

# M924XA InfiniiVision PXIe Modular Oscilloscopes

## Full-featured 1 GHz Oscilloscope for The Modular



Keysight is taking modular analysis to a whole new level

This is not just a digitizer with an oscilloscope SFP (soft front panel). The InfiniiVision PXIe modular oscilloscopes utilize Keysight's InfiniiVision benchtop oscilloscope technology and packages it for PXI.

- M9241A PXIe modular oscilloscope – 200 MHz bandwidth
- M9242A PXIe modular oscilloscope – 500 MHz bandwidth
- M9243A PXIe modular oscilloscope – 1 GHz bandwidth

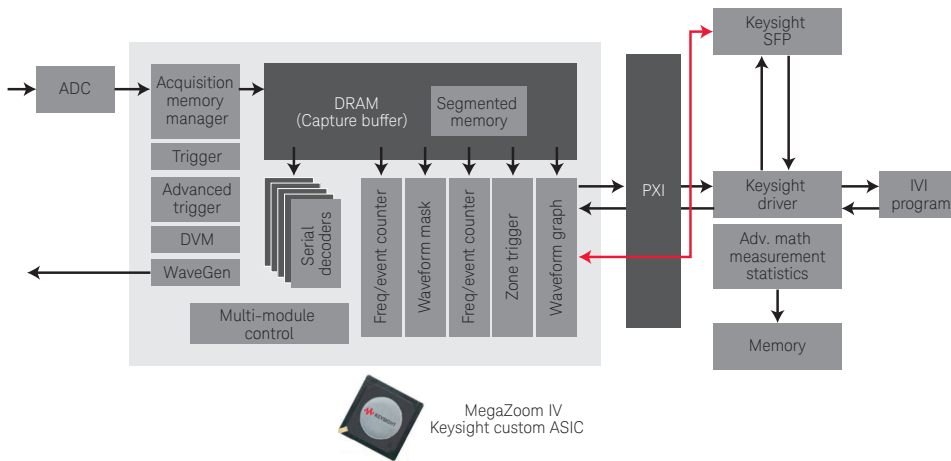


## Uncompromising Analysis Capability

Many modular users have been using digitizer hardware with software that simulates an oscilloscope for test and troubleshoot implementation. The limitations of this configuration are often overlooked, but they can cause significant problems. When an instrument says it has a high waveform update rate, people usually expect it to have a higher probability of catching random and infrequent glitches, but this isn't the case for those instruments. In addition, common measurements like waveform averaging and advanced waveform triggers are not available.

Keysight is currently the only vendor that delivers oscilloscope hardware in a PXI modular package. Keysight's M924XA Series PXIe oscilloscopes begin with basic digitizer hardware, but then they add measurement tools directly into the hardware of the PXI card.

The InfiniiVision PXIe modular oscilloscopes require minimum support from a central processing unit (CPU), as most of their core operations are handled by the MegaZoom IV smart memory ASIC, which is Keysight proprietary technology. 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 a WaveGen function/arbitrary waveform generator.



The M924XA Series PXIe modular oscilloscopes utilize hardware to perform many of the functions traditional digitizers do with software on the CPU. By doing more in hardware, M924XA Series oscilloscopes can analyze more of the signal than ever before.

## Industry-exclusive Zone Touch Trigger Makes Triggering Simple

Zone touch triggering eliminates the complexity of setting up advanced triggers. If you have a touch-enabled display on your controller, you can trigger on events by simply drawing a box with your finger on the display of the signal you want to isolate. Keysight pioneered the zone touch trigger, which allows easy capture of difficult-to-define trigger events.



The M924XA Series' high, uncompromised update rate increases your chance of seeing random and infrequent signal anomalies, and zone touch trigger helps you isolate the signals. Now your testing can be faster and more thorough.

### Other touch-based operation

Just like Keysight's touch-enabled InfiniiVision benchtop oscilloscopes (3000T, 4000 and 6000 X-Series), the M924XA Series also uses touch capability to interact with signal display. In addition to zone touch trigger, these oscilloscopes also let you move the waveform up/down; adjust the time offset and zoom; and define one of the two touch zone triggers. All that is required is a touch-enabled display connected to your modular scope.

## Probing Solutions for PXI Modular

Keysight has probing solutions for the most challenging test applications. The M924XA Series PXIe modular oscilloscopes support standard 50  $\Omega$  or 1 M $\Omega$  connections. They also support a wide range of passive and active probes.

M924XA Series oscilloscopes require the M9240A PXIe AutoProbe power module to use Keysight active probes. The M9240A provides power and the communication circuit required for proper operation of the active probes. One M9240A will supply the power and connection for up to four probes when two oscilloscope modules are installed on either side of the M9240A module.



M9240A AutoProbe PXIe power module.

Probes		
N2843A	Passive probe 500 MHz, 10:1, 1 M $\Omega$ , 11 pF	Optional Option 808 (2 probes)
N2870A	Passive probe 35 MHz, 1:1, 1 M $\Omega$	Optional
10076C	Passive probe 500 MHz, 100:1 (4 kV)	Optional
N2804A <sup>1</sup>	300 MHz, 100:1 differential probe, 4 M $\Omega$ , 4 pF, $\pm$ 300 V DC+peak AC with AutoProbe	Optional
N2805A <sup>1</sup>	200 MHz, 100:1 differential probe, 4 M $\Omega$ , 4 pF, $\pm$ 100 V, 5 m cable	Optional
N2790A <sup>1</sup>	100 MHz, 50:1/500:1 high-voltage differential probe, 8 M $\Omega$ , 3.5 pF, $\pm$ 1,400 V	Optional
N2795A <sup>1</sup>	Active single-ended probe 1 GHz, 1 pF, 1 M $\Omega$ with AutoProbe	Optional
N2797A <sup>1</sup>	Active single-ended probe 1.5 GHz extreme temperature	Optional
N2750A <sup>1</sup>	InfiniiMode differential probe 1.5 GHz, 700 fF, 200 k $\Omega$ with AutoProbe	Optional
N2790A <sup>1</sup>	Differential active probe 100 MHz, $\pm$ 1.4 kV with AutoProbe	Optional
N2791A	Differential active probe 25 MHz, $\pm$ 700 V	Optional
N2818A <sup>1</sup>	200 MHz, 10:1 differential probe with AutoProbe	Optional
N2819A <sup>1</sup>	800 MHz, 10:1 differential probe with AutoProbe	Optional
1146B <sup>1</sup>	AC/DC current probe 100 kHz, 100 A	Optional
1147B <sup>1</sup>	AC/DC current probe 50 MHz, 15 A with AutoProbe	Optional
N2893A <sup>1</sup>	AC/DC current probe 100 MHz, 15 A with AutoProbe	Optional
N2820A <sup>1</sup>	2-channel high-sensitivity current probe 50 $\mu$ A to 5 A	Optional
N2821A <sup>1</sup>	1-channel high-sensitivity current probe 50 $\mu$ A to 5 A	Optional
N7020A <sup>1</sup>	Power rail probe 2 GHz, 1:1, $\pm$ 24 V offset range at 50 $\Omega$	Optional
N2744A <sup>1</sup>	T2A probe interface adapter	Optional

1. Active probe that requires the use of M9240A AutoProbe power module.

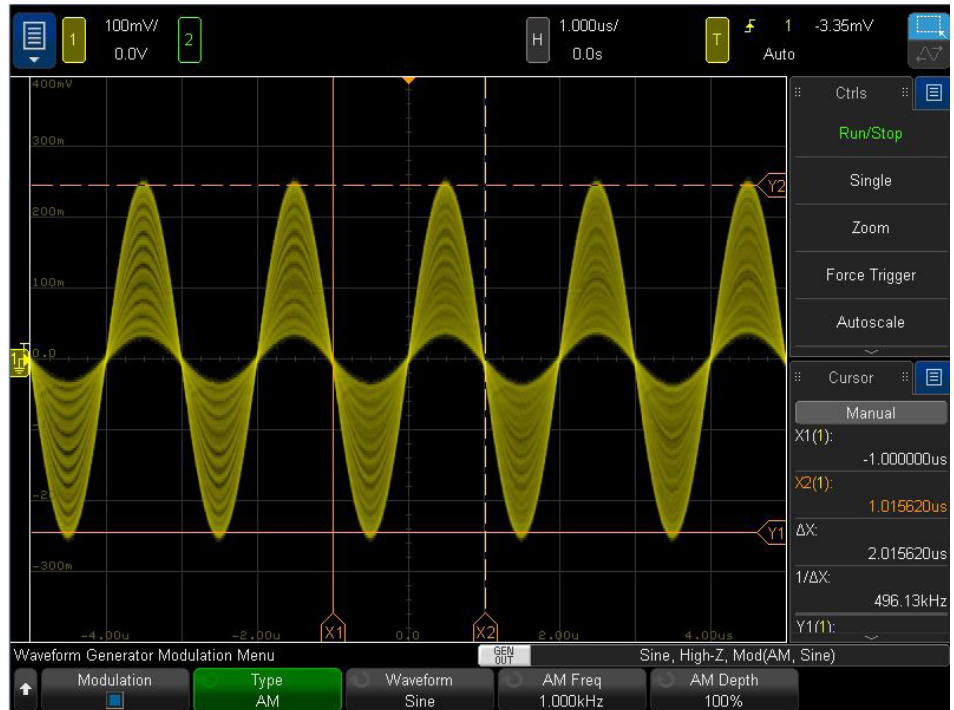


## Additional Software for Added Functionality

### M9240AWGA WaveGen 20 MHz Function/Arbitrary Waveform Generator

The M924XA Series oscilloscopes offer a 20-MHz built-in function/arbitrary waveform generator. The WaveGen provides standard stimulus output waveforms to your device under test as well as user-definable frequencies, amplitudes, offset and pulse widths and arbitrary waveform capability. The WaveGen output is routed to a MMCX connector on the front panel of the oscilloscope.

Use the built-in waveform editor to create custom waveforms to output on the oscilloscope's WaveGen. It is also possible to capture a known good or 'golden' waveform on a scope channel and then save that to the ARB so you can generate it to stimulate your system under test.



### Frequency Response Analysis (Optional)

Frequency response analysis (available with the purchase of any of the optional software package) is a critical measurement to characterize the stability of feedback networks and switch-mode power supplies. This capability is achieved with a gain and phase measurement versus frequency (Bode plot). By using the waveform generator output to stimulate your design and probing the input and output signals on channels 1 and 2, the oscilloscope provides a clear report on the gain and phase operation of the system.

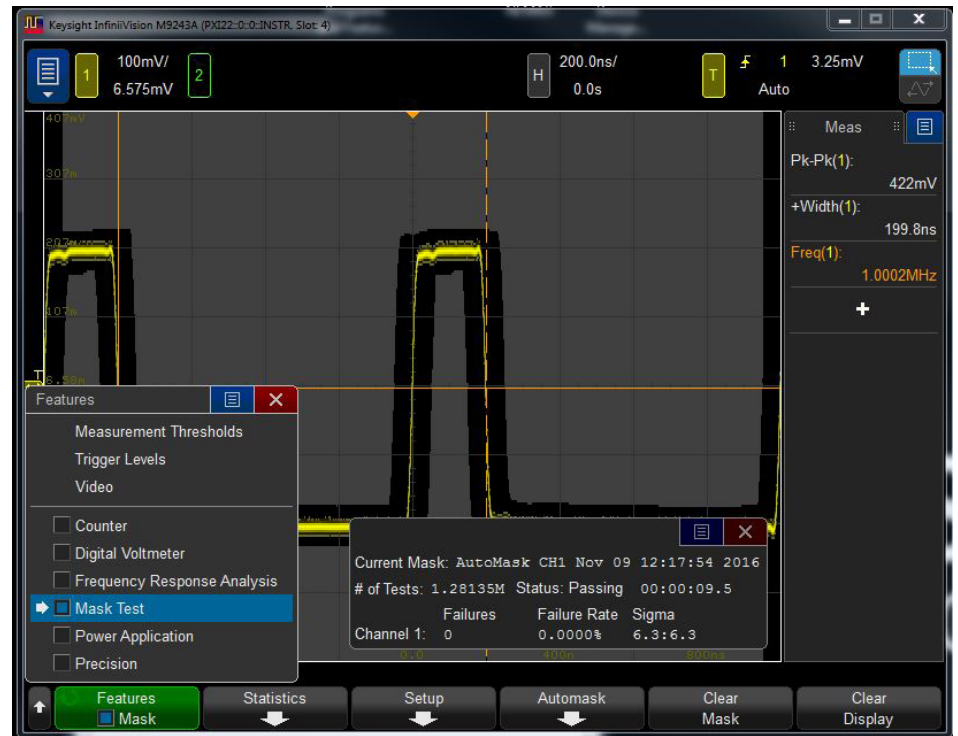


## Additional Software for Added Functionality (Continued)

### Mask Limit Testing (Optional)

With the mask limit testing (available with the purchase of any of the optional software package), you can quickly test more than 200,000 waveforms per second to a known good waveform with quick go/no-go test results, saving you valuable test time while providing you with more confidence in test results. Test your signals to specified standards, and uncover unexpected signal anomalies.

Mask testing on other oscilloscopes is usually based on software-intensive processing technology, which tends to be slow. Keysight's M924XA Series oscilloscopes' mask testING is based on hardware-based technology. This means M924XA Series oscilloscopes can perform more than 200,000 real-time waveform pass/fail tests per second. This provides testing throughput that is orders of magnitude faster than what is available on other oscilloscope mask test solutions, making valid pass/fail statistics almost instantly.



### Enhanced Video Analysis (Optional)

The M924XA Series oscilloscopes support a video IRE display grid, as well as cursors measurements performed in video IRE units for the NTSC and PAL standards. This new capability is standard on M924XA Series oscilloscopes. The optional Enhanced Video Analysis (available in the Embedded, Aero, and Ultimate Bundle software packages) provides an array of additional HDTV triggering standards. The additional triggering options provided by the the optional Enhanced Video Analysis speed debug and characterization for engineers working on HDTV video applications.



## Additional Software for Added Functionality (Continued)

### Power Analysis (Optional)

Today's power supply designers are facing an increasing number of constraints in the development of high-efficiency, low-cost power supplies. The optional Power software package (M9240PWRB) provides clear and consistent reporting on the operation of key operation parameters of your power supply design.

#### Input measurements

- Power quality: Real power, apparent power, reactive power, power factor, crest factor (V and I), phase angle
- Current harmonics (based on IEC 61000-3-2 up to the 40th harmonic)
- Inrush current

#### Switching measurements

- Rds-on and Vce-sat
- Switching loss (power and energy)
- Slew rate (dv/dt and di/dt)
- Modulation (duty cycle, pulse-width, period, frequency, versus time plot, etc.)

#### Output measurements

- Output ripple
- Turn-on/turn-off time
- Transient response time
- Efficiency

#### Frequency response measurements

- Power supply rejection ratio (PSRR)
- Control loop response - Bode



### NFC Triggering (Optional)

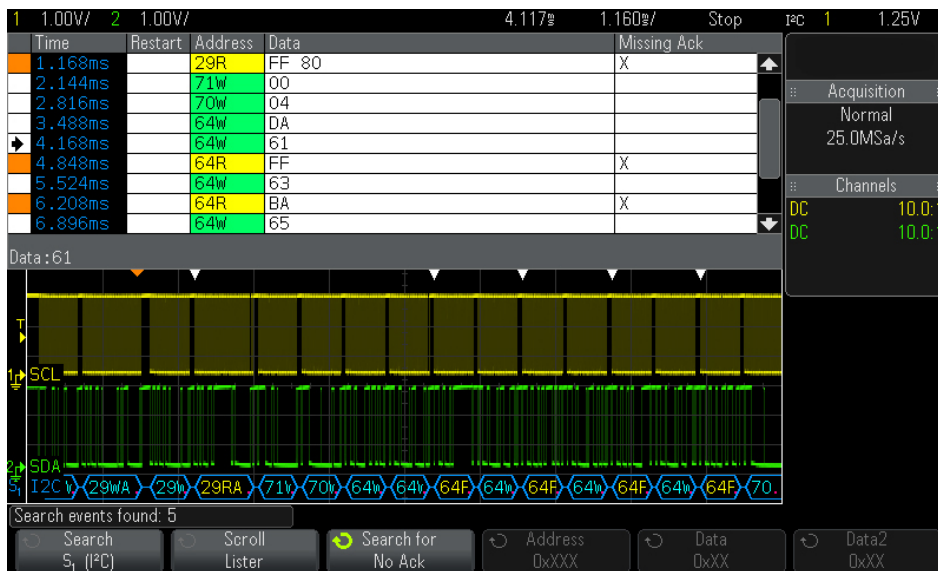
Testing NFC-enabled devices is essential during the design validation and manufacturing test phases to ensure quality and reliability of data transmission. This is especially important when you consider that the data being transferred/exchanged between NFC-enabled devices is often secured financial transactions. The M9240NFCB NFC software package enables easy configuration to capture the signals of interest for NFC-A, NFC-B and NFC-F messages.



## Serial Trigger & Decode

### I<sup>2</sup>C Serial Trigger And Analysis (Optional)

I<sup>2</sup>C serial decode and trigger displays responsive, time-aligned, on-screen decode of Inter-Integrated Circuit (I<sup>2</sup>C) serial communication. Because this capability is hardware-based, it provides the fastest throughput solution for triggering on and analyzing I<sup>2</sup>C serial buses found in a wide variety of embedded designs. You can easily isolate serial packets to find sources of errors due to hardware- or software-related problems. Sometimes it may be necessary to correlate data from one serial bus to another. Keysight's M924XA Series oscilloscopes can decode two serial buses simultaneously using hardware-based decoding.



### Uart (RS232/422/485) Serial Trigger And Analysis (Optional)

UART (RS232/422/485) serial triggering and decode displays responsive, time-aligned, on-screen decode of RS-232/422/485 and other UART serial buses. It provides triggering capabilities on specified transmit or receive values, as well as on parity errors. Trigger on and acquire RS-232/422/485/UART signals using either oscilloscope or logic channels. Hardware-based decode means the scope stays responsive and fast when decode is turned on. Real-time counters continually count transmit and receive frames and errors.

### CAN/CAN FD/LIN Serial Triggering And Analysis (Optional)

CAN/CAN FD serial triggering and analysis allows you to trigger on either standard or extended CAN message IDs, including the message ID of a remote transfer request frame. It supports triggering on a data frame and allows you to specify message IDs, data and data length for filtering messages of interest. Triggering on active error frames is also supported. In addition, this oscilloscope module supports triggering on LIN frame IDs and data and includes color-coded parity and check sums errors. You can easily isolate serial packets to find sources of errors due to hardware- or software-related problems. Sometimes it may be necessary to correlate data from one serial bus to another. The CAN, CAN FD, and LIN buses can also be decoded symbolically by importing the appropriate .dbc or .ldf file.

## Serial Trigger & Decode (Continued)

### SENT (Single Edge Nibble Transmission) Trigger And Analysis (Optional)

The SENT (single edge nibble transmission) is a point-to-point serial bus that interfaces sensors to ECUs and is used primarily in automotive applications. SENT provides decoding of fast and slow channel serial data and also offers extensive triggering selections, including the ability to trigger on various error conditions that can accelerate efficiency in debugging this bus.

Keysight's M924XA Series oscilloscopes can display captured data from multiple buses in a time-interleaved "lister" display. Sometimes it may be necessary to correlate data from one serial bus to another, such as CAN to SENT.

### CXPI Trigger And Decode (Optional)

CXPI (clock extension peripheral interface) is the next-generation automotive communication protocol intended to reduce the number and weight of wiring harnesses by making multiplexing possible even in advanced, multifunction HMI (human machine interface) automotive systems. In many cases, CXPI is an alternative serial bus used in place of many of today's LIN serial bus applications for automotive body control.

CXPI analysis provides decoding of standard and long CXPI frames and also offers extensive triggering selections, including the ability to trigger on various error conditions that can accelerate the engineer's efficiency in debugging this bus.

Keysight's M924XA Series oscilloscopes can display captured data from multiple buses in a time-interleaved "lister" display. This allows correlation of data being passed through gateways, such as CAN to CXPI.

### MIL-STD 1553 and ARINC 429 Triggering And Analysis (Optional)

The MIL-STD 1553 serial bus is primarily used to interconnect avionics equipment in military aircrafts. This bus is based on tri-level signaling (high, low and idle) and requires dual-threshold triggering, which the M924XA PXIe modular oscilloscopes support. This bus is also implemented as a redundant multi-lane bus (dual-bus analysis), which is also supported.

The ARINC 429 serial bus is used to interconnect avionics equipment in civilian aircrafts. This bus is also based on tri-level signaling (high, low and null) and requires dual-threshold triggering. Since ARINC 429 is a point-to-point bus, multi-lane analysis is also required to capture both send and receive data.

### User-Definable Manchester And NRZ Trigger And Analysis (Optional)

Keysight's Manchester and NRZ decode and trigger software supports user-defined protocols, offering flexibility and preventing the need to define multiple specific protocol decoding and triggering. This trigger and decode software application is geared toward automotive customers, who commonly use Manchester and NRZ encoded buses (ex: Profibus PA, DALI, PSI5, etc.).

# Configuration

## Step 1. Choose your bandwidth

M9241A – 2 channel, 200 MHz  
M9242A – 2 channel, 500 MHz  
M9243A – 2 channel, 1 GHz

## Step 2: Select hardware upgrades

Hardware Upgrade	Description	Model number to order
WaveGen	Built-in 20 MHz function/AWG waveform generator	M9240AWGA

## Step 3: Select licensed software

Licensed Software	Description	Model number to order
Embedded Software Package	I <sup>2</sup> C, UART (RS232/422/485), and USB PD serial trigger & decode, plus Mask Limit Testing, Frequency Response Analysis (Bode plots), and Enhanced Video Analysis	M9240GENB
Automotive Software Package	CAN (symbolic with .dbc file), CAN FD (symbolic with .dbc file), LIN (symbolic with .ldf file), SENT, CXPI, PS15 (user-definable Manchester), and User-definable NRZ serial trigger & decode, plus Mask Limit Testing (CAN/CAN FD mask files available to download) and Frequency Response Analysis (Bode plots)	M9240AUSB
Aero Software Package	MIL-STD 1553 and ARINC 429 serial trigger & decode, plus Mask Limit Testing (standard mask files available to download), Frequency Response Analysis (Bode plots), and Enhanced Video Analysis	M9240AERB
Power Software Package	Power quality, current harmonics, switching loss, transient response, turn-on/off time, output ripple, efficiency, loop response, PSRR, etc., plus Mask Limit Testing and Frequency Response Analysis (Bode plots), and USB PD serial trigger & decode	M9240PWRB
NFC Software Package	NFC trigger software	M9240NFCB
Ultimate Bundle Software Package	I <sup>2</sup> C, UART, CAN, CAN FD, LIN, CXPI, PS15 (User-definable Manchester), User-definable NRZ, USB PD, MIL-STD 1553, and ARINC 429 serial trigger & decode, plus Power Analysis, Mask Limit Testing, Frequency Response Analysis (Bode plots), Enhanced Video Analysis, NFC trigger	M9240BDLB

## Step 4. Choose your probes

The M924XA Series oscilloscopes do not include any probes.  
– Option 808 – Add N2843A 500 MHz passive probes

Other probes are supported but must be purchased as separate products (recommended probes are listed in page 5). Please note that active probes (current, differential, extreme environment probes) require the purchase of the M924XA AutoProbe power module. This module supports the connection, power and communication of the AutoProbe interface. A single M924XA AutoProbe power module will supply the connections and power for two modular oscilloscopes installed in adjacent module slots. For probing information, see the Keysight Oscilloscope Probes and Accessories Selection Guide, publication number [5968-8153EN](#).

## Configuration (Continued)

### Flexible Software Licensing and KeysightCare Software Support Subscriptions

Keysight offers a variety of flexible licensing options to fit your needs and budget. Choose your license term, license type, and KeysightCare software support subscription.

#### License Terms

- **Perpetual** – Perpetual licenses can be used indefinitely.
- **Time-based** – Time-based licenses can be used through the term of the license only (6, 12, 24, or 36 months).

#### License Types

- **Node-locked** – License can be used on one specified instrument.
- **Transportable** – License can be used on one instrument/computer at a time but may be transferred to another using Keysight Software Manager (internet connection required).

#### KeysightCare Software Support Subscriptions

Perpetual licenses are sold with a 12 (default), 24, 36, or 60-month software support subscription. Support subscriptions can be renewed for a fee after that.

Time-based licenses include a software support subscription through the term of the license.

#### Selecting your license:

- Step 1. Choose your Software Package (Ex: M9240BDLB)
- Step 2. Choose your license term: perpetual or time-based
- Step 3. Choose your license type: node-locked or transportable
- Step 4. Depending on the license term, choose your support subscription duration

#### Examples

<b>If you selected:</b>	<b>Your quote will look like:</b>	
	<b>Part Number</b>	<b>Description</b>
M9240AUTB node-locked perpetual license with a 12-month support subscription	M9240AUTB R-B5N-001-A R-B6N-001-L	Automotive software package for M9240 Series Node-locked perpetual license 12-month software support subscription
M9240BDLB transportable time-based 6-month license	M9240BDLB R-B4N-004-F	Software Bundle for M924xA oscilloscopes 6-month time-based, transportable license with software support subscription

KeysightCare Software Support Subscription provides peace of mind amid evolving technologies.

- Ensure your software is always current with the latest enhancements and measurement standards.
- Gain additional insight into your problems with live access to our team of technical experts.
- Stay on schedule with fast turnaround times and priority escalations when you need support.

# Performance Characteristics

## M924XA PXIe Modular Oscilloscopes

M924XA PXIe modular oscilloscopes overview			
	M9241A	M9242A	M9243A
Bandwidth (-3 dB) <sup>1</sup>	200 MHz	500 MHz	1 GHz
Calculated rise time (10 to 90%)	≤ 1.75 ns	≤ 700 ps	≤ 450 ps
Input channels	2	2	2
Maximum sample rate	5 GSa/s one channel, 2.5 GSa/s two channels		
Maximum memory depth	4 Mpts half channels, 2 Mpts all channels		
Waveform update rate	≥ 1,000,000 waveforms/sec <sup>2</sup>		

Vertical system analog channels			
	M9241A	M9242A	M9243A
Hardware bandwidth limits	Approximately 20 MHz (selectable)		
Input coupling	AC, DC		
Input impedance	Selectable: 1 MΩ ± 1% (15 pF), 50 Ω ± 3%		
Input sensitivity range	1 mV/div to 5 V/div (1 MΩ and 50 Ω)		1 mV/div to 5 V/div (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	135 Vrms With N2843A 10:1 probe: 300 Vrms Frequency de-rating (assumes sine wave input): 400 Vpk until 40 kHz. Then de-rates at 20 db/dec until 6 Vpk		
DC vertical accuracy	± [DC vertical gain accuracy + DC vertical offset accuracy + 0.21% full scale] <sup>3</sup>		
DC vertical gain accuracy <sup>1</sup>	± 2.0% full scale		
DC vertical offset accuracy	± 0.1 div ± 2 mV ± 1% of offset setting		
Channel-to-channel skew	> 100:1 from DC to maximum specified bandwidth of each model (measured with same V/div and coupling on channels)		
Offset range	± 2 V (1 mV/div to 200 mV/div) ± 50 V (> 200 mV/div to 5 V/div)		
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 <sup>1</sup>	Pre-trigger	± 1.6 ppm + aging factor (1st year: ± 0.5 ppm, 2nd year: ± 0.7 ppm, 5 years: ± 1.5 ppm, 10 years: ± 2.0 ppm)	
Time base delay time range	Post-trigger	Greater of 1 screen width or 250 μs 1 to 500 s	
Channel-to-channel deskew range	± 100 ns		
Δ Time accuracy (using cursors)	± (time base acc. x reading) ± (0.0016 x screen width) ± 100 ps		
Modes	Main, zoom		

1. Denotes warranted specifications. All others are typical.

2. Requires infinite persistence in order to visually display 1,000,000 wfm/sec.

3. Specifications are valid after a 30-minute warm-up period and ± 10 °C from firmware calibration temperature. 1 mV/div and 2 mV/div are 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.



## Performance Characteristics (Continued)

<b>Acquisition system</b>		<b>M9241A</b>	<b>M9242A</b>	<b>M9243A</b>
Maximum analog channels sample rate		5 GSa/s half channel interleaved, 2.5 GSa/s all channel		
Maximum analog channels record length		4 Mpts half channel interleaved, 2 Mpts all channel		
Acquisition mode	Normal	Default mode		
	Peak detect	Capture glitches as narrow as 250 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 to 12 bits of resolution when $\geq 10 \mu\text{s}/\text{div}$ at 5 GSa/s or $\geq 20 \mu\text{s}/\text{div}$ at 2.5 GSa/s		
	Segmented	Segmented memory optimizes available memory for data streams that have long dead times between activity. Maximum segments = 1000. Re-arm time = 1 $\mu\text{s}$ (minimum time between trigger events)		
	Digitizer	Allows independent selection of sample rate and memory depth		
Time mode	Normal	Default mode		

<b>Trigger system</b>		<b>M9241A</b>	<b>M9242A</b>	<b>M9243A</b>
Trigger sources		Analog channel (1-2), external, WaveGen (1 or mod) (FM/FSK)		
Trigger modes	Normal (triggered):	Requires trigger event for scope to trigger		
	Auto:	Triggers automatically in absence of trigger event		
	Single:	Triggers only once on a trigger event, press [Single] again for scope to find another trigger event, or press [Run] to trigger continuously in either Auto or Normal mode		
	Force:	Trigger immediately and display acquisition		
Trigger coupling	DC:	DC coupled trigger		
	AC:	AC coupled trigger, cutoff frequency: $< 10 \text{ Hz}$ (internal); $< 50 \text{ Hz}$ (external)		
	HF reject:	High-frequency reject, cutoff frequency $\sim 50 \text{ kHz}$		
	LF reject:	Low-frequency reject, cutoff frequency $\sim 50 \text{ kHz}$		
	Noise reject:	Selectable OFF or ON, decreases sensitivity 2x		
Trigger holdoff range		40 ns to 10.00 s		
<b>Trigger sensitivity</b>				
Internal <sup>1</sup>		$< 10 \text{ mV}/\text{div}$ : Greater of 1 div or 5 mV; $\geq 10 \text{ mV}/\text{div}$ : 0.6 div		
External <sup>1</sup>		200 mVpp from DC to 100 MHz		
		350 mVpp 100 to 200 MHz		
<b>Trigger level range</b>				
Any channel		$\pm 6 \text{ div}$ from center screen		
External		$\pm 8 \text{ V}$		

1. Denotes warranted specifications. All others are typical.

## Performance Characteristics (Continued)

Trigger type selections			
	M9241A	M9242A	M9243A
Zone touch trigger	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 scans/sec update rate Supported modes: normal, peak detect, high resolution Also works simultaneously with the serial trigger and mask/limit test		
Edge	Trigger on a rising, falling, alternating or either edge of any source		
Edge then edge (B trigger)	Arm on a selected edge, wait a specified time, then trigger on a specified count of another selected edge		
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), 6 ns (200 MHz) Maximum duration setting: 10 s Range minimum: 10 ns		
Runt	Trigger on a position 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 2~10 ns and maximum timesetting of 10 s Minimum time setting: 6 ns (200 MHz), 2 ns (500 MHz, 1 GHz)		
Setup and hold	Trigger and clock/data setup and/or hold time violation. Setup time can be set from -7 to 10 s. Hold time can be set from 0 s to 10 ns		
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), 3 ns (200 MHz) Maximum: 10 s		
N <sup>th</sup> edge burst	Trigger on the Nth (1 to 65535) edge of a pulse burst. Specify idle time (10 ns to 10 s) for framing		
Pattern	Trigger when a specified pattern of high, low and don't care levels on any combination of analog 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), 6 ns (200 MHz) Maximum duration setting: 10 s Range minimum: 10 ns		
Or	Trigger on any selected edge across multiple analog channels		
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 (optional)	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)		
I <sup>2</sup> C (optional)	Trigger at a start/stop condition or user defined frame with address and/or data values. Also trigger on missing acknowledge, address with no accq, restart, EEPROM read, and 10-bit write		
RS-232/422/485/UART (optional)	Trigger on Rx or Tx start bit, stop bit or data content or parity error		
CAN (optional)	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)		
LIN (optional)	Trigger on LIN (local interconnect network) sync break, sync frame ID, or frame ID and data, parity error, checksum error, frame (symbolic), frame and signal (symbolic)		
MIL-STD 1553 (optional)	Trigger on MIL-STD 1553 signals based on word type (data or command/status), remote terminal address, data and errors (parity, sync, Manchester encoding)		
ARINC 429 (optional)	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		

## Performance Characteristics (Continued)

Trigger type selections (Continued)			
	M9241A	M9242A	M9243A
SENT (optional)	Trigger and decode 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)		
CXPI (optional)	Trigger and decode on CXPI data. Trigger on frame, PTYPE, frame ID or error by type. Decodes all message types and errors		
NFC (optional)	Trigger for NFC-A, NFC-B, and NFC-F		

Waveform measurements			
	M9241A	M9242A	M9243A
Cursors	Single cursor accuracy: $\pm$ [DC vertical gain accuracy + DC vertical offset accuracy + 0.21% full scale] Dual cursor accuracy <sup>1</sup> : $\pm$ [DC vertical gain accuracy + 0.42% full scale] Units: Seconds(s), Hz (1/s), phase (degrees), ratio (%)		
Automatic measurements	Measurements continuously updated with statistics. Cursors track last selected measurement. Select up to eight measurements from the list below: <ul style="list-style-type: none"> <li>– Snapshot all: Measure all single waveform measurements (31)</li> <li>– Vertical: 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 (std deviation), ratio-N cycle, ratio-full screen, Y at X</li> <li>– Time: Period, frequency, counter, + width, - width, burst width, +duty cycle, -duty cycle, bit rate, rise time, fall time, delay, phase, X at min Y, X at max Y, time at edge</li> <li>– Count: Positive pulse count, negative pulse count, rising edge count, falling edge count</li> <li>– Mixed: Area-N cycles, area-full screen, slew rate</li> </ul>		
Automatic measurement logging	Available via BenchVue		
Counter	Built-in frequency counter Source: On any analog Resolution: 8 digits Maximum frequency: Bandwidth of scope		

Waveform math			
Number of math functions	Two, displays FFT and one math simultaneously. Can be cascaded		
Arithmetic	Add, subtract, multiply, divide, differentiate, integrate, FFT, Ax + B, squared, square root, absolute value, common logarithm, natural logarithm, exponential, base 10 exponential, low pass filter, high pass filter, averaged value, smoothing, envelope, magnify, max hold, min hold, measurement trend, chart logic bus (timing or state)		
Enhanced FFT	Record size	Up to 64 kpts resolution	
	Window types	Hanning, Flat Top, Rectangular, Blackman-Harris	
	Time gated FFT	Gate the time range of data for FFT analysis in the zoom view. For time and frequency domain correlated analysis	
	Waveforms	FFT, max hold, min hold, average	
	Peak search	Max 11 peaks, threshold and excursion control	
	Channel power	Power across one frequency range	
	Occupied bandwidth	Percentage of the total power, centered on an assigned channel frequency as specified by user	
	Adjacent channel power ratio	Ratio the power in the main frequency range to the power contained in one or more sidebands	
	Total harmonic distortion	Ratio the power in the fundamental frequency to the power contained in the rest of the harmonics and noise	

1. Denotes warranted specifications. All other are typical.

## Performance Characteristics (Continued)

Search, navigate and lister		M9241A	M9242A	M9243A
Type		Edge, pulse width, rise/fall, runt, frequency peak, serial bus 1, serial bus 2		
Copy		Copy to trigger, copy from trigger		
Frequency peak	Source	Math functions		
	Max # of Peaks	11		
	Control	Results order in frequency or amplitude		
Result display	Event lister or navigation. Manual or auto scroll via navigation or touch event lister entry to jump to a specific event			

WaveGen - Built-in function/arbitrary waveform generator (specifications are typical)		M9241A	M9242A	M9243A
WaveGen out		Front-panel MMCX connector		
Waveforms		Sine, square, ramp, pulse, DC, noise, sine cardinal (sinc), exponential rise, exponential fall, cardiac, Gaussian pulse and arbitrary		
Modulation		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:		
		<ul style="list-style-type: none"> <li>- Modulation: sine, square, ramp</li> <li>- Modulation frequency: 1 Hz to 20 kHz</li> <li>- Depth: 0 to 100%</li> </ul>		
		FM:		
		<ul style="list-style-type: none"> <li>- Modulation: sine, square, ramp</li> <li>- Modulation frequency: 1 Hz to 20 kHz</li> <li>- Minimum carrier frequency: 10 Hz</li> <li>- Deviation: 1 Hz to carrier frequency or (2e12/carrier frequency), whichever is smaller</li> </ul>		
		FSK:		
		<ul style="list-style-type: none"> <li>- Modulation: 50% duty cycle square wave</li> <li>- FSK rate: 1 Hz to 20 kHz</li> <li>- Hop frequency: 2 x FSK rate to 10 MHz</li> </ul>		
Sine		Frequency range: 0.1 Hz to 20 MHz		
		Amplitude flatness: $\pm 0.5$ dB (relative to 1 kHz)		
		Harmonic distortion: $-40$ dBc		
		Spurious (non harmonics): $-40$ dBc		
		Total harmonic distortion: 1%		
		SNR (50 $\Omega$ load, 500 MHz bandwidth): 40 dB ( $V_{pp} > 0.1$ V); 30 dB ( $V_{pp} < 0.1$ V)		
Square wave /pulse		Frequency range: 0.1 Hz to 10 MHz		
		Duty cycle: 20 to 80%		
		Duty cycle resolution: Larger of 1% or 10 ns		
		Pulse width: 20 ns minimum		
		Rise/fall time: 19 ns (10 to 90%)		
		Pulse width resolution: 10 ns or 5 digits, whichever is larger		
		Overshoot: $< 2\%$		
		Asymmetry (at 50% DC): $\pm 1\% \pm 5$ ns		
		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%		

## Performance Characteristics (Continued)

<b>WaveGen – Built-in function/arbitrary waveform generator (specifications are typical)</b>	
	<b>M9241A</b>
	<b>M9242A</b>
	<b>M9243A</b>
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 8k points Amplitude resolution: 10 bits (including sign bit) <sup>1</sup> 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: – 20 mVpp to 5 Vpp into Hi-Z – 10 mVpp to 2.5 Vpp into 50 Ω Resolution: 100 μV or 3 digits, whichever is higher Accuracy: 2% (frequency = 1 kHz)
DC offset	Range: – ± 2.5 V into Hi-Z – ± 1.25 V into 50 Ω Resolution: 100 μV or 3 digits, whichever is higher Accuracy (waveform modes): ± 1.5% of offset setting ± 1% of amplitude ± 1 mV Accuracy (DC mode): ± 1.5% of offset setting ± 3 mV
Trigger output	Trigger output available on trig out MMCX
Main output	Impedance: 50 Ω typical Isolation: Not available Protection: Overload automatically disables output
Output mode	Normal Single-shot (arbitrary, sine, ramp, sine cardinal, exp rise/fall, cardiac, Gaussian pulse)

1. Full resolution is not available at output due to internal attenuator stepping.

Note: Gaussian pulse: 4 Vpp maximum into Hi-Z; 2 Vpp maximum into 50 Ω.



## Performance Characteristics (Continued)

Digital voltmeter (specifications are typical)		M9241A	M9242A	M9243A
Functions		ACrms, DC, DCrms		
Resolution		ACV/DCV: 3 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		

Precision counter/totalizer (specifications are typical)		M9241A	M9242A	M9243A
Counter	Source	Any analog channel or trigger qualified event		
	Resolution	8 digits (for trigger qualified event)		
	Max frequency	1 GHz		
	Trig qual events	1/(trigger hold off time) for trigger qualified events (max 25 MHz, minimum dead time of 40 ns)		
Measurement		Frequency, period, totalize		
Totalizer	Counter size	64-bit totalizing counter		
	Edge	Rise or fall		
	Gating	Positive or negative level. Select from analog channels except the source		

## Connectivity

Physical and virtual connections		M9241A	M9242A	M9243A
Probe		50 $\Omega$ /1 M $\Omega$		
Autoprobe connection		Supported with M9240A AutoProbe power module		
WaveGen connector		MMCX		
External trigger		MMCX 30Vrms/60Vdc max		
Auxiliary output		MMCX		
Reference I/O		MMCX		
PXI trigger		Off/Slave/Master		
		PXI_TRIG[0 - 7]		
		ARM PXI_TRIG[0-7]		

## General and Environmental Characteristics

General and environmental			
	M9241A	M9242A	M9243A
Power consumption	35 W (typical) power on PXI connector + 3.3 V 3.2 A (typical) + 12 V 2.0 A (typical)		
	Operating	Storage	
Temperature	0 to 55 °C	-40 to 70 °C	
Altitude	Up to 10,000 ft (3048 m)	Up to 15,000 ft (4572 m)	
Humidity	Type tested 95% RH @ 40C non-condensing		
Dimensions	PXIe 3U/1 slot (W x D x H) 20 mm x 210 mm x 135 mm		
Weight	.38 kg		

System requirements			
	M9241A	M9242A	M9243A
Operating systems	Windows 10 (32-bit and 64-bit) Windows 8.1 (32-bit and 64-bit) Windows 7 SP1 (32-bit and 64-bit)		
Processor speed	1 GHz 32-bit (x86), 1 GHz 64-bit (x64)		
Memory	Available memory 1 GB minimum		
Disk	Available disk space 2.5 GB available hard disk space		
Required application	Keysight IO Libraries Suite version 17.2 or greater Microsoft .NET Framework		
Display minimum	1024 x 768, 96 or 120 DPI		

Included standard with oscilloscope			
	M9241A	M9242A	M9243A
Calibration	2 year		