OSCILLOSCOPE

Quick Reference Guide for the SIA-4000 / GigaView 2.0 and later

Applications of Oscilloscope tool

- Display a waveform as voltage vs. time
- Measure voltage parameters of signals
- Measure Rise and Fall time
- Eye mask / Eye Diagram measurements

Introduction

The focus of this note is to familiarize the user with the Oscilloscope tool allowing quick and easy measurements and interpretation of results. Refer to the Online Help or the SIA-4000 User's Manual for more information.

This paper is divided into 4 major sections:

- Theory of operation
- Making a measurement
- Understanding views, plots or results
- Dialog Bars (instrument settings)

Theory of Operation

The SIA-4000 performs specific measurements using the most appropriate hardware techniques. The Sampling Oscilloscope uses circuitry optimized for voltage measurements. Timing and Jitter measurement tools use different internal circuitry optimized for time measurements. For amplitude measurements and rise or fall time measurements (which are amplitude dependent) the Oscilloscope uses a standard Repetitive Sampling methodology. This allows eye-masks to be created. The time measurements made for the other tools, such as histogram, *are not* derived from the measurements that this oscilloscope makes. The reason for the use of different sampling techniques is that for jitter measurements, an oscilloscope is an inefficient sampler. The high sampling efficiency of the jitter measurement tools ensures that every jitter measurement made is at a specific threshold.

There are also two bandwidth settings: 15GHz and 10GHz. The setting is displayed in the status bar area (Figure 1). The setting can be toggled, if needed, by using a mouse to click on the button. For normal operation the setting defaults to 15GHz. The setting will automatically reduce to 10GHz when measuring an eye diagram using a bit clock trigger.

Oscilloscope panel

Refer to the "Navigating GigaView" Quick Reference Guide for details on using the GigaView™ Interface.

Results Area

When specific parameters are selected for measurement, this area displays the results.

View Area

Displays waveform and/or eye mask.

Status Bar

Cursor coordinates - *Bandwidth setting* and jumper settings are located here.

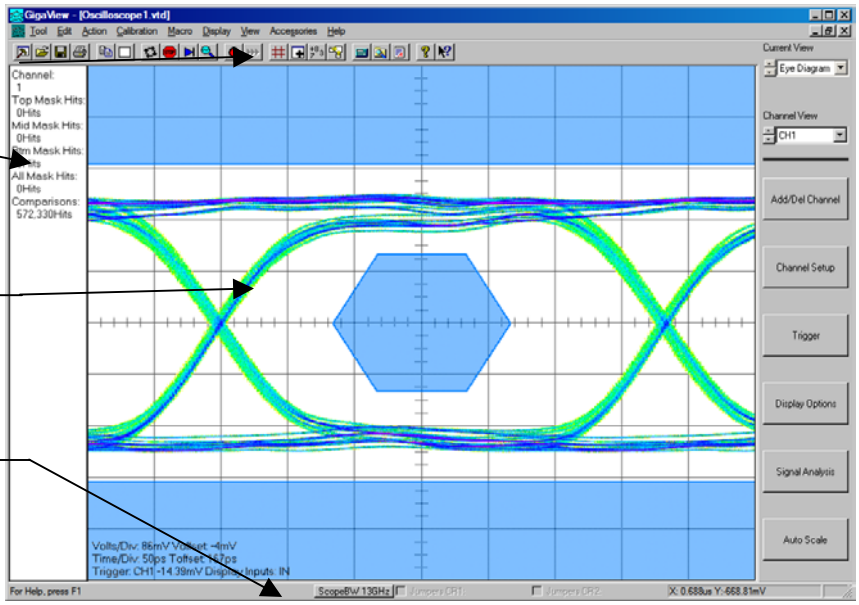


Figure 1 - Oscilloscope

Making a Measurement—Initial Setup

The Oscilloscope has many different capabilities. It can display the waveform, measure voltage parameters, and create eye masks. This section describes how to setup and make these measurements.

Displaying the Waveform

- Connect the Device Under Test to a measurement channel. The SIA-4000 defaults to CH1, no additional configuration is necessary if connected to CH 1.
- Press AUTOSCALE and the waveform will be displayed. The scope will trigger on CH1.
- Use the "Scale" and "Position" knobs on the front panel to place the waveform vertically and horizontally (see Figure 2). These values can be manually selected in the Channel Setup menu.
- To "Run" a measurement, use the buttons on the front panel or the menu bar. A Single Acquire can be made in the same way (see Figure 3).

Figure 2 – Scale/Position knobs

Figure 3 - Acquiring a Measurement

- Enable measurements from the main oscilloscope menu. Press Signal Analysis and toggle measurements 'On' or 'Off' (Figure 4)

In this menu, enable rise and fall time or voltage measurements. The oscilloscope will measure rise/fall times to ~25ps. These measurements will be displayed on the left of the plot (Figure 12).

Note: Rise/Fall Time measurements the default is 20%-80%. To change it, go to the Edit|Global Tool Settings… menu on the top tool bar.

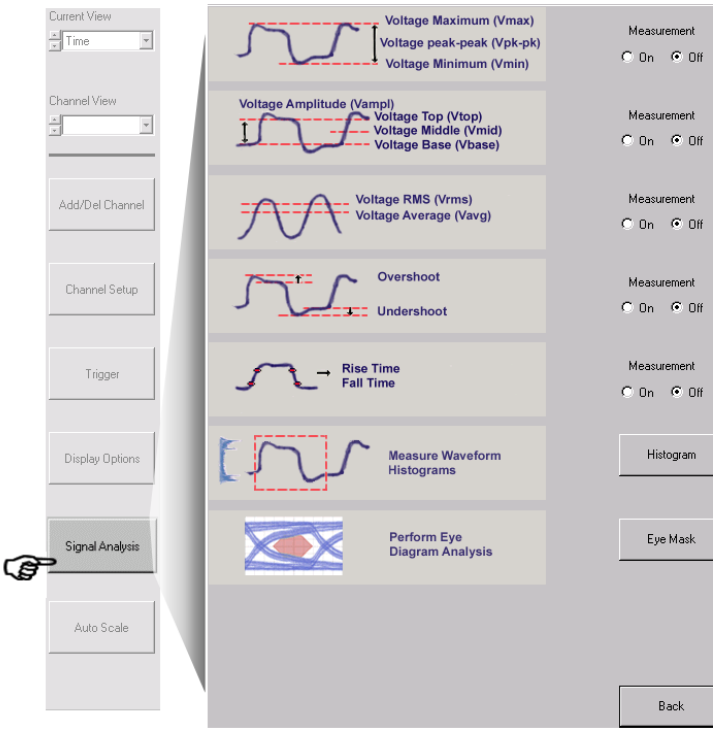


Figure 4 - Enabling Measurements

- To add or change channels, press Add/Del Channel and select the channel (Figure 5).

- To change the trigger channel, press Trigger to open the trigger setup menu, then press Trigger to open a dialog box similar to Figure 5.

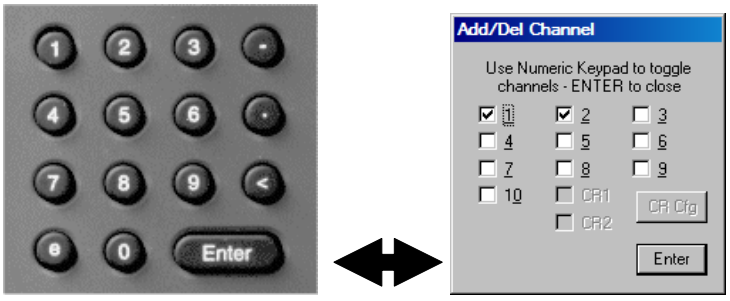


Figure 5 - Channel Selection

Eye Mask/ Eye Diagram Measurements

The SIA-4000 offers the choice of two different methods of creating an Eye Diagram:
1. Using a bit clock trigger – the traditional sampling oscilloscope method.
2. Using a pattern trigger -- a sampled portion of the waveform is repeatedly folded to form an eye.

Eye Mask with bit clock trigger

- Connect the data signal to CH 1 and a bit clock to CH 2 (Figure 6).
- Press Trigger and select CH2 to trigger on the bit clock.
- Press Signal Analysis (Figure 7).
- Press Eye Mask.
- Select ON in Enable Eye Mask.
- Press Zoom to Eye to automatically place the mask in the display.
- Press Run.

Note: This feature will automatically reduce the Oscilloscope bandwidth to 10GHz.

The bit clock is "at-rate" and synchronous with the data. It may be derived from the SerDes itself, but more frequently comes from a clock recovery. If you have access to a bit clock, you can create an eye diagram using this method. Clock recovery for the SIA-4000 is available only under 3 Gb/s.

To change the mask position or size, press Mask Setup. Mask Setup opens a menu allowing you to recall saved masks and edit the mask size and position. For other configuration and tool settings, refer to the context sensitive help. The help describes the use of each setting.

Figure 6 - Setup and trigger with external bit-clock

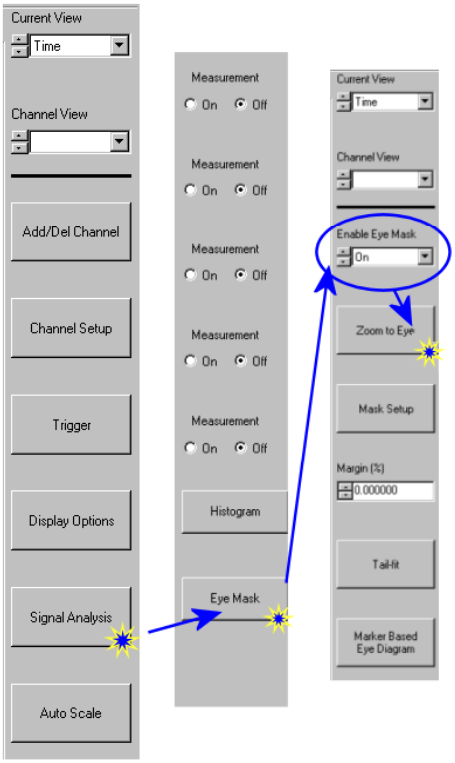


Figure 7 – Enabling eye mask

Noise Analysis and Tail-fit for Vertical Histograms

The SIA-4000 can perform a noise analysis of the amplitude and separate the results into random and deterministic noise. These components are used to generate a vertical bathtub curve showing the predicted vertical eye closure.

- Press Signal Analysis.
- Press Eye Mask.
- When Eye Mask is enabled, press TailFit.
- Enable TailFit in this menu.
- Press Run.

Areas on the 1 and 0 levels that are 10% UI wide are used as the samples for the histograms. These areas are centered on the middle of the eye.

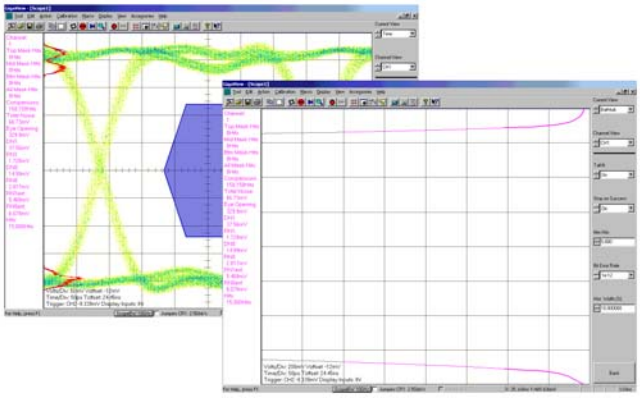
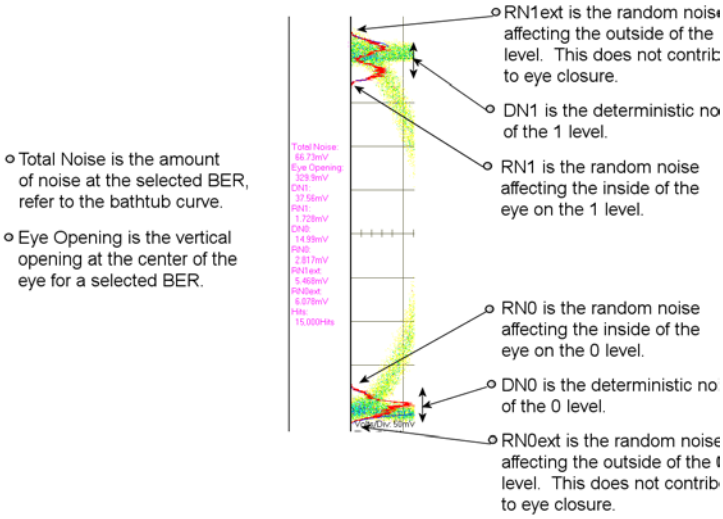


Figure 8 – Example of noise analysis to generate histograms and vertical bathtub curve

There are a number of values that are displayed once Tail-fit has completed. Figure 8 shows the histograms and the bathtub views that are generated. The results that are displayed are described in Figure 9.



Marker Based Eye Diagram

- Open the Marker Based Eye Diagram from the shown in Figure 7, or from SIA-4000 main menu, "Other Tools" menu.
- Connect the data signal to CH 1.
- Press Trigger Ensure that the trigger is set to CH 1 and Pattern Marker is checked. (Figure 10)
- If the pattern has been previously detected in another tool, proceed to Autoscale, otherwise Press Open PM Utility
- Press Pattern Options.
- Press Detect Pattern.
- Press Autoscale.

Figure 10 - Setup and trigger for Marker Based Eye Diagram

Note: This feature will automatically increase the Oscilloscope bandwidth to 15GHz.

The marker based eye diagram feature will open a separate window to create an eye mask when no bit clock is available. This is helpful because "at-rate" bit clocks or clock recovery are often unavailable or inaccessible. In this case though, the data must be a known repeating test pattern such as K28.5, CJTPAT, PRBS 2^n, etc. The SIA-4000 will automatically create an internal trigger based on this repeating pattern and sample a portion of the waveform. These waveforms are then superimposed on successive waveform samples to gradually build up an eye diagram.

The tool will measure the bit rate and display an eye diagram. If the pattern or bit rate cannot be determined, an error will occur. If so, enter the bit rate in the Bit Rate box. The pattern can be manually loaded from the Trigger menu: Open PM utility and choose pattern options to load or detect a pattern.

User Defined Horizontal and Vertical Histograms

Histograms can be enabled to sample specific areas, horizontal (time) or vertical (amplitude).

- Press Signal Analysis.
- Press Histogram.
- Enable either Vertical or Horizontal histograms.
- Press Dimensions to size the histogram.

Histograms are particularly useful for obtaining statistics on specific areas of the waveform. (Figure 11).

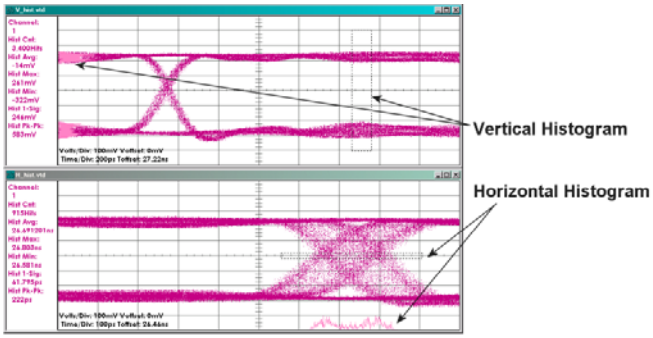


Figure 11 – Example of noise analysis to generate histograms and vertical bathtub curve

Viewing Results from Different Channels

When multiple channels have been selected, use the "Channel View" setting (Figure 12) on the Oscilloscope main menu to toggle the results from each channel. Measured results from only one channel are shown at a time. To see a table of all results, change to, or add, the "Summary View" from the Oscilloscope main menu.

"Channel View" is a global control within the oscilloscope. It allows you to choose which channel controls are currently active. When you select a channel from this list, you can then view voltage measurements and change scale or position offset for that channel using the horizontal or vertical knobs on the front panel.

Note: When viewing a single channel, the waveform appears as a persistence color gradient. Viewing more than one channel disables the color gradient and shows each channel as a different single color.

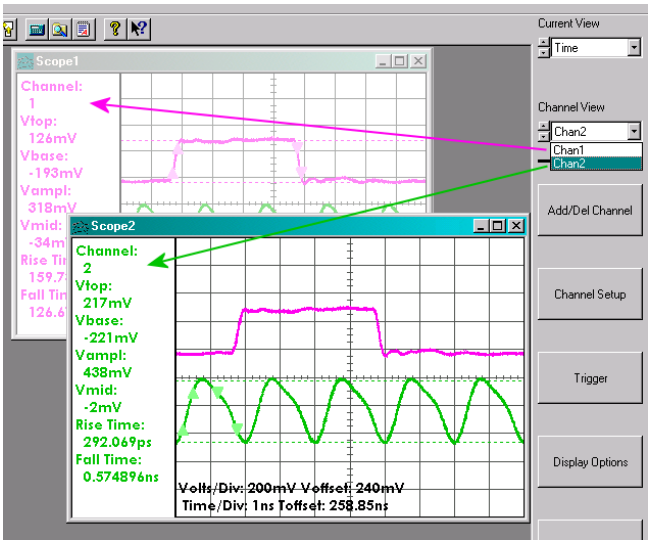


Figure 12 - Viewing results from different channels

Eye Mask/Eye Diagram Results

Violations of the mask are shown in the results area. 'Comparisons' displays the number of total samples on the display. In addition to total mask violations, the hits are shown separately for the top mask, center of the eye and bottom mask. (Figure 13)

Margins can be enabled to help determine how much a part is passing or failing.

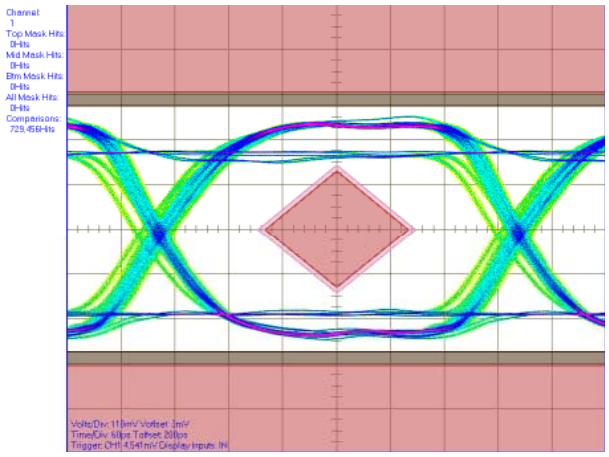


Figure 13 - Shows the results of the eye mask

Note: A differential eye cannot be displayed. In the Display Options menu you have the choice of displaying just the IN input, the /IN (inverting) input, Differential, Both, or Common-mode waveforms. When the eye diagram is enabled IN - /IN differential cannot be displayed. The default setting displays only the top input, IN. See page 11 for a description of the display options.

Histograms and jitter measurements

Often histograms are used to quantify the jitter of the signal measured with the eye diagram. This can be a slow process to acquire a large number of time samples at a voltage threshold. Once a histogram is obtained from the oscilloscope, there is still very little quantitative information. For this reason, it is recommended to use the time measurement tools of the SIA. Specifically, the Random Data with Bit Clock tool will make time measurements at a specific voltage threshold. An advantage of this tool is that it acquires results much faster than the oscilloscope can. It can show separate histograms of the rising and falling data edges, and more quantitative information such as Random, Deterministic and Total jitter is shown.

The two types of Eye Diagram tools described in previous sections have corresponding dataCOM jitter measurement tools for quantitative jitter measurements. See Table 1.

When using Oscilloscope:	Use DataCom tool:
Eye Diagram with Bit Clock	Random Data with Bitclock
Marker Based Eye Diagram	Known Pattern with Marker

Table 1

A full discussion of the "Random Data with Bit-clock" tool is provided in the Getting Started Guide for that tool, but it is helpful to describe some of the uses of that tool and how they relate directly to the Oscilloscope. Using both the Oscilloscope and the dataCOM tools together provide a better overall picture of signal integrity. Starting with an example Eye Diagram and a time histogram of the voltage threshold crossing of data high/low, a few observations can be made. (Figure 14).

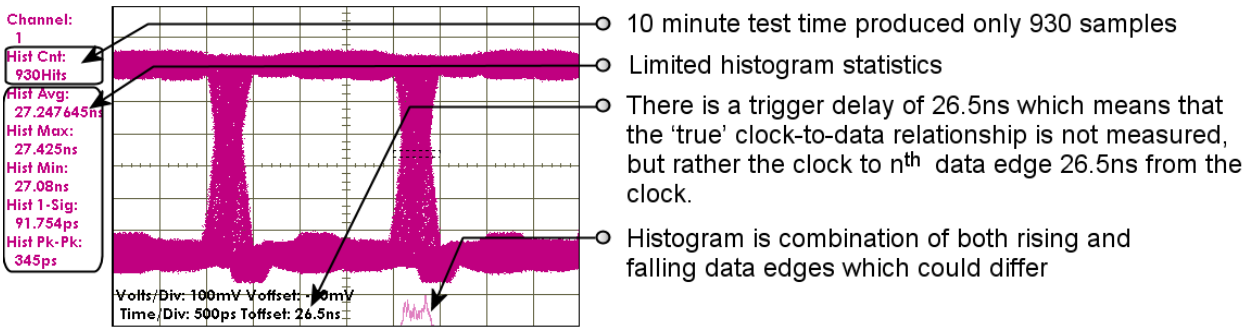


Figure 14 – Example of jitter results from Oscilloscope

Test time, limited jitter samples, indistinguishable rising and falling edges are all drawbacks to using the oscilloscope for timing jitter. Using the dataCOM "Random Data with Bit-Clock" (Figure 15) or "Known Pattern with Marker" (Figure 16) tools eliminate these drawbacks. The dataCOM tools in conjunction with the oscilloscope provide a comprehensive picture of signal integrity. The Known Pattern with marker tool also provides diagnostic plots such as DCD+ISI, FFT, 1-sigma, and bathtub curve. Additionally, using the other timing tools in the SIA-4000 an analysis of the bit-clock can be performed to determine if some of the signal integrity problems are caused by the clock rather than the data.

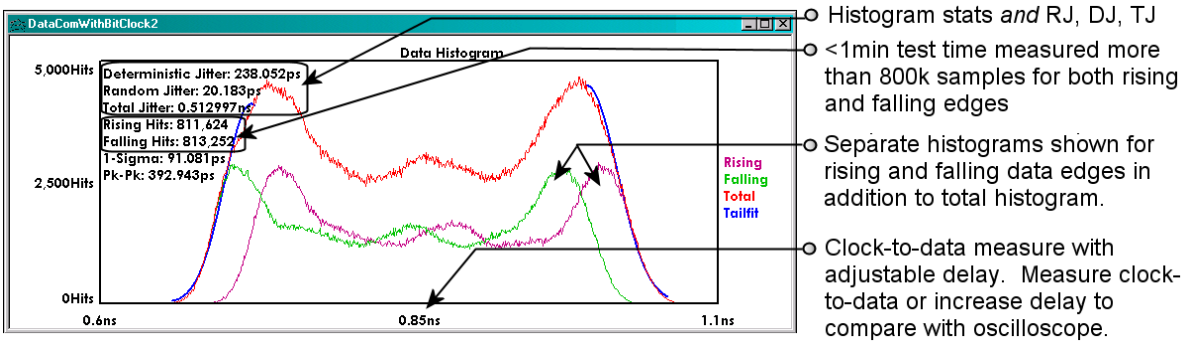


Figure 15 – Example of jitter results from dataCOM Random Data with Bit clock tool.

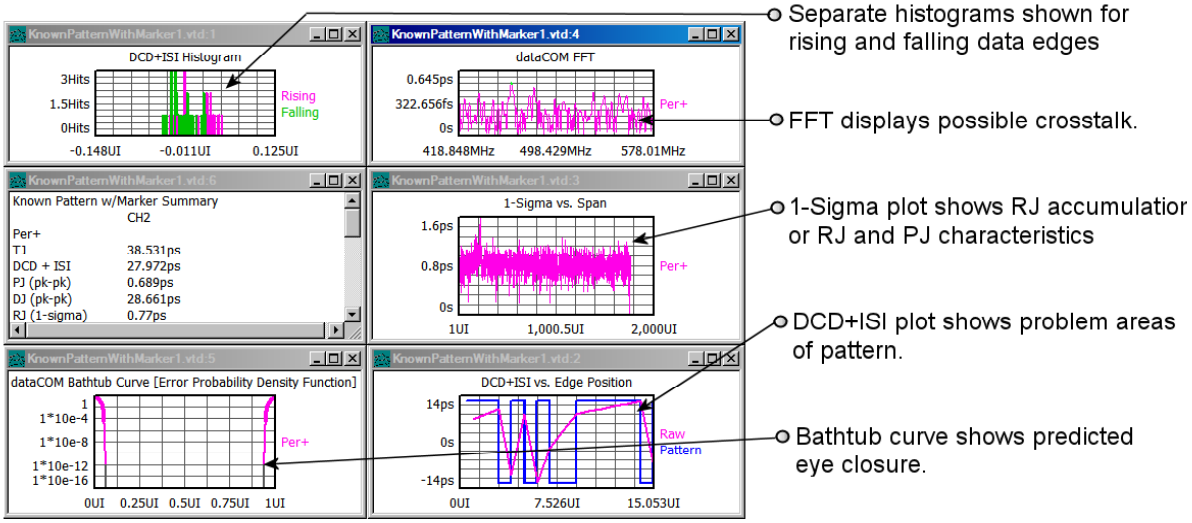
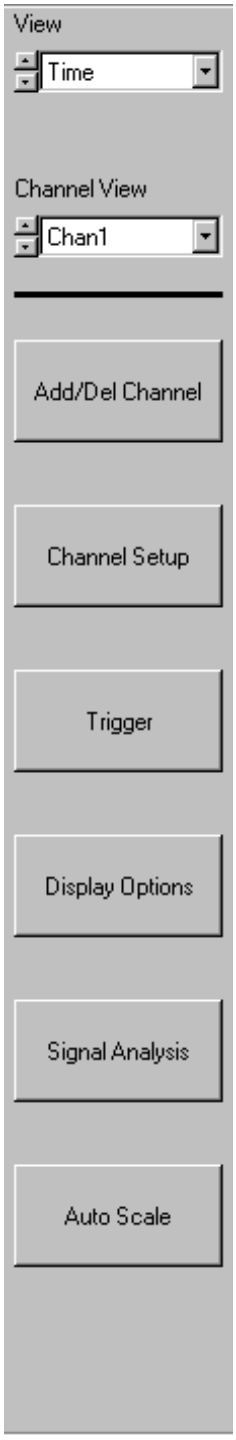


Figure 16 – Example of jitter results from Known Pattern with Marker

Dialog Bar Descriptions

Oscilloscope Main Menu



View
Time or summary. Changes current active view to show a graphical representation of the measurement or text of the results.

Channel View
This is a global control within the Oscilloscope. Use it to change a particular channel's settings. For instance, you would go to the CHANNEL SETUP menu and change a channel's settings. Channel View allows you to select which channel's settings you are changing.

Add/Del Channel
Opens a choice box. Use the mouse or keypad on the front panel to select or deselect a channel to measure.

Channel Setup
Configure a particular channel (as chosen by "Channel View"). You can set Delay (time), Offset (voltage), and Volts/division

Trigger
Select and configure a trigger channel.

Display options
Choose persistence time, show IN or /IN channel--both or either, enable averaging, change zoom reference.

Signal analysis
View Eye Mask, Voltage measurements, Rise/Fall times and Voltage Histograms.

Auto Scale
Automatically sets the delay, time/division, and volts/division to view the signal on Channel 1. If a different channel is configured, Auto Scale will automatically position the waveform for that channel.

Channel Setup

Volts Per Division
Set the Vertical Scale or use the "Vertical Scale" knob on front panel.

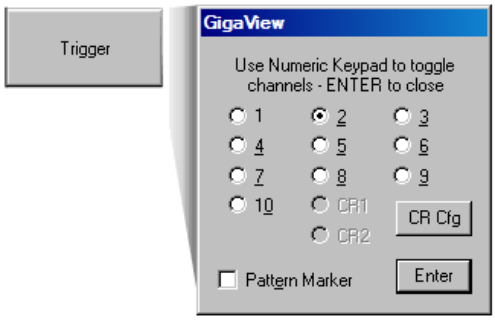
Offset (mV)
Sets the voltage offset of the waveform. Or, use the "Vertical Position" knob on the front panel (see figure below).

Time Per Division
Set the horizontal time scale, or use the "Horizontal Scale" knob on the front panel (see figure above).

Delay (ns)
Set the time delay of the waveforms, or use the "Horizontal Position" knob on the front panel (see figure above).

Trigger

Trigger
Clicking on button will display the selection box for to choose the trigger channel (see figure below). Use the mouse or keypad on the front panel to select one channel. To trigger on a repeating pattern, check the Pattern Marker box. When a repeating pattern is applied to the selected channel a trigger will be generated for each pattern repetition.



Trigger Method
"Auto" uses threshold values calculated from pulsefind.
"User Volts" allows the threshold to be manually set.

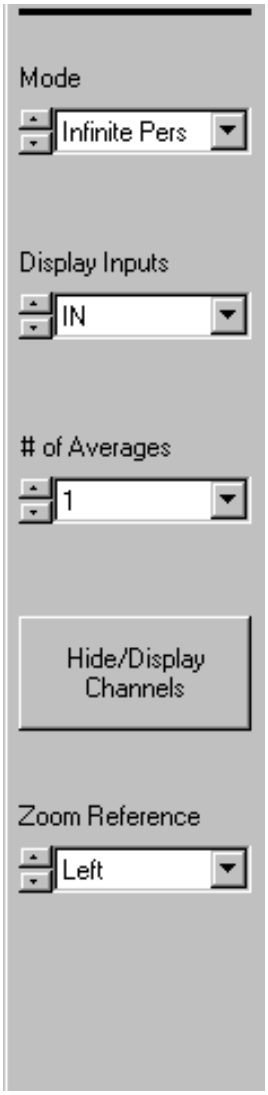
Trigger Voltage
This panel is grayed out when Trigger Method is in "Auto" and will display the threshold value. When Trigger Method "User Volts" is selected, the desired threshold voltage can be manually entered in this place.

Trigger Edge
Select the Rising or Falling edge to be used as the trigger.

Patn Mkr Mode
Used only when "Pattern Marker" is checked in the Trigger channel selection.

Open PM Utility
This button will open the Pattern Marker configuration utility which is useful for selecting different patterns or other advanced operations.

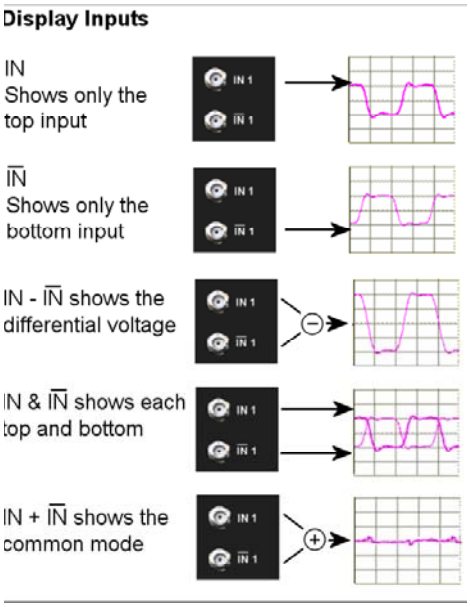
Display Options



Mode
This mode selects the amount of persistence. Infinite persistence holds all measured samples on the screen until "clear" is pressed or the configuration is changed. The other persistence values hold the measured samples on the screen for the persistence time selected. Dot Connect connects samples with a line. Note that a color gradient is applied only when one channel is displayed. If more than one channel is displayed, each channel is assigned a unique solid color.

Display Inputs
Choose which traces to display. Default is IN which only shows voltages from the top input. If a differential signal is applied, this setting must be changed to view differential voltage. View the IN, /IN, IN-/IN, IN&/IN, or IN+/IN. (refer to the diagram).
IN - /IN shows differential voltage.
IN & /IN shows each input.
IN + /IN shows common mode.

Note: Eye Diagram is not available for the differential IN - /IN display.

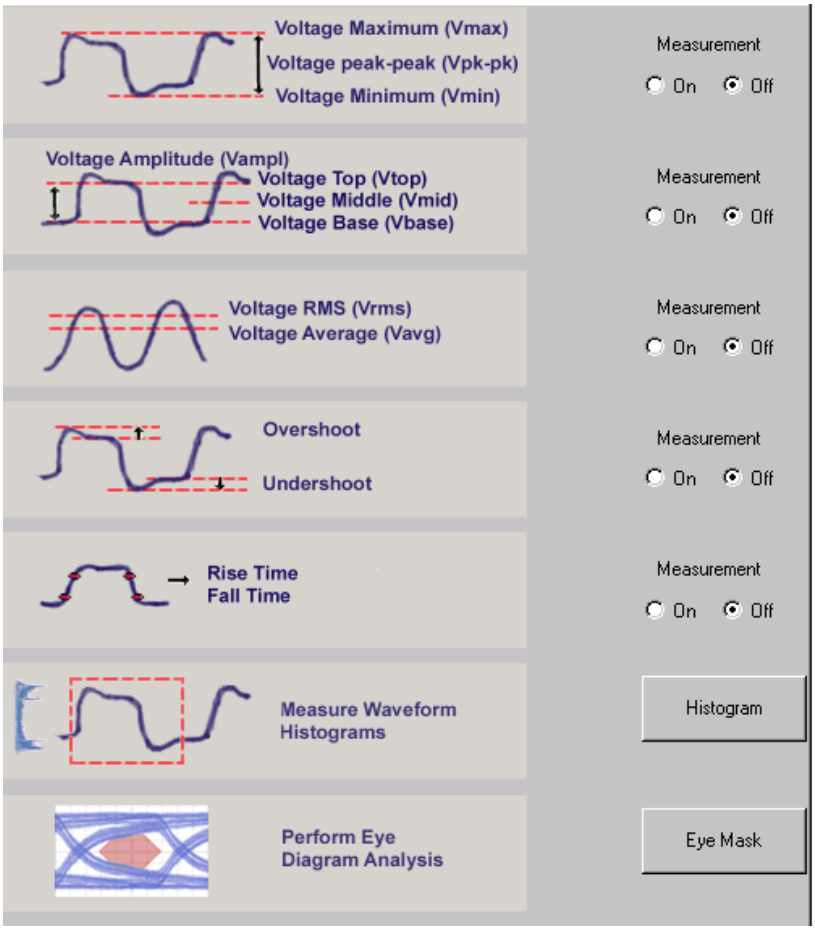


# of Averages
Selects the number of averages for each sampled point displayed on the screen

Hide/Display Channels
Open a selection box to turn on or off a view of a specific channel.

Zoom Reference
"Left" will zoom holding the left position.
"Center" will zoom holding the center position. This setting will affect how the "Horizontal Scale" knobs zoom on the waveform.

Signal Analysis



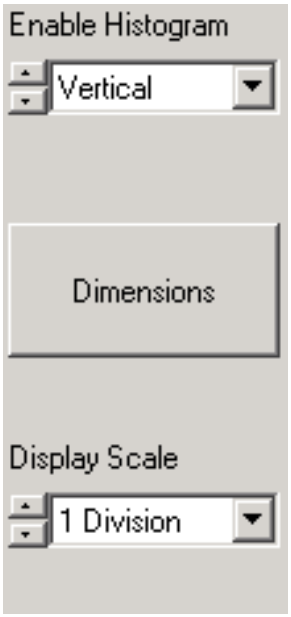
Measurement
Toggle the radio buttons to make voltage measurements such as Vmax, Vmin, Vavg, Vovershoot, Vundershoot, Vmid, Vtop, Vbase.

Rise time / Fall time
Toggles rise and fall time measurements On/Off. Set 10%-90% or 20%-80% in the Edit|Global Tool Settings on the top menu. The default is 20%-80%.

Histogram
This button will open a menu for configuring a histogram window. The histogram shows statistics from the samples that fall inside this window. Display either a horizontal or vertical histogram.

Eye Mask
This button opens a menu for measuring and configuring an eye mask.

Histogram Setup

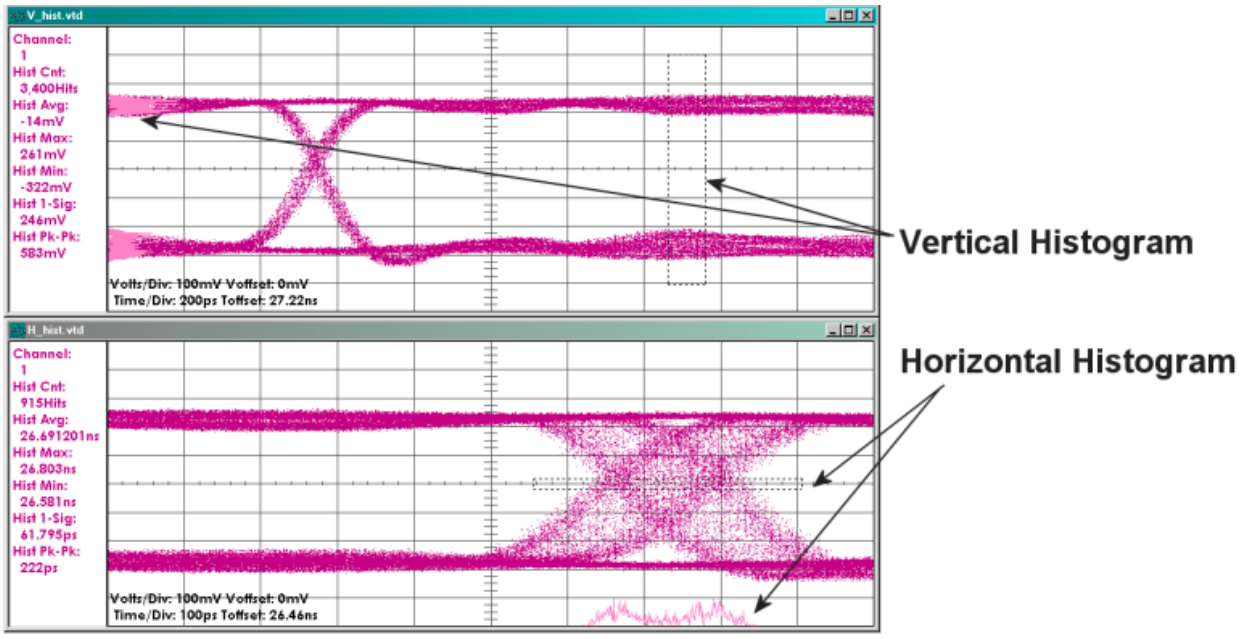


Enable Histogram
"Disabled" turns off any histograms. "Vertical" turns on a sample box used to create vertical, or voltage, histograms of the samples that fall inside the box. "Horizontal" turns on a sample box used to create horizontal, or time, histograms of the samples that fall inside the box. See the figure below.

It is important to note that these samples are derived from the Oscilloscope or Voltage Measurement Engine. To get the best time-measurement histograms, use the HISTOGRAM Tool, which allows calculation of RJ, DJ, and TJ.

Dimensions
Opens menu for the sizing and positioning of the box used for histograms.

Display Scale
Choose the number of divisions for the histogram display.



Histogram Dimensions Submenu

Voffset (mV)
Position the histogram box vertically

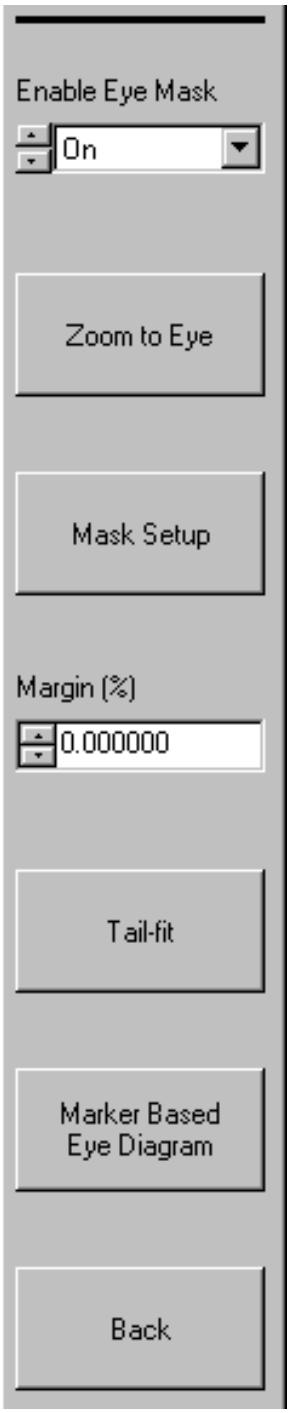
Height (mV)
Scale the height of the histogram box.

Tdelay (ns)
Position the histogram box horizontally

Width (ns)
Scale the width of the histogram box.

Default
Sets the histogram box to a center default position and size.

Eye Mask Menu



Enable Eye Mask
Turns On or Off the Eye Mask feature.

Zoom to Eye
Automatically positions Eye on the display.

Mask Setup
Open a menu for sizing and positioning the Mask.

Margin (%)
The amount of margin allowed in the masked regions.

Tail-fit
This button will open the Tail-fit menu to perform an analysis of the 1 and 0 level noise. This breaks amplitude noise into its Random and Deterministic components and shows a vertical bathtub curve indicating vertical eye closure over time.

Marker Based Eye Diagram
This button opens a separate tool window. The tool creates an eye diagram without the need for a bit-clock. See the discussion earlier in this document on Page 5.

Back
Returns to the previous menu

Mask Setup Menu

Load Mask
Open a dialog box for choice of a previously saved mask.

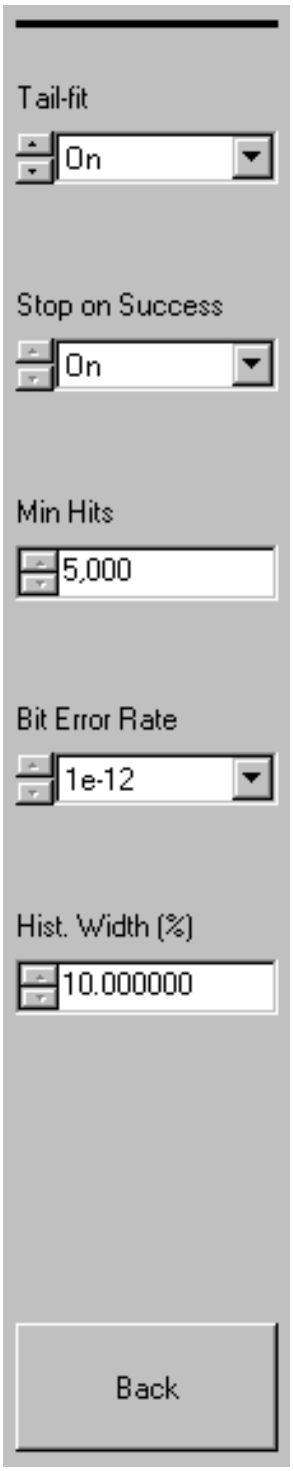
Mask Name
Display the currently loaded mask.

Save Mask
Open a dialog box to save a mask.

Edit Mask
Change the position or size of the mask

Back
Returns to the previous menu

Tail-fit Setup Menu



Tail-fit
Enabling this setting turns on vertical Tailfitting. This will create a histogram of the 1 and 0 level and separate the random and deterministic noise.

Stop On success
The Tail-fit option has certain quality requirements that must be met in order to successfully separate RJ and DJ. If there is a large DJ component, this may require several passes. Enable this option and then use Cycle in order to accumulate until the requirements are met.

Min Hits
A TailFit is not attempted until the number of hits specified is acquired.

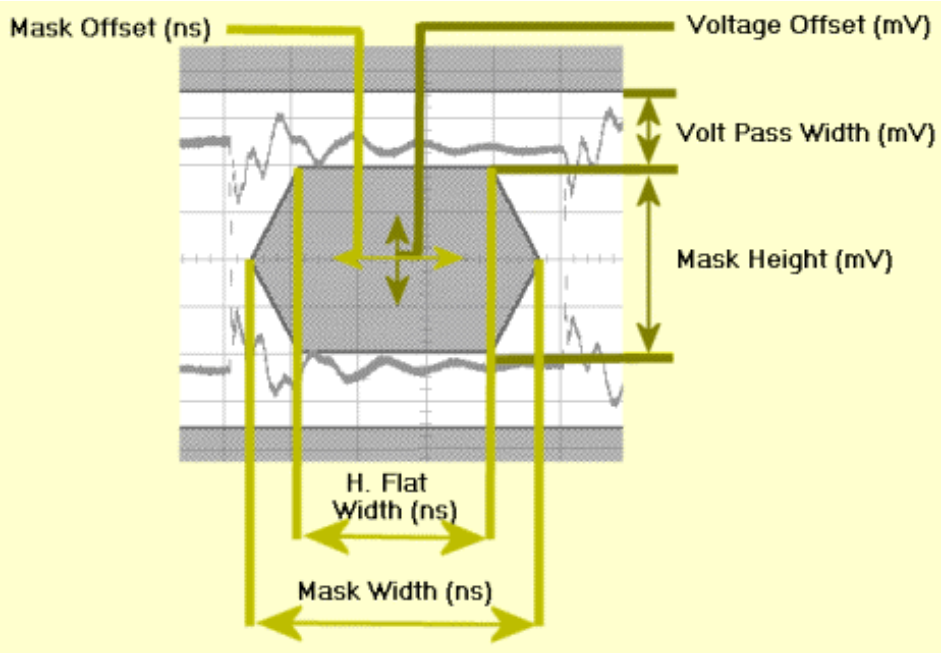
Bit Error Rate
Determines the Bit Error Rate to be used when extracting total jitter from the Bathtub Curve. The default value is $1e^{-12}$. This setting has a direct effect on the TJ value that is calculated. For example, TJ at $1e^{-6}$ will be lower (smaller) than TJ at $1e^{-12}$.

Hist. Width (%)
This is the percent width of a UI of the histogram. Default is 10%. For example, boxes 10% the width of the UI is placed in the center of the eye at the 1 and 0 levels. The samples that fall in these boxes are used to determine a histogram of the amplitude noise for the 1 and 0 levels.

Back
Returns to the previous menu

Edit Mask

Refer to the diagram to see what each setting controls:



Scale to Fit

This setting will scale the mask based on the settings (relative or absolute).

For more information contact:

WAVECREST Corporation
7626 Golden Triangle Drive
Eden Prairie, MN 55344
www.wavecrest.com
1(952)-646-0111