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# Keysight Infiniium MXR/EXR-Series Real-Time Oscilloscopes

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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.

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# Infiniium MXR/EXR-Series Real-Time Oscilloscopes—At a Glance



**Table 1** Infiniium MXR-Series real-time oscilloscopes

8-Channel Model	4-Channel Model	Bandwidth	Sampling rate
MXR608A	MXR604A	6 GHz	16 GSa/s
MXR408A	MXR404A	4 GHz	16 GSa/s
MXR258A	MXR254A	2.5 GHz	16 GSa/s
MXR208A	MXR204A	2 GHz	16 GSa/s
MXR108A	MXR104A	1 GHz	16 GSa/s
MXR058A	MXR054A	500 MHz	16 GSa/s

**Table 2** Infinium EXR-Series real-time oscilloscopes

8-Channel Model	4-Channel Model	Bandwidth	Sampling rate
EXR608A	EXR604A	6 GHz	16 GSa/s
EXR408A	EXR404A	4 GHz	16 GSa/s
EXR258A	EXR254A	2.5 GHz	16 GSa/s
EXR208A	EXR204A	2 GHz	16 GSa/s
EXR108A	EXR104A	1 GHz	16 GSa/s
EXR058A	EXR054A	500 MHz	16 GSa/s

In addition to the number of input channels, bandwidths, and sampling rates described in the previous table, the Keysight Infinium MXR/EXR-Series real-time oscilloscopes deliver these features:

- 10-bit analog-to-digital converter (ADC) with low noise and high effective number of bits (ENOB), with additional high-resolution settings that increase the effective number of bits at lower bandwidths.
- Hardware acceleration and high waveform update rates that make it more likely to capture waveform anomalies.
- 16 digital input channels (1-bit vertical resolution) enabled with the MSO license.  
A mixed-signal oscilloscope (MSO) lets you debug your mixed-signal designs using analog signals and tightly correlated digital signals simultaneously. The 16 digital channels have a 8 GSa/s sample rate, with a 400 MHz toggle rate. Thresholds levels can be set per nibble.
- Many trigger modes including: edge, glitch, pulse width, pattern/state, runt, setup and hold, edge transition, edge then edge, timeout, window, OR'd edges, Nth edge, and burst. Also available are sequential triggering and InfiniiScan (Zone triggering and finders for measurements, serial bit streams, runts, and non-monotonic edges).
- Protocol triggering and decode options for many types of protocols including: ARINC-429, BroadR-Reach/100BaseT1, CAN, CAN-FD, eSPI, eUSB2, Ethernet 10BT, Ethernet 100BT, I2C, I2S (LJ, RJ, TDM), LIN, Manchester, MIL-STD 1553, MIPI-I3C, Quad-SPI, RS-232/UART, SENT, Spacewire, SPI, SPMI, SVID, USB 2.0, USB-PD, and more.
- Protocol decode and search options for even more protocols.
- Built-in counter and digital voltmeter (DVM) hardware for the analog input channels.
- Built-in, license-enabled waveform generator with: sine, square, ramp, pulse, DC, noise, sine cardinal, exponential rise, exponential fall, cardiac, Gaussian pulse, PRBS, and demo waveforms output to the GEN OUT side-panel BNC connector. Generated signals can be used to provide stimulus to a device under test (DUT) or for demos.

- Front-panel knobs and keys for: default and autoscale setups, acquisition run control (run, stop, and single), horizontal settings (time/division, trigger position, zoom window, and time navigation), vertical settings (scaling down to 1 mV/div in hardware and offset), multiple markers (to check voltage or  $\Delta$ -time at any point on a waveform), trigger level, digital channels, protocol decode, clearing acquisitions from the display, and more.  
Knobs are pushable for making quick selections.
- 15.6 inch color 1920x1080 (FHD) capacitive touch screen display with multi-touch (gestures), handles, and resizing allows oscilloscope operation without an external pointing device.
- High-capacity removable solid state hard drive for fast boot-up, storing setups, and saving measurement results.
- USB 3.0 and LAN ports make printing, saving, and sharing data easy.
- VGA and DisplayPort ports on the motherboard I/O panel for displaying the screen on a different monitor.
- 64-bit Windows operating system and graphical user interface with familiar menus, toolbars, etc. Ability to install other Windows applications like vector signal analysis (VSA) software.
- Eight analog channel waveform memories and one digital channels waveform memory for comparing with other channels or math waveforms.
- More than 50 automated measurements and measurement statistics.
- Up to 16 math function waveforms selectable from these operations: add, subtract, multiply, divide, d/dt, integrate, invert, FFT magnitude, FFT phase, magnify/duplicate, square, square root, absolute value, low pass filter, high pass filter, averaged value, smoothing, envelope, magnify, maximum, minimum, peak-peak, measurement trend, bus chart, and user-defined functions with MATLAB analysis.
- New analysis tools including: Fault Hunter and Power Analysis.
- Legacy Infiniium analysis tools including: histograms, mask testing (now with multiple masks for separate waveforms), jitter, real-time eye, equalization, crosstalk, and phase noise.
- Supports many compliance testing applications for technologies like: 100BASE-T1, 1000BASE-T1, 10/100/1G Ethernet, 10GBASE-T, 10GBASE-CX4, Broad-R Reach, CPRI, DDR2/LPDDR2, DDR3/LPDDR3, Energy Efficient Ethernet, HDMI, MGBASE-T (2.5G/5G), MIPI C-PHY, MIPI D-PHY, MIPI M-PHY, MOST, NBASE-T (2.5G/5G), OBSAI, ONFI, PCI Express Gen 1-4, Serial RapidIO, TC8 (OPEN), USB 2.0, and XAUI.

## In This Guide

This guide provides the information you need to begin using the Infinium MXR/EXR-Series real-time oscilloscopes.

**Chapter 1**, “Setting Up,” starting on page 13, includes unpacking steps, power and air flow requirements, and other setup information.

**Chapter 2**, “Getting Started,” starting on page 23, familiarizes you with the inputs and outputs, front-panel knobs and keys, the graphical user interface, and describes how to perform basic operations with the oscilloscope.

**Chapter 3**, “Demos and Online Help,” starting on page 51, describes the Infinium oscilloscope application’s online demos and online help contents. The online help describes in detail how to use the Infinium oscilloscope.

**Chapter 4**, “Other Oscilloscope Tasks,” starting on page 55, describes the Infinium oscilloscope application’s online help contents and online demos. The online help describes how to use the Infinium oscilloscope application in detail.

**Chapter 5**, “Calibrating the Oscilloscope,” starting on page 61, describes how to perform a user calibration.

**Chapter 6**, “Testing Performance,” starting on page 67, describes the procedures used to verify that the oscilloscope is operating within specification.

**Chapter 7**, “Troubleshooting,” starting on page 109, describes what to do if you encounter any problems with your MXR/EXR-Series oscilloscope.

### For More Information

- For detailed information on how to use the oscilloscope, see the Infinium oscilloscope application’s online help. See **"Accessing the Online Help"** on page 53.
- For information on controlling the oscilloscope from a remote computer, see the *Oscilloscopes Programmer’s Guide* found in the Infinium oscilloscope application’s online help.

For technical assistance, contact your local Keysight Technologies representative at <http://www.keysight.com/find/contactus>.



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This chapter shows how to set up and prepare your Infiniium oscilloscope for first-time use.

## Inspecting Package Contents

- ✓ Inspect the shipping container for damage.
  - Keep the shipping container or cushioning material until you have inspected the contents of the shipment for completeness and have checked the oscilloscope mechanically and electrically.
  - If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier and your Keysight Technologies Sales Office. Keep the shipping materials for the carrier's inspection. The Keysight Technologies Sales Office will arrange for repair or replacement at Keysight's option without waiting for claim settlement.

- ✓ Inspect the oscilloscope.

If there is mechanical damage or a defect, or if the oscilloscope does not operate properly or does not pass performance tests, notify your Keysight Technologies Sales Office.

- ✓ Verify that you received the following items in the Infinium oscilloscope packaging.

- Infinium oscilloscope
- Power cord
- Keyboard
- Mouse (USB optical)
- Accessory pouch (mounts on rear of oscilloscope)
- Front panel cover
- Calibration cable
- Quick Start poster
- 500 MHz passive probes (one for each of the analog channel inputs)
- Digital channels cable, BNC probe tip adapter, and 17-channel flying lead kit (with the MSO option)

If anything is missing, contact your nearest Keysight Technologies Sales Office.

- ✓ Verify that you received the options and accessories you ordered and that none were damaged.

For a complete list of options and accessories available for the MXR/EXR-Series real-time oscilloscopes, see:

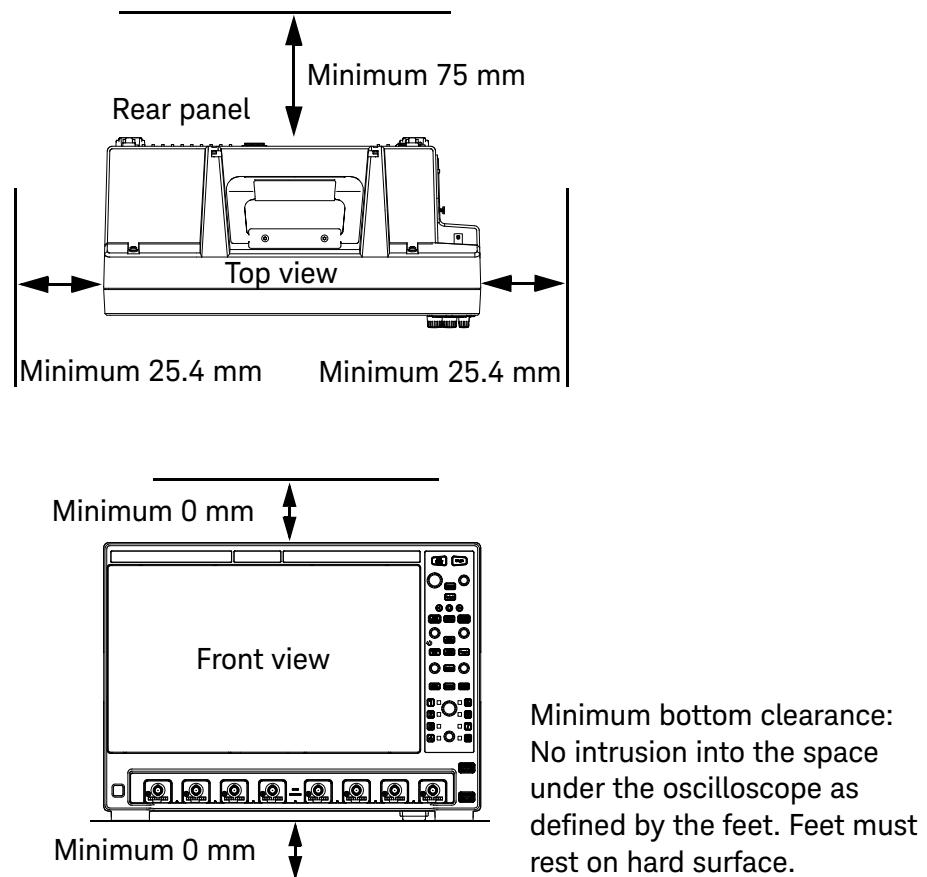
- [Infinium MXR-Series Real-Time Oscilloscopes Data Sheet](#)
- [Infinium EXR-Series Real-Time Oscilloscopes Data Sheet](#)

## Environmental Characteristics

Environment	Indoor use only
Ambient Temperature	<p>Operating: +5 °C to +40 °C  Non-operating: -40 °C to +70 °C  <b>CAUTION:</b> If storing the oscilloscope above +40 °C, make sure the flip-out front feet are retracted.</p>
Humidity	<p>Operating: maximum relative humidity 80 percent for temperatures up to 31 °C, decreasing linearly to 50 percent relative humidity at 40 °C  Non-operating: up to 95 percent relative humidity, non-condensing, at 40 °C; decreasing linearly to 50 percent relative humidity at 70 °C</p>
Altitude	<p>Operating: up to 3,000 meters (9,842 feet)  Non-operating: up to 15,300 meters (50,000 feet)</p>
Weight	32 lbs (14.5 kg)
Dimensions	<p>Height = 328 mm (12.91 in, with flip-out front feet and handle retracted)  Width = 445 mm (17.52 in)  Depth = 224 mm (8.82 in, including knobs and rear feet)</p>
Safety	<p>UL 61010-1:2010/CAN/CSA C22.2 No. 61010-1-12  IEC 61010-1:2017  IEC 61010-2-030:2017  UL 61010-2-030:2018  CAN/CSA-22.2 No. 61010-2-030-17</p>
Installation Category	II
Voltage Fluctuations	Note that the mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage. Temporary overvoltages may not exceed the allowed voltage fluctuations of +10% nominal.
Pollution Degree	The Infinium MXR/EXR-Series real-time oscilloscopes may be operated in environments of Pollution Degree 2.
Pollution Degree Definitions	<p>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.</p> <p>Pollution Degree 2. Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation may occur. Example: General indoor environment.</p> <p>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.</p>

## Positioning for Proper Airflow

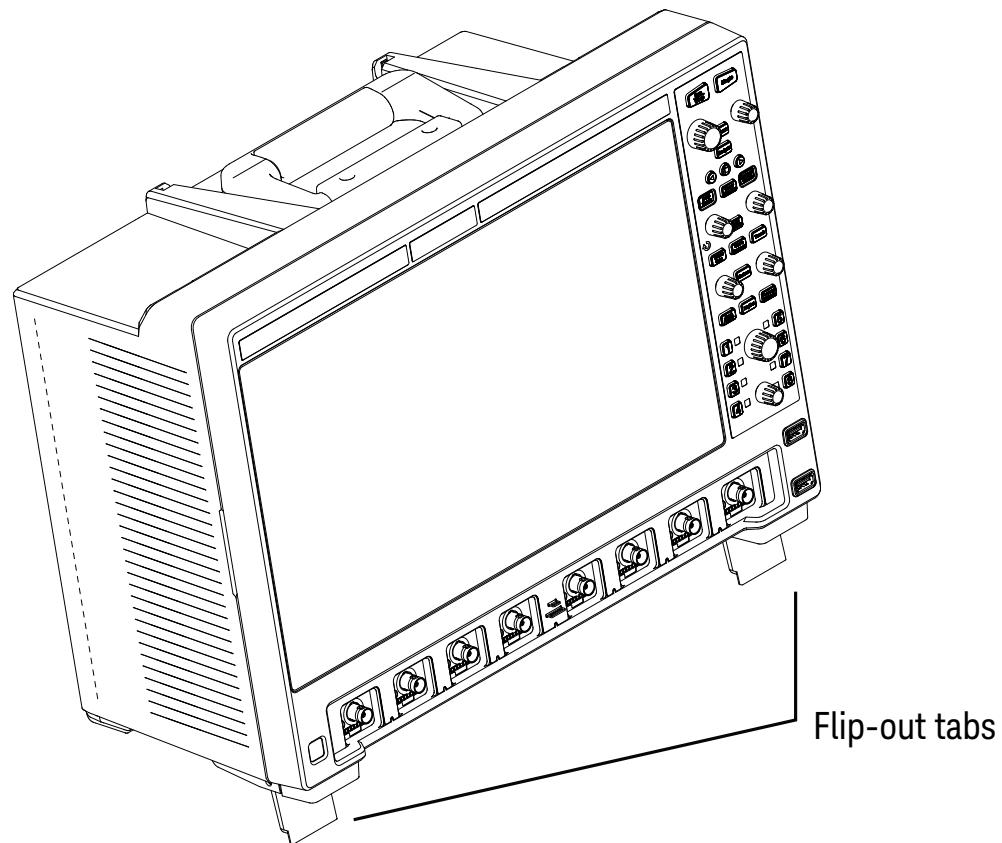
Position the oscilloscope where it will have sufficient clearance for airflow around the back and sides.



**Figure 1** Positioning the MXR/EXR-Series oscilloscope with sufficient clearance

## Tilting the Oscilloscope for Easier Viewing

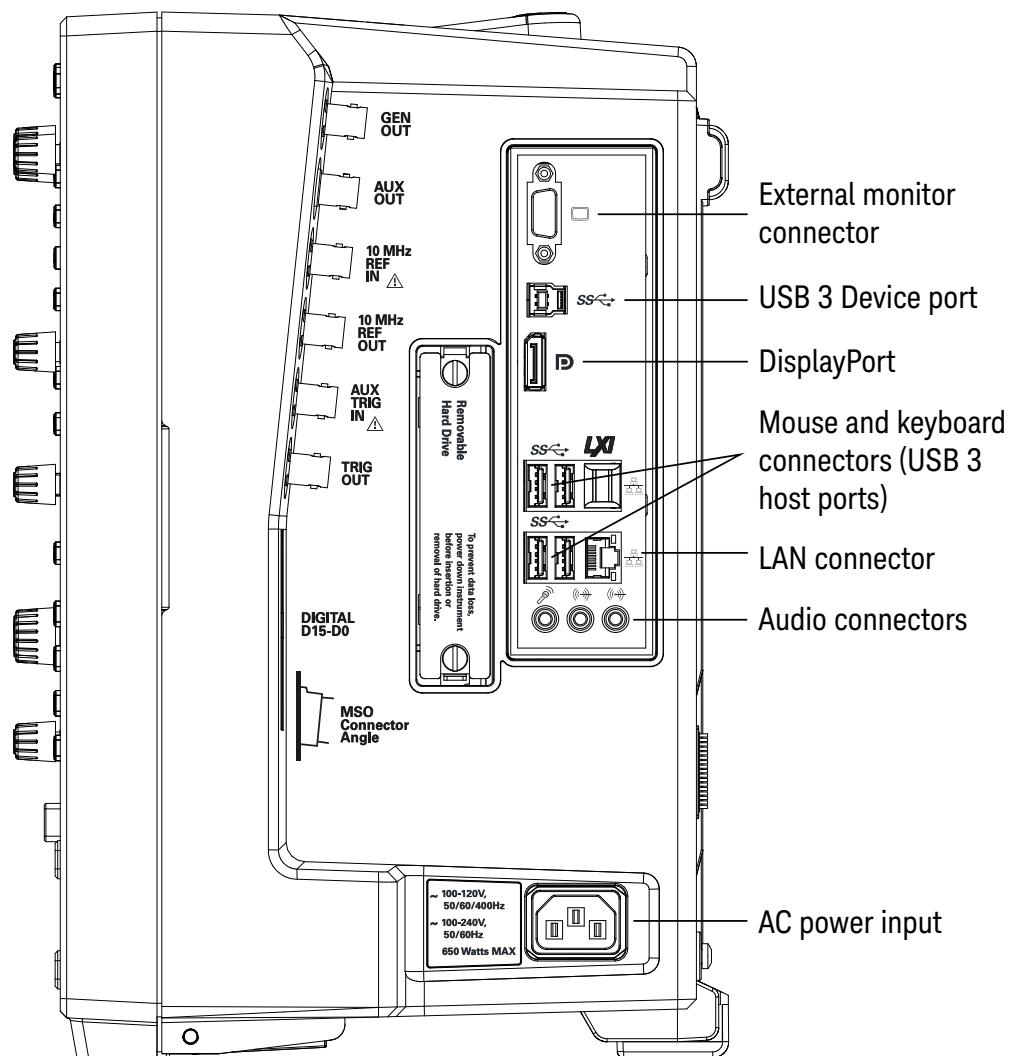
Tabs under the front feet of the oscilloscope can be flipped out to tilt the oscilloscope for easier viewing.



**Figure 2** Latching the front feet

## Connecting Accessories and a LAN Cable to the Oscilloscope

- 1 Plug the mouse and keyboard into the USB host ports. Four host ports are on the side panel, with two more on the front panel.
- 2 If you want to connect to a Local Area Network, connect your LAN cable to the RJ-45 connector on the side panel. Connect the other end to an open LAN port.



**Figure 3** Side panel

## Connecting Power to the Oscilloscope

**Table 3** Power requirements

Power	100-120 V, 50/60/400 Hz 100-240 V, 50/60 Hz 650 W MAX on 8-channel models 450 W MAX on 4-channel models
-------	--

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

The power cord is the disconnecting device for Mains. Position the equipment so the power cord is easily reached by the operator.

**CAUTION**

**Use only the power cord that came with the oscilloscope**

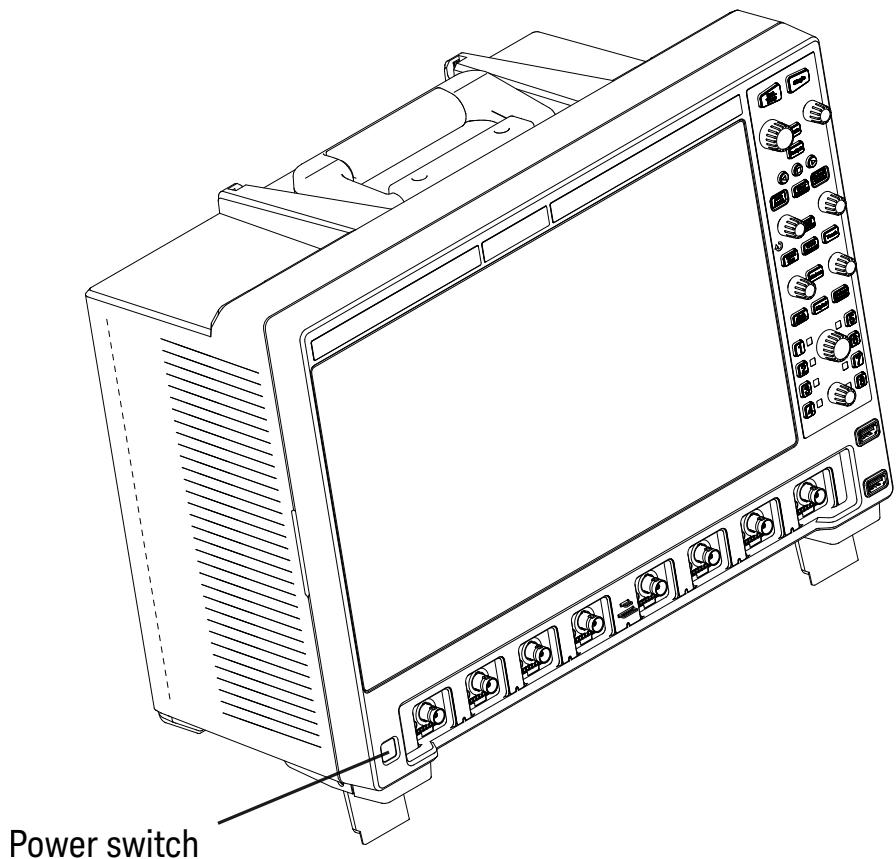
The power cord provided is matched to the country of origin of the order.

**WARNING**

**To avoid electric shock, be sure the oscilloscope is properly grounded.**

## Turning On the Oscilloscope

Press the power switch in the lower left corner of the oscilloscope front panel.



**Figure 4** Turning On the oscilloscope

After a short initialization period, the oscilloscope display appears. The oscilloscope is ready to use.

You can connect and disconnect probes and cables while the oscilloscope is turned on.

### Turning Off the Oscilloscope

To turn the oscilloscope off, press the power switch at the lower left corner of the oscilloscope front panel. The oscilloscope will go through a normal Windows operating system shutdown process.

## Changing the Administrator Password

On Keysight Infinium MXR/EXR-Series real-time oscilloscopes with the Windows 10 operating system, depending on when the oscilloscope was manufactured, the default Administrator user account password is either "keysight4u" or "Keysight4u!". Change the Administrator password to something more secure (and less well-known).

**See Also**

- ["Changing Windows Operating System Settings" on page 56](#)
- ["Installing Application Programs on Infinium" on page 57](#)

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This chapter describes how to use the Infiniium MXR/EXR-Series oscilloscope's inputs and outputs, front panel controls, and user interface.

- The familiar front-panel oscilloscope interface with knobs and keys is optimized for common tasks and basic measurements.
- With the graphical user interface for the Infiniium MXR/EXR-Series oscilloscope you can access all of the oscilloscope's configuration and measurement features through an easy-to-use system of windows, menus, toolbars, dialog boxes, and buttons.
- You have the option of using either the front panel controls or the user interface for many common tasks.

## Front Panel Connectors

On the Infiniium MXR/EXR-Series oscilloscopes, the channel inputs, probe compensation terminal, and ground lug appear on the lower part of the front panel. Two USB 3.0 host ports are also located here.



**Figure 5** Front panel connectors

### Channel inputs

Your Infiniium oscilloscope comes with 10:1 500 MHz passive probes for each analog input channel.

The AutoProbe interface also works with the InfiniiMax probing system.

See "[Connecting Oscilloscope Probes](#)" on page 32.

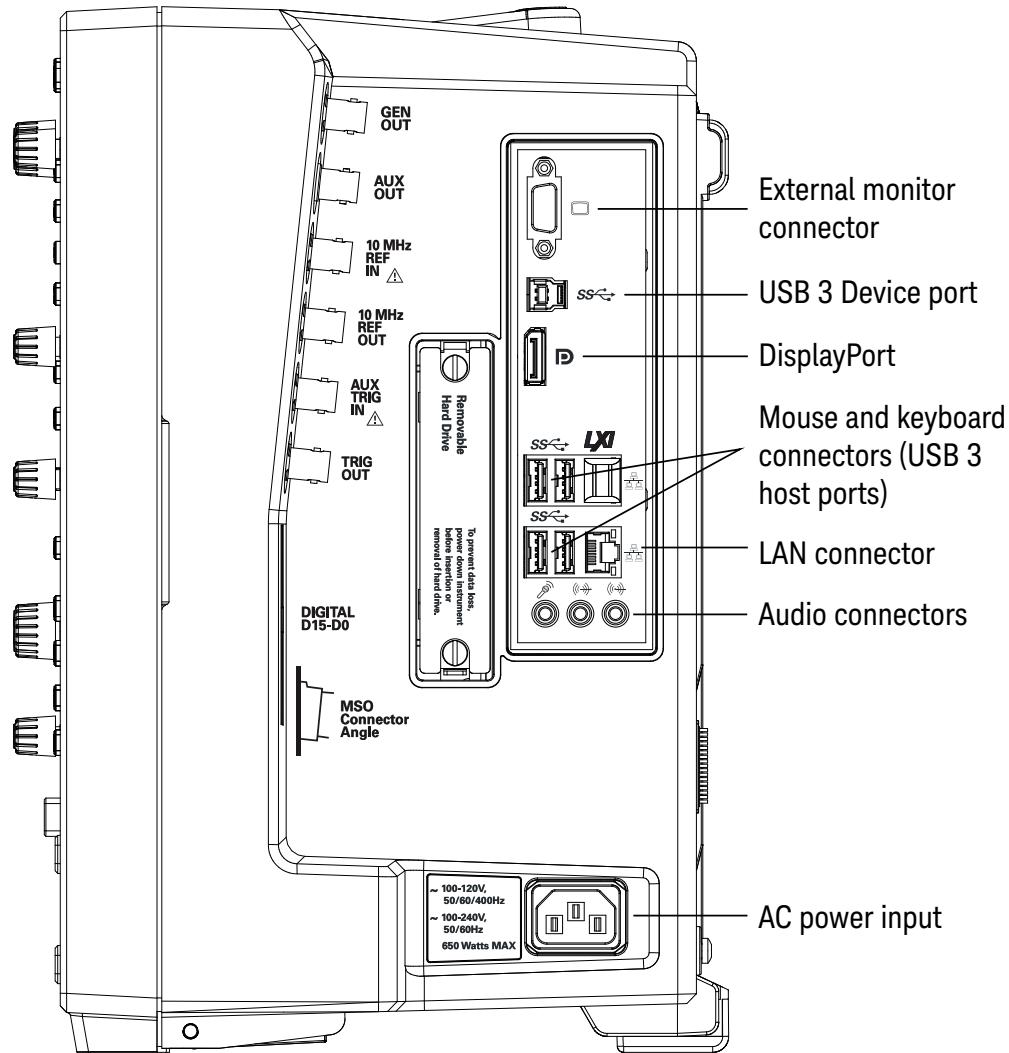
### Probe compensation terminal

This terminal has a square wave signal that is used to adjust compensated passive probes.

You can also output a DC level on this terminal using the Infiniium oscilloscope application's Calibration Output dialog box (**Utilities > Calibration Output...**).

## Side Panel Connectors

The Infinium MXR/EXR-Series oscilloscope's right side panel has the motherboard I/O connectors, reference clock synchronization connectors, and BNC connectors.



**Figure 6** Infinium MXR/EXR-Series oscilloscope side panel I/O

## Motherboard I/O

The motherboard provides these inputs/outputs/ports in the oscilloscope: four USB ports for peripherals, an external monitor connector, a USB III device port (for remote control of the oscilloscope from a PC), a LAN port, and speaker and microphone connectors.

## Digital channels connector

The MSO option includes a 17-channel flying lead set logic probe, an MSO cable, and a calibration fixture.

The MSO cable operating temperature range is 0 °C to 55 °C, and its non-operating (storage) temperature range is -40 °C to 70 °C.

### GEN OUT

Waveform generator signals are output to this BNC connector. See "["Waveform Generator"](#) on page 45.

### AUX OUT

This output signal is selected by the Infiniium oscilloscope application's Calibration Output dialog box. It can be a DC level, the probe compensation signal (a square wave used to adjust compensated passive probes), the trigger out signal, or a demo signal.

### 10 MHz REF IN (50Ω)

The 10 MHz REF IN (50Ω) BNC connector is used to synchronize the oscilloscope's horizontal timebase system to a reference clock that you provide.

#### CAUTION

#### Maximum input voltage at 10 MHz REF IN input

The clock you provide must meet the following specifications:

- **Input frequency lock range:** 10 MHz ±20 ppm
- **Amplitude, sine wave input:** 356 mVpp (-5 dBm) min to 5 Vpp (+18 dBm) max
- **Amplitude, square wave input:** 285 mVpp min to 4 Vpp max
- **Input impedance:** 50Ω (typical)

---

To use an external reference clock, connect the external clock to the 10 MHz REF IN (50Ω) BNC connector; then, in the Infiniium oscilloscope application's Horizontal dialog box (**Setup > Horizontal...**), enable the **External 10 MHz Reference Clock**.

### 10 MHz REF OUT (50Ω)

You can use the 10 MHz REF OUT (50Ω) BNC connector to send the oscilloscope's 10 MHz reference clock output signal to another instrument's reference clock input.

The output has these characteristics:

- **Amplitude into 50Ω (internal or external timebase reference selected):**  $1.65 \pm 0.05$  Vpp ( $8.3 \pm 0.3$  dBm) sine wave
- **Frequency accuracy, internal timebase reference selected:**  $10 \text{ MHz} \pm (8 \text{ ppb initial} + 75 \text{ ppb/year aging})$
- **Frequency accuracy, external timebase reference selected:** external reference frequency (input to 10 MHz REF IN 50Ω)

## AUX TRIG IN (50Ω)

You can set up the oscilloscope to trigger on the auxiliary trigger signal connected to this BNC input.

### CAUTION

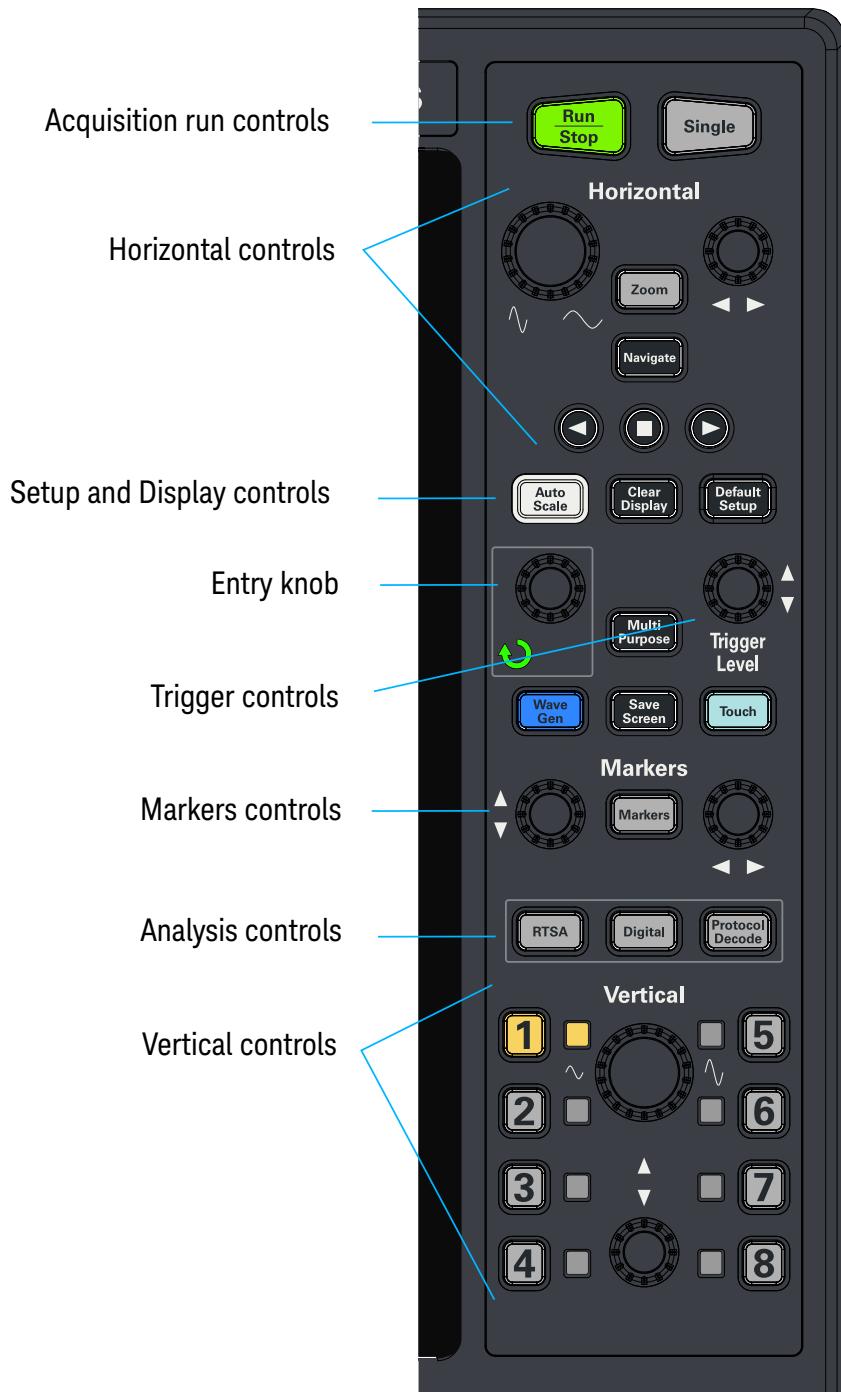
#### ⚠ Maximum voltage at AUX TRIG IN input

The input impedance is 50Ω, and the signal you provide must be 5 Vpp maximum between -5 V and +5 V.

## TRIG OUT

Pulses corresponding to oscilloscope triggers can be sent to this BNC output. TTL levels into a high impedance load are output.

## Knobs and Keys on the Front Panel



**Figure 7** Front panel controls

The Infinium MXR/EXR-Series oscilloscope front panel controls provide direct access to the functions needed to perform the most common measurements. Knobs and keys let you directly set vertical and horizontal parameters. You can see the oscilloscope's configuration at a glance.

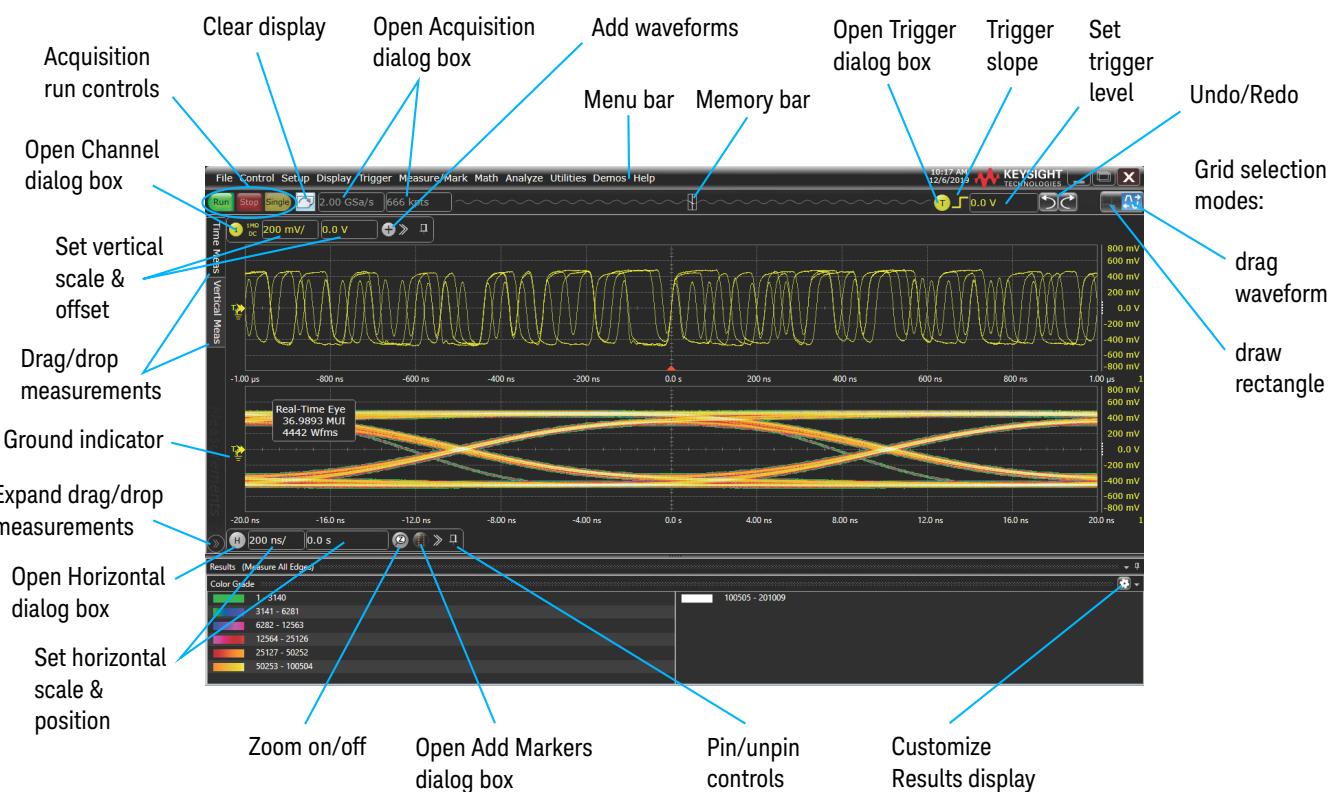
The oscilloscope uses color consistently throughout the front panel and user interface. For example, the color of the knob for channel 1 is the same color as the waveform for channel 1. All configuration items and values related to channel 1 are displayed in the same color.

The MXR-Series oscilloscopes have the **[RTSA]** front panel key for the RTSA (Real-Time Spectrum Analysis) mode. At the same location in the EXR-Series oscilloscopes is the **[Fault Hunter]** key for the Fault Hunter analysis feature.

## Graphical User Interface (GUI)

The user interface is arranged so the most common functions affecting the waveform display are located around the edge of the waveform display area.

Context-sensitive menus are available by right-clicking something in the waveform display area, such as a grid, a signal, a bookmark, or a measurement. You can mouse over or touch other areas, such as the drag-and-drop measurements area and horizontal and acquisition control regions, to find more information about those areas or to enter data.



**Figure 8** Infiniium oscilloscope display

**Table 4** Infinium oscilloscope display descriptions

Menu bar	Use menu selections to perform defined operations and access every function the oscilloscope provides.
Grid selection modes	The selected grid mode determines whether you draw a selection box or manipulate waveforms when you touch the screen.
Waveform display area	The waveform display area shows up to eight waveform windows. Several display options are available, such as grids or horizontal and vertical scales.
Results pane	A Results pane is visible at the bottom of the display when you do something that produces results, such as taking a measurement or using bookmarks. When it is not needed, the Results pane is not visible.

## Connecting Oscilloscope Probes



8 or 4 analog input channels where probes are connected

**Figure 9** MXR/EXR-Series oscilloscope probe connectors

### CAUTION

#### ⚠ Maximum input voltage at analog inputs

Do not exceed the maximum input voltage rating.

The maximum input voltage for the  $50\ \Omega$  input impedance setting is  $\pm 5\ V$ .

The maximum input voltage for the  $1\ M\Omega$  input impedance setting is  $30\ V_{rms}$  or  $\pm 40\ V_{max}$  (DC+Vpeak).

Probing technology allows for testing of higher voltages; the included N2873A 10:1 probe supports  $300\ V_{rms}$  or  $\pm 400\ V_{max}$  (DC+Vpeak). No transient overvoltage allowed. Mains isolated circuits only.

### CAUTION

When measuring voltages over  $30\ V$ , use a 10:1 probe.

The Keysight Infiniium MXR/EXR-Series oscilloscopes are not rated for Measurement Category II, III, or IV.

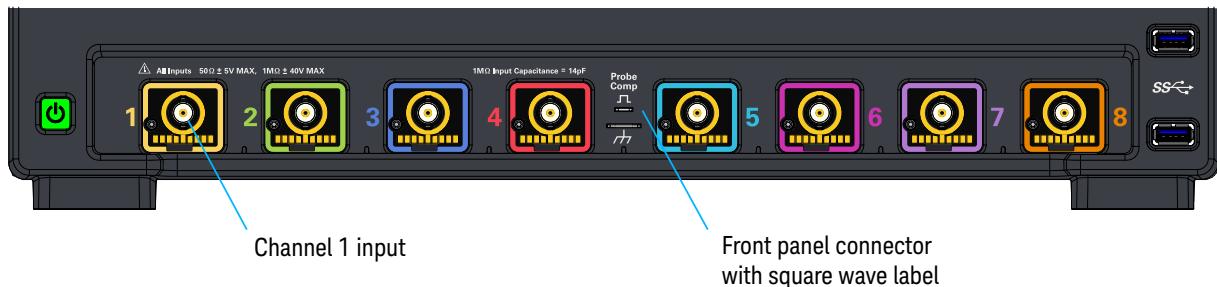
For complete documentation on Keysight oscilloscope probes for your Infiniium oscilloscope, see the Probe Resource Center at: [keysight.com/find/prc](http://keysight.com/find/prc)

To connect oscilloscope probes:

- 1 Attach the probe connector to the desired oscilloscope channel or trigger input using the probe instructions.
- 2 Connect the probe to the circuit of interest using the browser or other probing accessories.

## Verifying Basic Oscilloscope Operation

- 1 Connect one end of the passive probe cable to oscilloscope input channel 1.
- 2 Connect the other end of the passive probe cable to the front panel Probe Comp terminal with the square wave label.



**Figure 10** Verifying basic oscilloscope operation

- 3 Press [**Default Setup**] on the front panel.

The display will pause momentarily while the oscilloscope is configured to its default settings. The oscilloscope is now in a known operating condition.

- 4 Press [**Auto Scale**] on the front panel.

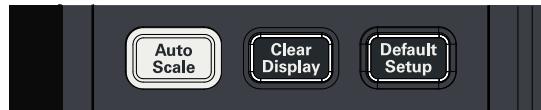
The display will pause momentarily while the oscilloscope adjusts the time/div setting and vertical scale so the oscilloscope can best display the input signals. You should then see a square wave with about four cycles on screen and a peak-to-peak amplitude of approximately five divisions.

If you do not see the waveform, make sure your power source is adequate, the oscilloscope is properly powered on, and the cable is connected securely to the front panel connector output.

- 5 Move the mouse around the mouse surface and verify that the on-screen pointer follows the mouse movement.
- 6 Press the [**Touch**] key on the front panel to turn on the touch screen. Press and hold your finger to the screen. A right-click menu appears, which verifies that the touch screen is working properly.

## Default Setup and Autoscale

With the setup and display controls you can quickly get a stable waveform display, clear the display, and set the oscilloscope to a known starting condition.



**Figure 11** [Auto Scale] and [Default Setup] keys

### Using Default Setup

To reset the oscilloscope to its default setup, press [**Default Setup**]. You can use the **Undo** button to undo a default setup.

#### NOTE

#### Save the Current Oscilloscope Configuration

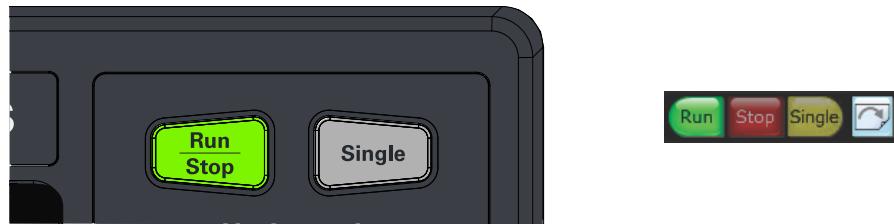
Before using the default setup, you may want to save the current oscilloscope configuration for later use. See the online help for instructions on saving setups, and for information on the exact configuration that is set when you use the default setup. See "["Accessing the Online Help"](#) on page 53.

### Using Autoscale

To automatically configure the oscilloscope to best display the current input signal(s), press [**Auto Scale**] or choose **Control > Autoscale**.

## Starting and Stopping Waveform Acquisitions

Use the acquisition run controls to run and stop acquisitions or make a single acquisition. The boxed area of the memory bar above the waveform display area shows which portion of the channel's acquisition memory you are viewing.



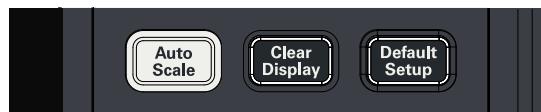
**Figure 12** Acquisition run control keys and buttons

- To start waveform acquisition, press **[Run/Stop]** or click **Run**.

The oscilloscope begins acquiring data. When the event that triggers the oscilloscope is found (or, in the Auto sweep mode when a good amount of time has elapsed without the trigger event – see "Setting Up Triggers" on page 44), the oscilloscope finishes acquiring data, updates the display, and then starts another acquisition cycle.

- To stop waveform acquisition, press **[Run/Stop]** or click **Stop**. Data that was last acquired remains on the screen.
- To make a single acquisition, press **[Single]** or click **Single**.
- You can also choose the Run, Stop, and Single commands from the Control menu.
- To set up how you want the signals to be sampled, such as sampling rate and mode, choose **Setup > Acquisition....**

## Clearing the Waveform Display



**Figure 13** [Clear Display] key

When you press [**Clear Display**] or click , the oscilloscope clears acquired waveform data from the display in preparation for another acquisition. If the oscilloscope is in Run mode and is receiving triggers, it will update the display as it collects new waveform data.

Clearing the waveform display also resets averaging, infinite persistence, color grade persistence, histograms, and the mask testing database.

## Adjusting the Horizontal Settings

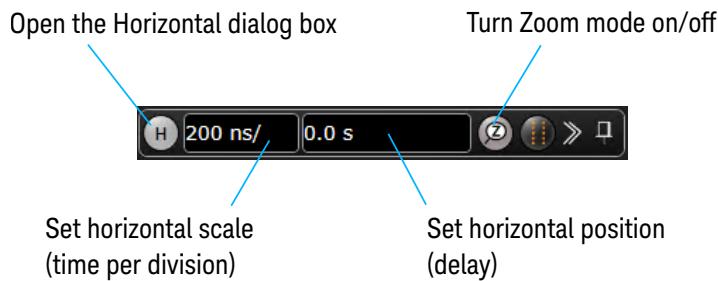
Use the horizontal controls to configure the horizontal scale and horizontal position of the waveform. You can view a magnified section of the waveform using the zoom window.

To adjust the horizontal scale and position, use gestures on the touch screen or use the horizontal knobs, horizontal controls, or Horizontal dialog box.

### Adjusting the Horizontal Scale



**Figure 14** Front panel horizontal knobs and controls



**Figure 15** Graphical user interface horizontal controls

- The horizontal scale knob is the larger of the two horizontal control knobs. To stretch the waveform horizontally (displaying fewer seconds per division), turn the knob clockwise. To shrink it horizontally, turn the knob counter-clockwise.
- Push and turn the horizontal scale knob to change the scaling in finer (Vernier) increments.
- You can also use multi-touch gestures to stretch or shrink the waveform.

- To adjust the horizontal scale using the controls in the horizontal toolbar, mouse over or touch the horizontal scale field and use the resulting controls to set a particular horizontal scale. Click the scale field to enter an exact value, or click the "narrower" or "wider" buttons.

### Adjusting the horizontal trigger position (delay)

- The horizontal position knob is the smaller of the two horizontal control knobs. Turn the knob to move the waveform to the right or left.
- Moving the waveform to the right shows more of the pre-trigger data (data acquired before the trigger event). Moving it to the left shows more post-trigger data.
- When you drag a waveform, the horizontal position will change for all channels and functions on the display. Waveform memories will also move if you select the **Tie to Timebase** box in the Waveform Memories dialog box.
- To adjust the horizontal position using the controls in the horizontal toolbar, mouse over or touch the horizontal position field and use the resulting controls to set a particular horizontal position (time relative to the trigger at the highlighted horizontal reference point).

### Magnifying a part of the waveform using Zoom

- To turn on zoom, press the  key or click the Zoom button .

The waveform display area splits into two regions. The top one is the main timebase. The bottom is the zoomed timebase, which represents an expansion of the acquired waveform data. A section of the waveform in the main timebase window is highlighted to indicate the part shown in the zoomed timebase window.

The horizontal scale and position controls now change how the waveform is shown in the zoomed timebase window. The horizontal scale will change the amount of magnification, while the position will change the part of the waveform in the main window that is shown in the zoomed window.

- To turn off zoom, press  or click  again.

#### NOTE

#### Avoid Overdriving Vertical Input Amplifiers

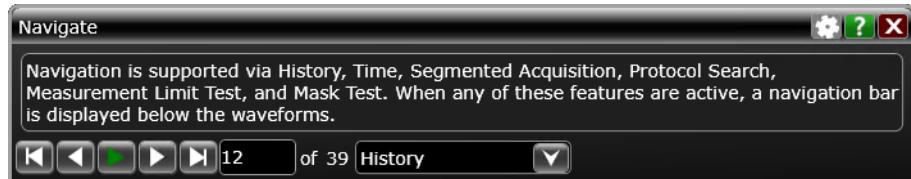
When zooming on a waveform with the oscilloscope running, be careful to keep the signal within the screen vertically to avoid overdriving the vertical input amplifiers. Overdriving causes waveform distortion and erroneous measurement results.

"ADC clipping" indicators appear when a signal exceeds the input voltage range of the ADC. These indicators can sometimes appear when a signal appears to be within the vertical range of the screen due to DSP filtering, but it really is not.

## Using the Navigate Controls

Navigation can be performed for acquisition history (which is available when running acquisitions are stopped), time, segmented memory acquisitions, protocol search, measurement limit test, and mask test.

The **[Navigate]** key opens the Navigate dialog box where you can choose what to navigate.



Press the navigation keys to step or play backward, stop (when navigation is being played), or step or play forward. When playing, you can press the or keys multiple times to speed up the playback. There are three speed levels.

Additionally, the graphical user interface provides first and last buttons for navigating to the first or last item in the collection, and sometimes there is a play button for playing items.

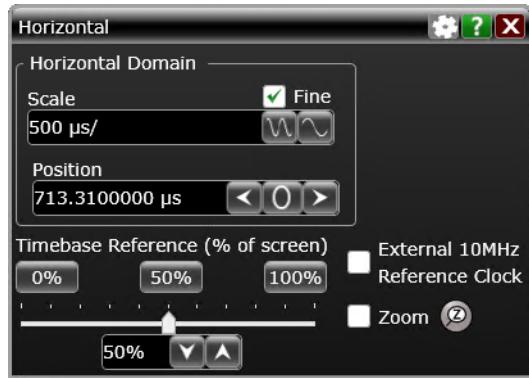
The navigation controls also appear in the horizontal controls bar and can be displayed or hidden by clicking the clock button.



## Setting the scale, position, and timebase reference point

To set scale, position, and timebase reference, use the Horizontal dialog box or set up the zoomed timebase window.

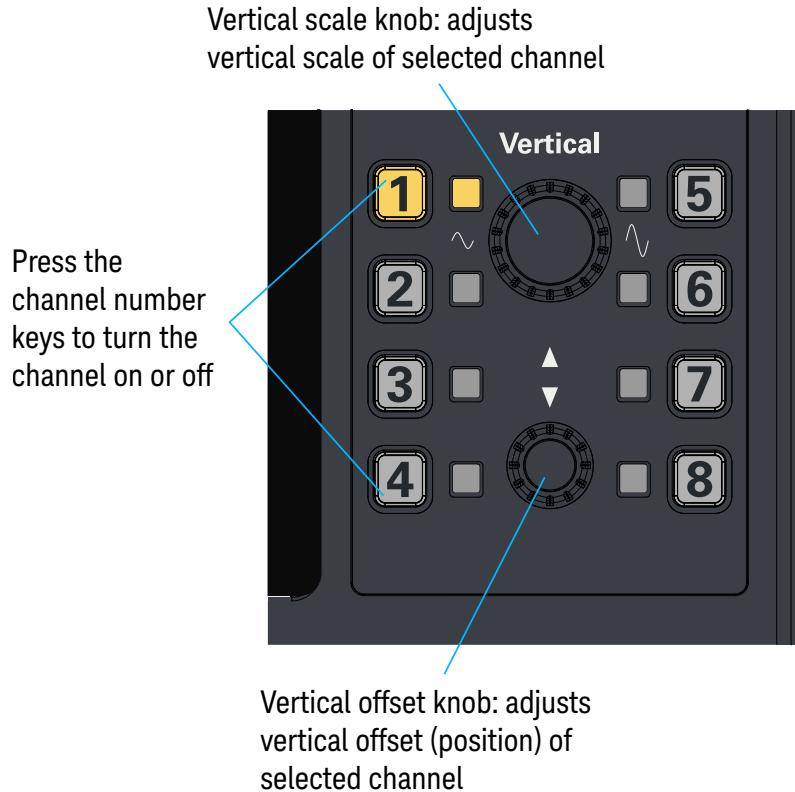
To access the Horizontal dialog box, click the in the horizontal toolbar, or choose **Setup > Horizontal...** from the main menu.



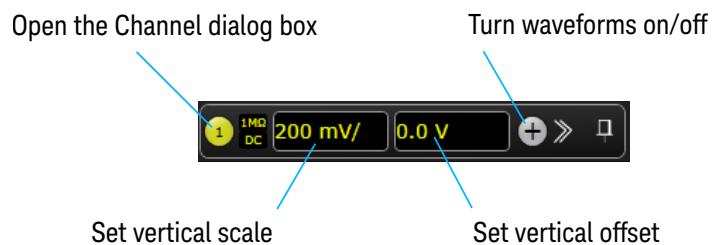
The Timebase Reference range is from 0 to 100% of the screen. The center of the screen is at 50%. The slider correlates to the hollow orange triangle at the bottom of the display area, showing where the horizontal offset is on the screen.

## Adjusting the Vertical Settings

Use the vertical controls to set the vertical scaling and vertical offset for each analog channel, and to turn the display on or off for a specific channel.



**Figure 16** Front panel vertical controls



**Figure 17** Graphical user interface vertical controls

## Turning an analog channel on or off

To turn an analog channel on or off, press the channel number key on the front panel or click the Add Waveforms button . When you turn off a channel, the current vertical scale and offset fields for that channel disappear.

If you are not using a particular analog channel, you can turn it off to simplify the waveform display and increase the display update rate. Functions continue to run on a channel source that is turned off. Data acquisition continues for a channel if a function requires it.

### NOTE

#### Using an Analog Channel as Trigger

Any analog channel can be used as a trigger source. If you need a trigger but do not need all analog channels, you can use an analog channel as a trigger without displaying it by turning the analog channel display off.

## Adjusting an analog channel's vertical scale and offset

To adjust the vertical scale and offset, use the vertical scale and offset knobs, vertical user interface controls, or Channel dialog box.

The vertical scale knob is the larger of the two knobs for a channel. Turn the knob to make the waveform bigger (fewer volts per division) or smaller. You can also mouse over or touch the vertical scale field and use the resulting controls to set an exact value for the scaling.

The vertical offset knob is the smaller knob for a channel. Turn it to move the waveform up or down.

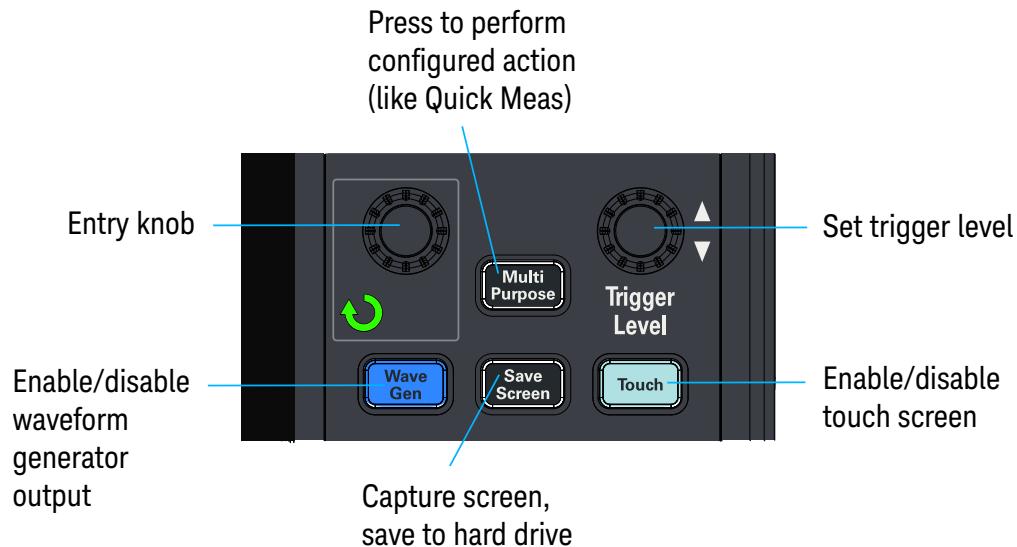
You can drag the waveform or its ground reference indicator to the desired vertical offset if the grid is in drag mode .

Choose **Setup > Channel N...** or click a channel number to open the Channel dialog box, in which you can set the vertical scale, offset, skew, and labels. You can also specify the characteristics of a probe, or perform a probe calibration.

For Keysight Technologies probes that are compatible with the AutoProbe interface, the oscilloscope will automatically set these characteristics (except for skew) after identifying the probe when it is connected to the channel input.

## Trigger Level and Other Controls

Around the Trigger Level knob, centrally located on the front panel, are controls for performing various tasks.



**Figure 18** Front panel trigger level (and other) controls

### Entry Knob

The Entry knob is a multiplexed knob that can be used to adjust values in selected dialog box fields.

The curved arrow LED on the front panel illuminates whenever the Entry knob can be used to adjust a value. The value being adjusted is displayed in a popup message box.

Also, when the symbol appears in a field, you can use the Entry knob to adjust values.

The Entry knob can sometimes be pushed to make a selection or default value setting.

### [Multi Purpose] Key

The **[Multi Purpose]** key can be configured to perform one of many quick actions, such as loading a setup file, saving composite data or a measurement report to a file, saving the screen image to a bitmap file, or performing automatic measurements.

The action taken when **[Multi Purpose]** is pressed (or when **Utilities > Multipurpose** is chosen) depends on the feature selected in the Customize Multipurpose dialog box (**Utilities > Customize Multipurpose...**).

## Setting Up Triggers

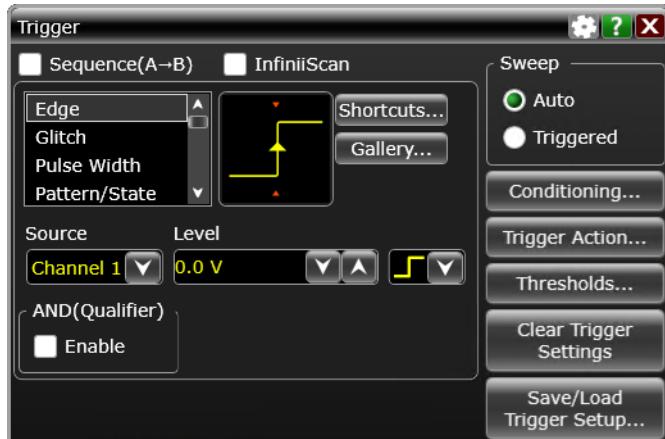
Use the graphical user interface trigger controls to set the conditions on which the oscilloscope will trigger and acquire an input signal. You can set up a variety of trigger conditions.



**Figure 19** Graphical user interface trigger controls

For example, to set up an Edge trigger:

- 1 Click the **T** button in the graphical user interface to open the Trigger dialog box.



- 2 In the Trigger dialog box, select the **Edge** trigger type.
  - 3 Select the **Source**.
- You can choose any channel or the **Aux** (AUX TRIG IN) or **Line** (the 50% level of the oscilloscope's AC power source signal) input as the source for an edge trigger.
- 4 Enter the voltage level at which the oscilloscope will trigger either by using the **Level** field or by turning the Trigger Level knob.
  - 5 Select a rising edge, falling edge, or both edges slope to trigger on.
  - 6 Select the desired **Sweep**:

- When **Triggered** is selected, the oscilloscope must find the trigger before saving and displaying captured data.
- When **Auto** is selected, if a trigger does not occur within a certain amount of time, an acquisition is automatically saved and displayed. In Auto trigger mode, you are able to see your signals while setting up the desired trigger.

Use the Trigger dialog box to select any of the modes of triggering, the parameters and conditions for each trigger mode, and advanced configuration items.

You can also mouse over the Trigger Level field and use the resulting controls to set a particular trigger level when the oscilloscope is set for edge trigger on a particular channel. You can drag the trigger reference indicator at the left side of the display, or drag the trigger line itself, which appears when you click or touch the grid.

## Waveform Generator

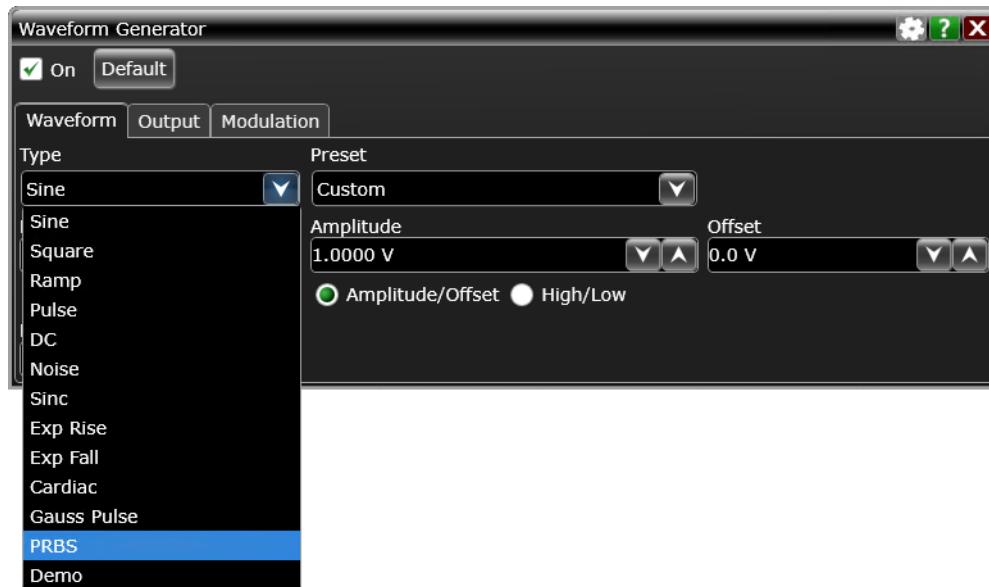
The built-in license-enabled waveform generator can output sine, square, ramp, pulse, DC, noise, sine cardinal, exponential rise, exponential fall, cardiac, Gaussian pulse, PRBS, and demo waveforms on the GEN OUT output.

Noise can be added to all waveform types except: noise and demo.

AM, FM, or FSK modulation can be performed on all waveform types except: square, pulse, DC, noise, Gaussian pulse, and demo.

The **[Wave Gen]** key enables or disables the waveform output on GEN OUT.

To select the waveform type and its parameters in the graphical user interface, choose **Setup > Waveform Generator...** to open the Waveform Generator dialog box.



## Saving and Printing

You can press the **[Save Screen]** key to capture and save a screen image to the oscilloscope's hard drive in the *C:\Users\Public\Documents\Infiniium\Screen Images\* folder.

In the graphical user interface, you can:

- Choose **File > Save** > and use the menu selections to save composite files (setups and waveforms), setup files, waveform data, screen images, or measurement data. You can also save waveforms to waveform memories.
- Choose **File > Copy Screen Image** to easily copy and paste a screen image into a document.
- Choose **File > Print...** to send screen images and setup data to a specified printer.

Note that you can customize the **[Multi Purpose]** key to perform a QuickPrint.

## Using the Touch Screen

- 1 To enable the touch screen so it responds to multi-touch gestures, similar to those used on tablets and smart phones, press **[Touch]** or choose **Utilities > User Preferences...** and select the **Enable Touch Screen** check box.
- 2 Touch the drag waveform icon  to highlight it.

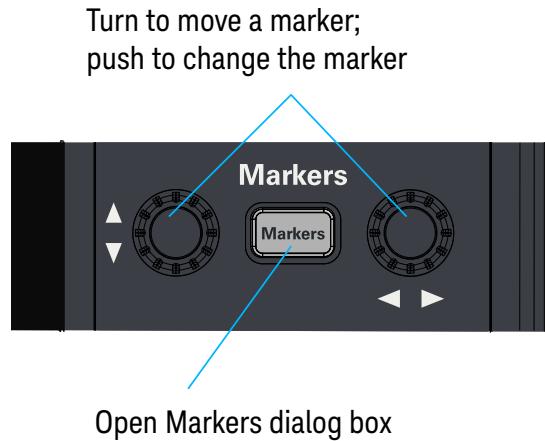
Now you can use gestures to flick items horizontally, drag a waveform vertically, drag horizontally to change the horizontal delay, pinch horizontally to adjust time/div and delay settings, pinch vertically to adjust a waveform's V/div and offset settings, or tap to select waveforms and other selections on the display.

## Using Markers

Use the Markers controls to display and adjust markers.

Markers make it easier to make precise measurements because the marker measurement readouts show exact voltage and time positions for the markers. The measurements are based on actual waveform data from the acquisition system, not on approximations based on the display position, so you can be sure the values are highly accurate.

Using the markers controls, you can control multiple sets of markers within the oscilloscope grid.



**Figure 20** Front panel markers controls

Both time and voltage differences between the markers are updated continuously on the screen. By default, the markers track the source waveform. Voltage measurements from the markers are the value of the waveform at the time set with the marker arrow keys.

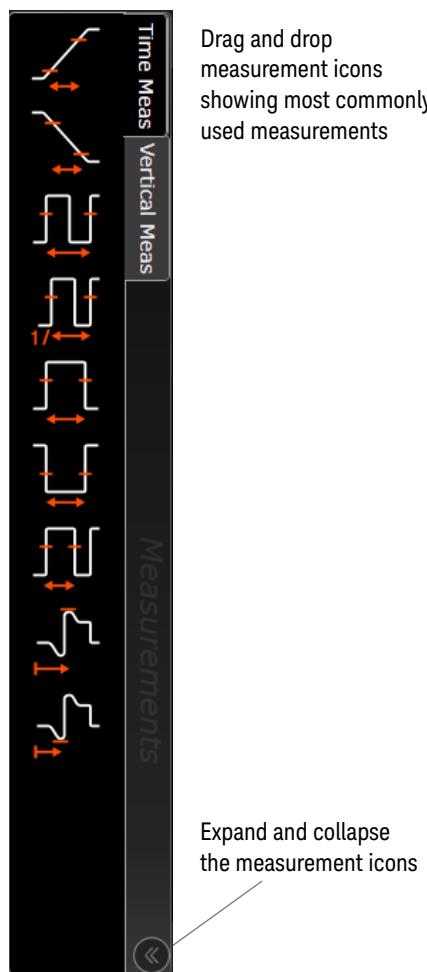
- To add a marker, press the **[Markers]** key or choose **Measure/Mark > Add Markers...** or click the Markers button ; then, select the sources and mode.

Notice the drawing in the **Mode** area of the Marker dialog box.

- To select one of the markers, push one of the marker Position knobs. Turn the knob to move the marker. Push the knob again to select the next marker.
- Marker 1 has a solid line pattern on the waveform display. It is associated with the first available source on the display.
- You can drag a marker to quickly move to the position you want on the waveform.
- You can use the front panel Position knob for fine adjustment, or use the Add Marker dialog box to set the marker position precisely.

## Making Measurements

To make a measurement, either drag a measurement icon to the waveform event you want to measure, or click a measurement icon and use the resulting dialog box to specify which source you want to measure.



**Figure 21** Drag-and-drop measurements

For measurements on waveform features, such as those that involve waveform edges, if you click the measurement icon and specify a source, the measurement defaults to using the feature closest to the horizontal reference point. If you make the measurement using drag and drop, the measurement uses the waveform feature closest to the point where you drop the icon.

The most commonly used measurements are available in the drag-and-drop area. Others are available from the Add Measurement dialog box (**Measure/Mark > Add Measurement...**).

When you drag and drop a measurement icon on a waveform, the icon outline changes color to match the color of each waveform it touches so you can easily see which waveform will be measured.

For edge-sensitive measurements, a circled number appears in the waveform marker color when you drop the measurement icon on a waveform. This number shows exactly where the measurement is being made. It appears next to the measurement readout in the Results pane. This feature helps you distinguish measurement results from each other when you make multiple measurements on the same waveform but at different waveform features.

## Using Quick Measurements

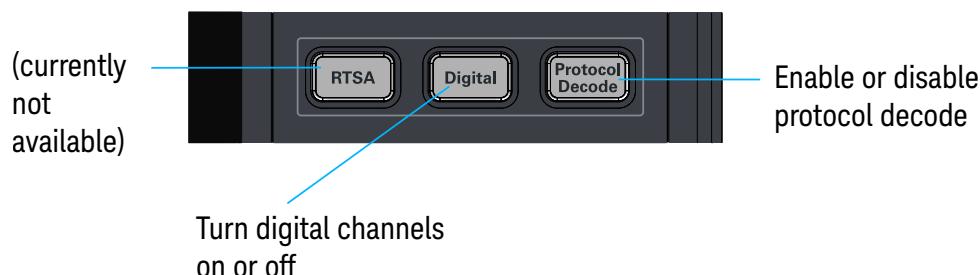
The default **[Multi Purpose]** key action is QuickMeas (see "**[Multi Purpose] Key**" on page 43). With this configuration:

- To turn on the quick measurement display, press **[Multi Purpose]**. The 10 preset measurements defined in the Quick Measurement configuration are enabled and results appear on the screen for the first waveform source.
- To measure parameters for another waveform, press **[Multi Purpose]** until that waveform is the one shown in the measurements window in the Results pane. Continuing to press **[Multi Purpose]** cycles through each of the waveforms available.
- To turn off the quick measurement display, cycle through all channels until the measurements are turned off.

See the Infiniium oscilloscope application's online help for information on how to configure the quick measurement capability. See "**Accessing the Online Help**" on page 53.

## Using Digital Channels and Protocol Decode

On the front panel, just above the Vertical controls, are keys for digital channels and protocol decode.



**Figure 22** Front panel [Digital] and [Protocol Decode] keys

### Controlling Digital Channels

If your oscilloscope's MSO option is enabled, choose **Setup > Digital Channels...** to open the Digital dialog box so you can set up controls for the digital channels.

To turn the digital channels on, click the Add Waveforms button and select the check box next to the , or press **[Digital]**.

### Decoding Serial Protocol Data

- To open the Protocol Decode dialog box so you can define parameters for selected decodes, choose **Setup > Protocol Decode...** or press **[Protocol Decode]**. You can perform up to four decodes at the same time using p1-p4.
- After selecting the protocol decode parameters, click **Auto Setup** to automatically configure the oscilloscope for the selected decode type.
- Decoded acquisition data appears in the Protocol Listing window.

## 3 Demos and Online Help

Using the Demo Wizard / 52

Accessing the Online Help / 53

The graphical user interface has a Demo Wizard that illustrates many oscilloscope features and capabilities. There is also online help that describes oscilloscope features and capabilities in more detail.

## Using the Demo Wizard

Your MXR/EXR-Series oscilloscope comes with a built-in demo wizard that showcases many Infinium oscilloscope features. To see the demos, choose **Demos > Tutorials & Demos...** (or **Help > Tutorials & Demos...**). You can then select a specific demo, such as one for a particular protocol or one for a user interface showing bookmarks.

For example, the following screen display shows the initial demo page for the FFT function. To experiment with the demo, click **Load Demo....**

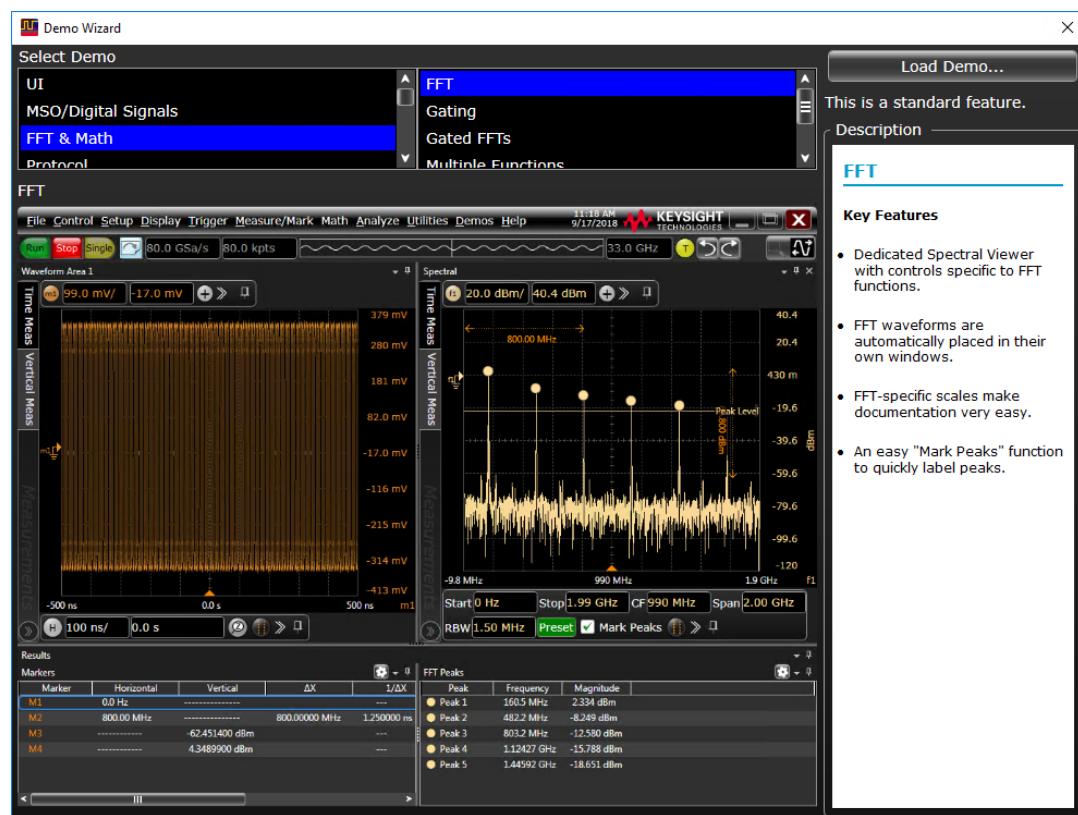
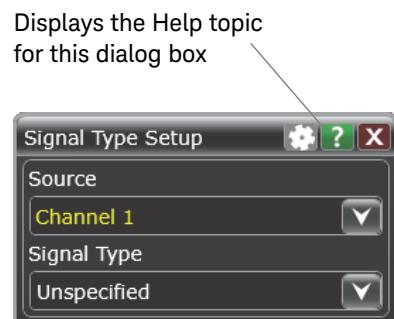


Figure 23 FFT Demo

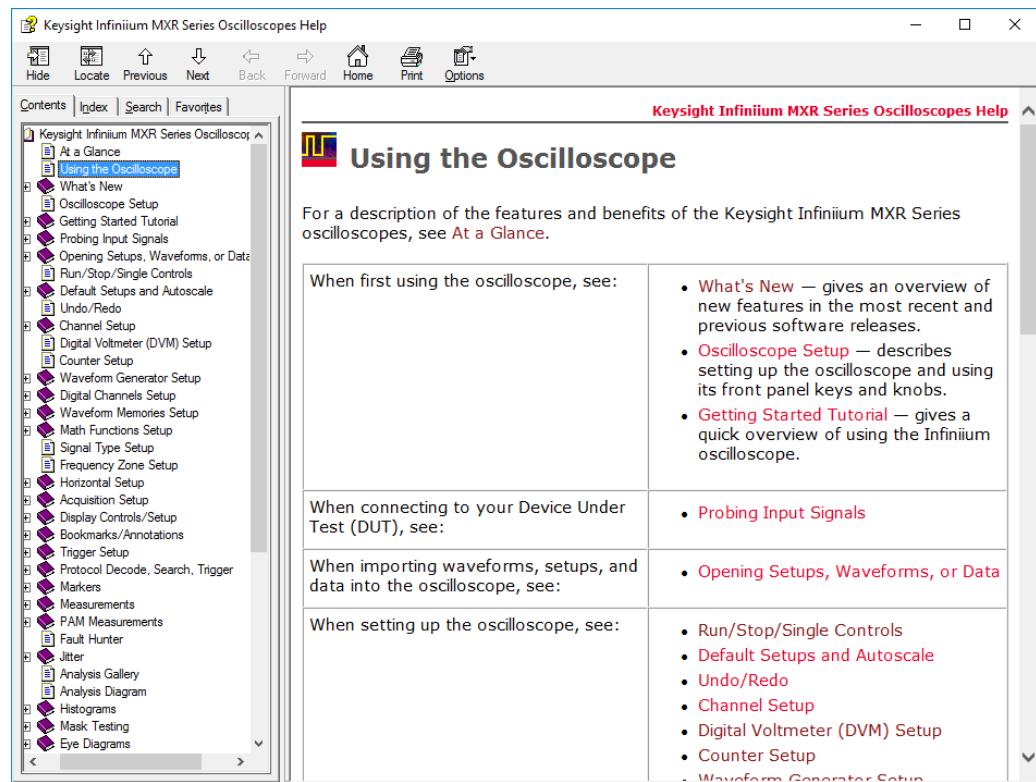
## Accessing the Online Help

There are two ways to access the online help:

- Click the question mark near the top right corner of a dialog box to open the help topic for that dialog box (**Figure 24**).
- Choose **Help > Contents...** from the main menu to open the online help home page (**Figure 25**).



**Figure 24** Help button for dialog box Help



**Figure 25** Online Help home page

There are several ways to find the information you need:

- Use the **Search** tab to search for a word or phrase. Use quotation marks to search for an exact phrase, such as "add waveform".
- Use the **Contents** tab to browse topics by double-clicking topics in the left pane.
- Use the **Index** tab to type in a keyword and search the index for that keyword, or scroll through the alphabetical list to find a topic.
- Use the **Favorites** tab to add preferred help topics to a list for easy reference.

For more details on using online help, click **How to Use This Help** under the **Help and More Information** topic in the **Contents** tab.

## 4 Other Oscilloscope Tasks

Changing Windows Operating System Settings / 56

Installing Application Programs on Infinium / 57

Forcing a Default Setup / 58

Hard Drive Recovery / 59

Cleaning the Oscilloscope / 60

This chapter describes tasks you may need to perform during ongoing use of the oscilloscope.

## Changing Windows Operating System Settings

**NOTE**

Exit the oscilloscope application before changing any Windows operating system settings outside of the oscilloscope application.

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Many Windows operating system settings can be changed to suit your own personal preferences. However, some operating system settings should not be changed because doing so would interfere with the proper operation of the oscilloscope.

- Do not change the Power Options.
- Do not change the Language settings.
- Do not remove Fonts.
- Do not change the screen resolution from 1920 by 1080 pixels.
- Do not use the Administrative Tools to enable or disable Internet Information Services (IIS) Manager. Use the Infinium Remote Setup dialog box (**Utilities > Remote...**) to enable or disable the Web Server.
- Do not delete or modify the Infinium Administrator user account.

## Installing Application Programs on Infinium

The Infinium oscilloscope has an open Windows operating system, which lets you install your own application software. Any application that runs on Microsoft Windows 10 and uses 16 GB of RAM or less may be installed on your Infinium oscilloscope.

**NOTE**

Exit the oscilloscope application before installing any software.

---

**CAUTION**

Installing an application that does not meet these requirements may break the oscilloscope application and require a hard drive recovery.

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## Forcing a Default Setup

If your Infiniium oscilloscope is not working properly when you start it up, follow these steps to perform a default setup and return the Infiniium to normal operation.

- 1 Choose **Control > Default Setup** or press **[Default Setup]**.
- 2 If the oscilloscope is still not working properly, choose **Control > Factory Default** to return the oscilloscope to the default settings it had when it left the factory.
- 3 If the oscilloscope is still not working properly, turn it off.
- 4 Turn the oscilloscope back on. If it does not successfully restart, try recycling the power again.
- 5 As soon as the Windows load screen disappears, press **[Default Setup]**. If the oscilloscope still does not successfully restart, follow the instructions for recovering the hard drive. See "[Hard Drive Recovery](#)" on page 59.

## Hard Drive Recovery

If you need to recover your Infinium oscilloscope hard drive, follow these steps:

- 1** Back up your calibration and license files if they are still accessible:
  - a** If the Infinium application is available, launch the Keysight License Manager (**Utilities > Launch License Manager...**) and capture a screen shot of the page. It lists the transportable and fixed perpetual licenses that Keysight will need to reissue.
  - b** Copy the calibration folder (*C:\ProgramData\Infinium\cal*) to an external device, such as a flash drive.
  - c** Copy the license file (*C:\ProgramData\Infinium\license.dat*), which contains legacy licenses, to an external device.
- 2** Turn off the oscilloscope.
- 3** Make sure a keyboard and mouse are connected to the USB host ports.
- 4** Turn on the oscilloscope and watch closely for the system prompts. As soon as you see the prompt to choose Microsoft Windows or Instrument Image Recovery System, select **Instrument Image Recovery System** and follow the on-screen instructions.
- 5** Once the recovery process is finished and the oscilloscope is running, check in the About Infinium dialog box under installed options to see if all of the options you ordered are installed. If the options are not installed, install them using the license keys provided on the oscilloscope option license certificates you received, or refer to the back of the oscilloscope.
- 6** Restore the calibration folder and license files back to their original locations.
- 7** Restart the oscilloscope application to ensure the license.dat file reflects any factory bandwidth licenses.
- 8** Send an email message to [csg.support@keysight.com](mailto:csg.support@keysight.com). Provide the License Manager screen shot page you captured earlier, the oscilloscope's model and serial number from the rear panel of the scope, and the zip file you created earlier.
- 9** From the oscilloscope desktop, launch the Infinium application. When the application is active, perform an oscilloscope self-test (**Utilities > Self Test...**).

## Cleaning the Oscilloscope

**WARNING**

**To prevent electrical shock, disconnect the Infiniium oscilloscope from mains before cleaning.**

---

Clean the Infiniium oscilloscope with a soft dry cloth or one slightly dampened with a mild soap and water solution to clean the external case parts. Do not attempt to clean internally.

**CAUTION**

**Do not use too much liquid in cleaning the oscilloscope. Water can enter the Infiniium oscilloscope panels, damaging sensitive electronic components.**

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To avoid electrostatic discharge (ESD), wear a grounded wrist strap when cleaning connectors.

**WARNING**

**Use alcohol to clean connectors. The power cord must be removed, and the oscilloscope must be in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to powering up the oscilloscope. Dispose of the cleaning materials in a responsible manner.**

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# 5 Calibrating the Oscilloscope

When to Perform a User Calibration / 62

Equipment Required / 63

Calibration Time / 64

Calibration Procedure / 65

A calibration is simply an oscilloscope self-adjustment. The purpose of a calibration is performance optimization.

There are two ways to calibrate an Infinium MXR/EXR-Series oscilloscope:

- A user calibration, also known as a self calibration, includes the minimum set of calibrations and is intended to be run by oscilloscope users. It can include a time scale calibration.
- A service calibration is performed only by Keysight Service Center technicians.

This chapter describes how to run a user (self) calibration.

## When to Perform a User Calibration

When to perform a user calibration:

- Standard calibration only—When the oscilloscope's operating temperature (after the 30-minute warm-up period) is more than  $\pm 5^{\circ}\text{C}$  different from that of the last calibration. Be sure to perform a standard user calibration (do not perform the time scale cal)—even if one was recently performed—when environmental temperature conditions cause the oscilloscope's operating temperature to change, such as when the oscilloscope is moved to a test rack or chamber.
- Standard and time scale cal—When it has been more than 1 year since the last time scale calibration, or when you replace the acquisition board.

## Equipment Required

Equipment	Critical specifications	Recommended part number
50 Ω BNC Cable	50 Ω characteristic impedance BNC cable	54609-61609
10 MHz Signal Source (required for time scale calibration)	Frequency accuracy better than ±41 ppb	53220A with Opt. 010

## Calibration Time

It takes approximately 70 minutes to run the user calibration on the oscilloscope, including the time required to change cables from channel to channel.

## Calibration Procedure

### NOTE

Performing a user calibration will invalidate the oscilloscope's Certificate of Calibration. If NIST (National Institute of Standards and Technology) traceability is required, perform the procedures in [Chapter 6](#), "Testing Performance," starting on page 67 using traceable sources.

- 1 Let the oscilloscope warm up before running the calibration.

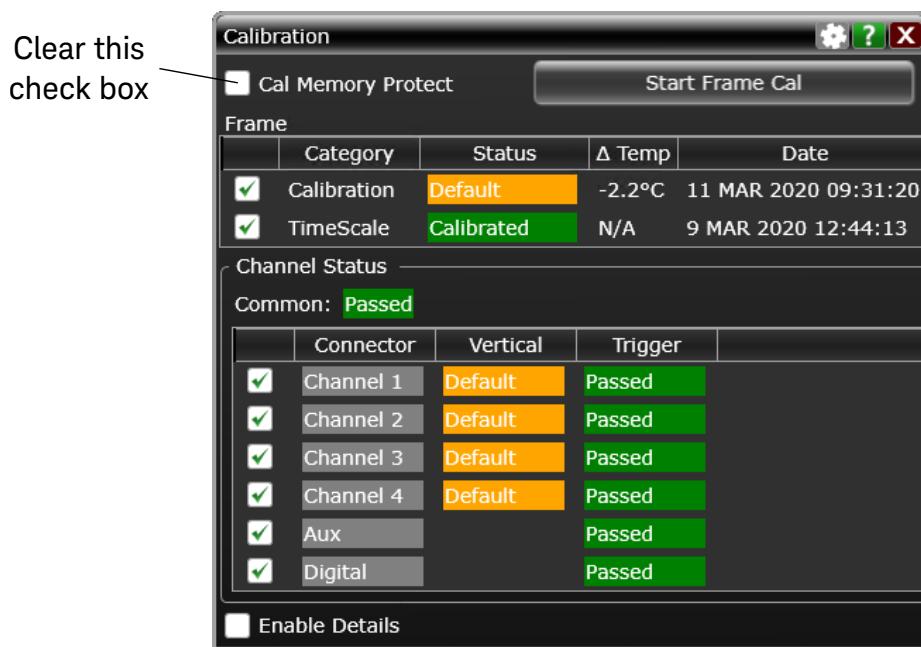
### CAUTION

The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature before starting the calibration procedure. Failure to allow warm up may result in inaccurate calibration.

- 2 Click **Utilities > Calibration....**

- 3 Clear the **Cal Memory Protect** check box.

You cannot run a user calibration if this check box is selected. See the following figure.



- 4 Click **Start Frame Cal**; then, follow the instructions on the screen.

The routine will prompt you to follow these steps:

- Disconnect everything from all inputs and Aux Out.
- Select the level of calibration you want to perform.

- Standard Calibration – Time scale calibration will not be performed. Time scale calibration factors from the previous time scale calibration will be used and the 10 MHz reference signal will not be required. The remaining calibration procedure will continue.
- Standard Calibration and Time Scale Calibration – Time scale calibration will be performed. This option requires you to connect a 10 MHz reference signal to channel 1 that meets the following specifications. Failure to use a reference signal that meets these specifications will result in an inaccurate calibration.
  - Frequency: 10 MHz, max  $\pm 41$  ppb = 10 MHz, max  $\pm 0.41$  Hz
  - Amplitude: 0.2 V peak-to-peak to 5.0 V peak-to-peak
  - Wave shape: Sine or Square

**NOTE**

When performing the time scale calibration using the 53220A-010 universal frequency counter/timer, the precision 10 MHz reference is available from the Int Ref Out connector on the rear panel of the 53220A counter/timer.

- c Connect the 50  $\Omega$  BNC cable from Aux Out to each of the channel inputs as requested.
- d Connect the 50  $\Omega$  BNC cable to Aux Trig In as requested.
- e Follow the directions for calibrating the digital channels (models with MSO option).
- f A Passed/Failed indication is displayed for each calibration section.

If any section has failed, wait until the calibration is complete and then select the **Enable Details** check box for information on the failures. Also check the cable connections.

- 5 When the calibration procedure is complete, click **Close**.

# 6 Testing Performance

Performance Verification General Information / 68
Input Impedance Test / 69
Offset Accuracy Test / 71
DC Gain Accuracy Test / 78
Analog Bandwidth–Maximum Frequency Test / 81
Time Scale Accuracy (TSA) Test / 88
Performance Test Record / 91

Full performance verification for the MXR/EXR-Series oscilloscopes consists of three main procedures:

- 1 Performing the internal oscilloscope self-tests to ensure that the measurement system is functioning properly. To perform the self-tests, click **Utilities > Self Test....** Then select **Scope SelfTest** from the Available Self Test drop-down list box, click **Start**, and follow the on-screen instructions. If any of the self tests fail, ensure that the failure is diagnosed and repaired before calibrating and testing performance.
- 2 Calibrating the oscilloscope, as described in **Chapter 5**, “Calibrating the Oscilloscope,” starting on page 61.
- 3 Testing the oscilloscope to ensure that it is performing to specification. This chapter describes these performance test procedures.

## Performance Verification General Information

### Performance Test Interval

The procedures in this section may be performed for incoming inspection and should be performed periodically to verify that the oscilloscope is operating within specification. The recommended test interval is once per year or after 2000 hours of operation. Performance should also be tested after repairs or major upgrades.

### Performance Test Record

A test record form is provided at the end of this section. This record lists performance tests and test limits, and provides space to record test results.

### Test Order

The tests in this section may be performed in any order. However, we recommend conducting the tests in the order presented, as the order represents an incremental approach to performance verification. This approach may be useful when you are troubleshooting a suspected problem.

### Test Equipment

Lists of equipment needed to conduct each test are provided for each test procedure. The procedures are written to minimize the number and types of test equipment and accessories required. The test equipment in these lists are currently available for sale by Keysight at the time this document was written. In some cases, the test procedures use features specific to the test equipment in the recommended equipment list. However, other equipment, cables, and accessories that satisfy the critical specifications in these lists may be substituted for the recommended models with some modification to the test procedures.

Contact Keysight Technologies for more information about the Keysight products in these lists.

## Input Impedance Test

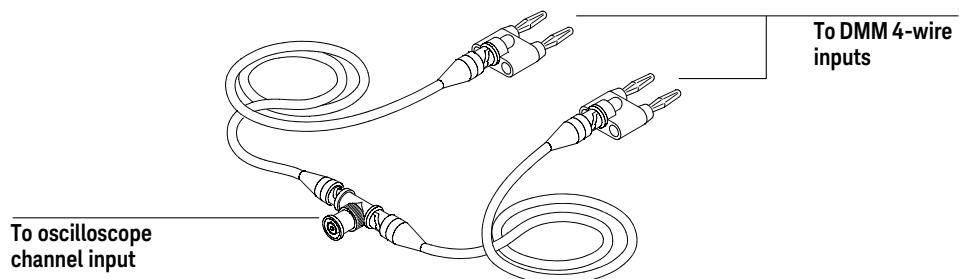
This test checks the input impedance of the vertical inputs. A four-wire measurement is used to accurately measure the 50 Ω and 1 MΩ inputs.

- Specifications**
- 1 MΩ ±1%
  - 50 Ω ±3.5%

**Equipment Required**

Description	Critical specifications	Recommended model or part number
Digital Multimeter	Measure resistance (4-wire) at better than ±0.1% accuracy	34411A, 3458A, or 34465A
Cables (2)	BNC	10503A
Adapter	BNC Tee (m)(f)(f)	1250-0781
Adapters (2)	BNC (f) to dual banana (m)	1251-2277

- Procedure**
- 1 Set up the multimeter to make a four-wire resistance measurement.
  - 2 Assemble the test cables:
    - a Use the two BNC-to-banana adapters to connect one end of each BNC cable to the four-wire resistance connections on the multimeter.
    - b Connect the free ends of the cables to the BNC tee as shown here.



- 3 Connect the male end of the BNC tee to the channel 1 input of the oscilloscope.
- 4 Click **Control > Factory Default** to set the oscilloscope to default conditions.
- 5 Open the Channel dialog box for channel 1 (**Setup > Channel 1...**). Set the scale to 5 mV/div and set the channel input impedance to 50 Ω. Verify a resistance reading of 50 Ω ±1.75 Ω.
- 6 Record the readings in the "Input Impedance Test" table of the "**Performance Test Record**" on page 91.
- 7 Repeat step 5 and step 6 for the remaining 50 Ω vertical scale settings in **Table 6**.

- 8** Repeat step 3 through step 7 on the remaining channels of the oscilloscope.
- 9** Repeat step 3 through step 8 using an input resistance of  $1 \text{ M}\Omega$  instead of  $50 \Omega$  and verify resistance readings of  $1 \text{ M}\Omega \pm 10 \text{ k}\Omega$ .

**NOTE**

Due to the current source limitations of the 34411A/3458A/34465A DMM, be sure to set it to  $10 \text{ M}\Omega$  range instead of Auto Range when testing the  $1 \text{ M}\Omega$  resistance.

---

## Offset Accuracy Test

### CAUTION

Ensure that the input voltage to the oscilloscope never exceeds  $\pm 5$  V.

### NOTE

The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature prior to the start of any performance test.

### Specifications

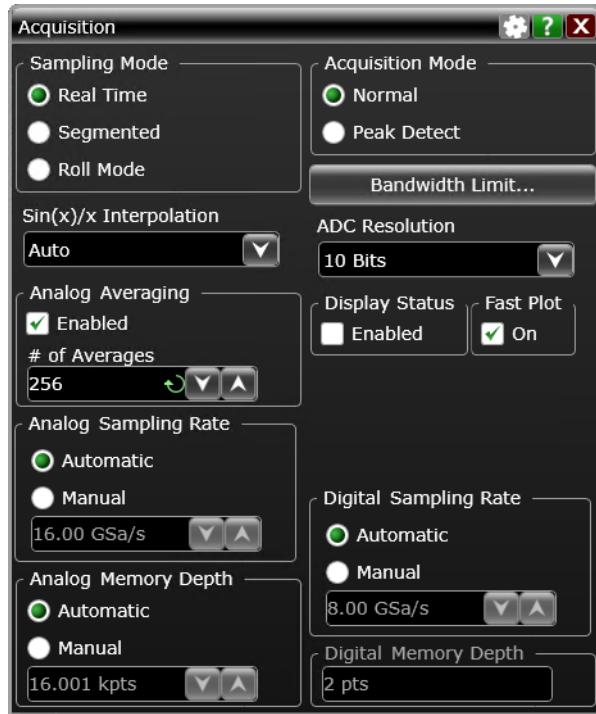
Offset Accuracy	$\pm 0.1$ div $\pm 2$ mV $\pm 1.0\%$ of offset setting for offsets $< 2$ V $\pm 0.1$ div $\pm 2$ mV $\pm 1.5\%$ of offset setting for offsets $\geq 2$ V
<b>50 <math>\Omega</math> Input Impedance:</b> Full scale is defined as 8 vertical divisions. Magnification is used below 2 mV/div. Below 2 mV full scale is defined as 16 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV and 1 V.	
<b>1 M<math>\Omega</math> Input Impedance:</b> Full scale is defined as 8 vertical divisions. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, and 5 V.	

### Equipment Required

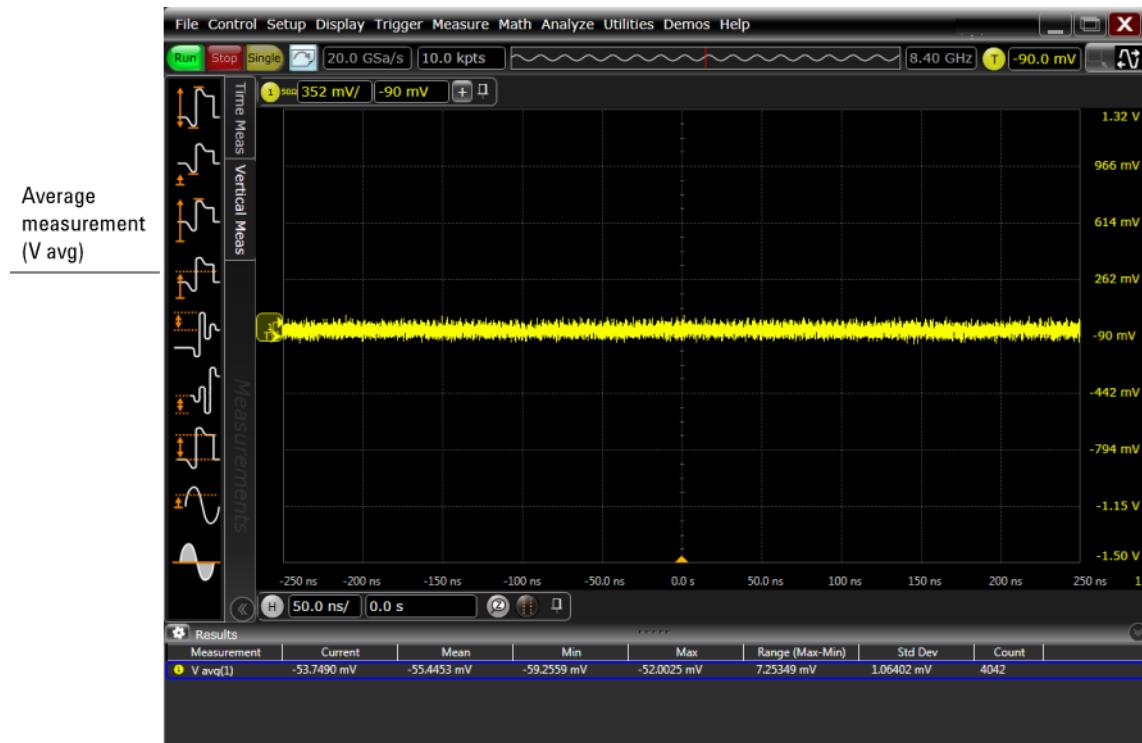
Description	Critical specifications	Recommended model or part number
Digital Multimeter	DC voltage measurement accuracy better than $\pm 0.1\%$ of reading	34411A, 3458A, or 34465A
Cable Assembly (2 required)	50 $\Omega$ characteristic impedance, BNC (m) connectors	8120-1840
DC Power Supply	40 V	6614C
Adapter	BNC Tee (m)(f)(f)	1250-0781
Adapters (2)	BNC (f) to dual banana (m)	1251-2277

### Procedure

- 1 Disconnect all cables from the oscilloscope channel inputs.
- 2 Click **Control > Factory Default**. The input impedance for channel 1 should be 50  $\Omega$ .
- 3 Click **Setup > Acquisition....** In the Acquisition dialog box, enable averaging and set # of Averages to 256.



- 4 Configure the oscilloscope to measure the average voltage (V avg) on channel 1 as follows:
  - a Change the vertical scale of channel 1 to 5 mV/div.
  - b Click the Vertical Meas tab on the left side of the screen, then drag and drop the Average measurement icon onto the channel 1 waveform.



- 5 Press [Clear Display] on the oscilloscope and wait for the number of averages display (top right area of screen) to return to 256. Record the oscilloscope's mean V avg reading in the Vzero-error column of **Table 8** of the Performance Test Record. Use the Channel dialog box to select 1 M $\Omega$  impedance and then repeat step 3 to step 5. Record the reading in **Table 9** for channel 1.

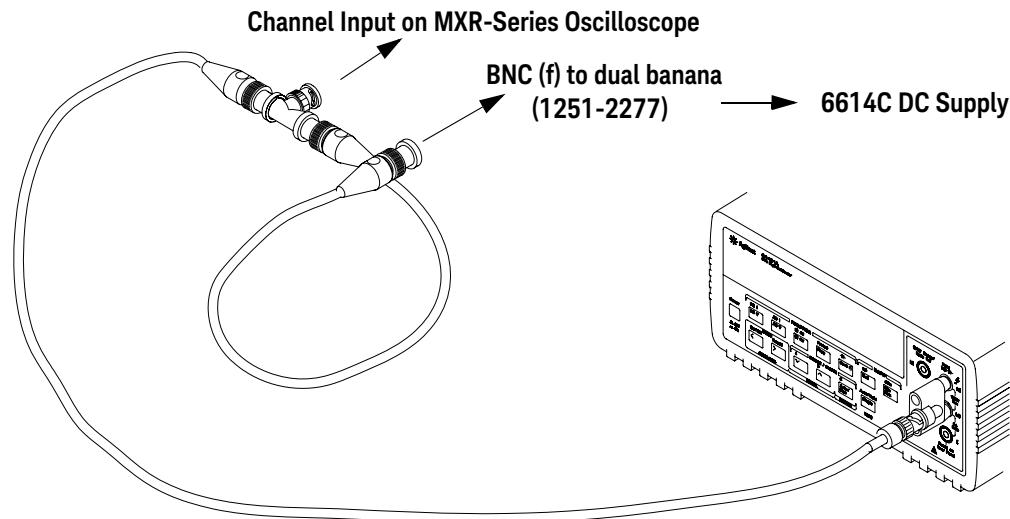
#### NOTE

- For all oscilloscope readings in this procedure, use the mean value in the Measurement Results pane at the bottom of the screen.
- If a question mark appears in front of any values in the Results pane, press [Clear Display] on the oscilloscope, wait for the number of averages to return to 256, and then record the oscilloscope reading. The question mark indicates that the oscilloscope could not make a reliable measurement.



- 6 Change the vertical scale of channel 1 to 10 mV/div, press [**Clear Display**], wait for the number of averages to return to 256, and then record the oscilloscope's mean V avg reading in the Vzero-error column of **Table 8**. Use the Channel dialog box to select 1 MΩ impedance and repeat for 1 MΩ. Record the results in **Table 9**.
- 7 Repeat step 6 for the remaining vertical scale settings for channel 1 in **Table 8** and in **Table 9** of the Performance Test Record.
- 8 Click **Control > Factory Default**, turn off channel 1, and turn the channel 2 display on.
- 9 Configure the oscilloscope to measure V avg on channel 2 as follows:
  - a In the Acquisition dialog box, enable averaging and set # of Averages to 256.
  - b Change the vertical scale of channel 2 to 5 mV/div.
  - c Drag and drop the Average voltage measurement icon onto the channel 2 waveform.
- 10 Press [**Clear Display**] on the oscilloscope, wait for the number of averages to return to 256, and then record the oscilloscope's mean V avg reading in the Vzero-error column of **Table 8**. Use the Channel dialog box to select 1 MΩ impedance and repeat for 1 MΩ. Record the results in **Table 9**.

- 11 Repeat step 9b and step 10 for the remaining vertical scale settings for channel 2.
- 12 Repeat step 8 through step 11 for the remaining channels.
- 13 Ensure that each Vzero-error is less than the corresponding Vzero-error Limit entry in the Offset Accuracy Test table.
- 14 Make the connections to oscilloscope channel 1 as shown below.



#### NOTE

- Where the BNC Tee adapter is used, it is important to connect it directly to the oscilloscope channel input to minimize ground potential differences and to ensure that the DMM measures the input voltage to the oscilloscope channel as accurately as possible. Differences in ground potential can be a significant source of measurement error, particularly at high scope sensitivities.
- It also helps to reduce ground potential differences if the oscilloscope and DMM are connected to the same AC supply circuit.
- 256 averages are used in the oscilloscope measurements of this section to reduce measurement noise and to reduce the measurement error due to resolution.

- 15 Set up the DMM to perform DC voltage measurements.
- 16 Click **Control > Factory Default** to default to channel 1.
- 17 Configure the oscilloscope to measure the average voltage on channel 1 as follows:
  - a Click **Setup > Acquisition....** In the Acquisition dialog box, enable averaging and set # of Averages to 256.
  - b Change the vertical scale of the channel under test to 5 mV/div.
  - c Drag and drop the Average voltage measurement icon onto the channel 1 waveform.

- 18** Using the Channel dialog box, set the channel's offset value to 60.0 mV and the impedance to 50  $\Omega$  (or to an offset of 2 V and the impedance to 1 M $\Omega$  if this is your second pass through this test and you are using the 1 M $\Omega$  input impedance version).



- 19** Set the DC supply voltage (External Supply Setting) to +60.0 mV (or +2 V for the 1 M $\Omega$  version of this test).
- 20** Press [**Clear Display**] on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading as VDMM+ and the scope V avg reading as VSscope+ in either [Table 8](#) or [Table 9](#) (depending on which version of the test you are on). Fill in the Verror+ column by using the following equation:
- $$\text{Verror+} = \text{VDMM+} - \text{VSscope+}$$
- Verror+ must be within the limits specified by the corresponding Offset Accuracy Limit listed in the table.
- 21** Change the channel 1 offset value to -60.0 mV (or -2 V for the 1 M $\Omega$  version of this test).
- 22** Set the DC supply voltage to -60.0 mV (or -2 V for the 1 M $\Omega$  version of this test).
- 23** Press [**Clear Display**] on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading as VDMM- and the scope V avg reading as VSscope- in either [Table 8](#) or [Table 9](#) (depending on

which version of the test you are on). Fill in the Verror- column by using the following equation:

$$V_{\text{error-}} = V_{\text{DMM-}} - V_{\text{scope-}}$$

Verror- must be within the limits specified by the corresponding Offset Accuracy Limit listed in the table.

- 24 Repeat step 17b and step 18 to step 23 for the remaining channel 1 vertical scale settings in [Table 8](#) or [Table 9](#) (depending on which version of the test you are performing). For each measurement, set both the DC supply voltage (External Supply Setting) and the Channel offset voltage to the positive External Supply Setting value and then to the negative External Supply Setting value in the External Supply Setting column of the Offset Accuracy Test table for each of the vertical scale settings.
- 25 Move the Tee connector to the next channel input and repeat step 17 to step 24 for the remaining channels.
- 26 Repeat step 16 through step 25 for the  $1 \text{ M}\Omega$  channel input impedance setting. This means you should follow the directions exactly as stated except in step 18 you will select the  $1 \text{ M}\Omega$  button instead of the  $50 \Omega$  one and all values will be entered in [Table 9](#) of the Performance Test Record rather than [Table 8](#). Also be sure to use the external supply settings and offset values from the  $1 \text{ M}\Omega$  version of the Offset Accuracy Test table as they are different than the  $50 \Omega$  version.

## DC Gain Accuracy Test

**CAUTION**

Ensure that the input voltage to the oscilloscope never exceeds  $\pm 5$  V.

**NOTE**

The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature prior to the start of any performance test.

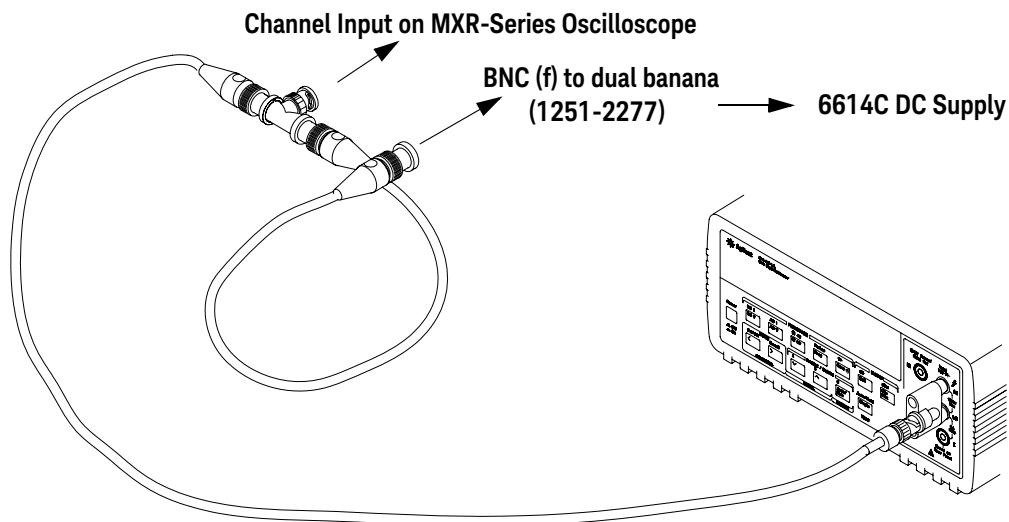
**Specifications**

DC Gain Accuracy	$\pm 2\%$ of full scale at full resolution channel scale ( $\pm 5$ °C from calibration temperature)
<b>50 Ω Input Impedance:</b> Full scale is defined as 8 vertical divisions. Magnification is used below 2 mV/div. Below 2 mV full scale is defined as 16 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV and 1 V.	
<b>1 MΩ Input Impedance:</b> Full scale is defined as 8 vertical divisions. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, and 5 V.	

**Equipment Required**

Description	Critical specifications	Recommended model or part number
Digital Multimeter	DC voltage measurement accuracy better than $\pm 0.1\%$ of reading	34411A, 3458A, or 34465A
Cable Assembly (2 required)	50 Ω characteristic impedance, BNC (m) connectors	8120-1840
DC Power Supply	40 V	6614C
Adapter	BNC Tee (m)(f)(f)	1250-0781
Adapters (2)	BNC (f) to dual banana (m)	1251-2277

**Procedure 1** Make the connections to oscilloscope channel 1 as shown below.



**NOTE**

- Where the BNC Tee adapter is used, it is important to connect it directly to the oscilloscope channel input to minimize ground potential differences and to ensure that the DMM measures the input voltage to the oscilloscope channel as accurately as possible. Differences in ground potential can be a significant source of measurement error, particularly at high scope sensitivities.
- It also helps to reduce ground potential differences if the oscilloscope and DMM are connected to the same AC supply circuit.
- 256 averages are used in the oscilloscope measurements of this section to reduce measurement noise and to reduce the measurement error due to resolution.

- 2 Click **Control > Factory Default**, then configure the oscilloscope as follows:
  - a Click **Setup > Acquisition....**
  - b In the Acquisition dialog box, enable averaging and set # of Averages to 256.
- 3 Set the DC Supply voltage (External Supply Setting) to +15 mV.
- 4 Use the Channel dialog box to set the channel 1 vertical scale to 5 mV/div, and make sure the input impedance is set to  $50 \Omega$ .
- 5 Drag and drop the Average voltage measurement icon onto the channel 1 waveform.
- 6 Press [**Clear Display**] on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading as VDMM+ and the scope mean V avg reading as VScope+ in **Table 10** of the Performance Test Record.
- 7 Change the DC Supply voltage to -15 mV.
- 8 Press [**Clear Display**] on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading (VDMM- column) and

the scope V avg reading (Vscope- column) in **Table 10** of the Performance Test Record.

- 9** Repeat step 8 for the remaining vertical scale settings for channel 1 shown in **Table 10** of the Performance Test Record.
- 10** Click **Control > Factory Default**, turn off channel 1 and turn the channel 2 display on.
- 11** Set the DC Supply voltage (External Supply Setting) to +15 mV.
- 12** Configure the oscilloscope to measure the average voltage on channel 2:
  - a** Click **Setup > Acquisition....** In the Acquisition dialog box, enable averaging and set # of Averages to 256.
  - b** Change the vertical scale of channel 2 to 5 mV/div.
  - c** Drag and drop the Average voltage measurement icon onto the channel 2 waveform.
- 13** Press [**Clear Display**] on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading (VDMM+) and the scope V avg reading (VScope+) in **Table 10** of the Performance Test Record.
- 14** Repeat step 13 for the remaining vertical scale settings for channel 2 in **Table 10** of the Performance Test Record.
- 15** Repeat step 10 through step 14 for the remaining channels.
- 16** Repeat step 2 through step 15 using  $1\text{ M}\Omega$  for the scope input impedance rather than  $50\text{ }\Omega$ . The steps should be followed exactly except in step 4, you should select the  $1\text{ M}\Omega$  button from the Impedance section of the Channel dialog box rather than  $50\text{ }\Omega$  and all values should be entered in **Table 11** rather than **Table 10**.
- 17** Calculate the offset gains for the  $50\text{ }\Omega$  test and the  $1\text{ M}\Omega$  test using the following expression and record these values in **Table 10** and **Table 11** of the Performance Test Record.

$$\text{DC Gain Error} = \frac{\Delta V_{\text{out}}}{\Delta V_{\text{in}}} = \left( \frac{V_{\text{scope+}} - V_{\text{scope-}}}{V_{\text{DMM+}} - V_{\text{DMM-}}} - 1 \right) 75$$

## Analog Bandwidth—Maximum Frequency Test

**CAUTION**

Ensure that the input voltage to the oscilloscope never exceeds  $\pm 5$  V.

**NOTE**

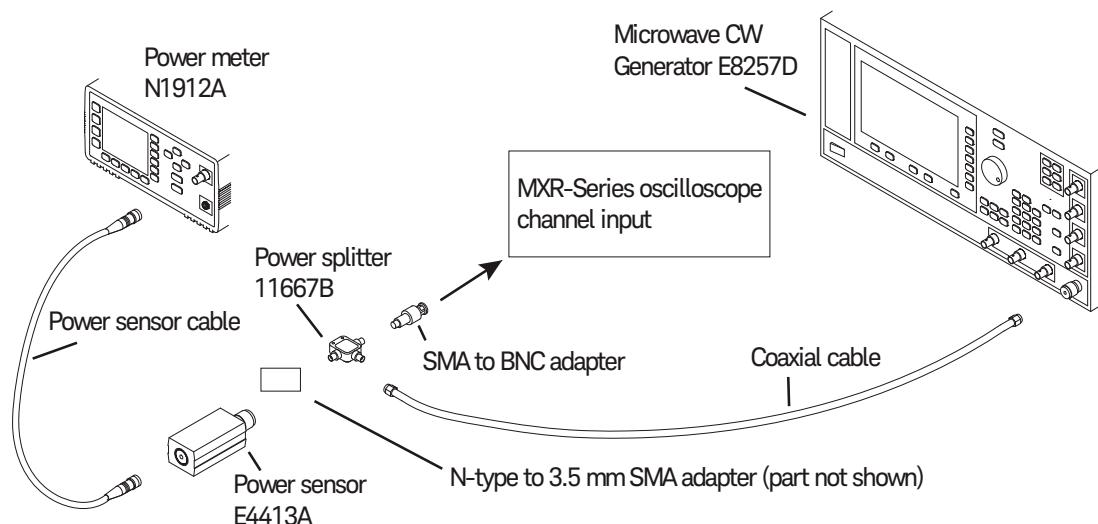
The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature prior to the start of any performance test.

### Specifications

Analog Bandwidth (-3 dB)	
MXR608A, MXR604A, EXR608A, EXR604A	6 GHz
MXR408A, MXR404A, EXR408A, EXR404A	4 GHz
MXR258A, MXR254A, EXR258A, EXR254A	2.5 GHz
MXR208A, MXR204A, EXR208A, EXR204A	2 GHz
MXR108A, MXR104A, EXR108A, EXR104A	1 GHz
MXR058A, MXR054A, EXR058A, EXR054A	500 MHz

Equipment Required	Description	Critical specifications	Recommended model or part number
Microwave CW Generator	Maximum Frequency $\geq$ 14 GHz Power range: -20 dBm to +16 dBm into 50 $\Omega$ Output resistance = 50 $\Omega$		E8257D with Opt 520
Power Sensor Cable			N1912-61020
Power Splitter	2 Resistor Power Splitter (f) Max Frequency $\geq$ 18 GHz		11667B
Power Meter	Keysight P-series with power sensor compatibility		N1912A
Power Sensor	Maximum Frequency $\geq$ 14 GHz Power range: -24 dBm to +16 dBm		E4413A
Coaxial Cable	50 $\Omega$ Characteristic Impedance 3.5 mm (m) to 3.5 mm (m) SMA connectors Max Frequency $\geq$ 8 GHz		8120-4948
N-Type to SMA Adapter	N-type to 3.5 mm (m) SMA		1250-1750
SMA to BNC Adapter	SMA (m) to BNC (m) (No Substitute)		1250-2375

## Connections



**NOTE**

- Connect output 1 of the 11667B splitter to the oscilloscope Channel n input directly using the 1250-2375 adapter, without any additional cabling or adapters.
  - Connect output 2 of the 11667B power splitter to the power sensor using the 1250-1750 N-type to 3.5 mm adapter, without any additional cabling or adapters.
  - Minimize the use of other adapters.
  - Ensure that SMA and 3.5 mm connectors are tightened properly:
    - 8 in-lbs (90 N-cm) for 3.5 mm
    - 5 in-lbs (56 N-cm) for SMA
- 

**Procedure** 1 Preset the power meter.

- 2 Ensure that the power sensor is disconnected from any source and zero the meter.
- 3 Connect the power sensor to the power meter's Power Ref connector and calibrate the meter.
- 4 Make the connections to oscilloscope channel 1 as shown in the preceding connection diagram.
- 5 Set up the power meter to display measurements in units of Watts.
- 6 Click **Control > Factory Default**, then configure the oscilloscope as follows:
  - a Ensure the channel under test is displayed and all other channels are turned off.
  - b In the Channel dialog box, set the vertical scale of the channel under test to 5 mV/div and the input impedance to 50 Ohms.
  - c Set the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).
  - d Click **Setup > Acquisition...** and ensure the acquisition parameters are set up as follows:
    - Sin(x)/x Interpolation = Auto
    - Analog Averaging = Enabled with # of Averages set to 16
    - Analog Memory Depth = Automatic
    - Analog Sampling rate = Maximum (select the Manual button and click the up-arrow as high as it goes)
  - e Click **Measure > Add Measurement....**
  - f In the Add Measurement dialog box, click Vertical and RMS, and configure the measurement as follows:
    - Source = Channel 1
    - Measurement Area = Entire Display
    - RMS Type = AC

- 7** Set the generator to apply a 50 MHz sine wave with a peak-to-peak amplitude of about four divisions.

Use the following table to determine the approximate required signal amplitude.

The amplitude values in the table are not absolutely required. If your generator is unable to produce the recommended amplitude, then set the generator to the highest value that does not produce a vertically clipped signal on the oscilloscope.

**Table 5** Nominal Generator Amplitude Settings

Oscilloscope Vertical Scale	Generator Signal Amplitude (Vp-p)	Generator Signal Amplitude (dBm)
5 mV/div	0.02	-30
10 mV/div	0.04	-24
20 mV/div	0.08	-18
50 mV/div	0.20	-10
100 mV/div	0.40	-4
200 mV/div	0.80	+2
500 mV/div	2.0	+10
1 V/div	4.0	+16

- 8** Measure the input power to the oscilloscope channel and convert this measurement to Volts RMS using the expression:

$$V_{in} = \sqrt{P_{meas} \times 50\Omega}$$

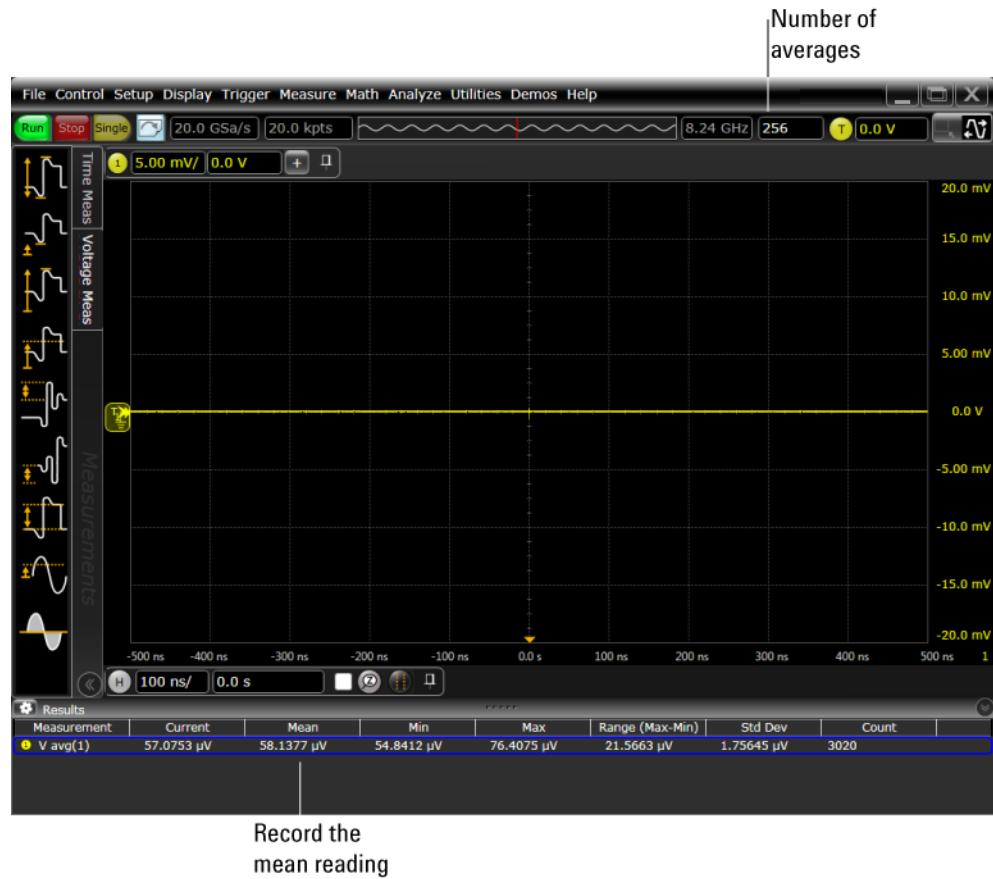
For example, if the power meter reading is 4.0  $\mu$ W, then  $V_{in} = (4.0 \times 10^{-6} \times 50 \Omega)^{1/2} = 14.1$  mVrms.

Record the RMS voltage in **Table 12** of the Performance Test Record (in the  $V_{in}$  @ 50 MHz column).

- 9** Press [**Clear Display**] on the oscilloscope and record the scope V rms reading in **Table 12** of the Performance Test Record ( $V_{out}$  @ 50 MHz column).

#### NOTE

- For all oscilloscope readings in this procedure, use the mean value in the Measurement Results area at the bottom of the screen.
- If a question mark appears in front of any value at the bottom of the screen, press [**Clear Display**] on the oscilloscope, wait for the number of averages to return to 16, and then record the oscilloscope reading.



**10** Calculate the reference gain as follows:

$$\text{Gain}_{50 \text{ MHz}} = \frac{V_{\text{out} @ 50\text{MHz}}}{V_{\text{in} @ 50 \text{ MHz}}}$$

Record this value in the Calculated Gain @50 MHz column in **Table 12** of the Performance Test Record.

**11** Change the generator frequency to the maximum value for the model being tested as shown in the table below. It is not necessary to adjust the signal amplitude at this point in the procedure.

Setting	Model					
	MXR608A, MXR604A, EXR608A, EXR604A	MXR408A, MXR404A, EXR408A, EXR404A	MXR258A, MXR254A, EXR258A, EXR254A	MXR208A, MXR204A, EXR208A, EXR204A	MXR108A, MXR104A, EXR108A, EXR104A	MXR058A, MXR054A, EXR058A, EXR054A
<b>Maximum Frequency</b>	6 GHz	4 GHz	2.5 GHz	2 GHz	1 GHz	500 MHz
<b>Scope Horizontal Scale</b>	150 ps/div	200 ps/div	320 ps/div	400 ps/div	800 ps/div	1.6 ns/div

- 12 Change the oscilloscope horizontal scale to the value for the model under test in the preceding table.
- 13 Measure the input power to the oscilloscope channel at the maximum frequency and convert this measurement to Volts RMS using the expression:

$$V_{in} = \sqrt{P_{meas} \times 50\Omega}$$

For example, if the power meter reading is 4.0  $\mu$ W, then  $V_{in} = (4.0 \times 10^{-6}) / (50 \Omega) / 2 = 14.1$  mVrms.

Record the RMS voltage in **Table 12** of the Performance Test Record ( $V_{in}$  @ Max Freq column).

- 14 Press [**Clear Display**] on the oscilloscope and record the scope V rms reading in **Table 12** of the Performance Test Record ( $V_{out}$  @ Max Freq column).
- 15 Calculate the gain at the maximum frequency using the expression:

$$\text{Gain}_{\text{Max Freq}} = 20 \log_{10} \left[ \frac{(V_{out \text{ Max Freq}}) / (V_{in \text{ Max Freq}})}{\text{Gain}_{50 \text{ MHz}}} \right]$$

For example, if ( $V_{out}$  @ Max Frequency) = 13.825 mV, ( $V_{in}$  @ Max Frequency) = 13.461 mV and Gain @ 50MHz = 1.0023, then:

$$\text{Gain}_{\text{Max Freq}} = 20 \log_{10} \left[ \frac{(13.825 \text{ mV}) / (13.461 \text{ mV})}{1.0023} \right] = 0.212 \text{ dB}$$

Record this value in the Calculated Gain @Max Freq column in **Table 12** of the Performance Test Record. To pass this test, this value must be greater than -3.0 dB.

- 16 Change the scope setup as follows:
  - a Change the channel vertical scale to 10 mV/div.
  - b Reset the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).
- 17 Change the generator output as follows:
  - a Reset the generator frequency to 50 MHz.
  - b Change the amplitude to the value suggested for this scale setting in the Nominal Generator Amplitude Settings table.
- 18 Repeat step 8, step 9, and step 10 to measure the reference gain at 50 MHz for this scale.
- 19 Repeat step 11 through step 15 to measure the gain at maximum frequency for this scale setting.

- 20** Repeat step 15 through step 19 to complete measuring gains for remaining scale settings for channel 1 in **Table 12** of the Performance Test Record.
- 21** For each of the remaining channels, move the splitter to the channel under test and change the oscilloscope configuration as follows:
  - a** Click **Control > Factory Default**.
  - b** Ensure the channel under test is displayed and all other channels are turned off.
  - c** Set the vertical scale of the channel to 5 mV/div.
  - d** Set the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).
  - e** Click **Trigger > Setup Trigger...** and change the source to the channel.
  - f** Click **Measure > Add Measurement...**. Select the Vertical RMS voltage measurement, the channel under test as the source, Entire Display as the Measurement Area, and AC for the RMS Type.
  - g** Repeat step 6d and step 7 to step 20 to complete measuring gains for the channel.

## Time Scale Accuracy (TSA) Test

This procedure verifies the maximum TSA specification for the oscilloscope.

**Description** TSA refers to the absolute accuracy of an oscilloscope's time scale. Because TSA depends directly on frequency of a crystal oscillator, it is comprised of two components: an initial setting accuracy component and an aging component.

The initial setting accuracy component applies to the oscilloscope's 10 MHz OCXO frequency accuracy immediately after a calibration, whether performed at the factory, by a customer, or by a Keysight service center. The aging component scales linearly from the time since the last time scale calibration and adds to the initial setting accuracy component.

**Specifications** TSA is published as a warranted specification, expressed by the following formula. The aging component is specified by the 10 MHz OCXO manufacturer while the initial setting accuracy component is derived from absolute frequency measurements of the 10 MHz OCXO in a large sample of production units after a time scale calibration prior to shipment.

### NOTE

These measurements require the 10 MHz OCXO to be powered on for a minimum of 2 hours.

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Longer is better to further reduce the uncertainty and allow the OCXO frequency to settle onto the aging trajectory of the crystal inside the oscillator.

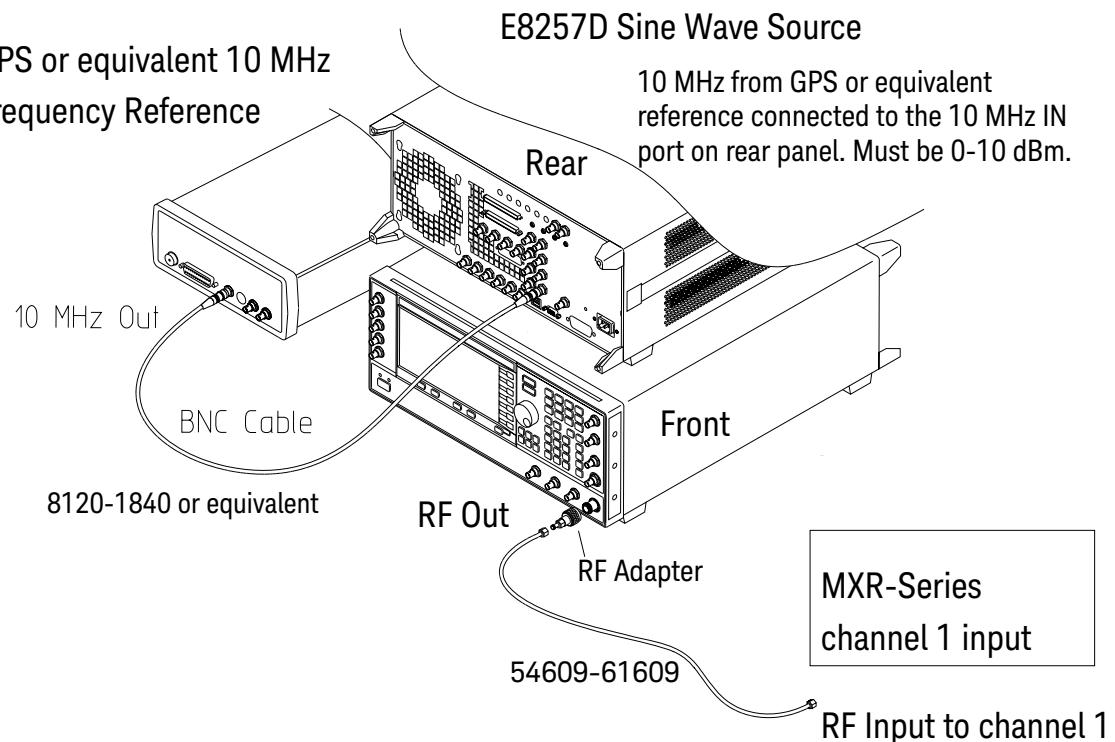
$$\text{TSA} = \pm(8 \text{ ppb initial} + 75 \text{ ppb/year aging})$$

To see the number of years since the last time scale calibration, open the oscilloscope application and click **Utilities > Calibration...**. The TimeScale entry in the Calibration dialog box shows the date of the last time scale calibration.

### Equipment Required

Description	Critical specifications	Recommended model or part number
Synthesized sine wave source	Output Frequency: $\geq 10$ MHz Output Amplitude: 0 dBm Frequency Resolution: 0.1 Hz	E8257D PSG w/opt. 520
10 MHz frequency reference	Output Frequency: 10 MHz Output Amplitude: 0 dBm to 10 dBm Absolute Freq. accuracy: $< \pm 1$ ppb	GPS or equivalent 10 MHz reference
High-frequency cable (provided)	50 ohm characteristic impedance	54609-61609
RF cable	50 ohm characteristic impedance BNC (m) connectors	8120-1840
RF adapter	APC 3.5 (f) to BNC (f) or equivalent For example: APC 3.5 (f) to (f) plus SMA (m) to BNC (f)	

### Connections



- Procedure**
- 1 Make sure the 10 MHz OCXO has been powered on for at least 2 hours, preferably longer if possible.
  - 2 Configure the E8257D sine wave source to output a 0 dBm (633 mVpp) sine wave into 50 ohms with a frequency of 10.00002000 MHz. **Note: Make sure the E8257D is locked to the GPS or equivalent reference.** The EXT REF indicator on the E8257D will be on when locked.
  - 3 Click **Control > Factory Default** on the oscilloscope.
  - 4 Set the vertical scale of channel 1 to 100 mV/div.
  - 5 Set the oscilloscope sampling rate to 100 kSa/s (**Setup > Acquisition...**). (The resulting measurement will be aliased.)
  - 6 Set the horizontal scale of the oscilloscope to 20 ms/div.
  - 7 Set the measurement thresholds for all waveforms to a fixed voltage level of 0 V and  $\pm 20$  mV hysteresis:
    - a Click **Measure > Thresholds...**
    - b Select Custom: level +/- hysteresis from the Thresholds drop-down list box.
    - c Enter 20 mV in the Hysteresis field and 0 V in the Threshold Level field.
  - 8 Enable a frequency measurement on channel 1.
  - 9 On the oscilloscope, press **[Stop]**.
  - 10 Press **[Clear Display]**.
  - 11 Press **[Run]**, wait until 10 acquisitions have accumulated, and then press **[Stop]**.
  - 12 Convert the average frequency value to time scale error by subtracting 20 Hz and dividing by 0.01 Hz/ppb. Record the result in the Measured Time Scale Error (ppb) column of **Table 13** of the Performance Test Record.
  - 13 Record the time since the previous calibration (in years) in the table. Click **Utilities > Calibration...** to find the most recent Time Scale calibration.
  - 14 Calculate the specification for Time Scale Accuracy based on the oscilloscope's last time scale calibration using the following formula:
$$\text{TSA} = \pm(8 \text{ ppb} + 75 \text{ ppb}(\text{years since last time scale calibration}))$$
  - 15 Compare the measured time scale error to the TSA specification.
  - 16 Record the results in **Table 13**.

## Performance Test Record

Model Number:	Tested by:
Serial Number:	Work Order No.:
Recommended Test Interval—1 Year/2000 hours	Date:
Recommended next test date:	Ambient temperature:

**Table 6** Input Impedance Test, Channels 1 through 4

Input Resistance	Vertical Scale	Channel 1	Channel 2	Channel 3	Channel 4	Limits
50 Ω	5 mV/div					48.25 Ω to 51.75 Ω
50 Ω	10 mV/div					48.25 Ω to 51.75 Ω
50 Ω	20 mV/div					48.25 Ω to 51.75 Ω
50 Ω	50 mV/div					48.25 Ω to 51.75 Ω
50 Ω	100 mV/div					48.25 Ω to 51.75 Ω
50 Ω	200 mV/div					48.25 Ω to 51.75 Ω
50 Ω	500 mV/div					48.25 Ω to 51.75 Ω
50 Ω	1 V/div					48.25 Ω to 51.75 Ω
1 MΩ	5 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	10 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	20 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	50 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	100 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	200 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	500 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	1 V/div					990 kΩ to 1.010 MΩ
1 MΩ	2 V/div					990 kΩ to 1.010 MΩ
1 MΩ	5 V/div					990 kΩ to 1.010 MΩ

**Table 7** Input Impedance Test, Channels 5 through 8

Input Resistance	Vertical Scale	Channel 5	Channel 6	Channel 7	Channel 8	Limits
50 Ω	5 mV/div					48.25 Ω to 51.75 Ω
50 Ω	10 mV/div					48.25 Ω to 51.75 Ω
50 Ω	20 mV/div					48.25 Ω to 51.75 Ω
50 Ω	50 mV/div					48.25 Ω to 51.75 Ω
50 Ω	100 mV/div					48.25 Ω to 51.75 Ω
50 Ω	200 mV/div					48.25 Ω to 51.75 Ω
50 Ω	500 mV/div					48.25 Ω to 51.75 Ω
50 Ω	1 V/div					48.25 Ω to 51.75 Ω
1 MΩ	5 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	10 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	20 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	50 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	100 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	200 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	500 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	1 V/div					990 kΩ to 1.010 MΩ
1 MΩ	2 V/div					990 kΩ to 1.010 MΩ
1 MΩ	5 V/div					990 kΩ to 1.010 MΩ

**Table 8** Offset Accuracy Test (50 Ω)

Vertical Scale	Ext. Supply Setting	V <sub>DMM</sub> + -	V <sub>Scop</sub> e+ e-	V <sub>error</sub> + -	V <sub>DMM</sub>	V <sub>Scop</sub>	V <sub>error</sub>	Offset Accuracy Limit (±)	V <sub>zero-error</sub>	V <sub>zero-error</sub> Limit (±)
Channel 1										
5 mV/div	±60 mV						3.1 mV			2.5 mV
10 mV/div	±120 mV						4.2 mV			3.0 mV
20 mV/div	±240 mV						6.4 mV			4.0 mV
50 mV/div	±600 mV						13.0 mV			7.0 mV
100 mV/div	±1.2 V						24.0 mV			12.0 mV
200 mV/div	±2.4 V						58.0 mV			22.0 mV

**Table 8** Offset Accuracy Test ( $50 \Omega$ ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scop e+}$	$V_{error+}$	$V_{DMM-}$	$V_{Scop e-}$	$V_{error-}$	Offset Accuracy Limit ( $\pm$ )	$V_{zero-error}$	$V_{zero-error} Limit (\pm)$
500 mV/div	$\pm 4.0 \text{ V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0 \text{ V}$							162.0 mV		102.0 mV
Channel 2										
5 mV/div	$\pm 60 \text{ mV}$							3.1 mV		2.5 mV
10 mV/div	$\pm 120 \text{ mV}$							4.2 mV		3.0 mV
20 mV/div	$\pm 240 \text{ mV}$							6.4 mV		4.0 mV
50 mV/div	$\pm 600 \text{ mV}$							13.0 mV		7.0 mV
100 mV/div	$\pm 1.2 \text{ V}$							24.0 mV		12.0 mV
200 mV/div	$\pm 2.4 \text{ V}$							58.0 mV		22.0 mV
500 mV/div	$\pm 4.0 \text{ V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0 \text{ V}$							162.0 mV		102.0 mV
Channel 3										
5 mV/div	$\pm 60 \text{ mV}$							3.1 mV		2.5 mV
10 mV/div	$\pm 120 \text{ mV}$							4.2 mV		3.0 mV
20 mV/div	$\pm 240 \text{ mV}$							6.4 mV		4.0 mV
50 mV/div	$\pm 600 \text{ mV}$							13.0 mV		7.0 mV
100 mV/div	$\pm 1.2 \text{ V}$							24.0 mV		12.0 mV
200 mV/div	$\pm 2.4 \text{ V}$							58.0 mV		22.0 mV
500 mV/div	$\pm 4.0 \text{ V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0 \text{ V}$							162.0 mV		102.0 mV
Channel 4										
5 mV/div	$\pm 60 \text{ mV}$							3.1 mV		2.5 mV
10 mV/div	$\pm 120 \text{ mV}$							4.2 mV		3.0 mV
20 mV/div	$\pm 240 \text{ mV}$							6.4 mV		4.0 mV
50 mV/div	$\pm 600 \text{ mV}$							13.0 mV		7.0 mV
100 mV/div	$\pm 1.2 \text{ V}$							24.0 mV		12.0 mV
200 mV/div	$\pm 2.4 \text{ V}$							58.0 mV		22.0 mV
500 mV/div	$\pm 4.0 \text{ V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0 \text{ V}$							162.0 mV		102.0 mV

**Table 8** Offset Accuracy Test ( $50 \Omega$ ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM}^+$	$V_{Scop e+}$	$V_{error}^+$	$V_{DMM}^-$	$V_{Scop e-}$	$V_{error}^-$	Offset Accuracy Limit ( $\pm$ )	$V_{zero-error}$	$V_{zero-error} \text{ Limit } (\pm)$
<b>Channel 5</b>										
5 mV/div	$\pm 60 \text{ mV}$							3.1 mV		2.5 mV
10 mV/div	$\pm 120 \text{ mV}$							4.2 mV		3.0 mV
20 mV/div	$\pm 240 \text{ mV}$							6.4 mV		4.0 mV
50 mV/div	$\pm 600 \text{ mV}$							13.0 mV		7.0 mV
100 mV/div	$\pm 1.2 \text{ V}$							24.0 mV		12.0 mV
200 mV/div	$\pm 2.4 \text{ V}$							58.0 mV		22.0 mV
500 mV/div	$\pm 4.0 \text{ V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0 \text{ V}$							162.0 mV		102.0 mV
<b>Channel 6</b>										
5 mV/div	$\pm 60 \text{ mV}$							3.1 mV		2.5 mV
10 mV/div	$\pm 120 \text{ mV}$							4.2 mV		3.0 mV
20 mV/div	$\pm 240 \text{ mV}$							6.4 mV		4.0 mV
50 mV/div	$\pm 600 \text{ mV}$							13.0 mV		7.0 mV
100 mV/div	$\pm 1.2 \text{ V}$							24.0 mV		12.0 mV
200 mV/div	$\pm 2.4 \text{ V}$							58.0 mV		22.0 mV
500 mV/div	$\pm 4.0 \text{ V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0 \text{ V}$							162.0 mV		102.0 mV
<b>Channel 7</b>										
5 mV/div	$\pm 60 \text{ mV}$							3.1 mV		2.5 mV
10 mV/div	$\pm 120 \text{ mV}$							4.2 mV		3.0 mV
20 mV/div	$\pm 240 \text{ mV}$							6.4 mV		4.0 mV
50 mV/div	$\pm 600 \text{ mV}$							13.0 mV		7.0 mV
100 mV/div	$\pm 1.2 \text{ V}$							24.0 mV		12.0 mV
200 mV/div	$\pm 2.4 \text{ V}$							58.0 mV		22.0 mV
500 mV/div	$\pm 4.0 \text{ V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0 \text{ V}$							162.0 mV		102.0 mV
<b>Channel 8</b>										
5 mV/div	$\pm 60 \text{ mV}$							3.1 mV		2.5 mV

**Table 8** Offset Accuracy Test ( $50\ \Omega$ ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM}^+$	$V_{Scop e+}$	$V_{error}^+$	$V_{DMM}^-$	$V_{Scop e-}$	$V_{error-}$	Offset Accuracy Limit ( $\pm$ )	$V_{zero-error}$	$V_{zero-error} \text{ Limit } (\pm)$
10 mV/div	$\pm 120\ \text{mV}$							4.2 mV		3.0 mV
20 mV/div	$\pm 240\ \text{mV}$							6.4 mV		4.0 mV
50 mV/div	$\pm 600\ \text{mV}$							13.0 mV		7.0 mV
100 mV/div	$\pm 1.2\ \text{V}$							24.0 mV		12.0 mV
200 mV/div	$\pm 2.4\ \text{V}$							58.0 mV		22.0 mV
500 mV/div	$\pm 4.0\ \text{V}$							112.0 mV		52.0 mV
1 V/div	$\pm 4.0\ \text{V}$							162.0 mV		102.0 mV

**Table 9** Offset Accuracy Test ( $1\ M\Omega$ )

Vertical Scale	Ext. Supply Setting	$V_{DMM}^+$	$V_{Scop e+}$	$V_{error}^+$	$V_{DMM}^-$	$V_{Scop e-}$	$V_{error-}$	Offset Accuracy Limit ( $\pm$ )	$V_{zero-error}$	$V_{zero-error} \text{ Limit } (\pm)$
<b>Channel 1</b>										
5 mV/div	$\pm 2\ \text{V}$							32.5 mV		2.5 mV
10 mV/div	$\pm 5\ \text{V}$							78.0 mV		3.0 mV
20 mV/div	$\pm 10\ \text{V}$							154.0 mV		4.0 mV
50 mV/div	$\pm 10\ \text{V}$							157.0 mV		7.0 mV
100 mV/div	$\pm 20\ \text{V}$							312.0 mV		12.0 mV
200 mV/div	$\pm 20\ \text{V}$							322.0 mV		22.0 mV
500 mV/div	$\pm 20\ \text{V}$							352.0 mV		52.0 mV
1 V/div	$\pm 40\ \text{V}$							702.0 mV		102.0 mV
2 V/div	$\pm 40\ \text{V}$							802.0 mV		202 mV
5 V/div	$\pm 40\ \text{V}$							1.102 V		502 mV
<b>Channel 2</b>										
5 mV/div	$\pm 2\ \text{V}$							32.5 mV		2.5 mV
10 mV/div	$\pm 5\ \text{V}$							78.0 mV		3.0 mV
20 mV/div	$\pm 10\ \text{V}$							154.0 mV		4.0 mV
50 mV/div	$\pm 10\ \text{V}$							157.0 mV		7.0 mV
100 mV/div	$\pm 20\ \text{V}$							312.0 mV		12.0 mV
200 mV/div	$\pm 20\ \text{V}$							322.0 mV		22.0 mV

**Table 9** Offset Accuracy Test (1 MΩ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scop e+}$	$V_{error+}$	$V_{DMM-}$	$V_{Scop e-}$	$V_{error-}$	Offset Accuracy Limit ( $\pm$ )	$V_{zero-error}$	$V_{zero-error} \text{ Limit } (\pm)$
500 mV/div	$\pm 20 \text{ V}$							352.0 mV		52.0 mV
1 V/div	$\pm 40 \text{ V}$							702.0 mV		102.0 mV
2 V/div	$\pm 40 \text{ V}$							802.0 mV		202 mV
5 V/div	$\pm 40 \text{ V}$							1.102 V		502 mV
Channel 3										
5 mV/div	$\pm 2 \text{ V}$							32.5 mV		2.5 mV
10 mV/div	$\pm 5 \text{ V}$							78.0 mV		3.0 mV
20 mV/div	$\pm 10 \text{ V}$							154.0 mV		4.0 mV
50 mV/div	$\pm 10 \text{ V}$							157.0 mV		7.0 mV
100 mV/div	$\pm 20 \text{ V}$							312.0 mV		12.0 mV
200 mV/div	$\pm 20 \text{ V}$							322.0 mV		22.0 mV
500 mV/div	$\pm 20 \text{ V}$							352.0 mV		52.0 mV
1 V/div	$\pm 40 \text{ V}$							702.0 mV		102.0 mV
2 V/div	$\pm 40 \text{ V}$							802.0 mV		202 mV
5 V/div	$\pm 40 \text{ V}$							1.102 V		502 mV
Channel 4										
5 mV/div	$\pm 2 \text{ V}$							32.5 mV		2.5 mV
10 mV/div	$\pm 5 \text{ V}$							78.0 mV		3.0 mV
20 mV/div	$\pm 10 \text{ V}$							154.0 mV		4.0 mV
50 mV/div	$\pm 10 \text{ V}$							157.0 mV		7.0 mV
100 mV/div	$\pm 20 \text{ V}$							312.0 mV		12.0 mV
200 mV/div	$\pm 20 \text{ V}$							322.0 mV		22.0 mV
500 mV/div	$\pm 20 \text{ V}$							352.0 mV		52.0 mV
1 V/div	$\pm 40 \text{ V}$							702.0 mV		102.0 mV
2 V/div	$\pm 40 \text{ V}$							802.0 mV		202 mV
5 V/div	$\pm 40 \text{ V}$							1.102 V		502 mV
Channel 5										
5 mV/div	$\pm 2 \text{ V}$							32.5 mV		2.5 mV
10 mV/div	$\pm 5 \text{ V}$							78.0 mV		3.0 mV

**Table 9** Offset Accuracy Test (1 MΩ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scop e+}$	$V_{error+}$	$V_{DMM-}$	$V_{Scop e-}$	$V_{error-}$	Offset Accuracy Limit ( $\pm$ )	$V_{zero-error}$	$V_{zero-error} \text{ Limit } (\pm)$
20 mV/div	$\pm 10 \text{ V}$							154.0 mV		4.0 mV
50 mV/div	$\pm 10 \text{ V}$							157.0 mV		7.0 mV
100 mV/div	$\pm 20 \text{ V}$							312.0 mV		12.0 mV
200 mV/div	$\pm 20 \text{ V}$							322.0 mV		22.0 mV
500 mV/div	$\pm 20 \text{ V}$							352.0 mV		52.0 mV
1 V/div	$\pm 40 \text{ V}$							702.0 mV		102.0 mV
2 V/div	$\pm 40 \text{ V}$							802.0 mV		202 mV
5 V/div	$\pm 40 \text{ V}$							1.102 V		502 mV
Channel 6										
5 mV/div	$\pm 2 \text{ V}$							32.5 mV		2.5 mV
10 mV/div	$\pm 5 \text{ V}$							78.0 mV		3.0 mV
20 mV/div	$\pm 10 \text{ V}$							154.0 mV		4.0 mV
50 mV/div	$\pm 10 \text{ V}$							157.0 mV		7.0 mV
100 mV/div	$\pm 20 \text{ V}$							312.0 mV		12.0 mV
200 mV/div	$\pm 20 \text{ V}$							322.0 mV		22.0 mV
500 mV/div	$\pm 20 \text{ V}$							352.0 mV		52.0 mV
1 V/div	$\pm 40 \text{ V}$							702.0 mV		102.0 mV
2 V/div	$\pm 40 \text{ V}$							802.0 mV		202 mV
5 V/div	$\pm 40 \text{ V}$							1.102 V		502 mV
Channel 7										
5 mV/div	$\pm 2 \text{ V}$							32.5 mV		2.5 mV
10 mV/div	$\pm 5 \text{ V}$							78.0 mV		3.0 mV
20 mV/div	$\pm 10 \text{ V}$							154.0 mV		4.0 mV
50 mV/div	$\pm 10 \text{ V}$							157.0 mV		7.0 mV
100 mV/div	$\pm 20 \text{ V}$							312.0 mV		12.0 mV
200 mV/div	$\pm 20 \text{ V}$							322.0 mV		22.0 mV
500 mV/div	$\pm 20 \text{ V}$							352.0 mV		52.0 mV
1 V/div	$\pm 40 \text{ V}$							702.0 mV		102.0 mV
2 V/div	$\pm 40 \text{ V}$							802.0 mV		202 mV

## 6 Testing Performance

**Table 9** Offset Accuracy Test (1 MΩ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scope+}$	$V_{error+}$	$V_{DMM-}$	$V_{Scope-}$	$V_{error-}$	Offset Accuracy Limit ( $\pm$ )	$V_{zero-error}$	$V_{zero-error}$ Limit ( $\pm$ )
5 V/div	$\pm 40$ V							1.102 V		502 mV
Channel 8										
5 mV/div	$\pm 2$ V							32.5 mV		2.5 mV
10 mV/div	$\pm 5$ V							78.0 mV		3.0 mV
20 mV/div	$\pm 10$ V							154.0 mV		4.0 mV
50 mV/div	$\pm 10$ V							157.0 mV		7.0 mV
100 mV/div	$\pm 20$ V							312.0 mV		12.0 mV
200 mV/div	$\pm 20$ V							322.0 mV		22.0 mV
500 mV/div	$\pm 20$ V							352.0 mV		52.0 mV
1 V/div	$\pm 40$ V							702.0 mV		102.0 mV
2 V/div	$\pm 40$ V							802.0 mV		202 mV
5 V/div	$\pm 40$ V							1.102 V		502 mV

**Table 10** DC Gain Accuracy Test (50 Ω)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scope+}$	$V_{DMM-}$	$V_{Scope-}$	Calculated DC Gain Error	DC Gain Error Test Limits
Channel 1							
5 mV/div	$\pm 15$ mV						$\pm 2$ %
10 mV/div	$\pm 30$ mV						$\pm 2$ %
20 mV/div	$\pm 60$ mV						$\pm 2$ %
50 mV/div	$\pm 150$ mV						$\pm 2$ %
100 mV/div	$\pm 300$ mV						$\pm 2$ %
200 mV/div	$\pm 600$ mV						$\pm 2$ %
500 mV/div	$\pm 1.5$ V						$\pm 2$ %
1 V/div	$\pm 3.0$ V						$\pm 2$ %
Channel 2							
5 mV/div	$\pm 15$ mV						$\pm 2$ %
10 mV/div	$\pm 30$ mV						$\pm 2$ %
20 mV/div	$\pm 60$ mV						$\pm 2$ %

**Table 10** DC Gain Accuracy Test ( $50\ \Omega$ ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scope+}$	$V_{DMM-}$	$V_{Scope-}$	Calculated DC Gain Error	DC Gain Error Test Limits
50 mV/div	$\pm 150\text{ mV}$						$\pm 2\%$
100 mV/div	$\pm 300\text{ mV}$						$\pm 2\%$
200 mV/div	$\pm 600\text{ mV}$						$\pm 2\%$
500 mV/div	$\pm 1.5\text{ V}$						$\pm 2\%$
1 V/div	$\pm 3.0\text{ V}$						$\pm 2\%$
Channel 3							
5 mV/div	$\pm 15\text{ mV}$						$\pm 2\%$
10 mV/div	$\pm 30\text{ mV}$						$\pm 2\%$
20 mV/div	$\pm 60\text{ mV}$						$\pm 2\%$
50 mV/div	$\pm 150\text{ mV}$						$\pm 2\%$
100 mV/div	$\pm 300\text{ mV}$						$\pm 2\%$
200 mV/div	$\pm 600\text{ mV}$						$\pm 2\%$
500 mV/div	$\pm 1.5\text{ V}$						$\pm 2\%$
1 V/div	$\pm 3.0\text{ V}$						$\pm 2\%$
Channel 4							
5 mV/div	$\pm 15\text{ mV}$						$\pm 2\%$
10 mV/div	$\pm 30\text{ mV}$						$\pm 2\%$
20 mV/div	$\pm 60\text{ mV}$						$\pm 2\%$
50 mV/div	$\pm 150\text{ mV}$						$\pm 2\%$
100 mV/div	$\pm 300\text{ mV}$						$\pm 2\%$
200 mV/div	$\pm 600\text{ mV}$						$\pm 2\%$
500 mV/div	$\pm 1.5\text{ V}$						$\pm 2\%$
1 V/div	$\pm 3.0\text{ V}$						$\pm 2\%$
Channel 5							
5 mV/div	$\pm 15\text{ mV}$						$\pm 2\%$
10 mV/div	$\pm 30\text{ mV}$						$\pm 2\%$
20 mV/div	$\pm 60\text{ mV}$						$\pm 2\%$
50 mV/div	$\pm 150\text{ mV}$						$\pm 2\%$
100 mV/div	$\pm 300\text{ mV}$						$\pm 2\%$

**Table 10** DC Gain Accuracy Test ( $50\ \Omega$ ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scope+}$	$V_{DMM-}$	$V_{Scope-}$	Calculated DC Gain Error	DC Gain Error Test Limits
200 mV/div	$\pm 600\text{ mV}$						$\pm 2\%$
500 mV/div	$\pm 1.5\text{ V}$						$\pm 2\%$
1 V/div	$\pm 3.0\text{ V}$						$\pm 2\%$
<b>Channel 6</b>							
5 mV/div	$\pm 15\text{ mV}$						$\pm 2\%$
10 mV/div	$\pm 30\text{ mV}$						$\pm 2\%$
20 mV/div	$\pm 60\text{ mV}$						$\pm 2\%$
50 mV/div	$\pm 150\text{ mV}$						$\pm 2\%$
100 mV/div	$\pm 300\text{ mV}$						$\pm 2\%$
200 mV/div	$\pm 600\text{ mV}$						$\pm 2\%$
500 mV/div	$\pm 1.5\text{ V}$						$\pm 2\%$
1 V/div	$\pm 3.0\text{ V}$						$\pm 2\%$
<b>Channel 7</b>							
5 mV/div	$\pm 15\text{ mV}$						$\pm 2\%$
10 mV/div	$\pm 30\text{ mV}$						$\pm 2\%$
20 mV/div	$\pm 60\text{ mV}$						$\pm 2\%$
50 mV/div	$\pm 150\text{ mV}$						$\pm 2\%$
100 mV/div	$\pm 300\text{ mV}$						$\pm 2\%$
200 mV/div	$\pm 600\text{ mV}$						$\pm 2\%$
500 mV/div	$\pm 1.5\text{ V}$						$\pm 2\%$
1 V/div	$\pm 3.0\text{ V}$						$\pm 2\%$
<b>Channel 8</b>							
5 mV/div	$\pm 15\text{ mV}$						$\pm 2\%$
10 mV/div	$\pm 30\text{ mV}$						$\pm 2\%$
20 mV/div	$\pm 60\text{ mV}$						$\pm 2\%$
50 mV/div	$\pm 150\text{ mV}$						$\pm 2\%$
100 mV/div	$\pm 300\text{ mV}$						$\pm 2\%$
200 mV/div	$\pm 600\text{ mV}$						$\pm 2\%$

**Table 10** DC Gain Accuracy Test ( $50\ \Omega$ ) (continued)

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scope+}$	$V_{DMM-}$	$V_{Scope-}$	Calculated DC Gain Error	DC Gain Error Test Limits
500 mV/div	$\pm 1.5\ V$						$\pm 2\ %$
1 V/div	$\pm 3.0\ V$						$\pm 2\ %$

**Table 11** DC Gain Accuracy Test ( $1\ M\Omega$ )

Vertical Scale	Ext. Supply Setting	$V_{DMM+}$	$V_{Scope+}$	$V_{DMM-}$	$V_{Scope-}$	Calculated DC Gain Error	DC Gain Error Test Limits
<b>Channel 1</b>							
5 mV/div	$\pm 15\ mV$						$\pm 2\ %$
10 mV/div	$\pm 30\ mV$						$\pm 2\ %$
20 mV/div	$\pm 60\ mV$						$\pm 2\ %$
50 mV/div	$\pm 150\ mV$						$\pm 2\ %$
100 mV/div	$\pm 300\ mV$						$\pm 2\ %$
200 mV/div	$\pm 600\ mV$						$\pm 2\ %$
500 mV/div	$\pm 1.5\ V$						$\pm 2\ %$
1 V/div	$\pm 3.0\ V$						$\pm 2\ %$
2 V/div	$\pm 6.0\ V$						$\pm 2\ %$
5 V/div	$\pm 15.0\ V$						$\pm 2\ %$
<b>Channel 2</b>							
5 mV/div	$\pm 15\ mV$						$\pm 2\ %$
10 mV/div	$\pm 30\ mV$						$\pm 2\ %$
20 mV/div	$\pm 60\ mV$						$\pm 2\ %$
50 mV/div	$\pm 150\ mV$						$\pm 2\ %$
100 mV/div	$\pm 300\ mV$						$\pm 2\ %$
200 mV/div	$\pm 600\ mV$						$\pm 2\ %$
500 mV/div	$\pm 1.5\ V$						$\pm 2\ %$
1 V/div	$\pm 3.0\ V$						$\pm 2\ %$
2 V/div	$\pm 6.0\ V$						$\pm 2\ %$
5 V/div	$\pm 15.0\ V$						$\pm 2\ %$
<b>Channel 3</b>							

**Table 11** DC Gain Accuracy Test (1 MΩ) (continued)

Vertical Scale	Ext. Supply Setting	V <sub>DMM+</sub>	V <sub>Scope+</sub>	V <sub>DMM-</sub>	V <sub>Scope-</sub>	Calculated DC Gain Error	DC Gain Error Test Limits
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 4							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 5							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %

**Table 11** DC Gain Accuracy Test (1 MΩ) (continued)

Vertical Scale	Ext. Supply Setting	V <sub>DMM+</sub>	V <sub>Scope+</sub>	V <sub>DMM-</sub>	V <sub>Scope-</sub>	Calculated DC Gain Error	DC Gain Error Test Limits
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 6							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 7							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 8							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %

## 6 Testing Performance

**Table 11** DC Gain Accuracy Test (1 MΩ) (continued)

Vertical Scale	Ext. Supply Setting	V <sub>DMM+</sub>	V <sub>Scope+</sub>	V <sub>DMM-</sub>	V <sub>Scope-</sub>	Calculated DC Gain Error	DC Gain Error Test Limits
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %

**Table 12** Analog Bandwidth—Maximum Frequency Test

Vertical Scale	Measurement					
	Vin @ 50 MHz	Vout @ 50 MHz	Calculated Gain @ 50 MHz	Vin @ Max Freq	Vout @ Max Freq	Calculated Gain @ Max Freq Test Limit is > -3dB
<b>Channel 1</b>						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
<b>Channel 2</b>						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						

**Table 12** Analog Bandwidth–Maximum Frequency Test (continued)

Vertical Scale	Measurement					
	Vin @ 50 MHz	Vout @ 50 MHz	Calculated Gain @ 50 MHz	Vin @ Max Freq	Vout @ Max Freq	Calculated Gain @ Max Freq Test Limit is > -3dB
500 mV/div						
1 V/div						
Channel 3						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
Channel 4						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
Channel 5						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						

**Table 12** Analog Bandwidth–Maximum Frequency Test (continued)

Vertical Scale	Measurement					
	Vin @ 50 MHz	Vout @ 50 MHz	Calculated Gain @ 50 MHz	Vin @ Max Freq	Vout @ Max Freq	Calculated Gain @ Max Freq Test Limit is > -3dB
1 V/div						
Channel 6						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
Channel 7						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
Channel 8						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						

**Table 13** Time Scale Accuracy

Measured Time Scale Error (ppb)	Years Since Calibration	Calculated TSA Spec	Pass/Fail



# 7 Troubleshooting

Verifying Basic Operation / 110

Before You Contact Keysight / 115

Returning the Oscilloscope to Keysight for Service / 116

This chapter describes what to do if you encounter any problems with your MXR/EXR-Series oscilloscope.

**WARNING**

**There are no operator-serviceable parts inside the oscilloscope. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

---

## Verifying Basic Operation

Follow the procedures in this section to verify the basic operation of the oscilloscope. Where problems occur, you are directed to the section that provides detailed troubleshooting help.

### Power Up the oscilloscope

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

The power cord is the disconnecting device for Mains. Position the equipment so the power cord is easily reached by the operator.

Use *only* the power cord that came with the oscilloscope.

The power cord provided is matched to the country of origin.

- 2 Press the power button in the lower left corner of the front panel. If the oscilloscope is working properly, it will take several minutes to start up, and the grid will appear on the screen. The exact appearance may look slightly different than shown below, depending on the setup selected before the oscilloscope was turned off.



If the oscilloscope turns off without you pressing the front panel power button, unplug the AC power cord from the rear of the instrument and wait 20 to 30 seconds. Then plug the AC power cord back into the oscilloscope and press the

front panel power button. (Or, you can perform a hard shutdown by holding the power button down for 5-6 seconds so the power turns off, and then pressing the power button again to restart the oscilloscope.)

## Run the oscilloscope self tests

Running the oscilloscope self tests performs a series of internal procedures to verify that the oscilloscope is working properly.

- 1 Click **Utilities > Self Test....**
- 2 Select **Scope SelfTest** from the Available Self Tests drop-down list box.
- 3 Click **Start** and follow the instructions on the screen.

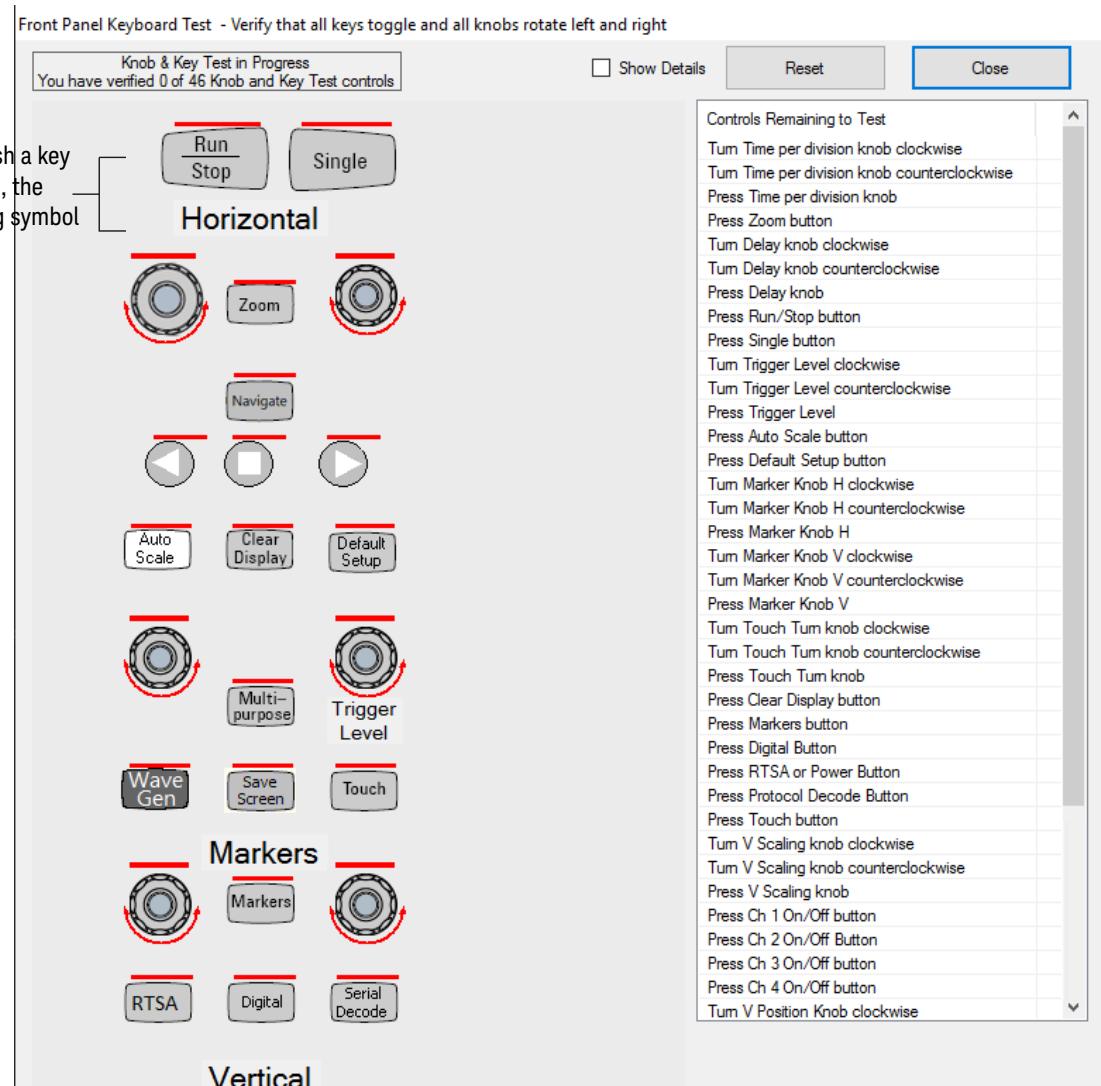
If any of the self tests fail, see "[Before You Contact Keysight](#)" on page 115 and "[Returning the Oscilloscope to Keysight for Service](#)" on page 116.

## Run the keyboard, LED, and touch screen self tests

To verify correct keyboard operation:

- 1 Click **Utilities > Self Test....**
- 2 Select **Keyboard Test** from the drop-down list box, then click **Start**.

The Front Panel Keyboard Test window appears, showing a symbolic representation of the keyboard.



- 3 Press each key on the keyboard until you have pressed all keys. When you press a key or push a knob, the bar above the corresponding key/knob symbol on the display should change from red to green.
- 4 Turn each knob in both directions until you have turned all knobs. When you turn a knob in one direction, half the rotation arrow under the corresponding knob symbol should turn green. When you then turn the knob in the other direction, the entire rotation arrow under the knob symbol should turn green.
- 5 When you are finished, click **Close**.

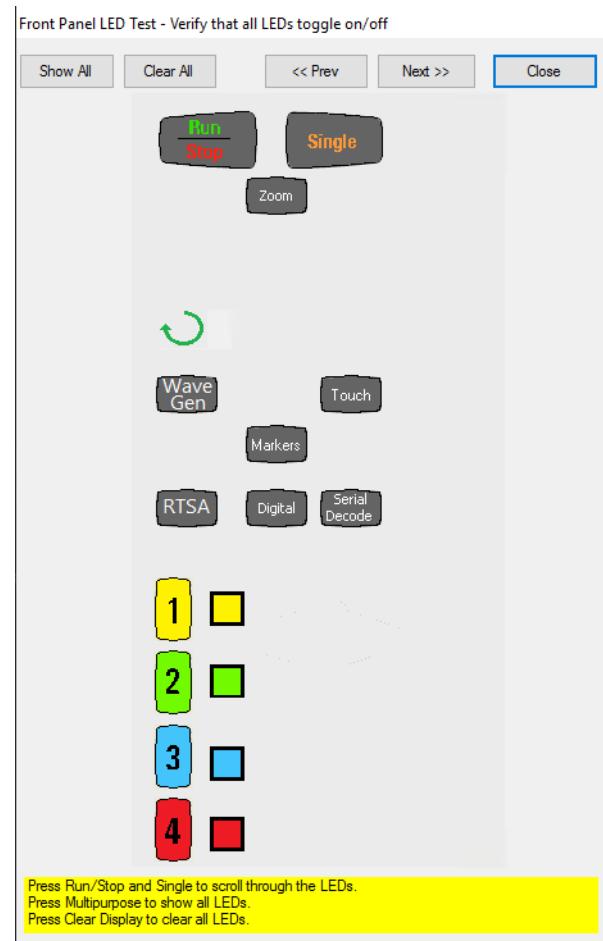
If any of the knobs or keys do not work, see "[Before You Contact Keysight](#)" on page 115 and "[Returning the Oscilloscope to Keysight for Service](#)" on page 116.

## To test the front panel LED indicators

To test the front panel LED indicators:

- 1 Click **Utilities > Self Test....**
- 2 Select **LED Test** from the drop-down list box, then click **Start**.

The Front Panel LED Test window appears, showing a symbolic representation of all front panel LED indicators.



- 3 Repeatedly press the **[Single]** button on the front panel to step through and highlight each LED symbol in the test screen. You can also step through the LEDs by pressing the **<<Prev** or **Next>>** buttons on the display screen. Verify that the corresponding LEDs on the front panel are the only ones illuminated. Pressing the **[Multi Purpose]** button on the front panel illuminates all the LEDs, and pressing **[Clear Display]** turns off all the LEDs.
- 4 When you are finished, click **Close**.

If any of the LEDs do not work, see "[Before You Contact Keysight](#)" on page 115 and "[Returning the Oscilloscope to Keysight for Service](#)" on page 116.

### To verify correct touch screen operation

To verify correct touch screen operation:

- 1 Click **Utilities > Self Test....**
- 2 Select **Touch Screen Test** from the Available Self Tests drop-down list box, then click **Start** and follow the on-screen instructions.

If the touch screen is not working properly, see "[Before You Contact Keysight](#)" on page 115 and "[Returning the Oscilloscope to Keysight for Service](#)" on page 116.

### Run a user calibration

- 1 Complete a user calibration by following the procedures in [Chapter 5](#), "Calibrating the Oscilloscope," starting on page 61.
- 2 If the calibration test fails, see "[Before You Contact Keysight](#)" on page 115 and "[Returning the Oscilloscope to Keysight for Service](#)" on page 116.

### Verify system performance

After you have verified the basic operation of the oscilloscope, you need to verify that it meets all warranted specifications by following the procedures in [Chapter 6](#), "Testing Performance," starting on page 67.

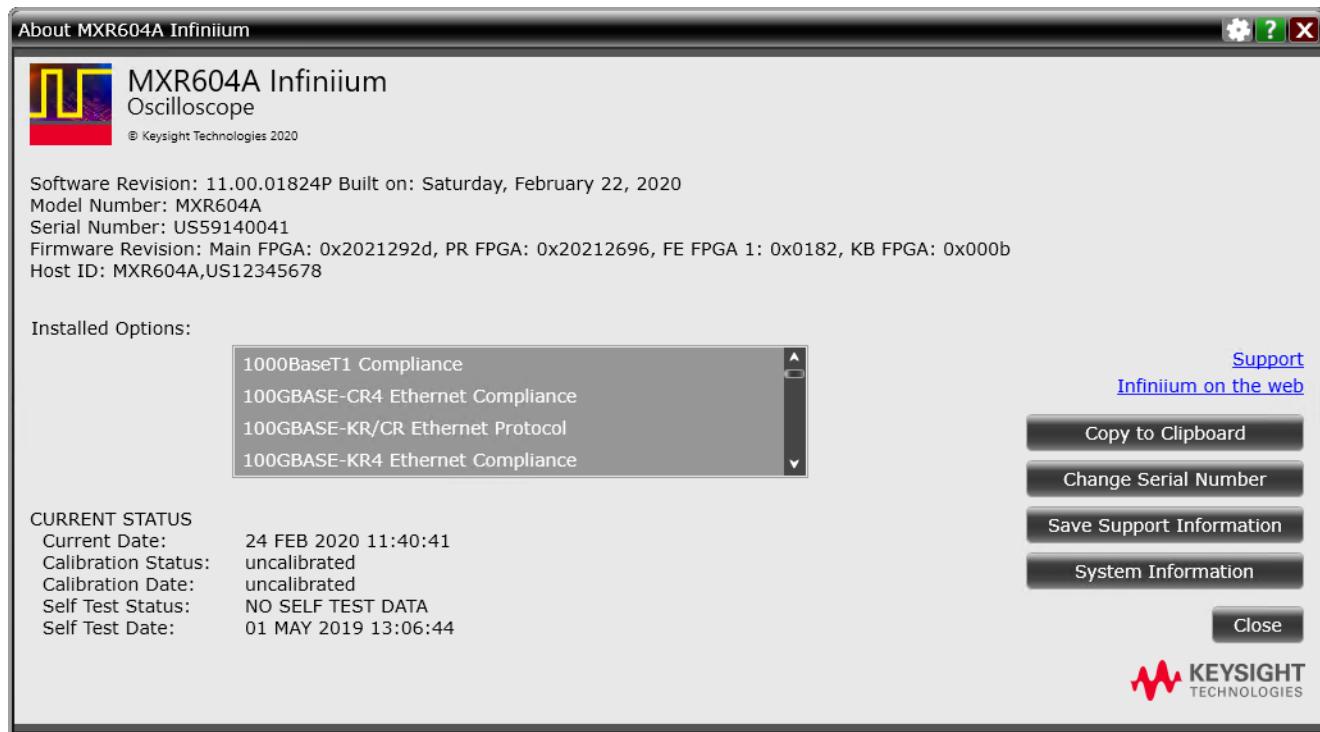
## Before You Contact Keysight

If you have read this Troubleshooting chapter and have unresolved questions about troubleshooting the oscilloscope, be ready to provide system information such as the current software version and installed options. This information will be useful when you contact Keysight Technologies.

To find and save system information, follow these steps:

- 1 Click **Help > About Infiniium....**

A dialog box similar to this one appears.



- 2 Click **Save Support Information**. A zip file containing useful information is created and saved to the desktop. You can email this file to your Keysight Technical Support representative.

## Returning the Oscilloscope to Keysight for Service

Before shipping the oscilloscope, contact Keysight Technologies for more details.

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

- name and address of owner
- oscilloscope model numbers
- oscilloscope serial numbers
- description of the service required or failure indications

**2** Remove all accessories from the oscilloscope.

Accessories include all cables. Do not include accessories unless they are associated with the failure symptoms.

**3** Protect the oscilloscope by wrapping it in plastic or heavy paper.

**4** Pack the oscilloscope in foam or other shock-absorbing material and place it in a strong shipping container.

If the original shipping materials are not available, place 8 to 10 cm (3 to 4 inches) of shock-absorbing material around the oscilloscope and place it in a box that does not allow movement during shipping.

**5** Seal the shipping container securely.

**6** Mark the shipping container as FRAGILE.

In any correspondence, refer to the oscilloscope by model number and full serial number.

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