High Frequency Measurements with the UDS-2020 PC-Sampling Oscilloscope

General

Product Description

The UDS-2020 is a 20-GHz, dual channel Sampling Oscilloscope for the Personal Computer. Used it with the LPT connection on a laptop you will have the only portable sampling scope of its' kind. Test engineers, production engineers and system integrators will be able to create high throughput test systems (ATE systems) capable of measuring a wide variety of waveforms using the simple user interface.

The 20-GHz bandwidth plus low-noise specifications allow very precise measurements of low-level, high-speed signals. Superior time base stability, accuracy and resolution allow the characterization of jitter in the most demanding measurement applications. This instrument provides you with necessary capabilities to test and measure both analogue and digital circuits.

The instrument provides:

- High-speed acquisition.
- Repeatable waveform performance analysis with automated direct or statistical measurements.
- Markers and Histograms.
- Math or FFT-analysis.
- High resolution TDR/TDT.
- Color-Graded Display.
- Parametric Limit Testing and Mask Template Testing (These measurements can be used independently or in concert).

Heads for the UDS-2020

UDX-G01 Pulse Head

The UDS-2020 includes a less than 35 ps rise time Pulse (step) Generator based on tunnel diode. It provides capability of performing single-ended TDT measurements as well as TDR measurements. Combined Oscilloscope and Pulse Head rise time does not exceed 40 ps. The amplitude of the positive step pulse is about 200mV. Dimensions: 20x25x65mm.

Internal Step Generators (only with UDS-2021 model)

UDS-2021 can be supplied with two Internal Step Generators. One of the generators is internally connected to channel 1 and generates a positive step. Another generator is internally connected to channel 2 and generates a negative step. Both step generators are based on a tunnel diode. They generate 200 mV p-p 40 ps steps, and combined Oscilloscope and Pulse Head rise time does not exceed 50 ps.

UDX-T01 Countdown Trigger Head

The Trigger Head is a free-running countdown tunnel diode oscillator designed to provide stable sampling display of signals up to 10 GHz. It is an UHF bandwidth trigger that offers low jitter and good sensitivity for triggering and capturing of high-speed signals. With the UDX-T01 the synchronous triggering capability is extended up to 10 GHz.

UDX-P01 Prescale Trigger Head

The UDX-P01 Prescale Trigger Head extends direct triggering on signals up to 10 GHz. In this mode, there is no control over the trigger level or slope. The Head includes a high-speed IC is used to divide the incoming signal frequency by a factor of 8. The input threshold of the IC is set for maximum sensitivity and bandwidth, and it will operate correctly on a sine wave input from 1 GHz to 10 GHz.

UDX-PH01 Photodiode Receiver (preliminary data)

The microwave photodiode receiver is a wide bandwidth (1 to 20 GHz), flat response (±2 dB) device intended for use in connection with analog and digital fiber-optic communication systems. This receiver is excellent also in other time domain, fast time response measurement applications. The output coupling is AC with 50 ohm output impedance. The UDX-P01 receiver can be directly coupled to one of the UDS-2020 input channels.

Recommended Probes

The UDS-2020 can be used with both Passive or Active Probe. The following **Passive Probes** are recommended: Tektronix P6150 (9 GHz), Tektronix P6158 (3,5 GHz, Agilent HP54006A (6 GHz), LeCroy PP 063 (8 GHz). The following **Active Probes** are recommended: Tektronix P6249 (4 GHz), Agilent 54701A (2,5 GHz), Tektronix P6245 (1.5 GHz).

Graphical User Interface

With the Graphical User Interface (GUI) for the UDS-2020, you can access all the configuration and measurement features of the oscilloscope through an easy to use system of menus, tool bars, icons and buttons. The GUI contains map of the display, which are placed on the Monitor, and helps operator to navigate the UDS-2020. The GUI is divided into several areas as shown in Figure 1.

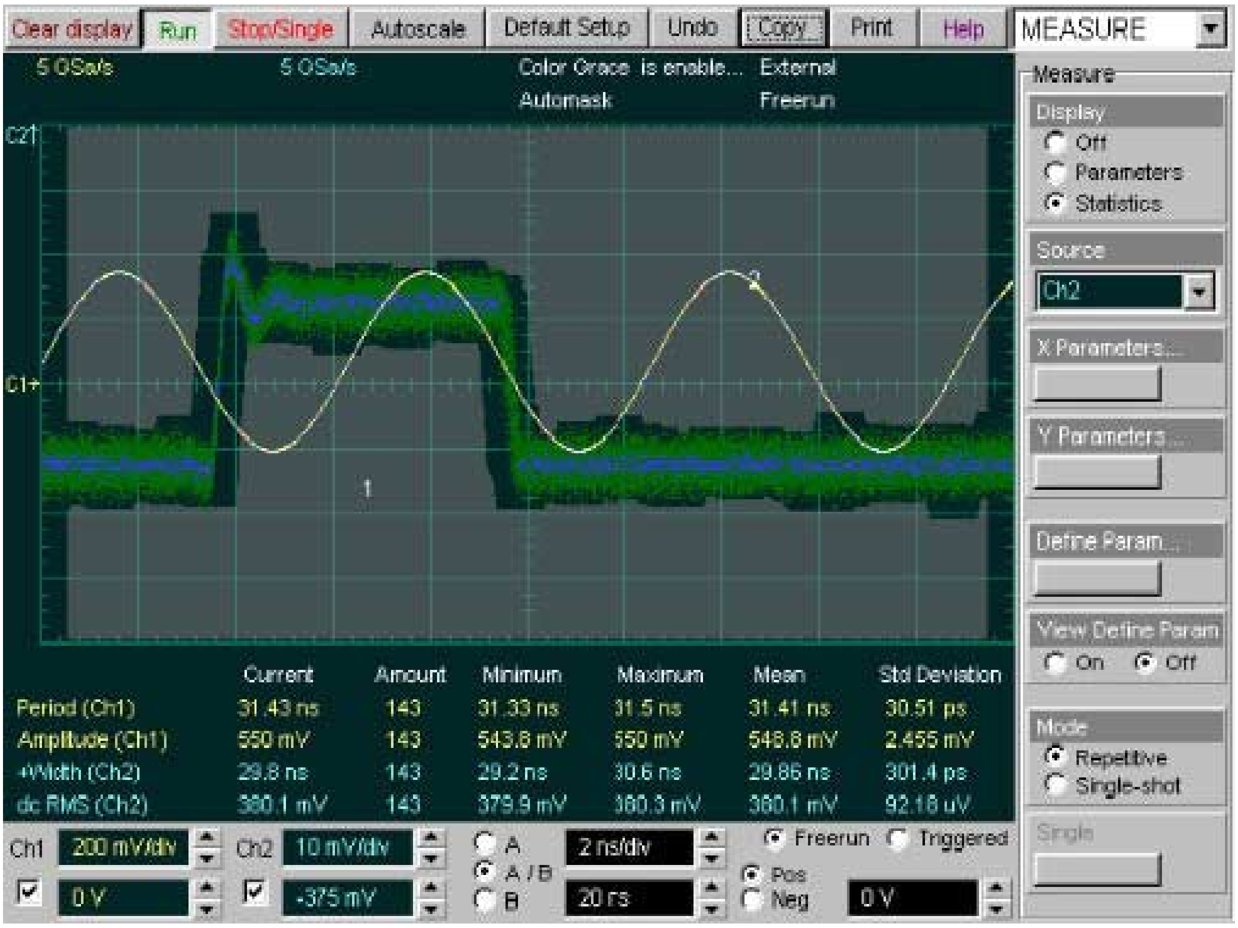

Figure 1. The UDS-2020 PC-Sampling Oscilloscope GUI areas

Applications

Automatic Measurements

You use automatic measurements with the UDS-2020 by pressing a few buttons. The sampling oscilloscope does the calculations for you. Because these measurements use the waveform record points directly, they are more accurate than markers or graticules. Measurements cover voltage, timing, and FFT. Amplitude measurements are made on vertical parameters. They typically mean voltage. They include such parameters as Maximum, Peak-Peak, Middle, RMS, etc. Timing measurements are made on horizontal parameters. They typically mean seconds or hertz. They include such parameters as Period, Width, Rise Time, etc. FFT measurements are made on both vertical and horizontal parameters. They typically mean volts and hertz. They include such parameters as FFT Magnitude, FFT Frequency, etc. Figures 2 and 3 show comparative automatic measurements of a pulse in Time Domain and Frequency Domain.

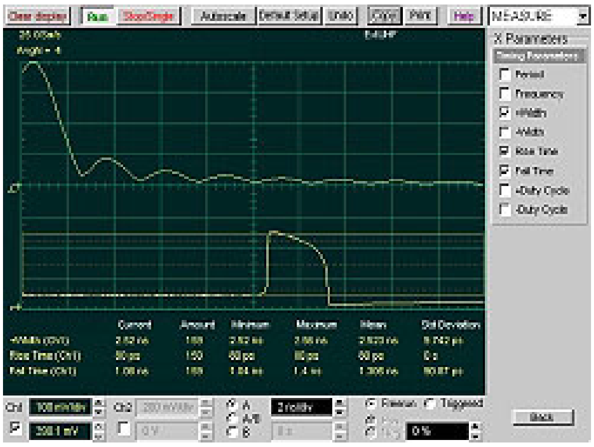

Figure 2. Pulse Width = 2.523 ns, Rise Time = 80 ps (10%-90%), Fall Time = 1.3 ns (10%-90%)

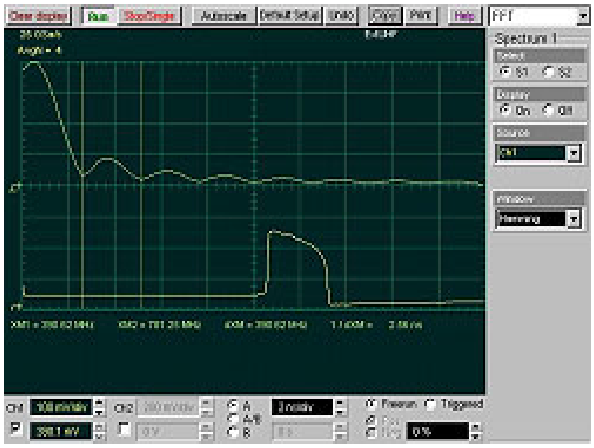

Figure 3. The magnitude of continuous Sinx/x-type spectrum of the pulse. 1/Tw = 390.62 MHz, 2/Tw = 781.25 MHz, Measured Tw (Pulse Width) = 2.56 ns

Figures 4 and 5 show the spectrum and key parameters of a pulse train.

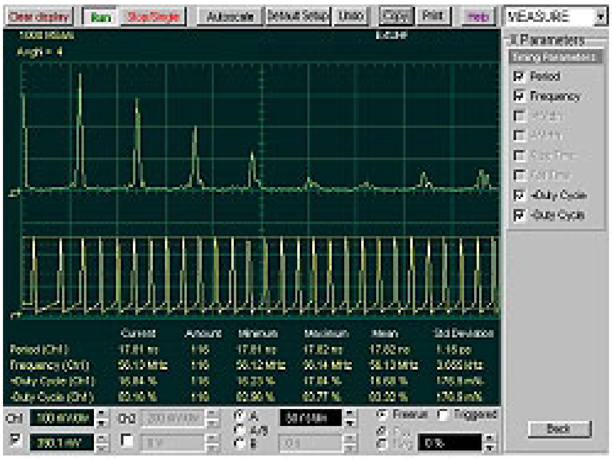

Figure 4. A periodic pulse train. Freq. = 56.13 MHz, Period = 17.82 ns, +Duty Cycle = 16.68%, -Duty Cycle = 83.32%

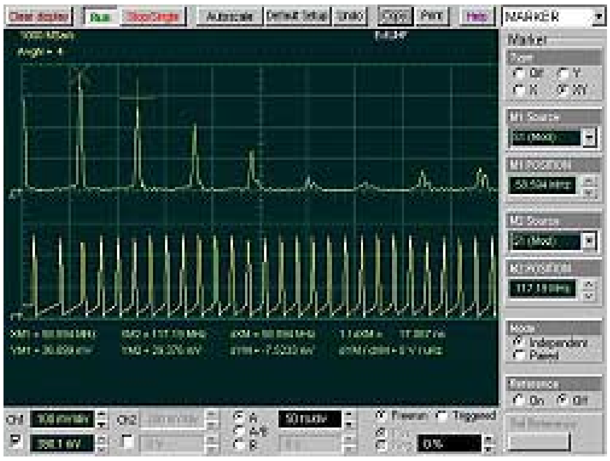

Figure 5. The Sinx/x-type spectrum of the pulse train. Fo = 58.594 MHz, 2Fo = 117.19 MHz. Period calculated from the spectrum is 17.067 ns

TDT/TDT-measurements

Time Domain Reflectometry, or TDR, is a method of characterizing a transmission line or network by sending a signal into one end and monitoring the electrical reflections. A TDR step can also be used to make Time Domain Transmission (TDT) measurements. TDT is a technique that allows you to measure the response of a system by sending steps through a device and monitoring the output of the device. The measurements are made on signals transmitted through the device, rather that reflections from the device (as in TDR). Figures 6 - 9 show two examples of TDR/TDT measurement by using the UDS-2020.

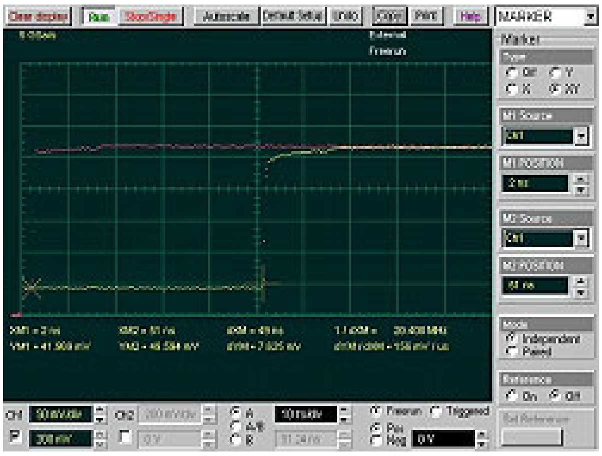

Figure 6. Pulse delay in a 9.6-m long 50-ohm coaxial cable (RG-213 type) is 49 ns. Propagation speed is 5.1 ns/m

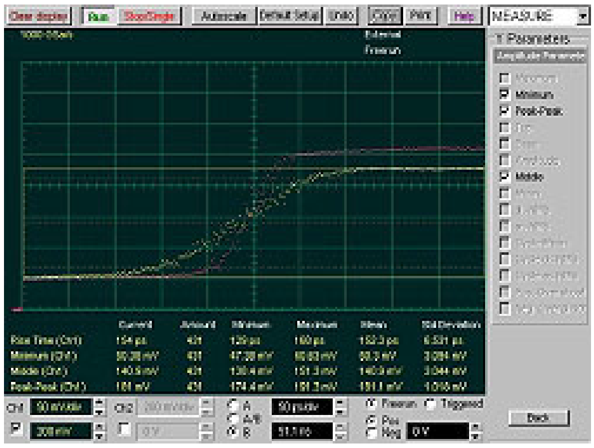

Figure 7. Step response of the pulses shown in Figure 6. The Rise Time of the input pulse is equal to 55 ps, and the Rise Time of the output pulse is equal to 152.3 ps. The Rise Time of the 9,6-m long cable line can be calculated as 142 ps, and a bandwidth (-3dB) = 2.6 GHz

Figure 8. TDR of a 220-mm long PCB-pairline (no ground level). The coupling between the SMA connector (PCB I/O line) and pulse source made with 0.5-m RG-316 coaxial cable. The line is terminated with 120 Ohm (red), 75 Ohm (yellow) and 50 Ohm (green) resistors. Waveforms of the reflections show that the characteristic impedance Zc of the line is equal to (85 ± 3) Ohm. Inductive and capacitive discontinuities of the line and the connectors can clearly be seen.

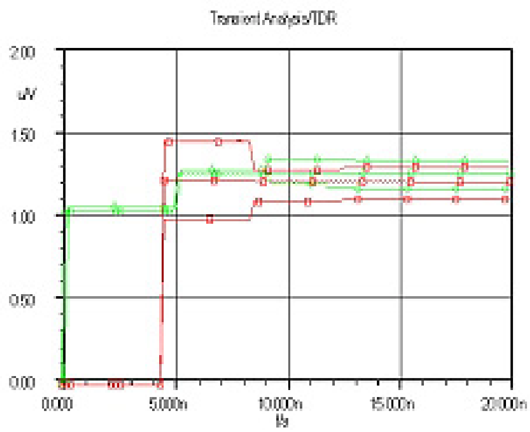

Figure 9. Simulation of the situation described in Figure 8. The green curves correspond to the reflected voltage at the generator end like in Figure 8. The red curves in the contrary depict the voltage variation at load end for three different resistive loads: 50, 75 and 120 Ohm respectively.

Jitter measurements with histogram and automask

The UDS-2020 offers two kinds of histograms: time and voltage. The histograms are configured by counting the frequency of “hits” in small voltage or time intervals. Histograms may be produced by analysis of data in either the voltage or time axis of the oscilloscope. Figure 10 shows statistical measurements of jitter with timing histogram. Figure 11 shows the same measurements by using automask feature.

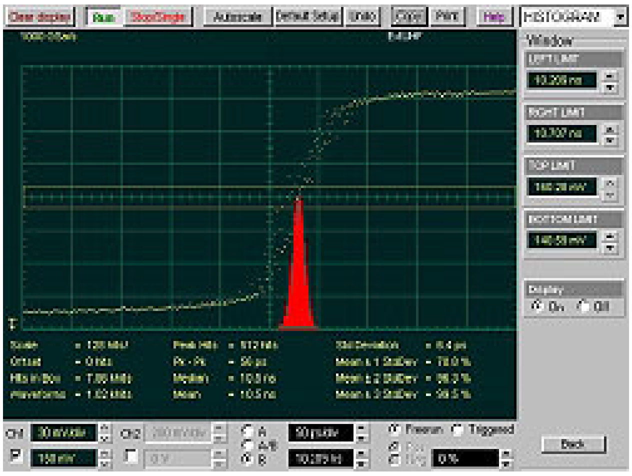

Figure 10. Absolute jitter measurement in a voltage window between 140.59 mV and 160.28 mV of the leading edge of a fast pulse. Peak-to-peak jitter = 56 ps, Standard Deviation = 6.4 ps. The jitter pdf is assumed Gaussian

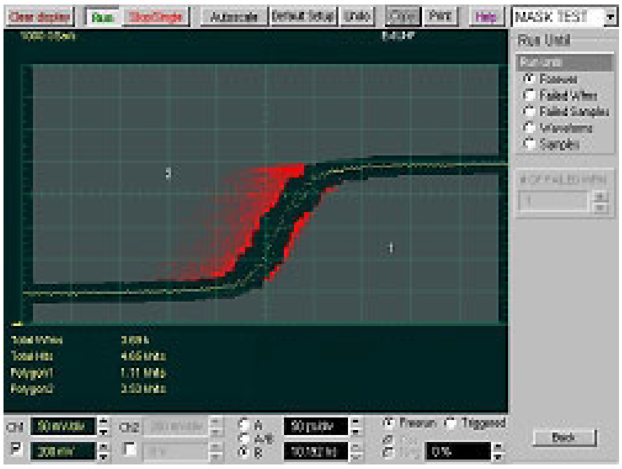

Figure 11. Mask test and the jitter. The leading edge exceeds the given limits in polygon 1 on 23,8 % of all outruns and in polygon 2 76,2% respectively. Total number of waveforms is 3690

Mathematical features assist telecom measurements

Phase delay measurements

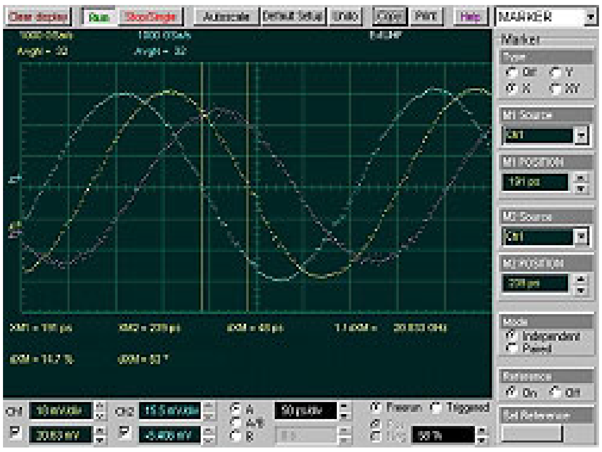

Figure 12. Reading the phase or delay difference, equal to 53 degrees and 48 ps respectively, between two 3.012-GHz signals (blue and yellow) with X-markers. The violet one is the difference or subtraction operation between the signals.

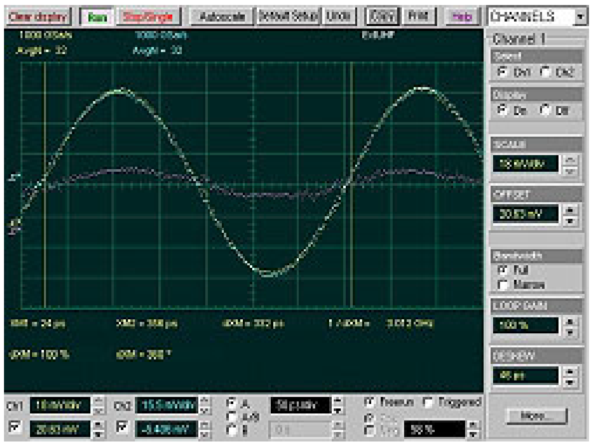

Figure 13. The same procedure made in Figure 12 can also be done without markers using the "DESKEW" between channels property and minimizing the difference curve (red).
The delay is 46 ps corresponding to a physical length difference between cables 9,2 mm (measured 9 ± 0,5 mm).

Convolution

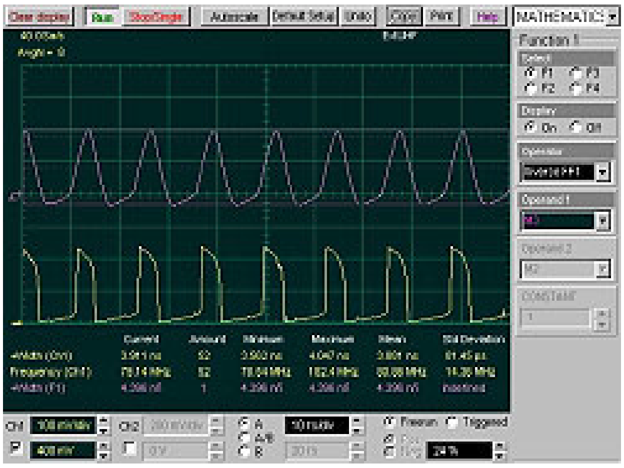

Figure 14. Many telecom, system analysis and probability theory applications take advantage of convolution. Above is depicted the time domain convolution (violet) of a pulse train (yellow) with itself

Defining high frequency roll-off

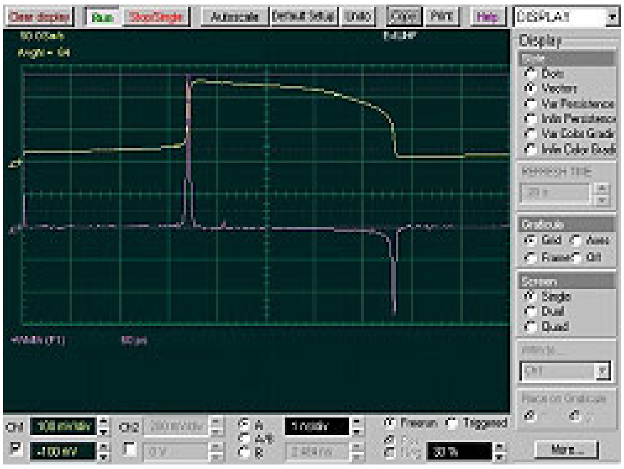

Figure 15. A signal´s high-frequency content can be predicted with the order n of the spectral roll-off. In the figure above the signal (yellow) is differentiated once (violet) with large impulses as result.

Eye Diagram Measurements

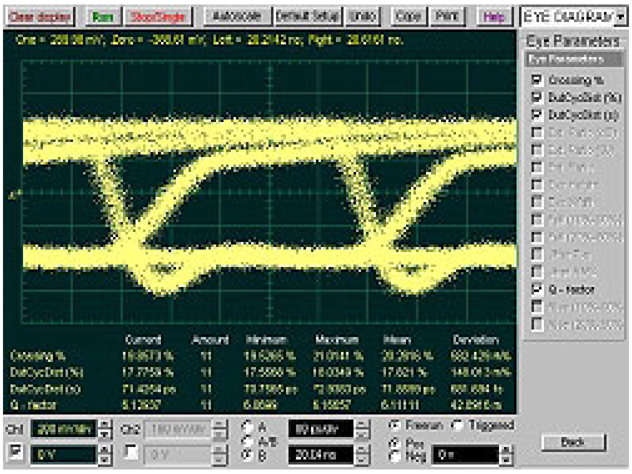

Figure 16. The UDS-2020 has the ability to automatically characterize an NRZ eye pattern. The eye diagram is typically produced by triggering the instrument with a synchronous clock signal. Measurements are based upon a statistical analysis of the waveform, and require a statistical database. From the list of fifteen eye parameters up to four measurements be active at the same time. The Figure shows the Eye Crossing percentage, Duty Cycle Distortion both in time and percent and Q-factor measurements

Short electrical or optical pulses

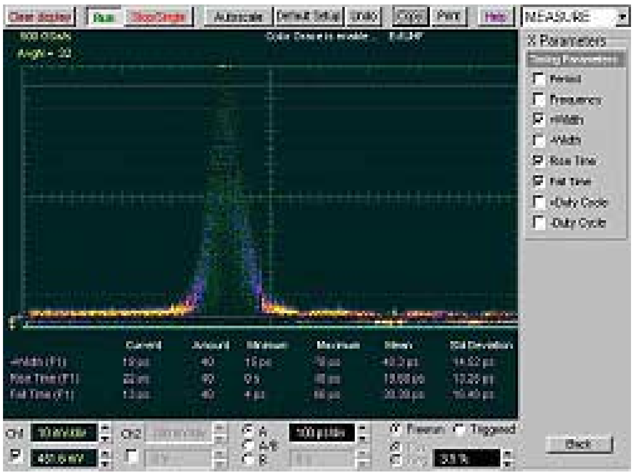

Figure 17. Color Graded Display mode helps to monitor very short pulses with enough jitter composition. Pulses of width down to 25...50 ps (FWHM) can reliable be detected (the depicted pulse has Pulse Width =40 ps, Rise Time = 19,7 ps and Fall Time =30,4 ps). The actual wave shape is reproduced on the screen if pulse minimum width Tmin >= 100 ps. Display: Axis On, Inf. Color Grade.

About Eltesta

ELTESTA is a company which designs and manufacturers an extensive line of high-performance electronic equipment based on Time-Domain Technologies in Pico- and Nanosecond Areas. The key point of these technologies is generating and acquiring electrical signals with very fast rise time. Main coaxial and waveguide units of the instruments built under this technology are: GHz-Samplers, ps-Finite Generators, Wide-Bandwidth Antennas, HF Accessories. All they use very fast semiconductors.
Line of the instruments includes: Wide-Bandwidth PC-Sampling Oscilloscopes also working as Communication Analyzer, Time Domain Reflectometer and Network Analyzer; Pulse, Step and One Sine-wave Generators, Impulse Radars (Ground Penetrating Radar and Mine Detector).

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