Keysight P9241/42/43A Oscilloscopes

Service Guide

Notices

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Safety Notices

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 information for the Keysight P9241/42/43A oscilloscopes. This manual is divided into these chapters:

1 Characteristics and Specifications

This chapter contains a partial list of characteristics and specifications for the Keysight InfiniiVision P9241/42/43A oscilloscopes.

2 Testing Performance

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

3 Calibrating and Adjusting

This chapter explains how to adjust the oscilloscope for optimum operating performance.

4 Troubleshooting

This chapter begins with suggestions for solving general problems that you may encounter with the oscilloscope. Procedures for troubleshooting the oscilloscope follow the problem solving suggestions.

5 Replacing Assemblies

The service policy for P9241/42/43A oscilloscopes is unit replacement, so there are no instructions for replacing internal assemblies in this service guide.

6 Replaceable Parts

Because the service policy for P9241/42/43A oscilloscopes is unit replacement, no replaceable parts are available for these oscilloscopes.

7 Safety Notices

At the front of the book you will find safety notice descriptions and document warranties.

Abbreviated instructions for selecting menus and softkeys

Instructions for selecting a series of menus and softkey label buttons are written in an abbreviated manner. Instructions for selecting Menu Item1, Menu Item2, then Softkey1 and Softkey2 are abbreviated as follows:

Choose **Main Menu > Menu Item1 > Menu Item2 > Softkey1 > Softkey2**.

Softkey label buttons are the six buttons located at the bottom of the Soft Front Panel oscilloscope display.

Contents

Figures

Tables

1 Characteristics and Specifications

This chapter contains a partial list of characteristics and specifications for the Keysight InfiniiVision P9241/42/43A oscilloscopes.

For a full list of Keysight InfiniiVision P9241/42/43A oscilloscopes characteristics and specifications see the data sheets.

The data sheets are available at www.keysight.com/products/P9241A.

Measurement Category

Measurement Category

The InfiniiVision P9241/42/43A 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 overvol tages 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 Voltage for Analog Inputs

CAUTION

Maximum input voltage for analog inputs

135 Vrms

50 Ω 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.

Environmental Conditions

The Keysight P9241/42/43A oscilloscopes have been safety-evaluated to these environmental characteristics.

Environment	Indoor use only.
Weight	2.50 kg
Dimensions (W x H x D)	177 mm x 50 mm x 335 mm
Ambient temperature	Operating: 0 °C to +55 °C Non-operating: –40 °C to +70 °C
Humidity	95% rH, non-condensing to temperatures up to 40 °C decreasing linearly to 50% rH at 55 °C
Altitude	Operating: 3,000 m (9,842 ft) Non-operating: 4,500 m (14,764 ft)
Pollution Degree	The InfiniiVision P9241/42/43A 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. Pollution Degree 2. Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation may occur. Example: General indoor environment. 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.

Specifications

Please see the *InfiniiVision P9241/42/43A Oscilloscopes Data Sheet* for complete, up-to-date specifications and characteristics.

To download a copy of the data sheet please visit: www.keysight.com/products/P9241A.

Contact Us

To contact Keysight, see: www.keysight.com/find/contactus

2 Testing Performance

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

Overview

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 on page 43. 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 46.

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 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	25 MHz, 100 MHz, 350 MHz, 500 MHz, and 1 GHz sine waves	Keysight N5171B
Power Meter	1 GHz ±3% accuracy	Keysight N1914A
Power Sensor	1 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
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 + Pomona 4289 + Pomona 5088
Adapter (qty 3)	N(m) to BNC(f)	Keysight 1250-0780
50 Ohm Feedthrough Termination	50 Ω BNC (f) to BNC (m)	Keysight 0960-0301
MMCX to BNC Cable	MMCX - BNC, 600 mm length	Keysight 75045-61610

Most parts and equipment are available at www.keysight.com. See respective manufacturer’s websites for their equipment.
† 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:
P9241A	200 MHz Models
P9242A	500 MHz Models
P9243A	1 GHz Models

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 3 DC Vertical Gain Accuracy Test Limits

Models	Test Limits	Notes
P9241/42/43A	±2.0% of full scale	▪ Full scale is defined as 32 mV on the 2 mV/div range and the 1 mV/div range. ▪ Full scale on all other ranges is defined as 8 divisions times the V/div setting.

Table 4 Equipment Required to Verify DC Vertical Gain Accuracy

Equipment	Critical Specifications	Recommended Model/Part
Precision Source	DC voltage of 7 mV to 35 V, 0.1 mV resolution	Keysight B2912A/B2962A
Digital multimeter	Better than 0.01% 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 + Pomona 4289 + Pomona 5088

1 Choose **Main Menu > File > Default Menu**.
2 In the Default Menu, click **Factory Default** to recall the factory default setup.

3 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 Table 5.

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.

Table 5 Settings Used to Verify DC Vertical Gain Accuracy, P9241/42/43A Models

Volts/Div Setting	Precision Source Setting	Test Limits		
5 V/Div	35 V	34.2 V	to	35.8 V
2 V/Div	14 V	13.68 V	to	14.32 V
1 V/Div	7 V	6.84 V	to	7.16 V
500 mV/Div	3.5 V	3.42 V	to	3.58 V
200 mV/Div	1.4 V	1.368 V	to	1.432 V
100 mV/Div	700 mV	684 mV	to	716 mV
50 mV/Div	350 mV	342 mV	to	358 mV
20 mV/Div	140 mV	136.8 mV	to	143.2 mV
10 mV/Div	70 mV	68.4 mV	to	71.6 mV
5 mV/Div[1]	35 mV	34.2 mV	to	35.8 mV
2 mV/Div[1, 2]	14 mV	13.36 mV	to	14.64 mV
1 mV/Div[1, 2]	7 mV	6.36 mV	to	7.64 mV

[1] A blocking capacitor is required at this range to reduce noise. See "Use a Blocking Capacitor to Reduce Noise" on page 25.

[2] Full scale is defined as 32 mV on the 2 mV/div range and the 1 mV/div range. Full scale on all other ranges is defined as 8 divisions times the V/div setting.

d Choose **Main Menu > Setup > Acquire Menu**.

e In the Acquire Menu, click the **Acq Mode** softkey and select **Averaging**.

f Then click the **# of Averages** softkey and set it to 64.

Wait a few seconds for the measurement to settle.

4 Add a measurement for the average voltage:

   a Choose **Main Menu > Measure > Measurements**.

   b In the Measurement Menu, click **Add Meas**.

   c In the Add Measurements Menu, click **Source**; then, select the channel you are testing.

   d Click **Type:**; then, select **Average - Full Screen**, and click **Add Measurement**.

5 Read the “current” average voltage value as V1.

6 Use the BNC tee and cables to connect the precision source /power supply to both the oscilloscope and the multimeter (see Figure 1).

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.

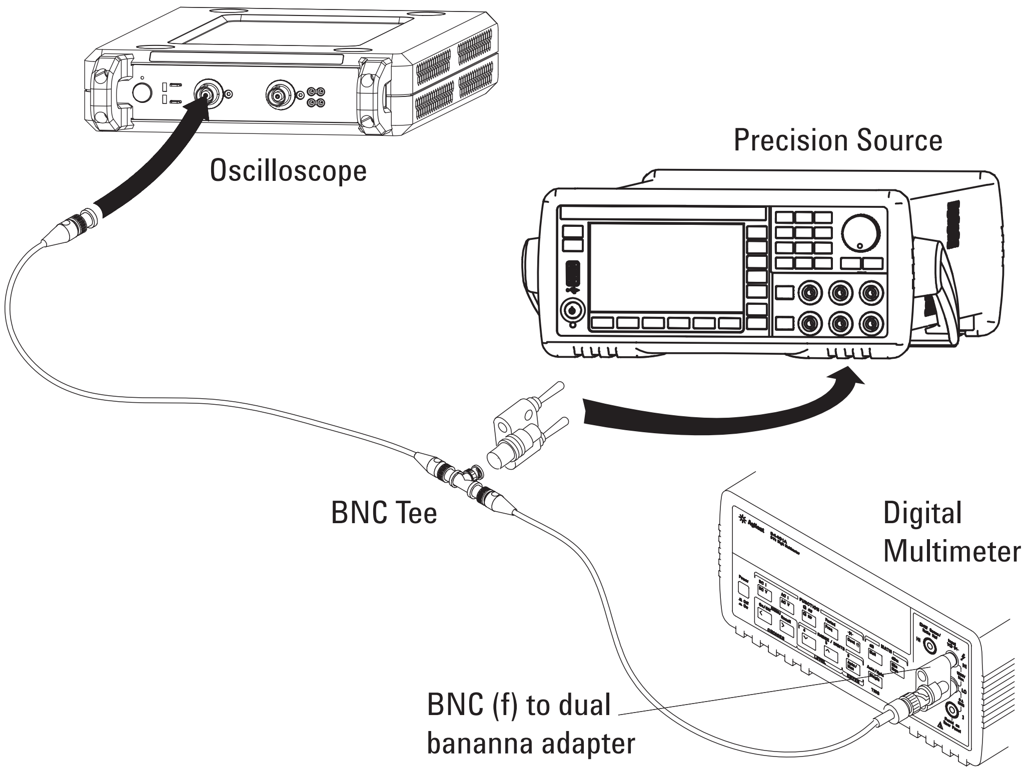


Figure 1 Setting up Equipment for DC Vertical Gain Accuracy Test

7 Adjust the output so that the multimeter reading displays the first Volts/div precision source setting value in Table 5.
8 Disconnect the multimeter.
9 Wait until the measurement settles.
10 Read the "current" average voltage value again as V2.
11 Calculate the difference V2 - V1.

The difference in average voltage readings should be within the test limits of Table 5.

If a result is not within the test limits, go to the "Troubleshooting" chapter. Then return here.

12 Disconnect the precision source from the oscilloscope.

13 Repeat this procedure to check the DC vertical gain accuracy with the remaining Volts/div setting values in Table 5.

14 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 Figure 2. If a BNC capacitor is not available, use an SMA blocking capacitor, adapter, and cap. See “Blocking capacitor in the equipment list on page 19 for details.

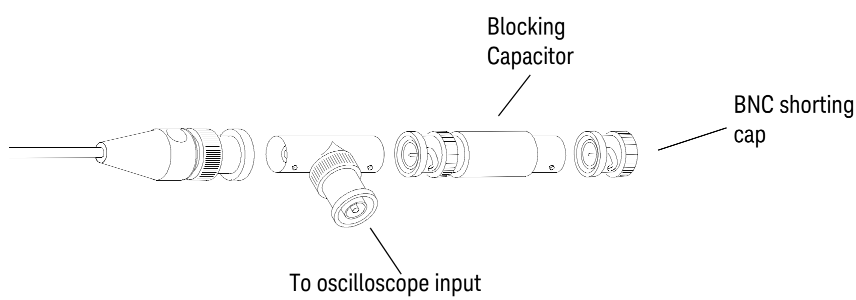


Figure 2 Using a Blocking Capacitor to Reduce Noise

To verify dual cursor accuracy

This test verifies the dual cursor 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 cursors on the oscilloscope and compare the results with the multimeter reading.

Dual cursor accuracy test limits: ±[DC vertical gain accuracy + 0.42% full scale]

For the DC vertical gain accuracy test limits, see Table 3 on page 21.

Table 6 Equipment Required to Verify Dual Cursor Accuracy

Equipment	Critical Specifications	Recommended Model/Part
Precision Source	DC voltage of 7 mV to 35 V, 0.1 mV resolution	Keysight B2912A/B2962A
Digital multimeter	Better than 0.01% 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 + Pomona 4289 + Pomona 5088

1 Choose **Main Menu > File > Default Menu**.
2 In the Default Menu, click **Factory Default** to recall the factory default setup.
3 Set up the oscilloscope.
   a Set the Volts/Div setting to the value in the first line in Table 7.
   b Adjust the channel 1 position knob to place the baseline at 0.5 major division from the bottom of the display.

Table 7 Settings Used to Verify Dual Cursor Accuracy, P9241/42/43A Models

Volts/Div Setting	Precision Source Setting	Test Limits		
5 V/Div	35 V	34.032 V	to	35.968 V
2 V/Div	14 V	13.613 V	to	14.387 V
1 V/Div	7 V	6.806 V	to	7.194 V
500 mV/Div	3.5 V	3.403 V	to	3.597 V
200 mV/Div	1.4 V	1.361 V	to	1.439 V
100 mV/Div	700 mV	680.64 mV	to	719.36 mV
50 mV/Div	350 mV	340.32 mV	to	359.68 mV
20 mV/Div	140 mV	136.13 mV	to	143.87 mV
10 mV/Div	70 mV	68.064 mV	to	71.936 mV
5 mV/Div[1]	35 mV	34.032 mV	to	35.968 mV
2 mV/Div[1, 2]	14 mV	13.226 mV	to	14.774 mV
1 mV/Div[1, 2]	7 mV	6.226 mV	to	7.774 mV

[1] A blocking capacitor is required at this range to reduce noise. See "Use a Blocking Capacitor to Reduce Noise" on page 29.

[2] Full scale is defined as 32 mV on the 2 mV/div range and the 1 mV/div range. Full scale on all other ranges is defined as 8 divisions times the V/div setting.

c Choose **Main Menu > Setup > Acquire Menu**.

d In the Acquire Menu, click the **Acq Mode** softkey and select **Averaging**.

e Then click the **# of Averages** softkey and set it to 64.

Wait a few seconds for the measurement to settle.

4 Choose **Main Menu > Measure > Cursors**.

5 In the Cursors Menu, click **Mode** and select **Manual**.

6 Drag the Y1 cursor to the baseline of the signal.

7 Use the BNC tee and cables to connect the precision source /power supply to both the oscilloscope and the multimeter (see Figure 3).

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.

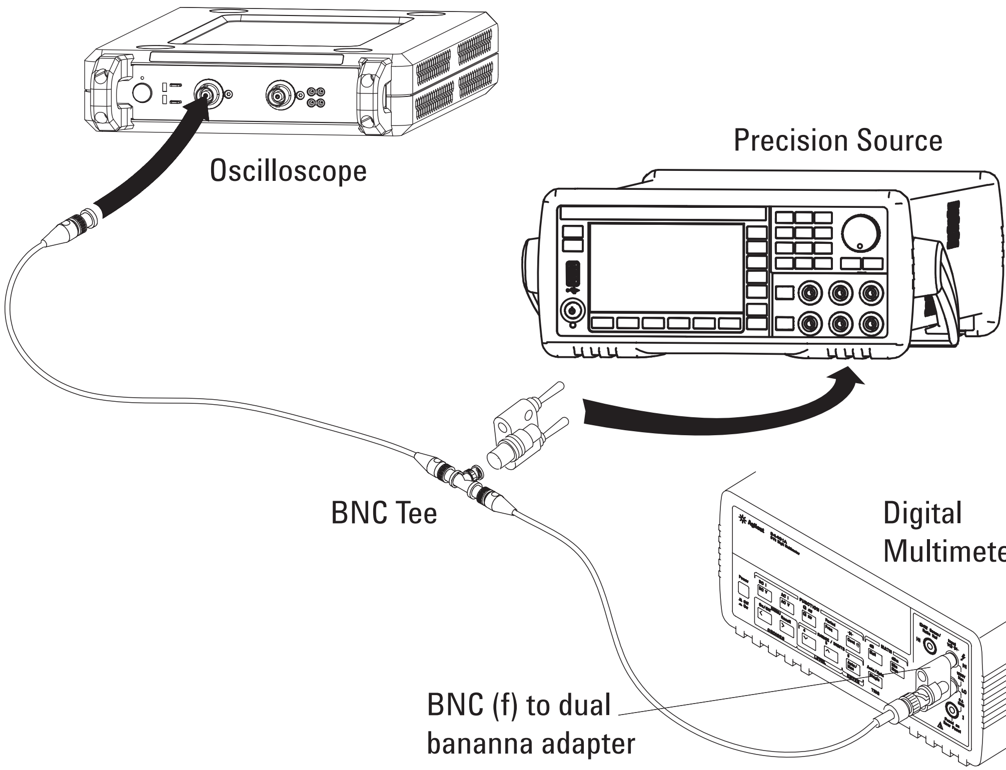


Figure 3 Setting up Equipment for Dual Cursor Accuracy Test

8 Adjust the output so that the multimeter reading displays the first Volts/div precision source setting value in Table 7.
9 Disconnect the multimeter.
10 Wait until the measurement settles.
11 Drag the Y2 cursor to the center of the voltage trace.

The ΔY value on the lower line of the display should be within the test limits of Table 7.

If a result is not within the test limits, go to the “Troubleshooting” chapter. Then return here.

12 Disconnect the precision source from the oscilloscope.

13 Repeat this procedure to check the dual cursor accuracy with the remaining Volts/div setting values in Table 7.

14 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 Figure 4. If a BNC capacitor is not available, use an SMA blocking capacitor, adapter, and cap. See “Blocking capacitor in the equipment list on page 19 for details.

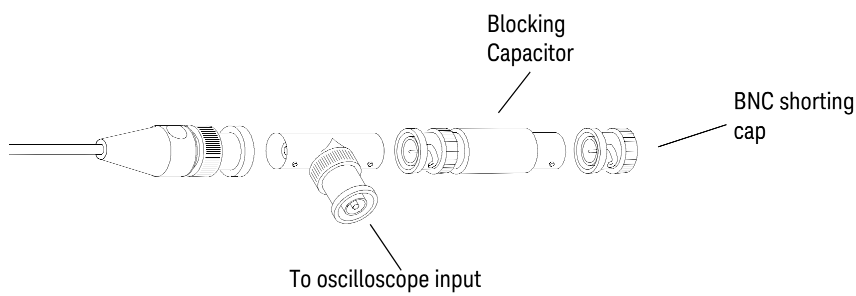


Figure 4 Using a Blocking Capacitor to Reduce Noise

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 8 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
200 MHz Models	All channels (-3 dB), dc to 200 MHz

Table 9 Equipment Required to Verify Bandwidth (-3 dB)

Equipment	Critical Specifications	Recommended Model/Part
Signal Generator	100 kHz - 1 GHz at 200 mVrms	Keysight N5171B
Power Meter	1 MHz - 1 GHz ±3% accuracy	Keysight N1914A
Power Sensor	1 MHz - 1 GHz ±3% accuracy	Keysight E9304A or N8482A
Power Splitter	outputs differ by < 0.15 dB	Keysight 11667A
Cable	Type N (m) 24 inch	Keysight 11500B
Adapter	Type N (m) to BNC (m)	Keysight 1250-0082 or Pomona 3288 with Pomona 3533

1 Connect the equipment (see Figure 5).

  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.

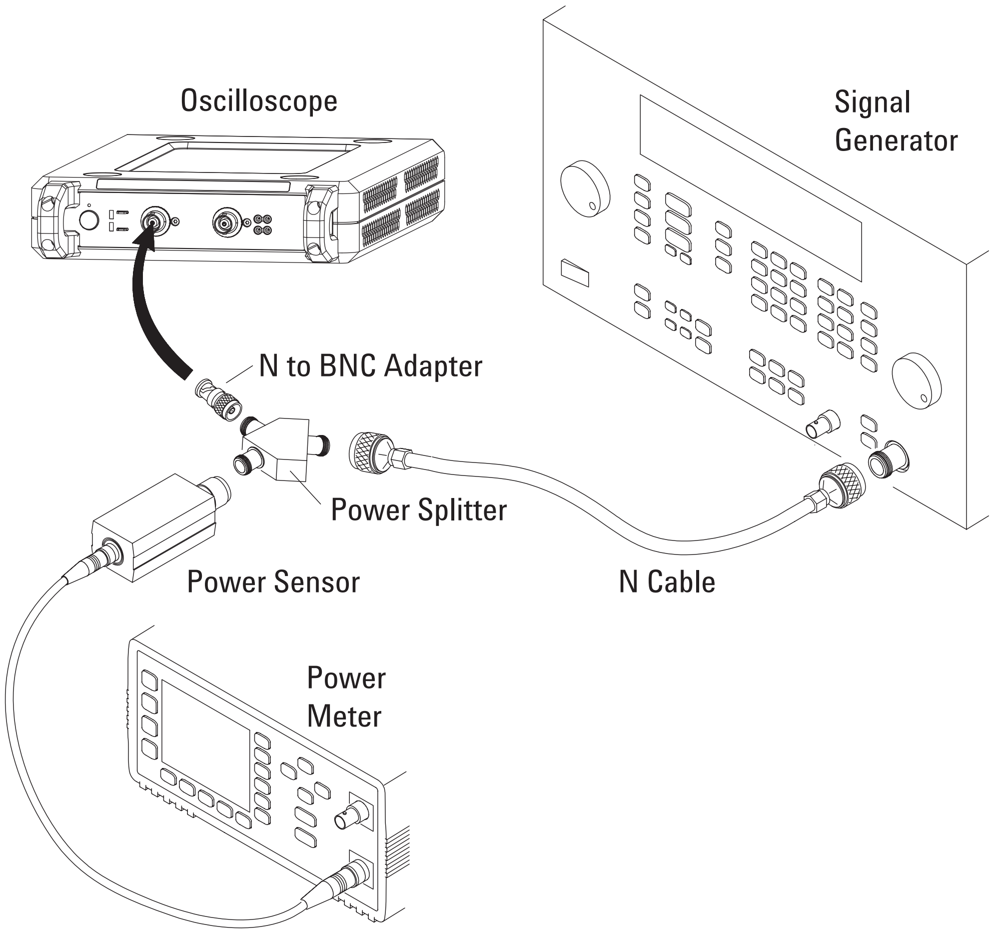


Figure 5 Setting Up Equipment for Bandwidth (-3 dB) Verification Test

2 Set up the power meter.

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

3 Set up the oscilloscope.
   a Choose **Main Menu > Default Setup**.
   b Set channel 1 **Coupling** to **DC**.
   c Set channel 1 **Impedance** to **50 Ohm**.
   d Set the time base to 500 ns/div.
   e Set the Volts/Div for channel 1 to 200 mV/div.
   f Choose **Main Menu > Setup > Acquire Menu**.
   g In the Acquire Menu, click the **Acq Mode** softkey and select **Averaging**.
   h Then click the **# of Averages** softkey and set it to 8.
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 Set up the Amplitude measurement:
   a Choose **Main Menu > Measure > Measurements**.
   b In the Measurement Menu, click **Clear Meas**.
   c In the Clear Measurements Menu, click **Clear All**.
   d In the Measurement Menu, click **Add Meas**.
   e In the Add Measurements Menu, click **Source**; then, select the channel you are testing.
   f Click **Type:**; then, select **AC RMS - Full Screen (Std Deviation)**, and click **Add Measurement**.
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 $Vin_{1MHz} = (892 \times 10^{-6} * 50\Omega)^{1/2} = 211.2\ mV_{rms}$.

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
   - 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
   - 200 MHz Models: 2 ns/div

12 Note the oscilloscope Std Dev(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:

$$\text{response(dB)} = 20 \log_{10}\left[\frac{\text{Vout}_{\text{max freq}} / \text{Vin}_{\text{max freq}}}{\text{Vout}_{1\text{MHz}} / \text{Vin}_{1\text{MHz}}}\right]$$

Example If:
$Pmeas_{1\_MHz}$ = 892 uW
Std Dev(n) $_{1MHz}$ = 210.4 mV
Pmeas $_{max\_freq}$ = 687 uW
Std Dev(n) $_{max\ freq}$ = 161.6 mV

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

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

15 The result from step 14 should be between +3.0 dB and -3.0 dB. Record the result in the Performance Test Record (see page 43).

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 10 Equipment Required to Verify Time Base Accuracy

Equipment	Critical Specifications	Recommended Model/Part
Signal Generator	100 kHz - 1 GHz, 0.01 Hz frequency resolution, jitter: <2 ps	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 V_{pp} sine wave.
2. Connect the output of the signal generator to oscilloscope channel 1 using the BNC cable.
3. Set up the oscilloscope:
   a. Choose **Main Menu > 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.
   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 Measure the number of nanoseconds from where the rising edge crosses the center horizontal grid line to the center vertical grid line. Each ns equals 1 ppm of time base error.

e Get the date code from the oscilloscope’s serial number label to calculate the number of years since manufacture. Include any fractional portion of a year.

In the Date Code, the first two digits represent the year, and the second two digits represent the week in the year. For example, for “1738”, the year is “17” and the week is “38”.

f Use the following formula to calculate the test limits.

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

g In the Performance Test Record (see page 43), record the time base error in ppm and whether it is within the specified limit.

To verify trigger sensitivity

This test verifies the trigger sensitivity. In this test, you will apply a sine wave to the oscilloscope at the upper bandwidth limit. You will then decrease the amplitude of the signal to the specified levels, and check to see if the oscilloscope is still triggered.

Test limits for:

- Internal trigger sensitivity on all models:
  - < 10 mV/div: greater of 1 div or 5 mV_{pp}
  - >= 10 mV/div: 0.6 div
- External trigger sensitivity on all models:
  - DC to 100 MHz: < 200 mV_{pp}
  - 100 MHz - 200 MHz: < 350 mV_{pp}

Table 11 Equipment Required to Verify Trigger Sensitivity

Equipment	Critical Specifications	Recommended Model/Part
Signal Generator	25 MHz, 100 MHz, 350 MHz, 500 MHz, and 1 GHz sine waves	Keysight N5171B
Power splitter	Outputs differ < 0.15 dB	Keysight 11667A
Power Meter		Keysight N1914A
Power Sensor		Keysight E9304A or N8482A
50 Ω BNC Cable (qty 3)	BNC - BNC, 48” length	Keysight 8120-1840
Adapter	N (m) to BNC (f), Qty 3	Keysight 1250-0780
Feedthrough	50 Ω BNC (f) to BNC (m)	Keysight 0960-0301
MMCX to BNC Cable	MMCX - BNC, 600 mm length	Keysight 75045-61610

Test Internal Trigger Sensitivity (all models)

1 Choose **Main Menu > Default Setup**.
2 Choose **Main Menu > Trigger > Trigger Mode and Coupling Menu**.
3 In the Trigger Mode and Coupling Menu, click the **Mode** softkey to select **Normal**.
4 Connect the equipment (see Figure 6).
   a Connect the signal generator output to the oscilloscope channel 1 input.
   b Set channel 1 **Impedance** to **50 Ohm**.

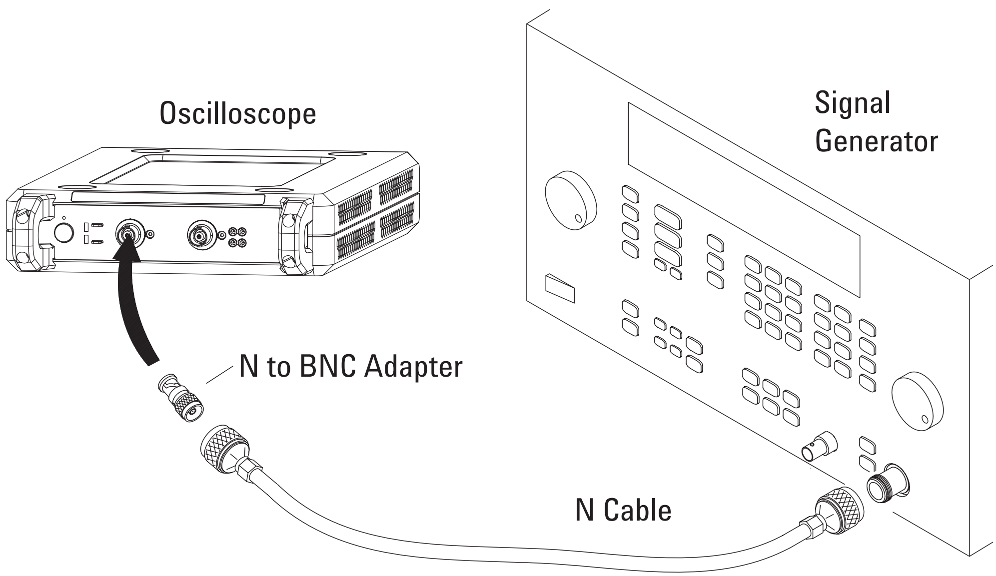


Figure 6 Setting Up Equipment for Internal Trigger Sensitivity Test

5 To verify the trigger sensitivity at the oscilloscope's maximum bandwidth, set the output frequency of the signal generator to the maximum bandwidth of the oscilloscope:
   - 1 GHz models: 1 GHz.
   - 500 MHz models: 500 MHz.
   - 200 MHz models: 200 MHz.

6 Perform these steps to test at the 5 mV/div setting:
   a Set the signal generator amplitude to about 10 mV_{pp}.
   b Choose **Main Menu > Autoscale**.
   c Set the time base to 10 ns/div.
   d Set channel 1 to 5 mV/div.
   e Decrease the amplitude from the signal generator until 1 vertical division of the signal (about 5 mV_{pp}) is displayed.

   The trigger is stable when the displayed waveform is stable. If the trigger is not stable, try adjusting the trigger level. If adjusting the trigger level makes the trigger stable, the test still passes. If adjusting the trigger does not help, see the “Troubleshooting” chapter. Then return here.
   f Record the result as Pass or Fail in the Performance Test Record (see page 43).
   g Repeat this step for the remaining oscilloscope channels.
7 Perform these steps to test at the 10 mV/div setting:
   a Set the signal generator amplitude to about 20 mV_{pp}.
   b Choose **Main Menu > Autoscale**.
   c Set the time base to 10 ns/div.
   d Set channel 1 to 10 mV/div.
   e Decrease the amplitude from the signal generator until 0.6 vertical divisions of the signal (about 6 mV_{pp}) is displayed.

   The trigger is stable when the displayed waveform is stable. If the trigger is not stable, try adjusting the trigger level. If adjusting the trigger level makes the trigger stable, the test still passes. If adjusting the trigger does not help, see the “Troubleshooting” chapter. Then return here.
   f Record the result as Pass or Fail in the Performance Test Record (see page 43).
   g Repeat this step for the remaining oscilloscope channels.

Test External Trigger Sensitivity

This test applies to all models.

Verify the external trigger sensitivity at these settings:

- 100 MHz, 200 mV_{pp}
- 200 MHz, 350 mV_{pp}

1 Connect the equipment (see Figure 7).

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.

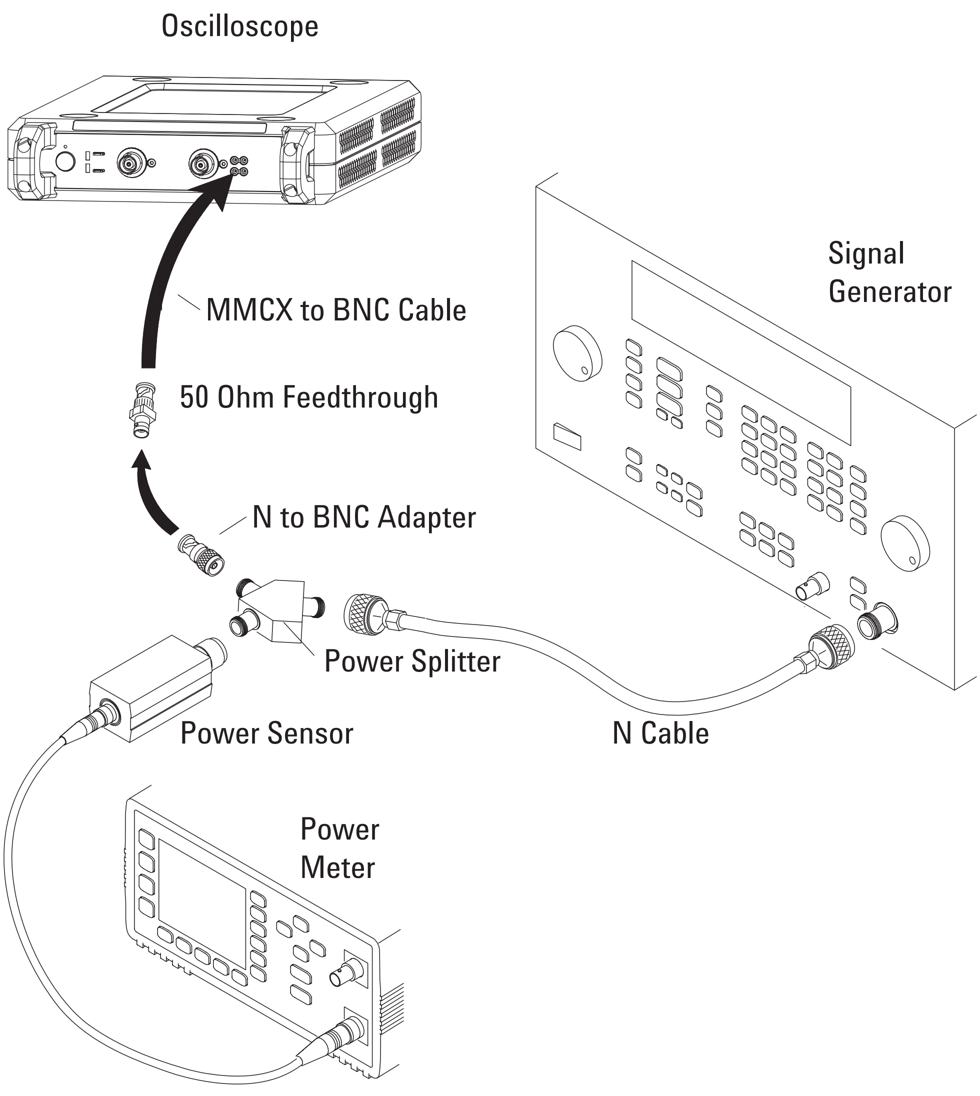


Figure 7 Setting Up Equipment for External Trigger Sensitivity Test

2 Set up the oscilloscope:

a Choose **Main Menu > Default Setup**.

b Choose **Main Menu > Trigger > Trigger Mode and Coupling Menu**.

c In the Trigger Mode and Coupling Menu, click the **Mode** softkey to select **Normal**.

3 Change the signal generator output frequency to 100 MHz or 200 MHz.

4 Set the power meter Cal Factor % to the appropriate value (100 MHz or 200 MHz) on the calibration chart on the power sensor. If necessary, do a linear interpolation if a 100 MHz or 200 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 mV_{pp} = 70.71 mV rms, Power = $Vin^2/50\Omega$ = 70.71 $mV^2/50\Omega$	100 μW
200 MHz	350 mV_{pp} = 123.74 mV rms, Power = $Vin^2/50\Omega$ = 123.74 $mV^2/50\Omega$	306 μW

6 Choose **Main Menu > Trigger > Trigger Menu**.

7 In the Trigger Menu, click the **Source** softkey to set the trigger source to **External**.

8 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 it is flashing, the oscilloscope is not triggered. When it is not flashing, the oscilloscope is triggered.

9 Record the results as Pass or Fail in the Performance Test Record (see page 43).

If the test fails, see the "Troubleshooting" chapter. Then return here.

Keysight P9241/42/43A Oscilloscopes Performance Test Record

Serial No. ________________________________ Test by ________________________

Test Interval ______________________________ Work Order No. __________________

Recommended Next Testing ____________________ Temperature __________

DC Vertical Gain Accuracy

Range	Power Supply Setting	Test Limits	Channel 1	Channel 2
5 V/Div	35 V	34.2 V to 35.8 V	_______	_______
2 V/Div	14 V	13.68 V to 14.32 V	_______	_______
1 V/Div	7 V	6.84 V to 7.16 V	_______	_______
500 mV/Div	3.5 V	3.42 V to 3.58 V	_______	_______
200 mV/Div	1.4 V	1.368 V to 1.432 V	_______	_______
100 mV/Div	700 mV	684 mV to 716 mV	_______	_______
50 mV/Div	350 mV	342 mV to 358 mV	_______	_______
20 mV/Div	140 mV	136.8 mV to 143.2 mV	_______	_______
10 mV/Div	70 mV	68.4 mV to 71.6 mV	_______	_______
5 mV/Div	35 mV	34.2 mV to 35.8 mV	_______	_______
2 mV/Div	14 mV	13.36 mV to 14.64 mV	_______	_______
1 mV/Div	7 mV	6.36 mV to 7.64 mV	_______	_______

Continued on next page.

Dual Cursor Accuracy					
Range	**Power Supply Setting**	**Test Limits**	**Channel 1**	**Channel 2**	
5 V/Div	35 V	34.032 V to 35.968 V	______	______	
2 V/Div	14 V	13.613 V to 14.387 V	______	______	
1 V/Div	7 V	6.806 V to 7.194 V	______	______	
500 mV/Div	3.5 V	3.403 V to 3.597 V	______	______	
200 mV/Div	1.4 V	1.361 V to 1.439 V	______	______	
100 mV/Div	700 mV	680.64 mV to 719.36 mV	______	______	
50 mV/Div	350 mV	340.32 mV to 359.68 mV	______	______	
20 mV/Div	140 mV	136.13 mV to 143.87 mV	______	______	
10 mV/Div	70 mV	68.064 mV to 71.936 mV	______	______	
5 mV/Div	35 mV	34.032 mV to 35.968 mV	______	______	
2 mV/Div	14 mV	13.226 mV to 14.774 mV	______	______	
1 mV/Div	7 mV	6.226 mV to 7.774 mV	______	______	
Band wid th (-3 dB)	**Model**	**Test Limits**	**Channel 1**	**Channel 2**	
	P9243A	-3 dB at 1 GHz	______	______	
	P9242A	-3 dB at 500 MHz	______	______	
	P9241A	-3 dB at 200 MHz	______	______	
Time Base Accuracy	**Limits**		**Calculated time base accuracy limit (ppm)**	**Measured time base error (ppm)**	**Pass/Fail**
	Time Base Accuracy Limit: ±1.6 ppm + aging		________	________	________
Internal Trigger Sensitivity					
	Generator Setting	**Test Limits**	**Channel 1**	**Channel 2**	
1 GHz models:	1 GHz	< 10 mV/div: greater of 1 div	______	______	
500 MHz models:	500 MHz	or 5 mVpp			
200 MHz models:	200 MHz	>= 10 mV/div: 0.6 div	______	______	
External Trigger Sensitivity					
	Generator Setting	**Test Limits**	**Ext Trig In**		
	200 MHz	350 mV	______		
	100 MHz	200 mV	______		
* Where applicable					

3 Calibrating and Adjusting

This chapter explains how to adjust the oscilloscope for optimum operating performance.

KEYSIGHT TECHNOLOGIES

User Calibration

Perform user-calibration:

- Every two years or after 4000 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 Cal intervals.

User Cal 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. Disconnect all inputs and allow the oscilloscope to warm up before performing this procedure.

Performing User Cal will invalidate your Certificate of Calibration. If NIST (National Institute of Standards and Technology) traceability is required perform the procedures in Chapter 2 in this book using traceable sources.

To perform User Calibration

1. Disconnect all inputs from the front panel and allow the oscilloscope to warm up before performing this procedure.

   A powered-on oscilloscope is not sufficient for the oscilloscope to reach its operating temperature. The oscilloscope must be enabled by connecting a driver (like the Soft Front Panel) and running with a default setup for at least 30 minutes to stabilize the operating temperature.
2. From the Aux Out output, connect a MMCX-to-BNC cable to a BNC tee adapter.
3. From the tee adapter, connect equal length cables to the channel 1 and channel 2 inputs.
4. Turn off calibration protection (**Main Menu** > **Utilities** > **Service Menu**, **Cal Protect**).
5. Click **Start User Calibration** to begin the user calibration.

User Calibration Status

Clicking the **User Calibration Status** softkey displays the following summary results of the previous User Cal, and the status of probe calibrations for probes that can be calibrated. Note that AutoProbes do not need to be calibrated, but InfiniiMax probes can be calibrated.

```
Results:
User Calibration date:
Change in temperature since last User Calibration:
Failure:
Comments:
Probe Calibration Status:
```

4 Troubleshooting

This chapter begins with "Basic Troubleshooting.

Next is "Solving General Problems with the Oscilloscope. It tells you what to do in these cases:

- If there is no trace display.
- If the trace display is unusual or unexpected.
- If you cannot see a channel.

Next, are procedures for "Verifying Basic Operation of the oscilloscope:

- To perform hardware self test.
- To verify default setup.
- To perform an Autoscale on the Probe Comp signal.
- To compensate passive probes.

Basic Troubleshooting

Where you begin troubleshooting depends upon the symptoms of the failure. Start by checking the basics as outlined in the following section.

1. Is there power at the mains receptacle?
2. Is the chassis powered on? Check to see if the power LED for the chassis line switch glows.

   Explanation of power LED colors:

   - OFF: Power supply is off. The P924xA oscilloscope is disconnected from the external power supply.
   - AMBER: Power supply is connected, but instrument power button switch is off.
   - GREEN: Power button switch is on.
3. If the chassis has power applied, but the power LED is not on, and the fans are not turning, the power switch might be bad. Contact Keysight and return to factory.
4. If the chassis fans are on and PCA LEDs (visible through the fan vents) are on, but the power LED is not on, contact Keysight and return to factory.
5. If other equipment, cables, and connectors are being used with the oscilloscope, make sure they are clean, connected properly, and operating correctly.

Solving General Problems with the Oscilloscope

This section describes how to solve general problems that you may encounter while using the Keysight P9241/42/43A oscilloscopes.

If there is no trace display

- ✔ Check that the waveform intensity is adjusted correctly.
- ✔ In the Keysight InfiniiVision SFP interface, recall the default setup by choosing **Main Menu > 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.
- ✔ Choose **Main Menu > Autoscale**.
- ✔ 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 click the **Clear Display** softkey.

✔ Choose **Main Menu > Autoscale**.

If you cannot see a channel

✔ In the Keysight InfiniiVision SFP interface, recall the default setup by choosing **Main Menu > 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 chosen **Main Menu > Autoscale** 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 Click the analog channel button until it is illuminated.

✔ Choose **Main Menu > Autoscale** to automatically set up all channels.

Verifying Basic Operation

To perform hardware self test

1 In the Keysight InfiniiVision SFP interface, click the top left blue menu icon, and choose **Utilities > Service Menu**.

2 In the Service Menu, click **Hardware Self Test**.

Hardware Self Test performs a series of internal procedures to verify that the oscilloscope is operating properly.

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 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 setup:

1 Choose **Main Menu > Default Setup**.

   This returns the oscilloscope to its default settings and places the oscilloscope in a known operating condition. The major default settings are:

   - **Horizontal**:
     - main mode.
     - 100 us/div scale.
     - 0 s delay.
     - center time reference.
   - **Vertical**:
     - Channel 1 on.
     - 5 V/div scale.

    - dc coupling.
    - 0 V position.
    - probe factor to 1.0 if an AutoProbe probe is not connected to the channel.
- **Trigger**:
    - Edge trigger.
    - Auto sweep mode.
    - 0 V level.
    - channel 1 source.
    - dc coupling.
    - rising edge slope.
    - 40 ns holdoff time.
- **Display**:
    - 20% grid intensity.
    - persistence off.
- **Other:**
    - Acquire mode normal.
    - Run/Stop to Run.
    - cursor measurements off.

Figure 8 Default setup screen

To perform an Autoscale on the Probe Comp signal

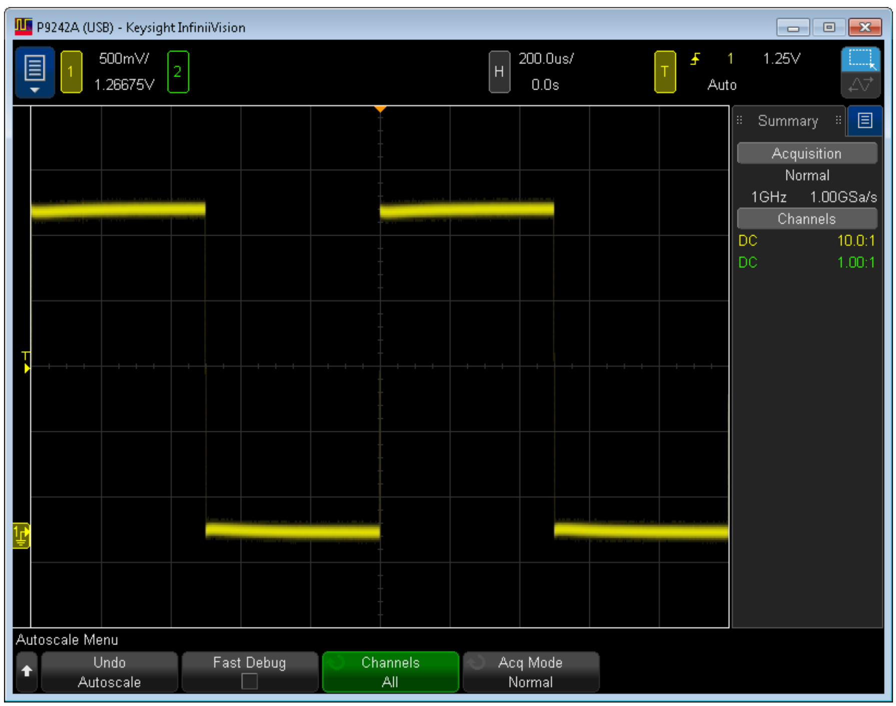
1 Choose **Main Menu > Default Setup**. The oscilloscope is now configured to its default settings.

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 next to the Probe Comp terminal.

4 Choose **Main Menu > Autoscale**.

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, ensure the probe is connected securely to the front-panel analog channel input BNC and to the Probe Comp terminal.

To compensate passive probes

You should compensate your passive probes to match their characteristics to the oscilloscope's channels. A poorly compensated probe can introduce measurement errors.

1 Perform the procedure "To perform an Autoscale on the Probe Comp signal" on page 56
2 Click the channel button to which the probe is connected (color-coded **1**, **2**, etc. at the top of the SFP window).
3 In the Channel Menu, click **Probe**.
4 In the Channel Probe Menu, click **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.

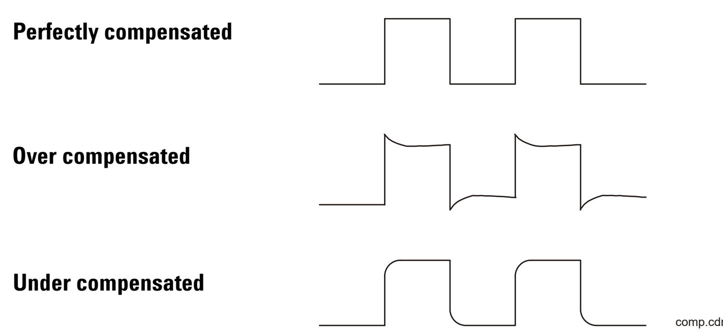


Figure 9 Example pulses

5 Connect probes to all other oscilloscope channels (that is, channel 2 of a 2-channel oscilloscope).
6 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

The service policy for Keysight P9241/42/43A oscilloscopes is unit replacement, so there are no instructions for replacing internal assemblies in this service guide.

6 Replaceable Parts

Because the service policy for the Keysight P9241/42/43A oscilloscopes is unit replacement, no replaceable parts are available.

7 Safety Notices

This apparatus has been designed and tested in accordance with IEC Publication 61010, 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.”

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.

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.

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.

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