TELEDYNE LECROY
Everywhereyoulook™

QPHY PCIE3-TX-RX

PCIe 3.0 Compliance Test Software

Instruction Manual

October, 2021

Relating to:

MAUI Version 9.7.x.x and later

QualiPHY Version 9.7.x.x and later

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QualiPHYPCIE3-TX-RXManual.pdf
October, 2021

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About This Manual

This manual assumes that you are familiar with using an oscilloscope–in particular the Teledyne LeCroy oscilloscope that will be used with QualiPHY–and that you have purchased the QPHY-PCIE3-TX-RX software option. Some of the images in this manual may show QualiPHY products other than QPHY-PCIE3-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

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:

- **Multiple Data Source Capability**
- **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 device performance distribution or obtain process information from the devices under test.

The QPHY-PCIE3-TX-RX option is an automated test package performing all compliance tests in accordance with PCI Express Card Electromechanical Specification, Rev. 3.0.

The software can be run on any Teledyne LeCroy real-time oscilloscope with at least 13 GHz bandwidth and a sample rate of at least 40 GS/s.

Required Equipment

Testing as shown in this manual requires the following equipment and software. For the latest list of required equipment, see:

PCI Express 3.0 Test Guides at www.pcisig.com/specifications/pciexpress/compliance

All Testing

- Teledyne LeCroy real-time oscilloscope, ≥ 13 GHz BW, installed with:
  - MAUI v.9.7.x.x minimum* with an activated QPHY-PCIE3-TX-RX option key
  - QualiPHY v.9.7.x.x minimum with an activated PCIE3-TX-RX component

    Note: The versions listed above are the minimum versions required for this release of the product. MAUI and QualiPHY software versions must match, so upgrade your version of QualilPHY if you have upgraded your oscilloscope firmware. The QualiPHY software may be installed on a remote PC, but all other software must be run on the oscilloscope.
  - Teledyne LeCroy PCIe Decoder software with ProtoSync option (installed on oscilloscope)
  - Teledyne LeCroy PCIe ProtoSync Software v.11.67 (installed on oscilloscope)

    Note: Download the PCIe ProtoSync software from the ProtoSync product page. The Release Notes refer to PCIe Protocol Suite. They are the same.
  - SigTest v.3.2.0.3
- DC blocks
- One pair standard SMA-SMP cables (2 total)
- Three pair short SMA-SMP cables (6 total)
- One pair standard SMA-SMA cables (2 total)
- Two pair high-quality SMA-SMA cables (4 total)
- PCIE 3.0 test fixtures, CBB3 and CLB3
- SMP extractor tool and torque wrench
- Power supply

LEQ Testing

- Teledyne LeCroy PeRT3 Phoenix or Anritsu MP1900A
    - If using PeRT3, PeRT3 Software and PETracer Summit Software on oscilloscope
    - If using PeRT3 to test long channels, PeRT3 Receiver Conditioner
- Four pairs SMA(m)-SMA(m) phase matched cables, phase matched to 1 ps (8 total)
- Two pairs SMA(m)-SMA(f) right-angle adapters, phase matched to 1 ps (4 total)
- One pair SMA(m)-SMA(f) phase matched cables (2 total)
- Four SMA(m)-SMA(m) cables
- One SMA(f)-BNC(m) adapter
- Four power dividers
- Two DC blocks
- One AT power supply (if testing add-in cards)
- 7mm fixed wrench, SMA torque wrench and SMP extractor tool
- PCIe 3.0 compliance load board

Receiver Calibration and Testing

- Teledyne LeCroy PeRT3 Phoenix or Anritsu MP1900A

Remote Host Computer 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 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 wizard 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 with one or more serial data compliance components. Each compliance component is purchased as a software option.

Install Base Application

Download the latest version of the QualiPHY software from:

teledynelecroy.com/support/softwaredownload/ 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.

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**.

Install SigTest.exe

SigTest.exe ver. 3.2.0, which is the current version required by the PCI SIG, must be installed on the oscilloscope for the QualiPHY scripts to execute properly. It is available for download from the PCI SIG website.

Activate Components

The serial data compliance components are factory installed as part of the main application in your oscilloscope and are individually activated through the use of an alphanumeric code uniquely matched to the oscilloscope's serial number. This option 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 waveform 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 LAN 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 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 detailed test information, see PCIe3 Transmitter & Receiver Testing and PCIe3 Link Equalization (LEQ) 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 dialog 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.

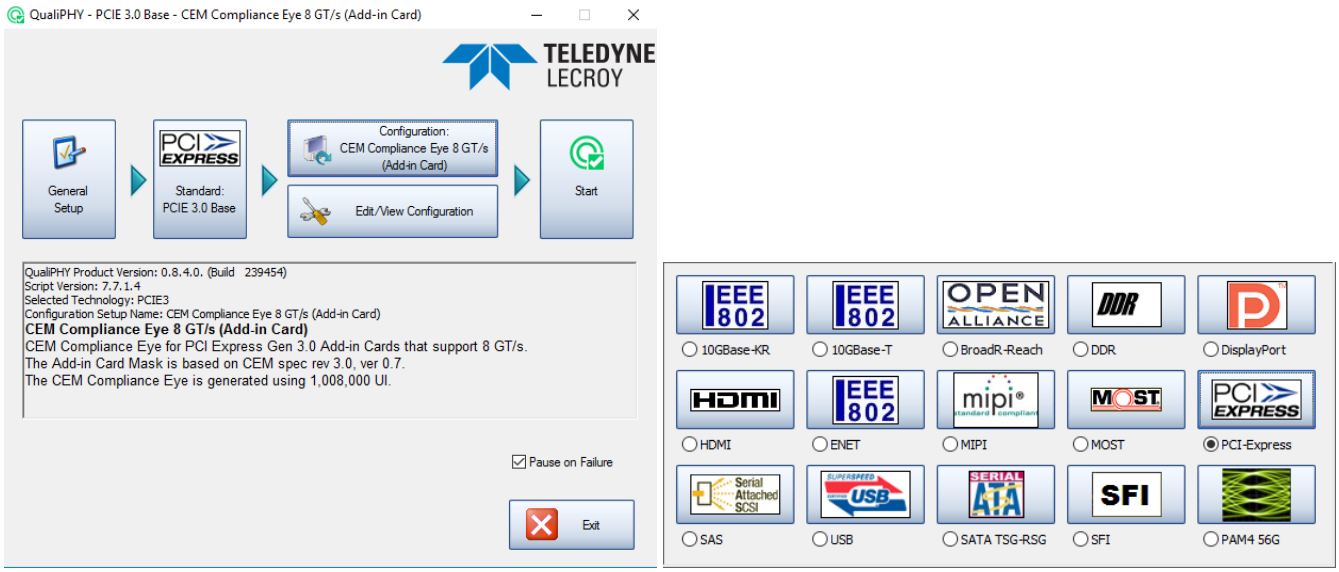


Figure 1 - QualiPHY wizard dialog and Standard selection menu

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, QualiPHY 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 dialog 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 oscilloscope (local host 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, such as: **Operator Name**, **Device Under Test** (DUT) name, **Temperature** (in °C) of the test location, and any additional **Comments**. These are global settings that will be used on all reports if you choose to **Disable session information dialog** at the start of tests. Otherwise, the initial session information settings will override these.

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

Report tab

Settings related to 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. The new report will overwrite the previous report, unless you change the report name at the start of each session.

  Note: Unlike some QualiPHY components, PCIE3 test scripts do not overwrite a generic file when autogenerating reports, but create a new report file each session named "LeCroyReport_<Device Under Test>" (or if the Device Under Test field is empty, "LeCroyReport_DUT"). You can omit entering a new Output file name at the start of each session.
- **Default** report output format of XML, HTML, or PDF.

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

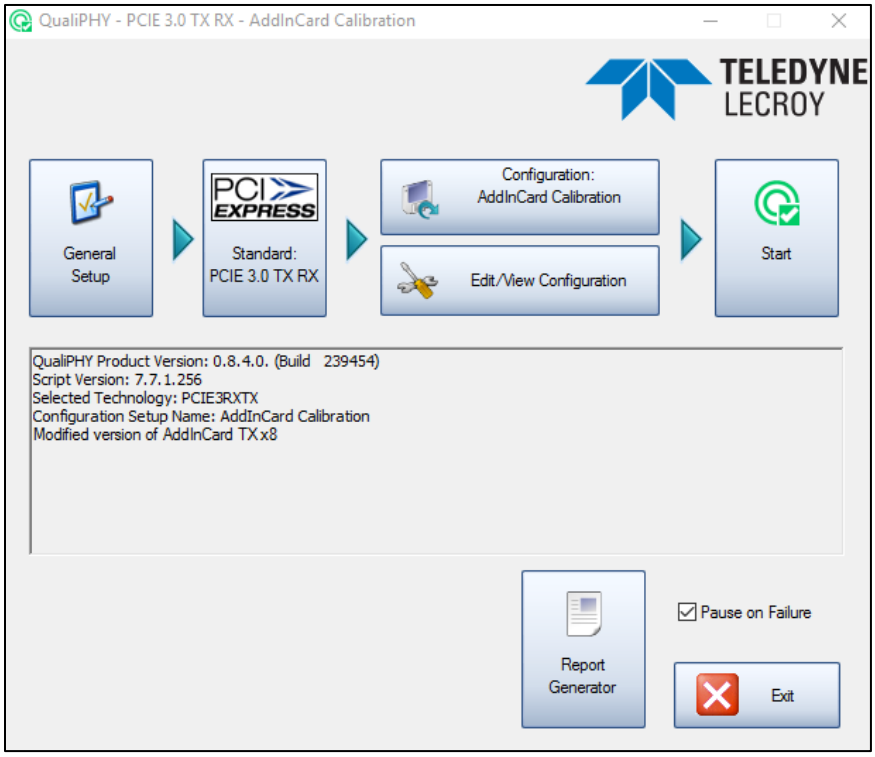
Information about your QualiPHY installation.

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.
2. Access the QualiPHY software to display the wizard dialog.



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 for selection now.

5. Click the **Configuration** button and select the test configuration to run. These pre-loaded configurations are set up 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 internal compliance tests by copying and modifying the pre-loaded configurations. See Customizing QualiPHY for details.

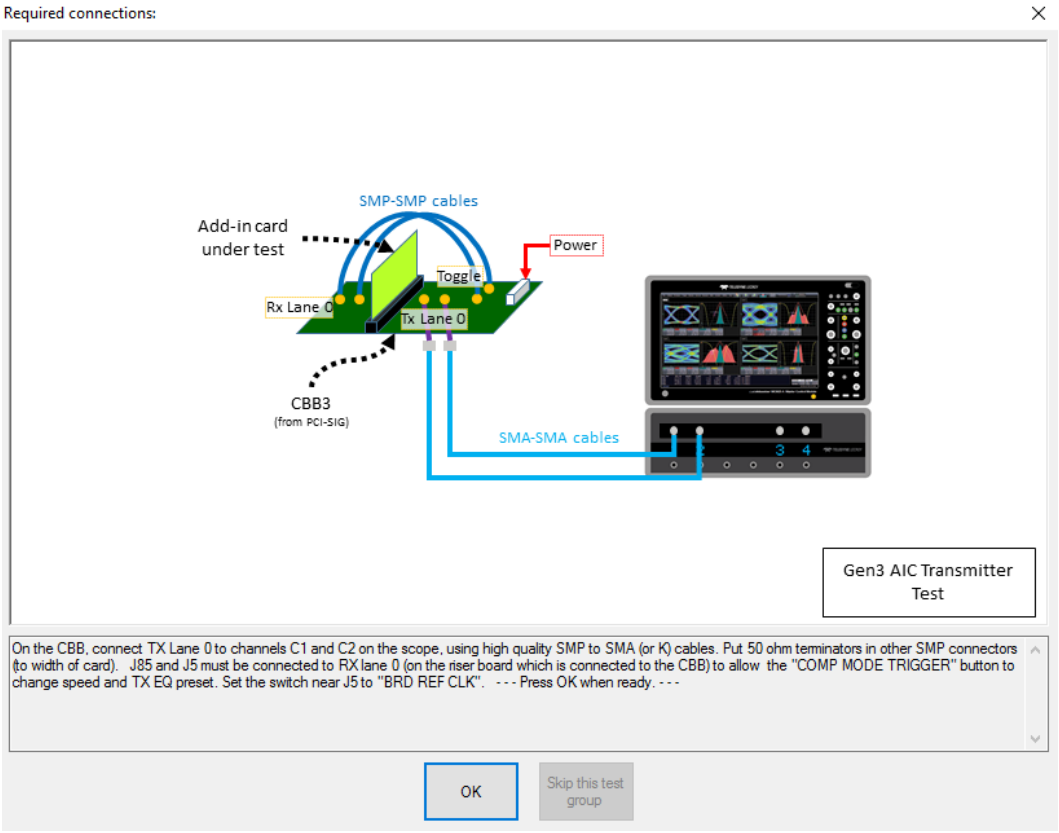
6. **Close** the Edit/View Configuration dialog to return to the wizard dialog.

Run Tests

1. On the wizard dialog, 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 dialog 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 dialog 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 dialog, go to **General Setup > Report** to pre-configure reporting behavior. You can also manually launch the **Report Generator** from the wizard dialog 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. 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.

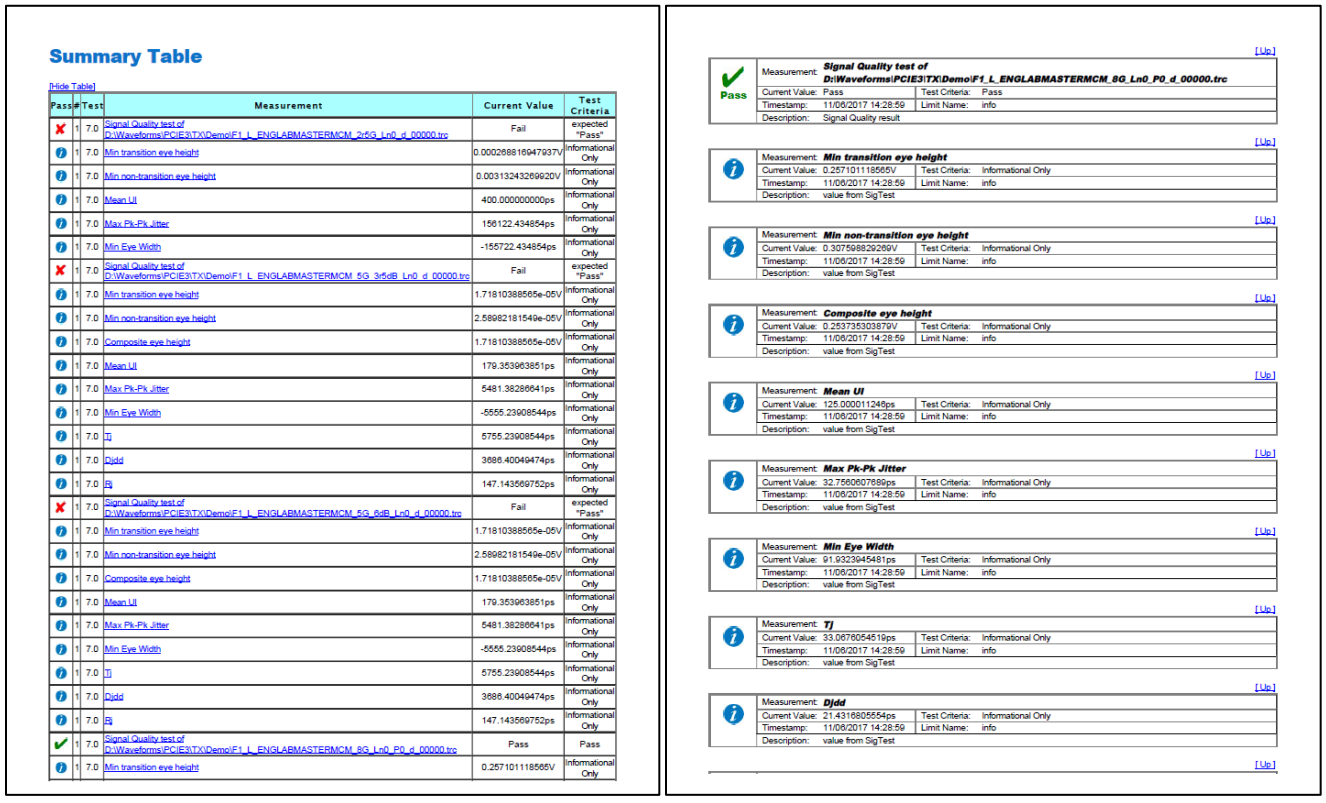


Figure 2 - The Test Report Summary Table and Details pages

Reports are output to the folder D:\QPHY\Reports, or C:\LeCroy\QPHY\Reports if QualiPHY is installed on a remote PC.

You can add your own logo to the report by replacing the file *\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.

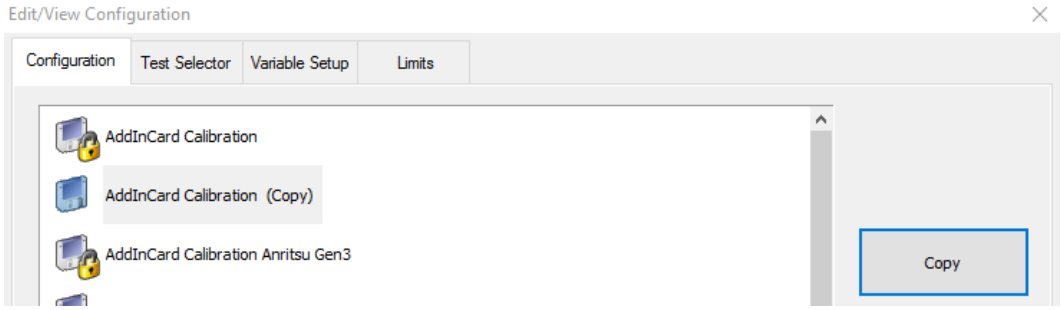
Customizing QualiPHY

The pre-loaded configurations cannot be modified. However, you can create your own test configurations by copying one of the pre-loaded configurations and modifying it.

Copy Configuration

1. Access the QualiPHY wizard dialog 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 followed by "(Copy)."

   Note: Until you enter a new name, the new configuration is shown followed by "(Copy)".



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

   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, rather than create a new one.

Select Tests

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

To loop any of the tests in this configuration, select the test from the list, then choose to **Loop selected test** until stopped or enter the number of repetitions. When defining a number of repetitions, enter the number of repetitions before selecting the checkbox.

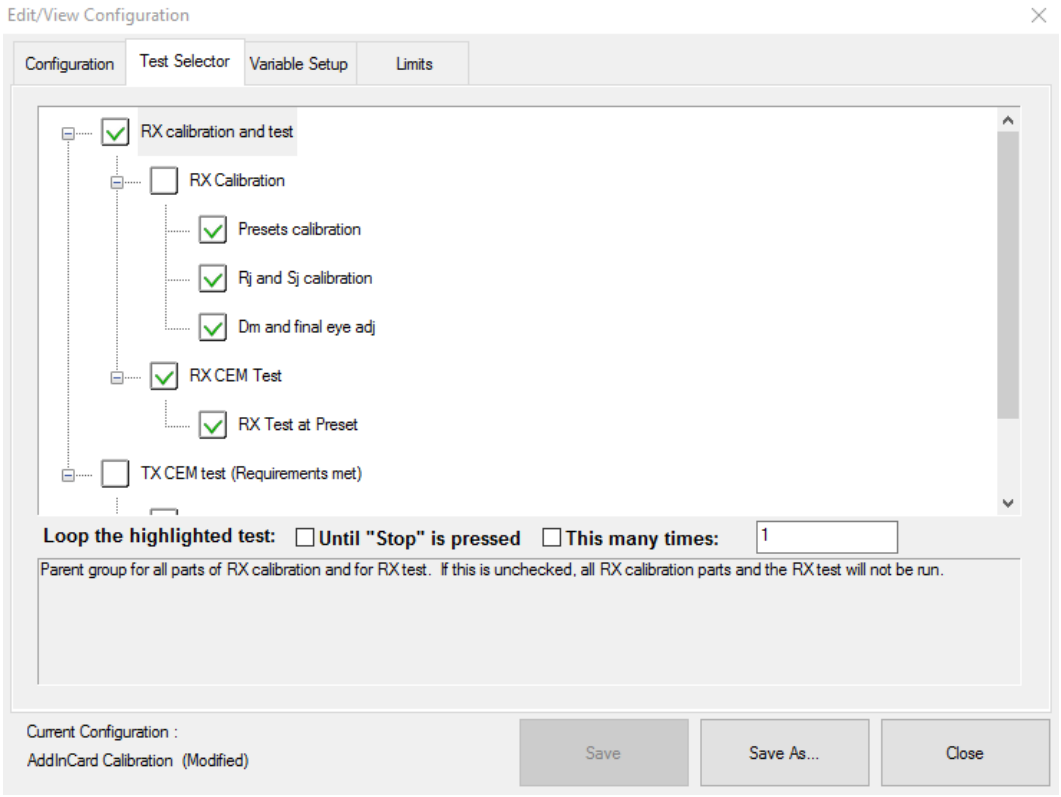


Figure 3 – Configuration Test Selector tab

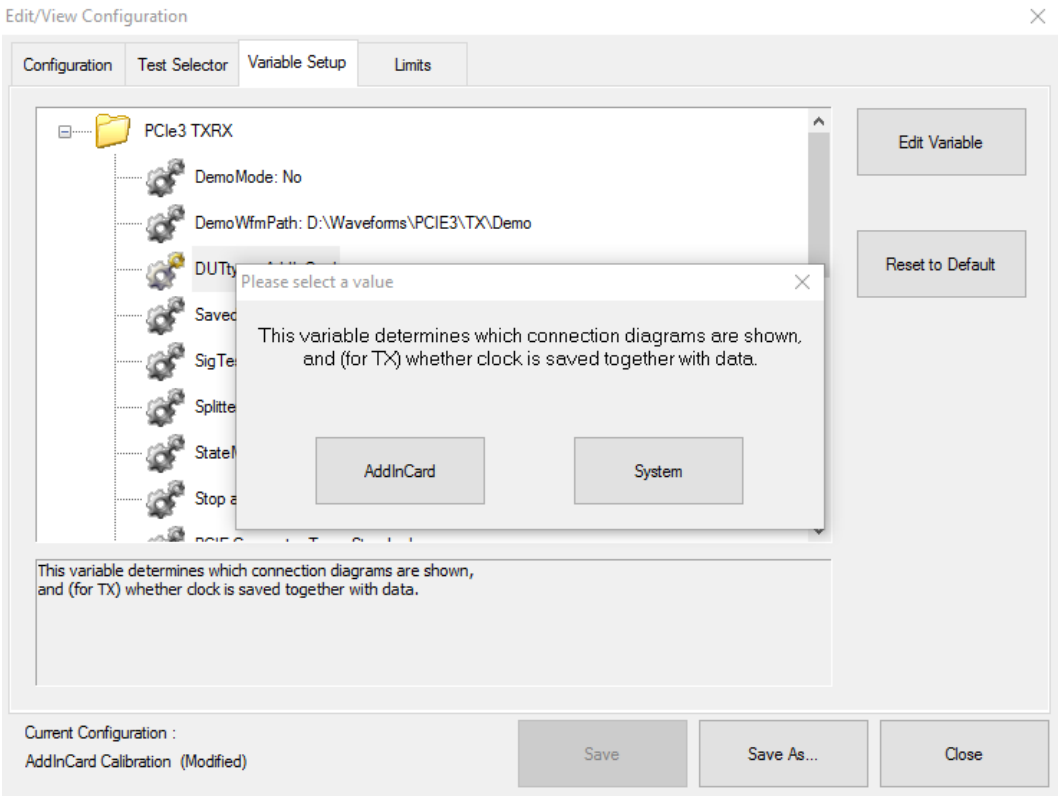
Edit Variables

The Variable Setup tab contains a list of test variables. To modify a variable:

1. Select the variable on the Variable Setup tab, then click **Edit Variable**. (You can also choose to Reset to Default at any time.)

   Note: Especially check the SigTest Path variable. The default value for this variable is SigTest.exe ver. 3.2.0, which is currently the version required by the PCI SIG. It is available for download from the PCI SIG website.

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



Edit Test Limits

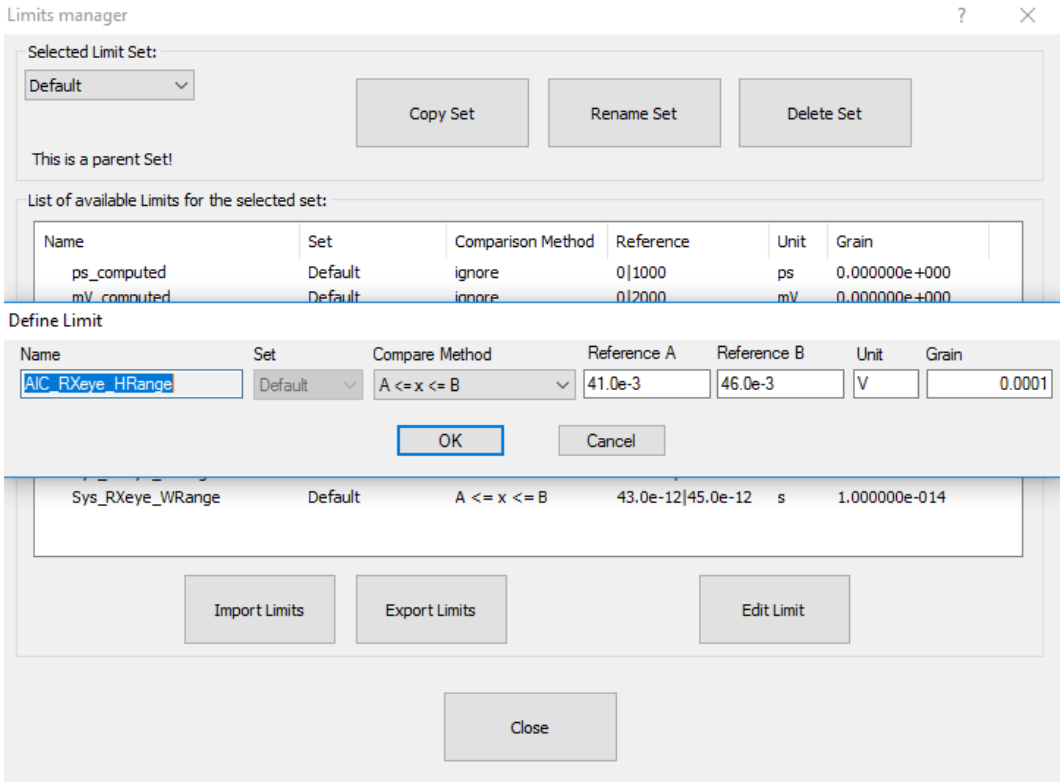
The Limits tab shows the Limit Set currently associated with the configuration. Any limit set can be associated with a custom configuration by selecting it in this field.

The Limits Manager shows the settings 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.



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 test scripts, 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. Right-click on the session and choose **Create Report** from context menu.
- 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.

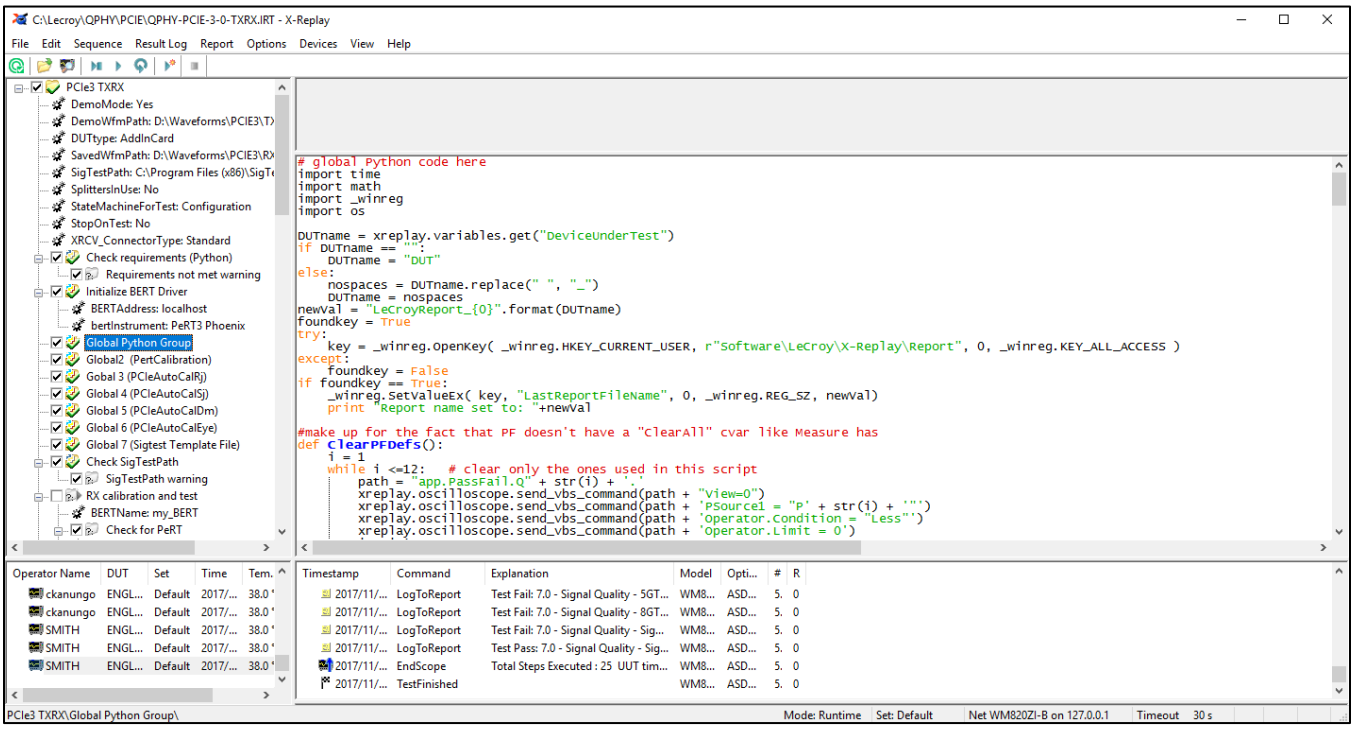


Figure 4 – X-Replay Mode window

PCIe 3.0 Base Testing

Test Preparation

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

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

The QualiPHY script requires that you place the DUT in the required test modes. The script will prompt you to do so before each test, but it is recommended that you ensure the DUT is capable of being placed in the required test modes before beginning testing.

PCIe 3.0 Base Test Configurations

Test configurations include variable settings, limit sets, and test selections.

For detailed descriptions of tests, please refer to the Teledyne LeCroy PCIE Gen3 test procedure on PCISIG.com and the official test specification, PCI Express Card Electromechanical Specification, Rev. 3.0.

Empty Template

This configuration includes all tests and default variable settings specified in the PCI Express Base Specification rev 3.0, ver 0.9. It is meant to serve as a basis for creating custom configurations. Copy and save it with a unique name, then follow the steps in Customizing QualiPHY to modify the new configuration.

CEM Compliance Eye 8 GT/s (Add-in Card)

This configuration generates the CEM Compliance Eye (without SSC) for a PCI Express 3.0 Add-In Card operating at 8 GT/s. The limit set in use is Compliance Limits. All variables are set to their defaults, except that De-embed Fixture Breakout Channel is “No” and Product Type is set to Add-In Card. Test 1.4 – Compliance Eye 8 GT/s is performed.

CEM Compliance Eye 8 GT/s (System Board)

This configuration generates the CEM Compliance Eye (without SSC) for a PCI Express 3.0 System Board operating at 8 GT/s. A 100 MHz system reference clock must be provided. The limit set in use is Compliance Limits. All variables are set to their defaults, except that De-embed Fixture Breakout Channel is “No” and Product Type is set to System Board. Test 1.4 – Compliance Eye 8 GT/s is performed.

Demo of Transmitter Tests

This configuration runs all transmitter tests in the PCI Express Base Specification rev 3.0, ver 0.9, including Test 1.4 - Compliance Eye 8 GT/s, using waveforms saved on the oscilloscope in D:\PCIe3\Demo and the default limit set, Compliance Limits. It is meant to easily demonstrate QualiPHY capabilities when live signals cannot be tested. You will see dialogs and connection diagrams similar to what you would see during an actual test.

Transmitter Tests

This configuration performs all transmitter tests in the PCI Express Base Specification rev 3.0, ver 0.9, except for Test 1.4 – CEM Compliance Eye 8 GT/s. The limit set in use is Compliance Limits. All variables are set to their defaults, except that De-embed Fixture Breakout Channel is “No”.

PCIe 3.0 Base Test Descriptions

Test 1.1 – Tx Equalization Presets

This test measures the transmitter's ability to output the proper amount of pre-shoot and de-emphasis for a given preset as specified in the PCI Express Base Specification rev 3.0, ver 0.9, section 4.3.3.5.2. Table 4-16 defines the pre-shoot and de-emphasis coefficients as well as the tolerance for each preset. The measurement is made on the 1st block of the PCI Express 3.0 compliance pattern, UI 57-62 corresponding to the high and low parts of the pattern.

Test 1.2 – Vtx-fs-no-eq

Transmitter Voltage Full Swing No Equalization. This test measures the transmitter's peak-to-peak voltage with 0 dB of pre-shoot and de-emphasis. The measurement is made on the 1st block of the PCI Express 3.0 compliance pattern, UI 57-62 corresponding to the high and low parts of the pattern. See section 4.3.3.5.3 of the PCI Express Base Specification rev 3.0, ver 0.9.

Test 1.3 – Vtx-eieos-rs/fs Limits

Transmitter EIEOS Reduced Swing / Full Swing. This test measures the peak-to-peak EIEOS reduced swing and full swing voltages. Accurately measuring the EIEOS voltage requires de-embedding the breakout channel. The breakout channel's 4-port s-parameter file should be provided for this test. See section 4.3.3.5.5 of the PCI Express Base Specification rev 3.0, ver 0.9.

Test 1.4 – Compliance Eye 8 GT/s

CEM Compliance Eye 8 GT/s. This test forms an eye diagram using 1,008,000 UI from the PCI Express 3.0 compliance pattern (PCI Express Base Specification rev 3.0, ver 0.9). Masks for System Board TX and Add-In Card TX, as defined in rev 0.7 of the PCI Express 3.0 CEM Specification, are available. QualiPHY uses Eye Doctor II to apply the behavioral Rx equalizer, then uses SDAII to create the eye diagrams.

Test 1.5 – 8 GT/s Tx Jitter Parameters

PCIe 3.0 8 GT/s Tx Jitter Parameters. This test measures all transmitter jitter parameters for 8 GT/s introduced in the PCI Express Base Specification rev 3.0, ver 0.9. They include Ttx-ddj (4.3.3.10.5), Ttx-utj (4.3.3.10.6), Ttx-udjdd (4.3.3.10.6), Ttx-upw-tj (4.3.3.10.7), and Ttx-upw-djdd (4.3.3.10.7).

Test 1.7 – Common Transmitter Parameters

Test 1.7.1 – UI and Vtx-cm-ac-pp

Unit Interval. This test measures the unit interval from the bitrate. SSC should be disabled for this test.

Transmitter AC common mode peak-to-peak voltage. This test measures the common mode AC peak-to-peak voltage where common mode is half the sum of a differential voltage signal. Measurement must be made over at least 1e6 UI. See section 4.3.3.2 of the PCI Express Base Specification rev 3.0, ver 0.9.

Test 1.7.2 –Vtx-dc-cm

DC common mode measures the DC sit of a differential signal. Measurement must be made over at least 1e6 UI. See section 4.3.3.2 of the PCI Express Base Specification rev 3.0, ver 0.9.

Test 1.7.3 – Ltx-skew

Lane-to-Lane Skew. This test measures the skew between lanes belonging to a single link.

PCIe 3.0 Base Test Variables

Main Variables

Breakout Channel S-Parameter File

Name of the four-port s-parameter file (.s4p) to be used for de-embedding the breakout channel when necessary. The file should be located on the oscilloscope in the folder indicated by the S-Parameter Files Path variable.

De-embed fixture breakout channel?

Specify whether or not to de-embed the fixture's breakout channel. This is required for some tests. If you have the s-parameter files for the breakout channel, select "Yes". Otherwise, the fixture will be set to ideal.

Run in Demo Mode?

When “Yes”, the tests are run as a demonstration using saved waveforms. The waveform files must be placed in the Saved Waveform Path. During Demo Mode, you are still prompted with connection diagrams based on other variable selections. This allows you to experience the tests as if run on live signals. The default value for this variable is “No” for compliance configurations, “Yes” for Demo configurations.

Display connection diagrams?

Enables/disables the display of DUT connection diagrams during the test process. Default is “Yes”.

Input Type

Specify whether to use the A (top row) or B (bottom row) inputs for the channel. Depending on the scope model, either Input A or B may support the full bandwidth of the scope. It is recommended that you use the channel that supports the full bandwidth of the scope.

Product Type

Specify the type of product being tested. The Compliance Eye test is done on add-in cards or system boards. The other Tx tests are defined for a transmitter through a breakout channel.

Saved Waveform Path

Full path to the oscilloscope folder from which to recall waveforms when Test Mode is set to Use Saved Data.

Save individual runs?

Specify whether or not to save results from every run. When “Yes”, waveforms are saved in a separate folder each time the test is run. For example: D:\Waveforms\PCIe3\[Device Under Test]\Run1. When “No”, waveforms are overwritten on every run and saved in D:\Waveforms\PCie3\[Device Under Test].

S-Parameter Files Path

Full path to the oscilloscope folder containing the S-Parameter files used for emulation and/or de-embedding. Default is D:\Applications\EyeDr\PCIe3.

Pause to review results?

When “Yes”, the script stops after each test allowing you to view the results. Oscilloscope setups are saved so that they can be modified if needed before resuming. On resuming the test, the new setup is recalled. Default is “No”.

Note: Any new acquisition made while QualiPHY is paused may cause the script to produce unexpected results.

Test Mode

Select whether to Acquire New Data or Use Saved Data for testing. The default value for this variable is Acquire New Data. If set to Use Saved Data, waveforms are recalled from the Saved Waveform Path folder.

Tx Negative Source

Specify the channel being used to measure Lane A Tx-. QPHY-PCIe3 Software Option 918801 Rev A 19

Tx2 Negative Source

Specify the channel being used to measure Lane B Tx-.

Tx Positive Source

Specify the channel being used to measure Lane A Tx+.

Tx2 Positive Source

Specify the channel being used to measure Lane B Tx+.

Vdiv

Set the V/div for the oscilloscope channels in use. The Max Tx voltage is 1300 mVpp. At FS, each side of the differential voltage should be at most 650 mVpp or ± 325 mV. An 85 mV Vertical scale (*8 divisions) defines the A-to-D voltage range to be between -340 mV and 340 mV.

Transmitter Test Variables

Deskew Measure Mode

Specify the method used for deskewing cables: Wizard Measured or User Defined. 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.

Skew (Txn, Txp) (in picoseconds)

Specify the cable skew between cables attached to Tx- and Tx+. The value (in picoseconds) is applied to the channel attached to Tx-. Skew calculation: Txp - Txn (edge crossing time).

Skew (Tx2p, Txp) (in picoseconds)

Specify the cable skew between cables attached to Tx2+ and Tx+. The value (in picoseconds) is applied to the channel attached to Tx2+. Skew calculation: Txp - Tx2p (edge crossing time).

Skew (Tx2n, Txp) (in picoseconds)

Specify the cable skew between cables attached to Tx2- and Tx+. The value (in picoseconds) is applied to the channel attached to Tx2-. Skew calculation: Txp - Tx2n (edge crossing time)

Test 1.4 Compliance Eye 8 GT/s Variables

Clock Slope

Specify the edges on which data transitions occur relative to the 100 MHz system reference clock. This variable pertains only to the system board CEM Compliance Eye. This variable is set to Pos by default.

CTLE DC Gain (dB)

Specify the DC Gain (dB) for the Continuous Time Linear Equalizer (CTLE).

Use CTLE?

Specify whether or not to apply Continuous Time Linear Equalization (CTLE). Default is “Yes”.

Use DFE?

Specify whether or not to apply Decision Feedback Equalization (DFE). Default is “Yes”.

PCIe 3.0 Base Test Limit Sets

The default installation contains only one limit set, called Compliance Limits. In this script, limits are only used to convey Unit labels. The actual limits for each value tested are encoded in or computed by the script and cannot be changed.

The limits used by QPHY-PCIE3-TX-RX script are specified in PCI Express Card Electromechanical Specification, Rev. 3.0.

PCIe 3.0 Transmitter & Receiver Testing

Test Preparation

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

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

Required Test Modes

The QualiPHY script requires that you place the DUT in the required test modes. The script will prompt you to do so before each test, but it is recommended that you ensure the DUT is capable of being placed in the required test modes before beginning testing.

Connecting to the BERT (for Rx Testing)

PeRT3

Follow the instructions in the PeRT3 manual to make the connection from oscilloscope to PeRT3. Set the PeRT3 below the oscilloscope to keep the connection cable length as short as possible.

Anritsu MP1900A

See Figure 5 for MP1900A calibration connections and Figure 6 for MP1900A RX CEM test connections.

PCIe 3.0 TX and RX Test Configurations

Test configurations include variable settings, limit sets, and test selections.

For detailed descriptions of calibration and testing, please refer to the Teledyne LeCroy PCIE 3.0 test procedure on PCISIG.com and the official test specification, PCI Express Card Electromechanical Specification, Rev. 3.0.

Add-In Card Calibration

This configuration runs the calibration step (only) for the Add-In Card test.

Add-In Card Calibration, Anritsu

This configuration runs the calibration step (only) for the Add-In Card test, preconfigured for using the Anritsu MP1900A BERT.

Demo Add-In Card TX

This configuration runs all transmitter tests using previously saved waveforms located on the oscilloscope in the Saved Waveform Path, with variables preconfigured for Add-in Cards. It is meant to easily demonstrate the QualiPHY capabilities when live signals cannot be tested.

Contact your Teledyne LeCroy representative to obtain the demo waveform files and instructions for loading them.

Add-In Card RX

This configuration includes two steps.

Step 1 is to perform RX calibration of the MP1900A by using the CBB3 and CLB3. Calibration includes the following parameters:

- Preset 0-10 plus -6 dB deemphasis/6 dB preshoot, and Amplitude
- RJ
- SJ
- Differential Mode Noise
- Eye Height and Eye Width

Calibration can be reused for multiple tests. The calibration table is saved under the path: D:\QPHY\Results. All results are saved with time stamped file name. The file with no time stamp is the latest result.

Within the same session, you will be prompted to run additional RX Tests (with a different preset). To use previous calibration results in a new session, uncheck the “RX Calibration” test group. If “RX Calibration” is deselected, you will be prompted to use the saved calibration.

Step 2 is to perform the actual receiver tolerance test using the calibrated values above. You will be promoted to select which preset to test with. The test criteria for RX compliance are to run BER with the calibrated stressed eye for 2:05 with one or no errors using any preset and pass 10e-4 BER using Preset 7 and Preset 8. If enabled, the script will vary the TX equalization around the selected preset, if the test does not pass at the selected preset. This should be enabled for system testing especially.

For 95% confidence level BER testing, the test criterion is to run BER with the calibrated stressed eye for 6 minutes and 15 seconds, with no errors.

Physical Setup

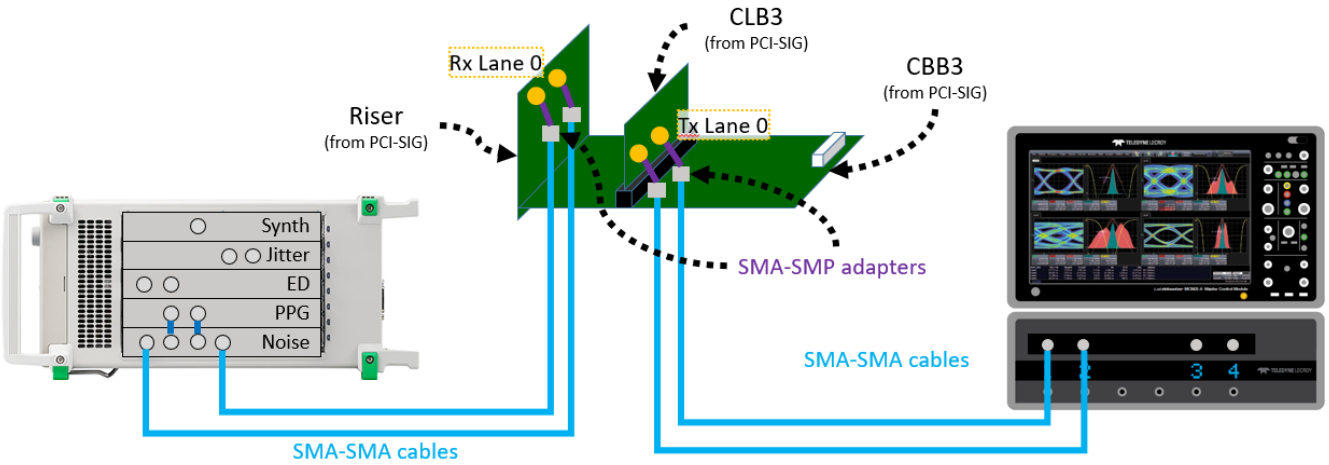


Figure 5 – Step 1 setup for Preset, Amplitude, RJ and SJ Calibration

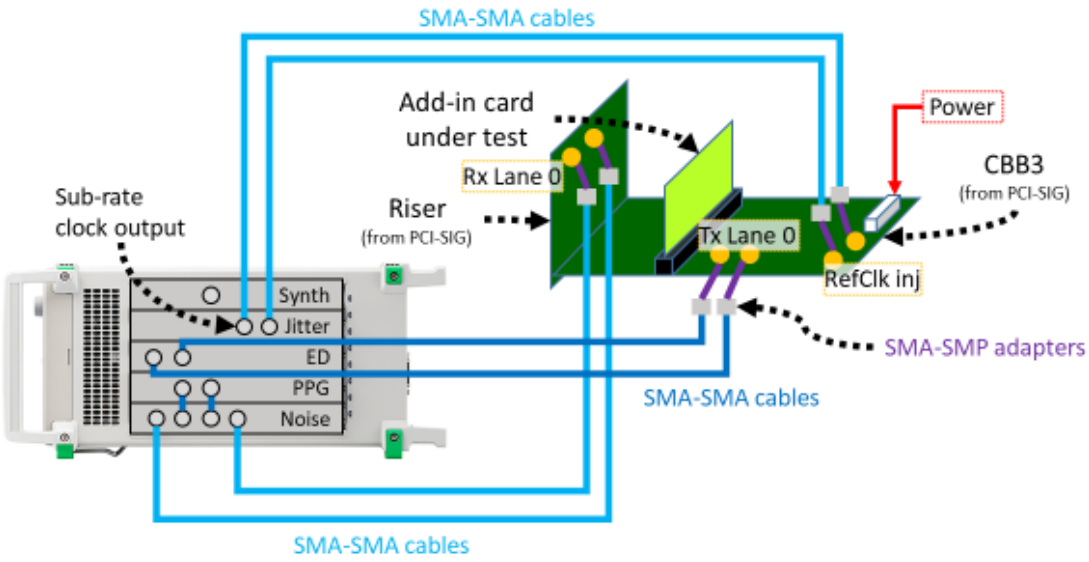


Figure 6 – Step 2 setup for actual RX CEM test

Add-In Card TX

This configuration will run the Add-In Card TX compliance tests using the CBB3 fixture. TX Compliance tests are performed using the SigTest software. SigTest uses raw waveforms (.trc) from the oscilloscope, embeds the reference channel, and applies the CTLE/DFE filter. Predefined configurations exist for testing 1, 4, 8, and 16-lane devices.

The test items are:

- Min Transition Eye Height
- Min NonTransition Eye Height
- Composite Eye Height
- Mean UI
- Max Pk-Pk Jitter
- Min Eye Width
- Tj
- Djdd
- Rj

Physical Setup

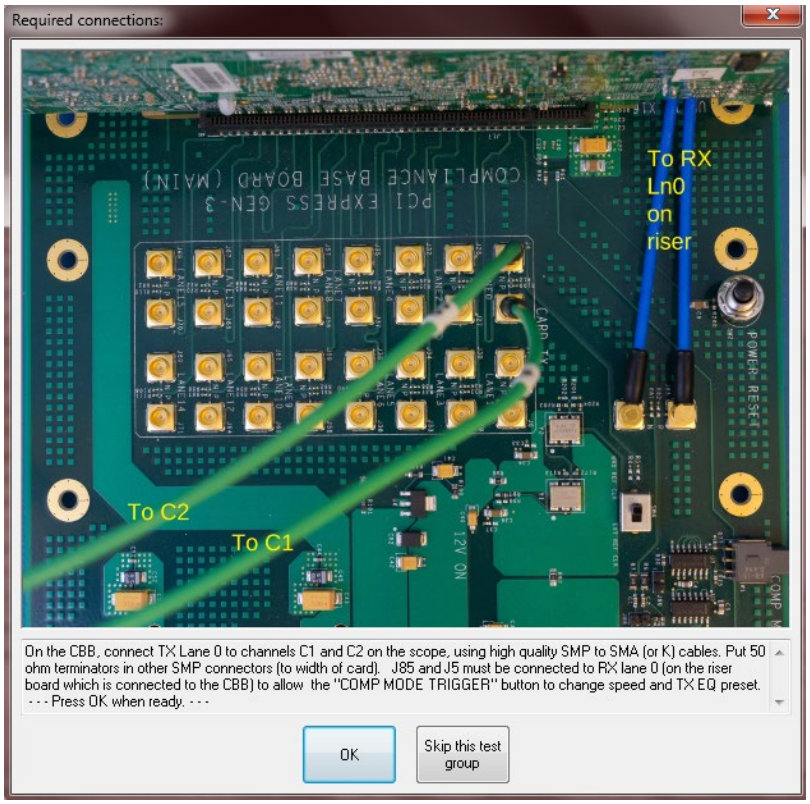


Figure 7 – Add-In Card TX connection diagram

Showing oscilloscope (green) and RX Ln0 (blue) physical connections

A toggle switch on the CLB controls the clock to RX lane0. Every time the switch is pressed, J5/J85 sends clock toggle to RX lane0, which will cause the compliance pattern to cycle to the next pattern.

The diagram below shows the location of the toggle switch (circled in red). The blue lines indicate the required SMP to SMP cable connections to allow the signal caused by pressing the toggle button to be coupled into the RX lane 0 that goes to the add in card.

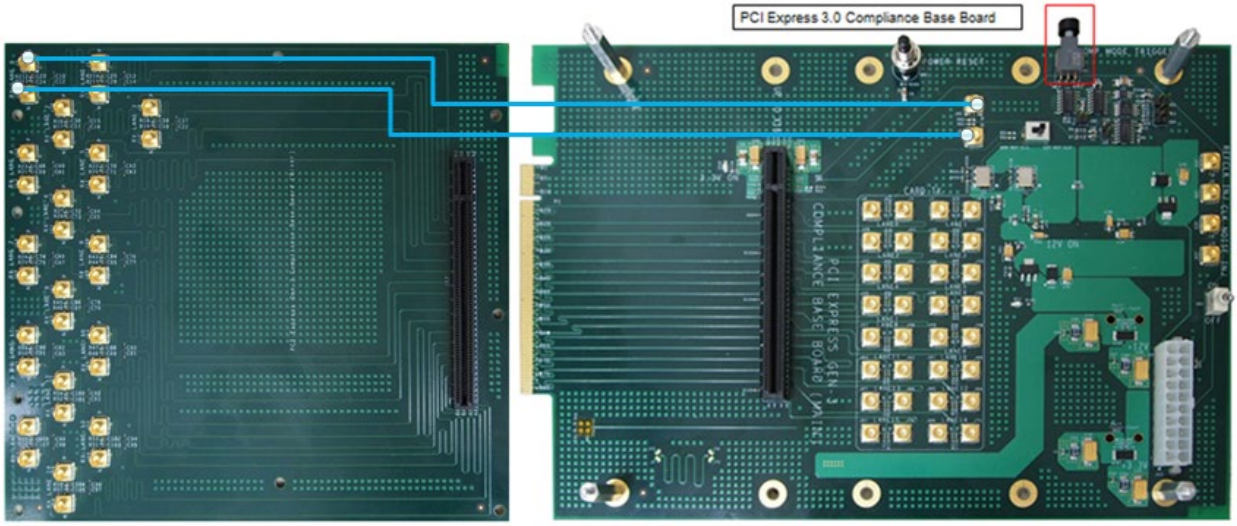


Figure 8 – Add-In Card TX connection diagram

Below are the built-in compliance patterns for all PCIE 3.0 Add-In Cards and Systems, starting from the first pattern after power up (2.5 Gbps 1.0 compliance pattern). The cycle repeats after pattern 14. Press the toggle sufficient times to go from the current pattern to the desired pattern.

1. 2.5 Gbps PCIe 1.0 compliance pattern
2. 5.0 Gbps PCIe 2.0 compliance pattern with 3.5dB deemphasis
3. 5.0 Gbps PCIe 2.0 compliance pattern with 6dB deemphasis
4. 8.0 Gbps PCIe 3.0 compliance pattern with preset 0
5. 8.0 Gbps PCIe 3.0 compliance pattern with preset 1
6. 8.0 Gbps PCIe 3.0 compliance pattern with preset 2
7. 8.0 Gbps PCIe 3.0 compliance pattern with preset 3
8. 8.0 Gbps PCIe 3.0 compliance pattern with preset 4
9. 8.0 Gbps PCIe 3.0 compliance pattern with preset 5
10. 8.0 Gbps PCIe 3.0 compliance pattern with preset 6
11. 8.0 Gbps PCIe 3.0 compliance pattern with preset 7
12. 8.0 Gbps PCIe 3.0 compliance pattern with preset 8
13. 8.0 Gbps PCIe 3.0 compliance pattern with preset 9
14. 8.0 Gbps PCIe 3.0 compliance pattern with preset 10

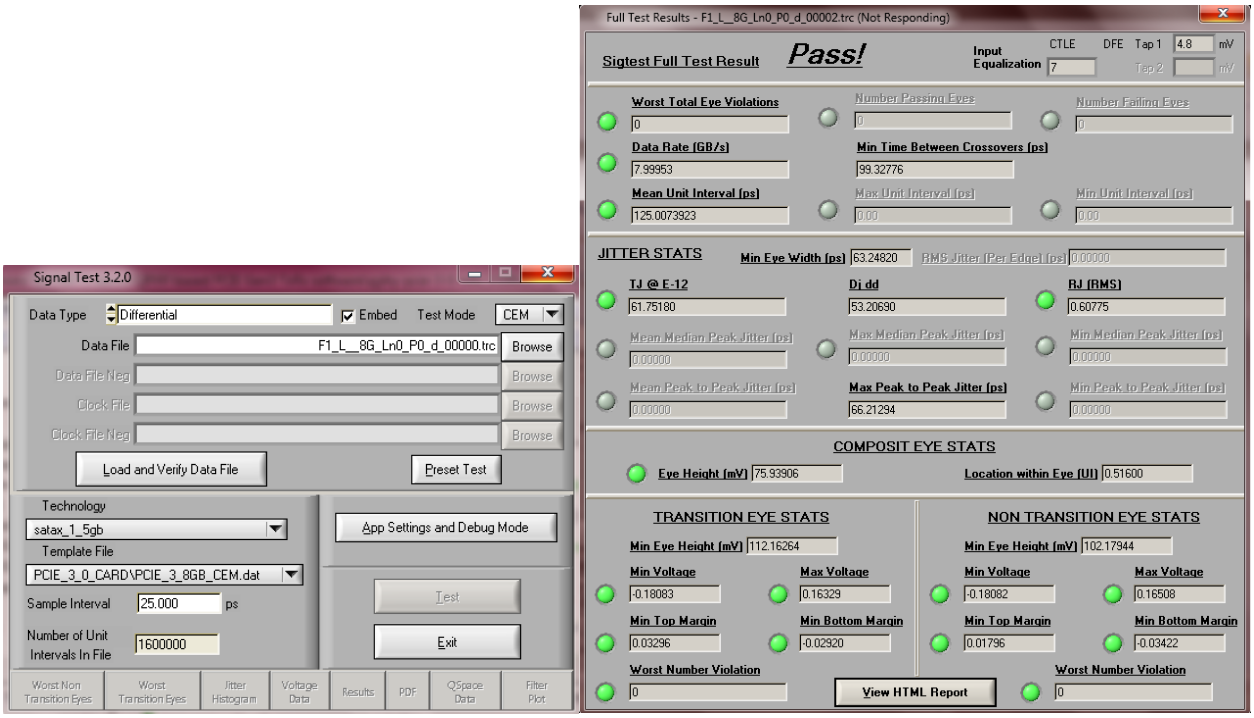


Figure 9 – Example SigTest dialog and SigTest results

System RX

This configuration includes two steps.

Step 1 is to perform RX calibration by using the CBB3 and CLB3. Calibration includes the following parameters:

- Preset 0-10 plus -6 dB deemphasis/6 dB preshoot, and Amplitude
- Rj
- Sj
- Differential Mode Noise
- Eye Height and Eye Width

Calibration can be reused for multiple tests. The calibration table is saved under the path: D:\QPHY\Results. All results are saved with a time stamped file name. The file with no time stamp is the latest result.

Within the same session, you will be prompted to run additional RX Tests (with a different preset). To use previous calibration results in a new session, uncheck “RX Calibration” group of tests. If “RX Calibration” is deselected, you will be prompted to use the saved calibration.

Step 2 is to perform the actual receiver tolerance test using the calibrated values above. The test criteria for RX compliance are to run BER with the calibrated stress eye for 2:05 with no errors using any Preset or cursor setting. You will be prompted to select the TXEQ setting as calibrated in step 1. If enabled, the script will vary the TX equalization around the selected preset, if the test does not pass at the selected preset. This should be enabled for system testing especially.

For 95% confidence level BER testing, the test time required will be 6 minutes and 5 seconds.

System TX

This configuration will set up for System TX compliance testing using the CLB3. Predefined configurations exist for testing 1, 4, 8, and 16-lane devices. TX Compliance tests are performed using the SigTest software. SigTest uses binary waveforms (.trc) from the oscilloscope, embeds the reference channel, and applies the CTLE/DFE filter. The wizard will instruct you to capture both data and clock from the system board.

The test items are:

- Min Transition Eye Height
- Min NonTransition Eye Height
- Composite Eye Height
- Mean UI
- Max Pk-Pk Jitter
- Min Eye Width
- Tj
- Djdd
- Rj

PCIe 3.0 TX and RX Test Variables

Run using saved waveforms?

When Yes, tests are run using previously saved waveform files stored in the <Saved Waveform Path>\SourceWaveforms (no timestamp) subfolder.

You will still be prompted with connection diagrams based on other variable selections.

Note: This should always be Yes when running any Demo configuration.

DUT Type

This variable determines which connection diagrams are shown, and (for TX) whether clock is saved and tested together with data. It does not affect RX calibration and only affects one connection diagram for TX testing.

Saved Waveform Path

Full path to the root oscilloscope folder where waveform files are saved/recalled.

After each run, waveforms acquired for testing are saved in \<DUTName>\SourceWaveforms. SigTest results are stored in \<DUTName>\SigTestAnalysis.

If you choose to save individual runs, multiple date-stamped subfolders are created.

Save individual runs?

When Yes, new date-stamped subfolders \<DUTName>\SourceWaveforms and<DUTName>\SigTestAnalysis will be created in the Saved Waveform Path after each acquisition.

When No, files in <DUTName>\SourceWaveforms and <DUTName>\SigTestAnalysis are overwritten after each acquisition.

SigTest Path

Full path to the installed version of SigTest.exe on the oscilloscope. The script runs SigTest on the oscilloscope, and fetches results from there for testing and inclusion in the log.

Splitters in use?

This variable specifies whether or not the test setup uses power splitters and that the signals seen by the scope are half the nominal signal amplitude. If the connection diagrams in the script are followed, splitters are not used.

State Machine for Test

State machine used for the test:

- Configuration goes directly to Loopback.
- Recovery goes to L0 (normal operating state), then to Loopback. Compliance testing requires using “Recovery.”

Pause after tests to review results?

When Yes, the script will pause after each test to allow you to review results on the oscilloscope display. You will be prompted to continue execution when ready.

Note: After initial setup, the script always stops to allow you to adjust channel V/div and Offset, independent of this variable.

PCIe Connector Type

Specifies the connector type in use on the DUT.

Initialize BERT Driver Variables

BERT Address

Hostname or IP address of the PeRT3 Server machine or Anritsu BERT, *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, or if you are using the Anritsu BERT, enter the IP address of that machine.

BERT In Use

Model of the PeRT3 or Anritsu BERT in use.

RX Calibration and Test Variables

Calibration Data Set Name

Identifier for the calibration data set. This can be the BERT’s serial number or any string that can be used to create a folder. Calibration files will be saved and recalled from a subfolder with this name.

Preset Cal X-Shift (Time in ps)

Time in picoseconds to shift measurement points away from center of UI, constrained to -30 to +30. A negative shift is expected to raise measured Vd, therefore reducing amplitude setting of PeRT3 by 800 mV. A positive shift is expected to lower measured Vd, therefore increasing amplitude setting of PeRT3 by 800 mV.

Pause to configure BERT?

Enables/disables a pause in script execution before initially linking in order to adjust the PeRT3 or MX183000A application.

Prompt to reset DUT?

Enables/disables prompts to reset or power cycle the DUT before each change of deemphasis or preshoot. Most DUTs do not require the reset, therefore default is No (disabled).

Search around preset?

If “No”, the RX test is done at the calibrated settings for the chosen preset.

If “Yes”, before the actual RX test, short tests are run at various levels of deemphasis and preshoot searching for the best BER to give you an opportunity to pass at some TX EQ setting close to the selected preset. The RX test is then done at the best settings found.

SKP Filter

Enables/disables the SKP Filter, which is needed for testing DUTs operating with the system/add-in card running on different clock domain than the test equipment. This option can also be enabled for synchronous test setups where the DUT is enabled to filter SKP symbols. On means that SKP is ignored by the BER test.

Test Type

Compliance runs for 2 minutes and 5 seconds (1e12 bits) limit with 0 or 1 error for pass criteria during RX BER testing. The 95% Confidence runs for 6 minutes and 15 seconds (3e12bits) limit with no errors for pass criteria, which is 95% confidence at 1e-12 BER testing.

TX CEM Test Variables

Number of TX Lanes

Number of lanes on which the DUT transmits (for purpose of TX test).

- 1-lane devices: only lane 0 is tested
- 4-lane devices: lanes 0 and 3 are tested
- 8-lane devices: lanes 0, 3 and 7 are tested
- 16-lane devices: lanes 0, 7, and 15 are tested

PCIe 3.0 TX and RX Test Limit Sets

The default installation contains only one limit set, called “Default.” In the PCIE3-TX-RX script, limits are only used to convey Unit labels. The actual limits for each value tested are encoded in or computed by the script and cannot be changed.

The limits used by the script are specified in the PCI Express Card Electromechanical Specification, Rev. 3.0.

PCIe 3.0 Link Equalization (LEQ) Testing

Test Preparation

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

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

Required Test Modes

The PCIE3LEQ script requires that you place the DUT in the required test modes. The script will prompt you to do so before each test, but it is recommended that you ensure the DUT is capable of being placed in the required test modes before beginning testing.

Physical Setup

See the description of each test configuration for specific set up information.

PCIe 3.0 LEQ Test Configurations

Test configurations include variable settings, limit sets, and test selections.

For detailed descriptions of calibration and testing, please refer to the Teledyne LeCroy PCIE 3.0 test procedure on PCISIG.com and the official test specification, PCI Express Card Electromechanical Specification, Rev. 3.0.

Add-in Card Calibration

Executes all calibration steps for Add-in Card testing.

Add-in Card LEQ Tests

Executes all Add-in Card LEQ tests at 8 GT/s.

Demo Add-in Card

Executes the 8 GT/s TX LEQ tests as a demonstration using previously saved waveform files stored in <Saved Waveform Path>\SourceWaveforms (no timestamp).

Contact your Teledyne LeCroy representative to obtain the demo waveform files and instructions for loading them.

Host Program Control Tests

Test configuration for use with Host Program Control. Runs calibration and LEQ tests for Add-in Cards.

System Calibration

Executes all calibration steps for System testing.

System LEQ Tests

Executes all System LEQ tests at 8 GT/s.

PCIe 3.0 LEQ Test Descriptions

Receiver Calibration Tests

This test group performs all RX calibration steps.

Preset Calibration

Calibrates amplitude, deemphasis and preshoot using a direct connection from the BERT to the oscilloscope.

Rj and Sj Calibration

Determines the relationship between Rj setting and measured value in order to choose the Rj and Sj settings to use when calibrating and testing. The step uses a direct connection from the BERT to the oscilloscope.

DM Calibration

Determines the relationship between the DM (Differential Mode noise/interference) setting and measured value in order to choose the DM setting to use when calibrating and testing.

Final Eye Calibration

Uses the channel riser/CBB/CLB and finds DM and SJ values required to obtain an eye with extrapolated Eye Height and Eye Width that are within the targets.

Receiver Link Equalization Tests

This group executes the RX LEQ test at 8 GT/s.

Note: An existing calibration set must be specified, or the calibration groups must be selected as well.

The first step, Transfer Calibration Settings to Anritsu MP1900A, is used to configure the MP1900A to execute the RX test. This is only required when executing the test from the MP1900A manually, rather than using QualiPHY to execute the test.

When executing 8 GT/s TX tests, the MP1900A will be configured such that this group need not be selected.

Transmitter Initial TX EQ Tests (AIC only)

This group executes the TX EQ preset test at 8 GT/s. Waveforms for this test are saved after executing the LTSSM into loopback, skipping phases 2 and 3 in order to command the add-in card to output a waveform using a specific preset. After all waveforms are acquired, the SigTest preset test is executed and the result file analyzed.

Transmitter Link Equalization Response Tests

This group executes the TX LEQ test at 8 GT/s.

PCIe 3.0 LEQ Test Variables

Basic Variables

+ Signal Channel

Channel used to input the positive side of the differential pair used during calibration and for traffic from the DUT in TX LEQ tests.

- Signal Channel

Channel used to input the negative side of the differential pair used during calibration and for traffic from the DUT in TX LEQ tests.

PCIE Connector Type

Specifies the connector type in use on the DUT.

DUT Type

Determines which connection diagrams are shown, Add-in Card or System, and (for TX testing) whether the clock is saved and tested together with data. It does not affect RX calibration and only affects one connection diagram for TX testing.

Saved Waveform Path

Full path to the root oscilloscope folder where waveform files are saved/recalled.

After each run, waveforms acquired for testing are saved in \<DUTName>\SourceWaveforms.
SigTest results are stored in \<DUTName>\SigTestAnalysis.

If you choose to save individual runs, multiple date-stamped subfolders are created.

Save individual runs?

When Yes, new date-stamped subfolders \<DUTName>\SourceWaveforms and <DUTName>\SigTestAnalysis will be created in the Saved Waveform Path after each acquisition.

When No, files in <DUTName>\SourceWaveforms and <DUTName>\SigTestAnalysis are overwritten after each acquisition.

SigTest Path

Path to the installed version of SigTest.exe on the oscilloscope.

Note: SigTest Version must be 3.2.0 or later.

Pause after tests to review results?

When Yes, the script will pause after each test to allow you to review results on the oscilloscope display. You will be prompted to continue execution when ready.

Note: After initial setup, the script always stops to allow you to adjust channel V/div and Offset, independent of this variable.

Run using saved waveforms?

When Yes, tests are run using previously saved waveform files stored in the <Saved Waveform Path>\SourceWaveforms (no timestamp) subfolder.

You will still be prompted with connection diagrams based on other variable selections.

Note: This should always be Yes when running any Demo configuration.

BERT Settings

BERT Type

Specifies the model of the PeRT3 or Anritsu BERT in use.

BERT IP Address

IP address of the Anritsu MP1900A or Teledyne LeCroy PeRT3.

Note: When PeRT3 is attached to the oscilloscope via USB, as is normally done, set address to localhost.

Calibration Data Set Name

Identifier for the calibration data set. This can be the BERT's serial number or any text string that can be used to create a folder. Calibration files will be saved and recalled from a subfolder with this name.

Pause to configure BERT?

Enables/disables pause in script execution before initially linking in order to adjust the PeRT3 or MX183000A settings.

Anritsu MP1900A Settings

Synthesizer Slot

Mainframe slot used for the Synthesizer module.

PPG Slot

Mainframe slot used for the PPG module.

Error Detector Slot

Mainframe slot used for the Error Detector module.

Jitter Modulation Slot

Mainframe slot used for the Jitter module.

DM Generator Slot

Mainframe slot used for the Noise Generator module.

Data Channel

BERT channel used to input the PPG module.

Error Detector Channel

BERT channel used to input the Error Detector module.

Host Program Control Variables

Sync File Name

Full path to the Sync file to be used for Host Program Control.

Enable Host Program Control?

Enables/disables Host Program Control using Sync file.

Receiver Calibration Variables

Preset Cal X-Shift (fraction of UI)

Fraction of the UI to shift the measurement points away from center of UI. Shifting the measurement point can affect the measured voltage, deemphasis and preshoot since the signals will vary across each UI.

Link Equalization Test Variables

Error Detector RX CTLE to Apply

CTLE value (in dB) for the Error Detector to apply to the signal. Allowed values are -12 to 0, inclusive.

Note: This variable applies to Anritsu MP1900A operation only.

Loopback Method

Specifies state machine applied. Configuration goes directly to Loopback and should be used for debug purposes only. Recovery goes to L0 (normal operating state), then to Loopback. Compliance testing requires using Recovery.

Receiver LEQ Test Variables

Continue after reaching max errors?

When Yes, the script will continue to run even after the maximum number of failures has been reached. Use only for debug purposes.

Preset to Use

Preset to use when performing loopback through Configuration state machine.

Transmitter LEQ Response Test Variables

Volts per Division (VDIV) for DUT Lane

Oscilloscope vertical resolution at which to acquire the DUT output. If the default value is insufficient due to channel loss, enter a value that yields a reasonable vertical resolution.

Volts per Division (VDIV) for PPG Lane

Oscilloscope vertical resolution at which to acquire the PPG output. If the default value is insufficient due to channel loss, enter a value that yields a reasonable vertical resolution.

Presets for Response Time Test

Comma-delimited list of the preset numbers to test. Enter the word All to test all presets required by the PCIe 4.0 CTS (Presets P0-P9). Presets are tested in the order listed. Repeats are allowed to facilitate repetitive testing.

Note: If fewer than 5 presets are tested, SigTest willl not give results.

Example 1: 1,4,7 tests presets 1, 4 and 7 in that order
Example 2: 3,3,3 tests preset 3 three times

Method for Setting Changed TXEQ

Method for configuring the DUT's changed preset for the response time test. Select Both to test as per the compliance test spec; select Preset Only for debugging purposes.

Both performs the response time test twice at each preset, first by commanding the DUT to set its TXEQ to specific presets, and then by requesting the cursor values reported by the DUT.

PCIe 3.0 LEQ Test Limit Sets

The default installation contains only one limit set, called Default. In the PCIE3LEQ script, limits are only used to convey Unit labels. The actual limits for each value tested are encoded in or computed by the script and cannot be changed.

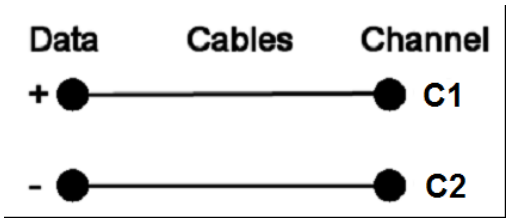
The limits used by the script are specified in the PCI Express Card Electromechanical Specification, Rev. 3.0.

Appendix A: Manual Deskewing Procedure

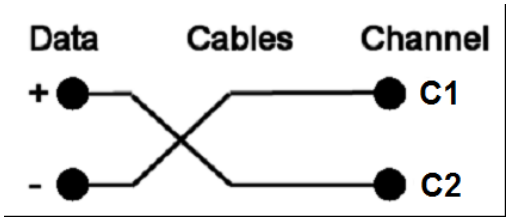
The following procedure demonstrates how to manually deskew two oscilloscope channels and cables using the differential data signal, with no need for any additional T-connector or adapters.

This can be done once the temperature of the oscilloscope is stable. The oscilloscope must be warmed up for at least 20 min. 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:

$$\frac{[\text{Data skew} + \text{cable skew} + \text{channel skew}] + [(-\text{Data skew}) + \text{cable skew} + \text{channel skew}]}{2}$$

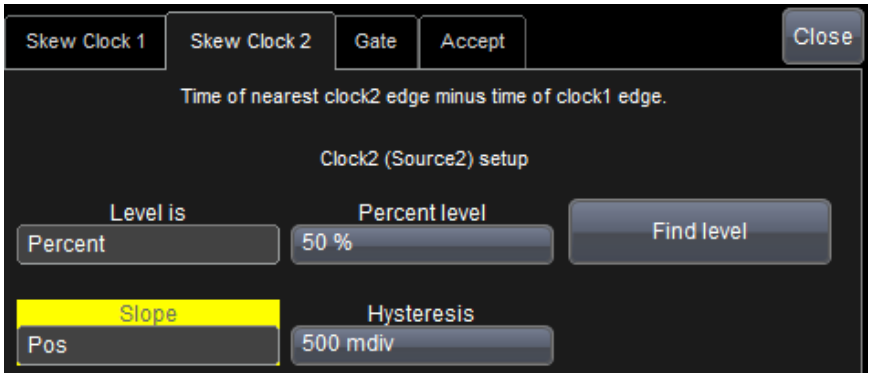
   The above formula simplifies to:

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

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.


Skew Clock 1
Skew Clock 2
Gate
Accept
Close
Time of nearest clock2 edge minus time of clock1 edge.
Clock2 (Source2) setup
Level is
Percent
Percent level
50 %
Find level
Slope
Pos
Hysteresis
500 mdiv

Appendix B: Using Host Program Control Mode

Note: Host Program Control Mode is available only for PCIe3 LEQ testing.

Host Program Control Mode (HPC) is a feature that allows QualiPHY to be started by a user's host program with a number of arguments. Once running, QualiPHY uses a simple "Sync File" protocol to signal the host program.

When the QualiPHY script requires action from the host program, it writes a User Sync File to the disk in .xml format containing several tags. QualiPHY then pauses execution and waits. The host program should set the requested DUT parameters or test system configuration, respond as necessary, then delete the User Sync File. When QualiPHY sees that the User Sync File is deleted, it continues execution.

In a QualiPHY PCIe script, there are three situations when a Sync File is written out:

1. When the user host program needs to change which signals are connected to the oscilloscope (typically utilized in systems involving an RF switch)
2. When the user host program needs to change the signal type output from the DUT (e.g., the signal's character rate)
3. When an error condition has occurred

In order to use Host Program Control Mode, the following considerations should be taken into account.

Preparing Special Configuration for Host Program Control Mode

In QualiPHY, create a custom Configuration that has the variables configured in the way you will need them when you run in Host Program Control Mode. Make sure you save the configuration after editing the variables so that it will be available to refer to when you startup QualiPHY via command line.

Variables that need to be considered to run in HPC are:

- **Host Program Control sync filename**
  - Definition: Use to specify sync file path.
  - Default: C:\PCIE3_sync_file.xml
  - Comments: Just use default unless conflict.
- **Use Host Program Control?**
  - Definition: Set to "Yes" to use the Host Program Control feature, "No" otherwise.
  - Default: No
  - Comment: When set to "Yes", QualiPHY will pause execution after it creates a sync file and while it is waiting for the sync file to be deleted.

Host Program Elements Needed to Control the QualiPHY Script

Launching QualiPHY (XReplay.exe)

The Host program needs to launch the QualiPHY application (the actual program is named XReplay.exe) with the following command line, including arguments for PCIE3.

The variable *script* refers to the standard you are running, either PCIE3LEQ or PCIE3RXTX (including Base):

```
C:\Program Files(x86)\LeCroy\XReplay\XReplay.exe –A –R –E –WIZARD – TECH:tecPCIE\script
–CONFIG:HostProgramControlTests –N:IP Address
```

The path shown above is where the XReplay.exe program (QualiPHY) is placed by the installer.

Arguments are:

`–A`	Stops all manual user interaction. (Always use)
`–R`	Causes the test script to be run automatically. (Always use)
`–E`	Automatically exit when test script is done executing. (Always use)
`–WIZARD`	Required.
`–TECH:tecPCIE\PCIE3LEQ`	Sets the technology to test, in this case PCIE3LEQ
`–CONFIG:HostProgramControlTests`	Sets the name of the configuration that will be used; HostProgramControlTests.
`–N:`*`IP Address`*	IP address of the oscilloscope: If QualiPHY is running on the oscilloscope, set to *localhost*. If QualiPHY is not running on the oscilloscope, set to *Host ID* or *IP Address* of the oscilloscope.

Monitoring for QualiPHY Termination

The host program needs to continuously test to see if the QualiPHY process still exists, to be able to know when the QualiPHY test script has completed and take appropriate action.

File Transfer Synchronization

The host synchronization consists of three parts:

1. Waiting for C:\PCIE3_sync_file.xml (or other name specified in configuration) to be written by QualiPHY.
2. Reading the file and performing the required actions.
3. Deleting C:\PCIE3_sync_file.xml in order to signal QualiPHY that the operation is complete.

Renaming the Test Report

The test report that is created by the QualiPHY test script is always created with the same name (for example, D:\QPHY\Reports\LeCroyReport.pdf). For this reason, it needs to be renamed after QualiPHY (XReplay.exe) terminates in order to avoid overwriting it the next time QualiPHY is run.

Note: The report path is C:\LeCroy\QPHY\Reports if QualiPHY is installed on a remote PC instead of the oscilloscope.

Sample Host Program

This sample Python host program performs all the essential tasks involved in launching and synchronizing with the test script. It is shown below and referred to in the text following it.

```
import time
import os
import shutil
import subprocess
import xml.etree.ElementTree as ET
import ctypes

def mbox(title, text, style = 0):
    '''
    message box with ok
    '''
    return ctypes.windll.user32.MessageBoxA(0, text, title, style)
def main():
    SyncFilePath = r'D:\QPHY\PCIe3LEQ_sync_file.xml'
    args_list = [r'C:\Program Files (x86)\LeCroy\XReplay\XReplay.exe', r'-A',
r'-R', r'-E', r'-WIZARD', r'-TECH:tecPCIE\PCIE3LEQ', r'-
CONFIG:HostProgramControlTests', r'-N:127.0.0.1']
    process =
subprocess.Popen(args_list,stdout=subprocess.PIPE,stderr=subprocess.PIPE,
shell=True)
    time.sleep(1)
    while process.poll() is None:
        time.sleep(1)
        if os.path.isfile(SyncFilePath) == True:
            file = open(SyncFilePath, 'r')
            xmlstring = file.read()
            file.close()
            root = ET.fromstring(xmlstring)
            #print XML tags
            print 'Check XML tags'
            for child in root:
                print (child.tag)
            #print tag if text exists
            print 'Check XML text'
            for child in root:
                if child.text != None:
                    print (child.text)
            #send prompt if connectionsReq has text
            print 'Pause if connection change required'
```

```
            for child in root:
                if child.tag == 'connectionsReq':
                    if child.text != None:
                        mbox('Pause for Connections', child.text)
                    else:
                        print 'No Connections required'
            #send prompt if error detected
            print 'Pause if error detected'
            for child in root:
                if child.tag == 'error':
                    if child.text != None and child.text!= '0':
                        mbox('Error!!', child.text)
            ###other actions based on XML may be performed here###
            try:
                os.remove(SyncFilePath)
            except:
                pass
    args_list_report = [r'C:\Program Files
(x86)\LeCroy\XReplay\XReplay.exe',r'-D',r'-WIZARD']
    process =
subprocess.Popen(args_list_report,stdout=subprocess.PIPE,stderr=subprocess.PIP
E, shell=True)
    time.sleep(1)
    print 'Generating Report...'
    while process.poll() is None:
        time.sleep(3)
    # Check for report and rename if present
    ReportPathSource = r'D:\Qphy\Reports\LeCroyReport_Auto.pdf'
    ReportPathDest = r'D:\Qphy\Reports\PCIe3LEQ_Test_Results.pdf'
    if os.path.isfile(ReportPathSource) == True:
        try:
            shutil.move(ReportPathSource, ReportPathDest)
        except:
            print 'Error renaming report'
    else:
        print 'File not found'
    done = "Host Program Control python example script complete"
    return done
end = main()
print end
```

HPC Sync File

Sync File Tags

The Host Program Control synchronization file includes the following tags:

- **connectionsReq**: describes the connections that should be made.
  - When instructed to, connect bert output channels to the oscilloscope input channels.
  - Example: **"C1, C2, Data_Out1, Data_Out1-bar"**
- **error**: includes an error code. Refer to the "detail" field for information about the error.
- **detail**: gives additional information, especially in situations where the error code is 0, which would indicate an issue. Example: "No trigger: Trigger timed out. Is signal present and trigger set correctly?"

Sample XML Sync Files

Request to change the connections

```
<TestConfig>

<connectionsReq>C1, C2, Data_Out1, Data_Out1-bar</connectionsReq>

<detail>Connect a matched pair of 1-meter high quality SMA cables from the Data
Output1 and Data Output1-bar outputs of the Noise Module to the channels configured
in the variables dialog (C1 and C2).</detail>

<error>0</error>

</TestConfig>
```

Request to check error condition

```
<TestConfig>

<connectionsReq/>

<detail>No trigger: Trigger timed out. Is signal present and trigger set
correctly?</detail>

<error>3</error>

</TestConfig>
```

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