

# 5 Series MSO Low Profile

## MSO58LP Datasheet

*More system visibility in less rack space.*



Standard rack mount configuration



Optional bench conversion configuration

## Strength in numbers

### Input channels

- 8 FlexChannel<sup>®</sup> inputs
- Each FlexChannel provides one analog signal input or eight digital logic inputs with TLP058 logic probe

### Bandwidth

- 1 GHz (not upgradeable)

### Sample rate (all analog / digital channels)

- Real-time: 6.25 GS/s
- Interpolated: 500 GS/s

### Record length (all analog / digital channels)

- 125 Mpoints

### Waveform capture rate

- >500,000 waveforms/s

### Vertical resolution

- 12-bit ADC
- Up to 16 bits in High Res mode
- 7.6 ENOB at 1 GHz

### Standard trigger types

- Edge, Pulse Width, Runt, Timeout, Window, Logic, Setup & Hold, Rise/Fall Time, Parallel Bus, Sequence, Visual Trigger
- Auxiliary Trigger  $\leq 5 V_{RMS}$ , 50  $\Omega$ , 200 MHz (Edge Trigger only)

### Standard analysis

- Cursors: Waveform, V Bars, H Bars, V&H Bars
- Measurements: 36
- FastFrame<sup>™</sup>: 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
- Jitter: TIE and Phase Noise

### Optional analysis <sup>1</sup>

- Advanced Jitter and Eye Diagram Analysis
- Advanced Power Analysis

### Optional serial bus trigger, decode and analysis <sup>1</sup>

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

### Arbitrary/Function Generator <sup>1</sup>

- 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 <sup>2</sup>

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

### Trigger frequency counter <sup>2</sup>

- 8-digit

### Video display output

- High Definition (1,920 x 1,080) resolution video output

### Connectivity

- USB Host (6 ports), USB Device (1 port), LAN (10/100/1000 Base-T Ethernet), Display Port, DVI-D, Video Out

### e\*Scope<sup>®</sup>

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

### Operating system

- Closed Linux

### Warranty

- 3 years standard

### Dimensions

- 3.44 in (87.3 mm) H x 17.01 in (432 mm) W x 24.74 in (621.5 mm) D
- Weight: 28 lbs. (12.7 kg)

<sup>1</sup> Optional and upgradeable.

<sup>2</sup> Free with product registration.

With a remarkable 8 input channels in a 2U high package and a 12-bit ADC, the 5 Series MSO Low Profile sets a new standard for performance in applications where extreme analog or digital channel density is required.

### Based on the highly successful 5 Series MSO

The 5 Series MSO Low Profile is based on the 5 Series MSO benchtop platform. The benchtop 5 Series MSO has a remarkably innovative pinch-swipe-zoom touchscreen user interface, the industry's largest high-definition display, and 4, 6, or 8 FlexChannel® inputs that let you measure one analog or eight digital signals per channel. The 5 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.

Like the benchtop 5 Series MSO, the low profile instrument offers FlexChannel inputs, an optional arbitrary/function generator output, and a built-in digital voltmeter and trigger frequency counter. And, if you plug in an external touch-capable monitor you can experience the same revolutionary pinch-swipe-zoom user experience as if you were in front of the benchtop 5 Series MSO.

For more information on the capabilities of the benchtop 5 Series MSO, including the revolutionary user experience and the various analysis software options, please see the 5 Series MSO datasheet at [www.tek.com/5SeriesMSO](http://www.tek.com/5SeriesMSO).

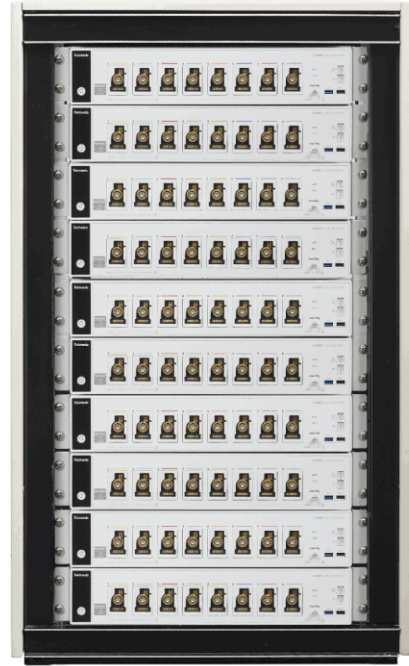


The 5 Series MSO Low Profile is based on the 5 Series MSO benchtop platform.

### Low-profile, high-density package saves space

The 5 Series MSO Low Profile has 8 FlexChannel inputs plus an auxiliary trigger input in a space-saving 2U high package designed to fit into 19-inch wide racks. The instrument has side air vents so that instruments can be mounted in a rack directly on top of one another, saving even more space.

The 5 Series MSO Low Profile comes standard with rack mount brackets installed, ready for mounting into a rack right out of the box.

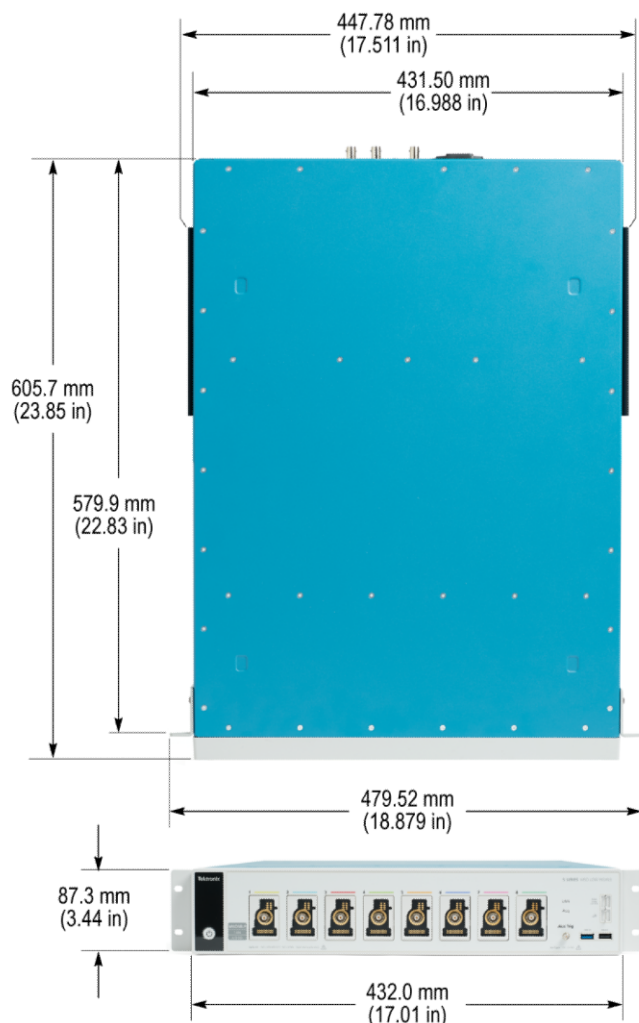


Multiple MSO58LP instruments installed in a rack, making efficient use of available space.

An optional bench conversion kit includes four feet and a strap handle for use in a lab environment on a bench surface.



The MSO58LP with the optional bench conversion kit installed, optimizing the instrument for use on a benchtop.



The 5 Series MSO Low Profile saves valuable rack space.

## Experience the performance difference

With 1 GHz analog bandwidth, 6.25 GS/s sample rate, 125 M record length, and 12-bit analog to digital converters (ADCs), the 5 Series MSO Low Profile has the performance you need to capture accurate waveform data with the best possible signal integrity and vertical resolution for seeing small waveform details.

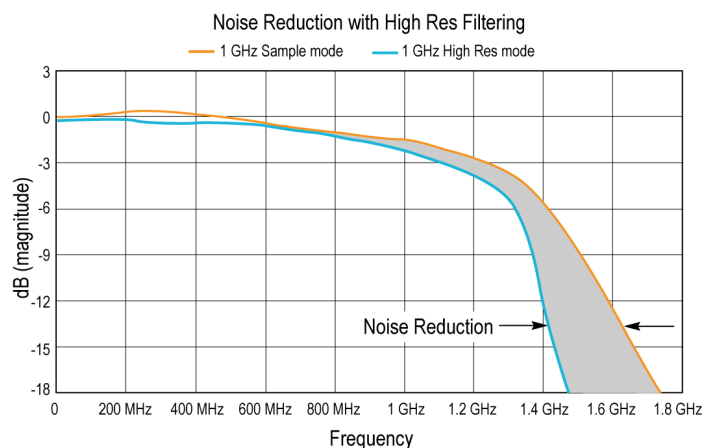
The 5 Series MSO Low Profile has up to 6.25 GS/s sample rate on all channels, providing more than 5x oversampling, enabling better noise performance and fine timing resolution.

The standard 125 M record length provides 20 ms of acquisition time at the highest sample rate (6.25 GS/s), enabling long time captures while maintaining high timing resolution for more accurate measurements.

## Industry leading vertical resolution

The 5 Series MSO Low Profile 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 5 Series MSO Low Profile 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.



1 GHz frequency plot with High Res filter overlaid shows the reduction in noise when High Res mode is enabled

High Res mode always provides at least 12 bits of vertical resolution and extends all the way to 16 bits of vertical resolution at  $\leq 125$  MS/s sample rates. The following table shows the number of bits of vertical resolution for each sample rate setting when in High Res.

Sample rate	Number of bits of vertical resolution
6.25 GS/s <sup>3</sup>	8
3.125 GS/s	12
1.25 GS/s	13
625 MS/s	14
312.5 MS/s	15
$\leq 125$ MS/s	16

Typical 8-bit ADC oscilloscopes have an Effective Number of Bits (ENOB) of between 4 and 6, depending on bandwidth and vertical scale selected. The 12-bit ADC in the 5 Series MSO Low Profile, coupled with a new low-noise front-end amplifier, provides an ENOB of between 7 and 9 bits, enabling better viewing of fine signal detail in the presence of large amplitude signals.

<sup>3</sup> 6.25 GS/s not available as real-time sample rate when High Res is on.



The following table shows the typical ENOB values for the 5 Series MSO Low Profile measured with High Res mode, 50  $\Omega$ , 10 MHz input with 90% full screen.

Bandwidth	ENOB
1 GHz	7.6
500 MHz	7.9
350 MHz	8.2
250 MHz	8.1
20 MHz	8.9

## TekVPI Probe Interface

The TekVPI<sup>®</sup> 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 probe compensation box. 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 5 Series MSO Low Profile 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.

The TekVPI probe interface is key to enabling the high bandwidth and low attenuation versions of the optional TPP Series of passive voltage probes. The TPP Series 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. At 1 GHz bandwidth, the optional TPP1000 probes enable you to see high frequency components in your signals, and extremely low 3.9 pF capacitive loading minimizes adverse effects on your circuits. The optional low-attenuation (2x) TPP0502 has 500 MHz bandwidth and is exceptional at measuring low voltages.



MSO58LP with TekVPI probes and touch monitor attached for use in a lab environment.

## Designed with your needs in mind

### Remote operation to speed automated test

IVI-COM<sup>4</sup>, IVI-C<sup>5</sup>, and LabVIEW<sup>4</sup> instrument drivers are available for free and enable easy communication with the oscilloscope using LAN or USBTMC connections from an external PC. A full set of programmatic commands to setup and control the instrument remotely enable easy test automation.

### Remote operation to improve collaboration

The embedded e\*Scope<sup>®</sup> 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 ways you do in-person, whether you are across the lab or across the globe. e\*Scope enables multiple sites to connect to an instrument providing data acquisition results in real-time.



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

### Enhanced security option

The 5-SEC enhanced security option enables password-protected enabling/disabling of all USB communication ports and firmware upgrades. In addition, option 5-SEC provides the highest level of security by ensuring that internal memory is clear of all setup and waveform data in compliance with National Industrial Security Program Operating Manual (NISPOM) DoD 5220.22-M, Chapter 8 requirements as well as Defense Security Service Manual for the Certification and Accreditation of Classified Systems under the NISPOM. This ensures you can confidently move the instrument out of a secure area.

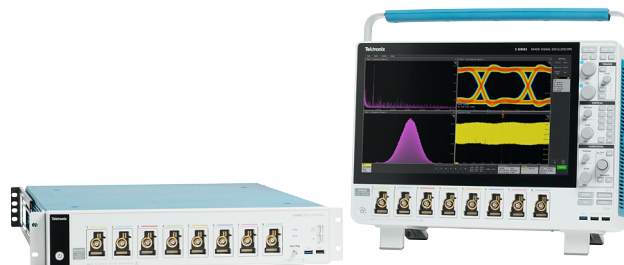
To permanently store data, you can save it to an external flash memory device or programmatically to USBTMC ports in keeping with your lab security protocols.

<sup>4</sup> Drivers are available from [www.tek.com/downloads](http://www.tek.com/downloads).

<sup>5</sup> Drivers are available from [www.ni.com](http://www.ni.com).

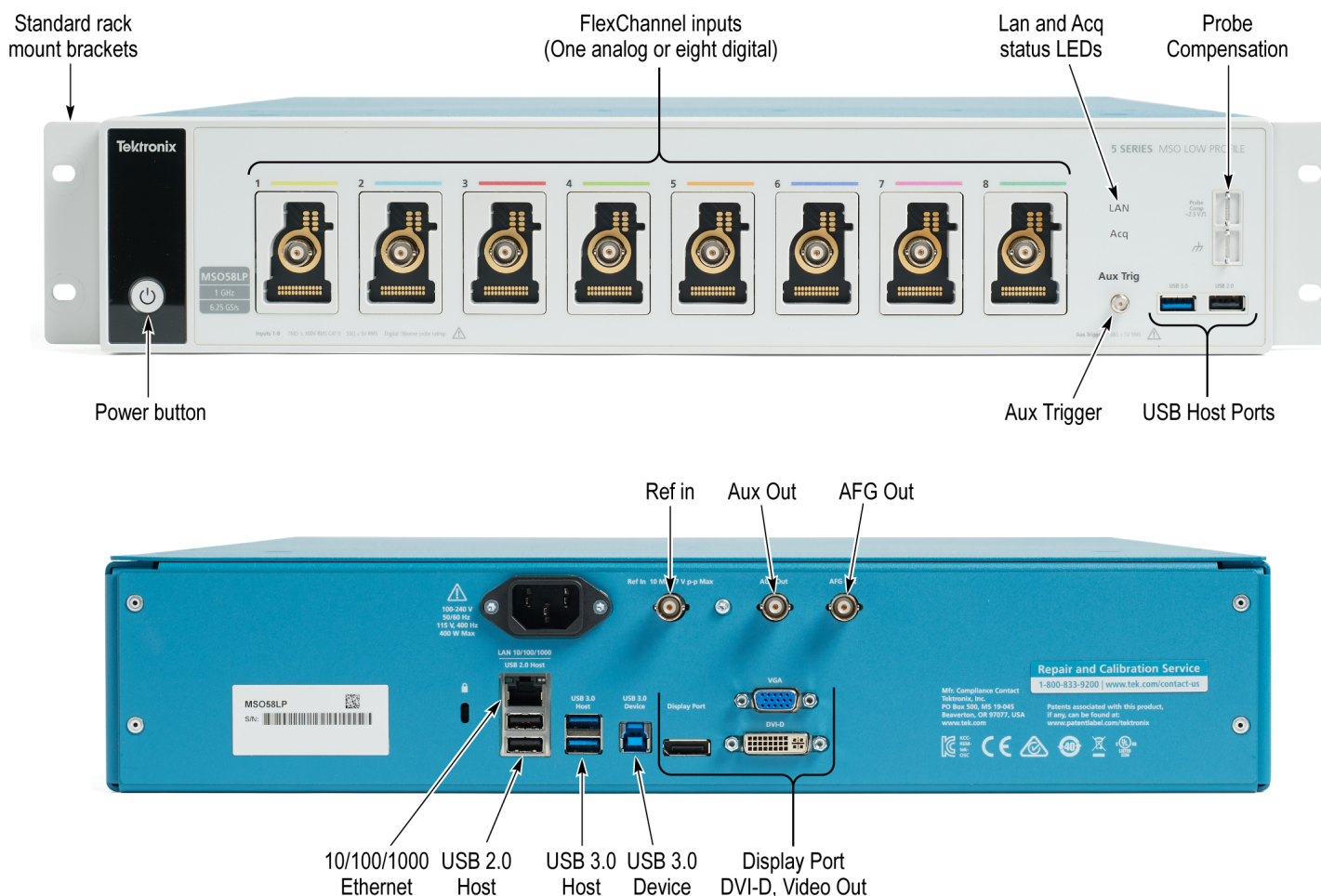
## Quickly transition from the lab to manufacturing

The 5 Series MSO Low Profile is based on the successful 5 Series MSO platform. This means you can use the benchtop 5 Series MSO with its beautiful 15.6-in touch display and its full measurement analysis capabilities during the development process. Then, when you are ready to transition your product to manufacturing, you can use the same software and test routines developed during R&D in your manufacturing test application, saving time and rack space.



Use the benchtop 5 Series MSO during R&D, then seamlessly transition to the low profile version for manufacturing test.

## 5 Series MSO Low Profile - The highest channel density and greatest performance in its class



# Specifications

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

## Model overview

### Oscilloscope

	MSO58LP, MSO58LPGSA
FlexChannel inputs	8
Maximum analog channels	8
Maximum digital channels (with optional logic probes)	64
Bandwidth (calculated rise time)	1 GHz (400 ps)
DC Gain Accuracy	50 $\Omega$ , 1 M $\Omega$ : $\pm 1.0\%$ , ( $\pm 2.0\%$ at $\leq 1$ mV/div), derated at 0.1 %/°C above 30°C
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 @ $\leq 125$ MS/s (High Res)
Sample Rate	6.25 GS/s on all analog / digital channels (160 ps resolution)
Record Length	125 Mpoints on all analog / digital channels
Waveform Capture Rate	>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	20 MHz, 250 MHz, and 1 GHz
Input coupling	DC, AC
Input impedance	50 $\Omega \pm 1\%$ 1 M $\Omega \pm 1\%$ with 13.0 pF $\pm 1.5$ pF
Input sensitivity range	
1 M $\Omega$	500 $\mu$ V/div to 10 V/div in a 1-2-5 sequence
50 $\Omega$	500 $\mu$ V/div to 1 V/div in a 1-2-5 sequence Note: 500 $\mu$ V/div is a 2X digital zoom of 1 mV/div.
Maximum input voltage	50 $\Omega$ : 5 V <sub>RMS</sub> , with peaks $\leq \pm 20$ V (DF $\leq 6.25\%$ ) 1 M $\Omega$ : 300 V <sub>RMS</sub> , CAT II For 1 M $\Omega$ , 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 <sub>RMS</sub>

## Vertical system - analog channels

Effective bits (ENOB), typical

High Res mode, 50  $\Omega$ , 10 MHz  
input with 90% full screen

Bandwidth	ENOB
1 GHz	7.6
500 MHz	7.9
350 MHz	8.2
250 MHz	8.1
20 MHz	8.9

Random noise, RMS, typical

1 GHz, High Res mode (RMS)

1 GHz	50 $\Omega$					1 M $\Omega$			
V/div	1 GHz	500 MHz	350 MHz	250 MHz	20 MHz	500 MHz	350 MHz	250 MHz	20 MHz
1 mV/div <sup>6</sup>	254 $\mu$ V	198 $\mu$ V	141 $\mu$ V	118 $\mu$ V	70.0 $\mu$ V	189 $\mu$ V	143 $\mu$ V	118 $\mu$ V	64.8 $\mu$ V
2 mV/div	255 $\mu$ V	198 $\mu$ V	143 $\mu$ V	121 $\mu$ V	70.4 $\mu$ V	194 $\mu$ V	145 $\mu$ V	121 $\mu$ V	66.0 $\mu$ V
5 mV/div	262 $\mu$ V	202 $\mu$ V	150 $\mu$ V	133 $\mu$ V	72.8 $\mu$ V	196 $\mu$ V	152 $\mu$ V	130 $\mu$ V	69.6 $\mu$ V
10 mV/div	283 $\mu$ V	218 $\mu$ V	169 $\mu$ V	158 $\mu$ V	79.8 $\mu$ V	212 $\mu$ V	167 $\mu$ V	154 $\mu$ V	78.2 $\mu$ V
20 mV/div	357 $\mu$ V	273 $\mu$ V	222 $\mu$ V	223 $\mu$ V	102 $\mu$ V	269 $\mu$ V	214 $\mu$ V	223 $\mu$ V	104 $\mu$ V
50 mV/div	677 $\mu$ V	516 $\mu$ V	436 $\mu$ V	460 $\mu$ V	196 $\mu$ V	490 $\mu$ V	410 $\mu$ V	480 $\mu$ V	207 $\mu$ V
100 mV/div	1.61 mV	1.23 mV	1.02 mV	1.04 mV	464 $\mu$ V	1.16 mV	964 $\mu$ V	1.05 mV	475 $\mu$ V
1 V/div	13.0 mV	9.88 mV	8.41 mV	8.94 mV	3.77 mV	13.6 mV	10.6 mV	11.1 mV	5.47 mV

Position range

 $\pm 5$  divisions

Offset ranges, maximum

Volts/div Setting	Maximum offset range	
	50 $\Omega$ Input	1 M $\Omega$ Input
500 $\mu$ V/div - 63 mV/div	$\pm 1$ V	$\pm 1$ V
64 mV/div - 999 mV/div	$\pm 10$ V	$\pm 10$ V
1 V/div - 10 V/div	$\pm 10$ V	$\pm 100$ V

Offset accuracy

 $\pm(0.005 \times |\text{offset} - \text{position}| + \text{DC balance})$ Crosstalk (channel isolation),  
typical $\geq 200:1$  up to the rated bandwidth for any two channels having equal Volts/div settings

DC balance

0.1 div with DC-50  $\Omega$  oscilloscope input impedance (50  $\Omega$  BNC terminated)

0.2 div at 1 mV/div with DC-50  $\Omega$  oscilloscope input impedance (50  $\Omega$  BNC terminated)

0.4 div at 500  $\mu$ V/div with DC-50  $\Omega$  oscilloscope input impedance (50  $\Omega$  BNC terminated)

0.2 div with DC-1 M $\Omega$  oscilloscope input impedance (50  $\Omega$  BNC terminated)

0.4 div at 500  $\mu$ V/div with DC-1 M $\Omega$  scope input impedance (50  $\Omega$  BNC terminated)

<sup>6</sup> Bandwidth at 500  $\mu$ V/div is limited to 250 MHz in 50  $\Omega$ .



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
Maximum input toggle rate	500 MHz
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 <sub>pp</sub> for F <sub>in</sub> ≤ 200 MHz, 10 V <sub>pp</sub> for F <sub>in</sub> > 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 125 Mpoints in single sample increments								
Maximum duration at highest sample rate	20 ms								
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 <sup>-6</sup> over any ≥1 ms time interval								
<table><tr><th>Description</th><th>Specification</th></tr><tr><td>Factory Tolerance</td><td>±5.0 x10<sup>-7</sup> . At calibration, 23 °C ambient, over any ≥1 ms interval</td></tr><tr><td>Temperature stability</td><td>±5.0 x10<sup>-7</sup> . Tested at operating temperatures</td></tr><tr><td>Crystal aging, typical</td><td>±1.5 x 10<sup>-6</sup> . Frequency tolerance change at 25 °C over a period of 1 year</td></tr></table>		Description	Specification	Factory Tolerance	±5.0 x10 <sup>-7</sup> . At calibration, 23 °C ambient, over any ≥1 ms interval	Temperature stability	±5.0 x10 <sup>-7</sup> . Tested at operating temperatures	Crystal aging, typical	±1.5 x 10 <sup>-6</sup> . Frequency tolerance change at 25 °C over a period of 1 year
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## Horizontal system

Delta-time measurement accuracy

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

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

(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 (1<sup>st</sup> Edge) around 1<sup>st</sup> point in measurement

$SR_2$  = Slew Rate (2<sup>nd</sup> Edge) around 2<sup>nd</sup> 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	$\leq 0.450 \text{ ps} + (1 \times 10^{-11} \times \text{Measurement Duration})_{RMS}$ , for measurements having duration $\leq 100 \text{ ms}$
Delay between analog channels, full bandwidth, typical	$\leq 100 \text{ ps}$ for any two channels with input impedance set to $50 \Omega$ , DC coupling with equal Volts/div or above $10 \text{ mV/div}$
Delay between analog and digital FlexChannels, typical	$< 1 \text{ ns}$ when using a TLP058 and a TPP1000/TPP0500B with no bandwidth limits applied
Delay between any two digital FlexChannels, typical	$320 \text{ ps}$
Delay between any two bits of a digital FlexChannel, typical	$160 \text{ ps}$

## Trigger system

Trigger modes	Auto, Normal, and Single
Trigger coupling	DC, AC, HF reject (attenuates $> 50 \text{ kHz}$ ), LF reject (attenuates $< 50 \text{ kHz}$ ), noise reject (reduces sensitivity)
Trigger holdoff range	$0 \text{ ns}$ to $10 \text{ seconds}$
Trigger jitter, typical	$\leq 5 \text{ ps}_{RMS}$ for sample mode and edge-type trigger $\leq 7 \text{ ps}_{RMS}$ for edge-type trigger and FastAcq mode $\leq 40 \text{ ps}_{RMS}$ for non edge-type trigger modes $\leq 200 \text{ ps}_{RMS}$ for AUX trigger in, Sample acquisition mode, edge trigger $\leq 220 \text{ ps}_{RMS}$ for AUX trigger in, FastAcq acquisition mode, edge trigger
AUX In trigger skew between instruments, typical	$\pm 100 \text{ ps}$ jitter on each instrument with $150 \text{ ps}$ skew; $\leq 350 \text{ ps}$ total between instruments. Skew improves for sinusoidal input voltages $\geq 500 \text{ mV}$

## Trigger system

Edge-type trigger sensitivity, DC coupled, typical

Path	Range	Specification
1 M $\Omega$ path (all models)	0.5 mV/div to 0.99 mV/div	4.5 div from DC to instrument bandwidth
	$\geq 1$ mV/div	The greater of 5 mV or 0.7 div from DC to lesser of 500 MHz or instrument BW, & 6 mV or 0.8 div from > 500 MHz to instrument bandwidth
50 $\Omega$ path		The greater of 5.6 mV or 0.7 div from DC to the lesser of 500 MHz or instrument BW, & 7 mV or 0.8 div from > 500 MHz to instrument bandwidth
Line		Fixed
AUX Trigger in		200 mV <sub>PP</sub> , DC to 250 MHz

### Trigger level ranges

Source	Range
Any Channel	$\pm 5$ divs from center of screen
Aux In Trigger	$\pm 5$ 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

<b>Edge:</b>	Positive, negative, or either slope on any channel. Coupling includes DC, AC, noise reject, HF reject, and LF reject
<b>Pulse Width:</b>	Trigger on width of positive or negative pulses. Event can be time- or logic-qualified
<b>Timeout:</b>	Trigger on an event which remains high, low, or either, for a specified time period. Event can be logic-qualified
<b>Run:</b>	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
<b>Window:</b>	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
<b>Logic:</b>	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
<b>Setup &amp; Hold:</b>	Trigger on violations of both setup time and hold time between clock and data present on any input channels
<b>Rise / Fall Time:</b>	Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative, or either. Event can be logic-qualified
<b>Sequence:</b>	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
<b>Visual trigger</b>	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.
<b>Parallel Bus:</b>	Trigger on a parallel bus data value. Parallel bus can be from 1 to 64 bits (from the digital and analog channels) in size. Supports Binary and Hex radices
<b>I<sup>2</sup>C Bus (option 5-SREMBD):</b>	Trigger on Start, Repeated Start, Stop, Missing ACK, Address (7 or 10 bit), Data, or Address and Data on I <sup>2</sup> C buses up to 10 Mb/s
<b>SPI Bus (option 5-SREMBD):</b>	Trigger on Slave Select, Idle Time, or Data (1-16 words) on SPI buses up to 20 Mb/s
<b>RS-232/422/485/UART Bus (option 5-SRCOMP):</b>	Trigger on Start Bit, End of Packet, Data, and Parity Error up to 15 Mb/s
<b>CAN Bus (option 5-SRAUTO):</b>	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
<b>CAN FD Bus (option 5-SRAUTO):</b>	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
<b>LIN Bus (option 5-SRAUTO):</b>	Trigger on Sync, Identifier, Data, Identifier and Data, Wakeup Frame, Sleep Frame, and Error on LIN buses up to 1 Mb/s

## Trigger system

<b>FlexRay Bus (Option 5-SRAUTO):</b>	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
<b>SENT Bus (Option 5-SRAUTOSEN)</b>	Trigger on Start of Packet, Fast Channel Status and Data, Slow Channel Message ID and Data, and CRC Errors
<b>SPMI Bus (option 5-SRPM):</b>	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
<b>USB 2.0 LS/FS/HS Bus (Option 5-SRUSB2):</b>	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
<b>Ethernet Bus (option 5-SRENET):</b>	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
<b>Audio (I<sup>2</sup>S, LJ, RJ, TDM) Bus (option 5-SRAUDIO):</b>	Trigger on Word Select, Frame Sync, or Data. Maximum data rate for I <sup>2</sup> S/LJ/RJ is 12.5 Mb/s. Maximum data rate for TDM is 25 Mb/s
<b>MIL-STD-1553 Bus (option 5-SRAERO):</b>	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
<b>ARINC 429 Bus (option 5-SRAERO):</b>	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

<b>Sample</b>	Acquires sampled values
<b>Peak Detect</b>	Captures glitches as narrow as 640 ps at all sweep speeds
<b>Averaging</b>	From 2 to 10,240 waveforms
<b>Envelope</b>	Min-max envelope reflecting Peak Detect data over multiple acquisitions
<b>High Res</b>	<p>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.</p> <p>High Res mode always provides at least 12 bits of vertical resolution and extends all the way to 16 bits of vertical resolution at <math>\leq 125</math> MS/s sample rates.</p>
<b>FastAcq®</b>	FastAcq optimizes the instrument for analysis of dynamic signals and capture of infrequent events by capturing >500,000 wfms/s.
<b>Roll mode</b>	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.
<b>FastFrame™</b>	<p>Acquisition memory divided into segments.</p> <p>Maximum trigger rate &gt;5,000,000 waveforms per second</p> <p>Minimum frame size = 50 points</p> <p>Maximum Number of Frames: For frame size <math>\geq 1,000</math> points, maximum number of frames = record length / frame size. For 50 point frames, maximum number of frames = 950,000</p>

## 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 $\geq 16$ waveforms	$\pm((\text{DC Gain Accuracy}) *  \text{reading} - (\text{offset} - \text{position})  + \text{Offset Accuracy} + 0.1 * \text{V/div setting})$
	Delta volts between any two averages of $\geq 16$ waveforms acquired with the same oscilloscope setup and ambient conditions	$\pm(\text{DC Gain Accuracy} *  \text{reading}  + 0.05 \text{ div})$

### Automatic measurements

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

### 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

### Jitter measurements (standard)

TIE and Phase Noise

### 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 or unique for each measurement

### Gating

Isolate the specific occurrence within an acquisition to take measurements on, using either the screen or waveform cursors. Gating can be set to global for all measurements or unique for each measurement a to local where a second type of gating can be used.

### Measurement plots

Time Trend, Histogram, and Spectrum plots are available for all standard measurements

### Jitter analysis (option 5-DJA, SUP5-DJA) adds the following:

#### Measurements

Jitter Summary, TJ@BER, RJ- $\delta\delta$ , DJ- $\delta\delta$ , PJ, RJ, DJ, DDJ, DCD, SRJ, J2, J9, NPJ, F/2, F/4, F/8, Eye Height, Eye Height@BER, Eye Width, Eye Width@BER, Eye High, Eye Low, Q-Factor, Bit High, Bit Low, Bit Amplitude, DC Common Mode, AC Common Mode (Pk-Pk), Differential Crossover, T/nT Ratio, SSC Freq Dev, SSC Modulation Rate

#### Measurement Plots

Eye Diagram and Jitter Bathtub

#### Eye Diagram Mask Testing

Automated mask pass/fail testing

### Power analysis (option 5-PWR, SUP5-PWR) 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,  $R_{DS(on)}$ )

Magnetic Analysis (Inductance, I vs.  $\text{Intg}(V)$ , Magnetic Loss, Magnetic Property)

Output Analysis (Line Ripple, Switching Ripple, Efficiency, Turn-on Time, Turn-off Time)

Frequency Response Analysis (Control Loop Response Bode Plot, Power Supply Rejection Ratio)

#### Measurement Plots

Harmonics Bar Graph, Switching Loss Trajectory Plot, and Safe Operating Area



**Waveform math**

<b>Number of math waveforms</b>	Unlimited
<b>Arithmetic</b>	Add, subtract, multiply, and divide waveforms and scalars
<b>Algebraic expressions</b>	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)
<b>Math functions</b>	Invert, Integrate, Differentiate, Square Root, Exponential, Log 10, Log e, Abs, Ceiling, Floor, Min, Max, Degrees, Radians, Sin, Cos, Tan, ASin, ACos, and ATan
<b>Relational</b>	Boolean result of comparison >, <, ≥, ≤, =, and ≠
<b>Logic</b>	AND, OR, NAND, NOR, XOR, and EQV
<b>Filtering function</b>	User-definable filters. Users specify a file containing the coefficients of the filter
<b>FFT functions</b>	Spectral Magnitude and Phase, and Real and Imaginary Spectra
<b>FFT vertical units</b>	Magnitude: Linear and Log (dBm) Phase: Degrees, Radians, and Group Delay
<b>FFT window functions</b>	Hanning, Rectangular, Hamming, Blackman-Harris, Flattop2, Gaussian, Kaiser-Bessel, and TekExp

**Search**

<b>Number of searches</b>	Unlimited
<b>Search types</b>	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 (available only through the video out ports or e\*Scope)**

	1,920 horizontal × 1,080 vertical pixels (High Definition)
<b>Display modes</b>	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.
<b>Zoom</b>	Horizontal and vertical zooming is supported in all waveform and plot views.
<b>Interpolation</b>	Sin(x)/x and Linear
<b>Waveform styles</b>	Vectors, dots, variable persistence, and infinite persistence
<b>Graticules</b>	Grid, Time, Full, and None
<b>Color palettes</b>	Normal, inverted, and inverted for screen captures
<b>Format</b>	YT, XY, and XYZ

## Arbitrary/Function Generator (optional)

<b>Function types</b>	Arbitrary, sine, square, pulse, ramp, triangle, DC level, Gaussian, Lorentz, exponential rise/fall, $\sin(x)/x$ , random noise, Haversine, Cardiac
<b>Sine waveform</b>	
Frequency range	0.1 Hz to 50 MHz
Frequency setting resolution	0.1 Hz
Frequency accuracy	130 ppm (frequency $\leq$ 10 kHz), 50 ppm (frequency $>$ 10 kHz)
	This is for Sine, Ramp, Square and Pulse waveforms only.
Amplitude range	20 mV <sub>pp</sub> to 5 V <sub>pp</sub> into Hi-Z; 10 mV <sub>pp</sub> to 2.5 V <sub>pp</sub> into 50 $\Omega$
Amplitude flatness, typical	$\pm 0.5$ dB at 1 kHz
	$\pm 1.5$ dB at 1 kHz for $<$ 20 mV <sub>pp</sub> amplitudes
Total harmonic distortion, typical	1% for amplitude $\geq$ 200 mV <sub>pp</sub> into 50 $\Omega$ load
	2.5% for amplitude $>$ 50 mV AND $<$ 200 mV <sub>pp</sub> into 50 $\Omega$ load
	This is for Sine wave only.
Spurious free dynamic range, typical	40 dB ( $V_{pp} \geq 0.1$ V); 30 dB ( $V_{pp} \geq 0.02$ V), 50 $\Omega$ load
<b>Square and pulse waveform</b>	
Frequency range	0.1 Hz to 25 MHz
Frequency setting resolution	0.1 Hz
Frequency accuracy	130 ppm (frequency $\leq$ 10 kHz), 50 ppm (frequency $>$ 10 kHz)
Amplitude range	20 mV <sub>pp</sub> to 5 V <sub>pp</sub> into Hi-Z; 10 mV <sub>pp</sub> to 2.5 V <sub>pp</sub> into 50 $\Omega$
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 ns, 10% - 90%
Pulse width resolution	100 ps
Overshoot, typical	$<$ 6% for signal steps greater than 100 mV <sub>pp</sub>
	This applies to overshoot of the positive-going transition (+overshoot) and of the negative-going (-overshoot) transition
Asymmetry, typical	$\pm 1\% \pm 5$ ns, at 50% duty cycle
Jitter, typical	$<$ 60 ps TIE <sub>RMS</sub> , $\geq$ 100 mV <sub>pp</sub> amplitude, 40%-60% duty cycle
<b>Ramp and triangle waveform</b>	
Frequency range	0.1 Hz to 500 kHz
Frequency setting resolution	0.1 Hz
Frequency accuracy	130 ppm (frequency $\leq$ 10 kHz), 50 ppm (frequency $>$ 10 kHz)
Amplitude range	20 mV <sub>pp</sub> to 5 V <sub>pp</sub> into Hi-Z; 10 mV <sub>pp</sub> to 2.5 V <sub>pp</sub> into 50 $\Omega$
Variable symmetry	0% - 100%
Symmetry resolution	0.1%
<b>DC level range</b>	
	$\pm 2.5$ V into Hi-Z
	$\pm 1.25$ V into 50 $\Omega$
<b>Random noise amplitude range</b>	
	20 mV <sub>pp</sub> to 5 V <sub>pp</sub> into Hi-Z
	10 mV <sub>pp</sub> to 2.5 V <sub>pp</sub> into 50 $\Omega$

**Arbitrary/Function Generator (optional)****Sin(x)/x**

Maximum frequency	2 MHz
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**Gaussian pulse, Haversine, and Lorentz pulse**

Maximum frequency	5 MHz
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**Lorentz pulse**

Frequency range	0.1 Hz to 5 MHz
Amplitude range	20 mV <sub>pp</sub> to 2.4 V <sub>pp</sub> into Hi-Z
	10 mV <sub>pp</sub> to 1.2 V <sub>pp</sub> into 50 Ω

**Cardiac**

Frequency range	0.1 Hz to 500 kHz
Amplitude range	20 mV <sub>pp</sub> to 5 V <sub>pp</sub> into Hi-Z
	10 mV <sub>pp</sub> to 2.5 V <sub>pp</sub> into 50 Ω

**Arbitrary**

Memory depth	1 to 128 k
Amplitude range	20 mV <sub>pp</sub> to 5 V <sub>pp</sub> into Hi-Z
	10 mV <sub>pp</sub> to 2.5 V <sub>pp</sub> 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)
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Signal amplitude resolution	1 mV (Hi-Z)
	500 μV (50 Ω)

Sine and ramp frequency accuracy	(frequency ≤10 kHz)
	(frequency >10 kHz)

DC offset range	±2.5 V into Hi-Z
	±1.25 V into 50 Ω

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 <sub>RMS</sub> +DC, AC <sub>RMS</sub>
Voltage resolution	4 digits
Voltage accuracy	
DC:	$\pm((1.5\% *  \text{reading} - \text{offset} - \text{position} ) + (0.5\% *  (\text{offset} - \text{position}) ) + (0.1 * \text{Volts/div}))$ De-rated at 0.100%/°C of  reading - offset - position  above 30 °C Signal $\pm 5$ divisions from screen center
AC:	$\pm 2\%$ (40 Hz to 1 kHz) with no harmonic content outside 40 Hz to 1 kHz range AC, typical: $\pm 2\%$ (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	$\pm(1 \text{ count} + \text{time base accuracy} * \text{input frequency})$ The signal must be at least 8 mV <sub>pp</sub> 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 <sub>pp</sub> or 2 div, whichever is greater.
Resolution	8-digits

## Processor system

Host processor	Intel i5-4400E, 2.7 GHz, 64-bit, dual core processor
Operating system	Default instrument: Closed Linux
Internal storage	$\geq 80$ GB. Form factor is an 80 mm m.2 card with a SATA-3 interface

## Input-Output ports

DisplayPort connector	A 20-pin DisplayPort connector; connect to show the oscilloscope display on an external monitor or projector
DVI connector	A 29-pin DVI-D connector; connect to show the oscilloscope display on an external monitor or projector
VGA	DB-15 female connector; connect to show the oscilloscope display on an external monitor or projector
Probe compensator signal, typical	
Connection:	Connectors are located on the lower right front panel of the instrument
Amplitude:	0 to 2.5 V
Frequency:	1 kHz
Source impedance:	1 k $\Omega$
External reference input	The time-base system can phase lock to an external 10 MHz reference signal ( $\pm 4$ ppm).
USB interface (Host, Device ports)	Front panel USB Host ports: One USB 2.0 Hi-Speed port, one USB 3.0 SuperSpeed port Rear panel USB Host ports: Two USB 2.0 Hi-Speed ports, two USB 3.0 SuperSpeed ports Rear panel USB Device port: One USB 3.0 SuperSpeed Device port providing USBTMC support

## Input-Output ports

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)	$\geq 2.5$ V open circuit; $\geq 1.0$ V into a $50\ \Omega$ load to ground
Vout (LO)	$\leq 0.7$ V into a load of $\leq 4$ mA; $\leq 0.25$ V into a $50\ \Omega$ load to ground

### Aux Trigger In

**Connection** Front-panel SMA connector  
**Input impedance**  $50\ \Omega$   
**Maximum input**  $\leq 5\ V_{RMS}$

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

## Power source

### Power

**Power consumption** 400 Watts maximum  
**Source voltage** 100 - 240 V  $\pm 10\%$  at 50 Hz to 60 Hz  $\pm 10\%$   
 115 V  $\pm 10\%$  at 400 Hz  $\pm 10\%$

## Physical characteristics

**Dimensions** Height: 3.44 in (87.3 mm)  
 Width: 17.01 in (432 mm)  
 Depth: 23.85 in (605.7 mm)  
 Fits rack depths from 24 inches to 32 inches

**Weight** 25.5 lbs (11.6 kg)

**Cooling** The clearance requirement for adequate cooling is 2.0 in (50.8 mm) on the left and right sides of the instrument (when viewed from the front). Air flows through the instrument from left to right

**Rackmount configuration** 2U

## Environmental specifications

### Temperature

**Operating**  $+0\ ^\circ\text{C}$  to  $+50\ ^\circ\text{C}$  ( $32\ ^\circ\text{F}$  to  $122\ ^\circ\text{F}$ )  
**Non-operating**  $-20\ ^\circ\text{C}$  to  $+60\ ^\circ\text{C}$  ( $-4\ ^\circ\text{F}$  to  $140\ ^\circ\text{F}$ )

### Humidity

**Operating** 5% to 90% relative humidity (% RH) at up to  $+40\ ^\circ\text{C}$   
 5% to 55% RH above  $+40\ ^\circ\text{C}$  up to  $+50\ ^\circ\text{C}$ , noncondensing, and as limited by a maximum wet-bulb temperature of  $+39\ ^\circ\text{C}$   
**Non-operating** 5% to 90% relative humidity (% RH) at up to  $+40\ ^\circ\text{C}$   
 5% to 39% RH above  $+40\ ^\circ\text{C}$  up to  $+50\ ^\circ\text{C}$ , noncondensing, and as limited by a maximum wet-bulb temperature of  $+39\ ^\circ\text{C}$



## Environmental specifications

### Altitude

Operating	Up to 3,000 meters (9,843 feet)
Non-operating	Up to 12,000 meters (39,370 feet)

### Random vibration

Operating	0.31 GRMS, 5-500 Hz, 10 minutes per axis, 3 axes (30 minutes total)
Non-operating	2.46 GRMS, 5-500 Hz, 10 minutes per axis, 3 axes (30 minutes total)

## EMC, Environment, and Safety

Regulatory	CE marked for the European Union and UL approved for the USA and Canada RoHS compliant
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## 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.

## Ordering information

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

### Step 1

Start by selecting the 5 Series MSO Low Profile model that you need.

Model	Description
MSO58LP	Low Profile Mixed Signal Oscilloscope; 1 GHz bandwidth, (8) FlexChannels with 125 M record length
MSO58LPGSA	Low Profile Mixed Signal Oscilloscope; 1 GHz bandwidth, (8) FlexChannels with 125 M record length; Trade Agreements Act (TAA) compliant

### Each instrument includes

- Rackmount attachments installed
- Installation and safety manual (translated in English, Japanese, Simplified Chinese)
- Integrated online 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.

### Step 2

#### Add instrument functionality

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

Instrument Option	Built-in Functionality
5-AFG	Add Arbitrary / Function Generator
5-SEC <sup>7</sup>	Add enhanced security for instrument declassification and password protected enabling and disabling of all USB and Ethernet ports and firmware upgrade.

### Step 3

#### 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
5-SRAERO	Aerospace (MIL-STD-1553, ARINC 429)
5-SRAUDIO	Audio (I <sup>2</sup> S, LJ, RJ, TDM)
5-SRAUTO	Automotive (CAN, CAN FD, LIN, FlexRay)
5-SRAUTOSEN	Automotive sensor (SENT)
5-SRCOMP	Computer (RS-232/422/485/UART)
5-SREMBD	Embedded (I <sup>2</sup> C, SPI)
5-SRENET	Ethernet (10BASE-T, 100BASE-TX)
5-SRPM	Power Management (SPMI)
5-SRUSB2	USB (USB2.0 LS, FS, HS)

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

<sup>7</sup> This option must be purchased at the same time as the instrument. Not available as an upgrade.

Step 4

Add optional analysis capabilities

Instrument Option	Advanced Analysis
5-DJA	Advanced Jitter and Eye Analysis
5-PWR	Power Measurement and Analysis
5-PS2 <sup>8</sup>	Power Solution Bundle (5-PWR, THDP0200, TCP0030A, 067-1686-xx deskew fixture)

<sup>8</sup> This option must be purchased at the same time as the instrument. Not available as an upgrade.

## Step 5

### 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, $\pm 8$ V input voltage
TAP2500	2.5 GHz TekVPI® active single-ended voltage probe, $\pm 4$ V input voltage
TAP3500	3.5 GHz TekVPI® active single-ended voltage probe, $\pm 4$ V input voltage
TAP4000	4 GHz TekVPI® active single-ended voltage probe, $\pm 4$ 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, $\pm 42$ V differential input voltage
TDP1000	1 GHz TekVPI® differential voltage probe, $\pm 42$ V differential input voltage
TDP1500	1.5 GHz TekVPI® differential voltage probe, $\pm 8.5$ V differential input voltage
TDP3500	3.5 GHz TekVPI® differential voltage probe, $\pm 2$ V differential input voltage
TDP4000	4 GHz TekVPI® differential voltage probe, $\pm 2$ V differential input voltage
THDP0100	$\pm 6$ kV, 100 MHz TekVPI® high-voltage differential probe
THDP0200	$\pm 1.5$ kV, 200 MHz TekVPI® high-voltage differential probe
TMDP0200	$\pm 750$ 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, $\pm 2500$ V, TekVPI, 3 Meter Cable
TIVH02L	Isolated Probe; 200 MHz, $\pm 2500$ V, TekVPI, 10 Meter Cable
TIVH05	Isolated Probe; 500 MHz, $\pm 2500$ V, TekVPI, 3 Meter Cable
TIVH05L	Isolated Probe; 500 MHz, $\pm 2500$ V, TekVPI, 10 Meter Cable
TIVH08	Isolated Probe; 800 MHz, $\pm 2500$ V, TekVPI, 3 Meter Cable
TIVH08L	Isolated Probe; 800 MHz, $\pm 2500$ V, TekVPI, 10 Meter Cable
TIVM1	Isolated Probe; 1 GHz, $\pm 50$ V, TekVPI, 3 Meter Cable
TIVM1L	Isolated Probe; 1 GHz, $\pm 50$ V, TekVPI, 10 Meter Cable
TPP0500B	500 MHz, 10X TekVPI® passive voltage probe, 1.3 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
P6015A	20 kV, 75 MHz high-voltage passive probe
TPA-BNC <sup>9</sup>	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](http://www.tek.com/probes).

<sup>9</sup> Recommended for connecting your existing TekProbe probes to the MSO58LP Low Profile.

## Step 6

### Add digital probes

Each FlexChannel input can be configured as eight digital channels simply by connecting a TLP058 logic probe. TLP058 probes are ordered separately.

For this instrument	Order	To add
MSO58LP, MSO58LPGSA	1 to 8 TLP058 Probes	8 to 64 digital channels

## Step 7

### Add bench conversion or hard case accessories

Optional Accessory	Description
020-3180-xx	Benchtop conversion kit including four (4) instrument feet and a strap handle
016-2139-xx	Hard transit case with handles and wheels for easy transportation

## Step 8

### Select power cord option

Power Cord Option	Description
A0	North America power plug (115 V, 60 Hz); includes mechanism that retains power cord to instrument
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 9

### 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** The 5 Series MSO products offer many ways to 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	SUP5-AFG	SUP5-AFG-FL	Add arbitrary function generator
Add protocol analysis	SUP5-SRAERO	SUP5-SRAERO-FL	Aerospace serial triggering and analysis (MIL-STD-1553, ARINC 429)
	SUP5-SRAUDIO	SUP5-SRAUDIO-FL	Audio serial triggering and analysis (I <sup>2</sup> S, LJ, RJ, TDM)
	SUP5-SRAUTO	SUP5-SRAUTO-FL	Automotive serial triggering and analysis (CAN, CAN FD, LIN, FlexRay)
	SUP5-SRAUTOSEN	SUP5-SRAUTOSEN-FL	Automotive sensor serial triggering and analysis (SENT)
	SUP5-SRCOMP	SUP5-SRCOMP-FL	Computer serial triggering and analysis (RS-232/422/485/UART)
	SUP5-SREMBD	SUP5-SREMBD-FL	Embedded serial triggering and analysis (I <sup>2</sup> C, SPI)
	SUP5-SRENET	SUP5-SRENET-FL	Ethernet serial triggering and analysis (10Base-T, 100Base-TX)
	SUP5-SRPM	SUP5-SRPM-FL	Power Management serial triggering and analysis (SPMI)
	SUP5-SRUSB2	SUP5-SRUSB2-FL	USB 2.0 serial bus triggering and analysis (LS, FS, HS)
Add advanced analysis	SUP5-DJA	SUP5-DJA-FL	Advanced jitter and eye analysis
	SUP5-PWR	SUP5-PWR-FL	Advance power measurements and analysis
Add digital voltmeter	SUP5-DVM	N/A	Add digital voltmeter / trigger frequency counter (Free with product registration at <a href="http://www.tek.com/register5mso">www.tek.com/register5mso</a> )



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](http://www.tek.com).

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