# Keysight InfiniiVision HD3-Series Oscilloscopes

KEYSIGHT

SERVICE GUIDE

# Notices



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## Safety Notices

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

**CAUTION**

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

**WARNING**

**A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.**

# In This Service Guide

This book provides the service documentation for the Keysight Technologies HD3 Series oscilloscopes. It is has these chapters:

Chapter 1, “Characteristics and Specifications,” starting on page 7, contains a partial list of characteristics and specifications for the Keysight InfiniiVision HD3-Series oscilloscopes.

Chapter 2, “Calibrating and Adjusting,” starting on page 13, explains how to adjust the oscilloscope for optimum operating performance.

Chapter 3, “Testing Performance,” starting on page 17, explains how to verify correct oscilloscope operation and perform tests to ensure that the oscilloscope meets the performance specifications.

Chapter 4, “Troubleshooting,” starting on page 51, begins with suggestions for solving general problems that you may encounter with the oscilloscope. Procedures for troubleshooting the oscilloscope follow the problem solving suggestions.

Chapter 5, “Replacing Assemblies,” starting on page 59, because there are no operator serviceable parts inside the oscilloscope, there are no longer instructions for replacing internal assemblies in this service guide.

Chapter 6, “Replaceable Parts,” starting on page 61, describes how to order replaceable assemblies and parts for the Keysight HD3-Series oscilloscopes. It includes diagrams and parts lists for hardware that you can order.

At the back of the book you will find Chapter 7, “Safety Notices,” starting on page 67.

**TIP**

**Pressing keys, selecting user interface items, and choosing a series of menu items**

Instructions for pressing front panel keys include square brackets around the key name and bold typeface, for example: Press **[Key]**.

Instructions for selecting user interface items include bold typeface, for example: Select **Option Name** or **Button...**.

Instructions for choosing a series of menu items are abbreviated. For example, instead of saying choose **Menu Item**, then choose **Sub Item**, then choose **Sub Sub Item**, those stages are abbreviated into: Choose **Menu Item > Sub Item > Sub Sub Item**.

# Contents

# 1 Characteristics and Specifications



This chapter contains a partial list of characteristics and specifications for the Keysight InfiniiVision HD3-Series oscilloscopes.

For a full list of Keysight InfiniiVision HD3-Series oscilloscopes characteristics and specifications see the data sheets.

The data sheets are available at www.keysight.com/find/HD3-Series

## Power Requirements

Line voltage, frequency, and power:

- ~ 100-120 Vac, 50/60/400 Hz
- ~ 100-240 Vac, 50/60 Hz
- 275 Watts MAX

Mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.

# Measurement Category



## Oscilloscope Measurement Category

The InfiniiVision oscilloscopes are not intended to be used for measurements in Measurement Category II, III, or IV.

**WARNING** **Use this instrument only for measurements within its specified measurement category (not rated for CAT II, III, IV). No transient overvoltages allowed.**

## Measurement Category Definitions

The "Not rated for CAT II, III, IV" measurement category is for measurements performed on circuits not directly connected to MAINS. Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS derived circuits. In the latter case, transient stresses are variable; for that reason, the transient withstand capability of the equipment is made known to the user.

Measurement category II is for measurements performed on circuits directly connected to the low voltage installation. Examples are measurements on household appliances, portable tools and similar equipment.

Measurement category III is for measurements performed in the building installation. Examples are measurements on distribution boards, circuit-breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to the fixed installation.

Measurement category IV is for measurements performed at the source of the low-voltage installation. Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units.

## Maximum Input Voltages

**CAUTION**

⚠ **Maximum input voltage at analog inputs**

135 Vrms

50Ω input: 5 Vrms Input protection is enabled in 50 Ω mode and the 50 Ω load will disconnect if greater than 5 Vrms is detected. However the inputs could still be damaged, depending on the time constant of the signal. The 50 Ω input protection only functions when the oscilloscope is powered on.

**CAUTION**

When measuring voltages over 80 V, use a 10:1 probe.

**CAUTION**

⚠ **Maximum input voltage at digital channels**

±40 V peak

# Environmental Conditions

| | |
|---|---|
| Environment | Indoor use only. |
| Ambient temperature | 0 to 50 °C |
| Humidity | Maximum Relative Humidity (non-condensing): 95% RH up to 40 °C<br>From 40 °C to 50 °C, the maximum % Relative Humidity follows the line of constant dew point |
| Altitude | 3,000 m max |
| Overvoltage Category | This product is intended to be powered by MAINS that comply to Overvoltage Category II, which is typical of cord-and-plug connected equipment. |
| Pollution Degree | The InfiniiVision HD3-Series oscilloscopes may be operated in environments of Pollution Degree 2 (or Pollution Degree 1). |
| Pollution Degree Definitions | Pollution Degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. Example: A clean room or climate controlled office environment.<br>Pollution Degree 2. Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation may occur. Example: General indoor environment.<br>Pollution Degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected. Example: Sheltered outdoor environment. |

# Contact Us

Information on contacting Keysight Technologies can be found at:
www.keysight.com/find/contactus

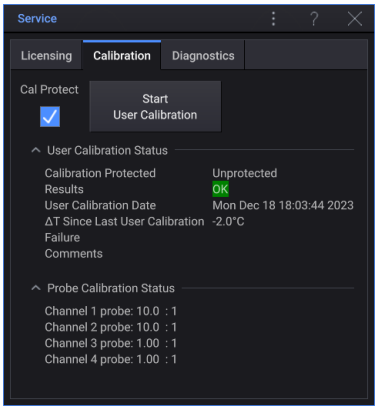
# 2 Calibrating and Adjusting

## To display the user calibration status

To display the summary results of the previous User Calibration and the status of probe calibrations for probes that can be calibrated:

1 From the main menu, choose **Utilities > Service...**.

2 In the Service dialog box, select the **Calibration** tab.




Note that passive probes do not need to be calibrated, but InfiniiMax probes can be calibrated.

## To perform user calibration

Perform user-calibration:

- Every three years or after 6000 hours of operation.
- If the ambient temperature is >10° C from the calibration temperature.
- If you want to maximize the measurement accuracy.

The amount of use, environmental conditions, and experience with other instruments help determine if you need shorter User Calibration intervals.

User Calibration performs an internal self-alignment routine to optimize the signal path in the oscilloscope. The routine uses internally generated signals to optimize circuits that affect channel sensitivity, offset, and trigger parameters.

Performing User Calibration will invalidate your Certificate of Calibration. If NIST (National Institute of Standards and Technology) traceability is required, perform the "Performance Verification" procedure in the *Service Guide* using traceable sources.

To perform user calibration:

1 Disconnect all inputs from the front and rear panels, including the digital channels cable. Disconnect the waveform generator output. No cables are needed.

**CAUTION** **Disconnecting oscilloscope inputs and the waveform generator output before user calibration is important because the oscilloscope's measurement accuracy depends on proper calibration.**

2 Allow the oscilloscope to warm up 30 minutes before performing this procedure.

3 From the main menu, choose **Utilities > Service...**.

4 In the Service dialog box, select the **Calibration** tab.

5 Clear the **Cal Protect** check box.

6 Select **Start User Calibration**.

# 3 Testing Performance



This chapter explains how to verify correct oscilloscope operation and perform tests to ensure that the oscilloscope meets the performance specifications.

# Overview

To completely test and troubleshoot digital channels, create and use the test connector accessory as described in this chapter.

- The test connector is required for testing oscilloscope digital channels.
- The connector is used in the digital channel threshold accuracy test.
- The test connector keeps electrical distortion to a minimum and makes it easy for you to connect the oscilloscope probes to function generators and measurement equipment.

**Let the Equipment Warm Up Before Testing**

For accurate test results, let the test equipment and the oscilloscope warm up 30 minutes before testing.

**Verifying Test Results**

During the tests, record the readings in the Performance Test Record (see "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48). To verify whether a test passes, verify that the reading is within the limits in the Performance Test Record.

**If a Performance Test Fails**

If a performance test fails, first perform the User Calibration procedure. See "To perform user calibration" on page 15.

# List of Test Equipment

Below is a list of test equipment and accessories required to perform the performance test verification procedures.

**Table 1** List of test equipment

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| Digital channels test connector, 8-by-2* | For instructions on building test connector, see "To construct the digital channels test connector" on page 22. | n/a |
| Digital Multimeter | 0.1 mV resolution, 0.005% accuracy | Keysight 34401A/34461A |
| Power Splitter | Outputs differ by 0.15 dB | Keysight 11667A |
| Precision Source | DC voltage of -5.5 V to 35.5 V, 0.1 mV resolution | Keysight B2912A/B2962A |
| Signal Generator | 100 kHz to 1 GHz sine waves | Keysight N5171B |
| Power Meter | 1.5 GHz ±3% accuracy | Keysight N1914A |
| Power Sensor | 1.5 GHz ±3% accuracy | Keysight E9304A or N8482A |
| 50 Ω BNC cable (qty 3) | BNC - BNC, 48" length | Keysight 8120-1840† |
| Cable | Type N (m) 609.6 mm (24 in.) | Keysight 11500B |
| Probe cable* | No substitute | 16-chanel: Keysight N6450-60001 or N2756-60001<br>8-channel: Keysight N6459-60001 or N2755-60001† |
| Adapter (qty 2) | BNC(f) to banana(m) | Keysight 1251-2277† |
| BNC Tee | BNC Tee (m) (f) (f) | Keysight 1250-0781† or Pomona 3285 |
| Adapter | Type N (m) to BNC (m) | Keysight 1250-0082 or Pomona 3288 with Pomona 3533 |
| Shorting cap | BNC | Keysight 1250-0774 |
| Blocking capacitor | Note: if a BNC blocking capacitor is not available use an SMA blocking capacitor. | Keysight 11742A +<br>Pomona 4289 +<br>Pomona 5088 |
| Adapter (qty 3) | N(m) to BNC(f) | Keysight 1250-0780 |

**Table 1** List of test equipment (continued)

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| 50 Ohm Feedthrough Termination | 50Ω BNC (f) to BNC (m) | Keysight 0960-0301 |
| * Required only for testing digital channels. Most parts and equipment are available at www.Keysight.com. See respective manufacturer's websites for their equipment.<br>† These parts available at www.parts.Keysight.com at the time this manual was published. | | |

# Conventions

The following conventions will be used when referring to oscilloscope models throughout this chapter.

**Table 2** Conventions

| Models | Referred to as: |
|---|---|
| HD302MSO and HD304MSO, standard bandwidth | 200 MHz Models |
| HD302MSO and HD304MSO, 350 MHz bandwidth option | 350 MHz Models |
| HD302MSO and HD304MSO, 500 MHz bandwidth option | 500 MHz Models |
| HD302MSO and HD304MSO, 1 GHz bandwidth option | 1 GHz Models |

## To construct the digital channels test connector

Keysight HD3-Series oscilloscopes have digital channels that require the test connector described below. Follow the steps to build the test connector.

**Table 3** Materials required to construct the test connectors

| Description | Recommended Part | Qty |
|---|---|---|
| BNC (f) Connector | Keysight 1250-1032 or Pomona 4578 | 1 |
| Berg Strip, 8-by-2 | 3M .100" x .100" Pin Strip Header or similar | 1 strip, cut to length (8x2) |
| Jumper wire | | |

1. Obtain a BNC connector and an 8-by-2 section of Berg strip. A longer strip can be cut to length using wire cutters.
2. On one side of the Berg strip, solder a jumper wire to all of the pins (shown in ithe following figure).
3. On the other side of the Berg strip, solder another jumper wire to all of the pins.
4. Solder the center of the BNC connector to a center pin on one of the rows on the Berg strip.
5. Solder the ground tab of the BNC connector to a center pin on the other row on the Berg strip.

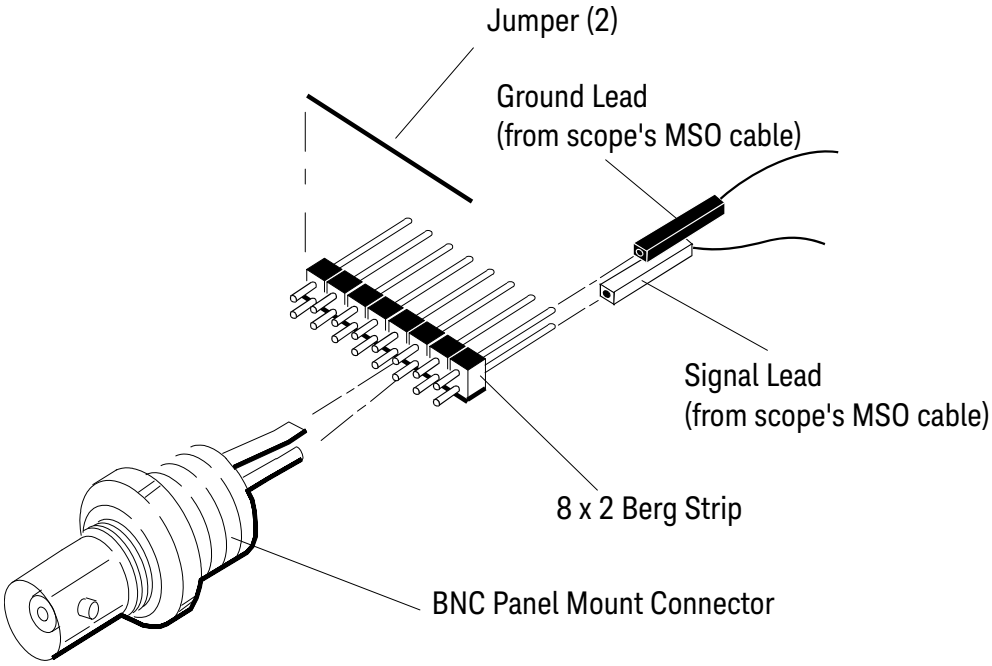



**Figure 1** Constructing the 8-by-2 Connector

## To test digital channels

The acquisition system testing provides confidence that the acquisition system is functioning correctly. It does not, however, check a particular specification.

1. Disconnect all probes from the circuit under test and from any other input source.
2. Using probe leads and grabbers, connect digital channels D0, D1, D2, and D3 to the Probe Comp signal on the center of the front panel.
3. Press the **[AutoScale]** key.

   If four square waves appear, the acquisition system is functioning correctly.

   If the square waves do not appear, go to Chapter 4, “Troubleshooting,” starting on page 51. Then, return here to finish testing the digital channels.
4. Disconnect the digital channels from the calibration point.
5. Use steps 2 and 3 to test the following sets of digital channels. After you test one set of digital channels, remove them before connecting the next set.
   - D4, D5, D6, D7
   - D8, D9, D10, D11
   - D12, D13, D14, D15

# To verify digital channel threshold accuracy

This test verifies the digital channel threshold accuracy specification of the Keysight HD3-Series oscilloscopes.

Threshold accuracy test limits: ±(100 mV + 3% of threshold setting)

**When to Test** You should perform this test every three years or after 6000 hours of operation, whichever comes first.

**What to Test** Use these instructions to test the threshold settings of digital channels D7-D0. Then, use the same instructions to test digital channels D15-D8.

**Verifying Test Results** After each threshold test, record the voltage reading in the "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48. To verify whether a test passes, verify that the voltage reading is within the limits in the Performance Test Record.

**Table 4** Equipment Required to Test Digital Channel Threshold Accuracy

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| Digital Multimeter | 0.1 mV resolution, 0.005% accuracy | Keysight 34401A/34461A |
| Precision Source | DC voltage of -5.5 V to 35.5 V, 0.1 mV resolution | Keysight B2912A/B2962A |
| Adapter (qty 2) | BNC(f) to banana(m) | Keysight 1251-2277 |
| BNC Tee | BNC Tee (m) (f) (f) | Keysight 1250-0781 or Pomona 3285 |
| 50 Ω BNC cable (qty 2) | BNC - BNC, 48" length | Keysight 8120-1840 |
| Digital channels test connector, 8-by-2* | For instructions on building test connector, see "To construct the digital channels test connector" on page 22. | n/a |
| Probe cable | No substitute | 16-chanel: Keysight N6450-60001 or N2756-60001<br>8-channel: Keysight N6459-60001 or N2755-60001 |

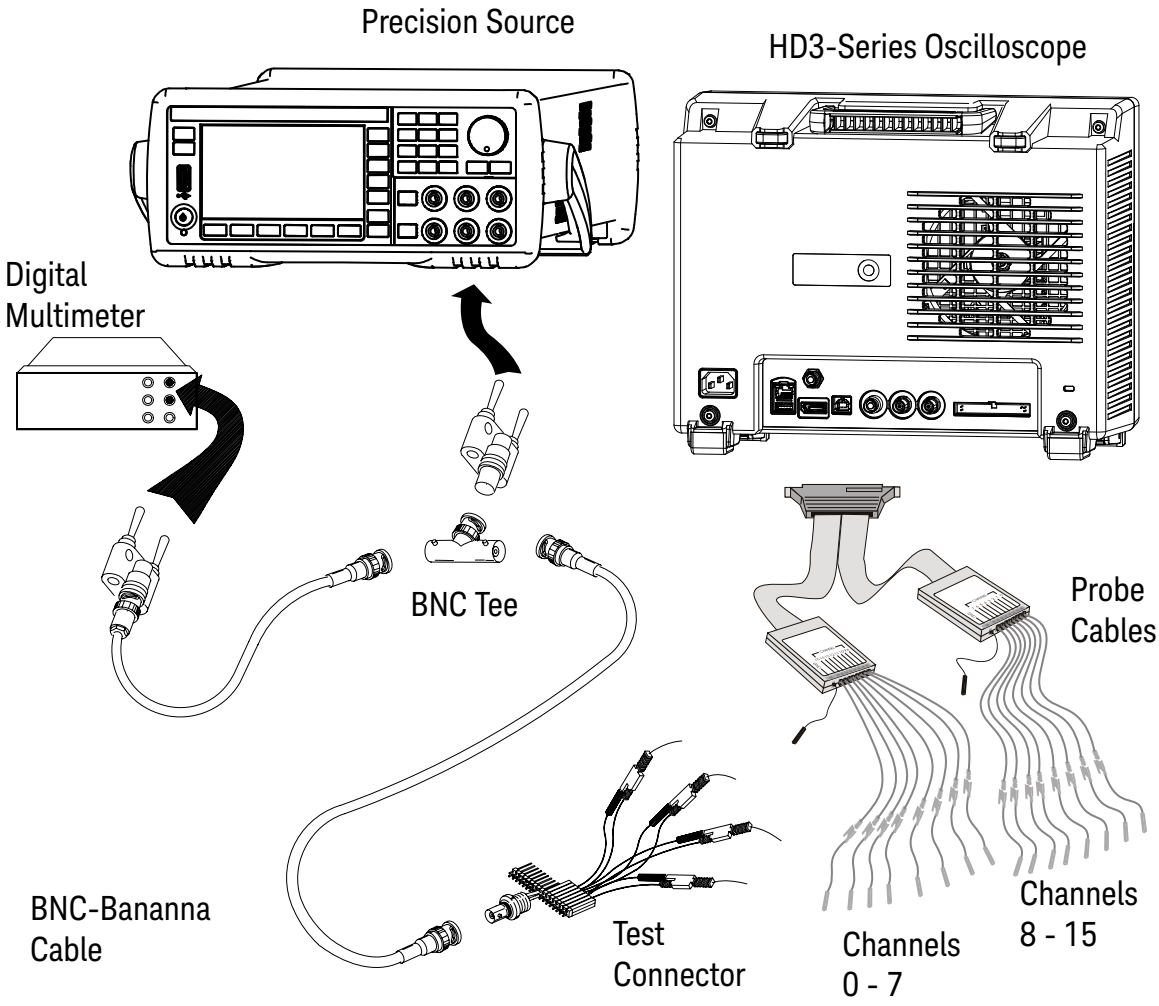



**Figure 2** Setting Up Equipment for Digital Channel Threshold Accuracy Test

**Table 5** Threshold Accuracy Voltage Test Settings

| Threshold voltage setting (in oscilloscope User field) | DC offset voltage setting (on precision source) | Limits |
|---|---|---|
| +5.00 V | +5.250 V ±1 mV dc | Lower limit = +4.750 V<br>Upper limit = +5.250 V |
| –5.00 V | –4.750 V ±1 mV dc | Lower limit = –5.250 V<br>Upper limit = –4.750 V |
| 0.00 V | +100 mV ±1 mV dc | Upper limit = +100 mV<br>Lower limit = –100 mV |

1 Turn on the test equipment and the oscilloscope. Let them warm up for 30 minutes before starting the test.

2 Set up the precision source:

   a Set the precision source to provide a DC offset voltage at the Channel 1 output.

**NOTE** Set the Low Force terminal of the Precision Source to its "Floating" state to prevent offset error caused by ground loop current from the Precision Source ground to the DUT ground.

   b Use the multimeter to monitor the precision source DC output voltage.

3 Use the 8-by-2 test connector and the BNC cable assembly to connect digital channels D0-D7 to one side of the BNC Tee. Then, connect the D0-D7 ground lead to the ground side of the 8-by-2 connector. See the previous figure.

4 Use a BNC-banana cable to connect the multimeter to the other side of the BNC Tee.

5 Connect the BNC Tee to the Channel 1 output of the precision source as shown in the previous figure.

6 Specify user-defined threshold voltage levels for the digital channels:

   a On the oscilloscope, from the main menu, choose **Sources > Digital Channels...**.

   b In the Digital dialog box, select **On** to turn the display of digital channels.

   c Select the **Thresholds** tab.

   d For each group of four digital channels, select the **User** option.

7 For each of the threshold voltage levels shown in the previous Threshold Accuracy Voltage Test Settings table:

   a Set the threshold voltage in the **User** fields for the D7 - D0 channnels.

   b On the precision source front panel, enter the corresponding DC offset voltage.

Use the multimeter to verify the voltage.

**c** On the oscilloscope, in the Digital dialog box, select the **Channels** tab.

The digital channel activity indicators for D7-D0 should show all of the channels at digital high levels.

**d** Use the knob on the precision source to decrease the offset voltage, in increments of 10 mV, until the activity indicators for digital channels D7-D0 are all at digital low levels. Record the precision source voltage in the "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48.

**e** Use the knob on the precision source to increase the offset voltage, in increments of 10 mV, until the activity indicators for digital channels D7-D0 are all at digital high levels. Record the precision source voltage in the "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48.

Before proceeding to the next step, make sure that you have recorded the precision source voltage levels for each of the threshold settings shown in the previous Threshold Accuracy Voltage Test Settings table.

**8** When testing HD3-Series MSOs, use the 8-by-2 test connector to connect digital channels D15-D8 to the output of the precision source. Then connect the D15-D8 ground lead to the ground side of the 8-by-2 connector.

**9** Repeat this procedure (steps 6 through 8) for digital channels D15-D8 to verify threshold accuracy and record the threshold levels in the "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48. Be sure to set the thresholds with the **User** field for the appropriate set of channels.

# To verify DC vertical gain accuracy

This test verifies the accuracy of the analog channel DC vertical gain for each channel.

In this test, you will measure the dc voltage output of a precision source using the oscilloscope's **Average - Full Screen** voltage measurement and compare the results with the multimeter reading.

**Table 6** DC Vertical Gain Accuracy Test Limits

| Models | Test Limits | Notes |
|---|---|---|
| HD3-Series | ±1.5% of full scale | ▪ Full scale is defined as 16 mV on the 1 mV/div and 500 µV/div range.<br>▪ Full scale on all other ranges is defined as 8 divisions times the V/div setting. |

**Table 7** Equipment Required to Verify DC Vertical Gain Accuracy

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| Precision Source | DC voltage of -5.5 V to 35.5 V, 0.1 mV resolution | Keysight B2912A/B2962A |
| Digital Multimeter | 0.1 mV resolution, 0.005% accuracy | Keysight 34401A/34461A |
| 50 Ω BNC cable (qty 2) | BNC - BNC, 48" length | Keysight 8120-1840 |
| Adapter (qty 2) | BNC(f) to banana(m) | Keysight 1251-2277 |
| BNC Tee | BNC Tee (m) (f) (f) | Keysight 1250-0781 or Pomona 3285 |
| Shorting cap | BNC | Keysight 1250-0774 |
| Blocking capacitor | Note: if a BNC blocking capacitor is not available use an SMA blocking capacitor. | Keysight 11742A +<br>Pomona 4289 +<br>Pomona 5088 |

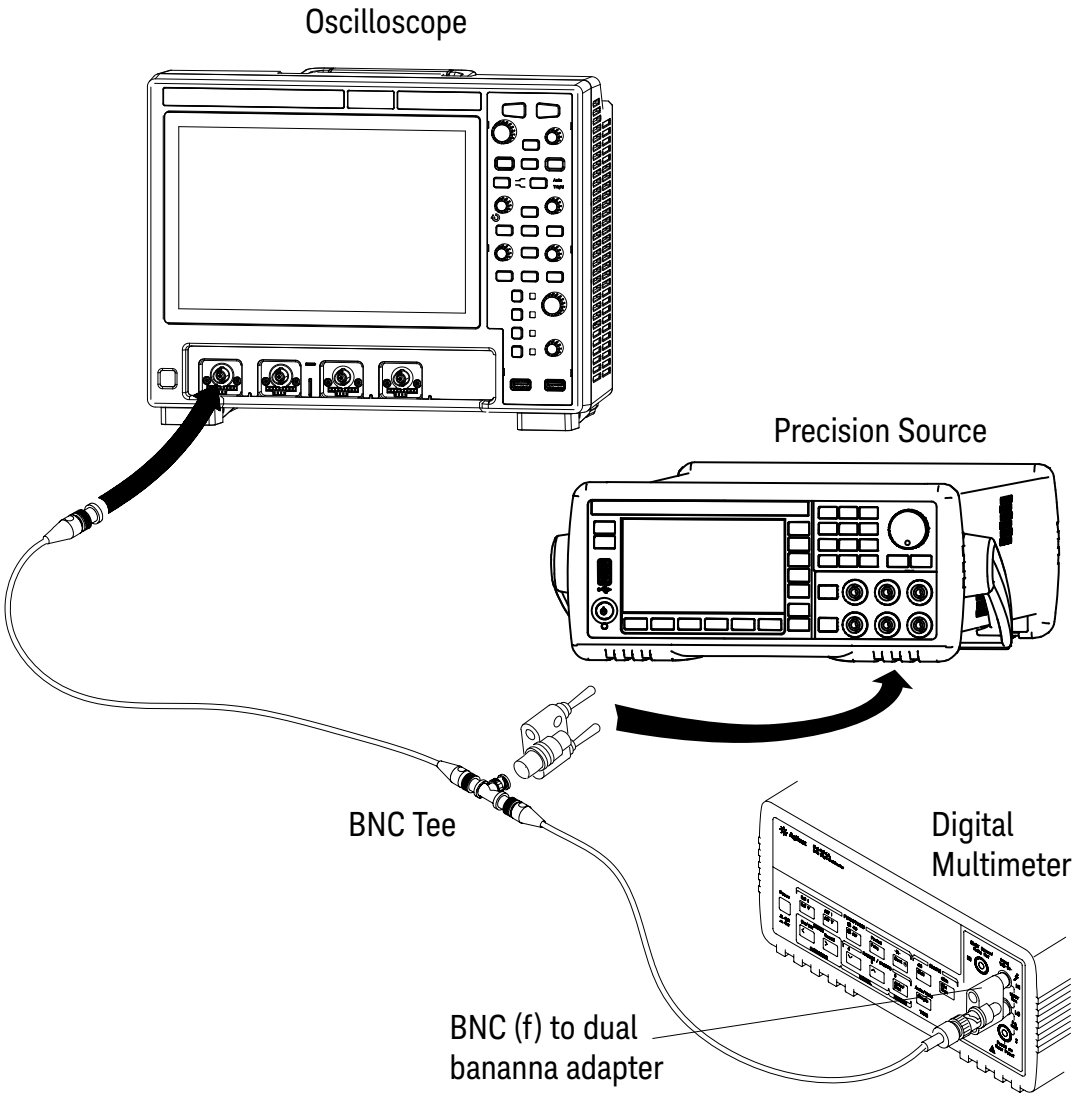



**Figure 3** Setting up Equipment for DC Vertical Gain Accuracy Test

**Table 8** Settings Used to Verify DC Vertical Gain Accuracy

| Volts/Div Setting | Precision Source Setting | Test Limits | | |
|---|---|---|---|---|
| 10 V/Div | 70 V | 68.8 V | to | 71.2 V |
| 5 V/Div | 35 V | 34.4 V | to | 35.6 V |
| 2 V/Div | 14 V | 13.76 V | to | 14.24 V |
| 1 V/Div | 7 V | 6.88 V | to | 7.12 V |
| 500 mV/Div | 3.5 V | 3.44 V | to | 3.56 V |
| 200 mV/Div | 1.4 V | 1.368 V | to | 1.432 V |
| 100 mV/Div | 700 mV | 688 mV | to | 712 mV |
| 50 mV/Div | 350 mV | 344 mV | to | 356 mV |
| 20 mV/Div | 140 mV | 137.6 mV | to | 142.4 mV |
| 10 mV/Div | 70 mV | 68.8 mV | to | 71.2 mV |
| 5 mV/Div[1] | 35 mV | 34.4 mV | to | 35.6 mV |
| 2 mV/Div[1] | 14 mV | 13.76 mV | to | 14.24 mV |
| 1 mV/Div[1, 2] | 7 mV | 6.76 mV | to | 7.24 mV |
| 500 µV/Div[1, 2] | 3.5 mV | 3.26 mV | to | 3.74 mV |

[1] A blocking capacitor is required at this range to reduce noise. See "Use a Blocking Capacitor to Reduce Noise" on page 33.

[2] Full scale is defined as 16 mV on the 2 mV/div, 1 mV/div, and 500 µV/div range. Full scale on all other ranges is defined as 8 divisions times the V/div setting.

1 Recall the factory default setup:

   a From the main menu, choose **Control > Default...**.

   b In the Default dialog box, select **Factory Default**.

2 Set up the oscilloscope:
   a Adjust the horizontal scale to 200.0 us/div.
   b Set the Volts/Div setting to the value in the first line in the previous settings table (depending on the oscilloscope model).
   c Adjust the channel's vertical position knob to place the baseline (reference level) at 0.5 major division from the bottom of the display.
   d Open the Acquire dialog box by selecting the sample rate and memory depth (Acquire) badge or by choosing **Setup > Acquire...** from the main menu.
   e From the **Acq Mode** drop-down list, select **Averaging**.
   f In the **# of Averages** field, enter **64**.

   Wait a few seconds for the measurement to settle.
3 Add a measurement for the average voltage:
   a Press the **[Meas]** key.
   b In the Measurements dialog box (Add, Edit & Delete tab), from the **Source** drop-down list, select the channel you are testing.
   c (Optional) From the **Category** list, select **Voltage**.
   d From the **Type** list, select **Average - Full Screen**.
   e Select **Add Avg - FS**.
4 Read the "Current" average voltage value as V1.
5 Use the BNC tee and cables to connect the precision source power supply to both the oscilloscope and the multimeter (see the previous equipment setup figure).

**NOTE** **Set the Low Force terminal of the Precision Source to its "Floating" state to prevent offset error caused by ground loop current from the Precision Source ground to the DUT ground.**

6 Adjust the output so that the multimeter reading displays the first Volts/div precision source setting value in the previous settings table (depending on the oscilloscope model).
7 Disconnect the multimeter.
8 Wait until the measurement settles.
9 Read the "Current" average voltage value again as V2.
10 Calculate the difference V2 - V1.

   The difference in average voltage readings should be within the test limits of the previous settings table (depending on the oscilloscope model).

   If a result is not within the test limits, go to Chapter 4, “Troubleshooting,” starting on page 51. Then return here.

11 Disconnect the precision source from the oscilloscope.

12 Repeat this procedure to check the DC vertical gain accuracy with the remaining Volts/div setting values in the previous settings table (depending on the oscilloscope model).

13 Finally, repeat this procedure for the remaining channels to be tested.

## Use a Blocking Capacitor to Reduce Noise

On the more sensitive ranges, such as 1 mV/div, 2 mV/div, and 5 mV/div, noise may be a factor. To eliminate the noise, add a BNC Tee, blocking capacitor, and shorting cap at the oscilloscope channel input to shunt the noise to ground. See the following figure. If a BNC capacitor is not available, use an SMA blocking capacitor, adapter, and cap. For details, see "Blocking capacitor" in the "List of Test Equipment" on page 19.

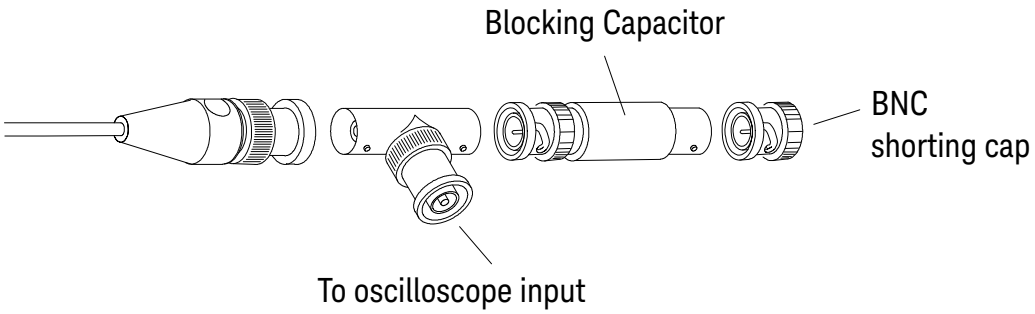



**Figure 4** Using a Blocking Capacitor to Reduce Noise

# To verify dual marker accuracy

This test verifies the dual marker accuracy for each analog channel.

This test is similar to the test for verifying the DC vertical gain, except you will measure the dc voltage output of a precision source using dual markers on the oscilloscope and compare the results with the multimeter reading.

Dual marker accuracy test limits: ±[DC vertical gain accuracy + 0.16% full scale]

For the DC vertical gain accuracy test limits, see "To verify DC vertical gain accuracy" on page 29.

**Table 9** Equipment Required to Verify Dual Marker Accuracy

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| Precision Source | DC voltage of -5.5 V to 35.5 V, 0.1 mV resolution | Keysight B2912A/B2962A |
| Digital Multimeter | 0.1 mV resolution, 0.005% accuracy | Keysight 34401A/34461A |
| 50 Ω BNC cable (qty 2) | BNC - BNC, 48" length | Keysight 8120-1840 |
| Adapter (qty 2) | BNC(f) to banana(m) | Keysight 1251-2277 |
| BNC Tee | BNC Tee (m) (f) (f) | Keysight 1250-0781 or Pomona 3285 |
| Shorting cap | BNC | Keysight 1250-0774 |
| Blocking capacitor | Note: if a BNC blocking capacitor is not available use an SMA blocking capacitor. | Keysight 11742A +<br>Pomona 4289 +<br>Pomona 5088 |

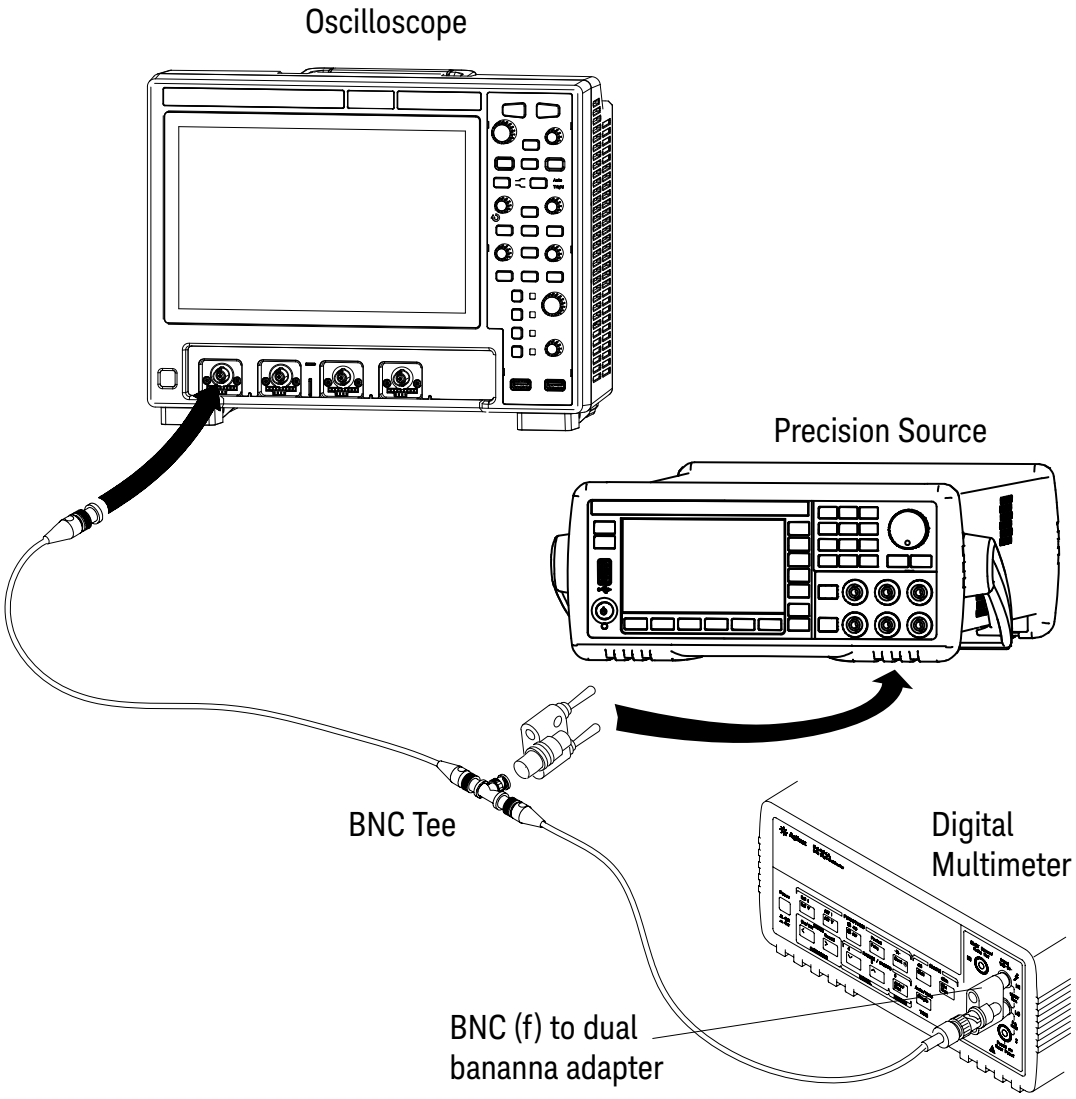



**Figure 5** Setting up Equipment for Dual Marker Accuracy Test

**Table 10** Settings Used to Verify Dual Marker Accuracy

| Volts/Div Setting | Precision Source Setting | Test Limits | | |
|---|---|---|---|---|
| 10 V/Div | 70 V | 68.672 V | to | 71.328 V |
| 5 V/Div | 35 V | 34.336 V | to | 35.664 V |
| 2 V/Div | 14 V | 13.734 V | to | 14.266 V |
| 1 V/Div | 7 V | 6.867 V | to | 7.133 V |
| 500 mV/Div | 3.5 V | 3.434 V | to | 3.566 V |
| 200 mV/Div | 1.4 V | 1.373 V | to | 1.427 V |
| 100 mV/Div | 700 mV | 686.72 mV | to | 713.28 mV |
| 50 mV/Div | 350 mV | 343.36 mV | to | 356.64 mV |
| 20 mV/Div | 140 mV | 137.344 mV | to | 142.656 mV |
| 10 mV/Div | 70 mV | 68.672 mV | to | 71.328 mV |
| 5 mV/Div[1] | 35 mV | 34.336 mV | to | 35.664 mV |
| 2 mV/Div[1] | 14 mV | 13.734 mV | to | 14.266 mV |
| 1 mV/Div[1, 2] | 7 mV | 6.734 mV | to | 7.266 mV |
| 500 µV/Div[1, 2] | 3.5 mV | 3.234 mV | to | 3.766 mV |

[1] A blocking capacitor is required at this range to reduce noise. See "Use a Blocking Capacitor to Reduce Noise" on page 33.

[2] Full scale is defined as 16 mV on the 1 mV/div range and 500 µV/div range. Full scale on all other ranges is defined as 8 divisions times the V/div setting.

1 Recall the factory default setup:
   a From the main menu, choose **Control > Default...**.
   b In the Default dialog box, select **Factory Default**.
2 Set up the oscilloscope:
   a Set the Volts/Div setting to the value in the first line in the previous settings table (depending on the oscilloscope model).
   b Adjust the channel's vertical position knob to place the baseline (reference level) at 0.5 major division from the bottom of the display.
   c Open the Acquire dialog box by selecting the sample rate and memory depth (Acquire) badge or by choosing **Setup > Acquire...** from the main menu.
   d From the **Acq Mode** drop-down list, select **Averaging**.
   e In the **# of Averages** field, enter **64**.

Wait a few seconds for the measurement to settle.

3 Position the **Y1** marker on the baseline of the signal:

   a Press the **[Markers]** key to enable markers.

   b To open the Markers dialog box, in the Results area, select the  Edit button in the Markers window (or you can choose **Measure > Markers...** from the main menu).

   c From the **Mode** drop-down list, select **Manual**.

   d Turn off the **X1** and **X2** markers by deselecting them.

   e From the **Selected Y** drop-down list, select **Y1**.

   f Turn the Markers vertical position knob to position the **Y1** marker on the baseline of the signal.

   g Close the Markers dialog box. For the remainder of this test, you need only use the Markers vertical position knob.

4 Use the BNC tee and cables to connect the precision source power supply to both the oscilloscope and the multimeter (see the previous equipment setup figure).

**NOTE** **Set the Low Force terminal of the Precision Source to its "Floating" state to prevent offset error caused by ground loop current from the Precision Source ground to the DUT ground.**

5 Adjust the output so that the multimeter reading displays the first Volts/div precision source setting value in the previous settings table.

6 Disconnect the multimeter.

7 Wait until the measurement settles.

8 Position the **Y2** marker to the center of the voltage trace:

   a Push the Markers vertical position knob to highlight (select) only the **Y2** marker.

   b Turn the Markers vertical position knob to position the **Y2** marker to the center of the voltage trace.

   The ΔY value in the Results area Markers window should be within the test limits of the previous settings table.

   If a result is not within the test limits, go to Chapter 4, “Troubleshooting,” starting on page 51. Then return here.

9 Disconnect the precision source from the oscilloscope.

10 Repeat this procedure to check the dual marker accuracy with the remaining Volts/div setting values in the previous settings table.

11 Finally, repeat this procedure for the remaining channels to be tested.

# To verify bandwidth (-3 dB)

This test checks the bandwidth (-3 dB) of the oscilloscope. In this test you will use a signal generator and a power meter.

**Table 11** Bandwidth (-3 dB) Test Limits

| Models | Test Limits |
|---|---|
| 1 GHz Models | All channels (-3 dB), dc to 1 GHz |
| 500 MHz Models | All channels (-3 dB), dc to 500 MHz |
| 350 MHz Models | All channels (-3 dB), dc to 350 MHz |
| 200 MHz Models | All channels (-3 dB), dc to 200 MHz |

**Table 12** Equipment Required to Verify Bandwidth (-3 dB)

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| Signal Generator | 100 kHz to 1 GHz sine waves | Keysight N5171B |
| Power Meter | 1.5 GHz ±3% accuracy | Keysight N1914A |
| Power Sensor | 1.5 GHz ±3% accuracy | Keysight E9304A or N8482A |
| Power Splitter | Outputs differ by 0.15 dB | Keysight 11667A |
| Cable | Type N (m) 609.6 mm (24 in.) | Keysight 11500B |
| Adapter | Type N (m) to BNC (m) | Keysight 1250-0082 or Pomona 3288 with Pomona 3533 |

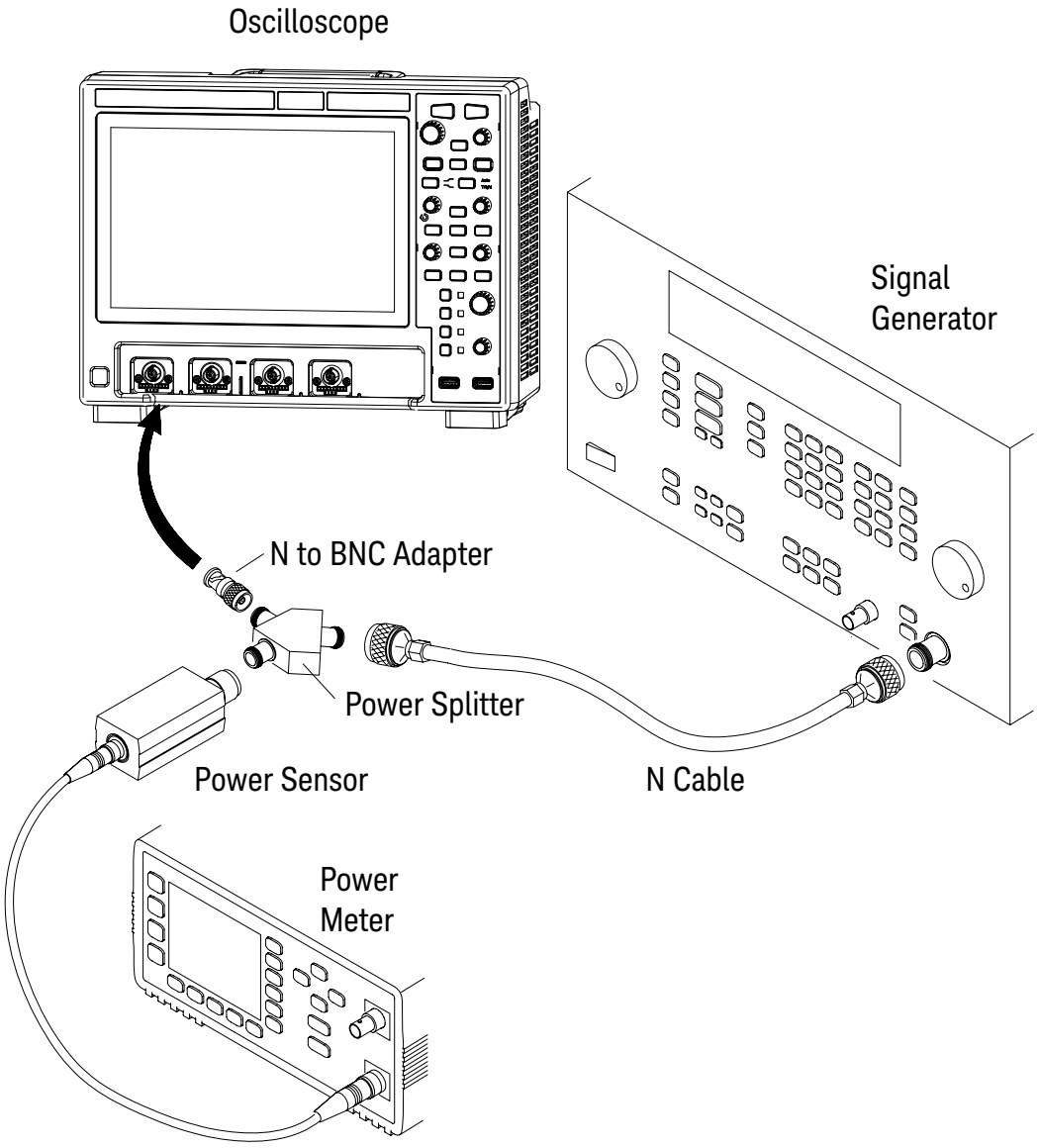



**Figure 6** Setting Up Equipment for Bandwidth (-3 dB) Verification Test

1 Connect the equipment (see the previous figure):

   a Use the N cable to connect the signal generator to the input of the power splitter input.

   b Connect the power sensor to one output of the power splitter.

   c Use an N-to-BNC adapter to connect the other splitter output to the channel 1 input.

2 Set up the power meter.

   Set the power meter to display measurements in units of watts.

3 Set up the oscilloscope:

   a Press the **[Default Setup]** key.

   b Open the Channel dialog box by selecting the Channel 1 badge or by choosing **Sources > Channel 1...** from the main menu.

   c For **Coupling**, select **DC**.

   d For **Impedance**, select **50 Ω**.

   e For **Channel 1 Scale**, enter **200 mV/div**, and close the Channel dialog box.

   f Set the time base to **500 ns/div**.

   g Open the Acquire dialog box by selecting the sample rate and memory depth (Acquire) badge or by choosing **Setup > Acquire...** from the main menu.

   h From the **Acq Mode** drop-down list, select **Averaging**.

   i In the **# of Averages** field, enter **8**.

   Wait a few seconds for the measurement to settle.

4 Set the signal generator for 1 MHz and six divisions of amplitude.

   The signal on the oscilloscope screen should be about five cycles at six divisions amplitude.

5 Add a measurement for AC RMS full screen:

   a Press the **[Meas]** key.

   b In the Measurements dialog box (Add, Edit & Delete tab), from the **Source** drop-down list, select the channel you are testing.

   c (Optional) From the **Category** list, select **Voltage**.

   d From the **Type** list, select **AC RMS - Full Screen (Std Deviation)**.

   e Select **Add AC RMS FS**.

6 Note the oscilloscope **AC RMS - FS(1)** reading at the bottom of the screen. (This is the RMS value with any dc offset removed.)

7 Set the power meter Cal Factor % to the 1 MHz value on the calibration chart on the power sensor.

8 Note the reading on the power meter and covert to Vrms using the expression:

$$Vin_{1MHz} = \sqrt{Pmeas_{1MHz} \times 50\Omega}$$

   For example, if the power meter reading is 892 uW, then $Vin_{1MHz}$ = (892*10-6 * 50Ω)$^{1/2}$ = 211.2 mVrms.

9 Change the signal generator output frequency according to the maximum frequency for the oscilloscope using the following:

   - 1 GHz Models: 1 GHz

- 500 MHz Models: 500 MHz
- 350 MHz Models: 350 MHz
- 200 MHz Models: 200 MHz

**10** Referencing the frequency from step 9, set the power meter Cal Factor % to the frequency value on the calibration chart on the power sensor.

**11** Set the oscilloscope sweep speed according to the following:

- 1 GHz Models: 500 ps/div
- 500 MHz Models: 1 ns/div
- 350 MHz Models: 2 ns/div
- 200 MHz Models: 2 ns/div

**12** Note the oscilloscope AC RMS - FS(1) reading at the bottom of the screen.

**13** Note the reading on the power meter and covert to Vrms using the expression:

$$Vin_{maxfreq} = \sqrt{Pmeas_{maxfreq} \times 50\Omega}$$

**14** Calculate the response using the expression:

$$response(dB) = 20\ log_{10}\left[\frac{Vout_{maxfreq}/Vin_{maxfreq}}{Vout_{1MHz}/Vin_{1MHz}}\right]$$

For example, if:

- $Pmeas_{1MHz}$ = 892 uW
- AC RMS - $FS(n)_{1MHz}$ = 210.4 mV
- $Pmeas_{max\ freq}$ = 687 uW
- AC RMS - $FS(n)_{max\ freq}$ = 161.6 mV

Then after converting the values from the power meter to Vrms:

$$response(dB) = 20\ log_{10}\left[\frac{161.6\ mV/185.3\ mV}{210.4\ mV/211.2\ mV}\right] = -1.16\ dB$$

**15** The result from step 14 should be within -3.0 dB. Record the result in the "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48.

**16** Move the power splitter from the channel 1 to the channel 2 input.

**17** Turn off the current channel and turn on the next channel using the channel keys.

**18** Repeat steps 3 through 17 for the remaining channels, setting the parameters of the channel being tested where appropriate.

## To verify time base accuracy

This test verifies the accuracy of the time base. In this test you will measure the absolute error of the time base oscillator and compare the results to the specification.

**Table 13** Equipment Required to Verify Time Base Accuracy

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| Signal Generator | 100 kHz to 1 GHz sine waves | Keysight N5171B |
| 50 Ω BNC cable | BNC - BNC, 48" length | Keysight 8120-1840 |

1. Set up the signal generator:
   a. Set the output to 10 MHz, approximately 1 Vpp sine wave.
2. Connect the output of the signal generator to oscilloscope channel 1 using the BNC cable.
3. Set up the oscilloscope:
   a. Press **[AutoScale]**.
   b. Set the oscilloscope Channel 1 vertical sensitivity to **200 mv/div**.
   c. Set the oscilloscope horizontal sweep speed control to **5 ns/div**.
   d. Adjust the intensity to get a sharp, clear trace (from the main menu, choose **Setup > Waveform Intensity...**).
   e. Adjust the oscilloscope's trigger level so that the rising edge of the waveform at the center of the screen is located where the center horizontal and vertical grid lines cross (center screen).
   f. Ensure the horizontal position control is set to **0.0 seconds**.
4. Make the measurement:
   a. Set oscilloscope horizontal sweep speed control to **1 ms/div**.
   b. Set horizontal position control to **+1 ms**.
   c. Set the oscilloscope horizontal sweep speed control to **5 ns/div**.
   d. Record the number of nanoseconds from where the rising edge crosses the center horizontal grid line to the center vertical grid line. The number of nanoseconds is equivalent to the time base error in ppm.

      Time base accuracy limit: ±1.6 ppm + aging

      Aging factors:

      - 1 year: ±0.5 ppm
      - 2 years: ±0.7 ppm

- 5 years: ±1.5 ppm
- 10 years: ±2.0 ppm

Use the date code on the oscilloscope's serial tag to calculate the number of years since manufacture.


**e** Record the result and compare it to the limits in the "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48.

## To verify external trigger sensitivity

This test verifies the external trigger sensitivity. In this test, you apply a sine wave to the oscilloscope at the test limits and check to see if the oscilloscope is triggered.

This test applies to all models.

**Table 14** Equipment Required to Verify External Trigger Sensitivity

| Equipment | Critical Specifications | Recommended Model/ Part Number |
|---|---|---|
| Signal Generator | 100 kHz to 1 GHz sine waves | Keysight N5171B |
| Power Splitter | Outputs differ by 0.15 dB | Keysight 11667A |
| Power Meter | 1.5 GHz ±3% accuracy | Keysight N1914A |
| Power Sensor | 1.5 GHz ±3% accuracy | Keysight E9304A or N8482A |
| 50 Ω BNC cable (qty 3) | BNC - BNC, 48" length | Keysight 8120-1840 |
| Adapter (qty 3) | N(m) to BNC(f) | Keysight 1250-0780 |
| 50 Ohm Feedthrough Termination | 50Ω BNC (f) to BNC (m) | Keysight 0960-0301 |

**Table 15** External Trigger Sensitivity Test Limits, All Models

| Frequency | Sensitivity |
|---|---|
| DC to 100 MHz | 200 mVpp |
| 100 MHz to 500 MHz | 350 mVpp |

Verify the external trigger sensitivity at these settings:

**Table 16** External Trigger Sensitivity Test Settings

| 100 MHz | 500 MHz |
|---|---|
| 200 mVpp | 350 mVpp |

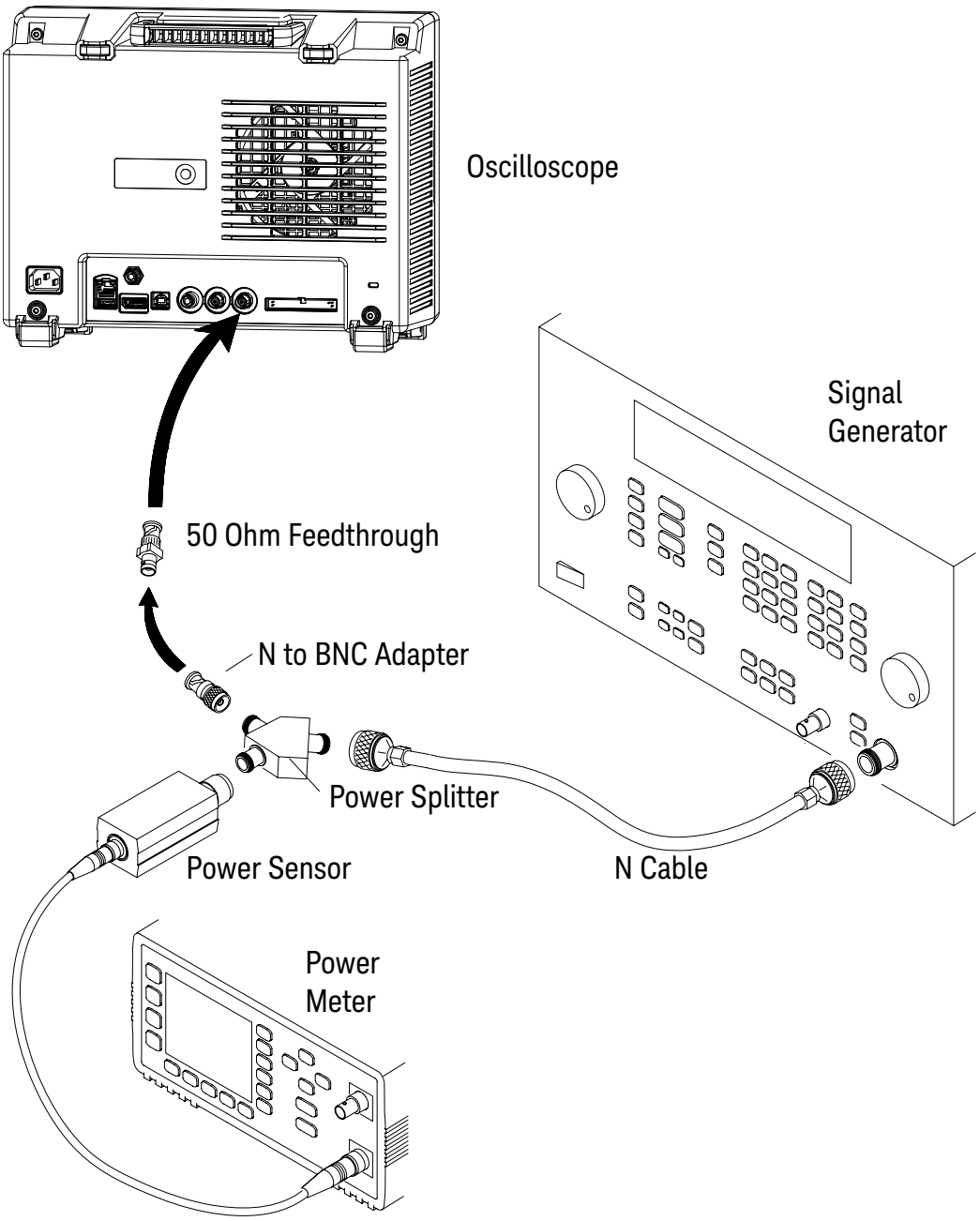



**Figure 7** Setting Up Equipment for External Trigger Sensitivity Test

**1** 1 Connect the equipment (see the previous figure):

- **a** Use the N cable to connect the signal generator to the power splitter input.
- **b** Connect one output of the power splitter to the Aux Trig input through a 50Ω feedthrough termination.
- **c** Connect the power sensor to the other output of the power splitter.

2 Set up the oscilloscope:

   a Press the **[Default Setup]** key.

   b Select the trigger badge. In the quick settings pop-up dialog box, from the **Mode** drop-down list, select **Normal** to turn off automatic triggering.

3 Change the signal generator output frequency to 100 MHz or 500 MHz.

4 Set the power meter Cal Factor % to the appropriate value (100 MHz or 500 MHz) on the calibration chart on the power sensor. If necessary, do a linear interpolation if a 100 MHz or 500 MHz factor is not included in the power meter's calibration chart.

5 Adjust the signal generator output for reading on the power meter of:

| Signal Generator Frequency | Calculation | Power Meter Reading |
|---|---|---|
| 100 MHz | 200 mVpp = 70.71 mV rms, Power = Vin2/50Ω = 70.71 mV2/50Ω | 100 µW |
| 500 MHz | 350 mVpp = 123.74 mV rms, Power = Vin2/50Ω = 123.74 mV2/50Ω | 306 µW |

6 Select the trigger badge. In the quick settings pop-up dialog box, from the **Source** drop-down list, select **External**.

7 Check for stable triggering and adjust the trigger level if necessary. Triggering is indicated by the **Trig'd** indicator at the top of the display. When **Trig'd?** is displayed, the oscilloscope is not triggered. When **Trig'd** is displayed (no question mark), the oscilloscope is triggered.

8 Record the results as Pass or Fail in the "Keysight HD3-Series Oscilloscopes Performance Test Record" on page 48.

   If the test fails, see Chapter 4, “Troubleshooting,” starting on page 51. Then return here.

# Keysight HD3-Series Oscilloscopes Performance Test Record

| Keysight Technologies | Keysight InfiniiVision HD3-Series Oscilloscopes |
|---|---|
| Model Number: | Tested by: |
| Serial Number: | Work Order No.: |
| Recommended Test Interval–3 Years/6000 hours | Date: |
| Recommended next test date: | Ambient temperature: |

**Table 17** Digital Channel Threshold Accuracy Test

| Specification | Limits | D7-D0 | D15-D8 |
|---|---|---|---|
| 5 V - 250 mV | 4.750 V | | |
| 5 V + 250 mV | 5.250 V | | |
| -5 V - 250 mV | -5.250 V | | |
| -5 V + 250 mV | -4.750 V | | |
| 0 V - 100 mV | -100 mV | | |
| 0 V + 100 mV | 100 mV | | |

**Table 18** DC Vertical Gain Accuracy Test

| Range | Power Supply Setting | Test Limits | | | Channel 1 | Channel 2 | Channel 3 (if present) | Channel 4 (if present) |
|---|---|---|---|---|---|---|---|---|
| 10 V/div | 70 V | 68.8 V | to | 71.2 V | | | | |
| 5 V/div | 35 V | 34.4 V | to | 35.6 V | | | | |
| 2 V/div | 14 V | 13.76 V | to | 14.24 V | | | | |
| 1 V/div | 7 V | 6.88 V | to | 7.12 V | | | | |
| 500 mV/div | 3.5 V | 3.44 V | to | 3.56 V | | | | |
| 200 mV/div | 1.4 V | 1.376 V | to | 1.424 V | | | | |
| 100 mV/div | 700 mV | 688 mV | to | 712 mV | | | | |
| 50 mV/div | 350 mV | 344 mV | to | 356 mV | | | | |
| 20 mV/div | 140 mV | 137.6 mV | to | 142.4 mV | | | | |
| 10 mV/div | 70 mV | 68.8 mV | to | 71.2 mV | | | | |
| 5 mV/div | 35 mV | 34.4 mV | to | 35.6 mV | | | | |
| 2 mV/div | 14 mV | 13.76 mV | to | 14.24 mV | | | | |

**Table 18** DC Vertical Gain Accuracy Test (continued)

| Range | Power Supply Setting | Test Limits | | | Channel 1 | Channel 2 | Channel 3 (if present) | Channel 4 (if present) |
|---|---|---|---|---|---|---|---|---|
| 1 mV/div | 7 mV | 6.76 mV | to | 7.24 mV | | | | |
| 500 µV/div | 3.5 mV | 3.26 mV | to | 3.74 mV | | | | |

**Table 19** Dual Marker Accuracy Test

| Range | Power Supply Setting | Test Limits | | | Channel 1 | Channel 2 | Channel 3 (if present) | Channel 4 (if present) |
|---|---|---|---|---|---|---|---|---|
| 10 V/div | 70 V | 68.672 V | to | 71.328 V | | | | |
| 5 V/div | 35 V | 34.336 V | to | 35.664 V | | | | |
| 2 V/div | 14 V | 13.734 V | to | 14.266 V | | | | |
| 1 V/div | 7 V | 6.867 V | to | 7.133 V | | | | |
| 500 mV/div | 3.5 V | 3.434 V | to | 3.566 V | | | | |
| 200 mV/div | 1.4 V | 1.373 V | to | 1.427 V | | | | |
| 100 mV/div | 700 mV | 686.72 mV | to | 713.28 mV | | | | |
| 50 mV/div | 350 mV | 343.36 mV | to | 356.64 mV | | | | |
| 20 mV/div | 140 mV | 137.344 mV | to | 142.656 mV | | | | |
| 10 mV/div | 70 mV | 68.672 mV | to | 71.328 mV | | | | |
| 5 mV/div | 35 mV | 34.336 mV | to | 35.664 mV | | | | |
| 2 mV/div | 14 mV | 13.734 mV | to | 14.266 mV | | | | |
| 1 mV/div | 7 mV | 6.734 mV | to | 7.266 mV | | | | |
| 500 µV/div | 3.5 mV | 3.234 mV | to | 3.766 mV | | | | |

**Table 20** Bandwidth (-3 dB) Test

| Oscilloscope Bandwidth | Test Limits | Channel 1 | Channel 2 | Channel 3 (if present) | Channel 4 (if present) |
|---|---|---|---|---|---|
| 1 GHz | -3 dB at 1 GHz | | | | |
| 500 MHz | -3 dB at 500 MHz | | | | |
| 350 MHz | -3 dB at 350 MHz | | | | |
| 200 MHz | -3 dB at 200 MHz | | | | |

**Table 21** Time Base Accuracy Test

| Limits | Measured time base error (ppm) | Pass/Fail |
|---|---|---|
| Time Base Accuracy Limit: ±1.6 ppm + aging factor (1 year: ±0.5 ppm, 2 years: ±0.7 ppm, 5 years: ±1.5 ppm, 10 years: ±2.0 ppm) | | |

**Table 22** External Trigger Sensitivity Test

| Generator Setting | Test Limits | Pass/Fail |
|---|---|---|
| 500 MHz | 350 mV | |
| 100 MHz | 200 mV | |

# 4 Troubleshooting



This chapter begins with "Solving General Problems with the Oscilloscope" on page 52. It tells you what to do in these cases:

- "If there is no display" on page 52
- "If there is no trace display" on page 52
- "If the trace display is unusual or unexpected" on page 52
- "If you cannot see a channel" on page 53

Next, this chapter describes procedures for "Verifying Oscilloscope Operation" on page 54:

- "To power-on the oscilloscope" on page 54
- "To perform hardware self test" on page 54
- "To perform front panel self test" on page 55
- "To verify default setup" on page 55
- "To perform an Auto Scale on the Probe Comp signal" on page 57
- "To compensate passive probes" on page 57

# Solving General Problems with the Oscilloscope

This section describes how to solve general problems that you may encounter while using the Keysight HD3-Series oscilloscopes.

## If there is no display

- Check that the power cord is firmly seated in the oscilloscope power receptacle.
- Check that the power source is live.
- Check that the front-panel power switch is on.
- If there is still no display, go to the troubleshooting procedures in this chapter.

## If there is no trace display

- Check that the Intensity (on the front panel) is adjusted correctly.
- Recall the default setup by pressing **[Default Setup]**. This will ensure that the trigger mode is **Auto**.
- Check that the probe clips are securely connected to points in the circuit under test, and that the ground is connected.
- Check that the circuit under test is powered on.
- Press the **[Auto Scale]** key.
- Obtain service from Keysight Technologies, if necessary.

## If the trace display is unusual or unexpected

- Check that the Horizontal time/division setting is correct for the expected frequency range of the input signals.
- The sampling speed of the oscilloscope depends on the time/division setting. It may be that when time/division is set to slower speeds, the oscilloscope is sampling too slowly to capture all of the transitions on the waveform. Use peak detect mode.
- Check that all oscilloscope probes are connected to the correct signals in the circuit under test.
- Ensure that the probe's ground lead is securely connected to a ground point in the circuit under test. For high-speed measurements, each probe's individual ground lead should also be connected to a ground point closest to the signal point in the circuit under test.
- Check that the trigger setup is correct.

- A correct trigger setup is the most important factor in helping you capture the data you desire. See the *User's Guide* for information about triggering.
- Check that persistence in the Display menu is turned off, then press **[Clear Display]**.
- Press the **[Auto Scale]** key.

## If you cannot see a channel

- Recall the default setup by pressing **[Default Setup]**. This will ensure that the trigger mode is **Auto**.
- Check that the oscilloscope probe's BNC connector is securely attached to the oscilloscope's input connector.
- Check that the probe clips are securely connected to points in the circuit under test.
- Check that the circuit under test is powered on.

  You may have pressed the **[Auto Scale]** key before an input signal was available.

  Performing the checks listed here ensures that the signals from the circuit under test will be seen by the oscilloscope. Perform the remaining checks in this topic to make sure the oscilloscope channels are on, and to obtain an automatic setup.
- Check that the desired oscilloscope channels are turned on.
  - **a** Press the analog channel key until it is illuminated.
  - **b** Press the digital channels **[Digital]** key until it is illuminated.
- Press the **[Auto Scale]** key to automatically set up all channels.

# Verifying Oscilloscope Operation

## To power-on the oscilloscope

1 Connect the power cord to the rear of the oscilloscope, then to a suitable AC voltage source. Route the power cord so the oscilloscope's feet and legs do not pinch the cord.

Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

2 The oscilloscope automatically adjusts for input line voltages in the range 100 to 240 VAC. The line cord provided is matched to the country of origin.

**WARNING** **Always use a grounded power cord. Do not defeat the power cord ground.**

3 Press the power switch.

The power switch is located on the lower left corner of the front panel. The oscilloscope will perform a self-test and will be operational in a minute or so.

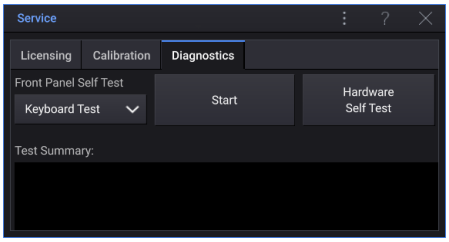
Proceed to "To perform hardware self test" on page 54.

## To perform hardware self test

To perform a series of internal procedures to verify that the oscilloscope is operating properly:

1 From the main menu, choose **Utilities > Service...**.

2 In the Service dialog box, select the **Diagnostics** tab.



3 Select **Hardware Self Test**.

It is recommended you run Hardware Self Test:

- After experiencing abnormal operation.
- For additional information to better describe an oscilloscope failure.
- To verify proper operation after the oscilloscope has been repaired.

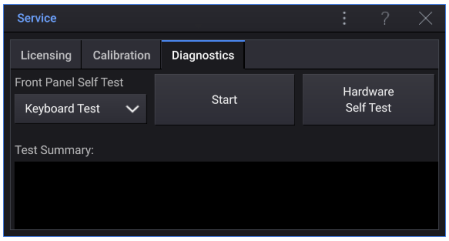
Successfully passing Hardware Self Test does not guarantee 100% of the oscilloscope's functionality. Hardware Self Test is designed to provide an 80% confidence level that the oscilloscope is operating properly.

## To perform front panel self test

To test the front panel keys and knobs, LEDs, display, and touch screen:

1 From the main menu, choose **Utilities > Service...**.

2 In the Service dialog box, select the **Diagnostics** tab.




3 From the **Front Panel Self Test** drop-down list, select the test you want to perform:

- **Keyboard Test** – Tests the front panel keys and knobs.
- **LED Test** – Test the front panel LEDs.
- **Display Test** – Tests the display's ability to output basic colors.
- **Touch Screen Test** – Tests the touch screen.

4 Select **Start**.

Follow the on-screen instructions.

When the test is complete, status information appears in the **Test Summary** box.

## To verify default setup

The oscilloscope is designed to turn on with the setup from the last turn on or previous setup.

To recall the default oscilloscope setup:

1 Press **[Default Setup]**.

The default setup restores the oscilloscope's default settings. This places the oscilloscope in a known operating condition. The major default settings are:

| | |
|---|---|
| Horizontal | Normal mode, 100 µs/div scale, 0 s delay, center time reference. |
| Vertical (Analog) | Channel 1 on, 5 V/div scale, DC coupling, 0 V position, 1 MΩ impedance. |
| Trigger | Edge trigger, Auto trigger mode, 0 V level, channel 1 source, DC coupling, rising edge slope, 40 ns holdoff time. |
| Display | Persistence off, 20% grid intensity, 50% waveform intensity. |
| Other | Acquire mode normal, **[Run/Stop]** to Run, markers and measurements off. |
| Labels | All custom labels that you have created in the Label Library are preserved (not erased), but all channel labels will be set to their original names. |

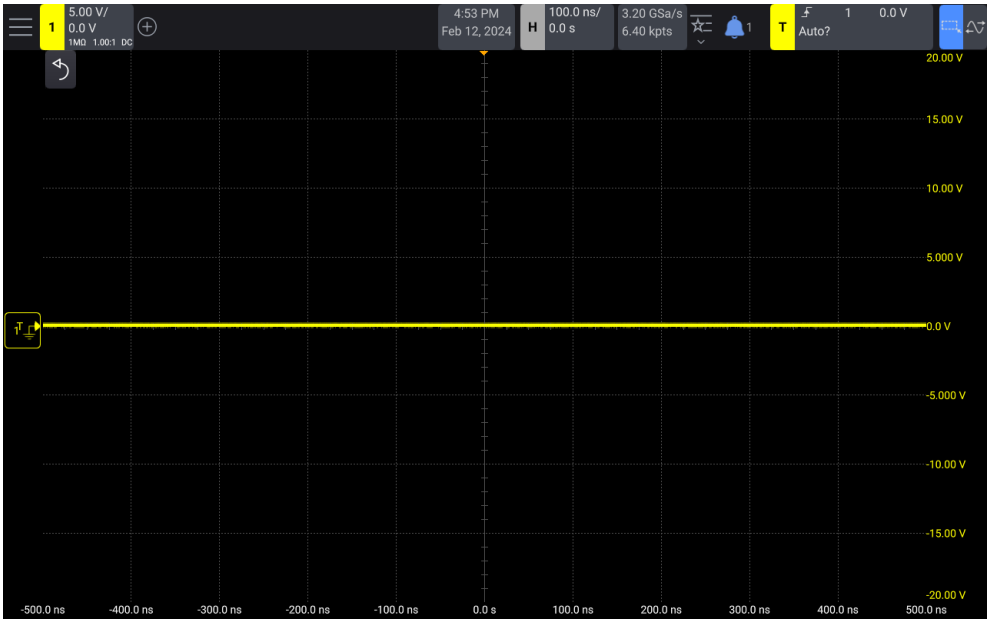


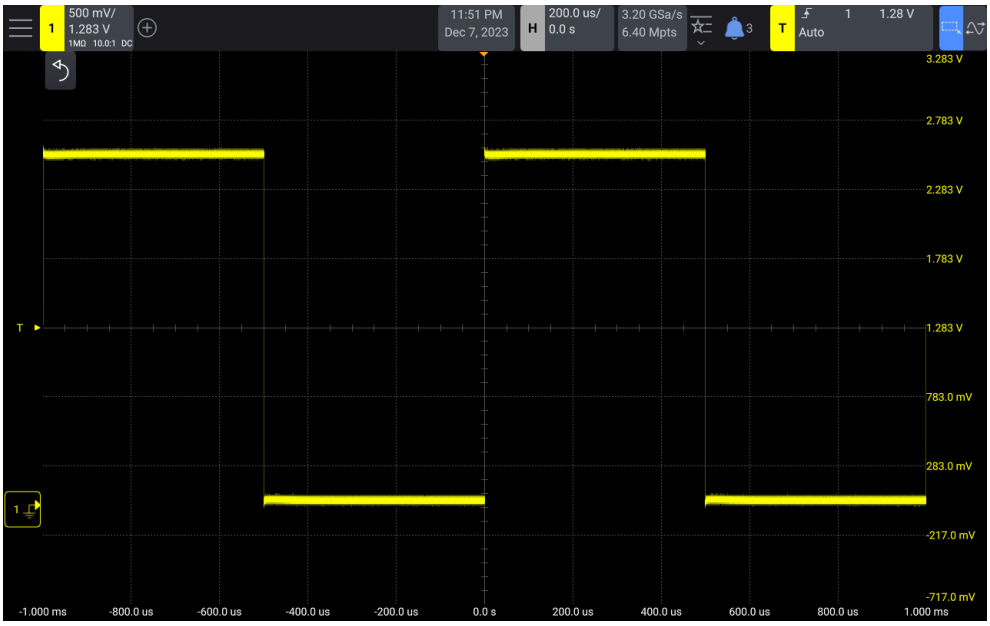

**Figure 8** Default setup screen

2 If your screen looks substantially different, the oscilloscope may need to be returned for service.

## To perform an Auto Scale on the Probe Comp signal

1. Press the **[Default Setup]** key. The oscilloscope is now configured to its default settings.
2. Connect an oscilloscope probe from channel 1 to the **Probe Comp** signal terminal on the front panel.
3. Connect the probe's ground lead to the ground terminal that is below the **Probe Comp** terminal.
4. Press **[Auto Scale]**.

   You should see a waveform on the oscilloscope's display similar to this:




   If you see the waveform, but the square wave is not shaped correctly as shown above, perform the procedure "To compensate passive probes" on page 57.

   If you do not see the waveform, make sure the probe is connected securely to the front panel channel input BNC and to the Probe Comp terminal.

## To compensate passive probes

Each oscilloscope passive probe must be compensated to match the input characteristics of the oscilloscope channel to which it is connected. A poorly compensated probe can introduce significant measurement errors.

1. Input the Probe Comp signal.
2. Press **[Default Setup]** to recall the default oscilloscope setup.

3 Press **[Auto Scale]** to automatically configure the oscilloscope for the Probe Comp signal.

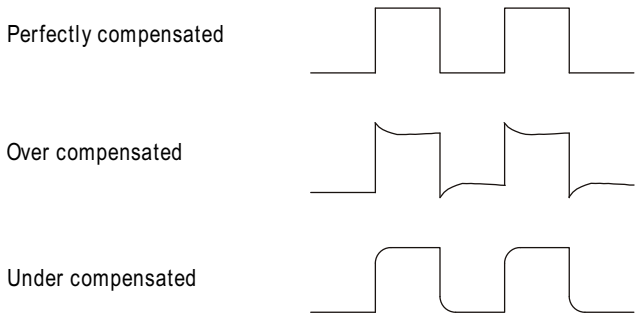
4 Open the Channel dialog box (from the menu, choose **Sources > Channel N...**) where N is the channel to which the probe is connected (**1**, **2**, etc.).

5 Select **Probe...**.

6 In the Probe dialog box, select **Probe Check**; then, follow the instructions on-screen.

If necessary, use a nonmetallic tool (supplied with the probe) to adjust the trimmer capacitor on the probe for the flattest pulse possible.

On N2894A probes, the trimmer capacitor is located on the probe BNC connector.




7 Connect probes to all other oscilloscope channels (channel 2 of a 2-channel oscilloscope, or channels 2, 3, and 4 of a 4-channel oscilloscope).

8 Repeat the procedure for each channel.

The process of compensating the probes serves as a basic test to verify that the oscilloscope is functional.

# 5 Replacing Assemblies

Because there are no operator serviceable parts inside the oscilloscope, there are no instructions for replacing internal assemblies in this service guide.

**WARNING** **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

# 6 Replaceable Parts



This chapter describes how to order replaceable assemblies and parts for the Keysight HD3-Series oscilloscopes.

Diagrams and parts lists are included for assemblies and hardware that you can order.

# Ordering Replaceable Parts

**Listed Parts**

To order a part in the parts list, quote the Keysight Technologies part number, indicate the quantity desired, and address the order to the nearest Keysight Technologies Sales Office.

**Unlisted Parts**

To order a part not listed in the parts list, include the oscilloscope part number, oscilloscope serial number, a description of the part (including its function), and the number of parts required. Address the order to the nearest Keysight Technologies Sales Office.

**Direct Mail Order System**

Within the USA, Keysight Technologies can supply parts through a direct mail order system. There are several advantages to this system:

- Direct ordering and shipping from the Keysight Technologies parts center in California, USA.
- No maximum or minimum on any mail order. (There is a minimum amount for parts ordered through a local Keysight Technologies Sales Office when the orders require billing and invoicing.)
- Prepaid transportation. (There is a small handling charge for each order.)
- No invoices.

In order for Keysight Technologies to provide these advantages, please send a check or money order with each order.

Mail order forms and specific ordering information are available through your local Keysight Technologies Sales Office. Addresses and telephone numbers are located in a separate document shipped with the manuals.

**Exchange Assemblies**

Exchange assemblies have been set up for Keysight Service Center use only.

# Exploded View

The following exploded view provides a graphical representation of the oscilloscope at the time this manual was released. Not all parts are shown. Your parts may be slightly different than those shown. These views provide reference designator numbers that map to those used in the parts list table in this chapter.

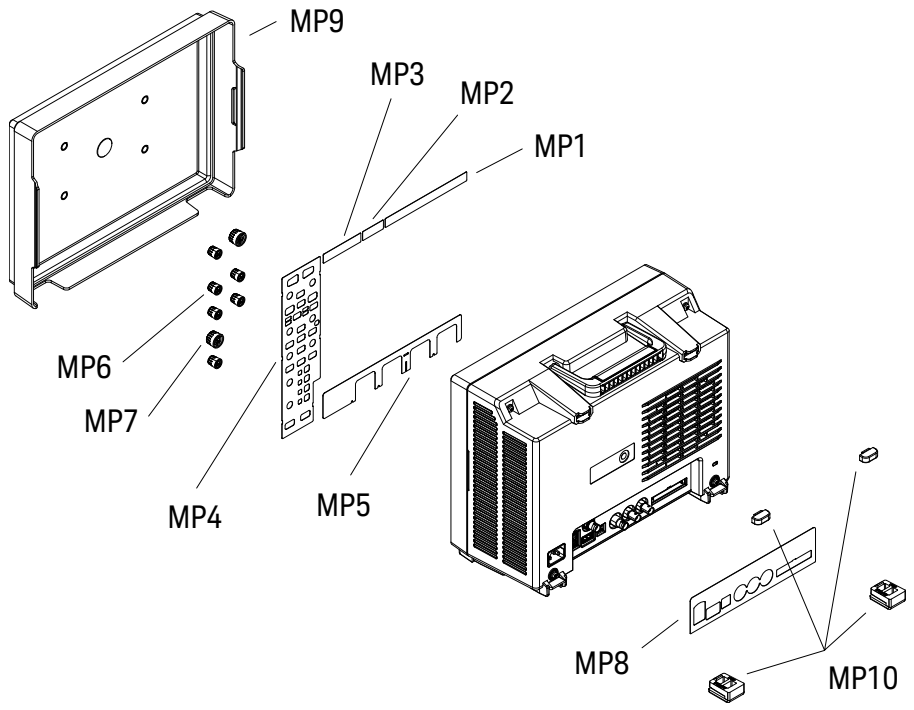



**Figure 9** Exploded View

# Replaceable Parts List

The following table is a list of replaceable parts.

The information given for each part consists of the following:

- Reference designation (These will be included when the exploded views are added to this Service Guide).
- Keysight Technologies part number.
- Total quantity (Qty) in oscilloscope or on assembly. The total quantity is given once and at the first appearance of the part number in the list.
- Description of the part.

**Table 23** Replaceable Parts

| Ref. Des. | Keysight Part Number | Qty | Description |
|---|---|---|---|
| MP1 | 54760-94320 | 1 | Label HD304MSO |
| MP1 | 54761-94320 | 1 | Label HD302MSO |
| | | | |
| MP2 | 54760-94330 | 1 | Label 200MHz |
| MP2 | 54760-94331 | 1 | Label 350MHz |
| MP2 | 54760-94332 | 1 | Label 500MHz |
| MP2 | 54760-94333 | 1 | Label 1GHz |
| | | | |
| MP3 | 54760-94304 | 1 | Label InfiniiVision |
| | | | |
| MP4 | 54762-94300 | 1 | Label Keyboard 4Ch |
| MP4 | 54763-94300 | 1 | Label Keyboard 2Ch |
| | | | |
| MP5 | 54760-94303 | 1 | Label 4Ch |
| MP5 | 54761-94301 | 1 | Label 2Ch |
| | | | |
| MP6 | 54964-47405 | 6 | Small Rotary Knob |
| MP7 | 54964-47450 | 2 | Large Rotary Knob |
| | | | |
| MP8 | 54760-94305 | 1 | Label IO |
| | | | |

**Table 23** Replaceable Parts (continued)

| Ref. Des. | Keysight Part Number | Qty | Description |
|---|---|---|---|
| MP9 | 54760-44101 | 1 | Front Cover |
| | | | |
| MP10 | 54904-44001 | 1 | Rubber Foot set |
| | | | |
| MP11 | 54762-94340 | * | Overlay - Traditional Chinese, 4 channel (not shown) |
| MP11 | 54762-94341 | * | Overlay - Korean, 4 channel (not shown) |
| MP11 | 54762-94342 | * | Overlay - Simplified Chinese, 4 channel (not shown) |
| MP11 | 54762-94343 | * | Overlay - Thai, 4 channel (not shown) |
| MP11 | 54762-94345 | * | Overlay - Portuguese, 4 channel (not shown) |
| MP11 | 54762-94346 | * | Overlay - German, 4 channel (not shown) |
| MP11 | 54762-94347 | * | Overlay - Spanish, 4 channel (not shown) |
| MP11 | 54762-94348 | * | Overlay - French, 4 channel (not shown) |
| MP11 | 54762-94349 | * | Overlay - Japanese, 4 channel (not shown) |
| MP11 | 54762-94350 | * | Overlay - Italian, 4 channel (not shown) |
| MP11 | 54763-94340 | * | Overlay - Traditional Chinese, 2 channel (not shown) |
| MP11 | 54763-94341 | * | Overlay - Korean, 2 channel (not shown) |
| MP11 | 54763-94342 | * | Overlay - Simplified Chinese, 2 channel (not shown) |
| MP11 | 54763-94343 | * | Overlay - Thai, 2 channel (not shown) |
| MP11 | 54763-94345 | * | Overlay - Portuguese, 2 channel (not shown) |
| MP11 | 54763-94346 | * | Overlay - German, 2 channel (not shown) |
| MP11 | 54763-94347 | * | Overlay - Spanish, 2 channel (not shown) |
| MP11 | 54763-94348 | * | Overlay - French, 2 channel (not shown) |
| MP11 | 54763-94349 | * | Overlay - Japanese, 2 channel (not shown) |
| MP11 | 54763-94350 | * | Overlay - Italian, 2 channel (not shown) |
| | | | |
| Not shown | Power cord | 1 | Part number varies by country. Contact your local Keysight sales office for replacement. |
| | | | |
| Not shown | N2843A | * | Passive Probe 10:1, 500 MHz |
| | | | |

**Table 23** Replaceable Parts (continued)

| Ref. Des. | Keysight Part Number | Qty | Description |
|---|---|---|---|
| Not shown | 54760-60002 | * | Rack Mount Kit for HD3-Series Oscilloscope |
| * Optional item. | | | |

# 7 Safety Notices



This apparatus has been designed and tested in accordance with the following safety standards and has been supplied in a safe condition: IEC 61010-1:2010; CAN/CSA-C22.2 No. 61010-1-12; EN 61010-1:2010; UL61010-1 3rd Ed. and the following National Differences: United States and Canada. 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" on page 70.

# Warnings

- 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 or fire hazard.
- Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended. Discard used batteries according to manufacturer's instructions.
- If you energize this instrument by an auto transformer (for voltage reduction or mains isolation), the common terminal must be 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.
- 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.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- For continued protection against fire hazard, replace fuse, circuit breakers only with the same type and ratings. The use of other fuses, circuit breakers, or materials is prohibited.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.
- 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 use the instrument in a manner not specified by the manufacturer.

## To clean the instrument

If the instrument requires cleaning:

1. Remove power from the instrument.
2. Clean the external surfaces of the instrument with a soft cloth dampened with a mixture of mild detergent and water.
3. Make sure that the instrument is completely dry before reconnecting it to a power source.

## 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.

# Index