Online Help

Tektronix

RT-Eye Serial Data Compliance and Analysis Application

PHP022210

Adapted from the RT-Eye Online Help,Version 1.0.0 (August, 2003)

www.tektronix.com

Tektronix, Inc. P.O. Box 500, Beaverton, OR 97077

RT–Eye Serial Data Compliance and Analysis Online Help, OLH0222, Version 1.0.0

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury:

Connect and Disconnect Properly: Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Observe All Terminal Ratings: To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do Not Operate With Suspected Failures: If you suspect there is damage to this product, have it inspected by qualified service personnel.

Symbols and Terms: The following terms and symbols may appear in the online help.

⚠ **WARNING:** Warning statements identify conditions or practices that could result in injury or loss of life.

⚠ **CAUTION:** Caution statements identify conditions or practices that could result in damage to this product or other property.

Terms on the Product: The following terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product: The following symbol may appear in the product:

CAUTION Refer to Help

Welcome to the RT-Eye™ Serial Data Compliance and Analysis Application

The RT-Eye product is an application that enhances basic capabilities of some Windows-based oscilloscopes from Tektronix. The application incorporates MATLAB run-time and uses it to display real-time graphical representations of the measurement results in plot windows.

The Real-Time Eye (RT-Eye) application provides general compliance measurements and analysis capabilities for emerging serial data standards, and includes the following features:

- Selects and configures multiple measurements on one differential or two single-ended probe inputs
- Performs Timing, Amplitude, and Jitter measurements per industry standard methods
- Displays an RT-Eye rendering of the serial bit stream, as well as other plots such as Jitter Trend, Jitter Spectrum, and Jitter Eye Opening analysis
- Specifies configurable Limits for Pass/Fail analysis on waveforms and measurements when a Limits file is enabled
- Performs "Plug-Fest" level compliance measurements defined by industry working groups using an optional Compliance Module
- Exports analysis results to a .csv file for further analysis
- Tracks and saves the worst case waveforms to .wfm files
- Creates, formats, and generates reports
- Automates compliance tests for production

5-Time Free Trial

A 5-Time Free Trial is available for all applications in the "Applications on this CD and Compatible Oscilloscope" table found in the *Optional Applications Software on a Windows-Based Oscilloscope Installation Manual*. You can start and exit an application up to five times to help you evaluate Tektronix software solutions.

Note: *To evaluate an application, check that your TDS6000- or TDS/CSA7000-series oscilloscope firmware version is V 2.1.0 or above. You can check the firmware version number from the oscilloscope Help drop down list (About ...).*

If an application becomes available after you receive your oscilloscope, you can download the application as described in the installation manual (Tektronix part number 071-1078-xx) to try the free trial.

Related Documentation

In addition to the online help, the application includes a Reference guide. Refer to the *RT-Eye Serial Data Compliance and Analysis Application Reference* for the following information:

- A mini-tutorial to help you quickly take measurements, especially if you have experience with other Tektronix applications
- An overall menu map of the entire application

Refer to the Optional Applications Software on a Windows-Based Oscilloscope Installation Manual for the following information:

- Software warranty
- Software license agreement
- List of all available applications, compatible oscilloscopes, and relevant software and firmware version numbers
- How to use the 5-time free trial
- Installation procedures
- How to enable an application
- How to download files from the Tektronix web site

The *Optional Applications Software on a Windows-Based Oscilloscope CD-ROM* includes many PDF files in the Documents directory that you can view and print.

GPIB Information

For information on how to operate the oscilloscope and use the application-specific GPIB commands, refer to the following documents:

- This online help for an example RT-Eye program that illustrates how to set up and use remote automation
- The user manual for your oscilloscope provides general information on how to operate the oscilloscope
- The online help for your oscilloscope can provide details on how to use GPIB commands to control the oscilloscope if you install the GPIB Programmer guide (and code examples) from the oscilloscope CD-ROM.

Relevant Web Sites

The Tektronix web site offers the following literature:

- *Understanding and Characterizing Jitter Primer*, number 55W-16146-0
- *Basics of Serial Data Validation, Debug, and Compliance Primer*, number 55W-16736-0

You can also find useful information on serial data standards on the following web sites:

- www.Infinibandta.org
- www.pcisig.com
- www.T11.org
- www.tektronix.com/serial_data

Application CD Contents

The *Optional Applications Software on a Windows-Based Oscilloscope CD-ROM* includes files for the following types of documentation:

- Printable file of the RT-Eye Serial Data Compliance and Analysis online help formatted to resemble a user manual
- PDF files of the Methods of Implementation (MOI) for the InfiniBand and the PCI Express serial data standards as they apply to the corresponding compliance modules
- Reference guides
- Optional Applications Installation manual

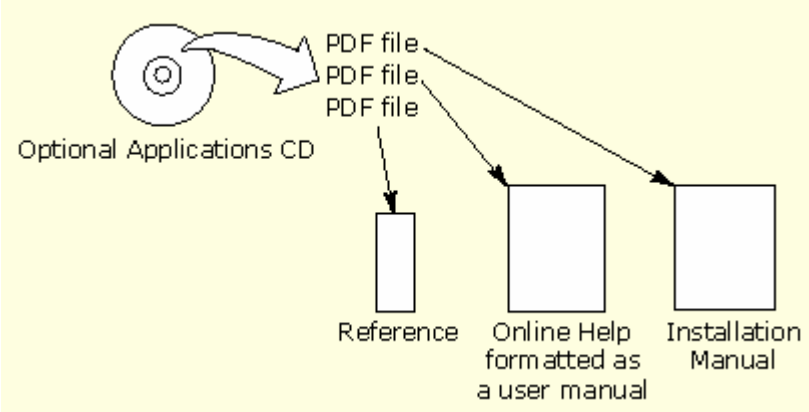


Figure 1. PDF files on the Applications CD.

Access to PDF Files

You can use any of the following methods to view the various PDF files associated with this application:

- Access a file in the Documents directory on the Applications CD from any PC
- Select a file from the Start menu in the oscilloscope task bar; you may need to first minimize the RT-Eye application
- Access a file from the Help drop down list in the RT-Eye application

***Note**: If you do not have an Acrobat reader to view a PDF file, you can get a free copy of the reader from the www.adobe.com/products/acrobat web page.*

Conventions

Online help topics use the following conventions:

- The terms "RT-Eye application" or "application" refer to the RT-Eye Serial Compliance and Analysis Application.
- The term "oscilloscope" refers to any product on which this application runs.
- The term "select" is a generic term that applies to the two mechanical methods of choosing an option: with a mouse or with the Touch Screen.
- The term "Compliance Module" refers to optional "plug-in applications" from Tektronix used for compliance testing to specific serial data standards.
- The term "Limits Module" refers to a formatted text file used to specify user limits on mask geometry and measurement boundary conditions for Pass/Fail testing.
- The term "channel" is context dependent. It can refer to the transmit channel of the device under test or to an oscilloscope channel.
- The term "DUT" is an abbreviation for Device Under Test.
- User interface screen graphics are from a TDS7000 series oscilloscope; there may be minor differences in the displays on other types of oscilloscopes.
- When steps require a sequence of selections using the application interface, the ">" delimiter marks each transition between a menu and an option. For example, one of the steps to recall a setup file would appear as File> Recall.

Types of Online Help Information

The online help contains the following types of information:

- A Getting Started group of topics briefly describes the application, contains connection procedures, and includes a deskew procedure, if required.
- An Operating Basics group of topics covers basic operating principles of the application. The sequence of topics reflects the steps you perform to operate the application and includes definitions for all menus and options.
- A Tutorial group of topics teaches you how to set up the application to acquire a waveform, take a measurement, view the results, view a plot, and save data to a file.
- A Serial Analysis Laboratory group of topics demonstrates how to use serial analysis measurements to identify a problem with a serial data waveform through the process of elimination. This should give you ideas on how to solve your own measurement problems.
- A Reference group of topics includes the parameters (range of values) for all options and the default values.
- A Measurement Algorithms group of topics includes information on measurement guidelines and on how the application calculates each measurement.
- A GPIB Command Syntax group of topics contains a list of arguments and values that you can use with the remote commands and their associated parameters. The application includes a simple remote interface program to show you how to operate the application using GPIB commands.

The application Help drop down list includes a PDF Help menu item you can use to access a PDF file of the help topics. The file is printable and is formatted to resemble a user manual.

The Report Generator utility also has an independent online help system that you can launch from the Report Generator window.

Using Online Help

Online help has many advantages over a printed manual because of advanced search capabilities. You can select Help> Topics on the right side of the application menu bar to display the Help file.

The main (opening) Help screen shows a series of book icons and three tabs along the top menu, each of which offers a unique mode of assistance:

- Table of Contents (TOC) tab - organizes the Help into book-like sections. Select a book icon to open a section; select any of the topics listed under the book.

- Index tab - enables you to scroll a list of alphabetical keywords. Select the topic of interest to display the corresponding help page.
- Find tab - allows a text-based search. Follow these steps:

1. Type the word or phrase you wish to find in the search box.

   If the word or phrase is not found, try the Index tab.

2. Select some matching words in the next box to narrow your search.

3. Choose a topic in the lower box, and then select the Display button.

Note: *The Find tab function does not include words found in graphics. Refer to the Find Tab and Searches topic for more information.*

- To print a topic, select the Print button from the help topics menu bar.
- Select Options from the menu bar for other commands, such as to annotate a topic, to keep the help window on top, or to use system colors.
- Select the Back button to return to the previous help window. Sometimes you can jump from one topic to another through a hyperlink. If the Back button is grayed out, or a jump is not available, choose the Help Topics button to return to the originating help folder.
- Browse buttons (Next >> and Previous <<) allow you to move forward and backward through topics in the order of the Table of Contents (TOC).
- A **Note**: in the topic text indicates important information.

Note: *Green-underlined text indicates a Jump (hyperlink) to another topic. Select the green text to jump to the related topic. For example, select the green text to jump to the topic on Feedback to contact Tektronix.*

You can tell when the cursor is over an active hyperlink (button, jump, or popup), because the arrow cursor changes to a small pointing hand cursor.

The light bulb icon and word Tip in the graphic above indicates additional information to help you operate the application more efficiently.

Online Help for the Report Generator

The Report Generator utility is a separate program that appears when you want to create a new test template or report layout, or when you want to edit an existing one. The online help for the Report Generator explains how to use the utility.

Find Tab and Searches

Many online help topics only contain tables. To retain vertical and horizontal lines, the tables are graphical objects. The Find tab in the online help does not recognize words in these tables.

The online help is extensively indexed with the proper names of all menus and options as they appear in the application and in the left column of graphical tables.

Note: *If you conduct a Find tab search with no results, try the Index tab instead.*

Contacting Tektronix

Phone	1-800-833-9200*
Address	Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA
Web site	www.Tektronix.com
Sales support	1-800-833-9200, select option 1*
Service support	1-800-833–9200, select option 2*
Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3* 1-503-627-2400 6:00 a.m. - 5:00 p.m. Pacific time

*** This Telephone number is toll free in North America. After office hours, please leave a voice mail message. Outside North America, contact a Tektronix sales office or distributor; See the Tektronix web site for a list of offices.**

Feedback

Tektronix values your feedback on our products. To help us serve you better, please send us suggestions, ideas, or other comments you may have about your application or oscilloscope.

You can email your feedback to techsupport@tektronix.com, FAX at (503) 627-5695, or by phone. Please be as specific as possible and include the following information:

General Information

- Oscilloscope model number and hardware options, if any
- Probes used
- Serial data standard
- Signaling rate
- Your name, company, mailing address, phone number, FAX number

Note: *Please indicate if you would like to be contacted by Tektronix regarding your suggestion or comments.*

Application-Specific Information

- Software version number
- Description of the problem such that technical support can duplicate the problem
- If possible, save the oscilloscope waveform file as a .wfm file
- If possible, save the oscilloscope and application setup files from the application to obtain both the oscilloscope .set file and the application .ini file. Refer to Saving a Setup File.

Once you have gathered this information, you can contact technical support by phone or through e-mail. If using e-mail, be sure to enter in the subject line "RT-Eye Problem," and attach the .set, .ini, and .wfm files.

Note: *To include screen shots, from the oscilloscope menu bar, select File> Export. In the Export dialog box, enter a file name with a .bmp extension and select Save. The file is saved in the C:\TekScope\Images directory. You can then attach the file to your email (depending on the capabilities of your email editor).*

Getting Started

The RT-Eye Serial Compliance and Analysis Application is a software product that enhances basic capabilities of some MS Windows based oscilloscopes offered by Tektronix. The RT-Eye application is a general analysis tool you can use to test, debug, and verify serial-data based designs. The compliance applications are specific tools you can use with device designs that must comply with serial data standards, such as PCI Express or InfiniBand.

You can use this application to do the following tasks:

- Select and configure many amplitude and timing measurements on an 8B/10B encoded data signal
- Conduct RT-Eye rendering and mask testing, Time Interval Error analysis, Rj/Dj (random jitter and deterministic jitter) analysis, and display results as a Bathtub plot
- Display the results as eye diagram, histogram, time trend, spectrum, or bathtub curve plots
- Perform Pass or Fail limits testing based on waveform masks and based on measurements that use Limits Modules
- Perform "plug-fest" level compliance tests for available compliance modules that test against a specific standard
- Save the statistical results to a file
- Save the worst case waveforms to files
- Generate reports

Analysis and Compliance Modules

The RT-Eye (real-time eye) serial data analysis, the InfiniBand serial data compliance, and the PCI Express serial data compliance applications are the first in a series of products you can use to characterize serial transmission signal integrity. The applications were developed to help you perform analysis on the following types of designs:

- General serial-data based designs
- Device designs that need to comply with a specific serial-data standard

The RT-Eye application is the foundation for current and for future compliance modules. The PCI Express and InfiniBand compliance applications are for compliance testing to serial data standards. The number of compliance applications will increase as new serial data standards emerge.

Each enabled compliance application shows at least two choices in the Modules drop down list; one will always be for Serial Analysis.

Compatibility

For information on oscilloscope compatibility, refer to the *Optional Application Software on MS Windows Based Oscilloscopes Installation Manual,* Tektronix part number 071-1078-xx. The manual is also available as a PDF file.

Minimum Required System Configuration

To operate the RT-Eye application, check Help> About TekScope from the oscilloscope menu bar to verify that the oscilloscope has the following required system configuration:

- Windows 2K OS
- 850 MHz Processor
- 512 MB SDRAM
- Firmware Version 2.4.0

Requirements and Restrictions

The Sun Java Run-Time Environment (JRE) and The Mathworks MATLAB Run-Time Server are components of the RT-Eye application. When you install the application, the InstallShield Wizard automatically installs the proper software components.

MATLAB Server. The MATLAB server is dedicated to the RT-Eye application and cannot be used for other purposes. Do not close the Matlab Server icon  in the oscilloscope task bar as this will disrupt the operation of the RT-Eye application. The application will close the MATLAB sever when you exit the application.

Oscilloscope. A sampling rate of 20 GS/s with interpolation is often necessary to ensure accurate results. Be sure to consider the following differences in sampling rates before taking measurements:

- The TDS6604 oscilloscope samples at 20 GS/s on two channels and at 10 GS/s on four.
- The TDS7404 oscilloscope samples at 20 GS/s on one channel and at 10 GS/s on two.

When the Record Length of the oscilloscope is set to less than 4 M, the application can take all measurements. When the Record Length is set to 4 MHz or more, the RT-Eye application can take up to four measurements.

Keyboard. You will need to use a keyboard to enter new names for some file save operations.

Distiller Software. You will need distiller siftware to convert an RTF file from the Report Generator utility to a PDF file, such as Adobe Acrobat 6.0.

Accessories

There are no standard accessories for this product. However, you can refer to the product datasheet available on the Tektronix web site for information on optional accessories relevant to your application. For example, Tektronix recommends that you use the following probes:

Table 1: Probe Information

Probe*	Description
P7350SMA	5 GHz SMA Input Active Differential
P7350	5 GHz Differential Active
P7260	6 GHz Single Ended Active
***Check the www.Tektronix.com web site for an up-to-date list of probes and information on standard-specific test fixtures.**	

Installation

Refer to the *Optional Applications Software on a Windows-Based Oscilloscope Installation Manual,* Tektronix part number 071-1078-xx, for the following information:

- List of all available applications, compatible oscilloscopes, and relevant software and firmware version numbers
- How to use the 5-time free trials
- How to apply a new authorized Option Installation key label
- Installation procedures
- How to enable an application
- How to download updates from the Tektronix web site

Connecting to a Device Under Test

You can use any compatible probes to connect between your DUT (Device Under Test) and oscilloscope. Refer to the General Safety Summary earlier in this file and in your oscilloscope user manual.

There are four typical probing configurations for serial data links: two for Pseudo Differential Waveforms and two for True Differential Waveforms. The method of setting up your measurement channel(s) is dependent on your application and what you want to measure.

⚠ ***WARNING:*** *To avoid electric shock, you must ensure that power is removed from the DUT before attaching probes to it. Do not touch exposed conductors except with the properly rated probe tips. Refer to the probe manual for proper use.*

Table 2: Probe Configuration

		Probing Configurations			Captured Waveforms		System Specifications			
							TDS6604		TDS/CSA7404	
		Probe	Break Serial Link	Channels Used	Differential Mode	Common Mode	Band Width	Rise* Time (20-80)	Band Width	Rise* Time (20-80)
SMA Connection	A	2 x TCA-SMA	Y	2	Pseudo	AC	6GHz	53ps	4GHz	75ps
	B	1 x P7350SMA	Y	1	True	No	5GHz	75ps	4GHz	75ps
ECB Pad Connection	C	2 x P7260	Y/N	2	Pseudo	AC/DC	6GHz	53ps	4GHz	75ps
		2 x P7350	Y/N	2	Pseudo	AC/DC	5GHz	75ps	4GHz	75ps
		2 x P7240	Y/N	2	Pseudo	AC/DC	na	na	4GHz	75ps
	D	1 x P7350	Y/N	1	True	No	5GHz	75ps	4GHz	75ps

*Based on 10-90 Gauranteed Specification

Note: *When deciding what oscilloscope and probe combination to use, it is recommended that the system bandwidth is greater than 1.5 times the bit rate. This provides adequate bandwidth for reasonable Rise Time measurements because most of the energy in high-speed serial data signals is contained in the 1st and 3rd harmonic*

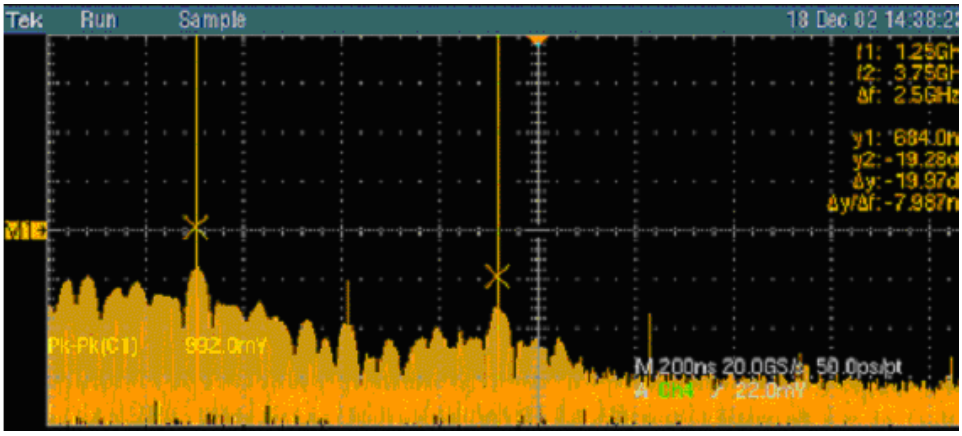


Figure 2. Power Spectrum of a 2.5 Gb/sec signal example. The 1st and 3rd harmonics are the two highest peaks.

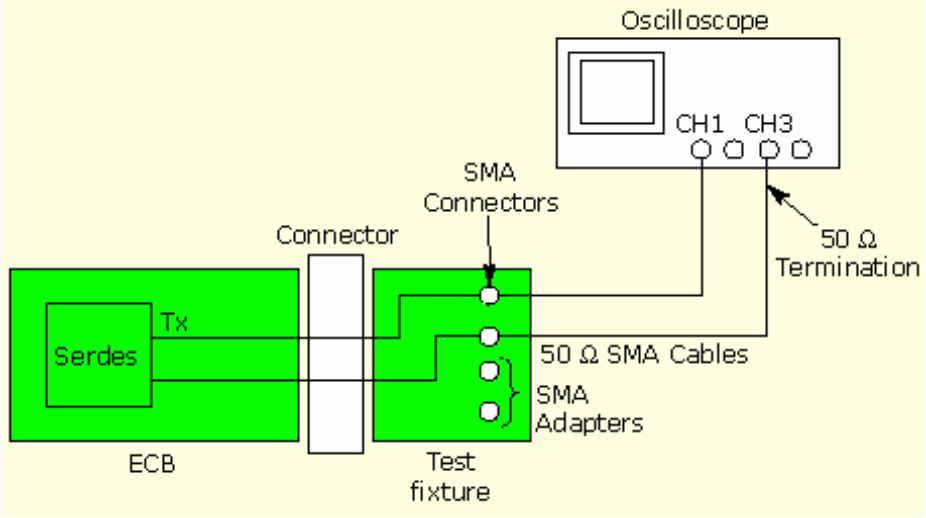


Figure 3. Two TCA-to-SMA Adaptors, Diagram A.

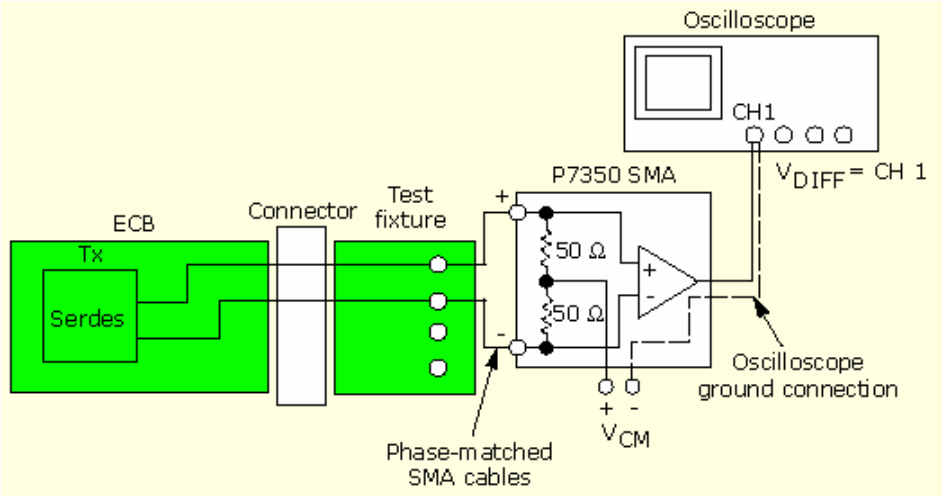


Figure 4. One P73XXSMA Differential Probe, Diagram B.

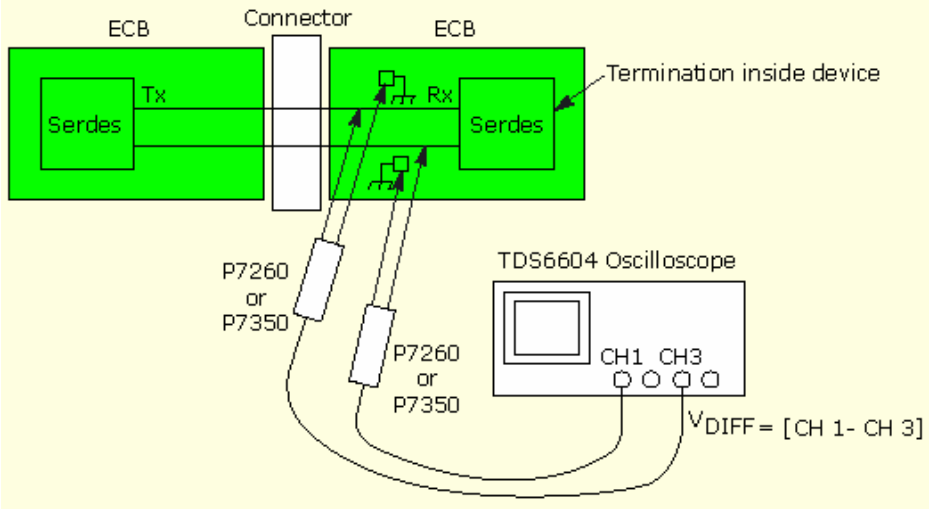


Figure 5. Two P72XX Single Ended or P73XX Differential Probes, Diagram C.

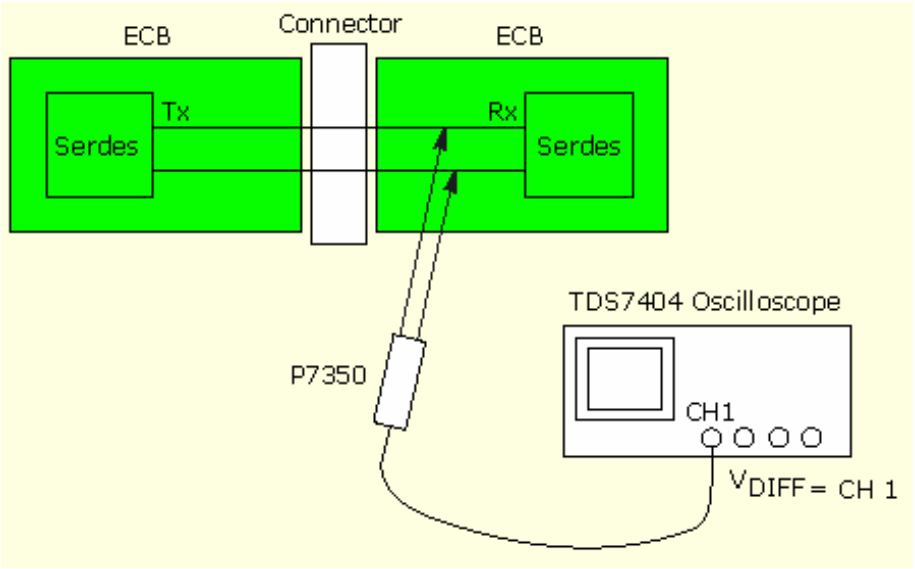


Figure 6. One P73XX Differential Probe, Diagram D.

Deskewing Probes and Channels

When using two channels to perform pseudo-differential measurements, it is important to deskew the probes. Be sure to use the proper deskew fixture and procedure as described in the online help of your oscilloscope.

Note: *The RT-Eye application relies on upsampled, deskewed data from the oscilloscope to conduct math operations for differential and common mode waveform measurements. Upsampling prior to deskew is required to ensure accurate measurements.*

Operating Basics

The topics in the Operating Basics book cover the following definitions and tasks:

- Application user interface
- Basic oscilloscope functions
- Saving and recalling set up files
- Setting up the application
- Using a Limits file
- Using User Masks
- Taking measurements
- Saving the measurement results
- Viewing the measurement results as plots
- Using the plot window zoom and cursors
- Saving plots
- Logging the worst case waveforms
- Creating and generating a custom compliance report

Starting an Application

On the oscilloscope menu bar, select File> Run Application> RT-Eye Serial Compliance and Analysis.

The application starts and displays the Measurements Select menu.

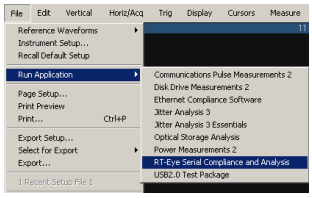


Figure 7. Oscilloscope Menu Bar and Selected Application.

Application Interface

The RT-Eye application uses a Microsoft Windows based interface.

Note: *The oscilloscope application shrinks to half size and appears in the top half of the screen when the application is running.*

Table 3: Application User Interface Items Definitions

Item	Description
Area	Visual frame that encloses a set of related options
Box	Use to define an option; enter a value with the Keypad or a Multipurpose knob to
Browse	Displays a window where you can look through a list of directories and files
Button	Use to define an option; not a command button
Check box	Use to select or clear an option
Command button	Initiates an immediate action, such as the Start command button in the Control panel
Control panel	Located to the right of the application; contains command buttons that you use often, such as to Start sequencing
Keypad	On-screen keypad that you can use to enter numeric values
List box	Use to define an option from a list of
Menu	All options in the application window (except the Control panel) that display when you select a menu bar item
Menu bar	Located at the top of the application display and contains application menus
Option	Any named button (other than a command button) or any named box that defines a control or task
Status bar	Line located at the bottom of the application display that shows the name of the current menu (location) and the next step that you might take (action)
Tab	Short cut to a menu in the menu bar or a category of menu options; most tabs are short cuts
Virtual keyboard	On-screen keyboard that you can use to enter alphanumeric strings, such as for file names
Scroll bar	Vertical or horizontal bar at the side or bottom of a display area that you use to move around in that area

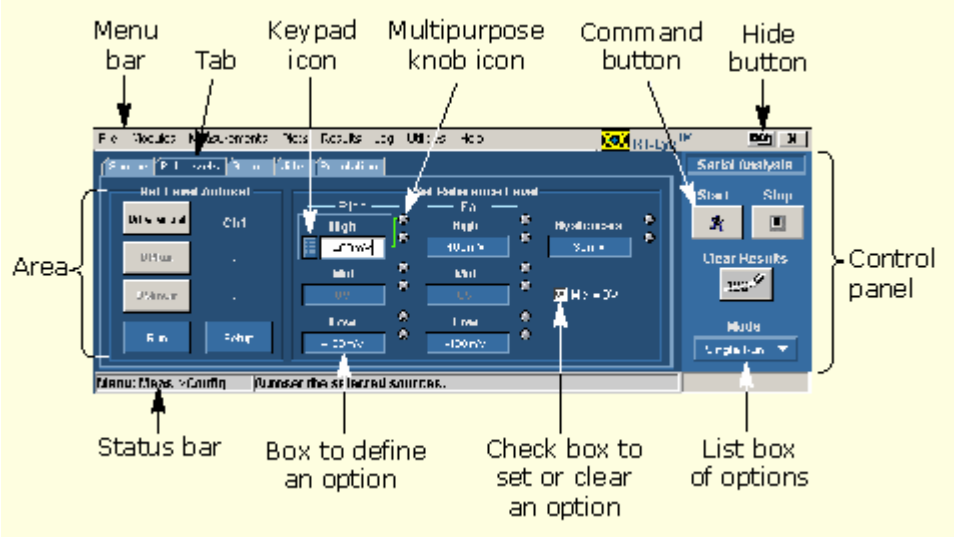


Figure 8. Menu with Application User Interface Items

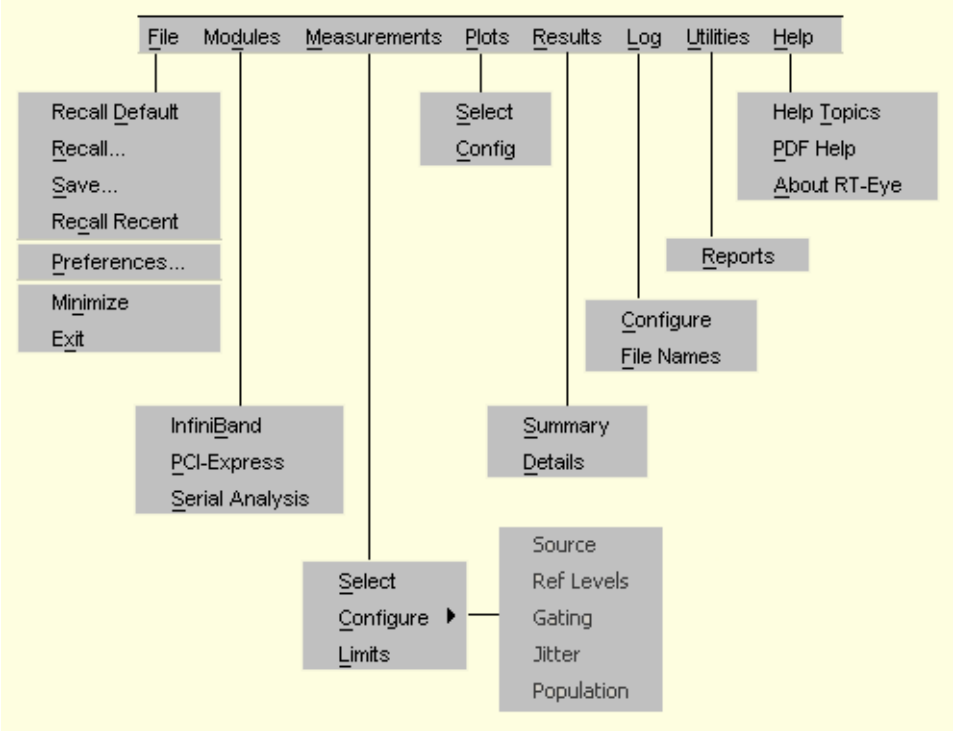


Figure 9. Application Menu Bar and Drop-Down Lists

Using Basic Oscilloscope Functions

You can use oscilloscope controls and functions. To do so, select a menu from the Menu bar (or Toolbar) and access menus, or use the front-panel knobs and buttons. You can also use the oscilloscope Help menu to access information about the oscilloscope and how to use it.

When you access some oscilloscope controls, the oscilloscope fills the display.

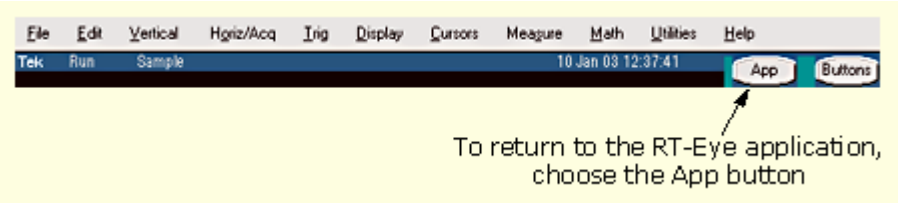


Figure 10. Returning to the Application

Hiding the Application

The Hide function minimizes the application and the oscilloscope fills the display. To hide and return to the application, follow these steps:

1. Select the  command button in the application menu bar.
2. Use the oscilloscope.
3. Return to the application.

Minimizing and Maximizing the Application

To minimize the RT-Eye application, select File> Minimize in the application menu bar.

To maximize the application, select 

in the task bar.

Exiting the Application

To exit the RT-Eye application, select File> Exit or the  (Exit) command button in the application menu bar. When you exit the application, you can select to keep the oscilloscope setup currently in use with the application or to restore the oscilloscope setup that was present before you started the application.

Application Directories and Usage

During installation, the application sets up directories for various functions, such as to save setup files, and uses extensions appended to file names to identify the file types.

Table 4: Application Directories and Usge

Default directory names*	Directory use
\modules\SerialAnalysis	Serial Analysis application home location
\modules\SerialAnalysis\data	Measurement results files
\modules\SerialAnalysis\limits	Limits files for Pass or Fail compliance tests
\modules\SerialAnalysis\masks	Waveform mask files for plots and limits testing
\modules\SerialAnalysis\setup	Setup files
\modules\SerialAnalysis\waveforms	Log worst case waveforms and recall waveform files
\Examples\Masks	Mask files for many serial data standards
\Examples\RemoteCtrl	Sample remote control program
\Examples\WFMS	Waveforms for learning
\images	Plot files
\temp	Temporary files
\ReportGenerator\modules\Serial Analysis\Reports	Files created by the Report Generator utility
*** All subdirectories are located in the C:\TekApplications\tdsrt-eye directory.**	

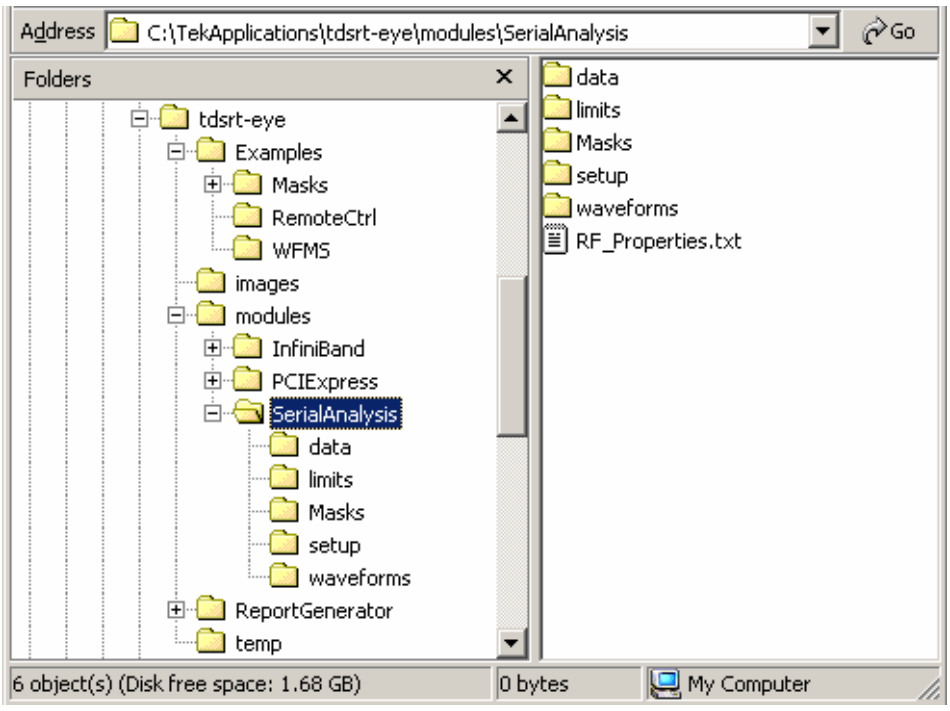


Figure 11. Directory Structure for the Serial Analysis Application.

Table 5: File Name Extensions

Extension	Description
.bmp	File that uses a “bitmap” format
.csv	File that uses a "comma separated variable" format
.dat	File with binary format; stores waveform vectors
.fig	Plot file with binary data
.gif	File that uses a “graphics interchange format”
.ini	RT-Eye application setup file
.jpg	File that uses a “joint photographic experts group” format; also known as JPEG
.lim	Limits file used with Pass/Fail compliance tests
.mat	MATLAB waveform vector header saved to the hard disk
.msk	Waveform mask file used with plots
.pdf	File that uses a “portable data format”
.png	File that uses a “portable network graphics” format
.rgt	File that defines the report template
.rpl	File that defines the report layout
.rpt	File created by the Report Generator utility
.rtf	File that uses a “rich text format”
.set	Oscilloscope setup file saved that is recalled with an application .ini file; both files will have the same name
.wfm	Waveform file; can be recalled into Reference memory

How to Enter Alphanumerical Values

Note: *Press the FINE button on the oscilloscope to enter or select the smallest values or units.*

Note: *Be sure to select the CLR button when using the keypad before you enter a value.*

Table 6: Methods to Enter Alphanumeric Values

Method	Description
 Keypad	When you select the keypad icon, the virtual keypad appears (looks similar to a calculator); use to enter a value
 Multipurpose knob*	When you select a knob icon, a line appears between the upper icon and the option box. This activates the upper multipurpose knob on the front panel of the oscilloscope; turn the knob to select a value
 Keyboard	When you select the keyboard icon, the virtual keyboard appears (looks similar to a physical keyboard); use it to enter a file name
Edit box*	Type in a value from the physical keyboard and press the Enter key
*** When selected twice, the Keypad appears.**	

Virtual Keypad

Note: *Select the*  *icon, and then use the virtual keypad to enter information, such as reference voltage levels.*

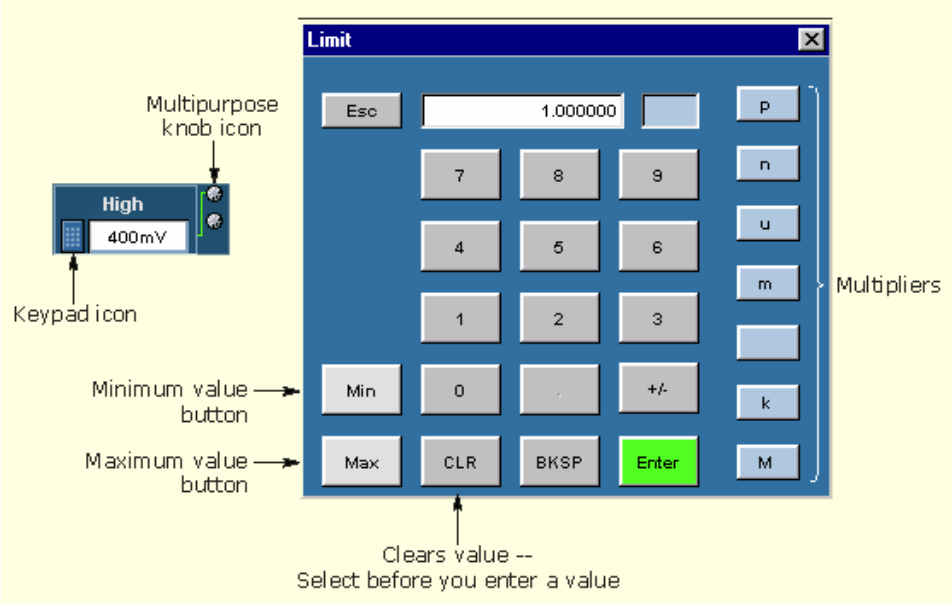


Figure 12. Virtual Keypad.

Virtual Keyboard

Note: *Select the*  *icon, and then use the virtual keyboard to enter information, such as file names.*

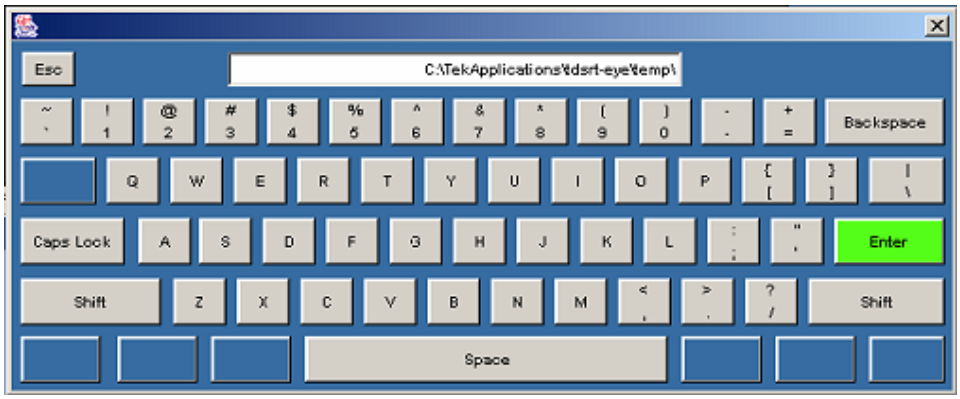


Figure 13. Virtual Keyboard.

File Menus

You can use the File menus to save and recall different application setups and recently accessed files. Display the definitions of the file menus.

Note: *The File> Save function saves application settings in an .ini file and the settings of the oscilloscope application in a .set file with a matching name.*

If an oscilloscope .set file with a matching name is found when you recall an application setup file, then the oscilloscope settings are recalled also. If the .set file is missing or cannot be opened by the oscilloscope, then the application recalls the application settings and displays a message that the Recall of the .set file failed.

⚠ ***CAUTION:*** *Do not edit a setup file or recall a file not generated by the application.*

Table 7: File Menus

Menu/function	Description or function
Recall Default	Recalls most default (startup) parameters for the active module
Recall*	Browse to select an application setup (.ini) file to recall the setup file. Recall restores the application to the values saved in the setup
Save*	Save the current application settings in a .ini
Recall Recent	Select from a list of the four most recently accessed setup files (saved or recalled) and recall that setup
Preferences	Displays the Preferences menu; settings apply until you exit the application; saved setup files include the settings
Minimize	Minimizes the application
Exit	Exits the application; you can choose to retain the current oscilloscope settings or restore the oscilloscope to settings prior to starting the application
***Save or Recall functions also save or recall the associated oscilloscope setup file (.set); an oscilloscope file is recalled if the application finds a .set file with a matching name.**	

Saving a Setup File

To save the application and oscilloscope settings to a setup file, follow these steps:

1. Select File> Save. View the Save browser.

   The Save dialog box appears. To view details about the file, such as size, type, and date modified, select the Details tool.

2. In the file browser, select the directory in which to save the setup file or use the current directory.

3. Select or use the keyboard to enter a new file name.

   The application appends an ".ini" extension to the name of the application setup file.

4. Select the Save command button.

Note: *The application also saves the oscilloscope setup to a ".set" file when you save an application setup. Both the application .ini file and oscilloscope .set file have the same file name.*

Note: *To view details, such as file size, type, and date modified, select the Details tool.*

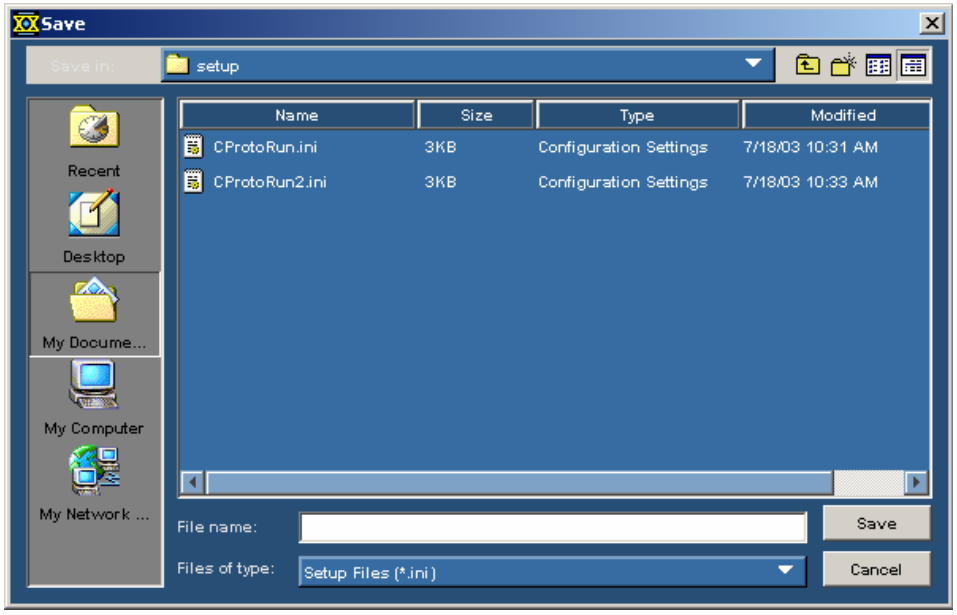


Figure 14. File: Save Browser.

Recalling a Saved Setup File

To recall the application and oscilloscope settings from saved setup files, follow these steps:

1. Select File> Recall. View the Recall browser.

   The Recall dialog box appears. To view details about the file, such as size, type, and date modified, select the Details tool.

2. In the Recall dialog box, select the directory from which to recall the setup file.

3. Select a setup file name, and then select Open.

Note: *The application recalls the .ini setup file and the associated oscilloscope setup if the application can find a .set file with a matching name.*

⚠ ***CAUTION:*** *Do not edit setup files. If you try to recall a setup file that has been edited, the recall operation fails.*

⚠ ***CAUTION:*** *If a matching .set file is not found or if the .set file does not recall correctly to the oscilloscope, then a warning appears that says the oscilloscope recall failed while the RT-Eye application recall succeeded.*

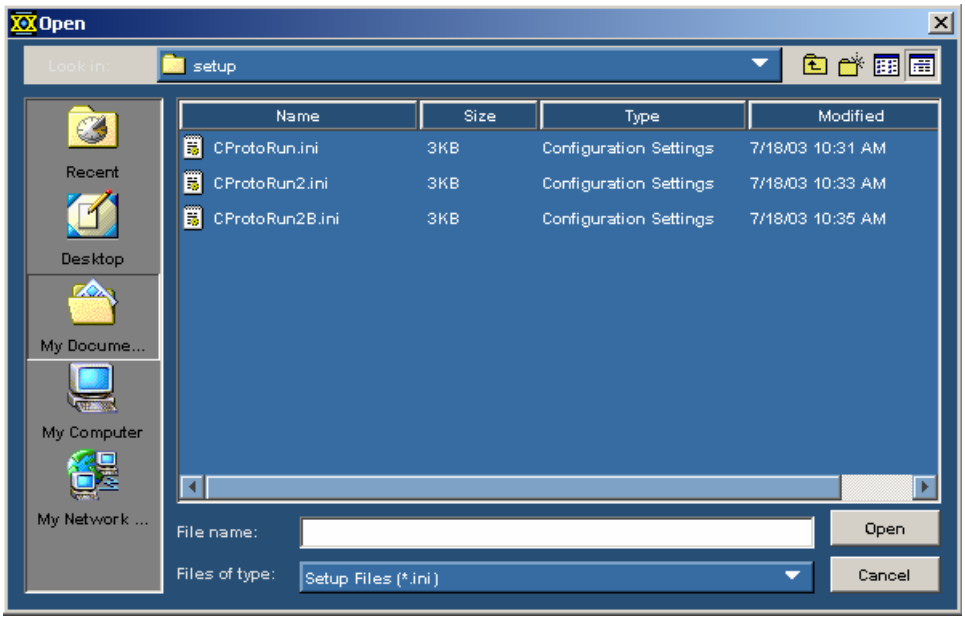


Figure 15. File: Recall Browser.

Recalling the Default Setup

To recall the default application settings, select File> Recall Default.

Note: *Most of the settings for the active module are recalled to the default state.*

Recalling a Recently Saved or Accessed Setup File

To recall a recently saved or accessed setup file, select File> Recall Recent… and then the file from the drop down list of setup file names.

Note: *The application also recalls the associated oscilloscope setup if the application can find a .set file with a matching name.*

⚠ ***CAUTION:*** *Do not edit setup files. If you try to recall a setup file that has been edited, the recall operation fails.*

⚠ ***CAUTION:*** *If a matching .set file is not found or if the .set file does not recall correctly to the oscilloscope, then a warning appears that says the oscilloscope recall failed while the RT-Eye application recall succeeded.*

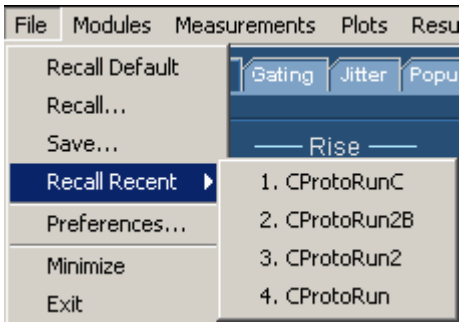


Figure 16. Recall Recent Drop Down List Example.

Defining Preferences

The application includes options that you can set, and these options remain applied until you change them or until you exit the application. The options can help you to operate the application more efficiently.

The File Preferences menu contains several check box options that you can set (enable) or clear (disable). Saved setup files include the File Preferences settings.

Table 8: File Preferences Menu Options

Option	Description
Popup Autoset Summary everytime Autoset is selected	Applies the Autoset functions from the Measurements Select menu without displaying the Autoset Summary menu
Limit Rise/Fall measurements to transition bits only	Acquires and takes measurements only from transition bits; non-transition bits are not acquired
Limit Amplitude measurements to transition bits only	Acquires and takes measurements only from transition bits; non-transition bits are not acquired
Apply	Applies options that are set (checked)
Cancel	Discards changes and closes
OK	Accepts changes and closes

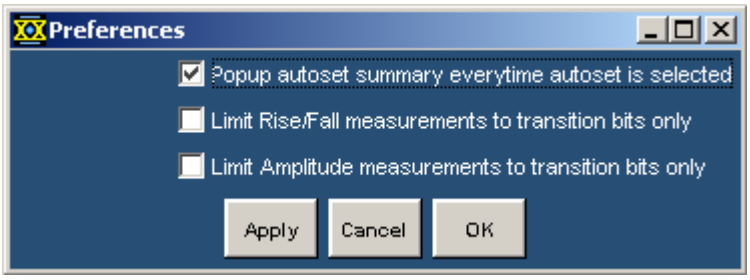


Figure 17. File: Preferences Menu.

Setting Up the Application

You need to set up the RT-Eye application for serial data analysis or for serial data standard compliance testing. To do so may require that you perform some or all of the following tasks:

- Choose the probe configuration: differential or single-ended
- Select all desired measurements
- Select the Autoset command button

This automatically sets the range of the vertical scale, sets the horizontal resolution, and dynamically sets the waveform crossing thresholds based on signal characteristics.

- Configure measurement options manually in the Source, Ref Levels, Gating, Jitter, and Population menus
- Select and configure all desired plots (up to four at one time)

After setting up the application, you can select the Start command button to take measurements. The application displays the results as statistics and as plots if you set up the Plots menus and enabled the Plots Display option.

Note: *You can enable and adjust Measurement Limits checking to create a Pass or Fail type of compliance test. You can also import and modify your own masks.*

After taking measurements, you can do any of the following tasks:

- View the results as statistics
- Save statistics in a .csv file
- View the results as a plot
- Use the Zoom functions in a plot
- Use the Cursors functions in a plot
- Save a plot file
- Print a plot
- Save the worst case waveforms as .wfm files
- Generate a report file

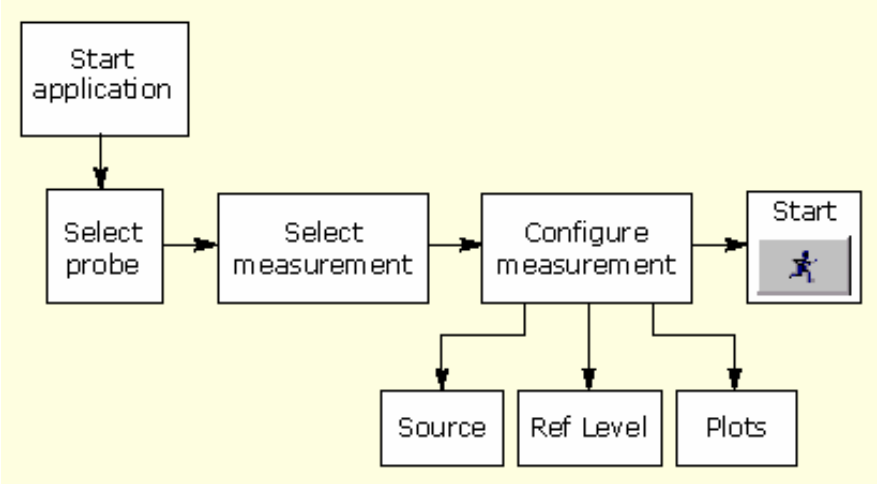


Figure 18. General Steps to Set Up the Application.

Selecting an Analysis or Compliance Module

The RT-Eye application supports dedicated, technology-specific compliance modules.

The application accepts Tektronix compliance modules for industry-specified testing. These modules are available as options and require the RT-Eye software. If the application does not detect a compliance module, only "Serial Analysis" appears in the Modules drop down list. If the application detects other compliance modules, then multiple selections appear in the list.

The RT-Eye online help only discusses the "Serial Analysis" module operation. However, the application also includes separate PDF files with Methods of Implementation (MOI) for the InfiniBand and the PCI Express serial data standards specific to the corresponding compliance module.

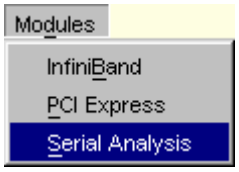


Figure 19. Selecting the Analysis Module.

Note: *Compliance modules have static configurations and reporting formats unique to a specific standard. In general, you can use these modules for design verification and "Plug-Fest" testing.*

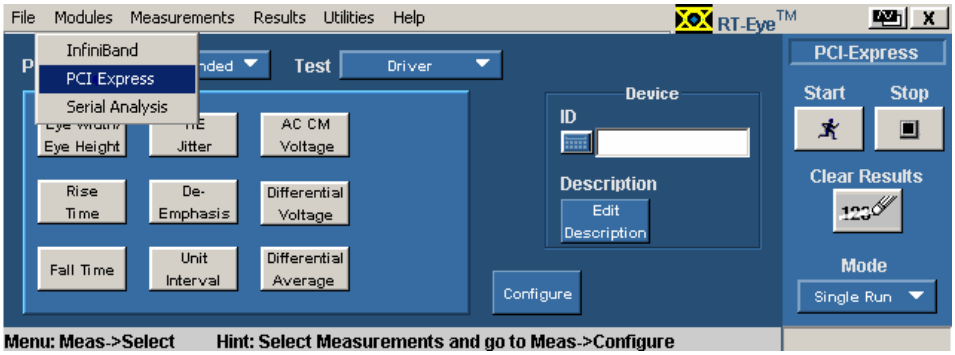


Figure 20. Selecting a Compliance Module (If Installed and Enabled).

Choosing the Probe Configuration

Two of the four typical probing configurations discussed in Connecting to a Device Under Test use two channels to make up the differential serial data signal. Additional measurements are also available with these probing configurations. To set the probing configuration (or if you have two reference waveforms), select Single Ended as the Probe Type option. If the signal is probed differentially, select Differential as the Probe Type option.

Table 9: Measurement Definitions

Area	Option	Description	Units
Timing*	Eye Width/ Eye Height	Eye Width is the *measured* minimum horizontal eye opening at the middle reference level as shown in the eye diagram Eye Height is the *measured* minimum vertical eye opening at the UI center as shown in the eye diagram	s or V
	Rise Time**	Time difference between when the Hi reference level is crossed and the Lo reference level is crossed on the rising edge of the waveform	s
	Fall Time**	Time difference between when the Hi reference level is crossed and the Lo reference level is crossed on the falling edge of the waveform	s
	Unit Interval	Cycle duration of the recovered clock	s
	Bit Rate	Inverse of Unit Interval	Gb/s
	Differential Skew†	Time delay between two single ended waveform sources	s
Amplitude	Differential Voltage**	Statistics for a differential waveform	V
	High Amplitude	Histogram mode of all differential waveform values greater than zero	V
	Low Amplitude	Histogram mode of all differential waveform values less than zero	V
	CM Voltage†	Statistics of the Common Mode voltage waveform	V
	AC CM Voltage†	AC statistics of the Common Mode voltage waveform	V
	De-Emphasis	Ration of any non-transition eye-voltage to its nearest preceding transition eye voltage	dB
Jitter*	Jitter @ BER	Deterministic and random components of jitter	s
	TIE Jitter	*Measured* time difference between a data edge and a recovered clock edge	s
*** Use the Time Units option (Results menu) to convert and display the results as Unit Interval.**			
**** Use the File Preferences menu to restrict measurements to transition bits only.**			
† Added when Single Ended is the Probe Type option.			

Selecting a Measurement

You can use Measurements Select menu to select measurements for the application to take. The application takes measurements for all selected.

This is the default menu when you start the application. You can also access the menu by selecting Measurements> Select in the menu bar.

The measurements will vary depending on the type of probe selected as the Probe Type option. View the Measurements Select menu for differential probes or the menu for single-ended probes.

Note: *Use the* Autoset *button to automatically set the Horizontal and Vertical scales of the Sources and the corresponding reference voltage levels.*

Display the Autoset Summary menu options, or view an example of an Autoset Summary menu.

Note: *Use the* Select Plots *button as a short cut to the Plots Select menu.*

Note: *Use the* Configure *button as a short cut to the Measurements Configure menus.*

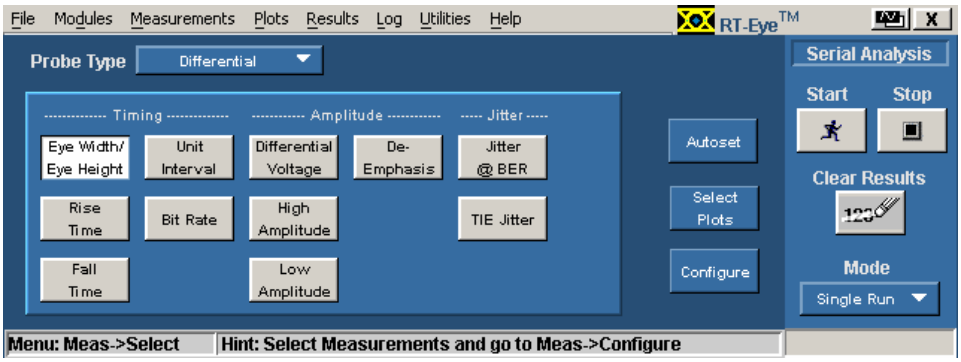


Figure 21. Measurements: Select Menu for Differential Probes.

The application adds measurements when Single Ended is the Probe Type option: Differential Skew, CM Voltage, and AC CM Voltage.

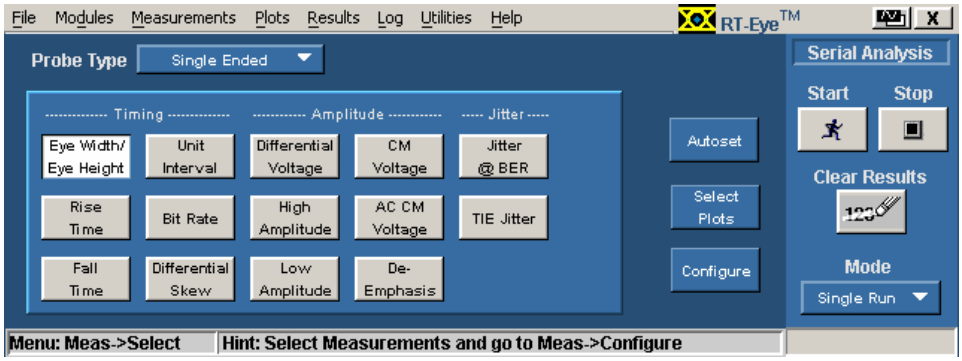


Figure 22. Measurements: Select Menu for Single-Ended Probes.

Autoset Button in the Measurements Select Menu

When you select the 

button in the Measurements Select menu, the application displays the Autoset Summary menu (except when disabled in the File Preferences menu). The Autoset Summary menu shows the current selections in the Configure Source and the Configure Ref Levels menus.

When you select the 

command button in the Autoset Summary menu, the application calculates and sets the vertical scale, the horizontal resolution, and the reference voltage levels for all sources.

Note: *Use the* 

button as a short cut to the Measurements Configure menus.

Table 10: Autoset Summary Menu Options

Option/function	Description
Autoset	Performs the Source Autoset and the Ref Levels Autoset functions; values update accordingly
Configure	Accesses the Configure Ref Levels menu
Close	Discards changes and closes the menu
Do not show this menu again*	Defines whether or not the application displays the Autoset Summary menu every time you select the Autoset command button in the Measurements Select menu
*** If set, use the File Preferences menu to display the Autoset Summary menu.**	

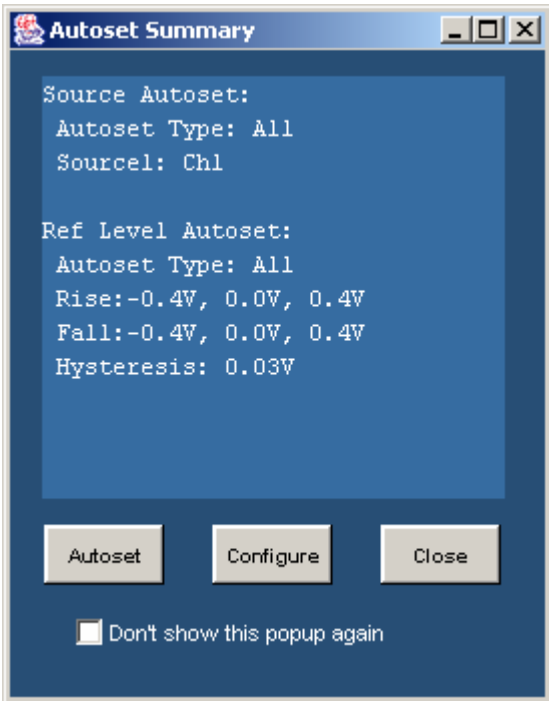


Figure 23. Autoset Summary Menu Example.

Configuring a Measurement

Measurements may or may not require configuration. A quick way to configure measurements is to select the Autoset button in the Measurements Select menu.

Note: *Use the*  *button from the Measurements Select menu as a short cut to the Configure menus.*

The application includes the following Configure menus:

- Source
- Ref Levels
- Gating
- Jitter
- Population

Table 11: Configure Menus Definitions

Menu name	Description
Source*	Select the source of the measurement to be a channel (live) or reference waveform, or to be a File; you can use the Autoset functions to change the vertical scale or horizontal resolution of the waveform The automatic Vertical Scale function ensures that the entire waveform occupies the full vertical space available in the graticule The automatic Horizontal Resolution function ensures that there are enough samples for accurate results
Ref Levels	Set the reference voltage levels for the thresholds of the rising and the falling edges as an absolute value The automatic function sets the thresholds relative to the minimum and maximum levels of the peak-to-peak values; default percentages are 20% and 80%
Gating	Sets a gated region: Cursor gating, SmartGating (Custom), or no gating at all(Off)
Jitter	Defines the Clock Data Recovery method for timing measurements and the RJ/DJ parameters for jitter measurements
Population**	Sets the required population used for measurements or specifies the number of acquisitions
*** All sources must have the same Horizontal Sample Rate, Record Length, and Position to assure that measurements function properly.**	
**** In Free Run mode, sequencing stops when the population limit is met.**	

Sources

The application takes measurements from waveforms or files specified as input sources. You can select an oscilloscope channel input (live), a reference waveform, or a saved waveform file as a source.

Note: *Use the* 

button as a short cut to the Measurements Select menu.

Note: *Differential probes do not provide common mode voltage components.*

Table 12: Configure Source Menu Options for a Differential Probe

Area	Option	Description
Source Type	Live/Ref	Lists channel or reference waveforms for the Select Differential option
	File*	Recalls the input from a single .csv or .wfm file; enables the Select File area
Select Differential**	Ch1, Ch2, Ch3, Ch4, Ref1, Ref2, Ref3, Ref4	Use a channel or reference waveform from which to take V_{DIFF} measurements
Autoset†	Vertical Scale	Sets the display of the waveform to the full screen vertically based on the amplitude of the source; the Peak-Peak of the waveform is 80% of the ADC full scale
	Horizontal Resolution	Sets the time base parameters to the necessary horizontal resolution and record length to ensure accurate results; the Sample Rate takes five samples on the fastest rising or falling edge found on any of the waveforms being measured
	Vertical & Horizontal	Sets the vertical scale and the horizontal resolution
*** Use the Browser to select a Differential File.**		
**** Uses a differential mode waveform as the source when Differential is the Probe Type option. You can use a Math waveform, such as for a CH1-CH3 operation, if you save the resultant waveform, recall the waveform to a reference memory location (Ref1, Ref2, Ref3, or Ref4), and then use the Ref waveform as a source.**		
† Only available for live (channel) waveforms.		

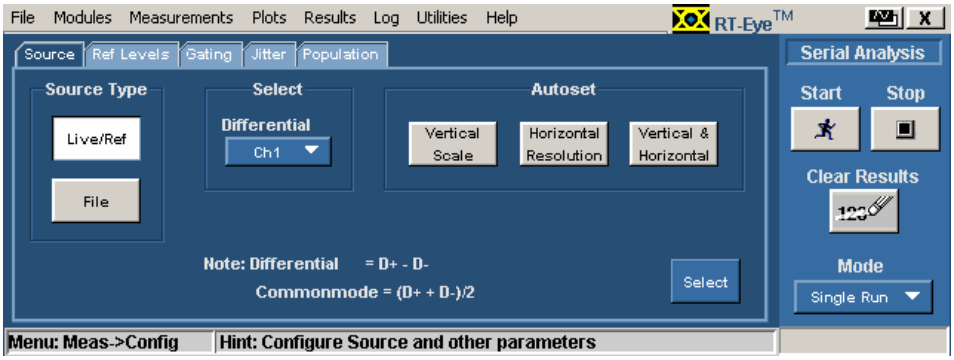


Figure 24. Configure: Source Menu for Differential Probes.

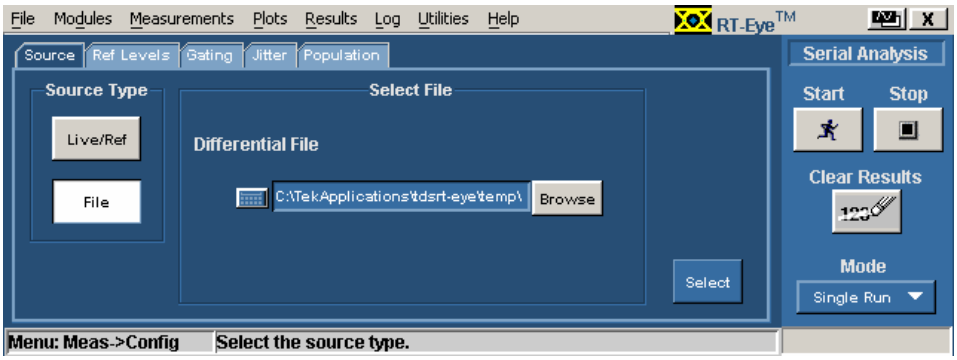


Figure 25. Configure: Source from a File for Differential Probes.

Note: *You must use single-ended probes for common mode voltage measurements.*

Table 13: Configure Source Menu Options for Single-Ended Probes

Area	Option	Description
Source Type	Live	Uses one of the following channel combinations for the D+ and D- waveforms: CH1, CH3 CH1, CH4 CH2, CH3 CH2, CH4
	Ref	Uses any combination of reference waveforms for the D+ and D- waveforms
	File	Enables the Select File area
Select D+, D-	Selections are based on a Live or Ref Source Type option	
Autoset*	Vertical Scale	Sets the display of each waveform to the full screen vertically based on the amplitude of the source; the Peak-Peak of the waveform is 80% of the ADC full scale
	Horizontal Resolution	Sets the time base parameters to the necessary horizontal resolution and record length to ensure accurate results; the Sample Rate takes five samples on the fastest rising or falling edge found on any of the waveforms being measured
	Vertical & Horizontal	Sets the vertical scale and the horizontal resolution
Select Files**	Browse	Recalls single-ended inputs from two .csv or .wfm files, a D+ and D-
*** Only available for channel waveforms.**		
**** Use the Browser to select the Differential File(s).**		

Note: *The TDS6604 oscilloscope samples at 20 GS/s on two channels and at 10 GS/s on four. The TDS7404 oscilloscope samples at 20 GS/s on one channel and at 10 GS/s on two.*

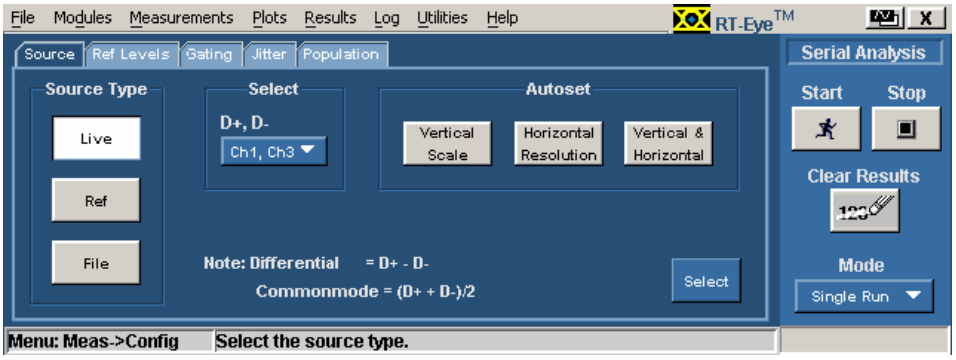


Figure 26. Configure: Source Menu for Single-Ended Probes.

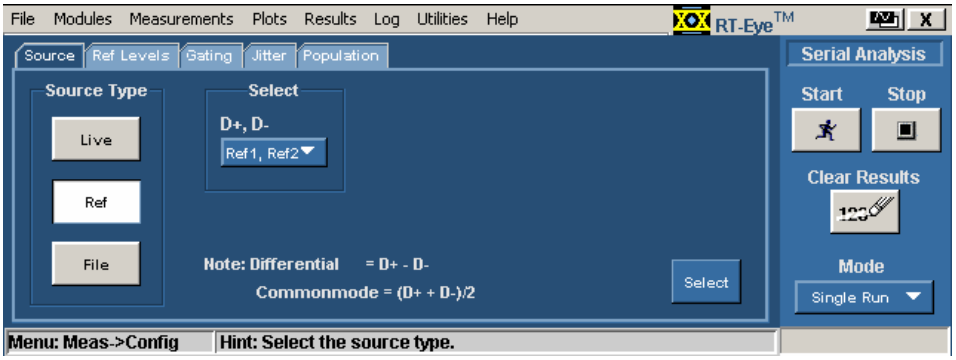


Figure 27. Configure: Source from Ref Waveform for Single-Ended Probes.

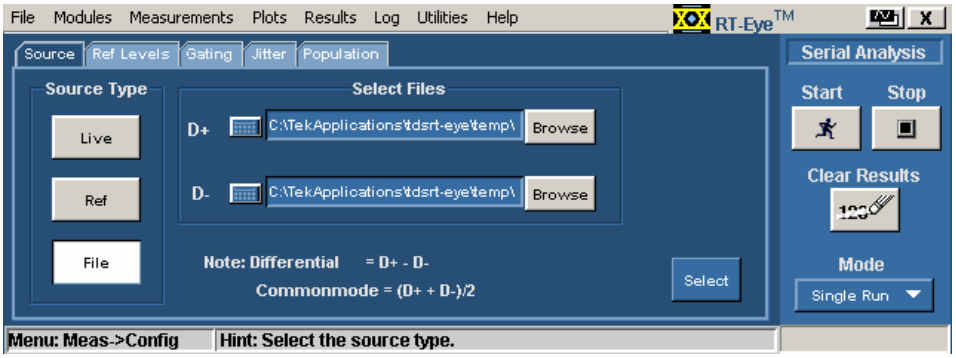


Figure 28. Configure: Source from File for Single-Ended Probes.

Autosetting Sources for Live (Channel) Waveforms

In most situations where you want to take measurements from a "live" (channel) waveform, you can improve measurement accuracy by using the Autoset options to optimize the vertical scale or horizontal resolution settings of the oscilloscope.

To automatically define the vertical and horizontal settings for a source, follow these steps:

1. Select Measurements> Configure> Source (or the 

tab).
2. For differential probes, select the 

button.
3. For single-ended probes, select the 

button.
4. Select one of the Autoset area command buttons. Refer to the Configure Source Menu Options for Single-Ended Probes topic for a description of each option.

Note: *At rise times less than 100 ps, the RT-Eye application will have only two sample points per edge to work with. The application will setup a suitable level of interpolation to increase the point count per edge to around 5 points.*

Reference Voltage Levels

You need to set reference voltage levels so that the application can identify state transitions on a waveform. Serial data timing measurements are based on state transition times in waveforms. By definition, edges occur when a waveform crosses specified reference voltage levels. There are two ways to set the reference voltage levels: automatically or manually.

High, Mid and Low Reference Voltage Levels

The application uses three reference voltage levels: High, Mid, and Low.

- For most Time Interval and Jitter measurements, the application only uses the Mid reference voltage level.

The Mid reference level defines when the waveform transition occurs at a given threshold. For most NRZ AC coupled signals, you would set the Mid reference level to Zero volts.

The Configure Ref Levels menu includes a "Mid = 0V" option which is set by default. You can clear the check box to allow the Autoset function to calculate the proper Mid reference level in the presence of common mode voltages frequently encountered when using single-ended probes.

- For Rise Time and Fall Time measurements, the High and Low reference voltage levels define when the waveform is fully high or low.

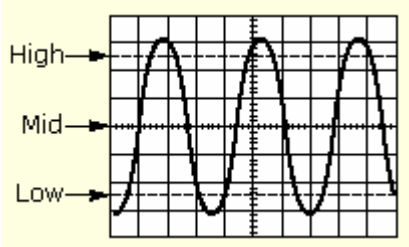


Figure 29. Reference Voltage Levels Diagram.

Rising Versus Falling Thresholds

You can specify thresholds for each of the reference voltage levels: High, Mid, and Low. The application uses the thresholds to determine the following events:

- A rising event occurs when the waveform falls through the Rise threshold.
- A falling event occurs when the waveform falls through the Fall threshold.
- For a given reference level, rising and falling events alternate as time progresses.

Note: *In many cases, the rising and falling thresholds for a given reference voltage level are set to the same value. In this case, a hysteresis value helps prevent spurious edges produced by small amounts of noise in a waveform.*

Using the Hysteresis Option

The hysteresis option can prevent small amounts of noise in a waveform from producing multiple threshold crossings. You can use a hysteresis when the rising and falling thresholds for a given reference voltage level are set to the same value.

The reference voltage level ± the hysteresis value defines a voltage range that must be fully crossed by the waveform for an edge event to occur. If the decision threshold is crossed more than once before the waveform exits the hysteresis band, the mean value of the first and last crossing are used as the edge event time.

For example, if the waveform rises through the Threshold - Hysteresis, then rises through the Threshold, then falls through the Threshold, then rises through both the Threshold and the Threshold + Hysteresis, a single edge event occurs at the mean value of the two rising crossings.

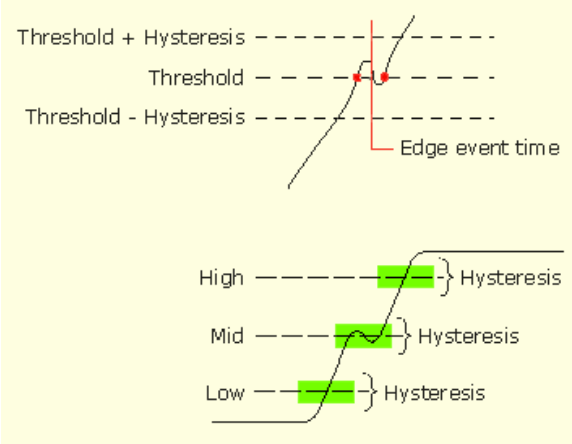


Figure 30. Example of Hysteresis on a Noisy Waveform.

Cursor Gating and Reference Voltage Levels Autoset

You can use cursor gating with the reference voltage levels Autoset function. If you enable and set up Cursors in the Configure Gating menu, the application uses the data within the gated region to automatically calculate the reference voltage levels.

Autosetting Reference Voltage Levels

The Ref Level Autoset Setup menu sets all reference voltage thresholds and the hysteresis value to percentages of the base-top voltage amplitude for the waveform. The application applies the calculated values to all sources of the selected measurements.

Quick Method to Set Reference Voltage Levels

To configure the Ref Level Autoset Setup menu options, follow these steps:

1. Select Measurements> Configure> Ref Levels> Setup.

   The Ref Level Autoset Setup menu appears. View the Ref Level Autoset Setup menu.

2. Select the keypad icon or multipurpose knob icon, and enter the percentage of the reference voltage levels. The settings are based on the following definitions:

   $$0\% = mean(v_{EYE-HI-TRAN}(n))$$

   $$100\% = mean(v_{EYE-LO-TRAN}(n))$$

3. Select the OK button to update the values and close the Ref Level Autoset Setup menu.

4. Select the Run command button in the Configure Ref Levels menu.

   The application calculates the reference voltage levels based on the percentages set in the Ref Level Autoset Setup menu.

5. If necessary, refine the calculated values in the Configure Ref Levels menu to suit your analysis situation.

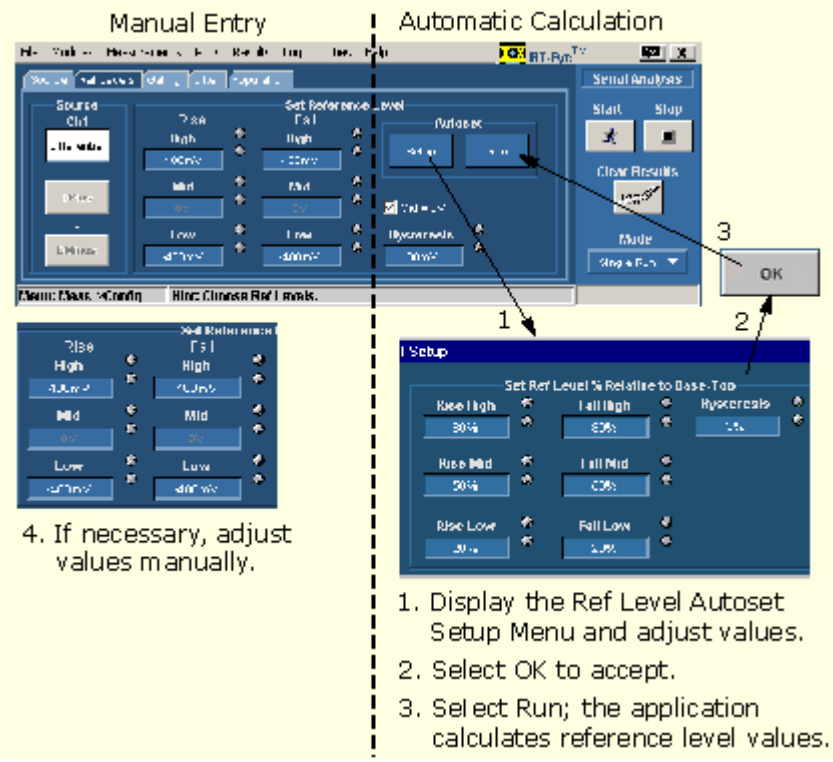


Figure 31. Steps to Set the Reference Voltage Levels.

Table 14: Ref Level Autoset Setup Menu Options

Option*	Description**
Rise, High	Sets the high threshold level for the rising edge of the source
Rise, Mid	Sets the middle threshold level for the rising edge of the source
Rise, Low	Sets the low threshold level for the rising edge of the source
Fall, High	Sets the high threshold level for the falling edge of the source
Fall, Mid	Sets the middle threshold level for the falling edge of the source
Fall, Low	Sets the low threshold level for the falling edge of the source
Hysteresis	Sets the threshold margin to the reference level which the voltage must cross to be recognized as changing; the margin is the relative reference level plus or minus half the hysteresis; use to filter out spurious events
*** Default settings are 80% (High), 50% (Mid), 20% (Low), and 3% (Hysteresis)**	
** **Where** 0% = mean($v_{EYE\text{-}HI\text{-}TRAN}(n)$) **and** 100% = mean($v_{EYE\text{-}LO\text{-}TRAN}(n)$).	

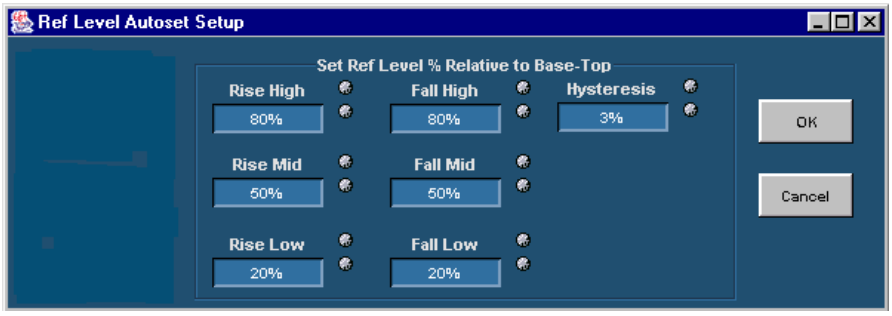


Figure 32. Ref Level Autoset Setup Menu

Manually Adjusting the Reference Voltage Levels

Whether or not you use the application to automatically calculate the reference voltage levels, you may need to manually change the values. To set the reference levels manually, follow these steps:

1. Select Measurements> Configure> Ref Levels> Source and choose a source (channel or reference waveform) for which you wish to set the reference levels.

2. In the Set Reference Level area, adjust the values of the reference voltage levels and the hysteresis.

Table 15: Configure Ref Levels Menu Options

Area	Option	Description
Source	Differential	Selects the reference levels for the Differential waveform or file
	DPlus*	Selects the reference levels for the DPlus waveform or file
	DMinus*	Selects the reference levels for the DMinus waveform or file
Ref Level Autoset	Setup	Displays the Ref Level Autoset Setup menu
	Run	Automatically calculates and sets the reference levels according the settings in the Ref Level Autoset Setup menu
Set Reference Level	Rise, High	Sets the high threshold level on the slope in volts for the rising edge of the source
	Rise, Mid	Sets the middle threshold level on the slope in volts for the rising edge of the source
	Rise, Low	Sets the low threshold level on the slope in volts for the rising edge of the source
	Fall, High	Sets the high threshold level on the slope in volts for the falling edge of the source
	Fall, Mid	Sets the middle threshold level on the slope in volts for the falling edge of the source
	Fall, Low	Sets the low threshold level on the slope in volts for the falling edge of the source
	Hysteresis	Sets the threshold margin, in volts, relative to the reference level which the voltage must cross to be recognized as changing; the margin is the reference voltage level plus or minus half the hysteresis; use to filter out spurious events
Mid = 0V**	Set or clear	When checked, sets the middle threshold level to 0 Volts; when cleared (unchecked), sets the level to the value calculated by the application
*** Only available when Single Ended is the Probe Type.**		
**** Common mode voltages can be frequently found with single-ended probes. Clear this option before you use the Reference Level Autoset function.**		

Note: *The Source DPlus and DMinus options are only usable when you select Single Ended as the Probe Type option in the Measurements Select menu.*

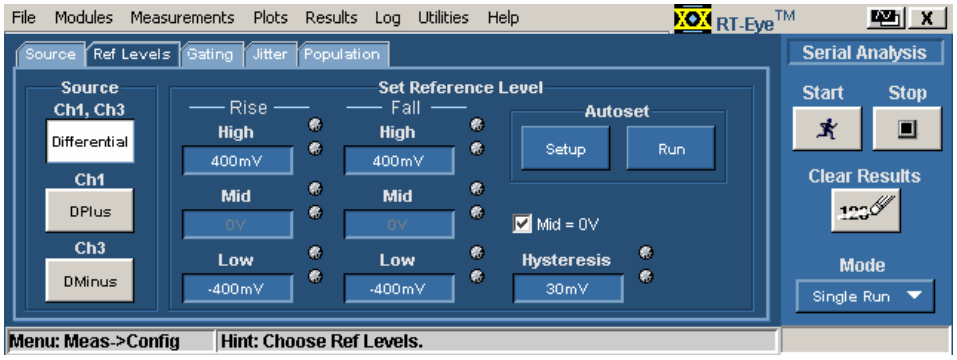


Figure 33. Configure: Ref Levels Menu.

Gating Measurements

Gating allows you to focus the analysis on a specific area of the waveform bound by a gated region, which is a way to filter unnecessary information. To access the Gating menu, select Measurements> Configure> Gating.

You can set up a gated region in one of the following ways:

- Cursors (vertical)
- Unit Intervals (Custom)
- Edges (Custom)

The application uses the SmartGating function when you select Custom as the Gating option. With SmartGating, the application establishes a Clock Recovery Window and an Analysis Window within the clock recovery window.

Table 16: Configure Gating Menu Options

Area	Option	Description
Gating	Off	No gating occurs; application takes measurements over the entire waveform
	Cursors	Gates the waveform with Vertical cursors
	Custom	Enables the SmartGating function; refer to the Configure Gating Menu Options for Custom Gating topic

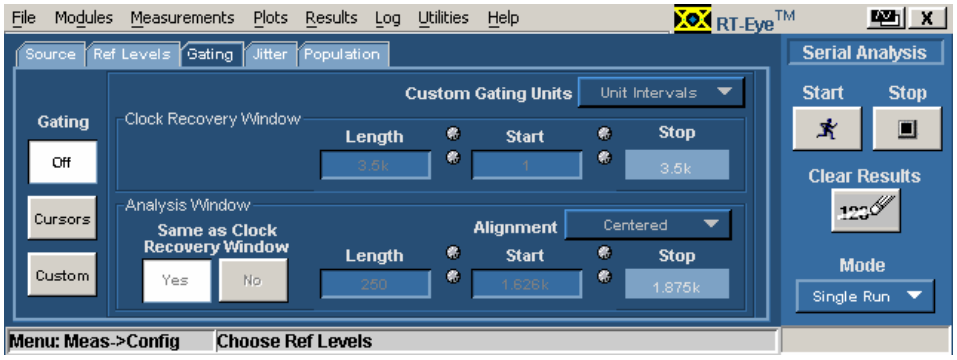


Figure 34. Configure: Gating Menu with Gating Off.

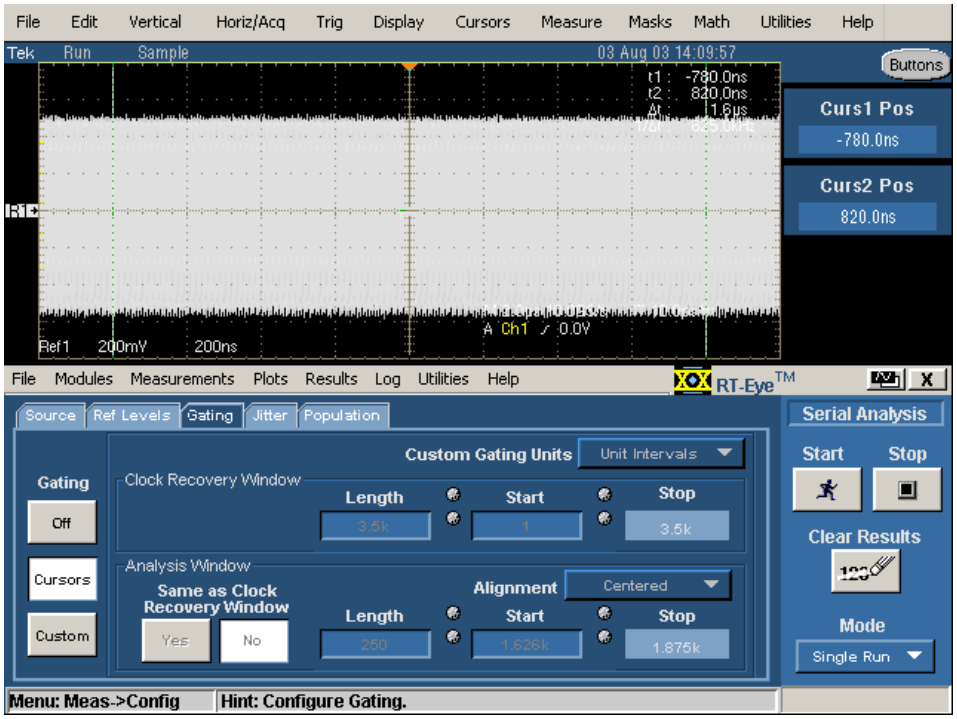


Figure 35. Configure: Gating Menu with Cursors Gating.

Table 17: Configure Gating Menu Options for SmartGating (Custom)

Area	Option	Description
Custom Gating Units	Unit Intervals	Gates the waveform by Unit Intervals
	Edges	Gates the waveform by Edges
Clock Recovery Window	Length	Number of Unit Intervals or Edges that defines the size of the window over which the application recovers the clock
	Start	Specific Unit Interval or Edge within the record where the application starts to recover the clock
	Stop	Reports the Unit Interval or Edge on which the application will stop the clock recovery
Analysis Window	Same as Clock Recovery Window On Off	Enables or disables reusing the same settings for the Analysis Window as for the Clock Recovery Window option
	Alignment Centered	Centers the Analysis Window within the Clock Recovery Window
	User Defined	Specifies the absolute position of the Analysis Window within the Clock Recovery Window
	Length	Number of Unit Intervals or Edges that defines the size of the window
	Start	Specific Unit Interval or Edge where the window starts
	Stop	Reports the UI or Edge on which the window will stop

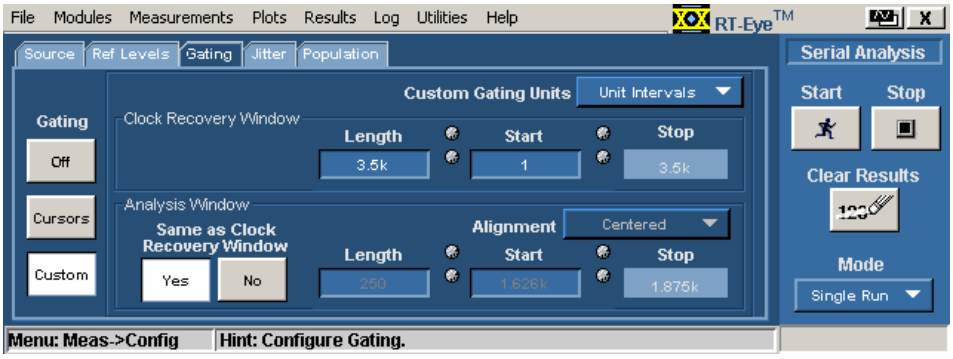


Figure 36. Configure: Gating Menu with Clock Recovery Window.

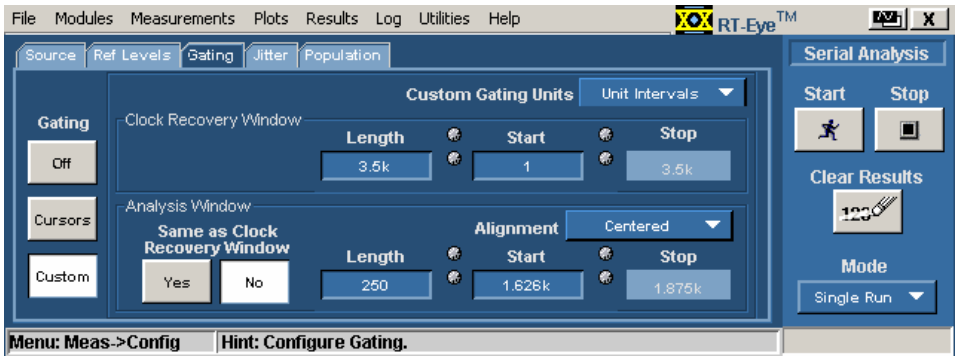


Figure 37. Configure: Gating Menu with Analysis Window.

Clock Recovery and Jitter Measurements

In serial data standards, there are several ways that standards working groups have decided to define jitter measurements. Establishing the jitter reference time (or ideal clock) is key to making Time Interval Error (TIE) measurements in which all jitter measurements are based. To comply with industry standards, the RT-Eye application allows you to select a Clock Recovery method (PLL or Constant Clock). View the Constant Clock and PLL Loop Diagram.

When you select the PLL (Phase Loop Lock) method, you must also specify the Loop BW. By default, the clock recovery system configures itself to mirror a T11 "Golden PLL." This is defined as a characteristic tracking response with a lower corner frequency at the baud rate of 1667. Below this frequency, the response rolls off at 20 dB/Decade.

You can use the Configure Jitter menu to set up these options. View the Configure Jitter Menu.

Repeating Pattern from DUT for Jitter and Rj/Dj Measurements

The RT-Eye application requires that the DUT transmit a repeating pattern of a known length. This is to ensure that the Total Jitter, the Rj, and the Dj components are accurate.

Common patterns are available in the Pattern Type option (CJTPAT, CRPAT, TS1, and so on) or you can enter the value manually in the Pattern Length option.

You can use the Configure Jitter menu to set up these options.

Refer to T11.2 MJSQ (Methodologies in Jitter and Signal Quality) to understand the technical details and aspects of jitter on signal quality.

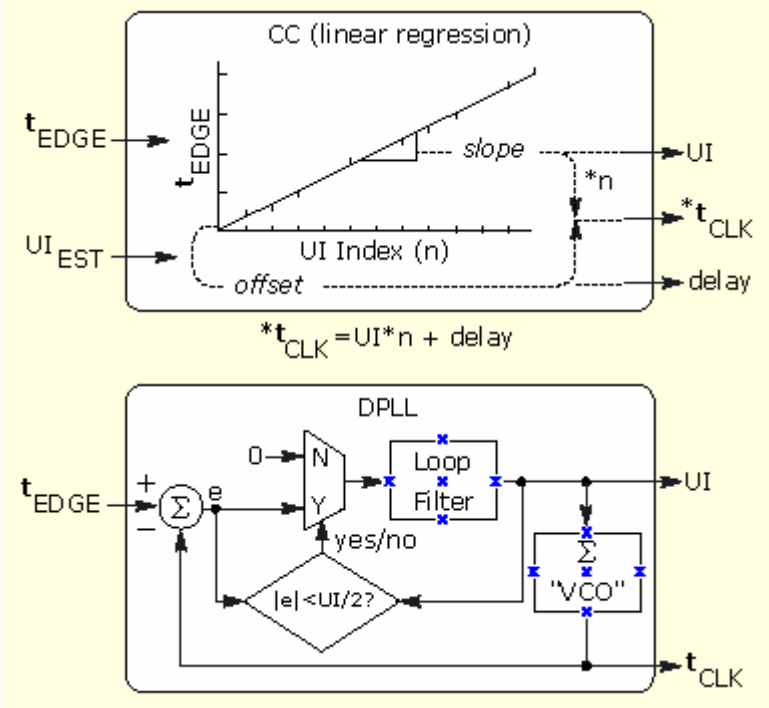


Figure 38. Clock Recovery Method Diagram.

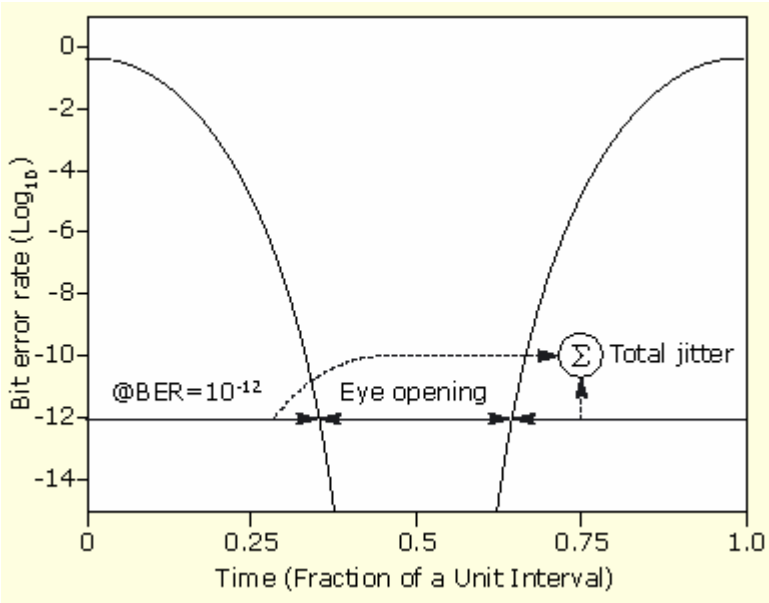


Figure 39. Bathtub Curve: BER Versus Decision Time.

Table 18: Configure Jitter Menu Options

Area	Option	Description
Clock Recovery	Method	Select an industry standard clock recovery method: PLL: Standard BW, Const Clk: Mean, Const Clk: Median, or PLL: User BW
	PLL Loop BW Standard: b/s	Applies the cut-off frequency of the Method option and sets up other options relative to the selected industry standard and data rate
	User BW*	When you select PLL: User BW as the Method option, you can specify the cut-off frequency
Rj/Dj	BER=10-e?	Calculates the bit error ratio curve and the eye opening for a given bit error ratio
	Pattern Type	Select a pattern from a list of industry standard patterns
	Pattern Len**	When you select Custom as the Pattern Type option, you can specify the pattern length
*** Only available when you use the PLL: User BW Method option.**		
**** Only available when you use the Custom Pattern Type option.**		

Table 19: Clock Recovery Methods Definitions

Method	Description*
Const Clk: Mean	Constant clock recovery based on a least squares line fit to the data edge times; the mean error between the recovered clock edges and the corresponding data edges is zero
Const Clk: Median	Constant clock recovery based on a least squares line fit to the data edge times; the clock frequency is the same as the Const Clk: Mean, but the overall phase (delay) is adjusted so the Median error between the recovered clock edges and the corresponding data edges is zero
PLL: Standard BW	SW PLL based clock recovery; loop BW is based on a standard selected as the Standard: b/x option; typically, a standards PLL loop BW is 1/1667 (0.0006) of the Baud
PLL: User BW	SW PLL based clock recovery; loop BW is set directly by the user as the User BW option; BW range is 10 kHz to 50 MHz
***Refer to the Clock Recovery Method diagram for a graphical representation.**	

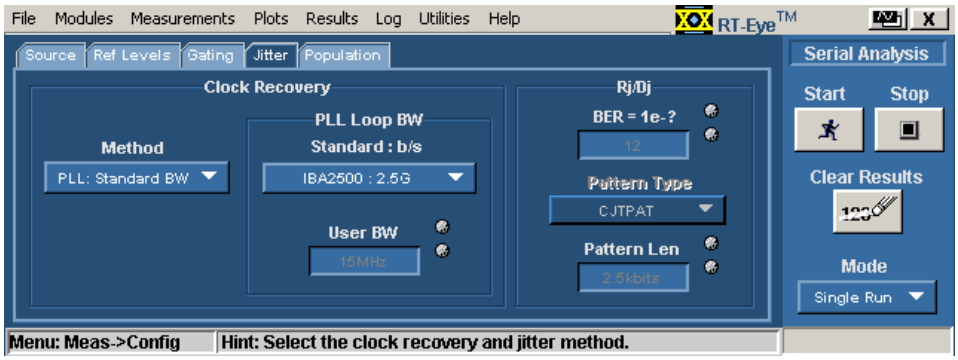


Figure 40. Configure: Jitter Menu.

Population for Measurements

The Population control allows you to limit the amount of waveform data that is analyzed. This is often done in industry standards to make sure that there is consistency between measurement techniques. You can use the Configure Population menu to set a limit on a maximum population to obtain for all selected measurements. View the Configure Population menu.

To define the maximum population for measurements, follow these steps:

1. Select Measurements> Configure> Population> On.
2. Select Limit By and choose a waveform characteristic on which to base the population.
3. Select Limit and specify a population limit from one to one million.

If you use a population limit, Statistics individually accumulate for each measurement that reports the Current acquisition statistic to the population limit. A Free Run stops when all such active measurements reach the population limit. An acquisition population limit applies to all active measurements; statistics will accumulate until the acquisition limit is reached.

You can use a population limit for a Single Run. If the limit is less than the normal population for that Single Run then the measurement statistics will stop at the limit.

Table 20: Configure Population Menu Options

Area	Option	Description
Population Limit	On Off	Enables or disables the application from using a population limit while taking measurements
Configure	Limit By	Uses Acquisitions or Measurements to count the population
	Limit	Specifies the maximum number of Acquisitions or Measurements the application takes before sequencing stops

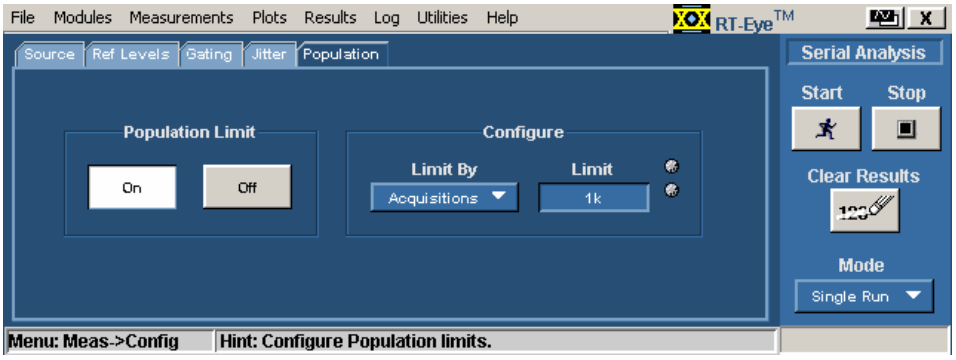


Figure 41. Configure: Population Menu

Measurements Limits

Each serial data application provides a Limits file that includes combinations of all measurements and statistical characteristics, and an appropriate range of values for each combination. The application can use the Limits file and a mask file to determine the Pass or Fail status for compliance tests.

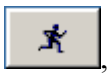
To test against a Limits file, you need to enable measurements limits checking, and enable a mask file in the Plots menus. View the Measurements Limits menu.

Creating a Measurements Limits File

You can use the Limits File Editor functions to create a Limits file. The editor includes variable range options to suit your specific needs.

To create a Limits file, follow these steps:

1. Select Measurements> Limits.
2. Select New. The Limits Editor window appears.
3. Select +. The editor adds a measurement with None selected.
4. In the new row, select a Measurement, type of Statistic, a Lower Limit value and an Upper Limit value as appropriate.
5. Select Validate. The application verifies that the limits for each measurement are valid and that there are no duplicates.
6. Select Compact. The application removes measurements where the selection is None.
7. Select File> Show Summary.

The next time you select  , the application compares the measurement results against the Limits file and the mask file, and then displays the status as Pass or Fail in the results menus.

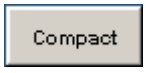
Editing a Measurements Limits File

You can use the Limits File Editor functions to edit an existing Limits file. To edit a Limits file, follow these steps:

1. Select Measurements> Limits.
2. Select 

and navigate to the directory where the Limits file resides.
3. Select a file, and then Open.

   The selected file appears in the Limits Editor window.
4. Edit the file as necessary. To delete a measurement, select None.
5. Select 

. The application verifies that the limits for each measurement are valid and that there are no duplicates.
6. Select 

to remove the rows where None is selected as the measurement.
7. Select File> Show Summary.

Table 21: Measurements Limits Menu Options

Area	Option	Description
Limits	On Off	Enables or disables the application from checking the measurements limits; when enabled, the application displays the results as Pass or Fail
Limits File Editor*	Current	Edit the currently displayed Limits file
	New	Create a new Limits file
Limits File	Browse	Locate the directory and select an existing Limits file; you can use the virtual keyboard to enter a file name
*** Opens the Limits File Editor window.**		

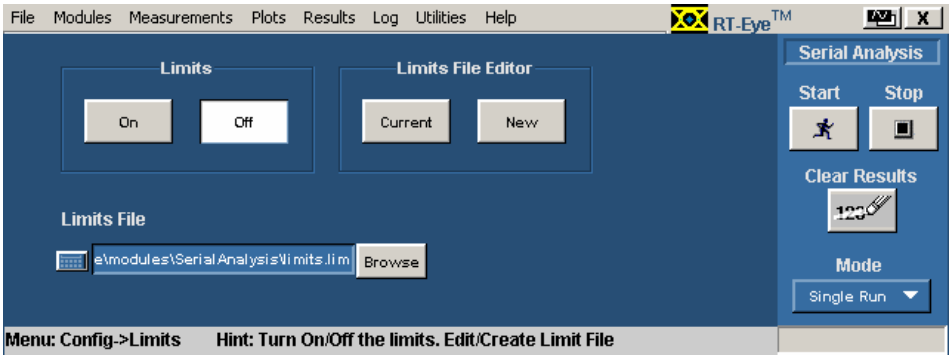


Figure 42. Measurements: Limits Menu.

Table 22: Measurements Limits Editor Toolbar Functions

Tool/option	Description
New	Opens a new file
Open	Opens an existing file
Add	Adds a measurement and associated limits
Clear All	Deletes all measurements

Table 23: Measurements Limits Editor Menu Options

Tool/option	Description
Compact	Removes measurements where None is selected
Validate	Verifies that limits are valid, such as an upper limit can not be lower than a corresponding lower limit
Save As	Opens a Save File dialog box
Cancel	Discards changes and closes the Limits Editor window

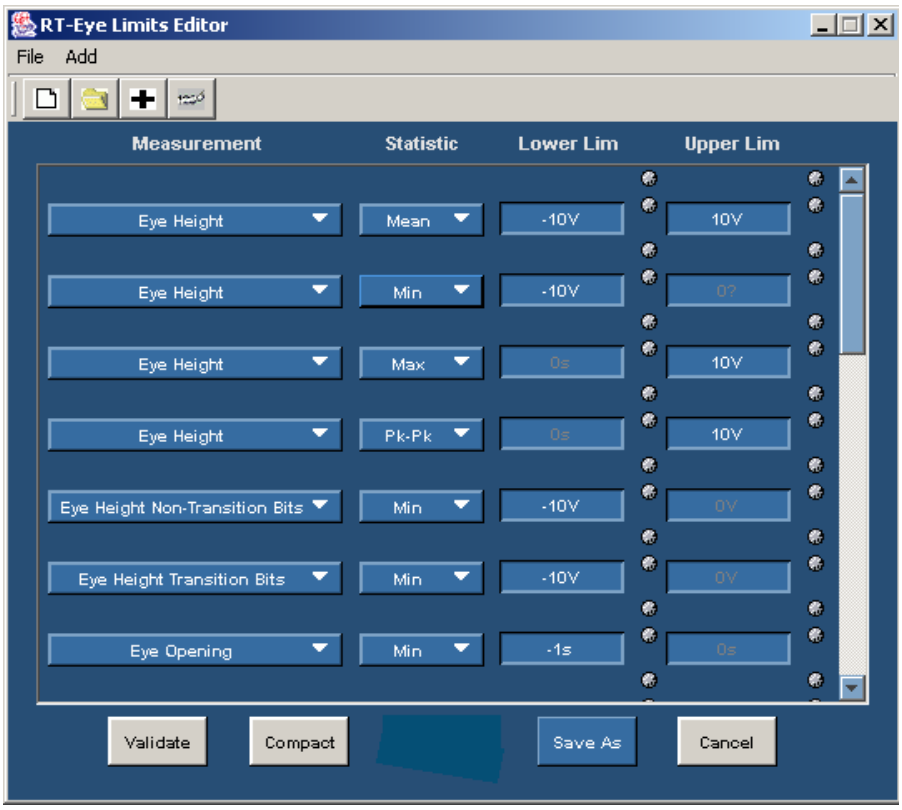


Figure 43. Measurements: Limits Editor Menu.

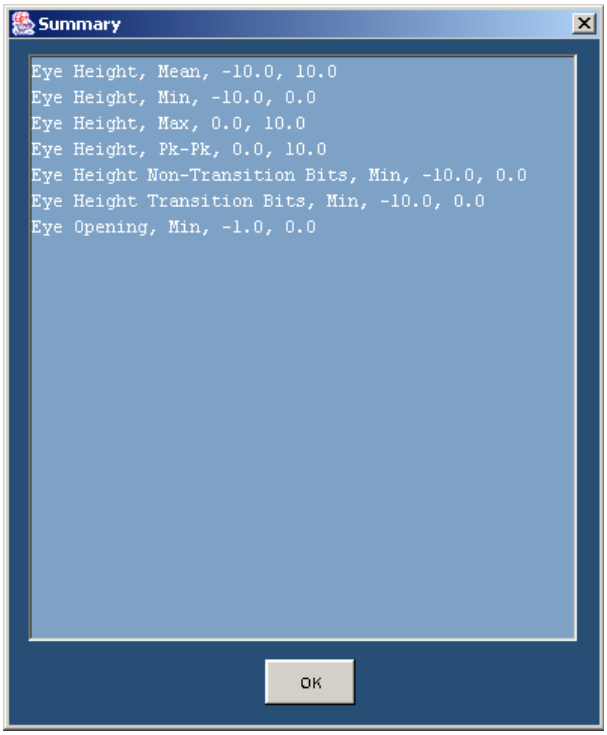


Figure 44. Measurements Limits File Summary.

User Masks

You can use masks based on serial data standards for compliance testing of DUTs. Waveform masks for PCI Express and InfiniBand serial data standards appear in the drop down list for the Standard option in the Plots> Configure menu (for an Eye Diagram plot). One of the other selections in the list is User.

You can modify and use mask files for custom compliance testing. The RT-Eye application provides many mask files and installs them in the following directory:

C: TekApplications/tdsrt-eye/Examples/Masks

Each mask file uses a .msk format. Many mask files reside in the directory, such as for the following standards:

- InfiniBand: Test Points
- PCI Express: Transmitter Tbit, Transmitter nTbit, Receiver
- Ethernet: 1000BaseCX, XAUI
- 1394B: 400b, 800b, 1600b
- Fibre Channel: 133, 266, 531, 1063, 2125
- Serial ATA: 5Cycle, 250Cycle
- Serial Rapid IO: 1.25G, 2.5G 3.125G

\You can edit a mask file to create a custom user mask through one of the following methods:

- Using the User Mask File Editor available in the Mask menu (if enabled) in your oscilloscope
- Manually using a text editor

Using the User Mask File Editor

To edit a mask file with the User Mask File Editor of the oscilloscope, follow these steps:

1. From the menu bar of the oscilloscope, select Masks> Mask Edit Setup.
2. Select the Recall button and navigate to the following directory:
3. C:\TekApplications\tdsrt-eye\modules\SerialAnalysis\masks
4. Recall the user.msk file.
5. Follow the instructions in the online help of the oscilloscope to edit and save the file.

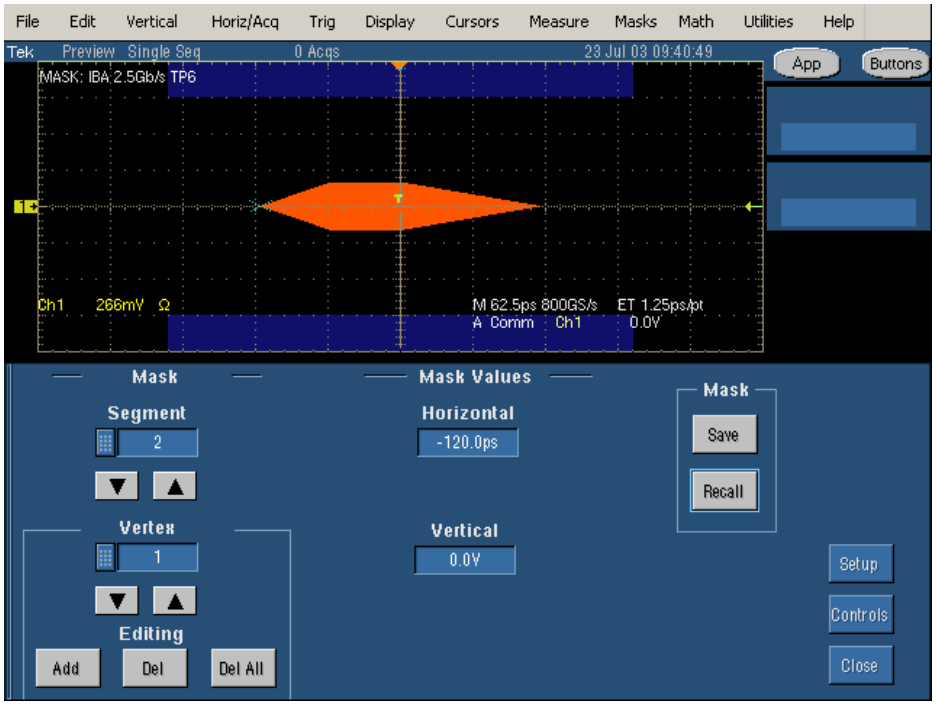


Figure 45. Mask File in the Oscilloscope Mask Editor.

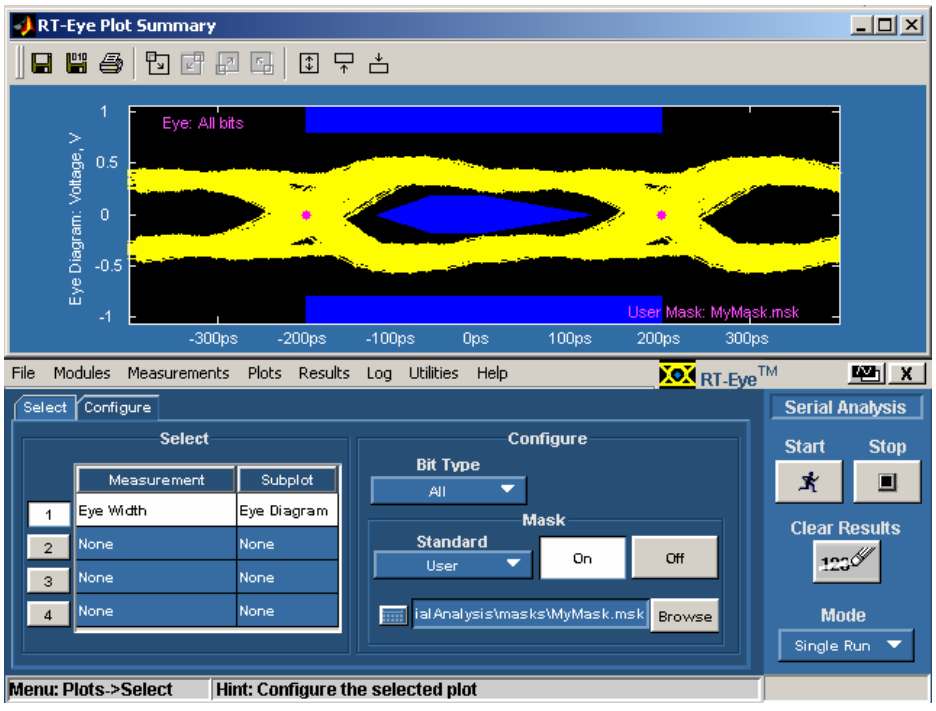


Figure 46. Plots Configure Menu Setup for User Masks.

Manually Editing a Mask File

If you do not have a Mask Editor available in your oscilloscope, you can use a text editor to manually edit a mask file.

The User Mask File Opened in a Text Editor diagram shows an .msk file revised using the Mask Editor in a TDS7000 series oscilloscope. The diagram shows the fields used by the RT-Eye application in red boxes.

Note: *The application ignores all other fields.*

To change the geometry of the mask, use a text editor to edit the mask file fields:

Table 24: Mask File Fields

Mask file field	Description*
MASK: USER: WID	Defines unit interval
MASK: USER: SEG1: POINTS	Defines 1st segment vertices in X,Y coordinates
MASK: USER: SEG2: POINTS	Defines 2nd segment vertices in X,Y coordinates
MASK: USER: SEG3: POINTS	Defines 3rd segment vertices in X,Y coordinates
*** Where the X coordinate is in time (ps) and the Y coordinate is in amplitude (V).**	

This diagram shows the fields used by the RT-Eye application in red boxes. You can edit these fields to change the geometry of the mask.

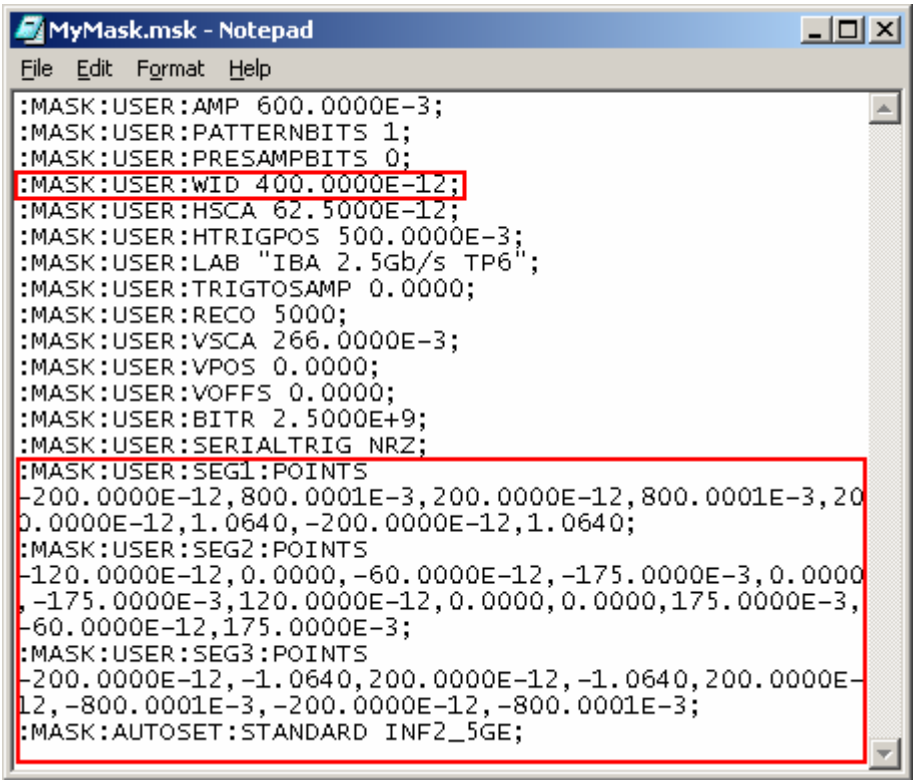


Figure 47. User Mask File Opened in a Text Editor.

Creating a New User Mask File

If need be, you can create a new User Mask file using a text editor. This is an alternative to editing an existing mask. To do so, follow these steps:

1. Create a new file using a text editor.
2. Enter User Mask information.
3. Save as a .msk file.
4. Recall the file in the Plots Configure menu.

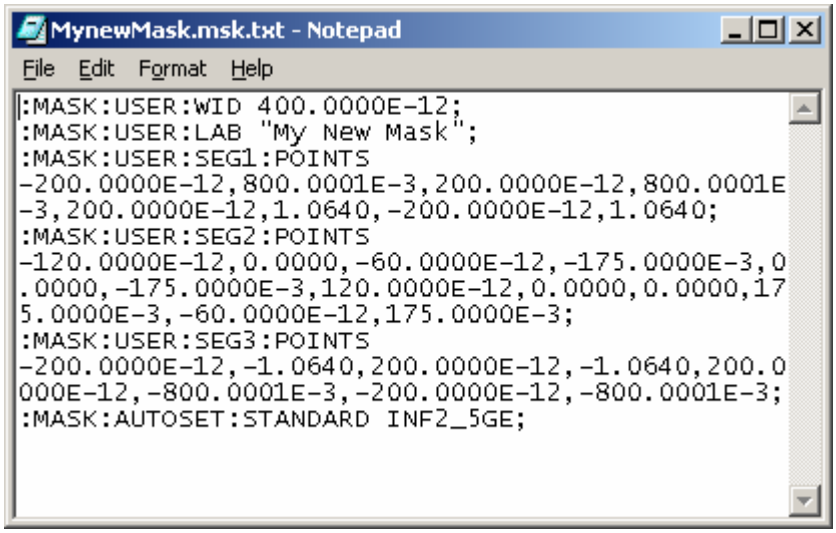


Figure 48. Mask File Edited Using a Text Editor Example

Recalling a User Mask in the Plots Configure Menu

To recall a User Mask file to the RT-Eye application, follow these steps:

1. From the menu bar of the RT-Eye application, select Plots> Configure.
2. Select On in the Mask area.
3. Select User as the Standard option.

Taking Measurements

If you want to change trigger settings or localize the measurement, you should do so before you take any measurements.

Note: *If you select a reference waveform as the source, you need to recall and display the waveform on the oscilloscope before the application can take a measurement. To do so, refer to recalling a waveform file.*

Note: *If an error message displays because there are not enough cycles from which to take a measurement, adjust the Horizontal setting on the oscilloscope to increase cycles.*

Localizing Measurements

By specifying the trigger position, the starting point, and the length of the waveform, you can effectively filter out information that is not useful to analyze before taking a measurement.

To focus the application measurement on a part of the waveform, you can use the Configure Gating menu. You can also adjust the Record Length, Scale, or pre-trigger information in the oscilloscope Horizontal menu, or the trigger level and slope in the Trigger menu.

You can also set up the File Preferences menu for the application to use only transition bits.

Sequencing

You use the Control Panel to start or stop the sequence of processes for the application and oscilloscope to acquire information from a waveform. The application then determines if the algorithm for the selected measurement can be applied to the waveform information. Sequencing is the steps to acquire waveform information, determine if the information is usable for the measurement, take the measurement, and display the results.

There are three Sequencing modes: Single Run, Single No Acq, and Free Run. View the Control Panel.

Acquiring Data

To acquire data from waveforms and take measurements, follow these steps:

1. In the Control Panel (on the right side of the application display), select a Sequence mode.

   The application uses the Sequence mode to acquire waveforms and take measurements when you select the Start command button. The choices are: Single Run, Free Run, and Single No Acq.

2. Select the  button for continuous acquisitions or for measurements on a new or existing acquisition.

   If you select the Single Run or the Single No Acq mode, the application displays the results when the sequencing is complete.

3. If you select the Free Run mode or decide to stop sequencing, select the  Stop button to stop the sequencing. In Free Run mode, the sequencing also stops once the application has reached the limit set in the Configure Population menu.

Note: *The application displays a status bar when it is busy sequencing. The status at the bottom of the Control Panel indicates Ready when the sequencing is complete. It may also indicate Stopping prior to indicating Ready.*

Note: *Use the*  *command button to delete all measurement results.*

Table 25: Control Panel Functions

Command button	Description
Start	Start command button; use to start the sequencing based on the selected Sequence Mode
Stop	Stop command button; use to stop the sequencing
Clear Results	Clear Results command button; use to clear all previous results in the Results Summary menu, Results Details menu, Plot Summary window, and Plot Details window; data saved to files remains intact (.csv, .wfm files, etc.)

Table 26: Sequence Mode Option Definitions

Mode	Description
Single Run	Acquires a new waveform if the source is Ch1, Ch2, Ch3, or Ch4; for all sources, the application sequences until complete and displays the results or plots (if set up)
Single No Acq	Recalculates the selected measurements without acquiring new data and displays the results or plots (if setup)
Free Run*	Continuously acquires waveforms and sequences until you select the Stop command button
***Sequencing stops when the sequencing reaches the population limit; plots display (if set up and enabled) when you select Stop.**	

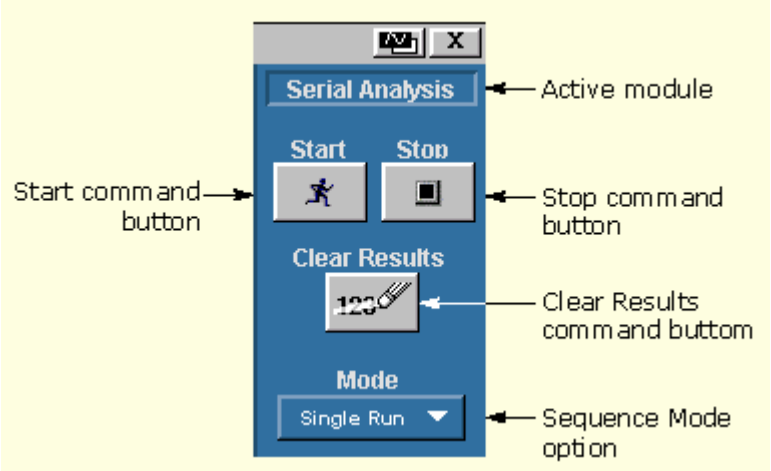


Figure 49. Control Panel.

There are two ways to view the results after an analysis is complete: statistical values or graphical plots.

If you enable the plots before taking measurements, the application shows the selected plots in a separate window in the oscilloscope part of the display. The application shows statistics in the application part of the display. When you use a Limits Module, the application also shows the results as Pass or Fail.

Statistical Results

There are two ways to view the statistical results of measurements: Results Summary Menu or Results Details Menu.

Viewing Statistics

To view measurement statistics, select the Results Summary or the Results Details menu. The application displays results for the measurements of all acquisitions or for the current acquisition.

The Results Summary menu shows the current data and all acquisition data for each statistical value.

The Results Details menu contains statistical values for the following characteristics:

- Population
- Mean
- Standard deviation (StdDev)
- Maximum (Max)
- Minimum (Min)

- Pk-Pk

Table 27: Results Summary Menu Options

Option	Description
Select View	Bases the results summary on All Stats or Limits Status*
(Table) Measurement	Lists selected measurements
Mean	Lists a statistical value for the mean characteristic
Min	Lists a statistical value for the minimum characteristic
Max	Lists a statistical value for the maximum characteristic
Pk-Pk	Lists a statistical value for the peak-to-peak characteristic
Status	Displays if the measurement is Pass or Fail
Show Plot	Updates and displays the Plot window, if enabled
Export to CSV	Displays the Export to CSV file dialog where you can locate a suitable directory and enter an appropriate file name
Details	Shortcut to the Results Details menu
Time Units	Displays results in Unit Intervals, seconds, or the natural unit for the measurement, such as mV
*** Only available when you enable measurement limits.**	

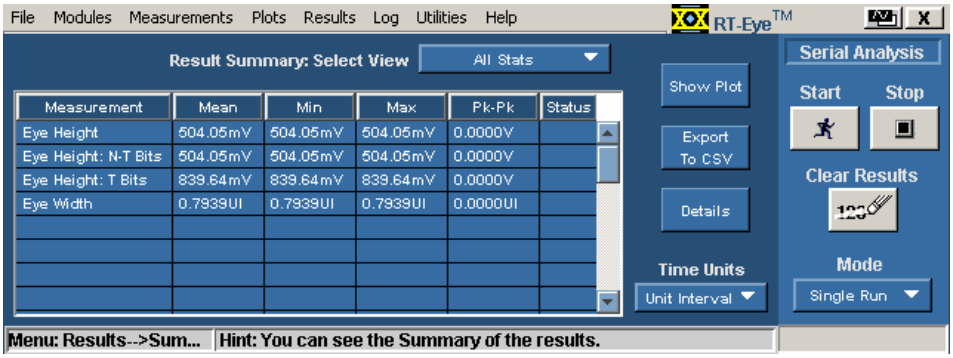


Figure 50. Results: Summary Menu.

Table 28: Results Details Menu Options

Option	Description
Select View	Display details for the measurement selected as this option
Show Plot	Displays the Plot window if enabled
Export to CSV	Displays the Export to CSV file dialog where you can locate a suitable directory and enter an appropriate file name
Summary	Shortcut to the Results Summary menu
Time Units	Displays results based on Unit Intervals seconds, or the natural unit for the measurement, such as mV

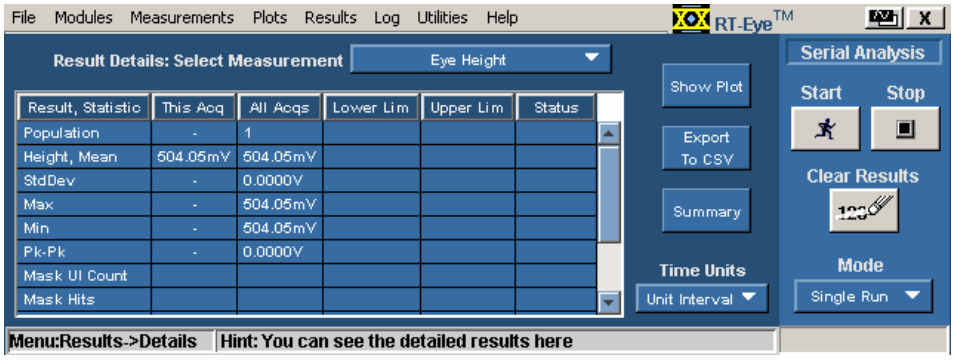


Figure 51. Results: Details Menu.

Saving Statistics to a .CSV File

You can save the statistics to a "comma separated variable" file to import into a text editor, a spreadsheet, or an analysis tool.

To save the results summary or details to a "comma separated variable" (.csv) file, follow these steps:

1. Select either Results menu.
2. For the Results Details menu, select the measurement whose details you want to save from the Results Details Select View drop down list.

   For the Results Summary menu, Limits Status is only available if you enabled measurement limits before taking measurements.
3. Set the Time Units option to Seconds or to Unit Interval. To save both types of information, you need to save two .csv files.
4. Select the 

button. The Save browser opens.
5. Enter a file name. The application appends the .csv suffix to the name.
6. Select the Save button to save the file.
   - If the oscilloscope is connected to a network, you can use the Explorer to move the file.
   - If the oscilloscope is not connected to a network, you can copy the file to a floppy disk.

View an example of a .csv file using a text editor.

View an example of a .csv file edited in a spreadsheet program.

Plotting the Results

The application can display the results as 2-dimensional plots for easier analysis. Before you take measurements, you can set up the Plots Select and Plots Configure menus to define up to four plots. When enabled, the plots will display when the application completes sequencing.

The application uses MATLAB-based windows to display plots.

Would you like to learn more about the plots, such as how the application computes each or when each is a good choice to use for analysis?

- Eye Diagram Plot Usage
- Histogram Plot Usage
- Time Trend Plot Usage
- Spectrum Plot Usage
- Bathtub Plot Usage

***Note**: When taking measurements in the Free Run mode, you must stop the sequencing before you use the Plots Select or Plots Configure menus.*

***Note**: Be sure to configure a printer before you print a plot.*

Table 29: Plot Type Definitions

Plot type	Description
Eye Diagram	Represents data for the eye diagram based on the recovered clock as the timing reference; used for mask testing
Histogram	Represents measurements sorted by value as a distribution of measurement values versus the number of times the value occurred
Time Trend	Represents the measurement values versus the time location
Spectrum	Represents the frequency content computed using the FFT of the Time Trend plot
Bathtub	Represents the Bit Error Rate versus the jitter eye opening for measurements that include Rj/Dj analysis

Table 30: Plot Coordinate System

Plot type	X-Axis units	Y-Axis units
Eye Diagram	Time, sec	Voltage, V
Histogram	Units of selected measurement	Histogram bin hits; no units
Time Trend	Time, sec	Units of selected measurement
Spectrum	Frequency, Hz	Units of selected measurement
Bathtub	Time, sec	Bit error ratio; no units

Note: *Measurements not listed are unsuitable for plots (Unit Interval, Differential Skew, Differential Voltage, High Amplitude, Low Amplitude, CM Voltage, or AC CM Voltage).*

Table 31: Measurements and Available Plots

Measurement	Eye Diagram	Histogram	Time Trend	Spectrum	Bathtub
Eye Width/ Eye Height	Yes	No	No	No	No
Rise Time	No	Yes	Yes	No	No
Fall Time	No	Yes	Yes	No	No
Unit Interval	No	Yes	Yes	No	No
Bit Rate	No	Yes	Yes	No	No
Differential Skew	No	Yes	Yes	No	No
Differential Amplitude	No	Yes	Yes	No	No
De-Emphasis	No	Yes	Yes	No	No
Jitter@BER	No	No	No	No	Yes
TIE Jitter	No	Yes	Yes	Yes	No

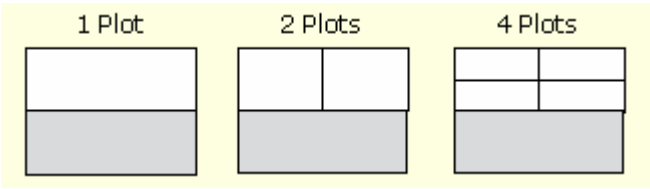


Figure 52. Plot Window Layouts.

Eye Diagram Plot Usage

The clock recovery used for Real-Time Eye (RT-Eye) rendering is software based. The ideal clock (jitter reference clock) is recovered from the serial bit stream. The actual locations of the rising and falling edges of the acquired waveform are then "rendered" with respect to the recovered clock, creating an eye diagram. The clock is recovered from a single waveform acquisition which means that trigger jitter is eliminated from the eye diagram.

If you use a CSA7000 series or a TDS6000/7000 series oscilloscope with Option SM, hardware (HW) clock recovery is also available through the Masks menu in

the oscilloscope application. The HW clock recovery is Phase Locked Loop (PLL) based.

Eye diagrams created using HW PLL are called Equivalent Time (ET) eye diagrams and are susceptible to trigger jitter. The ET Eye diagram is useful as a first check of signal quality and for debug purposes. RT-Eye rendering provides high precision "de-jittered" eye diagram with a very small Jitter Noise Floor (JNF) required for compliance testing.

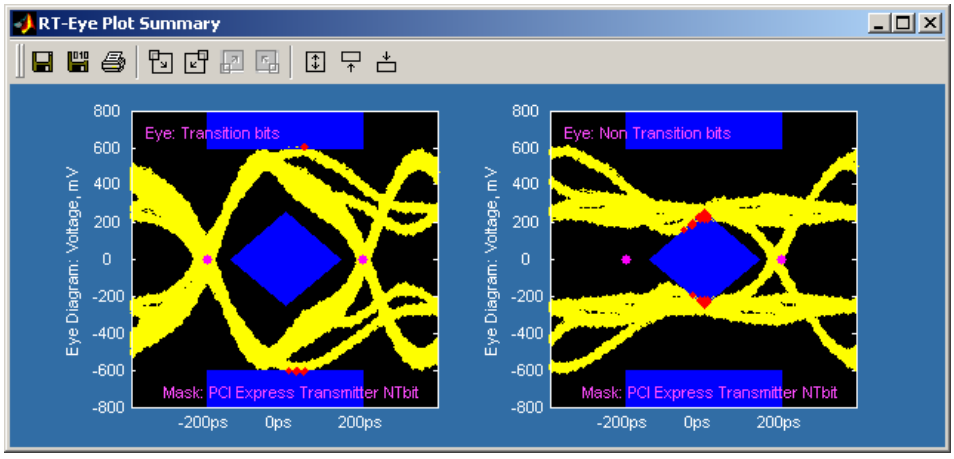


Figure 53. RT-Eye (Real Time) Rendering

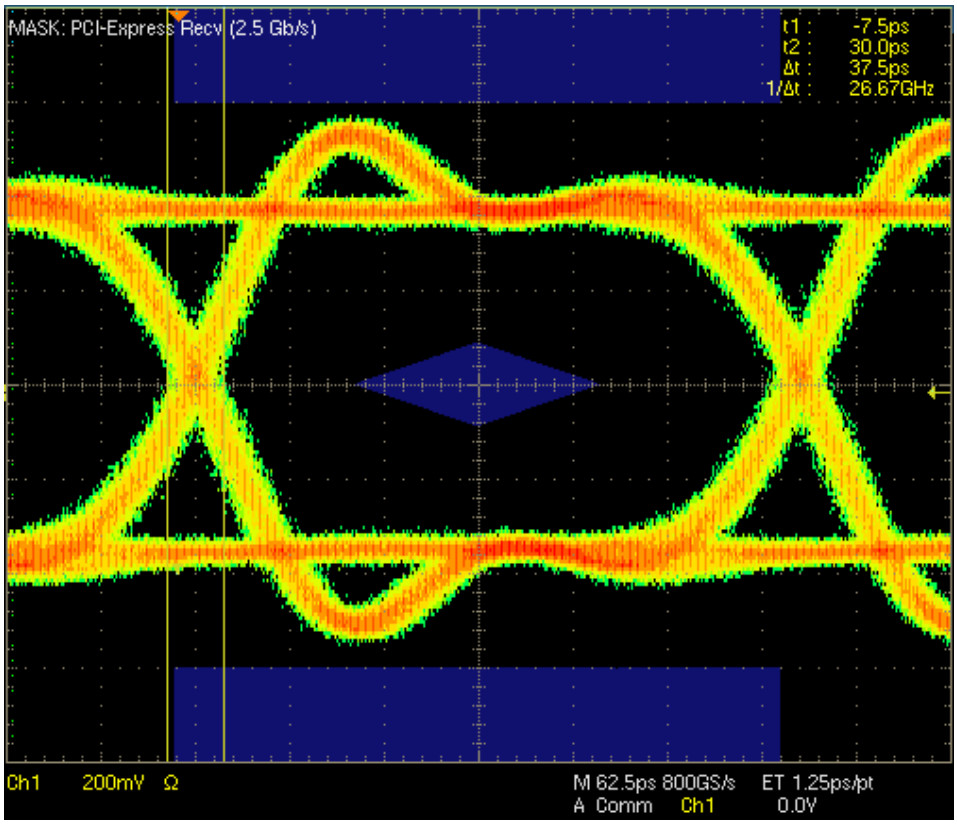


Figure 54. ET-Eye (Equivalent Time) Rendering

Histogram Plot Usage

Histogram plots display the results such that the horizontal axis represents the measurement values and the vertical axis represents the number of times that the value occurred. Unlike any other plot, a histogram plot accumulates measurements over multiple acquisitions, up to a total population size of 2.1 billion.

Histograms are particularly useful in analyzing jitter. A histogram of the Time Interval Error (TIE) represents the basis of jitter analysis using a histogram approach. In a histogram, Deterministic Jitter (Dj) is bounded in a system and shows up as a non-gaussian distribution. Random Jitter (Rj) is unbounded and amplitude will continue to grow the more population is acquired. The TIE histogram is a good first look analysis of jitter.

Time Trend Plot Usage

A Time Trend plot is a waveform trace of a measurement versus time. An example of where this is useful is determining if the embedded clock in a serial bit stream is modulated outside the capabilities of your receiver to recover the clock. The time trend plot provides data for the time interval error (TIE). If this waveform starts to take an unexpected periodic shape, then this could indicate that you have uncorrelated periodic jitter from cross talk or from power supply coupling.

Also available in the Time Trend plot window are the real-time waveform and recovered bit times. These are useful for correlating excessive jitter excursions with the differential voltage waveform to completely understand what the modulation does to waveform signal integrity. A Time Trend plot could also be used for simpler measurements such as Rise Time or Differential Amplitude giving a cycle-cycle analysis of these measurements for the full acquisition record.

Spectrum Plot Usage

A spectrum plot is the Fast Fourier Transform of a Time Trend plot. This plot is useful in identifying frequency components that contribute to timing errors, such as modulation of the measurements. An example of where this is useful is plotting a "Jitter Spectrum." Jitter Spectrum is the FFT of the trend of time interval error. What this reveals is the frequency components of the output jitter.

Further analysis on the Jitter Spectrum can be used to separate Random Jitter (Rj) from Deterministic Jitter (Dj) as well as separate Dj components of Periodic Jitter (PJ) and other Dj components such as ISI and DCD. The frequency of periodic jitter spikes that do not correlate to frequencies contained in the data pattern can be a clue that you should look at frequencies of different components in your design as possible sources of jitter.

Bathtub Plot Usage

Bathtub curves are the industry standard way of viewing the Jitter Eye Opening. A Bathtub curve represents a plot of the eye opening versus the BER (Bit Error

Ratio). Most 8B/10B encoded copper standards call for Total Jitter to be measured at 10^{-12} BER. The eye opening represented by the Bathtub Curve is what is left of the unit interval after the total jitter measurement is subtracted. A detailed discussion of bathtub analysis can be found in the MJSQ document at www.t11.org.

The Jitter Eye opening and the Total Jitter have the following relationship:

Total Jitter + Jitter Eye Opening = 1 Unit Interval

Selecting Plots for Configuration

Before you take measurements, you can set up plots in the Plots Select menu.

To select a plot to configure, follow these steps:

1. Select Plots> Select.
2. Select the On button.
3. Select a measurement in the Select Measurement column.
4. Select a plot type in the Select Subplot column.

Note: *Use the* Select Meas *button as a short cut to the Measurements Select menu.*

Table 32: Plots Select Menu Options

Area	Option	Description
Select Subplot	Measurement	Select an active measurement to plot
	Plot Type	Select the type of plot to depict
Plots Display	On Off	Enables or disables the display of plots
Plots	Refresh	Updates the plot window when you deselect a plot or when you reselect a plot

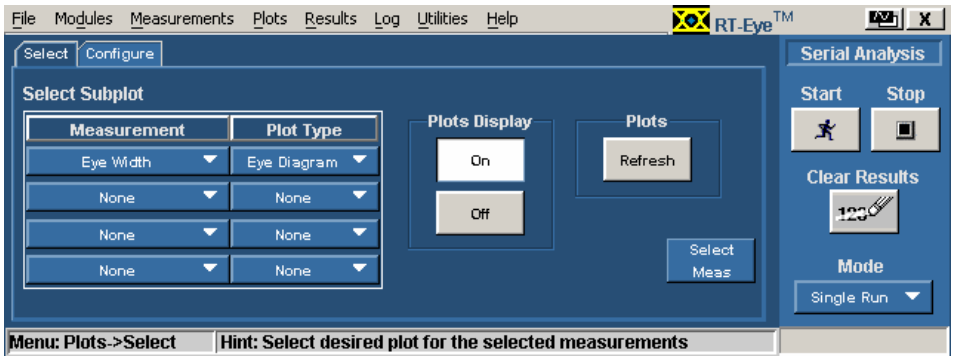


Figure 55. Plots: Select Menu.

Configuring Plots

After you select the plots, you can further configure each measurement and plot combination. The options are relative to the selected plot type in the Subplot column.

To configure a plot, follow these steps:

1. Select the Configure tab.
2. Select a measurement in the Select Measurement column.
3. Select a plot type in the Select Subplot column. Plot options depend on the type of plot selected.

   For the Eye Diagram plot, masks are available for many standards and you can create your own custom designed mask. For more information on User masks, refer to the Using User Masks topic.
4. Configure the plot.
5. Select the Select tab.
6. Select the Refresh command button.

The Plot Summary Window updates and displays the selected plots. View an example of the Plot Summary Window.

Table 33: Plots Configure Menu Options for an Eye Diagram

Area	Option	Description
Bit Type	Transition	Renders an Eye Diagram only for transition bits
	Non Transition	Renders an Eye Diagram only for nontransition bits
	All	Renders an Eye Diagram for all bits
Mask	On Off	Enables or disables the display and mask testing
	Standard	Specifies a User-defined* mask or a mask based on a serial data standard, such as InfiniBand or PCI Express
	Type**	Selects a type of mask specific to the selected standard; See list (receivers, cables, test points)
*** Browse for a mask file to import from the tdsrt-eye/Examples/Masks directory.**		
**** Available when you select a serial data standard as the Standard option.**		

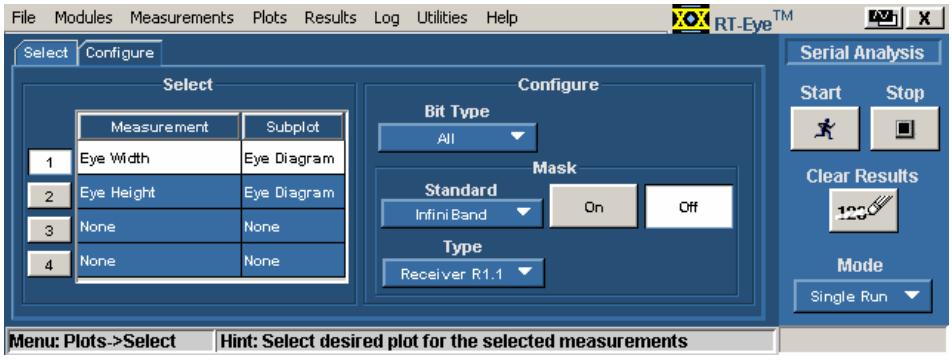


Figure 56. Plots Configure Menu for an Eye Diagram.

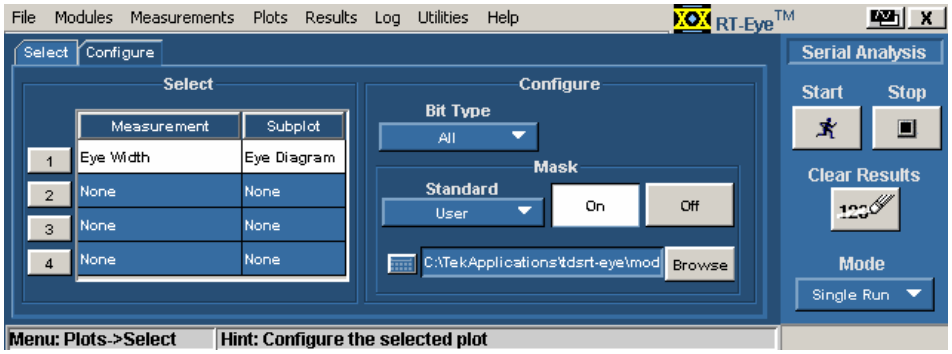


Figure 57. User as the Standard Mask Option.

Table 34: Plots Configure Menu Options for a Histogram

Option	Description
Vertical Axis	Sets the vertical axis in a linear scale (default) or in a logarithmic scale
Bin Resolution	Defines resolution by time

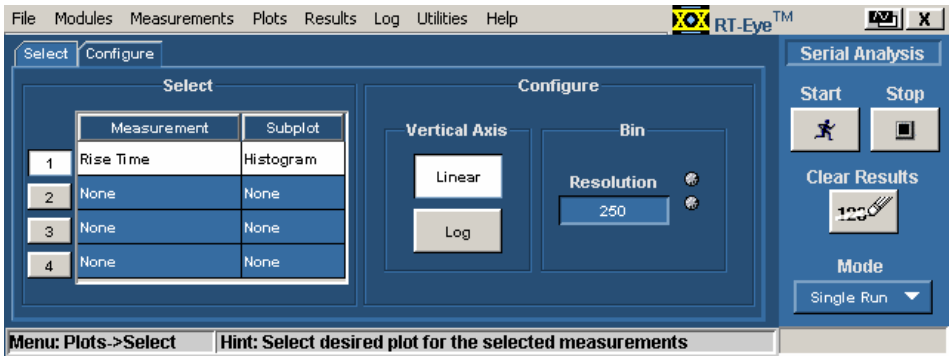


Figure 58. Plots Configure Menu for a Histogram.

Table 35: Plots Configure Menu Option for a Time Trend

Option	Description
Waveform Overlay	Enables or disables adding the waveform to the plot

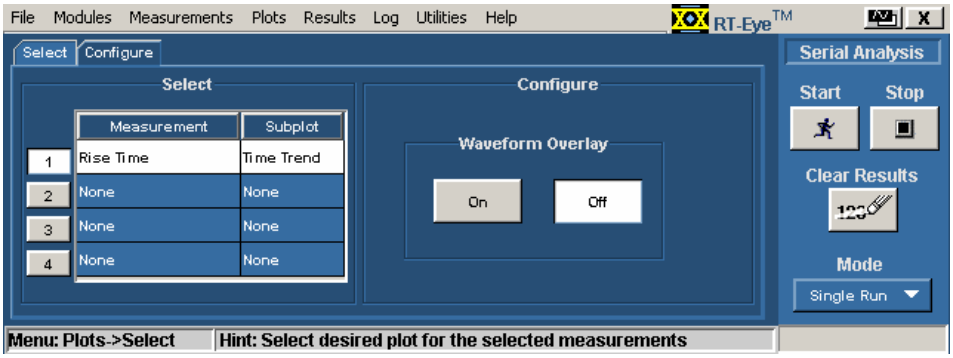


Figure 59. Plots Configure Menu for a Time Trend.

Table 36: Plots Configure Menu Options for a Spectrum

Option	Description
Vert. Scale	Depicts the vertical axis in a linear scale (default) or in a logarithmic scale
Horiz. Scale	Depicts the horizontal axis in a linear scale (default) or in a logarithmic scale

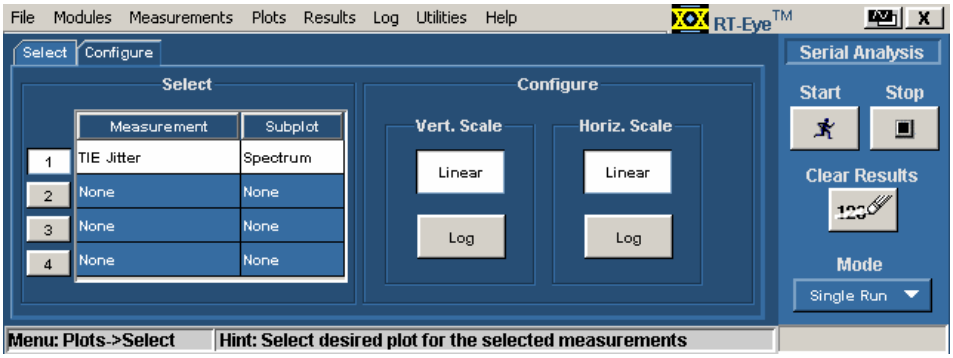


Figure 60. Plots Configure Menu for a Spectrum.

Table 37: Plots Configure Menu Option for a Bathtub

Option	Description
Scale	Depicts both axes in logarithmic scale (default) or in linear scale

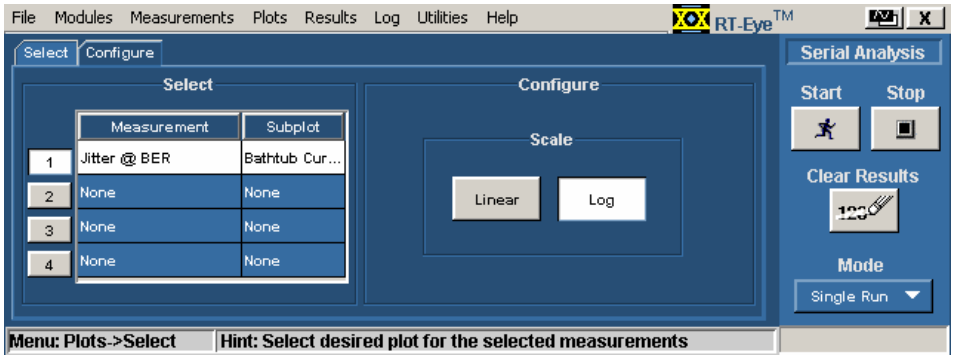


Figure 61. Plots Configure Menu for a Bathtub.

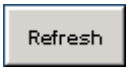
Viewing Plots

There are two windows you can use to view and analyze plots: Plot Summary and Plot Details. The application includes tools to help you size and position the window, display either window, and display the details of another plot directly from the details window.

After you select and configure a plot, select the  command button. When sequencing is complete, the Plot Summary Window appears with up to four plots.

If you reconfigure a plot and want to view the updated plot, follow these steps:

1. Select the  button.

2. Select the  command button.

The plots window updates according to any changes you made to the Plots Select or Plots Configure menus.

The Plot Details tools represent the plots by quadrant in the Plot Summary Window. For example, you can select the  tool to display details for the plot in the upper left quarter of the Plot Summary window..

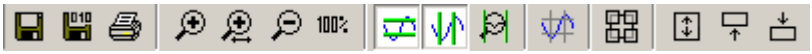
Note: *If you have a keyboard, you can use the alt-tab Window shortcut to quickly select a window for viewing.*

Note: *If you have a second monitor, you can select and drag the title bar of the plot window to position it in the other monitor. This allows you to simultaneously display a waveform on the oscilloscope, the RT-Eye measurement results, and the plot for easy viewing.*

Toolbar Functions in Plot Windows

The Plot Summary window includes the following toolbar:

The Plot Details window includes the following toolbar:



Some functions are specific to the Plot Summary window and others are specific to the Plot Details window. The next table lists the available functions in each type of plot window.

Table 38: Toolbar Functions in Plot Windows

Tool icon	Function	Summary	Details
	Save	Yes	Yes
	Print	Yes	Yes
	View Details	Yes	No
	Size and position window	Yes	Yes
	Zoom	No	Yes
	Cursors	No	Yes
	Grid	No	Yes
	Return to Summary	No	Yes

The Plot Summary window includes save, print, view details, and size and position window functions.

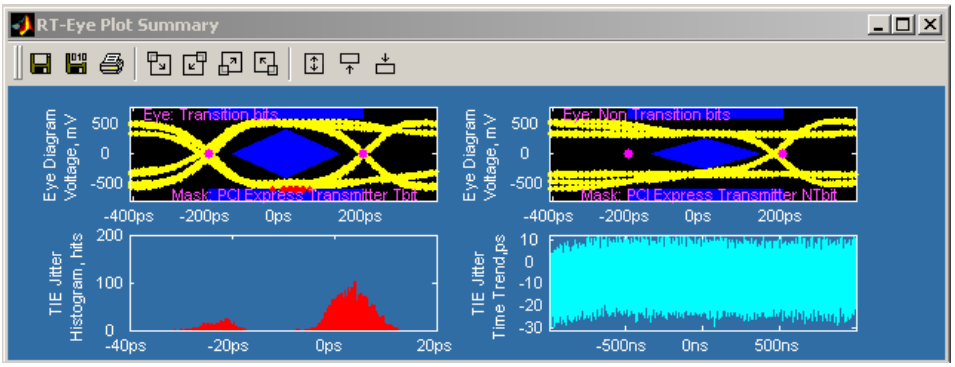


Figure 62. Plot Summary Window Example.

The Plot Details window includes save, print, zoom, cursors, grid, view summary, and size and position window functions.

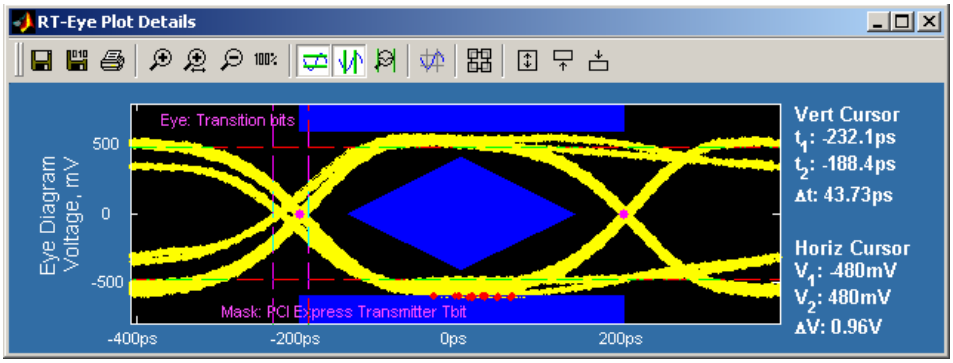


Figure 63. Plot Details Window Example.

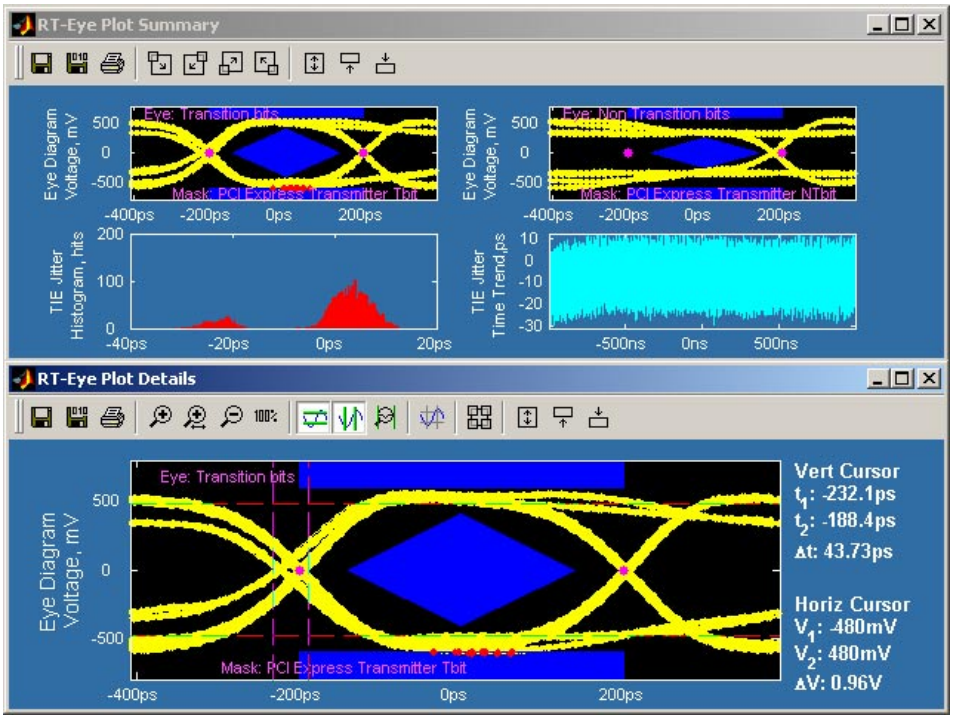


Figure 64. Plot Summary and Details Window Example.

Viewing a Plot in the Whole Display or in Half the Display

You can change the plot size to the whole display of the oscilloscope, or to half the display. When viewing a plot in half the display, you can position the plot in the upper or lower half.

-  enlarges the plot to fill the entire display
-  reduces the plot to half the display, if need be, and positions it in the upper half
-  reduces the plot to half the display, if need be, and positions it in the lower half

Returning to the Plot Summary Window

To return to the Plot Summary window, select the  tool.

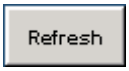
Using Zoom and Cursors in a Plot

You can use the zoom and the cursors functions simultaneously in the Plot Details window. To do so, follow these steps:

1. Select the  tool and draw a box around the area bound with the cursors.
2. Use the cursors to take measurements.
3. Repeat the previous steps if need be. You can zoom in by a magnification of 20X.
4. Select the  and the  tools to display the horizontal and the vertical cursors.
5. Move the cursors to bound the area you want to view more closely.

Removing Plots

To remove a plot from a plot window, follow these steps:

1. Select Plots> Select.
2. Select None for the measurement in the Select Measurement column.
3. Select the 

command button.

The plot window updates and does not display the deselected plot.

Using Zoom in a Plot

Once you have created a plot, you can use the Zoom tools in either plot window to examine the data at various scales. View the Plot Zoom tools.

Note: *You can quickly restore the view to display all the data. To do so, select the* *tool.*

Note: *If you prefer to move the cursors in the plot window with your finger, you can activate the Touch Screen on the oscilloscope.*

Table 39: Plot Zoom Definitions

Zoom type	Description
In	Expands part of the plot; the data appears in more detail
Out	Contracts part of the plot; the data appears in less detail
X axis	Expands the horizontal axis only and retains the vertical axis
100%	Restores the plot to display all the data

Changing the Scale of Data in a Plot (Zoom)

To change the scale of the data in a Plot Details window, select one of the following plot zoom tools:

- zooms in to expand the scale
- zooms out to contract the scale
- zooms in to expand the horizontal axis only
- zooms in to restore all the data

When you select the tool, you can use a select-drag-release action to expand part of the waveform (zoom in) by an arbitrary amount on both axes. After you select (touch with a finger or click with the mouse) and begin dragging, a bounding box appears to show what part of the waveform will be expanded upon release.

Select any part of the plot to expand the data by a factor of two (2X) equally on both axes. Double selecting expands the data to the maximum factor.

To contract an expanded part of the data (zoom out), select anywhere on the data. The view contracts to the values that existed before the most recent expansion of the data. Selecting multiple times will restore successively earlier views.

To expand the scale of the horizontal axis only by a factor of two (2X), click a part of the waveform. The plot retains the scale of the vertical axis.

Note: *You can quickly restore the view to the entire waveform. To do so, select the* *tool.*

Using Cursors in a Plot

Cursors allow you to view numerical values associated with a plot based on cursor locations. There are two cursor modes: Horizontal-paired and Vertical-paired. Each mode displays two cursors.

Table 40: Plot Cursors Definitions

Cursors type	Description
Horizontal	Displays the vertical coordinate where each cursor touches the plot and the difference (delta) between the cursors
Vertical	Displays the horizontal coordinate where each cursor touches the plot and the difference (delta) between the cursors
Reset	Brings the cursors into the visible part of the plot

Using Cursors in a Plot

You can use cursors to read the coordinate where each cursor (line) touches the plot and also view the difference (delta) between the two cursors.

To use cursors in the Plot Details window, follow these steps:

1. Select one of the following cursor tools:

- to use Horizontal cursors
- to use Vertical cursors
- to bring the cursors into the visible plot

2. Select and drag either cursor to move the cursor to the part of the plot desired.

The cursor readout changes value to reflect the cursor position.

Note: *You can drag cursors only when the Zoom functions are disabled.*

Note: *If you prefer to move the cursors in the plot window with your finger, you can activate the Touch Screen on the oscilloscope.*

Using Grid Points in a Plot

To display or remove grid points in a Plot Details window, select the tool.

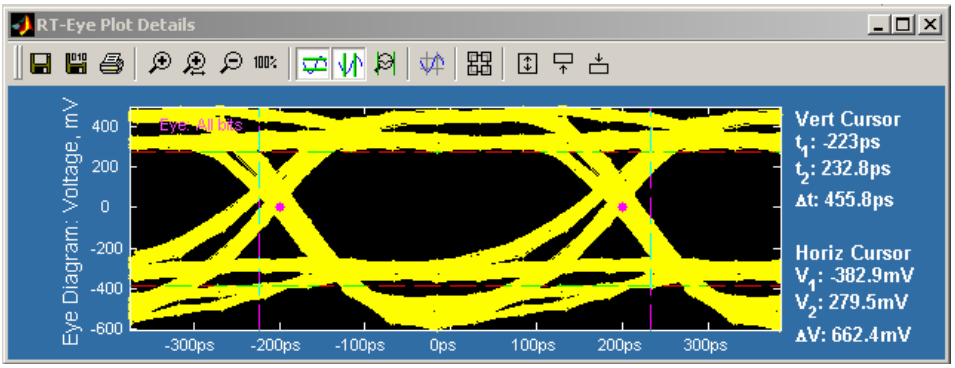


Figure 65. Horizontal and Vertical Cursors in a Plot Example.

Saving Plots to Files

Both plot windows include the save plot file tools. However, the contents of saved plot files are dependent on the type of plot window: Summary or Detail.

Table 41: Save Plot Files Definitions

File type	Description
Graphic	Saves the contents of the plot window in the format you select from the list
Data	Saves the contents of the plot window as a binary .fig file

Saving Plot Files

To save a plot file, follow these steps:

1. Set up the plot window.
2. Select one of the following save plot file tools:
   - to save the plot as graphic file
   - to save a data file
3. Select the Browse button to select a directory and then enter a file name.
4. Select the Save button to save the plot file. The application saves the file.

Printing Plots

To send a plot to a printer, follow these steps:

1. Verify that a printer is configured.
2. Set up the plot window (with the zoom, cursor, or grid points functions).
3. Select the Print... tool.

   The Plot Print dialog appears. View the Plot Print Preview window.
4. Select the Print... button and set up the options.

5. To customize the print of the plot, select the Page Setup... tool.

The Page Setup menu appears which is a part of the MATLAB software.

Note: *The online help topics for the RT-Eye application do NOT describe how to use the MATLAB Page Setup menu. Refer to the MATLAB documentation for more information.*

Select the Print button to print the plot file. If you selected Print to File, use the Browse button to select a directory and then enter a file name. The application saves the file.

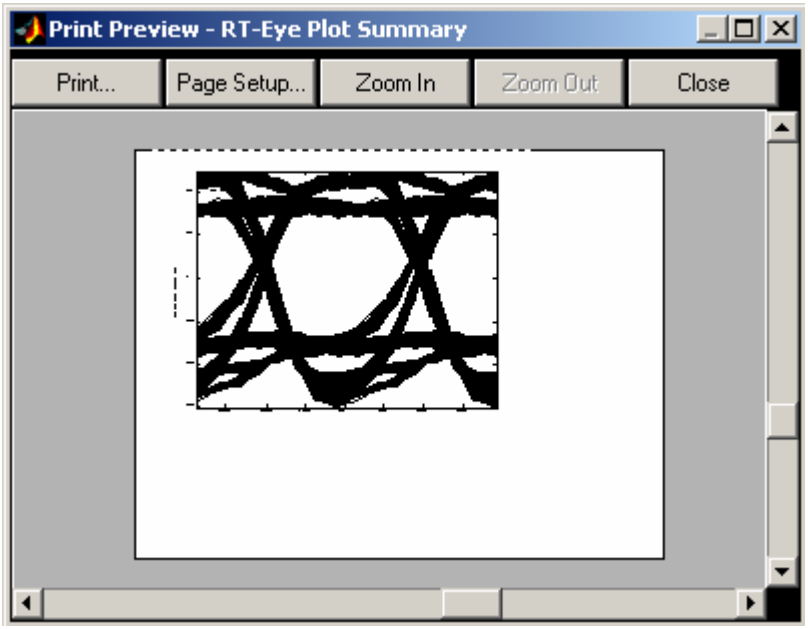


Figure 66. Plot Print Preview Window.

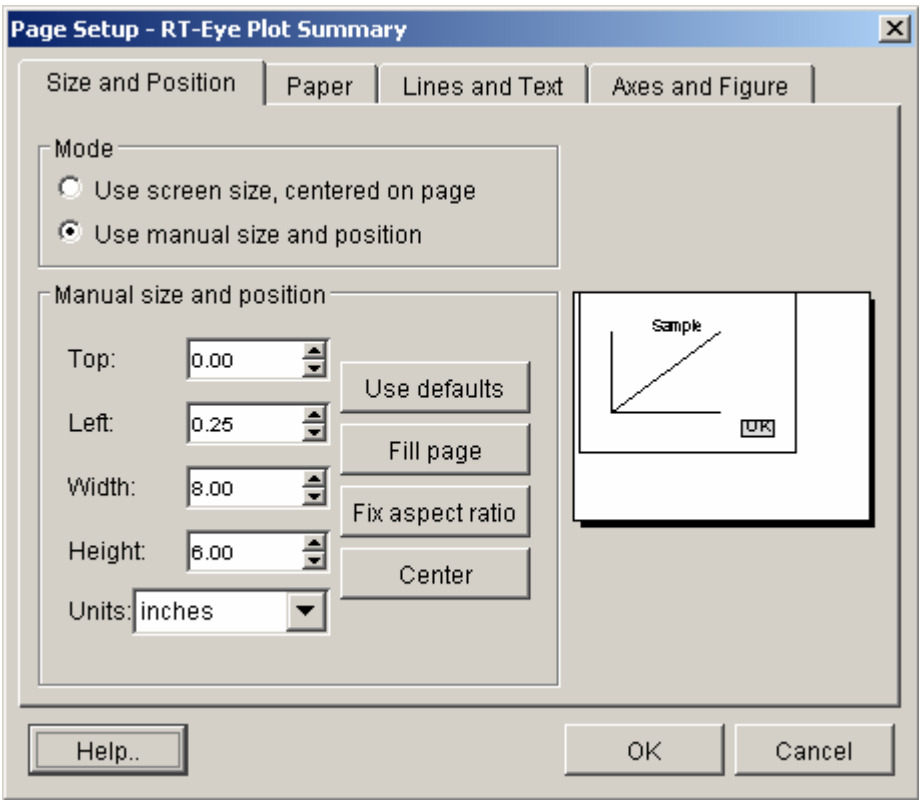


Figure 67. Plot Page Setup Window.

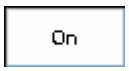
Logging Worst Case Waveforms

You can use the Log Worst Case menus to save the acquired waveforms whenever a selected measurement exceeds the highest or lowest prior value. When enabled, the waveforms are saved to a set of .wfm files.

Saving Worst Case Waveforms From a Live Source

The application also exports the contents of the files to a worstcasetable.csv file located in the Log directory.

To log worst case waveforms, follow these steps:

1. Select Log> Worst Case> Configure.
2. Select the 

button to enable logging.
3. Select the 

button to select a directory.
4. Select the  command button in the Control Panel.

The application saves the waveforms with the worst case maximum and minimum values for all selected measurements in the tdsrteye\modules\SerialAnalysis\waveforms directory.

To disable logging, select the Off button.

Note: *Use the* Purge *button to delete all the .wfm files in the selected directory.*

Table 42: Log Worse Case Waveforms Configure Menu Options

Option	Description
Log	Enables or disables saving the maximum and minimum values of the worst case waveforms to files for each source
Choose Directory	Browse to select the directory in which to save the waveforms when the log worst case waveforms function is enabled
Purge	Deletes all waveform files from the selected directory

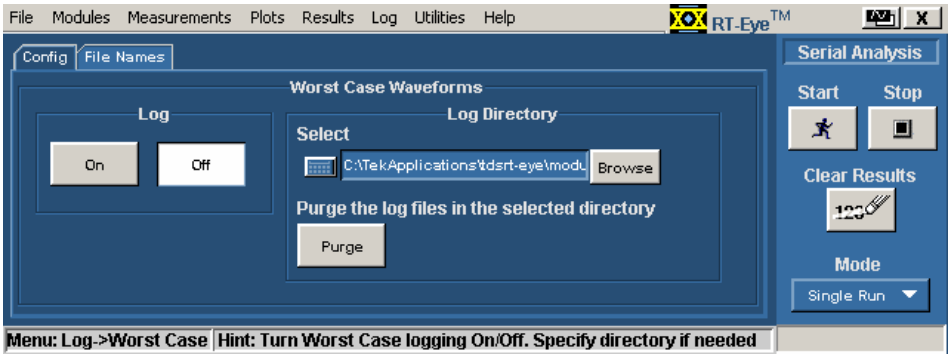


Figure 68. Log: Worst Case Configure Menu.

File Names of Worst Case Waveforms

The application automatically names the files for you. The file names include the following information:

- Type of measurement
- Whether the file is a maximum or minimum value waveform
- Date and time that the file was saved

File names appear after sequencing is complete and measurement results display.

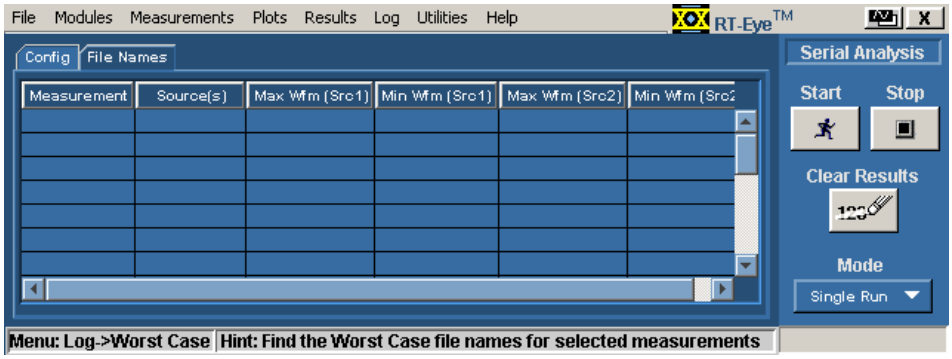


Figure 69. Log: Worst Case File Names Menu.

Generating a Report

You can use the Report Generator utility to customize and generate a compliance report to view later or to share with others. The utility is independent from the RT-Eye application, yet is accessible from the application.

Note: *The utility yields a .rpt file that can only be viewed from the Report Generator. You can select to export to an .rtf formatted file.*

Table 43: Report Generator File Directories

Directory	Description
Reports	Default location where the utility stores reports
Templates	Each .rgt template file defines the contents and layout of one page in the report; you can use existing page templates, edit templates or create new templates
Layouts	Each .rpl layout file defines all the pages (template files) to include in a report; you can use an existing report layout, edit layouts or create new layouts

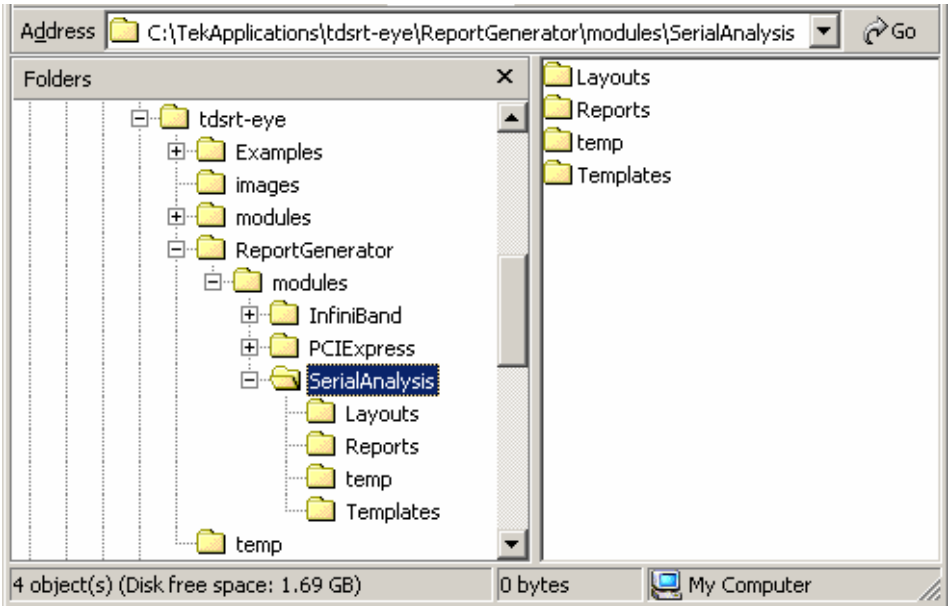


Figure 70. Directory Structure for the Report Generator Utility.

Starting the Report Generator and Accessing the Online Help

The online help for the Report Generator utility contains all the information you need to design and produce compliance report files. To start the report generator utility from the RT-Eye application and access the online help, follow these steps:

1. Select Utilities> Reports.

2. Select the Define Test Template or the Define Report Layout tab.

3. Select the 

command button.

4. From the menu bar in the Report Generator window, select Help> Help Topics. The Help system for the utility starts and displays.

You can refer to the online help topics for the Report Generator utility for information on how to do the following tasks:

- Use an existing test template or report layout
- Edit an existing test template or report layout
- Create a new test template or report layout
- Add Fields: Native, Oscilloscope, Serial Analysis

Setting Up a Test Template and Layout for a Report

The Report Generator utility allows you to design the contents and layout of a report that reflects your unique needs. In addition to a predefined template for each page, there is also a predefined report that includes all the predefined pages.

Generating and Printing a Report

To generate and print a report, follow these steps:

1. Select Utility> Reports.

2. Select the Generate Report tab.

   Do not touch the screen. Wait while the Report Generator creates the report. The oscilloscope fills the display while the application takes a screen print. When complete, the oscilloscope shrinks to half size and automatically redisplays the RT-Eye application.

   The report displays when it is complete. You may need to use the Alt+Tab key combination to bring the Report Generator window to the front.

3. You need to save the report to retain the file. To save the report, select File> Save from the menu bar of the Report Viewer. The report file is in a .rpt format and can only be viewed with the Report Viewer.

   Later, you can use the Browse and View buttons in the Generate Report menu to open your saved report file.

4. To use a different file, edit a file, or create a new report layout (or test template) file, refer to the Report Generator online help.

5. To print the report, first verify that a printer is configured from the oscilloscope task bar.

6. From the Report Generator menu in the RT-Eye application, select the Print button.

   You can also navigate to the saved file in the Report Generator window and send the file to a printer without having to open the file in the Report Viewer.

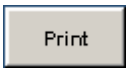
   To share a report with others, you may want to generate a smaller file. To do so, refer to the Creating a PDF File of the Compliance Report topic.

7. To export the report as an .rtf file, select File> Export to RTF from the menu bar of the Report Generator window. You can transfer the .rtf file to a personal computer, and view or print the file from a word processing program.

Creating a PDF File of the Compliance Report

You can send a report file to a "virtual" printer to create a smaller and more portable PDF file of your compliance report. To create a PDF, follow these steps:

1. Verify that a distiller program (for example, Adobe Acrobat Distiller 6.0) is configured from the oscilloscope task bar.

2. From the Report Generator menu in the RT-Eye application, select the 

button.

3. Select the Distiller from the Printer Name selection menu.

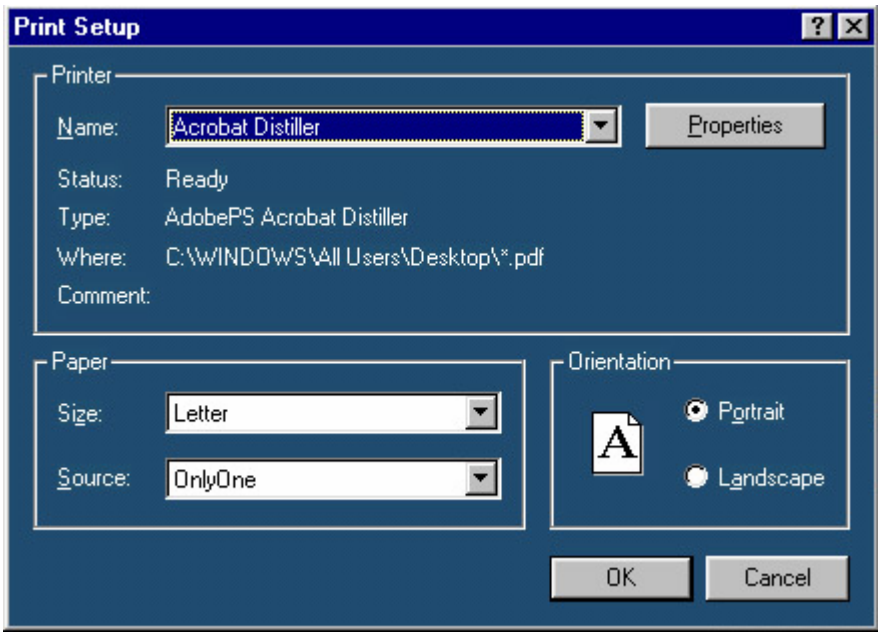


Figure 71. Print Setup Dialog to Process the Report in to a PDF File.

4. Send the report to the distiller (select OK).

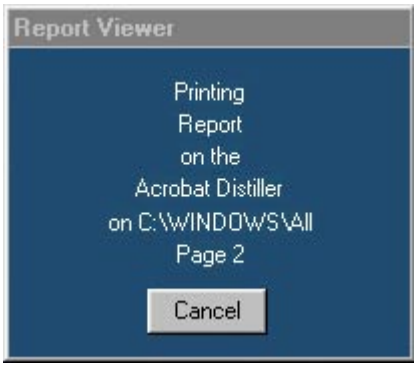


Figure 72. Report is Being Distilled.

5. When the PDF file is complete, you can use other features of the distiller to further enhance the report, such as add watermarks if available.

Note: *Refer to the online help topics for the Report Generator utility for information on how to create a new test template or on how to edit an existing test template.*

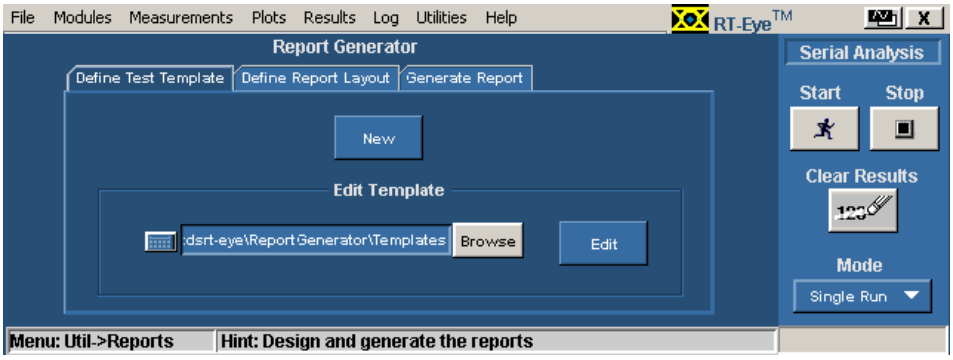


Figure 73. Test Template Menu.

Note: *Refer to the online help topics for the Report Generator utility for information on how to create a new report layout or how to edit an existing report layout.*

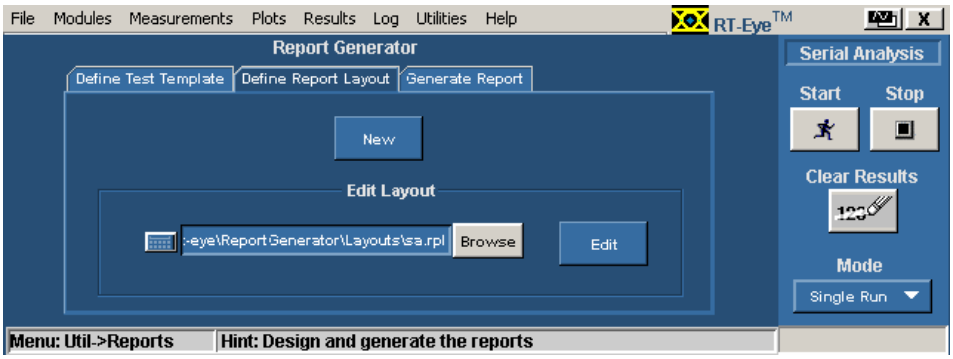


Figure 74. Report Layout Menu.

Table 44: Report Generate Menu Options

Option	Description
Browse	Select a directory in which to save the report file and enter a file name; select a file for the template or layout and edit as needed
Generate	Create a report
View	View a report
Print	Print a report

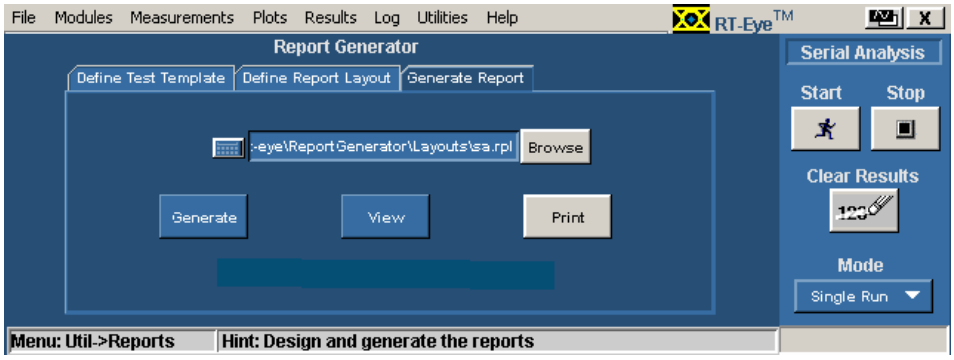


Figure 75. Report Generate Menu.

Report Generator Fields

You can use the fields in the report generator utility to customize the contents and layout of a report. The utility has the following groups of fields:

- Oscilloscope
- Application
- Native

This is an example of the fields available for the general oscilloscope information in the report.

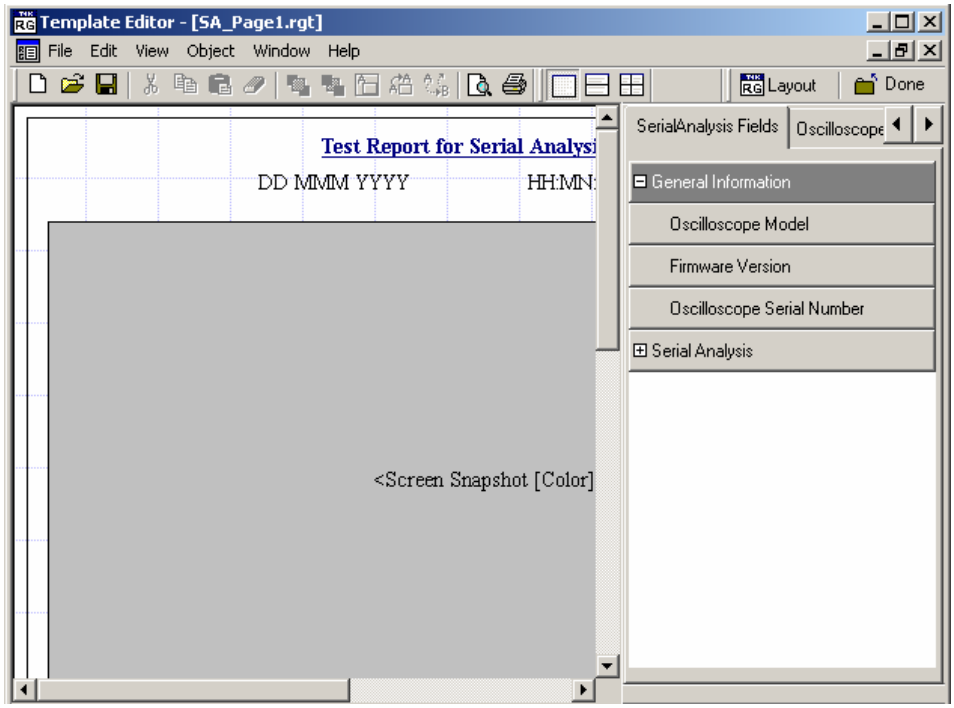


Figure 76. Application Fields General Information List.

This is an example of the fields available for the configuration information. This example also shows the expanded list of fields available for the Ref Levels in the report.

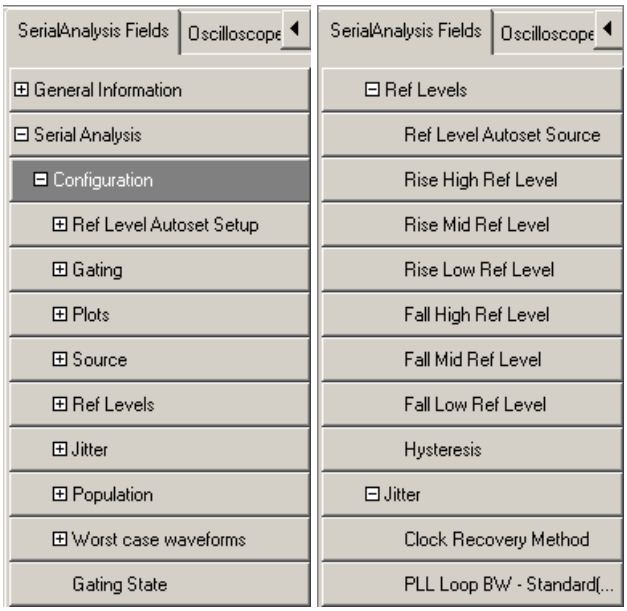


Figure 77. Application Fields Configuration List and Ref Levels Example.

This is an example of the fields available for the measurement results information. This example also shows the expanded list of fields available for an EyeWidth/Eye Height measurement and for a Rise Time measurement in the report.

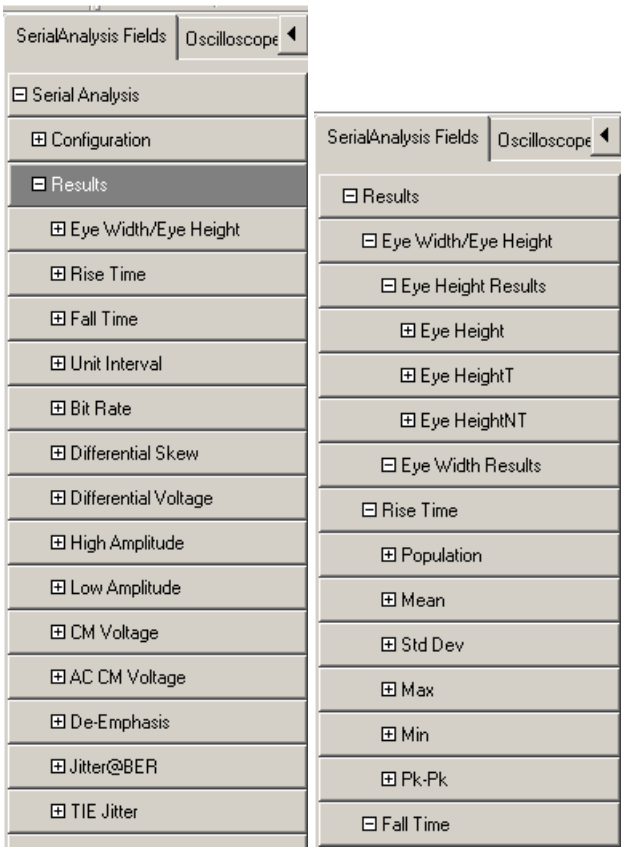


Figure 78. Application Fields Results List and Specific Measurements Example.

This is an example of the fields available for the oscilloscope controls and other miscellaneous accoutrements in the report, such as lines.

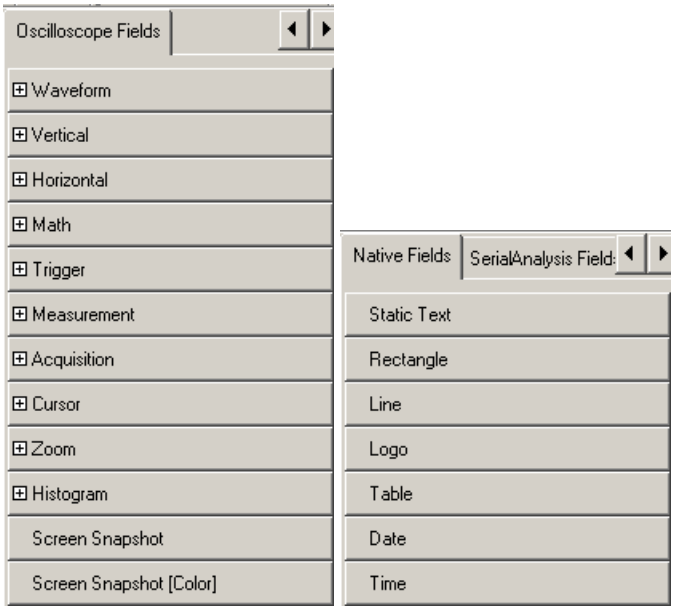


Figure 79. Oscilloscope Fields and Native Fields Lists.

Tutorial

This tutorial teaches you how to set up the application, take measurements, and view the results.

Before you begin the tutorial, you must do the following tasks:

- Set up the oscilloscope
- Start the application
- Recall the tutorial waveform

Note: *The screen captures shown are from a TDS7000 oscilloscope; there may be minor differences in the screens from other types of oscilloscopes.*

Setting Up the Oscilloscope

To set up the oscilloscope, follow these steps:

1. In the oscilloscope menu bar, select File> Recall Default Setup to set the oscilloscope to the default factory settings.
2. Press the individual CH1, CH2, CH3, and CH4 buttons as needed to remove active waveforms from the display.

Starting the Application

In the oscilloscope menu bar, select File> Run Application> RT-Eye Serial Compliance and Analysis.

The application starts up and displays the Measurements Select menu.

Waveform Files

The application includes a waveform file to use with this tutorial. The file is from a PCE Express signal and is named RT-EyeTutorial.wfm.

Recalling a Waveform File

To recall a waveform file, follow these steps:

1. In the oscilloscope menu bar, select File> Reference Waveforms> Reference Setup.

   Ref1 is the default memory location to recall a waveform file.

2. Select the 

button for Recall Ref1 from File.

3. Navigate to the C:\TekApplications\ tds-rteye\examples\WFMs directory.

4. Select the RT-EyeTutorial.wfm file and then Recall.

   The oscilloscope recalls the waveform file to reference memory and displays the waveform when the recall is complete.

5. To return to the application, select the App button in the oscilloscope menu bar.

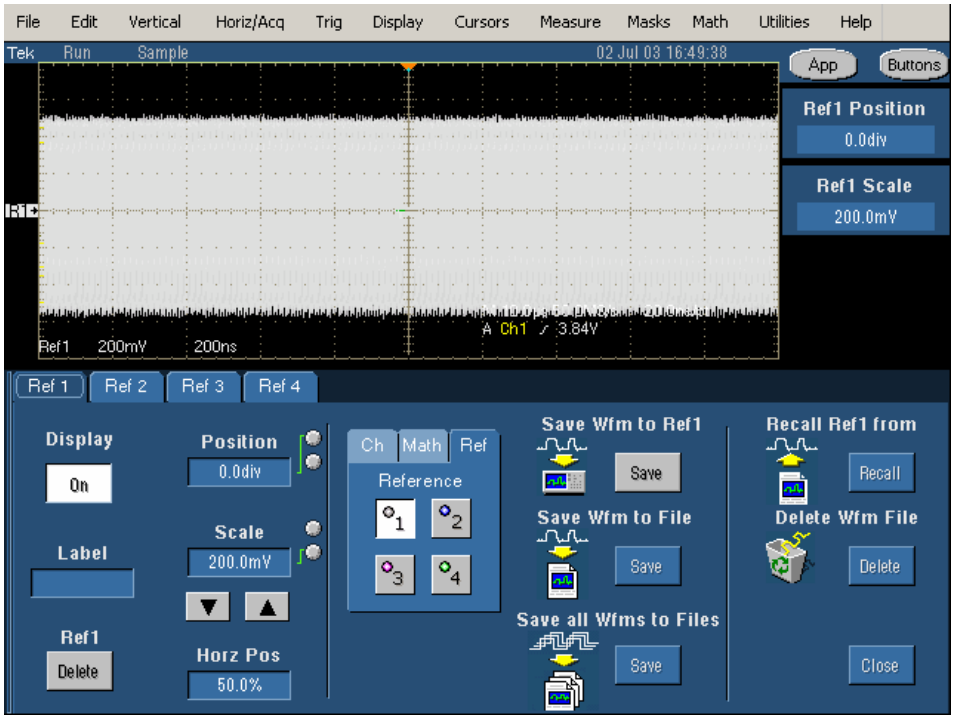


Figure 80. Oscilloscope Reference Memory Setup Menu.

Eye Width/Eye Height Measurement Lesson

In this lesson, you will learn how to use the application to take an Eye Width/Eye Height measurement and view the results. This lesson teaches you how to do the following tasks:

- Select a measurement
- Configure a measurement
- Take measurements
- View the measurement results
- View a Real-Time Eye diagram
- Stop the application

- Return to the application

To perform these lessons, the application must be installed and enabled on the oscilloscope.

Setting Up an Eye Width Measurement

To set up the application to take an Eye Width/Eye Height measurement, follow these steps:

1. To set the application to default values, select File> Recall Default.

   The tutorial uses the default measurement and probe type. The measurement selections vary depending on the Probe Type option: Differential or Single Ended.

2. Select the 

button.

3. The Configure Source menu appears with tabs for other Configure menus, 

.

4. Select Ref1 as the source. View the waveform recalled to Ref1 and selected as the source.

5. Select the 

tab. The Configure Ref Levels Menu appears.

6. Select the 

command button. The application automatically calculates the appropriate reference voltage level values.

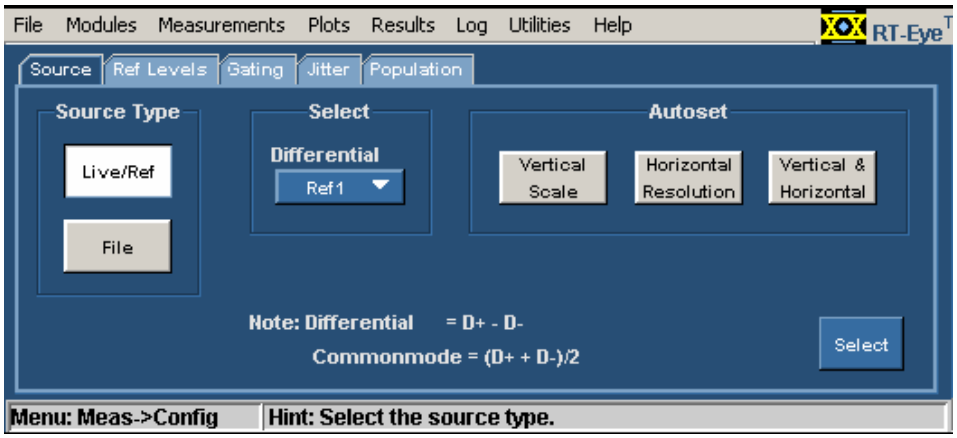


Figure 81. Ref1 Selected as the Source.

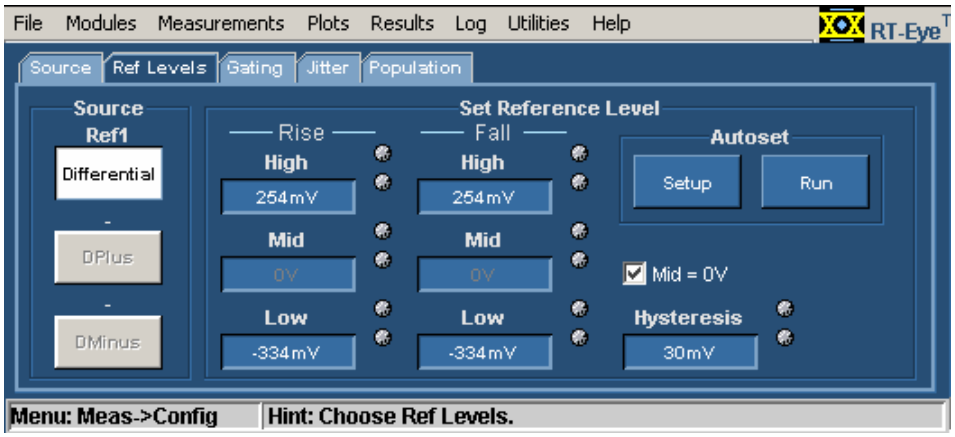


Figure 82. Using Autoset for Reference Voltage Levels.

Taking a Measurement and Viewing as an Eye Diagram

The default setup for the application includes an Eye Diagram plot. To take measurements and view the results as statistics and as a plot, follow these steps:

1. Select the  command button in the Control Panel.

   The application displays a real-time eye diagram that shows the characteristics of the waveform in a Plot Summary window. View the results of the Eye Width measurement as an Eye Diagram Plot.

2. You can view details of the results and details of the plot. To do so, select the  command button in the Results Summary menu and the  in the Plot Summary window.

3. You can use the Results Details: Select Measurement option to view details of other measurements.

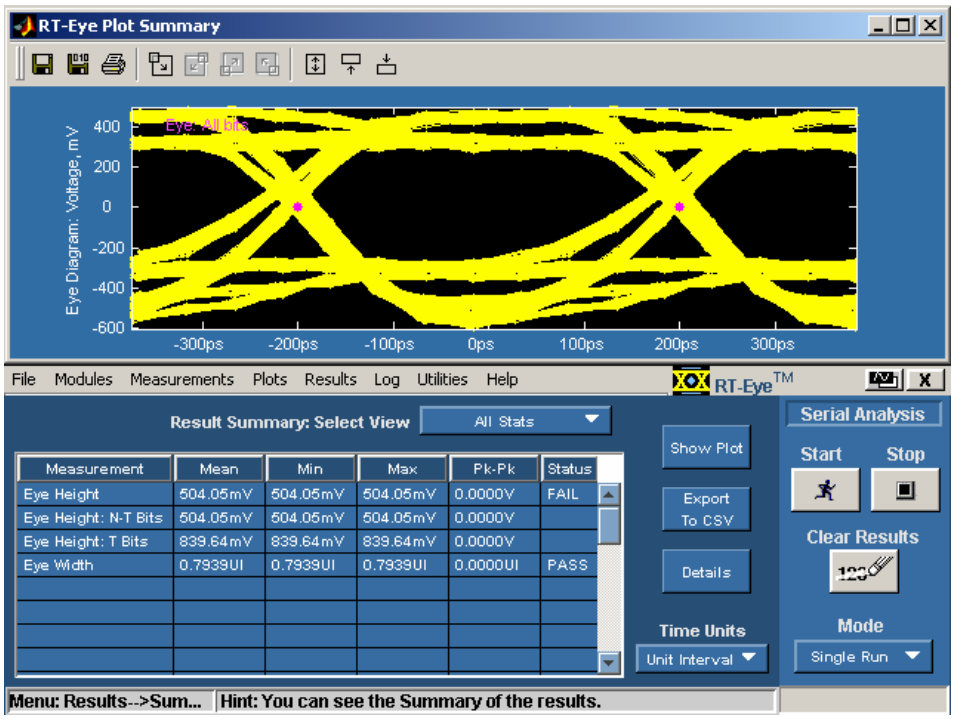


Figure 83. Results Summary and Plots Summary Window Example.

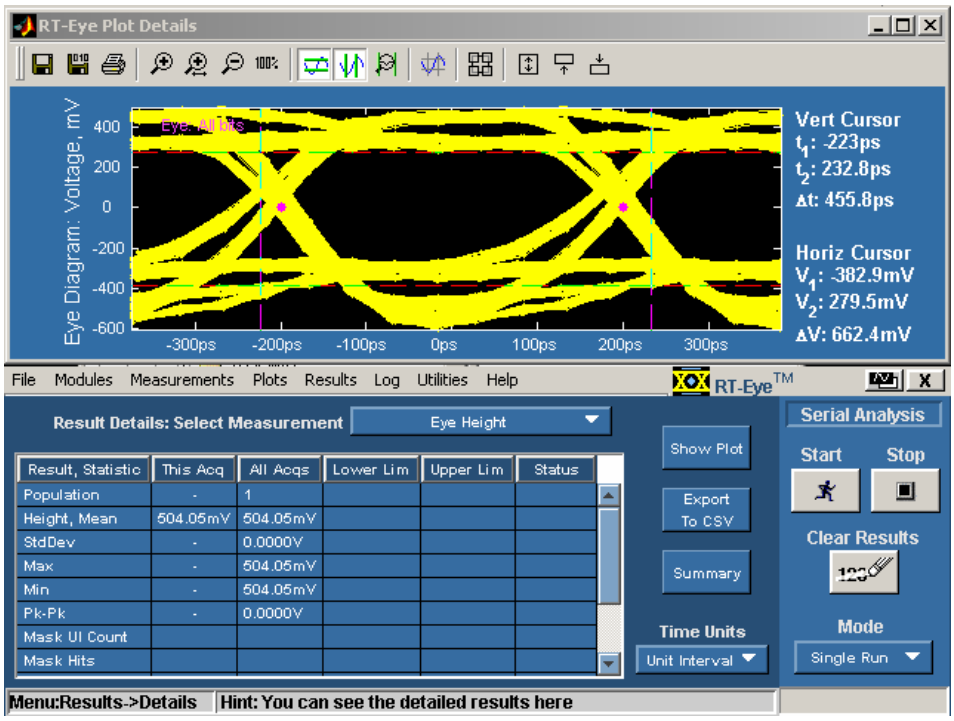


Figure 84. Results Details and Plot Details Window Example.

Ending a Session

If you need more than one session to complete the tutorial lessons, you can stop the tutorial and return to it another time. See Stopping the Tutorial and Returning to the Tutorial.

Note: *The purpose of this tutorial is to familiarize you with the basic functions of the application, menus, and steps you may need to take if the quick method does not yield expected results.*

Stopping the Tutorial

If you need more than one session to complete the tutorial lessons, you can stop the tutorial and return to it another time.

To save the application setup and stop your session, refer to Saving a Setup File and to Exiting the Application.

Returning to the Tutorial

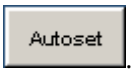
To return to the tutorial setup, you can start the application and then recall the saved setup. To recall the application setup, refer to Recalling a Saved Setup File.

Quick Method Lesson

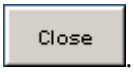
There is a quick method you can use to take measurements that may yield reasonable results for your situation. The results from the quick method should indicate whether or not the setup is adequate. If it is not, then you can set up the application manually as shown in the first lesson.

You can use the quick method to take measurements from channel (live) waveforms. To quickly take measurements, follow these steps:

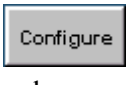
1. Start the application (also clears previous results), and make your Probe Type and measurement selections in the Measurements Select menu.
2. Select 

. The Autoset Summary menu appears
3. In the Autoset Summary menu, select 

.

   The application calculates and applies appropriate settings for the vertical scale and horizontal resolution of the source and values for the reference voltage levels.
4. If the values are acceptable, select 

.

   If need be, select 

 to adjust the reference voltage levels in the Configure Ref Levels menu.

5. Select the  command button to take measurements.

When sequencing is complete, the application displays statistical results and a real-time eye diagram that shows the characteristics of the waveform.

TIE Jitter Measurement Lesson

In this lesson, you will learn how to use the application to take a TIE Jitter measurement on the waveform already recalled to the Ref1 location. This lesson teaches you how to do the following tasks:

- View the results as a Histogram, a Time Trend plot, and a Spectrum plot
- Save statistical results to a .csv file
- View a .csv file with Wordpad or in a spreadsheet
- Generate a simple report

Clearing Results

Before taking more measurements, be sure to clear the results. To do so, select the  command button in the Control Panel.

Setting Up a TIE Jitter Measurement and Plots

To set up, take, and plot a TIE Jitter measurement, follow these steps:

1. Clear any previous results.
2. Select Measurements > Select and deselect the Eye Width/Eye Height measurement (from the previous lesson).

   When you deselect a measurement, the application discards the corresponding options in the Plots menus.

3. Select the 

measurement.

   The vertical scale, horizontal resolution and reference voltage levels were set for the source (Ref1) in the previous lesson.

4. Select the 

button.
5. In the Select Subplot table, select TIE Jitter in the Measurement column and Histogram in the Plot Type column.
6. Select the  command button.

The application displays the Results Summary menu and the Histogram plot.

7. Select Plots> Select.
8. In the second row of the Select Subplot table, select TIE Jitter in the Measurement column and Time Trend in the Plot Type column.
9. Select Refresh to update the plot window.
10. In the third row of the Select Subplot table, select TIE Jitter in the Measurement column and Spectrum in the Plot Type column.
11. Select Refresh to update the plot window.

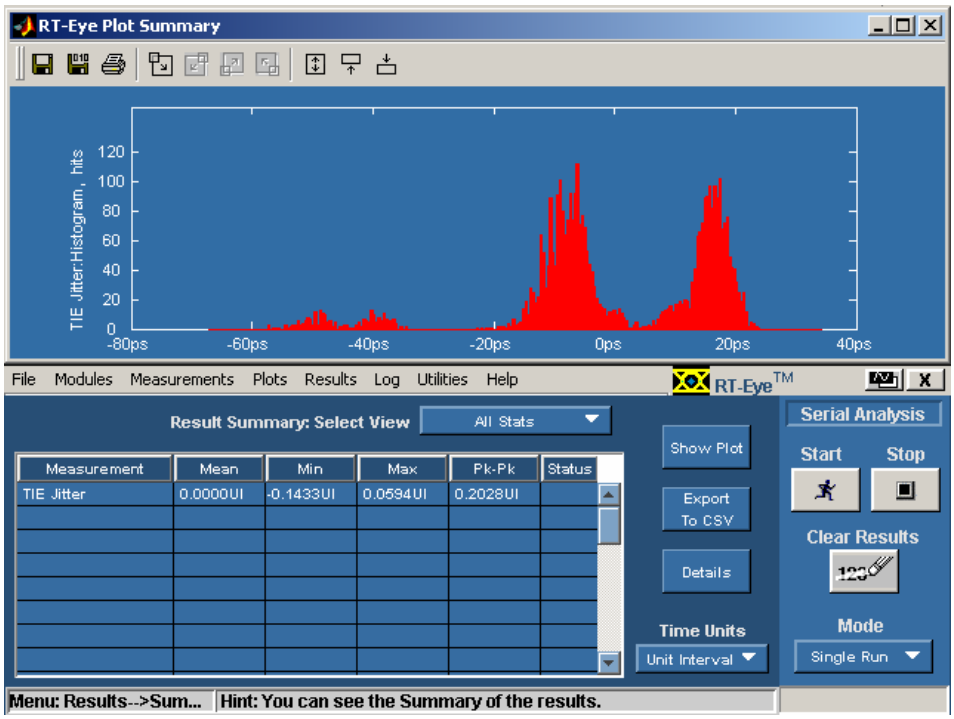


Figure 85. TIE Jitter Results with Histogram Example.

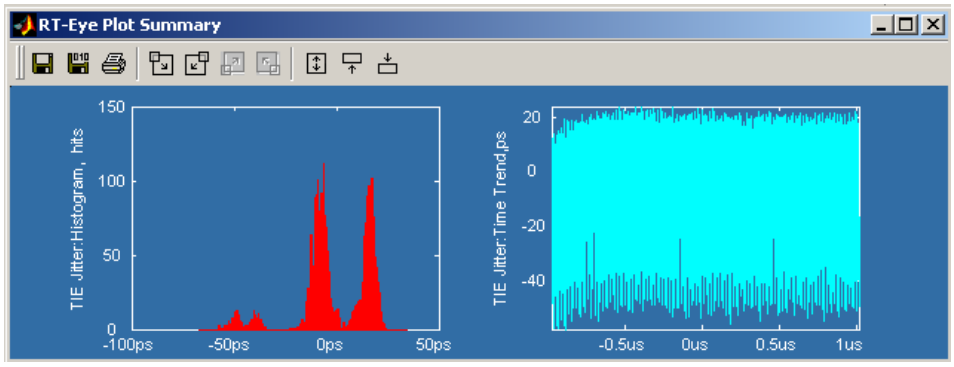


Figure 86. TIE Jitter Histogram and Time Trend Plots Example.

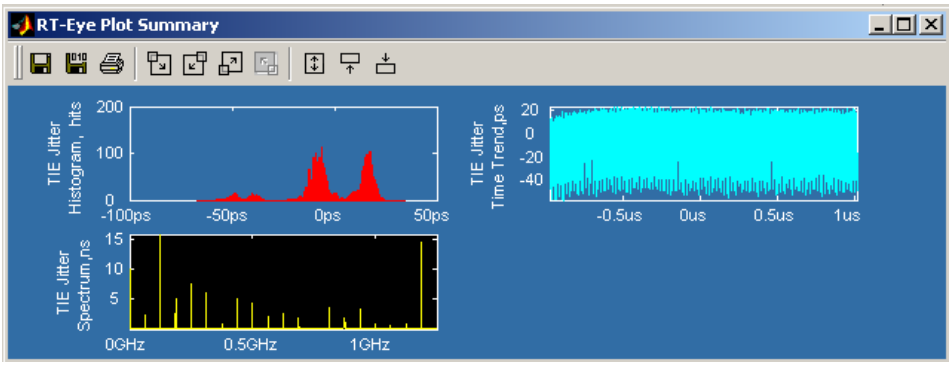


Figure 87. TIE Jitter Results in Three Types of Plots Example.

Examples of Plot Details

Here are details from the plots in this lesson.

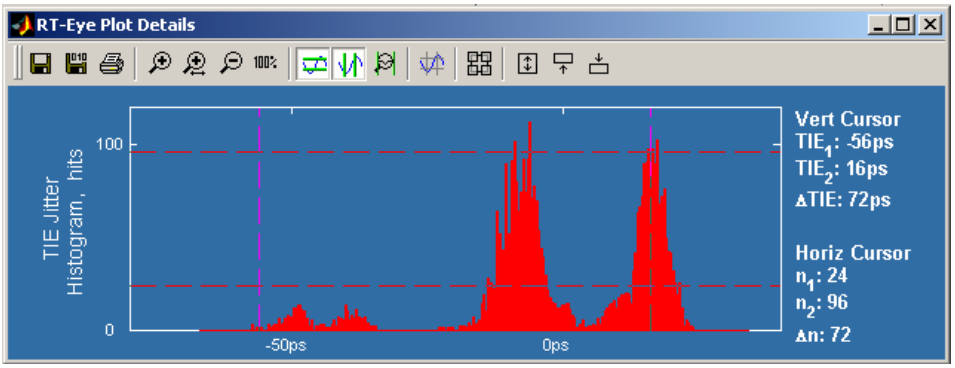


Figure 88. Details of a Histogram Plot Example.

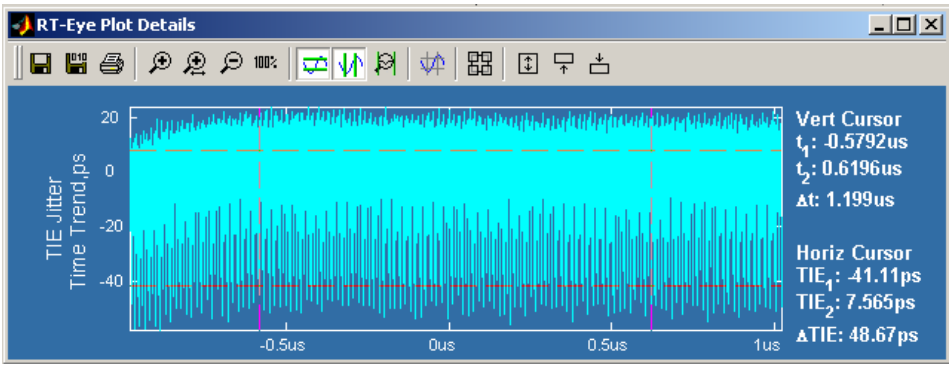


Figure 89. Details of a Time Trend Plot Example.

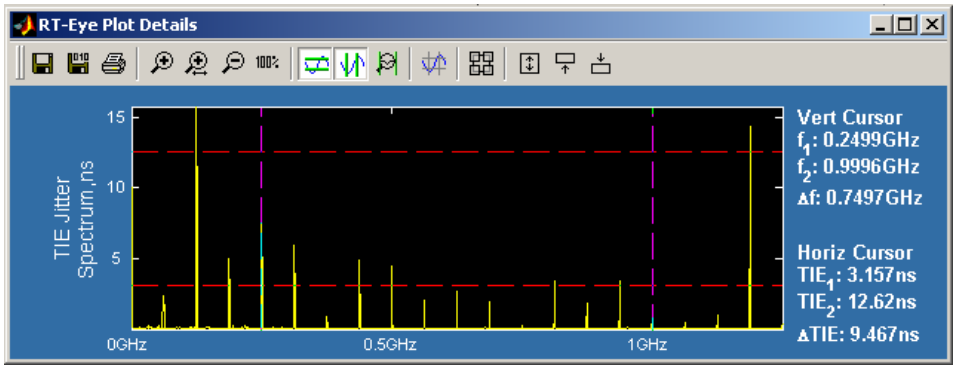


Figure 90. Details of a Spectrum Plot Example.

Saving Statistical Results to a .CSV File

To save the statistical results to a .csv (comma separated variable) file, follow these steps:

1. Select the Export To CSV command button. The Save dialog appears.
2. Use the Browse command button to select a directory to save the .csv file in.
3. Enter a file name and select Save.
4. Select the command button.
5. Start the Wordpad program on the oscilloscope and select File> Open.
6. Navigate and select the file you just created. View the .csv file with Wordpad.
7. Close the Wordpad program.
8. Copy the file to your PC, start a spreadsheet or other analysis program, and open the .csv file. You can customize the results to suit your analysis needs.

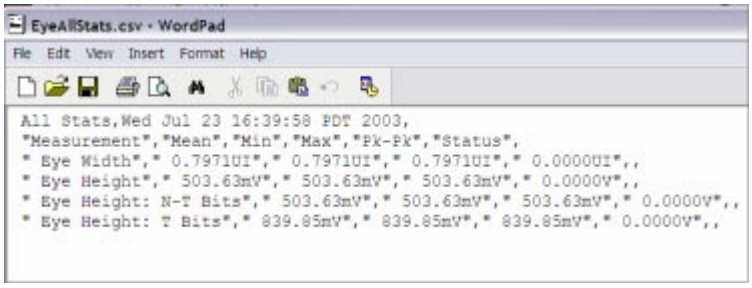


Figure 91. A .CSV File Viewed with Wordpad Example.

EyeAllStats.csv

	A	B	C	D	E	F
1	All Stats	Wed Jul 23 16:39:58 PDT 2003				
2	Measurement	Mean	Min	Max	Pk-Pk	Status
3	Eye Width	0.7971UI	0.7971UI	0.7971UI	0.0000UI	
4	Eye Height	503.63mV	503.63mV	503.63mV	0.0000V	
5	Eye Height: N-T Bits	503.63mV	503.63mV	503.63mV	0.0000V	
6	Eye Height: T Bits	839.85mV	839.85mV	839.85mV	0.0000V	
7						

Figure 92. A .CSV File Viewed in a Spreadsheet Example.

Generating a Simple Report

To generate a simple report, follow these steps:

1. Select Utilities> Report.

   The Report Generator menu appears and is set to use the default Define Test Template and Define Report Layout definitions.

2. Select the Generate command button.

   The application generates and displays the report.

3. To print the report, select the Print command button.

Note: *Before the application can send the file to a printer, you need to check if the printer is set up from the Start menu (in the oscilloscope task bar).*

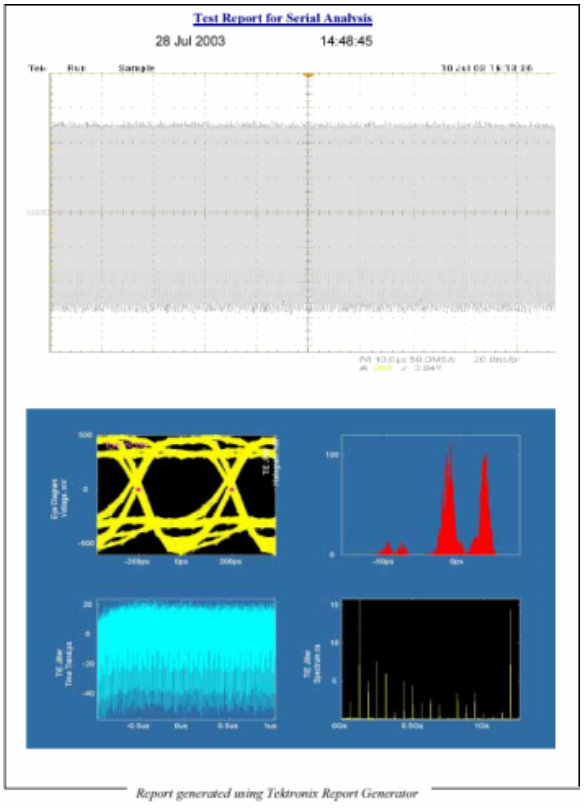
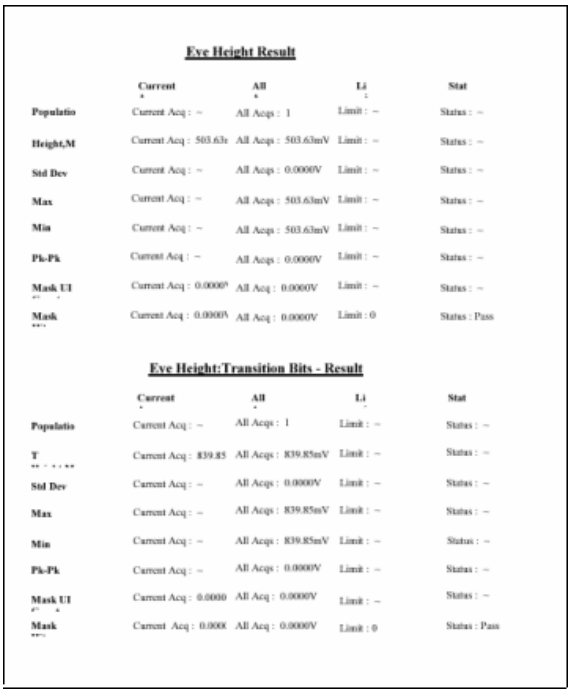


Figure 93. Simple Report Example Page 1.



Eye Height Result

	Current	All	Li	Stat
Populatio	Current Acq : –	All Acqs : 1	Limit : –	Status : –
Height,M	Current Acq : 503.63r	All Acqs : 503.63mV	Limit : –	Status : –
Std Dev	Current Acq : –	All Acqs : 0.0000V	Limit : –	Status : –
Max	Current Acq : –	All Acqs : 503.63mV	Limit : –	Status : –
Min	Current Acq : –	All Acqs : 503.63mV	Limit : –	Status : –
Pk-Pk	Current Acq : –	All Acqs : 0.0000V	Limit : –	Status : –
Mask UI	Current Acq : 0.0000	All Acq : 0.0000V	Limit : –	Status : –
Mask	Current Acq : 0.0000	All Acq : 0.0000V	Limit : 0	Status : Pass

Eye Height:Transition Bits - Result

	Current	All	Li	Stat
Populatio	Current Acq : –	All Acqs : 1	Limit : –	Status : –
T	Current Acq : 839.85	All Acqs : 839.85mV	Limit : –	Status : –
Std Dev	Current Acq : –	All Acqs : 0.0000V	Limit : –	Status : –
Max	Current Acq : –	All Acqs : 839.85mV	Limit : –	Status : –
Min	Current Acq : –	All Acqs : 839.85mV	Limit : –	Status : –
Pk-Pk	Current Acq : –	All Acqs : 0.0000V	Limit : –	Status : –
Mask UI	Current Acq : 0.0000	All Acq : 0.0000V	Limit : –	Status : –
Mask	Current Acq : 0.0000	All Acq : 0.0000V	Limit : 0	Status : Pass

Figure 94. Simple Report Example Page 2..

Serial Analysis Laboratory

The Serial Analysis Laboratory presents a typical application example that highlights the powerful compliance and analysis capabilities of the RT-Eye application, and will give you ideas on how to use the application to solve your own test problems. This lab covers and explores the following areas:

- How to use the application to view an eye diagram and to validate measurements on a 2.5 Gb/s serial bit stream
- How to perform a detailed data jitter analysis of the 2.5 Gb/s bit stream including Histogram, Time Trend, Spectrum, and Bathtub curve
- How to change the clock recovery technique of the 2.5 Gb/s bit stream
- Create a Limits file to use as a custom Compliance Test
- Create a Compliance Report
- Perform a PCI Express Compliance test (PCI Express Compliance Module required)

Note: *To use this lab, you must have the RT-Eye application installed and enabled on the oscilloscope. For information, see Installation.*

Requirements:

- TDS/CSA7000 series oscilloscope (1.5 GHz and above) or TDS6000 series oscilloscope if you use a reference waveform

  Optionally, the Training Board 2 (P/N 020-2460-00) by Tektronix; the "live" signal (channel) from the training board requires an oscilloscope with a minimum bandwidth of 4 GHz

- RT-Eye Serial Data Compliance and Analysis software (Opt. RTE)

Note: *If your oscilloscope setup includes a second monitor, you can select and drag the title bar of the online help window to position it in the second monitor. This allows you to display these lab exercises in the second monitor, and still view the waveform (or a plot) and the RT-Eye measurement results on the oscilloscope.*

Recall Default Settings

To ensure that your lab results match the results shown in these exercises, you need to recall the default settings to the oscilloscope. To do so, follow these steps:

1. Push the DEFAULT SETUP front-panel button to start from a known setup.
2. Push the CH 1 front-panel button to turn off the Channel 1 waveform.

Note: *The RT-Eye application recalls its default settings when you start the application.*

Will you be using a Reference Waveform File or a live signal from the Training Board 2?

Reference Waveform File Setup

This laboratory uses a waveform file saved from a 2.5 Gb/s differential signal. You can recall the waveform to reference memory, view the waveform, and analyze it with the RT-Eye application.

To recall the waveform file to reference memory, follow these steps:

1. In the oscilloscope menu bar, select File> Reference Waveforms> Reference Setup.
2. Ref1 is the default memory location to recall a waveform file.
3. Select the Recall button in the Recall Ref1 From area.
4. Navigate to the C:\TekApplications\tdsrt-eye\Examples\WFMS directory.
5. Select the 2_5Gbps_PRBS.wfm file and then Recall.
6. The oscilloscope recalls the waveform file to reference memory and displays the waveform when the recall is complete.
7. Use the Zoom control to zoom in and view individual bits.
8. To start the application, select File > Run Application > RT-Eye Serial Compliance and Analysis. The application starts with the default setup. View the waveform recalled to Ref1 for the lab.
9. Proceed to the Reference Waveform Setup.

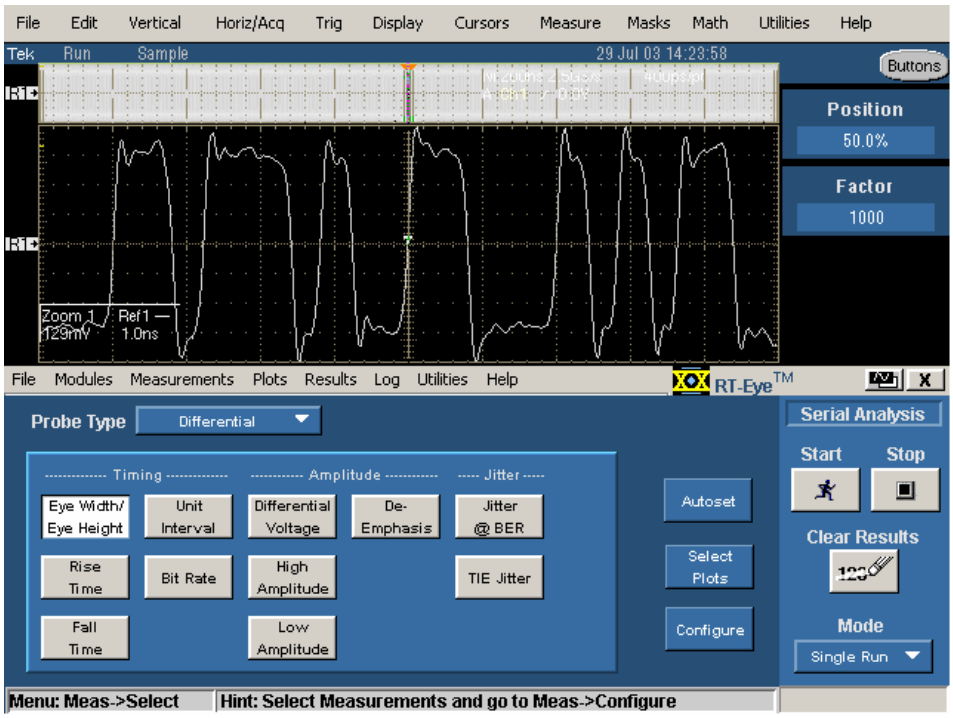


Figure 95. Ref1 Setup for the Lab.

Reference Waveform Setup

This configuration step defines the measurements and establishes the source as the Ref1 waveform.

1. The application displays the Measurements Select menu by default when you start the application. In that menu, select the measurements as shown:

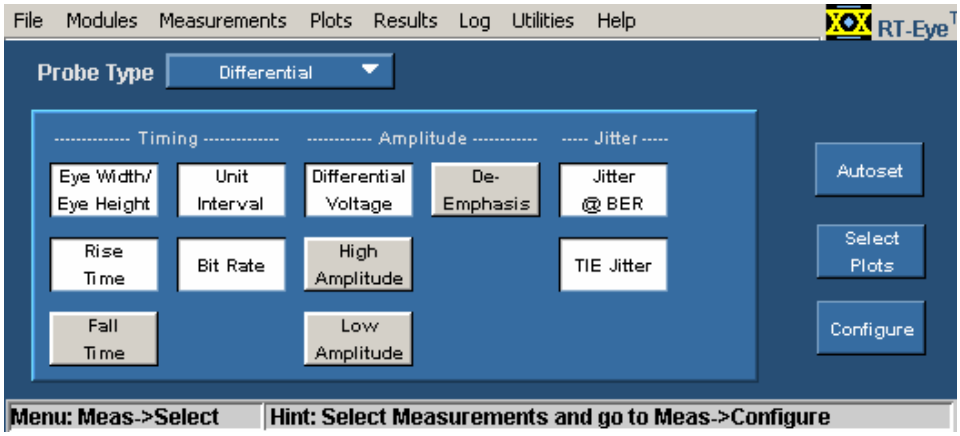


Figure 96. Measurements Select Menu Setup.

2. Select the 

button.

Use the default setup for the Configure Source menu, where **Live/Ref** is the Source Type option and **Ch1** is the Differential option.

3. Select **Ref1** as the Select Differential option. View the Configure Source menu setup.

4. Proceed to the Ref Levels Setup.

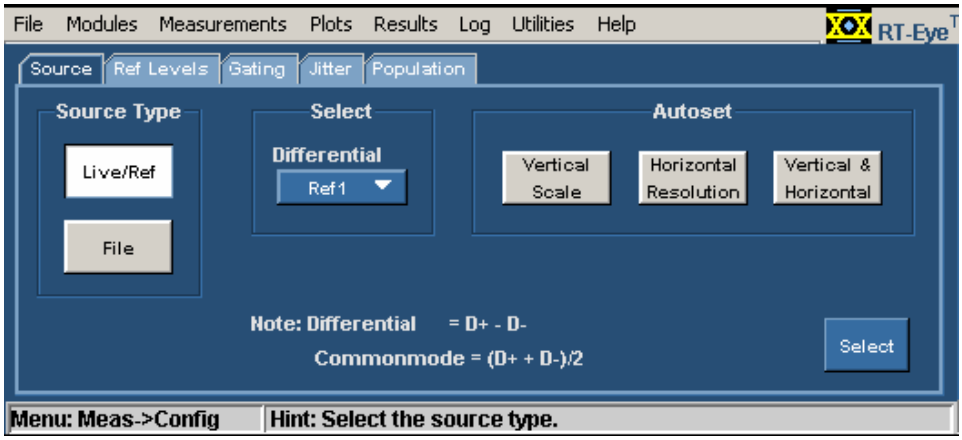


Figure 97. Ref1 as the Differential Source.

Requirements for the Training Board 2

You can use the Training Board 2 to do these exercises. To do so, you will use the 2.5 Gb/s signal from the T2 signal (Tektronix part number 020-2460-00). This signal has rise times of <100 ps, thus needs full sample rate (20 GS/s) to perform measurements accurately.

You can use one of the following configurations:

- TDS7000 Series (TDS7404): P7350SMA with CH1 as the Differential Source for Analysis
- TDS6000 Series: P7350SMA with CH1 as the Differential Source for Analysis or TCA-SMA Adapters on CH1 and CH3 as Single-Ended Sources for Analysis

Use P7350SMA with CH 1 as the Differential Source for Analysis

1. Use the phase-matched SMA cables (provided with the P7350SMA probe) to connect between J11 on the training board and CH 1 on the oscilloscope.

2. Connect the other end of the phase-matched cables to the "+" and "-" connections of the P7350SMA probe input.

3. Connect the TekConnect end of the P7350SMA probe to CH 1 of the oscilloscope.

4. Use a shorting strap to short the red and black terminals of the COMMON MODE TERMINATION inputs.
5. Push the AUTOSET front-panel button to view the differential signal.
6. Set the SCALE to 1 µs/div.
7. Use the Zoom control to zoom in and view individual bits.
8. To start the application, select **File> Run Application> RT-Eye Serial Compliance and Analysis**. The application starts with the default setup. View the differential waveform setup.
9. Proceed to the Live Differential Signal Source Setup.

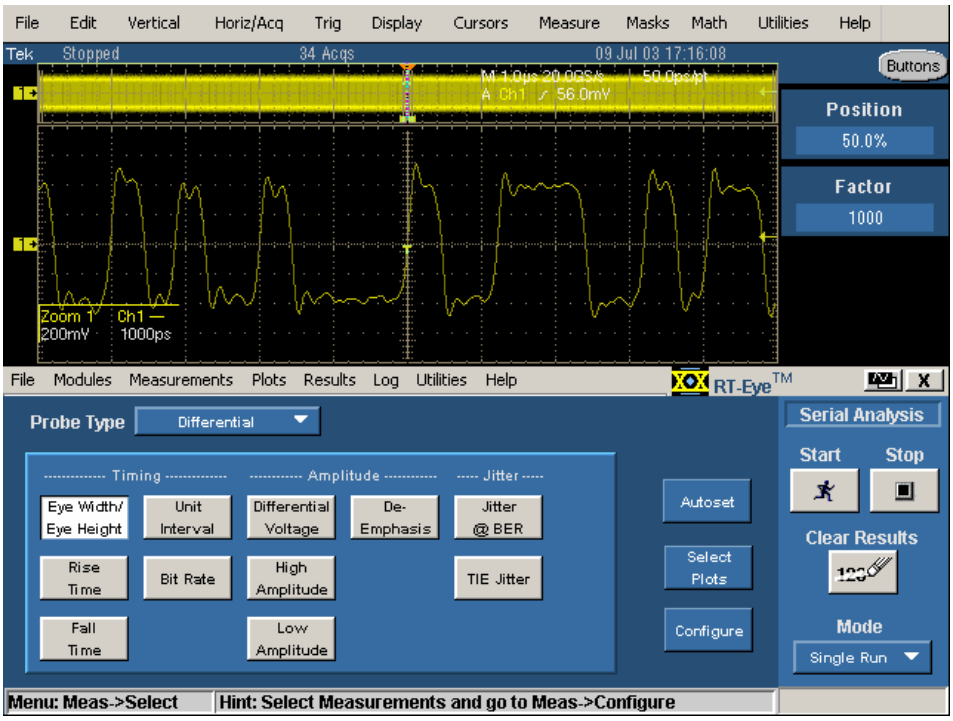


Figure 98. Differential Waveform Setup.

Live Differential Signal Source Setup

This configuration step defines the measurements to take, configures the live source waveform on Ch1 as input to the analysis, and optimizes the signal for accurate measurements.

1. The application displays the Measurements Select menu by default when you start the application. In that menu, select the measurements as shown:

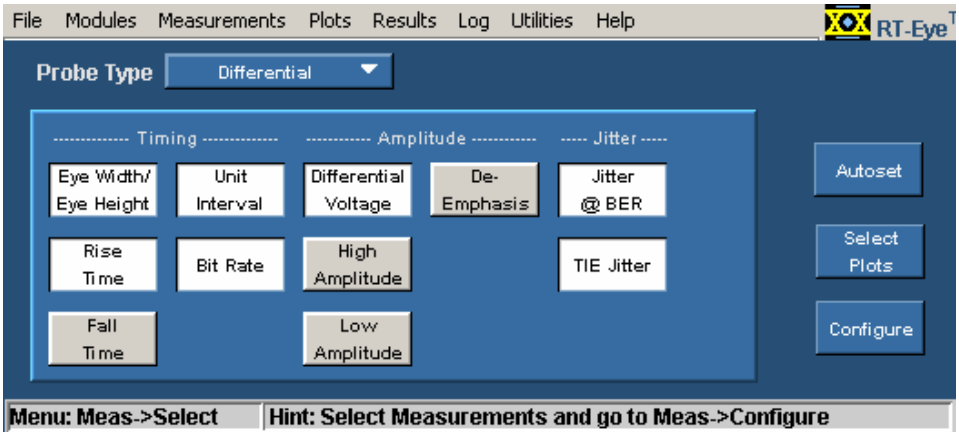
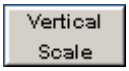


Figure 99. Measurements for Differential Probes.

2. Select the 

button.

   Use the default setup for the Configure Source menu, where **Live/Ref** is the Source Type option and **Ch1** is the Differential option.

3. Select the 

Autoset command button.

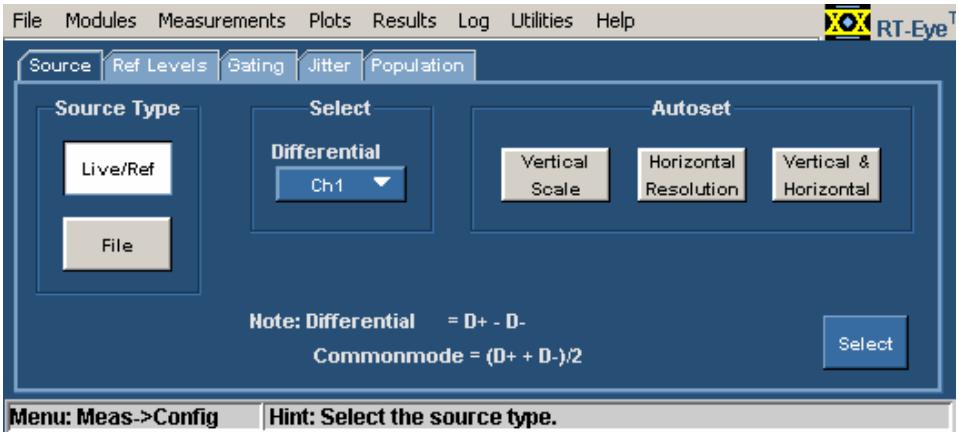


Figure 100. Differential Signal Source Setup.

4. Proceed to the Ref Levels Setup.

Use TCA-SMA Adapters on CH 1 and CH 3 as Single-Ended Sources for Analysis

1. Use a 1 Meter SMA cable and TCA-SMA adapter to connect between J11 on the training board and CH 1 on the oscilloscope.

2. Use another 1 Meter SMA cable and TCA-SMA adapter to connect between J14 on the training board and CH 3 on the oscilloscope.

3. Push the CH 3 vertical channel button to display the waveform on Ch3.

4. Push the AUTOSET front-panel button to view both signals.
5. Set the SCALE to 1 µsec/div.
6. Set the RESOLUTION to 50 ps/pt.
7. Use the Zoom control to zoom in and view individual bits.
8. To start the application, select **File> Run Application> RT-Eye Serial Compliance and Analysis**. The application starts with the default setup.
9. Proceed to the Live Single-Ended Sources Setup.

Live Single-Ended Sources Setup

This configuration step defines the measurements that will be made; configures the live source waveforms on Ch1 and Ch3 as the pseudo-differential input to the analysis, and optimizes the signal for accurate measurements.

1. The application displays the Measurements Select menu by default when you start the application. In that menu, select **Single Ended** as the Probe Type option.
2. Select the following measurements:

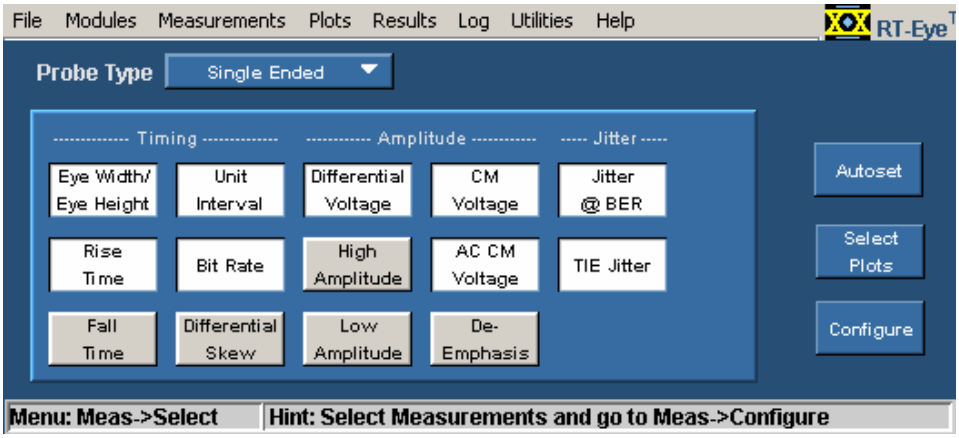
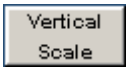


Figure 101. Measurements Single Ended Probes.

3. Select the 

button to access the Configure menus.

   Use the default setup for the Configure Source menu, where **Live** is the Source Type option and **Ch1, Ch3** is the D+,D- option.

4. Select the 

Autoset command button.
5. Proceed to the Ref Levels Setup.

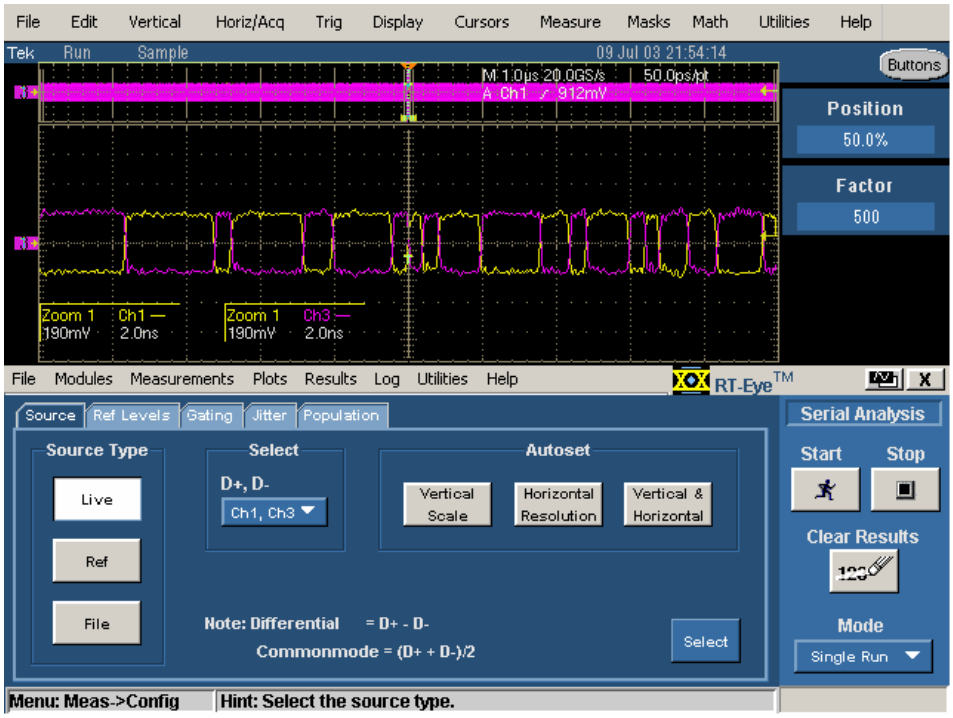


Figure 102. Single Ended Waveform Setup.

Ref Levels Setup

This configuration step defines the proper measurement levels for zero crossing and 20%-80% levels for Rise Time measurements.

1. Select the Ref Levels tab.
2. Select the Autoset Run button.
3. Proceed to the Jitter Setup.

Jitter Setup

This configuration step sets up the clock recovery and jitter parameters. As a result of this step, the clock will be recovered using a "Golden PLL" method as defined in the Fibre Channel MJSQ (Methodologies in Jitter and Signal Quality) document. The signal being tested is an 8-bit PRBS (Pseudo-Random Bit Stream) of length [27 – 1] = 127 bits. The repeating pattern length needs to be provided to the software to correctly analyze jitter components when the Jitter @ BER measurement has been selected.

1. Select the Jitter tab.

Use the default setup for the Configure Jitter menu, where **PLL: Standard BW** is the Method option, **IBA2500: 2.5G** is the Standard: b/s option, and **12** is the BER=1e-? option, meaning the value is 10^{-12} for the Bit Error Rate.

2. Select **Custom** as the Pattern Type option.

3. Select the  icon. The on-screen keypad appears.

4. Select the 

button, enter **127**, and then select the 

button. View the Configure Jitter Menu Setup.

5. Proceed to Population Setup.

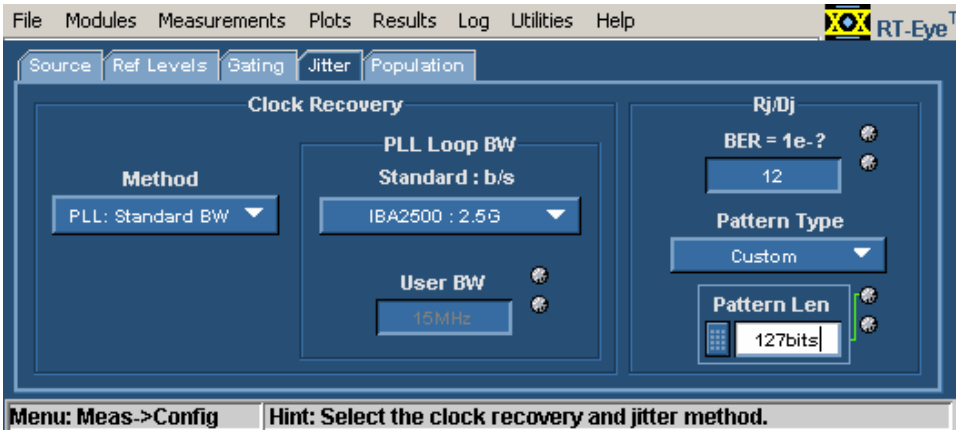


Figure 103. Configure Jitter Menu Setup.

Population Setup

This configuration step will set the RT-Eye software so that analysis will be limited to a population of three acquisitions.

1. Select the **Population** tab.

2. Select the **On** button.

3. Use the default setup for the Configure Population menu, where **Acquisitions** is the Limit By option.

4. Double select the  icon twice for the Limit option. The virtual keypad displays.

5. Select the 

button, enter **3**, and then select the 

button. View the Configure Population menu setup.

6. Proceed to Eye Diagram Plot Setup.

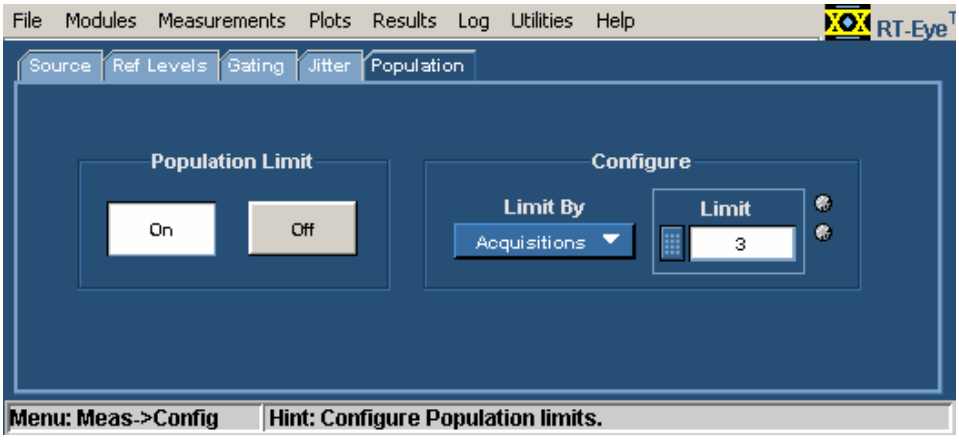


Figure 104. Configure Population Menu Setup.

Eye Diagram Plot Setup

This configuration step will select the InfiniBand Receiver mask for the waveform mask test.

1. Select Plots> Config.

   Use the default setup for the Plots Configure menu for an Eye Diagram plot, where All is the Bit Type option, InfiniBand is the Standard option, and Receiver R1.1 is the Type option.

2. Select the On button to enable the Mask option. View the setup of the Plot Eye Diagram menu.

3. Proceed to Run the Analysis and View Results.

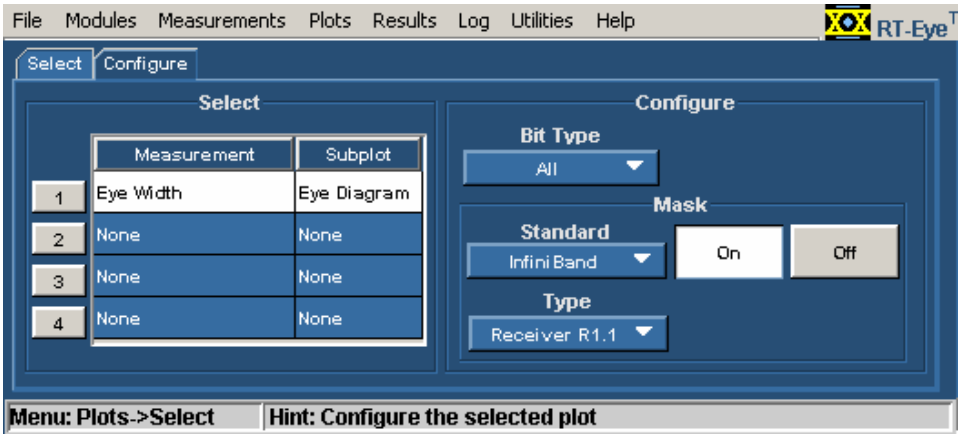


Figure 105. Plot Eye Diagram Menu Setup.

Run the Analysis and View Results

1. Select the Start command button,  .

   View the analysis results and eye diagram plot.

   Statistics of measurement results are shown in the lower half of the oscilloscope display. The RT-Eye diagram and mask are shown in the upper half of the oscilloscope display. Time units can be changed from Unit Intervals to seconds depending on what the serial data standard calls for.

   The magenta dots represent the recovered clock. The magenta arrow represents the Jitter Eye Opening at 10^{-12} BER that is activated by selecting the Jitter @ BER measurement.

   Note: *The Jitter Eye Opening is much smaller than the waveform eye opening. This is because the Jitter Eye Opening is based on 10^{12} statistical certainty and the waveform eye diagram is based on the acquisition of 10 µsec (1.25 x 105 edges). This number comes from dividing the capture time by the bit time and multiplying by 50% edge density of an 8B/10B encoded signal. The details of each measurement can be viewed by selecting the Details button.*

2. Proceed to Detailed Jitter Analysis.

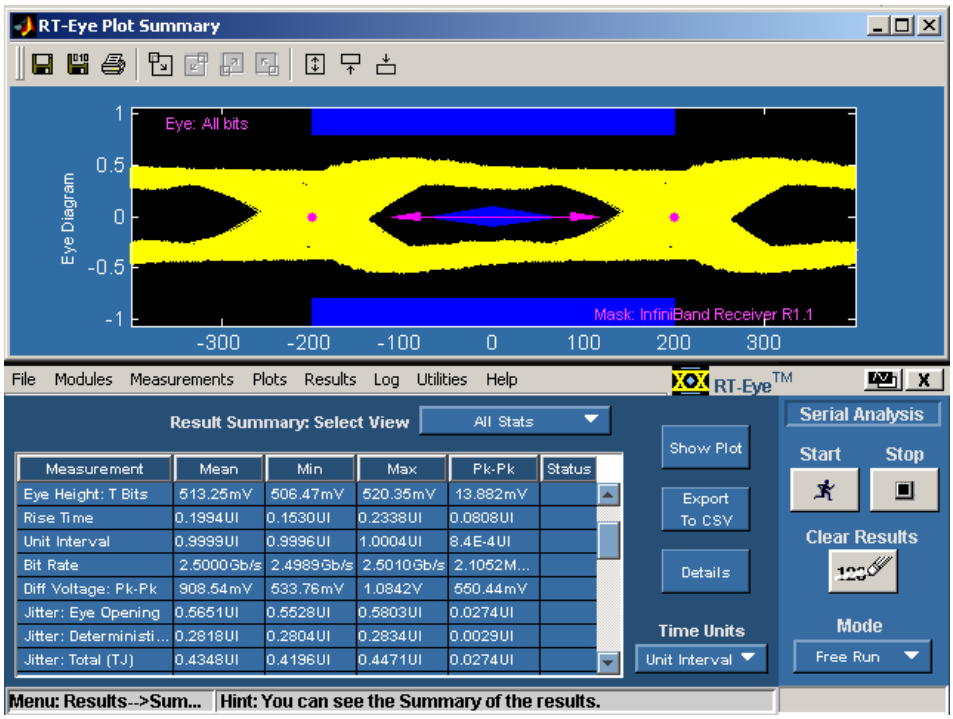


Figure 106. Lab Eye Measurement Results and Plot.

Detailed Jitter Analysis

Here you will discover how to create different views of jitter: Histogram, Spectrum, Time Trend, and Bathtub Curve. All are useful for debugging serial data systems.

1. Select Plots> Select.
2. Select the following in the Measurements and Plot Types columns:

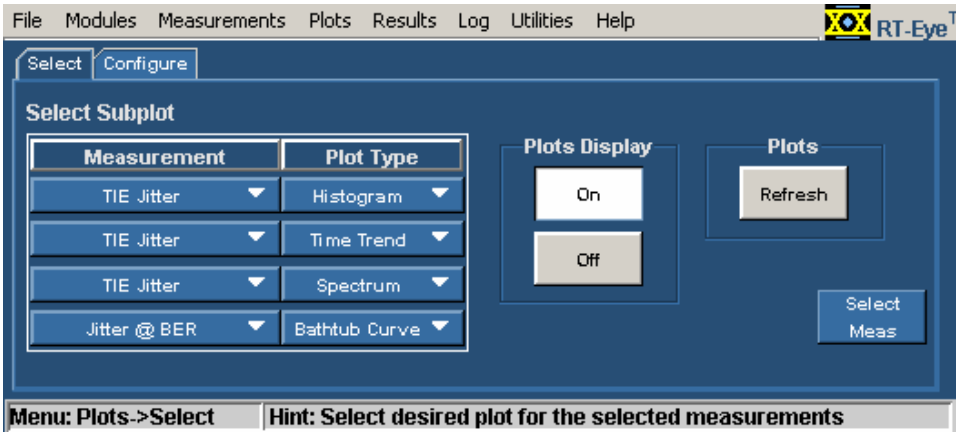


Figure 107. Jitter Analysis Plot Select Menu Setup.

1. Select the **Refresh** command button.
2. Select **Results> Details**.
3. Select **Jitter @ BER** from the drop down list for the Select Measurements option. View the results of the detailed jitter analysis.
4. Proceed to Changing Clock Recovery and Jitter Method to PCI Express.

Jitter Analysis Results

View the jitter analysis results and plots.

The four views of jitter and the measurements should give you a better understanding of the way jitter measurements are made with the Spectrum Method of Rj/Dj separation. The TIE histogram is the traditional way of measuring jitter on an oscilloscope. This method is limited by the amount of statistical certainty that can be achieved in a reasonable amount of time. Thus, more advanced DSP (digital signal processor) methods are used to determine the Jitter Eye Opening, Total Jitter, Random Jitter, and Deterministic Jitter.

The TIE Time Trend shown in the upper right quadrant plot is transformed into the frequency domain using FFT creating the jitter spectrum shown in the lower left quadrant plot. The spikes in the frequency domain represent deterministic jitter. Further analysis can be done to determine which spikes are Duty Cycle Distortion (DCD), which are Data Dependent (DDj), and which are Periodic (Pj).

Once these values are removed (Dj), then what's left is a noise floor which represents the Random Jitter (Rj). These values are used to create the Cumulative Distribution Function (CDF), commonly known as the Bathtub Curve, shown in the lower right quadrant plot. The magenta line at 10^{-12} BER represents the Jitter Eye Opening measurement. As can be seen by the measurement results, the following equation applies.

Jitter Eye Opening + Total Jitter = 1 UI

This jitter method is used in many serial standards including InfiniBand, FibreChannel, XAUI, as well as others.

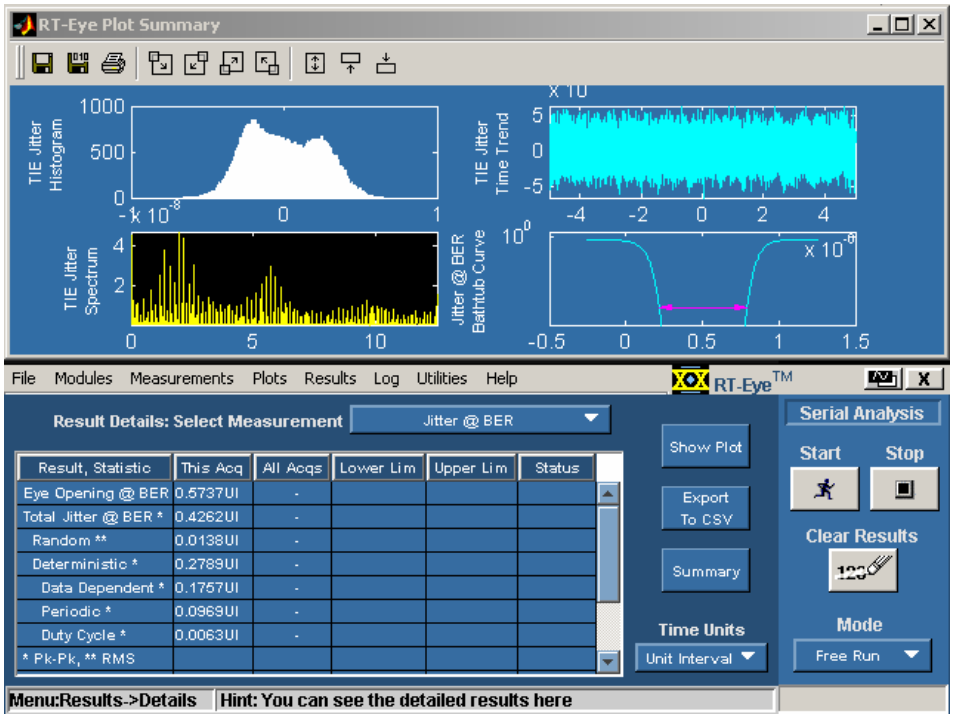


Figure 108. Lab Jitter Results and Plots.

Changing Clock Recovery and Jitter Method to PCI Express

Some standards require that you use a different clock recovery and jitter analysis method. An example of this is the PCI Express serial standard.

The PCI Express specification calls for recovering the clock over 3500 consecutive Unit Intervals and then placing an analysis window centered in the clock recovery window. This is done using the RT-Eye SmartGating feature in conjunction with changing the clock recovery model. This method was developed by the PCI-SIG to address multiple clock recovery techniques in receiver circuits such as PLL, phase interpolation, and over-sampling. The method is also useful when Spread Spectrum Clocking (SSC) is being used because the 3500 consecutive Unit Interval time window is affected very little by the 30-33 kHz spread in PCI Express signals.

1. Select the **Clear Results** command button in the control panel.
2. Select **Measurements> Configure> Gating**.
3. Select **Custom** in the Gating area.
4. In the Clock Recovery Window area, adjust the Length option to **3.5k** (default).
5. Select **No** for the Analysis Window Same as Clock Recovery Window option.
6. Adjust the Length option to **250** (default) and select **Centered** (default) as the Alignment option in the Analysis Window area.
7. Select the **Jitter** Configuration tab.
8. Select **Const Clk: Median** as the Clock Recovery Method option.
9. Select **Measurements> Select**.
10. Deselect the **Jitter @ BER** measurement.
11. Select **Plots> Select**.
12. Select the following subplots:

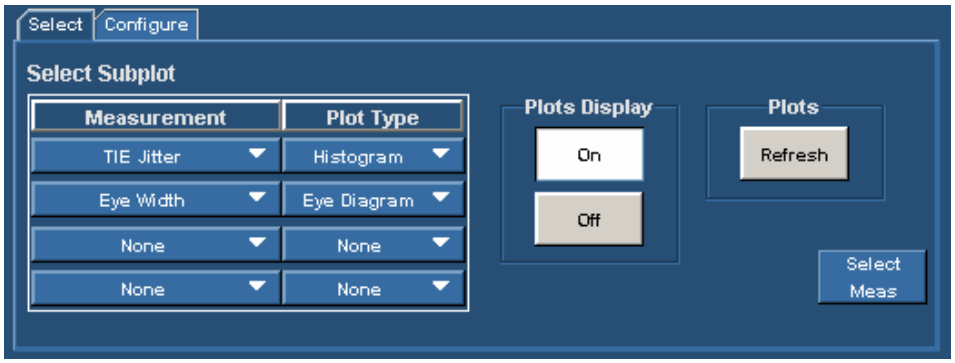


Figure 109. Jitter Analysis Plot Select Menu Setup for PCI Express.

1. Select the **Configure** tab.
2. Select Subplot **2. Eye Width**.
3. Select **PCI Express** as the standard for the Mask option.
4. Select **Receiver** as the Type under Mask.
5. Select the **On** button to enable the Mask option.
6. Select the **Start** command button.
7. Select the **Details** button in the Results menu.

8. Select **TIE Jitter** as the Select Measurement option.
9. Select **Seconds** for Time Units.
10. View the Results.
11. Proceed to the Limits Module setup.

PCI Express and Jitter Analysis Results

The jitter analysis for PCI Express is histogram-based. The measurement called out in the specification is $Jitter_{MEDIAN\text{-}MAX\text{-}OUTLIER}$. This measurement is shown by the Min and Max values of the Results Details menu in the RT-Eye application. Since the clock recovery method being used is median-based, the mean of the measurement in the results is not zero, but instead is the difference between the mean and the median of the TIE Jitter histogram. All values are based on 250 consecutive cycles. Accumulated results can be achieved by selecting Free Run as the sequence mode in the control panel.

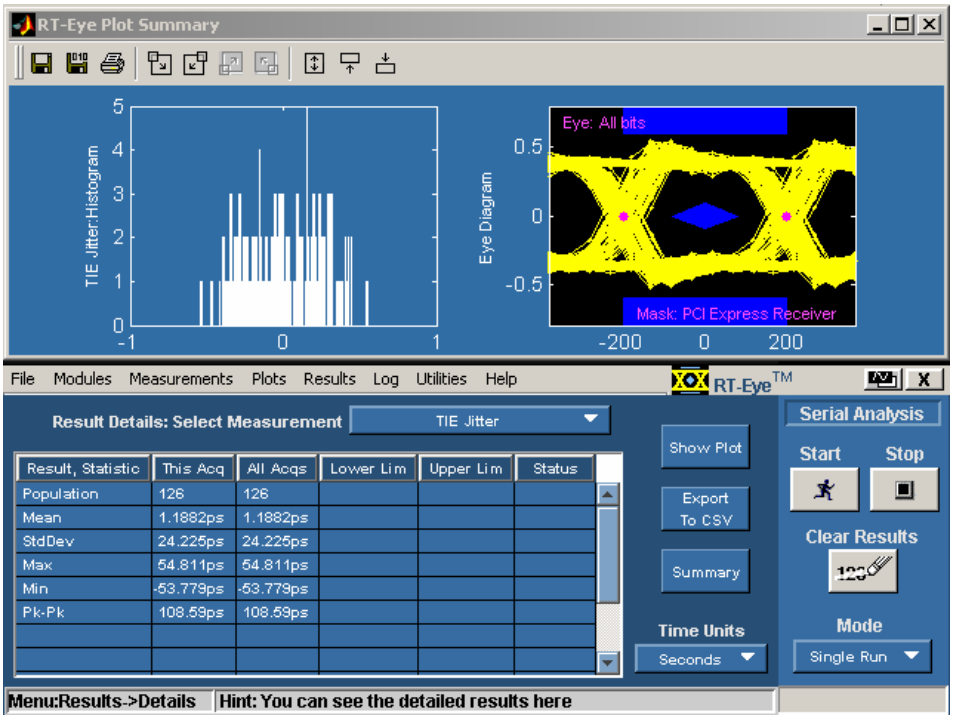


Figure 110. Lab PCI Express and Jitter Analysis Results.

Defining a Limits Module

This section demonstrates how to apply a limit to a measurement and create a custom Pass/Fail condition on the TIE jitter measurement described in the previous section.

1. Select Measurements> Limits.
2. Select New in the Measurement Limits Editor area.
3. Select the + button to add a measurement limit.
4. Select TIE Jitter as the Measurement.
5. Select Min as the Statistic and enter –60ps for the limit.
6. Select the + button to add a measurement limit.
7. Select TIE Jitter as the Measurement.

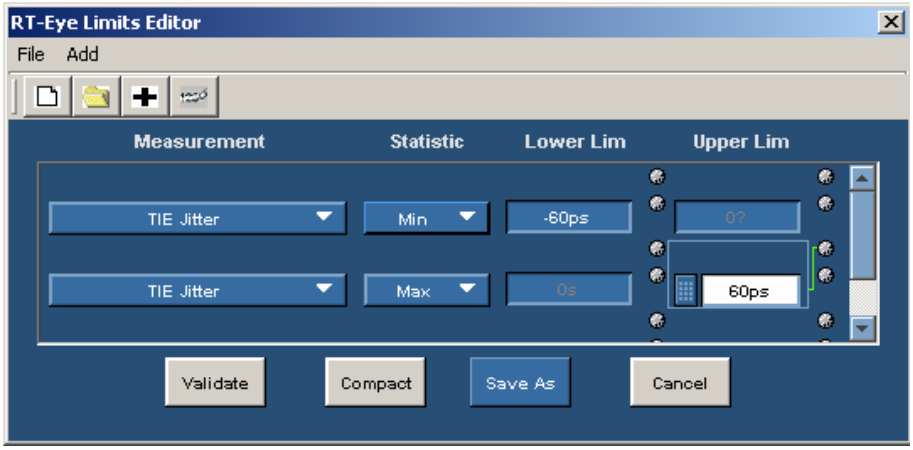


Figure 111. Limits Editor Setup.

8. Select **Max** as the Statistic and enter **+60ps** for the limit.
9. Select the **Save As** button.
10. Save the file as **Jitter.lim**.
11. Close the Limits Editor window.
12. Select **Browse** from the Measurements Limits menu.
13. Select **Jitter.lim** as the Limits File.
14. Select **Open**.
15. Select **On** for the Limits option.
16. Select **Results> Details**.

17. Select the **Clear Results** command button.
18. Select the **Start** button. View the results with a Limits file enabled.
19. Proceed to Creating a Compliance Report.

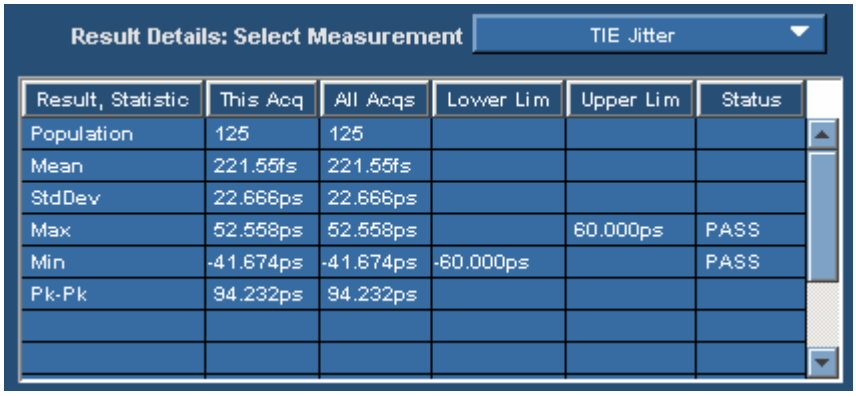


Figure 112. Lab Results Using a Limits File.

Creating a Compliance Report

This section demonstrates how to create a compliance report based on the previous analysis.

1. Select Utilities> Reports.
2. Select the Generate Command button.

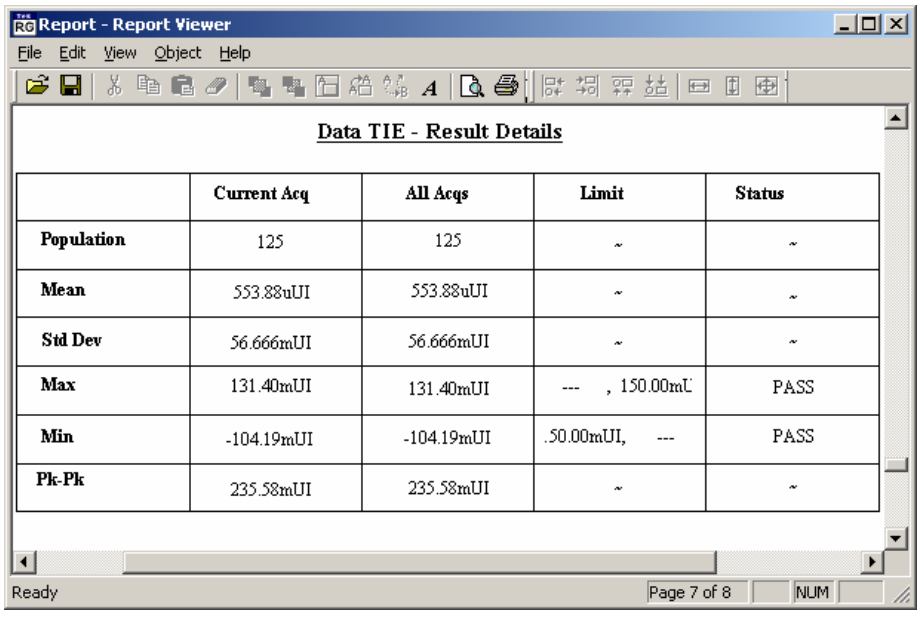


Figure 113. Compliance Report Example.

The report can be exported to an RTF file format and read by other applications, such as Microsoft Word.

Proceed to PCI Express Compliance Tests.

PCI Express Compliance Tests, Transmitter

This section demonstrates how to perform a PCI Express Compliance Test. The PCI Express module must be present to complete this part of the lab. If your instrument does not have a PCI Express Compliance Module installed, proceed to Serial Analysis Lab Conclusion.

1. From the RT-Eye application menu bar, select **Modules> PCI Express**.
2. Select **Differential** as the Probe Type.
3. Select **Driver** (default) as the Test.
4. Select the following measurements:

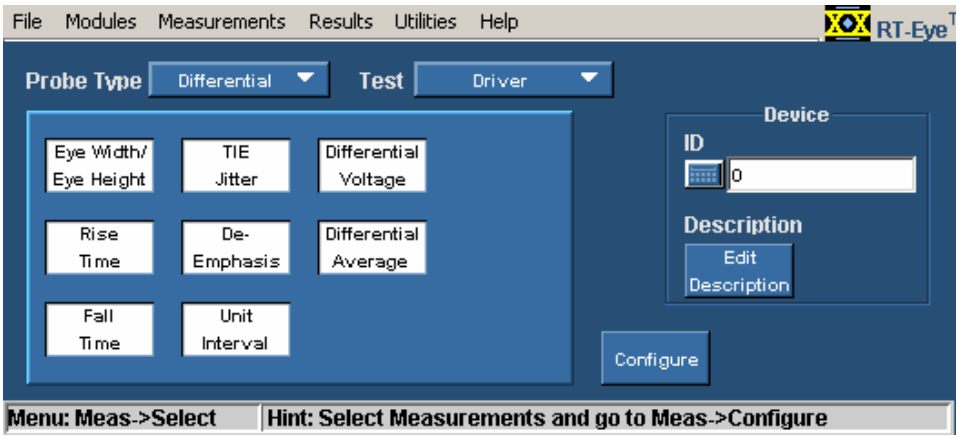


Figure 114. Measurements for PCI Express Compliance Transmitter Tests.

5. Select the **Start** button.

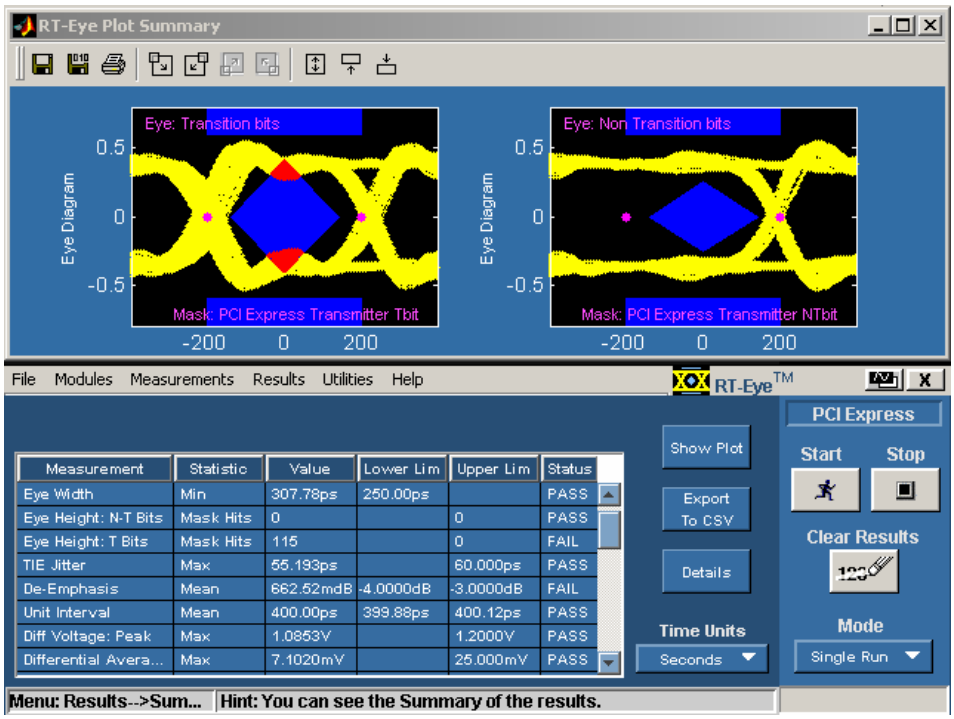


Figure 115. PCI Express Eye Compliance Test Results, Transmitter.

As can be seen, the signal being tested fails the PCI Express compliance test for the Transition bit. This is because the PCI Express specification calls for 3-4dB of deEmphasis on the non-Transition bits (or PreEmphasis on Transition bits). Since the signal does not have the proper level of DeEmphasis, it fails the Transition bit mask. The number of mask hits shows up in the compliance results as a Mask failure. This signal Fails DeEmphasis and Transition bit mask test, but passes all other PCI Express Transmitter measurements.

PCI Express Compliance Tests, Receiver

1. Select the **Clear Results** command button.
2. Select **Measurements> Select**.
3. Select **Receiver** as the Test.
4. Select the following measurements:

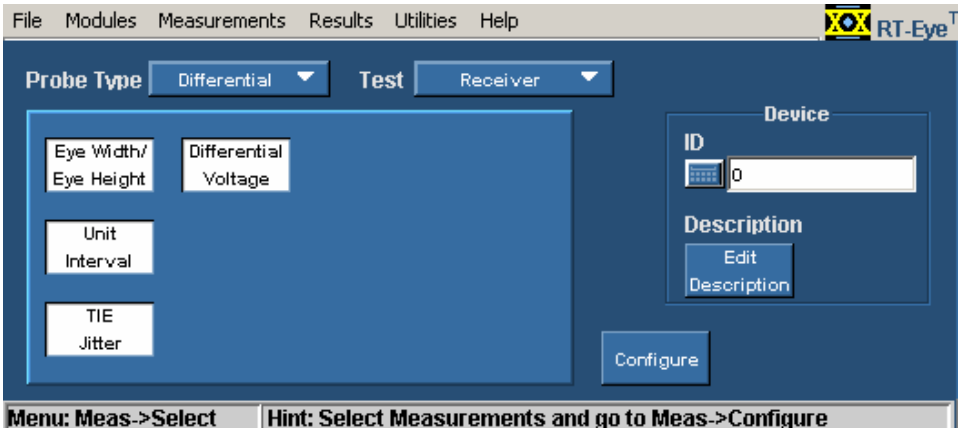


Figure 116. Measurements for PCI Express Compliance Receiver Tests.

5. Select the **Start** button.

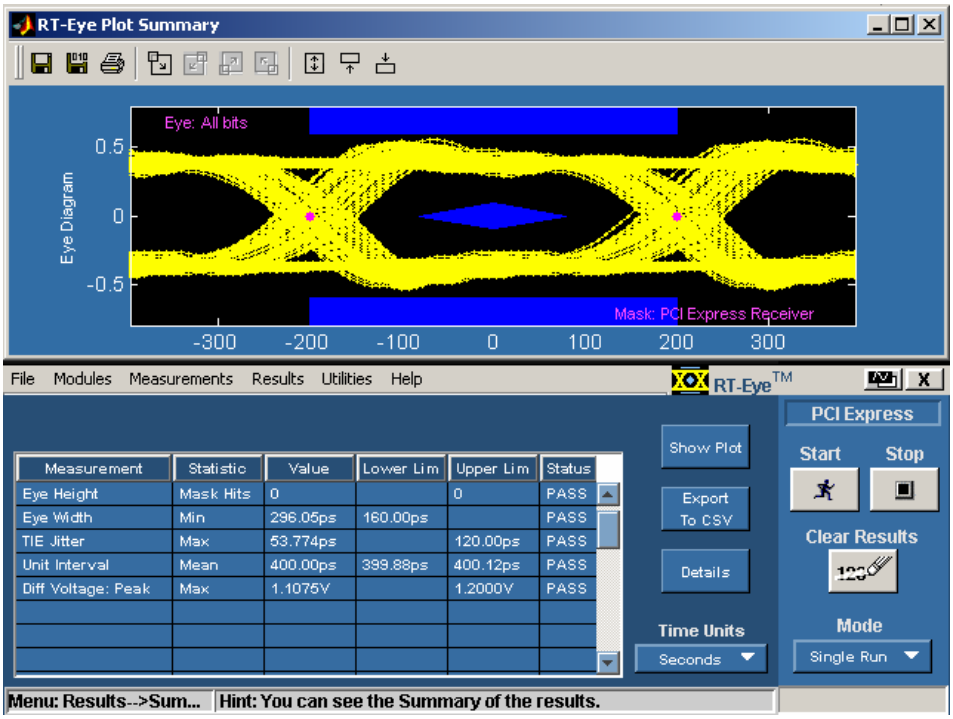


Figure 117. PCI Express Eye Compliance Test Results, Receiver.

Conclusion for the Serial Analysis Laboratory

Congratulations! You have completed the RT-Eye Serial Analysis Lab. We hope that this has been helpful in understanding the capabilities of the RT-Eye software solution and will help you in the validation and compliance testing of your devices.

Parameters

This section describes the RT-Eye application parameters, and includes the menu default settings. You should refer to the user manual for your oscilloscope for operating details of other controls, such as front-panel buttons.

The parameter tables list the selections or range of values available for each option, the incremental unit of numeric values, and the default selection or value.

Note: *Refer to the GPIB topics for a complete list of the GPIB Command Syntax. The topics include a complete list of the GPIB commands along with the arguments, variables, and variable values that correspond to the RT-Eye parameters.*

Note: *Unit values shown are valid when the FINE button is enabled on the oscilloscope.*

File Menus Parameters

The File drop down list includes the following command buttons:

- Recall Default
- Minimize
- Exit

Table 45: File Menus Parameters

Option	Parameters	Default setting
Recall	<Browser>	Default directory*
Save	<Browser>	Default directory*
Recall Recent	Lists up to five most recently saved or accessed setup files: 1. <setup file name> 2. <setup file name> 3. <setup file name> 4. <setup file name> 5. <setup file name>	Default directory*
Preferences	See File Preferences Menu Parameters topic, next	
*** Refer to the Application Directories and Usage topic for default path names.**		

File Preferences Menu Parameters

The File Preferences menu includes the following command buttons:

- Apply
- Cancel
- OK

Table 46: File Preferences Menu Parameters

Option	Parameters	Default setting
Popup Autoset Summary everytime Autoset is selected	Set, Clear	Set
Limit Rise/Fall measurements to transition bits only	Set, Clear	Clear
Limit Amplitude measurements to transition bits only	Set, Clear	Clear

Control Panel Parameters

The Control Panel menu includes the following command buttons:

- Start
- Stop
- Clear Results

Table 47: Control Panel Parameters

Option	Parameters	Default setting
Mode	Single Run, Single No Acq, Free Run	Single Run

Measurements Select Menu Parameters

Available measurements in the Measurements Select menu are dependant on the selection for the Probe Type option. Measurements available by area are as follows:

- Timing area: Rise Time, Fall Time, Unit Interval, Bit Rate, Eye Height, Eye Width, and Differential Skew
- Amplitude area: Differential Voltage, High Amplitude, Low Amplitude, CM Voltage, AC CM Voltage, and De-Emphasis
- Jitter area: Jitter@BER and TIE Jitter

Note: The Differential Skew, CM Voltage, and AC CM Voltage measurements are added when you select Single Ended as the Probe Type option.

Autoset Summary Menu Parameters

The Autoset Summary menu includes the following command buttons:

- Autoset
- Configure
- Close

Table 48: Autoset Summary Menu Parameter

Option	Parameters	Default setting
Do not show this menu again	Set, Clear	Clear

Measurements Configure Menus

The application includes the following Measurements Configure menus:

- Source for Single Ended Probes or
- Source for Differential Probes
- Ref Levels
- Gating
- Jitter Method
- Population

Note: These menus are generally referred to as the Configure menus.

The application automatically calculates parameters for reference voltage levels in the Ref Level Autoset Setup menu. Display the Ref Level Autoset Setup menu parameters.

Configure Source Menu Parameters for Differential Probes

The Configure Source menu includes the following command buttons in the Autoset area:

- Vertical Scale
- Horizontal Resolution

- Vertical & Horizontal

Table 49: Configure Source Menu Parameters for Differential Probes

Option	Parameters	Default setting
Live/Ref Select Differential	Ch1, Ch2, Ch3, Ch4, Ref1, Ref2, Ref3, Ref4	Ch1
File Differential File	<Browser>	Default directory*
*** Refer to the Application Directories and Usage topic for default path names.**		

Configure Source Menu Parameters for Single-Ended Probes

The Configure Source menu includes the following command buttons in the Autoset area:

- Vertical Scale
- Horizontal Resolution
- Vertical & Horizontal

Table 50: Configure Source Menu Parameters for Single Ended Probes

Option	Parameters	Default setting
Live Select D+, D-	Ch1, Ch3 Ch1, Ch4 Ch2, Ch3 Ch2, Ch4	Ch1, Ch3
Ref	All combinations of two Ref waveforms	Ref1, Ref2
File Select File D+	<Browser>	Default directory*
Select File D-	<Browser>	Default directory*
*** Refer to the Application Directories and Usage topic for default path names.**		

Configure Ref Levels Menu Parameters

The Configure Ref Levels menu includes the following command buttons in the Autoset area:

- Setup
- Run

Table 51: Configure Ref Levels Menu Parameters

Option	Parameters	Default setting
Source	Differential, DPlus*,DMinus*	Differential
Rise, High	10.00 V to -10.00 V in units of 1 mV	400 mV
Rise, Mid	10.00 V to -10.00 V in units of 1 mV	0 V
Rise, Low	10.00 V to -10.00 V in units of 1 mV	-400 mV
Fall, High	10.00 V to -10.00 V in units of 1 mV	400 mV
Fall, Mid	10.00 V to -10.00 V in units of 1 mV	0 V
Fall, Low	10.00 V to -10.00 V in units of 1 mV	-400 mV
Hysteresis	0 V to 10.00 V in units of 10 mV	30 mV
Mid = 0V**	Set, Clear	0 V (set)
*** Only available when Single Ended is the Probe Type option.**		
**** 50% ($VRef_{MID}$) of signal swing if the option is clear.**		

Configure Ref Level Autoset Setup Menu Parameters

The Configure Ref Level Autoset Setup menu includes the following command buttons:

- OK
- Cancel

Table 52: Configure Ref Level Autoset Setup Menu Parameters

Option	Parameters*	Default setting
Rise, High	0 to 100% in units of 1%	80%
Rise, Mid	0 to 100% in units of 1%	50%
Rise, Low	0 to 100% in units of 1%	20%
Fall, High	0 to 100% in units of 1%	80%
Fall, Mid	0 to 100% in units of 1%	50%
Fall, Low	0 to 100% in units of 1%	20%
Hysteresis	0 to 50% in units of 1%	3%
* **Where** 0% = mean($v_{EYE\text{-}HI\text{-}TRAN}(n)$) **and** 100% = mean($v_{EYE\text{-}LO\text{-}TRAN}(n)$).		

Configure Gating Menu Parameters

Table 53: Configure Gating Menu Parameter

Option	Parameter	Default setting
Gating	Off, Cursors, Custom	Off

Configure Gating Menu with Custom Parameters

The value that displays under Stop shows the sum of the Length and Start options.

Table 54: Configure Gating Menu with Custom Parameters

Area	Option	Parameter	Default setting
	Custom Gating Units	Unit Intervals, Edges	Unit Intervals
Clock Recovery Window	Length	1 to 50 M in increments of 1	3.5k
	Start	1 to 50 M in increments of 1	1
Analysis Window	Same as Clock Recovery Window	Yes, No	Yes
	Alignment*	Centered, User Defined	Centered
	Length*	1 to 50 M in increments of 1	250
	Start***	1 to 50 M in increments of 1	1.626k
*** Available when you select No as the Same as Clock Recovery Window option.**			
**** Available when you select User Defined as the Alignment option.**			

Configure Jitter Menu Parameters

Table 55: Configure Jitter Menu Parameters

Area	Option	Parameter	Default setting
Clock Recovery Method	Method	PLL: Standard BW, Const Clk: Mean, Const Clk: Median, PLL: User BW	PLL: Standard BW
PLL Loop BW	Standard: b/s	IBA2500 : 2.5, PCIEX : 2.5, plus various other standards, such as: <1394> <Fibre Channel> <GigaBit Ethernet> <Serial ATA> <SONET> <USB>	IBA2500 : 2.5
	User BW*	10 kHz to 50 MHz in units of 10 kHz	15 MHz
Rj/Dj**	BER=1e-?	2 to 15 in units of 1 (negative exponents)	12
	Pattern Type	CJTPAT, CSPAT, CRPAT, B2BTS1, Custom	CJTPAT
	Pattern Len†	2 to 5000 bits in units of 1	2.5 kbits
*** Available only when PLL: User BW is the Method option; the roll off corner frequency is in MHz.**			
****Available only for Jitter @ BER measurements.**			
†Available only when Custom is the Pattern Type option.			

Configure Population Menu Parameters

Table 56: Configure Population Menu Parameters

Area/option	Parameter	Default setting
Population Limit	On, Off	Off
Configure Limit By	Acquisitions, Measurement	Acquisitions
Limit	1 to 10 T in units of 1	1 K

Measurements Limits Menu Parameters

Table 57: Measurements Limits Menu Parameters

Option	Parameters	Default setting
Limits	On, Off	Off
Limits File	<Browser>	Default directory*
*** Refer to the Application Directories and Usage topic for default path names.**		

Results Menus

The application includes the following Results Menus:

- Summary
- Details

Results Summary Menu Parameters

The Results Summary menu includes the following command buttons:

- Show Plot
- Export to CSV

Table 58: Results Summary Menu Parameters

Option	Parameters	Default setting
Select View	All Stats, Limits Status*	All Stats
Time Units	Unit Intervals, Seconds	Unit Intervals
*** Available only when Measurements Limits is enabled.**		

Results Details Menu Parameters

The Results Details menu includes the following command buttons:

- Show Plot
- Export to CSV

Table 59: Results Details Menu Parameters

Option	Parameters	Default setting
Select View	<list of all selected measurements>	<first selected>
Time Units	Unit Intervals, Seconds	Unit Intervals

Plots Select Menu Parameters

The Plots Select menu includes the following command buttons:

- Refresh

Table 60: Plots Select Menu Parameters

Option	Parameters	Default setting
Measurement	<any selected measurement>	Eye Width
Plot Type	See Measurement and Available Plots topic	Eye Diagram
Plots Display	On, Off	On

Eye Diagram Configure Menu Parameters

Table 61: Eye Diagram Configure Menu Parameters

Area/option	Parameters	Default setting
Bit Type	All, Transition, Non Transition	All
Mask	On, Off	Off
Standard	InfiniBand, PCI Express, User*	InfiniBand
Type for InfiniBand	Receiver, Cable, TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10	Receiver
for PCI Express	Receiver, Transmitter Tbit, Transmitter NTbit	Receiver
*** When you select User, a file browser displays; refer to the User Mask topics.**		

Time Trend Plot Configure Menu Parameter

Table 62: Time Trend Plot Configure Menu Parameter

Option	Parameter	Default Setting
Waveform Overlay	On, Off	Off

Histogram Plot Configure Menu Parameters

Table 63: Histogram Plot Configure Menu Parameters

Option	Parameters	Default setting
Vertical Axis	Linear, Log	Linear
Bin Resolution	1 to 50 K in units of 1	250

Spectrum Plot Configure Menu Parameters

Table 64: Spectrum Plot Configure Menu Parameters

Option	Parameters	Default setting
Vert. Scale	Linear, Log	Linear
Horiz. Scale	Linear, Log	Linear

Bathtub Plot Configure Menu Parameter

Table 65: Bathtub Plot Configure Menu Parameter

Option	Parameter	Default setting
Scale	Linear, Log	Linear

Log Worst Case Configure Menu Parameters

The Log Worst Case menu includes the following command button:

- Purge

Table 66: Log Worst Case Configure Menu Parameters

Option	Parameters	Default setting
Log	On, Off	Off
Choose Directory	<Browser>	Default directory*
*** Refer to the Application Directories and Usage topic for default path names.**		

Utilities Report Generator Menus Parameters

There are no parameters for the Report Generator utility menus.

Algorithms

The RT-Eye application can take measurements from one or two serial data waveforms. The number of waveforms used by the application depends on the probe selected in the Probe Type option of the Measurements Select menu.

Note: *The Algorithms book includes Field Notes that you may use to ensure good measurement results.*

Oscilloscope Setup Guidelines

For all measurements, use the following guidelines to set up the oscilloscope:

1. The signal is any channel, reference, or math waveform.
2. The vertical scale for the waveform must be set so that the waveform does not exceed the vertical range of the oscilloscope.
3. The sample rate must be set small enough to capture sufficient waveform detail and avoid "aliasing."
4. Longer record lengths increase measurement accuracy (though at the same time decreasing measurement speed).

Test Methodology

The application performs the measurement according to the following steps:

1. Imports the current waveform.
2. For timing measurements, checks that there are a minimum number of edges in the waveform to calculate the measurement as follows:

- Single edge: Rise Time, Fall Time
- Two cycle-start edges: Unit Interval
- Three cycle-start edges: TIE
- Jitter measurements require at least 50 pattern repeats for RjDj analysis; accuracy may be degraded for fewer than 100 pattern repeats
- Two edges on each of two waveforms: Differential Skew

3. Performs the measurement.
4. Displays the results as statistics where you can save the results to a .csv file.
5. Displays the results as a plot if defined and enabled.

Measurements by Module

Table 67: Measurements by Module

Button name	Measurement names	Applicable module test
Timing		
Eye Width/ Eye Height	Eye Width Eye Height Eye Height: Transition Bits Eye Height: Non-Trans Bits	Eye Height: All Eye Width: Infinband-Cable Assembly, PCI Express, Serial Analysis
Rise Time	Rise Time	All. Applied to v_{D+} and v_{D-} in PCI Express w/ Single Ended Probes
Fall Time	Fall Time	All. Applied to v_{D+} and v_{D-} in PCI Express w/ Single Ended Probes
Unit Interval	Unit Interval	Infiniband-Driver, PCI-Express, Serial Analysis
Bit Rate	Bit Rate	Serial Analysis
Differential Skew*	Differential Skew	Serial Analysis
Amplitude		
Differential Voltage	Differential Amplitude	Infiniband-Driver/Receiver, Serial Analysis
	Differential Peak Voltage	PCI Express
Differential Average		PCI Express-Driver
High Amplitude	High Amplitude	Serial Analysis
Low Amplitude	Low Amplitude	Serial Analysis
CM Voltage*	CM Voltage	Infiniband-Driver/Receiver, PCI Express, Serial Analysis
AC CM Voltage*	AC CM Voltage	Serial Analysis
	AC CM RMS Voltage	InfiniBand and PCI-Express Driver
	AC CM Pk Voltage	PCI-Express Receiver
De-Emphasis	De-Emphasis	PCI-Express Driver, Serial Analysis
Jitter		
Jitter @ BER	Jitter @ BER Jitter: Eye Opening Jitter: Total (TJ) Jitter: Deterministic (DJ) Jitter: Random (RJ)	Infiniband-Driver/Receiver, Serial Analysis RJ only available in Serial Analysis
TIE Jitter	TIE Jitter	Infiniband-Cable Assembly, PCI Express, Serial Analysis
*** Available only when Single Ended is the Probe Type option in the Measurements Select menu.**		

Notation in Algorithms

All measurements are made on one of several voltage waveforms. Timing measurements are based on edge locations in the waveform or on clock edge times derived from the waveform edge locations. Amplitude measurements are made on the entire waveform or on waveform values based on recovered clock times. To represent measurements as formulas, the algorithm descriptions follow notational rules.

Table 68: Notational Rules

Notation	Use
Lower case character	Reserved for fundamental signals or measurements. For instance, sampled waveforms are of the form $v(i)$ and edge times are of the form $t(n)$. The character is indicative of the units of the quantity, such as v for a voltage and t for a time. They are always indexed.
Upper case character	Used for a quantity that is fixed or for a measurement. The character is indicative of the units of the quantity, such as V for a voltage and T for a time.
Subscripts	Used to identify the variable, measurement or quantity.
Indices variables	Indices for variables or measurements have multiple values over the course of an acquisition. The indices are between parentheses. If the index is a measurement, it will have statistics for both the current acquisition and all acquisitions (accumulated). Non-indexed measurements that have a single result for the entire waveform will only have all acquisition statistics.

Summary Definitions of Fundamental Signals and Measurements

The next several topics list the annotation of the signals and measurements as they appear in the algorithm specific to each measurement. The algorithms comprise the following types of annotation:

- Waveforms
- Edge Time Threshold Voltages

Crossing Times

- Recovered Clock Times
- Eye Center Voltages

Table 69: Waveforms

Waveform	Definition
i	Index into sampled voltage waveforms
$v_{D+}(i)$	Positive conductor (D+) voltage acquired with a single ended probe
$v_{D-}(i)$	Negative conductor (D–) voltage acquired with a single ended probe
$v_{DIFF}(i)$	Differential voltage signal acquired with either a differential probe or calculated from two single ended probe signals: $= v_{D+}(i) - v_{D-}(i)$
$v_{CM}(i)$	Common mode voltage calculated from two single ended probe signals: $= (v_{D+}(i) + v_{D-}(i))/2$

Table 70: Edge Time Threshold Voltages

Edge Time Threshold Voltage	Definition
$V_{REF\text{-}HI}$	High level reference voltage
$V_{REF\text{-}MID}$	Mid level reference voltage
$V_{REF\text{-}LO}$	Low level reference voltage
V_{HYST}	Hysteresis voltage; minimum voltage swing required at any threshold before a crossing is recognized

Table 71: Crossing Times

Crossing Time	Definition
n	Index into array of crossing times
t	Interpolated time when v_{DIFF} crosses a V_{REF}
$t_{HI}(n)$	When $v_{DIFF}(t)$ crosses $V_{REF\text{-}HI}$
$t_{DAT}(n)$	When $v_{DIFF}(t)$ crosses $V_{REF\text{-}MID}$
$t_{LO}(n)$	When $v_{DIFF}(t)$ crosses $V_{REF\text{-}LO}$
$t_{D+HI}(n)$	When $v_{D+}(t)$ crosses $V_{D+REF\text{-}HI}$
$t_{D+MID}(n)$	When $v_{D+}(t)$ crosses $V_{D+REF\text{-}MID}$
$t_{D+LO}(n)$	When $v_{D+}(t)$ crosses $V_{D+REF\text{-}LO}$
$t_{D-HI}(n)$	When $v_{D-}(t)$ crosses $V_{D-REF\text{-}HI}$
$t_{D-MID}(n)$	When $v_{D-}(t)$ crosses $V_{D-REF\text{-}MID}$
$t_{D-LO}(n)$	When $v_{D-}(t)$ crosses $V_{D-REF\text{-}LO}$

Table 72: Recovered Clock Times

Recovered Clock Time	Definition
$t_{R\text{-}CLK}(n)$	Recovered clock edge times referenced to the UI boundaries: = PLL(t_{MID}) for PLL based clock recovery = CCR(t_{MID}) for Constant Clock based clock recovery
$i_{UI\text{-}TRAN}(n)$	List of transition UIs immediately following a transition
$i_{UI\text{-}NTRAN}(n)$	List of non-transition UIs not immediately following a transition
$t_{R\text{-}DAT}(n)$	Recovered data edge times: = $t_{R\text{-}CLK}(i_{UI\text{-}TRAN}(n))$
$UI(n)$	Unit Interval (UI): = $t_{R\text{-}CLK}(n+1) - t_{R\text{-}CLK}(n)$

Table 73: Eye Center Voltages

Eye Center Voltage	Definition
$v_{EYE}(n)$	Voltage at middle of a UI: = $v_{DIFF}(t_{R\text{-}CLK}(n) + UI_{AVG}/2)$
$v_{EYE\text{-}TRAN}(n)$	Voltage at middle of a transition UI*: = $v_{EYE}(i_{UI\text{-}TRAN}(n))$
$v_{EYE\text{-}NTRAN}(n)$	Voltage at middle of a non-transition UI*: = $v_{EYE}(i_{UI\text{-}NTRAN}(n))$
$v_{EYE\text{-}HI}(n)$	High voltage at middle of a UI*: = subset($v_{EYE}(n) >= 0$)
$v_{EYE\text{-}LO}(n)$	Low voltage at middle of a UI*: = subset($v_{EYE}(n) < 0$)
$v_{EYE\text{-}HI\text{-}TRAN}(n)$	High voltage at middle of a transition UI*: = $v_{EYE\text{-}HI}(i_{UI\text{-}TRAN}(n))$
$v_{EYE\text{-}HI\text{-}NTRAN}(n)$	High voltage at middle of a non-transition UI*: = $v_{EYE\text{-}HI}(i_{UI\text{-}NTRAN}(n))$
$v_{EYE\text{-}LO\text{-}TRAN}(n)$	Low voltage at middle of a transition UI*: = $v_{EYE\text{-}LO}(i_{UI\text{-}TRAN}(n))$
$v_{EYE\text{-}LO\text{-}NTRAN}(n)$	Low voltage at middle of a non-transition UI*: = $v_{EYE\text{-}LO}(i_{UI\text{-}NTRAN}(n))$
* A subset of $v_{EYE}(n)$.	

Timing Measurements

Timing measurements are all based on either Crossing Times or Recovered Clock Times. Crossing times are dependent on Ref Level thresholds. Recovered Clock Times are affected by clock recovery method specified in Clock Recovery and Jitter Configuration.

Eye Width Measurement

The *measured* minimum horizontal eye opening at the zero reference level as shown in the eye diagram.

$$T_{EYE-WIDTH} = UI_{AVG} - TIE_{Pk-Pk}$$

Where:

UI_{AVG} is the average UI

TIE_{Pk-Pk} is the Peak-Peak TIE

Rise Time Measurement

The Rise Time measurement is the time difference between when the V_{REF-HI} reference level is crossed and the V_{REF-LO} reference level is crossed on the rising edge of the waveform.

$$t_{RISE}(n) = t_{HI+}(i) - t_{LO+}(j)$$

Where:

t_{RISE} is a Rise Time measurement

t_{HI+} is a set of t_{HI} for rising edges only

t_{LO+} is a set of t_{LO} for rising edges only

i and *j* are indexes for nearest adjacent pairs of t_{LO+} and t_{HI+}.

n is the index of rising edges in the waveform

Rise time can be limited to only rising edges of consecutive transitions in the File Preferences menu. In the PCI-Express module, Rise Time is taken independently on each single ended waveform sources when you use two single ended probes as the signal source.

Rise Time for $v_{D+}(t)$ is as follows:

$$t_{D+RISE}(n) = t_{D+HI+}(i) - t_{D+LO+}(j)$$

and for $v_{D-}(t)$

$$t_{D-RISE}(n) = t_{D-HI+}(i) - t_{D-LO+}(j)$$

Fall Time Measurement

The Fall Time measurement is the time difference between when the V_{REF-HI} reference level is crossed and the V_{REF-LO} reference level is crossed on the falling edge of the waveform.

$$t_{FALL}(n) = t_{LO-}(i) - t_{HI-}(j)$$

Where:

t_{FALL} is a Fall Time measurement

t_{HI-} is a set of t_{HI} for falling edges only

t_{LO-} is a set of t_{LO} for falling edges only

i and *j* are indexes for nearest adjacent pairs of t_{LO-} and t_{HI-}

n is the index of falling edges in the waveform

Fall time can be limited to only falling edges of consecutive transitions in the File Preferences menu. In the PCI-Express module, Fall Time is taken independently on each single ended waveform sources when you use two single ended probes as the signal source.

Fall Time for $v_{D+}(t)$ is as follows:

$$t_{D+FALL}(n) = t_{D+LO-}(i) - t_{D+HI-}(j)$$

and for $v_{D-}(t)$

$$t_{D-FALL}(n) = t_{D-LO-}(i) - t_{D-HI-}(j)$$

Unit Interval Measurement

The Unit Interval measurement calculates the cycle duration of the recovered clock.

$$UI(n) = t_{R-CLK}(n+1) - t_{R-CLK}(n)$$

$$UI_{AVG} = Mean(UI(n))$$

Where:

t_{R-CLK} is a recovered clock edge

n is the index to UI in the waveform

Bit Rate Measurement

The Bit Rate measurement calculates the baud (such as frequency) of the recovered clock.

BR(n) = 1/UI(n)

Where:

UI is the associated Unit Interval measurement

n is the index to UI in the waveform

Differential Skew Measurement

The Skew measurement is the time delay between the two single ended waveform sources.

$$t_{SKEW}(n) = t_{D+MID}(n) - t_{D-MID}(n)$$

Where:

t_{SKEW} is the Skew measurement

t_{D+MID} is the mid level crossing time of v_{D+}

t_{D-MID} is the mid level crossing time of v_{D-}

n is the index to edges in the waveform

Amplitude Measurements

Some amplitude measurements can be limited to only the high or only the low amplitude of consecutive transitions in the File Preferences menu.

Eye Height Measurement

The *measured* minimum vertical eye opening at the UI center as shown in the plot of the eye diagram. There are three types of Eye Height values.

Eye Height:

$$V_{EYE-HEIGHT} = V_{EYE-HI-MIN} - V_{EYE-LO-MAX}$$

Where:

$V_{EYE-HI-MIN}$ is the minimum of the High voltage at mid UI

$V_{EYE-LO-MAX}$ is the maximum of the Low voltage at mid UI

Eye Height – Transition:

$$V_{EYE-HEIGHT-TRAN} = V_{EYE-HI-TRAN-MIN} - V_{EYE-LO-TRAN-MAX}$$

Where:

$V_{EYE-HI-TRAN-MIN}$ is the minimum of the High transition bit eye voltage at mid UI

$V_{EYE-LO-TRAN-MAX}$ is the maximum of the Low transition bit eye voltage at mid UI

Eye Height – Non-Transition:

$$V_{EYE-HEIGHT-NTRAN} = V_{EYE-HI-NTRAN-MIN} - V_{EYE-LO-NTRAN-MAX}$$

Where:

$V_{EYE-HI-NTRAN-MIN}$ is the minimum of the High non-transition bit eye voltage at mid UI

$V_{EYE-LO-NTRAN-MAX}$ is the maximum of the Low non-transition bit eye voltage at mid UI

Differential Amplitude Measurement

The Differential Amplitude measurement calculates the change in voltage level across a transition in the differential waveform.

$$v_{DIFF-AMP}(n) = | v_{DIFF-LEVEL}(i) - v_{DIFF-LEVEL}(i+1) |$$

Where

n is the index of transitions of interest

i is the index of UI (bit) locations preceding/following the transition

$v_{DIFF-LEVEL}$ is the state level of the unit interval (bit period)

$$v_{DIFF-LEVEL} = mean(v_{DIFF}(j))$$

Where

j is the sample index; in the previous equation, j spans the samples that fall in the center 30% of UIs *i* or *i*+1.

v_{DIFF} is the differential voltage.

Note: *Eligible transitions are either all (**Blue** and **Red**) or consecutive (**Red** only). This is set in the File Preferences menu.*

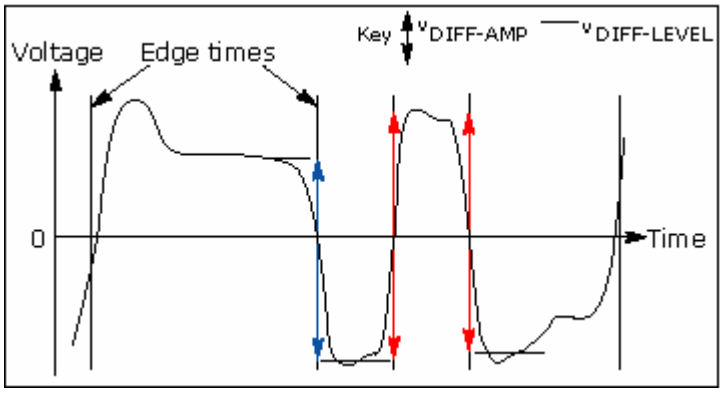


Figure 118. Differential Amplitude Change in Voltage Level Across a Transition.

Differential Peak Voltage Measurement

The Differential Peak Voltage measurement returns two times the larger of the Min or Max statistic of the differential voltage waveform.

$$V_{DIFF-PK} = 2 * Max(Max(v_{DIFF}(i)); Min(v_{DIFF}(i)))$$

Where:

i is the index of all waveform values

v_{DIFF} is the Differential voltage signal

Differential Average Measurement

The Differential Average measurement returns the Mean of the differential voltage waveform.

$$V_{DIFF-AVG} = Mean(v_{DIFF}(i))$$

Where:

i is the index of all waveform values

v_{DIFF} is the Differential voltage signal

High Amplitude Measurement

The High Amplitude measurement calculates the mode of all differential waveform values greater than zero.

$$V_{HI} = Mode(v_{DIFF}(i) > 0)$$

Where:

v_{DIFF} is Differential voltage signal

i is the index of all waveform values

Low Amplitude Measurement

The Low Amplitude measurement calculates the mode of all differential waveform values less than zero.

$$V_{LO} = Mode(v_{DIFF}(i) < 0)$$

Where:

v_{DIFF} is Differential voltage signal

i is the index of all waveform values

CM Voltage Measurement

The Common Mode Voltage measurement (also called DC Common Mode) calculates the mean of the Common Mode voltage waveform.

$$V_{CM} = Mean(v_{CM}(i))$$

Where:

v_{CM} is the Common Mode voltage signal

V_{CM} is the Common Mode voltage signal

i is the index of Common Mode waveform values

AC CM Voltage Measurement

The AC Common Mode Voltage measurement calculates the AC statistics of the Common Mode voltage waveform with the DC value removed.

$$v_{AC-CM}(i) = v_{CM}(i) - V_{CM}$$

Where:

i is the index of all waveform values

v_{AC-CM} is the AC Common Mode voltage signal

v_{CM} is the Common Mode voltage signal

V_{CM} is the DC Common Mode voltage signal

AC CM RMS Voltage Measurement

The AC Common Mode RMS Voltage measurement calculates the RMS statistic of the Common Mode voltage waveform with the DC Value removed.

$$V_{AC-RMS-CM}(i) = RMS(v_{AC-CM}(i))$$

Where:

i is the index of all waveform values

$V_{AC-RMS-CM}$ is the RMS of the AC Common Mode voltage signal

v_{AC-CM} is the AC Common Mode voltage signal

AC CM Peak Voltage Measurement

The AC Common Mode Pk Voltage measurement returns the larger of the Min or Max statistic of the Common Mode voltage waveform with the DC Value removed.

$$V_{AC-PK-CM} = Max(Max(v_{AC-CM}(i)); Min(v_{AC-CM}(i)))$$

Where:

i is the index of all waveform values

$V_{AC-PK-CM}$ is the Peak of the AC Common Mode voltage signal

v_{AC-CM} is the AC Common Mode voltage signal

De-Emphasis Measurement

The De-Emphasis measurement calculates the ratio of any non-transition eye voltage (2nd, 3rd, etc. eye voltage succeeding an edge) to its nearest preceding transition eye voltage (1st eye voltage succeeding an edge). In the accompanying diagram, it is the ratio of the **Black** voltages over the **Blue** voltages. The results are given in dB.

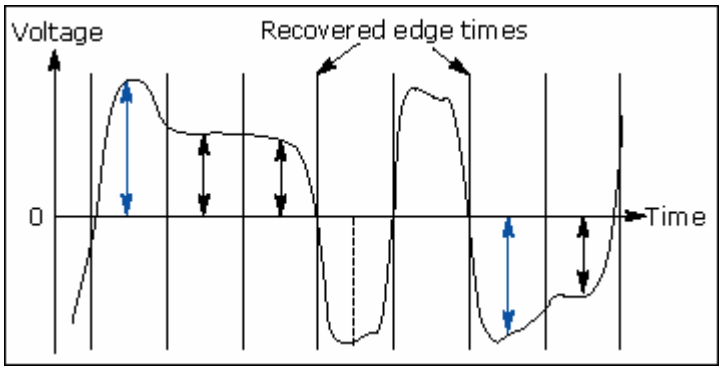


Figure 119. De-Emphasis Ratio of Non-Transition Eye Voltages.

$$DEEM(m) = dB\left(\frac{v_{EYE-HI-NTRAN}(m)}{v_{EYE-HI-TRAN}(n)}\right)$$ or

$$DEEM(m) = dB\left(\frac{v_{EYE-LO-NTRAN}(m)}{v_{EYE-LO-TRAN}(n)}\right)$$

Where:

$v_{EYE-HI-TRAN}$ is the High voltage at mid UI following a positive transition

$v_{EYE-LO-TRAN}$ is the Low voltage at mid UI following a negative transition

$v_{EYE-HI-NTRAN}$ is the High voltage at mid UI following a positive transition bit

$v_{EYE-LO-NTRAN}$ is the Low voltage at mid UI following a negative transition bit

m is the index for all non-transition UIs

n is the index for the nearest transition UI preceding the UI specified by *m*

Jitter Measurements

In the context of this RT-Eye analysis package, the term Jitter is used solely in relation to timing errors between data signal edges and recovered clocks. The two measurements in this category are TIE Jitter and Jitter @ BER. TIE Jitter is a direct measurement of the time difference (error) between data edges and associated clock edges, which is recovered from the data signal edges. Jitter @ BER is the label for Random and Deterministic Jitter analysis (*Rj/Dj*) on a TIE Jitter measurement.

The purpose of the *Rj/Dj* analysis is two fold: to decompose the TIE into component elements and to extrapolate jitter measurements (Total Jitter or Eye Opening) @ BERs that would require very large data sets for direct measurement.

TIE, and therefore Jitter @ BER, correlates to Eye Diagram statistics. A time Histogram at the eye crossing (at the mid reference voltage level) is the same as Histogram Plot of the TIE Jitter measurement on the same signal.

The method of clock recovery has a big impact on Jitter results.

Jitter @ BER Measurement

The *Rj/Dj* measurement calculates the deterministic and random components of jitter. The jitter is obtained from the TIE Jitter measurements. *Rj* is the random jitter and *Dj* is the deterministic jitter.

Dj is caused by multiple sources: periodic jitter (*Pj*) from periodic interference that is not correlated to the data, data dependent jitter (*DDj*) from interference of nearby edges (also called ISI or Inter-Symbol Interference), Duty Cycle Distortion jitter (*DCDj*) from slew rate differenced between rising and falling edges, plus other non-random sources.

Dj components can be identified in a jitter spectrum under a set of conditions. *Pj* will appear as spectral peaks regardless of conditions. *DDj* and *DCDj* will appear as spectral peaks provided that the data signal is a repeating pattern. The frequencies *DDj* and *DCDj* spectral peaks are at harmonics of the (Bit Rate / Pattern length). The remaining spectral energy is attributed to *Rj*. *Dj* components are spectrally separated from *Rj*.

The *Dj* measurement is the peak-to-peak value of the inverse Fourier transform of the deterministic jitter spectral components. *Tj* is the total jitter, which is composed of *Dj* and *Rj*. The *Tj* measurement calculates the peak-to-peak value of the total jitter. *Rj* is assumed to be *near* Gaussian. The standard deviation of *Rj* is calculated from the power in the *Rj* portion or the spectrum.

A Jitter PDF is formed by convolving a Gaussian based on *Rj* and Histograms of *Dj* and *Pj*. A Bathtub curve is calculated from the left and right side CDFs of the Jitter PDF. The Bathtub curve will yield *Tj* and Eye Opening ($T_{EYE-OPEN}$). View the Bathtub Curve: BER versus Decision Time diagram.

Dj = PkPk(IFFT(DjSpectralPeaksOf(FFT(TIE))))

Rj = RMSPower(FFT(TIE) – DjSpectralPeaksOf (FFT(TIE))))

Tj_{-PDF} = NormalizedHistogram(Dj) * Gaussian(Rj)

$$Tj = Tj_{MAX} - Tj_{MIN}$$

$$T_{EYE-OPEN} = UI_{AVG} = Tj$$

Where:

Dj is the Deterministic jitter

Rj is the Random jitter

Tj is the Total jitter

Tj_{-PDF} is the PDF of the Total jitter

Tj_{MIN} is the minimum total jitter at a given BER

Tj_{MAX} is the maximum total jitter at a given BER

Additionally, *Dj* is further decomposed as follows:

Pj = PkPk(IFFT(PjSpectralPeaksOf(FFT(TIE))))

$$DDj = \frac{PkPk(Dj_{-RISE}) - PkPk(Dj_{-FALL})}{2}$$

$$DCDj = | Mean(Dj_{-RISE}) - Mean(Dj_{-FALL}) |$$

$$Dj_{-RISE} =$$

RiseEdgeJitter(IFFT(DDjAndDCDjSpectralPeaksOf(FFT(TIE))))

$$Dj_{-FALL} =$$

FallEdgeJitter(IFFT(DDjAndDCDjSpectralPeaksOf(FFT(TIE))))

Where:

Pj is the periodic jitter

DDj is the data dependent (or ISI) jitter

DCDj is the duty cycle jitter

Dj_{-FALL} is the jitter of all the combined *DDj* and *DCDj* falling edges

Dj_{-RISE} is the jitter of all the combined *DDj* and *DCDj* rising edges

Jitter Measurements Field Notes

Data pattern generation techniques vary from one serial data standard to another. Refer to the Standards Methods Of Implementation (MOIs) documents for specific details on how to set up those system-to-broadcast testable data/test patterns.

Both PCI Express and InfiniBand serial data traffic test patterns are interspersed with Skip Ordered Sets (SOSs) on regular intervals. When conducting jitter measurements that require repeated data sets (such as for Jitter @ BER), you will need to set up the acquisition system to acquire between these non-deterministic Skip Characters. Refer to the Standards MOIs documents for specific details on how to set up the system to work under these conditions.

TIE Jitter Measurement

The *measured* time difference between a data edge and a recovered clock edge.

$$tie(n) = t_{R-DAT}(n) - t_{DAT}(n)$$

Where:

t_{DAT} is the original data edge

t_{R-DAT} is the recovered data edge (for example, the recovered clock edge corresponding to the UI boundary of t_{DAT}

n is the index of all edges in the waveform

Statistics

The application calculates statistics for all selected measurements. The application displays the following statistics in the Results menus:

- Maximum value
- Minimum value
- Mean value
- Standard deviation value
- Peak-Peak value
- Population

Maximum Value

The application calculates this statistic using the following equation:

$$Max(x) = Highest\ value\ of\ x$$

Minimum Value

The application calculates this statistic using the following equation:

$$Min(x) = Lowest\ value\ of\ x$$

Mean Value

The application calculates this statistic using the following equation:

$$Mean(x) = \bar{x} = \frac{1}{N}\sum_{n=0}^{N-1} x(n)$$

Standard Deviation Value

It may seem odd that the equation for the estimate of the Standard Deviation contains a 1/(N-1) scaling factor. If you knew the true mean of X and used in place of the estimated mean $\overline{X}$, then you would, in fact, scale by1/N. But, $\overline{X}$ is an estimate and is likely to be in error (or bias), causing the estimate of the Standard Deviation to be too small I scaled by 1/N. This is the reason for the scaling shown in the equation. (Refer to Chapter 9.2 in A. Papoulis, *Probability, Random Variables, and Stochastic Processes*, McGraw Hill, 1991.)

The application calculates this statistic using the following equation:

$$StdDev(x) = \sigma_x = \sqrt{\frac{1}{(N-1)}\sum_{n=0}^{N-1}(x(n) - \bar{x})^2}$$

Peak-to-Peak Value

The application calculates this statistic using the following equation:

$$PkPk(x) = Max(x) - Min(x)$$

Population Value

Population is the total number of data points applied to the displayed statistics.

GPIB

An example of a GPIB program that can execute the RT-Eye application is included with the application. The oscilloscope hard disk includes the example file, rt-eyectrl.c. On the hard drive, the file resides in the C:\TekApplications\tdsrt-eye\Examples\RemoteCtrl directory.

The example shows how a GPIB program executes the application to do the following tasks:

- Start the application
- Recall a setup
- Take a measurement
- Check for an error
- Exit the application

Guidelines to GPIB Programming

The application includes an example file of a GPIB program. Your GPIB program should comply with the following guidelines:

- The application startup must complete before sending additional GPIB commands to the application; query the variable application; it will return "TDSRT-EYE" when the application startup is complete
- Recall a setup file from GPIB to select measurements and set up the application
- The measurements cycle must complete before data is queried; query the variable SequencerState; it will return "Ready" when sequencing is complete
- The resultFor and resultAcq variables must be set before querying results; pause a second after setting each variable
- The error variable should be checked to ensure that an error has not occurred because of a measurement command problem; the measError variable returns errors specific to the measurement selected by resultFor

Program Example

The program example shows how to communicate to the RT-Eye application using remote GPIB commands. The program includes the following steps:

- Start up the application
- Recall a setup
- Take a measurement
- Display results or errors
- Exit the application

In the example, you will recall a setup file named rt-eyectrl.c (setup). You can use the File> Save function in the application to save setup files according to your own needs.

GPIB Commands

Introduction to GPIB Command Syntax

With knowledge of the GPIB command syntax, you can design a GPIB program to do the following tasks:

- Start the RT-Eye application
- Recognize an active application with GPIB protocol
- Program and read application setup parameters
- Sequence measurements
- Read measurement results
- Generate reports

GPIB Reference Materials

To use GPIB commands with your oscilloscope, you can refer to the following materials:

- The rt-eyectrl.c file on the oscilloscope hard drive (located in the c:\TekApplications\tdsrt-eye\Examples\RemoteCtrl directory) for an example of a GPIB program that can execute the application
- The GPIB Program Example topic for guidelines to use while designing a GPIB program
- The Parameters topics for range of values, minimum units and default values of parameters

- The programmer information in the online help of your oscilloscope

Starting and Setting Up the Application Using GPIB

To start the RT-Eye application, you must send the oscilloscope the following GPIB command:

application:activate "RT-Eye Serial Compliance and Analysis"

Note: *The name of the application in the previous string is identical to the name of the application from the oscilloscope Run Application list.*

The application uses the GPIB VARIABLE:VALUE command with arguments to execute some features. The set of GPIB commands does not include the variable names and variable values necessary to select and configure the measurements in the GPIB program.

You must manually set up the application and oscilloscope, selecting and configuring the measurements that you want to use with your GPIB program, and save them in a setup file in the default setup folder for that module. To save a setup file, refer to Saving a Setup File. Use the name of the saved setup file as the value for the "recallName" variables in your GPIB program.

Variable:Value RT-Eye Command

Description

This command accepts string arguments for a control or data variable and a value to which to set the argument.

Syntax

VARIABLE:VALUE "<variable name>","<variable value>"

Note: *The arguments <variable name> and <variable value> are required in the order indicated.*

VARIABLE:VALUE? <variable name> for query.

⚠ **CAUTION:.** *Commands are case and space sensitive. Your program will not operate correctly if you do not follow the capitalization and spacing precisely.*

Table 74: Variable:Value RT-Eye Command Arguments and Queries (Part 1)

Group/name	Value	Function	Query returns
application	{exit}	Terminates the active application	Returns *TDSRT-EYE* when the application is active
version	Query only		Returns the version number of the application
Sequencer			
sequencerMode	{SingleNoAcq, FreeRun, Single}	Sets the sequencer mode	Returns the sequencer mode
sequencerState	{Stop, Sequencing}	Sends the Measurement Sequencing command	Returns {Most recent setting, Ready}; *Ready* indicates that the value was processed
reset	{Results}	Clears the active measurement results and plots	Returns {Most recent setting, Ready}; *Ready* indicates that the value was processed
Active module			
module	{SerialAnalysis, InfiniBand, PCIExpress}	Switches to the module specified	Returns the active module
Recall setup			
setup*	{Default, Recall}	Performs the Recall Default setup function	Returns {Most recent setting, Ready}; *Most recent setting indicates* that the value is being processed; *Ready* indicates that the value was processed
recallName	Any string from 1 to 40 characters: A to Z, 0 to 9, or special characters like “.”	Sets the Recall setup file name; file name extension of .ini is optional	Returns the name of the set up file to be recalled (without an extension)
recallDirectory	Query only		Returns the current setting (determined from module command) of recall directory default, such as *InfiniBand\setup*
***Query may return an error code if command fails.**			

Table 75: Variable:Value RT-Eye Command Arguments and Queries (Part 2)

Group/name	Value	Function	Query returns
Source scaling			
sourceAutoset***	{Vert, Horiz, vertAndHoriz}	Starts the automatic scaling if the sources are channel waveforms	Returns {Most recent setting, Ready}; Ready indicates that the value was processed
Source ref levels			
refLevelSelect***	{Diff, DPlus, DMinus}†	Selects the source on which to automatically calculate the reference voltage levels	Returns the current value
refLevelAutoset***	{Run}	Starts the automatic calculation of the reference levels if the sources are channel waveforms	Returns {Most recent setting, Ready}; Ready indicates that the value was processed
Report generator setup			
reportGen*	{Now}	Exports content from current measurements into a report template/layout where the template/layout are default or as specified in the recalled setup file; concatenates the Template name and a timestamp for the file name	{*Most recent setting*, Ready} Ready indicates report has been created and saved.
Compliance module only			
reportDeviceID	Any string from 1 to 40 characters: A to Z, 0 to 9, or special characters like "."	Specifies the device ID field for report generation	Returns the specified DeviceID; applies to compliance modules only
Result variables			
resultFor	{Measurement Name}	Specifies the measurement that is the source for detailed results queries; refer to the tables between this one and the error codes table	Returns the selected measurements for the queries associated with the resultFor command
resultAcq	{All, Current}	Specifies the measurement result group as the most recent acquired or as an accumulation of all the measurements in the current session	Returns the current value
*** Query may return an error code if command fails.**			
**** Serial Analysis module only.**			
† DPlus and DMinus values are only available when Single Ended is the Probe Type option.			

Measurements Results Queries

⚠ ***CAUTION:*** *Prior to doing measurement queries, be sure to insert a one second delay after the resultFor and the resultAcq commands to allow the statistics variables to refresh.*

You need to use the VARIABLE:VALUE? form to enter measurement results queries in your GPIB program. Before you can do this, you must first set the measurement with the resultFor command. You can select the Current or all acquisition statistics with the resultAcq command.

The next several tables list the measurement results queries for the measurement selected in the resultFor variable.

Table 76: Measurements Results Queries Variable Names (Part 1)

Variable name	Query returns for measurement
Statistics for all measurements selected with resultFor	
max	Returns the maximum measurement value
mean	Returns the mean measurement value
min	Returns the minimum measurement value
pkpk	Returns the peak-to-peak measurement value
population	Returns the number of measurements used to the current statistics
stdDev	Returns the standard deviation measurement set
Other for non-statistical information that appears in the Results menus	
value	Returns a generic message for measurements with no statistical results, such as for amplitude measurements
maskUIControl	Returns the number of UIs examined for mask hits
maskHits	Returns the number of UIs containing one or more mask hit
Limits	
statusMax	Pass or Fail status; Pass when the measurement is below the maximum limit or Fail
statusMin	Pass or Fail status; Pass when the measurement is above the minimum limit or Fail
status	Pass or Fail status; Pass when the measurement passes the compliance test or Fail; also applies to the RT-Eye analysis with limits defined
Misc	
measUnits	Return a units string for the measurement, such as s for seconds

Table 77: Measurements Results Queries Variable Names (Part 2)

Variable name	Query returns for measurement
Jitter@BER only	
dataDependent	Returns the data dependent jitter component of the TIE measurement
dutyCycle	Returns the duty cycle jitter component of the TIE measurement
deterministic	Returns the deterministic jitter component of the TIE measurement
periodic	Returns the periodic jitter component of the TIE measurement
random	Returns the estimated random jitter component of the TIE measurement
totalJitter	Returns the estimated total jitter component at the BER of the TIE measurement
eyeOpening	Returns the estimated eye opening at the BER of the TIE measurement
Messages return strings if there are problems; refer to the Error Codes tables	
resultForStatus	Returns one of the following strings: "Active" when the value of *resultFor* is an active measurement "Inactive" when the value of *resultFor* is a known measurement that's not active "Unknown" when the value of *resultFor* is an unknown measurement Any of the results specified in this table are not valid unless this variable is "Active"
error	Returns a general error
warning	Returns a warning from the most recent measurement
measError	Returns a measurement specific error

Table 78: Serial Analysis Measurement Names for the resultFor Variable

Measurement Names	Results when resultAcq= All Stats	And …	Current Stats	Value	And …
Eye Width	Yes			Yes	
Eye Height	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Eye Height Transition Bits	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Eye Height Non-Transition Bits	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Rise Time	Yes		Yes		
Fall Time	Yes		Yes		
Unit Interval	Yes		Yes		
Bit Rate	Yes		Yes		
Differential Skew*	Yes		Yes		
Differential Amplitude	Yes		Yes		
High Amplitude	Yes			Yes	
Low Amplitude	Yes			Yes	
CM Voltage*	Yes			Yes	
AC CM Voltage*	Yes		Yes		
De-Emphasis	Yes		Yes		
Jitter @ BER					Jitter@BER variables; see previous topic
Eye Opening	Yes			Yes	eyeOpening
Total Jitter	Yes			Yes	totalJitter
Deterministic Jitter	Yes			Yes	deterministic
TIE Jitter	Yes		Yes		
*** Added when the Probe Type option is Single Ended.**					

Table 79: InfiniBand Driver Measurement Names for the resultFor Variable

Measurement Names	Results when resultAcq= All Stats	And …	Current Stats	Value	And …
Eye Height	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Eye Height Transition Bits	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Eye Height Non-Transition Bits	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Rise Time	Yes		Yes		
Fall Time	Yes		Yes		
Unit Interval	Yes		Yes		
Differential Amplitude	Yes		Yes		
CM Voltage*	Yes			Yes	
AC CM RMS Voltage*	Yes			Yes	
Total Jitter	Yes			Yes	totalJitter
Deterministic Jitter	Yes			Yes	deterministic
*** Added when the Probe Type option is Single Ended.**					

Table 80: InfiniBand Receiver Measurement Names for the resultFor Variable

Measurement Names	Results when resultAcq= All Stats	And …	Current Stats	Value	And …
Eye Height	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Differential Amplitude	Yes		Yes		
CM Voltage*	Yes			Yes	
Eye Opening	Yes			Yes	eyeOpening
Total Jitter	Yes			Yes	totalJitter
Deterministic Jitter	Yes			Yes	deterministic
*** Added when the Probe Type option is Single Ended.**					

Table 81: InfiniBand Cable Assembly Measurement Names for the resultsFor Variable

Measurement Names	Results when resultAcq= All Stats	And …	Current Stats	Value	And …
Eye Width	Yes			Yes	
Eye Height	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
TIE Jitter	Yes		Yes		
* Added when the Probe Type option is Single Ended.					

Table 82: PCI Express Driver Measurement Names for the resultFor Variable

Measurement Names	Results when resultAcq= All Stats	And …	Current Stats	Value	And …
Eye Width	Yes			Yes	
Eye Height	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Eye Height Transition Bits	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Eye Height Non-Transition Bits	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Rise Time*	Yes		Yes		
Fall Time**	Yes		Yes		
Unit Interval	Yes		Yes		
Differential Peak Voltage	Yes			Yes	
Differential Average Voltage	Yes			Yes	
De-Emphasis	Yes		Yes		
AC CM RMS Voltage†	Yes			Yes	
TIE Jitter	Yes		Yes		
* For Single Ended two measurements: Rise Time D+ and Rise Time D-.					
** For Single Ended two measurements: Fall Time D+ and Fall Time D-.					
† Added when the Probe Type option is Single Ended.					

Table 83: PCI Express Receiver Measurement Names for the resultFor Variable

Measurement Names	Results when resultAcq= All Stats	And …	Current Stats	Value	And …
Eye Width	Yes			Yes	
Eye Height	Yes	maskUICount, maskHits		Yes	maskUICount, maskHits
Unit Interval	Yes		Yes		
Differential Peak Voltage	Yes			Yes	
AC CM Pk Voltage*	Yes			Yes	
TIE Jitter	Yes		Yes		
*** Added when the Probe Type option is Single Ended.**					

Table 84: GPIB Commands Warning Codes

Code	Description
W999	An unspecified warning has occurred
W410	Number of edges is not sufficient for a measurement
W402	RjDj separation accuracy not guaranteed; less than 100 pattern repeats detected
W701	Worst case waveform logging timed out while saving; stopping the sequencer

Table 85: GPIB Commands Error Codes

Code	Description
E999	An recognized error has occurred
E101	No measurements have been selected; select a measurement
E103	Record length changed in between
E105	Unable to initialize measurement sequence
E107	Unable to enable and display requested signal source
E108	Reduce record length or number of measurements, sequencing stopped.
E109	Setup file is corrupted or there is another problem with recall
E151	Level too high for primary Vref High - Autoset Ref Level
E202	Upper range should be more than Lower range
E300	Oscilloscope signal acquisition failure due to PC memory limitation
E301	Sequencing was stopped; a timeout occurred while acquiring signal from the oscilloscope; check the signal or trigger level
E400	Measurement failed to complete successfully
E403	Invalid Pattern Length
E440	Signal is unstable. Clock Recovery failed.
E410	Number of edges are not sufficient for a measurement
E424	No edges or UI of required type found in waveform; check the Vref threshold or record length
E420	Could not complete RjDj separation; less than 50 pattern repeats detected
E425	RjDj separation accuracy not guaranteed, less than 100 pattern repeats detected
E417	Not enough Record Length for required analysis window
E408	Missing data file or crossing times file
E702	File not found; stopping sequencer
E703	I/O Error; stopping sequencer
E704	Unable to write worst case file; stopping sequencer
E800	File not found
E801	File already exists
E802	Cannot create the file
E803	Illegal character(s) in the file name
E804	Cannot create the directory
E805	Application .ini file successfully recalled, but the .set file was not recalled because it was not found or was corrupted
E806	Invalid CSV File/Incompatible CSV Files
E807	Invalid wfm File
E1001	Process did not complete; no signal
E1002	Process did not complete; signal exceeds top of scale
E1003	Process did not complete; signal exceeds bottom of scale
E1004	Process did not complete; signal removed
E1005	Process did not complete; failed to measure rising and falling edge speed
E1006	Process did not complete; Horizontal resolution at maximum

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