



QPHY-PCIE (Gen 1 and 2) Operator's Manual

Revision A – March, 2014

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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-PCIE software option. Some of the images in this manual may show QualiPHY products other than QPHY-PCIE, 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 a 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 “framework” application that enables the configuration and control of separate tests for each standard through a common user interface. Features include:

- **Multiple Data Source Capability:** Connect to your X-Stream oscilloscope via LAN or other interfaces.
- **User-Defined Test Limits:** Parameter interconnect losses can be factored into the parametric results.
- **Flexible Test Results Reporting** that includes XML Test Record Generation. Understand a device performance distribution, or obtain process related information from the devices under test.

About QPHY-PCIE

QPHY-PCIE is an automated test package performing all the normative, real-time oscilloscope tests for sources 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 6 GHz bandwidth for 2.5 GT/s testing and 13 GHz for 5.0 GT/s testing.

Required Hardware

- Real-time Teledyne LeCroy oscilloscope with the QualiPHY software and an activated QPHY-PCIE component
- 2 pair standard SMA-SMA cables for Gen 1 fixtures
- 1 pair standard SMA-SMP cables for Gen 2 fixtures
- PCIE base board (CBB) for testing system boards
- PCIe load board (CLB) for testing add-in cards

For the most complete and up-to-date list, see the PCI SIG website:

www.pcisig.com/specifications/pciexpress/compliance

Test Fixtures

The PCI Express standard describes a set of two fixtures used for connection to the signal under test: the compliance load board (CLB) used to test system boards and the compliance base board (CBB) used to test add-in cards. Both the CLB and CBB are available through the PCI special interest group (PCI-SIG) at www.pcisig.org. Fixtures that are compliant with Revision 1.1 of the Base and CEM Specifications are required to execute QPHY-PCIe tests for Gen 1 add-in cards and system boards; likewise, fixtures compliant with Revision 2.0 of the specifications are required to execute tests for Gen 2 devices.

Using SMA type cables with the Gen 1 fixtures, or SMA-to-SMP type cables with the Gen 2 fixtures, allows positive and negative line attachment of the differential signals directly to separate channels on the instrument. The fixtures are designed to apply the compliance test load to the ports of the device under test. The CBB provides a 100 MHz system clock used by add-in cards plugged into the fixture and a socket for a standard ATX power supply.

The 50 Ω impedance on each oscilloscope channel provides the proper loading for compliance testing. All PCI Express add-in cards and system boards must transmit a standard compliance pattern when loaded with 50 Ω to ground on each line – all while no signal is being received.

The compliance load board (CLB1) provides probing access for 1, 4, 8 and 16 lane connectors that connect to Gen 1.1 system boards. This is used for testing system boards that only perform at 2.5GT/s.

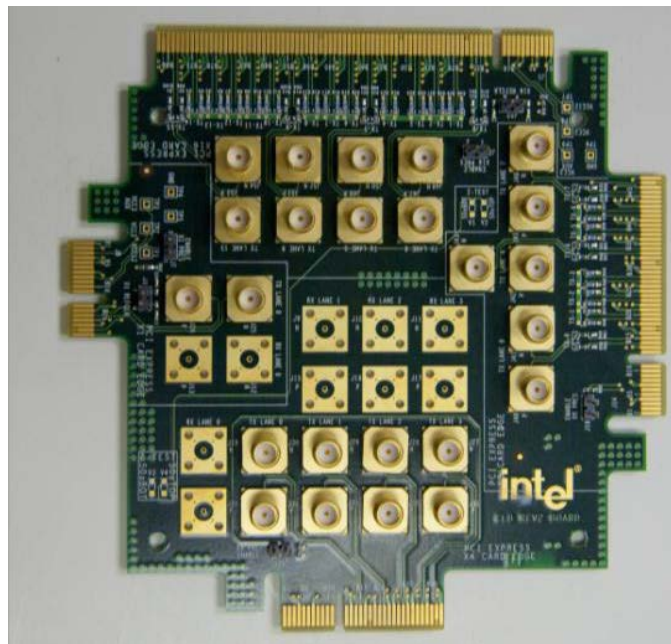


Figure 1. Compliance Load Board for 1, 4, 8 and 16 lane connectors (CLB1).

The compliance base board (CBB1) provides probing access for 1, 4, 8 and 16 lane connectors that connect to Gen 1.1 add-in cards. This is used for testing add-in cards that only perform at 2.5GT/s.

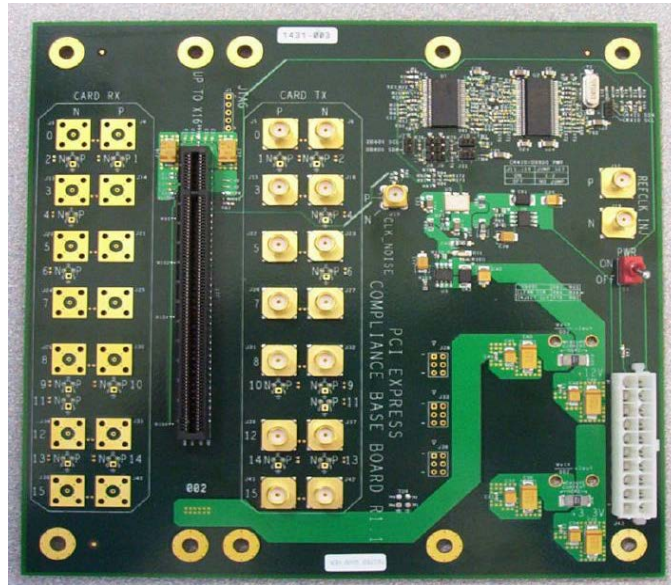


Figure 2. Compliance Base Board for 1, 4, 8 and 16 lane connectors (CBB1).

The compliance load board (x1/x16 CLB2) provides probing access for 1 and 16 lane connectors that connect to Gen 2.0 system boards.

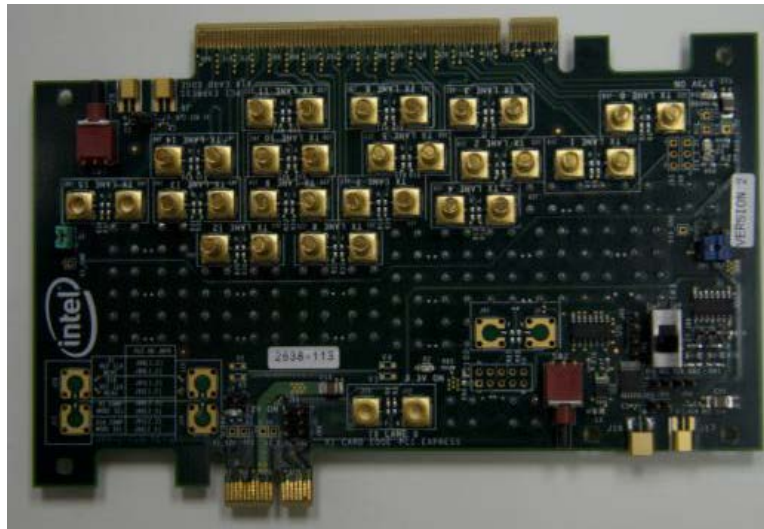


Figure 3. Compliance Load Board for 1 and 16 lane connectors (x1/x16 CLB2).

The compliance load board (x4/x8 CLB2) provides probing access for 4 and 8 lane connectors that connect to Gen 2.0 system boards.

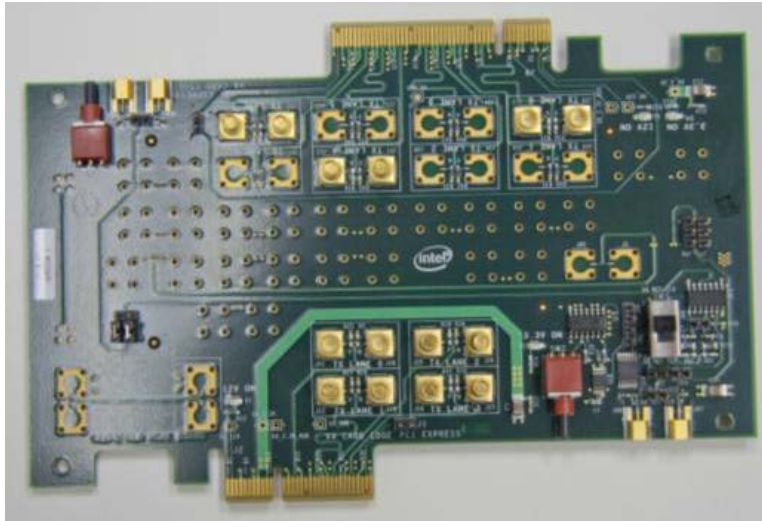


Figure 4. Compliance Load Board for 4 and 8 lane connectors (x4/x8 CLB2).

The compliance base board (CBB2) provides probing access for 1, 4, 8 and 16 lane connectors that connect to Gen 2.0 add-in cards. Also, the CBB2 provides a clean reference clock and clock noise injection capabilities.



Figure 5. Compliance Base Board for 4 and 8 lane connectors (CBB2).

Required Host Computer System

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:
 - o Windows 2000 Professional with service pack 4
 - o Windows XP Professional with service pack 2
 - o Windows VISTA with service pack 1
 - o Windows 7 Professional
- 1 GHz or faster processor
- 1 GB (32-bit) or 2 GB (64-bit) of RAM
- Ethernet (LAN) network capability
- Hard Drive:
 - o At least 100 MB free to install the framework application
 - o Up to 1GB per standard installed to store the log database (each database grows from a few MB to a maximum of 1 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 with at least 30MB free space, 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.

Note: Any previous installations of X-Replay, the QualiPHY base application, are overwritten during the installation process.

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 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 or Getting Started 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.

Note: LXI, GPIB, LSIB, and USBTMC remote control is available for some model instruments. Follow the same procedure, selecting the appropriate connection type on the oscilloscope and in QualiPHY.

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, using examples from the QPHY-BroadR-Reach option. For detailed information about the QPHY-PCIE software option, see [QPHY-PCIE 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 framework 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.

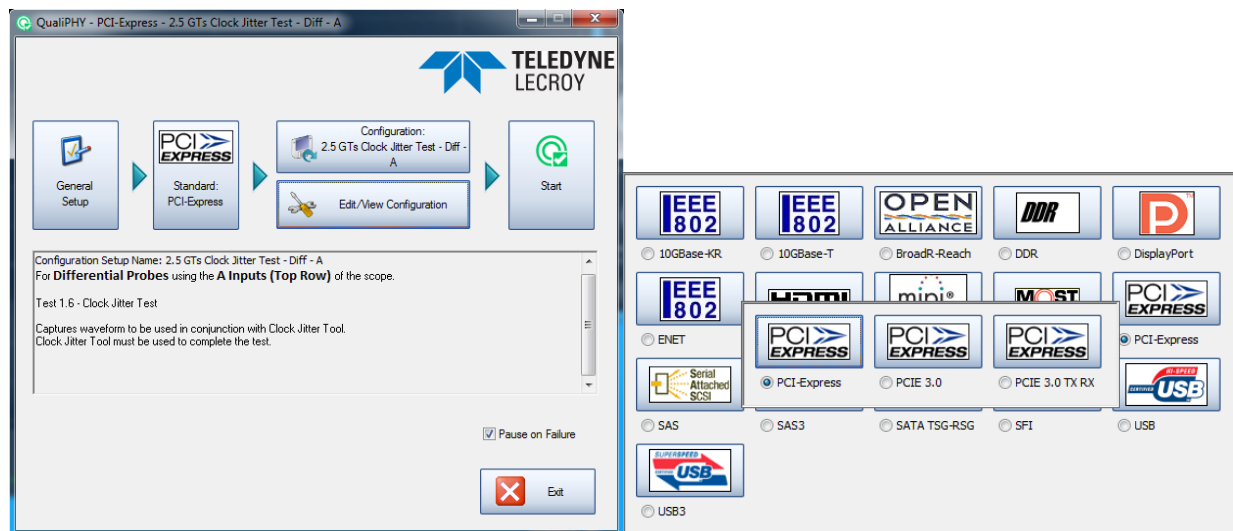


Figure 6 - QualiPHY framework dialog and Standard selection menu.

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 framework 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 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.

Report tab

Settings related to report generation. Choose:

- **Reporting behavior** of:
 - o “Ask to generate a report after tests,” where you’ll be prompted to create a new file for each set of test results.
 - o “Never generate a report after tests,” where you’ll need to manually execute the Report Generator to create a report.
 - o “Always generate a report after tests,” to autogenerate a report of the latest test results.
- **Default** report output format 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 [QPHY-PCIE Testing Physical Setup](#).
2. Access the QualiPHY software to display the framework 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 activated on the oscilloscope are enabled for selection.

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. See [QPHY-PCIE Test Configurations](#) for a description of your configurations.

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 framework dialog.

Run Tests

1. On the framework 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 window 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 framework 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**

Run Reports

The QualiPHY software automates report generation. On the framework dialog, go to **General Setup > Report** to pre-configure reporting behavior. You can also manually launch the **Report Generator** from the framework dialog.

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.



PCIE 3.0 TX RX Test Report

Overall result: **PASS**

DUT: Modified_Script
 Comment: 02/27/2014 15:50:26
 Operator: HAW
 Temperature: 0° C
 Standard in use: PCIE 3.0 TX RX

Run 1:
 Time of run: 2014/02/27 15:50:28
 Configuration in use: System RX
 Limits in use: Default
 Oscilloscope Name: LCRV0439N69276 Model: SD483021-A
 Oscilloscope Serial #: LCRV0439N69276
 Computer: LCRV0439N69276
 Oscilloscope firmware version: 7.3.1.3a (Build 196056)
 QualiPHY core version: 7.3.1.3 (Build 194698)

QualiPHY script version: 1.1.0.287
 Stylesheet version: 1.2.0.6

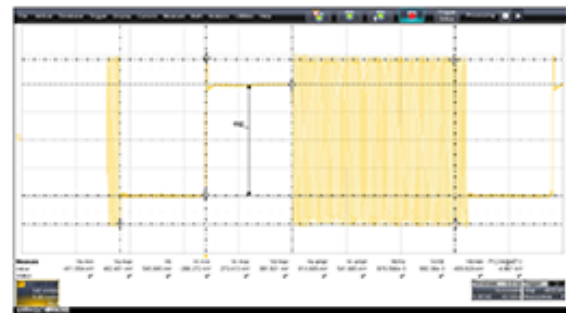


Summary Table

[Hide Table]

Pass	Run #	Test	Measurement	Current Value	Test Criteria
✓	1	1.0	P0 calibration succeeded	Succeeded	info
?	1	1.0	P0 PeRT amplitude setting for 800mV	0.802V	Informational Only
?	1	1.0	P0 PeRT de-emphasis setting for -5dB	-5.900dB	Informational Only
?	1	1.0	P0 PeRT preshoot setting for 0dB	0.500dB	Informational Only
✓	1	1.1	P1 calibration succeeded	Succeeded	info
?	1	1.1	P1 PeRT amplitude setting for 800mV	0.799V	Informational Only
?	1	1.1	P1 PeRT de-emphasis setting for -3.5dB	-3.600dB	Informational Only
?	1	1.1	P1 PeRT preshoot setting for 0dB	0.400dB	Informational Only
✓	1	1.2	P2 calibration succeeded	Succeeded	info
?	1	1.2	P2 PeRT amplitude setting for 800mV	0.799V	Informational Only
?	1	1.2	P2 PeRT de-emphasis setting for -4.5dB	-4.600dB	Informational Only
?	1	1.2	P2 PeRT preshoot setting for 0dB	0.300dB	Informational Only
✓	1	1.3	P3 calibration succeeded	Succeeded	info
?	1	1.3	P3 PeRT amplitude setting for 800mV	0.800V	Informational Only
?	1	1.3	P3 PeRT de-emphasis setting for -2.5dB	-2.800dB	Informational Only
?	1	1.3	P3 PeRT preshoot setting for 0dB	0.400dB	Informational Only
✓	1	1.4	P4 calibration succeeded	Succeeded	info
?	1	1.4	P4 PeRT amplitude setting for 800mV	0.795V	Informational Only
?	1	1.4	P4 PeRT de-emphasis setting for 0dB	-0.800dB	Informational Only
?	1	1.4	P4 PeRT preshoot setting for 0dB	0.400dB	Informational Only

✓	Pass	Measurement: P0 calibration succeeded	Unit Name: info	Current Value: Succeeded	Test Criteria: info	Timestamp: 02/27/2014 15:54:00	Run Number: 1	Description: P0 calibration status
?	?	Measurement: P1 PeRT amplitude setting for 800mV	Unit Name: 7. computed	Current Value: 0.799V	Test Criteria: Informational Only	Timestamp: 02/27/2014 15:54:00	Run Number: 1	Description: P1 PeRT calibration amp setting
?	?	Measurement: P1 PeRT de-emphasis setting for -3.5dB	Unit Name: 8B. computed	Current Value: -3.600dB	Test Criteria: Informational Only	Timestamp: 02/27/2014 15:54:00	Run Number: 1	Description: P1 PeRT calibration de-emphasis setting
?	?	Measurement: P1 PeRT preshoot setting for 0dB	Unit Name: 8B. computed	Current Value: 0.400dB	Test Criteria: Informational Only	Timestamp: 02/27/2014 15:54:00	Run Number: 1	Description: P1 PeRT calibration preshoot setting



Test 1.1 - P1 cal
 Timestamp: 02/27/2014 15:54:00

Figure 7 - The Test Report Summary and Details pages.

Reports are output to the base installation folder *\\LeCroy\\XReplay\\Reports.

You can add your own logo to the report by replacing the file *\\LeCroy\\XReplay\\StyleSheets\\CustomerLogo.jpg.

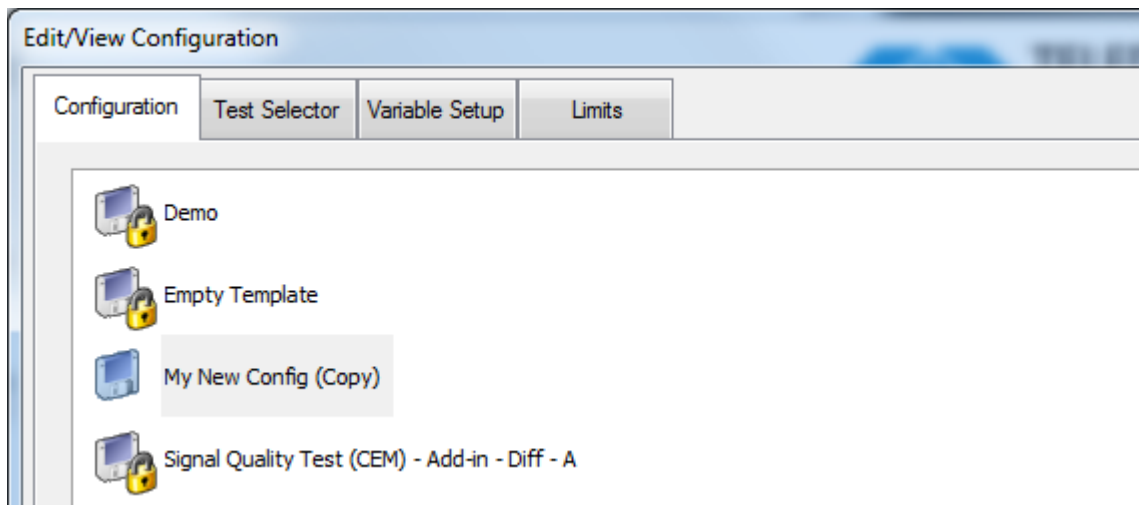
The recommended maximum size is 250x100 pixels at 72 ppi, 16.7 million colors, 24 bits. Use the same file name and format.

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 framework 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).”



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.

Select Tests

On the **Test Selector** tab, select/deselect 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.

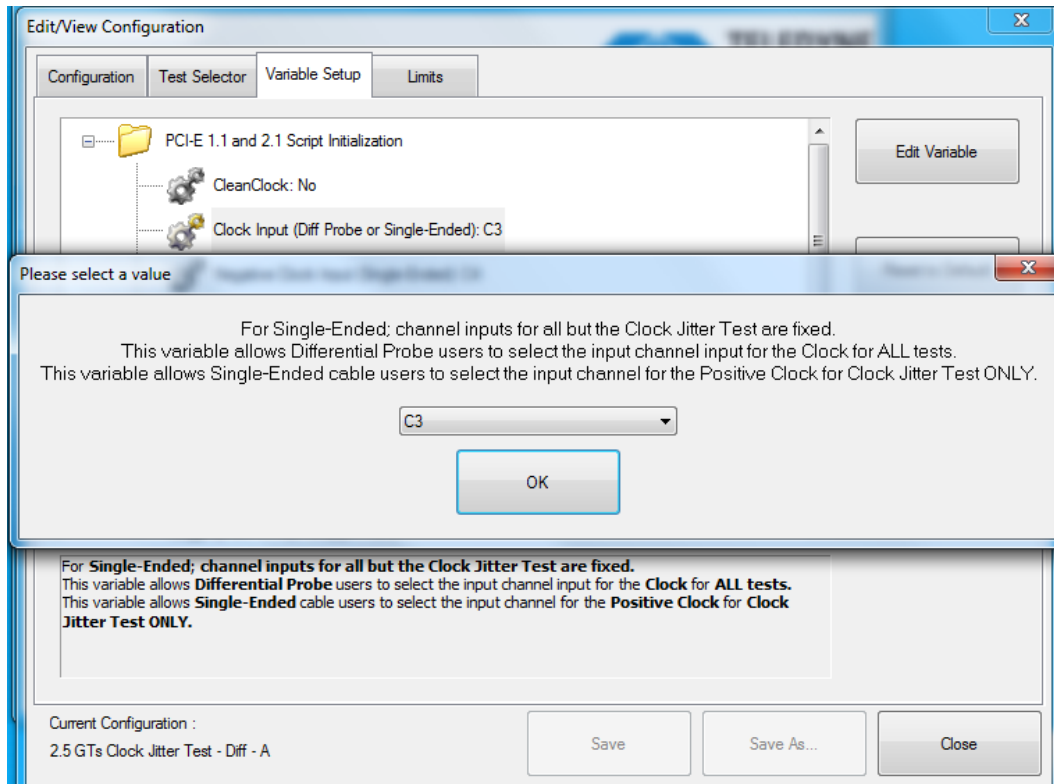
To loop any of the tests in this configuration, select the test from the list, then choose to loop indefinitely until stopped or enter the number of repetitions.

Edit Variables

The Variable Setup tab contains a list of test variables. See [QPHY-PCIE Variables](#) for a description of each.

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.)
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.

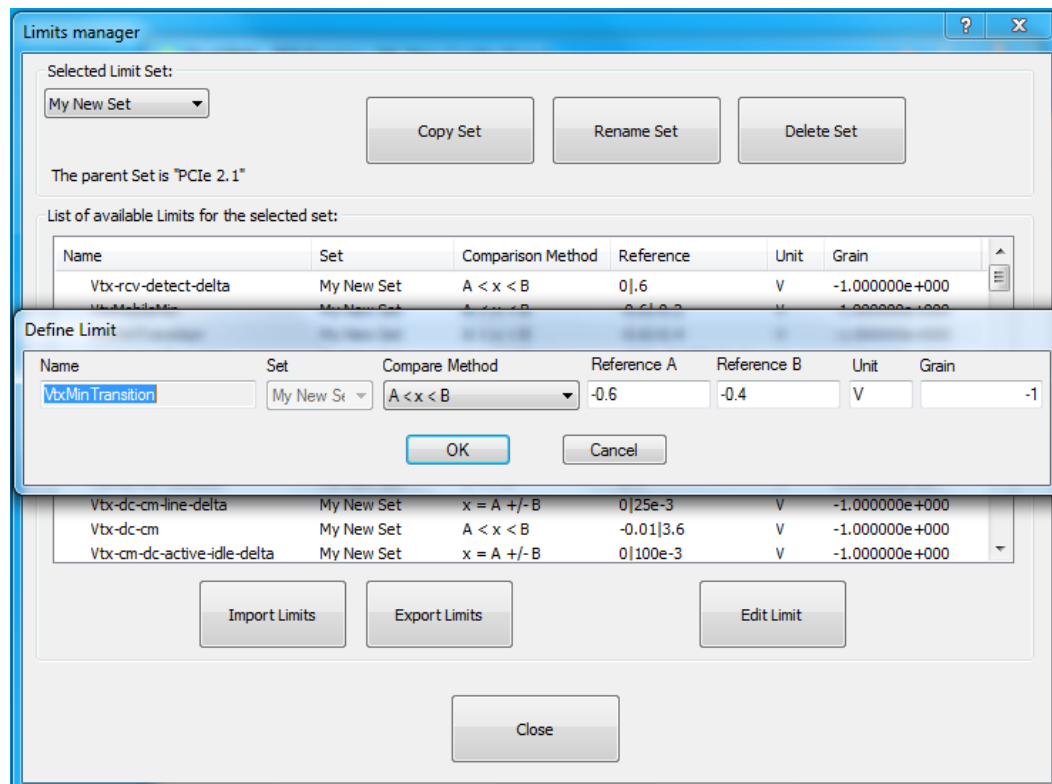
The Limits Manager shows the settings for every test limit in a limit set. Those in the default Compliance Limits set are the limits defined by the standard.

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 PCIE 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. 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.

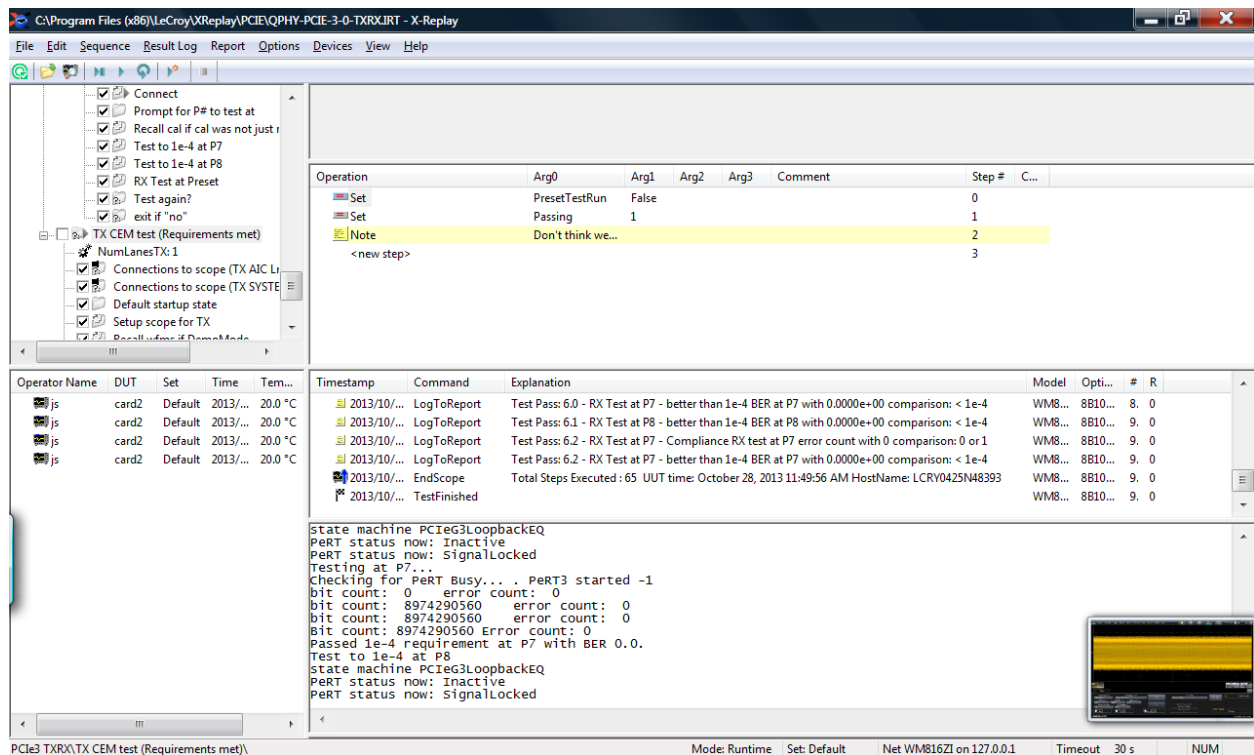


Figure 8 – X-Replay Mode window.

QPHY-PCIE Testing

Test Preparation

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

Calibration is automatic under software control and no manual calibration is required. This procedure will be run again if the oscilloscope temperature changes by more than a few degrees.

Required Test Modes

The QPHY-PCIE 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.

QPHY-PCIE 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 Gen1 and Gen2 test procedures on PCISIG.com and the official test specification, PCI Express Card Electromechanical Specification, Rev. 3.0.

2.5 GTs Clock Jitter Test

This configuration runs only Test 1.6 Clock Jitter for 2.5Gbps signals. Variations exist for different source configurations: differential inputs on Input A or Input B, and single inputs on Input A or Input B. This test requires the use of the PCI Express Clock Phase Jitter Test Software, which can be downloaded from:

http://www.pcisig.com/specifications/pciexpress/compliance/compliance_library

Demo

This configuration runs all the Transmitter tests using waveforms saved on the oscilloscope in D:\PCIE\Demo and the default limit set, Compliance Limits. This configuration is meant to easily demonstrate the QPHY-PCIE capabilities when live signals cannot be tested. You will see dialogs and connection diagrams similar to what you would see during an actual test.

Empty Template

This configuration includes all tests and default variable settings specified in the PCIe standard. It is meant to serve as a basis for creating custom configurations. The limit set in use is PCIe 2.1. Copy and save it with a unique name, then follow the steps in [Customizing QualiPHY](#) to modify the new configuration.

Signal Quality Test (CEM), Add-in Card

This configuration is meant to run all of the transmitter tests on a PCIe Add-In card. All the variables are set to default, except Device Type is set to "Add-In" and CleanClock is set to "Yes". The limit set used is PCIe 2.1. Both 2.5Gbps and 5.0Gbps Signal Quality tests are run.

Variations exist for different source configurations: differential inputs on Input A or Input B, and single inputs on Input A or Input B.

Signal Quality Test (CEM), System

This configuration is meant to run all of the transmitter tests on a PCIe System board. All the variables are set to default. The limit set is use is PCIe 2.1. Both 2.5Gbps and 5.0Gbps Signal Quality tests are run. Variations exist for different source configurations: differential inputs on Input A or Input B, and single inputs on Input A or Input B.

QPHY-PCIE Test Descriptions

2.5 GT/s Signal Quality Tests

These tests use the "PCIe Compliance" Signal Type selection from the SDA II analysis software. When "PCIe Compliance" is selected, SDA II uses the SigTest DLL in the background to generate the Eye Diagrams and the Jitter results. This can only be done using 2.5GT/s signals.

- Mean Unit Interval
- Max Unit Interval
- Min Unit Interval
- Min Time Between Crossovers
- Data Rate
- Per Edge RMS Jitter
- Mean Median to Peak Jitter
- Max Median to Peak Jitter
- Min Median to Peak Jitter
- Mean peak-to-peak jitter
- Max peak-to-peak jitter
- Min peak-to-peak jitter
- Minimum transition eye voltage
- Maximum transition eye voltage
- Minimum non-transition eye voltage
- Maximum non-transition eye voltage
- Minimum transition eye voltage margin above eye
- Minimum transition eye voltage margin below eye
- Minimum non-transition eye voltage margin above eye
- Minimum non-transition eye voltage margin above eye
- Transition eye mask violations
- Non-transition eye mask violations
- Minimum Eye Width
- Differential peak to peak voltage

5.0 GT/s Signal Quality Tests

The following tests are run on the 5.0GT/s compliance pattern with 3.5dB of de-emphasis and also with 6.0dB of de-emphasis.

- Mean Unit Interval
- Min Time Between Crossovers
- Data Rate
- Max Peak to Peak Jitter
- Total Jitter at BER of 10^{-12}
- Deterministic Jitter Delta-Delta
- Random Jitter (RMS)
- Minimum Transition Eye Voltage
- Maximum Transition Eye Voltage
- Minimum Non Transition Eye Voltage
- Maximum Non Transition Eye Voltage
- Minimum Transition Eye Voltage Margin Above Eye
- Minimum Transition Eye Voltage Margin Below Eye
- Maximum Non Transition Eye Voltage Margin Above Eye
- Maximum Non Transition Eye Voltage Margin Below Eye
- Mask Violations Transition Eye
- Mask Violations Non Transition Eye

These tests use the SigTest analysis package that is built into the oscilloscope software. The SigTest settings are set to be the same as when the SigTest software runs independently.

- Bit Rate = 5.0 GHz
- BER = 10^{-12}
- Eye Type = Monochrome
- UIsPerEye = 1.67UI
- Jitter Filter Settings
 - o Order = Brick Wall
 - o Corner Freq = 1.5 MHz
 - o Damping = 707.11×10^{-3}
 - o Extra Pole = 0 Hz
 - o Delay = 0 fs
- Standard = PCIe2.0 Compliance
- Masks
 - o System Testing = System Dual Port 250mV
 - o Add-in Card 3.5dB Testing = Add-in card 3.5dB
 - o Add-in Card 6.0dB Testing = Add-in card 6.0dB

QPHY-PCIE Variables

CLEAN CLOCK

This variable allows the user to select whether or not they are using a clean clock. This variable maps directly to the clean clock variable in SigTest. When set to Yes, this variable guarantees that the clock does not have SSC and is known to be good. This variable should be set to Yes for add in card testing (using a CBB, which generates the clock), and No for a system board test (because the System board generates the clock). This control is only of use in the 2.5GT/s testing. The new SigTest algorithm for 5G does not ask for this input. The default value for this variable is No.

DESKEW VALUE IN PICOSECONDS

This variable allows the user to specify the channel + cable deskew between channels C2 and C3. The value is in picoseconds and is applied to the channel C2. This value is only applied to C2 if "User Defined" is selected for the Deskew measure mode method variable.

DESKEW MEASURE MODE METHOD

This variable allows the user to select the method for deskewing their cables. The choices for this variable are "Wizard Method" and "User Defined." "Wizard Measured" is used to launch the automated deskew measurement. "User Defined" is used if the user would like to set the Deskew value in picoseconds variable when the deskew value is already known. The default value for this variable is "Wizard Method."

DEVICE TYPE

This variable allows the user to select whether device type is a System Board or an Add-in Card. When testing System Boards both the clock signal and the data signal must be captured simultaneously. When testing Add-In Cards only the data signal is required for testing. The default value for this variable is System.

FORMFACTOR

This variable allows the user to select whether their form factor is Desktop or Mobile. This variable maps directly to the form factor variable in SigTest. The default value is Desktop.

SAVED WAVEFORM PATH

This variable allows the user to specify the path that saved waveforms are recalled from when running in demo mode or when TestMode is "Use Saved Data." The default value for this variable is "D:\Waveforms\PCIe."

Waveforms are saved in a directory with the name of the Device Under Test, under this path.

The saved waveforms have a channel name prefix (such as "C2") followed by the bit rate, deemphasis setting, and lane number; and the extension ".trc". For example:

C2_2.5GT_3.5dB_L0.trc. If the Test Mode variable is set to Use Saved Data the script will look for files in the appropriate directory and with exactly these names, to repeat the tests using previously saved data.

TEST MODE

This variable allows the user to decide whether the tests should be run on newly acquired data or if previously saved waveforms should be used. The choices for this variable are "Acquire New Data" and "Use Saved Data." If "Use Saved Data" is selected, the waveforms are recalled from the location specified in the Saved Waveform Path variable. The default value for this variable is "Acquire New Data."

QPHY-PCIE Limit Sets

The default installation of QPHY-PCIE contains only one limit set, called PCIe 2.1 This set contains all of the limits for PCIe 1.1a and PCIe 2.1.

Manual Deskewing Procedures

This section is only applicable to the oscilloscope and the cables connecting to the oscilloscope channels. Note that the cables connecting the PeRT3 to the fixture or to the DUT must be phase matched within a tight tolerance because the PeRT, like any generator, does not have the capability to compensate for mismatched cables connected to its outputs.

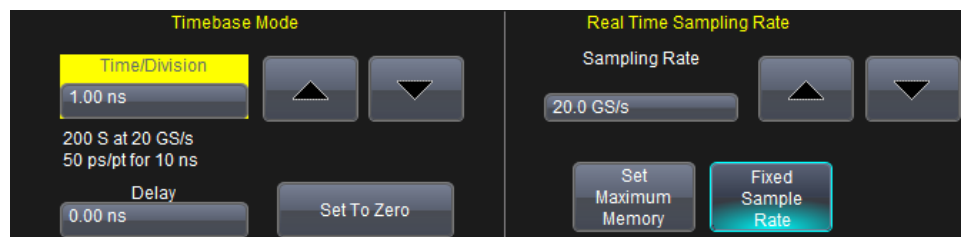
Cable Deskewing Using the Fast Edge Output

The following procedure demonstrates how to manually deskew two oscilloscope channels and cables using the fast edge output, with no need for any 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 a half-hour before proceeding. This procedure should be run again if the temperature of the oscilloscope changes by more than a few degrees.

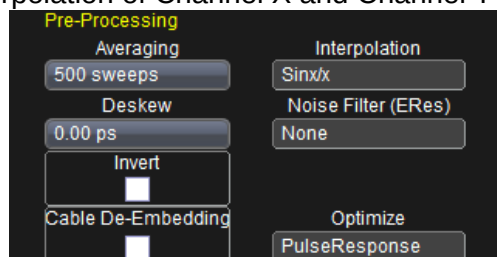
For the purpose of this procedure, the two channels being deskewed are referred to as Channel X and Channel Y. The reference channel is Channel X and the channel being deskewed is Channel Y.

1. Begin by recalling the Default Oscilloscope Setup.
2. Configure the oscilloscope as follows:

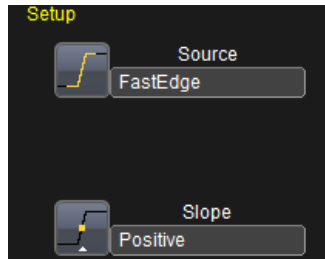
- Timebase
 - i. Fixed Sample Rate
 - ii. Set the Sample Rate to 40 GS/s
 - iii. Set the Time/Division to 1 ns/div



- Channels
 - i. Turn on Channel X and Channel Y.
 - ii. Set V/div for Channel X and Channel Y to 100mV/div.
 - iii. Set the Averaging of Channel X and Channel Y to 500 sweeps.
 - iv. Set the Interpolation of Channel X and Channel Y to Sinx/x.



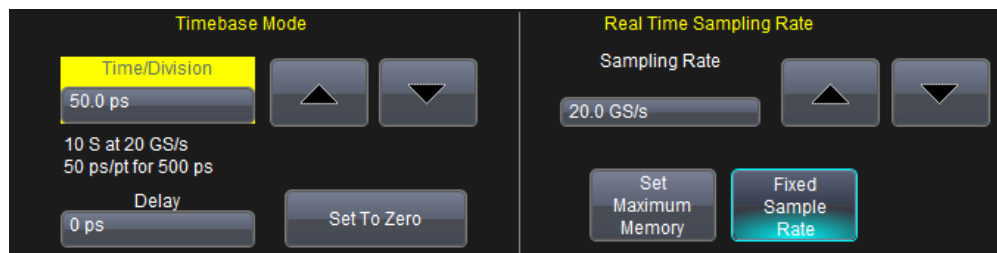
- Trigger
 - i. Configure to **Source** to be **FastEdge**.
 - ii. Set the **Slope** to **Positive**.



- Parameter Measurements:
 - i. Set the **source** for P1 to CX and the **measure** to Delay.
 - ii. Set the **source** for P2 to CY and the **measure** to Delay.
 - iii. Set the **source** for P3 to M1 and the **measure** to Delay.

Measure	P1:delay(C2)	P2:delay(C3)	P3:delay(M2)
value	---	---	---
status	⚠	⚠	⚠

3. Set the display to Single Grid.
 - Click **Display → Single Grid**.
4. Using the appropriate adapter, connect Channel X to the Fast Edge Output of the oscilloscope.
5. Adjust the Trigger Delay so that the Channel X signal crosses at the center of the screen.
6. Change the **Timebase** to 50 ps/div.



7. Fine tune the Trigger Delay so that the Channel X signal crosses at the exact center of the screen.
8. Press the **Clear Sweeps** button on the front panel to reset the averaging.
9. Allow multiple acquisitions to occur until the waveform is stable on the screen.

10. Save Channel X to M1.

- Click **File** → **Save Waveform**.
- Set **Save To Memory**.
- Set the **Source** to **CX**.
- Set the **Destination** to **M1**.
- Click **Save Now**.



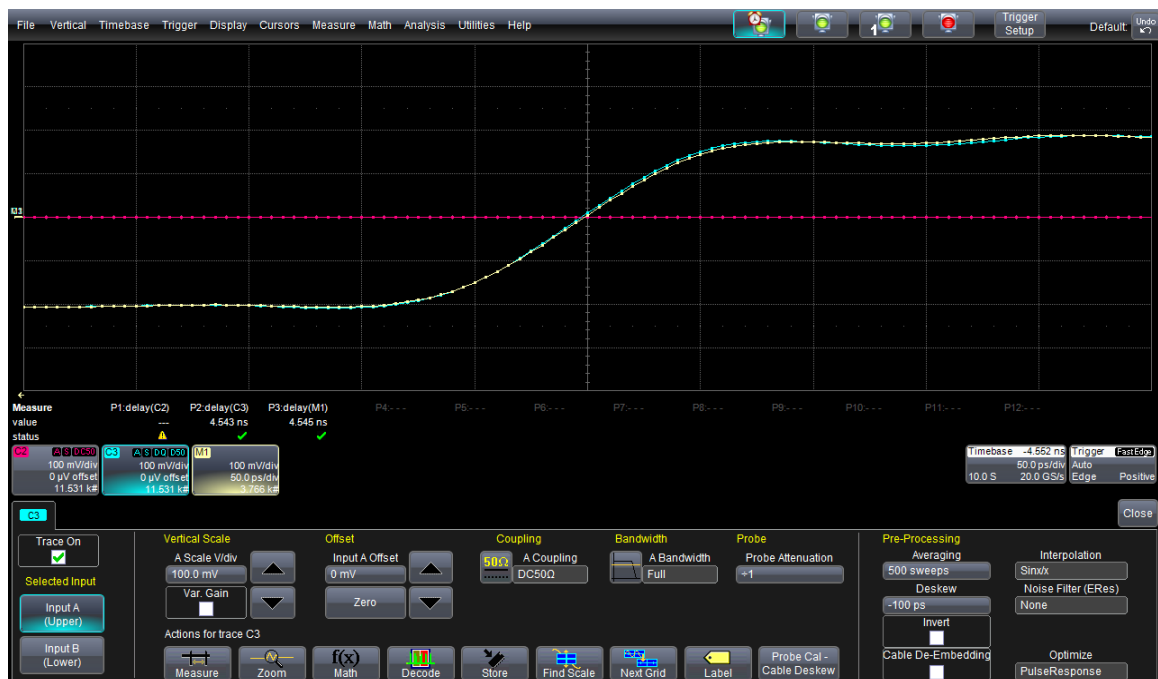
11. Disconnect Channel X from the Fast Edge Output and connect Channel Y to the Fast Edge Output.

12. Press the **Clear Sweeps** button on the front panel to reset the averaging.

13. Allow multiple acquisitions to occur until the waveform is stable on the screen.

14. From the Channel Y menu, adjust the **Des skew** of Channel Y until Channel Y is directly over the M1 trace.

15. Ensure that P3 and P2 are reasonably close to the same value. (Typically < 5ps difference)

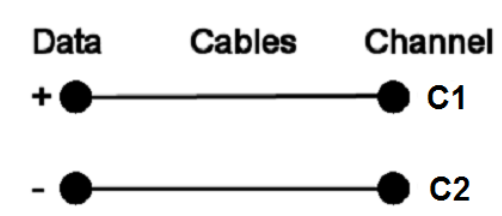


Cable Deskewing Without Using the Fast Edge Output

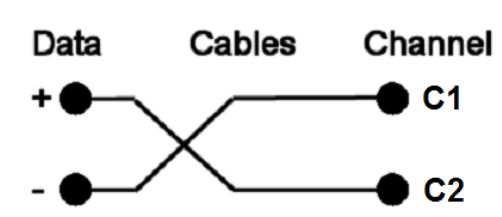
The following procedure demonstrates how to manually deskew two oscilloscope channels and cables using the differential data signal, with no need for any T connector or adapters.

This can be done once the temperature of the oscilloscope is stable. The oscilloscope must be warmed up for at least 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 C3 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 from the display as it shows C2 and C3 with the same polarity.

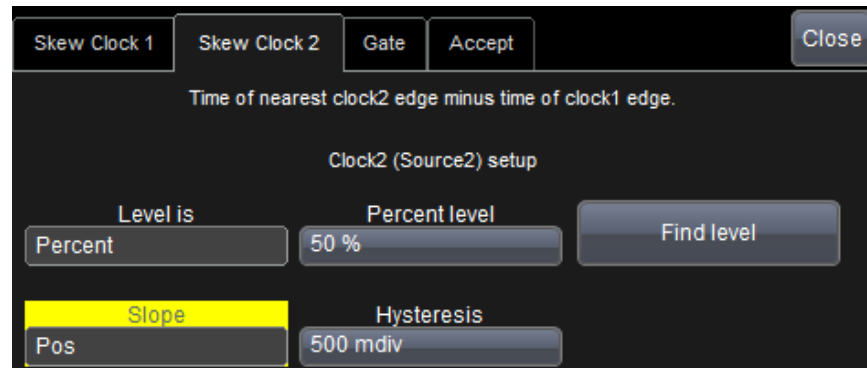


Figure 9 - The Skew parameter right side dialog, Skew clock 2 tab, showing default setup.

Error Messages

These messages may appear when using QualiPHY.

“Warning, no valid technology package has been found...” This message appears if none of the QualiPHY components have been activated on the oscilloscope before launching the QualiPHY application. [See Activate Components.](#)

“No devices connected to the application or device not alive...” This message appears if you are running QualiPHY from a remote PC, but a) you have not connected any oscilloscopes to the installation, or b) the oscilloscopes are offline. See [Set Up Remote Control](#) to connect an oscilloscope.

“This test requires Firmware version x.x.x.x or higher.” The test oscilloscope firmware needs to be updated. Go to teledynelecroy.com/support/softwaredownload under Oscilloscope Downloads > Firmware Update to download the latest firmware.

“An <oscilloscope model> or better is required for <test>.” The test cannot be run with this oscilloscope. If using remote control, you may be able to choose another oscilloscope connection.

“This test requires the <name> option.” Besides the QualiPHY component, you must purchase and activate the named software option on the oscilloscope.



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