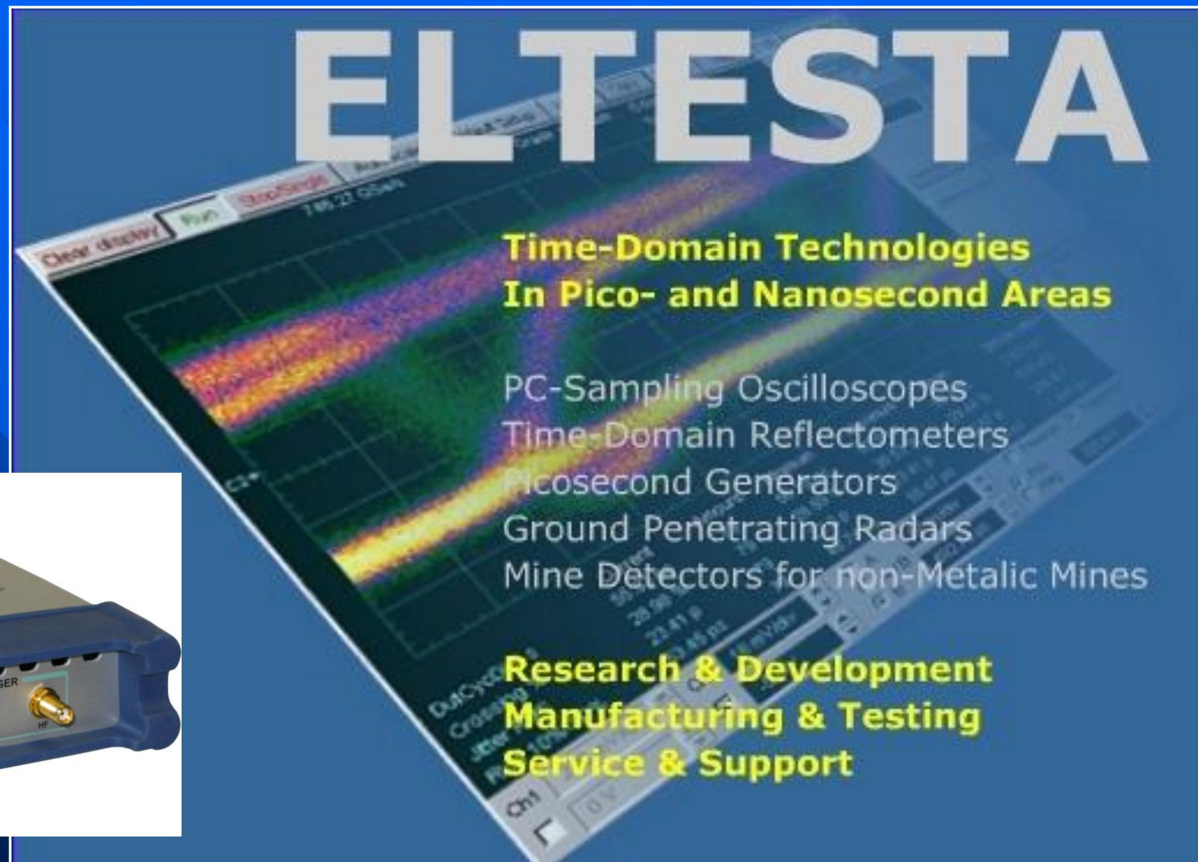
Welcome!
PicoScope 9201 – World Smallest 12–GHz PC Sampling Oscilloscope



Product Presentation

Introduction

The *PicoScope 9201* is the world smallest PC Sampling Oscilloscope

12 GHz Channel Bandwidth	***16-bit*** ADC	***2%*** Vertical and ***0.4%*** Horizontal Accuracy
10 GHz Trigger Bandwidth	***200 fs*** Time Resolution	***<2.5 mV max*** RMS Noise
2 mV/div Best Sensitivity	***20 ps/div*** Faster Time Base	***200 ks/s*** Acquisition Speed

The **PicoScope 9201** PC Sampling Oscilloscope

- The **PicoScope 9201** is a dual-channel, wide-bandwidth PC Sampling Oscilloscope that uses sequential equivalent-time sampling technology to achieve bandwidth of up to ***12 GHz***.
- The The instrument provides fast acquisition, repeatable waveform performance analysis with:
  - *Automated direct or statistical measurements*
  - *Markers*
  - *Histograms*
  - *Math or FFT analysis*
  - *Color-Graded Display*
  - *Parametric Limit Testing*
  - *Eye Diagram Measurements*
  - *Mask Template Testing*

A Structure of the PicoScope 9201

The **PicoScope 9201** is a PC Sampling Oscilloscope, or the oscilloscope for the Personal Computer.

- It requires just USB 2.0 connector in your PC to give you the power of a stand-alone instrument within your PC.

The **PicoScope 9201** needs only simple USB connection with PC.

PicoScope 9201 Features

VERTICAL

- DC to *12 GHz* Bandwidth
- *29.2 ps* calculated Rise Time
- Two Channels
- *±2 %* Vertical Gain Accuracy
- *16-Bit* Vertical Resolution
- *<2.5 mV* RMS Noise
- Up to *4 k-point/channel* record length

HORIZONTAL

- Dual Time Base *20 ps/div* to *2 ms/div*
- *0.4%+15 ps* Time Interval Accuracy
- *<200 fs* Sampling Interval

TRIGGER

- DC to *1 GHz* Full Direct Trigger
- *10 GHz* Prescaled Trigger
- *<3.5 ps* RMS Jitter

OPERATIONAL

- Power Consumption: *15 W max*
- Weight: *1 kg*
- Size: *W170 x H40 x D255 mm*

DISPLAY, MEASUREMENTS and ANALYSIS

- Infinitive and Variable Persistence, Grey Scaling and Color Grading
- High Resolution Cursors
- Automatic Waveform Measurements with Statistics and Pass/Fail Limit Test
- Waveform Processing including FFT with five FFT windows
- Statistical Analysis with Time and Voltage Histograms
- Automated Mask Test with Standard and Custom Masks
- Eye Diagram Measurements

UTILITY

- Autoscale
- Automatic Calibration
- Win NT/XP/2000
  Intuitive Graphical User Interface
- Built-in information system,Windows Help

PicoScope 9201 Applications

Signal Analysis
- Electrical Standards Compliance Testing
- Spectrum Analysis
- Statistic Analysis
- Eye-Diagram Analysis

Network Analysis with TDR/TDT
- Circuits Boards Characterization
- IC Packages Characterization
- Computer Backplane
- Z-Impedance Measurements

High-Speed Digital Communication
- Designing/Verification of Telecom and Datacom Elements
- Manufacturing/Testing for ITU/ANSI Conformance

Semiconductor Testing
- Hi-Speed Diodes
- Fast Logic Families
- Analogue Component Pulse Response

R & D
- Microwave & RF Charac-terization
- High-Energy Physics
- Digital Design
- Informative Waveform Displays

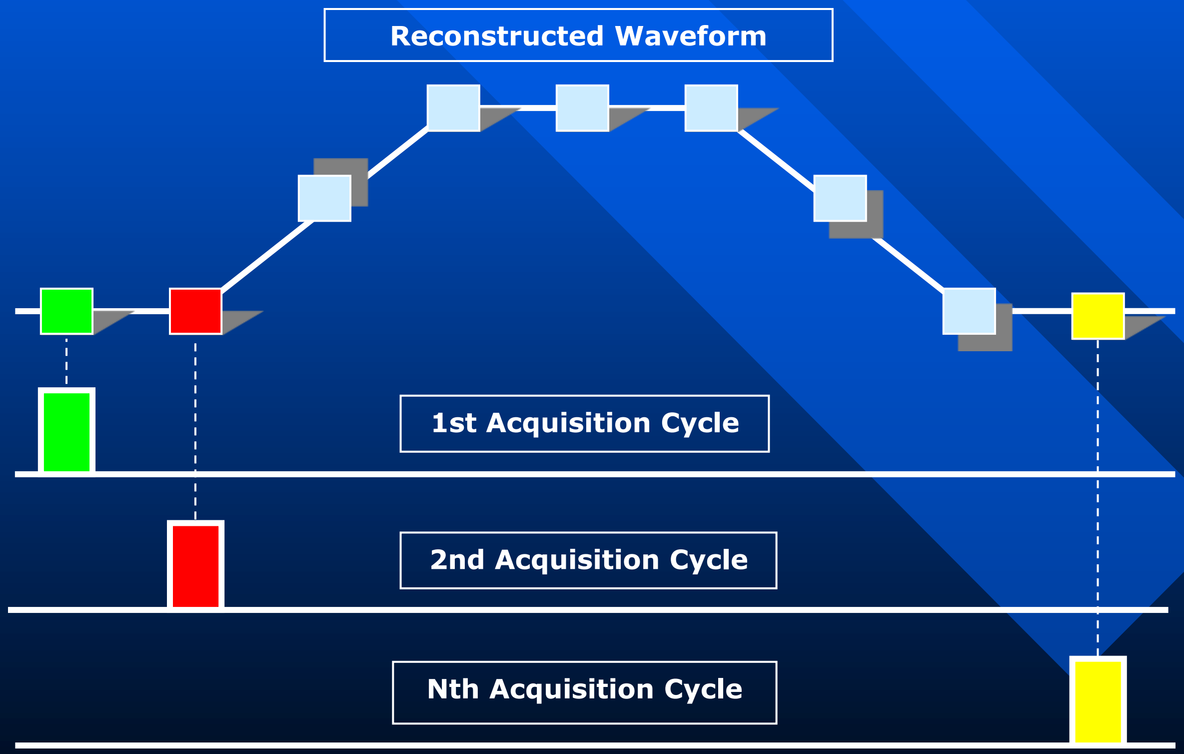
Timing Analysis
- Automatic Parametric Measurements
- Pulsed RF Switches
- Compliance Testing

Manufacturing
- Limit and Mask Test
- Testing for ITU/ANSI Conformance
- Automatic Test Systems
- Auto-calibration Routine

Sequential Sampling

The PicoScope 9201 used digital sequential sampling technology to acquire and display high bandwidth waveforms.

- **A sampling oscilloscope does not continuously monitor the input signal applied to the channel, but looks at it only at discrete points in time. At each discrete point, the oscilloscope samples the signal and stores a replica of the input voltage on an input sampling capacitor.**



- **Sequential Sampling Technique means:**
  - **Wide Bandwidth Applications *(> 10 GHz)***
  - **Used with Repetitive Signals, NRZ or RZ signals.**
  - ***One sample* is taken for each trigger**
  - ***Multiple Trigger* Events Build Up Waveform**
  - ***No Pre-Trigger* Information**

USB Interface

USB 2.0 for fast data transfer

The **PicoScope 9201** PC Sampling Oscilloscope is connected to the **USB** port on any modern laptop or desktop PC. The **USB 2.0** interface ensures a quick screen update rate, even when collecting large amounts of data, whilst still retaining backward compatibility with PC's using **USB 1.1.**

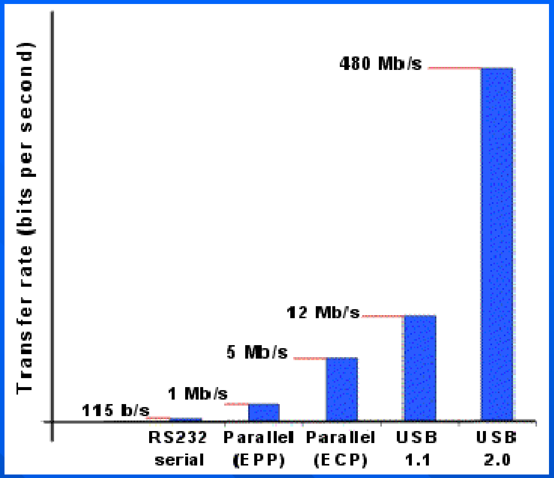
Easy to setup and use

Connecting and using a **USB-**oscilloscope could not be easier. Simply connect the oscilloscope to the PC using a standard USB cable (supplied). The host PC will automatically detect the PicoScope 9201 avoiding the need for any complex setup procedures, and without the need to reboot the PC.

Why USB ?

The Universal Serial Bus (**USB**) has become the standard method for interfacing peripherals to PCs. Today virtually all PCs, including laptops and notebooks, are fully **USB**-ready and include at least one **USB** port. The PicoScope 9201 used USB 2.0 Full-Speed USB. This allows PicoScope 9201 to take advantage of the fast data transfer rate that ensures a quick screen update rate, even when collecting large amounts of data.

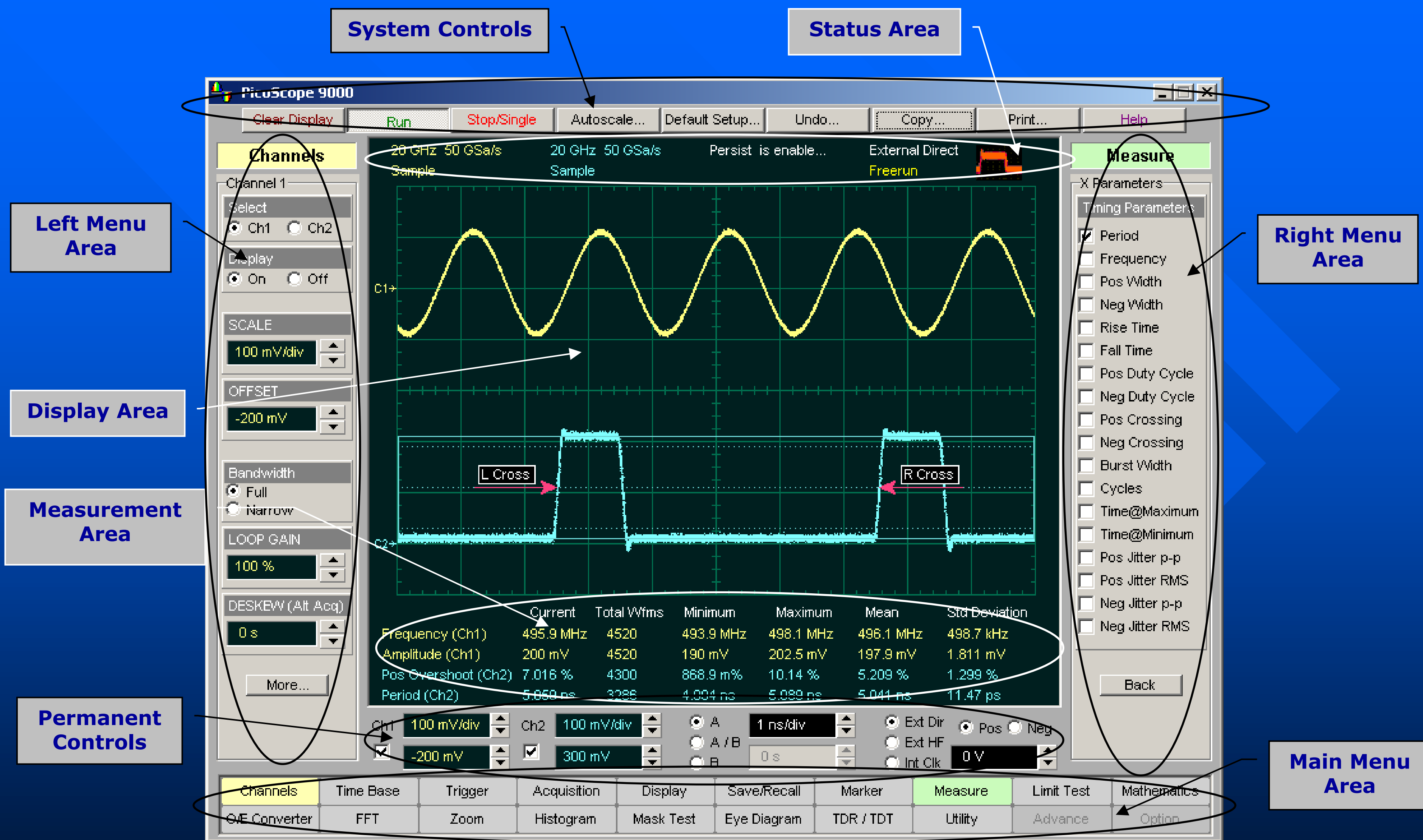
USB 2.0 is backward compatible with USB 1.1 allowing PicoScope 9201 to be used on older PCs with USB 1.1 ports. Although the data transfer rate will be slower when using USB 1.1, it is still faster than a parallel port connection.



The benefits of USB

- **Easy to use:** All USB peripherals are detected by the PC automatically and can be connected and reconnected without the need for rebooting the PC.
- **Fast:** Transfer rates many times faster than USB 1.1 or parallel port devices.
- **Expandable:** Up to 127 peripherals can be plugged into one host computer.
- **Compatibility:** USB 2.0 is backward compatible with USB 1.1.

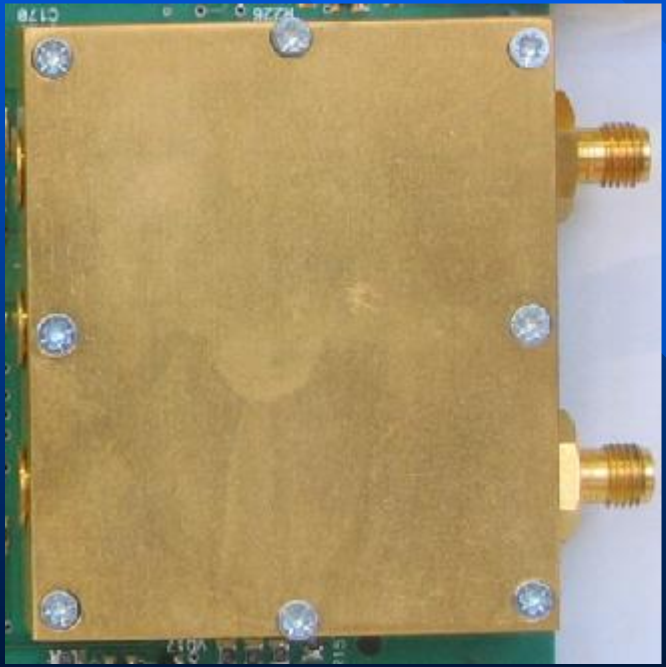
User Interface



The PicoScope 9201 has a Windows Intuitive Graphical User Interface, so you won't have to spend a lot of time learning or relearning the instrument. Pull-down menus give you easy access to advanced features and icons provide quick access to an extensive set of common tests and measurements.

Dual-Channel 12-GHz Miniature Sampler

The **PicoScope 9201** includes a dual-channel **sampler**. This sampler is designed for precise measurements on high speed, low amplitude signals and low-loss testing in applications such as microwave systems research and development, digital device characterisation, and high-speed digital communications circuit design.
It provides an acquisition rise time of ***29.2 ps***, with a typical ***12-GHz*** equivalent bandwidth, and maximum RMS noise ***2.5 mV*** to ensure clean, undistorted signals.
The electrical channel has both a ***12 GHz*** mode for better waveform fidelity, and a ***8 GHz*** mode for optimum noise performance. Changing the bias on the sampling bridge alters the bandwidth of both channels.

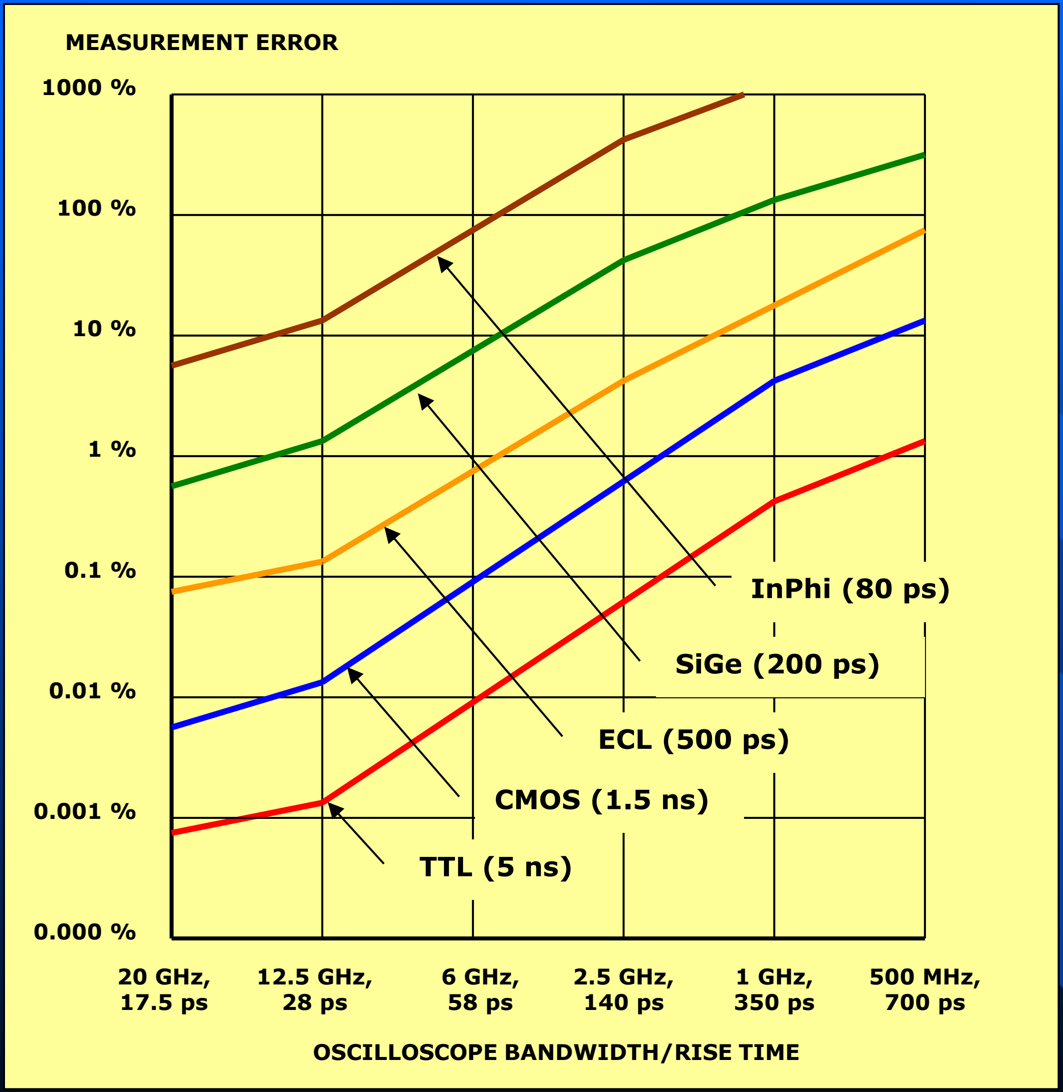


Dual-Channel ***12-GHz*** Sampler used in the **PicoScope 9201**

Key Specifications of the Sampler:

- Number of Channels - 2 (Simultaneous acquisition)
- Bandwidth (-3dB) – Full BW: DC to ***12 GHz***, Narrow BW: DC to ***8 GHz***
- Rise Time (10%-90%) - Full BW: ***≤29.2 ps***, Narrow BW: ***≤43.8 ps***
- RMS Noise (maximum) - Full BW: ***≤2.5 mV***, Narrow BW: ***≤2 mV***
- Maximum operating input voltage - ***1.0 V p-p*** at ***±1 V*** range
- Maximum Safe Input Voltage - ***16 dBm***, or ***±2 V (dc + peak ac)***
- Nominal Input Impedance - ***(50 ± 1) Ω***
- Input connectors - ***SMA-type***, 3.5 x 1.52 (f)

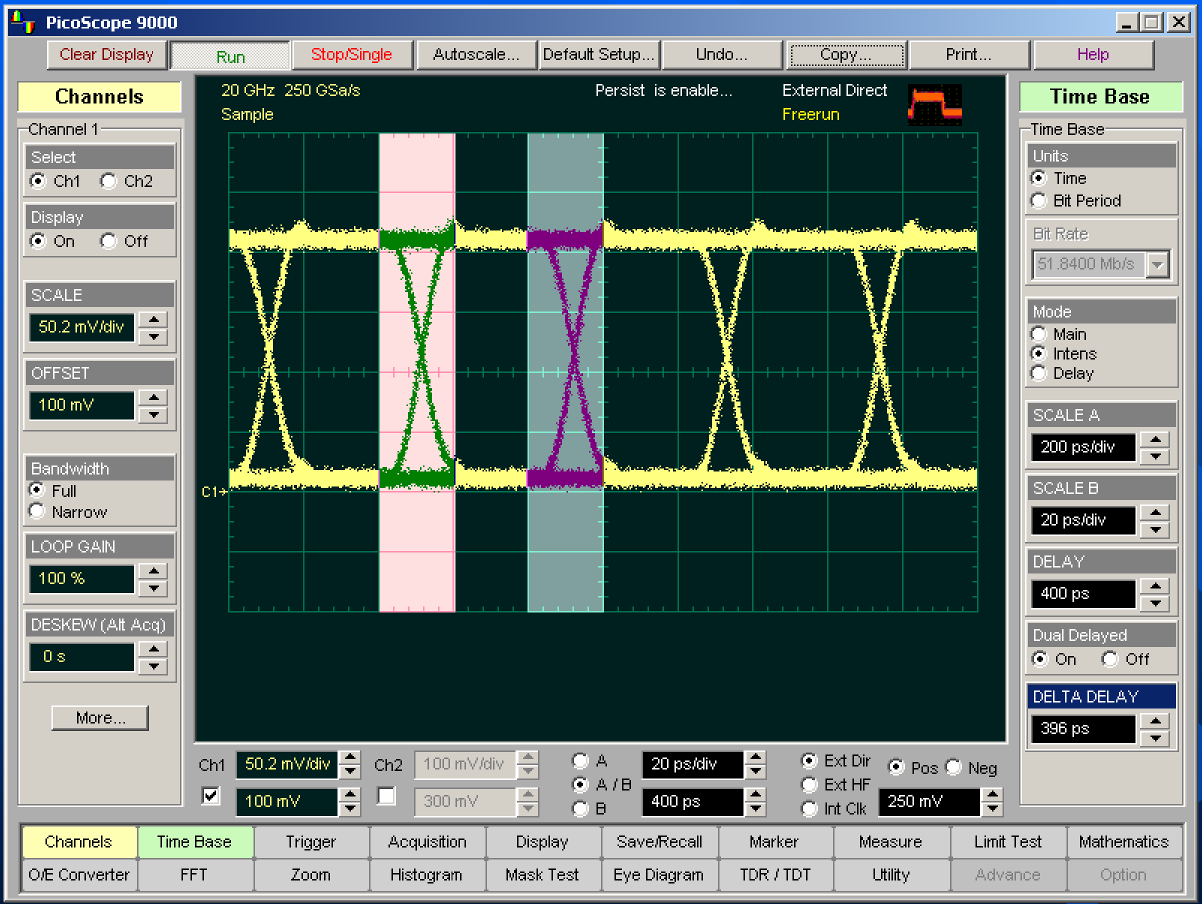
Electrical Rise Time Measurement Error vs. Oscilloscope Bandwidth



When the Scope Bandwidth (BW) is:	Rise Time Slowing Error is:
Equal to Signal Edge BW	41%
Twice as fast as Signal Edge BW	12%
Three times as fast as Signal Edge BW	5%
Five times as fast as Signal Edge BW	2%

Time Base

The Time Base allows you to control the horizontal display through the Main, Intensified, Delayed or Dual Delayed time bases also TIME/DIV and DELAY functions.

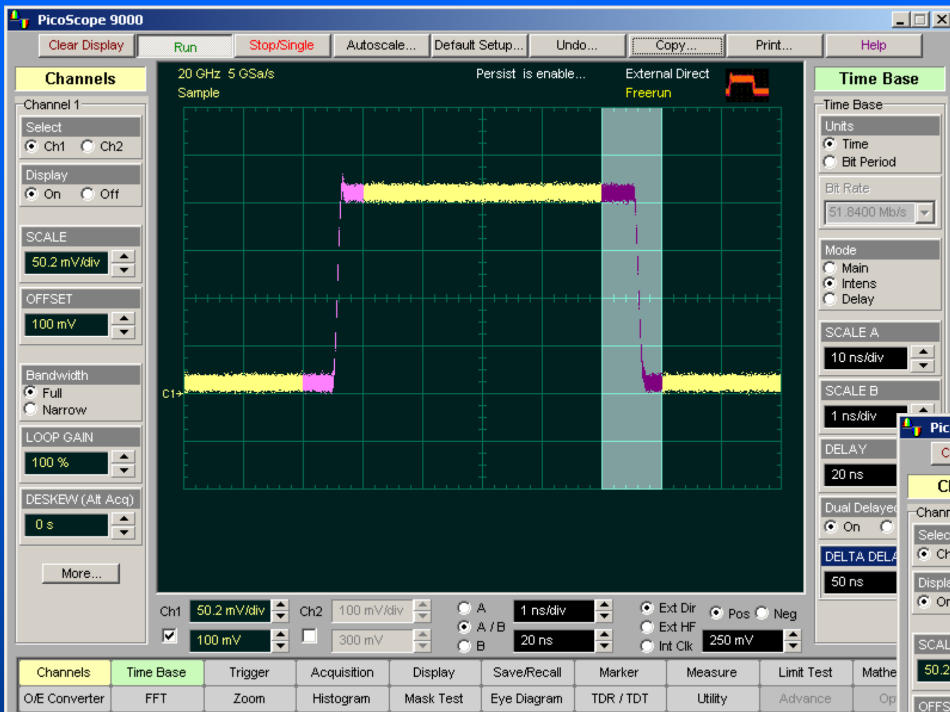


A *2.5-Gbps* Eye Diagram displayed with dual-intensified time base

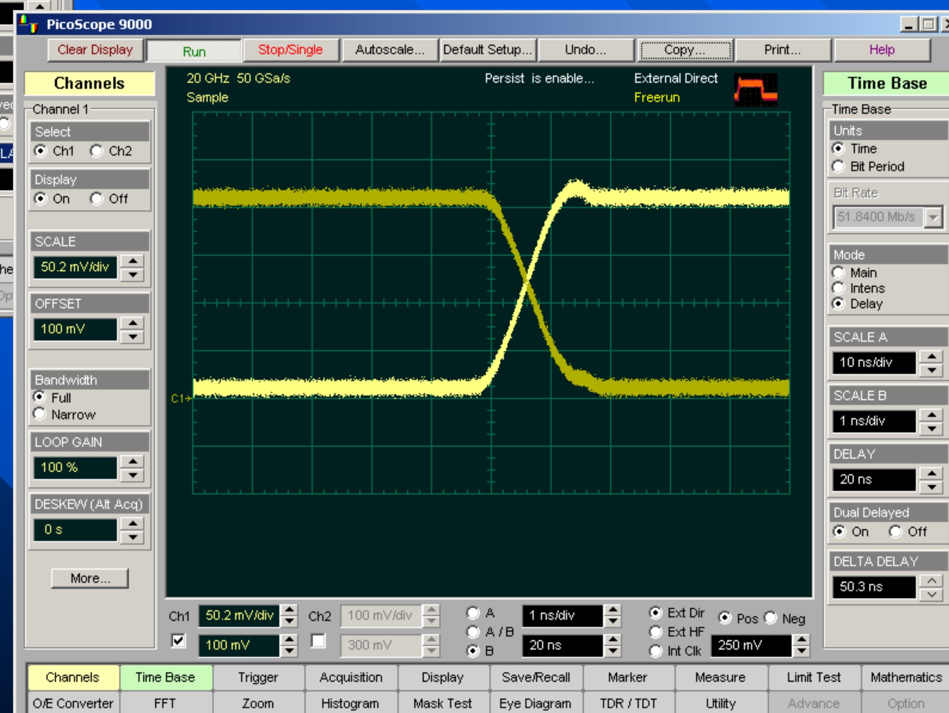
- **The Units function of the PicoScope 9201 Time Base lets you set the instrument time base to:**
  - **Basic time units (second)**
  - **Meter, foot, inch**
  - **Bit period (data rate)**
- **Bit period units provide an easy and intuitive way to display digital communication signals.**
- **TIME BASE:**
  20 ps/div to 2 ms/div
- **Delta Time Interval Accuracy:**
  ± 0.4 % of reading ± 15 ps ± 100 ppm of delay setting (typical)

Time Base Windowing

- The Time Base windowing function is similar to the delayed or dual delayed sweep on analog oscilloscopes because it turns on an expanded time base
- Expanded time base allows you to pinpoint and to horizontally expand a portion (or two portions) of the signal for a more detailed or high-resolution analysis



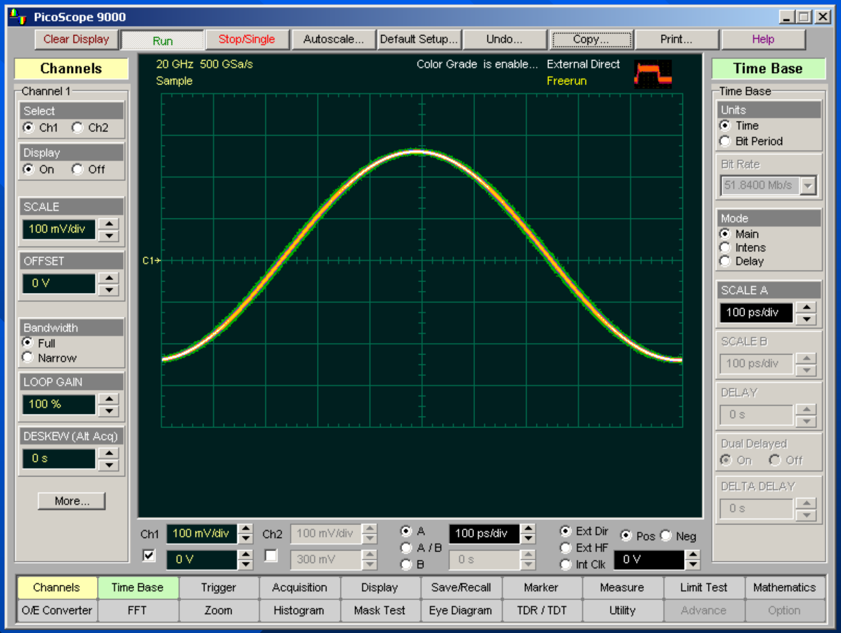
- Left picture shows a waveform acquired with Intensified Time Base
- Right picture shows the same waveform acquired with Dual Delay Time Base. Measured Pulse Width = *50.3 ns*



Direct Trigger

Equipment connections for Direct Trigger Test

The power of wide-bandwidth sampling oscilloscopes is largely useless without fast, low-jitter triggering. **PicoScope 9201** is equipped with built-in direct trigger for signals up to ***1 GHz*** repetitive rates without using an external trigger unit.

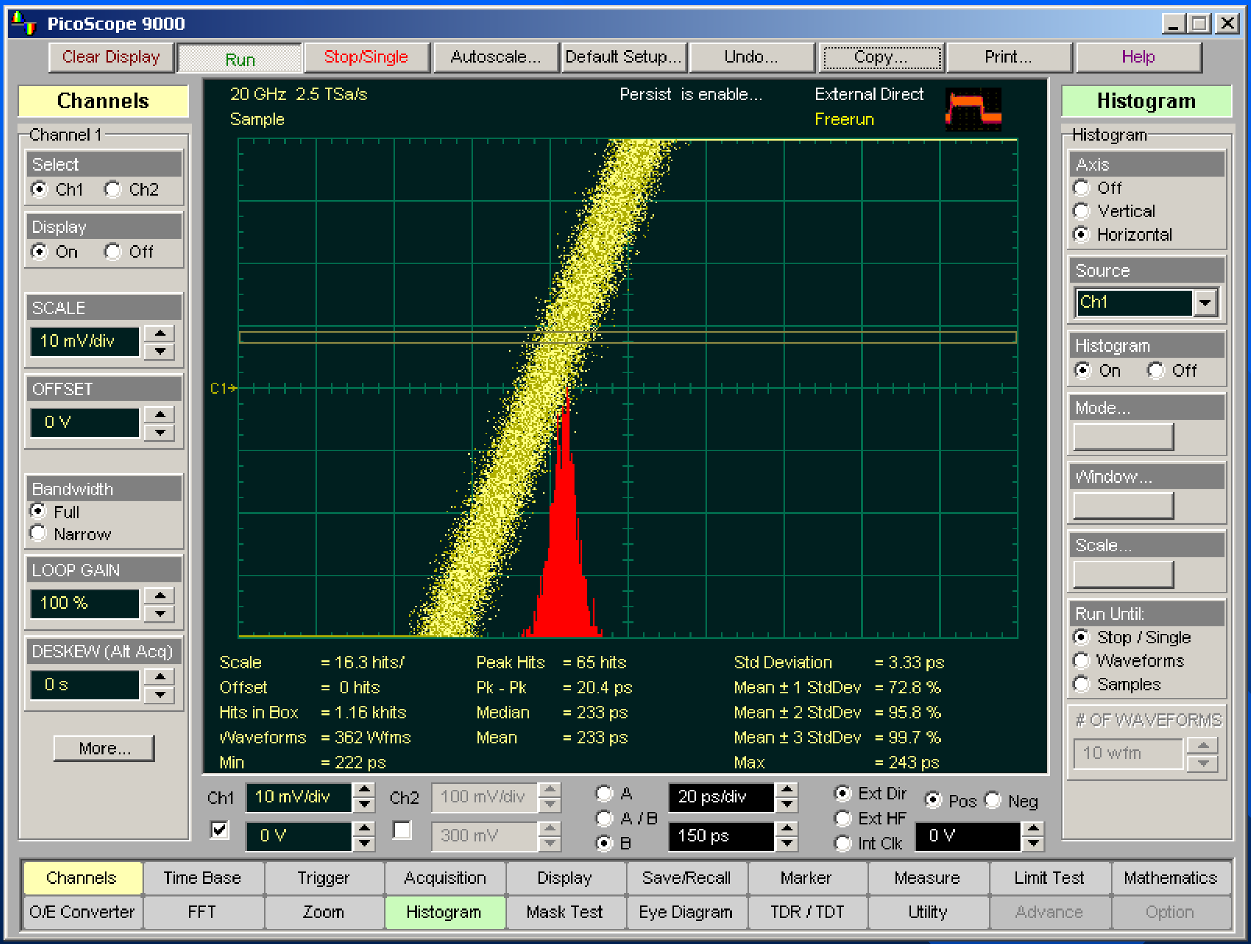


A typical picture of ***1 GHz*** signal by using Direct Trigger

Key specifications of **Direct Trigger**:

- DC to ***1 GHz*** trigger bandwidth
- ***100 mV p-p*** DC to ***100 MHz***, ***400 mV p-p*** at ***1 GHz*** sensitivity
- ***<3.5 ps*** max RMS jitter

Direct Trigger Jitter



Timing accuracy leads to waveform jitter.

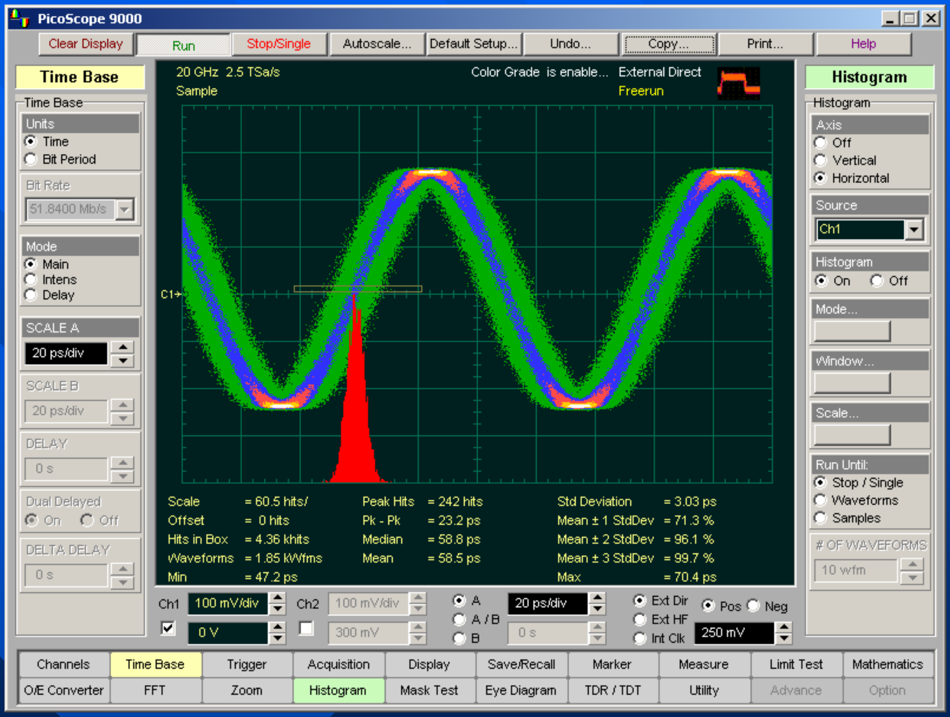
- **RMS Direct Trigger Jitter :**
  Max *3.5 ps + 20 ppm of Delay*

A typical picture showing *3.33 ps* RMS Direct Trigger Jitter with *1-GHz* sine wave signal.

HF Prescaled Trigger

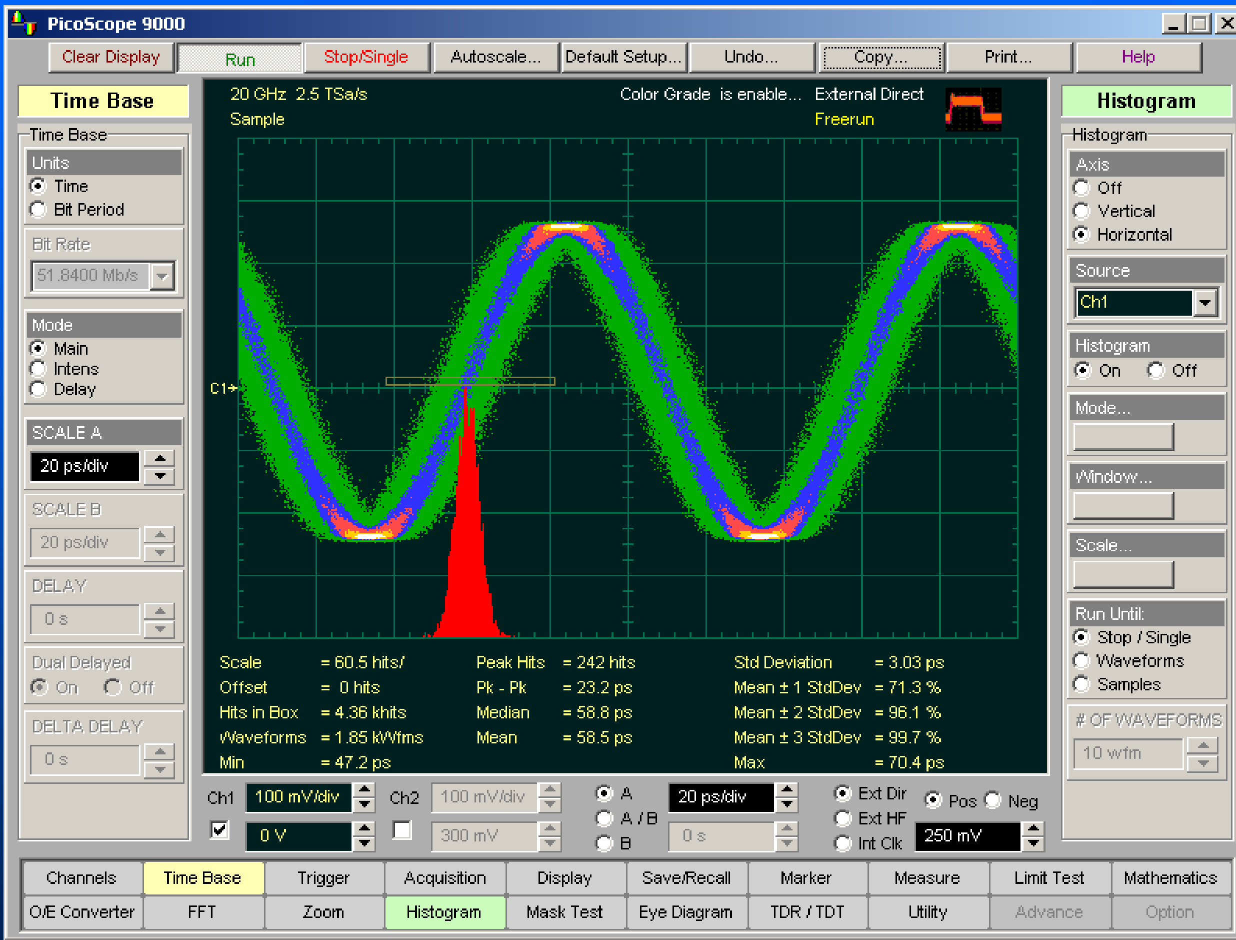
The *PicoScope 9201's* HF (Prescaled) trigger is an AC-coupled *10-GHz* prescaler for triggering on high-speed data without cumbersome manual adjustment.
The heart of the trigger is a low-noise GaAs frequency divider. Low RMS jitter *<3.5 ps typ* is available.

Equipment connections for Prescaled Trigger Test



A *10 GHz* sine-wave signal with prescaled trigger

HF Trigger Jitter



Timing accuracy leads to waveform jitter.

- **Max RMS HF Trigger Jitter: *3.5 ps***

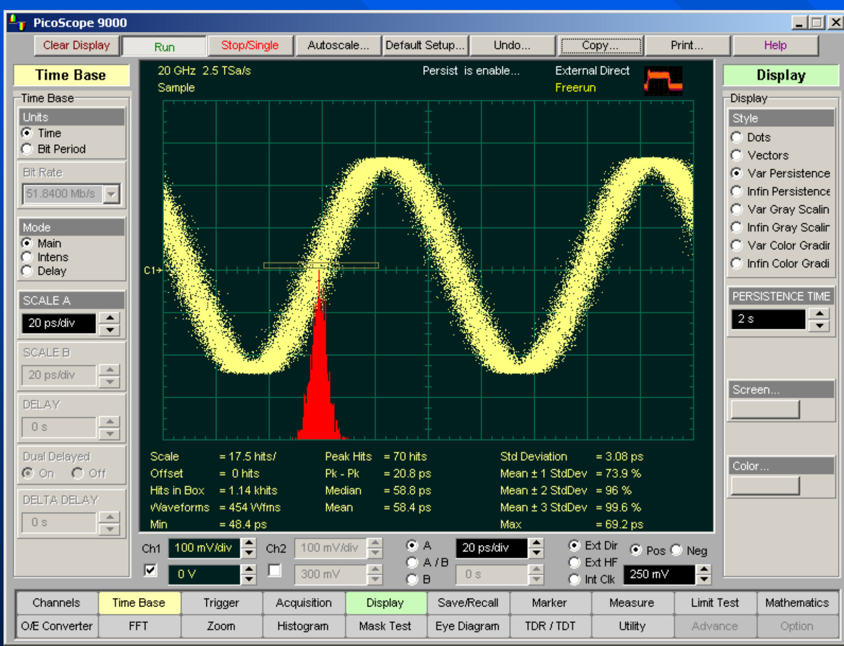
A typical picture showing *3.03 ps* RMS HF Trigger Jitter with *10-GHz* sine wave signal.

Averaging Reduces Noise

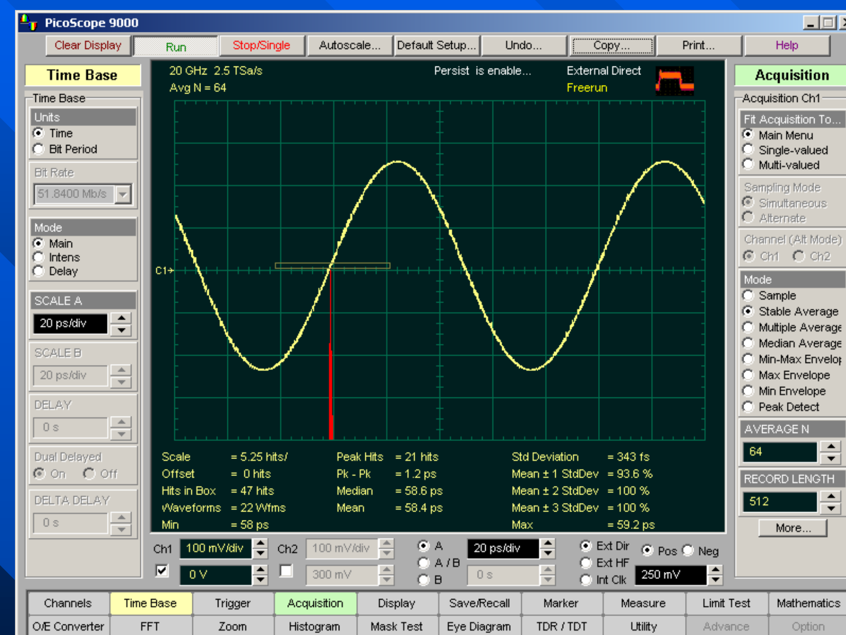
Averaging is often used eliminate random noise on the display and increase resolution and accuracy of measurements. If a waveform is "buried" in noise, averaging can be used to extract a signal from the noise as shown in this illustration.

- **Averaging allows you to measure even noisy signal to less than *0.5 ps* standard deviation enabling extreme accuracy when you need it most.**

- **The PicoScope 9201 used three averaging algorithms:**
  - **Stable Average**
  - **Multiple Average**
  - **Median Average**



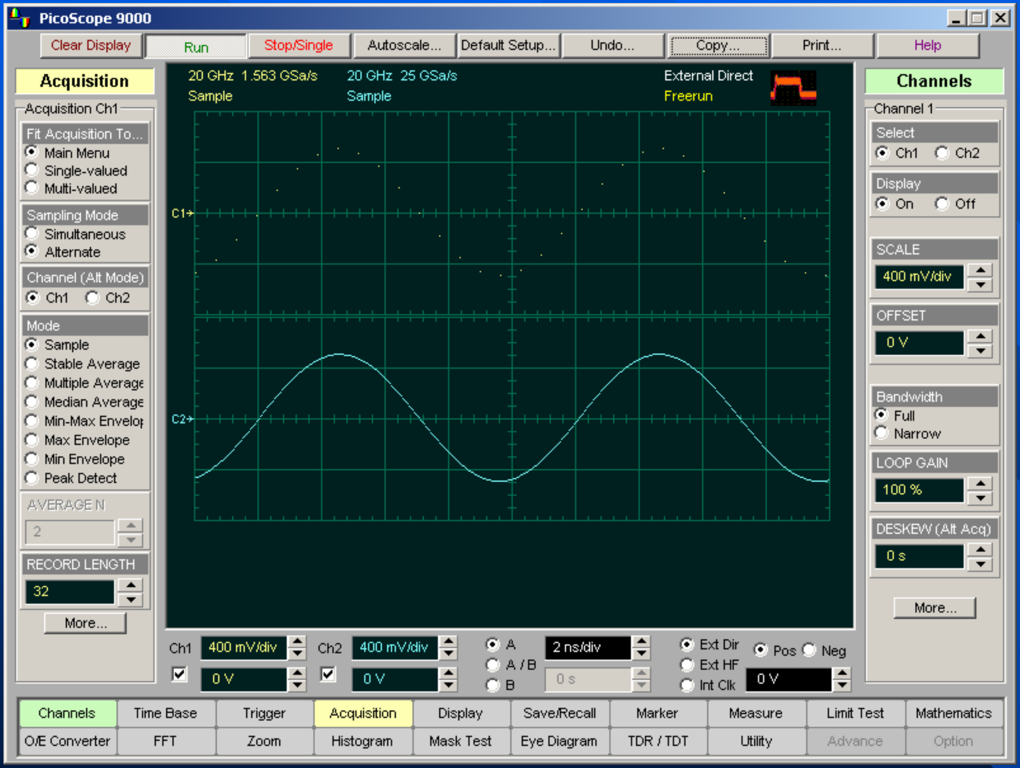
10-GHz **signal with noise and jitter components**



The same ***10-GHz*** **signal without noise and jitter components after deep averaging.**

Record Length

The number of samples that form a trace is called Record Length (points per waveform). The greater the amount of sampled data that is available for analysis or measurements, the greater the record length. Record length in the PicoScope 9201 can be selected from *32* to *4096* samples by a multiple of two.

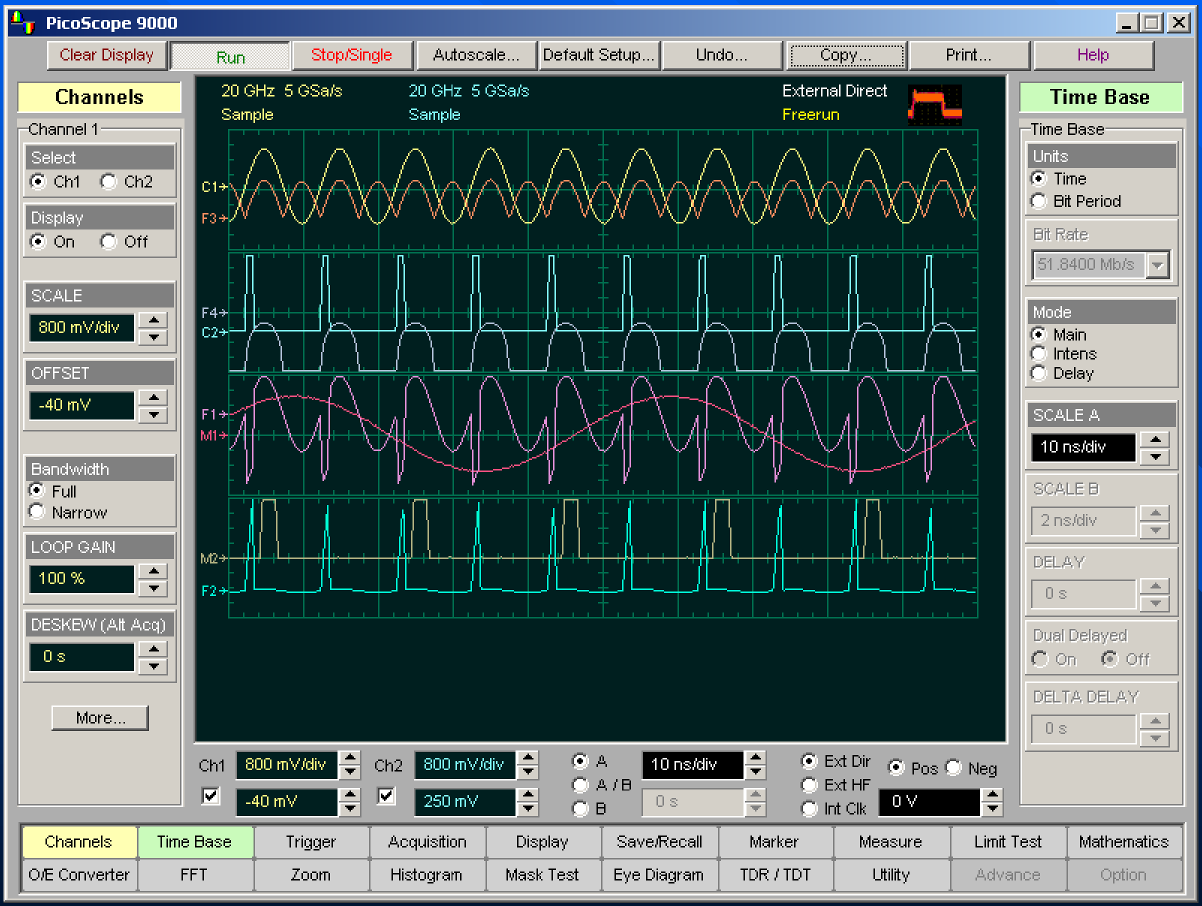


PicoScope 9201 traces with Record Length of *32* (top) and *512* (bottom) samples.

- **Record length sets independently for each channel.**
- **Equivalent sample rate and record length work together. If you combine a small record length memory depth with a high equivalent sample rate, you will have a very fast throughput (display update rate) but very little data in the channel memory.**
- **If more data points need to be acquired, a waveform with a long record length takes longer to construct than one with a short record length. However, a long record length produces a waveform with higher horizontal resolution, therefore a trade off exists between throughput and resolution.**

Multi-Waveform Display

Up to eight traces can be displayed at the same time. The PicoScope 9201 can display two channels, four waveforms from waveform memories, four math waveforms (functions), and two FFTs (spectrums). Real and imaginary parts of memories, functions, and spectrums can be displayed separately.

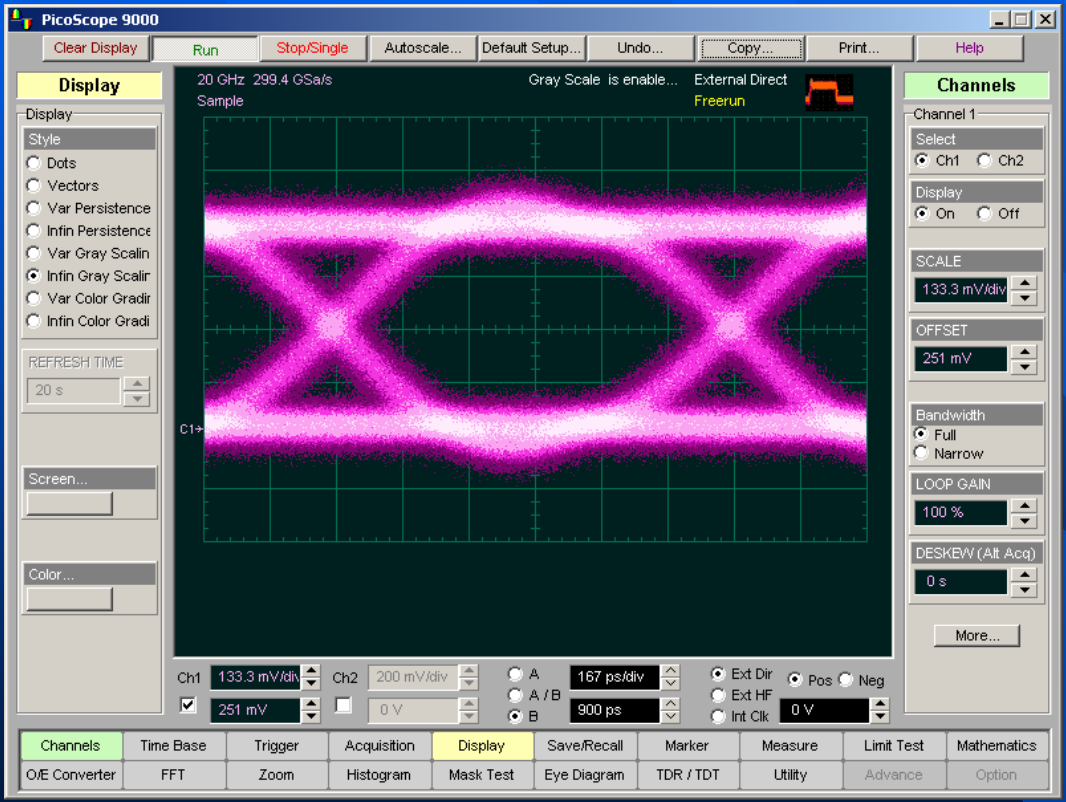


PicoScope 9201 eight-waveform display

The PicoScope 9201's color GUI dedicates a different color for each trace and its associated readouts to simplify the viewing of complex signals on multiple channels.

Informative Waveform Display: Grey Scaling

When you select Grey Scaling mode, is assigned a single color. As a persistence data map develops, different intensities of that color are assigned to the range between a minimum and a maximum population.

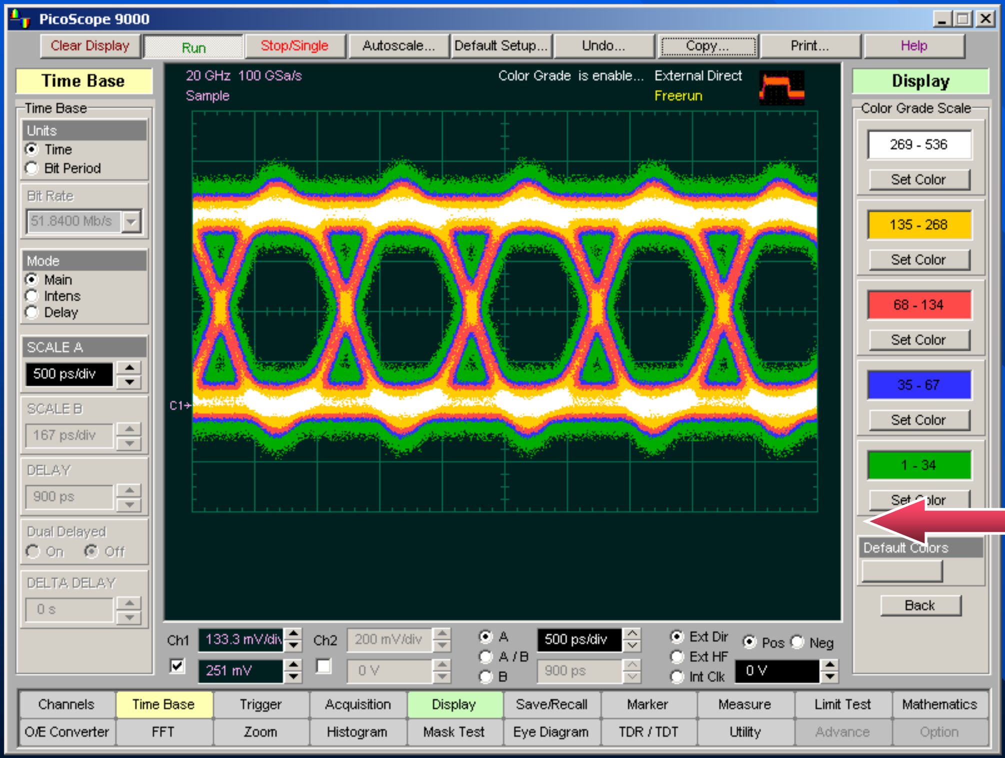


- **The maximum population automatically gets the highest color intensity, the minimum population gets the lowest color intensity, and intermediate populations get intensities in between these extremes**
- **The information in the lower populations (for example, down at the noise level) could be of greater interest to you than the rest.**
- **The Grey Scaling persistence view highlights the distribution of data so that you can examine it in detail.**

Get valuable insight into your device behavior with gray scaling display.
View pattern dependencies and different rare versus common events

Informative Waveform Display: Color Grading

With Color Grading display style the accumulated points are color graded (shaded with different colors) to indicate the density of the points, and a color-graded database is built. You can use the color-graded database with histograms, mask testing, statistical measurements, and eye diagrams. You can also use color grading to provide more visual information about the waveforms.



The Color Graded display allows you clearly view any point of interest on the *1-GHz* eye-diagram.

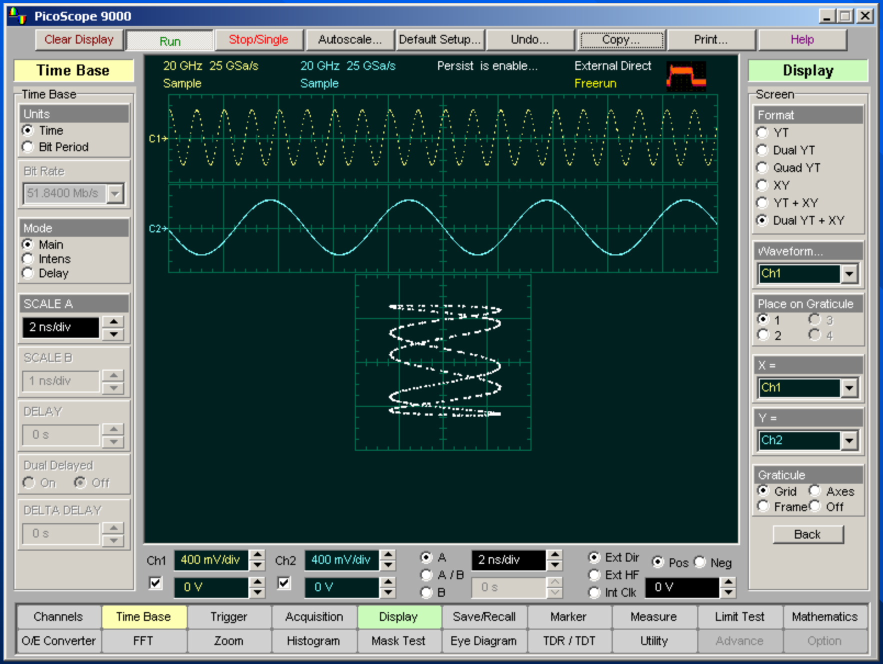
- **The Color Grading function uses the database in the size of the graticule area, which are *257 pixels* high by *501 pixels* wide. Behind each pixel is a *16-bit counter*. Each time a pixel is hit by data, the counter for that pixel is incremented. Each color used for the color grade mode represents a range of data counts. As the total count increases, the range of hits represented by each color also increases. The maximum count for each counter is *65 535.***

- **There are five colors used in the color-graded display. Each color shows the number of hits per pixel over the graticule area, and represents a range of counts, which depends on the total number of hits. As the total count increases, the range of hits represented by each color also increases. The colors can be changed form the Color Grade menu.**

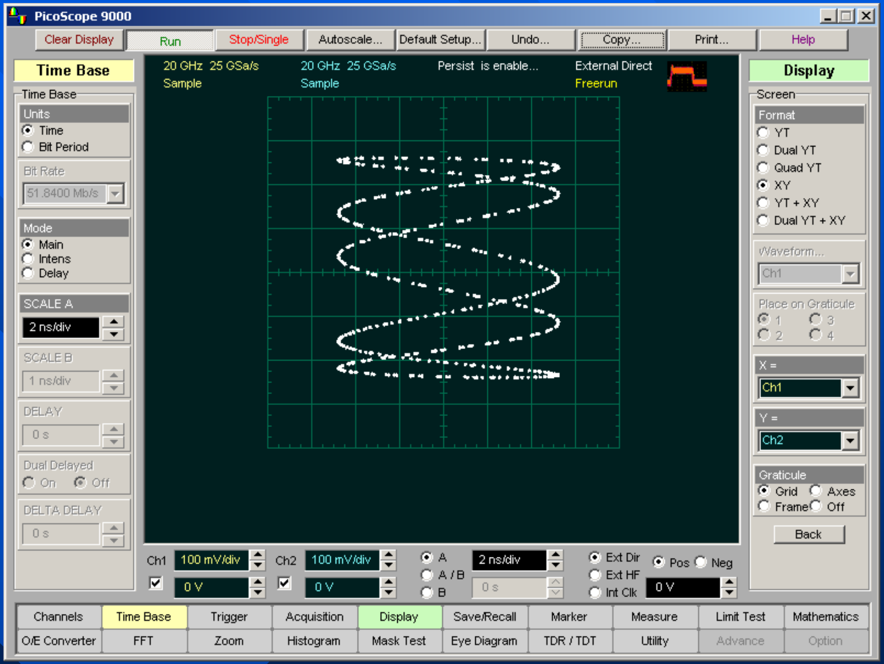
X-Y Display Format

Three Format menus determines how the instrument draws the waveforms:

- **The YT format is the normal time (on the horizontal axis) versus voltage (on the vertical axis).**
- **The XY format displays voltages of two waveforms against each other, and draws as the Source 1 versus Source 2 display of the two selected sources. Source 1's amplitude is plotted on the horizontal X axis and the Source 2's amplitude is plotted on the vertical Y axis**
- **The XY & YT format displays both YT and XY pictures. The YT format places on upper part of the screen, and XY format places on lower part of the screen.**



YT & XY Display Format



XY Display Format

You can use the XY format to:

- **Compare frequency and phase relationships between two signals.**
- **Display strain vs. displacement, flow versus pressure, volts versus current, or voltage versus frequency.**

Waveform Manipulation

Two features are available that can simplify your work with waveforms:

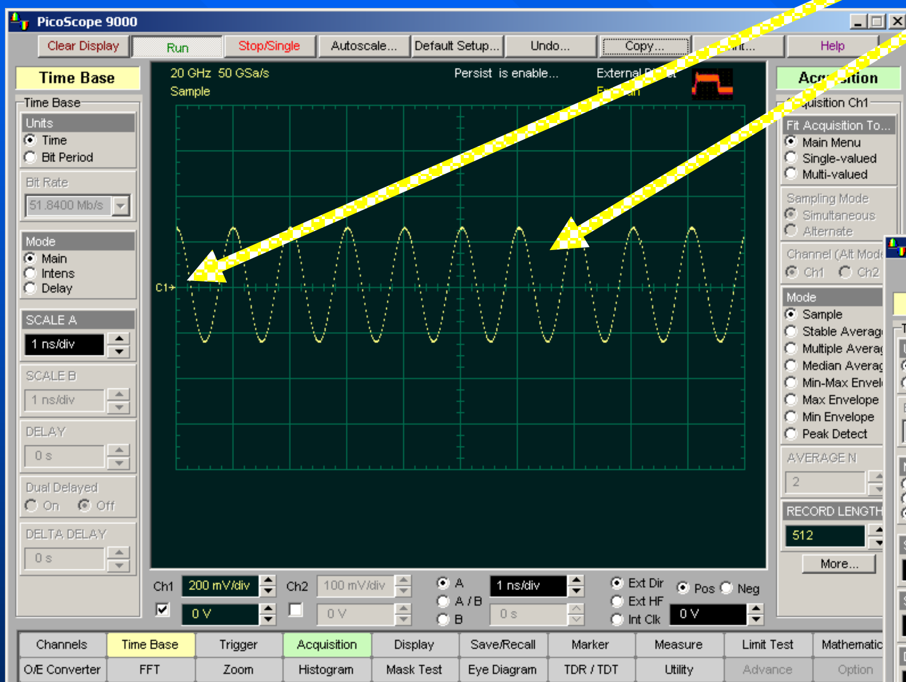
- **Direct Manipulation**
- **Zoom**

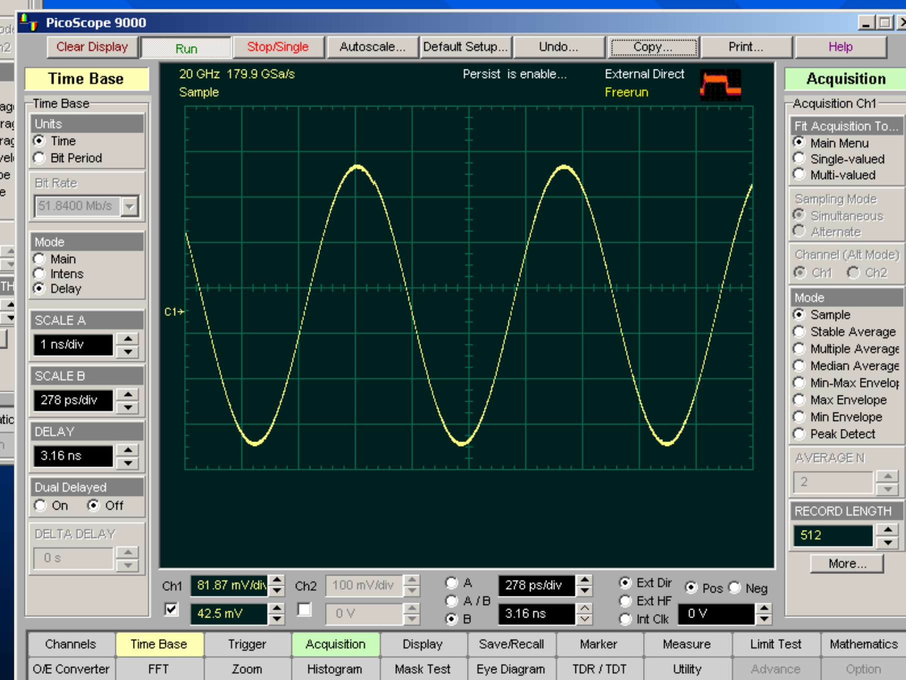
Direct Manipulation

Use the mouse to click and drag:

- **Ground Reference Indicator**
- **Waveform**

to new vertical positions, which changes the vertical offset, or to new horizontal positions, which changes the horizontal position or delay value.

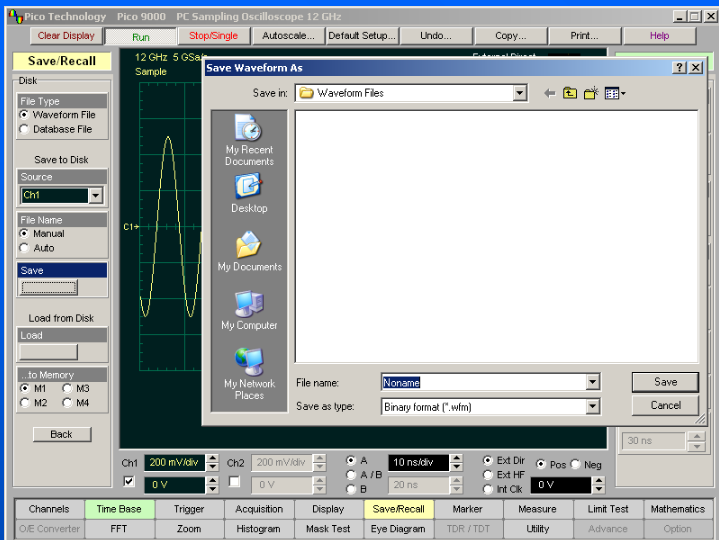




Zoom

- **Draw a box around the section of the waveform you want to expand**
- **Then click inside the box**

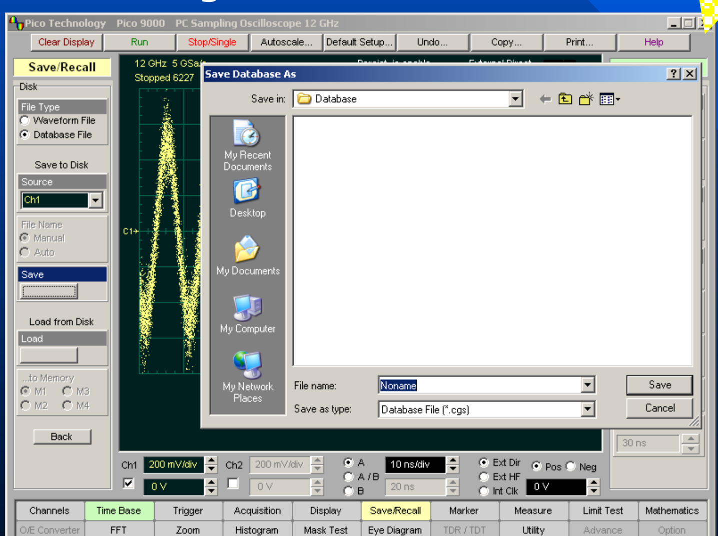
Familiar File Management



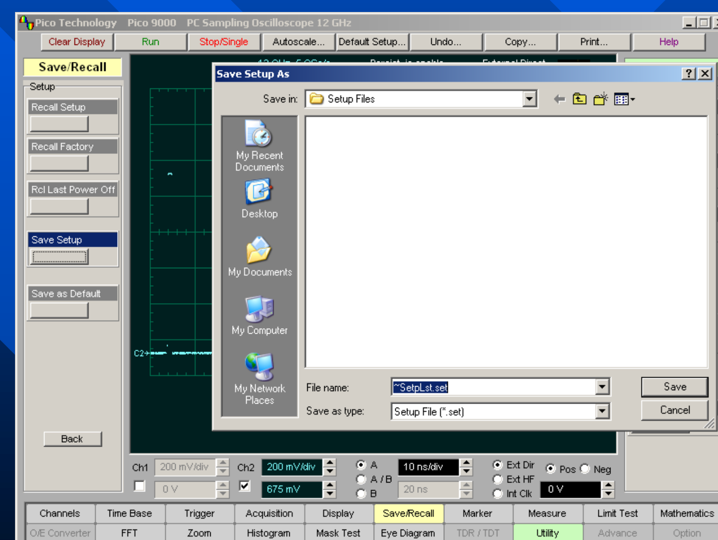
Saving into Waveform File

Standard Windows user interface allows you save and recall on PCs hard disks:

- **Waveforms in various formats**
- **Waveform Database**
- **Scope setups**
- **Screen images**



Recalling Waveform Database



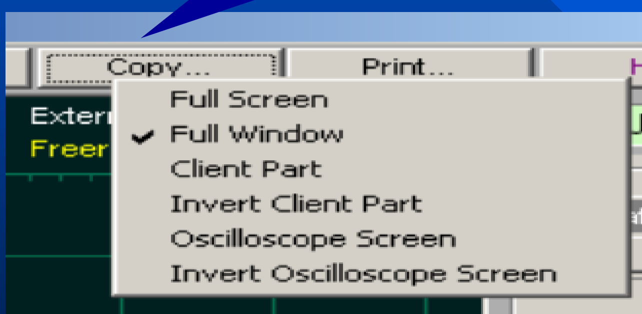
Recalling Setups

Copying a Waveform

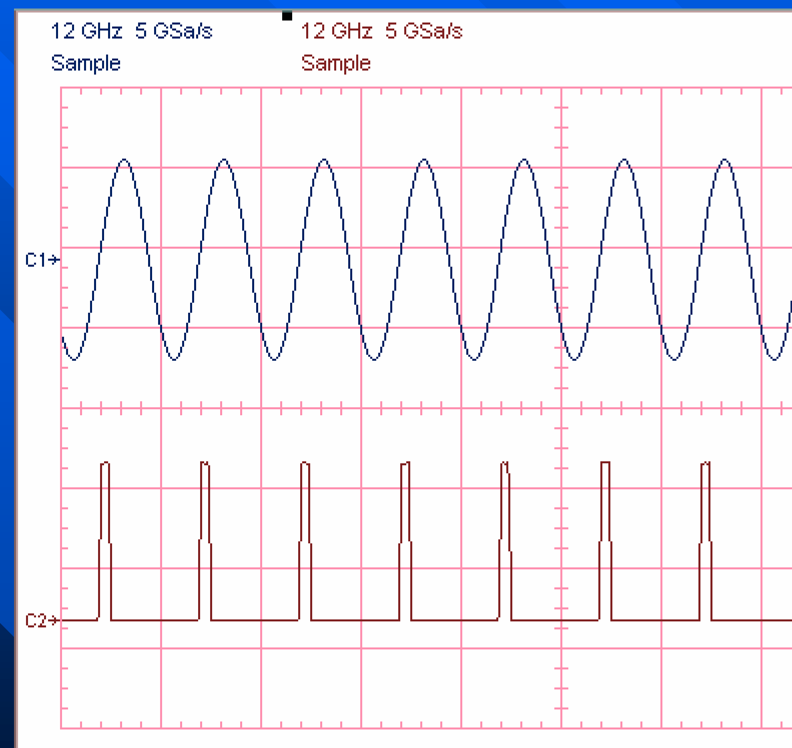
Clicking the Copy button copies the programming window into the Window Clipboard. You can paste copied information in such Windows programs as Word, Corel Draw, Paint Brash, and etc.

Use Copy function when preparing documentation based on usage of the PicoScope 9201.

Copy function includes four different options



PicoScope 9201 Copy function

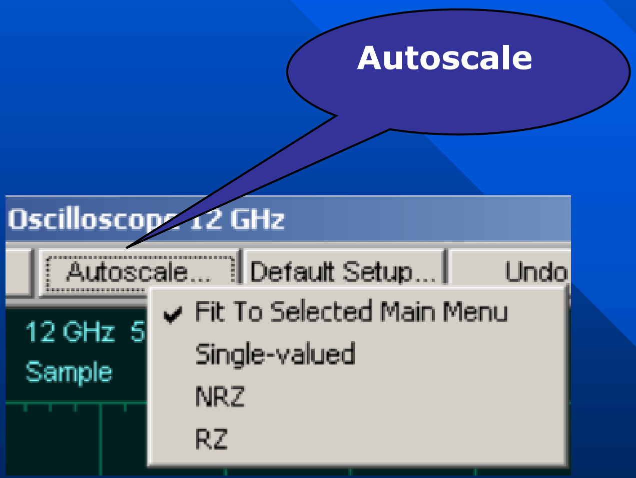


Screen image copied with Invert Oscilloscope Screen option

Autoscale

Get waveform on screen quickly with Autoscale button.

- **Autoscale function adjusts an oscilloscope to display a stable trace of usable size and amplitude. The Autoscale feature of the PicoScope 9201 can quickly give you a stable, meaningful trace display.**



The Austoscale button location

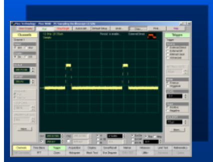
- **The Autoscale function can find repetitive signal with:**
  - **Frequency greater than *1 kHz*.**
  - **Duty cycle greater than *1 %.***
  - **Vertical amplitude greater than *50 mV p-p*.**
  - **Trigger amplitude greater than *200 mV p-p*.**

- **When you click the Autocale button, you tell the PicoScope 9201 to examine the signal and adjust the following controls for optimum display:**
  - **Vertical scale and offset.**
  - **Time base scale and delay.**
  - **Trigger level, if appropriate to that trigger source.**

Measurements and Tests

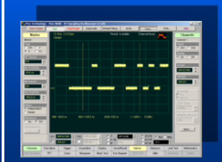
Types of Measurements

Graticule Measurements



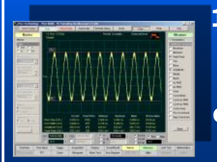
10 by 8 display graticule with **Grid, Axes, Frame and Off** options

Marker Measurements



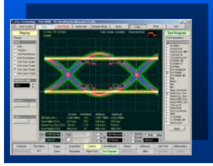
Two X, Y, or XY markers provide absolute, delta or ratiometric measurements

Pulse Measurements



19 ***Amplitude***, 29 ***Timing*** and 5 ***FFT Measurements*** can be performed automatically

NRZ Eye Measurements

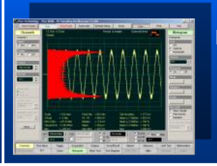


Measurement list includes 42 NRZ eye parameters

RZ Eye Measurements

43 automatic measurements are built for characterization of RZ signals

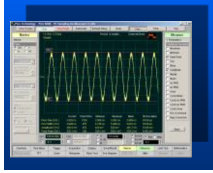
Histogram Measurements



Up to 15 statistic measurements of vertical and horizontal histogram

Types of Measurement Test

Limit Test



Allows you to automatically compare up to 4 measurement results with pass or fail limits

Mask Test

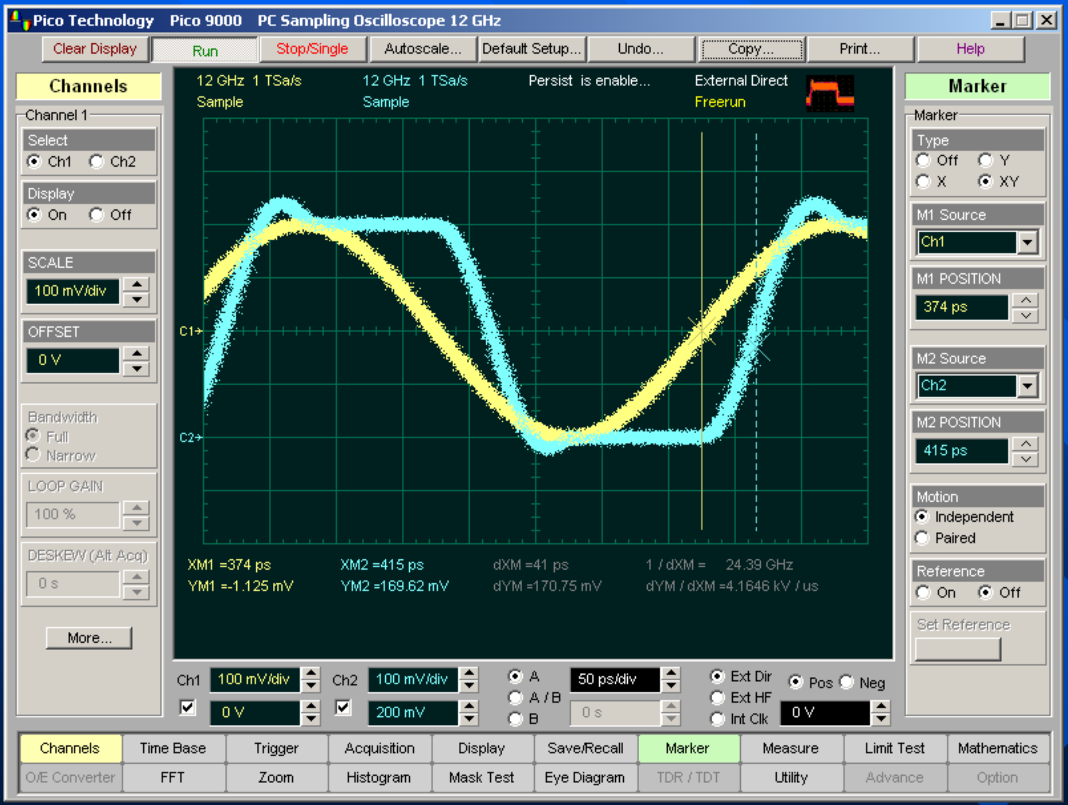
Standard, auto- or custom mask can be used for mask test

Mask Margin Test

Test is used to determine the margin of compliance for a standard or scaled mask

Marker Customize Measurements

Markers are movable lines on the display that provide Customize Measurements. You set marker's value by positioning them on the display. Their actual value, however, comes from internal data. This makes marker measurements more precise than graticules.



Markers measure timing shift of ***2.5-GHz*** signals with ***1-ps*** resolution

Marker Measurements:

- Absolute vertical (voltage)
- Ratiometric vertical (voltage)
- Absolute horizontal (timing)
- Ratiometric horizontal (timing)

Best Marker Resolution:

- Voltage: ***50 uV***
- Time Interval: ***0.2 ps***

Automatic Measurements

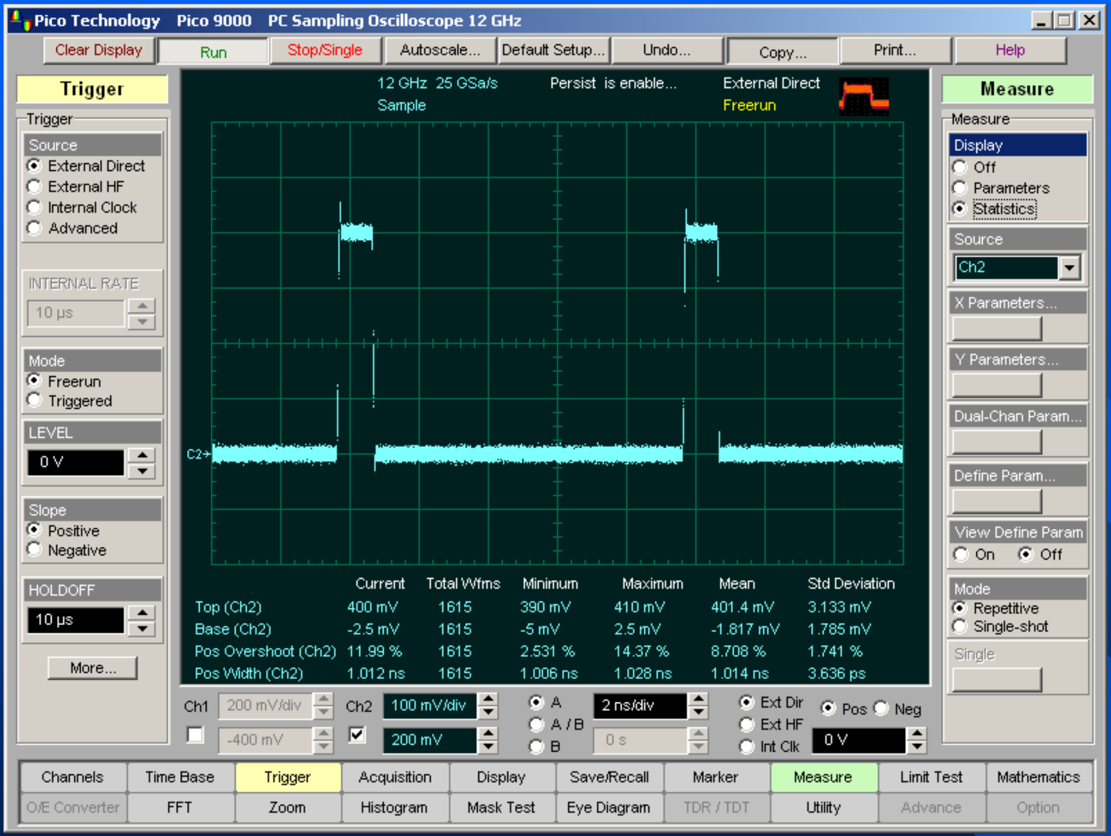
The PicoScope 9201 provides accurate Automatic Measurements. They make the measurement process fast and easy, while reducing human errors, particularly essential for repetitive test. All measurements conform to the *IEEE standards*. Measurements cover *Voltage*, *Timing* and *FFT*.

- **19 *Amplitude Measurements* are made on vertical parameters. They typically mean voltage. They are: ● *Maximum*, ● *Minimum*, ● *Peak-Peak*, ● *Top*, ● *Base*, ● *Amplitude*, ● *Middle*, ● *Mean*, ● *dc RMS*, ● *ac RMS*, ● *Area*, ● *Cycle Middle*, ● *Cycle Mean*, ● *Cycle dc RMS*, ● *Cycle ac RMS*, ● *Cycle Area*, ● *Pos. Overshoot*, ● *Neg. Overshoot*, ● *Gain*.**
- **29 *Timing Measurements* are made on horizontal parameters. They typically mean seconds or hertz. Main of them are: ● *Period*, ● *Frequency*, ● *Pos. Width*, ● *Neg.Width*, ● *Rise Time*, ● *Fall Time*, ● *Pos.Duty Cycle*, ● *Neg. Duty Cycle*, ● *Pos Crossing*, ● *Neg Crossing*, ● *Burst Width*, ● *Cycles*, ● *Time@Maximum*, ● *Time@Minimum*, ● *Delay*.**
- **5 *FFT Measurements* are made on both vertical and horizontal parameters. They typically mean volts and hertz. They are: ● *FFT Magnitude*, ● *FFT Delta Magnitude*, ● *THD*, ● *FFT Frequency*, ● *FFT Delta Frequency*.**

The PicoScope 9201 measures up to 10 parameters simultaneously on 8 sources with maximum time resolution of *0.2 ps* and *2%* vertical accuracy

Statistics Measurements

The PicoScope 9201 measures up to 4 statistics parameters simultaneously



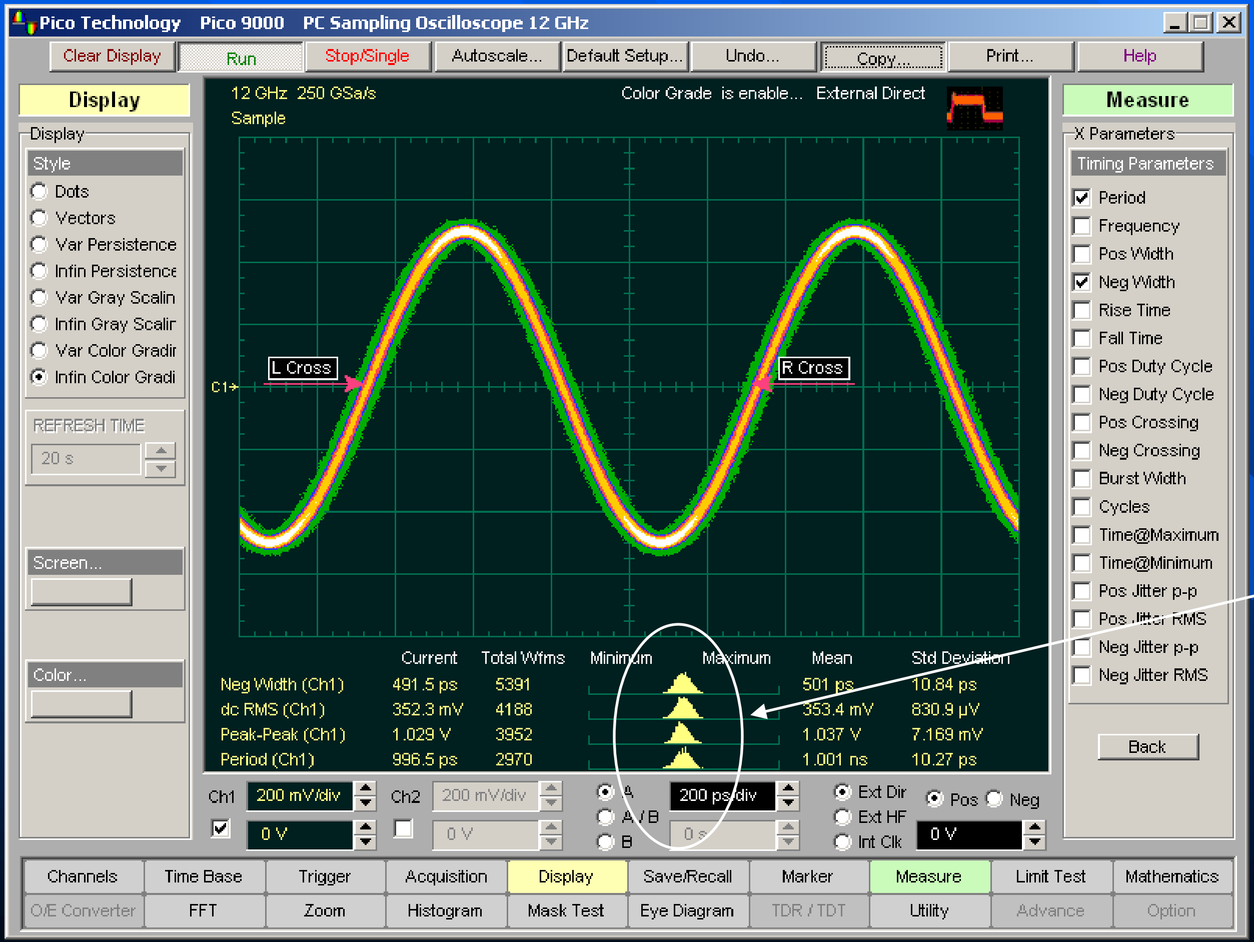
Simultaneous statistics measurements of Top, Base, Positive Overshoot and Positive Width of a pulse signal.

- **The Statistics function calculates the following values of the automatic measurement results:**
  - **Minimum**
  - **Maximum**
  - **Mean**
  - **Standard Deviation**
  - **Current Value**
  - **Amount of measurements**
- **Minimum and maximum are the absolute extremes of the automatic measurements.**
- **Mean and standard deviation calculates the mean and standard deviation of the automatic measurement results.**
- **Mean is the statistical average of all results for a particular measurement.**
- **Standard deviation measures the dispersion of those measurement results.**

Histicons

Histicons are miniature histograms of parameter measurements that appear in Measurement Area. These thumbnail histograms let you see at a glance the statistical distribution of each parameter.

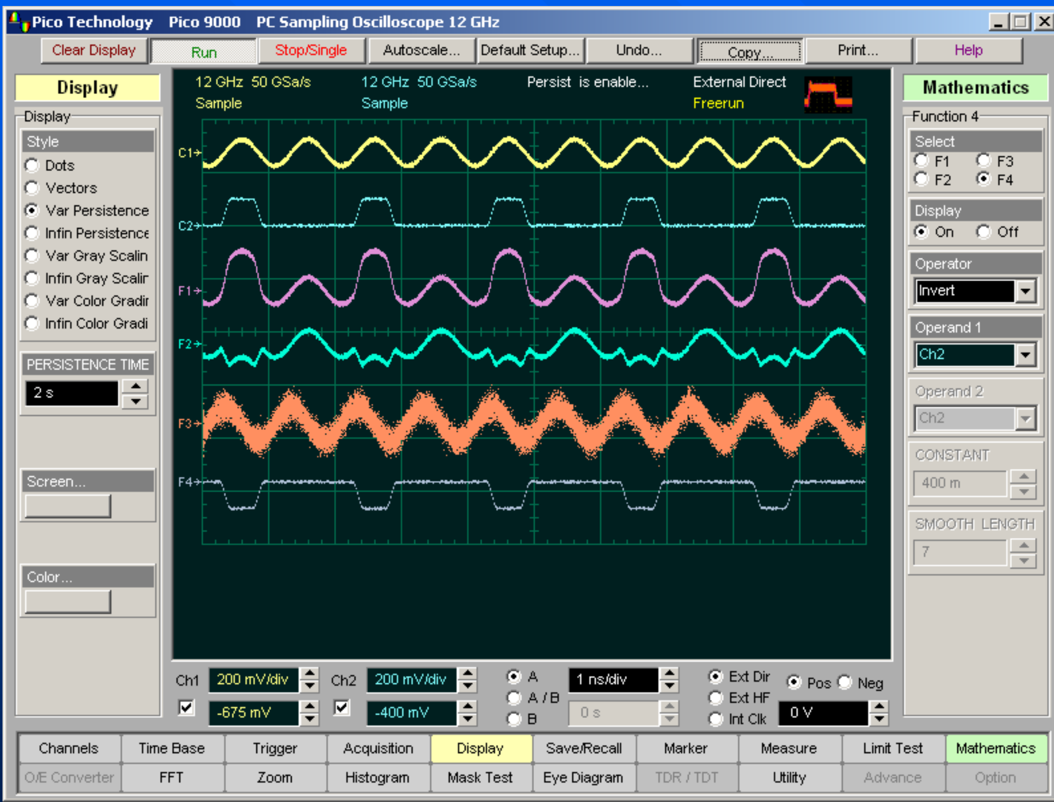
- **Histicons** provide a fast, dynamic view of parameters and wave shape characteristics.



Four **Histicons** correspond to each of statistics measurement

Mathematics

The PicoScope 9201 supports up to four simultaneous mathematical combination and functional transformation of waveforms that is acquires.



An examples of PicoScope 9201 Math Functions.
F1=Ch1+Ch2 F2=Ch1-Ch2
F3=Diff(Ch1) F4=Inv(Ch2)

Source (operand) waveform (Ch1) **Math function (operator, Divide)** **Math function (waveform F1)**

Functional transformation of an acquired waveform

You can select any of the math functions as a math operator to act on the operand or operands. A waveform math operator is a math function that requires either one or two sources.

The operators that involve two waveform sources are: ● *Add*, ● *Subtract*, ● *Multiply*, and ● *Divide*.

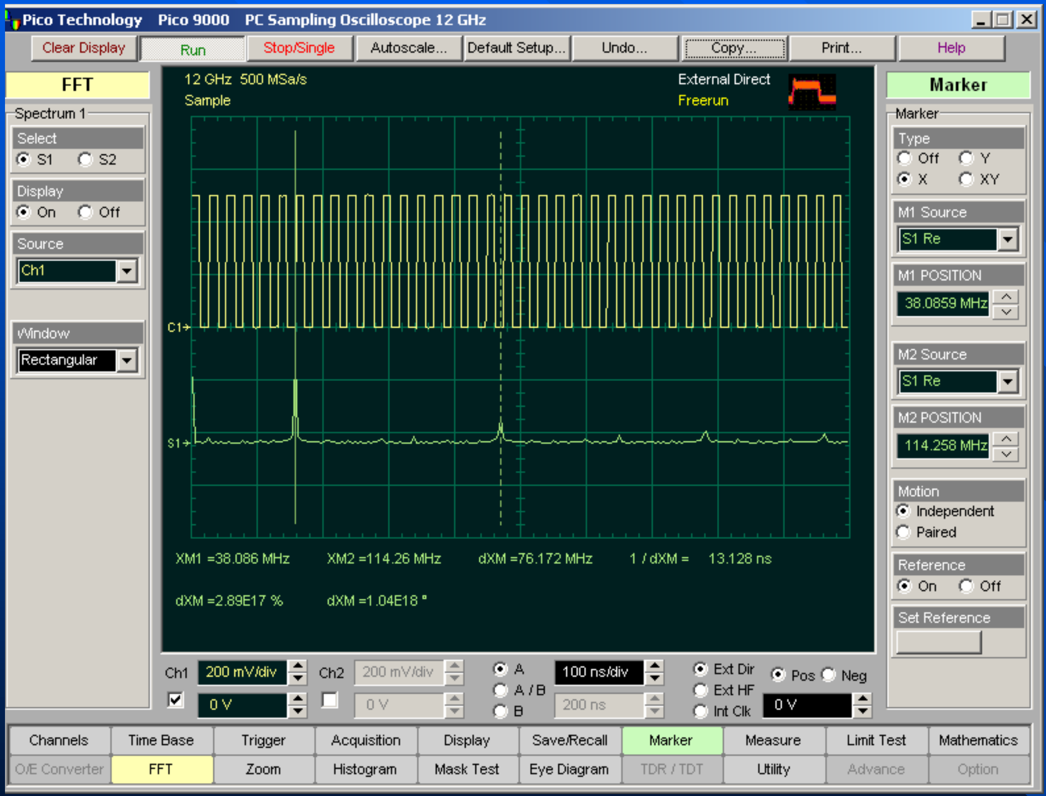
The operators that involve one waveform source are: ● *Invert*, ● *Absolute*, ● *Exponent (e)*, ● *Exponent (10)*, ● *Logarithm (e)*, ● *Logarithm (10)*, ● *Differentiate*, ● *Integrate*, ● *Inverse FFT*, ● *Linear Interpolation*, ● *Smoothing*, ● *Trend* and ● *Sin(x)/x Interpolation*.

Fast Fourier Transform

The math option of the PicoScope 9201 includes FFT capabilities for examine the harmonic content of high-frequency signals. You can perform FFT on any waveform. The record length of the waveform can be up to maximum *4096 points*.

Use the FFT function to:

- **Find cross-talk problems.**
- **Find distortion problems in analogue waveforms caused by non-linear amplifiers.**
- **Adjust filter circuits designed to filter out certain harmonics in a waveform.**



To compensates some of the limitations of FFT analysis You can use windowing. The window type defines the bandwidth and shape of the equivalent filter associated with the FFT processing.

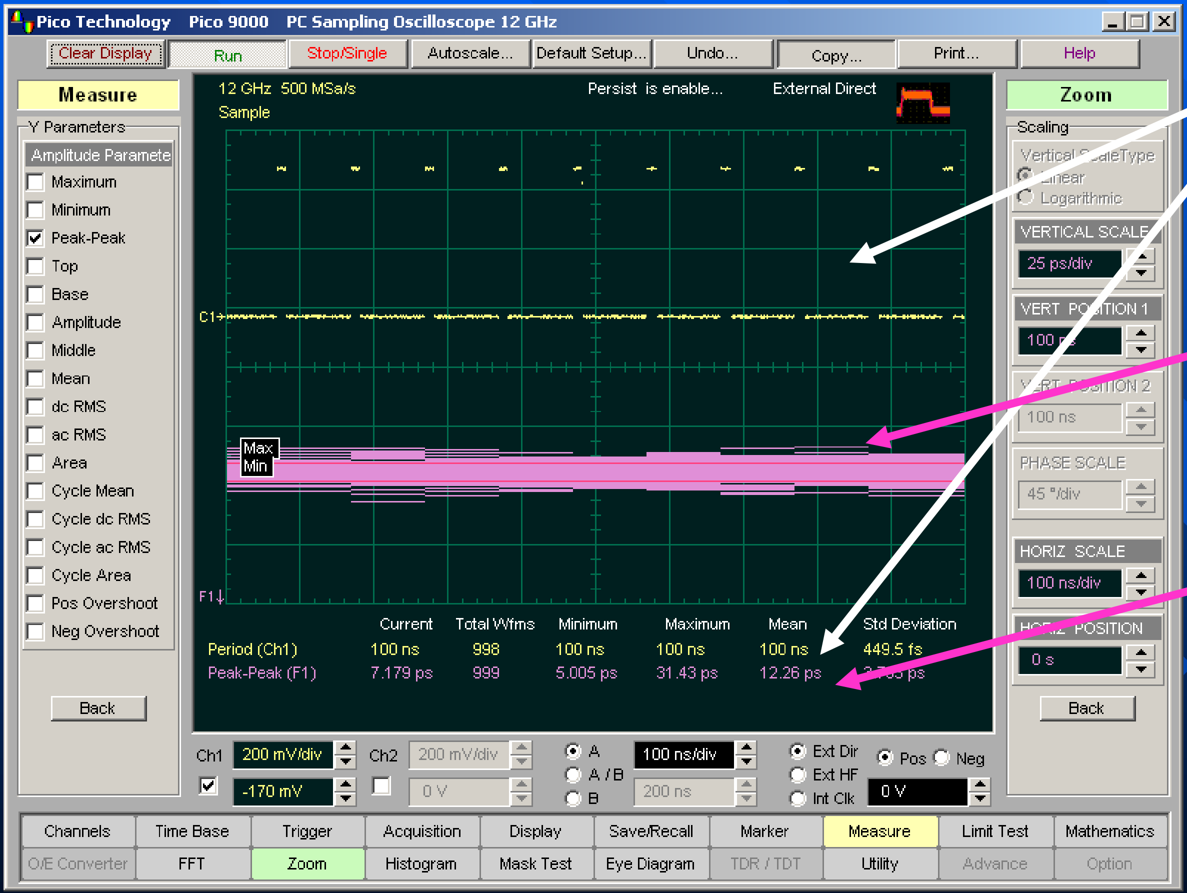
The PicoScope 9201 supports six types of windows:

- **Rectangular FFT window, which does not taper the time domain data,**
- **Five tapering FFT windows of different shapes –**
  - **Hamming window**
  - **Hanning window**
  - **Flattop window**
  - **Blackman-Harris window**
  - **Kaiser-Bessel window**

FFT analysis provides an extra dimension of performance with simultaneous displays in the time and frequency domain. Picture shows an example of FFT made with *38-MHz* pulse with near *50 %* duty cycle.

Trend Function

Trend is a math function that represents the evolution of timing parameters in line graphs whose vertical axes are the value of the parameter, and horizontal axes the order in which the values were acquired.



- The **PicoScope 9201** makes period measurement of pulses
- Trend of period measurement is displayed as a math function
- Amplitude measurement of trend function gives evolution of period value

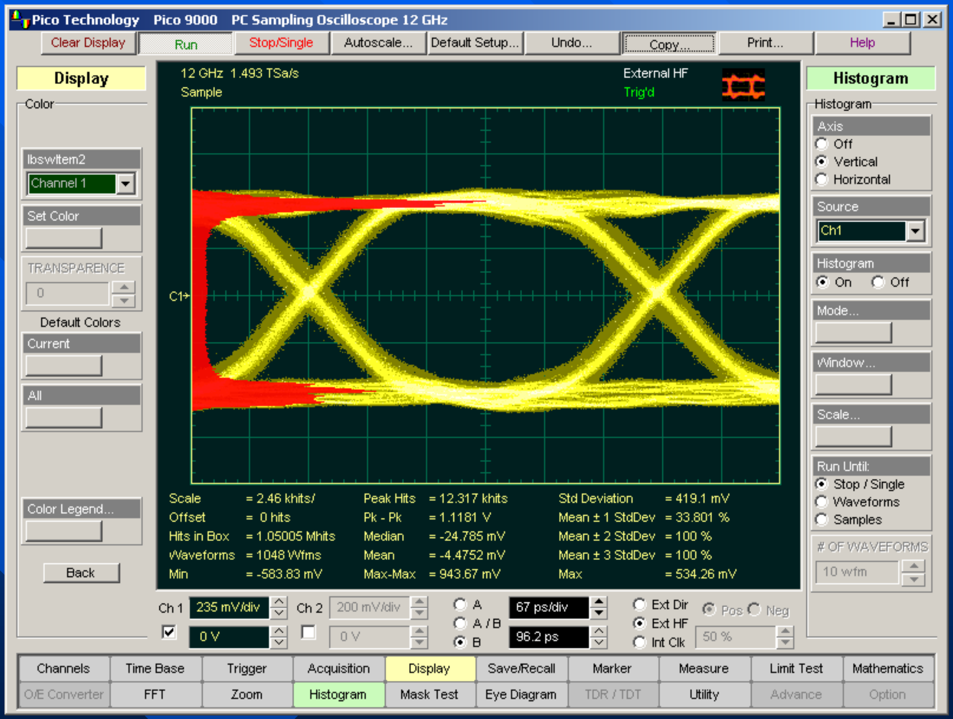
Vertical Histogram

A **histogram** is a probability distribution that shows the distribution of acquired data from a source within a user-definable histogram window.

The information gathered by the histogram is used to perform statistical analysis on the source. The most common use for vertical histogram is measuring and characterizing noise on displayed waveforms.

The list of histogram statistics:

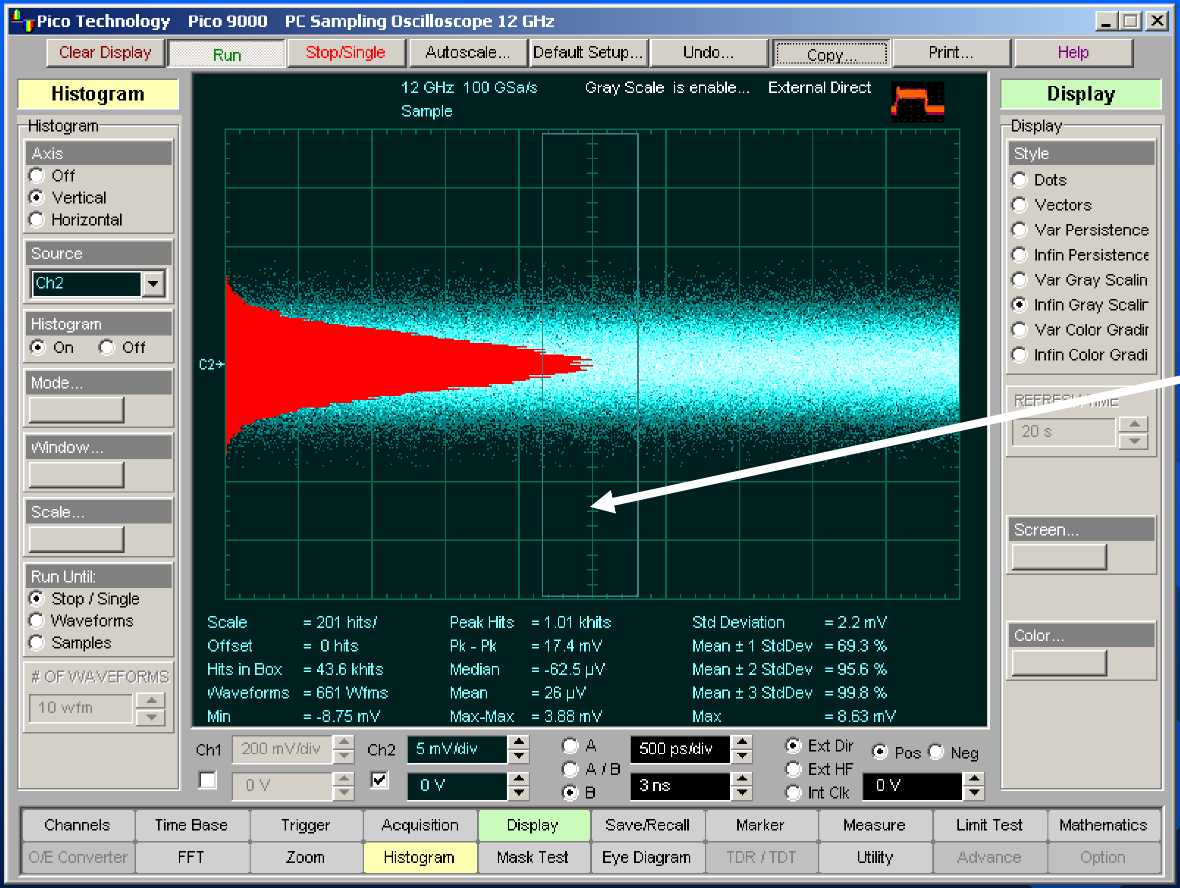
- **Scale** lists the display scale in hits per division or dB per division.
- **Offset** lists the offset in hits or dB. Offset is the number of hits or dB at the bottom of the display, as opposed to the center of the display.
- **Hits in Box**-The total number of samples included in the histogram box.
- **Waveforms** - Displays the number of waveforms that have contributed to the histogram.
- **Peak Hits** - The number of hits in the histogram's greatest peak.
- **Pk – Pk** - The width of histogram.
- **Median** - 50 % of the histogram samples are above the median and 50% are below the median.
- **Mean - Mean** is the average value of all the points in the histogram.
- **StdDev** - The Standard deviation (σ) value of the histogram.
- **$\mu \pm 1$ StdDev, $\mu \pm 2$ StdDev, $\mu \pm 3$ StdDev** - The percentage of points that are within $\pm 1\sigma$, $\pm 2\sigma$, or $\pm 3\sigma$ of the mean value.



An example of **Vertical Histogram Measurement**

Statistical Analysis of Noise

Vertical Histogram is the most common use for measuring and characterizing noise on displayed waveforms.



Sizing the histogram window to a narrow portion of time and observing a vertical histogram that measures the noise on an edge measure noise.

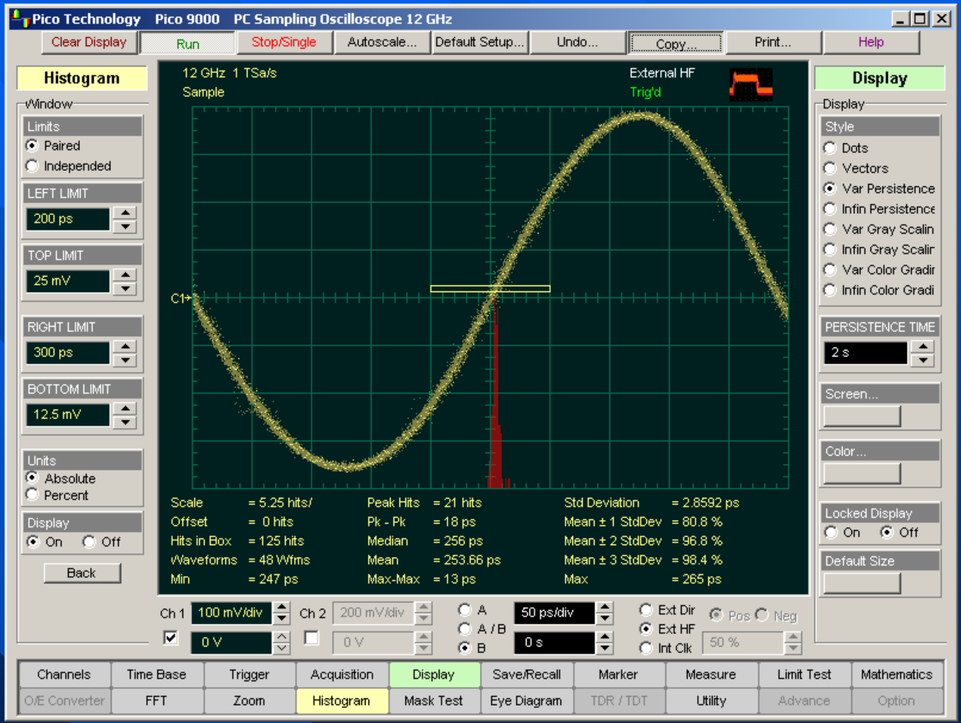
Picture shows PicoScope 9201 noise level measurement with **Vertical Histogram**.

Horizontal Histogram

A **histogram** is a probability distribution that shows the distribution of acquired data from a source within a user-definable histogram window. The information gathered by the histogram is used to perform statistical analysis on the source. The most common use for horizontal histogram is measuring and characterizing jitter on displayed waveforms

The list of histogram statistics:

- **Scale** lists the display scale in hits per division or dB per division.
- **Offset** lists the offset in hits or dB. Offset is the number of hits or dB at the bottom of the display, as opposed to the center of the display.
- **Hits in Box**-The total number of samples included in the histogram box.
- **Waveforms** - Displays the number of waveforms that have contributed to the histogram.
- **Peak Hits** - The number of hits in the histogram's greatest peak.
- **Pk – Pk** - The width of histogram.
- **Median** - 50 % of the histogram samples are above the median and 50% are below the median.
- **Mean - Mean** is the average value of all the points in the histogram.
- **StdDev** - The Standard deviation (σ) value of the histogram.
- **$\mu \pm 1$ StdDev, $\mu \pm 2$ StdDev, $\mu \pm 3$ StdDev** - The percentage of points that are within $\pm 1\sigma$, $\pm 2\sigma$, or $\pm 3\sigma$ of the mean value.



An example of **Jitter Measurement** with **Horizontal Histogram**

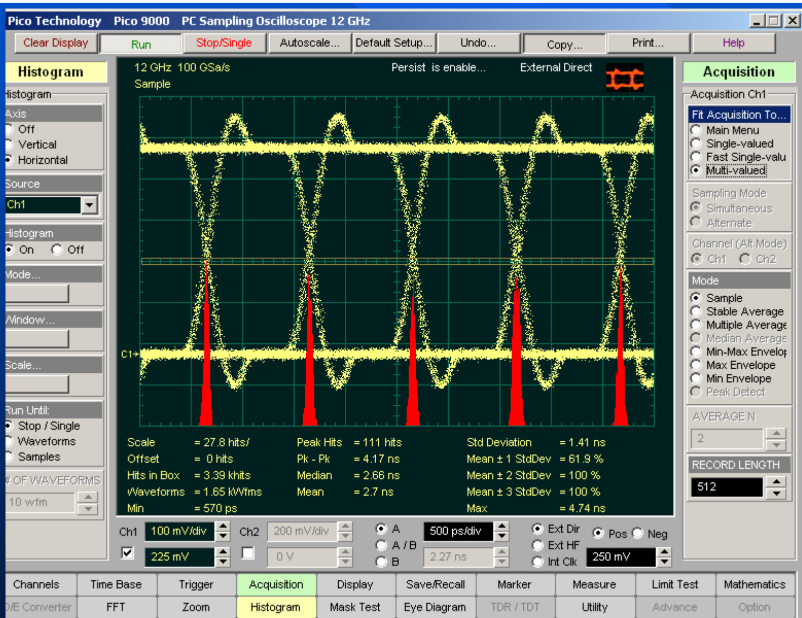
Jitter Mesurements

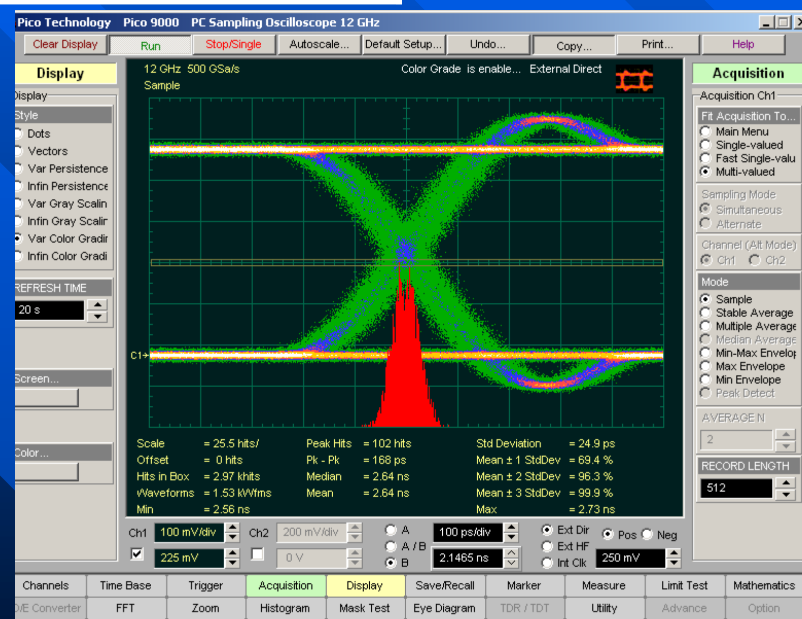
Among other things Jitter is caused by:

Thermal noise	▶ Random and ever changing, always Gaussian
Upstream reference clocks	▶ From power supplies and oscillators, with harmonic content
Injected noise (EMI/RFI)	▶ Cabling or wiring, from distance sources
Circuit instabilities	▶ Loop bandwidth, dead-band oscillations

Types of Jitter:

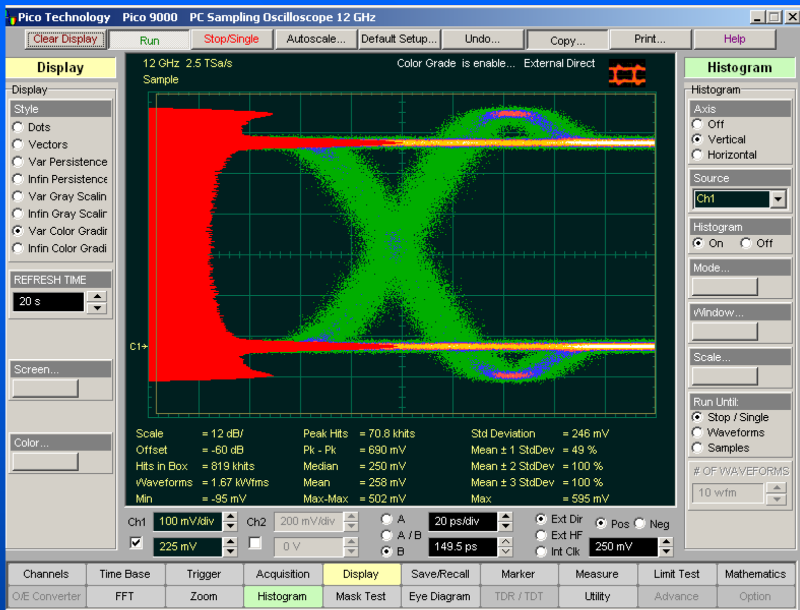
- Period Jitter
- Cycle-to-Cycle Jitter
- Delay Jitter
- Time Interval Error
- Clock Jitter
- Data Jitter



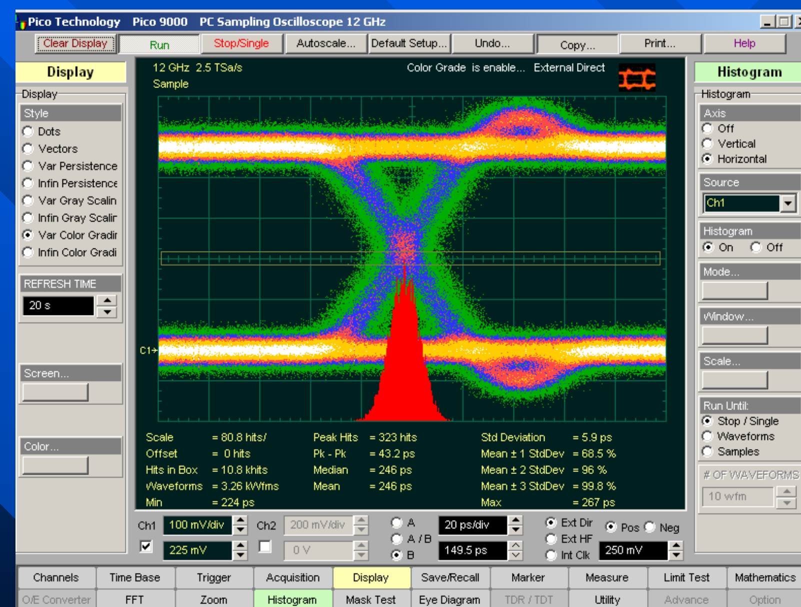


Eye-Crossing Jitter can be quantified with horizontal histogram.
Two examples of **NRZ Eye Pattern** with jitter histogram

Histogram Measurements of Eye Diagrams

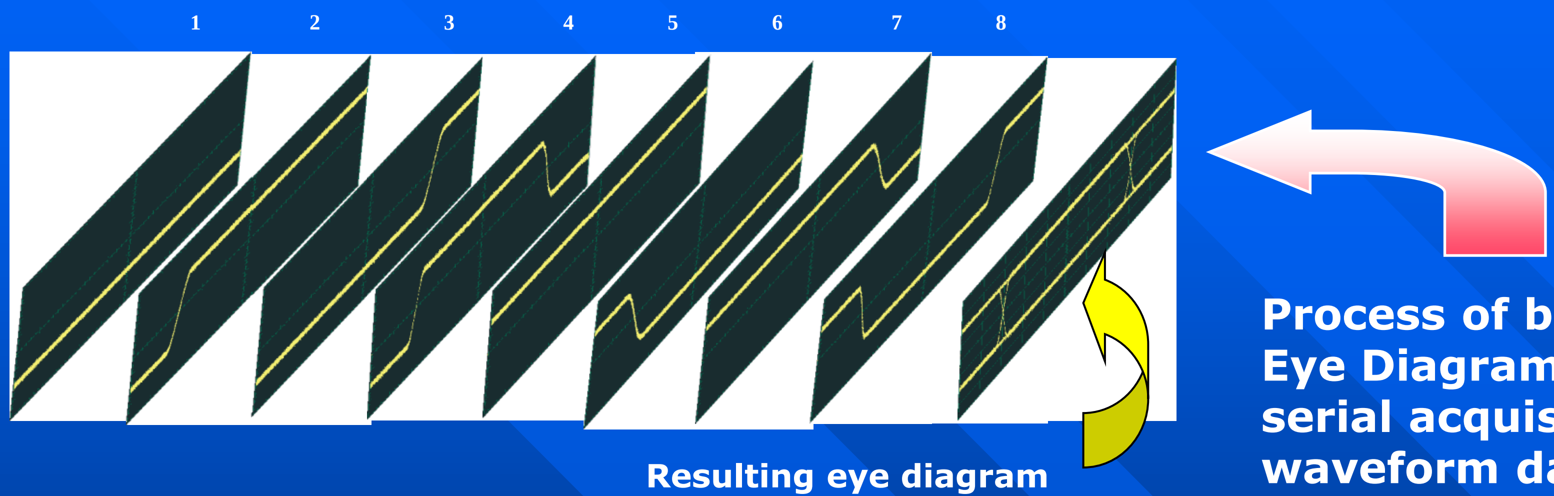


The left picture demonstrates how the PicoScope 9201 quickly measures all parameters of vertical histogram for *5-Gbit* Eye Diagram



The right picture demonstrates how the PicoScope 9201 quickly measures all parameters of horizontal histogram for *12-Gbit* Eye Diagram

Building Eye Diagram

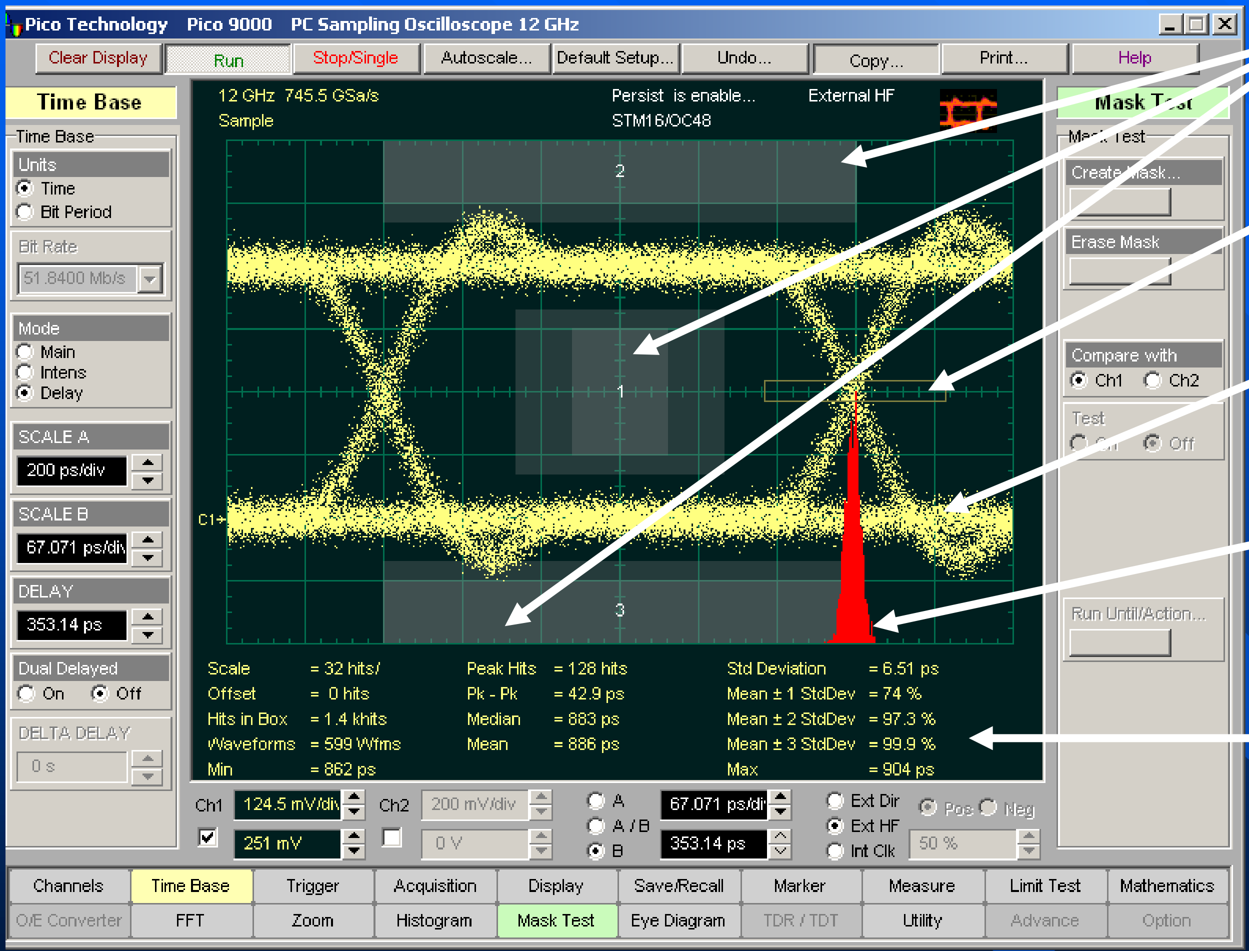


Process of building Eye Diagram includes serial acquisitions of waveform data base

- **Eye Diagram** is valuable because of comprehensive view of all signal integrity faults(except clock jitter):
  - Noise
  - Jitter
  - Reflections
  - Ringing
  - Inter-symbol interference
  - Power and ground coupling

- **Eye Diagram Problems with Sequential Sampling Oscilloscope:**
  - It is not possible to resolve pattern dependencies
  - Averaging is not available
  - Input Dynamic Range is ±350 mV
  - Random Noise and pattern dependent, deterministic errors mask each other

A typical PicoScope 9201 Eye Diagram with Mask, Margins and Histogram



Customizeable Mask with Margins

Histogram window

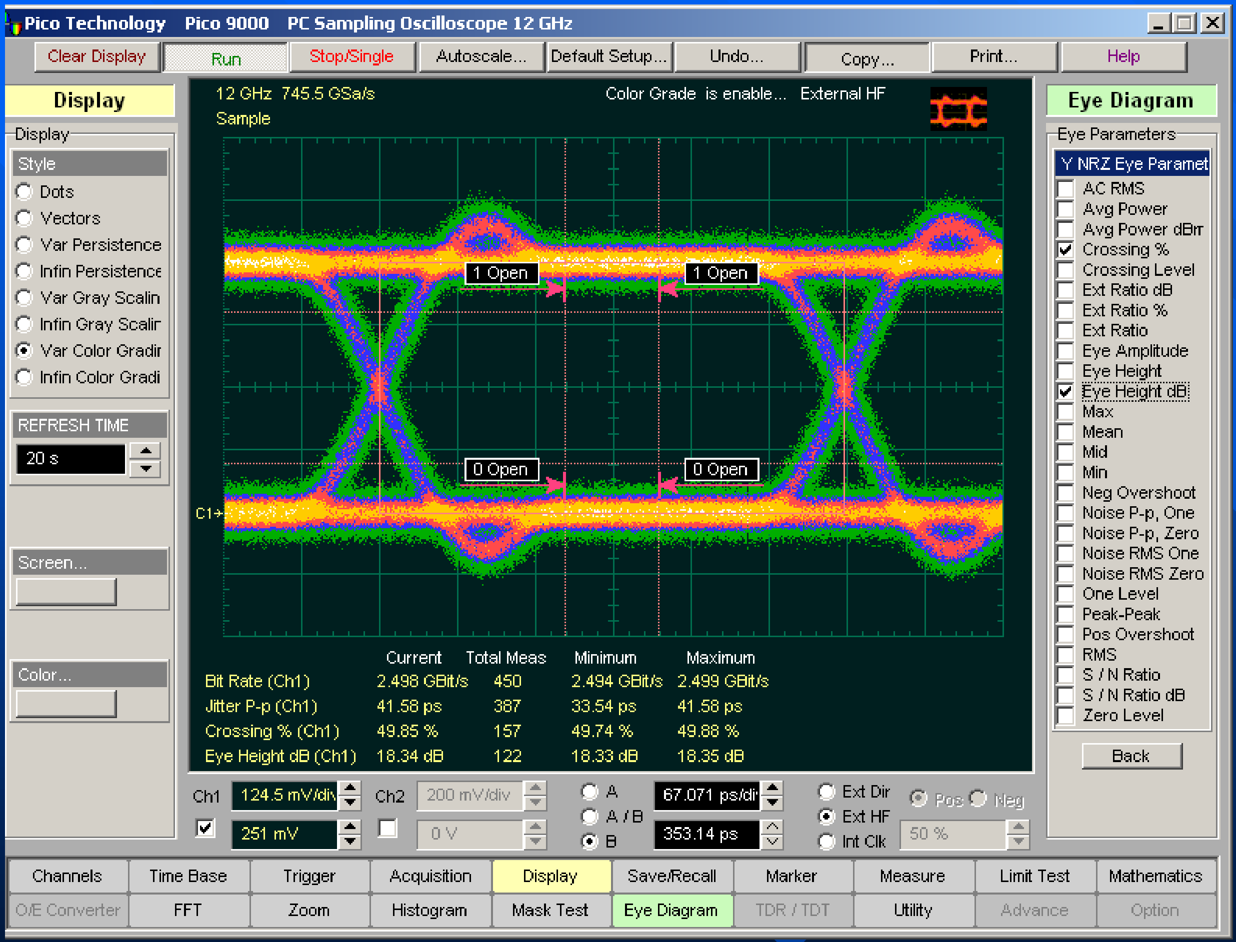
***2.5-Gb/s* Eye Diagram**

Using Histogram on the eye crossing to characterize jitter

Histogram measurement results

NRZ Eye Diagram Measurements

The PicoScope 9201 quickly measures 42 fundamental parameters used to characterize non-return-to-zero (NRZ) signals. Up to four parameters can be measured simultaneously.



A picture demonstrates of how the PicoScope 9201 measures four *2.5-Gbit* NRZ eye-diagram.

Examples of NRZ Measurements

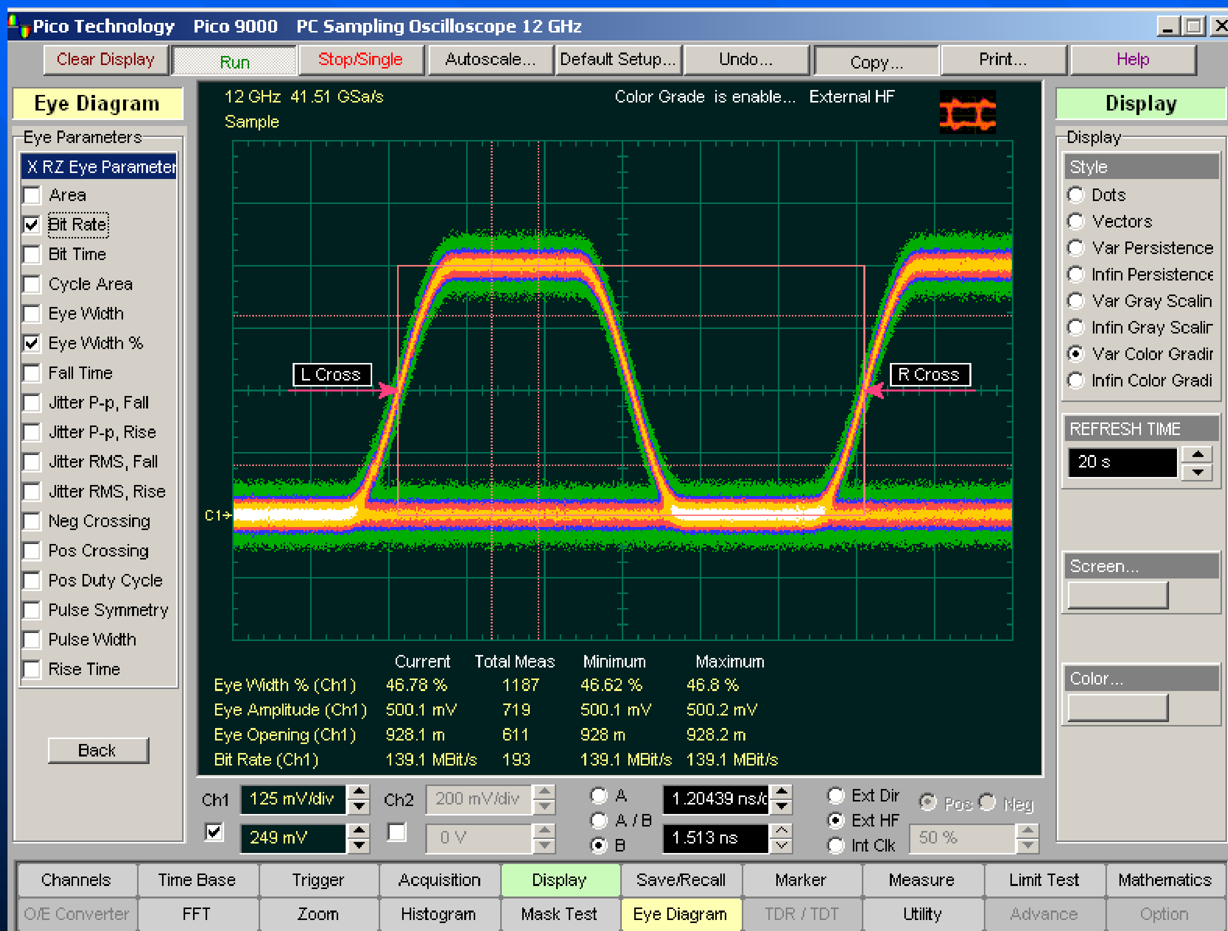
Measurements of ***622-Mbit*** Eye Diagram

Measurements of ***1.25-Gbit*** Eye Diagram

Measurement of ***2.5-Gbit*** Eye Diagram

RZ Eye-Diagram Analysis

The PicoScope 9201 quickly measures 43 fundamental parameters used to characterize an return-to-zero (RZ) signals. Up to four parameters can be measured simultaneously.



The PicoScope 9201 measures *139-Mbit* RZ eye-diagram

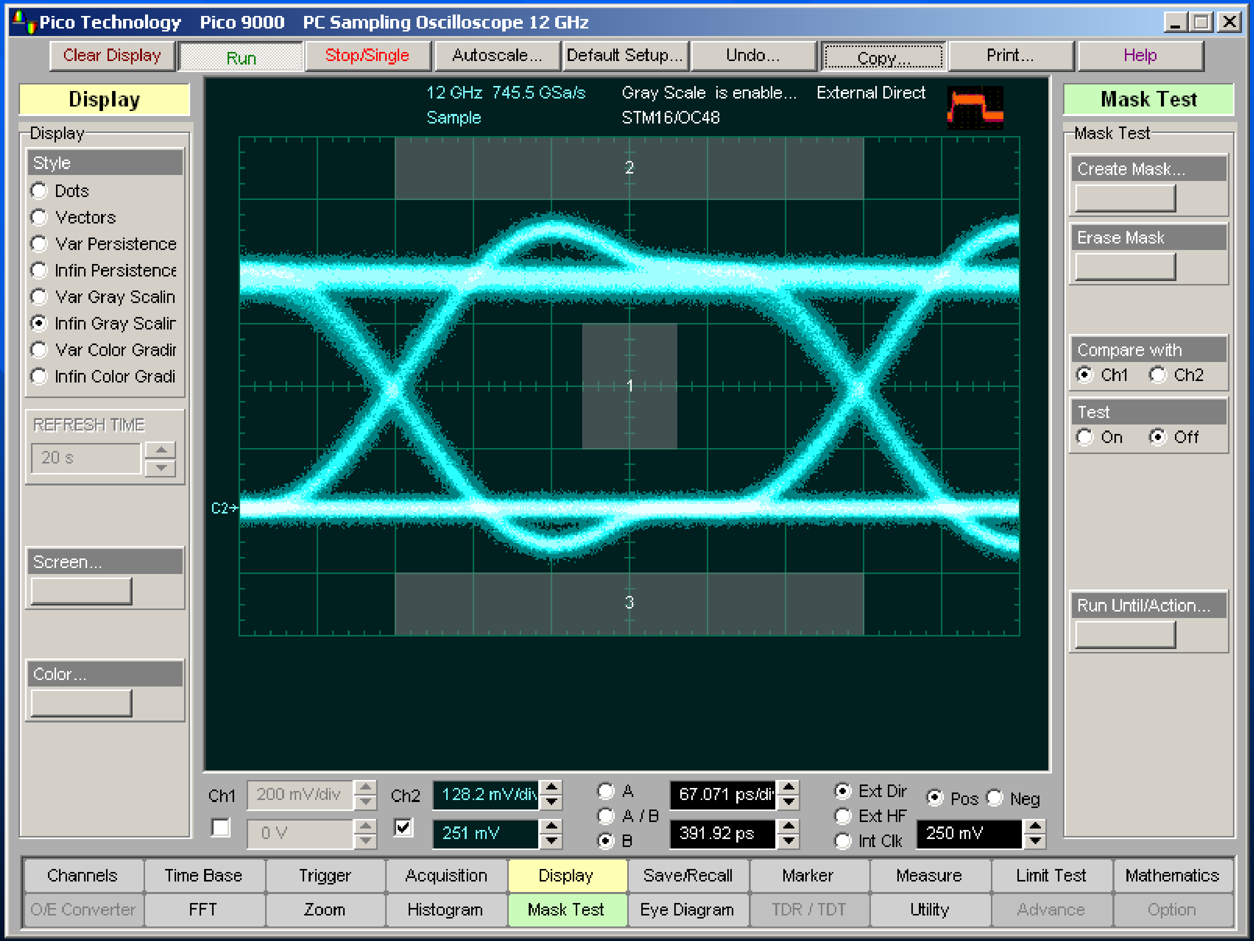
Mask Test

For eye-diagram masks, such as those specified by the SONET and SDH standards, the PicoScope 9201 supports on-board mask drawing for visual comparison. The display can create gray scaled or color-graded display to aid in analyzing noise and jitter in eye-diagrams.

Mask Test quickly characterizes:

- **Noise**
- **Jitter**
- **Aberrations**
- **Rise Time**
- **Fall Time**

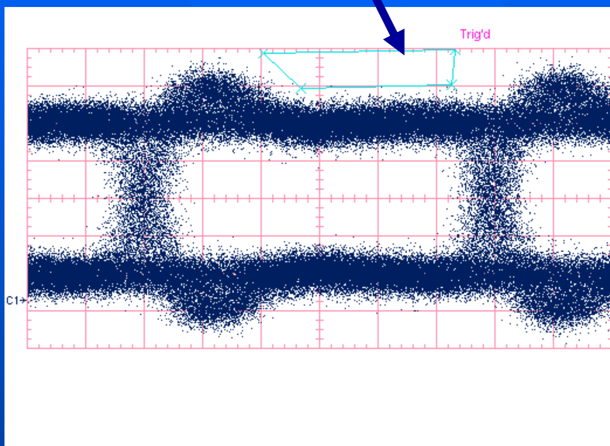
On-board mask drawing capability allows simple, operator-independent visual comparison of signal to standard mask.
Picture demonstrates a SONET/SDH (OC64/STM16) signal compared with the standard mask, showing a compliant waveform.



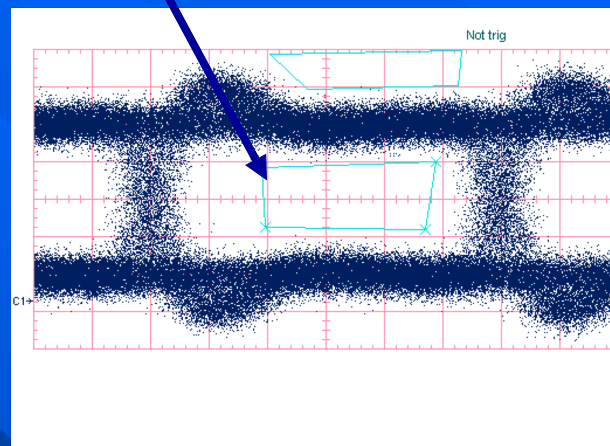
Creating Custom Mask

Five pictures below demonstrate how PicoScope 9201 builds Custom Mask for NRZ waveform

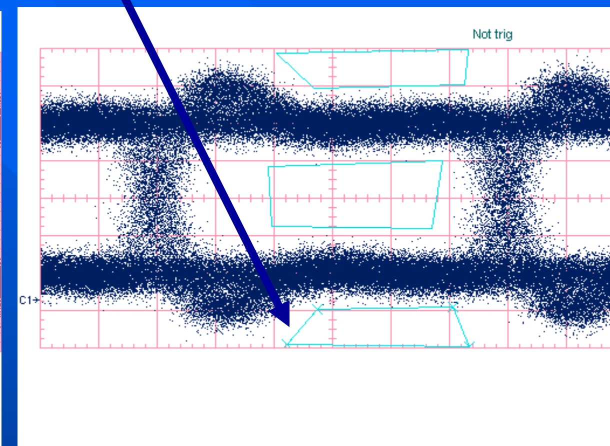
1. Create the top Polygon of the Mask

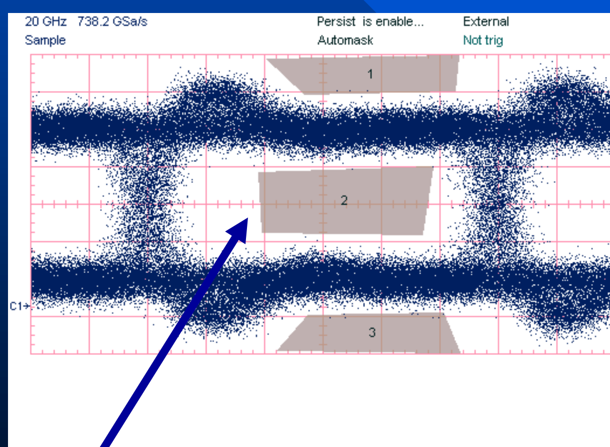


2. Create the center Polygon of the Mask

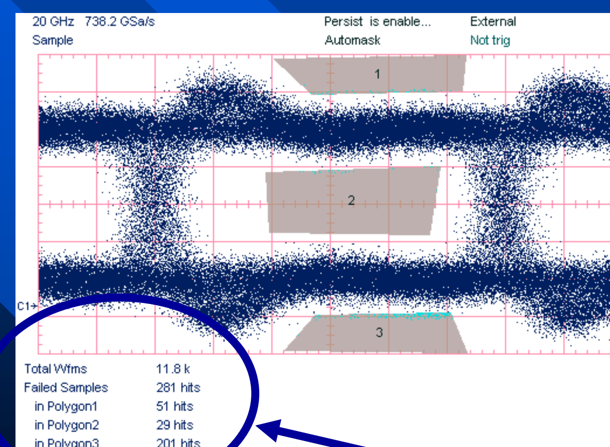


3. Create the bottom Polygon of the Mask





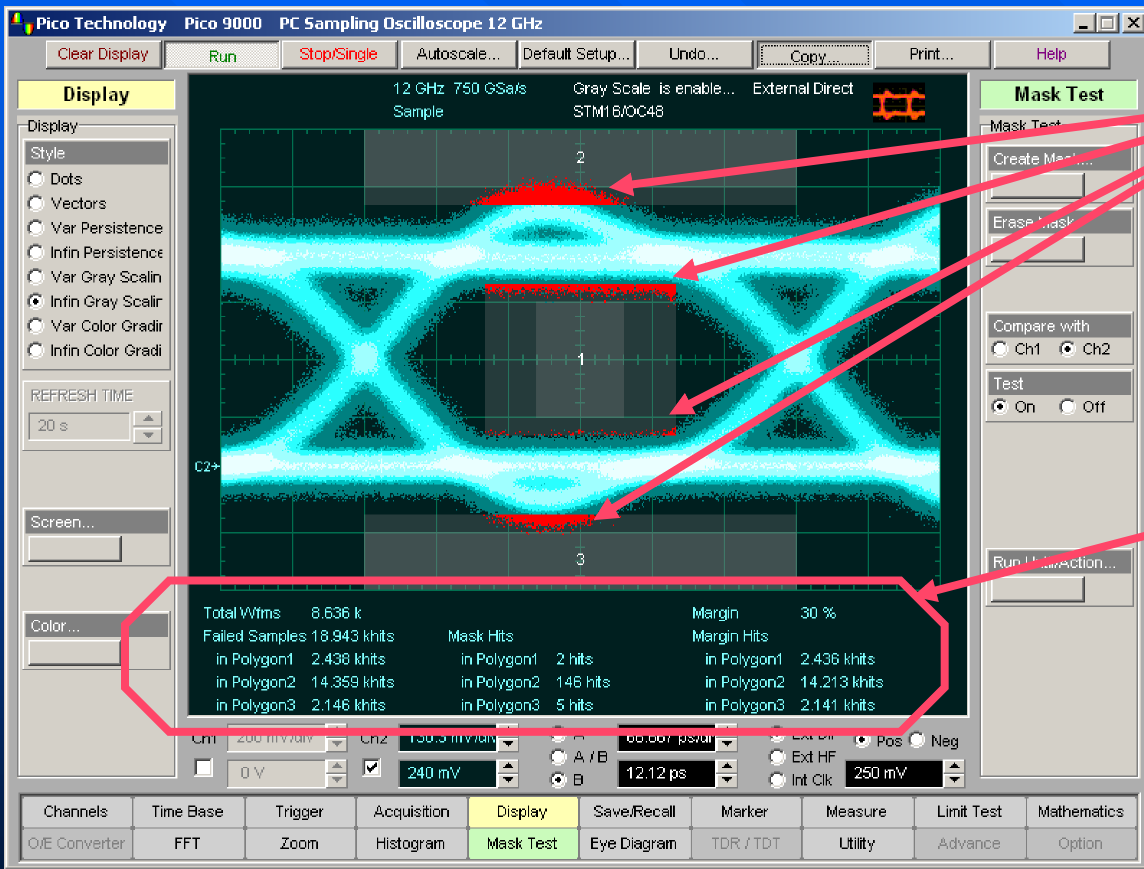
4. Create full Mask



5. Perform Mask Test

Mask Margins

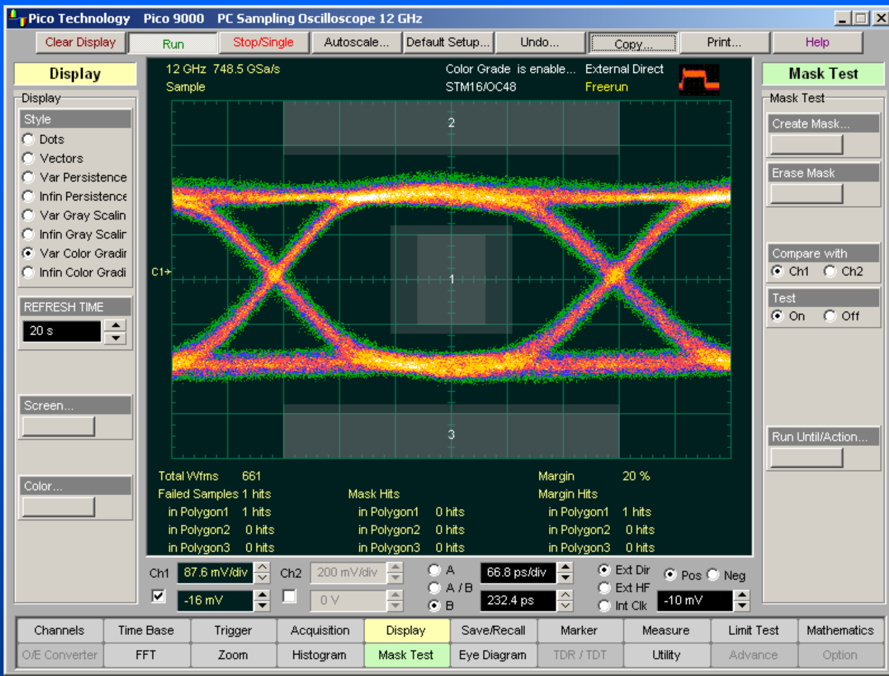
Mask Margins are used to determine the margin of compliance for a standard or scaled mask. The **PicoScope 9201** goes beyond basic testing with mask margin analysis for process monitoring.



- **Mask hits/failures are easily viewed with red pixels.**
- **Mask Test results show:**
  - Total Waveforms
  - Failed Samples
  - Mask Hits
  - Mask Margin Value
  - Margin Hits
  - Margin Hits In Polygon

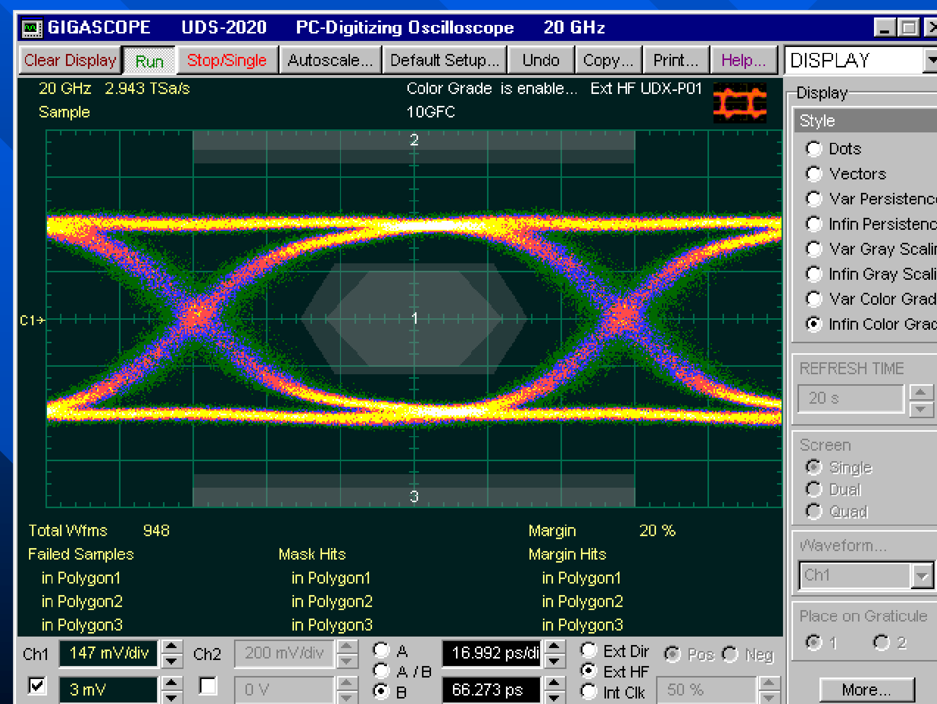
Mask margins are used to determine the margin of compliance for a standard *2.5 Gbps STM16/OC48* eye-diagram or scaled mask.

Examples of Mask Test



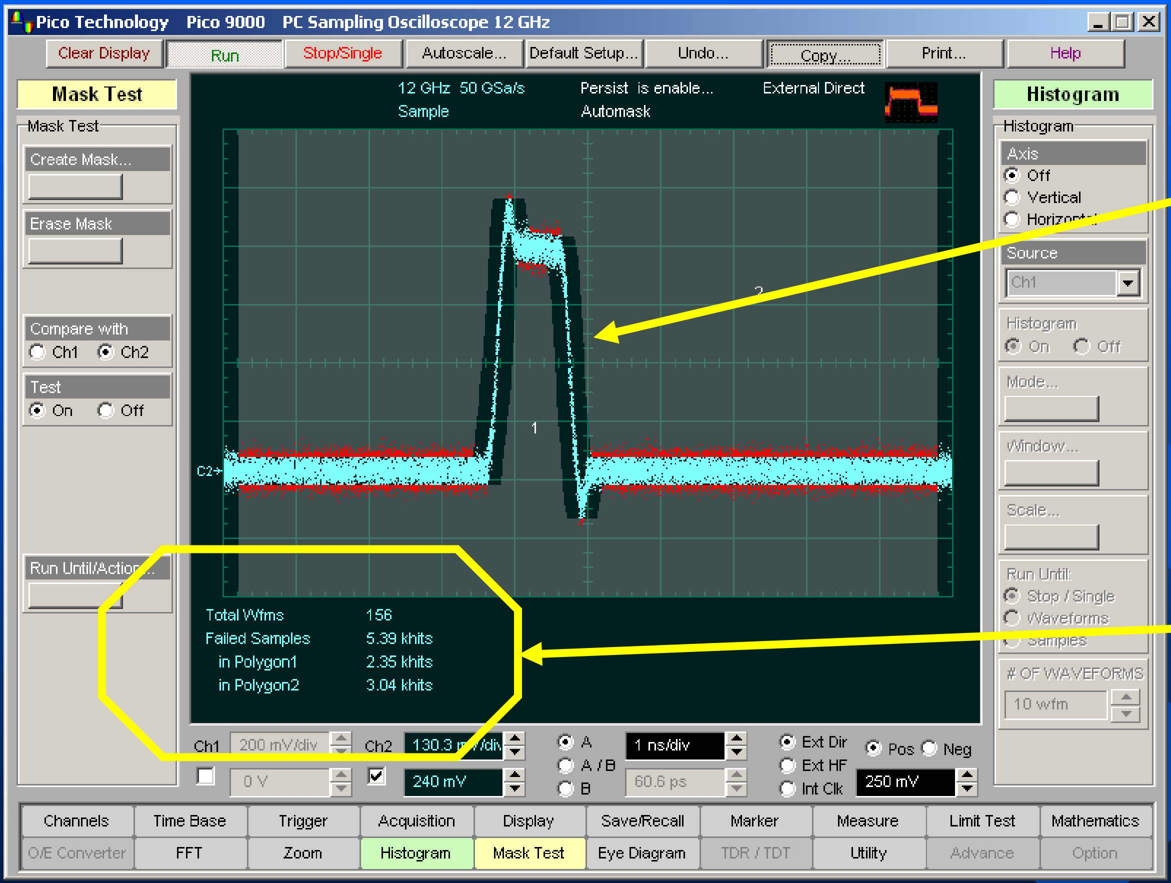
Mask Test and 20-% Margin Test performed for a standard *2.5 Gbps STM16/OC48* eye-diagram.

Mask Test and 20-% Margin Test performed for a standard *9.5 Gbps STM64/OC192* eye-diagram.



On-Fly Limit Test

The PicoScope 9201 offers fully automatic pass-fail limit testing. You can built a limit template from acquired waveforms or download a template from disk.



Using a reference waveform method (Automask), masks are constructed by adding a DELTA X and DELTA Y tolerance around a reference waveform. This method is simple to use, though not as flexible as the polygon method.

Mask Test results show:

- **Total Waveforms**
- **Failed Samples**
- **Hits In Polygon**

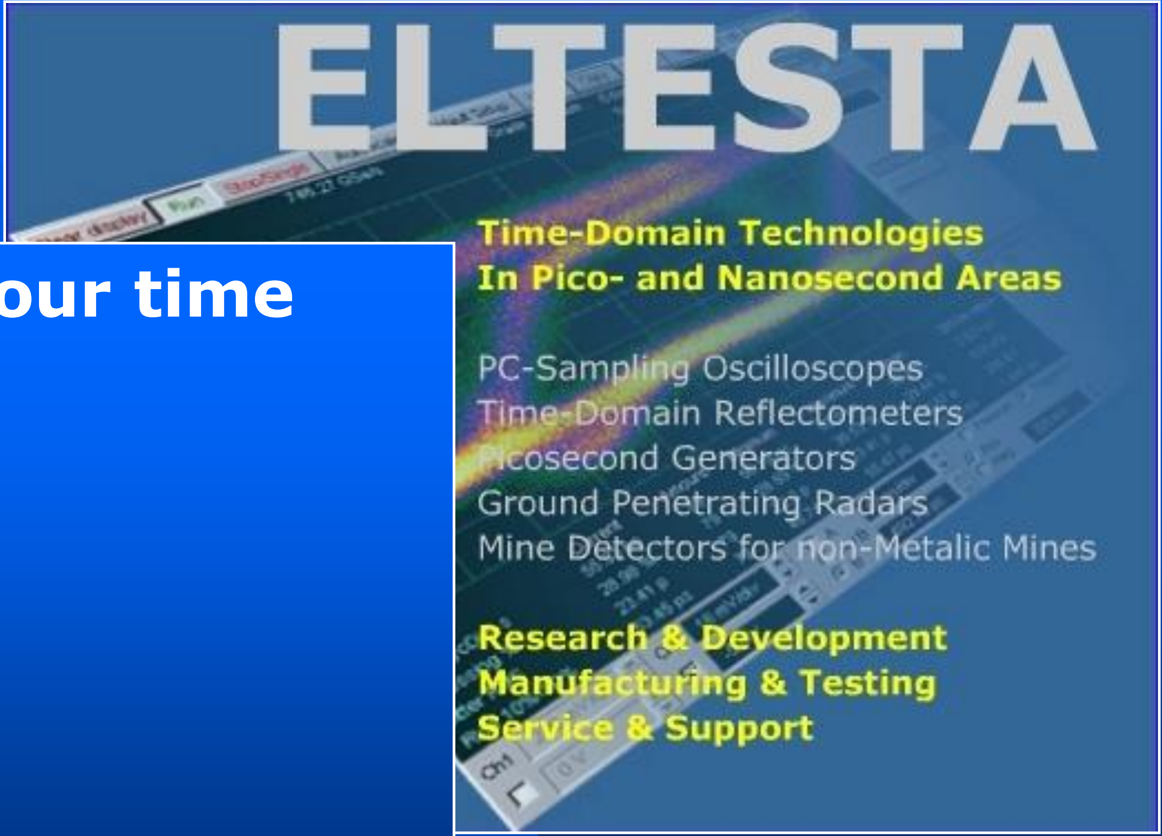
The PicoScope 9201's automatic, on-the-fly limit testing makes manufacturing pass-fail testing simple.

PC- Oscilloscopes

Eltesta offers a wide range of wide bandwidth PC Sampling Oscilloscopes for electrical and optical signals to cover your measurement needs.

PicoScope 9201		UDS-2128		UDS-2030	
					
20 GHz	**Electrical Bandwidth**	***20 GHz***	**Electrical Bandwidth**	***30 GHz***	**Electrical Bandwidth**
12 GHz	**Trigger Bandwidth**	***8 GHz***	**Optical Bandwidth**	***12 GHz***	**Trigger Bandwidth**
35 ps	**Step Generator**	***2.7 Gb***	**Clock-Data Recovery**	***2 ps***	**RMS Jitter**

The End



Thank You for Your time

Questions?

info@eltesta.com

Application Notes available @ www.eltesta.com