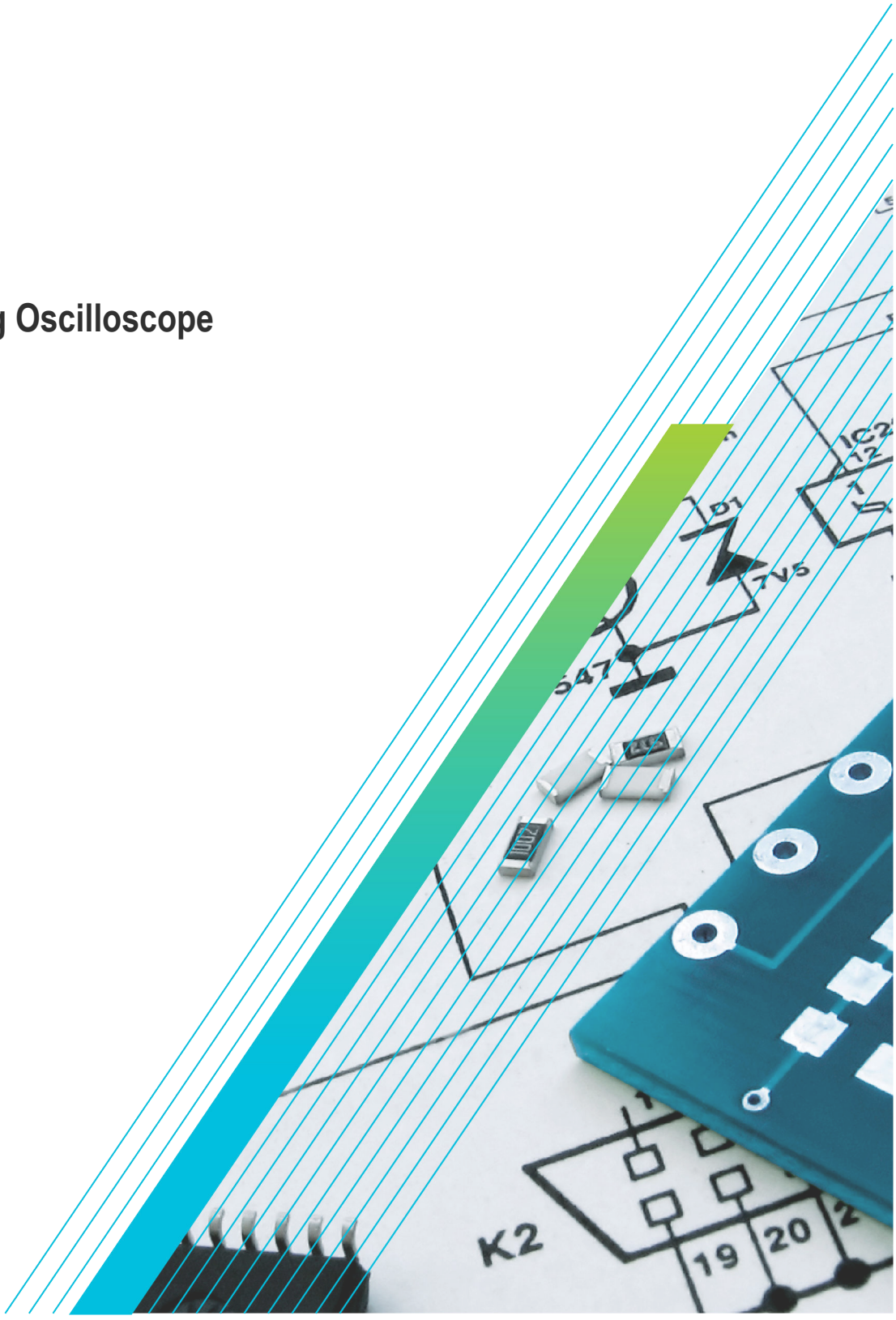
Tektronix®

8 Series Sampling Oscilloscope

Application Help



077-1607-03

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tek.com/register

077-1607-03 November 2023

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US

For product information, sales, service, and technical support visit *tek.com* to find contacts in your area. For warranty information visit *tek.com/warranty*.

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List of Tables

Welcome and key features

This document provides information on how to use the TSOVu™ software platform to operate your TSO 8 Series sampling oscilloscope. The 8 Series disaggregated platform provides you with a scalable, reconfigurable sampling oscilloscope with up to 4 channels of simultaneous acquisition (with two 2-channel modules installed). The 8 Series consists of:

- TSO820 mainframe: Sampling oscilloscope mainframe
- TSOVu software: Application installed on 64-bit Windows 10 PC, connects to a TSO820 mainframe
- TSO8C17, TSO8C18: Available optical modules to be installed in mainframe

The 8 Series is an equivalent time sampling oscilloscope suitable for use in a variety of test and measurement applications and systems. The mainframe must be configured with at least one of the above optical sampling modules. The 8 Series supports optical device Characterization depending on the plug-in module installed. Currently available TSO8C17/18 modules focus on devices at 56 GBd and 28 GBd, and bandwidths up to 30+ GHz with slow (Bessel-Thomson) roll-off past 50 GHz.

Key performance specifications

- Fast acquisition for long patterns and for eye diagrams, with up to 4 channels
- Module TSO8C17/18 supports Optical bandwidth past 30 GHz
- Single mode and multi-mode support, short and long wavelength optical testing
- Optical Reference Receiver (ORR) support for standard-mandated compliance testing

New system architecture

- Disaggregated architecture separates acquisition hardware and software analysis, allowing data to be streamed over Ethernet to any connected PC running TSOVu™ . Scale your analysis platforms to fit your needs and connect from anywhere on the network.
- Swap modules for various configuration.

Optical modules

- Accurate testing and characterization of short or long wave optical signals using the high sensitivity and low noise performance of the TSO8C17 or TSO8C18 modules.
- Optical Reference Receivers (ORR) to support specified requirements for standards mandated compliance testing.
- Calibrated extinction ratio measurements and variable correction ER measurements to ensure accuracy and repeatability.

Analysis with TSOVu™

- The TSOVu™ software platform runs independent of the oscilloscope mainframe on your PC to support both live and post-processing of acquired data.
- Offers comprehensive analysis of PAM4 optical signals. Includes support for eye diagrams, optical measurements such as TDECQ, and other standard measurements. Measurements on PAM2 / NRZ are also available.
- Measurement includes a plug-in interface. User-defined measurements are added directly to the TSOVu™ interface to increase flexibility and productivity.

High test throughput

- High sample acquisition rate at 300 kS/s per channel standard
- Sophisticated Programmatic Interface (PI) for automation environments to enable the highest test throughput. Each command supports full data synchronization. Wait 2 seconds after Clear Data to clear the waveform pipeline for long record lengths.

Get started

Start with the **Initial setup** topics for a quick start guide to initial signal acquisition and configuration. For an overview of the instrument user interface and controls, see the **Introduction to mainframe and modules** topic.

How to find help topics

This Help provides context-sensitive topics with information about the various features and capabilities to the 8 Series. When any badge or screen is active in TSOVu, select Help to view the topic related to that item.

You can also select **Help** from the TSOVu main menu bar to open the Help file. Select one of the following tabs to search for topics:

- **Contents**. Click any entry to display information on the subject.
- **Index**. Double-click an entry to display information on the subject; or, enter a keyword you are looking for (the list scrolls to that topic). Click Display to open the topic.
- **Search**. Type in the keyword you are looking for and then click List Topics. Every topic that contains the keyword will be displayed. Double-click a topic to open it, or select a topic, and then click Display to open it.

Need extra help?

If you cannot find the information that you are looking for in this Help, check the *Available product documentation* on page 12 topic for a list of other product related documents. You can also contact Tektronix technical support at *www.tek.com* (select Support from the main menu) for help with operating your instrument.

Product support and feedback

Tektronix values your feedback on our products. To help us serve you better, please send us your suggestions, ideas, or comments on your instrument, application, or product documentation.

Contact us through mail, telephone, or the website. See *Contact and Copyright* for more information or assistance with your product.

When you contact Tektronix Technical Support, please include the following information (be as specific as possible):

General information

- All instrument model numbers
- Hardware options, if any
- Modules used
- Your name, company, mailing address, phone number, FAX number
- Please indicate if you would like to be contacted by Tektronix about 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 and send the setup files for all the instruments used and the application
- If possible, save and send status messages text files
- If possible, save and send the waveform on which you are performing the measurement as a .wfm file

Available product documentation

The following documents for the TSO8 Series are available for download. For the most recent versions of these documents, visit the Tektronix web site at *www.tek.com*. You can find manuals by searching for the product name and selecting the manuals filter.

To learn about	Use this document
How to install and turn on the instrument software and hardware; read safety and compliance information	TSO8 Series installation and safety instructions Printed and shipped with the instrument. Also available online as a downloadable PDF. This document contains content in English, Japanese, and Simplified Chinese.
How to operate the instrument, take measurements, and navigate the UI.	TSO8 Series help Available in the TSOVu application (Help menu) and as a downloadable PDF at *www.tek.com*.
How to remotely control the instrument using GPIB programmatic commands. Syntax provided.	TSO8 Series programming manual
Mainframe and module specifications. Includes procedures to verify that the mainframe and modules meet warranted specifications.	TSO8 Series specifications and performance verification technical reference
Installing up to two mainframes, or one mainframe and one TCR801 clock recovery unit, into a standard instrument rack using the rackmount kit.	TSO8 Series rackmount kit instructions
How to declassify, sanitize, and clear memory devices in the instrument.	TSO8 Series declassification and security instructions

Available application notes and demo guides

Available for download on www.tek.com.

- **Taking IEEE 802.3 bs/cd optical measurements**

  This demonstration guide walks you through how to take IEEE 802.3 bs/cd optical measurements.

- **Physical Layer Tests of 100 Gb/s Communications Systems**

  This application note shows you how to prepare for compliance measurements on 100G standards including IEEE802.3ba/bj/bm and the tests for optical, electrical, or PAM4 transmitters and receivers that help diagnose noncompliant components and systems.

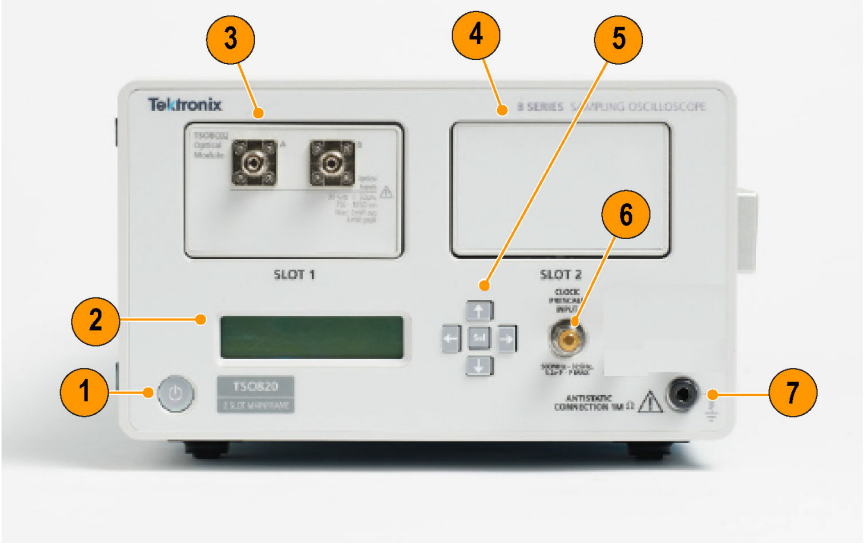
- **PAM4 Signaling in High Speed Serial Technology: Test, Analysis, and Debug**

  This application note presents information on testing PAM4 technology and approaches for validating PAM4 signals. It describes PAM4 technology for 50-400G applications, details of PAM4 signaling, outline of the important aspects of evaluating electrical and optical transmitters, and an explanation of methods for evaluating PAM4 receivers and more.

Introduction to mainframe and modules

Front panel

The front panel of your instrument gives you access to the following.



Number	Item	Description
1	Power button	Turn on/off power to instrument and installed modules. Blue indicates power is on. Amber indicates standby power is on.
2	LCD display	Shows MAC and IP addresses. Navigate using scroll/select buttons. 61 mm (W) x 12 mm (H) x 2x20 liquid crystal display (LCD).
3	Slot 1	Slot for module.
4	Slot 2	Slot for module.
5	Keypad buttons	Scroll/select buttons to navigate LCD display.
6	Clock Prescale Input	2.92 mm. 50 Ω, AC-coupled, divide-by-one/two/four/eight external trigger input port, enabling direct or prescaled triggering for clocks in the frequency range of 500MHz - 32 GHz.
7	Antistatic connection 1MΩ	A banana-jack antistatic connection of 1 MΩ to ground.

Rear panel

The rear panel of your instrument gives you access to the following.

Number	Item	Description
1	Security cable slot	Security cable can be attached to secure instrument to a physical location.
2	Module vents	Provides airflow for installed modules. There is one fan in each module slot.
3	USB port	USB 3.0
4	Mfg port	Not for use.
5	LAN port	10/100/1000 Gb Ethernet
6	Side feet	The side feet (4) protect the product when placed on its side. Do not use this equipment while turned on if the instrument is sitting on its side feet.
7	Power	Input voltage: 100 - 240 V, 115 V
		Frequency: 50 - 60 Hz, 400 Hz
		Power: 200 W max
8	Rear feet	The rear feet (4) are for preventing damage of connected cables or power cord if those are connected and the instrument is placed on its rear. Do not use this equipment while turned on if the instrument is sitting on its rear feet.
9	Handle	Carrying handle.

WARNING: Do not use this equipment while turned on if the instrument is sitting on its rear feet. This can prevent proper air flow.

Electrostatic discharge information

Read the electrostatic discharge (ESD) Read This First document that shipped with the mainframe and module for complete information about how to prevent damage to the modules and mainframe due to ESD. Following is some of that information.

CAUTION: To prevent damage to the instrument and electrical modules from electrostatic discharge (ESD), install 50 Ω terminations on the module connectors before removing them from the mainframe or when it is not in use.

CAUTION: Store modules in static-free containers. Whenever you move a module from one instrument to another, use a static-free container in which to transport it. This will help prevent damage due to ESD.

CAUTION: To prevent damage to the electrical module, discharge to ground any electrostatic charge that may be present on the center and outer conductors of cables before attaching a cable to a module.

CAUTION:

To prevent damage to the modules, always wear a grounded antistatic strap (provided with the instrument) when handling modules or making connections. Wear anti-static clothing and work at a static-free workstation when using the modules.

Module installation and removal

Procedure for installing and removing modules.

The TSO820 sampling oscilloscope allows for installation of the following two modules. For detailed specifications information, see the *TSO820, TSO8C17, TSO8C18 Sampling Oscilloscope and Modules Specifications and Performance Verification* manual available for download on www.tek.com.

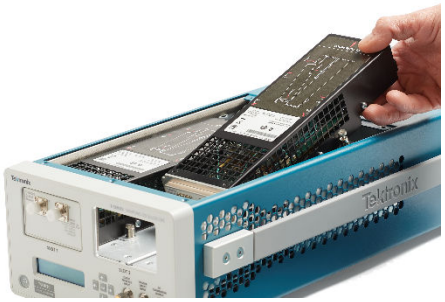
- TSO8C17, 1 channel 28 GBd / 53 GBd
- TSO8C18, 2 channel 28 GBd / 53 GBd

CAUTION: Only qualified personnel should perform the following procedures. Ensure power is off to the unit before installing or removing modules.

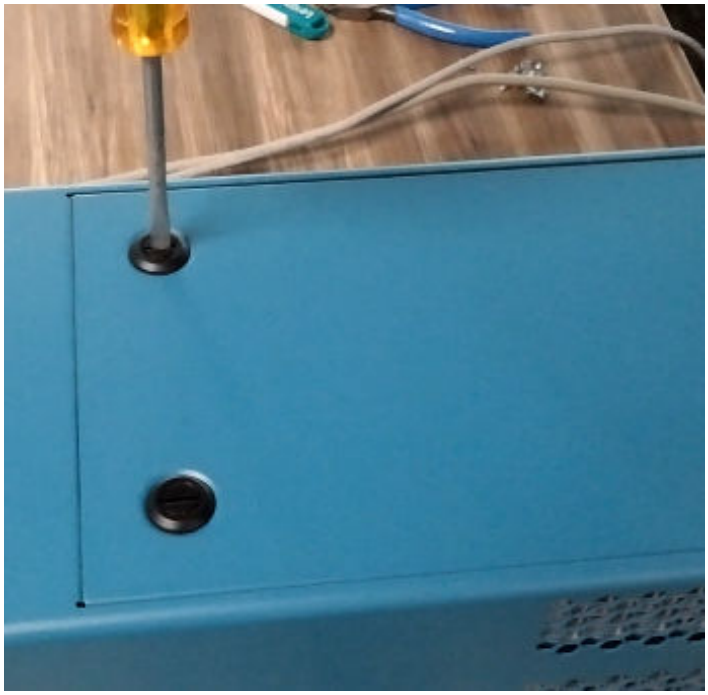
CAUTION: To prevent damage to the modules, wear a grounded antistatic strap when removing and installing modules and cables connected to modules.

Install a module

CAUTION: Do not hot swap modules. Installing or removing modules into/from the mainframe with the power on will damage the module. To avoid damage, turn off the power before installing or removing a module.



1. Power off the mainframe.
2. Use a flathead screw driver to loosen the two latch screws that secure the top cover to the mainframe and lift off the cover.



3. Notice that the mainframe ships with one filler module installed. This is a place holder that ensures proper air flow and temperature stability when only one module is installed.

   Before installing a module, remove the filler module from the side into which you want to insert the regular module by loosening the securing screws (they are captive and stay attached to the filler module).

   Never leave a module slot empty while the instrument is powered on and running. Always have a filler or regular modules installed to ensure proper air flow and temperature stability.
4. Insert the desired module into the mainframe at an angle, as shown.
5. Push down lightly on the rear of the module to seat it securely into the mainframe. You will hear a click when it seats fully.
6. Tighten the 4 attached screws to secure the module to the mainframe.
7. Replace the mainframe cover and use the driver again to turn the screw latches to secure it in place.

8. Before taking measurements, allow a minimum 30 minutes warmup and run a compensation.

Remove a module

CAUTION: Do not hot swap modules. Installing or removing modules into/from the mainframe with the power on will damage the module. To avoid damage, turn off the power before installing or removing a module.

1. Power off the mainframe.
2. Use a flathead screw driver to loosen the two latch screws that secure the top cover to the mainframe and lift off the cover.

3. Loosen the 4 screws that secure the module to the mainframe. These are captive screws and stay attached to the module.
4. Grasp the rear of the module (as noted on the module) and pull up at an angle to unseat the module.
5. Lift the module from the mainframe at an angle to remove it.
6. Before powering on the mainframe, ensure a filler module or module is installed in the side from which you removed the module.

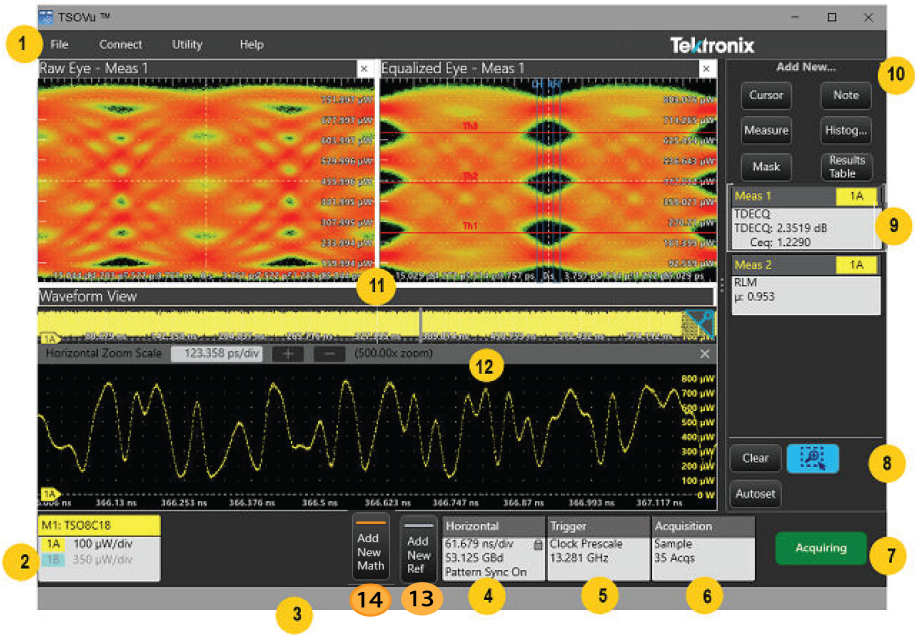
   The mainframe ships with one filler module installed. This is a place holder that ensures proper air flow and temperature stability when only one or module is installed.

   Never leave a module slot empty while the instrument is powered on and running. Always have a filler or regular modules installed to ensure proper air flow and temperature stability.
7. Replace the mainframe cover and turn the screw latches to secure it in place.
8. Before taking measurements, allow a minimum 30 minutes warmup and run a compensation.

TSOVu user interface

The TSOVu application contains waveforms and plots, measurement readouts, and controls to access all oscilloscope functions.

TSOVu display and navigation



The areas of the display as numbered in the previous image are as follows.

1

The **Menu bar** allows you access the following these menus and functions.

Menu	Options	Description
File	Recall	Recall setup, waveform, or session files.
	Save	Save the current file.
	Save As	**Waveform** files (.wfm, .csv): a waveform data file includes the acquired waveform data. You can select the file type, source, location, and if you want to auto increment the file name. Checking the Auto Increment File Name lets you save sequential files without needing to manually rename them each time. The count number is added to the end of the file name. The Count defaults to 000 if there are no files at the specified location and file name that already use incremented file names. If there are files at the save location that already use the specified file name, and have already been saved using count increments, the Count field shows the next count value that will be added to the file name when the file is saved. **Setup** files (.set): a setup file includes all instrument settings and user configured analysis. This allows you to recreate the current setup on another compatible instrument with newly acquired data. You can select the file name, location, if you want to auto increment the file name, and if you want to include all references. **Session** files (.tss): a session file is a zipped file that includes a setup file and all acquired waveform data. This allows you to move analysis activities offline. You can select the file name, location, and if you want to auto increment the file name. **Reports** files (.pdf, .html): a report file can be saved as a full report or summary. The full report includes all measurement configuration data in addition to results. The summary report only includes results. You can select the file name, location, and if you want to auto increment the file name. (You can read more about these options in the *Save As* topic.)
	Default setup	Stops acquisition and returns the application to its default setup.
	Exit	Closes the TSOVu application.
Connect	System Configuration	Allows you to connect to the TSO820 instrument by entering the IP address or host name. Once connected, this screen shows the serial numbers of the connected mainframe and module(s).

Table continued…

Menu	Options	Description
Utility	User Preferences	Allows you to adjust the Autoset.
	Calibration	Display instrument and module last calibration date, temperature, and pass/fail status.
	Compensation	Compensation controls allow you to run compensation on the mainframe and modules.
	Diagnostics	Shows the status of the power-on self test and allows you to export log files.
	Disable Error Pop-ups	Click to check or uncheck this menu item. Check it to disable error pop-up messages from appearing on the display. Uncheck to enable them. When disabled, this icon shows on the status bar: 
Help	Help	Opens this navigable Help file.
	About	View installed options, licenses, and SW versions. Install new licenses using the About window.

2

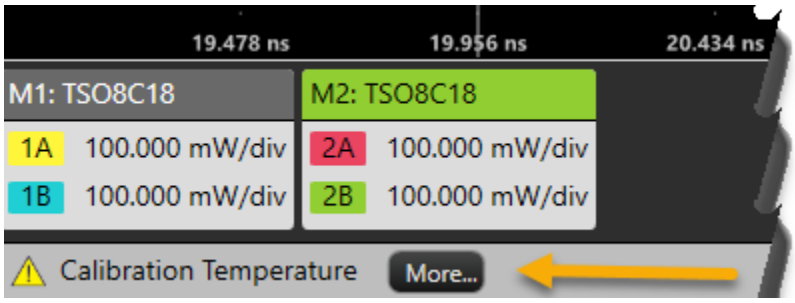
Channel badges provide access to the vertical settings, optical settings, persistence, deskew, and external attenuation for that specific channel.

See the *Vertical configuration* topic for details.

3

Status bar. Error messages will appear here. You can also disable error message pop-ups and a disabled icon will appear on the status bar indicating that pop-ups are disabled.

Some badges display errors on the badge. TSOVu shows warnings and messages in the bar at the very bottom of the application screen. Click More for the error details.



4

Horizontal configuration badge. A **locked** padlock icon idicates that Pattern Sync is On. An **unlocked** padlock icon indicates Pattern Sync is Off. Double click the Horizontal badge to access the configuration menu.

See the *Horizontal configuration menu* topic for details.

5

Trigger configuration badge. Double click to access the trigger configuration menu. See the *Trigger configuration menu* topic for details.

6

Acquisition configuration badge. Double click to access the acquisition configuration menu. See the *Acquisition configuration menu* topic for details.

7

Click button to start and stop signal acquisition. When there is no instrument connected to TSOVu, this button shows "Offline".

8

Clear button resets acquisitions to zero.

Autoset button positions the waveform vertically.

Draw A Box for zoom or histogram button is a dual purpose button that allows you to define zoom areas and histograms. See the following topics for details: *Draw a box for zoom or histogram*, *Add a histogram*, and *Zoom elements*.

9

Measurement and histogram badges. These badges appear here below the Add New... panel. Double click a badge for related configuration options. See the *Add measurement* and *Add a histogram* topics for details.

10

Use the buttons here to add measurements, masks, cursors, notes on the display, histograms, and results tables. See these topics for more details: *Add measurement*, *Add a mask*, *Add cursors*, *Add a note to a view*, *Add a histogram*, and *Add Results Table*.

11

Waveform view area. See the *Waveform View configuration* topic for details.

12

Zoom view and controls when zoom is defined and active. See the *Zoom elements* topic for details.

13

Add New Ref icon adds the new reference waveform.

13

Add New Math icon adds the math waveform.

SW and FW Installation and network connection

Software installation and requirements

The following software is available for the 8 Series. The TSOVu base software enables mainframe connectivity and operation, cursors, results tables, and other features. The base software package includes the pulse and NRZ Eye measurements plug-ins. Other plug-ins are available for purchase and download separately.

PC system requirements

Install the software on a PC with the following specifications.

Item	Requirement
Operating system	Microsoft® Windows 10, 64 Bit
CPU	Recommended: AMD Ryzen 7 or Intel i7 class CPU with 4 core / 8 thread Minimum: AMD Ryzen 5 or Intel i5 with hyperthreading *Note that the time to calculate the TDECQ result is inversely proportionate to the clock speed.*
Memory	16 Gbytes recommended
Disk	256 GBytes SSD or more
Networking	1 Gigabit Ethernet wired

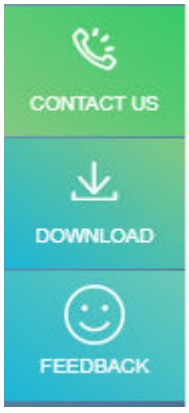
Other software requirements

You must install MATLAB® Compiler Runtime version 9.3 on to the host PC. Go to MathWorks (*ch.mathworks.com/products/compiler/matlab-runtime.html*) to download and install it.

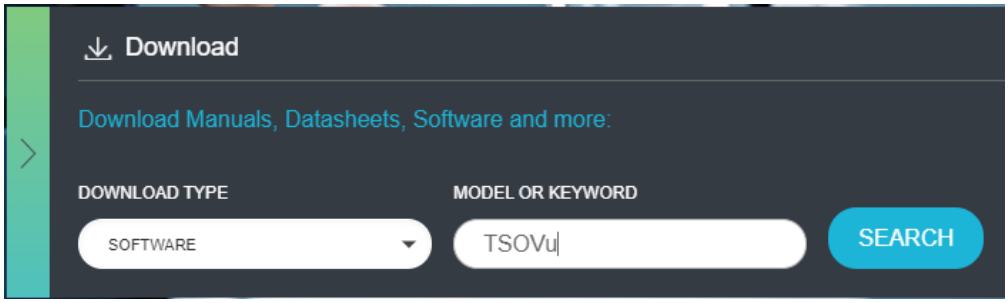
Install TSOVu software

You must install the base software before installing any plug-ins. The downloadable package include the base software and the Pulse and PAM4 measurement plug-ins. The PAM4 plug-in is optional and requires a purchased license to enable it. Install the software as follows.

1. Go to www.tek.com and click the Download icon.



2. Select Software, enter TSOVu, and click Search.



3. Find the most recent version of the TSOVu base software and download the package to the PC you can use to connect with and control the mainframe.
4. Double click the .exe file to launch the install wizard. Follow the instructions to install the software. Your PC with automatically restart when the installation is complete.
5. A TSOVu icon install on the Windows Desktop. Click to launch the application.

The following items are installed with the base software package:

- **TSOVu™:** The application that runs on your PC and is the analysis engine and UI of the mainframe and modules. It is required to connect to a mainframe.
- **Pulse measurement plug-in:** This plug-in comes standard with the base installation package and provides pulse measurement capabilities.
- **PAM4 measurement plug-in:** Use of this plug-in is optional. To enable it, you must purchase a license. FFE in math is available only if you purchase PAM4 measurement plug-in.
- **NRZ Eye measurement plug-in:** This plug-in comes standard with the base installation package and provides NRZ Eye measurement capabilities.
- **TSO8 firmware**
- **TekVISA™:** A library of industry-standard compliant software components, organized according to the standard VISA model established by the VXIplug&play Systems Alliance. Use TekVISA software to write interoperable instrument drivers to handle communicating between software applications and your instrument.

Install optional plug-ins

For a full list of optional plug-ins, see the *Software licenses and options* topic in the Help or view the TSO 8 Series product datasheet on *www.tek.com*. Due to the plug-in architecture of TSOVu, measurement plug-ins must be installed prior to TSOVu software launch. To purchase and download optional plug-ins, do the following.

1. Navigate to your TekAMS system account and purchase the desired plug-in(s).
2. Run the plug-in installer with administrative privileges and walk through the installation procedure for each measurement plug-in.
3. Re-launch TSOVu.
4. Install the new plug-in license(s) from **Help** > **About** in the TSOVu application.

   (See the Software licenses and options topic next for more information.)

See these TSOVu Help topics for more information:

Software licenses and options

Connect to network and TSOVu

Firmware installation and requirements

Run signal path compensation (SPC)

Software licenses and options

The TSOVu application is made up of the base software, Pulse measurement plug-in, and any additionally purchased plug-in software (licensed optional software). The base package enables mainframe connectivity and operation, cursors, results tables, pulse measurements, and other baseline features. It is free and available for download at www.tek.com\downloads.

To install a license in TSOVu

1. Select **Help** > **About** from the TSOVu main menu bar to view installed options and system information.
2. Click the **Install License** button under the **Installed Options** table.
3. Select the appropriate install location:
   a. TSOVu: The license will install on the PC. Anyone using that PC will have access to the license for any instruments to which it connects.
   b. Instrument: The license will install on the selected instrument. Any PC connecting to that instrument will have access to license.
4. Click the **Browse** button to open a file explorer window and navigate to the location to which you saved the license file from the Tek AMS system.
5. Click **Open**.
6. Click the **Install** button.

To copy system information (TSOVu SW version, host ID, plug-in versions)

1. Select **Help** > **About** from the TSOVu main menu bar to view installed options and system information.
2. Click the **Copy System Information** button under the **System Information** table.
3. The information from the table has been copied to a clipboard. You can now paste it into a document of your choice.

Plug-in options

The following optional plug-ins are available to add to the TSOVu base software. These plug-ins enable new capabilities. For the most updated list of options, please view the TSO 8 Series datasheet at *www.tek.com*.

Plug-in description	Option	License
Measurements for PAM4 optical signals. Enables TDECQ equalization and analysis.	TSO8SW-NLP-PAM4-O	License; PAM4 Optical Measurements; Node-Locked Perpetual
	TSO8SW-FLP-PAM4-O	License; PAM4 Optical Measurements; Floating Perpetual
	TSO8SW-NL1-PAM4-O	License; PAM4 Optical Measurements; Node-Locked 1-Year subscription
	TSO8SW-NL3-PAM4-O	License; PAM4 Optical Measurements; Node-Locked 3-Year subscription
	TSO8SW-FL1-PAM4-O	License; PAM4 Optical Measurements; Floating 1-Year subscription
	TSO8SW-FL3-PAM4-O	License; PAM4 Optical Measurements; Floating 3-Year subscription

License options

License types

- **Perpetual**: This license does not expire, but updates and support are available for a set time period. Support can be renewed for an annual fee. When that annual subscription of the perpetual license expires, the software will be usable but frozen to the last released version before the expiration date.
- **Subscription**: This license provides use, updates, and support of the software throughout the term of the license. When the license expires, those software features will no longer work.

License terms

- **Node-locked**: License assigned to a specific instrument/PC. It cannot be transferred to any other instrument/PC.
- **Floating**: License can be transferred from one instrument/PC to another. It can only be used on one instrument/PC at a time.

See these topics for more information:

Software installation and requirements

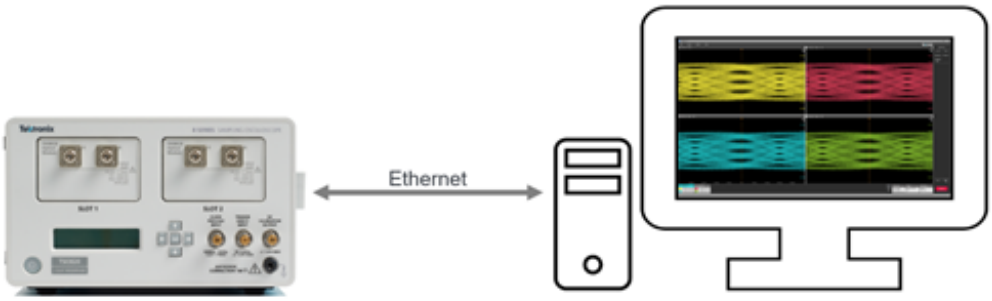
Connect to network and TSOVu

Available product documentation

Connect the mainframe to the network and TSOVu

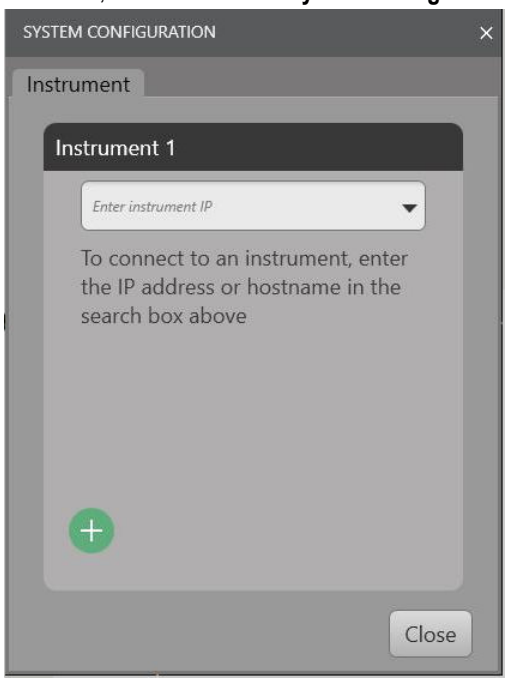
To control the instrument with the TSOVu application, the instrument must be made available to the same LAN as the PC hosting TSOVu. The oscilloscope has a standard Ethernet (RJ-45) interface for connecting to a network.

Use the included CAT6 Ethernet cable. If you use a different type of Ethernet cable, it must be a CAT6 or faster cable and it should be consistent with the network speed you require.

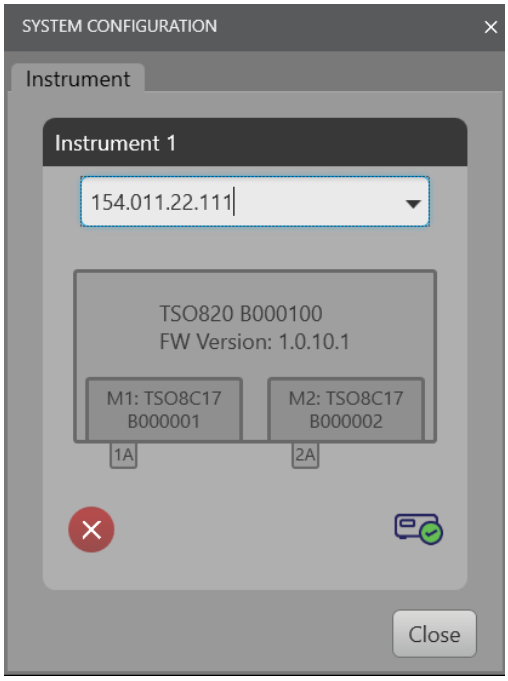


1. Connect the CAT6 Ethernet cable to the LAN connector on the rear panel of the instrument.
2. Plug in the instrument power cord to the instrument and then a power source. The instrument will power on automatically.
3. Press the right/left arrow keys on the mainframe front panel until you see IP address on the LCD display. Note the IP address. Only DHCP addresses are supported.
4. Launch TSOVu.

5. In TSOVu, select **Connect** > **System Configuration** and enter the previously noted IP address.



6. Press the green + button (or the Enter key on a keyboard) and the instrument will connect. Mainframe and modules names and firmware versions will appear.



Next steps:

See the *Run signal path compensation (SPC)* topic in the Help for instructions for running a SPC before connecting a signal to view.

Firmware installation and requirements

Keep the mainframe firmware updated to ensure the latest features are available and the instrument is taking the most accurate measurements. You can do this by downloading the latest firmware from www.tek.com and installing it yourself. Module firmware can only be updated by the Tektronix service organization.

Before you begin

Determine the current version of firmware installed on the instrument using the front panel LCD screen menu.

Procedure

1. Download the instrument firmware to a USB drive:
   a) Navigate to *C:\Program Files\Tektronix\TSOVu_Firmware* to locate the firmware that was downloaded to your PC when you installed the TSOVu installation package.
   b) If the available firmware version is newer than what is on your instrument, select that file.
   c) Copy the .img file to a USB memory device.
2. Install firmware on instrument:
   a) Power on the instrument and wait for the instrument to fully boot up.
   b) Insert the USB flash drive into the USB port on the instrument rear panel.
   c) Cycle the power on the mainframe to begin the update process. The process status will appear on the front panel LCD until finished.
   d) The instrument will update the firmware and power on immediately following installation completion.
   e) Remove the USB stick after the instrument has powered on successfully.

   Note: Do not power off the instrument or remove the USB flash drive until the instrument finishes installing the firmware. Remove the USB drive before powering on the instrument.
3. Confirm that the firmware was updated:
   a) Check the Firmware version in the Firmware menu on the front panel LCD. It should now show the updated version.

Results

If an error occurs, try to reformat your USB drive. Navigate to **Computer Management** > **Disk Management** on your PC to repartition the USB drive with the default allocation unit size.

Remote firmware upgrade

Keep the firmware on your instrument up to date with the firmware on your computer.

About this task

When the firmware version installed on your computer is more recent than the version installed on the instrument you remote into, you are prompted to upgrade the instrument firmware.

Before you begin

Check the firmware version installed on your computer is up to date. Your firmware default location is *C:\Program Files\Tektronix\TSOVu_Firmware*.

Procedure

1. Connect to the instrument.

2. A firmware upgrade window is automatically displayed.
   - Select upgrade to begin the firmware upgrade process on the connected instrument.
   - Select skip to continue the connection process without the upgrade.

Results

When upgrade is selected, the firmware upgrade process begins and the instrument is upgraded to the firmware image located at the default firmware location on your computer. The upgrade status is indicated by a progress window with the message *Firmware upgrade in progress*. When the upgrade process is complete, the instrument connection shall automatically continue.

Initial setup

Run signal path compensation (SPC)

Run signal path compensation of the mainframe and optical modules at regular intervals for the best measurement accuracy. You should run a compensation whenever the ambient (room) temperature has changed by more than 5 °C (9 °F),

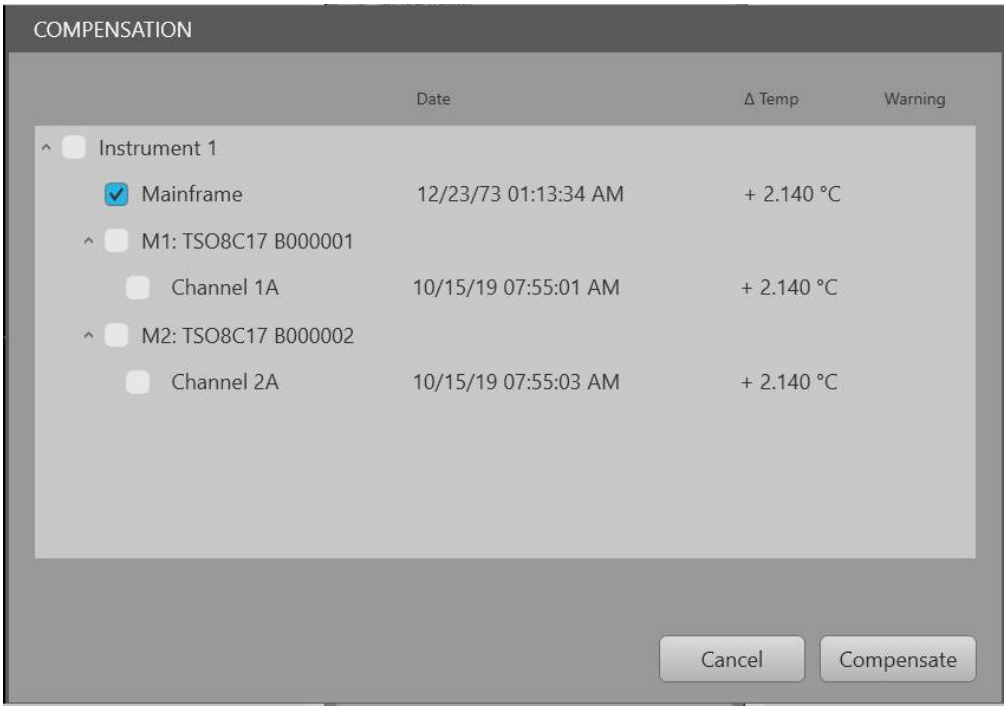
About this task

Compensation corrects DC inaccuracies caused by temperature variations. Failure to run a compensation on a regular basis may result in the instrument not meeting warranted performance levels at low volts per division settings.

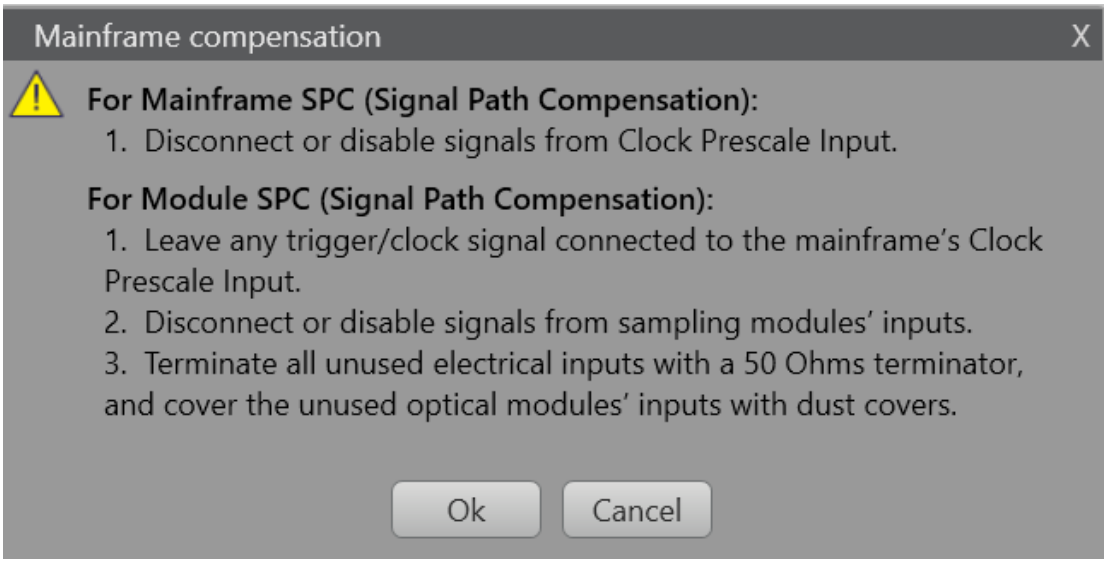
There are two nonvolatile compensation memory areas in the mainframe and for each channel within a sampling module, referred to as Factory and User compensation memories. Also, there is a volatile, in-use memory version of all compensation data, referred to as the run-time compensation memory, that holds the compensation data that is actually used during operation of the instrument. On power-on, the instrument automatically retrieves the compensation data stored in the nonvolatile User memories into the volatile run-time memory version.

Procedure

1. **Run the mainframe SPC**
   a) Terminate the Clock/prescaler input with a 50 Ω terminator.
   b) Power on and warm up the instrument for at least 20 minutes.
   c) Ensure that the instrument is connected to TSOVu. In TSOVu, click **Utility > Compensation** and check the Mainframe box.
   The Compensation window opens.



   d) Click the **Compensate** button.
   A dialog window appears. Read the information in the dialog and ensure signals are disconnected/disabled and trigger signals are handled appropriately.



e) Click the **OK** button.
The SPC will run. This may take several minutes. The Compensation window shows you the results of the test. If the instrument passed, a message appears in the lower left portion of the window stating compensation was successful and the timestamp will be updated.

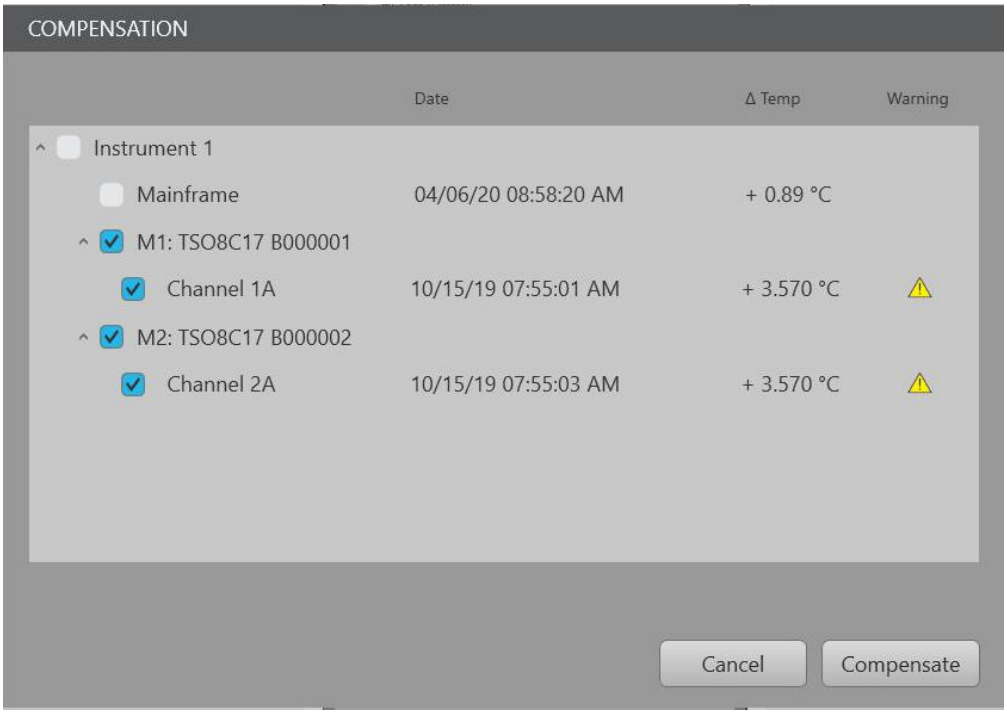
If the SPC fails, a pop-up error dialog will appear. Make sure that all cables are disconnected and run the SPC again. If the SPC still fails, contact Tektronix Customer Support.

2. Run the module(s) SPC

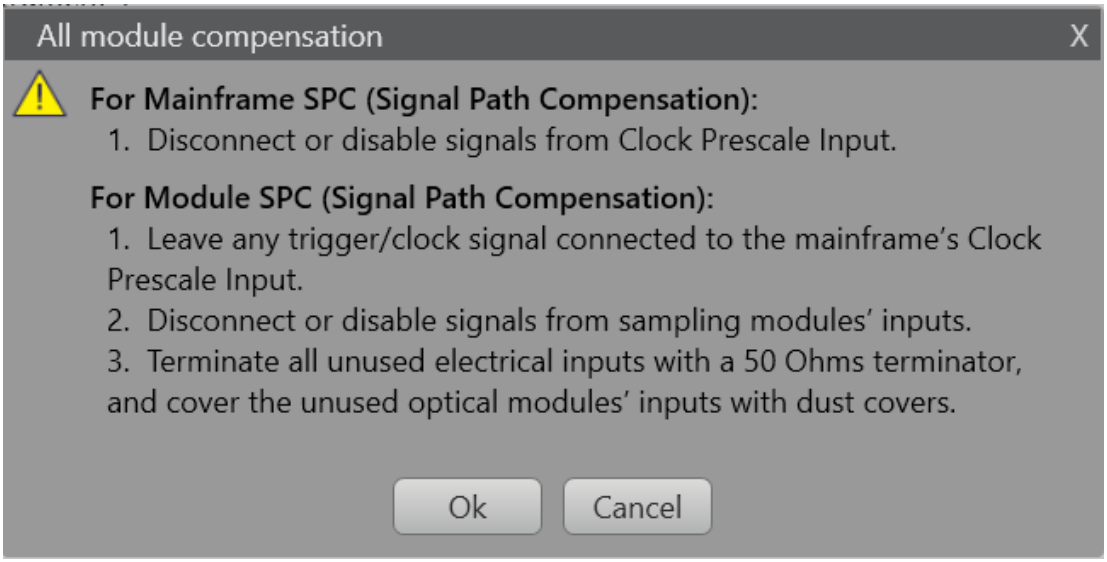
a) Remove the 50 Ω terminator from the Clock/prescaler input.

b) Connect a clock signal to the Clock/prescaler input.

c) In TSOVu, click **Utility > Compensation** and check the Modules boxes.
This will check all of the channels under the selected modules.



d) Click the **Compensate** button.
A dialog window appears. Read the information in the dialog and ensure that the mainframe SPC was valid and trigger signals are handled appropriately.



e) Click the **OK** button.
The SPC will run. This may take several minutes. The Compensation window shows you the results of the test. If the modules passed, the timestamp will be updated. If the SPC fails, a pop-up error dialog will appear. Make sure that the clock signal is properly connected and run the SPC again. If the SPC still fails, contact Tektronix Customer Support.

f) When the compensation process finishes, click the **Cancel** button to close the Compensation window.

Dark-level compensation

Dark-level compensation maximizes the accuracy of the extinction ratio and other optical automatic measurements.

If Dark Level Compensation is needed, run a module *compensation*.

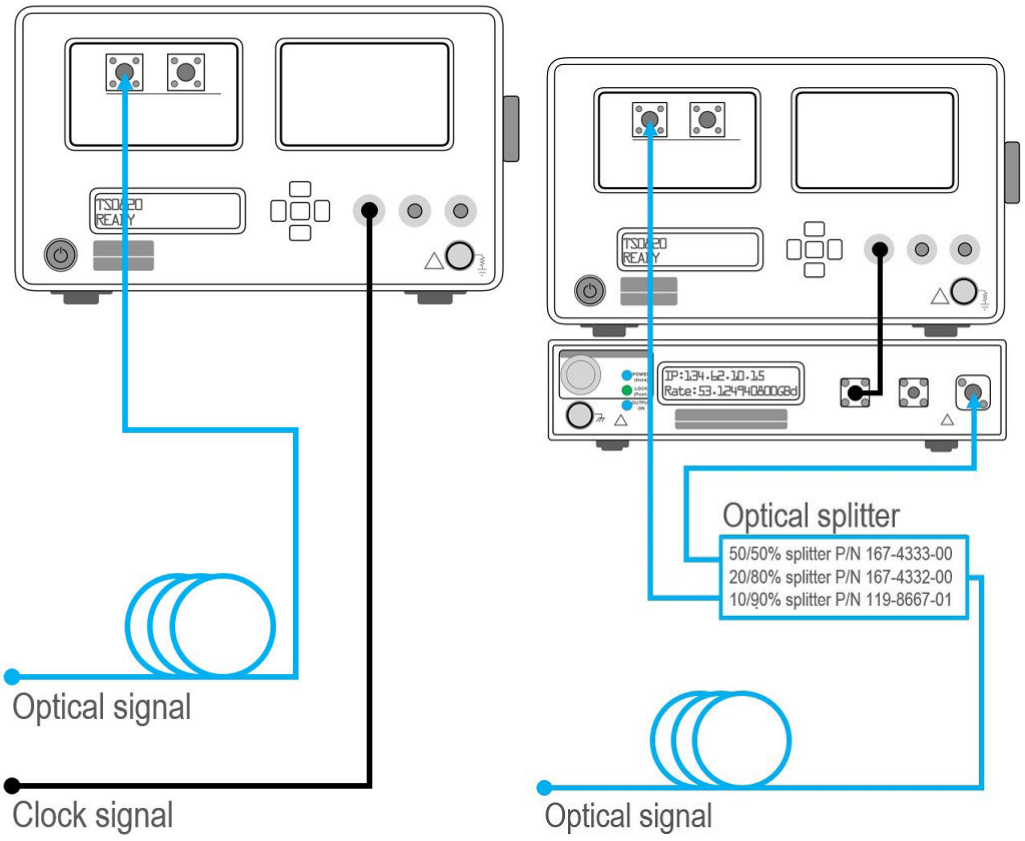
Dark-level compensation maximizes the accuracy of the extinction ratio and other optical automatic measurements. Dark-level compensation is not saved and is only valid for the selected bandwidth or filter path and the internal optical power meter.

Connect a signal

After running compensation, connect an optical signal, such as a transceiver signal, to the module input to verify you can see a signal.

After running compensation of the mainframe and modules, connect an optical signal, such as a transceiver signal, to the module input to verify you can see a signal.

There are various ways to connect signals, depending on your application. Here are two examples.



See these topics for more information:

Run signal path compensation (SPC)

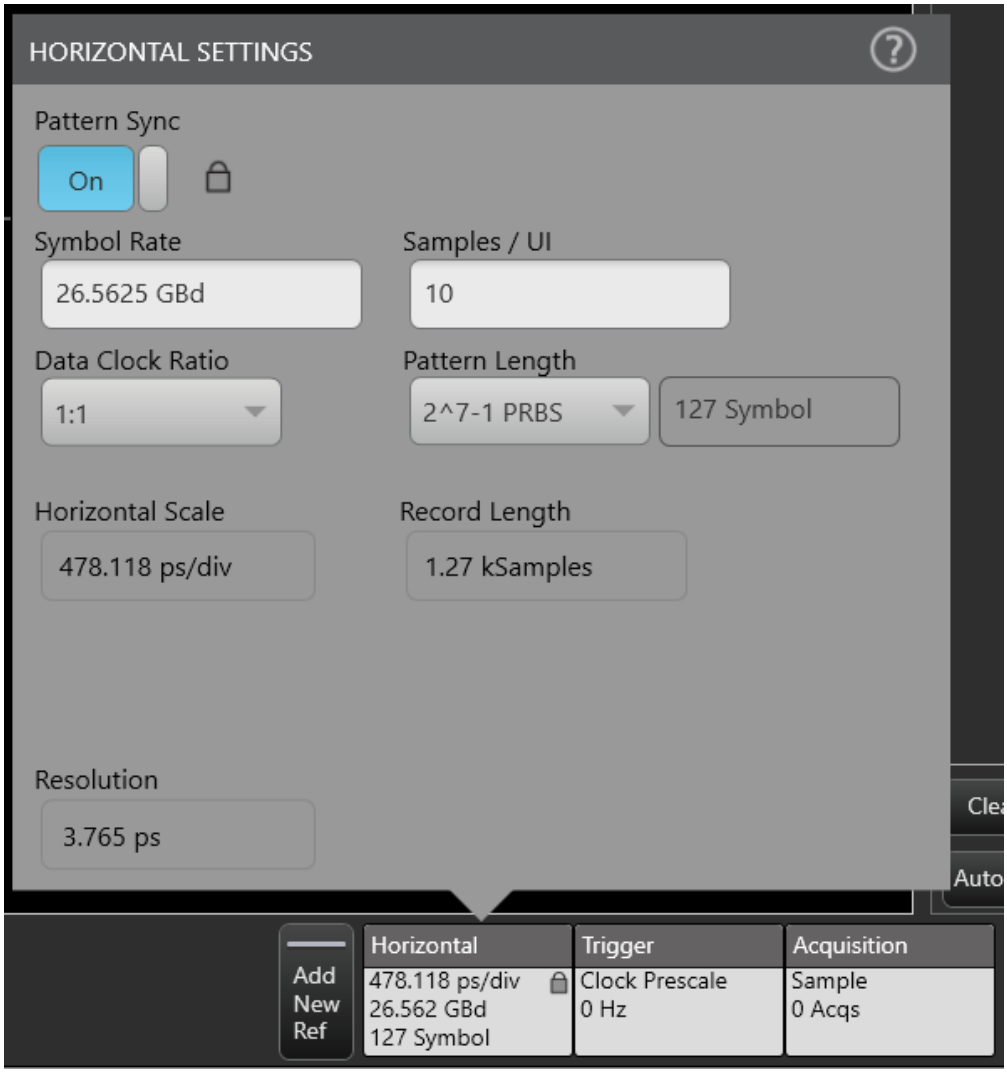
Horizontal configuration

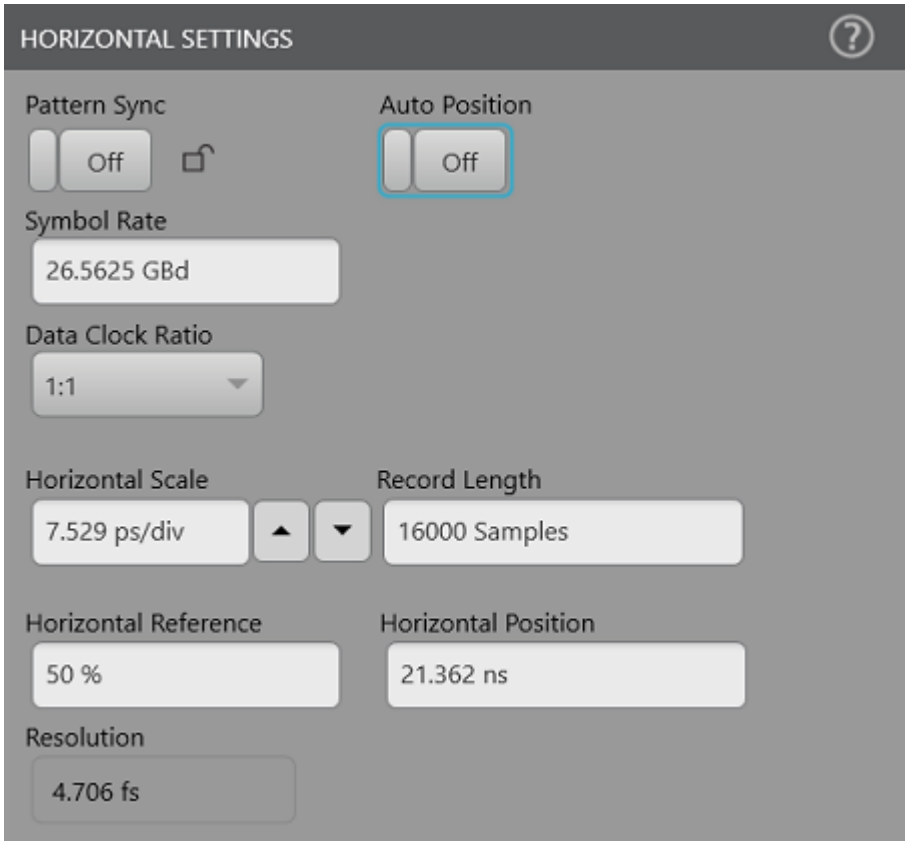
Vertical configuration

Horizontal configuration

Use the Horizontal Settings menu to select the acquisition mode (Pattern Sync), Symbol Rate, Pattern Length, and related parameters.

To open the **Horizontal Settings** menu, double-click the **Horizontal** badge. Fields vary when Pattern Sync is set to On and Off.


HORIZONTAL SETTINGS
Pattern Sync
On
Symbol Rate
26.5625 GBd
Samples / UI
10
Data Clock Ratio
1:1
Pattern Length
2^7-1 PRBS
127 Symbol
Horizontal Scale
478.118 ps/div
Record Length
1.27 kSamples
Resolution
3.765 ps
Add New Ref
Horizontal
478.118 ps/div
26.562 GBd
127 Symbol
Trigger
Clock Prescale
0 Hz
Acquisition
Sample
0 Acqs



Ensure that the horizontal parameters match the input signal and that horizontal parameters are set accurately.

Horizontal Settings menu fields and controls

Field or control	Description
Pattern Sync	Toggle to turn pattern synchronization on and off. On is Pattern Mode acquisition. Off is eye mode acquisition. The padlock icon appears locked when Pattern Sync in On. It appears unlocked when Pattern Sync is Off. This icon also appears on the Horizontal badge.
Auto Position *(Only available when Pattern Sync is Off)*	Toggle to set automatic position on and off. When set to On, the record length and horizontal scale, reference, and position are automatically set. When set to Off, you can manually set the record length and horizontal scale, reference, and position.
Symbol Rate	Symbol Rate of the input signal.
Samples / UI *(Only available when Pattern Sync is On)*	Pattern Sync must be On for this field to be active. You can set the samples per unit interval by typing in this field.
Data Clock Ratio	Sets the ratio of the input signal data rate to the clock signal frequency applied through the CLOCK PRESCALE INPUT connector.

Table continued…

Field or control	Description
Pattern Length *(Only available when Pattern Sync is On)*	Set the Pattern Length by selecting the pattern type from the drop-down list. Selecting User Defined allows you to set any pattern length value.
Horizontal Scale	With Pattern Sync on, this is a read only field that shows the current horizontal scale, measured as s/div. With Pattern Sync off, you can change the value by typing in this field.
Record Length	With Pattern Sync on, this is a read only field showing the number of samples to collect given the current settings. With Pattern Sync off, you can change the value by typing in this field within the valid range of 1000 to 100,000.
Horizontal Reference *(Only available when Pattern Sync is Off)*	Shows the point around which channel waveforms expand and contract horizontally on screen as you change the Horizontal Scale control.
Horizontal Position *(Only available when Pattern Sync is Off)*	The horizontal units are time. The horizontal position is the time between trigger and the first point in the record. When horizontal scale changes, horizontal position automatically changes to keep the horizontal reference at the same point in time in the acquired waveform. If this results in a position value that is not within the valid range, the position value moves to the nearest valid value and the horizontal reference adjusts to stay at the same point in time in the acquired waveform.
Resolution	This read only field shows the time between two samples (s).

Vertical configuration

Use the vertical configuration menu to set parameters such as vertical scale, wavelength, filter, and persistence.

Double-click on a channel badge (M1 or M2) to access the vertical configuration menu for the selected channel tab. This menu provides access to the following channel settings.

- Vertical Settings
- Optical Settings
- Persistence
- Other (deskew and external attenuation)

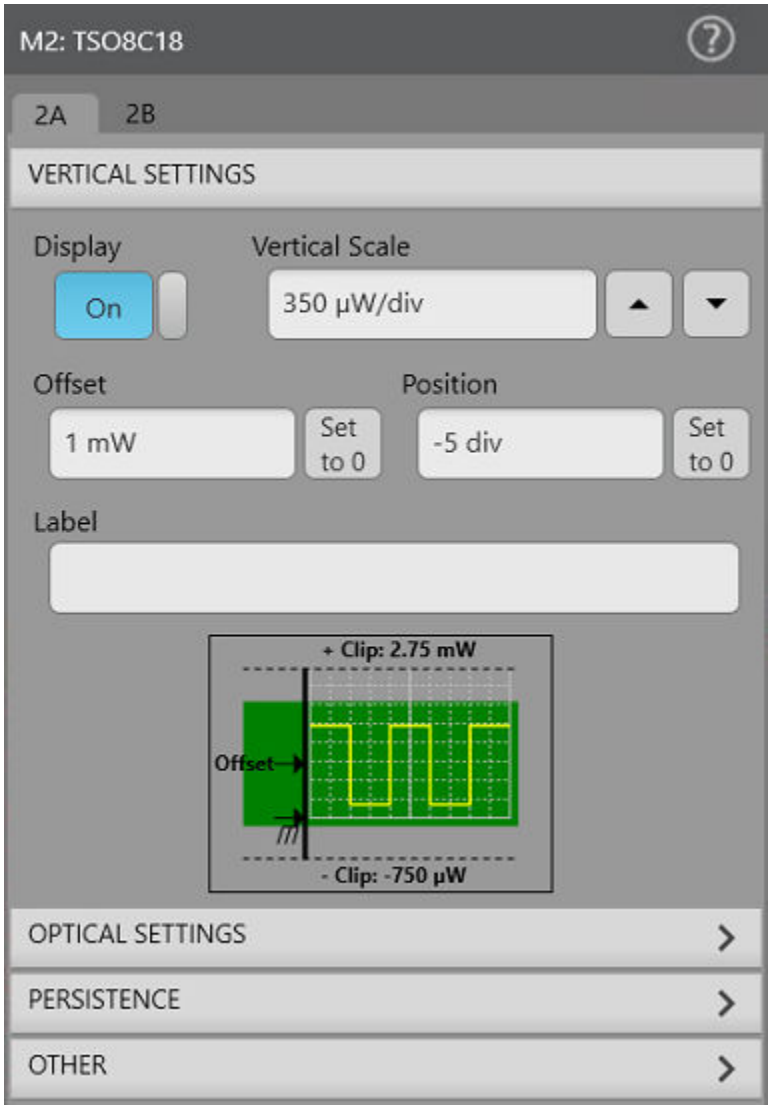


Table 1: Vertical Settings

Field or control	Description
Display	Toggles the selected channel On and Off.
Vertical Scale	Set the vertical scale. Click the up and down arrows to change the scale or type in the value in the field.
Offset	Sets the channel signal vertical offset. Type the value that you want in the field. Click Set to 0 to set the vertical offset to 0 Watts. For more accurate measurements, set this to 200 µW for small signals (signals with Average Optical Power (AOP) < 500 uW). You will never need to set the offset to < 400 µW on the TSO8C17 and TSO8C18 optical modules. For signals > 400 µW, we recommend setting the vertical offset to within 100 µW of the signal's AOP, which is particularly important for the TDECQ measurement.

Table continued…

Field or control	Description
Position	Sets the vertical position. Type the value that you want in the field. Click Set to 0 to set the Position to 0 divisions.
Label	Type in the field to add a label for the selected channel waveform. To modify an existing label, double click on the label in the display to open the Label edit window.
Vertical thumbnail	The Vertical thumbnail displays the Offset and Clip behavior, including: • Clip Lines with +Clip and -Clip values as per Offset settings • Green area representing optimal acquisition region • Offset indicator • Graticule drawn according to the Vertical Position, Scale, and Offset settings • Ground indicator drawn according to the Vertical Position and Offset settings • Waveform Trace drawn according to the Vertical Position, Scale and Offset settings

Table 2: Optical Settings

Field or control	Description
Wavelength	Select a wavelength from the drop-down menu.
Config User Wavelength	Specify a wavelength outside of factory calibrated wavelength selections.
AOP	Average Optical Power of the signal. Select dBm or Watts.
Filter Type	You can select either a Hardware Filter (attach to the instrument) or a BWE Filter (Bandwidth Enhancement).
Signal Type *(Only available when BWE Filter is selected)*	Select PAM4 or NRZ.
BW Electrical	Select the appropriate bandwidth. This option depends on the data rate of the signal. BW Electrical contains user defined option, where you can enter any bandwidth between 7.5 GHz to 35 GHz. When the BWE bandwidth is lesser than the symbol rate, a warning message is displayed in the status bar.
Filter Details	Read only text shows you the filter details.

Table 3: Persistence

Field or control	Description
Persist Data	Toggle persistence data on or off. Data is cleared either by an explicit clear action or by any setting change that controls acquisition parameters.

Table continued…

Field or control	Description
Persistence *(Available only when Pattern Sync is off.)*	**Infinite**: Accumulates the data record points until you change an acquisition parameter or explicitly clear the data, causing the display to be erased. Waveform data builds up as new data records acquire. **Variable**: Stores and displays accumulated data in the specified database until the user-specified waveform count is surpassed. Each waveform accumulated beyond the count removes the oldest waveform data in the database. Enter the waveform count in the field when this option is selected.
Color Grading	Use the drop-down menu to choose the color for the persistence data.

Table 4: Other

Field or control	Description
Deskew	Use the Deskew and field to set the values to compensate for skew (signal delay) between channels. Type in the deskew value, or click Set to Zero to reset the value to zero seconds.
External Attenuation	Use this control to set a value matching the amount of attenuation applied externally, before the signal enters the sampling module input. You can select the unit of "External Attenuation" from a radio button type control. The unit selections for External Attenuation are "dB" or "Linear".

Vertical channel deskew

Use the Deskew field in the Vertical settings menu to set the values to compensate for skew (signal delay) between channels.

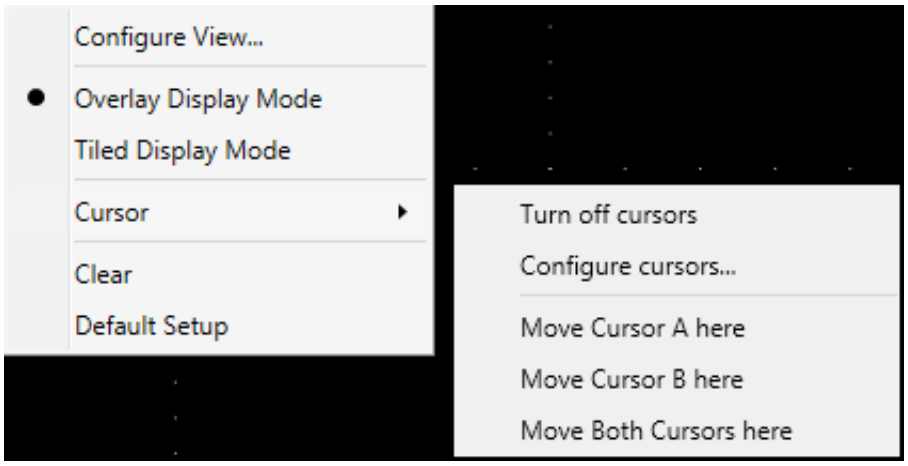
Critical timing measurements on multiple channels require that all channels be deskewed to compensate for signal timing differences between channels.

Adjust deskew to add an independent, channel-based delay time to the horizontal position. (For the left position indicator, this is the common trigger point to the first sample taken for each channel). Deskew is applied to the strobe drive and is common to both channels in the module. It is therefore necessary to operate in a double-pass acquire on alternate triggers (whenever the deskew values differ within channels in a module) to satisfy the requested deskew difference.

Waveform View configuration

Double click anywhere inside the Waveform View graph to open the Waveform View configuration window.

You can also right click anywhere in the display for access to this menu and its functions.



Control	Options	Description
Display Mode	Overlay	Layers waveforms from active channels on top of each other.
	Tiled	Shows each waveform in a separate segment of the waveform view display.

Table continued…

Control	Options	Description
Interpolation	Sin(x)/x	Calculates record points along a curve between the actual acquired samples. This form of interpolation is useful when acquiring rounded waveforms such as sine waves. It is good for general-purpose uses, but may introduce overshoot or undershoot in signals with fast rise times. This interpolation is also useful for looking at high-frequency signals, especially where the frequency components are just below the Nyquist frequency.
	Linear	Calculates record points between actual acquired samples using a straight-line fit. This interpolation is useful for measuring waveforms with fast rise times, such as pulse trains.
	None	No interpolation calculated.
Waveform Style	Vectors	Draws waveforms with lines between record points.
	Dots	Draws waveform record points as dots on the screen.
Waveform Intensity	% field and up/down arrows	Enter the desired intensity in % or click the up or down arrows to adjust the intensity of the waveform vectors/dots.
Graticule Style	Grid	Default style. Displays the graticule lines lightly, the time (s) and power (W) scales, and the zero lines as most visible.
	Time	Displays only the power (W) graticule lines and scale.
	Full	Displays all of the graticule lines with equal weight and shows the time (s) and power (W) scales.
	None	Hides the graticule.
Graticule Intensity	% field and up/down arrows	Enter the desired intensity in % or click the up or down arrows to adjust the intensity of the graticule lines.

Add a note to a view

In the **Add New...** panel, click the **Note** button to add text labels to your waveform and plot views.

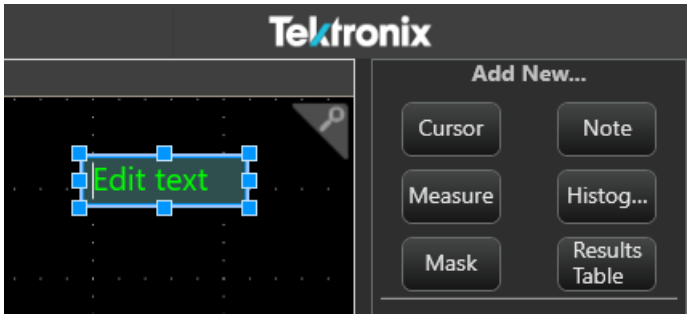
About this task

You can add notes to your waveforms. The text is not attached to the waveform. If you turn off the waveform source, the text remains on the screen.

Procedure

1. In the **Add New...** panel, click the **Note** button. TSOVu adds a text box to the Waveform view.

Note: You can type long strings of text in the field.



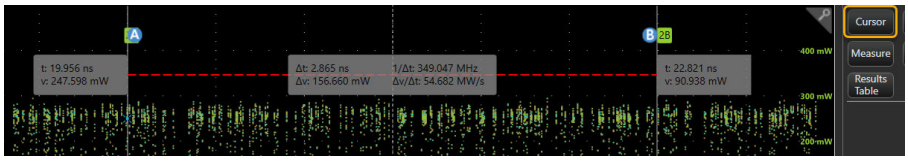
2. You can click once in the note text later to change it if needed.
3. You can click and drag the text to position in wherever you need.
4. You can add multiple notes to the same waveform view.
5. To change the color and font size of the note, right click on it and choose **Configure Note**.
6. To delete the note, right click on it and choose **Delete**.

Cursors

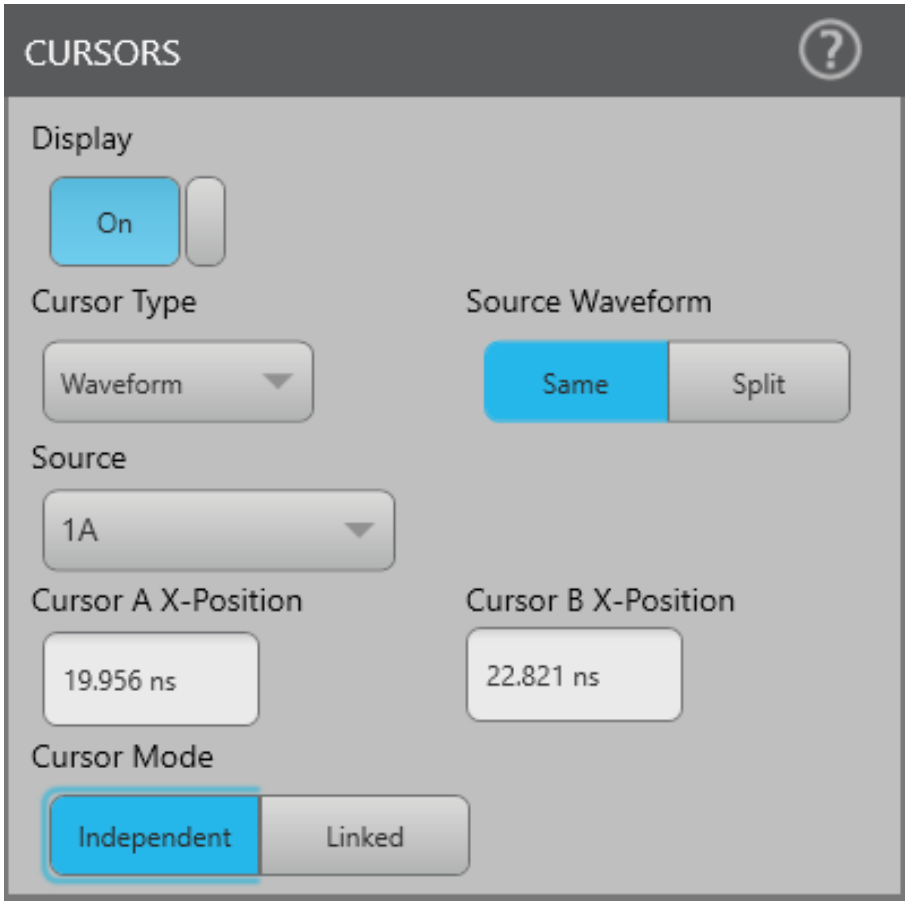
Use one of four different cursor types in the measurement view.

Before you can add a cursors, you must be acquiring a waveform. You should also ensure that the horizontal parameters match the input signal and that horizontal parameters are set accurately. See the *Horizontal configuration* topic for details.

1. Click the **Cursor** button in the **Add New...** panel and cursors will be added to the active measurement view.

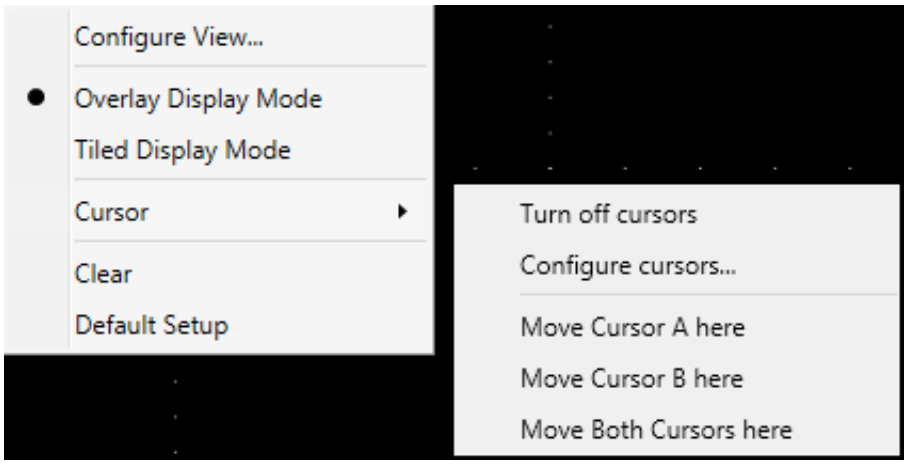


2. Double-click on one of the gray cursor readouts to open the cursors configuration window. You can also right-click on a gray cursor readout or on the waveform and select **Configure cursors**.



3. Configure the cursors as desired. See the following information for a description of settings and actions.

Moving readouts and cursors on the display



- Delete cursors by right-clicking on a cursor readout or the waveform display and selecting **Turn off cursors**.
- Right click at the location on the waveform where you want to place the cursor and then select **Move Cursor A here**, **Move Cursor B here**, or **Move Both Cursor here**. This will move the specified cursor(s) to that location.
- Drag and move cursors vertically or horizontally directly on the graticule by clicking and dragging the cursor line.
- Move the cursor readouts by clicking and dragging them along the cursor lines.

Configuration menu

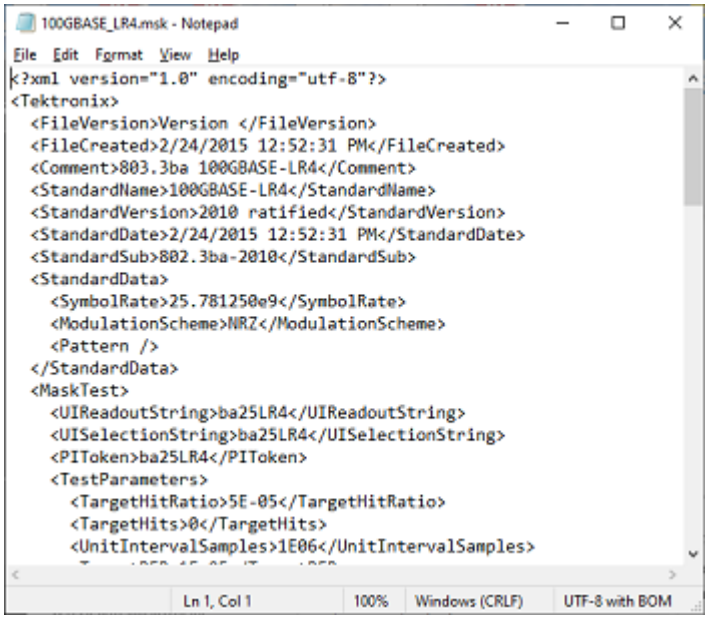
Field or control	Description
Display	Toggle the cursor display **On** or **Off**.
Cursor Type	Select one of the following the cursor types: **Waveform** cursors measure vertical amplitude and horizontal time parameters simultaneously at the point the cursor intersects a waveform. The cursor intersect point tracks waveform amplitude changes. Waveform cursors are not supported when pattern sync is off. **V Bars** are vertical cursors that measure horizontal parameters (typically time). They are not associated with the waveform, but show the time position of the cursor in the waveform record. **H Bars** are horizontal cursors that measure amplitude. They are not associated with the waveform, but show the amplitude position of the cursor. **V&H Bars** cursors measure vertical and horizontal parameters simultaneously. They are not associated with the waveform, but show the time and amplitude position of the cursors.
Source	Select the waveform source to which you want to apply cursors.
Source Waveform	Select whether to apply cursor configurations to a single source or multiple sources. **Same** sets the A and B cursors to the same waveform source. **Split** allows you to set cursors A and B to different waveform sources. The **Cursor B Source** and **Cursor A Source** selections appear when Split is selected.
Cursor A X-Position	Only available when Cursor Type is set to Waveform. Set the position of cursor A on the x-axis, either by moving it with your mouse on the display, or by changing the value settings in the configuration menu.
Cursor B X-Position	Only available when Cursor Type is set to Waveform. Set the position of cursor B on the x-axis, either by moving it with your mouse on the display, or by changing the value settings in the configuration menu.
Cursor Mode	Select the cursor mode. **Independent** mode allows you to move each cursor separately. **Linked** mode allows you to move both cursors at the same time.

Mask

Mask settings allow you to define the target and parameters of mask testing on NRZ signals.

What is Mask?

Mask testing allows you to validate signal under test against standards. The Mask button allows you to define the target of mask testing on NRZ signals for the standards shown in the following table and accessible from the Add Mask window. The mask definitions are loaded from Tektronix standard XML format mask files. These files include parameters that describe the signal and the mask testing qualifiers. An example of a XML mask file is shown here.

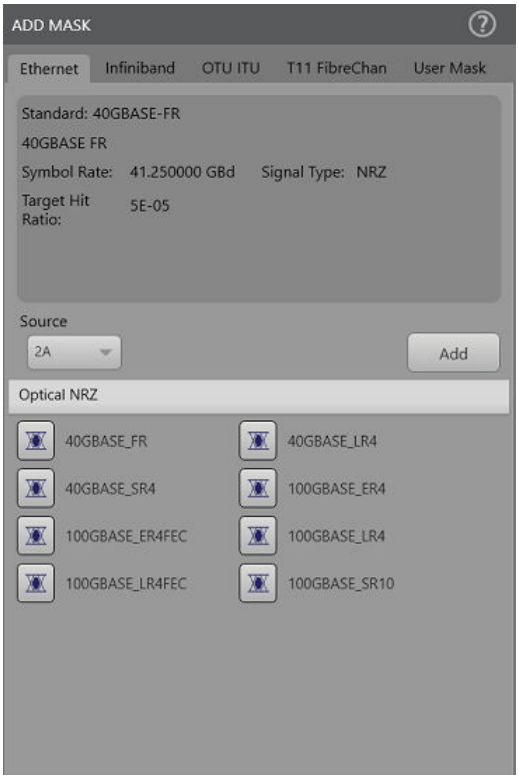


Mask testing can be performed on multiple sources in parallel. You can perform mask testing for every acquistion, when the acquisition stops, or after a specific number of acquisitions you set. See the Acquisition configuration menu topic.

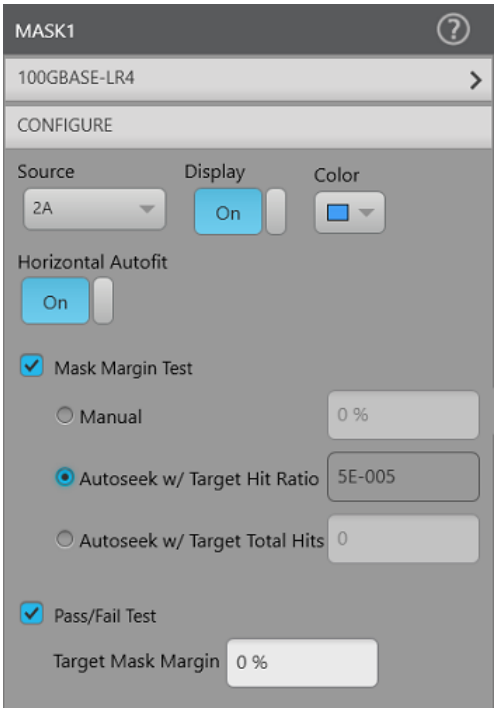
Standard	Description
Ethernet	Select from 40GBASE_FR, SR4, and LR4. 100GBASE_ER4FEC, LR4FEC, ER4, LR4, SR4, SR4RX, and SR10.
Infiniband	Select from IB_EDR25GIn, EDR25GOut, FDR14GIn, FDR14GTX, QDR10GIn, QDR10GOut, 2G5_Op, and 5G_Op.
OUT ITU	Select 100G_OTL4_4.
T11 FibreChan	Select from 8GFC, 16GFCMMr6_1, 16GFCSMr6_1, 32GFCMMr310, and 32GFCSMr310.
User Mask	You can load your own *.msk files from this tab. The drop-down menu allows you to quickly select from recently used files.

How to perform a mask test

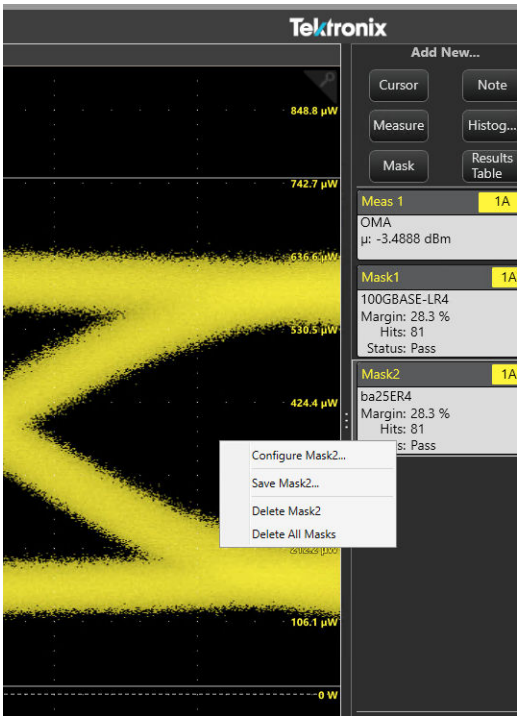
1. Set up acquisition parameters according to the target signal.
2. Turn Pattern Sync OFF (from the Horizontal settings badge) to acquire an eye diagram or use FOLD (math expression) to create an eye diagram.
3. Select the hardware bandwidth based on the data rate (from the M1 or M2 channel badge in the Optical Settings panel).
4. Set Auto Position to On (from the Horizontal settings badge) to center the eye diagram and maximize data throughput for the mask testing cycle.
5. Click the Mask button in the Add new... panel to open the Add Mask window.



6. Select the Source.
7. Select the desired standard tab. If you want to load your own NRZ mask file (*.msk), select User Mask, click Browse to navigate to the desired file, and then click the Add button load the mask file. The Mask badge will appear in the Add New... panel.
8. Click an Optical NRZ signal to select it and then click the Add button to load the mask. The Mask badge will appear in the Add New... panel.
9. Double-click the Mask badge to open the Mask window. Select the Configure panel and set as desired. See the Configure the Mask topic below for details about configuration options.

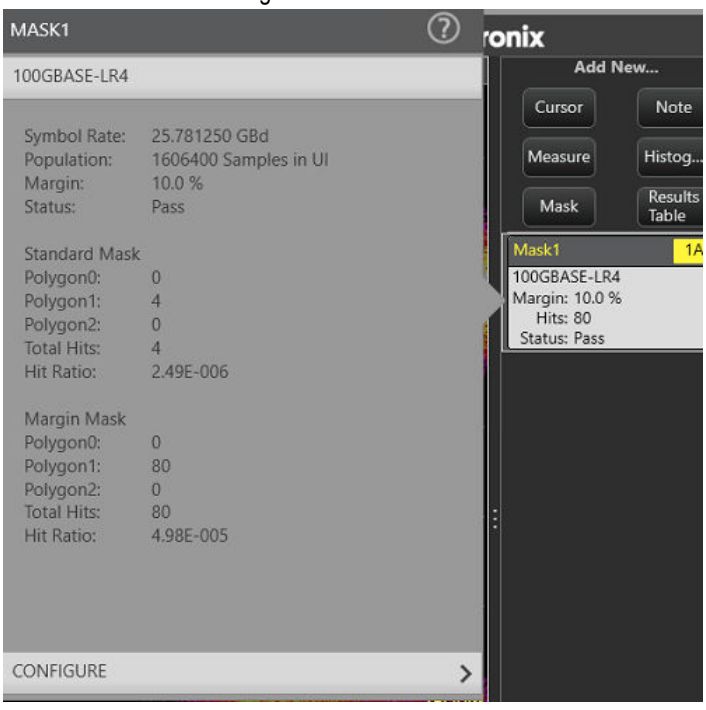


10. Click the Autoset button to perform an autoset to optimize the acquisition offset and vertical scale settings.
11. Right-click the Mask badge to access other mask actions (Configure, Save, and Delete) as needed.

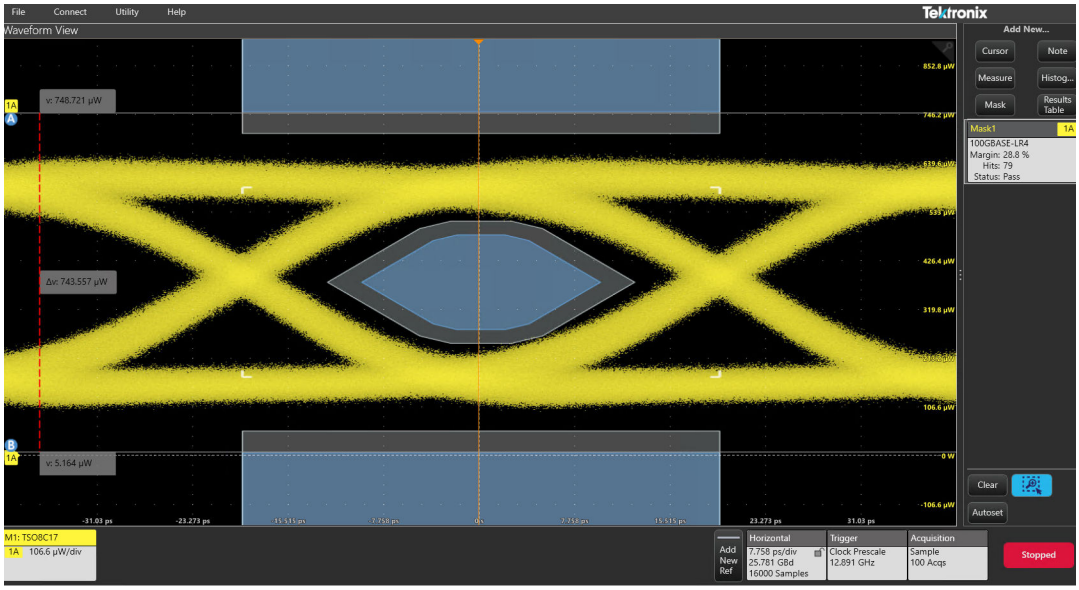


12. The following options are available to control the acquisition process and schedule the mask test cycle.
    a. Set the total number of acquisitions required for relevant statistics on Hit Ratio.
    b. Set testing to occur on every acquisition, when acquisition stops after reaching the total target, or after a specific number of acquisitions you specify. Select your acquisition cadence in order to optimize throughput.

13. Double-click the Mask badge to view the results.



The following image shows horizontal positioning.



Mask configuration options

The Mask configure window provides the following options.

Setting	Description
Source	Allows you to select the signal source.
Display	Allows you to select to show or hide the mask in the display.
Color	Allows you to select the color of the mask.
Horizontal Autofit	Allows you to turn horizontal autofit On or Off. Turning this on causes the mask test to be evaluated at all horizontal positions to obtain the best test result in terms of maximum mask margins or minimum hit ratios.
Mask Margin Test	Check to enable mask margin test.
Manual	Allows you to manually enter % for margin.
Autoseek w/ Target Hit Ratio	Automatically seeks mask margins with the sum of probabilities that the signal is within the mask region.
Autoseek w/ Target Total Hits	Automatically seeks mask margins with total hits.
Pass/Fail Test	Check box to enable pass/fail notification.
Target Hit Ratio	Enter Target Hit Ratio for Pass/Fail Test. Default is 5E-005. Target Hit Ratio is read-only for Mask Margin Test and Pass/Fail Test.

Select runtime options

When changing the Mask target, the relevant plot with the mask will be displayed. If the target plot is displayed already, the mask will be added to the plot.

Use cases for mask testing

1. Find the largest mask margin that does not exceed the hit ratio given a target Hit Ratio.
   a. Enable Mask Margin Test
   b. Optionally activate the Horizontal Autofit

   c. Select Autoseek w/ Target Hit Ratio
2. Find the actual hit ratio given a target Mask Margin.
   a. Enable Mask Margin Test
   b. Optionally activate the Horizontal Autofit
   c. Select Manual setting for Mask Margin
   d. Set the target Mask Margin
   e. Outcome will be the measured actual hit ratio
3. Find the largest mask margin that does not exceed that hit count given a target Total Hits.
   a. Enable Mask Margin Test
   b. Optionally activate the Horizontal Autofit
   c. Select Autoseek w/ Target Total Hits
   d. Outcome will be the measured mask margin
4. Determine the Pass or Fail status given a target Mask Margin for a specified hit ratio.
   a. Enable the Pass/Fail Test
   b. Optionally activate the Horizontal Autofit
   c. Set a Target Mask Margin. Default is 0%
   d. Outcome will be a Pass/Fail status

The Acquisition configuration menu

Before setting up and starting acquisitions for signal analysis, configure horizontal settings first. Then use this procedure to set the method used to acquire and display the signal.

Procedure

1. Double-click the **Acquisition** badge on the Settings bar to open the Acquisition configuration menu.
2. Select the acquisition method from the **Acquisition Mode** list. You can select **Sample** or **Average**. You can set the number of samples to use in the average by typing in the field.
3. Select the **Run Analysis** setting. You can set analysis to occur for every acquisition, when the acquisition stops, or after a specific number of acquisitions you specify.

   Note:

   Run Analysis applies to the running measurement, histogram and mask analysis.

4. Select from the **Stop After** options. If you leave the **Run/Stop** button enabled, then you need to use the **Acquiring/Stopped** button at the lower right of the Settings bar to start and stop your acquisition. If you chose Condition, another panel opens with more options.
5. In **Stop After Condition**, you can choose the **Number of Acquisitions** and set the number to however many acquisitions you need. The instrument stops acquiring data when it reaches the limit you set in Number of Acquisitions.
6. If you choose **Average Complete**, you must also have Average enabled for the Acquisition Mode.
   In this case, the instrument stops acquiring data when it reaches the number of samples you specified in Average in the Acquisition Mode section.
7. Click outside the menu to close it.

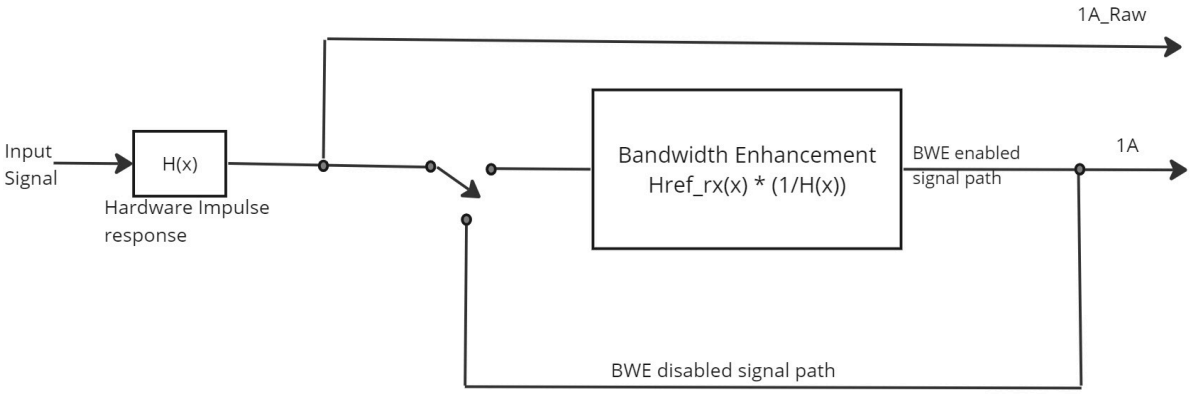
Use default setup

Use Default Setup to restore instrument settings to their factory defaults.

In the Menu bar, choose **File > Default Setup**. TSOVu returns the instrument to its factory default settings (horizontal, vertical, scale, position, and so on).

Access to signal before Bandwidth Enhancement (BWE)

The signal before BWE is accessible as **"<live_channel>_Raw"**. This signal is accessible in the MATH subsystem. For example, If the user wants to access the signal before BWE on 1A, then configure MATH as 1A_raw.



If the user wants to perform measurements on the signal before BWE, then configure MATH with the input source as **"<live_channel>_Raw"** and use MATH as the source for measurements.

For executing "PAM4 Summary" on signal before BWE, configure

- MATH1 = 1A_raw
- Execute "PAM4 summary" with MATH1 as source.

If BWE is not enabled on "live_channel", then **"live channel"** and **"<live_channel>_Raw"** are the same.

Measurements

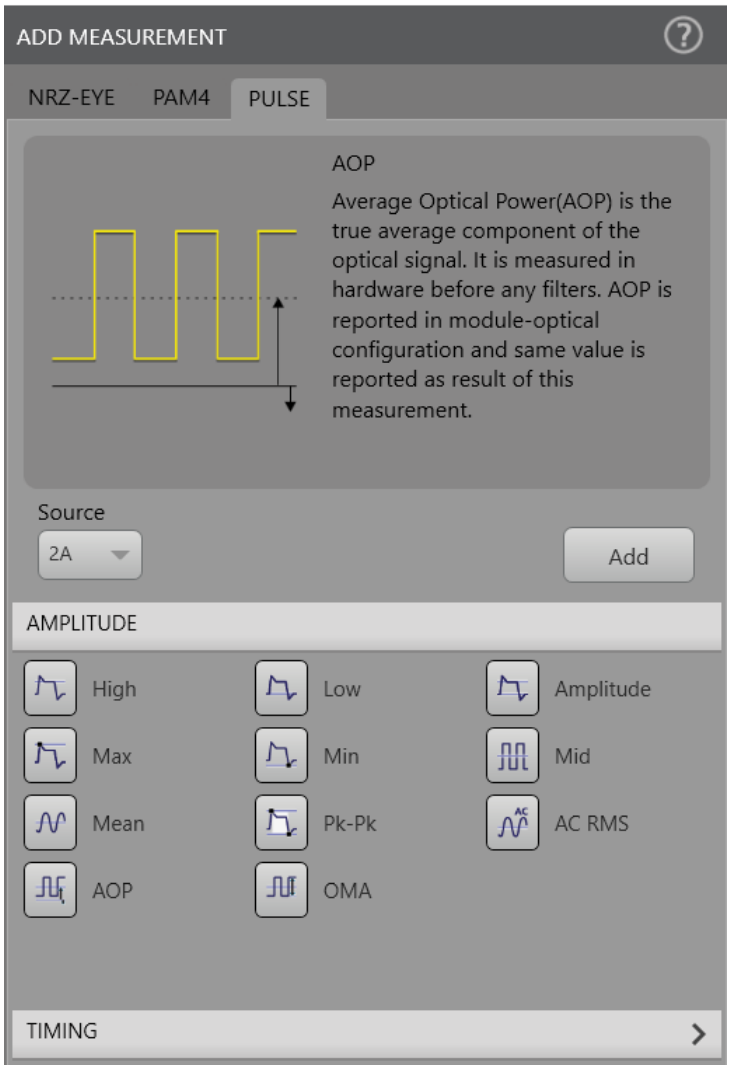
Add Measurement

Use this menu to select measurements you want to enable. If you have purchased optional plug-ins, the related tab will appear here.

Before you can add a measurement, you must be acquiring a waveform or load a reference waveform file. You should also ensure that the horizontal parameters match the input signal and that horizontal parameters are set accurately. See the *Horizontal configuration* topic for details.

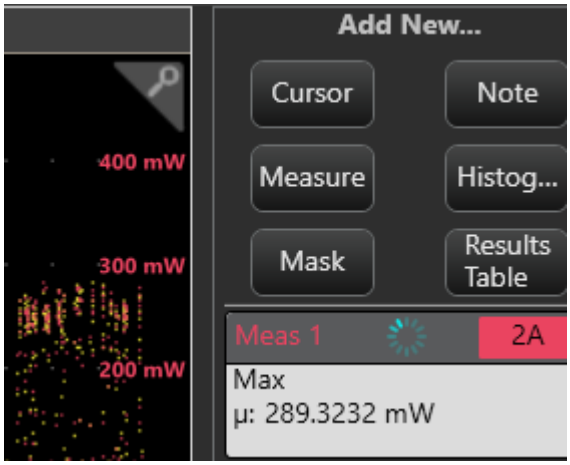
1. Click the **Measure** button in the **Add New...** panel.

   The **Add Measurement** window will open to the last tab that you used. The listed tabs and measurements depend on the installed measurement options and the selected signal source.



2. To add a measurement, select the measurement type tab.
3. Select the input **Source**.
4. Select the measurement category, if present. For Pulse measurements, you can select Amplitude or Timing.
5. Select a measurement and then click the **Add** button. The related measurement badge will be added to the **Add New...** panel.

6. **Wait indicator** is shown in the measurement badge header between measurement title and source(s). Wait indicator appears the moment when measurement is added until the results are shown for every acquisition and analysis cycle.
7. Double-click the measurement badge to open a configuration menu for that measurement and configure according to your setup and needs.



Add Measurement menu fields and controls

Field or control	Description
Measurement tabs	The tabs along the top organize measurements by their type. The tabs that you see depend on your installed plug-ins.
Measurement description	Shows a graphic and short description of each measurement as you click on it. Use this information to verify that the measurement is what you want.
Source	Use the drop-down menu to select the measurement source. If the measurement requires more than one source (for example, Delay), the menu shows two sources to set.
Add	Click the **Add** button to enable the selected measurement. The measurement badge will appear in the **Add New...** panel.

See these topics for more information:

Pulse Amplitude measurements

Pulse Timing measurements

PAM4 measurements (requires Option PAM4)

NRZ Eye Amplitude measurements on page 92

NRZ Eye Timing measurements on page 102

Dark-level compensation

Dark-level compensation maximizes the accuracy of the extinction ratio and other optical automatic measurements.

If Dark Level Compensation is needed, run a module *compensation*.

Dark-level compensation maximizes the accuracy of the extinction ratio and other optical automatic measurements. Dark-level compensation is not saved and is only valid for the selected bandwidth or filter path and the internal optical power meter.

Delete a Measurement badge

Use this procedure to remove a Measurement badge from the Add New... panel.

Procedure

1. Right click on the banner of the Measurement badge that you want to delete. TSOVu opens a right-click menu.
2. Select **Delete Meas #** (where # is the number of the badge you wish to delete) to remove that badge from the **Add New ...** panel.
   You can also use the right-click menu to delete all measurement badges at once, or to configure the measurement that you clicked on.

Pulse Amplitude measurements

High

High measures the top reference level of the waveform. The mean value (μ) displays in the High measurement badge.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Low

Low measures the bottom reference level of the waveform. The mean value (μ) displays in the Low measurement badge.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value below the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Amplitude

Amplitude measures the vertical difference between the high and low levels of the signal.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low value using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above and below the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above and below the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum

- Peak to peak
- Population

Max

Max measures the largest amplitude peak of the waveform over the measurement region.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Min

Min measures the smallest amplitude value of the waveform over the measurement region.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Mid

Mid measures the middle point between the maximum and minimum amplitude levels of the waveform over the measurement region.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Mean

Mean measures the arithmetic mean of the waveform over the measurement region.

Controls

Control	Description
Configure	

Table continued…

Control		Description
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Pk-Pk

Pk-pk measures the difference between the maximum and minimum amplitude values of the waveform over the measurement region.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak

- Population

AC RMS

AC RMS measures the root-mean-square, minus the DC component, of the waveform that is sampled within the measurement region.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start in %.
	Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

AOP

Average Optical Power (AOP) is the true average component of the optical signal. It is measured in hardware before any filters. AOP is reported in module-optical configuration and same value is reported as result of this measurement.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Units	dBm or Signal Ordinate

Results

The following statistics are shown in the result table.

- Mean

- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

OMA

Optical Modulation Amplitude (OMA) measures the difference in optical power between the nominal "1" and "0" levels of the optical signal.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Hysteresis	Hysteresis is used to find the edge. The default value is 3%.
Aperture	Aperture is the percentage of pulse width of the signal used for computation of high/low and in turn OMA. Default value is 20 %. The valid value range is 5% to 50%.
Run Length Auto Detect	**On**: OMA is computed on longest run length of 1s and 0s in the signal.
	Off: OMA is computed using high from all positive pulses where the width is greater than the configured run length and the low from all negative pulses whose width is greater than the configured run length
Run Length	Configure the run length. The default value is 7. The valid value range is 7 to 23. Run Length is only available if Run Length Auto Detect is set to Off.
High/Low Tracking	The High and Low values are the outermost amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Auto switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
	Mean sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
	Mode sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
	Min/Max uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
Units	dBm or Signal Ordinate
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Table continued…

Control	Description
Reference Levels	
Reference method	Select Absolute (W) or Relative (%).
Ref Level	Set mid-reference level. Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Pulse Timing measurements

Period

Period measures the collection of time intervals between two consecutive crossings on the same slope of the signal at the mid-reference level.

Period = Tcross3 - Tcross1, where Tcross3 and Tcross1 are the times of the first two consecutive crossings on the same slope at the mid-reference level.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the outermost amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Set mid-reference level. Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak

- Population

Frequency

Frequency measures the reciprocal of the period of the signal. This measurement is made on each cycle in the record.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
	High/Low Tracking	The High and Low values are the outermost amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		

Table continued…

Control		Description
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Set mid-reference level. Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Rise

Rise measures the collection of time intervals between the low-reference level and the high reference level crossings on the positive slopes of the signal.

Rise Time = TcrossH - TcrossL on rising edges, where:

TcrossH is the time of crossing of the high reference level.

TcrossL is the time of crossing of the low reference level.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level High	Default for Absolute is 1W. Default for Relative is 80% of the pulse amplitude.
	Ref Level Low	Default for Absolute is -1W. Default for Relative is 20% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum

- Minimum
- Peak to peak
- Population

Measuring signals for which there are no measurements

When measuring signals like a PAM4 or NRZ signal, use the appropriate specialized measurements. See the below example.

If the specialized measurement appropriate for the particular signal is not available, we recommend the generic Pulse measurements that mostly follow the IEEE Std 181™. Doing this often requires adjustments of threshold levels, etc., in order to yield the expected results.

For example: a Pulse type measurement of risetime of a PAM4 signal might give the result that exceeds 1 UI. This would be because the Pulse type measurement does not expect the particular UI duration. It is not a specialized measurement that expects data stream changing on clock boundaries (in unit intervals). Moreover, this general Pulse measurement does not know that there are 4 signal levels. Therefore, if the signal presents a staircase pattern (0 to 1 to 2 to 3), then the Pulse risetime measurement will simply measure the time from the 0 to 3 (10% of total amplitude to 90% of total amplitude) by default, which is likely not the intended measurement. For example, gating can be used to coerce the intended behavior.

Fall

Fall measures the collection of time intervals between the high reference level and the low reference level crossings on the negative slopes of the signal.

Fall Time = TcrossL - TcrossH on falling edges, where:

TcrossH is the time of crossing of the high reference level.

TcrossL is the time of crossing of the low reference level.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level High	Default for Absolute is 1W. Default for Relative is 80% of the pulse amplitude.
	Ref Level Low	Default for Absolute is -1W. Default for Relative is 20% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum

- Minimum
- Peak to peak
- Population

Measuring signals for which there are no measurements

When measuring signals like a PAM4 or NRZ signal, use the appropriate specialized measurements. See the below example.

If the specialized measurement appropriate for the particular signal is not available, we recommend the generic Pulse measurements that mostly follow the IEEE Std 181™. Doing this often requires adjustments of threshold levels, etc., in order to yield the expected results.

For example: a Pulse type measurement of risetime of a PAM4 signal might give the result that exceeds 1 UI. This would be because the Pulse type measurement does not expect the particular UI duration. It is not a specialized measurement that expects data stream changing on clock boundaries (in unit intervals). Moreover, this general Pulse measurement does not know that there are 4 signal levels. Therefore, if the signal presents a staircase pattern (0 to 1 to 2 to 3), then the Pulse risetime measurement will simply measure the time from the 0 to 3 (10% of total amplitude to 90% of total amplitude) by default, which is likely not the intended measurement. For example, gating can be used to coerce the intended behavior.

Positive Cross

Positive Cross measures the time of the first positive crossing of the signal at the middle reference level in the measurement region.

Positive cross = Tcross, where Tcross is the horizontal coordinate of the first positive crossing.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum

- Peak to peak
- Population

Negative Cross

Negative Cross measures the time of the first negative crossing of the signal at the middle reference level in the measurement region.

Negative cross = Tcross, where Tcross is the horizontal coordinate of the first negative crossing.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).

Table continued…

Control		Description
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Positive Width

Positive Width measures the horizontal intervals between the crossings of the rising and falling edges of all positive pulses at the middle reference level in the measurement region.

Positive width = Tcross2 - Tcross1, where Tcross1 and Tcross2 are the two consecutive horizontal crossings in the first positive pulse.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum

- Peak to peak
- Population

Negative Width

Negative Width measures the horizontal intervals between the crossings of the rising and falling edges of all negative pulses at the middle reference level in the measurement region.

Negative width = Tcross2 - Tcross1, where Tcross1 and Tcross2 are the two consecutive horizontal crossings in the first negative pulse.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 3%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).

Table continued…

Control		Description
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

RMS Jitter

RMS Jitter measures the time variance on the time crossings of data sampled at the mid-reference level of the first positive or negative crossing. RMS Jitter is defined as one standard deviation of that variance.

RMS Jitter = Tcross, where Tcross is one standard deviation of the variance of crossing times for a histogram of the Tcross values. Tcross is the horizontal coordinate of the first positive or negative crossing.

Controls

Control		Description
Configure		
	Source	Select the signal source.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 2%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum

- Peak to peak
- Population

Pk-Pk Jitter

Pk-Pk Jitter measures the delta between the minimum and maximum of time crossings of data sampled at the mid-reference level.

Pk-Pk Jitter = Tcrosspp, where Tcrosspp is the difference between the maximum crossing time and the minimum crossing time for a histogram of the Tcross values. Tcross is the horizontal coordinate of the first positive or negative crossing.

This measurement requires the use of a waveform database. When this measurement is turned on, it will automatically set the measurement system to use a waveform database, if available.

Controls

Control		Description
Configure		
	Source	Select signal source.
	Label	Customize label. This appears on the measurement badge.
	High/Low Tracking	The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
	Hysteresis	Default is 2%. This is the level transition band around a crossing level that makes crossing time less vulnerable to noise.
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).

Table continued…

Control		Description
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value.
	Gate2	Stop value.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Delay

Delay measures the time interval between the first crossing of the middle reference level on the two sources of the measurement.

Delay = Tcross(source1) - Tcross(source2), where Tcross is the first positive or negative crossing time at the mid-reference level.

Controls

Control		Description
Configure		
	Source 1	Select signal source 1.
	Source 2	Select signal source 2.
	Label	Customize label. This appears on the measurement badge.

Table continued…

Control		Description
	High/Low Tracking	The High and Low values are the outermost amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
		Auto Switches between methods. Auto method first attempts to calculate the high and low values using the Mode method. Then, if the histogram does not show obvious consistent high and low levels, it automatically switches to the Min/Max or Mean method.
		Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
		Mode Sets the values statistically. Using a histogram, it selects the most common value above the midpoint. Since this statistical approach ignores short-term aberrations (overshoot, ringing, etc.), Mode is the best setting for examining pulses.
		Min/Max Uses the highest and lowest values of the waveform record. This setting is best for examining waveforms that have no large, flat portions at a common value, such as sine waves and triangle waves (almost any waveform except for pulses).
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	Toggle on/off to enable/disable gating. By default, the algorithm searches forward from the Start Gate for the first rising edge, but the direction of traversal can be reversed, so that the search will be backward from the Stop Gate.
	Gate1	Start value. NEC in %.
	Gate2	Stop value. NEC in %.
Reference Levels		
	Reference method	Select Absolute (W) or Relative (%).
	Ref Level	Default for Absolute is 0W. Default for Relative is 50% of the pulse amplitude.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak

- Population

PAM4 measurements

PAM4 Summary

PAM4 Summary automatically adds RLM, OMAouter, Extinction Ratio, Average Optical Power, Transition Time and Level measurements to the badge.

Configuration

Right-click the PAM4 Summary badge and select Configure to open the measurement window. You will see the measurement results under PAM4 Summary. Expand CONFIGURE to show and set the following:

Setting	Description
Source	Select signal source channel.
Label	You can modify the label for this measurement in the Label field.
ER Adjust	Allows you to add or subtract a specified percentage from the measured ER value, adjusting for a better match between multiple oscilloscopes.
Normalized Outputs	**On** enables display of normalized levels as measurement output. **Off** enables display of absolute levels as measurement output.
AOP Units	Set the units for AOP in PAM4 Summary.
RLM Method	Method for computing RLM.
Levels for RLM Method	Method of computing Levels measurement for RLM.

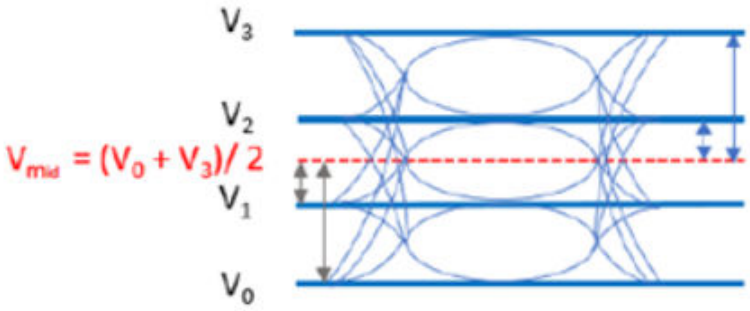
Results

Right-click the PAM4 Summary badge to view the results. You can also add a results table in the view by clicking the Results Table button and selecting Add.

RLM

The Level Mismatch Ratio (RLM) badge shows the vertical linearity of the signal. It is a measure of how close the four symbol levels are to being equally spaced in the vertical dimension. RLM denotes the ratio; hence, it has no unit. This measurement is defined in IEEE Ethernet (802.3) and OIF-CEI specifications.

Given the mean signal levels of PAM4 signal (V0, V1, V2 and V3; V0 refers to lowest signal level), the RLM is computed as shown in the following graph from Intel®:



V_{mid} is computed as average of Vo and V3.

The mean signal levels are then normalized and offset adjusted so that V_{mid} corresponds to 0, V0 to −1, V1 to −ES1, V2 to ES2, and V3 to 1.

Effective symbol levels are defined as follows:

$$ES1 = \frac{(V_1 - V_{mid})}{(V_0 - V_{mid})} \qquad ES2 = \frac{(V_2 - V_{mid})}{(V_3 - V_{mid})}$$

RLM according to Clause 120D.3.1.2

RLM = min [(3 × *ES*1),(3 × *ES*2),(2 - 3 × *ES*1),(2 - 3 × *ES*2)]

Ideal eye will have an RLM equal to 1.

In an ideal eye, distance between all three levels remain same. Distance of V1 to V_{mid} is one third of distance between V0 to V_{mid} (ES1 = 1/3). Distance of V2 to V_{mid} is again one third of distance between V3 to V_{mid} (ES2 = 1/3). This results in a best case RLM of 1.

RLM = min ((3 x (1/3)), (3 x (1/3)), (2 - 3 x (1/3)), (2 - 3 x (1/3))) = min (1, 1, 1, 1) = 1

If ES1 or ES2 equals (2/3), then RLM equals to 0.

RLM according to Clause 94.3.12.5.1

$$RLM = \frac{min(V_3 - V_2, V_2 - V_1, V_1 - V_0)}{\frac{(V_3 - V_0)}{3}}$$

Setting	Description
Source	Select the signal source channel.
Label	Allows you to modify label for the measurement

Table continued…

Setting	Description
Method	Choose the required methods for computing RLM. • IEEE 802.3 Clause 120D.3.1.2 • IEEE 802.3 Clause 94.3.12.5.1 • All When All is chosen, RLM computed using both "IEEE 802.3 Clause 120D.3.1.2" and "IEEE 802.3 Clause 94.3.12.5.1" will be displayed on the measurement badge. Default : All
Levels Method	Choose the required method for computing Levels for RLM. • Central sample from each UI • Central 2UI of longest run length When "Central sample from each UI" is chosen, levels are computed using the center sample of all the symbols. When "Central 2UI of longest run length" is chosen, levels are computed using the 2UI from the center of the longest sequence of a symbol. Default : Central sample from each UI

Level Deviation

Level Deviation is an eye related measurement. It represents the deviation of the vertical intervals between PAM4 levels from perfectly equal spacing, where 0% represents perfect spacing.

Measurement

Given the mean signal levels of the PAM4 signal (V0, V1, V2, and V3; where V0 is the lowest signal level), the level deviation is computed as follows:

$$Level\ \ deviation = \frac{1}{3}\frac{1}{(V_3 - V_0)/3}\sum_{ij=10,21,32}\left|d_{ij} - (V_3 - V_0)/3\right|$$

where $d_{ij} = |V_i - V_j|$.

Level deviation in % = Level deviation * 100.0

Results

The level deviation value is shown in % for the selected waveform source.

Level Thickness

Level Thickness is an eye related measurement. It represents the vertical thickness of the symbol levels, where an ideal signal with maximally open eyes would have a thickness of 0%.

Measurement

Given the level statistics of the PAM4 signal (mean and standard deviation), the level thickness is computed as follows:

$$Level\ \ thickness = \frac{1}{4}\frac{1}{(V_3 - V_0)/2}\sum_{0}^{3}\sigma_x$$

Level thickness in % = Level thickness * 100.0

Results

The level thickness value is shown in % for the selected waveform source. In the result table for a single acquisition, the max, min, mean will all be same value. Standard deviation will be zero.

Eye Width

The Eye Width badge shows width and threshold for each of the PAM4 eyes (upper, middle and lower). Eye width represents widths of the PAM4 rendered eyes at the corresponding reference voltage.

Measurement

Given the levels of PAM4 signal, eye widths for all PAM4 eyes are computed as follows:

- Initial estimation of thresholds are computed for all PAM4 eyes using levels.
- Target SER = Maximum((1/Total symbols in the acquired signal), 1e-5)
- PDF eye of entire PAM4 signal is computed.
- PDF eye is separated into three sections corresponding to three PAM4 eyes.
- CDF/eye contours for all PAM4 eyes are computed using PDFs and target SER.
- CDFs are used to compute finer thresholds for each PAM4 eye.
- Eye width is computed for each eye at the thresholds obtained in the step.

Results

Width and threshold values for all three PAM4 eyes (upper, middle and lower) are given.

Eye Height

The Eye height badge shows height and offset for each of the PAM4 eyes (upper, middle and lower). Eye height represents heights of the PAM4 rendered eyes, at the center of the unit interval, for the corresponding eye.

Measurement

Given the levels of the PAM4 signal, eye heights for all PAM4 eyes are computed as follows:

- Initial estimation of thresholds are computed for all PAM4 eyes using levels.
- Target SER is computed as: Target SER = Maximum ((1/Total symbols in the acquired signal), 1e-5)
- PDF eye of entire PAM4 signal is computed.
- PDF eye is separated into three sections corresponding to three PAM4 eyes.
- CDF/eye contours for all PAM4 eyes are computed using PDFs and target SER.
- Maximum width of CDF/eye contour of middle eye is determined. Tmid is the time corresponding to center of maximum width.
- Eye height is computed for each eye at the Tmid obtained in the previous step.

Results

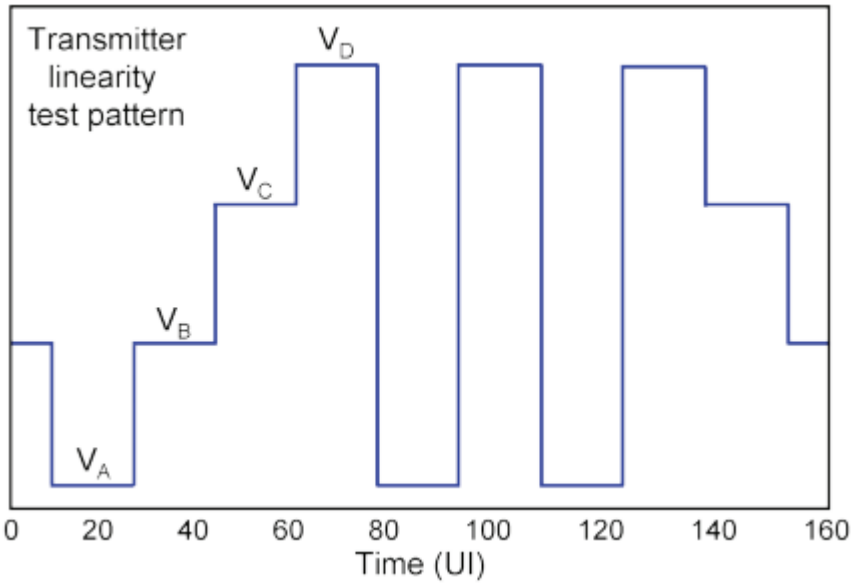
Height and offset values for all three PAM4 eyes (upper, middle and lower) are given.

ES Levels

The Effective Symbol (ES) Levels , ES_1 and ES_2, are the average levels of the two center symbols.

$$ES_1 = \frac{V_B - V_{avg}}{V_A - V_{avg}}$$

$$ES_2 = \frac{V_C - V_{avg}}{V_D - V_{avg}}$$



Level

The Level measurements are symbol related and show the level measurements for each of the 4 levels for the selected waveform source. It represents statistics of the signal levels for each PAM4 symbol. This measurement if defined in IEEE Ethernet (802.3) and OIF-CEI specifications.

Measurement

The PAM4 signal, if not already, it is processed to contain M samples per UI and aligned such that the 1st M samples of the waveform correspond to the 1st PAM4 symbol; the 2nd M samples to the 2nd PAM4 symbol; etc.

For each symbol *i*, choose the center sample (index closest to M/2) from each UI: $\{v_{i1}, v_{i2}, \ldots, v_{iN}\}$. The statistics of that symbol are computed as:

Measurement	Description
Minimum ISI point	For each level (0 - 3) in the correlated eye, there exists a horizontal position across the unit interval where the standard deviation of the waveform voltage is minimized, so that the level is thinnest at this point. (In theory there may be more than one point for each level that matches this description, but in practice that is seldom a problem.)
Time (e)	For each level, the horizontal offset from the Minimum ISI Point to the nominal center of the eye.
Amplitude (d)	For each level, the mean voltage at the Minimum ISI Point
Standard deviation (σ)	For each level, the standard deviation at the Minimum ISI Point.

Controls

Enable Normalized Outputs to display normalized levels as the measurement output. When disabled, absolute levels are displayed.

Results

The following statistics are shown for each of the four levels (L0, L1, L2, L4).

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

Transmitter Transition Time

Transmitter Transition Time measures the slower of the time interval of the transition from 20% of OMA_{outer} to 80% OMA_{outer}, or from 80% OMA_{outer} to 20% OMA_{outer}, for the rising and falling edges, respectively, for a PAM4 optical signal. This measurement is defined in IEEE 802.3cd specification.

Transmitter Transition Time result will be returned in seconds.

Overshoot

Overshoot of a PAM4 signal measures the ratio of the difference in the amplitude of the signal at its 99% of full range and level 3 to its difference between level 3 and level 0.

The levels of a PAM4 signal, from bottom most to top most, are Level 0, Level 1, Level 2, and Level 3. Refer hit ratio based *overshoot* in TPE.

Measurement

Given the crossing time of the PAM4 eye and baud rate, the overshoot level(99% of the full range of the signal) is computed over an aperture centered on PAM4 eye.

Overshoot = (Overshoot level - Level 3)/(Level 3 - Level 0)

Configuration

Right-click on the Overshoot badge and select **CONFIGURE** to open the measurement window. You can see the measurement results under Overshoot. Expand **CONFIGURE** to display and set the following:

Setting	Description
Source	Select the signal source channel.
Label	Allows you to modify label for the measurement
Method	Choose the required method configuration. - Amplitude - OMA outer Default is OMA outer
Histogram span	This controls the fraction of Unit Interval used to create the histogram for P_{max} computation. The histogram is placed at the center of the Unit Interval. Default is 1.0

Results

The overshoot value is a scalar.

Undershoot

Undershoot of a PAM4 signal measures the ratio of the difference of level-0 and the amplitude of the signal at its 1% of full range to its difference between level 3 and level 0.

The levels of a PAM4 signal, from bottom most to top most, are Level 0, Level 1, Level 2, and Level 3. Refer hit ratio based *undershoot* in TPE.

Measurement

Given the crossing time of the PAM4 eye and baud rate, the overshoot level(1% of the full range of the signal) is computed over an aperture centered on PAM4 eye.

Undershoot = (Level 0 - Undershoot level)/(Level 3 - Level 0)

Configuration

Right-click the Undershoot badge and select **CONFIGURE** to open the measurement window. You can see the measurement results under Undershoot. Expand **CONFIGURE** to show and set the following:

Setting	Description
Source	Select the signal source channel.
Label	Allows you to modify label for the measurement
Method	Choose the required method configuration. - Amplitude - OMA outer Default is OMA outer

Table continued…

Setting	Description
Histogram span	This controls the fraction of Unit Interval used to create the histogram for P_{min} computation. The histogram is placed at the center of the Unit Interval. Default is 1.0

Results

The overshoot value is a scalar.

TDECQ

TDECQ (transmitter and dispersion eye closure quaternary) is a measure of each optical transmitter's vertical eye closure when transmitted through a worst case optical channel and equalized with the reference equalizer. This measurement is defined in IEEE Ethernet (802.3) specifications.

Controls

Name	Type	Default	Range	Descriptions
Vertical threshold adjust	Boolean	True	True, false	When enabled, the sub-eye threshold levels are allowed to adjust around OMAouter by a small range. IEEE 802.3cd allows this option to compute optimal TDECQ. When disabled, the sub-eye threshold levels are determined by OMAouter and AOP.
Target SER	Float	4.8e-4	[1e-15, 1e-2]	Target SER at which TDECQ is computed.
Histogram width	Float	0.04	[0.01, 0.08]	Widths of the left and right histograms processed to compute TDECQ.
Histogram spacing	Float	0.1	[0.08, 0.12]	Horizontal spacing of the left and right histograms processed to compute TDECQ. They are located symmetrically across the UI center.
Vertical adjustment limit (%)	Float	1	[0,3]	Limit by which vertical threshold can adjust relative to OMAouter.
Scope noise	Float	NA	NA	Calibrated oscilloscope noise from the connected instrument and module.
Ceq in dB	Boolean	False	True, False	Enabling this configuration will report Ceq in dB.
Extended Search	Boolean	False	True, False	When enabled, the algorithms perform an extended search for the optimal FFE taps to optimize the TDECQ value, at a cost of long execution time. When disabled, the FFE taps are adapted faster but may be less optimal.
Autoset FFE	Boolean	True	True, False	When enabled, the algorithms automatically optimize the FFE taps to minimize TDECQ. When disabled, the user provided FFE taps are used.

Table continued…

Name	Type	Default	Range	Descriptions
Always recalculate FFE	Boolean	True	True, False	When enabled, the algorithms re-calculate FFE taps at every run (when "Autoset FFE" is enabled). When disabled, the algorithms first attempt to use FFE taps from the previous calculation.
FFE Lock Main Cursor	Boolean	True	True, False	When enabled, the TDECQ FFE adaptation happens with main cursor locked to a position mentioned in "FFE Main Cursor Position" configuration.
FFE Main Cursor Position	Integer	2	[0, FFE number of taps - 1]	Indicates the position of main cursor with 0 indicating first tap. This parameter used only if "FFE Lock Main Cursor" is enabled.
FFE number of taps	Integer	5	[1,99]	Number of FFE taps.
FFE number of taps per UI	Integer	1	[1,2]	Number of FFE taps per unit interval.
FFE maximum number of precursors	Integer	2	[0,FFE number of taps - 1]	Maximum number of pre-cursor FFE taps. Must be less than the number of FFE taps.

If FFE is already done on the source, FFE won't be performed. The badge will display the message "FFE will not be performed as FFE is already done on the Source."

Plots

You can enable FFE equalized eye plot. Eyes are displayed for 2 unit intervals.

FFE Equalized Eye

1. Displays the eye diagram of the FFE equalized signal.
2. Thresholds for each eye are shown as th1, th2, th3. These cannot be disabled.
3. Left and right histogram boxes optimized for TDECQ measurement are shown as LH and RH, respectively. These cannot be disabled.

Optimizing offset to ensure a valid measurement

For accurate TDECQ results, set the vertical offset on the modules according to the signal's AOP. See the *Vertical configuration* topic for more detailed information about adjusting vertical offset.

Results

The following measurement results for the selected waveform source will show.

Result	Unit
TDECQ	dB
C_{eq}	N/A
AOP	W
Partial SER (ULeft)	N/A
Partial SER (URight)	N/A
Partial SER (MLeft)	N/A
Partial SER (MRight)	N/A
Partial SER (LLeft)	N/A

Table continued…

Result	Unit
Partial SER (LRight)	N/A

OMAouter

Outer Optical Modulation Amplitude (OMAouter) measures the difference between the highest and lowest optical power levels of a PAM4 optical signal.

Select the OMAouter units in the Configure tab.

- **Signal Ordinate**: the OMA results display the ordinate unit of a signal given as input to measurement.
- **dBm**: the OMA result display as dBm.

(If *Dark Level Compensation* is needed, run a module *compensation*.)

Results

The OMAouter result shows in dBm.

Extinction Ratio

The Extinction Ratio (ER) measures the ratio of the highest and lowest optical power levels of a PAM4 optical signal.

(If *Dark Level Compensation* is needed, run a module *compensation*.)

Controls

Add or subtract a specified percentage (float %) from the measured ER value, adjusting for a better match between multiple oscilloscopes. Range: [-100, 100]. Default: 0

Results

The ER result shows in dB.

Transmitter Power Excursion

The TPE (Transmitter Power Excursion) measurement is part of the PAM4 group and it is accessible if the user has a PAM4 license.

This measurement in turn executes the following sub-measurements.

- *TPE*
- *Overshoot*
- *Undershoot*

All three sub-measurements are computed at a given hit ratio. Overshoot and undershoot reported as part of TPE are different from traditional oscilloscope measurements.

TPE measurement has the following configurations:

Measurements	Default	Supported range/options	Description
Hit ratio	1e-2	1e-15 to 1e-2	TPE, overshoot, and undershoot are computed on the input signal at the hit ratio set by the user.
TPE unit	dBm	dBm and W	TPE is reported with the unit set by the user.
TPE at	Both	Level-3, Level-0 and Both	TPE is measured based on what the user sets in this configuration. Refer *TPE* for more information.

TPE

Transmitter power excursion describes the amount of over-drive the signal carries at a given hit ratio. This measurement is computed as per the details given in IEEE802.3db specification.

TPE is defined as:

$$Transmitter\ Power\ Excursion = maximum\ (Pmax - Paverage, Paverage - Pmin)$$

TPE result reported based on the configuration of **TPE at** is as follows:

TPE at	TPE result
Both	maximum ($P_{max} - P_{average}$, $P_{average} - P_{min}$)
Level-3	$P_{max} - P_{average}$
Level-0	$P_{average} - P_{min}$

Results

This sub-measurement result is reported in the measurement badge as **TPE**.

Overshoot

Overshoot is computed at the configured hit ratio relative to the OMA outer. This measurement is computed as per the details given in IEEE802.3db specification.

Overshoot is defined as:

$$Overshoot = [(Pmax - P3)/\mathrm{OMAouter}]*100$$

Results

This sub-measurement result is reported in the measurement badge as **Oversh.HR**.

Undershoot

Undershoot is computed at the configured hit ratio relative to the OMA outer. This measurement is computed as per the details given in IEEE802.3db specification.

Undershoot is defined as:

$$Undershoot = [(P0 - Pmin)/OMAouter]^{*}100$$

Results

This sub-measurement result is reported in the measurement badge as **Undersh.HR**.

NRZ Eye Amplitude measurements

NRZ High

This NRZ amplitude High measurement measures the top reference level of an NRZ eye. High is the logical 1 of the NRZ signal. The data within the Eye Aperture is sampled, a histogram is built from the upper half of the NRZ eye, and then the mean of the histogram yields the High level.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the high (top) level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values above the midpoint.
	Min/Max: Uses the highest value of the waveform record.
Eye Aperture	The Eye area to measure the Low measurement. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Eye Low

This NRZ amplitude Low measurement measures the bottom reference level of an NRZ eye. Low is the logical 0 of the NRZ signal. The data within the Eye Aperture is sampled, a histogram is built from the lower half of the NRZ eye, and then the mean of the histogram yields the Low level.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the low (bottom) level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the lowest values of the waveform record.
Eye Aperture	The Eye area to measure the Low measurement. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Amplitude

This NRZ Amplitude measurement measures the difference between the logical 1 level (High) and the logical 0 level (Low) of the NRZ signal. The data within the Eye Aperture is sampled, a histogram is built from the upper and lower half of the eye. The mean of the histogram levels gives logical 1 and logical 0 levels, respectively.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the amplitude level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the highest and lowest values of the waveform record.
Eye Aperture	The Eye area to measure the difference of High and Low values. You can configure the region where High and Low values are found inside the Eye. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Extinction Ratio

The Extinction Ratio (ER) measures the ratio of the average power levels at the logical 1 (high) level to the logical 0 (low) level of an optical NRZ signal. All level measurements are made within the eye aperture region.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Eye Aperture	The Eye area to measure. Default value is 20 %. Range:1% to 100%.
ER Adjust	Subtract a fixed value from the NRZ Extinction Ratio (dB) measurement. The value is specified in percentage. The percentage value is converted to a dB value and then subtracted from the measurement value.
Units	dB, Linear, or %
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The results badge displays the Mean (μ) value in the selected units. The units default is dB.

NRZ OMA

Optical Modulation Amplitude (OMA) measures the difference between high and low power levels at the crossing time of an optical signal.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Units	dBm or Signal Ordinate
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Signal to Noise Ratio

Signal to Noise is the ratio of the NRZ Eye amplitude to the RMS noise. Amplitude is measured with the selected tracking method and RMS Noise is measured on the selected High (logical 1) or Low (logical 0) level.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the amplitude level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the highest and lowest values of the waveform record.
Eye Aperture	The Eye area to measure. Default value is 20 %. Range:1% to 100%.
Units	dB, Linear, or %
Noise At	**High**: The noise (standard deviation) of the vertical histogram in High region.
	Low: The noise (standard deviation) of the vertical histogram in Low region.
	High + Low: The sum of the noise (Standard deviation) of the vertical histogram in High and Low region are considered.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The results badge displays the Mean (μ) value in the selected units. The units default is dB.

NRZ RMS

RMS measures the true root mean square amplitude considering AC and DC components of the selected waveform within the measurement region.

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ AC RMS

AC RMS measures the true root mean square amplitude without considering the DC component of the selected waveform within the measurement region. This is done by calculating the standard deviation of all samples about the mean amplitude level.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ RMS Noise

RMS Noise is the measure of standard deviation of the amplitude variance sampled within a vertical slice located at the center of the Eye.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Noise At	**High**: The noise (standard deviation) of the vertical histogram in High region.
	Low: The noise (standard deviation) of the vertical histogram in Low region.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Eye height

Eye height is a measure of how noise affects the vertical opening between the High and Low levels of an NRZ eye. The eye is sampled within the Eye Aperture, where the High and Low regions are found. Eye height is the 3-Sigma guarded delta between High and Low.

Controls

Control	Description
Configure	

Table continued…

Control	Description
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Eye Aperture	The Eye area to measure the Low measurement. Default value is 20 %. Range:1% to 100%.
Format	**Absolute**: Eye height = (High – 3 * S_{high}) – (Low + 3 * S_{low}). Where High and Low are the logical 1 and 0 levels, and S_{high} and S_{low} are the standard deviations. The units are the same as input signal's Ordinate
	Relative: Eye height = ((High – 3 * S_{high}) – (Low + 3 * S_{low}))/OMA. Where High and Low are the logical 1 and 0 levels, and S_{high} and S_{low} are the standard deviations.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ VECP

Vertical Eye Closure Penalty (VECP) is defined as the ratio of OMA to the eye opening from the 99.95th percentile of the histogram placed at the lower half of the eye to the 0.05th percentile of the histogram placed at the upper half of the eye within the eye aperture measure in dB.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Eye Aperture	The Eye area to measure the Low measurement. Default value is 20 %. Range:1% to 100%.

Table continued…

Control	Description
OMA Definition	**OMA At Crossing**Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	User Defined OMA: The user can enter the OMA value. This is the recommended setting for performing TDEC because the OMA measured using the eye diagram is informative only. The Pulse OMA measurement can be used for computing OMA accurately.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Stop in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ TDEC

Transmitter and Dispersion Eye Closure (TDEC) is the measure of the optical transmitter's vertical eye closure when transmitted through a worst case optical channel. This measurement is defined in IEEE Ethernet 802.3 specifications.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Target SER	The Target SER value is a configurable field with a range of 1e-15 to 1e-2. The default value is 5e-5.
Histogram Width	Configure the width of the histogram, which is used to create all 4 histogram around the eye center. The default is 0.04UI. The value range is 0.01UI to 0.08UI.
Histogram Spacing	Configure the spacing between the Early and Late histograms. The default is 0.2UI. The value range is 0.1UI to 0.3UI.
OMA Definition	**OMA At Crossing**: OMA is measured from the eye diagram at the crossing. This is the default setting. Refer to NRZ Eye OMA Measurement for details.
	User Defined OMA: The user can enter the OMA value. This is the recommended setting for performing TDEC because the OMA measured using the eye diagram is informative only. The Pulse OMA measurement can be used for computing OMA accurately.

Table continued…

Control	Description
Scope Noise	The scope noise value is automatically read from the channel.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Crossing Level

Crossing level measures the mean signal value at the NRZ eye crossing.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Crossing Percentage

Crossing Percentage measures the height of eye crossing as a percentage of eye height measured in the Eye Aperture.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Eye Aperture	The Eye area to measure the Low measurement. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Eye Timing measurements

NRZ Crossing Time

Crossing time measures the time instant at which the crossing occurs in the NRZ eye.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Bit Time

Bit Time measures the time duration between two consecutive crossings in the NRZ Eye.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Bit Rate

Bit Rate measures the number of unit intervals per second by using the bit duration observed in the NRZ Eye.

Controls

Control	Description
Configure	

Table continued…

Control	Description
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Eye Width

Eye Width is defined as the 3-Sigma guarded delta between two consecutive crossings.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
Format	**Absolute**: Eye Width = (SecondCrossingTime - (3 * SigmaSecondCrossingTime)) - (FirstCrossingTime + (3 * SigmaFirstCrossingTime)), where Sigma is the standard deviation of samples about the crossing time.
	Relative: Eye Width = (SecondCrossingTime - (3 * SigmaSecondCrossingTime)) - (FirstCrossingTime + (3 * SigmaFirstCrossingTime))/(Bit Time), where Sigma is the standard deviation of samples about the crossing time.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.

Results

The following statistics are shown in the result table.

- Mean
- Standard

- Maximum
- Minimum
- Peak to peak
- Population

NRZ RMS Jitter

RMS Jitter measures one standard deviation of time variance at the NRZ eye crossing.

Controls

Table 5: Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the amplitude level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements. Selectable tracking algorithm settings:
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the highest and lowest values of the waveform record.
Eye Aperture	The Eye area to measure the difference of High and Low values. You can configure the region where High and Low values are found inside the Eye. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.
Reference Levels	
Auto Detect	The Crossing Level of the first eye crossing is measured and used as the reference level.
Reference Method	**Relative**: Adjust the reference level relative to the High/Low levels measured with the Tracking Method that has been chosen. The value for reference level input is %.
	Absolute: Configure the reference level as a ordinate value at which RMS Jitter has to be measured.

Results

The following statistics are shown in the result table.

- Mean

- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Pk-Pk Jitter

Pk-Pk Jitter measures the delta between minimum and maximum time variance at the NRZ eye crossing.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the amplitude level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the highest and lowest values of the waveform record.
Eye Aperture	The Eye area to measure the difference of High and Low values. You can configure the region where High and Low values are found inside the Eye. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.
Reference Levels	
Auto Detect	The Crossing Level of the first eye crossing is measured and used as the reference level.
Reference Method	**Relative**: Adjust the reference level relative to the High/Low levels measured with the Tracking Method that has been chosen. The value for reference level input is %.
	Absolute: Configure the reference level as a ordinate value at which RMS Jitter has to be measured.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak

- Population

NRZ Rise Time

Rise Time is the measure of positive slope of the NRZ eye by computing the time between the mean crossings of the low reference level and the high reference level.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the amplitude level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the highest and lowest values of the waveform record.
Eye Aperture	The Eye area to measure the difference of High and Low values. You can configure the region where High and Low values are found inside the Eye. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.
Reference Levels	
Reference Method	**Relative**: Adjust the reference level relative to the High/Low levels measured with the Tracking Method that has been chosen. The value for reference level input is %.
	Absolute: Configure the reference level as a ordinate value at which RMS Jitter has to be measured.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ Fall Time

Fall Time is the measure of negative slope of the NRZ eye by computing the time between the mean crossings of the high reference level and the low reference level.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the amplitude level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the highest and lowest values of the waveform record.
Eye Aperture	The Eye area to measure the difference of High and Low values. You can configure the region where High and Low values are found inside the Eye. Default value is 20 %. Range:1% to 100%.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.
Reference Levels	
Reference Method	**Relative**: Adjust the reference level relative to the High/Low levels measured with the Tracking Method that has been chosen. The value for reference level input is %.
	Absolute: Configure the reference level as a ordinate value at which RMS Jitter has to be measured.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

NRZ DCD

Duty Cycle Distortion (DCD) measures the ratio of the time interval between the points where the rising and falling edges cross the mid-reference level and the bit time.

Controls

Control	Description
Configure	
Source	Select the signal source.
Label	Customize label. This appears on the measurement badge.
High/Low Tracking	There are several ways to track and identify the amplitude level for an NRZ eye. The High and Low values are the amplitude values that can be used to derive other reference measurement parameters for a waveform. This influences the fidelity of amplitude and aberration measurements.
	Mean: The sample mean of the signal above (min(signal))+max(signal))/2. This method is best for examining eye patterns. Using a histogram, it selects the mean or average value derived using all values below the midpoint.
	Min/Max: Uses the highest and lowest values of the waveform record.
Eye Aperture	The Eye area to measure the difference of High and Low values. You can configure the region where High and Low values are found inside the Eye. Default value is 20 %. Range:1% to 100%.
Format	**Time**: Sets the DCD result value as the absolute difference between the time at which the rising edge and falling edge cross the selected reference level.
	%: Sets the DCD result value as the ratio of the time interval between the points where the rising and falling edges cross the mid-reference level and the NRZ bit time.
Gating	
Enable	Toggle on/off to enable/disable gating. When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
Gate1	Start in %.
Gate2	Stop in %.
Reference Levels	
Reference Method	**Relative**: Adjust the reference level relative to the High/Low levels measured with the Tracking Method that has been chosen. The value for reference level input is %.
	Absolute: Configure the reference level as a ordinate value at which RMS Jitter has to be measured.

Results

The following statistics are shown in the result table.

- Mean
- Standard
- Maximum
- Minimum
- Peak to peak
- Population

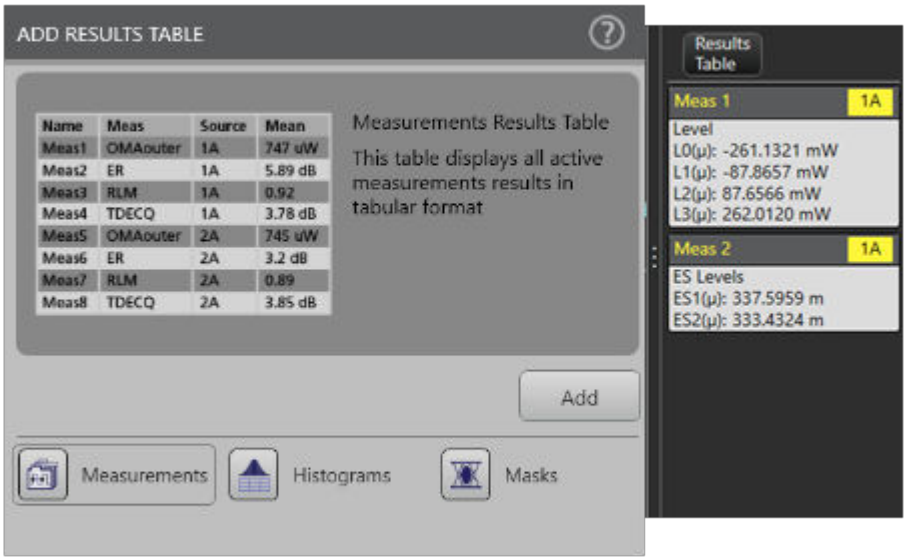
Menus and dialogs

Explore the following functions.

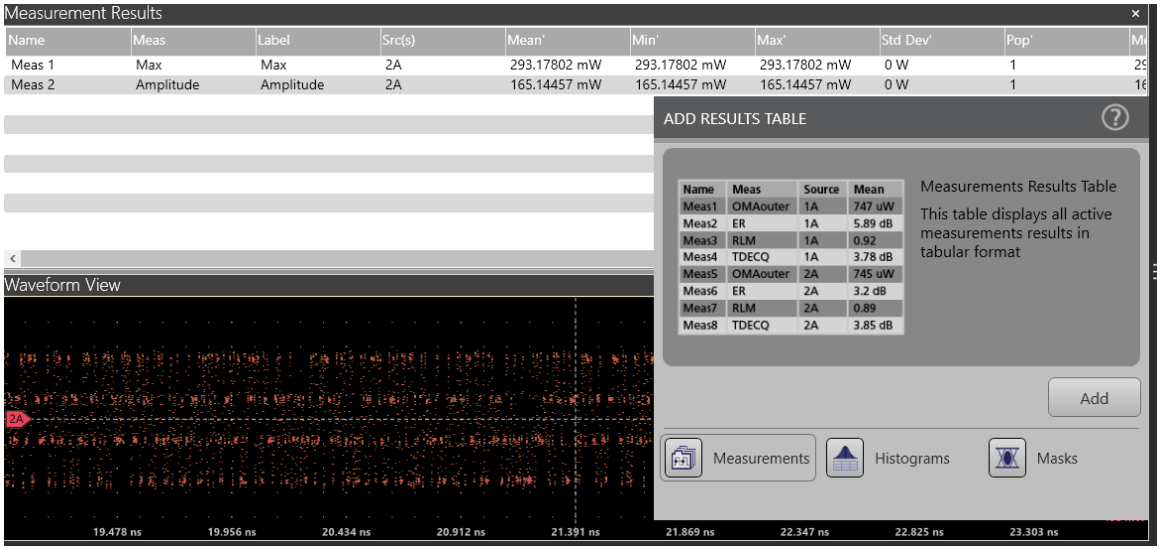
Add Results Table

Use this menu to add a table of all active measurement values, historgrams, or masks. Results tables show values in a spreadsheet-like format.

1. You must have active measurements before you can use the Results Table. See the *Add measurements* topic for details.
2. In the **Add New ...** panel, click the **Results Table** button to open the menu.



3. Click one of the followign buttons depending on which results you want: **Measurements**, **Histograms**, and **Masks**.
4. Click the **Add** button on the right. This displays the selected table type. You can add as many tables as you want to the screen. The results table displays across the top of the Waveform View, showing the data for the active measurement badges or histograms, or masks.



In the Measurement Results table, there are two set of statistics displayed: statistics of present acquisition and statistics across acquisitions.

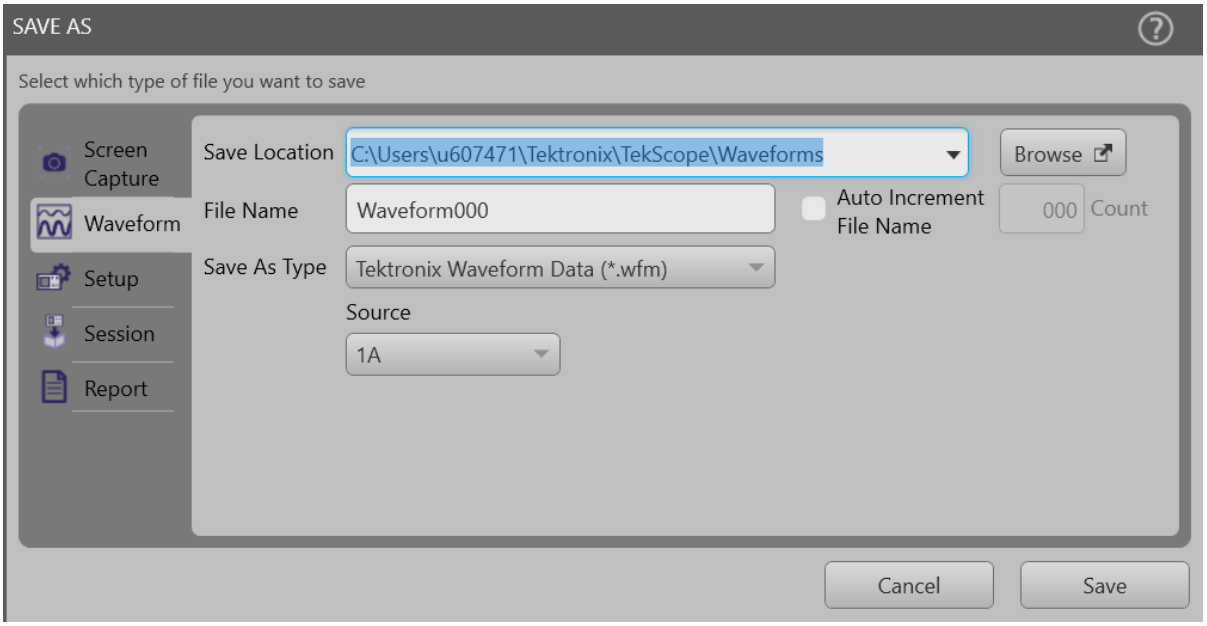
5. You can configure what columns to display and column resolution.
6. You can click on the banner at the top of the table and drag it away from the TSOVu window. The table detaches and you can put it anywhere on your desktop. You can do this with the Waveform View also.

Save As

Use this procedure to save waveform data to a comma-separated values (csv) or Tektronix waveform data (wfm) file, for later analysis or inclusion in reports. You can also save instrument setup information, sessions, and reports.

Procedure

1. In the Menu bar, choose **File > Save As**.
   The Save As configuration menu opens. The menu shows the last type of file that you saved. You can save Waveforms, Setups, Sessions, and Reports.



2. Look at the **Save Location** field. You can save files in the default location, or click **Browse**, or type, or paste a different path location to save the file. This is true for saving setup and session information, as well.
3. **File Name** shows the name last used to save a file. The default name is Waveform000, or Setup000, or Session000 depending on the file type. To change the file name, click anywhere in the file name and change the name as you would in any Save As dialog.
4. You can also click the **Auto Increment File Name** checkbox to enable or disable automatic incrementing of a file name. Auto Increment File Name lets you save sequential files without needing to manually rename them each time. The count number is added to the end of the file name.
   - If Auto Increment File Name is enabled the **Count** defaults to 000 if there are no files at the specified location and file name that already use incremented file names. If there are files at the save location that already use the specified file name, and have already been saved using count increments, the Count field shows the next count value that will be added to the file name when the file is saved.
   - To change the starting count value, click in the Count field on the right and type to change the value.
5. Use the **Save As Type** dropdown menu to select the waveform data type you want from the list. For waveforms, you can save the data to a comma-separated values (csv) file or Tektronix waveform data (wfm) file. You must save Setup files as .set and Session files as .tss. For Reports, you can save a report as .pdf or .html.
6. **Screen Capture**, The "Save as Type" dropdown with the below dropdown items is used to select the image format in portable network graphics (*.png), 24-bit Bitmap (*.bmp), and JPEG (*.jpg). The Cursors, histograms, notes, and masks are visible in the screen capture when they are added and displayed in the TSOVu waveform view.
7. **For Waveform files**, you can use the **Source** dropdown menu to select the source of the waveform to save from the list. You can save a single waveform or all waveforms.
8. **For Setup files**, you can click the checkbox to **Include All References**, which saves additional data for you.
9. **For Report files**, you can select to save a **Full Report** or **Summary**. The full report will include all measurement configuration data in addition to results. The Summary will only include results only.
10. Click **Save** to save the file.

Add a reference waveform

A reference waveform is a static waveform record displayed for comparison.

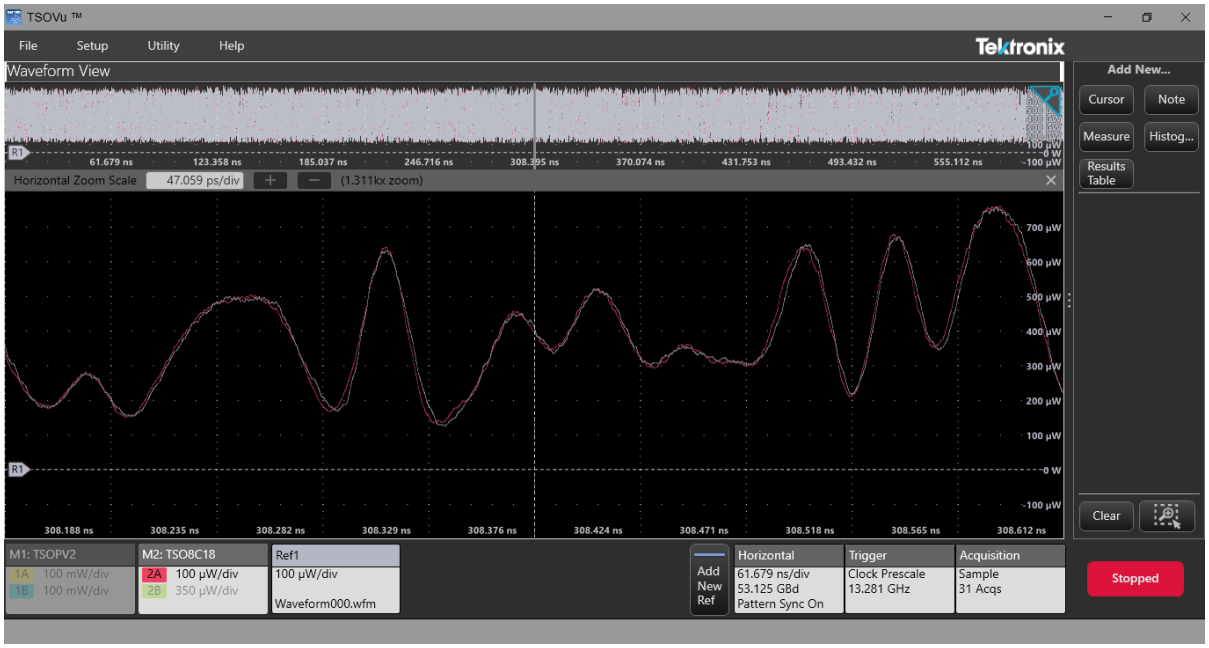
About this task

There is no set limit to the number of reference waveforms you can add to the Waveform View, other than system physical memory constraints.

Procedure

1. Click the **Add New Ref** button on the bottom of the display.
2. TSOVu opens the Recall window. Choose the reference file that you want. Like any File Explorer window, you can navigate to a different directory if necessary. Click **Open** when you are ready.

   The instrument adds the waveform to the Waveform view and adds a Reference badge on the bottom of the display on the Settings bar. In this example, the channel 2 waveform is being compared with the reference waveform.



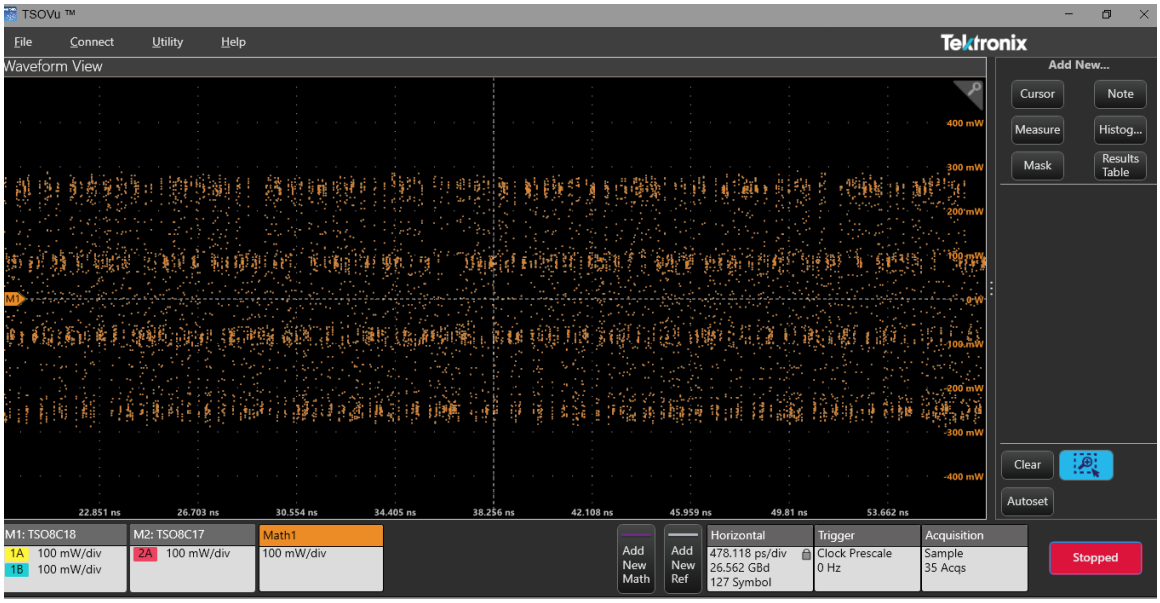
3. To open the configuration menu, double click the **Ref1** badge.
   Use the configuration menu to refine the waveform parameters. The displayed fields depend on the waveform and selections made in the menu. Selection changes take effect immediately.
4. Click outside the menu to close it.

Add a Math waveform

A Math waveform is a static waveform record displayed for comparison.

Other than system physical memory constraints, there is a limit of 25 Math waveforms you can add to the Waveform View.

1. Click the **Add New Math** button on the bottom of the display.
2. In the Waveform view, a new Math is added with the source as the last selected source, and a Math badge is added to the bottom of the display on the Settings bar. As shown in the following example, the channel 2 waveform is added to the Math waveform.

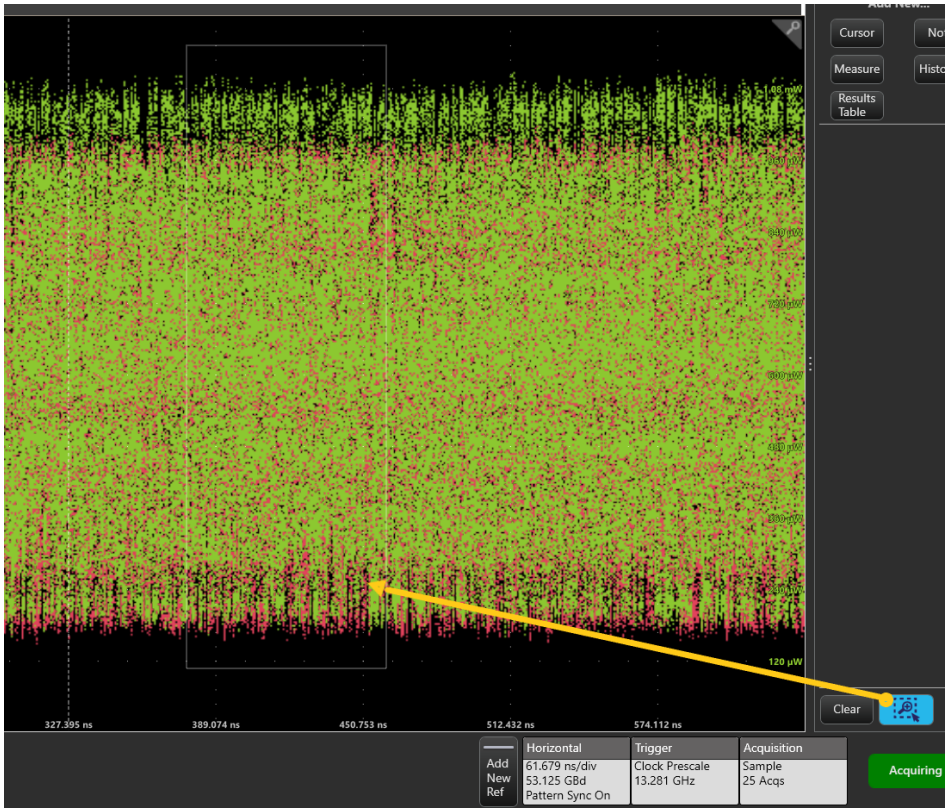


3. To open the configuration menu, double click the **Math1** badge.

   Use the configuration menu to refine the Math waveform parameters. The displayed fields depend on the Math waveform and selections made in the menu. Selection changes take effect immediately.
4. Click outside the menu to close it.

Draw a box for zoom or histogram

1. Double click the **Draw a Box** icon button to open the Draw A Box window.
2. Select **Zoom** or **Histogram** depending on what you want to define. The icon and mouse-over text change with the selection and retain the selection until you change it.
3. Click in the graph and draw a box around the area of interest.



4. See the *Zoom elements* topic for detailed information about the zoom view.
5. See the *Add a histogram* topic for detailed information about the histogram view.

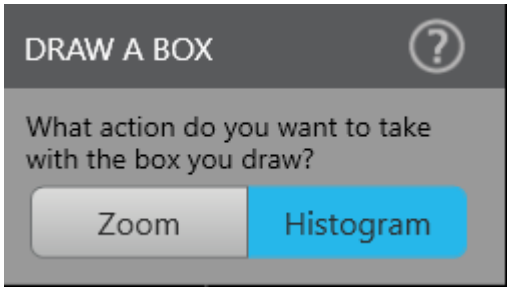
Add a histogram

Use histograms to analyze a range of waveform data that you select. The instrument can display both vertical and horizontal histograms.

Before you can add a histogram, you must be acquiring a waveform. You should also ensure that the horizontal parameters match the input signal and that horizontal parameters are set accurately. See the *Horizontal configuration* topic for details.

1. At the bottom of the **Add New...** panel, view the draw a box button.

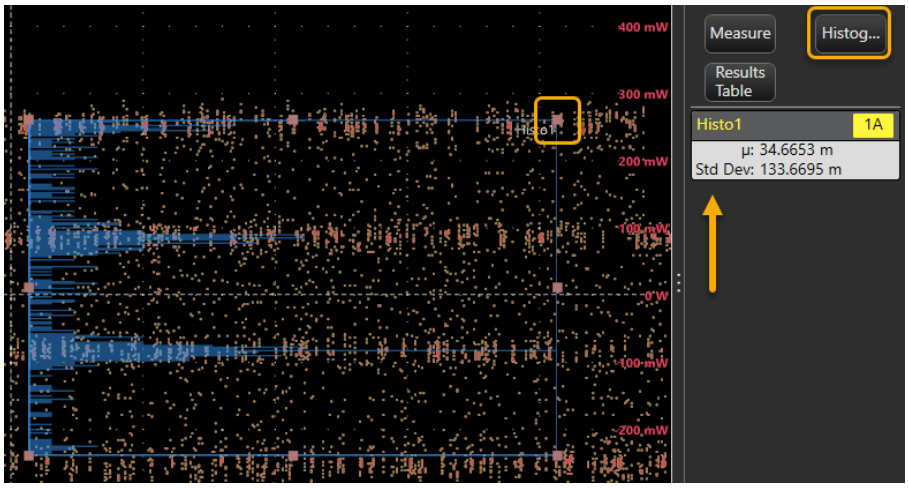
If it is gray, as shown here, double click on the button to open the Draw A Box window and select **Histogram.**



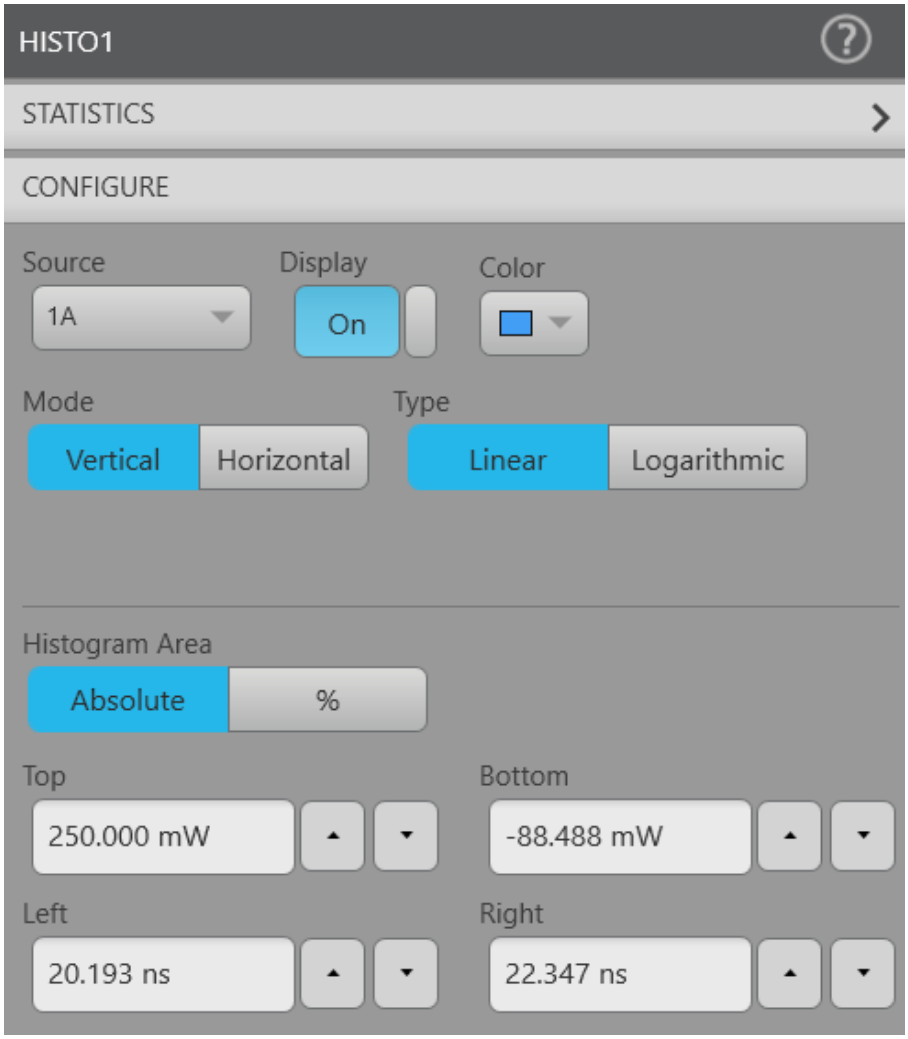
2. If the Histogram icon button is blue, that means the histogram function is on and you can simply draw a box on the waveform to define a new histogram.

   If the button icon is different, then that means it is in Zoom mode. See the *Zoom elements* and *Draw a box for zoom or histogram* topics for more information.

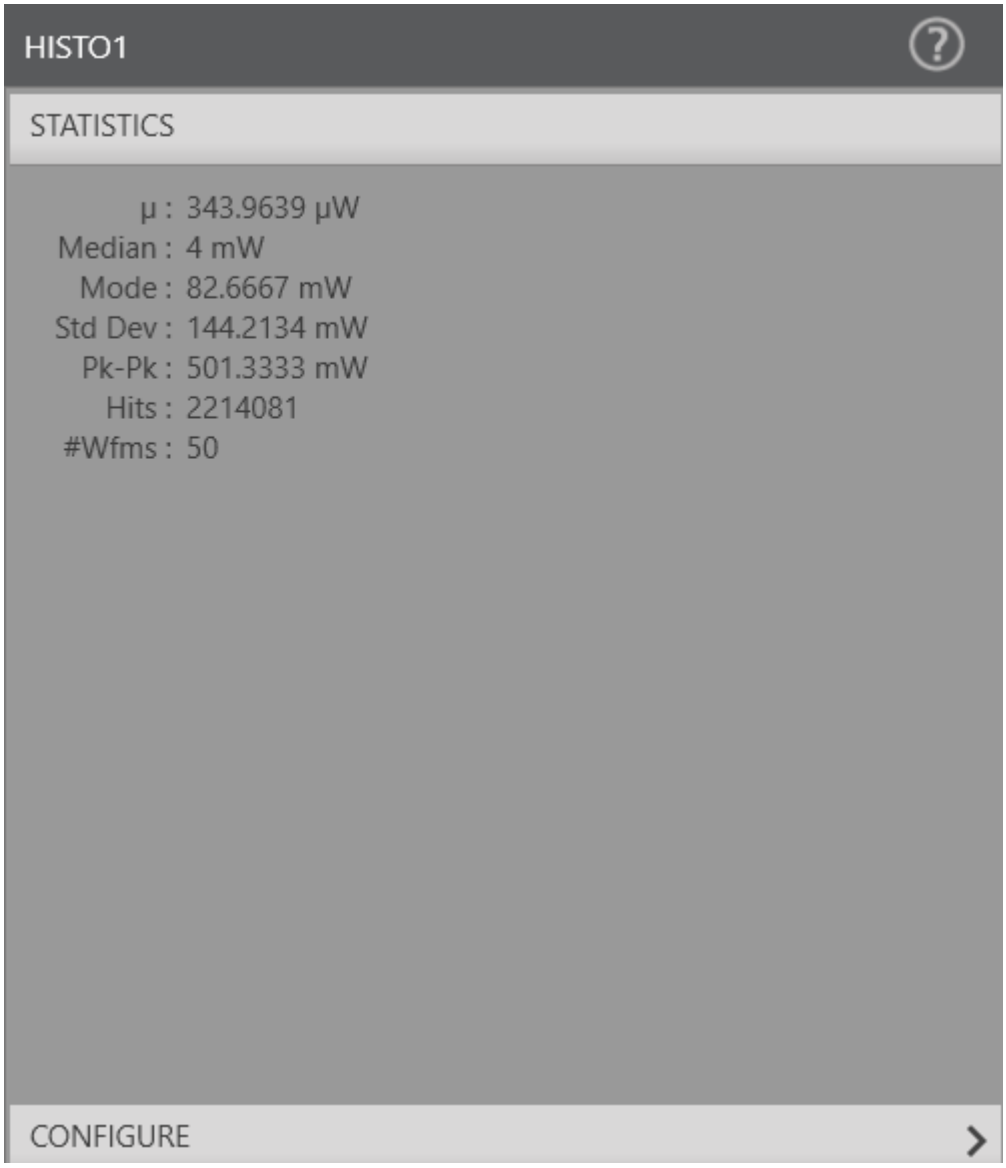
3. Draw a box on the area of the waveform for which you want to define the histogram. A Histogram badge will appear in the **Add New...** panel. The badge shows several of the current histogram statistics. You can add as many histograms as you need.



4. You can resize and reposition the box and use the mouse to drag the histogram box boundaries on screen to surround the data that you want to analyze.
5. You can also double click on the Histogram badge and use the Histogram **Configure** menu to completely configure the histogram.



6. View all of the histogram statistics in the **Statistics** panel.


HISTO1
STATISTICS
μ : 343.9639 μW
Median : 4 mW
Mode : 82.6667 mW
Std Dev : 144.2134 mW
Pk-Pk : 501.3333 mW
Hits : 2214081
#Wfms : 50
CONFIGURE

Zoom elements

Use the zoom elements to magnify waveforms to view signal details.

1. The **Waveform overview** shows the entire waveform record. Waveforms are shown in Overlay mode by default. You can use *the Waveform Configuration menu* to change to Tile mode.
2. The **area of interest** shows the area of the waveform that is magnified and shown in the graticule area below. You can click and drag this box to change the area of interest.

   Note: Moving the area of interest, or changing its position, does not change the horizontal time base settings.
3. The **Zoom** icon in the upper right corner of the Waveform View hides or shows the zoom view without turning zoom off.

   
4. The **Draw a box** button allows you to draw a box around an area of interest. Double click on this button to open the Draw a Box window and toggle the Draw A Box icon between a zoom box and a histogram box. *(See the Draw a box for zoom or histogram topic for details.)*
5. The **Zoom View** shows the zoomed area of the waveform, as defined by the Zoom Box, in the Zoom Waveform Record View. Use click and/or drag options in the zoom view to change the zoomed area of interest.
6. Use the **Horizontal Zoom Scale** bar controls to adjust the horizontal scale of the zoom area. You can enter a value directly into the field or click the + or - buttons to zoom in and out horizontally.

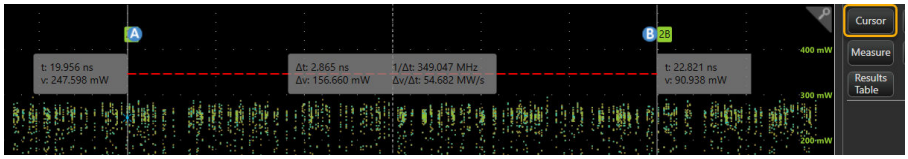
   Click the X on the Horizontal Zoom Scale bar to turn off zoom mode. Doing this will delete the zoom configurations.

Cursors

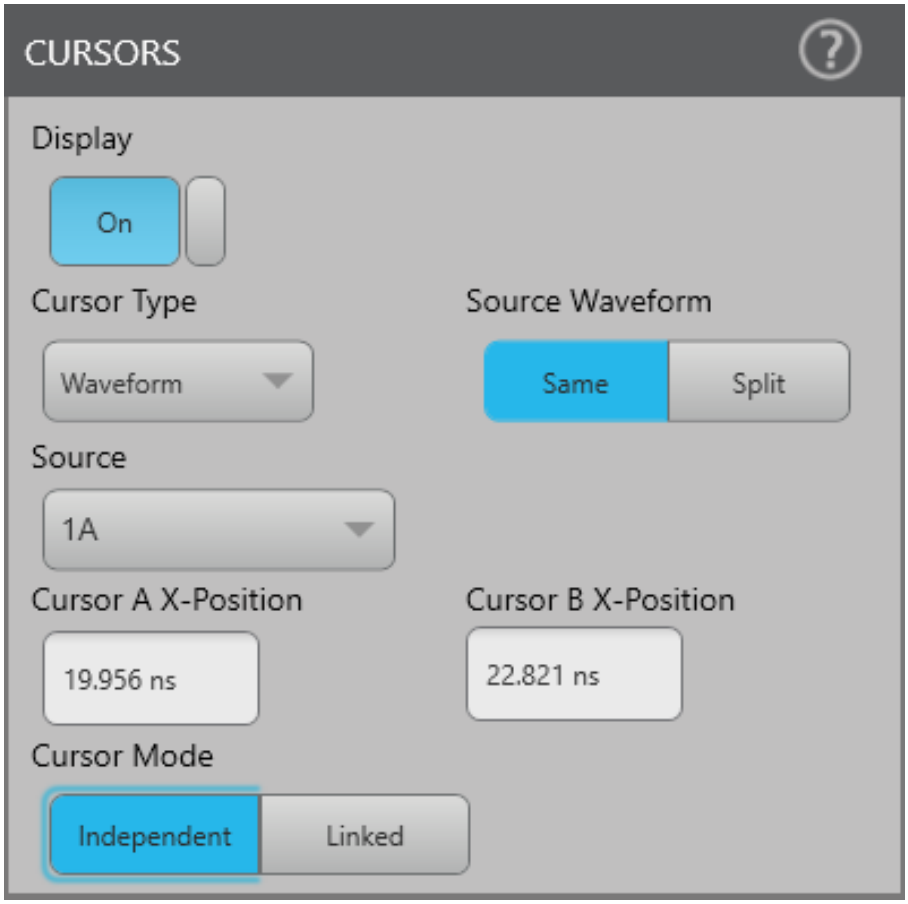
Use one of four different cursor types in the measurement view.

Before you can add a cursors, you must be acquiring a waveform. You should also ensure that the horizontal parameters match the input signal and that horizontal parameters are set accurately. See the *Horizontal configuration* topic for details.

1. Click the **Cursor** button in the **Add New...** panel and cursors will be added to the active measurement view.

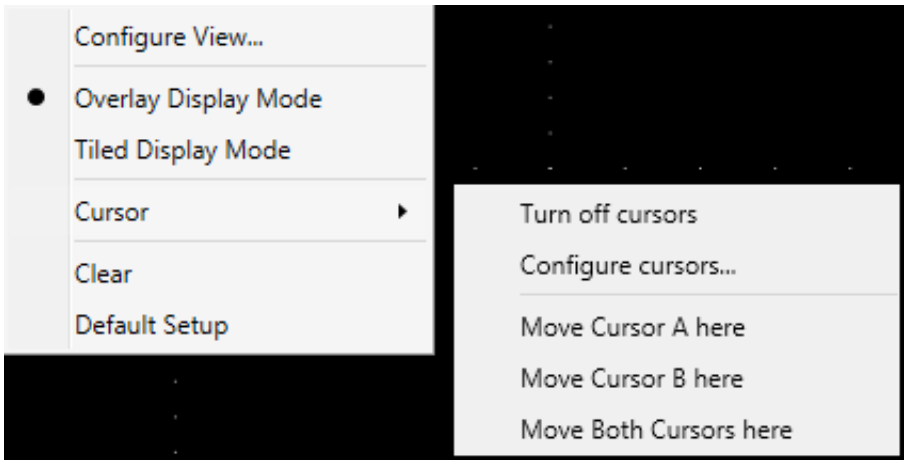


2. Double-click on one of the gray cursor readouts to open the cursors configuration window. You can also right-click on a gray cursor readout or on the waveform and select **Configure cursors**.



3. Configure the cursors as desired. See the following information for a description of settings and actions.

Moving readouts and cursors on the display



- Delete cursors by right-clicking on a cursor readout or the waveform display and selecting **Turn off cursors**.
- Right click at the location on the waveform where you want to place the cursor and then select **Move Cursor A here**, **Move Cursor B here**, or **Move Both Cursor here**. This will move the specified cursor(s) to that location.
- Drag and move cursors vertically or horizontally directly on the graticule by clicking and dragging the cursor line.
- Move the cursor readouts by clicking and dragging them along the cursor lines.

Configuration menu

Field or control	Description
Display	Toggle the cursor display **On** or **Off**.
Cursor Type	Select one of the following the cursor types: **Waveform** cursors measure vertical amplitude and horizontal time parameters simultaneously at the point the cursor intersects a waveform. The cursor intersect point tracks waveform amplitude changes. Waveform cursors are not supported when pattern sync is off. **V Bars** are vertical cursors that measure horizontal parameters (typically time). They are not associated with the waveform, but show the time position of the cursor in the waveform record. **H Bars** are horizontal cursors that measure amplitude. They are not associated with the waveform, but show the amplitude position of the cursor. **V&H Bars** cursors measure vertical and horizontal parameters simultaneously. They are not associated with the waveform, but show the time and amplitude position of the cursors.
Source	Select the waveform source to which you want to apply cursors.
Source Waveform	Select whether to apply cursor configurations to a single source or multiple sources. **Same** sets the A and B cursors to the same waveform source. **Split** allows you to set cursors A and B to different waveform sources. The **Cursor B Source** and **Cursor A Source** selections appear when Split is selected.
Cursor A X-Position	Only available when Cursor Type is set to Waveform. Set the position of cursor A on the x-axis, either by moving it with your mouse on the display, or by changing the value settings in the configuration menu.

Table continued…

Field or control	Description
Cursor B X-Position	Only available when Cursor Type is set to Waveform. Set the position of cursor B on the x-axis, either by moving it with your mouse on the display, or by changing the value settings in the configuration menu.
Cursor Mode	Select the cursor mode. **Independent** mode allows you to move each cursor separately. **Linked** mode allows you to move both cursors at the same time.

Add a note to a view

In the **Add New...** panel, click the **Note** button to add text labels to your waveform and plot views.

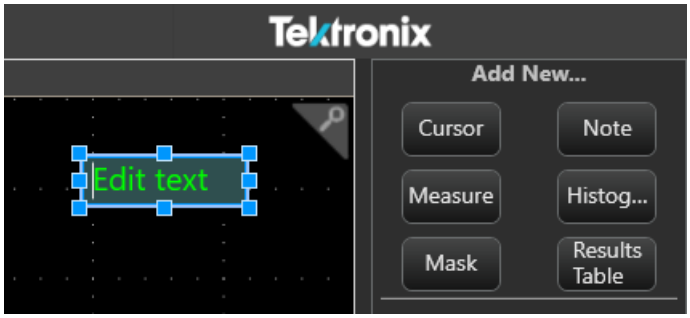
About this task

You can add notes to your waveforms. The text is not attached to the waveform. If you turn off the waveform source, the text remains on the screen.

Procedure

1. In the **Add New...** panel, click the **Note** button. TSOVu adds a text box to the Waveform view.

   Note: You can type long strings of text in the field.



2. You can click once in the note text later to change it if needed.
3. You can click and drag the text to position in wherever you need.
4. You can add multiple notes to the same waveform view.
5. To change the color and font size of the note, right click on it and choose **Configure Note**.
6. To delete the note, right click on it and choose **Delete**.

Reference waveform configuration menu

Use this menu to configure display settings for a reference waveform.

To open a reference waveform configuration menu, you must first have added a reference waveform using the Add New Ref button, then selecting a reference waveform from the list of available waveforms. After the reference waveform displays on the Waveform View screen, on the Settings bar, double-click the **Ref** badge.

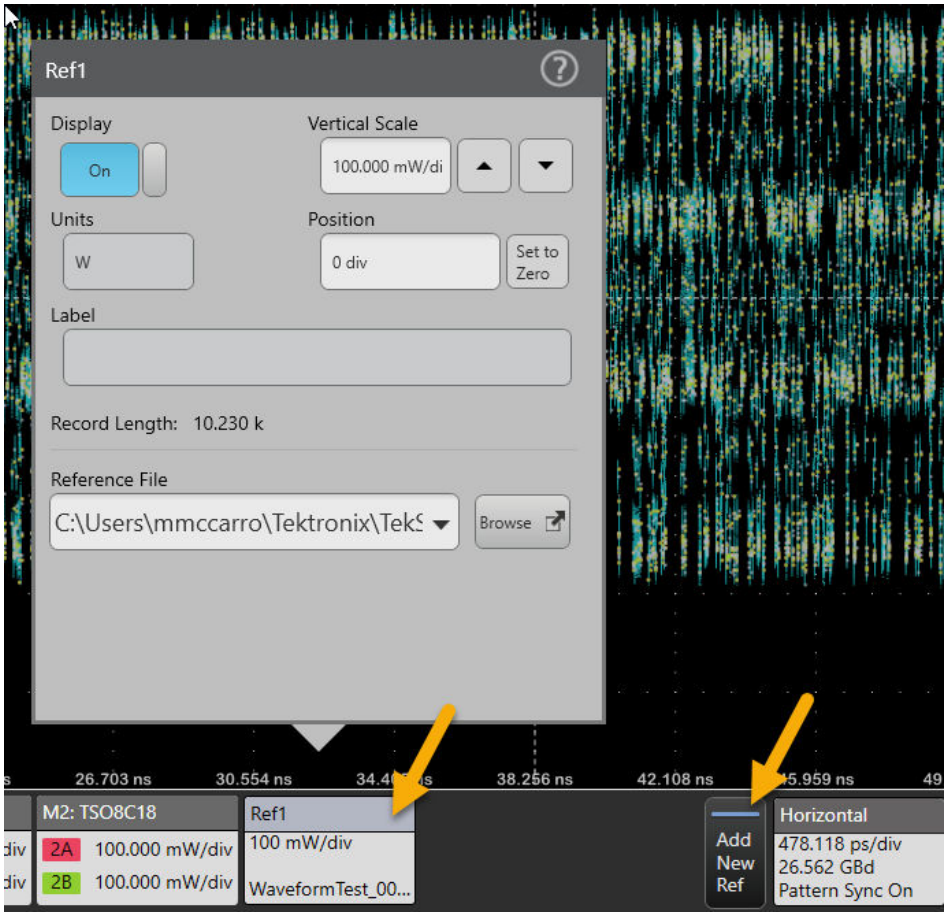


Table 6: Reference waveform configuration menu fields and controls

Field or control	Description
Display	Displays the reference waveform or turns the display off. Reference waveforms are shown in lighter colors than the souce waveforms.
Vertical Scale	Use the up and down arrows to set the vertical scale.
Units	Set the units label that you want to display on the vertical scale.
Position	Set the vertical position of the waveform by typing a new value in this field.
Set to 0	Click to reset the vertical position to 0.
Label	Adds a label to the waveform. Put the cursor in this field and type the text. The label text is the same color as the waveform. You can double-click a label to open a menu that will allow you to change the text, or you can open the Reference configuration menu for that label and change the text there.
Record Length	Read-only text that shows the sample rate and record length values of the reference waveform.
Reference File	Shows the path and file name of the current Reference waveform. Use the dropdown arrow to choose another reference waveform, or click the browse button to navigate to a new reference waveform. The dropdown arrow shows a list the twenty most recently accessed reference waveform files.

Table continued…

Field or control	Description
Browse	Opens the Browse Waveform File dialog. Use this dialog to navigate to and select a waveform file to load.

Math waveform configuration menu

Use this menu to configure the display settings for a Math waveform.

To open a Math waveform configuration menu, you must first have added a Math waveform using the **Add New Math** button, then a new math will be added with source as last selected source. After the math waveform displays on the waveform view screen double-click the **Math1** badge on the Settings bar.

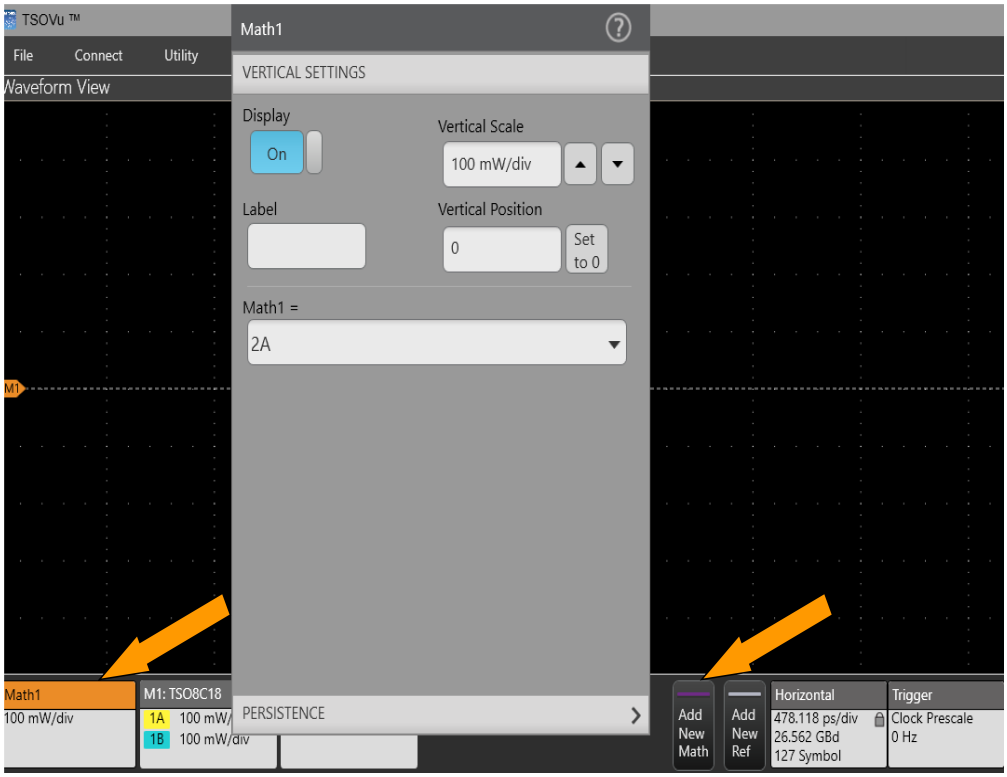


Table 7: Vertical Settings

Field or control	Description
Display	Displays the Math waveform or turns the display off.
Vertical Scale	Use the up and down arrows to set the vertical scale.
Position	Set the vertical position of the waveform by typing a new value in this field.
Set to 0	Click to reset the vertical position to 0.
Label	Adds a label to the waveform. Put the cursor in this field and type the text. The label text is the same color as the waveform. You can double-click a label to open a menu that allows you to change the text, or you can open the Math configuration menu for that label and change the text there.

Table continued…

Field or control	Description
Math[X]=	Math expression is shown using an editable drop down. The math expression may include any sequence of sources, operators, and functions using standard mathematical notation. The first entry in the drop down is the math expression using which the math was newly created. The math expression drop down contains the last five math expressions used to create that math source. Math supports standard arithmetic operators (+, -, *, /) and supports functions (FFE, FOLD, RESAMPLE).

Vertical Scale and Position are not editable when math is an eye.

Table 8: Persistence

Field or control	Description
Persist Data	Toggle persistence data on or off. Persist toggle button enables or disables the persistence for a given math.
Persistence	**Infinite**: Accumulates the data record points. **Variable**: Stores and displays accumulated data in the specified database until the user-specified waveform count is surpassed. Each waveform accumulated beyond the count removes the oldest waveform data in the database. Enter the waveform count in the field when this option is selected.
Color Grading	Use the drop-down menu to choose the color for the persistence data. The default selection of the persistence color combo box is the corresponding Math source channel color.

If math source is an eye then Persistence controls are available.

Math functions

FFE

FFE returns the FFE result vector.

Example: FFE(1A) applies FFE on the input waveform 1A.

The following configuration is available in the vertical settings:

Table 9: FFE configuration control

Name	Type	Default	Range	Descriptions
Extended search	Boolean	False	True, false	When enabled, the algorithms perform an extended search for the optimal FFE taps to optimize the TDECQ value, at a cost of long execution time. When disabled, the FFE taps are adapted faster but may be less optimal.
Vertical threshold adjust	Boolean	False	True, false	When enabled, the sub-eye threshold levels are allowed to adjust around OMAouter by a small range. IEEE 802.3cd allows this option to compute optimal TDECQ. When disabled, the sub-eye threshold levels are determined by OMAouter and AOP
Autoset FFE	Boolean	True	True, false	When enabled, the algorithms automatically optimize the FFE taps to minimize TDECQ. When disabled, the user provided FFE taps are used.
Always recalculate FFE	Boolean	True	True, false	When enabled, the algorithms re-calculate FFE taps at every run (when "Autoset FFE" is enabled). When disabled, the algorithms first attempt to use FFE taps from the previous calculation.
FFE Lock Main Cursor	Boolean	False	True, false	When enabled, the TDECQ FFE adaptation happens with main cursor locked to a position mentioned in "FFE Main Cursor Position" configuration

Table continued…

Name	Type	Default	Range	Descriptions
FFE Main Cursor Position	Integer	2	[0, FFE number of taps - 1]	Indicates the position of main cursor with 0 indicating first tap. This parameter used only if "FFE Lock Main Cursor" is enabled.
FFE number of taps	Integer	5	[1,99]	Number of FFE taps.
FFE number of taps per UI	Integer	1	[1,2]	Number of FFE taps per unit interval.
FFE maximum number of precursors	Integer	2	[0,FFE number of taps - 1]	Maximum number of pre-cursor FFE taps. Must be less than the number of FFE taps.
Target SER	Float	4.8e-4	[1e-15, 1e-2]	Target SER at which TDECQ is computed.
Histogram width	Float	0.04	[0.01, 0.08]	Widths of the left and right histograms processed to compute TDECQ.
Histogram spacing	Float	0.1	[0.08, 0.12]	Horizontal spacing of the left and right histograms processed to compute TDECQ. They are located symmetrically across the UI center
Vertical adjustment limit (%)	Float	1	[0,3]	Limit by which vertical threshold can adjust relative to OMAouter.

The Taps text box is editable if Autoset FFE is turned off else read-only. In editable mode, the tap values are shown with original precision and in read-only mode, the tap values are shown with precision of up to six decimal places only.

RESAMPLE

Resamples the input waveform to the user given SPUI. If the required SPUI does not result in an integer record length, the SPUI is coerced into the next valid SPUI, which would result in an integer record length.

Record Length = Pattern Length x SPUI.

Example: resample(1A, 41.1)

FOLD

Folds the input waveform to create an eye diagram. If the input vector has integer SPUI, it is upsampled to the next valid non integer SPUI to get a proper eye diagram.

Example: fold(1A)

When **FOLD** is applied on the math waveform, the following configuration shall be available in the vertical settings.

Table 10: Fold configuration control

Name	Type	Default	Range	Description
Auto Position	Boolean	TRUE	True, False	When enabled, the eye diagram is auto positioned. When disabled, you can enter the Horizontal position value to allign the eye diagram.
Horizonal Position	Float	First sample time of the input waveform	First sample time of the input waveform to the last sample time of the input waveform	The Horizontal units are time. The Horizontal position is the time between trigger and the first point in the record.

Multi-mode dispersion filter

A Multi-mode dispersion filter as per the IEEE802.3db (Section 167.8.5) specification is supported in the MATH sub-system.

The expression for executing the dispersion filter in MATH is as follows:

dispersionfilter(source, [mm_dispfilter_elec_BW], [ref_rx_elec_BW], [samples_per_UI])

Where:

- **source**: The input on which dispersion filtering is done
- **mm_dispfilter_elec_BW**: Multi-mode dispersion filter electrical BW. This is an optional parameter. If not given, then internally it will assume as 33.6 GHz.
- **ref_rx_elec_BW**: Reference receiver electrical BW. This is an optional parameter. If not given, then internally it will assume as 26.5625 GHz.
- **samples_per_UI**: Samples per UI. This needs to be given if “source” is having different samples per UI than what is configured in the horizontal subsystem. For example, dispersionfilter(resample(source, x), mm_dispfilter_elec_BW, ref_rx_elec_BW, x)

"source" can be live channel (after BWE or before BWE), MATH or Ref. It should be single valued signal.

If **"mm_dispfilter_elec_BW"** is 0, then the multimode dispersion filter is disabled.

If **"ref_rx_elec_BW"** is 0, then the reference receiver filter is disabled.

If expression is set to dispersionfilter(source, mm_dispfilter_elec_BW), then **"ref_rx_elec_BW"** is set to 26.5625 GHz.

If expression is set to dispersionfilter(source) then **"mm_dispfilter_elec_BW"** is set to 33.6 GHz and **"ref_rx_elec_BW"** is set to 26.5625 GHz.

When the input source for the dispersion filter is a reference waveform, the H(x) of the s-parameter is an all-pass filter.

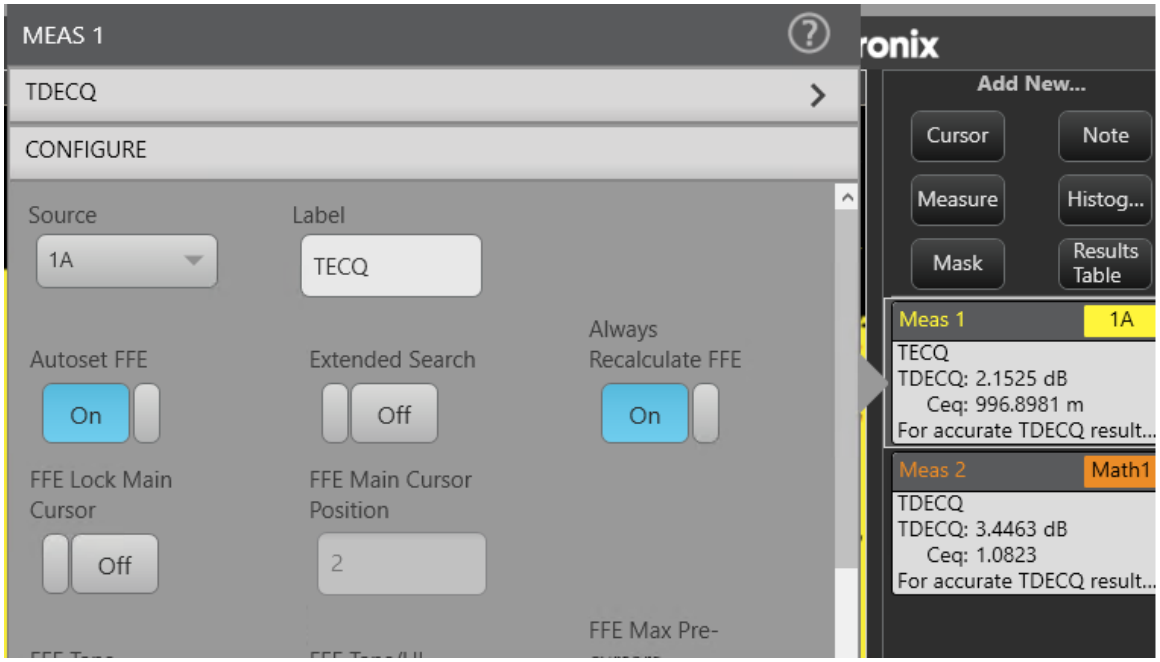
When the input source for the dispersion filter is another MATH in live mode, the H(x) of the s-parameter corresponds to the live source on which MATH was executed.

Example: Math1 = functionX(1A), Math2 = function(Math1), Math3 = dispersionfilter(Math2) then dispersion filter uses the S-parameter of 1A.

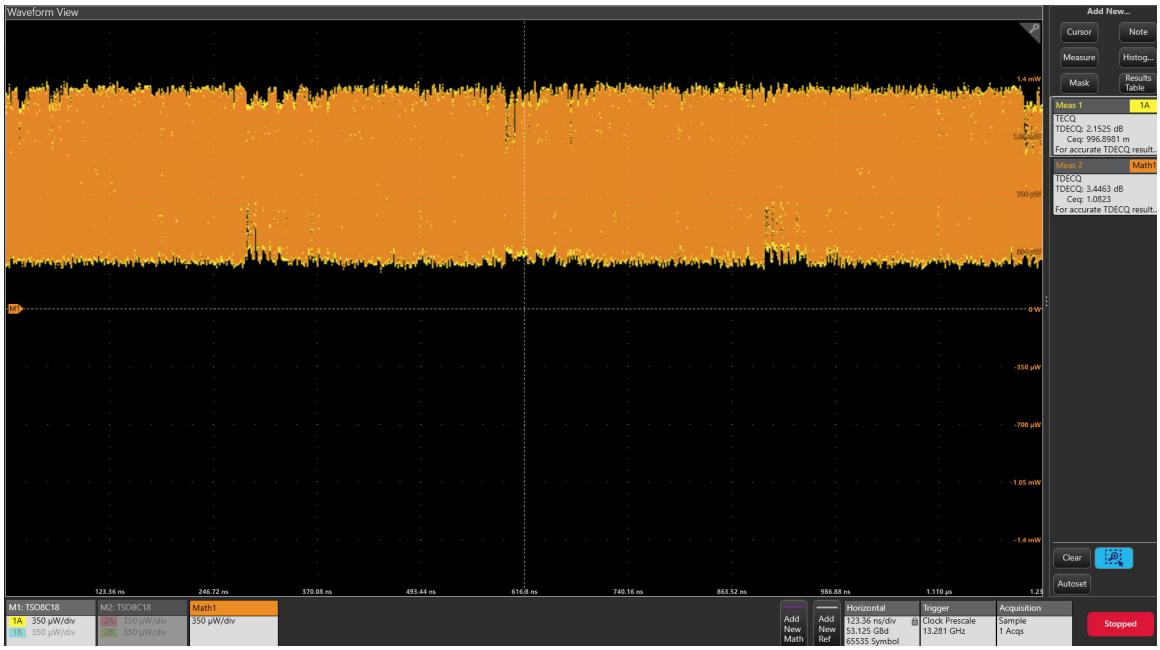
Execute TECQ and TDECQ in one single acquisition

By using this filter in MATH, user can execute TECQ an TDECQ in one single acquisition.

1. Configure horizontal settings (symbol rate, pattern length, and data-to-clock ratio).
2. Assuming 1A is the channel, go to the optical settings of 1A, enable BWE, and set the electrical bandwidth to 26.5625 GHz.
3. Configure MATH1 as dispersionfilter(1A_raw, 33.6, 26.5625).
4. Execute TDECQ on 1A (meas 1) and MATH1 (meas 2).
5. Change the label of meas1 to **"TECQ"**.



6. **"meas1"** will give a TECQ result, and **"meas2"** will give a TDECQ result.



Examples of math expressions supported with dispersion filter

- dispersionfilter(1A_raw)
- dispersionfilter(1A_raw,33.6)

- dispersionfilter(1A_raw,0,26.5625)
- dispersionfilter(1A_raw,0,0)
- dispersionfilter(resample(1A_raw,19.276),33.6,26.5625,19.276)
- resample(dispersionfilter(1A_raw,33.6),12.2)
- ffe(dispersionfilter(1A_raw,0,26.5625))
- ffe(dispersionfilter(resample(1A_raw,10.1),33.6,26.5625,10.1))
- ffe(resample(dispersionfilter(1A_raw,0,26.5625),9.84))
- fold(dispersionfilter(1A_raw,33.6,0))
- fold(resample(dispersionfilter(1A_raw,0,26.5625),21.2))

Add a label

About this task

Labels appear in the Waveform View and as the name of the designated measurement badge.

Before you begin

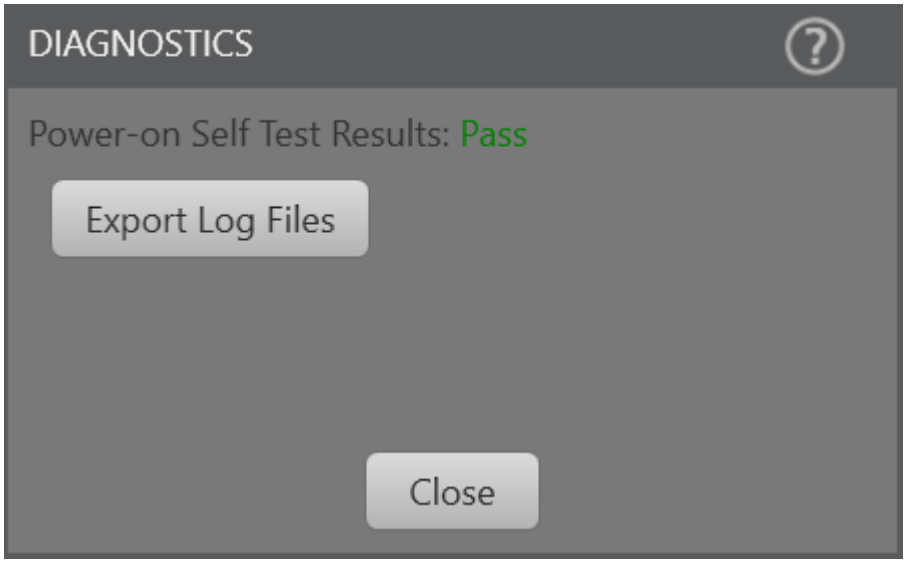
Prerequisite: You must first have added a measurement. See the *Add measurement* topic for details.

Procedure

1. Under the Add New... panel, double-click a measurement badge to open its configuration window.
2. Select the **Configure** panel.
3. Click the **Label** field and enter the desired text.
4. Click anywhere outside the configuration menu to close it.

Diagnostics

Shows the status of the power-on self test and allows you to export log files.



See also: *TSOVu user interface*

Set the graticule style and intensity

Use this procedure to set the graticule (display grid) style and intensity.

Procedure

1. Double-click on an open graticule area to open the Waveform View configuration menu.
2. Click the **Graticule Style** field to select a graticule style from the list.

   Grid provides a grid, cross hairs, and frame on the waveform view.

   Time provides a vertical grid of time marks, cross hairs, and frame on the waveform view.

   Full shows a frame and a grid on the waveform view. This style is useful for making quick, full-screen measurements with cursors and automatic readouts when cross hairs are not needed.

   None provides a frame without a grid and cross hairs.
3. Use the up and down arrow buttons to set the intensity, that is, brightness, of all graticules.

   Note: Changing the graticule intensity also changes the intensity of vertical scale readouts and horizontal time readouts on the screen. Graticule intensity does not change the intensity of note text on the screen.

Trigger

Trigger settings

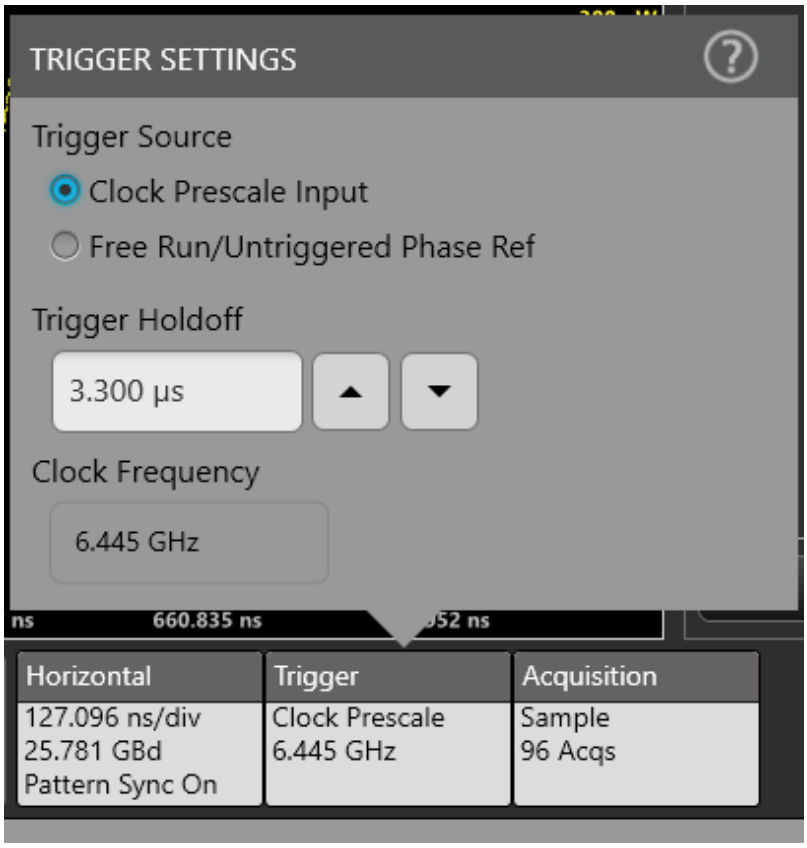
Use the Trigger menu to define the channel or signal conditions on which to trigger the oscilloscope.

Operate the instrument either in free run mode or use a clock signal that is synchronized to data as a trigger.

Clock Prescale Input. To use this trigger type, you must connect the trigger signal to the Clock Prescale Input.

Free Run/Untriggered Phase Ref. Sets the instrument to free run (untriggered) acquisition mode. Use Free Run to quickly validate signal presence and amplitude of input signals.

Double-click the **Trigger** badge to access the Trigger Settings menu.



Use the **Trigger Holdoff** controls to set the holdoff.

You cannot change the **Clock Frequency**. This read-only field shows the current clock frequency.

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