QualiPHY™

Compliance Test Software

QPHY-USB3.1-TX-RX and QPHY-USB3.2-TX-RX

USB3.1/3.2 Serial Data Compliance Software

Instruction Manual

Revision C – March, 2019

Related to version:

XStreamDSO™ 8.6.x.x and later

QualiPHY 8.6.x.x and later

700 Chestnut Ridge Road
Chestnut Ridge, NY, 10977-6499
Tel: (845) 425-2000, Fax: (845) 578 5985
teledynelecroy.com

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About This Manual

This manual assumes that you are familiar with using Teledyne LeCroy oscilloscopes and that you have purchased a QPHY-USB3.x-TX-RX software option.

Some of the images in this manual may show QualiPHY products other than QPHY-USB3.x-TX-RX, or were captured using different model oscilloscopes, as they are meant to illustrate general concepts only. Rest assured that while the user interface may look different from yours, the functionality is identical.

Introduction

About QualiPHY

QualiPHY is highly automated compliance test software meant to help you develop and validate the PHY (physical-electrical) layer of a device, in accordance with the official documents published by the applicable standards organizations and special interest groups (SIGs). You can additionally set custom variables and limits to test compliance to internal standards.

QualiPHY is composed of a “wizard” application that enables the configuration and control of separate tests for each standard through a common user interface. Features include:

- **User-Defined Test Limits**: Tighten limits to ensure devices are well within the passing region, even if subsequently measured with different equipment.
- **Flexible Test Results Reporting** that includes XML Test Record Generation. Understand a device performance distribution, or obtain procedural information from the devices under test.

About the QPHY-USB3.x-TX-RX Options

QPHY-USB3.1-TX-RX and QPHY-USB3.2-TX-RX are software packages designed to capture, analyze, and report measurements in conformance with USB 3.1/USB3.2 electrical specifications.

A copy of the specifications can be found at www.usb.org.

USB 3.2 Gen 1 testing can be run on any Teledyne LeCroy oscilloscope with at least 13 GHz bandwidth and a sample rate of 40 GS/s.

USB 3.2 Gen 2 testing can be run on any Teledyne LeCroy oscilloscope with at least 16 GHz bandwidth and a sample rate of 80 GS/s.

Required Equipment

Transmitter Testing

- Teledyne LeCroy real-time oscilloscope installed with:
  - XStreamDSO™ v.8.6.x.x or later with an activated QPHY-USB3.x-TX-RX option key
  - QualiPHY v.8.6.x.x or later with an activated USB3.x component

    Note: XStreamDSO and QualiPHY versions must match, so upgrade QualilPHY if you have upgraded your oscilloscope firmware since installing. The QualiPHY software may be installed on a remote PC, but all other software must be run on the oscilloscope. The versions above are the minimum required for USB 3.2 testing. USB 3.1 testing can be performed with v.8.5.x.x, although it will not exactly match the descriptions in this manual.
  - SigTest software v.3.2.11 for Gen1 testing and v.4.0.23 for Gen2 testing

    Note: QualiPHY is preset to use SigTest, which is the only method we guarantee for compliance. If you wish to use the legacy LeCroy tests, you must copy and modify the standard configurations.
  - SDA III software option (standard on SDA Zi and DDA Zi model oscilloscopes)
  - Eye Dr. II software option
- Teledyne LeCroy USB 3.0/3.1 Test Fixture Kit (TF-USB3) – for Gen1 Standard-A short channel Rx test

continued

- USB-IF Test Fixtures (available from http://www.usb.org/developers/estoreinfo/)
    - Gen2: USB3.1 Gen2 Type-C or Type-A and Micro-B fixture kit
    - Gen1 Type-C: USB3.1 Gen2 Type-C fixture kit
    - Gen1 Standard-A and Micro-B: USB3.0 Electrical Test Fixture Kit

Note: TF-USB3 is also required for Rx Testing.

- Two pair of +/1 phase matched SMA cables

Receiver Testing

- Teledyne LeCroy real-time oscilloscope with all software listed above
- 1-channel Phoenix PeRT3 System (PER-R008-S01-X) installed with:
    - 10 Gbps Options for PeRT3 Phoenix (PER-R008-10G-A)
    - Phoenix Receiver Tolerance Test Suite (PER-R006-008-A)
    - Phoenix USB 3.0 Receiver Test Suite (USB-R008-001-A)
    - Phoenix USB 3.1 Receiver Test Suite (USB-R008-PLS-A)
- Two pair of +/1 phase matched SMA cables

Remote Host System Requirements

Usually, the oscilloscope is the host computer for the QualiPHY software, and all models that meet the acquisition requirements will also meet the host system requirements. However, if you wish to run the QualiPHY software from a remote computer, these minimum requirements apply:

- Operating System:
    - Windows 7 Professional
    - Windows 10 Professional
- 1 GHz or faster processor
- 1 GB (32-bit) or 2 GB (64-bit) of RAM
- Ethernet (LAN) network capability
- Hard Drive:
    - At least 100 MB free to install the framework application
    - Up to 2 GB per standard installed to store the log database (each database grows from a few MB to a maximum of 2 GB)

See Set Up Remote Control for configuration instructions.

Installation and Setup

QualiPHY is a Windows-based application that can be configured to run one or more serial data compliance components. Each compliance component is purchased as a separate software option.

Install Base Application

Download the latest versions of the XStreamDSO firmware and QualiPHY software from:

teledynelecroy.com/support/softwaredownload

The link is under Oscilloscope Downloads > Software Utilities.

If the oscilloscope is not connected to the Internet, copy the installer onto a USB memory stick then transfer it to the oscilloscope desktop or a folder on a D:\ drive to execute it.

First, update the oscilloscope firmware. Then, run **QualiPHYInstaller.exe** and follow the installer prompts. Choose all the components you plan to activate. If you omit any components now, you will need to update the installation to activate them later.

By default, the oscilloscope appears as local host when QualiPHY is executed on the oscilloscope. Follow the steps under Add Connection to QualiPHY to check that the IP address is **127.0.0.1**.

Activate Components

The serial data compliance components are installed as part of the main oscilloscope application and are individually activated through the use of an alphanumeric code uniquely matched to the oscilloscope's serial number. This key code is what is delivered when purchasing a software option.

To activate a component on the oscilloscope:

1. From the menu bar, choose **Utilities > Utilities Setup**.
2. On the Options tab, click **Add Key**.
3. Use the Virtual Keyboard to **Enter Option Key**, then click **OK**.

   If activation is successful, the key code now appears in the list of Installed Option Keys.
4. Restart the oscilloscope application by choosing **File > Exit**, then double-clicking the **Start DSO** icon on the desktop.

Set Up Dual Monitor Display

Teledyne LeCroy recommends running QualiPHY on an oscilloscope equipped with Dual Monitor Display capability. This allows the waveforms and measurements to be shown on the oscilloscope LCD display while the QualiPHY application and test results are displayed on a second monitor.

See the oscilloscope *Operator's Manual* for instructions on setting up dual monitor display.

Set Up Remote Control

QualiPHY software can be executed from a remote host computer, controlling the oscilloscope through a LAN Connection. To set up remote control:

- The oscilloscope must be connected to a LAN and assigned an IP address (fixed or dynamic).
- The host computer must be on the same subnet as the oscilloscope.

Configure Oscilloscope for Remote Control

1. From the menu bar, choose **Utilities → Utilities Setup...**
2. Open the **Remote** tab and set Remote Control to **TCP/IP**.
3. Verify that the oscilloscope shows an IP address.

Add Connection to QualiPHY

1. On the host PC, download and run **QualiPHYInstaller.exe**.
2. Start QualiPHY and click the **General Setup** button.
3. On the **Connection** tab, click **Scope Selector**.
4. Click **Add** and choose the connection type. Enter the oscilloscope IP address from Step 3 above. Click **OK**.
5. When the oscilloscope is properly detected, it appears on the Scope Selector dialog. Select the connection, and click **OK**.

   QualiPHY is now ready to control the oscilloscope.

Select Connection

Multiple oscilloscopes may be accessible to a single remote host. In that case, go to General Setup and use the Scope Selector at the start of the QPHY session to choose the correct connection.

QualiPHY tests the oscilloscope connection when starting a test. The system warns you if there is a connection problem.

Using QualiPHY

This section provides an overview of the QualiPHY user interface and general procedures. For information about using the USB 3.1/3.2 compliance testing, see USB 3.1/3.2 Transmitter Testing and QPHY-USB3.2 Receiver Testing.

Accessing the Software

Once QualiPHY is installed and activated, it can be accessed from the oscilloscope menu bar by choosing **Analysis > QualiPHY**, or by double-clicking the **QualiPHY desktop icon** on a remote computer.

The QualiPHY wizard illustrates the overall software flow, from general set up through running individual compliance tests. Work from left to right, making all desired settings on each sub-dialog.

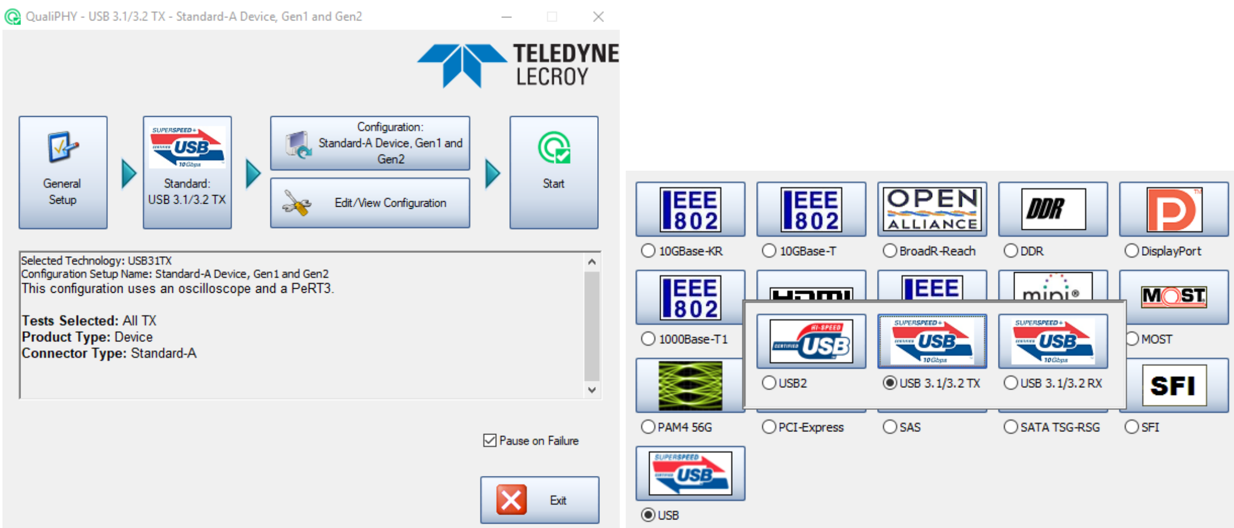


Figure 1 – QualiPHY wizard and Standard selection menu.

The sub-dialogs are organized into tabs each containing configuration controls related to that part of the process. These are described in more detail in the following sections.

If **Pause on Failure** is checked, QauliPHY prompts to retry a measure whenever a test fails.

Report Generator launches the manual report generator dialog.

The **Exit** button at the bottom of the wizard closes the QualiPHY application.

General Setup

The first sub-dialog contains general system settings. These remain in effect for each session, regardless of Standard, until changed.

Connection tab

Shows **IP Address** of the test oscilloscope (localhost 127.0.0.1 if QualiPHY is run from the oscilloscope). The **Scope Selector** allows you to choose the oscilloscope used for testing when several are connected to the QualiPHY installation. See Set Up Remote Control for details.

Session Info tab

Optional information about the test session that may be added to reports, such as: **Operator Name**, **Device Under Test** (DUT), **Temperature** (in °C) of the test location, and any additional **Comments**. There is also an option to **Append Results** or **Replace Results** when continuing a previous session.

To optimize report generation, enter at least a DUT name at the beginning of each session.

Note: Although the product tested may be a device or host, the conventional term DUT is retained to refer to either.

Report tab

Settings related to automatic report generation. Choose:

- **Reporting behavior** of:
  - "Ask to generate a report after tests," where you'll be prompted to create a new file for each set of test results.
  - "Never generate a report after tests," where you'll need to manually execute the Report Generator to create a report.
  - "Always generate a report after tests," to autogenerate a report of the latest test results.
- **Default** report output type of XML, HTML, or PDF.
- A generic **Output file name**, including the full path to the report output folder.

Optionally, check **Allow style sheet selection in Report Generator** to enable the use of a custom .xslt when generating reports (XML and HTML output only). The path to the .xslt is entered on the Report Generator dialog.

Report Generator launches the Report Generator dialog, which contains the same settings as the Report tab, only applied to individual reports.

Advanced tab

This tab launches the **X-Replay Mode** dialog. See X-Replay Mode.

About tab

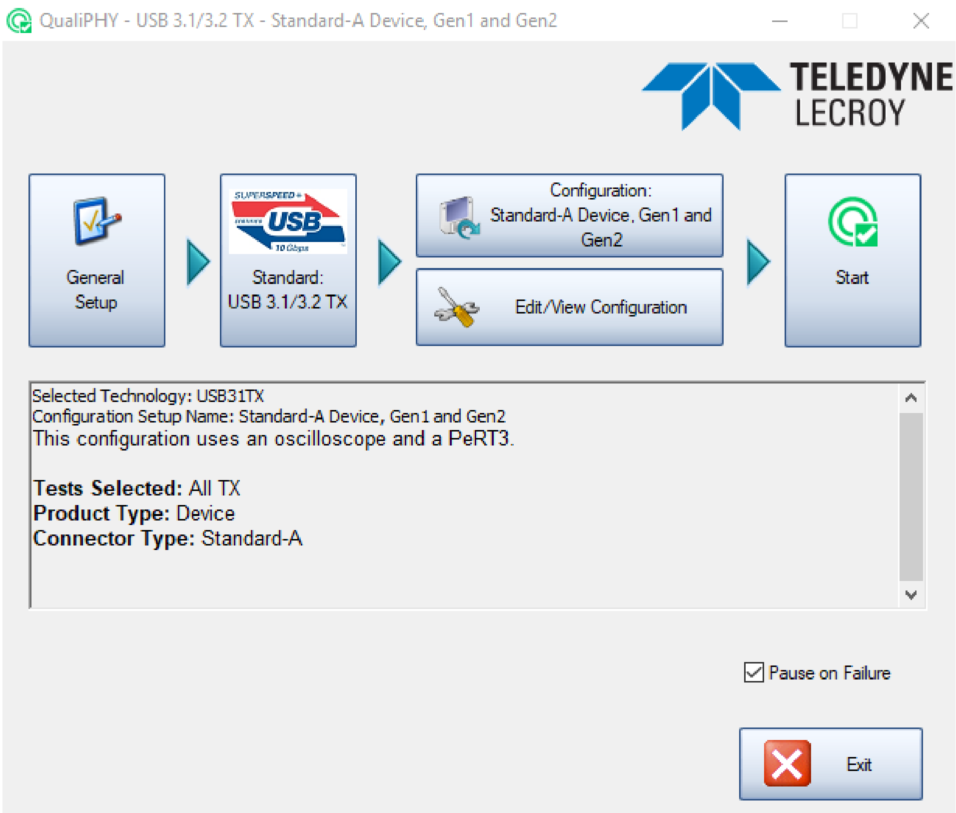
Information about your QualiPHY installation.

QualiPHY Test Process

Once general system settings are in place, these are the steps for running test sessions.

Set Up Test Session

1. Connect the oscilloscope to the DUT. See the connection diagrams in the test descriptions.
2. Access the QualiPHY software to display the wizard.



3. If running QualiPHY remotely, click **General Setup** and open the **Scope Selector** to select the correct oscilloscope connection.
4. If you have more than one component activated, click **Standard** and select the desired standard to test against. Otherwise, your one activated component will appear as the default selection.

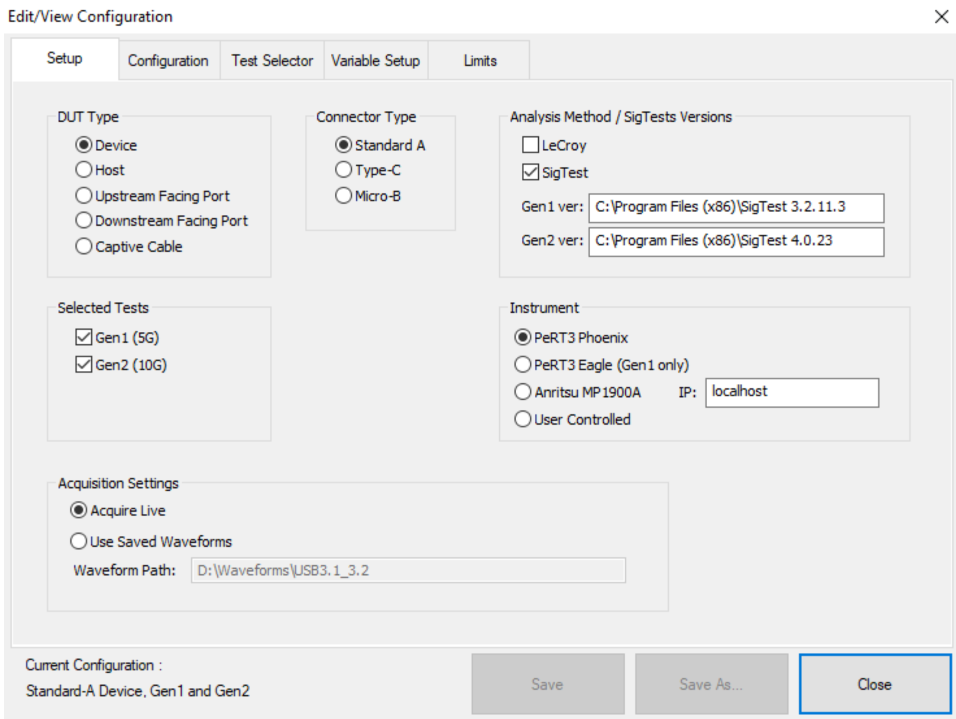
   Note: Although all the QualiPHY components appear on this dialog, only those selected when installing QualiPHY are enabled.

5. Click the **Configuration** button and select the test configuration to run. These pre-loaded configurations are set to run all the tests required for compliance and provide a quick, easy way to begin compliance testing.

   You can also create custom configurations for informative tests by copying and modifying the pre-loaded configurations. See Customizing QualiPHY for details.

6. Return to the wizard, then click the **Edit/View Configuration** button to open the Configuration **Setup** tab. Make selections as required to tailor the configuration to your test setup (e.g., changing DUT or Connector Type).

   If you make changes, **Save As** a new configuration.



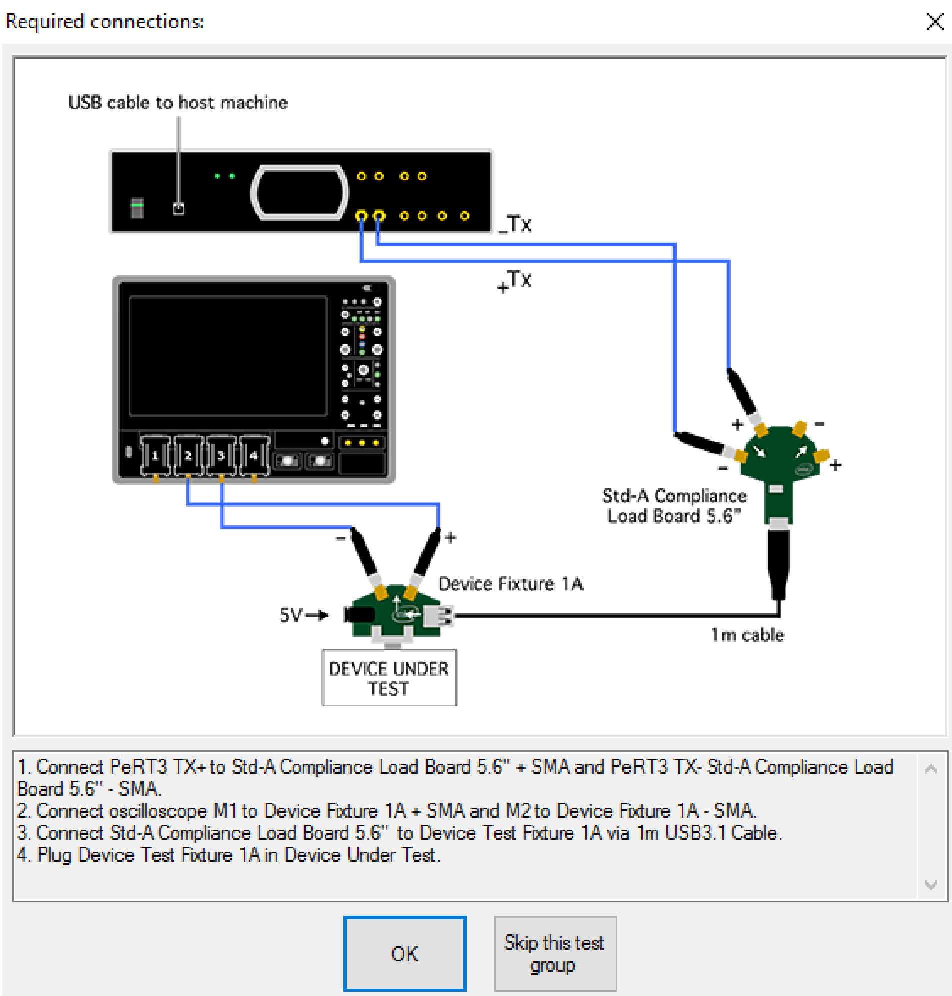
7. **Close** the Edit/View Configuration dialog to return to the wizard. The modified configuration will be pre-selected on the wizard.

Run Tests

1. On the wizard, click **Start** to begin testing.

   When tests are in progress, this button changes to **Stop**. Click it at any time to stop the test in process. You'll be able to resume from the point of termination or from the beginning of the test.

2. Follow the pop-up prompts. QualiPHY guides you step-by-step through each of the tests described in the standard specification, including diagrams of the connection to the DUT for each required test mode.



3. When all tests are successfully completed, both progress bars on the wizard are completely green and the message "All tests completed successfully" appears. If problems are encountered, you'll be offered options to:

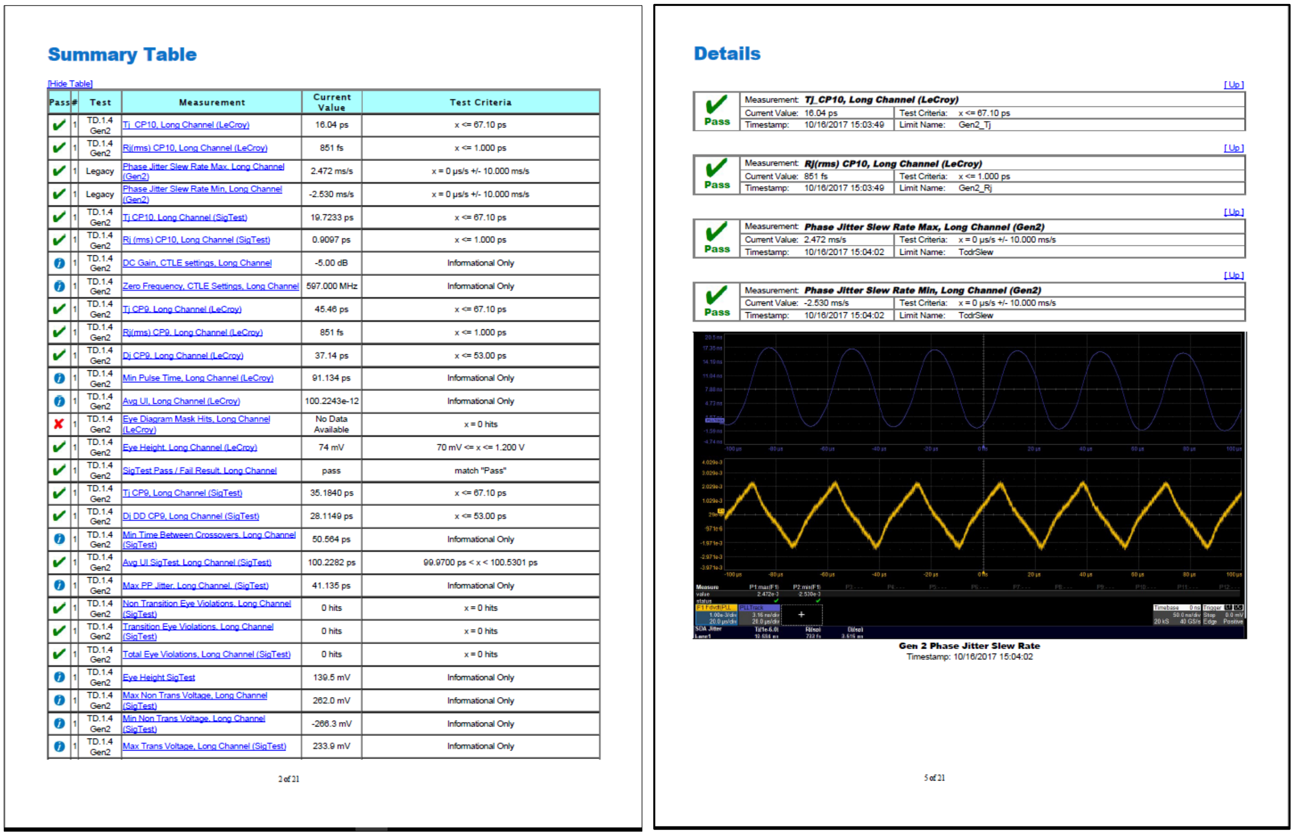
   - **Retry** the test from the latest established point defined in the script
   - **Ignore and Continue** with the next test
   - **Abort Session**

Generate Reports

The QualiPHY software automates report generation. On the wizard, go to **General Setup > Report** to pre-configure reporting behavior. You can also manually launch the **Report Generator** from the wizard once a test is run.

The Report Generator offers the same selections as the Report tab, only applied to each report individually, rather than as a system setting. This enables you to save reports for each test session, rather than overwrite the generic report file. There are also options to link a custom style sheet (.xslt) to the report, or to Exclude Informative Results.

The Test Report includes a summary table with links to the detailed test result pages.



Summary Table

[Hide Table]

Pass	#	Test	Measurement	Current Value	Test Criteria
✔	1	TD.1.4 Gen2	Tj_CP10, Long Channel (LeCroy)	16.04 ps	x <= 67.10 ps
✔	1	TD.1.4 Gen2	Rj(rms) CP10, Long Channel (LeCroy)	851 fs	x <= 1.000 ps
✔	1	Legacy	Phase Jitter Slew Rate Max, Long Channel (Gen2)	2.472 ms/s	x = 0 µs/s +/- 10.000 ms/s
✔	1	Legacy	Phase Jitter Slew Rate Min, Long Channel (Gen2)	-2.530 ms/s	x = 0 µs/s +/- 10.000 ms/s
✔	1	TD.1.4 Gen2	Tj CP10, Long Channel (SigTest)	19.7233 ps	x <= 67.10 ps
✔	1	TD.1.4 Gen2	Rj (rms) CP10, Long Channel (SigTest)	0.9097 ps	x <= 1.000 ps
i	1	TD.1.4 Gen2	DC Gain, CTLE settings, Long Channel	-5.00 dB	Informational Only
i	1	TD.1.4 Gen2	Zero Frequency, CTLE Settings, Long Channel	597.000 MHz	Informational Only
✔	1	TD.1.4 Gen2	Tj CP9, Long Channel (LeCroy)	45.46 ps	x <= 67.10 ps
✔	1	TD.1.4 Gen2	Rj(rms) CP9, Long Channel (LeCroy)	851 fs	x <= 1.000 ps
✔	1	TD.1.4 Gen2	Dj CP9, Long Channel (LeCroy)	37.14 ps	x <= 53.00 ps
i	1	TD.1.4 Gen2	Min Pulse Time, Long Channel (LeCroy)	91.134 ps	Informational Only
i	1	TD.1.4 Gen2	Avg UI, Long Channel (LeCroy)	100.2243e-12	Informational Only
✘	1	TD.1.4 Gen2	Eye Diagram Mask Hits, Long Channel (LeCroy)	No Data Available	x = 0 hits
✔	1	TD.1.4 Gen2	Eye Height, Long Channel (LeCroy)	74 mV	70 mV <= x <= 1.200 V
✔	1	TD.1.4 Gen2	SigTest Pass / Fail Result, Long Channel	pass	match "Pass"
✔	1	TD.1.4 Gen2	Tj CP9, Long Channel (SigTest)	35.1840 ps	x <= 67.10 ps
✔	1	TD.1.4 Gen2	Dj DD CP9, Long Channel (SigTest)	28.1149 ps	x <= 53.00 ps
i	1	TD.1.4 Gen2	Min Time Between Crossovers, Long Channel (SigTest)	50.564 ps	Informational Only
✔	1	TD.1.4 Gen2	Avg UI SigTest, Long Channel (SigTest)	100.2282 ps	99.9700 ps < x < 100.5301 ps
i	1	TD.1.4 Gen2	Max PP Jitter, Long Channel, (SigTest)	41.135 ps	Informational Only
✔	1	TD.1.4 Gen2	Non Transition Eye Violations, Long Channel (SigTest)	0 hits	x = 0 hits
✔	1	TD.1.4 Gen2	Transition Eye Violations, Long Channel (SigTest)	0 hits	x = 0 hits
✔	1	TD.1.4 Gen2	Total Eye Violations, Long Channel (SigTest)	0 hits	x = 0 hits
i	1	TD.1.4 Gen2	Eye Height SigTest	139.5 mV	Informational Only
i	1	TD.1.4 Gen2	Max Non Trans Voltage, Long Channel (SigTest)	262.0 mV	Informational Only
i	1	TD.1.4 Gen2	Min Non Trans Voltage, Long Channel (SigTest)	-266.3 mV	Informational Only
i	1	TD.1.4 Gen2	Max Trans Voltage, Long Channel (SigTest)	233.9 mV	Informational Only

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Details

[Up]

✔ Pass	Measurement: **Tj_CP10, Long Channel (LeCroy)**	
	Current Value: 16.04 ps	Test Criteria: x <= 67.10 ps
	Timestamp: 10/16/2017 15:03:49	Limit Name: Gen2_Tj

[Up]

✔ Pass	Measurement: **Rj(rms) CP10, Long Channel (LeCroy)**	
	Current Value: 851 fs	Test Criteria: x <= 1.000 ps
	Timestamp: 10/16/2017 15:03:49	Limit Name: Gen2_Rj

[Up]

✔ Pass	Measurement: **Phase Jitter Slew Rate Max, Long Channel (Gen2)**	
	Current Value: 2.472 ms/s	Test Criteria: x = 0 µs/s +/- 10.000 ms/s
	Timestamp: 10/16/2017 15:04:02	Limit Name: TcdrSlew

[Up]

✔ Pass	Measurement: **Phase Jitter Slew Rate Min, Long Channel (Gen2)**	
	Current Value: -2.530 ms/s	Test Criteria: x = 0 µs/s +/- 10.000 ms/s
	Timestamp: 10/16/2017 15:04:02	Limit Name: TcdrSlew

Gen 2 Phase Jitter Slew Rate
Timestamp: 10/16/2017 15:04:02

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Figure 2 – The Test Report Summary Table and Details pages.

Reports are output to the folder D:\QPHY\Reports on the oscilloscope, or C:\LeCroy\QPHY\Reports on remote computers.

You can add your own logo to the report cover by replacing the file D:\QPHY\StyleSheets\CustomerLogo.jpg.

The recommended maximum size is 250x100 pixels at 72 ppi, 16.7 million colors, 24 bits. Use the same file name and format.

Customizing QualiPHY

The preformatted configurations reflect what is required for compliance based on the DUT type and should rarely require changes. Customizations made on the Setup tab are usually sufficient for testing compliance to the standard. However, it may be beneficial to modify tests, variables, or limits for purposes of testing internal compliance.

Create custom test configurations by copying one of the standard configurations and modifying it. The pre-loaded configurations cannot be modified.

Copy Configuration

1. Access the QualiPHY wizard and select a **Standard**.
2. Click **Edit/View Configuration** and select the configuration upon which to base the new configuration. This can be a pre-loaded configuration or another copy.
3. Click **Copy** and enter a name and description. Once a custom configuration is defined, it appears on the Configuration tab for selection.

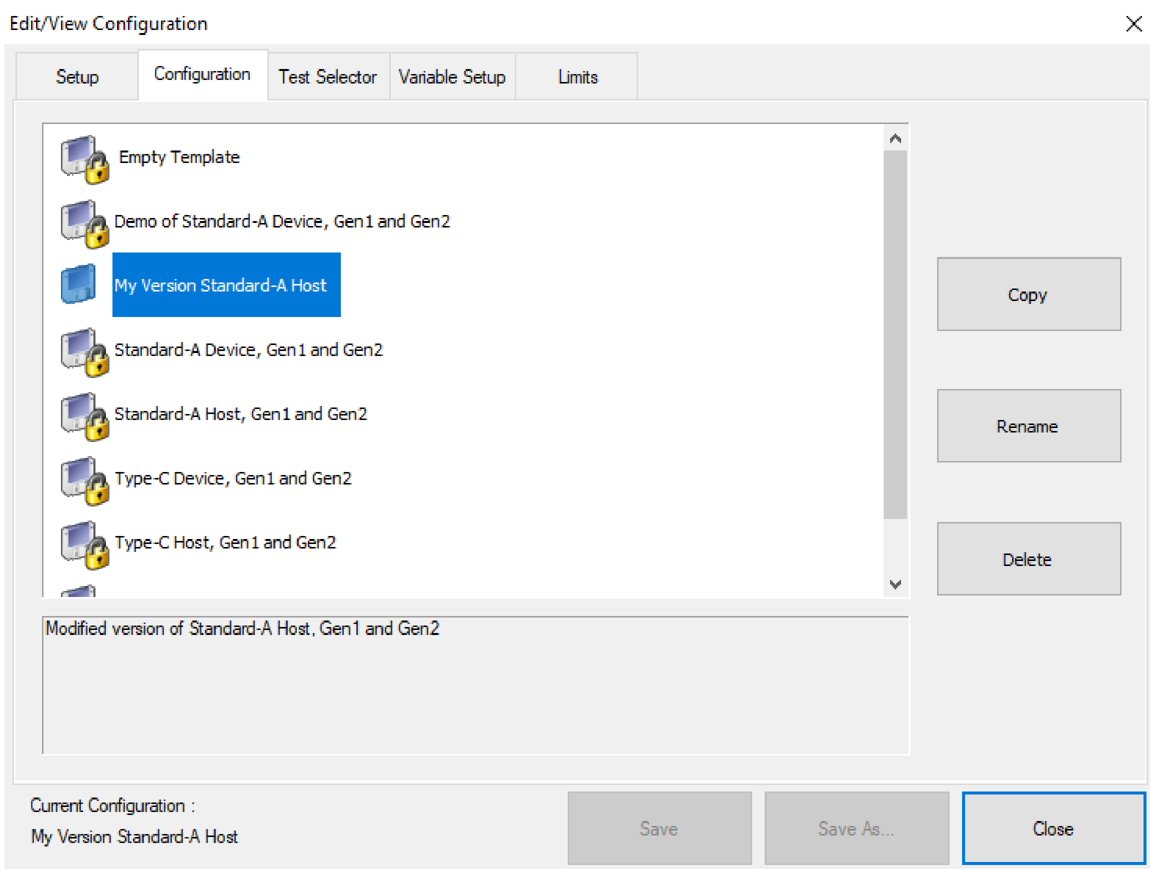


Figure 3 – Configuration Selector Tab

4. Select the new, copied configuration and follow the procedures below to continue making changes.

Edit Setup

On the Setup tab, make any changes required to tailor the configuration to your DUT. Your selections here will modify the corresponding test variables.

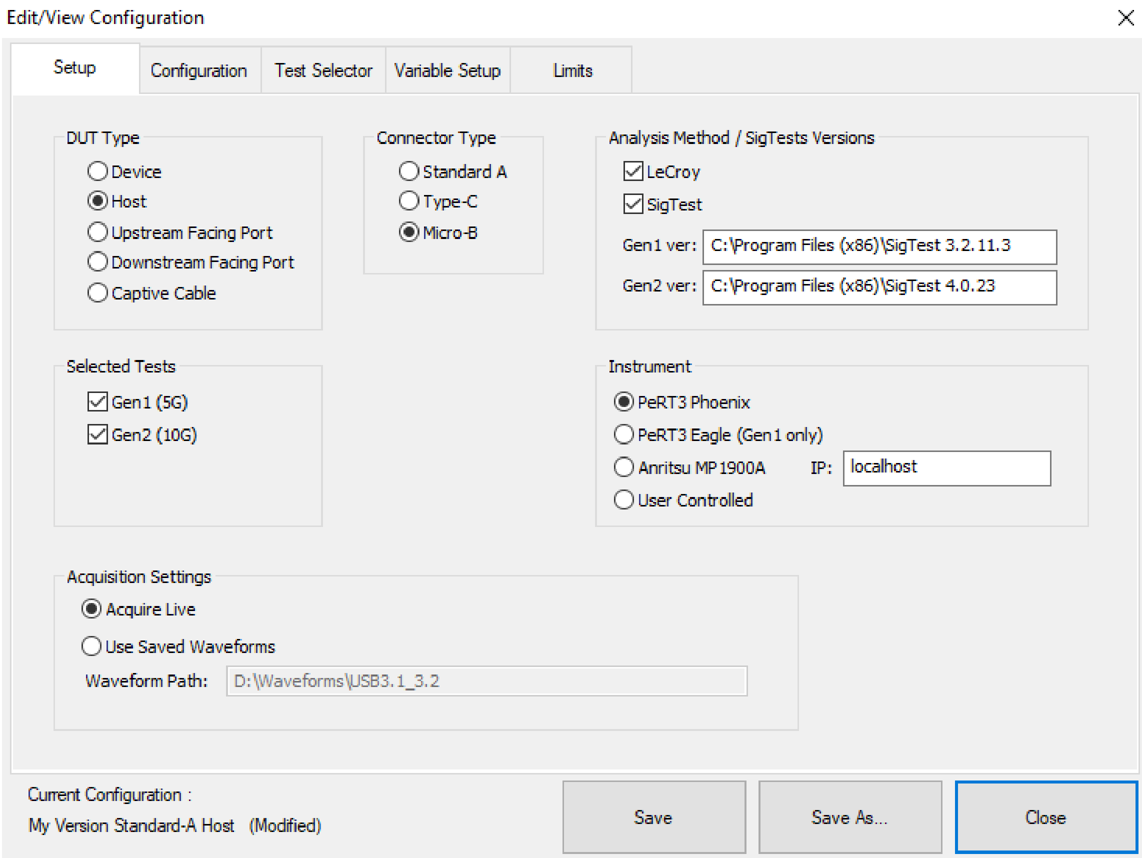


Figure 4 – Configuration Setup Tab

Note: If any part of a configuration is changed, the Save As button becomes active on the bottom of the dialog. If a custom configuration is changed, the Save button will also become active to apply the changes to the existing configuration.

Select Tests

On the **Test Selector** tab, check the tests that make up the configuration. Each test is defined by the USB 3.2 standard. A description of each test is displayed when it is selected.

To loop an individual test or group of tests, select it from the list, then choose to **Loop the highlighted test** either until stopped or for the number of repetitions entered.

Tip: When defining a number of repetitions, enter the number before checking the box.

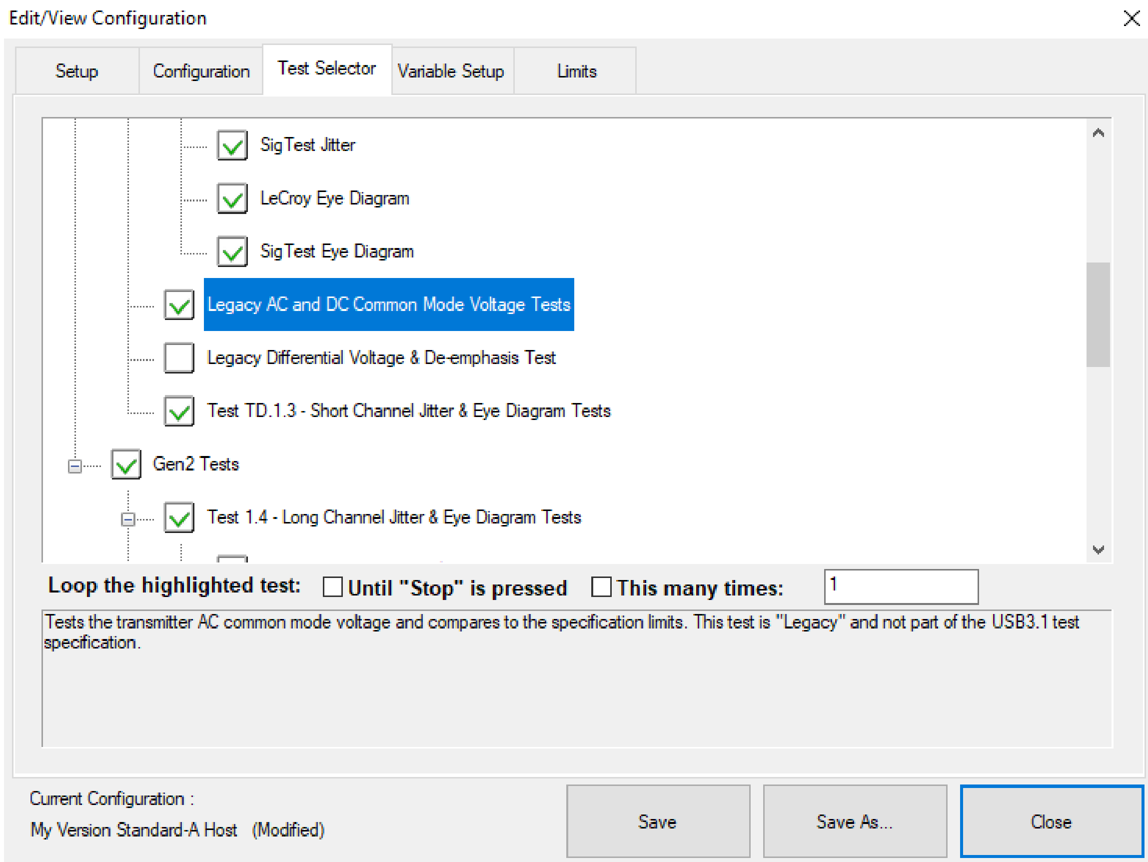


Figure 5 – Configuration Test Selector Tab

Edit Variables

The Variable Setup tab contains a list of test variables. See USB3.x TX Test Variables and USB3.x RX Test Variables for a description of each.

To modify a variable, select it from the Variable Setup tab, then click **Edit Variable**. (You can also choose to Reset to Default at any time.)

The conditions of this variable appear on a pop-up. Choose the new condition to apply.

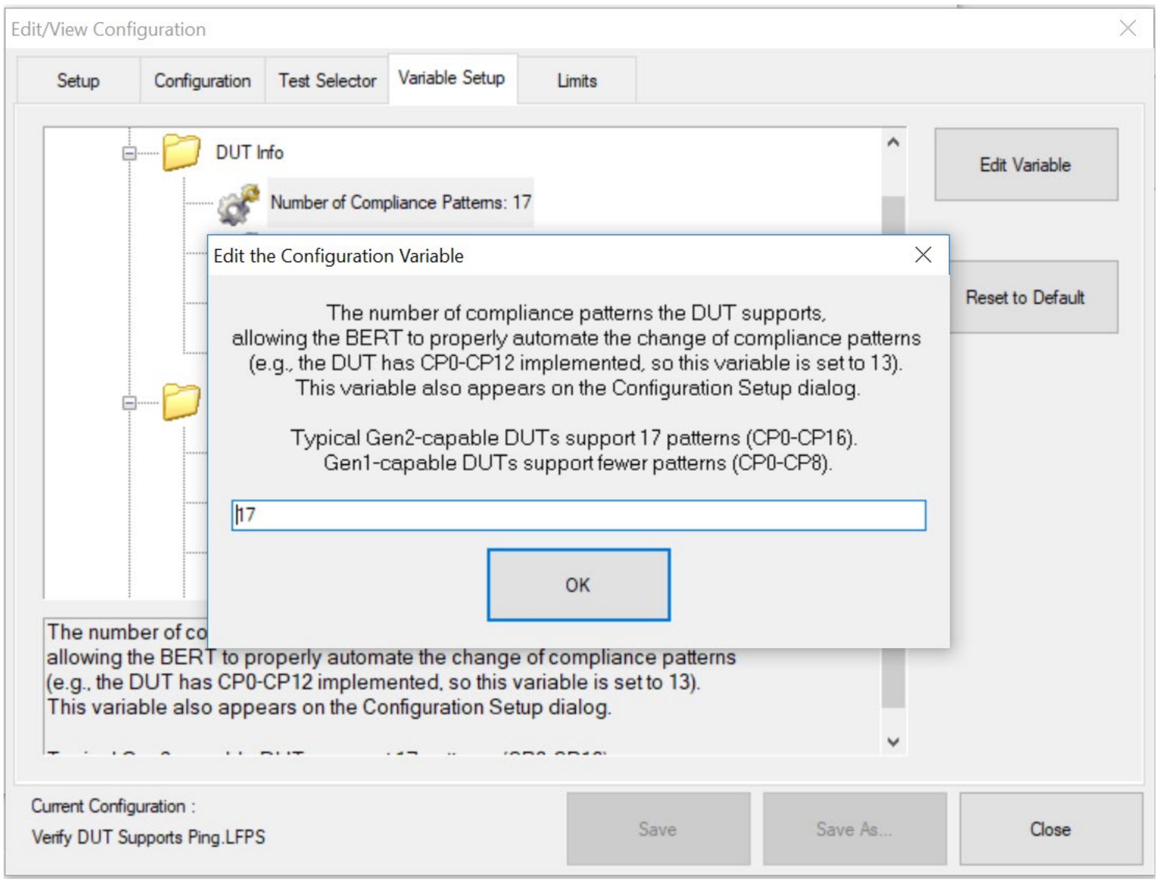


Figure 6 – Configuration Variable Setup Tab

Edit Test Limits

The Limits tab shows the Limit Set currently associated with the configuration. Any limit set can be associated with a custom configuration by selecting it from this field.

The Limits Manager shows the value for every test limit in a limit set. Those in the default set are the limits defined by the standard.

To create a custom limit set:

1. On the Limits tab, click **Limits Manager**.
2. With the default set selected, click **Copy Set** and enter a name.

   Note: You can also choose to copy and/or modify another custom set that has been associated with this configuration.

3. Double click the limit to be modified, and in the pop-up enter the new values.

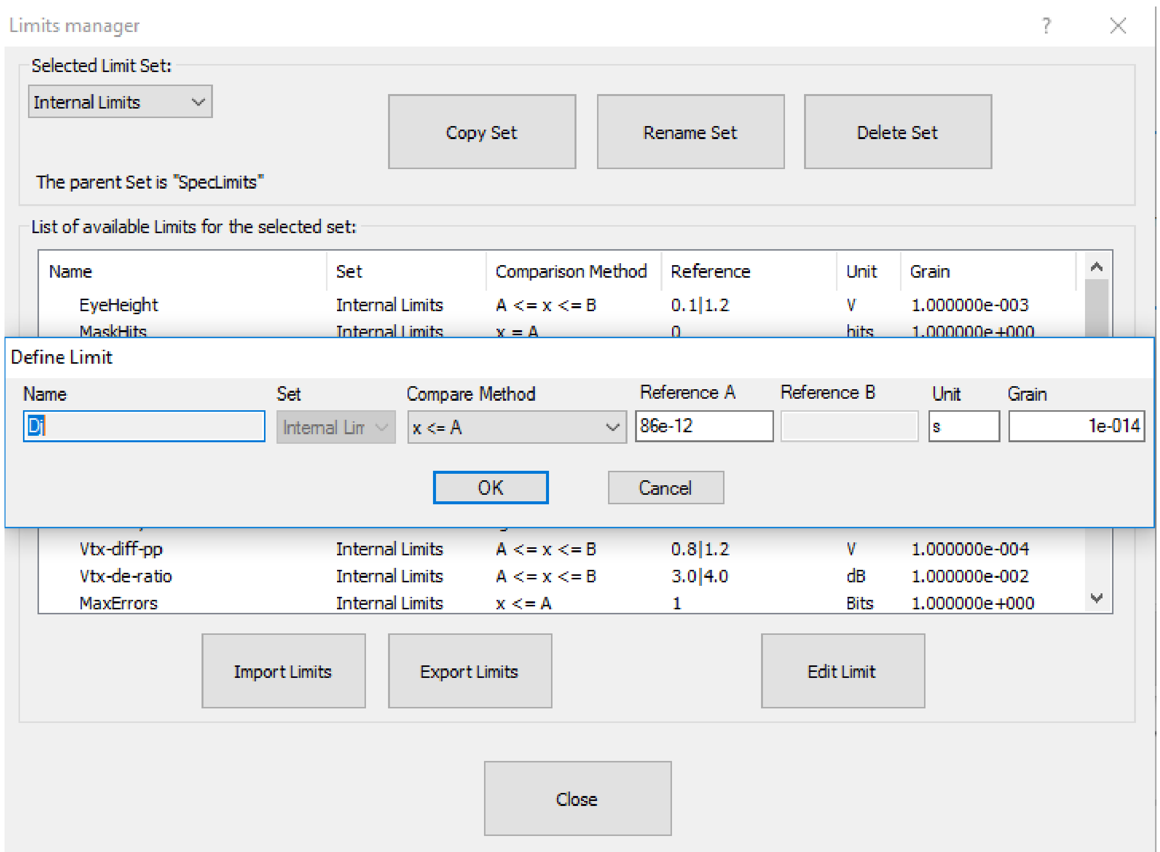


Figure 7 – Limits Manager Dialog

You can also **Import Limits** from a .csv file. Navigate to the file location after clicking the button.

Tip: Likewise, Export Limits creates a .csv file from the current limit set. You may wish to do this and copy it to format the input .csv file.

X-Replay Mode

The X-Replay mode window is an advanced ("developer") view of QualiPHY. The tree in the upper-left frame enables you to navigate to processes in the QualiPHY test script, in case you need to review the code, which appears in the upper-right frame.

Two other particularly useful features are:

- A **list of recent test sessions** in the lower-left frame. While you can only generate a report of the current test session in the QualiPHY wizard, in X-Replay Mode you can generate a report for any of these recent sessions. Select the session and choose **Report > Create Report** from the menu bar.
- The **QualiPHY log** in the bottom-right frame. The frame can be split by dragging up the lower edge. The bottom half of this split frame now shows the **raw Python output**, which can be useful if ever the script needs debugging.

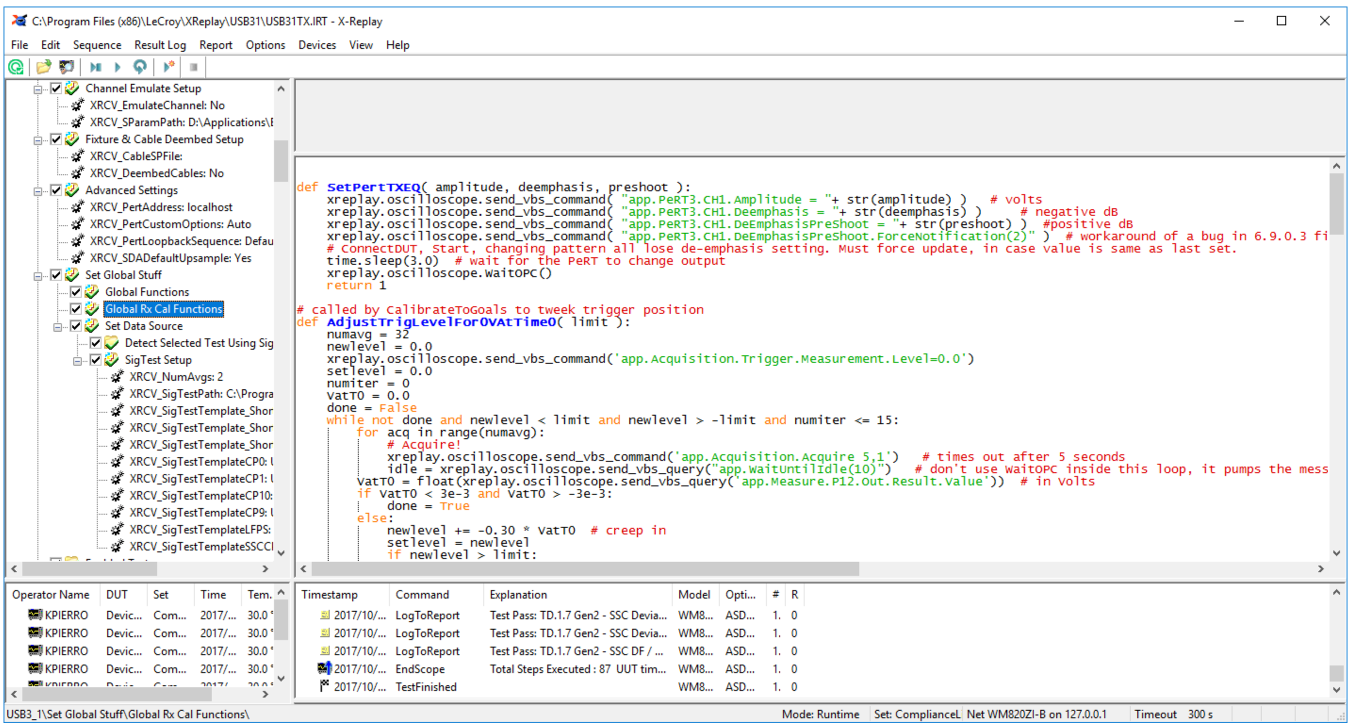


Figure 8 – X-Replay Mode window

USB 3.1/3.2 Transmitter Testing

Test Approach

Transmitter testing requires the DUT to output specific compliance patterns upon which tests are performed. This can be done using only the oscilloscope, or the oscilloscope and a BERT together.

Oscilloscope Plus BERT

With the addition of a Bit Error Ratio Test (BERT) instrument, such as a Teledyne LeCroy PeRT3 or an Anritsu MP1900A, the control of the DUT can be automated, with the BERT stimulating the DUT to enter compliance mode and transmit the proper compliance pattern for the test. The BERT selection should be made under **Instrument** on the Configuration Setup tab to ensure that the proper variable settings are made to support the BERT in use.

The DUT must support Ping.LFPS to enable the BERT to cycle the DUT through the different compliance patterns CP0 – CP16 (Gen1 DUTS may not support all 17 patterns). If the DUT does not support the LFPS Ping method of changing the compliance pattern, do not use BERT automation for compliance testing.

If the DUT supports loopback (but not Ping.LFPS), BERT automation can be used to place the DUT into loopback mode for informative tests only.

Note: Not all tests can be performed correctly using the loopback method. When using this approach, results should be considered informative only and not be used for compliance testing. In particular, the deemphasis test requires a compliance pattern that does *not* have deemphasis; therefore, the measurement cannot be made properly, since in loopback mode deemphasis cannot be disabled in the DUT. Also, in loopback mode there are usually skips present in the data that may cause variations in the results when compared to the LFPS Ping mode.

Oscilloscope Only

In the absence of a BERT, the user must manually make the proper connections between the DUT and the oscilloscope for compliance testing. Additionally, the user must be able to stimulate the DUT to output the proper transmitter compliance patterns. On the Configuration Setup tab, select **Instrument User Controlled**.

SigTest vs. LeCroy Analysis Method

All SigTest USB 3.1 and USB 3.2 compliance tests are included in the standard QualiPHY test configurations. We guarantee these tests for compliance. You will need an installation of SigTest on the oscilloscope: version 3.2.11.3 or later for Gen1 tests and 4.0.23 or later for Gen2 tests.

For informative testing, the LeCroy variants of the USB3.1 Gen1 and Gen2 tests are available to be added to your custom configurations. These tests utilize our SDA III and Eye Dr. II software to provide many additional diagrams and measurements for a rich exploration environment.

Except for the demo, the pre-loaded configurations are all set to use only SigTest. If you wish to perform the LeCroy tests instead of, or in addition to, the SigTest tests, select **Analysis Method LeCroy** on the Configuration Setup tab. This will select all the LeCroy variants on the Test Selector tab.

Test Preparation

Before beginning any test or data acquisition, warm the oscilloscope for at least 20 minutes.

Calibration is performed automatically by the oscilloscope; no manual calibration is required. Calibration will be run again if the temperature of the oscilloscope changes by more than a few degrees.

USB 3.1/3.2 TX Test Configurations

These pre-set test configurations are available for selection on the Wizard Configuration tab. They may be copied and used as the basis for custom configurations.

Empty Template

The test selection is intentionally left blank so it can be easily customized. The limit set in use is Compliance Limits. All variables are set to their defaults.

Demo of Standard-A Device, Gen1 and Gen2

This configuration runs all the SigTest Standard-A device tests as a demonstration using saved waveforms placed in oscilloscope D:\Waveforms\USB3.1_3.2\Demo. The legacy LeCroy tests are included for comparison, except for the legacy common mode and differential voltage tests. The Ping.LFPS test (intended for BERT automation) is also omitted.

The demo waveform files can be downloaded from:

https://teledynelecroy.com/doc/usb32-demo

Standard-A Device, Gen1 and Gen2

This configuration runs the SigTest variants of all Gen1 and Gen2 tests for a Standard-A connector device port. The LeCroy tests are omitted.

Standard-A Host, Gen1 and Gen2

This configuration runs the SigTest variants of all Gen1 and Gen2 tests for a Standard-A connector host port. The LeCroy tests are omitted.

Type-C Device, Gen1 and Gen2

This configuration runs the SigTest variants of all Gen1 and Gen2 tests for a Type-C device port. The LeCroy tests are omitted.

Type-C Host, Gen1 and Gen2

This configuration runs the SigTest variants of all Gen1 and Gen2 tests for a Type-C host port. The LeCroy tests are omitted.

Verify DUT Supports Ping.LFPS

This configuration runs only the Ping.LFPS Support test to confirm that the DUT responds to a ping from the BERT to change compliance patterns. It is recommended only if you are using LFPS signaling for BERT automation, in which case it should be performed prior to any other tests.

USB 3.1/3.2 TX Test Descriptions

Gen1 Tests

- TD 1.1 Low Frequency Periodic Signaling (LFPS) Test
  - LeCroy LFPS
  - SigTest LFPS
- TD 1.6 Spread Spectrum Test
- TD 1.3 Long Channel Jitter & Eye Diagram Tests
  - LeCroy Long Channel Jitter
  - Phase Jitter Slew Rate
  - SigTest Long Channel Jitter
  - LeCroy Long Channel Eye Diagram
  - SigTest Long Channel Eye Diagram
- Legacy AC & DC Common Mode Voltage* Tests
- Legacy Differential Voltage & Deemphasis* Tests
- TD 1.3 Short Channel Jitter & Eye Diagram Tests

Gen2 Tests

- TD 1.4 Long Channel Jitter & Eye Diagram Tests
  - LeCroy Long Channel Jitter, CP9 & CP10
  - Phase Jitter Slew Rate
  - SigTest Long Channel Jitter, CP9 & CP10
  - LeCroy Long Channel Eye Diagram
  - SigTest Long Channel Eye Diagram
- TD 1.4 Short Channel Jitter & Eye Diagram Tests
  - LeCroy Short Channel Jitter, CP9 & CP10
  - Phase Jitter Slew Rate
  - SigTest Short Channel Jitter, CP9 & CP10
  - LeCroy Short Channel Eye Diagram
  - SigTest Short Channel Eye Diagram
- TD 1.7 SSC Profile Test
- TD 1.5 Transmit Equalization Test

* Test not included in any pre-set configuration; retained for informational purposes only.

Ping.LFPS Support Test

This test confirms that the DUT supports the Ping.LFPS command required to use BERT automation for compliance testing. The BERT sends the Init.LFPS command to the DUT to stimulate the DUT to enter compliance mode. Then, the BERT sends repeated Ping.LFPS commands to the DUT, checking that the DUT responds by outputting the correct compliance pattern. This cycle is repeated for all compliance patterns through CP12.

TD 1.1 Low Frequency Periodic Signaling (LFPS) Tests

This test group verifies that the voltage and timing parameters of the Low Frequency Periodic Signaling (LFPS) are within the specification limits.

LeCroy LFPS

This version of the LFPS test uses the Teledyne LeCroy algorithm for LFPS detection and measurement. These test results should not be directly used for compliance, but do provide a rich debug environment.

At the completion of the LFPS Test, the oscilloscope is in the following state:

Figure 9 – LeCroy LFPS Test

Shown on this screen:

- F1 is the differential LFPS trace (subtraction of C1 and C2)
- F2 is the common mode LFPS trace (addition of C1 and C2 divided by 2)
- F3 shows only the first 5 bursts of the differential LFPS trace after the trigger
- F7 shows only the first 5 bursts of the common mode LFPS trace after the trigger

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.1	Gen1	LFPS Minimum Burst Width	Long	LeCroy	996 ns	600 ns <= x <= 1.400 µs
✔	1	TD.1.1	Gen1	LFPS Mean Burst Width	Long	LeCroy	1.019 µs	600 ns <= x <= 1.400 µs
✔	1	TD.1.1	Gen1	LFPS Maximum Burst Width	Long	LeCroy	1.029 µs	600 ns <= x <= 1.400 µs
✔	1	TD.1.1	Gen1	LFPS Minimum Burst Repeat Time	Long	LeCroy	7.57 µs	6.00 µs <= x <= 14.00 µs
✔	1	TD.1.1	Gen1	LFPS Mean Burst Repeat Time	Long	LeCroy	9.03 µs	6.00 µs <= x <= 14.00 µs
✔	1	TD.1.1	Gen1	LFPS Maximum Burst Repeat Time	Long	LeCroy	12.75 µs	6.00 µs <= x <= 14.00 µs
✔	1	TD.1.1	Gen1	LFPS Period	Long	LeCroy	32 ns	20 ns <= x <= 100 ns
✔	1	TD.1.1	Gen1	LFPS Rise Time	Long	LeCroy	647 ps	x <= 4.0 ns
✔	1	TD.1.1	Gen1	LFPS Fall Time	Long	LeCroy	631 ps	x <= 4.0 ns
✔	1	TD.1.1	Gen1	LFPS Duty Cycle	Long	LeCroy	50.6 %	40.0 % <= x <= 60.0 %
✔	1	TD.1.1	Gen1	LFPS Differential Voltage Peak	Long	LeCroy	1.043 V	800 mV <= x <= 1.200 V
✔	1	TD.1.1	Gen1	LFPS AC Common Mode Voltage Peak-Peak	Long	LeCroy	32.659 mV	x <= 100.000 mV

Figure 10 – Test Report from LeCroy LFPS Tests

In the Measure table:

- **burstW** (P1) is measuring the burst width. The minimum value is the measured value for **LFPS Minimum Burst Width**. The mean value is the measured value for **LFPS Mean Burst Width**. The maximum value is the measured value for **LFPS Maximum Burst Width**.
- **tRepeat** (P2) is measuring the time between the bursts (tRepeat). The minimum value is the measured value for **LFPS Minimum Burst Repeat Time**. The mean value is the measured value for **LFPS Mean Repeat Time**. The maximum value is the measured value for **LFPS Maximum Repeat Time**.
- **Period** (P3) is the period measurement of the signal within the burst (F3). The mean value is the measured value for **LFPS Period**.
- **Rise2080** (P4) is the 20-80% rise time of the pulses within the burst (F3). The mean value is the measured value for **LFPS Rise Time**.
- **Fall2080** (P5) is the 20-80% fall time of the pulses within the burst (F3). The mean value is the measured value for **LFPS Fall Time**.
- **Duty** (P6) measures the duty cycle of the pulses within the burst (F3). The mean value is the measured value for **LFPS Duty Cycle**.
- **Pkpk** (P7) measures the peak-to-peak amplitude of the pulses within the burst (F3). The mean value is the measured value for **LFPS Differential Voltage Peak Peak**.
- **Pkpk** (P8) measures the peak-to-peak amplitude of the Common Mode Trace (F7). The mean value is the measured value for **LFPS AC Common Mode Voltage Peak Peak**.

SigTest LFPS

This version of the LFPS tests uses the SigTest algorithm and results for compliance. The results from SigTest are displayed in the report as shown below.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.1	Gen1	LFPS Min Amplitude	Long	SigTest	1.026 V	800 mV <= x <= 1.200 V
✔	1	TD.1.1	Gen1	LFPS Max Amplitude	Long	SigTest	1.043 V	800 mV <= x <= 1.200 V
✔	1	TD.1.1	Gen1	LFPS Max CM AC	Long	SigTest	32.650 mV	x <= 100.000 mV
✔	1	TD.1.1	Gen1	LFPS Min Period	Long	SigTest	32 ns	20 ns <= x <= 100 ns
✔	1	TD.1.1	Gen1	LFPS Max Period	Long	SigTest	32 ns	20 ns <= x <= 100 ns
✔	1	TD.1.1	Gen1	LFPS Min Burst Time	Long	SigTest	1.075 µs	600 ns <= x <= 1.400 µs
✔	1	TD.1.1	Gen1	LFPS Max Burst Time	Long	SigTest	1.079 µs	600 ns <= x <= 1.400 µs
✔	1	TD.1.1	Gen1	LFPS Min Repeat Time	Long	SigTest	7.59 µs	6.00 µs <= x <= 14.00 µs
✔	1	TD.1.1	Gen1	LFPS Max Repeat Time	Long	SigTest	12.75 µs	6.00 µs <= x <= 14.00 µs
✔	1	TD.1.1	Gen1	LFPS Min Duty Cycle	Long	SigTest	50.6 %	40.0 % <= x <= 60.0 %
✔	1	TD.1.1	Gen1	LFPS Max Duty Cycle	Long	SigTest	50.7 %	40.0 % <= x <= 60.0 %
✔	1	TD.1.1	Gen1	LFPS Rise Time	Long	SigTest	695 ps	x <= 4.0 ns
✔	1	TD.1.1	Gen1	LFPS Fall Time	Long	SigTest	669 ps	x <= 4.0 ns

Figure 11 – Test Report from SigTest LFPS Tests

TD 1.6 Spread Spectrum Test

This test measures spread spectrum modulation frequency and deviation at the compliance port, and verifies that the transmitter operating at Gen1 speed meets the SSC profile requirements with the required TX equalization.

At the completion of the Spread Spectrum Test, the oscilloscope is in the following state:

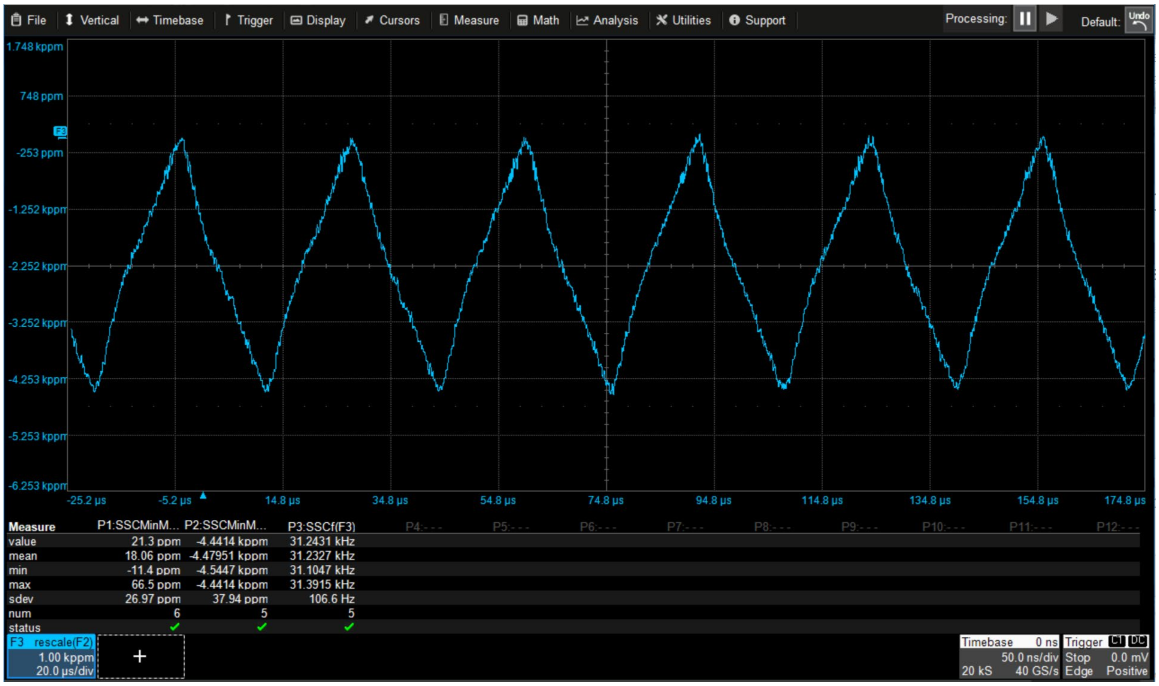


Figure 12 – LeCroy Spread Spectrum Test

Shown on this screen:

- F3 is the **SSCTrack** of the captured waveform

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.6	Gen1	SSC Deviation Max (max)	Long	LeCroy	66.5 PPM	-300.0 PPM <= x <= 300.0 PPM or -2.3000 kPPM <= x <= -1.7000 kPPM
✔	1	TD.1.6	Gen1	SSC Deviation Max (min)	Long	LeCroy	-11.4 PPM	-300.0 PPM <= x <= 300.0 PPM or -2.3000 kPPM <= x <= -1.7000 kPPM
✔	1	TD.1.6	Gen1	SSC Frequency Modulation Rate	Long	LeCroy	31.233 kHz	30.000 kHz <= x <= 33.000 kHz
✔	1	TD.1.6	Gen1	SSC Deviation Min (max)	Long	LeCroy	-4.4414 kPPM	-5.3000 kPPM <= x <= -3.7000 kPPM
✔	1	TD.1.6	Gen1	SSC Deviation Min (min)	Long	LeCroy	-4.5447 kPPM	-5.3000 kPPM <= x <= -3.7000 kPPM

Figure 13 – Test Report from SSC Tests

In the Measure table:

- **SSCMinMax** (P1) is measuring the SSC Deviation Max, which are the maximum values (peaks of the SSC Track). The maximum value is the measured value for **SSC Deviation Max (max)**. The minimum value is the measured value for **SSC Deviation Max (min)**.
- **SSCMinMax** (P2) is measuring the SSC Deviation Min, which are the minimum values (peaks of the SSC Track). The maximum value is the measured value for **SSC Deviation Min (max)**. The minimum value is the measured value for **SSC Deviation Min (min)**.
- **SSCf** (P3) is measuring the frequency of the SSC Track. The mean value is the measured value for **SSC Frequency Modulation Rate**.

TD 1.3 Gen1 Long Channel Jitter & Eye Diagram Tests

This test group verifies that the transmitter meets the eye width, deterministic jitter and random jitter requirements for Gen1 when measured at the compliance test port with nominal transmitter equalization. The oscilloscope emulates the presence of the long channel.

LeCroy Long Channel Jitter

This test uses the SDA toolkit to verify that the jitter on CP0 and CP1 is within the USB 3.2 Gen1 specification limits. It includes emulation of the Long Channel S-parameter model required by the USB 3.2 test specification.

The measurements are made on the compliance channel after applying the reference Continuous Time Linear Equalizer (CTLE) function. First, the jitter is measured while the DUT is transmitting the CP1 (101010) pattern. Then, the jitter is measured while the DUT is transmitting the CP0 (scrambled D0.0) pattern, however the random jitter (Rj) that was measured during the jitter test of CP1 must be injected into this measurement. This simplifies the separation of random (Rj) and deterministic jitter (Dj) since there is no data dependent jitter (DDj, a component of Dj) when CP1 is transmitted.

At the completion of the LeCroy Jitter Test, the oscilloscope is in the following state:

Figure 14 – LeCroy CP1 Jitter Test

Shown on this screen:

- **TIEHist** is the TIEHistogram of the CP1 pattern
- **BathTub** is the Bathtub Curve of the CP1 pattern

In the Measure table:

- **TMnPls** (P1) is measuring the minimum pulse width of the CP1 pattern.

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are measured on CP1 pattern. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique. The Tj value is reported as **Tj CP1** and the Rj value is reported as **Rj(rms) CP1**.

At the completion of the CP0 Jitter Test, the oscilloscope is in the following state:

Figure 15 – LeCroy CP0 Jitter Test

Shown on this screen:

- TIEHist is the TIEHistogram of the CP0 pattern
- BathTub is the Bathtub Curve of the CP0 pattern

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.3	Gen1	Tj CP1	Long	LeCroy	26.66 ps	x <= 132.00 ps
✔	1	TD,1.3	Gen1	Rj(rms) CP1	Long	LeCroy	1.113 ps	x <= 3.270 ps
✔	1	TD.1.3	Gen1	Tj CP0	Long	LeCroy	62.87 ps	x <= 132.00 ps
✔	1	TD.1.3	Gen1	Rj(rms) CP0	Long	LeCroy	0 fs	x <= 3.270 ps
✔	1	TD.1.3	Gen1	Dj CP0	Long	LeCroy	62.87 ps	x <= 86.00 ps
i	1	TD.1.3	Gen1	Min Pulse Time	Long	LeCroy	189.587 ps	Informational Only
i	1	TD.1.3	Gen1	Avg UI	Long	LeCroy	200.45 ps	Informational Only

Figure 16 – Test Report from Jitter Tests

In the Measure table:

- **TMnPls** (P1) is measuring the minimum pulse width of the CP1 pattern and is displayed in the report as **Min Pulse Time** for informational purposes. **Average UI** is not shown on the screen, but is reported with the other results.

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are measured on CP0 pattern. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique. However, as per the USB 3.2 test specification, the Rj that was measured on CP1 is injected into this measurement. The Tj value is reported as **Tj CP0**, the Rj value is reported as **Rj(rms) CP0** and the DJ value is reported as **DJ CP0**.

Phase Jitter Slew Rate

This test uses the SDA toolkit to measure how fast the PLL in a USB 3.2 receiver must change in order to keep up with changes in the clock frequency, and verifies that the Max and Min slew rates are within USB 3.2 Gen1 limits. It requires calculation of the first derivative of the PLL Track. The PLL Track is a waveform that shows the phase change that the PLL was able to follow and track out of the signal. By taking the first derivative of the PLL Track, we can easily measure the minimum and maximum phase jitter slew rate on the derivative waveform.

At the completion of the Phase Jitter Slew Rate Test, the oscilloscope is in the following state:

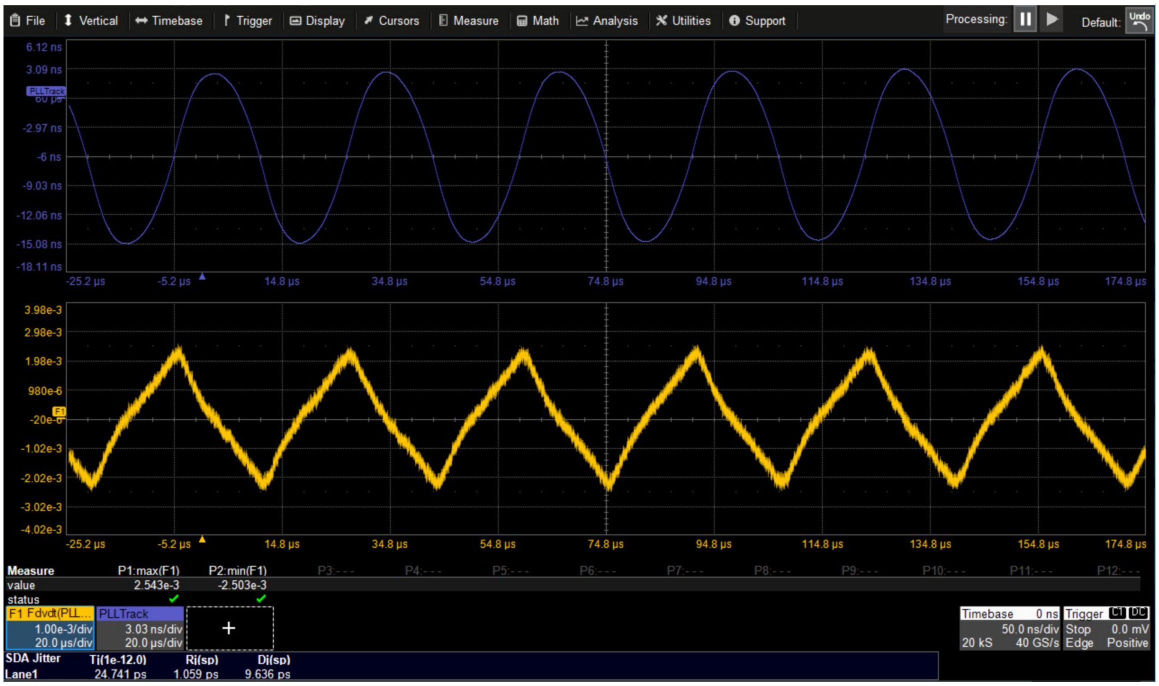


Figure 17 – LeCroy Gen1 Phase Jitter Slew Rate Test

Shown on this screen:

- **PLLTrack** is the PLL Track of the CP1 pattern
- **Fdvdt** is the first derivative of the PLL Track

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	Legacy	Gen1	Phase Jitter Slew Rate Max	Long	SigTest	2.543 ms/s	x = 0 µs/s +/- 10.000 ms/s
✔	1	Legacy	Gen1	Phase Jitter Slew Rate Min	Long	SigTest	-2.503 ms/s	x = 0 µs/s +/- 10.000 ms/s

Figure 18 – Test Report from Phase Jitter Slew Rate Test

In the Measure table:

- **Max** (P1) is measuring the maximum of the derivative of the PLL track (F1). This is the measured value for **Phase Jitter Slew Rate Max.**
- **Min** (P2) is measuring the minimum of the derivative of the PLL track (F1). This is the measured value for **Phase Jitter Slew Rate Min.**

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are displayed for informational purposes. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique.

SigTest Long Channel Jitter

This test verifies that the jitter on CP0 and CP1 is within the USB 3.2 Gen1 specification limits. It includes emulation of the Long Channel S-parameter model required by the USB 3.2 test specification. The test is performed in the same manner as is TD 1.3 LeCroy Long Channel Jitter, except that SigTest is used for analysis, instead of the SDA software.

The measurements are made on the compliance channel by applying the reference Continuous Time Linear Equalizer function. The SigTest currently implements the CTLE function, however, it does not implement the channel emulation. For this reason, the channel emulation is still performed in Eye Doctor II before the signal is seen by SigTest. Measuring the jitter is a multiple step process. First, the jitter must be measured while the DUT is transmitting the CP1 (101010) pattern. Then, the jitter is measured while the DUT is transmitting the CP0 (scrambled D0.0) pattern, however the Rj that was measured during the jitter test of CP1 must be injected into this measurement. This simplifies the separation of Rj and Dj since there is no DDj when CP1 is transmitted.

There are no traces displayed on the screen for this test. All calculations are done in SigTest.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.3	Gen1	Tj CP1	Long	SigTest	26.8775 ps	x <= 132.00 ps
✔	1	TD.1.3	Gen1	Rj (rms) CP1	Long	SigTest	1.1019 ps	x <= 3.270 ps
✔	1	TD.1.3	Gen1	SigTest Long Channel Pass / Fail Result	Long	SigTest	pass	match "Pass"
✔	1	TD.1.3	Gen1	Tj CP0	Long	SigTest	49.6183 ps	x <= 132.00 ps
✔	1	TD.1.3	Gen1	Rj (rms) CP0	Long	SigTest	1.1019 ps	x <= 3.270 ps
✔	1	TD.1.3	Gen1	Dj DD CP0	Long	SigTest	34.1260 ps	x <= 86.00 ps
ℹ	1	TD.1.3	Gen1	Min Time Between Crossovers	Long	SigTest	163.075 ps	Informational Only
✔	1	TD.1.3	Gen1	Avg UI	Long	SigTest	200.4517 ps	199.9400 ps < x < 201.0656 ps
ℹ	1	TD.1.3	Gen1	Max PP Jitter	Long	SigTest	51.764 ps	Informational Only

Figure 19 – Test Report from Phase Jitter Slew Rate Test

LeCroy Long Channel Eye Diagram

Creates an eye diagram for CP0 using the Teledyne LeCroy SDA toolkit, and performs a mask test to verify that the eye meets the USB 3.2 Gen1 specification limits. Test includes emulation of the Long Channel S-parameter model required by the USB 3.2 test specification. For compliance testing, the measurements are made after a compliance channel by applying the reference Continuous Time Linear Equalizer (CTLE) function.

At the completion of the Eye Diagram Test the oscilloscope is in the following state:

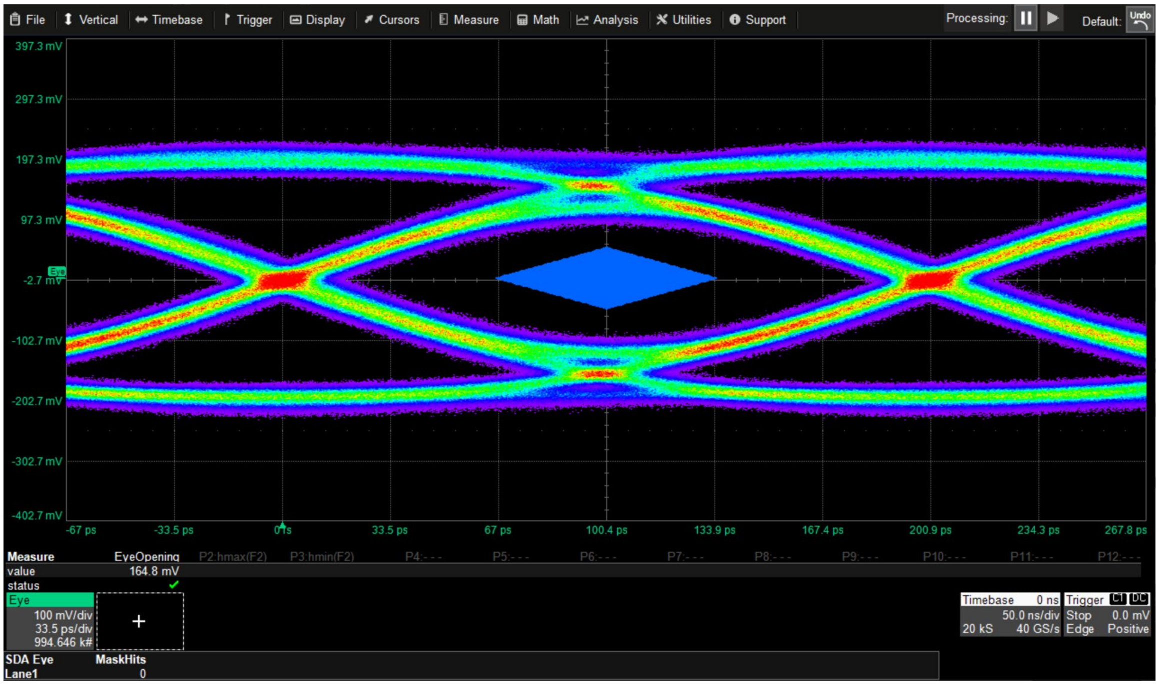


Figure 20 – LeCroy Gen1 Eye Diagram Test

Shown on this screen:

- Eye Diagram of CP0 with the USB 3.2 compliance mask displayed

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.3	Gen1	Eye Diagram Mask Hits	Long	LeCroy	0 hits	x = 0 hits
✔	1	TD.1.3	Gen1	Eye Height	Long	LeCroy	165 mV	100 mV <= x <= 1.200 V

Figure 21 – Test Report from Eye Diagram Test

In the Measure table:

- **EyeOpening** (P1) is measuring the vertical eye opening and is reported as **Eye Height**.

In the SDA Eye table:

MaskHits is counting the number of mask hits and is reported as Eye Diagram Mask Hits.

SigTest Long Channel Eye Diagram

This test verifies that the CP0 eye diagram is within the USB 3.2 Gen1 specification limits. The test is performed in the same manner as is TD 1.3 LeCroy Long Channel Eye Diagram, except that SigTest is used for analysis, instead of the SDA software.

The measurements are made on the compliance channel by applying the reference Continuous Time Linear Equalizer function. SigTest currently implements the CTLE function, however, it does not implement the channel emulation. For this reason, the channel emulation is still performed in Eye Doctor II before the signal is seen by SigTest.

There are no traces displayed on the screen for this test. All calculations are done in SigTest. Images of the eye diagrams and all results can be found in the report.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.3	Gen1	Non Transition Eye Violations	Long	SigTest	0 hits	x = 0 hits
✔	1	TD.1.3	Gen1	Transition Eye Violations	Long	SigTest	0 hits	x = 0 hits
✔	1	TD.1.3	Gen1	Total Eye Violations	Long	SigTest	0 hits	x = 0 hits
✔	1	TD.1.3	Gen1	SigTest Long Channel Pass / Fail Result	Long	SigTest	pass	match "Pass"
i	1	TD.1.3	Gen1	Eye Height	Long	SigTest	162.7 mV	Informational Only
i	1	TD.1.3	Gen1	Max Non Trans Voltage	Long	SigTest	229.0 mV	Informational Only
i	1	TD.1.3	Gen1	Min Non Trans Voltage	Long	SigTest	-235.4 mV	Informational Only
i	1	TD.1.3	Gen1	Max Trans Voltage	Long	SigTest	229.5 mV	Informational Only
i	1	TD.1.3	Gen1	Min Trans Voltage	Long	SigTest	-233.5 mV	Informational Only
i	1	TD.1.3	Gen1	Min Non Trans Upper Margin	Long	SigTest	67.5 mV	Informational Only
i	1	TD.1.3	Gen1	Max Non Trans Lower Margin	Long	SigTest	-75.2 mV	Informational Only
i	1	TD.1.3	Gen1	Max Trans Upper Margin	Long	SigTest	27.1 mV	Informational Only
i	1	TD.1.3	Gen1	Max Trans Lower Margin	Long	SigTest	-35.6 mV	Informational Only
i	1	TD.1.3	Gen1	Min Eye Width	Long	SigTest	150.382 ps	Informational Only

Figure 22 – Test Report from SigTest Eye Test

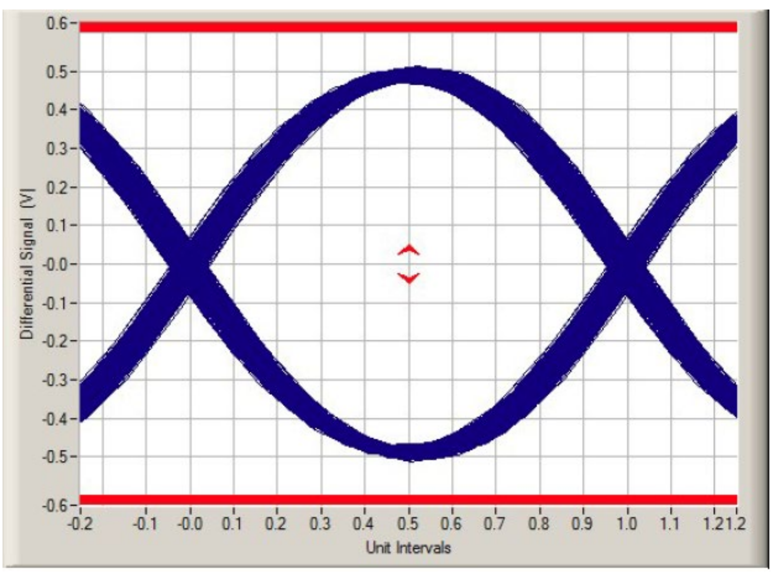


Figure 23 –SigTest CP1 Eye Diagram

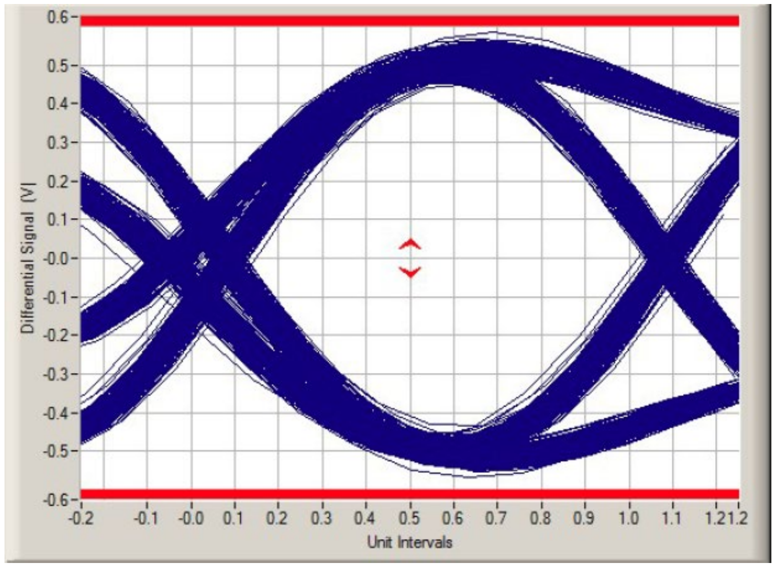


Figure 24 – SigTest CP0 Transition Eye Diagram

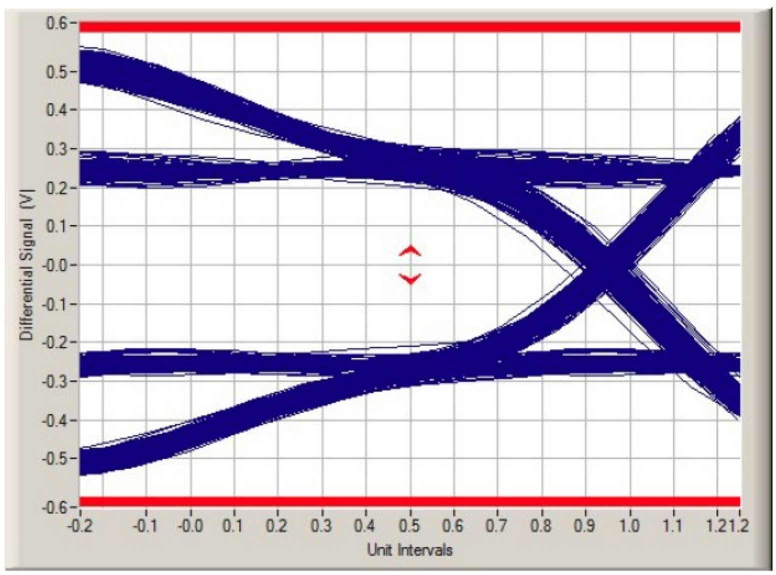


Figure 25 – SigTest CP0 Non-Transitioning Eye Diagram

Legacy AC & DC Common Mode Voltage Tests

These tests are no longer required for compliance, but are included in QualiPHY for informative testing. The purpose of this test group is to verify that the AC and DC common mode voltages are within the specification limits. The AC Common Mode Voltage is defined as the peak-to-peak Voltage of the common mode signal and the DC Common Mode Voltage is defined as the mean voltage of the common mode signal.

At the completion of the tests, the oscilloscope is in the following state:

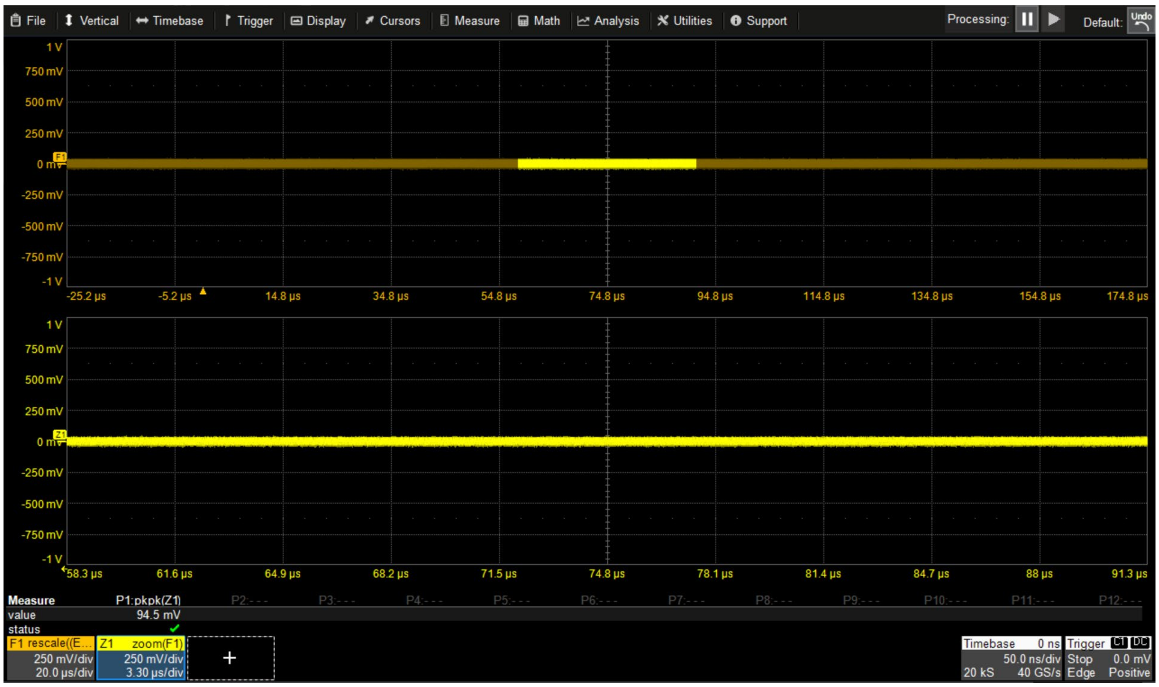


Figure 26 – LeCroy AC and DC Common Mode Test

Shown on this screen:

- F1 is the common mode trace (addition of C1 and C2 divided by 2)
- Z1 is a zoom of the common mode trace

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
i	1	Legacy	Gen1	Vtx-ac-cm-pp active	Long	LeCroy	94.455 mV	Informational Only
i	1	Legacy	Gen1	Vtx-dc-cm	Long	LeCroy	227 µV	Informational Only

Figure 27 – Test Report from AC and DC Common Mode Test

In the Measure table:

- **Pkpk** (P1) is measuring the peak-to-peak amplitude of Z1 and is the measured value for **Vt-ac-cm-pp active.**
- **Mean** (P2) is measuring the DC Common mode and is calculated over a longer interval of time by measuring the mean value of (F1). This is the measured value for **Vtx-dc-cm.**

Legacy Differential Voltage & Deemphasis Tests

These tests are no longer required for compliance, but are included in QualiPHY for informative testing. The purpose of this test is to verify that the transmitter differential voltage and deemphasis are within the specification limits. These two tests are performed together in two steps. The first step acquires the CP7 pattern. This pattern consists of 50-250 1's followed by 50-250 0's with deemphasis applied to the signal. Once this acquisition is performed, a histogram is created from the data. The difference between the two modes of the histogram is calculated and is the amplitude of the deemphasized bits.

At the completion of this part of the Differential Voltage & Deemphasis test, the oscilloscope is in the following state:

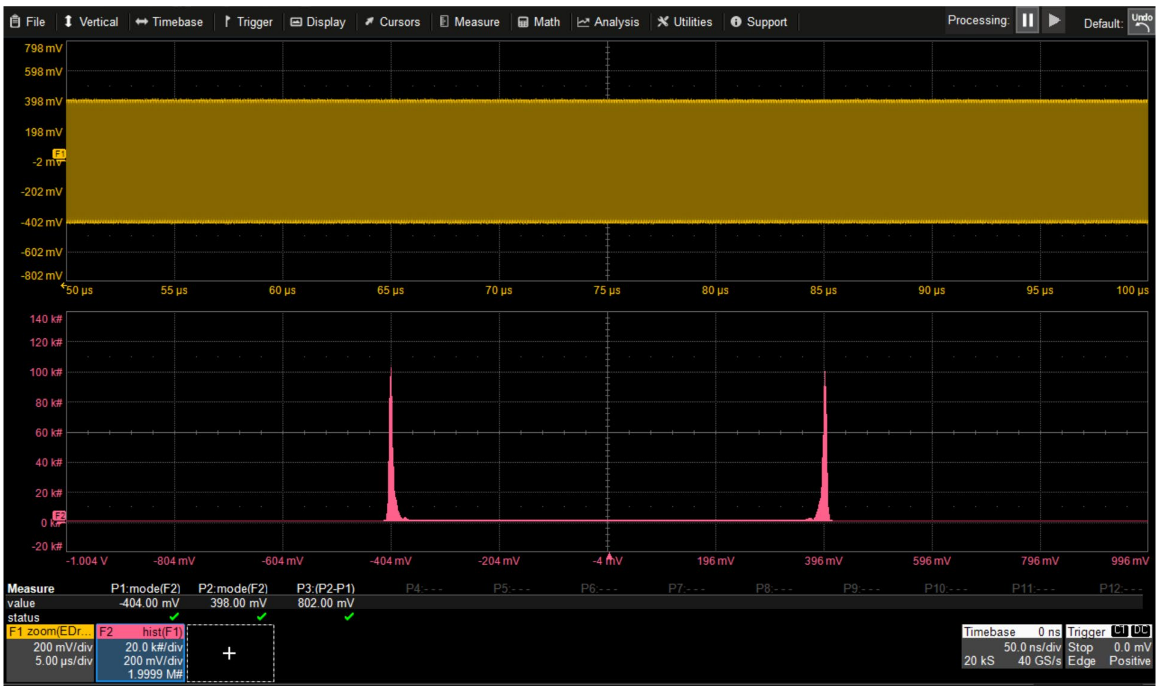


Figure 28 – LeCroy Differential Voltage & Deemphasis Test on CP7

Shown on this screen:

- F1 is the acquired differential CP7 signal
- F2 is the histogram created from this signal

In the Measure table:

- **Mode** (P1) is measuring the mode of the left portion of the histogram
- **Mode** (P2) is measuring the mode of the right portion of the histogram
- **P2-P1** (P3) is measuring the difference of the two modes and is the measured value for **Differential Voltage Deemphasized Level**.

This is then repeated on the CP8 pattern (no deemphasis). This pattern consists of the same 50-250 1's followed by 50-250 0's without deemphasis applied to the signal. The histogram is created and the difference between the 2 modes is calculated. This result is the differential voltage (without deemphasis). The differential voltage and the amplitude of the deemphasized bits are then used to calculate the deemphasis ratio.

At the completion the CP8 test, the oscilloscope is in the following state:

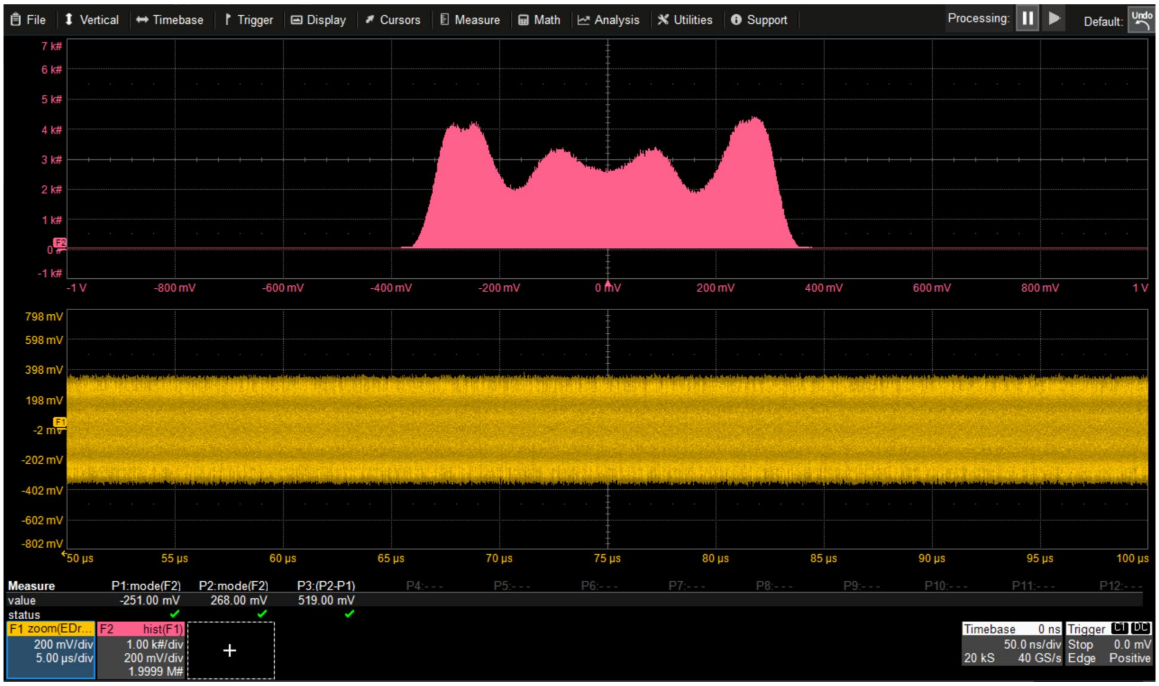


Figure 29 – LeCroy Differential Voltage & Deemphasis Test on CP8

Shown on this screen:

- F1 is the acquired differential CP8 signal
- F2 is the histogram created from this signal

In the Measure table:

- **Mode** (P1) is measuring the mode of the left portion of the histogram and is the measured value for **Differential Voltage Min**.
- **Mode** (P2) is measuring the mode of the right portion of the histogram and is the measured value for **Differential Voltage Max**.
- **P2-P1** (P3) is measuring the difference of the two modes and is the measured value for **Differential Voltage Full Swing Level**.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
i	1	Legacy	Gen1	Differential Voltage Deemphsized Level	Long	LeCroy	802.0 mV	Informational Only
i	1	Legacy	Gen1	Differential Voltage Min	Long	LeCroy	-242.0 mV	Informational Only
i	1	Legacy	Gen1	Differential Voltage Max	Long	LeCroy	268.0 mV	Informational Only
i	1	Legacy	Gen1	Differential Voltage Full Swing Level	Long	LeCroy	510.0 mV	Informational Only
i	1	Legacy	Gen1	De-emphasis Ratio	Long	LeCroy	-3.93 dB	Informational Only

Figure 30 – Test Report from Differential Voltage & De-emphasis Test

TD 1.3 Gen1 Short Channel Jitter & Eye Diagram Tests

This test group replicates the TD 1.3 Long Channel Jitter & Eye Diagram Tests, only instead using the Short Channel model. It verifies that the transmitter meets the eye width, deterministic jitter and random jitter requirements for Gen1 when measured at the compliance test port with nominal transmitter equalization.

There are no traces displayed on the screen for this test. All calculations are done in SigTest. Images of the eye diagrams and all results can be found in the report.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.3	Gen1	Tj CP1	Short	SigTest	13.2415 ps	x <= 132.00 ps
✔	1	TD.1.3	Gen1	Rj (rms) CP1	Short	SigTest	0.8797 ps	x <= 3.270 ps
✔	1	TD.1.3	Gen1	SigTest Short Channel SigTest Pass / Fail Result	Short	SigTest	pass	match "Pass"
✔	1	TD.1.3	Gen1	Tj CP0	Short	SigTest	17.3270 ps	x <= 132.00 ps
✔	1	TD.1.3	Gen1	Rj (rms) CP0	Short	SigTest	0.8797 ps	x <= 3.270 ps
✔	1	TD.1.3	Gen1	Dj DD CP0	Short	SigTest	4.9580 ps	x <= 86.00 ps
i	1	TD.1.3	Gen1	Min Time Between Crossovers (after channel)	Short	SigTest	186.778 ps	Informational Only
✔	1	TD.1.3	Gen1	Avg UI	Short	SigTest	200.4320 ps	199.9400 ps < x < 201.0656 ps
i	1	TD.1.3	Gen1	Max PP Jitter	Short	SigTest	15.685 ps	Informational Only
✔	1	TD.1.3	Gen1	Non Transition Eye Violations	Short	SigTest	0 hits	x = 0 hits
✔	1	TD.1.3	Gen1	Transition Eye Violations	Short	SigTest	0 hits	x = 0 hits
✔	1	TD.1.3	Gen1	Total Eye Violations	Short	SigTest	0 hits	x = 0 hits
i	1	TD.1.3	Gen1	Eye Height SigTest	Short	SigTest	796.8 mV	Informational Only
i	1	TD.1.3	Gen1	Max Non Trans Voltage SigTest	Short	SigTest	519.4 mV	Informational Only
i	1	TD.1.3	Gen1	Min Non Trans Voltage SigTest	Short	SigTest	-569.4 mV	Informational Only
i	1	TD.1.3	Gen1	Max Trans Voltage SigTest	Short	SigTest	517.3 mV	Informational Only
i	1	TD.1.3	Gen1	Min Trans Voltage SigTest	Short	SigTest	-563.7 mV	Informational Only
i	1	TD.1.3	Gen1	Min Non Trans Upper Margin	Short	SigTest	343.6 mV	Informational Only
i	1	TD.1.3	Gen1	Max Non Trans Lower Margin	Short	SigTest	-399.0 mV	Informational Only
i	1	TD.1.3	Gen1	Max Trans Upper Margin	Short	SigTest	318.5 mV	Informational Only
i	1	TD.1.3	Gen1	Max Trans Lower Margin	Short	SigTest	-378.3 mV	Informational Only
i	1	TD.1.3	Gen1	Min Eye Width SigTest	Short	SigTest	182.673 ps	Informational Only

Figure 31 – Test Report from SigTest Eye Test

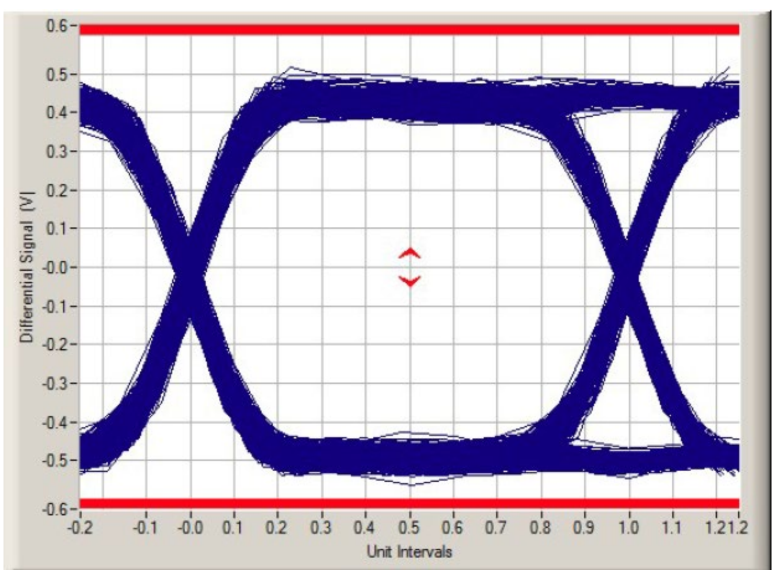


Figure 32 – SigTest Short Channel CP0 Transition Eye Diagram

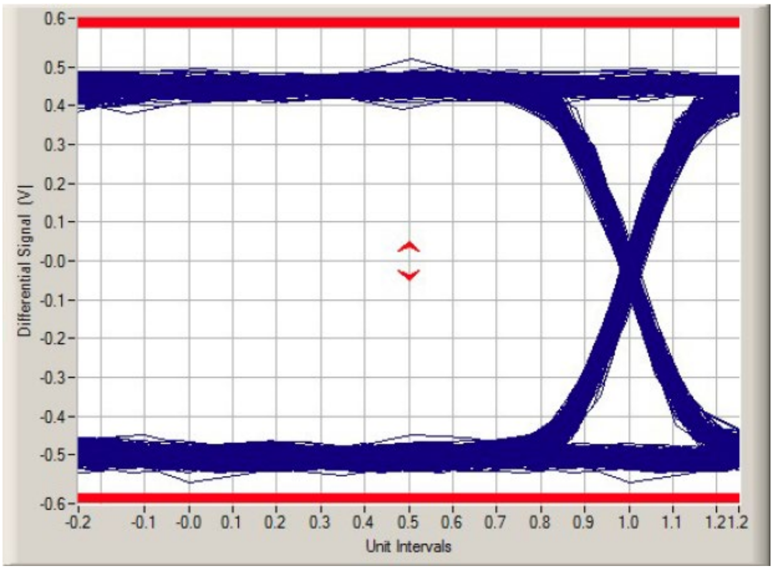


Figure 33 – SigTest Short Channel CP0 Non-Transitioning Eye Diagram

TD 1.4 Gen2 Long Channel Jitter & Eye Diagram Tests

This test group verifies that the transmitter meets the eye width, deterministic jitter and random jitter requirements for Gen2 speeds of 10 Gb/s when measured at the compliance test port with nominal transmitter equalization. The oscilloscope emulates the presence of the long channel. The Phase Jitter Slew Rate test is optional.

LeCroy Long Channel Jitter, CP9 & CP10

This test uses the SDA toolkit to verify that the jitter on CP9 and CP10 is within Gen2 specification limits. It includes emulation of the Long Channel S-parameter model required by the USB 3.2 test specification. The measurements are made on the compliance channel after applying the reference Continuous Time Linear Equalizer (CTLE) function. First, the jitter is measured while the DUT is transmitting the CP10 (101010) pattern. Then, the jitter is measured while the DUT is transmitting the CP9 (PRBS) pattern, however the random jitter (Rj) that was measured during the jitter test of CP10 must be injected into this measurement. This simplifies the separation of random (Rj) and deterministic jitter (Dj) since there is no data dependent jitter (DDj, a component of Dj) when CP10 is transmitted.

At the completion of the CP10 Jitter Test, the oscilloscope is in the following state:

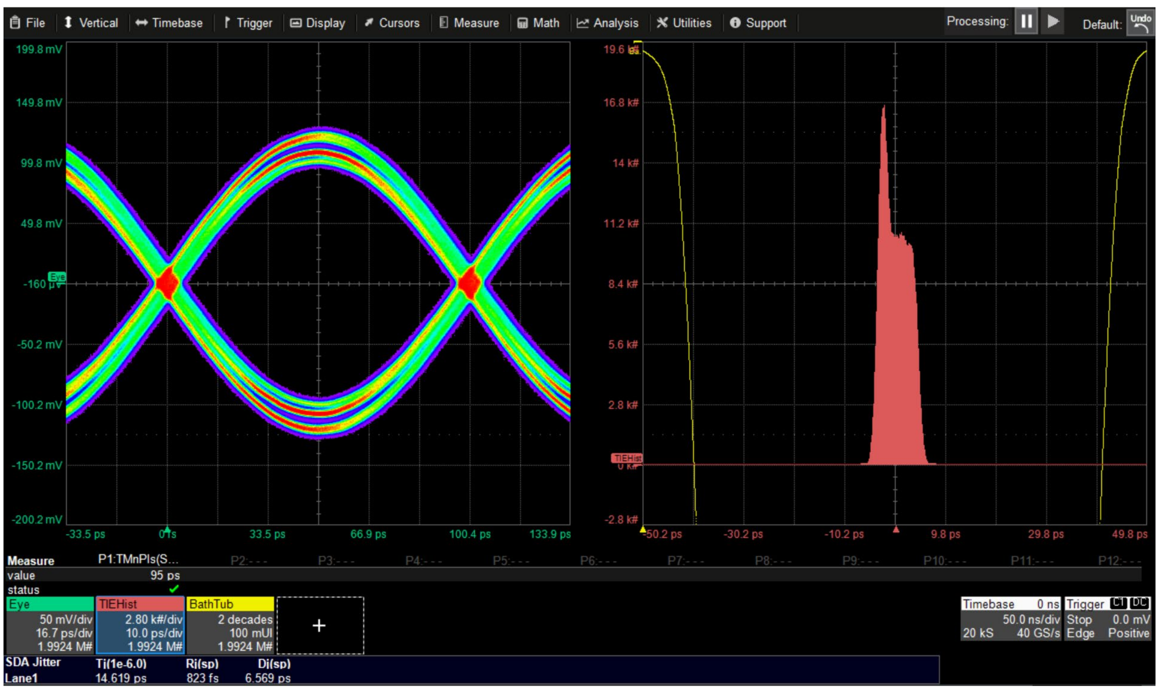


Figure 34 – LeCroy CP10 Jitter Test

Shown on this screen:

- **Eye** is the eye diagram of the CP10 pattern
- **TIEHist** is the TIEHistogram of the CP10 pattern
- **BathTub** is the Bathtub Curve of the CP10 pattern

In the Measure table:

- **TMnPls** (P1) is measuring the minimum pulse width of the CP10 pattern

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are measured on CP10 pattern. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique. The Tj value is reported as **Tj CP10** and the Rj value is reported as **Rj(rms) CP10**.

At the completion of the CP9 Jitter Test, the oscilloscope is in the following state:

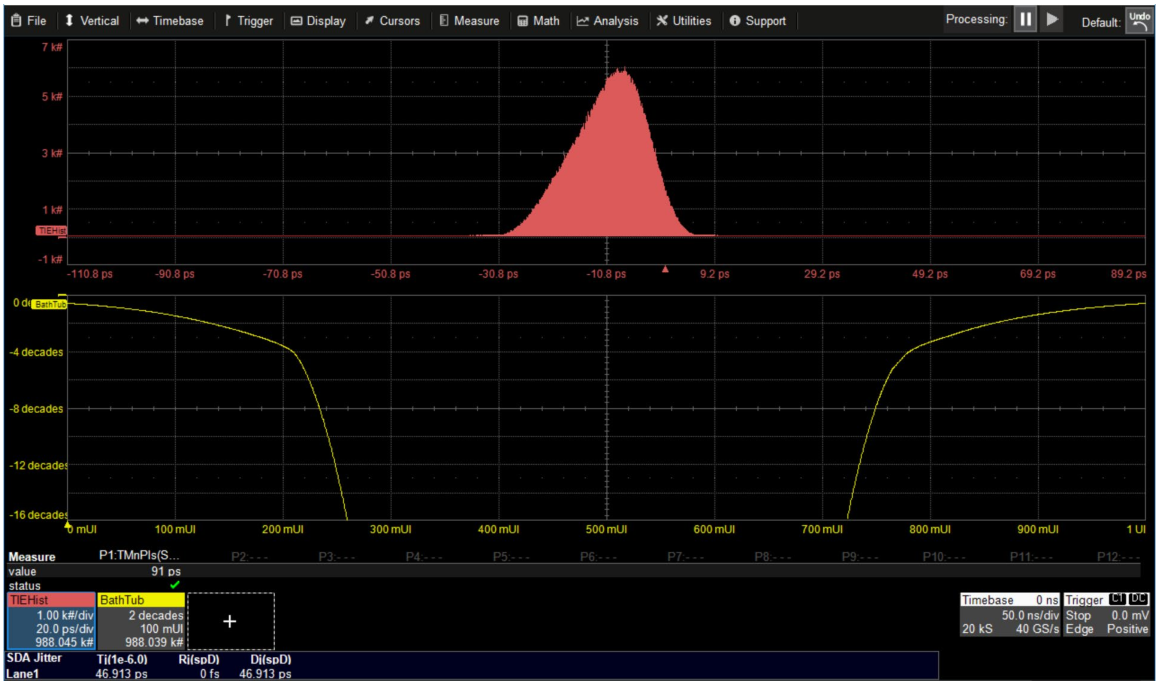


Figure 35 – LeCroy CP9 Jitter Test

Shown on this screen:

- **TIEHist** is the TIEHistogram of the CP9 pattern
- **BathTub** is the Bathtub Curve of the CP9 pattern

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.4	Gen2	Tj_CP10	Long	LeCroy	14.62 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Rj(rms) CP10	Long	LeCroy	823 fs	x <= 1.000 ps
✔	1	TD.1.4	Gen2	Tj CP9	Long	LeCroy	46.75 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Rj(rms) CP9	Long	LeCroy	0 fs	x <= 1.000 ps
✔	1	TD.1.4	Gen2	Dj CP9	Long	LeCroy	46.75 ps	x <= 53.00 ps
i	1	TD.1.4	Gen2	Min Pulse Time	Long	LeCroy	91.134 ps	Informational Only
i	1	TD.1.4	Gen2	Avg UI, Long Channel (LeCroy)	Long	LeCroy	100.2243e-12	Informational Only

Figure 36 – Test Report from Jitter Tests

In the Measure table:

- **TMnPls** (P1) is measuring the minimum pulse width of the CP10 pattern and is displayed in the report as **Min Pulse Time** for informational purposes. **Average UI** is not shown on the screen, but is reported with the other results.

In the SDA Jitter table:

Tj(1e-12), Rj(sp), and **Dj(sp)** are measured on CP9 pattern. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique. However, as per the USB 3.2 test specification, the Rj that was measured on CP10 is injected into this measurement. The Tj value is reported as **Tj CP9**, the Rj value is reported as **Rj(rms) CP9** and the DJ value is reported as **DJ CP9**

Phase Jitter Slew Rate

The purpose of this test is to verify that the jitter slew rate is within the USB 3.2 Gen2 specification limits. This is a measure of how fast the PLL in a USB 3.2 receiver has to change in order to keep up with changes in the clock frequency. Performing this test requires calculation of the first derivative of the PLL Track. The PLL Track is a waveform that shows the phase change that the PLL was able to follow and track out of the signal. By taking the first derivative of the PLL Track we can easily measure the minimum and maximum phase jitter slew rate on the derivative waveform.

At the completion of the Phase Jitter Slew Rate Test, the oscilloscope is in the following state:

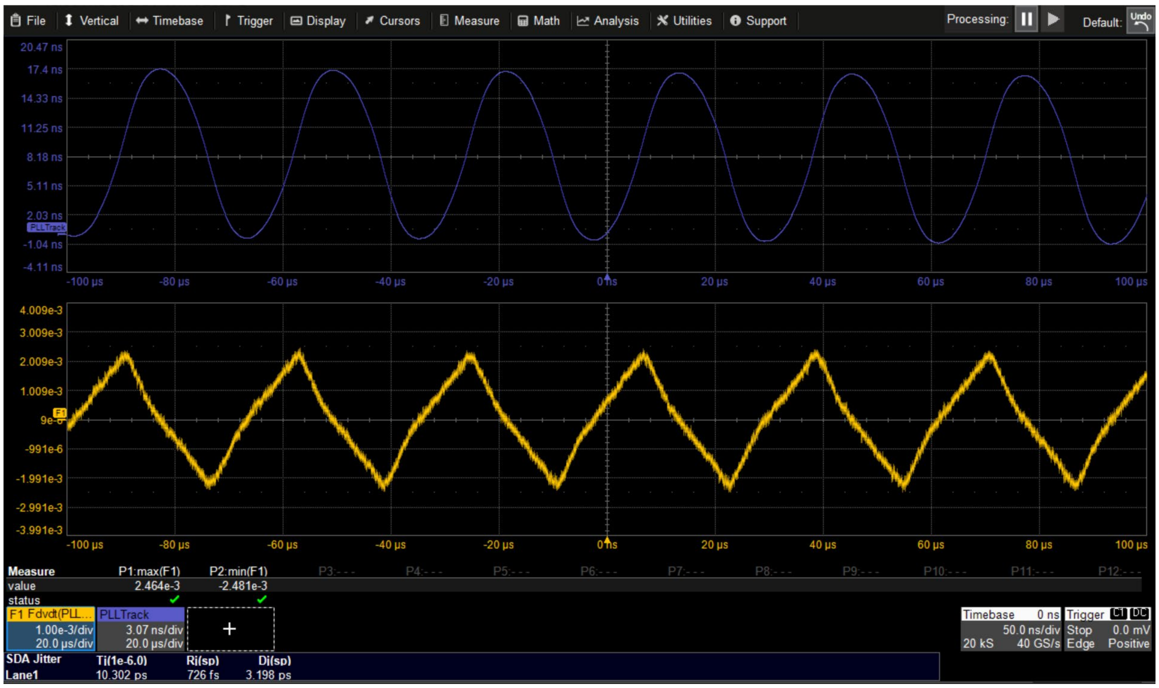


Figure 37 – LeCroy Gen2 Phase Jitter Slew Rate Test

Shown on this screen:

- **PLLTrack** is the PLL Track of the CP10 pattern
- **Fdvdt** is the first derivative of the PLL Track

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	Legacy	Gen2	Phase Jitter Slew Rate Max	Long	LeCroy	2.464 ms/s	x = 0 µs/s +/- 10.000 ms/s
✔	1	Legacy	Gen2	Phase Jitter Slew Rate Min	Long	LeCroy	-2.481 ms/s	x = 0 µs/s +/- 10.000 ms/s

Figure 38 – Test Report from Phase Jitter Slew Rate Test

In the Measure table:

- **Max** (P1) is measuring the maximum of the derivative of the PLL track (F1). This is the measured value for **Phase Jitter Slew Rate Max**.
- **Min** (P2) is measuring the minimum of the derivative of the PLL track (F1). This is the measured value for **Phase Jitter Slew Rate Min**.

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are displayed for informational purposes. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique.

SigTest Long Channel Jitter (CP9 & CP10)

This test is equivalent to TD 1.3 SigTest Jitter, only using Gen2 CP9 and CP10 with the Long Channel model.

There are no traces displayed on the screen for this test. All calculations are done in SigTest. Images of the eye diagrams and all results can be found in the report.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.4	Gen2	Tj CP10	Long	SigTest	19.7233 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Rj (rms) CP10	Long	SigTest	0.9097 ps	x <= 1.000 ps
✔	1	TD.1.4	Gen2	SigTest Pass / Fail Result, Long Channel	Long	SigTest	pass	match "Pass"
✔	1	TD.1.4	Gen2	Tj CP9	Long	SigTest	35.9842 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Dj DD CP9, Long Channel (SigTest)	Long	SigTest	28.9151 ps	x <= 53.00 ps
ℹ	1	TD.1.4	Gen2	Min Time Between Crossovers	Long	SigTest	50.561 ps	Informational Only
✔	1	TD.1.4	Gen2	Avg UI SigTest	Long	SigTest	100.2282 ps	99.9700 ps < x < 100.5301 ps
ℹ	1	TD.1.4	Gen2	Max PP Jitter	Long	SigTest	41.135 ps	Informational Only

Figure 39 – Test Report from SigTest Eye Test

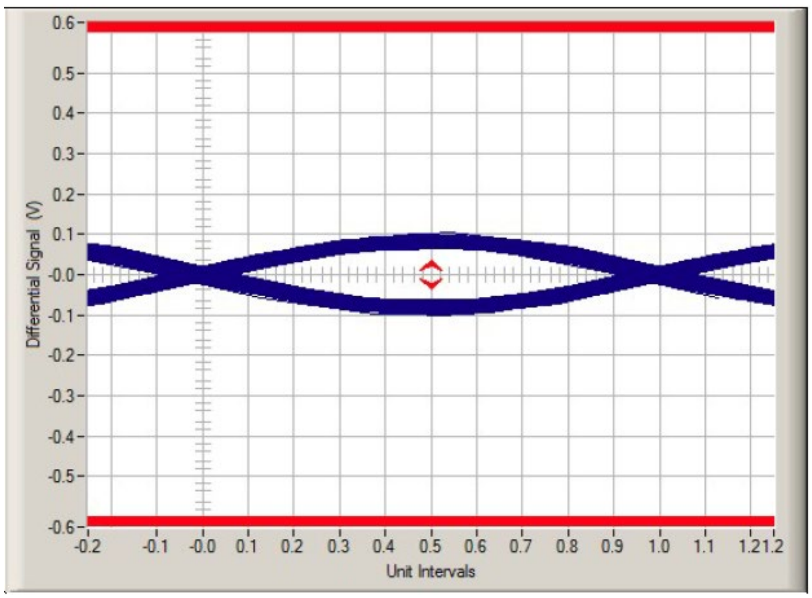


Figure 40 – SigTest CP10 Eye Diagram

LeCroy Long Channel Eye Diagram

This test creates an eye diagram for CP0 using the Teledyne LeCroy SDA toolkit, and performs a mask test to verify that the eye meets the USB 3.2 Gen1 specification limits. Test includes emulation of the Long Channel S-parameter model required by the USB 3.2 test specification. Measurements are made on the compliance channel after applying the reference Continuous Time Linear Equalizer (CTLE) function. The measurements are made on the compliance channel after applying the reference Continuous Time Linear Equalizer function.

At the completion of the Eye Diagram Test the oscilloscope is in the following state:

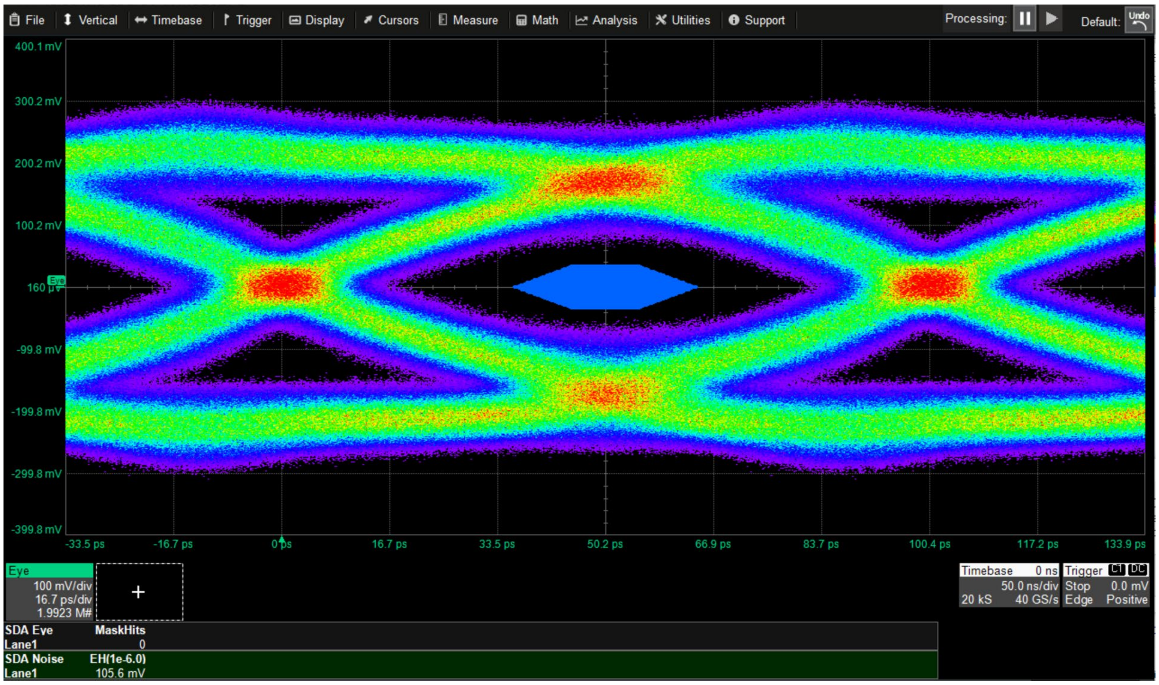


Figure 41 – LeCroy CP9 Eye Diagram Test

Shown on this screen:

- Eye Diagram of CP9 with the USB 3.2 compliance mask displayed

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.4	Gen2	Eye Diagram Mask Hits, Long Channel (LeCroy)	Long	LeCroy	0 hits	x = 0 hits
✔	1	TD.1.4	Gen2	Eye Height, Long Channel (LeCroy)	Long	LeCroy	106 mV	70 mV <= x <= 1.200 V

Figure 42 – Test Report from Eye Diagram Test

In the SDA Eye table:

- **MaskHits** is counting the number of mask hits and is reported as **Eye Diagram Mask Hits, Long Channel (LeCroy)**.

In the SDA Noise table:

- **EH(1e-12)** is measuring the vertical eye opening at an extrapolated BER of 1e-12 and is reported as **Eye Height, Long Channel (LeCroy)**.

SigTest Long Channel Eye Diagram

This test is equivalent to TD 1.3 SigTest Eye Diagram, only using Gen2 CP9 and CP10 with the Long Channel model.

There are no traces displayed on the screen for this test. All calculations are done in SigTest. Images of the eye diagrams and all results can be found in the report.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.4	Gen2	Non Transition Eye Violations	Long	SigTest	0 hits	x = 0 hits
✔	1	TD.1.4	Gen2	Transition Eye Violations	Long	SigTest	0 hits	x = 0 hits
✔	1	TD.1.4	Gen2	Total Eye Violations	Long	SigTest	0 hits	x = 0 hits
ℹ	1	TD.1.4	Gen2	Eye Height SigTest	Long	SigTest	139.5 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Max Non Trans Voltage	Long	SigTest	262.0 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Min Non Trans Voltage	Long	SigTest	-266.3 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Max Trans Voltage	Long	SigTest	233.9 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Min Trans Voltage	Long	SigTest	-239.8 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Min Non Trans Upper Margin	Long	SigTest	46.6 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Max Non Trans Lower Margin	Long	SigTest	-48.6 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Max Trans Upper Margin	Long	SigTest	46.4 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Max Trans Lower Margin	Long	SigTest	-38.7 mV	Informational Only
ℹ	1	TD.1.4	Gen2	Min Eye Width	Long	SigTest	64.016 ps	Informational Only

Figure 43 – Test Report from SigTest Eye Test

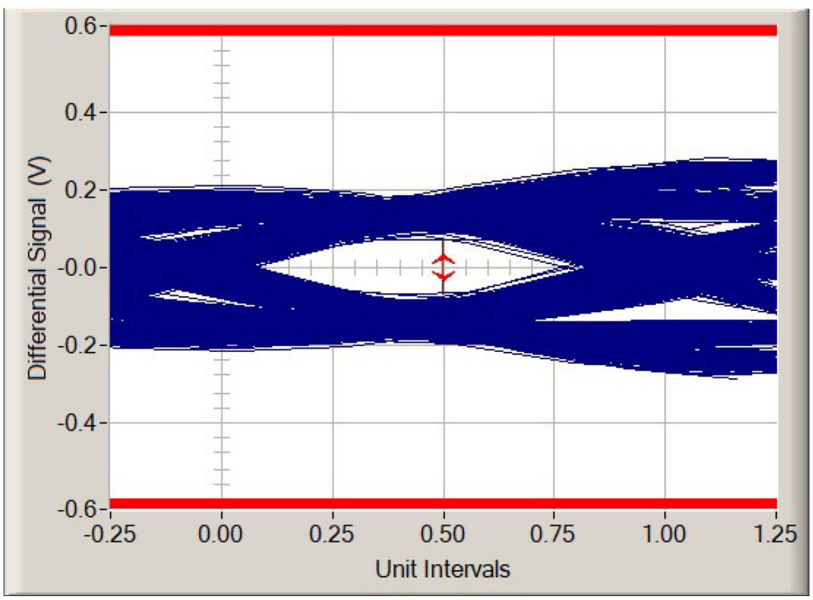


Figure 44 – SigTest CP9 Non Transition Eye Diagram

TD 1.4 Gen2 Short Channel Jitter & Eye Diagram Tests

The purpose of this group is to verify that the jitter and eye diagram tests for the Short Channel are within USB 3.2 Gen2 specification limits. The Phase Jitter Slew Rate test is optional.

LeCroy Short Channel Jitter, CP9 & CP10

The test is equivalent to TD 1.4 LeCroy Long Channel Jitter, except the Short Channel model is used.

The measurements are made on the compliance channel after applying the reference Continuous Time Linear Equalizer (CTLE) function. Measuring the jitter is a multiple step process. First, the jitter must be measured while the DUT is transmitting the CP10 (101010) pattern. Then, the jitter is measured while the DUT is transmitting the CP9 (PRBS) pattern, however the random jitter (Rj) that was measured during the jitter test of CP10 must be injected into this measurement. This simplifies the separation of random (Rj) and deterministic jitter (Dj) since there is no data dependent jitter (DDj, a component of Dj) when CP10 is transmitted.

At the completion of the CP10 Jitter Test the oscilloscope is in the following state:

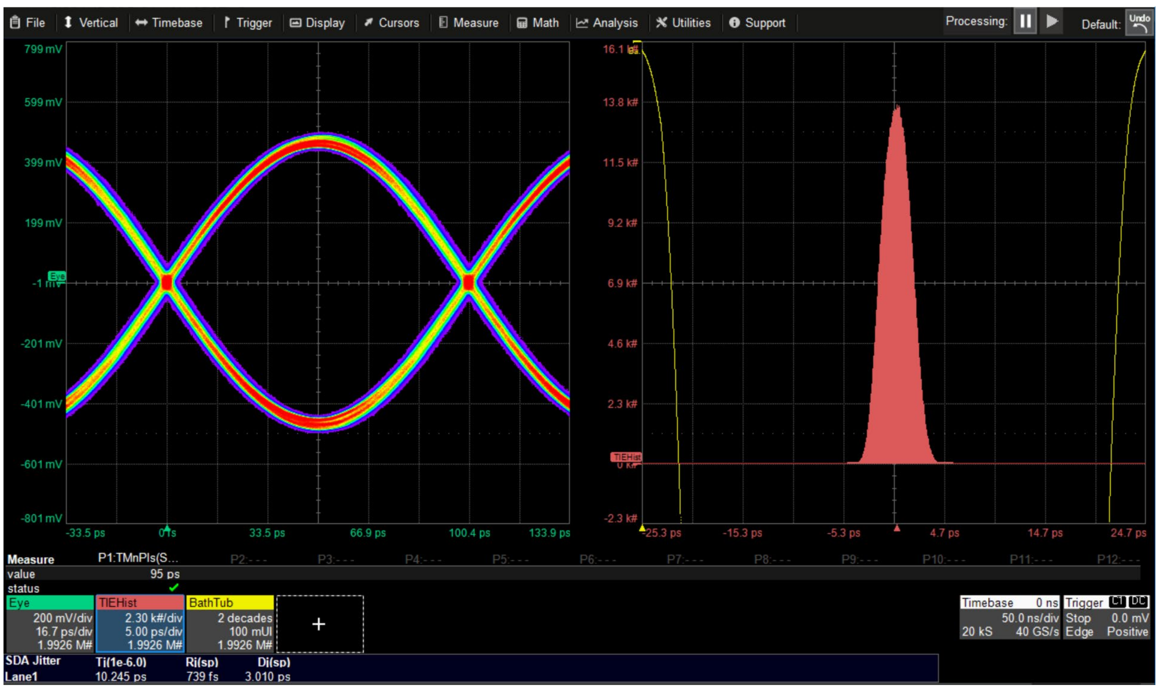


Figure 45 – LeCroy Short Channel CP10 Jitter Test

Shown on this screen:

- Eye is the eye diagram of the CP10 pattern
- TIEHist is the TIEHistogram of the CP10 pattern
- BathTub is the Bathtub Curve of the CP10 pattern

In the Measure table:

- **TMnPls** (P1) is measuring the minimum pulse width of the CP10 pattern

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are measured on CP10 pattern. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique. The Tj value is reported as **Tj CP10, Short Channel (LeCroy)** and the Rj value is reported as **Rj(rms) CP10, Short Channel (LeCroy)**.

At the completion of the CP9 Jitter Test the oscilloscope is in the following state:

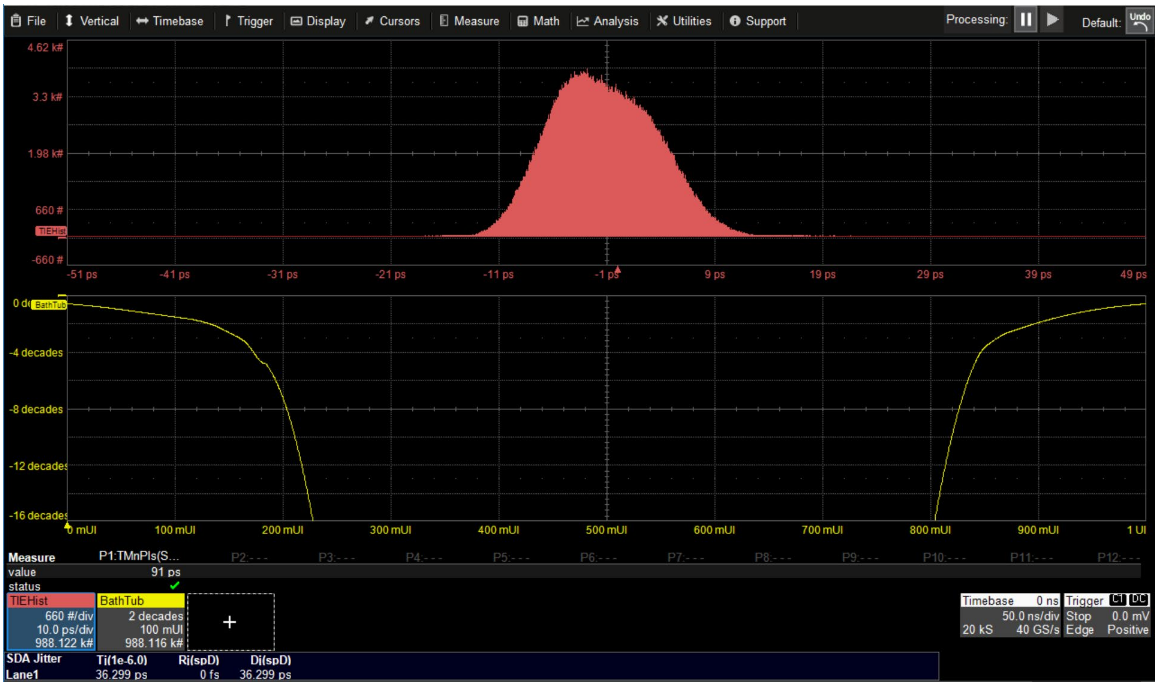


Figure 46 – LeCroy Short Channel CP9 Jitter Test

Shown on this screen:

- **TIEHist** is the TIEHistogram of the CP9 pattern
- **BathTub** is the Bathtub Curve of the CP9 pattern

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.4	Gen2	Tj CP10, Short Channel (LeCroy)	Short	LeCroy	10.24 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Rj(rms) CP10, Short Channel (LeCroy)	Short	LeCroy	739 fs	x <= 1.000 ps
✔	1	TD.1.4	Gen2	Tj CP9	Short	LeCroy	36.30 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Rj(rms) CP9)	Short	LeCroy	0 fs	x <= 1.000 ps
✔	1	TD.1.4	Gen2	Dj CP9	Short	LeCroy	36.30 ps	x <= 53.00 ps
i	1	TD.1.4	Gen2	Min Pulse Time	Short	LeCroy	91.394 ps	Informational Only
i	1	TD.1.4	Gen2	Avg UI	Short	LeCroy	100.2254e-12	Informational Only

Figure 47 – Test Report from Jitter Tests

In the Measure table:

- **TMnPls** (P1) is measuring the minimum pulse width of the CP10 pattern and is displayed in the report as **Min Pulse Time** for informational purposes. **Average UI** is not shown on the screen, but is reported with the other results.

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are measured on CP9 pattern. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique. However, as per the USB 3.2 test specification, the Rj that was measured on CP10 is injected into this measurement. The Tj value is reported as **Tj CP9**, the Rj value is reported as **Rj(rms) CP9** and the DJ value is reported as **DJ CP9**.

Phase Jitter Slew Rate

The purpose of this test group is to verify that the jitter slew rate is within the specification limits. The test is performed in the same manner as is the Long Channel Phase Jitter Slew Rate, except the Short Channel model is used instead.

This is a measure of how fast the PLL in a USB 3.2 receiver has to change in order to keep up with changes in the clock frequency. Performing this test requires calculation of the first derivative of the PLL Track. The PLL Track is a waveform that shows the phase change that the PLL was able to follow and track out of the signal. By taking the first derivative of the PLL Track we can easily measure the minimum and maximum phase jitter slew rate on the derivative waveform.

At the completion of the Phase Jitter Slew Rate Test the oscilloscope is in the following state:

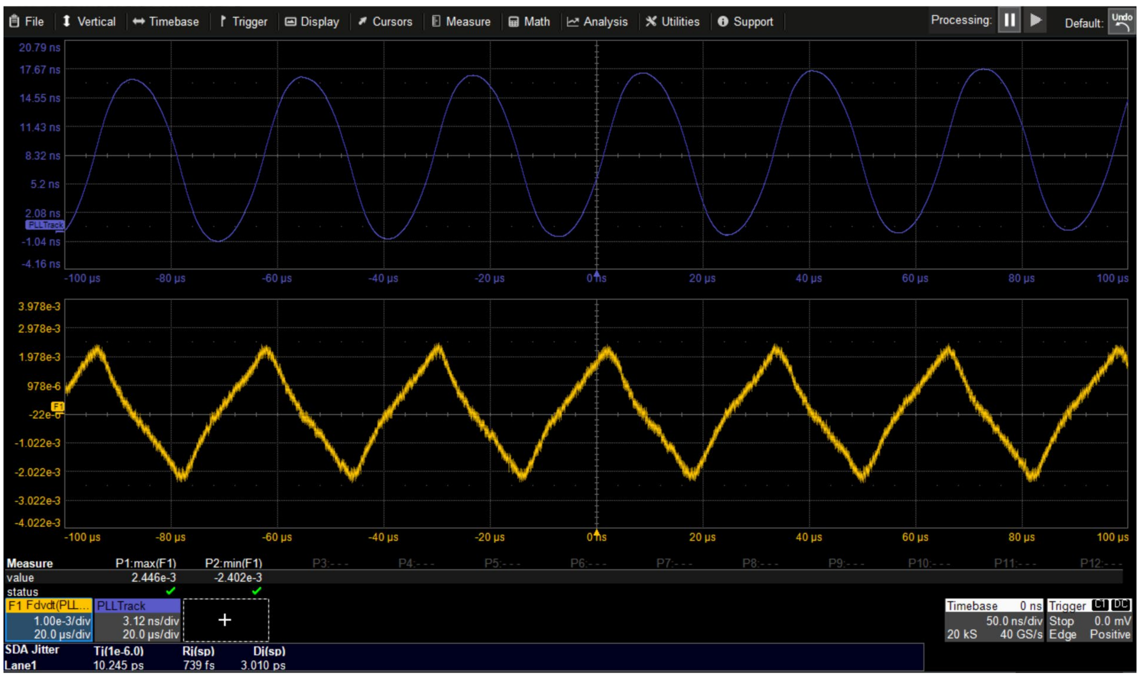


Figure 48 – LeCroy Short Channel Phase Jitter Slew Rate Test

Shown on this screen:

- PLLTrack is the PLL Track of the CP10 pattern
- Fdvdt is the first derivative of the PLL Track

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	Legacy	Gen2	Phase Jitter Slew Rate Max	Short	LeCroy	2.446 ms/s	x = 0 µs/s +/- 10.000 ms/s
✔	1	Legacy	Gen2	Phase Jitter Slew Rate Min	Short	LeCroy	-2.402 ms/s	x = 0 µs/s +/- 10.000 ms/s

Figure 49 – Test Report from Phase Jitter Slew Rate Test

In the Measure table:

- **Max** (P1) is measuring the maximum of the derivative of the PLL track (F1). This is the measured value for **Phase Jitter Slew Rate Max**.
- **Min** (P2) is measuring the minimum of the derivative of the PLL track (F1). This is the measured value for **Phase Jitter Slew Rate Min**.

In the SDA Jitter table:

- **Tj(1e-12), Rj(sp),** and **Dj(sp)** are displayed for informational purposes. **Rj(sp)** and **Dj(sp)** are measured using the spectral technique.

SigTest Short Channel Jitter (CP9 & CP10)

These tests are equivalent to the other TD 1.4 SigTest Jitter tests, except the Short Channel model is used.

There are no traces displayed on the screen for this test. All calculations are done in SigTest. Images of the eye diagrams and all results can be found in the report.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.4	Gen2	Tj CP10	Short	SigTest	13.0478 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Rj (rms) CP10	Short	SigTest	0.7344 ps	x <= 1.000 ps
✔	1	TD.1.4	Gen2	SigTest Pass / Fail Result	Short	SigTest	pass	match "Pass"
✔	1	TD.1.4	Gen2	Tj CP9	Short	SigTest	34.1012 ps	x <= 67.10 ps
✔	1	TD.1.4	Gen2	Rj (rms) CP9	Short	SigTest	0.7344 ps	x <= 1.000 ps
✔	1	TD.1.4	Gen2	Dj DD CP9	Short	SigTest	27.1196 ps	x <= 53.00 ps
ℹ	1	TD.1.4	Gen2	Min Time Between Crossovers	Short	SigTest	80.703 ps	Informational Only
✔	1	TD.1.4	Gen2	Avg UI	Short	SigTest	100.2273 ps	99.9700 ps < x < 100.5301 ps
ℹ	1	TD.1.4	Gen2	Max PP Jitter	Short	SigTest	41.738 ps	Informational Only

Figure 50 – Test Report from SigTest Eye Test

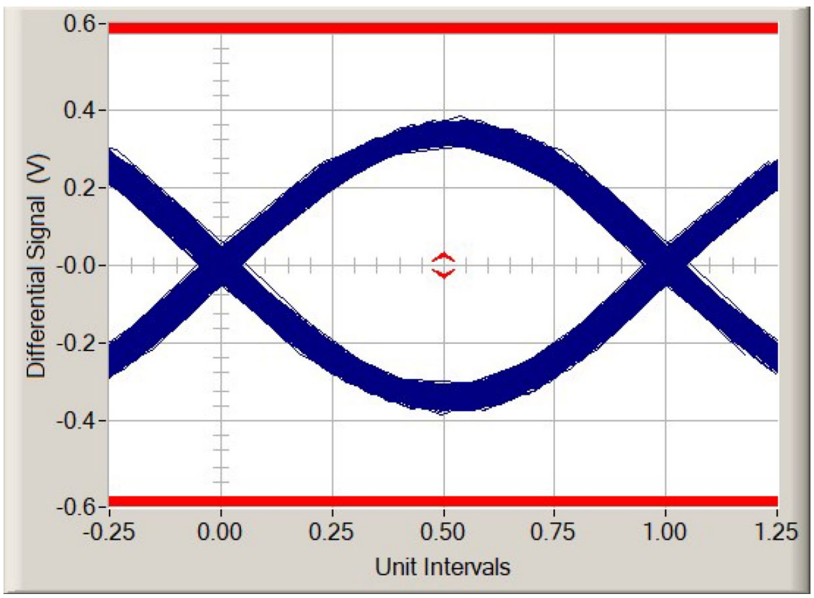


Figure 51 – SigTest CP10 Eye Diagram

LeCroy Short Channel Eye Diagram

The purpose of this test is to verify that the eye diagram is within the USB 3.2 Gen2 specification limits. The test is performed in the same manner as TD 1.4 LeCroy Eye Diagram test, except the Short Channel model is used.

Measurements are made on the compliance channel by applying the reference Continuous Time Linear Equalizer function.

At the completion of the Eye Diagram Test, the oscilloscope is in the following state:

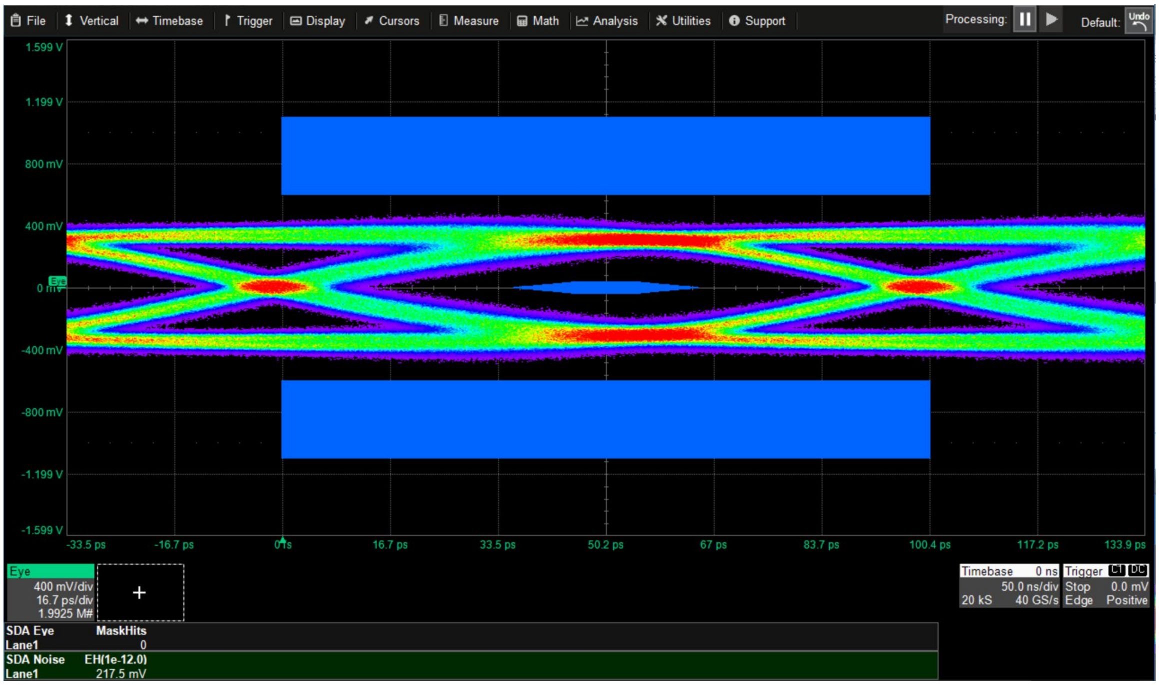


Figure 52 – LeCroy Short Channel CP9 Eye Diagram Test

Shown on this screen:

- Eye Diagram of CP9 with the USB 3.2 compliance mask displayed

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.4	Gen2	Eye Diagram Mask Hits, Short Channel (LeCroy)	Short	LeCroy	0 hits	x = 0 hits
✔	1	TD.1.4	Gen2	Eye Height, Short Channel (LeCroy)	Short	LeCroy	217 mV	70 mV <= x <= 1.200 V

Figure 53 – Test Report from Eye Diagram Test

In the SDA Eye table:

- **MaskHits** is counting the number of mask hits and is reported as **Eye Diagram Mask Hits, Short Channel (LeCroy)**.

In the SDA Noise table:

- **EH(1e-12)** is measuring the vertical eye opening at an extrapolated BER of 1e-12 and is reported as **Eye Height, Short Channel (LeCroy)**.

SigTest Short Channel Eye Diagram

These tests are equivalent to the other TD 1.4 SigTest Eye Diagram tests, except that the Short Channel model is used.

There are no traces displayed on the screen for this test. All calculations are done in SigTest. Images of the eye diagrams and all results can be found in the report.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
i	1	TD.1.4	Gen2	Transition Eye Violations	Short	SigTest	0	Informational Only
i	1	TD.1.4	Gen2	Non Transition Eye Violations	Short	SigTest	0	Informational Only
i	1	TD.1.4	Gen2	Total Eye Violations	Short	SigTest	0	Informational Only
i	1	TD.1.4	Gen2	Eye Height	Short	SigTest	325.3 mV	Informational Only
i	1	TD.1.4	Gen2	Max Non Trans Voltage	Short	SigTest	534.5 mV	Informational Only
i	1	TD.1.4	Gen2	Min Non Trans Voltage	Short	SigTest	-531.9 mV	Informational Only
i	1	TD.1.4	Gen2	Max Trans Voltage	Short	SigTest	521.5 mV	Informational Only
i	1	TD.1.4	Gen2	Min Trans Voltage	Short	SigTest	-516.1 mV	Informational Only
i	1	TD.1.4	Gen2	Min Non Trans Upper Margin	Short	SigTest	188.6 mV	Informational Only
i	1	TD.1.4	Gen2	Max Non Trans Lower Margin	Short	SigTest	-192.8 mV	Informational Only
i	1	TD.1.4	Gen2	Max Trans Upper Margin	Short	SigTest	163.7 mV	Informational Only
i	1	TD.1.4	Gen2	Max Trans Lower Margin	Short	SigTest	-146.7 mV	Informational Only
i	1	TD.1.4	Gen2	Min Eye Width	Short	SigTest	65.899 ps	Informational Only

Figure 54 – Test Report from SigTest Eye Test

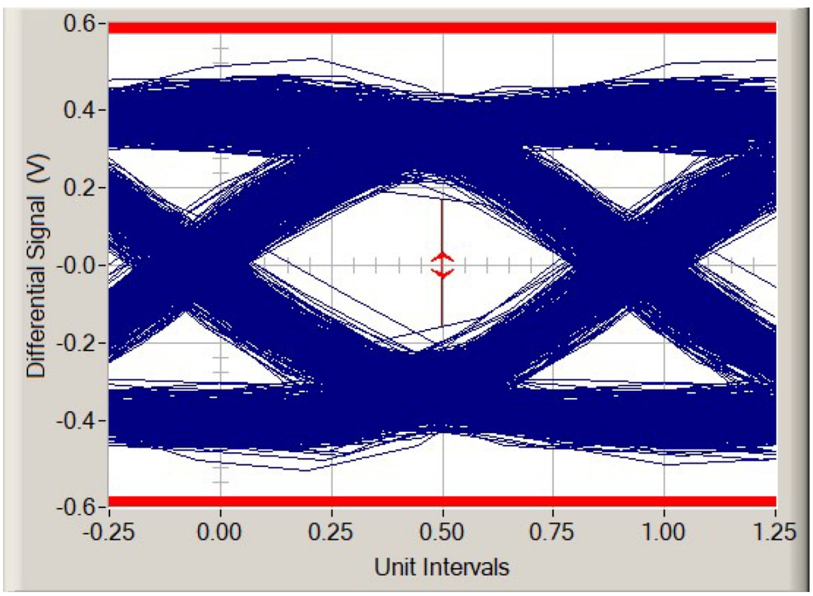


Figure 55 – SigTest Short Channel CP9 Non-Transitioning Eye Diagram

TD 1.7 SSC Profile Test

This test verifies that the transmitter operating at Gen2 speed meets the SSC profile requirements when measured at the compliance test port with the required TX equalization.

There are no traces displayed on the screen for this test. All calculations are done in SigTest.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.7	Gen2	SSC Deviation Max (max)	Short	SigTest	103.3 PPM	-300.0 PPM <= x <= 300.0 PPM or -2.3000 kPPM <= x <= -1.7000 kPPM
✔	1	TD.1.7	Gen2	SSC Deviation Max (min)	Short	SigTest	17.7 PPM	-300.0 PPM <= x <= 300.0 PPM or -2.3000 kPPM <= x <= -1.7000 kPPM
✔	1	TD.1.7	Gen2	SSC Frequency Modulation Rate	Short	SigTest	31.120 kHz	30.000 kHz <= x <= 33.000 kHz
✔	1	TD.1.7	Gen2	SSC Deviation Min (max)	Short	SigTest	-4.3809 kPPM	-5.3000 kPPM <= x <= -3.7000 kPPM
✔	1	TD.1.7	Gen2	SSC Deviation Min (min)	Short	SigTest	-4.4326 kPPM	-5.3000 kPPM <= x <= -3.7000 kPPM
✔	1	TD.1.7	Gen2	SSC DF / DT	Short	SigTest	642.70201	x <= 1.2500000e+3

Figure 56 – Test Report from SSC Test

TD 1.5 Transmit Equalization Test

This test verifies that the transmitter meets Gen2 requirements for transmit equalization.

There are no traces displayed on the screen for this test. All calculations are done in SigTest.

Pass	#	Test	Gen	Measurement	Chan	Analysis	Current Val	Test Criteria
✔	1	TD.1.5	Gen2	TXEQ tests, Deemphasis	Short	SigTest	-3.77 dB	x = -3.10 dB +/- 1.00 dB
✔	1	TD.1.5	Gen2	TXEQ tests, Preshoot	Short	SigTest	2.41 dB	x = 2.20 dB +/- 1.00 dB

Figure 57 – Test Report from Tx EQ Test

USB 3.1/3.2 TX Test Variables

QualiPHY Setup

Gen1 Test Fixture
This variable controls which connection diagrams are displayed during the Gen1 tests. “USB 3.1 10G Test Fixture” will use the same fixture and connection diagrams for Gen1 tests as for Gen2 tests. “USB 3.0 5G Test Fixture” will use the legacy fixture and connection diagrams used for USB 3.0 testing.

Saved Waveform Path
Full path to the directory in which to save waveform files, and from which waveform files are recalled when running on saved waveforms. Default is D:\ Waveforms\USB3.1_3.2.

Save individual runs?
When Yes, waveform files from each run are saved in separate subfolders of the Save Waveform Path (e.g., D:\Waveforms\USB3.1_3.2\<*DUT Name*>\Run1). When No, the files in the Save Waveform Path are overwritten on each run. Default is No.

Show connection diagrams?
Enables/disables the display of connection diagrams during a test run. If No, the user will still be given necessary prompts (e.g., to change Compliance Test Pattern). Default is Yes.

Pause after tests to review results?
When Yes, QualiPHY pauses after each test to allow the user to review results on the oscilloscope display. The user will be prompted to continue after each pause. Default is No. Note that acquiring new data while testing is paused may cause problems with the software.

Run using saved waveforms?
When Yes, tests are run on waveform files recalled from the Save Waveform Path folder; When No, new data is acquired with each test run. Default is No.

DUT Info

Number of Compliance Patterns
The number of compliance patterns the DUT supports, allowing the BERT to properly automate the change of compliance patterns (e.g., the DUT has CP0-CP16 implemented, so this variable is set to 17). This variable also appears on the Configuration Setup dialog. The default is 17.

Connector Type
The DUT connector type: Micro-B, Standard (either Std-A or Std-B), or Type-C. This variable also appears on the Configuration Setup dialog. Default is Standard.

Port Type
The port tested: Device, Host, Upstream Facing Port, or Downstream Facing Port. This variable also appears on the Configuration Setup tab. Default is Device.

Note: Regardless of port type, the unit tested will be referred to as DUT in the software.

SSC
The state of Spread Spectrum Clocking (SSC) on the DUT. The SigTest Average UI test uses different limits based on whether or not SSC is enabled. This variable ensures the correct limits are used. The default is Enabled. because SSC testing is required by the USB 3.2 Specification.

Oscilloscope Setup

- Data Input Channel
Oscilloscope channel used to input negative side of differential data signal (D-). Default is C3.

+ Data Input Channel
Oscilloscope channel used to input positive side of differential data signal (D+). Default is C2.

Deskew Measure Mode
Method used for deskewing cables. Wizard Measured will launch the automated deskew measurement wizard at the start of a test. User Defined allows users to set a known Deskew Value in Picoseconds. Default is Wizard Measured.

Deskew Value in Picoseconds
The channel plus cable deskew between the positive input channel and the negative input channel. The value is in picoseconds and is applied to the positive channel. This value is only applied when Deskew Measure Mode is set to User Defined.

BERT Setup

BERT Hostname or IP Address
Hostname or IP Address of the Anritsu MP1900A or the PeRT3 server machine, *from the point of view of the oscilloscope*. In the default configuration, where the PeRT3 is connected by USB to the oscilloscope, the oscilloscope is the PeRT3 Server, therefore this variable is set to “localhost”. If the PeRT3 is connected to another host, enter the address of that machine. Default is localhost.

BERT Amplitude
The signal amplitude (in V) of the BERT during testing when using loopback to set the pattern. Default is 0.8 V.

BERT Deemphasis
The deemphasis level (in dB) of the BERT during testing. Default is -3 dB.

Note: Using the PeRT3 Eagle platform requires the external deemphasis box.

BERT TX Init Mode
Method used by the BERT to configure the DUT to output test patterns: Loopback or Low Frequency Periodic Signaling (LFPS).

LFPS mode brings the DUT into Compliance Mode and outputs a Ping.LFPS signal to prompt the DUT to switch to the next compliance pattern. This is the recommended choice if the DUT supports it. Perform the Ping.LFPS test to ensure support.

Loopback mode places the DUT in Loopback Mode, then outputs the required Compliance Test Pattern. This mode does not produce valid compliance test results, because the DUT outputs SKP symbols into the data.

PeRT3 Model
Model of PeRT3, when used as the BERT: Eagle or Phoenix. Default is Phoenix.

Enable SSC on BERT output?
Enables/disables SSC on the BERT clock output. Default is Yes.

Note: This variable applies to TX tests only. RX tests must have SSC enabled for compliance testing.

Ping Source

Source of the Ping.LFPS command used to stimulate the DUT to output the compliance patterns for testing. If using PeRT3 or Anritsu MP1900A, choose BERT. If you cannot use BERT automation (because the DUT does not support Ping.LFPS) and must stimulate the DUT manually, choose User Controlled. This variable also appears on the Configuration Setup tab. Default is PeRT3.

Anritsu MP1900A Settings

Synthesizer Slot

Mainframe slot used for the Synthesizer module.

PPG Slot

Mainframe slot used for the PPG module.

Jitter Modulation Slot

Mainframe slot used for the Jitter Modulation module.

DM Generator Slot

Mainframe slot used for the Noise Generator module. Enter None when not using a Noise module for the ping source.

Data Channel

BERT channel used to input the PPG module.

CTLE Setup

CTLE Parameter

The CTLE setting to be used, according to the table below. This value is only applied when Enable CTLE optimization? is No. This variable also appears on the Configuration Setup tab. Default is -6 dB.

CTLE Name	Adc	fz	Aac	Fp1	Fp2
0 dB	0 dB	1.06 GHz	1.4125	1.5 GHz	5 GHz
-1 dB	-1 dB	946 MHz			
-2 dB	-2 dB	843 MHz			
-3 dB	-3 dB	751 MHz			
-4 dB	-4 dB	670 MHz			
-5 dB	-5 dB	597 MHz			
-6 dB	-6 dB	532 MHz			

Enable CTLE optimization?

When Yes, the QualiPHY script will iterate the different DC gain and zero frequency settings to find the maximum eye area (height * width) for Gen2 eye diagram tests. When No, the value defined in CTLE Parameter is used. This variable also appears on the Configuration Setup tab. Default is Yes.

Use CTLE?

Enables/disables use of Continuous Time Linear Equalization (CTLE). Default is Yes.

Channel Emulation Setup

S-Parameter File Path

Full path to the S-Parameter file (s4p) used for emulation and/or deembedding. Default is oscilloscope D:\Applications\EyeDr\USB3_1.

Fixture & Cable Deembedding Setup

Cable S-Parameters File

Filename of the four-port S-Parameter file (s4p) used for deembedding cables and fixtures. File should be located on the oscilloscope in D:\Applications\EyeDr. This variable is only used when Deembed cables and fixture? is set to Yes. It is blank by default.

Deembed cables and fixture?

Enables/disables deembedding of cables and/or fixtures. When Yes, also specify an S-Parameter file (*.s4p) in the Cable S-Parameters File variable. Default is No.

Advanced Settings

PeRT3 Custom Options String

Custom options string to be used when initializing the PeRT3 Phoenix (only) for loopback. Select Auto to allow QualiPHY to determine the appropriate string.

Pairs of variables and values should separated by commas.

Example: HANDSHAKING=Blind,AUTOPOLARITY=Disable

Following are the state machine options and the default values.

USB 3.1 Gen1:

HANDSHAKING=Full

TS_HANDSHAKE=Enable

LFPS_DETECTION_METHOD=Full

AUTOPOLARITY=Enable

SKP_TYPE=Default_Two

USB 3.1 Gen2:

tPERIOD_(ns)=48

LBPM_Tx=Consecutive

SKP_Frequency_(blocks)=22

SKP_Size_(symbols)=16

INITIALIZATION=LOOPBACK

Debug=Off

Trigger=Off

BERT Custom Sequence (Loopback)

Alternate sequence for the BERT to use when putting the DUT in the loopback state. Enter the name of the sequence. When set to Default, the default sequence (set on the BERT) is used.

Use default upsampling for SDA?

When two inputs are sampled at 80GS/s, the SDA software will by default upsample the waveforms by a factor of 2 for jitter and eye measurements. Select Yes to retain the default behavior, which is required for the USB3.x compliance tests. Select No only for regression testing.

SigTest Setup

Number of Acquisitions for SigTest
Number of waveforms to acquire for the SigTest Gen2 transmitter tests. The average results from all acquisitions is used. The default is 1.

SigTest EXE for Gen1 Testing
Path to the SigTest installation used for Gen1 tests. Default is C:\Program Files (x86)\SigTest 3.2.11.3.

SigTest EXE for Gen2 Testing
Path to the SigTest installation used for Gen2 tests. Default is C:\Program Files (x86)\SigTest 4.0.23.

Short Channel CP0 Test Template File
SigTest template file for the Gen1 short channel CP0 test. Default is USB_3_5Gb_CP0_RjIN_SHORT.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

Short Channel CP1 Test Template File
SigTest template file for the Gen1 short channel CP1 test. Default is USB_3_5Gb_CP1_SHORT.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

Short Channel CP9 Test Template File
SigTest template file for the Gen2 short channel CP9 test. Default is USB_3_10Gb_CP9_Tx_Short.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

Long Channel CP0 Test Template File
SigTest template file for the Gen1 CP0 test. Default is USB_3_5Gb_CP0_RjIN.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

Long Channel CP1 Test Template File
SigTest template file for the Gen1 CP1 test. Default is USB_3_5Gb_CP1.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

Long Channel CP9 Test Template File
SigTest template file for the Gen2 CP9 test. Default is USB_3_10Gb_CP9_Tx.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

CP10 Test Template File
SigTest template file for the Gen2 CP10 test. Default is USB_3_10Gb_CP10_Tx_Rj_Test.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

LFPS Test Template File
SigTest template file for the LFPS test. Default is USB_3_LFPS.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

SSC Test Template File
SigTest template file for the Gen2 SSC profile test. Default is USB_3_10Gb_SSC_Profile_Test.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

TD 1.1 Ping.LFPS Test Settings

LFPS V/div

Oscilloscope channel Volts per division setting used during the LFPS tests. The default is 0.110 V.

TD 1.3 Long Channel Jitter & Eye Diagram Test Settings

Gen1/Gen2 CTLE Pole 1 Frequency

Frequency of Pole 1 for the Continuous Time Linear Equalizer (CTLE) function. The default value matches the Reference CTLE Function in the USB3.2 Specification.

Gen1/Gen2 CTLE Pole 2 Frequency

Frequency of Pole 2 for the Continuous Time Linear Equalizer (CTLE) function. The default value matches the Reference CTLE Function in the USB3.2 Specification.

Gen1/Gen2 CTLE Zero Frequency

Zero Frequency for the Continuous Time Linear Equalizer (CTLE). The default value matches the Reference CTLE Function in the USB3.2 Specification.

Gen1/Gen2 CTLE DC Gain

DC Gain for the Continuous Time Linear Equalizer (CTLE). The default value matches the Reference CTLE Function in the USB3.2 Specification.

Use CTLE?

Enables/disables use of CTLE. Default is Yes.

Use custom channel file?

Enables/disables the use of a custom S-parameter file for channel emulation, rather than the default file installed in D:\Applications\EyeDr\USB3_2. When Yes, the file set in the Custom Channel File variable is used. Default is No.

Custom Channel File

Full path to the S-parameter file (s4p) to be used for channel emulation. This file is only used when Use custom channel file? is set to Yes. The variable is blank by default.

Legacy AC & DC Common Mode Voltage Test Settings

Compliance Test Pattern

Sets the pattern used to perform the AC and DC common mode voltage tests. The default value is 0, which corresponds to the CP0 compliance pattern. CP1 – CP8 can also be selected.

Legacy Differential Voltage & Deemphasis Test Settings

Low-Power Setting
When Yes, the differential voltage swing is tested against the low-power limit. The default is No.

Pattern With Deemphasis
Pattern containing deemphasis used to measure the level of the deemphasized bits. The default is CP7 (50-250 1's followed by 50-250 0's with deemphasis).

Pattern Without Deemphasis
Pattern that does not contain deemphasis used to measure the level of the full-swing bits. The default is CP8 (50-250 1's followed by 50-250 0's without deemphasis).

Gen2 Test Settings

Compliance Test Pattern
Compliance pattern to use for the Gen2 Long Channel Jitter tests. When CP9/CP10 is selected, the QualiPHY script will first measure the Rj using CP10, then use the fixed Rj method to extract Dj using pattern CP9. When CP12 (PRBS15) is selected, since it is a repeating pattern, Rj and Dj are both measured using this pattern. The eye diagram shown is also based on CP12. The default is CP9/10.

TD 1.4 Long Channel Jitter & Eye Diagram Test Settings

Use custom channel file?
Enables/disables the use of a custom S-parameter file for channel emulation, rather than the default file installed in D:\Applications\EyeDr\USB3_2. When Yes, the file named in Custom Channel File is used. Default is No.

Custom Channel File
Full path to the S-parameter file (s4p) to be used for channel emulation. This file is only used when Use custom channel file? is set to Yes. The variable is blank by default.

TD 1.4 Short Channel Jitter & Eye Diagram Test Settings

Compliance Test Pattern
Compliance pattern to use for the Gen2 Short Channel jitter tests, if different from the Long Channel tests.

USB 3.1/3.2 TX Limit Sets

The default installation contains two limit sets:

- **Compliance**, which compares the results only to the limits included in the Electrical Compliance Test Specification. Only the tests specified in the compliance specification are included in this limit set. The remainders of the tests are considered Informational Only.
- **Specification**, which compares the results of all of the tests to the appropriate limit. Only the tests that don't have specified limits as per the specification are considered Informational Only.

The limits for each value tested are encoded in or computed by the script and cannot be changed. Any change to a limit for internal testing purposes requires that the limit set be copied and the new limit set assigned to a copied configuration.

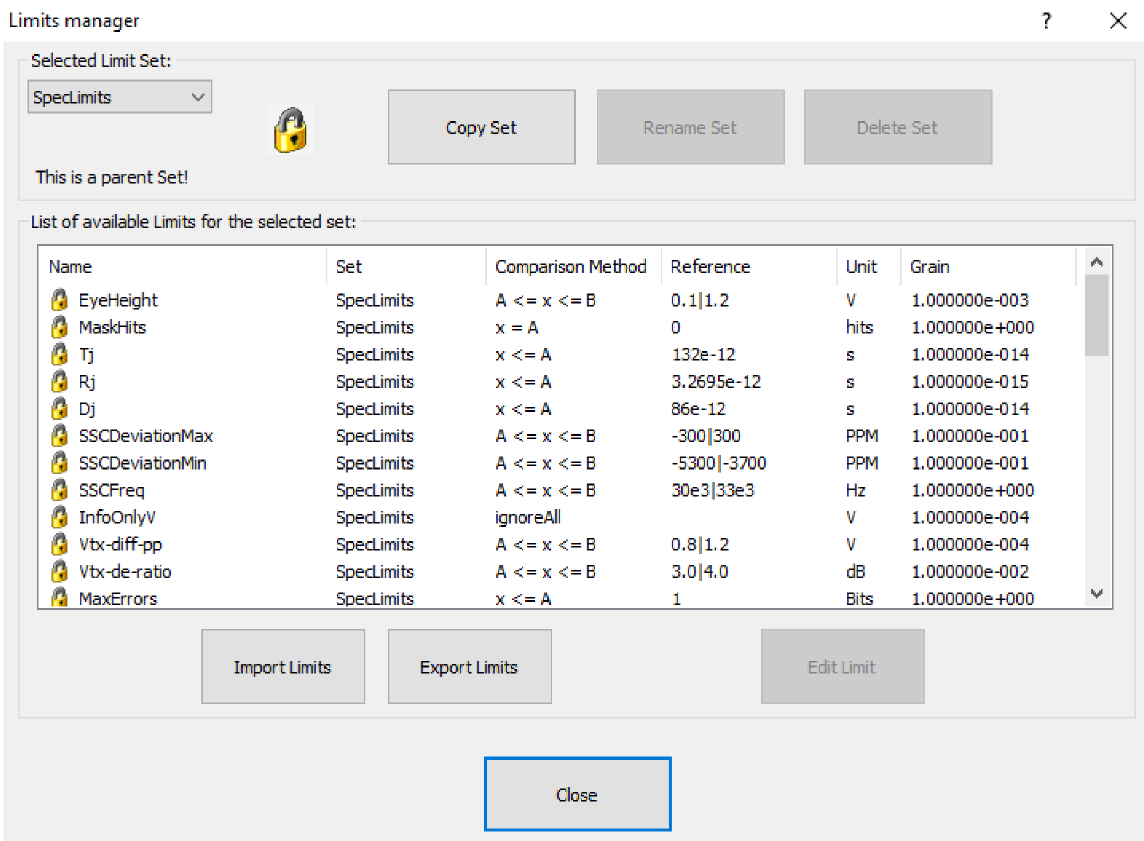


Figure 58 – Configuration Limits Manager

USB 3.1/3.2 Receiver Testing

USB 3.1/3.2 RX Test Configurations

Empty Template

The test selection for this configuration is intentionally left blank so it can be easily customized. The limit set in use is Compliance. All variables are set to their defaults.

Standard-A Device Jitter Tolerance Tests

This configuration performs all the Gen1 and Gen2 receiver tests (without calibrations) for a Standard-A connector type Device port. It includes:

Gen1 Tests (5 GT/s)

- TD 1.2 Low Frequency Periodic Signaling Test
- TD 1.8 and 1.9 Receiver Jitter Tolerance Tests

Gen2 Tests (10 GT/s)

- TD 1.10 Receiver Jitter Tolerance Tests

Standard-A Device JTOL Calibrations

This configuration performs all required calibrations for the LFPS and Gen1/Gen2 receiver JTOL tests, using Standard-A connector type Device settings:

Gen1 Tests (5 GT/s)

- LFPS Calibration
- Gen1 RX JTOL Test Calibrations
  - Deemphasis Calibration
  - Rj Calibration
  - Sj Calibration
  - Eye Height Calibration

Gen2 Tests (10 GT/s)

- Gen2 RX JTOL Test Calibrations
  - TXEQ and Short Channel Calibrations
  - Rj Calibration
  - Sj Calibration
  - CLB Selection
  - Eye Width Calibration
  - Eye Height Calibration

Standard-A Host Jitter Tolerance Tests

This configuration performs all the Gen1 and Gen2 receiver tests (without calibrations) for a Standard-A connector type Host port.

Standard-A Host JTOL Calibrations

This configuration performs all required calibrations for the LFPS and Gen1/Gen2 receiver JTOL tests, using Standard-A connector type Host port settings.

Type-C Device Jitter Tolerance Tests

This configuration performs all the Gen1 and Gen2 receiver tests (without calibrations) for a Type-C connector type Device port.

Type-C Device JTOL Calibrations

This configuration performs all required calibrations for the LFPS and Gen1/Gen2 receiver JTOL tests, using Type-C connector type Device port settings.

Type-C Host Jitter Tolerance Tests

This configuration performs all the Gen1 and Gen2 receiver tests (without calibrations) for a Type-C connector type Host port.

Type-C Host JTOL Calibrations

This configuration performs all required calibrations for the LFPS and Gen1/Gen2 receiver JTOL tests, using Type-C connector type Host port settings.

USB 3.1/3.2 RX Test Descriptions

QualiPHY fully automates the Receiver Test procedure as defined in the USB 3.2 Compliance Test Specification. When running any of the RX tests, the user is given the option to run the calibration procedure prior to running the test. If QualiPHY detects that there is a pre-existing calibration file, then the user is given the option of skipping the calibration and using the existing file.

TD 1.2 Low Frequency Periodic Signaling (LFPS) Test

The purpose of this test is to verify that the receiver properly responds to compliant LFPS signals that are within the limits of the specification.

To do this, the BERT is first calibrated to output the specified LFPS patterns with varying amplitudes and duty cycles (see table).

Once the BERT output is calibrated, the BERT outputs four different LFPS patterns, and the software checks that voltage and timing are within USB 3.2 Gen1 specification limits.

tPeriod	$V_{TX\text{-}DIFF\text{-}PP\text{-}LFPS}$	Duty Cycle
50 ns	800 mV	50%
50 ns	1200 mV	50%
50 ns	1000 mV	40%
50 ns	1000 mV	60%

There are no traces displayed on the screen for this test. All calculations are done by the BERT.

TD 1.8 and 1.9 Gen1 Receiver Jitter Tolerance Tests

The purpose of this test group is to verify that the receiver functions properly in the presence of random and deterministic jitter as defined in the USB 3.2 Gen1 Compliance Test Specification.

To do this, the BERT must first be calibrated to output the specified amount of jitter by running the Gen1 RX JTOL Calibrations (below).

Once the BERT output is calibrated, the BERT sets the DUT into loopback mode and performs the Gen1 Long Channel RX JTOL Test at 5 Gb/s using the specified compliance test pattern and frequency. The default configuration tests all eight required points using CP0: 50 MHz, 33 MHz, 20 MHz, 10 MHz, 4.9 MHz, 2 MHz, 1 MHz and 500 kHz.

This is followed by the Gen1 Short Channel RX JTOL Test. The short channel test requires peak-to-peak differential voltage calibrated to 1200 mV before channel.

There are no traces displayed on the screen for these tests. All the calculations are done by the BERT.

Gen1 RX JTOL Calibrations

This “test” calibrates the BERT output to the parameters required for TD 1.8 and TD 1.9, Gen1 Receiver Jitter Tolerance Tests. Calibration results are stored in D:\Applications\USB3_1. Each time the calibration is run, the previous calibration file is overwritten. It is recommended to calibrate at least once a day or if there has been a change in temperature of more than a few degrees.

The calibrations include:

Deemphasis Calibration

Calibrates amplitude to 800 mV peak to peak and deemphasis to 3.0 +0.3/-0 dB (before channel).

Rj Calibration

Calibrates Rj to 2.42 ps +/-10% ps RMS

Sj Calibration

Calibrates Sj to each of the following parameters:

50 MHz:	40 +0/-10% ps
33 MHz:	40 +0/-10% ps
20 MHz:	40 +0/-10% ps
10 MHz:	40 +0/-10% ps
4.9 MHz:	40 +0/-10% ps
2.0 MHz:	100 +0/-5% ps
1.0 MHz:	200 +0/-5% ps
500 kHz:	400 +0/-5% ps

Eye Height Calibration

Calibrates Eye Height to:

180 mV +5/-0 mV for testing a Host (or Downstream Hub)

145 mV +5/-0 mV for testing a Device (or Upstream Hub)

TD 1.10 Gen2 Receiver Jitter Tolerance Tests

These are the same as the Gen1 JTOL tests over the Long and Short Channel, only using Gen2 speeds of 10 Gb/s. The default configuration tests all frequencies using CP9.

Gen2 RX JTOL Calibrations

This "test" calibrates the BERT output to the parameters required for TD 1.10, Gen2 Receiver Jitter Tolerance Tests. These are equivalent to the Gen1 calibrations, with the addition of calibrations required by the USB 3.2 standard, and include:

TX EQ and Short Channel Calibrations

Step 1. Calibrates amplitude to 800 mV peak to peak.

Step 2. Calibrates the measured TX EQ to 2.2 +/- .1 dB fixed preshoot.

Step 3. Calibrates deemphasis settings for -1.0 +/- .1 dB, -3.1 +/- 1 dB, and -5.0 +/- .1 dB.

Rj Calibration

Calibrates Rj to 1.0 +0/-.1 ps RMS with clock pattern CP10.

The reference equalizer is not used for this Rj calibration. The JTF is applied. SSC is off and all other jitter sources are on but set to zero.

Sj Calibration

Calibrates Sj to each of the following parameters:

100 MHz	17.0 +0/-10% ps
50 MHz	17.0 +0/-10% ps
30 MHz	17.0 +0/-10% ps
15 MHz	17.0 +0/-10% ps
7.5 MHz	17.0 +0/-10% ps
4 MHz	37.0 +0/-10% ps
2 MHz	87.0 +0/-10% ps
1 MHz	204 +0/-10% ps
500 kHz	476 +0/-10% ps

CLB Selection

With TX EQ, Rj, and Sj @100 MHz calibrated settings, selects the compliance load board that yields the eye height measurement closest to 70 mV and uses this compliance load board for the remaining calibration and testing. Three different lengths of CLBs are used: 5.6", 7.1", and 8.1".

Eye Width Calibration

Adjusts deemphasis from 1 dB to 5 dB to adjust the eye width with a target of 48* +2/-0 ps.

If the width target was not met, then:

a. If the width is too big, add a second Sj tone at 87 MHz and adjust until the width target is met.

b. If the width is too small, reduce the 100 MHz Sj tone until the width target is met.

Eye Height Calibration

Adjusts swing to calibrate eye height to 70 mV +5/-0 mV.

USB 3.1/3.2 RX Test Variables

+ Data Input Channel
Oscilloscope channel used to input positive side of differential data pair (D+).

- Data Input Channel
Oscilloscope channel used to input negative side of differential data pair (D-).

Always reconnect DUT?
When using the PeRT3 or Anritsu MP1900 to automate the connection to the DUT, set this to Yes to always disconnect and reconnect on every run. This is useful in case the DUT loses loopback mode during testing (especially a risk when switching to another Sj test frequency). By setting this variable to Yes, you'll be able to power cycle the DUT each run to ensure the DUT is in loopback mode.

Connector Type
Specifies the test port connector type: Micro-B, Standard (either Std-A or Std-B), or Type-C. The default is Standard.

Max Retries
Maximum number of times for the BERT to try to connect to the DUT for putting it into loopback.

Disable connection diagrams?
Disables/enables the display of connection diagrams during a test run. The default is No, which retains the connection diagrams.

Port Type
Port being tested: Device, Host, Upstream Facing Port, or Downstream Facing Port. This variable also appears on the Configuration Setup dialog. The default is Device.

Note: Regardless of port type, the unit tested will be referred to as DUT in the software.

SigTest Setup Variables

SigTest EXE for Gen1 Testing
Path to the installation of SigTest used for Gen1 testing. Default is C:\Program Files (x86)\SigTest 3.2.11.3.

SigTest EXE for Gen2 Testing
Path to the installation of SigTest used for Gen2 testing. Default is C:\Program Files (x86)\SigTest 4.0.23.

Gen2 Rj Cal Template File
SigTest template file for Gen2 Rj calibration. The default is USB_3_10Gb_Rj_Cal.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

Gen2 Sj Cal Template File
SigTest template file for Gen2 Sj calibration. The default is USB_10Gb_Sj_Cal.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

Short Channel CP0 Test Template File
SigTest template file for the Gen1 Short Channel CP0 test. The default is USB_3_5Gb_CP0_RjIN_SHORT.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

Short Channel CP1 Test Template File

SigTest template file for the Gen1 Short Channel CP1 test. The default is USB_3_5Gb_CP1_SHORT.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

Long Channel CP0 Test Template File

SigTest template file for the Gen1 Long Channel CP0 test. The default is USB_3_5Gb_CP0_RjIN.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

Long Channel CP1 Test Template File

SigTest template file for the Gen1 Long Channel CP1 test. The default is USB_3_5Gb_CP1.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

CP10 Test Template File

SigTest template file for the Gen2 CP10 test. The default is USB_3_10Gb_CP10.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

CP9 Test Template File

SigTest template file for the Gen2 CP9 test. The default is USB_3_10Gb_CP9_RjIN.dat located in <SigTest Folder>\templates\USB_3_10Gb\.

Gen1 Sj Cal Template File

SigTest template file to be used for Gen1 Sj calibration. The default is USB_3_5Gb_CP0_RjIN_SjCal.dat located in <SigTest Folder>\templates\USB_3_5Gb\.

BERT Setup

BERT IP Address

Hostname or IP Address of the Anritsu MP1900A or PeRT3 Server machine, *from the point of view of the oscilloscope*. In the default configuration, where the PeRT3 is connected by USB to the oscilloscope, the oscilloscope is the PeRT3 Server, therefore this variable is set to "localhost". If the PeRT3 is connected to another host, enter the address of that machine. Default is localhost.

PeRT3 Custom Options String

Custom options string to be used when initializing the PeRT3 Phoenix (only) for loopback. Select Auto to allow QualiPHY to determine the appropriate string.

Pairs of variables and values should separated by commas.

Example: HANDSHAKING=Blind,AUTOPOLARITY=Disable

Following are the state machine options and the default values.

USB 3.1 Gen1:

HANDSHAKING=Full
TS_HANDSHAKE=Enable
LFPS_DETECTION_METHOD=Full
AUTOPOLARITY=Enable
SKP_TYPE=Default_Two

USB 3.1 Gen2:

tPERIOD_(ns)=48
LBPM_Tx=Consecutive
SKP_Frequency_(blocks)=22
SKP_Size_(symbols)=16
INITIALIZATION=LOOPBACK
Debug=Off
Trigger=Off

PeRT3 Custom Sequence (Loopback)
Name of the sequence to be used by the PeRT3 for putting the DUT into loopback state. When Default is selected, the default sequence set on the PeRT3 is used.

BERT Used
BERT instrument used for receiver testing: Anritsu MP1900A or PeRT3 Phoenix.

Pause to configure PeRT3/MX183000A?
Select Yes to pause script execution before initially linking in order to adjust the PeRT3 or MX183000 settings.

Anritsu MP1900A Settings

Synthesizer Slot
Mainframe slot used for the Synthesizer module.

PPG Slot
Mainframe slot used for the PPG module.

Jitter Modulation Slot
Mainframe slot used for the Jitter Modulation module.

DM Generator Slot
Mainframe slot used for the Noise Generator module. Enter None when not using a Noise module for the ping source.

Data Channel
BERT channel used to input the PPG module.

MP1900A Ping Method
Ping method when using the MP1900A, Noise Module or Pick Off Tees.

Receiver Tests Variables

Number of Acquisitions for RX Cal
Number of waveforms to acquire for RX calibration. The average results from all acquisitions will be used.

Deskew Measure Mode
Method used for deskewing cables at the start of a test. Wizard Measured launches the automated deskew measurement wizard. User Defined allows users to set a known Deskew Value in Picoseconds. Default is Wizard Measured.

Deskew Value in Picoseconds
The channel plus cable deskew between the positive input channel and the negative input channel. The value is in picoseconds and is applied to the positive channel. This value is only applied when Deskew Measure Mode is set to User Defined.

Gen1/Gen2 Long and Short Channel RX JTOL Tests

This group of variables may be set separately for each of the four RX JTOL tests.

Sj Frequency for Loopback

Sinusoidal jitter frequency used when placing the DUT into loopback. If All is selected, the JTOL test will reconnect when testing at each frequency. Otherwise, it will connect initially at the selected frequency and only reconnect if the DUT drops out of loopback. Default is 20 MHz.

BERT Termination Type

Methodology used for the RX jitter tolerance tests. MaxBitCount: the BERT will terminate testing when the number of bits sent to the DUT has reached the limit set by the Bit Count variable. ElapsedTime: the BERT will keep running for the time set in the JTOL Test Time variable. Default is MaxBitCount.

JTOL Test Time

Time (in seconds) used for the JTOL test when BERT Termination Type is ElapsedTime.

Note: Gen2 testing requires 2 minutes for each Sj frequency test point. Gen1 requires 30e9 bits.

Long/Short Channel Bit Count

Number of bits transmitted by the BERT for receiver testing when BERT Termination Type is MaxBitCount.

Frequency to Test

Frequencies to be included in the test. Default is “All”.

Compliance Test Pattern

Compliance pattern to use for this test. Selections are:

9 = CP9 (Gen2 10Gbit/s scrambled 0.0)

10 = CP10 (Gen2 10Gbit/s 0101 Pattern)

11 = CP11 (Gen2 Nyquist / 2 0011 Pattern)

12 = CP12 (Gen2 10Gbit/s PRBS15)

Eye Width Calibration

This group of variables applies to the Eye Width Calibration Test.

Stop on first passing deemphasis value?

This variable allows you to choose how the eye width calibration is performed. Select Yes to end the Eye Width calibration step when finding the first deemphasis value that yields an eye width between 48 and 50 mV. This the default method and will result in a quicker calibration convergence.

Select No to continue testing in order to measure the eye width using deemphasis values over the full range of -1 dB to -5 db.

USB 3.1/3.2 RX Test Limit Sets

The default installation of QualiPHY contains two limit sets, **Compliance** and **Specification**, which differ in the same way as do the USB 3.1/3.2 TX Test Limit Sets

Appendix A: Compliance Pattern Definitions

The USB3.2 compliance patterns are defined in Table 6-14 from section 6.4.4 of the Universal Serial Bus 3.2 Specification, Revision 1.0. It is and displayed below for convenience.

Compliance Pattern	Value	Description
CP0	D0.0 scrambled	A pseudo-random data pattern that is exactly the same as logical idle (refer to Chapter 7) but does not include SKP sequences.
CP1	D10.2	Nyquist frequency
CP2	D24.3	Nyquist/2
CP3	K28.5	COM pattern
CP4	LFPS	The low frequency periodic signaling pattern
CP5	K28.7	With de-emphasis
CP6	K28.7	Without de-emphasis
CP7	50-250 1's and 0's	With de-emphasis. Repeating 50-250 1's and then 50-250 0's.
CP8	50-250 1's and 0's	Without de-emphasis. Repeating 50-250 1's and then 50-250 0's.
CP9		Pseudo-random data pattern (see section 6.4.4.1)
CP10	AAh	Nyquist pattern at 10 Gb/s. This is not 128b132b encoded.
CP11	CCh	Nyquist/2 at 10 Gb/s, This is not 128b132b encoded.
CP12	LFSR15	Uncoded LFSR15 for PHY level testing and fault isolation. This is not 128b132b encoded. The polynomial is x^15+x^14+1.
CP13	64 1's and 0's	With pre-shoot defined in section 6.7.5.2 (no de-emphasis). Repeating 64 1's and then 64 0's at 10 Gb/s. This is not 128b132b encoded.
CP14	64 1's and 0's	With de-emphasis defined in section 6.7.5.2 (no pre-shoot). Repeating 64 1's and then 64 0's at 10 Gb/s. This is not 128b132b encoded.
CP15	64 1's and 0's	With pre-shoot and de-emphasis defined in section 6.7.5.2. Repeating 64 1's and then 64 0's at 10 Gb/s. This is not 128b132b encoded.
CP16	64 1's and 0's	No de-emphasis or pre-shoot. Repeating 64 1's and then 64 0's at 10 Gb/s. This is not 128b132b encoded.

Appendix B: Operating the PeRT3 Manually

USB3.2 receiver tests require the use of a PeRT3 with the oscilloscope. The PeRT3 can be operated from the stand-alone PeRT3 application or from within the oscilloscope application (XStreamDSO). For instructions on using the stand-alone application, consult the PeRT3 documentation.

The PeRT3 dialog can be accessed by choosing Analysis > PeRT3 from the oscilloscope menu bar:

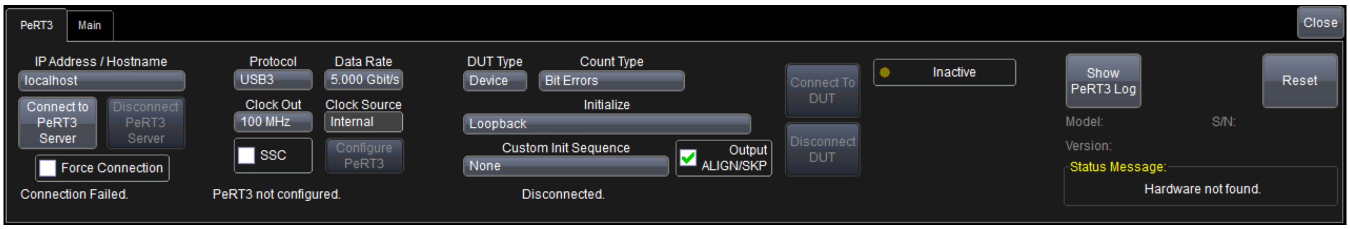


Figure 59 – PeRT3 Dialog in the XStreamDSO application

Note: The stand-alone PeRT3 application must be installed on the oscilloscope in order for the PeRT3 controls to appear on the Analysis menu.

Connect to Server

1. Set the **IP Address / Hostname** control to the IP address or hostname of the machine that is physically connected to the PeRT3 via USB2 cable. The default value is "localhost," which is used when the PeRT3 is connected to the oscilloscope.
2. Click **Connect to PeRT3 Server** to establish communication with the PeRT3. The text below the button should change to indicate the connection is being established, and after a few minutes it should indicate that the PeRT3 is connected.

Note: If the connection fails, an error message appears in the Status Message field at the bottom right of the dialog. This may occur because the PeRT3 is already being accessed from the PeRT3 stand-alone application, or by another oscilloscope or computer.

Configure PeRT3

1. After the connection is established a dialog tab is added for each PeRT3 channel. Use these to set the **Protocol**, **Data Rate**, **Clock Out** and **SSC** as desired for the respective channel.
2. When finished, click **Configure PeRT3**. After a brief delay, the text below the button indicates that the PeRT3 is configured successfully.

At this point the PeRT3 is ready for use. Most of the controls on the PeRT3 dialogs correspond closely with the controls in the PeRT3 stand-alone application. One exception is the **Output ALIGN/SKP** checkbox. When this checkbox is unchecked the PeRT3 suppresses the symbols required to be inserted periodically (SKP for USB3, ALIGN for SATA, etc). The default state is checked; however, you may disable those symbols for transmitter testing in loopback or for receiver test calibration.

The remainder of this section specifically focuses on using the PeRT3 controls when testing USB3. The key operations are: **LFPS Ping**, **Loopback** and **receiver test calibration**.

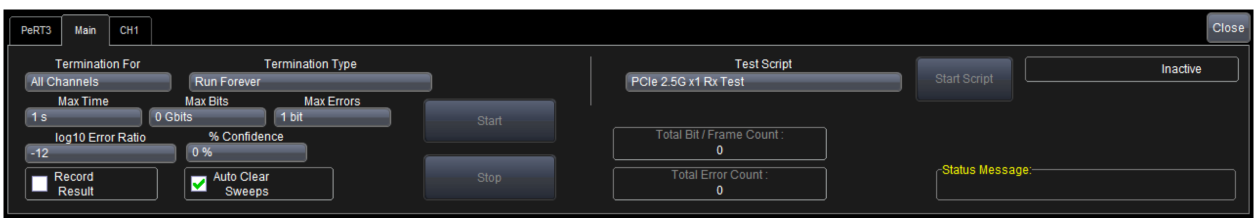
LFPS Ping Using the PeRT3

1. Connect the PeRT3 TX+ and TX- should be connected to RX+ and RX- of the DUT.
2. Set the PeRT3 controls as follows:
   Count Type: Bit Errors
   Initialize: Custom Sequence
   Custom Init Sequence: TX Test Init
3. Click **Connect to DUT**. The **TX Test Init** sequence sets the PeRT3 output to electrical idle to prepare for sending an LFPS Ping. (Some USB3 implementations have been observed to react to the TX Test Init as an LFPS Ping.)
4. Change the **Custom Init Sequence** to **TX Test Ping**.
5. Click **Connect to DUT** to send an LFPS Ping.

   Tip: It is convenient to view the output of the DUT on the screen and watch the pattern change when the Ping is sent.

Loopback Mode Using the PeRT3

1. Connect the PeRT3 to the DUT.
2. Set the PeRT3 controls as follows:
   Count Type: Bit Errors
   Initialize: Loopback
   Custom Init Sequence: No Disconnect Support (Default)
   Output ALIGN/SKP: Checked
3. Power off the DUT.
4. Click **Connect to DUT**. The PeRT3 sends out LFPS and waits to see LFPS from the DUT.
5. Power on the DUT. For devices, VBUS power may need to be applied as well. The DUT should now be connected.
6. Open the **Main** tab behind the PeRT3 tab:



7. The Termination controls how long a receiver test runs. The termination can be set separately for individual channels or for all channels at once using the **Termination For** control. Verify the DUT is correctly in loopback by setting the controls as follows:

   Termination For: All Channels
   Termination Type: Run Forever
8. Click the **Start** button. The Status Message should indicate that the PeRT3 is running, and “Pattern Locked” should appear in the top right with a green light next to it.

   Note: It may take a few seconds to load the pattern the first time Start is pressed. If the PeRT3 cannot obtain a pattern lock it stops running after a short time. If this occurs, different Initialize and Custom Init Sequence settings may help debug the problem. Debugging loopback operation is beyond the scope of this manual. Please consult the PeRT3 documentation for more guidance.

Receiver Test Calibration using the PeRT3

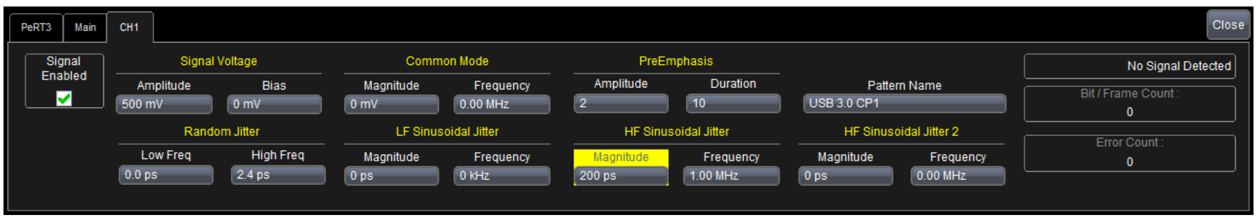
Receiver testing involves applying a fixed amount of jitter to a signal and controlling the amplitude and pre-emphasis. It is important that these be applied correctly, and therefore it is desirable to measure the jitter, amplitude and pre-emphasis of the PeRT3.

1. Set the PeRT3 controls as follows:
   Count Type: Bit Errors
   Initialize: Loopback (blind / no handshake)
   Custom Init Sequence: No Disconnect Support (Default)
   Output ALIGN/SKP: unchecked

2. Click the **Connect to DUT** button. The Initialize setting **Loopback (blind / no handshake)** causes the PeRT3 to skip through the LFPS handshake and behave as if the link is up.

   Tip: In this state the PeRT3 can be used to generate USB3.2 signals without the RX inputs connected. By connecting the TX outputs to the oscilloscope, jitter, amplitude and pre-emphasis can be measured.

3. Open the **CH1** tab to display the following dialog:

   Adjust the controls on the dialog to apply the amplitude, pre-emphasis and jitter as desired. You can also choose a pattern.

   Note: The USB3.2 specification refers to deemphasis, not pre-emphasis. They are effectively the same. However, for pre-emphasis the amplitude refers to the amplitude of the bits before emphasis is added. For deemphasis the amplitude refers to the amplitude of the bits before emphasis is removed. Since the PeRT3 controls are for pre-emphasis, the target amplitude is lower than the USB3.2 specification. For example, if the desired amplitude of the emphasized bits is 750mV and the amount of emphasis is 3.5dB the amplitude setting for the PeRT3 is 3.5dB less than 750mV, which is 500mV.

4. Open the **Main** tab behind the PeRT3 tab. Configure the controls as follows:
   Termination For: All Channels
   Termination Type: Run Forever

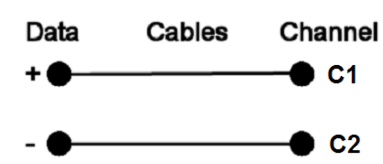
5. Click the **Start** button to begin sending out the pattern with the applied jitter, amplitude and pre-emphasis.

Appendix C: Manual Deskewing Procedure

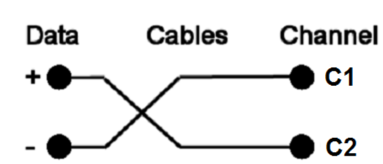
The following procedure demonstrates how to manually deskew two oscilloscope channels and cables using the differential data signal, with no need for any additional T-connector or adapters.

Warm the oscilloscope for at least a half-hour before proceeding. This procedure should be run again if the temperature of the oscilloscope changes by more than a few degrees.

1. Connect a differential data signal to C1 and C2 using two approximately matching cables. Set up the oscilloscope to use the maximum sample rate. Set the timebase for a few repetitions of the pattern (at least a few dozen edges).



2. On the C2 menu, check **Invert**. Now C1 and C2 should look the same.
3. Using the **Measure Setup**, set P1 to measure the Skew of C1, C2. Turn on **Statistics** (**Measure** menu). Write down the mean skew value after it stabilizes. This mean skew value is the addition of Data skew + cable skew + channel skew.
4. Swap the cable connections on the Data source side (on the test fixture), and then press the **Clear Sweeps** button on the oscilloscope (to clear the accumulated statistics; since we changed the input).



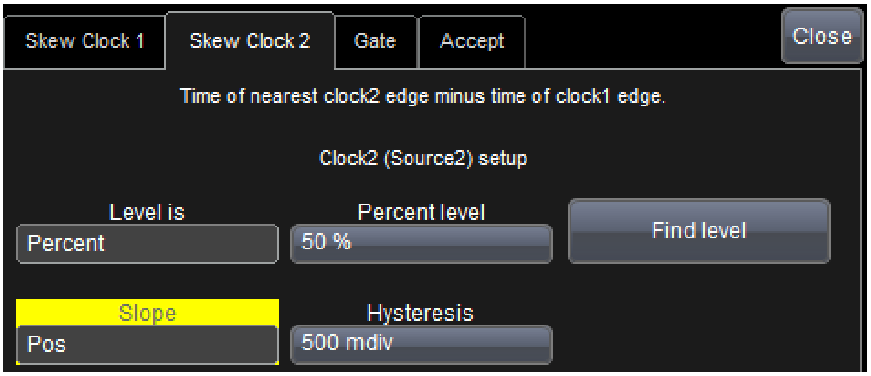
5. Write down the mean skew value after it stabilizes. This mean skew value is the addition of (-Data skew) + cable skew + channel skew.
6. Add the two mean skew values and divide the sum in half:

$$\frac{[\text{cable skew} + \text{channel skew}]}{2}$$

7. Set the resulting value as the Deskew value in C1 menu.
8. Restore the cable connections to their Step 1 settings (previous). Press the **Clear Sweeps** button on the oscilloscope. The mean skew value should be approximately zero - that is the data skew. Typically, results are <1ps given a test fixture meant to minimize skew on the differential pair.
9. On the C2 menu, clear the **Invert** checkbox and turn off the parameters.

In the previous procedure, we used the default setup of the Skew parameter (which is detecting positive edges on both signals at 50%). We also inverted C2 in order to make C1 and C2 both have positive edges at the same time.

Alternately, we clearly could have not inverted C2 and instead selected the Skew clock 2 tab in the P1 parameter menu and set the oscilloscope to look for negative edges on the second input (C2). However, we believe that the previous procedure looks much more aesthetically pleasing on the display, as it shows C1 and C2 with the same polarity.



TELEDYNE LECROY
Everywhereyoulook™

700 Chestnut Ridge Road
Chestnut Ridge, NY 10977
USA

teledynelecroy.com