Keysight Technologies
Infiniium 9000 H-Series
High-Definition Oscilloscopes

Data Sheet

KEYSIGHT
TECHNOLOGIES
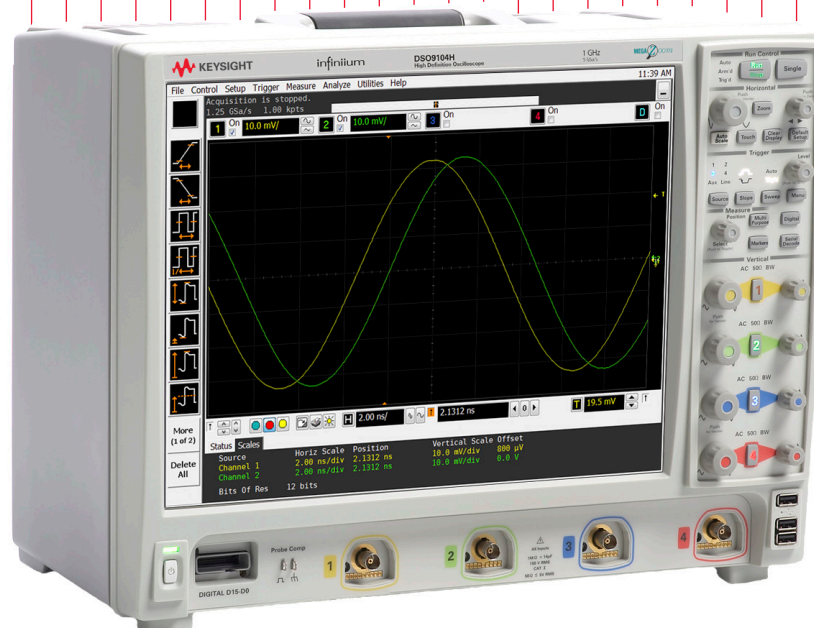
See Your Signals in HD

The high-definition Keysight Technologies, Inc. 9000 H-Series oscilloscope offers up to 12 bits of resolution, which represents 4096 quantization levels, for precision signal viewing. The 9000 H-Series' combination of hypersampling and linear noise reduction technology achieves a noise level up to three times lower than traditional 8-bit oscilloscopes. Engineered to provide low noise and high-dynamic-range measurement capability, these scopes also offer comprehensive measurement capability with MSO upgrades, a variety of apps, and compatibility with Keysight's probing portfolio.

There is no better way to experience the superiority of the Infiniium 9000 H-Series than to see it.

Contact Keysight today to request an evaluation.

Or visit:
www.keysight.com/find/9000H
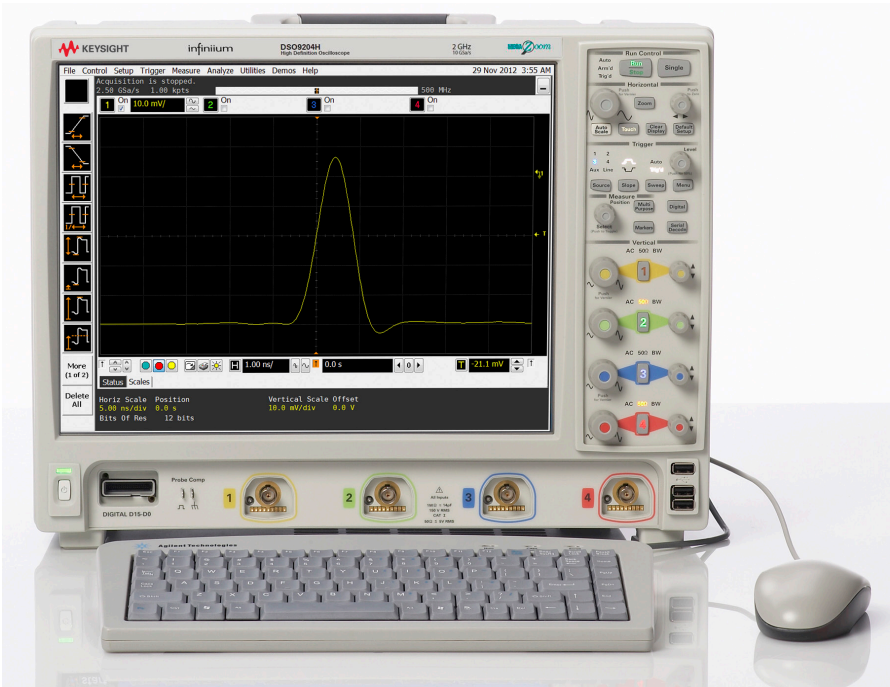
The Infiniium 9000 H-Series offers bandwidths up to 2 GHz. Each model, equipped with a large 15" XGA LCD display, comes in a whisper-quiet package that is just 9" (23 cm) deep and weighs only 26 pounds (11.8 kg).

	DSO9024H	DSO9054H	DSO9104H	DSO9204H
Scope channels	4	4	4	4
Bandwidth	250 MHz	500 MHz	1 GHz	2 GHz[1]
Max sample rate	1.25 GSa/s	2.5 GSa/s	5 GSa/s	10 GSa/s
Standard memory (2-ch)	100 Mpts	100 Mpts	100 Mpts	100 Mpts
Bits of resolution	12	12	12 at < 500 MHz	12 at < 500 MHz
			10 at 1 GHz	10 at 1 GHz
				10 at 2 GHz
Noise (at 100 mV/div)	700 uV	720 uV	1.1 mV	1.5 mV
MSO and app upgrades	√	√	√	√

1. 2 GHz bandwidth in 2-channel mode, and 1 GHz bandwidth when all 4 channels are enabled.
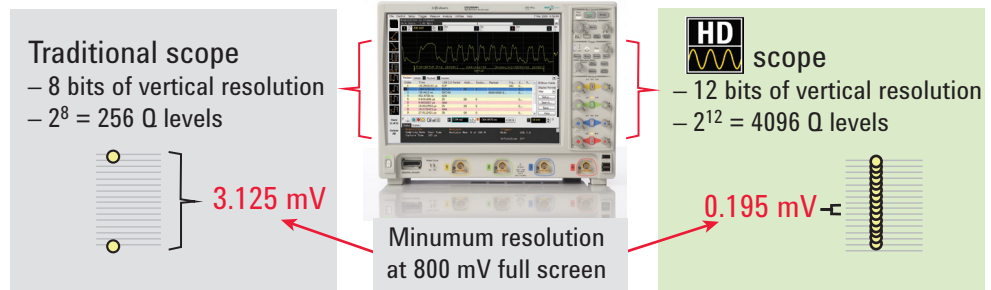
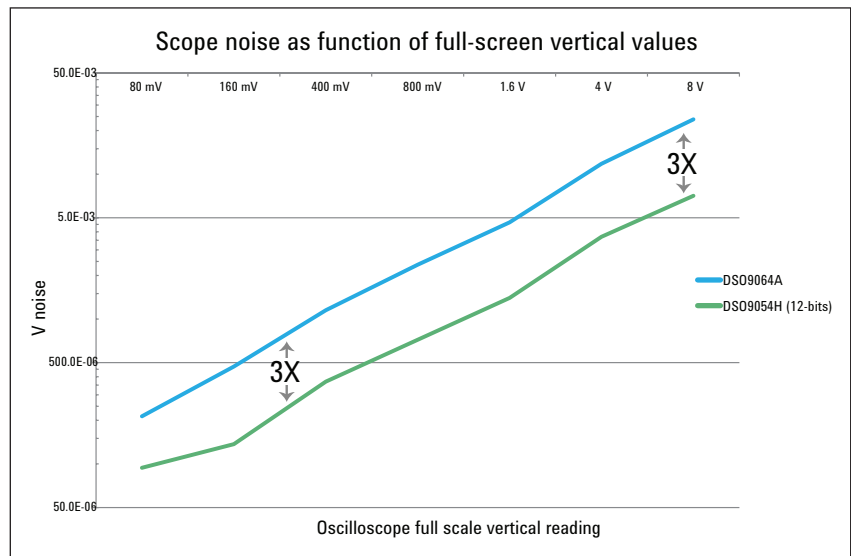# What is an HD (High-Definition) Oscilloscope?
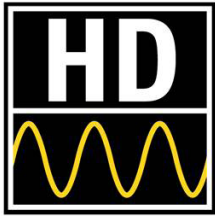
What is an HD oscilloscope?

– High-definition scopes offer > 8 bits of vertical resolution to reveal more signal detail.

– High-definition scopes must have significantly lower noise to view small detail normally masked by scope noise.

– MSO, application options, and probes give HD scopes greater utility.

Infiniium 9000 H-Series offers 12 bits of resolution, 16X more than its counterparts with 8-bit ADCs as shown in this example.

Traditional scope
− 8 bits of vertical resolution
− $2^8 = 256$ Q levels

3.125 mV

Minumum resolution at 800 mV full screen

HD scope
− 12 bits of vertical resolution
− $2^{12} = 4096$ Q levels

0.195 mV

Uncover detail normally masked by scope noise. Infiniium 9000 H-Series hypersampling combined with linear averaging technology reduces noise by up to 3X versus 8-bit scopes of equivalent bandwidth.

Scope noise as function of full-screen vertical values

V noise

Oscilloscope full scale vertical reading

DSO9064A
DSO9054H (12-bits)

Need to customize your scope?
The H-Series offers a wide range of debug, analysis, and compliance apps, along with MSO upgrades and ultrasensitive probes.
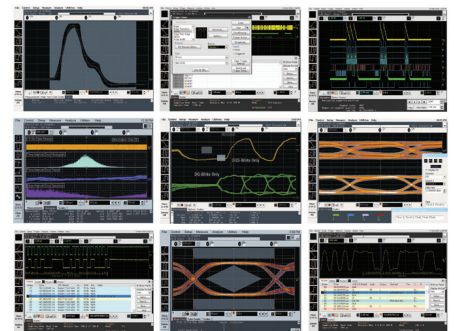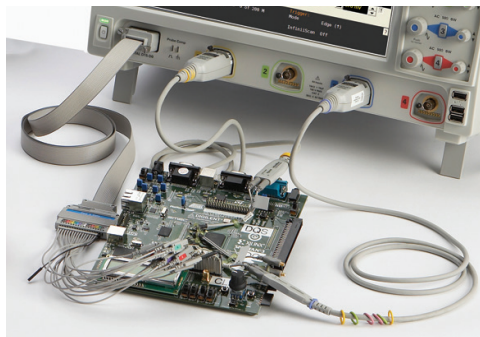
# Up to 12 bits of Resolution and 3X Less Noise

How does hypersampling and linear noise reduction work?

For traditional oscilloscopes, as a signal under test passes through the oscilloscope, front-end noise from the scope gets added to the signal, acquired, stored and displayed as shown below.

As small V/div values or in high-dynamic range measurements, this approach is problematic as oscilloscopes noise can mask small signal detail.

Keysight 9000 H-Series' hypersampling and linear noise reduction produces more precise viewing.

- The hyper-sampled ADC produces up to 16 hypersamples in a group.
- Each group vertical value is averaged, minimizing random noise that the scope added to the initial signal.
- The resulting vertical group value is saved to scope memory at the scope's published sample rate and displayed.
- View clear, precise waveforms even at small V/div settings.
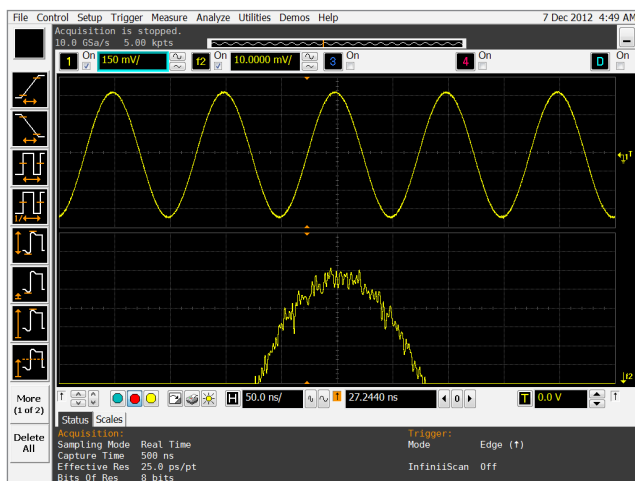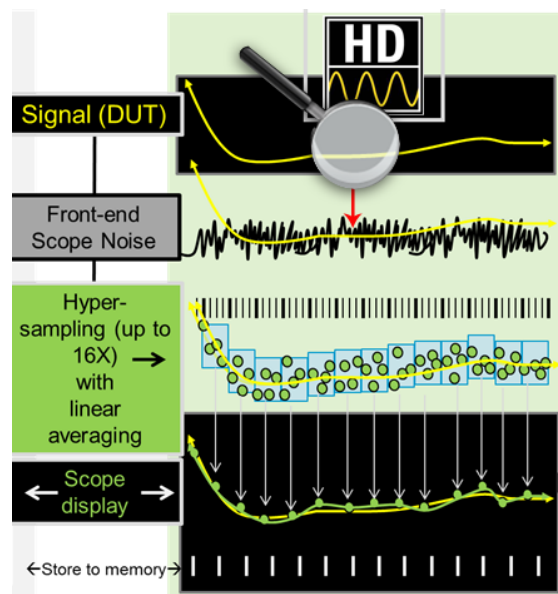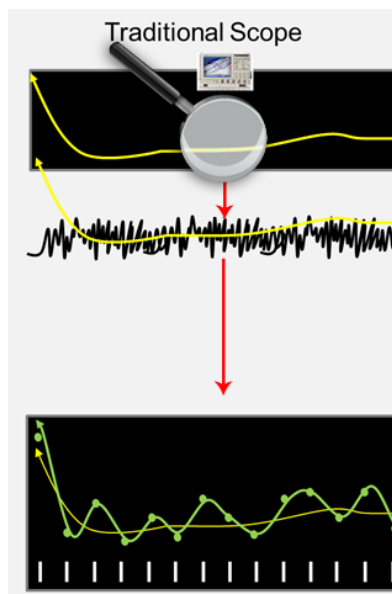
Zoom on top of clean sin wave shows more noise with 8-bit scope
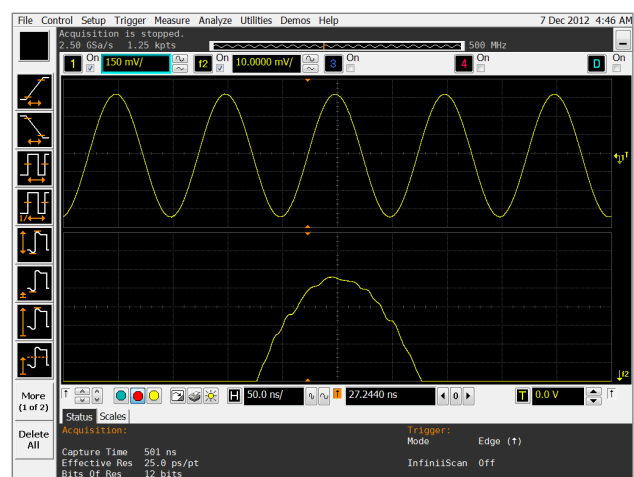
Zoom on top of same clean sin wave with equal bandwidth 9000 H-Series scope shows significantly less noise

What Makes the 9000H a Great HD Scope?

Keysight's first high-definition scope, the 9000 H-Series, is built on Keysight's highly-successful 9000 Series frame. The 9000H incorporates two pieces of noise reduction technology not found natively in other Infiniium scopes.

Hypersampled ADCs

– Low-pass front-end filter prevents aliased signal content.

– Each ADC produces up to 16 'hypersamples" between each acquisition point.

– Each hypersample vertical value includes random scope noise.

– Hypersamples are not stored to acquisition memory, as any single individual hypersample carries a signal plus noise component.

Linear Noise Reduction (LNR)

– Hardware-based technology implemented across the scope's ADC, memory controller, and FPGA for DSP noise reduction.

– DSP filter averages each group of hypersamples to cancel out noise across linear hypersamples.

– The scope stores the group vertical average value to memory at the scope sample rate.

– Produces up to 4096 quantization levels.

– Reduces noise by 3X (at 12 bits of resolution).

Infiniium 9000 H-Series acquisition boards incorporate HW-based hypersampling and LNR technology. See clear, precise waveforms without the noise a traditional scope would show.
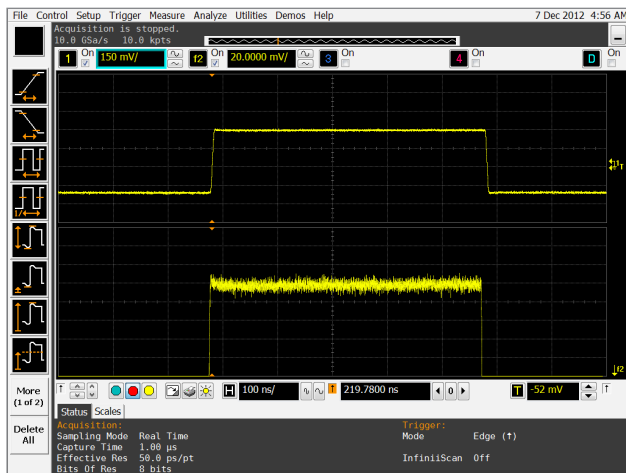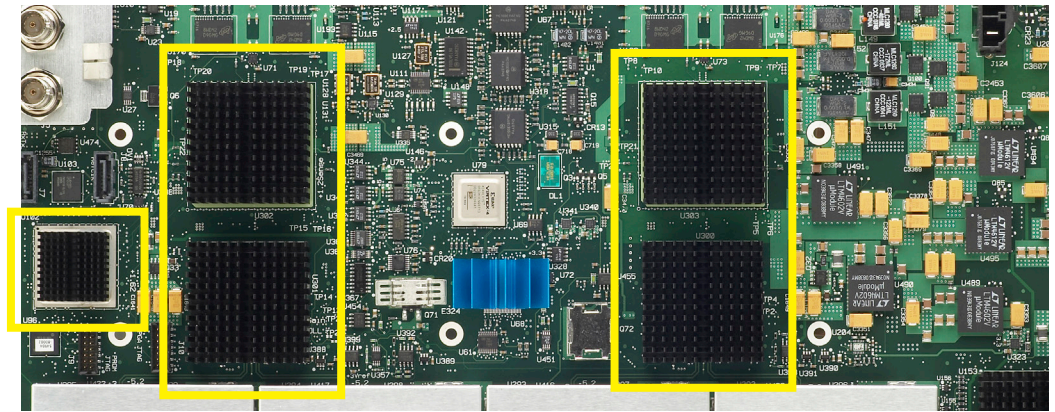
Zoom on top of square wave shows 3X more noise with 8-bit scope
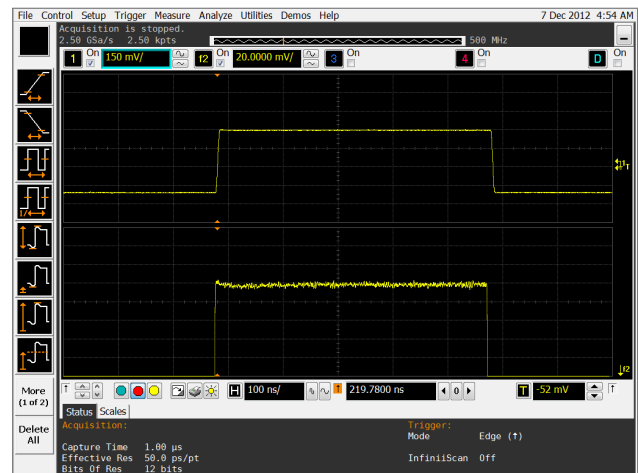
Zoom on top of square wave with equal bandwidth 9000 H-Series scope shows 3X less noise

Comprehensive Measurement Capability

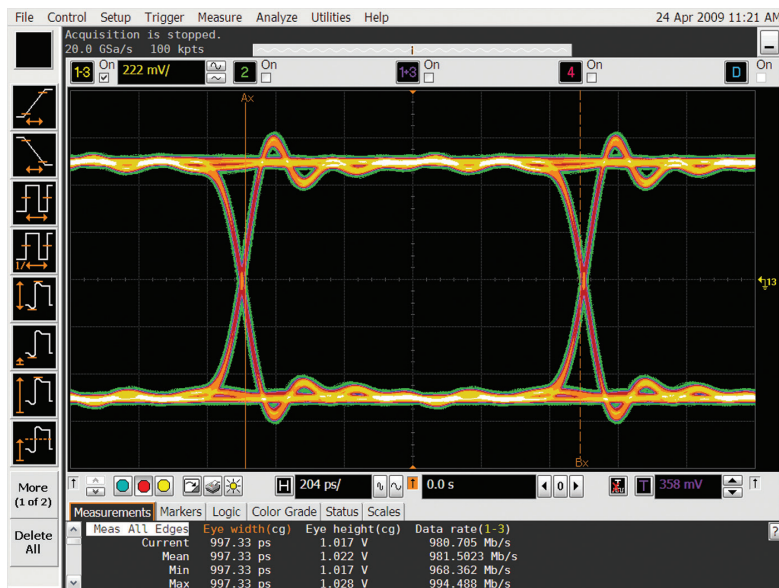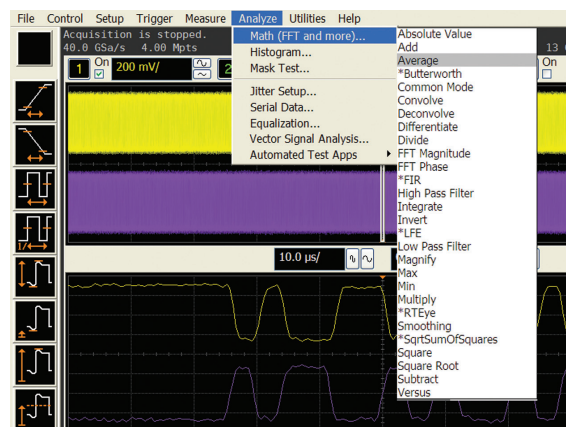In addition to precise waveform viewing, 9000 H-Series models incorporate the powerful scope capability found in all Infiniium oscilloscopes.

You'll have the ability to access a large variety of automated measurements and signal views.

Mask tests, histograms and a wide variety of functions provide deep signal analysis.

Responsive deep memory

With standard 100 Mpts (2-ch) of memory, 9000 H-Series oscilloscopes include the deepest standard memory in the industry. You can capture long time periods while retaining fast sample rates.

Advanced triggering

Advanced triggers are essential when you are investigating suspected problems. Infiniium offers a full range of advanced triggers to help you isolate and capture
the condition you need to characterize. The 9000 H-Series simplifies trigger setups by using intuitive dialog boxes with descriptive graphics.
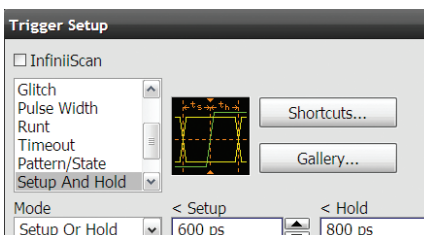
Drag and drop measurements

It's simple: drag an icon from the measurement bar and drop it on the cycle you want to measure. You can make up to ten measurements on your waveforms. All of the measurements appear at the bottom of the display with statistics and are color-coded to the channel you are measuring.
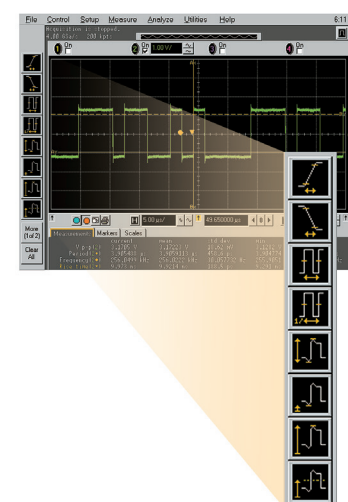
Comprehensive Measurement Capability (continued)

If you're like most engineers, you never know what your next project will demand from you. You need an oscilloscope that can adapt to a wide variety of debug and test challenges.

Use the MSO timing channels to evaluate control signal relationships and data buses up to 16 bits wide. Use symbols to more quickly interpret waveforms.

Keysight's ultrasensitive N2820A/N2821A current probes excel at measuring with resolution as low as 50 uA for small current levels typically found in mobile devices. Or, the probes can be configured for current up to 5A.
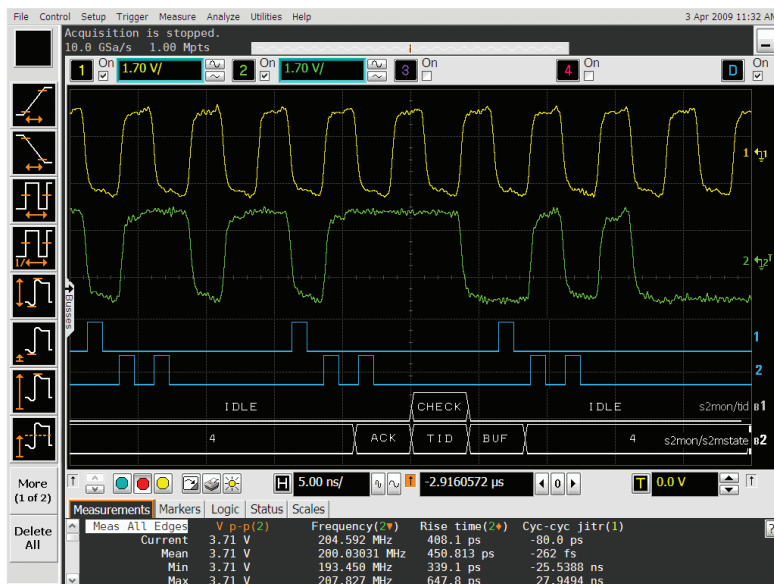
MSO Upgrade

MSO upgrade can be done in less than 5 minutes and add 16 high-speed timing channels.
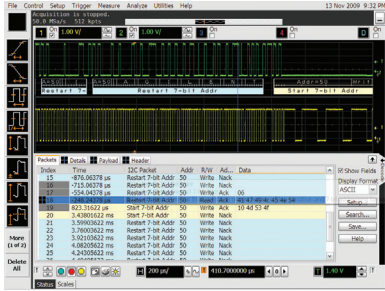
Applications

More than 20 optional apps can help give you faster insight. Does your design include a serial bus that is a key point for testing? Need additional analysis? See pages 8–12.

Probes

Choose from a wide variety of about 80 different current and voltage probes compatible with 9000 H-Series. This includes Keysight's ultrasensitive current probes.
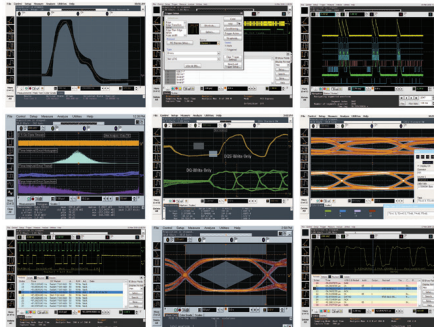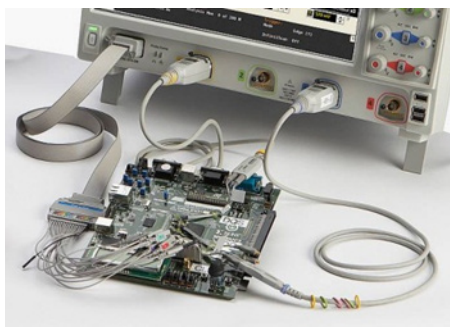
Widest Range of Optional Applications

Trigger and view on-screen serial decode of I2C packets.

I2C/SPI serial trigger and decode (N5391B or Option 007 on new scope purchases)

This application displays real-time time-aligned decode of I2C and SPI serial buses. Hardware-based triggering means triggering reliably, even on the most infrequent events.

This application works on all models and can use any combination of scope or logic acquisition channels.

For more information: www.keysight.com/find/9000_I2C-SPI
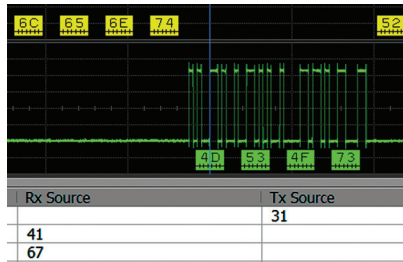
Trigger on and decode RS-232/UART transmission.

RS-232/UART serial decode and trigger (N5462B or Option 001 on new scope purchases)

This application eliminates the need to manually decode bus traffic. Using data captured on the scope or logic channels, the application lets you easily view the information sent over an RS-232 RS-422, RS-485 or other UART serial buses.

Display real-time time-aligned decode of transmit and receive lines. Hardware-based triggering means triggering reliably, even on the most infrequent events.

This application works on all models and can use any combination of the scope or logic acquisition channels.

For more information: www.keysight.com/find/9000_RS-232
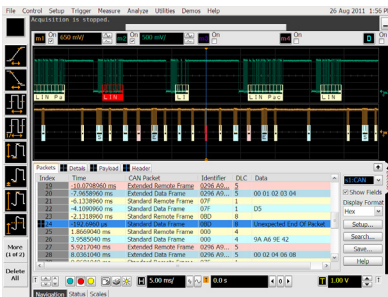
Trigger on and decode CAN, LIN and FlexRay serial packets.

CAN, LIN and FlexRay triggering and decode (N8803B or Option 008 on new scope purchases)

Trigger on and view both protocol layer information and physical layer signal characteristics for CAN, LIN and FlexRay buses. Numerical decode values are automatically displayed and synchronized below the captured signal or seen in protocol viewer.

Hardware-based triggering for CAN and LIN means triggering reliably, even on the most infrequent events. FlexRay uses software-based protocol triggering.

This application works on all models and can use any combination of scope or logic acquisition channels.

For more information: www.keysight.com/find/9000_CAN

Import BSDL files and decode JTAG scan chain activity.

JTAG (IEEE 1149.1) triggering and decode (N8817A or Option 042 on new scope purchases)

This application displays real-time time-aligned decode of JTAG (IEEE 1149.1) TDI and TDO signals. The application eliminates the difficult task of manually determining JTAG TAP controller states, instruction and data register decode, and flags error conditions. The application includes scan chain description features including the ability to import .bsdl files for each device and displays device names and opcodes in the protocol listing.

This application works on all models and can use any combination of scope or logic acquisition channels.

For more information: www.keysight.com/find/9000_JTAG

Widest Range of Optional Applications (continued)
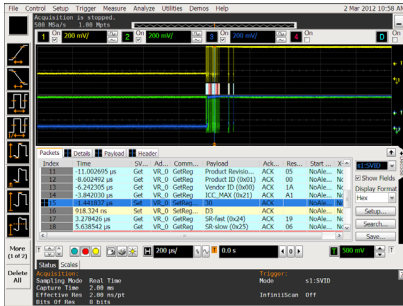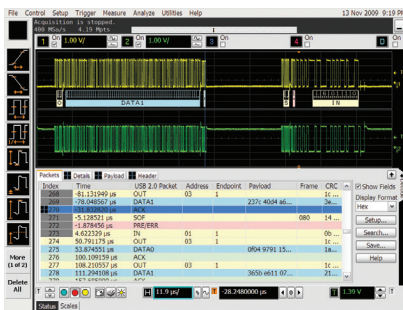

Trigger on and decode SVID protocol.

SVID protocol trigger and decode (N8812A or option 46 on new scope purchases)

This application includes a suite of configurable protocol-level trigger conditions specific to SVID. When serial triggering is selected, the application enables special real-time triggering hardware to ensure the oscilloscope never misses a trigger when armed.

The multi-tab protocol viewer includes correlation between the waveforms and the selected packet, enabling you to quickly move between the physical and protocol layer information using the time-correlated tracking marker.

For more information: www.keysight.com/find/n8812a

Trigger on and decode USB packets.

USB serial trigger and protocol viewer (N5464B or Option 005 on new scope purchases)

Trigger on and quickly view USB packets, payload, header and detail information. Powerful time-correlated views of waveform and symbol, to the bit level, make it easy to isolate communication faults to logic or analog sources.

USB hardware-based triggering means triggering reliably, even on the most infrequent events.

Low- and full-speed USB protocol is supported on digital and scope channels of all models. High-speed USB protocol is supported on scope channels of 1 GHz and 2 GHz models.

For more information: www.keysight.com/find/9000_USB
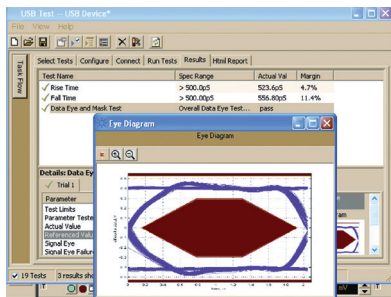
Check for USB compliance.

USB 2.0 compliance testing (N5416A or Option 029 on new scope purchases)

Quickly determine USB compliance with this USB-IF recognized solution. A setup wizard guides you through test selection and configuration.

This application is USB-IF approved and supported on all 2 GHz models.

For more information: www.keysight.com/find/9000_USB-compliance
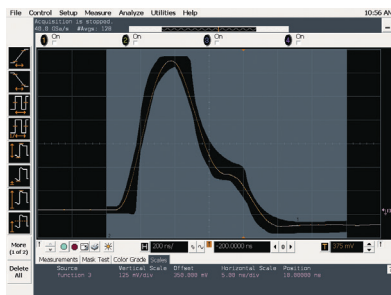
Validate Ethernet compliance.

Ethernet compliance testing (N5392A or Option 021 on new scope purchases)

Perform a wide range of electrical tests for 10-, 100-, and 1000-Base-T systems. An N5395C test fixture and N5396A jitter test cable speed compliance testing.

This application is supported on all 500 MHz and higher bandwidth models.

For more information: www.keysight.com/find/9000_ethernet

Widest Range of Optional Applications (continued)
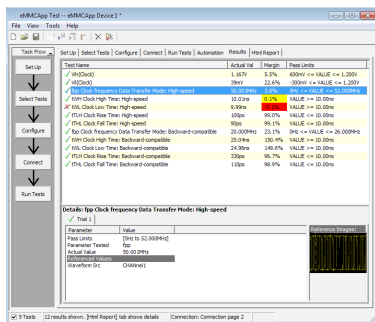
Perform eMMC compliance.

eMMC Compliance testing (N6465A or option 64 on new scope purchases)

Use the eMMC application to test, debug and characterize your eMMC designs quickly and easily. It automatically configures the oscilloscope for each test and generates an informative HTML report at the end of the test. The application not only compares the results with the specification test limit but also includes margin analysis, which indicates how closely the device passes or fails each test. On top of that, the complex analysis of the eMMC signals is taken care of by the application, which saves the time and effort it would have taken to do the measurements manually.

For more information: www.keysight.com/find/n6465a

Identify signal integrity issues with InfiniiScan Zone – Qualify triggering.

InfiniiScan event identification (N5415B or Option 009 on new scope purchases)

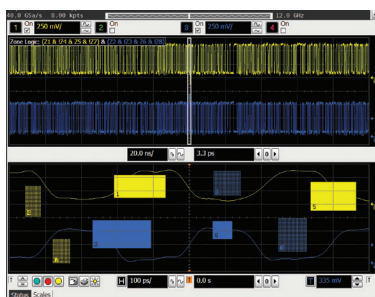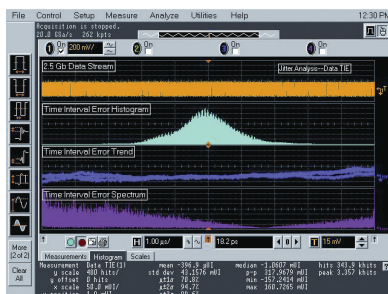Rapidly trigger on complex events and identify signal integrity issues.
This innovative software quickly scans through thousands of acquired waveform cycles and isolates anomalous signal behavior. Up to eight zones across channels are available.

This application is supported on all models.

For more information: www.keysight.com/find/infiniiScan

Conduct jitter analysis.

EZJIT analysis software (E2681A or option 002 on new scope purchases)

Quickly characterize and evaluate most commonly needed jitter measurements, including cycle-cycle, N-cycle, period, time-interval, error, setup and hold time, histograms, measurement trending and jitter spectrum.

This application is supported on all models.

For more information: www.keysight.com/find/EZJIT

Analyze jitter plus RJ/DJ separation.

EZJIT Plus analysis software (N5400A or Option 004 on new scope purchases. To upgrade from EZJIT to EZJIT Plus, order N5401A.)

EZJIT Plus adds additional compliance views and an expanded measurement setup wizard to simplify and automate RJ/DJ separation for testing against industry standards.

This application is supported on all models.

For more information: www.keysight.com/find/EZJITPlus

Widest Range of Optional Applications (continued)

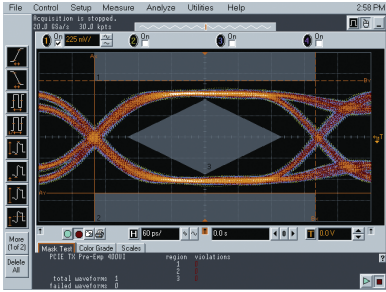Recover embedded clocks with serial data analysis (SDA).

High-speed serial data analysis software (N5384A or Option 003 on new scope purchases)

Quickly validate signal integrity for high-speed serial interfaces with embedded clocks. Recover embedded clocks synchronized with the analog waveform view. Build and validate eye diagrams.

The SDA package also includes software-based bit-level triggering and decode for 8B/10B.

This application is supported on all models.

For more information: www.keysight.com/find/9000_SDA
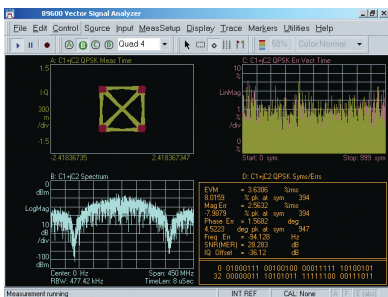
Use vector signal analysis software to see FFT-based spectrum analysis.

Vector signal analysis software (89601B)

Expand the measurement capability of your scope with the 89601B vector signal analysis software. This advanced DSP-based software takes the digitized signal data from the scope. Then it provides FFT-based spectrum analysis and wide-bandwidth digital modulation analysis for wireless communication signals such as W-CDMA and cdma2000® and wireless networking signals such as 802.11 WiFi and 802.16 WiMax®.

Take advantage of the super-wide bandwidth of your scope to capture and evaluate radar signals.

For more information: www.keysight.com/find/VSA
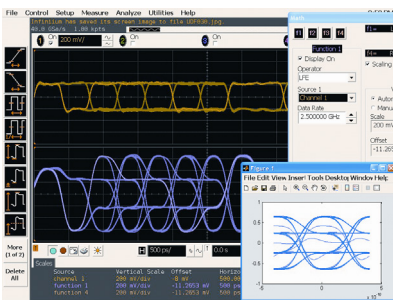
Signal equalization using user-defined function.

User-defined function (N5430A or Option 010 on new scope purchases)

Install MATLAB® on your scope and add your favorite MATLAB .m scripts as function operators and use them as standard waveform functions.

This application is supported on all models and requires MATLAB software (not included with UDF)

For more information: www.keysight.com/find/UDF
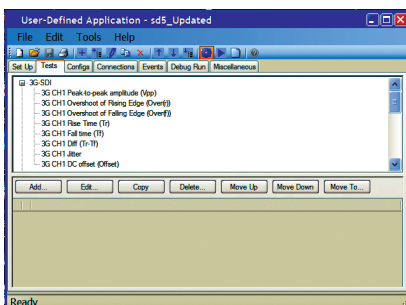
Quickly automate oscilloscope measurements.

User-definable application (5467A or Option 040 on new scope purchases)

Rapidly develop your own automated measurements and tests. This application provides the framework you need to quickly program and automate any single or set of measurements the oscilloscope can make.

The application also provides full control of other Keysight instruments and HTML reporting capabilities.

For more information: www.keysight.com/find/9000_UDA

Widest Range of Optional Applications (continued)
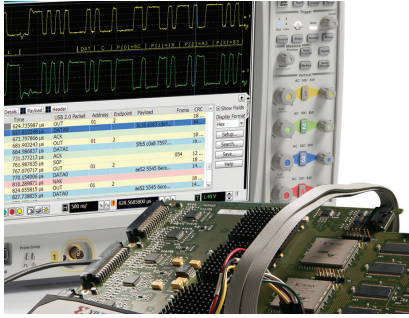
Rapid FPGA debug.

FPGA dynamic probe application (N5397A or Option 016 on new scope purchases)

Keysight's MSO FPGA dynamic probe provides internal FPGA visibility and quick instrument setup using an innovative core-assisted debug approach. Measurement tasks that previously took hours can be done in seconds with a few mouse clicks.

This application is supported with MSO upgrade.

For more information: www.keysight.com/find/9000_xilinx
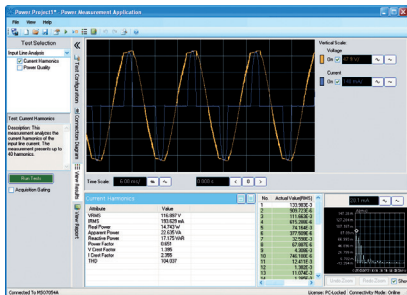
Use your scope to quickly make and analyze power measurements.

Power application (U1882A or Option 015 on new scope purchases)

Keysight's power application provides a full suite of power measurements. Make more accurate power-supply efficiency measurements by using an U1880A de-skew fixture to de-skew your voltage and current probes.

This application is supported on all models.

For more information: www.keysight.com/find/9000_power-app

InfiniiView Oscilloscope Analysis Software (N8900A)

Wish you could do additional signal viewing, analysis and documentation tasks away from your scope and target system? With Keysight's InfiniiView oscilloscope analysis software you can. Capture waveforms on your scope, save to a file, and open the data record into Keysight's InfiniiView application. View, analyze, share, and document scope measurements anywhere your PC goes.

Keysight Oscilloscope Compare

Keysight's real-time oscilloscope lineup in this bandwidth range includes the InfiniiVision 4000 X-Series, Infiniium 9000 H- and Infiniium 9000 Series oscilloscopes. Use the following selection guide to determine which best matches your specific needs.

	InfiniiVision 4000 X-Series	Infiniium 9000 H-Series	Infiniium 9000 Series
Bandwidth	200 MHz to 1.5 GHz	250 MHz to 2 GHz	600 MHz to 4 GHz
Max sample rate	5 GSa/s	10 GSa/s	20 GSa/s
Standard memory (2-ch)	4 Mpts	100 Mpts	40 Mpts
Max bits of resolution (default setup)	8	12	8
Display size	12" capacitive touch screen	15" touch screen	15" touch screen
Operating system	Embedded	Windows 7	Windows 7
Internal storage	Limited	250 GB HDD (SSD option)	250 GB HDD (SSD option)
Max update rate (waveforms/sec)	1M	2K	4K
Integrated function generator	√		
Noise at 100 mV/div with 1 GHz bandwidth	2.4 mV	1.1 mV	2.4 mV

Keysight Infiniium 9000 H-Series Oscilloscopes

15" XGA display makes it easier to view analog, digital and serial signals.

Comprehensive built-in information system gives you fast answers to your questions. The task-oriented setup guide provides step-by-step instructions for several measurement procedures.

Touchscreen display comes standard for mouse-free operation.

Drag-and-drop measurements from the measurement bar provide an intuitive way to make a measurement on a particular cycle of your waveform.

Mixed-signal oscilloscope (MSO) upgrades seamlessly integrate four analog scope channels with 16 digital channels.
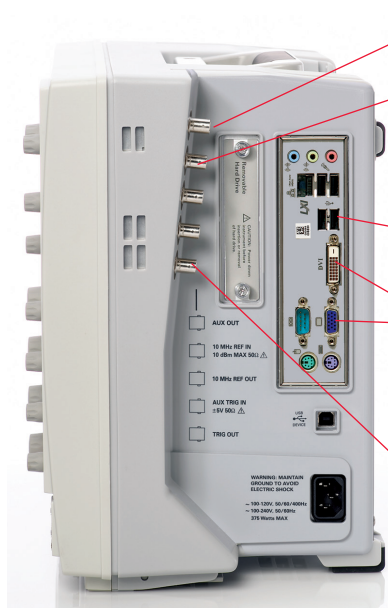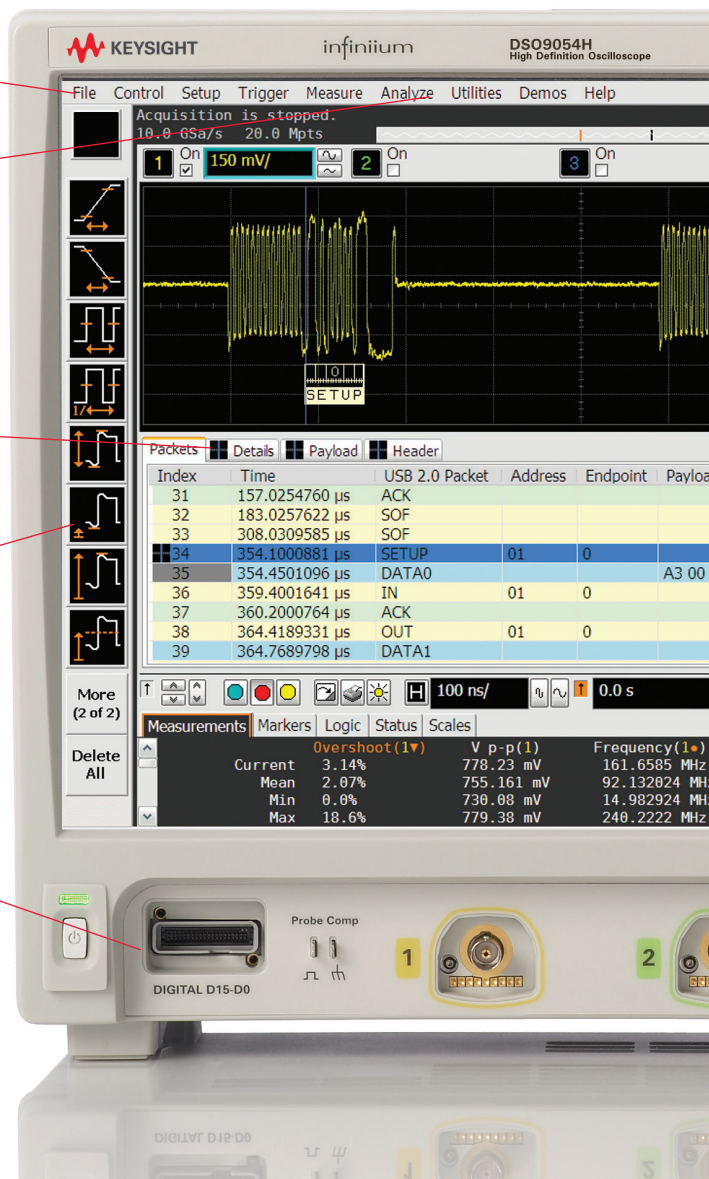
AUX OUT for calibration

Built-in 10-MHz reference in/out port synchronizes multiple measurement instruments in a system.

Standard USB and LAN ports provide PC and printer connectivity.

XGA and DVI video output port lets you connect to an external monitor.

Trig in/out ports provide an easy way to synchronize your scope to other instruments.
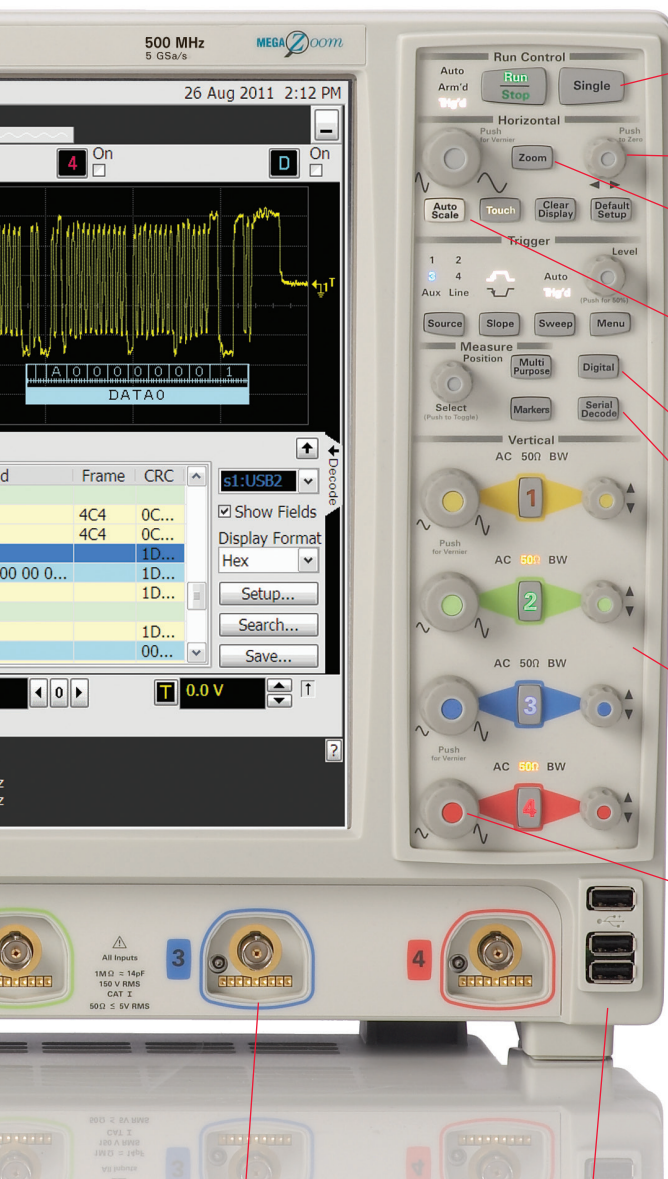
Dedicated **single acquisition button** provides better control to capture a unique event.

Pressing **horizontal delay knob** sets the delay to zero. A **zoom button** provides quick access to two screen-zoom modes.

MegaZoom instant response and optimum resolution allows you to pan and zoom quickly.

Autoscale lets you rapidly display any analog or digital active signals, automatically setting the vertical, horizontal and trigger controls for the best display, while optimizing memory.

Digital channel button provides quick setup access.

Serial decode button enables quick setup access.

Dedicated per-channel front panel controls make it easy to access the vertical and horizontal scaling and offset.

Quick access to fine/vernier control by pressing the horizontal and vertical sensitivity knobs.

AutoProbe interface automatically configures the attenuation ratio of the probe and provides probe power for Keysight's active probes.

Built-in USB ports makes it easy to save your work and update your system software quickly.

Accessory pouch detaches easily.

Connectivity and Probing

Connectivity

Industry compatibility

Export screen shots and waveforms in numerous industry-standard formats. In addition, the 9000 H-Series supports compatibility with the following

– IVI COM driver for application development environments such as Visual Studio, Keysight VEE, NI LabView and MATLAB instrument control toolbox. www.keysight.com/find/adn

– IntuiLink tool bars and data capture. www.keysight.com/find/intuilink

– LXI Class C including built-in Web control

– NI LabView PnP and IVI drives www.keysight.com/find/ni9404

Probing

Each Infiniium 9000 H-Series oscilloscope ships with four N2873A 10:1 divider passive probes and probe accessory pouch.

With both 50 Ω and 1 MΩ inputs, Infiniium 9000 H-Series scopes support a wide range of probes, including Keysight's InfiniiMax and InfiniiMode Series probes.

Keysight offers an innovative family of probes that are engineered for signal access and measurement accuracy. Whether you're looking for simple passive probes, the high bandwidth and low loading of an active probe, or specialty probes for current or high voltage, we can meet your needs. Our innovative accessories allow reliable connection to challenging components like small pitch

devices, and surface mount. To see our entire award-winning portfolio of probes for Infiniium oscilloscopes, please view the *Infiniium Oscilloscope Probes and Accessories* data sheet, publication number 5968-7141EN.

Recommended optional active probes

	Single-ended	InfiniiMax (Differential/ Single-ended)	InfiniiMode (Differential/ Single-ended/Common mode)
DSO9204H	1157A 2.5 GHz	1131A 3.5 GHz	N2751A 3.5 GHz
DSO9104H	N2796A 2 GHz	1130A 1.5 GHz	N2750A 1.5 GHz
DSO9054H	N2795A 1 GHz	1130A 1.5 GHz	N2750A 1.5 GHz
DSO9024H	N2795A 1 GHz	1130A 1.5 GHz	N2750A 1.5 GHz
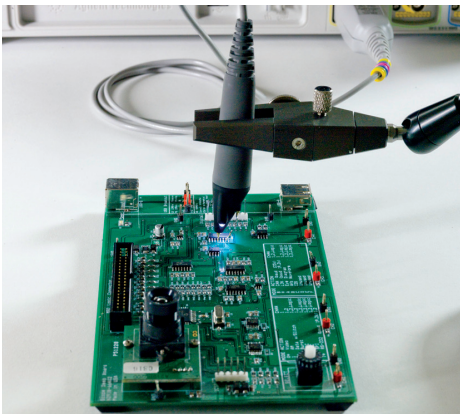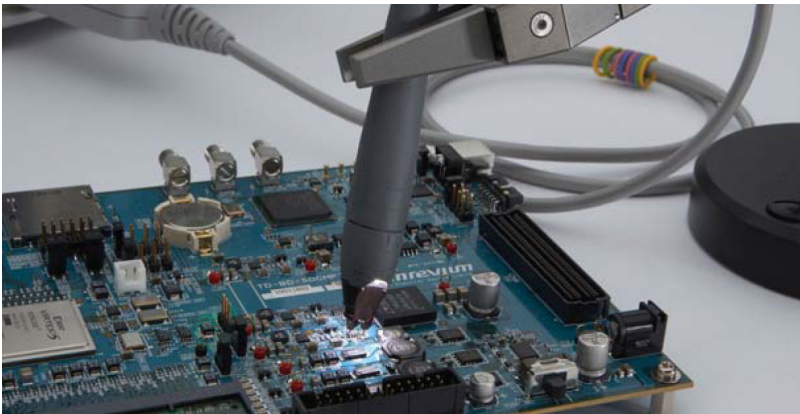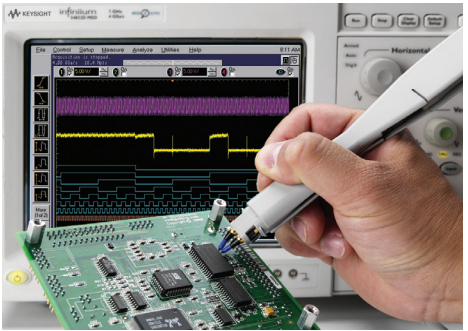
N2820A/N2821A High-Sensitivity Current Probes

Developing a battery powered product? Need to make your design more green and energy efficient? You need to make high-sensitivity, low-level current measurements to ensure the current consumption of your design is within acceptable limits.

We've designed the N2820A Series high-sensitivity current probes for you. Unlike traditional current probes, these are the industry's first that are designed using sense resistors. The result? You'll make the highest-sensitivity current measurements with the widest dynamic range. The probes offer multiple ways to connect to your target and precisely view currents as small as 50 uA.
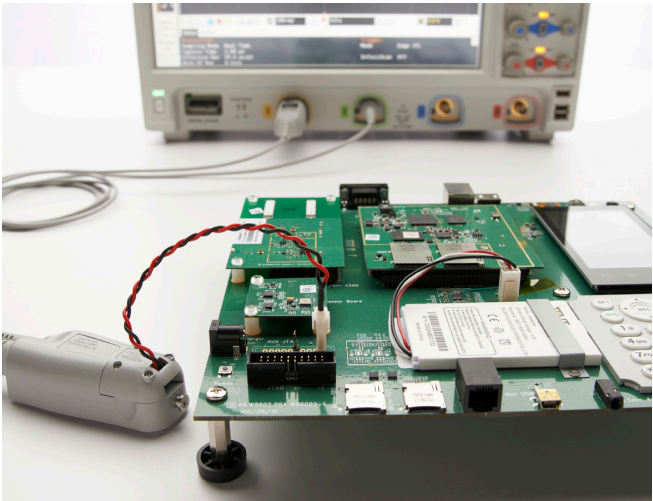
	Measurable current range	Dynamic range	Bandwidth
N2820A 2-channel high-sensitivity current probe	250 uA – 5 A, AC/DC (with N2822A 20 mΩ)	20,000:1 or 86 dB	3 MHz (zoom-out channel), 500 kHz (zoom-in channel)
N2821A 1-channel normal-sensitivity current probe	50 uA – 2.2 A, AC/DC (with N2824A 100 mΩ)	1,000:1 or 60 dB	3 MHz (zoom-out channel), 500 kHz (zoom-in channel) – choose one or the other

Want to determine how much charge your design is consuming? Keysight's Infiniium oscilloscopes provide an area under the curve measurement (Charge) where you can easily calculate the integrated current consumptions over time in Coulombs.
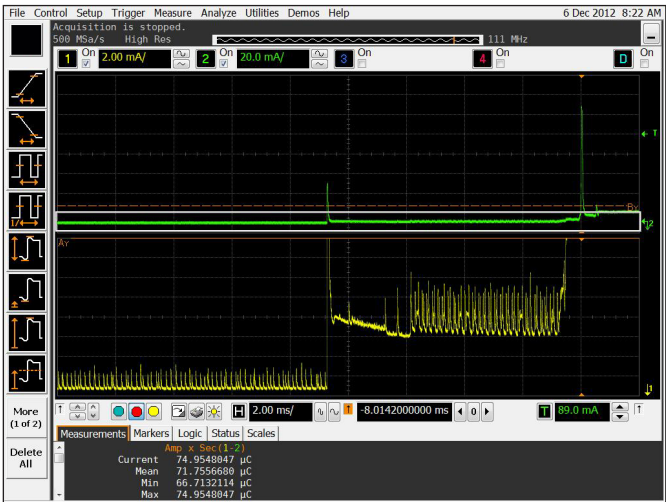
Both a zoomed-out view of the current, as well as a zoomed-in version that shows detail not normally seen with traditional probes.

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Infiniium 9000 H–Series Performance Characteristics

Vertical: scope channels	DSO9024H	DSO9054H	DSO9104H	DSO9204H
Analog bandwidth (–3 dB) 50 Ω[1]	250 MHz	500 MHz	1 GHz	2 GHz
1 MΩ	250 MHz	500 MHz	500 MHz	500 MHz
Typical Rise Time / Fall Time 10% to 90% at 50 Ω	748 ps	747 ps	253 ps	85 ps
Typical Rise Time / Fall Time 20% to 80% at 50 Ω	512 ps	511 ps	174 ps	59 ps
Input channels	DSO9000H – 4 analog MSO upgrade – 4 analog + 16 digital			
Input impedance[1]	50 Ω ±2.5%, 1 MΩ ±1% (11pF typical)			
Input sensitivity[3]	1 MΩ: 1 mV/div to 5 V/div 50 Ω: 1 mV/div to 1 V/div			
Input coupling	1 MΩ: AC (3.5 Hz), DC 50 Ω:DC			
Bandwidth limit	20 MHz on 1 MΩ input ; 500 MHz up to full scope bandwidth in increments of 500 MHz			
Vertical bits of resolution[2,3]	12 at < 500 MHz 10 at 1 GHz 10 at 2 GHz			
Channel-to-channel isolation	DC to 50 MHz: 50 dB > 50 MHz to 2 GHz: 40 dB			
DC gain accuracy[1,2,3]	±2% of full scale at full resolution on channel scale ±5 °C from cal temp (typically < 1% at cal temp)			
Maximum input voltage	1 MΩ: 150V RMS or DC, CAT I ± 250 V (DC + AC) in AC coupling 50 Ω: 5 Vrms			

Offset range	Vertical sensitivity	Available offset
1 MΩ	1 mV to < 10 mV/div	±2 V
	10 mV to < 20 mV/div	±5 V
	20 mV to < 100 mV/div	±10 V
	100 mV to < 1 V/div	±20 V
	1 V to 5 V/div	±100 V
50 Ω		±12 div or ±4V, whichever is smallest

1. –3 db typical, –4 db warranted specification. Specifications are valid after a 30-minute warm-up period and ±5 °C from firmware calibration temperature. Input impedance is   valid when V/div scaling is adjusted to show all waveform vertical values within scope display.
2. Vertical resolution for 8 bits = 0.4% of full scale, 12 bits = 0.024% of full scale.
3. 50Ω input: Full scale is defined as 8 vertical divisions. Magnification is used below 10 mV/div, full-scale is defined as 80 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V. 1MΩ input: Full scale is defined as 8 vertical divisions. Magnification is used below 5 mV/div, full-scale is defined as 40 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V.

Vertical: scope channels (con't)

Offset accuracy[1,3]	±(1.25% of channel offset + 1% of full scale + 1 mV)
Dynamic range	1 MΩ: ±8 div from center screen 50 Ω: ±8 div from center screen
DC voltage measurement accuracy[2]	

	Dual cursor	±[(DC gain accuracy) + (resolution)]
	Single cursor	±[(DC gain accuracy) + (offset accuracy) + (resolution/2)]

RMS Noise Floor (V $_{RMS\,AC}$)

Volts/div	DSO9024H	DSO9054H	DSO9104H	DSO9204H
10 mV	95 uV	94 uV	181 uV	210 uV
20 mV	135 uV	137 uV	279 uV	290 uV
50 mV	370 uV	370 uV	641 uV	790 uV
100 mV	710 uV	720 uV	1.2 mV	1.5 mV
200 mV	1.4 mV	1.4 mV	2.5 mV	3 mV
500 mV	3.6 mV	3.7 mV	6.2 mV	8 mV
1 V	7.1 mV	7.1 mV	11.6 mV	15 mV

Vertical: digital channels	On MSO upgrades
Input channels	16 digital channels
Threshold groupings	16 digital channels Pod 2: D15 – D8, Pod 1: D7 - D0
Threshold selections	TTL (1.4V), CMOS, (5.0V, 3.3V, 2.5V), ECL (-1.3V), PECL (3.7V), user defined (±8.00 V in 100 mV increments)
Maximum input voltage	±40 V peak CAT I
Threshold accuracy	±(100 mV + 3% of threshold setting)
Input dynamic range	±10 V about threshold
Minimum input voltage swing	500 mV peak-to-peak
Input impedance (flying leads)	100 kΩ ±2% (~ 8 pF) at probe tip
Resolution	1 bit
Analog bandwidth	400 MHz

Horizontal	
Channel-to-channel skew (digital MSO upgrade)	2 ns typical
Glitch detect (digital MSO upgrade)	≥ 2.0 ns
Main time base range	5 ps/div to 20 s/div
Horizontal position range	0 to ±200 s
Delayed sweep range	1 ps/div to current main time base setting
Resolution	1 ps
Modes	Main, delayed, roll (200 ms to 20 sec)
Reference positions	Left, center, right
Channel deskew	–1 ms to +1 ms range
Time scale accuracy (internal reference) (External reference clock = off)	Horizontal time base setting ± ((Horizontal time base setting) *(0.4 + 0.5* years since calibration)) ppm

1. –3 db typical, –4 db warranted specification. Specifications are valid after a 30-minute warm-up period and ±5 °C from firmware calibration temperature.
2. Vertical resolution for 8 bits = 0.4% of full scale, for 12 bits = 0.024% of full scale.
3. 50Ω input: Full scale is defined as 8 vertical divisions. Magnification is used below 10 mV/div, full-scale is defined as 80 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V.
    1MΩ input: Full scale is defined as 8 vertical divisions. Magnification is used below 5 mV/div, full-scale is defined as 40 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V.

		9024	9054	9104	9204
Max sample rate	2-ch	1.25 GSa/s	2.5 GSa/s	5 GSa/s	10 GSa/s
	4-ch	1.25 GSa/s	2.5 GSa/s	5 GSa/s	5 GSa/s

		Option 100		Option 200		Option 500	
		2-ch	4-ch	2-ch	4-ch	2-ch	4-ch
Memory depth per channel	Single	200 Mpts	100 Mpts	400 Mpts	200 Mpts	500 Mpts	250 Mpts
	Repetitive	200 Mpts	100 Mpts	200 Mpts	100 Mpts	256 Mpts	128 Mpts

Sampling Modes
  Real-time   12 bits of resolution at 250 MHz
               12 bits of resolution up to 500 MHz
               10 bits of resolution at 1 GHz
               10 bits of resolution at 2 GHz
  Real-time with roll mode (200 ms to 20 sec. per division)
  Segmented memory (1 ps time stamp resolution between segments)
               Up to 8192 segments for 20 Mpts standard memory, up to 131,072 segments with Option 500
               Maximum time between triggers is 562,950 seconds (6.5 days)
               Re-arm time (minimum time between trigger events) is 4.5 µs with analog channels, 5.8 µs with digital channels on

Filters	Sin (x) / x Interpolation

Acquisition: digital channels (MSO upgrades)

Maximum real time sample rate	2 GSa/s
Maximum memory depth per channel	128/64 Mpts with 2 GSa/s. 64/32 Mpts with sampling < 2 GSa/s (single/repetitive mode).
Minimum width glitch detection	2 ns

Trigger: scope channels

Trigger sources	Channel 1, channel 2, channel 3, channel 4, aux, and line	
Sensitivity	1 MΩ input, edge trigger, 50 Ω	DC to 500 MHz: 0.6 div DC to 2 GHz, 0.5 div 2 GHz to 4 GHz: 1.0 div
	Auxiliary	DC to 700 MHz: 300 mVp-p

Trigger level range
  Channel 1,2,3,4
  Auxiliary
	± 8 V at 5 V/div, < 5 V/div ± 4 div from center screen (50 Ω)
	± 8 V at 5 V/div, < 5 V/div ± 8 div from center screen (1 MΩ)
	± 5 V (50Ω up to 500 MHz with at least 500 mV signal swing)	

Sweep modes	Auto, triggered, single	
Display jitter (displayed trigger jitter)	Typical of 1-2 ps	
Trigger holdoff range	100 ns to 10 s fixed and random	
Trigger actions	Specify an action to occur, and the frequency of the action, when a trigger condition occurs. Actions include: e-mail on trigger and execute "multipurpose" user settings	
Trigger coupling	1 MΩ: DC, AC, (10 Hz) low frequency reject (50 kHZ high pass filter), high frequency reject (50 kHz low pass filter)	

Infiniium 9000 H–Series Performance Characteristics (continued)

Trigger: digital channels MSO upgrade	
Threshold range (user defined)	±8.0 V in 100-mV increments
Threshold accuracy	±(100 mV + 3% of threshold setting)

Measurements and math	
Waveform measurements	(can be made on either min or zoom window with up to 10 simultaneous measurements with statistics)
Voltage (scope channels)	Peak-to-peak, minimum, maximum, average, RMS, amplitude, base, top, overshoot, V overshoot, preshoot, V preshoot, upper, middle, lower, crossing point voltage , pulse top, pulse base, pulse amplitude
Time (digital channels)	Period, frequency, positive width, negative width, duty cycle, delta time
Time (scope channels)	Rise time, fall time, period, frequency, positive width, negative width, duty cycle, Tmin, Tmax, Tvolt, channel-to-channel delta time, channel-to-channel phase , count pulses , burst width, burst period, burst interval, setup time, hold time
Mixed (scope channels only)	Area, slew rate
Frequency domain	FFT frequency, FFT magnitude, FFT delta frequency, FFT delta magnitude
Level qualification	Any channels that are not involved in a measurement can be used to level-qualify all timing measurements
Eye-diagram measurements	Eye height, eye width, eye jitter, crossing percentage, Q factor, and duty-cycle distortion
Measurement modes	
Statistics	Displays the mean, standard deviation, minimum, maximum range, and number of measurement values for the displayed automatic measurements
Histograms (scope channels)	
Source	Waveform or measurement (histogram on measurement requires EZJIT or EZJIT+ option)
Orientation	Vertical (for timing and jitter measurements) or horizontal (noise and amplitude change) modes, regions are defined using waveform markers
Measurements	Mean, standard deviation, mean ± 1, 2, and 3 sigma, median, mode, peak-to-peak, min, max, total hits, peak (area of most hits), X scale hits, and X offset hits
Marker modes	Manual markers, track waveform data, track measurements
Waveform math	
Number of functions	Four
Operators	Absolute value, add, average, Butterworth[2], common mode, differentiate, divide, FFT magnitude, FFT phase, FIR[11], high pass filter, integrate, invert, LFE[2], low pass filter (4th-order Bessel Thompson filter), magnify, max, min, multiply, RT Eye[2], smoothing, SqrtSumOfSquare[2], square, square root, subtract, versus Chartstate (MSO models), charttiming (MSO models)
Automatic measurements	Measure menu access to all measurements, ten measurements can be displayed simultaneously
Multipurpose	Front-panel button activates up to ten pre-selected or ten user-defined automatic measurements
Drag-and-drop measurement toolbar	Measurement toolbar with common measurement icons that can be dragged and dropped onto the displayed waveforms
FFT	
Frequency settings	Start, stop, CF, span, resolution BW
Window modes	Hanning, flattop, rectangular , Blackman Harris, Force

2. Requires MATLAB software.

Trigger modes	
Edge (analog and digital)	Triggers on a specified slope (rising, falling or alternating between rising and falling) and voltage level on any channel.
Edge transition (analog)	Trigger on rising or falling edges that cross two voltage levels in > or < the amount of time specified. Edge transition setting from 250 ps.
Edge then edge (time) (analog and digital)	The trigger is qualified by an edge. After a specified time delay between 10 ns to 10 s, a rising or falling edge on any one selected input will generate the trigger.
Edge then edge (event) (analog and digital)	The trigger is qualified by an edge. After a specified delay between 1 to 16,000,000 rising or falling edges, another rising or falling edge on any one selected input will generate the trigger.
Glitch (analog and digital)	Triggers on glitches narrower than the other pulses in your waveform by specifying a width less than your narrowest pulse and a polarity. Glitch range settings equal pulse width settings
Line	Triggers on the line voltage powering the oscilloscope.
Pulse width (analog and digital)	Trigger on a pulse that is wider or narrower than specified.
2 GHz model	Minimum detectable pulse width: 200 ps for analog channels, 1 ns for digital channels. Pulse width range settings: 350 ps to 10 s for analog channels, 2 ns to 10 s for digital channels.
1 GHz, 500 MHz, 250 MHz models	Minimum detectable pulse width: 500 ps for analog channels, 1 ns for digital channels. Pulse width range settings: 700 ps to 10 s for analog channels, 2 ns to 10 s for digital channels.
Runt (analog)	Triggers on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again. Runt settings equal pulse width settings.
Timeout (analog and digital)	Trigger when a channel stays high, low, or unchanged for too long. Timeout settings equal pulse width settings.
Pattern/pulse range (analog and digital)	Triggers when a specified logical combination of the channels is entered, exited, present for a specified period of time or is within a specified time range or times out. Each channel can have a value of High (H), Low (L) or Don't care (X).
State (analog and digital)	Pattern trigger clocked by the rising, falling or alternating between rising and falling edge of one channel.
Setup/hold (analog)	Triggers on setup, hold, or setup and hold violations in your circuit. Requires a clock and data signal on any two inputs (except aux or line) channels as trigger sources. Setup and/or hold time must then be specified.
Window (analog)	Trigger on entering, exiting, or inside specified voltage range
Video (analog)	NTSC, PAL-M(525/60), PAL, SECAM(625,50) EDTV(480p/60), EDTV(576/50), HDTV(720p/60), HDTV(720p/50) HDTV(1080i/60)
Serial (analog and digital)	Requires specified serial software option, I^2C, SPI, CAN, LIN,FlexRay, RS-232/UART, JTAG, USB, SVIP
Zone-qualified	Requires InfiniiScan software option. SW-based triggering across up to 8 user-drawn zones. For each zone, user specifies "must intersect" or "must not intersect." Zones can be drawn on multiple channels and combined using Boolean expressions.

Display

Display	15 inch color XGA TFT-LCD with touch screen
Display intensity grayscale	64-level intensity-graded display
Resolution	1024 pixels horizontally x 768 pixels vertically
Annotation	Up to 12 labels, with up to 100 characters each, can be inserted into the waveform area
Grids	Can display 1, 2 or 4 waveform grids
Waveform styles	Connected dots, dots, variable persistence, infinite persistence, color graded infinite persistence. Includes up to 64 levels of intensity-graded waveforms.

Waveform update rate (10 GS/s, 50 ns/div, sin(x)/x: on)	Segmented mode:	Maximum up to 250,000 waveforms/sec
	Real time mode	Maximum of 3,000 waveforms/sec.
		Typical of 1,100 waveforms/sec with 1kpts memory.
		Typical of 200 waveforms/sec with 100 kpts memory
		Typical of 35 waveforms/sec with 1 Mpts memory
		Typical of 5 waveforms/sec with 10 Mpts

Computer system and peripherals, I/O ports

Computer system and peripherals	
Operating system	Windows 7 Embedded Standard
CPU	Intel Core 2 Duo, M890, 3.0 GHz microprocessor
PC system memory	4 GB
Drives	≥ 250-Gb internal hard drive (Option 801 solid state drive), external DVD-RW drive (optional)
Peripherals	Optical USB mouse and compact keyboard supplied. All Infiniium models support any Windows-compatible input device with a PS/2 or USB interface.

File types	
Waveforms	Compressed internal format (*.wfm), comma separated values (*.csv), .hdf5, .bin, tab separated values (*.tsv), ability to save .osc (composite including both setup and waveform). and Y value files (*.txt)
Images	BMP, TIFF, GIF, PNG or JPEG

I/O ports	
LAN	RJ-45 connector, supports 10Base-T, 100Base-T, and 1000Base-T. Enables Web-enabled remote control, e-mail on trigger, data/file transfers and network printing.
RS-232 (serial)	9-pin, COM1, pointing device support
PS/2	Two ports. Supports PS/2 pointing and input devices.
USB 2.0 Hi-Speed	Three 2.0 high-speed ports on front panel plus four ports on side panel. Allows connection of USB peripherals like storage devices and pointing devices while the oscilloscope is on. One device port on side for instrument control
Video output	15 pin XGA on side of scope, full output of scope display or dual monitor video output, DVI
Auxiliary output	DC (± 2.4 V); square wave ~755 Hz with ~200 ps rise time.

Time base reference output	10 MHz, Amplitude into 50 ohms: 800 mV pp to 1.26 V pp (4 dBm ±2 dB) if derived from internal reference. Tracks external reference input amplitude ±1 dB if applied and selected.

Time base reference input	Must be 10 MHz, input Z = 50 ohms. Minimum 500 mV pp (−2 dBm), maximum 2.0 V pp (+10 dBm).

LXI compliance	LXI Class C

General characteristics	
Temperature	
Operating	5 °C to + 40 °C
Non-operating	−40 °C to + 65 °C
Humidity	
Operating	Up to 95% relative humidity (non-condensing) at +40 °C
Non-operating	Up to 90% relative humidity at +65 °C
Altitude	
Operating	Up to 4,000 meters (12,000 feet)
Non-operating	Up to 15,300 meters (50,000 feet)
Vibration	
Operating	Random vibration 5-500 Hz, 10 minutes per axis, 0.3 g (rms)
Non-operating	Random vibration 5-500 Hz, 10 minutes per axis, 2.41 g (rms); resonant search 5-500 Hz, swept sine, 1 octave/minute sweep rate, (0.75 g), 5 minute resonant dwell at 4 resonances per axis
Power	100-120 V, ± 10% 50/60/400 Hz 100-240 V, ± 10% 50/60 Hz Max power dissipated: 375 W
Typical operator noise	30 dB at front of instrument
Weight	Net: 11.8 kg (26 lbs.) Shipping: 17.8 kg (39 lbs.)
Dimensions (with feet retracted)	Height: 12.9 in (33 cm); width: 16.8 in (43 cm); depth: 9 in (23 cm)
Safety	Meets IEC1010-1 Second Edition, certified to UL61010-1 and CAN/CSA-C22.2 No 61010-1 Second Edition (IEC61010-1:2001, MOD).

Infiniium 9000 H-Series Ordering Information

How to configure an Infiniium 9000 Series

1. Choose needed bandwidth
2. Choose MSO upgrade if desired
3. Choose desired software applications
4. Choose memory depth upgrade
5. Choose any additional probes and accessories

Accessories included:

All models ship standard with:

- Four N2873A 500 MHz passive probes
- Probe accessory pouch (mounts on rear of instrument
- Keysight I/O libraries suite 15.0
- Localized power cord, front panel cover, keyboard, mouse, and stylus
- User guide and programmer's guide ship on oscilloscope hard drive. Service guide available on Keysight.com.

|	DSO9024H	DSO9054H	DSO9104H	DSO9204H
Scope channels	4	4	4	4
Bandwidth	250 MHz	500 MHz	1 GHz	2 GHz[1]
Max sample rate	1.25 GSa/s	2.5 GSa/s	5 GSa/s	10 GSa/s
Standard memory (2-ch/4-ch)	100 Mpts/50 Mpts	100 Mpts/50 Mpts	100 Mpts/50 Mpts	100 Mpts/50 Mpts
Bits of resolution	12	12	12 at < 500 MHz / 10 at 1 GHz	12 at < 500 MHz / 10 at 1 GHz / 10 at 2 GHz
Noise (at 100 mV/div)	700 uV	720 uV	1.1 mV	1.5 mV
MSO and app upgrades	√	√	√	√

1. 2 GHz bandwidth in 2-channel mode, and 1 GHz bandwidth when all 4 channels are enabled.

Additional options and accessories	
Option A6J	ANSI Z540 compliant calibration
DSO9000A-820	External DVD-RW with USB connection
N2902A or Option 1CM (8U)	9000 Series oscilloscope rackmount kit
Option 801	Removable SSD (solid state drive)
N2746A (requires Option 801)	Additional SSD Windows 7
Gemstar 5000 custom-molded case	Available from www.gemstarmfg.com
N2918B	Infiniium 9000 H-Series Evaluation Kit
N4865A	GPIB to LAN adapter

Quickly remove your SSD for additional security with Option 801.
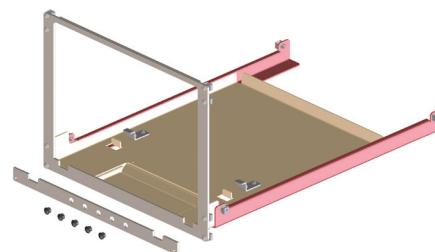
Mount your 9000 H-Series scope in an 8U high, 19" (487mm) wide rack with option ICM.

Infiniium 9000 H–Series Ordering Information

Software applications	Factory-installed option for new scope purchases	User-installed stand-alone product number	User-installed floating license (N5435A option)
RS-232/UART triggering and decode	001	N5462B	031
EZJIT jitter analysis software	002	E2681A	002
High-speed SDA and clock recovery	003	N5384A	003
EZJIT Plus jitter analysis software	004	N5400A	001
USB triggering and decode	005	N5464B	034
I²C/SPI triggering and decode	007	N5391B	006
CAN, LIN, and FlexRay triggering and decode	008	N8803B	033
InfiniiScan	009	N5415B	004
User-defined function	010	N5430A	005
Power measurement application software	015	U1882A	
Xilinx FPGA dynamic probe	016	N5397A	
RS-232, SPI and I²C triggering and decode bundle	018	N8800B	
Ethernet compliance application	021	N5392A	008
USB2.0 compliance application	029	N5416A	017
User definable application	040	N5467A	
JTAG (IEEE 1149.1) triggering and decode	042	N8817A	038
USB HSIC compliance test	043	U7248	042
SVID protocol triggering and decode	046	N8812A	054
Communication mask test kit		E2625A	
MATLAB basic	061		
MATLAB advanced	062		
Precision Probe		N2808A	044
eMMC compliance	064	N6465A	061
MOST compliance	073	N6466A	068
BroadR-Reach compliance	065	N6467A	062

Upgrades

DSO to MSO upgrades
(N2901A/B/C/D)

Upgrade your existing DSO to an MSO model in 5 minutes. The upgrade kit turns on all MSO capability and includes an MSO cable, 16-channel lead set with grabbers, an MSO-enabled sticker, and a digital-analog deskew fixture.

Post-sales upgrades

DSO → MSO upgrades	
N2901D	DSO9024H/DSO9054H MSO Upgrade Kit
N2901A	DSO9104H MSO Upgrade Kit
N2901B	DSO9254H MSO Upgrade Kit

Additional acquisition memory
(N2900A or Options 100, 200, and 500 on new scope purchase)

Increase memory depth to capture longer time periods and maintain faster speeds.

Memory upgrade

Need additional acquisition memory? Memory upgrades can be ordered as a factory-installed option for new oscilloscopes or using N2900A for a user-installed upgrade. Memory upgrade option depths are identical for factory installation or user installation and are described in the chart below.

Memory depth per channel	Run mode	Standard		Option 100		Option 200		Option 500	
		2-ch	4-ch	2-ch	4-ch	2-ch	4-ch	2-ch	4-ch
	Single	100 Mpts	50 Mpts	200 Mpts	100 Mpts	400 Mpts	200 Mpts	500 Mpts	250 Mpts
	Repetitive	100 Mpts	50 Mpts	200 Mpts	100 Mpts	200 Mpts	100 Mpts	256 Mpts	128 Mpts

Evolving Since 1939

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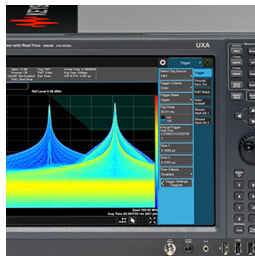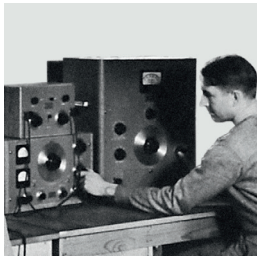
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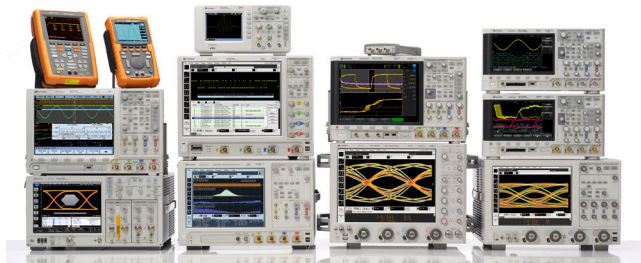
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