TELEDYNE LECROY
Everywhereyoulook™

# UNBELIEVABLY POWERFUL. INSANELY EASY.


## WaveRunner 9000

**500 MHz - 4 GHz Oscilloscopes**

- **MAUI with OneTouch** Power and capability at your fingertips
- **Deepest Toolbox** Powerful signal analysis accelerates insight
- **Exceptional Serial Data Tools** Most complete debug and validation

**teledynelecroy.com/wr9000**

# MAUI® with OneTouch

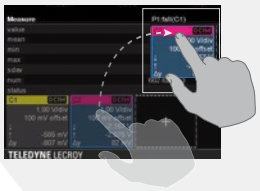
Designed for Touch

Built for Simplicity

Made to Solve

MAUI

OneTouch delivers a superior user experience by providing gesture control of common operations.



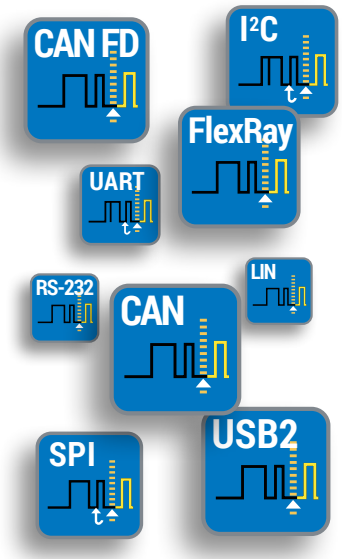
# Deep Toolbox

WaveRunner 9000 has the greatest breadth and depth of tools to simplify any debug task.


# Serial Data Tools

WaveRunner 9000 features exceptional serial data debug and validation solutions

- Triggering
- Decoding
- Measurement and Graphing
- Eye Diagram and Physical Layer Analysis
- Jitter analysis and other advanced tools



# Faster Time to Insight

**Insight** alone is not enough.
Markets and **technologies** change too rapidly.
The **timing** of **critical design decisions** is significant.

**Faster Time to Insight is what matters.**

TIME TO **INSIGHT**™

## UNBELIEVABLY POWERFUL.
## INSANELY EASY.


WaveRunner 9000

# MAUI – SUPERIOR USER EXPERIENCE


**A** Channel, timebase, and trigger descriptors provide easy access to controls without navigating menus.

**B** Configure parameters by touching measurement results.

**C** Shortcuts to commonly used functions are displayed at the bottom of the channel, math and memory menus.

**D** Use the "Add New" button for one-touch trace creation.

**E** Drag to change source, copy setup, turn on new trace, or move waveform location.

**F** Drag to copy measurement parameters to streamline setup process.

**G** Drag to quickly position cursors on a trace.

## Designed for touch

Operate the oscilloscope just like a phone or tablet with the most unique touch screen features on any oscilloscope. All important controls are always one touch away. Touch the waveform to position or zoom in for more details using intuitive actions.

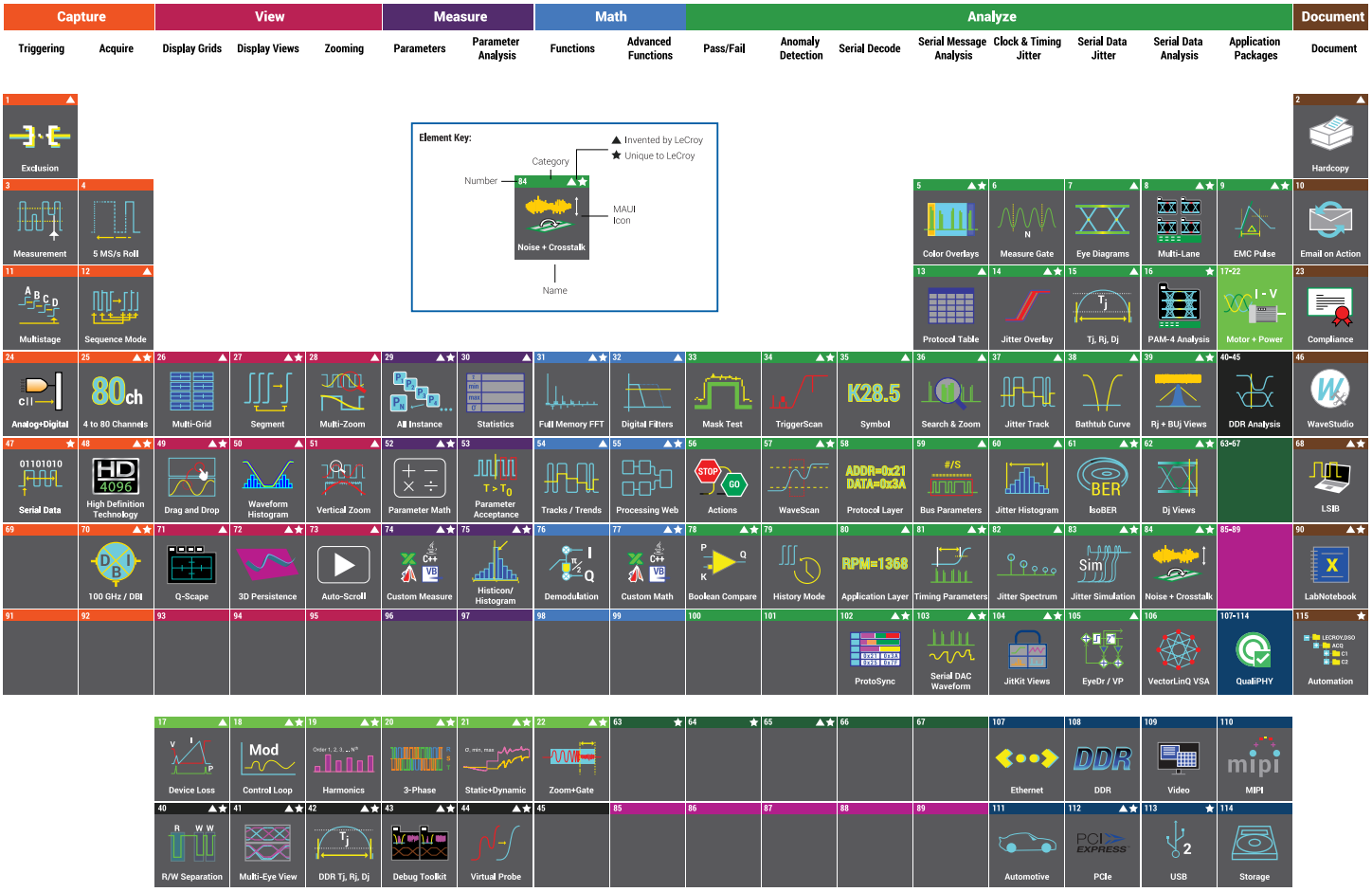
## Built for simplicity

Basic waveform viewing and measurement tools as well as advanced math and analysis capabilities are seamlessly integrated in a single user interface. Time saving shortcuts and intuitive dialogs simplify setup and shorten debug time.

## Made to solve

A deep set of integrated debug and analysis tools help identify problems and find solutions quickly. Unsurpassed integration provides critical flexibility when debugging. Solve problems fast with powerful analysis tools.

# POWERFUL, DEEP TOOLBOX




## Our heritage

Teledyne LeCroy's 50+ year heritage is in processing long records to extract meaningful insight. We invented the digital oscilloscope and many of the additional waveshape analysis tools.

## Our obsession

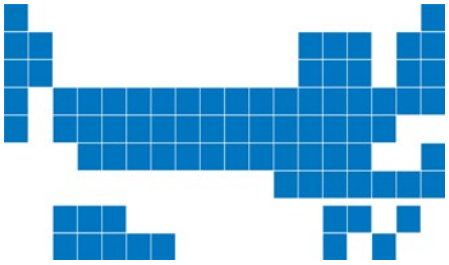
Our tools and operating philosophy are standardized across much of our product line. This deep toolbox inspires insight; and your moment of insight is our reward.

## Our invitation

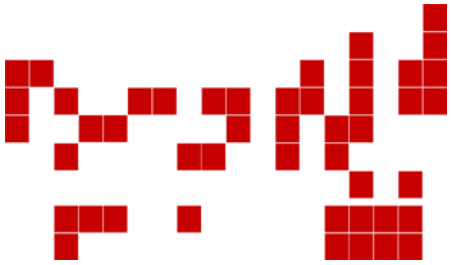
Our Periodic Table of Oscilloscope Tools explains the toolsets that Teledyne LeCroy has deployed in our oscilloscopes. Visit our interactive website to learn more about them.

**teledynelecroy.com/tools**

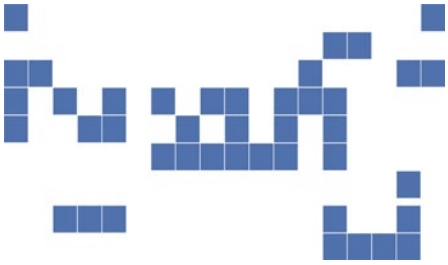
WaveRunner 9000



Competitor A



Competitor B



# MOST COMPLETE SERIAL DATA DEBUG AND VALIDATION

**The WaveRunner 9000 features the widest range and most complete serial data debug and validation solutions.**

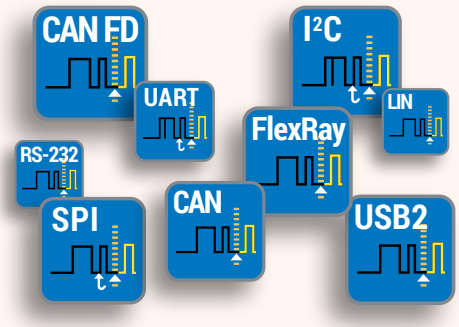
- Triggering
- Decoding
- Measurement and Graphing
- Eye Diagram and Physical Layer Analysis

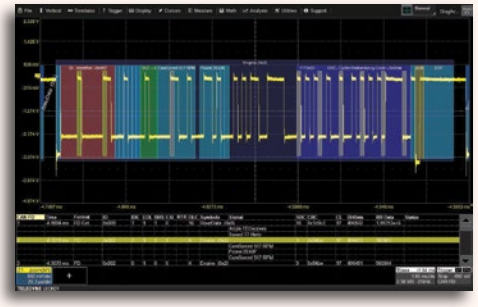
**Other advanced capabilities include**

- Compliance Test
- Advanced jitter analysis tools
- Synchronization to protocol analyzer

**Solutions address the following markets and applications:**

- Embedded Computing
- Automotive
- Industrial
- Military and Avionics
- Peripherals
- Memory
- Handset/Mobile/Cellular
- High Speed Computing
- Data Storage
- Serial Digital Audio



## Trigger

Designed by people who know the standards, with the unique capabilities you want to isolate unusual events. Conditional data triggering permits maximum flexibility, and highly adaptable error frame triggering is available to isolate error conditions. Frame definition groups UART or SPI packets into message frames for customization. Sequence Mode ignores idle time and acquires only data of interest.

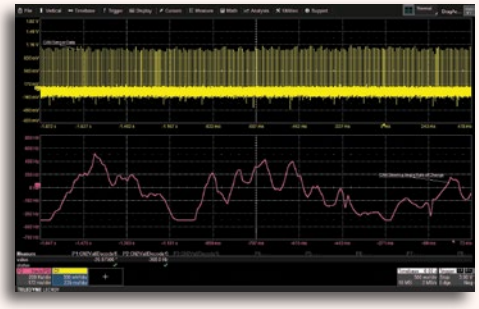
## Decode

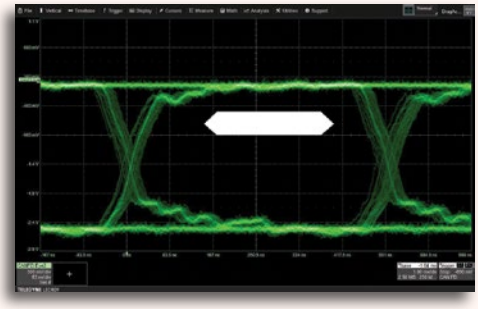
Decoded protocol information is color-coded to specific portions of the serial data waveform and transparently overlaid for an intuitive, easy-to-understand visual record. All decoded protocols are displayed in a single time-interleaved table. Touch a row in the interactive table to quickly zoom to a packet of interest and easily search through long records for specific protocol events using the built-in search feature.

## ProtoSync

ProtoSync combines the oscilloscope view with a simultaneous view of data link layer decodes on the same instrument. This combination makes ProtoSync very effective in debugging protocol-specific negotiation rates.

Compatible with PCI Express, USB 2.0, USB2-HSIC, SAS, SATA, and Fibre Channel.





## Measure/Graph

Quickly validate cause and effect with automated timing measurements to or from an analog signal or another serial message. Make multiple measurements in a single long acquisition to quickly acquire statistics during corner-case testing. Serial (digital) data can be extracted to an analog value and graphed to monitor system performance over time, as if it was probed directly. Complete validation faster and gain better insight.

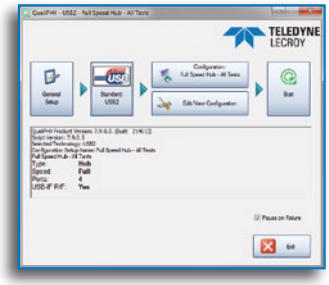
## Eye Diagram

Rapidly display an eye diagram of your packetized low-speed serial data signal without additional setup time. Use eye parameters to quantify system performance and apply a standard or custom mask to identify anomalies. Mask failures can be indicated and can force the scope into Stop mode.

SDAIII or DDR Debug (optional) create eye diagrams of streaming NRZ serial data or DDR signals, and measure and analyze jitter breakdown.

## QualiPHY / Compliance

Compliance testing is a critical part of the design cycle in order to ensure that requirements are met. The QualiPHY framework provides an automated and easy-to-use compliance testing platform for a number of serial data standards.

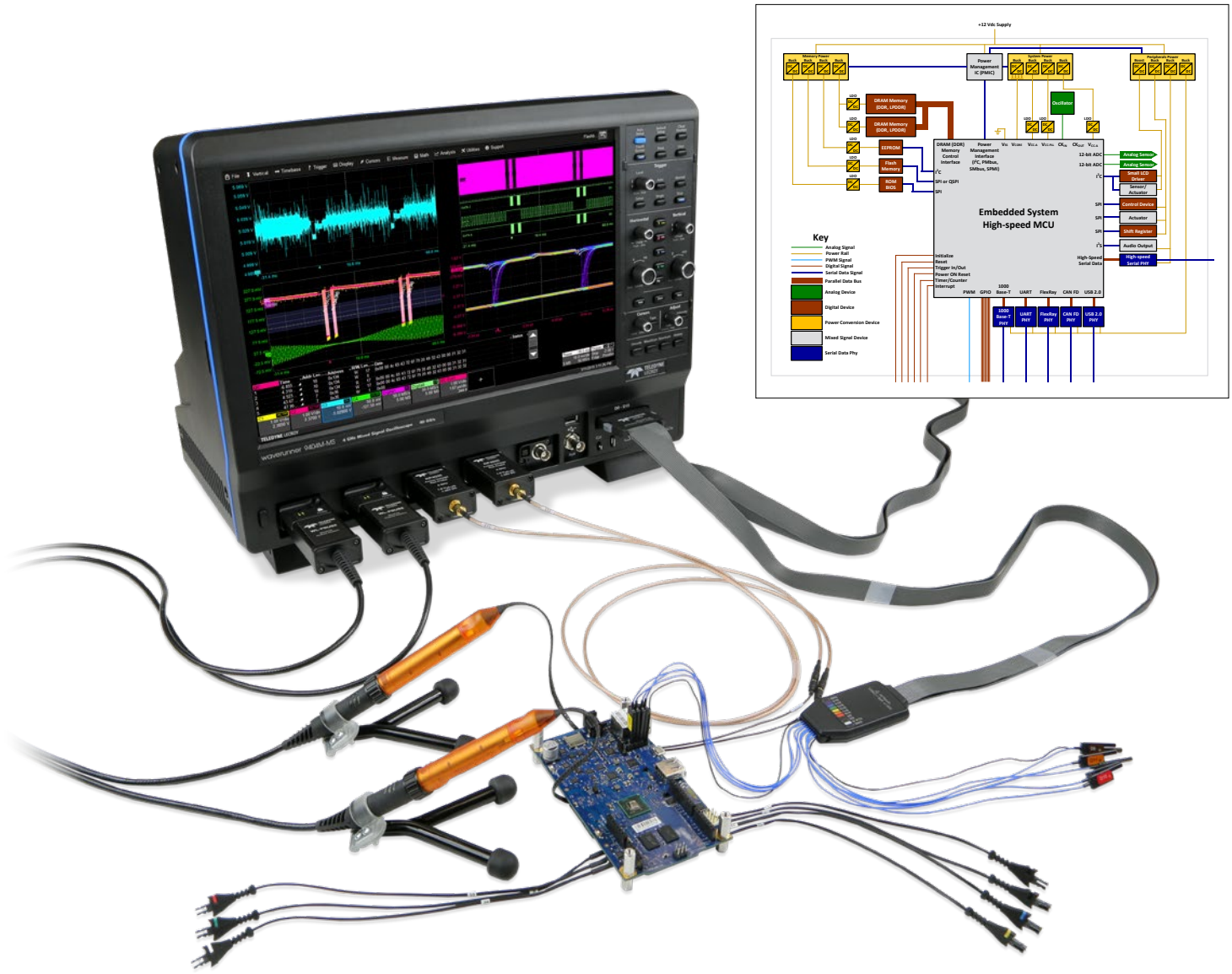



QualiPHY™

## WaveRunner 9000 Serial Data Protocol Support

| | | Trigger | Decode | Measure/Graph | Eye Diagram | Protosync | QualiPHY |
|---|---|---|---|---|---|---|---|
| Embedded Computing | $I^2C$ | • | • | • | • | | |
| | SPI | • | • | • | • | | |
| | UART-RS232 | • | • | • | • | | |
| | USB2-HSIC | | • | | | | |
| Automotive + Industrial | CAN | • | • | • | • | | |
| | CAN FD | • | • | • | • | | |
| | FlexRay | • | • | • | • | | |
| | LIN | • | • | • | • | | |
| | SENT | | • | | | | |
| | MOST50/150 | | | | | | • |
| | BroadR-Reach/ 100Base-T1 | | | | | | • |
| | 1000Base-T1 | | | | | | • |
| Avionics | ARINC429 | | • | • | • | | |
| | MIL-STD-1553 | • | • | • | • | | |
| | SPACEWIRE | | • | | | | |
| High Speed Computing, Storage +Peripherals | Ethernet (10/100Base-T) | | • | | | | • |
| | Ethernet (1000Base-T) | | | | | | • |
| | MDIO | | • | | | | |
| | USB 2.0 | • | • | • | • | • | • |
| | 8b/10b | • | • | | • | | |
| | Fibre Channel | | • | | | | |
| | SATA (1.5 & 3 Gb/s) | • | • | | | • | |
| | SAS (1.5 & 3 Gb/s) | | • | | | • | |
| | PCI Express (Gen1) | | • | | | • | |
| Memory | LPDDR2 | | | | • | | • |
| | DDR2 | | | | • | | • |
| | DDR3 | | | | • | | • |
| MIPI | D-PHY/CSI-2/DSI | | • | | • | | • |
| | DigRF3G | | • | • | | | |
| | DigRFv4 | | • | • | | | |
| | SPMI | | • | | | | |
| | UniPro | | • | | | | |
| | M-PHY | | • | | • | | |
| Other | Audio ($I^2S$, LJ, RJ, TDM) | • | • | • | | | |
| | Manchester | | • | | | | |
| | NRZ | • | • | | • | | |

# EMBEDDED COMPUTING SYSTEMS TESTING




**WaveRunner 9000 oscilloscopes have unsurpassed test, debug and validation tools to enable the most comprehensive embedded computing system (analog, digital and serial data) testing.**

## Powerful, deep toolbox

More standard math, measure, pass/fail and other toolsets provide faster and more complete insight into circuit problems. Many additional application packages are optionally available to enhance understanding.

## Superior serial data toolsets

Comprehensive low-speed serial data triggers and decoders, plus measure/graph and eye diagram testing, provide the best causal analysis. Powerful serial data jitter analysis toolsets and compliance packages simplify complex validation.

## Comprehensive probe offering

A wide selection of low voltage, high voltage and current probes accurately measures every signal in your circuit. In addition, probe adapters provide a simple and easy interface of third-party probes.

# AUTOMOTIVE TESTING

**WaveRunner 9000 oscilloscopes provide a wide-range of validation and debug software which has been tailored to the specific test needs of the automotive industry.**

## Vehicle bus debug tools

Unique capabilities that build on triggering and decoding provide the most complete serial data debug and validation of automotive buses such as CAN, CAN FD, LIN, FlexRay, SENT, MOST, and more.

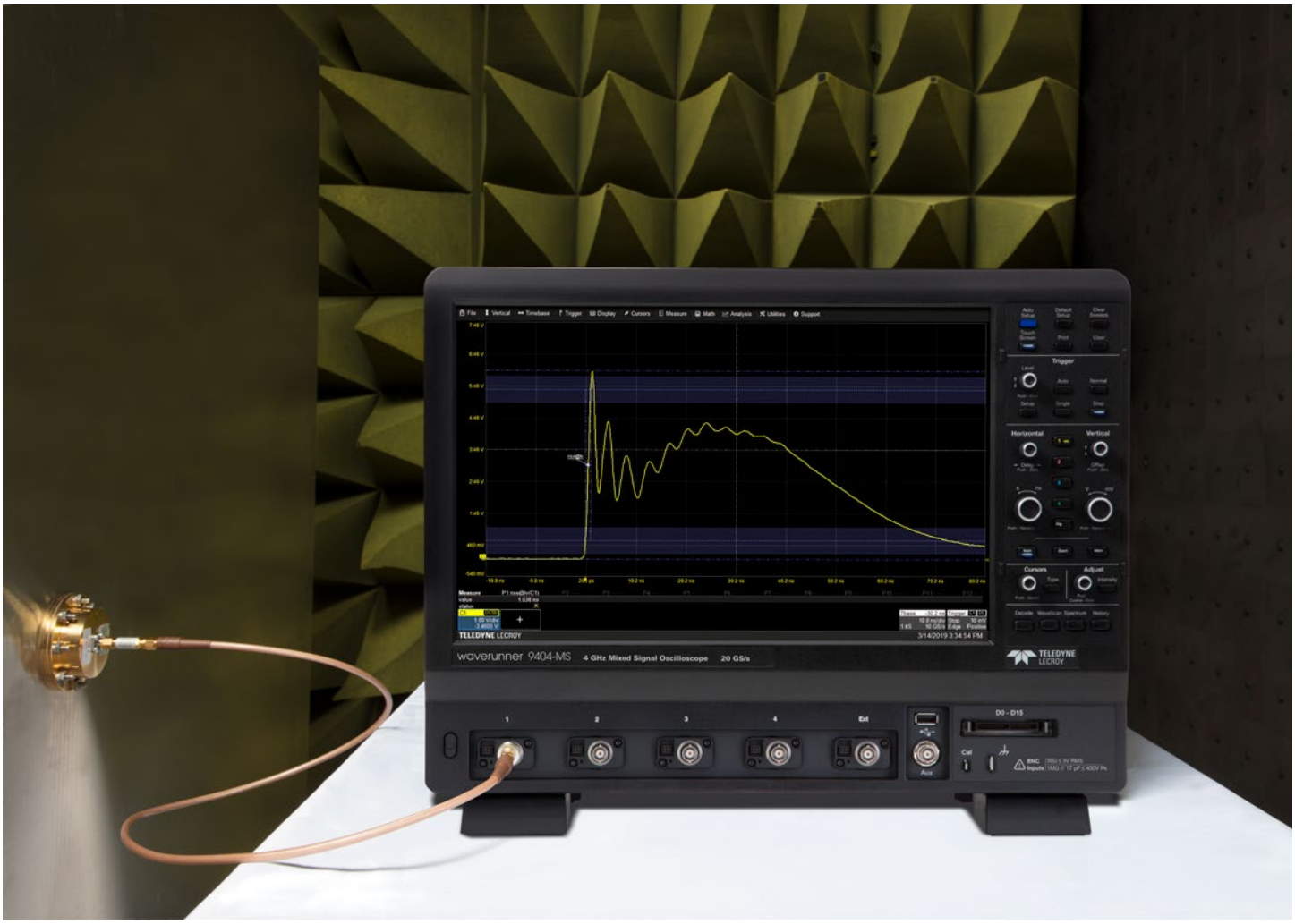
## Ethernet beyond compliance

Cover all aspects of physical layer testing needs with compliance testing for 100Base-T1 and 1000Base-T1, and go beyond compliance with the unique and dedicated Automotive Ethernet debug toolkit.

## Precise EMI/EMC analysis

4 GHz bandwidth and 40 GS/s sample rate along with dedicated, fully integrated Spectrum Analyzer and EMI/EMC packages enable root causes to be found quickly and easily.

# ELECTROMAGNETIC COMPATIBILITY (EMC/EMI)




**WaveRunner 9000 oscilloscopes accurately characterize EMC test signals with 40 GS/s, 1% gain accuracy, and a dedicated EMC pulse parameter package.**

## Pulse measurement fidelity

Fast pulse rise times require 2.5 to 4 GHz bandwidth at very high sample rates to ensure measurement confidence. WaveRunner 9000 provides the most accurate characterization using 40 GS/s sample rate and 1% gain accuracy.

## Simplified frequency analysis

Spectrum Analyzer mode simplifies setup for analyzing EMI effects precisely. Identify instantaneous peak, quasi-peak, and maximum hold peaks across a wide EMI band using an interactive peaks and markers table. View the repetitive nature of harmonics with Spectrogram.

## EMC pulse parameter package

Customizable measurements provide values per specific EMC/ESD standards. Level selections can be made to ignore undershoot, overshoot, or tail perturbations. Measurement filtering can limit measurement sets or ignore unwanted perturbations.

# WAVERUNNER 9000 OSCILLOSCOPES AT A GLANCE



## Key Attributes

1. 15.4" WXGA capacitive-touch screen display
2. MAUI with OneTouch optimized for convenience and efficiency
3. "Add New" button for fast waveform creation
4. "Push" Knobs – Provide shortcuts for common actions
5. Waveform Control Knobs – multiplexed for channel, zoom, math and memory traces
6. Cursor Knobs – Use cursors without opening a menu
7. Serial trigger captures signals up to 3 Gb/s
8. Dedicated buttons to quickly access popular debug tools.
9. Mixed Signal Capability with 16 digital channels
10. Four USB 3.1 Gen 1 ports
11. Reference Clock Input/Output connectors
12. USBTMC over USB 3.1

## Enhanced Resolution using Filtering

WaveRunner 9000 oscilloscopes have standard capability to provide improved resolution (with bandwidth tradeoffs) by filtering. Each channel can be filtered independently. The filter result shows the number of effective bits improvement at a given bandwidth. Filtering is a good approach to higher resolution provided the tradeoffs between resolution and bandwidth are acceptable.


For more details, reference the section on filtering in the white paper:
Comparing High Resolution Oscilloscope Design Approaches

# WAVERUNNER 8000-R LOW-PROFILE OSCILLOSCOPE

## Key Features

**Low-profile design - <2U (3.5")**

**1, 2.5, and 4 GHz bandwidths**

**Up to 40 GS/s sample rate**

**Deep Memory - up to 128 Mpts**

**Fully software-compatible with the WaveRunner 9000**

**Remote connectivity via LXI, USBTMC, and LAN**

**Rackmount kit and removable SSD standard**

**Same powerful, deep toolbox of WaveRunner 9000 oscilloscopes**

**Support for ProBus active probes**


**WaveRunner 8000-R oscilloscopes utilize the WaveRunner 9000 acquisition system to provide a high-performance, 4 GHz oscilloscope in a convenient, low-profile form factor.**

### Low-Profile Form Factor

The WaveRunner 8000-R models provide a convenient form factor for a 4 GHz oscilloscope. The compact design has a height of less than 2U (3.5", 8.89 cm) and includes a standard rackmount kit, easily lending itself to be installed in an automated test environment.

### Powerful, Deep Toolbox

Unlike most digitizing systems the WaveRunner 8000-R provides the powerful, deep toolbox that is expected in a Teledyne LeCroy oscilloscope. The full range of the WaveRunner 9000's analysis capability is available; including an array of serial protocol analysis packages and application specific packages.

### Easily Transition Test Programs

The WaveRunner 8000-R models are fully software-compatible with their WaveRunner 9000 counterparts. Development can be conducted with the assistance of the front panel and display of the WaveRunner 9000 and then seamlessly transitioned to automated testing.

### Flexible Connectivity Options

A variety of remote connectivity options (LXI, USBTMC, and LAN) offer flexibility when connecting to the WaveRunner 8000-R. Teledyne LeCroy's free WaveStudio software is a fast and easy way to analyze acquired waveforms off-line, or remotely control an oscilloscope from your desktop.

# PROBES

**Teledyne LeCroy offers an extensive range of probes to meet virtually every probing need.**

| | | |
|---|---|---|
| **Differential Probes (4 GHz)**<br>Various<br>(see ordering information) |  | General purpose high-bandwidth probes with high dynamic range and offset. Wide variety of tips and leads available, including solder-in, QuickLink solder-in, HiTemp solder-in, quick connect tip, browser tip, square-pin. |
| **ZS Series High Impedance Active Probes**<br>ZS1000<br>ZS1500<br>ZS2500<br>ZS4000 |  | High input impedance (1 MΩ), low 0.9 pF input capacitance and an extensive set of probe tips and ground accessories make these low-cost, single-ended probes ideal for a wide range of applications. The ZS Series is available up to 4 GHz bandwidth. |
| **Differential Probes (200 MHz – 1.5 GHz)**<br>ZD200, ZD500,<br>ZD1000, ZD1500<br>AP033 |  | High bandwidth, excellent common-mode rejection ratio (CMRR) and low noise make these active differential probes ideal for applications such as automotive electronics and data communications. AP033 provides 10x gain for high-sensitivity measurement of series/shunt resistor voltages. |
| **Active Voltage/Power Rail Probe**<br>RP4030 |  | Specifically designed to probe a low impedance power/voltage rail. The RP4030 has 30 V built-in offset adjust, low attenuation (noise), and high DC input impedance with 4 GHz of bandwidth. Featuring a wide assortment of tips and leads, including solder-in and U.FL receptacle connections. |
| **High Voltage Fiber Optically-isolated Probe**<br>HVFO103 |  | The HVFO103 is a compact, simple, affordable probe for measurement of small signals (gate-drives, sensors, etc.) floating on an HV bus in power electronics designs, or for EMC, EFT, ESD and RF immunity testing sensor monitoring. Suitable for up to 35kV common-mode. 140 dB CMRR. |
| **HVD Series High Voltage Differential Probes**<br>HVD3102A, HVD3106A (1 kV)<br>HVD3206A (2 kV)<br>HVD3605A (6 kV) |  | Available with 1, 2 or 6 kV common-mode ratings. Excellent CMRR (65 dB @ 1 MHz) at high frequencies is combined with low inherent noise, wide differential voltage range, high offset voltage capabilities, and 1% gain accuracy. The ideal probe for power conversion system test. |
| **High Voltage Passive Probes**<br>HVP120, PPE4KV,<br>PPE5KV, PPE6KV |  | The HVP and PPE Series includes four fixed-attenuation probes covering a range from 1 kV to 6 kV. These probes are ideal for lightning/surge or EFT testing, or for probing in-circuit beyond the range of a LV-rate passive probe. |
| **Current Probes**<br>CP030, CP030A<br>CP031, CP031A,<br>CP150, CP500,<br>DCS025 |  | Available in bandwidths up to 100 MHz with peak currents of 700 A and sensitivities to 1 mA/div. Extra-long cables (3 or 6 meters) available on some models. Ideal for component or power conversion system input/output measurements. DCS025 deskew calibration source also available. |
| **Probe and Current Sensor Adapters**<br>TPA10, CA10 |  | TPA10 adapts supported Tektronix TekProbe-compatible probes to Teledyne LeCroy ProBus interface. CA10 is a programmable adapter for third-party current sensors that have voltage or current outputs proportional to measured current. |

# SPECIFICATIONS

## Vertical - Analog Channels

| | WaveRunner 9054 | WaveRunner 9104/ 8104-R | WaveRunner 9254/ 9254M/8254M-R | WaveRunner 9404/ 9404M/8404M-R |
|---|---|---|---|---|
| Analog Bandwidth @ 50 Ω (-3 dB) | 500 MHz (≥ 2 mV/div) | 1 GHz (≥ 2 mV/div) | 2.5 GHz (≥ 5 mV/div) | 4 GHz (≥ 5 mV/div) |
| Analog Bandwidth @ 1 MΩ (-3 dB) | 500 MHz (typical) | 500 MHz (typical) | 500 MHz (typical) | 500 MHz (typical) |
| Rise Time (10–90%, 50 Ω – test limit) | 700 ps (typical) | 415 ps (typical) | 160 ps (typical) | 100 ps (typical) |
| Rise Time (20–80%, 50 Ω – typical) | 480 ps (typical) | 290 ps (typical) | 120 ps (typical) | 75 ps (typical) |
| Input Channels | 4 | | | |
| Vertical Resolution | 8-bits; up to 11-bits with enhanced resolution (ERES) | | | |
| Effective Number of Bits (ENOB) | 7.1 bits | 6.9 bits | 6.7 bits | 6.4 bits |

| Vertical Noise Floor (rms, 50 Ω) | | | WR 9254 | WR 9254M/ 8254M-R | WR 9404 | WR 9404M/ 8404M-R |
|---|---|---|---|---|---|---|
| 1 mV/div | 122 µV | 165 µV | 165 µV | 165 µV | 165 µV | 165 µV |
| 2 mV/div | 122 µV | 165 µV | 165 µV | 165 µV | 165 µV | 165 µV |
| 5 mV/div | 135 µV | 177 µV | 277 µV | 274 µV | 393 µV | 368 µV |
| 10 mV/div | 190 µV | 247 µV | 346 µV | 315 µV | 476 µV | 420 µV |
| 20 mV/div | 315 µV | 406 µV | 589 µV | 504 µV | 771 µV | 657 µV |
| 50 mV/div | 0.74 mV | 0.95 mV | 1.25 mV | 0.97 mV | 1.48 mV | 1.21 mV |
| 100 mV/div | 1.44 mV | 1.83 mV | 2.38 mV | 1.79 mV | 2.74 mV | 2.25 mV |
| 200 mV/div | 3.15 mV | 4.18 mV | 6.01 mV | 5.18 mV | 7.38 mV | 6.35 mV |
| 500 mV/div | 7.41 mV | 9.58 mV | 12.43 mV | 9.81 mV | 14.01 mV | 11.57 mV |
| 1 V/div | 14.38 mV | 18.52 mV | 24.31 mV | 18.52 mV | 26.85 mV | 21.74 mV |

| | | |
|---|---|---|
| Sensitivity | **50 Ω**: 1 mV/div–1 V/div, fully variable; **1 MΩ**: 1 mV/div–10 V/div, fully variable | |
| DC Vertical Gain Accuracy (Gain Component of DC Accuracy) | ±1% F.S. (typical), offset at 0 V | |
| Channel-Channel Isolation | > 100:1 up to rated BW (typical) | DC -2.5 GHz: >100:1; 2.5 GHz to rated BW: >30:1 (typical) |
| Offset Range | **50 Ω:**<br>±1.6 V @ 1 mV– 4.95 mV/div, ±4 V @ 5 mV–9.9 mV/div, ±8 V @ 10 mV–19.8 mV/div, ±10 V @ 20 mV–1 V/div<br>**1 MΩ:**<br>±1.6 V @ 1 mV–4.95 mV/div, ±4 V @ 5 mV–9.9 mV/div, ±8 V @ 10 mV–19.8 mV/div, ±16 V @ 20 mV–100 mV/div, ±80 V @ 102 mV–1.0 V/div, ±160 V @ 1.02 V–10 V/div | **50 Ω:**<br>**BWL ≤ 1 GHz**<br>±1.6 V @ 1 mV–4.95 mV/div, ±4 V @ 5 mV–9.9 mV/div, ±8 V @ 10 mV–19.8 mV/div, ±10 V @ 20 mV–1 V/div<br>**BWL > 1 GHz**<br>±1.4 V @ 5 mV–100 mV/div, ±10 V @ 102 mV–1 V/div<br>**1 MΩ:**<br>±1.6 V @ 1 mV–4.95 mV/div, ±4 V @ 5 mV–9.9 mV/div, ±8 V @ 10 mV–19.8 mV/div, ±16 V @ 20 mV–140 mV/div, ±80 V @ 142 mV–1.4 V/div, ±160 V @ 1.42 V–10 V/div |
| DC Vertical Offset Accuracy | ±(1.5% of offset setting +1% of full scale + 1 mV) (test limit) | |
| Maximum Input Voltage | **50 Ω**: 5 $V_{rms}$ ±10 V peak; **1 MΩ**: 400 V max. (DC + peak AC < 10 kHz) | |
| Input Coupling | 1 MΩ: AC, DC, GND; 50 Ω: DC, GND | |
| Input Impedance | 50 Ω ±2% or 1 MΩ \|\| 17pF, 10 MΩ \|\| 9.5 pF with supplied Probe | |
| Bandwidth Limiters | 20 MHz, 200 MHz | 20 MHz, 200 MHz | 20 MHz, 200 MHz, 1 GHz | 20 MHz, 200 MHz, 1 GHz |
| Rescaling | Length: meters, inches, feet, yards, miles; Mass: grams, slugs; Temperature: Celsius, Fahrenheit, Kelvin; Angle: radian, arcdegr, arcmin, arcsec, cycles, revolutions, turns; Velocity: m/s, in/s, ft/s, yd/s, miles/s; Acceleration: m/s2, in/s2, ft/s2, g0; Volume: liters, cubic meters, cubic inches, cubic feet, cubic yards; Force (Weight): Newton, grain, ounce, pound; Pressure: Pascal, bar, atmosphere (technical), atmosphere (standard), torr, psi; Electrical: Volts, Amps, Watts, Volt-Amperes, Volt-Amperes reactive, Farad, Coulomb, Ohm, Siemen, Volt/meter, Coulomb/m2, Farad/meter, Siemen/meter, power factor; Magnetic: Weber, Tesla, Henry, Amp/meter, Henry/meter; Energy: Joule, BTU, calorie; Rotating Machine: radian/second, frequency, revolution/second, revolution/minute, N·m, lb-ft, lb-in, oz-in, Watt, horsepower; Other: % | |

## Horizontal - Analog Channels

| | |
|---|---|
| Timebases | Internal timebase common to 4 input channels; an external clock may be applied at the EXT input |
| Time/Division Range | 20 ps/div - 1.6 ks/div with standard memory<br>**M Models:** 20 ps/div - 6.4 ks/div with standard memory<br>RIS available at ≤ 10 ns/div;<br>Roll Mode available at ≥ 100 ms/div and ≤ 5 MS/s |
| Clock Accuracy | ≤ 1.5 ppm +(aging of 0.5 ppm/yr from last calibration) |
| Sample Clock Jitter | Up to 10 µs Acquired Time Range: 100 fsrms (Internal Timebase Reference)<br>Up to 10 ms Acquired Time Range: 360 fsrms (Internal Timebase Reference) |
| Delta Time Measurement Accuracy | $\sqrt{2} * \sqrt{\left(\frac{Noise}{SlewRate}\right)^2 + (Sample\ Clock\ Jitter)^2}$ *(RMS) + (clock accuracy * reading) (seconds)* |
| Jitter Measurement Floor | $\sqrt{\left(\frac{Noise}{SlewRate}\right)^2 + (Sample\ Clock\ Jitter)^2}$ *(RMS, seconds, TIE)* |

# SPECIFICATIONS

| | WaveRunner 9054 | WaveRunner 9104/ 8104-R | WaveRunner 9254/ 9254M/8254M-R | WaveRunner 9404/ 9404M/8404M-R |
|---|---|---|---|---|
| **Horizontal - Analog Channels (cont'd)** | | | | |
| Channel-Channel Deskew Range | ±9 x time/div. setting, each channel | | | |
| External Timebase Reference (Input) | 10 MHz ±25 ppm | | | |
| External Timebase Reference (Output) | 10 MHz 3.5 dBm ±1 dBm, synchronized to reference being used by user (internal or external reference) | | | |
| **Acquisition - Analog Channels** | | | | |
| Sample Rate (Single-Shot) | 10 GS/s on 4 Ch; 20 GS/s on 2 Ch | | 10 GS/s on 4 Ch; 20 GS/s on 2 Ch<br>**M Models:** 20 GS/s on 4 Ch; 40 GS/s on 2 Ch | |
| Memory Length Options (4 Ch / 2 Ch) (Number of segments in sequence acquisition mode) | 16M / 32M / 32M (5,000) | | 16M / 32M / 32M (5,000)<br>**M Models:** 64M / 128M / 128M (15,000) | |
| Intersegment time | 1 µs | | | |
| Averaging | Summed averaging to 1 million sweeps; continuous averaging to 1 million sweeps | | | |
| Interpolation | Linear or Sin x/x (2 pt and 5 pt) | | | |
| **Vertical, Horizontal, Acquisition - Digital Channels (-MS Models only)** | | | | |
| Maximum Input Frequency | 250 MHz | | | |
| Minimum Detectable Pulse Width | 2 ns | | | |
| Input Dynamic Range | ± 20V | | | |
| Input Impedance (Flying Leads) | 100 kΩ \|\| 5 pF | | | |
| Input Channels | 16 Digital Channels | | | |
| Maximum Input Voltage | ±30V Peak | | | |
| Minimum Input Voltage Swing | 400 mV | | | |
| Threshold Groupings | Pod 2: D15 - D8, Pod 1: D7 - D0 | | | |
| Threshold Selections | TTL, ECL, CMOS (2.5 V, 3.3 V, 5 V), PECL, LVDS or User Defined | | | |
| Threshold Accuracy | ±(3% of threshold setting + 100mV) | | | |
| User Defined Threshold Range | ±10 V in 20 mV steps | | | |
| User Defined Hysteresis Range | 100 mV to 1.4 V in 100 mV steps | | | |
| Sample Rate | 1.25 GS/s | | | |
| Record Length | 32MS - 16 Channels | | 32MS - 16 Channels<br>**M Models:** 128MS - 16 Channels | |
| Channel-to-Channel Skew | 350 ps | | | |
| **Triggering System** | | | | |
| Modes | Normal, Auto, Single, and Stop | | | |
| Sources | Any input channel, Ext, Ext/10, or line; slope and level unique to each source (except line trigger) | | | |
| Coupling | DC, AC, HFRej, LFRej | | | |
| Pre-trigger Delay | 0 - 100% of memory size (adjustable in 1% increments or 100 ns) | | | |
| Post-trigger Delay | 0 - 10,000 divisions in real time mode, limited at slower time/div settings or in roll mode | | | |
| Hold-off | From 2 ns up to 20 s or from 1 to 99,999,999 events | | | |
| Trigger and Interpolator Jitter | ≤ 4 ps RMS (typical), < 0.1 ps RMS (typical, software assisted) | | | |
| Internal Trigger Level Range | ±4.1 div from center (typical) | | | |
| External Trigger Level Range | Ext (±0.4 V); Ext/10 (±4 V) | | | |
| Maximum Trigger Rate | 1,000,000 waveforms/second | | | |
| Trigger Sensitivity with Edge Trigger (Ch 1–4) | 2 div @ < 500 MHz<br>1.5 div @ < 250 MHz<br>1 div @ < 200 MHz<br>0.9 div @ < 10 MHz<br>(DC, AC, and LFRej coupling) | 2 div @ < 1 GHz<br>1.5 div @ < 500 MHz<br>1 div @ < 200 MHz<br>0.9 div @ < 10 MHz<br>(DC, AC, and LFRej coupling) | 2 div @ < 2.5 GHz<br>1.5 div @ < 1.25 GHz<br>1 div @ < 200 MHz<br>0.9 div @ < 10 MHz<br>(DC, AC, and LFRej coupling) | 2 div @ < 4 GHz<br>1.5 div @ < 2 GHz<br>1 div @ < 200 MHz<br>0.9 div @ < 10 MHz<br>(DC, AC, and LFRej coupling) |
| External Trigger Sensitivity, (Edge Trigger) | 2 div @ 1 GHz<br>1.5 div @ < 500 MHz<br>1 div @ < 200 MHz<br>0.9 div @ < 10 MHz<br>(DC, AC, and LFRej coupling) | | | |
| Max. Trigger Frequency, SMART Trigger | 500 MHz @ ≥ 10 mV/div 1.2 ns (minimum triggerable width 1.2 ns) | 1.0 GHz @ ≥ 10 mV/div (minimum triggerable width 750 ps) | 2.0 GHz @ ≥ 10 mV/div (minimum triggerable width 300 ps) | 2.0 GHz @ ≥ 10 mV/div (minimum triggerable width 200 ps) |

# SPECIFICATIONS

| | WaveRunner 9054 | WaveRunner 9104/ 8104-R | WaveRunner 9254/ 9254M/8254M-R | WaveRunner 9404/ 9404M/8404M-R |
|---|---|---|---|---|
| **Trigger Types** | | | | |
| Edge | Triggers when signal meets slope (positive, negative, or either) and level condition. | | | |
| Width | Triggers on positive or negative glitches with widths selectable as low as 500 ps (depending on oscilloscope bandwidth) to 20 s, or on intermittent faults | | | |
| Glitch | Triggers on positive or negative glitches with widths selectable as low as 200 ps (depending on oscilloscope bandwidth) to 20 s, or on intermittent faults | | | |
| Window | Triggers when signal exits a window defined by adjustable thresholds | | | |
| Pattern | Logic combination (AND, NAND, OR, NOR) of 5 inputs (4 channels and external trigger input. Each source can be high, low, or don't care. The High and Low level can be selected independently. Triggers at start or end of the pattern | | | |
| TV-Composite Video | Triggers NTSC or PAL with selectable line and field;<br>HDTV (720p, 1080i, 1080p) with selectable frame rate (50 or 60 Hz) and Line; or<br>CUSTOM with selectable Fields (1–8), Lines (up to 2000), Frame Rates (25, 30, 50, or 60 Hz), Interlacing (1:1, 2:1, 4:1, 8:1), or Synch Pulse Slope (Positive or Negative) | | | |
| Runt | Trigger on positive or negative runts defined by two voltage limits and two time limits.<br>Select between 1 ns and 20 ns | | | |
| Slew Rate | Trigger on edge rates. Select limits for dV, dt, and slope. Select edge limits between 1 ns and 20 ns | | | |
| Interval | Triggers on intervals selectable between 1 ns and 20 s | | | |
| Dropout | Triggers if signal drops out for longer than selected time between 1 ns and 20 s | | | |
| Exclusion Triggering | Trigger on intermittent faults by specifying the expected behavior and triggering when that condition is not met | | | |
| Measurement Trigger | Select from a large number of measurement parameters trigger on a measurement value with qualified limits. | | | |
| Multi-stage: Qualified | Triggers on any input source only if a defined state or edge occurred on another input source. Delay between sources is selectable by time or events. | | | |
| Multi-stage: Qualified First | In Sequence acquisition mode, triggers repeatably on event B only if a defined pattern, state, or edge (event A) is satisfied in the first segment of the acquisition. Holdoff between sources is selectable by time or events. | | | |
| **Low Speed Serial Protocol Triggering (Optional)** | | | | |
| | I2C, SPI (SPI, SSPI, SIOP), UART-RS232, CAN1.1, CAN2.0, CAN FD, LIN, FlexRay, MIL-STD-1553 | | | |
| **Measurement Tools** | | | | |
| Measurement Functionality | Display up to 8 measurement parameters together with statistics including mean, minimum, maximum, standard deviation, and total number. Each occurrence of each parameter is measured and added to the statistics table. Histicons provide a fast, dynamic view of parameters and waveshape characteristics. Parameter math allows addition, subtraction, multiplication, or division of two different parameters. Parameter gates define the location for measurement on the source waveform. Parameter accept criteria define allowable values based on range setting or waveform state. | | | |
| Measurement Parameters - Horizontal + Jitter | Cycles (number of), Delay (from trigger, 50%), Δ Delay (50%), Duty Cycle (50%, @level), Edges (number of, @level), Fall Time (90-10, @levels), Frequency (50%, @level), Half Period (@level), Hold Time (@level), N Cycle Jitter (peak-peak), Number of Points, Period (50%, @level), Δ Period (@level), Phase (@level), Rise Time (10-90, @levels), Setup (@levels), Skew (@levels), Slew Rate (@levels), Time Interval Error (@level), Time (@level), Δ Time (@level), Width (50%, @level), Δ Width (@level), X(value)@max, X(value)@min | | | |
| Measurement Parameters - Vertical | Amplitude, Base, Level@X, Maximum, Mean, Median, Minimum, Peak-to-Peak, RMS, Std. Deviation, Top | | | |
| Measurement Parameters - Pulse | Area, Base, Fall Time (90-10, 80-20, @levels), Overshoot (positive, negative), Rise Time (10-90, 80-20, @levels), Top, Width (50%) | | | |
| Measurement Parameters - Statistical (on Histograms) | Full Width (@ Half Max, @%), Amplitude, Base, Peak@MaxPopulation, Maximum, Mean, Median, Minimum, Mode, Range, RMS, Std. Deviation, Top, X(value)@Peak, Peaks (number of), Percentile, Population (@bin, total) | | | |
| **Math Tools** | | | | |
| Math Functionality | Display up to 8 math function traces (F1–F8). The easy-to-use graphical interface simplifies setup of up to two operations on each function trace, and function traces can be chained together to perform math-on-math. | | | |
| Math Operators - Basic Math | Average (summed), Average (continuous), Difference (–), Envelope, Floor, Invert (negate), Product (x), Ratio (/), Roof, Sum (+) | | | |
| Math Operators - Digital (incl. with MSO models/options) | Digital AND, Digital DFlipFlop, Digital NAND, Digital NOR, Digital NOT, Digital OR, Digital XOR | | | |
| Math Operators - Filters | Enhanced resolution (to 11 bits vertical), Interpolate (linear, cubic, sinx/x) | | | |
| Math Operators - Frequency Analysis | FFT (power spectrum, magnitude, phase, power density, real, imaginary, magnitude squared) up to full analysis memory length. Select from Rectangular, VonHann, Hamming, FlatTop and Blackman Harris windows. | | | |
| Math Operators - Functions | Absolute value, Correlation (two waveforms), Derivative, Deskew (resample), Exp (base e), Exp (base 10), Integral, Invert (negate), Log (base e), Log (base 10), Reciprocal, Rescale (with units), Square, Square root, Zoom (identity) | | | |
| Math Operators - Other | Segment, Sparse | | | |
| **Measurement and Math Integration** | | | | |
| | Histograms to display statistical distributions of up to 2 billion measurement parameters. Trend (datalog) of up to 1 million measurement parameters. Track (display parameter vs. time, time-correlated to acquisitions) any parameter. Persistence histogram and persistence trace (mean, range, sigma) | | | |
| **Pass/Fail Testing** | | | | |
| | Simultaneously test multiple parameters against selectable parameter limits or pre-defined masks. Pass or fail conditions can initiate actions including document to local or networked files, e-mail the image of the failure, save waveforms, send a pulse out at the front panel auxiliary BNC output, or (with the GPIB option) send a GPIB SRQ. | | | |

# SPECIFICATIONS

| | WaveRunner 9054 | WaveRunner 9104/ 8104-R | WaveRunner 9254/ 9254M/8254M-R | WaveRunner 9404/ 9404M/8404M-R |
|---|---|---|---|---|
| **Display System** | | | | |
| Size | Color 15.4" widescreen capacitive touch screen | | | |
| Resolution | WXGA; 1280 x 800 pixels | | | |
| Number of Traces | Display a maximum of 16 traces. Simultaneously display channel, zoom, memory and math traces | | | |
| Grid Styles | Auto, Single, Dual, Quad, Octal, X-Y, Single+X-Y, Dual+X-Y, Tandem, Quatro, Twelve, Sixteen | | | |
| Waveform Representation | Sample dots joined, or sample dots only | | | |
| **Processor/CPU** | | | | |
| Type | Intel® i5-6500 Quad Core, 3.2 GHz (or better), **R Models:** Intel® Celeron, 1.4 GHz (or better) | | | |
| Processor Memory | 8 GB standard, up to 16 GB optional<br>**M Models:** 16 GB standard, **R Models:** 8 GB maximum | | | |
| Operating System | Microsoft Windows® 10;<br>**R Models:** Microsoft Windows® 7 Professional Edition (64-bit) | | | |
| Real Time Clock | Date and time displayed with waveform in hardcopy files. SNTP support to synchronize to precision internal clocks | | | |
| **Connectivity** | | | | |
| Ethernet Port | Supports 10/100/1000Base-T Ethernet interface (RJ45 port), **R Models:** includes 2 ports | | | |
| USB Host Ports | 4 side USB 3.1 Gen1 ports and 1 front USB 2.0 port support Windows compatible devices<br>R Models: 2 rear USB 3.1 Gen1 ports, 2 rear USB 2.0 ports and 1 front 1 USB 2.0 port | | | |
| USB Device Port | 1 port - USBTMC over USB 3.1 Gen1, **R Models:** USBMTMC over USB 2.0 | | | |
| GPIB Port (Optional) | Supports IEEE—488.2 (External) | | | |
| External Monitor Port | 1 HDMI 1.4 and 1 DisplayPort 1.2 Port. Includes support for extended desktop operation with UHD 3840 x 2160 pixel resolution on second monitor. **R Models:** 1 full-size Display Port connectors and 1 VGA. | | | |
| Remote Control | Via Windows Automation, or via Teledyne LeCroy Remote Command Set | | | |
| Network Communication Standard | VXI-11 or VICP, LXI Class C (v1.2) Compliant | | | |
| **Power Requirements** | | | | |
| Voltage | 100—240 VAC ±10% at 50/60 Hz ±5%; 100—120 VAC ±10% at 400 Hz ±5%;<br>Automatic AC Voltage Selection | | | |
| Nominal Power Consumption | 285 W / 285 VA, **M Models:** 415 W / 415 VA, **R Models:** 240 W / 240 VA, **M-R Models:** 340 W / 340 VA | | | |
| Max Power Consumption | 375 W / 375 VA, **M Models:** 500 W / 500 VA, **R Models:** 320 W / 320 VA, **M-R Models:** 420 W / 420 VA<br>with all PC peripherals, active probes connected to 4 channels, and MSO active | | | |
| **Environmental** | | | | |
| Temperature (Operating) | +5 °C to +40 °C | | | |
| Temperature (Non-Operating) | –20 °C to +60 °C | | | |
| Humidity (Operating) | 5% to 90% relative humidity (non-condensing) up to +31 °C<br>Upper limit derates to 50% relative humidity (Non-condensing) at +40 °C | | | |
| Humidity (Non-Operating) | 5% to 95% relative humidity (non-condensing) as tested per MIL-PRF-28800F | | | |
| Altitude (Operating) | Up to 3,000 m at or below +30 °C | | | |
| Altitude (Non-Operating) | Up to 40,000 ft (12,192 m) | | | |
| Random Vibration (Operating) | 0.31 $g_{rms}$ 5 Hz to 500 Hz, 15 minutes in each of three orthogonal axes | | | |
| Random Vibration (Non-Operating) | 2.4 $g_{rms}$ 5 Hz to 500 Hz, 15 minutes in each of three orthogonal axes | | | |
| Functional Shock | 30 $g_{peak}$, half sine, 11 ms pulse, 3 shocks (positive and negative) in each of three orthogonal axes, 18 shocks total | | | |
| **Size and Weight** | | | | |
| Dimensions (HWD) | 14.1" H x 17.5" W x 9.5" D (358 x 445 x 242 mm) | | | |
| Weight | 25.8 lbs. (11.7 kg) | | | |
| **Certifications** | | | | |
| CE Certification<br>UL and cUL Listing | CE Compliant, UL and cUL listed; Conforms to UL 61010-1 (3rd Edition), UL 61010-2-030 (1st Edition)<br>CAN/CSA C22.2 No. 61010-1-12, **R Models:** CE Compliant | | | |
| **Warranty and Service** | | | | |
| | 3-year warranty; calibration recommended annually. Optional service programs include extended warranty, upgrades, and calibration services. | | | |

# ORDERING INFORMATION

## WaveRunner 9000 Oscilloscopes

| Product Description | Product Code |
|---|---|
| 500 MHz, 20 GS/s, 4ch, 16 Mpts/Ch Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode. | WaveRunner 9054 |
| 1 GHz, 20 GS/s, 4ch, 16 Mpts/Ch Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode. | WaveRunner 9104 |
| 2.5 GHz, 20 GS/s, 4ch, 16 Mpts/Ch Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode. | WaveRunner 9254 |
| 4 GHz, 20 GS/s, 4ch, 16 Mpts/Ch Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode. | WaveRunner 9404 |
| 2.5 GHz, 40 GS/s, 4ch, 64 Mpts/Ch Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 128 Mpts/Ch in interleaved mode. | WaveRunner 9254M |
| 4 GHz, 40 GS/s, 4ch, 64 Mpts/Ch Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 128 Mpts/Ch in interleaved mode. | WaveRunner 9404M |
| 500 MHz, 20 GS/s, 4ch, 16 Mpts/Ch Mixed Signal Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode. | WaveRunner 9054-MS |
| 1 GHz, 20 GS/s, 4ch, 16 Mpts/Ch Mixed Signal Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode. | WaveRunner 9104-MS |
| 2.5 GHz, 20 GS/s, 4ch, 16 Mpts/Ch Mixed Signal Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode | WaveRunner 9254-MS |
| 4 GHz, 20 GS/s, 4ch, 16 Mpts/Ch Mixed Signal Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 32 Mpts/Ch in interleaved mode. | WaveRunner 9404-MS |
| 2.5 GHz, 40 GS/s, 4ch, 64 Mpts/Ch Mixed Signal Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 128 Mpts/Ch in interleaved mode. | WaveRunner 9254M-MS |
| 4 GHz, 40 GS/s, 4ch, 64 Mpts/Ch Mixed Signal Oscilloscope with 15.4" WXGA widescreen capacitive touch screen. 128 Mpts/Ch in interleaved mode. | WaveRunner 9404M-MS |

## Included with Standard Configurations (WaveRunner 9000 and WaveRunner 9000-MS)

÷10, 500 MHz Passive Probe (Qty. 4), Protective Cover, Getting Started Guide, Anti-virus Software (Trial Version), Microsoft Windows® 10, Commercial NIST Traceable Calibration with Certificate, Power Cable for the Destination Country, 3-year Warranty

## Included with WaveRunner 9000-MS

16-Channel Digital Leadset, Extra Large Gripper Probe Set (Qty. 22), Ground Extenders (Qty. 20), Flexible Ground Leads (Qty. 5)

## Computer Upgrade

| | |
|---|---|
| 256 GB Removable Solid State Drive Option | WR9K-256GB-RSSD |
| Additional 256 GB Solid State Drive for use with RSSD option. Includes Windows 10, LeCroy Oscilloscope Software and Critical Scope Operational File Duplicates. | WR9K-256GB-RSD-02 |
| Upgrade from 8 GB RAM to 16 GB RAM | WR9K-UPG-16GBRAM |

## WaveRunner 8000-R Oscilloscopes

| Product Description | Product Code |
|---|---|
| 1 GHz, 10 GS/s, 4ch, 16 Mpts/Ch, 2U form factor Oscilloscope. 20 GS/s, 32 Mpts/Ch in interleaved mode. | WaveRunner 8104-R |
| 2.5 GHz, 20 GS/s, 4ch, 64 Mpts/Ch, 2U form factor Oscilloscope. 40 GS/s, 128 Mpts/Ch in interleaved mode. | WaveRunner 8254M-R |
| 4 GHz, 20 GS/s, 4ch, 64 Mpts/Ch, 2U form factor Oscilloscope. 40 GS/s, 128 Mpts/Ch in interleaved mode. | WaveRunner 8404M-R |

## Serial Trigger and Decode

| | |
|---|---|
| MIL-STD-1553 Trigger and Decode Option | WR9K-1553 TD |
| MIL-STD-1553 Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-1553 TDME |
| 8b10b Decode Option - Includes 80 bit 3.125 Gb/s serial trigger | WR9K-80B-8b10b TD |
| ARINC 429 Bus Symbolic Decode, Measure/Graph, and Eye Diagram Option | WR9K-ARINC429BUS DME SYMBOLIC |
| ARINC 429 Bus Symbolic Decode Option | WR9K-ARINC429BUS DSYMBOLIC |
| AudioBus Trigger and Decode Option | WR9K-Audiobus TD |
| AudioBus trigger, decode, and graph Option | WR9K-Audiobus TDG |
| CAN FD Trigger and Decode Option | WR9K-CAN FDBUS TD |
| CAN FD Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-CAN FDBUS TDME |
| CAN FD Symbolic Trigger, Decode, and Measure/Graph, and Eye Diagram Option | WR9K-CAN FDBUS TDME SYMBOLIC |
| CAN Trigger & Decode Option | WR9K-CANBUS TD |
| CAN Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-CANBUS TDME |
| CAN Symbolic Trigger, Decode, and Measure/Graph, and Eye Diagram Option | WR9K-CANBUS TDME SYMBOLIC |
| DigRF 3G Bus Decode Option | WR9K-DigRF3Gbus D |
| DigRF V4 Bus Decode Option | WR9K-DigRFV4bus D |
| MIPI D-PHY CSI-2, DSI Bus Decode Option | WR9K-DPHYbus D |
| MIPI D-PHY CSI-2, DSI Bus Decode and Physical Layer Test Option | WR9K-DPHYbus DP |
| Bundle: includes I2C, SPI, UART-RS232 Trigger and Decode Option | WR9K-EMB TD |
| Bundle: includes I2C, SPI, UART-RS232 Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-EMB TDME |
| ENET Bus Decode Option | WR9K-ENETbus D |
| FibreChannel decode annotation Option | WR9K-FCbus D |
| FlexRay Trigger and Decode Option | WR9K-FLEXRAYBUS TD |
| FlexRay Trigger, Decode, Measure/Graph and Physical Layer Option | WR9K-FLEXRAYBUS TDMP |
| I2C Trigger and Decode Option | WR9K-I2CBUS TD |
| I2C Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-I2CBUS TDME |
| LIN Trigger and Decode Option | WR9K-LINBUS TD |
| LIN Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-LINBUS TDME |
| Manchester Bus Decode Option | WR9K-MANCHESTERbus D |
| MDIO Decode Option | WR9K-MDIOBUS D |
| MIPI M-PHY Bus Decode Option | WR9K-MPHYbus D |
| MIPI M-PHY Bus Decode and Physical Layer Test Option | WR9K-MPHYbus DP |
| NRZ Bus Decode Option | WR9K-NRZbus D |
| PCIe Gen 1 Decode Option | WR9K-PCIebus D |
| Serial Debug Toolkit - Measure Analyze Graph Option | WR9K-PROTOBUS MAG |

# ORDERING INFORMATION

| Product Description | Product Code |
|---|---|
| **Serial Trigger and Decode (cont'd)** | |
| Decode Annotation and Protocol Analyzer Synchronization Option | WR9K-ProtoSync |
| Decode Annotation and Protocol Analyzer+Bit Tracer Synchronization Option | WR9K-ProtoSync-BT |
| SAS Decode annotation Option | WR9K-SASbus D |
| SATA Decode Option | WR9K-SATAbus D |
| SENT Bus Decode Option | WR9K-SENTbus D |
| SpaceWire Decode Option | WR9K-SPACEWIREbus D |
| SPI Trigger and Decode Option | WR9K-SPIBUS TD |
| SPI Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-SPIBUS TDME |
| SPMI Decode Option | WR9K-SPMIbus D |
| UART-RS232 Trigger and Decode Option | WR9K-UART-RS232BUS TD |
| UART-RS232 Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-UART-RS232BUS TDME |
| MIPI UniPro Protocol Decoder Software Option | WR9K-UNIPRObus D |
| MPHY to UniPro Decoder Software Upgrade MPHY REQUIRED | WR9K-UPG-MPHY-UNIPRObus D |
| USB 2.0 Trigger and Decode Option | WR9K-USB2BUS TD |
| USB 2.0 Trigger, Decode, Measure/Graph, and Eye Diagram Option | WR9K-USB2BUS TDME |
| USB 2.0 HSIC Decode Option | WR9K-USB2-HSICbus D |
| **Serial Data Compliance** | |
| QualiPHY Enabled BroadR-Reach Software Option | QPHY-BroadR-Reach |
| QualiPHY Enabled DDR2 Software Option | QPHY-DDR2 |
| QualiPHY Enabled DDR3 Software Option | QPHY-DDR3 |
| QualiPHY Enabled 1000-BaseT1 Compliance Software Option | QPHY-1000BASE-T1 |
| QualiPHY Enabled Ethernet 10/100/1000BT Software Option | QPHY-ENET* |
| QualiPHY Enabled LPDDR2 Software Option | QPHY-LPDDR2 |
| QualiPHY Enabled MIPI D-PHY Software Option | QPHY-MIPI-DPHY |
| QualiPHY Enabled MOST150 Software Option | QPHY-MOST150 |
| QualiPHY Enabled MOST50 Software Option | QPHY-MOST50 |
| QualiPHY Enabled USB 2.0 Software Option | QPHY-USB‡ |
| 10/100/1000Base-T Ethernet Test Fixture | TF-ENET-B** |
| USB 2.0 Compliance Test Fixture | TF-USB-B |

* TF-ENET-B required ‡ TF-USB-B required
** Includes ENET-2CAB-SMA018 and ENET-2ADA-BNCSMA

| Product Description | Product Code |
|---|---|
| **DDR Debug Toolkits** | |
| DDR2 and LPDDR2 Debug Toolkit | WR9K-DDR2-TOOLKIT |
| DDR3, DDR3L, LPDDR3, DDR2, and LPDDR2 Debug Toolkit | WR9K-DDR3-TOOLKIT |
| DDR3, DDR3L, LPDDR3, DDR2, and LPDDR2 Debug Toolkit Upgrade | WR9K-UPG-DDR3-TOOLKIT |
| **Serial Data Analysis** | |
| Single-Lane Serial Data Analysis, Eye, Jitter and Noise Measurements for WaveRunner 9000 | WR9K-SDAIII |
| Eye Doctor II - Channel & Fixture De-embedding/Emulation, Tx/Rx Equalization | WR9K-EYEDRII |
| Serial Data Mask Software Package | WR9K-SDM |
| Cable De-Embedding Option | WR9K-CBL-DE-EMBED |

| Product Description | Product Code |
|---|---|
| **Data Storage Software** | |
| Advanced Optical Recording Measurement Package | WR9K-AORM |
| Disk Drive Analyzer Software Package | WR9K-DDA |
| Disk Drive Measurements Software Package | WR9K-DDM2 |
| **Power Analysis Software** | |
| Power Analyzer Software Option | WR9K-PWR |
| **Jitter Analysis Software** | |
| Clock, Clock-Data Jitter Analysis and Views of Time, Statistical, Spectral, and Jitter Overlay | WR9K-JITKIT |
| **Digital Filtering Software** | |
| Digital Filter Software Option | WR9K-DFP2 |
| **Other Software Options** | |
| EMC Pulse Parameter Software | WR9K-EMC |
| Electrical Telecom Pulse Mask Test | WR9K-ET-PMT |
| Spectrum Analyzer and Advanced FFT | WR9K-SPECTRUM |
| VectorLinQ Vector Signal Analysis | WR9K-VECTORLINQ |
| Advanced Customization | WR9K-XDEV |
| **Remote Control/Network Options** | |
| External USB2 to GPIB Adaptor | USB2-GPIB |
| **General Accessories** | |
| WaveRunner 9000 Rackmount Kit | WR9K-RACK |
| WaveRunner 9000 Carrying Case | WR9K-CARRYCASE |

# ORDERING INFORMATION

| Product Description | Product Code |
|---|---|
| **Probes** | |
| Power/Voltage Rail Probe with 4 GHz bandwidth, 1.2x attenuation, ±30 V offset, ±800 mV | RP4030 |
| High Voltage Fiber Optic Probe, 60 MHz bandwidth | HVFO103 |
| 500 MHz Passive Probe, 2.5mm, 10:1, 10 MΩ | PP022 |
| 500 MHz Passive Probe, 5mm, 10:1, 10 MΩ | PP024 |
| 1 GHz, 0.9 pF, 1 MΩ High Impedance Active Probe | ZS1000 |
| Set of 4 ZS1000 Active Probes | ZS1000-QUADPAK |
| 1.5 GHz, 0.9 pF, 1 MΩ High Impedance Active Probe | ZS1500 |
| Set of 4 ZS1500 Active Probes | ZS1500-QUADPAK |
| 2.5 GHz, 0.9 pF, 1 MΩ High Impedance Active Probe | ZS2500 |
| Set of 4 ZS2500 Active Probes | ZS2500-QUADPAK |
| 4 GHz, 0.6 pF, 1 MΩ High Impedance Active Probe | ZS4000 |
| 200 MHz, 3.5 pF, 1 MΩ Active Differential Probe, ±20 V | ZD200 |
| 500 MHz, 1.0 pF Active Differential Probe, ±8 V | ZD500 |
| 1 GHz, 1.0 pF Active Differential Probe, ±8 V | ZD1000 |
| 1.5 GHz, 1.0 pF Active Differential Probe, ±8 V | ZD1500 |
| 500 MHz, Active Differential Probe (÷1, ÷10, ÷100) | AP033 |
| 4 GHz ProBus2 Differential Probe with Adjustable Tip | D400A-AT-PB2 |
| 4 GHz, 2.5 Vp-p ProBus2 Differential Probe | D410-A-PB2 |
| 4 GHz, 5 Vp-p ProBus2 Differential Probe | D420-A-PB2 |
| WaveLink ProBus2 Platform/Cable Assembly | WL-PBUS2 |
| 30 A; 50 MHz Current Probe – AC/DC; 30 Arms; 50 A Peak Pulse | CP030 |
| 30 A, 10 MHz Current Probe - AC/DC, 30 Arms, 50 A Peak Pulse, 3-meter Cable | CP030-3M |
| 30A, 50 MHz High Sensitivity Current Probe - AC/DC, 30 Arms, 50 A Peak Pulse, 1.5-meter Cable | CP030A |
| 30 A; 100 MHz Current Probe – AC/DC; 30 Arms; 50 A Peak Pulse | CP031 |
| 30A, 100 MHz High Sensitivity Current Probe - AC/DC, 30 Arms, 50 A Peak Pulse, 1.5-meter Cable | CP031A |
| 150 A; 10 MHz Current Probe – AC/DC; 150 Arms; 500 A Peak Pulse | CP150 |
| 150 A, 5 MHz Current Probe - AC/DC, 150 Arms, 500 A Peak Pulse, 6-meter Cable | CP150-6M |
| 500 A; 2 MHz Current Probe – AC/DC; 500 Arms; 700 A Peak Pulse | CP500 |
| Deskew Calibration Source | DCS025 |
| Programmable Current Sensor to ProBus Adapter (for third-party current sensors) | CA10 |
| 100:1 400 MHz 50 MΩ 1 kV High-Voltage Probe | HVP120 |
| 100:1 400 MHz 50 MΩ 4 kV High-Voltage Probe | PPE4KV |
| 1000:1 400 MHz 50 MΩ 5 kV High-Voltage Probe | PPE5KV |
| 1000:1 400 MHz 5 MΩ / 50 MΩ 6 kV High-Voltage Probe | PPE6KV |

| Product Description | Product Code |
|---|---|
| **Probes (cont'd)** | |
| TekProbe to ProBus Probe Adapter | TPA10 |
| Optical-to-Electrical Converter, 500-870 nm ProBus BNC Connector | OE425 |
| Optical-to-Electrical Converter, 950-1630 nm ProBus BNC Connector | OE455 |
| 1 kV, 25 MHz High Voltage Differential Probe | HVD3102A |
| 1 kV, 25 MHz High Voltage Differential Probe (without tip accessories) | HVD3102A-NOACC |
| 1 kV, 120 MHz High Voltage Differential Probe | HVD3106A |
| 1 kV, 120 MHz High Voltage Differential Probe (without tip accessories) | HVD3106A-NOACC |
| 1 kV, 80 MHz High Voltage Differential Probe with 6-meter Cable and Auto Zero Disconnect | HVD3106A-6M |
| 2 kV, 120 MHz High Voltage Differential Probe | HVD3206A |
| 2 kV, 80 MHz High Voltage Differential Probe with 6-meter Cable | HVD3206A-6M |
| 6 kV, 100 MHz High Voltage Differential Probe | HVD3605A |

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