Agilent Technologies
16533A/34A Digitizing Oscilloscope
Service Guide

Install this package in the binder that includes
the Service Guide for the Agilent Technologies 16500 Logic Analysis System.

Service Guide

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For Safety information, Warranties, and Regulatory information, see the pages at the end of the book.

Agilent Technologies 16533A 1-GSa/s and 16534A 2-GSa/s Digitizing Oscilloscope

The Agilent Technologies 16533A/34A Oscilloscope

The Agilent Technologies 16533A/34A Oscilloscope is an oscilloscope module for the Agilent Technologies 16500B Logic Analysis system, and is designed to extend system troubleshooting capabilities for viewing analog effects on the fastest CMOS, ECL, and TTL logic circuitry.

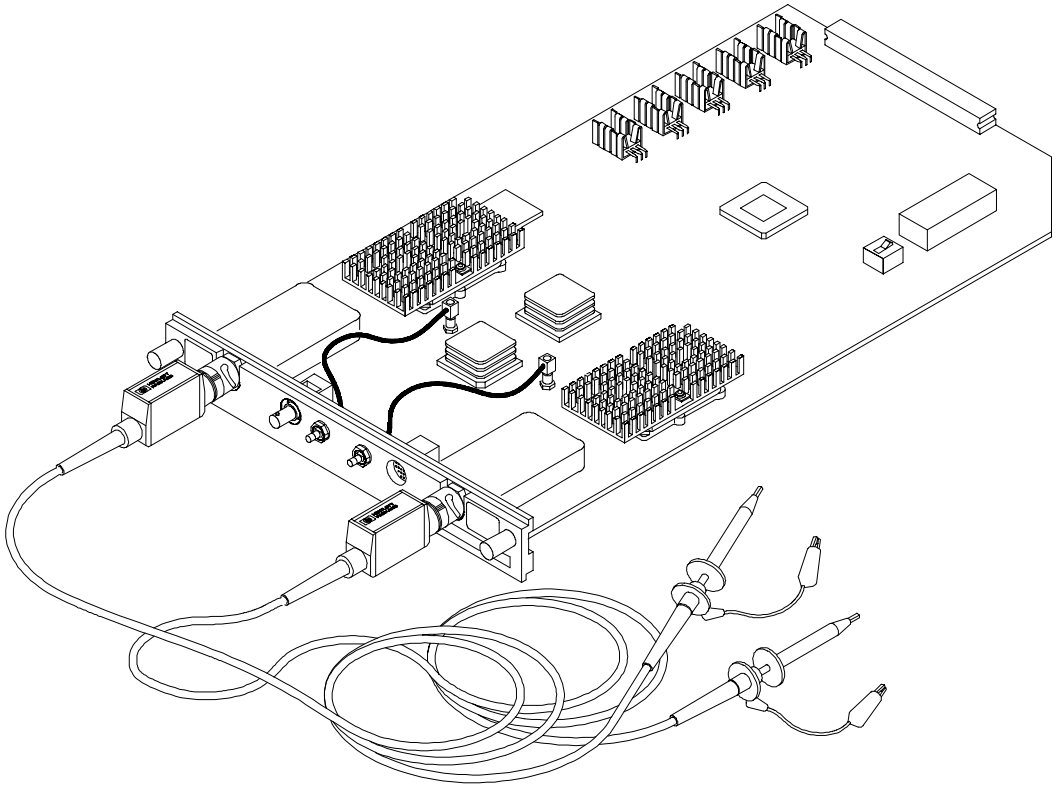
Features

- 1 GSa/s digitizing for 250 MHz bandwidth single shot oscilloscope (16533A)
- 2 GSa/s digitizing for 500 MHz bandwidth single shot oscilloscope (16534A)
- 32,768 samples per channel
- Automatic pulse parameters, displays time between markers, acquires until specified time between markers is captured, performs statistical analysis on time between markers
- Lightweight miniprobes

Service Strategy

The service strategy for this instrument is the replacement of defective assemblies. This service guide contains information for finding a defective assembly by testing and servicing the 16533A/34A Oscilloscope.

This logic analyzer can be returned to Agilent Technologies for all service work, including troubleshooting. Contact your nearest Agilent Technologies Sales Office for more details.



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The Agilent Technologies 16533A/34A Oscilloscope

In This Book

This book is the service guide for the 16533A and 16534A Oscilloscopes and is divided into eight chapters.

Chapter 1 contains information about the oscilloscope and includes accessories, specifications and characteristics, and equipment required for servicing.

Chapter 2 tells how to prepare the oscilloscope for use.

Chapter 3 gives instructions on how to test the performance of the oscilloscope.

Chapter 4 contains calibration instructions for the oscilloscope.

Chapter 5 contains self-tests and flowcharts for troubleshooting the oscilloscope.

Chapter 6 tells how to replace assemblies of the oscilloscope and how to return them to Agilent Technologies.

Chapter 7 lists replaceable parts, shows an exploded view, and gives ordering information.

Chapter 8 explains how the oscilloscope works and what the self-tests are checking.

Contents

6 Replacing Assemblies

7 Replaceable Parts

8 Theory of Operation

1

General Information

General Information

This chapter lists the accessories, the specifications and characteristics, and the recommended test equipment.

Accessories

Accessories Supplied	Agilent Part Number	Qty
10:1 probes	10441A	2
BNC miniprobe adapter	1250-1454	1

Accessories Available

Other accessories available for the Agilent Technologies 16533A/34A oscilloscope are listed in the *Accessories for Agilent Logic Analyzers* brochure and the *Accessories for Agilent Oscilloscopes* brochure.

Specifications

The specifications are the performance standards against which the 16533A/34A Oscilloscope is tested. Both the 16533A and the 16534A requires Agilent Technologies 16500B operating systems V 3.03 or later to operate.

Bandwidth(*):

16533A - dc to 250 MHz (realtime, dc coupled)
16534A - dc to 500 MHz (realtime, dc coupled)

Time Interval Measurement Accuracy(*)(1): +/-[(0.005% of delta t) + (2 x 10e-6 x delay setting) + 100 ps]

DC Offset Accuracy(*): +/-(1.0% of channel offset + 2.0% of full scale)

Voltage Measurement Accuracy(*): +/-(1.25% of full scale + offset accuracy + 0.016 V/div)

Trigger Sensivity(*):

	10mV-10V/div	4mV/div
dc to 50 MHz:	0.25 div	0.63 div
50 MHz to 250 MHz (16533A):	0.50 div	1.25 div
50 MHz to 500 MHz (16534A):	0.50 div	1.25 div

Input R: 1 Meg Ohm +/-1%
50 Ohms +/-1%

* = Specifications valid within +/-10 degrees C of self-calibration temperature

(1) Specification applies at the maximum sample rate. At lower rates, specification should be +/-(0.005% x delta t) + (2 x $10e^{-6}$ x delay setting) + (0.15 x sample interval) for bandwidth limited signals (tr = 1.4 x sample interval). Sample interval is defined as $\frac{1}{sample\ rate}$

Characteristics

The characteristics are not specifications, but are included as additional information.

VERTICAL (at BNC Input):

Vertical Sensitivity: 4 mV/div to 10 V/div Range (1:1 Probe) in 1:2:4 increments

DC Offset Range (1:1 Probe):

Vertical Sensitivity	Available Offset
4mV - 100mV/div	+/- 2V
100mV - 400mV/div	+/- 10V
400mV - 2.5V/div	+/- 50V
2.5V - 10V/div	+/- 250V

Probe Factors: Any integer ratio from 1:1 to 1000:1

Maximum Safe Input Voltage: 1 Meg ohm: +/-250V (dc + ac, 10 KHz)
50 Ohms: 5 V rms

Channel-to-Channel Isolation: (With Channels at equal sensitivity)

dc to 50 MHz:	40 dB
50 MHz to 250 MHz (16533A):	30 dB
50 MHz to 500 MHz (16534A):	30 dB

Number of Channels: 2,4,6,8 simultaneous channels using the same trigger OR up to 10 with independent triggers for each pair of channels. Maximum of 20 channels with Agilent Technologies 16501A expansion frame.

Rise Time(1): 1.4 ns (16533A) and 700 ps (16534A)

Vertical (dc) Gain Accuracy(2): +/-1.25% of full scale

Input Coupling: 1 Meg Ohm: ac, dc
50 Ohms: dc only

Input C: Approximately 7 pF

Probes Included: Two Agilent Technologies 10441A probes:10:1, 10 Meg Ohm, 9 pF, 2m

HORIZONTAL:

Time Base Range: 0.5 ns/div to 5 s/div

Time base Resolution: 10 ps

Delay Pre-trigger Range: 81.8 sec - 5 divisions

Delay Post-trigger Range: 2.5 x 10e3 seconds

TRIGGERING:

Trigger Level Range: Within display window (vertical offset +/- 2 divisions)

Trigger Modes:

Immediate: Triggers immediately after arming condition is met.

Edge: Triggers on rising or falling edge from channel 1 or channel 2.

Pattern: Triggers on entering or exiting a specified pattern across two channels.

Auto Trigger: Self-triggers if no trigger condition is found within approximately 50 ms after arming.

Events Delay: The trigger can be set to occur on the nth edge or pattern, as specified by the user.

Intermodule:Arms another measurement module or triggers the rear panel BNC.

(1) Rise time is calculated from $t_r = \frac{0.35}{bandwidth}$

(2) Vertical gain accuracy decreases 0.08% per degree C from software calibration temperature

Supplemental Characteristics

Digitizer

A/D Resolution 8 bits (1 part in 256) real time 4 vertical divisions (+/- 0.4%)

Digitizing Rate

Up to 1 Gigasample per second (16533A)
Up to 2 Gigasample per second (16534A)

Digitizing Technique Real-time digitizing; each 32,768 samples are acquired on a single acquisition

Acquisition Memory Size 32,768 samples per channel

Waveform Record Length: 32,768 points

Waveform Display

Displayed Waveforms Eight waveform windows maximum, with scrolling across 96 waveforms.

Display Formats Waveforms can be displayed in an overlapping and/or non-overlapping format. Display capability of A-B and A+B is also provided.

Display Resolution 500 points horizontal, 240 points vertical

Display Modes

Normal (Single) New acquisition replaces old acquisition on screen.

Accumulate New acquisition is displayed in addition to previous acquisitions until screen is erased.

Average New acquisitions are averaged with old acquisitions, with the updated waveform displayed until erased. Maximum number of averages is 256.

Overlay Up to 8 acquired waveforms from separate channels can be overlayed in the same display area.

Connect-the-dots Provides a display of the sample points connected by straight lines.

Waveform Reconstruction When there is insufficient data to fill every horizontal location, a post acquisition reconstruction filter fills in missing data points for time base < 50 ns/div.

Waveform Math Display capability of A-B and A+B functions is provided.

Measurement and Display Functions

Time Markers Two vertical markers, X and O, are provided for measurements of time and voltage. Capabilities are: measure voltage at point where X and O markers cross each analog waveform; measure time from trigger to X, trigger to O, and X to O; automatic marker placement by specifying percentage of edge, edge number, and rising or falling edge type; run until X to O > than, < than, in range, and not in range provides selective event search; X to O statistics (mean, max, and min) provide analysis of time interval deviation.

Voltage Markers Two horizontal markers, A and B, are provided for voltage measurements. These markers can each be placed on any acquisition channel trace. A delta voltage display provides delta V between markers on the same channel or between channels.

Automatic Search Searches for a percentage voltage level at a positive or negative edge, count adjustable from 1 to 100.

Auto Search Statistics Mean, maximum, and minimum values for elapsed time from X to O markers for multiple runs. Number of valid runs and total number of runs available.

Automatic Measurements The following pulse parameter measurements can be performed automatically:

- Frequency
- Rise time
- + pulse width
- Period
- Fall time
- -pulse width
- V p-p
- Preshoot
- $V_{amplitude}$*
- Overshoot

(*gives difference between top and base voltages; only available over bus)

Grid Graticules can be displayed in background of waveform.

Setup Aids

Autoscale: Autoscales the vertical and horizontal ranges, offset, and trigger level to display the input signals. Requires a frequency between 50 Hz and 250 MHz.

Presets Scales the vertical range, offset, and trigger level to predetermined values for displaying ECL or TTL waveforms.

Calibration Vertical, trigger, delay, and all defaults. Calibration factors stored in NV-RAM on the circuit board.

Probe Compensation Source External BNC supplies a square wave approximately 0.0 mV to -800 mV into the open circuit at approximately 1000 Hz.

Recommended Test Equipment

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part	Use*
Signal Generator	Frequency: 1 - 500 MHz at approx . 170 mV RMS Output Accuracy: ± 1 dB 1 MHz time base accuracy 0.25 ppm	8656B Option 001	P
DC Power Supply	Range: –35.000 to +35.000 Vdc, ±1 mV Resolution: 10 mV	3245A Option 002	P
Digital Multimeter	0.1 mV resolution Accuracy: better than 0.005% Resistance measurement: better than 0.25% accuracy	3458A	P
Power Meter/Sensor	1 - 500 MHz ±3% accuracy	436/8482A	P
Power Splitter	Outputs differ by <0.15 dB	11667B	P
Blocking Capacitor	BNC (m)(f), 0.18 μF, ±200 V	10240B	P
BNC Shorting Cap		1250-0074	P
Adapter	BNC (f)(f) (UG-914/U)	1250-0080	C
Adapter	BNC(f)-to-Dual Banana Plug	1251-2277	P
Adapter	Type N(m)-to-BNC(f)	1250-0780	P
BNC Tee	BNC (m)(f)(f)	1250-0781	P,C
Cable	Type N(m-to-m) 24-inch	11500B	P
Cable	50 Ω BNC (m-to-m) 48-inch	8120-1840	P, C
Cable (2)	50 Ω BNC (m-to-m) 9 inch	8120-1838	C

*A = Adjustment C = Calibrations P = Performance Tests T = Troubleshooting

2

Preparing for Use

Preparing For Use

This chapter gives you instructions for preparing the oscilloscope module for use.

Power Requirements

All power supplies required for operating the oscilloscope are supplied through the backplane connector in the mainframe.

Operating Environment

The operating environment is listed below. Note the noncondensing humidity limitation. Condensation within the instrument can cause poor operation or malfunction. Provide protection against internal condensation.

The oscilloscope module will operate at all specifications within the temperature and humidity range given below. However, reliability is enhanced when operating the module within the following ranges:

- Temperature: +20 °C to +35 °C (+68 °F to +95 °F)
- Humidity: 20% to 80% noncondensing

Storage

Store or ship the oscilloscope in environments within the following limits:

- Temperature: –40 °C to + 75 °C
- Humidity: Up to 90% at 65 °C
- Altitude: Up to 15,300 meters (50,000 feet)

Protect the module from temperature extremes which cause condensation on the instrument.

To inspect the module

1 Inspect the shipping container for damage.

If the shipping container or cushioning material is damaged, keep them until you have checked the contents of the shipment and checked the instrument mechanically and electrically.

2 Check the supplied accessories.

Accessories supplied with the module are listed in "Accessories" in chapter 1.

3 Inspect the product for physical damage.

Check the module and the supplied accessories for obvious physical or mechanical defects. If you find any defects, contact your nearest Agilent Technologies Sales Office. Arrangements for repair or replacement are made, at Agilent Technologies' option, without waiting for a claim settlement.

To prepare the mainframe

CAUTION Turn off the mainframe power before removing, replacing, or installing the module.

CAUTION Electrostatic discharge can damage electronic components. Use grounded wriststraps and mats when performing any service to this module.

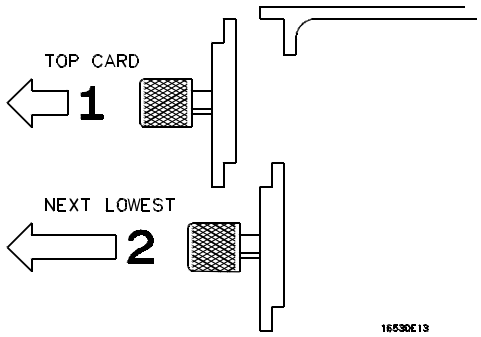
1. Turn off the mainframe power switch, then unplug the power cord. Disconnect any input or output connections.
2. Plan your module configuration.

   If you are installing a one-card module, use any available slot in the mainframe.

   If you are installing a multicard module, use adjacent slots in the mainframe.
3. Loosen the thumb screws.

   Cards or filler panels below the slots intended for installation do not have to be removed.

   Starting from the top, loosen the thumb screws on filler panels and cards that need to be moved.



4. Starting from the top, pull the cards and filler panels that need to be moved halfway out.

CAUTION All multicard modules will be cabled together. Pull these cards out together to prevent damage to the cables and connectors.

5. Remove the cards and filler panels.

   Remove the cards or filler panels that are in the slots intended for the module installation. Push all other cards into the card cage, but not completely in. This is to get them out of the way for installing the module.

   Some modules for the Logic Analysis System require an operational accuracy calibration if you move them to a different slot. For calibration information, refer to the manuals for the individual modules.

To install the module

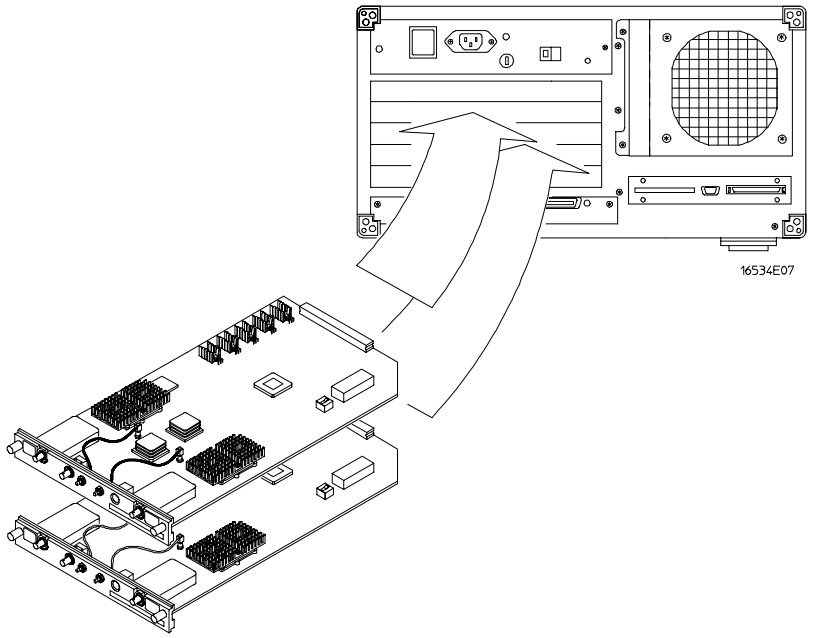
The Agilent Technologies 16533A/34A oscilloscope module functions as either a master board or expander board. A single board 16533A/34A module provides 2 acquisition channels and a multicard 16533A/34A module can provide up to 8 acquisition channels that operate from a single trigger.

The only requirements to configuring a multicard 16533A or a multicard 16534A module (more than one card) is connecting the cards together with the master/expander trigger cables. This is done after installing all cards and before applying power to the mainframe. In addition, a multicard module should contain either all 16533A or 16534A cards.

To configure the 16534A module

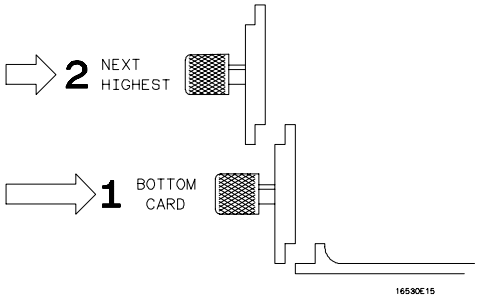
1 Slide the cards above the slot for the 16533A/34A module about halfway out of the mainframe.

2 Slide the 16533A/34A module approximately halfway into the mainframe. If a multicard module is being configured, all 16533A/34A cards must be in adjacent slots.



3 Position all cards and filler panels so that the endplates overlap.

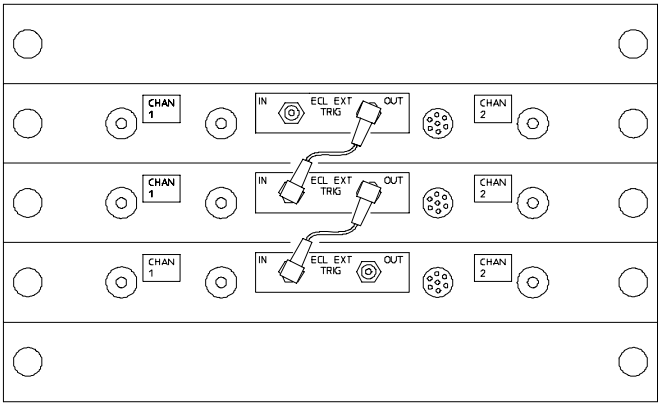
4 Seat the cards and tighten the thumbscrews. DO NOT use a Torx screwdriver to tighten the thumbscrews.



WARNING

For correct air circulation, filler panels must be installed in all unused card slots. Correct air circulation keeps the instrument from overheating. Keep any extra filler panels for future use.

5 To configure a multicard module, use the master/expander trigger cable included with the accessory kit of each 16533A/34A card. Starting with the top-most 16533A/34A card, connect the ECL EXT TRIG OUT to the ECL EXT TRIG IN of the card immediately below. Repeat for all cards in the module.



To reconfigure a multicard module into single card modules

To reconfigure a multicard 16533A/34A module into single board modules, first remove power from the Agilent Technologies 16500B mainframe. Remove all master/expander trigger cables from the rear panel of each 16533A/34A card in the module. Remove and reinstall each 16533A/34A card as desired and reapply power to the mainframe.

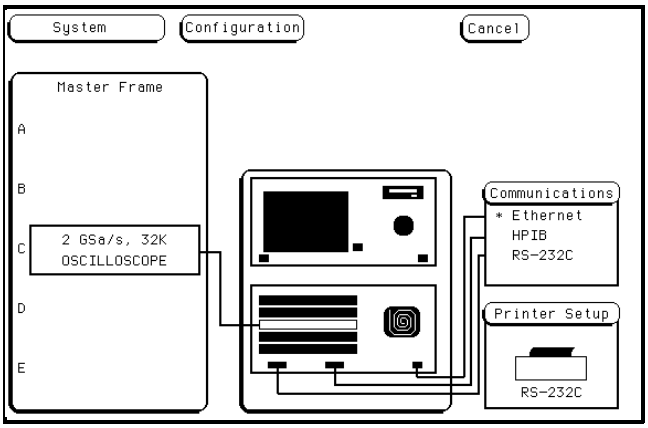
Performing an operational accuracy calibration on each reconfigured 16533A/34A card is recommended. Refer to Chapter 4 Calibrating and Adjusting.

To turn on the system

1 Connect the power cable to the mainframe.

2 Turn on the power switch.

When you turn on the power switch, the oscilloscope performs power-up tests that check mainframe circuitry. After the power-up tests are complete, the screen will look similar to the sample screen below.



To test the module

- If you require a test to initially accept the operation, perform the self tests in chapter 3.
- If you need to deskew the channel-to-channel variations, go to chapter 4, "Calibrating and Adjusting."
- If you require a test to verify the specifications, start at the beginning of chapter 3, "Testing Performance."
- If the module does not operate correctly, go to the beginning of chapter 5, "Troubleshooting."

3

Testing Performance

Testing Performance

This chapter tells you how to test the performance of the oscilloscope against the specifications listed in chapter 1. To ensure the oscilloscope is operating as specified, you perform software tests (self-tests) and manual performance tests on the oscilloscope. The oscilloscope is considered performance-verified if all of the software tests and manual performance tests have passed. The procedures in this chapter indicate what constitutes a "Pass" status for each of the tests. The procedures in this chapter are for both the Agilent Technologies 16533A and 16534A.

Test Strategy

For a complete test, start at the beginning with the software tests and continue through to the end of the chapter. For an individual test, follow the procedure in the test.

The performance verification procedures starting on page 3–6 are each shown from power-up. To exactly duplicate the set-ups in the tests, save the power-up configuration to a file on a disk, then load that file at the start of each test.

If a test fails, check the test equipment set-up, check the connections, and verify adequate grounding.

Test Strategy for a Multicard Module

A multicard 16533A/34A module must be separated into single card modules for all tests in this chapter. After testing the performance of each single card module, the module can then be reconfigured as a multicard module. At this point the 16533A/34A multicard module is ready for use.

Test Interval

Test the performance of the oscilloscope against specifications (full calibration) at two-year intervals or if it is replaced or repaired.

Performance Test Record

A performance test record for recording the results of each procedure is located at the end of this chapter. Use the performance test record to gauge the performance of the oscilloscope over time.

Test Equipment

Each procedure lists the recommended test equipment. You can use equipment that satisfies the specifications given. However, the procedures are based on using the recommended model or part number. Before testing the performance of the oscilloscope, warm-up the instrument and the test equipment for 30 minutes.

To perform the self-tests

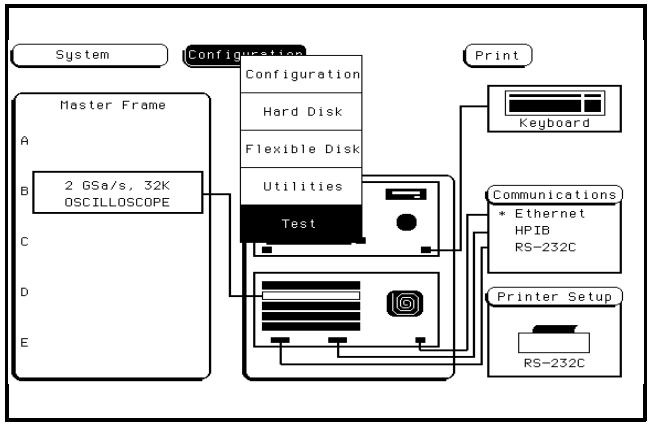
The self-tests for the 16533A/34A oscilloscope module will identify the improper operation of major functional areas in the module. They are not intended for component level diagnostics.

If a multicard oscilloscope module is present, the user must select the specific card to be tested at the main system menu. A multicard module is recognized as individual single card modules in the test menu. The external trigger cables connected to the ECL IN and ECL OUT do not need to be removed in order to do the self test for each board. All other cable connections must be removed.

All self-tests can be run without access to the interior of the instrument. If a self-test fails, refer to Chapter 5, Troubleshooting.

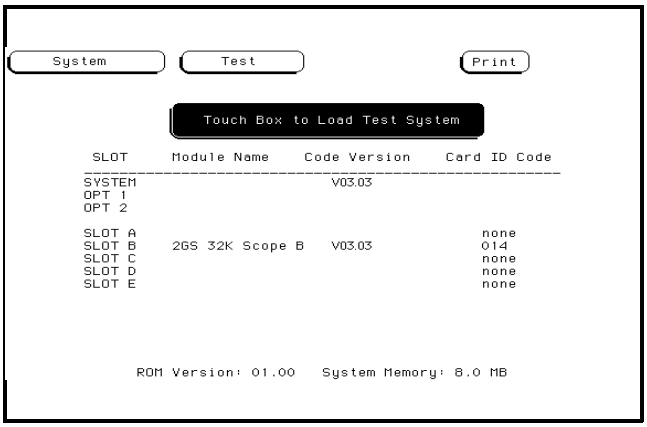
1 Disconnect all oscilloscope inputs, then turn on the power switch. Wait until the power-up tests are complete.

2 From the startup screen, touch the **Configuration** field. Then touch **Test** in the pop-up menu.



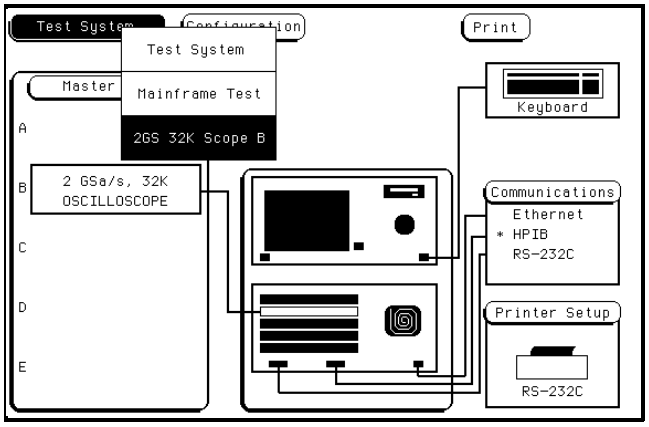
3 Touch the box labeled **Touch box to Load Test System**.

When the self-test software is loaded, the user operating system is overwritten in the mainframe system RAM.



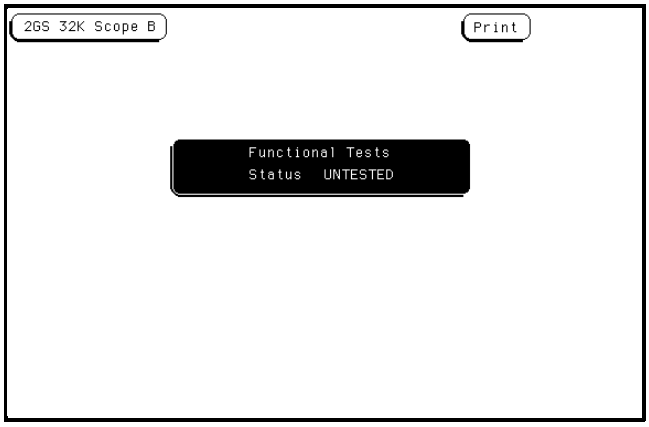
4 From the test system screen, touch **Test System**, then **1GS/2GS 32K Scope B**.

For the example shown, the oscilloscope module is in slot B. If multiple oscilloscope modules are present, select the one to be tested.



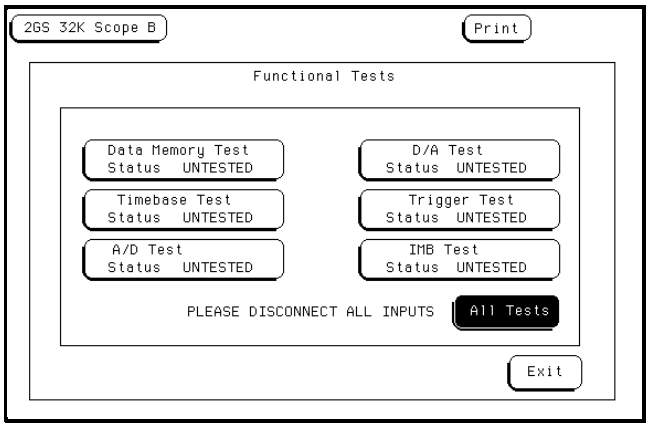
5 Touch the **Functional Tests** field.

The following screen shows the selection menu for choosing to perform functional tests. The status of the functional tests is given. In multicard configurations, each expanded module is tested separately.



6 In the main test menu, touch **All Tests**.

When the tests finish, the status for each test shows Passed or Failed.



7 To exit the self-tests, touch the following fields in the lettered sequence below.

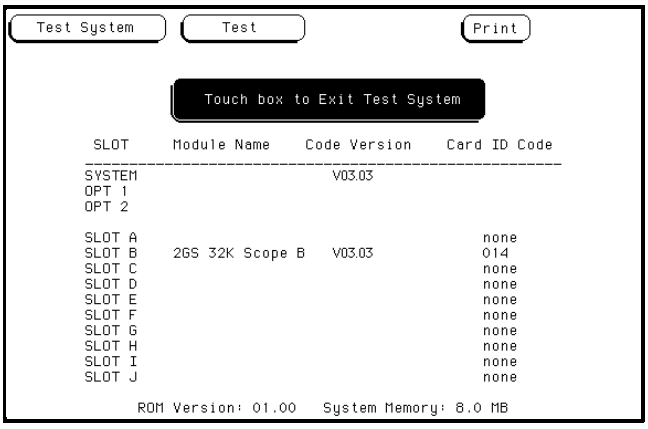
a 1GS/2GS 32K Scope

b Test System

c Configuration

d Test

8 Touch the box that reads **Touch box to Exit Test System**.



To test the CAL OUTPUT ports

Testing the CAL OUTPUT ports does not check a specification , but does check the following:

- DC CAL OUTPUT voltage
- AC CAL OUTPUT voltage

This test verifies that the CAL OUTPUT voltages are operating within limits, so that they can provide an accurate signal source for the instrument operational accuracy calibration and probe calibration.

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
Digital Multimeter	0.1 mV resolution, better than 0.005% accuracy	3458A
Cable	BNC (m)(m) 48-inch	8120-1840
Adapter	BNC (f) to Dual Banana Plug	1251-2277

Set up the equipment

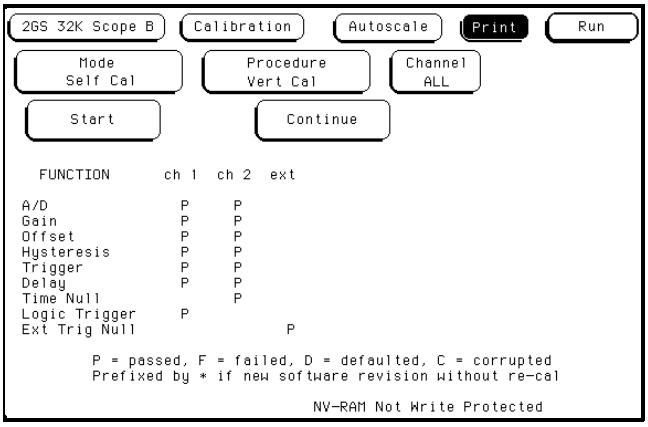
Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

Set up the oscilloscope

1 Set up the Calibration menu.

a Touch System, then touch 1GS/2GS 32K Scope.

b Touch Channel, then touch Calibration.

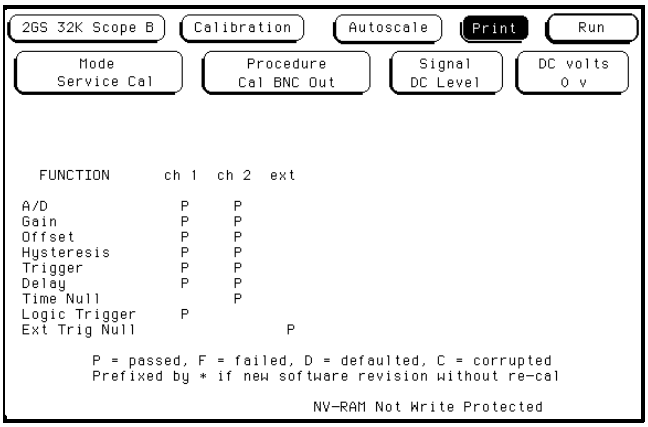


c Touch the Mode field, then touch Service Cal.

d Touch the Procedure field, then touch Cal BNC Out.

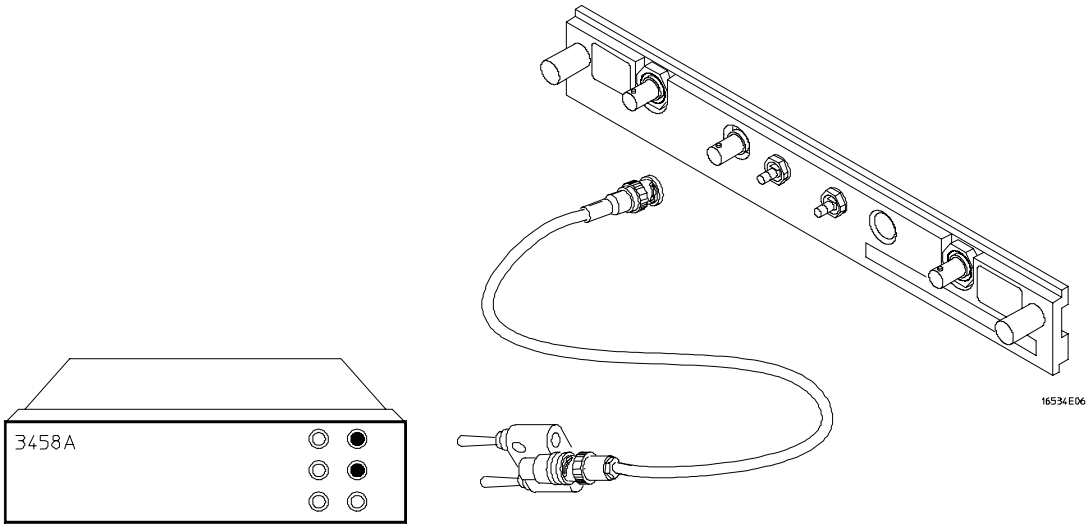
e Touch the Signal field, then touch DC Level.

f Touch the DC volts field, and set it to O V.



Verify the DC CAL OUTPUT port

1 Using the BNC-to-banana adapter, connect the BNC cable between the multimeter and the oscilloscope DC CAL OUTPUT connector.



2 The digital voltmeter should read close to 0.0000 V. Record the reading to four decimal places. V_1 = _____.

3 In the oscilloscope module Calibration menu set the DC Volts to 5 V.

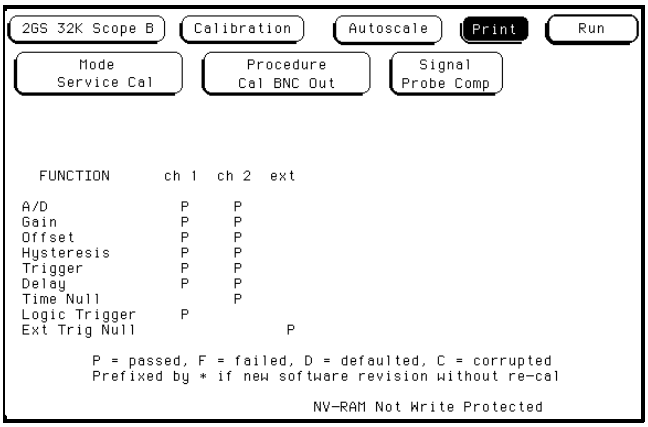
4 The digital voltmeter should read close to 5.0000 V. Record the reading to four decimal places. V_2 = _____.

5 In the oscilloscope module Calibration menu set the DC Volts to 0 V.

6 Subtract V_1 from V_2. The difference should be between 4.990 and 5.010 V. Record the reading in the performance test record.

Set up the oscilloscope

1 In the oscilloscope module Calibration menu, touch the Signal field, then touch Probe Comp.

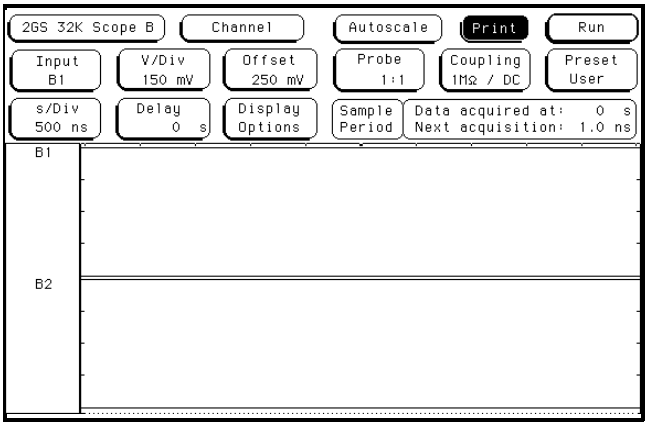


2 Set up the Channel menu.

a Touch Calibration, then touch Channel.

b Touch the Coupling field, then touch 1MΩ / DC.

c Touch the Probe field, then use the RPG knob to dial in 1:1.



Verify the AC CAL OUTPUT port

1 Using the BNC cable, connect channel 1 of the oscilloscope module to the AC CAL OUTPUT connector.

2 Touch Autoscale.

3 Touch Channel, then touch Auto-measure. Verify that the waveform is approximately 0.8 Vp_p at approximately 1.0000 KHz. Record the reading in the performance test record.

To test the input resistance

Testing the input resistance verifies the performance of the following specification:

- Input resistance

This test checks the input resistance at the 50 Ω and 1 MΩ settings in the Coupling field.

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
Digital Multimeter	Measure resistance (4-wire) better than 0.25% accuracy	3458A
Cables (2)	BNC (m)(m) 48-inch	8120-1840
Adapter	BNC Tee (m)(f)(f)	1250-0781
Adapters (2)	BNC (f) to Dual Banana Plug	1251-2277

Set up the equipment

1. Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.
2. Set up the multimeter to make a 4-wire resistance measurement.

Set up the oscilloscope

1 Set up the Channel menu.

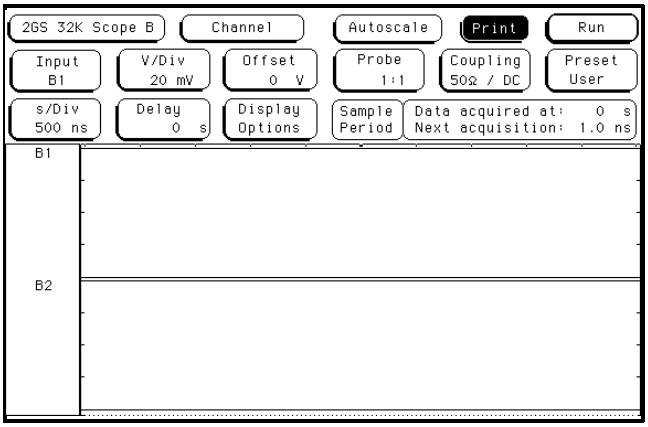
a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

b Touch the Probe field, then use the RPG knob to dial in 1:1.

c Touch the V/Div field, then use the RPG knob to dial in 20 mV.

d Touch the Offset field twice. Set the Offset to 0 V by typing 0 at the numeric keypad, then touch Done.

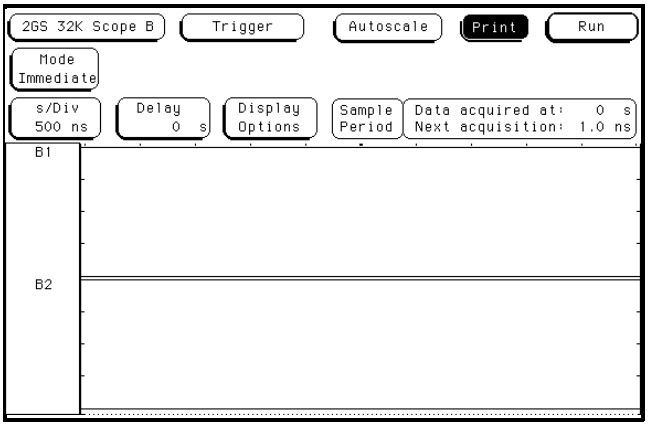
e Touch the Coupling field, then touch 50Ω / DC.



2 Set up the Trigger menu.

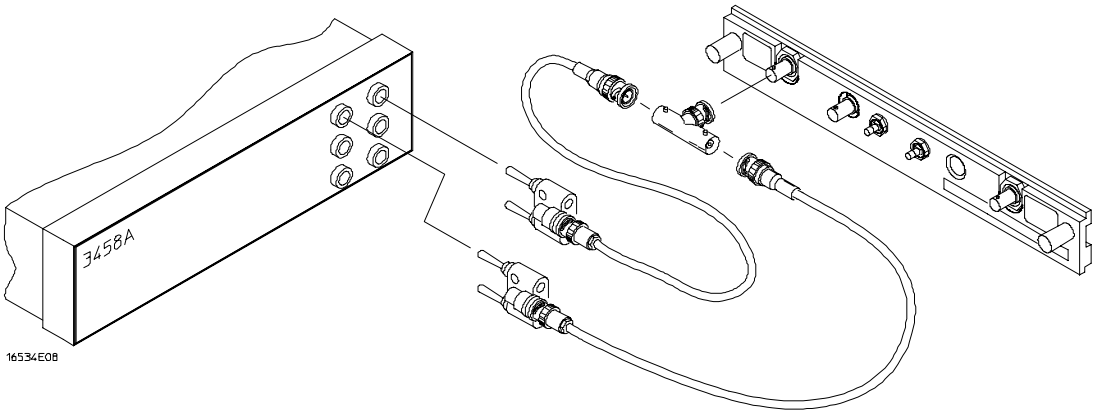
a Touch Channel, then touch Trigger.

b Touch the Mode field, then touch Immediate.



Connect the oscilloscope

Using the BNC-to-banana adapters, connect one end of each BNC cable to the 4-wire resistance connections on the multimeter, and connect the free ends of the cables to the BNC Tee. Connect the male end of the BNC tee to the channel 1 input of the oscilloscope module.



Acquire the data

1. Touch Run-Single. The clicking of attenuator relays should be audible. Verify resistance readings on the digital multimeter of 50 Ω ± 0.5 Ω (49.5 to 50.5 Ω). Record the reading in the performance test record.
2. In the Channel menu change the Coupling field to 1MΩ / DC. The clicking of attenuator relays should be audible.
3. Touch Run. Verify resistance readings on the digital multimeter of 1 MΩ ± 10 kΩ (0.990 to 1.010 MΩ). Record the reading in the performance test record.
4. In the Channel menu change the Coupling field to 50 Ω/DC and V/Div to 200 mV/Div. Repeat steps 1 through 3.
5. In the Channel menu change the Coupling field to 50 Ω /DC and V/Div to 1 V/Div. Repeat steps 1 through 3.
6. In the Channel menu change the Coupling field to 50 Ω /DC and V/Div to 4 V/Div. Repeat steps 1 through 3.
7. Connect the male end of the BNC tee to the channel 2 input of the oscilloscope module.
8. Repeat from "Set up the oscilloscope" for channel 2, replacing channel 1 with channel 2 where applicable.

See Also

If a reading is not within limits, then the attenuator for the out-of-bounds channel should be replaced (see chapter 6).

Perform an operational accuracy calibration

At this point, an operational accuracy calibration should be performed. Follow the procedure in chapter 4, "To calibrate the oscilloscope."

To test the voltage measurement accuracy

Testing the voltage measurement accuracy verifies the performance of the following specification:

- Voltage measurement accuracy

This test verifies the DC voltage measurement accuracy of the instrument, using a dual cursor measurement that nullifies offset error.

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
DC Power Supply	–14 Vdc to +14 Vdc, 0.1 mV resolution	3245A Option 002
Digital Multimeter	Better than 0.1% accuracy	3458A
Cable	BNC (m)(m) 48-inch	8120-1840
Adapter (cable to power supply)	BNC (f) to Dual Banana Plug	1251-2277
Adapter	BNC tee (m)(f)(f)	1250-0781
Blocking Capacitor	BNC (m)(f) 0.18 μF, ±200 V	10240B
BNC Shorting Cap		1250-0074

Set up the equipment

Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

Set up the oscilloscope

1 Set up the Channel menu.

a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

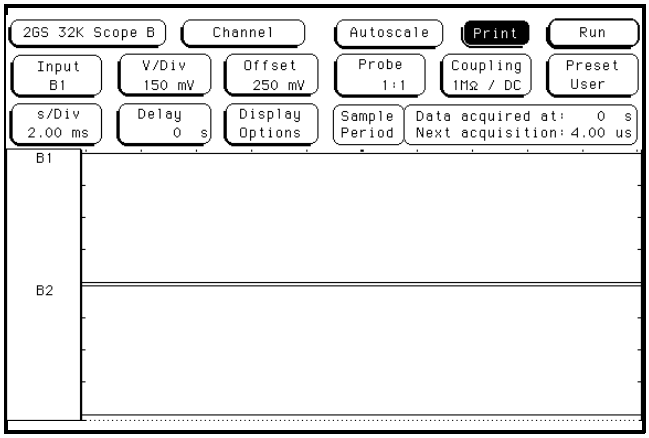
b Touch the Probe field, then use the RPG knob to dial in 1:1.

c Touch the Coupling field, then touch 1MΩ / DC.

d Touch the s/Div field, then use the RPG knob to dial in 2 ms.

CAUTION

Set the Channel Coupling field to 1MΩ / DC or damage to the equipment will result.



2 Set up the Display menu.

a Touch Channel, then touch Display.

b Touch the Mode field, then touch Average.

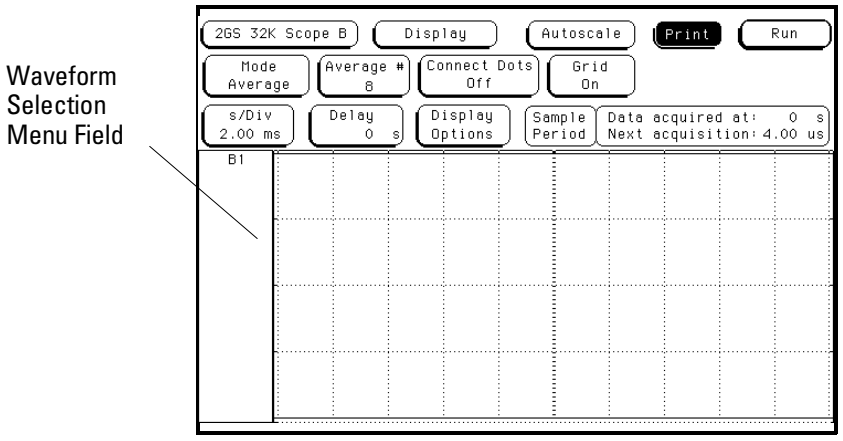
c Touch the Average # field, then use the RPG knob to set 8.

d Touch the Grid field and toggle it to On.

e Touch Waveform selection field twice.

f In Waveform selection menu, select channel 2 using the RPG knob, then touch delete. If channel 1 is not inserted, insert it.

g Touch Done.



3 Set up the Trigger menu.

a Touch Display, then touch Trigger.

b Touch the Mode field, then touch Immediate.

4 Set up the Marker menu.

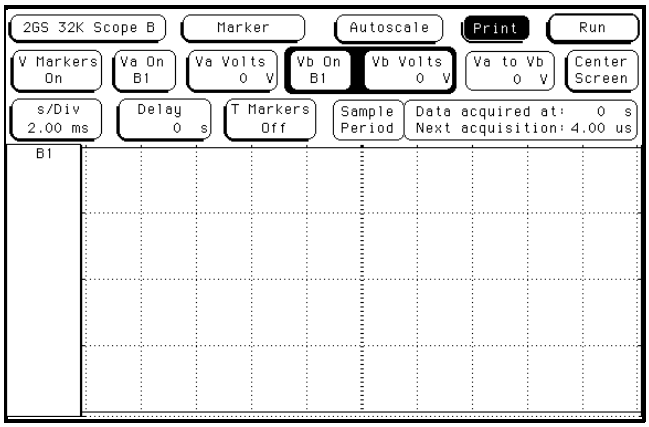
a Touch Trigger, then touch Marker.

b Touch the V Markers field. The voltage markers should now be On.

c Touch Va field, then select Channel 1.

d Touch Vb field, then select Channel 1.

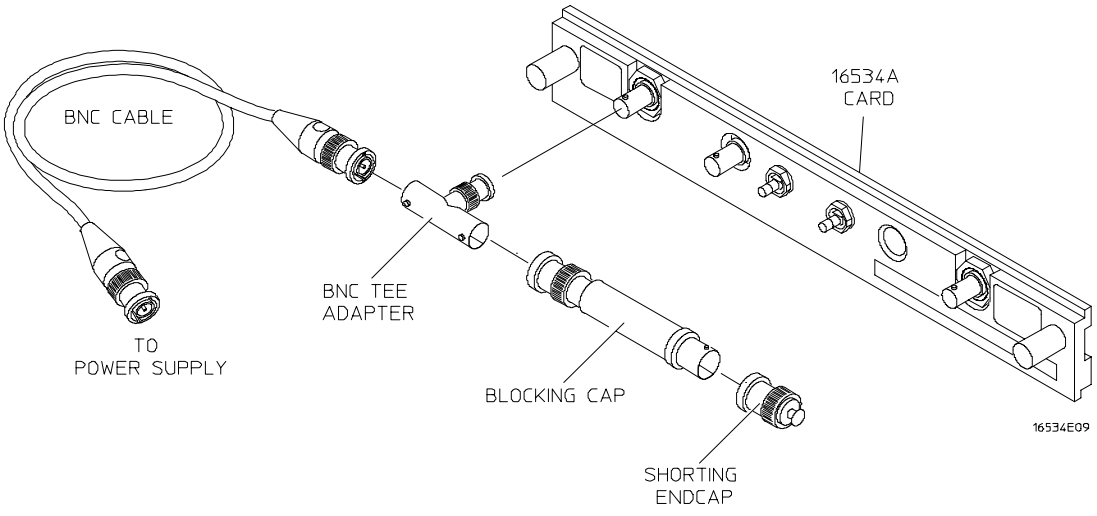
e If the T markers are On, turn the T markers Off by touching the T markers field then touch Off.



Connect the oscilloscope

1 Using a BNC-to-banana adapter, connect one end of the cable to the power supply. Connect the BNC tee, the blocking capacitor, and the shorting endcap to the other end of the cable.

2 Monitor the power supply output with the Digital Multimeter.



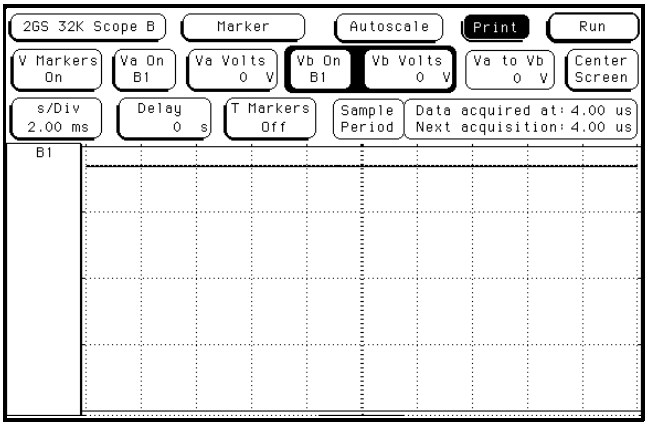
Acquire the data

Use the following table for steps 1 through 5.

Oscilloscope Settings			**Voltage Readings**	
V/Div	**Offset**	**Supply**	**Upper Limit**	**Lower Limit**
4 V/Div	-7.0 V	-12.0 V	-11.74V	-12.26 V
1 V/Div	-1.75 V	-3.0 V	-2.94 V	-3.06 V
400 mV/Div	-700.0 mV	-1.2 V	-1.174 V	-1.226 V
40 mV/Div	-70.0 mV	-120 mV	-117.4 mV	-122.6 mV
40 mV/Div	70.0 mV	120 mV	122.6 mV	117.4 mV
400 mV/Div	700.0 mV	1.2 V	1.226 V	1.174 V
1 V/Div	1.75 V	3.0 V	3.06 V	2.94 V
4 V/Div	7.0 V	12.0 V	12.26 V	11.74 V

1 Set up the oscilloscope according to the table above.
   - **a** Touch Marker, then touch Channel.
   - **b** Touch the V/Div field, then use the RPG knob to dial in the V/Div values shown on the first line of the table.
   - **c** Touch the Offset field twice. Use the numeric keypad to enter the offset value shown on the first line of the table.

2 Acquire the zero input voltage.
   - **a** Disconnect the power supply cable from the oscilloscope channel input.
   - **b** Touch Run-Repetitive. Wait for approximately five seconds (averaging complete), then touch Stop.
   - **c** Touch Channel, then touch Marker. Touch the Va Volts field. Using the RPG knob, move the Va marker over the oscilloscope trace on the display.



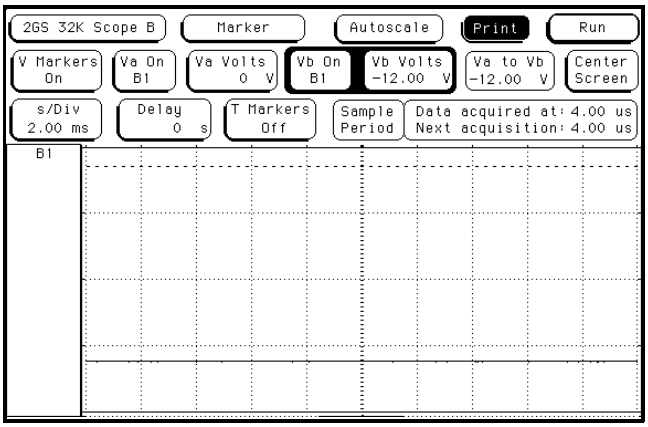
3 Acquire the measured voltage.

a Connect the power supply to the channel input. Set the power supply voltage according to the first line of the table above.

b Touch Run-Repetitive. Wait for approximately five seconds (averaging complete), then touch Stop.

c Touch the Vb Volts field. Using the RPG knob, move the Vb marker over the oscilloscope trace on the display.

d Read the voltage from the Va to Vb field. The value should be between the minimum and maximum values listed in the table. Record the value in the performance test record.



4 Repeat steps 1 through 3 for the second line of the table, then for the rest of the lines of the table for channel 1.

5 Repeat from "Set up the oscilloscope" for channel 2, replacing channel 1 with channel 2 where applicable.

To test the offset accuracy

Testing the offset accuracy verifies the performance of the following specification:

- Offset accuracy

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
DC Power Supply	–35.000 to +35.000 Vdc, ± 1 mV resolution	3245A Option 002
Digital Multimeter	Better than 0.1% accuracy	3458A
Cable	BNC (m)(m) 48-inch	8120-1840
Adapter (cable to power supply)	BNC (f) to Dual Banana Plug	1251-2277
Adapter	BNC tee (m)(f)(f)	1250-0781
Blocking Capacitor	BNC (m)(f) 0.18 μF, ±200 V	10240B
BNC Shorting Cap		1250-0074

Set up the equipment

Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

Set up the oscilloscope

1 Set up the Channel menu.

a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

b Touch the Probe field, then use the RPG knob to dial in 1:1.

c Touch the V/Div field, then use the RPG knob to dial in 4.00 V.

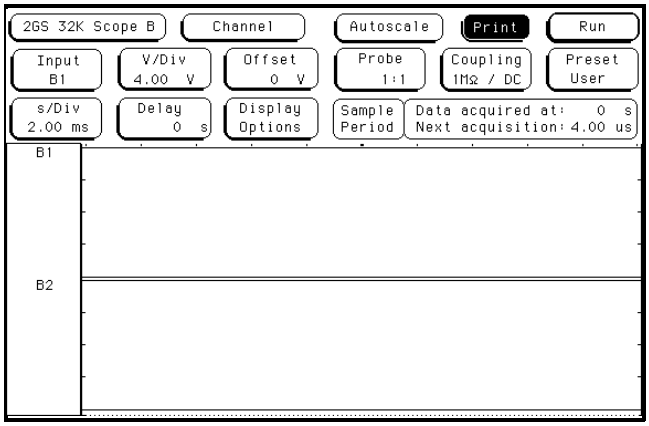
d Touch the Offset field twice. Enter 0 at the numeric keypad, then touch Done.

e Touch the Coupling field, then touch 1MΩ / DC.

Caution

Set the Channel Coupling field to 1MΩ / DC or damage to the equipment will result.

f Touch the s/Div field, then use the RPG knob to dial in 2 ms.



2 Set up the Display menu.

a Touch Channel, then touch Display.

b Touch the Mode field, then touch Average.

c Touch the Average # field, then use the RPG knob to dial in 32.

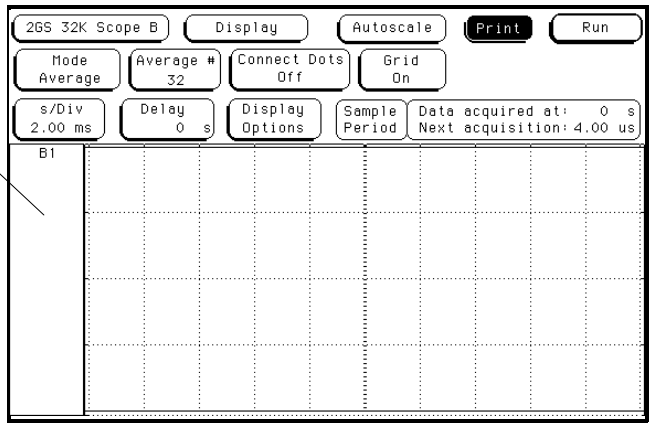
d Touch the Grid field and toggle it to On.

e Touch Waveform selection field twice.

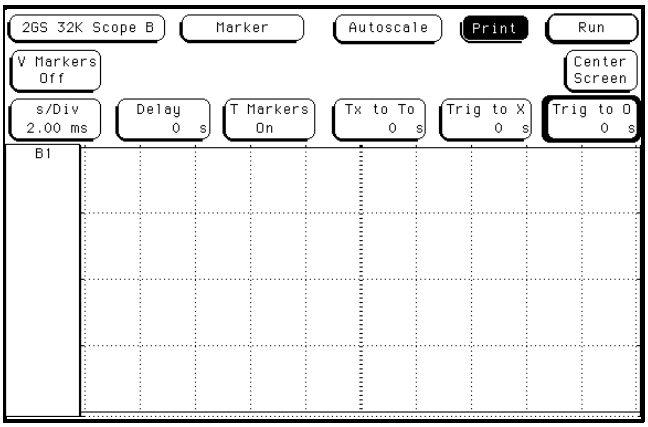
f In Waveform selection menu, select channel 2 using the RPG knob, then touch delete. If channel 1 is not inserted, insert it.

g Touch Done.

Waveform Selection Menu Field

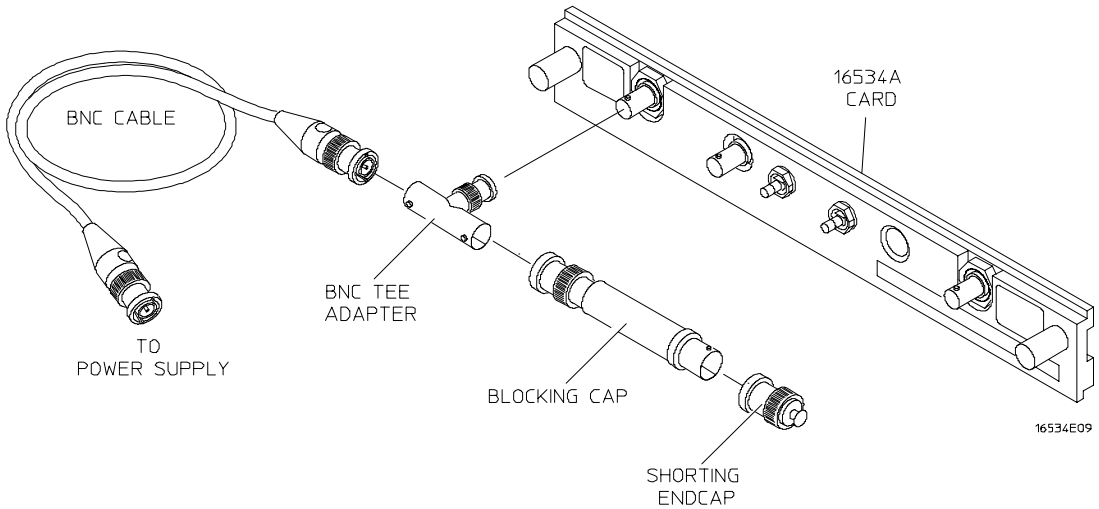


3 Set up the Trigger menu.
   a Touch Display, then touch Trigger.
   b Touch the Mode field, then touch Immediate.
4 Set up the Marker menu.
   a Touch Trigger, then touch Marker.
   b Touch the T Markers field, then touch On.
   c If the V markers are On, turn the V markers Off by touching the V markers field. The VMarkers should toggle Off.



Connect the oscilloscope

1 Using a BNC-to-banana adapter, connect one end of the cable to the power supply. Connect the BNC tee, the blocking capacitor, and the shorting endcap to the other end of the cable.
2 Monitor the power supply output with the Digital Multimeter.

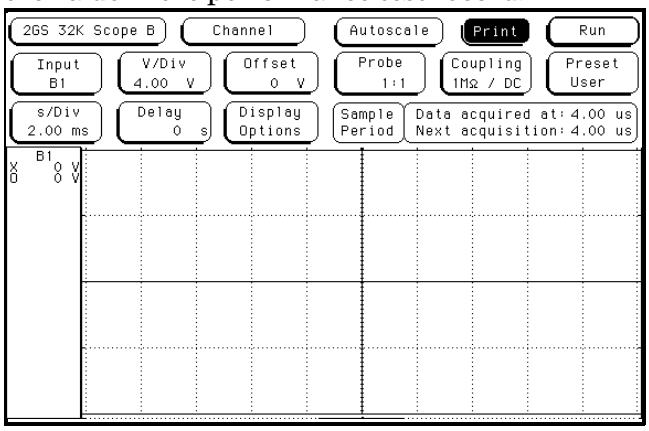


Acquire the zero input data

1 Disconnect the power supply cable from the oscilloscope's channel 1 input.

2 Touch Marker, then touch Channel. Touch the V/Div field twice. Using the numeric keypad, enter 4.0V/div, then touch Done.

3 Touch Run-Repetitive. After approximately 15 seconds (averaging complete), touch Stop. Read the voltage from the Markers voltage field (0.00 V ± 320 mV) and enter the value in the performance test record.



4 Use the RPG knob to dial in 1 V/Div. Touch Run-Repetitive. After approximately 15 seconds (averaging complete), touch Stop. Read the voltage from the Markers voltage field (0.00 V ± 80 mV) and enter the value in the performance test record.

5 Use the RPG knob to dial in 100 mV/Div. Touch Run-Repetitive. After approximately 15 seconds (averaging complete), touch Stop. Read the voltage from the Markers voltage field (0.00 V ± 8 mV) and enter the value in the performance test record.

6 Use the RPG knob to dial in 10 mV/Div. Touch Run-Repetitive. After approximately 15 seconds (averaging complete), touch Stop. Read the voltage from the Markers voltage field (0.00 V ± 800 µV) and enter the value in the performance test record.

Acquire the DC input data

Use the following table for steps 1 through 5.

Oscilloscope Settings

V/Div	Offset	Supply	Lower Limit	Upper Limit
1 V/Div	–35.00 V	–35.00 V	–34.6 V	–35.4 V
200 mV/Div	–10.00 V	–10.00 V	–9.90 V	–10.1 V
20 mV/Div	–2.00 V	–2.00 V	–1.98 V	–2.02 V
20 mV/Div	+2.00 V	+2.00 V	+2.02 V	+1.98 V
200 mV/Div	+10.00 V	+10.00 V	+10.1 V	+9.90 V
1 V/Div	+35.00 V	+35.00 V	+35.4 V	+34.6 V

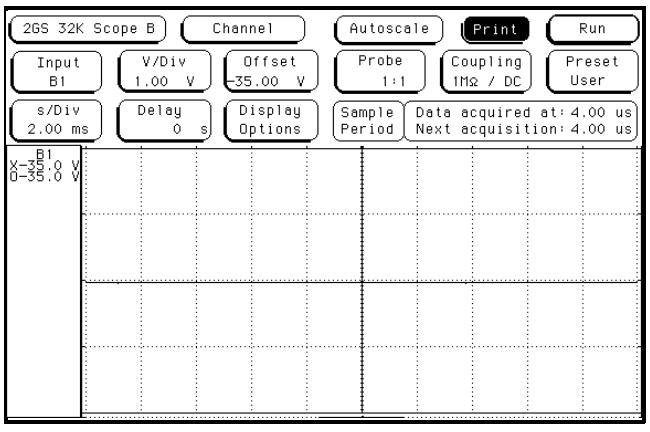
1 Connect the power supply to the oscilloscope channel 1 input. Set the power supply according to the first line of the table above.

2 Set up the oscilloscope according to the table above.

- **a** Touch the V/Div field, then use the RPG knob to dial in the V/Div value shown on the first line of the table.
- **b** Touch the Offset field twice. At the numeric keypad, enter the offset value shown in the first line of the table, then touch Done.

3 Acquire the measured voltage.

- **a** Touch Run-Repetitive. After approx. 15 seconds (averaging complete), touch Stop.
- **b** Read the voltage from the Markers voltage field. The value should be between the minimum and maximum values listed in the table. Record the value in the performance test record.



4 Repeat steps 1 through 3 for the second line of the table, then for the rest of the lines of the table for channel 1.

5 Repeat from "Set up the oscilloscope" for channel 2, replacing channel 1 with channel 2 where applicable.

To test the bandwidth (16533A only)

Testing the bandwidth verifies the performance of the following specification:

- Bandwidth

This test verifies the bandwidth (dc coupled) of the instrument.

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
Signal Generator	1 - 250 MHz at approx 170 mV rms	8656B
Power Meter/Sensor	1 - 250 MHz ± 3% accuracy	436/8482A
Power Splitter	Outputs differ by <0.15 dB	11667B
Cable	Type N (m)(m) 24-inch	11500B
Adapter	Type N (m) to BNC (f)	1250-0082

Set up the equipment

Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

Set up the oscilloscope

1 Set up the Channel menu.

a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

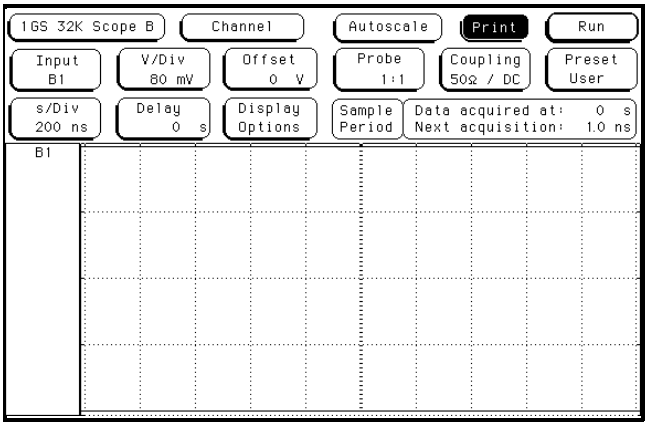
b Touch the Probe field, then use the RPG knob to dial in 1:1.

c Touch the V/Div field twice. At the numeric keypad, enter 80 mV, then touch Done.

d Touch the Offset field twice. At the numeric keypad, enter 0, then touch Done.

e Touch the Coupling field, then touch 50Ω / DC.

f Touch the s/Div field, then use the RPG knob to dial in 200 ns.



2 Set up the Display menu.

a Touch Channel, then touch Display.

b Touch the Mode field, then touch Average.

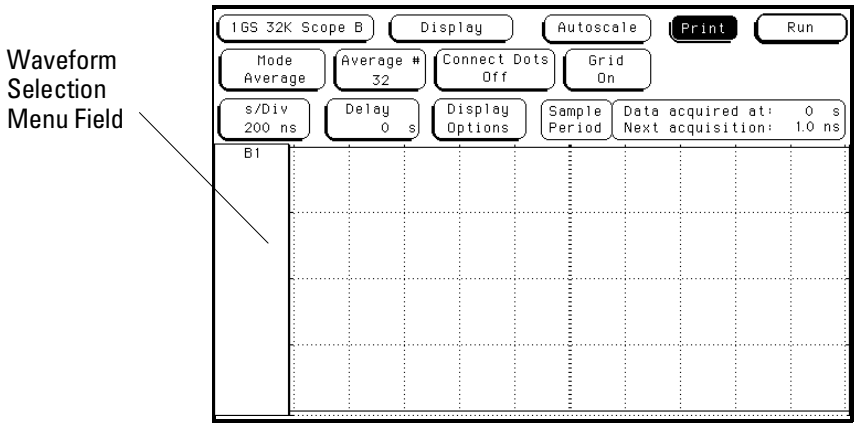
c Touch the Average # field, then use the RPG knob to dial in 32.

d Touch the Grid field and toggle it to On.

e Touch Waveform selection field twice.

f In Waveform selection menu, select channel 2 using the RPG knob, then touch delete. If channel 1 is not inserted, insert it.

g Touch Done.



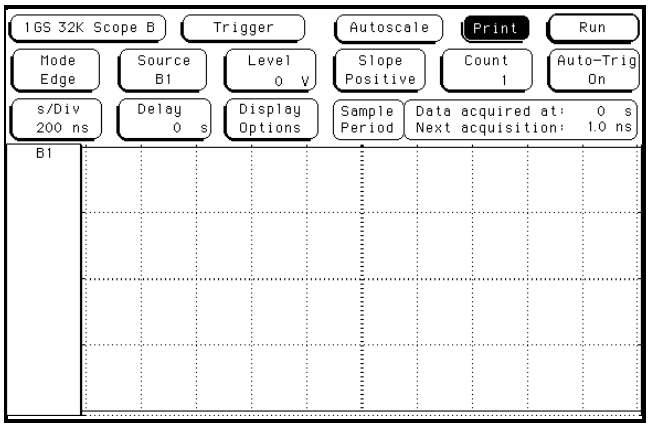
3 Set up the Trigger menu.

a Touch Display, then touch Trigger.

b Touch the Mode field, then touch Edge.

c Touch the Source field, then touch Channel 1.

d Touch the Level field twice. At the numeric keypad, enter 0 then touch Done.

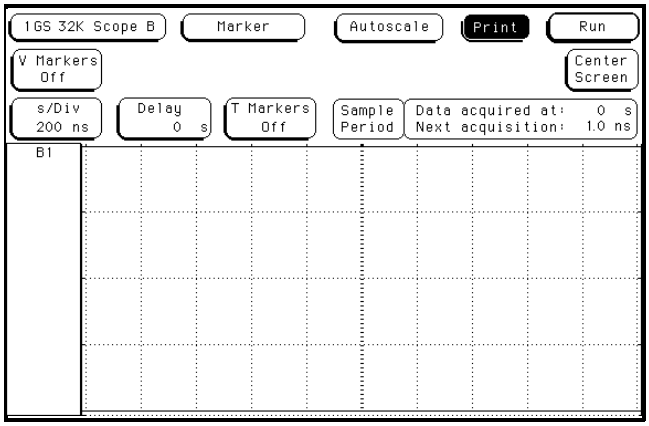


4 Turn off the voltage and time markers.

a Touch Trigger, then touch Marker.

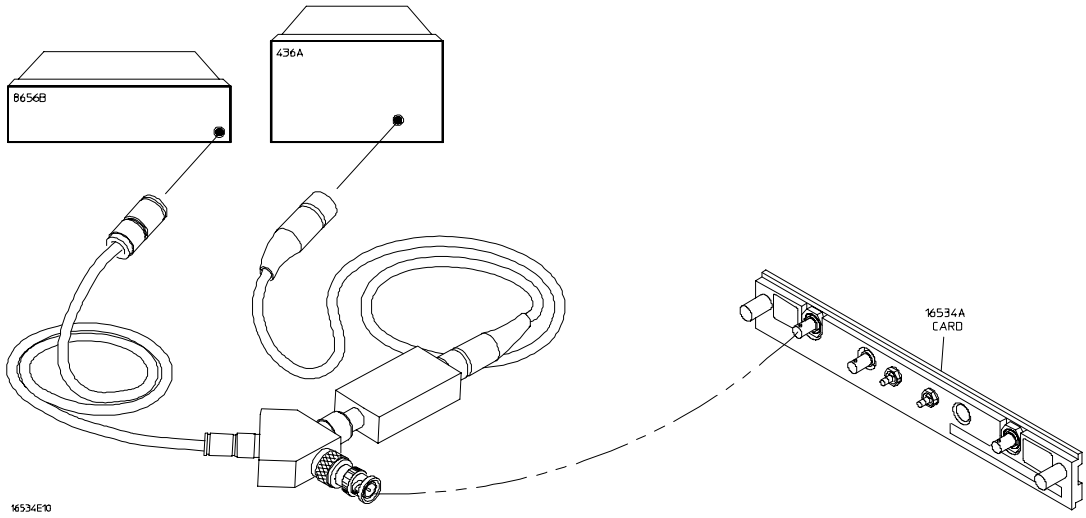
b Touch the V Markers field and toggle it to Off.

c Touch the T Markers field. At the pop up menu, touch Off.



Connect the oscilloscope

1. Using the N cable, connect the signal generator to the power splitter input. Connect the power sensor to one output of the power splitter.
2. Using the N-to-BNC adapter, connect the other power splitter output to the channel 1 input of the oscilloscope.



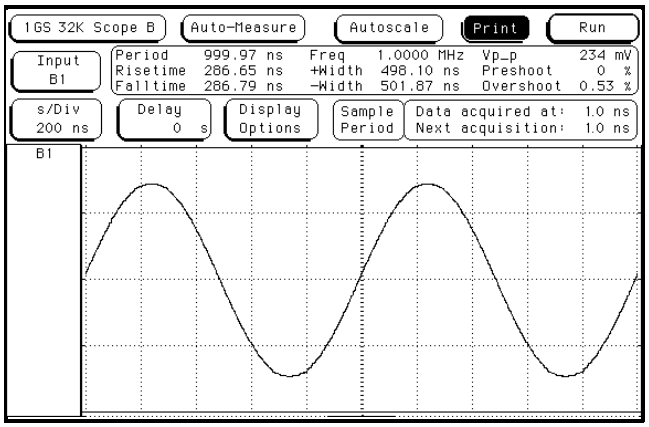
Acquire the data

1 Obtain the 1 MHz response.

a Set the signal generator for 1 MHz at –2.4 dBm.

b Touch Run-Repetitive. The signal on the screen should be two cycles at three divisions amplitude. After approximately 15 seconds (averaging complete), touch Stop.

c Touch Marker, then touch Auto-measure. Note the voltage reading in the V_{p-p} field. $V_{1\ MHz}$ = _____ mV.



2 Set the signal generator for 250 MHz frequency.

a Set the power meter Cal Factor % to the 1 MHz value from the calibration chart on the power splitter. Press dB[REF] to set a 0 dB reference.

b Change the signal generator frequency to 250 MHz. Set the power meter Cal Factor % to the 250 MHz value from the chart.

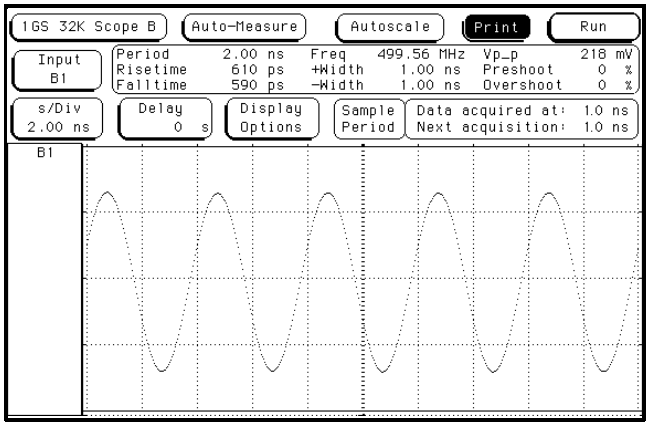
c Adjust the signal generator amplitude for a power reading as close as possible to 0.0 dB[REL] and note the power reading. Reading = _____ dB.

3 Obtain the 250 MHz response.

a Touch Sec/Div and use the RPG knob to dial in a s/Div value of 2 ns/Div.

b Touch Run-Repetitive. After approximately 15 seconds (averaging complete), touch Stop.

c Note the voltage reading in the V_{p-p} field V_{250MHz} = _____mV.



4 Determine the oscilloscope response.

a Calculate the response using the formula:

$$response\ (dB) = 20\log_{10}\frac{V_{250Mhz}}{V_{1MHz}} = 20\log_{10}(\_\_\_\_\_) = \_\_\_\_\_dB$$

b Correct the result from step 4a above with any differences in the power meter from step 2c. Observe signs. For example:

Result from step 4a = –2.3 dB
Power meter reading = –0.2 dB[REL]
then true response = (–2.3) – (–0.2) = –2.1dB

(_____) – (_____) = _____ dB

c The result from step 4b should be ≤ –3.0 dB. Record the result in the performance test record.

5 Remove the power splitter from the oscilloscope module channel 1 input and connect it to the channel 2 input.

6 Repeat from "Set up the oscilloscope" for channel 2, replacing channel 1 with channel 2 where applicable.

See Also

Failure of the bandwidth test can be caused by a faulty attenuator or main assembly (see chapter 6).

To test the bandwidth (16534A only)

Testing the bandwidth verifies the performance of the following specification:

- Bandwidth

This test verifies the bandwidth (dc coupled) of the instrument.

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
Signal Generator	1 - 500 MHz at approx 170 mV rms	8656B
Power Meter/Sensor	1 - 500 MHz ± 3% accuracy	436/8482A
Power Splitter	Outputs differ by <0.15 dB	11667B
Cable	Type N (m)(m) 24-inch	11500B
Adapter	Type N (m) to BNC (f)	1250-0082

Set up the equipment

Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

Set up the oscilloscope

1 Set up the Channel menu.

a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

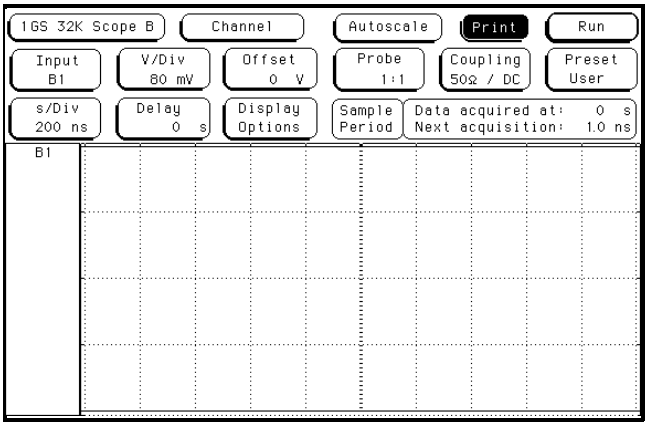
b Touch the Probe field, then use the RPG knob to dial in 1:1.

c Touch the V/Div field twice. At the numeric keypad, enter 80 mV, then touch Done.

d Touch the Offset field twice. At the numeric keypad, enter 0, then touch Done.

e Touch the Coupling field, then touch 50Ω / DC.

f Touch the s/Div field, then use the RPG knob to dial in 200 ns.



2 Set up the Display menu.

a Touch Channel, then touch Display.

b Touch the Mode field, then touch Average.

c Touch the Average # field, then use the RPG knob to dial in 32.

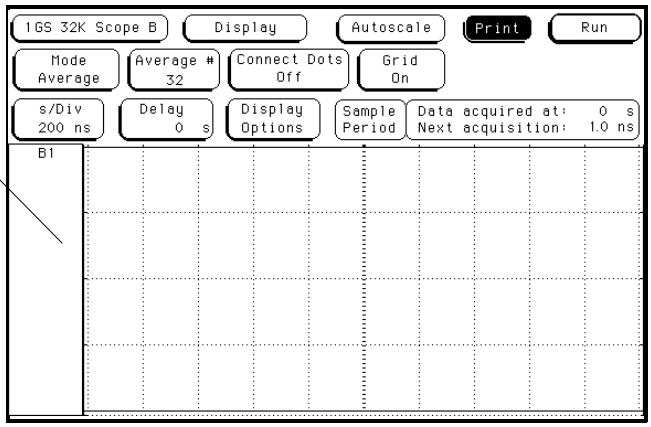
d Touch the Grid field and toggle it to On.

e Touch Waveform selection field twice.

f In Waveform selection menu, select channel 2 using the RPG knob, then touch delete. If channel 1 is not inserted, insert it.

g Touch Done.

Waveform Selection Menu Field



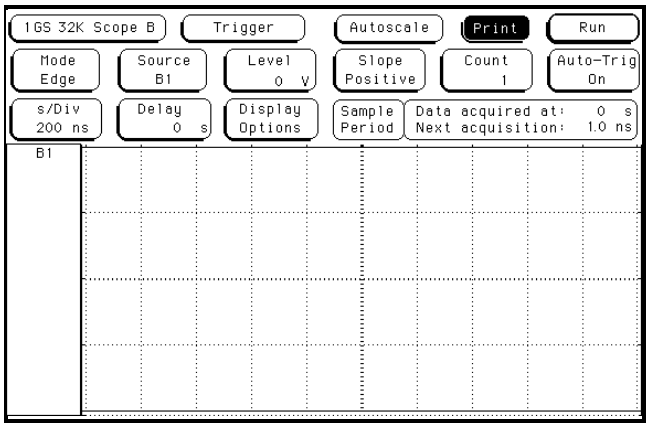
3 Set up the Trigger menu.

a Touch Display, then touch Trigger.

b Touch the Mode field, then touch Edge.

c Touch the Source field, then touch Channel 1.

d Touch the Level field twice. At the numeric keypad, enter 0 then touch Done.

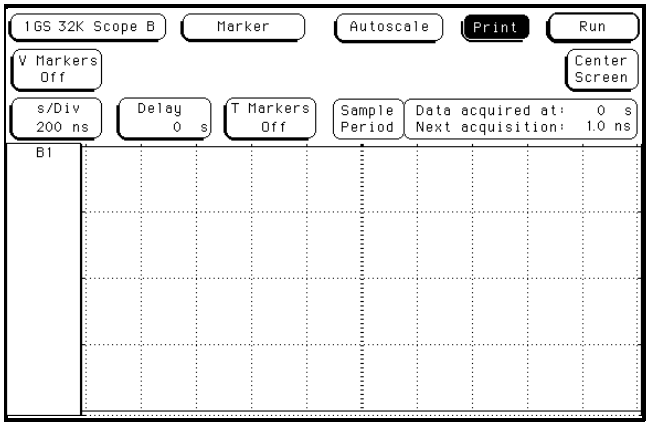


4 Turn off the voltage and time markers.

a Touch Trigger, then touch Marker.

b Touch the V Markers field and toggle it to Off.

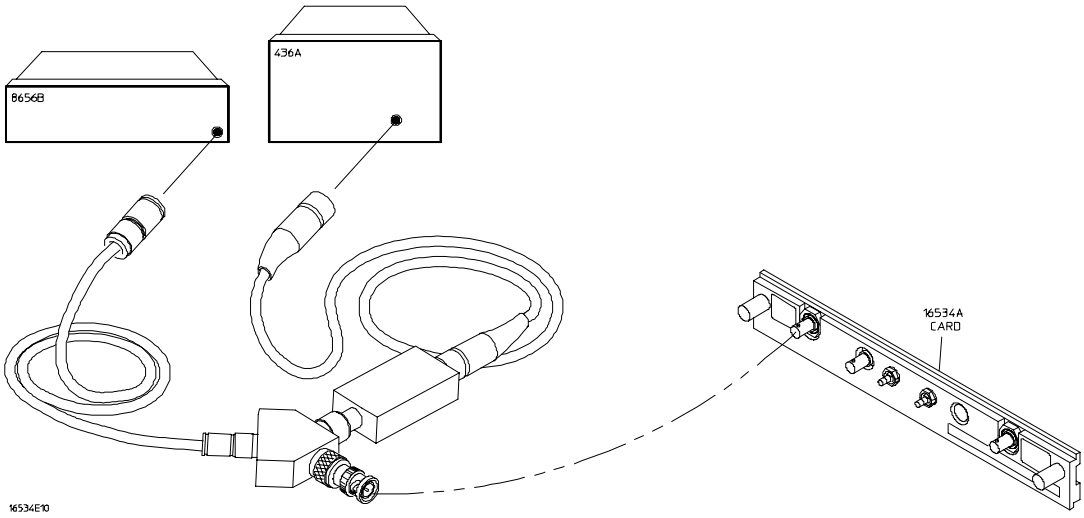
c Touch the T Markers field. At the pop up menu, touch Off.



Connect the oscilloscope

1 Using the N cable, connect the signal generator to the power splitter input. Connect the power sensor to one output of the power splitter.

2 Using the N-to-BNC adapter, connect the other power splitter output to the channel 1 input of the oscilloscope.



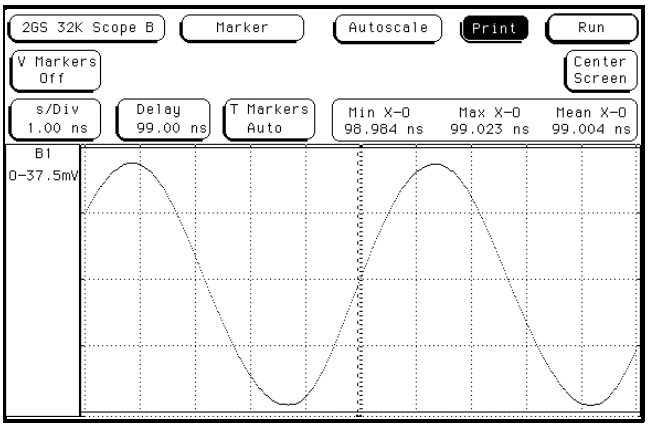
Acquire the data

1 Obtain the 1 MHz response.

a Set the signal generator for 1 MHz at –2.4 dBm.

b Touch Run-Repetitive. The signal on the screen should be two cycles at three divisions amplitude. After approximately 15 seconds (averaging complete), touch Stop.

c Touch Marker, then touch Auto-measure. Note the voltage reading in the $V_{p\text{-}p}$ field. $V_{1\ MHz}$ = _____ mV.



2 Set the signal generator for 500 MHz frequency.

a Set the power meter Cal Factor % to the 1 MHz value from the calibration chart on the power splitter. Press dB[REF] to set a 0 dB reference.

b Change the signal generator frequency to 500 MHz. Set the power meter Cal Factor % to the 500 MHz value from the chart.

c Adjust the signal generator amplitude for a power reading as close as possible to 0.0 dB[REL] and note the power reading. Reading = _____ dB.

3 Obtain the 500 MHz response.

a Touch Sec/Div and use the RPG knob to dial in a s/Div value of 1 ns/Div.

b Touch Run-Repetitive. After approximately 15 seconds (averaging complete), touch Stop.

c Note the voltage reading in the $V_{p\text{-}p}$ field V_{500MHz} = _____mV.

4 Determine the oscilloscope response.

a Calculate the response using the formula:

$$response\ (dB) = 20\log_{10}\frac{V_{500Mhz}}{V_{1MHz}} = 20\log_{10}(\_\_\_\_\_) = \_\_\_\_\_dB$$

b Correct the result from step 4a above with any differences in the power meter from step 2c. Observe signs. For example:

Result from step 4a = –2.3 dB
Power meter reading = –0.2 dB[REL]
then true response = (–2.3) – (–0.2) = –2.1dB

(_____) – (_____) = _____ dB

c The result from step 4b should be ≤ –3.0 dB. Record the result in the performance test record.

5 Remove the power splitter from the oscilloscope module channel 1 input and connect it to the channel 2 input.

6 Repeat from "Set up the oscilloscope" for channel 2, replacing channel 1 with channel 2 where applicable.

See Also

Failure of the bandwidth test can be caused by a faulty attenuator or main assembly (see chapter 6).

To test the time measurement accuracy

Testing the time measurement accuracy verifies the performance of the following specification:

- Time Measurement accuracy

This test uses a precise frequency source to check the accuracy of time measurement functions.

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
Signal Generator	200 MHz, timebase accuracy 0.25 ppm	8656B Opt. 001
Cable	BNC (m)(m) 48-inch	8120-1840
Adapter	Type N (m) to BNC (f)	1250-0780

Set up the equipment

1 Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

2 Set the signal generator to 181.81818 MHz (5.5 ns period) and approximately 600 mV rms.

Set up the oscilloscope

1 Set up the Channel menu.

a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

b Touch the Probe field, then use the RPG knob to dial in 1:1.

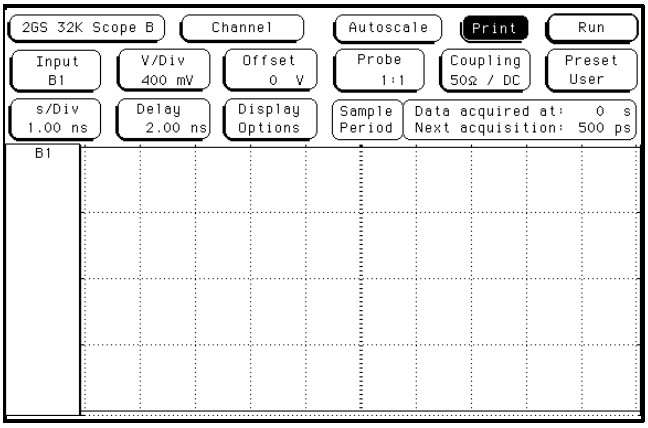
c Touch the V/Div field, then use the RPG knob to dial in 400 mV.

d Touch the Offset field twice. At the numeric keypad, enter 0, then touch Done.

e Touch the Coupling field, then touch 50Ω / DC.

f Touch the s/Div field, then use the RPG knob to dial in 1.00 ns.

g Press Delay twice. At the numeric keypad, enter 2.00 ns, then touch Done.



2 Set up the Display menu.

a Touch Channel, then touch Display.

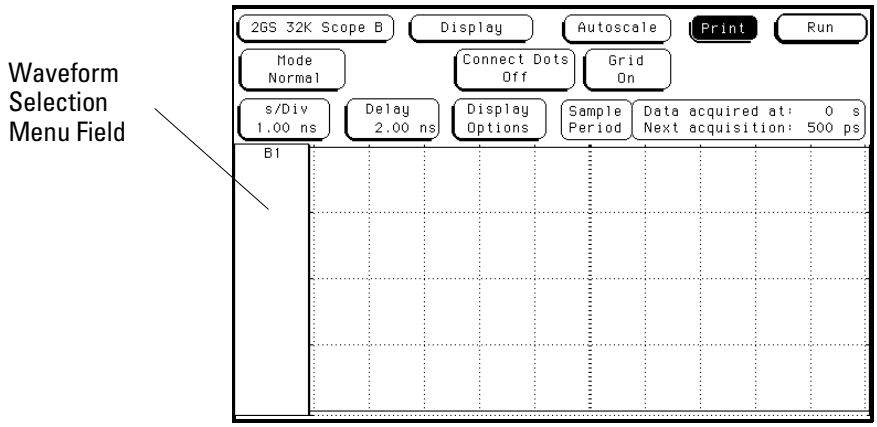
b Touch the Mode field, then touch Normal.

c Touch the Grid field and toggle it to On.

d Touch Waveform selection field twice.

e In Waveform selection menu, select channel 2 using the RPG knob, then touch delete. If channel 1 is not inserted, insert it.

f Touch Done.



3 Set up the Trigger menu.

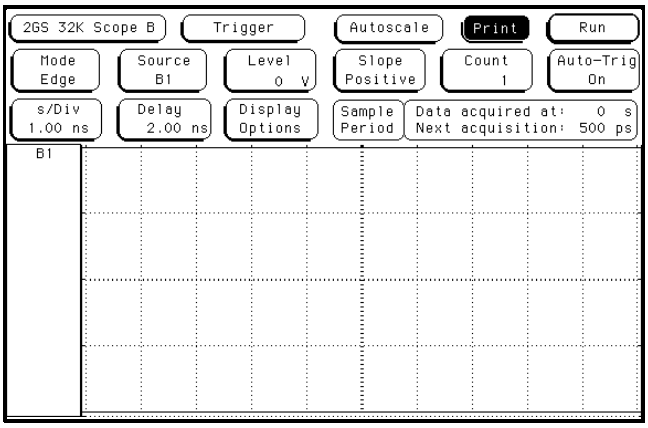
a Touch Display, then touch Trigger.

b Touch the Mode field, then touch Edge.

c Touch the Source field, then select Channel 1.

d Touch the Level field twice. At the numeric keypad, enter 0, then touch Done.

e If the Slope field is set to Negative, touch the Slope field and toggle it to Positive.



4 Set up the Markers menu.

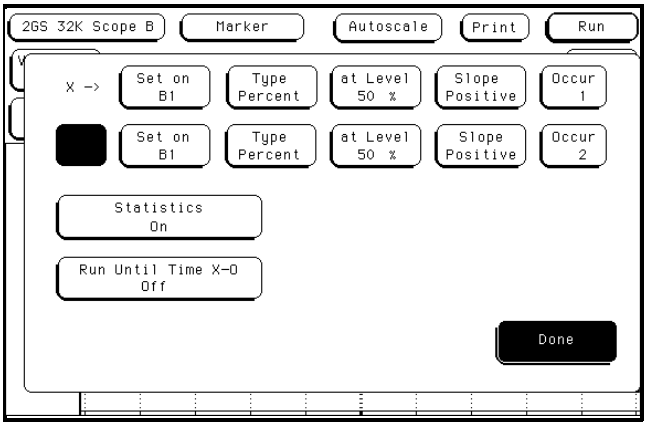
a Touch Trigger, then touch Marker.

b Touch the T Markers field, then touch Auto.

c Touch the X marker, and set it on Channel 1 at Level 50%, Slope Positive, Occur 1 (use the RPG knob for Occur).

d Touch the O marker, and set it on Channel 1 at Level 50%, Slope Positive, Occur 2 (use the RPG knob for Occur).

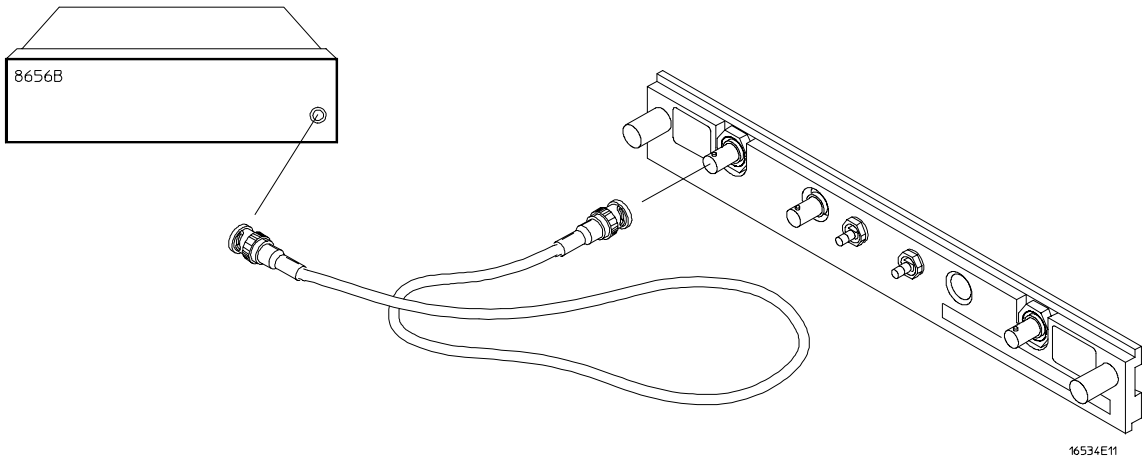
e If the Statistics field is set to Off, touch the Statistics field and toggle it to On.



f Touch Done.

Connect the oscilloscope

Using the N-to-BNC adapter and the BNC cable, connect the signal generator output to the channel 1 input of the oscilloscope.

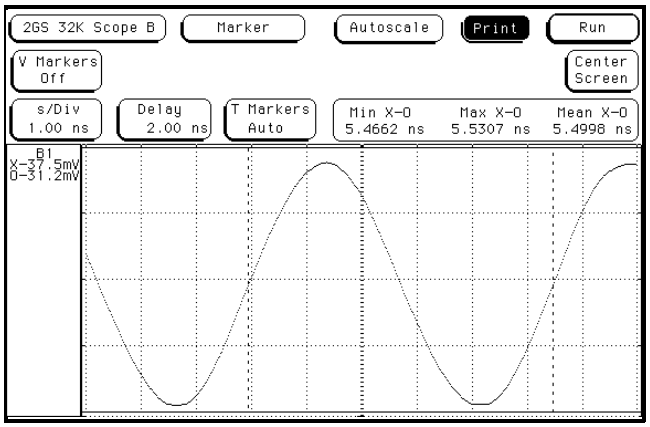


Acquire the data

1 Determine short time period accuracy.

a Touch Run-Repetitive. If the waveform is clipping, reduce the signal generator output voltage level until the waveform no longer clips. After approximately two minutes, touch Stop.

b In the Statistics field, check to see that the Mean X - O field is approximately 5.500 ns. Check that both the Min X - O and the Max X - O are within 100 ps of the Mean X - O. Record the results in the performance test record.



2 Determine longer time period accuracy.

a Touch T Marker, then touch Auto.

b Touch the X marker Set On field. At the pop up menu, touch Manual.

c Touch the O marker Occur field. Use the RPG knob to dial in 1.

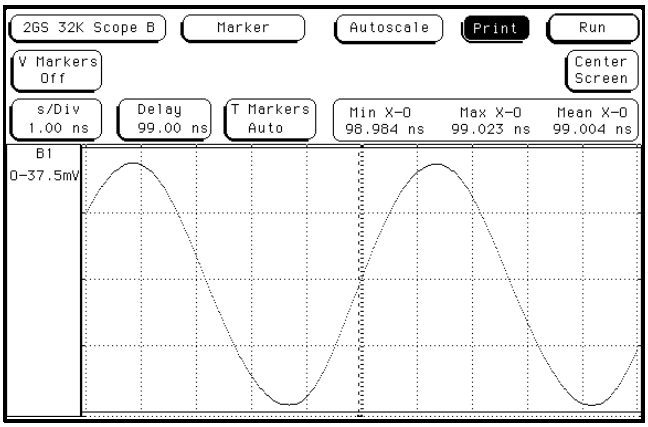
d Touch Done.

e Touch Marker, then Display. Touch the Mode field, then touch Average. Touch the Average # field. Use the RPG knob to dial in 8.

f Touch the Delay field twice. At the numeric keypad, enter 99 ns, then touch Done.

g Touch Display, then touch Marker. Touch Run-Repetitive. After approximately two minutes, touch Stop.

h In the Statistics field, check to see that the Mean X - O field is approximately 99 ns. Check that both the Min X - O and the Max X - O are within 105 ps of the Mean X - O. Record the results in the performance test record.



To test the trigger sensitivity (16533A only)

Testing the trigger sensitivity verifies the performance of the following specifications:

- DC to 50 MHz: 0.063 x full scale (0.25 division)
- 50 to 250 MHz: 0.125 x full scale (0.5 division)

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
Signal Generator	50 and 225 MHz, 30 - 80 mV RMS output	8656B Opt. 001
Cable	BNC 48-inch	8120-1840
Adapter	Type N (m) to BNC (f)	1250-0780

Set up the equipment

Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

Set up the oscilloscope

1 Set up the Channel menu.

a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

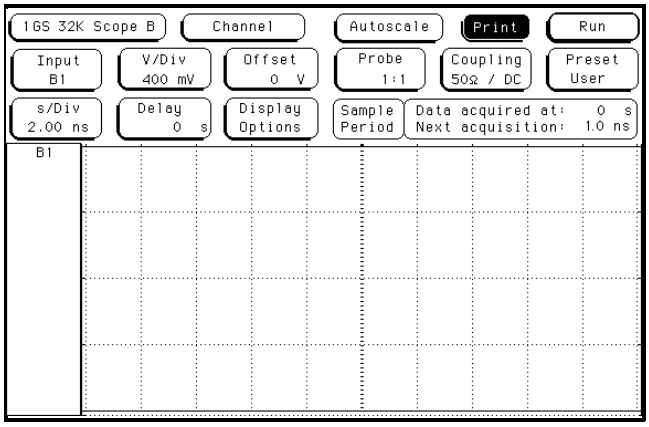
b Touch the Probe field, then use the RPG knob to dial in 1:1.

c Touch the V/Div field, then use the PRG knob to dial in 400 mV.

d Touch the Offset field twice. At the numeric keypad, enter 0, then touch Done.

e Touch the Coupling field, then touch 50Ω / DC.

f Touch the s/Div field, then use the RPG knob to dial in 2.00 ns.



2 Set up the Display menu.

a Touch Channel, then touch Display.

b Touch the Mode field, then touch Average.

c Touch the Average # field. Use the RPG knob to dial in 8.

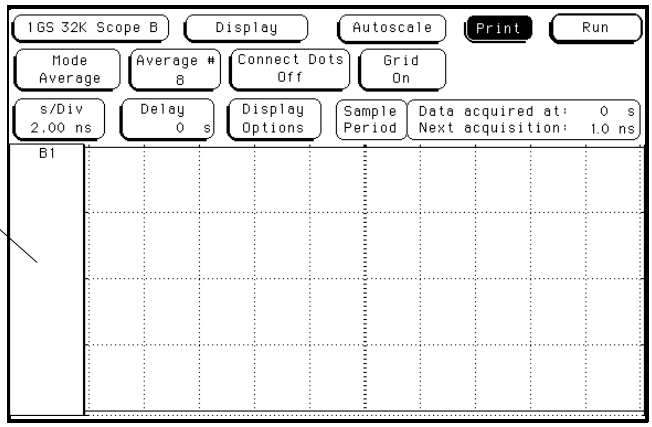
d Touch the Grid field and toggle it to On.

e Touch Waveform selection field twice.

f In Waveform selection menu, select channel 2 using the RPG knob, then touch delete. If channel 1 is not inserted, insert it.

g Touch Done.

Waveform Selection Menu Field



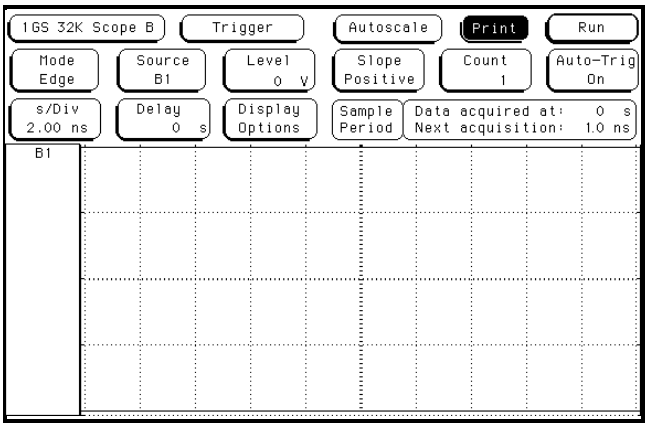
3 Set up the Trigger menu.

a Touch Display, then touch Trigger.

b Touch the Mode field, then touch Edge.

c Touch the Source field then touch Channel 1.

d Touch the Level field twice. At the numeric keypad, enter 0, then touch Done.

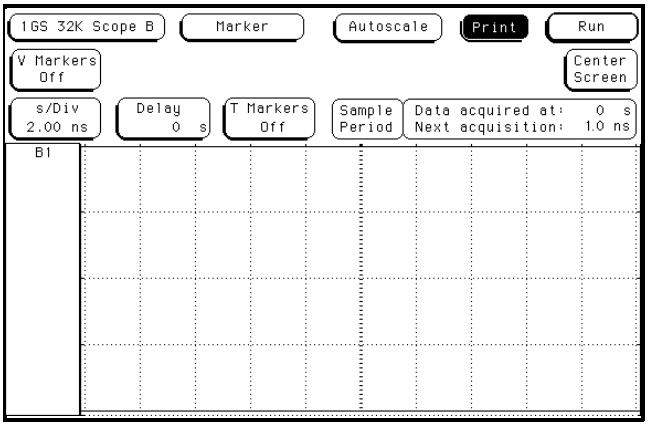


4 Turn off the voltage and time markers.

a Touch Trigger, then touch Marker.

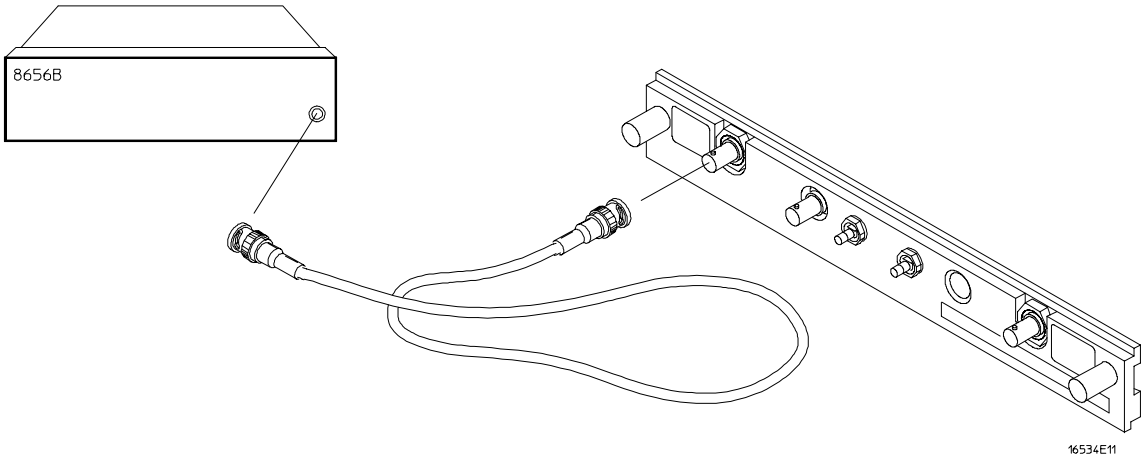
b Touch the V Markers field and toggle the marker to Off.

c Touch the T Markers field. At the pop up menu, touch Off.



Connect the oscilloscope

Using the N-to-BNC adapter and the BNC cable, connect the signal generator output to the channel 1 input of the oscilloscope.



Acquire the data

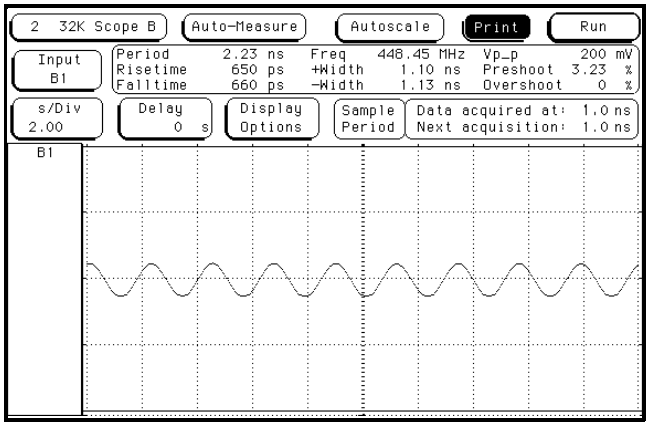
1 Test the upper bandwidth trigger sensitivity.

a Set the signal generator to provide a 225 MHz signal with 70 mV rms amplitude.

b Touch Run-Repetitive. Touch Marker, then touch Auto-Measure. Adjust the signal generator amplitude until the auto-measure Vp-p field displays 200 mV (maximum). Touch Auto-Measure, then touch Trigger.

c If the Auto triggered message appears (oscilloscope doesn't trigger), touch the Level field and use the RPG knob to adjust the trigger level until the oscilloscope triggers (Auto triggered message goes away).

d If the oscilloscope triggers, record a pass in the performance test record. Touch Stop to halt the acquisition.



2 Test the lower bandwidth trigger sensitivity.

a Touch the s/Div field and use the RPG knob to dial in s/Div of 20 ns.

b Set the signal generator to provide a 50 MHz signal. Set the signal generator's amplitude to one-half the current setting (from upper bandwidth trigger sensitivity).

c Touch Run.

d If the oscilloscope doesn't trigger, touch the Level field and use the RPG knob to adjust the trigger level until the oscilloscope triggers (Auto triggered message goes away).

e If the oscilloscope triggers, record a pass in the performance test record.

f Press Stop to halt the acquisition.

3 Remove the signal generator output from channel 1 and connect the BNC cable to channel 2. Repeat from "Set up the oscilloscope" for channel 2, replacing channel 1 with channel 2 where appropriate.

To test the trigger sensitivity (16534A only)

Testing the trigger sensitivity verifies the performance of the following specifications:

- DC to 50 MHz: 0.063 x full scale (0.25 division)
- 50 to 500 MHz: 0.125 x full scale (0.5 division)

Equipment Required

Equipment	Critical Specifications	Recommended Agilent Model/Part
Signal Generator	50 and 450 MHz, 30 - 80 mV RMS output	8656B Opt. 001
Cable	BNC 48-inch	8120-1840
Adapter	Type N (m) to BNC (f)	1250-0780

Set up the equipment

Turn on the equipment required and the logic analysis system mainframe with the oscilloscope module to be tested. Let them warm up for 30 minutes if you have not already done so.

Set up the oscilloscope

1 Set up the Channel menu.

a In the oscilloscope module Channel menu, touch the Input field, then touch Channel 1.

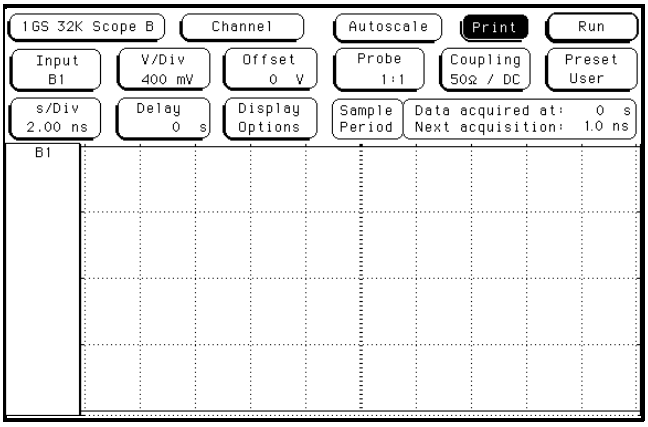
b Touch the Probe field, then use the RPG knob to dial in 1:1.

c Touch the V/Div field, then use the PRG knob to dial in 400 mV.

d Touch the Offset field twice. At the numeric keypad, enter 0, then touch Done.

e Touch the Coupling field, then touch 50Ω / DC.

f Touch the s/Div field, then use the RPG knob to dial in 2.00 ns.



2 Set up the Display menu.

a Touch Channel, then touch Display.

b Touch the Mode field, then touch Average.

c Touch the Average # field. Use the RPG knob to dial in 8.

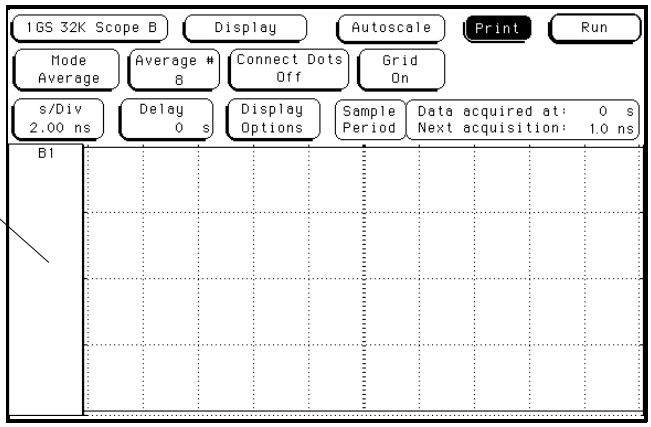
d Touch the Grid field and toggle it to On.

e Touch Waveform selection field twice.

f In Waveform selection menu, select channel 2 using the RPG knob, then touch delete. If channel 1 is not inserted, insert it.

g Touch Done.

Waveform Selection Menu Field



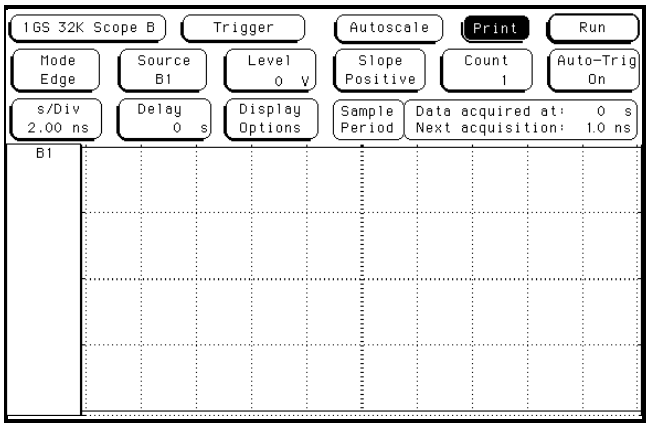
3 Set up the Trigger menu.

a Touch Display, then touch Trigger.

b Touch the Mode field, then touch Edge.

c Touch the Source field then touch Channel 1.

d Touch the Level field twice. At the numeric keypad, enter 0, then touch Done.

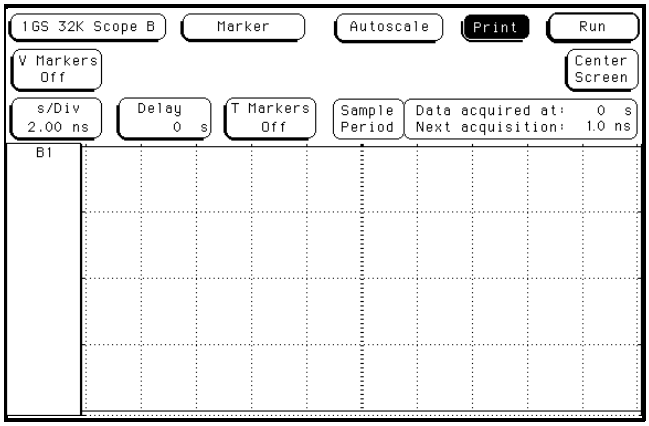


4 Turn off the voltage and time markers.

a Touch Trigger, then touch Marker.

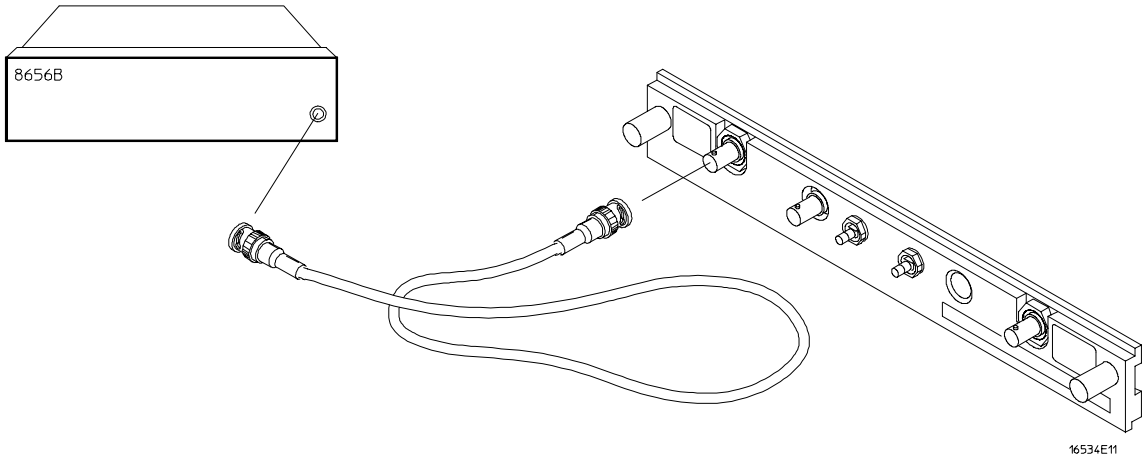
b Touch the V Markers field and toggle the marker to Off.

c Touch the T Markers field. At the pop up menu, touch Off.



Connect the oscilloscope

Using the N-to-BNC adapter and the BNC cable, connect the signal generator output to the channel 1 input of the oscilloscope.



Acquire the data

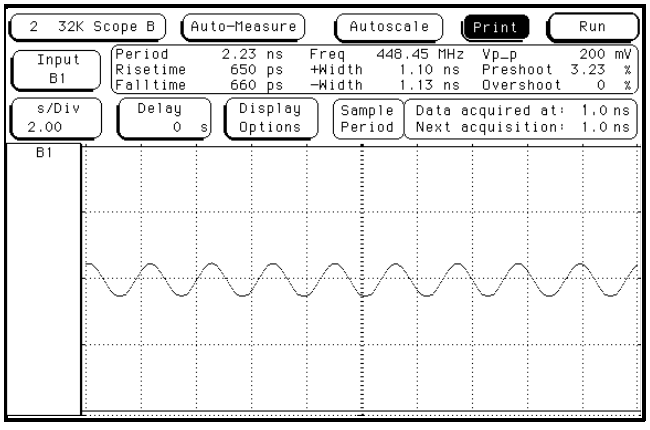
1 Test the upper bandwidth trigger sensitivity.

a Set the signal generator to provide a 450 MHz signal with 70 mV rms amplitude.

b Touch Run-Repetitive. Touch Marker, then touch Auto-Measure. Adjust the signal generator amplitude until the auto-measure Vp-p field displays 200 mV (maximum). Touch Auto-Measure, then touch Trigger.

c If the Auto triggered message appears (oscilloscope doesn't trigger), touch the Level field and use the RPG knob to adjust the trigger level until the oscilloscope triggers (Auto triggered message goes away).

d If the oscilloscope triggers, record a pass in the performance test record. Touch Stop to halt the acquisition.



2 Test the lower bandwidth trigger sensitivity.

   a Touch the s/Div field and use the RPG knob to dial in s/Div of 20 ns.

   b Set the signal generator to provide a 50 MHz signal. Set the signal generator's amplitude to one-half the current setting (from upper bandwidth trigger sensitivity).

   c Touch Run.

   d If the oscilloscope doesn't trigger, touch the Level field and use the RPG knob to adjust the trigger level until the oscilloscope triggers (Auto triggered message goes away).

   e If the oscilloscope triggers, record a pass in the performance test record.

   f Press Stop to halt the acquisition.

3 Remove the signal generator output from channel 1 and connect the BNC cable to channel 2. Repeat from "Set up the oscilloscope" for channel 2, replacing channel 1 with channel 2 where appropriate.

	16533A/34A Oscilloscope _____
Serial No._____	Work Order No._____
Recommended Test Interval - 2 Year/4000 hours	Date_____
Recommended next testing_____	Temperature_____

Test	Settings	Results	
Self-Tests		Pass/Fail	_____
DC CAL Output	5.000 Vdc ±10 mV	Limits	Measured
		4.990 Vdc 5.010 Vdc	_____
AC CAL Output	0.8 Vp_p ±10% 1.000 KHz ±10%	0.72 Vp_p 0.88 Vp_p	_____
		900 Hz 1100 Hz	_____
Input Resistance	50 Ω± 0.5 Ω (49.5 to 50.5 Ω) 1MΩ± 10 KΩ (0.990 to 1.010 MΩ)		
Channel 1			
		50 Ω @ 20 mV/Div	_____
		1 MΩ @ 20 mV/Div	_____
		50 Ω @ 200 mV/Div	_____
		1 MΩ @ 200 mV/Div	_____
		50 Ω @ 1 V/Div	_____
		1 MΩ @ 1 V/Div	_____
		50 Ω @ 4 V/Div	_____
		1 MΩ @ 4 V/Div	_____
Channel 2			
		50 Ω @ 20 mV/Div	_____
		1 MΩ @ 20 mV/Div	_____
		50 Ω @ 200 mV/Div	_____
		1 MΩ @ 200 mV/Div	_____
		50 Ω @ 1 V/Div	_____
		1 MΩ @ 1 V/Div	_____
		50 Ω @ 4 V/Div	_____
		1 MΩ @ 4 V/Div	_____

Test	Settings	Results	
Voltage Measurement Accuracy		Limits	Measured
Channel 1	Zero Input	-11.74V to -12.26V	_____
		-2.94V to -3.06V	_____
		-1.174V to -1.226V	_____
		-117.4mV to -122.6mV	_____
		122.6mV to 117.4mV	_____
		1.226V to 1.174V	_____
		3.06V to 2.94V	_____
		12.26V to 11.74V	_____
Channel 2	Zero Input	-11.74V to -12.26V	_____
		-2.94V to -3.06V	_____
		-1.174V to -1.226V	_____
		-117.4mV to -122.6mV	_____
		122.6mV to 117.4mV	_____
		1.226V to 1.174V	_____
		3.06V to 2.94V	_____
		12.26V to 11.74V	_____
Offset Accuracy	**Zero-input offset**		
Channel 1	4 V/Div	0.00 V±320.0 mV	_____
	1 V/Div	0.00 V±80.0 mV	_____
	100 mV/Div	0.00 V±8.0 mV	_____
	10 mV/Div	0.00 V±800.0 µV	_____
Channel 2	4 V/Div	0.00 V±320.0 mV	_____
	1 V/Div	0.00 V±80.0 mV	_____
	100 mV/Div	0.00 V±8.0 mV	_____
	10 mV/Div	0.00 V±800.0 µV	_____
	DC-input offset		
Channel 1	-35.00 V	-34.6 V to -35.4 V	_____
	-10.00 V	-9.90 V to -10.1 V	_____
	-2.00 V	-1.98 V to -2.02 V	_____
	+2.00 V	+2.02 V to +1.98 V	_____
	+10.00 V	+10.1 V to +9.90 V	_____
	+35.00 V	+35.4 V to +34.6 V	_____
Channel 2	-35.00 V	-34.6 V to -35.4 V	_____
	-10.00 V	-9.90 V to -10.1 V	_____
	-2.00 V	-1.98 V to -2.02 V	_____
	+2.00 V	+2.02 V to +1.98 V	_____
	+10.00 V	+10.1 V to +9.90 V	_____
	+35.00 V	+35.4 V to +34.6 V	_____

Test	Settings	Results
Bandwidth		Limit Measured
Channel 1		≤–3.0dB _____
Channel 2		≤–3.0dB _____
Time Measurement Accuracy	5.500ns ± 100ps	MEAN X-0 _____ MIN X-0 _____ MEAN X-0 - MIN X-0 _____ MAX X-0 _____ MAX X-0 - MEAN X-0 _____
	99.00ns ± 105ps	MEAN X-0 _____ MIN X-0 _____ MEAN X-0 - MIN X-0 _____ MAX X-0 _____ MAX X-0 - MEAN X-0 _____
16533A Trigger Sensitivity		
Channel 1	Trigger Stable @ 225 MHz (200mVp_p max) Trigger Stable @ 50 MHz (100mVp_p max)	Pass/Fail _____ _____
Channel 2	Trigger Stable @225 5 MHz (200mVp_p max) Trigger Stable @ 50 MHz (100mVp_p max)	Pass/Fail _____ _____
16534A Trigger Sensitivity		
Channel 1	Trigger Stable @ 450 MHz (200mVp_p max) Trigger Stable @ 50 MHz (100mVp_p max)	Pass/Fail _____ _____
Channel 2	Trigger Stable @450 5 MHz (200mVp_p max) Trigger Stable @ 50 MHz (100mVp_p max)	Pass/Fail _____ _____

4

Calibrating and Adjusting

Calibrating and Adjusting

This chapter gives you instructions for calibrating and adjusting the oscilloscope. The calibration and adjustment procedures in this chapter are for both the Agilent Technologies 16533A and 16534A.

Adjustments to the oscilloscope include adjusting the CRT monitor assembly.

To periodically verify the performance of the analyzer, refer to "Testing Performance" in chapter 3.

Oscilloscope calibration

The oscilloscope circuitry in the 16533A/34A oscilloscope requires an operational accuracy calibration by the user or service department under any of the following conditions:

- at six months intervals or every 1,000 hours
- if the ambient temperature changes more than 10° C from the temperature at full calibration
- to optimize measurement accuracy

To test the oscilloscope circuitry against specifications (full calibration), refer to chapter 3, Testing Performance.

Multicard oscilloscope calibration

A complete operational accuracy calibration on an 16533A/34A multicard module requires the module to first be separated into single card modules. The operational accuracy calibrations on the acquisition subsystem are done on the single card modules. After reconfiguring the 16533A/34A module into a multicard module, the timebase operational accuracy calibrations are done.

To calibrate the oscilloscope

Equipment Required

Equipment	Critical Specification	Recommended Agilent Model/Part	Qty
Cable (2)	BNC, 9-inch (equal length)	8120-1838	2
Adapter	BNC (m)(m)	1250-1236	1
Adapter	BNC tee (m)(f)(f)	1250-0781	1
Adapter	BNC (f)/SMB (m)	1250-1236	1

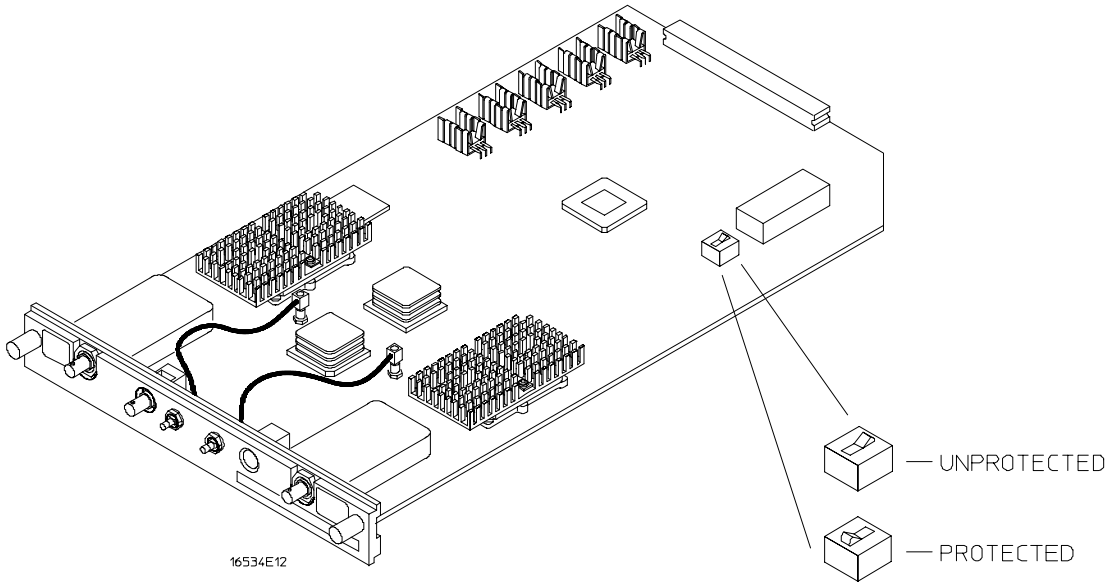
Set up the equipment

CAUTION The effects of ELECTROSTATIC DISCHARGE can damage components. Use grounded wrist straps and mats when you are performing any kind of service on this module.

The 16533A/34A oscilloscope module contains a calibration PROTECT/UNPROTECT switch. This switch must be set to UNPROTECT before new calibration values from the operational accuracy calibration can be stored to nonvolatile RAM.

16533A/34A multicard modules must be separated into single card modules before performing the operational accuracy calibration on the acquisition circuitry.

1. Remove power from the instrument. If a multicard module is being calibrated, Disconnect all Master/Expander Trigger Cables from the ECL EXT TRIG IN and OUT connectors on the rear panel of each 16533A/34A card.
2. Pull out halfway all cards and filler panels located above the oscilloscope, then remove the filler panels and cards located above the oscilloscope.
3. Remove the 16533A/34A module and set the PROTECT/UNPROTECT switch to the UNPROTECT position. On a multicard module, the PROTECT/UNPROTECT switch on all cards must be set to UNPROTECT.



4 Reinstall the modules and filler panels.

5 Apply power to the Agilent Technologies 16500B mainframe. Allow the 16533A/34A module to warm up approximately 30 minutes before doing the following steps.

Self Cal menu calibrations

1 Load the default calibrations factors.

Note that once the default calibration factors are loaded, all calibrations must be done. The calibration must be performed in the exact sequence listed below.

NOTE The calibration PROTECT/UNPROTECT switch on the 16533A/34A oscilloscope module must be set to UNPROTECT.

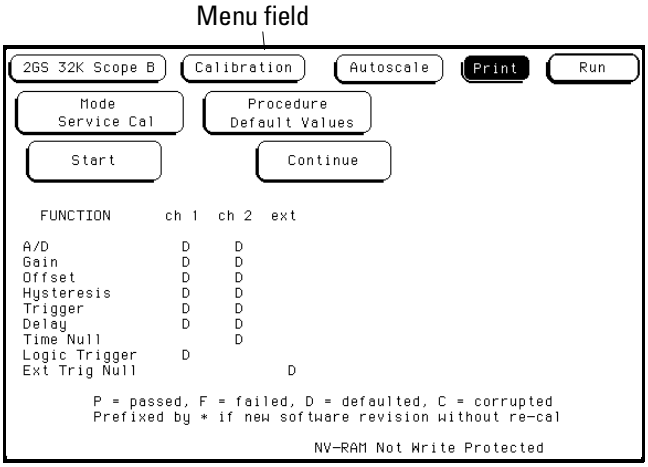
a Touch the module field, then at the pop-up menu touch the 1GS/2GS 32K Scope card to be calibrated.

b Touch the Menu field, then at the pop-up menu touch Calibration.

c Touch the mode field, then at the pop-up menu touch Service Cal.

d Touch the Procedure field, then at the pop-up menu touch Default Values.

e Touch the Start field, then follow the instructions on the display.



Messages will be displayed as each operational accuracy calibration routine is completed to indicate calibration has passed or failed. The resulting calibration factors are automatically stored to nonvolatile RAM at the conclusion of each calibration routine.

2 Calibrate Vert Cal of the Self Cal.

a Connect two BNC 50-Ω, 9-inch cables to the BNC tee adapter. Once you touch Start, the instrument will prompt you to connect the cables to the appropriate locations on the rear panel of the instrument.

b Touch the Mode field, then touch Self Cal from the pop-up menu.

c Touch the Procedure field, then touch Vert Cal from the pop-up menu.

d Touch the Channel field, then touch All from the pop-up menu.

e Touch the Start field and follow the instructions on the display.

f After completion of Vertical Calibration (approximately 15 minutes), remove the cables from the instrument.

3 Calibrate Delay of the Self Cal.

a Obtain a BNC 50-Ω, 9-inch cable. Once you touch Start, the instrument will prompt you to connect the cable to the appropriate location on the rear panel of the instrument.

b Touch the Procedure field, then touch Delay from the pop-up menu.

c Touch the Channel field, then select channel 1.

d Touch the Start field and follow the instructions on the display.

e Repeat steps c and d for channel 2.

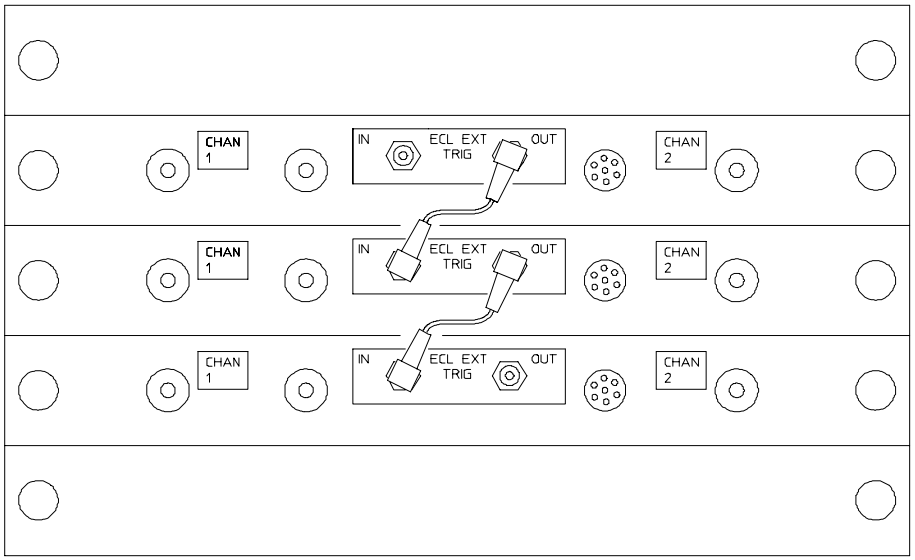
f After completing all of the channel delay calibrations, remove the cable from the oscilloscope.

4 If a multicard 16533A/34A module is being calibrated, repeat steps 1 through 3 for the next 16533A/34A card until all cards have been completed.

5 If a single card 16533A/34A module is being calibrated, proceed to step 6. If a multicard 16533A/34A module is being calibrated, perform the following steps before proceeding to step 6.

a Remove power from the Agilent Technologies 16500B mainframe.

b Install the Master/Expander Trigger Cables on the ECL EXT TRIG IN and OUT connectors on the rear panel of each 16533A/34A card. Starting with the top-most 16533A/34A card, connect the ECL EXT TRIG OUT to the ECL TRIG IN of the card immediately below. Repeat for all cards in the module.



16534E04

c Reapply power to the Agilent Technologies 16500B mainframe.

d When power-up is complete, Touch System, then touch 2GS 32K Scope. Touch Channel, then touch Calibration.

6 Calibrate the Time Null of the Self Cal.

- **a** Connect two BNC 50-Ω, 9-inch cables to the BNC tee adapter. Once you touch Start, the instrument will prompt you to connect the cables to the appropriate locations on the rear panel of the instrument.
- **b** Touch the Procedure field, then touch Time Null from the pop-up menu.
- **c** Touch the Start field and follow the instructions on the display.
- **d** After completion of the Time Null calibration, remove the cables from the instrument.

7 Calibrate the Logic Trigger of the Self Cal.

- **a** Obtain a BNC 50-Ω, 9-inch cable.
- **b** Touch the Procedure field, then touch Logic Trigger from the pop-up menu.
- **c** Touch the Start field and follow the instructions on the display.
- **d** After completion of the Logic Trigger calibration, remove the cable from the instrument.

8 Calibrate Ext Trig Null of the Self Cal.

- **a** Connect a BNC 50-Ω, 9-inch cable to the BNC tee adapter. Connect the BNC 50Ω (f)/SMB(m) adapter to one end of the BNC tee adapter using a BNC(m)(m) adapter. Once you touch Start, the instrument will prompt you to connect the cables to the appropriate locations on the rear panel of the instrument.
- **b** Touch the Procedure field, then touch Ext Trig Null from the pop-up menu.
- **c** Touch the Start field and follow the instructions on the display.
- **d** After completion of External Trigger Null Calibration, remove the cables from the instrument.

Protect the operational accuracy calibration factors

1 Remove power from the instrument. Pull out halfway all cards and filler panels located above the oscilloscope.

2 Remove the 16533A/34A module and set the PROTECT/UNPROTECT switch to the PROTECT position. On a multicard module, the PROTECT/UNPROTECT switch on all cards must be set to PROTECT.

3 Reinstall the modules and filler panels.

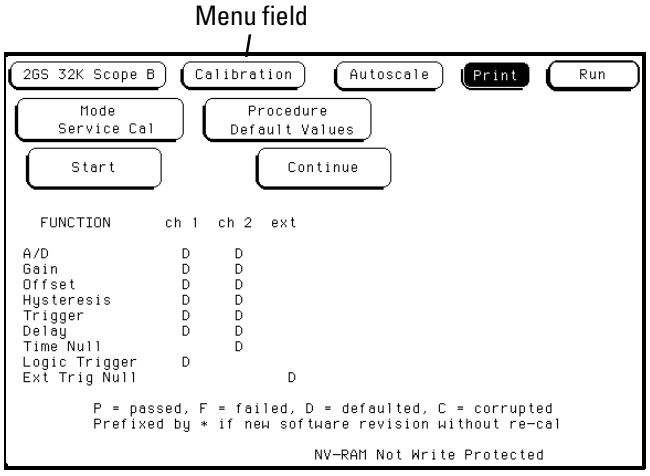
Load the default calibration factors

If data displayed by the 16533A/34A oscilloscope module appears to be incorrect and the calibration factors stored by the operational accuracy calibration factors is suspect, the default calibration factors can be loaded. Loading the default calibration factors can be used in this way to verify the 16533A/34A oscilloscope module hardware is operating properly and that an operational accuracy calibration should be performed.

Note that once the default calibration factors are loaded, all calibrations must be done. In a multicard 16533A/34A, the cards must be separated into single card modules to do the operational accuracy calibrations on the aqcuisition circuitry.

NOTE The calibration PROTECT/UNPROTECT switch on the 16533A/34A oscilloscope module must be set to UNPROTECT.

1. Touch the module field, then at the pop-up menu touch the 1GS/2GS 32K Scope card to be calibrated.
2. Touch the Menu field, then at the pop-up menu touch Calibration.
3. Touch the mode field, then at the pop-up menu touch Service Cal.
4. Touch the Procedure field, then at the pop-up menu touch Default Values.
5. Touch the Start field, then follow the instructions on the display.

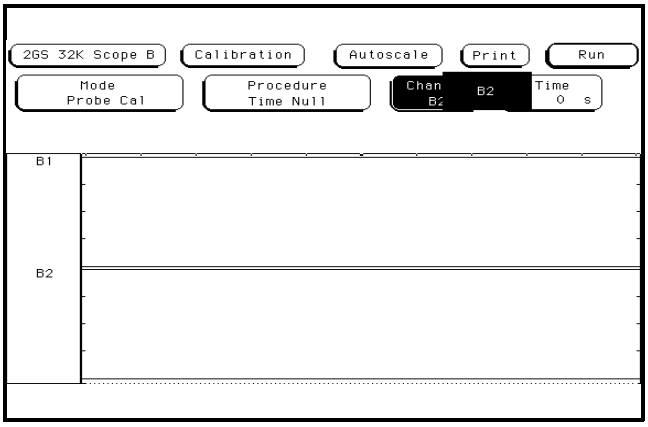


To deskew the channel-to-channel variations

Deskewing the channel-to-channel variations sets the timing of all channels to correspond to channel 1 at the probe tip. This eliminates time discrepancies between channels caused by variations in cable lengths. Also, you can use deskew to manually adjust for any differences in cable length by horizontally overlaying displayed waveforms that are time-skewed. The oscilloscope module channels are deskewed in 1 ns increments up to the maximum value of +/- 70 ns.

This procedure uses the probe compensation signal from the rear panel calibration port as a signal source for channel-to-channel deskewing. However, any signal source can be used for this procedure.

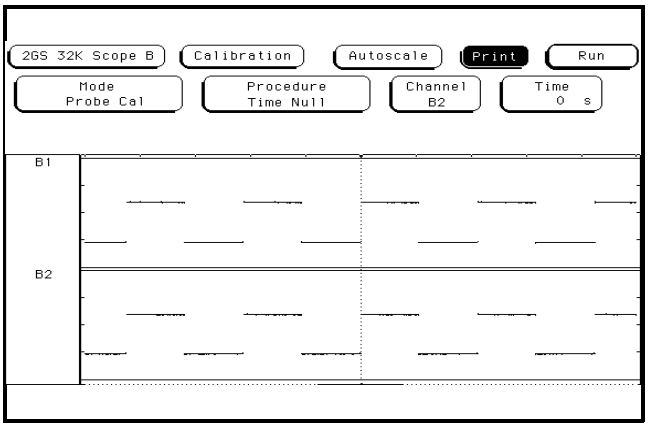
1. Touch the module field, then at the pop-up menu touch the 1GS/2GS 32K Scope module to be deskewed.
2. Set up the Calibration menu.
   a. Touch the menu field, then touch Calibration. Touch the mode field, then at the pop-up menu touch Probe Cal.
   b. Touch the Calibration menu Channel field, then select the channel to be deskewed.



3. Connect the oscilloscope module channels to the calibration signal output.
   a. Connect the male end of a BNC "Tee" adapter to the calibration signal port on the rear panel of the oscilloscope module.
   b. Connect Channel 1 of the oscilloscope module to one side of the BNC "Tee" adapter. Use any other adapters necessary to provide a good connection to the BNC "Tee"
   c. Connect the channel to be deskewed to the other side of the BNC "Tee". Again, use any other adapters necessary to provide a good connection to the BNC "Tee".

4 In the oscilloscope Calibration menu, touch Autoscale, then touch Continue.

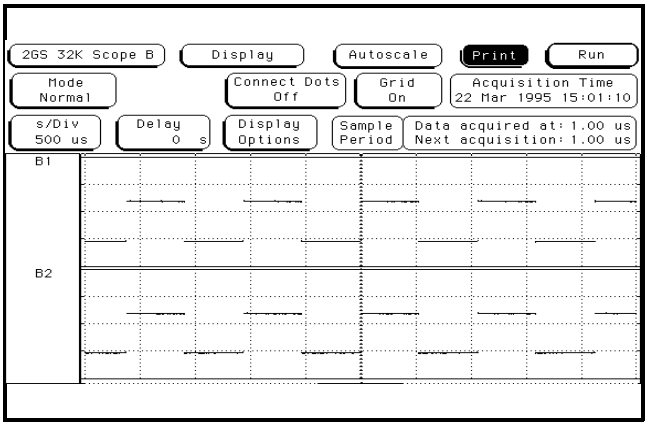
Note that to ensure the Probe and Coupling fields in the oscilloscope module Channel menu are properly set to match the oscilloscope probes being used.



5 Set up the display menu.

a Touch Calibration. then touch Display.

b Touch the Grid field to toggle the field to On.



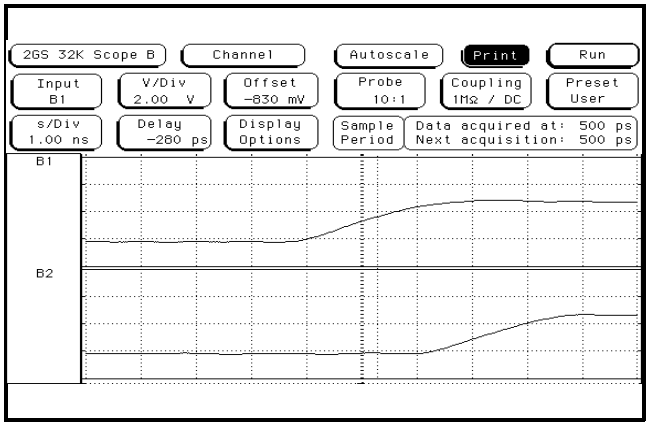
6 Set up the oscilloscope module Channel menu.

a Touch Display, then touch Channel.

b In the oscilloscope module Channel menu, set the timebase for 1.0 ns/Div.

c Touch Run-Single.

d Touch Delay to acivate the field (field turns light blue). Use the RPG to center the rising edge of the Channel 1 waveform on the display.

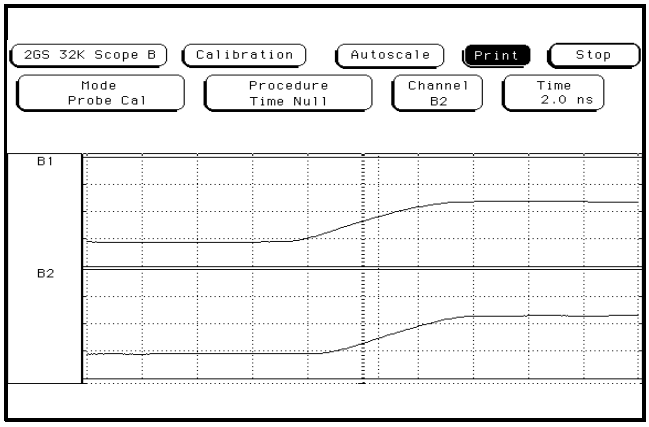


7 Perform the channel-to-channel deskewing.

a Touch Channel, then touch Calibration

b Touch the Time field to activate the field (field turns light blue).

c Touch Run-Repetative. Use the RPG to change the Time field value so the rising edges of the two waveforms occur as close as possible to the same time.



8 If a multicard module is being deskewed, repeat the above procedures for any other channels that you desire to deskew.

5

Troubleshooting

Troubleshooting

This chapter helps you troubleshoot the oscilloscope to find defective assemblies. The troubleshooting consists of flowcharts, self-test instructions, and tests. This information is not intended for component-level repair.

If you suspect a problem, start at the top of the first flowchart. During the troubleshooting instructions, the flowcharts will direct you to perform other tests.

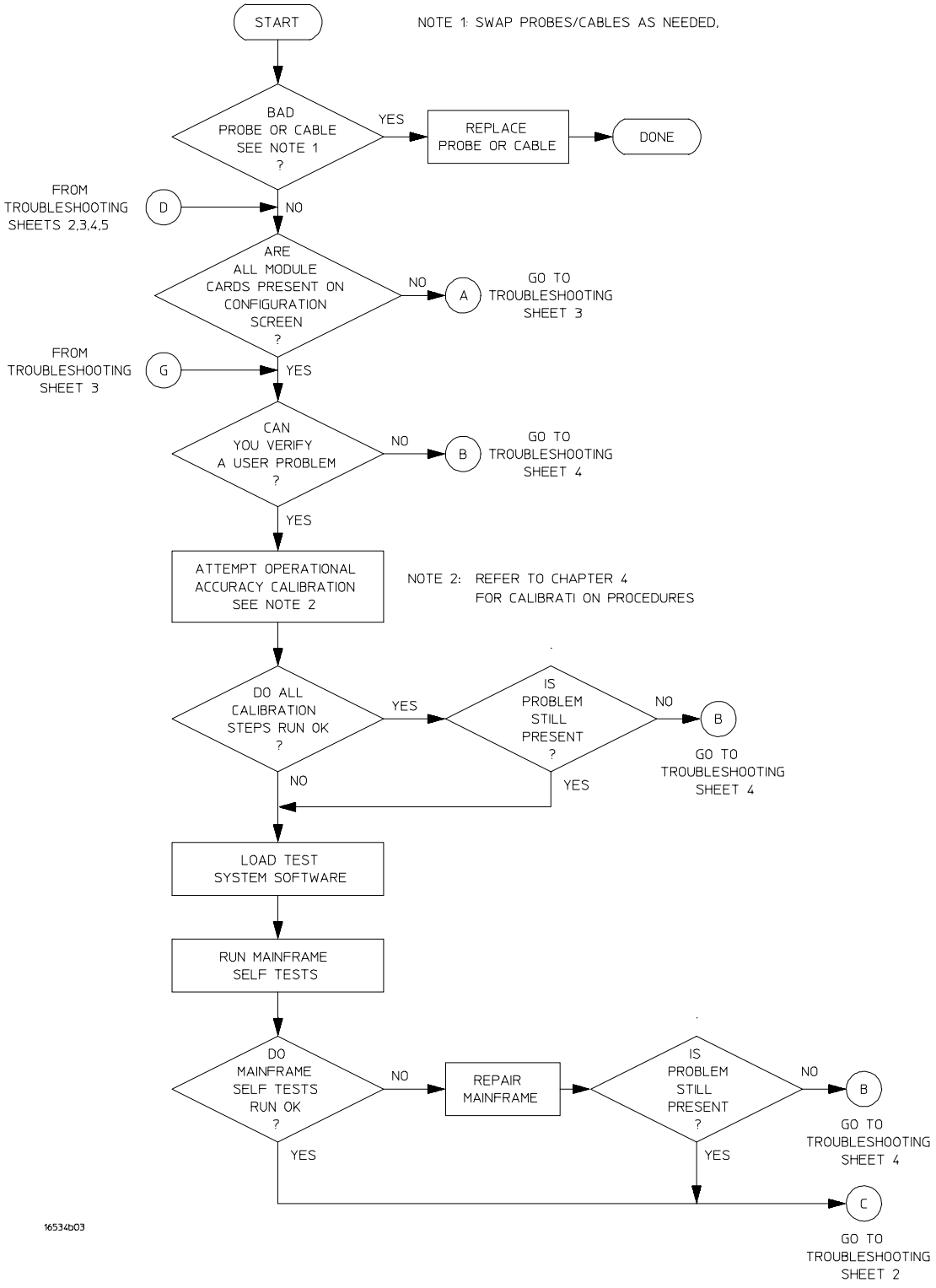
The service strategy for this instrument is the replacement of defective assemblies. This instrument can be returned to Agilent Technologies for all service work, including troubleshooting. Contact your nearest Agilent Technologies Sales Office for more details.

CAUTION

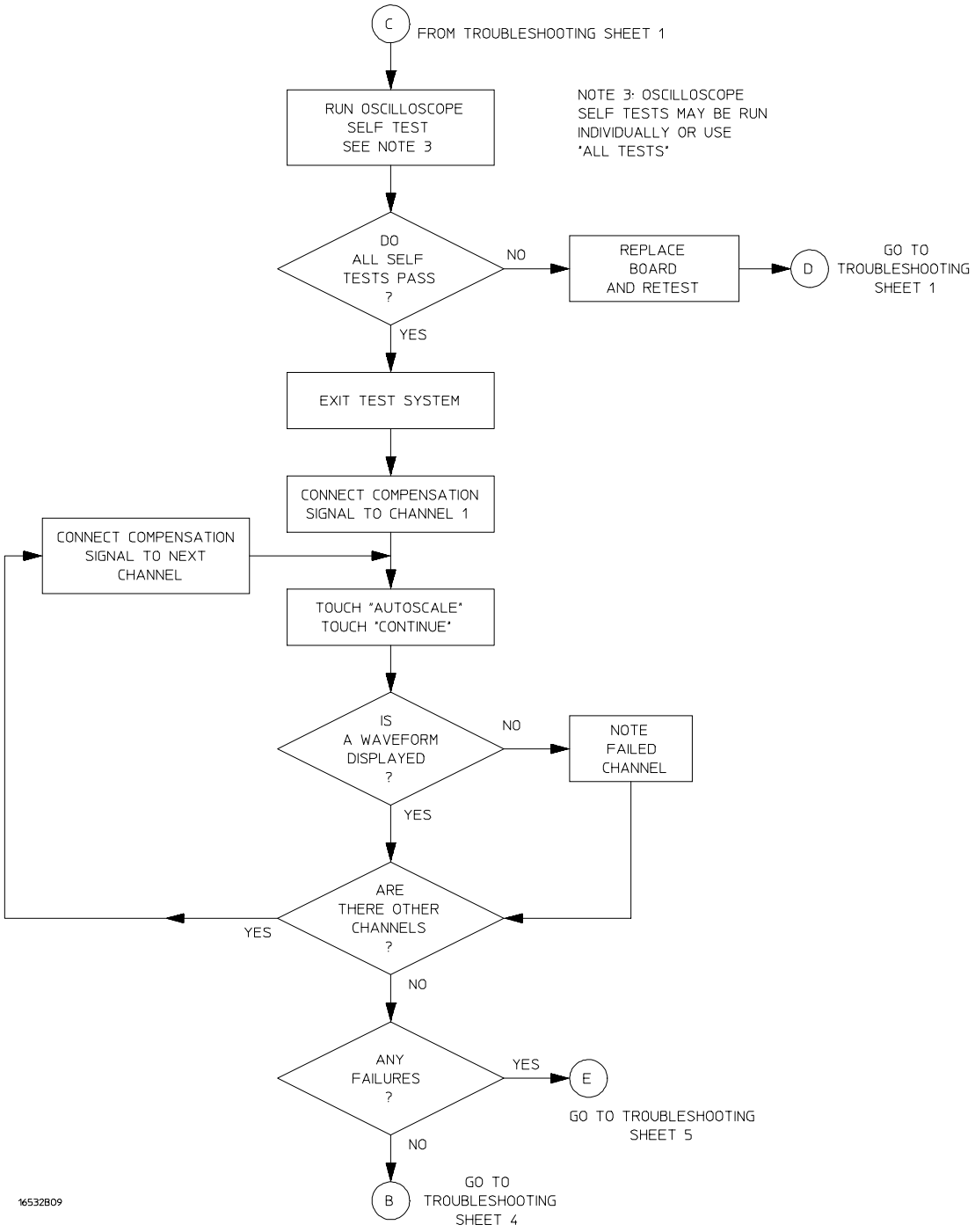
Electrostatic discharge can damage electronic components. Use grounded wriststraps and mats when you perform any service to this instrument or to the cards in it.

To use the flowcharts

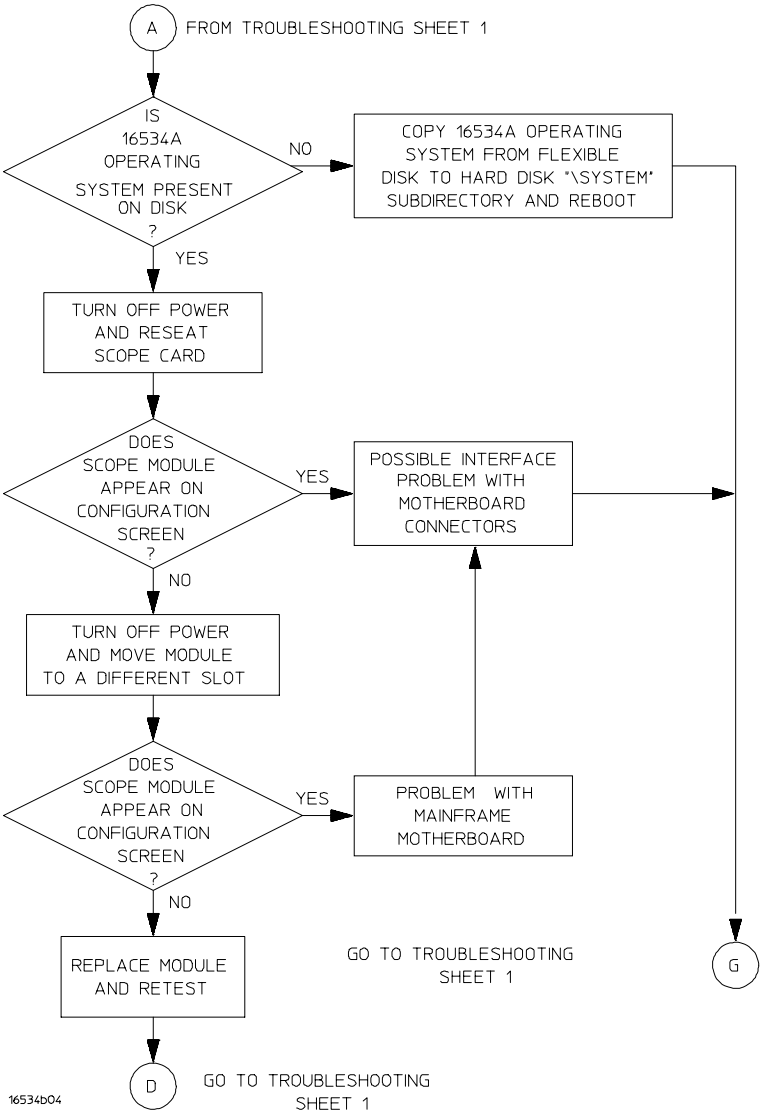
Flowcharts are the primary tool used to isolate defective assemblies. The flowcharts refer to other tests to help isolate the trouble. The circled letters on the charts indicate connections with the other flowcharts. Start your troubleshooting at the top of the first flowchart.



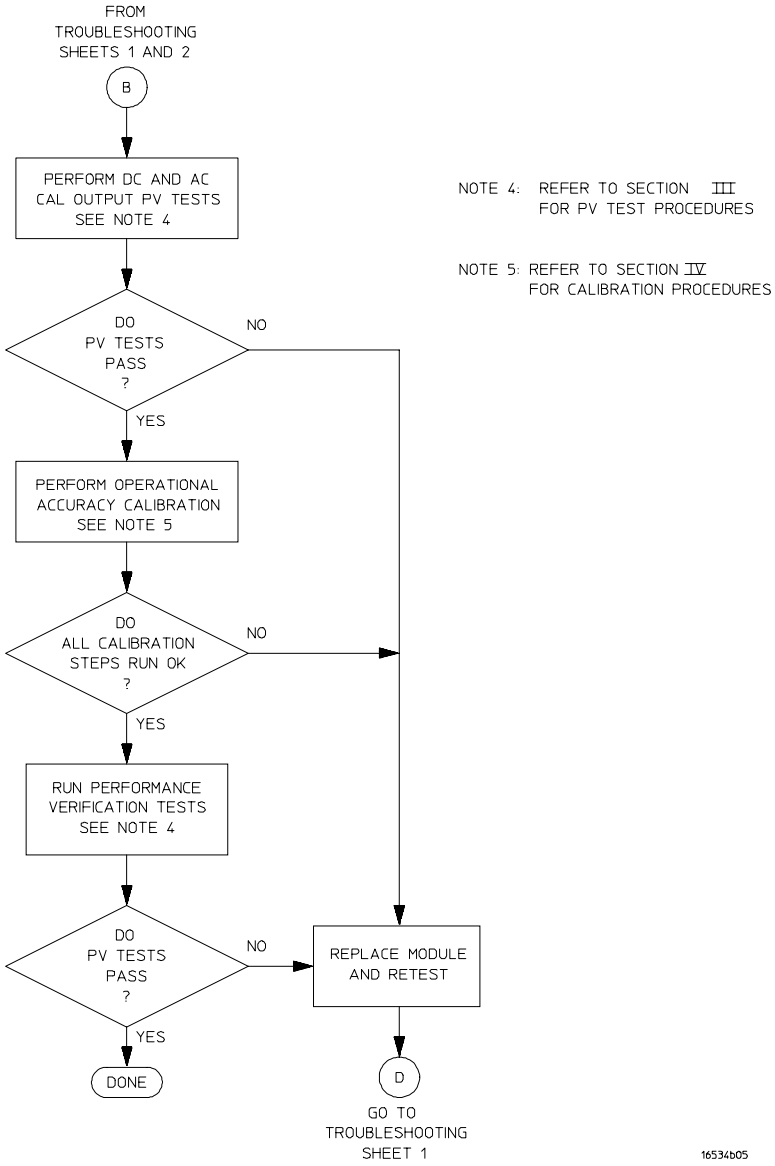
Troubleshooting Flowchart 1



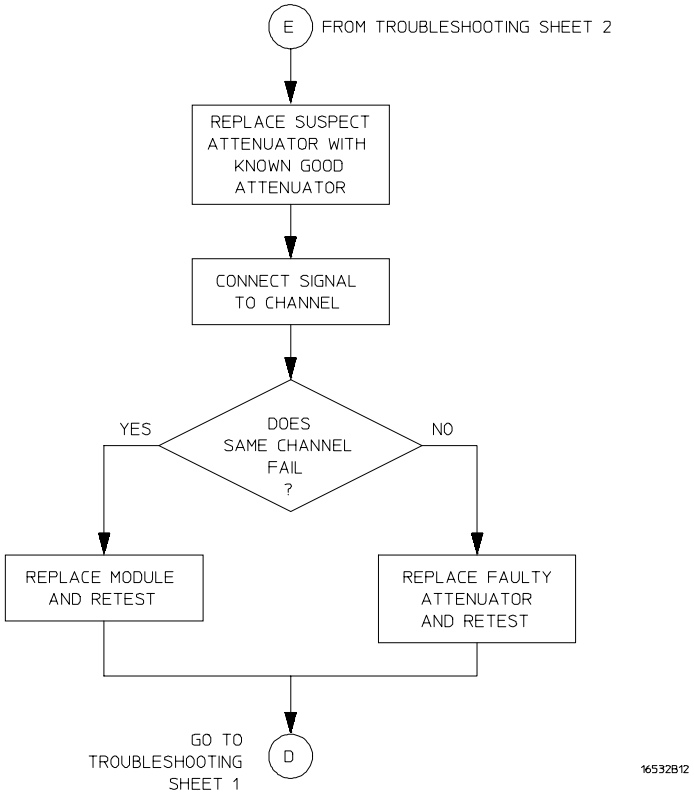
Troubleshooting Flowchart 2



Troubleshooting Flowchart 3



Troubleshooting Flowchart 4



Troubleshooting Flowchart 5

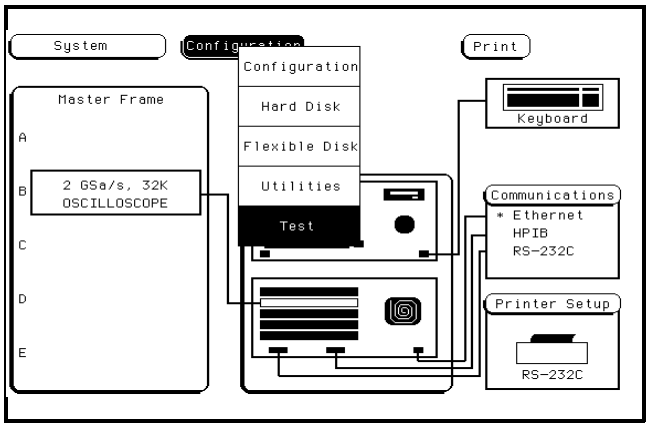
To run the self-tests

Self-tests identify the correct operation of major functional areas of the instrument. You can run all self-tests without accessing the interior of the instrument. If a self-test fails, the troubleshooting flowcharts instruct you to change a part of the instrument.

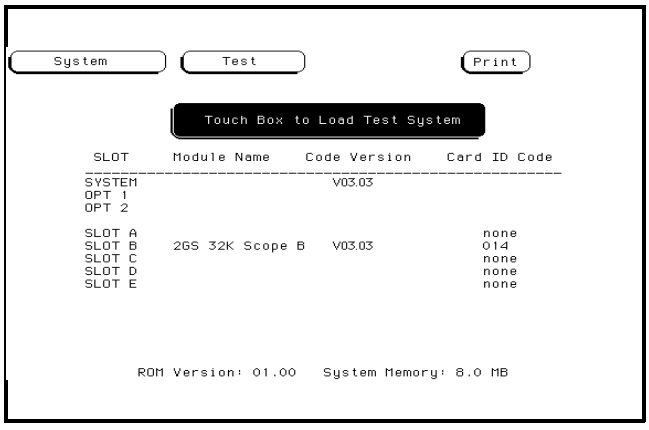
1 If you just did the power-up self-tests, go to step 2.

If you did not just do the power-up self-tests, disconnect all inputs, then turn on the power switch. Wait until the power-up tests are complete.

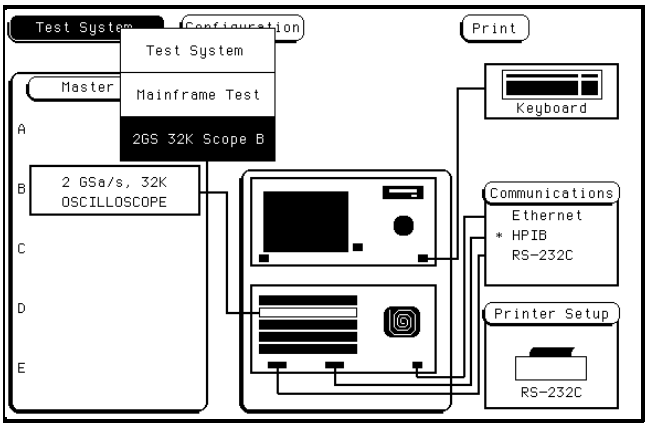
2 From the Startup screen, touch the Configuration field, then touch Test in the pop-up menu.



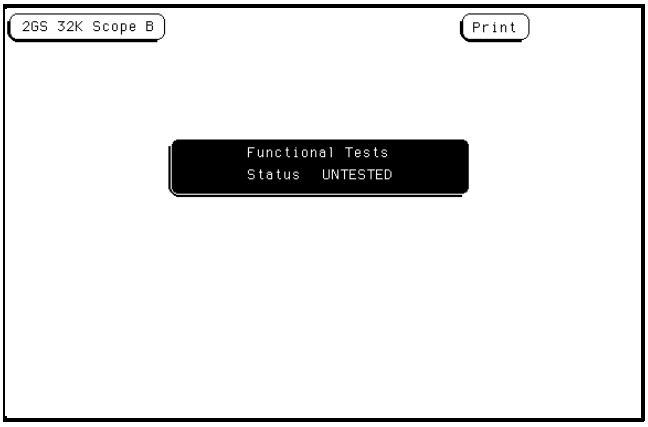
3 Touch the box labeled Touch box to Load Test System. Note that the self-test software is loaded, the user operating system is overwritten in the mainframe system RAM.



4 From the Test System screen, touch Test System, then touch 1GS/2GS 32K Scope B. (For the example shown below, the oscilloscope module is in slot B. If multiple oscilloscope modules are present, select the one to be tested.)

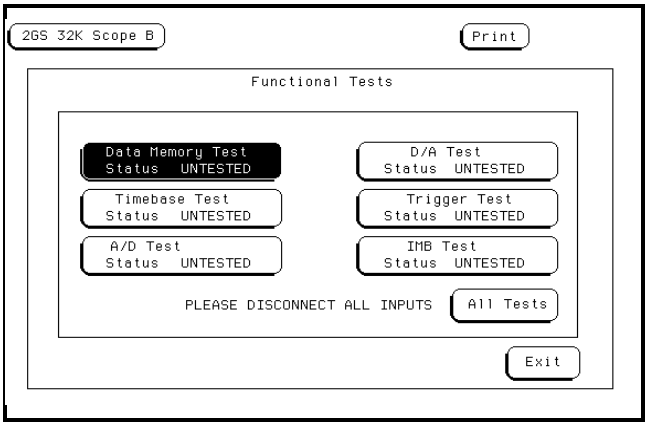


The following figure shows the selection menu for choosing to perform functional tests. The status of the functional tests is given.



5 Touch the Functional Tests field. In the main Test menu, touch the test to be run.

You can select and run each test individually, or run all tests at one time by running All Tests. Details about each test follow. The example provided steps through the Data Memory test.



Data Memory Test This test verifies the correct operation of the FISO (fast-in/slow-out) data memory on each board. Test patterns are written into the memory and then read and compared with known values.

Timebase Test The pre-trigger and post-trigger delay modes are first tested by programming a predetermined time interval in the trigger counters. At the end of the time intervals, the arm, trigger, and run status bits are read and compared with known values. The coarse and fine interpolators are then checked by reading the values of the interpolator counters after a simulated acquisition. The counter values are then compared with a known value. Finally, the sample clock is checked by programming a sample clock frequency and then reading the status of the clock to detect when one clock period has elapsed. The clock period time interval is then compared with a known value.

A/D Test This test verifies the correct operation of the A/D converter on each board. A check of the trigger in Trigger Immediate mode is first made. The A/D converters are then exercised by setting the reference voltage and channel offset such that a simulated acquisition obtains data in the extremes and middle of the quantization range of the A/D converter. After each simulated acquisition, the data is compared with known values.

D/A Test This test verifies the correct operation of the D/A converter on each board. Both the offset and trigger level D/A converters for each channel are set to a reference level and then changed. The logic trigger IC is programmed to detect the changes. The detection of a correct trigger indicates that the D/A converter is operating normally.

Trigger Test This test verifies the correct operation of the trigger components on each board. First, the logic trigger memory is checked by writing and then reading known patterns. The logic qualifiers, logic trigger output, and trigger holdoff are checked.

IMB Test This test verifies the correct operation of the oscilloscope card interface to the intermodule bus.

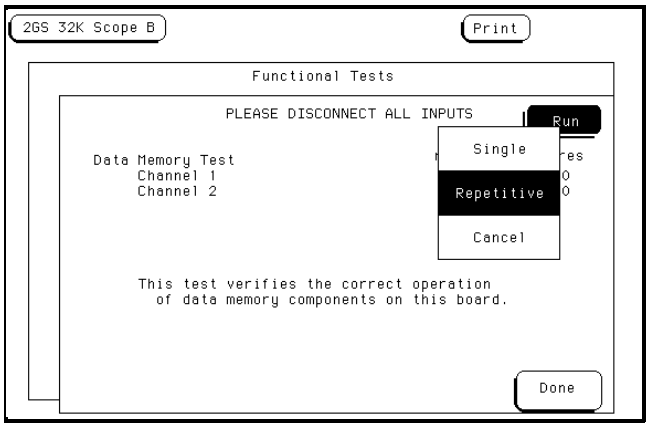
All Tests This will automatically execute each test, one at a time, until all tests are done.

6 Perform test.

a Touch test to be performed (example shows Data Memory Test).

b Touch Run, then touch Single or Repetitive.

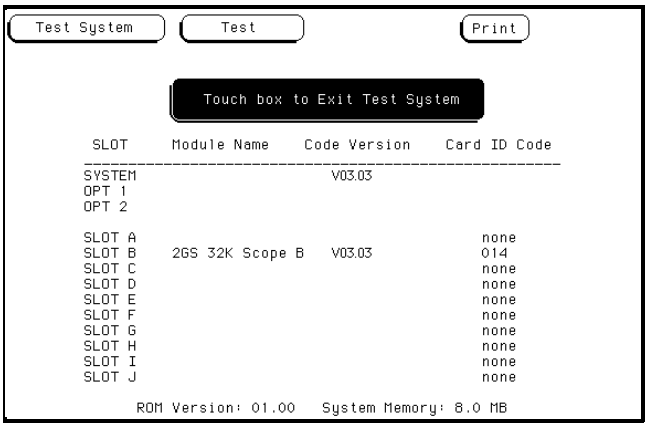
To run a test continuously, select Run-Repetitive. Select Stop to halt a repetitive test.



For a Single run, select Run-Single. The test runs one time, and the screen immediately shows the results.

c Touch Done to exit test.

7 To exit the self tests, touch the following fields in the lettered sequence below:
   a 1GS/2GS 32K Scope
   b Test System
   c Configuration
   d Test
8 Touch the box that reads "Touch box to Exit Test System.



6

Replacing Assemblies

Replacing Assemblies

This chapter contains the instructions for removing and replacing the oscilloscope module, the circuit board of the module, the trigger cable, attenuators, and the circuit board. Also in this chapter are instructions for returning assemblies.

CAUTION Turn off the instrument before installing, removing, or replacing a module in the instrument. Failure to do so could damage the equipment.

Tools Required

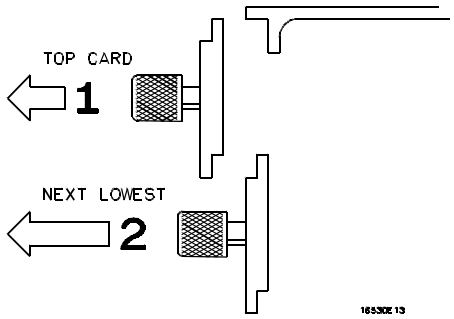
A T10 TORX screwdriver is required to remove screws connecting the rear panel to the circuit board.

To remove the module

CAUTION Electrostatic discharge can damage electronic components. Use grounded wriststraps and mats when performing any service to this module.

1. Turn off the instrument power switch, then unplug the power cord. Disconnect any input or output connections.
2. For multicard configurations, disconnect the master expander trigger cable.
3. Using a T10 TORX screwdriver, loosen the thumb screws.

   Starting from the top, loosen the thumb screws on the filler panels and cards located above the module and the thumb screws of the module.



4. Starting from the top, pull the cards and filler panels located above the module halfway out.
5. If the module consists of a single card, pull the card completely out. Then go to the next page, "To replace the module."

   If the module consists of more than one card, pull the complete module approximately halfway out.
6. Push all other cards into the card cage, but not completely in.

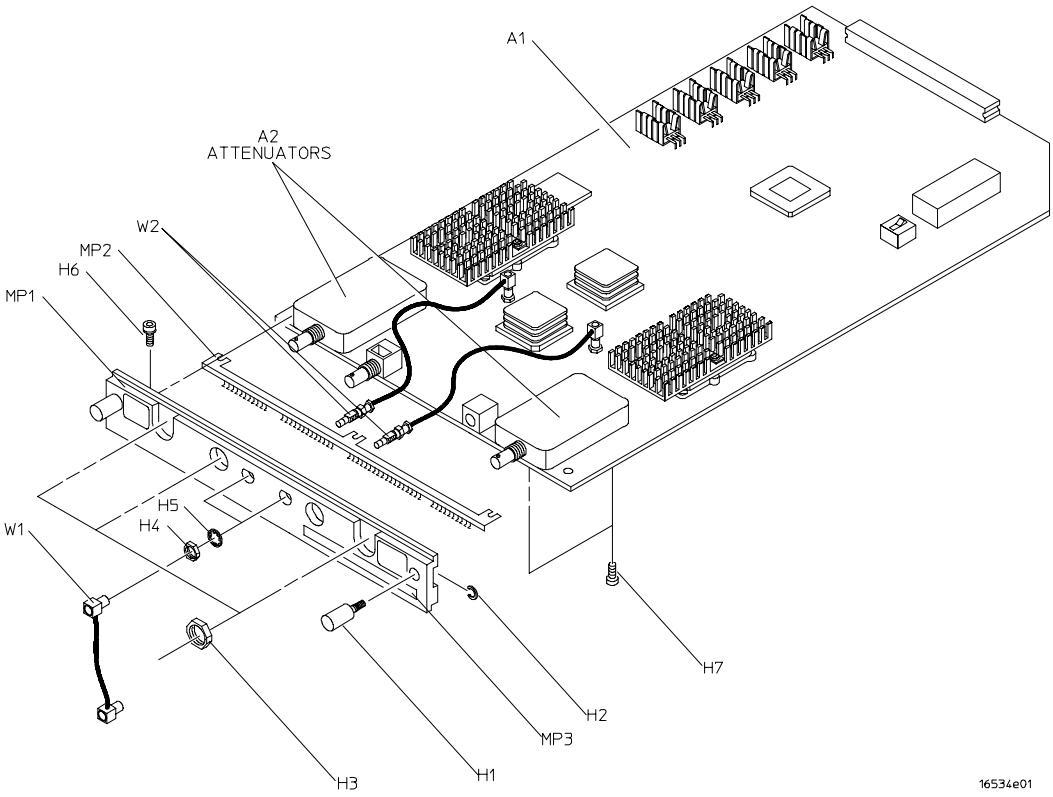
   This is to get them out of the way for removing and replacing the module or a card in the module.

6 Starting with the top card in the module, slide the card completely out. Remove each card in the same manner until the faulty card is removed. Then go to the next page, "To replace the module."

- **a** If a trigger cable was determined to be faulty, replace the faulty trigger cable on the oscilloscope module (see To remove/replace trigger cable).
- **b** If an attenuator was determined to be faulty, replace the faulty attenuator on the oscilloscope module (see To remove/replace Attenuator).
- **c** If the oscilloscope module was determined to be faulty, remove the attenuators from the oscilloscope module (see To remove/replace Attenuator), then acquire a replacement oscilloscope module and install the attenuators on the replacement oscilloscope module (see To replace the module).

To remove the trigger cable

1 Follow the procedures given in "To remove the module" to remove the 16533A/34A oscilloscope module to be serviced.



2 Remove the hex nut (H4) and the washer (H5) from the SMB connector on the cable to be removed.

3 Pull the straight SMB connector on the cable through the hole in the rear panel.

4 Pull the right-angle SMB connector on the cable away from its mating connector on the board.

5 Install a new cable (see To replace the trigger cable).

To replace the trigger cable

1 Install the straight SMB connector on the cable through the hole in the rear panel.

2 Attach the washer (H5) and the hex nut (H4) to the straight SMB connector on the cable. Tighten the hex nut.

3 Connect the right-angle SMB connector on the cable to its mating connector on the board.

To remove the attenuator

1. Follow the procedures given in "To remove the module" to remove the 16533A/34A Oscilloscope Module to be serviced.
2. Remove the four hex nuts (H3) from the BNC connectors on the rear panel (MP1).
3. Remove the two hex nuts (H4) and the two washers (H5) from the SMB connectors on the rear panel.
4. Remove the three end plate screws (H6) holding the rear panel (MP1) and the ground spring (MP2) to the board assembly (A1).
5. Pull the rear panel (MP1) and the ground spring (MP2) from the board assembly (A1). You may need to loosen the attenuator retainer screws (H7) before removing the ground spring.
6. Remove the two attenuator retainer screws (H7) holding the attenuator assembly (A2) to the board assembly (A1).
7. Gently pull the attenuator assembly (A2) straight up from the board assembly (A1) being careful not to damage the connector and the components beneath the attenuator assembly.
8. Install a new attenuator assembly (see "To replace the attenuator").

To replace the attenuator

1. Gently push the attenuator assembly (A2) straight down on the board assembly (A1) being careful not to damage the connector and the components beneath the attenuator assembly.
2. Attach the attenuator assembly (A2) to the board assembly (A1) with the two attenuator retainer screws (H7).
3. Assemble the rear panel (MP1) and the ground spring (MP2) to the board assembly (A1) and attach them with the three end plate screws (H6). You may need to loosen the attenuator retainer screws (H7) before assembling the ground spring to the board assembly, then tighten the attenuator screws (H7) when the assembly is finished.
4. Attach the SMB connectors to the rear panel (MP1) with two hex nuts (H4) and two washers (H5).
5. Attach the BNC connectors to the rear panel (MP1) with four hex nuts (H3). Tighten the hex nuts down so that they will not interfere with the installation of the board above the oscilloscope module. One of the flat surfaces on the outside edge of the nut should be parallel with the top edge of the rear panel.

To remove the circuit board

1. Follow the procedures given in "To remove the module" to remove the 16533A/34A oscilloscope module to be serviced.
2. Remove both trigger cables. Follow the procedures given in "To remove the trigger cable".
3. Remove both attenuators. Follow the procedures given in "To remove the attenuator".

To replace the circuit board

1. Install the attenuators and the rear panel onto the replacement circuit board. Follow the procedures given in "To replace the attenuator".
2. Install the trigger cables onto the replacement circuit board. Follow the procedures given in "To replace the trigger cable".

To replace the module

1 If the module consists of a single card, slide the card approximately halfway into the mainframe, then go to step 2.

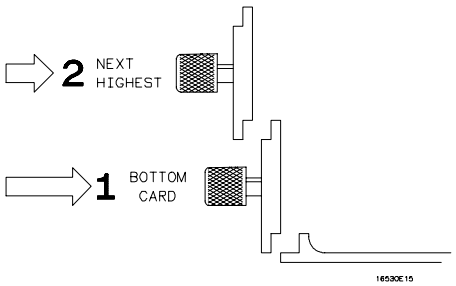
If the module consists of more than one card, perform the following steps:

a Slide the card(s) into the mainframe.

For multicard configurations, star with the lowest slot position.

b Slide the cards above the slots for the module about halfway out of the mainframe.

2 Starting with the bottom card, position all cards and filler panels so that the endplates overlap.



3 Seat the cards and hand tighten the thumbscrews. DO NOT use the TORX screwdriver to tighten the thumbscrews.

Starting with the bottom card, firmly seat the cards into the backplane connector of the mainframe. Keep applying pressure to the center of the card endplate while tightening the thumbscrews finger-tight. Repeat this for all cards and filler panels starting at the bottom and moving to the top.

CAUTION

For correct air circulation, filler panels must be installed in all unused card slots. Correct air circulation keeps the instrument from overheating. Keep any extra filler panels for future use.

4 If a multicard module is being reconfigured, use the master/expander trigger cable included with the accessory kit of each 16533A/34A card. Starting with the top-most 16533A/34A card, connect the ECL EXT TRIG OUT to the ECL EXT TRIG IN of the card immediately below. Repeat for all cards in the module.

To return assemblies

Before shipping the module to Agilent Technologies, contact your nearest Agilent Technologies sales office for additional details.

1 Write the following information on a tag and attach it to the module.

- Name and address of owner
- Model number
- Serial number
- Description of service required or failure indications

2 Remove accessories from the module.

Only return accessories to Agilent Technologies if they are associated with the failure symptoms.

3 Package the module.

You can use either the original shipping containers, or order materials from an Agilent Technologies sales office.

CAUTION

Electrostatic discharge can damage electronic components. For protection against electrostatic discharge, package the module in electrostatic material.

4 Seal the shipping container securely, and mark it FRAGILE.

7

Replaceable Parts

Replaceable Parts

This chapter contains information for identifying and ordering replaceable parts for your oscilloscope.

Replaceable Parts Ordering

Parts listed

To order a part on the list of replaceable parts, quote the Agilent Technologies part number, indicate the quantity desired, and address the order to the nearest Agilent Technologies Sales Office.

Parts not listed

To order a part not on the list of replaceable parts, include the model number and serial number of the module, a description of the part (including its function), and the number of parts required. Address the order to your nearest Agilent Technologies Sales Office.

Direct mail order system

To order using the direct mail order system, contact your nearest Agilent Technologies Sales Office.

Within the USA, Agilent Technologies can supply parts through a direct mail order system. The advantages to the system are direct ordering and shipment from the Agilent Technologies Part Center in Mountain View, California. There is no maximum or minimum on any mail order. (There is a minimum amount for parts ordered through a local Agilent Technologies Sales Office when the orders require billing and invoicing.) Transportation costs are prepaid (there is a small handling charge for each order) and no invoices.

In order for Agilent Technologies to provide these advantages, a check or money order must accompany each order. Mail order forms and specific ordering information are available through your local Agilent Technologies Sales Office. Addresses and telephone numbers are located in a separate document at the back of the service guide.

Exchange Assemblies

Some assemblies are part of an exchange program with Agilent Technologies.

The exchange program allows you to exchange a faulty assembly with one that has been repaired and performance verified by Agilent Technologies.

After you receive the exchange assembly, return the defective assembly to Agilent Technologies. A United States customer has 30 days to return the defective assembly. If you do not return the defective assembly within the 30 days, Agilent Technologies will charge you an additional amount. This amount is the difference in price between a new assembly and that of the exchange assembly. For orders not originating in the United States, contact your nearest Agilent Technologies Sales Office for information.

See Also "To return assemblies," in chapter 6.

Replaceable Parts List

The replaceable parts list is organized by reference designation and shows exchange assemblies, electrical assemblies, then other parts.

The exploded view does not show all of the parts in the replaceable parts list.

Information included for each part on the list consists of the following:

- Reference designator
- Agilent Technologies part number
- Total quantity included with the instrument (Qty)
- Description of the part

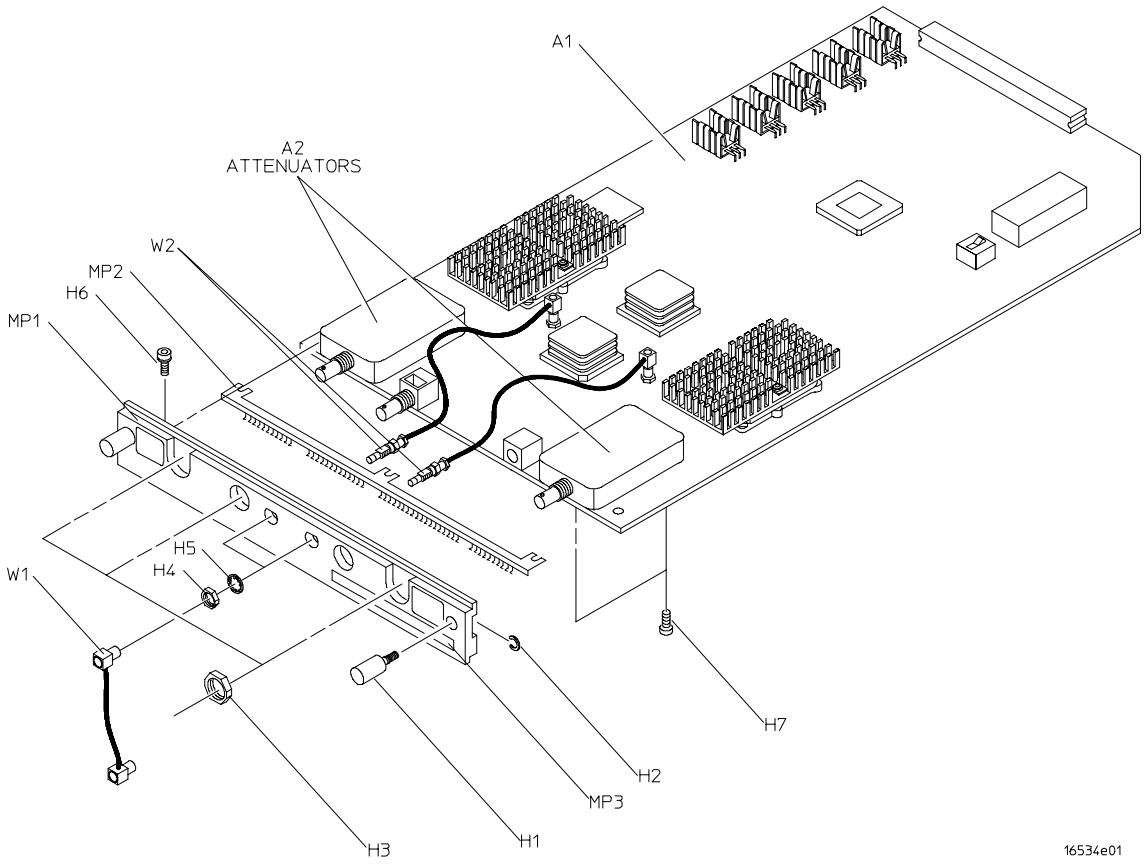
Reference designators used in the parts list are as follows:

- A Assembly
- H Hardware
- MP Mechanical Part
- W Cable

16533A/34A Replaceable Parts

Ref. Des.	Agilent Part Number	QTY	Description
Exchange Assembly			
	16533-69501	1	16533A Exchange Circuit Board (does not include attenuator assemblies)
	16534-69501	1	16534A Exchange Circuit Board (does not include attenuator assemblies)
Replacement Parts			
A1	16534-66501	1	16534A Circuit Board Assembly (does not include attenuator assemblies)
A1	16533-66501	1	16533A Circuit Board Assembly (does not include attenuator assemblies)
A2	16534-63401	2	Attenuator Assembly
H1	16500-22401	2	Rear Panel Thumbscrew
H2	0510-0684	2	Thumbscrew Retaining Ring
H3	1250-2075	3	Nut, Hex, 1/2-inch RF Connector
H4	0515-0430	3	Rear Panel Screw
H5	0515-1246	41	Attenuator Retainer Screw
MP1	16500-29101	1	Ground Spring
MP2	16534-40501	1	Rear Panel
MP3	16534-94301	1	ID Label
MP4	16534-94302	1	CAL/PWR Label
MP5	16532-94302	1	Warning Label
MP6	1401-0260	1	Vinyl Molded Cap
MP7	16534-44701	3	Circuit Board Spacer
W1	16532-61601	1	Master/Expander Trigger Cable
W2	16532-61602	2	External Trigger Cable

Exploded View



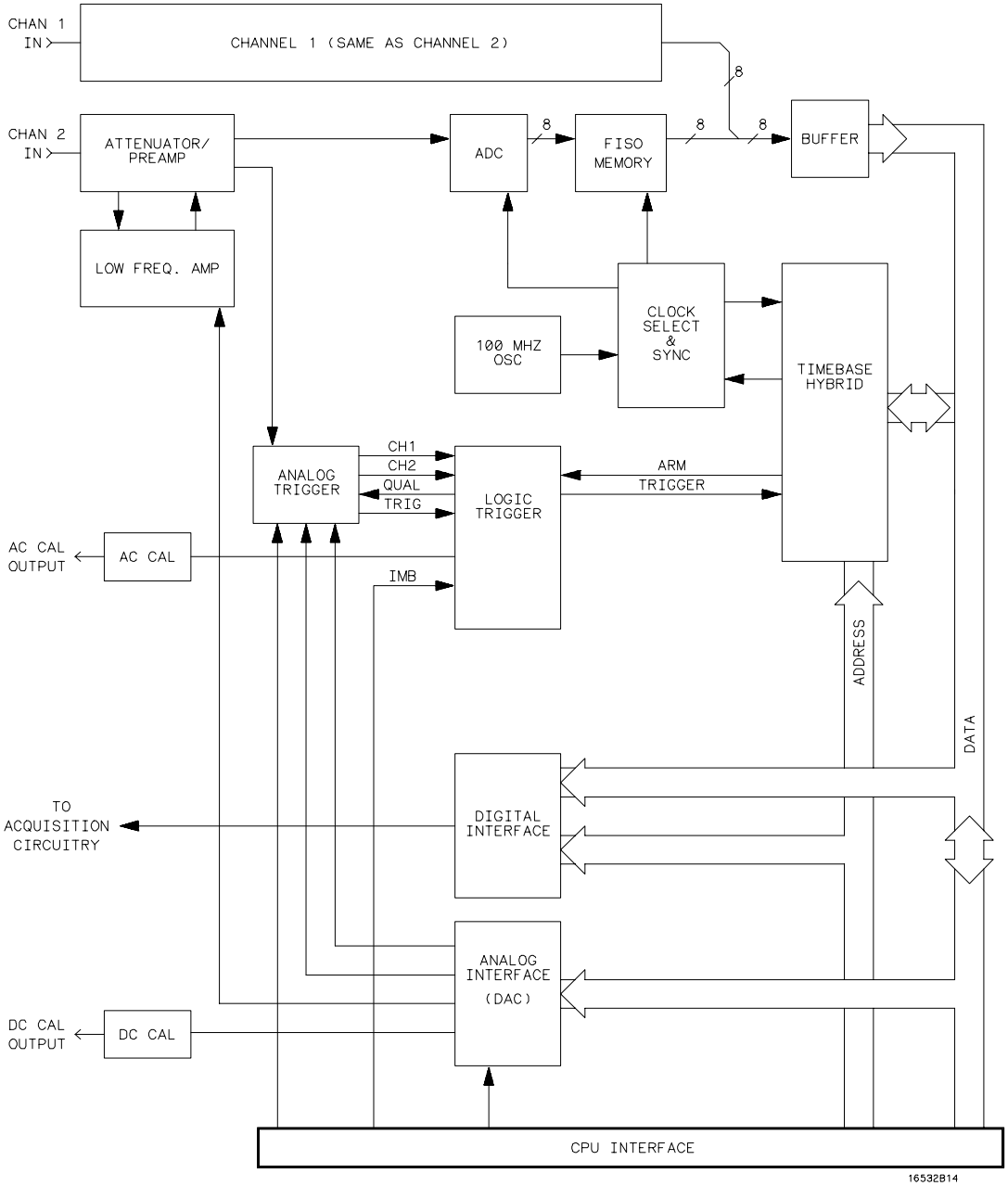
Exploded view of the 16533A/34A

8

Theory of Operation

Theory of Operation

This chapter tells the theory of operation for the oscilloscope and describes the self-tests. The information in this chapter is to help you understand how the oscilloscope operates and what the self-tests are testing. This information is not intended for component-level repair.



The Oscilloscope Board

Oscilloscope Board Theory

The following paragraphs contain block level theory of operation. This theory is not intended for component level troubleshooting, rather it is to be used to help isolate a module failure to card level.

The 16533A/34A Oscilloscope Module is contained on one board. It runs at a 2 GSa/s digitizing rate (16534A) and 1GSa/s digitizing rate (16533A), with a 500 MHz single-shot (real-time) bandwidth (16534A) and 250 MHz single-shot (real-time) bandwidth (16533A), 32,768 samples per measurement per channel, with 2-channel simultaneous acquisition which is expandable to up to 8 channels.

Attenuator Theory

The channel input signals are conditioned by the attenuator/preamps, thick film hybrids containing passive attenuators, an impedance converter, and a programmable amplifier. The channel sensitivity, as displayed, defaults to the standard 1-2-5 sequence (other calibrated sensitivities can also be set). However, the firmware uses two passive attenuators, 5:1 and 25:1 to get attenuations of 1:1, 5:1, 25:1, and 125:1. With the attenuation and programmable gain of the amplifier the entire sensitivity range is calibrated. (On ranges below 7 mV/div, the firmware expands the signal digitally.)

The input has a selectable 1 MΩ or 50 Ω input impedance. Compensation for the passive attenuators is laser trimmed and not adjustable. After the passive attenuators, the signal is split into high-frequency and low-frequency components. Low-frequency components are amplified on the main assembly where they are combined with the offset voltage. The ac coupling and low-frequency reject are implemented in the low-frequency amplifier.

The high- and low-frequency components of the signal are recombined and applied to the input FET of the preamp. The FET provides a high impedance load for the input attenuators and a low impedance drive for the preamp. The programmable preamp adjusts the gain to suit the required sensitivity and provides two output signals to the Main assembly. One signal is the same phase as the input and goes to the trigger circuitry. The other is of opposite phase and is sent to the ADC hybrid.

Oscilloscope Acquisition

The acquisition circuitry provides the sampling, digitizing, and storing of the signals from the channel attenuators. The channels are identical. The external trigger (ECL) input cannot be displayed. Trigger signals from each channel and the external triggers synchronize acquisition through the time base circuitry. A 100 MHz oscillator and a time base provide system timing and sample clocking. A voltage-controlled oscillator (VCO), frequency divider, and digital phase detector provide the sample clock for higher sample rates. After conditioning and sampling, the signals are digitized, then stored in a hybrid IC containing a FISO (fast in, slow out) memory.

ADC Hybrid The ADC hybrid provides all of the sampling, digitizing, and high-speed waveform storage. The ADC includes a phase-locked loop frequency converter that, for sample rates from 250 MHz to 2 GHz, multiplies the input clock from the time base.

FISO Memory 32,768 samples of the FISO (fast in, slow out) memory are used per measurement per channel. Memory positions are not addressed directly. The configuration is a ring which loops continuously as it is clocked. Memory position is tracked by counting clocks. The clocking rate is the same as the ADC, however the clock frequency is half that of the ADC since the FISO clocks on both transitions of the clock period. Data is buffered onto the CPU data bus for processing.

Triggering There are two main trigger circuits that trigger four trigger sources. The two trigger circuits are the analog trigger and the logic trigger. The analog trigger IC operates as a multichannel Schmidt trigger/comparator. A trigger signal (a copy of the analog input signal) from each of the inputs is directed to the analog trigger IC inputs. The trigger signal is continuously compared with the trigger reference level selected by the user. Once the trigger condition is met, the trigger TRUE signal is fed to the logic trigger, which begins the acquisition and store functions by way of the time base.

The four trigger sources are Channel 1, Channel 2, Intermodule Bus (IMB), and external BNC. The operation of the input channels was discussed previously. The IMB trigger signal is sent directly to the logic trigger. External triggering is provided by the BNC input of the 16500B Logic Analysis System mainframe.

Time Base The time base provides the sample clocks and timing necessary for data acquisition. It consists of the 100 MHz reference oscillator and time base hybrid.

The 100 MHz reference oscillator provides the base sample frequency.

The time base hybrid has programmable dividers to provide the rest of the sample frequencies appropriate for the time range selected. The time base uses the time-stretched output of the fine interpolator to time-reference the sampling to the trigger point. The time base has counters to control how much data is taken before (pre-trigger data) and after (post-trigger data) the trigger event. After the desired number of pre-trigger samples has occurred, the Time base hybrid sends a signal to the Logic Trigger (trigger arm) indicating it is ready for the trigger event. When the trigger condition is satisfied, the Logic Trigger sends a signal back to the time base hybrid. The time base hybrid then starts the post-trigger delay counter.

When the countdown reaches zero, the sample clocks are stopped and the CPU is signaled that the acquisition is complete. The Fine Interpolator is a dual-slope integrator that acts as a time-interval stretcher. When the logic trigger receives a signal that meets the programmed triggering requirements, it signals the time base. The time base then sends a pulse to the fine interpolator. The pulse is equal in width to the time between the trigger and the next sample clock. The fine interpolator stretches this time by a factor of approximately 500. Meanwhile, the time base hybrid runs a counter with a clock derived from the sample rate oscillator. When the interpolator indicates the stretch is complete, the counter is stopped. The count represents, with much higher accuracy, the time between the trigger and the first sample clock. The count is stored and used to place the recently acquired data in relationship with previous data.

AC Cal The AC Cal is a multiplexer circuit that provides several signals to the Probe Compensation/AC Calibrator outputs. The signal provided depends on the mode of the instrument. It provides a probe compensation signal, a pulse representing the trigger event, or signals used for self-calibration. The probe compensation signal is derived from the real-time clock oscillator and can be set from 250 mHz to approximately 32 kHz. The AC cal is sent through an analog multiplexer to the front panel for probe compensation.

DC Cal The DC Cal output, a rear panel signal, is used for self-calibration. It is one output from the 16-channel DAC.

Digital Interface The Digital Interface provides control and interface between the system control and digital functions in the acquisition circuitry.

Analog Interface The Analog Interface provides analog control of functions in the acquisition circuitry. It is primarily a 16-channel DAC with an accurate reference and filtered outputs. The analog interface controls:

- Channel offsets
- Trigger levels
- Two logic trigger functions
- The DC Cal output for instrument and probe calibration

Self-Tests Description

The self-tests identify the correct operation of major functional areas in the oscilloscope. The self-tests are not intended for component-level diagnostics.

The functional performance verification self-tests are run using a separate operating system, the PVTEST operating system. The PVTEST operating system resides in the \SYSTEM subdirectory in the Agilent Technologies 16500B hard disk drive. The system and oscilloscope tests are functional performance verification tests.

Parametric performance verification (full calibration) requires the use of external test equipment that generates and monitors test data for the oscilloscope to read. The performance verification procedures in chapter 3 of this service guide make up the parametric performance verification for the oscilloscope. Refer to chapter 3, "Testing Performance," for further information about parametric performance verification.

Oscilloscope Tests (PV)

The following self-tests check the major components of the 16533A/34A oscilloscope module as well as all associated circuitry. When the self-tests have all been completed with a "PASS" status, the major data and control pipelines in the 16533A/34A oscilloscope module are functioning properly.

Data Memory Test This test verifies the correct operation of the FISO (fast-in/slow-out) data memory on the board. Test patterns are written into the memory and then read and compared with known values.

Timebase Test The pre-trigger and post-trigger delay modes are first tested by programming a predetermined time interval in the trigger counters. At the end of the time intervals, the arm, trigger, and run status bits are read and compared with known values. The coarse and fine interpolators are then checked by reading the values of the interpolator counters after a simulated acquisition. The counter values are then compared with a known value. Finally, the sample clock is checked by programming a sample clock frequency and then reading the status of the clock to detect when one clock period has elapsed. The clock period time interval is then compared with a known value.

A/D Test This test verifies the correct operation of the A/D convertor on the board. A check of the trigger in Trigger Immediate mode is first made. The A/D convertors are then exercised by setting the reference voltage and channel offset such that a simulated acquisition obtains data in the extremes and middle of the quantization range of the A/D convertor. After each simulated acquisition, the data is compared with known values.

D/A Test This test verifies the correct operation of the D/A convertor on the board. Both the offset and trigger level D/A convertors for each channel are set to a reference level and then changed. The logic trigger IC is programmed to detect the changes. The detection of a correct trigger indicates that the D/A convertor is operating normally.

Trigger Test This test verifies the correct operation of the trigger components on the board. First, the logic trigger memory is checked by writing and then reading known patterns. The logic qualifiers, logic trigger output, and trigger holdoff are then checked.

IMB Test This test verifies the correct operation of the oscilloscope board interface to the intermodule bus.

All Tests This will automatically execute each test, one at a time, until all tests are done.

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Complete product warranty information is given at the end of this manual.

Safety

This apparatus has been designed and tested in accordance with IEC Publication 348, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

Warning

- Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock of fire hazard.
- Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.
- If you energize this instrument by an auto transformer (for voltage reduction), make sure the common terminal is connected to the earth terminal of the power source.
- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.
- Use caution when exposing or handling the CRT. Handling or replacing the CRT shall be done only by qualified maintenance personnel.

Safety Symbols

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product.

Hazardous voltage symbol.

Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis.

WARNING

The Warning sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a Warning sign until the indicated conditions are fully understood and met.

CAUTION

The Caution sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a Caution symbol until the indicated conditions are fully understood or met.

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P.O. Box 2197
1900 Garden of the Gods Road
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Product Warranty

This Agilent Technologies product has a warranty against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Agilent Technologies will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Agilent Technologies.

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Agilent Technologies warrants that its software and firmware designated by Agilent Technologies for use with an instrument will execute its programming instructions when properly installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument software, or firmware will be uninterrupted or error free.

Limitation of Warranty

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Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

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A software or firmware code may be printed before the date. This code indicates the version level of the software or firmware of this product at the time the manual or update was issued. Many product updates do not require manual changes; and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

The following list of pages gives the date of the current edition and of any changed pages to that edition.

All pages original edition.