 1.**

9 **Record the actual reading in the Performance Test Record (Test 3, Line 4).**

200 MHz to 225 MHz Sensitivity for HP 53131A/132A

1 **Leave the signal generator connected to Channel 1. Change the signal generator settings to 225 MHz at –30 dBm.**

2 **On the Counter, press *Run* key.**

3 **Increase the power level by 0.1 dB steps until the Counter displays a *stable* reading of 225 MHz.**

The Counter should read 225 MHz when the input signal level is ≤ –15.0 dBm (40 mVrms).

4 **Sweep the signal generator frequency from 225 MHz to 200 MHz.**

The Counter should read frequencies from 225 MHz to 200 MHz when the input signal level is ≤ –15.0 dBm (40 mVrms).

5 **Record the actual reading in the Performance Test Record (Test 3, Line 5).**

6 **Connect the signal generator to Channel 2.**

7 **On the Counter, press *Freq & Ratio* key until *Frequency 2* is displayed.**

8 **Repeat steps 1 through 4 for Channel 2.**

9 **Record the actual reading in the Performance Test Record (Test 3, Line 6).**

10 **Disconnect the test setup.**

Test 4: Channels 1 and 2 Frequency Accuracy (HP 53131A/132A Only)

This set of tests verifies the frequency accuracy specifications of the HP 53131A and HP 53132A Universal Counters.

Equipment

HP 8663A Synthesized Signal Generator
HP 1250-0780 Type N-to-BNC Connector
HP 10100C 50Ω Feedthrough
HP 10503A BNC Cables (2)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Using the Gate & ExtArm key, set the gate time to *TIME 1.000 s*.**

3 **Set CHANNEL 1 input conditions to:**

Trigger/Sensitivity, ***AUTO TRG: OFF***
Trigger/Sensitivity, ***LEVEL: 0.000 V***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

4 **Set CHANNEL 2 input conditions to:**

Trigger/Sensitivity, ***AUTO TRG: OFF***
Trigger/Sensitivity, ***LEVEL: 0.000 V***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

Procedure

1 **Connect the equipment as shown in Figure 1-8 with the signal generator connected to Channel 1 of the Counter.**

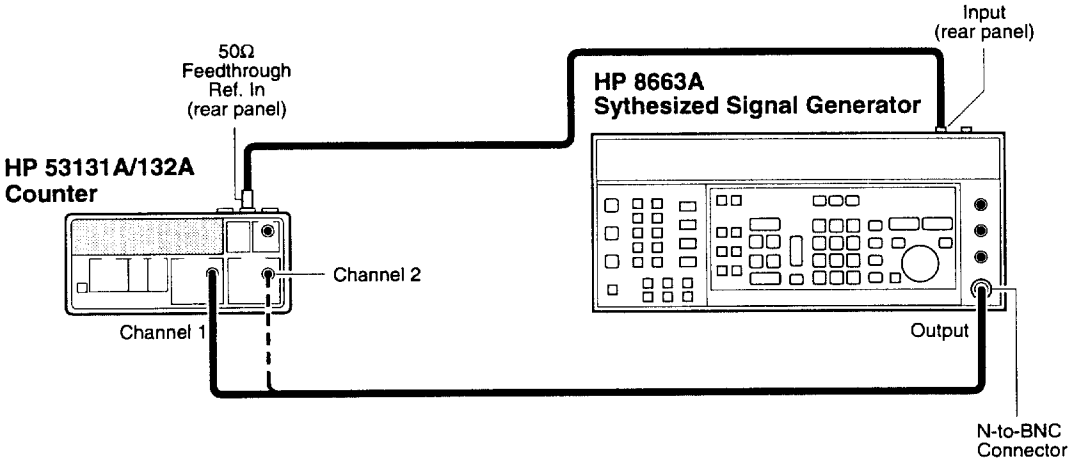


Figure 1-8. Channels 1 and 2 Frequency Accuracy Test Setup

2 **Set the Signal Generator to output 1 MHz at –7 dBm.**

3 **On the Counter, press *Run* key.**

Verify the HP 53131A Counter reads 1 MHz ±1 mHz.

Verify the HP 53132A Counter reads 1 MHz ±400 μHz.

4 **Record the actual reading in the appropriate place in the Performance Test Record (Test 4, Line 1 for HP 53131A or Test 4, Line 3 for HP 53132A.**

5 **Change the signal generator frequency to 100 MHz.**

Verify the HP 53131A Counter reads 100 MHz ±30 mHz.

Verify the HP 53132A Counter reads 100 MHz ±20 mHz.

6 **Record the actual reading in the appropriate place in the Performance Test Record (Test 4, Line 5 for HP 53131A or Test 4, Line 7 for HP 53132A).**

7 **Change the signal generator frequency to 200 MHz.**

Verify the HP 53131A Counter reads 200 MHz ±60 mHz.

Verify the HP 53132A Counter reads 200 MHz ±40 mHz.

8 **Record the actual reading in the appropriate place in Performance Test Record (Test 4, Line 9 for HP 53131A or Test 4, Line 11 for HP 53132A).**

9 **Change the signal generator frequency to 225 MHz.**

Verify the HP 53131A Counter reads 225 MHz ±70 mHz.

Verify the HP 53132A Counter reads 225 MHz ±40 mHz.

10 **Record the actual reading in the appropriate place in the Performance Test Record (Test 4, Line 13 for HP 53131A or Test 4, Line 15 for HP 53132A).**

11 **Connect the signal generator to Channel 2.**

12 **On the Counter, press *Freq & Ratio* key until *Frequency 1* is displayed.**

13 **Repeat steps 2 through 9 for Channel 2.**

14 **Record the actual readings in the appropriate places in the Performance Test Record.**

15 **Disconnect the test setup.**

Test 5: Option 030/050 Channel 3 Frequency Sensitivity HP 53131A/132A Only)

This test verifies the frequency range, and sensitivity of the optional 3-GHz and 5-GHz Channel 3 (Option 030/050) for the HP 53131A and the HP 53132A Universal Counters.

Equipment

HP 8663A Synthesized Signal Generator (not needed for Option 050)
HP 8340B Sweep Oscillator
HP 1250-0780 Type N-to-BNC Connector (not needed for Option 050)
HP 10503A BNC Cable(2)
HP 10100C 50Ω Feedthrough
HP 11500D N-N Cable (Option 050 only)
HP 1250-1250 N(M) to SMA(F)
HP 1250-0777 N(F) to N(F)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set the Counter as follows:**
Freq & Ratio, *FREQUENCY 3*

100 MHz to 2.5 GHz Sensitivity for HP 53131A/132A Option 030 only

1 **Set the HP 8663B Synthesized Signal Generator to output a 500 MHz, –60 dBm sine wave, and connect the signal to Channel 3 of the Counter as shown in Figure 1-9.**

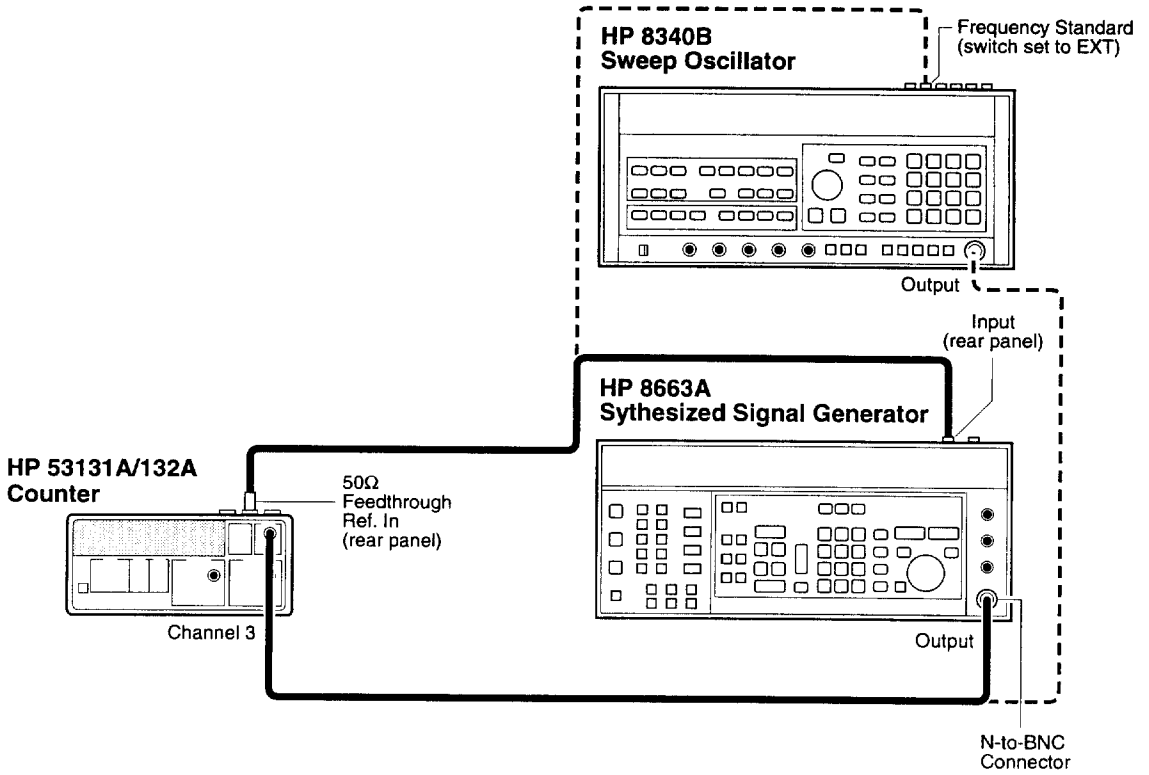


Figure 1-9. Option 030/050 Channel 3 Frequency Test Setup

2 **On the Counter, Press *Run* key.**

3 **Increase the power level in 5 dB steps until the Counter displays a *stable* reading of approximately 2.5 GHz.**

The Counter should display 2.5 GHz at ≤ –27.0 dBm (20 mVrms).

4 **Sweep the frequencies from 2.5 GHz to 100 MHz.**

The Counter should read frequencies from 2.5 GHz to 100 MHz at ≤ –27.0 dBm (20 mVrms).

5 **Record the actual reading in the Performance Test Record (Test 5, Line 1).**

2.8 to 3.0 GHz Sensitivity for Option 030 only

1 **Disconnect the HP 8663A Synthesized Signal Generator from the Counter (see Figure 1-9), and connect the HP 8340B Sweep Oscillator to Channel 3 of the Counter.**

2 **Change the settings of the Sweep Oscillator to 3.0 GHz, –40 dBm.**

3 **Increase the power level in 1 dB steps until the Counter displays a *stable* reading of approximately 3.0 GHz.**

The Counter should display 3.0 GHz at ≤ –21.0 dBm.

4 **Sweep the frequencies from 3.0 GHz to 2.8 GHz.**

The Counter should read frequencies from 3.0 to 2.8 GHz at ≤ –21.0 dBm.

5 **Record the actual reading in the Performance Test Record (Test 5, Line 2).**

6 **Disconnect the test setup.**

150 MHz to 5.0 GHz Sensitivity for HP 53131A/132A (Option 050 only)

1 **Connect the 8340B Sweep Oscillator to Channel 3 of the counter.**

2 **Change the settings of the Sweep Oscillator to 5.0 GHz, -30 dBm.**

3 **Increase the power level in 1 dB steps until the Counter displays a *stable* reading of approximately 5.0 GHz.**

The Counter should display 5.0 GHz at ≤ -23 dBm.

NOTE Use a power meter and sensor to ensure the accuracy of the power being input.

4 **Sweep the frequencies from 150 MHz to 5.0 GHz.**

The Counter should read frequencies from 150 MHz to 5.0 GHz at ≤ -23 dBm.

5 **Record the actual reading in the Performance Test Record (Test 5, Line 3).**

6 **Disconnect the test setup.**

Test 6: Option 030/050 Channel 3 Frequency Accuracy (HP 53131A/132A Only)

This test verifies the frequency accuracy of the optional 3-GHz or 5-GHz Channel 3 (Option 030).

Equipment

HP 8663A Synthesized Signal Generator (Option 030 only)
HP 8340B Sweep Oscillator
HP 1250-0780 Type N-to-BNC Connector (Option 030 only)
HP 10503A BNC Cable (2)
HP 10100C 50Ω Feedthrough
HP 11500D N-N Cable (Option 050 only)
HP 1250-1250 N(M) to SMA(F)
HP 1250-0777 N(F) to N(F)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set the Counter as follows:**
Freq & Ratio, *FREQUENCY 3*
Gate & ExtArm, *TIME: TIME 1.000 s*

Procedure

1 **Connect equipment as shown in Figure 1-10.**

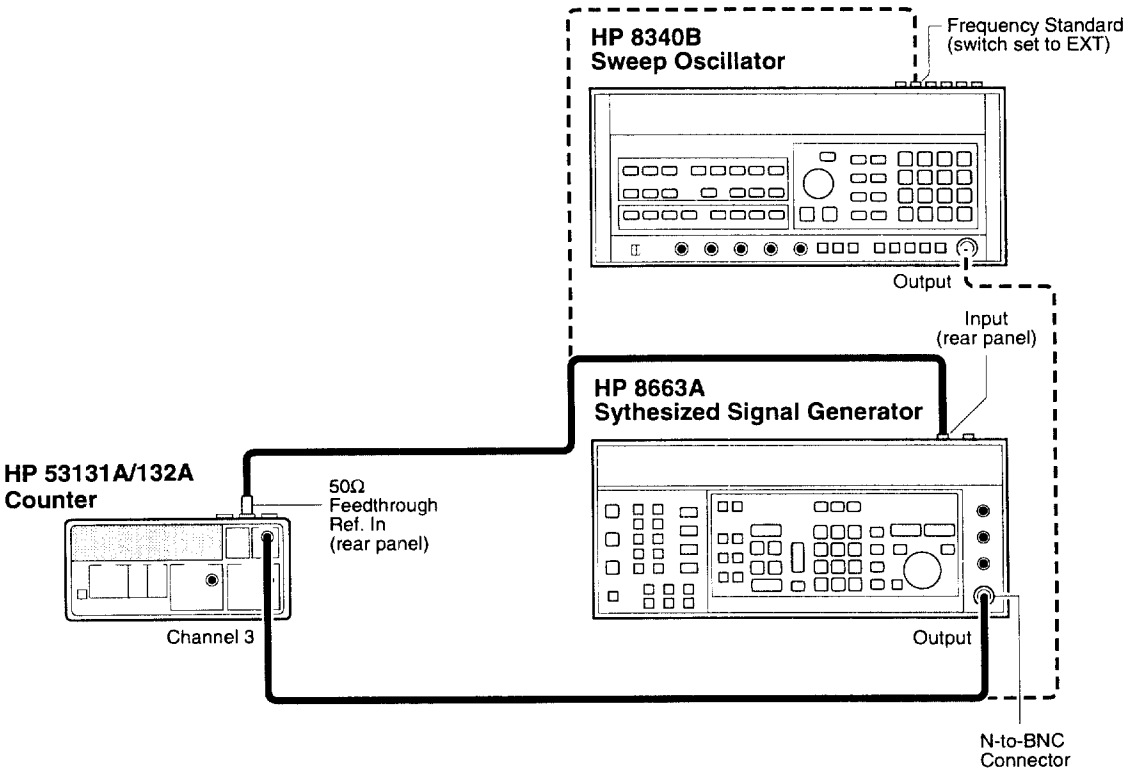


Figure 1-10. Option 030/ 050 Frequency Accuracy Test Setup

(NOTE: For Option 050, skip steps 2 through 8. Proceed to step 9.)

2 **Set the HP 8663A Synthesized Signal Generator to output 100 MHz at –17.0 dBm.**

3 **On the Counter, press *Run* key.**

Verify the HP 53131A Counter reads 100 MHz ±30 mHz.

Verify the HP 53132A Counter reads 100 MHz ±20 mHz.

4 **Record the actual reading in the Performance Test Record (Test 6, Line 1 for HP 53131A or Test 6, Line 2 for HP 53132A).**

5 **Disconnect the HP 8663A output from Channel 3 of the Counter, and connect the HP 8340B Sweep Oscillator output to Channel 3 of the Counter as shown in Figure 1-10.**

6 **Set the HP 8340B to output 3.0 GHz at –17.0 dBm.**

Verify the HP 53131A Counter reads 3.0 GHz ±1 Hz.

Verify the HP 53132A Counter reads 3.0 GHz ±0.5 Hz.

7 **Record the actual reading in the Performance Test Record (Test 6, Line 3 for HP 53131A or Test 6, Line 4 for HP 53132A).**

8 **Disconnect the test setup.**

9 **Set the HP 8340B to output 5.0 GHz at -17 dBm.**

Verify the HP 53131A Counter reads 5.0 GHz ±3 Hz.

Verify the HP 53132A Counter reads 5.0 GHz ±1 Hz.

10 **Record the actual reading in the Performance Test Record (Test 6 Line 5 for HP 53131A or Test 6, Line 6 for HP 53132A.)**

Test 7: Peak Volts, Channels 1 and 2 (HP 53131A/132A Only)

This test verifies the Peak Volts accuracy specification of the HP 53131A and HP 53132A Universal Counters.

Equipment

HP 3325B Synthesizer
HP 10100C 50Ω Feedthrough
HP 10503A BNC Cable

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Press *Other Meas* key until *VOLT PEAKS 1* is displayed.**

3 **Set CHANNEL 1 input to:**
50Ω/1MΩ, 50Ω
X10 Attenuate, Off
100kHz Filter, Off

4 **Set CHANNEL 2 input to:**
50Ω/1MΩ, 50Ω
X10 Attenuate, Off
100kHz Filter, Off

Volt Peak 1

1 **Connect the equipment as shown in Figure 1-11.**

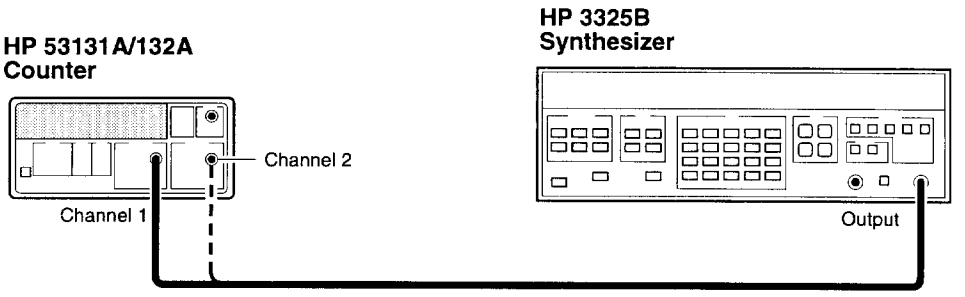


Figure 1-11. Peak Volts Test Setup

2 **Set the HP 3325B to output a 2 MHz, 2 Vp-p sine wave.**

The Counter should display –1.00 ±0.12V for the *negative peak* of the sine wave. This reading is displayed on the left side of the display.

Record the actual reading in the Performance Test Record (Test 7, Line 1a).

Also, the Counter should display +1.00 ±0.12V for the *positive peak* of the sine wave. This reading is displayed on the right side of the display.

Record the actual reading in the Performance Test Record (Test 7, Line 1b).

Volt Peak 2

1 **Remove the signal from Channel 1 of the Counter and connect it to Channel 2.**

2 **Press *Other Meas* key until *VOLT PEAK 2* is displayed.**

The Counter should display –1.00 ±0.12V for the *negative peak* of the sine wave. This reading is displayed on the left side of the display.

Record the actual reading in the Performance Test Record (Test 7, Line 2a).

Also, the Counter should display +1.00 ±0.12V for the *positive peak* of the sine wave. This reading is displayed on the right side of the display.

Record the actual reading in the Performance Test Record (Test 7, Line 2b).

3 **Disconnect the test setup.**

HP 53131A/132A HP-IB Verification Program (Optional)

The HP-IB Verification program exercises the HP 53131A/132A and through various operating modes via the its HP-IB interface. If the Counter successfully completes all phases of the verification program, there is a high probability that the HP-IB interface is operating correctly. If the Counter fails the verification program, refer to the troubleshooting section in Chapter 2, "Service," of this guide.

The HP-IB Verification program may be loaded into the HP 9000 series 200 or 300 Desktop Computer from the 3 1/2-inch disk (HP P/N 53131-13501) or the 5 1/4-inch disk (HP P/N 53131-13502).

1 **To run the program on the disk, insert the disk into the Desktop Computer, load the program by typing *Load "VER31"*, and press RUN key on the computer's keyboard.**

2 **Follow the instructions displayed in the computer's screen.**

3 **After running this program, record the result (Pass or Fail) on the last page (page 1-44) of the HP 53131A/132A Performance Test Record.**

HP 53131A/132A Performance Test Record (Page 1 of 6)

Hewlett-Packard Model 53131A/132A Universal Counter

Serial Number: _____ Repair/Work Order No. _____

Test Performed By: _____ Temperature: _____

Date: _____ Relative Humidity: _____

Notes: _____

Test Number	Operational Verification	Test Results Pass	Fail
1	Power on Self Test	❑	❑
2	Channel 1, 10 MHz Test	❑	❑
3	Channel 2, 10 MHz Test	❑	❑
4	Run Self Test	❑	❑
5a	Termination Check Ch 1, 50Ω	❑	❑
5b	Termination Check Ch 1, 1MΩ	❑	❑
6a	Termination Check Ch 2, 50Ω	❑	❑
6b	Termination Check Ch 2, 1MΩ	❑	❑
7	External Arm Test	❑	❑
8a	1 MHz External Timebase Input Test (HP 53131A Only)	❑	❑
8b	5 MHz External Timebase Input Test (HP 53131A Only)	❑	❑
8c	10 MHz External Timebase Input Test (HP 53131A Only)	❑	❑
8d	10 MHz External Timebase Input Test for the HP 53132A	❑	❑

HP 53131A/132A Performance Test Record (Page 2 of 6)

Complete Performance Tests				
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
1	**Time Interval** (HP 53131A/132A Only):			
	For HP 53131A	0.1460 µs	1. _____	0.1540 µs
	For HP 53132A	0.1475 µs	2. _____	0.1525 µs
2	**Trigger Level:**			
	Channel 1	−15 mV	1. _____	+15 mV
	Channel 2 (HP 53131A/132A Only)	−15 mV	2. _____	+15 mV

Test 3: Channels 1 and 2 Frequency Sensitivity (HP 53131A/132A Only)

Standard (Front Panel Terminals)	**Actual Reading**	**Specification**
100 kHz - 100 MHz, Channel 1	1. _____	≤ −21 dBm (20 mVrms)
100 kHz - 100 MHz, Channel 2	2. _____	≤ −21 dBm (20 mVrms)
100 MHz - 200 MHz, Channel 2	3. _____	≤ −17.5 dBm (30 mVrms)
100 MHz - 200 MHz, Channel 1	4. _____	≤ −17.5 dBm (30 mVrms)
200 MHz - 225 MHz, Channel 1	5. _____	≤ −15.0 dBm (40 mVrms)
200 MHz - 225 MHz, Channel 2	6. _____	≤ −15.0 dBm (40 mVrms)

Option 060 Rear Terminals	**Actual Reading**	**Specification**
100 kHz-225 MHz, Channel 1	1. _____	≤ −9.5 dBm (75 mVrms)
100 kHz-225 MHz, Channel 2	2. _____	≤ −9.5 dBm (75 mVrms)

HP 53131A/132A Performance Test Record (Page 3 of 6)

Complete Performance Tests (Continued)				
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
4	**Channels 1 and 2 Frequency Accuracy** (HP 53131A/132A Only)			
	1 MHz Test (HP 53131A):			
	Channel 1	999,999.999 Hz	1. _____	1,000,000.001 Hz
	Channel 2	999,999.999 Hz	2. _____	1,000,000.001 Hz
	1 MHz Test (HP 53132A):			
	Channel 1	999,999.99996 Hz	3. _____	1,000,000.0004 Hz
	Channel 2	999,999.99996 Hz	4. _____	1,000,000.0004 Hz
4	**100 MHz Test (HP 53131A):**			
	Channel 1	99.999,999,97 MHz	5. _____	100.000,000,03 MHz
	Channel 2	99.999,999,97 MHz	6. _____	100.000,000,03 MHz
	100 MHz Test (HP 53132A):			
	Channel 1	99.999,999,998 MHz	7. _____	100.000,000,020 MHz
	Channel 2	99.999,999,998 MHz	8. _____	100.000,000,020 MHz

HP 53131A/132A Performance Test Record (Page 4 of 6)

Complete Performance Tests (Continued)				
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
4	**200 MHz Test (HP 53131A):**			
	Channel 1	199.999,999,94 MHz	9. _____	200.000,000,06 MHz
	Channel 2	199.999,999,94 MHz	10. _____	200.000,000,06 MHz
	200 MHz Test (HP 53132A):			
	Channel 1	199.999,999,996 MHz	11. _____	200.000,000,040 MHz
	Channel 2	199.999,999,996 MHz	12. _____	200.000,000,040 MHz
4	**225 MHz Test (HP 53131A):**			
	Channel 1	224.999,999,93 MHz	13. _____	225.000,000,07 MHz
	Channel 2	224.999,999,93 MHz	14. _____	225.000,000,07 MHz
	225 MHz Test (HP 53132A):			
	Channel 1	224.999,999,996 MHz	15. _____	225.000,000,040 MHz
	Channel 2	224.999,999,996 MHz	16. _____	225.000,000,040 MHz

Test 5: Option 030/050 Channel 3 Frequency Sensitivity (HP 53131A/132A Only)

	Actual Reading	**Specification**
100 MHz - 2.5 GHz	1. _____	≤ -27 dBm
2.8 - 3.0 GHz	2. _____	≤ -21 dBm
150 MHz - 5.0 GHz	3. _____	≤ -23 dBm

HP 53131A/132A Performance Test Record (Page 5 of 6)

Complete Performance Tests (Continued)				
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
6	**Option 030 Channel 3 Frequency Accuracy** (HP 53131A/132A Only) **100 MHz Test (HP 53131A):** Channel 3 **100 MHz Test (HP 53132A):** Channel 3	99.999,999,97 MHz 99.999, 999,998 MHz	1. _____ 2. _____	100.000,000,03 MHz 100.000,000,020 MHz
6	**3.0 GHz Test (HP 53131A):** Channel 3 **3.0 GHz Test (HP 53132A):** Channel 3	2,999.999,999,0 MHz 2,999.999,999,50 MHz	3. _____ 4. _____	3,000.000,001,0 MHz 3,000.000, 000,50 MHz
6	**5.0 GHz Test (HP 53131A):** Channel 3 **5.0 GHz Test (HP 53132A):** Channel 3	4,999.999,997,0 MHz 4,999.999,999,0 MHz	5. _____ 6. _____	5,000.000,003,0 MHz 5,000.000, 001,0 MHz

HP 53131A/132A Performance Test Record (Page 6 of 6)

Complete Performance Tests (Continued)				
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
7	**Peak Volts, Channels 1 and 2** (HP 53131A/132A Only):			
	Volt Peak 1			
	Channel 1	−1.12 V +0.88 V	1 a._____ b._____	−0.88 V +1.12V
	Volt Peak 2			
	Channel 2	−1.12 V +0.88 V	2 a._____ b._____	−0.88 V +1.12V

Complete Performance Tests (Continued)		
HP-IB Verification (Optional)	**Test Results**	
	Pass	**Fail**
	❑	❑

HP 53181A Complete Performance Tests

The specifications of the **HP 53181A Frequency Counter** can be verified by performing the performance tests provided in this section. Table 1-3 lists a summary of the HP 53181A performance tests.

Record the results of the performance tests in the appropriate place on HP 53181A Performance Test Record, which starts on page 1-67.

(Note: the complete performance tests for the HP 53131A/132A Universal Counter begin on page 1-15 of this chapter.)

NOTE

To perform valid testing of the specifications, warm up the Counter and test equipment for 30 minutes.

Table 1-3. The HP 53181A Performance Tests

Page Number	*Test Description
1-46	Test 1: Trigger Level
1-49	Test 2: Channel 1 Frequency Sensitivity
1-53	Test 3: Channel 1 Frequency Accuracy
1-56	Test 4: Option 015/030/050 Channel 2 Frequency Sensitivity
1-60	Test 5: Option 015/030/050 Channel 2 Frequency Accuracy
1-64	Test 6: Peaks Volts, Channel 1
1-66	HP 53181A HP-IB Verification

*Other Counter measurement functions (e.g., Period) are mathematically derived by the microprocessor from the parameters verified by these performance tests.

Test 1: Trigger Level (HP 53181A Only)

This test verifies the Trigger Level accuracy of the HP 53181A Frequency Counter.

Equipment

HP 3325B Synthesizer
HP 10503A BNC Cable

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set CHANNEL 1 input condition to:**

Trigger/Sensitivity, ***AUTO TRG: OFF***
Trigger/Sensitivity, ***LEVEL: 0.000V***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

Procedure

1 **Connect the output of the HP 3325B to Channel 1 of the Counter as shown in Figure 1-12.**

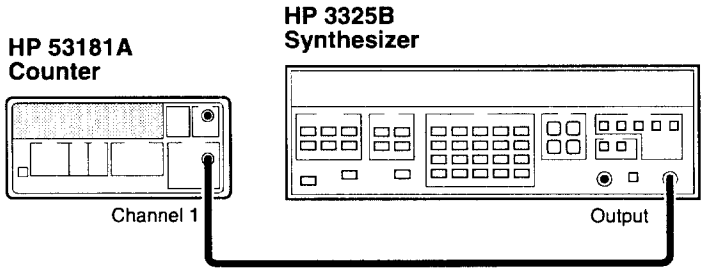


Figure 1-12. Trigger Level Test Setup

2 **Set the HP 3325B to output a 1 MHz, 80 mVp-p square wave signal.**

3 **Set the HP 3325B DC OFFSET to –60 mV.**

4 **On the Counter, press *Run* key.**

5 **Now, increment the dc offset on the HP 3325B by +1 mV until the Counter's *Gate* annunciator flashes and continue incrementing until the Counter displays approximately 1 MHz.**

Observe the offset value on the display of the HP 3325B.

Record the dc offset value_____ mV.

6 **Add the upper peak voltage (40 mV) of the 80 mV p-p signal to the offset value in step 5** (For example, –24 mV + 40 mV = 16 mv).

This is the upper hysteresis level.

Record the upper hysteresis level_____ mV.

7 **In the Counter's Channel 1 Trigger/Sensitivity menu, change the SLOPE to NEG.**

8 **On the Counter, press *Run* key.**

9 **Set the HP 3325B DC OFFSET to +60 mV.**

10 Now, decrement the offset on the HP 3325B by –1 mV until the Counter's *Gate* annunciator flashes and continue decrementing until the Counter displays approximately 1 MHz.

Observe the offset value on the display of the HP 3325B.

Record the value_____ mV.

11 Add the lower peak voltage (-40mV) of the 80 mVp-p signal to the offset value in step 10 (For example, 21 mV – 40 mV = –19 mV.)

This result is the lower hysteresis level.

Record the lower hysteresis level _____ mV.

12 Now, add the upper hysteresis value (recorded in step 6)and lower hysteresis value (recorded in step 11).

This is the trigger level; it should be 0.0 V ±15 mV.

13 Record the trigger level value in the Performance Test Record (Test 1, Line 1).

Test 2: Channel 1 Frequency Sensitivity (HP 53181A Only)

This set of tests verifies frequency sensitivity specifications of the HP 53181A Frequency Counter.

Equipment

HP 8663A Synthesized Signal Generator
HP 1250-0780 Type N-to-BNC Connector
HP 10100C 50Ω Feedthrough
HP 10503A BNC Cables (2)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set CHANNEL 1 input conditions to:**

Trigger/Sensitivity, ***AUTO TRG: OFF***
Trigger/Sensitivity, ***LEVEL: 0.000 V***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

100 kHz to 100 MHz Sensitivity for HP 53181A

1 **Connect the equipment as shown in Figure 1-13 with the signal generator connected to Channel 1 of the Counter.**

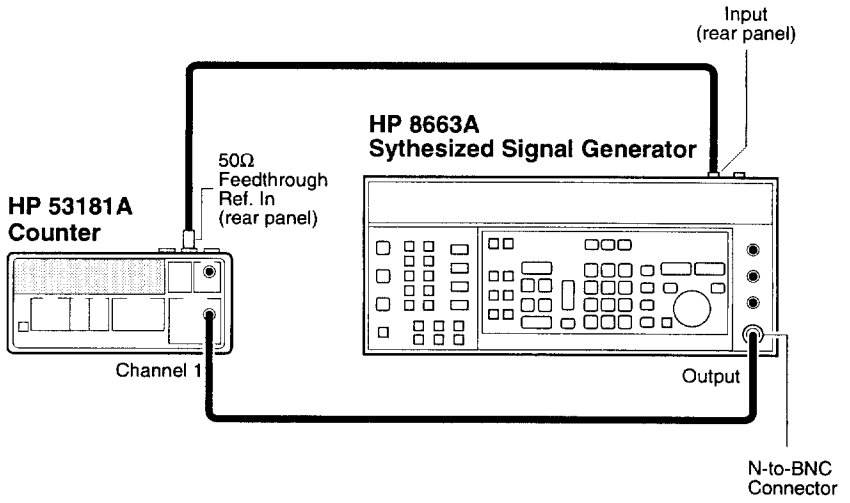


Figure 1-13. Channels 1 Frequency Sensitivity Test Setup

2 **Set the HP 8663A Signal Generator to output a 100 kHz, –35.0 dBm sine wave signal (–20.0 dBm for Option 060) to the Counter's Channel 1 input.**

3 **In 0.1 dB steps, increase the power level until the Counter displays a *stable* reading of 100 kHz.**

The Counter should display 100 kHz when the signal generator level is ≤ –21.0 dBm (20 mVrms). Counters with Option 060 Rear Terminals should display 100 kHz when the signal generator level is ≤ –9.5 dBm (75 mVrms).

4 **Sweep the frequency from 100 kHz to 100 MHz. *For Option 060, sweep frequencies from 100 kHz to 225 MHz.***

The Counter should read frequencies from 100 kHz to 100 MHz at an input power level of ≤ –21.0 dBm (20 mVrms). Option 060 Counters should read frequencies from 100 kHz to 225 MHz at ≤ –9.5 dBm (75 mVrms).

5 **Record the actual reading in the Performance Test Record (Test 2, Line 1).**

If you are testing a Counter with front-panel terminals (Standard), record the reading on Line 1 of the **Standard** portion of the test record.

If you are testing a Counter with rear terminals (Option 060), record the reading on Line 1 of the **Option 060** portion of the test record.

NOTE DO NOT test the front terminals if rear terminals are installed. The front terminal performance is not specified when the rear terminals are installed.

NOTE The remaining sensitivity procedures are NOT required for Counters that contain Option 060 Rear Terminals; thus, this completes the sensitivity portion of the Frequency Performance Test. Go to the Frequency Accuracy Test on page 1-53.

100 MHz to 200 MHz Sensitivity for HP 53181A

1 **Change the signal generator settings to 110 MHz at –30 dBm.**

2 **Increase the power level by 0.1 dB steps until the Counter displays a *stable* 110 MHz reading.**

The Counter should read 200 MHz when the input signal level is ≤ –17.5 dBm (30 mVrms).

3 **Sweep the signal generator frequency from 100 MHz to 200 MHz.**

The Counter should read frequencies from 100 MHz to 200 MHz when the input signal level is ≤ –17.5 dBm (30 mVrms).

4 **Record the actual reading in the Performance Test Record (Test 2, Line 2).**

200 MHz to 225 MHz Sensitivity for HP 53181A

1 **Change the signal generator settings to 200 MHz at -30 dBm.**

2 **Increase the power level by 0.1 dB steps until the Counter displays a *stable* 200 MHz reading.**

The Counter should read 200 MHz when the input signal level is ≤ −15.0 dBm (40 mVrms).

3 **Sweep the signal generator frequency from 200 MHz to 225 MHz.**

The Counter should read frequencies from 200 MHz to 225 MHz when the input signal level is ≤ −15.0 dBm (40 mVrms).

4 **Record the actual reading in the Performance Test Record (Test 2, Line 3).**

5 **Disconnect the test setup.**

Test 3: Channel 1 Frequency Accuracy (HP 53181A Only)

This set of tests verifies the frequency accuracy specifications of the HP 53181A Frequency Counter.

Equipment

HP 8663A Synthesized Signal Generator
HP 8340B Sweep Oscillator
HP 1250-0780 Type N-to-BNC Connector
HP 10100C 50Ω Feedthrough
HP 10503A BNC Cables (2)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Using the *Gate & ExtArm* key, set gate time to *TIME 1.000 s*.**

3 **Set CHANNEL 1 input conditions to:**

Trigger/Sensitivity, ***AUTO TRG: OFF***
Trigger/Sensitivity, ***LEVEL: 0.000 V***
50Ω/1MΩ, 50Ω
DC/AC, DC
X10 Attenuate, Off
100kHz Filter, Off

Procedure

1 **Connect the equipment as shown in Figure 1-14 with the signal generator connected to Channel 1 of the Counter.**

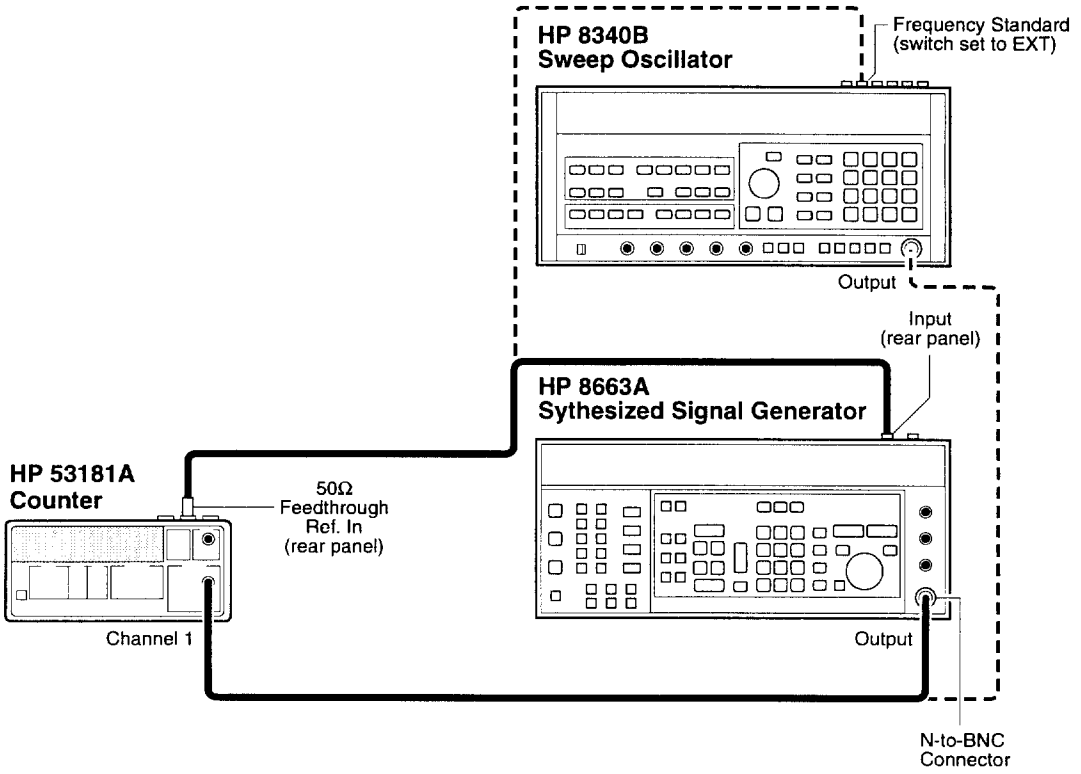


Figure 1-14. Channels 1 Frequency Accuracy Test Setup

2 **Set the HP 8663A Signal Generator to output 1 MHz at –7 dBm.**

3 **On the Counter, press *Run* key.**

Verify the Counter reads 1 MHz ±1 mHz.

4 **Record the actual reading in the Performance Test Record (Test 3, Line 1).**

5 **Change the signal generator frequency to 100 MHz.**

Verify the Counter reads 100 MHz ±30 mHz.

6 **Record the actual reading in the Performance Test Record (Test 3, Line 2).**

7 **Change the signal generator frequency to 200 MHz.**

Verify the Counter reads 200 MHz ±60 mHz.

8 **Record the actual reading in the Performance Test Record (Test 3, Line 3).**

9 **Change the signal generator frequency to 225 MHz.**

Verify the Counter reads 225 MHz ±70 mHz.

10 **Record the actual reading in the Performance Test Record (Test 3, Line 4).**

11 **Disconnect the test setup.**

Test 4: Option 015/030/050 Channel 2 Frequency Sensitivity

This test verifies the frequency range and sensitivity of the optional 1.5-GHz (Option 015), 3-GHz (Option 030), or 5.0 GHz (Option 050) Channel 2 for the HP 53181A Frequency Counter.

Equipment

HP 8663A Synthesized Signal Generator (Not needed for Option 050)
HP 8340B Sweep Oscillator
HP 1250-0780 Type N-to-BNC Connector (Not needed for Option 050)
HP 10503A BNC Cable (2)
HP 10100C 50Ω Feedthrough

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set the Counter as follows:**

Freq & Ratio, *FREQUENCY 2*

100 MHz to 1.5 GHz Sensitivity for Option 015 Only

1 **Set the HP 8663B Synthesized Signal Generator to output a 500 MHz, –60 dBm sine wave and connect the signal to Channel 2 of the Counter as shown in Figure 1-15.**

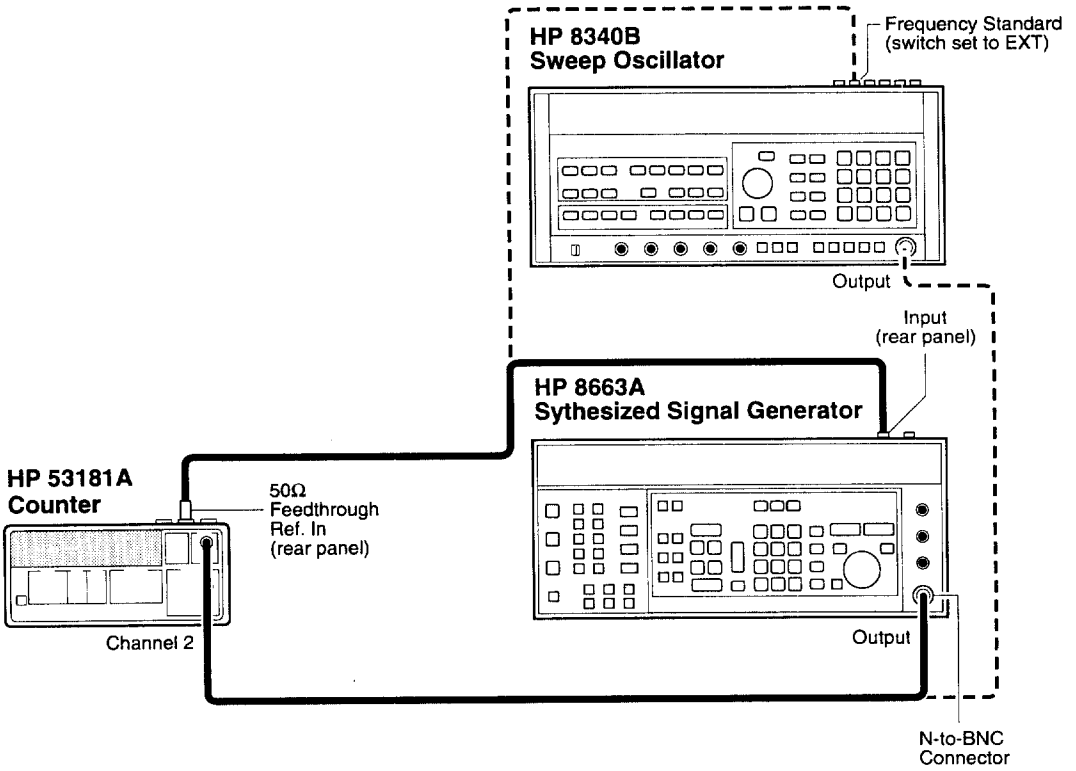


Figure 1-15. Option 015/030/050 Channel 2 Frequency Test

2 **On the Counter, Press *Run* key.**

3 **Increase the power level in 1 dB steps until the Counter reads 500 MHz.**

The Counter should display 500 MHz at ≤ –27.0 dBm (20 mVrms).

4 **Sweep the frequencies from 100 MHz to 1.5 GHz.**

The Counter should read frequencies from 100 MHz to 1.5 GHz at ≤ –27.0dBm (20 mVrms).

5 **Record the actual reading in the Performance Test Record (Test 4, Line 1).**

100 MHz to 2.7 GHz Sensitivity for Option 030 Only

1 **Set the HP 8663B Synthesized Signal Generator to output a 500 MHz, –60 dBm sine wave, and connect the signal to Channel 3 of the Counter as shown in Figure 1-15.**

2 **On the Counter, Press *Run* key.**

3 **Increase the power level in 1 dB steps until the Counter reads 500 MHz.**

The Counter should display 500 MHz at ≤ –27.0 dBm (20 mVrms).

4 **Sweep the frequencies from 100 MHz to 2.7 GHz.**

The Counter should read frequencies from 100 MHz to 2.7 GHz at ≤ –27.0 dBm (20 mVrms).

5 **Record the actual reading in the Performance Test Record (Test 4, Line 2).**

2.8 to 3.0 GHz Sensitivity for Option 030 Only

1 **Disconnect the HP 8663A Synthesized Signal Generator from the Counter (see Figure 1-15), and connect the HP 8340B Sweep Oscillator to Channel 3 of the Counter.**

2 **Change the settings of the Sweep Oscillator to 3.0 GHz, –40 dBm.**

3 **Increase the power level in 1 dB steps until the Counter displays 3.0 GHz.**

The Counter should display 3.0 GHz at ≤ –21.0 dBm.

4 **Sweep the frequencies from 3.0 GHz to 2.8 GHz.**

The Counter should read frequencies from 3.0 to 2.8 GHz at ≤ –21.0 dBm.

5 **Record the actual reading in the Performance Test Record (Test 4, Line 3).**

6 **Disconnect the test setup.**

150 MHz to 5.0 GHz Sensitivity for Option 050 only

1 **Connect the 8340B Sweep Oscillator to Channel 2 of the counter.**

2 **Change the settings of the Sweep Oscillator to 5.0 GHz, -30 dBm.**

3 **Increase the power level in 1 dB steps until the Counter displays a *stable* reading of approximately 5.0 GHz.**

The Counter should display 5.0 GHz at ≤ -23 dBm.

NOTE Use a power meter and sensor to ensure the accuracy of the power being input.

4 **Sweep the frequencies from 150 MHz to 5.0 GHz.**

The Counter should read frequencies from 150 MHz to 5.0 GHz at ≤ -23 dBm.

5 **Record the actual reading in the Performance Test Record (Test 4, Line 4).**

6 **Disconnect the test setup.**

Test 5: Option 015/030/050 Channel 2 Frequency Accuracy (HP 53181A Only)

This test verifies the frequency accuracy of the optional 1.5-GHz (Option 015) or 3-GHz (Option 030) or 5.0 GHz (Option 050)Channel 2 for the HP 53181A Frequency Counter.

The tests are organized as follows:

100 MHz to 1.5 GHz Accuracy Test for Option 015

Equipment

HP 8663A Synthesized Signal Generator
HP 8340B Sweep Oscillator
HP 1250-0780 Type N-to-BNC Connector
HP 10503A BNC Cable (2)
HP 10100C 50Ω Feedthrough
HP 11500D N-N Cable (Option 050 only)
HP 1250-1250 N(M) to SMA(F)
HP 1250-0777 N(F) to N(F)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set the Counter as follows:**
MEASURE/Freq & Ratio, *FREQUENCY 2*
Gate & ExtArm, *TIME: TIME 1.000 s*

Procedure

1 **Connect equipment as shown in Figure 1-16.**

Test 5: Option 015/030/050 Channel 2 Frequency Accuracy (HP 53181A Only)

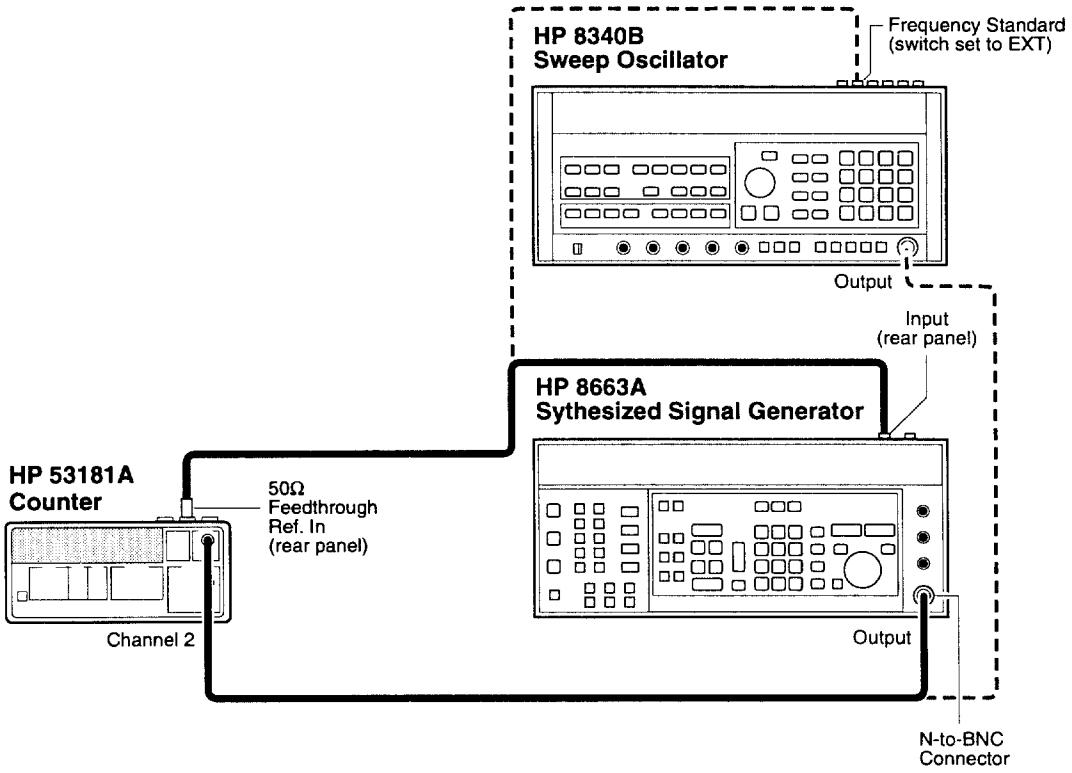


Figure 1-16. Option 015/030/050 Channel 2 Frequency Accuracy Test Setup

2 **Set the HP 8663A Synthesized Signal Generator to output 100 MHz at –17.0 dBm.**

Verify the Counter reads 100 MHz ±30 mHz.

3 **Record the actual reading in the Performance Test Record (Test 5, Line 1).**

4 **Change the synthesized signal generator's frequency to 1.5 GHz.**

Verify the Counter reads 1.5 GHz ±0.500 Hz

5 **Record the actual reading in the Performance Test (Test 5, Line 2).**

6 **Disconnect the test setup.**

100 MHz to 3.0 GHz Accuracy Test for Option 030/050

Equipment

HP 8663A Synthesized Signal Generator (not needed for Option 050)
HP 8340B Sweep Oscillator
HP 1250-0780 Type N-to-BNC Connector (not needed for Option 050)
HP 10503A BNC Cable (2)
HP 10100C 50Ω Feedthrough
HP 11500D N-N Cable (Option 050 only)
HP 1250-1250 N(M) to SMA(F)
HP 1250-0777 N(F) to N(F)

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Set the Counter as follows:**
MEASURE/Freq & Ratio, *FREQUENCY 2*
Gate & ExtArm, *TIME: TIME 1.000 s*

Procedure

1 **Connect equipment as shown in Figure 1-16.**

(NOTE: For Option 050, skip steps 2 through 8. Proceed to step 9.)

2 **Set the HP 8663A Synthesized Signal Generator to output 100 MHz at –17.0 dBm.**

3 **On the Counter, press *Run* key.**

Verify the HP 53181A Counter reads 100 MHz ±30 mHz.

4 **Record the actual reading in the Performance Test Record (Test 5, Line 1).**

5 **Disconnect the HP 8663A output from Channel 2 of the Counter, and connect the HP 8340B Sweep Oscillator output to Channel 2 of the Counter as shown in Figure 1-16.**

6 **Set the HP 8340B to output 3.0 GHz at –17.0 dBm.**

Verify the HP 53181A Counter reads 3.0 GHz ±1 Hz.

7 **Record the actual reading in the Performance Test Record. (Test 5, Line 4).**

8 **Disconnect the test setup.**

9 **Set the HP 8340B to output 5.0 GHz at -17 dBm.**

Verify the HP 53181A Counter reads 5.0 GHz ±3 Hz.

10. **Record the actual reading in the Performance Test Record (Test 5 Line 5 for HP 53131A or Test 6, Line 6 for HP 53132A).**

Test 6: Peak Volts, Channel 1 (HP 53181A Only)

This test verifies the Peak Volts accuracy specification of the HP 53181A Frequency Counter.

Equipment

HP 3325B Synthesizer
HP 10100C 50Ω Feedthrough
HP 10503A BNC Cable

Counter Setup

1 **Cycle the *POWER* key to preset the Counter.**

2 **Press *Other Meas* key until *VOLT PEAKS 1* is displayed.**

3 **Set CHANNEL 1 and CHANNEL 2 inputs to:**
50Ω/1MΩ, 50Ω
X10 Attenuate, Off
100kHz Filter, Off

Procedure

1 **Connect the equipment as shown in Figure 1-17.**

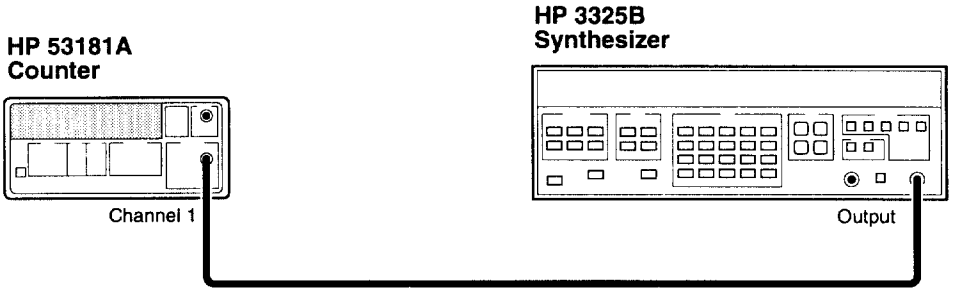


Figure 1-17. Peak Volts Test Setup

2 **Set the HP 3325B to output a 2 MHz, 2 Vp-p sine wave, and connect the signal to Channel 1 of the Counter.**

The Counter should display –1.00 ±0.12V for the *negative peak* of the sine wave. This reading is displayed on the left side of the display.

Record the actual readings in the Performance Test Record (Test 6, Line a).

Also, the Counter should display +1.00 ±0.12V for the *positive peak* of the sine wave. This reading is displayed on the right side of the display.

Record the actual readings in the Performance Test Record (Test 6, Line b).

3 **Disconnect the test setup.**

HP 53181A HP-IB Verification Program (Optional)

The HP-IB Verification program exercises the HP 53181A through various operating modes via the its HP-IB interface. If the Counter successfully completes all phases of the verification program, there is a high probability that the HP-IB interface is operating correctly. If the Counter fails the verification program, refer to the troubleshooting section in Chapter 2, "Service," of this guide.

The HP-IB Verification program may be loaded into the HP 9000 series 200 or 300 Desktop Computer from the 3 1/2-inch disk (HP P/N 53181-13501) or the 5 1/4-inch disk (HP P/N 53181-13501).

1 **To run the program on the disk, insert the disk into the Desktop Computer, load the program by typing *Load "VER81"*, and press RUN key on the computer's keyboard.**

2 **Follow the instructions displayed in the computer's screen.**

3 **After running this program, record the result (Pass or Fail) on the last page (page 1-70) of the HP 53181A Performance Test Record.**

HP 53181A Performance Test Record (Page 1 of 4)

Hewlett-Packard Model 53181A Frequency Counter

Serial Number: _____ Repair/Work Order No. _____

Test Performed By: _____ Temperature: _____

Date: _____ Relative Humidity: _____

Notes: _____

Test Number	Operational Verification	Test Results Pass	Fail
1	Power on Self Test	❑	❑
2	Channel 1, 10 MHz Test	❑	❑
3	Run Self Test	❑	❑
4a	Termination Check Ch 1, 50Ω	❑	❑
4b	Termination Check Ch 1, 1MΩ	❑	❑
5a	1 MHz External Timebase Input Test	❑	❑
5b	5 MHz External Timebase Input Test	❑	❑
5c	10 MHz External Timebase Input Test	❑	❑

HP 53181A Performance Test Record (Page 2 of 4)

Complete Performance Tests				
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
1	**Trigger Level:**			
	Channel 1	−15 mV	1. _____	+15 mV
		−15 mV	2. _____	+15 mV

Test 2: Channel 1 Frequency Sensitivity (HP 53181A Only)		
Standard (Front Panel Terminals)	**Actual Reading**	**Specification**
100 kHz - 100 MHz, Channel 1	1. _____	≤ −21 dBm (20 mVrms)
100 MHz - 200 MHz, Channel 1	2. _____	≤ −17.5 dBm (30 mVrms)
200 MHz - 225 MHz, Channel 1	3. _____	≤ −15.0 dBm (40 mVrms)
Option 060 Rear Terminals	**Actual Reading**	**Specification**
100 kHz-225 MHz, Channel 1	1._____	≤ −9.5 dBm (75 mVrms)

Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
3	**Channel 1 Frequency Accuracy** (HP 53181A Only)			
	1 MHz Test	999,999.999 Hz	1. _____	1, 000, 000.001 Hz
	100 MHz Test	99.999,999,97 MHz	2. _____	100.000, 000,03 MHz
	200 MHz Test	199.999,999,94 MHz	3. _____	200.000,000,06 MHz
	225 MHz Test	224.999,999,93 MHz	4. _____	225.000,000,07 MHz

HP 53181A Performance Test Record (Page 3 of 4)

Complete Performance Tests				
Test 4: Option 015/030/050 Channel 2 Frequency Sensitivity (HP 53181A Only)				
		Actual Reading	**Specification**	
100 MHz - 1.5 GHz (Option 015 Only)		1. _____	≤ -27 dBm	
100 MHz - 2.7 GHz (Option 030 Only)		2. _____	≤ -27 dBm	
2.8 - 3.0 GHz (Option 030 Only)		3. _____	≤ -21 dBm	
150 - 5.0 GHz (Option 050 Only)		4. _____	≤ -23 dBm	
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
5	**Option 015/030 Channel 2 Frequency Accuracy** (HP 53181A Only)			
	100 MHz to 1.5 GHz Test for Option 015 (HP 53181A):			
	Channel 2	99.999,999,97 MHz	1. _____	100.000,000,03 MHz
	Channel 2	1, 499.999,999,5 MHz	2. _____	1,500.000,000,5 MHz
5	**100 MHz to 3.0 GHz Test for Option 030 (HP 53181A):**			
	Channel 2	99.999,999,97 MHz	3. _____	100.000,000,03 MHz
	Channel 2	2,999.999,999,0 MHz	4. _____	3, 000.000,001,0 MHz
5	**150 MHz to 5.0 GHz Test for Option 050:**	4,999.999,998.0 MHz	5. _____	5,000.000,001,0 MHz

HP 53181A Performance Test Record (Page 4 of 4)

Complete Performance Tests				
Test Number	**Test Description**	**Minimum**	**Actual Reading**	**Maximum**
6	**Peak Volts, Channel 1** (HP 53181A Only):			
	Channel 1	−1.12 V +0.88 V	a._____ b._____	−0.88 V +1.12V
HP-IB Verification (Optional)			**Test Results** **Pass**	**Fail**
			❑	❑

2

Service

Introduction

This chapter provides service information for your HP 53131A/132A/181A and is divided into seven major sections:

- **Returning the Instrument to Hewlett-Packard for Service** (pg. 2-3). This section provides you with step-by-step instructions on how to return the instrument for service.
- **About the HP 53131A/132A Calibration Menu** (pg. 2-5). This section contains reference information that gives a complete overview of the calibration menu of the HP 53131A/132A.
- **The HP 53131A/132A Calibration Procedures** (pg. 2-13). This section provides step-by-step procedures for calibrating the HP 53131A/132A.
- **About the HP 53181A Calibration Menu** (pg. 2-23). This section contains reference information that gives a complete overview of the calibration menu of the HP 53181A.
- **The HP 53181A Calibration Procedures** (pg. 2-30). This section provides step-by-step procedures for calibrating the HP 53181A.
- **Pre-Troubleshooting Information** (pg. 2-35). This section provides you with pertinent information such as safety considerations, recommended test equipment, repair and after-service considerations, and assembly identification and location.
- **Troubleshooting the Counter** (pg. 2-44). This section provides you with troubleshooting procedures that isolate the faulty assembly or module.

If the instrument is under warranty, return the instrument to Hewlett-Packard for service. Refer to the first section of this chapter titled "Returning the Instrument to Hewlett-Packard." If you decide to troubleshoot the instrument yourself, refer to the section titled "Troubleshooting the Counter."

Returning the Instrument to Hewlett-Packard for Service

To Provide Repair Information

If you are shipping the instrument to an HP office for service or repair, call your nearest Hewlett-Packard Sales Office to make arrangements. Then tag and package the HP 53131A/132A/181A for shipment.

Note there is an Express Repair / Performance Calibration Service for USA customers if downtime is critical. You can receive your repaired Counter via overnight shipment. Just call 303-649-5512 and ask for Express Repair / Performance Calibration Service. When your Counter is repaired, it will be returned via overnight shipment at no extra charge.

1 **Write the following information on a tag:**

- Owner's name and address
- Instrument model number
- Complete serial number
- Description of service required or failure indications

2 **Attach the tag to the instrument.**

3 **Pack the instrument.**

If you have the original packaging materials, refer to the following section titled "To Pack in Original Package Materials." If the original packaging material are not available, you can order new materials through an HP Sales Office. The new materials are identical to those used by the factory when packaging the instrument. If you want to use commercially available materials, refer to the section titled "To Pack in Commercially Available Materials."

To Pack in the Original Packaging Materials

Whenever possible, repack the instrument in its original packaging for shipment. In any correspondence, refer to the instrument by the model number and complete serial number.

1 **Disconnect the power cord, probes, cables, or other accessories attached to the instrument.**

2 **Make sure the folded corrugated spacer (which normally contains the manuals) is in the box to ensure proper fitting.**

3 **Make sure one of the polystyrene block is in its proper position in the box.**

4 **Place the instrument, front panel end first, on the polystyrene block.**

5 **Place the other polystyrene block on top of the rear end of the instrument to secure it.**

6 **Do not return the manuals with the instrument. Return an accessory only when it is a part of the failure symptoms.**

7 **Seal the shipping container securely.**

To Pack in the Commercially Available Materials

If the factory packaging materials are not available, you can use commercially available materials for shipping.

1 **Wrap the instrument in heavy paper or plastic.**

2 **Place the instrument in a strong shipping container.**

A double-wall carton made of 350-lb. test material is adequate.

3 **Protect the control panel with cardboard.**

4 **Add a layer of shock-absorbing material.**

The shock-absorbing material should be 70 to 100 mm (3 to 4 inches) thick around all sides of the instrument to prevent movement inside the container.

5 **Seal the shipping container securely.**

6 **Mark the shipping container FRAGILE.**

About the HP 53131A/132A Calibration Menu

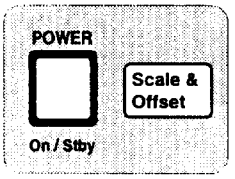
NOTE

If you are familiar with the information provided in this section, proceed to the section titled "The HP 53131A/132A Calibration Procedures" (page **2-13**) to calibrate your Counter. This section, "About the HP 53131A/132A Calibration Menu," can be used as a reference.

NOTE

With the exception of the standard timebase oscillator, no adjustments are required for the HP 53131A/132A Counter.

Overview of the HP 53131A/132A Calibration Menu



The Calibration menu is accessed by holding the **Scale & Offset** key and cycling the **POWER** key. All of the calibration factors and security settings are stored in *non-volatile* memory, and *do not* change when power has been off or after a remote interface reset.

A calibration security code feature allows you to enter a security code (electronic key) to prevent accidental or unauthorized calibrations of the Counter. The security code is set to 53131 or 53132 (corresponding to the model) when the Counter is shipped from the factory. If you forget your security code, you can reset the security code to the model-number default by resetting all of the non-volatile memory to a default state.

NOTE

This menu does not exist in early versions of the Counter. In the early versions (firmware revisions 3317, 3335, and 3402) of the HP 53131A/132A, the CAL: menu item resides in the Utility menu, and there is no calibration security capability. See Chapter 6, "Backdating," in this guide for the correct calibration procedures.

The Calibration menu, illustrated on page 2-7, allows you to:

- view the calibration security status of the Counter (**CAL SECURE** or **CAL UNSECURE**)

- initiate the Counter's calibration routines, which can perform automatic calibration of the voltage offset and gain of the front-end input amplifiers (**CAL: OFFS 1 / 2 ?, GAIN 1 / 2?**), of the optional timebase (**CAL: TIMEBAS?**), and of the differences in electrical path-length between channels 1 and 2 (**CAL: TI QUIK?** and **CAL: TI FINE?**)
- secure against calibration by entering the security code while the Counter is unsecured (**CODE:**)
- unsecure for calibration by entering the security code while the Counter is secured (**CODE:**)
- change the security code by entering a new code while the Counter is unsecured (**CODE:**)
- view the calibration count, which indicates the number of times that the Counter has been calibrated (**CAL COUNT?**). The calibration count increments up to a maximum of 32,767 after which it wraps around to 1. A calibration count of 0 indicates that the Counter is completely uncalibrated. (The calibration count is unaffected by interpolator calibration.)
- get Help (**HELP:**) with any of the following:
  - how to calibrate (**CAL?**),
  - how to secure (**SECURE?**), and
  - how to change the code (**CODE?**)

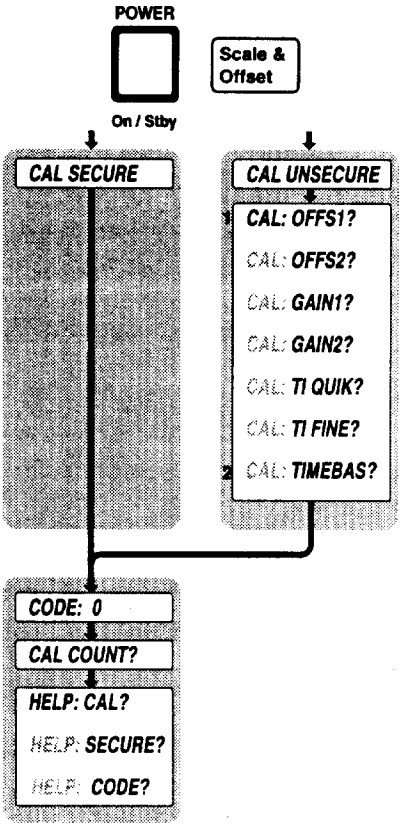
NOTE

A good precaution is to use an HP-IB program (see the programming example titled "To Read and Store Calibration Data" in Chapter 3 of the Programming Guide) to read and store the calibration factors prior to initiating any calibration.

The HP 53131A/132A Calibration Menu Tree

NOTE

Turn power off, press and hold **Scale & Offset** key, then press **POWER** key to access this menu. **This menu does not exist in early versions (firmware revisions 3317, 3335, and 3402) of the HP 53131A/132A. In the early versions of the Counter, the CAL: menu item resides in the Utility menu, and there is no calibration security capability. See Chapter 6, "Backdating," in this guide for correct calibration procedures.**



[1]This menu item appears and calibration is permitted only if calibration is unsecure. Enter in the correct code to change calibration to secure; refer to the section titled "Using the Calibration Menu" in Chapter 2 in this guide for more information.

[2]Timebase can be automatically calibrated only if the timebase option is installed.

To View the Calibration Menu and Security Status

The Calibration menu is accessed by holding the Scale & Offset key and cycling the POWER key. The first item in the Calibration menu is a message indicating the calibration security status: ***CAL SECURE*** or ***CAL UNSECURE***.

To Unsecure for Calibration

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

CAL SECURE is displayed.

If ***CAL UNSECURE*** is displayed, then the Counter is already unsecured for calibration, and the remaining steps are not applicable.

2 **Press *Scale & Offset* key until *CODE:* is displayed.**

3 **Press the appropriate arrow keys to enter the security code *"53131"*, for example, if 53131 was the security code set at the factory.**

4 **Press *Enter* key.**

CAL UNSECURE is displayed.

NOTE

If "53131" was NOT the correct security code, the Counter would have displayed ***BAD CODE***.

To Initiate the Calibration Routines

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Unsecure for calibration by performing the preceding procedure.**

3 **Press *Scale & Offset* key until *CAL: OFFS1?* is displayed.**

4 **Press any one of the arrow keys until your calibration choice (that is, *CAL: OFFS2?*, *CAL: GAIN 1?*, *CAL: GAIN 2?*, *CAL: TI QUIK?*, *CAL: TI FINE?*, or *CAL: TIMEBAS?*) is displayed.**

Note that the timebase choice (CAL: TIMEBAS?) only appears when the Timebase Option is installed.

5 **Press *Enter* key**

A scrolling message is displayed.

6 **Follow the instructions in the scrolling message, and press *Enter* key to start the calibration.**

The Counter momentarily displays ***CALIBRATING***, and then displays the calibration test name and pass/fail status (for example, ***OFFS 1 PASS***).

When the calibration completes, a pass/fail message will be displayed. If the calibration failed, then the calibration factors remain unchanged.

INFORMATION ABOUT CAL:TI QUIK? AND CAL:TI FINE?.
CAL:TI QUIK? and CAL:TI FINE? are two different ways to calibrate out the differences in electrical path length between Channel 1 and Channel 2. When you provide the calibration signal, the instrument measures how the difference in path length translates to an average delay between the two channels.

The Quick Time Interval Calibration requires a simple input signal. You provide on Channel 1 a clean square wave with a rapid rise time and an approximate frequency of 10 MHz. The instrument routes the calibration signal in COMMON to both channels 1 and 2, and measures the average delay between the two channels so configured. The advantage of the Quick Calibration is that it is easy, quick, and requires little special equipment. The disadvantage is that the calibration term is best fit for TI measurements configured COMMON and measured from rising to rising edge; it leaves uncorrected a small systematic error for all other configurations. The Fine Time Interval Calibration minimizes systematic error by calibrating the instrument in each configuration.

The Fine Time Interval Calibration requires a special calibrator signal source to provide input — because it produces eight calibration terms, each tailored to a different combination of input conditions. It requires the synthesizer driving the calibrator to produce a very accurate 10 MHz waveform — because it calibrates the pulse width configuration against the 50-nanosecond pulse width so provided. It minimizes systematic error by calibrating the instrument in each of the eight configurations: falling to falling edges, falling to rising edges, etc., and both SEPARATE and COMMON routing.

Notes Pertaining to CAL: TI QUIK?

Advantage: Calibration signal is simple.

Disadvantage: One correction term for all slope and routing configurations.

Input signal: clean square wave, fast rise time, approximately 10 MHz, 1 volt peak-to-peak, no dc offset (oscillating about 0.0 volts), driving 50Ω.

Timebase: Any external timebase you provide is ignored during calibration.

Procedure: From the front-panel calibration menu, one keypress invokes the calibration.

Notes Pertaining to CAL: TI FINE?

Advantage: Calibration minimizes systematic error for any supported combination of input slope and routing.

Disadvantage: Calibration signal is more complex. *If you perform a calibration that you feel is erroneous and do not feel you can perform the fine calibration, perform the CAL: TI QUIK? calibration instead, or restore the calibration factors that you saved prior to starting.*

Equipment: HP 8130A Pulse Generator or equivalent.
HP 59992A J06 Time Interval Calibrator or equivalent.

Equipment and Counter Setup: See Figure 2-1.

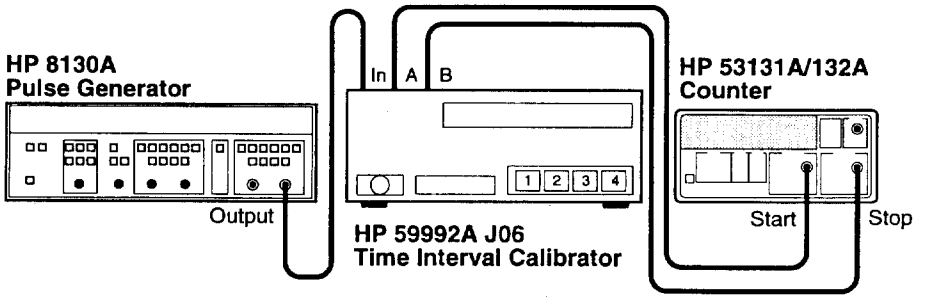


Figure 2-1. Calibration Setup for CAL: TI FINE?

Out of HP 8130A, into HP 59992A J06 Calibrator Signal:

PERIOD: 100 ns
WIDTH: 50 ns
High: 0.50 V Low: –0.50 V
Input Mode: Normal

Timebase: Any external timebase you provide is ignored during calibration.

Procedure: From the front-panel calibration menu, one keypress invokes the calibration. You are prompted to press buttons on the HP 59992A J06 Calibrator for each part of a four-part calibration.

Note that CAL: TI FINE? requires the completion of four steps in order.

To Secure Against Calibration

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

CAL UNSECURE is displayed. If ***CAL SECURE*** is displayed, then the Counter is already secured against calibration and the remaining steps are not applicable.

2 **Press *Scale & Offset* key until *CODE:* is displayed.**

3 **Press the appropriate arrow keys to enter the security code, then press *Enter* key.**

CAL SECURE is displayed.

To Change to a New Security Code

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Unsecure for calibration by the using the procedure described in the section titled "To Unsecure for Calibration."**

3 **Press *Scale & Offset* key until *CODE:* is displayed.**

4 **Press the appropriate arrow keys to enter the new or customized security code, then press *Enter* key.**

A scrolling message will appear, indicating what the new code is. For example, the Counter displays the ***NEW CODE IS 5*** if you entered "5" as the new code.

To View the Calibration Count

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Press *Scale & Offset* key until *CAL COUNT?* is displayed.**

3 **Press any one of the entry keys (arrow, +/-, *Enter*) to have a scrolling message appear, indicating what the calibration count is.**

Your Counter was calibrated before it left the factory. When you receive your Counter, read the calibration count to determine its initial value.

To Get Help with the Calibration Menu

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Press *Scale & Offset* key until *HELP: CAL?* is displayed.**

3 **Press any one of the arrow keys until your help choice (that is, *HELP: CAL?*, *HELP: SECURE?*, *HELP: CODE?*) is displayed.**

4 **Press *Enter* key to display the help information.**

The HP 53131A/132A Calibration Procedures

First Determine the Counter Firmware Revision

Press and hold *Recall (Utility)* key, then cycle *POWER* key.

REV: n is displayed; where "n" represents the numeric firmware revision code.

If **3317, 3335, or 3402** is displayed as the firmware revision code, **then perform the calibration procedures in Chapter 6, "Backdating."**

If the Counter's firmware revision code is different from the ones in the previous paragraph, then perform the following procedures in this section.

NOTE

After completing the instrument calibration, BE SURE to secure the calibration by performing the procedure in the section titled "To Secure Against Calibration" on page 2-11 of this chapter.

To Calibrate the Offset for Channels 1 and 2

1 **To access the Calibration menu, power down, and press and hold the *Scale & Offset* key, then press *POWER* key.**

The first item in the Calibration menu is a message indicating the calibration security status: ***CAL SECURE*** or ***CAL UNSECURE***.

The Counter calibration must be unsecured to perform calibration. If ***CAL UNSECURE*** is displayed, the Counter is already unsecured for calibration; go to step 5. However, if ***CAL SECURE*** is displayed then perform steps 2 through 4 to unsecure calibration.

2 **Press *Scale & Offset* key until *CODE: 0* is displayed.**

3 **Press the appropriate arrow keys to enter the security code *"53131"*, for example, if 53131 is the security code by performing the following steps:**

a. Press ▲ key four times.

The Counter should display ***CODE: 00000***.

b. Press ▲ key five times.

The Counter should display ***CODE: 50000***.

c. Press ▶ key once, and then press ▲ key three times.

The Counter should display ***CODE: 53000***.

d. Press ▶ key once, and then press ▲ key once.

The Counter should display ***CODE: 53100***.

e. Press ▶ key once, and then press ▲ key three times.

The Counter should display ***CODE: 53130***.

f. Press ▶ key once, and then press ▲ key once.

The Counter should display ***CODE: 53131***.

g. Finally, press *Enter* key.

CAL UNSECURE is displayed.

NOTE

If "53131" is NOT the correct security code, the Counter will display ***BAD CODE***.

4 Press *Scale & Offset* key until *CAL: OFFS 1 ?* is displayed.

5 Press *Enter* key.

A scrolling message on the display will ask you to remove any signals connected to Channel 1. Follow the instruction.

6 Press *Enter* key.

The Counter momentarily displays ***CALIBRATING***, and then it should display ***OFFS 1 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

7 **To calibrate Channel 2, press any one of the arrow keys until *CAL: OFFS 2 ?* is displayed.**

8 **Press *Enter* key.**

A scrolling message on the display will ask you to remove any signals connected to Channel 2. Follow the instruction.

9 **Press *Enter* key.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***OFFS 2 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

This completes the Offset Calibration procedure. Proceed to the next procedure to calibrate the gain.

To Calibrate the Gain for Channels 1 and 2

1 **Press any one of the arrow keys until *CAL: GAIN 1 ?* is displayed.**

2 **Press *Enter* key.**

A scrolling message is displayed. Follow the instruction by performing the following steps.

3 **Connect a BNC tee connector to Channel 1 of the Counter.**

4 **Connect the Counter, dc power supply, and digital multimeter as shown in Figure 2-2.**

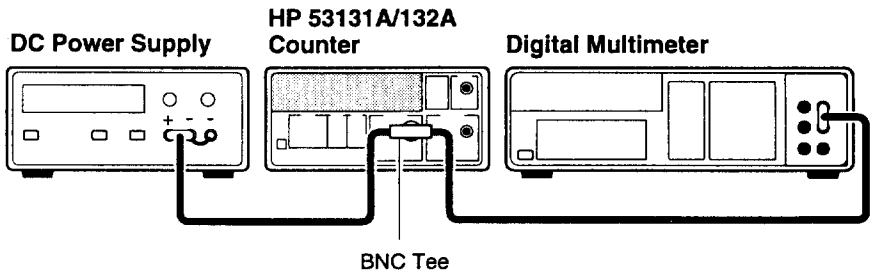


Figure 2-2. Gain Calibration Setup

5 **Adjust the power supply until the digital multimeter displays + 5.000 V ± 0.001 V.**

6 **Disconnect the digital multimeter from the Counter to prevent noise from being introduced into the measurement.**

7 **Press *Enter* key.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***GAIN 1 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

8 **To calibrate the gain for Channel 2, connect the input or the BNC Tee to Channel 2 of the Counter.**

9 **Press any one of the arrow keys until *CAL: GAIN 2 ?* is displayed.**

10 **Press *Enter* key.**

A scrolling message is displayed. (The +5V dc supply should already be connected to Channel 2 as you were previously instructed to do this in step 8.)

11 **Press *Enter* key again.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***GAIN 2 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

12 Disconnect the calibration setup.

This completes the Gain Calibration procedure. Proceed to the next procedure to calibrate the time interval.

To Calibrate Time Interval

Refer to the section titled "**INFORMATION ABOUT CAL:TI QUIK? AND CAL:TI FINE?**" (pages 2-9 and 2-10) for details on the differences between the two time interval calibrations.

CAL: TI QUIK? Calibration

1 Press any one of the arrow keys until *CAL: TI QUIK?* is displayed.

2 Press *Enter* key.

A scrolling message with instructions appears. Follow the instruction by performing the following procedure

3 Connect the HP 8130A Pulse Generator output to Channel 1 of the Counter as shown in Figure 2-3.

Equipment

HP 8130A Pulse Generator (or equivalent)
HP 10503A BNC Cable

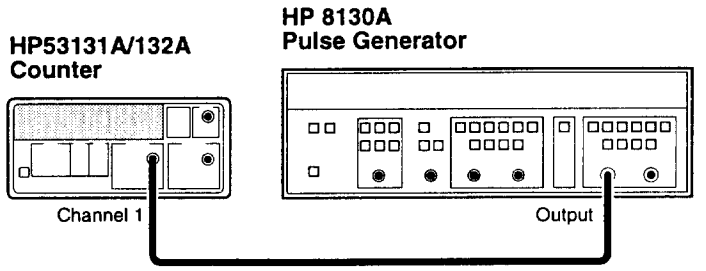


Figure 2-3. Calibration Setup for CAL: TI QUIK?

4 **Set the HP 8130A as follows:**

PERIOD: 100 ns
WIDTH: 50 ns
High: 0.50 V Low : –0.50 V
Input Mode: Normal

NOTE Any external timebase connected to the Counter is ignored during this calibration.

5 **Press *Enter* key.**

The Counter displays ***CALIBRATING***, and then it should display ***TI CAL PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

6 Disconnect the calibration setup.

This completes the TI QUIK? calibration procedures.

Depending on which timebase the Counter contains, proceed to the procedure "To Calibrate the Standard Timebase" (page 2-21) or the "To Calibrate the High Stability Timebase Option (Medium, High, or Ultra-High)" procedure (page 2-21) to calibrate the timebase.

CAL: TI FINE? Calibration

1 Connect the HP 8130A Pulse Generator, HP 59992A J06 Time Interval Calibrator, and HP 53131A/123A Counter as shown in Figure 2-4.

Equipment

HP 8130A Pulse Generator (or equivalent)
HP 59992A J06 Time Interval Calibrator (or equivalent)
HP 10503A BNC Cable (3)

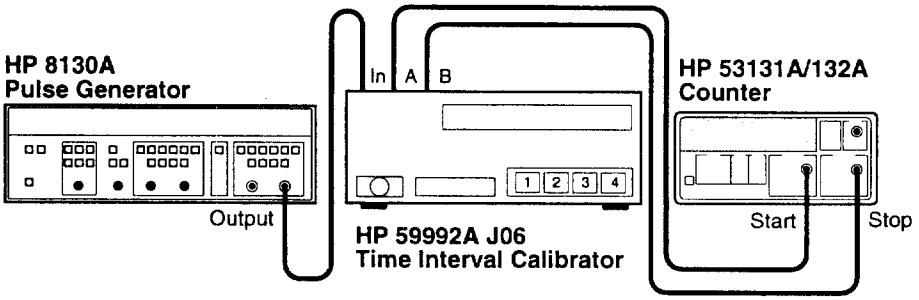


Figure 2-4. Calibration Setup for CAL: TI FINE?

2 Set the HP 8130A as follows:

PERIOD: 100 ns
WIDTH: 50 ns
High: 0.50 V Low : –0.50 V
Input Mode: Normal

NOTE

Any external timebase connected to the Counter is ignored during this calibration.

3 **Press any one of the arrow keys until *CAL: TI FINE?* is displayed.**

4 **Press *Enter* key.**

A scrolling message with instructions appears. Follow the instruction by performing the following procedure

Note the Counter display message prompts you to press buttons on the HP 59992A J06 Calibrator for each part of a four-part calibration.

Note that CAL: TI FINE? requires the completion of four steps in the proper order.

5 **Press *Enter* key after each displayed instruction.**

The Counter should display ***CALIBRATING***, and then it should display ***TI CAL PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

This completes the TI FINE? calibration procedures

Depending on which timebase the Counter contains, proceed to the following procedure "To Calibrate the Standard Timebase" or the "To Calibrate the High Stability Timebase Option (Medium, High, or Ultra-High)" procedure (page 2-21) to calibrate the timebase.

To Calibrate the Standard Timebase

1 **Connect the output of a 10 MHz house standard to Channel 1 of the Counter as shown in Figure 2-5.**

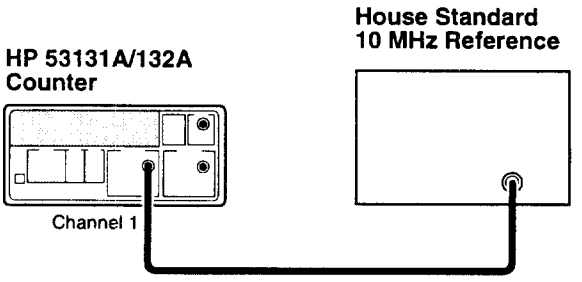


Figure 2-5. Standard Timebase Calibration Setup

2 **Cycle the *POWER* key to preset the Counter.**

3 **With an insulated tuning tool, turn the *OSC Adjust* potentiometer (located on the rear chassis of the Counter) until the frequency reading in the Counter display is 10.00000000 MHz ± 5 Hz.**

The Counter will be calibrated to the house standard.

If you are not able to adjust the frequency correctly, refer to the troubleshooting section in this chapter.

This completes the Standard Timebase Calibration procedure.

To Calibrate the High Stability Timebase Option (Medium, High, or Ultra-High)

NOTE

Allow the Counter to warm up for approximately 30 minutes before performing this calibration. This calibration is unlikely to fail, unless the Counter is not warmed up.

1 **Connect the output of a 10 MHz house standard to Channel 1 of the Counter as shown in Figure 2-5.**

2 **Press any one of the arrow keys until *CAL: TIMEBAS?* is displayed.**

Note that the timebase choice (CAL: TIMEBAS?) only appears when the Timebase Option is installed.

3 **Press *Enter* key and follow the instructions in the scrolling message that appears in the Counter display.**

4 **Press *Enter* key after each instruction.**

The Counter displays ***CALIBRATING***, and then it should display ***TB CAL PASS***.

If the fail message is displayed (even after the Counter has been warmed up for 30 minutes), refer to the troubleshooting section in this chapter.

This completes the High Stability Timebase Option Calibration procedure.

If all tests passed, the Counter is now calibrated.

About the HP 53181A Calibration Menu

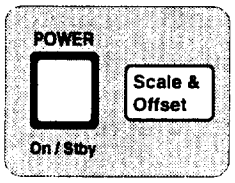
NOTE

If you are familiar with the information provided in this section, proceed to the section titled "The HP 53181A Calibration Procedures" (page **2-30**) to calibrate your Counter. This section, "About the HP 53181A Calibration Menu," can be used as a reference.

NOTE

With the exception of the standard timebase oscillator, no adjustments are required for the HP 53181A Counter.

Overview of the HP 53181A Calibration Menu



The Calibration menu is accessed by holding the **Scale & Offset** key and cycling the **POWER** key. All of the calibration factors and security settings are stored in *non-volatile* memory, and *do not* change when power has been off or after a remote interface reset.

A calibration security code feature allows you to enter a security code (electronic key) to prevent accidental or unauthorized calibrations of the Counter. The security code is set to 53181 when the Counter is shipped from the factory. If you forget your security code, you can reset the security code to the model-number default by resetting all of the non-volatile memory to a default state.

The Calibration menu, illustrated on page 2-25, allows you to:

- view the calibration security status of the Counter (**CAL SECURE** or **CAL UNSECURE**)
- initiate the Counter's calibration routines, which can perform automatic calibration of the voltage offset and gain of the front-end input amplifiers (**CAL: OFFS 1?**, **GAIN 1?**), of the optional timebase (**CAL: TIMEBAS?**)
- secure against calibration by entering the security code while the Counter is unsecured (**CODE:**)
- unsecure for calibration by entering the security code while the Counter is secured (**CODE:**)

- change the security code by entering a new code while the Counter is unsecured (**CODE:**)
- view the calibration count, which indicates the number of times that the Counter has been calibrated (**CAL COUNT?**). The calibration count increments up to a maximum of 32,767 after which it wraps around to 1. A calibration count of 0 indicates that the Counter is completely uncalibrated. (The calibration count is unaffected by interpolator calibration.)
- get Help (**HELP:**) with any of the following:
  - how to calibrate (**CAL?**),
  - how to secure (**SECURE?**), and
  - how to change the code (**CODE?**)

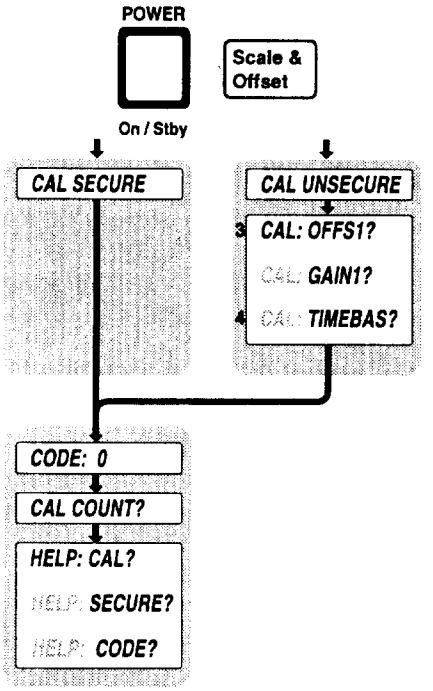
NOTE

A good precaution is to use an HP-IB program (see the programming example titled "To Read and Store Calibration Data" in Chapter 3 of the Programming Guide) to read and store the calibration factors prior to initiating any calibration.

The HP 53181A Calibration Menu Tree

NOTE

Turn power off, press and hold **Scale & Offset** key, then press **POWER** key to access this menu.



[3]This menu item appears and calibration is permitted only if calibration is unsecured. Enter in the correct code to change calibration to secure; refer to the section titled "Using the Calibration Menu" in Chapter 2 in this guide for more information.

[4]Timebase can be automatically calibrated only if the timebase option is installed.

To View the Calibration Menu and Security Status

The Calibration menu is accessed by holding the Scale & Offset key and cycling the POWER key. The first item in the Calibration menu is a message indicating the calibration security status: ***CAL SECURE*** or ***CAL UNSECURE***.

To Unsecure for Calibration

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

CAL SECURE is displayed.

If ***CAL UNSECURE*** is displayed, then the Counter is already unsecured for calibration, and the remaining steps are not applicable.

2 **Press *Scale & Offset* key until *CODE:* is displayed.**

3 **Press the appropriate arrow keys to enter the security code *"53181"*, for example, if 53181 was the security code set at the factory.**

4 **Press *Enter* key.**

CAL UNSECURE is displayed.

NOTE

If "53181" was NOT the correct security code, the Counter would have displayed ***BAD CODE***.

To Initiate the Calibration Routines

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Unsecure for calibration by performing the preceding procedure.**

3 **Press *Scale & Offset* key until *CAL: OFFS1?* is displayed.**

4 **Press any one of the arrow keys until your calibration choice (that is, *CAL: GAIN 1?*, or *CAL: TIMEBAS?*) is displayed.**

Note that the timebase choice (CAL: TIMEBAS?) only appears when the Timebase Option is installed.

5 **Press *Enter* key.**

A scrolling message is displayed.

6 **Follow the instructions in the scrolling message, and press *Enter* key to start the calibration.**

The Counter momentarily displays ***CALIBRATING***, and then displays the calibration test name and pass/fail status (for example, ***OFFS 1 PASS***).

When the calibration completes, a pass/fail message will be displayed. If the calibration failed, then the calibration factors remain unchanged.

To Secure Against Calibration

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

CAL UNSECURE is displayed. If ***CAL SECURE*** is displayed, then the Counter is already secured against calibration and the remaining steps are not applicable.

2 **Press *Scale & Offset* key until *CODE:* is displayed.**

3 **Press the appropriate arrow keys to enter the security code, then press *Enter* key.**

CAL SECURE is displayed.

To Change to New the Security Code

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Unsecure for calibration by the using the procedure described in the section titled "To Unsecure for Calibration."**

3 **Press *Scale & Offset* key until *CODE:* is displayed.**

4 **Press the appropriate arrow keys to enter the new or customized security code, then press *Enter* key.**

A scrolling message will appear, indicating what the new code is. For example, the Counter displays the ***NEW CODE IS 5*** if you entered "5" as the new code.

To View the Calibration Count

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Press *Scale & Offset* key until *CAL COUNT?* is displayed.**

3 **Press any one of the entry keys (arrow, +/-, *Enter*) to have a scrolling message appear, indicating what the calibration count is.**

Your Counter was calibrated before it left the factory. When you receive your Counter, read the calibration count to determine its initial value.

To Get Help with the Calibration Menu

1 **Press and hold *Scale & Offset* key, then cycle *POWER* key.**

2 **Press *Scale & Offset* key until *HELP: CAL?* is displayed.**

3 **Press any one of the arrow keys until your help choice (that is, *HELP: CAL?*, *HELP: SECURE?*, *HELP: CODE?*) is displayed.**

4 **Press *Enter* key to display the help information.**

The HP 53181A Calibration Procedures

First Determine the Counter Firmware Revision

Press and hold *Recall (Utility)* key, then cycle *POWER* key.

REV: n is displayed; where "n" represents the numeric firmware revision code.

NOTE

After completing the instrument calibration, BE SURE to secure the calibration by performing the procedure in the section titled "To Secure Against Calibration" on page 2-27 of this chapter.

To Calibrate the Offset for Channel 1

1 **To access the Calibration menu, power down, and press and hold the *Scale & Offset* key, then press *POWER* key.**

The first item in the Calibration menu is a message indicating the calibration security status: ***CAL SECURE*** or ***CAL UNSECURE***.

The Counter calibration must be unsecured to perform calibration. If ***CAL UNSECURE*** is displayed, the Counter is already unsecured for calibration; go to step 5. However, if ***CAL SECURE*** is displayed then perform steps 2 through 4 to unsecure calibration.

2 **Press *Scale & Offset* key until *CODE: 0* is displayed.**

3 **Press the appropriate arrow keys to enter the security code *"53181"*, for example, if 53181 is the security code by performing the following steps:**

a. **Press ◀ key four times.**

The Counter should display ***CODE: 00000***.

b. **Press ▲ key five times.**

The Counter should display ***CODE: 50000***.

c. **Press ▶ key once, and then press ▲ key three times.**

The Counter should display ***CODE: 53000***.

d. Press ▲ key once, and then press ◆ key once.

The Counter should display ***CODE: 53100***.

e. Press ▲ key once, and then press ◆ key eight times.

The Counter should display ***CODE: 53180***.

f. Press ▲ key once, and then press ◆ key once.

The Counter should display ***CODE: 53181***.

g. Finally, press *Enter* key.

CAL UNSECURE is displayed.

NOTE

If "53181" is NOT the correct security code, the Counter will display ***BAD CODE***.

4 Press *Scale & Offset* key until *CAL: OFFS 1 ?* is displayed.

5 Press *Enter* key.

A scrolling message on the display will ask you to remove any signals connected to Channel 1. Follow the instruction.

6 Press *Enter* key.

The Counter momentarily displays ***CALIBRATING***, and then it should display ***OFFS 1 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

This completes the Offset Calibration procedure. Proceed to the next procedure to calibrate the gain.

To Calibrate the Gain for Channel 1

1 **Press any one of the arrow keys until *CAL: GAIN 1 ?* is displayed.**

2 **Press *Enter* key.**

A scrolling message is displayed. Follow the instruction by performing the following steps.

3 **Connect a BNC tee connector to Channel 1 of the HP 53181A.**

4 **Connect the Counter, dc power supply, and digital multimeter shown in Figure 2-6.**

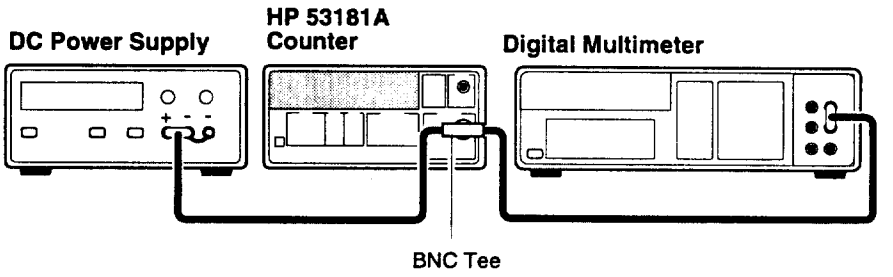


Figure 2-6. Gain Calibration Setup

5 **Adjust the power supply until the digital multimeter + 5.000 V ± 0.001 V.**

6 **Disconnect the digital multimeter from the Counter to prevent noise from being introduced into the measurement.**

7 **Press *Enter* key.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***GAIN 1 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

8 **Disconnect the calibration setup.**

This completes the Gain Calibration procedure.

Depending on which timebase the Counter contains, proceed to either the following procedure "To Calibrate the Standard Timebase" or the "To Calibrate the High Stability Timebase Option (Medium, High, or Ultra-High)"procedure (page 2-33) to calibrate the timebase.

To Calibrate the Standard Timebase

1 **Connect the output of a 10 MHz house standard to Channel 1 of the Counter as shown in Figure 2-7.**

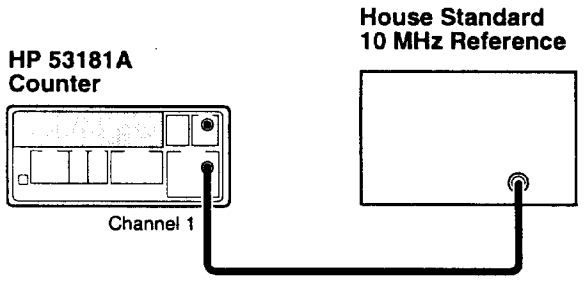


Figure 2-7. Standard Timebase Calibration Setup

2 **Cycle the *POWER* key to preset the Counter.**

3 **With a insulated tuning tool, turn the *OSC Adjust* potentiometer (located on the rear chassis of the Counter) until the frequency reading in the Counter display is 10.00000000 MHz ± 5 Hz.**

The Counter will be calibrated to the house standard.

If you are not able to adjust the frequency correctly, refer to the troubleshooting section in this chapter.

This completes the Standard Timebase Calibration procedure.

To Calibrate the High Stability Timebase Option (Medium, High, or Ultra-High)

NOTE

Allow the Counter to warm up for approximately 30 minutes before performing this calibration. This calibration is unlikely to fail, unless the Counter is not warmed up.

1 **Connect the output of a 10 MHz house standard to Channel 1 of the Counter as shown in Figure 2-7.**

2 **Press any one of the arrow keys until *CAL: TIMEBAS?* is displayed.**

Note that the timebase choice (CAL: TIMEBAS?) only appears when the Timebase Option is installed.

3 **Press *Enter* key and follow the instructions in the scrolling message that appears in the Counter display.**

4 **Press *Enter* key after each instruction.**

The Counter displays ***CALIBRATING***, and then it should display ***TB CAL PASS***.

If the fail message is displayed (even after the Counter has been warmed up for 30 minutes), refer to the troubleshooting section in this chapter.

This completes the High Stability Timebase Option Calibration procedure.

If all tests passed, the Counter is now calibrated.

Pre-Troubleshooting Information

This section contains the following pertinent troubleshooting information:

- Safety Considerations
- Recommended Test Equipment
- Repair Considerations
- After Service Considerations
- Assembly Identification and Location

Safety Considerations

Although this instrument has been designed in accordance with international safety standards, this guide contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition. Service instructions, and adjustment procedures requiring removal of the instrument cover, are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing or make any adjustments with the cover removed, unless qualified to do so.

WARNING

BEFORE APPLYING AC POWER, THE INSTRUMENT AND ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTO TRANSFORMERS, AND DEVICES CONNECTED TO THE INSTRUMENT SHOULD BE CONNECTED TO A PROTECTIVE EARTH GROUNDED SOCKET.

ANY INTERRUPTION OF THE PROTECTIVE GROUNDING CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY. INTENTIONAL INTERRUPTION IS PROHIBITED.

Any maintenance and repair of the opened instrument under voltage should be avoided as much as possible and, if necessary, should be carried out only by a skilled person who is aware of the hazards involved (for example, fire and electric shock).

Recommended Test Equipment

Test equipment recommended for testing and troubleshooting the HP 53131A/132A/181A is listed in Chapter 1, "Performance Tests." Substitute equipment may be used if it meets or exceeds the required characteristics listed in Table 1-1.

Repair Considerations

Electrostatic Discharge

Electronic components and assemblies in the HP 53131A/132A/181A can be permanently degraded or damaged by electrostatic discharge. Use the following precautions when servicing the instrument:

1 **ENSURE that static-sensitive devices or assemblies are serviced at static-safe work stations providing proper grounding for service personnel.**

2 **ENSURE that static-sensitive devices or assemblies are stored in static shielding bags or containers.**

3 **DO NOT wear clothing subject to static-charge buildup, such as wool or synthetic materials.**

4 **DO NOT handle components or assemblies in carpeted areas.**

5 **DO NOT remove an assembly or component from its static shielding protection until you are ready to install it.**

6 **AVOID touching component leads. (Handle by packaging only.)**

Surface Mount Repair

Surface mount components should only be removed using soldering irons or desoldering stations *expressly* designed for surface mount components. *Use of conventional solder removal equipment will almost always result in permanent damage to the printed circuit board and will void your Hewlett-Packard factory warranty.*

Disassembly and Reassembly Specifics

Refer to the Chapter 3, "Replacing Assemblies," in this guide for complete disassembly and reassemble details, and Chapter 5, "Replaceable Parts," for the appropriate exploded view of the instrument parts.

After Service Considerations

Product Safety Checks

The following safety checks must be performed after any troubleshooting and repair procedures have been completed to ensure the safe operation of the instrument.

WARNING

RESISTANCE CHECKS DESCRIBED IN THE FOLLOWING TEXT REQUIRE THAT THE POWER CORD BE CONNECTED TO THE INSTRUMENT AND THAT AC POWER BE DISCONNECTED. BE SURE THAT THE POWER CORD IS NOT CONNECTED TO POWER BEFORE PERFORMING ANY SAFETY CHECKS.

1 VISUAL INSPECTION. Visually inspect the interior of the instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy the cause of any such condition.

2 GROUND CONTINUITY TEST. Plug the power cord into the rear- panel power receptacle. (DO NOT connect the instrument to ac power at this time.) Using a suitable ohmmeter, check resistance from the instrument's metallic connection (such as the rear panel or BNC ground collar) to the ground pin on the power cord plug. The reading must be less that 1Ω. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist.

3 Check any indicated front- or rear-panel ground terminals marked, using the above procedure.

4 INSULATION RESISTANCE TEST. Tie the line and neutral pins of the power cord plug together. Measure the resistance from the instrument enclosure (chassis) to the line and neutral pins of the power cord plug. The minimum acceptable resistance is 2 MΩ. Replace any component which results in a failure.

Product Performance Checks

After replacement of any assembly or module, perform the operational verification test in Chapter 1, "Performance Test," of this guide.

Assembly Identification and Location

The assembly number, name and Hewlett-Packard part number of the HP 53131A , HP 53132A, and HP 53181A assemblies are listed in tables 2-1, 2-2, and 2-3, respectively. Figures 2-8A, 2-8B, and 5-1 illustrate the replaceable assemblies and cables in the HP 53131A/132A/181A.

Table 2-1. HP 53131A Assembly Identification

Assembly Name	HP Part No.	Exchange Part No.*
A1 Motherboard	53131-60001	53131-69001
A2 Display Board	53131-60002	no exchange
A3 Channel 3 Input Board (Option 030)	53132-60003	53132-69003
A3 Channel 3 Input Board (Option 050)	53132-60211	53132-69211
A4 AC Power Supply (Standard)	0950-2496	no exchange
A4 AC Power Supply for Option 002	53132-60207	no exchange
A4 AC Power Supply for Option 010 and 012	53132-60208	no exchange
A5 DC Power Supply (Option 002)	53132-60206	no exchange
A6 Medium Stability Oven Timebase (Option 001)	53132-60008 or 53132-60004 – Support Bd 1813-0931 – Oscillator	no exchange no exchange
A6 High Stability Oven Timebase (Option 010)	53132-60008 – Support Board HP 10811D – Oscillator	no exchange 10811-69001
A6 Ultra Stability Oven Timebase (Option 012)	53132-60008 – Support Board HP 10811-60211 – Oscillator	no exchange no exchange

*Exchange part availability subject to change without notice. Contact your local Hewlett-Packard Sales Office for current information.

Table 2-2. HP 53132A Assembly Identification

Assembly Name	HP Part No.	Exchange Part No.*
A1 Motherboard	53132-60001	53131-69001
A2 Display Board	53131-60002	no exchange
A3 Channel 3 Input Board (Option 030)	53132-60003	53132-69003
A3 Channel 3 Input Board (Option 050)	53132-60211	53132-69211
A4 AC Power Supply (Standard)	0950-2496	no exchange
A4 AC Power Supply for Option 002	53132-60207	no exchange
A4 AC Power Supply for Option 010 and 012	53132-60208	no exchange
A5 DC Power Supply (Option 002)	53132-60206	no exchange
A6 Medium Stability Oven Timebase (Option 001)	53132-60008 or 53132-60004 – Support Board 1813-0931 – Oscillator	no exchange no exchange
A6 High Stability Oven Timebase (Option 010)	53132-60008 – Support Board HP 10811D – Oscillator	no exchange 10811-69001
A6 Ultra-High Stability Oven Timebase (Option 012)	53132-60008 – Support Board HP 10811-60211 – Oscillator	no exchange no exchange

*Exchange part availability subject to change without notice. Contact your local Hewlett-Packard Sales Office for current information.

Table 2-3. HP 53181A Assembly Identification

Assembly Name	HP Part No.	Exchange Part No.*
A1 Motherboard	53181-60001	53181-69001
A2 Display Board	53131-60002	no exchange
A3 Channel 2 Input Board (Option 015/030)	53132-60003	53132-69003
A3 Channel 2 Input Board (Option 050)	53132-60211	53132-69211
A4 AC Power Supply (Standard)	0950-2496	no exchange
A4 AC Power Supply for Option 002	53132-60207	no exchange
A4 AC Power Supply for Option 010 and 012	53132-60208	no exchange
A5 DC Power Supply (Option 002)	53132-60206	no exchange
A6 Medium Stability Oven Timebase (Option 001)	53132-60008 or 53132-60004 – Support Board 1813-0931 – Oscillator	no exchane no exchange
A6 High Stability Oven Timebase (Option 010)	53132-60008 – Support Board HP 10811D – Oscillator	no exchange 10811-69001
A6 Ultra-High Stability Oven Timebase (Option 012)	53132-60008 – Support Board HP 10811-60211 – Oscillator	no exchange no exchange

*Exchange part availability subject to change without notice. Contact your local Hewlett-Packard Sales Office for current information.

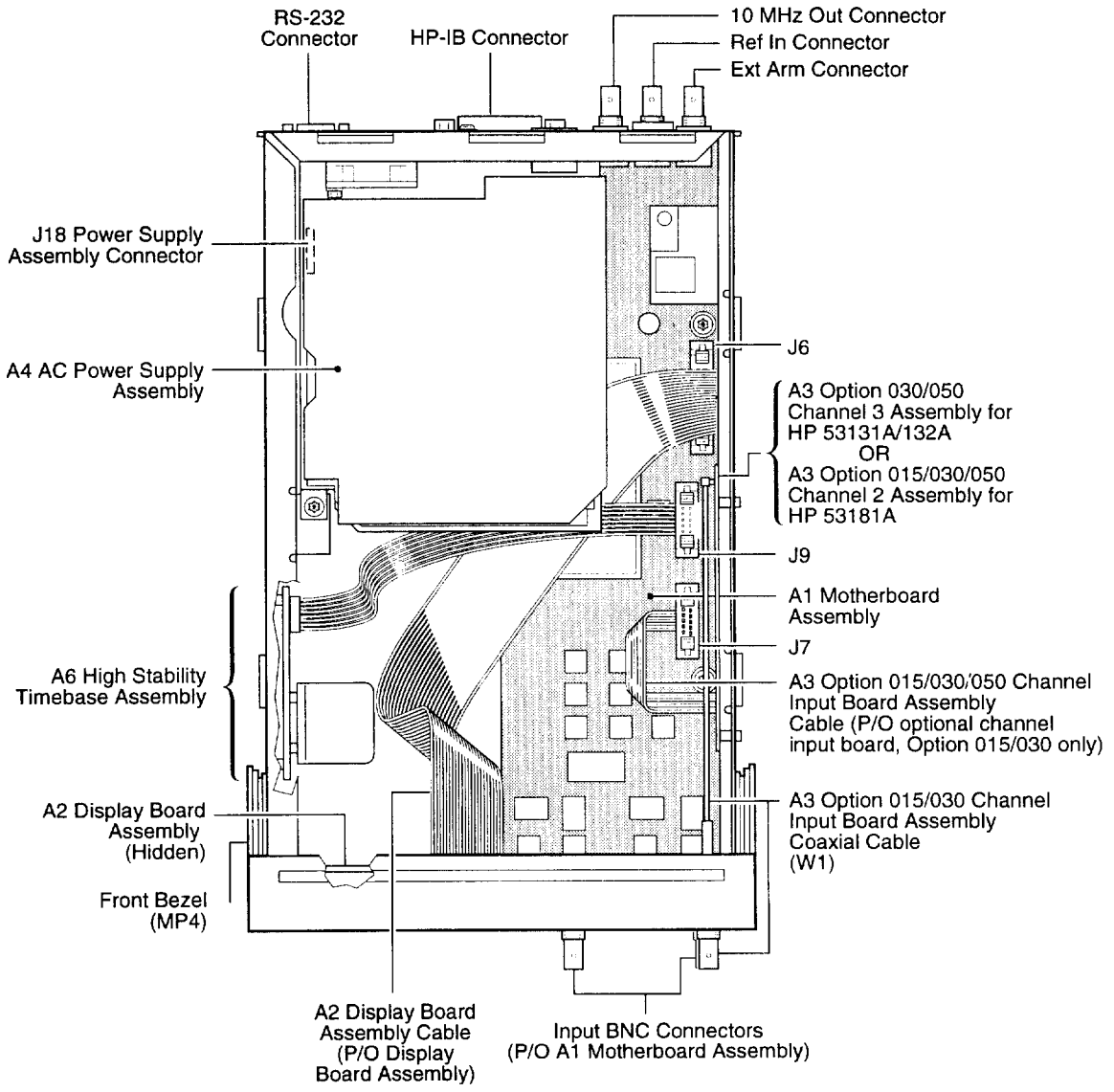


Figure 2-8A. Instrument Top Internal View

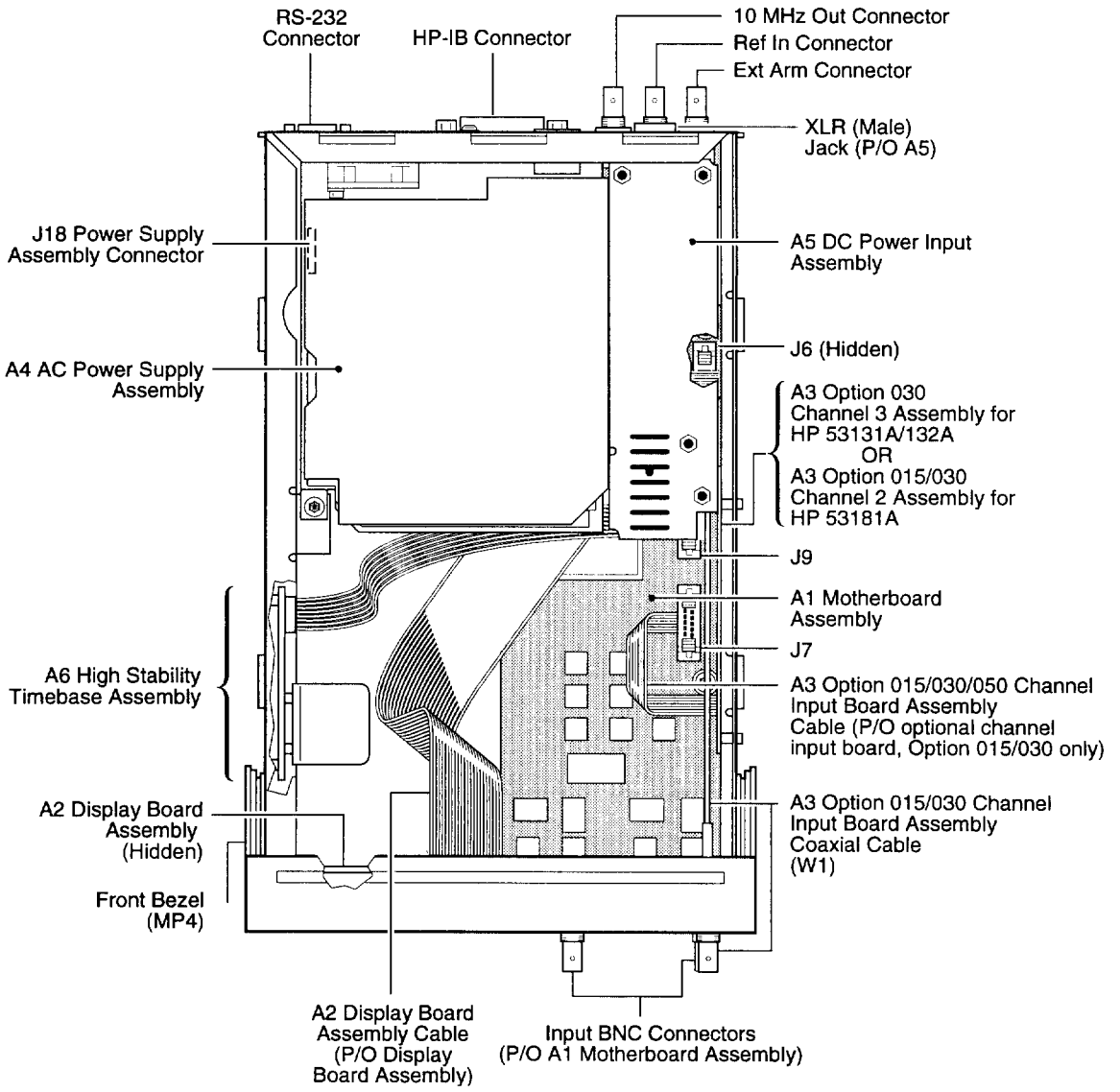


Figure 2-8B. Instrument Top Internal View (Option 002)

Troubleshooting the Counter

Power Supply Check

WARNING

HAZARDOUS VOLTAGES ARE ON THE POWER SUPPLY ASSEMBLY. ONLY SERVICE TRAINED AND QUALIFIED PERSONNEL SHOULD PERFORM THE FOLLOWING PROCEDURE.

1 **Remove the power cord from the back of the instrument to disconnect the Counter from the power source.**

2 **Remove the cover as described in Chapter 3.**

NOTE

A4 AC Power Supply Assembly is fused for safety reasons. It is assumed that if the fuses are blown, then damage has occurred to the power supply which will make it unreliable. Do not attempt to repair the power supply.

3 **Connect the Counter to the power source.**

The fan should begin to operate as soon as power is supplied. If the fan does not operate, replace A4 AC Power Supply Assembly.

Refer to Chapter 3, "Replacing Assemblies," in this service guide if you need to remove or replace an assembly.

After replacing the power supply assembly, perform the appropriate calibration procedures in this chapter.

4 **Connect the negative lead of a voltmeter to the chassis and verify that the voltages in Table 2-4 matches the voltages measured on connector J18 of A1 Motherboard Assembly. See Figure 2-9 for illustration of J18 viewing from the bottom of the Counter.**

CAUTION

BE CAREFUL to NOT short the positive-side lead of the voltmeter to the chassis when probing at the testpoints shown in Figure 2-9.

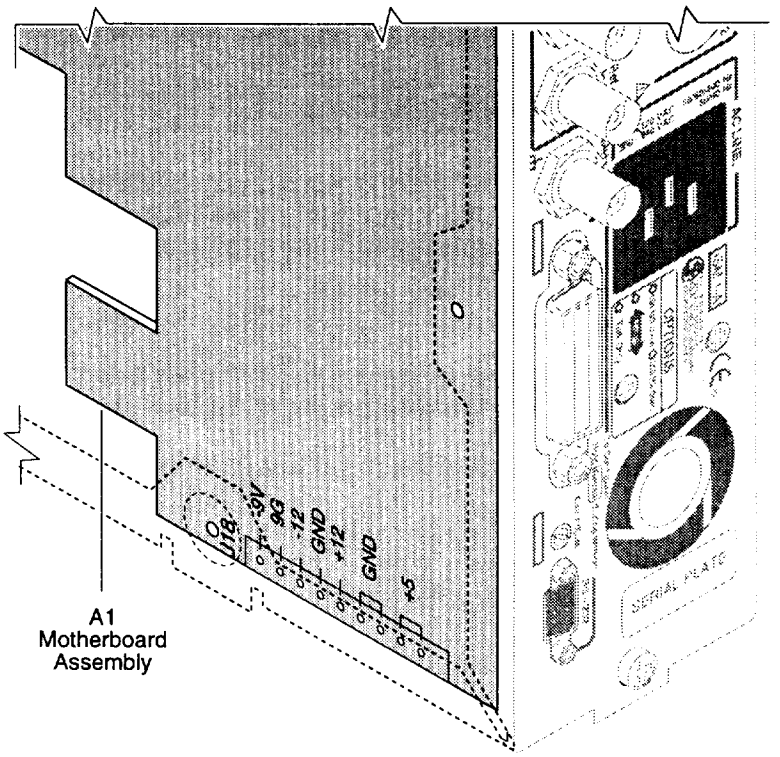


Figure 2-9. A4 AC Power Suppy Testpoint Locations on A1 Motherboard Assembly (Bottom View)

Table 2-4 lists A4 power supply's voltages, the corresponding wire color, and the tolerances.

Table 2-4. A4 AC Power Supply Voltages

Wire Color	Voltage	Tolerance
Red	+5.0 V	±0.250 V
Red	+5.0 V	±0.250 V
Black	0.0 V	———
Black	0.0 V	———
Yellow	+12.0 V	±0.6 V
Black	0.0 V	———
Blue	-12.0 V	±1.2 V

5 If the Counter under test contains Option 010 or 012 High Stability Timebase, perform the following:

a. Disconnect the power supply's two-wire cable from J2 of A6 High Stability Timebase Assembly as shown in Figure 2-10.

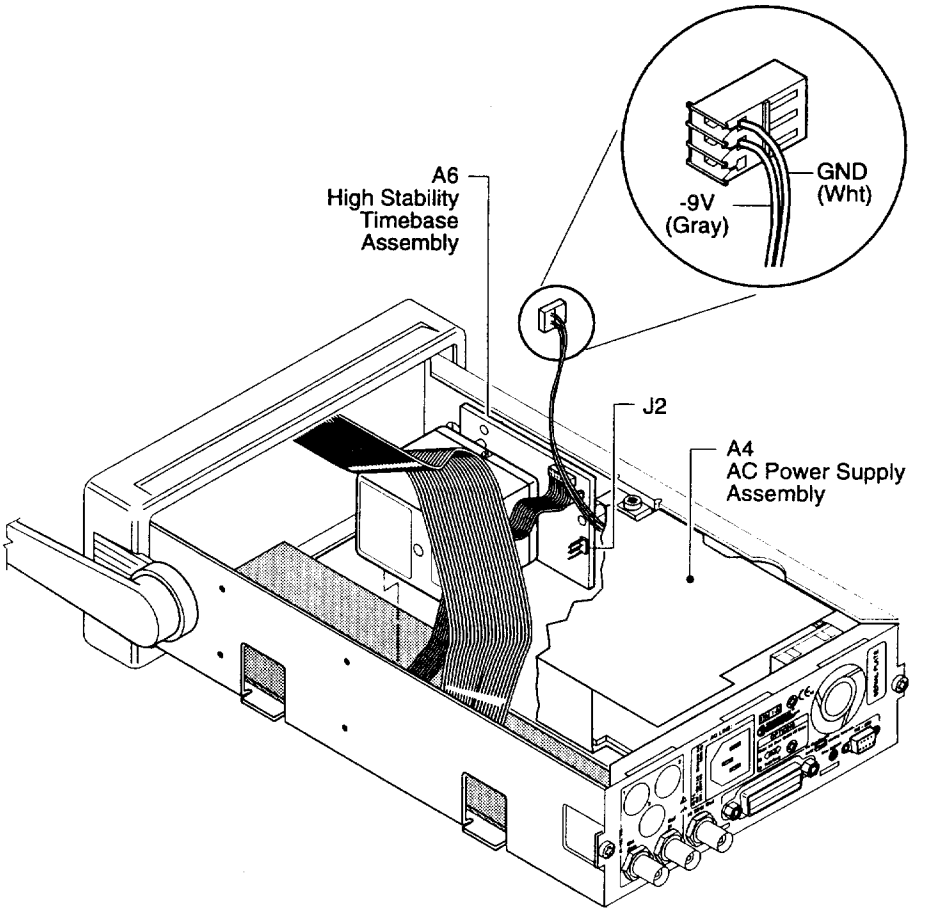


Figure 2-10. A4 AC Power Supply –9V Output Check (Option 010/012 Only)

b. Connect the negative lead of a voltmeter to the white wire connection (GND) on the connector of the two-wire cable, and connect the positive lead to the gray wire connection (–9V) as shown in Figure 2-10.

Verify a reading of –9.0 ± 0.45 V.

6 After verifying the correct voltages and that all calibrations passed, proceed to the following section.

Overview of the Self-Test Routines

The Utility menu includes the following three self-test menu items:

- TEST LOOP:
- TST PRINT:
- TEST:

The Counter includes several self-tests. Some self tests are performed at the power-up of the Counter. Some of these self tests can also be invoked from the Utility menu. Other tests can also be invoked from the Utility menu, but a slightly different test is performed. For example, a power-up self test might work regardless of connections to the inputs while a Utility menu self test may require a specific signal to be connected. Some self tests can only be invoked from the Utility menu, for example, the keypad test.

You can specify that the tests should loop forever (***TEST LOOP: ON*** or ***OFF***) or until any key is pressed.

You can also specify that failure messages be sent to a printer, the RS-232, and the HP-IB—if in talk-only (***TST PRINT: ON*** or ***OFF***).

There are 13 choices for the ***TEST:*** menu item. They are listed and described in the following text.

TEST: ***ALL?*** – run all tests, except display, keypad and printer tests.

DISP? – illuminate the indicators and vacuum-fluorescent display (VFD) segments. *Note, this test is not available if* ***TEST LOOP:*** *is ON.* ***TEST LOOP:*** *must be OFF.*

CPU? – test processor(s).

ROM? – checksum the ROM.

RAM? – test RAM.

EEPROM? – checksum the EEPROM, which is used for non-volatile memory.

HP-IB? – test HP-IB chip.

QSPI? – test serial hardware control loops.

FPGA? – internally measure the timebase to test count circuitry.

FR END? – check front end circuits, either by swinging trigger levels (during power on test and ALL test) or asking you to connect the timebase output to channels 1 and 2 using a BNC-T connector to split the signal.

MEAS? – make a measurement, either by swinging trigger levels (during power on test and ALL test) or asking you to connect the timebase output to channel 1.

INTERP? – test interpolators.

KEYPAD? – request user to press all keys. *Note, this test is not available if* ***TEST LOOP:*** *is ON.* ***TEST LOOP:*** *must be OFF.*

PRINT? – send three test lines to a printer via the RS-232. If in talk-only, also send three test lines to a printer via the HP-IB.

NOTE

When running the TEST LOOP self-test routine, be sure to connect the Counter to a serial printer via the RS-232 using a RS-232 printer interface cable (HP 24542G or HP 24542H) to receive more specific failure information. If you run the TEST LOOP test without Counter being connected to a printer, the Counter will only display pass or fail message.

Diagnosing the Faulty Assembly by Using the Self Tests

To Run the Test-All Self Test

1 **Press and hold *Recall (Utility)* key, then cycle *POWER* key.**

2 **Press *Recall (Utility)* key until *TEST: ALL?* is displayed.**

3 **Press *Enter* key to start the test.**

The counter will display the tests as they are being performed. When the tests are completed the display should show ***ALL: PASS***.

If the fail message is displayed, run the appropriate individual test as described in the following sub-section. If the individual test fail,. use Table 2-5 to determine which board or assembly you should replace.

To Run the Individual Self Tests

1 **Press and hold *Recall (Utility)* key, then cycle *POWER* key.**

NOTE If power does not cycle or the display does not light, go to the section titled "Power Supply Check" in this chapter on page 2-43.

2 **Press *Recall (Utility)* key until *TEST LOOP:* is displayed.**

3 **Ensure that *TEST LOOP:OFF* is displayed.**

Note that the DISP? and KEYPAD? tests are not available if ***TEST LOOP:*** is ***ON***.

If ***TEST LOOP: ON*** is displayed, press any one of the arrow keys to set ***TEST LOOP*** to ***OFF***.

4 **Press *Recall (Utility)* key until *TEST: ALL?* is displayed.**

5 **Press any one of the arrow keys to select the desired self test (for example, the *DISP?* self test).**

6 **Press *Enter* key to start the test.**

After a test is completed, a pass or fail message will be displayed.

NOTE After the DISP? (Display) test has cycled through each display segment and annunciator, press the **Enter** key to stop the test and to display the pass or fail message.

7 **If you are asked to do something, press *Enter* key when you have completed the requested task.**

After a test is completed, a pass or fail message will be displayed.

8 **Repeat steps 2 through 5 for each of the self tests.**

Note that for the TEST: FR END? test, connect Counter as shown in Figure 2-11A or Figure 2-11B (depending on which Counter you are testing) and press **Enter** key.

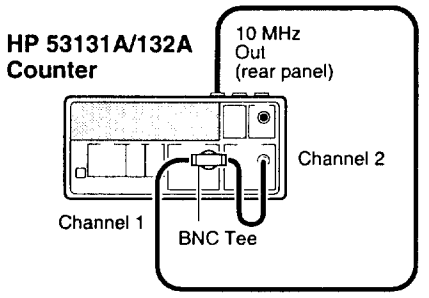


Figure 2-11A. HP 53131A/132A Self Test Troubleshooting Setup

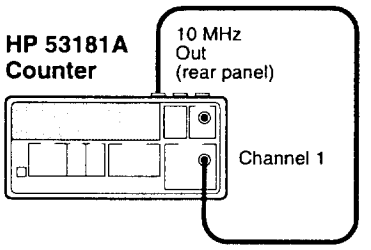


Figure 2-11B. HP 53181A Self Test Troubleshooting Setup

9 **If the *FAIL* message is displayed for a test, use Table 2-5 to determine which assembly may need replacing.**

Table 2-5. Troubleshooting

Failure Indicator	Assembly at Fault
DISP: FAIL	A2 Display Board Assembly or A1 Motherboard Assembly
CPU: FAIL	A1 Motherboard Assembly
ROM: FAIL	A1 Motherboard Assembly
RAM: FAIL	A1 Motherboard Assembly
EEPROM: FAIL	A1 Motherboard Assembly
HP-IB: FAIL	A1 Motherboard Assembly
QSPI: FAIL	A1 Motherboard Assembly or A2 Display Board Assembly
FPGA: FAIL	A1 Motherboard Assembly or A2 Display Board Assembly
FR END: FAIL	A1 Motherboard Assembly or A4 AC Power Supply Assembly
MEAS: FAIL	A1 Motherboard Assembly or A4 AC Power Supply Assembly
INTERP: FAIL	A1 Motherboard Assembly or A4 AC Power Supply Assembly
KEYPAD: FAIL	Keypad, or Front Panel Assembly, or A1 Motherboard Assembly.
PRINT: FAIL	A1 Motherboard Assembly

10 **Refer to Chapter 3, "Replacing Assemblies," in this service guide for dissasembly and reassembly procedures.**

NOTE

After replacing an assembly, perform the calibration procedures in this chapter.

3

Replacing Assemblies

Disassembly and Reassembly

Introduction

This chapter contains the instructions for removing major assemblies in the HP 53131A/132A/181A. To install an assembly, reverse the removal instructions.

This chapter provides the following disassembly and reassembly procedures:

WARNING **HAZARDOUS VOLTAGES ARE ON THE POWER SUPPLY ASSEMBLY. UNPLUG THE INSTRUMENT, THEN WAIT AT LEAST SIX MINUTES FOR THE CAPACITORS ON THE POWER SUPPLY ASSEMBLY TO DISCHARGE BEFORE WORKING ON THIS INSTRUMENT.**

CAUTION Do not replace assemblies with the instrument turned on. Damage to components can occur.

Refer to Chapter 5, "Replaceable Parts," for the part number of the assemblies.

Tools Required

The following tools are required for these removal and replacement procedures:

- Hand TORX® 10 screwdriver (T10)
- Hand TORX® 15 screwdriver (T15)
- 7-mm spin tight
- 14-mm deep-socket spin tight
- Soldering iron — for removing Option 060 Rear Terminals
- Small (1 point) Pozidri screwdriver — for removing Option 010/012 oven oscillator from A6 Timebase Support Board

Do This First

Before performing any of the removal and replacement procedures, the following steps must be performed.

1 **Turn Counter off.**

2 **Remove ac line power cord from the rear ac line socket.**

To Remove the Cover

The following steps are for removing the cover. The cover is removed to access the board and cable assemblies, and all other internal parts.

WARNING

WHEN THE COVER IS REMOVED FROM THE INSTRUMENT, LINE VOLTAGES ARE EXPOSED WHICH ARE DANGEROUS AND MAY CAUSE SERIOUS INJURY IF TOUCHED. DISCONNECT POWER.

1 **Turn off the Counter and remove power cord.**

2 **To remove the rear bezel, loosen the captive screws on the sides as shown in Figure 3-1 using the TORX 15 screwdriver.**

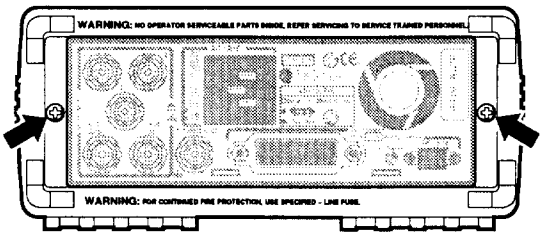


Figure 3-1. Rear Bezel Removal

3 **Remove the screw (H1) located at the bottom near the rear of the cover (MP3) as shown in Figure 3-2.**

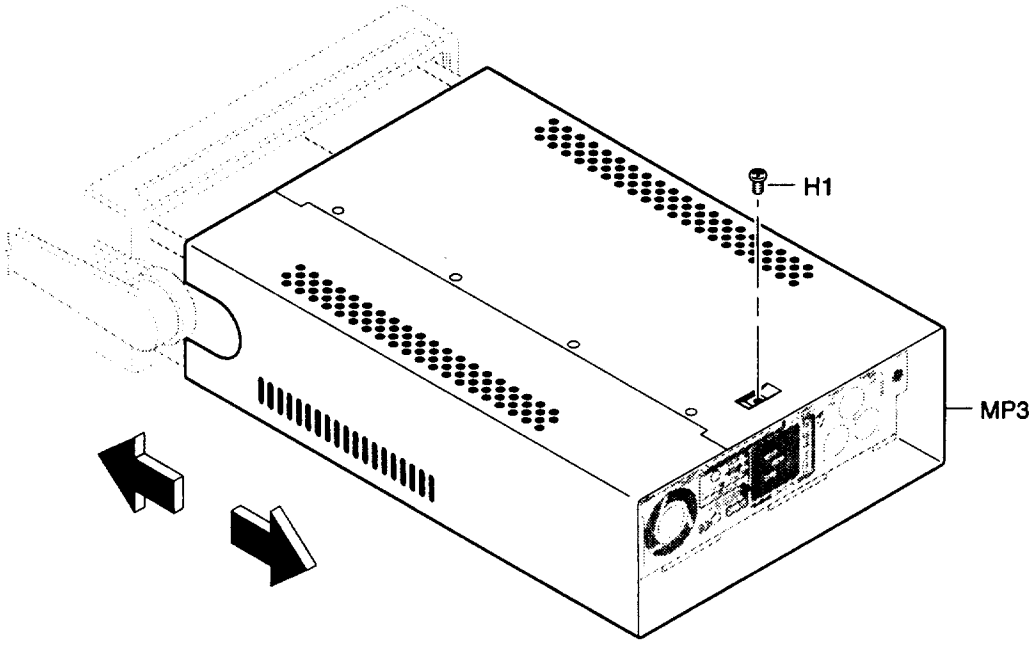


Figure 3-2. Bottom View for Cover Removal

4 **With one hand gripping the front bezel, pull the cover off with the other hand by sliding the cover backward.**

To Remove the Front Bezel

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Remove the bail handle (MP7) by rotating it to the vertical position and pull the ends outward as shown in Figure 3-3.**

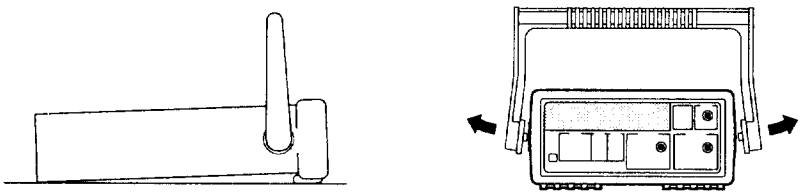


Figure 3-3. Handle Removal

3 **Remove the front rubber bumper (part of MP2), stretch a corner and then slide it off as shown in Figure 3-4.**

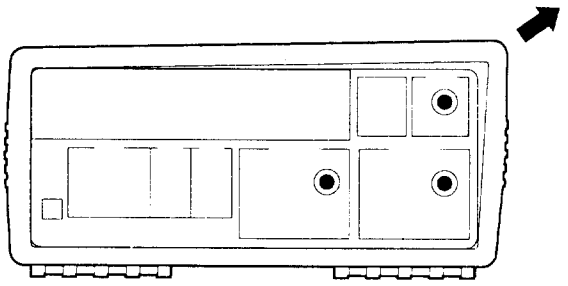


Figure 3-4. Front Rubber Bumper Removal

4 **Disconnect the front bezel flat-ribbon cable (which is actually A2 Display Board's cable) from J6 of A1 Motherboard Assembly as shown in Figure 3-5.**

5 **Remove the BNC nuts (H3), shown in Figure 3-5, from the front panel using the 14-mm deep-socket spin tight.**

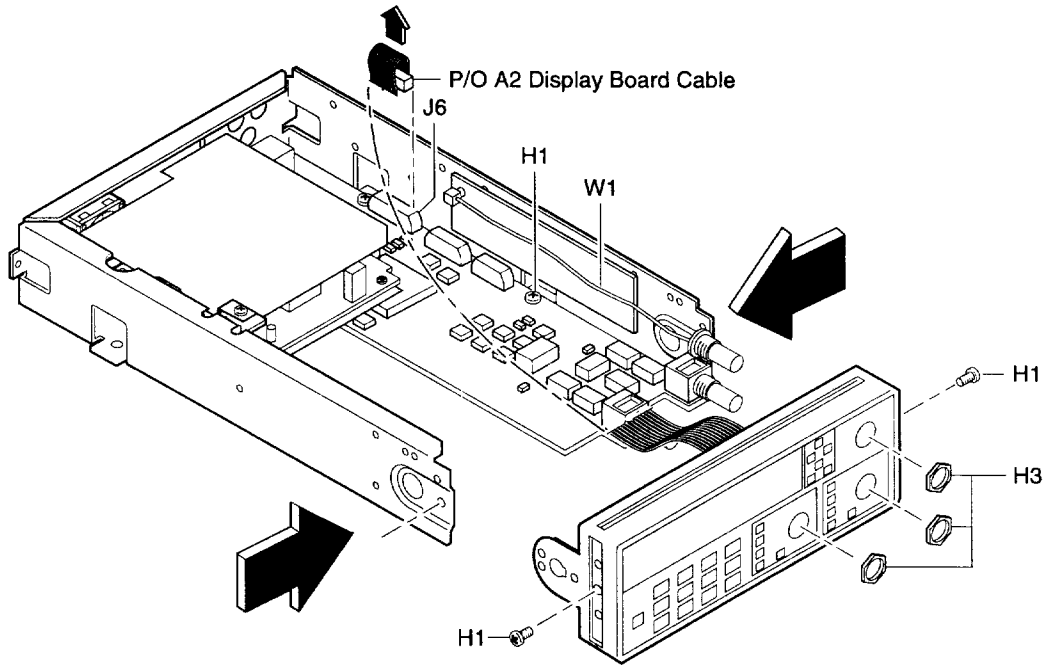


Figure 3-5. Front Bezel Removal

6 **For Counters with the optional 1.5 GHz or 3.0 GHz channel (Option 015 or 030), pull cable W1 out of the front bezel as shown in Figure 3-5. For the optional 5 GHz channel, remove knurled nut.**

CAUTION When reassembling A3 (Option 015/030) Assembly, ensure that cable W1 is not placed or folded on top of the input circuits of A1 Motherboard Assembly or is tucked behind A3 as the Counter may start reading or measuring noise.

7 **Remove the screws (H1), located in the sides of the front bezel, using the TORX 15 screwdriver as shown in Figure 3-5.**

8 **Loosen the screw (H1), shown in Figure 3-5, that helps secure A1 Motherboard Assembly to the chassis to make step 9 (the following step) easier.**

9 **Remove front bezel by pushing inward on the sides of the chassis.**

To Remove A1 Motherboard Assembly

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Remove the Power Supply Assembly.**

See the section titled "To Remove A4 AC Power Supply Assembly" in this chapter.

3 **Remove the front bezel.**

See the section titled "To Remove the Front Bezel" in this chapter.

4 **If the Counter contains Option 015/030/050 1.5/3.0/5.0 GHz Channel, disconnect the optional channel's flat-ribbon cable from J7 on A1 Motherboard Assembly as shown in Figure 3-6.**

5 **If the Counter contains one of the optional high stability timebase assemblies (Option 001, 010, 012), disconnect the flat-ribbon cable from J6 of A1 Motherboard as shown in Figure 2-8A (See Chapter 2, "Service.").**

6 **If the Counter contains the Option 002 DC Power Input Assembly, remove it.**

See the section titled "To Remove A5 DC Power Input Assembly" in this chapter.

7 **Remove the two hex screws (H4), shown in Figure 3-6, on the rear-panel HP-IB connector using the 7-mm spin tight.**

To Remove A1 Motherboard Assembly

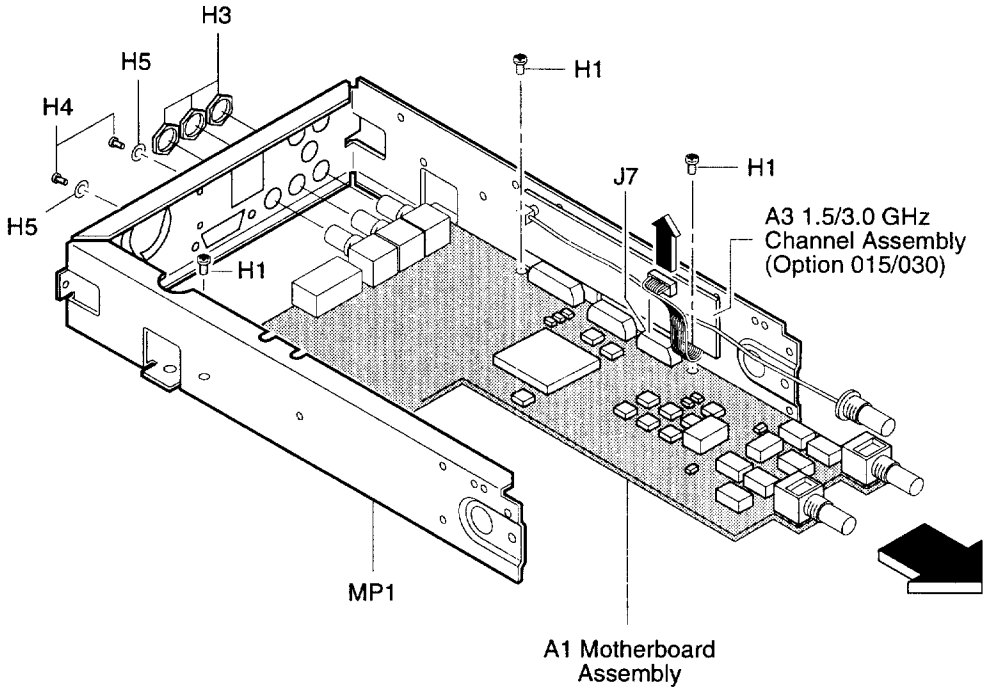


Figure 3-6. A1 Motherboard Assembly Removal

8 **Remove the BNC nuts (H3), shown in Figure 3-6, from the rear of the chassis using the 14-mm deep-socket spin tight (Opt 015/030 only). Remove knurled nut for Option 050.**

9 **Remove the three screws (H1) in A1 Motherboard Assembly as shown in Figure 3-6.**

10 **Finally, slide the motherboard assembly forward.**

To Remove the A2 Display Board, Keypads, and Window

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Remove the front bezel.**

See the section titled "To Remove the Front Bezel" in this chapter.

3 **Note that A2 Display Board Assembly, shown in Figure 3-7, is held in place by five tabs (two on top and three on bottom) which are part of the front bezel.**

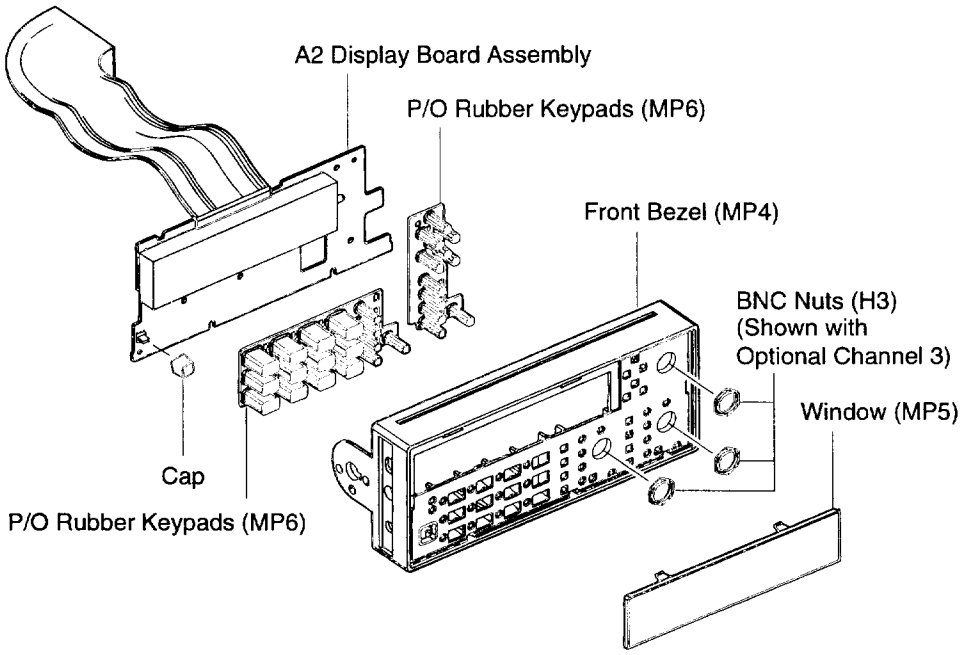


Figure 3-7. A2 Display Board, Keypad, and Window Removal

4 **Pull up on the top portion of the front bezel until the top portion of the display board is free from the top tabs.**

5 **Pull down on the bottom portion of the front bezel until the display board is free from the bottom tabs.**

If the board is still not free, insert a small flat-blade screw driver or object between the bottom of the display board and the bezel to gently pry the board loose from the bottom tabs.

6 **Remove A2 Display Assembly from the front bezel.**

NOTE

When installing A2 Display Board into the front bezel, pull up on the top portion of the front bezel and press display board into place. Make sure that the board is positioned all the way into the bezel until the two tabs on top and three on bottom are visible.

7 **Now, remove the POWER key cap by gripping and pulling it.**

NOTE

The cap must be removed to make installation of the A2 Display Board Assembly easier.

8 **As shown in Figure 3-7, the rubber keypads (MP6) are now free. Just pull them out of the bezel.**

9 **Remove the window (MP5), shown in Figure 3-7, by pressing down on the two top tabs and sliding the window forward.**

To Remove A3 1.5/3.0 GHz Channel Assembly (Option 015/030)

NOTE

The 1.5 GHz Channel 2 Assembly (Option 015) is available for the HP 53181A Frequency Counter only.

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Using the 14-mm deep-socket spin tight, remove the BNC nut (H3) from the optional Channel 3 (or Channel 2 for HP 53181A) input connector.**

3 **Pull W1, which is the optional channel assembly cable, out of the Channel 3 (or 2) opening in the front panel assembly as shown in Figure 3-8.**

CAUTION

When reassembling A3 (Option 030) Assembly, ensure that cable W1 is not placed or folded on top of the input circuits of A1 Motherboard Assembly or is tucked behind A3 as the Counter may start reading or measuring noise.

To Remove A3 1.5/3.0 GHz Channel Assembly (Option 015/030)

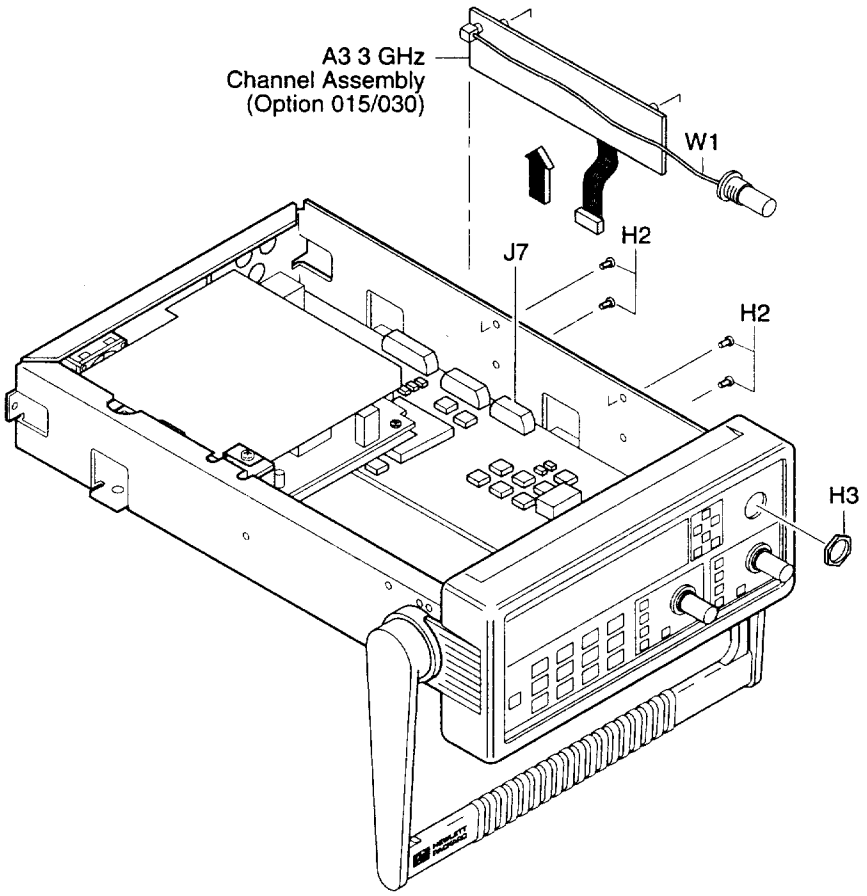


Figure 3-8. Option 030 3.0 GHz Channel Input Assembly Removal

4 **Disconnect flat-ribbon cable of the optional channel from connector J7 of A1 Motherboard Assembly as shown in Figure 3-8.**

5 **Remove the four screws (H2) attaching the optional channel to the chassis as shown in Figure 3-8.**

6 **Remove the optional channel assembly.**

To Remove A4 AC Power Supply Assembly

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Remove the TORX screw (H1) located in the upper-middle of the chassis using the TORX 15 screwdriver as shown in Figure 3-9.**

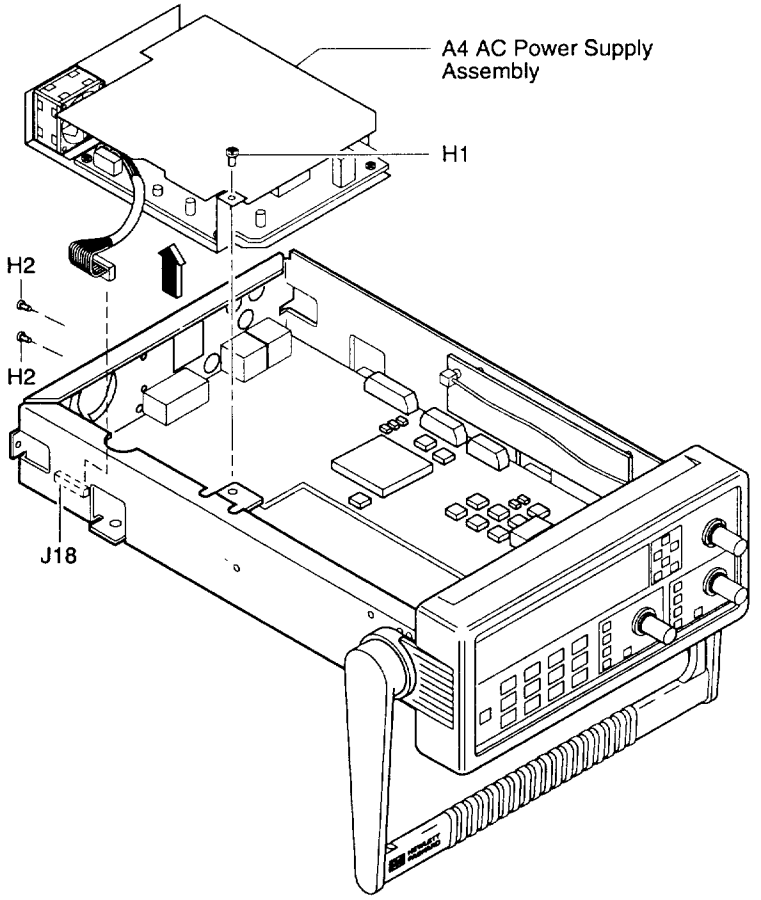


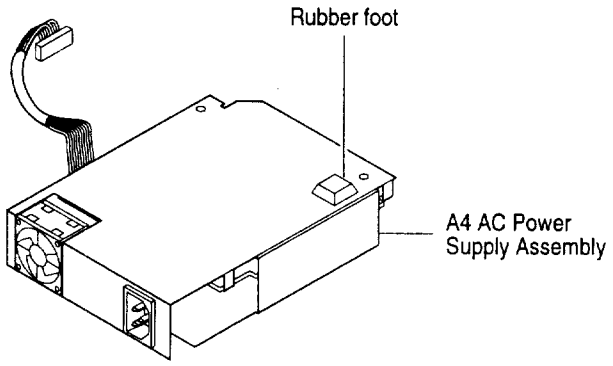
Figure 3-9. A4 AC Power Supply Assembly Removal

3 **Remove the two TORX screws (H2) on the rear panel using the TORX 10 screwdriver as shown in Figure 3-9.**

4 **Lift up A4 AC Power Supply Assembly and disconnect its cable from J18 on A1 Motherboard Assembly to remove the power supply assembly as shown in Figure 3-9.**

NOTE

When replacing the power supply, order the rubber foot (0403-0424). See defective assembly to note location or the following figure.



5 **If the Counter contains the Option 002 DC Power Input Assembly, disconnect A4 AC Power Supply's other cable from Option 002 as shown in Figure 3-10.**

To Remove A5 DC Power Input Assembly (Option 002)

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Remove the four TORX 10 screws (H2) that attach A5 DC Power Input Assembly to the side of the chassis as shown in Figure 3-10.**

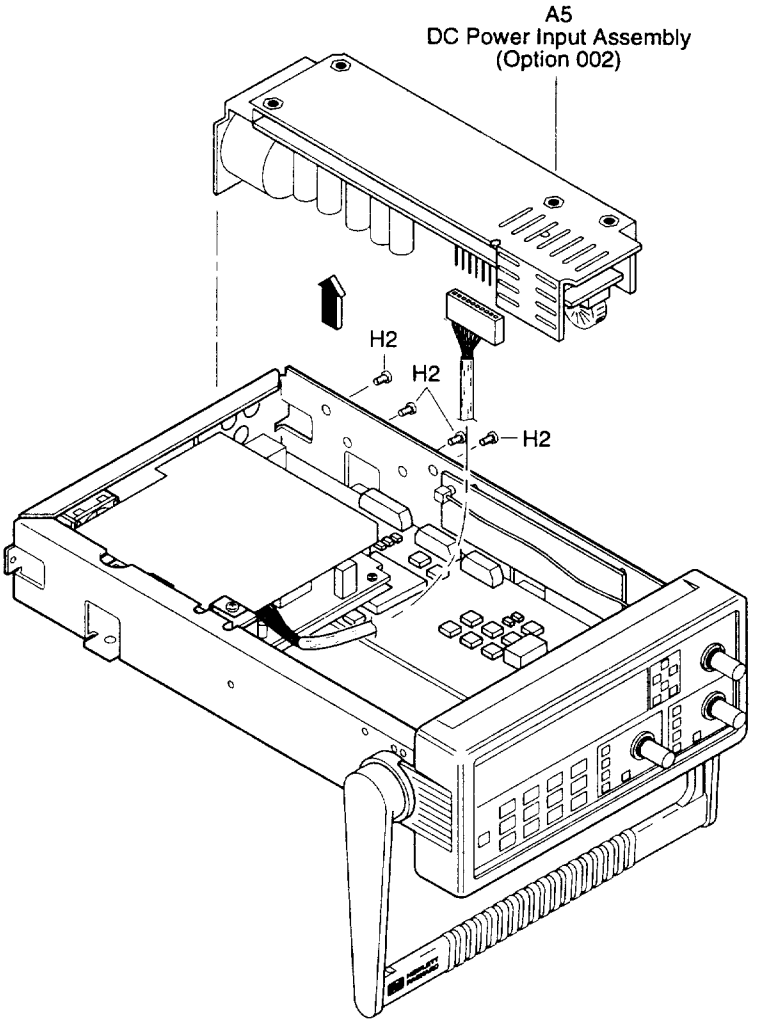


Figure 3-10. DC Power Input Assembly (Option 002) Removal

3 **Lift out A5 DC Power Input Assembly and disconnect cable as shown in Figure 3-10.**

To Remove A6 High Stability Timebase Assembly (Options 001, 010, and 012)

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Disconnect A6 High Stability Timebase Assembly cable from the J9 connector on A1 Motherboard Assembly as shown in Figure 3-11.**

To Remove A6 High Stability Timebase Assembly (Options 001, 010, and 012)

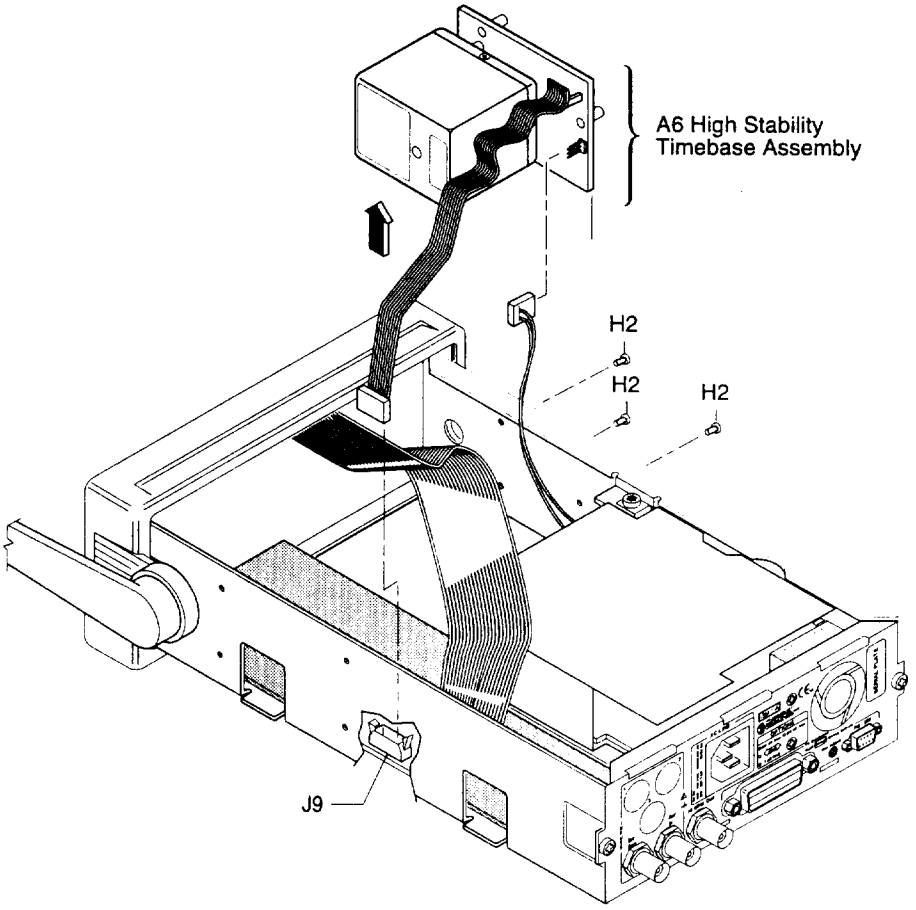


Figure 3-11. Option 001, 010, and 012 A6 High Stability Timebase Assembly Removal

3 **Disconnect the ac power supply's two-wire cable from A6 High Stability Timebase Assembly (if the two-wire cable exists).**

4 **Remove the three TORX 10 screws (H2) attaching the timebase to the chassis as shown in Figure 3-11.**

5 **Remove A6 High Stability Timebase Assembly.**

To Remove the Rear Terminals (Option 060)

1 **Remove the cover.**

See the section titled "To Remove the Cover" in this chapter.

2 **Unsolder the lead-end of the cables from their appropriate ground and input pads on the A1 Motherboard Assembly (J16, J17) as shown in Figure 3-12.**

For the HP 53131A/132A unsolder the rear chassis **INPUTS 1** cable to J16 and **INPUTS 2** to J17.

For the HP 53181A unsolder the rear chassis **INPUTS 1** cable to J17.

NOTE

If there are upper or lower shields installed on A1 Motherboard Assembly, cut them out and then remove Option 060 Rear Terminal cable(s). Replace the front bezel with the metalized version (53131-40001).

To Remove the Rear Terminals (Option 060)

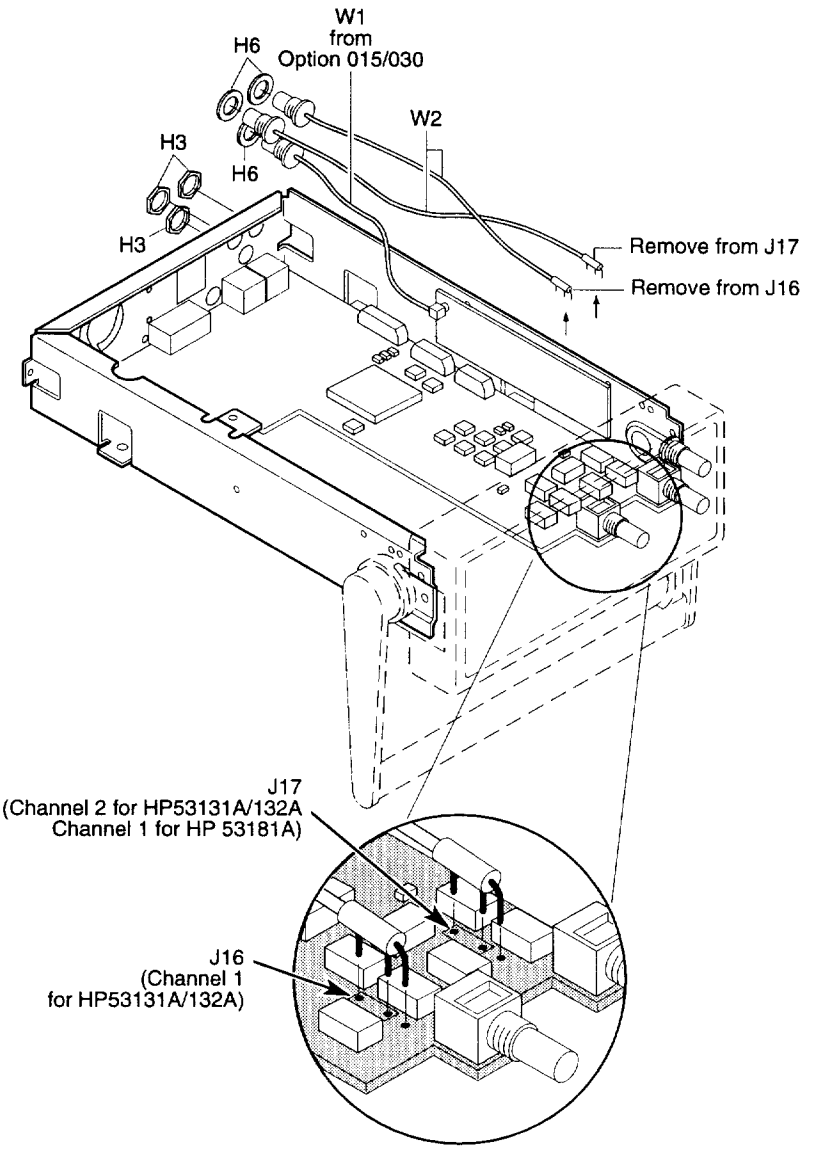


Figure 3-12. Rear Terminals (Option 060) Removal

NOTE Option 050 (5.0 GHz Input) is front panel only.

3 **Loosen and remove the 2940-0256 BNC nuts (H3) that secure the coaxial cable(s) to the rear chassis, using the 14-mm deep-socket spin tight.**

4 **Pull W2 and washers (H6) out of the rear *INPUTS* opening(s).**

5 **Pull the connector-end of W1 and washer (H6) out of the rear *INPUTS* opening.**

6 **Plug opening (s) with MP9 (6960-0159) if you are not going to re-install Option 060.**

4

Retrofitting Options

Introduction

This chapter provides the following retrofit procedures:

Tools Required

The following tools are required for these retrofitting procedures:

- Hand TORX® 10 screwdriver (T10)
- Hand TORX® 15 screwdriver (T15)
- 7-mm spin tight
- 14-mm deep-socket spin tight
- Soldering iron — for retrofitting Option 060 Rear Terminals
- Small (1 point) Pozidri screwdriver — for securing Option 010/012 oven oscillator to A6 Timebase Support Board
- pliers

Do This First

Before performing any of the retrofit procedures, the following steps must be performed.

1 **Turn Counter off.**

2 **Remove ac line power cord from the rear ac line socket.**

To Retrofit A3 1.5/3.0/5.0 GHz Channel Assembly (Option 015/030/050)

NOTE

Retrofitting from Option 015 (1.5 GHz) to Option 030 (3.0 GHz) must be performed by technicians at an HP Service Center.

Option 030 3.0 GHz and Option 050 5 GHz Channel Input Assembly Parts

Item	HP Part No.	Qty.
Option 030 Retrofit Kit	53131-67001	1
Option 050 Retrofit Kit *	53131-67002	1

Preliminary Procedure

1 **Remove the cover.**

See the section titled "To Remove the Cover" in Chapter 3 of this guide.

2 **If you are retrofitting Option 030 into an HP 53131A or HP 53132A, proceed to step 1 of the Retrofitting Procedure sub-section on page 4-4. For Option 050, proceed to step 4.**

3. **Remove the front bezel.**

See the section titled "To Remove the Front Bezel" in Chapter 3.

a. **For HP 53181A only, remove the window in the front bezel.**

See the section titled "To Remove A2 Display Board, Keypads, and Window" in Chapter 3 of this guide.

b. **Insert the new window (MP12) in the front bezel.**

4 **Now, replace the front bezel by performing the front bezel removal procedure, in Chapter 3 of this guide, in reverse.**

*** Instruments with the following serial prefixes also requires a new chassis:**

53131A	3416A and below
53132A	3404A and below
53181A	3418A and below

Retrofitting Procedure

1 **Mount A3 optional Channel Assembly (53132-60003 for 1.5 or 3.0 GHz, or 53132-60211 for 5.0 GHz) to the right side (viewing from the front of the Counter) of the chassis using the TORX 10 screws (H2, four for Option 015/030, three for Option 050) as shown in Figure 4-1. For Option 050, ensure knurled connector goes through the front bezel.**

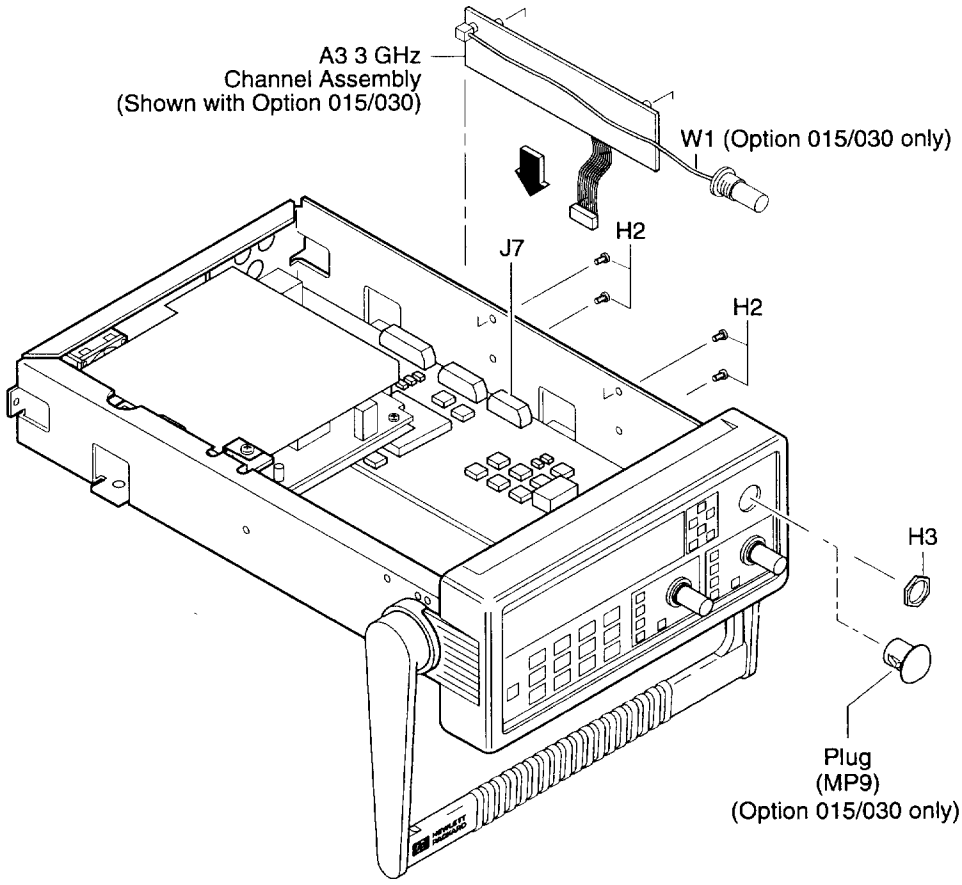


Figure 4-1. Optional Channel 3 (or 2) Input Assembly Retrofitting

2 **Plug A3's flat-ribbon cable into connector J7 on A1 Motherboard Assembly as shown in Figure 4-1.**

(NOTE: For Option 050 (5.0 GHz Input) skip steps 3 through 7.)

3 **Remove BNC nut that comes with the coaxial input cable ,W1 (Option 015/030 only).**

4 **From inside the front bezel, push out the plug in the Channel 3 (Channel 2 for the HP 53181A) hole. (See Figure 4-4A, on the page 4-18, for an illustration of the plug removal.)**

5 **Insert the BNC connector of W1 through the front bezel's Channel 3 or 2 hole.**

For Option 030 and Option 060 (Rear Terminals) combination, route W1 to the appropriate rear chassis opening (**INPUTS 3** or **2**).

6 **Insert and tighten the BNC nut (H3) using the 14-mm deep-socket spin tight.**

7 **Connect the other end of W1 to the coaxial connector on A3.**

8. **Tighten the knurled nut (Option 050 only)**

CAUTION

When reassembling A3 (Option 015/030) Assembly, ensure that cable W1 is not placed or folded on top of the input circuits of A1 Motherboard Assembly or is tucked behind A3 as the Counter may start reading or measuring noise.

9. **Re-install the cover by performing the cover removal procedure, in Chapter 3 of this guide, in reverse.**

This completes the optional Channel Assembly (Option 015/030/050) retrofit procedure.

To Retrofit A5 DC Power Input Assembly (Option 002)

Option 002 DC Power Input Assembly Parts

Item	HP Part No.	Qty.
• Chassis (MP10)	53131-00010	1
• A5 DC Power Input Assembly	53132-60206	1
• A4 AC Power Supply Assembly	53132-60207	1
• Rear label (MP11)	53131-80013	1
• TORX 10 screws (H2)	0515-0430	4

NOTE

Option 002 can NOT be installed or combined with Option 010 or 012 High Stability Timebase assemblies, or Option 060 Rear Terminals.

Preliminary Procedure

1 **Remove the cover.**

See the section titled "To Remove the Cover" in Chapter 3 of this guide.

2 **Remove the front bezel.**

See the section titled "To Remove the Front Bezel" in Chapter 3 of this guide.

3 **Remove the existing A4 AC Power Supply Assembly.**

4 **Remove A1 Motherboard Assembly from chassis MP1.**

See the section titled "To Remove A1 Motherboard Assembly" in Chapter 3 of this guide.

Retrofitting Procedure

1 **Slide A1 Motherboard Assembly into the new chassis (MP10) as shown in Figure 4-2A.**

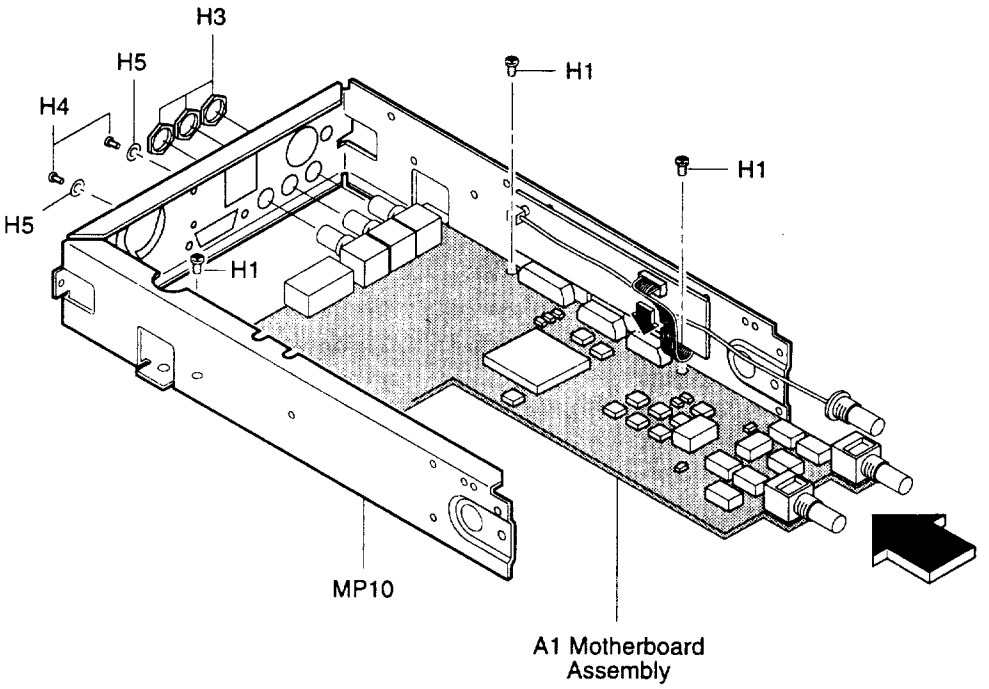


Figure 4-2A. DC Power Input Assembly Retrofitting

2 **Insert but do not tighten the three TORX 15 screws (H1) that attach A1 Motherboard Assembly to the new chassis (MP10) as shown in Figure 4-2A.**

3 **Insert and tighten the three BNC nuts (H3) onto the BNC connectors that protrude from the rear of the chassis using the 14-mm deep-socket spin tight.**

4 **Insert and tighten the two hex screws (H4) and the lock washers (H5) onto the HP-IB connector that protrudes from the rear of the chassis using the 7-mm spin tight.**

5 **Now, re-install the front bezel by performing the front bezel removal procedure, in Chapter 3 of this guide, in reverse. Be sure to insert A2 Display Board's cable into connector J6 on A1 Motherboard Assembly.**

6 **Tighten the three H1 screws, shown in Figure 4-2A, to secure the motherboard to the chassis.**

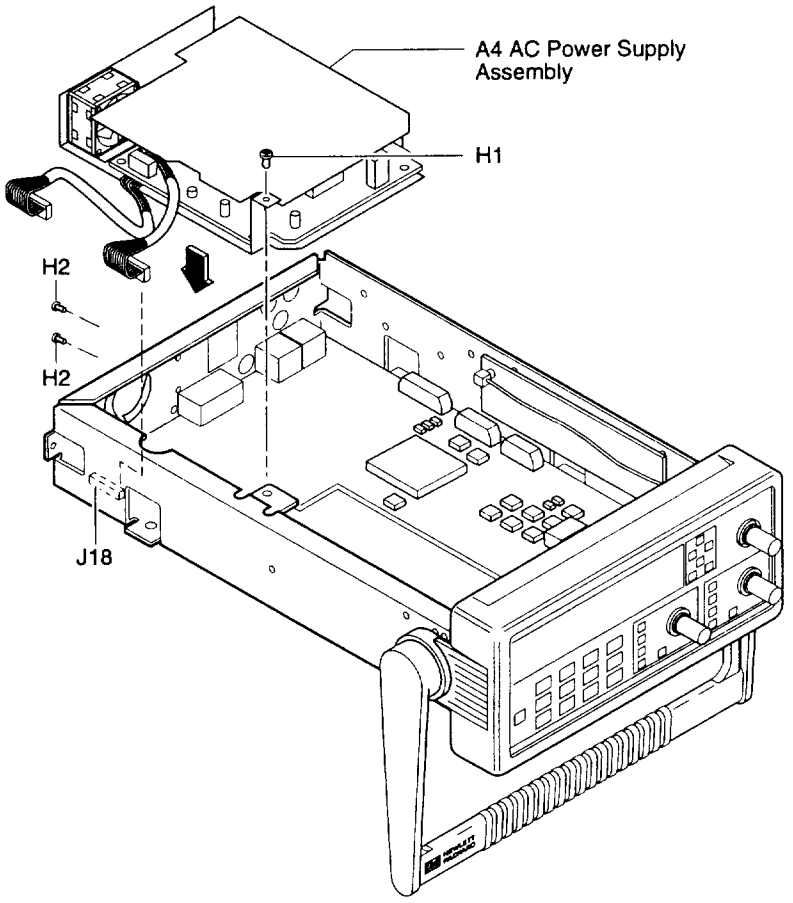


Figure 4-2B. DC Power Input Assembly Retrofitting

7 **To install the new A4 AC Power Supply Assembly (53132-60207), connect the ac power supply's shorter cable to connector J18 on A1 Motherboard Assembly as shown in Figure 4-2B.**

8 **Insert and tighten the two TORX 10 screws (H2) to attach A4 Power Supply Assembly to the rear of the chassis as shown in Figure 4-2B.**

9 Insert and tighten the TORX 15 screw (H1) into the upper-middle of the chassis as shown in Figure 4-2B.

10 Install A5 DC Power Input Assembly (53132-60206) into the chassis by performing the following:

a. First, connect the other ac power supply cable to the connector on A5 printed-circuit board as shown in Figure 4-2C.

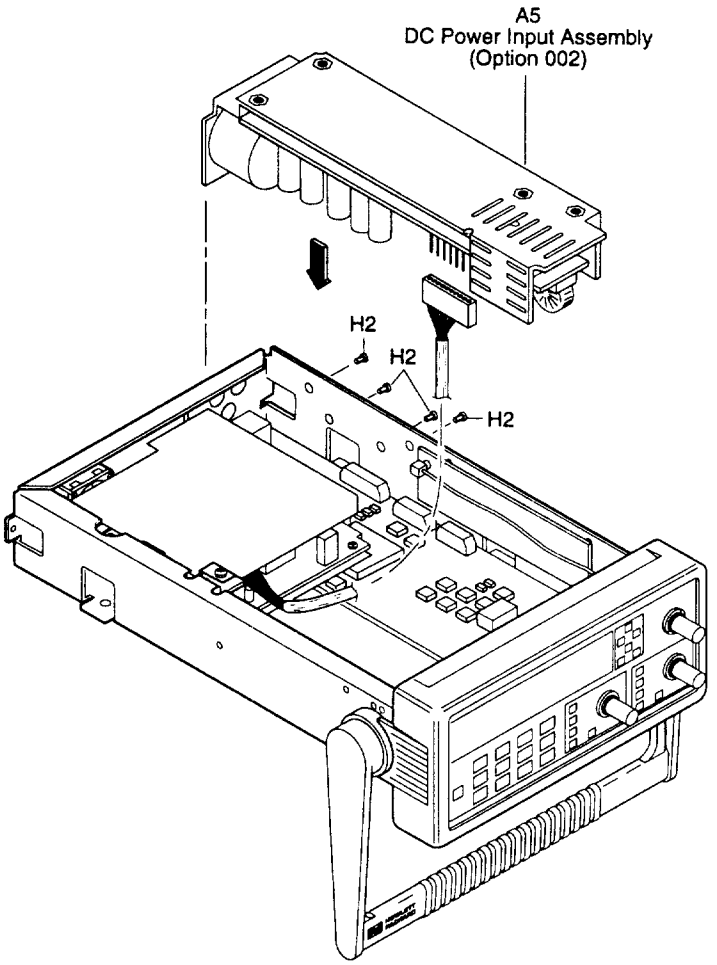


Figure 4-2C. DC Power Input Assembly Retrofitting

b. **Position A5 Power Input Assembly against the rear of the chassis and align it with the two appropriate holes in the rear of the chassis.**

c. **Using the four TORX 10 screws (H2), secure A5 DC Power Input Assembly to the side of the chassis (MP10) as shown in Figure 4-2C.**

11 **To install the rear label (MP11), remove the protective seal from the back of it and press into place making sure to properly align the label with the holes in the rear of chassis as shown in Figure 4-2D.**

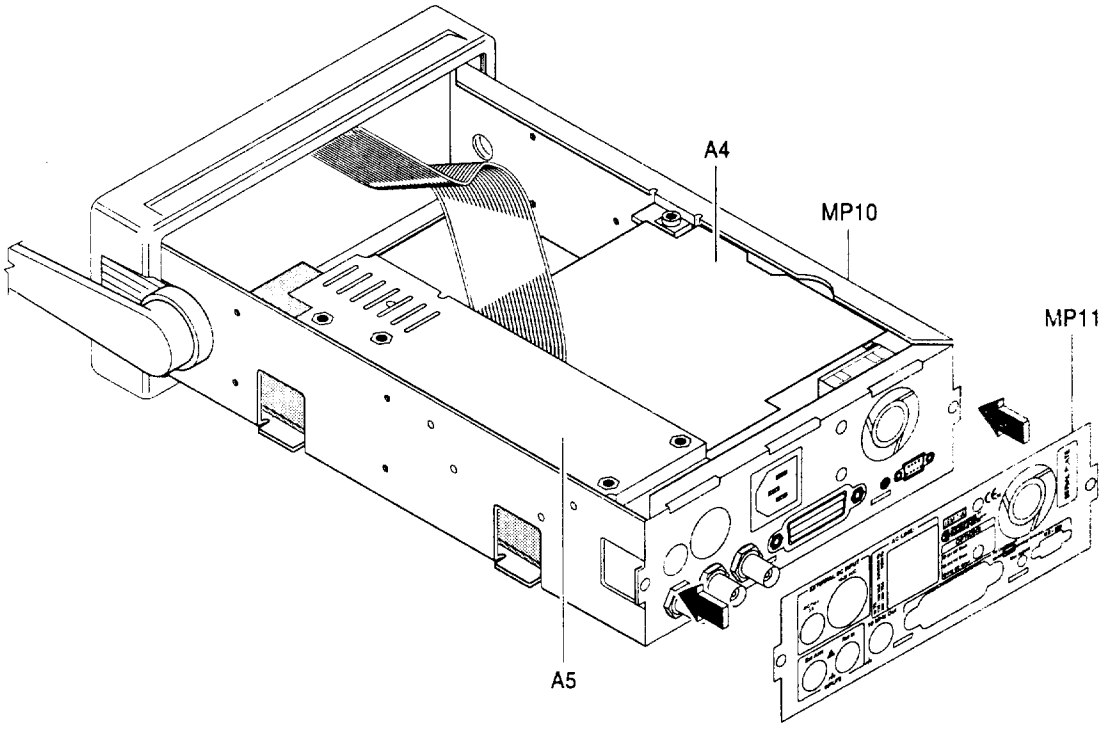


Figure 4-2D. DC Power Input Assembly Retrofitting

12 **Re-install the cover by performing the cover removal procedure, in Chapter 3 of this guide, in reverse.**

13 **Note that you will have to assemble your own dc power cable using 18 AWG connecting wires and a three-pin XLR (female) connector plug (shown in Figure 4-2E).**

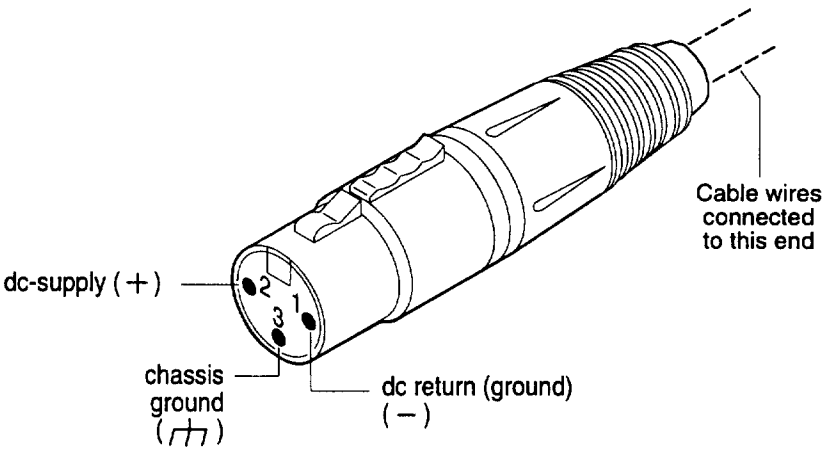


Figure 4-2E. Three-Pin XLR Plug Pinouts (Front View)

14 **From the rear of the XLR plug, connect the external power supply's supply-side wire to pin 2 of the XLR plug. Connect the external power supply's return (ground) wire to pin 1, and the chassis ground wire to pin 3 of the XLR plug.**

15 **Observing the correct polarity, attach the other ends of the wires to a dc source (+10 to +32V dc) to operate the Counter.**

This completes the DC Power Input Assembly (Option 002) retrofit procedure.

To Retrofit A6 High Stability Timebase Assembly (Options 001, 010, and 012)

Option 001 Medium Stability Timebase Assembly Parts

Item	HP Part No.	Qty.
• A6 Timebase Support Board	53132-60008	1
• Oven Oscillator	1813-0931	1
• TORX 10 screws (H2)	0515-0430	3

*Option 010 High Stability Timebase Assembly Parts

Item	HP Part No.	Qty.
• A6 Timebase Support Board	53132-60008	1
• A4 AC Power Supply Assembly	53132-60208	1
• Oven Oscillator	10811-60111	1
• TORX 10 screws (H2)	0515-0430	3
• Pozidrive screws (H7)	2360-0331	2

*Option 012 Ultra-High Stability Timebase Assembly Parts

Item	HP Part No.	Qty.
• A6 Timebase Support Board	53132-60008	1
• A4 AC Power Supply Assembly	53132-60208	1
• Oven Oscillator	10811D Opt 001	1
• TORX 10 screws (H2)	0515-0430	3
• Pozidriv screws (H7)	2360-0331	2

* These options can be installed or retrofitted in Counters that have firmware revisions 3402 and greater only. Contact your local HP Service Center for more information.

Procedure

1 **Turn off the Counter and remove power cord.**

2 **Remove the cover.**

See the section titled "To Remove the Cover" in Chapter 3 of this guide.

3 **If you are retrofitting the Option 001 Medium Stability Timebase Assembly, go to step 7.**

If you are retrofitting the Option 010 High Stability or Option 012 Ultra-High Stability assembly, go to step 4.

4 **Remove the existing A4 AC Power Supply Assembly.**

See the section titled "To Remove A4 AC Power Supply Assembly" in Chapter 3 of this guide.

5 **Install the new A4 AC Power Supply Assembly (53132-60208) by performing the following steps:**

a. **Connect the power supply's larger cable to J18 of A1 Motherboard as shown in Figure 4-3A.**

b. **Mount the power supply to the rear of the chassis using the two TORX 10 screws (H2) as shown in Figure 4-3A.**

c. **Insert TORX 15 screw (H1), 0515-0433, in the upper-middle of the chassis as shown in Figure 4-3A.**

6 **Plug the oven oscillator into the socket on A6 Timebase Support Board, and secure the oven oscillator to A6 using the two Pozidriv screws (H7) as shown in Figure 4-3B.**

To Retrofit A6 High Stability Timebase Assembly (Options 001, 010, and 012)

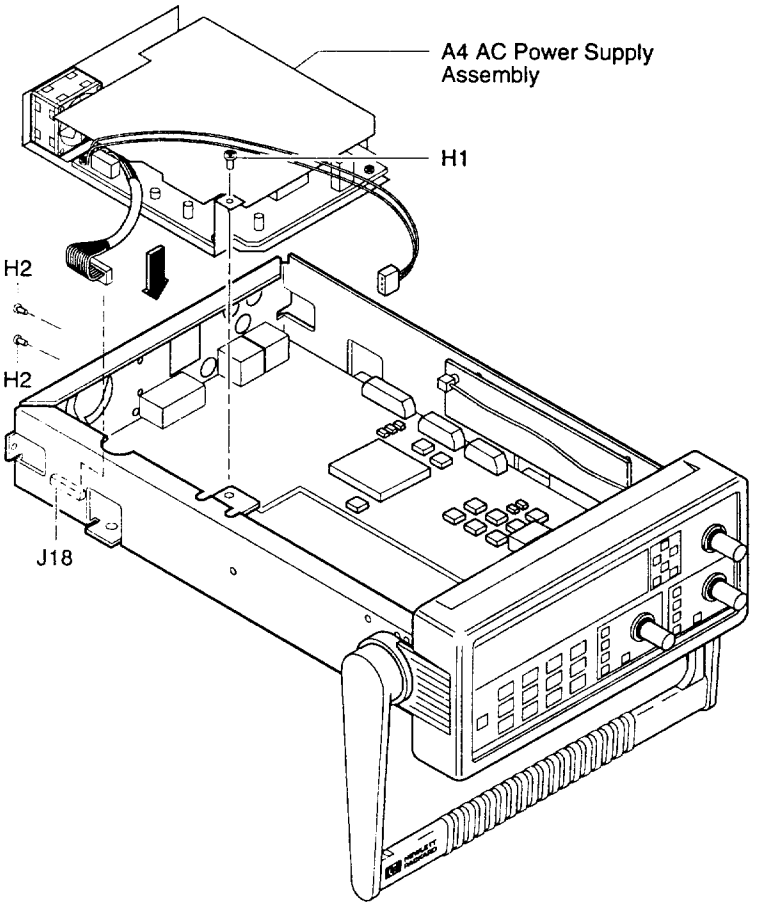


Figure 4-3A. High Stability Timebase Retrofitting (Option 001, 010, 012)

7 **If you are retrofitting the Option 001 Medium Stability Timebase, remove the jumper cap on P1 of A6 Timebase Support Board as shown in Figure 4-3B.**

If you are retrofitting the Option 010 High Stability and Option 012 Ultra-High Stability timebases, DO NOT remove the jumper cap on P1.

8 **Mount A6 High Stability Timebase Assembly on the left side using three TORX 10 screws (H1) as shown in Figure 4-3B.**

8 **Plug the power supply assembly's two-wire cable into the three-prong connector (J2) on the high stability timebase assembly as shown in Figure 4-3B (if the two-wire cable exists).**

9 **Connect A6 High Stability Timebase Assembly cable to connector J9 on A1 Motherboard Assembly as shown in Figure 4-3B.**

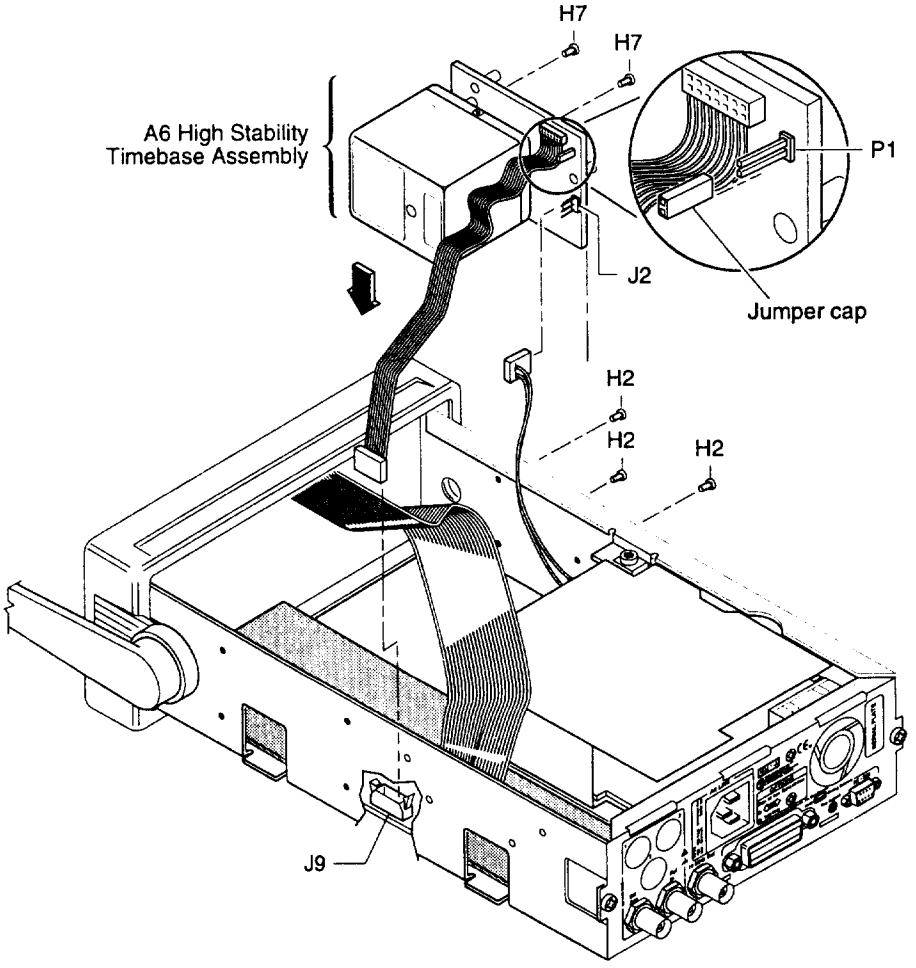


Figure 4-3B. High Stability Timebase Retrofitting (Option 001, 010, 012)

10 Re-install the cover by performing the cover removal procedure, in Chapter 3 of this guide, in reverse.

This completes A6 High Stability Timebase Assembly retrofit procedure.

To Retrofit the Rear Terminals (Option 060)

Option 060 Rear Terminals Parts

Item	HP Part No.	Qty.
• Coaxial cable assembly (W2)	8120-6150	2
• BNC washer (H6)	3050-0962	2
• BNC nut (H3)	2940-0256	2

1 **Remove the cover.**

See the section titled "To Remove the Cover" in Chapter 3 of this guide.

2 **For retrofitting the HP 53131A or HP 53132A, push out *INPUTS* plugs 1, 2, and 3 (located on rear of chassis) as shown in Figure 4-4A.**

For retrofitting HP 53181As that do NOT contain the optional Channel 2 (Option 015/030), push out *INPUTS* plug 1 (located on rear of chassis) as shown in Figure 4-4A.

For retrofitting the HP 53181As that contain the optional Channel 2, push out *INPUTS* plugs 1 and 2 (located on rear of chassis) as shown in Figure 4-4A. See the following NOTE.

NOTE

For the HP 53181A, the front and rear terminals can exist for Channel 1. However, HP 53181A's optional Channel 2 input (Option 015/030) can be configured as **rear terminals only** or **front terminals only**.

NOTE

If there are upper or lower shields installed on A1 Motherboard Assembly, cut them out and replace the front bezel with the metalized version (53131-40001).

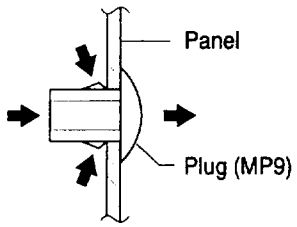


Figure 4-4A. Plug Removal for Rear Terminals Retrofitting

3 **Remove the side of the optional channel (Option 015/030) coaxial cable (W1) that is connected to the front-panel and insert it through the appropriate rear *INPUTS* opening (3 for HP 53131A/132A; 2 for HP 53181A) as shown in Figure 4-4B.**

To Retrofit the Rear Terminals (Option 060)

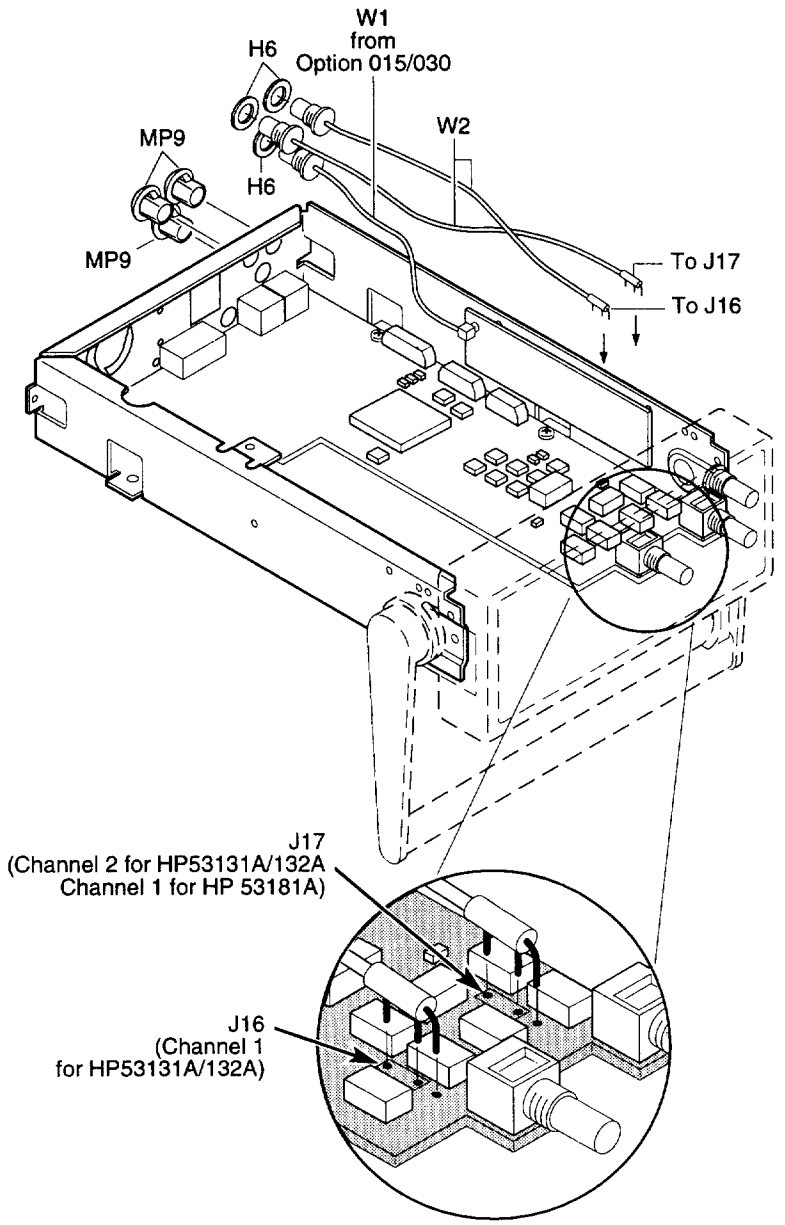


Figure 4-4B. Rear Terminals Retrofitting

4 **Insert the connector-end of the W1, with the washers (H6) in place on the connector, through the appropriate rear *INPUTS* opening.**

5 **Insert and tighten the BNC nuts (H3) to secure the coaxial cables to the rear of the chassis.**

6 **Solder the lead-end of the cables to their appropriate ground and input pads on A1 Motherboard Assembly (J16, J17)**

For the HP 53131A/132A solder the rear chassis **INPUTS 1** cable to J16 and **INPUTS 2** to J17. (See Figure 4-4B.)

For the HP 53181A solder the rear chassis **INPUTS 1** cable to J17. (See Figure 4-4B.)

7 **Re-install the cover by performing the cover removal procedure, in Chapter 3 of this guide, in reverse.**

This completes the Rear Terminals (Option 060) retrofit procedures.

5

Replaceable Parts

Introduction

This chapter contains information for ordering parts. Table 5-1 lists the exchange assemblies. Table 5-2 lists reference designations used in the parts list and throughout the guide, and Table 5-3 lists all replaceable assemblies and parts for the HP 53131A/132A/181A Counter. Table 5-4 is a list of manufacturer's code numbers given in the parts list (Table 5-3). It contains the names and addresses corresponding to the code number of the manufacturer. Figure 5-1 is an exploded view of the HP 53131A/132A/181A.

Exchange Assemblies

Table 5-1 lists assemblies within the HP 53131A/132A/181A that may be replaced on an exchange basis. Factory repaired and tested exchange assemblies are available only on a trade-in basis. Defective assemblies must be returned for credit. (Note that the part numbers for the new and exchange assemblies are also listed in Table 5-3.)

Table 5-1. Exchange Assemblies

Assembly Name	HP Part No.	Exchange Part No.*
A1 Motherboard (**HP 53131A**)	53131-60001	53131-69001
A1 Motherboard (**HP 53132A**)	53132-60001	53132-69001
A1 Motherboard (**HP 53181A**)	53181-60001	53181-69001
A3 Channel 3 Input Board	53132-60003	53132-69003
A3 5 GHz Channel 3 Input (Option 050)	53132-60211	53132-69211
High Stability Oven Timebase (Option 010)	HP 10811D – Oscillator	10811-69001

*Exchange part availability subject to change without notice. Contact your local Hewlett-Packard Sales Office for current information.

Reference Designations

Table 5-2 lists the reference designations used in the parts lists, block diagrams, and throughout the guide.

Replaceable Parts

Table 5-3 is a list of replaceable parts and is organized as follows:

Electrical assemblies in alphanumerical order by reference designation.

1. Electrical assemblies in alphanumerical order by reference designation.
2. Chassis-mounted electrical parts in alphanumerical order by reference designation.
3. Chassis-mounted mechanical parts in alphanumerical order by reference designation.

The information given for each part consists of the following:

1. Reference designation.
2. Hewlett-Packard part number.
3. Part number check digit (CD).
4. Total quantity (QTY) in instrument. The total quantity is given once and at the first appearance of the part number in the list.
5. Description of the part.
6. Typical manufacturer's part number for the part.

How To Order A Part

Hewlett-Packard wants to keep your parts ordering process as simple and efficient as possible. To order parts perform the following steps:

1 Identify the part and the quantity you want.

2 Determine the ordering method to be used and contact Hewlett-Packard.

Parts Identification

To identify the part(s) you want, first refer to the exploded view in Figure 5-1 at the back of this chapter or Figures 2-8A and 2-8B in Chapter 2, "Service."

When ordering from Hewlett-Packard, the important numbers to note from the Parts List are the HP Part Number and part-number check digit (in the "CD" column), and the quantity of the part you want.

If the part you want is NOT identified in the guide, you can call on Hewlett-Packard for help (see the following section titled "Contacting Hewlett-Packard"). Please have the following information at hand when you contact HP for help:

- Instrument Model Number (example, "HP 53131A").
- Complete instrument Serial Number (example, "1234A56789"). Information about where to find the serial number is given in the preface of this guide in the section titled "How to Use This Guide."
- Description of the part and its use.
- Quantity of the part required.

Contacting Hewlett-Packard

Depending on where you are in the world, there are one or more ways in which you can get parts or parts information from Hewlett-Packard.

- Outside the United States, contact your local HP sales office.
- Within the United States, we encourage you to order replacement parts or request parts information directly by telephone or mail from the HP Support Materials Organization, using the telephone numbers or address listed on the next page. (You can also contact your local HP sales office. HP sales offices are listed at the back of this package.)

By telephone:

- For Parts Ordering use our toll-free number, (800) 227-8164, Monday through Friday (except Holidays), 6 a.m. to 5 p.m. (Pacific Time).

  If you need a part in a hurry, an extra-cost Hotline phone ordering service is available 24 hours a day. Use the toll-free number above at the times indicated; at other times, use (916) 785-8460.

- For Parts Identification Assistance, call us at (916) 783-0804

  Our Parts Identification hours are from Monday through Friday, 6 a.m. to 5 p.m. (Pacific Time).

For mail correspondence, use the address below:

Hewlett-Packard
Support Materials Roseville
P. O. Box 1145
Roseville, CA 95661-1145

Cabinet Parts and Hardware

To locate and identify miscellaneous cabinet and chassis parts and instrument hardware, refer to Figures 2-8A, 2-8B, and 5-1. These figures provide different views of the instrument, with the parts identified by reference designations; the reference designations correspond with the ones in Table 5-3.

Table 5-2. Reference Designation

A	=	assembly	S	=	switch
H	=	hardware	T	=	transformer
J	=	electrical connector (stationary portion); jack	TP	=	test point
MP	=	miscellaneous mechanical part	U	=	integrated circuit; microcircuit
P	=	electrical connector (movable portion); plug	W	=	cable; transmission path; wire
P/O	=	part of			

Table 5-3. HP 53131A/132A/181A Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				EXCHANGE ELECTRONIC ASSEMBLIES		
A1 (HP 53131A)	53131-60001	2	1	MOTHERBOARD	28480	53131-60001
	53131-69001	0	1	MOTHERBOARD (EXCHANGE RESTORED)	28480	53131-69001
A1 (HP 53132A)	53132-60001	3	1	MOTHERBOARD	28480	53132-60001
	53132-69001	1	1	MOTHERBOARD (EXCHANGE RESTORED)	28480	53132-69001
A1 (HP 53181A)	53181-60001	2	1	MOTHERBOARD	28480	53181-60001
	53181-69001	0	1	MOTHERBOARD (EXCHANGE RESTORED)	28480	53181-69001
A3	53132-60003	5	1	OPTIONAL INPUT BOARDE (030 OR 015)	28480	53132-60003
	53132-69003	3	1	OPTIONAL INPUT BOARD (RESTORED)	28480	53132-69003
				ELECTRONIC ASSEMBLIES		
A2	53131-60002	3	1	DISPLAY BOARD	28480	53131-60002
A4 (Standard)	0950-2496	7	1	AC POWER SUPPLY (STANDARD)	28480	0950-2496
A4 (Option 002)	53132-60207	1	1	OPTIONAL AC POWER SUPPLY (002)	28480	53132-60207
A4 (Option 010/012)	53132-60208	2	1	OPTIONAL AC POWER SUPPLY (0-10 OR 012)	28480	53132-60208
A4 (Option 002 only)	53132-60206	0	1	OPTIONAL DC POWER SUPPLY (002)	28480	53132-60206
				CHASSIS PARTS		
H1	0515-0433	6	6	SCREW-MACH TORX 15	00000	ORDER BY DESCRIPTION
H2	0515-0430	3	3	SCREW-MACH TORX 10	00000	ORDER BY DESCRIPTION
H3	2940-0256	4	2	NUT-BNC	00000	ORDER BY DESCRIPTION
H4	0380-1332	7	2	SCREW-STDF, HP-IB CONN HEX	00000	ORDER BY DESCRIPTION
H5	2190-0577	1	2	WASKER-LOCK	00000	ORDER BY DESCRIPTION
H6	0590-0505		1	NUT-KNURLED	00000	ORDER BY DESCRIPTION
MP1	53131-00001	6	1	CHASSIS	28480	53131-00001
MP2	34401-86000	2	1	FRONT/REAR RUBBER BUMPER KIT	28480	34401-86000
MP3	53131-00002	5	1	COVER	28480	53131-80002
MP4	53131-40001	2	1	FRONT BEZEL	28480	53131-40001
MP5 (HP 53131A)	53131-40002	1	1	WINDOW FOR HP 53131A	28480	53131-40002
MP5 (HP 53132A)	53132-40001	1	1	WINDOW FOR HP 53132A	28480	53132-40001
MP5 (HP 53181A)	53181-40003	2	1	WINDOW FOR HP 53181A	28480	53181-40003
MP6 (HP 53131A/132A)	53131-40003	2		KEYPADS FOR HP 53131/132A	28480	53131-40003
MP6 (HP 53181A)	53181-40002	1		KEYPADS FOR HP 53181A	28480	53181-40002
MP7	34401-45001	7	1	HANDLE	28480	34401-45001
MP8	53131-80002	5	1	REAR LABEL	28480	53131-80002
MP9	6960-0167	2	3	PLUG, HOLE 0.5-IN DIA	28480	6960-0167
	0403-0424	8	1	RUBBER FOOT, BLACK	76381	SJ-5023
	5041-0564	4	1	CAP	28480	5041-0564

Table 5-3. HP 53131A/132A/181A Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
OPTION 001				**MEDIUM STABILITY TIMEBASE ASSY**		**OPTION 001**
A6	53132-60008	0	1	TIMEBASE SUPPORT BOARD	28480	53131-60008
	1813-0931	2	1	OSCILLATOR-OVEN	28480	1813-0931
H2	0515-0430	3	3	SCREW-MACH TORX 10	00000	ORDER BY DESCRIPTION
OPTION 002				**DC POWER INPUT ASSY**		**OPTION 002**
A5	53132-60206	0	1	DC POWER INPUT ASSY	28480	53132-60206
MP10	53131-00010	7	1	CHASSIS FOR OPT 002	28480	53131-00010
MP11	53131-80013	8	1	REAR LABEL	28480	53131-80013
	0515-0372	3	4	SCREW-MACH TORX 10 8MM LG	00000	ORDER BY DESCRIPTION
OPTION 010				**HIGH STABILITY TIMEBASE ASSY**		**OPTION 010**
A6	53132-60008	0	1	TIMEBASE SUKPPORT BOARD	28480	53132-60008
	53132-60208	2	3	AC POWER SUPPLY ASSY FOR OPT 010	28480	53132-60208
	10811-60211	9	1	OSCILLATOR-OVEN	28480	10811-60211
H2	0515-0430	3	3	SCREW-MACH TORX 10	00000	ORDER BY DESCRIPTION
H7	2360-0331	6	1	SCREW-MACH POZIDR 6-32 0.25-IN-LG	00000	ORDER BY DESCRIPTION
OPTION 012				**ULTRA-HIGH STABILITY TIMEBASE ASSY**		**OPTION 012**
A6	53132-60008	0	1	TIMEBASE SUPPORT BOARD	28480	53132-60008
	53132-60208	2	3	AC POWER SUPPLY ASSY FOR OPT 010	28480	53132-60208
	10811-60211	9	1	OSCILLATOR-OVEN	28480	10811-60211
H2	0515-0430	3	4	SCREW-MACH TORX 10	00000	ORDER BY DESCRIPTION
H7	2360-0331	6	1	SCREW-MACH POZIDR 6-32 0.25-IN-LG	00000	ORDER BY DESCRIPTION
OPTION 015				**1.5 GHz CHANNEL ASSY**		**OPTION 015**
A3	53132-60003	5	1	1.5 GHz CHANNEL ASSY	28480	53132-60003
	8120-6142	7	1	CABLE-COAXIAL INPUT	28480	8120-6142
	53181-40005	4	1	WINDOW, 1.5 GHz, FOR HP 53181A ONLY	28480	53181-40005
H2	0515-0430	3	4	SCREW-MACH TORX 10	00000	ORDER BY DESCRIPTION
OPTION 030				**3.0 GHz CHANNEL ASSY**		**OPTION 030**
	53131-67001	6	1	RETROFIT KIT, which includes:	28480	53131-67001
A3	53132-60003	5	1	3.0 GHz CHANNEL ASSY	28480	53132-60003
W1	8120-6142	7	1	CABLE-COAXIAL INPUT	28480	8120-6142
	53181-40004	3	1	WINDOW, 3.0 GHz, FOR HP 53181A ONLY	28480	53131-40004
H2	0515-0430	3	4	SCREW-MACH TORX 10	00000	ORDER BY DESCRIPTION
OPTION 050				**5.0 GHz CHANNEL ASSY**		**OPTION 050**
A3	53132-60211	7	1	5.0 GHz CHANNEL ASSY	28480	53132-60211
	0515-0430	3	3	SCREW-MACH TORX 10	00000	ORDER BY DESCRIPTION
MP4	53131-40006	5	1	BEZEL	28480	53131-40006
	0590-0505	1	1	KNURLED NUT	28480	0590-0505
	53131-00001	6	1	CHASSIS	28480	53131-00001
	53181-40007	6	1	WINDOW, 5 GHz, FOR HP 53181A ONLY	28480	53181-40007
OPTION 060				**REAR TERMINALS**		**OPTION 060**
W2	8120-6150	7	2	CABLE-COAXIAL ASSY (NOTE: ONLY ONE IS NEEDED FOR THE HP 53131A.)	28480	8120-06150
H6	3050-0962	3	2	WASHER-BNC	00000	ORDER BY DESCRIPTION
H3	2940-0256	4	2	NUT-BNC	00000	ORDER BY DESCRIPTION

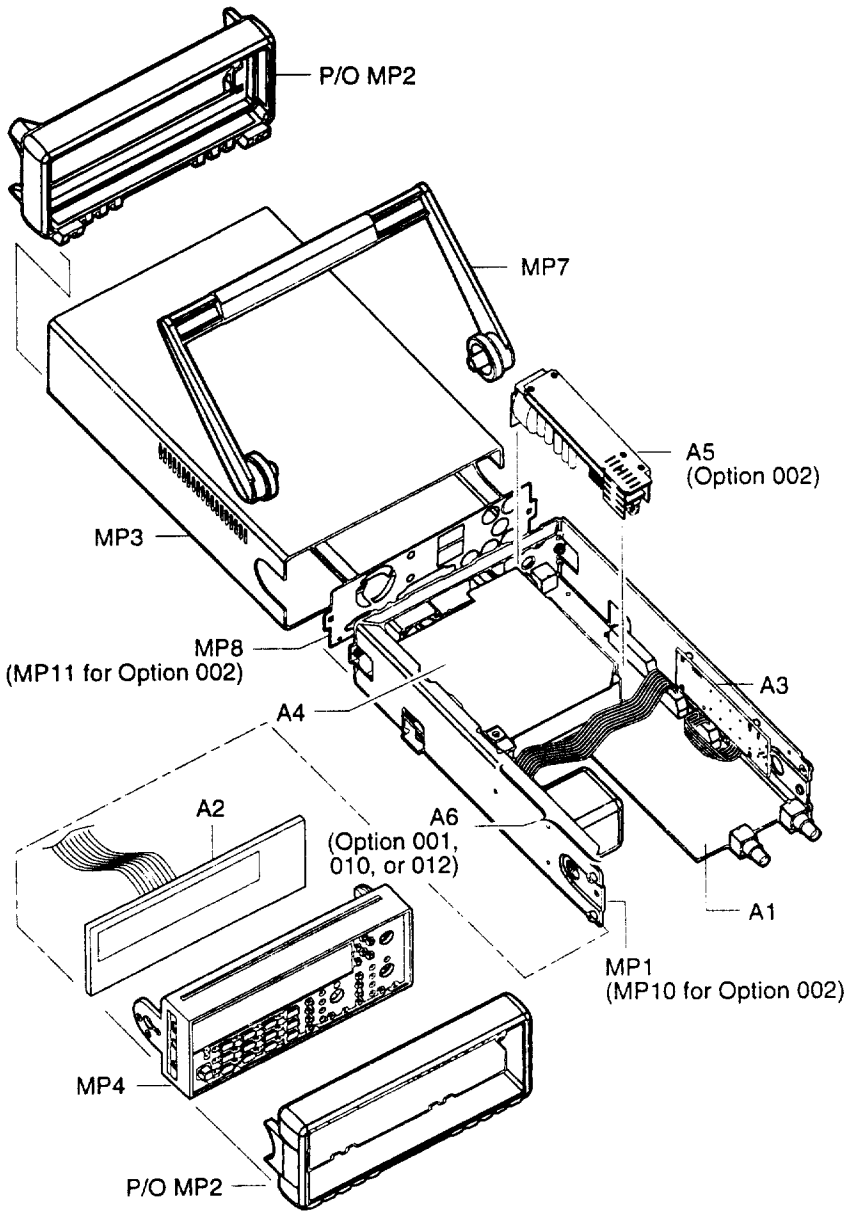


Figure 5-1. HP 53131A/132A/181A Exploded View (Chassis Parts and Assemblies)

Table 5-4. Manufacturer's Code List

Mfr Code	Manufacture Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
76381	3M CO	ST PAUL	MN	55144

6

Backdating

Manual Changes

Introduction

This chapter contains information necessary to adapt this guide to apply to older instruments.

Manual Changes

This guide applies directly to Counters with the following serial prefixes listed in Table 7-1.

Table 7-1. Instrument this Guide Directly Applies To

Instrument	Serial Prefix Number
HP 53131A Universal Counter	3416
HP 53132A Universal Counter	3404
HP 53181A Frequency Counter	3418

As engineering changes are made, newer instruments may have higher serial prefix numbers than the one shown on the title page of this guide. The guides for these instruments will be supplied with "Manual Updating Changes" package containing the required information. Replace the affected pages or modify existing guide information as directed in the pages of the Manual Updating Changes package. Contact the nearest Hewlett-Packard Sales and Support Office.

Older Instruments

To adapt this guide to older **HP 53131A** Counters having a serial prefix lower than 3416, perform the backdating provided in the following sections.

NOTE All of the following backdating applies to older HP 53131A Counters only.

Backdating Hardware

CHANGE 1 (Below Series Prefix 3416A) PCO 02-21774

This change deleted three unnecessary connectors from the A1 (53131-60001) board.

CHANGE 2 (Below Serial Number 3349A01906)

Page 5-7, Table 5-3. Replaceable Parts, under A1 (for the HP 53131A):

[1]Add 53131-00004; 9; 1; SHIELD UPPER; 28480; 53131-00004

[1]Add 53131-00005; 0; 1; SHIELD LOWER; 28480; 53131-00005

[1]Add 53131-00008; 3; 1; SHIELD CHASSIS; 28480; 53131-00008

[1]Add 53131-00009; 4: 1; GROUND CONNECTION 28480; 53131-00009

Change A4 (Standard) HP Part Number from 0950-2496 to 0950-2139.

Note: A4 AC Power Supply Assembly 0950-2496 allows 400 Hz operation from 100-120V.

[1]These shields were needed to reduce susceptibility to EMI. However, the shields are not needed on A1 Motherboard Assembly if the metalized front bezel is used in the Counter. Thus, when you order a new A1 Motherboard Assembly (53131-60001, same part number as the old A1) for your HP 53131A Counter, you need to order a new metalized front bezel (53131-40003, same part number of the old non-metalized front bezel).

CHANGE 3 (Below Serial Prefix 3404A)

Page 5-7, Table 5-3. Replaceable Parts:

Change, under OPTION 001, A6 HP Part Number from 53132-60008 to 53132-60004.

Change, under OPTION 001, 1812-0931; OSCILLATOR-OVEN; to 1812-0932; OSCILLATOR-OVEN.

Change, under OPTION 010, A6 HP Part Number from 53132-60008 to 53132-60005.

Change, under OPTION 011, 10811-60111; OSCILLATOR-OVEN; to BLILEY OSCILLATOR-OVEN.

Backdating Firmware

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427)

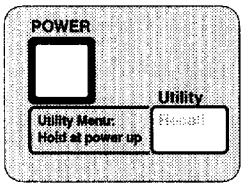
(Note: firmware revision 3413 added the new security menu item and the new Calibration Menu to the HP 53131A Counter.)

(Note: firmware revision 3427 was set up to work with the new FPGA [Xilinx 3042A]; and shortens TI delay from 1 ms to 100µs. This revision is backward compatible.

Pages 2-5 thru 2-22 ("About the HP 53131A/132A Calibration Menu," and "The HP 53131A/132A Calibration Procedures" sections).

Replace with the following calibration information and procedures:

About the HP 53131A Calibration Menu



The Utility menu is accessed by holding the **Recall** key and cycling **POWER** key.

The Utility menu's calibartion items, illustrated on the following page, provide you with the functions to:

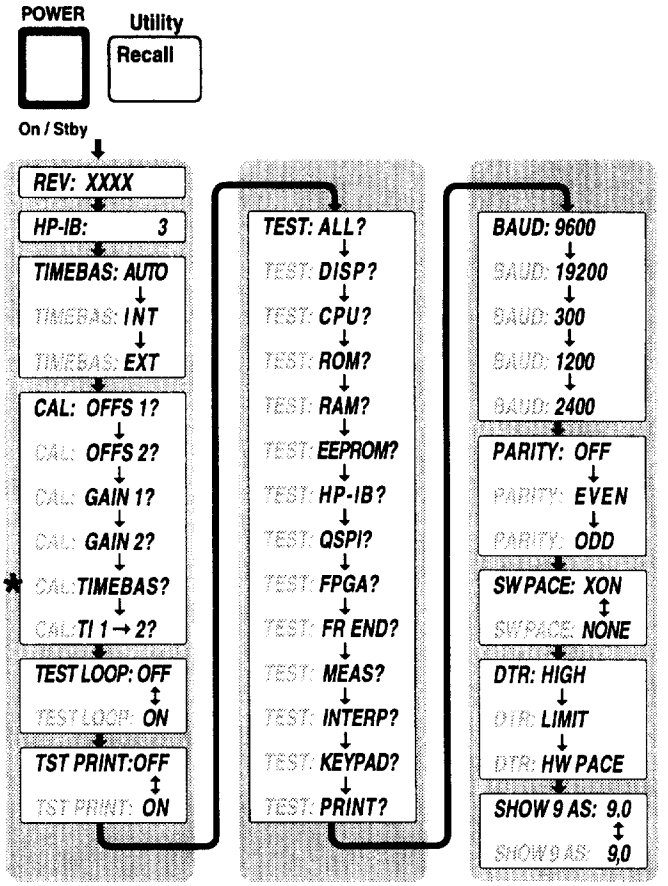
- initiate the Counter's calibration routines, which can perform automatic calibration of the voltage offset and gain of the front-end input amplifiers, and optional timebase (**CAL: OFFS 1 / 2 ?, GAIN 1 / 2 ?, TIMEBAS ?**, and **TI 1→2?**).

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427) (Continued)

The HP 53131A Utility/Calibration Menu Tree

NOTE

Turn power off, press and hold Recall (**Utility**) key, then press **POWER** key to access this menu.



*Timebase can be automatically calibrated only if the timebase option is installed.

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427) (Continued)

The HP 53131A Calibration Procedures

To Calibrate the Offset for Channels 1 and 2

1 **To access the Utility menu, power down, and press and hold the *Recall (Utility)* key, then press *POWER* key.**

2 **Press *Recall (Utility)* key until *CAL: OFFS 1 ?* is displayed.**

3 **Press *Enter* key.**

The display will ask you to remove any signals connected to Channel 1. Follow the instruction.

4 **Press *Enter* key.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***OFFS 1 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

5 **To calibrate Channel 2, press any one of the arrow keys until *CAL: OFFS 2 ?* is displayed.**

6 **Press *Enter* key.**

The display will ask you to remove any signals connected to Channel 2. Follow the instruction.

7 **Press *Enter* key.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***OFFS 2 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

This completes the Offset Calibration procedure. Proceed to the next procedure to calibrate the gain.

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427) (Continued)

To Calibrate the Gain for Channels 1 and 2

1 **Press any one of the arrow keys until *CAL: GAIN 1 ?* is displayed.**

2 **Press *Enter* key.**

A scrolling message is displayed. Follow the instruction by performing the following steps.

3 **Connect a BNC tee connector to Channel 1 of the Counter.**

4 **Connect the Counter, dc power supply, and multimeter as shown in Figure 2-1.**

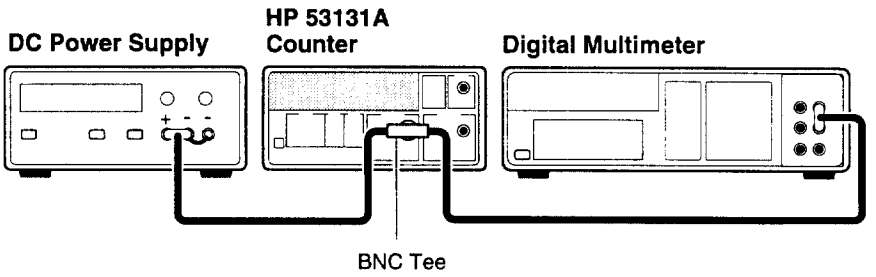


Figure 2-1. Gain Calibration Setup

5 **Adjust the power supply until the multimeter displays + 5.000 V ± 0.001 V.**

6 **Disconnect the digital multimeter from the Counter to prevent noise from being introduced into the measurement.**

7 **Press *Enter* key.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***GAIN 1 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427) (Continued)

8 **To calibrate the gain for Channel 2, connect the input or the BNC Tee to Channel 2 of the Counter.**

9 **Press any one of the arrow keys until *CAL: GAIN 2 ?* is displayed.**

10 **Press *Enter* key.**

A scrolling message is displayed. (The +5V dc supply should already be connected to Channel 2 as you were previously instructed to do this in step 8.)

11 **Press *Enter* key again.**

The Counter momentarily displays ***CALIBRATING***, and then it should display ***GAIN 2 PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

12 **Disconnect the calibration setup.**

This completes the Gain Calibration procedure. Proceed to the next procedure to calibrate the time interval.

To Calibrate Time Interval

1 **Press any one of the arrow keys until *CAL: TI → 2?* is displayed.**

2 **Press *Enter* key.**

A scrolling message with instructions appears. Follow the instruction by performing the following procedure

3 **Connect the HP 8130A Pulse Generator output to Channel 1 of the Counter as shown in Figure 2-3.**

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427) (Continued)

Equipment

HP 8130A Pulse Generator (or equivalent)
HP 10503A BNC Cable

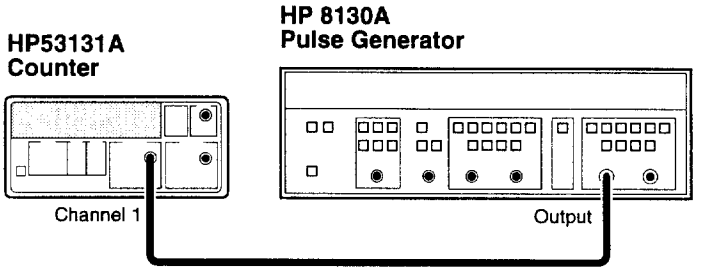


Figure 2-3. TI Calibration Setup

4 Set the HP 8130A as follows:

PERIOD: 100 ns
WIDTH: 50 ns
High: 0.50 V Low : –0.50 V
Input Mode: Normal

NOTE Any external timebase connected to the Counter is ignored during this calibration.

5 Press *Enter* key.

The Counter displays ***CALIBRATING***, and then it should display ***TI CAL PASS***.

If the fail message is displayed, refer to the troubleshooting section in this chapter.

6 Disconnect the calibration setup.

This completes the TI QUIK? calibration procedures.

Depending on which timebase the Counter contains, proceed to the following procedure "To Calibrate the Standard Timebase" or the "To Calibrate the High Stability Timebase Option (Medium or High)" procedure to calibrate the timebase.

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427) (Continued)

To Calibrate the Standard Timebase

1 **Connect the output of a 10 MHz house standard to Channel 1 of the Counter as shown in Figure 2-4.**

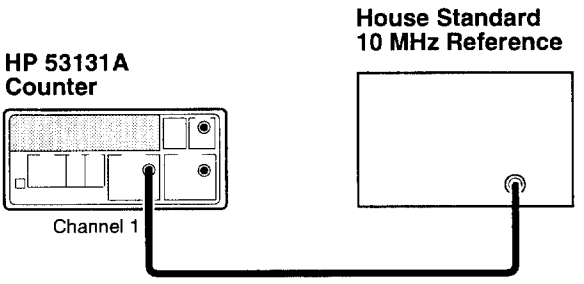


Figure 2-4. Standard Timebase Calibration Setup

2 **Cycle the *POWER* key to preset the Counter.**

3 **With an insulated tuning tool, turn the *OSC Adjust* potentiometer (located on the rear chassis of the Counter) until the frequency reading in the Counter display is 10.00000000 MHz ± 5 Hz.**

The Counter will be calibrated to the house standard.

If you are not able to adjust the frequency correctly, refer to the troubleshooting section in this chapter.

This completes the Standard Timebase Calibration procedure.

To Calibrate the High Stability Timebase Option (Medium or High)

NOTE

Allow the Counter to warm up for approximately 30 minutes before performing this calibration. This calibration is unlikely to fail, unless the Counter is not warmed up.

1 **Connect the output of a 10 MHz house standard to Channel 1 of the Counter as shown in Figure 2-4.**

2 **Press any one of the arrow keys until *CAL: TIMEBAS?* is displayed.**

Note that the timebase choice (CAL: TIMEBAS?) only appears when the Timebase Option is installed.

CHANGE 1 (Firmware Revisions 3317, 3335, 3402, 3427) (Continued)

3 **Press *Enter* key and follow the instructions in the scrolling message that appears in the Counter display.**

4 **Press *Enter* key after each instruction.**

The Counter displays ***CALIBRATING***, and then it should display ***TB CAL PASS***.

If the fail message is displayed (even after the Counter has been warmed up for 30 minutes), refer to the troubleshooting section in this chapter.

This completes the High Stability Timebase Option Calibration procedure.

If all tests passed, the Counter is now calibrated.

7

HP 53131A/132A Specifications

Introduction

The specifications of the HP 53131A/132A Universal Counter are shown in the following table.

Instrument Inputs

Channel 1 & 2 Input Specifications[1]

Frequency Range

DC Coupled:	DC to 225 MHz
AC Coupled:	1 MHz to 225 MHz (50 Ω) 30 Hz to 225 MHz (1 MΩ)
FM Tolerance:	25%

Voltage Range and Sensitivity (Sinusoid)[2]

DC to 100 MHz:	20 mVrms to ±5 V ac + dc (75 mVrms with optional rear connectors)[3]
100 MHz to 200 MHz:	30 mVrms to ±5 V ac + dc (75 mVrms with optional rear connectors)[3]
200 MHz to 225 MHz:	40 mVrms to ±5 V ac + dc (75 mVrms with optional rear connectors)[3]

Voltage Range and Sensitivity (Single-Shot Pulse)[2]

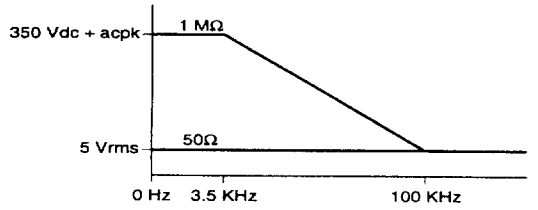
4.5 ns to 10 ns Pulse Width:	100 mVpp to 10 Vpp (150 mVpp with optional rear connectors)[3]
>10 ns Pulse Width:	50 mVpp to 10 Vpp (100 mVpp with optional rear connectors)[3]

Trigger Level[2]

Range:	±5.125 V
Accuracy:	±(15 mV + 1% of trigger level)
Resolution:	5 mV

Damage Level

50 Ω:	5 Vrms
0 to 3.5 kHz, 1 MΩ:	350 V dc + ac pk
3.5 kHz to 100 kHz, 1 MΩ:	350 V dc + ac pk linearly derated to 5 Vrms
>100 kHz, 1 MΩ:	5 Vrms



Channel 1 & 2 Input Characteristics[1]

Impedance:	1 MΩ or 50 Ω
1 MΩ Capacitance:	30 pF
Coupling:	AC or DC
Low-Pass Filter:	100 kHz (or disabled) -20 dB at > 1 MHz
Input Sensitivity:	Selectable between Low, Medium, or High (default). Low is approximately 2x High Sensitivity.

Trigger Slope: Positive or Negative

Auto Trigger Level

Range:	0 to 100% in 10% steps
Frequency:	> 100 Hz
Input Amplitude:	> 100 mVpp (No amplitude modulation)

Attenuator

Voltage Range:	x10
Trigger Range:	x10

[1]Specifications and Characteristics for Channels 1 and 2 are identical for both Common and Separate configurations.

[2]Values shown are for X1 attenuator setting. Multiply all values by 10 (nominal) when using the X10 attenuator setting. Note that it may be necessary to recalibrate the input offset in the application environment (especially at high temperature) to achieve maximum sensitivity.

[3]When ordered with optional rear terminals, the Channel 1 and 2 inputs are active on both the front and rear of the universal counter though the specifications provided only apply to the rear terminals. Performance for the front terminals is degraded, but may be improved by terminating the rear terminals into 50Ω.

Instrument Inputs (Continued)

Channel 3 Input Specifications[4, 5]

Frequency Range:

Option 030	100 MHz to 3 GHz
Option 050	150 MHz to 5 GHz

Power Range and Sensitivity (Sinusoid)

Option 030:

100 MHz to 2.7 GHz:	-27 dBm to +19 dBm
2.7 GHz to 3 GHz:	-21 dBm to +13 dBm

Option 050:

150 MHz to 5 GHz:	-24 dBm to +13 dBm

Damage Level:

Option 030	5 Vrms
Option 050	+34 dBm

Channel 3 Input Characteristics

Impedance:	50 Ω
Coupling:	AC
VSWR:	< 2.5:1

External Arm Input Specifications

Signal Input Range:

High-Level Input:	> 3.0 V
Low-Level Input:	< 1.5 V

Timing Restrictions:

Pulse Width:	> 50 ns
Transition Time:	< 250 ns
Start-to-Stop Time:	> 50 ns

Damage Level: 10 Vrms

Note: External Arm is referred to as External Gate for some measurements

External Arm Input Characteristics

Impedance:	1 kΩ
Input Capacitance:	17 pF
Start Slope:	Positive or Negative
Stop Slope:	Positive or Negative

Available for all measurements except Peak Volts.

[4]Channel 3 is available as an option.

[5]When ordered with optional rear terminals, the Channel 3 connector on the front panel for Option 030 will be routed to the rear panel (rear panel only). There is no degradation in specifications for this input.

NOTE Option 050 input connector is available on the front panel only.

Time Base

Internal Time Base Stability

	Standard (0° to 50°C)	Medium Stability Oven (Option 001)	High Stability Oven (Option 010)	Ultra High Stability Oven (Option 012)
Temperature Stability: (referenced to 25° C)	$< 5 \times 10^{-6}$	$< 2 \times 10^{-7}$	$< 2.5 \times 10^{-9}$	$< 2.5 \times 10^{-9}$
Aging Rate (after 30 days) Per Day:	$< 3 \times 10^{-7}$	$< 4 \times 10^{-8}$	$< 5 \times 10^{-10}$	$< 1 \times 10^{-10}$
Per Month:		$< 2 \times 10^{-7}$	$< 1.5 \times 10^{-8}$	$< 3 \times 10^{-9}$
Per Year:				$< 2 \times 10^{-8}$
Turn-on stability vs. time: (in 10 minutes)		$< 2 \times 10^{-7}$ (referenced to 2 hours)	$< 5 \times 10^{-9}$ (referenced to 24 hours)	$< 5 \times 10^{-9}$ (referenced to 24 hours)
Calibration:	Manual Adjust	Electronic	Electronic	Electronic

Note that power to the time base is maintained when the universal counter is placed in standby via the front panel switch. The internal fan will continue to operate under this condition, to maintain long-term instrument reliability.

External Time Base Input Specifications

Voltage Range: 200 mVrms to 10 Vrms
Damage Level: 10 Vrms

External Time Base Input Characteristics

Threshold: 0 V
Impedance: 1 kΩ
Input Capacitance: 23 pF
Frequency (53131A): 1 MHz, 5 MHz or 10 MHz (automatic selection)
Frequency (53132A): 10 MHz

Internal vs. External Time Base Selection:
Manual: select Internal or External
Automatic: Internal used when External not present (default)

Time Base Output Specifications

Output Frequency: 10 MHz
Voltage: > 1 Vpp into 50 Ω (centered around 0 V)

Measurement Specifications

Frequency, Period

Channel 1 and 2 Range: 0.1 Hz to 225 MHz 4.44 ns to 10 s
Channel 3 Range: 100 MHz to 3 GHz 0.33 ns to 10 ns
(Period 2 or 3 selectable only via the HP-IB interface)

For Automatic or External Arming:

(and signals < 100 Hz using Timed Arming)

LSD Displayed:

$$\left(\frac{t_{res}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

RMS Resolution:

$$\left(\frac{\sqrt{t_{res}^2 + (2 \times Trigger\ Error^2)}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

	HP 53131A t_{res}	HP 53132A t_{res}
typical	650 ps	200 ps

see graphs for worst case resolution performance

For Automatic Arming: $Gate\ Time = \frac{N}{Frequency}$

where N = 1 for Ch1 or Ch2 Frequency < 1 MHz
4 for Ch1 or Ch2 Frequency > 1 MHz
128 for Ch3

Systematic Uncertainty: $\left(\pm Time\ Base\ Error \pm \frac{t_{acc}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$

	HP 53131A t_{acc}	HP 53132A t_{acc}
typical	350 ps	100 ps
worst case	1.25 ns	500 ps

Trigger: Default setting is Auto Trigger at 50%

For Time or Digits Arming:

LSD Displayed:

$$\left(\frac{2\sqrt{2} \times t_{res}}{Gate\ Time \times \sqrt{Number\ of\ Samples}} + \frac{t_{jitter}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

RMS Resolution:

$$\left(\frac{4 \times \sqrt{t_{res}^2 + (2 \times Trigger\ Error^2)}}{Gate\ Time \times \sqrt{Number\ of\ Samples}} + \frac{t_{jitter}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

	HP 53131A t_{res}	HP 53131A t_{jitter}	HP 53132A t_{res}	HP 53132A t_{jitter}
typical	500 ps	50 ps	225 ps	3 ps

see graphs for worst case resolution performance

Number of Samples =
Gate Time × *Frequency* (Frequency < 200 kHz)
Gate Time × *200,000* (Frequency > 200 kHz)

Systematic Uncertainty: $\left(\pm Time\ Base\ Error \pm \frac{t_{acc}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$

	HP 53131A t_{acc}	HP 53132A t_{acc}
typical	100 ps	10 ps
worst case	300 ps	100 ps

Trigger: Default setting is Auto Trigger at 50%

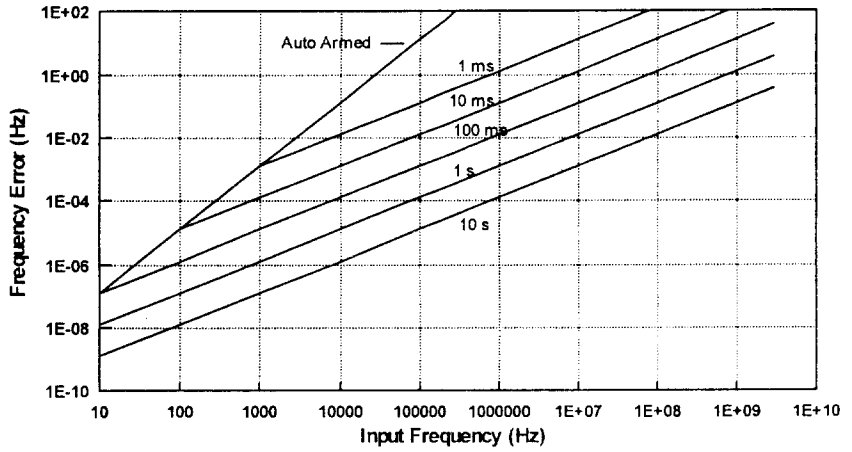
The following graphs may also be used to compute errors for Period Measurements. To find the Period error, invert the Period (P) of the input signal and find the frequency error (ΔF):

$$F = \frac{1}{P} \qquad \Delta P = \left(\frac{\Delta F}{F}\right) \times P$$

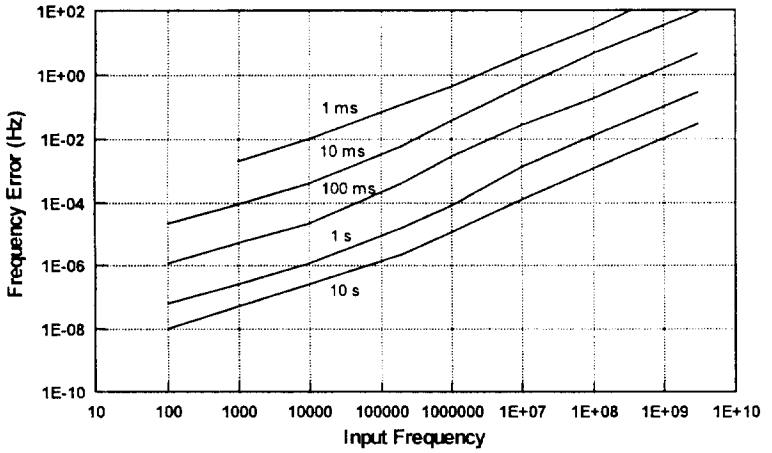
Measurement Specifications (Continued)

HP 53131A - Worst Case RMS Resolution

Automatic or External Arming:



Time or Digit Arming:



The preceding graphs do not reflect the effects of trigger error. To place an upper bound on the added effect of this error term, determine the frequency error from the appropriate graph and add a trigger error term as follows:

Automatic or External Arming

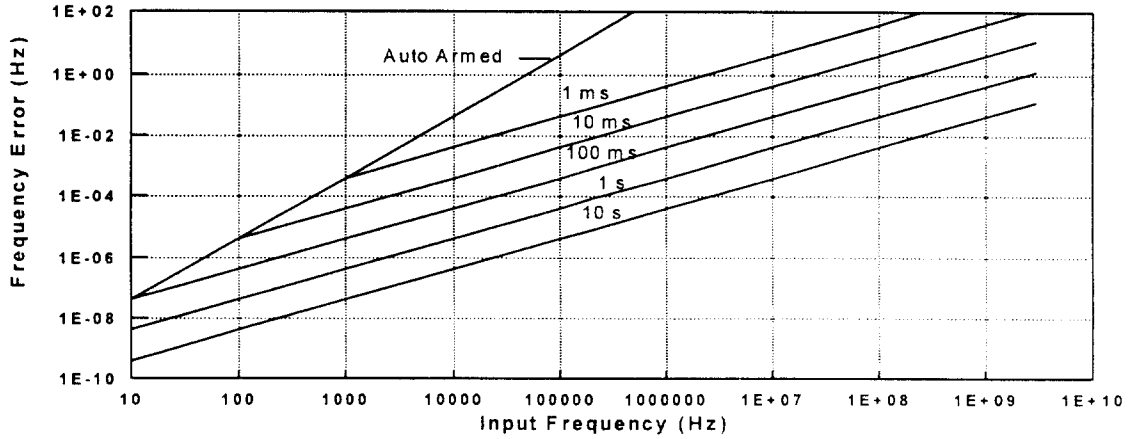
$$\text{Frequency Error} + \left(\frac{\sqrt{2} \times \text{Trigger Error}}{\text{Gate Time}} \right) \times \begin{matrix} \text{Frequency} \\ \text{or} \\ \text{Period} \end{matrix}$$

Time or Digit Arming

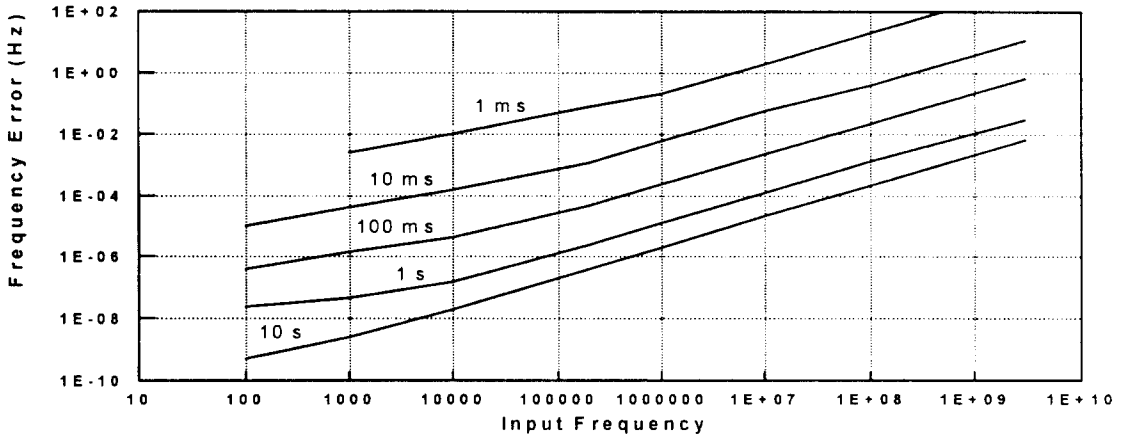
$$\text{Frequency Error} + \left(\frac{4 \times \sqrt{2} \times \text{Trigger Error}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}} \right) \times \begin{matrix} \text{Frequency} \\ \text{or} \\ \text{Period} \end{matrix}$$

HP 53132A - Worst Case RMS Resolution

Automatic or External Arming:



Time or Digit Arming:



The preceding graphs do not reflect the effects of trigger error. To place an upper bound on the added effect of this error term, determine the frequency error from the appropriate graph and add a trigger error term as follows:

Time or Digit Arming

$$\text{Frequency Error} + \left(\frac{4 \times \sqrt{2} \times \text{Trigger Error}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}} \right) \times \begin{matrix} \text{Frequency} \\ \text{or} \\ \text{Period} \end{matrix}$$

Automatic or External Arming

$$\text{Frequency Error} + \left(\frac{\sqrt{2} \times \text{Trigger Error}}{\text{Gate Time}} \right) \times \begin{matrix} \text{Frequency} \\ \text{or} \\ \text{Period} \end{matrix}$$

Measurement Specifications (Continued)

Frequency Measurement Example:

Given an HP 53132A with a High Stability Oven that was calibrated 3 days ago, measure a 15 MHz square wave signal (which has negligible trigger error) with a 1 second gate time. Compute the measurement error to within 2-sigma confidence.

$$\text{Measurement Error} = \text{Systematic Uncertainty} \pm 2 \times \text{RMS Resolution}$$

$$= \left(\left(\pm \text{Time Base Error} \pm \frac{t_{acc}}{\text{Gate Time}} \right) \pm 2 \times \left(\frac{4 \times \sqrt{t_{res}^2 + (2 \times \text{Trigger Error}^2)}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}} + \frac{t_{jitter}}{\text{Gate Time}} \right) \right) \times \text{Frequency}$$

$$\text{Number of Samples} = \text{200,000 since Frequency is greater than 200kHz and gate time equals 1 second}$$

$$\text{Time Base Error} = \text{Temperature Stability} + 3\text{Days} \times \text{Daily Aging Rate}$$

$$= 2.5 \times 10^{-9} + 3 \times \left(5 \times 10^{-10}\right)$$

$$= 4.0 \times 10^{-9}$$

$$\text{Measurement Error} = \left(\left(\pm 4.0 \times 10^{-9} \pm \frac{1 \times 10^{-11} s}{1s} \right) \pm 2 \times \left(\frac{4 \times \sqrt{\left(225 \times 10^{-12} s\right)^2 + (2 \times 0)}}{1s \times \sqrt{200{,}000}} + \frac{3 \times 10^{-12} s}{1s} \right) \right) \times 15MHz$$

$$= \left(\pm 4.0 \times 10^{-9} \pm 2 \times \left(2.01 \times 10^{-12} + 3 \times 10^{-12} \right) \right) \times 15MHz$$

$$= \left(\pm 4.0 \times 10^{-9} \pm 1 \times 10^{-11} \right) \times 15MHz$$

$$= \pm 60.2mHz$$

Which is to say that the HP 53132A would display results in the range 15 MHz ±60.2 mHz. Note however that the dominant error is the Time Base Error. If an even higher stability time base is available external to the instrument or if the instrument can be source locked to the 15 MHz signal, then this error term can be substantially reduced. The measurement resolution under these conditions is ±75μHz (1 sigma) which determines the number of digits displayed.

Measurement Specifications (Continued)

Time Interval

Measurement is specified over the full signal ranges[7] of Channels 1 and 2.

Results Range: -1 ns to 10^5 s

	53131A	53132A
LSD:	500 ps	150 ps

RMS Resolution: $\sqrt{t_{res}^2 + \text{Start Trigger Error}^2 + \text{Stop Trigger Error}^2}$

	53131A	53132A
t_{res}	750 ps	300 ps

Systematic Uncertainty: $\pm(\text{Time Base Error} \times TI) \pm \text{Trigger Level Timing Error}$ *±1.5 ns Differential Channel Error (HP 53131A)* *±900 ps Differential Channel Error (HP 53132A)*

Time Interval Delay

After a Time Interval Measurement has begun by satisfying the trigger conditions on Channel 1, the instrument will wait for the user-entered delay time to elapse before the end-of-measurement trigger will be accepted on Channel 2. The valid range of delay is 1 µs to 10s.

Frequency Ratio: $Ch1/Ch2$ $Ch1/Ch3$ $Ch2/Ch1$ $Ch3/Ch1$

Measurement is specified over the full signal range of each input.

Results Range: 10^{-10} to 10^{11}

'Auto' Gate Time: 100 ms (or sufficient cycles on Channel 2 or 3 to make a valid measurement, whichever is longer)

LSD:

$$\text{Ratio } 1/2: \frac{1}{Ch2\ Freq \times Gate\ Time} \qquad \text{Ratio } 1/3: \frac{1}{Ch3\ Freq \times Gate\ Time}$$

$$\text{Ratio } 2/1: \frac{Ch2\ Freq}{(Ch1\ Freq)^2 \times Gate\ Time} \qquad \text{Ratio } 3/1: \frac{Ch3\ Freq}{(Ch1\ Freq)^2 \times Gate\ Time}$$

RMS Resolution:

$$\text{Ratio } 1/2: \frac{2 \times \sqrt{1 + (Ch1\ Freq \times Ch2\ Trigger\ Error)^2}}{Ch2\ Freq \times Gate\ Time} \qquad \text{Ratio } 1/3: \frac{2 \times \sqrt{1 + (Ch1\ Freq \times Ch3\ Trigger\ Error)^2}}{Ch3\ Freq \times Gate\ Time}$$

$$\text{Ratio } 2/1: \frac{2 \times Ch2\ Freq \times \sqrt{1 + (Ch1\ Freq \times Ch2\ Trigger\ Error)^2}}{(Ch1\ Freq)^2 \times Gate\ Time} \qquad \text{Ratio } 3/1: \frac{2 \times Ch3\ Freq \times \sqrt{1 + (Ch1\ Freq \times Ch3\ Trigger\ Error)^2}}{(Ch1\ Freq)^2 \times Gate\ Time}$$

To minimize relative phase measurement error, connect the higher frequency signal to Channel 1 when possible.

[7] See Specifications for Pulse Width and Rise/Fall Time measurements for additional restrictions on signal timing characteristics

Measurement Specifications (Continued)

Pulse Width

Measurement is specified over the full signal range of Channel 1. The width of the opposing pulse must be greater than 4 ns (e.g., when measuring the positive pulse width, the negative pulse width must be greater than 4 ns).

Pulse Selection: Positive or Negative

Trigger: Default setting is Auto Trigger[8] at 50%

Results Range: 5 ns to 10^5 s

	53131A	53132A
LSD:	500 ps	150 ps

RMS Resolution: $\sqrt{t_{res}^2 + Start\ Trigger\ Error^2 + Stop\ Trigger\ Error^2}$

	53131A	53132A
t_{res}	750 ps	300 ps

Systematic Uncertainty: $\pm(Time\ Base\ Error \times Pulse\ Width) \pm Trigger\ Level\ Timing\ Error$

±1.5 ns Differential Channel Error (HP 53131A)
±900 ps Differential Channel Error (HP 53132A)

Rise/Fall Time

Measurement is specified over the full signal ranges of Channel 1. The interval between the end of one edge and start of a similar edge must be greater than 4 ns. (e.g., when measuring a rising edge, 4 ns must elapse between the 90% point of one rising edge and the 10% point of the next rising edge).

Edge Selection: Positive or Negative

Trigger: Default setting is Auto Trigger[8] at 10% and 90%

Results Range: 5 ns to 10^5 s

	53131A	53132A
LSD:	500 ps	150 ps

RMS Resolution: $\sqrt{t_{res}^2 + Start\ Trigger\ Error^2 + Stop\ Trigger\ Error^2}$

	53131A	53132A
t_{res}	750 ps	300 ps

Systematic Uncertainty: $\pm(Time\ Base\ Error \times Transition\ Time) \pm Trigger\ Level\ Timing\ Error$

±1.5 ns Differential Channel Error (HP 53131A)
±900 ps Differential Channel Error (HP 53132A)

Phase

Measurement is specified over the full signal range of Channels 1 and 2.

Results Range: -180° to +360°

RMS Resolution: $\sqrt{\left(t_{res}^2 + (2 \times Trigger\ Error^2)\right) \times \left(1 + \left(\frac{Phase}{360°}\right)^2\right)} \times Frequency \times 360°$

	53131A	53132A
t_{res}	750 ps	300 ps

Systematic Uncertainty: $(\pm Trigger\ Level\ Timing\ Error \pm 1.5\ ns\ Differential\ Channel\ Error) \times Frequency \times 360°$ *(HP 53131A)*
$(\pm Trigger\ Level\ Timing\ Error \pm 900\ ps\ Differential\ Channel\ Error) \times Frequency \times 360°$ *(HP 53132A)*

[8]Restrictions noted on page 7-2 for Auto Trigger apply to the proper operation of these measurements. The Peak Volts measurement is used to determine the signal amplitude and inaccuracies from this, noted on page 7-11, should be included in calculating the Trigger Level Timing Error.

Measurement Specifications (Continued)

Duty Cycle

Measurement is specified over the full signal range of Channel 1. However, both the positive and negative pulse widths must be greater than 4 ns.

Results Range: 0 to 1 (e.g. 50% duty cycle would be displayed as .5)

RMS Resolution: $\sqrt{\left(t_{res}^2 + (2 \times Trigger\ Error^2)\right) \times \left(1 + Duty\ Cycle^2\right)} \times Frequency$

	53131A	53132A
t_{res}	750 ps	300 ps

Systematic Uncertainty: $\left(\pm Trigger\ Level\ Timing\ Error \pm 1.5\ ns\ Differential\ Channel\ Error\right) \times Frequency\ (HP\ 53131A)$
$\left(\pm Trigger\ Level\ Timing\ Error \pm 900\ ps\ Differential\ Channel\ Error\right) \times Frequency\ (HP\ 53132A)$

Totalize

Measurement is specified over the full signal range of Channel 1.

Results Range: 0 to 10^{15}

Resolution: ± 1 count

Peak Volts

Measurement is specified on Channels 1 and 2 for DC signals; or for AC signals of frequencies between 100 Hz and 30 MHz with peak-to-peak amplitude greater than 100 mV. (The measurement will continue to operate up to 225 MHz, though results are for indication only.)

Results Range: -5.1 V to +5.1 V

Resolution: 10 mV

Systematic Uncertainty for AC signals: 25 mV + 10% of V
for DC signals: 25 mV + 2% of V

Use of the input attenuator multiplies all voltage specifications (input range, results range, resolution and systematic uncertainty) by a nominal factor of 10. For example with AC signals, the Systematic Uncertainty becomes: 250 mV + 10% of V.

Measurement Definitions

Definitions of Systematic Uncertainty Terms

- **Trigger Error**

  External source and input amplifier noise may advance or delay the trigger points that define the beginning and end of a measurement. The resulting timing uncertainty is a function of the slew rate of the signal and the amplitude of spurious noise spikes (relative to the input hysteresis band).

  The (rms) trigger error associated with a single trigger point is:

$$\text{Trigger Error} = \frac{\sqrt{(E_{input})^2 + (E_{signal})^2}}{\textit{Input Signal Slew Rate at Trigger Point}} \text{ (in seconds)}$$

  where

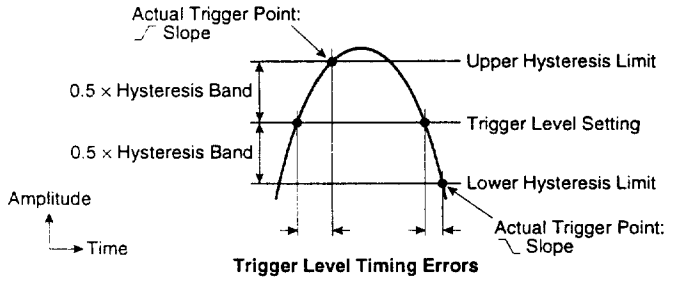
  E_{input} = RMS noise of the input amplifier: 1 mVrms (350 μVrms typical). Note that the internal measurement algorithms significantly reduce the contribution of this term.

  E_{signal} = RMS noise of the input signal over a 225-MHz bandwidth (100-kHz bandwidth when the low-pass filter is enabled). Note that the filter may substantially degrade the signal's slew rate at the input of the trigger comparator.

  For two-trigger-point measurements (e.g. Rise Time, Pulse Width), the Trigger Errors will be referred to independently as Start Trigger Error and Stop Trigger Error.

- **Trigger Level Timing Error**

  Trigger level timing error results from a deviation of the actual trigger level from the specified (indicated) level. The magnitude of the measurement timing error depends on several factors, primarily: resolution and accuracy of the trigger level circuit, fidelity of the input amplifier, slew rate of the input signal at the trigger point, and width of the input hysteresis band (see illustration).



Trigger Level Timing Errors

  Trigger level timing error is associated with Time Interval, Pulse Width, Rise Time, Fall Time, Phase, and Duty Cycle measurements. The following equations define the general interpretation of its component error terms for a measurement. These should be summed together to obtain the overall Trigger Level Timing Error.

Measurement Definitions (Continued)

Input Hysteresis: $\frac{0.5 \times \text{Hysteresis Band}}{\text{Input Signal Slew Rate at Start Trigger Point}} - \frac{0.5 \times \text{Hysteresis Band}}{\text{Input Signal Slew Rate at Stop Trigger Point}}$

Trigger Level Setting: $\pm \frac{15\ mV \pm (1\% \times \text{Start Trigger Level Setting})}{\text{Input Signal Slew Rate at Start Trigger Point}} \pm \frac{15\ mV \pm (1\% \times \text{Stop Trigger Level Setting})}{\text{Input Signal Slew Rate at Stop Trigger Point}}$

- **Fractional Time Base Error**

Time base error is the maximum fractional frequency variation of the time base due to aging or fluctuations in ambient temperature or line voltage:

Time Base Error = $\left(\frac{\Delta f}{f}\right)_{aging\ rate} + \left(\frac{\Delta f}{f}\right)_{temperature} + \left(\frac{\Delta f}{f}\right)_{line\ voltage}$

Multiply this quantity by the measurement result to yield the absolute error for that measurement. Averaging measurements will not reduce (fractional) time base error. The HP 53131A/132A universal counters exhibit negligible sensitivity to line voltage; consequently this term may be ignored.

- **Typical versus Worst Case Specifications**

Specifications identified as "Typical" represent performance of the instrument that the majority of users will perceive under a wide variety of conditions and signals. The specifications identified as "Worst Case" should be used when the instrument is under extreme environmental conditions or when the accuracy of the measurement results are critically important.

- **Differential Channel Error**

The Differential Channel Error term included in many of the Systematic Uncertainty equations accounts for channel-to-channel mismatch and internal noise. This error can be substantially reduced by performing the TI Calibration in the temperature environment in which future measurements are to be made and by careful measurement technique. Calibration is accessible via the Calibration Menu during power-up.

- **Additional Considerations for Digits and Time Arming Modes**

For sample rates defined below, resolution will be reduced by up to 1 decade. The instrument display detects this condition and displays a reduced resolution result. Resolution is reduced in a band about f_S such that

$$x.y = \frac{10MHz}{f_S}$$

where x is any integer, and y is any fraction in the set:

$$\{0,\ 1/2, 1/3, 2/3, 1/4, 2/4, 3/4, 1/5, 2/5, 3/5, 4/5, \ldots\}$$

For Example:

$$25.25 = \frac{10MHz}{396{,}039.6}$$

$x = 25$

$y = 0.25 = 1/4$

The width of the band is at most:

$$\pm \frac{6 \times 10^{-7} \times f_{input}}{\text{Gate Time}}$$

The value of f_S is not available to the user, but the instrument can be queried over HP-IB to determine if this condition exists. After the measurement completes, use the query :DIAGnostic:MEASure:PRESolution? The response is an ASCII text formatted string "Ø" for normal resolution and "1" for reduced resolution. This command is valid only when making frequency measurements in time or digits arming and the input frequency is greater than 100 Hz.

Measurement Arming and Processing

Gate Time

Auto Mode, or 1 ms to 1000 s

Measurement Throughput

HP-IB ASCII: 200 Measurements/s (maximum)
(See examples in the Programming Guide for ways to optimize measurement throughput)

Measurement Arming

Start Measurement: Free Run, Manual, or External
Stop Measurement: Continuous, Single, External, or Timed
Time Interval Delayed Arming: 1 µs to 10 s
Arming Modes:
(Note that not all arming modes are available for every measurement function.)

Auto Arming: Measurements are initiated immediately and acquired as fast as possible, using a minimum number of signal edges. Auto arming offers the highest measurement throughput, though measurement resolution may be reduced.

Timed Arming: The duration of the measurement is internally timed to a user-specified value (also known as the "gate time"). This mode should be used when the length of the measurement time must be controlled.

Digits Arming: Measurements are performed to the requested resolution (number of digits) through automatic selection of the acquisition time. This is the most convenient mode for when a specific measurement resolution is desired.

External Arming: An edge on the External Arm Input enables the start of each measurement. Auto Arming, Timed arming modes or another edge on the External Arm Input may be used to complete the measurement.

Time Interval Delayed Arming: For Time Interval measurements, the Stop Measurement condition on Channel 2 is inhibited for a user-specified time following the Start Measurement on Channel 1.

Measurement Statistics

Available Statistics: Mean, Minimum, Maximum, Standard Deviation
Number of Measurements: 2 to 1,000,000. Statistics may be collected on all measurements or on only those which are between the limit bands. When the Limits function is used in conjunction with Statistics, N (number of measurements) refers to the number of in-limit measurements. In general, measurement resolution will improve in proportion to $\sqrt{N}$, up to the numerical processing limits of the instrument.
Measurements: Statistics may be collected for all measurements except Peak Volts and Totalize.

Measurement Limits

Limit Checking: The measurement value is checked against user-specified limits at the end of each measurement.
Display Modes: The measurement result may be displayed as either the traditional numeric value or graphically as an asterisk moving between two vertical bars. These bars define the upper and lower limits, and the asterisk represents the current measurement result relative to these limits.
Out-of-Limits Indication: The out-of-limits condition can be indicated by any of the following methods:

- The limits annunciator will light on the front panel display.
- The instrument will generate an SRQ if enabled via HP-IB.
- The limits hardware signal provided via the RS-232 connector will go low for the duration of the out-of-limit condition (see the description of this connector under the General Information section of this specifications table).
- If the Analog Display mode is enabled, the asterisk appears outside the vertical bars, which define the upper and lower limits.

General Information

Save and Recall: Up to 20 complete instrument setups may be saved and recalled later. These setups are retained when power is removed from the universal counter.

Rack Dimensions (HxWxD): 88.5 mm x 212.6 mm x 348.3 mm

Weight: 3.5 kg maximum

	AC Line Supply	DC Supply (Option 002 Only)
Power Supply Voltage:	100 to 120 VAC ±10% - 50, 60 or 400 Hz ±10% 220 to 240 VAC ±10% - 50 or 60 Hz ±10%	10 to 32 VDC, 3-pin male XLR connector
	AC Line Voltage Selection: Automatic	Option 002 may not be ordered with Option 060
Power Requirements:	170 VA maximum (30 W typical)	4A initial inrush at 10 VDC 3A max, once stabilized

Operating Environment: 0°C to 55°C

Storage Environment: -40°C to 71°C

Remote Interface: HP-IB (IEEE 488.1-1987, IEEE 488.2-1987)

HP-IB Interface Capabilities: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2

Remote Programming Language: SCPI-1992.0 (Standard Commands for Programmable Instruments)

Safety: Designed in compliance with IEC 1010-1, UL 3111-1 (draft), CAN/CSA 1010.1

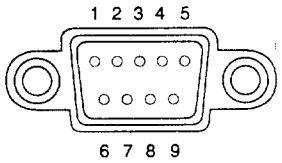
EMC: CISPR-11, EN50082-1, IEC 801-2, -3, -4

Electrostatic Discharge and Fast Transient/Burst Immunity Testing: When the product is operated at maximum sensitivity (20 mVrms) and tested with 8kV AD according to IEC801-2 or with 1kV power line transients according to IEC 801-4, frequency miscounts may occur that will affect measurement data made during these disturbances.

Radiated Immunity Testing: When the product is operated at maximum sensitivity (20 mVrms) and tested at 3 V/m according to IEC 801-3, external 100 to 200 MHz electric fields may cause frequency miscounts.

RS-232C: The rear-panel RS-232 connector is a 9-pin connector (DB-9, male). You can connect the universal counter to any terminal or printer with a properly configured DTE connector (DB-25). You can use a standard interface cable (HP part number 24542G or 24542H). Data is "output only"; the instrument can not be programmed via the RS-232 interface.

Note on pin 4: May be used as either a DTR signal or an indication of measurement in-limit as configured by the Utility menu. When used as an in-limit indicator, the signal will be high for every measurement within the user set limits.



Pin Number	Type	Description
2	Input	Receive Data (RxD) (for Xon/Xoff only)
3	Output	Transmit Data (TxD)
4	Output	Data Terminal Ready (DTR) Measurement In-Limit Signal
5	—	Signal Ground
6	Input	Data Set Ready (DSR)
*	All other pins: no connection	

8

HP 53181A Specifications

Introduction

The specifications of the HP 53181A Frequency Counter are shown in the following table.

Instrument Inputs

Channel 1 Input Specifications

Frequency Range

DC Coupled:	DC to 225 MHz
AC Coupled:	1 MHz to 225 MHz (50 Ω) 30 Hz to 225 MHz (1 MΩ)
FM Tolerance:	25%

Voltage Range and Sensitivity (Sinusoid)[1]

DC to 100 MHz:	20 mVrms to ±5 V ac + dc (75 mVrms with optional rear connector)[2]
100 MHz to 200 MHz:	30 mVrms to ±5 V ac + dc (75 mVrms with optional rear connector)[2]
200 MHz to 225 MHz:	40 mVrms to ±5 V ac + dc (75 mVrms with optional rear connector)[2]

Voltage Range and Sensitivity (Single-Shot Pulse)[1]

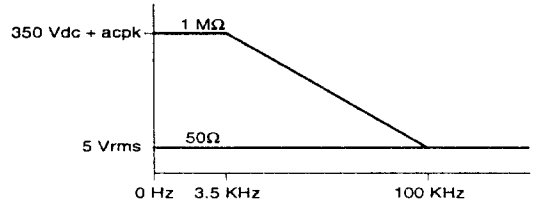
4.5 ns to 10 ns Pulse Width:	100 mVpp to 10 Vpp (150 mVpp with optional rear connector)[2]
>10 ns Pulse Width:	50 mVpp to 10 Vpp (100 mVpp with optional rear connector)[2]

Trigger Level[2]

Range:	±5.125 V
Accuracy:	±(15 mV + 1% of trigger level)
Resolution:	5 mV

Damage Level

50 Ω:	5 Vrms
0 to 3.5 kHz, 1 MΩ:	350 V dc + ac pk
3.5 kHz to 100 kHz, 1 MΩ:	350 V dc + ac pk linearly derated to 5 Vrms
>100 kHz, 1 MΩ:	5 Vrms



Channel 1 Input Characteristics

Impedance:	1 MΩ or 50 Ω
1 MΩ Capacitance:	30 pF
Coupling:	AC or DC
Low-Pass Filter:	100 kHz (or disabled) -20 dB at > 1 MHz
Input Sensitivity:	Selectable between Low, Medium, or High (default). Low is approximately 2x High Sensitivity.
Trigger Slope:	Positive or Negative

Auto Trigger Level

Range:	0 to 100% in 10% steps
Frequency:	> 100 Hz
Input Amplitude:	> 100 mVpp (No amplitude modulation)

Attenuator

Voltage Range:	x10
Trigger Range:	x10

[1]Values shown are for X1 attenuator setting. Multiply all values by 10 (nominal) when using the X10 attenuator setting. Note that it may be necessary to recalibrate the input offset in the application environment (especially at high temperature) to achieve maximum sensitivity.

[2]When ordered with optional rear terminal, the Channel 1 input is active on both the front and rear of the counter though the specifications provided only apply to the rear terminal. Performance for the front terminal is degraded, but may be improved by terminating the rear terminal into 50Ω.

Instrument Inputs (Continued)

Channel 2 Input Specifications[3, 4]

Frequency Range:

Opt. 015	100 MHz to 1.5 GHz
Opt. 030	100 MHz to 3 GHz
Opt. 050	150 MHz to 5 GHz

Power Range and Sensitivity (Sinusoid)

Option 015, 030

100 MHz to 2.7 GHz:	-27 dBm to +19 dBm
2.7 GHz to 3 GHz:	-21 dBm to +13 dBm

Option 050

5.0 GHz to 5 GHz:	-24 dBm to +13 dBm

Damage Level:

Option 015, 030:	5 Vrms
Option 050:	+34 dBm

Channel 2 Input Characteristics

Impedance:	50 Ω
Coupling:	AC
VSWR:	< 2.5:1

External Arm Input Specifications

Signal Input Range:

High-Level Input:	> 3.0 V
Low-Level Input:	< 1.5 V

Timing Restrictions:

Pulse Width:	> 50 ns
Transition Time:	< 250 ns
Start-to-Stop Time:	> 50 ns

Damage Level: 10 Vrms

Note: External Arm is referred to as External Gate for some measurements

External Arm Input Characteristics

Impedance:	1 kΩ
Input Capacitance:	17 pF
Start Slope:	Positive or Negative
Stop Slope:	Positive or Negative

Available for all measurements except Peak Volts.

[3]Channel 2 is available as an option.

[4]When ordered with optional rear terminals, the Channel 2 connector on the front panel will be removed. There is no degradation in specifications for this input.

Time Base

Internal Time Base Stability

		Standard (0° to 50°C)	Medium Stability Oven (Option 001)	High Stability Oven (Option 010)	Ultra High Stability Oven (Option 012)
Temperature Stability: (referenced to 25° C)		< 5×10^{-6}	< 2×10^{-7}	< 2.5×10^{-9}	< 2.5×10^{-9}
Aging Rate (after 30 days)	Per Day:	< 3×10^{-7}	< 4×10^{-8}	< 5×10^{-10}	< 1×10^{-10}
	Per Month:		< 2×10^{-7}	< 1.5×10^{-8}	< 3×10^{-9}
	Per Year:				< 2×10^{-8}
Turn-on stability vs. time: (in 10 minutes)			< 2×10^{-7} (referenced to 2 hours)	< 5×10^{-9} (referenced to 24 hours)	< 5×10^{-9} (referenced to 24 hours)
Calibration:		Manual Adjust	Electronic	Electronic	Electronic

Note that power to the time base is maintained when the universal counter is placed in standby via the front panel switch. The internal fan will continue to operate under this condition, to maintain long-term instrument reliability.

External Time Base Input Specifications

Voltage Range: 200 mVrms to 10 Vrms
Damage Level: 10 Vrms

External Time Base Input Characteristics

Threshold: 0 V
Impedance: 1 kΩ
Input Capacitance: 23 pF
Frequency: 1 MHz, 5 MHz or 10 MHz (automatic selection)

Internal vs. External Time Base Selection:
Manual: select Internal or External
Automatic: Internal used when External not present (default)

Time Base Output Specifications

Output Frequency: 10 MHz
Voltage: > 1 Vpp into 50 Ω (centered around 0 V)

Measurement Specifications

Frequency, Period

Channel 1 Range:	0.1 Hz to 225 MHz	4.44 ns to 10 s
Channel 2 Range:	Opt. 015 100 MHz to 1.5 GHz	0.67 ns to 10 ns
	Opt. 030 100 MHz to 3 GHz	0.33 ns to 10 ns

(Period 2 selectable only via the HP-IB interface)

For Automatic or External Arming:

(and signals < 100 Hz using Timed Arming)

LSD Displayed:

$$\left(\frac{t_{res}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

RMS Resolution:

$$\left(\frac{\sqrt{t_{res}^2 + (2 \times Trigger\ Error^2)}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

t_{res}: 650 ps typical[5]

For Automatic Arming: $Gate\ Time = \frac{N}{Frequency}$

where N = 1 for Ch1 Frequency < 1 MHz
4 for Ch1 Frequency > 1 MHz
128 for Ch2

Systematic Uncertainty: $\left(\pm Time\ Base\ Error \pm \frac{t_{acc}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$

t_{acc}: 350 ps typical
1.25 ns worst case

Trigger: Default setting is Auto Trigger at 50%

For Time or Digits Arming:

LSD Displayed:

$$\left(\frac{2\sqrt{2} \times t_{res}}{Gate\ Time \times \sqrt{Number\ of\ Samples}} + \frac{t_{jitter}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

RMS Resolution:

$$\left(\frac{4 \times \sqrt{t_{res}^2 + (2 \times Trigger\ Error^2)}}{Gate\ Time \times \sqrt{Number\ of\ Samples}} + \frac{t_{jitter}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

t_{res}: 500 ps typical[5]
t_{jitter}: 50 ps typical[5]

Number of Samples =
Gate Time × *Frequency* (Frequency < 200 kHz)
Gate Time × *200,000* (Frequency > 200 kHz)

Systematic Uncertainty: $\left(\pm Time\ Base\ Error \pm \frac{t_{acc}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$

t_{acc}: 100 ps typical
300 ps worst case

Trigger: Default setting is Auto Trigger at 50%

The following graphs may also be used to compute errors for Period Measurements. To find the Period error, invert the Period (P) of the input signal and find the frequency error (ΔF):

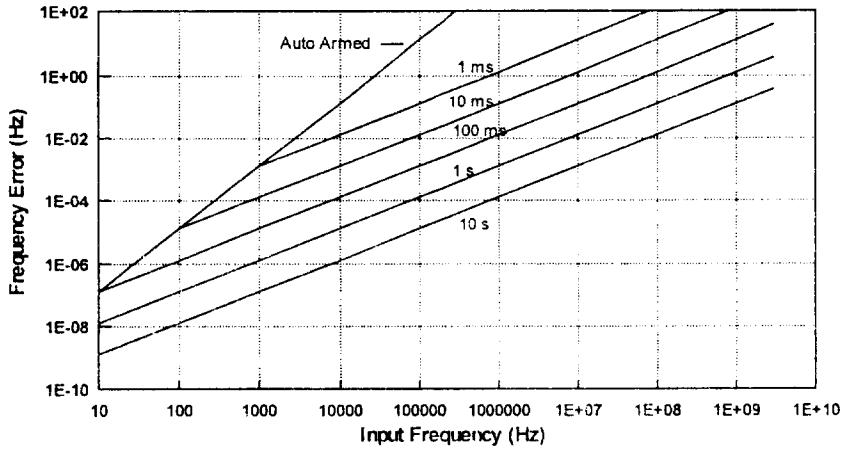
$$F = \frac{1}{P} \qquad \Delta P = \left(\frac{\Delta F}{F}\right) \times P$$

[5]See graphs on the following page for worst case resolution performance.

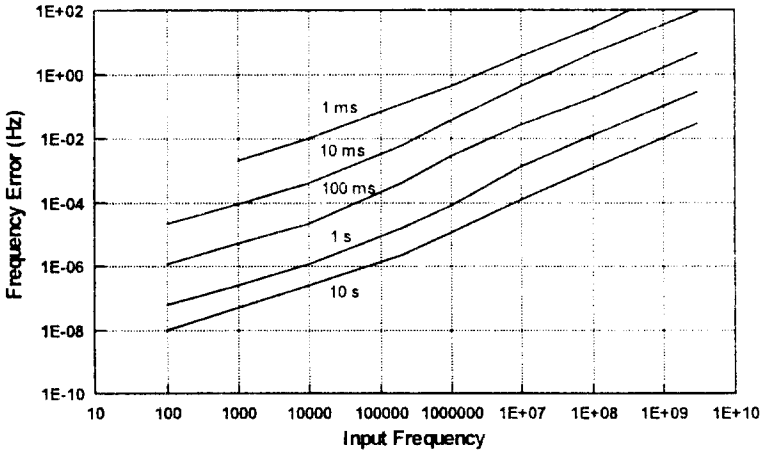
Measurement Specifications (Continued)

Worst Case RMS Resolution

Automatic or External Arming:



Time or Digit Arming:



The preceding graphs do not reflect the effects of trigger error. To place an upper bound on the added effect of this error term, determine the frequency error from the appropriate graph and add a trigger error term as follows:

Automatic or External Arming

$$\text{Frequency Error} + \left(\frac{\sqrt{2} \times \text{Trigger Error}}{\text{Gate Time}} \right) \times \begin{matrix} \text{Frequency} \\ \text{or} \\ \text{Period} \end{matrix}$$

Time or Digit Arming

$$\text{Frequency Error} + \left(\frac{4 \times \sqrt{2} \times \text{Trigger Error}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}} \right) \times \begin{matrix} \text{Frequency} \\ \text{or} \\ \text{Period} \end{matrix}$$

Measurement Specifications (Continued)

Frequency Measurement Example:

Given an HP 53181A with a High Stability Oven that was calibrated 3 days ago, measure a 15 MHz square wave signal (which has negligible trigger error) with a 1 second gate time. Compute the measurement error to within 2-sigma confidence.

$$\text{Measurement Error} = \text{Systematic Uncertainty} \pm 2 \times \text{RMS Resolution}$$

$$= \left(\left(\pm \text{Time Base Error} \pm \frac{t_{acc}}{\text{Gate Time}} \right) \pm 2 \times \left(\frac{4 \times \sqrt{t_{res}^2 + (2 \times \text{Trigger Error}^2)}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}} + \frac{t_{jitter}}{\text{Gate Time}} \right) \right) \times \text{Frequency}$$

$$\text{Number of Samples} = 200{,}000 \text{ since Frequency is greater than 200 kHz and gate time equals 1 second}$$

$$\text{Time Base Error} = \text{Temperature Stability} + 3 \text{ Days} \times \text{Daily Aging Rate}$$

$$= 2.5 \times 10^{-9} + 3 \times \left(5 \times 10^{-10}\right)$$

$$= 4.0 \times 10^{-9}$$

$$\text{Measurement Error} = \left(\left(\pm 4.0 \times 10^{-9} \pm \frac{1 \times 10^{-10}\ s}{1\ s} \right) \pm 2 \times \left(\frac{4 \times \sqrt{\left(500 \times 10^{-12}\ s\right)^2 + (2 \times 0)}}{1\ s \times \sqrt{200{,}000}} + \frac{50 \times 10^{-12}\ s}{1\ s} \right) \right) \times 15\ MHz$$

$$= \left(\pm 4.1 \times 10^{-9} \pm 2 \times \left(4.47 \times 10^{-12} + 50 \times 10^{-12} \right) \right) \times 15\ MHz$$

$$= \left(\pm 4.1 \times 10^{-9} \pm 1.09 \times 10^{-10} \right) \times 15\ MHz$$

$$= \pm 63.1\ mHz$$

Which is to say that the HP 53181A would display results in the range 15 MHz ±63.1 mHz. Note however that the dominant error is the Time Base Error. If an even higher stability time base is available external to the instrument or if the instrument can be source locked to the 15 MHz signal, then this error term can be substantially reduced. The measurement resolution under these conditions is ±0.8 mHz (1 sigma) which determines the number of digits displayed.

Measurement Specifications (Continued)

Frequency Ratio: $Ch1/Ch2$ $Ch2/Ch1$

Measurement is specified over the full signal range of each input.

Results Range: 10^{-10} to 10^{11}
'Auto' Gate Time: 100 ms (or sufficient cycles on Channel 1 to make a valid measurement, whichever is longer)

LSD:

$$Ratio\,1/2: \frac{1}{Ch2\ Freq \times Gate\ Time}$$

$$Ratio\,2/1: \frac{Ch2\ Freq}{(Ch1\ Freq)^2 \times Gate\ Time}$$

RMS Resolution:

$$Ratio\,1/2: \frac{2 \times \sqrt{1 + (Ch1\ Freq \times Ch2\ Trigger\ Error)^2}}{Ch2\ Freq \times Gate\ Time}$$

$$Ratio\,2/1: \frac{2 \times Ch2\ Freq \times \sqrt{1 + (Ch1\ Freq \times Ch2\ Trigger\ Error)^2}}{(Ch1\ Freq)^2 \times Gate\ Time}$$

To minimize relative phase measurement error, connect the higher frequency signal to Channel 1 when possible.

Peak Volts

Measurement is specified on Channel 1 for DC signals; or for AC signals of frequencies between 100 Hz and 30 MHz with peak-to-peak amplitude greater than 100 mV. (The measurement will continue to operate up to 225 MHz, though results are for indication only.)

Results Range: -5.1 V to +5.1 V

Resolution: 10 mV

Systematic Uncertainty for AC signals: 25 mV + 10% of V
for DC signals: 25 mV + 2% of V

Use of the input attenuator multiplies all voltage specifications (input range, results range, resolution and systematic uncertainty) by a nominal factor of 10. For example with AC signals, the Systematic Uncertainty becomes: 250 mV + 10% of V.

Measurement Definitions

Definitions of Systematic Uncertainty Terms

- **Trigger Error**

  External source and input amplifier noise may advance or delay the trigger points that define the beginning and end of a measurement. The resulting timing uncertainty is a function of the slew rate of the signal and the amplitude of spurious noise spikes (relative to the input hysteresis band).

  The (rms) trigger error associated with a single trigger point is:

$$\text{Trigger Error} = \frac{\sqrt{(E_{input})^2 + (E_{signal})^2}}{\textit{Input Signal Slew Rate at Trigger Point}} \text{ (in seconds)}$$

  where

  E_{input} RMS noise of the input amplifier: 1 mVrms (350 μVrms typical). Note that the internal measurement algorithms significantly reduce the contribution of this term.

  E_{signal} RMS noise of the input signal over a 225-MHz bandwidth (100-kHz bandwidth when the low-pass filter is enabled). Note that the filter may substantially degrade the signal's slew rate at the input of the trigger comparator.

- **Fractional Time Base Error**

  Time base error is the maximum fractional frequency variation of the time base due to aging or fluctuations in ambient temperature or line voltage:

$$\text{Time Base Error} = \left(\frac{\Delta f}{f}\Big|_{aging\ rate} + \frac{\Delta f}{f}\Big|_{temperature} + \frac{\Delta f}{f}\Big|_{line\ voltage}\right)$$

  Multiply this quantity by the measurement result to yield the absolute error for that measurement. Averaging measurements will not reduce (fractional) time base error. The HP 53181A counter exhibits negligible sensitivity to line voltage; consequently this term may be ignored.

- **Typical versus Worst Case Specifications**

  Specifications identified as "Typical" represent performance of the instrument that the majority of users will perceive under a wide variety of conditions and signals. The specifications identified as "Worst Case" should be used when the instrument is under extreme environmental conditions or when the accuracy of the measurement results are critically important.

Measurement Arming and Processing

Gate Time

Auto Mode, or 1 ms to 1000 s

Measurement Throughput

HP-IB ASCII: 200 Measurements/s (maximum)
(See examples in the Programming Guide for ways to optimize measurement throughput)

Measurement Arming

Start Measurement: Free Run, Manual, or External
Stop Measurement: Continuous, Single, External, or Timed
Arming Modes:
(Note: auto arming is the only mode available for the Peak Volts function.)

Auto Arming: Measurements are initiated immediately and acquired as fast as possible, using a minimum number of signal edges. Auto arming offers the highest measurement throughput, though measurement resolution may be reduced.

Timed Arming: The duration of the measurement is internally timed to a user-specified value (also known as the "gate time"). This mode should be used when the length of the measurement time must be controlled.

Digits Arming: Measurements are performed to the requested resolution (number of digits) through automatic selection of the acquisition time. This is the most convenient mode when a specific measurement resolution is desired.

External Arming: An edge on the External Arm Input enables the start of each measurement. Auto Arming, Timed arming modes or another edge on the External Arm Input may be used to complete the measurement.

Measurement Statistics

Available Statistics: Mean, Minimum, Maximum, Standard Deviation
Number of Measurements: 2 to 1,000,000. Statistics may be collected on all measurements or on only those which are between the limit bands. When the Limits function is used in conjunction with Statistics, N (number of measurements) refers to the number of in-limit measurements. In general, measurement resolution will improve in proportion to $\sqrt{N}$, up to the numerical processing limits of the instrument.
Measurements: Statistics may be collected for all measurements except Peak Volts.

Measurement Limits

Limit Checking: The measurement value is checked against user-specified limits at the end of each measurement.
Display Modes: The measurement result may be displayed as either the traditional numeric value or graphically as an asterisk moving between two vertical bars. These bars define the upper and lower limits, and the asterisk represents the current measurement result relative to these limits.
Out-of-Limits Indication: The out-of-limits condition can be indicated by any of the following methods:

- The limits annunciator will light on the front panel display.
- The instrument will generate an SRQ if enabled via HP-IB.
- The limits hardware signal provided via the RS-232 connector will go low for the duration of the out-of-limit condition (see the description of this connector under the General Information section of this specifications table).
- If the Analog Display mode is enabled, the asterisk appears outside the vertical bars, which define the upper and lower limits.

General Information

Save and Recall: Up to 20 complete instrument setups may be saved and recalled later. These setups are retained when power is removed from the counter.

Rack Dimensions (HxWxD): 88.5 mm x 212.6 mm x 348.3 mm

Weight: 3.5 kg maximum

	AC Line Supply	DC Supply (Option 002 Only)
Power Supply Voltage:	100 to 120 VAC ±10% - 50, 60 or 400 Hz ±10% 220 to 240 VAC ±10% - 50 or 60 Hz ±10% AC Line Voltage Selection: Automatic	10 to 32 VDC, 3-pin male XLR connector Option 002 may not be ordered with Option 060
Power Requirements:	170 VA maximum (30 W typical)	4A initial inrush at 10 VDC 3A max, once stabilized

Operating Environment: 0°C to 55°C

Storage Environment: -40°C to 71°C

Remote Interface: HP-IB (IEEE 488.1-1987, IEEE 488.2-1987)

HP-IB Interface Capabilities: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2

Remote Programming Language: SCPI-1992.0 (Standard Commands for Programmable Instruments)

Safety: Designed in compliance with IEC 1010-1, UL 3111-1 (draft), CAN/CSA 1010.1

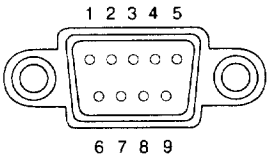
EMC: CISPR-11, EN50082-1, IEC 801-2, -3, -4

Electrostatic Discharge and Fast Transient/Burst Immunity Testing: When the product is operated at maximum sensitivity (20 mVrms) and tested with 8kV AD according to IEC801-2 or with 1kV power line transients according to IEC 801-4, frequency miscounts may occur that will affect measurement data made during these disturbances.

Radiated Immunity Testing: When the product is operated at maximum sensitivity (20 mVrms) and tested at 3 V/m according to IEC 801-3, external 100 to 200 MHz electric fields may cause frequency miscounts.

RS-232C: The rear-panel RS-232 connector is a 9-pin connector (DB-9, male). You can connect the universal counter to any terminal or printer with a properly configured DTE connector (DB-25). You can use a standard interface cable (HP part number 24542G or 24542H) Data is "output only"; the instrument can not be programmed via the RS-232 interface.

Note on pin 4: May be used as either a DTR signal or an indication of measurement in-limit as configured by the Utility menu. When used as an in-limit indicator, the signal will be high for every measurement within the user set limits.



Pin Number	Type	Description
2	Input	Receive Data (RxD) (for Xon/Xoff only)
3	Output	Transmit Data (TxD)
4	Output	Data Terminal Ready (DTR) Measurement In-Limit Signal
5	—	Signal Ground
6	Input	Data Set Ready (DSR)
*	All other pins: no connection	