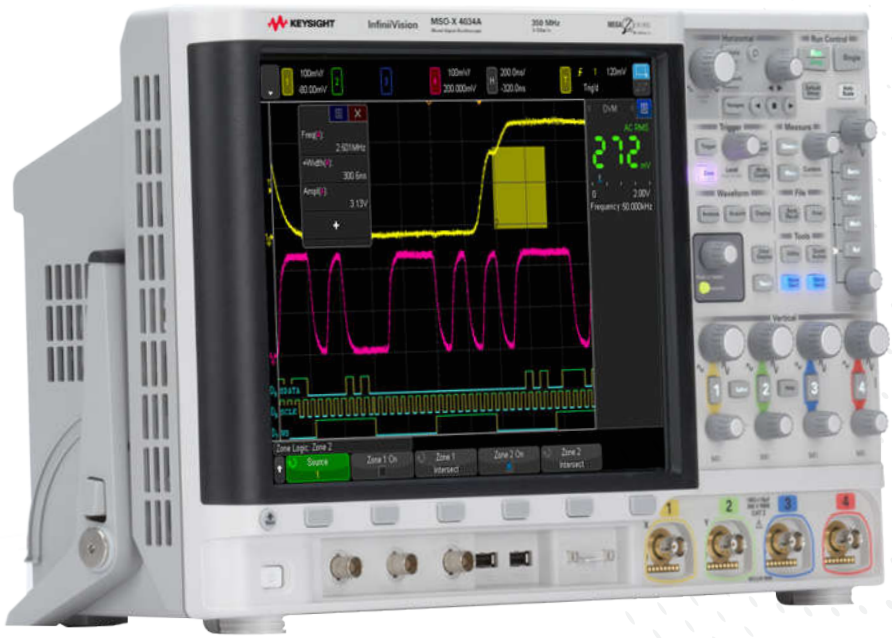
DATA SHEET

InfiniiVision 4000 X-Series Oscilloscopes



KEYSIGHT TECHNOLOGIES

Table of Contents

Oscilloscope Experience Redefined: Experience the Speed, Usability, and Integration 3

Oscilloscope Experience Redefined: Experience the Speed 5

Oscilloscope Experience Redefined: Experience the Usability 9

Oscilloscope Experience Redefined: Experience the Integration 11

Oscilloscope Experience Redefined: Other Key Productivity Tools 14

Oscilloscope Experience Redefined 22

Oscilloscope Experience Redefined: Configuring Your InfiniiVision 4000 X-Series Oscilloscope 24

Oscilloscope Experience Redefined: InfiniiVision 4000 X-Series Performance Characteristics 26

Oscilloscope Experience Redefined: License-only Bandwidth Upgrades and Measurement Applications 35

Oscilloscope Experience Redefined: Return-to-Keysight Service Center Bandwidth Upgrades 36

Keysight Oscilloscopes 37



Need more bandwidth, sampling rate, and analysis?

Consider the Infiniium 6000 X-Series

- 1, 2.5, 4, and 6 GHz
- 20 GSa/s
- Ultra-low noise at 1 mV/div
- 12.1-inch multi-touch capacitive display with gesture support
- Standard color grade, histogram, and enhanced FFT
- Optional jitter and real-time eye diagram analysis

See **www.keysight.com/find/6000X-Series** for more details.

Oscilloscope Experience Redefined: Experience the Speed, Usability, and Integration

Imagine an oscilloscope that sees everything, triggers on anything, has the ease-of-use of a tablet device...and grows with your projects.

The Keysight Technologies, Inc. 4000 X-Series oscilloscopes are engineered for next-generation performance, delivering waveform update rates 20 times faster than the competition to display the most signal detail. An industry-leading 12.1-inch capacitive touch screen with innovative hardware-based zone touch triggering provides the most intuitive interface to get you answers faster. The 4000 X-Series provides maximum investment protection with fully upgradable 5-instruments-in-1.

Experience the speed

Anomalies and elusive events are the toughest to debug. The 4000 X-Series oscilloscope redefines your debugging experience with MegaZoom IV smart memory technology. The industry-leading 1-million-waveforms-per-second update rate, means you see more of your signal behavior and can feel more confident in your design.

Experience the usability

You may be surprised just how easy it is to use the InfiniiVision 4000 X-Series. A 12.1-inch capacitive touch screen – the industry's largest – works just like your favorite tablet or smart phone, so debugging your devices is faster than ever before. Innovative zone touch triggering makes triggering on anything a snap. Just draw a box around signals of interest and the oscilloscope triggers on them. So, if you can see it, you can trigger on it.

Experience the integration

The 4000 X-Series further redefines your oscilloscope experience by integrating the capabilities of seven instruments in one: oscilloscope channels, logic channels, digital voltmeter (DVM), dual-channel WaveGen function/arbitrary waveform generator, frequency response analyzer, 8-digit hardware counter, and serial protocol analyzer including USB. All are upgradable, including bandwidth, for the ultimate investment protection.

best electronic design 2012

BEST IN TEST 2013 FINALIST

4000 X-Series – Oscilloscope experience redefined

Key features:

- Experience the speed:
  - One million waveforms per second update rate
  - MegaZoom IV smart memory technology
  - Standard segmented memory
- Experience the usability:
  - Industry's first capacitive touch screen
  - Industry's largest 12-inch display
  - Zone touch trigger
- Experience the integration:
  - Industry's first 5 instruments in 1
  - Industry's first fully upgradable including bandwidth to 1.5 GHz
  - Industry's leading application solutions



Figure 1. MegaZoom IV smart memory technology enables the speed, usability, and integration.



Figure 2. Take advantage of a new oscilloscope application bundle that will enable ALL software applications (including serial decode and WaveGen) for one low price (Option DSOX4APPBNDL).

Oscilloscope Experience Redefined: Experience the Speed, Usability, and Integration (Continued)

Overview of Keysight InfiniiVision X-Series oscilloscopes

InfiniiVision	6000 X-Series	4000 X-Series	3000T X-Series	2000 X-Series	1000 X-Series
Analog channels	2 or 4	2 or 4	2 or 4	2 or 4	2
Digital channels	16 (MSO models or upgrade)	16 (MSO models or upgrade)	16 (MSO models or upgrade)	8 (MSO models or upgrade)	External trigger can be used as a 3rd digital channel
Bandwidth	1, 2.5, 4, 6 GHz	200, 350, 500 MHz, 1, 1.5 GHz	100, 200, 350, 500 MHz, 1 GHz	70, 100, 200 MHz	50, 70, 100 MHz
Max sample rate	20 GSa/s	5 GSa/s	5 GSa/s	2 GSa/s	2 GSa/s
Max memory depth	4 Mpts	4 Mpts	4 Mpts	1 Mpts (standard)	1 Mpts
Max waveform update rate	> 450,000 wfms/sec	> 1,000,000 wfms/sec	> 1,000,000 wfms/sec	> 200,000 wfms/sec	> 50,000 wfms/sec
Display	12.1-inch, capacitive touch	12.1-inch, capacitive touch	8.5-inch, capacitive touch	8.5-inch	7 inch
Zone touch trigger	Standard	Standard	Standard	No	No
Voice control	Standard	No	No	No	No
WaveGen 20-MHz function/arbitrary waveform generator	Dual-channel AWG (option)	Dual-channel AWG (option)	Single-channel AWG (option)	Single-channel function (option)	Single-channel function (on G models)
Integrated DVM	Standard	Standard	Standard	Standard	**Free with registration**
Integrated hardware counter (standard)	10-digit frequency, period, or totalizer counter	5-digit frequency or period counter (8 digits with external 10 MHz clock reference)	8-digit frequency, period, or totalizer counter	5-digit frequency counter	5 digits
Search and navigate	Standard, lister supported	Standard, lister supported	Standard, lister supported	Serial only	No
Segment memory	Standard	Standard	Standard	Standard	Standard on DSO models
Mask/limit test	Option	Option	Option	Option	Standard on DSO models
Serial protocol analysis options	I^2C/SPI, UART/RS232, CAN/CAN-dbc/CAN-FD/ LIN/LIN symbolic, SENT, FlexRay, I^2S, MIL-STD1553, CXPI, ARINC429, USB 2.0, Manchester/NRZ, USB PD	I^2C/SPI, UART/RS232, CAN/CAN-dbc/CAN-FD/ LIN/LIN symbolic, SENT, FlexRay, I^2S, MIL-STD1553, CXPI, ARINC429, USB 2.0, Manchester/NRZ, USB PD	I^2C/SPI, UART/RS232, CAN/CAN-dbc/CAN-FD/ LIN/LIN symbolic, SENT, FlexRay, I^2S, MIL-STD1553, CXPI, ARINC429, Manchester/ NRZ, USB PD	I^2C/SPI, UART, CAN/ LIN (will not operate simultaneously with digital channels)	I^2C/SPI, UART, CAN/LIN
Advanced analysis options	Power analysis, USB 2.0 signal quality test, HDTV analysis, FRA	Power analysis, USB 2.0 signal quality test, HDTV analysis, FRA, NFC	Power analysis, HDTV analysis, FRA, NFC	No	FRA
Color grade	Standard	No	No	No	No
Histogram	Standard	No	No	No	No
FFT	Standard enhanced FFT	Standard enhanced FFT	Standard enhanced FFT	Standard	Standard
Multi-domain analysis	Gated FFT	Gated FFT	Gated FFT	No	No
Jitter analysis with clock recovery	Option	No	No	No	No
Realtime eye diagram	Option	No	No	No	No
Advanced math	Standard, display four functions simultaneously	Standard, display one function	Standard, display one function	Standard, display one function	No
Connectivity	Standard USB 2.0, LAN, video (GPIB option), USB mouse and keyboard support	Standard USB 2.0, LAN, video (GPIB option), USB mouse and keyboard support	Standard USB 2.0 (LAN/ video/GPIB option), USB mouse and keyboard support	Standard USB 2.0 (LAN/ video/GPIB option), USB keyboard support	Standard USB 2.0, USB keyboard support

Oscilloscope Experience Redefined: Experience the Speed

One million waveforms per second update rate

If you can't see the problem, it is hard to troubleshoot it. With an industry-leading one million waveforms per second update rate, the InfiniiVision 4000 X-Series gives you the highest probability of capturing random and infrequent events that you would miss on an oscilloscope with a lower waveform update rate.

Powered by MegaZoom IV smart memory technology, the InfiniiVision 4000 X-Series not only lets you see more waveforms, but it has the uncompromised ability to find the most difficult problems in your design. Unlike other oscilloscopes, uncompromised ability means:

- Always-fast, responsive operation
- No slowdown with logic channels on
- No slowdown with protocol decoding on
- No slowdown with math functions turned on
- No slowdown with measurements turned on

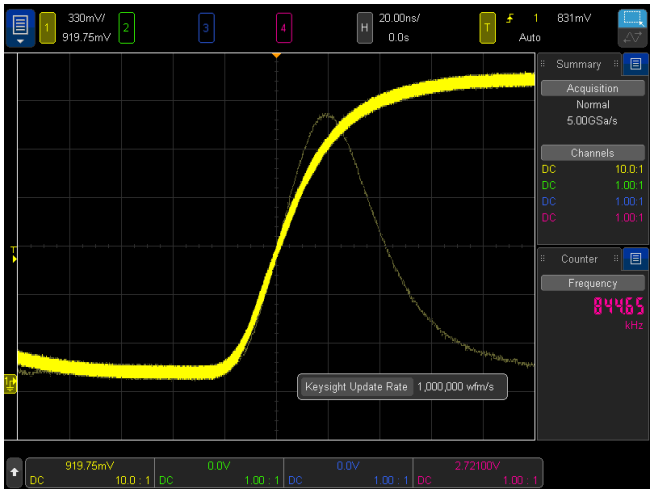


Figure 3. The 4000 X-Series captures a glitch occurring once in a million waveform cycles.

What is waveform update rate and why is it important?

As oscilloscopes acquire data, process it, and plot it to the screen, there is inevitable "dead time," or the time oscilloscopes miss signals completely. In general, the faster the waveform update rate, the shorter the dead time. The shorter the dead time, the more likely an oscilloscope is to capture anomalies and infrequent events. This is why it is critical to select an oscilloscope with a fast waveform update rate.

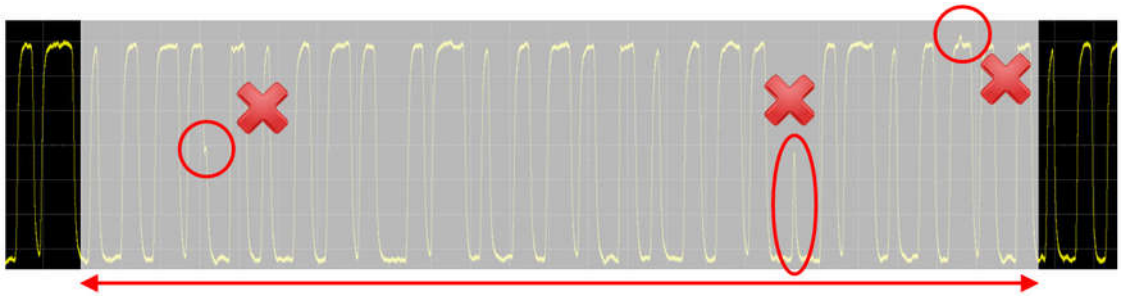


Figure 4. Other vendor's oscilloscope with 50,000 waveforms/second. A long dead time decreases your chances of capturing infrequent events.

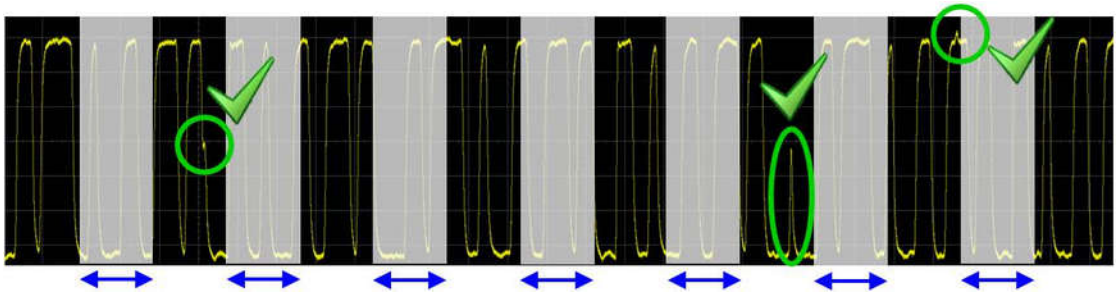


Figure 5. InfiniiVision 4000 X-Series with 1,000,000 waveforms/second. A short dead time increases your chances of capturing infrequent events.

Oscilloscope Experience Redefined: Experience the Speed (Continued)

Keysight achieves this industry-leading waveform update rate with MegaZoom IV smart memory technology

Traditionally, CPU processing was the major bottleneck for oscilloscope waveform update rate and responsiveness. Typically, the CPU handles interpolations, logic channel plotting, serial bus decoding, measurements and more, and the waveform update rate drops dramatically as these features are turned on.

The InfiniiVision 4000 X-Series requires minimum support from a CPU, as most core operations are handled by Keysight proprietary technology, the MegaZoom IV smart memory ASIC. MegaZoom includes hardware serial decoders and hardware mask/limit testing capability, plots analog and digital data directly to the display, supports GUI operation, and integrates additional instruments like the dual-channel WaveGen function/arbitrary waveform generator.

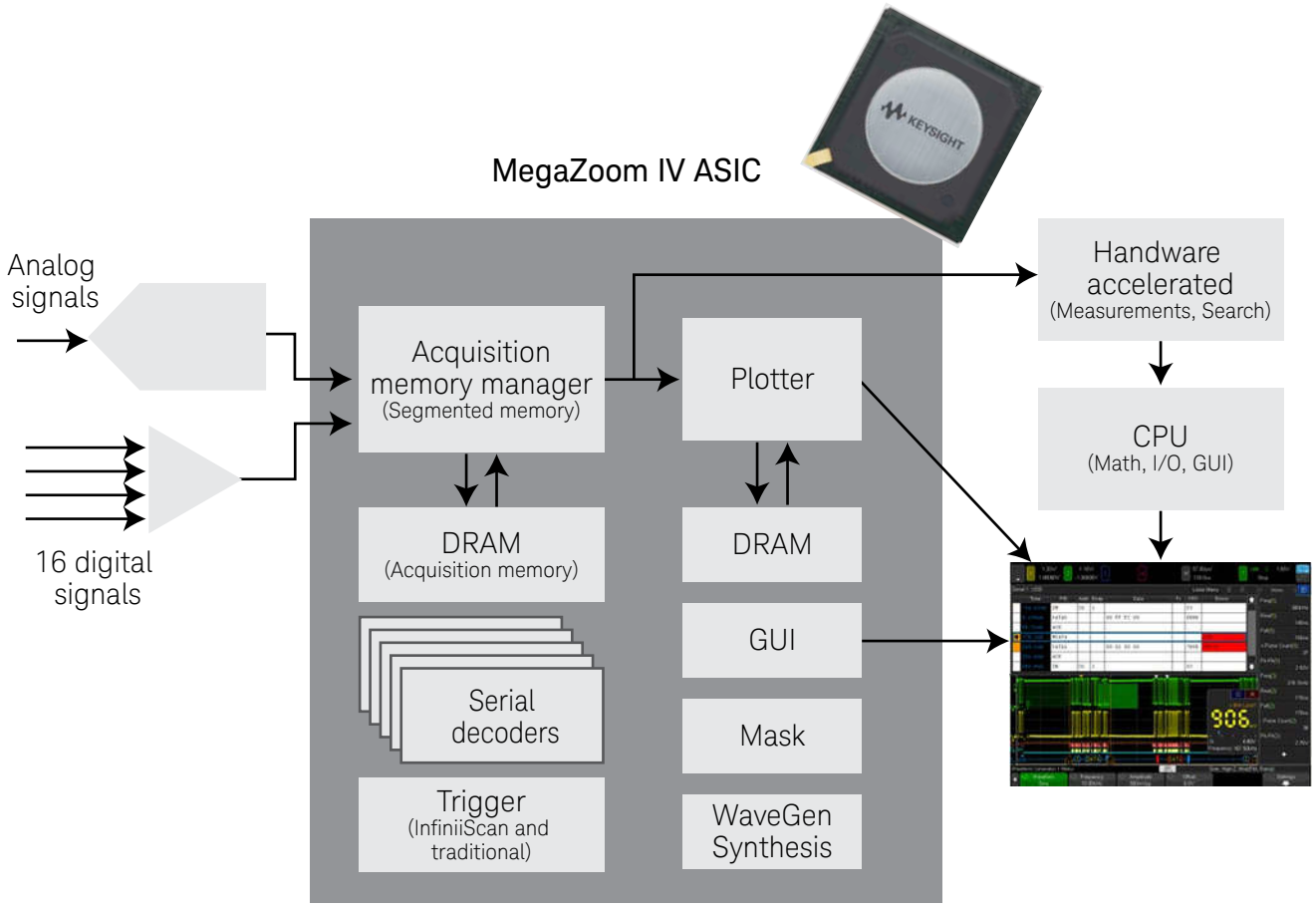


Figure 6. The 4000 X-Series oscilloscopes' uncompromised responsiveness, speed and waveform update rate is enabled by the MegaZoom IV, smart memory ASIC. The CPU is not used for core waveform operations.

Oscilloscope Experience Redefined: Experience the Speed (Continued)

Segmented memory: A smart and efficient way to capture waveforms

Acquisition memory size is an essential oscilloscope specification because it determines the amount of data you can capture in a single acquisition. In general, longer memory is better. However, no memory is always long enough to capture all the signals you need, especially when capturing infrequent anomalies, data bursts, or multiple serial bus packets. Segmented memory acquisition lets you selectively capture and store important signal activity without capturing unimportant signal idle time with the time stamp of each segment relative to the first trigger event. Segmented memory comes standard in the 4000 X-Series.

Figure 7 shows segmented memory successfully capturing 1,000 events in 3.27274 seconds. Traditional memory architecture would require 2.7 Gpts of memory to accomplish the same result. This memory is not available on any scope in the market.

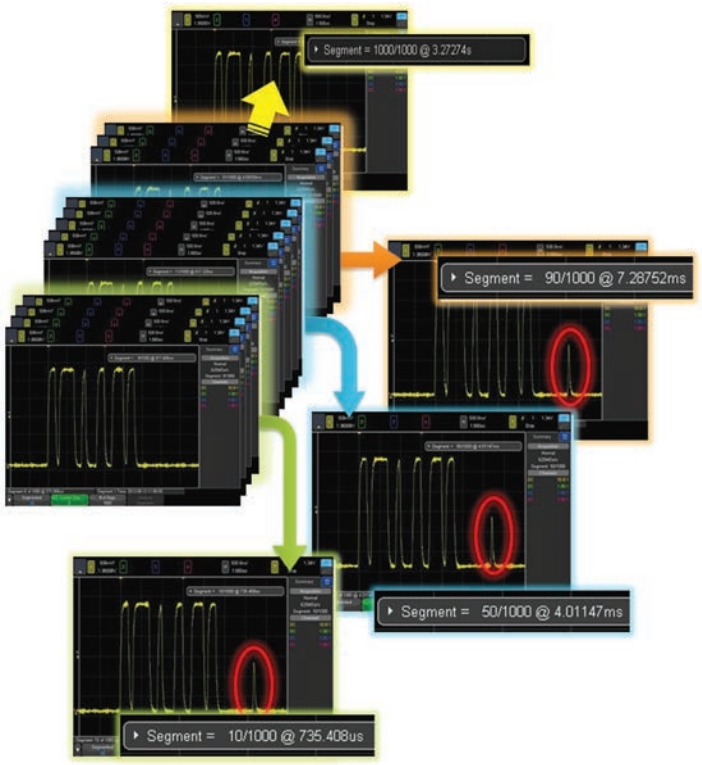


Figure 7. Segmented memory efficiently manages the memory to capture up to 1,000 segments of interest to you, making it an effective ultra-deep memory oscilloscope that can easily capture infrequent events and anomalies.

Segmented memory + serial decode

Segmented memory works in conjunction with serial protocol decode. For example, by setting the trigger condition to “CAN serial bus error,” segmented memory captures and stores only CAN error packets and stitches together each segment for easy viewing. You can quickly compare time tags in the event lister to discover time intervals between errors.

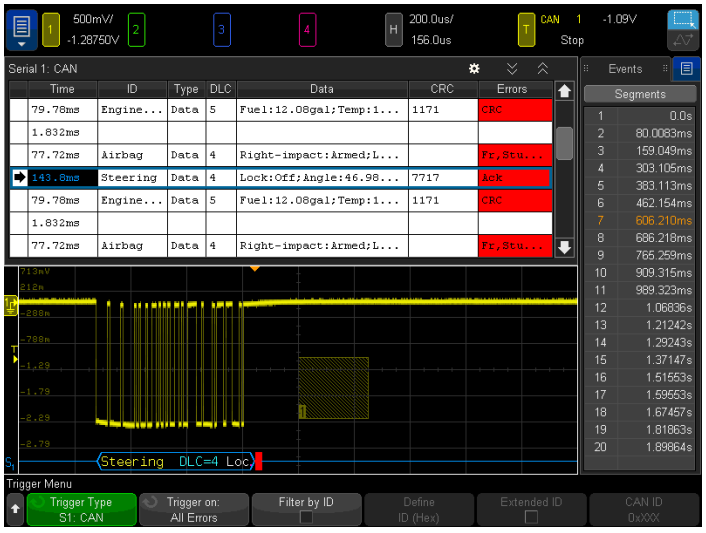


Figure 8. Segmented memory being used in conjunction with serial decode resulting in maximum insight into serial bus.

Oscilloscope Experience Redefined: Experience the Speed (Continued)

Mask/limit testing (option)

Whether you are performing pass/fail tests to specified standards in manufacturing or testing for infrequent signal anomalies, mask/limit testing can be a valuable productivity tool (DSOX4MASK). The 4000 X-Series features powerful hardware-based mask testing and can perform up to 270,000 tests per second. You can select multiple test criteria, including the ability to run tests for a specific number of acquisitions, a specified time, or until detection of a failure.

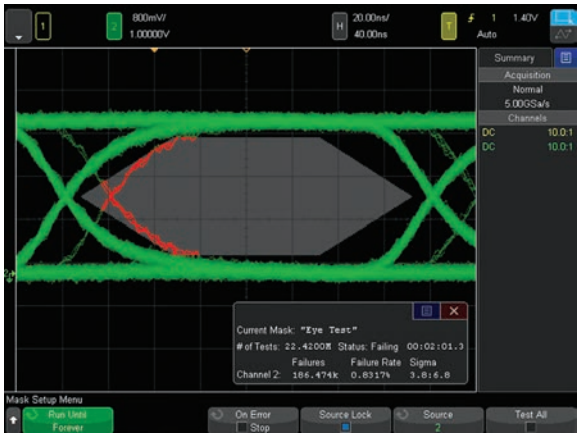


Figure 9. Mask testing evaluated > 22 M waveforms in just 2 minutes.

Search and navigation

The parametric and serial bus search and navigation feature comes standard on the 4000 X-Series oscilloscopes. When you are capturing long, complex waveforms using an oscilloscope's deep acquisition memory, manually scrolling through stored waveform data to find specific events of interest can be slow and cumbersome. With automatic search and navigation capability, you can easily set up specific search criteria and then quickly navigate to "found and marked" events. Available search criteria include edges, pulse width (time-qualified), rise/fall times (time-qualified), runt pulses (time-and level-qualified), frequency peaks (FFT function, threshold and excursion qualified), and serial bus frames, packets, and errors.



Figure 10a. The 4000 X-Series was set up to capture data signals with various rise time edges. Using the search and navigation capability, the oscilloscope was able to find, mark (white triangles), and quickly navigate to 16 occurrences of "out of compliance" rise-time edges.

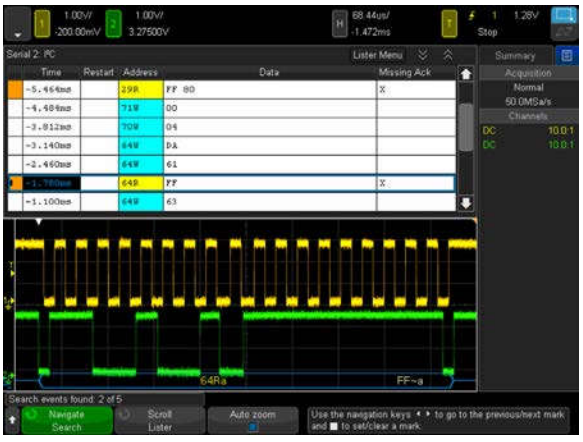


Figure 11. Using the error condition search, the 4000 X-Series quickly found 5 places with a missing acknowledgment in an I²C serial bus. The navigation feature moves between the errors and zooms automatically to show the error packet.



Figure 10b. The 4000 X-Series was set up to capture clock signals for FFT analysis. Using the search and navigation capability, the scope found, marked (white triangles) and quickly navigated to the first 11 frequency peaks occurrences. You can sort it in the order of frequency or amplitude.

Oscilloscope Experience Redefined: Experience the Usability

Industry's largest 12.1-inch display

From the start of product development, we designed every aspect of this oscilloscope for a touch interface. Large, easily touchable targets on the industry's largest 12.1-inch display with capacitive touch screen technology mean operation is quick and natural, just like your favorite tablet devices.

Capacitive touch screen technology

Capacitive touch screen technology provides enhanced productivity. Use the alphanumeric pad for quick annotation, place waveforms or cursors in exact positions and drag docking panels across the screen to see more measurement information.

The 4000 X-Series offers three ways to access key menus and features: touch GUI for those that prefer tablet or smart phone touch interfaces, front panel keypads for the traditional oscilloscope users, and Keysight pull down menu for users who prefer Windows-like operations. The 4000 X-Series also offers a "touch off" button as well as USB mouse and keyboard support.

Redefine your remote Web control oscilloscope experience. The 4000 X-Series not only supports traditional control via a PC Web browser, but also supports remote control through popular tablet devices.



Figure 12. The industry's largest 12.1-inch display and capacitive touch screen technology with large, touchable targets.

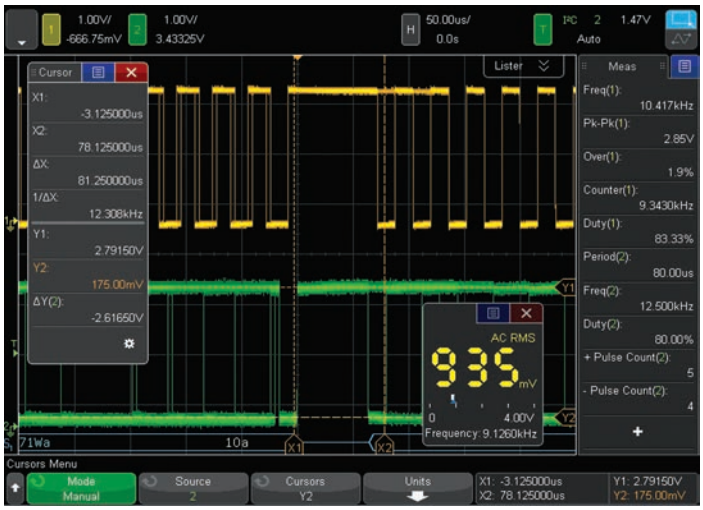


Figure 13. See 10 measurements, cursor information, and the DVM simultaneously by dragging the desired docking panel to any open area.

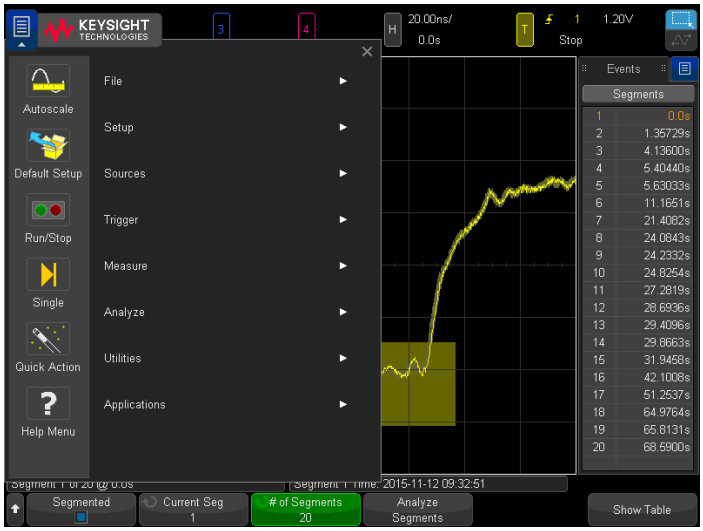


Figure 14. Use the Keysight pull-down menu for Windows-like operation.

Oscilloscope Experience Redefined: Experience the Usability (Continued)

Zone touch trigger

One of the biggest challenges of using an oscilloscope is setting up an advanced trigger to isolate a signal of interest. While advanced triggers are powerful features, zone touch trigger provides a turnkey trigger solution.

You simply observe the signal of interest on the display, and draw a zone (box) around it. What used to be hours of work can now take just a few seconds. If you want to move your zones to another location, just drag them over. The 4000 X-Series can be set up to easily trigger on one or two zone boxes simultaneously with either must intersect or must not intersect conditions.

Zone triggering does not compromise the waveform update rate; the 4000 X-Series will still maintain an ultra-fast 200,000 waveforms per second or more, even with additional features turned on. In other words, the oscilloscope that sees everything can easily trigger on anything.

Zone touch trigger + segment memory: A whole new experience

The combination of the industry's only hardware-based zone touch trigger with the 4000 X-Series' segment memory simplifies and enhances your debugging experience. In Figure 16, the 4000 X-Series has isolated and captured 1,000 metastable signals, showing the critical bit errors over a 32-second time span at 5 GS/s sampling rate in the segment memory. The segment memory also allows you to overlay all segments to identify the worst-case signal.

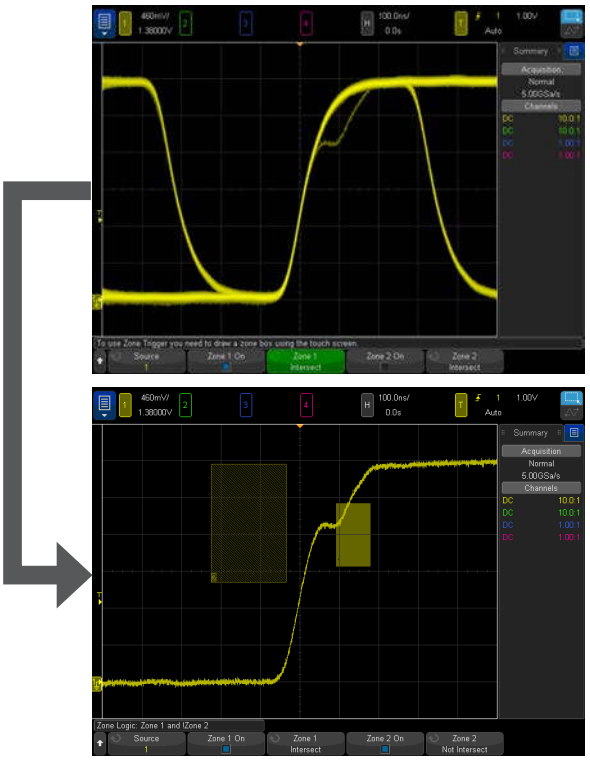


Figure 15. When you see anomalies, all you have to do is draw a zone box to trigger on them.

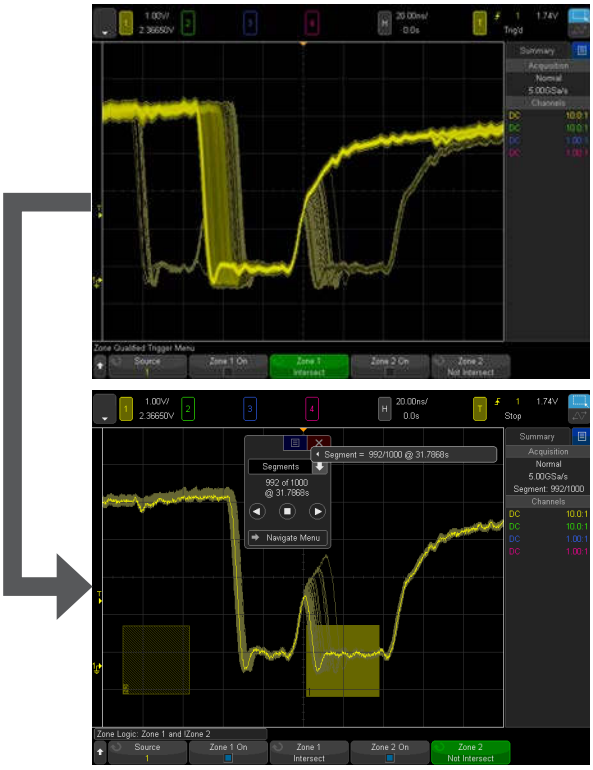


Figure 16. Combination of the zone touch trigger and segmented memory.

Oscilloscope Experience Redefined: Experience the Integration

Investment protection through a fully-upgradable 7-in-1 instrument

The InfiniiVision 4000 X-Series redefines the oscilloscope experience with unprecedented integration. This 7-in-1 instrument provides:

- Oscilloscope
- 16 digital channels
- Serial protocol analyzer
- Dual-channel WaveGen 20 MHz function/ arbitrary waveform generator
- 3-digit voltmeter
- Frequency response analysis
- 8-digit hardware counter with totalizer



Figure 17. The 4000 X-Series provides the capabilities of five instruments seamlessly integrated into one.

Multi-domain analysis: Time-correlate analog, digital, and frequency domain signals

Viewing the frequency content of waveforms is greatly simplified by a touch screen operation. Pop up keypads make inputting start, stop, span and center frequency easy. And the new problem solving feature called “gated FFT” lets you time correlate the analog, digital, and frequency domain to aid in analysis and debug. In addition, there are new capabilities for peak searching, max and min hold and averaging of FFTs to increase dynamic range.

When gated FFT is on, the oscilloscope goes into zoom mode. The FFT analysis shown in the zoomed (bottom) window is taken from the period of time indicated by the zoom box in the main (top) window. In the gated FFT mode, touch and flick the zoom box through the acquisition to investigate how the FFT analysis changes over time, correlating the RF phenomenon with the analog and digital phenomenon.



Figure 18. Gated FFT successfully correlated the hopping of the FSK modulation with the analog and I^2C control command.

Oscilloscope Experience Redefined: Experience the Integration (Continued)

Mixed signal oscilloscope (MSO): Integrated 16 digital channels

With an additional 16 integrated digital channels, you now have up to 20 channels of time-correlated triggering, acquisition and viewing on the same instrument. This is especially important in today's embedded designs with sophisticated digital control circuitry. Unlike other oscilloscopes in this class, you can buy a 2- or 4-channel DSO and enable the 16 digital channels already in the instrument at any time to make it an MSO. (DSOXPERFMSO)

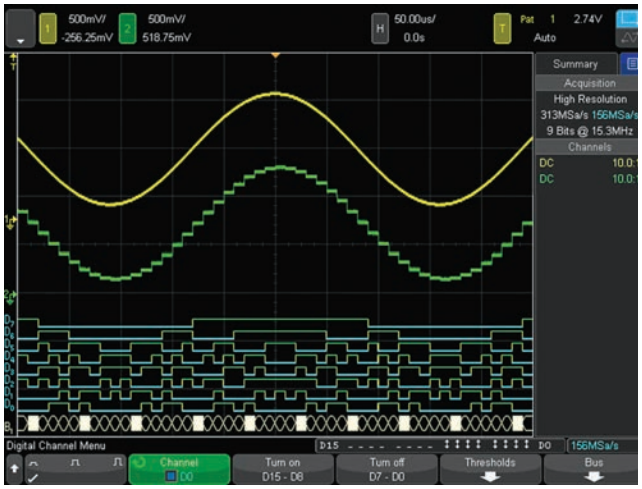


Figure 19. Digital channels are captured and displayed time-correlated with analog channels in MSOs or upgraded DSOs.

Serial protocol analysis: Hardware-based serial protocol decode and triggering

Keysight InfiniiVision Series, including the new 4000 X-Series, are the only oscilloscopes to use hardware-based serial protocol decoding. Other vendors' oscilloscopes use software post-processing techniques to decode serial packets/frames, and therefore have slow waveform and decode capture rates and could miss critical events and errors due to a long dead-time. Faster decoding with hardware-based technology enhances the probability of capturing infrequent serial communication errors.

After capturing serial bus communication, you can easily perform a search operation based on specific criteria and then quickly navigate to bytes/frames of serial data that satisfy that search criteria. The 4000 X-Series can decode two serial buses simultaneously using hardware-based decoding, and display the captured data in a time interleaved "lister"display.

Serial protocol decoding can be used simultaneously with segmented memory and zone touch triggering.

The 4000 X-Series has: SENT, I^2C, SPI, USB 2.0, RS232/UART, CAN, CAN FD, LIN, FlexRay, CXPI, MIL-STD 1553, ARINC 429, I^2S, user-definable Manchester, user-definable NRZ, and USB PD. (See page 23)



Figure 20. Dual serial bus CAN and LIN decode and interleaved "lister" display.



Figure 21. USB 2.0 trigger, decode and "lister" display.

Oscilloscope Experience Redefined: Experience the Integration (Continued)

Dual-channel WaveGen 20-MHz function/arbitrary waveform generator: Industry-exclusive

The 4000 X-Series offers the industry's only dual-channel, integrated 20-MHz function/arbitrary waveform generator. (DSOX4WAVEGEN2) The integrated generator provides stimulus output of sine, square, ramp, pulse, DC, noise, sine cardinal (sinc), exponential rise, exponential fall, cardiac, Gaussian pulse and arbitrary waveforms (AWG) to your device under test. Signal modulation capability is also available.

With AWG functionality, you can store waveforms from analog channels or reference memory to the arbitrary memory and output from WaveGen. Easily create and edit the waveform using the built-in editor or Keysight's free BenchLink Waveform Builder Basic software: **www.keysight.com/find/33503**.

With dual channels, you can generate differential signals to: output arbitrary clock and data signals to simulate serial buses, create complex modulations (more than the standard modulation feature), output IQ signals and more. The two channels can be tracked together as well (identical frequency, amplitude, offset and duty cycle).

3-digit voltmeter

The 4000 X-Series offers a standard integrated 3-digit voltmeter (DVM) and 5-digit frequency counter inside the oscilloscope. The voltmeter operates through the same probes as the oscilloscope channels. However, the DVM measurements are de-coupled from the oscilloscope triggering system so that both the DVM and triggered oscilloscope waveform capture can be made with the same connection. The voltmeter results are always displayed, keeping these quick characterization measurements at your fingertips.

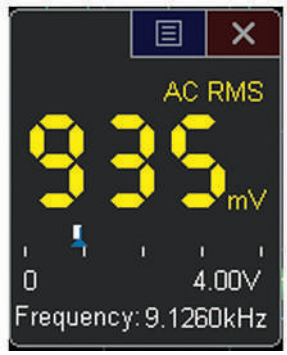


Figure 25. DVM 3-digit voltage and 5-digit frequency measurements always at your fingertips.



Figure 22. WaveGen sine wave output with and without added AM modulation.

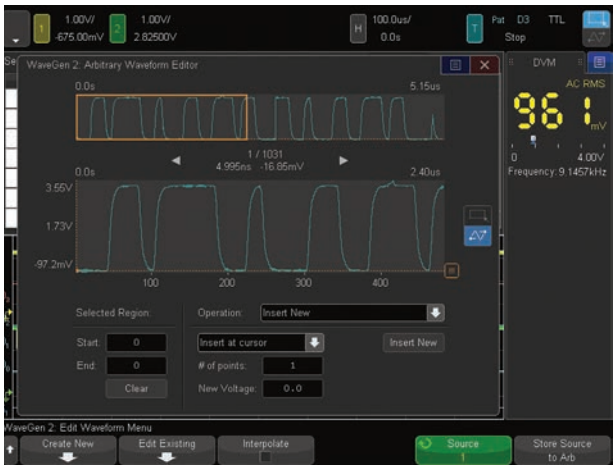


Figure 23. WaveGen arbitrary waveform editing screen.



Figure 24. Dual channel WaveGen output of differential arbitrary signals. Common mode is shown as a math function.

Oscilloscope Experience Redefined: Other Key Productivity Tools

Power measurements and analysis

When you are working with switching power supplies and power devices, the power measurements application (DSOX4PWR) provides a full suite of power measurements and analysis in the oscilloscope.

Included with the DSOX4PWR is a license for the U1881A PC-based power analysis software package, which provides additional offline measurements and report generation.

See **www.keysight.com/find/DSOX4PWR** for more information.



Figure 26. Power quality measurement, one of many in the power measurements application.

HDTV video triggering and analysis

Whether you are debugging consumer electronics with HDTV or characterizing a design, the HDTV measurement application (DSOX4VID) provides support for a variety of HDTV standards for triggering and analysis.

See **www.keysight.com/find/DSOX4VID** for more information.



Figure 27. Triggering on 1080p HDTV signal analysis.

USB 2.0 signal quality analysis

With the USB 2.0 signal quality test option (DSOX4USBSQ), designers of systems with USB interfaces can now perform automated signal quality testing. This option supports low-speed, full-speed, and hi-speed applications (hi-speed tests require 1.5 GHz models). The USB 2.0 signal quality test with HTML pass/fail report generation includes eye-diagram mask testing, jitter analysis, EOP bit-width, signaling rate, edge monotonicity, and rise/fall times; all based on official USB-IF algorithms embedded in the oscilloscope.

See **www.keysight.com/find/DSOX4USBSQ** for more information.



Figure 28. Perform automatic signal quality testing on USB 2.0 low-speed, full-speed, and hi-speed signals.

Oscilloscope Experience Redefined: Other Key Productivity Tools (Continued)

Frequency Response Analysis (FRA) option

Frequency Response Analysis (FRA) is an often-critical measurement used to characterize the frequency response (gain and phase versus frequency) of a variety of today's electronic designs, including passive filters, amplifier circuits, and negative feedback networks of switch mode power supplies (loop response). InfiniiVision 4000 X-Series oscilloscopes licensed with the DSOX4FRA option use the oscilloscope's built-in waveform generator (WaveGen) to stimulate the circuit under test at various frequency settings and capture the input and output signals using two oscilloscope channels. At each test frequency, the oscilloscope measures, computes, and plots gain (20LogVout/Vin) and phase logarithmically.



Educator's oscillocope training kit

Teach your students what an oscilloscope is and how to perform basic measurements with the Educator's Oscilloscope Training Kit. This complimentary kit includes training tools created specifically for electrical engineering and physics undergraduate students and professors. It contains an array of built-in training signals, a comprehensive oscilloscope lab guide and tutorial written specifically for undergraduate students and an oscilloscope fundamentals PowerPoint® slide set for professors and lab assistants. Also available is an advanced triggering guide to help even the most experienced oscilloscope users to get the most out of their 4000 X-Series oscilloscope.

See **www.keysight.com/find/dsoxedk** for more information.



Figure 30. The Educators Training Kit helps both students and experienced users quickly get up to speed on oscilloscope usage.

Oscilloscope Experience Redefined: Other Key Productivity Tools (Continued)

Advanced math analysis provides a variety of additional math functions and comes standard on the 4000 X-Series. Additionally, math functions can be nested to provide additional insight into your designs. You can create up to four math functions, with one resultant math function displayed at a time.

Operators
- Add, subtract, multiply, divide

Transforms
- Differentiate, integrate
- FFT
- Ax + B
- Squared, square root
- Absolute value
- Common logarithm, natural logarithm
- Exponential, base 10 exponential

Filters
- Low-pass filter, high-pass filter
- Averaged value, smoothing, envelope

Visualizations
- Magnify
- Max hold, min hold
- Measurement trend
- Chart logic bus timing, chart logic bus state

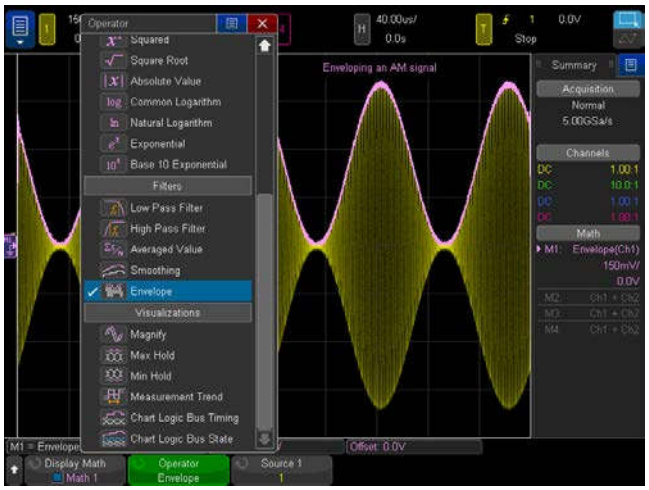


Figure 31. A variety of advanced math functions are standard in the 4000 X-Series.

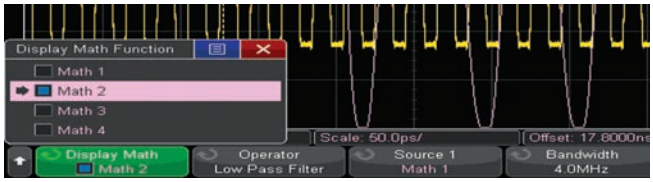


Figure 32. Four math functions can be created and nested with one resultant math function.

36 automatic measurements

Automatic measurements are the essential tool of an oscilloscope. In order to make quick and efficient measurements, the 4000 X-Series provides 36 powerful automatic measurements and can display up to 10 at a time. Measurements can be gated by auto select, main window, zoom window, or cursors.

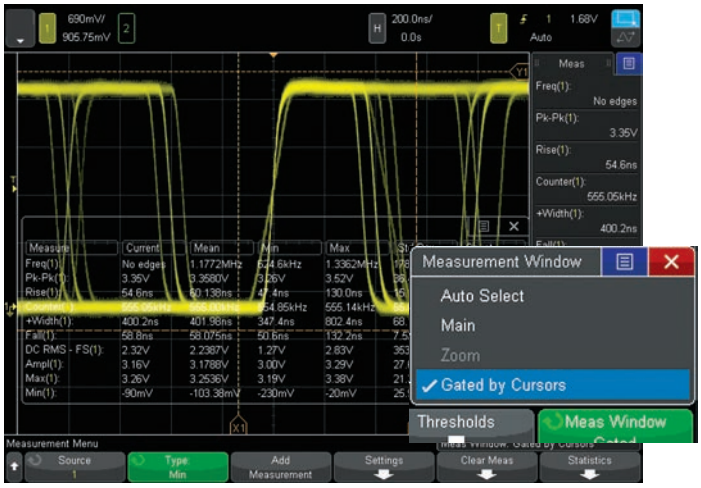


Figure 33. Up to 10 automated measurements displayed simultaneously. Measurements can be gated by cursors.

Oscilloscope Experience Redefined: Other Key Productivity Tools (Continued)

Reference waveforms

Store up to four waveforms in the scope's non-volatile reference waveform memory. Compare reference waveforms with live waveforms, and perform post analysis and measurements on stored data. You can also store waveforms on a removable USB memory device in *.h5 format and recall them back into oscilloscope's reference waveform memory later. Save and/or transfer waveforms to a PC as XY data pairs in a comma-separated values format (*.csv) or store bitmap images and transfer them to a PC for documentation purposes in a variety of image formats.



Figure 34. Store and recall up to four reference waveforms.

Powerful probe solutions and compatibility

Get the most out of your 4000 X-Series scope, by using Keysight's complete family of innovative probes and accessories for your application. The 4000 X-Series supports up to four active probes simultaneously with its full AutoProbe interface. [1]

All 4000 X-Series scopes come standard with a 700 MHz bandwidth, 10 MΩ input passive probe per each channel and gives you 700 MHz system bandwidth when used in conjunction with the 4000 X-Series 1 GHz/1.5 GHz models.Also available is the N2750A InfiniiMode differential probe and N2795A/96A single-ended active probe for high signal fidelity measurements without the high price. For ultra low current measurements, the N2820A Series high-sensitivity current probes are the best solution in the industry. For power rail measurement, the N7020A Power Rail Probe provides the unmatched measurement accuracy.

For the most up-to-date and complete information about Keysight's probes and accessories, visit our Web site at **www.keysight.com/find/scope_probes** or refer to the InfiniiVision Probes and Accessories data sheet with the Keysight literature number 5968-8153EN.



Figure 35. N7020A Power Rail Probe is the industry's only probe designed and developed to solve your toughest power integrity problems.

1. Some restriction may apply. Contact Keysight for more details.

Oscilloscope Experience Redefined: Other Key Productivity Tools (Continued)

Localized front panel, GUI and help

Operate the oscilloscope in the language most familiar to you. The graphical user interface, built-in help system, front panel overlays, and user's manual are available in 11 languages. During operation, access the built-in help system just by pressing and holding any button.

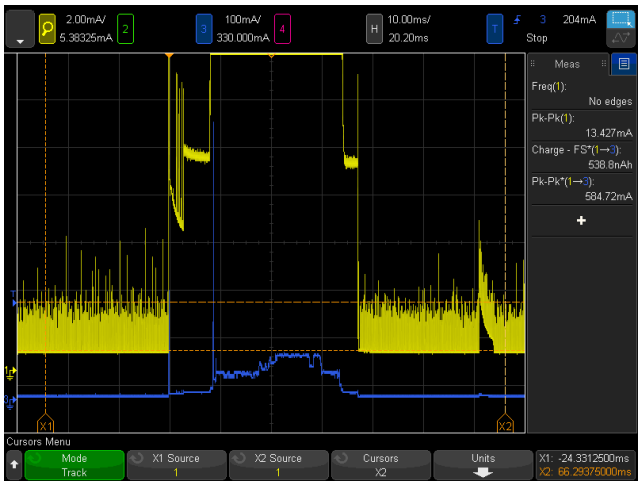


Figure 36. The 4000 X-Series and N2820A Series high-sensitivity current probe measuring > 500 mA and < 1 mA current simultaneously.

Connectivity and LXI compatibility

Standard USB 2.0 hi-speed host (two on front, one on back) and device (one on back) ports make PC connectivity easy. Operate the scope from your PC and save/recall stored waveforms and setup files via standard LAN (LXI IPv6 Extended Function). Connect your projector or external monitor through VGA output, standard with the 4000 X-Series, when sharing and presenting screen information. An optional external GPIB-to-LAN adapter is also available (N4865A).

The BV0004B oscilloscope control and automation application within BenchVue lets you control and visualize the 4000 X-Series and multiple measurements simultaneously. It lets you build automated test sequences just as easily as you can with the front panel. Save time with the ability to export measurement data to Excel, Word and MATLAB in three clicks. Monitor and control your 4000 X-Series with a mobile device from anywhere. Simplify your testing with BenchVue software.

Learn more at **www.keysight.com/find/BenchVue.**

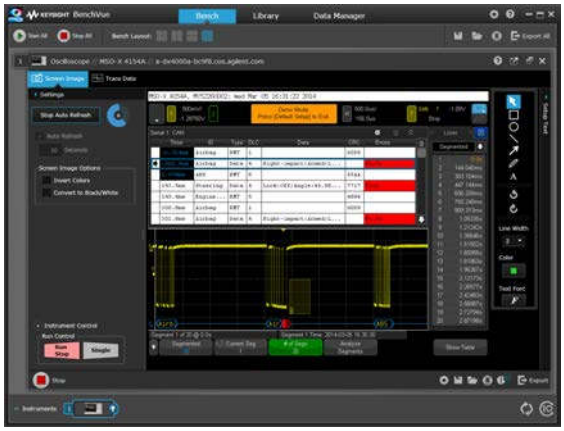


Figure 37. BV0004B BenchVue.

Oscilloscope Experience Redefined: Other Key Productivity Tools (Continued)

Virtual front panel

The 4000 X-Series' innovative capacitive touch screen matches perfectly with the latest tablet technologies. In addition to the traditional virtual front panel remote operation through your favorite PC Web browser, the 4000 X-Series supports remote oscilloscope control from your tablet devices (and smart phones with enough resolution). The tablet virtual front panel is identical to the 4000 X-Series' touch GUI so you can touch icons, draw zone touch trigger zones and drag slide panels as if you are sitting in front of the actual oscilloscope.



Figure 38. Tablet virtual front panel control.

Documentation and e-mail

Annotation becomes a simple task. Bring up the annotation menu and start editing it using the keypad, and then drag it to the desired location.

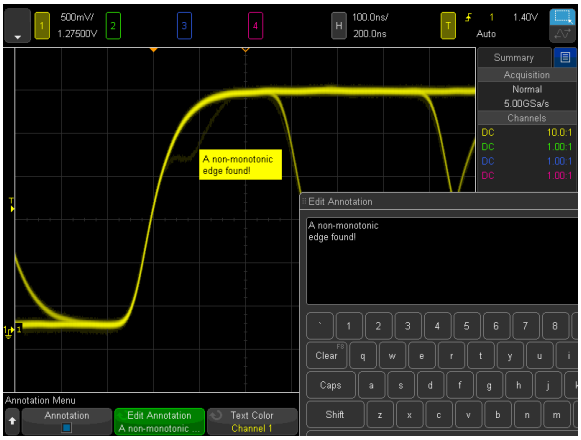


Figure 39(a). Annotation and keypad.

Quick e-mail allows you to e-mail the data you want instantly to your inbox. Send out the screenshot, waveform data, or even a USB signal quality test report. This removes the hassle of connecting your PC to your oscilloscope.

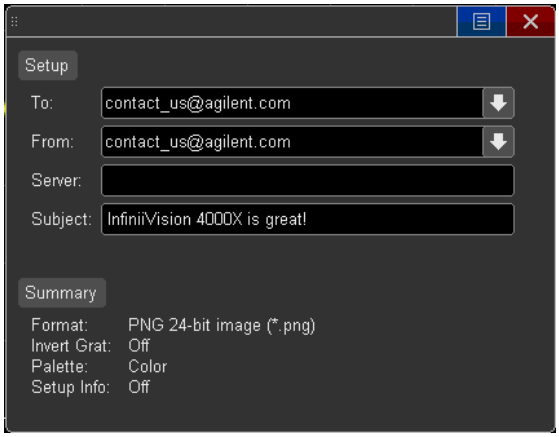


Figure 39(b). E-mail configuration screen.

Oscilloscope Experience Redefined: Other Key Productivity Tools (Continued)

Infinium Offline oscilloscope analysis software

Keysight's Infiniium Offline PC-based oscilloscope analysis software (N8900A) allows you to do additional signal viewing, analysis and documentation tasks away from your oscilloscope.

Capture waveforms, save to a file, and recall the waveforms into Infiniium Offline. The application supports a variety of popular waveform formats from multiple oscilloscope vendors and includes the following features: navigate, view, measurements, analyze, view windows, documentation, and optional analysis upgrades.

For more information, go to: **www.keysight.com/find/N8900A**.

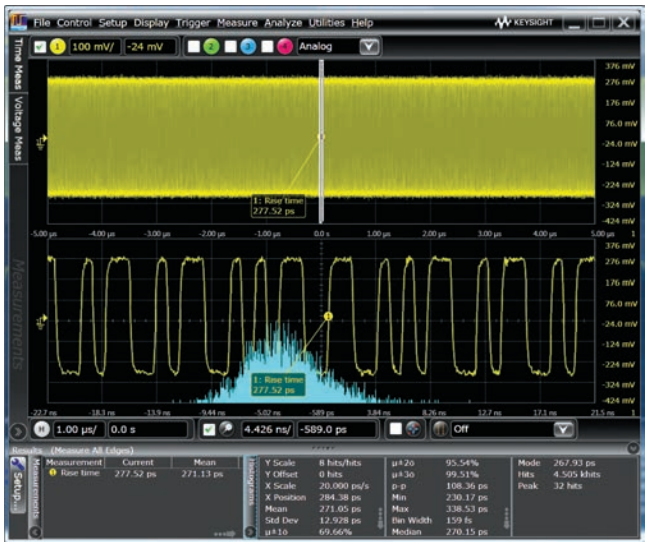


Figure 40. Infiniium Offline enables a variety of advanced signal analysis while providing extensive, yet intuitive, waveform documentation.

Secure erase

The secure erase feature comes standard with all 4000 X-Series models. At the press of a button, internal non-volatile memory is clear of all setup, reference waveforms, and user preferences, ensuring the highest level of security in compliance with National Industrial Security Program Operation Manual (NISPOM) Chapter 8 requirements.

Oscilloscope Experience Redefined: Other Key Productivity Tools (Continued)

High-resolution mode for viewing signal details

To build more confidence in your designs, sometimes you need to look into more signal detail than you can see with the standard 8-bit vertical resolution of the 4000 X-Series.

High-resolution mode offers additional resolution and insight into the signal, without requiring a repetitive signal. Using real-time boxcar averaging, high-resolution mode reduces random noise and effectively increases vertical resolution, up to 12 bits. For example, it achieves the 113 µVrms noise floor at 1 mV/div, 100 µs/div setting.

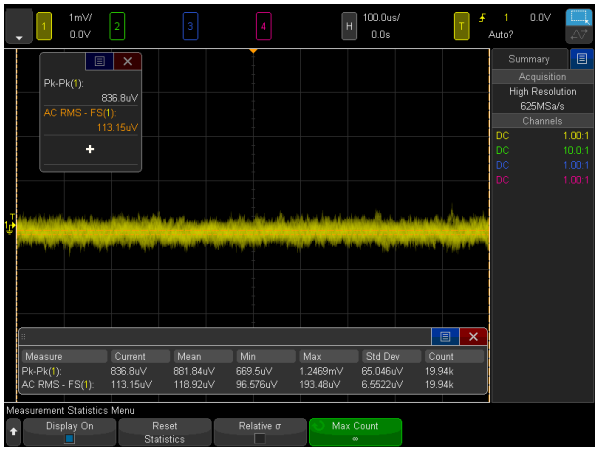


Figure 42. Getting 113 uVrms noise floor at 1 mV/div with the high resolution mode.

Advanced parametric triggering

With today's more complex signals, you often need to trigger on complex signal conditions to synchronize the oscilloscope's acquisition on specific events. The 4000 X-Series oscilloscope can trigger on the following conditions: edge, edge then edge, pulse width (time-qualified), pattern, or, rise/fall time, Nth edge burst, runt, setup and hold, video, and various serial buses (optional).



Figure 43. Wide array of advanced parametric trigger modes.

Freeze display

Perhaps you need to share with others an infrequent event you found. With the "freeze display" feature, you can keep intensity information on the screen while the oscilloscope is stopped or before saving a screen shot.

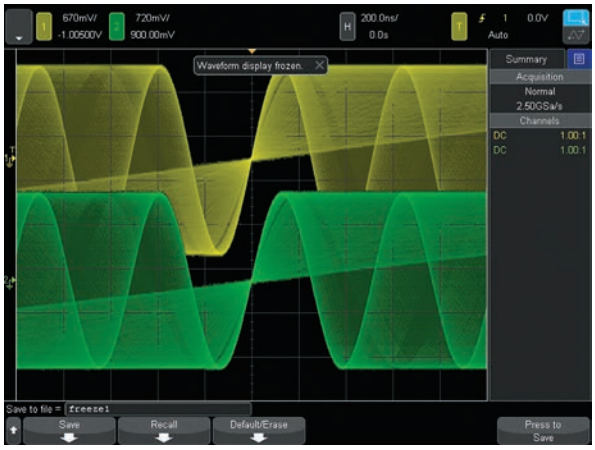


Figure 44. The "freeze screen" feature keeps the intensity-grading information while stopping the waveform acquisition.

Oscilloscope Experience Redefined

"Designed for touch." Industry's first and largest **12.1 inch capacitive touch screen** to redefine your oscilloscope experience. The way an oscilloscope was meant to be driven, with a designed-for-touch interface.

The new zone touch trigger, if you can see it, you can trigger on it by just drawing a box.

5-in-1 instruments redefines the integration experiences: oscilloscope channels, digital channels, serial protocol analysis, dual-channel WaveGen, and DVM. All features are **fully upgradeable**, including bandwidth.

Industry-leading coverage of serial protocol including **USB 2.0 trigger and decode**.

Industry's first **dual-channel WaveGen** function/arbitrary generator now allows you to generate differential, clock and data, two channel modulation, and IQ signals. Modulation of any signal is also included.

The class leading **1.5 GHz upgradeable bandwidth** expands your application coverage, including USB 2.0 hi-speed signal integrity testing.



Both **USB keyboard and mouse** are supported for additional ease of use.

Industry-leading **1 million waveform per second update rate** minimizes the dead-time for maximum probability of capturing infrequent events and anomalies.

Docking panels with the capacitive touch screen add a new dimension of usability. See setup summary, automatic measurements, cursor info, DVM, and navigation pane in any combination, anywhere on the screen.



Standard advanced math and **four cascade-able math functions** enable even the most sophisticated signal analysis.

Display up to **10 measurements** simultaneously, without compromising other key info. 35 automatic measurements can be **gated by cursors**.

Not a touch screen fan? **Turn off the touch screen** from a front panel button if desired.

Independent knobs per channel for fast operation. All front panel knobs are push-able for access to common controls.

Standard segmented memory powered by **MegaZoom IV** smart memory technology provides intelligent capture of just the signal of interest.

Industry's **first integrated DVM**. Asynchronous from the 4 analog triggered waveforms.

Simultaneous 1GHz bandwidth across all 4 channels.

Four AutoProbe (active or current probes) are supported simultaneously for demanding applications.

Oscilloscope Experience Redefined: Configuring Your InfiniiVision 4000 X-Series Oscilloscope

Step 1. Choose your bandwidth and number of channels

InfiniiVision 4000 X-Series scopes oscilloscopes									
		4022A	4024A	4032A	4034A	4052A	4054A	4104A	4154A
Bandwidth [1] (–3 dB)		200 MHz		350 MHz		500 MHz		1 GHz	1.5 GHz
Calculated rise time (10 to 90%)		≤ 1.75 ns		≤ 1 ns		≤ 700 ps		≤ 450 ps	≤ 300 ps
Input channels	DSOX	2	4	2	4	2	4	4	4
	MSOX	2 + 16	4 + 16	2 + 16	4 + 16	2 + 16	4 + 16	4 + 16	4 + 16

1. For example, if you chose 1 GHz, 4+16 channels, the model number will be MSOX4104A.

Step 2. Tailor your oscilloscope with integrated capabilities and measurement applications to save time and money. After purchase upgrade model numbers are listed below (values in parentheses are factory-installed option numbers)

Description	Model number
Enables all software options listed below	DSOX4APPBNDL
Serial protocols	
Embedded serial triggering and decode (I²C, SPI)	DSOX4EMBD(-EMB)
Computer serial triggering and decode (RS232/UART)	DSOX4COMP(-CMP)
USB 2.0 Full/Low Speed serial triggering and decode	DSOX4USBFL(-USF)
USB 2.0 Hi-Speed serial triggering and decode	DSOX4USBH(-U2H) [1]
Automotive serial triggering and decode CAN/CAN-FD/CAN-dbc/LIN/LIN symbolic	DSOX4AUTO(-AMS)
FlexRay serial triggering and decode	DSOX4FLEX(-FLX)
Single edge nibble transmission triggering and decode (SENT)	DSOX4SENSOR(-SEN)
CXPI serial triggering and decode	DSOX4CXPI(-CXP)
Audio serial triggering and decode (I²S)	DSOX4AUDIO(-SND)
Aerospace and defence serial triggering and decode (MIL-STD 1553, ARINC 429)	DSOX4AERO(-AER)
User-definable Manchester/NRZ triggering and decode	DSOX4NRZ
USB PD serial triggering and decode	DSOX4UPD
Measurement applications	
Dual-channel WaveGen 20 MHz arbitrary/function generator	DSOX4WAVEGEN2(-WAV)
Power analysis application	DSOX4PWR(-PWR)
Frequency Response Analysis (FRA)	DSOX4FRA
Mask limit testing	DSOX4MASK(-MSK)
Enhanced video/TV application package	DSOX4VID(-VID)
USB 2.0 signal quality test option	DSOX4USBSQ(-U2Q) [2]
NFC trigger and automated test software	DSOX4NFC
Productivity tools	
Infiniium Offline oscilloscope analysis software	N8900A
User-definable Application (UDA) PC-based test automation software	N5467B/C
Vector signal analyzer software (version 16 and higher)	89601B
BenchVue Software	BV0004B

1. DSOX4USBH is only available for 1 GHz and 1.5 GHz models.
2. USB 2.0 hi-speed tests require 1.5 GHz models.

See page 35 for more detailed upgradability and installation process information.

Oscilloscope Experience Redefined: Configuring Your InfiniiVision 4000 X-Series Oscilloscope (Continued)

Step 3. Choose your probes – For a complete list of compatible probes, visit www.keysight.com/find/scope_probes

Probes	4000 X-Series
N2894A passive probe 700 MHz, 10:1, 10 MΩ	Included standard. 1 per channel
N2756A 16 digital channel MSO cable	Included on MSOX models and DSOXPERFMSO
10076B high-voltage passive probe 250 MHz 4 kV	Optional
N2795A active single-ended probe 1-GHz 1-pF 1-MΩ with AutoProbe	Optional
N2796A active single-ended probe 2-GHz 1-pF 1-MΩ with AutoProbe	Optional
N2750A InfiniiMode differential probe 1.5-GHz 700-fF 200-kΩ with AutoProbe	Optional
N2797A extreme temperature active probe 1.5-GHz 1-pF 1-MΩ with AutoProbe	Optional
N2790A differential active probe 100 MHz, ± 1.4 kV with AutoProbe	Optional
N2791A differential active probe 25 MHz, ± 700 V	Optional
N2792A differential active probe 200 MHz, ± 20 V	Optional
N2793A differential active probe 800 MHz, ± 15 V	Optional
1147B AC/DC current probe 50 MHz 15 A with AutoProbe	Optional
N2893A AC/DC current probe 100 MHz 15 A with AutoProbe	Optional
N2820A 2-channel high-sensitivity current probe 50 uA to 5 A	Optional
N7020A power rail probe 2-GHz, 1:1, 50 kΩ, ± 24 V offset range	Optional
N2805A high voltage differential probe, 200 MHz, ± 100 V (DC + peak AC), 50:1, 4-MΩ, 4 pF	Optional
N2804A high voltage differential probe, 300 MHz, ± 300 V (DC + peak AC), 100:1, 4-MΩ, 4 pF	Optional
N7040A 23 MHz, 3 kA, AC current probe	Optional
N7041A 30 MHz, 600 A, AC current probe	Optional
N7042A 30 MHz, 300 A, AC current probe	Optional
N7026A 150 MHz, 40 Apk, AC/DC high-sensitivity current probe with AutoProbe	Optional

Step 4. Choose your accessories

Recommended accessories	4000 X-Series
GPIB-to-LAN external adapter	N4865A
Rack mount kit	N2763A
Soft carrying case	N2733B
Hard copy manual	N6455A

Step 5. Calibration plans

Calibration		
D/MSOX4000-A6J	ANSI Z540-1-1994 calibration	Optional
D/MSOX4000-AMG	Calibration + Uncertainties + Guardbanding (Accredited)	Optional

Oscilloscope Experience Redefined: InfiniiVision 4000 X-Series Performance Characteristics

DSO and MSO 4000 X-Series oscilloscopes

4000 X-Series specification overview									
		4022A	**4024A**	**4032A**	**4034A**	**4052A**	**4054A**	**4104A**	**4154A**
Bandwidth [1] (–3 dB)		200 MHz		350 MHz		500 MHz		1 GHz	1.5 GHz [3]
All-channel real-time bandwidth		200 MHz		350 MHz		500 MHz		1 GHz	1 GHz
Calculated rise time (10 to 90%)		≤ 1.75 ns		≤ 1 ns		≤ 700 ps		≤ 450 ps	≤ 300 ps
Input channels	DSOX	2	4	2	4	2	4	4	4
	MSOX	2 + 16	4 + 16	2 + 16	4 + 16	2 + 16	4 + 16	4 + 16	4 + 16
Maximum sample rate	5 GSa/s half channel, 2.5 GSa/s all channel								
Maximum memory depth	Standard 4 Mpts, standard segmented memory								
Display size and type	12.1-inch high-definition capacitive touch display								
Waveform update rate	> 1 million waveforms per second								
System bandwidth with N2894A standard passive probe		200 MHz	200 MHz	350 MHz	350 MHz	500 MHz	500 MHz	700 MHz	700 MHz
System analog channels									
Hardware bandwidth limits				Approximately 20 MHz (selectable)					
Input coupling				AC, DC					
Input impedance				Selectable: 1 MΩ ± 1% (16 pF), 50 Ω ± 1.5%					
Input sensitivity range				200 MHz ~ 500 MHz models: 1 mV/div to 5 V/div [2] (1 MΩ and 50 Ω)					
				1 and 1.5 GHz models: 1 mV/div to 5 V/div [2] (1 MΩ), 1 mV/div to 1 V/div (50 Ω)					
Vertical resolution				8 bits (measurement resolution is 12 bits with averaging)					
Maximum input voltage	1 MΩ			135 Vrms; 190 Vpk					
				Probing technology allows testing of higher voltages. For example, the included N2894A 10:1 probe supports testing up to 300Vrms					
				Use this instrument only for measurements within its specified measurement category (not rated for CAT II, III, IV). No transient overvoltage allowed					
	50 Ω			50 Ω: ≤ 5 Vrms max					
DC vertical gain accuracy [1]				± 2.0% full scale [2]					
DC vertical offset accuracy				± 0.1 div ± 2 mV ± 1% of offset setting					
Channel-to-channel isolation	200 MHz~1 GHz			≥ 40 dB from DC to maximum specified bandwidth of each model					
	1.5 GHz			≥ 40 dB from DC to 1 GHz, ≥ 35 dB from 1 to 1.5 GHz					
Offset range				± 5 V (< 10 mV/div), ± 20 V (10 to 200 mV/div), ± 75 V (> 200 mV/div)					
Vertical system digital channels									
Digital input channels				16 digital (D0 to D15. Pod 1: D7 ~ D0, Pod 2: D15 ~ D8)					
Thresholds				Threshold per pod					
Threshold selections				TTL (+1.4 V), 5 V CMOS (+2.5 V), ECL (–1.3 V), user-defined (selectable by pod)					
User-defined threshold range				± 8.0 V in 10 mV steps					
Maximum input voltage				± 40 V peak CAT I					
Threshold accuracy [1]				± (100 mV + 3% of threshold setting)					
Maximum input dynamic range				± 10 V about threshold					
Minimum voltage swing				500 mVpp					
Input impedance				100 kΩ ± 2% at probe tip					
Input capacitance				~8 pF					
Vertical resolution				1 bit					

1. Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ± 10 °C from firmware calibration temperature.
2. 1 mV/div and 2 mV/div is a magnification of 4 mV/div setting. For vertical accuracy calculations, use full scale of 32 mV for 1 mV/div and 2 mV/div sensitivity setting.
3. 1.5 GHz real time bandwidth in half-channel mode or full channel equivalent time mode.

Oscilloscope Experience Redefined: InfiniiVision 4000 X-Series Performance Characteristics (Continued)

Horizontal system analog channels									
		4022A	**4024A**	**4032A**	**4034A**	**4052A**	**4054A**	**4104A**	**4154A**
Time base range		2 ns/div to 50 s/div				1 ns/div to 50 s/div		500 ps/div to 50 s/div	
Time base accuracy [1]		± 10 ppm							
Time base delay time range	Pre-trigger	Greater of 1 screen width or 200 µs (400 µs in interleaving mode)							
	Post-trigger	1 to 500 s							
Channel-to-channel deskew range		± 100 ns							
Δ Time accuracy (using cursors)		± 0.001% of reading ± 0.16% screen width ± 30pS							
Modes		Main, zoom, roll, XY							
XY		On channels 1 and 2 only. Z Blanking on Ext Trigger Input, 1.4 V threshold							
		Bandwidth: Maximum bandwidth. Phase error at 1 MHz: < 0.5 degree							
		Time base: 200 ns/div to 50 ms/div							

Horizontal system digital channels		
Minimum detectable pulse width		2 ns
Channel-to-channel skew		2 ns (typical); 3 ns (maximum)

Acquisition system									
		4022A	**4024A**	**4032A**	**4034A**	**4052A**	**4054A**	**4104A**	**4154A**
Maximum analog channels sample rate		5 GSa/s half channel interleaved, 2.5 GSa/s all channels							
Analog channels equivalent sample rate		N/A						128 Gsa/s	
Maximum analog channels record length		4 Mpts half channel interleaved, 2 Mpts all channel							
Maximum digital channels sample rate		1.25 GSa/s							
Maximum digital channels record length		2 Mpts (with digital channels only)							
Modes	Normal	Default mode							
	Peak detect	Capture glitches as narrow as 200 ps at all time base settings							
	Averaging	Selectable from 2, 4, 8, 16, 64, ... to 65,536							
	High resolution	Real-time boxcar averaging reduces random noise and effectively increases vertical resolution – 12 bits: ≥ 50 µs/div – 11 bits: ≥ 20 µs/div – 10 bits: ≥ 10 us/div – 9 bits: ≥ 5 us/div							
	Segmented	Segmented memory optimizes available memory for data streams that have long dead times between activity. Maximum segments = 1000. Re-arm time = 1 µs (minimum time between trigger events). Re-arm time when used with the zone touch trigger = 65 µs or faster (typical)							
	Roll	Displays the waveform moving across the screen from right to left. Available at the time base 50 ms/div or slower							
	Equivalent time	1 GHz and 1.5 GHz models only. 7.8 ps fine interpolator resolution yields a maximum effective sample rate of 128 GSa/s							

1. Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ± 10 °C from firmware calibration temperature.

Oscilloscope Experience Redefined: InfiniiVision 4000 X-Series Performance Characteristics (Continued)

Trigger system		
Trigger sources		Analog channel (1 ~ 4), digital channel (D0 ~ D15), line, external, WaveGen (1, 2, or Mod) (FM/FSK)
Trigger modes	Normal	Requires trigger event for oscilloscope to trigger
	Auto	Triggers automatically in absence of trigger event
	Single	Front panel button that triggers only once on a trigger event. Press [Single] button again for oscilloscope to find another trigger event, or press [Run] front-panel button to trigger continuously in either auto or normal mode
	Force	Front panel button that forces a trigger
Trigger coupling	DC	DC coupled trigger
	AC	AC coupled trigger, cutoff frequency: < 10 Hz (internal); < 50 Hz (external)
	HF reject	High-frequency reject, cutoff frequency ~ 50 kHz
	LF reject	Low-frequency reject, cutoff frequency ~ 50 kHz
	Noise reject	Adds hysteresis to the trigger circuitry. Selectable OFF or ON, decreases sensitivity 2x
Trigger holdoff range		40 ns to 10.00 s
Trigger sensitivity (internal) [1]	200 MHz ~ 1 GHz	< 10 mV/div: greater of 1 div or 5 mV; ≥ 10 mV/div: 0.6 div
	1.5 GHz	DC to 1 GHz: < 10 mV/div: Greater of 1 div or 5 mV; ≥ 10 mV/div: 0.6 div
		1 to 1.5 GHz: < 10 mV/div: Greater of 1.5 div or 5 mV; ≥ 10 mV/div: 1.0 div
Trigger sensitivity (external) [1]	± 1.6 V	40 mVpp DC to 100 MHz, 70 mVpp 100 to 200 MHz
	± 8 V	200 mVpp DC to 100 MHz, 350 mVpp 100 to 200 MHz
Trigger level range	Any channel	± 6 div from center screen
	External	8 V range = ± 8 V, 1.6 V range = ± 1.6 V

1. Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ± 10 °C from firmware calibration temperature.

Oscilloscope Experience Redefined: InfiniiVision 4000 X-Series Performance Characteristics (Continued)

Trigger type selections	
InfiniiScan Zone (HW zone qualifier)	Trigger on user-defined zones drawn on the display. Applies to one analog channel at a time. Specify zones as either "must intersect" or "must not intersect." Up to two zones. > 200,000 wfm/sec update rate. Supported modes: normal, peak detect, high resolution. Also works simultaneously with the serial decodes and mask/limit test.
Edge	Trigger on a rising, falling, alternating, or either edge of analog channels, digital channels, or an external signal. Trigger on a rising or falling of a line signal.
Edge then edge (B trigger)	Arm on a selected edge, wait a specified time, then trigger on a specified count of another selected edge. Minimum 4 ns
Pulse width	Trigger on a pulse on a selected channel, whose time duration is less than a value, greater than a value, or inside a time range – Minimum duration setting: 2 ns (500 MHz, 1 GHz, 1.5 GHz), 4 ns (350 MHz), 6 ns (200 MHz) – Maximum duration setting: 10 s – Range minimum: 10 ns
Pattern	Trigger when a specified pattern of high, low, and don't-care levels on any combination of analog, digital, or trigger channels is [entered | exited]. Pattern must have stabilized for a minimum of 2 ns to qualify as a valid trigger condition. – Minimum duration setting: 2 ns (500 MHz, 1 GHz, 1.5 GHz), 4 ns (350 MHz), 6 ns (200 MHz) – Maximum duration setting: 10 s
Or	Trigger on any selected edges from available sources (analog and digital channels only up to 500 MHz)
Rise/fall time	Trigger on rise-time or fall-time edge speed violations (< or >) based on user-selectable threshold. Select from (< or >) and time settings range between – Minimum: 1 ns (500 MHz, 1 GHz, 1.5 GHz model), 2 ns (350 MHz model), 3 ns (200 MHz model) – Maximum: 10 s
Nth edge burst	Trigger on the Nth (1 to 65535) edge of a pulse burst. Specify idle time (10 ns to 10 s) for framing
Runt	Trigger on a positive runt pulse that fails to exceed a high-level threshold. Trigger on a negative runt pulse that fails to exceed a low-level threshold. Trigger on either polarity runt pulse based on two threshold settings. Runt triggering can also be time-qualified (< or >) with a minimum time setting of 2 ~ 6 ns and maximum time setting of 10 s – Minimum time setting: 2 ns (500 MHz, 1 GHz, 1.5 GHz), 4 ns (350 MHz), 6 ns (200 MHz)
Setup and hold	Trigger on setup/hold violations. Setup time can be set from –7 to 10 s. Hold time can be set from 0 s to 10 ns. Minimum window (setup time + hold time) must be 3 ns or greater
Video	Trigger on all lines or individual lines, odd/even or all fields from composite video, or broadcast standards (NTSC, PAL, SECAM, PAM-M)
Enhanced video (HDTV) (Option)	Trigger on lines and fields of enhanced and HDTV standards (480p/60, 567p/50, 720p/50, 720p/60, 1080p/24, 1080p/25, 1080p/30, 1080p/50, 1080p/60, 1080i/50, 1080i/60)
ARINC429 (Option)	Trigger and decode on ARINC429 data. Trigger on word start/stop, label, label + bits, label range, error conditions (parity, word, gap, word or gap, all), all bits (eye), all 0 bits, all 1 bits
CAN (Option)	Trigger on CAN (controller area network) version 2.0A,2.0B, and CAN-FD (Flexible Data-rate) signals. Trigger on the start of frame (SOF), the end of frame (EOF), data frame ID, data frame ID and data (non-FD), data frame ID and data (FD), remote frame ID, remote or data frame ID, error frame, acknowledge error, from error, stuff error, CRC error, spec error (ack or form or stuff or CRC), all errors, BRS Bit (FD), CRC delimiter bit (FD), ESI bit active (FD), ESI bit passive (FD), overload frame., message, message and signal (non-FD), message and signal (FD, first 8 bytes only)
FlexRay (Option)	Trigger on frame ID or specific error condition, along with cycle-base and repetition-cycle filtering. Can also trigger on specific events such as BSS, TSS, FES, and wake up
I²C (Option)	Trigger at a start/stop condition or user defined frame with address and/or data values. Also trigger on missing acknowledge, address with no acq, restart, EEPROM read, and 10-bit write
I²S (Option)	Trigger on 2's complement data of audio left channel or right channel (=, ≠, <, >, > <, < >, increasing value, or decreasing value)
LIN (Option)	Trigger on LIN (local interconnect network) sync break, sync frame ID, frame ID and data, parity error, or checksum error

Oscilloscope Experience Redefined: InfiniiVision 4000 X-Series Performance Characteristics (Continued)

Trigger type selections		
CXPI (Option)		Trigger on the start of frame (SOF), the end of frame (EOF), PTYPE, frame ID, data and info frame ID, data and info frame ID (long frame), CRC field error, parity error, inter-byte space error, inter-frame space error, framing error, data length error, sample error, all errors, sleep frame, wakeup pulse
MIL-STD1553 (Option)		Trigger on MIL-STD 1553 signals on data word start/stop, command/status start/stop, RTA, RTA + 11 bits, and error conditions (parity, sync, Manchester)
SPI (Option)		Trigger on SPI (serial peripheral interface) data pattern during a specific framing period. Supports positive and negative chip select framing as well as clock Idle framing and user-specified number of bits per frame. Supports MOSI and MISO data
UART/RS232/422/485 (Option)		Trigger on Rx or Tx start bit, stop bit, data content, or parity error
USB (Option)		Trigger on start of packet (SOP), end of packet (EOP), suspend [3], resume [3], reset [3], packets (token, data, handshake, or special), and errors (PID, CRC5, CRC16, glitch, bit stuff [3], SE1 [3]). Supports USB 2.0 low speed, full speed, and hi-speed (hi-speed is supported on 1 GHz and 1.5 GHz models only)
SENT (Option)		Trigger on SENT bus. start of fast channel message, start of slow channel message, fast channel SC and data, slow channel message ID, slow channel message ID and data, tolerance violation, fast channel CRC error, slow channel CRC error, all CRC errors, pulse period error, successive sync pulses error (1/64)
User-definable Manchester/NRZ (Option)		Trigger on start-of-frame (SOF), bus value, and Manchester errors
USB PD (Option)		Trigger on preamble, EDP, ordered sets, preamble errors, CRC errors, header content (control messages, data messages, extended messages and value in HEX)
Waveform measurements and cursors		
DC vertical accuracy/cursors [2]		Single cursor accuracy: ± [DC vertical gain accuracy + DC vertical offset accuracy + 0.21% full scale] Dual cursor accuracy: + [DC vertical gain accuracy + 0.42% full scale] [1]
Cursors		2 pairs of XY cursors Automatic measurement of positions, ΔX, 1/ΔX, ΔY, and ΔY/ΔX
Automatic measurements		Measurements continuously updated with statistics. Cursors track last selected measurement. Select up to four measurements from the list below:
	Voltage	Peak-to-peak, maximum, minimum, amplitude, top, base, overshoot, pre-shoot, average- N cycles, average- full screen, DC RMS- N cycles, DC RMS- full screen, AC RMS- N cycles, AC RMS- full screen (standard deviation), ratio (RMS1/RMS2)
	Time	Period, frequency, counter, + width, - width, burst width, duty cycle, bit rate, rise time, fall time, delay, phase, X at min Y, X at max Y
	Count	Positive pulse count, negative pulse count, rising edge count, falling edge count
	Mixed	Area- N cycles, area- full screen
Automatic measurement logging		Available via BenchVue
Counter		Built-in frequency counter
	Source	Any analog or digital channel
	Resolution	5 digits. Up to 8 digits with an external reference 10 MHz input
	Max frequency	Bandwidth of oscilloscope
Mask limit test option		Standard mask/limit test capability that provides easy, fast pass/fail comparison of a signal under test to a predefined mask template or auto-mask template. Predefined mask templates or edits to an auto-mask template can be made via a simple text editor. > 270,000 mask tests per second (waveform update rate)
Waveform math		
Number of math functions		Four (display one at a time)
Arithmetic		Add, subtract, multiply, divide, differentiate, integrate, FFT, Ax + B, squared, square root, absolute, common log, natural log, exponential, base 10 exponential, LP filter, HP filter, averaged value, smoothing, envelope, magnify, max hold, min hold, measurement trend, chart logic bus (timing or state)
FFT		Up to 64 kpts resolution. FFT window types: Hanning, flat top, rectangular, Blackman-Harris, Bartlett

1. Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ± 10 °C from firmware calibration temperature.
2. 1 mV/div and 2 mV/div is a magnification of 4 mV/div setting. For vertical accuracy calculations, use full scale of 32 mV for 1 mV/div and 2 mV/div sensitivity setting.
3. Suspend, resume, reset, bit stuff error, and SE1 error are USB 2.0 low and full speed only.

Oscilloscope Experience Redefined:
InfiniiVision 4000 X-Series Performance Characteristics (Continued)

Display characteristics	
Display	12.1-inch capacitive touch/gesture enabled color TFT LCD
Resolution	800 (H) x 600 (V) pixel format (screen area)
Graticules	8 vertical divisions by 10 horizontal divisions with intensity controls
Format	YT, XY and Roll
Maximum waveform update rate	> 1,000,000 wfm/s
Persistence	Off, infinite, variable persistence (100 ms to 60 s)
Intensity gradation	64 intensity levels
Connectivity	
USB 2.0 hi-speed host port	USB 2.0 hi-speed host ports x3, two front and one real panel. Supports memory devices, printers, keyboards and mice
USB 2.0 hi-speed device port	One USB 2.0 hi-speed device port on rear panel. USB Test and Measurement Class (USBTMC) compatible
LAN port	10/100Base-T port on rear panel. LXI IPv6 extended function
Web remote control	VNC Web interface (via major Web browsers)
Video out port	SVGA out on rear panel. Connect oscilloscope display to an external monitor or projector
GPIB port	N4865A GPIB-to-LAN adapter (optional)
10 MHz out/in	BNC connector on the rear panel. Supported modes: Off, 10 MHz out, or reference signal mode (10 MHz in)
Trigger out	BNC connector on the rear panel. Supported modes: triggers, mask, waveform generator 1 sync pulse, and waveform generator 2 sync pulse
Dual-channel WaveGen built-in function/arbitary waveform generator (specifications are typical)	
WaveGen outputs	Two (front-panel BNC connectors)
	Both waveform generator outputs can be frequency tracked, amplitude tracked, or completely tracked.* A generator's output can be inverted to create a differential signal
Waveforms	Sine, square, ramp, pulse, DC, noise, sine cardinal (sinc), exponential rise, exponential fall, cardiac, Gaussian pulse, and arbitrary
Modulation	Modulation is available on channel 1 only. Modulation is not available when tracking mode is enabled. Modulation types: AM, FM, FSK Carrier waveforms: Sine, Ramp, Sine Cardinal, Exponential Rise, Exponential Fall, and Cardiac.Modulation Source: Internal (no external modulation capability) AM: Modulation: Sine, Square, Ramp Modulation frequency: 1 Hz to 20 kHz Depth: 0% to 100% FM: Modulation: Sine, Square, Ramp Modulation frequency: 1 Hz to 20 kHz Minimum carrier frequency: 10 Hz Deviation: 1 Hz to carrier frequency or ($2e^{12}$/carrier frequency), whichever is smaller FSK: Modulation: 50% duty cycle square wave FSK rate: 1 Hz to 20 kHz Hop frequency: 2 x FSK rate to 10 MHz

1. Only the following combination of wave shapes can be frequency tracked or completely tracked:
   1) Sine, ramp, sine cardinal, cardiac, and Gaussian pulse.
   2) Square wave and pulse.
   3) Exponential rise and exponetial fall.
   4) Arbitrary.

Oscilloscope Experience Redefined:
InfiniiVision 4000 X-Series Performance Characteristics (Continued)

Dual-channel WaveGen built-in function/arbitary waveform generator (specifications are typical)		
Sine	Frequency range	0.1 Hz to 20 MHz
	Amplitude flatness	± 0.5 dB (relative to 1 kHz)
	Harmonic distortion	–40 dBc
	Spurious (non harmonics)	–40 dBc
	Total harmonic distortion	1%
	SNR (50-Ω load, 500-MHz BW)	40 dB (Vpp ≥ 0.1 V); 30 dB (Vpp < 0.1 V)
Square wave/pulse	Frequency range	0.1 Hz to 20 MHz
	Duty cycle	20 to 80%
	Duty cycle resolution	Larger of 1% or 10 ns
	Rise/fall time	19 ns (10 to 90%)
	Overshoot	< 2%
	Asymmetry (at 50% DC)	± 1% ± 5ns
	Jitter (TIE RMS)	500 ps
Ramp/triangle wave	Frequency range	0.1 Hz to 200 kHz
	Linearity	1%
	Variable symmetry	0 to 100%
	Symmetry resolution	1%
Pulse	Frequency range	0.1 Hz to 10 MHz
	Pulse width	20 ns minimum
	Pulse with resolution	10 ns
	Edge time	Fixed at 19 ns (not variable)
	Overshoot	< 2%
Noise	Bandwidth	20 MHz typical
Sine cardinal (Sinc)	Frequency range	0.1 Hz to 1.0 MHz
Exponential rise/fall	Frequency range	0.1 Hz to 5.0 MHz
Cardiac	Frequency range	0.1 Hz to 200.0 kHz
Gaussian pulse	Frequency range	0.1 Hz to 5.0 MHz
Arbitrary	Waveform length	1 to 8,192 points
	Amplitude resolution	10 bits (including sign bit) [2]
	Repetition rate	0.1 Hz to 12 MHz
	Sample rate	100 MSa/s
	Filter bandwidth	20 MHz
Frequency	Sine wave and ramp accuracy	130 ppm (frequency < 10 kHz)
		50 ppm (frequency > 10 kHz)
	Square wave and pulse accuracy	[50 + frequency/200] ppm (frequency < 25 kHz)
		50 ppm (frequency ≥ 25 kHz)
	Resolution	0.1 Hz or 4 digits, whichever is larger
Amplitude	Range: Minimum	20 mVpp if |offset| ≤ 0.5 Vpp into Hi-Z [1]
		10 mVpp if |offset| ≤ 0.5 Vpp into 50 Ω [1]
	Range: Maximum	10 Vpp except, 9 Vpp if Sinc or Cardiac, 7.5 Vpp if Gaussian pulse into Hi-Z; 5 Vpp/4.5 Vpp into 50 Ω
	Resolution	100 µV or 3 digits, whichever is higher
	Accuracy	1.5% (frequency = 1 kHz)

1. Sinc, cardiac and Gaussian pulse: ± 1.25 V into Hi-Z; ± 625 mV into 50 Ω.
2. Full resolution is not available at output due to internal attenuator stepping.

Oscilloscope Experience Redefined:
InfiniiVision 4000 X-Series Performance Characteristics (Continued)

Dual channel WaveGen - built-in function/arbitary waveform generator		
DC offset	Range	± 5 V into Hi-Z, except ± 4 V if sine wave, ± 2.5 V if sinc, cardiac, or Gaussian pulse into Hi-Z
		± 2.5 V into Hi-Z, except ± 2 V if sine wave, ± 1.25 V if sinc, cardiac, or Gaussian pulse into 50 Ω
	Resolution	Larger of 250 uV or 3 digits
	Accuracy (waveform modes)	± 1.5% of offset setting ± 1% of amplitude ± 1 mV
	Accuracy (DC mode)	± 1.5% of offset setting ± 3 mV
Main output	Impedance	50 Ω typical
	Isolation	Not available, main output BNC is grounded
	Protection	Overload automatically disables output
Trigger output	Trigger output available on trig-out BNC	

Digital voltmeter (specifications are typical)	
Source	Analog channels only (1-4)
Functions	ACrms, DC, DCrms, frequency
Resolution	ACV/DCV: 3 digits
	Counter frequency: 5.5 digits
Measuring rate	100 times/second
Autoranging	Automatic adjustment of vertical amplification to maximize the dynamic range of measurements
Range meter	Graphical display of most recent measurement, plus extrema over the previous 3 seconds

General and environmental characteristics	
Power line consumption	Maximum 120 W
Power voltage range	100 to 120 V, 50/60/400 Hz; 100 to 240 V, 50/60 Hz
Environmental rating	0 to 50 °C, 3000 m max, Maximum Relative Humidity (non-condensing): 95%RH up to 40°C, decreases linearly to 50%RH at 50°C From 40°C to 50°C, the maximum % Relative Humidity follows the line of constant dew point
Electromagnetic compatibility	Meets EMC Directive (2004/108/EC), meets or exceeds IEC 61326-1:2005/EN
	61326-1:2006 Group 1 Class A requirement
	CISPR 11/EN 55011
	IEC 61000-4-2/EN 61000-4-2
	IEC 61000-4-3/EN 61000-4-3
	IEC 61000-4-4/EN 61000-4-4
	IEC 61000-4-5/EN 61000-4-5
	IEC 61000-4-6/EN 61000-4-6
	IEC 61000-4-11/EN 61000-4-11
	Canada: ICES-001:2004
	Australia/New Zealand: AS/NZS
Safety	ANSI/UL Std. No. 61010-1:2012; CAN/CSA-C22.2 No. 61010-1-12
	ANSI/UL Std. No. 61010-2-030:2012; CAN/CSA-C22.2 No. 61010-2-030-12
Vibration	Meets IEC60068-2-6 and MIL-PRF-28800; class 3 random

Oscilloscope Experience Redefined: InfiniiVision 4000 X-Series Performance Characteristics (Continued)

General and environmental characteristics	
Shock	Meets IEC 60068-2-27 and MIL-PRF-28800; class 3 random; (operating 30 g, ½ sine. 11 ms duration, 3 shocks/axis along major axis, total of 18 shocks)
Dimensions (W x H x D)	454 mm x 275 mm x 156 mm
Weight	Net: 6.3 kg (13.9 lbs), shipping: 11.4 kg (25 lbs)
Kensington style lock	Rear-panel security slot connects to standard Kensington-style lock

Nonvolatile storage	
Reference waveform display	4 internal waveforms or USB thumb drive
Save formats	Setup (*.scp), 8- or 24-bit bitmap image (*.bmp), PNG 24-bit image (*.png), CSV data (*.csv), ASCII XY data (*.csv), binary data (*.bin), lister data (*.csv), reference waveform data (*.h5), multi-channel waveform data (*.h5), mask (*.mask), arbitrary waveform data (*.csv), power harmonics data (*.csv), USB signal quality (*.html & *.bmp)
Max USB flash drive size	Supports industry-standard flash drives
Set ups without USB flash drive	10 internal setups
Set ups with USB flash drive	Limited by size of USB drive

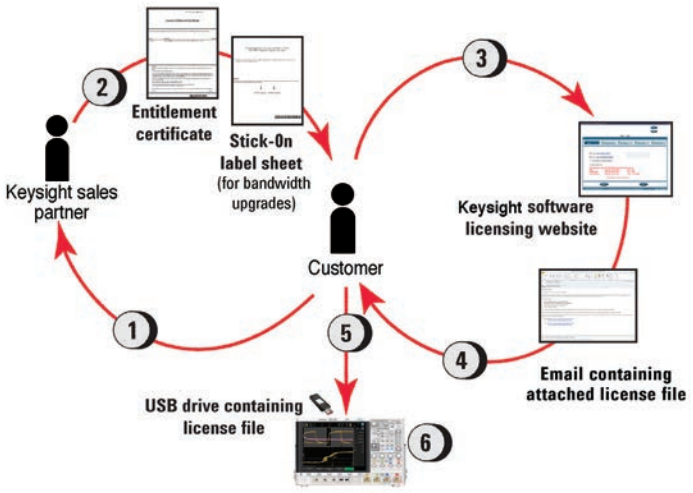
Included standard with oscilloscope	
Calibration	Certificate of Calibration, 2-year calibration interval
Probes	One per channel N2894A 700 MHz passive probe (10:1 attenuation)
	N2756A 16-digital-channel MSO cable (1 per oscilloscope included on all MSO models and DSOXPERFMSO)
Localized interface	English, Chinese (simplfied and traditional), French, German, Italian, Japanese, Korean, Portuguese, Russian, and Spanish localized front panel overlays, interface, and built-in help system
Power cord	Localized power cord
Front panel protection	Front panel cover
Documentation	CD containing localized user's guide, service guide, and programmer's manual

For MET/CAL procedures, visit the Cal Lab Solutions website: **http://www.callabsolutions.com/products/Keysight/**.

Related literature

Publication title	Publication number
Oscilloscope Memory Architectures – Why All Acquisition Memory is Not Created Equal - Application Note	5991-1024EN
Triggering on Infrequent Anomalies and Complex Signals using Zone Trigger - Application Note	5991-1107EN
Switch Mode Power Supply Measurements - Application Note	5991-1117EN
Characterizing Hi-Speed USB 2.0 Serial Buses In Embedded Designs - Data Sheet	5991-1148EN

Oscilloscope Experience Redefined: License-only Bandwidth Upgrades and Measurement Applications



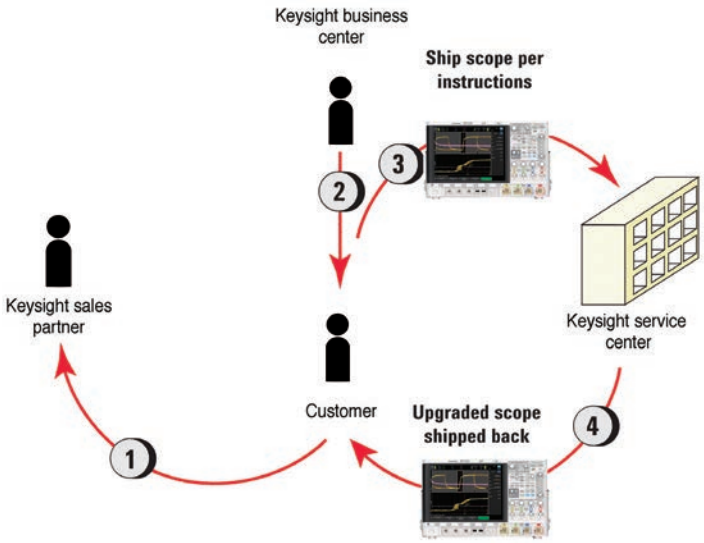
4000 X-Series bandwidth upgrade models		
Model number	**Description**	**Type**
DSOX4B3T52U	350 MHz ~ 500 MHz, 2 ch	License only
DSOX4B3T54U	350 MHz ~ 500 MHz, 4 ch	License only

Model number	Description
DSOX4EMBD	Embedded serial triggering and analysis (I²C, SPI)
DSOX4COMP	Computer serial triggering and analysis (RS232/UART)
DSOX4USBFL	USB 2.0 Full/Low Speed serial decode and triggering
DSOX4USBH [1]	USB 2.0 Hi-Speed serial decode and triggering
DSOX4USBSQ	USB 2.0 signal quality test
DSOX4UPD	USB PD serial triggering and decode
DSOX4AUTO	Automotive serial triggering and analysis (CAN/CAN-dbc/LIN)
DSOX4FLEX	FlexRay serial triggering and analysis
DSOX4CXPI	CXPI serial triggering and decode
DSOX4AUDIO	Audio serial triggering and analysis (I²S)
DSOX4AERO	Aerospace and defence serial triggering and decode (MIL-STD 1553 and ARINC 429)
DSOX4NRZ	User-definable Manchester and NRZ triggering and decode
DSOX4WAVEGEN2	Dual-channel WaveGen 20 MHz arbitrary/function generator
DSOX4PWR	Power analysis application
DSOX4FRA	Frequency Response Analysis (FRA)
DSOX4MASK	Mask Limit Testing
DSOX4VID	Enhanced video/TV application package
DSOXPERFMSO	4000 X-Series oscilloscope MSO upgrade (N2756A MSO cable is shipped separately)
DSOX4NFC	NFC triggering and automated test software

1. DSOX4USBH is available only for 1 GHz and 1.5 GHz models.

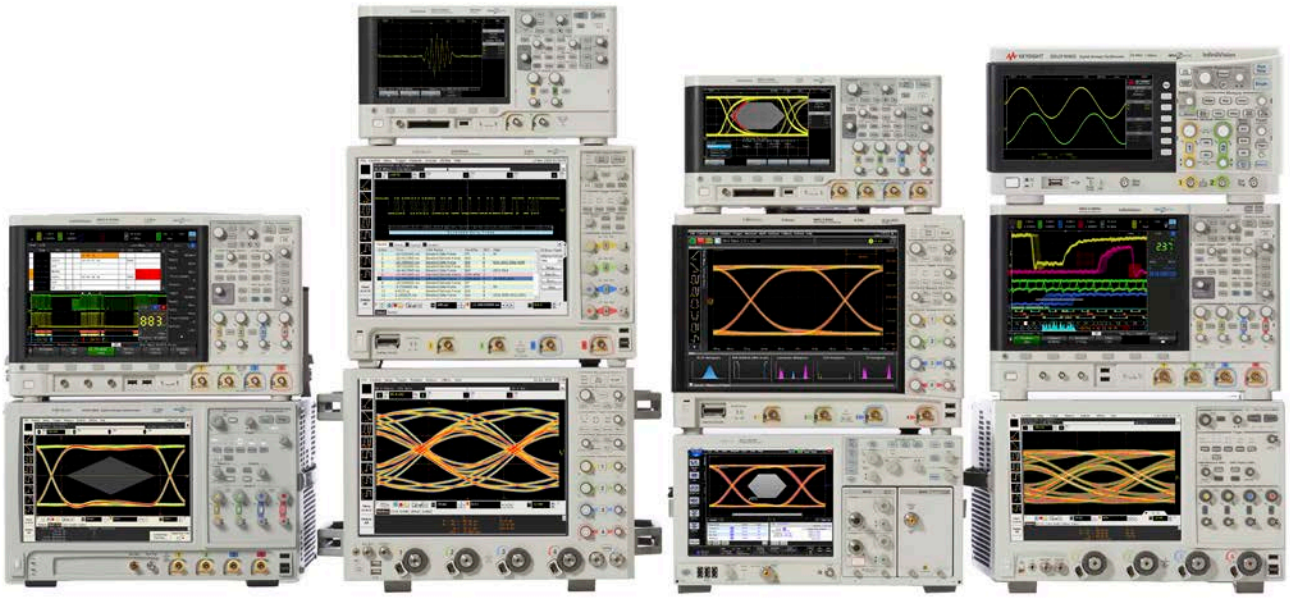
Process description	
1	Place order for a license-only upgrade or measurement application product with a Keysight sales partner.
2	For measurement applications, you will receive a paper or electronic .pdf entitlement certificate. For bandwidth upgrades only, you will receive a stick-on label document indicating upgraded bandwidth specification in addition to a paper entitlement certificate.
3	Use entitlement certificate containing instructions and certificate number needed to generate a license file for a particular 4000 X-Series oscilloscope model number and serial number unit.
4	Receive the licensed file and installation instructions via email.
5	Copy license file (.lic extension) from email to a USB drive and follow instructions in email to install the purchased bandwidth upgrade or measurement application on the oscilloscope.
6	For bandwidth upgrades only, attach bandwidth upgraded stick-on labels to front and rear panels of the oscilloscope. Model number and serial number of the oscilloscope do not change.

Oscilloscope Experience Redefined: Return-to-Keysight Service Center Bandwidth Upgrades



4000 X-Series bandwidth upgrade models		
Model number	**Description**	**Type**
DSOX4B2T32U	200 MHz ~ 350 MHz , 2 ch	Service center
DSOX4B2T34U	200 MHz ~ 350 MHz , 4 ch	Service center
DSOX4B5T104U	500 MHz ~ 1 GHz , 4 ch	Service center
DSOX4B1T154U	1 GHz ~ 1.5 GHz , 4 ch	Service center
DSOX4B2T52U	200 MHz ~ 500 MHz , 2 ch	Service center
DSOX4B2T54U	200 MHz ~ 500 MHz , 4 ch	Service center
DSOX4B2T104U	200 MHz ~ 1 GHz , 4 ch	Service center
DSOX4B2T154U	200 MHz ~ 1.5 GHz , 4 ch	Service center
DSOX4B3T104U	350 MHz ~ 1 GHz , 4 ch	Service center
DSOX4B3T154U	350 MHz ~ 1.5 GHz , 4 ch	Service center
DSOX4B5T154U	500 MHz ~ 1.5 GHz , 4 ch	Service center

Process description	
1	Place order for a return-to-Keysight service center bandwidth upgrade product to a Keysight sales partner. Serivce Center installation, calibration, shipment costs are in addition to bandwidth upgrade product price.
2	Keysight Business Center will contact you regarding process and timing of the service center installation. Continue to use oscilloscope until contacted again later when parts are available at service center.
3	Ship the oscilloscope per provided instructions to service center.
4	Service center ships back upgraded oscilloscope with stick-on labels applied to front and rear panels indicating upgraded bandwidth specification. Model number and serial number of the oscilloscope do not change.



Keysight Oscilloscopes

Multiple form factors from 20 MHz to > 90 GHz | Industry-leading specs | Powerful applications

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

KEYSIGHT TECHNOLOGIES

This information is subject to change without notice. © Keysight Technologies, 2018, Published in USA, August 7, 2018, 5991-1103EN