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FemtoScope 1000/2000 Series

5/16 GHz USB Wide-Bandwidth Oscilloscopes

Data Sheet

Laboratory Oscilloscope features at a Price of Miniature USB Oscilloscope

- *FemtoScope* 1051: 5 GHz bandwidth, 1 channel
- *FemtoScope* 2052: 5 GHz bandwidth, 2 channels
- *FemtoScope* 1161: 16 GHz bandwidth, 1 channel
- *FemtoScope* 2162: 16 GHz bandwidth, 2 channels

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Oscilloscope Overview

More recently, if you needed an oscilloscope with a bandwidth of more than 5 GHz, you had to accept the need for significant financial costs. The *FemtoScope* models set a new price/performance ratio standard for gigahertz frequency USB oscilloscopes.

These single-, or dual-channel instruments, having a bandwidth of 5 or 16 GHz and triggering over the entire frequency range, provide the acquisition, display, measurement and analysis of complex waveforms in the range from picoseconds to hundreds of seconds.

These oscilloscopes are designed for engineers working both in research laboratories and in production workshops, and who, above all, need characteristics associated with flexible measurements of wide-bandwidth signals.

Being a direct alternative to traditional benchtop oscilloscopes, these instruments are portable, and maybe even miniature, and, what is extremely important, they have an incomparably lower cost. Economical prices make the *FemtoScope* Series preferred for teaching basic scientific and engineering measurements at lab stations in schools and universities. Features normally only found on much higher priced scopes equip the *FemtoScope* Series to be a powerful choice for R&D applications.

Figure 1. The 16-GHz FemtoScopes 2162 and 1161 capture rise times as fast as 16 ps (20%/80%) while 5-GHz FemtoScopes 2052 and 1051 make the same as fast as 50 ps

Features

- 2 or 1 channels configuration.
- The industry's widest 5 or 16 GHz USB oscilloscope bandwidths available to match your measurement application,
- The industry's lowest 1.5 ps rms typical intrinsic jitter for USB oscilloscope.
- 12-bit Analog-to-Digital Converter with 500 MSa/s real time sampling rate per channel.
- The industry's highest equivalent time sampling rate up to 5 TSA/s for USB oscilloscope.
- 10 ps/div fastest time base scale.
- Up to 16 GHz trigger bandwidth enables capture and analysis wide-bandwidth complex signals.

- Up to 11.3 Gb/s clock recovery trigger data rate.
- Powerful SW and flexible, simple and intuitive user interface with built-in OnLine Help and demo training signals.
- Color graded display, automatic measurements, eye diagrams, mask test, histograms, waveform mathematics, 7-digit built-in frequency counter, spectrum analysis with FFT, autoscale, store waveforms and setups.
- Power consumption less than 15 or 22 W.
- Weight less than 370 or 790 grams.
- Footprint less than 1.9 or 3.4 sq.dm.
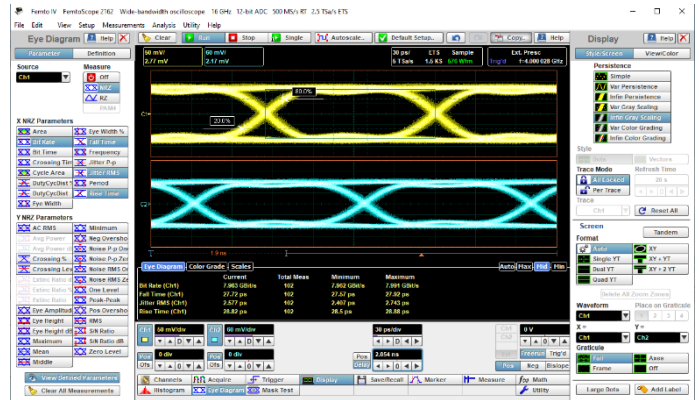- Economical price.

Figure 2. The FemtoScope instruments provide best solutions fast eye diagram measurements

Overview of the *FemtoScope* Series Key Specifications

Model	FS 2162	FS 1161	FS 2052	FS 1051
Input channels	2	1	2	1
Bandwidth	DC to 16 GHz		DC to 5 GHz	
Vertical scale	10 to 250 mV/div			
DC gain accuracy	±1.5 % of full scale			
DC offset range	-1 V to +1 V			
Input impedance	50 Ω			
Real TB range	10 ns/div to 1000 s/div			
Equivalent time base range	10 ps/div to 5 us/div		50 ps/div to 5 us/div	
Real time sampling rate	500 MSa/s max			
Equivalent time sampling rate	5 TSa/s max		1 TSa/s max	
Time base clock accuracy	± 35 ppm typ			
Δ time measurement accuracy	± (35 ppm * reading + 0.1% * screen width + 5 ps)			
ADC resolution	12 bits			
Record length	250 kSa max			
Trigger Source	Internal, External			
Trigger Style	Direct, Divided, Prescaled, Clock Recovery	Direct	Direct, Divided, Clock Recovery	Direct
Direct Trigger Bandwidth	DC to 3 GHz			
Divided Trigger Bandwidth	DC to 6 GHz	N/A	DC to 6 GHz	N/A
Prescaled Trigger Bandwidth	1 to 16 GHz	N/A	1 to 16 GHz	N/A
Clock Recovery Trigger Data Rate	6.5 MSa/s to 11.3 GSa/s	N/A	6.5 MSa/s to 5 GSa/s	N/A
RMS trigger jitter	1.5 ps typ			

The *FemtoScope* USB oscilloscopes utilize modern hardware to perform many of the functions that traditional digitizers do with software on the CPU. Built as a single-board oscilloscope, they are controlled from a computer via USB interface. Acquisition Board includes ultra-wideband track-and-hold amplifiers, 12-bit ADCs with 500 MSa/s sampling rate, high-speed trigger circuity and timing interpolator with sub-picosecond resolution. A state-of-the-art microprocessor, FPGA and precision clock oscillator provide structure flexibility, fast acquisition speed and effective interaction with PC.
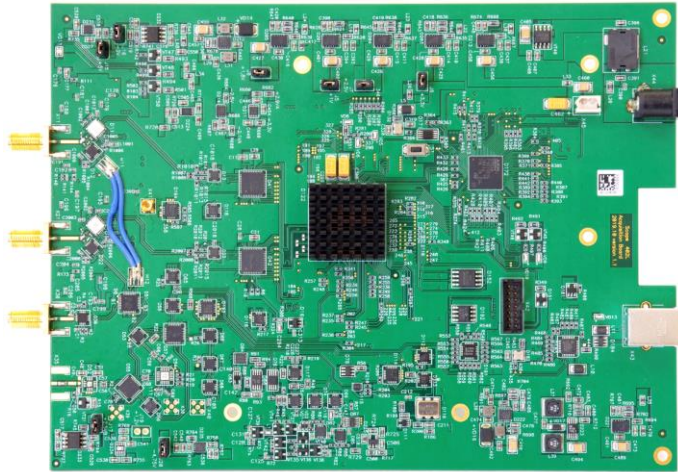

Figure 3. Acquisition Board of the FemtoScope 2052

Bandwidth and transient response

The *FemtoScope* 1000/2000 Series USB oscilloscopes have one or two input channels up to 5 or 16 GHz with market-leading ADC, timing and display resolutions for accurately measuring and visualizing high-speed analog and data signals. They are ideal for capturing pulse and step transitions down to 70 or 22 ps, impulses down to 140 or 45 ps and clocks and data eyes to 5 or 11.3 Gb/s. Most high-bandwidth applications involve repetitive signals or clock-related data streams that can be readily analyzed with these oscilloscopes by equivalent-time sampling.

The heart of each of the channel is a wide-bandwidth track-and-hold amplifier, which stores the analog voltage at the channel input at a time determined by the arrival of a 500-MHz sampling pulse. The inputs include wide-bandwidth symmetrical resistive voltage divider. One half of the signal goes to the THA, the other to the trigger comparator. The input impedance of the channel is (50 ± 1.5) Ohms. With a maximum permissible input voltage of ±2 V, the dynamic range of the input signals is ±1 V.
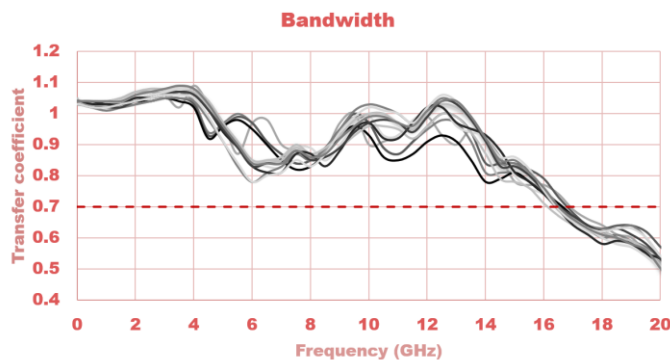

Figure 4. Frequency response of twelve channels (six oscilloscope) measured on the FemtoScope 2162

User-selectable hardware bandwidth-limiting reduces vertical noise. More bandwidth enhances quality of your measurements except when you want to limit noise level coming from additional bandwidth. However wide bandwidth may not be the best solution when you are making low-noise measurements as the additional bandwidth captures additional high-frequency noise along with high-frequency signal content.

All four models of oscilloscopes provide two bandwidth modes. Their transient response characteristics are shown in Figures 5-8.

Figure 5. Transient response of the FemtoScope 2162 tested with Keysight N2806A Calibration Generator. Total measured fall time is 23.71 ps, rms jitter is 1.256 ps, and negative overshoot is 5.495%
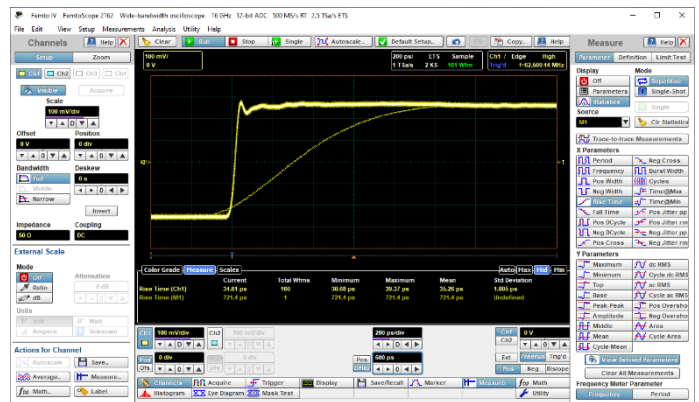

Figure 6. Comparative transient response of the FemtoScope 2162 made for two different bandwidths. Left response shows 35 ps rise time acquired in full (16 GHz) bandwidth mode, while the right waveform shows 721 ps rise time acquired in narrow 450 MHz bandwidth mode. Input has 25 ps rise time
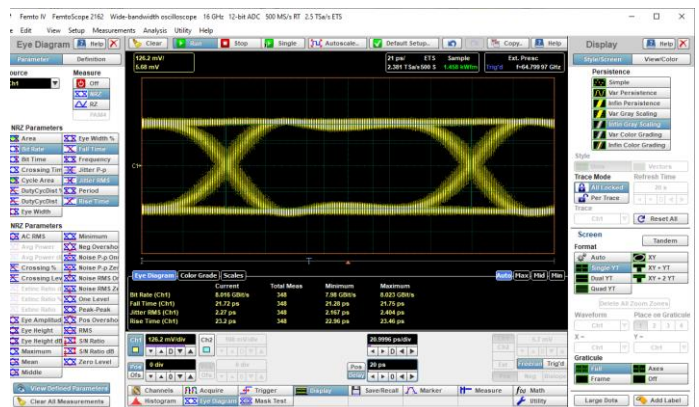

Figure 7. High quality 8 Gb/s eye diagram acquired by the FemtoScope 2162
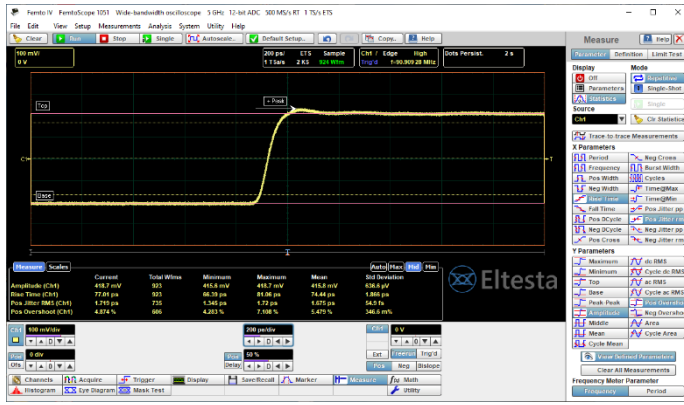
Figure 8. Transient response of 5-GHz channel shows less than 75 ps total rise time measured from Tektronix 1251 PPG (25 ps rise time)

In the full bandwidth mode, the instruments provide a typical rms noise level of less than 1.6 mV (for 5 GHz bandwidth) or 2.2 mV (for 16 GHz bandwidth). In narrow bandwidth mode, the THA operates in the "transparency" mode, providing a 450 MHz bandwidth at a typical rms noise level of less than 0.65 mV. This opens possibility to perform more sensitive measurements. Figure 9 shows wide opened 800 Mb/s eye diagram acquired in narrow bandwidth mode that demonstrates extremely good response characteristics.

The narrow bandwidth setting can also be used as an anti-alias filter.

Figure 9. 800 Mb/s wide opened eye diagram acquired in narrow bandwidth mode shows good response characteristics

Vertical channels and probes

Providing up to 12 bits of vertical resolution the *FemtoScope* allow to control vertical sensitivity between 10 mV/div and 250 mV/div. Full scale is defined as 8 vertical divisions, and further zooming may increase sensitivity in 100 times. With ±1.5% DC gain accuracy and ±1 V DC offset the scopes provide wide input dynamic range between -1 V and +1 V.

Figure 10 shows 1.9 V amplitude pulse symmetrical to zero. With rise time faster than 10 ns it has very small ringing within ±1 %.

With 50 Ω channel input impedance oscilloscopes used standard SMA female connector providing ±2 V (DC + peak AC) maximum input voltage.

You can use wide range of high-bandwidth low-impedance probes. The PicoConnect 900 family of high performance, ultra-low capacitance passive probes tailored to low invasive probing of high speed data lines out to 18 Gb/s (9 GHz). They are ideal companions for the *FemtoScope* Series, allowing cost-effective fingertip browsing of fast signals.

Two series are available: RF, microwave and pulse probes for broadband signals up to 5 GHz (10 Gb/s), and Gigabit probes for data

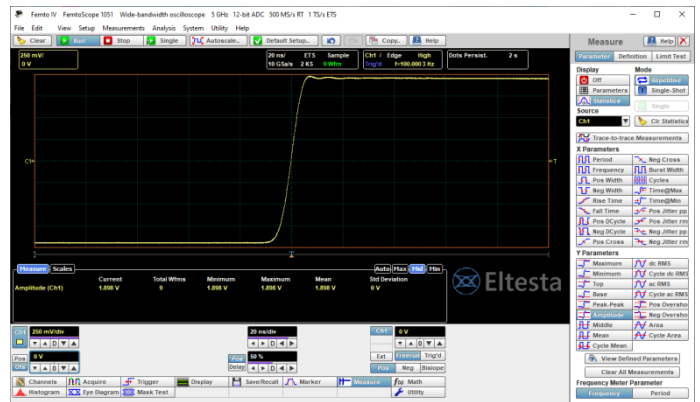streams such as USB 2, HDMI 1, Ethernet, PCIe and SATA up to 9 GHz (18 Gb/s).

Figure 10. Symmetrical to zero pulse having less than 10 ns rise time and 1.9 V amplitude shows less than ±1 % ringing

Acquisition and time base

The *FemtoScope* oscilloscopes used real-time, equivalent-time and roll sampling modes.

Real-time sampling mode is designed with a high enough sampling rate to capture a transient, non-repetitive signal with the instrument's specified analog bandwidth up to 250 MHz. According to Nyquist's sampling theorem, for accurate capture and display of the signal the scope's sampling rate must be at least twice the signal bandwidth. Typical high-bandwidth real-time oscilloscopes exceed this sampling rate by perhaps a factor of two, achieving up to four samples per cycle, or three samples in a minimum-width impulse.

Several acquisition modes let you choose how the oscilloscope will create points in the waveform record. Average calculates the average values for each record point over many waveform records. It is available in in real- and equivalent-time modes. Min-Max, Min and Max Envelope use the highest and lowest samples across several waveform records. These are also available in real- and equivalent-time modes. Peak Detect mode alternates between saving the highest sample in one acquisition interval and the lowest sample in the next acquisition interval. It is available in real-time only. High Resolution mode averages all samples taken during an acquisition interval to create a record point. This average results in a higher-resolution, lower-bandwidth waveform that works with real-time mode.

Time scale accuracy is critical, especially when you need deep-memory applications. In real-time acquisition the *FemtoScope* used stable internal 500 MHz clock that allows 10 ns/div faster time base scale (Fig 11).
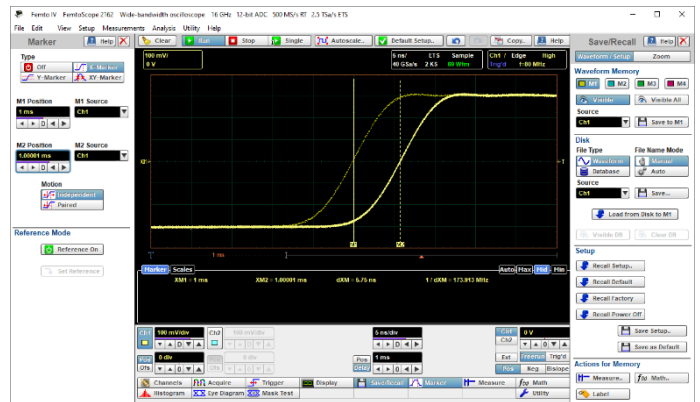

Figure 11. The FemtoScope 2162 measures real time base accuracy. Timing shift is 5.75 ns at 1 ms delay that is equivalent to 5.75 ppm timing accuracy

Stability of real-time clock can be estimated as a „long-time" jitter. Figure 12 demonstrates 60.7 ps rms jitter measured at 10 ms horizontal delay. This is equivalent to 6 ppb real-time rms jitter.
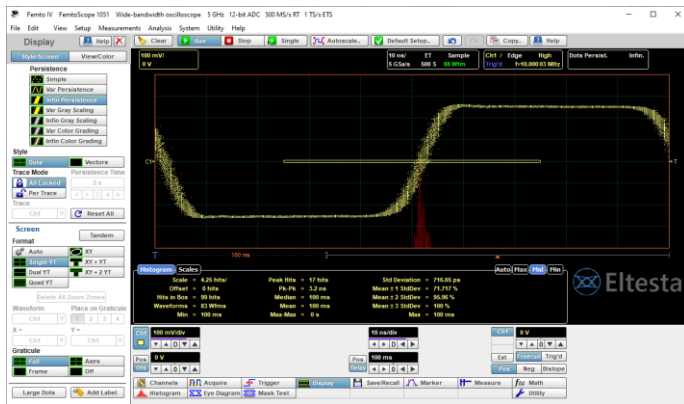

Figure 12. The FemtoScope 1051 measures real-time base long jitter from a stable 10 MHz clock source. RMS jitter value shows 716 ps at 100 ms horizontal delay that is equivalent to 7.16 ppb real-time rms jitter

For signals close to or above Nyquist limit, the *FemtoScopes* can be switched into equivalent-time sampling mode. In this mode the scope acquires as many samples as it can for each of many trigger events, each trigger contributing more and more samples and detail in a reconstructed waveform. Critical to alignment of these samples is a separate and precise measurement of time between each trigger and the next occurring sample clock. After a large number of trigger events the scope has enough samples to display the waveform with the desired time resolution. This is called the effective sampling resolution, which is many times higher than is possible in real-time mode. As an example the *FemtoScope* 2000s have 0.2 ps timing resolution that is equivalent to 5 TSa/s equivalent-time sampling rate. For the *FemtoScope* 1000s these two figures are 1 ps and 1 TSa/s.

As this technique relies on a random relationship between trigger events and the sampling clock, it is more correctly called random equivalent-time sampling (or sometimes random interleaved sampling, RIS). It can be used for repetitive signals or for data pattern when you want to build an eye diagrams.
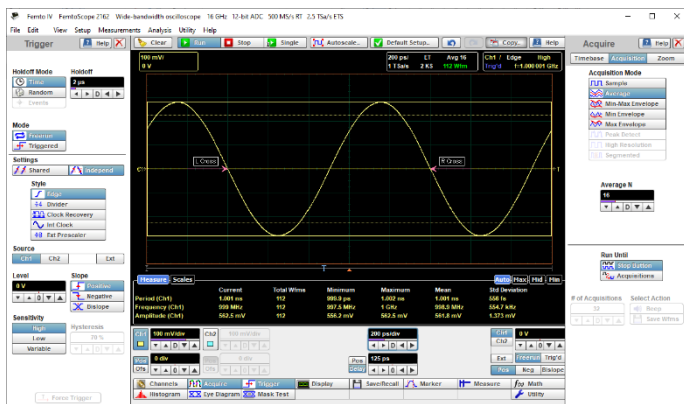

Figure 13. The FemtoScope 2162 measures 200 ps/div time scale with 1 GHz sinewave (1 ns period). Measured period mean value is 1.001 ns

Equivalent-time sampling mode is the most actual for signal integrity measurements when you need very accurate results for such parameters as rise time or jitter. Precise picosecond time base and low intrinsic trigger jitter are necessary for ensuring high-speed test system reliability. With more lower the value, the better you'll be able to characterize your device. See Figures 13 and 14.
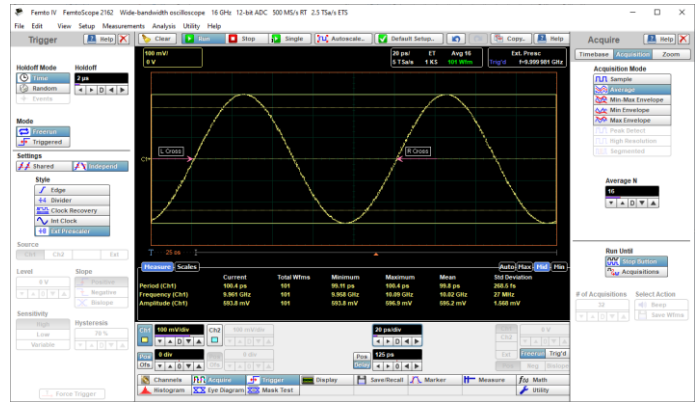

Figure 14. The FemtoScope 2162 measures accuracy of 10-GHz sinewave (period=100 ps) in equivalent time sampling with accuracy of 0.2 ps

Zoom

Due to the long memory, the zoom allows you to view and compare up to four vertically and horizontally enlarged waveform sections simultaneously. At the same time, it is possible to shift any of zoomed zones both vertically and horizontally (Fig. 15). The maximum vertical zoom is 100, and maximum horizontal zoom is 2048.
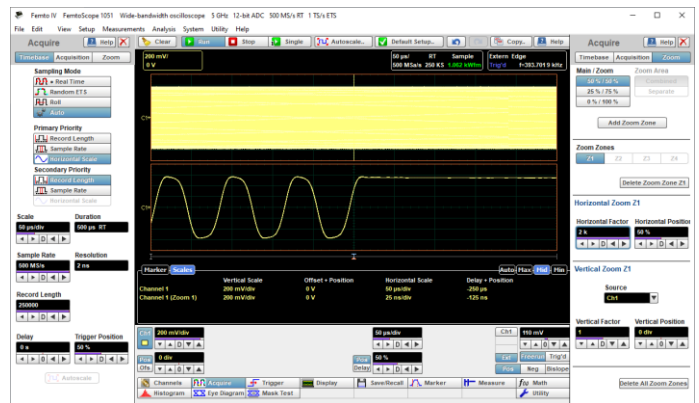

Figure 15. 50 Mb/s data pattern is acquired at 500 MSa/s sampling rate, 50 us/div time base scale and 250 KB record length (top).
With 2K horizontal zoom you have possibility to measure the details of the waveform at 25 ns/div time base (bottom)

Trigger

One of the most important properties of wide-bandwidth oscilloscopes is their ability to provide extremely low-jitter trigger in wide frequency range. The difficulties in providing such properties were primarily associated with the following reasons.

First, the *FemtoScopes* are not a fully real-time oscilloscope that meets the Nyquist criterion in full bandwidth. Therefore, the use of the so-called software trigger was not possible.

Secondly, the trigger electronics was not supposed to be designed as a custom IC, which would significantly increase the cost of development. As a result, the trigger was created on the basis of the fastest logic ICs having up to 10 GHz clock frequency and an output voltage slope of more than 4 V/ns.

All the models of the oscilloscopes provide full-function internal or external direct trigger up to 3 GHz. Input high-speed comparators allow you to adjust the trigger level and hysteresis, providing trigger sensitivity better than 50 mV. It is possible to select any of the trigger slope, as well as use the bi-slope trigger, which allows you to acquire the so-called pseudo-eye diagrams.

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Figure 16. The FemtoScope 1051 surely triggers from 2.5 GHz sinewave with 1.62 ps rms jitter using internal trigger source

Figure 18. The FemtoScope 1161 demonstrates internal direct trigger from 81-ps pulse having 400 mV amplitude and 781 MHz frequency

To expand the trigger frequency range up to 6 GHz, the *FemtoScope* 2000 models provides a frequency divider mode. This mode is especially relevant for measurements on such popular clock ranges as 3.25 GHz and 5 GHz.

Finally the *FemtoScope* 2162 provides external prescaled trigger within full 16-GHz bandwidth. This trigger is realized by using high-frequency divider. The divider has a programmable division factor of 1 to 8, as well as a small additive phase noise, which helps to achieve a low trigger jitter level (Fig. 17).
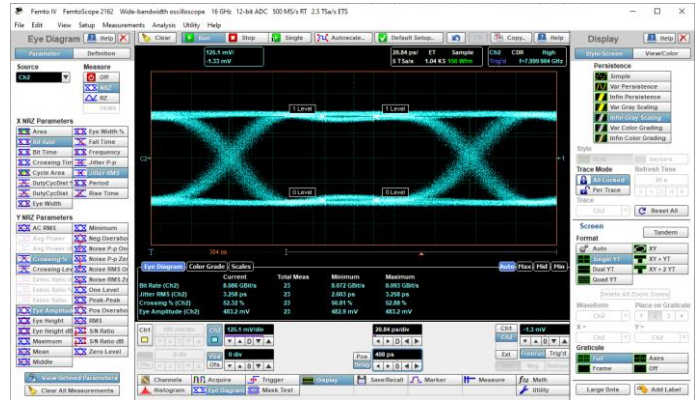

Figure 19. The FemtoScope 2162 acquired 8 Gb/s eye diagram with clock recovery trigger

Display

Display options include such functions as persistence, "gray scaling" and "color grading", various screen and graticule formats, as well as color adjustment.

In persistence mode, the oscilloscope updates the display of newly collected waveforms in 0.1 to 20 s. In "gray scaling" mode (Fig. 20), the oscilloscope uses five different degrees of intensity of the same color.
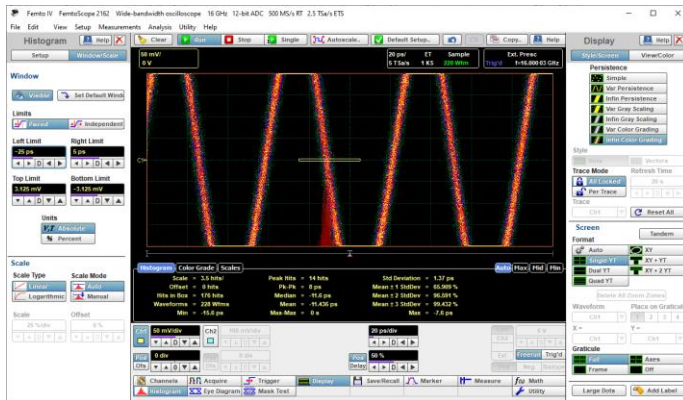
Figure 17. The FemtoScope 2162 provides external prescaled trigger from 16 GHz sinewave with 1.37 ps rms jitter

A distinctive feature of all the *FemtoScope* models is their ability to trigger from extremely short pulses. This is important both when you acquire simple pulse waveforms and when you want to analyse fast data patterns.

Figure 18 shows how the *FemtoScope* 1161 internally triggers with a short pulse having less than 81 ps width. Such pulses are the shortest in a 12.5 Gb/s data pattern.

Basically you can trigger your oscilloscope from 30 mV signal at 100 MHz to 70 mV signal at 5 GHz.

Clock recovery trigger

The *FemtoScope* 2000 oscilloscopes provide clock recovery trigger. This trigger mode is necessary when you need to display an eye diagram based on the clock recovered from input data pattern. The *FemtoScope* 2052 allows you to recover clock for up to 5 Gb/s data rate, while the *FemtoScope* 2162 provides this style of trigger up to 11.3 Gb/s, thereby ensuring the overlap of the most popular clock frequencies of data- and telecommunication standards.

Figure 19 shows an eye diagram of 8-Gb/s data pattern acquired with clock recovery trigger.
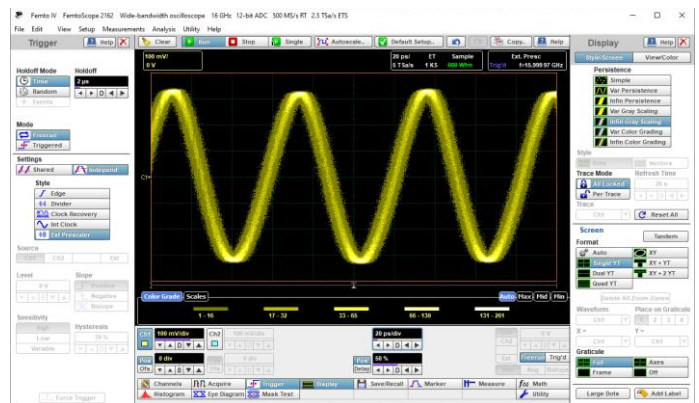

Figure 20. A 16-GHz sinewave displayed in "grey-scaling" format

Different color intensities depend on the number of hit points. The intensity accumulates between their possible minimum and maximum values. The maximum hit values automatically get the highest

brightness, and the minimum hit values get the lowest brightness. Refresh time can be selected from 1 to 200 s.

In the "color grading" format (Fig. 21) the display is formed by accumulated dots having different colors. The color indicates the density of the hits points on the waveform. The "color grading" format is useful when you work with histograms, eye diagrams, masks, that is, with statistical measurements. It is also used when necessary to obtain as much visual information about the signal. Refresh time here also can be selected from 1 to 200 s.
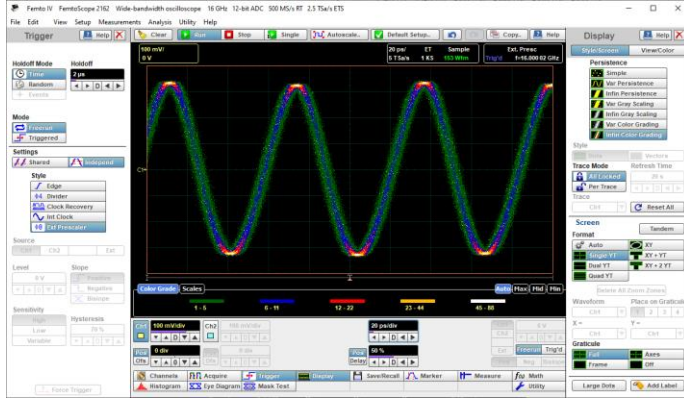

Figure 21. A 16 GHz sinewave displayed in "color-grading" format

The display function determines how many independent graticules can be used when displaying information - one when all information is displayed on one combined graticule, two when all information is displayed on two identical graticules, or four when all information is displayed on four identical graticules. Moreover, any of the signals can be moved to any of the screens (Fig. 22).
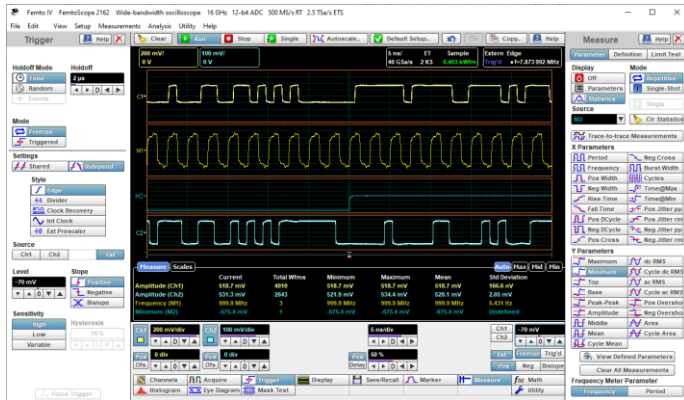

Figure 22. Display with four-graticules

For phase measurements, XY display formats are used. In the XY format, the horizontal axis is the voltage axis of one of the signal sources, while the vertical axis is the voltage axis of another signal source. The XY & YT format displays waveforms of both formats - YT and XY. The YT format is located at the top of the screen, and the XY format is at the bottom.

The XY format is used to compare frequencies and or phase differences between two signals, and also to display the mutual dependence of two quantities, for example, current on voltage or voltage on frequency.

We also note such an interesting format as "tandem", in which the screen is divided into several scales not only vertically, but also horizontally (Fig. 23).
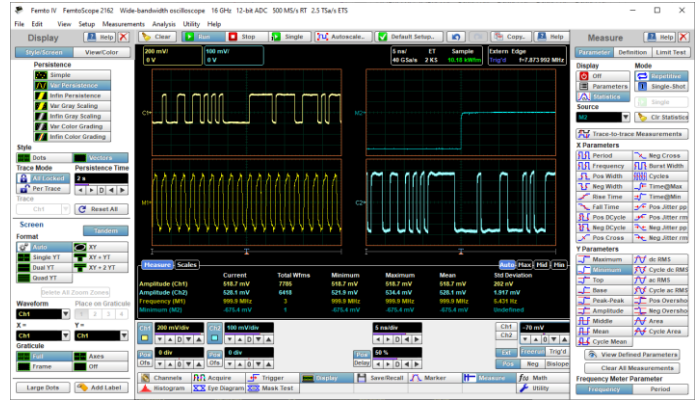
Figure 23. "Tandem" display format

Markers

Markers are vertical or horizontal lines moved around the screen, as well as the crosshairs of these lines with signals. Markers allow custom measurements of waveform parameters, since the marker can be installed at any point on the screen. They allow you to quickly make detailed measurements on the waveform.

The coordinates of the marker are displayed based on vertical and horizontal scale, which makes marker measurements more accurate than graticule measurements. Two Y-markers measure the absolute vertical value and the vertical difference (voltage). Two X-markers measure the absolute horizontal value (time), the difference in horizontal values (time), as well as its equivalent frequency. Two XY-markers combine the marker with the waveform, which makes measurements more accurate, and also allows you to measure the slope between the two points of intersection of the markers with the waveform.

Figure 24. Ratiometric measurements. 1-V pulse is used as a reference. Two Y-markers measure 1.27% peak-peak ringing on the top of pulse

Whether you're measuring voltage, time or frequency, the set of X- and Y-markers support precise user-defined measurement. The best resolution with marker measurements is as follows: voltage - 80 uV, time - 0.1 ps.

Ratiometric measurements with a reference marker allow you to measure the phase in degrees and percent, as well as the ratio in decibels.

Automatic measurements

The *FemtoScope* oscilloscopes provide a wide range of automatic measurements. More than 50 types of typical automatic oscilloscope measurements give you quick access to powerful functions. They are separated into four categories: amplitude, time, inter-channel and

spectral measurements. Each of the measurement can be performed on live signals, saved waveforms or math functions.

Figure 25: Up to ten individual measurements can be displayed on the screen simultaneously

Up to 10 measurements continuously updated with statistics (Fig.26). With statistical measurements, the oscilloscope measures the minimum, maximum, average and current values, as well as the standard deviation.
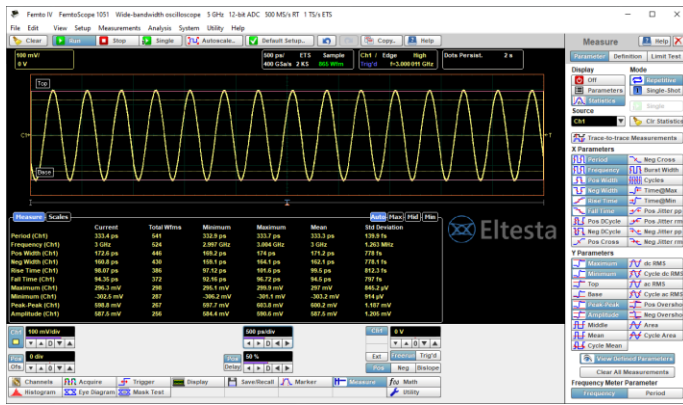

Figure 26. Snapshot tab with the results of ten measurements with full statistic

Amplitude measurements include 17 parameters such as maximum, minimum, top, base, peak-peak, amplitude, middle, mean, cycle mean, rms, etc.

18 timing measurements include period, frequency, positive or negative pulse width, rise or fall time, duty cycle, etc.
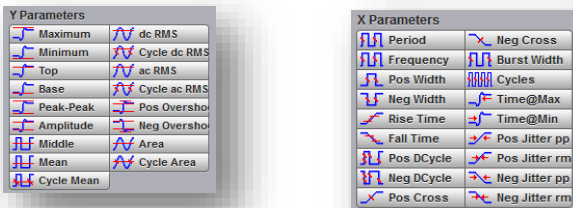

Figure 27. Measurement selection menu

Inter-channel measurements are those performed on two signals. These include delay, phase, and gain.

Spectral measurements are performed with FFT and include FFT magnitude and delta magnitude, total harmonic distortion, FFT frequency and delta frequency.

All measurement algorithms are based on several auxiliary parameters such as top and base vertical levels, threshold values, as well as horizontal margins.

The statistical top and base levels can be determined by a histogram, set by the minimum and maximum of the waveform, or selected by the operator. Thresholds are used when measuring rise and fall time or pulse width, they can be set as a percentage of the amplitude, units of the vertical scale or in divisions. Standard thresholds are 10% -50% - 90% and 20% -50% -80%. Measurements can be gated with the margins defined by arbitrary horizontal markers, inside which measurements are taken.

Histogram

Histograms are a statistical representation of a signal or its measurement results. The *FemtoScope* oscilloscopes use two types of histograms - vertical and horizontal. You can turn on the histogram to live signals, saved waveforms or math functions. Color grade display usually used with histogram on a waveform to add statistical view.

A vertical histogram is a probabilistic distribution of data collected about a signal along a vertical axis within a given histogram window. The information collected by such a histogram is used in the statistical analysis of the signal source. A vertical histogram is the most acceptable way to measure the noise characteristics of the waveforms (Fig. 28). Noise is measured by sizing the histogram window to a narrow portion of time and observing a vertical histogram that measures the noise on an edge.

Figure 28: Vertical histogram of 2.5-GHz sinewave measures 609.38 mV amplitude (Max-Max value)

The parameters of both the vertical and horizontal histograms include the display scale in hits per division or dB per division, the offset in hits or dB (the number of hits or dB at the bottom of the display, as opposed to the center of the display), the total number of samples included in the histogram box, the number of waveforms that have contributed to the histogram, the number of hits in the histogram's greatest peak, the width, median and mean of histogram, the standard deviation (σ) value of the histogram, also the percentage of points that are within ± 1σ, ± 2σ and ± 3σ of the mean value, etc.

The most common uses for horizontal histogram is measuring and characterizing timing jitter on displayed waveforms (Fig 29). Jitter is measured by sizing the histogram window to a narrow portion of voltage and observing a horizontal histogram that measures the jitter on an edge.
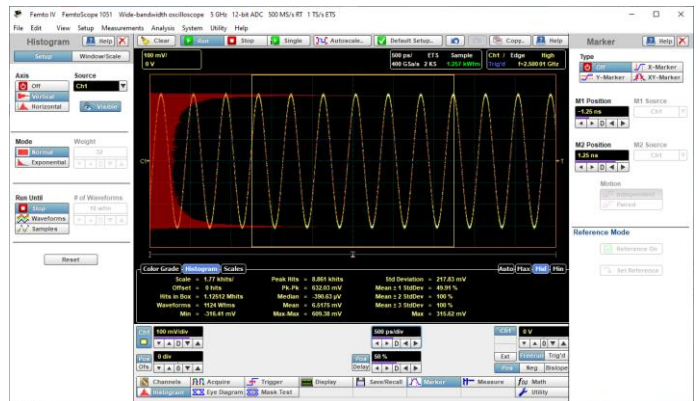
Figure 29. Horizontal histogram measures 1.64 ps rms jitter of 5-GHz sinewave (Std Deviation value)

Eye Diagram

An eye diagram is an effective graphical method for evaluating the quality of a digital pattern. The results of its measurements are integral characteristics that describe the quality of the data channel and its ability to reproduce waveforms in undistorted form. Eye diagram helps to visualize signal integrity.

The relationship between the required oscilloscope bandwidth and the maximum data rate is known. To acquire the third harmonic of the stream, this ratio is 1.8, and for the fifth harmonic it is already 3.

Following these relationships 16-GHz *Femtoscope* will acquire the third harmonic of the 8.8 Gb/s data pattern and the fifth harmonic of the 5.3 Gb/s data pattern. At the same time 5-GHz *Femtoscope* will acquire the third harmonic of the 2.5 Gb/s data pattern and the fifth harmonic of the 1.7 Gb/s data pattern.
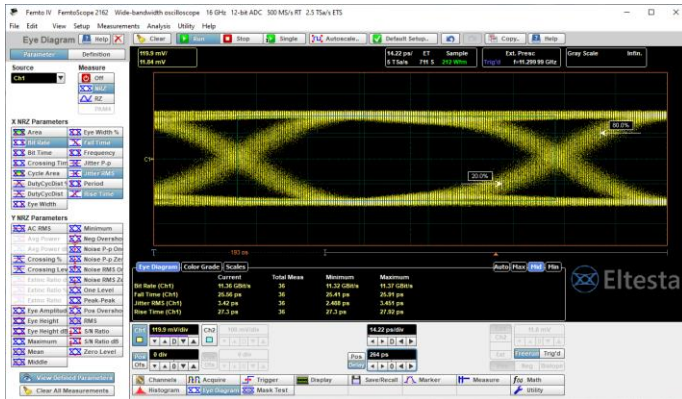

Figure 30. The FemtoScope 2162 acquire and measures parameters of 11.3 Gb/s NRZ eye diagram

In general, eye diagrams are multilevel waveforms. The *FemtoScopes* measures two-level eye diagrams, such as NRZ ("No return to zero") or RZ ("Return to zero").

A high-quality eye diagram on the *FemtoScope* screen can be obtained in two ways.

The first method is available when measuring data pattern is fed to the channel input, and it is also selected as the synchronization source. "Clock recovery" should be selected as the trigger style.

With this method, the data rate range reaches 11.3 Gb/s for the *FS2162*, and 5 Gb/s for the *FS2052*.

The second way is that the measuring data pattern is fed to the input of the channel, and the clock signal used as a trigger source is supplied to another channel or to the input of any of external trigger input. In principle, the second method does not need to use clock recovery style.

You can reach data rate up to 16 Gb/s for the *FS2162*, 6 Gb/s for the *FS2052*, and 3 Gb/s for both of the *FS1000s*.

In order to make the correct measurements, the eye diagram is automatically autoscaled so that its vertical size is four large divisions, its horizontal size is six large divisions (Fig. 31).

If, after autoscaling, the eye is fully open and takes a shape that is close to rectangular - the signal transmission channel is ideal. When the level of noise and jitter increases, rise and fall time becomes longer, other types of distortion becomes more visible, the "eye" hides. With the eye completely closed, distinguishing between pattern bits becomes difficult.
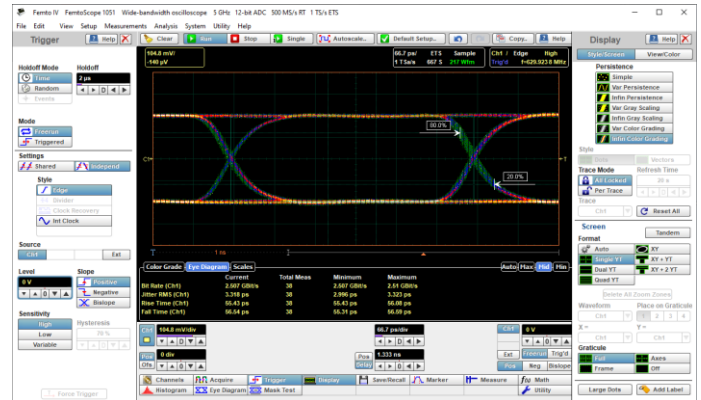
Figure 31. Disclosed 2.5 Gb/s eye diagram acquired with the FemtoScope 1051

Eye-diagram measurements include such parameters as eye height, eye width, jitter rms, crossing percentage, Q factor, and duty-cycle distortion. Totally the *FemtoScope* can measure 27 vertical and 15 horizontal parameters of NRZ eye diagram, ten of them can be measured simultaneously.

The *FemtoScope* also allows you to measure 26 vertical and 17 horizontal parameters of the RZ eye diagram.

Mask Test

This test is used when it is necessary to control the shape of the measured waveform. Such waveforms can be quite complex as, and example, eye diagrams, and the number of possible waveform anomalies can be significant, which makes it difficult to perform standard measurements.

Mask test is widely used in production, in the control of quality, as well as in its testing for compliance with the requirements of standards. It is useful when you need to validate the stability of your electronic components and systems.

The test works on a good / bad basis.

Masks are geometric templates that show acceptable areas of the screen into which testing waveform should not fall. The *FemtoScope* uses three types of masks - standard, automatic and arbitrary.

The shape of standard masks depends on the type of standard and its data rate. The oscilloscopes will allow to analyze standard masks of the following international standards - SONET / SDH, Ethernet, RapidIO, G.984.2, Fiber Channel, ITU G.703, PCI Express, ANSI T1.102, InfiniBand, Serial ATA and XAUI. The shape of standard masks is usually a quad or hexagon. There are options for editing standard masks (Fig. 32).

Depending on bandwidth specifications the *FemtoScope* provide up to 161 types of standard masks.

The principle of mask test is to determine if the waveform hits the mask, which violates the boundaries of the mask. Such a hit detects the exceeding the specified limits. This is fixed by changing the color of the waveform to red, which indicates an error in its shape.
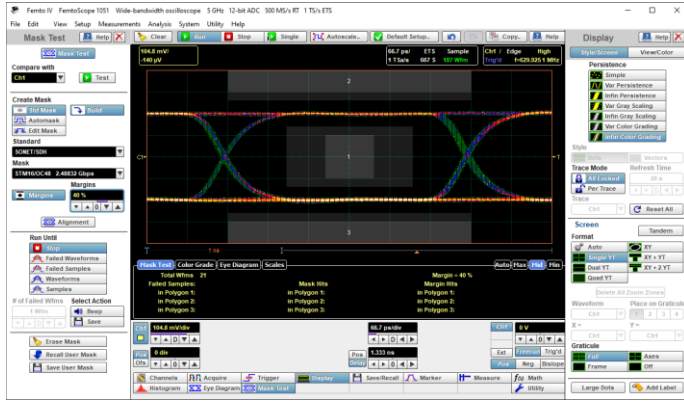
Figure 32. The FemtoScope 1051 performs 2.5 Gb/s SONET/SDH standard mask test

Statistical test results include information about errors registered within standard templates, registered within additional margins, as well as full error information.

Other commonly used is an automask. An automatic mask is constructed according to the shape of tested waveform by adding to it certain preset tolerances vertically and horizontally.

Figure 33. An example of of 80-ps pulse automask

Figure 33 shows an automatic mask constructed for a short 80-ps pulse. The mask consists of two patterns that seamlessly repeat the waveform on both sides of it. Figure also shows an automask test under the influence of noise. Acquired points on a pulse that go beyond tolerances are marked in red. In this example, horizontal tolerance limit is ±5 ps.
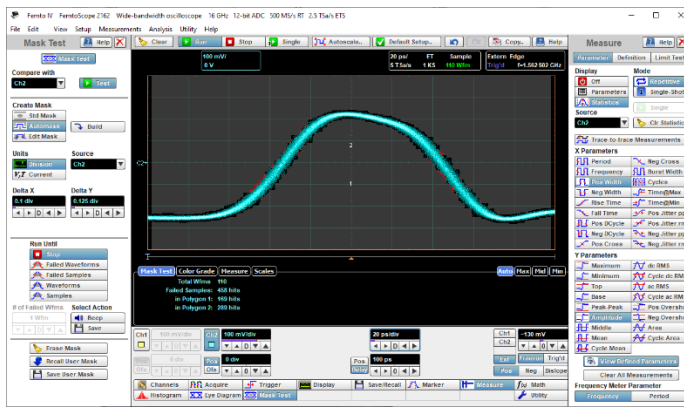
The last is arbitrary type of mask. It can be created directly by the user. Moreover, the number of templates can be up to eight, and their shape can be freely edited and saved.

Mathematics

Based on the data on acquired waveform, the *FemtoScope* allows the simultaneous calculation of up to four mathematical functions. Any mathematical function can be selected as an operator for one or two operands (sources). For example, inversion is a one-operand function, while addition is a two-operand function. Live waveforms, stored waveforms, or other mathematical functions can be selected as an operand.

The oscilloscopes used several categories of mathematical functions. These are arithmetic (12 functions), algebraic (14 functions), trigonometric (12 functions), spectral (6 functions), logical (7 functions), etc. It is also possible to use the formula editor.

Arithmetic functions include such functions as addition, subtraction, multiplication, division, absolute value, inversion, half-sum, scaling, etc. (Fig. 34).
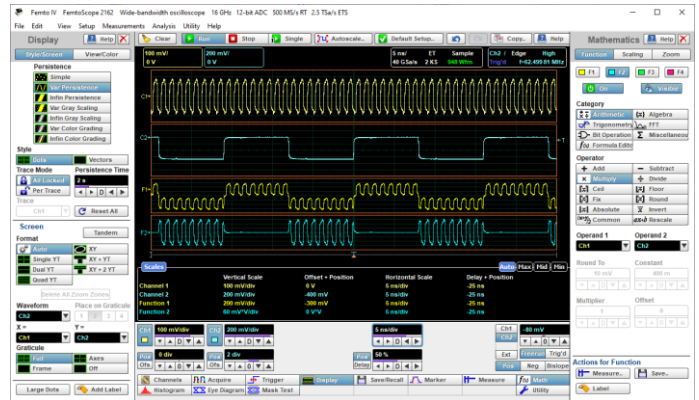
Figure 34. Example of arithmetic functions (from top to bottom): a) channel1, b) channel 2, c) a sum channel 1 + channel 2, d) multiplication channel 1 x channel2

Algebraic functions include functions such as the exponent on the base e, 10 or on an arbitrary base, the logarithm, differentiation, integration, square, cube, square root, etc. (Fig. 35).

Trigonometric functions include functions such as sine, cosine, tangent, cotangent, arcsine, arccosine, arctangent, arc tangent, hyperbolic tangent and hyperbolic cotangent.

Figure 35. Example of algebraic functions (from top to bottom): a) channel1 (data pattern), b) channel 2 (clock), c) integral of channel 1 d) differential of channel 1

FFT includes FFT magnitude and phase, the real and imaginary parts, also the inverse FFT (Fig. 36).

To compensate for the inherent limitations of the FFT, the operator must use the FFT windows. The type of window determines the bandwidth and slope of the corresponding mathematical filter. The oscilloscope supports six types of FFT windows. A rectangular FFT window does not change the signal data acquired in the time domain. Other five FFT windows have different filter characteristics in the time domain. They are Hamming window, Hanning window, flat window, Blackman-Harris window and Kaiser-Bessel window.

Logical functions include such functions as AND, AND-NOT, OR, OR-NOT, exclusive OR, exclusive OR-NOT, and also NOT.

In real time, when relation between sampling rate and the input frequency may significantly decrease, aliasing distortions occur. To avoid such distortions the oscilloscopes provide linear or Sin (x) / x interpolation functions. The Sin (x) / x interpolation function effectively restores the shape of the input signal.
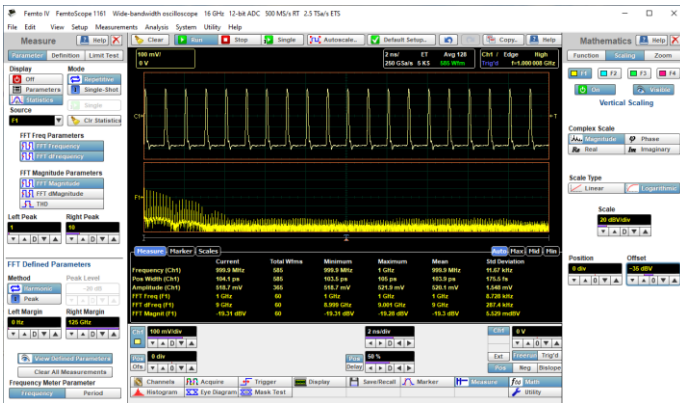
Figure 36. The FemtoScope 1161 performs Fast Fourier Transform with 1 GHz waveform having 100 ps pulse width. The first measured FFT harmonic is 1 GHz at -19.21 dBV magnitude

The oscilloscopes used trend as a mathematical function that shows the nature of the variation in the signal parameter over time. The vertical axis shows the value of the selected parameter, and the horizontal axis shows the period of the signal for which this parameter was calculated.

In the example in Fig. 37, the oscilloscope measures the period of the harmonic signal used to calibrate the sweep (purple). The trend function of the measured period (blue) is the mathematical function of this signal. Amplitude measurements of the trend function show the evolution of the change in the period value, i.e. show the magnitude of the non-linearity of the sweep at various horizontal points of the scale.

Figure 37. Trend of period measures nonlinearity of oscilloscope time base with 10-GHz sinewave (period 100 ps). Maximum trend of period = 102.3 ps. Minimum trend of period = 98.98 ps

Frequency counter

A dedicated frequency counter shows signal frequency (or period) at all times, regardless of measurement and time base settings, with a 7 digits resolution. For *FemtoScope* 2161 maximum frequency is 16 GHz.
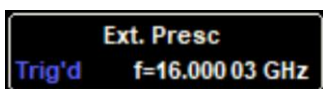
Figure 38. Frequency counter measurement results

Connectivity

Built-in USB device ports make PC connectivity easy for all models of the oscilloscopes. To provide a confident connectivity you need USB cable and external AC/DC power adapter (no power is used from the USB connection). Both parts are included in the oscilloscope kit.

Femto 4 Software has friendly user interface that easy lets you control, visualize, measure and analyze waveforms acquired by the *FemtoScope*-Series oscilloscope.

Figure 38. Rear panel of the Femtoscope 2000 with USB connector

Portability

Weighing less than 370 g with a 1.9 sq.dm small footprint, the *FemtoScope* 1000 Series USB oscilloscopes can go anywhere with ease. You can just put it in the pocket of your jacket or in a small briefcase

New *FemtoScope* 2000 Series USB oscilloscopes deliver the performance and features you expect in a big scope. 16 GHz bandwidth on two channels, less than 2 ps rms jitter, 8 Gb/s clock recovery trigger are now available with portable enclosure having less than 790 g weight and 3.4 sq.dm small footprint.

Standard accessories

Your *FemtoScope* Series oscilloscope kit contains the following items:

- *FemtoScope* USB Wide-Bandwidth Oscilloscope. Specified from FS1051, FS1161, FS2051 or FS2162.
- *Femto 4* software (supplied on a USB stick and also available as a free download from www.eltesta.com).
- Quick start guide (supplied on a USB stick and also available as a free download from www.eltesta.com)..
- 12 VDC power supply with specified localized IEC mains lead.
- 80 cm precision cable, 2 pcs.
- USB cable, 1.8 m.
- SMA / PC3.5 / 2.92 wrench.

Price

Economical price makes *FemtoScope* 1000 and 2000 Series ideal as production facilities, for engineering laboratories, and for teaching basic scientific and measurements at schools and universities.

Ordering information at 11th of May 2020	EUR
FemtoScope **1051**: 1 channel, 5 GHz bandwidth, 3 GHz trigger	€ 6 490
FemtoScope **2052**: 2 channels, 5 GHz bandwidth, 6 GHz trigger	€ 8 990
FemtoScope **1161**: 1 channel, 16 GHz bandwidth, 3 GHz trigger	€ 8 990
FemtoScope **2162**: 2 channels, 16 GHz bandwidth, 16 GHz trigger	€ 11 990

FemtoScope 1000 Inputs, Outputs and Indicators

FemtoScope 2000 Inputs, outputs and Indicators

FemtoScope 1051 front panel

Power LED

Trigger Output

5 GHz, 50 Ω
Channel Input

3 GHz, 50 Ω
Trigger Input
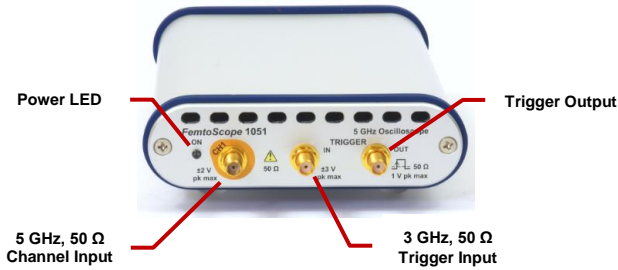
FemtoScope 2052 front panel

Power LED

6 GHz, 50 Ω
Trigger Input

5 GHz, 50 Ω
Channel Input

5 GHz, 50 Ω
Channel 2 Input
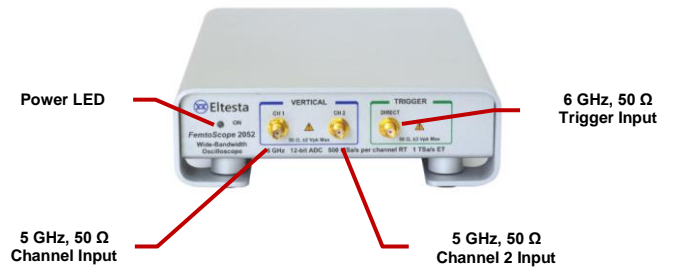
FemtoScope 1161 front panel

Power LED

Trigger Output

16 GHz, 50 Ω
Channel Input

3 GHz, 50 Ω
Trigger Input
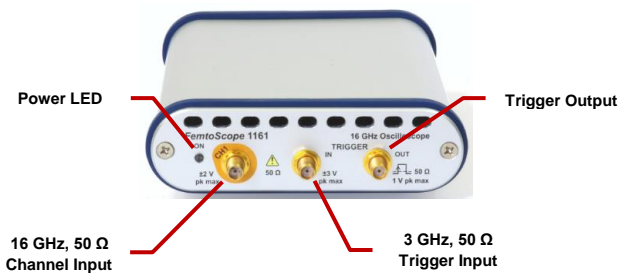
FemtoScope 2162 front panel

Power LED

6 GHz, 50 Ω
Trigger Input

16 GHz Prescaled
Trigger Input

16 GHz, 50 Ω
Channel Input

16 GHz, 50 Ω
Channel 2 Input
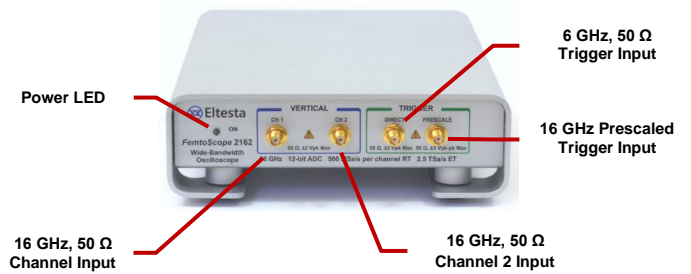
Power LED: Green under normal operation

CH1: Channel Input: The *FemtoScope* 1000s have one input channel that also is an internal trigger input. The *FemtoScope* 1051 has 5 GHz bandwidth, while the *FemtoScope* 1161 has 16 GHz bandwidth.

TRIGGER IN: DC to 3 GHz external trigger input.

TRIGGER OUT: Can be used to synchronize an external device to the *FemtoScope* 1000's rising edge.

Power LED: Green under normal operation

CH1 and **CH 2:** Channel Input: The *FemtoScope* 2000s have two input channels that also are an internal trigger input. The *FemtoScope* 2052 has 5 GHz channel bandwidth, and 6 GHz internal trigger bandwidth while the *FemtoScope* 2162 has 16 GHz channel bandwidth and also 6 GHz internal trigger bandwidth.

DIRECT TRIGGER: DC to 6 GHz external direct trigger input.

PRESCALE TRIGGER: 1 GHz to 16 GHz external prescaled trigger input.

FemtoScope 1000 Series rear panel
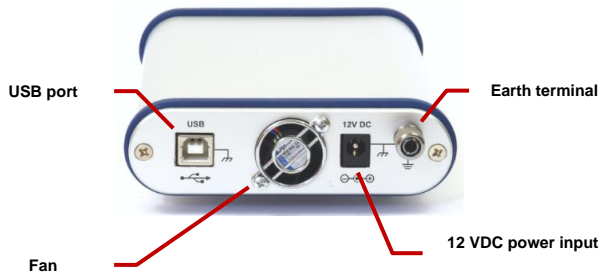
USB port

Earth terminal

Fan

12 VDC power input

FemtoScope 2000 Series rear panel

Recovered
data output

12 VDC power input
(AC adaptor supplied)

Recovered
clock output

Earth terminal

USB port

Fan

USB: The USB 2.0 port is used to connect the oscilloscope to the PC.

Fan: Low-noise fan inside the unit which blows air through the holes on the back and front panels.

12 VDC input: Use only the earthed mains adaptor supplied with the oscilloscope.

Earth terminal: For unit grounding.

RECOVERED CLOCK OUT: Recovered clock from the currently selected trigger source and the built-in clock recovery module (optional).

RECOVERED DATA OUT: Recovered data from the currently selected trigger source and the built-in clock recovery module (optional).

USB: The USB 2.0 port is used to connect the oscilloscope to the PC.

Fan: Low-noise fan inside the unit which blows air through the holes on the back and front panels.

12 VDC input: Use only the earthed mains adaptor supplied with the oscilloscope.

Earth terminal: For unit grounding.

Specifications and Characteristics

Vertical	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Input channels	1	2	1	2
	All channels are identical and digitized simultaneously.			
Analog bandwidth, –3 dB flatness	These specifications are valid after a 30-minute warm-up period and ±2 °C from firmware calibration temperature.			
Full bandwidth *****	DC to 5 GHz		DC to 16 GHz	
Narrow bandwidth	DC to 450 MHz			
Passband flatness (full BW)	±1 dB to 3 GHz		±1 dB to 5 GHz	
Calculated rise time (Tr), typical	Calculated from the bandwidth: 10% to 90%: calculated from Tr = 0.35/BW. 20% to 80%: calculated from Tr = 0.25/BW.			
Full bandwidth	10% to 90%: ≤ 70 ps, 20% to 80%: ≤ 50 ps.		10% to 90%: ≤ 21.9 ps, 20% to 80%: ≤ 15.6 ps.	
Narrow bandwidth	10% to 90%: ≤ 780 ps, 20% to 80%: ≤ 560 ps.			
Step response, typical				
Full bandwidth				
Overshoot	< 8%			
Ringing	±6% to 3 ns, ±4% from 3 ns to 10 ns, ±3% from 10 ns to 100 ns, ±2% from 100 ns to 400 ns, ±1% after 400 ns.			
Narrow bandwidth				
Overshoot	< 6%			
Ringing	±4% to 10 ns, ±3% from 10 ns to 100 ns, ±2% from 100 ns to 400 ns, ±1% after 400 ns.			
RMS noise				
Full bandwidth *****	1.8 mV, maximum. 1.6 mV, typical.		2.4 mV, maximum. 2.2 mV, typical.	
Narrow bandwidth	0.8 mV, maximum. 0.65 mV, typical.			
Scale factors (sensitivity)	10 mV/div to 250 mV/div. Full scale is 8 vertical divisions. Adjustable in a 10-12.5-15-20-25-30-40-50-60-80-100-125-150-200-250 mV/div sequence. Also adjustable in 1% fine increments or better. With manual or calculator data entry the increment is 0.1 mV/div.			
DC gain accuracy *	±1.5% of full scale, maximum. ±1% of full scale, typical.			
Position range	±4 divisions from center screen			
DC offset range	Adjustable from –1 V to +1 V in 10 mV increments (coarse). Also adjustable in fine increments of 2 mV. With manual or calculator data entry the increment is 0.01 mV for offset between –99.9 and 99.9 mV, and 0.1 mV for offset between –999.9 and 999.9 mV. Referenced to the center of display graticule.			
DC offset accuracy *	±1.5 mV ± 1.5% of offset setting, maximum. ±1 mV ± 1% of offset setting, typical.			
Operating input voltage	±1 V			
Vertical Zoom and Position	For all input channels, waveform memories, or functions.			
Vertical factor	0.01 to 100.			
Vertical position	±800 division maximum of zoomed waveform.			
Delay between channels	N/A	≤ 10 ps, typical at full bandwidth, equivalent time.	N/A	≤ 10 ps, typical at full bandwidth, equivalent time.

* Specifications marked with (*****) are checked in the Performance Verification.

Vertical (continued)	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Channel-to-channel crosstalk (channel isolation)	N/A	≥50 dB (316:1) for input frequency DC to 1 GHz. ≥40 dB (100:1) for input frequency >1 GHz to 3 GHz. ≥36 dB (63:1) for input frequency >3 GHz to ≤5 GHz	N/A	≥50 dB (316:1) for input frequency DC to 1 GHz. ≥40 dB (100:1) for input frequency >1 GHz to 3 GHz. ≥36 dB (63:1) for input frequency >3 GHz to ≤5 GHz
ADC resolution	12 bits			
Hardware vertical resolution	0.5 mV / LSB without averaging.			
Input impedance *	50 Ω ± 1.5 Ω maximum. 50 Ω ± 1 Ω, typical			
Input match	Reflections for 70 ps rise time: 10% or less.		Reflections for 50 ps rise time: 10% or less.	
Input coupling	DC			
Maximum safe input voltage	±2 V (DC + peak AC)			
Input connector	SMA female			
Attenuation	Attenuation factors may be entered to scale the oscilloscope for external attenuators connected to the channel inputs.			
Range	0.0001:1 to 1 000 000:1.			
Units	Ratio or dB.			
Scale	Volt, Watt, Ampere, or Unknown.			

Horizontal	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Time base	Internal time base common to all input channels.			
Time base range	Full horizontal scale is 10 divisions.			
Real time sampling	10 ns/div to 1000 s/div.			
Random equivalent time sampling	50 ps/div to 5 µs/div.		10 ps/div to 5 µs/div.	
Roll	100 ms/div to 1000 s/div.			
Segmented	Total number of segments: 2 to 1024. Dead time between segments: 3 µs.			
Horizontal zoom and position	For all input channels, waveform memories, or functions			
Horizontal factor	From 1 to 2000.			
Horizontal position	From 0% to 100% non-zoomed waveform.			
Time base clock accuracy				
Frequency	500 MHz			
Initial set tolerance	± 10 ppm @ 25 ºC ± 3 ºC			
Overall frequency stability *	± 35 ppm over operating temperature range			
Aging	± 7 ppm over 10 years @ 25 ºC			
Time base resolution	1.0 ps		0.2 ps	
	At random equivalent time sampling			
Delta time measurement accuracy *	± (35 ppm * reading + 0.1% * screen width + 5 ps)			
Pre-trigger delay	Record length / current sampling rate maximum at zero variable delay time			
Post-trigger delay	0 to 4.28 s. Coarse increment is one horizontal scale division, fine increment is 0.1 horizontal scale divisions, manual or calculator increment is 0.01 horizontal scale divisions.			
Channel deskew range	±50 ns range. Coarse increment is 100 ps, fine increment is 10 ps. With manual or calculator data entry the increment is four significant digits or 1 ps.			

Acquisition	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Sampling modes				
Real time	Captures all of the sample points used to reconstruct a waveform during a single trigger event			
Equivalent time	Acquires sample points over several trigger events, requiring the input waveform to be repetitive			
Roll	Acquisition data will be displayed in a rolling fashion starting from the right side of the display and continuing to the left side of the display (while the acquisition is running)			
Segmented	Segmented memory optimizes available memory for data streams that have long dead times between activity. Number of segments: up to 1024. Segments stamped with absolute and delta times.			
Maximum sampling rate				
Real time sampling	500 MS/s per channel simultaneously			
Equivalent time sampling	Up to 1 TS/s or 1.0 ps trigger placement resolution		Up to 5 TS/s or 0.2 ps trigger placement resolution	
Record length				
Real time sampling	50 S/ch to 250 kS/ch for one channel, to 125 kS/ch for two channels.			
Equivalent time sampling	500 S/ch to 250 kS/ch for one channel, to 125 kS/ch for two channels.			
Duration at highest sample rate	0.5 ms for one channel, 0.25 ms for two channels.			
Acquisition modes				
Sample (normal)	Acquires first sample in decimation interval and displays results without further processing.			
Average	Average value of samples in decimation interval. Number of waveforms for average: 2 to 4096.			
Envelope	Envelope of acquired waveforms. Minimum, Maximum or both Minimum and Maximum values acquired over one or more acquisitions. Number of acquisitions is from 2 to 4096 in ×2 sequence and continuously.			
Peak detect	Largest and smallest sample in decimation interval. Minimum pulse width: 1/(sampling rate) or 2 ns @ 50 µs/div or faster for single channel.			
High resolution	Averages all samples taken during an acquisition interval to create a record point. This average results in a higher-resolution, lower-bandwidth waveform. Resolution can be expanded to 12.5 bits or more, up to 16 bits.			

Trigger	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Trigger sources	Internal Direct, External Direct	Internal Direct or Divided, External Direct or Divided	Internal Direct, External Direct	Internal Direct, Divided or Clock Recovery, External Direct, Divided or Clock Recovery, External Prescaled
Trigger mode				
Freerun	Triggers automatically but not synchronized to the input in absence of trigger event.			
Normal (triggered)	Requires trigger event for oscilloscope to trigger.			
Single	Software button that triggers only once on a trigger event. Not suitable for random equivalent-time sampling			
Trigger holdoff mode	Time or Random			
Trigger holdoff range				
Holdoff by time	Adjustable from 500 ns to 15 s in a 1-2-5-10 sequence or in 4 ns fine increments.			
Random	This mode varies the trigger holdoff from one acquisition to another by randomizing the time value between triggers. The randomized time can be between the values specified in the Min Holdoff and Max Holdoff.			

Internal or External Trigger				
Trigger style				
Edge	Triggers on a rising and falling edge of any source within frequency range DC to 3 GHz.			
Divided	N/A	The trigger source is divided down four times (/4) before being applied to the trigger system. Maximum trigger frequency 6 GHz	N/A	The trigger source is divided down four times (/4) before being applied to the trigger system. Maximum trigger frequency 6 GHz
Clock recovery	N/A	6.5 Mb/s to 5 Gb/s	N/A	6.5 Mb/s to 11.3 Gb/s
Trigger level range	–1 V to 1 V in 10 mV increments (coarse). Also adjustable in fine increments of 1 mV.			

Trigger (continued)	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Internal or External Trigger				
Trigger bandwidth and sensitivity	Internal and External trigger.			
Low sensitivity (Edge trigger)	100 mV p-p DC to 100 MHz. Increasing linearly from 100 mV p-p at 100 MHz to 150 mV p-p at 3 GHz. Pulse Width: 80 ps @ 200 mV p-p typical.			
Low sensitivity (Divided trigger)	N/A	100 mV p-p DC to 100 MHz. Increasing linearly from 100 mV p-p at 100 MHz to 200 mV p-p at 6 GHz. Pulse Width: 80 ps @ 200 mV p-p typical.	N/A	100 mV p-p DC to 100 MHz. Increasing linearly from 100 mV p-p at 100 MHz to 200 mV p-p at 6 GHz. Pulse Width: 80 ps @ 200 mV p-p typical.
High sensitivity (Edge trigger) *	30 mV p-p DC to 100 MHz. Increasing linearly from 30 mV p-p at 100 MHz to 50 mV p-p at 3 GHz. Pulse Width: 80 ps @ 70 mV p-p typical.			
High sensitivity (Divided trigger) *	N/A	30 mV p-p DC to 100 MHz. Increasing linearly from 30 mV p-p at 100 MHz to 70 mV p-p at 6 GHz. Pulse Width: 80 ps @ 70 mV p-p typical.	N/A	30 mV p-p DC to 100 MHz. Increasing linearly from 30 mV p-p at 100 MHz to 70 mV p-p at 6 GHz. Pulse Width: 80 ps @ 70 mV p-p typical.
Edge trigger slope				
Positive	Triggers on rising edge.			
Negative	Triggers on falling edge.			
Bi-slope	Triggers on both edges of the signal.			
RMS trigger jitter *	Combined trigger and interpolator jitter			
Edge and Divided trigger	2 ps + 0.1 ppm of delay, maximum. 1.5 ps + 0.1 ppm of delay, typical.			
Clock recovery trigger	2 ps + 1.0% of unit interval + 0.1 ppm of delay, maximum. 2.5 ps + 1.0% of unit interval + 0.1 ppm of delay, typical.			
External direct trigger Input impedance *	50 Ω ± 1.5 Ω maximum. 50 Ω ± 1 Ω, typical			
External direct trigger maximum safe input voltage	±3 V (DC+peak AC)			
Trigger coupling	DC			
External direct trigger input connector	SMA female			
External Prescaled Trigger	N/A	N/A	N/A	
External prescaled trigger coupling				50 Ω, AC coupled, fixed level zero volts
External prescaled trigger bandwidth and sensitivity *				200 mV p-p from 1 to 16 GHz (sine wave input)
External prescaled RMS trigger jitter *				2 ps + 0.1 ppm of delay, maximum. 1.5 ps + 0.1 ppm of delay, typical. For trigger input slope > 2 V/ns.
Prescaler ratio				Divided by 1 / 2 /4 / 8, programmable.
External prescaled trigger maximum safe input voltage				±3 V (DC + peak AC)
External prescaled trigger input connector				SMA female

Display	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Persistence				
Off	No persistence			
Variable Persistence	Time that each data point is retained on the display. Persistence time can be varied from 100 ms to 20 s.			
Infinite Persistence	In this mode, a waveform sample point is displayed forever.			
Variable Gray Scaling	Five levels of a single color that is varied in saturation and luminosity. Refresh time varied from 1 s to 200 s.			
Infinite Gray Scaling				
Variable Color Grading	With Color Grading selected, historical timing information is represented by a temperature or spectral color scheme providing "z-axis" information about rapidly changing waveforms. Refresh time varied from 1 to 200 s			
Infinite Color Grading				
Style				
Dots	Displays waveforms without persistence, each new waveform record replaces the previously acquired record for a channel.			
Vector	This function draws a straight line through the data points on the display. Not suited to multi-value signals such as a displayed eye diagram.			
Graticule	Full Grid, Axes with tick marks, Frame with tick marks, Off (no graticule).			
Format				
Auto	Automatically places, adds or deletes graticules as you select more or fewer waveforms to display.			
Single XT	All waveforms are superimposed and are eight divisions high.			
Dual YT	With two graticules, all waveforms can be four divisions high, displayed separately or superimposed.			
Quad YT	With four graticules, all waveforms can be two divisions high, displayed separately or superimposed. When you select dual or quad screen display, every waveform channel, memory and function can be placed on a specified graticule.			
XY	Displays voltages of two waveforms against each other. The amplitude of the first waveform is plotted on the horizontal X axis and the amplitude of the second waveform is is plotted on the vertical Y axis.			
XY & YT	Displays both XY and YT pictures. The YT format appears on the upper part of the screen, and the XY format on the lower part of the screen. The YT format display area is one screen and any displayed waveforms are superimposed.			
XY + 2YT	Displays both YT and XY pictures. The YT format appears on the upper part of the screen, and the XY format on the lower part of the screen. The YT format display area is divided into two equal screens.			
Tandem	Displays graticules to the left and to the right.			
Colors	You may choose a default color selection, or select your own color set. Different colors are used for displaying selected items: background, channels, functions, waveform memories, FFTs, TDR/TDTs, and histograms.			
Trace annotation	The instrument gives you the ability to add an identifying label, bearing your own text, to a waveform display. For each waveform, you can create multiple labels and turn them all on or all off. Also, you can position them on the waveform by dragging or by specifying an exact horizontal position.			

Save/Recall	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Management	Store and recall setups, waveforms and user mask files to any drive on your PC. Storage capacity is limited only by disk space.			
File extensions	Waveform files: .wfm for binary format, .txt for verbose format (text), .txty for Y values formats (text). Database files: .wdb. Setup files: .set. User mask files: .pcm.			
Operating system	Microsoft Windows® 7, 8 or 10, 32-bit or 64-bit			
Waveform save/recall	Up to four waveforms may be stored into the waveform memories (M1 to M4), and then recalled for display.			

Save/Recall (continued)	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Save to/recall from disk	You can save or recall your acquired waveforms to or from any drive on the PC. To save a waveform, use the standard Windows **Save As** dialog box. From this dialog box you can create subdirectories and waveform files, or overwrite existing waveform files. You can load, into one of the Waveform Memories, a file with a waveform you have previously saved and then recall it for display.			
Save/recall setups	The instrument can store complete setups in the memory and then recall them.			
Screen image	You can copy a screen image into the clipboard with the following formats: Full Screen, Full Window, Client Part, Invert Client Part, Oscilloscope Screen and Oscilloscope Screen.			
Autoscale	Pressing the Autoscale key automatically adjusts the vertical channels, the horizontal scale factors, and the trigger level for a display appropriate to the signals applied to the inputs. The Autoscale feature requires a repetitive signal with a frequency greater than 100 Hz, duty cycle greater than 0.2%, amplitudes greater than 100 mV p-p. Autoscale is operative only for relatively stable input signals.			

Marker	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Marker type	X-Marker: vertical bars (measure time). Y-Marker: horizontal bars (measure volts). XY-Markers: waveform markers.			
Marker measurements	Absolute, Delta, Volt, Time, Frequency, Slope.			
Marker motion	Independent: both markers can be adjusted independently. Paired: both markers can be adjusted together.			
Ratiometric measurements	Provide ratiometric measurements between measured and reference values. These measurements give results in such ratiometric units as %, dB, and degrees.			

Measure	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Automated measurements	Up to ten simultaneous measurements are supported at the same time.			
Automatic parametric	53 automatic measurements available.			
Amplitude measurements (17)	Maximum, Minimum, Top, Base, Peak-Peak, Amplitude, Middle, Mean, Cycle Mean, DC RMS, Cycle DC RMS, AC RMS, Cycle AC RMS, Positive Overshoot, Negative Overshoot, Area, Cycle Area.			
Timing measurements (18)	Period, Frequency, Positive Width, Negative Width, Rise Time, Fall Time, Positive Duty Cycle, Negative Duty Cycle, Positive Crossing, Negative Crossing, Burst Width, Cycles, Time at Maximum, Time at Minimum, Positive Jitter p-p, Positive Jitter RMS, Negative Jitter p-p, Negative Jitter RMS.			
Inter-signal measurements (13)	Delay (8 options), Phase Deg, Phase Rad, Phase %, Gain, Gain dB.			
FFT measurements (5)	FFT Magnitude, FFT Delta Magnitude, THD, FFT Frequency, FFT Delta Frequency.			
Measurement statistics	Displays current, minimum, maximum, mean and standard deviation on any displayed waveform measurements.			
Method of top-base definition	Histogram, Min/Max, or User-Defined (in absolute voltage).			
Thresholds	Upper, middle and lower horizontal bars settable in percentage, voltage or divisions. Standard thresholds are 10–50–90% or 20–50–80%.			
Margins	Any region of the waveform may be isolated for measurement using left and right margins (vertical bars).			
Measurement mode	Repetitive or Single-shot.			
Counter	Built-in frequency counter			
Source	Internal or External	Internal from any of two channels or External Direct.	Internal or External	Internal from any of two channels, External Direct or External Prescaled.
Resolution	7 digits			
Maximum frequency	3 GHz	6 GHz	3 GHz	Internal or External Direct Trigger: 6 GHz. External Prescaled Trigger: 16 GHz
Measurement	Frequency, period			
Time reference	Internal 250 MHz reference clock			

Mathematics	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Waveform math	Up to four math waveforms can be defined and displayed using math functions F1 to F4			
Categories and math operators				
Arithmetic	Add, Subtract, Multiply, Divide, Ceil, Floor, Fix, Round, Absolute, Invert, Common, Rescale.			
Algebra	Exponentiation (e), Exponentiation (10), Exponentiation (a), Logarithm (e), Logarithm (10), Logarithm (a), Differentiate, Integrate, Square, Square Root, Cube, Power (a), Inverse, Square Root of the Sum.			
Trigonometry	Sine, Cosine, Tangent, Cotangent, Arcsine, Arc cosine, Arctangent, Arc cotangent, Hyperbolic Sine, Hyperbolic Cosine, Hyperbolic Tangent, Hyperbolic Cotangent.			
FFT	Complex FFT, FFT Magnitude, FFT Phase, FFT Realt, FFT Imaginary, Inverse FFT, FFT Group Delay.			
Bit Operator	AND, NAND, OR, NOR, XOR, XNOR, NOT.			
Miscellaneous	Trend, Linear Interpolation, Sin(x)/x Interpolation, Smoothing.			
Formula Editor	You can build math waveforms using the Formula Editor control window.			
FFT				
FFT frequency span	Frequency Span = Sample Rate / 2 = Record Length / (2 × Timebase Range)			
FFT frequency resolution	Frequency Resolution = Sample Rate / Record Length			
FFT windows	The built-in filters (Rectangular, Hamming, Hann, Flattop, Blackman–Harris and Kaiser–Bessel) allow optimization of frequency resolution, transients, and amplitude accuracy.			
FFT measurements	Marker measurements can be made on frequency, delta frequency, magnitude, and delta magnitude. Automated FFT Measurements include: FFT Magnitude, FFT Delta Magnitude, THD, FFT Frequency, and FFT Delta Frequency.			

Histogram	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Histogram axis	Vertical, or Horizontal. Both vertical and horizontal histograms, with periodically updated measurements, allow statistical distributions to be analyzed over any region of the signal.			
Histogram measurement set	Scale, Offset, Hits in Box, Waveforms, Peak Hits, Pk-Pk, Median, Mean, Standard Deviation, Mean ± 1 Std Dev, Mean ± 2 Std Dev, Mean ± 3 Std Dev, Min, Max-Max, Max.			
Histogram window	The histogram window determines which part of the database is used to plot the histogram. You can set the size of the histogram window to be any size that you want within the horizontal and vertical scaling limits of the scope.			

Eye Diagram	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Eye diagram	PicoScope 9400 Series oscilloscopes can automatically characterize an NRZ and RZ eye pattern. Measurements are based upon statistical analysis of the waveform.			
NRZ measurement set	AC RMS, Area, Bit Rate, Bit Time, Crossing %, Crossing Level, Crossing Time, Cycle Area, Duty Cycle Distortion (%, s), Extinction Ratio (dB, %, ratio), Eye Amplitude, Eye High, Eye High dB, Eye Width (%, s), Fall Time, Frequency, Jitter (p-p, RMS), Max, Mean, Mid, Min, Negative Overshoot, Noise p-p (One, Zero), Noise RMS (One, Zero), One Level, Peak-Peak, Period, Positive Overshoot, Rise Time, RMS, Signal-to-Noise Ratio, Signal-to-Noise Ratio dB, Zero Level.			
RZ measurement set	AC RMS, Area, Bit Rate, Bit Time, Contrast Ratio (dB, %, ratio), Cycle Area, Extinction Ratio (dB, %, ratio), Eye Amplitude, Eye High, Eye High dB, Eye Opening Factor, Eye Width (%, s), Fall Time, Jitter P-p (Fall, Rise), Jitter RMS (Fall, Rise), Max, Mean, Mid, Min, Negative Crossing, Noise P-p (One, Zero), Noise RMS (One, Zero), One Level, Peak-Peak, Positive Crossing, Positive Duty Cycle, Pulse Symmetry, Pulse Width, Rise Time, RMS, Signal-to-Noise, Zero Level.			

Mask Test	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Mask test	Acquired signals are tested for fit outside areas defined by up to eight polygons. Any samples that fall within the polygon boundaries result in test failures. Masks can be loaded from disk, or created automatically or manually.			
Mask creation	You can create the following Mask: Standard predefined Mask, Automask, Mask saved on disk, Create new mask, Edit any mask.			
Standard mask	Standard predefined optical or standard electrical masks can be created.			
SONET/SDH	OC1/STMO (51.84 Mb/s), OC3/STM1 (155.52 Mb/s), OC9/STM3 (466.56 Mb/s), OC12/STM4 (622.08 Mb/s), OC18/STM6 (933.12 Mb/s), OC24/STM8 (1.2442 Gb/s), OC48/STM16 (2.48832 Gb/s), FEC 2666 (2.6666 Gb/s)			

Mask Test (continued)	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Fibre Channel	FC133 Electrical (132.8 Mb/s), FC133 Optical (132.8 Mb/s), FC266 Electrical (265.6 Mb/s), FC266 Optical (265.6 Mb/s), FC531 Electrical (531.35 Mb/s), FC531 Optical (531.35 Mb/s), FC1063 Electrical (1.0625 Gb/s), FC1063 Optical (1.0625 Gb/s), FC1063 Optical PI Rev13 (1.0625 Gb/s), FC1063E Abs Beta Rx.mask (1.0625 Gb/s), FC1063E Abs Beta Tx.mask (1.0625 Gb/s), FC1063E Abs Delta Rx.mask (1.0625 Gb/s), FC1063E Abs Delta Tx.mask (1.0625 Gb/s), FC1063E Abs Gamma Rx.mask (1.0625 Gb/s), FC1063E Abs Gamma Tx.mask (1.0625 Gb/s), FC2125 Optical (2.1231 Gb/s), FC2125 Optical PI Rev13 (2.1231 Gb/s), FC2125E Abs Beta Rx.mask (2.125 Gb/s), FC2125E Abs Beta Tx.mask (2.125 Gb/s), FC2125E Abs Delta Rx.mask (2.125 Gb/s), FC2125E Abs Delta Tx.mask (2.125 Gb/s), FC2125E Abs Gamma Rx.mask (2.125 Gb/s), FC2125E Abs Gamma Tx.mask (2.125 Gb/s). **For 16-GHz models only:** FC4250 Optical PI Rev13 (4.25 Gb/s), FC4250E Abs Beta Rx.mask (4.25 Gb/s), FC4250E Abs Beta Tx.mask (4.25 Gb/s), FC4250E Abs Delta Rx.mask (4.25 Gb/s), FC4250E Abs Delta Tx.mask (4.25 Gb/s), FC4250E Abs Gamma Rx.mask (4.25 Gb/s), FC4250E Abs Gamma Tx.mask (4.25 Gb/s)			
Ethernet	100BASE-BX10 (125 Mb/s), 100BASE-BX/LX10 (125 Mb/s), 1.25 Gb/s 1000Base-CX Absolute TP2 (1.25 Gb/s), 1.25 Gb/s 1000Base-CX Absolute TP3 (1.25 Gb/s), GB Ethernet (1.25 Gb/s), 2XGB Ethernet (2.5 Gb/s), 3.125 Gb/s 10GBase-CX4 Absolute TP2 (3.125 Gb/s).			
Infiniband	2.5G InfiniBand Cable mask (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 1 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 10 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 2 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 3 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 4 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 5 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 6 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 7 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 8 (2.5 Gb/s), 2.5G InfiniBand Driver Test Point 9 (2.5 Gb/s), 2.5G InfiniBand Receiver mask (2.5 Gb/s), InfiniBand (2.5 Gb/s). **For 16-GHz models only:** 5.0G InfiniBand Driver Test Point 1 (5 Gb/s), 5.0G InfiniBand Driver Test Point 6 (5 Gb/s), 5.0G InfiniBand Transmitter Pins (5 Gb/s)			
XAUI	3.125 Gb/s XAUI Far End (3.125 Gb/s), 3.125 Gb/s XAUI Far End (3.125 Gb/s), XAUI-E Far (3.125 Gb/s), XAUI-E Near (3.125 Gb/s)			
ITU G.703	DS1, 100 Ω twisted pair (1.544 Mb/s), 2 Mb 120, 120 Ω twisted pair (2.048 Mb/s), 2 Mb 75, 75 Ω coax (2.048 Mb/s), DS2 110, 110 Ω twisted pair (6.312 Mb/s), DS2 75, 75 Ω coax (6.312 Mb/s), 8 Mb, 75 Ω coax (8.448 Mb/s), 34 Mb, 75 Ω coax (34.368 Mb/s), DS3, 75 Ω coax (44.736 Mb/s), 140 Mb 0, 75 Ω coax (139.264 Mb/s), 140 Mb 1, 75 Ω coax (139.264 Mb/s), 140 Mb 1 Inv, 75 Ω coax (139.264 Mb/s), 155 Mb 0, 75 Ω coax (155.520 Mb/s), 155 Mb 1, 75 Ω coax (155.520 Mb/s), 155 Mb 1 Inv, 75 Ω coax (155.520 Mb/s).			
ANSI T1/102	DS1, 100 Ω twisted pair, (1.544 Mb/s), DS1C, 100 Ω twisted pair, (3.152 Mb/s), DS2, 110 Ω twisted pair, (6.312 Mb/s), DS3, 75 Ω coax, (44.736 Mb/s), STS1 Eye, 75 Ω coax, (51.84 Mb/s), STS1 Pulse, 75 Ω coax, (51.84 Mb/s), STS3, 75 Ω coax, (155.520 Mb/s)			
RapidIO	RapidIO Serial Level 1, 1.25G Rx (1.25 Gb/s), RapidIO Serial Level 1, 1.25G Tx LR (1.25 Gb/s), RapidIO Serial Level 1, 1.25G Tx SR (1.25 Gb/s), RapidIO Serial Level 1, 2.5G Rx (2.5 Gb/s), RapidIO Serial Level 1, 2.5G Tx LR (2.5 Gb/s), RapidIO Serial Level 1, 2.5G Tx SR (2.5 Gb/s), RapidIO Serial Level 1, 3.125G Rx (3.125 Gb/s), RapidIO Serial Level 1, 3.125G Tx LR (3.125 Gb/s), RapidIO Serial Level 1, 3.125G Tx SR (3.125 Gb/s)			
PCI Express	R1.0a 2.5G Add-in Card Transmitter Non-Transition bit mask (2.5 Gb/s), R1.0a 2.5G Add-in Card Transmitter Transition bit mask (2.5 Gb/s), R1.0a 2.5G Exp.Card Host Non-Transition bit mask (2.5 Gb/s), R1.0a 2.5G Exp.Card Host Transition bit mask (2.5 Gb/s), R1.0a 2.5G Exp.Card Module Non-Transition bit mask (2.5 Gb/s), R1.0a 2.5G Exp.Card Module Transition bit mask (2.5 Gb/s), R1.0a 2.5G Exp.Card Transmitter Non-Transition bit mask (2.5 Gb/s), R1.0a 2.5G Exp.Card Transmitter Transition bit mask (2.5 Gb/s), R1.1 2.5G Add-in Card Transmitter Non-Transition bit mask (2.5 Gb/s), R1.1 2.5G Add-in Card Transmitter Transition bit mask (2.5 Gb/s), R1.1 2.5G Cable Receiver End Non-Transition bit mask (2.5 Gb/s), R1.1 2.5G Cable Receiver End Transition bit mask (2.5 Gb/s),			

Mask Test (continued)	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
PCI Express	R1.1 2.5G Cable Transmitter End Non-Transition bit mask (2.5 Gb/s), R1.1 2.5G Cable Transmitter End Transition bit mask (2.5 Gb/s), R1.1 2.5G Express Module System Non-Transition bit mask (2.5 Gb/s), R1.1 2.5G Express Module System Transition bit mask (2.5 Gb/s), R1.1 2.5G Express Module Transmitter Path Non-Transition bit mask (2.5 Gb/s), R1.1 2.5G Express Module Transmitter Path Transition bit mask (2.5 Gb/s), R1.1 2.5G Receiver mask (2.5 Gb/s), R1.1 2.5G System Board Transmitter Non-Transition bit mask (2.5 Gb/s), R1.1 2.5G System Board Transmitter Transition bit mask (2.5 Gb/s), R1.1 2.5G Transmitter Non-Transition bit mask (2.5 Gb/s), R1.1 2.5G Transmitter Transition bit mask (2.5 Gb/s) **For 16-GHz models only:** R2.0 5.0G Add-in Card 35 dB Transmitter Non-Transition bit mask (5 Gb/s), R2.0 5.0G Add-in Card 60 dB Transmitter Non-Transition bit mask (5 Gb/s), R2.0 5.0G Add-in Card 35 dB Transmitter Transition bit mask (5 Gb/s), R2.0 5.0G Add-in Card 60 dB Transmitter Transition bit mask (5 Gb/s), R2.0 5.0G Mobile Transmitter mask (5 Gb/s), R2.0 5.0G Receiver mask (5 Gb/s), R2.0 5.0G System Board Transmitter Non-Transition bit mask (5 Gb/s), R2.0 5.0G System Board Transmitter Transition bit mask (5 Gb/s), R2.0 5.0G Transmitter Non-Transition bit mask (5 Gb/s), R2.0 5.0G Transmitter Transition bit mask (5 Gb/s R2.1 5.0G Transmitter Non-Transition bit mask (5 Gb/s), R2.1 5.0G Transmitter Transition bit mask (5 Gb/s			
Serial ATA	Ext Length, 1.5G 250 Cycle, Rx Mask (1.5 Gb/s), Ext Length, 1.5G 250 Cycle, Tx Mask (1.5 Gb/s), Ext Length, 1.5G 5 Cycle, Rx Mask (1.5 Gb/s), Ext Length, 1.5G 5 Cycle, Tx Mask (1.5 Gb/s), Gen1, 1.5G 250 Cycle, Rx Mask (1.5 Gb/s), Gen1, 1.5G 250 Cycle, Tx Mask (1.5 Gb/s), Gen1, 1.5G 5 Cycle, Rx Mask (1.5 Gb/s), Gen1, 1.5G 5 Cycle, Tx Mask (1.5 Gb/s), Gen1m, 1.5G 250 Cycle, Rx Mask (1.5 Gb/s), Gen1m, 1.5G 250 Cycle, Tx Mask (1.5 Gb/s), Gen1m, 1.5G 5 Cycle, Rx Mask (1.5 Gb/s), Gen1m, 1.5G 5 Cycle, Tx Mask (1.5 Gb/s), Ext Length, 3.0G 250 Cycle, Rx Mask (3 Gb/s), Ext Length, 3.0G 250 Cycle, Tx Mask (3 Gb/s), Ext Length, 3.0G 5 Cycle, Rx Mask (3 Gb/s), Ext Length, 3.0G 5 Cycle, Tx Mask (3 Gb/s), Gen1, 3.0G 250 Cycle, Rx Mask (3 Gb/s), Gen1, 3.0G 250 Cycle, Tx Mask (3 Gb/s), Gen1, 3.0G 5 Cycle, Rx Mask (3 Gb/s), Gen1, 3.0G 5 Cycle, Tx Mask (3 Gb/s), Gen1m, 3.0G 250 Cycle, Rx Mask (3 Gb/s), Gen1m, 3.0G 250 Cycle, Tx Mask (3 Gb/s), Gen1m, 3.0G 5 Cycle, Rx Mask (3 Gb/s), Gen1m, 3.0G 5 Cycle, Tx Mask (3 Gb/s).			
Mask margin	Available for industry-standard mask testing			
Automask creation	Masks are created automatically for single-valued voltage signals. Automask specifies both delta X and delta Y tolerances. The failure actions are identical to those of limit testing.			
Data collected during test	Total number of waveforms examined, number of failed samples, number of hits within each polygon boundary			

Trigger Output	*FemtoScope* 1051	*FemtoScope* 2052	*FemtoScope* 1161	*FemtoScope* 2162
Timing	Positive transition equivalent to acquisition trigger point		Positive transition equivalent to acquisition trigger point	
Low level	(−0.2 ± 0.1) V. Measured into 50 Ω.		(−0.2 ± 0.1) V. Measured into 50 Ω.	
Amplitude	(900 ± 200) mV. Measured into 50 Ω.		(900 ± 200) mV. Measured into 50 Ω.	
Rise time	10% to 90%: ≤ 0.45 ns. 20% to 80%: ≤ 0.3 ns.		10% to 90%: ≤ 0.45 ns. 20% to 80%: ≤ 0.3 ns.	
RMS jitter	2 ps or less		2 ps or less	
Output delay	(4 ± 1) ns		(4 ± 1) ns	
Output coupling	DC-coupled		DC-coupled	
Output connectors	SMA female		SMA female	

Recovered data output	FemtoScope 1051	FemtoScope 2052	FemtoScope 1161	FemtoScope 2162
Data Rate		6.5 Mb/s to 5 Gb/s		6.5 Mb/s to 8 Gb/s
Eye amplitude		250 mV p-p, typical		250 mV p-p, typical
Eye rise/fall time		20%–80%: 75 ps, typical. Measured at 5-GHz channel.		20%–80%: 50 ps, typical. Measured at 16-GHz channel.
RMS jitter		2 ps +1% of UI, typical		2 ps +1% of UI, typical
Output coupling		AC-coupled		AC-coupled
Output connections		SMA female		SMA female

Recovered clock output	FemtoScope 1051	FemtoScope 2052	FemtoScope 1161	FemtoScope 2162
Output frequency		Full rate clock output, 3.25 MHz to 2.5 GHz		Full rate clock output, 3.25 MHz to 5.65 GHz
Output amplitude		250 mV p-p, typical		250 mV p-p, typical
Output coupling		AC-coupled		AC-coupled
Output connectors		SMA female		SMA female

Recovered clock output	FemtoScope 1051	FemtoScope 2052	FemtoScope 1161	FemtoScope 2162
Power requirements				
Power supply voltage	+12 V ± 5%			
Power supply current	1.3 A max	1,8 A max	1.3 A max	1.8 A max
Protection	Auto shutdown on excess or reverse voltage			
AC-DC adaptor	Universal adaptor supplied			
Physical characteristics				
Dimensions				
Width	113.9 mm	160 mm	113.9 mm	160 mm
Height	33.5 mm (w/o feet) 41.75 mm (with feet)	50 mm (w/o feet) 54 mm (with feet)	33.5 mm (w/o feet) 41.75 mm (with feet)	50 mm (w/o feet) 54 mm (with feet)
Depth	162 mm (w/o connectors) 187 mm (with connectors)	210 mm (w/o connectors) 225 mm (with connectors)	162 mm (w/o connectors) 187 mm (with connectors)	210 mm (w/o connectors) 225 mm (with connectors)
Footprint	1.85 sq. dm.	3.36 sq. dm.	1.85 sq. dm.	3.36 sq. dm.
Net weight	370 g	790 g	370 g	790 g
Environmental conditions				
Temperature				
Operating, normal	+5°C to +40°C			
Operating, for quoted accuracy	+15°C to +25°C			
Storage	−20°C to +50°C			
Humidity				
Operating	Up to 85 % relative humidity (non‑condensing) at +25°C			
Storage	Up to 95 % relative humidity (non‑condensing)			
Compliance	TBD			
Warranty	TBD			

System requirements	FemtoScope 1051	FemtoScope 2052	FemtoScope 1161	FemtoScope 2162
Processor	Pentium-class processor or equivalent			
Memory	4 GB			
Disk space	Software occupies about 50 MB			
Operating system	Windows 7, Windows 8 or Windows 10. 32-bit and 64-bit versions			
PC connection port	USB 2.0 (high speed). Also compatible with USB 3.0			

# Eltesta USB Sampling-, Real Time-, Near Real Time- Oscilloscopes, Picosecond Pulse Generators

- USB Sampling Oscilloscopes from 12 GHz to 25 GHz bandwidth
- USB Near Real Time Oscilloscopes from 5 GHz to 16 GHz bandwidth
- USB Real Time Oscilloscope 1 GHz bandwidth
- USB Picosecond Pulse Generators from 50 ps / 8 V to 35 ps / 0.2 V.

USB sampling oscilloscopes

PicoScope 9231
PicoScope 9211
PicoScope 9201

USB sampling oscilloscopes

PicoScope 9301
PicoScope 9302
PicoScope 9311

USB sampling oscilloscopes

PicoScope 9312
PicoScope 9321
PicoScope 9341

USB Picosecond Pulse Generators

PicoSource 911
PicoSource 912
PicoSource 914

USB wide-bandwidth oscilloscopes

FemtoScope 2162
FemtoScope 2052

Sampler-extended real-time USB oscilloscopes

PicoScope 9404-05
PicoScope 9404-16

USB wide-bandwidth oscilloscopes

FemtoScope 1051
FemtoScope 1161
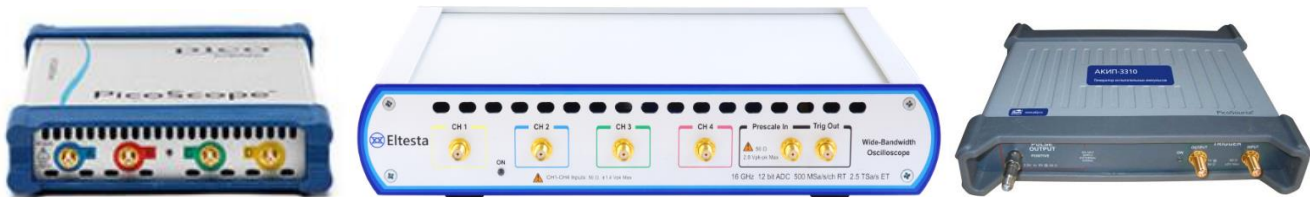
USB real-time oscilloscope
PicoScope 6407

USB wide-bandwidth oscilloscope
FemtoScope 3164

USB Picosecond Pulse Generator
PicoSource 901

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Our partners

www.picotech.com

Pico Technology is a UK-based manufacturer of high-precision PC-based oscilloscopes and automotive diagnostics equipment, founded in 1991. The product range includes the PicoScope line of PC-based oscilloscopes, data loggers, automotive equipment, and most recently, handheld USB-based oscilloscopes.

Since their inception in 1991, Pico Tech has been researching and developing PC-based oscilloscopes, when the market standard was analogue storage oscilloscopes. Pico Technology is one of two European scope manufacturers, and competes in the low to middle end of the instrumentation market.

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www.prist.ru

The Prist company was established in 1994 and has been developing fast since then. During these years the company has grown into one of the biggest Russian suppliers of devices for electrical measurements, radio measurements and the measurement of environmental parameters.

Today Prist has more than 80 highly qualified employees with offices in Moscow, Saint-Petersburg, Ekaterinburg and lots of partners-distributors throughout Russia, Belorussia and Kazakhstan.

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www.acquitek.com

Since 2004, ACQUITEK has been selling electronic systems and equipment related to data acquisition, Test and Measurement, and Time Frequency. Acquitek also provides the services associated with this equipment through specialized partners (Integration, Software Development, Mechanical Design and After-Sales Service)

The solutions available from more than 30 principals enable us to address the numerous projects of companies or research laboratories present in the fields of activity such as Aerospace, Automotive and Transport, Energy, Semiconductor , Industry and Universities. The solutions offered are available in the most current and most popular formats such as PCI Express, PXI Express, VPX and communication buses like LAN, USB or GPIB.

Contact information:

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www.signalsolutions.eu

Signal Solutions is a relatively young company but with highly experienced employees. It is focuses on RF/Microwave, Fiber Optics, EMC and Shielding technology. All engineers have long experience from the industry.

Signal Solutions targets to be a total solution provider in the RF/Microwave, EMC and Fiber Optics technology fields for R&D labs, Test Sites, Manufacturing Facilities and Data Centers. The company sells state of the art components and systems and provides knowledge to the customers.

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Eltesta

www.eltesta.com

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