N5991P PCI Express Test Automation Software Platform

KEYSIGHT

USER'S GUIDE

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1 Introduction

KEYSIGHT

Overview

This guide provides a detailed description of the Keysight N5991P PCI Express Test Automation Software Platform.

The BitifEye ValiFrame Test Automation software is globally marketed and supported by Keysight Technologies as N599x. This document describes in detail the setup preparation, calibration and test procedures conducted by N5991P software for PCI Express.

The N5991P software calibrates the stress conditions and controls the electronic test equipment for automated receiver tolerance tests. The Back-Channel Optimization, part of Setup Preparation, which requires an additional license, prepares the DUT and BERT for optimal test results. The other part of Setup Preparation, Guided Fixture Characterization, ensures that the fixtures are characterized according to the guidelines of the PCI-SIG.

The receiver tests described in this document are implemented according to the requirements of the Compliance Test Specification (CTS), and also some custom characterization tests are offered to provide more details about DUT behavior beyond the specification limits.

NOTE **The features available with the N5991 PCIe Receiver Test depend on the hardware used. Please contact the Keysight support team for further details.**

NOTE **The definitions of the acronyms and abbreviations used throughout this User's Guide are given in Appendix C, Acronyms and Abbreviations.**

Document History

First Edition (October 2019)

The first edition of this user's guide describes the functionality of the software version N5991 ValiFrame PCIe_1.00.

Second Edition (June 2020)

The second edition of this user's guide describes the functionality of the software version N5991 ValiFrame PCIe_2.07.

Third Edition (September 2020)

The third edition of this user's guide describes the functionality of the software version PCIe_ValiFrame_N5991_2.20.

Fourth Edition (October 2021)

The fourth edition of this user's guide describes the functionality of the software version PCIe_ValiFrame_N5991_3.00.

Fifth Edition (December 2022)

The fifth edition of this user's guide describes the functionality of the software version PCIe_ValiFrame_N5991_4.1.0.

Sixth Edition (December 2023)

The sixth edition of this user's guide describes the functionality of the software version PCIe_ValiFrame_N5991_5.0.0.

Seventh Edition (November 2024)

The seventh edition of this user's guide describes the functionality of the software version PCIe_ValiFrame_N5991_5.1.0.

Eighth Edition (October 2025)

The eighth edition of this user's guide describes the functionality of the software version PCIe_ValiFrame_N5991_5.2.0.

Ninth Edition (March 2026)

The ninth edition of this user's guide describes the functionality of the software version PCIe_ValiFrame_N5991_5.4.0.

Support and Troubleshooting

In the case of problems when running the software, check the log list at the bottom of the main window. The log file can be viewed by right-clicking within the log list section (see red frame in Figure 1-1). The log file is temporarily saved at C:\ProgramData\BitifEye\ValiFrameK1\Tmp. Note that all log information will be lost when the N5991 application is terminated unless you save the log file.

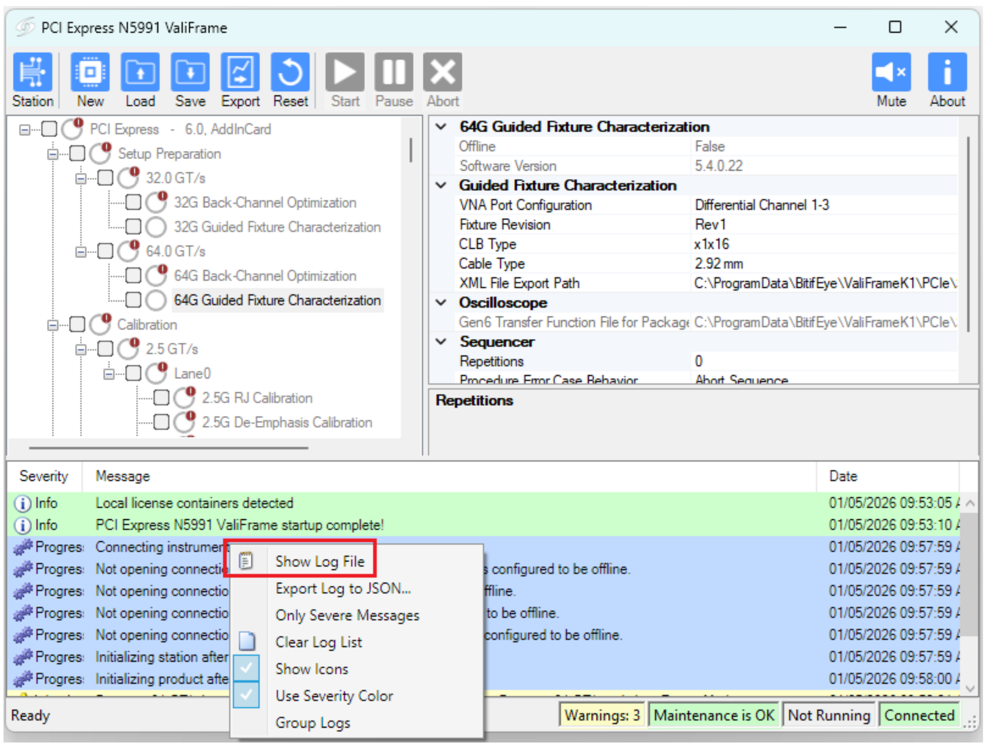

Figure 1-1 Accessing the log file

If a problem with an application persists, click About (in the main window, Figure 1-2), create an issue report file (in the About window, Figure 1-3) and send this zip file (BitifEye_IssueReportFile.zip, which will be saved to your desktop) to your Keysight support contact.

Figure 1-2 About button

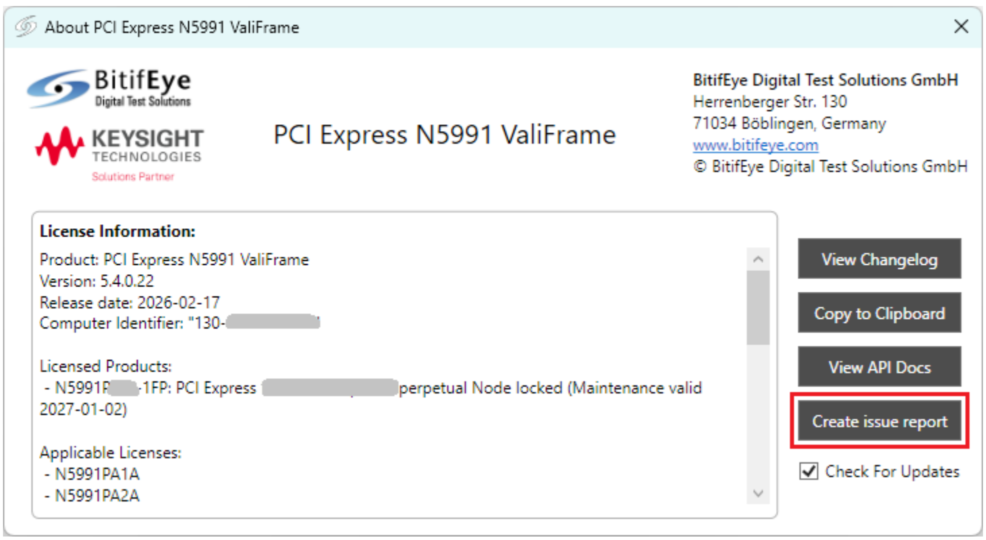

Figure 1-3 Creating an issue report file

The Keysight support team is also happy to help you should you require further information about a particular application.

For support options, visit www.keysight.com/find/contactus.

2 Preparing to Take Measurements

This chapter describes how to start the N5991 ValiFrame PCIe Rx Test automation software and to configure the test instruments, DUT and test parameters.

Overview

The set of test instruments that are used for PCIe test automation is referred to in the following as the “Test Station” or simply “Station”. The test station is controlled by a suitable PC and the N5991 PCI Express Test Automation Software Platform.

Downloading and Installing the ValiFrame Software

First download and install the BitifEye N5991 ValiFrame PCI Express software and then the relevant licenses. Further details about installing the software and the required licenses can be found in the ValiFrame Getting Started Guide.

Starting the ValiFrame Software

Double-click the PCIe ValiFrame (N5991) icon on the desktop (see Figure 2-1) to launch the app. Alternatively, to access the PCIe ValiFrame app on a Windows 11 PC, search PCIe ValiFrame (N5991).

Figure 2-1 PCIe ValiFrame (N5991) icon

Normal Workflow

After the ValiFrame software has been installed, the normal procedure when testing a DUT is as listed below. More details about each step are provided in the following sections.

- **Start the PCI Express N5991 ValiFrame app**
  (see Starting the ValiFrame Software on page 24)
- **Configure the station**
  (see Configuring the Test Station on page 26)
  - Station configuration
  - Instrument configuration
- **Configure the DUT**
  (see Configuring the DUT and Test Parameters on page 33)
- **Setup Preparation**
  (see Setup Preparation Procedures on page 91)
- **Calibrate the system**
  - Select calibration procedure(s) (see Selecting Procedures on page 57)
  - Modify parameters (see Modifying Parameters on page 57)
  - View connection diagram and connect setup (see Connection Diagrams on page 60)
  - Run calibration procedure(s) (see Running Procedures on page 58)
  - Save/export calibration results (see Exporting Results on page 65)
- **Run test procedures**
  - Select test procedures (see Selecting Procedures on page 57)
  - Modify parameters (see Modifying Parameters on page 57)
  - View connection diagram and connect setup (see Connection Diagrams on page 60)
  - Run test procedure(s) (see Running Procedures on page 58)
  - Save/export test results (see Exporting Results on page 65)

Configuring the Test Station

When the PCI Express ValiFrame app is launched, the main ValiFrame window opens (Figure 2-2).

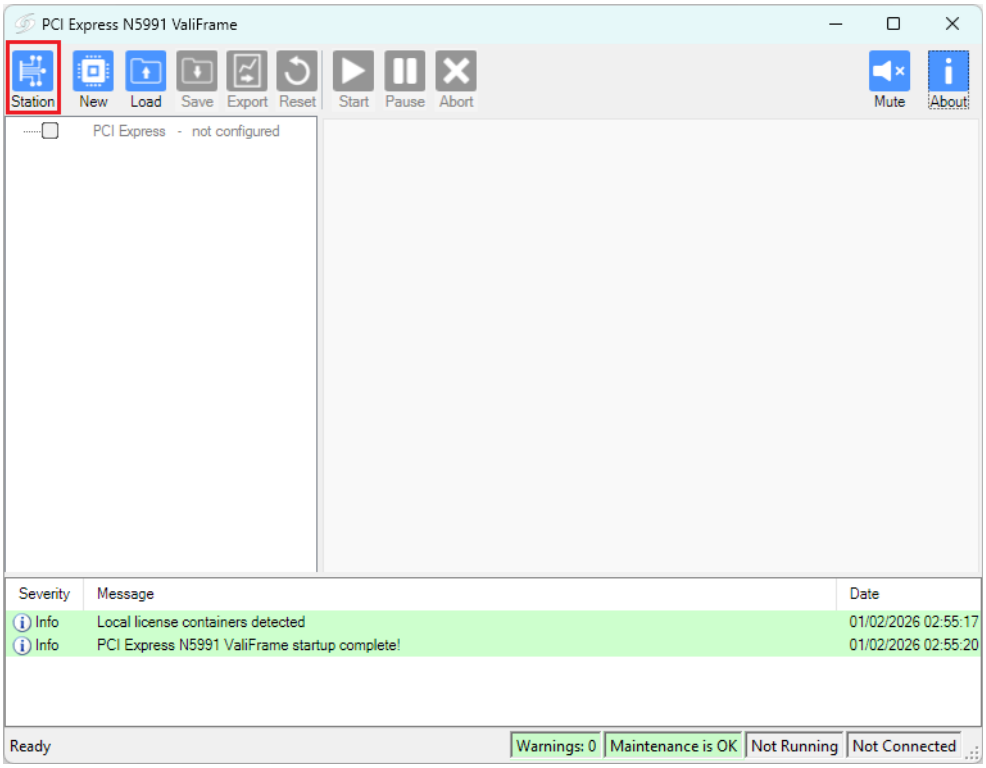

Figure 2-2 PCI Express ValiFrame main window

Click ‘Station’ (red frame in the figure) to open the Station Configuration window (Figure 2-3).

Test Station Configuration

The Station Configuration window shows the various options for instruments that can be used for PCI Express testing. The options are described here.

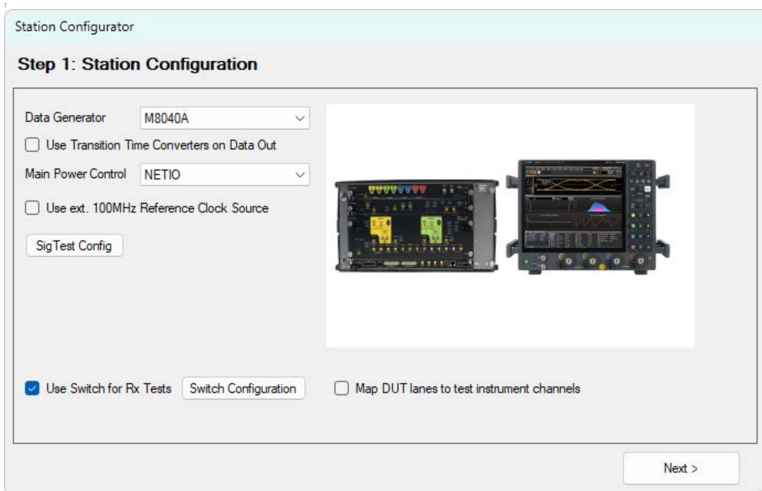

Figure 2-3 Station Configuration window

Data Generator

The pattern generator is used to create patterns with specified stress parameters. For PCIe the supported options are:

- M8020A (Keysight M8020A J-BERT High-Performance BERT), for spec versions PCIe4 and PCIe5, data rates up to 16 GT/s.
- M8040A (Keysight M8040A 64 GBd High-Performance BERT), for spec versions PCIe4, PCIe5 and PCIe6.
- M8050A (Keysight M8050A 120 GBd High-Performance BERT), for spec versions PCIe5 and PCIe6.
  - The M8046A error detector is required if you are using the M8050A.

The error detector of the selected data generator (BERT system) is used to check for errors contained in the data looped back from the DUT.

For further details about the clock module front end, error detector, recommended oscilloscopes, etc. for each BERT, contact your Keysight representative.

Use Transition Time Converters on Data Out

This option appears only for the M8040A BERT. For all calibrations where the output of the BERT is directly connected to the oscilloscope, it is required to use the high bandwidth (BW) inputs of the scope to avoid any measurement artifacts that may occur due to the fast edges of the M8040A. Using transition time converters (TTCs) slows down the M8040A's edge rates and reduces the required bandwidth of the oscilloscope. Therefore, adding TTCs to the setup allows low-bandwidth inputs to be used for all calibrations, thus avoiding re-connections on the oscilloscope. However, if TTCs are used, the 64 GT/s data rate is not available.

Main Power Control

Select one of the options from the drop-down menu:

- Manual
- NETIO (for the NETIO PowerPDU 4PS with four outlets)
- ALL4076 (a PDU from Allnet with six outlets)
- SynaccessNP (for Synaccess NP PDUs)

Use External 100 MHz Reference Clock Source

Select the "Use ext. 100 MHz Reference Clock Source" check box to use a 100 MHz reference clock as a clock source for the data generator and the DUT to obtain a constant clock signal. It is required only in Common Clock architecture.

SigTest Configuration

The SigTest software is used in several calibration procedures to calculate the eye height, eye width, and jitter parameters of the generated signal.

The SigTest Configuration dialog (see Figure 2-4) lets you select the installation directories, jitter measurement template and EH/EW measurement template used for the calibrations.

The SigTest software must be installed separately before ValiFrame is started. The various versions of SigTest can be downloaded from the Intel website. A link to this website is also provided in the SigTest Configuration dialog (see Figure 2-4). The appropriate version of MATLAB® Runtime should also be installed. Details can be found on the Intel website.

NOTE

There may be instances where the template names may change for different SigTest versions. To automatically modify the template names, click the “Default” button and the names are modified to correlate with the required SigTest version.

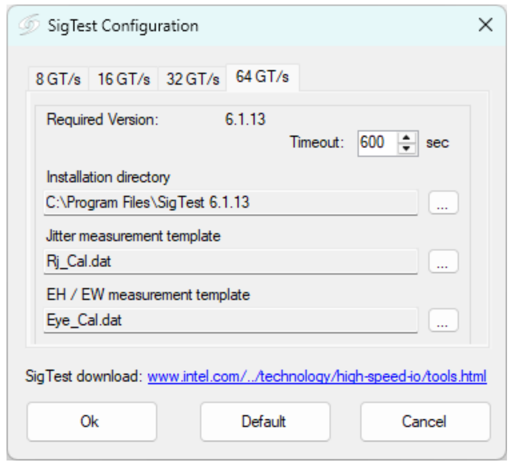

Figure 2-4 SigTest Configuration window

Use Switch for Rx Tests

Using a switch, you can test more than one lane without changing the setup connections. This greatly reduces user interventions during testing. Information about the advantages of using an RF switch for multilane PCIe testing can be found in this video.

Select the “Use Switch for Rx Tests” check box to enable the “Switch Configuration” button. Click this button to open the **Rx Switch Configuration** dialog (see Figure 2-5), where you can select the switch type. The exact appearance of the Rx Switch Configuration window will depend on the switch type chosen.

To use a BIT-2100 Series Switch System, you require a separate license. For hardware inquiries contact BitifEye, and for the necessary license contact your Keysight representative.

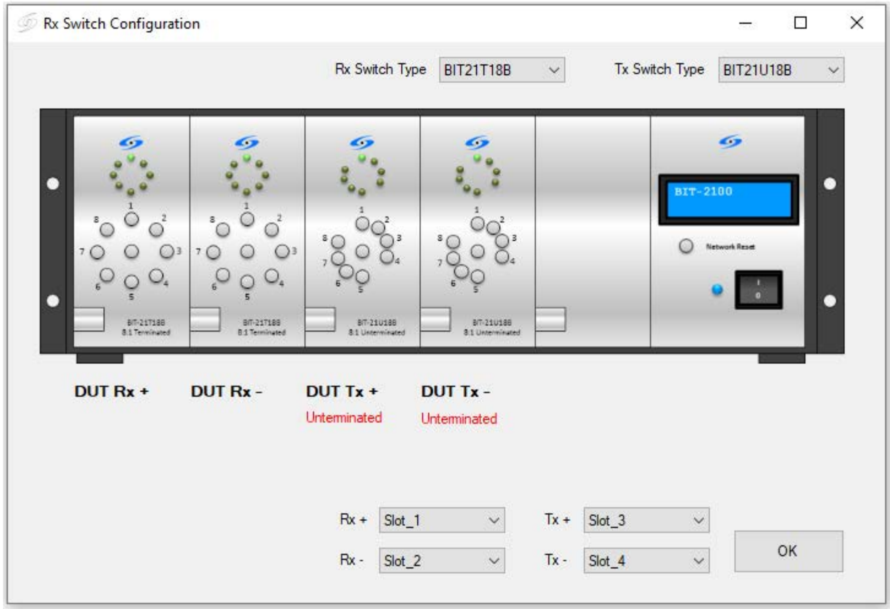

Figure 2-5 Rx Switch Configuration window

Map DUT lanes to test instrument channels

The “Map DUT lanes to test instrument channels” option is an alternative to “Use Switch for Rx Tests”. They cannot be used together. “Map DUT lanes to test instrument channels” is used to test several lanes without cabling re-connections. If this check box is selected, the Rx DUT lanes can be mapped to different data outputs of the generator instrument.

Test Instrument Configuration

Once the PCI Express station is configured, the instrument addresses must be set. An example of instrument configuration is shown in Figure 2-6.

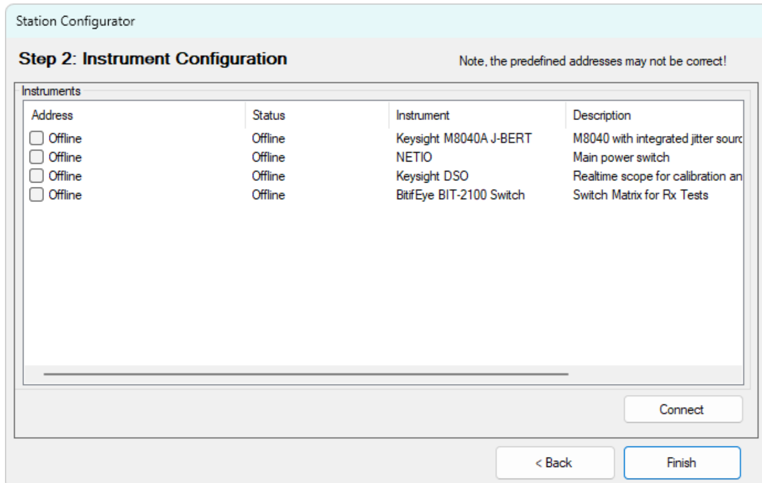

Figure 2-6 Instrument Configuration window

NOTE A UXR oscilloscope with a sample rate of 256 GSa/s and a bandwidth of at least 50 GHz (59 GHz or more is recommended) is required for M8040A and M8050A setups without TTCs.

NOTE Make sure that all the selected instruments for the test station are connected to the test station PC controller by remote control interfaces such as LAN or USB.

After the installation process, all instruments are configured by default in “Offline” mode. In this simulation mode, the hardware need not necessarily be physically connected to the test controller PC. The ValiFrame software cannot connect to any instrument in this mode.

In order to control the instruments that are connected to the PC, the instrument address must be entered. The address depends on the bus type used for the connection, for example, USB or LAN.

Most of the instruments used in the PCI Express station require a VISA (Virtual Instrument System Architecture) connection. To determine the VISA address, run the “Keysight Connection Expert”, which is part of the Keysight IO Libraries Suite. For each instrument, copy the address string from the Connection Expert entries and paste it as the instrument address in the ValiFrame Instrument Configuration window.

For further details about how to use the Keysight Connection Expert see the ValiFrame Getting Started Guide.

After the address strings have been entered, click **Connect** to verify that the connections for the instruments have been established properly. If an erroneous instrument address configuration is performed, the ValiFrame software will display a prompt to indicate so.

Click **Finish** to save the selected instruments and connections.

NOTE When a specific test station configuration is started for the first time, all instruments are set to the “Offline” mode. In this mode, the test automation software does not connect to any instrument. This mode can be used for demonstrations or checks only. NO VALID DATA IS PRODUCED.

You will need to repeat the station and instrument configuration whenever you change the instruments you are using or their connections.

Configuring the DUT and Test Parameters

Once the test station has been configured, the next step is to configure the DUT and test parameters.

Figure 2-7 New and Load buttons in the main window

Opening a Previously Saved Project

If you have already configured the N5991 PCI Express ValiFrame software and saved the settings as a configuration or project file, you can click **Load** (Figure 2-7) to use the same station, DUT and test parameters again, which can save time.

Beginning a New Project

To begin a new project, click **New** (Figure 2-7), which opens the PCI Express Configure DUT window (Figure 2-8).

Configure DUT Window

The Configure DUT window (Figure 2-8) allows you to select

- the types of procedures to be run (calibrations and tests and/or setup preparation)
- DUT parameters, such as DUT Type, Specification Version, Compliance Mode or Expert Mode
- test parameters that are related to the receiver test configuration

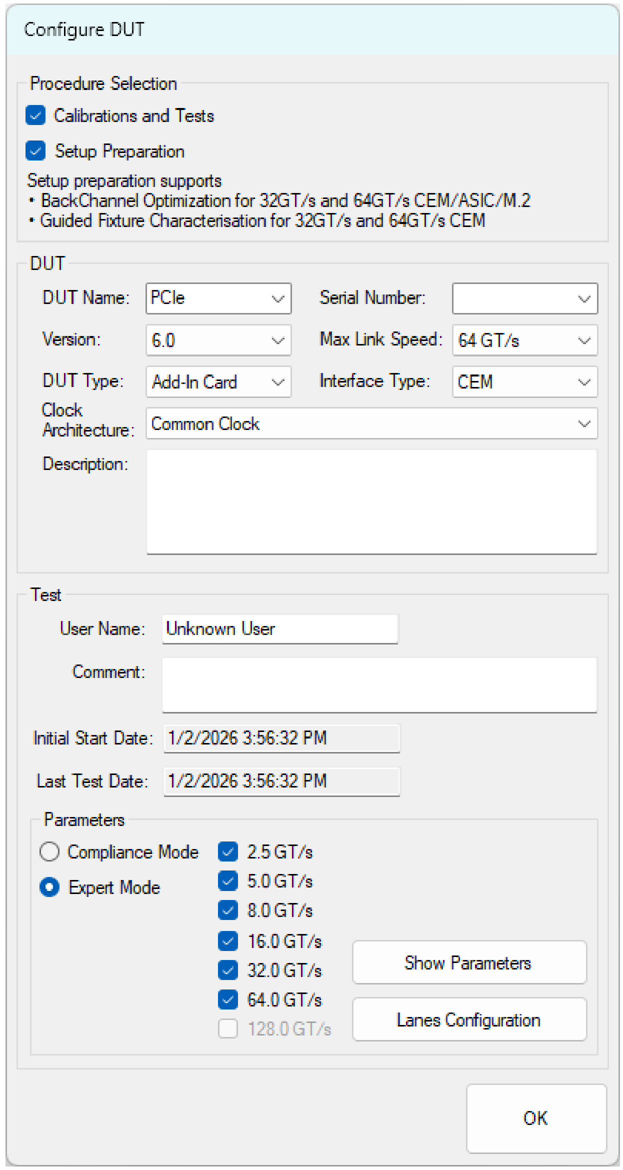

Figure 2-8 Configure DUT dialog

Procedure Selection

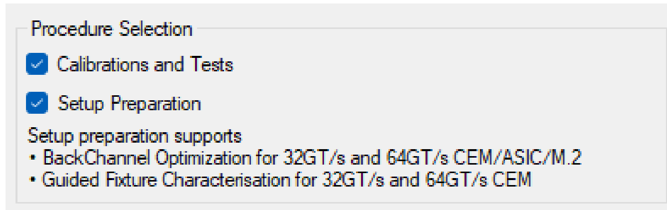

Figure 2-9 Procedure Selection part of Configure DUT dialog

Calibrations and Tests

Check this box in order to include the calibrations and tests in the procedure tree (see Figure 3-1 on page 54).

Setup Preparation

NOTE Setup Preparation requires an additional license. If this license is not available, Setup Preparation cannot be selected.

Check the Setup Preparation box to include setup preparation procedures in the procedure tree. The following setup preparation procedures are supported:

- **Back-Channel Optimization**
  This is available at 32 GT/s, for CEM, ASIC and M.2, and at 64 GT/s, for CEM (in Expert Mode) and ASIC.
  See Back-Channel Optimization on page 96.
- **Guided Fixture Characterization**
  This is available for CEM at 32 GT/s and (in Expert Mode) at 64 GT/s.
  See Guided Fixture Characterization on page 106.

DUT Configuration Parameters

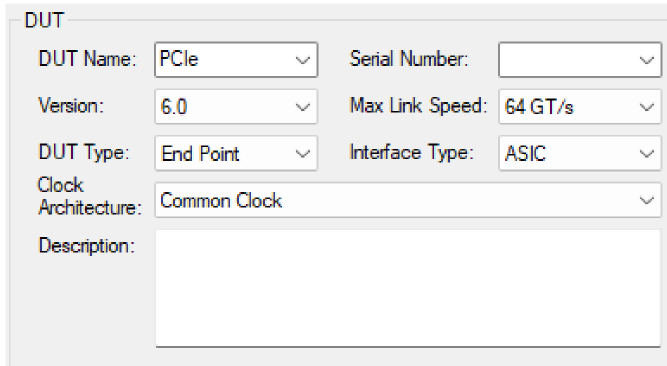

Figure 2-10 DUT part of Configure DUT dialog

DUT Name

The name of the DUT. This is used to identify the product. If you are using the Back-Channel Optimization procedure, this is used in the default name for the file used to save the back-channel optimization data.

Serial Number

Serial Number of the DUT. This is used to identify the product. If you are using the Back-Channel Optimization procedure, this is used in the default name for the file used to save the back-channel optimization data.

Version

The available PCI Express® Base Specification Revisions (Versions) are:

- 4.0 – supports the 2.5, 5, 8 and 16 GT/s data rates.
- 5.0 – supports the 2.5, 5, 8, 16 and 32 GT/s data rates.
- 6.0 – supports the 2.5, 5, 8, 16, 32 and 64 GT/s data rates.

Max Link Speed

The maximum link speed of the DUT. Different specification versions support different maximum link speeds. The availability of the data rate check boxes toward the bottom of the Configure DUT panel is dependent on the value of Max Link Speed.

NOTE If you increase the spec version number, for example from 4.0 to 6.0, the value shown as Max Link Speed does not automatically increase to the maximum given in the specification. You must make this change manually.

DUT Type

The available DUT types are:

- For Interface Type 'ASIC':
  - **End Point**: A PCIe end point (non-root-complex) silicon is tested according to the Base specification
  - **Root Complex**: A PCIe root complex silicon is tested according to the Base specification
- For Interface Type 'CEM':
  - **Add-In Card**: An add-in card with CEM connector is tested according to the PHY test specification
  - **System**: A system with CEM connector is tested according to the PHY test specification
- For Interface Type 'U.2' or 'M.2':
  - **Device**: A drive (for example) with U.2 or M.2 connector is tested according to the PHY test specification
  - **Host**: A motherboard (for example) with U.2 or M.2 connector is tested according to the PHY test specification

Interface Type

The supported interface types are:

- ASIC
- CEM
- U.2 (only for PCIe Versions 4.0 and 5.0; Link Speed: 8 GT/s)
- M.2 (only for PCIe Versions 4.0 and 5.0; Link Speeds: 8 GT/s, 16 GT/s and 32 GT/s (not 32 GT/s for Version 4.0))

Clock Architecture

The available options are:

- **Common Clock**: The default clock architecture, where all parts of the system use the same clock
- **Separate Ref Clocks Independent SSC**: Separate reference clocks with independent spread spectrum clocking (SRIS)

Description

A text field for product description.

Test Configuration Parameters

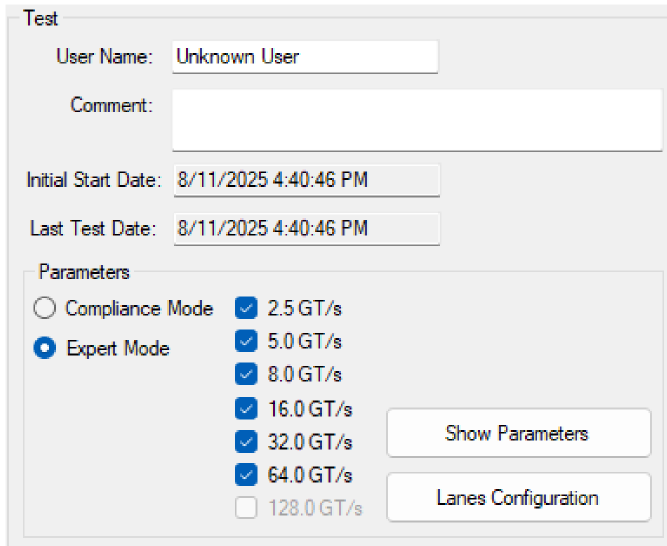

Figure 2-11 Test part of Configure DUT dialog

User Name

Enter your name in the text field.

Comment

Text field for your comments.

Initial Start Date

Time stamp of the start of the current session.

Last Test Date

Time stamp of the last test conducted in the current session.

Compliance Mode

If Compliance Mode is selected, the tests are conducted as mandated by the CTS. You cannot modify the parameters that are shown in the calibrations and test procedures.

Expert Mode

If Expert Mode is selected, the calibrations and tests can be conducted beyond the limits and constraints of the CTS and to identify the limits of the DUT. You can modify the parameters that are shown in the calibrations and test procedures. Some procedures (“Custom Procedures”) are available only in Expert Mode.

Data Rates

The available data rates in the current N5991 PCI Express software version depend on the specification version and the interface type selected. This is detailed in Table 2-1. Note that the M8020A and the M8050A do not support all data rates. M8020A supports only Spec Versions 4.0 and 5.0 and data rates only up to 16 GT/s. M8050A supports Spec Version 5.0 and above.

Table 2-1 Supported data rates according to interface type and spec version

Interface Type	Spec Version 4.0[a]	Spec Version 5.0	Spec Version 6.0[b]
ASIC	2.5, 5, 8 and 16 GT/s	2.5, 5, 8, 16 and 32 GT/s[c]	2.5, 5, 8, 16, 32 and 64 GT/s
CEM	2.5, 5, 8 and 16 GT/s	2.5, 5, 8, 16 and 32 GT/s[c]	2.5, 5, 8, 16, 32 and 64 GT/s[d]
U.2	8 GT/s	8 GT/s	–
M.2	8 and 16 GT/s	8, 16 and 32 GT/s[c]	–

a Spec Version 4.0 is not supported by M8050A.
b Spec Version 6.0 is not supported by M8020A.
c M8020A only supports tests up to 16 GT/s.
d Currently, the CEM interface is supported at 64 GT/s in Expert Mode only.

Show Parameters

Click the Show Parameters button to open the PCIe Parameters dialog box. See PCI Express Parameters on page 40.

Lanes Configuration

Click the Lanes Configuration button to open the Lanes dialog box. See Lanes Configuration on page 50.

PCI Express Parameters

In the Configure DUT window, click the **Show Parameters** button. If the DUT Type was selected as **End Point**, the “PCIe End Point Parameters” dialog box is displayed, as shown in Figure 2-12.

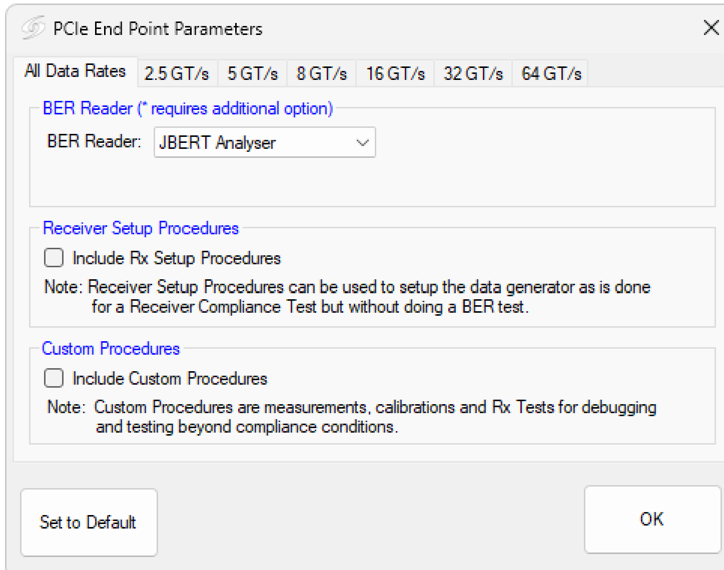

Figure 2-12 PCIe End Point Parameters configuration window

The selected speed class determines which individual tabs are displayed. The parameters displayed under the “All Data Rates” tab are described first.

BER Reader

BER Reader: The bit-error measurement can be done using the BERT Analyzer or with an Offline BER reader.

Receiver Setup Procedures

Include Rx Setup Procedures: Select this option to add the receiver setup procedures to the procedure tree. In these procedures, the data generator is configured for the calibrated compliance conditions, but a BER test is not performed.

Custom Procedures

Include Custom Procedures: Select this option to add to the test tree measurements, calibrations and Rx tests for debugging and testing that go beyond compliance conditions. This option is available only if Expert Mode is selected in the Parameters part of the Configure DUT panel.

2.5 GT/s and 5.0 GT/s Tabs

The 2.5 GT/s tab and 5.0 GT/s tab (Figure 2-13) of the PCIe Parameters dialogs are very similar and so are described together.

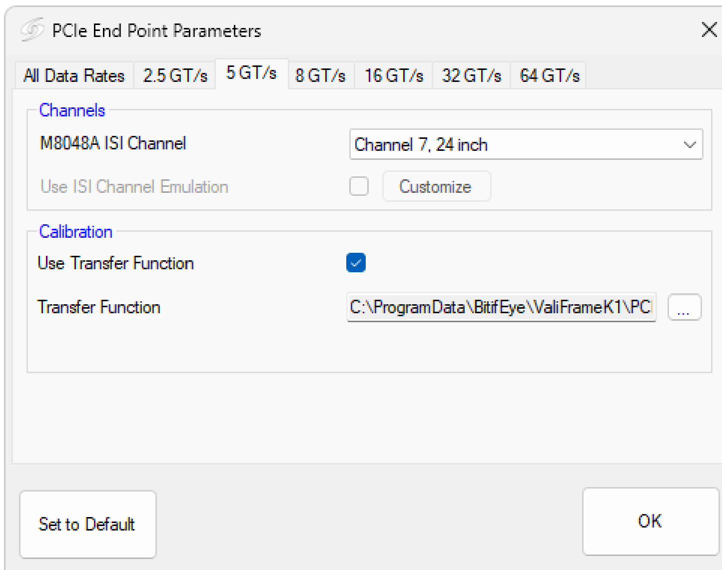

Figure 2-13 5 GT/s tab of the PCIe End Point Parameters dialog

Channels

- **M8048A ISI Channel**: (Not for CEM.) Select the channel to be used for testing (from Channel 0 (none) to Channel 7 (24 inches)).
- **Use ISI Channel Emulation**: (Not for M8040A or M8050A; the M8020A setup requires the M8020A BERT option M8041A-0G5.) Enable this option to generate ISI internally in the M8020A.
  If you click **Customize**, the “ISI Channel Customization” dialog (Figure 2-14) appears, where you can fine-tune the selected ISI Channel by modifying the insertion loss.

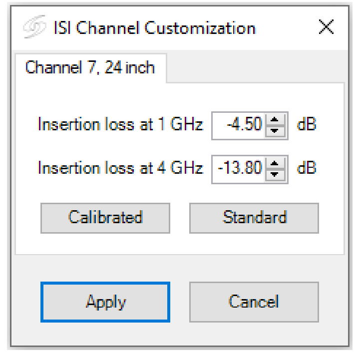

Figure 2-14 ISI Channel Customization dialog

If you have changed the IL settings in this dialog in the past and run a full calibration, when you restart ValiFrame again you can use the following buttons:

- **Calibrated** to reset the two IL values to the values of the previous calibration or
- **Standard** to reset the two IL values to the default values that ValiFrame used initially.

Calibration

- **Use Transfer Function**: Check this box to embed or de-embed using the transfer function.
- **Transfer Function**: (Only when “Use Transfer Function” is enabled.) Shows the name of the transfer function file for embedding. Generate the transfer function displayed in the dialog (Figure 2-13 on page 41) and then copy it to C:\ProgramData\BitifEye\ValiFrameK1\PCIe\Settings\TransferFunctions on the PC where ValiFrame is running.

8.0 GT/s Tab

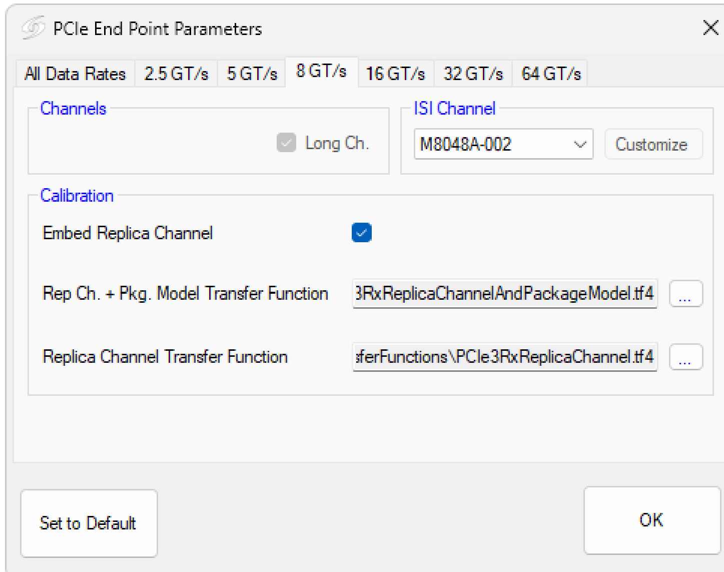

Figure 2-15 8 GT/s tab of the PCIe End Point Parameters dialog

Channels

- **Long Ch.**: (For ASIC) Long Channel is preselected and read-only.
- **CBB rev. 2**: (For CEM) Check this to perform Rx tests with CBB rev. 2, in addition to CBB rev. 3. See Figure 2-16 on page 44. Disabled for U.2 and M.2.
- **CBB rev. 3 riser card**: (For CEM, U.2 and M.2) The Rx tests must be performed with CBB Gen3; therefore, the CBB rev. 3 riser card check box is preselected and read-only.

ISI Channel (Only ASIC)

- Supported options are
  - M8041A-0G5 (only M8020A)
  - M8048A-002
  - N4915A-014
- **Customize**: (Enabled only for the ISI Channel M8041A-0G5.) Click to open the “ISI Channel Customization” dialog (Figure 2-14 on page 42), where you can fine-tune the selected ISI Channel by modifying the insertion loss.

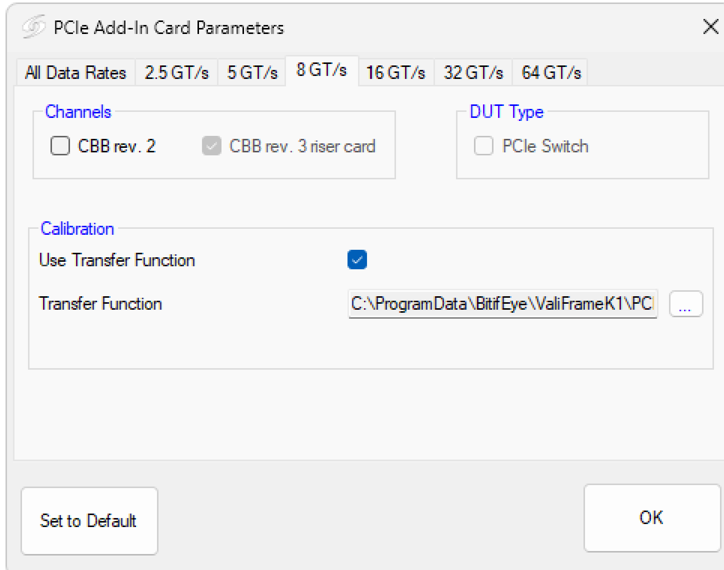

Figure 2-16 8 GT/s tab of the PCIe Add-In Card Parameters dialog

DUT Type (Only CEM, U.2, M.2)

- **PCIe Switch**: For Systems, Host, select this if the DUT is a PCIe switch.

Calibration

- **Embed Replica Channel**: (ASIC) Select this option to use a transfer function to embed a replica channel.
- **Package Model Transfer Function**: (ASIC, if “Embed Replica Channel” is not enabled.) The transfer function file for the package model.

NOTE The Package Loss value is read automatically from the specified transfer function files. When processing pre-recorded step responses, this parameter can be defined in the procedure parameters directly.

- **Rep Ch. + Pkg. Model Transfer Function**: (ASIC, when “Embed Replica Channel” is enabled.) The transfer function file that combines the replica channel and the package model.
- **Replica Channel Transfer Function**: (ASIC, when “Embed Replica Channel” is enabled.) The transfer function file for the replica channel.

- **Use Transfer Function**: (CEM, U.2, M.2) Use this check box to embed or de-embed calibration boards or additional cables using the transfer function on the oscilloscope.
- **Transfer Function**: (CEM, U.2, M.2; when “Use Transfer Function” is enabled.) Shows the path of the transfer function file for the package model.

Transfer Functions

For the 8 GT/s data rate, the following transfer functions can be used:

- Package Model Transfer Function — ASIC; Embed Replica Channel is **not** checked
- Replica Channel and Package Model Transfer Function — ASIC; Embed Replica Channel is checked
- Replica Channel Transfer Function — ASIC; Embed Replica Channel is checked
- Transfer Function — CEM, U.2, M.2; Use Transfer Function is checked

In each case the transfer function has to be generated (apart from the Package Model Transfer Function) and then copied to C:\ProgramData\BitifEye\ValiFrameK1\PCIe\Settings\TransferFunctions on the PC where ValiFrame is running.

If you change the name of the Package Model Transfer Function, this must also be copied to C:\ProgramData\BitifEye\ValiFrameK1\PCIe\Settings\TransferFunctions, otherwise it will not be found.

16 GT/s, 32 GT/s and 64 GT/s Tabs

The 16 GT/s tab (Figure 2-17), 32 GT/s tab and 64 GT/s tab of the PCIe Parameters dialog are very similar and so are described together.

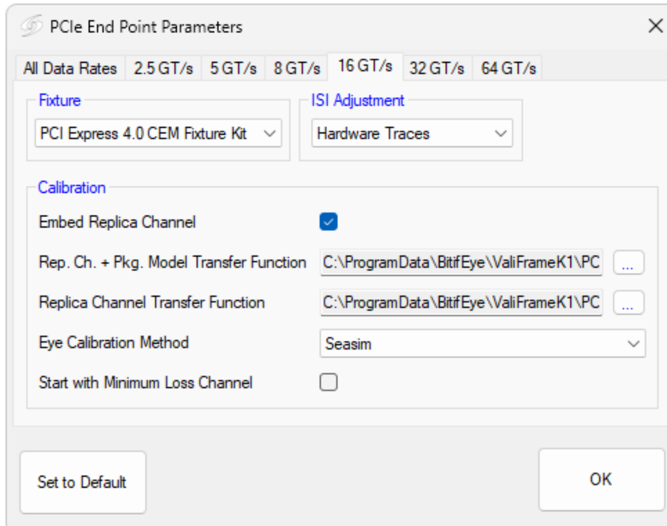

Figure 2-17 16 GT/s tab of the PCIe End Point Parameters dialog

Fixture (not 64 GT/s)

- Select the fixture. The options are
  - PCI Express 4.0 CEM Fixture Kit
    (ASIC 16 GT/s, Spec Versions 4.0, 5.0, 6.0;
    CEM 16 GT/s, Spec Versions 4.0, 5.0, 6.0;
    M.2 16 GT/s, Spec Versions 4.0, 5.0)
  - Generic
    (ASIC 16 GT/s, Spec Versions 4.0, 5.0, 6.0)
  - PCIe 5.0 FR4 Base Fixture
    (ASIC 32 GT/s, Spec Version 5.0, 6.0)
  - PCIe 5.0 MEG6 Base Fixture
    (ASIC 32 GT/s, Spec Version 5.0, 6.0)
  - PCIe 5.0 CEM Fixture Kit
    (ASIC 32 GT/s, Spec Version 5.0, 6.0;
    CEM 32 GT/s, Spec Version 5.0;
    M.2 32 GT/s, Spec Version 5.0)

NOTE To change the fixture for the long channel for M.2 for 16 GT/s or 32 GT/s, click Long Channel in the procedure tree for the appropriate data rate. In the parameter grid (right half of the ValiFrame main window), go to 'Gen5 M.2 Fixture' (for PCIe 5.0) or 'Gen4 M.2 Fixture' (for PCIe 4.0), which is under the heading Channel, and select the correct fixture from the drop-down menu.

ISI Adjustment (only 16 GT/s)

- The supported options are
  - **Hardware Traces**: Select this to use just the hardware traces to generate the ISI.
  - **Emulated ISI**: (Only M8020A and ASIC) Select this option to combine the internal ISI generated by the M8020A with the selected hardware traces to adjust the insertion loss. Note that the M8020A BERT option M8041A-0G5 is required to perform this operation.

NOTE For CEM tests, the CTS allows only the official PCI-SIG fixture sets. Therefore, in this case, the "PCI Express 4.0 CEM Fixture Kit" or the "PCIe 5.0 CEM Fixture Kit" and the ISI Adjustment with "Hardware Traces" are the only available options.

Calibration

- **Embed Replica Channel**: (ASIC) Select this option to use a transfer function to embed a replica channel.
- **Embed Additional Channel**: (CEM) Select this option to use a transfer function to embed an additional channel.
- **Package Model Transfer Function**: (When "Embed Replica Channel" (ASIC) or "Embed Additional Channel" (CEM) is not enabled.) The name of the transfer function file for the package model.

NOTE The Package Loss value is read automatically from the specified transfer function files. When processing pre-recorded step responses, this parameter can be defined in the procedure parameters directly.

- **Rep. Ch. + Pkg. Model Transfer Function**: (ASIC, when “Embed Replica Channel” is enabled.) The name of the transfer function file that combines the replica channel and the package model.
- **Add. Ch. + Pkg Model Transfer Function**: (CEM, when “Embed Additional Channel” is enabled.) The name of the transfer function file that combines the additional channel and the package model.
- **Replica Channel Transfer Function**: (ASIC, when “Embed Replica Channel” is enabled.) The name of the transfer function file for the replica channel.
- **Additional Channel Transfer Function**: (CEM, when “Embed Additional Channel” is enabled.) The name of the transfer function file for the additional channel.
- **Eye Calibration Method**: Select the tool to be used for the stressed eye calibration. Available options are:
  - ***Seasim***: (At 16 GT/s and 32 GT/s, Seasim is available only for ASIC) This is a processing tool that uses the standard method. A step pattern with 256 ones and zeros is applied at the input of the calibration channel and the step response is captured at the output of the replica channel. The oscilloscope averages the step response, which minimizes the noise. The step response defines the complete electrical behavior of the channel and calculates a statistical eye. Seasim also simulates the different impairments.
  - ***SigTest***: This uses the compliance channel methodology. A compliance pattern is applied and different impairments, such as random jitter, sinusoidal jitter and differential and common mode sinusoidal interference, are added to the signal.
- **Start with Minimum Loss Channel**: (Only 16 GT/s)
  - Not enabled: The Initial Equalization Preset Optimization Calibration will start with the maximum specification loss (–30 dB for 16 GT/s). Then the Channel Calibration reduces channel loss in 0.5 dB steps until Eye Height and Eye Width exceed the specification value (and the ratio is similar to the nominal value) or until the channel loss reaches the minimum specification loss (–27 dB for 16 GT/s).
  - Enabled: The Initial Equalization Preset Optimization Calibration will start with the minimum specification loss. Then the Channel Calibration increases channel loss in –0.5 dB steps until Eye Height and Eye Width are slightly below the specification value (and the ratio is close to the ratio of the nominal eye) or until the channel loss reaches the maximum specification loss.

  The remaining calibration procedures will use that channel.

Transfer Functions

For the 16 GT/s, 32 GT/s and 64 GT/s data rates, the following transfer functions can be used:

- Package Model Transfer Function – ASIC, CEM;
  Embed Replica/ Additional Channel is **not** checked
- Replica Channel and Package Model Transfer Function – ASIC;
  Embed Replica Channel is checked
- Replica Channel Transfer Function – ASIC;
  Embed Replica Channel is checked
- Additional Channel and Package Model Transfer Function – CEM;
  Embed Additional Channel is checked
- Additional Channel Transfer Function – CEM;
  Embed Additional Channel is checked

In each case the transfer function has to be generated (apart from the Package Model Transfer Function) and then copied to C:\ProgramData\BitifEye\ValiFrameK1\PCIe\Settings\TransferFunctions on the PC where ValiFrame is running.

If you change the name of the Package Model Transfer Function, this must also be copied to C:\ProgramData\BitifEye\ValiFrameK1\PCIe\Settings\TransferFunctions, otherwise it will not be found.

Lanes Configuration

If you do not check the ‘Map DUT lanes to test instrument channels’ box during station configuration, the Lanes window appears as shown in Figure 2-18 when you click the ‘Lanes Configuration’ button in the Configure DUT Panel.

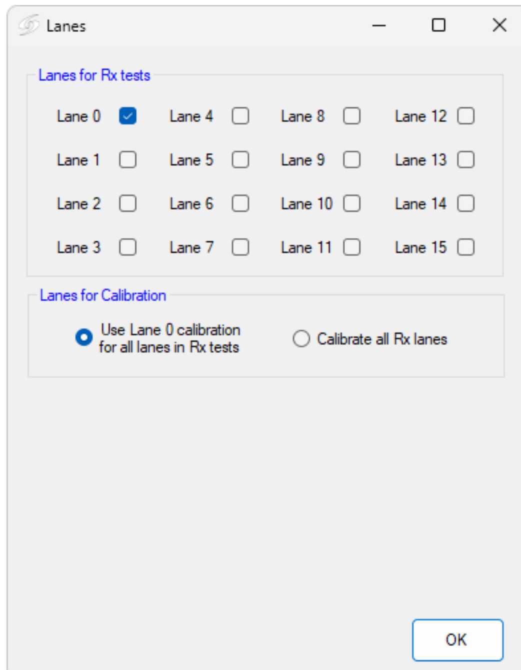

Figure 2-18 Lanes configuration panel

- **Lanes for Rx tests:** Select the corresponding check box for one or more lanes where testing is to be performed. The selection of one or more lanes depends on the following conditions in the Station Configuration window:
  - If the ‘Use Switch for Rx tests’ check box is left unchecked, you can select all lanes for testing. While the tests are being performed, you will be prompted to manually switch cables from lane to lane. This is the only option available for 64 GT/s.
  - If ‘Use Switch for Rx tests’ is enabled, the number of lanes to be tested depends on the module type selected. Module types BIT21T14B, BIT21T16B and BIT21T18B allow testing of up to 4, 6 and 8 lanes, respectively.

- **Lanes for Calibration:** Choose one of the following options:
  - *Use Lane 0 calibration for all lanes in Rx tests*: Only Lane 0 will be calibrated. These values will be used in the Rx tests for all lanes.
  - *Calibrate all Rx lanes*: (Not available if 'Use Switch for Rx tests' is enabled.) Calibrations will be performed for each Rx lane selected. Each Rx test uses the corresponding calibration for each specific lane to be tested.

If the 'Map DUT lanes to test instrument channels' check box is selected in the Station Configuration window, the Lanes dialog appears as shown in Figure 2-19. You may select all lanes and each tested lane can be mapped to one of the available generator and analyzer channels. Mapping of different lanes to various instruments can help you avoid cable re-connections.

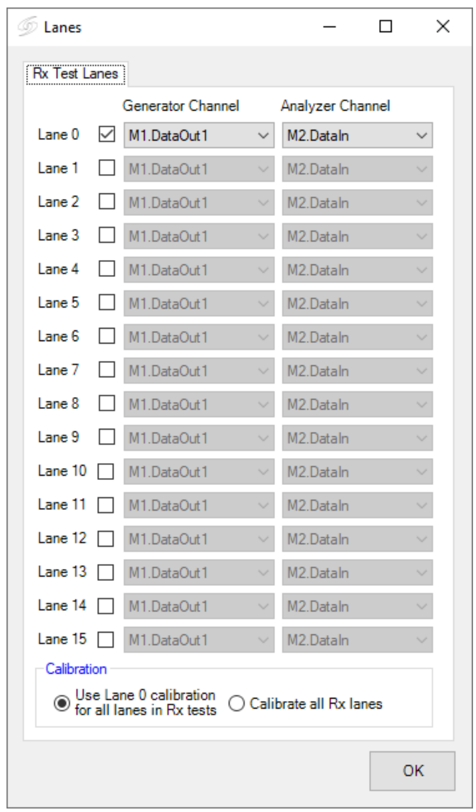

Figure 2-19 Lanes configuration panel when 'Map DUT lanes to test instrument channels' is selected

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3 Using the Software

This chapter describes how to select the calibrations and test procedures that are to be run and how — in expert mode — you can modify the parameters to go beyond the tests specified by the CTS.

KEYSIGHT

Introduction to Using the Software

Once the DUT has been configured, click ‘OK’ in the Configure DUT panel. The PCI Express main window will appear with the procedure tree in the left-hand pane (Figure 3-1). Click on a procedure or group to see the associated parameters in the right-hand pane.

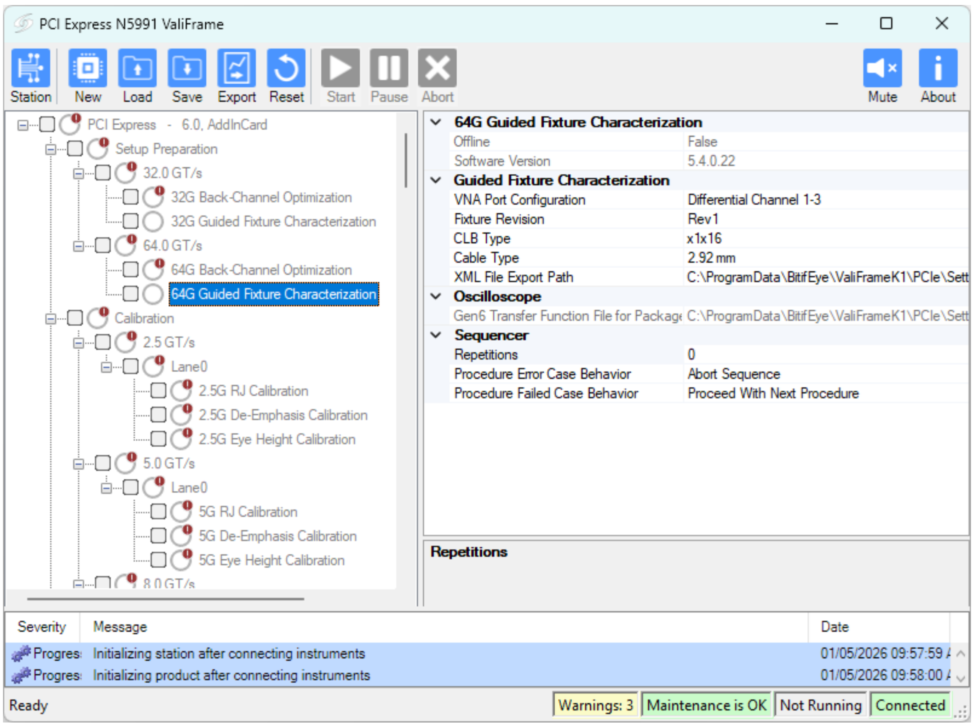

Figure 3-1 PCI Express N5991 ValiFrame main window

Parts of the Main Window

The functions of the buttons in the **toolbar** are described just below.

All the relevant calibration and test procedures are listed in groups in a **procedure tree** (left-hand pane, Figure 3-1), similarly to how they are organized in the CTS.

The **parameter grid** on the right side of the window shows the parameters that are related to the individual procedure or group of procedures selected on the left.

The **log list** in the bottom pane of the window shows calibration and test status messages (regular progress updates as well as warnings and error messages).

The **status bar** at the very bottom provides information about how many critical errors have occurred, how many warnings have been sent, the status of the software maintenance license and whether ValiFrame is running.

ValiFrame Toolbar

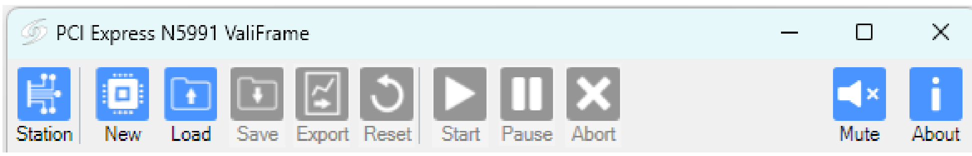

Figure 3-2 Toolbar

- Use the **Station** button to configure the Test Station. See Configuring the Test Station on page 26.
- Use **New** to open the PCI Express Configure Product window. This allows you to configure a new DUT or change the DUT and test parameters. See Configuring the DUT and Test Parameters on page 33.
- If you have already configured the N5991 PCI Express ValiFrame software for a particular product and saved the settings as a configuration file, you can click **Load** to use the same station, product and test parameters again, which can save time.
- The **Save** button is used to save settings for a particular project. You can save the settings as either a ValiFrame configuration file (.vfc; this contains the changed parameters and the selected procedures) or a ValiFrame project file (.vfp; contains the same as the configuration file and in addition the results of the current run). See the ValiFrame Getting Started Guide for more details.
- Use the **Export** button to save results of measurements. See Exporting Results on page 65 for details.
- **Reset** sets ALL parameters to their default values.
- To start one or more procedures, select the corresponding check box(es). Then the **Start** button is enabled and turns blue. Click ‘Start’ to run the selected procedure(s).
- **Pause** interrupts the current run at the end of the current step. When the test is paused, the Start button is relabeled **Step**. You have two options when a procedure is paused:

   - Click ‘Step’ to continue the procedure and pause at the next step.
   - Click ‘Pause’ again to toggle the state of the Start/Step button. Then click ‘Start’ to continue running the test until the end of the procedure.

  The Step feature is useful for debugging purposes, for example to analyze the signal on the oscilloscope at each step. When a procedure is paused, a message in the bottom-left corner of the main window indicates which step has been reached.

- **Abort** stops the current run and closes the procedure window.
- ValiFrame produces a sound to indicate when a different state of the program has been reached. You can turn this off (and on again) using the **Mute** button.
- The **About** button opens a window that provides details of the software, such as the version of ValiFrame that is being run, the Container ID of the license and when the software maintenance will expire. The window can also be used to send a report to Support if you encounter persistent problems. For more details see the ValiFrame Getting Started Guide.

CAUTION

Before executing the calibration or test procedures, ensure that the PCI Express Station is configured properly with all necessary instruments, such as the Infiniium oscilloscope, set to “online”. All calibrations can also be run in offline mode, that is, without any instrument connected. However, the offline mode is intended for product demonstrations with simulated data only. CALIBRATIONS RUN IN OFFLINE MODE DO NOT GENERATE VALID CALIBRATION DATA.

Selecting, Modifying & Running Procedures

Selecting Procedures

The setup preparation, calibration, receiver, link equalization and receiver-setup procedure groups can be selected globally by selecting the check box at the top of the group, as can a subgroups such as a certain data rate. Alternatively, one or more individual test procedures can be selected by checking the corresponding check boxes next to the procedure names. Click ‘Start’ (Figure 3-3) to run the selected procedures.

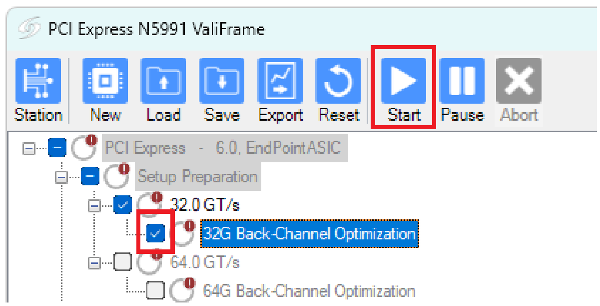

Figure 3-3 Selecting and starting a procedure

Modifying Parameters

Most calibration and test procedures, as well as the groups containing them, have parameters that control the details of how the procedures are run. In compliance mode, most of these parameters are read-only. In expert mode, most of the parameters can be modified.

To modify a parameter, first select a specific calibration or test procedure or one of the groups contained in the N5991 procedure tree, as shown in Figure 3-4. The corresponding parameters are displayed in a property list (parameter grid) in the right pane. These parameters can be configured only before the selected procedure subgroup or procedure is started. All of the selected test parameters are listed in the test results.

For more details about parameters, see PCI Express ValiFrame Parameters on page 68.

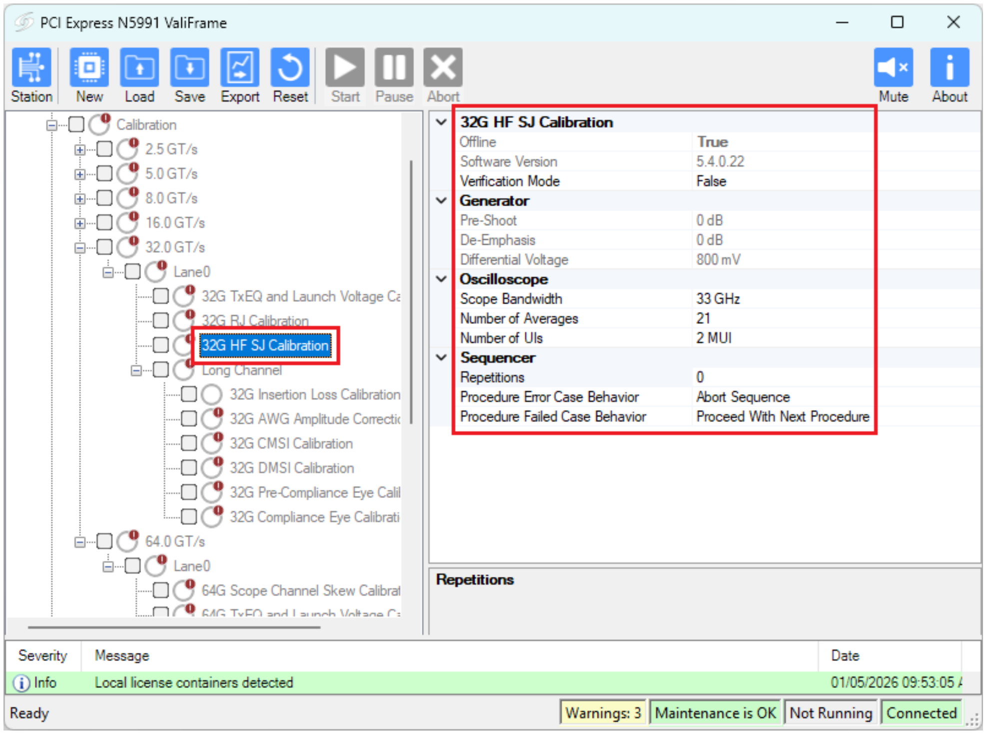

Figure 3-4 Modifying parameters

Running Procedures

To run the selected procedure(s), click the Start icon on the toolbar (see Figure 3-3). The procedures are run sequentially in the order shown in the procedure tree. Some procedures may require user intervention, such as changing cable connections or entering DUT parameters. The required action is prompted in pop-up dialog boxes.

To view the appropriate connection diagram, right-click the desired test or calibration. From the right-click menu, select ‘Show Connection...’. See also Connection Diagrams on page 60.

State Icons

Once the selected procedures have been run, the state icon next to a group or an individual procedure indicates the result (pass / fail / incomplete) and provides further information.

For an explanation of the icon beside a particular procedure, right-click the procedure name and select ‘Show State Details...’ (Figure 3-5). For more information about all state icons, refer to the ValiFrame Getting Started Guide.

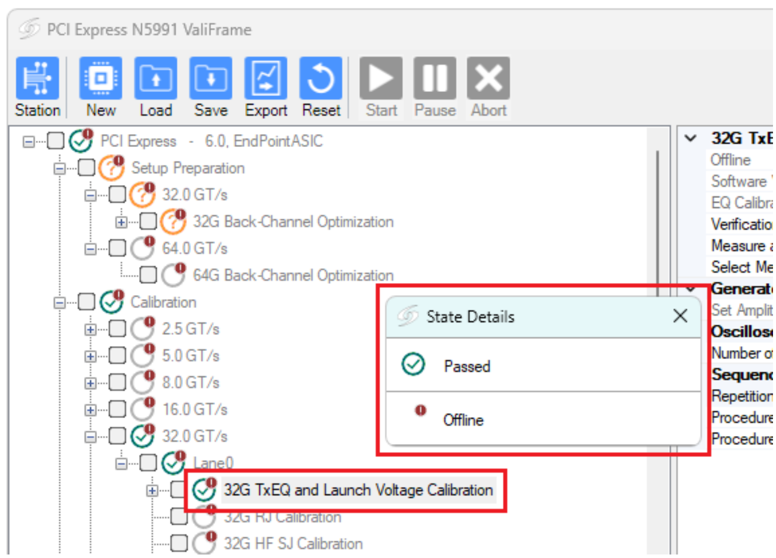

Figure 3-5 State icons

Connection Diagrams

To view the connection diagram for a particular set of instruments and procedure, right-click the desired test or calibration in the procedure tree. From the context menu select “Show Connection...”.

The window that opens consists of a connection diagram surrounded by five buttons, which are outlined in red and numbered in Figure 3-6.

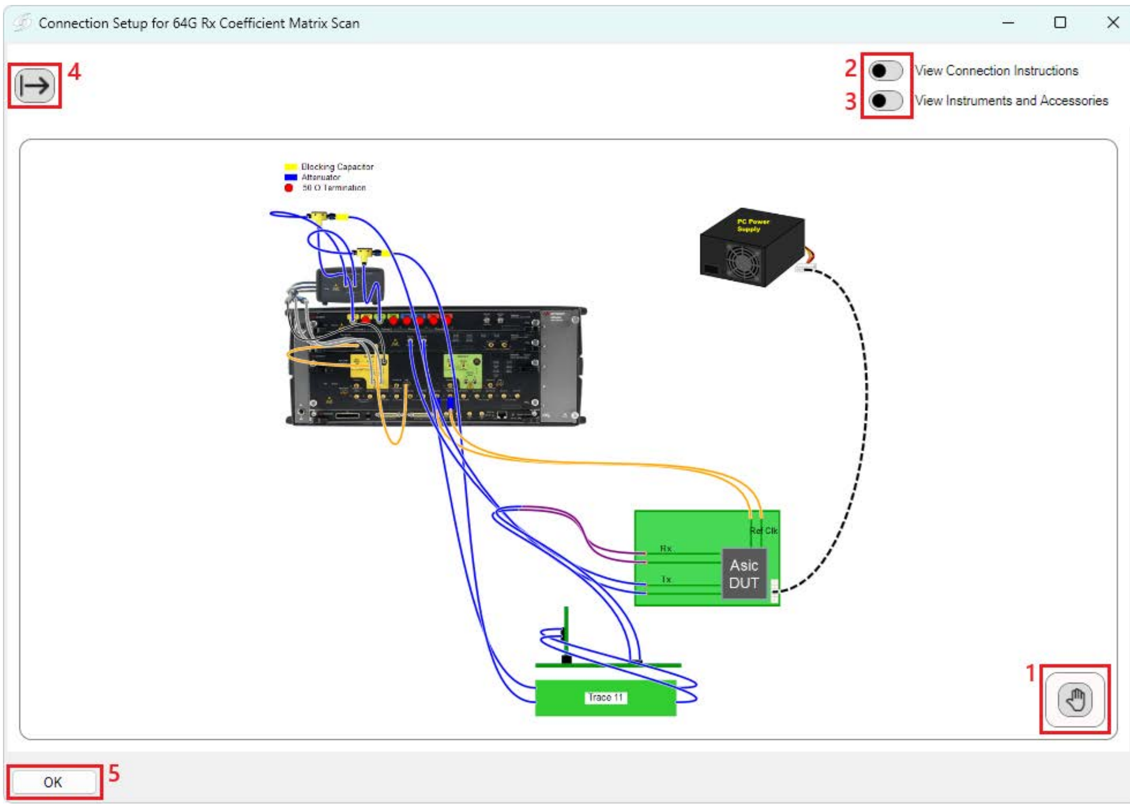

Figure 3-6 Example connection diagram, default view

1 **Export Mode**: Click here to change the positions of the individual instruments and cables in the connection diagram before exporting it. This is intended to increase the clarity of the connections. For more details about how to manipulate the components, see the ValiFrame Getting Started Guide. Try double-clicking a component and then either drag-and-dropping it or using the mouse wheel.

2 **Connection Instructions**: Toggle to 'on' to view the connection instructions and further information. It is possible to open step-by-step instructions, where the connection currently being made is highlighted (Figure 3-7).

3 **Instruments and Accessories**: Toggle to 'on' to view the list of required instruments and accessories (Figure 3-7). If the list of instruments and accessories is expanded, it will be included in the exported HTML report.

4 **Export**: Export the diagram as an HTML file.

5 **OK**: Click here to close the connection diagram window.

For more details, see the ValiFrame Getting Started Guide.

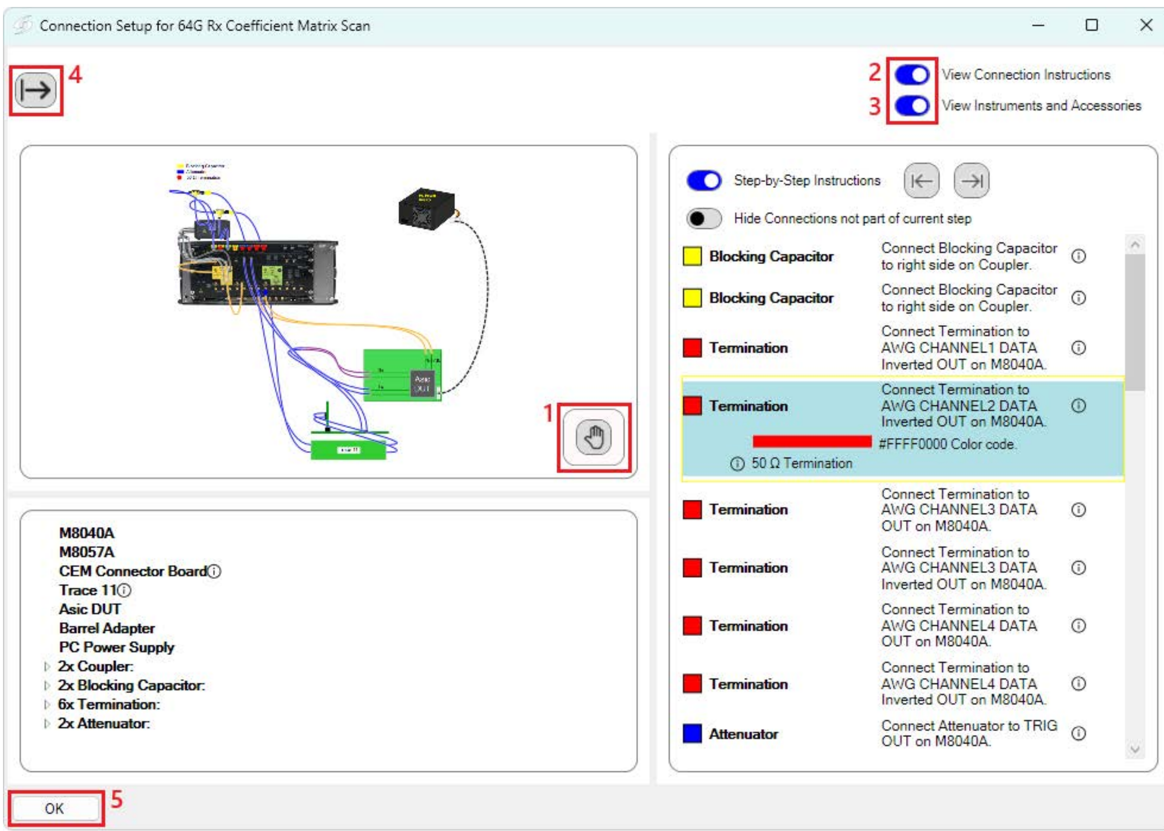

Figure 3-7 Connection diagram window with step-by-step instructions and list of instruments

Required Calibration Data

Some of the calibration procedures and most of the test procedures require calibration data that has been measured previously. You can see the calibration data required by a particular procedure by right clicking its name in the procedure tree and selecting 'Required Calibrations'. A list of the prerequisite calibrations drops down (Figure 3-8).

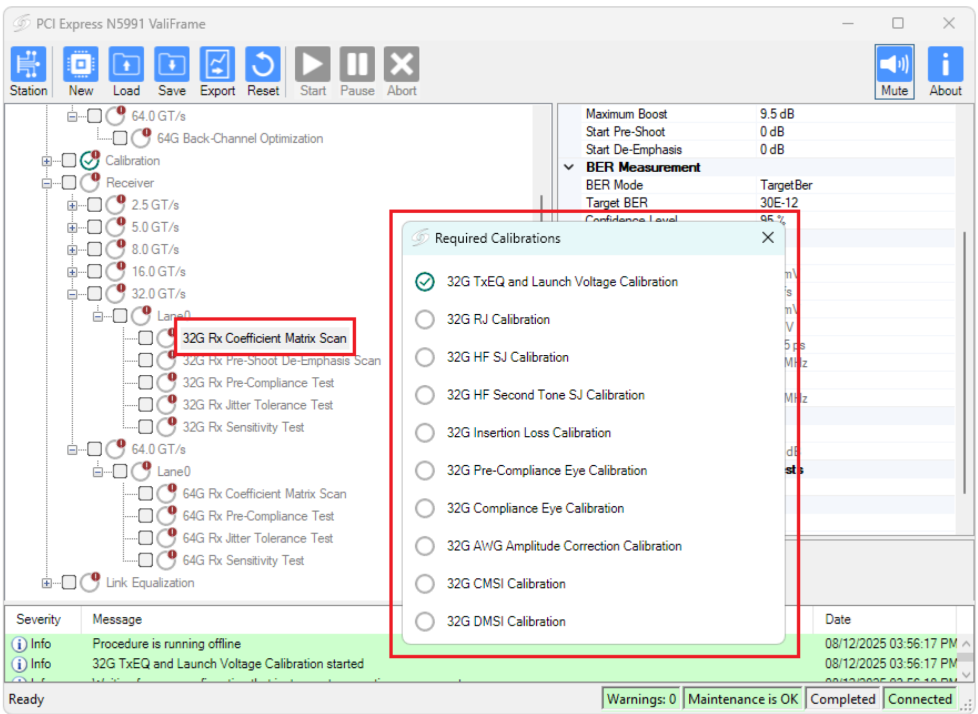

Figure 3-8 Example list of required calibrations

The icon next to the name of a calibration procedure in the list indicates whether the calibration has been run successfully (green), is incomplete (yellow), failed (red) or has not yet been run (gray).

N5991 PCI Express Data Structure

All the N5991 PCI Express internal data is saved on the PC's local disk in the application data folder ProgramData\BitifEye\ValiFrameK1\PCIe.

NOTE

Windows hides the system folders by default. To make the application data folder visible, check 'Hidden items' in the Windows file explorer > View > Show.

The N5991 PCI Express data folder contains the folders listed below:

- **Calibrations**: The calibration data is saved in the Calibrations folder. For each calibration procedure run, at least one calibration file is saved.
- **CalibrationsOffline**: If the calibration was run in offline (simulation/demonstration) mode, the calibration data is saved in the CalibrationsOffline folder. Offline calibrations are for demonstration purposes only. They do not yield valid data.
- **Data**: Data from the test runs are saved in the Data folder.
- **Pattern**: The pattern files (mainly .ptrn) used in the various procedures are saved in the Pattern folder.
- **Projects**: The Projects folder is the default folder for ValiFrame project (.vfp) and configuration (.vfc) files. These can be saved by clicking the Save icon in the PCI Express ValiFrame main window.
- **Settings**: The Settings folder contains settings files. These will include the instrument connection setup, the Station Configuration setup and settings for the last configured DUT, for example, as well as settings related to the specification and also training scripts, Seasim templates and transfer functions. If you are using the Setup Preparation procedure, this is where the toggle scripts and back-channel optimization files are saved. Similarly, if you are using the Guided Fixture Characterization, the results of that are saved here by default.
- **SParameter**: N5991 PCI Express does not save anything in the SParameter folder.

Results

Run-Time Data Display

Most procedures generate data output. While the procedure is running, the data is displayed in a results viewer window, which opens automatically for each individual procedure.

Any results windows that are open during the procedure runs are closed automatically once the specific procedure is finished. As long as the N5991 software is running, each result file (HTML page) can be reopened by double-clicking the respective procedure. However, the individual files are lost when the N5991 ValiFrame main window is closed, unless you save the individual files or a collection of them.

Description of Results

In this User's Guide, the descriptions of the calibration and test procedures include example descriptions of the results. In addition to a graph and a table, there is a text in each set of results that notes the conditions under which the procedure was carried out, including a list of instruments used and their associated firmware. In order to save space, the list of instruments is not shown completely for each procedure in this User's Guide, because they are very similar, but simply as an example here (Figure 3-9).

----Instruments----

Measurement Instrument 1	Name: Keysight M8050A J-BERT ; Company: Keysight Technologies ; Model: M8070B ; SN: MY[redacted] ; FW rev.: 12.0.150.6 ; Description: M8050 with integrated jitter sources for BER tests ; Firmware Version Supported: True ; Measurement Instrument
Measurement Instrument 2	Name: ClkGen ; Company: Keysight Technologies ; Model: M8009A ; SN: MY[redacted] ; FW rev. 5.0.50.0 ; Description: M8050 with integrated jitter sources for BER tests ; Firmware Version Supported: Unknown ; Measurement Instrument
Measurement Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ; Model: M8042A,M8058A ; SN: MY[redacted],US[redacted] ; FW rev.: 5.0.50.0 ; Description: M8050 with integrated jitter sources for BER tests ; Firmware Version Supported: Unknown ; Measurement Instrument
Measurement Instrument 4	Name: DataOut1 ; Company: Keysight Technologies ; Model: M8054A ; SN: MY[redacted] ; FW rev.: 1.0.34.0 ; Description: M8050 with integrated jitter sources for BER tests ; Firmware Version Supported: Unknown ; Measurement Instrument
Measurement Instrument 5	Name: DataOut2 ; Company: Keysight Technologies ; Model: M8054A ; SN: MY[redacted] ; FW rev.: 1.0.34.0 ; Description: M8050 with integrated jitter sources for BER tests ; Firmware Version Supported: Unknown ; Measurement Instrument
Measurement Instrument 6	Name: Keysight DSO ; Company: KEYSIGHT TECHNOLOGIES ; Model: UXR0804A ; SN: MY[redacted] ; FW rev.: 11.70.00015 ; Description: Realtime scope for calibration and transmitter tests ; Firmware Version Supported: True ; Measurement Instrument

Figure 3-9 Example 'Instruments' section in results for a calibration

Exporting Results

For your convenience, all individual results are summarized in an HTML document at the end of the test run. All calibration and test data report pages can be saved in a report by clicking the Export button on the toolbar of the PCI Express N5991 ValiFrame main window. More details can be found in the ValiFrame Getting Started Guide.

Keysight recommends exporting results at least at the end of each N5991 run to avoid any data loss. If several calibration and test procedures are conducted during the same N5991 run, the resulting report pages are combined in a single report.

NOTE

As a safety feature, all calibration and test results are saved by default to the N5991 “Tmp” directory (C:\ProgramData\BitifEye\ValiFrameK1\Tmp). The “Results\PCIe Station” sub-folder of this contains the files of the most-recent results measured for PCI Express for each calibration and test procedure.

In addition to the calibration data report, calibration data files are generated. These files are saved by default to the N5991 Calibrations folder. If these calibrations are run again, the data file is overwritten. To save the calibration data files at each configuration, the files must be copied from the directory *C:\ ProgramData\BitifEye\ValiFrameK1\PCIe\Calibrations* and saved manually in any folder before rerunning the calibrations.

An exported report includes a summary of the procedures performed in that run (Figure 3-10) and details of the instruments used (Figure 3-11).

Procedure result summary

Shows the procedure results as an overview

Product Number:	PCIe
Serial Number:	
Description:	
User Name:	Unknown User
User's Comment:	
Software Version:	
PCI Express N5991 ValiFrame	5.4.0.22

Procedure name	Timestamp	Result	Instruments	Software Version	Spec Deviations	Comments
L0_Cal_64GTps_ScopeChSkew	1/7/2026 1:03:30 PM	Passed	Offline	5.4.0.22		
L0_Cal_64GTps_TxEq	1/7/2026 1:07:39 PM	Passed	Offline	5.4.0.22		
L0_Cal_64GTps_RJ	1/7/2026 1:43:45 PM	Passed	Offline	5.4.0.22		
L0_Cal_64GTps_HFSJ	1/7/2026 1:56:18 PM	Passed	Offline	5.4.0.22		
L0_Cal_64GTps_HF2ndSJ	1/7/2026 1:56:18 PM	Passed	Offline	5.4.0.22		

Figure 3-10 Example Test Result Summary in a ValiFrame HTML report

- **Procedure Name**: The name of the procedure (test or calibration).
- **Timestamp**: The date and time at which the procedure ended.
- **Result**: Whether the procedure was passed or failed.
- **Instruments**: Either ‘Connected’ or ‘Offline’ (simulation mode).
- **Software Version**: The version of the ValiFrame software used to perform the procedure (calibration or test).
- **Spec Deviations**: The parameters that have been changed so that the procedure no longer agrees with the CTS.
- **Comments**.

Instrument Summary

This table lists the instruments used to run these procedures.

Company	Instrument Name	Serial	Instrument Revision	Description
Keysight Technologies	Keysight M8040A J-BERT	Unknown	Unknown	M8040 with integrated jitter sources for BER tests
Keysight Technologies	M8045A,M8057A	DE[redacted],DE[redacted]	7.5.700.8	M8040 with integrated jitter sources for BER tests
Keysight Technologies	M8195A	DE[redacted]	4.0.0.0	M8040 with integrated jitter sources for BER tests
Keysight Technologies	M8195A	DE[redacted]	4.0.0.0	M8040 with integrated jitter sources for BER tests
Keysight Technologies	DSO Infiniium Series	Unknown	Unknown	Realtime scope for calibration and transmitter tests

Figure 3-11 Example list of instruments in an N5991 ValiFrame PCI Express report

- **Company**: The manufacturer of the instrument.
- **Instrument Name**: The model number or name of the instrument.
- **Serial**: The serial number of the instrument.
- **Instrument Revision**: The revision number or version of the software running on the instrument.
- **Description**: The type of instrument, e.g., real-time oscilloscope.

PCI Express ValiFrame Parameters

PCI Express ValiFrame parameters are of three types:

- Sequencer Parameters
- Common Parameters
- Procedure Parameters

Sequencer Parameters

The sequencer parameters control the flow of the test sequencer only, not the behavior of individual procedures. One of them, Repetitions, is available for all procedures and groups in the procedure tree. The others are available only for individual procedures. Like all other parameters, the sequencer parameters are shown on the right side of the ValiFrame user interface, as illustrated in Figure 3-12, and you may manually change them. The sequencer parameters are described in Table A-1 on page 317.

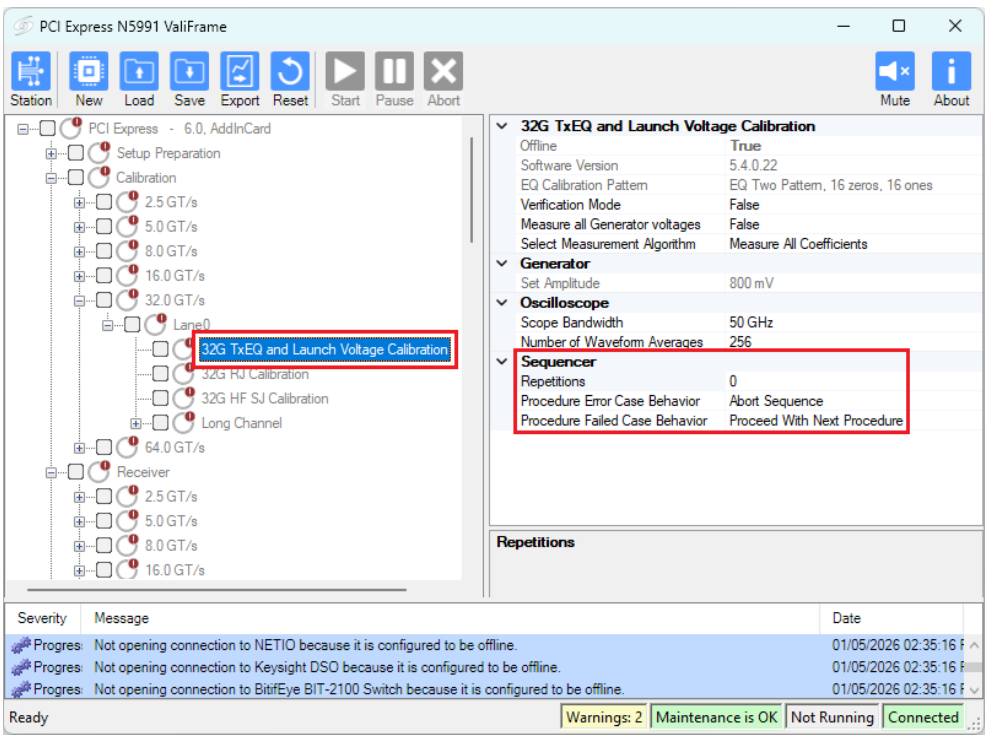

Figure 3-12 Sequencer parameters

Common Parameters

Common parameters are used for several related calibration or test procedures. They are shown on the right side of the ValiFrame user interface when the selected entry of the procedure tree on the left is a group instead of an individual procedure. The PCIe common parameters are listed and described as follows:

- Common setup preparation parameters: Table A-2 on page 318
- Common calibration parameters: Table A-3 on page 319
- Common receiver parameters: Table A-4 on page 324
- Common link equalization parameters: Table A-5 on page 334

Procedure Parameters

The Procedure Parameters are all those parameters that are not part of either of the previously described categories. They are shown on the right side of the ValiFrame user interface when the selected entry of the procedure tree on the left is an individual procedure. Their purpose is to modify the behavior of that single procedure. Different procedures often have parameters with the same name, but pre-configured settings always apply to the selected procedure. The meanings of the parameters may differ slightly between procedures.

The PCIe parameters for individual procedures that are available in Expert Mode are listed as follows:

- Setup preparation parameters for individual procedures: Table A-6 on page 345
- Calibration parameters for individual procedures: Table A-7 on page 348
- Receiver parameters and receiver setup parameters for individual procedures: Table A-8 on page 360
- Link equalization parameters for individual procedures: Table A-9 on page 370

NOTE

Some parameters that are read-only in the user interface main window can be changed when you configure the Test Station while others can be changed when you configure the DUT.

If the value of a parameter appears in boldface type in the parameter grid of the GUI, this indicates that the value is not the default value.

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4 Procedure Tree Overview

This chapter provides a convenient way of finding the description of the procedure that you want to perform.

Introduction

The tables in this chapter list the procedures exactly as in the procedure tree of the ValiFrame software.

NOTE **The order of the procedures varies slightly depending on the method used for eye calibration: Seasim or SigTest. The order used here is that for Seasim for interface type ASIC and SigTest for CEM, U.2 and M.2.**

NOTE **Click on the page number in the table to jump to the description of the corresponding procedure.**

The procedures are listed according to procedure type and interface type.

Setup Preparation

- Setup Preparation (ASIC): Table 4-1 on page 73
- Setup Preparation (CEM): Table 4-2 on page 73
- Setup Preparation (M.2): Table 4-3 on page 73

Calibrations

- Calibrations (ASIC): Table 4-4 on page 74
- Calibrations (CEM): Table 4-5 on page 76
- Calibrations (U.2): Table 4-6 on page 79
- Calibrations (M.2): Table 4-7 on page 79

Receiver Tests

- Rx Tests (ASIC): Table 4-8 on page 81
- Rx Tests (CEM): Table 4-9 on page 82
- Rx Tests (U.2: Table 4-10 on page 83
- Rx Tests (M.2): Table 4-11 on page 84

Link Equalization Tests

- LEQ Rx Tests (ASIC): Table 4-12 on page 85
- LEQ Rx Tests (CEM): Table 4-13 on page 86
- LEQ Rx Tests (U.2): Table 4-14 on page 86
- LEQ Rx Tests (M.2): Table 4-15 on page 87
- LEQ Tx Tests: Table 4-16 on page 87

Receiver Setup Procedures

- Rx Setup (ASIC): Table 4-17 on page 88
- Rx Setup (CEM): Table 4-18 on page 88
- Rx Setup (U.2; M.2): Table 4-19 on page 88

Setup Preparation Procedures

Table 4-1 Receiver setup procedures available for ASIC interfaces

Data Rate	Receiver Setup Procedure	Page Number of Description
32.0 GT/s	32G Back-Channel Optimization	96
64.0 GT/s*	64G Back-Channel Optimization	96

Table 4-2 Receiver setup procedures available for CEM interfaces

Data Rate	Receiver Setup Procedure	Page Number of Description
32.0 GT/s	32G Back-Channel Optimization	96
	32G Guided Fixture Characterization	106
64.0 GT/s*	64G Back-Channel Optimization	96
	64G Guided Fixture Characterization	106

* Procedures at 64 GT/s are available for CEM interfaces in Expert Mode only.

Table 4-3 Receiver setup procedures available for M.2 interfaces

Data Rate	Receiver Setup Procedure	Page Number of Description
32.0 GT/s	32G Back-Channel Optimization	96

Calibration Procedures

Table 4-4 Calibrations performed for ASIC interfaces

Data Rate	Calibration	Page Number of Description
2.5 GT/s	2.5G RJ Calibration	131
	2.5G ISI Calibration	129
	2.5G CMSI Calibration	120
	2.5G Eye Height Calibration	126
5.0 GT/s	5G RJ Calibration	131
	5G ISI Calibration	129
	5G CMSI Calibration	120
	5G Eye Height Calibration	126
8.0 GT/s	**Direct-Connection Calibrations**	
	8G TxEQ and Launch Voltage Calibration	155
	8G RJ Calibration	145
	Custom Measurements*	
	8G TxEQ and Launch Voltage Measurement	163
	Long Channel	
	8G Insertion Loss Calibration	212
	8G CMSI Calibration	173
	8G DMSI Calibration	193
	8G Stressed Jitter Eye Calibration	224
16.0 GT/s	**Direct-Connection Calibrations**	
	16G TxEQ and Launch Voltage Calibration	155
	16G RJ Calibration	145
	16G HF SJ Calibration	137
	16G HF Second Tone SJ Calibration	134
	Custom Measurements*	
	16G TxEQ and Launch Voltage Measurement	163
	Long Channel	
	16G Insertion Loss Calibration	212
	16G Initial Equalization Preset Optimization	209
	16G Channel Calibration	169
	16G Final Equalization Preset Optimization	205
	16G AWG Amplitude Correction Calibration	167
	16G CMSI Calibration	173
	16G DMSI Calibration	193
	16G Pre-Compliance Eye Calibration	219

Table 4-4 Calibrations performed for ASIC interfaces (cont.)

Data Rate	Calibration	Page Number of Description
	16G Compliance Eye Calibration	176
	Custom Calibrations*	
	16G Custom Eye Calibration	185
	16G Custom Eye Scan Calibration	188
	Custom Measurements*	
	16G Eye Height and Width Measurement	199
	16G Eye Height and Width Scan	202
	16G Processing of Pre-Recorded Steps	223
32 GT/s	**Direct-Connection Calibrations**	
	32G TxEQ and Launch Voltage Calibration	155
	32G RJ Calibration	145
	32G HF SJ Calibration	137
	32G HF Second Tone SJ Calibration	134
	Custom Measurements*	
	32G TxEQ and Launch Voltage Measurement	163
	Long Channel	
	32G Insertion Loss Calibration	212
	32G Pre-Compliance Eye Calibration	219
	32G Compliance Eye Calibration	176
	32G AWG Amplitude Correction Calibration	167
	32G CMSI Calibration	173
	32G DMSI Calibration	193
	Custom Calibrations*	
	32G Custom Eye Calibration	185
	32G Custom Eye Scan Calibration	188
	Custom Measurements*	
	32G Eye Height and Width Measurement	199
	32G Eye Height and Width Scan	202
	32G Processing of Pre-Recorded Steps	223
64.0 GT/s	**Direct-Connection Calibrations**	
	64G Scope Channel Skew Calibration	148
	64G TxEQ and Launch Voltage Calibration	155
	64G RJ Calibration	145
	64G HF SJ Calibration	137
	64G HF Second Tone SJ Calibration	134
	64G Pulsewidth Jitter Calibration	143

Table 4-4 Calibrations performed for ASIC interfaces (cont.)

Data Rate	Calibration	Page Number of Description
	64G SNDR Calibration	153
	Custom Measurements*	
	64G TxEQ and Launch Voltage Measurement	163
	Long Channel	
	64G Insertion Loss Calibration	212
	64G Pre-Compliance Eye Calibration	219
	64G Compliance Eye Calibration	176
	64G AWG Amplitude Correction Calibration	167
	64G CMSI Calibration	173
	64G DMSI Calibration	193
	Custom Calibrations*	
	64G Custom Eye Calibration	185
	64G Custom Eye Scan Calibration	188
	Custom Measurements*	
	64G Eye Height and Width Measurement	199
	64G Eye Height and Width Scan	202
	64G Processing of Pre-Recorded Steps	223

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

Table 4-5 Calibrations performed for CEM interfaces

Data Rate	Calibration	Page Number of Description
2.5 GT/s	2.5G RJ Calibration	131
	2.5G De-Emphasis Calibration	123
	2.5G Eye Height Calibration	126
5.0 GT/s	5G RJ Calibration	131
	5G De-Emphasis Calibration	123
	5G Eye Height Calibration	126
8.0 GT/s	**Direct Connection Calibrations**	
	8G TxEQ and Launch Voltage Calibration	155
	8G RJ Calibration	145
	8G SJ Calibration	150
	Custom Measurements*	
	8G TxEQ and Launch Voltage Measurement	163

Table 4-5 Calibrations performed for CEM interfaces (cont.)

Data Rate	Calibration	Page Number of Description
	Long Channel, CBB rev. 3	
	8G DMSI Calibration	193
	8G Eye Height and Width Calibration	196
	8G Compliance Eye Calibration	176
16.0 GT/s	**Direct Connection Calibrations**	
	16G TxEQ and Launch Voltage Calibration	155
	16G RJ Calibration	145
	16G LF SJ Calibration	140
	16G HF SJ Calibration	137
	Custom Measurements*	
	16G TxEQ and Launch Voltage Measurement	163
	Long Channel, CBB rev. 4	
	16G Insertion Loss Calibration	212
	16G AWG Amplitude Correction Calibration	167
	16G CMSI Calibration	173
	16G DMSI Calibration	193
	16G Initial Equalization Preset Optimization	209
	16G Channel Calibration	169
	16G Final Equalization Preset Optimization	205
	16G Pre-Compliance Eye Calibration	219
	16G Compliance Eye Calibration	176
	Custom Calibrations*	
	16G Custom Eye Calibration	185
	16G Custom Eye Scan Calibration	188
	Custom Measurements*	
	16G Eye Height and Width Measurement	199
	16G Eye Height and Width Scan	202
32 GT/s	**Direct Connection Calibrations**	
	32G TxEQ and Launch Voltage Calibration	155
	32G RJ Calibration	145
	32G HF SJ Calibration	137
	Custom Measurements*	
	32G TxEQ and Launch Voltage Measurement	163
	Long Channel	
	32G Insertion Loss Calibration	212
	32G AWG Amplitude Correction Calibration	167

Table 4-5 Calibrations performed for CEM interfaces (cont.)

Data Rate	Calibration	Page Number of Description
	32G CMSI Calibration	173
	32G DMSI Calibration	193
	32G Pre-Compliance Eye Calibration	219
	32G Compliance Eye Calibration	176
	Custom Calibrations*	
	32G Custom Eye Calibration	185
	32G Custom Eye Scan Calibration	188
	Custom Measurements*	
	32G Eye Height and Width Measurement	199
	32G Eye Height and Width Scan	202
64.0 GT/s**	**Direct-Connection Calibrations**	
	64G Scope Channel Skew Calibration	148
	64G TxEQ and Launch Voltage Calibration	155
	64G RJ Calibration	145
	64G HF SJ Calibration	137
	64G Pulsewidth Jitter Calibration	143
	Custom Measurements*	
	64G TxEQ and Launch Voltage Measurement	163
	Long Channel	
	64G Insertion Loss Calibration	212
	64G Pre-Compliance Eye Calibration	219
	64G Compliance Eye Calibration	176
	64G AWG Amplitude Correction Calibration	167
	64G CMSI Calibration	173
	64G DMSI Calibration	193
	Custom Calibrations*	
	64G Custom Eye Calibration	185
	64G Custom Eye Scan Calibration	188
	Custom Measurements*	
	64G Eye Height and Width Measurement	199
	64G Eye Height and Width Scan	202
	64G Processing of Pre-Recorded Steps	223

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

** Procedures at 64 GT/s are available for CEM interfaces in Expert Mode only.

Table 4-6 Calibrations performed for U.2 interfaces

Data Rate	Calibration	Page Number of Description
8.0 GT/s	**Direct Connection Calibrations**	
	8G TxEQ and Launch Voltage Calibration	155
	8G RJ Calibration	145
	8G SJ Calibration	150
	Custom Measurement*	
	8G TxEQ and Launch Voltage Measurement	163
	Long Channel, CBB rev. 3	
	8G DMSI Calibration	193
	8G Eye Height and Width Calibration	196
	8G Compliance Eye Calibration	176

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

Table 4-7 Calibrations performed for M.2 interfaces

Data Rate	Calibration	Page Number of Description
8.0 GT/s	**Direct Connection Calibrations**	
	8G TxEQ and Launch Voltage Calibration	155
	8G RJ Calibration	145
	8G SJ Calibration	150
	Custom Measurement*	
	8G TxEQ and Launch Voltage Measurement	163
	Long Channel, CBB rev. 3	
	8G Device Insertion Loss Calibration	191
	8G DMSI Calibration	193
	8G Host Insertion Loss Calibration	208
	8G Eye Height and Width Calibration	196
	8G Compliance Eye Calibration	176
16.0 GT/s	**Direct Connection Calibrations**	
	16G TxEQ and Launch Voltage Calibration	155
	16G RJ Calibration	145
	16G LF SJ Calibration	140
	16G HF SJ Calibration	137
	Custom Measurement*	
	16G TxEQ and Launch Voltage Measurement	163

Table 4-7 Calibrations performed for M.2 interfaces (cont.)

Data Rate	Calibration	Page Number of Description
	Long Channel	
	16G Insertion Loss Calibration	212
	16G AWG Amplitude Correction Calibration	167
	16G CMSI Calibration	173
	16G DMSI Calibration	193
	16G Initial Equalization Preset Optimization	209
	16G Channel Calibration	169
	16G Final Equalization Preset Optimization	205
	16G Pre-Compliance Eye Calibration	219
	16G Compliance Eye Calibration	176
	Custom Calibration*	
	16G Custom Eye Calibration	185
	16G Custom Eye Scan Calibration	188
	Custom Measurements*	
	16G Eye Height and Width Measurement	199
	16G Eye Height and Width Scan	202
32.0 GT/s	**Direct Connection Calibrations**	
	32G TxEQ and Launch Voltage Calibration	155
	32G RJ Calibration	145
	32G HF SJ Calibration	137
	Custom Measurement*	
	32G TxEQ and Launch Voltage Measurement	163
	Long Channel	
	32G Insertion Loss Calibration	212
	32G AWG Amplitude Correction Calibration	167
	32G CMSI Calibration	173
	32G DMSI Calibration	193
	32G Pre-Compliance Eye Calibration	219
	32G Compliance Eye Calibration	176
	Custom Calibration*	
	32G Custom Eye Calibration	185
	32G Custom Eye Scan Calibration	188
	Custom Measurements*	
	32G Eye Height and Width Measurement	199
	32G Eye Height and Width Scan	202

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

Receiver Tests

Table 4-8 Receiver tests available for ASIC interfaces

Data Rate	Receiver Test	Page Number of Description
2.5 GT/s	2.5G Rx Compliance Test	244
	2.5G Rx Jitter Tolerance Test	247
	2.5G Rx Sensitivity Test	268
5.0 GT/s	5G Rx Compliance Test	244
	5G Rx Jitter Tolerance Test	247
	5G Rx Sensitivity Test	268
8.0 GT/s	8G Rx Coefficient Matrix Scan	236
	8G Rx Pre-Shoot De-Emphasis Scan	262
	8G Rx Pre-Complicance Test	254
	8G Rx Jitter Tolerance Test	247
16.0 GT/s	16G Rx Coefficient Matrix Scan	236
	16G Rx Pre-Shoot De-Emphasis Scan	262
	16G Rx Pre-Compliance Test	254
	16G Rx Jitter Tolerance Test	247
	16G Rx Sensitivity Test	268
	Custom Tests*	
	16G Rx Custom Coefficient Matrix Scan	243
	16G Rx Custom Pre-Shoot De-Emphasis Scan	267
	16G Rx Custom Pre-Compliance Test	258
	16G Rx Custom Jitter Tolerance Test	253
	16G Rx Custom Sensitivity Test	272
32 GT/s	32G Rx Coefficient Matrix Scan	236
	32G Rx Pre-Shoot De-Emphasis Scan	262
	32G Rx Pre-Compliance Test	254
	32G Rx Jitter Tolerance Test	247
	32G Rx Sensitivity Test	268
	Custom Tests*	
	32G Rx Custom Coefficient Matrix Scan	243
	32G Rx Custom Pre-Shoot De-Emphasis Scan	267
	32G Rx Custom Pre-Compliance Test	258
	32G Rx Custom Jitter Tolerance Test	253
	32G Rx Custom Sensitivity Test	272
64 GT/s	64G Rx Coefficient Matrix Scan	236
	64G Rx Pre-Compliance Test	254

Table 4-8 Receiver tests available for ASIC interfaces (cont.)

Data Rate	Receiver Test	Page Number of Description
	64G Rx Jitter Tolerance Test	247
	64G Rx Sensitivity Test	268
	Custom Tests*	
	64G Rx Custom Coefficient Matrix Scan	243
	64G Rx Custom Pre-Compliance Test	258
	64G Rx Custom Jitter Tolerance Test	253
	64G Rx Custom Sensitivity Test	272

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

Table 4-9 Receiver tests available for CEM interfaces

Data Rate	Receiver Test	Page Number of Description
2.5 GT/s	2.5G Rx Compliance Test	244
	2.5G Rx Jitter Tolerance Test	247
	2.5G Rx Sensitivity Test	268
5.0 GT/s	5G Rx Compliance Test	244
	5G Rx Jitter Tolerance Test	247
	5G Rx Sensitivity Test	268
8.0 GT/s	8G Rx Coefficient Matrix Scan	236
	8G Rx Pre-Shoot De-Emphasis Scan	262
	8G Rx Preset Pre-Compliance Test	259
	8G Rx Pre-Compliance Test	254
	8G Rx Jitter Tolerance Test	247
	8G Rx Sensitivity Test	268
16.0 GT/s	16G Rx Coefficient Matrix Scan	236
	16G Rx Pre-Shoot De-Emphasis Scan	262
	16G Rx Pre-Compliance Test	254
	16G Rx Jitter Tolerance Test	247
	16G Rx Sensitivity Test	268
	Custom Tests*	
	16G Rx Custom Coefficient Matrix Scan	243
	16G Rx Custom Pre-Shoot De-Emphasis Scan	267
	16G Rx Custom Pre-Compliance Test	258
	16G Rx Custom Jitter Tolerance Test	253
	16G Rx Custom Sensitivity Test	272

Table 4-9 Receiver tests available for CEM interfaces (cont.)

Data Rate	Receiver Test	Page Number of Description
32 GT/s	32G Rx Coefficient Matrix Scan	236
	32G Rx Pre-Shoot De-Emphasis Scan	262
	32G Rx Pre-Compliance Test	254
	32G Rx Jitter Tolerance Test	247
	32G Rx Sensitivity Test	268
	Custom Tests*	
	32G Rx Custom Coefficient Matrix Scan	243
	32G Rx Custom Pre-Shoot De-Emphasis Scan	267
	32G Rx Custom Pre-Compliance Test	258
	32G Rx Custom Jitter Tolerance Test	253
	32G Rx Custom Sensitivity Test	272
64 GT/s**	64G Rx Coefficient Matrix Scan	236
	64G Rx Pre-Compliance Test	254
	64G Rx Jitter Tolerance Test	247
	64G Rx Sensitivity Test	268
	Custom Tests*	
	64G Rx Custom Coefficient Matrix Scan	243
	64G Rx Custom Pre-Compliance Test	258
	64G Rx Custom Jitter Tolerance Test	253
	64G Rx Custom Sensitivity Test	272

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

** Procedures at 64 GT/s are available for CEM interfaces only in Expert Mode.

Table 4-10 Receiver tests available for U.2 interfaces

Data Rate	Receiver Test	Page Number of Description
8 GT/s	8G Rx Coefficient Matrix Scan	236
	8G Rx Pre-Shoot De-Emphasis Scan	262
	8G Rx Preset Pre-Compliance Test	259
	8G Rx Pre-Compliance Test	254
	8G Rx Jitter Tolerance Test	247
	8G Rx Sensitivity Test	268

Table 4-11 Receiver tests available for M.2 interfaces

Data Rate	Receiver Test	Page Number of Description
8 GT/s	8G Rx Coefficient Matrix Scan	236
	8G Rx Pre-Shoot De-Emphasis Scan	262
	8G Rx Preset Pre-Compliance Test	259
	8G Rx Pre-Compliance Test	254
	8G Rx Jitter Tolerance Test	247
	8G Rx Sensitivity Test	268
16 GT/s	16G Rx Coefficient Matrix Scan	236
	16G Rx Pre-Shoot De-Emphasis Scan	262
	16G Rx Pre-Compliance Test	254
	16G Rx Jitter Tolerance Test	247
	16G Rx Sensitivity Test	268
	Custom Tests*	
	16G Rx Custom Coefficient Matrix Scan	243
	16G Rx Custom Pre-Shoot De-Emphasis Scan	267
	16G Rx Custom Pre-Compliance Test	258
	16G Rx Custom Jitter Tolerance Test	253
	16G Rx Custom Sensitivity Test	272
32 GT/s	16G Rx Coefficient Matrix Scan	236
	16G Rx Pre-Shoot De-Emphasis Scan	262
	16G Rx Pre-Compliance Test	254
	16G Rx Jitter Tolerance Test	247
	16G Rx Sensitivity Test	268
	Custom Tests*	
	16G Rx Custom Coefficient Matrix Scan	243
	16G Rx Custom Pre-Shoot De-Emphasis Scan	267
	16G Rx Custom Pre-Compliance Test	258
	16G Rx Custom Jitter Tolerance Test	253
	16G Rx Custom Sensitivity Test	272

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

Link Equalization Tests

Table 4-12 Link equalization receiver tests available for ASIC interfaces

Data Rate	Link Equalization Receiver Test	Page Number of Description
8.0 GT/s	8G LEQ Rx Compliance Test	280
	8G LEQ Rx Jitter Tolerance Test	282
16.0 GT/s	16G LEQ Rx Compliance Test	280
	16G LEQ Rx Jitter Tolerance Test	282
	16G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	16G LEQ Rx Custom Compliance Test	281
	16G LEQ Rx Custom Jitter Tolerance Test	283
	16G LEQ Rx Custom Sensitivity Test	285
32 GT/s	32G LEQ Rx Compliance Test	280
	32G LEQ Rx Jitter Tolerance Test	282
	32G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	32G LEQ Rx Custom Compliance Test	281
	32G LEQ Rx Custom Jitter Tolerance Test	283
	32G LEQ Rx Custom Sensitivity Test	285
64 GT/s	64G LEQ Rx Compliance Test	280
	64G LEQ Rx Jitter Tolerance Test	282
	64G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	64G LEQ Rx Custom Compliance Test	281
	64G LEQ Rx Custom Jitter Tolerance Test	283
	64G LEQ Rx Custom Sensitivity Test	285

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

Table 4-13 **Link equalization receiver tests available for CEM interfaces**

Data Rate	Link equalization receiver test	Page Number of Description
8.0 GT/s	8G LEQ Rx Compliance Test	280
	8G LEQ Rx Jitter Tolerance Test	282
	8G LEQ Rx Sensitivity Test	284
16.0 GT/s	16G LEQ Rx Compliance Test	280
	16G LEQ Rx Jitter Tolerance Test	282
	16G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	16G LEQ Rx Custom Compliance Test	281
	16G LEQ Rx Custom Jitter Tolerance Test	283
	16G LEQ Rx Custom Sensitivity Test	285
32 GT/s	32G LEQ Rx Compliance Test	280
	32G LEQ Rx Jitter Tolerance Test	282
	32G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	32G LEQ Rx Custom Compliance Test	281
	32G LEQ Rx Custom Jitter Tolerance Test	283
	32G LEQ Rx Custom Sensitivity Test	285
64 GT/s**	64G LEQ Rx Compliance Test	280
	64G LEQ Rx Jitter Tolerance Test	282
	64G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	64G LEQ Rx Custom Compliance Test	281
	64G LEQ Rx Custom Jitter Tolerance Test	283
	64G LEQ Rx Custom Sensitivity Test	285

* Procedures listed under these headings are available only if “Include Custom Procedures” is checked in the PCIe Parameters dialog (see Figure 2-12 on page 40).

** Procedures at 64 GT/s are available for CEM interfaces only in Expert Mode.

Table 4-14 **Link equalization receiver tests available for U.2 interfaces**

Data Rate	Link Equalization Receiver Test	Page Number of Description
8.0 GT/s	8G LEQ Rx Compliance Test	280
	8G LEQ Rx Jitter Tolerance Test	282
	8G LEQ Rx Sensitivity Test	284

Table 4-15 Link equalization receiver tests available for M.2 interfaces

Data Rate	Link Equalization Receiver Test	Page Number of Description
8.0 GT/s	8G LEQ Rx Compliance Test	280
	8G LEQ Rx Jitter Tolerance Test	282
	8G LEQ Rx Sensitivity Test	284
16.0 GT/s	16G LEQ Rx Compliance Test	280
	16G LEQ Rx Jitter Tolerance Test	282
	16G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	16G LEQ Rx Custom Compliance Test	281
	16G LEQ Rx Custom Jitter Tolerance Test	283
	16G LEQ Rx Custom Sensitivity Test	285
32.0 GT/s	32G LEQ Rx Compliance Test	280
	32G LEQ Rx Jitter Tolerance Test	282
	32G LEQ Rx Sensitivity Test	284
	Custom Tests*	
	32G LEQ Rx Custom Compliance Test	281
	32G LEQ Rx Custom Jitter Tolerance Test	283
	32G LEQ Rx Custom Sensitivity Test	285

Table 4-16 Link equalization transmitter tests available for ASIC, CEM, U.2 and M.2 interfaces

Data Rate	Link Equalization Transmitter Test	Page Number of Description
8.0 GT/s	8G LEQ Tx Initial Preset Compliance Test	286
	8G LEQ Tx Response Time Compliance Test	290
16.0 GT/s*	16G LEQ Tx Initial Preset Compliance Test	286
	16G LEQ Tx Response Time Compliance Test	290
32 GT/s*	32G LEQ Tx Initial Preset Compliance Test	286
	32G LEQ Tx Response Time Compliance Test	290
64 GT/s**	64G LEQ Tx Initial Preset Compliance Test	286
	64G LEQ Tx Response Time Compliance Test	290

* These data rates are not available for U.2 interfaces.

** Procedures at 64 GT/s are available for CEM interfaces only in Expert Mode and not at all for U.2 and M.2 interfaces.

Receiver Setup Procedures

For details about how to enable these procedures in the procedure tree, see Chapter 9, Receiver Setup Procedures.

Table 4-17 Receiver setup procedures available for ASIC interfaces

Data Rate	Receiver Setup Procedure	Page Number of Description
2.5 GT/s	2.5G Rx Compliance Setup	311
5.0 GT/s	5G Rx Compliance Setup	311
8.0 GT/s	8G Rx Stressed Jitter Eye Setup	314
16.0 GT/s	16G Rx Pre-Compliance Setup	313
32.0 GT/s	32G Rx Impairments Setup	312
64.0 GT/s	64G Rx Impairments Setup	312

Table 4-18 Receiver setup procedures available for CEM interfaces

Data Rate	Receiver Setup Procedure	Page Number of Description
2.5 GT/s	2.5G Rx Compliance Setup	311
5.0 GT/s	5G Rx Compliance Setup	311
8.0 GT/s	8G Rx Pre-Compliance Setup	313
16.0 GT/s	16G Rx Pre-Compliance Setup	313
32.0 GT/s	32G Rx Impairments Setup	312
64.0 GT/s**	64G Rx Impairments Setup	312

** Procedures at 64 GT/s are available for CEM interfaces only in Expert Mode.

Table 4-19 Receiver setup procedure available for U.2 and M.2 interfaces

Data Rate	Receiver Setup Procedure	Page Number of Description
8.0 GT/s	8G Rx Pre-Compliance Setup	313
16.0 GT/s*	16G Rx Pre-Compliance Setup	313
32.0 GT/s*	32G Rx Impairments Setup	312

* These data rates are not available for U.2 interfaces.

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5 Setup Preparation Procedures

The first Setup Preparation procedure, back-channel optimization of the setup, ensures that the contribution of the back channel to the BER measured during tests is minimized. The second, Guided Fixture Characterization, aims to make the characterization of the fixture easier.

Overview

The setup preparation procedures are intended to make achieving an optimal setup as convenient and efficient as possible.

Setup Preparation Procedures are available if “Setup Preparation” is checked when configuring the DUT (see Figure 2-8 on page 34) and the required additional license has been activated.

Back-Channel Optimization

When testing receivers using loopback mode, a digital stressed signal is sent to the receiver. This signal is then retransmitted from the receiver’s transmitter to the test equipment (BERT). At higher speeds with multi-level modulation, the path of the signal from the DUT’s transmitter back to the test equipment, known as the back channel, has become a particular challenge. We need to be sure that, if a DUT fails, then it failed because of errors at the DUT receiver and not because of errors introduced in the back channel. This means that it is necessary to ensure that the back channel introduces as few errors as possible, significantly fewer than those occurring in the DUT. The N5991 PCI Express test automation software now includes a procedure to automate this optimization.

It is important that all parts of the back channel (PCB, traces, connectors, cables, redrivers, bonding wires within the DUT and BERT but also the FFE and ADC inside the BERT) are adjusted together for a given setup to achieve the lowest BER in the back channel: The DUT must send the best preset, the redriver must be set correctly, the FFE steps need to be adjusted and the sampling setup (sampling delay, input range and threshold) has to be fine-tuned.

If back-channel optimization (BCO) is active for a test, so-called realignment is always carried out.This means that just before a procedure is run, a quick optimization (realignment) is performed that takes approximately 5 s per preset. It adjusts for any small shifts that have occurred and is done only for the presets that are used in the test. If this realignment does not find similar settings to the BCO, it is time to rerun the BCO.

For more details about the back-channel optimization automation, including a description of the workflow, see the video BitifEye Explains: PCI Express 6.0 Receiver Testing & Back-Channel Tuning Made Easy.

Guided Fixture Characterization

This procedure guides you through the characterization of the fixtures used in the subsequent calibrations and test procedures, saving the results for later use in the ValiFrame software. It is currently available for the CEM interface at 32 GT/s and 64 GT/s data rates.

Connection Diagrams

In this User's Guide, only example connection diagrams are given. The exact connection diagram for a specific situation can be viewed by right-clicking the appropriate procedure in the procedure tree of the main window of the user interface and selecting “Show Connection...”.

PCI Express Common Receiver Parameters

The PCI Express Common Parameters are listed in the parameter grid (right pane) of the main window of the user interface when you click the corresponding group in the procedure tree in the left half of the main window. Clicking a data rate in the procedure tree shows you the data-rate-specific PCIe Common Parameters for that data rate.

Details of PCI Express Common Setup Preparation Parameters can be found in Table A-2 on page 318.

Parameters in Expert Mode for Individual Procedures

The PCI Express Parameters in expert mode for an individual procedure are not listed in this User's Guide explicitly. They are displayed in the parameter grid (right half) of the main window of the user interface when you click on the corresponding entry in the procedure tree in the left half of the main window.

Details of PCI Express Setup Preparation Parameters for individual procedures can be found in Table A-6 on page 345.

Example Connection Diagrams

Just example connection diagrams are shown here. For more details, right-click the appropriate procedure in the procedure tree of the user interface and select “Show Connection...”.

NOTE

In general, PCI Express N5991 v. 5.4.0 supports Keysight M8047 redrivers M8047A, M8047B and M8047C. However, M8047A is not supported for the Back-Channel Optimization procedure. Also, M8047B is supported for BCO only at 32 GT/s.

Since the setup used for BCO must be the same as the setup used later in test procedures, make sure that you use the appropriate redriver for tests where you wish to use back-channel data.

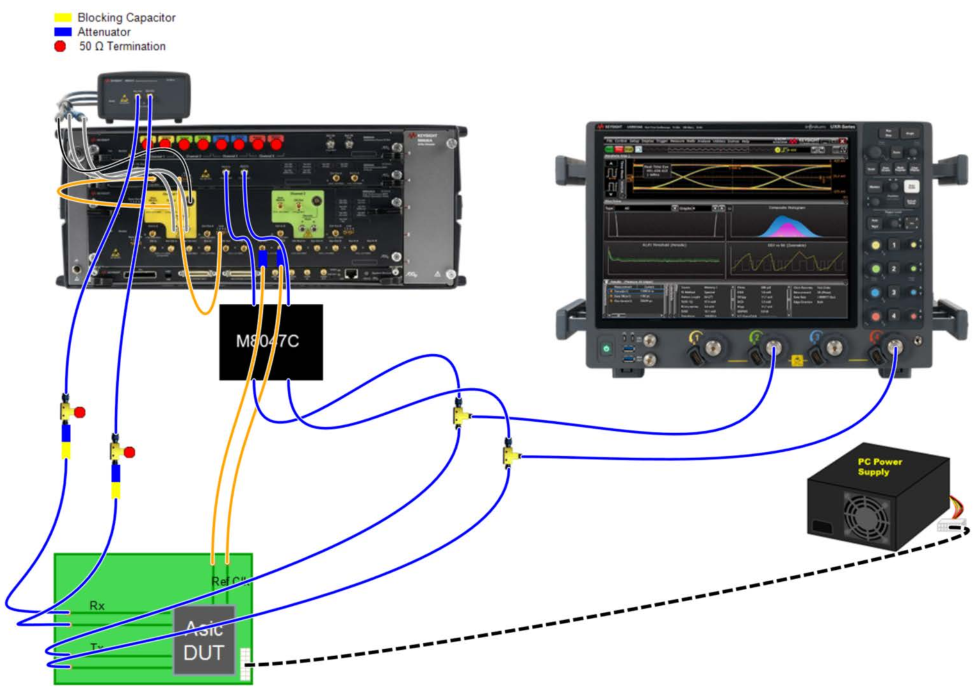

Figure 5-1 Example connection diagram for Back-Channel Optimization procedure (M8040A, ASIC) with M8047C redriver

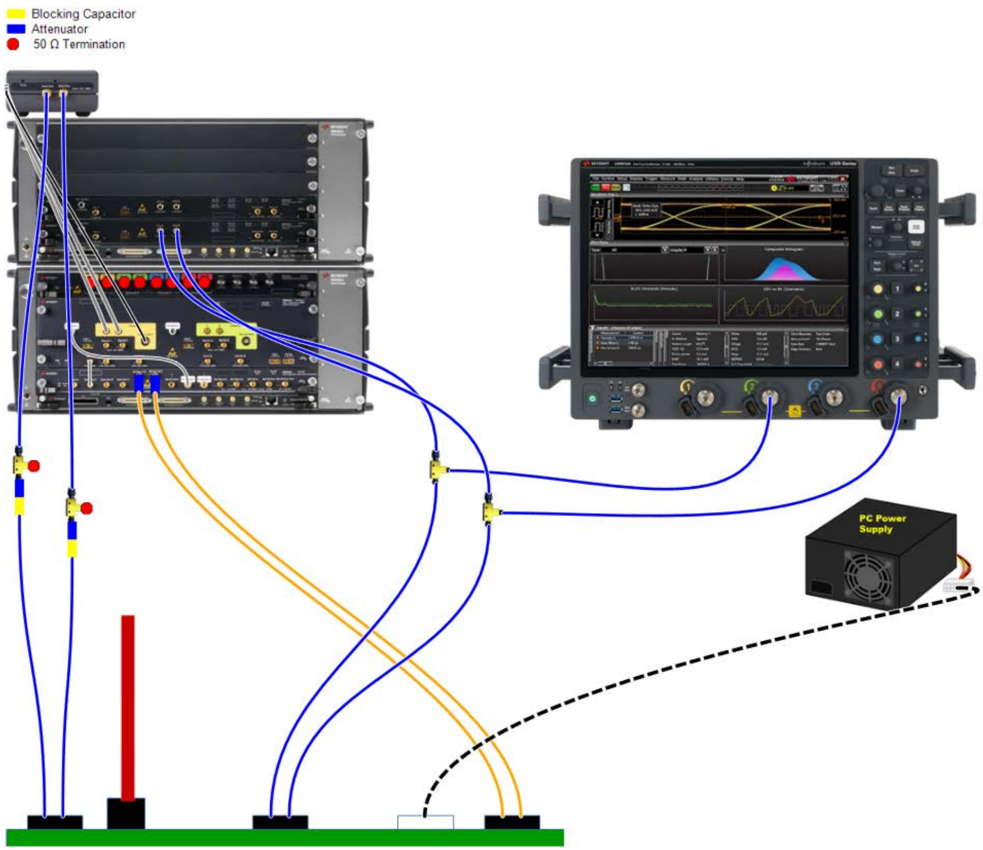

Figure 5-2 Example connection diagram for Back-Channel Optimization procedure (M8050A, CEM)

Descriptions of Setup Preparation Procedures

Back-Channel Optimization

Availability

Data Generator:	M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	32, 64 GT/s		

See also Table 2-1 on page 39.

The “Setup Procedures” option must be selected when configuring the DUT; refer to Figure 2-8 on page 34.

Purpose and Method

The purpose of this procedure is to achieve the lowest BER in the back channel for a given setup, to ensure that the back channel (the path of the signal from the DUT's transmitter (DUT Tx) back to the test equipment) introduces as few errors as possible to the signal path in loopback mode. It optimizes the back channel from the DUT Tx to the error detector for every specified DUT Tx preset. Since the back channel starts within the DUT, this procedure is DUT and setup dependent.

The test automation starts with a measurement of the estimated back-channel loss up to the redriver using a real-time oscilloscope. This is possible with Keysight UXR Infiniium oscilloscopes with a bandwidth of at least 50 GHz (59 GHz or more is recommended). Otherwise the estimated back-channel loss must be measured or estimated separately and entered in ValiFrame as a parameter.

If the property Preset Selection Mode is set to ‘All at Target Data Rate’, a good starting point for the procedure at 64G (if the procedure is to be run at 64G) is estimated from the Estimated Back-Channel Loss (either what the you, as the user, have set or, if Measure Estimated Back-Channel Loss is enabled, what ValiFrame has estimated).

If the property Preset Selection Mode is set to a different value (not ‘All at Target Data Rate’), the next step is an FFE optimization with a coarse adjustment of the sampling setup (sampling delay, input range and thresholds) for all 32G presets (or all those that are selected). This provides a good starting point for 64G.

For the 32G presets, you will repeatedly be asked to reset or power cycle the DUT between presets. This is because the presets are included in the compliance patterns, which causes changes in the error detector sampling setup. This is not the case for 64G presets, so power cycling is required only once when setting everything up for 64G.

When the optimization for the selected 32G presets is finished, the FFE optimization is run again, but this time for the first 64G preset. After that, the sampling setup fine optimization is run for the same 64G preset.

The procedure continues with the next 64G preset, performing the FFE optimization and sampling setup fine optimization as before, until all the selected 64G presets have been optimized.

There are two Optimization Modes: ‘Automatic’ and ‘Guided with manual interaction’. If you select ‘Automatic’, the default value, you also need to specify the ‘Maximum Number of Rerun Attempts’. For each PAM4 preset, the FFE optimization will be rerun until either the BER is smaller than 1e−7, or the Maximum Number of Rerun Attempts has been exceeded. Similarly, the criterion for NRZ is that the Eye Height at the current Sampling Delay is greater than the maximum level width at the current Sampling Delay, or the Maximum Number of Rerun Attempts has been exceeded. After that, the sampling point alignment is executed and the next preset is optimized. This automated procedure might take longer than an experienced user using the manual mode, but it is interaction-free (except for the power cycle instructions, if no power automation is used).

If ‘Guided with manual interaction’ is selected as the optimization mode, the procedure requests input from the user to decide if the optimization of a preset is “good enough”. After each FFE optimization step and after each sampling setup step, a dialog is shown with the option to rerun this step again (yes) or continue with the next step (no). Guidance is given in each dialog about whether rerunning the step is likely to further improve the result. An experienced user might find other indications to rerun by observing the sampling point setup inside the M8070B.

NOTE

The expected pattern and toggle pattern can be changed by supplying a different script to the parameter ‘Toggle Script File for 32/64 GT/s’. If you change the expected pattern, it is not possible to use the ‘Measure Estimated Back-Channel Loss’ feature.

NOTE

If running the back-channel optimization fails when ‘Preset Selection Mode’ is set to ‘All at target rate’, try running it with ‘Preset Selection Mode’ set to ‘Include NRZ Prerequisites’.

The back-channel optimization data is stored in an XML file at a user-specified path. During tests, this data can be used to set the error detector sampling setup, FFE coefficients and redriver to the optimal settings for the given back channel. The best DUT Initial Preset and DUT Target Preset are also automatically preselected from the BCO data.

For the default file-naming of the BCO data file, it is advisable to set the DUT name and serial number in the Configure DUT dialog, as well as the DUT type and interface type (Figure 5-3 on page 98).

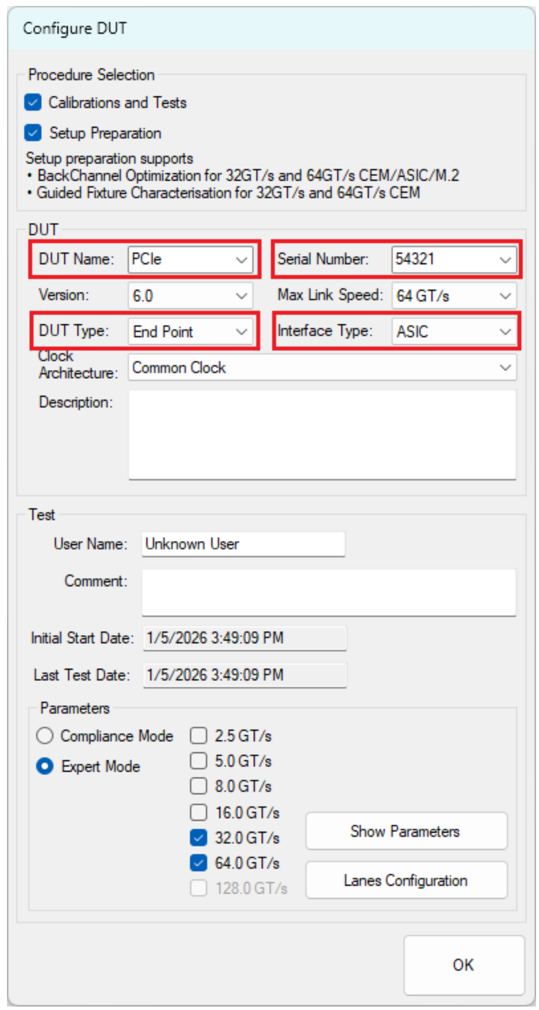

Figure 5-3 Values used in default naming of the back-channel optimization file

CAUTION

The back-channel optimization file is not saved as a ValiFrame project. It must be saved separately!

NOTE

Results can be reloaded by running the 64G Back-Channel Optimization procedure with both the “32 GT/s Presets to Optimize” property and the “64 GT/s Presets to Optimize” property empty.

If you run the back-channel optimization with a file path for an existing BCO, you will be asked if you want to load the data. If you load the data, it will be used as a starting point for the new BCO. With this feature, you can also add previously not optimized presets to an existing BCO file or improve upon already existing preset optimization. However, if already optimized presets are selected, the old optimization for the existing presets is overwritten. Therefore, it is advisable to create a backup before loading old BCO data.

CAUTION

If you decide not to load old back-channel optimization data and continue, the old data is deleted.

During the dialog you can still save the old BCO data or abort and then save the old BCO data.

Also, if old BCO data is loaded, the redriver settings from the old BCO data file are used and no estimation of the back-channel loss is performed. In this case, the user selection does not matter.

If it is not necessary to run all 64 GT/s presets for optimization (for example, because the test to be run requires just one preset), it may be possible also to reduce the number of 32 GT/s presets for optimization. Table 5-1 shows which 32 GT/s preset is the best match to each 64 GT/s preset.

Table 5-1 Closest 32 GT/s Preset for a 64 GT/s Preset

64 GT/s Preset	Closest 32 GT/s Preset
Q0	P4
Q1	P5
Q2	P9
Q3	P3
Q4	P1
Q5	P9
Q6	P8
Q7	P9
Q8	P9
Q9	P9

Connection Diagram

Refer to Example Connection Diagrams on page 94.

Result Description

The results file contains the figure of merit for all presets as well as all redriver and error detector settings.

When the procedure has been successfully finished, the best preset is highlighted in green in the table in the results. If multiple results have an equally good figure of merit for the back channel, all of them are highlighted.

For 32 GT/s

L0_DutPrep_32GTps_BChanOpt

for PCIe 5.0 M.2 Device

----General----	
Offline	False
Software Version	5.2.0.6
Spec Deviations	
Comments	
----Generator Clock----	
Use SSC	False
SSC Deviation	5000 ppm
Data Rate Deviation	0 ppm
----Error Detector----	
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s	C:\ProgramData\BitifEye\ValiFra
Pause after toggle	100 ms
----Back-Channel Optimization----	
Preset Selection Mode	All at Target Datarate
Optimization Result File	C: \ProgramData\BitifEye\ValiFrame PCIe_SNM8047B-Device-15Aug-M2_D
Number of Compliance Pattern	20
Scope Connection for Back-Channel Optimization	Chan 2 4 Direct Connect
Measure Estimated Back-Channel Loss	True
Serial Number	M8047B-Device-15Aug
----Redriver----	
Estimated Channel Loss	10 dB
Boost	12
Eye Expander	0
DC Gain	0
Driver Gain	2
----DUT----	
Max Link Training Speed	32 GT/s

----Instruments----

Measurement Instrument 1	Name: Keysight M8050A J-BERT ; integrated jitter sources for B
Measurement Instrument 2	Name: ClkGen ; Company: Keysigh for BER tests ; Firmware Versio
Measurement Instrument 3	Name: DataOut1 ; Company: Keysi integrated jitter sources for B
Measurement Instrument 4	Name: DataOut1 ; Company: Keysi sources for BER tests ; Firmwar
Measurement Instrument 5	Name: DataOut2 ; Company: Keysi sources for BER tests ; Firmwar
Measurement Instrument 6	Name: DataIn ; Company: Keysigh sources for BER tests ; Firmwar
Measurement Instrument 7	Name: DataIn ; Company: Keysigh BER tests ; Firmware Version Su
Measurement Instrument 8	Name: Keysight DSO ; Company: K calibration and transmitter tes

DUT Tx Preset	Bit Error Ratio [ ]	Minimum Level Width [mV]	Boost	Eye Expander	DC Gain	Driver Gain	Threshold [mV]	Sampling Delay [ps]	Input Range [V]	Cursor0 []	Cursor1 []	Cursor2 (Main) []	Cursor3 []	Cursor4 []	Cursor5 []	Curso []
P0	-	369.141	12	0	0	2	-2.93	-7.500	0.375	0.001	-0.002	1.000	-0.001	0.001	0.000	-0.00
P0	-	357.422	12	0	0	2	0.00	-6.900	0.375	0.000	0.000	1.000	0.000	0.000	0.000	0.00
P0	-	357.422	12	0	0	2	-2.93	-6.900	0.375	0.000	0.000	1.000	0.000	0.000	0.000	0.00
P1	-	179.906	12	0	0	2	4.73	-6.900	0.303	-0.001	-0.058	1.000	0.050	0.119	-0.081	0.06
P2	-	266.578	12	0	0	2	-2.84	-6.900	0.363	-0.001	-0.058	1.000	0.050	0.119	-0.081	0.06
P3	-	204.188	12	0	0	2	-3.00	-6.900	0.363	-0.001	-0.058	1.000	0.050	0.119	-0.081	0.06
P4	-	164.063	12	0	0	2	5.86	0.000	0.375	0.029	-0.173	1.000	0.217	-0.036	-0.035	0.03
P5	-	169.922	12	0	0	2	6.00	0.000	0.375	0.029	-0.173	1.000	0.217	-0.036	-0.035	0.03
P6	-	168.750	12	0	0	2	0.00	0.000	0.450	0.032	-0.089	1.000	0.253	-0.043	-0.045	0.02
P7	-	291.234	12	0	0	2	2.55	-7.500	0.327	0.000	0.000	1.000	0.000	0.000	0.000	0.00
P7	-	328.125	12	0	0	2	0.00	-7.500	0.375	0.000	0.000	1.000	0.000	0.000	0.000	0.00
P8	-	174.219	12	0	0	2	0.00	-7.500	0.446	0.013	0.062	1.000	0.121	0.055	-0.049	0.04
P9	-	136.109	12	0	0	2	0.00	-8.100	0.281	0.021	0.077	1.000	0.017	0.016	-0.040	0.04

Figure 5-4 Example result for Back-Channel Optimization at 32 GT/s

- DUT Tx Preset: DUT Tx Preset identifier.
- Bit Error Ratio: Not relevant for 32 GT/s.
- Minimum Level Width [mV]: The sum of all level widths for the best settings found during Back-Channel Optimization. The best setting has the smallest (minimal) sum of all levels.
- Boost: Setting for M8047B Redriver.
- Eye Expander: Setting for M8047B Redriver.
- DC Gain: Setting for M8047B Redriver.
- Driver Gain: Setting for M8047B Redriver.
- Threshold [mV]: Setting for M8046A error detector.
- Sampling Delay [ps]: Setting for M8046A error detector.
- Input Range [V]: Setting for M8046A error detector.

- CursorX: Values for M8046A error detector FFE cursors, where X = 0, ..., 15. Cursor2 is the main FFE cursor. **Note:** For space reasons (and to make the table more legible), the example result table has been cropped on the right so that several CursorX columns are not visible.

NOTE If an M8047C redriver is used instead of an M8047B, the M8047B redriver entries listed above will be replaced by those for M8047C. See the description for 64 GT/s.

For 64 GT/s

For 64G, in addition to the best preset(s) being highlighted in green in the table in the results, all presets with BER below the selected Back-Channel Target BER are highlighted in yellow to warn you about possible difficulties in training the DUT into loopback when using these presets during tests.

L0_DutPrep_64GTps_BChanOpt

for PCIe 6.0 AddInCard Preliminary

----General----	
Offline	False
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Generator Clock----	
Use SSC	True
SSC Deviation	5000 ppm
Data Rate Deviation	0 ppm
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Error Detector----	
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s	C:\ProgramData\BitifEye\ValiFra
Toggle Script File For 64 GT/s	C:\ProgramData\BitifEye\ValiFra
Pause after toggle	100 ms

----Back-Channel Optimization----	
Preset Selection Mode	All at Target Data Rate
Optimization Result File	C:\ProgramData\BitifEye\ValiFra PCIe_Marvell-Cem_AddInCard.xml
Scope Connection for Back-Channel Optimization	Chan 2 4 Direct Connect
Measure Estimated Back-Channel Loss	True
Number of Compliance Patterns	100
Serial Number	
Optimization Mode	Automatic
Maximum Number Of Rerun Attempts	2
----Redriver----	
Estimated Channel Loss	10.9 dB
Compensation Adjustment	0
Compensation Bias Factor	x2
----DUT----	
Max Link Training Speed	64 GT/s
----Instruments----	
Measurement Instrument 1	Name: Keysight M8040A J-BERT ; rev.: 12.6.45.8 ; Description: Supported: False ; Measurement
Measurement Instrument 2	Name: DataOut1 ; Company: Keysi FW rev.: 12.6.45.8 ; Descriptio Version Supported: Unknown ; Me
Measurement Instrument 3	Name: DataOut1 ; Company: Keysi ; Description: M8040 with integ Unknown ; Measurement Instrumen
Measurement Instrument 4	Name: DataOut2 ; Company: Keysi ; Description: M8040 with integ Unknown ; Measurement Instrumen
Measurement Instrument 5	Name: Keysight DSO ; Company: K 11.70.00015 ; Description: Unkn

DUT Tx Preset	Bit Error Ratio [ ]	Minimum Level Width [mV]	Estimated Channel Loss [dB]	Compensation Adjustment	Compensation Bias Factor	Upper Analyzer Threshold [mV]	Middle Analyzer Threshold [mV]	Lower Analyzer Threshold [mV]	Sampling Delay [ps]	Input Range [V]	Cursor0 []	Cursor1 []	Cursor2 (Main) []
Q0	4.331E-008	235.422	10.90	0	x2	79.00	0.00	-79.00	25.700	0.247	0.010	-0.088	1.000
Q1	5.409E-008	201.250	10.90	0	x2	52.00	0.00	-56.00	27.700	0.230	0.050	-0.028	1.000
Q2	0.000E+000	149.016	10.90	0	x2	45.29	-2.92	-48.21	31.100	0.187	0.039	0.018	1.000
Q3	2.157E-004	183.453	10.90	0	x2	60.63	-1.55	-63.74	21.400	0.199	0.009	-0.034	1.000
Q4	6.401E-004	158.625	10.90	0	x2	34.00	-1.00	-40.00	24.600	0.188	0.023	-0.084	1.000
Q5	6.302E-007	144.375	10.90	0	x2	35.00	-1.00	-37.00	34.300	0.165	0.046	0.002	1.000
Q6	2.351E-004	178.531	10.90	0	x2	41.55	-1.54	-44.63	36.900	0.197	-0.063	-0.196	1.000
Q7	2.339E-008	167.578	10.90	0	x2	47.00	0.00	-47.00	27.300	0.195	-0.070	0.124	1.000
Q8	1.409E-006	136.391	10.90	0	x2	36.00	-2.00	-40.00	-6.000	0.203	-0.006	0.239	1.000
Q9	6.787E-005	119.156	10.90	0	x2	28.83	-1.92	-32.67	33.900	0.246	0.015	0.149	1.000

Figure 5-5 Example result for Back-Channel Optimization at 64 GT/s

- DUT Tx Preset: DUT Tx Preset identifier.
- Bit Error Ratio: Measured Bit Error Ratio.
- Minimum Level Width [mV]: Not relevant for 64 GT/s.
- Estimated Channel Loss [dB]: Setting for M8047C Redriver.
- Compensation Adjustment: Setting for M8047C Redriver.

- Compensation Bias Factor: Setting for M8047C Redriver.
- Upper Analyzer Threshold [mV]: Setting for M8046A error detector.
- Middle Analyzer Threshold [mV]: Setting for M8046A error detector.
- Lower Analyzer Threshold [mV]: Setting for M8046A error detector.
- Sampling Delay [ps]: Setting for M8046A error detector.
- Input Range [V]: Setting for M8046A error detector.
- CursorX: Value for M8046A error detector FFE cursors, where X = 0, ..., 15. Cursor2 is the main FFE cursor. **Note:** For space reasons (and to make the table more legible), the example result table has been cropped on the right so that several CursorX columns are not visible.

Guided Fixture Characterization

Availability

Data Generator:	M8040A, M8050A
Interface Types:	CEM
DUT Types:	Add-In Card, System
Modes:	Compliance, Expert
Data Rates:	32, 64 GT/s

See also Table 2-1 on page 39.

Purpose and Method

This procedure guides you through the characterization of the fixtures used in the subsequent calibration and test procedures and saves the results for later use in the ValiFrame software. The measurement setups and calculations specified by PCI-SIG are followed. The procedure requires a fully calibrated VNA.

NOTE **This procedure is guided but not fully automatic. You have to set up the VNA for each procedure run and then enter the result in the ValiFrame application for each step.**

After you have entered the serial number of the fixture kit in a pop-up dialog, a connection diagram for the first measurement is displayed (Figure 5-7), followed by a dialog asking you to enter the value of the first measurement (Figure 5-6).

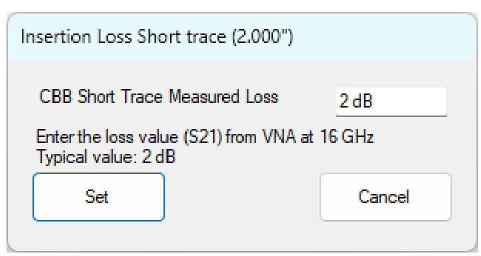

Figure 5-6 First pop-up dialog of the Guided Fixture Characterization

The procedure continues with further connection diagrams and dialogs until all of the required data has been entered. All of the values are displayed in the result report (Figure 5-8), which concludes with a list of trace numbers and the corresponding channel losses.

Connection Diagram

Throughout the Guided Fixture Characterization procedure, several different setups are required. Each time, you will be prompted by a pop-up connection diagram to change the setup. Just the first connection diagram is shown here.

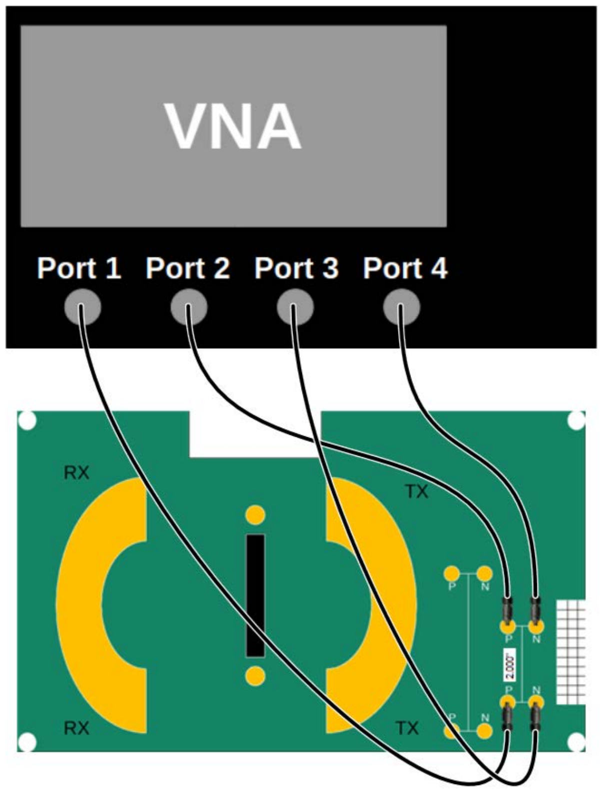

Figure 5-7 Example connection diagram for Guided Fixture Characterization

Result Description

L0_DutPrep_64GTps_FixtChar

for PCIe 6.0 AddInCard Preliminary

----General----	
Offline	False
Software Version	
Spec Deviations	
Comments	
----Guided Fixture Characterization----	
VNA Port Configuration	Differential Channel 1-3
Fixture Revision	Rev1
CLB Type	x1x16
Cable Type	2.92 mm
XML File Export Path	C:\ProgramData\BitifEye\ValiFra
Fixture Serial Number	12345
Transfer Function File	C:\ProgramData\BitifEye\ValiFra
----Guided Fixture Characterization Information----	
CBB Short Trace Measured Loss	2 dB
CBB Long Trace Measured Loss	4.33 dB
CBB Loss per inch	776.67 mdB
CBB Tx Loss	3.1067 dB
CBB Rx Loss	3.8833 dB
CLB Short Trace Measured Loss	2.07 dB
CLB Long Trace Measured Loss	3.67 dB
CLB Loss per inch	800 mdB
CLB Tx Loss	1.6 dB
CLB Rx Loss	3.2 dB
2.92 mm FM - 2.92 mm FM Barrel Adapters	0.06 dB
MMPX ML - 2.92 mm FM Adapter Measured Loss	0.34 dB
MMPX ML - 2.92 FM Adapter Loss	140 mdB
2.92 mm ML - MMPX ML 3 ft cable Measured loss	1.85 dB
2.92 ML - MMPX ML 3-ft cable loss	1.59 dB
MMPX ML - MMPX ML 1 ft cable Measured Loss	1.03 dB
MMPX ML - MMPX ML 1-ft cable loss	630 mdB
MMPX ML - MMPX ML 2 ft cable Measured Loss	1.48 dB
MMPX ML - MMPX ML 2-ft cable loss	1.08 dB
Differential Coaxial Launch Loss (2Pairs)	166.67 mdB
Differential Coaxial Launch Loss (1Pair)	83.333 mdB
CBB Rx to CLB Tx Measured Loss	6.08 dB
Mated CEM Connector Loss	150 mdB
CLB Fixed Side Target Loss	4.41 dB
CLB Fixed Side Loss	9.22 dB
CLB Fixed Side Loss - (CBB Rx Loss + Mated CEM Connector Loss)	4.9 dB
CLB ISI Pair	0
----Oscilloscope----	
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\ValiFra
----DUT----	
Max Link Training Speed	64 GT/s

Trace Number []	Channel Loss [dB]
21	25.00
22	25.20
23	25.40
24	26.37
25	27.07
26	27.50
27	29.41

Figure 5-8 Example result for Guided Fixture Characterization

- Trace Number: Number that identifies the trace.
- Channel Loss [dB]: Loss of the channel that corresponds to the trace.

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6 Calibrations

Before any receiver test procedure can be run, the PCI Express receiver test system has to be calibrated.

Calibration Overview

The ValiFrame calibration plane is given by the DUT input ports. The receiver test signal characteristics such as the PCI Express signal generator output voltage level and jitter parameters are typically affected by the signal transmission between the generator output ports and the DUT input ports. Thus, for any signal output parameter that you select (set value), the jitter and the signal received at the DUT input ports (actual value) deviate from the set value. Additional deviations can be caused by effects such as offset errors, hysteresis, and nonlinear behavior of the signal generator. The ValiFrame calibration procedures compensate for the deviations of the relevant signal output parameter actual values from the set values over the required parameter range.

All calibration procedures required for PCI Express receiver testing are included in the ValiFrame software. The ValiFrame calibration procedures are implemented such that the calibration process is automated as much as possible and is conducted as fast as possible, for example, by minimizing the number of re-configurations of the hardware connections.

NOTE **A UXR oscilloscope with 256 GSa/s sample rate is required in order to execute calibrations at 64 GT/s.**

Prerequisite Calibrations

Prerequisite calibrations for each procedure are displayed in the application itself. Right-click the procedure name in the procedure tree of the main window of the user interface and select “Required Calibration Data...”. See Required Calibration Data on page 62 for details.

Connection Diagrams

In this User’s Guide, only example connection diagrams are given in a separate section near the beginning of each chapter, for example for calibrations. The exact connection diagram for a specific situation can be viewed by right-clicking the appropriate procedure in the procedure tree of the main window of the user interface and selecting “Show Connection...”.

PCI Express Parameters

Common Parameters

N5991 PCI Express common parameters are listed in the parameter grid (right pane) of the main window of the user interface when you click the corresponding group in the procedure tree in the left half of the main window. Clicking a data rate in the procedure tree shows you the data-rate-specific PCI Express common parameters for that data rate. Similarly, clicking a lane shows you the corresponding lane-specific common parameters and clicking a channel shows you the corresponding channel-specific common parameters.

Details of N5991 PCI Express common parameters for calibrations can be found in Table A-3 on page 319.

Parameters for Individual Calibrations

The N5991 PCI Express parameters in expert mode for an individual procedure are not listed in this user's guide explicitly. They are displayed in the parameter grid (right half) of the main window of the user interface when you click on the corresponding entry in the procedure tree in the left half of the main window.

Details of N5991 PCI Express parameters for individual calibration procedures can be found in Table A-7 on page 348.

Order of the Calibration Descriptions

The calibration descriptions are arranged alphabetically under the headings

- Descriptions of Calibrations at 2.5 GT/s and 5.0 GT/s
- Descriptions of Direct-Connection Calibrations
- Descriptions of Long-Channel Calibrations

The descriptions of calibrations at 2.5 GT/s and 5.0 GT/s are in a separate section because the distinction between Direct Connection and Long Channel had not been introduced when these calibrations were defined.

To find a procedure description easily, go to Chapter 4, Procedure Tree Overview on page 71, where the procedures are listed in tables in the order they appear in the procedure tree in the application. Each listed procedure has a link to its description.

Example Connection Diagrams

In each case, for more details, right-click the appropriate procedure in the procedure tree of the user interface and select “Show Connection...”.

Calibrations at 2.5 GT/s and 5.0 GT/s

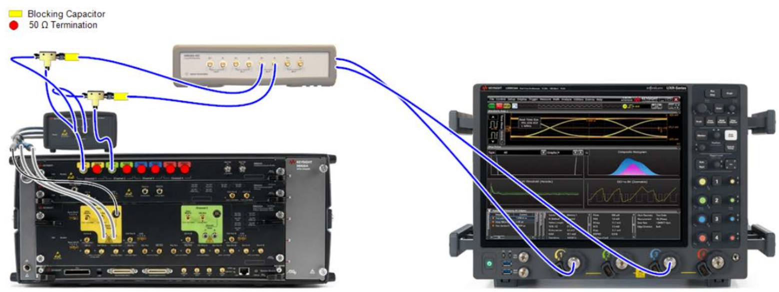


Figure 6-1 Example connection diagram for ASIC calibrations at 2.5 GT/s and 5.0 GT/s (M8040A)

Figure 6-2 Example connection diagram for CEM calibrations at 2.5 GT/s and 5.0 GT/s (M8020A)

Direct-Connection Calibrations

Figure 6-3 Example connection diagram for ASIC and CEM direct-connection calibrations, 8.0 GT/s and above (TP1, no TTC, 4-channel UXR, M8040A)

Figure 6-4 Example connection diagram for ASIC and CEM direct-connection calibrations, 8.0 GT/s and above (TP1, 4-channel UXR, M8050A)

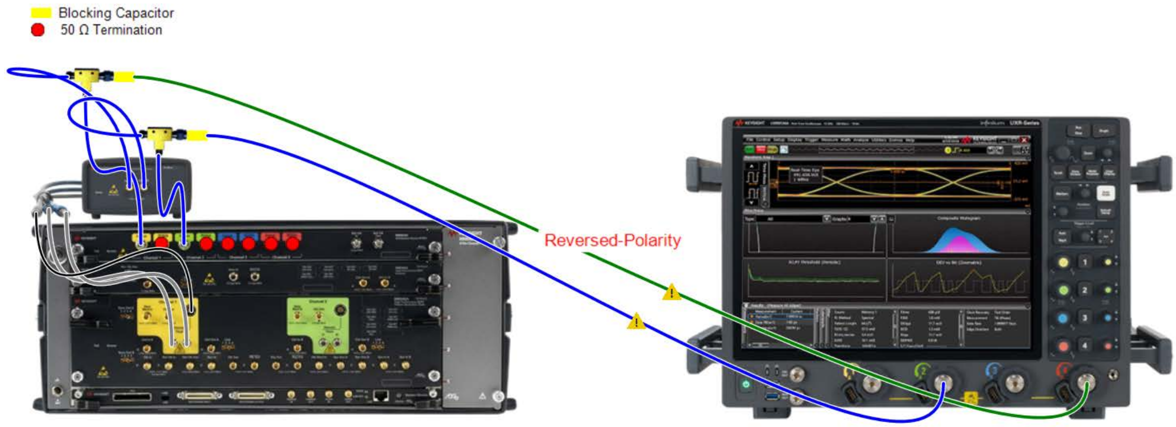


Figure 6-5 Example first connection diagram for the ASIC 64G Scope Channel Skew Calibration (4-channel UXR, M8040A)

Long-Channel Calibrations

In each case, for more details, right-click the appropriate procedure in the procedure tree of the user interface and select “Show Connection...”.

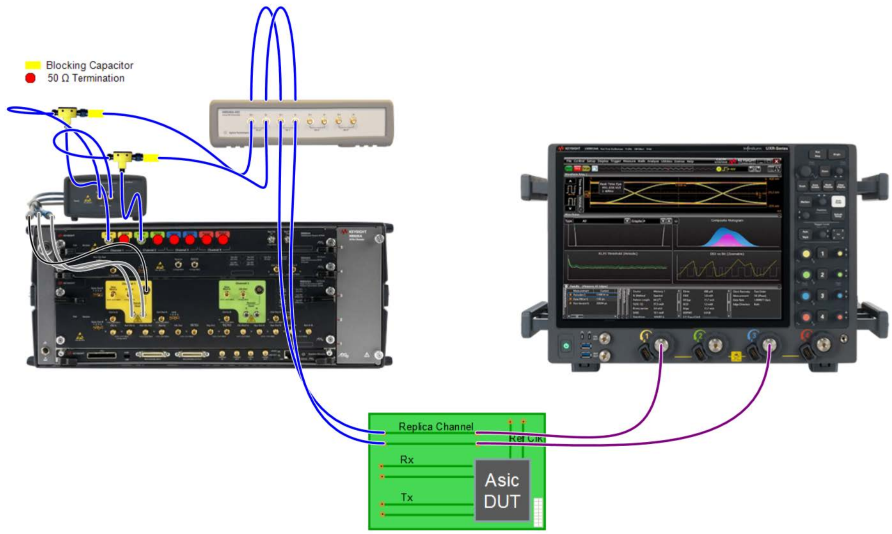


Figure 6-6 Example connection diagram for ASIC long-channel calibrations (M8040A, 8 GT/s)

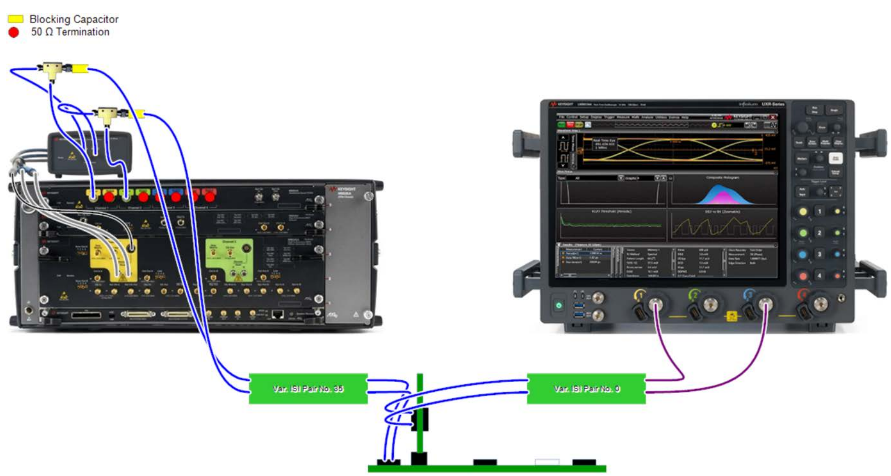


Figure 6-7 Example connection diagram for CEM long-channel calibrations (M8040A)

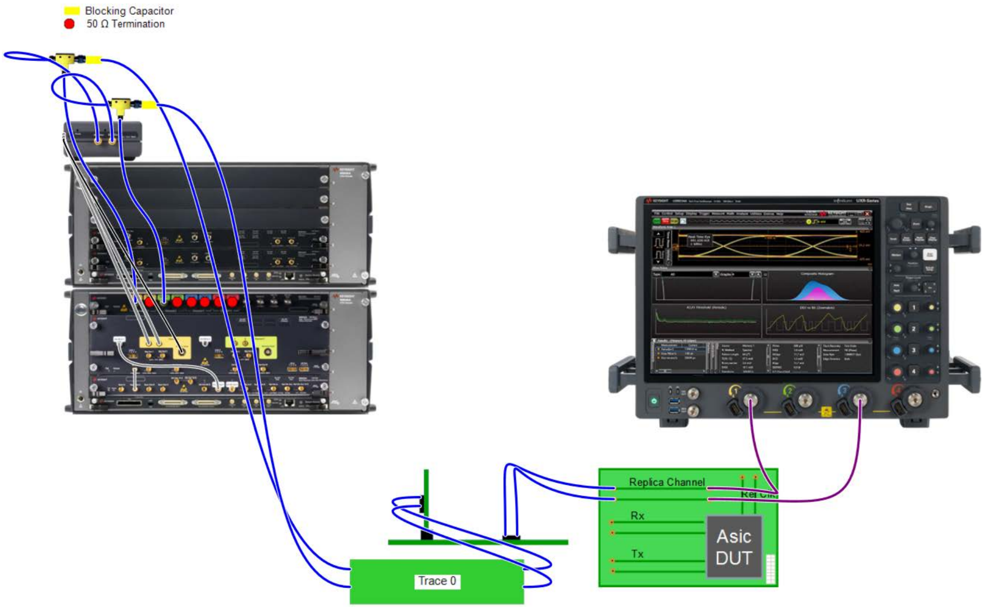


Figure 6-8 Example connection diagram for ASIC long-channel calibrations (M8050A, 64 GT/s)

Most long-channel calibrations (data rates 8 GT/s and above) are performed on the highest-loss channel. The hardware trace is set to the corresponding number based on the Insertion Loss Calibration. However, for 32 GT/s and 64 GT/s, during the Compliance Eye Calibration the channel (hardware trace) may have to be changed and the channel that is finally used in this calibration should be used for all subsequent calibrations.

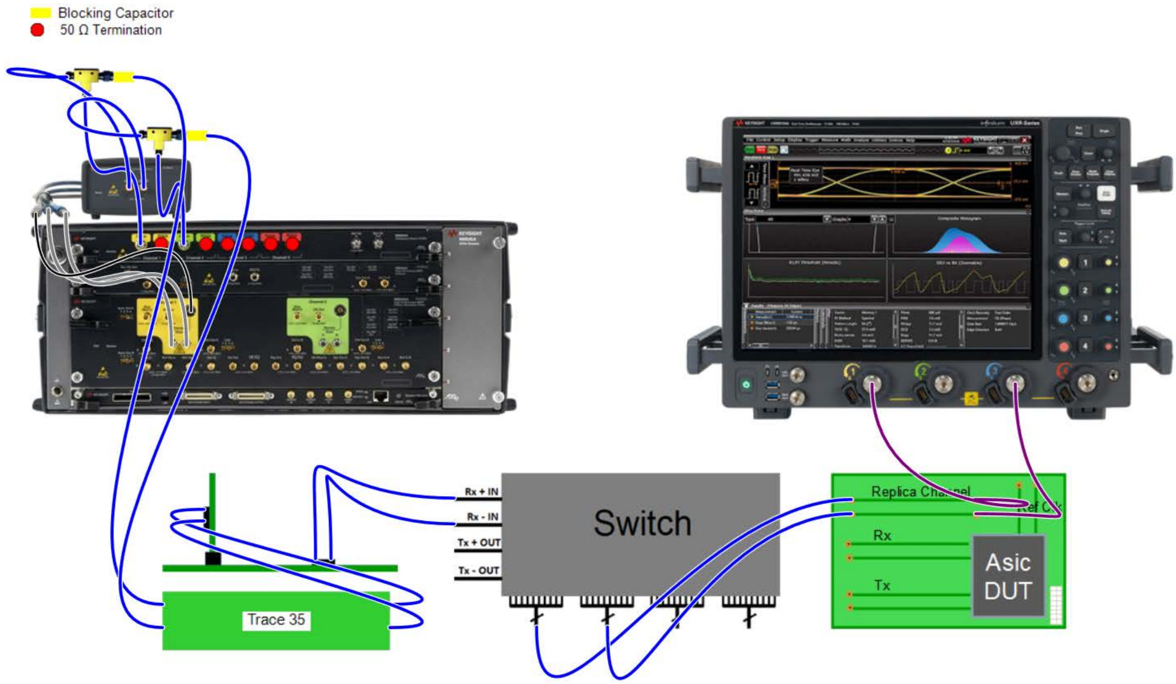


Figure 6-9 Example of a connection diagram with a switch (here, M8040A, ASIC long-channel calibration, 32 GT/s)

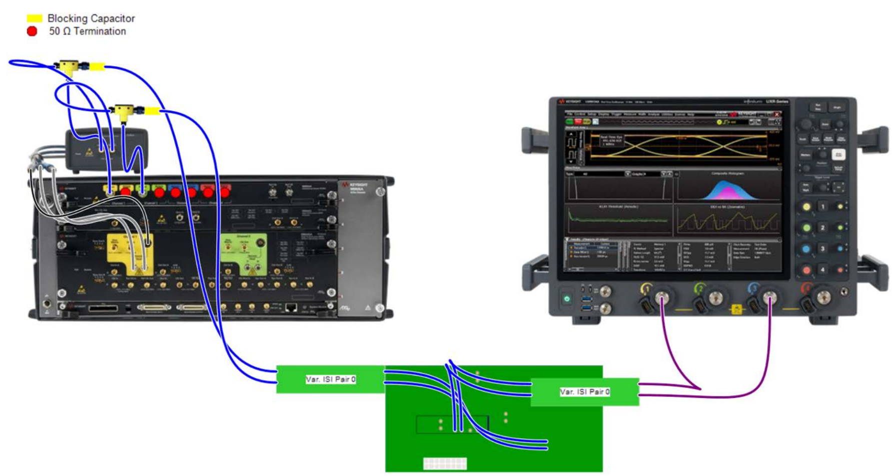


Figure 6-10 Example connection diagram for M.2 long-channel calibrations (M8040A)

Descriptions of Calibrations at 2.5 GT/s and 5.0 GT/s

CMSI Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A
Interface Types:	ASIC
DUT Types:	End Point, Root Complex
Modes:	Compliance, Expert
Data Rates:	2.5 GT/s, 5.0 GT/s

Purpose and Method

The Common Mode Sinusoidal Interference (CMSI) that is generated by the generator setup is attenuated before it reaches the receiver, and therefore the CMSI amplitude at the Rx input must be calibrated.

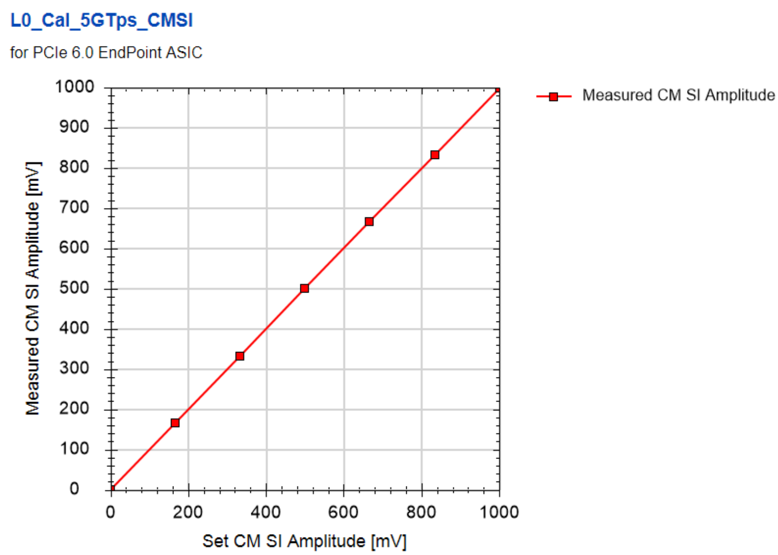
The test automation starts with a small CMSI amplitude and increases that value in several steps over a defined range. The minimum amplitude is 0 mV and the maximum amplitude is the maximum value that the data generator can generate. For each step, the procedure measures the actual CMSI with a real-time oscilloscope.

The calibration data is stored in a cal-data table. When measurements are performed, these calibration tables are used to adjust the voltage amplitude to the desired output CMSI.

Connection Diagram

Refer to Figure 6-1 on page 114.

Result Description



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Number of Averages	512
Scope Connection for Calibration	Chan 1 3 Direct Connect
Use PCIe2 Transfer Function	False
PCIe2 M8048A ISI Channel	Channel 7, 24 inch
PCIe2 M8048A ISI Channel Emulation	False
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysig
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologie
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologie
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologie
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technol

Set CM SI Amplitude [mV]	Measured CM SI Amplitude [mV]
0	0.00
167	166.67
333	333.33
500	500.00
667	666.67
833	833.33
1000	1000.00

Figure 6-11 Example result for CMSI Calibration, 2.5 GT/s and 5.0 GT/s

- Set CM SI Amplitude [mV]: The value of CMSI set on the generator.
- Measured CM SI Amplitude [mV]: The value of CMSI measured with the oscilloscope.

De-Emphasis Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A
Interface Types:	CEM
DUT Types:	Add-In Card, System
Modes:	Compliance, Expert
Data Rates:	2.5 GT/s, 5.0 GT/s

Purpose and Method

This procedure calibrates the de-emphasis.

By default, the test automation starts with –6 dB of de-emphasis, increasing it with a step size of 0.5 dB and measuring the corresponding de-emphasis for every set value. The calibration ends when the set de-emphasis is 0 or the measured de-emphasis is above 0 dB.

The calibration data is stored in cal-data tables. These calibration tables are used during measurements to calculate the de-emphasis level that must be set on the generator to get the desired de-emphasis level at the test point.

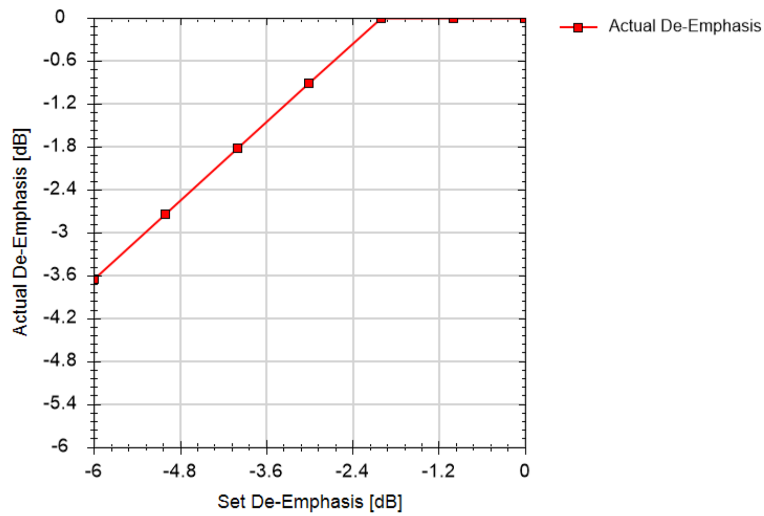
Connection Diagram

Refer to Figure 6-2 on page 114.

Result Description

L0_Cal_5GTps_DE

for PCIe 6.0 AddInCard



----General----

Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Eye Height	225 mV
Start De-Emphasis	-6 dB
Scope Connection for Calibration	Chan 1 3 Direct Connect
Use PCIe2 Transfer Function	False

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog:

Set De-Emphasis [dB]	Actual De-Emphasis [dB]
-6.0	-3.656
-5.0	-2.742
-4.0	-1.828
-3.0	-0.914
-2.0	0.000
-1.0	0.000
0.0	0.000

Figure 6-12 Example result for De-Emphasis Calibration

- Set De-Emphasis [dB]: Value of de-emphasis set on the generator.
- Actual De-Emphasis [dB]: Measured (actual) value of de-emphasis.

Eye Height Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	ASIC	CEM
DUT Types:	End Point Root Complex	Add-In Card System
Modes:	Compliance, Expert	
Data Rates:	2.5 GT/s, 5.0 GT/s	

Purpose and Method

The test fixtures attenuate the data signal. To compensate for the attenuation, the data signal differential swing is calibrated.

The test automation calibrates five equally spaced differential voltage amplitudes. The minimum amplitude is 300 mV and the maximum amplitude is the maximum value that the data generator can generate.

For this calibration, the data generator sends the compliance pattern.

The following impairments are added to the signal.

At the data rate **2.5 GT/s**

- random jitter
- ISI
- swept sinusoidal jitter
- CMSI

At the data rate **5.0 GT/s**

- high-frequency sinusoidal jitter
- SSC residual

The eye height is measured on the oscilloscope using horizontal histograms.

The calibration data is stored in a separate cal-data table for each data rate and DUT type. During measurements, these calibration tables are used to adjust the differential voltage amplitude to the desired eye height.

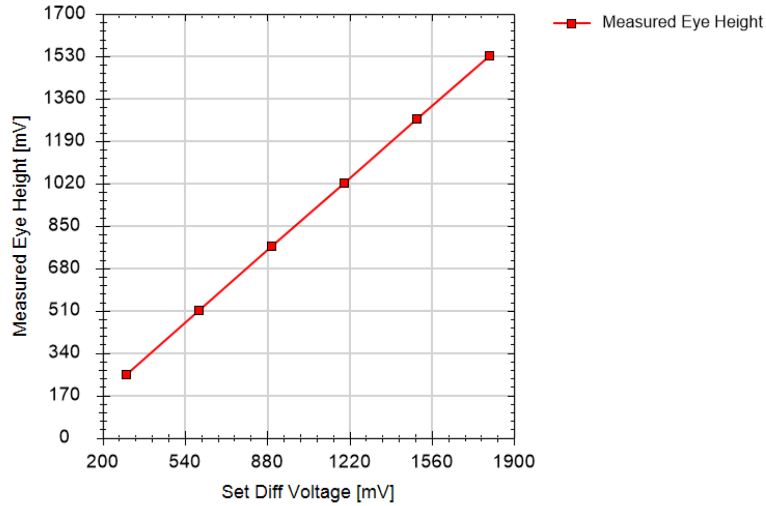
Connection Diagram

Refer to Figure 6-1 and Figure 6-2 on page 114.

Result Description

L0_Cal_5GTps_EH

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Scope Connection for Calibration	Chan 1 3 Direct Connect
Use PCIe2 Transfer Function	False
PCIe2 M8048A ISI Channel	Channel 7, 24 inch
PCIe2 M8048A ISI Channel Emulation	False
Final Eye Height	0.1
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysigh
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolo

Set Diff Voltage [mV]	Measured Eye Height [mV]
1800	1533
1500	1278
1200	1022
900	767
600	511
300	256

Figure 6-13 Example result for Eye Height Calibration, 2.5 GT/s and 5.0 GT/s

- Set Diff Voltage [mV]: Differential voltage set on the generator.
- Measured Eye Height [mV]: Corresponding measured eye height.

ISI Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A
Interface Types:	ASIC
DUT Types:	End Point, Root Complex
Modes:	Compliance, Expert
Data Rates:	2.5 GT/s, 5.0 GT/s

Purpose and Method

In ASIC Rx tests, ISI is generated to provide a close-to-real environment. As a result of the system intrinsic jitter, the effective jitter level is different from the value set in the data generator; therefore, the jitter amplitude has to be calibrated.

The test automation calibrates the ISI trace that was selected in the "Configure DUT" dialog. ISI can be injected by routing the signal through the M8048A ISI traces or can be generated internally with the M8020A. The actual value is calculated as the difference between the eye width that is obtained when the BERT sends a clock pattern and the eye width that is obtained when it sends a compliance pattern. The eye width is measured with a DSO using horizontal histograms.

The calibration data is stored in a separate cal-data table for each data rate. During measurements, these calibration tables are used to display the ISI amplitude.

Connection Diagram

Refer to Figure 6-1 on page 114.

Result Description

L0_Cal_5GTps_ISI

for PCIe 6.0 EndPoint ASIC

----General----

Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Scope Connection for Calibration	Chan 1 3 Direct Connect
Use PCIe2 Transfer Function	False
PCIe2 M8048A ISI Channel	Channel 7, 24 inch
PCIe2 M8048A ISI Channel Emulation	False

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysigh
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolo

Measured ISI [ps]
73.000

Figure 6-14 Example result for ISI Calibration, 2.5 GT/s and 5.0 GT/s

- Measured ISI [ps]: The ISI measured with the oscilloscope.

RJ Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	ASIC	CEM
DUT Types:	End Point Root Complex	Add-In Card System
Modes:	Compliance, Expert	
Data Rates:	2.5 GT/s, 5.0 GT/s	

Purpose and Method

During Rx tests, the input signal is stressed with a combination of jitter sources to simulate the possible impairments that are expected at the Rx input when operating in a target system. Random jitter is added to simulate the effects of thermal noise. Due to system-intrinsic jitter, the effective jitter level is different from the value set in the data generator; therefore, jitter amplitude has to be calibrated.

The test automation starts with a small RJ amplitude and increases that value in several steps over a defined range. For each step, the procedure measures the actual random jitter.

The generator sends a clock pattern during this calibration procedure.

The measurement is done using a real-time oscilloscope and the RJ/DJ-separation software EZJIT or SigTest. The method used depends on the Eye Calibration Method selected for the particular data rate in the PCIe Parameters dialog during DUT configuration. (If Seasim is selected, EZJIT is used for RJ and SJ calibrations.)

The calibration data is stored in a cal-data table. This calibration table is used during measurements to calculate the RJ amplitude that must be set on the generator to get the expected RJ amplitude at the test point.

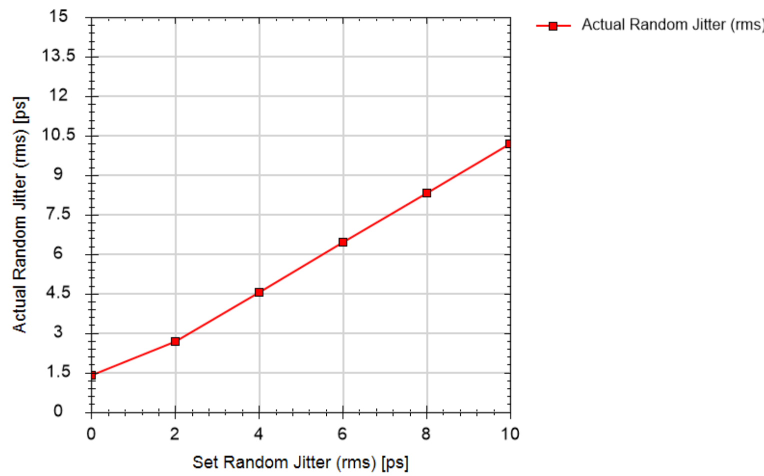
Connection Diagram

Refer to Figure 6-1 and Figure 6-2 on page 114.

Result Description

L0_Cal_5GTps_RJ

for PCIe 6.0 EndPoint ASIC




```
----General----
Offline                                 True
Software Version                        5.4.0.22
Spec Deviations
Comments
Scope Connection for Calibration        Chan 1 3 Direct Connect
Use PCIe2 Transfer Function             False
PCIe2 M8048A ISI Channel                Channel 7, 24 inch
PCIe2 M8048A ISI Channel Emulation      False
----Instruments----
Calibrated Instrument 1                 Name: Keysight M8040A J-BERT ; Company: Keysig
Calibrated Instrument 2                 Name: DataOut1 ; Company: Keysight Technologie
Calibrated Instrument 3                 Name: DataOut1 ; Company: Keysight Technologie
Calibrated Instrument 4                 Name: DataOut2 ; Company: Keysight Technologie
Measurement Instrument 1                Name: Keysight DSO ; Company: Keysight Technol
```

Set Random Jitter (rms) [ps]	Actual Random Jitter (rms) [ps]
0.0	1.40
2.0	2.68
4.0	4.56
6.0	6.44
8.0	8.32
10.0	10.20

Figure 6-15 Example result for RJ Calibration, 2.5 GT/s and 5.0 GT/s

- Set Random Jitter (rms) [ps]: Rms amplitude of random jitter set on the generator.
- Actual Random Jitter (rms) [ps]: Rms amplitude of random jitter measured with the oscilloscope.

Descriptions of Direct-Connection Calibrations

HF Second Tone SJ Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A
Interface Types:	ASIC
DUT Types:	End Point Root Complex
Modes:	Compliance, Expert
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s

See also Table 2-1 on page 39.

Purpose and Method

This procedure calibrates the second tone sinusoidal jitter amplitude for two frequencies (150 MHz and 250 MHz).

The test automation starts with small SJ amplitude and increases that value in steps over a defined range. For each step, the procedure measures the actual sinusoidal jitter for both frequencies. The measurement is done using a real-time oscilloscope and the RJ/DJ-separation software EZJIT.

The calibration data is stored in a cal-data table. This calibration table is used during measurements to adjust the second tone SJ amplitude to the desired output second tone SJ amplitudes.

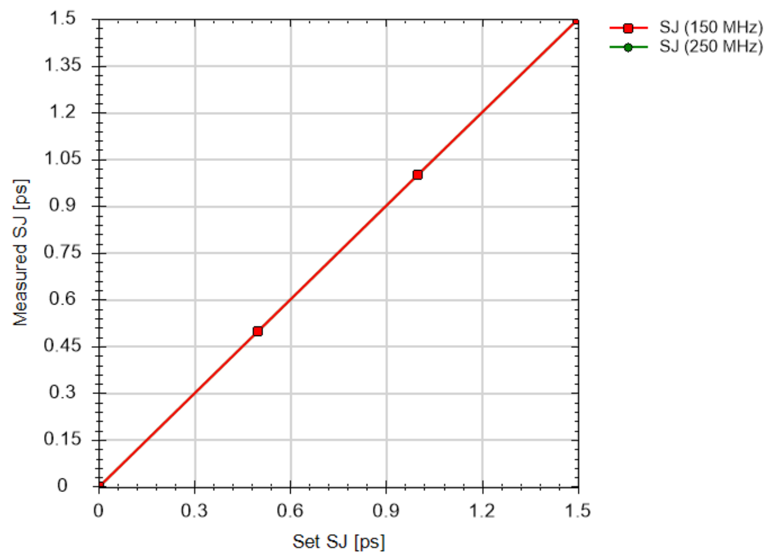
Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

L0_Cal_64GTps_HF2ndSJ

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
----Oscilloscope----	
Scope Bandwidth	50 GHz
Use Bessel Filter	True
Remove Scope Noise	False
Number of Averages	7
Number of UIs	3 MUI
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technologi

Set SJ [ps]	SJ (150 MHz) [ps]	SJ (250 MHz) [ps]
0.00	0.00	0.00
0.50	0.50	0.50
1.00	1.00	1.00
1.50	1.50	1.50

Figure 6-16 Example result for HF Second Tone SJ Calibration

- Set SJ [ps]: Sinusoidal jitter set at the instrument.
- SJ (x MHz) [ps]: Sinusoidal jitter measured at the frequency x MHz.

HF SJ Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This procedure calibrates the sinusoidal jitter amplitude for two high frequencies (15 MHz and 100 MHz).

The test automation starts with small SJ amplitude and increases that value in steps over a defined range. For each step, the procedure measures the actual sinusoidal jitter for both frequencies. The measurement is done using a real-time oscilloscope and the RJ/DJ-separation software EZJIT or SigTest. The method used depends on the Eye Calibration Method selected for the particular data rate in the PCIe Parameters dialog during DUT configuration. (If Seasim is selected, EZJIT is used for RJ and SJ calibrations.)

The calibration data is stored in a cal-data table. This calibration table is used during measurements to adjust the SJ amplitude to the desired output SJ amplitudes.

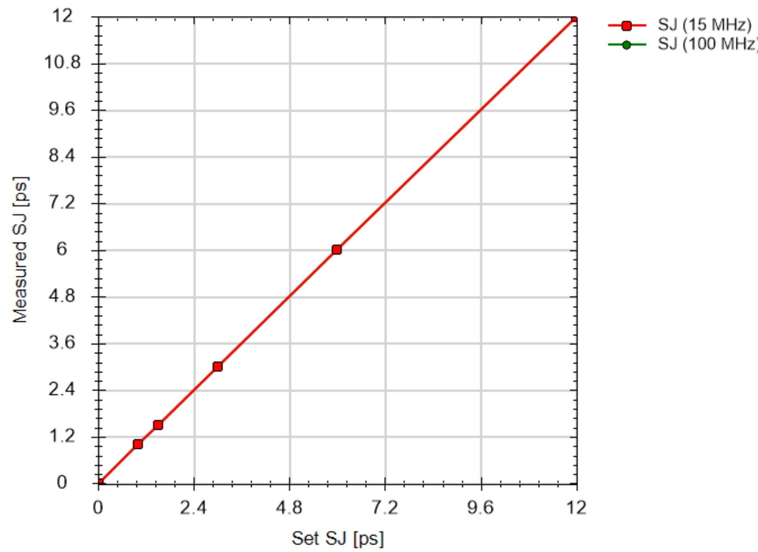
Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

L0_Cal_64GTps_HFSJ

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
----Oscilloscope----	
Scope Bandwidth	50 GHz
Use Bessel Filter	True
Remove Scope Noise	False
Number of Averages	7
Number of UIs	3 MUI
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog:

Set SJ [ps]	SJ (15 MHz) [ps]	SJ (100 MHz) [ps]
0.00	0.00	0.00
1.00	1.00	1.00
1.50	1.50	1.50
3.00	3.00	3.00
6.00	6.00	6.00
12.00	12.00	12.00

Figure 6-17 Example result for HF SJ Calibration

- Set SJ [ps]: The sinusoidal jitter set at the instrument.
- SJ (x MHz) [ps]: The sinusoidal jitter measured at the frequency x MHz.

LF SJ Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	CEM	M.2
DUT Types:	Add-In Card System	Device Host
Modes:	Compliance, Expert	
Data Rates:	16 GT/s	

See also Table 2-1 on page 39.

Purpose and Method

This procedure calibrates the sinusoidal jitter amplitude for a set of low frequencies (200 kHz, 500 kHz, 1 MHz, 2 MHz and 4 MHz).

The test automation starts with small SJ amplitude and increases that value in several steps over a defined range. For each step, the procedure measures the actual sinusoidal jitter for all the frequencies.

The calibration data is stored in a cal-data table. This calibration table is used during measurements to adjust the SJ amplitude to the desired output SJ amplitudes.

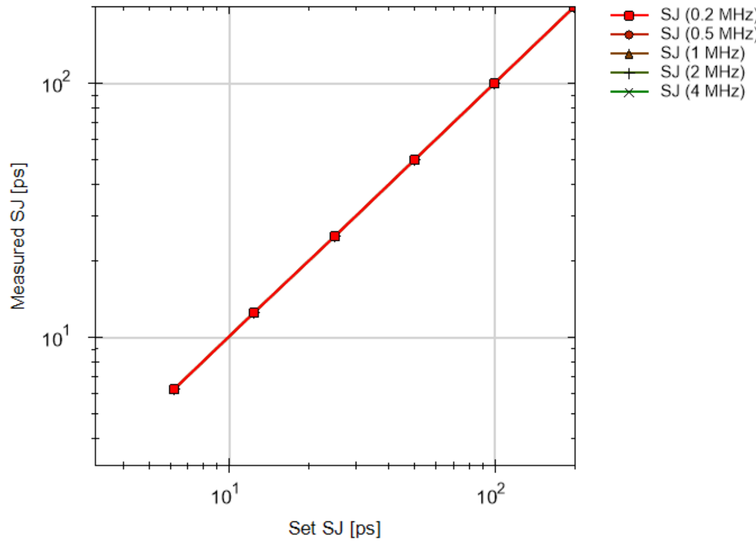
Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

L0_Cal_16GTps_LFSJ

for PCIe 6.0 AddInCard



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Start With Minimum Loss Channel	True
SigTest Version	4.0.52
----Generator----	
Pre-Shoot	0 dB
De-Emphasis	0 dB
Differential Voltage	800 mV
----Oscilloscope----	
Scope Bandwidth	25 GHz
Number of Averages	7
Number of UIs	2 MUI
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog:

Set SJ [ps]	SJ (0.2 MHz) [ps]	SJ (0.5 MHz) [ps]	SJ (1 MHz) [ps]	SJ (2 MHz) [ps]	SJ (4 MHz) [ps]
6.25	6.25	6.25	6.25	6.25	6.25
12.50	12.50	12.50	12.50	12.50	12.50
25.00	25.00	25.00	25.00	25.00	25.00
50.00	50.00	50.00	50.00	50.00	50.00
100.00	100.00	100.00	100.00	100.00	100.00
200.00	200.00	200.00	200.00	200.00	200.00

Figure 6-18 Example result for LF SJ Calibration

- Set SJ [ps]: The SJ jitter amplitude set on the instrument.
- SJ (X MHz) [ps]: The measured sinusoidal jitter amplitude for the set SJ amplitude and frequency X.

Pulsewidth Jitter Calibration

Availability

Data Generator:	M8040A, M8050A	
Interface Types:	ASIC	CEM
DUT Types:	End Point Root Complex	Add-In Card System
Modes:	Compliance, Expert	
Data Rates:	64 GT/s	

See also Table 2-1 on page 39.

Purpose and Method

This procedure calibrates the pulsewidth data-dependent jitter (DDJ) and pulsewidth random jitter.

During eye calibrations using Seasim, the pulsewidth DDJ and pulsewidth RJ of the generator need to be included in the simulation.

The generator sends the modified compliance pattern for 32 GT/s during this calibration procedure.

The measurement is done using a real-time oscilloscope and the SigTest application.

As a result, two calibration data tables are generated. Then, in further eye measuring procedures, these calibrations are used to provide the correct pulsewidth values for simulation with Seasim.

Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

This calibration produces two similar pages of results, one for DDJ and one for RJ. Only an example for DDJ is shown here.

L0_Cal_64GTps_Pulsewidth_DDJ

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
SigTest Version	6.1.13
----Oscilloscope----	
Scope Bandwidth	50 GHz
Use Bessel Filter	True
Remove Scope Noise	False
Number of Averages	5
Number of UIs	3 MUI
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog

Pulsewidth DDJ [ps]
1.000

Figure 6-19 Example result for Pulsewidth Jitter Calibration (DDJ)

- Pulsewidth DDJ [ps]: Measured pulsewidth data-dependent jitter.

On other page of results:

- Pulsewidth RJ [ps]: Measured pulsewidth random jitter.

RJ Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

During Rx tests, the input signal is stressed with a combination of jitter sources to simulate the possible impairments that are expected at the Rx input when operating in a target system. Random jitter is added to simulate the effects of thermal noise. Due to system intrinsic jitter, the effective jitter level is different from the value set in the data generator; therefore, jitter amplitude is calibrated.

The test automation starts with a small RJ amplitude and increases that value in several steps over a defined range. For each step, the procedure measures the actual random jitter.

The generator sends a clock pattern during this calibration procedure.

The measurement is done using a real-time oscilloscope and the RJ/DJ-separation software EZJIT or SigTest. The method used depends on the Eye Calibration Method selected for the particular data rate in the PCIe Parameters dialog during DUT configuration. (If Seasim is selected, EZJIT is used for RJ and SJ calibrations.)

The calibration data is stored in a cal-data table. This calibration table is used during measurements to calculate the RJ amplitude that must be set on the generator to get the expected RJ amplitude at the test point.

NOTE

For RJ Calibration at 64 GT/s, if you load calibration data measured with version 5.0 or earlier of N5991 PCI Express, NaN will be shown in the RJ Calibration result report, but the appropriate value of random jitter will still be applied in all tests, as indicated in the result report of each test.

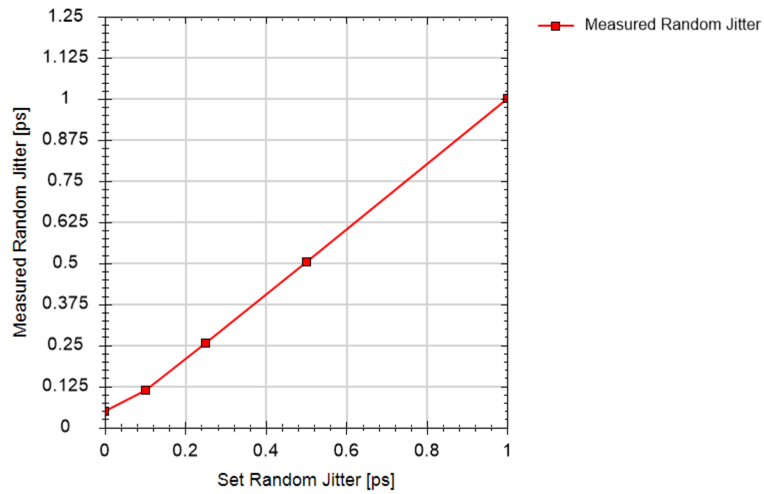
Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

L0_Cal_64GTps_RJ

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
----Oscilloscope----	
Scope Bandwidth	50 GHz
Use Bessel Filter	True
Remove Scope Noise	True
Scope RJ	78 fs
Number of Averages	7
Number of UIs	3 MUI
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog

Set Random Jitter [ps]	Measured Random Jitter [ps]
0.00	0.050
0.10	0.113
0.25	0.256
0.50	0.503
1.00	1.002

Figure 6-20 Example result for RJ Calibration

- Set Random Jitter [ps]: The jitter amplitude set on the instrument.
- Measured Random Jitter [ps]: The jitter amplitude measured with the oscilloscope.

Scope Channel Skew Calibration

Availability

Data Generator:	M8040A, M8050A
Interface Types:	ASIC
DUT Types:	End Point Root Complex
Modes:	Compliance, Expert
Data Rates:	64 GT/s

Purpose and Method

This procedure measures the skew between the differential channels used as input on the oscilloscope.

The procedure executes the auto deskew command, repeating this for different connections. The channel skew and setup skew are derived from the results of these measurements.

Connection Diagram

Refer to Figure 6-5 on page 116. Note that the cable connections must be changed during the calibration. A pop-up window informs you when to do this.

Result Description

L0_Cal_64GTps_ScopeChSkew

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Oscilloscope----	
Scope Bandwidth	50 GHz
Scope Connection for Calibration	Chan 2 4 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog:

Channel []	Inverted []	Skew [ps]
4	1	0.00
4	0	0.00
3	1	0.00
3	0	0.00

Figure 6-21 Example result for Scope Channel Skew Calibration

- Channel: Number of the oscilloscope channel.
- Inverted: 1 means that the cable is inverted, 0 that it is not.
- Skew [ps]: Value of skew for the given connection.

SJ Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	CEM	U.2 and M.2
DUT Types:	Add-In Card System	Device Host
Modes:	Compliance, Expert	
Data Rates:	8 GT/s	

See also Table 2-1 on page 39.

Purpose and Method

This procedure calibrates the sinusoidal jitter amplitude for two frequencies (16 MHz and 100 MHz).

The test automation starts with small SJ amplitude and increases that value in several steps over a defined range. For each step, the procedure measures the actual sinusoidal jitter for all the frequencies. The measurement is done using a real-time oscilloscope and the SigTest Application.

The calibration data is stored in a cal-data table. This calibration table is used during measurements to adjust the SJ amplitude to the desired output SJ amplitudes.

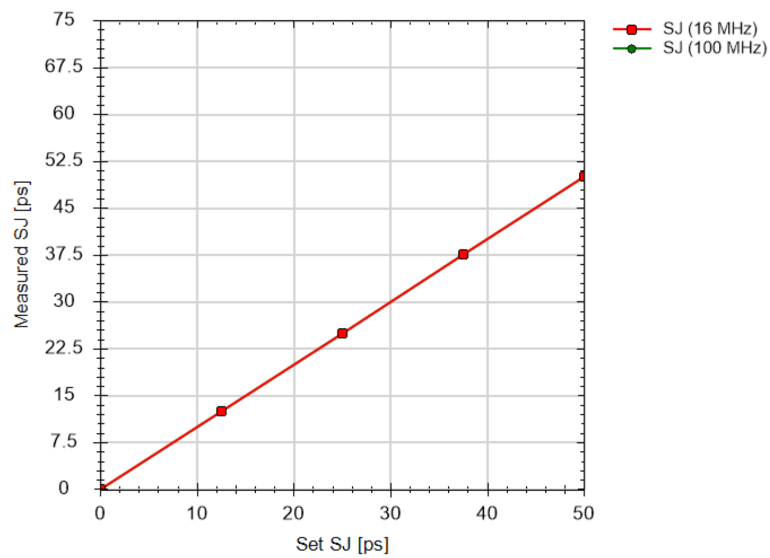
Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

L0_Cal_8GTps_SJ

for PCIe 6.0 AddInCard



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
CDR loop-bandwidth	50 kHz
Number of averages for jitter measurement	5
SigTest Version	3.2.0.3
----Oscilloscope----	
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Tech
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Tech
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Tech
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight

Set SJ [ps]	SJ (16 MHz) [ps]	SJ (100 MHz) [ps]
0.00	0.00	0.00
12.50	12.50	12.50
25.00	25.00	25.00
37.50	37.50	37.50
50.00	50.00	50.00

Figure 6-22 Example result for SJ Calibration

- Set SJ [ps]: The sinusoidal jitter amplitude set on the instrument.
- SJ (x MHz) [ps]: The measured sinusoidal jitter amplitude for the set SJ amplitude and frequency x MHz.

SNDR Calibration

Availability

Data Generator:	M8040A, M8050A
Interface Types:	ASIC
DUT Types:	End Point Root Complex
Modes:	Compliance, Expert
Data Rates:	64 GT/s

Purpose and Method

This procedure measures the ratio of signal to noise and distortion of the generator (SNDR: signal-to-(noise and distortion) ratio).

As a result, a calibration data table is generated. Then, in further eye-measuring procedures, these calibrations are used to provide the correct SNDR value for simulation with Seasim.

Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

L0_Cal_64GTps_SNDR

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Oscilloscope----	
Scope Bandwidth	50 GHz
Use Bessel Filter	True
Remove Scope Noise	True
Number of Averages	10
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog

SNDR [dB]
34.0

Figure 6-23 Example result for SNDR Calibration

- SNDR [dB]: Measured signal-to-(noise and distortion) ratio.

TxEQ and Launch Voltage Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This procedure calibrates the De-Emphasis, Pre-Shoot (for 64 GT/s: Pre-Shoot 1 and Pre-Shoot 2) and Differential Voltage at TP1.

The pattern generator sends an equalization pattern to the oscilloscope and performs a sweep of the equalization range according to the **measurement algorithm** selected in the user interface.

- **Speed Optimized Measurement:** The default – and recommended – algorithm for 64 GT/s. In this case, the test measures only a subset of the possible combinations of pre-cursor 2, pre-cursor 1 and post-cursor. This subset provides the best possible accuracy for the preset values Q0–Q9 and acceptable accuracy for the rest of the range.
- **Measure All Coefficients:**
  8 GT/s, 16 GT/s, 32 GT/s: The pre-cursor is set to the initial value (–0.28). For this set value, the post cursor is swept from –0.28 to 0.02 in linear steps of 0.02.
  64 GT/s: With this algorithm you can set the start value, stop value and step value for the pre-cursors and post-cursor. This procedure takes a very long time.

At each combination of values of the pre-cursor(s) and post-cursor, the de-emphasis, pre-shoot(s) and differential voltage are measured with the oscilloscope. The set Differential Voltage always remains fixed at 800 mV.

NOTE

The procedure explained above is specific to the M8040A and M8050A data generator setups. For the M8020A setup, the procedure is very similar but the sweep is performed not over the pre-cursor and post-cursor values but directly for the de-emphasis (from –6 dB to 2 dB) and pre-shoot (from 6 dB to –1 dB).

As a result, a single cal-data table is generated. In subsequent procedures, this calibration data is used to set equalization values that provide the desired de-emphasis, pre-shoot(s) and differential voltage at the test point.

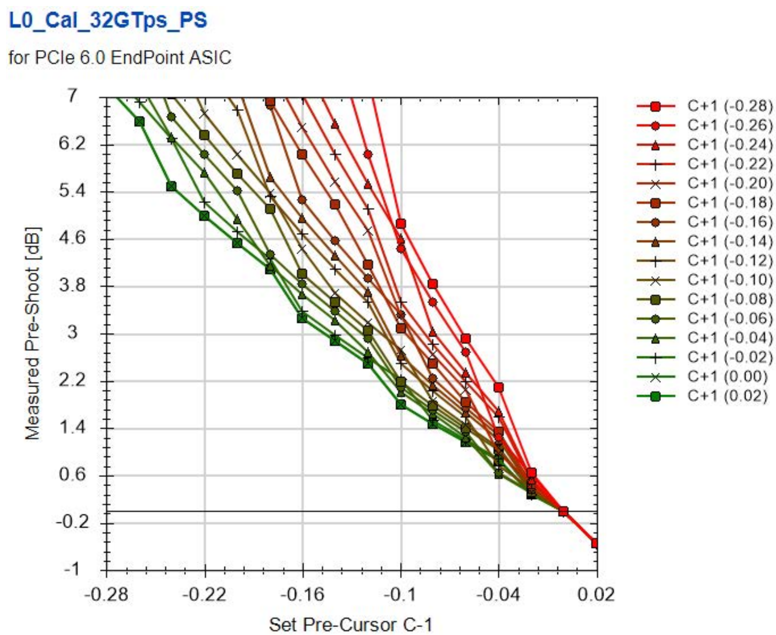
Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description (8 GT/s, 16 GT/s and 32 GT/s)

Pre-Shoot, De-Emphasis and Launch Voltage are presented separately.

Pre-Shoot



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
EQ Calibration Pattern	EQ Two Pattern, 16 zeros, 16 ones
Verification Mode	False
Measure all Generator voltages	False
Select Measurement Algorithm	Measure All Coefficients
Gen5 Fixture	PCIe 5.0 FR4 Base Fixture
Gen5 Asic Eye Calibration Method	Seasim
----Generator----	
Set Amplitude	800 mV
----Oscilloscope----	
Scope Bandwidth	50 GHz
Number of Waveform Averages	256
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog

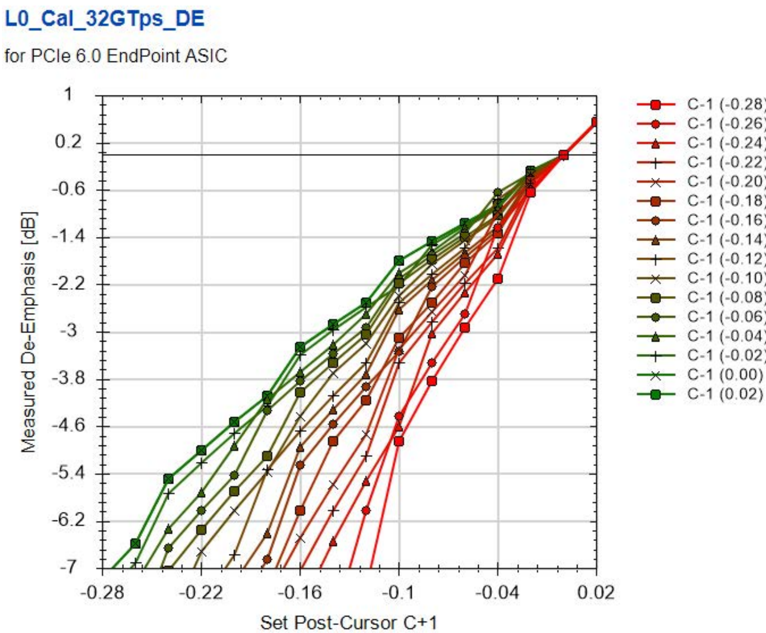
Set Pre-Cursor C-1 []	C+1 (-0.28) [dB]	C+1 (-0.26) [dB]	C+1 (-0.24) [dB]	C+1 (-0.22) [dB]	C+1 (-0.20) [dB]	C+1 (-0.18) [dB]	C+1 (-0.16) [dB]	C+1 (-0.14) [dB]	C+1 (-0.12) [dB]	C+1 (-0.10) [dB]	C+1 (-0.08) [dB]	C+1 (-0.06) [dB]	C+1 (-0.04) [dB]	C+1 (-0.02) [dB]	C+1 (0.00) [dB]	C+1 (0.02) [dB]
-0.28	N/A	N/A	N/A	N/A	N/A	N/A	14.81	13.26	12.04	10.24	9.54	8.94	8.42	7.55	7.18	7.18
-0.26	N/A	N/A	N/A	N/A	N/A	14.40	12.87	11.67	9.54	9.21	8.63	8.12	7.26	6.90	6.58	6.58
-0.24	N/A	N/A	N/A	N/A	13.53	12.04	9.95	9.17	8.52	7.96	7.04	6.66	6.33	6.31	5.49	5.49
-0.22	N/A	N/A	N/A	13.06	11.60	10.46	8.79	8.15	7.60	6.72	6.35	6.02	5.73	5.22	5.00	5.00
-0.20	N/A	N/A	12.57	11.13	10.01	8.38	7.76	7.23	6.78	6.02	5.70	5.42	4.93	4.72	4.53	4.53
-0.18	N/A	11.48	10.63	9.54	7.51	6.94	6.85	5.65	5.33	5.38	5.11	4.33	4.14	4.25	4.08	4.08
-0.16	10.88	9.54	7.71	7.04	6.49	6.02	5.26	4.96	4.68	4.44	4.02	3.84	3.67	3.38	3.25	3.25
-0.14	8.94	7.96	6.55	6.02	5.58	5.19	4.57	4.31	4.08	3.69	3.52	3.37	3.23	2.98	2.87	2.87
-0.12	7.36	6.02	5.52	5.11	4.75	4.17	3.93	3.71	3.52	3.19	3.05	2.92	2.69	2.59	2.50	2.50
-0.10	4.86	4.44	4.61	3.52	3.30	3.10	3.33	2.63	2.50	2.72	2.18	2.09	2.01	2.22	1.80	1.80
-0.08	3.84	3.52	3.03	2.83	2.65	2.50	2.24	2.13	2.03	1.86	1.78	1.71	1.64	1.53	1.48	1.48
-0.06	2.92	2.69	2.33	2.18	2.05	1.84	1.74	1.66	1.58	1.45	1.39	1.34	1.24	1.20	1.16	1.16
-0.04	2.09	1.24	1.69	1.58	0.97	1.34	1.27	1.21	0.76	1.06	1.02	0.64	0.62	0.88	0.86	0.86
-0.02	0.64	0.60	0.53	0.50	0.47	0.45	0.40	0.39	0.37	0.35	0.33	0.32	0.30	0.28	0.28	0.28
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55

Figure 6-24 Example result for TxEQ and Launch Voltage Calibration (Pre-Shoot, 32 GT/s)

- Set Pre-Cursor C-1: The pre-cursor value set on the data generator.
- The remaining table entries are the values of the Pre-Shoot [dB] measured for the combination of the Pre-Cursor values (C-1), listed in the first column, and the Post-Cursor values (C+1 (x)), listed in the first row, that are set on the data generator.

De-Emphasis

For De-Emphasis, the text in the results is the same as for Pre-Shoot (see Figure 6-24) and is not repeated here.



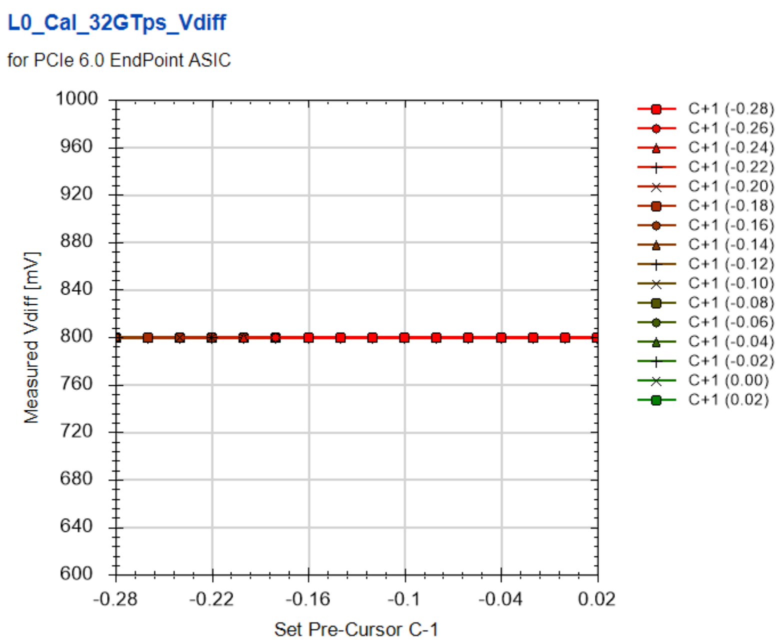
Set Post-Cursor C+1 []	C-1 (-0.28) [dB]	C-1 (-0.26) [dB]	C-1 (-0.24) [dB]	C-1 (-0.22) [dB]	C-1 (-0.20) [dB]	C-1 (-0.18) [dB]	C-1 (-0.16) [dB]	C-1 (-0.14) [dB]	C-1 (-0.12) [dB]	C-1 (-0.10) [dB]	C-1 (-0.08) [dB]	C-1 (-0.06) [dB]	C-1 (-0.04) [dB]	C-1 (-0.02) [dB]	C-1 (0.00) [dB]	C-1 (0.02) [dB]
-0.28	N/A	N/A	N/A	N/A	N/A	N/A	-14.81	-13.26	-12.04	-10.24	-9.54	-8.94	-8.42	-7.55	-7.18	-7.18
-0.26	N/A	N/A	N/A	N/A	N/A	-14.40	-12.87	-11.67	-9.54	-9.21	-8.63	-8.12	-7.26	-6.90	-6.58	-6.58
-0.24	N/A	N/A	N/A	N/A	-13.53	-12.04	-9.95	-9.17	-8.52	-7.96	-7.04	-6.66	-6.33	-5.74	-5.49	-5.49
-0.22	N/A	N/A	N/A	-13.06	-11.60	-10.46	-8.79	-8.15	-7.60	-6.72	-6.35	-6.02	-5.73	-5.22	-5.00	-5.00
-0.20	N/A	N/A	-12.57	-11.13	-10.01	-8.38	-7.76	-7.23	-6.78	-6.02	-5.70	-5.42	-4.93	-4.72	-4.53	-4.53
-0.18	N/A	-11.48	-10.63	-9.54	-7.51	-7.36	-6.85	-6.41	-5.33	-5.38	-5.11	-4.33	-4.14	-4.25	-4.08	-4.08
-0.16	-10.88	-9.54	-7.71	-7.04	-6.49	-6.02	-5.26	-4.96	-4.68	-4.44	-4.02	-3.84	-3.67	-3.38	-3.25	-3.25
-0.14	-8.94	-7.96	-6.55	-6.02	-5.58	-4.86	-4.57	-4.31	-4.08	-3.69	-3.52	-3.37	-3.23	-2.98	-2.87	-2.87
-0.12	-7.36	-6.02	-5.52	-5.11	-4.75	-4.17	-3.93	-3.71	-3.52	-3.19	-3.05	-2.92	-2.69	-2.59	-2.50	-2.50
-0.10	-4.86	-4.44	-4.61	-3.52	-3.30	-3.10	-3.33	-2.63	-2.50	-2.38	-2.18	-2.09	-2.01	-2.22	-1.80	-1.80
-0.08	-3.84	-3.52	-3.03	-2.83	-2.65	-2.50	-2.24	-2.13	-2.03	-1.86	-1.78	-1.71	-1.64	-1.53	-1.48	-1.48
-0.06	-2.92	-2.69	-2.33	-2.18	-2.05	-1.84	-1.74	-1.66	-1.58	-1.45	-1.39	-1.34	-1.24	-1.20	-1.16	-1.16
-0.04	-2.09	-1.24	-1.69	-1.58	-0.97	-1.34	-1.27	-1.21	-0.76	-1.06	-1.02	-0.64	-0.92	-0.88	-0.86	-0.86
-0.02	-0.64	-0.60	-0.56	-0.50	-0.47	-0.45	-0.40	-0.39	-0.37	-0.35	-0.33	-0.32	-0.30	-0.28	-0.28	-0.28
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55

Figure 6-25 Example result for TxEQ and Launch Voltage Calibration (De-Emphasis, 32 GT/s)

- Set Post-Cursor C+1: The post-cursor value set on the data generator.
- The remaining table entries are the values of the De-Emphasis [dB] measured for the combination of the Post-Cursor values (C+1), listed in the first column, and the Pre-Cursor values (C-1 (x)), listed in the first row, that are set on the data generator.

Launch Voltage

For Launch Voltage, the text in the results is the same as for Pre-Shoot (see Figure 6-24 on page 157) and is not shown here.



Set Pre-Cursor C-1 []	C+1 (-0.28) [mV]	C+1 (-0.26) [mV]	C+1 (-0.24) [mV]	C+1 (-0.22) [mV]	C+1 (-0.20) [mV]	C+1 (-0.18) [mV]	C+1 (-0.16) [mV]	C+1 (-0.14) [mV]	C+1 (-0.12) [mV]	C+1 (-0.10) [mV]	C+1 (-0.08) [mV]	C+1 (-0.06) [mV]	C+1 (-0.04) [mV]	C+1 (-0.02) [mV]	C+1 (0.00) [mV]	C+1 (0.02) [mV]
-0.28	N/A	N/A	N/A	N/A	N/A	N/A	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.26	N/A	N/A	N/A	N/A	N/A	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.24	N/A	N/A	N/A	N/A	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.22	N/A	N/A	N/A	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.20	N/A	N/A	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.18	N/A	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.16	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.14	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.12	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.10	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.08	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.06	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.04	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.02	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
0.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
0.02	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00

Figure 6-26 Example result for TxEQ and Launch Voltage Calibration (Launch Voltage, 32 GT/s)

- Set Pre-Cursor C-1: The post-cursor value set on the data generator.
- The remaining table entries are the values of the Differential Voltage [mV] measured for the combination of the Pre-Cursor values (C-1), listed in the first column, and the Post-Cursor values (C+1 (x)), listed in the first row, that are set on the data generator.

Result Description (64 GT/s)

For the TxEQ and Launch Voltage Calibration at data rate 64 GT/s, there are no plots.

L0_Cal_64GTps_TxEq

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Measurement Algorithm	Speed Optimized Measurement
----Oscilloscope----	
Scope Bandwidth	59 GHz
Use Bessel Filter	False
Number of Waveform Averages	1024
Vertical scale	85 mV
Calibrated Q0 Pre-Cursor 2	0
Calibrated Q0 Pre-Cursor 1	0
Calibrated Q0 Post-Cursor 1	0
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies ;
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies ;
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technologi

Set PreCursor2 []	Set PreCursor1 []	Set PostCursor []	Set VDiff [mV]	Measured PreShoot2 [dB]	Measured PreShoot1 [dB]	Measured DeEmphasis [dB]	Measured VDiff [mV]
0.000000	-0.281250	-0.156250	800	0.00	14.81	-10.88	800
0.000000	-0.281250	-0.140625	800	0.00	13.26	-8.94	800
0.000000	-0.281250	-0.125000	800	0.00	12.04	-7.36	800
0.000000	-0.281250	-0.109375	800	0.00	11.06	-6.02	800
0.000000	-0.281250	-0.093750	800	0.00	10.24	-4.86	800
0.000000	-0.281250	-0.078125	800	0.00	9.54	-3.84	800
0.000000	-0.281250	-0.062500	800	0.00	8.94	-2.92	800
0.000000	-0.281250	-0.046875	800	0.00	8.42	-2.09	800
0.000000	-0.281250	-0.031250	800	0.00	7.96	-1.34	800
0.000000	-0.281250	-0.015625	800	0.00	7.55	-0.64	800
0.000000	-0.281250	0.000000	800	0.00	7.18	0.00	800
0.000000	-0.265625	-0.140625	800	0.00	11.67	-7.96	800
0.000000	-0.265625	0.000000	800	0.00	6.58	0.00	800
0.000000	-0.250000	-0.140625	800	0.00	10.33	-7.18	800
0.000000	-0.250000	0.000000	800	0.00	6.02	0.00	800

(...)

0.000000	0.000000	-0.062500	800	0.00	0.00	-1.16	800
0.000000	0.000000	-0.046875	800	0.00	0.00	-0.86	800
0.000000	0.000000	-0.031250	800	0.00	0.00	-0.56	800
0.000000	0.000000	-0.015625	800	0.00	0.00	-0.28	800
0.000000	0.000000	0.000000	800	0.00	0.00	0.00	800
0.078125	-0.140625	-0.140625	800	-3.84	4.31	-4.31	800
0.015625	0.015625	0.015625	800	-0.28	-0.28	0.28	800
0.015625	0.015625	-0.015625	800	-0.28	-0.28	-0.28	800
0.015625	-0.015625	0.015625	800	-0.28	0.28	0.28	800
-0.015625	0.015625	0.015625	800	0.28	-0.28	0.28	800
-0.015625	0.015625	-0.015625	800	0.28	-0.29	-0.28	800
-0.015625	-0.015625	0.015625	800	0.28	0.28	0.29	800
-0.015625	-0.015625	-0.015625	800	0.29	0.29	-0.29	800

Figure 6-27 Example result for TxEQ and Launch Voltage Calibration (64 GT/s)

- Set Precursor2: Value of Pre-Cursor 2 set on the instrument.
- Set PreCursor1: Value of Pre-Cursor 1 set on the instrument.
- Set PostCursor: Value of Post-Cursor set on the instrument.
- Set VDiff: Value of Differential Voltage set on the instrument.
- Measured PreShoot2 [dB]: Value of Pre-Shoot 2 measured at the oscilloscope.
- Measured PreShoot1 [dB]: Value of Pre-Shoot 1 measured at the oscilloscope.
- Measured DeEmphasis [dB]: Value of De-Emphasis measured at the oscilloscope.
- Measured VDiff [mV]: Value of Differential Voltage measured at the oscilloscope.

TxEQ and Launch Voltage Measurement

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure sets the calibrated Differential Voltage, Pre-Shoot (Pre-Shoot 2 and Pre-Shoot 1 for 64 GT/s) and De-Emphasis values at TP1 and re-measures them. The measurement can be repeated as many times as a new impairment combination is selected.

The procedure is useful for checking whether the TxEQ and Launch Voltage Calibration is correct and the desired values at TP1 can be achieved.

Connection Diagram

Refer to Figure 6-3 and Figure 6-4 on page 115.

Result Description

Example presentation of results for all data rates except 64 GT/s.

L0_Meas_32GTps_EQ_Vdiff

for PCIe 6.0 EndPoint ASIC

```
----General----
Offline                                True
Software Version                       5.4.0.22
Spec Deviations
Comments
EQ Calibration Pattern                 EQ Two Pattern, 16 zeros, 16 ones
Gen5 Fixture                           PCIe 5.0 FR4 Base Fixture
Gen5 Asic Eye Calibration Method       Seasim
----Oscilloscope----
Scope Bandwidth                        50 GHz
Number of Waveform Averages            256
Scope Connection for Calibration       Chan 1 3 Direct Connect
----Instruments----
Calibrated Instrument 1                Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2                Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 3                Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 4                Name: DataOut2 ; Company: Keysight Technologies
Measurement Instrument 1               Name: Keysight DSO ; Company: Keysight Technolog
```

Requested Pre-Shoot [dB]	Requested De-Emphasis [dB]	Requested Differential Voltage [mV]	Set Coefficient 1 []	Set Coefficient 3 []	Set Generator Voltage [mV]	Measured Pre-Shoot [dB]	Measured De-Emphasis [dB]	Measured Differential Voltage [mV]
0.00	0.00	800	0.000	0.000	400	0.00	0.00	800
3.00	0.00	800	-0.147	0.000	400	3.00	0.00	800
4.00	0.00	800	-0.178	0.000	400	4.00	0.00	800
5.00	0.00	800	-0.220	0.000	400	5.00	0.00	800
6.00	0.00	800	-0.249	0.000	400	6.00	0.00	800
6.00	-2.00	800	-0.222	-0.053	400	6.00	-2.00	800
6.00	-4.00	800	-0.193	-0.112	400	6.00	-4.00	800
6.00	-6.00	800	-0.170	-0.165	400	6.00	-6.00	800

Figure 6-28 Example result for 32G TxEQ and Launch Voltage Measurement procedure

- Requested Pre-Shoot [dB]: Entered value of Pre-Shoot.
- Requested De-Emphasis [dB]: Entered value of De-Emphasis.
- Requested Differential Voltage [mV]: Entered value of voltage set in ValiFrame.
- Set Coefficient 1: Value of Pre-Cursor applied at the generator according to calibration.
- Set Coefficient 3: Value of Post-Cursor applied at the generator according to calibration.

- Set Generator Voltage [mV]: Value of Generator Voltage according to calibration.
- Measured Pre-Shoot [dB]: Measured value of Pre-Shoot.
- Measured De-Emphasis [dB]: Measured value of De-Emphasis.
- Measured Differential Voltage [mV]: Measured value of differential voltage at the generator output.

The presentation of results for 64 GT/s differs from that for the other data rates.

L0_Meas_64GTps_EQ_Vdiff

for PCIe 6.0 EndPoint ASIC

----General----

Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Use Coefficients as Input	False

----Oscilloscope----

Scope Bandwidth	59 GHz
Use Bessel Filter	False
Number of Waveform Averages	1024
Number of Averages	10
Use Linear Fit Pulse Response	True
Calibrated Q0 Pre-Cursor 2	0
Calibrated Q0 Pre-Cursor 1	0
Calibrated Q0 Post-Cursor 1	0
Scope Connection for Calibration	Chan 1 3 Direct Connect

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog

Requested Pre-Shoot2 [dB]	Requested Pre-Shoot1 [dB]	Requested De-Emphasis [dB]	Requested Vdiff [mV]	Set c-2 []	Set c-1 []	Set c+1 []	Set Amplitude [mV]	Measured Pre-Shoot2 [dB]	Measured Pre-Shoot1 [dB]	Measured De-Emphasis [dB]	Measured Vdiff [mV]
0.00	0.00	0.00	800	0.000	0.000	0.000	800	0.00	0.00	0.00	800
0.00	2.00	0.00	800	0.000	-0.103	0.000	800	0.00	2.00	0.00	800
0.00	4.00	0.00	800	0.000	-0.184	0.000	800	0.00	4.00	0.00	800
0.00	6.00	0.00	800	0.000	-0.249	0.000	800	0.00	6.00	0.00	800
-1.00	6.00	0.00	800	0.027	-0.249	0.000	800	-1.00	6.00	0.00	800
-2.00	6.00	0.00	800	0.051	-0.249	0.000	800	-2.00	6.00	0.00	800
-3.00	6.00	0.00	800	0.073	-0.249	0.000	800	-3.00	6.00	0.00	800
-3.00	6.00	-2.00	800	0.065	-0.221	-0.057	800	-3.00	6.00	-2.00	800
-3.00	6.00	-4.00	800	0.057	-0.193	-0.113	800	-3.00	6.00	-4.00	800
-3.00	6.00	-6.00	800	0.049	-0.166	-0.167	800	-3.00	6.00	-6.00	800

Figure 6-29 Example result for 64G TxEQ and Launch Voltage Measurement procedure

- Requested Pre-Shoot2 [dB]: Entered value of Pre-Shoot 2.
- Requested Pre-Shoot1 [dB]: Entered value of Pre-Shoot 1.
- Requested De-Emphasis [dB]: Entered value of De-Emphasis.
- Requested Vdiff [mV]: Entered differential voltage value set in ValiFrame.
- Set c-2: Value of Pre-Cursor 2 applied at the generator according to calibration.
- Set c-1: Value of Pre-Cursor 1 applied at the generator according to calibration.
- Set c+1: Value of Post-Cursor applied at the generator according to calibration.
- Set Amplitude [mV]: Value of Generator Voltage amplitude according to calibration.
- Measured Pre-Shoot2 [dB]: Measured value of Pre-Shoot 2.
- Measured Pre-Shoot1 [dB]: Measured value of Pre-Shoot 1.
- Measured De-Emphasis [dB]: Measured value of De-Emphasis.
- Measured Vdiff [mV]: Measured value of differential voltage at the generator output.

Descriptions of Long-Channel Calibrations

AWG Amplitude Correction Calibration

Availability

Data Generator:	M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This procedure calibrates the correction factor of the AWG.

The test automation measures the amplitude of each channel at TP2 with the oscilloscope when the AWG corrector factor is set to 1. With the measured values, the new correction factor is calculated.

Connection Diagram

Refer to Figure 6-7 on page 117 and Figure 6-8 on page 118.

If Seasim is used, the hardware trace is set to the optimal number based on the final channel from the Compliance Eye Calibration on page 176.

If SigTest is used, the calibration is done at the nominal loss channel.

Result Description

L0_Cal_64GTps_AWG_Correction

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Oscilloscope----	
Scope Bandwidth	5 GHz
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\Bitif
Scope Connection for Calibration	Chan 1 3 Direct Conn
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040 Calibrated Instrumen
Calibrated Instrument 2	Name: DataOut1 ; Com Instrument
Calibrated Instrument 3	Name: DataOut1 ; Com
Calibrated Instrument 4	Name: DataOut2 ; Com
Measurement Instrument 1	Name: Keysight DSO ; Instrument

Amplitude Correction Factor [x/x]
1.000

Figure 6-30 Example result for AWG Amplitude Correction Calibration

- Amplitude Correction Factor [x/x]: The correction factor that must be applied to the data channels of the AWG.

Channel Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	16 GT/s		

Purpose and Method

This procedure searches for the calibration channel loss that produces an eye closest to the target value.

When the “Start with Minimum Loss Channel” option is not selected in the “Configure DUT” dialog, the hardware trace is set to achieve –30 dB at 8 GHz and the Tx EQ preset to the value that gets the largest eye. Then, at each step, the channel loss is decreased by 0.5 dB and the eye measured until the eye width and the eye height exceed the target, or until the insertion loss at 8 GHz reaches the minimum of –27 dB.

When the “Start with Minimum Loss Channel” option is selected, the hardware trace is set to achieve –27 dB at 8 GHz and the Tx EQ preset to the value that gets the largest eye. Then, at each step, the channel loss is increased, by changing the hardware trace, and the eye measured until either the eye width or the eye height have fallen below the target, or until the insertion loss at 8 GHz reaches –30 dB.

The calibration data is stored in a cal-data table. This calibration data is used to evaluate the optimum ISI trace for the Rx tests.

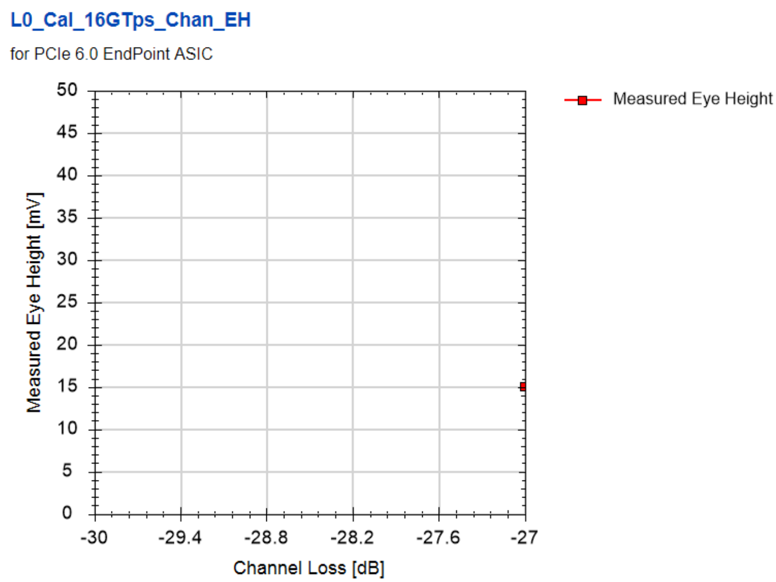
Connection Diagram

The initial setup is that for Long Channel (refer to Figure 6-7 on page 117 and Figure 6-8 on page 118) with the var. ISI Pair set to either the one that gives the maximum loss channel (if “Start with Minimum Loss Channel” is unchecked under ‘Configure DUT’ – ‘Show Parameters’ – ‘16 GT/s’) or the one that gives the minimum loss channel (if “Start with Minimum Loss Channel” is checked). Note that for each step you will be prompted to change the hardware trace until the optimum channel is found.

Result Description

There are two sets of results, one for Eye Height (Figure 6-31) and one for Eye Width (Figure 6-32).

Eye Height



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Gen4 Fixture	PCI Express 4.0 CEM Fix
Gen4 ISI Adjustment	Hardware Traces
Gen4 Asic Eye Calibration Method	Seasim
Start With Minimum Loss Channel	True
----Generator----	
Pre-Shoot	0 dB
De-Emphasis	-6 dB
Generator Launch Voltage	800 mV
DMSI	14 mV
CMSI	0 V
Random Jitter	1 ps
Sinusoidal Jitter	6.25 ps
Sinusoidal Jitter Frequency	100 MHz

----Oscilloscope----

Scope Bandwidth	25 GHz
Number of Averages	7
Number of Waveform Averages	1024
Gen4 Embed Replica Channel	False
Gen4 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye
Scope Connection for Calibration	Chan 1 3 Direct Connect

----Seasim----

Number of UI	120
Used Pattern	Clock Div 512

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040A J Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Compan Calibrated Instrument
Calibrated Instrument 3	Name: DataOut1 ; Compan
Calibrated Instrument 4	Name: DataOut2 ; Compan
Measurement Instrument 1	Name: Keysight DSO ; Co Measurement Instrument

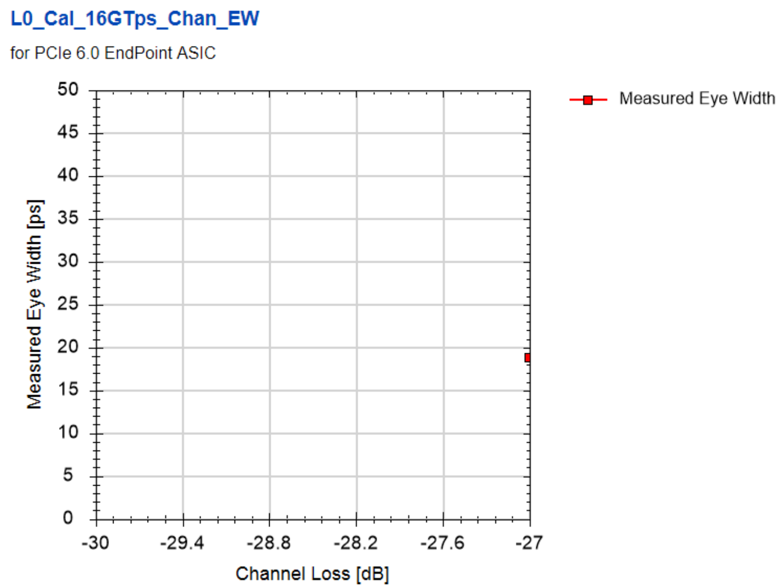
Set Channel Loss [dB]	Measured Eye Height [mV]
-27.00	15.00
-27.50	

Figure 6-31 Example result for Channel Calibration (Eye Height)

- Set Channel Loss [dB]: Loss of the channel used during the measurement.
- Measured Eye Height [mV]: Value of the eye height for the set channel loss.

Eye Width

For Eye Width, the text in the results is the same as for Eye Height (see Figure 6-31) and is not shown here.



Set Channel Loss [dB]	Measured Eye Width [ps]
-27.00	18.75
-27.50	

Figure 6-32 Example result for Channel Calibration (Eye Width)

- Set Channel Loss [dB]: Loss of the channel used during the measurement.
- Measured Eye Width [ps]: Value of the eye width for the set channel loss.

CMSI Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

The Common Mode Sinusoidal Interference (CMSI) that is generated by the generator setup is attenuated before it reaches the receiver, and therefore the CMSI amplitude at the Rx input must be calibrated.

The test automation starts with a small CMSI amplitude and increases that value in several steps over a defined range. The minimum amplitude is 0 mV and the maximum amplitude is the maximum value that the data generator can generate. For each step, the procedure measures the actual CMSI with a real-time oscilloscope.

The calibration data is stored in a cal-data table. When measurements are performed, these calibration tables are used to adjust the voltage amplitude to the desired output CMSI.

NOTE **With N5991 PCIe ValiFrame version 5.0, the calibration method for CMSI/DMSI changed, which means that the calibration data and files from earlier versions of the application will not work or will be shown as missing.**

Connection Diagram

The setup is that for Long Channel (refer to Figure 6-6, Figure 6-7 and Figure 6-8 on page 118).

For Seasim as the Eye Calibration Method, the hardware trace is set to the optimal one according to

- the Channel Calibration (16 GT/s),
- the Compliance Eye Calibration (32, 64 GT/s)

while for 8 GT/s the hardware trace is fixed and not changed during the calibrations.

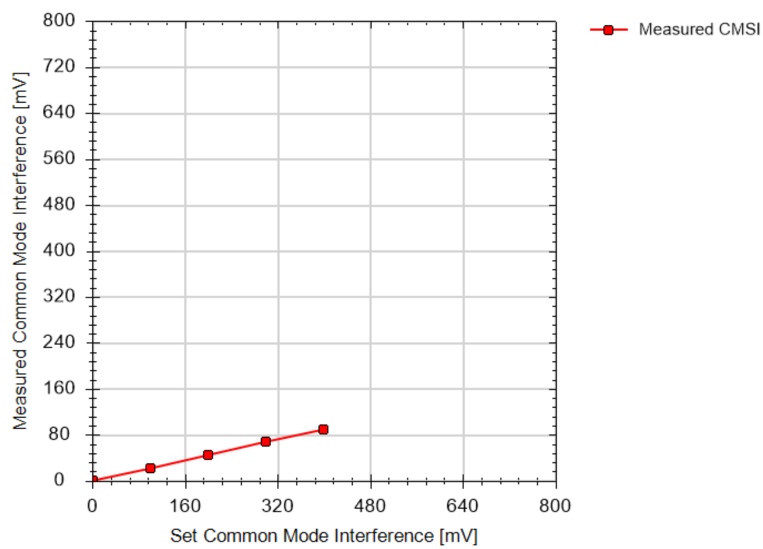
For SigTest as the Eye Calibration Method, the nominal channel is used:

- a –28 dB loss channel for 16 GT/s,
- a –36 dB loss channel for 32 GT/s.

Result Description

L0_Cal_64GTps_CMSI

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
----Generator----	
Set DMSI	40 mV
----Oscilloscope----	
Scope Bandwidth	5 GHz
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\Bitif
Scope Connection for Calibration	Chan 1 3 Direct Conn

----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040 Calibrated Instrumen
Calibrated Instrument 2	Name: DataOut1 ; Com Calibrated Instrumen
Calibrated Instrument 3	Name: DataOut1 ; Com
Calibrated Instrument 4	Name: DataOut2 ; Com
Measurement Instrument 1	Name: Keysight DSO ; Instrument

Set CMSI [mV]	Measured CMSI [mV]
0.00	0.00
100.00	22.39
200.00	44.77
300.00	67.16
400.00	89.55

Figure 6-33 Example result for CMSI Calibration

- Set CMSI [mV]: Value of CMSI set on the generator.
- Measured CMSI [mV]: Value of CMSI measured with the oscilloscope.

Compliance Eye Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

For 32 GT/s and 64 GT/s

This calibration searches for the optimum combination of DMSI, SJ and Launch Voltage values to generate an eye with values of eye height and eye width that are the closest possible to the Compliance Eye Height and Eye Width.

The calibration starts at the channel with the highest loss. In the first step, the eye is measured when the impairments are set to the nominal values. Then a search algorithm is used to re-calculate the optimum amount of SJ, DMSI and Vdiff. This process is repeated until the eye is in the middle of the specification values or until the “Max Number of Search Steps per Channel” is reached.

If no suitable combination is found, you are requested to connect the channel that is one step down in loss, as specified in the Insertion Loss Calibration.

The search is repeated for each channel (in order of decreasing loss) until a suitable combination of channel, DMSI, SJ and Launch Voltage is found.

If the minimum loss channel is reached and no combination is found, the calibration is considered to have failed.

For 16 GT/s

This calibration searches for the optimum combination of DMSI, SJ and Launch Voltage values to generate an eye with values of eye height and eye width that are the closest possible to the Compliance Eye Height and Eye Width.

In the first step, the eye is measured with the impairments set to their nominal values and the channel loss previously determined by the Channel Calibration. Then, a search algorithm is used to re-calculate the optimum amount of SJ, DMSI and V_{diff}. This process is repeated until the eye is in the middle of the specifications or until the “Max number of Search Steps” is reached.

If the automatic search does not find a suitable combination of impairments that generates an eye within the specifications (EH between 14 mV and 16 mV and EW between 18.5 ps and 19 ps), it is possible to perform a manual search by manually setting the SJ, DMSI and V_{diff} values.

For 8 GT/s

This procedure checks the possibility of generating an eye height and an eye width that meet the specifications by adding Random Jitter and Differential Mode Sinusoidal Interference.

The method starts with nominal RJ and DMSI values and checks if the obtained eye height and eye width are the target values. If they are not, RJ and DMSI are recalculated with an algorithm that uses the difference between the measured and the target values of the eye amplitudes. The procedure is repeated until the target values are reached or until the “Max Number of Search Steps” is reached. If the “Max Number of Search Steps” is reached, the algorithm checks whether or not the optimum combination of the tested RJ and DMSI meets the specification.

Connection Diagram

Refer to Figure 6-8 on page 118 (ASIC), Figure 6-7 on page 117 (CEM) and Figure 6-10 on page 119 (M.2).

Result Description

For 64G (Compliance Eye Calibration)

L0_Cal_64GTps_CompEye

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Skip Preset and CTLE Optimization	False
Re-calibrate on Final Channel	False
----Generator----	
Pre-Shoot2	-1.3 dB
Pre-Shoot1	4.7 dB
De-Emphasis	0 dB
CMSI	0 V
----Oscilloscope----	
Fixed Vertical Scale of Scope Channels	38 mV
Do Auto Scale	False
Scope Bandwidth	33 GHz
Number of Averages	7
Number of Waveform Averages	10240
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\Bitif
Scope Connection for Calibration	Chan 1 3 Direct Conn
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Preset and CTLE Optimization----	
Equalization Preset Range	Q5;Q6;Q9
DMSI	15 mV
Sinusoidal Jitter	1.5625 ps
Number of Averages	3
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Search Algorithm----	
Minimum Vdiff	720 mV
Maximum DMSI	25 mV
Minimum SJ	1 ps
Maximum SJ	3 ps
Max Number of Search Steps	7

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040 Calibrated Instrumen
Calibrated Instrument 2	Name: DataOut1 ; Com Calibrated Instrumen
Calibrated Instrument 3	Name: DataOut1 ; Com
Calibrated Instrument 4	Name: DataOut2 ; Com
Measurement Instrument 1	Name: Keysight DSO ; Instrument

Step	Trace []	Loss [dB]	CTLE [dB]	Vertical Scaling [mV]	Preset []	Pre-Shoot 2 [dB]	Pre-Shoot 1 [dB]	De-Emphasis [dB]	DMSI [mV]	SJ [ps]	RJ [ps]	VDiff [mV]	Eye Height [mV]	Eye Width [ps]
From Pre-Compliance Calibration	9	-33.0	0.0	0.0	5	-1.3	4.7	0.0	5.0	1.563	0.190	800	5.50	2.83
Channel Search Step 1	9	-33.0	0.0	0.0	5	-1.3	4.7	0.0	5.0	1.563	0.190	800	6.00	3.13
Final Result	9	-33.0	0.0	0.0	5	-1.3	4.7	0.0	5.0	1.563	0.190	800	6.00	3.13

Figure 6-34 Example result for Compliance Eye Calibration (ASIC, 64 GT/s)

- Step: Description of Step.
- Trace: Number of the trace used.
- Loss [dB]: The channel loss corresponding to the trace.
- CTLE [dB]: CTLE DC gain [dB] that results in the maximum eye area (eye height times eye width) for the current channel.
- Vertical Scaling [mV]: The vertical scaling used on the oscilloscope for the measurement.
- Preset: Corresponding Preset number.
- Pre-Shoot 2 [dB]: Value of Pre-Shoot 2 that results in the maximum eye area (eye height times eye width) for the current channel.
- Pre-Shoot 1 [dB]: Value of Pre-Shoot 1 that results in the maximum eye area (eye height times eye width) for the current channel.
- De-Emphasis [dB]: Value of de-emphasis that results in the maximum eye area (eye height times eye width) for the current channel.
- DMSI [mV]: The amount of DMSI set using the calibrations.
- SJ [ps]: The amount of SJ set using the calibrations.
- RJ [ps]: Amount of RJ set.
- VDiff [mV]: The differential voltage set using the calibrations.
- Eye Height [mV]: The measured eye height.
- Eye Width [ps]: The measured eye width.

For 32G (Compliance Eye Calibration)

L0_Cal_32GTps_CompEye

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Gen5 Fixture	PCIe 5.0 FR4 Base Fi
Gen5 Asic Eye Calibration Method	Seasim
----Generator----	
Pre-Shoot	3.5 dB
De-Emphasis	0 dB
Sinusoidal Jitter Frequency	100 MHz
Common Mode Interference	0 V
Random Jitter	500 fs
----Oscilloscope----	
Scope Bandwidth	33 GHz
Number of Averages	21
Number of Waveform Averages	1024
Gen5 Embed Replica Channel	False
Gen5 Transfer Function File for Package Model on Scope	C:\ProgramData\Bitif
Scope Connection for Calibration	Chan 1 3 Direct Conn
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 512
----Preset and CTLE Optimization----	
Presets Range	P5;P6;P9
DMSI	15 mV
SJ	5 ps
Number of Averages	7
----Calibration Flow----	
Skip Preset and CTLE Optimization	False
Re-calibrate on Final Channel	False
----Channel----	
Trace Number	6
Total Channel Loss	-37 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040 Calibrated Instrumen
Calibrated Instrument 2	Name: DataOut1 ; Com Calibrated Instrumen
Calibrated Instrument 3	Name: DataOut1 ; Com
Calibrated Instrument 4	Name: DataOut2 ; Com
Measurement Instrument 1	Name: Keysight DSO ; Instrument

ISI Pair []	Channel Loss [dB]	CTLE [dB]	Pre-Shoot [dB]	De-Emphasis [dB]	DMSI [mV]	SJ [ps]	Vdiff [mV]	Eye Height [mV]	Eye Width [ps]	Preset []
6	-37.0	0	1.9	0.0	10.0	3.125	800	15.00	9.38	5
6	-37.0	0	1.9	0.0	10.0	3.125	800	15.00	9.38	5
6	-37.0	0	1.9	0.0	10.0	3.125	800	15.00	9.38	5

Figure 6-35 Example result for Compliance Eye Calibration (ASIC, 32 GT/s)

- ISI Pair: Number of the ISI pair used.
- Channel Loss [dB]: Loss of the channel used.
- CTLE [dB]: Value of the applied CTLE.
- Pre-Shoot [dB]: Value of Pre-Shoot that results in the maximum eye area (eye height times eye width) for the current channel.
- De-Emphasis [dB]: Value of de-emphasis that results in the maximum eye area (eye height times eye width) for the current channel.
- DMSI [mV]: The amount of DMSI set using the calibrations.
- SJ [ps]: The amount of SJ set using the calibrations.
- VDiff [mV]: The differential voltage set using the calibrations.
- Eye Height [mV]: The measured eye height.
- Eye Width [ps]: The measured eye width.
- Preset: Corresponding Preset number.

For 16G (Compliance Eye Calibration)

L0_Cal_16GTps_CompEye

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Gen4 Fixture	PCI Express 4.0 CEM Fix
Gen4 ISI Adjustment	Hardware Traces
Gen4 Asic Eye Calibration Method	Seasim
Start With Minimum Loss Channel	True
----Generator----	
Pre-Shoot	0 dB
De-Emphasis	-6 dB
Sinusoidal Jitter Frequency	100 MHz
Common Mode Interference	0 V
Random Jitter	1 ps
----Oscilloscope----	
Scope Bandwidth	25 GHz
Number of Averages	21
Number of Waveform Averages	1024
Gen4 Embed Replica Channel	False
Gen4 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 512
----Channel----	
Trace Number	22
Total Channel Loss	-27 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Compan Instrument
Calibrated Instrument 3	Name: DataOut1 ; Compan
Calibrated Instrument 4	Name: DataOut2 ; Compan
Measurement Instrument 1	Name: Keysight DSO ; Co Instrument
----Search Algorithm----	
Minimum Vdiff	720 mV
Maximum DMSI	25 mV
Maximum SJ	10 ps
Max Number of Search Steps	7
Use nominal EH/EW results from Pre Comp Cal	True

Step	DMSI [mV]	SJ [ps]	Vdiff [mV]	Eye Height [mV]	Eye Width [ps]	CTLE [dB]
Step 0, Nominal Impairments	14.0	6.25	800	15.00	18.75	-8.00
Final Result	14.0	6.25	800	15.00	18.75	-8.00

Figure 6-36 Example result for Compliance Eye Calibration (ASIC, 16 GT/s)

- Step: Description of step.
- DMSI [mV]: Optimum value of DMSI.
- SJ [ps]: Optimum value of SJ.
- Vdiff [mV]: Optimum value of Differential Voltage.
- Eye Height [mV]: The measured Eye Height.
- Eye Width [ps]: The measured Eye Width.
- CTLE [dB]: Value of the applied CTLE.

For 8G (Compliance Eye Calibration)

L0_Cal_8GTps_LnCh_CompEye

for PCIe 6.0 AddInCard

----General----

Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Target Eye Height	44.5 mV
Target Eye Width	40.5 ps
Max Number of Search Steps	14
Number of Averages	21
Use PCIe3 Transfer Function	False
SigTest Version	3.2.0.3

----Oscilloscope----

Scope Connection for Calibration	Chan 1 3 Direct Connect

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysigh
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysight Technologies
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysight Technologies
Measurement Instrument 1	Name: Keysight DSO ; Company: Keysight Technolog

Step	DMSI [mV]	RJ [ps]	Eye Height [mV]	Eye Width [ps]
Step 0, Auto Search	23.8	1.01	44.5	40.5
Final Result	23.8	1.01	44.5	40.5

Figure 6-37 Example result for Compliance Eye Calibration (CEM, 8 GT/s)

- Step: Description of step.
- DMSI [mV]: Optimum value of DMSI.
- RJ [ps]: Optimum value of RJ.
- Eye Height [mV]: The measured Eye Height.
- Eye Width [ps]: The measured Eye Width.

Custom Eye Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Compliance Eye Calibration except that, in the custom case, multiple combinations of impairments that lead to values of Eye Height and Eye Width that are within the CTS limits are saved in a custom cal-data table. You can use this data later to select combinations of impairments for Receiver Custom Tests or Link Equalization Custom Tests.

You will be asked to enter values for Differential Voltage, DMSI and Sinusoidal Jitter. All other impairments are fixed. The eye is measured each time a new impairment combination is entered when prompted. If the Eye Height and Eye Width are within the CTS tolerance, this combination will be stored as a cal-data point.

Connection Diagram

Refer to Figure 6-8 on page 118 (ASIC) and Figure 6-7 on page 117 (CEM).

The hardware trace is set to the optimal number according to

- Channel Calibration on page 169 (16 GT/s) or
- Compliance Eye Calibration on page 176 (32 GT/s and 64 GT/s).

Result Description

L0_Cal_64GTps_CustEye

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Generator----	
Pre-Shoot2	-1.3 dB
Pre-Shoot1	4.7 dB
De-Emphasis	0 dB
CMSI	0 V
Generator Launch Voltage	800 mV
DMSI	15 mV
Sinusoidal Jitter	1.5625 ps
----Oscilloscope----	
Do Auto Scale	False
Fixed Vertical Scale of Scope Channels	38 mV
Scope Bandwidth	33 GHz
Number of Averages	21
Number of Waveform Averages	10240
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\Bitif
Scope Connection for Calibration	Chan 1 3 Direct Conn
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040 Calibrated Instrumen
Calibrated Instrument 2	Name: DataOut1 ; Com Instrument
Calibrated Instrument 3	Name: DataOut1 ; Com
Calibrated Instrument 4	Name: DataOut2 ; Com
Measurement Instrument 1	Name: Keysight DSO ; Instrument

Result	Step	DMSI [mV]	SJ [ps]	RJ [ps]	VDiff [mV]	Eye Height [mV]	Eye Width [ps]
pass	0	15.0	1.56	0.25	800	6.00	3.13
pass	1	20.0	1.56	0.25	800	6.00	3.13
pass	2	25.0	1.56	0.25	800	6.00	3.13
pass	3	25.0	2.00	0.25	800	6.00	3.13
pass	4	25.0	2.50	0.25	800	6.00	3.13
pass	5	25.0	3.00	0.25	800	6.00	3.13

Figure 6-38 Example result for Custom Eye Calibration

- Result: (pass/fail) “Pass” if eye height and eye width are within the spec limits; otherwise, fail.
- Step: Step number.
- DMSI [mV]: Applied differential mode sinusoidal interference.
- SJ [ps]: Applied sinusoidal jitter.
- RJ [ps]: Applied random jitter.
- VDiff [mV]: Applied differential voltage (launch voltage).
- Eye Height [mV]: Measured eye height.
- Eye Width [ps]: Measured eye width.

Custom Eye Scan Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Custom Eye Calibration except that, in the scan case, the values of the impairments are swept instead of being set by the user.

The “Loop levels” property determines the number of impairments to be scanned. For each loop, it is necessary to specify the impairment type and define the range to scan. Then, the test automation combines the defined loops and the eye is measured at each step.

Connection Diagram

Refer to Figure 6-8 on page 118 (ASIC) and Figure 6-7 on page 117 (CEM).

The hardware trace is set to the optimal number according to

- Channel Calibration on page 169 (16 GT/s) or
- Compliance Eye Calibration on page 176 (32 GT/s and 64 GT/s).

Results Description

L0_Cal_64GTps_CustScanEye

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Loop Levels	2
----Loop 1----	
Scan Parameter (Loop 1)	DifferentialModeSinusoid
DMSI Start Value	5 mV
DMSI Stop Value	25 mV
DMSI Scale Type	Linear
DMSI Number of Steps	11
----Loop 2----	
Scan Parameter (Loop 2)	SinusoidalJitter
Sinusoidal Jitter Start Value	1 ps
Sinusoidal Jitter Stop Value	3 ps
Sinusoidal Jitter Scale Type	Linear
Sinusoidal Jitter Number of Steps	9
----Fixed Parameters----	
Generator Launch Voltage	800 mV
----Generator----	
Pre-Shoot2	-1.3 dB
Pre-Shoot1	4.7 dB
De-Emphasis	0 dB
CMSI	0 V
----Oscilloscope----	
Scope Bandwidth	33 GHz
Number of Averages	21
Number of Waveform Averages	10240
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J- Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company Calibrated Instrument
Calibrated Instrument 3	Name: DataOut1 ; Company
Calibrated Instrument 4	Name: DataOut2 ; Company
Measurement Instrument 1	Name: Keysight DSO ; Com Instrument

Result	Step	DMSI [mV]	SJ [ps]	RJ [ps]	VDiff [mV]	Eye Height [mV]	Eye Width [ps]
pass	0	5.0	1.56	0.19	800	6.00	3.13
pass	1	5.0	1.56	0.22	800	6.00	3.13
pass	2	5.0	1.56	0.24	800	6.00	3.13
pass	3	5.0	1.75	0.25	800	6.00	3.13
pass	4	5.0	2.00	0.25	800	6.00	3.13
pass	5	5.0	2.25	0.25	800	6.00	3.13
pass	6	5.0	2.50	0.25	800	6.00	3.13
pass	7	5.0	2.75	0.25	800	6.00	3.13
pass	8	5.0	3.00	0.25	800	6.00	3.13
pass	9	7.0	1.56	0.19	800	6.00	3.13
pass	10	7.0	1.56	0.22	800	6.00	3.13
pass	11	7.0	1.56	0.24	800	6.00	3.13
pass	12	7.0	1.75	0.25	800	6.00	3.13
pass	13	7.0	2.00	0.25	800	6.00	3.13
pass	14	7.0	2.25	0.25	800	6.00	3.13
pass	15	7.0	2.50	0.25	800	6.00	3.13
pass	16	7.0	2.75	0.25	800	6.00	3.13
pass	17	7.0	3.00	0.25	800	6.00	3.13
pass	18	9.0	1.56	0.19	800	6.00	3.13
pass	19	9.0	1.56	0.22	800	6.00	3.13
pass	20	9.0	1.56	0.24	800	6.00	3.13
pass	21	9.0	1.75	0.25	800	6.00	3.13
pass	22	9.0	2.00	0.25	800	6.00	3.13
pass	23	9.0	2.25	0.25	800	6.00	3.13
pass	24	9.0	2.50	0.25	800	6.00	3.13
pass	25	9.0	2.75	0.25	800	6.00	3.13
pass	26	9.0	3.00	0.25	800	6.00	3.13
pass	27	11.0	1.56	0.19	800	6.00	3.13
pass	28	11.0	1.56	0.22	800	6.00	3.13
pass	29	11.0	1.56	0.24	800	6.00	3.13
pass	30	11.0	1.75	0.25	800	6.00	3.13
pass	31	11.0	2.00	0.25	800	6.00	3.13

(...)

Figure 6-39 Example result for Custom Eye Scan Calibration (only top of table)

- Result: (pass/fail) “Pass” if eye height and eye width are within the spec limits; otherwise, fail.
- Step: Step number.
- DMSI [mV]: Applied differential mode sinusoidal interference.
- SJ [ps]: Applied sinusoidal jitter.
- RJ [ps]: Applied random jiter.
- VDiff [mV]: Applied differential voltage (launch voltage).
- Eye Height [mV]: Measured eye height.
- Eye Width [ps]: Measured eye width.

Device Insertion Loss Calibration

Availability

Data Generator:	M8020A, M8040A
Interface Types:	M.2
DUT Types:	Device
Modes:	Compliance, Expert
Data Rates:	8 GT/s

Purpose and Method

The Insertion Loss (IL) of the calibration channels has to be in a well-defined range. This procedure calibrates the insertion loss for different hardware traces.

At the beginning of the calibration it is necessary to specify the variable ISI pair numbers that generate a channel loss of –16.5 dB. The var ISI pair number for the particular channel must be determined manually by a VNA. The package loss must be added to the VNA IL value. With these values, the procedure calculates for every ISI trace the insertion loss from 1 GHz to 4 GHz in steps of 100 MHz.

The calibration data is stored in a cal-data table. This calibration data is used to evaluate the optimal ISI trace for the Rx tests.

Connection Diagram

No connections are needed. The measurement is performed using a VNA.

Results Description

L0_Cal_8GTps_Device_IL

for PCIe 5.0 M.2 Device

----General----	
Offline	False
Software Version	5.4.0.22
Spec Deviations	
Comments	
Use PCIe3 Transfer Function	False
----Guided Fixture Characterization----	
Use result of Guided Fixture Characterization	False
----Oscilloscope----	
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Channel----	
CBB base ISI pair	15
----Instruments----	
Measurement Instrument 1	Name: Keysight M8040A J-BERT ; C Instrument
Measurement Instrument 2	Name: DataOut1 ; Company: Keysig Instrument
Measurement Instrument 3	Name: DataIn ; Company: Keysight
Measurement Instrument 4	Name: DataOut1 ; Company: Keysig
Measurement Instrument 5	Name: DataOut2 ; Company: Keysig
Measurement Instrument 6	Name: NETIO ; Company: Koukaam ;

Channel Loss [dB]	Trace Number []
-16.5	24

Figure 6-40 Example result for Device Insertion Loss Calibration

- Channel Loss [dB]: Measured insertion loss of the specified trace.
- Trace Number: The channel number of the channel that has the loss noted in the column ‘Channel Loss’.

DMSI Calibration

Availability

Data Generator:	M8050A, M8040A, M8020A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

The Differential Mode Sinusoidal Interference (DMSI) that is generated by the generator setup is attenuated before it reaches the receiver, and therefore the DMSI amplitude at the Rx input must be calibrated.

The test automation starts with a small DMSI amplitude and increases that value in several steps over a defined range.

For each step, the procedure measures the actual DMSI with a real-time oscilloscope. Measurements are made for two values of CMSI (0 V and 150 mV).

The calibration data is stored in a cal-data table. When measurements are performed, this calibration table is used to adjust the DMSI amplitude to the desired value at the Rx input.

NOTE

With N5991 PCIe ValiFrame version 5.0, the calibration method for CMSI/DMSI changed, which means that the calibration data and files from previous versions of the application will not work or will be shown as missing.

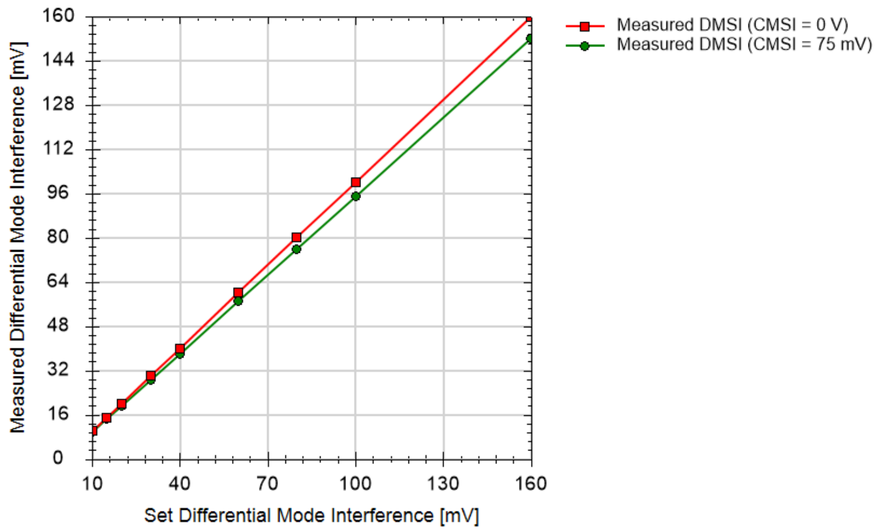
Connection Diagram

The setup is that for Long Channel (refer to Figure 6-6 on page 117 and Figure 6-7, Figure 6-8, Figure 6-10) with the hardware trace set to the optimal number according to the Insertion Loss Calibration on page 212 or based on the final channel from the Channel Calibration on page 169 (16 GT/s) or the Compliance Eye Calibration on page 176 (32 GT/s, 64 GT/s).

Result Description

L0_Cal_64GTps_DMSI

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
----Oscilloscope----	
Scope Bandwidth	5 GHz
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEy
Scope Connection for Calibration	Chan 1 3 Direct Connec
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Compa Calibrated Instrument
Calibrated Instrument 3	Name: DataOut1 ; Compa
Calibrated Instrument 4	Name: DataOut2 ; Compa
Measurement Instrument 1	Name: Keysight DSO ; C Instrument

Set DMSI [mV]	Measured DMSI (CMSI = 0 V) [mV]	Measured DMSI (CMSI = 75 mV) [mV]
10.00	10.20	9.70
15.00	15.05	14.30
20.00	20.02	19.02
30.00	30.01	28.51
40.00	40.01	38.01
60.00	60.01	57.01
80.00	80.00	76.00
100.00	100.00	95.00
160.00	160.00	152.00

Figure 6-41 Example result for DMSI Calibration

- Set DMSI [mV]: The value of DMSI set on the data generator.
- Measured DMSI (CMSI = x V) [mV]: The actual DMSI measured with the oscilloscope when CMSI = x V.

Eye Height and Width Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	CEM	U.2 and M.2
DUT Types:	Add-In Card System	Device Host
Modes:	Compliance, Expert	
Data Rates:	8 GT/s	

Purpose and Method

This procedure calibrates Eye Height and Eye Width by adding random jitter and differential mode sinusoidal interference (DMSI).

Starting with “Start DMSI”, the Jitter is increased with equally spaced steps from “Start RJ” to “Stop RJ” and the Eye Height and Eye Width are measured. This procedure is then repeated for all remaining DMSI amplitudes.

The eye is measured using the SigTest software.

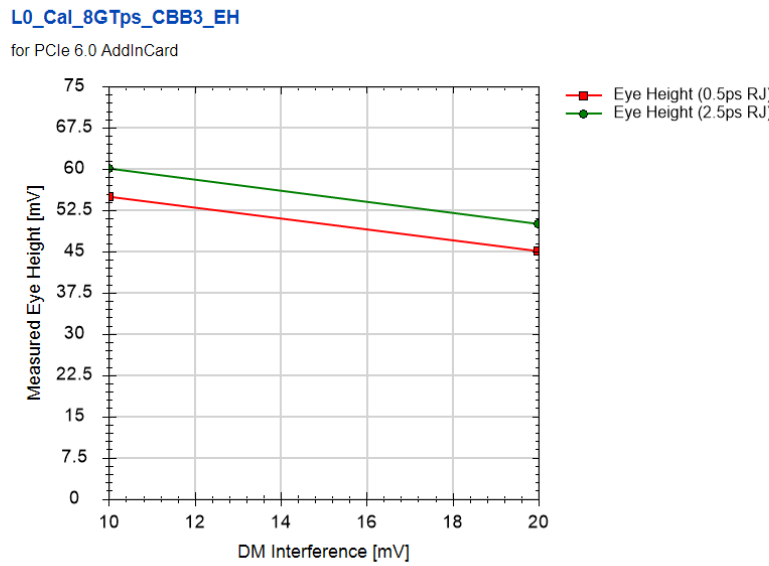
The calibration data is stored in a cal-data table. When measurements are performed, this calibration table is used to evaluate the optimum amount of DMSI and Random Jitter to get the desired Eye Height and Width.

Connection Diagram

Refer to Figure 6-7 and Figure 6-10 on page 119.

Result Description

Eye Height and Eye Width are presented separately. Since the graphs and tables are very similar, only the results for Eye Height are included here.




```
----General----
Offline                              True
Software Version                     5.4.0.22
Spec Deviations                      "Stop DMSI: 20 mV"
Comments
Optimize CTLE                        False
CTLE Index                           7
Start DMSI                           10 mV
Stop DMSI                            20 mV
Start RJ                             500 fs
Stop RJ                              2.5 ps
Number of Averages                   21
Use PCIe3 Transfer Function          False
----Oscilloscope----
Scope Connection for Calibration     Chan 1 3 Direct Connect
----Instruments----
Calibrated Instrument 1              Name: Keysight M8040A J-BERT ; Company: Keysig
Calibrated Instrument 2              Name: DataOut1 ; Company: Keysight Technologie
Calibrated Instrument 3              Name: DataOut1 ; Company: Keysight Technologie
Calibrated Instrument 4              Name: DataOut2 ; Company: Keysight Technologie
Measurement Instrument 1             Name: Keysight DSO ; Company: Keysight Technol
```

Set DM Interference [mV]	Eye Height (0.5ps RJ) [mV]	Eye Height (2.5ps RJ) [mV]
10	55.0	60.0
20	45.0	50.0

Figure 6-42 Example result for Eye Height and Width Calibration (eye height)

- Set DM Interference [mV]: The DMSI set on the instrument.
- Eye Height (X ps RJ) [mV]: The measured eye height for random jitter amplitude of X picoseconds.

Eye Height and Width Measurement

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Compliance Eye Calibration on page 176 except that, here, multiple combinations of impairments that lead to values of eye height and eye width that are within the CTS limits are saved in a report. You can use this data later to select combinations of impairments for Receiver Custom Measurements or Link Equalization Custom Tests.

The Pre-Shoot (Pre-Shoot 2 and Pre-Shoot 1 for 64 GT/s), De-Emphasis, Generator Launch Voltage, DMSI, Random Jitter and Sinusoidal Jitter values can be defined. All other impairments are fixed. The eye is measured each time a new impairment combination is selected when prompted. If the eye height and eye width are within the CTS tolerance, this combination will be stored as a cal-data point.

Connection Diagram

Refer to Figure 6-8 on page 118 (ASIC) and Figure 6-7 on page 117 (CEM).

The hardware trace is set to the optimal number based on the Insertion Loss Calibration on page 212.

Result Description

L0_Meas_64GTps_EHEW

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Scope Bandwidth	50 GHz
----Generator----	
Pre-Shoot2	-1.3 dB
Pre-Shoot1	4.7 dB
De-Emphasis	0 dB
Generator Launch Voltage	800 mV
DMSI	15 mV
Random Jitter	250 fs
Sinusoidal Jitter	1.5625 ps
----Oscilloscope----	
Fixed Vertical Scale of Scope Channels	38 mV
Do Auto Scale	True
Number of Waveform Averages	10240
Number of Averages	7
CTLE	-11 dB
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Optimize CTLE	True
Number of UI	120
Used Pattern	Clock Div 1024
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J- Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company Instrument
Calibrated Instrument 3	Name: DataOut1 ; Company
Calibrated Instrument 4	Name: DataOut2 ; Company
Measurement Instrument 1	Name: Keysight DSO ; Co Instrument

Set Pre-Shoot2 [dB]	Set Pre-Shoot1 [dB]	Set De-Emphasis [dB]	Set Generator Launch Voltage [mV]	Set DMSI [mV]	Set Random Jitter [ps]	Set Sinusoidal Jitter [ps]	Measured Eye Height [mV]	Measured Eye Width [ps]
-1.30	4.70	0.00	800.00	15.00	0.25	1.56	6.00	3.13
-1.30	4.70	0.00	800.00	20.00	0.25	1.56	6.00	3.13
-1.30	4.70	0.00	800.00	25.00	0.25	1.56	6.00	3.13
-1.30	4.70	0.00	800.00	25.00	0.26	1.56	6.00	3.13
-1.30	4.70	0.00	800.00	25.00	0.27	1.56	6.00	3.13
-1.30	4.70	0.00	800.00	25.00	0.28	1.56	6.00	3.13

Figure 6-43 Example result for Eye Height and Width Measurement

- Set Pre-Shoot2 [dB]: The value of Pre-Shoot 2 set in the ValiFrame user interface.
- Set Pre-Shoot1 [dB]: The value of Pre-Shoot 1 set in the ValiFrame user interface.
- Set De-Emphasis [dB]: The value of De-Emphasis set in the ValiFrame user interface.
- Set Generator Launch Voltage [V]: The value of Generator Launch Voltage set in the ValiFrame user interface.
- Set DMSI [mV]: The value of DMSI set in the ValiFrame user interface.
- Set Random Jitter [ps]: The value of Random Jitter set in the ValiFrame user interface.
- Set Sinusoidal Jitter [ps]: The value of Sinusoidal Jitter set in the ValiFrame user interface.
- Measured Eye Height [mV]: The eye height measured on the oscilloscope.
- Measured Eye Width [ps]: The eye width measured with Seasim.

Eye Height and Width Scan

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See alsoTable 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Eye Height and Width Measurement on page 199 except that, in the scan case, the values of the impairments are swept instead of being set by the user.

The “Loop levels” property determines the number of impairments to be scanned. For each loop, it is necessary to specify the impairment type and to define the range to scan. Then the test automation combines the defined loops and the eye is measured at each step.

Connection Diagram

Refer to Figure 6-8 on page 118 (ASIC) and Figure 6-7 on page 117 (CEM).

The hardware trace is set to the optimal number based on the Insertion Loss Calibration on page 212.

Result Description

L0_Scan_64GTps_EHEW

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Show Plots	False
Equalization Mode	Presets
Loop Levels	2
----Loop 1----	
Scan Parameter (Loop 1)	EqualizationPreset
Equalization Preset Range	Q0;Q1;Q2;Q3;Q4;Q5;Q6;Q7;
----Loop 2----	
Scan Parameter (Loop 2)	SinusoidalJitter
Sinusoidal Jitter Start Value	1 ps
Sinusoidal Jitter Stop Value	3 ps
Sinusoidal Jitter Scale Type	Linear
Sinusoidal Jitter Number of Steps	9
----Fixed Parameters----	
Generator Launch Voltage	800 mV
DMSI	15 mV
CMSI	0 V
Random Jitter	250 fs
Sinusoidal Jitter Frequency	100 MHz
CTLE	-11 dB
----Oscilloscope----	
Fixed Vertical Scale of Scope Channels	38 mV
Do Auto Scale	True
Number of Waveform Averages	10240
Number of Averages	7
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Optimize CTLE	True
Number of UI	120
Used Pattern	Clock Div 1024
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J- Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company Calibrated Instrument
Calibrated Instrument 3	Name: DataOut1 ; Company
Calibrated Instrument 4	Name: DataOut2 ; Company
Measurement Instrument 1	Name: Keysight DSO ; Com Instrument

Set Equalization Preset	Set Sinusoidal Jitter [ps]	Measured Eye Height [mV]	Measured Eye Width [ps]
Q0	1.00	6.00	3.13
Q0	1.25	6.00	3.13
Q0	1.50	6.00	3.13
Q0	1.75	6.00	3.13
Q0	2.00	6.00	3.13
Q0	2.25	6.00	3.13
Q0	2.50	6.00	3.13
Q0	2.75	6.00	3.13
Q0	3.00	6.00	3.13
Q1	1.00	6.00	3.13
Q1	1.25	6.00	3.13
Q1	1.50	6.00	3.13
Q1	1.75	6.00	3.13
Q1	2.00	6.00	3.13
Q1	2.25	6.00	3.13
Q1	2.50	6.00	3.13
Q1	2.75	6.00	3.13
Q1	3.00	6.00	3.13
Q2	1.00	6.00	3.13
Q2	1.25	6.00	3.13
Q2	1.50	6.00	3.13
Q2	1.75	6.00	3.13
Q2	2.00	6.00	3.13
Q2	2.25	6.00	3.13
Q2	2.50	6.00	3.13
Q2	2.75	6.00	3.13
Q2	3.00	6.00	3.13
Q3	1.00	6.00	3.13
Q3	1.25	6.00	3.13
Q3	1.50	6.00	3.13
Q3	1.75	6.00	3.13
Q3	2.00	6.00	3.13
Q3	2.25	6.00	3.13
Q3	2.50	6.00	3.13

(...)

Figure 6-44 Example result for Eye Height and Width Scan (64 GT/s). (Only top of table)

- Set Equalization Preset: Equalization Preset used.
- Set Sinusoidal Jitter [ps]: Value of SJ used.
- Measured Eye Height [mV]: The eye height measured on the oscilloscope.
- Measured Eye Width [ps]: The eye width measured on the oscilloscope.

Final Equalization Preset Optimization

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	16 GT/s		

Purpose and Method

This procedure measures the Eye Height and Eye Width for each Tx equalization preset when the channel loss has been adjusted to the optimum value. Depending on the Eye Calibration Method selected when configuring the DUT, the eye measurement is performed with either Seasim or SigTest software. There is no choice for CEM: SigTest is used.

The calibration data is stored in a cal-data table. This calibration data is used in subsequent procedures to set the preset that gets the largest eye.

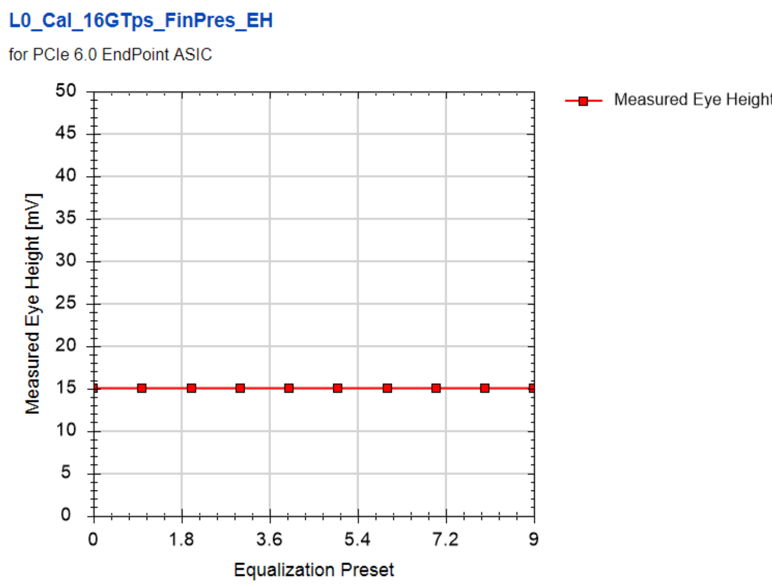
Connection Diagram

The setup is that for Long Channel (refer to Figure 6-8 on page 118 for ASIC and Figure 6-7 on page 117 for CEM) with the var. ISI Pair set to the optimal one according to the Channel Calibration.

Result Description

There are two sets of results, one for Eye Height and one for Eye Width. Since the results are very similar, just the results for Eye Height are given here as an example (Figure 6-45).

The results report the Set Equalization Preset and the Measured Eye Height (Eye Width). If SigTest is used, several values of Eye Height (Eye Width) are reported for various CTLE values.



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Equalization Preset Range	P0;P1;P2;P3;P4;P5;P6;P7
Gen4 Fixture	PCI Express 4.0 CEM Fix
Gen4 ISI Adjustment	Hardware Traces
Gen4 Asic Eye Calibration Method	Seasim
Start With Minimum Loss Channel	True
----Generator----	
Generator Launch Voltage	800 mV
DMSI	14 mV
CMSI	0 V
Random Jitter	1 ps
Sinusoidal Jitter	6.25 ps
Sinusoidal Jitter Frequency	100 MHz
----Oscilloscope----	
Scope Bandwidth	25 GHz
Number of Averages	7
Number of Waveform Averages	1024
Gen4 Embed Replica Channel	False
Gen4 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 512

----Channel----

Trace Number	22
Total Channel Loss	-27 dB

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040A J Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Compan Calibrated Instrument
Calibrated Instrument 3	Name: DataOut1 ; Compan
Calibrated Instrument 4	Name: DataOut2 ; Compan
Measurement Instrument 1	Name: Keysight DSO ; Co Measurement Instrument

Set Equalization Preset []	Measured Eye Height [mV]
0.00	15.00
1.00	15.00
2.00	15.00
3.00	15.00
4.00	15.00
5.00	15.00
6.00	15.00
7.00	15.00
8.00	15.00
9.00	15.00

Figure 6-45 Example result for Final Equalization Preset Optimization (Eye Height) when using Seasim

- Set Equalization Preset: The number of the equalization preset used.
- Measured Eye Height [mV]: Value of the eye height measured for the corresponding preset.

Host Insertion Loss Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A
Interface Types:	M.2
DUT Types:	Host
Modes:	Compliance, Expert
Data Rates:	8 GT/s

See Device Insertion Loss Calibration on page 191 for all further details of this calibration.

Initial Equalization Preset Optimization

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	16 GT/s		

Purpose and Method

This procedure measures the Eye Height and Eye Width for each Tx equalization preset and several values of CTLE (when using SigTest). When the “Start with Minimum Loss Channel” option is not selected in the Configure DUT dialog, the measurement is performed with a channel loss of –30 dB. When the “Start with Minimum Loss Channel” option is selected, the measurement is performed with a channel loss of –27 dB.

The eye measurement is performed with SigTest or Seasim software. (Seasim is available only for ASIC interfaces.)

A compliance pattern is applied and different impairments, such as random jitter, sinusoidal jitter and differential and common mode sinusoidal inference, are added to the signal.

The calibration data is stored in a cal-data table. This calibration data is used in the Channel Calibration to set the preset that gets the largest eye.

Connection Diagram

The setup is that for Long Channel (refer to Figure 6-8 on page 118 for ASIC and Figure 6-7 on page 117 for CEM) with the var. ISI Pair set to either the one that gives the maximum-loss channel (if “Start with Minimum Loss Channel” is unchecked) or the one that gives the minimum-loss channel (if “Start with Minimum Loss Channel” is checked).

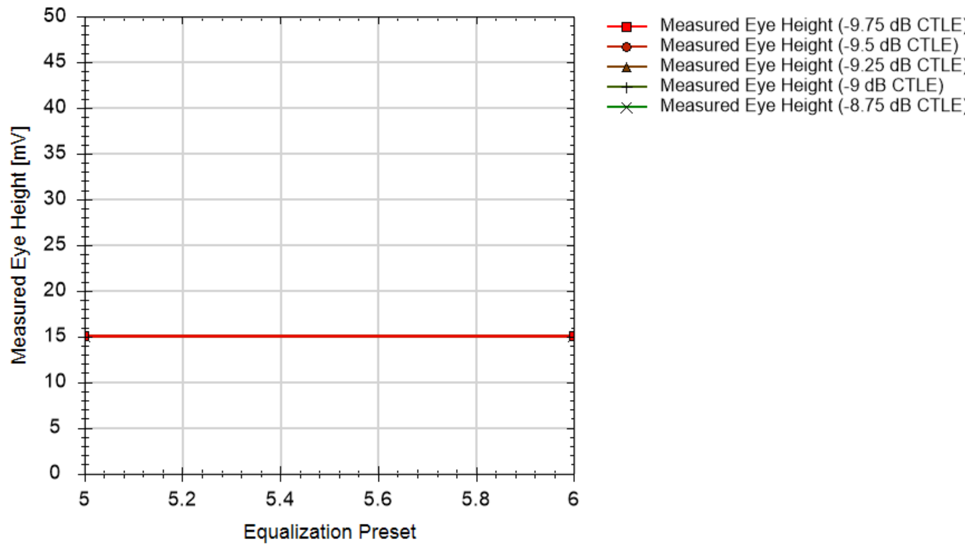
Result Description

There are two sets of results, one for Eye Height and one for Eye Width. Since the two results are very similar, just the one for Eye Height is presented here.

The results report the Set Equalization Preset and the Measured Eye Height (Eye Width). If SigTest is used, several values of Eye Height (Eye Width) are reported for various CTLE values.

L0_Cal_16GTps_IniPres_EH

for PCIe 6.0 AddInCard



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Equalization Preset Range	P5;P6
CTLE Start Value	-9.75 dB
CTLE Stop Value	-8.75 dB
Start With Minimum Loss Channel	True
SigTest Version	4.0.52
----Generator----	
Generator Launch Voltage	800 mV
DMSI	14 mV
Random Jitter	1 ps
Sinusoidal Jitter	6.25 ps
Sinusoidal Jitter Frequency	100 MHz
----Oscilloscope----	
Scope Bandwidth	25 GHz
Number of Averages	7
Number of UIs	2 MUI
Gen4 Embed Replica Channel	False
Gen4 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye'
Scope Connection for Calibration	Chan 1 3 Direct Connect

----Channel----

CBB var. ISI pair	22
CLB var. ISI pair	0
Total Channel Loss	-27 dB

----Instruments----

Calibrated Instrument 1	Name: Keysight M8040A J- Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Compan Calibrated Instrument
Calibrated Instrument 3	Name: DataOut1 ; Compan
Calibrated Instrument 4	Name: DataOut2 ; Compan
Measurement Instrument 1	Name: Keysight DSO ; Co Measurement Instrument

Set Equalization Preset []	Measured Eye Height (-9.75 dB CTLE) [mV]	Measured Eye Height (-9.5 dB CTLE) [mV]	Measured Eye Height (-9.25 dB CTLE) [mV]	Measured Eye Height (-9 dB CTLE) [mV]	Measured Eye Height (-8.75 dB CTLE) [mV]
5.00	15.00	15.00	15.00	15.00	15.00
6.00	15.00	15.00	15.00	15.00	15.00

Figure 6-46 Example result for Initial Equalization Preset Optimization (Eye Height) when using SigTest

- Set Equalization Preset: The number of the equalization preset used.
- Measured Eye Height (–X dB CTLE) [mV]: Value of the eye height for the corresponding preset and CTLE of –X dB.

Insertion Loss Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s (only ASIC), 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

The Insertion Loss (IL) of the calibration channels + the replica/additional channel must be in a well-defined range.

For 16 GT/s, 32 GT/s, 64 GT/s

NOTE

The description in this subsection is for ASIC and M.2, and also for CEM at 16 GT/s. For the use of values from Guided Fixture Characterization for CEM at 32 GT/s and 64 GT/s, see page 213.

This procedure calibrates the insertion loss for different hardware traces.

The procedure does not perform any measurement. At the beginning of the calibration, it is necessary to specify the variable ISI pair numbers that generate a channel loss of

- –27 dB to –30 dB in 0.5 dB steps for 16 GT/s
- –34 dB to –37 dB in 0.5 dB steps for 32 GT/s
- –30 dB to –33 dB in 0.5 dB steps for 64 GT/s

See Figure 6-47. Note:

- The var. ISI pair number for the channels must be determined manually using a VNA.
- For 16, 32 and 64 GT/s, the cable from the generator to the ISI traces must **not** be included in the VNA measurement.
- The package model IL must be added to the VNA IL value.
- If no trace can be found with the specified loss, the value “–1” can be entered to mark this trace as not available.

The package model can be changed in the user interface using the parameter “Transfer Function File for Package Model on Scope”. It is a channel-specific common parameter and is visible in the parameter grid when you select “Long Channel” in the left half of the main window of the PCIe ValiFrame user interface.

The calibration data is stored in a cal-data table. This calibration table is used to evaluate the optimum ISI trace for the Rx tests.

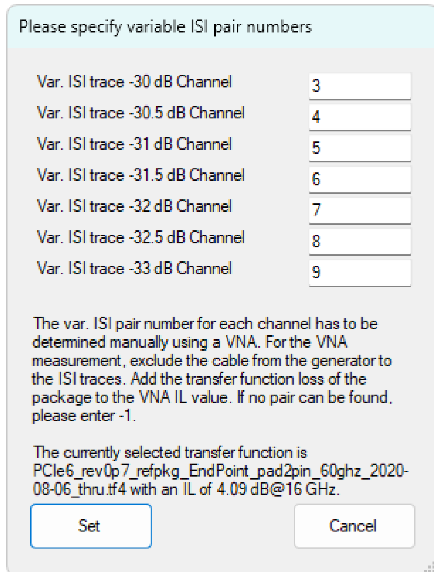


Figure 6-47 Panel for specifying variable ISI pair numbers in the Insertion Loss Calibration (example for 64 GT/s)

For CEM at 32 GT/s and 64 GT/s

In this case, there is the possibility of using the results of the Guided Fixture Characterization on page 106.

If you set ‘Use result of Guided Fixture Characterization’ in the parameter grid to ‘False’, the procedure will performed as described for ASIC just above.

If ‘Use result of Guided Fixture Characterization’ in the parameter grid is set to ‘True’, several other parameters will be visible, including the XML File Import Path. Then the stored data will be used to calculate the Insertion Loss and find suitable traces.

For 8 GT/s

This calibration calculates the Insertion Loss from the step response at three different de-emphasis levels. By adding de-emphasis, IL can be reduced to a certain degree. This procedure is used to compensate IL during the Rx tests.

For every de-emphasis level, the insertion loss is measured from 1 GHz to 4 GHz in steps of 100 MHz. The IL is measured using the Seasim software.

The calibration data is stored in a cal-data table. This calibration data is used to evaluate the optimum amount of de-emphasis for the Rx tests.

Connection Diagram

For 64G, 32G and 16G: None.

For 8G: Refer to Figure 6-6 on page 117.

Result Description

Example results are shown for 64G (ASIC; CEM) and 8G.

For 64G (Insertion Loss Calibration)

L0_Cal_64GTps_IL

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	False
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Guided Fixture Characterization----	
Use result of Guided Fixture Characterization	False
----Oscilloscope----	
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\Va
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BE Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company: Instrument
Calibrated Instrument 3	Name: DataOut1 ; Company:
Calibrated Instrument 4	Name: DataOut2 ; Company:
Measurement Instrument 1	Name: Keysight DSO ; Compa Instrument

Channel Loss [dB]	Trace Number []
-30.0	3
-30.5	4
-31.0	5
-31.5	6
-32.0	7
-32.5	8
-33.0	9

Figure 6-48 Example result for Insertion Loss Calibration (64 GT/s, ASIC)

- Channel Loss [dB]: Calculated insertion loss of the channel.
- Trace Number: Number of the trace corresponding to the Channel Loss. (–1 indicates that no suitable trace was found.)

The CEM example at 64 GT/s uses Guided Fixture Characterization.

L0_Cal_64GTps_IL

for PCIe 6.0 AddInCard Preliminary

----General----	
Offline	False
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Guided Fixture Characterization----	
Use result of Guided Fixture Characterization	True
CLB Type	x1x16
Fixture Serial Number	45456
XML File Import Path	C:\ProgramData\BitifEye\ValiFrameK1 \PCIe\Settings\GuidedFixtureCharacterization\64G_CEM_AddInCard.xml
----Oscilloscope----	
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\ValiFrameK1 \PCIe\Settings\TransferFunctions\PCIe6_rev0p7_refpkg_EndPoint_pad2 08-06_thru.tf4
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	960
Used Pattern	Clock Div 2048
----Channel----	
CLB var. ISI pair	0
----Instruments----	

(...)

Channel Loss [dB]	Trace Number []
-30.0	-1
-30.5	-1
-31.0	-1
-31.5	-1
-32.0	-1
-32.5	21
-33.0	25

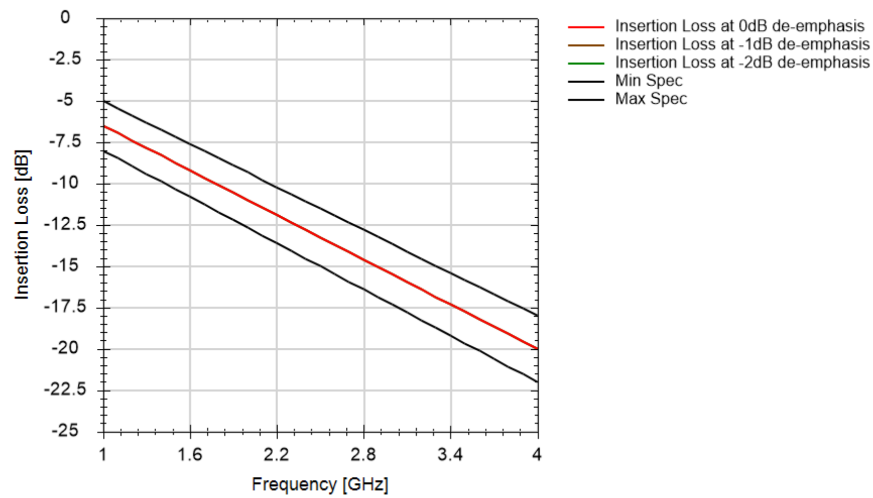
Figure 6-49 Example result for Insertion Loss Calibration (64 GT/s, CEM)

- Channel Loss [dB]: Calculated insertion loss of the channel.
- Trace Number: Number of the trace corresponding to the Channel Loss. (–1 indicates that no suitable trace was found.)

For 8G (Insertion Loss Calibration)

L0_Cal_8GTps_LnCh_IL

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Oscilloscope----	
Embed Replica Channel	False
Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\ValiFra
Number of Averages for Step Response	2048
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 256
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT ; Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company: Keysi Instrument
Calibrated Instrument 3	Name: DataOut1 ; Company: Keysi
Calibrated Instrument 4	Name: DataOut2 ; Company: Keysi
Measurement Instrument 1	Name: Keysight DSO ; Company: K Instrument

Frequency [GHz]	Insertion Loss at 0dB de-emphasis [dB]	Insertion Loss at -1dB de-emphasis [dB]	Insertion Loss at -2dB de-emphasis [dB]	Min Spec [dB]	Max Spec [dB]
1.00	-6.50	-6.50	-6.50	-8.00	-5.00
1.10	-6.95	-6.95	-6.95	-8.47	-5.43
1.20	-7.40	-7.40	-7.40	-8.93	-5.87
1.30	-7.85	-7.85	-7.85	-9.40	-6.30
1.40	-8.30	-8.30	-8.30	-9.87	-6.73
1.50	-8.75	-8.75	-8.75	-10.33	-7.17
1.60	-9.20	-9.20	-9.20	-10.80	-7.60
1.70	-9.65	-9.65	-9.65	-11.27	-8.03
1.80	-10.10	-10.10	-10.10	-11.73	-8.47
1.90	-10.55	-10.55	-10.55	-12.20	-8.90
2.00	-11.00	-11.00	-11.00	-12.67	-9.33
2.10	-11.45	-11.45	-11.45	-13.13	-9.77
2.20	-11.90	-11.90	-11.90	-13.60	-10.20
2.30	-12.35	-12.35	-12.35	-14.07	-10.63
2.40	-12.80	-12.80	-12.80	-14.53	-11.07
2.50	-13.25	-13.25	-13.25	-15.00	-11.50
2.60	-13.70	-13.70	-13.70	-15.47	-11.93
2.70	-14.15	-14.15	-14.15	-15.93	-12.37
2.80	-14.60	-14.60	-14.60	-16.40	-12.80
2.90	-15.05	-15.05	-15.05	-16.87	-13.23
3.00	-15.50	-15.50	-15.50	-17.33	-13.67
3.10	-15.95	-15.95	-15.95	-17.80	-14.10
3.20	-16.40	-16.40	-16.40	-18.27	-14.53
3.30	-16.85	-16.85	-16.85	-18.73	-14.97
3.40	-17.30	-17.30	-17.30	-19.20	-15.40
3.50	-17.75	-17.75	-17.75	-19.67	-15.83
3.60	-18.20	-18.20	-18.20	-20.13	-16.27
3.70	-18.65	-18.65	-18.65	-20.60	-16.70
3.80	-19.10	-19.10	-19.10	-21.07	-17.13
3.90	-19.55	-19.55	-19.55	-21.53	-17.57
4.00	-20.00	-20.00	-20.00	-22.00	-18.00

Figure 6-50 Example result for Insertion Loss Calibration (8 GT/s)

- Frequency [GHz]: Frequency used in the calculation.
- Insertion Loss at XdB de-emphasis [dB]: Calculated value of Insertion Loss at X dB de-emphasis at the given frequency.
- Min Spec [dB]: Minimum Insertion Loss allowed by the specification.
- Max Spec [dB]: Maximum Insertion Loss allowed by the specification.

Pre-Compliance Eye Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This procedure measures the effects on the Eye Height and Eye Width of changes made to each impairment (SJ, DMSI and Launch Voltage) individually.

The calibration measures the eye in a series of four situations, which differ slightly according to data rate.

For 64 GT/s

- All the impairments are set to the minimum values.
- The DMSI is set to the nominal value from the specification.
- The SJ is set to the maximum specification amplitude.
- The differential voltage is set to the minimum specification level.

For 16 GT/s and 32 GT/s

- All the impairments are set to their nominal values.
- The DMSI is set to a value greater than the nominal value from the specification.
- The SJ is set to the maximum specification amplitude.
- The differential voltage is set to the minimum specification level.

At each step, the eye is measured with either Seasim or SigTest software.

The calibration data is stored in a cal-data table. This calibration data is used in the Compliance Eye Calibration to calculate DMSI, SJ and V_{diff} adjustment to meet the target eye.

Connection Diagram

Refer to and Figure 6-7 on page 117, Figure 6-8 and Figure 6-10.

The hardware trace is set to the optimal number based on

- Insertion Loss Calibration on page 212 (for 32 GT/s and 64 GT/s)
- Channel Calibration on page 169 (for 16 GT/s, maximum loss trace)

Result Description

For 64G (Pre-Compliance Eye Calibration)

L0_Cal_64GTps_PreComp

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Generator----	
Pre-Shoot2	-1.3 dB
Pre-Shoot1	4.7 dB
De-Emphasis	0 dB
CMSI	0 V
Random Jitter	250 fs
----Oscilloscope----	
Fixed Vertical Scale of Scope Channels	NaN V
Do Auto Scale	True
Scope Bandwidth	33 GHz
Number of Averages	7
Number of Waveform Averages	10240
CTLE	NaN dB
Gen6 Embed Replica Channel	False
Gen6 Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\Va
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 1024
----Preset and CTLE Optimization----	
Equalization Preset Range	Q5;Q6;Q9
DMSI	15 mV
Sinusoidal Jitter	1.5625 ps
Number of Averages	3
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BE Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company: Instrument
Calibrated Instrument 3	Name: DataOut1 ; Company:
Calibrated Instrument 4	Name: DataOut2 ; Company:
Measurement Instrument 1	Name: Keysight DSO ; Compa Instrument

Step	DMSI [mV]	SJ [ps]	RJ [ps]	VDiff [mV]	Eye Height [mV]	Eye Width [ps]
Step 0, Minimum impairments	5.0	1.563	0.190	800	5.50	2.83
Step 1, Nominal DMSI	15.0	1.563	0.190	800	4.50	2.50
Step 2, Maximum SJ	5.0	3.000	0.250	800	3.50	2.00
Step 3, Minimum Vdiff	5.0	1.563	0.190	720	4.50	2.50

Figure 6-51 Example result for Pre-Compliance Eye Calibration for 64G

- Step: Step number and description.
- DMSI [mV]: The amount of applied DMSI.
- SJ [ps]: The amount of applied SJ.
- RJ [ps]: The amount of applied RJ.
- VDiff [mV]: The applied differential voltage.
- Eye Height [mV]: The measured eye height.
- Eye Width [ps]: The measured eye width.

For 32G (Pre-Compliance Eye Calibration)

L0_Cal_32GTps_PreComp

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Gen5 Fixture	PCIe 5.0 FR4 Base Fi
Gen5 Asic Eye Calibration Method	Seasim
----Generator----	
Pre-Shoot	1.9 dB
De-Emphasis	0 dB
Common Mode Interference	0 V
Random Jitter	500 fs
----Oscilloscope----	
Scope Bandwidth	33 GHz
Number of Averages	14
Number of Waveform Averages	1024
CTLE	NaN dB
Gen5 Embed Replica Channel	False
Gen5 Transfer Function File for Package Model on Scope	C:\ProgramData\Bitif
Scope Connection for Calibration	Chan 1 3 Direct Conn

----Seasim----	
Number of UI	120
Used Pattern	Clock Div 512
----Preset and CTLE Optimization----	
Presets Range	P5;P6;P9
DMSI	15 mV
SJ	5 ps
Number of Averages	7
----Channel----	
Trace Number	6
Total Channel Loss	-37 dB
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040 Calibrated Instrumen
Calibrated Instrument 2	Name: DataOut1 ; Com Instrument
Calibrated Instrument 3	Name: DataOut1 ; Com
Calibrated Instrument 4	Name: DataOut2 ; Com
Measurement Instrument 1	Name: Keysight DSO ; Instrument

Step	DMSI [mV]	SJ [ps]	Vdiff [mV]	Eye Height [mV]	Eye Width [ps]
Step 0, Nominal impairments	10.0	3.125	800	15.00	9.38
Step 1, Maximum DMSI	20.0	3.125	800	12.00	9.00
Step 2, Maximum SJ	10.0	5.000	800	7.50	8.50
Step 3, Minimum Vdiff	10.0	3.125	720	12.00	9.00

Figure 6-52 Example result for Pre-Compliance Eye Calibration for 32G

- Step: Step number and description.
- DMSI [mV]: The amount of applied DMSI.
- SJ [ps]: The amount of applied SJ.
- VDiff [mV]: The applied differential voltage.
- Eye Height [mV]: The measured eye height.
- Eye Width [ps]: The measured eye width.

Processing of Pre-Recorded Steps

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	ASIC	CEM (only at 64 GT/s)
DUT Types:	End Point Root Complex	Add-In Card System
Modes:	Expert – Custom Procedure	
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s	

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to Eye Height and Width Scan on page 202, except that the waveform is not measured on the oscilloscope. Previously recorded step responses selected by the user can be used.

Connection Diagram

Refer to Figure 6-8 on page 118.

The hardware trace is set to the optimal number based on the Insertion Loss Calibration on page 212.

Result Description

The Result Description is the same as that for Eye Height and Width Scan on page 202.

Stressed Jitter Eye Calibration

Availability

Data Generator:	M8020A, M8040A, M8050A
Interface Types:	ASIC
DUT Types:	End Point Root Complex
Modes:	Compliance, Expert
Data Rates:	8 GT/s

Purpose and Method

This procedure calibrates the eye height and eye width by adding differential mode sinusoidal interference (DMSI) at different random jitter levels.

The calibration is done for random jitter amplitudes of 1 ps, 1.5 ps, 2 ps, 2.5 ps and 3 ps. For each jitter amplitude value, the DMSI is increased from 0 to 30 mV in equally spaced steps. The eye height and width are measured by capturing a step response and using Seasim software. Sinusoidal jitter is always kept at 12.5 ps.

The calibration data is stored in two cal-data tables. This calibration data is used to evaluate the optimum amount of random jitter and DM voltage to get the desired eye.

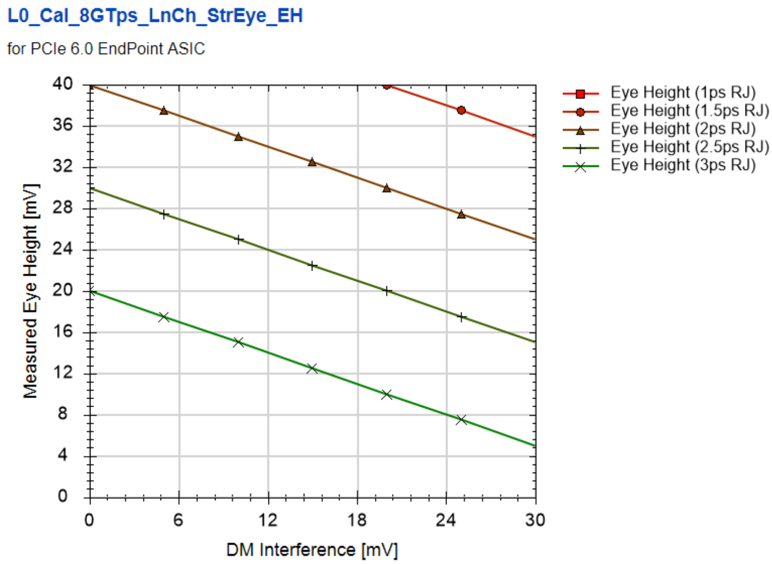
Connection Diagram

Refer to Figure 6-6 on page 117.

Result Description

There are two sets of results, one for Eye Height and one for Eye Width. They are very similar in format, so only example results for Eye Height (Figure 6-53) are shown here.

Eye Height



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
Verification Mode	False
Sinusoidal Jitter	12.5 ps
DM Interference Step Size	5 mV
----Oscilloscope----	
Embed Replica Channel	False
Transfer Function File for Package Model on Scope	C:\ProgramData\BitifEye\Vali
Number of Averages for Step Response	2048
Scope Connection for Calibration	Chan 1 3 Direct Connect
----Seasim----	
Number of UI	120
Used Pattern	Clock Div 256
----Instruments----	
Calibrated Instrument 1	Name: Keysight M8040A J-BERT Calibrated Instrument
Calibrated Instrument 2	Name: DataOut1 ; Company: Ke Calibrated Instrument
Calibrated Instrument 3	Name: DataOut1 ; Company: Ke
Calibrated Instrument 4	Name: DataOut2 ; Company: Ke
Measurement Instrument 1	Name: Keysight DSO ; Company Instrument

Set DM Interference [mV]	Eye Height (1ps RJ) [mV]	Eye Height (1.5ps RJ) [mV]	Eye Height (2ps RJ) [mV]	Eye Height (2.5ps RJ) [mV]	Eye Height (3ps RJ) [mV]
0	60.0	50.0	40.0	30.0	20.0
5	57.5	47.5	37.5	27.5	17.5
10	55.0	45.0	35.0	25.0	15.0
15	52.5	42.5	32.5	22.5	12.5
20	50.0	40.0	30.0	20.0	10.0
25	47.5	37.5	27.5	17.5	7.5
30	45.0	35.0	25.0	15.0	5.0

Figure 6-53 Example result for Stressed Jitter Eye Calibration (eye height)

- Set DM Interference [mV]: The amount of DM Interference set on the data generator.
- Eye Height (x ps RJ) [mV]: The measured Eye Height for the set RJ (x ps) and set DM interference.

7 Receiver Tests

Once the PCIe Test Station has been calibrated, receiver test procedures can be run.

Overview

The basic principles underlying all PCI Express receiver tests are:

- Train the DUT into loopback mode
- Send the training pattern with defined stress characteristics
- Use the error detector to verify that the DUT loops back the correct pattern without errors

NOTE **A bit error count shown in the results as –1 indicates either that the BERT lost synchronization during a measurement or that synchronization of the BERT to the Tx pattern could not be achieved at all.**

Most of the Rx tests constantly change the signal stress to collect more data and re-initialize the loopback mode if the DUT terminates from it. If calibration data is available, the data confirms that the signal stress is at the specified level and test point. If calibration data is missing, a warning message pops up. If you ignore the warning messages explicitly, you can run tests without the calibration data.

NOTE **You do not require a real-time oscilloscope to perform Receiver Tests.**

NOTE **Some Rx tests are available only in Expert Mode. This is the case when only “Expert” appears as the Mode under the heading Availability in the description of the test.**

Prerequisite Calibrations

Prerequisite calibrations for each procedure are displayed in the application itself. Right-click the procedure name in the procedure tree of the main window of the user interface and select “Required Calibration Data...”. See Required Calibration Data on page 62 for details.

Connection Diagrams

In this User's Guide, only example connection diagrams are given at the beginning of each chapter, for example for receiver tests. The exact connection diagram for a specific situation can be viewed by right-clicking the appropriate procedure in the procedure tree of the main window of the user interface and selecting "Show Connection...".

PCI Express Common Receiver Parameters

The PCI Express Common Parameters are listed in the parameter grid (right half) of the main window of the user interface when you click the corresponding group in the procedure tree in the left half of the main window. Clicking a data rate in the procedure tree shows you the data-rate-specific PCI Express Common Parameters for that data rate. Similarly, clicking a lane shows you the corresponding lane-specific common parameters and clicking a channel shows you the corresponding channel-specific common parameters.

Details of PCI Express Common Receiver Parameters can be found in Table A-4 on page 324.

Parameters in Expert Mode for Individual Tests

The PCI Express Parameters in expert mode for an individual procedure are not listed in this User's Guide explicitly. They are displayed in the parameter grid (right half) of the main window of the user interface when you click the corresponding entry in the procedure tree in the left half of the main window.

Details of PCI Express Receiver Parameters for individual procedures can be found in Table A-8 on page 360.

Parameters Related to FBER

In the CTS for PCI Express Version 6.0, the First Bit Error Ratio (FBER) is introduced. It is relevant only for Rx Test and LEQ Rx Test procedures at 64 GT/s. The relevant parameters used in those procedures are defined in Table A-8 and Table A-9, respectively, under the category heading 'BER Measurement'.

Note that FBER is supported only when the M8070EDAB Error Distribution Analysis Package plugin is installed and licensed in the M8070B system.

Using Back-Channel Optimization Data

For 32 GT/s

Using Back-Channel Optimization leads to the following changes for Rx (or LEQ Rx) test procedures at 32 GT/s. If “Use Back-Channel Optimization Data” is set to True in the corresponding Rx (or LEQ Rx) data rate node (32 GT/s), the “DUT Initial Preset Gen5” and “DUT Target Preset Gen5” parameters are set to the data for the first preset with the smallest Minimum Level Width from the selected Back-Channel Optimization file. The redriver parameters are hidden and the values specified in the selected Back-Channel Optimization file are used instead. The Back-Channel Optimization file can be selected with the parameter “Back-Channel Optimization file”.

For 64 GT/s

Using Back-Channel Optimization leads to the following changes for Rx (or LEQ Rx) test procedures at 64 GT/s. If “Use Back-Channel Optimization Data” is set to True in the corresponding Rx or (LEQ Rx) data rate node (64 GT/s), the “DUT Initial Preset Gen6” and “DUT Target Preset Gen6” parameters are set to the data for the first preset with the best BER from the selected Back-Channel Optimization file. The redriver parameters are hidden and the values specified in the selected Back-Channel Optimization file are used instead. The Back-Channel Optimization file can be selected with the parameter “Back-Channel Optimization file”.

Order of Descriptions of Receiver Tests

The receiver test descriptions are arranged alphabetically (except for “Custom” tests, which are placed directly after their “basic” versions).

To find a procedure description easily, go to Chapter 4, Procedure Tree Overview, where the procedures are listed in tables in the order they appear in the procedure tree in the application. Each listed procedure has a link to its description.

Example Connection Diagrams

For more details, right-click the appropriate procedure in the procedure tree of the user interface and select “Show Connection...”.

Figure 7-1 shows the connection diagram for receiver tests for ASIC end-point DUTs for M8040A. Note that the setup can differ depending on the ISI channel, clock architecture and external reference clock selection.

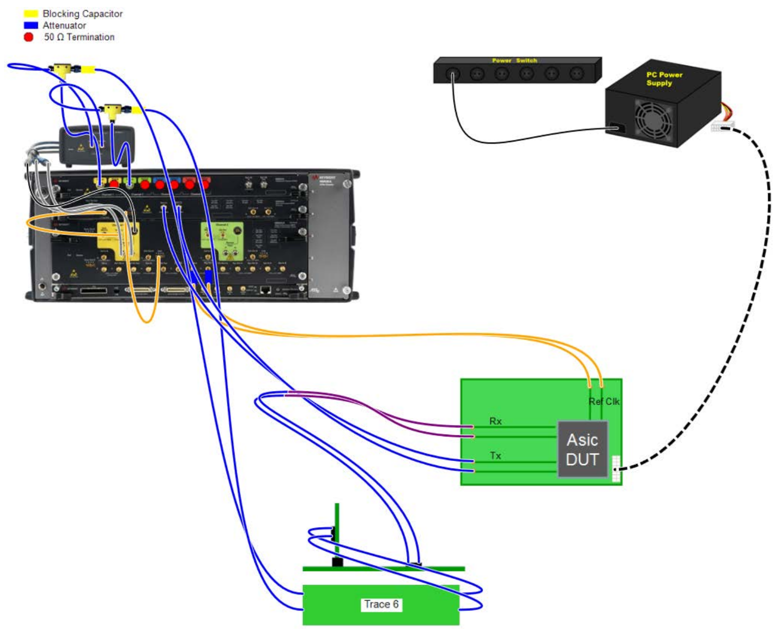


Figure 7-1 Example connection diagram for ASIC receiver tests (M8040A, 32 GT/s, End Point)

For ASIC Root Complex DUTs, the setup differs in the reference clock connection.

NOTE

If a Keysight M8047 Redriver is used, it must be connected between the test fixture Tx outputs and the BERT data inputs.

For redrivers it is important that the setup includes the couplers that are shown in the Connection Diagram in the application.

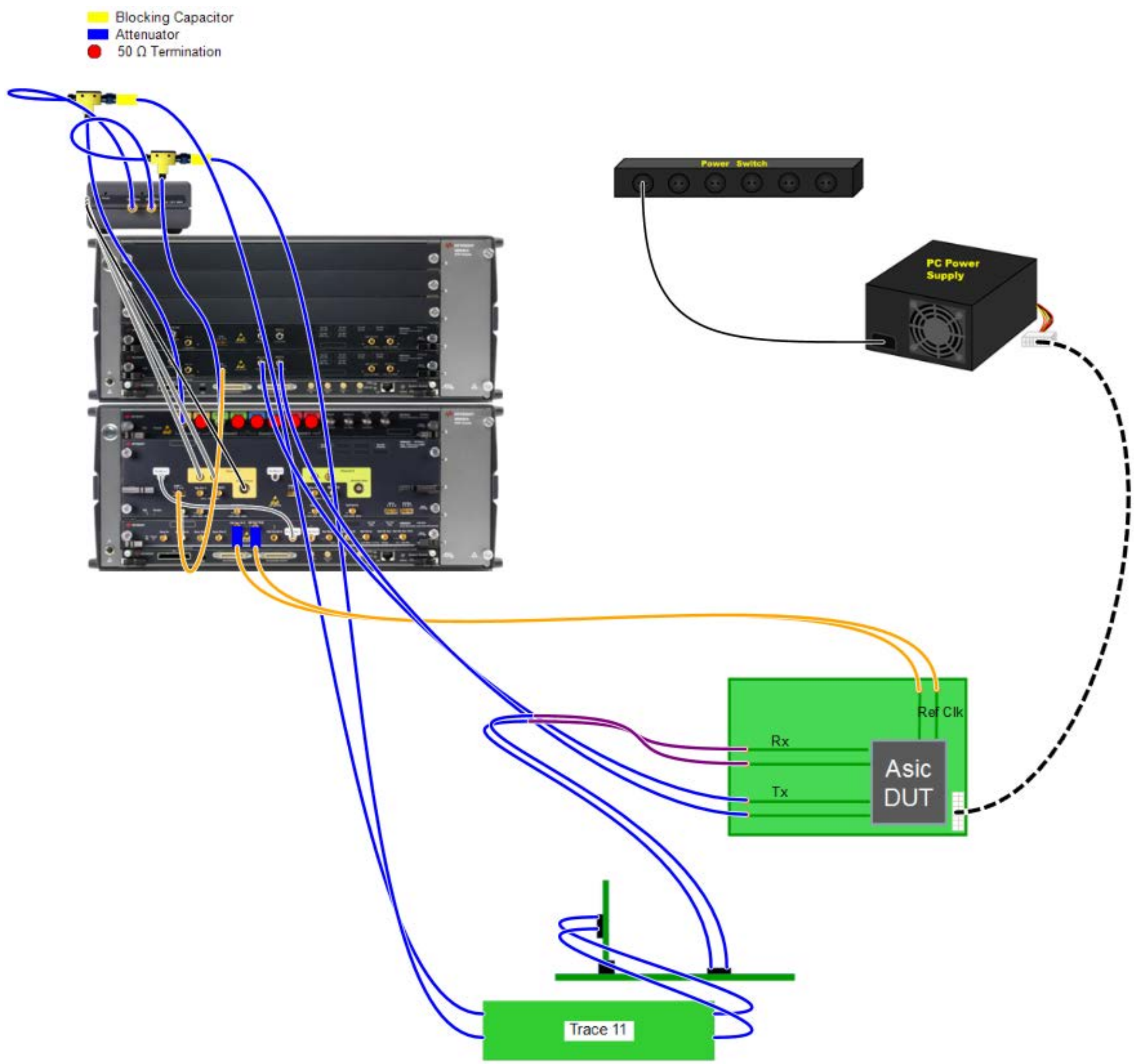


Figure 7-2 Example connection diagram for ASIC receiver tests (M8050A, 64 GT/s, End Point)

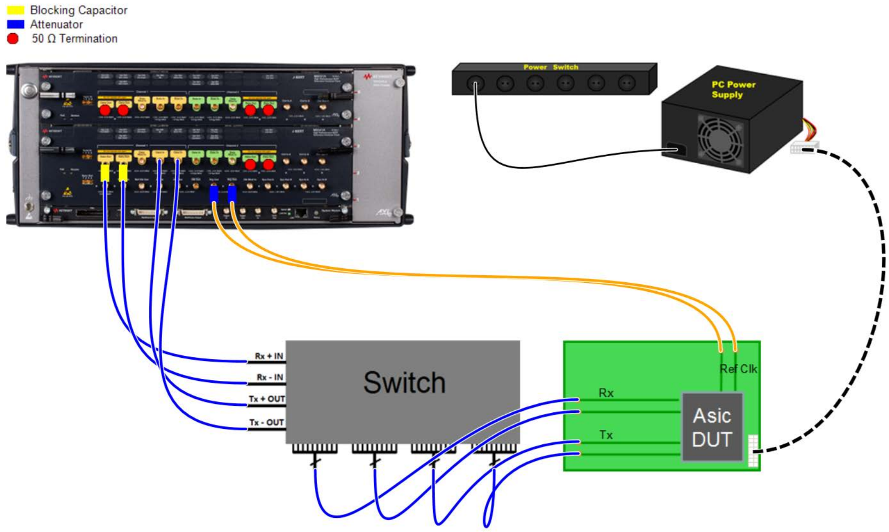


Figure 7-3 Example connection diagram for ASIC receiver tests with a switch (M8020A, 8 GT/s, End Point)

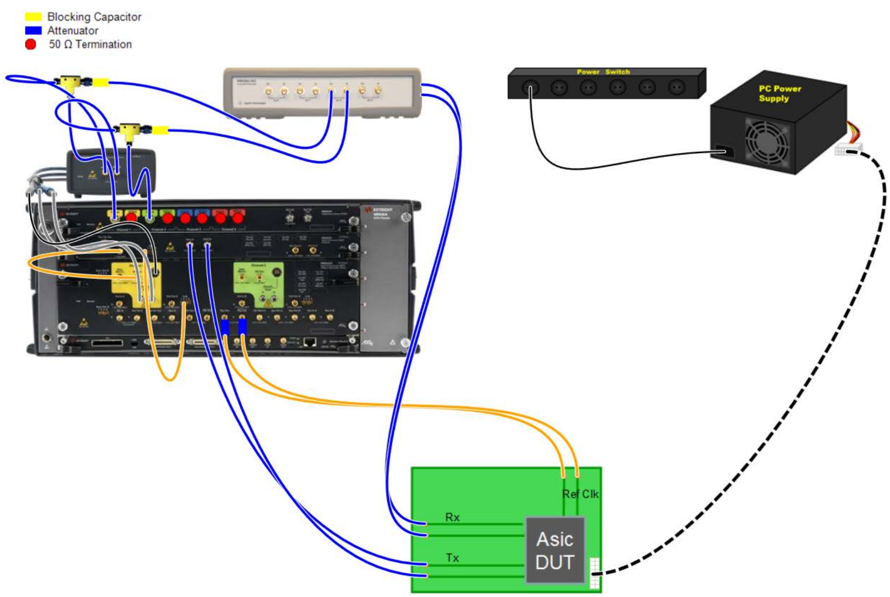


Figure 7-4 Example connection diagram for ASIC receiver tests (M8040A, 5 GT/s, End Point)

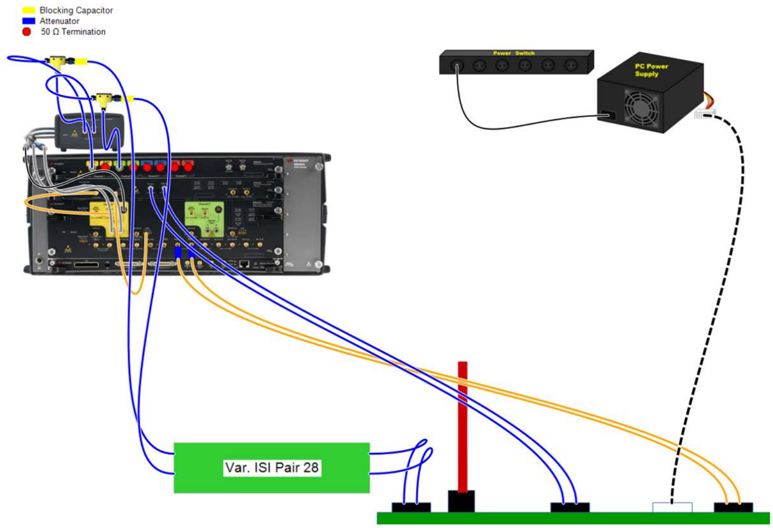


Figure 7-5 Example connection diagram for CEM receiver tests (M8040A, 16 GT/s, Add-In Card)

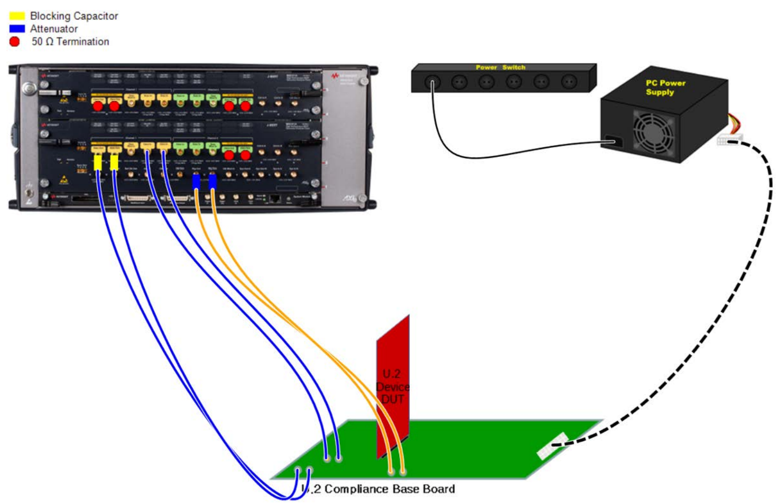


Figure 7-6 Example connection diagram for U.2 receiver tests (M8020A, 8 GT/s, Device)

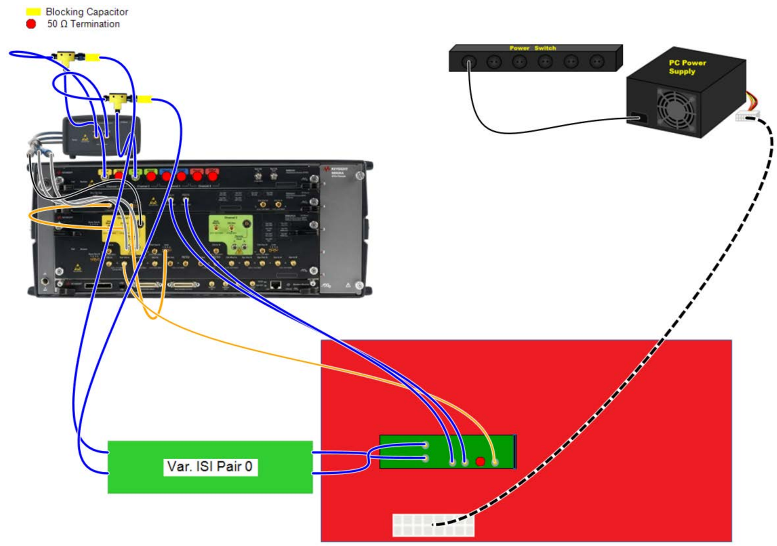


Figure 7-7 Example connection diagram for M.2 receiver tests (M8040A, 32 GT/s, Host)

Descriptions of Receiver Tests

Rx Coefficient Matrix Scan

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

For 64 GT/s: This procedure measures the BER with a combination of coefficients C+1 (Post-Cursor), C–1 (Pre-Cursor1) and C–2 (Pre-Cursor2) to create a coefficient matrix with the BER results. At each step, for a certain C–2, the BER value is measured for different values of C–1 and C+1. After repeating for different values of C–2, the resulting values are mapped onto three triangular matrices, where each element contains four entries (measured BER, pre-shoot, de-emphasis, and boost). Note that the BER level, which determines the color of each tile, will change if FEC is enabled.

For Other Data Rates: This procedure measures the BER with a combination of coefficients C+1 (Post-Cursor) and C–1 (Pre-Cursor) to create a coefficient matrix with the BER results. At each step, the BER value is measured for different values of C+1 coefficients while the C–1 coefficient value is kept constant. The resulting values are mapped onto a single triangular matrix, where each element contains four entries (measured BER, pre-shoot, de-emphasis, and boost).

Elements on a diagonal line from bottom left to top right in each triangle have the same maximum boost value. The elements of the matrix are displayed in different colors depending on the measured BER value. If the element appears in green, the entry values are valid and they can be used for testing. As the color changes to red, such values are invalid for testing.

If the parameter “Allow user to enter optimum equalization for remaining tests” (in the parameter grid of the main window of the user interface) is set to ‘True’, a window appears where you can select the values of pre-shoot and de-emphasis from the resulting table.

Connection Diagram

Refer to Figure 7-1 on page 231 and Figure 7-2, Figure 7-3, Figure 7-5, Figure 7-6, Figure 7-7.

Result Description

L0_Rx_64GTps_EQTable

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Loopback Training Settings----	
Use Custom Training Voltage	False
Suppress Loopback Training Messages	False
----Generator Clock----	
Data Rate Deviation	0 ppm
Use SSC	False
32 GT/s Use SSC	False
64 GT/s Use SSC	False
Reference Clock	100 MHz
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Enable Impairments during LB Training	True
Force Retraining at each BER measurement	False
Pre-Shoot2 used for LB Training	-1.3 dB
Pre-Shoot1 used for LB Training	4.7 dB
De-Emphasis used for LB Training	0 dB
Link Training Lane Number	0
Link Training Mode	Interactive
Link Training Suite Settings File	C:\ProgramData
Training through	L0-Recovery
----Interactive Link Training----	
Precoding Auto Detection	True
Generator Full Swing	24
Generator Start Preset	P5
DUT Initial Preset	P5
DUT Target Preset	P5
Select Start Preset Gen4	User Defined
Generator Start Preset Gen4	P5
DUT Initial Preset Gen4	P5
DUT Target Preset Gen4	P5

Select Start Preset Gen5	User Defined
Generator Start Preset Gen5	P5
DUT Initial Preset Gen5	P5
DUT Target Preset Gen5	P6
Select Start Preset Gen6	User Defined
Generator Start Preset Gen6	Q5
DUT Initial Preset Gen6	Q5
DUT Target Preset Gen6	Q5
Drop Link Method	LTSSM
----Error Detector----	
Enable FEC	False
Manually align error detector sampling point.	False
Fast Alignment	False
Use Auto Analyzer Equalization	True
Retries for Auto Analyzer Equalization	1
CDR Loop Bandwidth	20 MHz
Input Range for Loopback Training	600 mV
Input Range	600 mV
CDR Loop Selection	Loop1
Filter SKPOS	True
Upper Analyzer Threshold	150 mV
Middle Analyzer Threshold	0 V
Lower Analyzer Threshold	-150 mV
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance I
Toggle Script File For 32 GT/s	C:\ProgramData'
Toggle Script File For 64 GT/s	C:\ProgramData'
Pause after toggle	100 ms
----Back-Channel Optimization----	
Use Back-Channel Optimization Data	False
----Coefficient Variation----	
Coefficient Divider	24
Maximum Pre-Shoot2 for C-1 = 0 & C+1 = 0	2 dB
Maximum Pre-Shoot1 for C-2 = 0 & C+1 = 0	6 dB
Maximum Boost	9.5 dB
Start Pre-Shoot2	0 dB
Start Pre-Shoot1	0 dB
Start De-Emphasis	0 dB
----BER Measurement----	
Bit Error Ratio Measurement	FBER
Maximum number of consecutive symbols	24
FBER Mode	TargetBer
Target FBER	1E-6
Confidence Level	95 %
Relax Time	3 s

```
----Impairments----
Use Compliance Impairments                                          True
Differential Voltage                                                800 mV
Random Jitter                                                       190 fs
Common Mode Interference                                            75 mV
Differential Mode Interference                                      5 mV
Sinusoidal Jitter                                                   1.5625 ps
Sinusoidal Jitter Frequency                                         100 MHz
2nd Tone Sinusoidal Jitter                                          0 s
2nd Tone Sinusoidal Jitter Frequency                                210 MHz
Treat 33kHz as separate SJ frequency                                True
----Equalization----
Use Preset                                                          True
Generator Preset                                                    Q5
Pre-Shoot 2                                                         -1.3 dB
Pre-Shoot 1                                                         4.7 dB
De-Emphasis                                                         0 dB
----Channel----
Trace Number                                                        9
Total Channel Loss                                                  -33 dB
----Equalization for remaining Rx tests----
Allow user to enter optimum equalization for remaining Rx tests    True
----DUT----
Max Link Training Speed                                             64 GT/s
```

C-2	C-1 C+1	0/24	1/24	2/24	3/24	4/24	5/24	6/24	7/24	8/24
0/24	0/24	BER: 0.00e+0 PS2: 0.0dB PS1: 0.0dB DE: 0.0dB Boost: 0.0dB	BER: 1.00e-16 PS2: 0.0dB PS1: 0.0dB DE: -0.8dB Boost: 0.8dB	BER: 2.00e-14 PS2: 0.0dB PS1: 0.0dB DE: -1.6dB Boost: 1.6dB	BER: 3.00e-12 PS2: 0.0dB PS1: 0.0dB DE: -2.5dB Boost: 2.5dB	BER: 4.00e-10 PS2: 0.0dB PS1: 0.0dB DE: -3.5dB Boost: 3.5dB	BER: 5.00e-8 PS2: 0.0dB PS1: 0.0dB DE: -4.7dB Boost: 4.7dB	BER: 6.00e-6 PS2: 0.0dB PS1: 0.0dB DE: -6.0dB Boost: 6.0dB	BER: no sync PS2: 0.0dB PS1: 0.0dB DE: -7.6dB Boost: 7.6dB	BER: no sync PS2: 0.0dB PS1: 0.0dB DE: -9.5dB Boost: 9.5dB
0/24	1/24	BER: 0.00e+0 PS2: 0.0dB PS1: 0.8dB DE: 0.0dB Boost: 0.8dB	BER: 2.00e-16 PS2: 0.0dB PS1: 0.8dB DE: -0.8dB Boost: 1.6dB	BER: 3.00e-14 PS2: 0.0dB PS1: 0.9dB DE: -1.7dB Boost: 2.5dB	BER: 4.00e-12 PS2: 0.0dB PS1: 1.0dB DE: -2.8dB Boost: 3.5dB	BER: 5.00e-10 PS2: 0.0dB PS1: 1.2dB DE: -3.9dB Boost: 4.7dB	BER: 6.00e-8 PS2: 0.0dB PS1: 1.3dB DE: -5.3dB Boost: 6.0dB	BER: 7.00e-6 PS2: 0.0dB PS1: 1.6dB DE: -6.8dB Boost: 7.6dB	BER: no sync PS2: 0.0dB PS1: 1.9dB DE: -8.8dB Boost: 9.5dB	
0/24	2/24	BER: 0.00e+0 PS2: 0.0dB PS1: 1.6dB DE: 0.0dB Boost: 1.6dB	BER: 3.00e-16 PS2: 0.0dB PS1: 1.7dB DE: -0.9dB Boost: 2.5dB	BER: 4.00e-14 PS2: 0.0dB PS1: 1.9dB DE: -1.9dB Boost: 3.5dB	BER: 5.00e-12 PS2: 0.0dB PS1: 2.2dB DE: -3.1dB Boost: 4.7dB	BER: 6.00e-10 PS2: 0.0dB PS1: 2.5dB DE: -4.4dB Boost: 6.0dB	BER: 7.00e-8 PS2: 0.0dB PS1: 2.9dB DE: -6.0dB Boost: 7.6dB	BER: 8.00e-6 PS2: 0.0dB PS1: 3.5dB DE: -8.0dB Boost: 9.5dB		
0/24	3/24	BER: 0.00e+0 PS2: 0.0dB PS1: 2.5dB DE: 0.0dB Boost: 2.5dB	BER: 4.00e-16 PS2: 0.0dB PS1: 2.8dB DE: -1.0dB Boost: 3.5dB	BER: 5.00e-14 PS2: 0.0dB PS1: 3.1dB DE: -2.2dB Boost: 4.7dB	BER: 6.00e-12 PS2: 0.0dB PS1: 3.5dB DE: -3.5dB Boost: 6.0dB	BER: 7.00e-10 PS2: 0.0dB PS1: 4.1dB DE: -5.1dB Boost: 7.6dB	BER: 8.00e-8 PS2: 0.0dB PS1: 4.9dB DE: -7.0dB Boost: 9.5dB			
0/24	4/24	BER: 0.00e+0 PS2: 0.0dB PS1: 3.5dB DE: 0.0dB Boost: 3.5dB	BER: 5.00e-16 PS2: 0.0dB PS1: 3.9dB DE: -1.2dB Boost: 4.7dB	BER: 6.00e-14 PS2: 0.0dB PS1: 4.4dB DE: -2.5dB Boost: 6.0dB	BER: 7.00e-12 PS2: 0.0dB PS1: 5.1dB DE: -4.1dB Boost: 7.6dB	BER: 8.00e-10 PS2: 0.0dB PS1: 6.0dB DE: -6.0dB Boost: 9.5dB				
0/24	5/24	BER: 0.00e+0 PS2: 0.0dB PS1: 4.7dB DE: 0.0dB Boost: 4.7dB	BER: 6.00e-16 PS2: 0.0dB PS1: 5.3dB DE: -1.3dB Boost: 6.0dB	BER: 7.00e-14 PS2: 0.0dB PS1: 6.0dB DE: -2.9dB Boost: 7.6dB	BER: 8.00e-12 PS2: 0.0dB PS1: 7.0dB DE: -4.9dB Boost: 9.5dB					

1/24	0/24	BER: 0.00e+0 PS2: -0.8dB PS1: 0.0dB DE: 0.0dB Boost: 0.0dB	BER: 1.00e-16 PS2: -0.8dB PS1: 0.0dB DE: -0.8dB Boost: 0.8dB	BER: 2.00e-14 PS2: -0.9dB PS1: 0.0dB DE: -1.6dB Boost: 1.6dB	BER: 3.00e-12 PS2: -1.0dB PS1: 0.0dB DE: -2.5dB Boost: 2.5dB	BER: 4.00e-10 PS2: -1.2dB PS1: 0.0dB DE: -3.5dB Boost: 3.5dB	BER: 5.00e-8 PS2: -1.3dB PS1: 0.0dB DE: -4.7dB Boost: 4.7dB	BER: 6.00e-6 PS2: -1.6dB PS1: 0.0dB DE: -6.0dB Boost: 6.0dB	BER: no sync PS2: -1.9dB PS1: 0.0dB DE: -7.6dB Boost: 7.6dB	BER: no sync PS2: -2.5dB PS1: 0.0dB DE: -9.5dB Boost: 9.5dB
1/24	1/24	BER: 0.00e+0 PS2: -0.8dB PS1: 0.8dB DE: 0.0dB Boost: 0.8dB	BER: 2.00e-16 PS2: -0.9dB PS1: 0.8dB DE: -0.8dB Boost: 1.6dB	BER: 3.00e-14 PS2: -1.0dB PS1: 0.9dB DE: -1.7dB Boost: 2.5dB	BER: 4.00e-12 PS2: -1.2dB PS1: 1.0dB DE: -2.8dB Boost: 3.5dB	BER: 5.00e-10 PS2: -1.3dB PS1: 1.2dB DE: -3.9dB Boost: 4.7dB	BER: 6.00e-8 PS2: -1.6dB PS1: 1.3dB DE: -5.3dB Boost: 6.0dB	BER: 7.00e-6 PS2: -1.9dB PS1: 1.6dB DE: -6.8dB Boost: 7.6dB	BER: no sync PS2: -2.5dB PS1: 1.9dB DE: -8.8dB Boost: 9.5dB	
1/24	2/24	BER: 0.00e+0 PS2: -0.9dB PS1: 1.6dB DE: 0.0dB Boost: 1.6dB	BER: 3.00e-16 PS2: -1.0dB PS1: 1.7dB DE: -0.9dB Boost: 2.5dB	BER: 4.00e-14 PS2: -1.2dB PS1: 1.9dB DE: -1.9dB Boost: 3.5dB	BER: 5.00e-12 PS2: -1.3dB PS1: 2.2dB DE: -3.1dB Boost: 4.7dB	BER: 6.00e-10 PS2: -1.6dB PS1: 2.5dB DE: -4.4dB Boost: 6.0dB	BER: 7.00e-8 PS2: -1.9dB PS1: 2.9dB DE: -6.0dB Boost: 7.6dB	BER: 8.00e-6 PS2: -2.5dB PS1: 3.5dB DE: -8.0dB Boost: 9.5dB		
1/24	3/24	BER: 0.00e+0 PS2: -1.0dB PS1: 2.5dB DE: 0.0dB Boost: 2.5dB	BER: 4.00e-16 PS2: -1.2dB PS1: 2.8dB DE: -1.0dB Boost: 3.5dB	BER: 5.00e-14 PS2: -1.3dB PS1: 3.1dB DE: -2.2dB Boost: 4.7dB	BER: 6.00e-12 PS2: -1.6dB PS1: 3.5dB DE: -3.5dB Boost: 6.0dB	BER: 7.00e-10 PS2: -1.9dB PS1: 4.1dB DE: -5.1dB Boost: 7.6dB	BER: 8.00e-8 PS2: -2.5dB PS1: 4.9dB DE: -7.0dB Boost: 9.5dB			
1/24	4/24	BER: 0.00e+0 PS2: -1.2dB PS1: 3.5dB DE: 0.0dB Boost: 3.5dB	BER: 5.00e-16 PS2: -1.3dB PS1: 3.9dB DE: -1.2dB Boost: 4.7dB	BER: 6.00e-14 PS2: -1.6dB PS1: 4.4dB DE: -2.5dB Boost: 6.0dB	BER: 7.00e-12 PS2: -1.9dB PS1: 5.1dB DE: -4.1dB Boost: 7.6dB	BER: 8.00e-10 PS2: -2.5dB PS1: 6.0dB DE: -6.0dB Boost: 9.5dB				
1/24	5/24	BER: 0.00e+0 PS2: -1.3dB PS1: 4.7dB DE: 0.0dB Boost: 4.7dB	BER: 6.00e-16 PS2: -1.6dB PS1: 5.3dB DE: -1.3dB Boost: 6.0dB	BER: 7.00e-14 PS2: -1.9dB PS1: 6.0dB DE: -2.9dB Boost: 7.6dB	BER: 8.00e-12 PS2: -2.5dB PS1: 7.0dB DE: -4.9dB Boost: 9.5dB					

2/24	0/24	BER: 0.00e+0 PS2: -1.6dB PS1: 0.0dB DE: 0.0dB Boost: 0.0dB	BER: 1.00e-16 PS2: -1.7dB PS1: 0.0dB DE: -0.8dB Boost: 0.8dB	BER: 2.00e-14 PS2: -1.9dB PS1: 0.0dB DE: -1.6dB Boost: 1.6dB	BER: 3.00e-12 PS2: -2.2dB PS1: 0.0dB DE: -2.5dB Boost: 2.5dB	BER: 4.00e-10 PS2: -2.5dB PS1: 0.0dB DE: -3.5dB Boost: 3.5dB	BER: 5.00e-8 PS2: -2.9dB PS1: 0.0dB DE: -4.7dB Boost: 4.7dB	BER: 6.00e-6 PS2: -3.5dB PS1: 0.0dB DE: -6.0dB Boost: 6.0dB	BER: no sync PS2: -4.4dB PS1: 0.0dB DE: -7.6dB Boost: 7.6dB	BER: no sync PS2: -6.0dB PS1: 0.0dB DE: -9.5dB Boost: 9.5dB
2/24	1/24	BER: 0.00e+0 PS2: -1.7dB PS1: 0.8dB DE: 0.0dB Boost: 0.8dB	BER: 2.00e-16 PS2: -1.9dB PS1: 0.8dB DE: -0.8dB Boost: 1.6dB	BER: 3.00e-14 PS2: -2.2dB PS1: 0.9dB DE: -1.7dB Boost: 2.5dB	BER: 4.00e-12 PS2: -2.5dB PS1: 1.0dB DE: -2.8dB Boost: 3.5dB	BER: 5.00e-10 PS2: -2.9dB PS1: 1.2dB DE: -3.9dB Boost: 4.7dB	BER: 6.00e-8 PS2: -3.5dB PS1: 1.3dB DE: -5.3dB Boost: 6.0dB	BER: 7.00e-6 PS2: -4.4dB PS1: 1.6dB DE: -6.8dB Boost: 7.6dB	BER: no sync PS2: -6.0dB PS1: 1.9dB DE: -8.8dB Boost: 9.5dB	
2/24	2/24	BER: 0.00e+0 PS2: -1.9dB PS1: 1.6dB DE: 0.0dB Boost: 1.6dB	BER: 3.00e-16 PS2: -2.2dB PS1: 1.7dB DE: -0.9dB Boost: 2.5dB	BER: 4.00e-14 PS2: -2.5dB PS1: 1.9dB DE: -1.9dB Boost: 3.5dB	BER: 5.00e-12 PS2: -2.9dB PS1: 2.2dB DE: -3.1dB Boost: 4.7dB	BER: 6.00e-10 PS2: -3.5dB PS1: 2.5dB DE: -4.4dB Boost: 6.0dB	BER: 7.00e-8 PS2: -4.4dB PS1: 2.9dB DE: -6.0dB Boost: 7.6dB	BER: 8.00e-6 PS2: -6.0dB PS1: 3.5dB DE: -8.0dB Boost: 9.5dB		
2/24	3/24	BER: 0.00e+0 PS2: -2.2dB PS1: 2.5dB DE: 0.0dB Boost: 2.5dB	BER: 4.00e-16 PS2: -2.5dB PS1: 2.8dB DE: -1.0dB Boost: 3.5dB	BER: 5.00e-14 PS2: -2.9dB PS1: 3.1dB DE: -2.2dB Boost: 4.7dB	BER: 6.00e-12 PS2: -3.5dB PS1: 3.5dB DE: -3.5dB Boost: 6.0dB	BER: 7.00e-10 PS2: -4.4dB PS1: 4.1dB DE: -5.1dB Boost: 7.6dB	BER: 8.00e-8 PS2: -6.0dB PS1: 4.9dB DE: -7.0dB Boost: 9.5dB			
2/24	4/24	BER: 0.00e+0 PS2: -2.5dB PS1: 3.5dB DE: 0.0dB Boost: 3.5dB	BER: 5.00e-16 PS2: -2.9dB PS1: 3.9dB DE: -1.2dB Boost: 4.7dB	BER: 6.00e-14 PS2: -3.5dB PS1: 4.4dB DE: -2.5dB Boost: 6.0dB	BER: 7.00e-12 PS2: -4.4dB PS1: 5.1dB DE: -4.1dB Boost: 7.6dB	BER: 8.00e-10 PS2: -6.0dB PS1: 6.0dB DE: -6.0dB Boost: 9.5dB				
2/24	5/24	BER: 0.00e+0 PS2: -2.9dB PS1: 4.7dB DE: 0.0dB Boost: 4.7dB	BER: 6.00e-16 PS2: -3.5dB PS1: 5.3dB DE: -1.3dB Boost: 6.0dB	BER: 7.00e-14 PS2: -4.4dB PS1: 6.0dB DE: -2.9dB Boost: 7.6dB	BER: 8.00e-12 PS2: -6.0dB PS1: 7.0dB DE: -4.9dB Boost: 9.5dB					

Figure 7-8 Example result for Rx Coefficient Matrix Scan (64 GT/s)

- Matrix of the BER, Pre-Shoot 2, Pre-Shoot 1, De-Emphasis and Boost values for combinations of C–2 (values listed in first column), C–1 (values listed in second column) and C+1 (values listed in first row).

Rx Custom Coefficient Matrix Scan

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Rx Coefficient Matrix Scan on page 236, with the difference that you can use combinations of impairments that have been obtained with the Custom Eye Calibration on page 185 or Custom Eye Scan Calibration on page 188.

Rx Compliance Test

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	ASIC	CEM
DUT Types:	End Point Root Complex	Add-In Card System
Modes:	Compliance, Expert	
Data Rates:	2.5, 5 GT/s	

Purpose and Method

This test determines whether the DUT meets the receiver specifications. The procedure measures the BER when all jitter types and the eye height are set to their specification limit values (that is, maximum values for jitter, minimum value for eye height). In expert mode, these values can be changed.

Connection Diagram

Refer to Figure 7-4 on page 233.

Result Description

L0_Rx_5GTps_Comp

PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
ISI	73 ps
CMSI Amplitude	150 mV
Specification:	
Eye Height <= 100 mV	
Random Jitter(rms) >= 3.4 ps	
SSC Residual(peak-peak) >= 75.0 ps	
Deterministic Jitter(peak-peak) >= 88.0 ps	
High Frequency Deterministic Jitter(peak-peak)(>100MHz) >= 0.0 ps	
Test Properties:	
----Loopback Training Settings----	
Suppress Loopback Training Messages	False
----Generator Clock----	
Data Rate Deviation	0 ppm
Use SSC	False
32 GT/s Use SSC	False
64 GT/s Use SSC	False
Reference Clock	100 MHz
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Enable Impairments during Loopback Training	True
Link Training Lane Number	0
Link Training Mode	Static Seque
Link Training Suite Settings File	C:\ProgramDa
Training through	Configuratio
----Error Detector----	
CDR Loop Bandwidth	7.5 MHz
Input Range for Loopback Training	600 mV
Input Range	600 mV
CDR Loop Selection	Loop1
Filter SKPOS	True
Threshold	0 V
Polarity	Non-Inverted
Manually align error detector sampling point.	False
Fast Alignment	False
Analyzer Equalization	80
Use Auto Analyzer Equalization	False

```
----Generator Jitter----
LF Sinusoidal Jitter Amplitude                          15 ps
----Eye Height----
Eye Height                                              100 mV
----BER Measurement----
BER Mode                                                TargetBer
Target BER                                              1E-12
Confidence Level                                        95 %
Relax Time                                              3 s
----Impairments----
Use Compliance Impairments                              True
Random Jitter                                           3.4 ps
SSC Residual                                            75 ps
Treat 33kHz as separate SJ frequency                    True
----DUT----
Max Link Training Speed                                 64 GT/s
----Instruments----
```

(...)

Result	SJ Frequency [MHz]	SJ Amplitude [ps]	Target BER [ ]	Measured BER [ ]
pass	100.000	15.0	0.000E+000	0.000E+000

Figure 7-9 Example result for Rx Compliance Test

- Result: (pass/fail) “Pass” if the measured BER is smaller than the target BER.
- SJ Frequency [MHz]: Frequency of the applied SJ.
- SJ Amplitude [ps]: Amplitude of the applied SJ.
- Target BER: BER to be achieved.
- BER: Measured BER.

Rx Jitter Tolerance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert		
Data Rates:	2.5 GT/s, 5 GT/s, 8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

The Rx Jitter Tolerance Test determines how much jitter a DUT can tolerate at different SJ frequencies.

The test procedure applies a search algorithm that is used sequentially over a number of jitter frequencies, which are defined by the parameters in the category Sinusoidal Jitter Variation in the parameter grid.

Frequencies to be tested are defined with the “Frequency Mode” property.

- If ‘User Defined’, ‘Compliance Frequencies’ or ‘Single Frequency’ is selected, the enabled parameter is
  - Jitter frequencies/y
- If ‘Equally Spaced Frequencies’ is selected, the enabled parameters are
  - Start frequency value
  - Stop frequency value
  - Number of frequency steps
  - Frequency sweep scale

Other parameters that govern the jitter variation are

- Start jitter amplitude(s)
- Use fixed number of steps, which can be defined in terms of
  - Jitter step sizes or factors
  - Number of jitter steps
- Show min failed points

At each jitter frequency value, the minimum failed jitter value and the maximum passed jitter value are saved. The passed values are either the maximum jitter amplitudes where the DUT produced no more bit errors than the number of allowed bit errors (if BER Mode is “Fixed Time”) or the maximum jitter amplitude where the BER did not exceed the target BER (if BER Mode is “Target BER”). The results are curves that show the maximum jitter that the DUT can tolerate as a function of the SJ frequency.

There are different methods of finding the maximum passed jitter amplitude. Search Algorithm can be selected as Binary, Linear, Linear with two step sizes, Linear with two step sizes and hysteresis, Logarithmic up or Logarithmic down.

- With the “Binary” search algorithm, the jitter amplitude is initially set to the middle of the tested range. If the BER test is passed, the jitter amplitude is increased and if the BER test is failed, the amplitude is decreased. The step size is reduced at each step until the target resolution is reached. The binary search algorithm is recommended for DUTs with short recovery time.
- If “Linear” is selected, the test uses the defined step size to increase the jitter amplitude linearly from “Start Jitter” until the BER test fails.
- If “Linear with two step sizes” is selected, the test first uses relatively large steps to increase the jitter amplitude linearly from “Start Jitter”. When the BER test is failed, the jitter amplitude is returned to the last passed point and steps up again with small steps until an error is found again.
- If “Linear with two step sizes and hysteresis” is selected, the test first uses relatively large steps to increase the jitter amplitude linearly from “Start Jitter”. When the BER test is failed, the jitter amplitude goes back down with mid-sized steps (hysteresis) until the BER test is passed again. From that point, the jitter amplitude steps up again with small steps until an error is found again.
- If “Logarithmic up” is selected, the test uses the defined step factor to increase the jitter amplitude on a logarithmic scale from “Start Jitter” until the BER test is failed.
- If “Logarithmic down” is selected, the test uses the defined step factor to decrease the jitter amplitude on a logarithmic scale from “Start Jitter” until the BER test is passed.

Connection Diagram

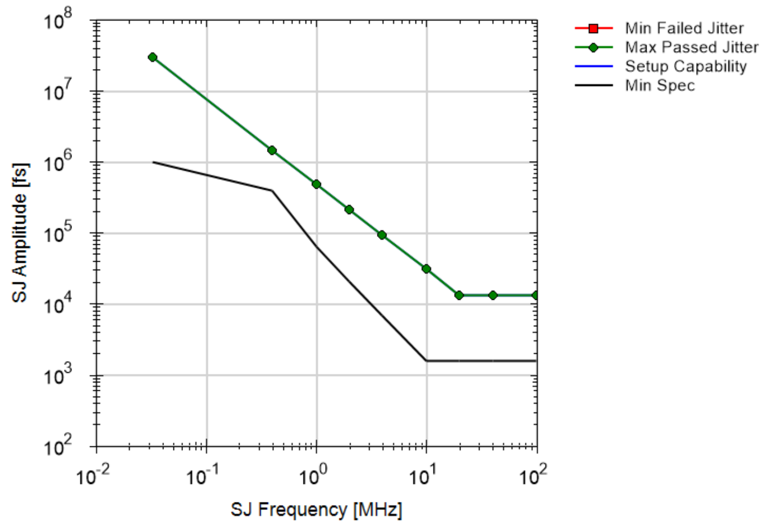
Refer to Figure 7-1 on page 231 to Figure 7-7 on page 235.

NOTE In the result table, Margin is given as N/A if there is no specification limit for a particular test point, i.e., Min spec is N/A.

Result Description

L0_Rx_64GTps_JTol

for for PCIe 6.0 EndPoint ASIC




```
----General----
Offline                                        True
Software Version                               5.4.0.22
Spec Deviations
Comments
----Loopback Training Settings----
Use Custom Training Voltage                    False
Suppress Loopback Training Messages            False
----Generator Clock----
Data Rate Deviation                            0 ppm
Use SSC                                        False
32 GT/s Use SSC                                False
64 GT/s Use SSC                                False
Reference Clock                                100 MHz
----Power Switch Automation----
Use Power Switch Automation                    True
Power Switch Channel Number                    1
Power Cycle Off On Duration                    3 s
Power Cycle Settling Time                      3 s
Power Cycle max. Retries for LB Training       1
```

----Loopback Training----	
Enable Impairments during LB Training	True
Force retraining on each frequency	False
Link Training Lane Number	0
Link Training Mode	Interactive
Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFram
Training through	L0-Recovery
----Interactive Link Training----	
Precoding Auto Detection	True
Generator Full Swing	24
Generator Start Preset	P5
DUT Initial Preset	P5
DUT Target Preset	P5
Select Start Preset Gen4	User Defined
Generator Start Preset Gen4	P5
DUT Initial Preset Gen4	P5
DUT Target Preset Gen4	P5
Select Start Preset Gen5	User Defined
Generator Start Preset Gen5	P5
DUT Initial Preset Gen5	P5
DUT Target Preset Gen5	P6
Select Start Preset Gen6	User Defined
Generator Start Preset Gen6	Q5
DUT Initial Preset Gen6	Q5
DUT Target Preset Gen6	Q5
Drop Link Method	LTSSM
----Error Detector----	
Enable FEC	False
Manually align error detector sampling point.	False
Fast Alignment	False
Use Auto Analyzer Equalization	True
Retries for Auto Analyzer Equalization	1
CDR Loop Bandwidth	20 MHz
Input Range for Loopback Training	600 mV
Input Range	600 mV
CDR Loop Selection	Loop1
Filter SKPOS	True
Upper Analyzer Threshold	150 mV
Middle Analyzer Threshold	0 V
Lower Analyzer Threshold	-150 mV
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s	C:\ProgramData\BitifEye\ValiFram
Toggle Script File For 64 GT/s	C:\ProgramData\BitifEye\ValiFram
Pause after toggle	100 ms
----Back-Channel Optimization----	
Use Back-Channel Optimization Data	False
----Sinusoidal Jitter Variation----	
Search Algorithm	Linear with 2 step sizes
Frequency mode	Compliance Frequencies
Use fixed number of steps	False
Show min failed points	True

```
----BER Measurement----
Bit Error Ratio Measurement                     FBER
Maximum number of consecutive symbols           24
FBER Mode                                       TargetBer
Target FBER                                     1E-6
Confidence Level                                95 %
Relax Time                                      3 s
----Impairments----
Use Compliance Impairments                      True
Differential Voltage                            800 mV
Random Jitter                                   190 fs
Common Mode Interference                        75 mV
Differential Mode Interference                  5 mV
2nd Tone Sinusoidal Jitter                      0 s
2nd Tone Sinusoidal Jitter Frequency            210 MHz
Treat 33kHz as separate SJ frequency            True
----Equalization----
Use Preset                                      False
Pre-Shoot 2                                     -1.3 dB
Pre-Shoot 1                                     4.7 dB
De-Emphasis                                     0 dB
----Channel----
Trace Number                                    9
Total Channel Loss                              -33 dB
----DUT----
Max Link Training Speed                         64 GT/s
----Instruments----
```

(...)

Result	SJ Frequency [MHz]	Min Failed Jitter [fs]	Max Passed Jitter [fs]	Setup Capability [fs]	Min Spec [fs]	Margin [%]
pass	0.03	NaN	29021500.00	29021500.0	1000000.00	2802.2
pass	0.40	NaN	1453600.00	1453600.0	389404.76	273.3
pass	1.00	NaN	484100.00	484100.0	62465.46	675.0
pass	2.00	NaN	210700.00	210700.0	20575.95	924.0
pass	4.00	NaN	91700.00	91700.0	6777.66	1253.0
pass	10.00	NaN	30500.00	30500.0	1562.50	1852.0
pass	20.00	NaN	12900.00	12900.0	1562.50	725.6
pass	40.00	NaN	12900.00	12900.0	1562.50	725.6
pass	100.00	NaN	12900.00	12900.0	1562.50	725.6

Figure 7-10 Example result for Rx Jitter Tolerance Test

- Result: “Pass” or “fail”.
- SJ Frequency [MHz]: The frequency of the sinusoidal jitter applied to the test signal.
- Min Failed Jitter [fs]: The first value of SJ amplitude where the DUT did not pass the BER test at a specific frequency.
- Max Passed Jitter [fs]: The maximum value of SJ that the DUT can tolerate at a specific SJ frequency.

- Setup Capability [fs]: The maximum value of jitter that the test setup can generate at a specific SJ frequency.
- Min Spec [fs]: Lower specification limit for jitter.
- Margin [%]: The margin between the max passed jitter and the specification.

Rx Custom Jitter Tolerance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Rx Jitter Tolerance Test on page 247, with the difference that you can use combinations of impairments that have been obtained with the Custom Eye Calibration on page 185 or Custom Eye Scan Calibration on page 188.

Rx Pre-Compliance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

For all data rates except ASIC at 8 GT/s

This test verifies that the DUT functions properly in the presence of the compliance eye defined in the specification.

The target eye height and eye width are generated by adding the optimum combination of Differential Mode Sinusoidal Interference, Sinusoidal Jitter and Launch Voltage. Random Jitter and Common Mode Sinusoidal interference are fixed to the nominal values. Then, the BER test is performed for different amplitudes of the sinusoidal jitter. For ASIC the frequency is also varied; otherwise the frequency is kept fixed at 100 MHz.

For ASIC at 8 GT/s

This test verifies that the receiver meets the eye width specification. Eye width is set to the minimum of the specification, which is 37.5 ps, and the eye height must be between 22.5 and 27.5 mVpp.

Eye width is generated by adding the combination of Random Jitter and DMSI that also gets as close as possible to the desired eye height. Launch Voltage is fixed to the value used in Stressed Jitter Eye Calibration. Then, the BER test is performed for different frequencies and amplitudes of the sinusoidal jitter.

Connection Diagram

Refer to Figure 7-1 on page 231 and Figure 7-2, Figure 7-5, Figure 7-6, Figure 7-7.

Result Description

The Result Description is basically the same for all data rates with just a few alterations for ASIC at 8 GT/s. Just one example is given here.

L0_Rx_64GTps_Comp

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Loopback Training Settings----	
Use Custom Training Voltage	False
Suppress Loopback Training Messages	False
----Generator Clock----	
Data Rate Deviation	0 ppm
Use SSC	False
32 GT/s Use SSC	False
64 GT/s Use SSC	False
Reference Clock	100 MHz
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Enable Impairments during LB Training	True
Link Training Lane Number	0
Link Training Mode	Interactive
Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFram
Training through	L0-Recovery
----Interactive Link Training----	
Precoding Auto Detection	True
Generator Full Swing	24
Generator Start Preset	P5
DUT Initial Preset	P5
DUT Target Preset	P5
Select Start Preset Gen4	User Defined
Generator Start Preset Gen4	P5
DUT Initial Preset Gen4	P5
DUT Target Preset Gen4	P5
Select Start Preset Gen5	User Defined
Generator Start Preset Gen5	P5
DUT Initial Preset Gen5	P5
DUT Target Preset Gen5	P6
Select Start Preset Gen6	User Defined
Generator Start Preset Gen6	Q5
DUT Initial Preset Gen6	Q5

DUT Target Preset Gen6	Q5
Drop Link Method	LTSSM
----Error Detector----	
Enable FEC	False
Manually align error detector sampling point.	False
Fast Alignment	False
Use Auto Analyzer Equalization	True
Retries for Auto Analyzer Equalization	1
CDR Loop Bandwidth	20 MHz
Input Range for Loopback Training	600 mV
Input Range	600 mV
CDR Loop Selection	Loop1
Filter SKPOS	True
Upper Analyzer Threshold	150 mV
Middle Analyzer Threshold	0 V
Lower Analyzer Threshold	-150 mV
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s	C:\ProgramData\BitifEye\ValiFram
Toggle Script File For 64 GT/s	C:\ProgramData\BitifEye\ValiFram
Pause after toggle	100 ms
----Back-Channel Optimization----	
Use Back-Channel Optimization Data	False
----BER Measurement----	
Bit Error Ratio Measurement	FBER
Maximum number of consecutive symbols	24
FBER Mode	TargetBer
Target FBER	1E-6
Confidence Level	95 %
Relax Time	3 s
----Impairments----	
Use Compliance Impairments	True
Differential Voltage	800 mV
Random Jitter	190 fs
Common Mode Interference	75 mV
Differential Mode Interference	5 mV
2nd Tone Sinusoidal Jitter	0 s
2nd Tone Sinusoidal Jitter Frequency	210 MHz
Treat 33kHz as separate SJ frequency	True
----Equalization----	
Use Preset	False
Pre-Shoot 2	-1.3 dB
Pre-Shoot 1	4.7 dB
De-Emphasis	0 dB
----Channel----	
Trace Number	9
Total Channel Loss	-33 dB
----DUT----	
Max Link Training Speed	64 GT/s

(...)

Result	SJ Frequency [MHz]	SJ Amplitude [ps]	Target FBER [ ]	Measured FBER [ ]
pass	100.000	1.5625	1.000E-006	5.000E-007
pass	40.000	1.5625	1.000E-006	5.000E-007
pass	20.000	1.5625	1.000E-006	5.000E-007
pass	10.000	1.5625	1.000E-006	5.000E-007
pass	4.000	6.7777	1.000E-006	5.000E-007
pass	2.000	20.5759	1.000E-006	5.000E-007
pass	1.000	62.4655	1.000E-006	5.000E-007
pass	0.400	389.4048	1.000E-006	5.000E-007
pass	0.033	1000.0000	1.000E-006	5.000E-007

Figure 7-11 Example result for Rx Pre-Compliance Test

- Result: “Pass” or “fail”.
- SJ Frequency [MHz]: The calibrated frequency of the sinusoidal jitter.
- SJ Amplitude [ps]: The calibrated amplitude of the sinusoidal jitter.
- Target FBER: The maximum value of FBER allowed for a “pass” result.
- Measured FBER: The measured FBER value.

OR, for the last two columns, if the BER Mode is selected as Fixed Time,

- Allowed Bit Error: The maximum number of bit errors allowed for a “pass” result.
- Measured Bit Error: The number of bit errors measured.

NOTE

For data rates below 64 GT/s or if ‘Bit Error Ratio Measurement’ is selected as ‘BER’, FBER is replaced by BER.

Rx Custom Pre-Compliance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Rx Pre-Compliance Test on page 254, with the difference that you can use combinations of impairments that have been obtained with the Custom Eye Calibration on page 185 or Custom Eye Scan Calibration on page 188.

Rx Preset Pre-Compliance Test

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	CEM	U.2 and M.2
DUT Types:	Add-In Card	Device
Modes:	Expert	
Data Rates:	8 GT/s	

Purpose and Method

This test determines whether the DUT meets the receiver specifications for different presets.

Eye height, eye width and sinusoidal jitter are set to the specified values. Eye height and eye width are generated by adding the appropriate amount of random jitter and DMSI.

The procedure measures the number of errors during “BER Measurement duration” and checks if the “Target BER” is met. In this procedure, presets P7 and P8 are tested.

Connection Diagram

Refer to Figure 7-6 on page 234.

Result Description

L0_Rx_8GTps_CBB3_PresPreComp

for PCIe 6.0 AddInCard

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Loopback Training Settings----	
Use Custom Training Voltage	False
Suppress Loopback Training Messages	False
----Generator Clock----	
Data Rate Deviation	0 ppm
Use SSC	False
32 GT/s Use SSC	True
32 GT/s SSC Deviation	5000 ppm
64 GT/s Use SSC	True
64 GT/s SSC Deviation	5000 ppm

```
----Power Switch Automation----
Use Power Switch Automation                        True
Power Switch Channel Number                        1
Power Cycle Off On Duration                        3 s
Power Cycle Settling Time                          3 s
Power Cycle max. Retries for LB Training           1
----Loopback Training----
Enable Impairments during Loopback Training        True
Link Training Lane Number                          0
Link Training Mode                                 Interactive
Link Training Suite Settings File                  C:\ProgramData\BitifEye\ValiFram
Training through                                   L0-Recovery
----Interactive Link Training----
Generator Full Swing                               24
Generator Start Preset                             P5
DUT Initial Preset                                 P5
DUT Target Preset                                  P5
Drop Link Method                                   LTSSM
----Error Detector----
Pause before Auto-Align                            False
CDR Loop Bandwidth                                 12 MHz
Input Range for Loopback Training                  600 mV
Input Range                                        600 mV
CDR Loop Selection                                 Loop1
Filter SKPOS                                       True
Threshold                                          0 V
Polarity                                           Non-Inverted
Manually align error detector sampling point.      False
Fast Alignment                                     False
Analyzer Equalization                              80
Use Auto Analyzer Equalization                     False
----Parameter----
Eye Height                                         44.5 mV
Eye Width                                          40.5 ps
----BER Measurement----
BER Measurement Duration                           12.5 s
Target BER                                         100E-6
Relax Time                                         3 s
----Impairments----
Use Compliance Impairments                         True
Random Jitter                                      1.01 ps
Differential Mode Sinusoidal Interference          23.8 mV
Sinusoidal Jitter                                  12.5 ps
Sinusoidal Jitter Frequency                        100 MHz
----Equalization----
Use Preset                                         True
Generator Preset                                   P7
Pre-Shoot                                          3.5 dB
De-Emphasis                                        -6 dB
----DUT----
Max Link Training Speed                            64 GT/s
```

(...)

Result	Preset	Target BER [ ]	Measured BER [ ]
pass	P7	1.000E-004	0.000E+000
pass	P8	1.000E-004	0.000E+000

Figure 7-12 Example result for Rx Preset Pre-Compliance Test

- Result: “Pass” or “fail”.
- Preset: The preset used for the measurement.
- Target BER: The maximum value of BER allowed for a “pass” result.
- Measured BER: The measured BER value.

Rx Pre-Shoot De-Emphasis Scan

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

The purpose of this test is to find the optimum combination of de-emphasis and pre-shoot amplitudes. As a first step, the procedure sets initial de-emphasis and pre-shoot values and adjusts the eye height to obtain the desired BER (slightly above 1e-9). Then, it retains the initial pre-shoot and performs a de-emphasis scan, measuring the BER for every de-emphasis value. After that, it retains the initial de-emphasis amplitude and makes a pre-shoot scan. Finally, the test shows the result tables, one for the de-emphasis scan and one for the pre-shoot scan. The results let you see the best combination with the initial values that were selected.

Connection Diagram

Refer to Figure 7-1 on page 231 and Figure 7-2, Figure 7-3, Figure 7-5, Figure 7-6, Figure 7-7.

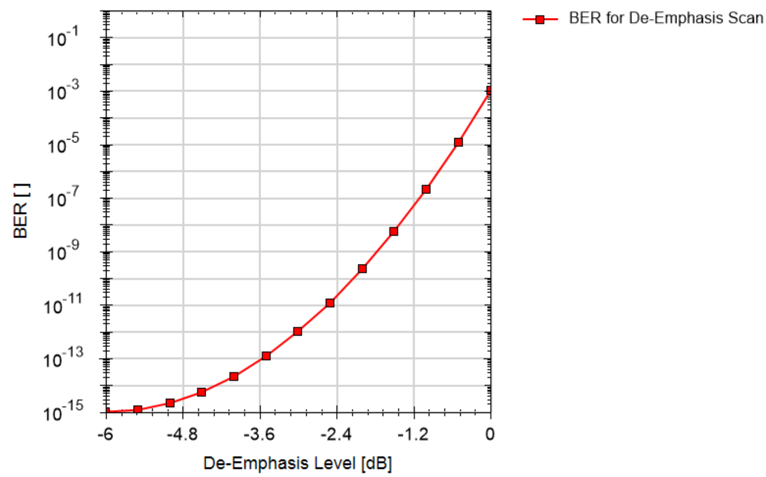
Result Description

The de-emphasis scan and the pre-shoot scan are presented separately.

De-Emphasis Scan

L0_Rx_32GTps_DeEmphasis_Scan

for PCIe 6.0 EndPoint ASIC



----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Loopback Training Settings----	
Use Custom Training Voltage	False
Suppress Loopback Training Messages	False
----Generator Clock----	
Data Rate Deviation	0 ppm
Use SSC	False
32 GT/s Use SSC	False
64 GT/s Use SSC	False
Reference Clock	100 MHz
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Enable Impairments during Loopback Training	True
Force Retraining at each Preset	False
Link Training Lane Number	0
Link Training Mode	Interactive
Link Training Suite Settings File	C:\ProgramData\
Training through	L0-Recovery

----Interactive Link Training----	
Precoding Auto Detection	True
Generator Full Swing	24
Generator Start Preset	P5
DUT Initial Preset	P5
DUT Target Preset	P5
Select Start Preset Gen4	User Defined
Generator Start Preset Gen4	P5
DUT Initial Preset Gen4	P5
DUT Target Preset Gen4	P5
Select Start Preset Gen5	User Defined
Generator Start Preset Gen5	P5
DUT Initial Preset Gen5	P5
DUT Target Preset Gen5	P6
Drop Link Method	LTSSM
----Error Detector----	
Manually align error detector sampling point.	False
Fast Alignment	False
Analyzer Equalization	80
Use Auto Analyzer Equalization	False
CDR Loop Bandwidth	20 MHz
Input Range for Loopback Training	600 mV
Input Range	600 mV
CDR Loop Selection	Loop1
Filter SKPOS	True
Threshold	0 V
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance I
Toggle Script File For 32 GT/s	C:\ProgramData\
Pause after toggle	100 ms
----Back-Channel Optimization----	
Use Back-Channel Optimization Data	False
----Pre-Shoot Variation----	
Start Pre-Shoot	0 dB
Stop Pre-Shoot	6 dB
Pre-Shoot Step Size	0.5 dB
----De-Emphasis Variation----	
Start De-Emphasis	0 dB
Stop De-Emphasis	-6 dB
De-Emphasis Step Size	-0.5 dB
----Parameter----	
Scan Order	DeEmphasis firs
Initial De-Emphasis	0 dB
Initial Pre-Shoot	1.9 dB
----BER Measurement----	
BER Mode	TargetBer
Target BER	30E-12
Confidence Level	95 %
Relax Time	3 s

```
----Impairments----
Use Compliance Impairments                                       True
Differential Voltage                                             800 mV
Random Jitter                                                    500 fs
Common Mode Interference                                         150 mV
Differential Mode Interference                                   0 V
Sinusoidal Jitter                                                3.125 ps
Sinusoidal Jitter Frequency                                      100 MHz
2nd Tone Sinusoidal Jitter                                       0 s
2nd Tone Sinusoidal Jitter Frequency                             210 MHz
Treat 33kHz as separate SJ frequency                             True
----Equalization----
Use Preset                                                       True
Generator Preset                                                 P5
Pre-Shoot                                                        1.9 dB
De-Emphasis                                                      0 dB
----Channel----
Trace Number                                                     6
Total Channel Loss                                               -37 dB
----Equalization for remaining Rx tests----
Allow user to enter optimum equalization for remaining Rx tests  True
----DUT----
Max Link Training Speed                                          64 GT/s
----Instruments----
```

(...)

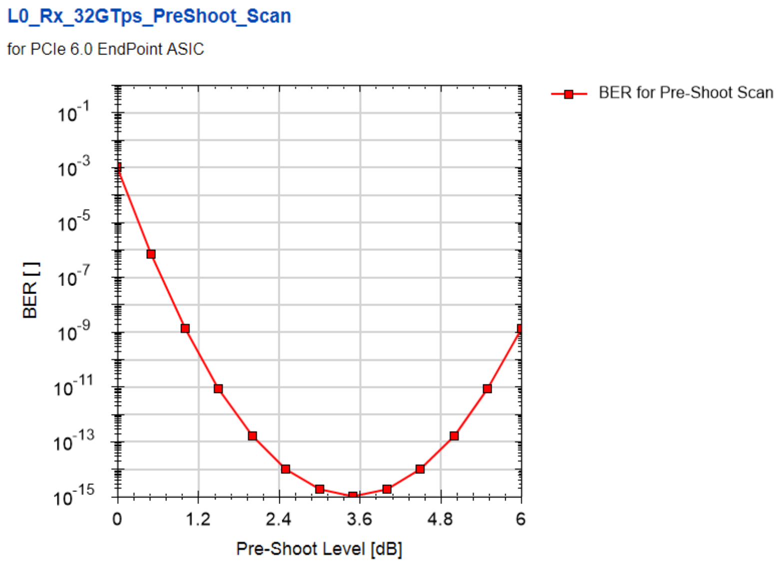
De-Emphasis Level [dB]	BER for De-Emphasis Scan [ ]
0.00	1.000E-003
-0.50	1.212E-005
-1.00	2.154E-007
-1.50	5.623E-009
-2.00	2.154E-010
-2.50	1.212E-011
-3.00	1.000E-012
-3.50	1.212E-013
-4.00	2.154E-014
-4.50	5.623E-015
-5.00	2.154E-015
-5.50	1.212E-015
-6.00	1.000E-015

Figure 7-13 Example result for Rx Pre-Shoot De-Emphasis Scan (de-emphasis)

- De-Emphasis Level [dB]: The value of de-emphasis added to the signal for each step.
- BER for De-Emphasis Scan: The BER measured at each de-emphasis level.

Pre-Shoot Scan

The text part of the result for the pre-shoot scan is exactly the same as for the de-emphasis scan in Figure 7-13 and so is not repeated here.



Pre-Shoot Level [dB]	BER for Pre-Shoot Scan [ ]
0.00	1.000E-003
0.50	6.551E-007
1.00	1.326E-009
1.50	8.286E-012
2.00	1.600E-013
2.50	9.541E-015
3.00	1.758E-015
3.50	1.000E-015
4.00	1.758E-015
4.50	9.541E-015
5.00	1.600E-013
5.50	8.286E-012
6.00	1.326E-009

Figure 7-14 Example result for Rx Pre-Shoot De-Emphasis Scan (pre-shoot)

- Pre-Shoot Level [dB]: The value of pre-shoot added to the signal for each step.
- BER for Pre-Shoot Scan: The BER measured at each pre-shoot level.

Rx Custom Pre-Shoot De-Emphasis Scan

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Rx Pre-Shoot De-Emphasis Scan on page 262, with the difference that you can use combinations of impairments that have been obtained with the Custom Eye Calibration on page 185 or Custom Eye Scan Calibration on page 188.

Rx Sensitivity Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert		
Data Rates:	2.5 GT/s, 5 GT/s, 8 GT/s (not ASIC), 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This test searches for the minimum Eye Height at which the DUT passes the BER test.

For 16 GT/s, 32 GT/s and 64 GT/s: The procedure starts with “Start DMSI” and increases it in steps of “DMSI Step Size”, which reduces the Eye Height. (Vdiff could also be used to reduce the Eye Height.) The random jitter is held fixed at the compliance value. The Eye Height corresponding to each DMSI value is reported. The minimum passed Eye Height value is the last test point that did not return an error.

For 2.5 GT/s, 5 GT/s and 8 GT/s: The method starts with “Start Eye Height” and decreases it in steps of “Step Size”. The minimum passed value is the last test point that did not return an error.

In principle, it is possible for a DUT to work without error even when the Eye Height is zero, because the Eye Height was calibrated with a reference receiver and the DUT may be better than that.

Connection Diagram

Refer to Figure 7-1 on page 231 and Figure 7-2, Figure 7-4, Figure 7-5, Figure 7-6, Figure 7-7.

Result Description

L0_Rx_64GTps_Sens

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
----Loopback Training Settings----	
Use Custom Training Voltage	False
Suppress Loopback Training Messages	False
----Generator Clock----	
Data Rate Deviation	0 ppm
Use SSC	False
32 GT/s Use SSC	False
64 GT/s Use SSC	False
Reference Clock	100 MHz
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Enable Impairments during LB Training	True
Link Training Lane Number	0
Link Training Mode	Interactive
Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrame
Training through	L0-Recovery
----Interactive Link Training----	
Precoding Auto Detection	True
Generator Full Swing	24
Generator Start Preset	P5
DUT Initial Preset	P5
DUT Target Preset	P5
Select Start Preset Gen4	User Defined
Generator Start Preset Gen4	P5
DUT Initial Preset Gen4	P5
DUT Target Preset Gen4	P5
Select Start Preset Gen5	User Defined
Generator Start Preset Gen5	P5
DUT Initial Preset Gen5	P5
DUT Target Preset Gen5	P6
Select Start Preset Gen6	User Defined
Generator Start Preset Gen6	Q5
DUT Initial Preset Gen6	Q5
DUT Target Preset Gen6	Q5
Drop Link Method	LTSSM

```
----Error Detector----
Enable FEC                                        False
Manually align error detector sampling point.     False
Fast Alignment                                    False
Use Auto Analyzer Equalization                    True
Retries for Auto Analyzer Equalization            1
CDR Loop Bandwidth                                20 MHz
Input Range for Loopback Training                 600 mV
Input Range                                       600 mV
CDR Loop Selection                                Loop1
Filter SKPOS                                      True
Upper Analyzer Threshold                          150 mV
Middle Analyzer Threshold                         0 V
Lower Analyzer Threshold                          -150 mV
Polarity                                          Non-Inverted
----Toggling----
Pattern Selection Mode                            Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s                    C:\ProgramData\BitifEye\ValiFram
Toggle Script File For 64 GT/s                    C:\ProgramData\BitifEye\ValiFram
Pause after toggle                                100 ms
----Back-Channel Optimization----
Use Back-Channel Optimization Data                False
----Sensitivity Variation----
Sensitivity Mode                                  DifferentialModeInterference
Start DMSI                                        15 mV
Stop DMSI                                         50 mV
DMSI Step Size                                    2.5 mV
----BER Measurement----
Bit Error Ratio Measurement                       FBER
Maximum number of consecutive symbols             24
FBER Mode                                         TargetBer
Target FBER                                       1E-6
Confidence Level                                  95 %
Relax Time                                        3 s
----Impairments----
Use Compliance Impairments                        True
Differential Voltage                              800 mV
Random Jitter                                     190 fs
Common Mode Interference                          75 mV
Sinusoidal Jitter                                 1.5625 ps
Sinusoidal Jitter Frequency                       100 MHz
2nd Tone Sinusoidal Jitter                        0 s
2nd Tone Sinusoidal Jitter Frequency              210 MHz
Treat 33kHz as separate SJ frequency              True
----Equalization----
Use Preset                                        False
Pre-Shoot 2                                       -1.3 dB
Pre-Shoot 1                                       4.7 dB
De-Emphasis                                       0 dB
----Channel----
Trace Number                                      9
Total Channel Loss                                -33 dB
```

```
----DUT----
Max Link Training Speed                    64 GT/s
----Instruments----
```

(...)

Result	Max Passed DMSI [mV]	Eye Height [mV]	Spec Limit [mV]	Margin [%]
pass	47.5	2.8	15.0	216.7

Figure 7-15 Example result for Rx Sensitivity Test

- Result: Either “pass” or “fail”.
- Max Passed DMSI [mV]: The maximum value of DMSI for which the BER test was passed.
- Eye Height [mV]: The eye height corresponding to the Max Passed DMSI value.
- Spec Limit [mV]: The lower limit of DMSI required by the specification.
- Margin [%]: The margin of the Max Passed DMSI to the Spec Limit.

Rx Custom Sensitivity Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the Rx Sensitivity Test on page 268, with the difference that you can use combinations of impairments that have been obtained with the Custom Eye Calibration on page 185 or Custom Eye Scan Calibration on page 188.

8 Link Equalization Tests

This chapter describes tests that use the link training feature of the BERT to put the DUT in loopback mode.

Overview

NOTE **LEQ Rx and LEQ Tx tests are available only if interactive link training for the selected data rate is licensed on the connected BERT.**

Prerequisite Calibrations

Prerequisite calibrations for each procedure are displayed in the application itself. Right-click the procedure name in the procedure tree of the main window of the user interface and select “Required Calibration Data...”. See Required Calibration Data on page 62 for details.

Connection Diagrams

In this User’s Guide, only example connection diagrams are given near the beginning of each chapter, for example for link equalization tests. The exact connection diagram for a specific situation can be viewed by right-clicking the appropriate procedure in the procedure tree of the main window of the user interface and selecting “Show Connection...”.

PCI Express Common Link Equalization Parameters

The PCI Express Common Parameters are listed in the parameter grid (right half) of the main window of the user interface when you click the corresponding group in the procedure tree in the left half of the main window. Clicking a data rate in the procedure tree shows you the data-rate-specific PCI Express Common Parameters for that data rate. Similarly, clicking “Custom Tests” shows you the parameters specific to custom tests.

Details of PCI Express Common Link Equalization Parameters can be found in Table A-5 on page 334.

Parameters in Expert Mode for Individual LEQ Tests

The N5991 PCI Express parameters in expert mode for an individual procedure are not listed in this User’s Guide explicitly. They are displayed in the parameter grid (right half) of the main window of the user interface when you click on the corresponding entry in the procedure tree in the left half of the main window.

Details of PCI Express Parameters for Individual LEQ Tests can be found in Table A-9 on page 370.

Parameters Related to FBER

See Parameters Related to FBER on page 229.

Using Back-Channel Optimization Data

See Using Back-Channel Optimization Data on page 230.

Order of Description of Link Equalization Receiver Tests

The LEQ test descriptions are arranged alphabetically (except for “Custom” tests, which are placed directly after their “basic” versions).

To find a procedure description easily, go to Chapter 4, Procedure Tree Overview on page 71, where the procedures are listed in tables in the order they appear in the procedure tree in the application. In those tables, each procedure has a link to its description.

Example Connection Diagrams

LEQ Rx Tests

Figure 8-1 and Figure 8-2 show example connection diagrams for LEQ Rx tests. Note that the setup can differ depending on the DUT type, ISI channel, clock architecture and external reference clock selection. For more details, right-click the appropriate procedure in the procedure tree of the user interface and select “Show Connection...”.

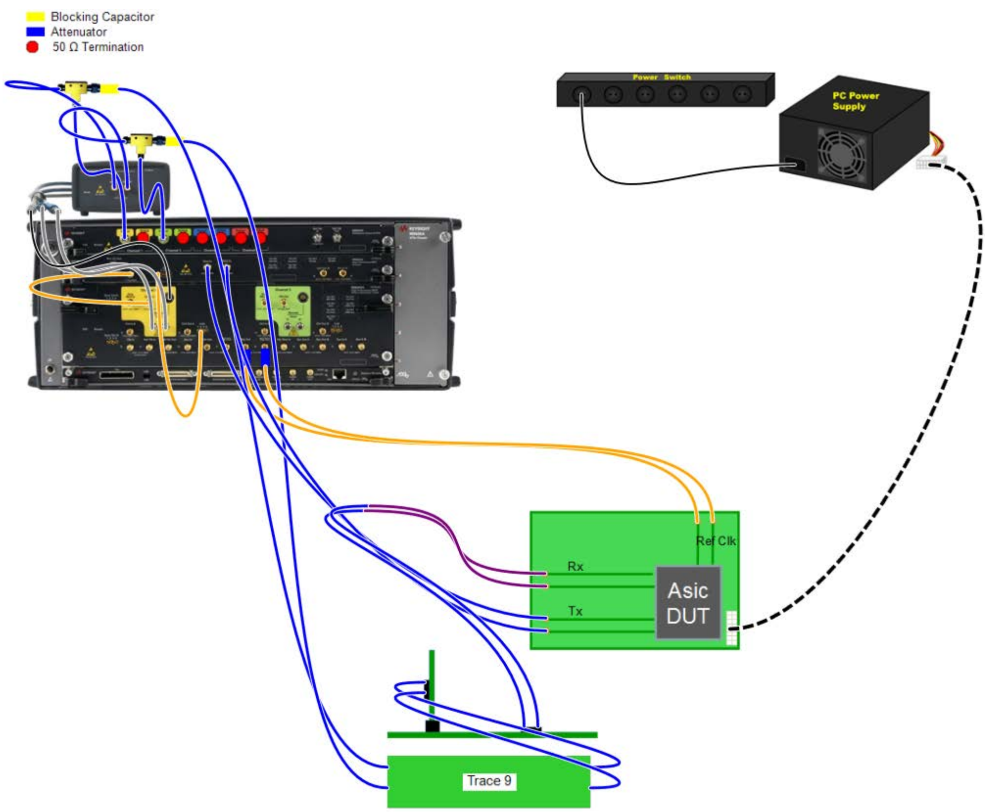


Figure 8-1 Example connection diagram for an LEQ Rx test (64G LEQ Rx Compliance Test; ASIC, End Point, M8040A)

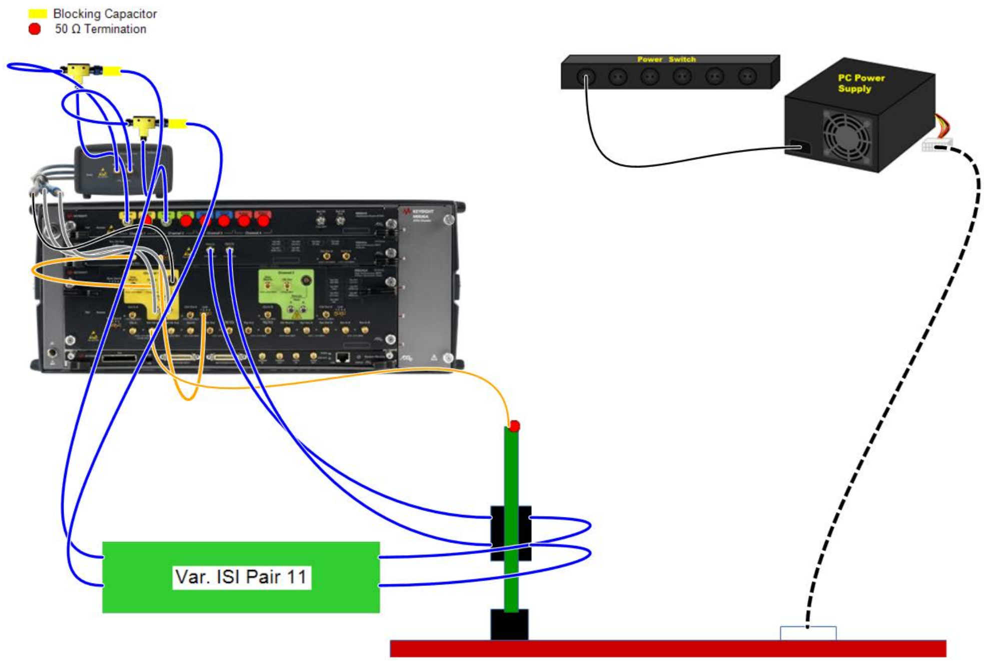


Figure 8-2 Example connection diagram for an LEQ Rx test (64G LEQ Rx Compliance Test; CEM, System, M8040A)

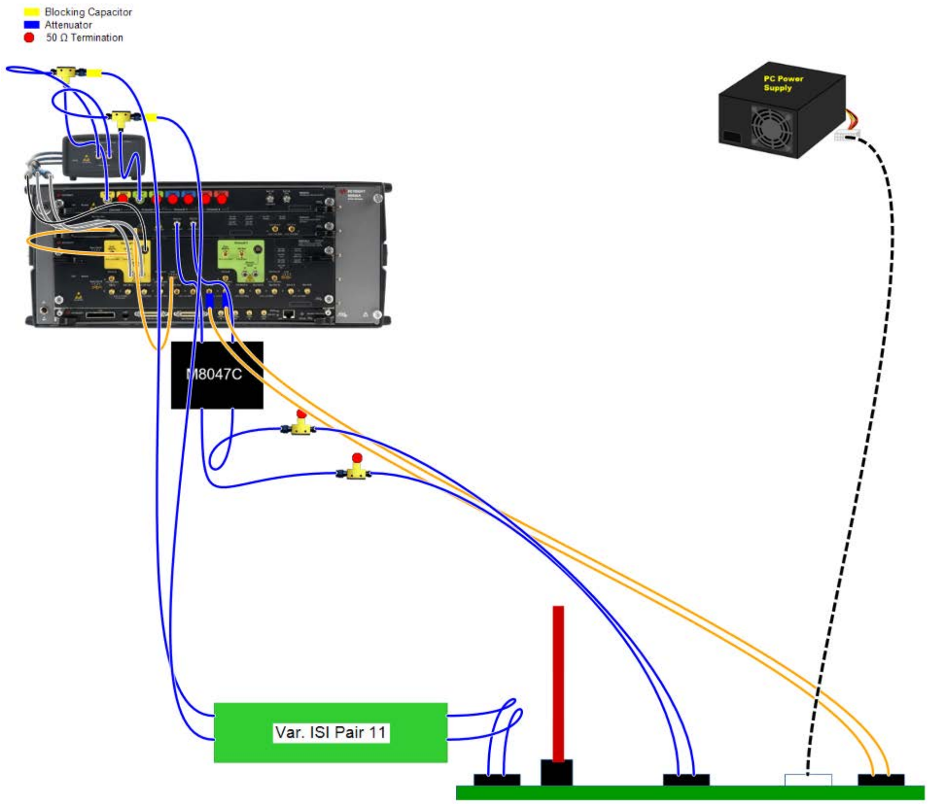


Figure 8-3 Example connection diagram for an LEQ Rx test with a redriver (32G LEQ Rx Compliance Test; CEM, Add-In Card, M8040A; redriver M8047C)

LEQ Tx Tests

Figure 8-4 shows an example connection diagram for LEQ Tx tests. For more details, right-click the appropriate procedure in the procedure tree of the user interface and select “Show Connection...”.

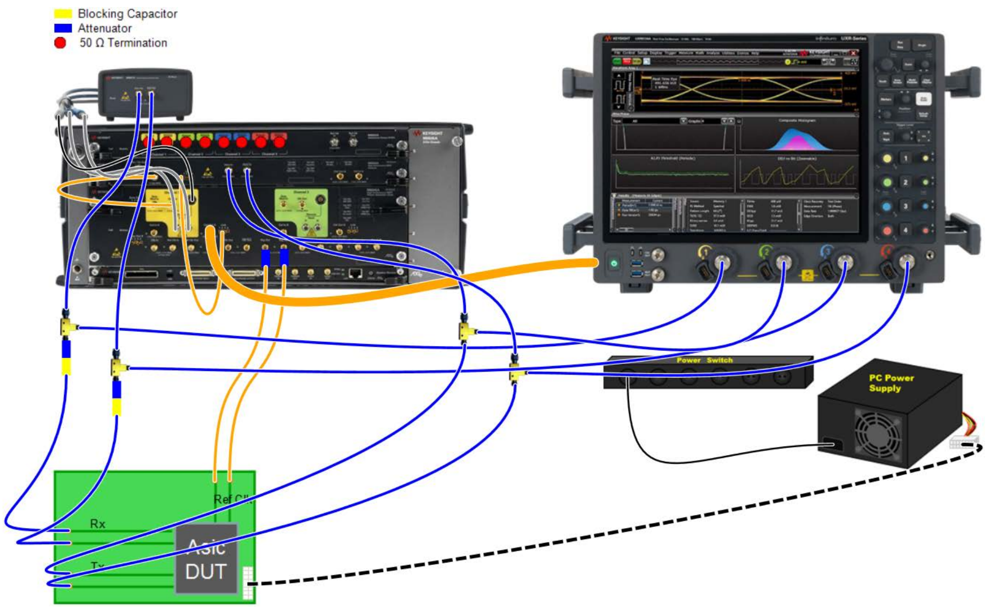


Figure 8-4 Example connection diagram for an LEQ Tx test (64G LEQ Tx Initial Preset Compliance Test; ASIC, End Point M8040A)

Descriptions of LEQ Receiver Tests

NOTE LEQ Rx tests are very similar to the usual Rx tests described in Chapter 7. The main difference is that LEQ Rx tests always use interactive training with TxEQ negotiation.

LEQ Rx Compliance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This test uses the interactive link training feature of the BERT to let the DUT negotiate the generator transmitter preset to be used.

Once the equalization training is finished and the DUT is in loopback mode, the test behaves in the same manner as the Rx Pre-Compliance Test on page 254.

The final transmitter equalization (TxEQ) settings (Pre-Shoot and De-Emphasis) are reported in the test results.

LEQ Rx Custom Compliance Test

Availability

Data Generator:	M8040A, M8020A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the LEQ Rx Compliance Test on page 280, with the difference that you can use combinations of impairments that have been obtained with custom calibrations.

Click “Custom Tests” under the appropriate data rate in the procedure tree in the GUI to select (in the right-hand pane)

- the Custom Calibration Source (either Custom Eye Calibration or Custom Eye Scan Calibration)
- the Custom Eye Calibration Point (from the drop-down list)

LEQ Rx Jitter Tolerance Test

Availability

Data Generator:	M8040A, M8020A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This test characterizes how much jitter a DUT can tolerate at different frequencies of sinusoidal jitter.

It uses the interactive link training feature of the BERT to let the DUT negotiate the generator transmitter preset to be used.

Once the equalization training is finished and the DUT is in loopback mode, the test behaves in the same manner as the Rx Jitter Tolerance Test on page 247.

For the LEQ Rx Jitter Tolerance Test, the final transmitter equalization (TxEQ) settings (Pre-Shoot and De-Emphasis) are reported in the test results. In addition, the Final Generator Preset and the Final Generator Cursors are also reported. (Note that the Final Generator Cursors are not reported for the M8020A.)

LEQ Rx Custom Jitter Tolerance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the LEQ Rx Jitter Tolerance Test on page 282, with the difference that you can use combinations of impairments that have been obtained with custom calibrations.

Click “Custom Tests” under the appropriate data rate in the procedure tree in the GUI to select (in the right-hand pane)

- the Custom Calibration Source (either Custom Eye Calibration or Custom Eye Scan Calibration)
- the Custom Eye Calibration Point (from the drop-down list)

LEQ Rx Sensitivity Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This test uses the interactive link training feature of the BERT to let the DUT negotiate the generator transmitter preset that must be used.

Once the equalization training is finished and the DUT is in loopback mode, the test behaves in the same manner as the Rx Sensitivity Test on page 268.

The final transmitter equalization (TxEQ) settings (Pre-Shoot and De-Emphasis) are reported in the test results.

LEQ Rx Custom Sensitivity Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Expert – Custom Procedure		
Data Rates:	16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Custom Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

This procedure is similar to the LEQ Rx Sensitivity Test on page 284, with the difference that you can use combinations of impairments that have been obtained with custom calibrations.

Click “Custom Tests” under the appropriate data rate in the procedure tree in the GUI to select (in the right-hand pane)

- the Custom Calibration Source (either Custom Eye Calibration or Custom Eye Scan Calibration)
- the Custom Eye Calibration Point (from the drop-down list)

Descriptions of LEQ Transmitter Tests

NOTE **Differential probes are not supported for LEQ Tx tests at 32 GT/s and 64 GT/s.**

LEQ Tx Initial Preset Compliance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point	Add-In Card	Device
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s 64 GT/s only with M8040A		

See also Table 2-1 on page 39.

Purpose and Method

This test uses the interactive link training feature of the BERT.

The BERT runs the link training, setting several initial equalization transmitter presets on the DUT and skipping the link equalization phase. Once the DUT is in loopback, the DUT signal is captured and analyzed to check whether the DUT is using the preset requested by the BERT.

NOTE **The specification has a special case for this test at 32 GT/s. For details see Special Case for LEQ Tx Tests at 32 GT/s on page 301.**

Connection Diagram

Refer to Figure 8-4 on page 279.

Result Description

L0_EqTx_64GTps_IniPreset

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
SigTest Version	Offline
----Loopback Training Settings----	
Suppress Loopback Training Messages	False
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Link Training Lane Number	0
Training through	L0-Recovery
Interactive Training Script File	C:\ProgramData\BitifEye\ValiFrameK1 \PCIe\Settings\TrainingScripts\Pcie6_
----Interactive Link Training----	
Link Training	Bypass
Generator Start Preset	P5
Generator Start Preset Gen4	P5
Generator Start Preset Gen5	P5
Generator Start Preset Gen6	Q5
----Error Detector----	
Fast Alignment	False
CDR Loop Bandwidth	20 MHz
CDR Loop Selection	Loop1
Use Auto Analyzer Equalization	True
Retries for Auto Analyzer Equalization	1
Input Range for Loopback Training	450 mV
Input Range	350 mV
Upper Analyzer Threshold	150 mV
Middle Analyzer Threshold	0 V
Lower Analyzer Threshold	-150 mV
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s	C:\ProgramData\BitifEye\ValiFrameK1 \PCIe\Settings\ToggleScripts\PCIe5_32
Toggle Script File For 64 GT/s	C:\ProgramData\BitifEye\ValiFrameK1 \PCIe\Settings\ToggleScripts\PCIe6_64
Pause after toggle	100 ms
----Back-Channel Optimization----	

```
----Back-Channel Optimization----
Use Back-Channel Optimization Data         False
----Parameter----
Presets                                    Q0;Q1;Q2;Q3;Q4;Q5;Q6;Q7;Q8;Q9
Scope Connection for Link EQ Tx Tests      Chan 1 2 3 4 Direct Connect
Generator Output Voltage Compensation      6 dB
Skip BER Check                             True
----Oscilloscope Preset Measurement----
Number of UIs                              3 MUI
Scope raw Bandwidth                        50 GHz
Use Bessel Filter                          False
----DUT----
Max Link Training Speed                    64 GT/s
----Instruments----
```

(...)

Result	DUT Initial Preset	Pre-Shoot 2 [dB]	Min Spec PS2 [dB]	Max Spec PS2 [dB]	Pre-Shoot 1 [dB]	Min Spec PS1 [dB]	Max Spec PS1 [dB]	De-Emphasis [dB]	Min Spec DE [dB]	Max Spec DE [dB]	Measurement Method	Comment
pass	Q0	0.00	N/A	N/A	0.00	N/A	N/A	0.00	N/A	N/A	LFPR	
pass	Q0	0.00	N/A	N/A	0.00	N/A	N/A	0.00	N/A	N/A	AC Fit	
pass	Q1	0.00	-0.50	0.50	1.60	1.10	2.10	0.00	-0.50	0.50	LFPR	
pass	Q1	0.00	-0.50	0.50	1.60	1.10	2.10	0.00	-0.50	0.50	AC Fit	
pass	Q2	0.00	-0.50	0.50	3.50	3.00	4.00	0.00	-0.50	0.50	LFPR	
pass	Q2	0.00	-0.50	0.50	3.50	3.00	4.00	0.00	-0.50	0.50	AC Fit	
pass	Q3	0.00	-0.50	0.50	0.00	-0.50	0.50	-1.60	-2.10	-1.10	LFPR	
pass	Q3	0.00	-0.50	0.50	0.00	-0.50	0.50	-1.60	-2.10	-1.10	AC Fit	
pass	Q4	0.00	-0.50	0.50	0.00	-0.50	0.50	-3.50	-4.00	-3.00	LFPR	
pass	Q4	0.00	-0.50	0.50	0.00	-0.50	0.50	-3.50	-4.00	-3.00	AC Fit	
pass	Q5	-1.30	-1.80	-0.80	4.70	3.70	5.70	0.00	-0.50	0.50	LFPR	
pass	Q5	-1.30	-1.80	-0.80	4.70	3.70	5.70	0.00	-0.50	0.50	AC Fit	
pass	Q6	-1.60	-2.10	-1.10	3.50	3.00	4.00	-3.50	-4.00	-3.00	LFPR	
pass	Q6	-1.60	-2.10	-1.10	3.50	3.00	4.00	-3.50	-4.00	-3.00	AC Fit	
pass	Q7	-2.90	-3.40	-2.40	4.70	3.70	5.70	0.00	-0.50	0.50	LFPR	
pass	Q7	-2.90	-3.40	-2.40	4.70	3.70	5.70	0.00	-0.50	0.50	AC Fit	
pass	Q8	-3.50	-4.00	-3.00	6.00	5.00	7.00	0.00	-0.50	0.50	LFPR	
pass	Q8	-3.50	-4.00	-3.00	6.00	5.00	7.00	0.00	-0.50	0.50	AC Fit	
pass	Q9	-4.40	-5.40	-3.40	6.90	5.90	7.90	-1.60	-2.10	-1.10	LFPR	
pass	Q9	-4.40	-5.40	-3.40	6.90	5.90	7.90	-1.60	-2.10	-1.10	AC Fit	
pass	Overall Result	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

Figure 8-5 Example result for the LEQ Tx Initial Preset Compliance Test

- Result: (pass/fail) The measured Pre-Shoot and De-Emphasis must be within the specification limits.
- DUT Initial Preset: Set by the BERT.

- Pre-Shoot 2 [dB]: (Only 64G) Measured Pre-Shoot 2 on the DUT waveform.
- Min Spec PS2 [dB]: (Only 64G) Pre-Shoot 2 lower specification limit.
- Max Spec PS2 [dB]: (Only 64G) Pre-Shoot 2 upper specification limit.
- Pre-Shoot 1 [dB]: Measured Pre-Shoot 1 on the DUT waveform.
- Min Spec PS1 [dB]: Pre-Shoot 1 lower specification limit.
- Max Spec PS1 [dB]: Pre-Shoot 1 upper specification limit.
- De-Emphasis [dB]: Measured De-Emphasis on the DUT waveform.
- Min Spec DE [dB]: De-Emphasis lower specification limit.
- Max Spec DE [dB]: De-Emphasis upper specification limit.
- Measurement Method: Measurement method used to calculate the Pre-Shoot and De-Emphasis.
- Comment: A comment may be added to each test step if it fails, explaining why.

LEQ Tx Response Time Compliance Test

Availability

Data Generator:	M8020A, M8040A, M8050A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s, 16 GT/s, 32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

Purpose and Method

This test uses the interactive link training feature of the BERT to train the DUT into loopback mode, running the link equalization phase completely.

A certain initial transmitter preset is set on the DUT. A successful link training raises an event, which is used to capture the waveforms of the BERT and the DUT. At that moment, the captured waveform from the BERT contains the preset change request and the waveform from the DUT contains the acknowledgment of that request. Additionally, the waveform from the DUT also contains the physical transition from the initial transmitter preset to the requested preset.

The captured data is decoded and two time intervals are calculated: one between the request and the acknowledgment, and other between the request and the electrical transition.

Finally, once the DUT is in loopback mode, a similar preset measurement is performed for the Initial Preset.

The test is divided into two parts. In the first part, the BERT requests transmitter presets. In the second part, the BERT requests the pre-cursor, cursor and post-cursor reported by the DUT.

For End Point DUTs (or Add-In-Cards or Devices), the initial transmitter preset is set by the BERT. For Root Complex DUTs (or Systems or Hosts), you must manually set the DUT initial transmitter preset.

NOTE **The specification has a special case for this test at 32 GT/s. For details see Special Case for LEQ Tx Tests at 32 GT/s on page 301.**

Connection Diagram

Refer to Figure 8-4 on page 279.

Result Description

Example presentation of results for 8 GT/s and 16 GT/s.

L0_EqTx_16GTps_RespTime

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
SigTest Preset Measurement Method	Vb
SigTest Version	Offline
----Loopback Training Settings----	
Suppress Loopback Training Messages	False
Use Gen3 EIEOS	False
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Link Training Lane Number	0
Training through	L0-Recovery
Interactive Training Script File	C:\ProgramData\BitifEye\ValiFrameK1\P
----Interactive Link Training----	
Generator Start Preset	P5
Generator Start Preset Gen4	P5
----Error Detector----	
Fast Alignment	False
CDR Loop Bandwidth	20 MHz
CDR Loop Selection	Loop1
Analyzer Equalization	80
Use Auto Analyzer Equalization	False
Input Range for Loopback Training	450 mV
Input Range	350 mV
Threshold	0 V
Polarity	Non-Inverted

```
----Parameter----
Presets                                    P0;P1;P2;P3;P4;P5;P6;P7;P8;P9
Skip response time measurements            False
Measure protocol response times            True
Max Number of Retries                      1
Scope Connection for Link EQ Tx Tests      Chan 1 2 3 4 Direct Connect
Generator Output Voltage Compensation      6 dB
Skip BER Check                             True
----Oscilloscope----
Scope Horizontal Range                     10 us
Scope Pre-Trigger Data                     1.5 us
Scope Request Vertical Range               800 mV
Scope Response Vertical Range              200 mV
----DUT----
Max Link Training Speed                    64 GT/s
----Instruments----
```

(...)

Result	DUT Target Preset	Electrical response time [ns]	Protocol response time [ns]	Pre-Shoot [dB]	Min Spec PS [dB]	Max Spec PS [dB]	De-Emphasis [dB]	Min Spec DE [dB]	Max Spec DE [dB]	Measurement Method	Comment
pass	P0	100.00	176.00	NaN	N/A	N/A	-6.00	-7.50	-4.50	Vb	DUT reported cursors: (0, 18, 6)
pass	P1	100.00	176.00	NaN	N/A	N/A	-3.50	-4.50	-2.50	Vb	DUT reported cursors: (0, 20, 4)
pass	P2	100.00	176.00	NaN	N/A	N/A	-4.40	-5.90	-2.90	Vb	DUT reported cursors: (0, 19, 5)
pass	P3	100.00	176.00	NaN	N/A	N/A	-2.50	-3.50	-1.50	Vb	DUT reported cursors: (0, 21, 3)
pass	P4	100.00	176.00	NaN	N/A	N/A	NaN	N/A	N/A	Vb	DUT reported cursors: (0, 24, 0)
pass	P5	100.00	176.00	1.90	0.90	2.90	NaN	N/A	N/A	Vb	DUT reported cursors: (2, 22, 0)
pass	P6	100.00	176.00	2.50	1.50	3.50	NaN	N/A	N/A	Vb	DUT reported cursors: (3, 21, 0)
pass	P7	100.00	176.00	3.50	2.50	4.50	-6.00	-7.50	-4.50	Vb	DUT reported cursors: (2, 17, 5)
pass	P8	100.00	176.00	3.50	2.50	4.50	-3.50	-4.50	-2.50	Vb	DUT reported cursors: (3, 18, 3)
pass	P9	100.00	176.00	3.50	2.50	4.50	NaN	N/A	N/A	Vb	DUT reported cursors: (4, 20, 0)
pass	P0' (0, 18, 6)	100.00	176.00	NaN	N/A	N/A	-6.00	-7.50	-4.50	Vb	
pass	P1' (0, 20, 4)	100.00	176.00	NaN	N/A	N/A	-3.50	-4.50	-2.50	Vb	
pass	P2' (0, 19, 5)	100.00	176.00	NaN	N/A	N/A	-4.40	-5.90	-2.90	Vb	
pass	P3' (0, 21, 3)	100.00	176.00	NaN	N/A	N/A	-2.50	-3.50	-1.50	Vb	
pass	P4' (0, 24, 0)	100.00	176.00	NaN	N/A	N/A	NaN	N/A	N/A	Vb	
pass	P5' (2, 22, 0)	100.00	176.00	1.90	0.90	2.90	NaN	N/A	N/A	Vb	
pass	P6' (3, 21, 0)	100.00	176.00	2.50	1.50	3.50	NaN	N/A	N/A	Vb	
pass	P7' (2, 17, 5)	100.00	176.00	3.50	2.50	4.50	-6.00	-7.50	-4.50	Vb	

pass	P8' (3, 18, 3)	100.00	176.00	3.50	2.50	4.50	-3.50	-4.50	-2.50	Vb	
pass	P9' (4, 20, 0)	100.00	176.00	3.50	2.50	4.50	NaN	N/A	N/A	Vb	
pass	Overall Result	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

Figure 8-6 Example result for LEQ Tx Response Time Compliance Test (16 GT/s)

- Result: (pass/fail) The values of Pre-Shoot and De-Emphasis should lie between the upper and lower specification limits and the electrical response time should not exceed the maximum specification limit.
- DUT Target Preset: The transmitter preset that is requested from the DUT by the BERT at each step.
- Electrical response time [ns]: The calculated timespan between the request from the BERT and the physical preset transition on the DUT waveform.
- Protocol response time [ns]: The calculated time interval between the request from the BERT and the acknowledgment of the request by the DUT.
- Pre-Shoot [dB]: The measured Pre-Shoot on the DUT waveform.
- Min Spec PS [dB]: The Pre-Shoot lower specification limit.
- Max Spec PS [dB]: The Pre-Shoot upper specification limit.
- De-Emphasis [dB]: The measured De-Emphasis on the DUT waveform.
- Min Spec DE [dB]: The De-Emphasis lower specification limit.
- Max Spec DE [dB]: The De-Emphasis upper specification limit.
- Measurement Method: The measurement method used to calculate the Pre-Shoot and the De-Emphasis.
- Comment: An explanatory comment may be added.

Example presentation of results for 32 GT/s.

L0_EqTx_32GTps_RespTime

for PCIe 6.0 AddInCard

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
SigTest Preset Measurement Method	AC Fit
SigTest Version	Offline
----Loopback Training Settings----	
Suppress Loopback Training Messages	False
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Link Training Lane Number	0
Training through	L0-Recovery
Interactive Training Script File	C:\ProgramData\BitifEye\ValiFrameK1\P
----Interactive Link Training----	
Generator Start Preset	P5
Generator Start Preset Gen4	P5
Generator Start Preset Gen5	P5
----Error Detector----	
Fast Alignment	False
CDR Loop Bandwidth	20 MHz
CDR Loop Selection	Loop3
Analyzer Equalization	80
Use Auto Analyzer Equalization	False
Input Range for Loopback Training	450 mV
Input Range	350 mV
Threshold	0 V
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s	C:\ProgramData\BitifEye\ValiFrameK1\P
Pause after toggle	100 ms
----Back-Channel Optimization----	
Use Back-Channel Optimization Data	False

----Parameter----	
Presets	P0;P1;P2;P3;P4;P5;P6;P7;P8;P9
Skip response time measurements	False
Measure protocol response times	False
Max Number of Retries	1
Scope Connection for Link EQ Tx Tests	Chan 1 2 3 4 Direct Connect
Generator Output Voltage Compensation	6 dB
Skip BER Check	True
----Oscilloscope----	
Scope Horizontal Range	10 us
Scope Pre-Trigger Data	1.5 us
Scope Request Vertical Range	800 mV
Scope Response Vertical Range	200 mV
----DUT----	
Max Link Training Speed	64 GT/s
----Instruments----	

(...)

Result	DUT Target Preset	Electrical response time [ns]	Pre-Shoot [dB]	Min Spec PS [dB]	Max Spec PS [dB]	De-Emphasis [dB]	Min Spec DE [dB]	Max Spec DE [dB]	Measurement Method	Comment
pass	P0	100.00	NaN	N/A	N/A	-6.00	-7.50	-4.50	AC Fit	DUT reported cursors: (0, 18, 6)
pass	P1	100.00	NaN	N/A	N/A	-3.50	-4.50	-2.50	AC Fit	DUT reported cursors: (0, 20, 4)
pass	P2	100.00	NaN	N/A	N/A	-4.40	-5.90	-2.90	AC Fit	DUT reported cursors: (0, 19, 5)
pass	P3	100.00	NaN	N/A	N/A	-2.50	-3.50	-1.50	AC Fit	DUT reported cursors: (0, 21, 3)
pass	P4	100.00	NaN	N/A	N/A	NaN	N/A	N/A	AC Fit	DUT reported cursors: (0, 24, 0)
pass	P5	100.00	1.90	0.90	2.90	NaN	N/A	N/A	AC Fit	DUT reported cursors: (2, 22, 0)
pass	P6	100.00	2.50	1.50	3.50	NaN	N/A	N/A	AC Fit	DUT reported cursors: (3, 21, 0)
pass	P7	100.00	3.50	2.50	4.50	-6.00	-7.50	-4.50	AC Fit	DUT reported cursors: (2, 17, 5)
pass	P8	100.00	3.50	2.50	4.50	-3.50	-4.50	-2.50	AC Fit	DUT reported cursors: (3, 18, 3)
pass	P9	100.00	3.50	2.50	4.50	NaN	N/A	N/A	AC Fit	DUT reported cursors: (4, 20, 0)
pass	P0' (0, 18, 6)	100.00	NaN	N/A	N/A	-6.00	-7.50	-4.50	AC Fit	
pass	P1' (0, 20, 4)	100.00	NaN	N/A	N/A	-3.50	-4.50	-2.50	AC Fit	
pass	P2' (0, 19, 5)	100.00	NaN	N/A	N/A	-4.40	-5.90	-2.90	AC Fit	
pass	P3' (0, 21, 3)	100.00	NaN	N/A	N/A	-2.50	-3.50	-1.50	AC Fit	
pass	P4' (0, 24, 0)	100.00	NaN	N/A	N/A	NaN	N/A	N/A	AC Fit	
pass	P5' (2, 22, 0)	100.00	1.90	0.90	2.90	NaN	N/A	N/A	AC Fit	

pass	P6' (3, 21, 0)	100.00	2.50	1.50	3.50	NaN	N/A	N/A	AC Fit	
pass	P7' (2, 17, 5)	100.00	3.50	2.50	4.50	-6.00	-7.50	-4.50	AC Fit	
pass	P8' (3, 18, 3)	100.00	3.50	2.50	4.50	-3.50	-4.50	-2.50	AC Fit	
pass	P9' (4, 20, 0)	100.00	3.50	2.50	4.50	NaN	N/A	N/A	AC Fit	
pass	Overall Result	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

Figure 8-7 Example result for LEQ Tx Response Time Compliance Test (32 GT/s)

- Result: (pass/fail) The values of Pre-Shoot and De-Emphasis should lie between the upper and lower specification limits and the electrical response time should not exceed the maximum specification limit.
- DUT Target Preset: The transmitter preset that is requested from the DUT by the BERT at each step.
- Electrical response time [ns]: The calculated timespan between the request from the BERT and the physical preset transition on the DUT waveform.
- Pre-Shoot [dB]: The measured Pre-Shoot on the DUT waveform.
- Min Spec PS [dB]: The Pre-Shoot lower specification limit.
- Max Spec PS [dB]: The Pre-Shoot upper specification limit.
- De-Emphasis [dB]: The measured De-Emphasis on the DUT waveform.
- Min Spec DE [dB]: The De-Emphasis lower specification limit.
- Max Spec DE [dB]: The De-Emphasis upper specification limit.
- Measurement Method: The measurement method used to calculate the Pre-Shoot and the De-Emphasis.
- Comment: An explanatory comment may be added.

Example presentation of results for 64 GT/s.

L0_EqTx_64GTps_RespTime

for PCIe 6.0 EndPoint ASIC

----General----	
Offline	True
Software Version	5.4.0.22
Spec Deviations	
Comments	
SigTest Version	Offline
----Loopback Training Settings----	
Suppress Loopback Training Messages	False
----Power Switch Automation----	
Use Power Switch Automation	True
Power Switch Channel Number	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1
----Loopback Training----	
Link Training Lane Number	0
Training through	L0-Recovery
Interactive Training Script File	C:\ProgramData\BitifEye\ValiFra
----Interactive Link Training----	
Generator Start Preset	P5
Generator Start Preset Gen4	P5
Generator Start Preset Gen5	P5
Generator Start Preset Gen6	Q5
----Error Detector----	
Fast Alignment	False
CDR Loop Bandwidth	20 MHz
CDR Loop Selection	Loop1
Use Auto Analyzer Equalization	True
Retries for Auto Analyzer Equalization	1
Input Range for Loopback Training	450 mV
Input Range	350 mV
Upper Analyzer Threshold	150 mV
Middle Analyzer Threshold	0 V
Lower Analyzer Threshold	-150 mV
Polarity	Non-Inverted
----Toggling----	
Pattern Selection Mode	Tx Compliance Pattern Toggling
Toggle Script File For 32 GT/s	C:\ProgramData\BitifEye\ValiFra
Toggle Script File For 64 GT/s	C:\ProgramData\BitifEye\ValiFra
Pause after toggle	100 ms
----Back-Channel Optimization----	
Use Back-Channel Optimization Data	False

```
----Parameter----
Presets                                       Q0;Q1;Q2;Q3;Q4;Q5;Q6;Q7;Q8;Q9
Skip response time measurements               False
Measure protocol response times               False
Max Number of Retries                         1
Scope Connection for Link EQ Tx Tests         Chan 1 2 3 4 Direct Connect
Generator Output Voltage Compensation         6 dB
Skip BER Check                                True
----Oscilloscope Preset Measurement----
Number of UIs                                 3 MUI
Scope raw Bandwidth                           50 GHz
Use Bessel Filter                             False
----Oscilloscope Response Time Measurement----
Scope Horizontal Range                        10 us
Scope Pre-Trigger Data                        1.5 us
Scope Request Vertical Range                  400 mV
Scope Response Vertical Range                 200 mV
----DUT----
Max Link Training Speed                       64 GT/s
----Instruments----
```

(...)

Result	DUT Target Preset	Electrical response time [ns]	Pre-Shoot 2 [dB]	Min Spec PS2 [dB]	Max Spec PS2 [dB]	Pre-Shoot 1 [dB]	Min Spec PS1 [dB]	Max Spec PS1 [dB]	De-Emphasis [dB]	Min Spec DE [dB]	Max Spec DE [dB]	Measurement Method	Comment
pass	Q0	100.00	0.00	N/A	N/A	0.00	N/A	N/A	0.00	N/A	N/A	LFPR	DUT reported cursors: (0, 0, 24, 0)
pass	Q0	100.00	0.00	N/A	N/A	0.00	N/A	N/A	0.00	N/A	N/A	AC Fit	DUT reported cursors: (0, 0, 24, 0)
pass	Q1	100.00	0.00	-0.50	0.50	1.60	1.10	2.10	0.00	-0.50	0.50	LFPR	DUT reported cursors: (0, 2, 22, 0)
pass	Q1	100.00	0.00	-0.50	0.50	1.60	1.10	2.10	0.00	-0.50	0.50	AC Fit	DUT reported cursors: (0, 2, 22, 0)
pass	Q2	100.00	0.00	-0.50	0.50	3.50	3.00	4.00	0.00	-0.50	0.50	LFPR	DUT reported cursors: (0, 4, 20, 0)
pass	Q2	100.00	0.00	-0.50	0.50	3.50	3.00	4.00	0.00	-0.50	0.50	AC Fit	DUT reported cursors: (0, 4, 20, 0)
pass	Q3	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-1.60	-2.10	-1.10	LFPR	DUT reported cursors: (0, 0, 22, 2)
pass	Q3	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-1.60	-2.10	-1.10	AC Fit	DUT reported cursors: (0, 0, 22, 2)
pass	Q4	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-3.50	-4.00	-3.00	LFPR	DUT reported cursors: (0, 0, 20, 4)
pass	Q4	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-3.50	-4.00	-3.00	AC Fit	DUT reported cursors: (0, 0, 20, 4)
pass	Q5	100.00	-1.30	-1.80	-0.80	4.70	3.70	5.70	0.00	-0.50	0.50	LFPR	DUT reported cursors: (1, 5, 18, 0)
pass	Q5	100.00	-1.30	-1.80	-0.80	4.70	3.70	5.70	0.00	-0.50	0.50	AC Fit	DUT reported cursors: (1, 5, 18, 0)
pass	Q6	100.00	-1.60	-2.10	-1.10	3.50	3.00	4.00	-3.50	-4.00	-3.00	LFPR	DUT reported cursors: (1, 3, 17, 3)
pass	Q6	100.00	-1.60	-2.10	-1.10	3.50	3.00	4.00	-3.50	-4.00	-3.00	AC Fit	DUT reported cursors: (1, 3, 17, 3)
pass	Q7	100.00	-2.90	-3.40	-2.40	4.70	3.70	5.70	0.00	-0.50	0.50	LFPR	DUT reported cursors: (2, 5, 17, 0)
pass	Q7	100.00	-2.90	-3.40	-2.40	4.70	3.70	5.70	0.00	-0.50	0.50	AC Fit	DUT reported cursors: (2, 5, 17, 0)
pass	Q8	100.00	-3.50	-4.00	-3.00	6.00	5.00	7.00	0.00	-0.50	0.50	LFPR	DUT reported cursors: (2, 6, 16, 0)
pass	Q8	100.00	-3.50	-4.00	-3.00	6.00	5.00	7.00	0.00	-0.50	0.50	AC Fit	DUT reported cursors: (2, 6, 16, 0)

pass	Q9	100.00	-4.40	-5.40	-3.40	6.90	5.90	7.90	-1.60	-2.10	-1.10	LFPR	DUT reported cursors: (2, 6, 15, 1)
pass	Q9	100.00	-4.40	-5.40	-3.40	6.90	5.90	7.90	-1.60	-2.10	-1.10	AC Fit	DUT reported cursors: (2, 6, 15, 1)
pass	Q0' (0, 0, 24, 0)	100.00	0.00	N/A	N/A	0.00	N/A	N/A	0.00	N/A	N/A	LFPR	
pass	Q0' (0, 0, 24, 0)	100.00	0.00	N/A	N/A	0.00	N/A	N/A	0.00	N/A	N/A	AC Fit	
pass	Q1' (0, 2, 22, 0)	100.00	0.00	-0.50	0.50	1.60	1.10	2.10	0.00	-0.50	0.50	LFPR	
pass	Q1' (0, 2, 22, 0)	100.00	0.00	-0.50	0.50	1.60	1.10	2.10	0.00	-0.50	0.50	AC Fit	
pass	Q2' (0, 4, 20, 0)	100.00	0.00	-0.50	0.50	3.50	3.00	4.00	0.00	-0.50	0.50	LFPR	
pass	Q2' (0, 4, 20, 0)	100.00	0.00	-0.50	0.50	3.50	3.00	4.00	0.00	-0.50	0.50	AC Fit	
pass	Q3' (0, 0, 22, 2)	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-1.60	-2.10	-1.10	LFPR	
pass	Q3' (0, 0, 22, 2)	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-1.60	-2.10	-1.10	AC Fit	
pass	Q4' (0, 0, 20, 4)	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-3.50	-4.00	-3.00	LFPR	
pass	Q4' (0, 0, 20, 4)	100.00	0.00	-0.50	0.50	0.00	-0.50	0.50	-3.50	-4.00	-3.00	AC Fit	
pass	Q5' (1, 5, 18, 0)	100.00	-1.30	-1.80	-0.80	4.70	3.70	5.70	0.00	-0.50	0.50	LFPR	
pass	Q5' (1, 5, 18, 0)	100.00	-1.30	-1.80	-0.80	4.70	3.70	5.70	0.00	-0.50	0.50	AC Fit	
pass	Q6' (1, 3, 17, 3)	100.00	-1.60	-2.10	-1.10	3.50	3.00	4.00	-3.50	-4.00	-3.00	LFPR	
pass	Q6' (1, 3, 17, 3)	100.00	-1.60	-2.10	-1.10	3.50	3.00	4.00	-3.50	-4.00	-3.00	AC Fit	
pass	Q7' (2, 5, 17, 0)	100.00	-2.90	-3.40	-2.40	4.70	3.70	5.70	0.00	-0.50	0.50	LFPR	
pass	Q7' (2, 5, 17, 0)	100.00	-2.90	-3.40	-2.40	4.70	3.70	5.70	0.00	-0.50	0.50	AC Fit	
pass	Q8' (2, 6, 16, 0)	100.00	-3.50	-4.00	-3.00	6.00	5.00	7.00	0.00	-0.50	0.50	LFPR	
pass	Q8' (2, 6, 16, 0)	100.00	-3.50	-4.00	-3.00	6.00	5.00	7.00	0.00	-0.50	0.50	AC Fit	
pass	Q9' (2, 6, 15, 1)	100.00	-4.40	-5.40	-3.40	6.90	5.90	7.90	-1.60	-2.10	-1.10	LFPR	
pass	Q9' (2, 6, 15, 1)	100.00	-4.40	-5.40	-3.40	6.90	5.90	7.90	-1.60	-2.10	-1.10	AC Fit	
pass	Overall Result	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

Figure 8-8 Example result for LEQ Tx Response Time Compliance Test (64 GT/s)

- Result: (pass/fail) The values of Pre-Shoot and De-Emphasis should lie between the upper and lower specification limits and the electrical response time should not exceed the maximum specification limit.
- DUT Target Preset: The transmitter preset that is requested from the DUT by the BERT at each step.
- Electrical response time [ns]: The calculated timespan between the request from the BERT and the physical preset transition on the DUT waveform.
- Pre-Shoot X [dB]: The measured Pre-Shoot X (X = 2, 1) on the DUT waveform.
- Min Spec PSX [dB]: The Pre-Shoot X (X = 2, 1) lower specification limit.

- Max Spec PSX [dB]: The Pre-Shoot X (X = 2, 1) upper specification limit.
- De-Emphasis [dB]: The measured De-Emphasis on the DUT waveform.
- Min Spec DE [dB]: The De-Emphasis lower specification limit.
- Max Spec DE [dB]: The De-Emphasis upper specification limit.
- Measurement Method: The measurement method used to calculate the Pre-Shoot and the De-Emphasis.
- Comment: An explanatory comment may be added.

Special Case for LEQ Tx Tests at 32 GT/s

For both LEQ Tx Initial Preset Compliance Test and LEQ Tx Response Time Compliance Test the specification includes a special case at 32 GT/s.

In each case, the usual ValiFrame analysis consists of up to two stages. If the DUT fails the first stage, where the AC fit method is used to measure the presets, i.e., some of the pre-shoot or de-emphasis values lie outside the spec limits, ValiFrame automatically checks to see if the values lie within the spec limits with extended tolerance. If the DUT fails this too, then the test is failed. However, if this second stage is passed, the user dialog window shown in Figure 8-9 opens.

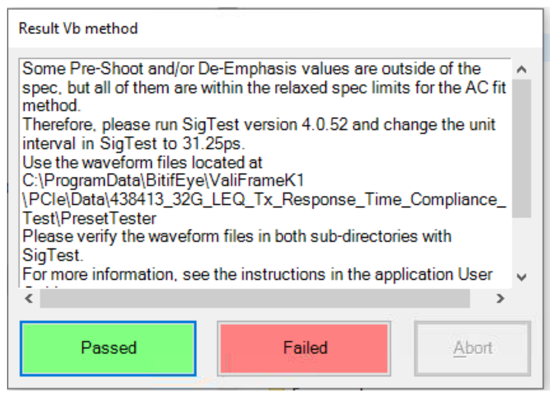


Figure 8-9 User dialog for LEQ Tx tests special cases at 32 GT/s

The brief outline there of the procedure to be followed – manual testing by the Vb method – is described in more detail here. In both cases SigTest is used to compute the presets.

Using SigTest to Compute the Presets Using the Vb Method

1 Start SigTest 4.0.52 and click 'EnablePTest' (Figure 8-10).

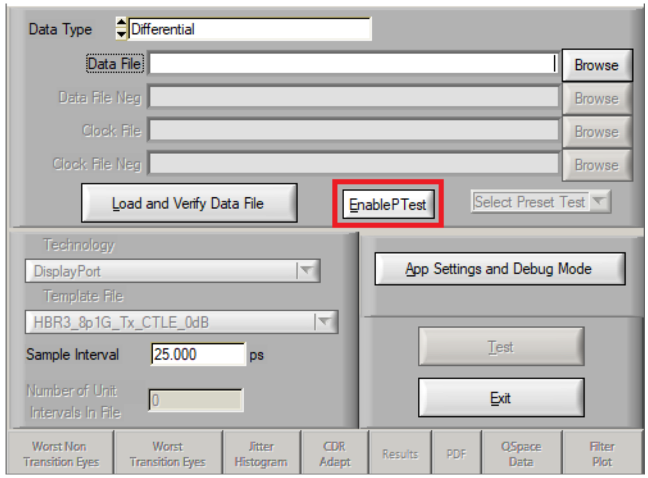


Figure 8-10 Enabling the Preset Test in SigTest 4.0.52

2 Select 'PCIE_4_0_PRESET' as the Technology and 'PCIE_GEN4_SYS_PRESET' as the Template File (Figure 8-11). This can be used for End Point, Root Complex, Add-In-Card and System DUTs.

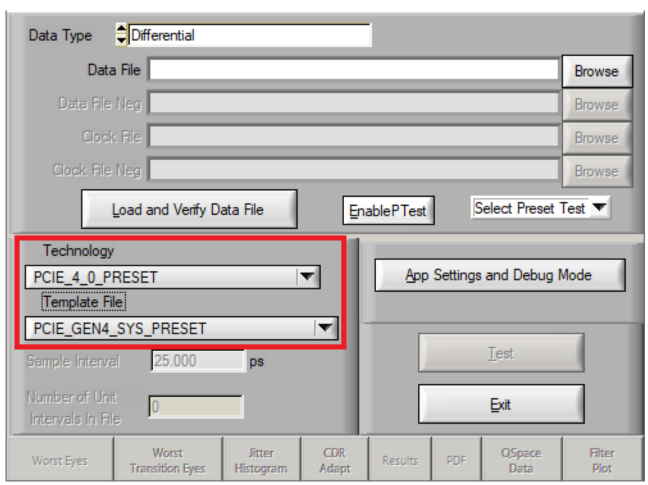


Figure 8-11 Selecting the Technology and the Template File

3 Select ‘PCIe Gen4 Presets’ from the drop-down menu under ‘Select Preset Test’ (Figure 8-12).

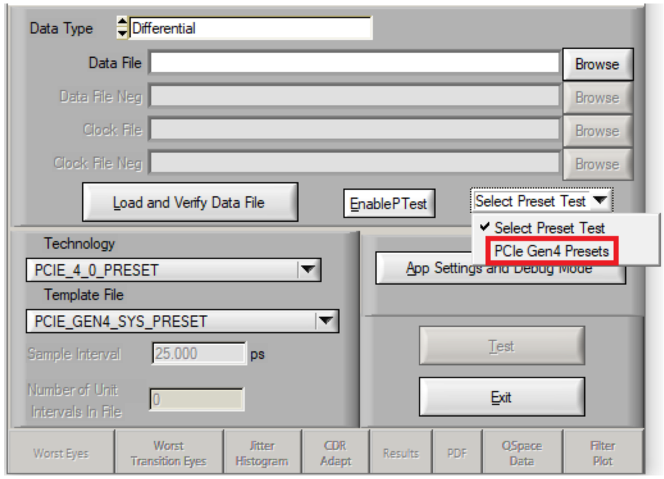


Figure 8-12 Select the preset test as ‘PCIe Gen4 Presets’

4 Change the Unit Interval to 31.25 ps (Figure 8-13).

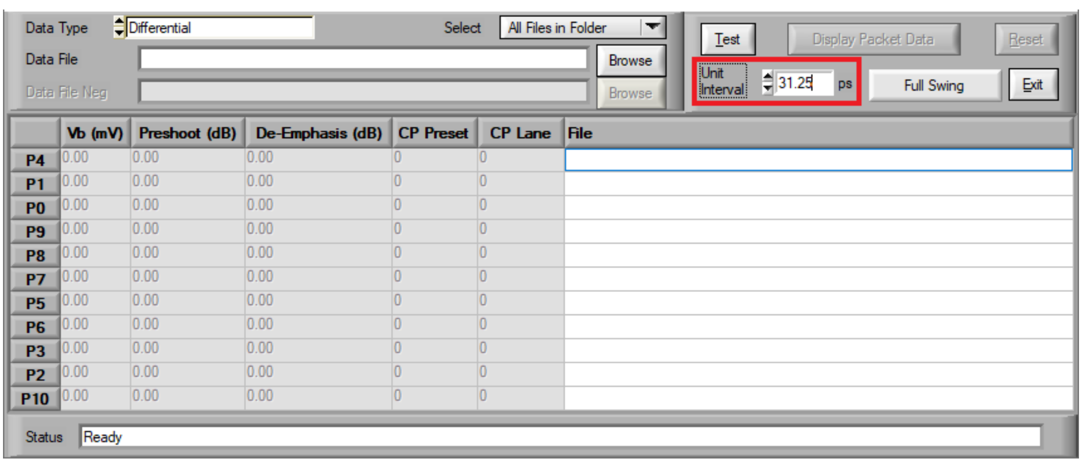


Figure 8-13 Changing the unit interval

5 Use the ‘Browse’ button to select the folder where the preset waveform files are located, then click ‘Test’ (Figure 8-14). The location of the preset files is given in the pop-up dialog window shown in Figure 8-9 on page 301.

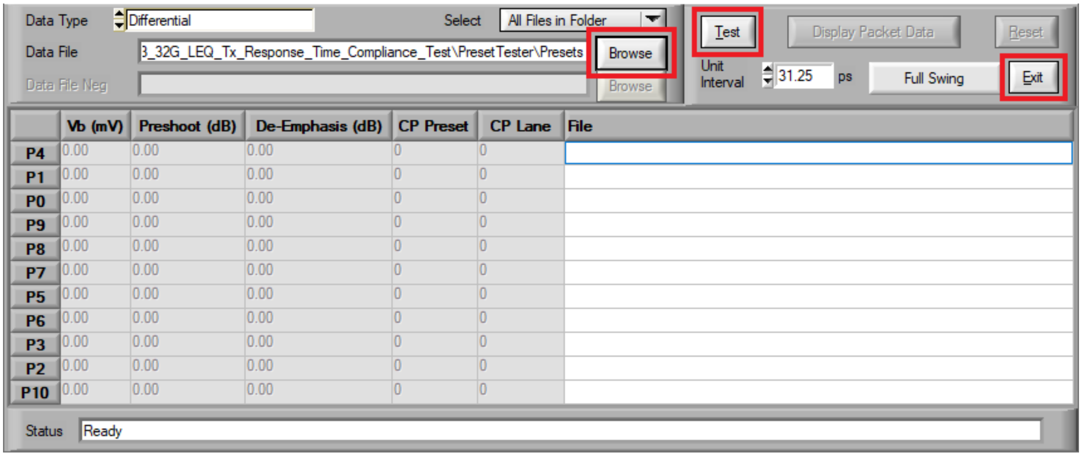


Figure 8-14 Select the folder for preset files then begin test

6 All of the presets (except P10) must pass in order to achieve an overall pass. When the run is finished, click ‘Exit’ (Figure 8-14) and a result file will be created in the same folder.

Procedure for 32G LEQ Tx Initial Preset Compliance Test (Special Case)

Compute the presets manually, as described above. The pop-up dialog window (Figure 8-9 on page 301) asks for the result. Click on ‘Passed’ or ‘Failed’, as appropriate. The result of the 32G LEQ Tx Initial Preset Compliance Test is marked accordingly, and a comment is added to the ‘Overall Result’ row of the test report.

Procedure for 32G LEQ Tx Response Time Compliance Test (Special Case)

This is similar to the procedure for the 32G LEQ Tx Initial Preset Compliance Test (Special Case), except that the test against the relaxed limits is performed not only for the defined presets but also for the reported cursors. Again, the pop-up window appears and the presets must be computed manually. The waveform files for the cursors as well as for the defined precursors must be used. If one or more presets or reported cursors do not comply, the procedure is considered failed. Once you have the result, click on ‘Passed’ or ‘Failed’ in the pop-up dialog (Figure 8-9 on page 301) to report the result to ValiFrame.

9 Receiver Setup Procedures

Receiver Setup Procedures can be used to set up the data generator as for a Receiver Compliance Test but without doing a BER test.

Overview

Receiver Setup Procedures are available in either Compliance or Expert Mode but only if “Include Rx Setup Procedures” is checked when configuring the DUT. To set this option, refer to Figure 2-12 on page 40.

Connection Diagrams

In this User’s Guide, only example connection diagrams are given at the beginning of each chapter, for example for receiver setup procedures. The exact connection diagram for a specific situation can be viewed by right-clicking the appropriate procedure in the procedure tree of the main window of the user interface and selecting “Show Connection...”.

PCI Express Common Receiver Parameters

The PCI Express Common Parameters are listed in the parameter grid (right pane) of the main window of the user interface when you click the corresponding group in the procedure tree in the left half of the main window. Clicking a data rate in the procedure tree shows you the data-rate-specific PCIe Common Parameters for that data rate. Similarly, clicking a lane shows you the corresponding lane-specific common parameters.

Details of PCI Express Common Receiver Parameters can be found in Table A-4 on page 324.

Parameters in Expert Mode for Individual Tests

The PCI Express Parameters in expert mode for an individual procedure are not listed in this User’s Guide explicitly. They are displayed in the parameter grid (right half) of the main window of the user interface when you click on the corresponding entry in the procedure tree in the left half of the main window.

Details of PCI Express Receiver Parameters for individual procedures can be found in Table A-8 on page 360.

Order of Descriptions of Receiver Setup Procedures

The descriptions of the Receiver Setup Procedures are arranged alphabetically.

To find a procedure description easily, go to Chapter 4, Procedure Tree Overview on page 71, where the procedures are listed in tables in the order they appear in the procedure tree in the application. Each procedure has a link to its description.

Example Connection Diagrams

The connections to the base boards for Rx setup procedures vary greatly depending on the data rate and interface type. For more details, right-click the appropriate procedure in the procedure tree of the user interface and select “Show Connection...”.

Figure 9-1 shows the connection diagram for receiver setup procedures for ASIC end-point DUTs for M8040A. Note that the setup can differ depending on the ISI channel, clock architecture and external reference clock selection.

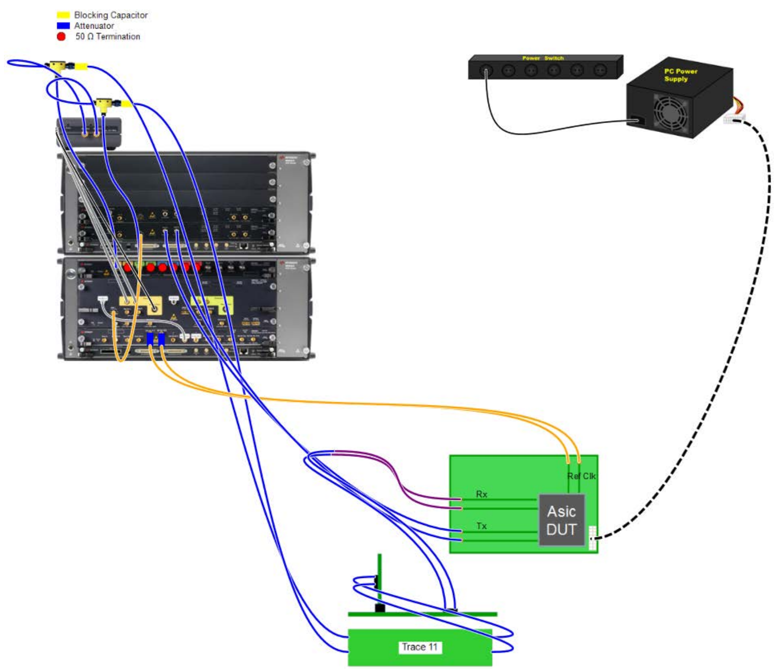


Figure 9-1 Example connection diagram for the Rx Impairments Setup procedure (M8050A, ASIC, End Point, 64 GT/s)

For ASIC Root Complex DUTs the setup differs in the reference clock connection.

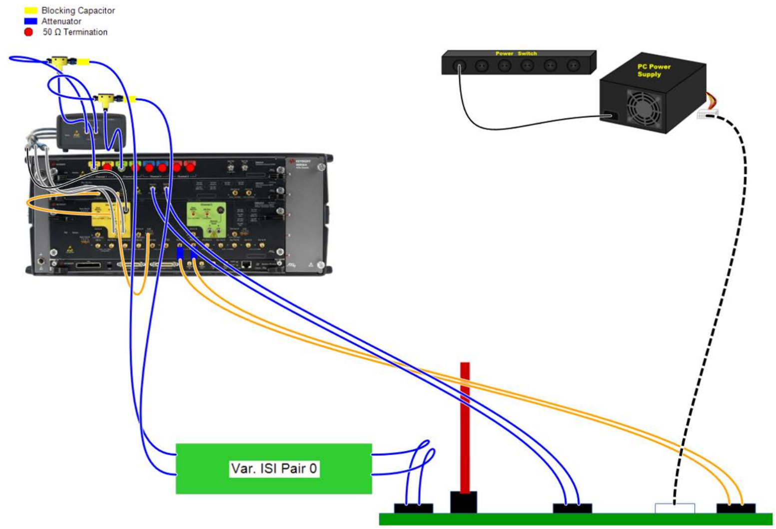


Figure 9-2 Example connection diagram for the Rx Pre-Compliance Setup procedure (M8040A, CEM, Add-in Card,16 GT/s)

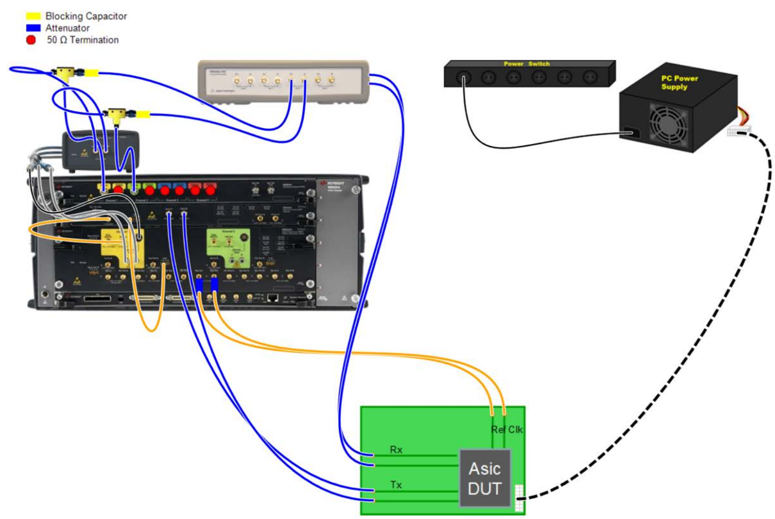


Figure 9-3 Example connection diagram for the Rx Compliance Setup procedure (M8040A, ASIC, End Point, 5 GT/s)

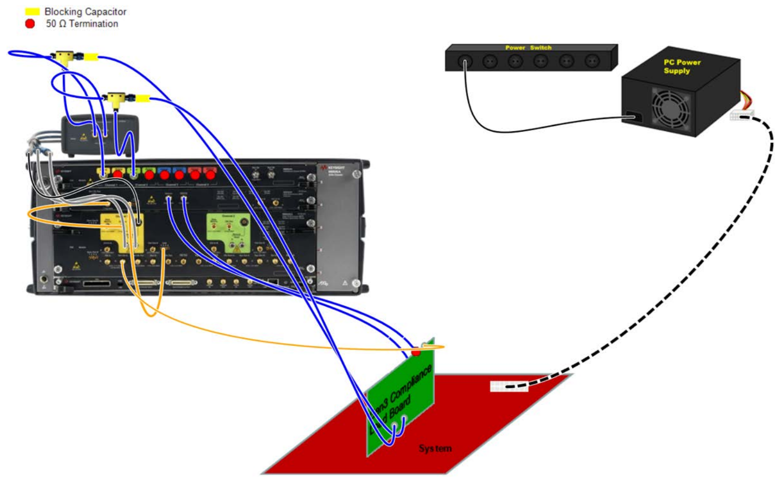


Figure 9-4 Example connection diagram for the Rx Pre-Compliance Setup procedure (M8040A, CEM, System, 8 GT/s)

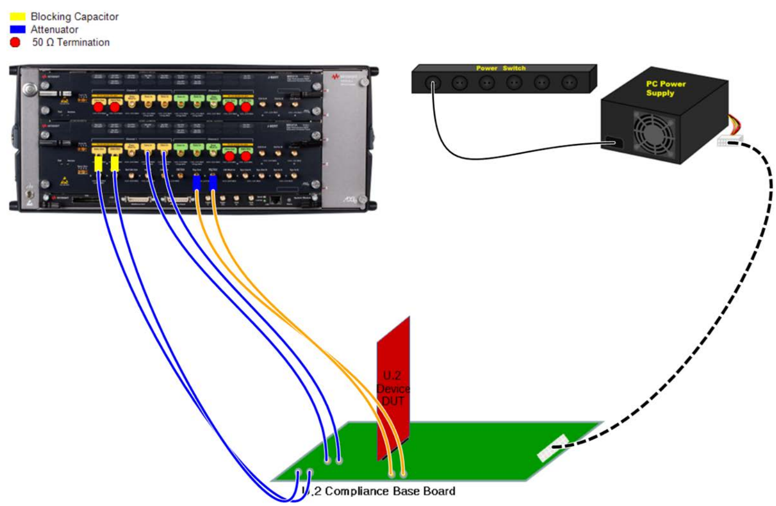


Figure 9-5 Example connection diagram for the Rx Pre-Compliance Setup procedure (M8020A, U.2, 8 GT/s)

Descriptions of Receiver Setup Procedures

Rx Compliance Setup

Availability

Data Generator:	M8020A, M8040A, M8050A	
Interface Types:	ASIC	CEM
DUT Types:	End Point Root Complex	Add-In Card System
Modes:	Compliance, Expert	
Data Rates:	2.5, 5 GT/s	

See also Table 2-1 on page 39.

The "Include Receiver Setup Procedures" option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

The purpose of this procedure is to configure the data generator with those parameters that are needed in the Rx Compliance Test, using the calibration data saved on the PC where the N5991 software is running. The method initiates in the same manner as the Rx Compliance Test but it does not proceed any further after the setup is prepared.

Connection Diagram

Refer to Example Connection Diagrams on page 308.

Result Description

None

Rx Impairments Setup

Availability

Data Generator:	M8040A, M8050A		
Interface Types:	ASIC	CEM	M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	32 GT/s, 64 GT/s		

See also Table 2-1 on page 39.

The “Include Receiver Setup Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

The purpose of this procedure is to configure the data generator with the parameters that are required in the Rx Pre-Compliance Test, using the calibration data saved on the machine where ValiFrame is running. The method initiates in the same manner as the Rx Pre-Compliance Test but it does not proceed any further after the setup is prepared.

Connection Diagram

Refer to Example Connection Diagrams on page 308.

Result Description

None

Rx Pre-Compliance Setup

Availability

Data Generator:	M8020A, M8040A		
Interface Types:	ASIC	CEM	U.2 and M.2
DUT Types:	End Point Root Complex	Add-In Card System	Device Host
Modes:	Compliance, Expert		
Data Rates:	8 GT/s (not ASIC), 16 GT/s		

See also Table 2-1 on page 39.

The “Include Receiver Setup Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

The purpose of this procedure is to configure the data generator with the parameters that are required in the Rx Pre-Compliance Test on page 254, using the calibration data saved on the machine where ValiFrame is running. The method initiates in the same manner as the Rx Pre-Compliance Test but it does not proceed any further after the setup has been prepared.

Connection Diagram

Refer to Example Connection Diagrams on page 308 (CEM).

Result Description

None

Rx Stressed Jitter Eye Setup

Availability

Data Generator:	M8020A, M8040A, M8050A
Interface Types:	ASIC
DUT Types:	End Point, Root Complex
Modes:	Compliance, Expert
Data Rates:	8 GT/s

The “Include Receiver Setup Procedures” option must be selected when configuring the DUT; refer to Figure 2-12 on page 40.

Purpose and Method

The purpose of this procedure is to configure the data generator with the parameters for ASIC at 8 GT/s that are required in the Rx Pre-Compliance Test on page 254, using the calibration data saved on the machine where ValiFrame is running. The method initiates in the same manner as the Rx Pre-Compliance Test but it does not proceed any further after the setup has been prepared.

Connection Diagram

Refer to Example Connection Diagrams on page 308.

Result Description

None

A PCI Express Parameters

This Appendix contains lists and descriptions of parameters used in the Keysight N5991P PCI Express Test Automation Software Platform user interface.

Overview

The parameters used in PCI Express N5991 ValiFrame are divided here into

- Sequencer Parameters (Table A-1 on page 317)
- Common Setup Preparation Parameters (Table A-2 on page 318)
- Common Calibration Parameters (Table A-3 on page 319)
- Common Receiver Parameters (Table A-4 on page 324)
- Common Link Equalization Parameters (Table A-5 on page 334)
- Setup Procedure Parameters for Individual Procedures (Table A-6 on page 345)
- Calibration Parameters for Individual Procedures (Table A-7 on page 348)
- Receiver Parameters for Individual Procedures (Table A-8 on page 360)
- Link Equalization Parameters for Individual Procedures (Table A-9 on page 370)

In each table, the parameters are listed under the categories that they appear under in the parameter grid of the GUI (e.g. Oscilloscope, Power Switch Automation), with the categories approximately in the order in which they appear in the GUI. It is not possible to keep to the exact order, because this varies from procedure to procedure. Within each category, the parameters are listed alphabetically.

NOTE If the value of a parameter appears in boldface type in the parameter grid of the GUI, this indicates that the value is not the default value.

NOTE If a parameter is read-only (gray) in the parameter grid, it can usually be set either in the Station Configurator or when configuring the DUT. If you are working in Compliance Mode, the grayed-out parameter may be editable in Expert Mode.

NOTE In several of the following tables, the relevant data rates are listed. Remember that, in addition, 64 GT/s is available only for PCIe Ver. 6.0 and 32 GT/s only for PCIe Ver. 5.0 and 6.0.

PCI Express N5991 ValiFrame Sequencer Parameters

The parameter ‘Repetitions’ appears when you click a group node in the procedure tree (e.g., Calibration, 16.0 GT/s or Custom Measurements) or an individual procedure. The other sequencer parameters are available for each individual procedure.

Table A-1 Sequencer parameters for individual procedures

Category/ Parameter	Description
Sequencer	
Procedure Error Case Behavior	Instruction for sequencer in error cases. ▪ “Proceed With Next Procedure”: If an error occurs in the current test or calibration procedure, continue by running the next procedure in the sequence. ▪ “Abort Sequence”: Abort further running of the sequence.
Procedure Failed Case Behavior	Instruction for sequencer if the procedure is failed. ▪ “Proceed With Next Procedure”: If the current test or calibration procedure is failed, continue by running the next procedure in the sequence. ▪ “Abort Sequence”: Abort further running of the sequence.
Repetitions	The number of times the procedure or group of procedures will be repeated. If the value is '0', it runs only once. Values: 0, ..., 2147483647

PCI Express N5991 ValiFrame Common Parameters

Common Parameters – Setup Preparation

These parameters are displayed in the GUI at a level higher than an individual procedure in the Setup Preparation part of the procedure tree.

Table A-2 PCIe common setup preparation parameters

Category/ Parameter	Level (where shown in GUI)	Values	Conditions/Description
Power Switch Automation			
Power Cycle max. Retries for LB Training	Setup Preparation		PCIe Ver. 5.0, 6.0; 32, 64 GT/s Available only if 'Use Power Switch Automation' is set to True. No effect for Setup Preparation, as no attempt is made to set the DUT in loopback mode.
Power Cycle Off On Duration	Setup Preparation		PCIe Ver. 5.0, 6.0; 32, 64 GT/s Available only if Use Power Switch Automation is set to True. The duration between powering the DUT off and then powering it on again.
Power Cycle Settling Time	Setup Preparation		PCIe Ver. 5.0, 6.0; 32, 64 GT/s Available only if Use Power Switch Automation is set to True. The wait time after the DUT is powered on and before the test continues with loopback (LB) training.
Power Switch Channel Number	Setup Preparation		PCIe Ver. 5.0, 6.0; 32, 64 GT/s Available only if Use Power Switch Automation is set to True. This sets the channel number of the power switch channel that is connected to the DUT.
Use Power Switch Automation	Setup Preparation	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s This is visible only if a power switch has been configured in the Station Configurator. If True, the DUT is powered on/off automatically by the software and the loopback training can be run without user intervention.
Generator Clock			
Data Rate Deviation	Data rates		PCIe Ver. 5.0, 6.0; 32, 64 GT/s
Reference Clock	Setup Preparation		PCIe Ver. 5.0, 6.0; 32, 64 GT/s Frequency of the reference clock.
DUT			
Max Link Training Speed	Setup Preparation	32 GT/s, 64 GT/s	PCIe Ver. 5.0, 6.0; 32, 64 GT/s
Error Detector			
Polarity	Data rates	Inverted Non-Inverted	PCIe Ver 5.0, 6.0; 32, 64 GT/s

Common Parameters – Calibration

These parameters are displayed in the GUI at a level higher than an individual procedure in the Calibration part of the procedure tree.

NOTE

For an overview of which data rates are supported for which interface type and spec version by this version of ValiFrame, see Table 2-1 on page 39.

Abbreviations used in "DUT Type column of Table A-4:
EP, End Point; RC, Root Complex (both ASIC)
AIC, Add-In Card; Sys, System (both CEM)
Dev, Device (U.2 and M.2)

Table A-3 PCIe common calibration parameters

Category/ Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description
None				
Gen4 ASIC Eye Calibration Method	EP, RC	Data rates	Seasim, SigTest	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
Gen4 Fixture	EP, RC	Data rates	Name of Fixture	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
Gen4 ISI Adjustment	EP, RC	Data rates	Hardware Traces Emulated ISI (only M8020A and ASIC)	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
Gen5 ASIC Eye Calibration Method	EP, RC	Data rates	Seasim, SigTest	PCIe Ver 5.0, 6.0; 32 GT/s
Gen5 Fixture	EP, RC	Data rates	Name of fixture	PCIe Ver 5.0, 6.0; 32 GT/s
PCIe1/PCIe2 M8048A ISI Channel	EP, RC	Data rates	Channel 0, None ... Channel 8, 34 inch	PCIe Ver. 4.0, 5.0, 6.0; 2.5 GT/s (PCIe1) and 5 GT/s (PCIe2) Default: Channel 7, 24 inch. The M8048A ISI channel used for PCIe1/PCIe2 ASIC Rx Calibration.
PCIe1/PCIe2 M8048A ISI Channel Emulation	EP, RC	Data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 2.5 GT/s (PCIe1) and 5 GT/s (PCIe2) Set to True if the internal ISI of the M8020A is used, otherwise set to False.
PCIe1/PCIe2 Transfer Function File on Scope	EP, RC AIC, Sys	Data rates	Name of transfer function file	PCIe Ver. 4.0, 5.0, 6.0; 2.5 GT/s (PCIe1), 5 GT/s (PCIe2) Visible only if "Use Transfer Function" was selected in Configure DUT > Show Parameters > [Data rate]. Path and filename of the transfer function that is located on the oscilloscope.

Table A-3 PCIe common calibration parameters (cont.)

Category/ Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description
PCIe3 Transfer Function File on Scope	AIC, Sys Dev, Host	Long Channel	Name of transfer function file	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s Visible only if “Use Transfer Function” was selected in Configure DUT > Show Parameters > 8 GT/s. Path and filename of the transfer function that is located on the oscilloscope.
Scope Connection for Calibration	EP, RC AIC, Sys	Data rates	Chan 1 3 Direct Connect Chan 2 4 Direct Connect	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5 GT/s (for other data rates see under “Oscilloscope”) All calibrations can be done with a single-ended direct connection to either channels 1&3 or channels 2&4. Note: The values available depend on the connected oscilloscope. The values given here are for a four-channel model; they will differ for a two-channel model.
Start with Minimum Loss Channel	EP, RC AIC, Sys Dev, Host	Data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s Enable or disable via Configure DUT > Show Parameters > 16 GT/s.
Use PCIe1/PCIe2 Transfer Function	EP, RC AIC, Sys	Data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 2.5 GT/s (PCIe1) and 5 GT/s (PCIe2)
Use PCIe3 Transfer Function	AIC, Sys Dev, Host	Long Channel	True, False	PCIe Ver. 4.0, 5.0; 8.0 GT/s Enable/disable via “Use Transfer Function” in Configure DUT > Show Parameters > 8 GT/s.
Oscilloscope				
Embed Replica Channel	EP, RC	Long Channel	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s
Gen4 Embed Replica Channel	EP, RC AIC, Sys Dev, Host	Long Channel	True, False	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
Gen4 Transfer Function File for Additional Channel on Scope	AIC Sys Dev, Host	Long Channel	Name of transfer function file	PCIe Ver. 4.0, 5.0; 16 GT/s
Gen4 Transfer Function File for Additional Channel and Package Model on Scope	AIC Sys Dev, Host	Long Channel	Name of transfer function file	PCIe Ver. 4.0, 5.0; 16 GT/s Visible only if “Embed Additional Channel” was selected in Configure DUT > Show Parameters > 16 GT/s.
Gen4 Transfer Function File for Package Model on Scope	EP, RC AIC, Sys Dev, Host	Long Channel	Name of transfer function file	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s This is the name of the package model file that is located on the oscilloscope. The package model must be embedded to perform some calibrations. Not visible if “Embed Additional Channel” was selected in Configure DUT > Show Parameters > 16 GT/s.

Table A-3 PCIe common calibration parameters (cont.)

Category/ Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description
Gen4 Transfer Function File for Replica Channel on Scope	EP, RC	Long Channel	Name of transfer function file	PCIe Ver. 4.0, 5.0; 16 GT/s Visible only if “Embed Additional Channel” was selected in Configure DUT > Show Parameters > 16 GT/s.
Gen4 Transfer Function File for Replica Channel and Package Model on Scope	EP, RC	Long Channel	Name of transfer function file	PCIe Ver. 4.0, 5.0; 16 GT/s Visible only if “Embed Additional Channel” was selected in Configure DUT > Show Parameters > 16 GT/s.
Gen5 Embed Replica Channel	EP, RC AIC, Sys Dev, Host	Long Channel	True, False	PCIe Ver. 5.0, 6.0; 32 GT/s Visible only if “Embed Replica Channel” was selected in Configure DUT > Show Parameters > 32 GT/s.
Gen5 Transfer Function File for Additional Channel on Scope	AIC Sys Dev, Host	Long Channel	Name of transfer function file	PCIe Ver. 5.0; 32 GT/s Not visible if “Embed Additional Channel” was selected in Configure DUT > Show Parameters > 32 GT/s.
Gen5 Transfer Function File for Additional Channel and Package Model on Scope	AIC Sys Dev, Host	Long Channel	Name of transfer function file	PCIe Ver. 5.0; 32 GT/s
Gen5 Transfer Function File for Package Model on Scope	EP, RC AIC, Sys Dev, Host	Long Channel	Name of transfer function file	PCIe Ver. 5.0, 6.0; 32 GT/s This is the name of the package model file that is located on the oscilloscope. The package model must be embedded to perform some calibrations.
Gen5 Transfer Function File for Replica Channel on Scope	EP, RC	Long Channel	Name of transfer function file	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if “Embed Replica Channel” was selected in Configure DUT > Show Parameters > 32 GT/s. This is the name of the transfer function of the replica channel, which is located on the oscilloscope.
Gen5 Transfer Function File for Replica Channel and Package Model on Scope	EP, RC	Long Channel	Name of transfer function file	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if “Embed Replica Channel” was selected in Configure DUT > Show Parameters > 32 GT/s. This is the name of the transfer function that includes the replica channel and package model, which is located on the oscilloscope.
Gen6 Embed Replica Channel	EP, RC AIC, Sys	Long Channel	True, False	PCIe Ver. 6.0; 64 GT/s
Gen6 Transfer Function File for Package Model on Scope	EP, RC AIC, Sys	Long Channel	Name of transfer function file	PCIe Ver. 6.0; 64 GT/s This is the name of the package model file that is located on the oscilloscope. The package model must be embedded to perform some calibrations.

Table A-3 PCIe common calibration parameters (cont.)

Category/ Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description
Gen6 Transfer Function File for Replica Channel on Scope	EP, RC AIC, Sys	Long Channel	Name of transfer function file	PCIe Ver. 6.0; 64 GT/s Visible only if “Embed Replica Channel” was selected in Configure DUT > Show Parameters > 64 GT/s. This is the name of the transfer function of the replica channel, which is located on the oscilloscope.
Gen6 Transfer Function File for Replica Channel and Package Model on Scope	EP, RC AIC, Sys	Long Channel	Name of transfer function file	PCIe Ver. 6.0; 64 GT/s Visible only if “Embed Replica Channel” was selected in Configure DUT > Show Parameters > 64 GT/s. This is the name of the transfer function that includes the replica channel and package model, which is located on the oscilloscope.
Number of Averages for Step Response	EP, RC	Long Channel		PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s The number of measurements averaged for the step response.
Range to Signal Ratio	EP, RC AIC, Sys Dev, Host	Long Channel (8, 16 GT/s) Data rate (32, 64 GT/s)	1.1 to 10	PCIe Ver. 4.0, 5.0, 6.0; 8, 16 GT/s Visible only if a UXR oscilloscope is connected.
Sampling Rate	EP, RC AIC, Sys Dev, Host	Long Channel (8, 16 GT/s) Data rate (32 GT/s)		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32 GT/s Visible only if a UXR oscilloscope is connected
Scope Connection for Calibration	EP, RC AIC, Sys Dev, Host	Data rates	Chan 1 3 Direct Connect Chan 2 4 Direct Connect,	PCIe Ver. 4.0, 5.0, 6.0 8, 16, 32, 64 GT/s (see under ‘None’ for 2.5, 5 GT/s) The values can be selected/preselected for some kinds of calibrations (all 32 GT/s calibrations and the TxEQ and Launch Voltage Calibration at 8 GT/s and 16 GT/s). All calibrations can be done with a single-ended direct connection to either channels 1&3 or channels 2&4. Note: The values available depend on the connected oscilloscope. The values given here are for a four-channel model, they will differ for a two-channel model.
Scope Skew	EP, RC AIC, Sys	Data rate		PCIe Ver. 6.0; 64 GT/s
Transfer Function File for Package Model on Scope	EP, RC	Data rates	Name of transfer function file	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s This is the file name of the package model, which is located on the oscilloscope. The package model must be embedded to perform some calibrations.
Transfer Function File for Replica (Channel) on Scope	EP, RC	Data rates	Name of transfer function file	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s Available only if “Embed Replica Channel” was selected in Configure DUT > Show Parameters > 8 GT/s. This is the name of the transfer function of the replica channel, which is located on the oscilloscope.

Table A-3 PCIe common calibration parameters (cont.)

Category/ Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description
Transfer Function File for Replica (Channel) and Package Model on Scope	EP, RC	Data rates	Name of transfer function file	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s Available only if “Embed Replica Channel” was selected in Configure DUT > Show Parameters > 8 GT/s. This is the name of the transfer function that includes the replica channel and package model, which is located on the oscilloscope.
UXR Calibration Mode	EP, RC AIC, Sys Dev, Host	Long Channel (8, 16 GT/s) Data rate (32 GT/s)	Compliance Custom	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32 GT/s Visible only if a UXR oscilloscope is connected.
Waveform Interpolation	EP, RC AIC, Sys	Long Channel	OFF INT2	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s Visible only if a UXR oscilloscope is connected. When the value is INT2 (two-point interpolation), an additional data point will be interpolated between each of the original points. This increases the resolution by a factor of 2.
Channel				
Gen5 M.2 Fixture	Dev, Host	Long Channel	WilderPCIEG5-M2-TP A3_CLBCBB IPass Labs PCIE-TF-M.2 Intel PCIE5.0 M.2 Fixture Set	PCIe Ver. 4.0, 5.0; 16, 32 GT/s Only for M.2. Available Gen5 M.2 fixtures.
Seasim				
Number of UI	EP, RC AIC, Sys	Long Channel	10 to 1000	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Number of UIs processed in Seasim.
Used Pattern	EP, RC AIC, Sys	Long Channel	Clock Div 256 / 512 / 1024 / 2048	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s

Common Parameters – Receiver

These parameters are displayed in the GUI at a level higher than an individual procedure in the Receiver and Receiver Setup parts of the procedure tree.

NOTE For an overview of which data rates are supported for which interface type and spec version by this version of ValiFrame, see Table 2-1 on page 39.

Abbreviations used in “DUT Type” column of Table A-4:
EP, End Point; RC, Root Complex (both ASIC)
AIC, Add-In Card; Sys, System (both CEM)
Dev, Device (U.2 and M.2)

Table A-4 PCIe common receiver parameters

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
None				
Custom Calibration Source	EP, RC AIC, Sys	Custom Tests	Custom Eye Calibration Custom Eye Scan Calibration	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
Custom Eye Calibration Point	EP, RC AIC, Sys	Custom Tests		PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s The values are impairment combinations (that give a valid eye) taken from the calibration chosen under ‘Custom Calibration Source’.
Pause Before Auto-Align	EP, RC AIC, Sys	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
Repetitions	All DUT types	All Receiver and Receiver Setup group levels	0, ..., 2147483647	The number of times the group of procedures is going to be repeated. If the value is '0', it runs only once.
Loopback Training Settings				
Custom Voltage	EP, RC AIC, Sys Dev, Host	Rx data rates	100 mV – 12 V	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Specify the Custom Training Voltage. Available only if ‘Use Custom Training Voltage’ is True.
Suppress Loopback Training Messages	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Use Custom Training Voltage	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
Use Gen3 EIEOS	EP, RC AIC, Sys	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
Clock Setup				
Use End Point Clock Setup	RC	Receiver Receiver Setup	True, False	PCIe Ver. 4.0, 5.0, 6.0 If set to True, the same clock setup will be used as for End Point DUTs.
Generator Clock				
32 GT/s SSC Deviation	EP AIC	Receiver Receiver Setup		PCIe Ver. 5.0, 6.0
32 GT/s Use SSC	EP AIC	Receiver Receiver Setup	True, False	PCIe Ver. 5.0, 6.0
64 GT/s SSC Deviation	EP AIC	Receiver Receiver Setup		PCIe Ver. 6.0
64 GT/s Use SSC	EP AIC	Receiver Receiver Setup	True, False	PCIe Ver. 6.0
Data Rate Deviation	EP AIC Dev	Data rates		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s
Ref Clock Multiplier Bandwidth	RC Sys Host	Receiver Receiver Setup	100 kHz, 2 MHz, 5 MHz	PCIe Ver. 4.0, 5.0, 6.0
Reference Clock	EP	Receiver Receiver Setup		PCIe Ver. 4.0, 5.0, 6.0 Frequency of the reference clock.
Use SSC	EP AIC Dev	Receiver Receiver Setup	True, False	PCIe Ver. 4.0, 5.0, 6.0 In Ver. 4.0, read only.
Power Switch Automation				
Power Cycle max. Retries for LB Training	EP, RC AIC, Sys Dev, Host	Receiver Receiver Setup		PCIe Ver. 4.0, 5.0, 6.0 Available only if 'Use Power Switch Automation' is set to True. Maximum number of times that ValiFrame tries to train the DUT into loopback mode. If it is not possible within these tries, the test is aborted automatically. When **Power Switch Automation** is not checked, ValiFrame prompts you to retry every time loopback fails.

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Power Cycle Off On Duration	EP, RC AIC, Sys Dev, Host	Receiver Receiver Setup		PCIe Ver. 4.0, 5.0, 6.0 Available only if 'Use Power Switch Automation' is set to True. The duration between powering the DUT off and then powering it on again.
Power Cycle Settling Time	EP, RC AIC, Sys Dev, Host	Receiver Receiver Setup		PCIe Ver. 4.0, 5.0, 6.0 Available only if 'Use Power Switch Automation' is set to True. The wait time after the DUT is powered on and before the test continues with loopback (LB) training.
Power Switch Channel Number	EP, RC AIC, Sys Dev, Host	Receiver Receiver Setup		PCIe Ver. 4.0, 5.0, 6.0 Available only if 'Use Power Switch Automation' is set to True. This sets the channel number of the power switch channel that is connected to the DUT.
Use Power Switch Automation	EP, RC AIC, Sys Dev, Host	Receiver Receiver Setup	True, False	PCIe Ver. 4.0, 5.0, 6.0 This is visible only if a power switch has been configured in the Station Configurator. If True, the DUT is powered on/off automatically by the software and the loopback training can be run without user intervention.
Impairments				
Treat 33kHz as separate SJ frequency	EP, RC AIC, Sys	Receiver Receiver Setup	True, False	PCIe Ver. 6.0 According to PCIe Ver. 6.0, the 33 kHz frequency must be treated as a separate frequency point. Read-only in Compliance Mode, editable in Expert Mode. Default value: True.
DUT				
Max Link Training Speed	EP, RC AIC, Sys Dev, Host	Receiver Link Equalization Receiver Setup		PCIe Ver. 4.0, 5.0, 6.0 This is a read-only parameter showing the value from the Configure DUT panel.
Loopback Training				
Link Training Lane Number	EP, RC AIC, Sys Dev, Host	Lane		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s
Link Training Mode	EP, RC AIC, Sys Dev, Host	Rx data rates	Static Sequence Vendor Specific Interactive	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s "Interactive" is not available for 2.5, 5 GT/s. "Static Sequence" is not available for 64 GT/s.
Link Training Suite Settings File	EP, RC AIC, Sys Dev, Host	Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s The path to the link training suite settings file (script file) that will be used for loopback training.

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Rx Setup Link Training Mode	EP, RC AIC, Sys Dev, Host	Rx Setup data rates	Vendor Specific Static Sequence	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s “Static Sequence” is not available for 64 GT/s.
Rx Setup Training Script File	EP, RC AIC, Sys Dev, Host	Rx Setup data rates		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s The Rx Setup Training Script File is used for loopback training.
Training through	EP, RC AIC, Sys Dev, Host	Rx data rates	L0-Recovery Configuration L0-Recovery with Speed Bypass (32, 64 GT/s) Configuration with Equalization (32, 64 GT/s)	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Default: L0-Recovery For 2.5 and 5 GT/s, ‘Training through’ is read only and set to ‘Configuration’.
Interactive Link Training				
Drop Link Method	EP, RC AIC, Sys Dev, Host	Rx data rates	LTSSM Power Cycle	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Select the method of dropping the link during link training.
DUT Initial Preset	EP AIC Dev	Rx data rates	P0, ..., P9	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s The DUT Tx will use this in link equalization phase 0.
DUT Initial Preset Gen4	EP AIC	Rx data rates	P0, ..., P9	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
DUT Initial Preset Gen5	EP AIC	Rx data rates	P0, ..., P9	PCIe Ver. 5.0, 6.0; 32, 64 GT/s
DUT Initial Preset Gen6	EP AIC	Rx data rates	Q0, ..., Q10	PCIe Ver. 6.0; 64 GT/s
DUT Start Preset Choice Gen4	RC Sys	Rx data rates	System Board Defined User Defined	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
DUT Start Preset Choice Gen5	RC Sys	Rx data rates	System Board Defined User Defined	PCIe Ver. 5.0, 6.0; 32, 64 GT/s
DUT Start Preset Choice Gen6	RC Sys	Rx data rates	System Board Defined User Defined	PCIe Ver. 6.0; 64 GT/s
DUT Target Preset	EP, RC AIC, Sys Dev, Host	Rx data rates	P0, ..., P10	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s The generator (downstream port) will request this preset in link equalization phase 3.
DUT Target Preset Gen4	EP, RC AIC, Sys	Rx data rates	P0, ..., P10	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
DUT Target Preset Gen5	EP, RC AIC, Sys	Rx data rates	P0, ..., P10	PCIe Ver. 5.0, 6.0; 32, 64 GT/s
DUT Target Preset Gen6	EP, RC AIC, Sys	Rx data rates	Q0, ..., Q10	PCIe Ver. 6.0; 64 GT/s
Generator Full Swing	EP, RC AIC, Sys Dev, Host	Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Full swing of generator used with LTSSM.
Generator Start Preset	EP AIC Dev	Rx data rates	P0, ..., P9	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s The generator Tx will use this preset in link equalization phase 1. Note: This setting will be applied in the Jitter Tolerance and Sensitivity tests only.
Generator Start Preset Gen4	EP, RC AIC, Sys	Rx data rates	P0, ..., P9	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s For Root Complex and System, only editable if ‘DUT Start Preset Gen4’ is set to ‘User Defined’.
Generator Start Preset Gen5	EP, RC AIC, Sys	Rx data rates	P0, ..., P9	PCIe Ver. 5.0, 6.0; 32, 64 GT/s For Root Complex and System, only editable if ‘DUT Start Preset Gen5’ is set to ‘User Defined’.
Generator Start Preset Gen6	EP, RC AIC, Sys	Rx data rates	Q0, ..., Q10	PCIe Ver. 6.0; 64 GT/s For Root Complex, only editable if ‘DUT Start Preset Gen6’ is set to ‘User Defined’.
Precoding Auto Detection	EP, RC AIC, Sys	Rx data rates	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s If set to True, the test automation will automatically switch to a precoded test pattern at the generator if the DUT has requested it during loopback training. When set to True, the test automation will also try to re-sync on a precoded pattern if the synchronization did not work with a non-precoded pattern at the first attempt. Please note that link training can take significantly longer when Precoding Auto Detection is enabled.
Select Start Preset Gen4	EP AIC	Rx data rates	User Defined LTSSM Defined LTSSM EQTS2 Defined	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
Select Start Preset Gen5	EP AIC	Rx data rates	User Defined LTSSM Defined LTSSM EQTS2 Defined	PCIe Ver. 5.0, 6.0; 32, 64 GT/s The value ‘LTSSM Defined’ is available only when the property ‘Training Through’ (under ‘Loopback Training’) is selected as ‘Configuration’ or ‘L0-Recovery’.
Select Start Preset Gen6	EP AIC	Rx data rates	User Defined LTSSM Defined LTSSM EQTS2 Defined	PCIe Ver. 6.0; 64 GT/s The value ‘LTSSM EQTS2 Defined’ is available only when the property ‘Training Through’ (under ‘Loopback Training’) is selected as ‘Configuration’ or ‘L0-Recovery’.

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Speed Change Control	RC Sys Host	Rx data rates	BERT, DUT	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Select the device that will control the speed change during link training. Default: BERT.
Error Detector				
Analyzer Equalization	EP, RC AIC, Sys Dev, Host	Rx data rates	1, ..., 120. For 64 GT/s: 1, ..., 55 For M8020A: Off, –6 dB, –9 dB, –12 dB	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s Available only if 'Use Auto Analyzer Equalization' is set to False. Not available if 'Use Back-Channel Optimization' is set to True.
CDR Loop Bandwidth	EP, RC AIC, Sys Dev, Host	Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s The loop bandwidth of the BERT error detector CDR.
CDR Loop Selection	EP, RC AIC, Sys Dev, Host	Rx data rates	For 2.5 GT/s: Loop1, Loop2 Otherwise: Loop1, ..., Loop4	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s The loops available depend on the value of the CDR Loop Bandwidth as follows: Always: Loop1 CDR Loop Bandwidth ≥ 3 MHz: Loop1, Loop2 CDR Loop Bandwidth ≥ 5 MHz: Loop1, Loop2, Loop3 CDR Loop Bandwidth ≥ 8 MHz: Loop1, Loop2, Loop3, Loop4
Enable FEC	EP, RC AIC, Sys	Rx data rates	True, False	PCIe Ver. 6.0; 64 GT/s If True, forward error correction is enabled.
Fast Alignment	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s Not available if 'Use Back-Channel Optimization' is set to True.
Filter SKPOS	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s When Filter SKPOS is set to True, skip order set filtering is enabled on the error detector. On M8046A this is done by setting the Phy Protocol token. Disable this when using custom patterns that use HardwarePRBS, for example.
Input Range	EP, RC AIC, Sys Dev, Host	Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s Not available if 'Use Back-Channel Optimization' is set to True.
Input Range for Loopback Training	EP, RC AIC, Sys Dev, Host	Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Not available if 'Use Back-Channel Optimization' is set to True.
Lower Analyzer Threshold	EP, RC AIC, Sys	Rx data rates	-400 mV to -1 mV	PCIe Ver. 6.0; 64 GT/s Not available if 'Use Back-Channel Optimization' is set to True.
Manually align error detector sampling point	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Middle Analyzer Threshold	EP, RC AIC, Sys	Rx data rates	-124 mV to +124 mV	PCIe Ver. 6.0; 64 GT/s Not available if 'Use Back-Channel Optimization' is set to True.
Pause before Auto-Align	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s The execution is paused to allow manual optimization of the DUT Rx.
Polarity	EP, RC AIC, Sys Dev, Host	Rx data rates	Non-inverted Inverted	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s Polarity of the analyzer input. Depending on the connected signal, the applied value at the instrument might change when auto-align is performed.
Retries for Auto Analyzer Equalization	EP, RC AIC, Sys Dev, Host	Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s Defines how often the Error Detector FFE Optimization will be performed. Available only if 'Use Auto Analyzer Equalization' is set to True. Not available if 'Use Back-Channel Optimization' is set to True.
Threshold	EP, RC AIC, Sys Dev, Host	Rx data rates	-400 mV to +400 mV	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32 GT/s Not available if 'Use Back-Channel Optimization' is set to True.
Upper Analyzer Threshold	EP, RC AIC, Sys	Rx data rates	+1 mV to +400 mV	PCIe Ver. 6.0; 64 GT/s Not available if 'Use Back-Channel Optimization' is set to True.
Use Auto Analyzer Equalization	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s This optimization will not be performed if "Manually align error detector sampling point" is enabled. Not available if 'Use Back-Channel Optimization' is set to True.
Redriver	Note 1: The M8047A redriver cannot be used if Back-Channel Optimization is used. Note 2: The M8047B redriver cannot be used at 64 GT/s if Back-Channel Optimization is used. Note 3: The parameters listed in this section are not available if 'Use Back-Channel Optimization' is set to True for the test procedure.			
Boost	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047B: 0 to 33	Only if an M8047B redriver is connected. Sets Equalizer Boost for the Linear Equalization.
Boost1	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047A: 0 to 7	Only if an M8047A redriver is connected.
Boost2	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047A: 0 to 7	Only if an M8047A redriver is connected.

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Boost Bandwidth	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047A: 0 to 3	Only if an M8047A redriver is connected.
Compensation Adjustment	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047C: –20 to 20	Only if an M8047C redriver is connected.
Compensation Bias Factor	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047C: No Bias, ×1, ×2, ×3	Only if an M8047C redriver is connected.
DC Gain	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047A: High, Low M8047B: 0 to 3	Only if an M8047A or M8047B redriver is connected. Sets Equalizer DC Gain for the Linear Equalization.
Driver Gain	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047A: 0 to 3 M8047B: 0 to 3	Only if an M8047A or M8047B redriver is connected. Sets Driver Gain.
Estimated Channel Loss	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047C: 8 dB to 37 dB	Only if an M8047C redriver is connected.
Eye Expander	EP, RC AIC, Sys Dev, Host	Rx data rates	M8047B: 0 to 3	Only if an M8047B redriver is connected. Sets Equalizer Eye Expander for the Linear Equalization.
Toggling				
Debug Pause after Toggle	EP, RC AIC, Sys Dev, Host	Rx data rates	100 ms to 10 s	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Debug' is selected as the Pattern Selection Mode. Determines the time between two consecutive toggling pulses.
Debug Toggle Script File for 32 GT/s	EP, RC AIC, Sys Dev, Host	Rx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Debug' is selected as the Pattern Selection Mode. Defines the script used for the pattern selection mode 'Debug'. The script contains the generator sequence with the sent pattern and the analyzer sequence with the expected pattern for 32 GT/s.
Debug Toggle Script File for 64 GT/s	EP, RC AIC, Syst	Rx data rates	Path and filename	PCIe Ver. 6.0; 64 GT/s Visible only if 'Debug' is selected as the Pattern Selection Mode. Defines the script used for the pattern selection mode 'Debug'. The script contains the generator sequence with the sent pattern and the analyzer sequence with the expected pattern for 64 GT/s.

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Manual Toggle Script File for 32 GT/s	EP, RC AIC, Sys Dev, Host	Rx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if ‘Manual’ is selected as the Pattern Selection Mode. Defines the script used for the Manual Tx Compliance Pattern Toggling. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 32 GT/s.
Manual Toggle Script File for 64 GT/s	EP, RC AIC, Sys	Rx data rates	Path and filename	PCIe Ver. 6.0; 64 GT/s Visible only if ‘Manual’ is selected as the Pattern Selection Mode. Defines the script used for the Manual Tx Compliance Pattern Toggling. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 64 GT/s.
Pattern Selection Mode	EP, RC AIC, Sys Dev, Host	Rx data rates	Tx Compliance Pattern Toggling Manual Debug	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Defines how the compliance pattern is selected for Back-Channel Optimization. ▪ Tx Compliance Pattern Toggling: Automatic Tx Compliance Pattern Toggling ▪ Manual: Manual toggling/forcing the DUT to transmit a specific pattern. ▪ Debug: This uses the BERT pattern generator as the DUT.
Pause after Toggle	EP, RC AIC, Sys Dev, Host	Rx data rates	100 ms to 10 s	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only when Pattern Selection Mode is set to ‘Tx Compliance Pattern Toggling’. Determines the time between two consecutive toggling pulses.
Toggle Script File for 32 GT/s	EP, RC AIC, Sys Dev, Host	Rx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Script for toggling the Tx Compliance Patterns sent by the DUT. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 32 GT/s.
Toggle Script File for 64 GT/s	EP, RC AIC, Sys	Rx data rates	Path and filename	PCIe Ver. 6.0; 64 GT/s Script for toggling the Tx Compliance Patterns sent by the DUT. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 64 GT/s.
Back-Channel Optimization				
Auto Adjust Sampling Delay during training	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if ‘Use Dynamic Rx Eq’ is enabled. If set to ‘True’, the sampling delay will be changed automatically when link training is not successful.

Table A-4 PCIe common receiver parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Back-Channel Optimization File	EP, RC AIC, Sys Dev, Host	Rx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Optimization File for the back channel specific to one DUT and maximum available data rate. Default: [ED]:[DUT Name]_SN[Serial Number]_[interface Type]_[DUT Type]
Default preset for Back-Channel Optimization data	EP, RC AIC, Sys Dev, Host	Rx data rates	For 32G: P0, ..., P10 For 64G: Q0, ..., Q10	PCIe Ver. 5.0, 6.0; 32 GT/s, 64G Default for 32G: P4; default for 64G: Q0 Back-Channel Optimization data from the given preset is used for the default sampling setup.
Use Back-Channel Optimization Data	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Default: False Loads and applies the Back-Channel Optimization data defined in 'Back-Channel Optimization File'.
Use Dynamic Rx Eq	EP, RC AIC, Sys Dev, Host	Rx data rates	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Use Back-Channel Optimization Data' is enabled. Default: True. If set to 'True', the Thresholds and FFE settings are adapted to the Preset sent by the DUT during Link Training.
BER Measurement				
Relax Time	EP, RC AIC, Sys Dev, Host	Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 2.5, 5, 8, 16, 32, 64 GT/s The time between when the stress signal is changed and the start of a BER measurement. This delay is to allow the DUT to adjust to the new settings.
Equalization				
De-Emphasis	EP, RC AIC, Sys Dev, Host	Channel (ASIC 8 GT/s) Lane		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Read-only if "Use Preset" is True.
Generator Preset	EP, RC AIC, Sys Dev, Host	Lane	P0, ..., P9. For 64 GT/s: Q0, ..., Q9	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s (not ASIC), 16, 32, 64 GT/s Available only if "Use Preset" is set to True.
Pre-Shoot	EP, RC AIC, Sys Dev, Host	Channel (ASIC 8 GT/s) Lane		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32 GT/s Read-only if "Use Preset" is True.
Pre-Shoot 1	EP, RC AIC, Sys	Lane		PCIe Ver. 6.0; 64 GT/s Read-only if "Use Preset" is True.
Pre-Shoot 2	EP, RC AIC, Sys	Lane		PCIe Ver. 6.0; 64 GT/s Read-only if "Use Preset" is True.
Use Preset	EP, RC AIC, Sys Dev, Host	Lane	True, False	PCIe Ver. 4.0, 5.0, 6.0 8 GT/s (not ASIC), 16, 32, 64 GT/s

Common Parameters – Link Equalization

These parameters are displayed in the GUI at a level higher than an individual procedure in the Link Equalization part of the procedure tree.

NOTE For an overview of which data rates are supported for which interface type and spec version by this version of ValiFrame, see Table 2-1 on page 39.

Abbreviations used in “DUT Type” column of Table A-4:
EP, End Point; RC, Root Complex (both ASIC)
AIC, Add-In Card; Sys, System (both CEM)
Dev, Device (U.2 and M.2)

Table A-5 Common link equalization parameters

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
None				
Custom Calibration Source	EP, RC AIC, Sys Dev, Host	LEQ Custom Tests (exist only for LEQ Rx data rates)	Custom Eye Calibration Custom Eye Scan Calibration	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
Custom Eye Calibration Point	EP, RC AIC, Sys Dev, Host	LEQ Custom Tests (exist only for LEQ Rx data rates)		PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s The values are impairment combinations (that give a valid eye) taken from the calibration chosen under ‘Custom Calibration Source’.
Pause before Auto-Align	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
SigTest Preset Measurement Method	EP, RC AIC, Sys Dev, Host	LEQ Tx data rates	Vb AC Fit (not 8 GT/s)	PCIe Ver 4.0, 5.0, 6.0; 8, 16, 32 GT/s (64 GT/s only for End Point) For Vb method, Gen4 (16 GT/s) SigTest version is used.
DUT				
Max Link Training Speed	EP, RC AIC, Sys Dev, Host	Link Equalization		PCIe Ver. 4.0, 5.0, 6.0 This is a read-only parameter showing the value from the Configure DUT panel.
Clock Setup				
Use End Point Clock Setup	RC	Link Equalization	True, False	PCIe Ver. 4.0, 5.0, 6.0 If set to True, the same clock setup will be used as for End Point DUTs.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Power Switch Automation				
Power Cycle max. Retries for LB Training	EP, RC AIC, Sys Dev, Host	Link Equalization		Maximum number of times that ValiFrame tries to train the DUT into loopback mode. If it is not possible within these tries, the test is aborted automatically. When **Power Switch Automation** is not checked, ValiFrame prompts you to retry every time loopback fails.
Power Cycle Off On Duration	EP, RC AIC, Sys Dev, Host	Link Equalization		The duration between powering the DUT off and then powering it on again.
Power Cycle Settling Time	EP, RC AIC, Sys Dev, Host	Link Equalization		The wait time after the DUT is powered on and before the test continues with loopback (LB) training.
Power Switch Channel Number	EP, RC AIC, Sys Dev, Host	Link Equalization		This sets the channel number of the power switch channel that is connected to the DUT
Use Power Switch Automation	EP, RC AIC, Sys Dev, Host	Link Equalization	True, False	This is visible only if a power switch has been configured during Station Configuration. If True, the DUT is powered on/off automatically by the software and the loopback training can be run without user intervention.
Loopback Training Settings				
Custom Voltage	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	100 mV to 1.2 V	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Visible only if ‘Use Custom Training Voltage’ is enabled.
Suppress Loopback Training Messages	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
Use Custom Training Voltage	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
Use Gen3 EIEOS	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 16 GT/s
Generator Clock				
32 GT/s Sinusoidal SSC Spur	EP, RC	LEQ Receiver	0 to 25 ns	PCIe Ver. 5.0, 6.0 Only available/editable if “Clock Architecture” (in Configure DUT dialog box) is set to “Separate Ref Clocks Independent SSC” and “Treat 33kHz as separate SJ frequency” (under “Impairments” for the LEQ Receiver node) is set to False.
32 GT/s SSC Deviation	AIC Dev	LEQ Receiver	0 to 5000 ppm	PCIe 5.0 Available only if ‘32 GT/s Use SSC’ is True.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
32 GT/s Use SSC	EP AIC Dev	LEQ Receiver	True, False	PCIe 5.0, 6.0 For End Point, only available if “Clock Architecture” (in Configure DUT dialog box) is set to “Separate Ref Clocks Independent SSC”.
64 GT/s Sinusoidal SSC Spur	EP	LEQ Receiver	0 to 25 ns	PCIe 6.0 Available only if ‘64 GT/s Use SSC’ is True.
64 GT/s Use SSC	EP	LEQ Receiver	True, False	PCIe 6.0 Only available/editable if “Clock Architecture” (in Configure DUT dialog box) is set to “Separate Ref Clocks Independent SSC” and “Treat 33kHz as separate SJ frequency” (under “Impairments” for the LEQ Receiver node) is set to False.
Data Rate Deviation	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s For End Point, Root Complex: Not 8 GT/s.
Ref Clock Multiplier Bandwidth	RC Sys Host	LEQ Receiver	100 kHz, 2 MHz, 5 MHz	PCIe Ver. 4.0, 5.0, 6.0
Sinusoidal SSC Spur	EP	LEQ Receiver		PCIe Ver. 4.0, 5.0, 6.0
SSC Deviation	AIC Dev	LEQ Receiver		PCIe Ver. 4.0, 5.0
SSC Frequency	EP AIC Dev	LEQ Receiver		PCIe Ver. 4.0, 5.0, 6.0 Only available/editable if “Clock Architecture” (in Configure DUT dialog box) is set to “Separate Ref Clocks Independent SSC”. Additionally, for PCIe Ver. 6.0, “Treat 33kHz as separate SJ frequency” (under “Impairments” for the LEQ Receiver node) must be set to False.
Use SSC	EP AIC Dev	LEQ Receiver	True, False	PCIe Ver. 4.0, 5.0, 6.0
Impairments				
Treat 33kHz as separate SJ frequency	EP, RC	LEQ Receiver	True, False	PCIe Ver. 6.0 According to PCIe Ver. 6.0, the 33 kHz frequency must be treated as a separate frequency point. Read-only in Compliance Mode, editable in Expert Mode. Default value: True.
Loopback Training				
Interactive Training Script File	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s The link training suite settings file (script file), and path, that will be used for loopback training.
Link Training Lane Number	EP, RC AIC, Sys Dev, Host	Lane		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s LEQ Rx and LEQ Tx are coupled for the same lane and data rate.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Training through	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	L0-Recovery L0-Recovery with Speed Bypass Configuration with Equalization	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Not all training methods are available for all data rates.
Interactive Link Training				
Drop Link Method	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	LTSSM Power Cycle	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Select the method used to drop the link during link training.
DUT Initial Preset	EP AIC Dev	LEQ Rx data rates	P0, ... P9	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
DUT Initial Preset Gen4	EP AIC Dev	LEQ Rx data rates	P0, ..., P9	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
DUT Initial Preset Gen5	EP AIC Dev	LEQ Rx data rates	P0, ..., P9	PCIe Ver. 5.0, 6.0; 32, 64 GT/s
DUT Initial Preset Gen6	EP	LEQ Rx data rates	Q0, ..., Q10	PCIe Ver. 6.0; 64 GT/s
DUT Start Preset Choice Gen4	RC Sys Host	LEQ Rx data rates	System Board Defined User Defined	PCIe Ver, 4.0, 5.0, 6.0; 16, 32, 64 GT/s The properties "DUT Start Preset Choice GenX" (for X = 4, 5, 6) are linked. Once you have chosen the value for one of them, the same value is used for the others.
DUT Start Preset Choice Gen5	RC Sys Host	LEQ Rx data rates LEQ Tx data rates	System Board Defined User Defined	PCIe Ver. 5.0, 6.0; 32, 64 GT/s The properties "DUT Start Preset Choice GenX" (for X = 4, 5, 6) are linked. Once you have chosen the value for one of them, the same value is used for the others.
DUT Start Preset Choice Gen6	RC Sys	LEQ Rx data rates	System Board Defined User Defined	PCIe Ver. 6.0; 64 GT/s The properties "DUT Start Preset Choice GenX" (for X = 4, 5, 6) are linked. Once you have chosen the value for one of them, the same value is used for the others.
DUT Target Preset	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	P0, ..., P10	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
DUT Target Preset Gen4	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	P0, ..., P10	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
DUT Target Preset Gen5	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	P0, ..., P10	PCIe Ver. 5.0, 6.0; 32, 64 GT/s
DUT Target Preset Gen6	EP, RC AIC, Sys	LEQ Rx data rates	Q0, ..., Q10	PCIe Ver. 6.0; 64 GT/s

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Expected DUT Start Preset Gen5	Sys Host	LEQ Rx data rates LEQ Tx data rates	P0, ..., P10	PCIe Ver. 5.0, 6.0; 32, 64 GT/s The preset that the DUT is most likely to use as Start Preset. Updating this value can help to select the correct back-channel settings during link training.
Expected DUT Start Preset Gen6	Sys	LEQ Rx data rates LEQ Tx data rates	Q0, ..., Q10	PCIe Ver. 6.0; 64 GT/s The preset that the DUT is most likely to use as Start Preset. Updating this value can help to select the correct back-channel settings during link training.
Generator Full Swing	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates		PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
Generator Start Preset	EP AIC Dev	LEQ Rx data rates LEQ Tx data rates	P0, ..., P9	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
Generator Start Preset Gen4	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	P0, ..., P9	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s The generator Tx will use this preset in link equalization phase 1. Note: This setting will be applied in the Jitter Tolerance and Sensitivity tests only. For Root Complex and System: This parameter is visible/editable only if the parameter “DUT Start Preset Choice Gen4” is set to “User Defined”.
Generator Start Preset Gen5	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	P0, ..., P9	PCIe Ver. 5.0, 6.0; 32, 64 GT/s The generator Tx will use this preset in link equalization phase 1. Note: This setting will be applied in the Jitter Tolerance and Sensitivity tests only. For Root Complex and System: This parameter is visible/editable only if the parameter “DUT Start Preset Choice Gen5” is set to “User Defined”.
Generator Start Preset Gen6	EP, RC AIC, Sys	LEQ Rx data rates LEQ Tx data rates	Q0, ..., Q10	PCIe Ver. 6.0; 64 GT/s The generator Tx will use this preset in link equalization phase 1. Note: This setting will be applied in the Jitter Tolerance and Sensitivity tests only. For Root Complex and System: This parameter is visible/editable only if the parameter “DUT Start Preset Choice Gen6” is set to “User Defined”.
Precoding Auto Detection	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	True, False	PCIe 5.0, 6.0; 32, 64 GT/s If set to True, the test automation will automatically switch to a precoded test pattern at the generator if the DUT has requested it during loopback training. When set to True, the test automation will also try to re-sync on a precoded pattern if the synchronization did not work with a non-precoded pattern at the first attempt. Please note that link training can take significantly longer when Precoding Auto Detection is enabled.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Select Start Preset Gen4	EP AIC Dev	LEQ Rx data rates	User Defined LTSSM Defined LTSSM EQTS2 Defined	PCIe Ver. 4.0, 5.0, 6.0; 16, 32, 64 GT/s
Select Start Preset Gen5	EP AIC Dev	LEQ Rx data rates	User Defined LTSSM Defined LTSSM EQTS2 Defined	PCIe Ver. 5.0, 6.0; 32, 64 GT/s The value ‘LTSSM Defined’ is available only when the property ‘Training Through’ (under ‘Loopback Training’) is selected as ‘Configuration’ or ‘L0-Recovery’.
Select Start Preset Gen6	EP	LEQ Rx data rates	User Defined LTSSM Defined LTSSM EQTS2 Defined	PCIe Ver. 6.0; 64 GT/s The value ‘LTSSM EQTS2 Defined’ is available only when the property ‘Training Through’ (under ‘Loopback Training’) is selected as ‘Configuration’ or ‘L0-Recovery’.
Speed Change Control	RC Sys Host	LEQ Rx data rates	BERT, DUT	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s
Error Detector				
Analyzer Equalization	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	1, ..., 120. 1, ..., 55 for 64 GT/s	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Available only if ‘Use Auto Analyzer Equalization’ is set to False. Not available if ‘Use Back-Channel Optimization Data’ is set to True.
CDR Loop Bandwidth	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	5 kHz to 20 MHz	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s The loop bandwidth of the BERT error detector CDR.
CDR Loop Selection	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	Loop1, ..., Loop4	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s The loops available depend on the value of the CDR Loop Bandwidth as follows: Always: Loop1 CDR Loop Bandwidth ≥ 3 MHz: Loop1, Loop2 CDR Loop Bandwidth ≥ 5 MHz: Loop1, Loop2, Loop3 CDR Loop Bandwidth ≥ 8 MHz: Loop1, Loop2, Loop3, Loop4
Enable FEC	EP, RC AIC, Sys	LEQ Rx data rates	True, False	PCIe Ver. 6.0; 64 GT/s
Fast Alignment	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Not available if ‘Use Back-Channel Optimization Data’ is set to True.
Filter SKPOS	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s When Filter SKPOS is set to True, skip order set filtering is enabled on the error detector. On M8046A this is done by setting the Phy Protocol token. Disable this when using custom patterns that use HardwarePRBS, for example.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Input Range	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	100 mV to 800 mV	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Not available if 'Use Back-Channel Optimization Data' is set to True.
Input Range for Loopback Training	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	100 mV to 800 mV	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Not available if 'Use Back-Channel Optimization Data' is set to True.
Lower Analyzer Threshold	EP, RC AIC, Sys	LEQ Rx data rates LEQ Tx data rates	-400 mV to -1 mV	PCIe Ver. 6.0; 64 GT/s Not available if 'Use Back-Channel Optimization Data' is set to True.
Manually align error detector sampling point	EP, RC AIC, Sys Dev, Host	LEQ Receiver	True, False	PCIe Ver. 4.0, 5.0, 6.0
Middle Analyzer Threshold	EP, RC AIC, Sys	LEQ Rx data rates LEQ Tx data rates	-124 mV to +124 mV	PCIe Ver. 6.0; 64 GT/s Not available if 'Use Back-Channel Optimization Data' is set to True.
Pause Before Auto-Align	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8 GT/s The execution is paused to let the user carry out manual optimization of the DUT receiver.
Polarity	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	Non-inverted Inverted	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Polarity of the analyzer input.
Retries for Auto Analyzer Equalization	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	1, ..., 5	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Available only if 'Use Auto Analyzer Equalization' is enabled. Not available if 'Use Back-Channel Optimization Data' is set to True. This defines how often the Error Detector FFE Optimization will be performed. Between each optimization the sample delay will be aligned.
Threshold	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	-400 mV to +400 mV	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32 GT/s Not available if 'Use Back-Channel Optimization Data' is set to True.
Upper Analyzer Threshold	EP, RC AIC, Sys	LEQ Rx data rates LEQ Tx data rates	+1 mV to +400 mV	PCIe Ver. 6.0; 64 GT/s Not available if 'Use Back-Channel Optimization Data' is set to True.
Use Auto Analyzer Equalization	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	True, False	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s Not available if 'Use Back-Channel Optimization Data' is set to True. This optimization will not be performed if 'Manually align error detector sampling point' is enabled.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Redriver	Note 1: The M8047A redriver cannot be used if Back-Channel Optimization is used. Note 2: The M8047B redriver cannot be used at 64 GT/s if Back-Channel Optimization is used. Note 3: The parameters listed in this section are not available if 'Use Back-Channel Optimization' is set to True for the test procedure.			
Boost	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	M8047B: 0 to 33	Only if an M8047B redriver is connected. Sets Equalizer Boost for the Linear Equalization.
Boost1	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	M8047A: 0 to 7	Only if an M8047A redriver is connected.
Boost2	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	M8047A: 0 to 7	Only if an M8047A redriver is connected.
Boost Bandwidth	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	M8047A: 0 to 3	Only if an M8047A redriver is connected.
Compensation Adjustment	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	M8047C: –20 to 20	Only if an M8047C redriver is connected.
Compensation Bias Factor	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	M8047C: No Bias, ×1, ×2, ×3	Only if an M8047C redriver is connected.
DC Gain	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	M8047A: High, Low M8047B: 0 to 3	Only if an M80470A or M8047B redriver is connected. Sets Equalizer DC Gain for the Linear Equalization.
Driver Gain	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	M8047A: 0 to 3 M8047B: 0 to 3	Only if an M80470A or M8047B redriver is connected. Sets Driver Gain.
Estimated Channel Loss	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	M8047C: 8 dB to 37 dB	Only if an M8047C redriver is connected.
Eye Expander	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	M8047B: 0 to 3	Only if an M8047B redriver is connected. Sets Equalizer Eye Expander for the Linear Equalization.
Toggling				
Debug Pause after Toggle	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	100 ms to 10 s	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Debug' is selected as the Pattern Selection Mode. Determines the time between two consecutive toggling pulses.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Debug Toggle Script File for 32 GT/s	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Debug' is selected as the Pattern Selection Mode. Defines the script used for the pattern selection mode 'Debug'. The script contains the generator sequence with the sent pattern and the analyzer sequence with the expected pattern for 32 GT/s.
Debug Toggle Script File for 64 GT/s	EP, RC AIC, Syst	LEQ Rx data rates LEQ Tx data rates	Path and filename	PCIe Ver. 6.0; 64 GT/s Visible only if 'Debug' is selected as the Pattern Selection Mode. Defines the script used for the pattern selection mode 'Debug'. The script contains the generator sequence with the sent pattern and the analyzer sequence with the expected pattern for 64 GT/s.
Manual Toggle Script File for 32 GT/s	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Manual' is selected as the Pattern Selection Mode. Defines the script used for the Manual Tx Compliance Pattern Toggling. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 32 GT/s.
Manual Toggle Script File for 64 GT/s	EP, RC AIC, Sys	LEQ Rx data rates LEQ Tx data rates	Path and filename	PCIe Ver. 6.0; 64 GT/s Visible only if 'Manual' is selected as the Pattern Selection Mode. Defines the script used for the Manual Tx Compliance Pattern Toggling. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 64 GT/s.
Pattern Selection Mode	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	Tx Compliance Pattern Toggling Manual Debug	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Defines how the compliance pattern is selected for Back-Channel Optimization. ▪ Tx Compliance Pattern Toggling: Automatic Tx Compliance Pattern Toggling ▪ Manual: Manual toggling/forcing the DUT to transmit a specific pattern. ▪ Debug: This uses the BERT pattern generator as the DUT.
Pause after Toggle	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	100 ms to 10 s	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only when Pattern Selection Mode is set to 'Tx Compliance Pattern Toggling'. Determines the time between two consecutive toggling pulses.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Toggle Script File for 32 GT/s	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Script for toggling the Tx Compliance Patterns sent by the DUT. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 32 GT/s.
Toggle Script File for 64 GT/s	EP, RC AIC, Sys	LEQ Rx data rates LEQ Tx data rates	Path and filename	PCIe Ver. 6.0; 64 GT/s Script for toggling the Tx Compliance Patterns sent by the DUT. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 64 GT/s.
Back-Channel Optimization				
Auto Adjust Sampling Delay during training	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Use Dynamic Rx Eq' is enabled. If set to 'True', the sampling delay will be cycled automatically through various sampling delay settings if link training is not successful.
Back-Channel Optimization File	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	Path and filename	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Optimization File for the back channel specific to one DUT and maximum available data rate. Default: [ED]:[DUT Name]_SN[Serial Number]_[interface Type]_[DUT Type]
Default preset for Back-Channel Optimization data	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	For 32G: P0, ..., P10 For 64G: Q0, ..., Q10	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Default for 32 GT/s: P4; Default for 64 GT/s: Q0 Back-Channel Optimization data from the given Preset is used for the default sampling setup.
Use Back-Channel Optimization Data	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Default: False Loads and applies the Back-Channel Optimization data defined in 'Back-Channel Optimization File'.
Use Dynamic Rx Eq	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates LEQ Tx data rates	True, False	PCIe Ver. 5.0, 6.0; 32, 64 GT/s Visible only if 'Use Back-Channel Optimization Data' is enabled. Default: True. If set to 'True', the Thresholds and FFE settings are adapted to the Preset sent by the DUT during Link Training.
BER Measurement				
Relax Time	EP, RC AIC, Sys Dev, Host	LEQ Rx data rates	100 ms, ..., 37 500 s	PCIe Ver. 4.0, 5.0, 6.0; 8, 16, 32, 64 GT/s The time between when the eye-opening is changed and the start of a BER measurement. This delay is to allow the DUT to adjust to the new settings.

Table A-5 Common link equalization parameters (cont.)

Category/Parameter	DUT Type	Level (where shown in GUI)	Values	Conditions/Description/Where it can be changed
Parameter				
Generator Output Voltage Compensation	EP, RC AIC, Sys Dev, Host	LEQ Transmitter	0 dB, ..., 6 dB	PCIe Ver. 4.0, 5.0, 6.0 Compensation for voltage attenuation caused by the combination of power splitters and attenuators.
Scope Connection for Link EQ Tx Tests	EP, RC AIC, Sys Dev, Host	LEQ Transmitter	Chan 1 2 3 4 Direct Connect Channel 1 3 Differential Probe Channel 2 4 Differential Probe	PCIe Ver. 4.0, 5.0, 6.0 Oscilloscope Channels for LEQ Tx Tests
Skip BER Check	EP, RC AIC, Sys Dev, Host	LEQ Transmitter	True, False	PCIe Ver. 4.0, 5.0, 6.0 If True, LTSSM trains DUT into loopback but then skips the BER check. It can be helpful if at some DUT Tx preset the error detector shows a constant BER because of high insertion loss.

PCI Express N5991 ValiFrame Individual-Procedure Parameters

Parameters for Individual Procedures — Setup Procedure

These parameters are displayed in the GUI at the level of an individual procedure in the Setup Procedure part of the procedure tree. See Table A-1 on page 317 for sequencer parameters.

Table A-6 Setup procedure parameters for individual procedures

Category/Parameter	Description, Values, Where shown in GUI (which procedures)
None	
Offline	▪ If True, the test automation software is not connected to any instrument. This mode should be used for demonstrations and checks only. It is not valid for calibrations or measurements. ▪ If False, the software is connected to instruments and produces valid data. It is read-only in the parameter grid. It can be set in the Instrument Configuration step during station configuration.
	All procedures
Software Version	The version number of the N5991 ValiFrame software currently being used.
	All procedures
Generator Clock	
SSC Deviation	This setting should have the same value as for the test where the optimization data is used.
	Back-Channel Optimization (32, 64 GT/s)
Use SSC	This setting can have an impact on the optimization result. It should be set to 'False' when optimizing the back channel for LEQ Tx tests.
	Back-Channel Optimization (32, 64 GT/s)
Toggling	
Debug Pause after Toggle	Determines the time between two consecutive toggling pulses. Visible when pattern election mode is set to 'Debug'.
	Back-Channel Optimization (32, 64 GT/s)
Debug Toggle Script File for 32 GT/s	Script for toggling the Tx Compliance Patterns sent by the DUT when pattern selection mode is 'Debug'. The script contains the generator sequence with the sent pattern and the analyzer sequence with the expected pattern for 32 GT/s. Value: Path and filename (for 32 GT/s).
	Back-Channel Optimization (32, 64 GT/s)
Debug Toggle Script File for 64 GT/s	Script for toggling the Tx Compliance Patterns sent by the DUT when pattern selection mode is 'Debug'. The script contains the generator sequence with the sent pattern and the analyzer sequence with the expected pattern for 64 GT/s. Value: Path and filename (for 64 GT/s).
	Back-Channel Optimization (64 GT/s)
Pattern Selection Mode	Defines how the compliance pattern is selected for Back-Channel Optimization. ▪ Tx Compliance Pattern Toggling: Automatic Tx Compliance Pattern Toggling ▪ Manual: Manual toggling/forcing the DUT to transmit a specific pattern. ▪ Debug: This uses the BERT pattern generator as the DUT.
	Back-Channel Optimization (32, 64 GT/s)

Table A-6 Setup procedure parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)
Manual Toggle Script File for 32 GT/s	Script file for toggling the Tx Compliance Patterns sent by the DUT when pattern selection mode is ‘Manual’. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 32 GT/s. Value: Path and filename (for 32 GT/s).
	Back-Channel Optimization (32, 64 GT/s)
Manual Toggle Script File for 64 GT/s	Script file for toggling the Tx Compliance Patterns sent by the DUT when pattern selection mode is ‘Manual’. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 64 GT/s. Value: Path and filename (for 64 GT/s).
	Back-Channel Optimization (64 GT/s)
Pause after Toggle	Determines the time between two consecutive toggling pulses. Visible when pattern selection mode is set to ‘Tx Compliance Pattern Toggling’.
	Back-Channel Optimization (32, 64 GT/s)
Toggle Script File for 32 GT/s	Script file used for toggling the Tx Compliance Patterns sent by the DUT when pattern selection mode is ‘Tx Compliance Pattern Toggling’. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 32 GT/s. Value: Path and filename (for 32 GT/s).
	Back-Channel Optimization (32, 64 GT/s)
Toggle Script File for 64 GT/s	Script file for toggling the Tx Compliance Patterns sent by the DUT when pattern selection mode is ‘Tx Compliance Pattern Toggling’. The script contains the generator sequence for toggling and the analyzer sequence with the expected pattern for 64 GT/s. Value: Path and filename (for 64 GT/s).
	Back-Channel Optimization (64 GT/s)
Back-Channel Optimization	
32 GT/s Presets to Optimize	List of the 32 GT/s presets that will be (re-)optimized. Can be empty. Values: P0, ..., P9.
	Back-Channel Optimization (32 GT/s)
64 GT/s Presets to Optimize	List of the 64 GT/s presets that will be (re-)optimized. Can be empty. Values: Q0, ..., Q9.
	Back-Channel Optimization (64 GT/s)
Maximum Number of Rerun Attempts	Visible only if the optimization mode is chosen as ‘Automatic’. It limits the number of times the FFE optimization process will be run for each preset.
	Back-Channel Optimization (32, 64 GT/s)
Measure Estimated Back-Channel Loss	Set to ‘True’ to measure the estimated back-channel loss using the oscilloscope. This is only possible with oscilloscopes with a bandwidth of at least 50 GHz (59 GHz or more is recommended).
	Back-Channel Optimization (32, 64 GT/s)
Number of Auto FFE optimization runs	Number of Auto FFE optimization runs used to determine the best FFE cursors. Values: 1, ..., 40.
	Back-Channel Optimization (32, 64 GT/s)
Number of Compliance Patterns	Visible only if Measure Estimated Back-Channel Loss is enabled. Number of repeats of a compliance pattern captured on the real-time oscilloscope to measure the back-channel loss. Values: 20, ..., 1000.
	Back-Channel Optimization (32, 64 GT/s)

Table A-6 Setup procedure parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)
Optimization Mode	If you select 'Automatic', the amount of user interaction is reduced. The advantage of 'Guided with manual interaction' for an experienced user is that a shorter time may be required for the optimization and the result may be better than in Automatic mode.
	Back-Channel Optimization (32, 64 GT/s)
Optimization Result File	File where the results from the error detector optimization will be saved.
	Back-Channel Optimization (32, 64 GT/s)
Preset Selection Mode	Determines how the presets to be optimized will be selected. Values: All at Target Data Rate, Custom. Additional value at 64G: Include NRZ Prerequisites.
	Back-Channel Optimization (32, 64 GT/s)
Scope Connection for Back-Channel Optimization	Oscilloscope connection used for Back-Channel Optimization.
	Back-Channel Optimization (32, 64 GT/s)
Guided Fixture Characterization	
Cable Type	Values: 2.92 mm, 2.4 mm for 64 GT/s. Only 2.92 mm for 32 GT/s.
	Guided Fixture Characterization (32, 64 GT/s)
CLB Type	Visible only if 'Use result of Guided Fixture Characterization' is set to 'True'. Values: ×1×16, ×4×8
	Guided Fixture Characterization (32, 64 GT/s)
Fixture Revision	Values: Rev2, Rev3, Rev4 for 32 GT/s; Rev1 for 64 GT/s.
	Guided Fixture Characterization (32, 64 GT/s)
VNA Port Configuration	Values: Differential Channel 1-3, Differential Channel 1-2
	Guided Fixture Characterization (32, 64 GT/s)
XML File Export Path	Enter the path where the XML file should be saved.
	Guided Fixture Characterization (32, 64 GT/s)
Oscilloscope	
Gen5 Transfer Function File for Package Model on Scope	The path to the Gen5 transfer function file being used.
	Guided Fixture Characterization (32 GT/s)
Gen6 Transfer Function File for Package Model on Scope	The path to the Gen6 transfer function file being used.
	Guided Fixture Characterization (64 GT/s)
Sequencer	
	The parameters listed in the category Sequencer in the parameter grid are described in Table A-1 on page 317.

Parameters for Individual Procedures — Calibration

These parameters are displayed in the GUI at the level of an individual procedure in the Calibration part of the procedure tree. See Table A-1 on page 317 for sequencer parameters.

Table A-7 Calibration parameters for individual procedures

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
None		
CDR Loop-Bandwidth	The CDR bandwidth passed to SigTest.	
	SJ Calibration (8 GT/s)	
CTLE	The CTLE value passed to SigTest.	
	Compliance Eye Calibration (16 GT/s) Custom Eye Calibration (16, 32 GT/s)	Custom Eye Scan Calibration (16, 32 GT/s) Pre-Compliance Eye Calibration (16 GT/s)
CTLE Index	Values: 1,..., 7. For each index, the DC gain is as follows: 1, –12 dB; 2, –11 dB; 3, –10 dB; 4, –9 dB; 5, –8 dB; 6, –7 dB; 7, –6 dB.	
	SJ Calibration (8 GT/s)	
CTLE Start Value	The CTLE will be optimized during these calibrations. The presets that will be tested to find an optimum point are those that lie between CTLE Start Value and CTLE Stop Value. Making this range smaller might speed up the calibration but it will also negatively impact the accuracy.	
	Channel Calibration (16 GT/s) Final Equalization Preset Optimization (16 GT/s)	Initial Equalization Preset Optimization (16 GT/s)
CTLE Stop Value	See CTLE Start Value.	
	Channel Calibration (16 GT/s) Final Equalization Preset Optimization (16 GT/s)	Initial Equalization Preset Optimization (16 GT/s)
DM Interference Step Size	The amount of additional DM interference added to the simulation at each step.	
	Stressed Jitter Eye Calibration (8 GT/s)	
DMSI for CTLE Optimization	Visible only if Optimize CTLE is enabled. Value of DMSI used for the optimization of CTLE.	
	Eye Height and Width Calibration (8 GT/s)	
EQ Calibration Pattern	Two pattern is usually used in order to remove reflections. Values: EQ Two Pattern, 64 zeros, 64 ones; EQ Two Pattern, 16 zeros, 16 ones; EQ One Pattern, 64 zeros, 64 ones	
	TxEQ and Launch Voltage Calibration (8, 16, 32 GT/s)	TxEQ and Launch Voltage Measurement (8, 16, 32 GT/s)
Equalization Mode	Values: Presets, Custom Values, Cursors	
	Eye Height and Width Scan (16, 32, 64 GT/s)	
Equalization Preset Range	Values: P0, ..., P9	
	Final Equalization Preset Optimization (16 GT/s)	Initial Equalization Preset Optimization (16 GT/s)
Eye Height	Value of eye height used in the calibration.	
	De-Emphasis Calibration (2.5, 5 GT/s)	

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Loop Levels	Values: 2 to 14	
	Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s)	Processing of Pre-Recorded Steps (64 GT/s)
Max Number of Search Steps	The maximum number of steps in the search for optimum DMSI and RJ. After that the search is aborted.	
	Compliance Eye Calibration (8 GT/s)	
Measure All Generator Voltages	For M8040A and M8050A: If True, all generator voltages are measured. If False, only voltages where the cursors have different signs are measured. This increases the speed of the calibration. With the M8020A, all generator voltages are always measured.	
	TxEQ and Launch Voltage Calibration (8, 16, 32 GT/s)	
Measurement Algorithm	For details of the algorithms, see TxEQ and Launch Voltage Calibration on page 155. Values: Measure All Coefficients, Speed-Optimized Measurement	
	TxEQ and Launch Voltage Calibration (64 GT/s)	
Number of Averages	The number of measurements averaged for each value.	
	CMSI Calibration (2.5, 5, 8 GT/s) Compliance Eye Calibration (8 GT/s)	Eye Height and Width Calibration (8 GT/s)
Number of Averages for Jitter Measurement	The number of averages (SigTest measurements) for one RJ or SJ measurement.	
	RJ Calibration (8 GT/s)	SJ Calibration (8 GT/s)
Offline	▪ If True, the test automation software is not connected to any instrument. This mode should be used for demonstrations and checks only. It is not valid for calibrations or measurements. ▪ If False, the software is connected to instruments and produces valid data. It is read-only in the parameter grid. It can be set in the Instrument Configuration step during Station Configuration.	
	All procedures	
Optimize CTLE	When set to 'True', the CTLE index is swept and the optimum CTLE is determined by ValiFrame using SigTest. When set to 'False, the user-selected CTLE index is used for all measurements.	
	Eye Height and Width Calibration (8 GT/s)	
Random Jitter Step Size	The amount by which the random jitter amplitude is increased at each step.	
	RJ Calibration (8 GT/s)	
Re-calibrate on Final Channel	If True, the calibration starts on the final channel from the previous compliance eye calibration instead of the highest loss channel. A successful previous compliance eye calibration is required when selecting this. Values: True, False	
	Compliance Eye Calibration (64 GT/s)	
RJ for CTLE Optimization	Visible only if Optimize CTLE is enabled. Value of RJ used for the optimization of CTLE.	
	Eye Height and Width Calibration (8 GT/s)	
Save Calibration Data	Choose whether to save the created calibration data (True) or not (False). If False, the calibration will have to be rerun when ValiFrame is restarted.	
	Insertion Loss Calibration (16 GT/s)	
Scope Bandwidth	Bandwidth selected on the oscilloscope.	
	Eye Height and Width Measurement (64 GT/s)	

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Select Measurement Algorithm	For details of the algorithms, see TxEQ and Launch Voltage Calibration on page 155. Values: Measure All Coefficients, Speed-Optimized Measurement	
	TxEQ and Launch Voltage Calibration (8, 16, 32 GT/s)	
Show Plots	Values: True, False	
	Eye Height and Width Scan (16, 32, 64 GT/s)	Processing of Pre-Recorded Steps (64 GT/s)
Sinusoidal Jitter	The amount of sinusoidal jitter added to the simulation of the stressed eye.	
	Stressed Jitter Eye Calibration (8 GT/s)	
Skip Preset and CTLE Optimization	Values: True, False	
	Compliance Eye Calibration (64 GT/s)	
Software Version	The version number of the N5991 ValiFrame software currently being used.	
	All procedures	
Start De-Emphasis	Start value of de-emphasis.	
	De-Emphasis Calibration (2.5, 5 GT/s)	
Start DMSI	The first DMSI value set for the calibration table.	
	Eye Height and Width Calibration (8 GT/s)	
Start RJ	The first RJ value set for the calibration table.	
	Eye Height and Width Calibration (8 GT/s)	
Stop DMSI	The last DMSI value set for the calibration table.	
	Eye Height and Width Calibration (8 GT/s)	
Stop RJ	The last RJ value set for the calibration table.	
	Eye Height and Width Calibration (8 GT/s)	
Stop Random Jitter	The maximum RJ amplitude that is calibrated.	
	RJ Calibration (8 GT/s)	
Target Eye Height	Target value of eye height.	
	Compliance Eye Calibration (8 GT/s)	
Target Eye Width	Target value of eye width.	
	Compliance Eye Calibration (8 GT/s)	
Use Coefficients as Input	When set to 'True', the user can input coefficients to be requested during the measurement. When set to 'False', the user can input pre-shoot and de-emphasis values to be requested during the measurement.	
	TxEQ and Launch Voltage Measurement (64 GT/s)	

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Verification Mode	If True, instead of calibrating, the procedure uses the last successful calibration to apply values to the instrument. This can be used to confirm the calibration data if necessary. Values: True, False	
	CMSI Calibration (8, 16, 32, 64 GT/s) Compliance Eye Calibration (8, 16, 32, 64 GT/s) DMSI Calibration (8, 16, 32, 64 GT/s) Eye Height Calibration (2.5, 5 GT/s) HF Second Tone SJ Calibration (64 GT/s) HF SJ Calibration (16, 32, 64 GT/s)	LF SJ Calibration (16 GT/s) RJ Calibration (8, 16, 32, 64 GT/s) SJ Calibration (8 GT/s) Stressed Jitter Eye Calibration (8 GT/s) TxEQ and Launch Voltage Calibration (8, 16, 32, 64 GT/s)
Parameter		
Keep SigTest Files	Set to 'True' to keep the SigTest files.	
	Eye Height and Width Measurement (16 GT/s)	
Generator		
CMSI	Common mode sinusoidal interference added to the signal.	
	Channel Calibration (16 GT/s) Compliance Eye Calibration (64 GT/s) Custom Eye Calibration (64 GT/s) Custom Eye Scan Calibration (64 GT/s)	Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s) Pre-Compliance Eye Calibration (64 GT/s)
Common Mode Interference	Common mode interference added to the signal.	
	Compliance Eye Calibration (16, 32 GT/s) Custom Eye Calibration (16, 32 GT/s)	Custom Eye Scan Calibration (16, 32 GT/s) Pre-Compliance Eye Calibration (16, 32 GT/s)
De-Emphasis	Value of De-Emphasis in dB applied to the signal.	
	Channel Calibration (16 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16, 32, 64 GT/s)	HF SJ Calibration (16, 32 GT/s) LF SJ Calibration (16 GT/s) Pre-Compliance Eye Calibration (16, 32, 64 GT/s) RJ Calibration (16, 32 GT/s) TxEQ and Launch Voltage Measurement (8, 16, 32 GT/s)
Differential Mode Interference	Differential mode interference added to the signal.	
	Custom Eye Calibration (16, 32 GT/s)	Eye Height and Width Measurement (16, 32 GT/s)
Differential Voltage	Value of differential voltage at the generator.	
	Custom Eye Calibration (16, 32 GT/s) Eye Height and Width Measurement (16, 32 GT/s) HF SJ Calibration (16, 32 GT/s)	LF SJ Calibration (16 GT/s) RJ Calibration (16 GT/s)
DMSI	Differential mode sinusoidal interference added to the signal.	
	Channel Calibration (16 GT/s) Custom Eye Calibration (64 GT/s) Eye Height and Width Measurement (64 GT/s)	Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s)
Generator Launch Voltage	Value of launch voltage at the generator.	
	Channel Calibration (16 GT/s) Custom Eye Calibration (64 GT/s) Eye Height and Width Measurement (64 GT/s)	Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s)

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Generator Voltage	Value of voltage at the generator.	
	HF SJ Calibration (16, 32 GT/s) RJ Calibration (16, 32 GT/s)	TxEQ and Launch Voltage Measurement (8, 16, 32 GT/s)
Pre-Shoot	Value of Pre-Shoot in dB applied to the signal.	
	Channel Calibration (16 GT/s) Compliance Eye Calibration (16, 32 GT/s) Custom Eye Calibration (16, 32 GT/s) Custom Eye Scan Calibration (16, 32 GT/s) Eye Height and Width Measurement (16, 32 GT/s)	HF SJ Calibration (16, 32 GT/s) LF SJ Calibration (16 GT/s) Pre-Compliance Eye Calibration (16, 32 GT/s) RJ Calibration (16, 32 GT/s) TxEQ and Launch Voltage Measurement (8, 16, 32 GT/s)
Pre-Shoot1	Value of Pre-Shoot1 in dB applied to the signal.	
	Compliance Eye Calibration (64 GT/s) Custom Eye Calibration (64 GT/s) Custom Eye Scan Calibration (64 GT/s)	Eye Height and Width Measurement (64 GT/s) Pre-Compliance Eye Calibration (64 GT/s)
Pre-Shoot2	Value of Pre-Shoot2 in dB applied to the signal.	
	Compliance Eye Calibration (64 GT/s) Custom Eye Calibration (64 GT/s) Custom Eye Scan Calibration (64 GT/s)	Eye Height and Width Measurement (64 GT/s) Pre-Compliance Eye Calibration (64 GT/s)
Random Jitter	Amount of random jitter added to the signal.	
	Channel Calibration (16 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32, 64 GT/s)	Eye Height and Width Measurement (16, 32, 64 GT/s) Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s) Pre-Compliance Eye Calibration (16, 32, 64 GT/s)
Set Amplitude	Value of launch voltage at the generator.	
	TxEQ and Launch Voltage Calibration (8, 16, 32 GT/s)	
Sinusoidal Jitter	Amount of sinusoidal jitter added to the signal.	
	Channel Calibration (16 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16, 32, 64 GT/s)	Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s)
Sinusoidal Jitter Frequency	Frequency of sinusoidal jitter added to the signal.	
	Channel Calibration (16 GT/s) Compliance Eye Calibration (16, 32 GT/s) Custom Eye Calibration (16, 32 GT/s)	Custom Eye Scan Calibration (16, 32 GT/s) Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s)

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)
Loop n	Here n can take the values 1 to 14. There must be at least two loops.

Scan Parameter (Loop n)	▪ For Custom Eye Scan Calibration (16, 32, 64 GT/s):
	  ▪ By default, Scan Parameter (Loop 1) is set to Differential Mode Sinusoidal Interference
	  ▪ The other available parameters are Generator Launch Voltage and Sinusoidal Jitter.
	▪ For Eye Height and Width Scan (16, 32, 64 GT/s):
	  ▪ By default, Scan Parameter (Loop 1) is set to Equalization Preset.
	▪ For Processing of Pre-Recorded Steps (64 GT/s):
	  ▪ By default, Scan Parameter (Loop 1) is set to Differential Mode Sinusoidal Interference.
	  ▪ The values Equalization Preset and Generator Launch Voltage are not available to be scanned.
	Values: Equalization Preset, Generator Launch Voltage, Differential Mode Sinusoidal Interference (DMSI), Common Mode Sinusoidal Interference (CMSI), Random Jitter, Sinusoidal Jitter, Sinusoidal Jitter Frequency, CTLE, Trace (only 16 GT/s)

	Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
Equalization Preset Range	Available if Scan Parameter (Loop n) is set to Equalization Preset. Values: Q0–Q9
	Eye Height and Width Scan (16, 32, 64 GT/s)
“Parameter” Start Value	Here “Parameter” can be any of the values given for Scan Parameter (Loop n), apart from Equalization Preset.
	Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
“Parameter” Stop Value	Here “Parameter” can be any of the values given for Scan Parameter (Loop n), apart from Equalization Preset.
	Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
“Parameter” Scale Type	Here “Parameter” can be any of the values given for Scan Parameter (Loop n), apart from Equalization Preset. Values: Linear, Logarithmic
	Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
“Parameter” Number of Steps	Here “Parameter” can be any of the values given for Scan Parameter (Loop n), apart from Equalization Preset.
	Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
Fixed Parameters	
CBB var. ISI pair	Number of the ISI trace that will be connected on the CBB side during the scan by the user. This will be prepopulated based on the ISI calibration data.
	Eye Height and Width Scan (16 GT/s)
CLB var. ISI pair	Number of the ISI trace that will be connected on the CLB side during the scan by the user. This will be prepopulated based on the ISI calibration data.
	Eye Height and Width Scan (16 GT/s)
Package Loss at 2.1 GHz	Loss of the package model that was used to record the selected step responses. This is required for the TP2P to TP2 conversion of DMSI. If this value is not correct, the effect of DMSI might be misjudged. It is prepopulated with values of the default package model.
	Processing of Pre-Recorded Steps (64 GT/s)

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
"Parameter"	The parameters listed under "Fixed Parameters" are those listed under "Scan Parameter (Loop n)" (see Loop n just above) that are not scanned but held fixed. ISI is not included here.	
	Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Scan (32, 64 GT/s)	Processing of Pre-Recorded Steps (64 GT/s)
Oscilloscope		
Calibrated Q0 Post-Cursor	Value of the Post-Cursor that was applied to record the Q0 reference waveform during the TxEQ Calibration. For the Measurement it will be loaded from the Calibration result.	
	TxEQ and Launch Voltage Calibration (64 GT/s)	TxEQ and Launch Voltage Measurement (64 GT/s)
Calibrated Q0 Pre-Cursor 1	Value of Pre-Cursor1 that was applied to record the Q0 reference waveform during the TxEQ Calibration. For the Measurement it will be loaded from the Calibration result.	
	TxEQ and Launch Voltage Calibration (64 GT/s)	TxEQ and Launch Voltage Measurement (64 GT/s)
Calibrated Q0 Pre-Cursor 2	Value of the Pre-Cursor2 that was applied to record the Q0 reference waveform during the TxEQ Calibration. For the Measurement it will be loaded from the Calibration result.	
	TxEQ and Launch Voltage Calibration (64 GT/s)	TxEQ and Launch Voltage Measurement (64 GT/s)
CTLE	The value of CTLE in dB.	
	Compliance Eye Calibration (32 GT/s) Eye Height and Width Measurement (16, 32, 64 GT/s)	Pre-Compliance Eye Calibration (32, 64 GT/s)
Do Auto Scale	If True, the vertical scale of the oscilloscope channel is set automatically. Value: True, False	
	Compliance Eye Calibration (64 GT/s) Custom Eye Calibration (64 GT/s) Custom Eye Scan Calibration (64 GT/s) Eye Height and Width Measurement (64 GT/s)	Eye Height and Width Scan (64 GT/s) Pre-Compliance Eye Calibration (64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
Fixed Vertical Scale of Scope Channels	The vertical scale of the oscilloscope channel. If "Do Auto Scale" is set to True, the value here is read only.	
	Compliance Eye Calibration (64 GT/s) Custom Eye Calibration (64 GT/s) Custom Eye Scan Calibration (64 GT/s) Eye Height and Width Measurement (64 GT/s)	Eye Height and Width Scan (64 GT/s) Pre-Compliance Eye Calibration (64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
Horizontal Range	The Horizontal Range that will be set on the oscilloscope during the calibration. This will determine how many UIs will be displayed during the calibration.	
	DMSI Calibration (16 GT/s)	

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Number of Averages	Number of measurements averaged for each (jitter) value.	
	AWG Amplitude Correction Calibration (32 GT/s) Channel Calibration (16 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s) Final Equalization Preset Optimization (16 GT/s) HF Second Tone SJ Calibration (64 GT/s) HF SJ Calibration (16, 32, 64 GT/s)	Initial Equalization Preset Optimization (16 GT/s) Insertion Loss Calibration (16, 32 GT/s) LF SJ Calibration (16 GT/s) Pre-Compliance Eye Calibration (16, 32, 64 GT/s) Processing of Pre-Recorded Steps (64 GT/s) Pulsewidth Jitter Calibration (64 GT/s) RJ Calibration (16, 32, 64 GT/s) SNDR Calibration (64 GT/s) TxEQ and Launch Voltage Calibration (64 GT/s) TxEQ and Launch Voltage Measurement (64 GT/s)
Number of UIs	Number of unit intervals tested.	
	Channel Calibration (16 GT/s) CMSI Calibration (16 GT/s) Compliance Eye Calibration (16 GT/s) Custom Eye Calibration (16 GT/s) Custom Eye Scan Calibration (16 GT/s) Eye Height and Width Measurement (16 GT/s) Eye Height and Width Scan (16 GT/s) Final Equalization Preset Optimization (16 GT/s)	HF Second Tone SJ Calibration (16, 32, 64 GT/s) HF SJ Calibration (16, 32, 64 GT/s) Initial Equalization Preset Optimization (16 GT/s) LF SJ Calibration (16 GT/s) Pre-Compliance Eye Calibration (16 GT/s) Pulsewidth Jitter Calibration (64 GT/s) RJ Calibration (16, 32, 64 GT/s)
Number of Waveform Averages	Number of waveforms that are averaged during the scope acquisition. A higher number will reduce the noise floor.	
	AWG Amplitude Correction Calibration (32 GT/s) Channel Calibration (16 GT/s) CMSI Calibration (16, 32 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32, 64 GT/s) DMSI Calibration (16, 32 GT/s) Eye Height and Width Measurement (16, 32, 64 GT/s) Eye Height and Width Scan (16, 32, 64 GT/s)	Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s) Insertion Loss Calibration (16, 32 GT/s) Pre-Compliance Eye Calibration (16, 32, 64 GT/s) Processing of Pre-Recorded Steps (64 GT/s) TxEQ and Launch Voltage Calibration (8, 16, 32, 64 GT/s) TxEQ and Launch Voltage Measurement (8, 16, 32, 64 GT/s)
Optimize CTLE	Values: True, False	
	Eye Height and Width Measurement (16 GT/s)	Eye Height and Width Scan (16 GT/s)
Remove Scope Noise	This parameter is editable only in RJ Calibration; the same value is applied to the other calibrations listed here. Values: True, False	
	HF Second Tone SJ Calibration (64 GT/s) HF SJ Calibration (64 GT/s) Pulsewidth Jitter Calibration (64 GT/s)	RJ Calibration (64 GT/s) SNDR Calibration (64 GT/s)

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Scope Bandwidth	Bandwidth selected on the oscilloscope.	
	AWG Amplitude Correction Calibration (16, 32, 64 GT/s) Channel Calibration (16 GT/s) CMSI Calibration (16, 32, 64 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32, 64 GT/s) DMSI Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16, 32 GT/s) Eye Height and Width Scan (16, 32 GT/s) Final Equalization Preset Optimization (16 GT/s) HF Second Tone SJ Calibration (64 GT/s)	HF SJ Calibration (16, 32, 64 GT/s) Initial Equalization Preset Optimization (16 GT/s) Insertion Loss Calibration (16, 32 GT/s) LF SJ Calibration (16 GT/s) Pre-Compliance Eye Calibration (16, 32 GT/s) Pulsewidth Jitter Calibration (64 GT/s) RJ Calibration (16, 32, 64 GT/s) Scope Channel Skew Calibration (64 GT/s) TxEQ and Launch Voltage Calibration (8, 16, 32, 64 GT/s) TxEQ and Launch Voltage Measurement (8, 16, 32, 64 GT/s)
Scope RJ	Read-only value of intrinsic RJ of the oscilloscope. If ‘Remove Scope Noise’ is set to True, this value is removed internally in the scope RJ measurement.	
	RJ Calibration (64 GT/s)	
Scope Skew	If the used channels have an inter-channel skew, the value can be added here and will be compensated during measurements.	
	Compliance Eye Calibration (64 GT/s) Custom Eye Calibration (64 GT/s) Custom Eye Scan Calibration (64 GT/s) Eye Height and Width Measurement (64 GT/s)	Eye Height and Width Scan (64 GT/s) Pre-Compliance Eye Calibration (64 GT/s) Processing of Pre-Recorded Steps (64 GT/s)
Use Bessel Filter	Values: True, False	
	HF Second Tone SJ Calibration (64 GT/s) HF SJ Calibration (64 GT/s) Pulsewidth Jitter Calibration (64 GT/s) RJ Calibration (64 GT/s)	SNDR Calibration (64 GT/s) TxEQ and Launch Voltage Calibration (64 GT/s) TxEQ and Launch Voltage Measurement (64 GT/s)
Use Linear Fit Pulse Response	When set to ‘True’, pre-shoot and de-emphasis are calibrated using the linear fir pulse response measurement, in contrast to previous measurement using the voltage levels. The default value, True, is read-only; it cannot be changed by the user.	
	TxEQ and Launch Voltage Calibration (64 GT/s)	TxEQ and Launch Voltage Measurement (64 GT/s)
Vertical Scale	Scale of the vertical axis on the oscilloscope.	
	TxEQ and Launch Voltage Calibration (64 GT/s)	
Preset and CTLE Optimization		
CTLE Start Value	Start Value of the CTLE for the calibration.	
	Compliance Eye Calibration (32 GT/s)	Pre-Compliance Eye Calibration (32 GT/s)
CTLE Stop Value	Stop value of the CTLE for the calibration.	
	Compliance Eye Calibration (32 GT/s)	Pre-Compliance Eye Calibration (32 GT/s)
DMSI	Differential mode sinusoidal interference added to the signal.	
	Compliance Eye Calibration (32, 64 GT/s)	Pre-Compliance Eye Calibration (32, 64 GT/s)
Equalization Preset Range	Compliance Eye Calibration (64 GT/s)	Pre-Compliance Eye Calibration (64 GT/s)

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Number of Averages	Number of measurements averaged for each jitter value.	
	Compliance Eye Calibration (32, 64 GT/s)	Pre-Compliance Eye Calibration (32, 64 GT/s)
Presets Range	Compliance Eye Calibration (32 GT/s)	Pre-Compliance Eye Calibration (32 GT/s)
Sinusoidal Jitter	Sinusoidal jitter added to the signal.	
	Compliance Eye Calibration (64 GT/s)	Pre-Compliance Eye Calibration (64 GT/s)
SJ	Sinusoidal jitter added to the signal.	
	Compliance Eye Calibration (32 GT/s)	Pre-Compliance Eye Calibration (32 GT/s)
Search Algorithm		
Maximum DMSI	Compliance Eye Calibration (16, 32, 64 GT/s)	
Maximum SJ	Compliance Eye Calibration (16, 32, 64 GT/s)	
Max Number of Search Steps	Compliance Eye Calibration (16, 64 GT/s)	
Max Number of Search Steps per Channel	Compliance Eye Calibration (32 GT/s)	
Minimum SJ	Values: 1 ps to 1.5625 ps	
	Compliance Eye Calibration (64 GT/s)	
Minimum Vdiff	Compliance Eye Calibration (16, 32, 64 GT/s)	
Use Nominal EH/EW Results from Pre Comp Cal	Values: True, False	
	Compliance Eye Calibration (16 GT/s)	
Calibration Flow		
Skip Preset and CTLE Optimization	Values: True, False	
	Compliance Eye Calibration (32 GT/s)	
Re-calibrate on Final Channel	Values: True, False	
	Compliance Eye Calibration (32 GT/s)	
Seasim		
Directory that contains the step responses to process	Here you can specify the directory where the files that are to be used for the procedure are stored. All step response files must have the extension '.rfstep1'.	
	Processing of Pre-Recorded Steps (64 GT/s)	
Optimize CTLE	Value: True, False	
	Custom Eye Calibration (64 GT/s) Custom Eye Scan Calibration (64 GT/s)	Eye Height and Width Measurement (32, 64 GT/s) Eye Height and Width Scan (32, 64 GT/s)
SigTest		
Add SigTest Result Details	When set to 'True', more details about each individual SigTest average are added to the results table. Values: True, False.	
	Eye Height and Width Measurement (16 GT/s)	Eye Height and Width Scan (16, 32 GT/s)

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Eye Height Result Type	Selects which type of eye height calculation is used to determine the eye height. Values: Composite Eye Height, Extrapolated Eye Height	
	Eye Height and Width Measurement (16 GT/s)	Eye Height and Width Scan (16, 32 GT/s)
Number of UI	Number of unit intervals that the oscilloscope is set up to capture.	
	Eye Height and Width Measurement (16 GT/s)	Eye Height and Width Scan (16, 32 GT/s)
SigTest Template for EH/EW Measurement	Specifies the template (file) that is used for the eye calibration in SigTest.	
	Eye Height and Width Measurement (16 GT/s)	Eye Height and Width Scan (16, 32 GT/s)
Use SigTest	Default: True. Set to ‘False’ to use Seasim.	
	HF SJ Calibration (64 GT/s)	
Channel		
CBB var. ISI pair	Number of the ISI trace that will be connected on the CBB side during the procedure by the user. A value might already be present, based on previous calibration data.	
	AWG Amplitude Correction Calibration (16, 32, 64 GT/s) CMSI Calibration (16, 32, 64 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32 GT/s)	DMSI Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16 GT/s) Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s) Pre-Compliance Eye Calibration (16, 32 GT/s)
CLB var. ISI pair	Number of the ISI trace that will be connected on the CBB side during the procedure by the user. A value might already be present, based on previous calibration data.	
	AWG Amplitude Correction Calibration (16, 32, 64 GT/s) Channel Calibration (16 GT/s) CMSI Calibration (16, 32, 64 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s)	Custom Eye Scan Calibration (16, 32 GT/s) DMSI Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16 GT/s) Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s) Pre-Compliance Eye Calibration (16, 32 GT/s)
Total Channel Loss	Total insertion loss of the calibration channel.	
	AWG Amplitude Correction Calibration (16, 32, 64 GT/s) CMSI Calibration (16, 32, 64 GT/s) Compliance Eye Calibration (16, 32, 64 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32, 64 GT/s)	DMSI Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16, 32, 64 GT/s) Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s) Pre-Compliance Eye Calibration (16, 32, 64 GT/s)
Trace Number	Hardware trace number used for the procedure.	
	AWG Amplitude Correction Calibration (32, 64 GT/s) CMSI Calibration (16, 64 GT/s) Compliance Eye Calibration (16, 32 GT/s) Custom Eye Calibration (16, 32, 64 GT/s) Custom Eye Scan Calibration (16, 32, 64 GT/s)	DMSI Calibration (16, 32, 64 GT/s) Eye Height and Width Measurement (16 GT/s) Final Equalization Preset Optimization (16 GT/s) Initial Equalization Preset Optimization (16 GT/s) Pre-Compliance Eye Calibration (16, 32, 64 GT/s)

Table A-7 Calibration parameters for individual procedures (cont.)

Category/Parameter	Description, Values, Where shown in GUI (which procedures)	
Capture		
Capture Mode	This allows waveforms to be saved for the current configuration for each step of the procedure. Values: ▪ Do only local eye measurement ▪ Only save waveform on the oscilloscope – The waveforms are saved but no measurement is performed. ▪ Do local eye measurement and save waveform on the oscilloscope – The normal calibration/measurement is performed and additionally the waveforms are saved on the oscilloscope.	
	Eye Height and Width Measurement (16, 32 GT/s)	Eye Height and Width Scan (32 GT/s)
Guided Fixture Characterization		
CLB Type	Visible only if ‘Use result of Guided Fixture Characterization’ is set to ‘True’. Values: ×1×16, ×4×8	
	Insertion Loss Calibration (32, 64 GT/s)	
Use result of Guided Fixture Characterization	Set to ‘True’ to use the results of the Guided Fixture Calibration. This is possible only if the Setup Preparation license is activated.	
	Insertion Loss Calibration (32, 64 GT/s)	
XML File Import Path	Visible only if ‘Use result of Guided Fixture Characterization’ is set to ‘True’. Enter the path from where the XML file should be imported.	
	Insertion Loss Calibration (32, 64 GT/s)	
Sequencer		
	The parameters listed in the category Sequencer in the parameter grid are described in Table A-1 on page 317.	
Variable ISI Pairs		
CBB var. ISI pair –XXdB Channel	The number of the variable ISI pair on the CCB side required for –XX dB.	
	Insertion Loss Calibration (16, 32 GT/s)	

Parameters for Individual Procedures — Receiver

These parameters are displayed in the GUI at the level of an individual procedure in the Receiver and Receiver Setup parts of the procedure tree. See Table A-1 on page 317 for sequencer parameters.

For more details about the parameters listed in the category Sinusoidal Jitter Variation and the relationships between them, see Rx Jitter Tolerance Test on page 247.

Table A-8 Receiver parameters for individual procedures

Category/ Parameter	Description/ Values/Where shown in GUI	
None		
CMSI Amplitude	Rx Compliance Setup (2.5, 5 GT/s) Rx Compliance Test (2.5, 5 GT/s)	Rx Jitter Tolerance Test (2.5, 5 GT/s) Rx Sensitivity Test (2.5, 5 GT/s)
Eye Height	Rx Stressed Jitter Eye Setup (8 GT/s)	
Eye Width	Rx Stressed Jitter Eye Setup (8 GT/s)	
ISI	Rx Compliance Setup (2.5, 5 GT/s) Rx Compliance Test (2.5, 5 GT/s)	Rx Jitter Tolerance Test (2.5, 5 GT/s) Rx Sensitivity Test (2.5, 5 GT/s)
Offline	▪ If True, the test automation software is not connected to any instrument. This mode should be used for demonstrations and checks only. It is not valid for calibrations or measurements. ▪ If False, the software is connected to instruments and produces valid data. It is read-only in the parameter grid. It can be set in the Instrument Configuration step during Station Configuration.	
	All procedures	
Repeat Setup	Values: True, False	
	Rx Impairments Setup (32, 64 GT/s)	
Software Version	The version number of the N5991 ValiFrame software currently being used.	
	All procedures	
Swap HF PJ Sources	Swap the HF jitter sources PJ1 and PJ2. When True, ValiFrame uses the same sources as the M8070B JTOL plugin.	
	Rx Impairments Setup (32 GT/s)	
Loopback Training		
De-Emphasis used for LB Training	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s)	Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s)
Enable Impairments during Loopback Training	Values: True, False	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Custom Sensitivity Test (16, 32, 64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Preset Pre-Compliance Test (8 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 8, 16, 32, 64 GT/s)
Force Retraining at each BER Measurement	Values: True, False. If True, retraining is forced at each BER measurement for different Pre-Shoot2/Pre-Shoot1/DE combinations.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s)	Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Force Retraining at each Preset	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Force Retraining on each Frequency	Values: True, False	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16 GT/s)
Pre-Shoot used for LB Training	Rx Coefficient Matrix Scan (8, 16, 32 GT/s)	Rx Custom Coefficient Matrix Scan (16, 32 GT/s)
Pre-Shoot1 used for LB Training	Rx Coefficient Matrix Scan (64 GT/s)	Rx Custom Coefficient Matrix Scan (64 GT/s)
Pre-Shoot2 used for LB training	Rx Coefficient Matrix Scan (64 GT/s)	Rx Custom Coefficient Matrix Scan (64 GT/s)
Eye Parameter		
Common Mode Sinusoidal Interference	Rx Coefficient Matrix Scan (8 GT/s)	
Eye Height	Rx Coefficient Matrix Scan (8 GT/s)	
Eye Width	Rx Coefficient Matrix Scan (8 GT/s)	
Coefficient Variation		
Coefficient Divider	The coefficient divider (for C−2, C−1 and C+1 for 64 GT/s).	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s)	Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s)
Maximum Boost	Coefficient C+1 is increased until this Boost level is exceeded.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s)	Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s)
Maximum Pre-Shoot1 for C−2 = 0, C+1 = 0	Maximum pre-shoot1 for C−2 = 0 (0 dB pre-shoot2) and C+1 = 0 (0 dB de-emphasis). Coefficient C−1 is increased until this pre-shoot1 level is exceeded.	
	Rx Coefficient Matrix Scan (64 GT/s)	Rx Custom Coefficient Matrix Scan (64 GT/s)
Maximum Pre-Shoot2 for C−1 = 0, C+1 = 0	Maximum pre-shoot2 for C−1 = 0 (0 dB pre-shoot1) and C+1 = 0 (0 dB de-emphasis). Coefficient C−2 is increased until this pre-shoot2 level is exceeded.	
	Rx Coefficient Matrix Scan (64 GT/s)	Rx Custom Coefficient Matrix Scan (64 GT/s)
Start De-Emphasis	Start De-Emphasis value in dB	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s)	Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s)
Start Pre-Shoot	Start Pre-Shoot value in dB.	
	Rx Coefficient Matrix Scan (8, 16, 32 GT/s)	Rx Custom Coefficient Matrix Scan (16, 32 GT/s)
Start Pre-Shoot1	Start Pre-Shoot1 value in dB.	
	Rx Coefficient Matrix Scan (64 GT/s)	Rx Custom Coefficient Matrix Scan (64 GT/s)
Start Pre-Shoot2	Start Pre-Shoot2 value in dB.	
	Rx Coefficient Matrix Scan (64 GT/s)	Rx Custom Coefficient Matrix Scan (64 GT/s)
Test Presets Only	When set to 'True', only the equalization preset are swept (varied) during the procedure. When set to 'False', a matrix of pre-shoot and de-emphasis values can be swept.	
	Rx Coefficient Matrix Scan (8 GT/s)	
Pre-Shoot Variation		
Pre-Shoot Step Size	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Start Pre-Shoot	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Stop Pre-Shoot	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
De-Emphasis Variation		
De-Emphasis Step Size	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Start De-Emphasis	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Stop De-Emphasis	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Parameter		
Eye Height	Rx Pre-Compliance Setup (8 GT/s) Rx Pre-Compliance Test (8 GT/s)	Rx Preset Pre-Compliance Test (8 GT/s)
Eye Width	Rx Pre-Compliance Setup (8 GT/s) Rx Pre-Compliance Test (8 GT/s)	Rx Preset Pre-Compliance Test (8 GT/s)
Initial De-Emphasis	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Initial Pre-Shoot	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Scan Order	Values: De-emphasis first, Pre-shoot first	
	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Generator Jitter		
LF Sinusoidal Jitter Amplitude	Rx Compliance Test (2.5, 5 GT/s)	Rx Sensitivity Test (2.5, 5 GT/s)
LF Sinusoidal Jitter Frequency	Rx Sensitivity Test (2.5, 5 GT/s)	
Use Jitter	If True, jitter is added to the test signal.	
	Rx Sensitivity Test (2.5, 5 GT/s)	
Sinusoidal Jitter Variation (see Rx Jitter Tolerance Test on page 247)		
Frequency Mode	Defines jitter frequencies that will be tested. Values: Compliance Frequencies, Equally Spaced Frequencies, User Defined Frequencies, Single Frequency. Default: Compliance frequencies.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Frequency sweep scale	Defines how the frequency values are calculated. Values: Logarithmic, Linear Enabled when Frequency Mode is ‘Equally Spaced Frequencies’.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Jitter Frequencies/Frequency	Read-only when Frequency Mode is Compliance Frequencies.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Jitter step size(s) or factor(s)	Read-only when Frequency Mode is Compliance Frequencies and Use fixed number of steps is False.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Number of frequency steps	Enabled when Frequency Mode is Equally Spaced Frequencies.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Number of jitter steps	Available when Use fixed number of steps is True.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Search Algorithm	Values: Binary, Linear, Linear with 2 step sizes, Linear with 2 step sizes and hysteresis, Logarithmic up, Logarithmic down. Default: Linear with 2 step sizes. The binary search algorithm is recommended for DUTs with short recovery time. For more details about the search algorithms, see Rx Jitter Tolerance Test on page 247.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Show min failed points	If True, the minimum sinusoidal jitter amplitude at which the BER test failed is included in the results graph.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Start frequency value	Enabled when Frequency Mode is Equally Spaced Frequencies.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Start jitter amplitude(s)	Read-only when Frequency Mode is Compliance Frequencies.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Stop frequency value	Enabled when Frequency Mode is Equally Spaced Frequencies.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Stop jitter amplitude(s)	Read-only when Frequency Mode is Compliance Frequencies.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Use fixed number of steps	▪ If True, the range from the start amplitude to the jitter capability at each frequency is divided into a fixed number of steps. ▪ If False, the jitter steps are calculated depending on the Frequency Mode.	
	Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s)
Eye Height		
Eye Height	Rx Compliance Setup (2.5, 5 GT/s) Rx Compliance Test (2.5, 5 GT/s)	Rx Jitter Tolerance Test (2.5, 5 GT/s)
Loopback Training Eye Height	The eye height used for loopback training.	
	Rx Sensitivity Test (2.5, 5 GT/s)	
Start Eye Height	The eye height with which the test starts.	
	Rx Sensitivity Test (2.5, 5 GT/s)	
Step Size	The amount by which the eye height is decreased in each step to search for the “Min Passed Eye Height”. “Min Passed Eye Height” is the smallest eye height at which the DUT passes the BER test. At the next lower eye height the DUT fails the BER test.	
	Rx Sensitivity Test (2.5, 5 GT/s)	
Stop Eye Height	The eye height at which the test is aborted if the DUT does not fail the BER test before.	
	Rx Sensitivity Test (2.5, 5 GT/s)	

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Sensitivity Variation		
Sensitivity Mode	Values: Differential Mode Interference, Generator Launch Voltage	
	Rx Custom Sensitivity Test (16, 32, 64GT/s)	Rx Sensitivity Test (16, 32, 64 GT/s)
Start "Parameter"	Start value of "Parameter", where "Parameter" refers to the parameter selected in Sensitivity Mode (for 16, 64 GT/s, e.g., Differential Mode Interference, Generator Launch Voltage) or Eye Height (8 GT/s).	
	Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Sensitivity Test (8, 16, 32, 64 GT/s)
Stop "Parameter"	Stop value of "Parameter", where "Parameter" refers to the parameter selected in Sensitivity Mode (for 64 GT/s, e.g., Differential Mode Interference, Generator Launch Voltage) or Eye Height (8 GT/s).	
	Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Sensitivity Test (8, 16, 32, 64 GT/s)
"Parameter" Step Size	Step size of "Parameter", where "Parameter" refers to the parameter selected in Sensitivity Mode (for 64 GT/s, e.g., Differential Mode Interference, Generator Launch Voltage) or Eye Height (8 GT/s).	
	Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Sensitivity Test (8, 16, 32, 64 GT/s)
BER Measurement		
Abort BER measurement when failed	Values: True, False. If True, the BER measurement is aborted when the allowed bit errors are exceeded (for BER Mode 'Fixed Time').	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Custom Sensitivity Test (16, 32, 64 GT/s) Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 8, 16, 32, 64 GT/s)
Abort FBER measurement when failed	Visible only if Bit Error Ratio Measurement is set to 'FBER'. Values: True, False. If True, the FBER measurement is aborted when the allowed bit errors are exceeded (for FBER Mode 'Fixed Time').	
	Rx Coefficient Matrix Scan (64 GT/s) Rx Custom Coefficient Matrix Scan (64 GT/s) Rx Custom Jitter Tolerance Test (64 GT/s) Rx Custom Pre-Compliance Test (64 GT/s) Rx Custom Sensitivity Test (64 GT/s)	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (64 GT/s) Rx Pre-Compliance Test (64 GT/s) Rx Sensitivity Test (64 GT/s)
Allowed Bit Error	Number of bit errors that are allowed when BER Mode or FBER Mode is 'Fixed Time'.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Custom Sensitivity Test (16, 32, 64 GT/s) Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 8, 16, 32, 64 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
BER Measurement Duration	Duration of the BER measurement in seconds when BER Mode is 'Fixed Time'.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Preset Pre-Compliance Test (8 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 8, 16, 32, 64 GT/s)
BER Mode	Values: Target BER, Fixed Time	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Custom Sensitivity Test (16, 32, 64 GT/s) Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 8, 16, 32, 64 GT/s)
Bit Error Ratio Measurement	Values: FBER, BER. For more details about when FBER is supported, see Parameters Related to FBER on page 229. If 'BER' is selected, the BER measurement is performed as usual. If 'FBER' is selected, only the first bit of a possible error burst counts as an error. Any number of bit errors in a PAM4 symbol (that is, 1 or 2) are considered as a symbol error. The number of consecutive symbol errors that constitute an error burst can be selected using Maximum Number of Consecutive Symbols.	
	Rx Coefficient Matrix Scan (64 GT/s) Rx Custom Coefficient Matrix Scan (64 GT/s) Rx Custom Jitter Tolerance Test (64 GT/s) Rx Custom Pre-Compliance Test (64 GT/s) Rx Custom Sensitivity Test (64 GT/s)	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (64 GT/s) Rx Pre-Compliance Test (64 GT/s) Rx Sensitivity Test (64 GT/s)
Confidence Level	The value of the confidence level when BER Mode is 'Target BER' or FBER Mode is 'Target FBER'.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s)	Rx Custom Sensitivity Test (16, 32, 64 GT/s) Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 816, 32, 64 GT/s)
FBER Measurement Duration	Visible only if Bit Error Ratio Measurement is set to 'FBER'. Duration of the FBER measurement in seconds when FBER Mode is 'Fixed Time'.	
	Rx Coefficient Matrix Scan (64 GT/s) Rx Custom Coefficient Matrix Scan (64 GT/s) Rx Custom Jitter Tolerance Test (64 GT/s) Rx Custom Pre-Compliance Test (64 GT/s) Rx Custom Sensitivity Test (64 GT/s)	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (64 GT/s) Rx Pre-Compliance Test (64 GT/s) Rx Sensitivity Test (64 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
FBER Mode	Visible only if Bit Error Ratio Measurement is set to 'FBER'. Values: Target FBER, Fixed Time	
	Rx Coefficient Matrix Scan (64 GT/s) Rx Custom Coefficient Matrix Scan (64 GT/s) Rx Custom Jitter Tolerance Test (64 GT/s) Rx Custom Pre-Compliance Test (64 GT/s Rx Custom Sensitivity Test (64 GT/s))	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (64 GT/s) Rx Pre-Compliance Test (64 GT/s) Rx Sensitivity Test (64 GT/s)
Maximum number of consecutive symbols	The number of consecutive symbols errors that together count as just one error for FBER. Visible only if Bit Error Ratio Measurement is set to 'FBER'.	
	Rx Coefficient Matrix Scan (64 GT/s) Rx Custom Coefficient Matrix Scan (64 GT/s) Rx Custom Jitter Tolerance Test (64 GT/s) Rx Custom Pre-Compliance Test (64 GT/s) Rx Custom Sensitivity Test (64 GT/s)	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (64 GT/s) Rx Pre-Compliance Test (64 GT/s) Rx Sensitivity Test (64 GT/s)
Target BER	The target value of BER to be reached when BER Mode is 'Target BER'.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Preset Pre-Compliance Test (8 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 8, 16, 32, 64 GT/s)
Target FBER	Visible only if Bit Error Ratio Measurement is set to 'FBER'. The target value of FBER to be reached when FBER Mode is 'Target BER'.	
	Rx Coefficient Matrix Scan (64 GT/s) Rx Custom Coefficient Matrix Scan (64 GT/s) Rx Custom Jitter Tolerance Test (64 GT/s) Rx Custom Pre-Compliance Test (64 GT/s) Rx Custom Sensitivity Test (64 GT/s)	Rx Impairments Setup (64 GT/s) Rx Jitter Tolerance Test (64 GT/s) Rx Pre-Compliance Test (64 GT/s) Rx Sensitivity Test (64 GT/s)
Impairments (Most of the parameters listed under Impairments are read-only unless Use Compliance Impairments is set to False)		
2nd Tone Sinusoidal Jitter	Only for ASIC or if the Jitter Eye Adjustment Mode is set to ASIC (Rx Jitter Tolerance Test only).	
	Rx Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (16, 32, 64 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Sensitivity Test (16, 32, 64 GT/s)
2nd Tone Sinusoidal Jitter Frequency	Only for ASIC or if the Jitter Eye Adjustment Mode is set to ASIC (Rx Jitter Tolerance Test only).	
	Rx Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (16, 32, 64 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Sensitivity Test (16, 32, 64 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Common Mode Interference	Rx Coefficient Matrix Scan (32, 64 GT/s) Rx Custom Coefficient Matrix Scan (32, 64 GT/s) Rx Custom Jitter Tolerance Test (32, 64 GT/s) Rx Custom Pre-Compliance Test (32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (32 GT/s) Rx Custom Sensitivity Test (32, 64 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (32, 64 GT/s) Rx Pre-Compliance Test (32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (32 GT/s) Rx Sensitivity Test (32, 64 GT/s)
Common Mode Sinusoidal Interference	Rx Coefficient Matrix Scan (16 GT/s) Rx Custom Coefficient Matrix Scan (16 GT/s) Rx Custom Jitter Tolerance Test (16 GT/s) Rx Custom Pre-Compliance Test (16 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16 GT/s) Rx Custom Sensitivity Test (16 GT/s)	Rx Jitter Tolerance Test (8, 16 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (8, 16 GT/s) Rx Pre-Shoot De-Emphasis Scan (16 GT/s) Rx Sensitivity Test (16 GT/s)
Differential Mode Interference	Rx Coefficient Matrix Scan (32, 64 GT/s) Rx Custom Coefficient Matrix Scan (32, 64 GT/s) Rx Custom Jitter Tolerance Test (32, 64 GT/s) Rx Custom Pre-Compliance Test (32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (32 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (32, 64 GT/s) Rx Pre-Compliance Test (32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (32 GT/s)
Differential Mode Sinusoidal Interference	Rx Coefficient Matrix Scan (8, 16 GT/s) Rx Custom Coefficient Matrix Scan (16 GT/s) Rx Custom Jitter Tolerance Test (16 GT/s) Rx Custom Pre-Compliance Test (16 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16 GT/s) Rx Jitter Tolerance Test (8, 16 GT/s)	Rx Pre-Compliance Setup (8, 16 GT/s) Rx Pre-Compliance Test (8, 16 GT/s) Rx Preset Pre-Compliance Test (8 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16 GT/s) Rx Stressed Jitter Eye Setup (8 GT/s)
Differential Voltage	Rx Coefficient Matrix Scan (32, 64 GT/s) Rx Custom Coefficient Matrix Scan (32, 64 GT/s) Rx Custom Jitter Tolerance Test (32, 64 GT/s) Rx Custom Pre-Compliance Test (32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (32 GT/s) Rx Custom Sensitivity Test (32, 64 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (32, 64 GT/s) Rx Pre-Compliance Test (32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (32 GT/s) Rx Sensitivity Test (32, 64 GT/s)
Generator Launch Voltage	Rx Coefficient Matrix Scan (16 GT/s) Rx Custom Coefficient Matrix Scan (16 GT/s) Rx Custom Jitter Tolerance Test (16 GT/s) Rx Custom Pre-Compliance Test (16 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16 GT/s) Rx Custom Sensitivity Test (16 GT/s)	Rx Jitter Tolerance Test (8, 16 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (8, 16 GT/s) Rx Pre-Shoot De-Emphasis Scan (16 GT/s) Rx Sensitivity Test (16 GT/s) Rx Stressed Jitter Eye Setup (8 GT/s)
HF Sinusoidal Jitter	The amplitude of the SJ component fixed at a high frequency during the test.	
	Rx Compliance Setup (5 GT/s) Rx Compliance Test (5 GT/s)	Rx Jitter Tolerance Test (5 GT/s) Rx Sensitivity Test (5 GT/s)
HF Sinusoidal Jitter Frequency	The frequency of the HF SJ component.	
	Rx Compliance Setup (5 GT/s) Rx Compliance Test (5 GT/s)	Rx Jitter Tolerance Test (5 GT/s) Rx Sensitivity Test (5 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Jitter Eye Adjustment Mode	Values: ASIC, CEM ASIC: Either a 2nd tone SJ or RJ reduction is used to adjust to the target EH and EW. SJ pass/fail limit is nominal SJ.	
	Rx Custom Jitter Tolerance Test (16, 32 GT/s)	Rx Jitter Tolerance Test (16, 32 GT/s)
LF Sinusoidal Jitter	Rx Compliance Setup (2.5, 5 GT/s)	
LF Sinusoidal Jitter Frequency	Rx Compliance Setup (2.5, 5 GT/s)	
Random Jitter	The amount of random jitter (rms) added to the test signal.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Compliance Setup (2.5, 5 GT/s) Rx Compliance Test (2.5, 5 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Pre-Compliance Setup (8, 16 GT/s) Rx Pre-Compliance Test (8, 16, 32, 64 GT/s) Rx Preset Pre-Compliance Test (8 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (2.5, 5, 8, 16, 32, 64 GT/s) Rx Stressed Jitter Eye Setup (8 GT/s)
Residual SSC (Triangular)	Magnitude of the residual SSC when residual SSC is selected to be in triangular modulation. Only for CEM. Visible only if Use Residual SSC (Triangular) is set to 'True'.	
	Rx Coefficient Matrix Scan (16 GT/s) Rx Custom Coefficient Matrix Scan (16 GT/s) Rx Custom Jitter Tolerance Test (16 GT/s) Rx Custom Pre-Compliance Test (16 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16 GT/s)	Rx Custom Sensitivity Test (16 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (16 GT/s) Rx Pre-Shoot De-Emphasis Scan (16 GT/s) Rx Sensitivity Test (16 GT/s)
RJ Low Pass Filter Frequency	1000 MHz low-pass filter frequency is compliant with the spec but it reduces the total amount of SJ for high jitter frequencies. In order to have the full amount of SJ, change to 500 MHz. This is only available for M8020A and M8040A.	
	Rx Custom Jitter Tolerance Test (16, 32 GT/s)	Rx Jitter Tolerance Test (2.5, 5, 8, 16, 32 GT/s)
Sinusoidal Jitter	Amplitude of the sinusoidal jitter added to the signal.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s) Rx Impairments Setup (32, 64 GT/s)	Rx Pre-Compliance Setup (8, 16 GT/s) Rx Pre-Compliance Test (32 GT/s) Rx Preset Pre-Compliance Test (8 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (8, 16, 32, 64 GT/s) Rx Stressed Jitter Eye Setup (8 GT/s)
Sinusoidal Jitter Frequency	Frequency of the sinusoidal jitter added to the signal.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s) Rx Impairments Setup (32, 64 GT/s)	Rx Pre-Compliance Setup (8, 16 GT/s) Rx Pre-Compliance Test (32 GT/s) Rx Preset Pre-Compliance Test (8 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s) Rx Sensitivity Test (8, 16, 32, 64 GT/s) Rx Stressed Jitter Eye Setup (8 GT/s)

Table A-8 Receiver parameters for individual procedures (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
SSC Residual	This emulates the residual that is caused in "real world systems" by path length differences in the clock distribution and SSC modulation. See Appendix B.	
	Rx Compliance Setup (5 GT/s) Rx Compliance Test (5 GT/s)	Rx Jitter Tolerance Test (5 GT/s) Rx Sensitivity Test (5 GT/s)
Use Compliance Impairments	If True, the compliance values of impairments are used. The listed impairments are read only. If False, all the parameters listed under "Impairments" become editable and their values can be changed.	
	All Rx tests, Rx Custom tests and Receiver Setup tests for all data rates.	
Use Residual SSC (Triangular)	Set to 'True' to change the residual SSC modulation form from sinusoidal to triangular. Only for CEM.	
	Rx Coefficient Matrix Scan (16 GT/s) Rx Custom Coefficient Matrix Scan (16 GT/s) Rx Custom Jitter Tolerance Test (16 GT/s) Rx Custom Pre-Compliance Test (16 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16 GT/s)	Rx Custom Sensitivity Test (16 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (16 GT/s) Rx Pre-Shoot De-Emphasis Scan (16 GT/s) Rx Sensitivity Test (16 GT/s)
Channel		
CBB var. ISI pair	Variable ISI pair selected on the CBB side.	
	Rx Coefficient Matrix Scan (16, 32 GT/s) Rx Custom Coefficient Matrix Scan (16, 32 GT/s) Rx Custom Jitter Tolerance Test (16, 32 GT/s) Rx Custom Pre-Compliance Test (16, 32 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32 GT/s)	Rx Impairments Setup (32 GT/s) Rx Jitter Tolerance Test (16, 32 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (16, 32 GT/s) Rx Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Sensitivity Test (16, 32 GT/s)
Total Channel Loss	Rx Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (16, 32, 64 GT/s) Rx Pre-Compliance Setup (16 GT/s) Rx Pre-Compliance Test (16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Sensitivity Test (16, 32, 64 GT/s)
Trace Number	Rx Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s) Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s) Rx Custom Pre-Compliance Test (16, 32, 64 GT/s) Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Custom Sensitivity Test (16, 32, 64 GT/s)	Rx Impairments Setup (32, 64 GT/s) Rx Jitter Tolerance Test (16, 32, 64 GT/s) Rx Pre-Compliance Test (16, 32, 64 GT/s) Rx Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Sensitivity Test (16, 32, 64 GT/s)
Equalization for Remaining Rx tests		
Allow user to enter optimum equalization for remaining Rx tests	Values: True, False.	
	Rx Coefficient Matrix Scan (8, 16, 32, 64 GT/s) Rx Custom Coefficient Matrix Scan (16, 32, 64 GT/s)	Rx Custom Pre-Shoot De-Emphasis Scan (16, 32 GT/s) Rx Pre-Shoot De-Emphasis Scan (8, 16, 32 GT/s)
Sequencer		
	The parameters listed in the category Sequencer in the parameter grid are described in Table A-1 on page 317.	

Parameters for Individual Procedures — Link Equalization

These parameters are displayed in the GUI at the level of an individual procedure in the Link Equalization part of the procedure tree. See Table A-1 on page 317 for sequencer parameters.

For more details of the parameters listed in the category Sinusoidal Jitter Variation and the relationships between them, see Rx Jitter Tolerance Test on page 247.

Table A-9 Parameters for individual link equalization tests

Category/ Parameter	Description/ Values/Where shown in GUI	
None		
Offline	▪ If True, the test automation software is not connected to any instrument. This mode should be used for demonstrations and checks only. It is not valid for calibrations or measurements. ▪ If False, the software is connected to instruments and produces valid data. It is read-only in the parameter grid. It can be set in the Instrument Configuration step during Station Configuration.	
	All procedures	
Software Version	The version number of the N5991 ValiFrame software currently being used.	
	All procedures	
Loopback Training		
Enable Impairments during Loopback (LB) Training	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
Force Retraining on each Frequency	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Interactive Link Training		
Link Training	The method used for link training: Bypass, Presets only, Full. If the DUT does not support Bypass mode, select ‘Full’ to make this test procedure possible for the DUT.	
	LEQ Tx Initial Preset Compliance Test (64 GT/s)	
Parameter		
Eye Height	LEQ Rx Compliance Test (8 GT/s)	
Eye Width	LEQ Rx Compliance Test (8 GT/s)	
Max Number of Retries	The maximum number of tries if the electrical and/or protocol response time cannot be evaluated. If it is not possible within these tries, the test is aborted automatically.	
	LEQ Tx Response Time Compliance Test (8, 16, 32, 64 GT/s)	
Measure Protocol Response Times	Values: True, False.	
	LEQ Tx Response Time Compliance Test (8, 16, 32, 64 GT/s)	
Presets	The presets used in the test.	
	LEQ Tx Initial Preset Compliance Test (8, 16, 32, 64 GT/s) LEQ Tx Response Time Compliance Test (8, 16, 32, 64 GT/s)	

Table A-9 Parameters for individual link equalization tests (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Skip Response Time Measurements	If you are only interested in the reported pre-shoot, de-emphasis or cursor values, setting this to 'True' allows you to skip the response time measurements and thus save test time.	
	LEQ Tx Response Time Compliance Test (8, 16, 32, 64 GT/s)	
Sensitivity Variation		
Eye Height Step Size	LEQ Rx Sensitivity Test (8 GT/s)	
Sensitivity Mode	Values: Differential Mode Interference, Generator Launch Voltage	
	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s)	LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
Start Eye Height	LEQ Rx Sensitivity Test (8 GT/s)	
Start "Parameter"	"Parameter" is that selected in Sensitivity Mode.	
	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s)	LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
Stop Eye Height	LEQ Rx Sensitivity Test (8 GT/s)	
Stop "Parameter"	"Parameter" is that selected in Sensitivity Mode.	
	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s)	LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
"Parameter" Step Size	"Parameter" is that selected in Sensitivity Mode.	
	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s)	LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
Sinusoidal Jitter Variation (see Rx Jitter Tolerance Test on page 247)		
Frequency Mode	Defines jitter frequencies that will be tested. Values: Compliance Frequencies, Equally Spaced Frequencies, User Defined Frequencies, Single Frequency. Default: Compliance frequencies.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Frequency sweep scale	Defines how the frequency values are calculated. Values: Logarithmic, Linear Enabled when Frequency Mode is Equally Spaced Frequencies.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Jitter Frequencies/Frequency	Read-only when Frequency Mode is Compliance Frequencies.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Jitter step size(s) or factor(s)	Read-only when Frequency Mode is Compliance Frequencies and Use fixed number of steps is False.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Number of frequency steps	Enabled when Frequency Mode is Equally Spaced Frequencies.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Number of jitter steps	Available when Use fixed number of steps is True.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Search Algorithm	Values: Binary, Linear, Linear with 2 step sizes, Linear with 2 step sizes and hysteresis, Logarithmic up, Logarithmic down. Default: Linear with 2 step sizes. The binary search algorithm is recommended for DUTs with short recovery time. For more details about the search algorithms, see Rx Jitter Tolerance Test on page 247.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)

Table A-9 Parameters for individual link equalization tests (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Show min failed points	If True, the minimum sinusoidal jitter amplitude at which the BER test failed is included in the results graph.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Start frequency value	Enabled when Frequency Mode is Equally Spaced Frequencies.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Start Jitter Amplitude(s)	Read-only when Frequency Mode is Compliance Frequencies.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Stop frequency value	Enabled when Frequency Mode is Equally Spaced Frequencies.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
Use fixed number of steps	▪ If True, the range from the start amplitude to the jitter capability at each frequency is divided into a fixed number of steps. ▪ If False, the jitter steps are calculated depending on the Frequency Mode.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s)
BER Measurement		
Abort BER measurement when failed	Enabled for BER Mode Fixed Time. Values: True, False. If True, the BER measurement is aborted when the allowed bit errors are exceeded.	
	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
Abort FBER measurement when failed	Visible only if Bit Error Ratio Measurement is set to ‘FBER’. Values: True, False. If True, the FBER measurement is aborted when the allowed bit errors are exceeded (for FBER Mode ‘Fixed Time’).	
	LEQ Rx Compliance Test (64 GT/s) LEQ Rx Custom Compliance Test (64 GT/s) LEQ Rx Custom Jitter Tolerance Test (64 GT/s)	LEQ Rx Custom Sensitivity Test (64 GT/s) LEQ Rx Jitter Tolerance Test (64 GT/s) LEQ Rx Sensitivity Test (64 GT/s)
Allowed Bit Error	Number of bit errors that are allowed when BER Mode or FBER Mode is Fixed Time.	
	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
BER Measurement Duration	Duration of the BER measurement in seconds when BER Mode is Fixed Time.	
	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
BER Mode	Values: Target BER, Fixed Time	
	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)

Table A-9 Parameters for individual link equalization tests (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Bit Error Ratio Measurement	Values: FBER, BER. For more details about when FBER is supported, see Parameters Related to FBER on page 229. If 'BER' is selected, the BER measurement is performed as usual. If 'FBER' is selected, only the first bit of a possible error burst counts as an error. Any number of bit errors in a PAM4 symbol (that is, 1 or 2) are considered as a symbol error. The number of consecutive symbol errors that constitute an error burst can be selected using Maximum Number of Consecutive Symbols.	
	LEQ Rx Compliance Test (64 GT/s) LEQ Rx Custom Compliance Test (64 GT/s) LEQ Rx Custom Jitter Tolerance Test (64 GT/s)	LEQ Rx Custom Sensitivity Test (64 GT/s) LEQ Rx Jitter Tolerance Test (64 GT/s) LEQ Rx Sensitivity Test (64 GT/s)
Confidence Level	The value of the confidence level when BER Mode is 'Target BER' or FBER Mode is 'Target FBER'.	
	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
FBER Measurement Duration	Visible only if Bit Error Ratio Measurement is set to 'FBER'. Duration of the FBER measurement in seconds when FBER Mode is 'Fixed Time'.	
	LEQ Rx Compliance Test (64 GT/s) LEQ Rx Custom Compliance Test (64 GT/s) LEQ Rx Custom Jitter Tolerance Test (64 GT/s)	LEQ Rx Custom Sensitivity Test (64 GT/s) LEQ Rx Jitter Tolerance Test (64 GT/s) LEQ Rx Sensitivity Test (64 GT/s)
FBER Mode	Visible only if Bit Error Ratio Measurement is set to 'FBER'. Values: Target FBER, Fixed Time	
	LEQ Rx Compliance Test (64 GT/s) LEQ Rx Custom Compliance Test (64 GT/s) LEQ Rx Custom Jitter Tolerance Test (64 GT/s)	LEQ Rx Custom Sensitivity Test (64 GT/s) LEQ Rx Jitter Tolerance Test (64 GT/s) LEQ Rx Sensitivity Test (64 GT/s)
Maximum number of consecutive symbols	The number of consecutive symbols errors that together count as just one error for FBER. Visible only if Bit Error Ratio Measurement is set to 'FBER'.	
	LEQ Rx Compliance Test (64 GT/s) LEQ Rx Custom Compliance Test (64 GT/s) LEQ Rx Custom Jitter Tolerance Test (64 GT/s)	LEQ Rx Custom Sensitivity Test (64 GT/s) LEQ Rx Jitter Tolerance Test (64 GT/s) LEQ Rx Sensitivity Test (64 GT/s)
Target BER	The target value of BER to be reached when BER Mode is Target BER.	
	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
Target FBER	Visible only if Bit Error Ratio Measurement is set to 'FBER'. The target value of FBER to be reached when FBER Mode is 'Target BER'.	
	LEQ Rx Compliance Test (64 GT/s) LEQ Rx Custom Compliance Test (64 GT/s) LEQ Rx Custom Jitter Tolerance Test (64 GT/s)	LEQ Rx Custom Sensitivity Test (64 GT/s) LEQ Rx Jitter Tolerance Test (64 GT/s) LEQ Rx Sensitivity Test (64 GT/s)
Impairments (Most of the parameters listed under Impairments are read-only unless Use Compliance Impairments is set to False)		
2nd Tone Sinusoidal Jitter	Sinusoidal jitter used to fine adjust the eye height and width. Only for ASIC or if the Jitter Eye Adjustment Mode is set to ASIC (LEQ Rx Jitter Tolerance Test only).	
	LEQ Rx Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (16, 32, 64 GT/s) LEQ Rx Sensitivity Test (16, 32, 64 GT/s)

Table A-9 Parameters for individual link equalization tests (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
2nd Tone Sinusoidal Jitter Frequency	Only for ASIC or if the Jitter Eye Adjustment Mode is set to ASIC (LEQ Rx Jitter Tolerance Test only).	
	LEQ Rx Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (16, 32, 64 GT/s) LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
Common Mode Interference	LEQ Rx Compliance Test (32, 64 GT/s) LEQ Rx Custom Compliance Test (32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (32, 64 GT/s) LEQ Rx Jitter Tolerance Test (32, 64 GT/s) LEQ Rx Sensitivity Test (32, 64 GT/s)
Common Mode Sinusoidal Interference	LEQ Rx Compliance Test (16 GT/s) LEQ Rx Custom Compliance Test (16 GT/s) LEQ Rx Custom Jitter Tolerance Test (16 GT/s)	LEQ Rx Custom Sensitivity Test (16 GT/s) LEQ Rx Jitter Tolerance Test (8, 16 GT/s) LEQ Rx Sensitivity Test (16 GT/s)
Differential Mode Interference	LEQ Rx Compliance Test (32, 64 GT/s) LEQ Rx Custom Compliance Test (32, 64 GT/s)	LEQ Rx Custom Jitter Tolerance Test (32, 64 GT/s) LEQ Rx Jitter Tolerance Test (32, 64 GT/s)
Differential Mode Sinusoidal Interference	LEQ Rx Compliance Test (8, 16 GT/s) LEQ Rx Custom Compliance Test (16 GT/s)	LEQ Rx Custom Jitter Tolerance Test (16 GT/s) LEQ Rx Jitter Tolerance Test (8, 16 GT/s)
Differential Voltage	LEQ Rx Compliance Test (32, 64 GT/s) LEQ Rx Custom Compliance Test (32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (32, 64 GT/s) LEQ Rx Jitter Tolerance Test (32, 64 GT/s) LEQ Rx Sensitivity Test (32, 64 GT/s)
Generator Launch Voltage	LEQ Rx Compliance Test (16 GT/s) LEQ Rx Custom Compliance Test (16 GT/s) LEQ Rx Custom Jitter Tolerance Test (16 GT/s)	LEQ Rx Custom Sensitivity Test (16 GT/s) LEQ Rx Jitter Tolerance Test (8, 16 GT/s) LEQ Rx Sensitivity Test (16 GT/s)
Jitter Eye Adjustment Mode	Values: ASIC, CEM For CEM, only one SJ frequency is used and swept. For ASIC, the first SJ frequency is fixed while the second frequency is swept.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32 GT/s)	LEQ Rx Jitter Tolerance Test (16, 32 GT/s)
Random Jitter	LEQ Rx Compliance Test (8, 16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (8, 16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
Residual SSC (Triangular)	Magnitude of the residual SSC when residual SSC is selected to be in triangular modulation. Only CEM. Visible only if Use Residual SSC (Triangular) is set to 'True'.	
	LEQ Rx Compliance Test (16 GT/s) LEQ Rx Custom Compliance Test (16 GT/s) LEQ Rx Custom Jitter Tolerance Test (16 GT/s)	LEQ Rx Custom Sensitivity Test (16 GT/s) LEQ Rx Jitter Tolerance Test (16 GT/s) LEQ Rx Sensitivity Test (16 GT/s)
RJ Low Pass Filter Frequency	Values: 500 MHz, 1000 MHz. The 1000 MHz low-pass filter frequency is compliant with the specification, but it reduces the total amount of SJ for high jitter frequencies. In order to have the full amount of SJ, switch to 500 MHz. This is only available for M8020A and M8040A.	
	LEQ Rx Custom Jitter Tolerance Test (16, 32 GT/s)	LEQ Rx Jitter Tolerance Test (8, 16, 32 GT/s)
Sinusoidal Jitter	Sinusoidal jitter applied during the test.	
	LEQ Rx Compliance Test (8, 16, 32 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)

Table A-9 Parameters for individual link equalization tests (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI	
Sinusoidal Jitter Frequency	Frequency of the sinusoidal jitter applied during the test.	
	LEQ Rx Compliance Test (8, 16, 32 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Sensitivity Test (8, 16, 32, 64 GT/s)
Use Compliance Impairments	Values: True, False. Editable only in Expert Mode. If True, the amount of RJ and DMSI used during the compliance test is applied. Together with 12.5 ps SJ, this results in the eye height and eye width specified for the compliance test.	
	All LEQ Rx and LEQ Rx Custom tests at all data rates	
Use Residual SSC (Triangular)	Set to ‘True’ to change the residual SSC modulation form from sinusoidal to triangular. Only for CEM.	
	LEQ Rx Compliance Test (16 GT/s) LEQ Rx Custom Compliance Test (16 GT/s) LEQ Rx Custom Jitter Tolerance Test (16 GT/s)	LEQ Rx Custom Sensitivity Test (16 GT/s) LEQ Rx Jitter Tolerance Test (16 GT/s) LEQ Rx Sensitivity Test (16 GT/s)
Channel		
CBB var. ISI pair	LEQ Rx Compliance Test (16, 32 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (16, 32, 64 GT/s) LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
Total Channel Loss	LEQ Rx Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Compliance Test (16, 32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (16, 32, 64 GT/s) LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
Trace Number	LEQ Rx Compliance Test (32, 64 GT/s) LEQ Rx Custom Compliance Test (32, 64 GT/s) LEQ Rx Custom Jitter Tolerance Test (16, 32, 64 GT/s)	LEQ Rx Custom Sensitivity Test (16, 32, 64 GT/s) LEQ Rx Jitter Tolerance Test (16, 32, 64 GT/s) LEQ Rx Sensitivity Test (16, 32, 64 GT/s)
Oscilloscope		
Scope Horizontal Range	LEQ Tx Response Time Compliance Test (8, 16, 32 GT/s)	
Scope Pre-Trigger Data	The interval that is captured before the trigger event. Default: 1.5 µs.	
	LEQ Tx Response Time Compliance Test (8, 16, 32 GT/s)	
Scope Request Vertical Range	The vertical range on the scope display used for the request signal.	
	LEQ Tx Response Time Compliance Test (8, 16, 32 GT/s)	
Scope Response Vertical Range	The vertical range on the scope display used for the response signal.	
	LEQ Tx Response Time Compliance Test (8, 16, 32 GT/s)	
Oscilloscope Preset Measurement		
Number of UIs	The number of UIs that the oscilloscope is set up to record.	
	LEQ Tx Initial Preset Compliance Test (64 GT/s)	LEQ Tx Response Time Compliance Test (64 GT/s)
Scope Raw Bandwidth	Bandwidth that the acquisition hardware is configured to. It must be higher than the bandwidth after any filters such as Bessel, etc.	
	LEQ Tx Initial Preset Compliance Test (64 GT/s)	LEQ Tx Response Time Compliance Test (64 GT/s)
Use Bessel Filter	When set to ‘True’, the Bessel–Thomson filter is enabled on the oscilloscope.	
	LEQ Tx Initial Preset Compliance Test (64 GT/s)	LEQ Tx Response Time Compliance Test (64 GT/s)

Table A-9 Parameters for individual link equalization tests (cont.)

Category/ Parameter	Description/ Values/Where shown in GUI
Oscilloscope Response Time Measurement	
Scope Horizontal Range	LEQ Tx Response Time Compliance Test (64 GT/s)
Scope Pre-Trigger Data	The interval that is captured before the trigger event. Default: 1.5 µs.
	LEQ Tx Response Time Compliance Test (64 GT/s)
Scope Request Vertical Range	The vertical range on the scope display used for the request signal.
	LEQ Tx Response Time Compliance Test (64 GT/s)
Scope Response Vertical Range	The vertical range on the scope display used for the response signal.
	LEQ Tx Response Time Compliance Test (64 GT/s)
Sequencer	
	The parameters listed in the category Sequencer in the parameter grid are described in Table A-1 on page 317.

B SSC Settings

This Appendix contains tables that list the SSC settings according to specification version, interface type, clock architecture and data rate.

SSC Settings

The CTSs lay down exactly which type and value of SSC should be used. In addition to the specification version, this depends on the interface type (ASIC or CEM), clock architecture (CC or SRIS) and data rate. Table B-1 to Table B-3 provide details.

Table B-1 SSC settings for PCIe Specification Version 6.0

Data rate [GT/s]	CC	SRIS
ASIC		
2.5	N/A	25 ns sinusoidal SSC Spur (1)
5	75 ps residual triangular SSC	25 ns sinusoidal SSC Spur (1)
8	N/A	25 ns sinusoidal SSC Spur (1)
16	1 ns residual sinusoidal SSC (1)	25 ns sinusoidal SSC Spur (1)
32	1 ns residual sinusoidal SSC (1)	15 ns sinusoidal SSC Spur (1)
64	1 ns residual sinusoidal SSC (1)	15 ns sinusoidal SSC Spur (1)

(1) Using LF PJ12 and tested as a separate 33 kHz frequency point. Not applied for other SJ frequencies. Always using nominal DR.

(2) The rSSC for 16 GT/s Rx and LEQ Rx tests are now dependent on the Max Link Speed. For example, for DUTs NOT supporting 32 GT/s and higher, 500 ps residual triangular SSC is used.

Table B-2 SSC settings for PCIe Specification Version 5.0

Data rate [GT/s]	CC	SRIS
ASIC		
2.5	N/A	25 ns sinusoidal SSC Spur (1)
5	75 ps residual triangular SSC	25 ns sinusoidal SSC Spur (1)
8	N/A	25 ns sinusoidal SSC Spur (1)
16	1 ns residual sinusoidal SSC (4)	25 ns sinusoidal SSC Spur (1)
32	1 ns residual sinusoidal SSC (4)	15 ns sinusoidal SSC Spur (1)
CEM		
2.5	N/A	triangular 5000 ppm ds. (2)
5	75 ps residual triangular SSC	triangular 5000 ppm ds. (2)
8	N/A	triangular 5000 ppm ds. (2)
16	Optional: 500 ps res. triang. SSC (3)	triangular 5000 ppm ds. (2)
32	triangular 5000 ppm ds. (2)	triangular 5000 ppm ds. (2)

(1) Using custom sinusoidal SSC profile and setting the data rate (DR) in the middle: (DR = nominal DR – (SSC deviation)/2).
(2) Using center-spread triangular SSC and setting the DR in the middle: (DR = nominal DR – (SSC deviation)/2).
(3) Using residual SSC from LF RJ (triangular profile). Always using nominal DR.
(4) Using LF RJ2 because 100 MHz should not contain that tone in CC. Always using nominal DR.

Table B-3 SSC settings for PCIe Specification Version 4.0

Data rate [GT/s]	CC	SRIS
ASIC		
2.5	N/A	25 ns sinusoidal SSC (1)
5	75 ps residual triangular SSC (3)	25 ns sinusoidal SSC (1)
8	N/A	25 ns sinusoidal SSC (1)
16	500 ps residual triangular SSC (3)	25 ns sinusoidal SSC (1)
CEM		
2.5	N/A	triangular 5000 ppm ds. (2)
5	75 ps residual triangular SSC (3)	triangular 5000 ppm ds. (2)
8	N/A	triangular 5000 ppm ds. (2)
16	Optional: 500 ps res. triang. SSC (3)	triangular 5000 ppm ds. (2)

(1) Using custom sinusoidal SSC profile and setting the data rate (DR) in the middle: (DR = nominal DR – (SSC deviation)/2).
(2) Using center-spread triangular SSC and setting the DR in the middle: (DR = nominal DR – (SSC deviation)/2).
(3) Using residual SSC from LF RJ (triangular profile). Always using nominal DR.

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C Acronyms and Abbreviations

This Appendix contains a list of acronyms and abbreviations used in the Keysight N5991P PCI Express Test Automation Software Platform User’s Guide.

List of Acronyms

Acronym	Definition
A	
ADC	Analog–Digital Converter
AIC	Add-In Card
ASIC	Application-Specific Integrated Circuit
AWG	Arbitrary Waveform Generator
B	
BCO	Back-Channel Optimization
BER	Bit Error Ratio
BERT	Bit Error Ratio Tester
BW	Bandwidth
C	
CBB	Compliance Base Board
CC	Common Clock
CDR	Clock Data Recovery
CE	Circuit Emulation
CLB	Compliance Load Board
CMSI	Common Mode Sinusoidal Interference
CTLE	Continuous Time Linear Equalization
CTS	Compliance Test Specification
D	
DDJ	Data-Dependent Jitter
DE	De-Emphasis
dev	Device
DJ	Deterministic Jitter
DMSI	Differential Mode Sinusoidal Interference

Acronym	Definition
DR	Data Rate
ds	Downspread
DSO	Digital Storage Oscilloscope
DUT	Device Under Test
E	
EH	Eye Height
EIEOS	Electric Idle Exit Ordered Set
EP	End Point
EW	Eye Width
F	
FBER	First Bit Error Rate
FEC	Forward Error Correction
FFE	Feed Forward Equalization
G	
GPIB	General Purpose Interface Bus
GSa/s	Gigasamples per second
GT/s	Gigatransfers per second
GUI	Graphical User Interface
H	
HF	High Frequency
HTML	Hypertext Markup Language
I	
IL	Insertion Loss
IO	Input–Output
ISI	Inter-Symbol Interference
J	
J-BERT	Jitter Bit Error Rate Tester

Acronym	Definition
L	
LAN	Local Area Network
LB	Loopback
LEQ	Link Equalization
LF	Low Frequency
LFPR	Linear Fit Pulse Response
LTSSM	Link Training and Status State Machine
M	
MMPX ML	Type of male RF coaxial connector
N	
N/A	Not Applicable
NaN	Not a Number
P	
PC	Personal Computer
PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect Express
PCI-SIG	Peripheral Component Interconnect Special Interest Group
PDU	Power Distribution Unit
PJ	Periodic jitter
PLL	Phase-Locked Loop
PS	Pre-Shoot
R	
RC	Root Complex
RJ	Random Jitter
rSSC	Residual Spread Spectrum Clocking
Rx	Receiver

Acronym	Definition
S	
SJ	Sinusoidal Jitter
SKPOS	Skip Ordered Set
SN, S/N	Serial Number
SNDR	Signal-to-(Noise and Distortion) Ratio
SRIS	Separate Reference Clock with Independent SSC
SSC	Spread Spectrum Clocking
T	
TP	Test Point
TTC	Transition Time Converter
Tx	Transmitter
TxEQ	Transmitter Equalization
U	
UI	Unit Interval
USB	Universal Serial Bus
V	
VISA	Virtual Instrument System Architecture
VNA	Vector Network Analyzer
X	
XML	Extensible Markup Language

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