Tektronix

dataTec

Mess- und Prüftechnik. Die Experten.

3 Series MDO

Mixed Domain Oscilloscopes

Key performance specifications

- 2 and 4 analog channel models
- 100 MHz, 200 MHz, 350 MHz, 500 MHz, 1 GHz bandwidth models
- Bandwidth is upgradable (up to 1 GHz)
- Up to 5 GS/s sample rate
- 10 M record length on all channels
- >280,000 wfm/s maximum waveform capture rate
- Standard passive voltage probes with 3.9 pF capacitive loading and 250 MHz, 500 MHz or 1 GHz analog bandwidth
- Spectrum Analyzer
  - Frequency range: 9 kHz - 1 GHz (standard) or 3 GHz (optional)
  - Ultra-wide capture bandwidth up to 3 GHz
- Arbitrary Function Generator (optional)
  - 13 predefined waveform types
  - 50 MHz waveform generation
  - 128 k arbitrary generator record length
  - 250 MS/s arbitrary generator sample rate
- Digital Channels (optional)
  - 16 digital channels
  - 10 M record length on all channels
  - 121.2 ps timing resolution
- Serial Bus Decode, Triggering and Search (optional)
  - Serial bus support for I^2C, SPI, RS-232/422/485/UART, USB 2.0, CAN, CAN FD, LIN, FlexRay, MIL-STD-1553, ARINC429, and Audio standards
- Digital Voltmeter / Frequency Counter (Free with product registration)
  - 4-digit DC, AC RMS, and DC+AC RMS voltage measurements
  - 5-digit frequency measurements

Typical applications

- **Embedded design and IoT**

  Discover and solve issues quickly by performing system level debug on mixed signal embedded systems including today's most common serial bus technologies with the 3 Series MDO and support for a broad set of common serial buses.
- **Power design**

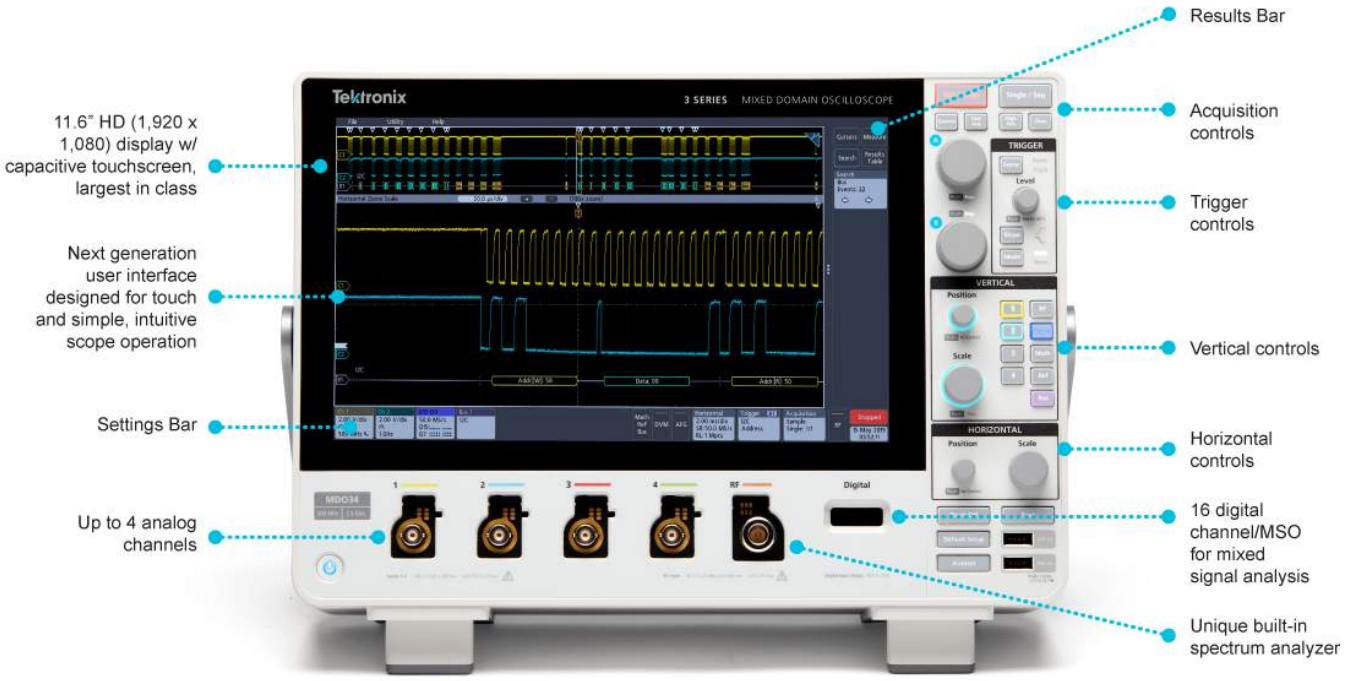
  Make reliable and repeatable voltage, current, and power measurements using automated power quality, switching loss, harmonics, ripple, modulation, and safe operating area measurements with the widest selection of power probes in an affordable solution.
- **Education**

  Managing multiple instruments on a bench can be troublesome. The 3 Series MDO combines analog, digital, and RF measurements with a signal source in a single, small (5.9 in., 149 mm deep) instrument. The combination of a small instrument and high level of integration aids in the teaching of various electronics principles as well as in its usage for more sophisticated lab experiments. Full upgradeability enables adding functionality over time as needs change or budgets allow.
- **Manufacturing Test and Troubleshooting**

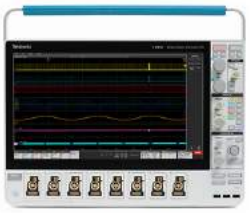
  Size and space constraints can play havoc on a manufacturing floor. The 3 Series MDO minimizes rack or bench space by integrating multiple instruments into one small package. Integration reduces cost associated with utilizing multiple different instrument types in manufacturing test or troubleshooting stations.
- **Service Installation and Maintenance**

  Having the right instruments when and where you need them is critical. The 3 Series MDO combines analog waveforms, digital logic, and spectrum analysis in a lightweight (11.7 lbs, 5.3 kg), portable package - making it the perfect choice where space is limited and flexibility is desired.

3 Series MDO front panel overview



The next generation of oscilloscopes

				
	3 Series MDO	**4 Series MSO**	**5 Series MSO**	**6 Series MSO**
Bandwidth	up to 1 GHz	up to 1.5 GHz	up to 2 GHz	up to 8 GHz
Vertical Resolution	8 bits	12 bits	12 bits	12 bits
Display	11.6" HD	13.3" HD	15.6" HD	15.6" HD
Inputs	TekVPI	FlexChannel / TekVPI	FlexChannel / TekVPI	FlexChannel / TekVPI
Advanced Analysis	-	-	Compliance / Jitter / Windows OS	Compliance / Jitter / Windows OS

Exceptionally easy-to-use user interface lets you focus on the task at hand

The Settings Bar - key parameters and waveform management

Waveform and scope operating parameters are displayed in a series of badges in the Settings Bar that runs along the bottom of the display. The Settings Bar provides immediate access for the most common waveform management tasks. With a single tap, you can:

- Turn on channels
- Add math waveforms
- Add reference waveforms
- Add bus waveforms
- Enable 16 digital channels MSO
- Enable the Spectrum Analyzer
- Enable the integrated Arbitrary/Function generator (AFG)
- Enable the integrated digital voltmeter (DVM)

The Results Bar - analysis and measurements

The Results Bar on the right side of the display includes immediate, one-tap access to the most common analytical tools such as cursors, measurements, searches and bus decode results tables.

Cursors, measurements and search results badges are displayed in the Results Bar without sacrificing any waveform viewing area. For additional waveform viewing area, the Results Bar can be dismissed and brought back at any time.

Figure 1: Configuration menus are accessed by simply double-tapping on the item of interest on the display. In this case, the Channel badge was double-tapped to open the channel configuration menu. Menus are dismissed by simply tapping outside of them.

Touch interaction finally done right

Scopes have included touch screens for years, but the touch screen has been an afterthought. The 3 Series MDO 11.6" display includes a capacitive touchscreen and provides a user interface truly designed for touch.

The touch interactions that you use with phones and tablets, and expect in a touch enabled device, are supported in the 3 Series MDO.

- Drag waveforms left/right or up/down to adjust horizontal and vertical position or to pan a zoomed view
- Pinch and expand to change scale or zoom in/out in either horizontal or vertical directions
- Swipe in from the right to reveal the Results Bar or down from the top to access the menus in the upper left corner of the display

Smooth, responsive front panel controls allow you to make adjustments with familiar knobs and buttons, and you can add a mouse or keyboard as a third interaction method.

Figure 2: Interact with the capacitive touch display in the same way you do on your phones and tablets.

Powerful Waveform Capture and Analysis

At the core of the 3 Series MDO is a world-class oscilloscope, offering comprehensive tools that speed each stage of debug – from quickly discovering anomalies and capturing them, to searching your waveform record for events of interest and analyzing their characteristics and your device's behavior.

Digital phosphor technology with FastAcq™ high-speed waveform capture

To debug a design problem, first you must know it exists. Every design engineer spends time looking for problems in their design, a time-consuming and frustrating task without the right debug tools.

Digital phosphor technology provides you with fast insight into the real operation of your device. Its fast waveform capture rate – greater than 280,000 wfms/s with FastAcq – gives you a high probability of quickly seeing the infrequent problems common in digital systems: runt pulses, glitches, timing issues, and more.

To further enhance the visibility of rarely occurring events, intensity grading is used to indicate how often rare transients are occurring relative to normal signal characteristics. There are four waveform palettes available in FastAcq acquisition mode.

- The *Temperature palette* uses color-grading to indicate frequency of occurrence with hot colors like red/yellow indicating frequently occurring events and colder colors like blue/green indicating rarely occurring events.
- The *Spectral palette* uses color-grading to indicate frequency of occurrence with colder colors like blue indicating frequently occurring events and hot colors like red indicating rarely occurring events.
- The *Normal palette* uses the default channel color (like yellow for channel one) along with gray-scale to indicate frequency of occurrence where frequently occurring events are bright.
- The *Inverted palette* uses the default channel color along with gray-scale to indicate frequency of occurrence where rarely occurring events are bright.

These color palettes quickly highlight the events that over time occur more often or, in the case of infrequent anomalies, occur less often.

Infinite or variable persistence choices determine how long waveforms stay on the display, helping you to determine how often an anomaly is occurring.

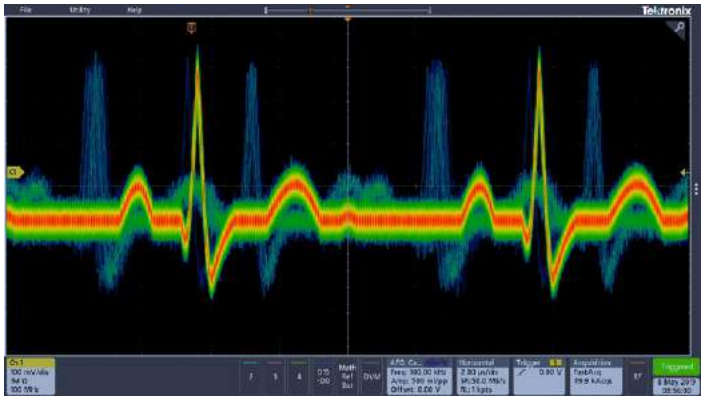


Figure 3: Digital phosphor technology with FastAcq enables greater than 280,000 wfms/s waveform capture rate and real-time color-intensity grading.

Triggering

Discovering a device fault is only the first step. Next, you must capture the event of interest to identify root cause. To enable this, the 3 Series MDO contains over 125 trigger combinations providing a complete set of triggers - including runt, logic, pulse width/glitch, setup and hold violation, serial packet, and parallel data - to help quickly locate your event of interest. And with up to a 10 M record length, you can capture many events of interest, even thousands of serial packets, in a single acquisition for further analysis while maintaining high resolution to zoom in on fine signal details.

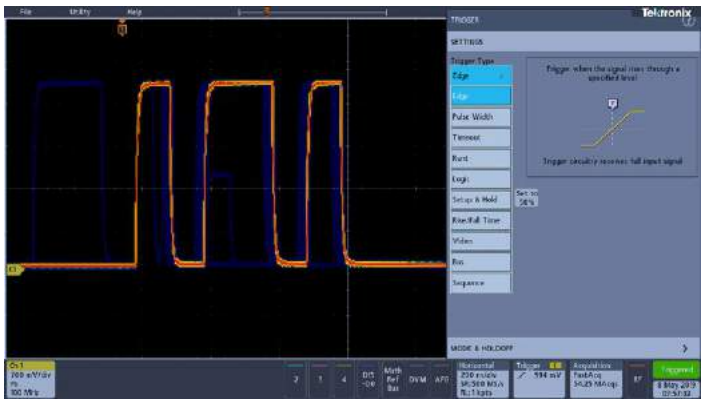


Figure 4: Over 125 trigger combinations make capturing your event of interest easy.

Basic waveform analysis and automated measurements

Verifying that your prototype's performance matches simulations and meets the project's design goals requires careful analysis, ranging from simple checks of rise times and pulse widths to sophisticated power loss analysis, characterization of system clocks, and investigation of noise sources.

The 3 Series MDO offers a comprehensive set of standard analysis tools including:

- Waveform- and screen-based cursors
- Up to 8 automated measurements
- Basic waveform math
- Basic FFT analysis
- Advanced waveform math with equation editor

Measurement results tables provide comprehensive statistical views of measurement results.

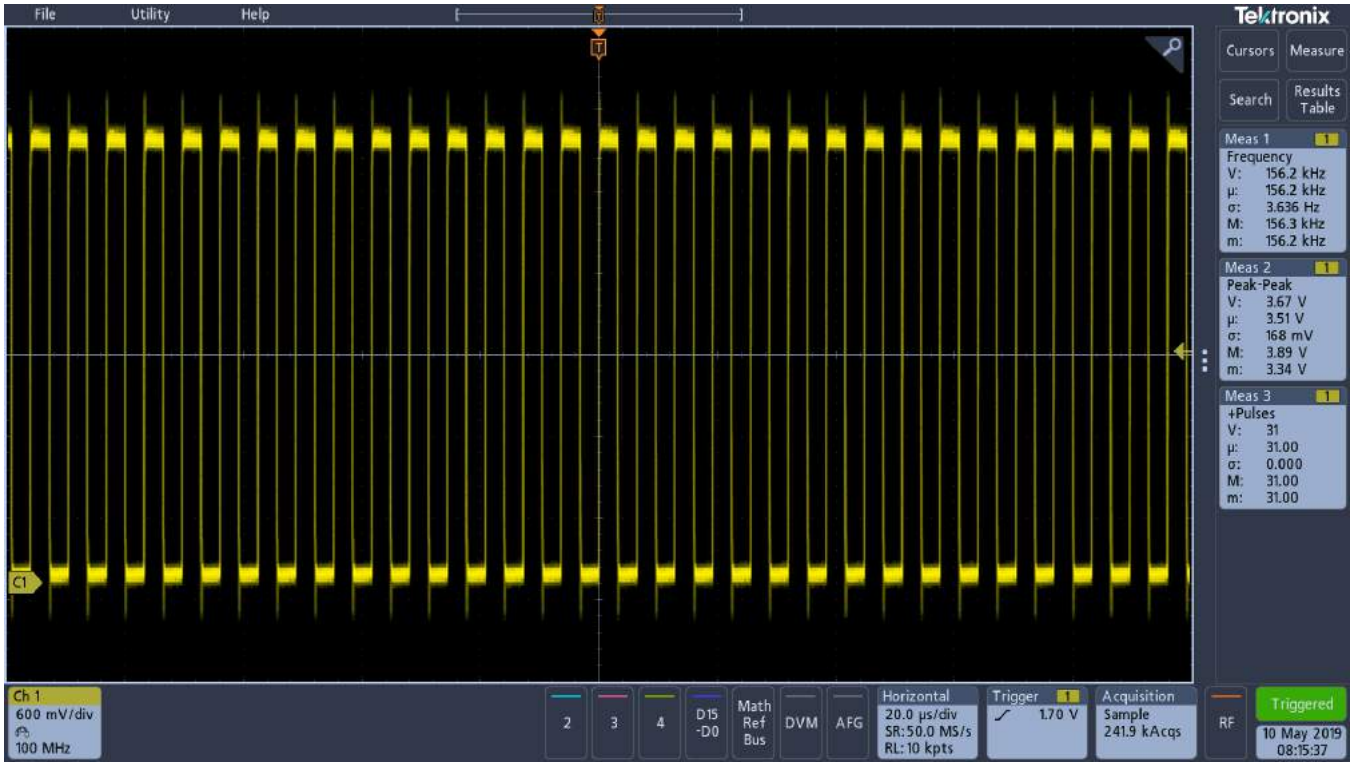


Figure 5: Automated measurements on Frequency, Peak-Peak and Positive Pulse Count with statistics shown.

Easy navigation and search

Finding your event of interest in a long waveform record can be time consuming without the right search tools. With today's record lengths of many millions of data points, locating your event can mean scrolling through literally thousands of screens of signal activity.

The 3 Series MDO offers the industry's most comprehensive search and waveform navigation with its innovative on-screen controls. These controls speed panning and zooming through your record. Use intuitive pinch/expand gestures on the display or the multipurpose knobs to investigate areas of interest in a long record.

The Search feature allows you to automatically search through your long acquisition looking for user-defined events. All occurrences of the event are highlighted with search marks and are easily navigated to, using the Previous (←) and Next (→) buttons found on the Search badge on the display. Search types include edge, pulse width, timeout, runt, logic, setup and hold, rise/fall time and parallel/serial bus packet content.

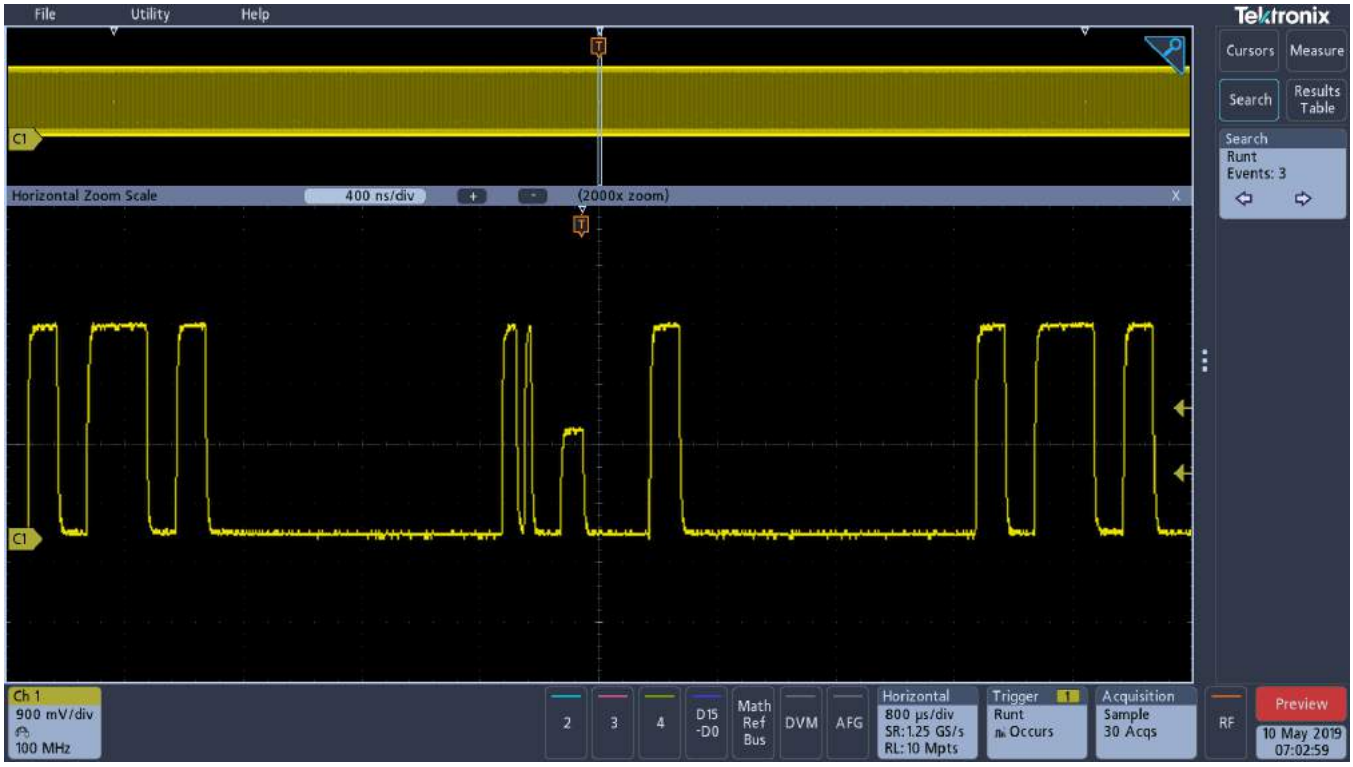


Figure 6: FastAcq helps with revealing the presence of runt pulses in the digital data stream for further investigation. In this test case, Search revealed and marked 3 runt pulses in the 10 Mpoints acquisition.

Comprehensive power analysis (optional)

Ever increasing consumer demands for longer battery-life devices and for green solutions that consume less power require power-supply designers to characterize and minimize switching losses to improve efficiency. In addition, the supply's power levels, output purity, and harmonic feedback into the power line must be characterized to comply with national and regional power quality standards. Historically, making these and many other power measurements on an oscilloscope has been a long, manual, and tedious process. The 3 Series MDO optional power analysis tools greatly simplify these tasks, enabling quick, repeatable and accurate analysis of power quality, switching loss, harmonics, safe operating area (SOA), modulation, ripple, and slew rate (di/dt, dv/dt). Completely integrated into the oscilloscope, the power analysis tools provide automated, repeatable power measurements with a touch of a button. The optional power analysis functionality is offered free for a 30-day trial period. This free trial period starts automatically when the instrument is powered on for the first time.

Figure 7: Power Quality measurement table. Automated power measurements enable quick and accurate analysis of common power parameters.

Unique built-in Spectrum Analyzer

The Tektronix MDO series is the only oscilloscope to offer an integrated, hardware-based spectrum analyzer. The spectrum analyzer frequency range of the 3 Series MDO can be from 9 kHz to 1 GHz or 3 GHz (option 3-SA3), enabling spectral analysis on IoT and most consumer wireless standards. 1 GHz comes standard on all models, 3 GHz is optional.

Fast and accurate spectral analysis

When using the spectrum analyzer standard N-connector input, the 3 Series MDO display becomes a full-screen Spectrum Analyzer view.

Key spectral parameters such as Center Frequency, Span, Reference Level, and Resolution Bandwidth are all adjusted quickly and easily using on-screen touch controls.

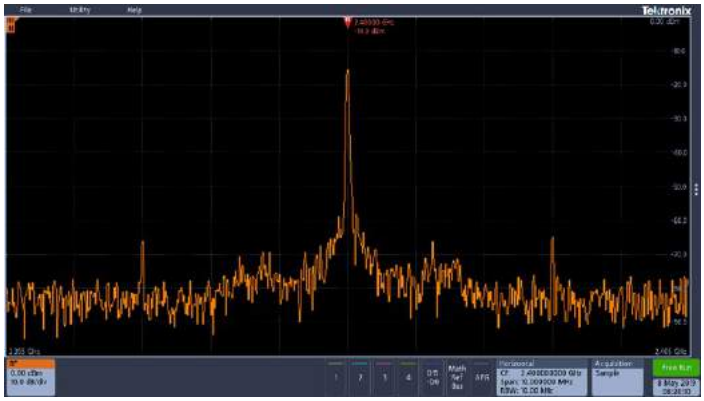


Figure 8: 3 Series MDO frequency domain display.

Intelligent efficient markers

In a traditional spectrum analyzer, it can be a very tedious task to turn on and place enough markers to identify all your peaks of interest. The 3 Series MDO makes this process far more efficient by automatically placing markers on peaks that indicate both the frequency and the amplitude of each peak. You can adjust the criteria that the oscilloscope uses to automatically find the peaks.

The highest amplitude peak is referred to as the reference marker and is shown in red. Marker readouts can be switched between Absolute and Delta readouts. When Delta is selected, marker readouts show each peak's delta frequency and delta amplitude from the reference marker.

Two manual cursors are also available for measuring non-peak portions of the spectrum. When enabled, the reference marker is attached to one of the cursors, enabling delta measurements from anywhere in the spectrum. In addition to frequency and amplitude, cursor readouts also include noise density and phase noise readouts depending on whether Absolute or Delta readouts are selected. A "Reference Marker to Center" function instantly moves the frequency indicated by the reference marker to center frequency.

Figure 9: Automated peak markers identify critical information at a glance. As shown here, the five highest amplitude peaks that meet the threshold and excursion criteria are automatically marked along with each peak's frequency and amplitude.

Spectrogram

The 3 Series MDO includes a spectrogram display which is ideal for monitoring slowly changing RF phenomena. The x-axis represents frequency, just like a typical spectrum display. However, the y-axis represents time, and color is used to indicate amplitude.

Spectrogram slices are generated by taking each spectrum and "flipping it up on its edge" so that it's one pixel row tall, and then assigning colors to each pixel based on the amplitude at that frequency. Cold colors (blue, green) are low amplitude and hotter colors (yellow, red) are higher amplitude. Each new acquisition adds another slice at the bottom of the spectrogram and the history moves up one row. When acquisitions are stopped, you can scroll back through the spectrogram to look at any individual spectrum slice.

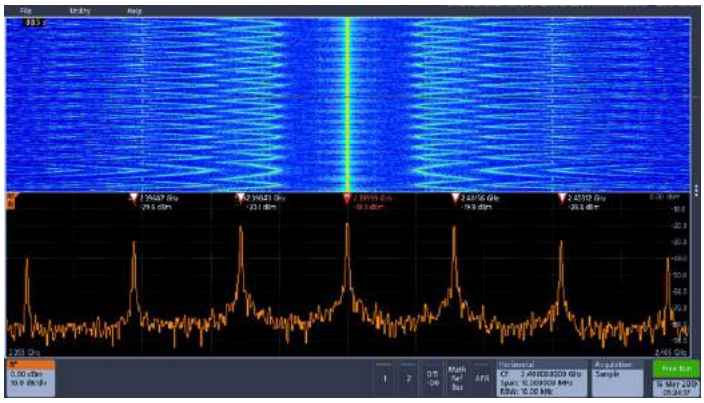


Figure 10: Spectrogram display illustrates slowly moving RF phenomena. As shown here, a signal that has multiple peaks is being monitored. As the peaks change in both frequency and amplitude over time, the changes are easily seen in the Spectrogram display.

Ultra-wide capture bandwidth

Today's wireless communications vary significantly with time, using sophisticated digital modulation schemes and, often, transmission techniques that involve bursting the output. These modulation schemes can have very wide bandwidth as well. Traditional swept or stepped spectrum analyzers are ill equipped to view these types of signals as

they are only able to look at a small portion of the spectrum at any one time.

The amount of spectrum acquired in one acquisition is called the capture bandwidth. Traditional spectrum analyzers sweep or step the capture bandwidth through the desired span to build the requested image. As a result, while the spectrum analyzer is acquiring one portion of the spectrum, the event you care about may be happening in another portion of the spectrum. Most spectrum analyzers on the market today have 10 MHz capture bandwidths, sometimes with expensive options to extend that to 20, 40, or even 160 MHz in some cases.

In order to address the bandwidth requirements of modern RF, the 3 Series MDO provides up to 3 GHz of capture bandwidth. The spectrum is generated from a single acquisition, thus guaranteeing you'll see the events you're looking for in the frequency domain.

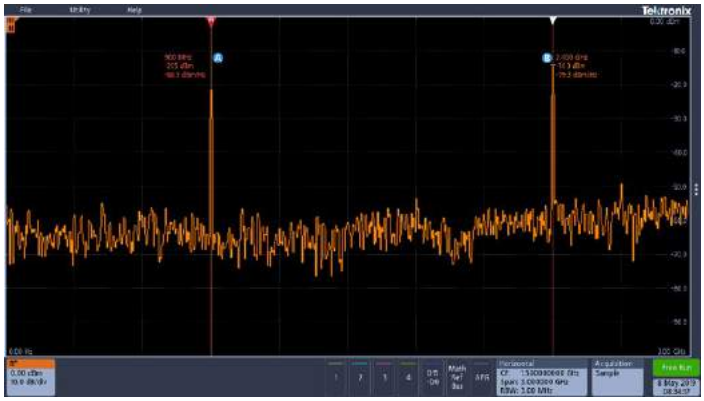


Figure 11: Spectral display of a bursted communication both into a device through Zigbee at 900 MHz and out of the device through Bluetooth at 2.4 GHz, captured with a single acquisition.

Spectrum traces

The 3 Series MDO spectrum analyzer offers four different traces or views including Normal, Average, Max Hold, and Min Hold.

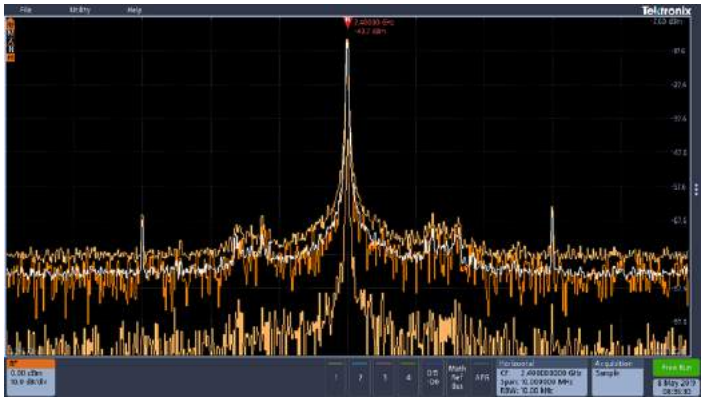


Figure 12: Normal, Average, Max Hold, and Min Hold spectrum traces

RF measurements

The 3 Series MDO includes three automated RF measurements - Channel Power, Adjacent Channel Power Ratio, and Occupied Bandwidth. When one of these RF measurements is activated, the oscilloscope automatically turns on the Average spectrum trace and sets the detection method to Average for optimal measurement results.

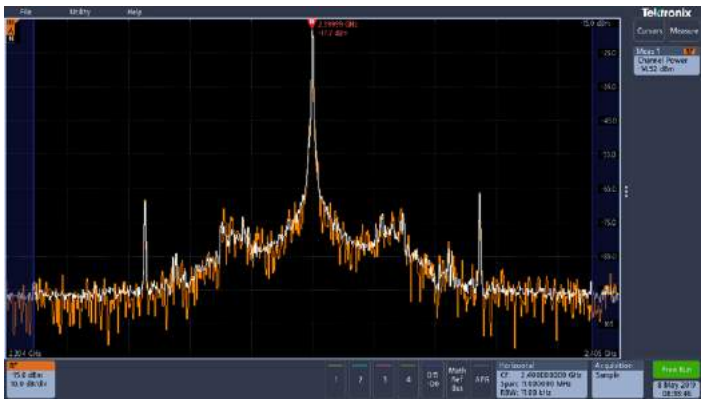


Figure 13: Automated Channel Power measurement

RF probing

Signal input methods on spectrum analyzers are typically limited to cabled connections or antennas. In addition to using the standard N-connector, the 3 Series MDO Spectrum Analyzer can use 50 Ω TekVPI probes with the optional TPA-N-VPI adapter. This enables additional flexibility when hunting for noise sources and enables easier spectral analysis by using true signal browsing on a spectrum analyzer input.

In addition, an optional preamplifier accessory assists in the investigation of lower-amplitude signals. The TPA-N-PRE preamplifier provides 10 dB nominal gain across the 9 kHz – 3 GHz frequency range.

Arbitrary Function Generator (optional)

The 3 Series MDO contains an optional integrated arbitrary function generator (option 3-AFG), perfect for simulating sensor signals within a design or adding noise to signals to perform margin testing.

The integrated function generator provides output of predefined waveforms up to 50 MHz for sine, square, pulse, ramp/triangle, DC, noise, sin(x)/x (Sinc), Gaussian, Lorentz, exponential rise/fall, Haversine and cardiac.

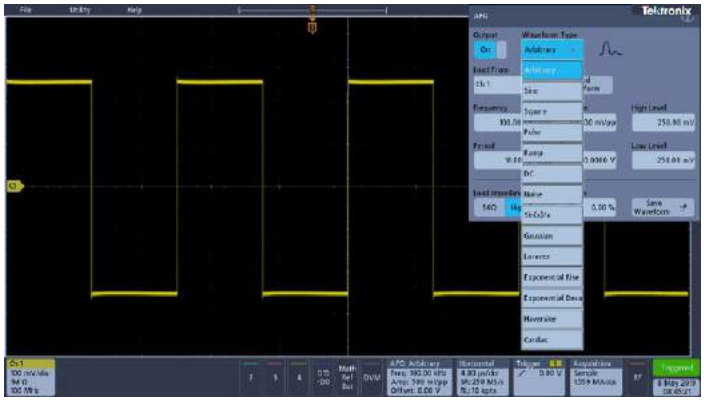


Figure 14: Waveform type selection in the integrated AFG.

The arbitrary waveform generator provides 128 k points of record for storing waveforms from the analog input, a saved internal file location, a USB mass storage device, or from an external PC. Transfer waveform files to your 3 Series MDO edit memory via USB or LAN or using a USB mass storage device to be output from the AFG in the oscilloscope.

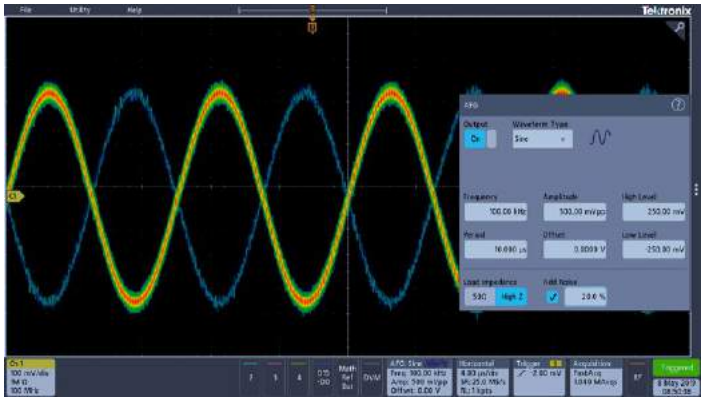


Figure 15: Flexible settings of AFG outputs. In this test case, 20% of noise was added to the Sine waveform.

Digital Channels (optional)

The logic analyzer (option 3-MSO) provides 16 digital channels which are tightly integrated into the oscilloscope's user interface. This simplifies operation and makes it possible to solve mixed-signal issues easily.

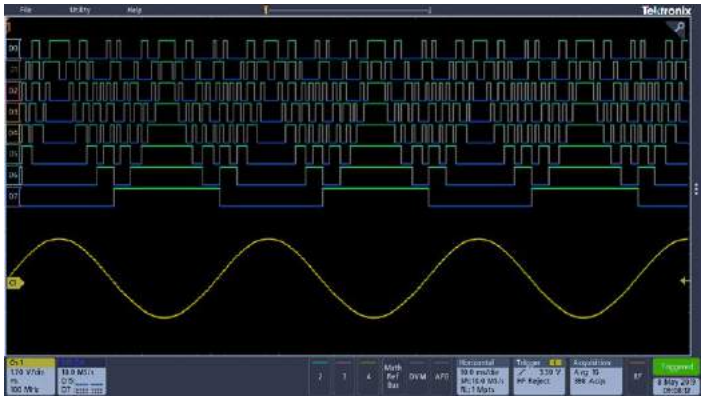


Figure 16: The 3 Series MDO with 3-MSO option is used to simultaneously view analog and digital signals by probing both sides of a D/A converter.

Color-coded digital waveform display

Color-coded digital traces display ones in green and zeros in blue. This coloring is also used in the digital channel monitor. The monitor shows if signals are high, low, or are transitioning so you can see channel activity at a glance without having to clutter your display with unneeded digital waveforms.

The multiple transition detection hardware shows you a white edge on the display when the system detects multiple transitions. White edges indicate that more information is available by zooming in or acquiring at faster sampling rates. In most cases zooming in will reveal the pulse that was not viewable with the previous settings. If the white edge is still present after zooming in as far as possible, this indicates that increasing the sample rate on the next acquisition will reveal higher frequency information than the previous settings could acquire.

You can group digital waveforms and enter waveform labels easily on the touchscreen. By simply placing digital waveforms next to each other, they form a group.

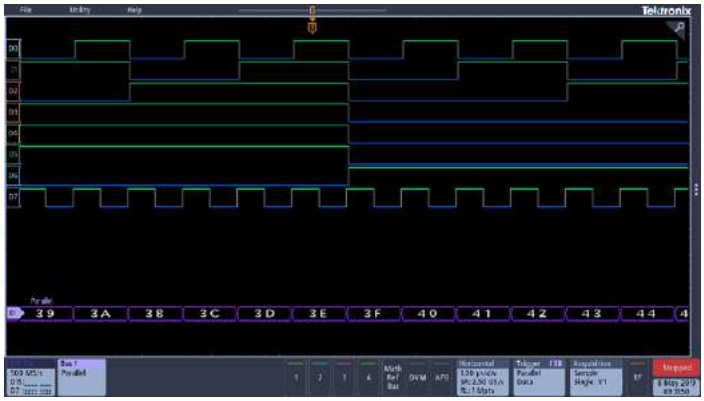


Figure 17: With color-coded digital waveform display, groups are created by simply placing digital channels together on the screen, allowing digital channels to be moved as a group.

Once a group is formed, you can position all the channels contained in that group collectively. This greatly reduces the normal setup time associated with positioning channels individually

MagniVu™ high-speed acquisition

The main digital acquisition mode on the 3 Series MDO will capture up to 10 M at 500 MS/s (2 ns resolution). In addition to the main record, the 3 Series MDO provides an ultra high-resolution record called MagniVu which acquires 10,000 points at up to 8.25 GS/s (121.2 ps resolution). Both main and MagniVu waveforms are acquired on every trigger and can be switched between in the display at any time, running or stopped. MagniVu provides significantly finer timing resolution than comparable oscilloscopes on the market, instilling confidence when making critical timing measurements on digital waveforms.

P6316 MSO probe

This unique probe design offers two eight-channel pods, simplifying the process of connecting to the device-under-test. When connecting to square pins, the P6316 can connect directly to 8×2 square pin headers spaced on tenth-inch centers. When more attachment flexibility is required, you can use the included flying lead sets and grabbers to clip onto surface mount devices or test points. The P6316 offers outstanding electrical characteristics applying only 8 pF of capacitive loading with 101 kΩ input impedance.

Figure 18: The P6316 MSO probe offers two eight-channel pods to simplify connecting to your device.

Serial Protocol Triggering and Analysis (optional)

On a serial bus, a single signal often includes address, control, data, and clock information. This can make isolating events of interest difficult. Automatic trigger, decode, and search on bus events and conditions gives you a robust set of tools for debugging serial buses. The optional serial protocol triggering and analysis functionality is offered free for a 30-day trial period. This free trial period starts automatically when the instrument is powered on for the first time.

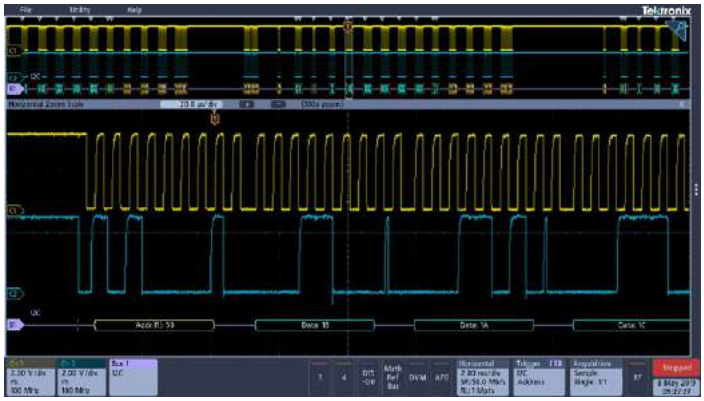


Figure 19: Triggering on a specific address and data packet going across an I^2C bus. The yellow waveform is clock and the blue waveform is the data. A bus waveform provides decoded packet content including Start, Address, Read/Write, Data, and Stop.

Serial triggering

Trigger on packet content such as start of packet, specific addresses, specific data content, unique identifiers, etc. on popular serial interfaces such as I^2C, SPI, RS-232/422/485/UART, USB2.0, CAN, CAN FD, LIN, FlexRay, MIL-STD-1553, ARINC429, and I^2S/LJ/RJ/TDM.

Bus display

Provides a higher-level, combined view of the individual signals (clock, data, chip enable, etc.) that make up your bus, making it easy to identify where packets begin and end and identifying sub-packet components such as address, data, identifier, CRC, etc.

Bus decoding

Tired of having to visually inspect the waveform to count clocks, determine if each bit is a 1 or a 0, combine bits into bytes, and determine the hex value? Let the oscilloscope do it for you! Once you've set up a bus, the 3 Series MDO will decode each packet on the bus, and display the value in hex, binary, decimal (USB, CAN, CAN FD, LIN, FlexRay, MIL-STD-1553, and ARINC429 only), signed decimal (I^2S/LJ/RJ/TDM only), or ASCII (USB, MIL-STD-1553 and RS-232/422/485/UART only) in the bus waveform.

Table 1: Serial bus technologies supported by the 3 Series MDO

Technology		Trigger, Decode, Search	Order product
Embedded	I^2C	Yes	3-SREMBD
	SPI	Yes	3-SREMBD
Computer	RS232/422/485, UART	Yes	3-SRCOMP
USB	USB LS, FS, HS	Yes (trigger on LS and FS only; HS decode only on 1 GHz models)	3-SRUSB2
Automotive	CAN, CAN FD	Yes	3-SRAUTO
	LIN	Yes	3-SRAUTO
	FlexRay	Yes	3-SRAUTO
Military and Aerospace	MIL-STD-1553, ARINC429	Yes	3-SRAERO
Audio	I^2S	Yes	3-SRAUDIO
	LJ, RJ	Yes	3-SRAUDIO
	TDM	Yes	3-SRAUDIO

Event table

In addition to seeing decoded packet data on the bus waveform itself, you can view all captured packets in a tabular view much like you would see in a software listing. Packets are time stamped and listed consecutively with columns for each component (Address, Data, etc.). You can save the event table data in .CSV format.

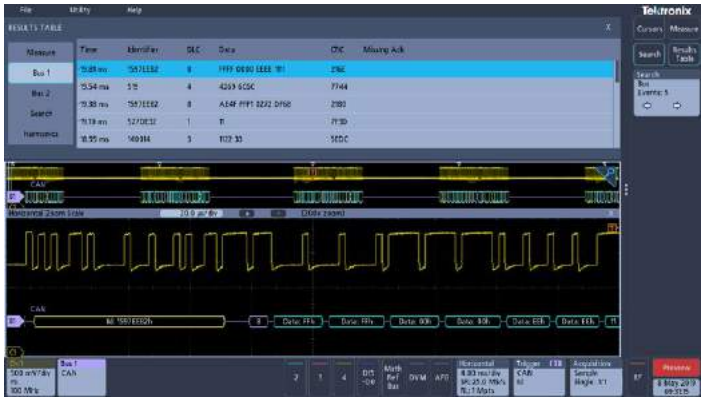


Figure 20: Event table showing decoded identifier, DLC, DATA, and CRC for every CAN packet in a long acquisition.

Search (serial triggering)

Serial triggering is very useful for isolating the event of interest, but once you've captured it and need to analyze the surrounding data, what do you do? In the past, users had to manually scroll through the waveform counting and converting bits and looking for what caused the event. You can have the oscilloscope automatically search through the acquired data for user-defined criteria including serial packet content. Each occurrence is highlighted by a search mark. Rapid navigation between marks is as simple as pressing the **Previous** (←) and **Next** (→) buttons on the screen.

Digital Voltmeter (DVM) and Frequency Counter (free with registration)

The 3 Series MDO contains an integrated 4-digit digital voltmeter (DVM) and 5-digit frequency counter. Any of the analog inputs can be a source for the voltmeter, using the same probes that are already attached for general oscilloscope usage. The DVM and frequency counter is available on any 3 Series MDO and is activated when you register your product.

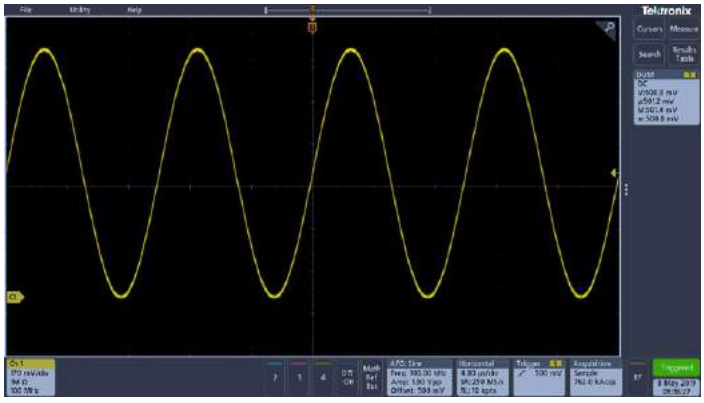


Figure 21: A DC measurement value is shown.

The 3 Series MDO Platform

Large high-resolution touch display

The 3 Series MDO features an 11.6 inch (295 mm) wide-screen, HD display (1920 x 1080) for seeing intricate signal details.

Connectivity

The 3 Series MDO contains a number of ports which can be used to connect the instrument to a network, directly to a PC, or other test equipment.

- Front and rear USB host ports enable easy transfer of screen shots, instrument settings, and waveform data to a USB mass storage device. A USB keyboard or mouse can also be attached to a USB host port for data entry or control.
- Rear USB device port is useful for controlling the oscilloscope remotely from a PC.
- The standard 10/100 Ethernet port on the rear of the instrument enables easy connection to networks, provides network printing, and provides LXI Core 2011 compatibility.
- A HDMI port on the rear of the instrument allows the display to be exported to an external monitor or projector.

Remote connectivity and instrument control

Exporting data and measurements is as simple as connecting a USB cable from the oscilloscope to your PC. Key software applications – OpenChoice® Desktop, and Microsoft Excel and Word toolbars enable fast and easy direct communication with your Windows PC.

The OpenChoice Desktop enables fast and easy communication between the oscilloscope and your PC through USB or LAN for transferring settings, waveforms, and screen images.

The embedded e*Scope® capability enables fast control of the oscilloscope over a network connection through a standard web browser. Simply enter the IP address or network name of the oscilloscope and a web page will be served to the browser. Transfer and save settings, waveforms, measurements, and screen images or make live control changes to settings on the oscilloscope directly from the web browser.

Compact form factor

With the compact, portable form factor, you can easily move the oscilloscope between labs. And with a depth of just 5.9 inches (149 mm), it saves you valuable space on your test bench. The 3 Series MDO has all the tools you'll need for everyday debug tasks, all in a single instrument.

Figure 22: The 3 Series MDO compact form factor frees up valuable space on your bench or desktop while making sure you will always have the debug tools you need.

Accurate high-speed probing

The 3 Series MDO ships standard with passive voltage probes and uses the TekVPI probe interface.

Standard passive voltage probes

The 3 Series MDO include passive voltage probes with industry best capacitive loading of only 3.9 pF. The included TPP probes minimize the impact on devices under test and accurately deliver signals to the oscilloscope for acquisition and analysis. The following table shows which TPP probes come standard with each 3 Series MDO model.

3 Series models: MDO32, MDO34	Included probe
100 MHz, 200 MHz	TPP0250: 250 MHz, 10x passive voltage probe. One per analog channel.
350 MHz, 500 MHz	TPP0500B: 500 MHz, 10x passive voltage probe. One per analog channel.
1 GHz	TPP1000: 1 GHz, 10x passive voltage probe. One per analog channel.

TekVPI probe interface

The TekVPI probe interface sets the standard for ease of use in probing. In addition to the secure, reliable connection that the interface provides, TekVPI probes feature status indicators and controls, as well as a probe menu button right on the comp box itself. This button brings up a probe menu on the oscilloscope display with all relevant settings and controls for the probe. The TekVPI interface enables direct attachment of current probes without requiring a separate power supply. TekVPI probes can be controlled remotely through USB, GPIB, or LAN, enabling more versatile solutions in ATE environments. The instrument provides up to 25 W of power to the front panel connectors from the internal power supply.

Figure 23: TekVPI probe interface simplifies connecting your probes to the oscilloscope.

Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Model overview

MDO32 and MDO34										
Analog channel bandwidth	100 MHz	100 MHz	200 MHz	200 MHz	350 MHz	350 MHz	500 MHz	500 MHz	1 GHz	1 GHz
Analog channels	2	4	2	4	2	4	2	4	2	4
Rise time (typical, calculated) *(10 mV/div setting with 50 Ω input termination)*	4 ns	4 ns	2 ns	2 ns	1.14 ns	1.14 ns	800 ps	800 ps	400 ps	400 ps
Sample rate (1 ch)	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	5 GS/s	5 GS/s
Sample rate (2 ch)	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	2.5 GS/s	5 GS/s	5 GS/s
Sample rate (4 ch)	-	2.5 GS/s	-	2.5 GS/s	-	2.5 GS/s	-	2.5 GS/s	-	2.5 GS/s
Record length (1 ch)	10 M	10 M	10 M	10 M	10 M	10 M	10 M	10 M	10 M	10 M
Record length (2 ch)	10 M	10 M	10 M	10 M	10 M	10 M	10 M	10 M	10 M	10 M
Record length (4 ch)	-	10 M	-	10 M	-	10 M	-	10 M	-	10 M
Digital channels with 3-MSO option	16	16	16	16	16	16	16	16	16	16
Arbitrary Function Generator outputs with 3-AFG option	1	1	1	1	1	1	1	1	1	1
Spectrum analyzer channels	1	1	1	1	1	1	1	1	1	1
Standard spectrum analyzer frequency range	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz	9 kHz - 1 GHz
Optional spectrum analyzer frequency range with 3-SA3 option	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz	9 kHz - 3 GHz

Oscilloscope

Vertical system analog channels

Hardware bandwidth limits

≥350 MHz models	20 MHz or 250 MHz
100 MHz and 200 MHz models	20 MHz

Input coupling AC, DC

Input impedance 1 MΩ ±1%, 50 Ω ±1%

Input sensitivity range

1 MΩ	1 mV/div to 10 V/div
50 Ω	1 mV/div to 1 V/div

Vertical resolution 8 bits (11 bits with Hi Res)

Maximum input voltage

1 MΩ	300 V_{RMS} CAT II with peaks ≤ ±425 V
50 Ω	5 V_{RMS} with peaks ≤ ±20 V

DC gain accuracy ±1.5% for 5 mV/div and above, derated at 0.10%/°C above 30 °C ±2.0% for 2 mV/div, derated at 0.10%/°C above 30 °C

±2.5% for 1 mV/div, derated at 0.10%/°C above 30 °C

±3.0% for variable gain, derated 0.10%/°C above 30 °C

Channel-to-channel isolation (typical) Any two channels at equal vertical scale ≥100:1 at ≤100 MHz and ≥30:1 at >100 MHz up to the rated bandwidth

Random noise, sample acquisition mode, 50 Ω termination setting, full bandwidth, typical

	1 mV/div	100 mV/div	1 V/div
1 GHz	-	1.98 mV	17.07 mV
500 MHz	-	1.54 mV	13.47 mV
350 MHz	-	1.7 mV	12.7 mV
200 MHz	111 µV	1.6 mV	15.19 mV
100 MHz	98 µV	1.38 mV	15.87 mV

Offset range

Volts/div setting	Offset range	
	1 M Ω input	50 Ω input
1 mV/div to 50 mV/div	±1 V	±1 V
50.5 mV/div to 99.5 mV/div	±0.5 V	±0.5 V
100 mV/div to 500 mV/div	±10 V	±10 V
505 mV/div to 995 mV/div	±5 V	±5 V
1 V/div to 10 V/div	±100 V	±5 V

Horizontal system analog channels

Time base range

1 GHz models	400 ps/div to 1000 s/div
≤ 500 MHz models	1 ns/div to 1000 s/div

Maximum duration at highest sample rate (all/half channels)

1 GHz models	4/2 ms
≤ 500 MHz models	4/4 ms

Time-base delay time range -10 divisions to 5000 s

Channel-to-channel deskew range ±125 ns

Time base accuracy ±10 ppm over any ≥1 ms interval

Trigger system

Trigger modes Auto, Normal, and Single

Trigger coupling DC, AC, HF reject (attenuates >50 kHz), LF reject (attenuates <50 kHz), noise reject (reduces sensitivity)

Trigger holdoff range 20 ns to 8 s

Trigger sensitivity (typical) Edge type, DC coupled

Trigger source	Sensitivity
Any analog channel input	For 1 mV/div to 4.98 mV/div; 0.75 div from DC to 50 MHz, increasing to 1.3 div at instrument bandwidth ≥ 5 mV/div: 0.40 div from DC to 50 MHz, increasing to 1 div at instrument bandwidth
Aux In (External); available on two-channel instruments only	200 mV from DC to 50 MHz, increasing to 500 mV at 200 MHz
Line	Fixed

Trigger level ranges

Any input channel	±8 divisions from center of screen, ±8 divisions from 0 V when vertical LF reject trigger coupling is selected
Aux In (External)	±8 V
Line	The line trigger level is fixed at about 50% of the line voltage.

Trigger frequency readout Provides 6-digit frequency readout of triggerable events.

Trigger types

Edge	Positive, negative, or either slope on any channel. Coupling includes DC, AC, HF reject, LF reject, and noise reject.
Sequence (B-trigger)	Trigger Delay by Time: 9.2 ns to 8 s. Or Trigger Delay by Events: 1 to 4,000,000 events. Not available when “Either” edge is selected.
Pulse Width	Trigger on width of positive or negative pulses that are >, <, =, ≠, or inside/outside a specified period of time.

Timeout	Trigger on an event which remains high, low, or either, for a specified time period (4 ns to 8 s).
Runt	Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again.
Logic	Trigger when any logical pattern of channels goes false or stays true for specified period of time. Any input can be used as a clock to look for the pattern on a clock edge. Pattern (AND, OR, NAND, NOR) specified for all input channels defined as High, Low, or Don't Care.
Setup and Hold	Trigger on violations of both setup time and hold time between clock and data present on any of the analog and digital input channels.

Setup and hold trigger type	Description
Setup Time Range	-0.5 ns to 1.024 ms
Hold Time Range	1.0 ns to 1.024 ms
Setup + Hold Time Range	0.5 ns to 2.048 ms

Rise/Fall Time	Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative, or either and time range is 4.0 ns to 8 s.
Video	Trigger on all lines, odd, even, or all fields on NTSC, PAL, and SECAM video signals. 480p/60, 576p/50, 720p/30, 720p/50, 720p/60, 875i/60, 1080i/50, 1080i/60, 1080p/24, 1080p/24sF, 1080p/25, 1080p/30, 1080p/50, 1080p/60 Custom bi-level and tri-level sync video standards.
Parallel (available when option 3-MSO is installed)	Trigger on a parallel bus data value. Parallel bus can be from 1 to 20 bits (from the digital and analog channels) in size. Binary and Hex radices are supported.

Acquisition system

Acquisition modes

Sample	Acquire sampled values.
Peak Detect	Captures glitches as narrow as 1.5 ns (1 GHz models), 2.0 ns (500 MHz models), 3.0 ns (350 MHz models), 5.0 ns (200 MHz models), 7.0 ns (100 MHz models) at all sweep speeds
Averaging	From 2 to 512 waveforms included in average.
Envelope	Min-max envelope reflecting Peak Detect data over multiple acquisitions. Number of waveforms in the envelope selectable between 1 and 2000 and infinity
Hi Res	Real-time boxcar averaging reduces random noise and increases vertical resolution.
Roll	Scrolls waveforms right to left across the screen at sweep speeds slower than or equal to 40 ms/div.
FastAcq®	FastAcq optimizes the instrument for analysis of dynamic signals and capture of infrequent events, capturing >280,000 wfms/s on 1 GHz models and >235,000 wfms/s on 100 MHz – 500 MHz models.

Waveform measurements

Cursors	Waveform and Screen
Automatic measurements (time domain)	30, of which up to 8 can be displayed on-screen at any one time. Measurements include: Period, Frequency, Delay, Rise Time, Fall Time, Positive Duty Cycle, Negative Duty Cycle, Positive Pulse Width, Negative Pulse Width, Burst Width, Phase, Positive Overshoot, Negative Overshoot, Total Overshoot, Peak to Peak, Amplitude, High, Low, Max, Min, Mean, Cycle Mean, RMS, Cycle RMS, Positive Pulse Count, Negative Pulse Count, Rising Edge Count, Falling Edge Count, Area and Cycle Area.
Automatic measurements (frequency domain)	3, of which one can be displayed on-screen at any one time. Measurements include Channel Power, Adjacent Channel Power Ratio (ACPR), and Occupied Bandwidth (OBW)
Measurement statistics	Mean, Min, Max, Standard Deviation.

Reference levels	User-definable reference levels for automatic measurements can be specified in either percent or units.
Gating	Isolate the specific occurrence within an acquisition to take measurements on, using either the screen or waveform cursors.

Waveform math

Arithmetic	Add, subtract, multiply, and divide waveforms.
Math functions	Integrate, differentiate, FFT
FFT	Spectral magnitude. Set FFT Vertical Scale to Linear RMS or dBV RMS, and FFT Window to Rectangular, Hamming, Hanning, or Blackman-Harris.
Spectrum math	Add or subtract frequency-domain traces.
Advanced math	Define extensive algebraic expressions including waveforms, reference waveforms, math functions (FFT, Intg, Diff, Log, Exp, Sqrt, Abs, Sine, Cosine, Tangent, Rad, Deg), scalars, up to two user-adjustable variables and results of parametric measurements (Period, Freq, Delay, Rise, Fall, PosWidth, NegWidth, BurstWidth, Phase, PosDutyCycle, NegDutyCycle, PosOverShoot, NegOverShoot, TotalOverShoot, PeakPeak, Amplitude, RMS, CycleRMS, High, Low, Max, Min, Mean, CycleMean, Area, CycleArea, and trend plots). For example, (Intg(Ch1 - Mean(Ch1)) × 1.414 × VAR1)

Act on Event

Events	None or when a trigger occurs
Actions	Stop acquisition, save waveform to file, save screen image, send AUX OUT pulse, and remote interface SRQ
Repeat	1 to 1,000,000

Power measurements (optional)

Power quality measurements	V_{RMS}, $V_{Crest\ Factor}$, Frequency, I_{RMS}, $I_{Crest\ Factor}$, True Power, Apparent Power, Reactive Power, Power Factor, Phase Angle.
Switching loss measurements	
Power loss	T_{on}, T_{off}, Conduction, Total.
Energy loss	T_{on}, T_{off}, Conduction, Total.
Harmonics	THD-F, THD-R, RMS measurements. Graphical and table displays of harmonics. Test to IEC61000-3-2 Class A and MIL-STD-1399, Section 300A.
Ripple measurements	V_{Ripple} and I_{Ripple}.
Modulation analysis	Graphical display of +Pulse Width, -Pulse Width, Period, Frequency, +Duty Cycle, and -Duty Cycle modulation types.
Safe operating area	Graphical display and mask testing of switching device safe operating area measurements.
dV/dt and dI/dt measurements	Cursor measurements of slew rate

Spectrum Analyzer

(1 GHz standard on all models, or with 3-SA3 option)

Capture bandwidth	All models: 1 GHz standard or 3 GHz with option 3-SA3
Span	All models: 9 KHz - 1 GHz standard or 3 GHz with option 3-SA3, in a 1-2-5 sequence
Resolution bandwidth	20 Hz - 150 MHz in a 1-2-3-5 sequence
Reference level	-140 dBm to +20 dBm in steps of 5 dBm
Vertical scale	1 dB/div to 20 dB/div in a 1-2-5 sequence
Vertical position	-100 divs to +100 divs (displayed in dB)
Vertical units	dBm, dBmV, dBµV, dBµW, dBmA, dBµA

Displayed average noise level (DANL)

9 kHz - 50 kHz	< -109 dBm/Hz (< -113 dBm/Hz typical)
50 kHz – 5 MHz	< -126 dBm/Hz (< -130 dBm/Hz typical)
5 MHz - 2 GHz	< -136 dBm/Hz (< -140 dBm/Hz typical)
2 GHz – 3 GHz	< -126 dBm/Hz (< -130 dBm/Hz typical)

DANL with TPA-N-PRE preamp attached

Preamp set to "Auto", and Reference Level set to -40 dB

9 kHz - 50 kHz	< -117 dBm/Hz (< -121 dBm/Hz typical)
50 kHz – 5 MHz	< -136 dBm/Hz (< -140 dBm/Hz typical)
5 MHz - 2 GHz	< -146 dBm/Hz (< -150 dBm/Hz typical)
2 GHz – 3 GHz	< -136 dBm/Hz (< -140 dBm/Hz typical)

Spurious response

2nd harmonic distortion	>100 MHz: < -55 dBc (< -60 dBc typical) 9 kHz to 100 MHz: < -55 dBc
3rd harmonic distortion	>100 MHz: < -53 dBc (< -58 dBc typical) 9 kHz to 100 MHz: < -55 dBc (< -60 dBc typical)
2nd order intermodulation distortion	>15 MHz: < -55 dBc (< -60 dBc typical) 9 kHz to 15 MHz, < -47 dBc (< -52 dBc typical)
3rd order intermodulation distortion ()	>15 MHz: < -55 dBc (< -60 dBc typical) 9 kHz to 15 MHz: < -55 dBc (< -60 dBc typical)

Residual spurious response

< -78 dBm (< -84 dBm typical, ≤ -15 dBm reference level and RF input terminated with 50 Ω)

At 2.5 GHz	< -62 dBm (< -73 dBm typical)
At 1.25 GHz	< -76 dBm (< -82 dBm typical)

Crosstalk to spectrum analyzer from oscilloscope channels

≤800 MHz input frequencies	< -60 dB from ref level (typical)
>800 MHz - 2 GHz input frequencies	< -40 dB from ref level (typical)

Phase noise from 1 GHz CW

10 kHz	< -81 dBc/Hz, < -85 dBc/Hz (typical)
100 kHz	< -97 dBc/Hz, < -101 dBc/Hz (typical)
1 MHz	< -118 dBc/Hz, < -122 dBc/Hz (typical)

Level measurement uncertainty

Reference level 10 dBm to -15 dBm. Input level ranging from reference level to 40 dB below reference level. Specifications exclude mismatch error.

18 °C to 28 °C	9 kHz-1.5 GHz < ±1 dBm (<±0.4 dBm typical) 1.5 GHz-2.5 GHz < ±1.3 dBm (<±0.6 dBm typical) 2.5 GHz-3 GHz < ±1.5 dBm (<±0.7 dBm typical)
Over operating range	< ±2.0 dBm

Level measurement uncertainty with TPA-N-PRE preamp attached

Preamp mode set to “Auto”. Reference level 10 dBm set to -40dBm. Input level ranging from reference level to 30 dB below reference level. Specifications exclude mismatch error.

18 °C - 28 °C	< ±1.5 dBm (typical) either preamp state
Over operating range	< ±2.3 dBm either preamp state

Frequency measurement accuracy	±(([Reference Frequency Error] x [Marker Frequency]) + (span/750 + 2)) Hz; Reference Frequency Error = 10ppm (10 Hz / MHz)

Maximum operating input level

Average continuous power	+20 dBm (0.1 W)
DC maximum before damage	±40 V DC
Maximum power before damage (CW)	+33 dBm (2 W)
Maximum power before damage (pulse)	+45 dBm (32 W) (<10 µs pulse width, <1% duty cycle, and reference level of ≥ +10 dBm)

Maximum operating input level with TPA-N-PRE preamp attached

Average continuous power	+20 dBm (0.1 W)
DC maximum before damage	±20 V DC
Maximum power before damage (CW)	+30 dBm (1 W)
Maximum power before damage (pulse)	+45 dBm (32 W) (<10 µs pulse width, <1% duty cycle, and reference level of ≥ +10 dBm)

Frequency domain trace types	Normal, Average, Max Hold, Min Hold

Detection methods +Peak, -Peak, Average, Sample

Automatic markers One to eleven peaks identified based on user-adjustable threshold and excursion values

Manual markers Two manual markers indicating frequency, amplitude, noise density, and phase noise

Marker readouts Absolute or Delta

FFT windows

FFT window	Factor
Kaiser	2.23
Rectangular	0.89
Hamming	1.30
Hanning	1.44
Blackman-Harris	1.90
Flat-Top	3.77

Arbitrary Function Generator

(Requires 3-AFG option)

Waveforms Sine, Square, Pulse, Ramp/Triangle, DC, Noise, Sin(x)/x (Sinc), Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine, Cardiac, Arbitrary, and AM/FM.

Sine

- **Frequency range** 0.1 Hz to 50 MHz
- **Amplitude range** 20 mV_{p-p} to 5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 2.5 V_{p-p} into 50 Ω
- **Amplitude flatness (typical)** ±0.5 dB at 1 kHz (±1.5 dB for <20 mV_{p-p} amplitudes)
- **Total harmonic distortion (typical)** 1% into 50 Ω 2% for amplitude < 50 mV and frequencies > 10 MHz
  3% for amplitude < 20 mV and frequencies > 10 MHz
- **Spurious free dynamic range (SFDR) (typical)** -40 dBc (V_{p-p} ≥ 0.1 V); -30dBc (V_{p-p} ≤ 0.1 V), 50 Ω load

Square / Pulse

- **Frequency range** 0.1 Hz to 25 MHz
- **Amplitude range** 20 mV_{p-p} to 5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 2.5 V_{p-p} into 50 Ω
- **Duty cycle** 10% to 90% or 10 ns minimum pulse, whichever is larger cycle
- **Duty cycle resolution** 0.1%
- **Pulse width minimum (typical)** 10 ns
- **Rise/fall time (typical)** 5 ns (10% - 90%)
- **Pulse width resolution** 100 ps
- **Overshoot (typical)** < 4% for signal steps greater than 100 mV
- **Asymmetry** ±1% ±5 ns, at 50% duty cycle
- **Jitter (TIE RMS) (typical)** < 500 ps

Ramp / Triangle

Frequency range	0.1 Hz to 500 kHz
Amplitude range	20 mV_{p-p} to 5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 2.5 V_{p-p} into 50 Ω
Variable symmetry	0% to 100%
Symmetry resolution	0.1%

DC

Level range (typical)	±2.5 V into Hi-Z; ±1.25 V into 50 Ω

Random noise waveform

Amplitude range	20 mV_{p-p} to 5 V_{p-p} in to Hi-Z; 10 mV_{p-p} to 2.5 V_{p-p} into 50 Ω
Amplitude resolution	0% to 100% in 1% increments

Sin(x)/x (Sinc)

Frequency range (typical)	0.1 Hz to 2 MHz
Amplitude range	20 mV_{p-p} to 3.0 V_{p-p} into Hi-Z; 10 mV_{p-p} to 1.5 V_{p-p} into 50 Ω

Gaussian

Frequency range (typical)	0.1 Hz to 5 MHz
Amplitude range	20 mV_{p-p} to 2.5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 1.25 V_{p-p} into 50 Ω

Lorentz

Frequency range (typical)	0.1 Hz to 5 MHz
Amplitude range	20 mV_{p-p} to 2.4 V_{p-p} into Hi-Z; 10 mV_{p-p} to 1.2 V_{p-p} into 50 Ω

Exponential Rise / Decay

Frequency range (typical)	0.1 Hz to 5 MHz
Amplitude range	20 mV_{p-p} to 2.5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 1.25 V_{p-p} into 50 Ω

Haversine

Frequency range (typical)	0.1 Hz to 5 MHz
Amplitude range	20 mV_{p-p} to 2.5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 1.25 V_{p-p} into 50 Ω

Cardiac (typical)

Frequency range	0.1 Hz to 500 kHz
Amplitude range	20 mV_{p-p} to 5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 2.5 V_{p-p} into 50 Ω

Arbitrary

Memory depth	1 to 128 k

Amplitude range	20 mV_{p-p} to 5 V_{p-p} into Hi-Z; 10 mV_{p-p} to 2.5 V_{p-p} into 50 Ω
Repetition rate	0.1 Hz to 25 MHz
Sample rate	250 MS/s

Frequency accuracy

Sine wave and ramp	130 ppm (frequency < 10 kHz) 50 ppm (frequency ≥ 10 kHz)
Square wave and pulse	130 ppm (frequency < 10 kHz) 50 ppm (frequency ≥ 10 kHz)
Resolution	0.1 Hz or 4 digits; whichever is larger

Signal amplitude accuracy ±[(1.5% of peak-to-peak amplitude setting) + (1.5% of DC offset setting) + 1 mV] (frequency = 1 kHz)

DC offset

DC offset range	±2.5 V into Hi-Z; ±1.25 V into 50 Ω
DC offset resolution	1 mV into Hi-Z; 500 uV into 50 Ω
DC offset accuracy	±[(1.5% of absolute offset voltage setting) + 1 mV] Add 3 mV for every 10 °C change from 25 °C

AM/FM Modulation characteristics

Carrier Waveform	All except Pulse, Noise, DC, and Cardiac
Internal modulating waveform	Sine, Square, Triangle, Down Ramp, Up Ramp, Noise
Internal modulating frequency	100 mHz to 50 kHz
AM modulation depth	0.0% to 100.0%
Min FM peak deviation	DC
Max FM peak deviation	

Output Function	Max Deviation Frequency
ARB	12.5 MHz
Sine	25 MHz
Square	12.5 MHz
Ramp	250 kHz
Sinc	1 MHz
Other	2.5 MHz

Logic Analyzer

(Requires 3-MSO option)

Vertical system digital channels

Input channels	16 digital (D15 to D0)
Thresholds	Threshold per set of 8 channels
Threshold selections	TTL, CMOS, ECL, PECL, User-defined
User-defined threshold range	-15 V to +25 V

Maximum input voltage	-20 V to +30 V
Threshold accuracy	±[130mV + 3% of threshold setting]
Input dynamic range	50 V_{p-p} (threshold setting dependent)
Minimum voltage swing	500 mV
Input resistance	101 kΩ
Probe loading	8 pF
Vertical resolution	1 bit

Horizontal system digital channels

Maximum sample rate (Main)	500 MS/s (2 ns resolution)
Maximum record length (Main)	10 M
Maximum sample rate (MagniVu)	8.25 GS/s (121.2 ps resolution)
Maximum record length (MagniVu)	10k centered on the trigger
Minimum detectable pulse width (typical)	2 ns
Channel-to-channel skew (typical)	500 ps
Maximum input toggle rate	250 MHz (Maximum frequency sine wave that can accurately be reproduced as a logic square wave. Requires the use of a short ground extender on each channel. This is the maximum frequency at the minimum swing amplitude. Higher toggle rates can be achieved with higher amplitudes.)

Serial Protocol Analyzer

Automated Serial Triggering, Decode, and Search options for I^2C, SPI, RS-232/422/485/UART, USB2.0, CAN, CAN FD (ISO and non-ISO), LIN, FlexRay, MIL-STD-1553, ARINC429, and Audio buses.

For more detailed information about serial bus support products please see the *Serial Triggering and Analysis* datasheet.

Trigger types

I^2C (optional)	Trigger on Start, Repeated Start, Stop, Missing ACK, Address (7 or 10 bit), Data, or Address and Data on I^2C buses up to 10 Mb/s.
SPI (optional)	Trigger on SS active, Start of Frame, MOSI, MISO, or MOSI and MISO on SPI buses up to 50.0 Mb/s.
RS-232/422/485/UART (optional)	Trigger on Tx Start Bit, Rx Start Bit, Tx End of Packet, Rx End of Packet, Tx Data, Rx Data, Tx Parity Error, and Rx Parity Error up to 10 Mb/s.
USB: Low speed (optional)	Trigger on Sync Active, Start of Frame, Reset, Suspend, Resume, End of Packet, Token (Address) Packet, Data Packet, Handshake Packet, Special Packet, Error. Token packet trigger - Any token type, SOF, OUT, IN, SETUP; Address can be specified for Any Token, OUT, IN, and SETUP token types. Address can be further specified to trigger on ≤, <, =, >, ≥, ≠ a particular value, or inside or outside of a range. Frame number can be specified for SOF token using binary, hex, unsigned decimal and don't care digits. Data packet trigger - Any data type, DATA0, DATA1; Data can be further specified to trigger on ≤, <, =, >, ≥, ≠ a particular data value, or inside or outside of a range. Handshake packet trigger - Any handshake type, ACK, NAK, STALL. Special packet trigger - Any special type, Reserved Error trigger - PID Check, CRC5 or CRC16, Bit Stuffing.
USB: Full speed (optional)	Trigger on Sync, Reset, Suspend, Resume, End of Packet, Token (Address) Packet, Data Packet, Handshake Packet, Special Packet, Error. Token packet trigger - Any token type, SOF, OUT, IN, SETUP; Address can be specified for Any Token, OUT, IN, and SETUP token types. Address can be further specified to trigger on ≤, <, =, >, ≥, ≠ a particular value, or inside or outside of a range. Frame number can be specified for SOF token using binary, hex, unsigned decimal and don't care digits. Data packet trigger - Any data type, DATA0, DATA1; Data can be further specified to trigger on ≤, <, =, >, ≥, ≠ a particular data value, or inside or outside of a range. Handshake packet trigger - Any handshake type, ACK, NAK, STALL. Special packet trigger - Any special type, PRE, Reserved. Error trigger - PID Check, CRC5 or CRC16, Bit Stuffing.
CAN, CAN FD (optional)	Trigger on Start of Frame, Frame Type (data, remote, error, overload), Identifier (standard or extended), Data, Identifier and Data, End of Frame, Missing ACK, or Bit Stuffing Error on CAN signals up to 1 Mb/s and on CAN FD signals up to 7 Mb/s (ISO and non ISO). Data can be further specified to trigger on ≤, <, =, >, ≥, or ≠ a specific data value. User-adjustable sample point is set to 50% by default.
LIN (optional)	Trigger on Sync, Identifier, Data, Identifier and Data, Wakeup Frame, Sleep Frame, Errors such as Sync, Parity, or Checksum Errors up to 100 kb/s (by LIN definition, 20 kb/s).
FlexRay (optional)	Trigger on Start of Frame, Type of Frame (Normal, Payload, Null, Sync, Startup), Identifier, Cycle Count, Complete Header Field, Data, Identifier and Data, End of Frame or Errors such as Header CRC, Trailer CRC, Null Frame, Sync Frame, or Startup Frame Errors up to 10 Mb/s.
MIL-STD-1553 (optional)	Trigger on Sync, Word Type (Command, Status, Data), Command Word (set RT Address, T/R, Sub-address/Mode, Data Word Count/Mode Code, and Parity individually), Status Word (set RT Address, Message Error, Instrumentation, Service Request Bit, Broadcast Command Received, Busy, Subsystem Flag, Dynamic Bus Control Acceptance (DBCA), Terminal Flag, and Parity individually), Data Word (user-specified 16-bit data value), Error (Sync, Parity, Manchester, Non-contiguous data), Idle Time (minimum time selectable from 2 µs to 100 µs; maximum time selectable from 2 µs to 100 µs; trigger on < minimum, >

	maximum, inside range, outside range). RT Address can be further specified to trigger on =, ≠, <, >, ≤, ≥ a particular value, or inside or outside of a range.
ARINC429 (optional)	Trigger on Word Start/End, Label, SDI, Data, Label and Data, Error conditions (any, parity, word, gap).
I^2S/LJ/RJ/TDM (optional)	Trigger on Word Select, Frame Sync, or Data. Data can be further specified to trigger on ≤, <, =, >, ≥, ≠ a specific data value, or inside or outside of a range. Maximum data rate for I^2S/LJ/RJ is 12.5 Mb/s. Maximum data rate for TDM is 25 Mb/s.

Digital Voltmeter

(Free with product registration)

Source	Channel 1, Channel 2, Channel 3, Channel 4
Measurement types	AC_{rms}, DC_{rms}, $AC+DC_{rms}$ (reads out in volts or amps); frequency count
Resolution	Voltage: 4 digits Frequency: 5 digits
Frequency accuracy	±(10 µHz/Hz + 1 count)
Measuring rate	100 times/second; measurements updated on the display 4 times/second
Vertical settings autorange	Automatic adjustment of vertical settings to maximize measurement dynamic range; available for any non-trigger source
Graphical measurement	Graphical indication of minimum, maximum, current value, and five second rolling range

General product specifications

Display system

Display type	11.6 in. (295 mm) TFT LCD with capacitive touch
Display resolution	1920 horizontal × 1080 vertical HD
Interpolation	Sin(x)/x
Waveform styles	Vectors, Dots, Variable Persistence, Infinite Persistence
FastAcq. palettes	Temperature, Spectral, Normal, Inverted
Graticules	Full, Grid, Solid, Cross Hair, Frame, IRE and mV
Format	YT, XY, and simultaneous XY/YT
Maximum waveform capture rate	>280,000 wfms/s in FastAcq acquisition mode on 1 GHz models >230,000 wfms/s in FastAcq acquisition mode on 100 MHz – 500 MHz models >50,000 wfms/s in DPO acquisition mode on all models

Input/output ports

USB 2.0 high-speed host port	Supports USB mass storage devices and keyboard. Two ports on front and one port on rear of instrument.
USB 2.0 device port	Rear-panel connector allows for communication/control of oscilloscope through USBTMC or GPIB (with a TEK-USB-488).
Printing	Print to network printer or to a printer that supports e-mail printing. Note: This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit.
LAN port	RJ-45 connector, supports 10/100 Mb/s
HDMI port	19-pin, HDMI type connector

Auxilliary input (typical)

(Available on two-channel models only)

Front-panel BNC connector	Input impedance, 1 MΩ
Maximum input	300 V_{RMS} CAT II with peaks ≤ ±425 V

Probe compensator output voltage and frequency

Front-panel pins

Amplitude	0 to 2.5 V
Frequency	1 kHz

Aux Out	Rear-panel BNC connector V_{OUT} (Hi): ≥2.25 V open circuit, ≥1.0 V into 50 Ω to ground V_{OUT} (Lo): ≤0.7 V into a load of ≤4 mA; ≤0.25 V into 50 Ω to ground Output can be configured to provide a pulse out signal when the oscilloscope triggers, a trigger signal from the internal arbitrary function generator, or an event out

Kensington-style lock	Rear-panel security slot connects to standard Kensington-style lock.

LAN eXtensions for Instrumentation (LXI)

Class	LXI Core 2011
Version	V1.4

Software

OpenChoice® Desktop	Enables fast and easy communication between a Windows PC and your oscilloscope using USB or LAN. Transfer and save settings, waveforms, measurements, and screen images. Word and Excel toolbars automate the transfer of acquisition data and screen images from the oscilloscope into Word and Excel for quick reporting or further analysis.
IVI driver	Provides a standard instrument programming interface for common applications such as LabVIEW, LabWindows/CVI, MicrosoftNET, and MATLAB.
e*Scope® Web-based interface	Enables control of the oscilloscope over a network connection through a standard web browser. Simply enter the IP address or network name of the oscilloscope and a web page will be served to the browser. Transfer and save settings, waveforms, measurements, and screen images or make live control changes to settings on the oscilloscope directly from the web browser.
LXI Core 2011 Web interface	Connect to the oscilloscope through a standard Web browser by simply entering the oscilloscope IP address or network name in the address bar of the browser. The Web interface enables viewing of instrument status and configuration, status and modification of network settings, and instrument control through e*Scope Web-based remote control. All Web interaction conforms to LXI Core 2011 specification, version 1.4.

Power source

Power source voltage	100 to 240 V ±10%
Power source frequency	50 to 60 Hz at 100 to 240 V 400 Hz ±10% at 115 V
Power consumption	130 W maximum

Physical characteristics

Dimensions

Height	252 mm (9.93 in.)
Width	370 mm (14.57 in.)
Depth	148.6 mm (5.85 in.)

Weight

Net	MDO34 1GHz: 11.7 lbs (5.31 kg)
	MDO32 1GHz: 11.6 lbs (5.26 kg)
Shipping	17.4 lbs (7.89 kg)

Rackmount configuration	6U
Cooling clearance	2 in. (50.8 mm) required on right side (facing the instrument) and rear of instrument

EMC and safety

Temperature

Operating	-10 °C to +50 °C (+14 °F to +122 °F)
Non-operating	–40 °C to +71 °C (–40 °F to +160 °F)

Humidity

Operating	5% to 90% relative humidity (% RH) at up to +40 °C 5% to 60% RH above +40 °C up to +55 °C, non-condensing, and as limited by a maximum wet-bulb temperature of +39 °C
Non-operating	5% to 90% relative humidity up to +40 °C, 5% to 60% relative humidity above +40 °C up to +55 °C 5% to 40% relative humidity above +55 °C up to +71 °C, non-condensing, and as limited by a maximum wet-bulb temperature of +39 °C

Altitude

Operating	3,000 m (9,843 feet)
Non-operating	12,000 m (39,370 feet)

Regulatory

Electromagnetic compatibility	EC Council Directive 2004/108/EC
Safety	UL61010-1:2004, CAN/CSA-C22.2 No. 61010.1: 2004, Low Voltage Directive 2006/95/EC and EN61010-1:2001, IEC 61010-1:2001, ANSI 61010-1-2004, ISA 82.02.01

Random vibration

Non-operating:	2.46 G_{RMS}, 5-500 Hz, 10 minutes per axis, 3 axes, 30 minutes total
Operating:	0.31 G_{RMS}, 5-500 Hz, 10 minutes per axis, 3 axes, 30 minutes total Meets IEC60068 2-64 and MIL-PRF-28800 Class 3

Shock

Operating:	50 G, 1/2 sine, 11 ms duration, 3 drops in each direction of each axis, total of 18 shocks Meets IEC 60068 2-27 and MIL-PRF-28800 Class 3
Non-operating	50 G, 1/2 sine, 11 ms duration, 3 drops in each direction of each axis, total of 18 shocks Exceeds MIL-PRF-28800F

Acoustic noise emission

Sound power level	38 dBA - 40 dBA typical in accordance with ISO 9296

Ordering information

Use the following steps to select the appropriate instrument and options for your measurement needs.

Step 1: Choose the 3 Series MDO base model

3 Series MDO family

MDO32	Mixed Domain Oscilloscope with (2) analog channels, (1) auxiliary trigger input, a 1 GHz spectrum analyzer, (1) spectrum analyzer input, and (1) logic analyzer input
MDO34	Mixed Domain Oscilloscope with (4) analog channels, a 1 GHz spectrum analyzer, (1) spectrum analyzer input, and (1) logic analyzer input

Standard accessories

Probes

1 GHz models	TPP1000, 1 GHz bandwidth, 10X, 3.9pF. One passive voltage probe per analog channel
350 MHz and 500 MHz models	TPP0500B, 500 MHz bandwidth, 10X, 3.9 pF. One passive voltage probe per analog channel
100 MHz and 200 MHz models	TPP0250, 250 MHz bandwidth, 10X, 3.9 pF. One passive voltage probe per analog channel
Any model with 3-MSO option	One P6316 16-channel logic probe and accessories

Accessories

071-3608-00	Installation and Safety Instructions, printed manual (translated in English, Japanese, and Simplified Chinese)
016-2144-xx	Accessory bag
-	Power cord
-	OpenChoice® Desktop Software available for download. Calibration certificate documenting traceability to
-	National Metrology Institute(s) and ISO9001 quality system registration

Warranty

Three-year warranty covering all parts and labor on the 3 Series MDO instrument. One-year warranty covering all parts and labor on included probes.

Step 2: Configure your 3 Series MDO by adding options

Instrument options

3-AFG	Arbitrary Function Generator with 13 predefined waveforms, arbitrary waveform generation, and frequency and amplitude modulation.
3-MSO	16 digital channels; includes P6316 digital probe and accessories.
3-SA3	Spectrum analyzer; frequency range from 9 kHz to 3 GHz and capture bandwidth to 3 GHz.
3-SEC	Enhanced instrument security to enable password protected control of turning on/off all instrument ports and instrument firmware update functionality.

Bandwidth options

Choose the bandwidth you need today by choosing one of these bandwidth options. You can upgrade it later by purchasing an upgrade kit.

3-BW-100	100 MHz Bandwidth for analog channels, 1 GHz spectrum analyzer standard
3-BW-200	200 MHz Bandwidth for analog channels, 1 GHz spectrum analyzer standard
3-BW-350	350 MHz Bandwidth for analog channels, 1 GHz spectrum analyzer standard

3-BW-500	500 MHz Bandwidth for analog channels, 1 GHz spectrum analyzer standard
3-BW-1000	1 GHz Bandwidth for analog channels, 1 GHz spectrum analyzer standard

Power cord and plug options

Opt. A0	North America power plug (115 V, 60 Hz)
Opt. A1	Universal Euro power plug (220 V, 50 Hz)
Opt. A2	United Kingdom power plug (240 V, 50 Hz)
Opt. A3	Australia power plug (240 V, 50 Hz)
Opt. A5	Switzerland power plug (220 V, 50 Hz)
Opt. A6	Japan power plug (100 V, 50/60 Hz)
Opt. A10	China power plug (50 Hz)
Opt. A11	India power plug (50 Hz)
Opt. A12	Brazil power plug (60 Hz)
Opt. A99	No power cord

Localized user interface and online help

The Instrument user interface is localized into eleven languages.

The Instrument help, localized in eleven languages, is included in each product and in PDF format on the Web.

All products are shipped with an Installation and Safety manual that is in English, Japanese, and Simplified Chinese, except instruments ordered with option L99, which receives no printed manual.

Opt. L99	No manual

Service options

Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. R5	Repair Service 5 Years (including warranty)
Opt. T3	Three Year Total Protection Plan, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS plus preventative maintenance, including a 5 day turnaround time and priority access to customer support.
Opt. T5	Five Year Total Protection Plan, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS plus preventative maintenance, including a 5 day turnaround time and priority access to customer support.

Probes and accessories are not covered by the oscilloscope warranty and service offerings. Refer to the datasheet of each probe and accessory model for its unique warranty and calibration terms.

Step 3: Select triggering and analysis options

Triggering and analysis options

3-BND	Adds an application bundle (includes all serial options and power analysis option).
3-SRAERO	Adds aerospace serial triggering and analysis (MIL-STD-1553, ARINC429).

3-SRAUDIO	Adds audio serial triggering and analysis (I2S, LJ, RJ, TDM).
3-SRAUTO	Adds automotive serial triggering and analysis (CAN, CAN FD, LIN, FlexRay).
3-SRCOMP	Adds computer serial triggering and analysis (RS-232/422/485/UART).
3-SREMBD	Adds embedded serial triggering and analysis (I2C, SPI).
3-SRUSB2	Adds USB serial triggering and analysis (USB 2.0 LS, FS, HS).
3-PWR	Adds power measurement and analysis.

Recommended accessories

Probes

Tektronix offers over 100 different probes to meet your application needs.

TPP0250	250 MHz, 10X attenuation passive probe with TekVPI® interface
TPP0500B	500 MHz, 10X attenuation passive probe with TekVPI® interface
TPP0502	500 MHz, 2X attenuation passive probe with TekVPI® interface
TPP0850	2.5 kV, 800 MHz, 50X TekVPI® passive high-voltage probe
TPP1000	1 GHz, 10X TekVPI® passive voltage probe, 1.3 Meter cable
TDP0500	500 MHz TekVPI® differential voltage probe, ±42 V differential input voltage
TDP1000	1 GHz TekVPI® differential voltage probe, ±42 V differential input voltage
THDP0100	±6 kV, 100 MHz TekVPI® high-voltage differential probe
THDP0200	±1.5 kV, 200 MHz TekVPI® high-voltage differential probe
TMDP0200	±750 V, 200 MHz TekVPI® high-voltage differential probe
TIVM1 / L	Isolated Probe; 1 GHz, ±50 V, TekVPI, 10 Meter Cable
P6246	400 MHz differential active FET probe (Level II TekProbe)
P6427	1 GHz differential active FET probe (Level II TekProbe)
P5100	2.5 kV, 100x high voltage probe (Level II TekProbe)
TCP0020	20 A AC/DC TekVPI® current probe, 50 MHz BW
TCP0030A	30 A AC/DC TekVPI® current probe, 120 MHz BW
TCP0150	150 A AC/DC TekVPI® current probe, 20 MHz BW
A621	2000 A AC Current probe/BNC
A622	100 A AC/DC Current probe/BNC
TCPA300	AC/DC current probe, DC to 100 MHz, (Requires TCP305A or TCP312A or TCP303 probes)
TCPA400	AC/DC current probe, DC to 50 MHz, (Requires TCP404XL probe)
TCP303	15MHz AC/DC 150A current probe for TCPA300
TCP305	50MHz AC/DC 50A current probe for TCPA300
TCP312	100MHz AC/DC 30A current probe for TCPA300
TCP404XL	2 MHz AC/DC 500A current probe for TCPA400
ADA400A	100x, 10x, 1x, 0.1x high gain differential amplifier
P6316	16 Channel Logic Probe

Accessories

TPA-N-PRE	Preamplifier, 12 dB nominal Gain, 9 kHz - 6 GHz
TPA-N-VPI	N-to-TekVPI adapter
119-4146-00	Near field probe set, 100 kHz - 1 GHz
119-6609-00	Flexible monopole antenna
077-1500-xx	Service manual, download from Web (English only)
TPA-BNC	TekVPI® to TekProbe™ BNC adapter
TEK-DPG	TekVPI Deskew pulse generator signal source
067-1686-xx	Power measurement deskew and calibration fixture
TEK-USB-488	GPIB-to-USB adapter
RM3	Rackmount kit
HC3	Hard transit case
SC3	Soft transit case (includes front protective cover)
200-5480-xx	Front protective cover

Other RF probes

Contact Beehive Electronics to order.

101A	EMC probe set
150A	EMC probe amplifier
110A	Probe cable
0309-0001	SMA probe adapter
0309-0006	BNC probe adapter

Future instrument upgrades after purchase

The 3 Series MDO products offer a number of ways to add functionality after the initial purchase. Listed below are the various product upgrades available and the method of upgrade used for each product.

Post-purchase instrument options

The following products are sold as stand-alone products and can be purchased at any time to add functionality to a 3 Series MDO product. Software option key products require that the instrument model and serial number be provided at the time of purchase. The software option key is specific to the model and serial number combination. One-time, permanent upgrade to any model enabled through software option key.

SUP3 AFG	Add arbitrary function generator to any 3 Series MDO product.
SUP3 MSO	Add 16 digital channels; includes P6316 digital probe and accessories .
SUP3 SA3	Add spectrum analyzer; frequency range from 9 kHz to 3 GHz and capture bandwidth to 3 GHz.
SUP3 BND	Add an application bundle (includes all serial options and power analysis option).
SUP3 SRAERO	Add aerospace serial triggering and analysis (MIL-STD-1553, ARINC429).
SUP3 SRAUDIO	Add audio serial triggering and analysis (I2S, LJ, RJ, TDM).
SUP3 SRAUTO	Add automotive serial triggering and analysis (CAN, CAN FD, LIN, FlexRay).
SUP3 SRCOMP	Add computer serial triggering and analysis (RS-232/422/485/UART).
SUP3 SREMBD	Add embedded serial triggering and analysis (I2C, SPI).
SUP3 SRUSB2	Add USB serial triggering and analysis (USB 2.0 LS, FS, HS).
SUP3 PWR	Add power measurement and analysis.

SUP3 T3 Three Year Total Protection Plaln, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS plus preventative maintenance, including a 5 day turnaround time and priority acdess to customer support.

SUP3 T5 Five Year Total Protection Plaln, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS plus preventative maintenance, including a 5 day turnaround time and priority acdess to customer support.

Bandwidth upgrade options

Instrument bandwidth can be upgraded on any 3 Series MDO product after initial purchase. Bandwidth upgrades are purchased based on the combination of the current bandwidth and the desired bandwidth. Software option key products depend on instrument model and serial number combination. Bandwidth upgrades up to 500 MHz can be performed in the field, while upgrades to 1 GHz require installation at a Tektronix service center.

Model to be upgraded	Bandwidth before upgrade	Bandwidth after upgrade	Order option
MDO32	100 MHz	200 MHz	SUP3 BW1T22
	100 MHz	350 MHz	SUP3 BW1T32
	100 MHz	500 MHz	SUP3 BW1T52
	100 MHz	1 GHz	SUP3 BW1T102
	200 MHz	350 MHz	SUP3 BW2T32
	200 MHz	500 MHz	SUP3 BW2T52
	200 MHz	1 GHz	SUP3 BW2T102
	350 MHz	500 MHz	SUP3 BW3T52
	350 MHz	1 GHz	SUP3 BW3T102
	500 MHz	1 GHz	SUP3 BW5T102
MDO34	100 MHz	200 MHz	SUP3 BW1T24
	100 MHz	350 MHz	SUP3 BW1T34
	100 MHz	500 MHz	SUP3 BW1T54
	100 MHz	1 GHz	SUP3 BW1T104
	200 MHz	350 MHz	SUP3 BW2T34
	200 MHz	500 MHz	SUP3 BW2T54
	200 MHz	1 GHz	SUP3 BW2T104
	350 MHz	500 MHz	SUP3 BW3T54
	350 MHz	1 GHz	SUP3 BW3T104
	500 MHz	1 GHz	SUP3 BW5T104

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

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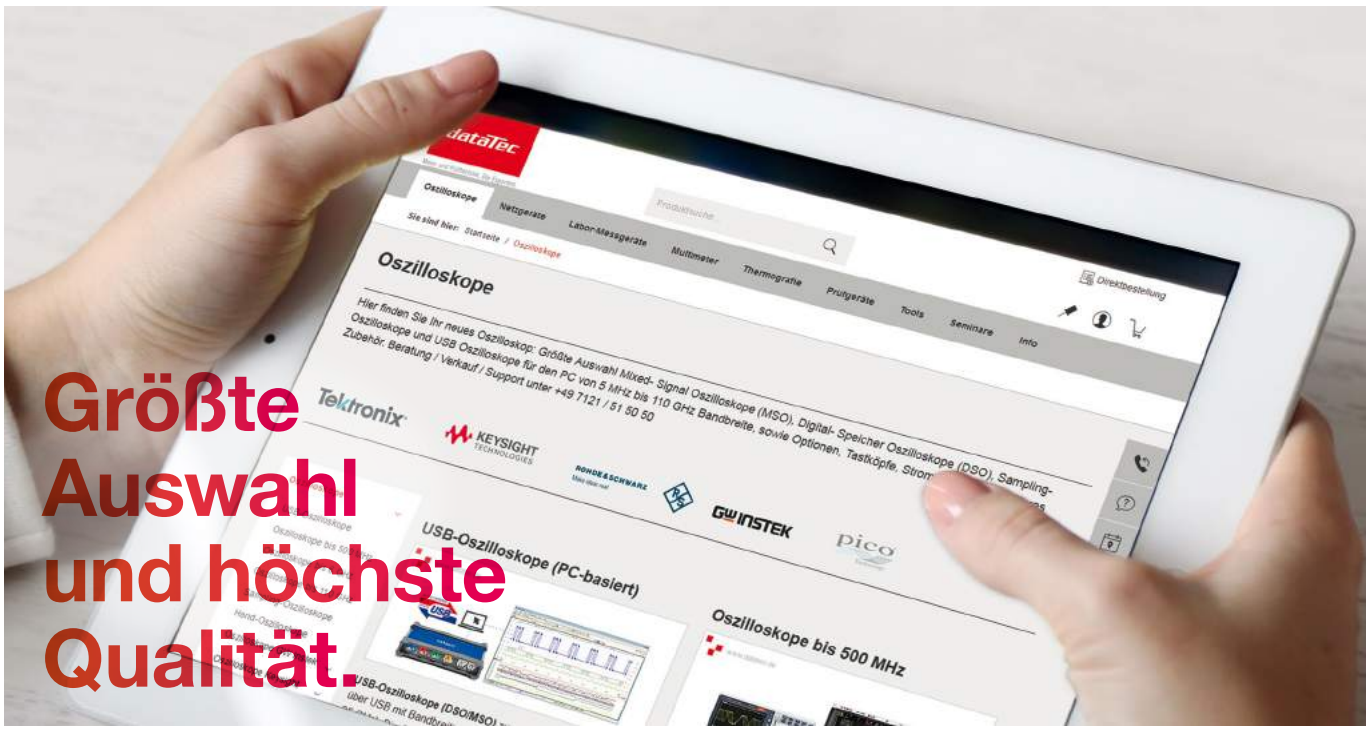

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