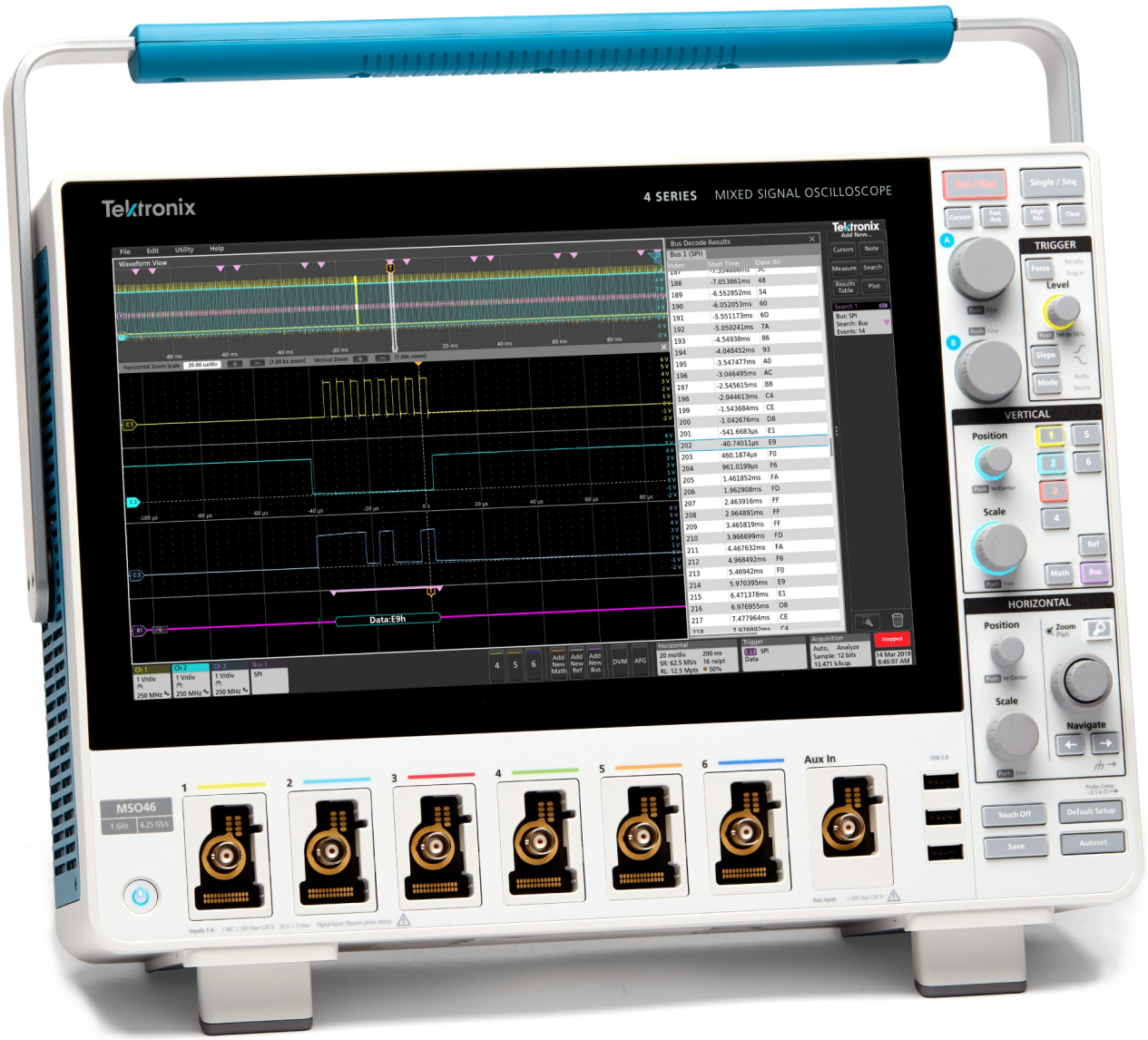
Tektronix®

4 Series MSO

Mixed Signal Oscilloscope Datasheet

More Display. More Signals. More Usability.



Strength in numbers

Input channels

- 4 or 6 FlexChannel® inputs
- Each FlexChannel provides:
  - One analog signal that can be displayed as a waveform view, a spectrum view [1], or both simultaneously
  - Eight digital logic inputs with TLP058 logic probe

Bandwidth (all analog channels)

- 200 MHz, 350 MHz, 500 MHz, 1 GHz, 1.5 GHz (upgradable)

Sample rate (all analog / digital channels)

- Real-time: 6.25 GS/s

Record length (all analog / digital channels)

- 31.25 Mpoints standard (62.5 Mpoints optional upgrade)

Waveform capture rate

- >500,000 waveforms/s

Vertical resolution

- 12-bit ADC
- Up to 16-bits in High Res mode

Standard trigger types

- Edge, Pulse Width, Runt, Timeout, Window, Logic, Setup & Hold, Rise/Fall Time, Parallel Bus, Sequence, Visual Trigger
- Auxiliary Trigger ≤300 V_{RMS} (Edge Trigger only)

Standard analysis

- Cursors: Waveform, V Bars, H Bars, V&H Bars
- Measurements: 36
- FastFrame™: Segmented memory acquisition mode with maximum trigger rate >5,000,000 waveforms per second
- Plots: Time Trend, Histogram and Spectrum
- Math: Basic waveform arithmetic, FFT, and advanced equation editor
- Search: Search on any trigger criteria

Optional analysis

- Spectrum View: Frequency-domain analysis with independent controls for frequency and time domains, RF vs. time traces (magnitude, frequency, phase)
- Power Measurements and Analysis

Optional serial bus trigger, decode and analysis

- I^2C, SPI, I3C, RS-232/422/485/UART, SPMI, CAN, CAN FD, LIN, FlexRay, SENT, USB 2.0, Ethernet, I^2S, LJ, RJ, TDM, MIL-STD-1553, ARINC 429, Spacewire

Arbitrary/Function Generator [1]

- 50 MHz waveform generation
- Waveform Types: Arbitrary, Sine, Square, Pulse, Ramp, Triangle, DC Level, Gaussian, Lorentz, Exponential Rise/Fall, Sin(x)/x, Random Noise, Haversine, Cardiac

Digital voltmeter [2]

- 4-digit AC RMS, DC, and DC+AC RMS voltage measurements

Trigger frequency counter [2]

- 8-digit

Display

- 13.3-inch (338 mm) TFT color
- High Definition (1,920 x 1,080) resolution
- Capacitive (multi-touch) touchscreen

Connectivity

- USB 2.0 Host, USB 2.0 Device (5 ports); LAN (10/100/1000 Base-T Ethernet); HDMI [3]

e*Scope ®

- Remotely view and control the oscilloscope over a network connection through a standard web browser

Warranty

- 3 years standard

Dimensions

- 9.8 in (249 mm) H x 17.7 in (450 mm) W x 6.1 in (155 mm) D
- Weight: <16.8 lbs. (7.6 kg)

With a remarkably innovative pinch-swipe-zoom touchscreen user interface, a high-definition display, and 4 or 6 FlexChannel® inputs that let you measure one analog or eight digital signals per channel, the 4 Series MSO is ready for today's toughest challenges, and tomorrow's too. It sets a new standard for performance, analysis, and overall user experience.

1 Optional and upgradable.

2 Free with product registration.

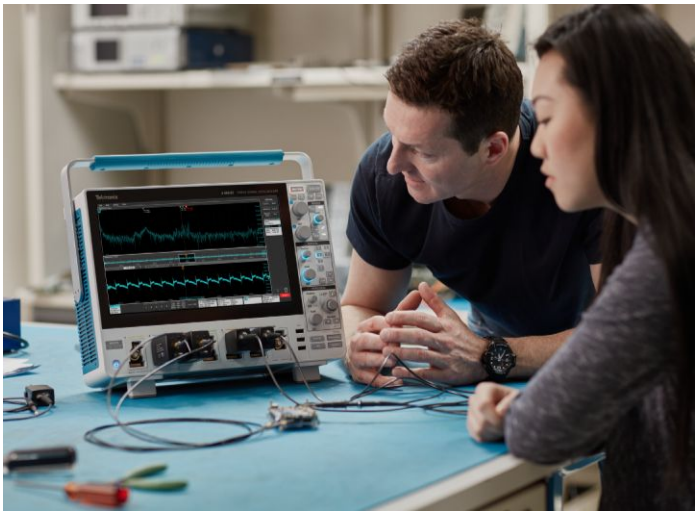
3 Requires connection to high definition display (1,920 x 1,080 resolution).

Never let a lack of channels slow down your verification and debug process again!

The 4 Series MSO offers better visibility into complex systems by offering four and six channel models with a 13.3-inch high-definition (1,920 x 1,080) display. Many applications, such as embedded systems, three-phase power electronics, automotive electronics, power supply design, and DC-to-DC power converters, require the observation of more than four analog signals to verify and characterize device performance, and to debug challenging system issues.

Most engineers can recall situations in which they were debugging a particularly difficult problem and wanted greater system visibility and context, but the scope they were using was limited to two or four analog channels. Using a second scope involves significant effort to align trigger points, difficulty in determining timing relationships across the two displays, and documentation challenges.

And while you might assume that a six channel scope would cost 50% more than a four-channel scope, you'll be pleasantly surprised to find that six channel models are only ~20% more than four channel models. The additional analog channels can pay for themselves quickly by enabling you to keep current and future projects on schedule.



Voltage measurements on a switch-mode power supply showing the ripple voltage on one of the power rails.

FlexChannel® technology enables maximum flexibility and broader system visibility

The 4 Series MSO redefines what a Mixed Signal Oscilloscope (MSO) should be. FlexChannel technology enables each channel input to be used as a single analog channel, eight digital logic inputs (with the TLP058 logic probe), or simultaneous analog and spectrum views [4] with independent acquisition controls for each domain. Imagine the flexibility and configurability this provides.

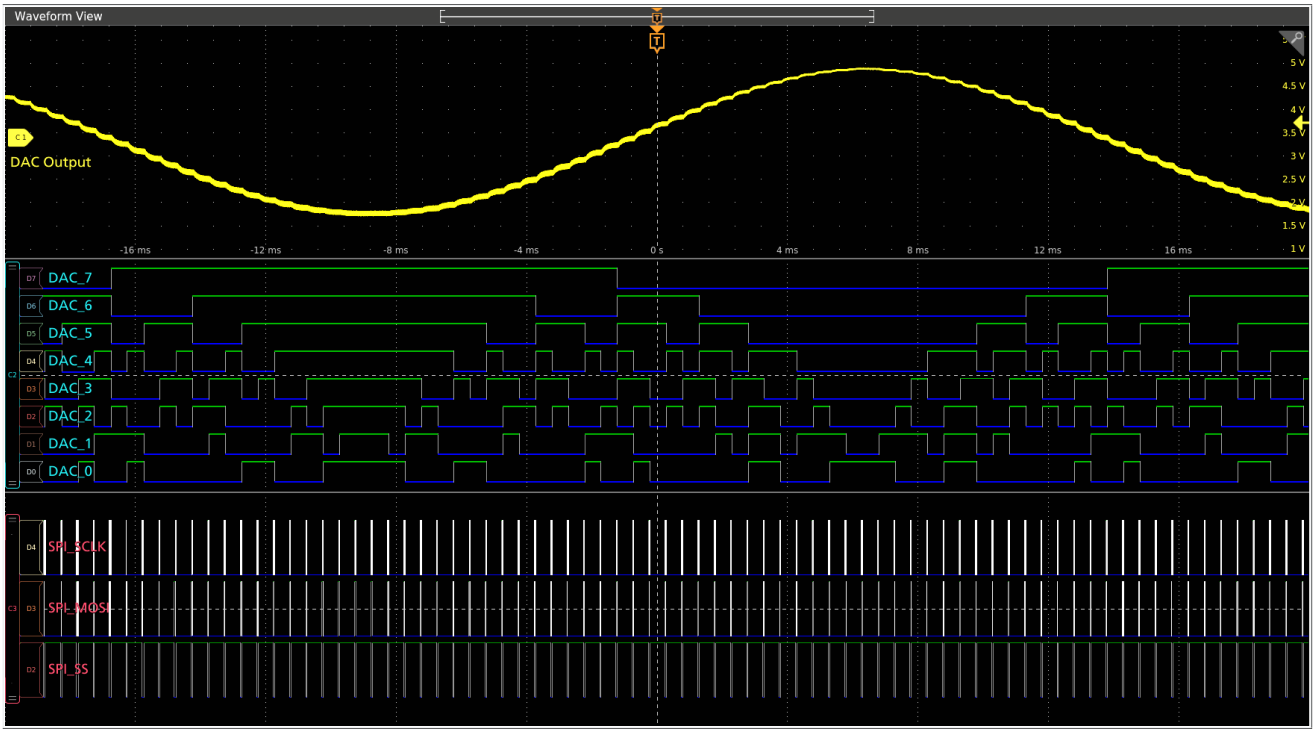
With a six FlexChannel model, you can configure the instrument to look at six analog and zero digital signals. Or five analog and eight digital. Or four analog and 16 digital, three analog and 24 digital and so on. You can change the configuration at any time by simply adding or removing TLP058 logic probes, so you always have the right number of digital channels.

FlexChannel technology enables the ultimate in flexibility. Each input can be configured as a single analog or eight digital channels based on the type of probe you attach.

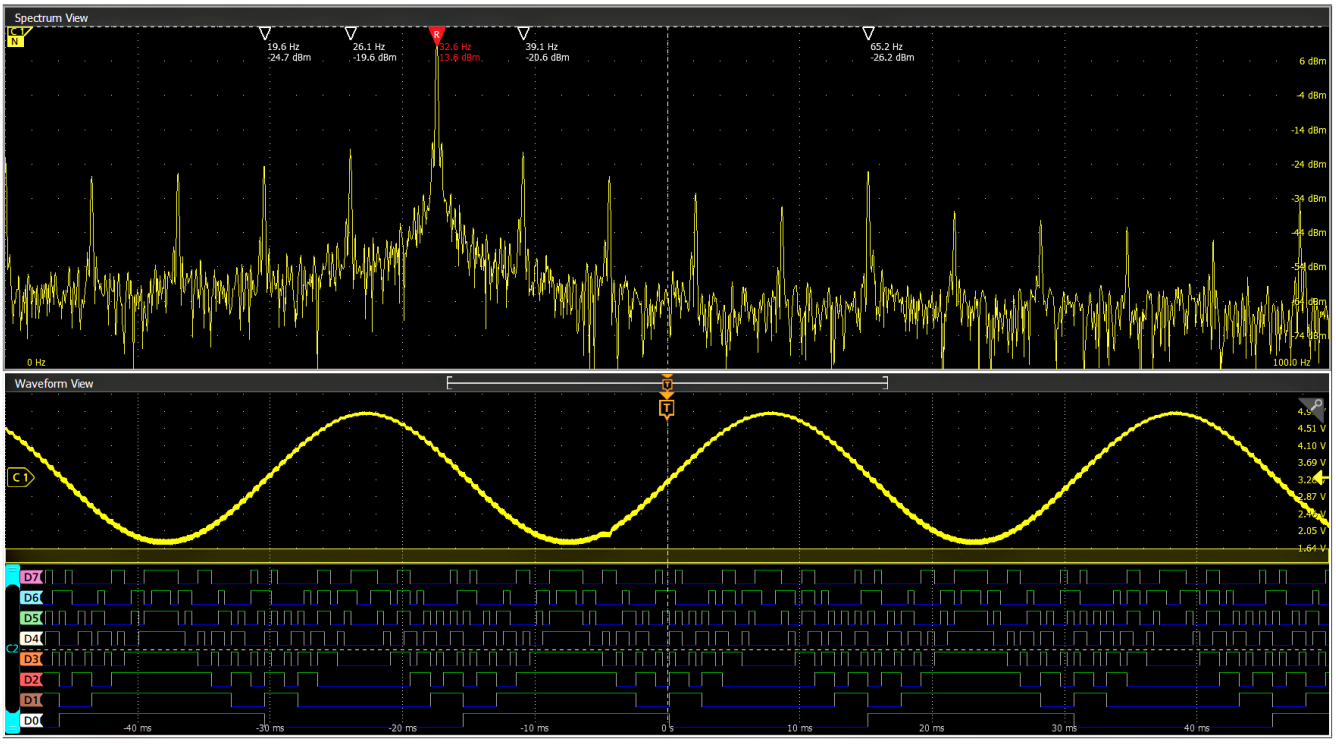
Previous-generation MSOs required tradeoffs, with digital channels having lower sample rates or shorter record lengths than analog channels. The 4 Series MSO offers a new level of integration of digital channels. Digital channels share the same high sample rate (up to 6.25 GS/s), and long record length (up to 62.5) Points for analog channels.

The TLP058 provides eight high performance digital inputs. Connect as many TLP058 probes as you like, enabling up to a maximum of 48 digital channels.

4 Optional.



Channel 2 has a TLP058 Logic Probe connected to the eight inputs of a DAC. Notice the green and blue color coding, where ones are green and zeros are blue. Another TLP058 Logic Probe on Channel 3 is probing the SPI bus driving the DAC. The white edges indicate higher frequency information is available by either zooming in or moving to a faster sweep speed on the next acquisition.

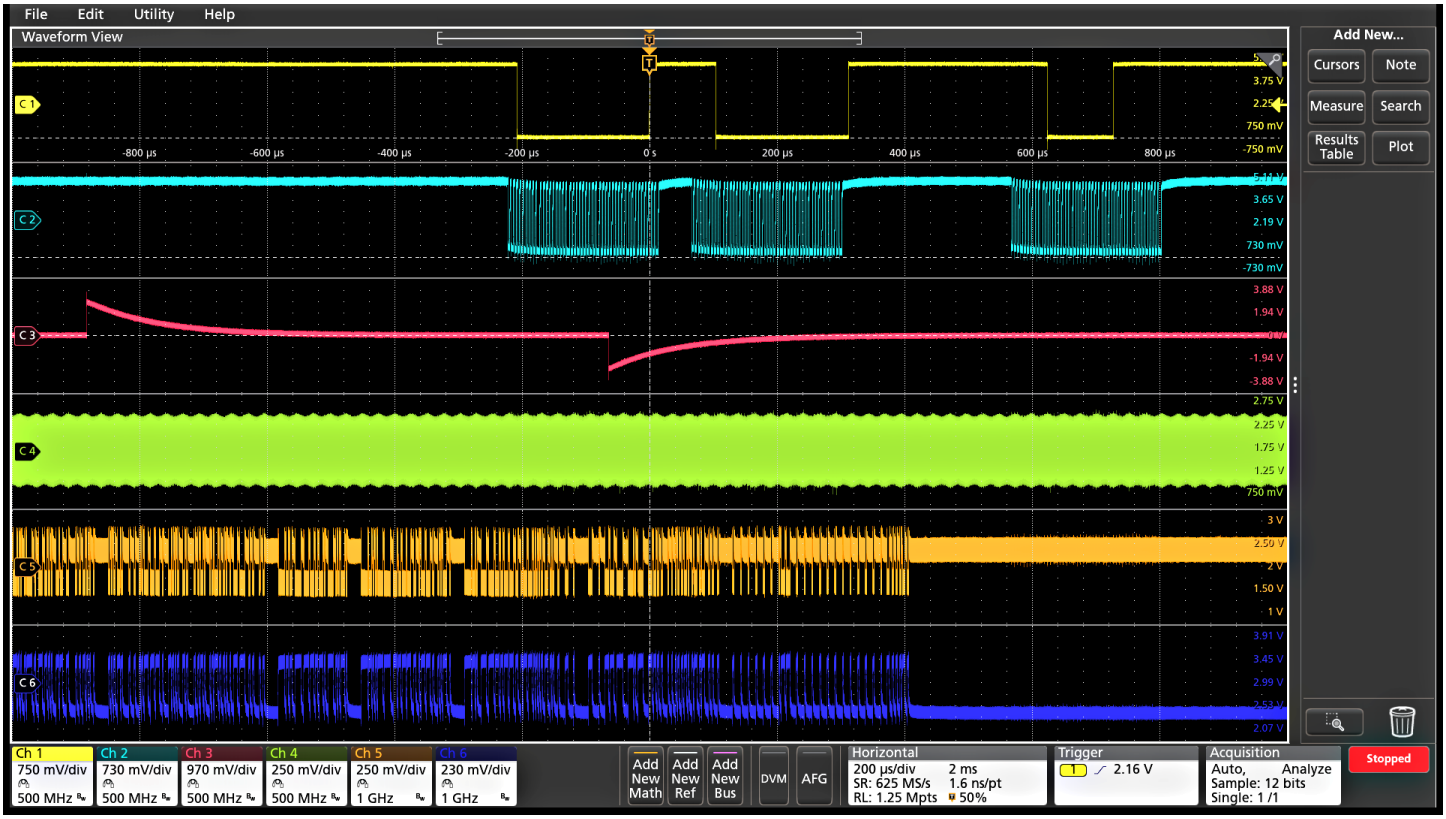


Beyond just analog and digital, FlexChannel inputs include Spectrum View. This Tektronix-patented technology enables you to simultaneously view both analog and spectral views of all your analog signals, with independent controls in each domain.

Unprecedented signal viewing capability

The stunning 13.3-inch (338 mm) display in the 4 Series MSO is the largest display in its class. It is also the highest resolution display, with full HD resolution (1,920 x 1,080), enabling you to see many signals at once with ample room for critical readouts and analysis.

The viewing area is optimized to ensure that the maximum vertical space is available for waveforms. The Results Bar on the right can be hidden, enabling the waveform view to use the full width of the display.



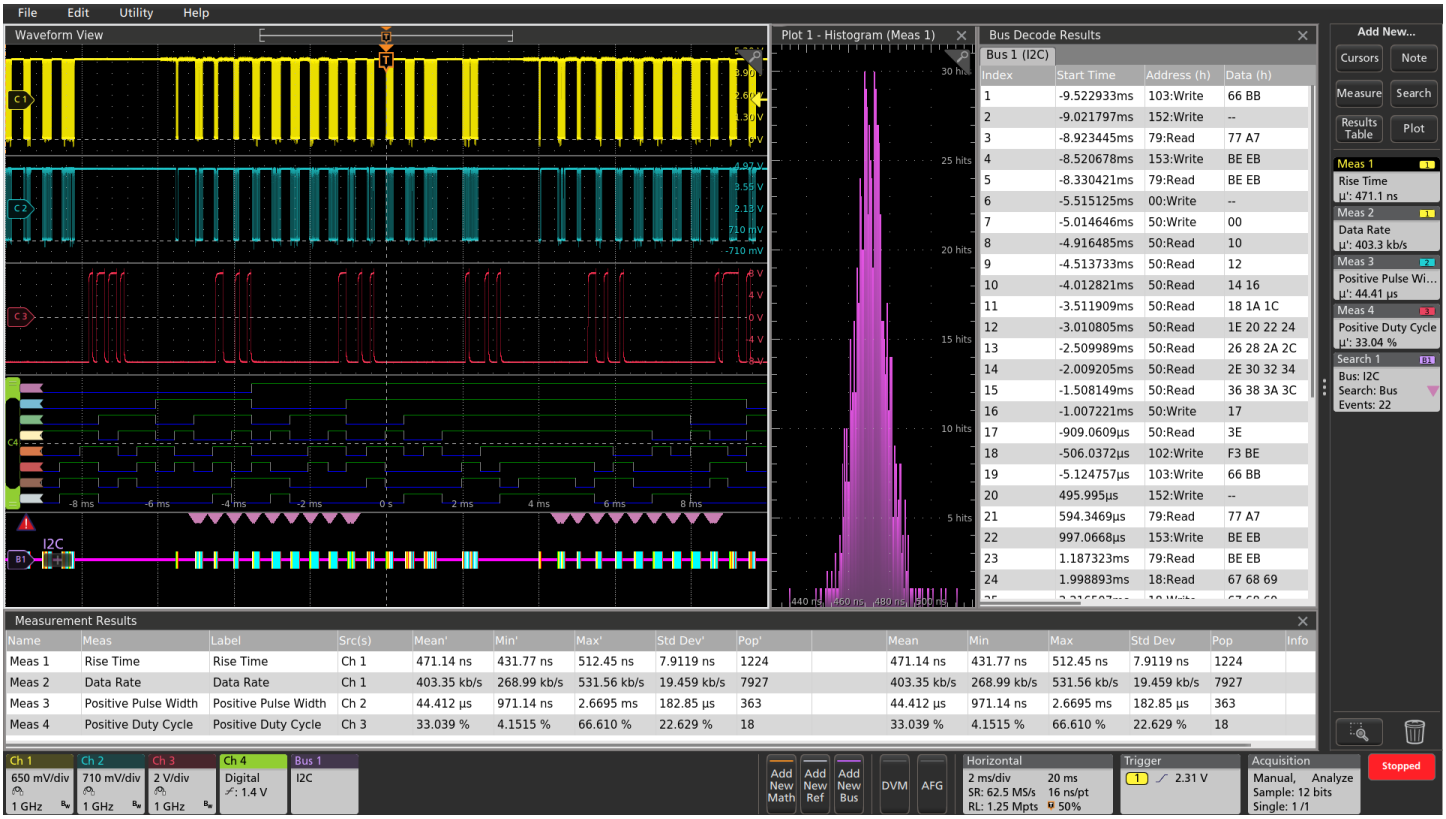
Stacked display mode enables easy visibility of all waveforms while maintaining maximum ADC resolution on each input for the most accurate measurements.

The 4 Series MSO offers a revolutionary new Stacked display mode. Historically, scopes have overlaid all waveforms in the same graticule, forcing difficult tradeoffs:

- To make each waveform visible, you vertically scale and position each waveform so that they don't overlap. Each waveform uses a small percentage of the available ADC range, leading to less accurate measurements.
- For measurement accuracy, you vertically scale and position each waveform to cover the entire display. The waveforms overlap each other, making it hard to distinguish signal details on individual waveforms

The new Stacked display eliminates this tradeoff. It automatically adds and removes additional horizontal waveform 'slices' (additional graticules) as waveforms are created and removed. Each slice represents the full ADC range for the waveform. All waveforms are visually separated from each other while still using the full ADC range, enabling maximum visibility and accuracy. And it's all done automatically as waveforms are added or removed! Channels can easily be reordered in stacked display mode by dragging and dropping the channel and waveform badges in the Settings bar at the bottom of the display. Groups of channels can also be overlaid within a slice to simplify visual comparison of signals.

The large display in the 4 Series MSO also provides plenty of viewing area not only for signals, but also for plots, measurement results tables, bus decode tables and more. You can easily resize and relocate the various views to suit your application.



Viewing three analog channels, eight digital channels, a decoded serial bus waveform, decoded serial packet results table, four measurements, a measurement histogram, measurements results table with statistics and a search on serial bus events - simultaneously!

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

The Settings Bar - key parameters and waveform management

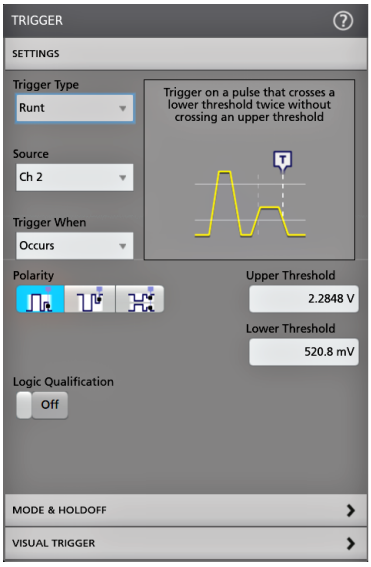
Waveform and scope operating parameters are displayed in a series of "badges" in the Settings Bar that runs along the bottom of the display. The Settings Bar provides Immediate access for the most common waveform management tasks. With a single tap, you can:

- Turn on channels
- Add math waveforms
- Add reference waveforms
- Add bus waveforms
- Enable the optional integrated Arbitrary/Function generator (AFG)
- Enable the optional 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, measurement and bus decode results tables, plots, and notes.

DVM, measurement 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.



Configuration menus are accessed by simply double-tapping on the item of interest on the display. In this case, the Trigger badge was double-tapped to open the Trigger configuration menu.

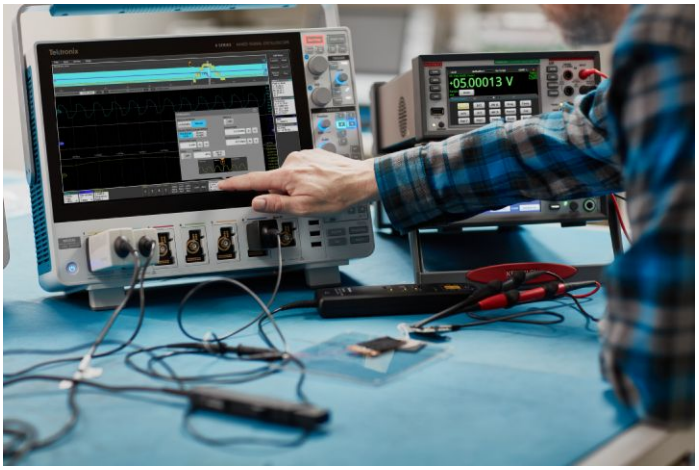
Touch interaction finally done right

Scopes have included touch screens for years, but the touch interface has been an afterthought. The 4 Series MSO's display includes a capacitive touchscreen and provides the industry's first oscilloscope 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 4 Series MSO.

- 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
- Drag items to the trash can to delete them
- 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.

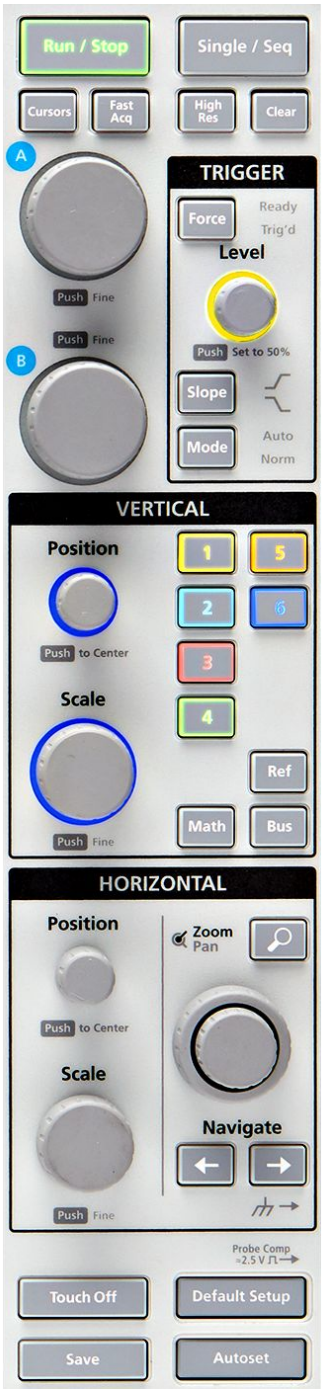


Interact with the capacitive touch display in the same way you do on your phones and tablets.

Attention to detail in the front-panel controls

Traditionally, the front face of a scope has been roughly 50% display and 50% controls. The 4 Series MSO display fills about 75% of the face of the instrument. To achieve this, it has a streamlined front panel that retains critical controls for simple intuitive operation, but with a reduced number of menu buttons for functions directly accessed via objects on the display.

Color-coded LED light rings indicate trigger source and vertical scale/ position knob assignments. Large, dedicated Run/ Stop and Single Sequence buttons are placed prominently in the upper right, and other functions like Force Trigger, Trigger Slope, Trigger Mode, Default Setup, Autoset and Quick-save functions are all available using dedicated front panel buttons.

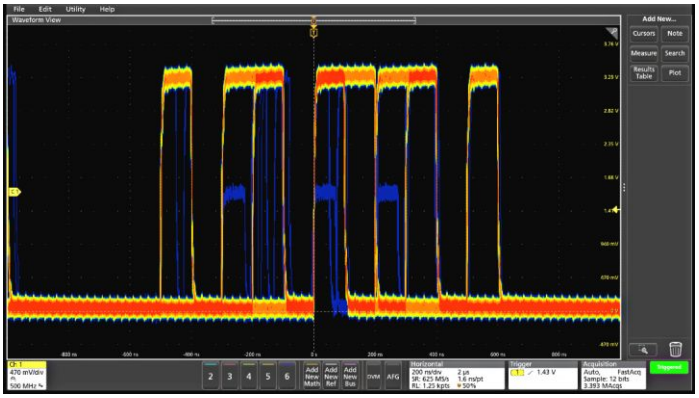


Efficient and intuitive front panel provides critical controls while still leaving room for the largehigh definition display.

Experience the performance difference

Digital Phosphor technology with FastAcq™ high-speed waveform capture

To debug a design problem, first you must know it exists. Digital phosphor technology with FastAcq provides you with fast insight into the real operation of your device. Its fast waveform capture rate - greater than 500,000 waveforms per second - gives you a high probability of 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 indicates how often rare transients are occurring relative to normal signal characteristics.



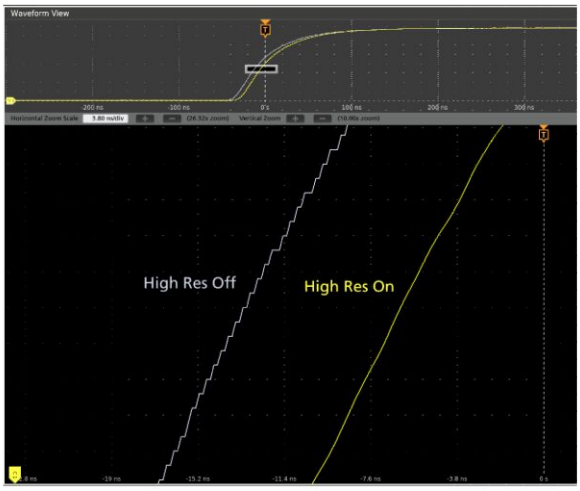
FastAcq's high waveform capture rate enables you to discover infrequent problems common in digital design.

Industry leading vertical resolution

The 4 Series MSO provides the performance to capture the signals of interest while minimizing the effects of unwanted noise when you need to capture high-amplitude signals while seeing smaller signal details. At the heart of the 4 Series MSO are 12-bit analog-to-digital converters (ADCs) that provide 16 times the vertical resolution of traditional 8-bit ADCs.

A new High Res mode applies a hardware-based unique Finite Impulse Response (FIR) filter based on the selected sample rate. The FIR filter maintains the maximum bandwidth possible for that sample rate while preventing aliasing and removing noise from the oscilloscope amplifiers and ADC above the usable bandwidth for the selected sample rate. High Res mode always provides at least 12 bits of vertical resolution and extends all the way to 16 bits of vertical resolution at ≤125 MS/s sample rates.

New lower-noise front end amplifiers further improve the 4 Series MSO's ability to resolve fine signal detail.



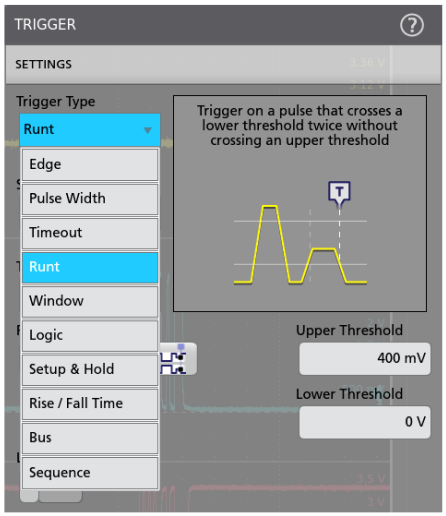
The 4 Series MSO's 12-bit ADC, along with the new High Res mode, enable industry leading vertical resolution.

Triggering

Discovering a device fault is only the first step. Next, you must capture the event of interest to identify root cause. The 4 Series MSO provides a complete set of advanced triggers, including:

- Runt
- Logic
- Pulse width
- Window
- Timeout
- Rise/Fall time
- Setup and Hold violation
- Serial packet
- Parallel data
- Sequence
- Visual Trigger

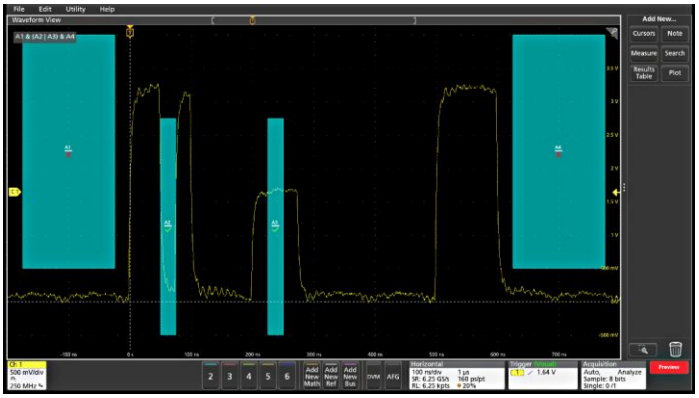
With up to a 62.5 Mpoint record length, you can capture many events of interest, even thousands of serial packets in a single acquisition, providing high-resolution to zoom in on fine signal details and record reliable measurements.



The wide variety of trigger types and context-sensitive help in the trigger menu make it easier than ever to isolate the event of interest.

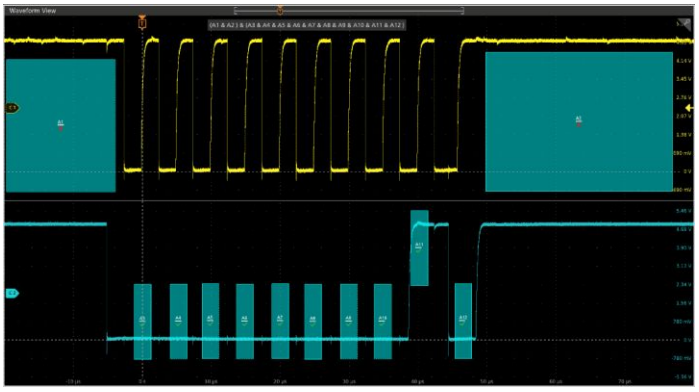
Visual Trigger - finding the signal of interest quickly – Finding the right cycle of a complex bus can require hours of collecting and sorting through thousands of acquisitions for an event of interest. Defining a trigger that isolates the desired event speeds up debug and analysis efforts.

Visual Trigger extends the instrument's triggering capabilities by scanning through all waveform acquisitions and comparing them to on-screen areas (geometric shapes). You can create an unlimited number of areas using the mouse or touchscreen, and a variety of shapes (triangles, rectangles, hexagons, or trapezoids) can be used to specify the desired trigger behavior. Once shapes are created, they can be edited interactively to create custom shapes and ideal trigger conditions. Once multiple areas are defined, a Boolean logic equation can be used to set complex trigger conditions using on-screen editing features.



Visual Trigger areas isolate an event of interest, saving time by only capturing the events you want to see.

By triggering only on the most important signal events, Visual Trigger can save hours of capturing and manually searching through acquisitions. In seconds or minutes, you can find the critical events and complete your debug and analysis efforts. Visual Trigger even works across multiple channels, extending its usefulness to complex system troubleshooting and debug tasks.



Multiple channel triggering. Visual Trigger areas can be associated with events spanning multiple channels, such as triggering on a specific burst-width on channel 1 and a specified bit pattern on channel 2.

Accurate high-speed probing

The TPP Series passive voltage probes offer all the benefits of general-purpose probes -- high dynamic range, flexible connection options, and robust mechanical design -- while providing the performance of active probes. Up to 1 GHz analog bandwidth enables you to see high frequency components in your signals, and extremely low 3.9 pF capacitive loading minimizes adverse effects on your circuits and is more forgiving of longer ground leads.

An optional, low-attenuation (2X) version of the TPP probe is available for measuring low voltages. Unlike other low-attenuation passive probes, the TPP0502 has high bandwidth (500 MHz) as well as low capacitive loading (12.7 pF).

4 Series MSOs come standard with four probes for four or six channel models (TPP0250 for 200 MHz models; TPP0500B for 350 MHz, 500 MHz, 1 GHz, and 1.5 GHz models).

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, many 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 or LAN, enabling more versatile solutions in ATE environments. The 4 Series MSO provides up to 80 W of power to the front panel connectors, sufficient to power all connected TekVPI probes without the need for an additional probe power supply.

IsoVu™ Isolated Measurement System

Whether designing an inverter, optimizing a power supply, testing communication links, measuring across a current shunt resistor, debugging EMI or ESD issues, or trying to eliminate ground loops in your test setup, common mode interference has caused engineers to design, debug, evaluate, and optimize "blind" until now.

Tektronix' revolutionary IsoVu technology uses optical communications and power-over-fiber for complete galvanic isolation. When combined with the 4 Series MSO equipped with the TekVPI interface, it is the first, and only, measurement system capable of accurately resolving high bandwidth, differential signals, in the presence of large common mode voltage with:

- Complete galvanic isolation
- Up to 1 GHz bandwidth
- 1 Million to 1 (120 dB) common mode rejection at 100 MHz
- 10,000 to 1 (80 dB) of common mode rejection at full bandwidth
- Up to 2,500 V differential dynamic range
- 60 kV common mode voltage range

The Tektronix TIVM Series IsoVu™ Measurement System offers a galvanically isolated measurement solution to accurately resolve high bandwidth, differential signals up to 2,500 Vpk in the presence of large common mode voltages, with the best in class common mode rejection performance across its bandwidth.

Comprehensive analysis for fast insight

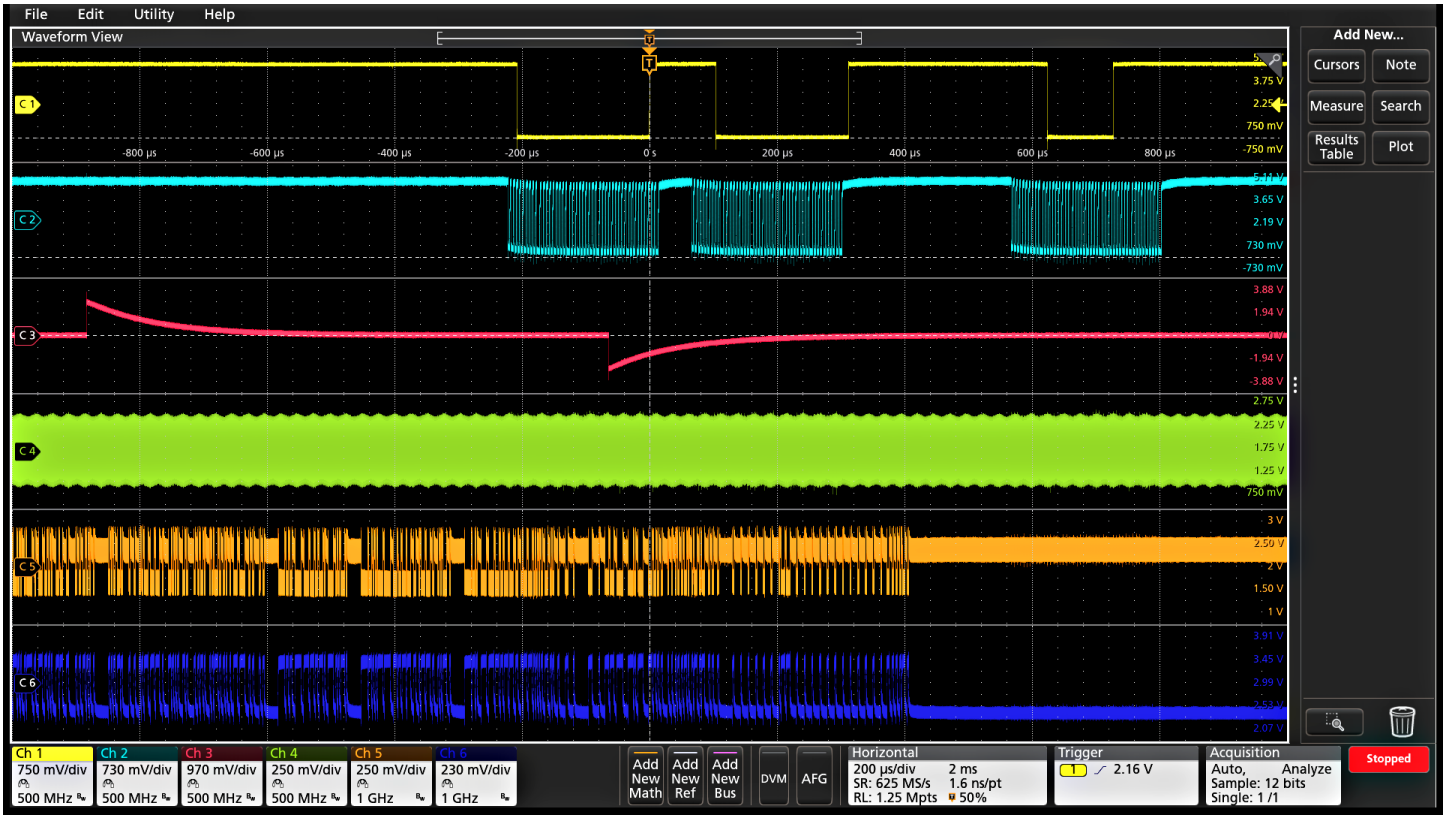
Basic waveform analysis

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 4 Series MSO offers a comprehensive set of standard analysis tools including:

- Waveform- and screen-based cursors
- 36 automated measurements. Measurement results include all instances in the record, the ability to navigate from one occurrence to the next, and immediate viewing of the minimum or maximum result found in the record
- Basic waveform math
- Basic FFT analysis
- Advanced waveform math including arbitrary equation editing with filters and variables
- FastFrame™ Segmented Memory enables you to make efficient use of the oscilloscope's acquisition memory by capturing many trigger events in a single record while eliminating the large time gaps between events of interest. View and measure the segments individually or as an overlay.

Measurement results tables provide comprehensive statistical views of measurement results with statistics across both the current acquisition and all acquisitions.



Using multiple channels to visualize multiple clock and data lines.

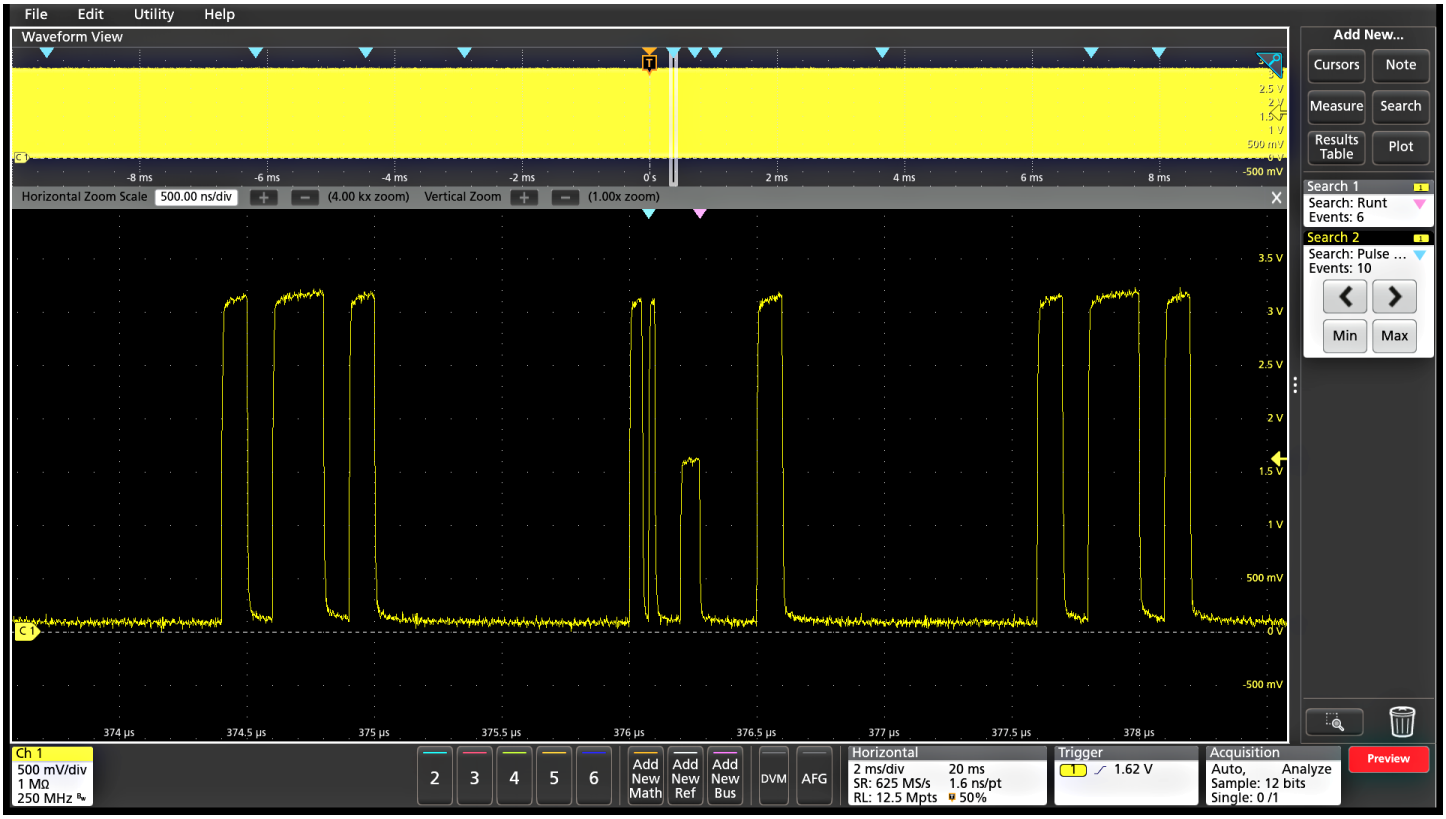
Navigation and search

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 4 Series MSO offers the industry's most comprehensive search and waveform navigation with its innovative Wave Inspector® controls. These controls speed panning and zooming through your record. With a unique force-feedback system, you can move from one end of your record to the other in just seconds. Or, use intuitive drag and pinch/expand gestures on the display itself 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 front panel or on the Search badge on the display. Search types include edge, pulse width, timeout, runt, window, logic, setup and hold, rise/fall time and parallel/serial bus packet content. You can define as many unique searches as you like.

You can also quickly jump to the minimum and maximum value of search results by using the Min and Max buttons on the Search badge.

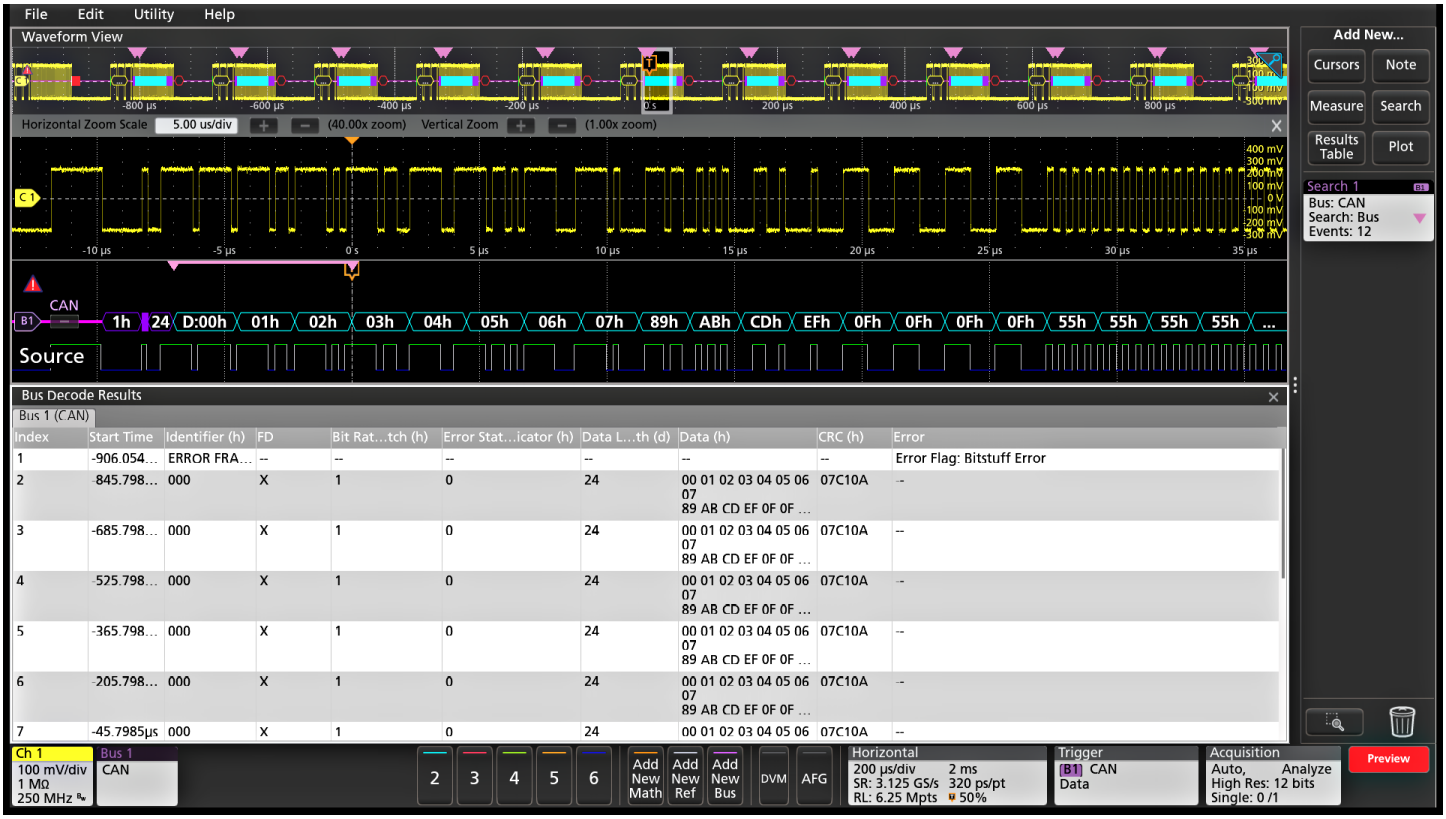


Earlier, FastAcq revealed the presence of a runt pulse in a digital data stream prompting further investigation. In this acquisition, Search 1 reveals that there are six runt pulses in the acquisition.

Serial protocol triggering and analysis (optional)

During debugging, it can be invaluable to trace the flow of activity through a system by observing the traffic on one or more serial buses. It could take many minutes to manually decode a single serial packet, much less the thousands of packets that may be present in a long acquisition.

And if you know the event of interest that you are attempting to capture occurs when a particular command is sent across a serial bus, wouldn't it be nice if you could trigger on that event? Unfortunately, it's not as easy as simply specifying an edge or a pulse width trigger.



Triggering on a CAN serial bus. A bus waveform provides time-correlated decoded packet content including Start, Arbitration, Control, Data, CRC and ACK while the bus decode table presents all packet content from the entire acquisition.

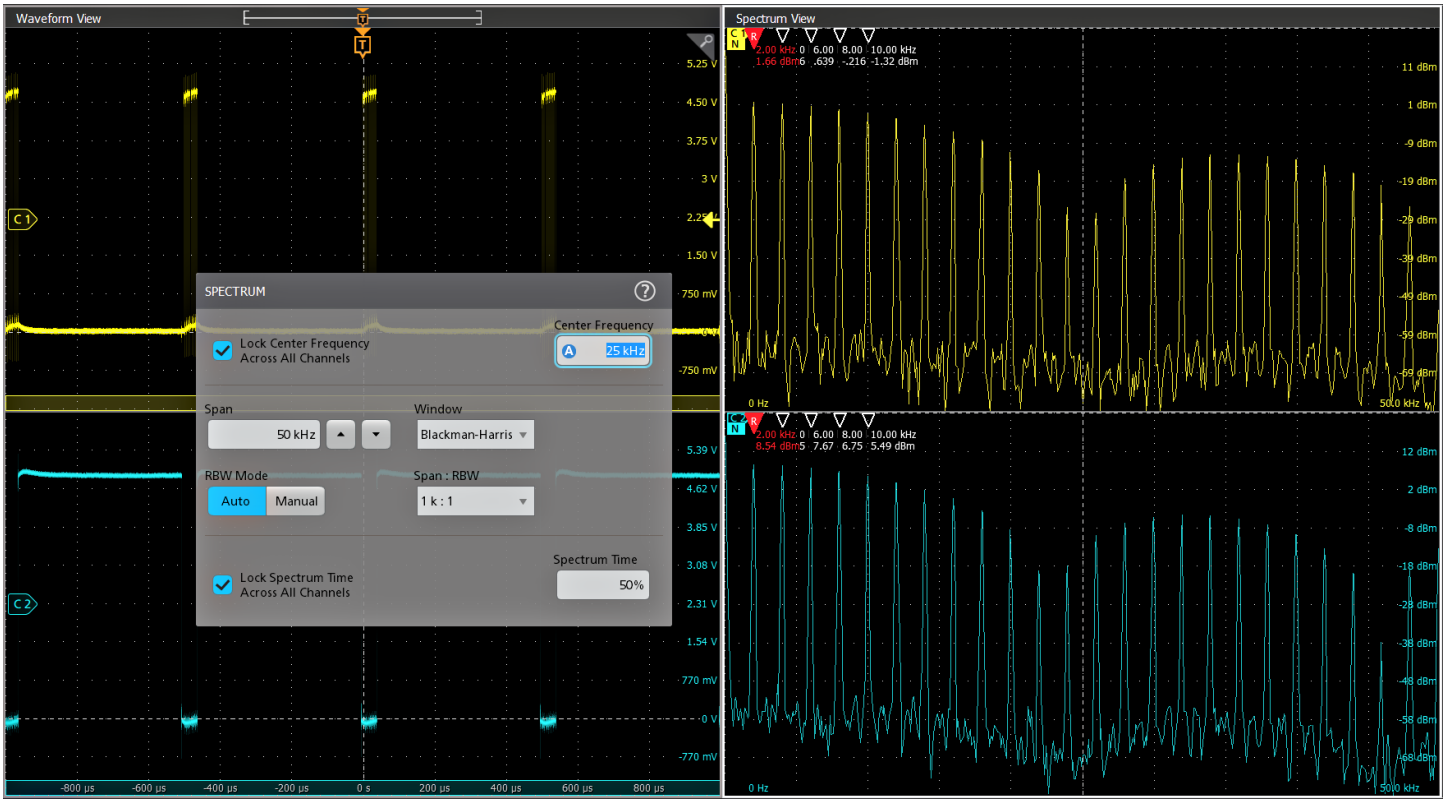
The 4 Series MSO offers a robust set of tools for working with the most common serial buses found in embedded design including I^2C, SPI, I3C, RS-232/422/485/UART, SPMI, CAN, CAN FD, LIN, FlexRay, SENT, USB LS/FS/HS, Ethernet 10/100, Audio (I^2S/LJ/RJ/TDM), MIL-STD-1553, ARINC 429, and Spacewire.

Serial protocol search enables you to search through a long acquisition of serial packets and find the ones that contain the specific packet content you specify. Each occurrence is highlighted by a search mark. Rapid navigation between marks is as simple as pressing the Previous (←) and Next (→) buttons on the front panel or in the Search badge that appears in the Results Bar.

The tools described for serial buses also work on parallel buses. Support for parallel buses is standard in the 4 Series MSO. Parallel buses can be up to 48 bits wide and can include a combination of analog and digital channels.

- Serial protocol triggering lets you trigger on specific packet content including start of packet, specific addresses, specific data content, unique identifiers, and errors.
- Bus waveforms provide a higher-level, combined view of the individual signals (clock, data, chip enable, and so on) 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, and so on.
- The bus waveform is time aligned with all other displayed signals, making it easy to measure timing relationships across various parts of the system under test.
- Bus decode tables provide a tabular view of all decoded packets in an acquisition much like you would see in a software listing. Packets are time stamped and listed consecutively with columns for each component (Address, Data, and so on).

Spectrum View (optional)



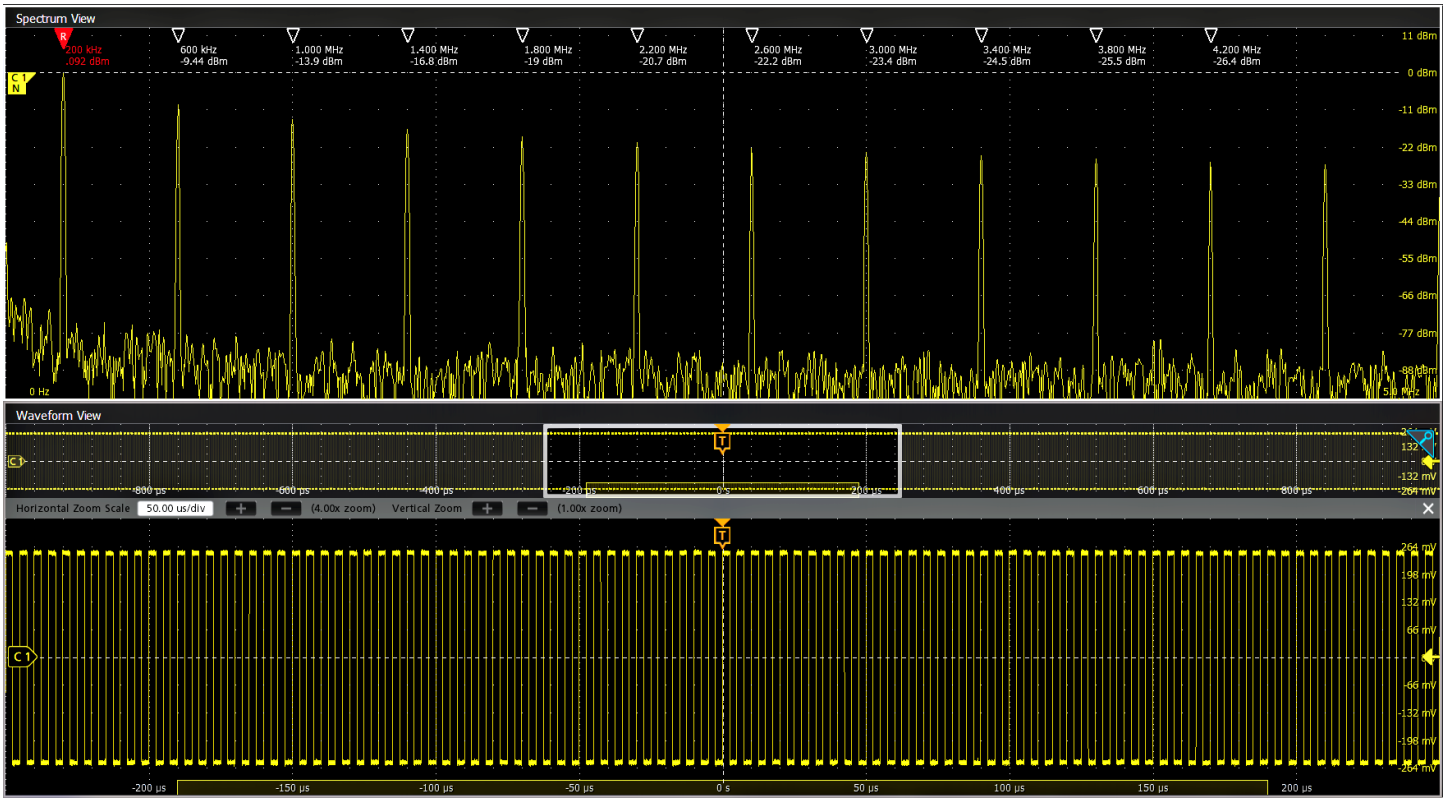
Intuitive spectrum analyzer controls like center frequency, span and resolution bandwidth (RBW), independent from time domain controls, provide easy setup for frequency domain analysis. A spectrum view is available for each FlexChannel analog input, enabling multi-channel mixed domain analysis.

It is often easier to debug an issue by viewing one or more signals in the frequency domain. Oscilloscopes have included math-based FFTs for decades in an attempt to address this need. However, FFTs are notoriously difficult to use for two primary reasons.

First, when performing frequency-domain analysis, you think about controls like Center Frequency, Span, and Resolution Bandwidth (RBW), as you would typically find on a spectrum analyzer. But then you use an FFT, where you are stuck with traditional scope controls like sample rate, record length and time/div and have to perform all the mental translations to try to get the view you're looking for in the frequency-domain.

Second, FFTs are driven by the same acquisition system that's delivering the analog time-domain view. When you optimize acquisition settings for the analog view, your frequency-domain view isn't what you want. When you get the frequency-domain view you want, your analog view is not what you want. With math-based FFTs, it is virtually impossible to get optimized views in both domains.

Spectrum View changes all of this. Tektronix' patented technology provides both a decimator for the time-domain and a digital downconverter for the frequency-domain behind each FlexChannel. The two different acquisition paths let you simultaneously observe both time- and frequency-domain views of the input signal with independent acquisition settings for each domain. Other manufacturers offer various 'spectral analysis' packages that claim ease-of-use, but they all exhibit the limitations described above. Only Spectrum View provides both exceptional ease-of-use and the ability to achieve optimal views in both domains simultaneously.

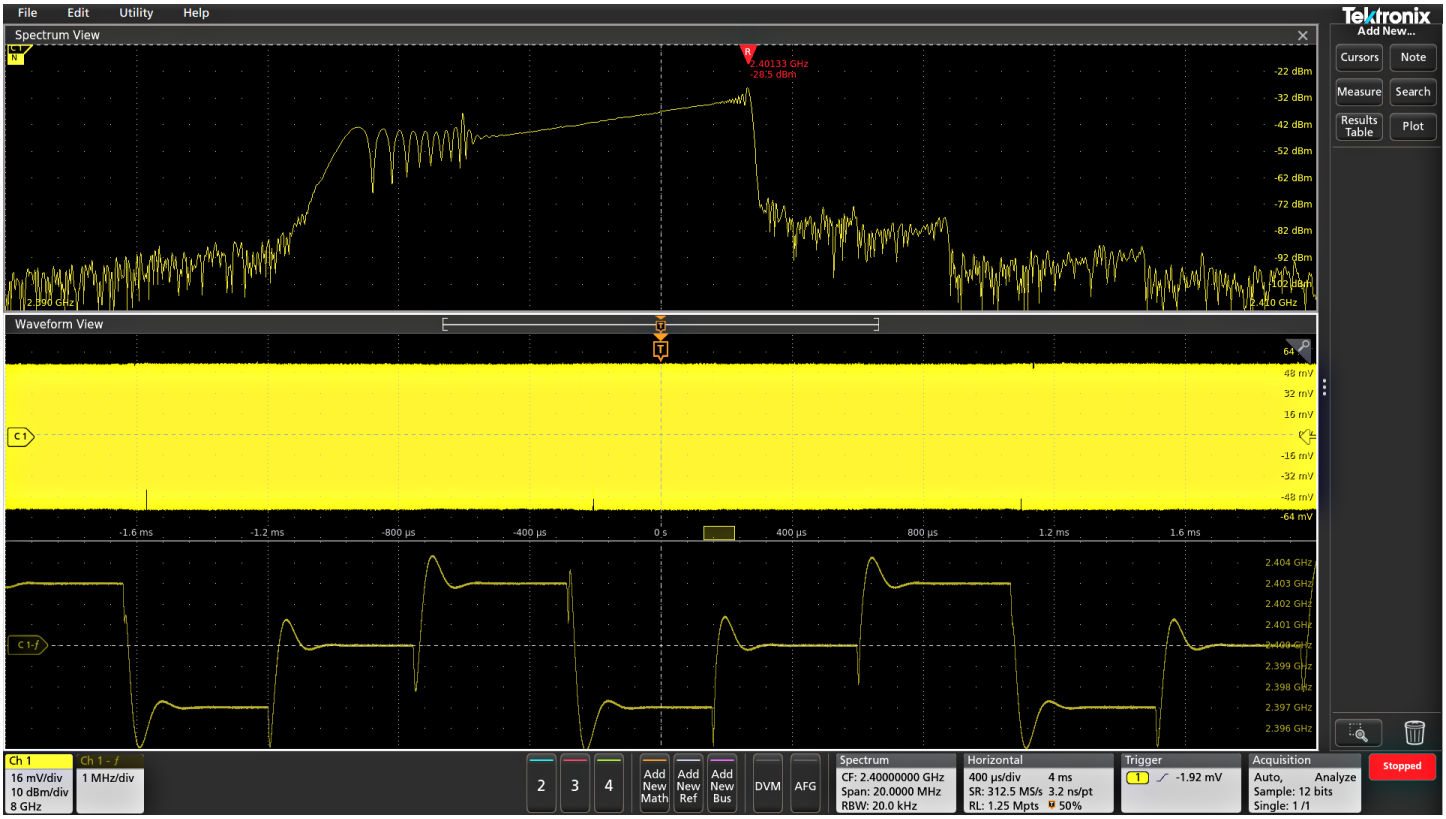


Spectrum Time gates the range of time where the FFT is being calculated. Represented by a small graphical rectangle in the time domain view, it can be positioned to provide time correlation with the time domain waveform. Perfect for conducting Mixed Domain Analysis. Up to 11 automated peak markers provide frequency and magnitude values of each peak. The Reference marker is always the highest peak shown and is indicated in red.

Visualizing changes in the RF signal – RF time domain traces make it easy to understand what's happening with a time-varying RF signal. There are three RF time domain traces that are derived from the underlying I and Q data of Spectrum View:

- Magnitude – The instantaneous amplitude of the spectrum vs. time.
- Frequency – The instantaneous frequency of the spectrum relative to the center frequency vs. time.
- Phase – The instantaneous phase of the spectrum relative to the center frequency vs. time.

Each of these traces can be turned on and off independently, and all three can be displayed simultaneously.

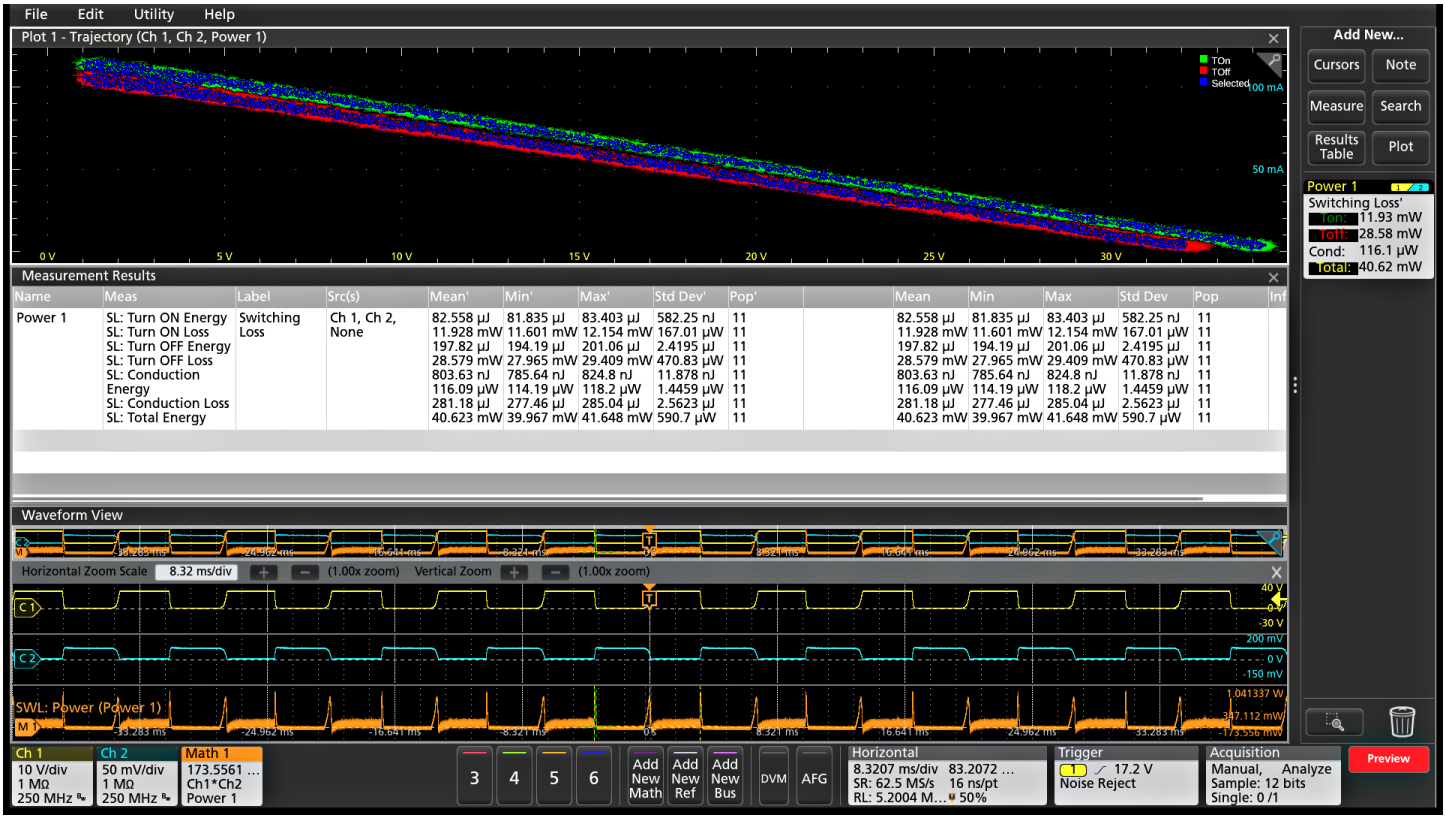


The lower trace is the frequency vs. time trace derived from the input signal. Notice that the Spectrum Time is positioned during a transition from the lowest frequency to the middle frequency, so the energy is spread across a number of frequencies. With the frequency vs. time trace, you can easily see the different frequency hops, simplifying characterization of how the device switches between frequencies.

Power analysis (optional)

The 4 Series MSO has also integrated the optional 4-PWR-BAS/SUP4-PWR-BAS power analysis package into the oscilloscope's automatic measurement system to enable quick and repeatable analysis of power quality, input capacitance, in-rush current, harmonics, switching loss, safe operating area (SOA), modulation, ripple, efficiency, amplitude and timing measurements, and slew rate (dv/dt and di/dt).

Measurement automation optimizes the measurement quality and repeatability at the touch of a button, without the need for an external PC or complex software setup.



The Power Analysis measurements display a variety of waveforms and plots.

Designed with your needs in mind

Connectivity

The 4 Series MSO contains a number of ports which you can use to connect the instrument to a network, directly to a PC, or to other test equipment.

- Three USB 2.0 ports on the front and two more USB 2.0 host ports on the rear panel enable easy transfer of screen shots, instrument settings, and waveform data to a USB mass storage device. A USB mouse and keyboard can also be attached to USB host ports for instrument control and data entry.
- The rear panel USB Device port is useful for controlling the oscilloscope remotely from a PC.
- The standard 10/100/1000BASE-T Ethernet port on the rear of the instrument enables easy connection to networks and provides LXI Core 2011 compatibility.
- The HDMI port on the rear of the instrument lets you duplicate the instrument display on an external monitor or projector with 1,920 x 1,080 resolution.

The I/O you need to connect the 4 Series MSO to the rest of your design environment.

Remote operation to improve collaboration

Want to collaborate with a design team on the other side of the world?

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. Control the oscilloscope remotely in the exact same way that you do in-person.

The industry-standard TekVISA™ protocol interface is included for using and enhancing Windows applications for data analysis and documentation. IVI-COM instrument drivers are included to enable easy communication with the oscilloscope using LAN or USBTMC connections from an external PC.

*e*Scope provides simple remote viewing and control using common web browsers.*

Arbitrary/Function Generator (AFG)

The instrument contains an optional integrated arbitrary/function generator, 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. The AFG can load waveform records up to 128 k points in size from an internal file location or a USB mass storage device.

The AFG feature is compatible with Tektronix' ArbExpress PC-based waveform creation and editing software, making creation of complex waveforms fast and easy.

Digital Voltmeter (DVM) and Trigger Frequency Counter

The instrument contains an integrated 4-digit digital voltmeter (DVM) and 8-digit trigger 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 trigger frequency counter provides a very precise readout of the frequency of the trigger event on which you're triggering.

Both the DVM and trigger frequency counter are available for free and are activated when you register your product.

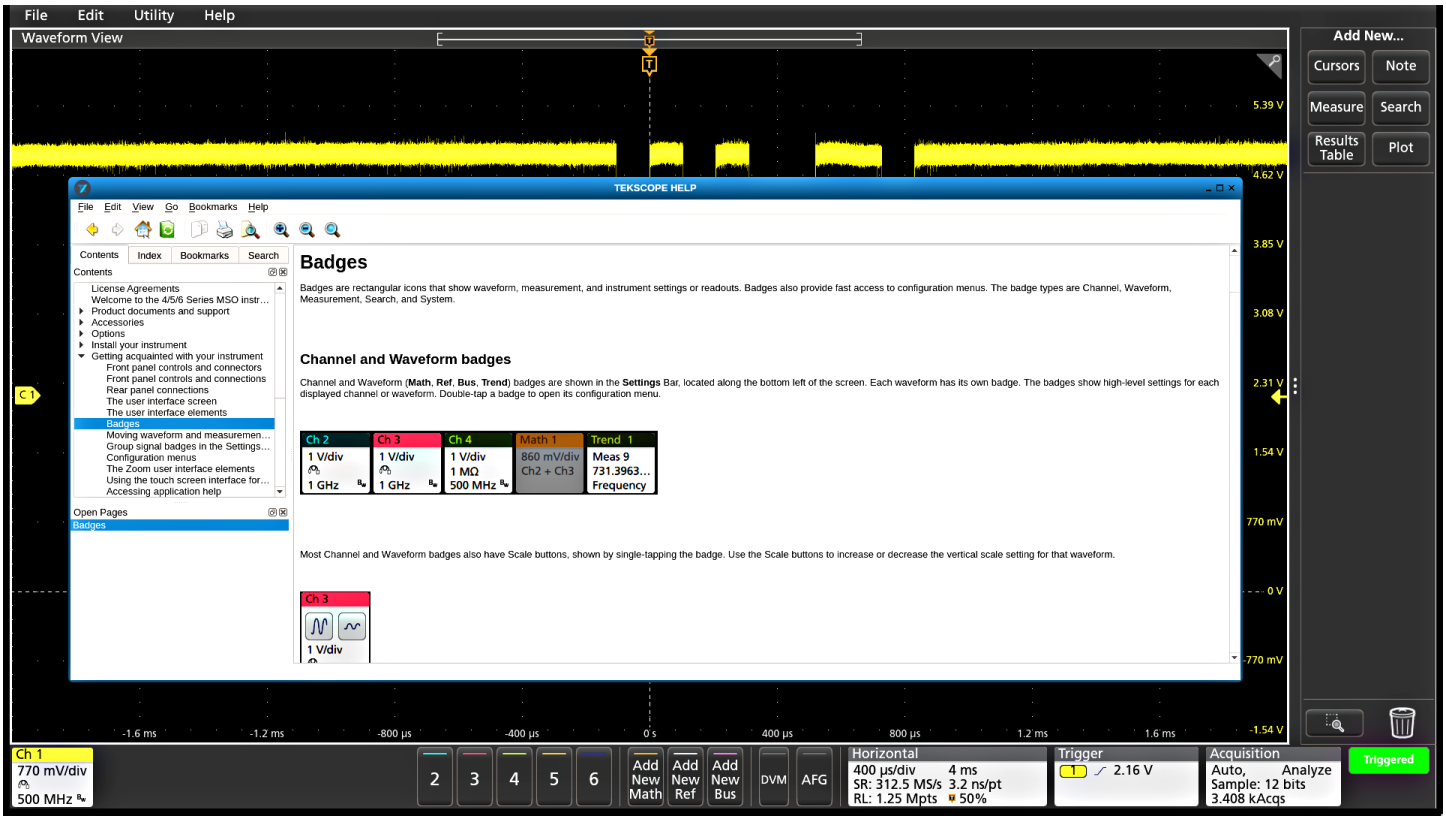
Enhanced security option

The optional 4-SEC enhanced security option enables password-protected enabling/disabling of all instrument I/O ports and firmware upgrades. In addition, option 4-SEC provides the highest level of security by ensuring that internal memory never stores user settings or waveform data, in compliance with National Industrial Security Program Operating Manual (NISPOM) DoD 5220.22-M, Chapter 8 requirements and Defense Security Service Manual for the Certification and Accreditation of Classified Systems under the NISPOM. This ensures that you can confidently move the instrument out of a secure area.

Help when you need it

The 4 Series MSO includes several helpful resources so you can get your questions answered rapidly without having to find a manual or go to a website:

- Graphical images and explanatory text are used in numerous menus to provide quick feature overviews.
- All menus include a question mark icon in the upper right that takes you directly to the portion of the integrated help system that applies to that menu.
- A short user interface tutorial is included in the Help menu for new users to come up to speed on the instrument in a matter of a few minutes.



Integrated help answers your questions rapidly without having to find a manual or go to the internet.

Specifications

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

Model overview

Oscilloscope

	MSO44	MSO46
FlexChannel inputs	4	6
Maximum analog channels	4	6
Maximum digital channels (with optional logic probes)	32	48
Auxiliary Trigger Input	≤300 V_{RMS} (Edge Trigger only)	
Bandwidth (calculated rise time)	200 MHz, 350 MHz, 500 MHz, 1 GHz, 1.5 GHz	
DC Gain Accuracy	50 Ω: ±1%, (±2.5% at 1 mV/Div and 500 µV/Div settings), de-rated at 0.100%/°C above 30 °C 1 MΩ and 250 kΩ: ±1.0%, (±2.0% at 1 mV/Div and 500 µV/Div settings)	
ADC Resolution	12 bits	
Vertical Resolution	8 bits @ 6.25 GS/s 12 bits @ 3.125 GS/s 13 bits @ 1.25 GS/s (High Res) 14 bits @ 625 MS/s (High Res) 15 bits @ 312.5 MS/s (High Res) 16 bits @ ≤125 MS/s (High Res)	
Sample Rate	6.25 GS/s on all analog / digital channels (160 ps resolution)	
Record Length (std.)	31.25 Mpoints on all analog / digital channels	
Record Length (opt.)	62.5 Mpoints on all analog / digital channels	
Waveform Capture Rate, typical	>500,000 wfms/s	
Arbitrary/Function Generator (opt.)	13 predefined waveform types with up to 50 MHz output	
DVM	4-digit DVM (free with product registration)	
Trigger Frequency Counter	8-digit frequency counter (free with product registration)	

Vertical system - analog channels

Bandwidth selections

50 Ω: 20 MHz, 250 MHz, and the full bandwidth value of your model

1 MΩ: 20 MHz, 250 MHz, 500 MHz

Input coupling

DC, AC

Input impedance

50 Ω ± 1%

1 MΩ ± 1% with 13.0 pF ± 1.5 pF

Input sensitivity range

1 MΩ

500 µV/div to 10 V/div in a 1-2-5 sequence

50 Ω

500 µV/div to 1 V/div in a 1-2-5 sequence

Note: 500 µV/div is a 2X digital zoom of 1 mV/div or a 4x zoom of 2 mV/div depending upon instrument settings

Vertical system - analog channels

Maximum input voltage

50 Ω: 5 V_{RMS}, with peaks ≤ ±20 V (DF ≤ 6.25%)

1 MΩ: 300 V_{RMS}

For 1 MΩ, derate at 20 dB/decade from 4.5 MHz to 45 MHz;

Derate at 14 dB/decade from 45 MHz to 450 MHz; > 450 MHz, 5.5 V_{RMS}

Effective bits (ENOB), typical

High Res mode, 50 Ω, 10 MHz input with 90% full screen

Bandwidth	ENOB
1.5 GHz	7.1
1 GHz	7.6
500 MHz	7.9
350 MHz	8.2
250 MHz	8.2
20 MHz	8.9

Random noise, RMS, typical

1.5 GHz, 1 GHz, 500 MHz, 350 MHz, 200 MHz models, High Res mode (RMS), typical

	50 Ω					1 MΩ			
V/div	1 GHz	500 MHz	350 MHz	250 MHz	20 MHz	500 MHz	350 MHz	250 MHz	20 MHz
≤1 mV/div	260 µV	200 µV	150 µV	125 µV	75.0 µV	200 µV	140 µV	120 µV	75.0 µV
2 mV/div	280 µV	200 µV	150 µV	125 µV	75.0 µV	200 µV	140 µV	120 µV	75.0 µV
5 mV/div	305 µV	235 µV	185 µV	135 µV	75.0 µV	210 µV	150 µV	130 µV	75.0 µV
10 mV/div	335 µV	275 µV	220 µV	160 µV	80.0 µV	230 µV	160 µV	150 µV	80.0 µV
20 mV/div	425 µV	360 µV	270 µV	230 µV	110 µV	280 µV	200 µV	200 µV	100 µV
50 mV/div	800 µV	800 µV	570 µV	460 µV	200 µV	520 µV	370 µV	410 µV	180 µV
100 mV/div	1.62 mV	1.23 mV	1.04 mV	1.04 mV	470 µV	1.24 mV	880 µV	930 µV	460 µV
1 V/div	13.0 mV	9.90 mV	8.95 mV	8.95 mV	3.78 mV	14.30 mV	10.20 mV	10.30 mV	5.45 mV

Position range

±5 divisions

Offset ranges, maximum

All models

Volts/div Setting	Maximum offset range, 50 Ω Input
500 µV/div - 99 mV/div	±1 V
100 mV/div - 1 V/div	±10 V

Volts/div Setting	Maximum offset range, 1 MΩ Input
500 µV/div - 63 mV/div	±1 V
64 mV/div - 999 mV/div	±10 V
1 V/div - 10 V/div	±100 V

Offset accuracy

±(0.005 X | offset - position | + 0.2 div (0.4 div in 500 µV/div))

Crosstalk (channel isolation), typical

≥ 200:1 up to the rated bandwidth for any two channels having equal Volts/div settings

Vertical system - digital channels

Number of channels	8 digital inputs (D7-D0) per installed TLP058 (traded off for one analog channel)
Vertical resolution	1 bit
Minimum detectable pulse width, typical	1 ns
Thresholds	One threshold per digital channel
Threshold range	±40 V
Threshold resolution	10 mV
Threshold accuracy	± [100 mV + 3% of threshold setting after calibration]
Input hysteresis, typical	100 mV at the probe tip
Input dynamic range, typical	30 V_{pp} for $F_{in} \leq$ 200 MHz, 10 V_{pp} for F_{in} > 200 MHz
Absolute maximum input voltage, typical	±42 V peak
Minimum voltage swing, typical	400 mV peak-to-peak
Input impedance, typical	100 kΩ
Probe loading, typical	2 pF

Horizontal system

Time base range	200 ps/div to 1,000 s/div
Sample rate range	1.5625 S/s to 6.25 GS/s (real time) 12.5 GS/s to 500 GS/s (interpolated)
Record length range	
Standard	1 kpoints to 31.25 Mpoints in single sample increments
Option 4-RL-1	62.5 Mpoints
Maximum duration at highest sample rate	5 ms (std.) or 10 ms (opt.)
Time base delay time range	-10 divisions to 5,000 s
Deskew range	-125 ns to +125 ns with a resolution of 40 ps
Timebase accuracy	±2.5 x 10^{-6} over any ≥1 ms time interval

Description	Specification
Factory Tolerance	±5.0 x10^{-7} . At calibration, 25 °C ambient, over any ≥1 ms interval
Temperature stability, typical	±5.0 x10^{-7} . Tested at operating temperatures
Crystal aging	±1.5 x 10^{-6} . Frequency tolerance change at 25 °C over a period of 1 year

Horizontal system

Delta-time measurement accuracy

$$DTA_{pp}(typical) = 10 \times \sqrt{\left(\frac{N}{SR_1}\right)^2 + \left(\frac{N}{SR_2}\right)^2 + \left(0.450\ ps + \left(1 \times 10^{-11} \times t_p\right)\right)^2} + TBA \times t_p$$

$$DTA_{RMS} = \sqrt{\left(\frac{N}{SR_1}\right)^2 + \left(\frac{N}{SR_2}\right)^2 + \left(0.450\ ps + \left(1 \times 10^{-11} \times t_p\right)\right)^2} + TBA \times t_p$$

(assume edge shape that results from Gaussian filter response)

The formula to calculate delta-time measurement accuracy (DTA) for a given instrument setting and input signal assumes insignificant signal content above Nyquist frequency, where:

SR_1 = Slew Rate (1st Edge) around 1st point in measurement

SR_2 = Slew Rate (2nd Edge) around 2nd point in measurement

N = input-referred guaranteed noise limit (V_{RMS})

TBA = timebase accuracy or Reference Frequency Error

t_p = delta-time measurement duration (sec)

Aperture uncertainty	≤ 0.450 ps + (1 * 10^{-11} * Measurement Duration)$_{RMS}$, for measurements having duration ≤ 100 ms
Delay between analog channels, full bandwidth, typical	≤ 100 ps for any two channels with input impedance set to 50 Ω, DC coupling with equal Volts/div or above 10 mV/div
Delay between analog and digital FlexChannels, typical	3 ns when using a TLP058 and a passive probe matching the bandwidth of the scope, with no bandwidth limits applied
Delay between any two digital FlexChannels, typical	3 ns from bit 0 of a FlexChannel to bit 0 of any other FlexChannel
Delay between any two bits of a digital FlexChannel, typical	160 ps

Trigger system

Trigger modes	Auto, Normal, and Single
Trigger coupling	DC, HF Reject (attenuates > 50 kHz), LF Reject (attenuates < 50 kHz), noise reject (reduces sensitivity)
Trigger holdoff range	0 ns to ??? seconds
Trigger jitter, typical	≤ 7 ps_{RMS} for sample mode and edge-type trigger

Edge-type trigger sensitivity, DC coupled, typical

Path	Range	Specification
1 MΩ path (all models)	0.5 mV/div to 0.99 mV/div	4.5 div from DC to instrument bandwidth
	≥ 1 mV/div	The greater of 5 mV or 0.7 div
50 Ω path, all models		The greater of 5.6 mV or 0.7 div from DC to the lesser of 500 MHz or instrument BW 8 mV or 0.7 div from >500 MHz to 1 GHz 12 mV or 0.7 div from >1 GHz to instrument BW
Aux In (External)		200 mV from DC to 50 MHz, increasing to 500 mV at 200 MHz
Line		Fixed

Trigger system

Trigger level ranges

Source	Range
Any Channel	±5 divs from center of screen
Aux In Trigger, typical	±8 V
Line	Fixed at about 50% of line voltage

This specification applies to logic and pulse thresholds.

Trigger frequency counter 8-digits (free with product registration)

Trigger types

Edge: Positive, negative, or either slope on any channel. Coupling includes DC, AC, noise reject, HF reject, and LF reject

Pulse Width: Trigger on width of positive or negative pulses. Event can be time- or logic-qualified

Timeout: Trigger on an event which remains high, low, or either, for a specified time period. Event can be logic-qualified

Runt: Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again. Event can be time- or logic-qualified

Window: Trigger on an event that enters, exits, stays inside or stays outside of a window defined by two user-adjustable thresholds. Event can be time- or logic-qualified

Logic: Trigger when logic pattern goes true, goes false, or occurs coincident with a clock edge. Pattern (AND, OR, NAND, NOR) specified for all input channels defined as high, low, or don't care. Logic pattern going true can be time-qualified

Setup & Hold: Trigger on violations of both setup time and hold time between clock and data present on any input channels

Rise / Fall Time: Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative, or either. Event can be logic-qualified

Sequence: Trigger on B event X time or N events after A trigger with a reset on C event. In general, A and B trigger events can be set to any trigger type with a few exceptions: logic qualification is not supported, if A event or B event is set to Setup & Hold, then the other must be set to Edge, and Ethernet and High Speed USB (480 Mbps) are not supported

Visual trigger Qualifies standard triggers by scanning all waveform acquisitions and comparing them to on-screen areas (geometric shapes). An unlimited number of areas can be defined with In, Out, or Don't Care as the qualifier for each area. A boolean expression can be defined using any combination of visual trigger areas to further qualify the events that get stored into acquisition memory. Shapes include rectangle, triangle, trapezoid, hexagon and user-defined.

Parallel Bus: Trigger on a parallel bus data value. Parallel bus can be from 1 to 48 bits (from the digital and analog channels) in size. Supports Binary and Hex radices

I^2C Bus (option 4-SREMBD): 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 Bus (option 4-SREMBD): Trigger on Slave Select, Idle Time, or Data (1-16 words) on SPI buses up to 20 Mb/s

RS-232/422/485/UART Bus (option 4-SRCOMP): Trigger on Start Bit, End of Packet, Data, and Parity Error up to 15 Mb/s

CAN Bus (option 4-SRAUTO): Trigger on Start of Frame, Type of Frame (Data, Remote, Error, or Overload), Identifier, Data, Identifier and Data, End Of Frame, Missing Ack, and Bit Stuff Error on CAN buses up to 1 Mb/s

CAN FD Bus (option 4-SRAUTO): Trigger on Start of Frame, Type of Frame (Data, Remote, Error, or Overload), Identifier (Standard or Extended), Data (1-8 bytes), Identifier and Data, End Of Frame, Error (Missing Ack, Bit Stuffing Error, FD Form Error, Any Error) on CAN FD buses up to 16 Mb/s

LIN Bus (option 4-SRAUTO): Trigger on Sync, Identifier, Data, Identifier and Data, Wakeup Frame, Sleep Frame, and Error on LIN buses up to 1 Mb/s

FlexRay Bus (option 4-SRAUTO): Trigger on Start of Frame, Indicator Bits (Normal, Payload, Null, Sync, Startup), Frame ID, Cycle Count, Header Fields (Indicator Bits, Identifier, Payload Length, Header CRC, and Cycle Count), Identifier, Data, Identifier and Data, End Of Frame, and Errors on FlexRay buses up to 10 Mb/s

SENT Bus (option 4-SRAUTOSEN) Trigger on Start of Packet, Fast Channel Status and Data, Slow Channel Message ID and Data, and CRC Errors

SPMI Bus (option 4-SRPM): Trigger on Sequence Start Condition, Reset, Sleep, Shutdown, Wakeup, Authenticate, Master Read, Master Write, Register Read, Register Write, Extended Register Read, Extended Register Write, Extended Register Read Long, Extended Register Write Long, Device Descriptor Block Master Read, Device Descriptor Block Slave Read, Register 0 Write, Transfer Bus Ownership, and Parity Error

USB 2.0 LS/FS/HS Bus (option 4-SRUSB2): Trigger on Sync, Reset, Suspend, Resume, End of Packet, Token (Address) Packet, Data Packet, Handshake Packet, Special Packet, Error on USB buses up to 480 Mb/s

Trigger system

Ethernet Bus (option 4-SRENET):	Trigger on Start of Frame, MAC Addresses, MAC Q-tag, MAC Length/Type, MAC Data, IP Header, TCP Header, TCP/IPV4 Data, End of Packet, and FCS (CRC) Error on 10BASE-T and 100BASE-TX buses
Audio (I^2S, LJ, RJ, TDM) Bus (option 4-SRAUDIO):	Trigger on Word Select, Frame Sync, or Data. Maximum data rate for I^2S/LJ/RJ is 12.5 Mb/s. Maximum data rate for TDM is 25 Mb/s
MIL-STD-1553 Bus (option 4-SRAERO):	Trigger on Sync, Command (Transmit/Receive Bit, Parity, Subaddress / Mode, Word Count / Mode Count, RT Address), Status (Parity, Message Error, Instrumentation, Service Request, Broadcast Command Received, Busy, Subsystem Flag, Dynamic Bus Control Acceptance, Terminal Flag), Data, Time (RT/IMG), and Error (Parity Error, Sync Error, Manchester Error, Non-contiguous Data) on MIL-STD-1553 buses
ARINC 429 Bus (option 4-SRAERO):	Trigger on Word Start, Label, Data, Label and Data, Word End, and Error (Any Error, Parity Error, Word Error, Gap Error) on ARINC 429 buses up to 1 Mb/s

Acquisition system

Sample	Acquires sampled values
Peak Detect	Captures glitches as narrow as 640 ps at all sweep speeds
Averaging	From 2 to 10,240 waveforms
Envelope	Min-max envelope reflecting Peak Detect data over multiple acquisitions
High Res	Applies a unique Finite Impulse Response (FIR) filter for each sample rate that maintains the maximum bandwidth possible for that sample rate while preventing aliasing and removing noise from the oscilloscope amplifiers and ADC above the usable bandwidth for the selected sample rate. High Res mode always provides at least 12 bits of vertical resolution and extends all the way to 16 bits of vertical resolution at ≤ 125 MS/s sample rates.
FastAcq®	FastAcq optimizes the instrument for analysis of dynamic signals and capture of infrequent events by capturing >500,000 wfms/s (one channel active; >100K wfms/s with all channels active).
Roll mode	Scrolls sequential waveform points across the display in a right-to-left rolling motion, at timebase speeds of 40 ms/div and slower, when in Auto trigger mode.
FastFrame™	Acquisition memory divided into segments. Maximum trigger rate >5,000,000 waveforms per second Minimum frame size = 50 points Maximum Number of Frames: For frame size ≥ 1,000 points, maximum number of frames = record length / frame size. For 50 point frames, maximum number of frames = 1,500,000

Waveform measurements

Cursor types	Waveform, V Bars, H Bars, and V&H Bars

DC voltage measurement accuracy, Average acquisition mode

Measurement Type	DC Accuracy (In Volts)
Average of ≥ 16 waveforms	±((DC Gain Accuracy) * |reading - (offset - position)| + Offset Accuracy + 0.1 * V/div setting)
Delta volts between any two averages of ≥ 16 waveforms acquired with the same oscilloscope setup and ambient conditions	±(DC Gain Accuracy * |reading| + 0.05 div)

Automatic measurements	36, of which an unlimited number can be displayed as either individual measurement badges or collectively in a measurement results table

Waveform measurements

Amplitude measurements	Amplitude, Maximum, Minimum, Peak-to-Peak, Positive Overshoot, Negative Overshoot, Mean, RMS, AC RMS, Top, Base, and Area
Timing measurements	Period, Frequency, Unit Interval, Data Rate, Positive Pulse Width, Negative Pulse Width, Skew, Delay, Rise Time, Fall Time, Phase, Rising Slew Rate, Falling Slew Rate, Burst Width, Positive Duty Cycle, Negative Duty Cycle, Time Outside Level, Setup Time, Hold Time, Duration N-Periods, High Time, and Low Time
Measurement statistics	Mean, Standard Deviation, Maximum, Minimum, and Population. Statistics are available on both the current acquisition and all acquisitions
Reference levels	User-definable reference levels for automatic measurements can be specified in either percent or units. Reference levels can be set to global for all measurements, per source channel or signal, or unique for each measurement
Gating	Screen, Cursors, Logic, Search, or Time. Specifies the region of an acquisition in which to take measurements. Gating can be set to Global (affects all measurements set to Global) or Local (all measurements can have a unique Time gate setting; only one Local gate is available for Screen, Cursors, Logic, and Search actions).
Measurement plots	Time Trend, Histogram, and Spectrum plots are available for all standard measurements
Power analysis adds the following:	
Measurements	Input Analysis (Frequency, V_{RMS}, I_{RMS}, voltage and current Crest Factors, True Power, Apparent Power, Reactive Power, Power Factor, Phase Angle, Harmonics, Inrush Current, Input Capacitance) Amplitude Analysis (Cycle Amplitude, Cycle Top, Cycle Base, Cycle Maximum, Cycle Minimum, Cycle Peak-to-Peak) Timing Analysis (Period, Frequency, Negative Duty Cycle, Positive Duty Cycle, Negative Pulse Width, Positive Pulse Width) Switching Analysis (Switching Loss, dv/dt, di/dt, Safe Operating Area, R_{DSon}) Output Analysis (Line Ripple, Switching Ripple, Efficiency, Turn-on Time, Turn-off Time)
Measurement Plots	Harmonics Bar Graph, Switching Loss Trajectory Plot, and Safe Operating Area

Waveform math

Number of math waveforms	Unlimited
Arithmetic	Add, subtract, multiply, and divide waveforms and scalars
Algebraic expressions	Define extensive algebraic expressions including waveforms, scalars, user-adjustable variables, and results of parametric measurements. Perform math on math using complex equations. For example (Integral (CH1 - Mean(CH1)) X 1.414 X VAR1)
Math functions	Invert, Integrate, Differentiate, Square Root, Exponential, Log 10, Log e, Abs, Ceiling, Floor, Min, Max, Degrees, Radians, Sin, Cos, Tan, ASin, ACos, and ATan
Relational	Boolean result of comparison >, <, ≥, ≤, =, and ≠
Logic	AND, OR, NAND, NOR, XOR, and EQV
Filtering function	User-definable filters. Users specify a file containing the coefficients of the filter
FFT functions	Spectral Magnitude and Phase, and Real and Imaginary Spectra
FFT vertical units	Magnitude: Linear and Log (dBm) Phase: Degrees, Radians, and Group Delay
FFT window functions	Hanning, Rectangular, Hamming, Blackman-Harris, Flattop2, Gaussian, Kaiser-Bessel, and TekExp

Spectrum View

Center Frequency	Limited by instrument analog bandwidth
Span	18.6 Hz to 312.5 MHz 18.6 Hz to 500 MHz (with option 4-SV-BW-1) Coarse adjustment in a 1-2-5 sequence
RF vs. Time Traces	Magnitude vs. time, Frequency vs. time, Phase vs. time
Resolution Bandwidth (RBW)	18.6 µHz to 15.625 MHz 18.6 µHz to 25 MHz (with option 4-SV-BW-1)

Window types and factors

Window type	Factor
Blackman-Harris	1.90
Flat-Top 2	3.77
Hamming	1.30
Hanning	1.44
Kaiser-Bessel	2.23
Rectangular	0.89

Spectrum Time	FFT Window Factor / RBW
Reference level	Reference level is automatically set by the analog channel Volts/div setting Setting range: -42 dBm to +44 dBm
Vertical Position	-100 divs to +100 divs
Vertical units	dBm, dBµW, dBmV, dBµV, dBmA, dBµA

Search

Number of searches	Unlimited
Search types	Search through long records to find all occurrences of user specified criteria including edges, pulse widths, timeouts, runt pulses, window violations, logic patterns, setup & hold violations, rise/fall times, and bus protocol events. Search results can be viewed in the Waveform View or in the Results table.

Display

Display type	13.3 in. (338 mm) liquid-crystal TFT color display
	1,920 horizontal × 1,080 vertical pixels (High Definition)
Display modes	Overlay: traditional oscilloscope display where traces overlay each other Stacked: display mode where each waveform is placed in its own slice and can take advantage of the full ADC range while still being visually separated from other waveforms. Groups of channels can also be overlaid within a slice to simplify visual comparison of signals.
Zoom	Horizontal and vertical zooming is supported in all waveform and plot views.
Interpolation	Sin(x)/x and Linear

Display

Waveform styles	Vectors, dots, variable persistence, and infinite persistence
Graticules	Movable and fixed graticules, selectable between Grid, Time, Full, and None
Color palettes	Normal and inverted for screen captures Individual waveform colors are user-selectable
Format	YT, XY, and XYZ
Local Language User Interface	English, Japanese, Simplified Chinese, Traditional Chinese, French, German, Italian, Spanish, Portuguese, Russian, Korean
Local Language Help	English, Japanese, Simplified Chinese

Arbitrary-Function Generator (optional)

Function types	Arbitrary, sine, square, pulse, ramp, triangle, DC level, Gaussian, Lorentz, exponential rise/fall, sin(x)/x, random noise, Haversine, Cardiac
Sine waveform	
Frequency range	0.1 Hz to 50 MHz
Frequency setting resolution	0.1 Hz
Frequency accuracy	130 ppm (frequency ≤ 10 kHz), 50 ppm (frequency > 10 kHz) This is for Sine, Ramp, Square and Pulse waveforms only.
Amplitude range	20 mV_{pp} to 5 V_{pp} into Hi-Z; 10 mV_{pp} to 2.5 V_{pp} into 50 Ω
Amplitude flatness, typical	±0.5 dB at 1 kHz ±1.5 dB at 1 kHz for < 20 mV_{pp} amplitudes
Total harmonic distortion, typical	1% for amplitude ≥ 200 mV_{pp} into 50 Ω load 2.5% for amplitude > 50 mV AND < 200 mV_{pp} into 50 Ω load This is for Sine wave only.
Spurious free dynamic range, typical	40 dB (V_{pp} ≥ 0.1 V); 30 dB (V_{pp} ≥ 0.02 V), 50 Ω load
Square and pulse waveform	
Frequency range	0.1 Hz to 25 MHz
Frequency setting resolution	0.1 Hz
Frequency accuracy	130 ppm (frequency ≤ 10 kHz), 50 ppm (frequency > 10 kHz)
Amplitude range	20 mV_{pp} to 5 V_{pp} into Hi-Z; 10 mV_{pp} to 2.5 V_{pp} into 50 Ω
Duty cycle range	10% - 90% or 10 ns minimum pulse, whichever is larger Minimum pulse time applies to both on and off time, so maximum duty cycle will reduce at higher frequencies to maintain 10 ns off time
Duty cycle resolution	0.1%
Minimum pulse width, typical	10 ns. This is the minimum time for either on or off duration.
Rise/Fall time, typical	5.5 ns, 10% - 90%
Pulse width resolution	100 ps
Overshoot, typical	< 4% for signal steps greater than 100 mV_{pp} This applies to overshoot of the positive-going transition (+overshoot) and of the negative-going (-overshoot) transition
Asymmetry, typical	±1% ±5 ns, at 50% duty cycle
Jitter, typical	< 60 ps TIE_{RMS}, ≥ 100 mV_{pp} amplitude, 40%-60% duty cycle

Arbitrary-Function Generator (optional)

Ramp and triangle waveform	
Frequency range	0.1 Hz to 500 kHz
Frequency setting resolution	0.1 Hz
Frequency accuracy	130 ppm (frequency ≤ 10 kHz), 50 ppm (frequency > 10 kHz)
Amplitude range	20 mV_{pp} to 5 V_{pp} into Hi-Z; 10 mV_{pp} to 2.5 V_{pp} into 50 Ω
Variable symmetry	0% - 100%
Symmetry resolution	0.1%
DC level range	±2.5 V into Hi-Z ±1.25 V into 50 Ω
Random noise amplitude range	20 mV_{pp} to 5 V_{pp} into Hi-Z 10 mV_{pp} to 2.5 V_{pp} into 50 Ω
Sin(x)/x	
Maximum frequency	2 MHz
Gaussian pulse, Haversine, and Lorentz pulse	
Maximum frequency	5 MHz
Lorentz pulse	
Frequency range	0.1 Hz to 5 MHz
Amplitude range	20 mV_{pp} to 2.4 V_{pp} into Hi-Z 10 mV_{pp} to 1.2 V_{pp} into 50 Ω
Cardiac	
Frequency range	0.1 Hz to 500 kHz
Amplitude range	20 mV_{pp} to 5 V_{pp} into Hi-Z 10 mV_{pp} to 2.5 V_{pp} into 50 Ω
Arbitrary	
Memory depth	1 to 128 k
Amplitude range	20 mV_{pp} to 5 V_{pp} into Hi-Z 10 mV_{pp} to 2.5 V_{pp} into 50 Ω
Repetition rate	0.1 Hz to 25 MHz
Sample rate	250 MS/s
Signal amplitude accuracy	±[(1.5% of peak-to-peak amplitude setting) + (1.5% of absolute DC offset setting) + 1 mV] (frequency = 1 kHz)
Signal amplitude resolution	1 mV (Hi-Z) 500 µV (50 Ω)
Sine and ramp frequency accuracy	1.3×10^{-4} (frequency ≤10 kHz) 5.0×10^{-5} (frequency >10 kHz)
DC offset range	±2.5 V into Hi-Z ±1.25 V into 50 Ω

Arbitrary-Function Generator (optional)

DC offset resolution	1 mV (Hi-Z) 500 µV (50 Ω)
DC offset accuracy	±[(1.5% of absolute offset voltage setting) + 1 mV] Add 3 mV of uncertainty per 10 °C change from 25 °C ambient

Digital volt meter (DVM)

Measurement types	DC, AC_{RMS}+DC, AC_{RMS}
Voltage resolution	4 digits
Voltage accuracy	
DC:	±((1.5% * |reading - offset - position|) + (0.5% * |(offset - position)|) + (0.1 * Volts/div)) De-rated at 0.100%/°C of |reading - offset - position| above 30 °C Signal ± 5 divisions from screen center
AC:	± 2% (40 Hz to 1 kHz) with no harmonic content outside 40 Hz to 1 kHz AC, typical: ± 2% (20 Hz to 10 kHz) For AC measurements, the input channel vertical settings must allow the V_{PP} input signal to cover between 4 and 10 divisions and must be fully visible on the screen

Trigger frequency counter

Accuracy	±(1 count + time base accuracy * input frequency) The signal must be at least 8 mV_{pp} or 2 div, whichever is greater.
Maximum input frequency	10 Hz to maximum bandwidth of the analog channel The signal must be at least 8 mV_{pp} or 2 div, whichever is greater.
Resolution	8-digits

Processor system

Host processor	ARM 1.5 GHz, 32-bit, dual core processor
Internal storage	64 GB eMMC

Input-Output ports

HDMI video port	A 29-pin HDMI connector Supported resolution: 1920 x 1080 @ 60Hz (only). The monitor must be attached before powering on the instrument
Probe compensator signal, typical	
Connection:	Connectors are located on the lower right-hand side of the instrument
Amplitude:	0 to 2.5 V
Frequency:	1 kHz
Source impedance:	1 kΩ
External reference input	The time-base system can phase lock to an external 10 MHz reference signal (±4 ppm).

Input-Output ports

USB interface (Host, Device ports)

Front panel USB Host ports: Three USB 2.0 Hi-Speed ports

Rear panel USB Host ports: Two USB 2.0 Hi-Speed ports

Rear panel USB Device port: One USB 2.0 High Speed Device port providing USBTMC support

Ethernet interface

10/100/1000 Mb/s

Auxiliary output

Rear-panel BNC connector. Output can be configured to provide a positive or negative pulse out when the oscilloscope triggers, the internal oscilloscope reference clock out, or an AFG sync pulse

Characteristic	Limits
Vout (HI)	≥ 2.5 V open circuit; ≥ 1.0 V into a 50 Ω load to ground
Vout (LO)	≤ 0.7 V into a load of ≤ 4 mA; ≤0.25 V into a 50 Ω load to ground

Kensington-style lock

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

LXI

Class: LXI Core 2016

Version: 1.5

Power source

Power

Power consumption

400 Watts maximum

Source voltage

100 - 240 V ±10% at 50 Hz to 60 Hz

115 V ±10% at 400 Hz

Physical characteristics

Dimensions

Height: 9.8 in (249 mm), feet folded in, handle to back

Height: 13.8 in (351 mm) feet folded in, handle up

Width: 15.9 in (405 mm) from handle hub to handle hub

Depth: 6.1 in (155 mm) from back of feet to front of knobs, handle up

Depth: 10.4 in (265 mm) feet folded in, handle to the back

Weight

< 16.8 lbs (7.6 kg)

Cooling

The clearance requirement for adequate cooling is 2.0 in (50.8 mm) on the right side of the instrument (when viewed from the front) and on the rear of the instrument

Rackmount configuration

7U (with optional RM4 Rackmount Kit)

Environmental specifications

Temperature	
Operating	+0 °C to +50 °C (32 °F to 122 °F)
Non-operating	-30 °C to +70 °C (-22 °F to 158 °F)
Humidity	
Operating	5% to 90% relative humidity (% RH) at up to +40 °C 5% to 50% RH above +40 °C up to +50 °C, noncondensing, and as limited by a maximum wet-bulb temperature of +39 °C
Non-operating	5% to 90% relative humidity (% RH) at up to +40 °C 5% to 50% RH above +40 °C up to +50 °C, noncondensing, and as limited by a maximum wet-bulb temperature of +39 °C
Altitude	
Operating	Up to 3,000 meters (9,843 feet)
Non-operating	Up to 12,000 meters (39,370 feet)
Regulatory	CE marked for the European Union and CSA approved for the USA and Canada RoHS compliant

Software

Software	
IVI driver	Provides a standard instrument programming interface for common applications such as LabVIEW, LabWindows/CVI, Microsoft .NET, and MATLAB. Compatible with Python, C/C++/C# and many other languages through VISA.
e*Scope®	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 Web interface	Connect to the oscilloscope through a standard Web browser by simply entering the oscilloscope's 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 the e*Scope web-based remote control. All web interaction conforms to LXI Core specification, version 1.4.

Ordering information

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

Step 1

Start by selecting a model based on the number of FlexChannel inputs you need. Each FlexChannel input supports 1 analog or 8 digital input signals, interchangeably.

Model	Number of FlexChannels
MSO44	4
MSO46	6

Each model includes
Four passive analog probes (with both four- and six-channel models): • 200 MHz bandwidth models: Four TPP0250 250 MHz probes • 350 MHz, 500 MHz, 1 GHz or 1.5 GHz bandwidth models: Four TPP0500B 500 MHz probes
Installation and safety manual (translated in English, Japanese, Simplified Chinese)
Embedded Help
Power cord
Calibration certificate documenting traceability to National Metrology Institute(s) and ISO9001/ISO17025 quality system registration
Three-year warranty covering all parts and labor on the instrument. One-year warranty covering all parts and labor on included probes

Step 2

Configure your oscilloscope by selecting the analog channel bandwidth you need

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

Bandwidth Option	Bandwidth
4-BW-200	200 MHz
4-BW-350	350 MHz
4-BW-500	500 MHz
4-BW-1000	1 GHz
4-BW-1500	1.5 GHz

Step 3

Add instrument functionality

Instrument functionality can be ordered with the instrument or later as an upgrade kit.

Instrument Option	Built-in Functionality
4-RL-1	Extend record length from 31.25 Mpoints/channel to 62.5 Mpoints/channel
4-AFG	Add Arbitrary / Function Generator
4-SEC [5]	Add enhanced security for instrument declassification and password-protected enabling and disabling of all USB ports and firmware upgrade.

Step 4

Add optional serial bus triggering, decode, and search capabilities

Choose the serial support you need today by choosing from these serial analysis options. You can upgrade later by purchasing an upgrade kit.

Instrument Option	Serial Buses Supported
4-SRAERO	Aerospace (MIL-STD-1553, ARINC 429)
4-SRAUDIO	Audio (I^2S, LJ, RJ, TDM)
4-SRAUTO	Automotive (CAN, CAN FD, LIN, FlexRay, and CAN symbolic decoding)
4-SRAUTOSEN	Automotive sensor (SENT)
4-SRCOMP	Computer (RS-232/422/485/UART)
4-SREMBD	Embedded (I^2C, SPI)
4-SRENET	Ethernet (10BASE-T, 100BASE-TX)
4-SRI3C	MIPI I3C (I3C decode and search only)
4-SRPM	Power Management (SPMI)
4-SRSPACEWIRE	Spacewire serial analysis
4-SRUSB2	USB (USB2.0 LS, FS, HS)

Differential serial bus? Be sure to check *Add analog probes and adapters* for differential probes.

Step 5

Add optional analysis capabilities

Instrument Option	Advanced Analysis
4-PWR-BAS [6]	Power Measurements and Analysis
4-SV-BAS	Spectrum View frequency domain analysis
4-SV-RFVT	Spectrum View RF versus Time analysis
4-SV-BW-1	Increase Spectrum View capture bandwidth to 500 MHz
4-PS2	Power Solution Bundle (4-PWR-BAS, THDP0200, TCP0030A, 067-1686-xx deskew fixture)

Step 6

Add digital probes

Each FlexChannel input can be configured as eight digital channels simply by connecting a TLP058 logic probe to a FlexChannel input. You can order TLP058 probes with the instrument or separately.

For this instrument	Order	To add
MSO44	1 to 4 TLP058 Probes	8 to 32 digital channels
MSO46	1 to 6 TLP058 Probes	8 to 48 digital channels

5 This option must be purchased at the same time as the instrument. Not available as an upgrade.

6 This option is not compatible with option 4-PS2

Step 7

Add analog probes and adapters

Add additional recommended probes and adapters

Recommended Probe / Adapter	Description
TAP1500	1.5 GHz TekVPI® active single-ended voltage probe, ±8 V input voltage
TAP2500	2.5 GHz TekVPI® active single-ended voltage probe, ±4 V input voltage
TCP0030A	30 A AC/DC TekVPI® current probe, 120 MHz BW
TCP0020	20 A AC/DC TekVPI® current probe, 50 MHz BW
TCP0150	150 A AC/DC TekVPI® current probe, 20 MHz BW
TRCP0300	30 MHz AC current probe, 250 mA to 300 A
TRCP0600	30 MHz AC current probe, 500 mA to 600 A
TRCP3000	16 MHz AC current probe, 500 mA to 3000 A
TDP0500	500 MHz TekVPI® differential voltage probe, ±42 V differential input voltage
TDP1000	1 GHz TekVPI® differential voltage probe, ±42 V differential input voltage
TDP1500	1.5 GHz TekVPI® differential voltage probe, ±8.5 V differential input voltage
TDP7704	4 GHz TriMode™ voltage probe
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
TPR1000	1 GHz, Single-Ended TekVPI® Power-Rail Probe; includes one TPR4KIT accessory kit
TIVH02	Isolated Probe; 200 MHz, ±2500 V, TekVPI, 3 Meter Cable
TIVH02L	Isolated Probe; 200 MHz, ±2500 V, TekVPI, 10 Meter Cable
TIVH05	Isolated Probe; 500 MHz, ±2500 V, TekVPI, 3 Meter Cable
TIVH05L	Isolated Probe; 500 MHz, ±2500 V, TekVPI, 10 Meter Cable
TIVH08	Isolated Probe; 800 MHz, ±2500 V, TekVPI, 3 Meter Cable
TIVH08L	Isolated Probe; 800 MHz, ±2500 V, TekVPI, 10 Meter Cable
TIVM1	Isolated Probe; 1 GHz, ±50 V, TekVPI, 3 Meter Cable
TIVM1L	Isolated Probe; 1 GHz, ±50 V, TekVPI, 10 Meter Cable
TPP0502	500 MHz, 2X TekVPI® passive voltage probe, 12.7 pF input capacitance
TPP0850	2.5 kV, 800 MHz, 50X TekVPI® passive high-voltage probe
TPP1000	1 GHz, 10X TekVPI® passive voltage probe, 1.3 Meter cable, 3.9 pF input capacitance
P6015A	20 kV, 75 MHz high-voltage passive probe
TPA-BNC [7]	TekVPI® to TekProbe™ BNC adapter
TEK-DPG	TekVPI deskew pulse generator signal source
067-1686-xx	Power measurement deskew and calibration fixture

Looking for other probes? Check out the probe selector tool at www.tek.com/probes.

7 Recommended for connecting your existing TekProbe probes to the .

Step 8

Add accessories

Add traveling or mounting accessories

Optional Accessory	Description
HC4	Hard carrying case with instrument front protective cover
RM4	Rackmount kit
SC4	Soft carrying case with instrument front protective cover

Step 9

Select power cord option

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

Step 10

Add extended service and calibration options

Service Option	Description
T3	Three Year Total Protection Plan, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS.
T5	Five Year Total Protection Plan, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS.
R5	Standard Warranty Extended to 5 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process.
C3	Calibration service 3 Years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 2 years calibration coverage.
C5	Calibration service 5 Years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 4 years calibration coverage.
D1	Calibration Data Report
D3	Calibration Data Report 3 Years (with Option C3)
D5	Calibration Data Report 5 Years (with Option C5)

Feature upgrades after purchase

Add feature upgrades in the future

You can easily add functionality after the initial purchase. Node-locked licenses permanently enable optional features on a single product. Floating licenses allow license-enabled options to be easily moved between compatible instruments.

Upgrade feature	Node-locked license upgrade	Floating license upgrade	Description
Add instrument functions	SUP4-AFG	SUP4-AFG-FL	Add arbitrary function generator
	SUP4-RL-1	SUP4-RL-1-FL	Extend record length to 62.5 Mpts / channel
Add protocol analysis	SUP4-SRAERO	SUP4-SRAERO-FL	Aerospace serial triggering and analysis (MIL-STD-1553, ARINC 429)
	SUP4-SRAUDIO	SUP4-SRAUDIO-FL	Audio serial triggering and analysis (I^2S, LJ, RJ, TDM)
	SUP4-SRAUTO	SUP4-SRAUTO-FL	Automotive serial triggering and analysis (CAN, CAN FD, LIN, FlexRay, and CAN symbolic decoding)
	SUP4-SRAUTOSEN	SUP4-SRAUTOSEN-FL	Automotive sensor serial triggering and analysis (SENT)
	SUP4-SRCOMP	SUP4-SRCOMP-FL	Computer serial triggering and analysis (RS-232/422/485/UART)
	SUP4-SREMBD	SUP4-SREMBD-FL	Embedded serial triggering and analysis (I^2C, SPI)
	SUP4-SRENET	SUP4-SRENET-FL	Ethernet serial triggering and analysis (10Base-T, 100Base-TX)
	SUP4-SRI3C	SUP4-SRI3C-FL	MIPI I3C serial analysis
	SUP4-SRPM	SUP4-SRPM-FL	Power Management serial triggering and analysis (SPMI)
	SUP4-SRSPACEWIRE	SUP4-SRSPACEWIRE-FL	Spacewire serial analysis
	SUP4-SRUSB2	SUP4-SRUSB2-FL	USB 2.0 serial bus triggering and analysis (LS, FS, and HS)
Add advanced analysis	SUP4-SV-BAS	SUP4-SV-BAS-FL	Spectrum View frequency domain analysis
	SUP4-SV-RFVT	SUP4-SV-RFVT-FL	Spectrum View RF versus time analysis
	SUP4-SV-BW-1	SUP4-SV-BW-1-FL	Increase Spectrum View capture bandwidth to 500 MHz
	SUP4-PWR-BAS	SUP4-PWR-BAS-FL	Power measurements and analysis
Add digital voltmeter	SUP4-DVM	N/A	Add digital voltmeter / trigger frequency counter (Free with product registration at www.tek.com/register4mso)

Bandwidth upgrades after purchase

Add bandwidth upgrades in the future

You can easily upgrade the analog bandwidth of products after initial purchase. Bandwidth upgrades are purchased based on the number of FlexChannel inputs, the current bandwidth, and the desired bandwidth.

All 4 Series MSO models can be upgraded in the field to any bandwidth.

Model to be upgraded	Bandwidth before upgrade	Bandwidth after upgrade	Order this bandwidth upgrade
MSO44	200 MHz	350 MHz	SUP4-BW02T034
	200 MHz	500 MHz	SUP4-BW02T054
	200 MHz	1 GHz	SUP4-BW02T104
	200 MHz	1.5 GHz	SUP4-BW02T154
	350 MHz	500 MHz	SUP4-BW03T054
	350 MHz	1 GHz	SUP4-BW03T104
	350 MHz	1.5 GHz	SUP4-BW03T154
	500 MHz	1 GHz	SUP4-BW05T104
	500 MHz	1.5 GHz	SUP4-BW05T154
	1 GHz	1.5 GHz	SUP4-BW10T154
MSO46	200 MHz	350 MHz	SUP4-BW02T036
	200 MHz	500 MHz	SUP4-BW02T056
	200 MHz	1 GHz	SUP4-BW02T106
	200 MHz	1.5 GHz	SUP4-BW02T156
	350 MHz	500 MHz	SUP4-BW03T056
	350 MHz	1 GHz	SUP4-BW03T106
	350 MHz	1.5 GHz	SUP4-BW03T156
	500 MHz	1 GHz	SUP4-BW05T106
	500 MHz	1.5 GHz	SUP4-BW05T156
	1 GHz	1.5 GHz	SUP4-BW10T156

CE

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

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

Product Area Assessed: The planning, design/development and manufacture of electronic Test and Measurement instruments.

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For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tek.com.

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