



8 Series Sampling Oscilloscope and TSOVu Application Help

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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 at 56 Gb/s and 28 Gb/s at up to 30 GHz bandwidth (determined by the bandwidth of installed modules).

Key performance specifications

- Low time base jitter
- Optical bandwidth above 30 GHz
- Single mode and multi-mode support for 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 like 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, eliminating the need to wait / sleep statements.

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 4 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 [Contacting Tektronix](#) on page 0 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 these documents, visit the Tektronix Web site at www.tek.com. You can find manuals by searching on 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.	8 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.

Tektronix Learning Center, YouTube, and Blog

You can browse the Tektronix YouTube channel, Tektronix Blog, and the Tektronix Learning Center to access all the latest online tutorials and resources, from primers and white papers to demos and webinars, to help you grow your expertise.

Finding the Tektronix Learning Center

Select Support > Learning Center Tutorials to access the Tektronix Learning Center. You can browse tutorials by product family and view the top 5 downloads.

Tektronix / Learning Center

Learning Center

Home to the most downloaded Tektronix learning materials.

The Tektronix Learning Center provides you with access to all the latest online tutorials and resources - from primers and white papers to demos and webinars - to help grow your expertise.

Compare features and functions of products ranging from [oscilloscopes](#) to [arbitrary waveform generators](#) to better understand how Tektronix products can help solve your application needs.



All tutorials by content area:

- [Source Measure Unit \(SMU\) Tutorials](#)
- [Oscilloscope Tutorials](#)
- [Logic Analyzer Tutorials](#)
- [Signal Generator Tutorials](#)
- [Digital Multimeter Tutorials](#)
- [Spectrum Analyzer Tutorials](#)
- [Video Test Tutorials](#)
- [Probes Tutorials](#)

Top 5 Downloads:

1. [XYZs of Oscilloscopes](#)
2. [ABCs of Probes](#)
3. [A Guide to MPEG Fundamentals](#)
4. [Real-time Spectrum Analysis Fundamentals](#)
5. [Understanding and Characterizing Timing Jitter](#)

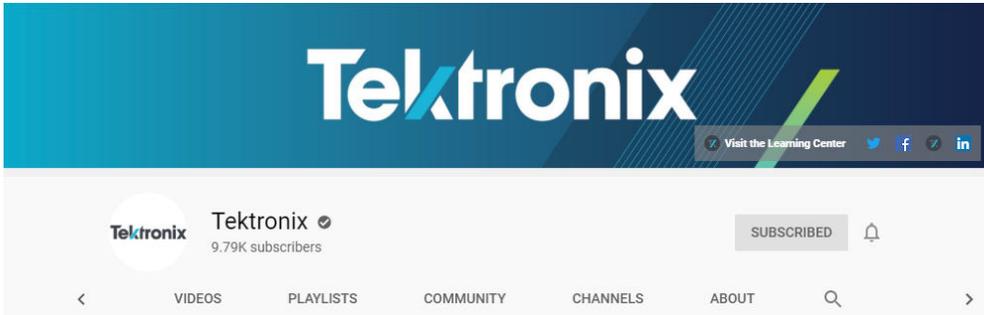
Runner up: [The Oscilloscope: Basic Features & Functions Poster](#)



Searching for topics on the Tek YouTube channel

Go to www.youtube.com/tektronix to find video tutorials about various topics related to your product and applications. You can subscribe to the Tektronix YouTube channel to keep up with new postings.

For example, you can watch a video demonstration of eye diagram measurements on 25Gb/s data transmission over single-mode and multi-mode fiber. To find a video on a topic, do the following. (The following image shows you what the Tektronix YouTube Channel looks like.)



1. Click on the search icon located next to About.

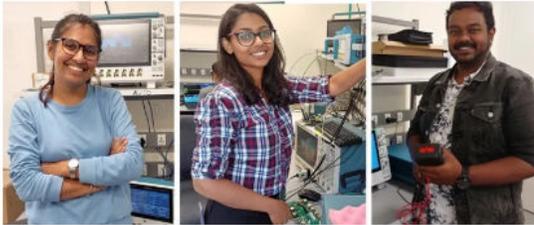
This icon allows you to search the Tektronix YouTube channel specifically. The search icon located at the top of the page allows you to search all of YouTube.

2. Type in the key phrase you are looking for in the search field. For example, "optical measurements".
3. Click the search icon to start the search.
4. Videos related to the topic will appear. Click a video to view it.

Finding the Tektronix Blog

Search for "blog" on www.tek.com to see what's new and what is happening in the Tektronix community. You can also search for postings from our experts.

Blog



Engineer's Day 2019

NEW

Sunday, September 15, 2019 by:

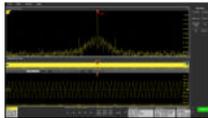
Experts

My first mentor once told me, "There is noth called *advanced*. There's *basics* and there's *basics*." Since that day, nothing has stoppec hunger for learning and improving. Every da

challenge. But an engineer doesn't need motivation to complete a task. My older sister likes to remind me th dedicated person is always on the go." Surprisingly she was right! -- Tektronix India engineer, Avantika

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Posts



Tektronix 4 Series MSO vs Keysight 4000A X-Series Oscilloscopes

Thursday, April 2, 2020 | by: [Tektronix Experts](#)

With all the information out there comparing oscilloscopes, it can be time consuming trying to determine which model is right for your needs. You can do your own comparisons based on information published in datasheets, or even find where others have done these comparisons for you. The challenge is understanding how the key specifications and instrument limitations impact what you ultimately need ...

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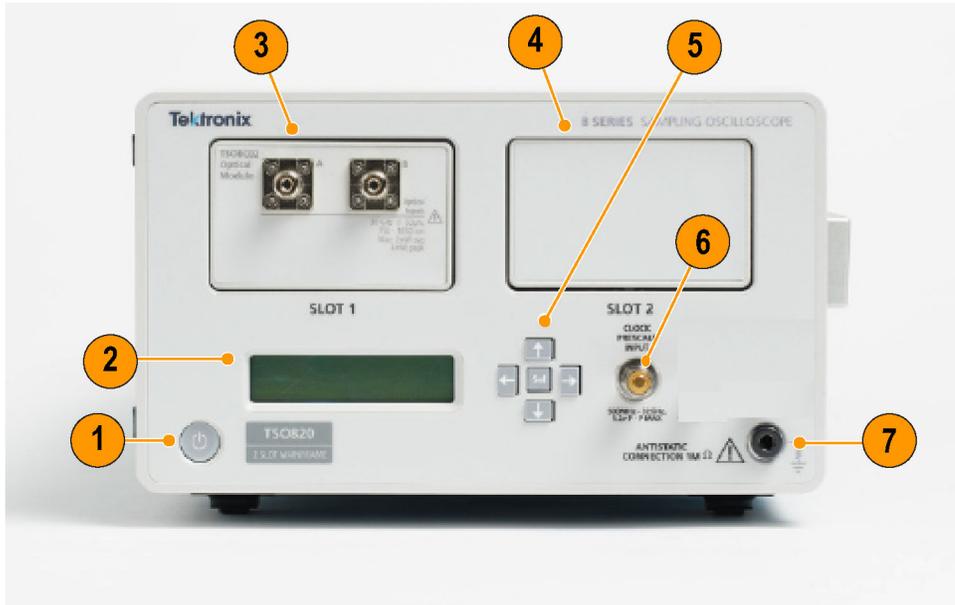


[David Pereles](#)
Blog Posts: 18

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 1M Ω	A banana-jack antistatic connection of 1 M Ω 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.

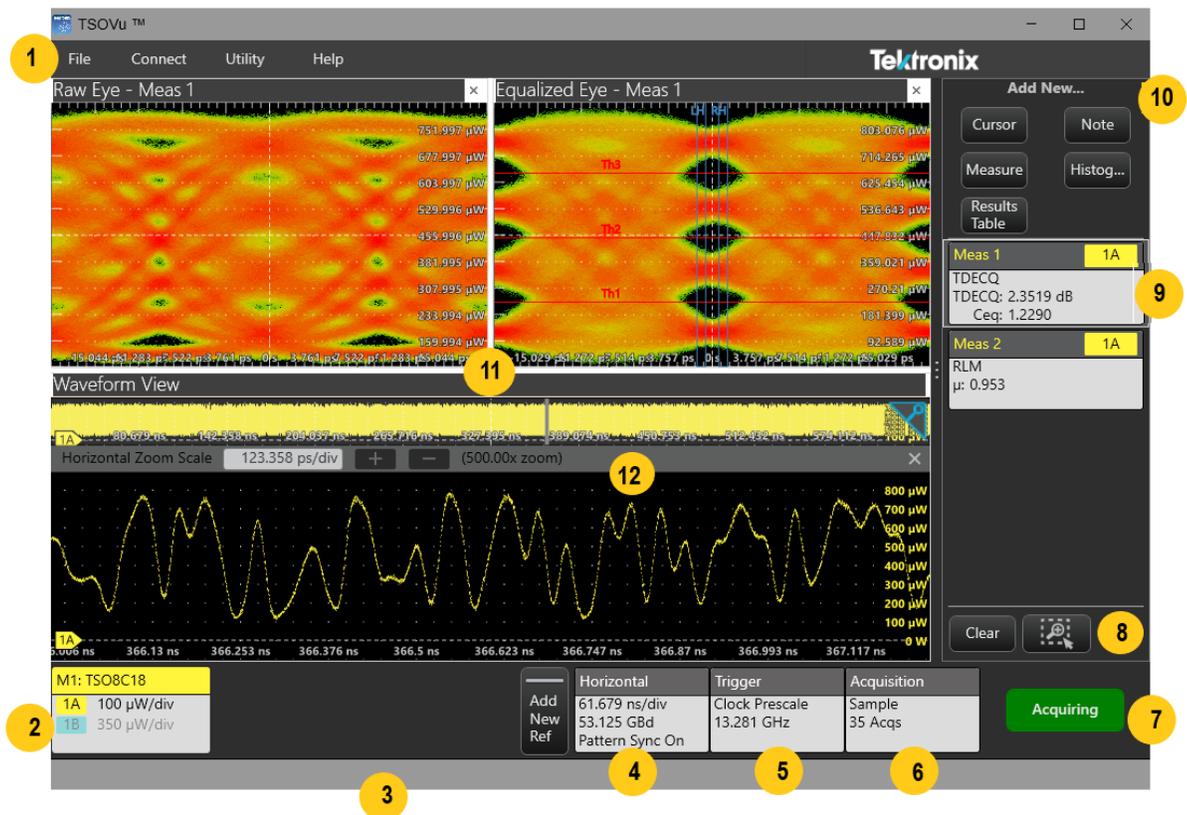
Never leave a module slot empty while the instrument is powered on and running. Always have a filler or regular modules installed to ensure proper air flow and temperature stability.

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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>
	Default setup	Stops acquisition and returns the application to its default setup.
Exit	Closes the TSOVu application.	

Table continued...

Menu	Options	Description
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).
Utility	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.

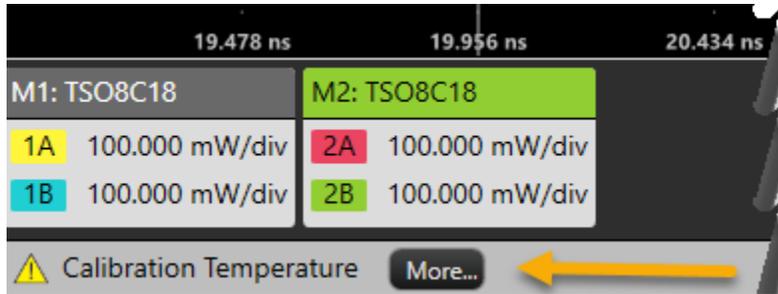
See the [Vertical configuration](#) topic for details.

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. Double click 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

Draw A Box for zoom or histogram button. This dual purpose button 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, cursors, notes on the display, histograms, and results tables. See these topics for more details: [Add measurement](#), [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.

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 also includes the Pulse measurements plug-in. 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 <i>Note that the time to calculate the TDECQ result is inversely proportionate to the clock speed.</i>
Memory	Minimum 16 Gbytes
Disk	256 GBytes SSD or more
Networking	1 Gigabit Ethernet wired

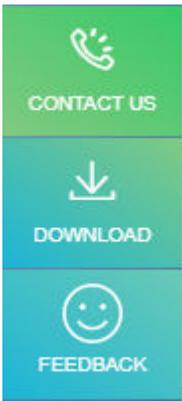
Other software requirements

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

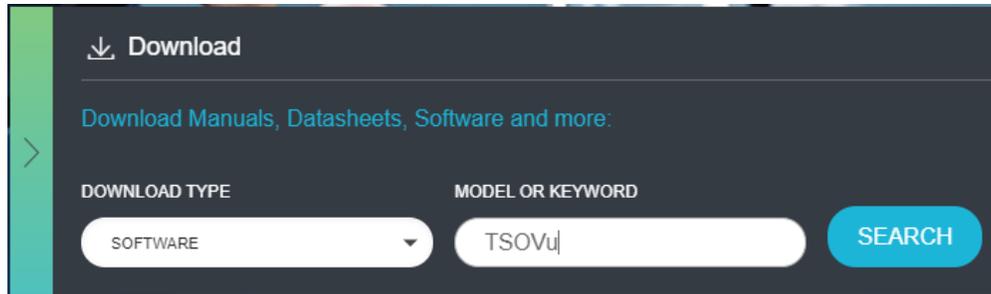
Install TSOVu software

You must install the base software before installing any plug-ins. The downloadable package will 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 will 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 will automatically restart when the installation is complete.
5. A TSOVu icon will 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.
- **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

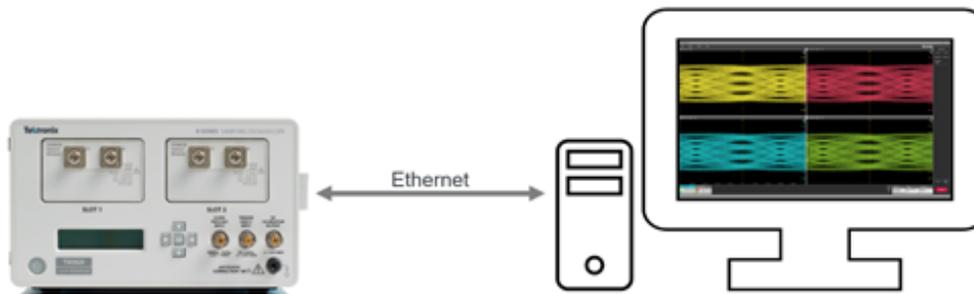
Connect to network and TSOVu

Available product documentation

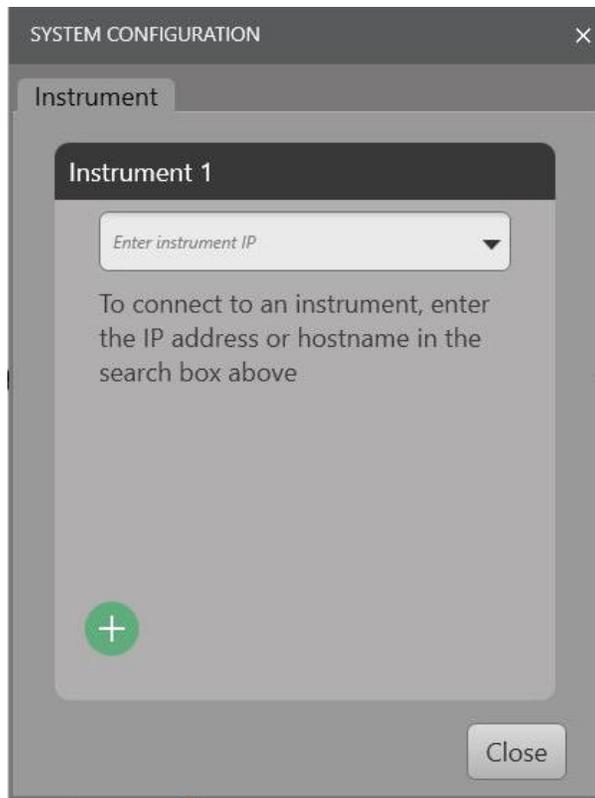
Connect the mainframe to the network and TSOVu

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.

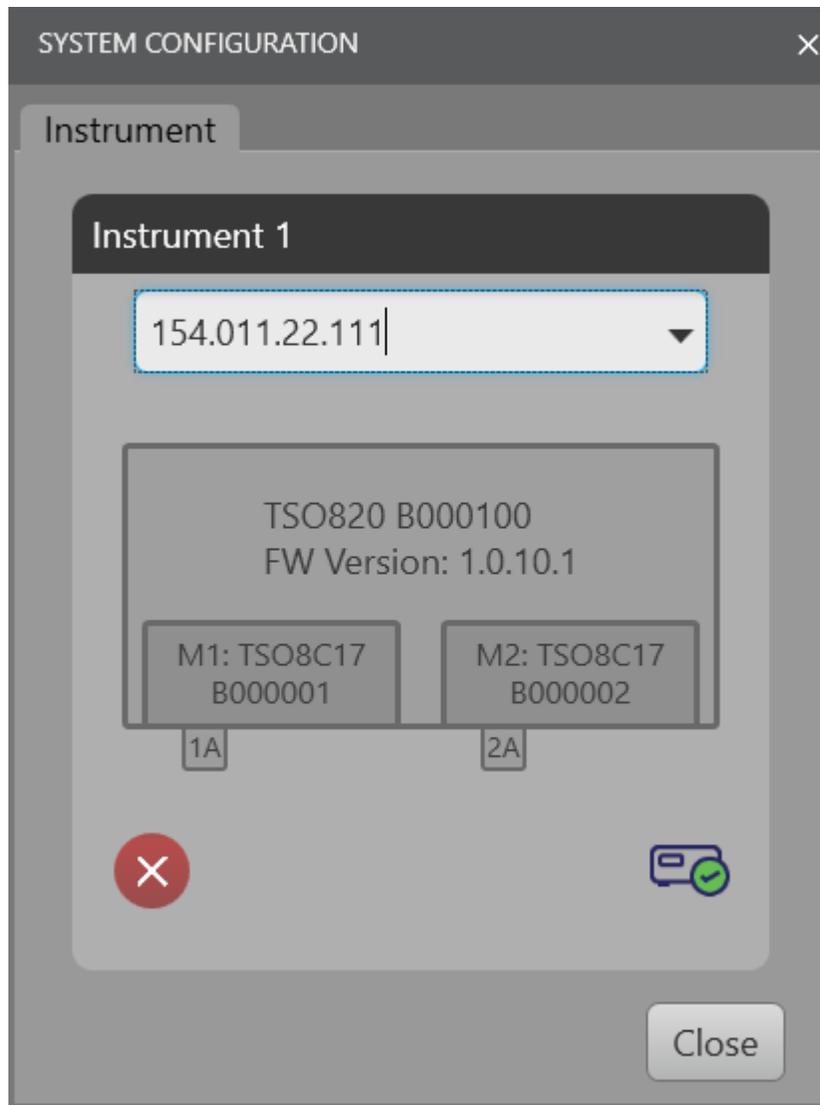
Use the included CAT6 Ethernet cable. If you use a different type of Ethernet cable, it must be a CAT6 or faster cable and it should be consistent with the network speed you require.



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.

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.

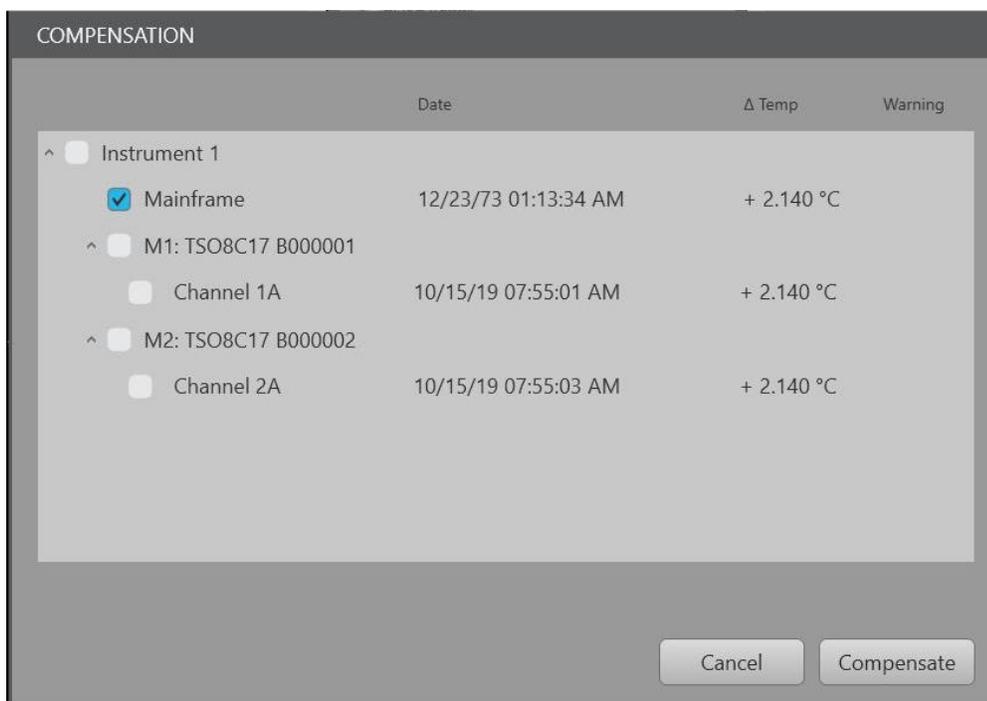
There are two nonvolatile compensation memory areas in the mainframe and for each channel within a sampling module, referred to as Factory and User compensation memories. Also, there is a volatile, in-use memory version of all compensation data, referred to as the run-time compensation memory, that holds 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

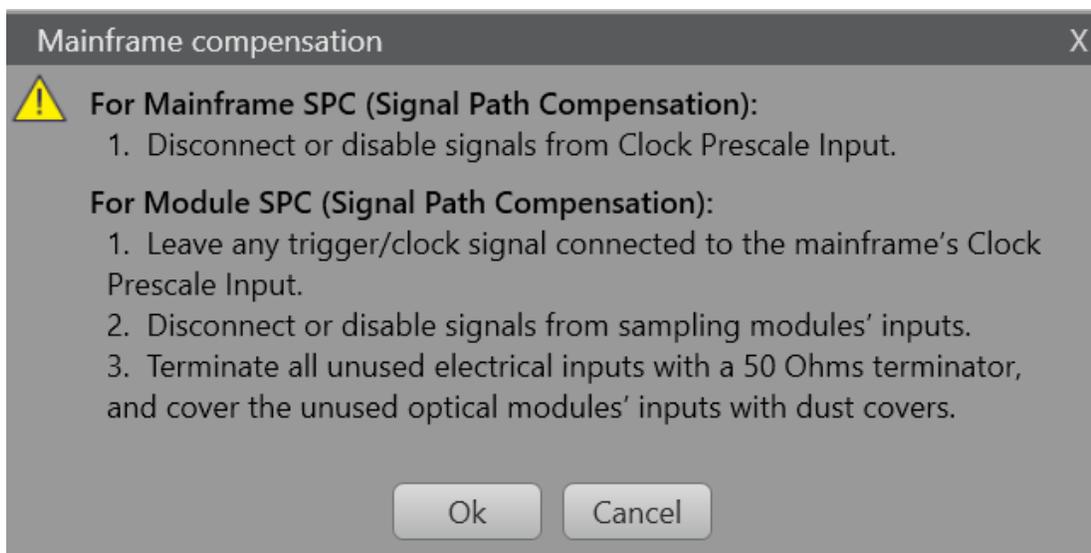
1. Run the mainframe SPC

- 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.

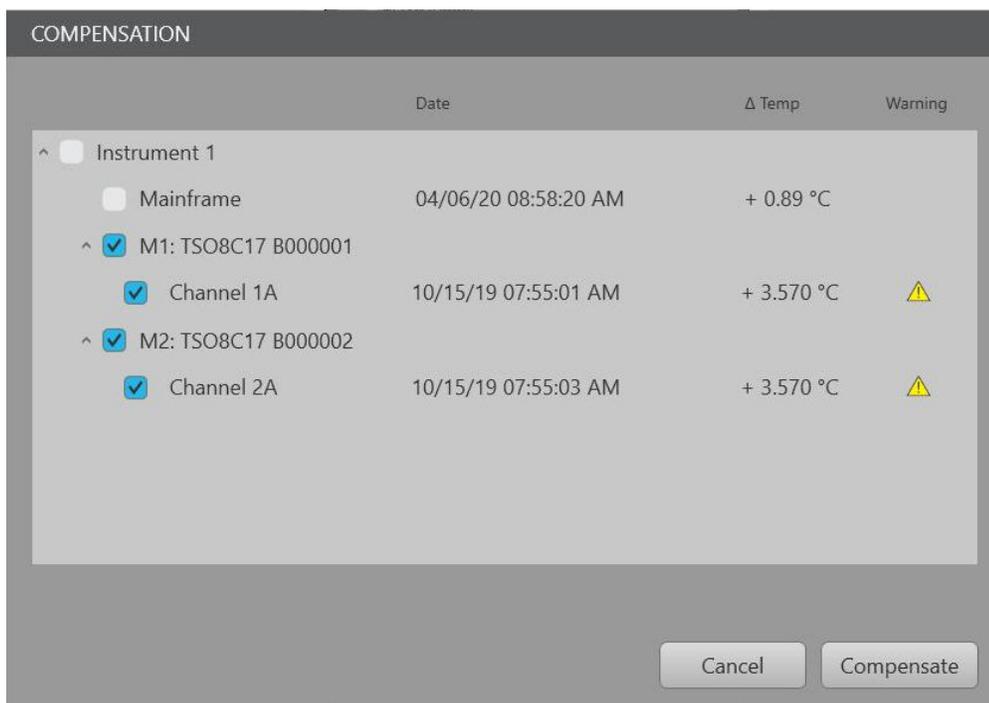


- e) Click the **OK** button.
 The SPC will run. This may take several minutes. The Compensation window shows you the results of the test. If the instrument passed, a message appears in the lower left portion of the window stating compensation was successful and the timestamp will be updated.

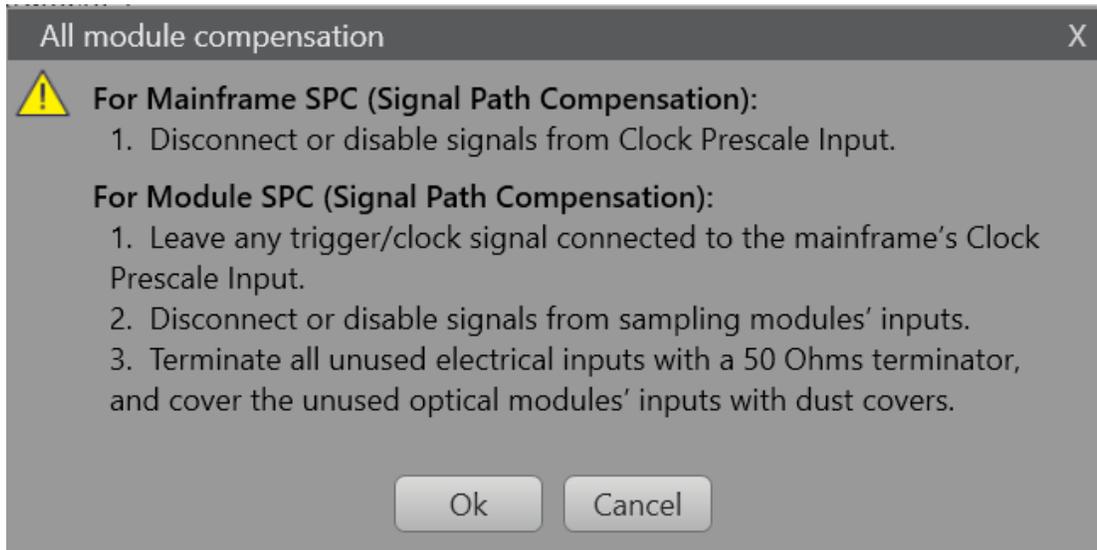
If the SPC fails, a pop-up error dialog will appear. Make sure that all cables are disconnected and run the SPC again. If the SPC still fails, contact Tektronix Customer Support.

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](#).

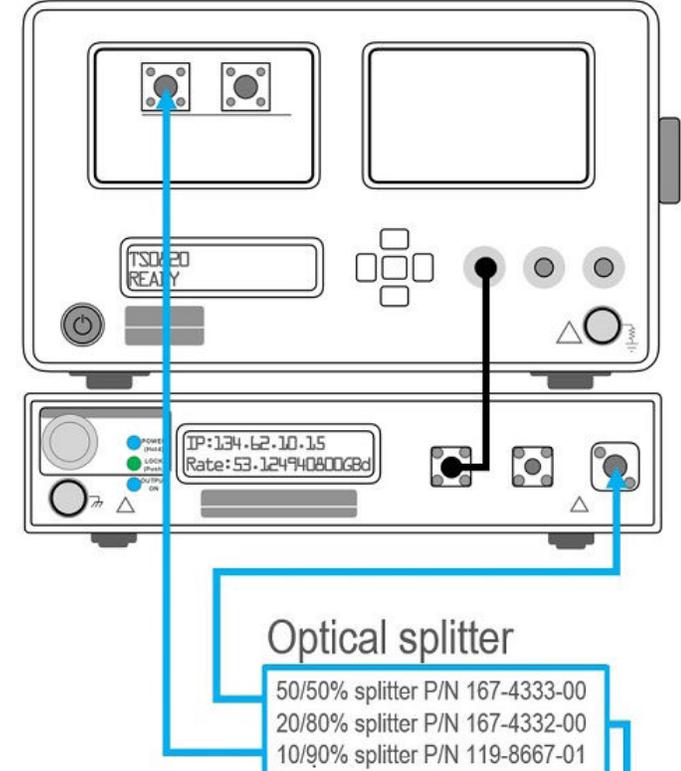
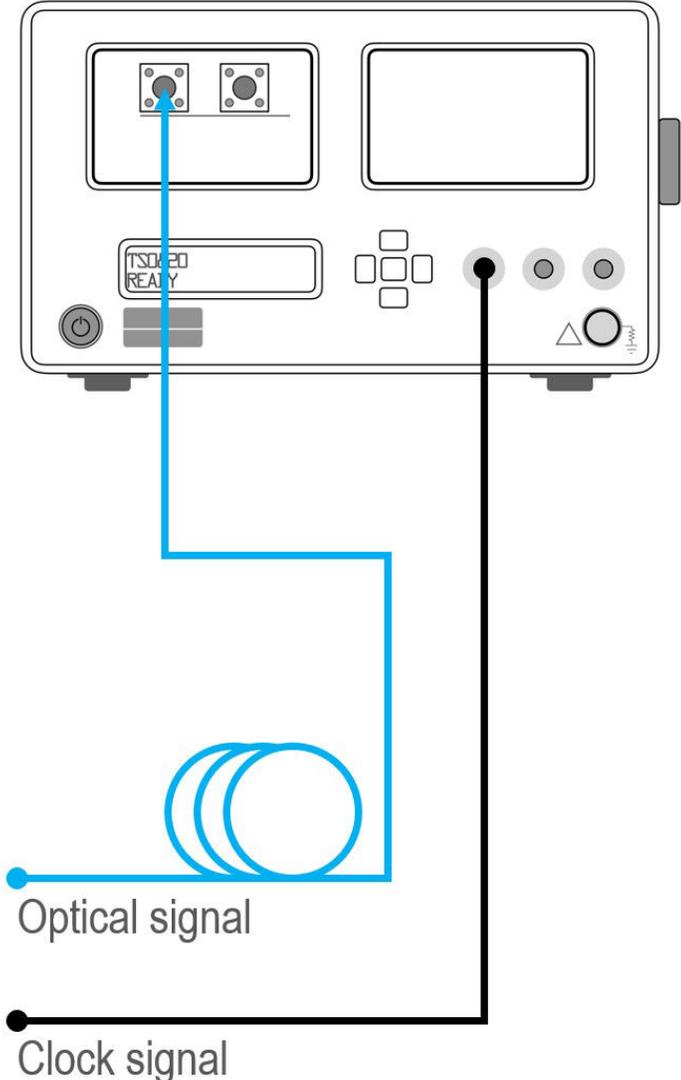
Dark-level compensation maximizes the accuracy of the extinction ratio and other optical automatic measurements. Dark-level compensation is not saved and is only valid for the selected bandwidth or filter path and the internal optical power meter.

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.



Optical splitter

- 50/50% splitter P/N 167-4333-00
- 20/80% splitter P/N 167-4332-00
- 10/90% splitter P/N 119-8667-01

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.

The screenshot shows the 'HORIZONTAL SETTINGS' dialog box. It contains the following settings:

- Pattern Sync:** On (toggle)
- Symbol Rate:** 53.125 GBd
- Samples / UI:** 10
- Data Clock Ratio:** 4:1
- Pattern Length:** 2¹⁵-1 PRBS (32767 Symbol)
- Horizontal Scale:** 61.679 ns/div
- Record Length:** 327.670 kSamples
- Resolution:** 1.882 ps

At the bottom, there is a table summarizing the settings:

	Horizontal	Trigger	Acquisition
Add New Ref	61.679 ns/div 53.125 GBd Pattern Sync On	Clock Prescale 13.281 GHz	Sample 37 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.
Symbol Rate	Symbol Rate of the input signal.
Samples / UI <i>(Only available when Pattern Sync is On)</i>	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.
Pattern Length <i>(Only available when Pattern Sync is On)</i>	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.
Horizontal Reference <i>(Only available when Pattern Sync is Off)</i>	Shows the point around which channel waveforms expand and contract horizontally on screen as you change the Horizontal Scale control.
Horizontal Position <i>(Only available when Pattern Sync is Off)</i>	The horizontal units are time. The horizontal position is the time between trigger and the first point in the record.
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)

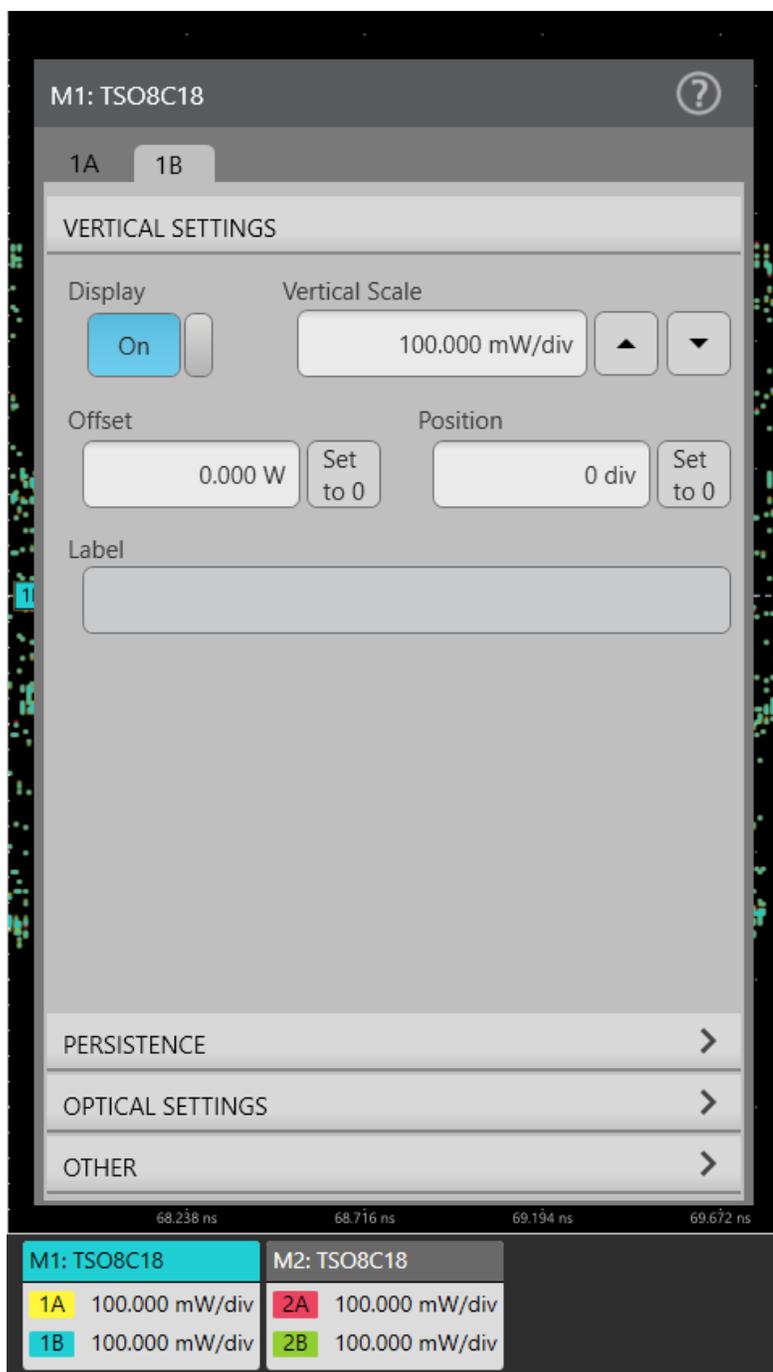


Table 1: Vertical Settings

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.

Table continued...

Field or control	Description
Offset	<p>Sets the channel signal vertical offset. Type the value that you want in the field.</p> <p>Click Set to 0 to set the vertical offset to 0 Watts.</p> <p>For more accurate measurements, set this to 400 μW for small signals (signals with Average Optical Power (AOP) < 500 μW). 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.</p>
Position	<p>Sets the vertical position. Type the value that you want in the field.</p> <p>Click Set to 0 to set the Position to 0 divisions.</p>
Label	<p>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.</p>

Table 2: Optical Settings

Field or control	Description
Wavelength	Select a wavelength from the drop-down menu.
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 <i>(Only available when BWE Filter is selected)</i>	Select PAM4 or NRZ.
BW Electrical	Select the appropriate bandwidth. This option depends on the data rate of the signal.
Filter Details	Read only text shows you the filter details.

Table 3: Persistence

Field or control	Description
Persist Data	<p>Toggle persistence data on or off.</p> <p>Data is cleared either by an explicit clear action or by any setting change that controls acquisition parameters.</p>
Persistence <i>(Available only when Pattern Sync is off.)</i>	<p>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.</p> <p>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.</p> <p>Enter the waveform count in the field when this option is selected.</p>

Table continued...

Field or control	Description
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.

Vertical channel deskew

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

About this task

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

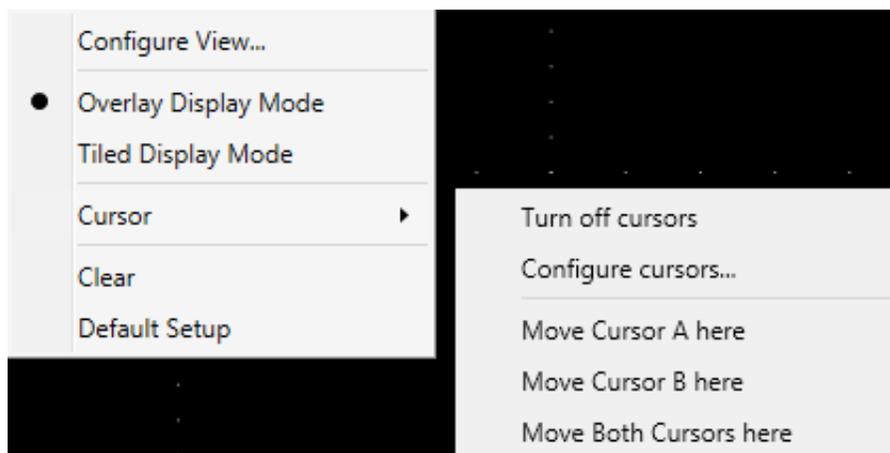
Adjust deskew to add an independent, channel-based delay time to the horizontal position. (For the left position indicator, this is the common trigger point to the first sample taken for each channel). Deskew is applied to the strobe drive and is common to both channels in the module. It is therefore 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.
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

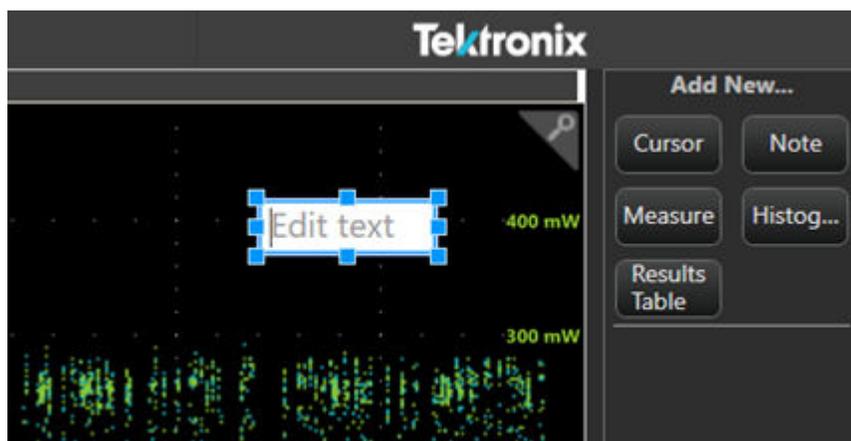
You can add notes to your waveforms. The text is not attached to the waveform. If you turn off the waveform source, the text remains on the screen.

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.



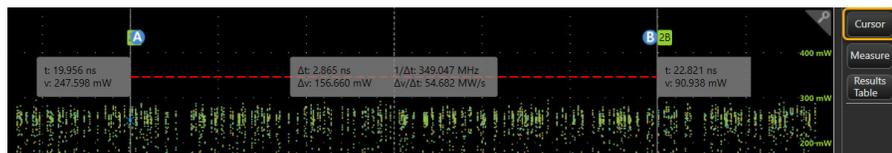
2. You can click once in the note text later to change it if needed.
3. You can click and drag the text to position in wherever you need.
4. You can add multiple notes to the same waveform view.
5. To delete a note, right click on it and choose **Delete**.

Cursors

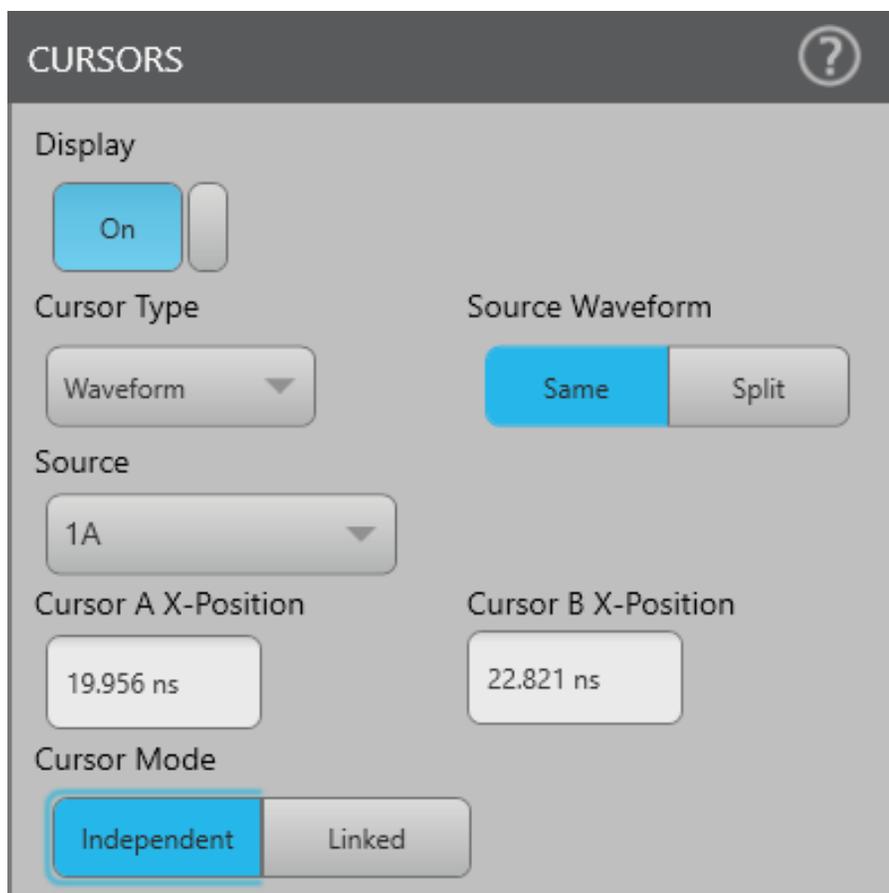
Use one of four different cursor types in the measurement view.

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.

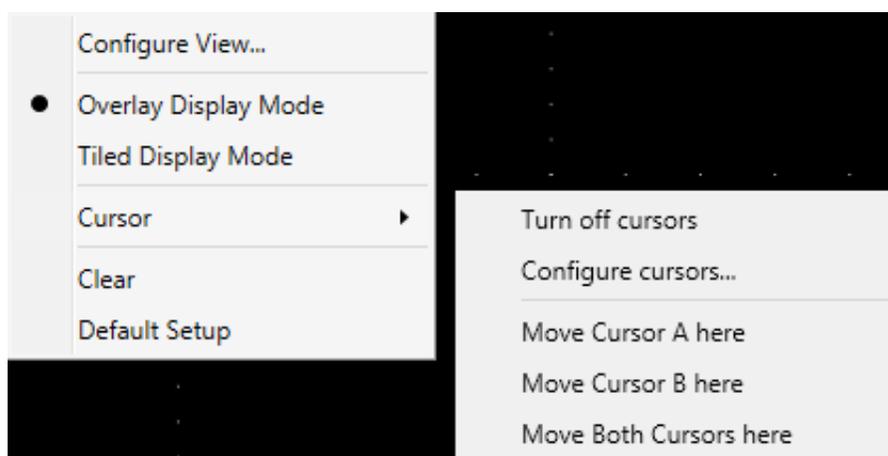


2. Double-click on one of the gray cursor readouts to open the cursors configuration window. You can also right-click on a gray cursor readout or on the waveform and select **Configure cursors**.



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

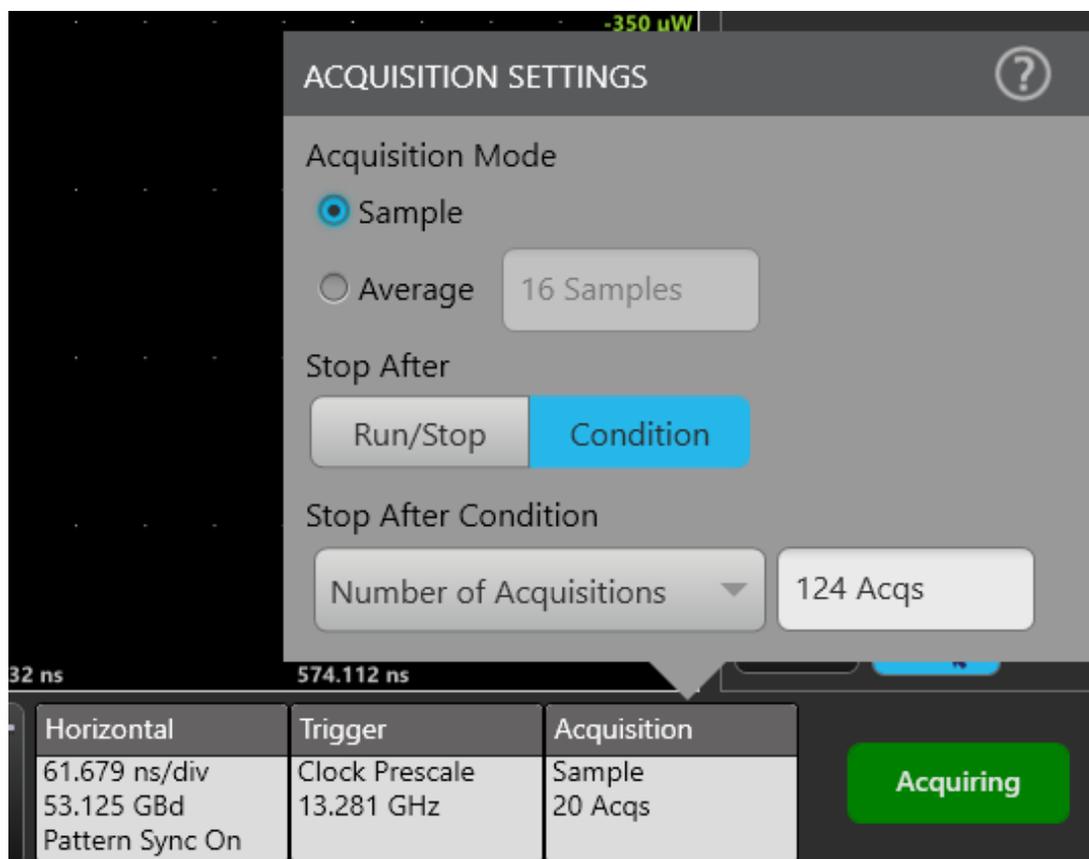
Field or control	Description
Display	Toggle the cursor display On or Off .
Cursor Type	<p>Select one of the following the cursor types:</p> <p>Waveform cursors measure vertical amplitude and horizontal time parameters simultaneously at the point the cursor intersects a waveform. The cursor intersect point tracks waveform amplitude changes.</p> <p>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.</p> <p>H Bars are horizontal cursors that measure amplitude. They are not associated with the waveform, but show the amplitude position of the cursor.</p> <p>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.</p>
Source	Select the waveform source to which you want to apply cursors.
Source Waveform	<p>Select whether to apply cursor configurations to a single source or multiple sources.</p> <p>Same sets the A and B cursors to the same waveform source.</p> <p>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.</p>
Cursor A X-Position	<p>Only available when Cursor Type is set to Waveform.</p> <p>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.</p>
Cursor B X-Position	<p>Only available when Cursor Type is set to Waveform.</p> <p>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.</p>
Cursor Mode	<p>Select the cursor mode.</p> <p>Independent mode allows you to move each cursor separately.</p> <p>Linked mode allows you to move both cursors at the same time.</p>

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 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.
4. 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.
5. 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.
6. 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).

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. 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.

ADD MEASUREMENT ⓘ

PAM4 PULSE

High
High indicates top reference level for the waveform.

Source
2A ▼ Add

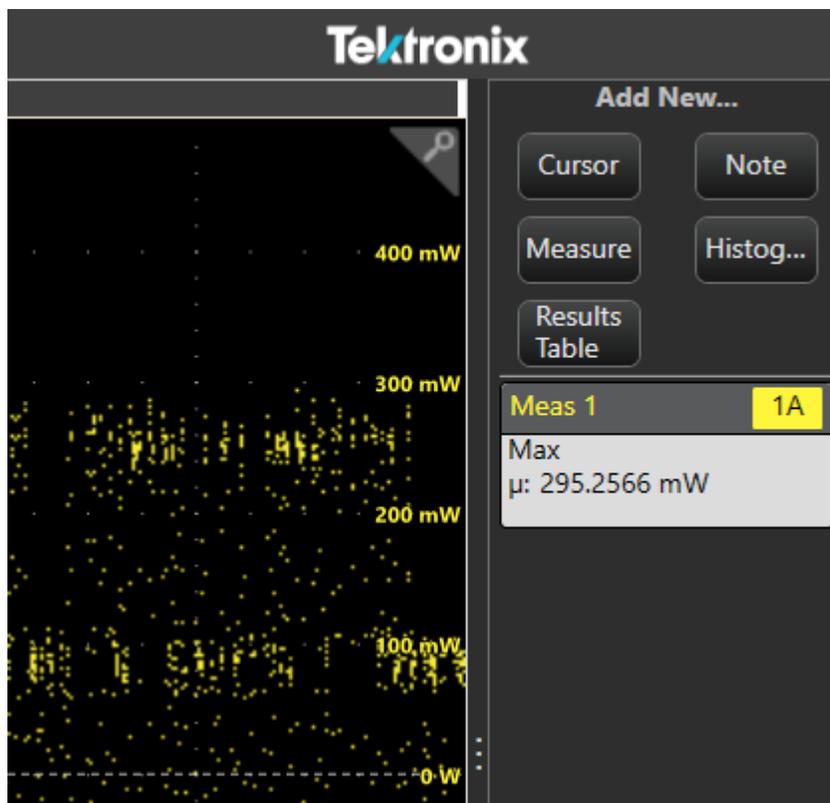
AMPLITUDE

	High		Low		Amplitude
	Max		Min		Mid
	Mean		Pk-Pk		AC RMS

TIMING >

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. 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)

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:
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
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	<p>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.</p> <p>Selectable tracking algorithm settings:</p> <p>Auto</p> <p>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.</p> <p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values below the midpoint.</p> <p>Mode</p> <p>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.</p> <p>Min/Max</p> <p>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).</p>
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	<p>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.</p> <p>Selectable tracking algorithm settings:</p> <p>Auto</p> <p>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.</p> <p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above and below the midpoint.</p> <p>Mode</p> <p>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.</p> <p>Min/Max</p> <p>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).</p>
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		
	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.

Table continued...

Control		Description
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

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 = $T_{cross3} - T_{cross1}$, where T_{cross3} and T_{cross1} 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	<p>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.</p> <p>Selectable tracking algorithm settings:</p>
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
	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	<p>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.</p> <p>Selectable tracking algorithm settings:</p> <p>Auto</p> <p>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.</p> <p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p> <p>Mode</p> <p>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.</p> <p>Min/Max</p> <p>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).</p>
	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

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 = $T_{\text{crossH}} - T_{\text{crossL}}$ on rising edges, where:

T_{crossH} is the time of crossing of the high reference level.

T_{crossL} 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	<p>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.</p> <p>Selectable tracking algorithm settings:</p>
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
	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	<p>Toggle on/off to enable/disable gating.</p> <p>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.</p>
	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 à 1 à 2 à 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	<p>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.</p> <p>Selectable tracking algorithm settings:</p>
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
	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	<p>Toggle on/off to enable/disable gating.</p> <p>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.</p>
	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 à 1 à 2 à 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	<p>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.</p> <p>Selectable tracking algorithm settings:</p>
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
	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	<p>Toggle on/off to enable/disable gating.</p> <p>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.</p>
	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	<p>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.</p> <p>Selectable tracking algorithm settings:</p> <p>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.</p> <p>Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p> <p>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.</p> <p>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).</p>
	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 = $T_{cross2} - T_{cross1}$, where T_{cross1} and T_{cross2} 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	<p>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.</p> <p>Selectable tracking algorithm settings:</p>
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
	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	<p>Toggle on/off to enable/disable gating.</p> <p>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.</p>
	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 = $T_{\text{cross2}} - T_{\text{cross1}}$, where T_{cross1} and T_{cross2} 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	<p>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.</p> <p>Selectable tracking algorithm settings:</p> <p>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.</p> <p>Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p> <p>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.</p> <p>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).</p>
	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.

$RMS\ Jitter = T_{cross}$, where T_{cross} is one standard deviation of the variance of crossing times for a histogram of the T_{cross} values. T_{cross} 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	<p>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.</p> <p>Selectable tracking algorithm settings:</p>
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
	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	<p>Toggle on/off to enable/disable gating.</p> <p>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.</p>
	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	<p>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.</p> <p>Selectable tracking algorithm settings:</p> <p>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.</p> <p>Mean Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p> <p>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.</p> <p>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).</p>
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	<p>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.</p> <p>Selectable tracking algorithm settings:</p>
		<p>Auto</p> <p>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.</p>
		<p>Mean</p> <p>Sets the values statistically. Using a histogram, it selects the mean or average value derived using all values above the midpoint.</p>
		<p>Mode</p> <p>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.</p>
		<p>Min/Max</p> <p>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).</p>
Gating		When enabled, gates constrain the measurement region to the area between the start gate (Gate1) and the stop gate (Gate2).
	Enable	<p>Toggle on/off to enable/disable gating.</p> <p>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.</p>
	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.

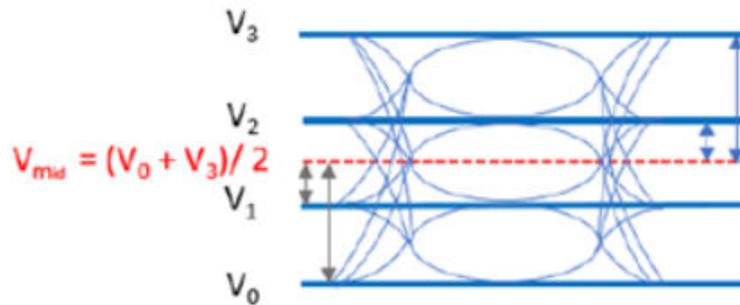
- Mean
- Standard deviation
- Maximum
- Minimum
- Peak to peak
- Population

PAM4 measurements

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 (V_0 , V_1 , V_2 and V_3 ; V_0 refers to lowest signal level), the RLM is computed as shown in the following graph from Intel®:



V_{mid} is computed as average of V_0 and V_3 .

The mean signal levels are then normalized and offset adjusted so that V_{mid} corresponds to 0, V_0 to -1 , V_1 to $-ES1$, V_2 to $ES2$, and V_3 to 1.

Effective symbol levels are defined as follows:

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

RLM is computed as

$$RLM = \min [(3 \times ES1), (3 \times ES2), (2 - 3 \times ES1), (2 - 3 \times ES2)]$$

Ideal eye will have an RLM equal to 1.

In an ideal eye, distance between all three levels remain same. Distance of V_1 to V_{mid} is one third of distance between V_0 to V_{mid} ($ES1 = 1/3$). Distance of V_2 to V_{mid} is again one third of distance between V_3 to V_{mid} ($ES2 = 1/3$). This results in a best case RLM equal to 1.

$$RLM = \min ((3 \times (1/3)), (3 \times (1/3)), (2 - 3 \times (1/3)), (2 - 3 \times (1/3))) = \min (1, 1, 1, 1) = 1$$

If $ES1$ or $ES2$ equals $(2/3)$, then it is the worst case RLM equal to 0.

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 (V_0 , V_1 , V_2 , and V_3 ; where V_0 is the lowest signal level), the level deviation is computed as follows:

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

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:

$$\text{Level thickness} = \frac{1}{4} \frac{1}{(V_3 - V_0)/2} \sum_0^3 \sigma_x$$

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

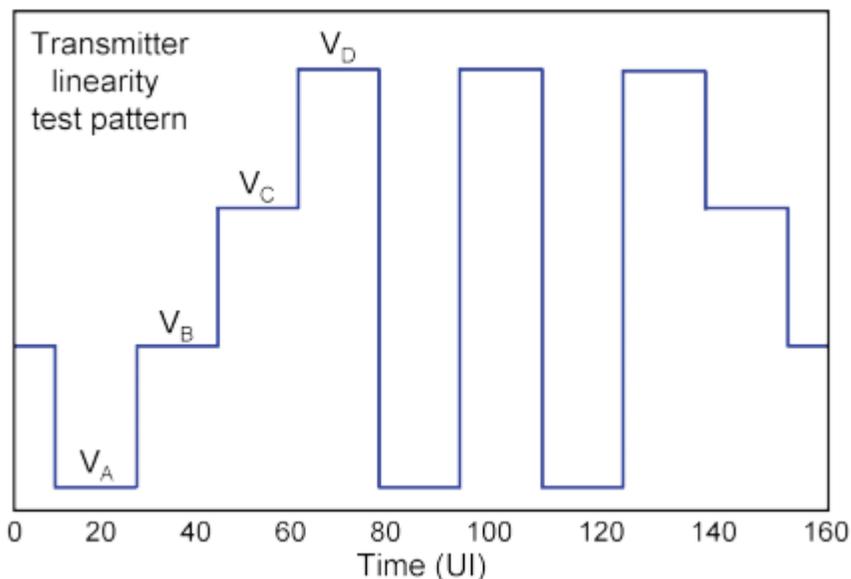
Height and offset values for all three PAM4 eyes (upper, middle and lower) are given.

ES Levels

The Effective Symbol (ES) Levels , ES₁ and ES₂, 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 is 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: $\{v_{i1}, v_{i2}, \dots, v_{iN}\}$. 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.

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.

$$\text{Overshoot} = (\text{Overshoot level} - \text{Level 3}) / (\text{Level 3} - \text{Level 0})$$

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.

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.

$$\text{Undershoot} = (\text{Level 0} - \text{Undershoot level}) / (\text{Level 3} - \text{Level 0})$$

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	Description
Extended search	When enabled, searches for optimal FFE taps to optimize the TDECQ value. Increases execution time. When disabled, FFE taps are adopted more quickly, but may be less optimal.
Vertical threshold adjust	When enabled, sub-eye threshold levels are allowed to adjust around OMAouter by a small range, per IEEE 802.3 allowance for computing optimal TDECQ. When disabled, sub-eye threshold levels are determined by OMAouter and AOP.
Autoset FFE	When enabled, optimizes FFE taps to minimize TDECQ. When disabled, user provided taps are used.

Table continued...

Name	Description
Always recalculate FFE	When enabled, recalculates FFE taps at every run (when Autoset FFE is enabled). When disabled, uses FFE taps from previous calculation when available.
FFE number of taps	Enter number of FFE taps. Default is 5. Must be an odd integer between 1 and 99.
FFE number of taps per UI	Enter number of FFE taps per unit interval. Default is 1. Range: 1,2
FFE maximum number of precursors	Enter maximum number of precursor FFE taps. Must be less than the number of FFE taps. Default is 2. Range: 1,2
Target SER	Enter the target SER at which TDECQ is computed. Default is 4.8E-4.
Histogram width	Widths of the left and right histograms processed to compute TDECQ.
Histogram spacing	Horizontal spacing of the left and right histograms processed to compute TDECQ. They are located symmetrically across the UI center.
Vertical adjustment limit (%)	Limit by which the vertical threshold can adjust relative to OMAouter.
Scope noise	Calibrated oscilloscope noise from the connected instrument and module. Read-only when the source is set to a live channel. Shows the same value as in the vertical channel badge. Editable when the source is set to a reference channel. Scope noise is computed and it is a function of wavelength, filter type, and bandwidth. It changes in the TDECQ configuration whenever these parameters change.

Plots

You can enable one or both of the following plots. Eyes are displayed for 2 unit intervals.

Raw Eye

1. Displays the eye diagram of the raw signal before equalization.

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
Partial SER (LRight)	N/A

OMAouter

OMAouter (outer optical modulation amplitude) measures the difference between the highest and lowest optical power levels of a PAM4 optical signal.

(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.

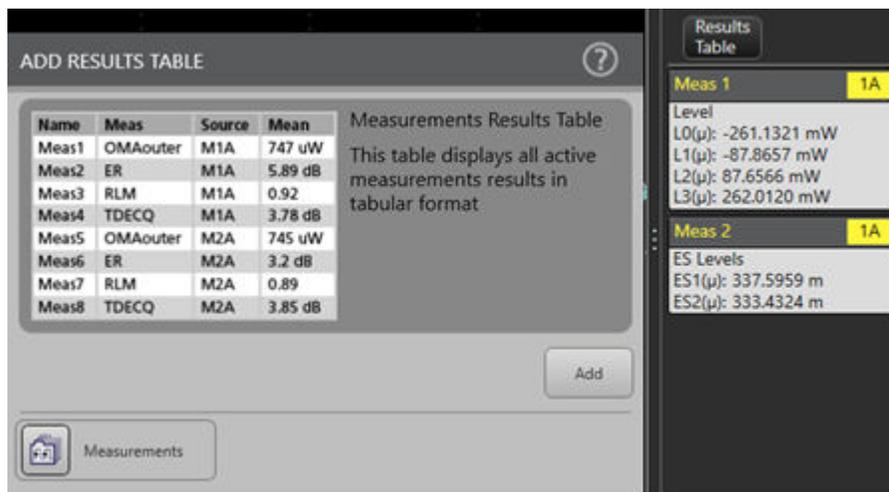
Menus and dialogs

Explore the following functions.

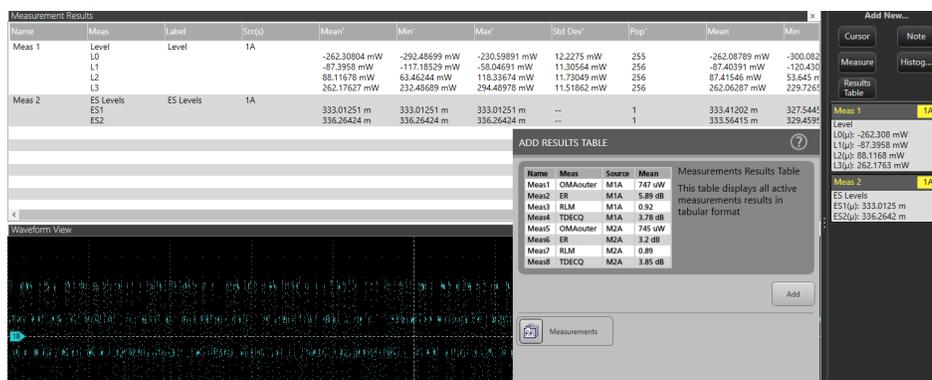
Add Results Table

Use this menu to add a table of all active measurement values. 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 the **Measurements** button at the lower left of the Add Results Table.
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 **Measurement Results** table displays across the top of the Waveform View, showing the data for the active measurement badges.



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 Measurement Results 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.

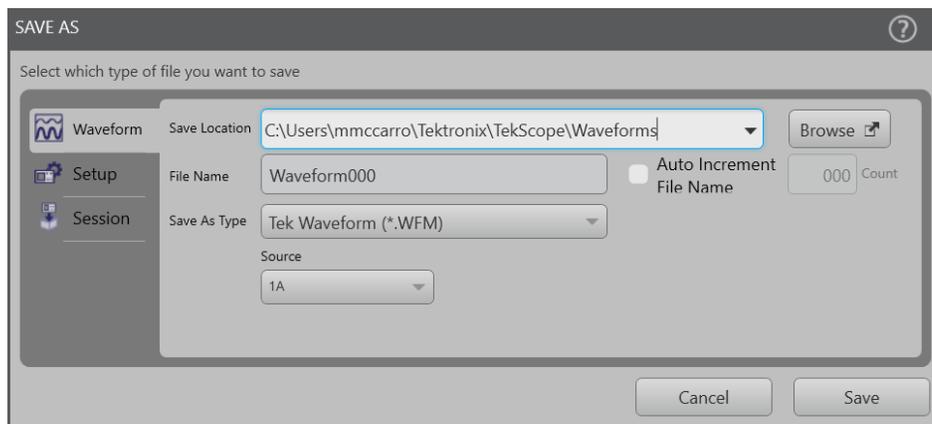
Save As

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 or sessions to files.

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, and Sessions.



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.
6. 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.
7. For Setup files, you can click the checkbox to **Include All References**, which saves additional data for you.
8. 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.

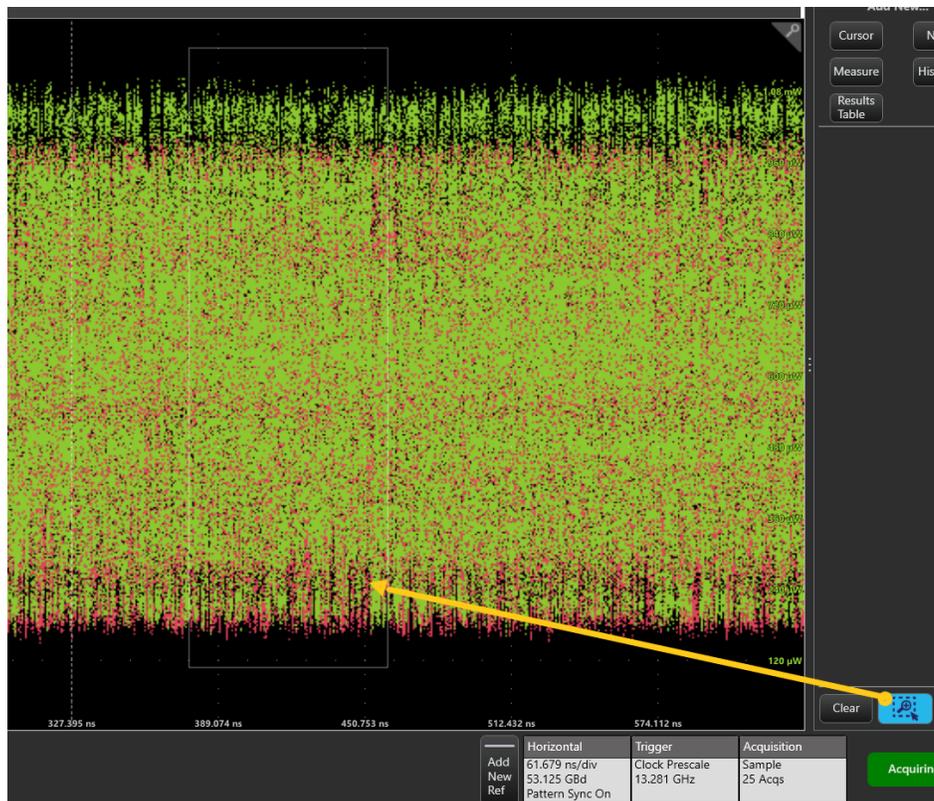
The instrument adds the waveform to the Waveform view and adds a Reference badge on the bottom of the display on the Settings bar. In this example, the channel 2 waveform is being compared with the reference waveform.



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.

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.



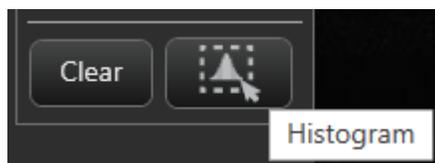
4. See the [Zoom elements](#) topic for detailed information about the zoom view.
5. See the [Add a histogram](#) topic for detailed information about the histogram view.

Add a histogram

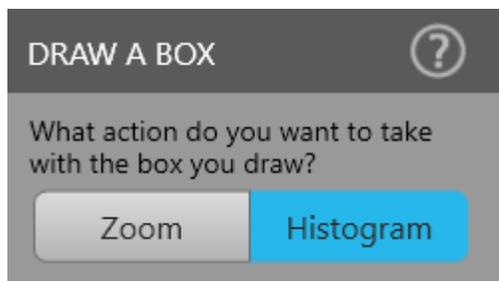
Use histograms to analyze a range of waveform data that you select. The instrument can display both vertical and horizontal histograms.

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.



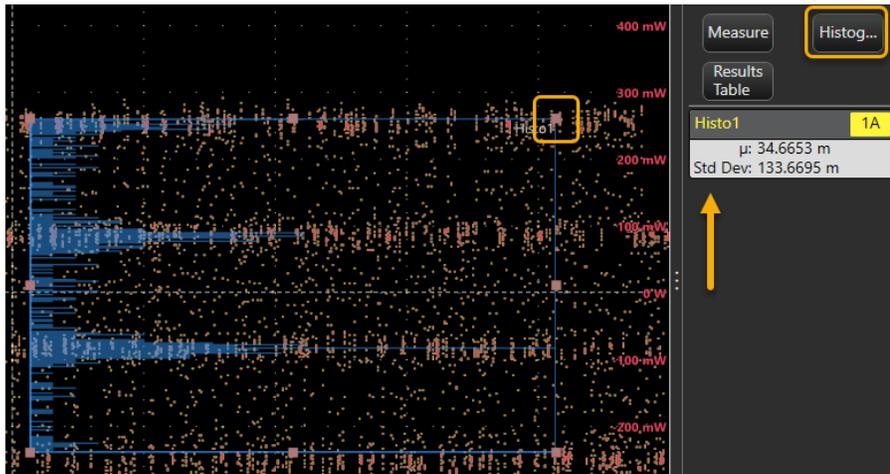
If it is gray, as shown here, double click on the button to open the Draw A Box window and select **Histogram**.



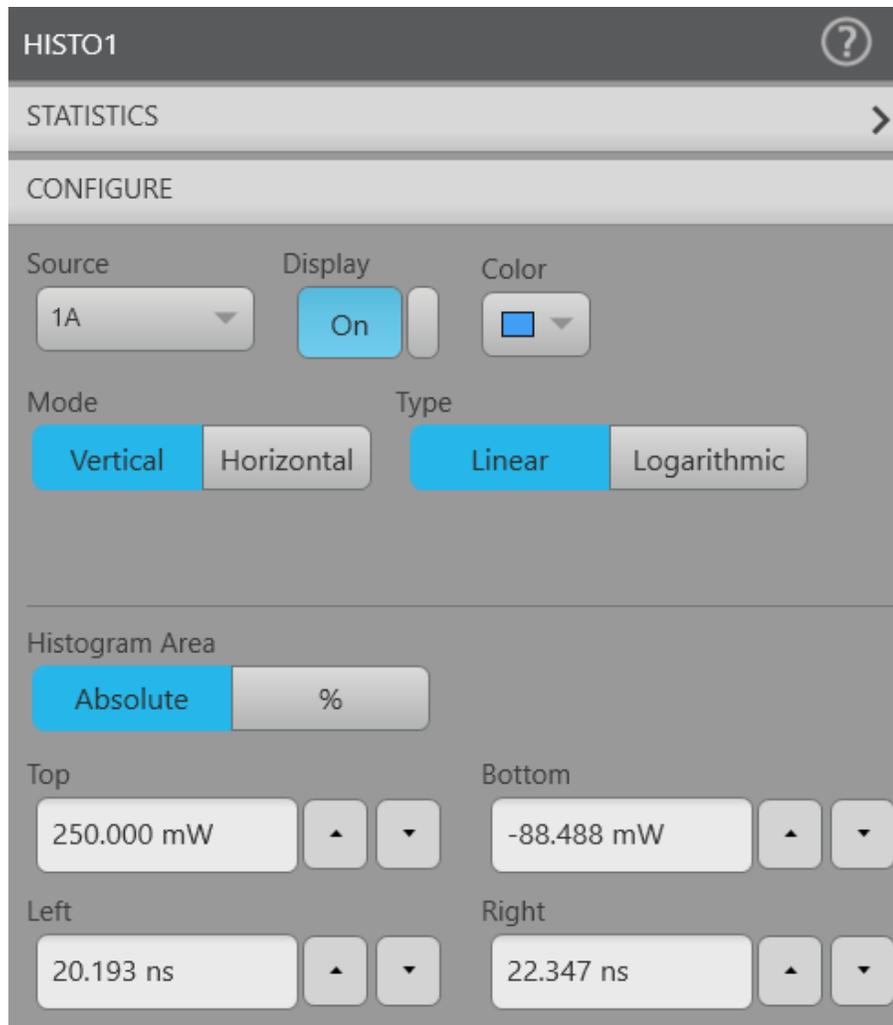
2. If the Histogram icon button is blue, that means the histogram function is on and you can simply draw a box on the waveform to define a new histogram.

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.

The image shows a software dialog box titled "HISTO1" with a help icon (question mark in a circle) in the top right corner. Below the title bar is a section labeled "STATISTICS" containing the following data:

- μ : 343.9639 μ W
- Median : 4 mW
- Mode : 82.6667 mW
- Std Dev : 144.2134 mW
- Pk-Pk : 501.3333 mW
- Hits : 2214081
- #Wfms : 50

At the bottom of the dialog is a "CONFIGURE" button with a right-pointing arrow.

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.

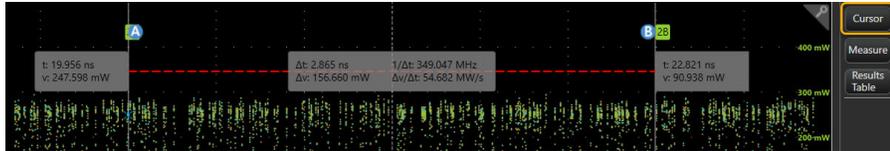
Click the X on the Horizontal Zoom Scale bar to turn off zoom mode. Doing this will delete the zoom configurations.

Cursors

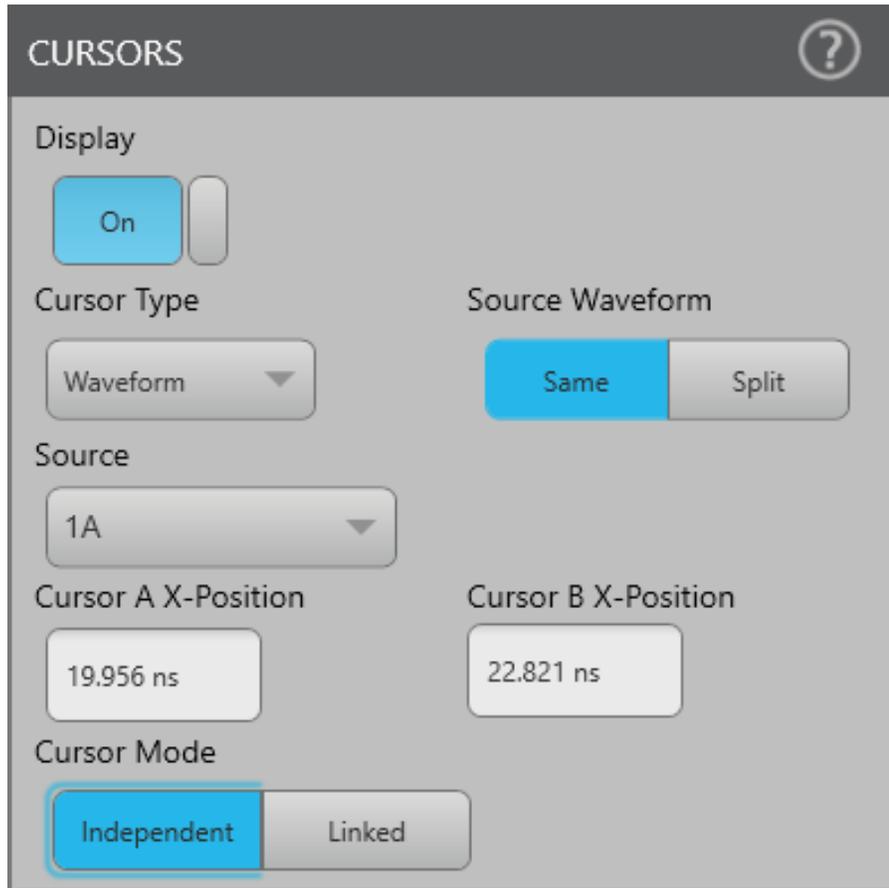
Use one of four different cursor types in the measurement view.

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.

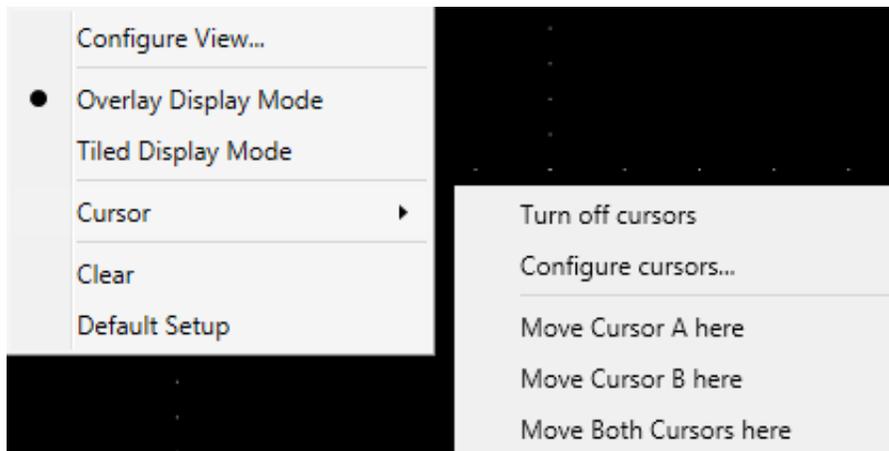


2. Double-click on one of the gray cursor readouts to open the cursors configuration window. You can also right-click on a gray cursor readout or on the waveform and select **Configure cursors**.



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. 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.

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.

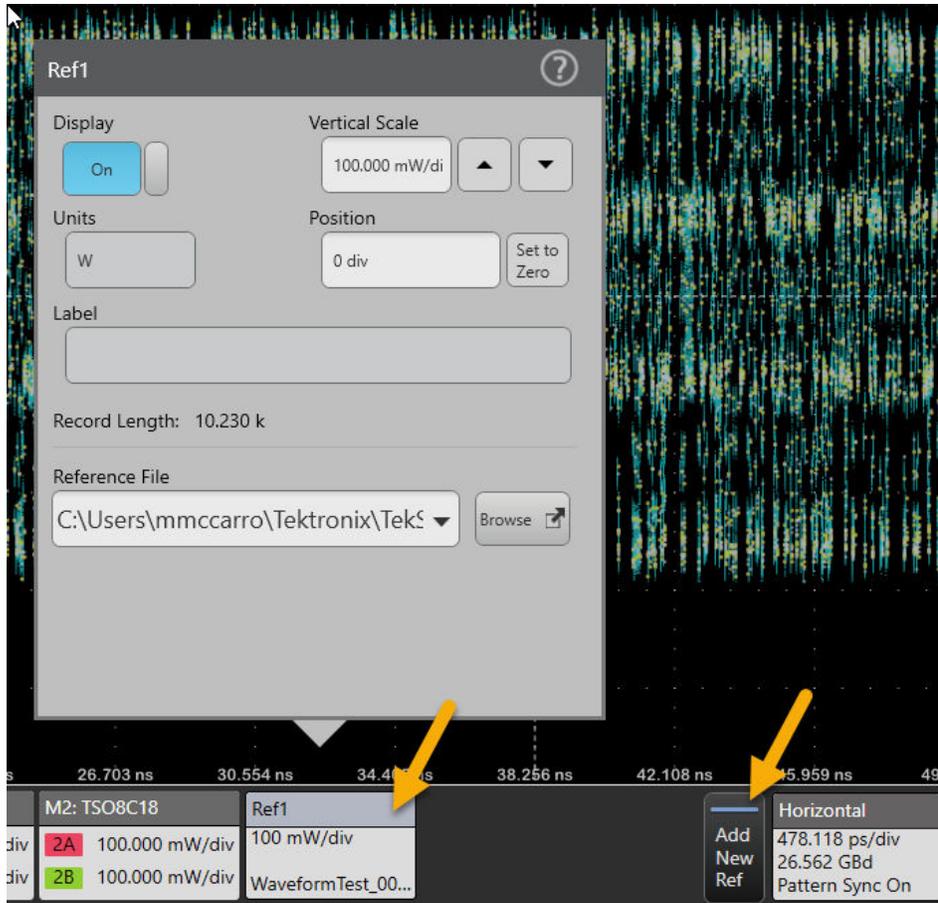


2. You can click once in the note text later to change it if needed.
3. You can click and drag the text to position in wherever you need.
4. You can add multiple notes to the same waveform view.
5. To delete a note, right click on it and choose **Delete**.

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.



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 source 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	<p>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.</p> <p>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.</p>
Record Length	Read-only text that shows the sample rate and record length values of the reference waveform.

Table continued...

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

Add a label

About this task

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

Before you begin

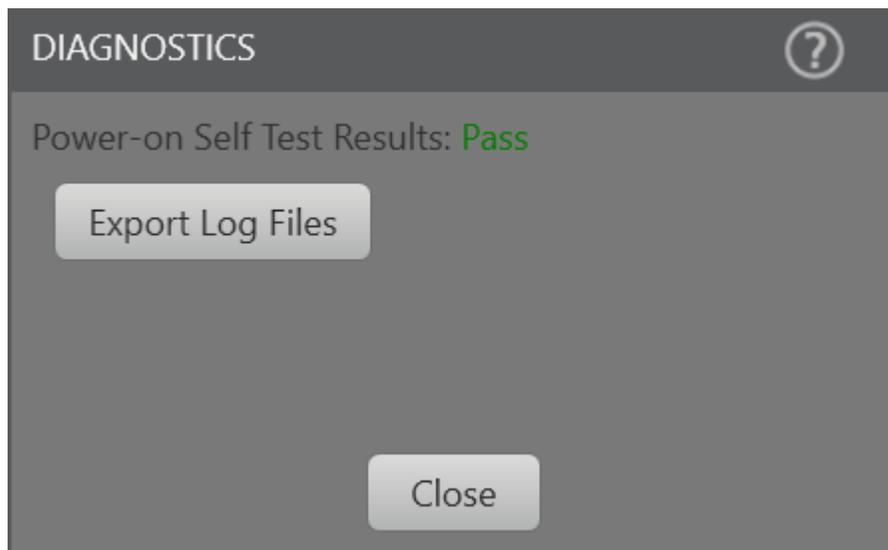
Prerequisite: You must first have added a measurement. See the [Add measurement](#) topic for details.

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

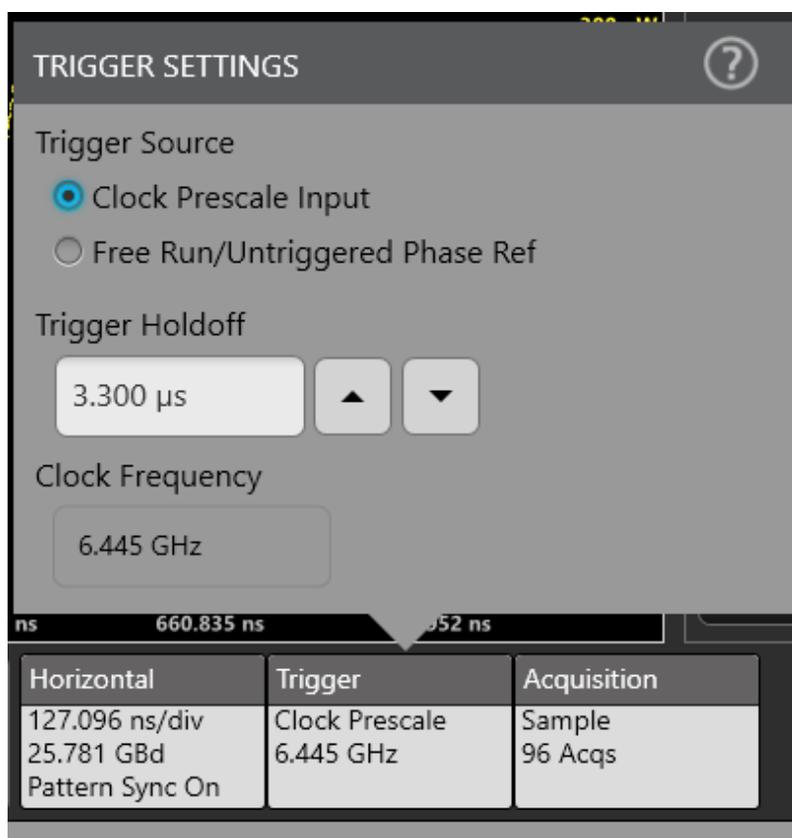
Use the Trigger menu to define the channel or signal conditions on which to trigger the oscilloscope.

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

External Clock Input/Prescale Trigger. 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. Select this Trigger Source to operate in Untriggered Phase Reference mode.

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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