Applications of tool

- Clock to Data analysis, independently analyze data rising and data falling edge histograms relative to either clock rising or clock falling.
- Perform TailFit™ to separate Random and Deterministic Jitter

Introduction

The focus of this paper is to describe the DataCOM—Data with Bit-clock tool and a basic setup for most common tests. This guide will highlight the menus and setup required to perform measurements under most common circumstances. It will also provide a summary of the theory of operation.

The tool analyzes a data signal compared to the bit clock. Because the SIA is able to distinguish rising or falling edges, the instruments are able to display rising edge and falling edge histograms. The Histogram from a familiar eye-diagram provided by an oscilloscope does not distinguish between rising and falling edges.

Random Data with Bit-Clock Panel

Typical view of Random Data Bit Clock:

This particular panel is setup to show three different views within the tool. The top view shows the statistics window. The middle view shows the actual histograms of the rising and falling edges. In this view tailfit is turned on to separate Rj and Dj (note the green tailfit lines on the left and right of the histograms). The bottom view shows the bathtub curve used to gather BER information.

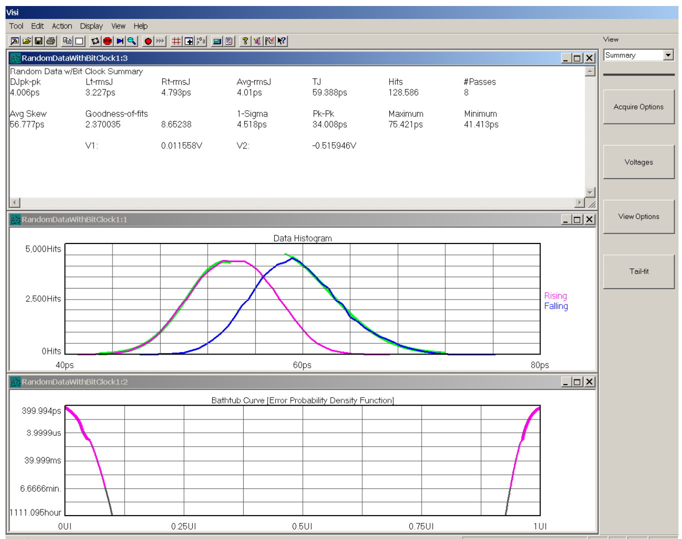


Figure 1. Random Data with Bit Clock views

Interpreting Views/plots

Histogram View

This view shows the measured time on the x-axis and the number of acquired measurements on the y axis. The rising and falling data edge histograms are denoted by the color in the legend to the right. In this view, Tail fit has been enabled. Note the left and right Tail-fits in green.

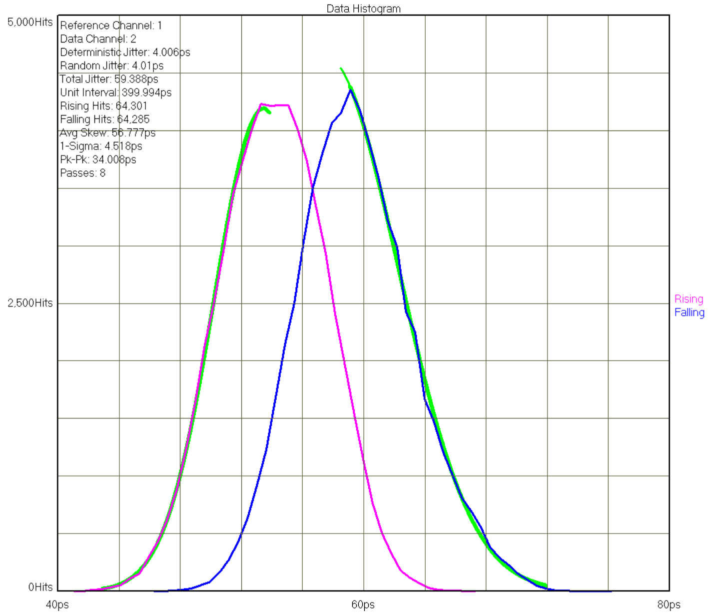


Figure 2. Histogram View

Probability View

This view shows the probability of any particular time being measured. The x-axis shows the measured times and the y-axis shows the probabilities. The rising and falling data edge probabilities are denoted by the color in the legend to the right.

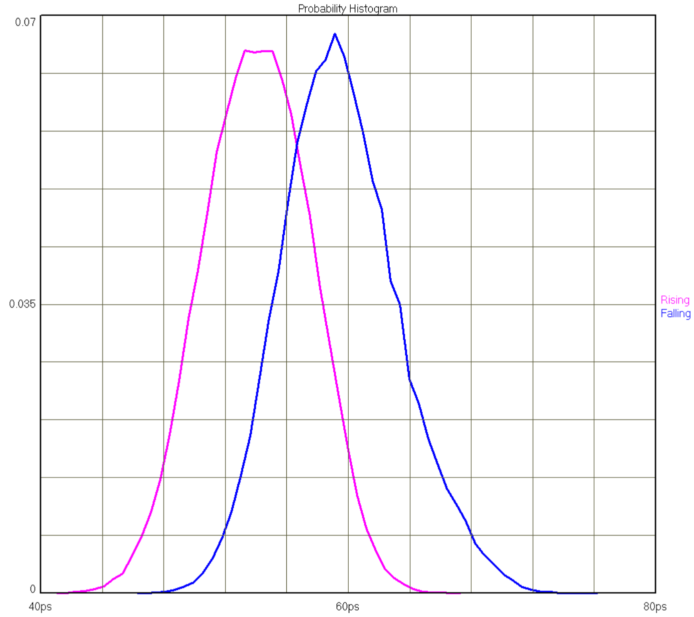


Figure 3. Probability View

Bathtub curve

Shows the "error probability density plot" of a data signal. The plot is normalized to one UI and the Total Jitter (TJ) number in the statistics area is derived from this view. The thick part of the line represents actual measurements. The thin part indicates extrapolated information based on RJ and DJ values. The point at which the color stops is the BER that TJ is determined.

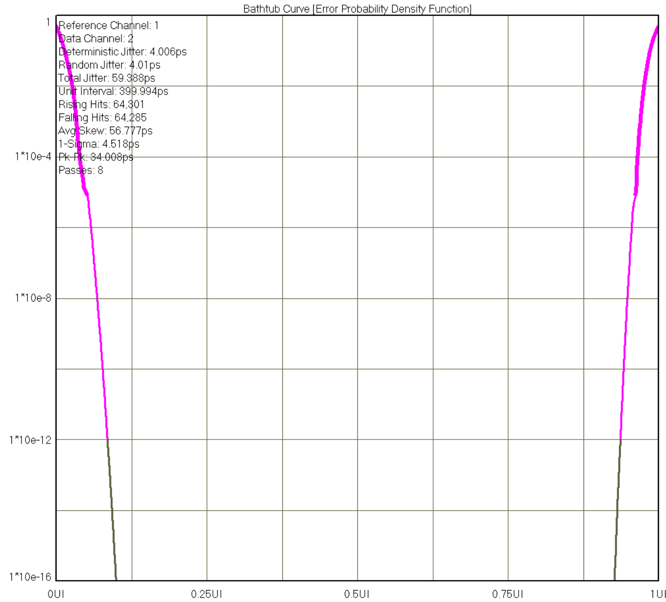


Figure 4. Bathtub Curve

Theory of Operation

This tool provides results very similar to those obtained from an oscilloscope: The histogram of a particular rising/falling edge referenced to a bit-clock (see figure 2). Because of the sampling method rising and falling edge histograms can be displayed separately.

The underlying technique for this measurement is a propagation delay or skew measurement from the bitclock on one channel to the data rising and falling edges on another channel. It is important to note that using this tool has the same disadvantages as the oscilloscope. For instance, jitter is measured relative to the bit clock therefore jitter on the clock may or may not be noticed. There is also no way to determine Data Dependent Jitter (DDJ) on an edge by edge basis.

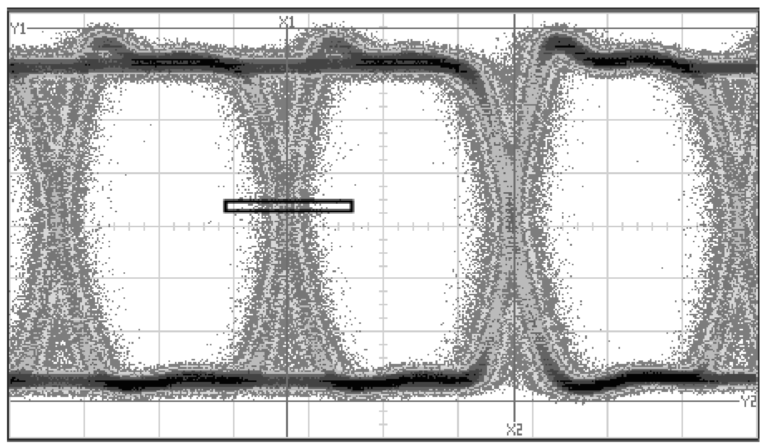
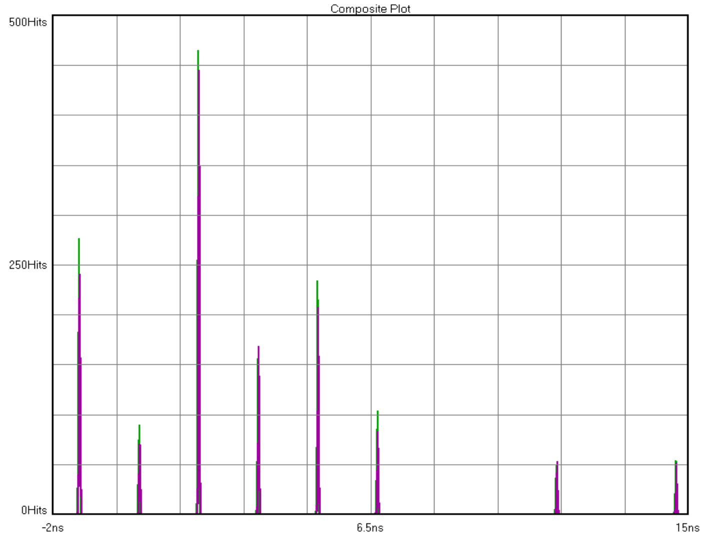


Figure 5. Example of a comparable Oscilloscope measurement

In-depth theory

When making a propagation delay measurement, the instrument will measure various combinations of bit clock edges to different data "periods". For example, a "101" transition would give a distribution of lower values than a "110011" transition. Therefore, the resulting histograms will have many distributions separated by the time of a Unit Interval (UI) see figure 6.



Each of these "unwanted" portions of the histogram are filtered out to yield only the positive measurements not more than one UI from the Clock reference edge. Additionally, the output of the tool shows the data transition closest to the bit-clock reference edge. This is why the chosen "hits per edge" will not equal the "Hits" on the summary page. An oscilloscope has a trigger delay. For a Tail-fit to be performed, the measurement is cycled until enough samples are acquired in the filtered histogram.

Figure 7 shows the Rising and Falling histograms which are the actual output of the tool.

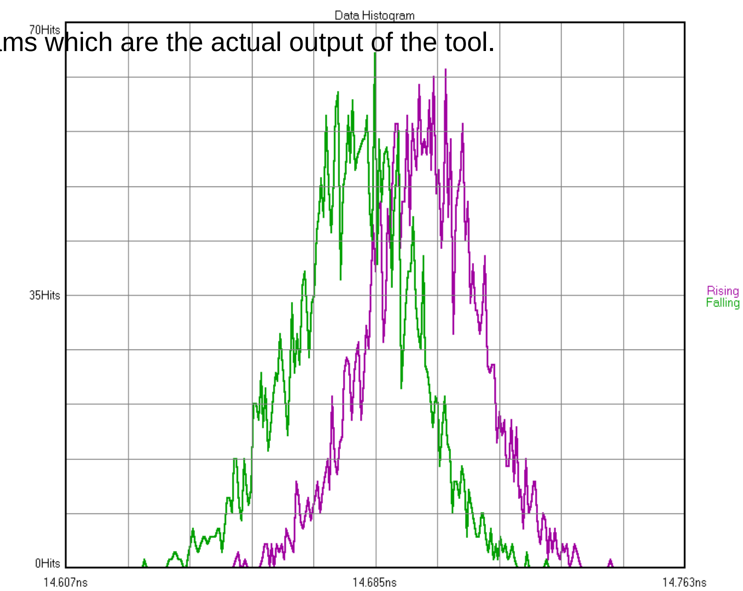


Figure 7. Shows actual results from the Measurement.

Making a Measurement

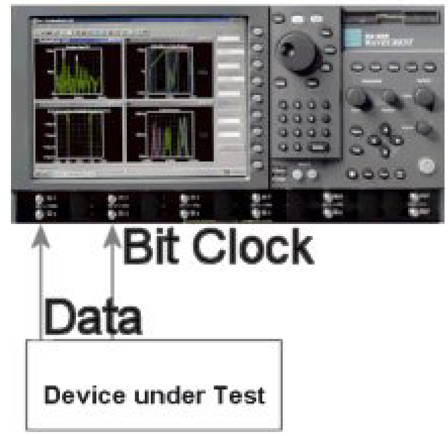
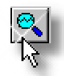


Figure 8. Instrument Setup.

Software channel defaults are:

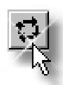
- Connect the **Data signal to CH1.** Choose Ch1 under Acquire Options "Data Channel"

- Connect the **Bit-clock to CH2**. Choose Ch2 under Acquire Options "Reference Channel".

  Press pulse find to set the threshold level. This will use the 50% voltage of the data signal. It is often the case on an oscilloscope, that the measurement is made at the narrowest point of the rising and falling edges. Pressing "Crosspoint detect" will accomplish this (see Figure 9). This will change pulse find mode to USER Volts and optimize the voltage level for the crossing point by moving the Rising/Falling histograms to be on top of each other.

- Press Run to make the measurement.



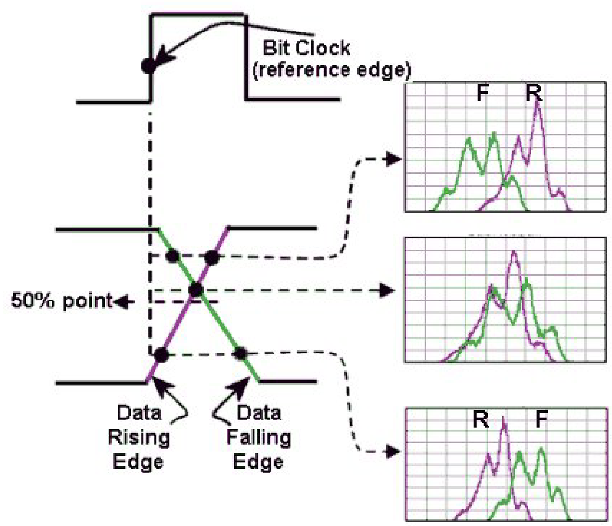


Figure 9. Crosspoint detect

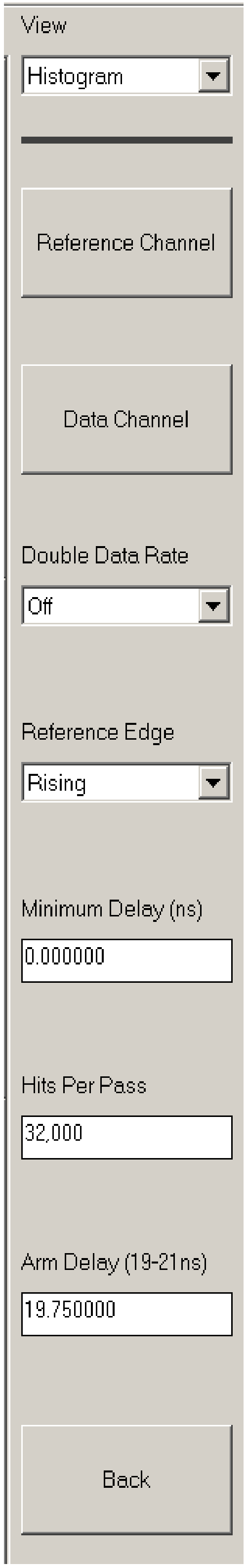
Advanced measurements:

- Choose Tail-fit 'enabled' if you require the TJ calculation from DJ and RJ components. Choose 'Stop Cycle on Success'. When Cycle has been pressed, this will stop the acquisition of data on the first successful Tail-Fit.
- A Delay may be added between the clock and data measurement. In order to choose a different data transition, enter a time value in "Minimum Span". This is useful when trying to compare to Oscilloscope measurements with trigger delays.

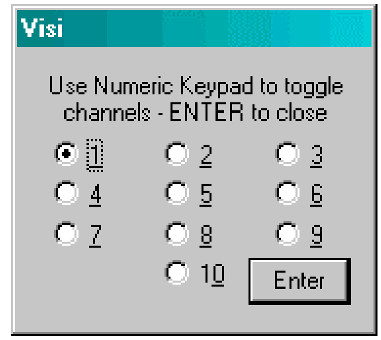
Summary

The oscilloscope based eye diagram is an ideal tool for verifying voltage level stability, over shoot ringing and other voltage based measurements. It is not a good tool for jitter measurement. The Eye Histogram Tool takes the traditional Eye Diagram to a new level. It makes it possible to analyze the rising and falling edges separately. Because of the unique Wavecrest measurement technique, there is no trigger delay. Patented Tailfit algorithms provide for complete RJ/DJ separation leading to timely and accurate reliability modeling.

Acquire Options Menu



View menu
Select the View (plot) type. Choose Histogram, Probability, Bathtub or Summary



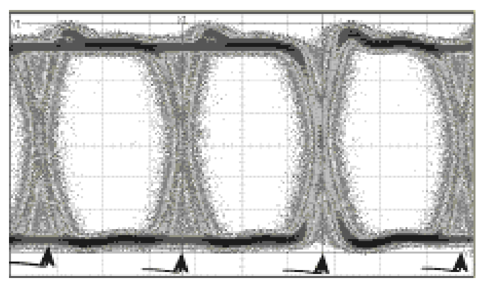
Reference Channel
Select channel for clock input.
Use the keypad or mouse to select a channel, then press enter.

Data Channel
Select Channel For data input.
Use the keypad or mouse to select a channel, then press enter.

Double Data Rate
Double Data Rate should be turned on when a DDR clock is being used. DDR uses BOTH edges (rising and falling) of the clock, therefore the Data with Bit-clock tool measures from both the clock rising and falling to both the data rising and falling edges.

Reference Edge
Select the rising or falling Bit Clock edge to be used to reference the measurements. Arms the measurement based on the Reference edge type chosen and the Measurement edge type chosen.

Minimum Delay
Sets time delay between reference clock edge and data edge allowing different data edges to be measured. Due to the measurement technique of DTS, the closest data edges to a clock reference edge are captured. An oscilloscope has an inherent trigger delay. This value corresponds to the trigger delay on an oscilloscope.

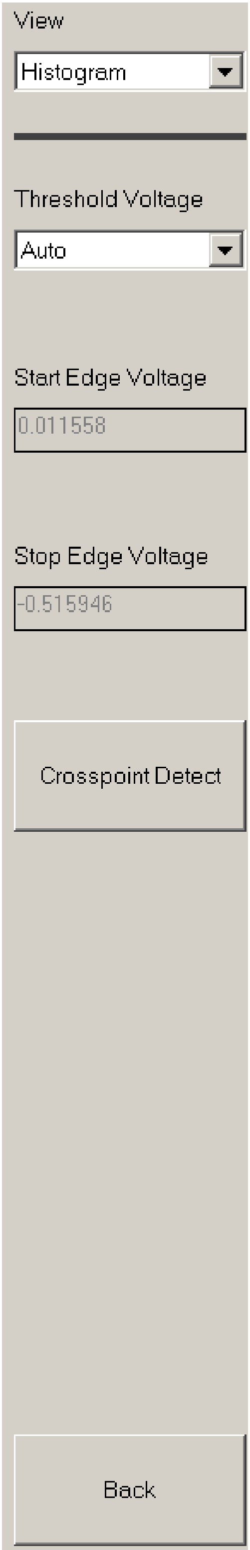


Hits Per Pass
Number of time measurements made before the histograms are filtered to display the final results.

Arm Delay
The arm delay sets the minimum time from an arm event to the first measurement edge. As the diagram below shows, there is a user selectable 19 to 21 ns delay from the Arm event to the first measurement. Typically, if the clock and data signals do not travel on equal path lengths, the arm may have to be adjusted. Negative values, outliers in the histogram, or unexpected results will occur when the arm delay is not properly positioned.

Back
Returns to previous menu.

Voltage Options Menu



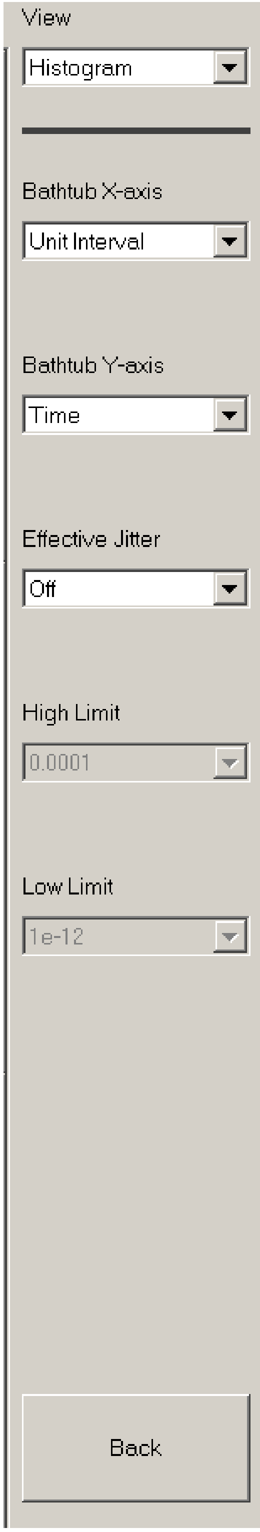
Threshold Voltage
When set to Auto, sets start and stop threshold reference voltages based on the minimum and maximum pulse level found on each channel from the pulsefind. “User Volts” allows the voltages to be set by the user.

Start Edge Voltage
When Threshold Voltage is in Auto, this box displays the voltages set by Pulsefind. When Threshold Voltage is in USER, the box permits manual entry of a voltage.

Stop Edge Voltage
When Threshold Voltage is in Auto, this box displays the voltages set by Pulsefind. When Threshold Voltage is in USER, the box permits manual entry of a voltage.

Crosspoint Detect
Selects the “crossing point” of the rising and falling data edges. See figure 9.

View Options Menu



Bathtub X-axis
Toggles x-axis between UI and Time

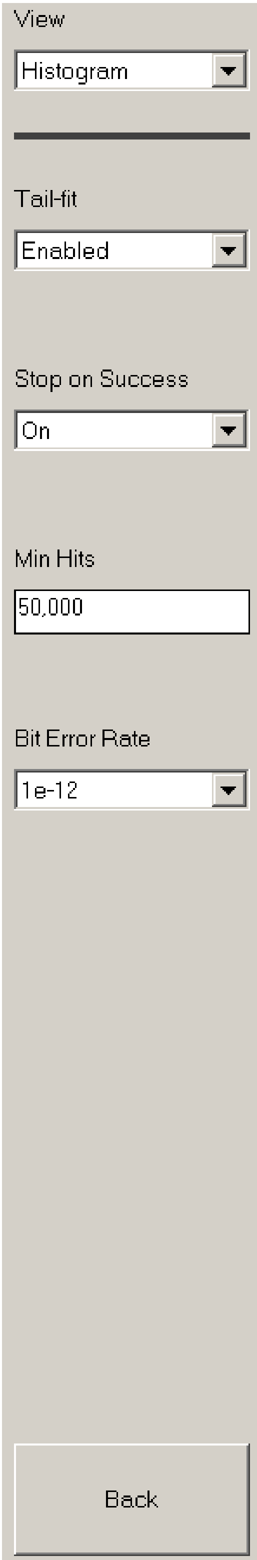
Bathtub Y-axis –
Toggles y-axis between Probability and Time

Effective Jitter –
Several Bit Error Rate Testers (BERT) offer the ability to derive Deterministic Jitter and Random Jitter from a Bathtub Curve. Since this method is based on a pure DCD/DDJ jitter model, it tends to generate lower DJ and higher RJ values. This option is offered in the event values are desired that are determined on a comparable basis to a BERT. The Effective Jitter algorithm uses a total jitter (TJ) value to derive both DJ and RJ. This is opposite of the Tail-Fit (TM) algorithm which determines DJ and RJ to derive TJ.

High Limit –
Set upper limit for Effective Jitter Calculation

Low Limit –
Set lower limit for Effective Jitter Calculation

Tail-fit Menu

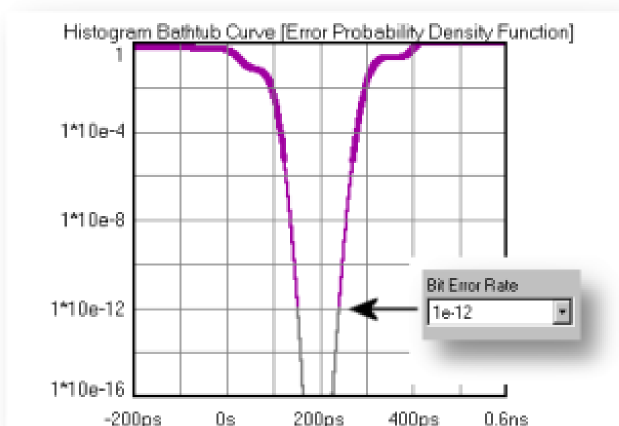


Tail-Fit
Pull-down menu list for enabling/disabling tail-fit feature. When Tail-fit is enabled, Random Jitter and Deterministic Jitter can be separated in order to calculate Total Jitter. To accurately predict long-term clock performance, Tail-fit is necessary when the histogram is not Gaussian.

Stop on Success
The Tailfit 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.



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