Keysight N5991U32A USB3.2 Test Automation Software Platform

User Guide

KEYSIGHT TECHNOLOGIES

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1 Introduction

Overview

This guide provides a detailed description of the Keysight N5991U32A USB3.2 Test Automation Software Platform.

The BitifEye “ValiFrame” Test Automation software is globally marketed and supported by Keysight Technologies as N5991. This document describes the calibrations and test procedures conducted by N5991 ValiFrame for USB3.2 (Universal Serial Bus).

The N5991 software calibrates the stress conditions and controls all test electronic equipment for automated receiver tolerance tests. The receiver tests described in this document are implemented according to the requirements of the Compliance Test Specification (for short: CTS) and also offers some custom characterization tests to provide more details on DUT behavior beyond the limits.

The N5991 USB Receiver tests support the Keysight Technologies J-BERT M8020A and M8040A high-performance serial BERT (Bit Error Ratio Tester). An Infiniium oscilloscope is always required.

NOTE

The definitions of the acronyms and abbreviations used throughout this User Guide are given in Chapter 6, Appendix: Acronyms and Abbreviations**.**

Document History

First Edition (March 2020)

The first edition of this user guide describes functionality of software version N5991U32A ValiFrame USB3.2_1.00 based on the *USB3.2 Base* specification.

Second Edition (October 2021)

The second edition of this user guide describes functionality of software version N5991U32A ValiFrame USB3.2_1.10 based on the *USB3.2 Base* specification.

2 USB3.2 ValiFrame Station

After the software has been installed, two icons are added to the desktop as shown in Figure 1 and Figure 7. One is for the Station Configurator and the other icon pertains to USB3.2 ValiFrame.

USB3.2 ValiFrame Station Configurator

Test Station Selection

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

The USB3.2 ValiFrame Station Configurator must be started prior to launching ValiFrame. It allows you to select the required set of instruments. Double-click the icon (see Figure 1) to launch the software. Alternatively, to access the ValiFrame Station Configurator on a Windows-based PC, click

Start > **BitifEye USB3.2 N5991** > **USB3.2 Station Configurator (N5991)**.

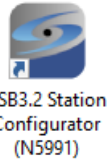


Figure 1 Icon for USB3.2 Station Configurator

When the USB3.2 ValiFrame Station Configurator is launched, the **Station Configurator** window appears as shown in Figure 2.

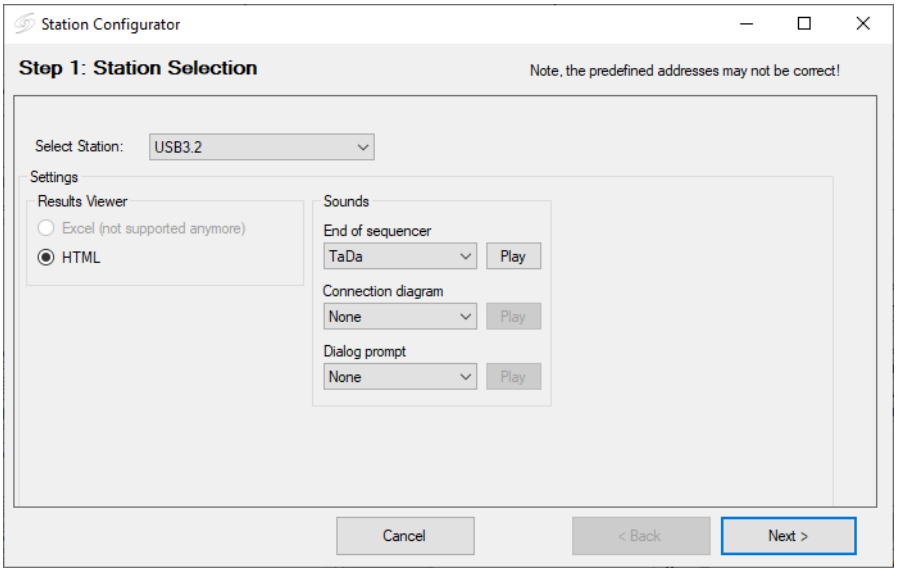


Figure 2 Station selection window

Next, you may optionally assign sounds that mark the different states of the program.

1 End of Sequencer plays the selected sound at the end of a sequence.

2 Connection Diagram plays the selected sound every time a connection diagram pops up.

3 Dialog Prompt plays the selected sound at each dialog prompt.

Select a sound tone from the following options available in the drop-down options. The option 'None' disables the sound for the respective action.

- Car Brakes
- Feep Feep
- Ringing
- TaDa
- Tut

4 Click **Play** to test a sound before assigning it to a specific action.

Test Station Configuration

The **Test Station** is preselected as **USB3.2**. Click **Next** to continue. The "Station Configuration" stage of the Station Configurator is displayed as shown in Figure 3. It shows the various options for instruments that can be used for USB3.2 testing. It contains the following options:

- Data Generator
- Power Switch
- Power Supply
- Tx Scope Application (not available for the USB3.2 Station)
- Type-C Test Controller
- SigTest Configuration
- Test Type-C PDOs

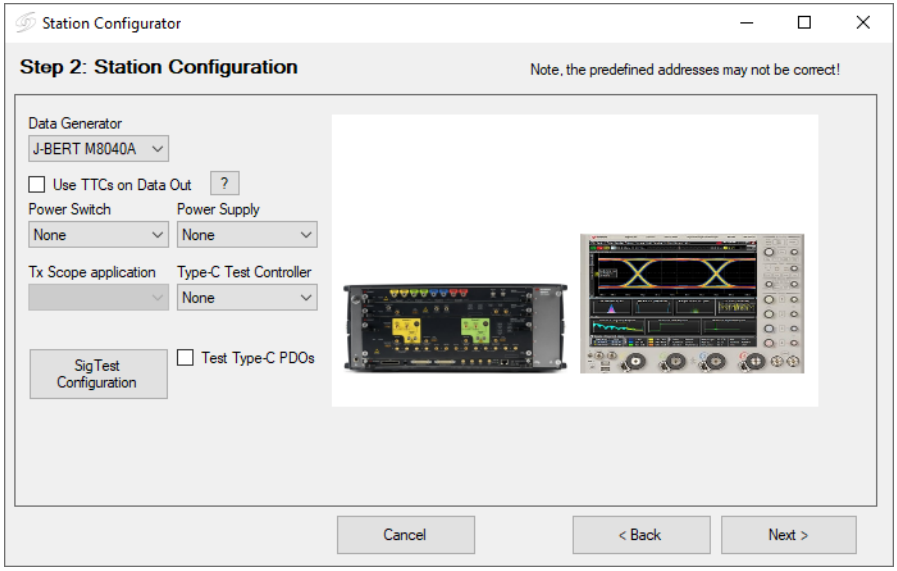


Figure 3 Station configuration window with Data Generator option M8040A

Data Generator

The 'Data Generator' is used to create patterns with specified stress parameters. Available options are:

- J-BERT M8020A (Keysight M8020A J-BERT High-Performance BERT)
- J-BERT M8040A (Keysight M8040A 64 Gbaud J-BERT High-Performance BERT)

The error detector of the selected data generator (BERT system) is used to check if the data looped back from the DUT (Device Under Test) contains errors.

Use Transition Time Converters on DataOut

The fast edges on the M8040A require use of the high bandwidth (BW) inputs of the oscilloscope, so as to avoid measurement artifacts in all calibrations where the output of the BERT is directly connected to the oscilloscope.

Using TTCs slows down the M8040A's edge rates and reduces the required BW of the oscilloscope.

If 20 ps TTCs are used, an oscilloscope with a BW of at least 25 GHz is sufficient.

Without TTCs, a BW of at least 50 GHz is required for Z-series oscilloscopes or 59 GHz for UXR-series oscilloscopes.

Power Switch (for Auto Loopback Training)

Select one of the following options:

- None
- Netlo 230 B (a power distribution unit with one 230V input and four 230V outlets)
- ALL4076
- SynaccessNP

The DUT is power-cycled automatically when a Power Switch is selected.

Power Supply (for Auto Loopback Training)

Select one of the following options:

- None
- E3631A (Keysight Triple Output DC Power Supply)
- E363xA (Keysight E363xA Series Programmable DC Power Supplies)
- E364xA (Keysight E364xA Single Output DC Power Supplies)

- N67xx (Keysight N67xx Modular System Power Supply)

The DUT is power-cycled automatically when a Power Supply is selected.

Tx Scope Application

- Not available for USB3.2.

Type-C Test Controller

Select one of the following options:

- None
- N7018A

SigTest Configuration

The SigTest software is used for USB3.2 5 Gb/s and 10 Gb/s receiver calibrations.

Click the weblink to download the required version of SigTest. As shown in Figure 4, you must install the versions of SigTest displayed on the “SigTest Configuration” window and manually specify the installation directories, if they are different than the default locations.

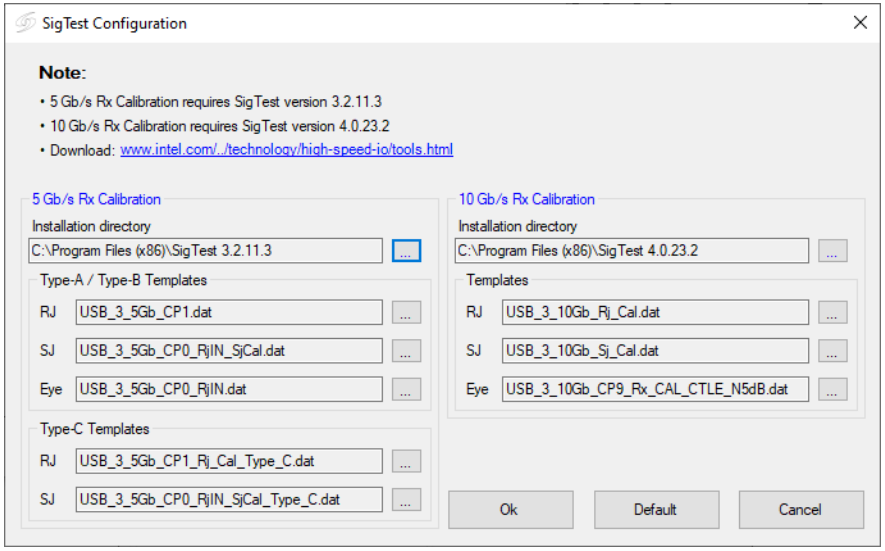


Figure 4 SigTest configuration window

The “SigTest Configuration” dialog shows those SigTest templates that will be used for random jitter, sinusoidal jitter and eye calibrations. Keysight does not recommend using different templates or modifying the existing SigTest templates, even though it is possible.

Test Type-C PDOs

To add the Type-C PDO test, select the **Test Type-C PDOs** check box.

If checked, the option ‘N7018A ‘is automatically selected by the software from the “Type-C Test Controller” options.

Test Instrument Configuration

Once the USB3.2 station is configured, the instrument addresses must be set. An example of instrument configuration is shown in Figure 5.

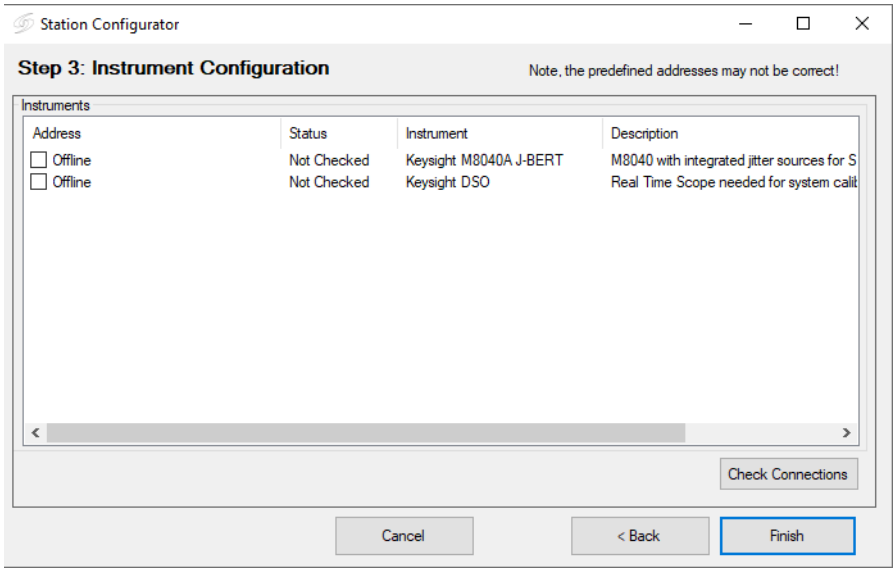


Figure 5 Instrument configuration window

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 the 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, GPIB (General Purpose Interface Bus) or LAN (Local Area Network). Most of the instruments used in the USB3.2 station require a VISA (Virtual Instrument System Architecture) connection. To determine the VISA address, run the “Connection Expert” (right-click the Keysight IO Control icon in the task bar and select the first entry “Connection Expert”). Copy the address string for each instrument from the Connection Expert entries and paste it as the instrument address in the ‘Station Configurator’. After the address strings have been entered, uncheck the “Offline” check box to configure the instruments in online mode and click **Check Connections** to verify that the connections for the instruments are established properly. If an erroneous instrument address configuration is performed, the Station Configurator displays a prompt to indicate so.

NOTE

When starting a specific test station configuration 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.

You may configure the Keysight N7015A Type-C High-Speed Test Fixture and the Keysight N7018A Type-C Low-Speed Signal Access and Control Fixture either manually or through ValiFrame.

If you require ValiFrame to automate the configuration of these fixtures, you must use the BitifEye Remote Instruments Server and follow the steps listed below. To download and install the BitifEye Remote Instruments Server, visit http://www.bitifeye.com.

1 Start the BitifEye Remote Instruments Server from any PC of the test setup (such as an oscilloscope or the ValiFrame host).
2 Connect the N7018A fixture to the mentioned PC with a USB cable.
3 Set the Keysight N7018A fixture to Online.
4 Enter the IP address of the PC.
5 Verify the connection.

However, if you are manually configuring these fixtures, you do not have to specify:

- IP address to set the instrument to “Online” in the USB Station

- Configuration—You can find the configuration instructions in the Connection Diagram description for each receiver test.

Using Keysight IO VISA Connection Expert

The Keysight Connection Expert is recommended for setting up new connections or verifying existing connections. Start the Connection Expert by right-clicking on the **Keysight IO Libraries Suite** icon in the task bar and selecting **Connection Expert**. A window similar to the one shown in Figure 6 is displayed.

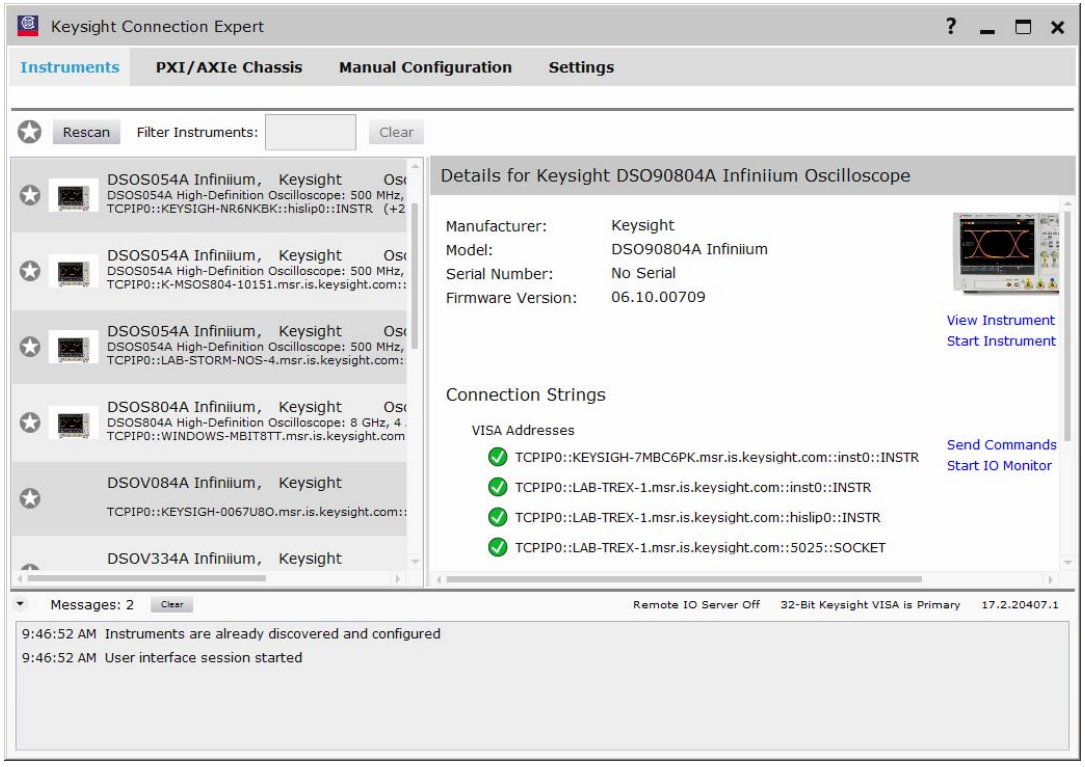


Figure 6 Keysight Connection Expert

Under **Instruments**, click **Rescan**.

For each instrument that must be connected, verify that the corresponding information is listed in the menu on the left and that the VISA Address for each instrument shows a green tick.

Once all the instruments to be used are listed properly, their address strings can be entered in the Instrument Configuration stage of the Station Configurator (see Figure 5). The recommended way of doing this is to copy and paste each instrument address as follows:

Click the **VISA Address** field next to an instrument in the Connection Expert and copy the address. Highlight the corresponding entry of that instrument in the Instrument Configuration window of the Station Configurator, paste the address in the **Instrument Address** text field and click **Apply Address**. Repeat this procedure for all the instruments being used, except standard specific applications running on the oscilloscope.

The applications running on the oscilloscope use a different technology to provide remote access to ValiFrame, called *.NET Remoting Communication*. The remote access is only possible using a LAN connection to the oscilloscope; therefore, only an IP address is used to connect to such an instrument.

Once all the instruments are set with the appropriate addresses, tick the check boxes for all instruments that shall be used by the Test Automation Software. This will set the instrument mode to “Online”. Click **Check Connections** to verify that the instrument addresses are valid.

Click **Finish** to save the changes and close the ValiFrame Station Configurator.

Starting the USB3.2 Station

Start the ValiFrame USB3.2 Test Station by double-clicking the **USB3.2 ValiFrame (N5991)** icon on the desktop as shown in Figure 7. Alternatively, click

Start > **BitifEye USB3.2 N5991** > **USB3.2 ValiFrame (N5991)**.

Figure 7 USB3.2 ValiFrame Test Station icon

Clicking the **USB3.2 ValiFrame (N5991)** icon launches the **USB3.2 N5991 ValiFrame** window as shown in Figure 8.

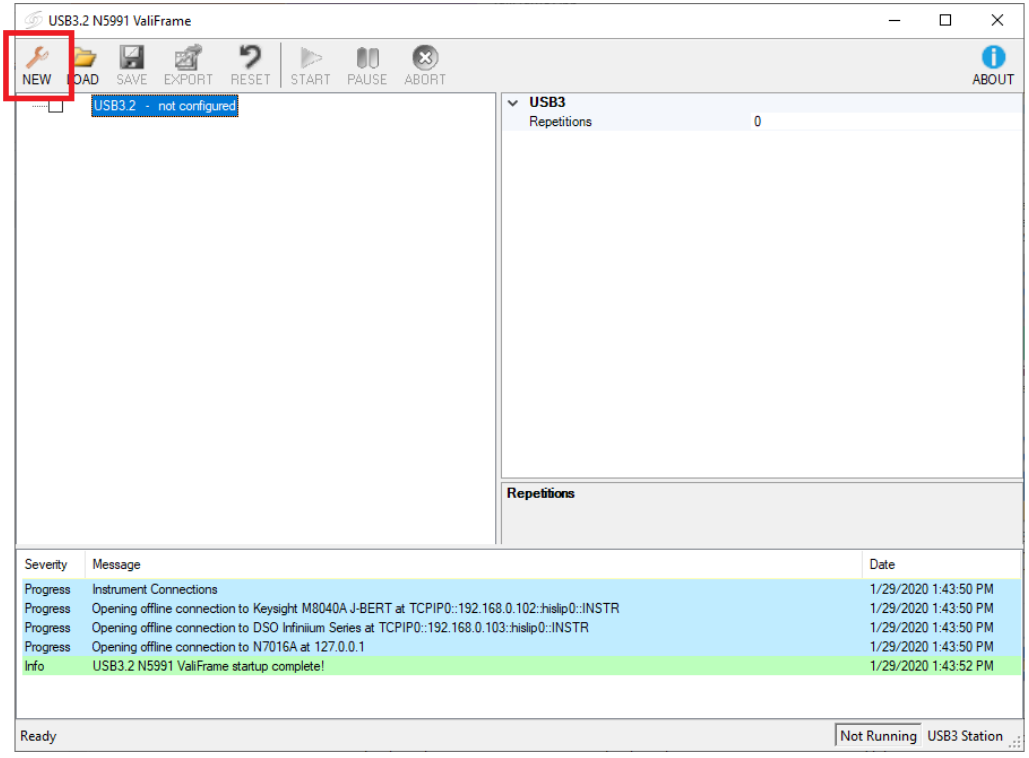


Figure 8 ValiFrame USB3.2 user interface

The test parameters must be configured before running any test or calibration procedure. Click the **NEW** button to open the **Configure DUT** window (Figure 9).

Configuring the DUT

The Configure DUT window allows you to select the DUT parameters, such as DUT Type, Spec Version, Compliance Mode or Expert Mode and also test parameters that are related to the receiver test configuration. These parameters shall be used later in several calibrations and test procedures.

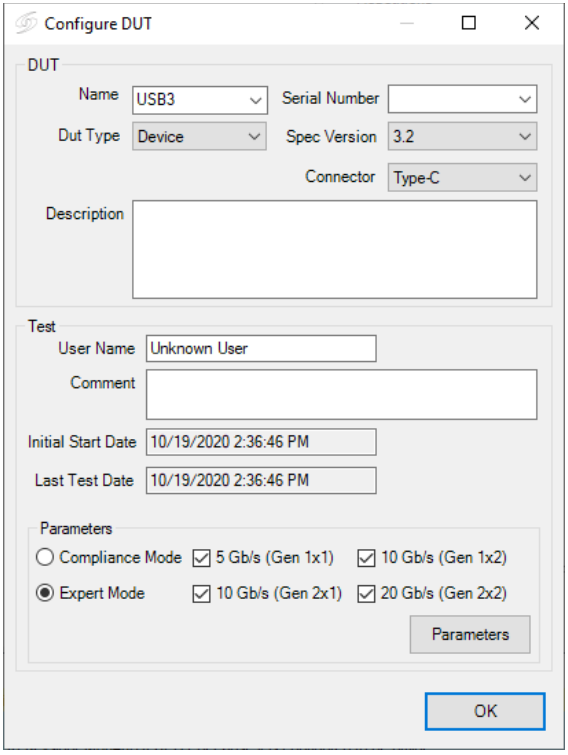


Figure 9 Configure DUT panel

Configuration Parameters

The parameters that appear in the Configure DUT window and their descriptions are listed in Table 1.

Table 1 List of configuration parameters and their description

Parameter name	Description
DUT Parameters	
Name	Name of the DUT. Used to identify the product.
Serial Number	Serial Number of the DUT.
Dut Type	The DUT types are either 'Device' or 'Host' for specification versions 3.0 and 3.1. For the specification version 3.2, the DUT types 'Active Cable' and 'Component Retimer' are also available. They have different specification limits.
Spec Version	The available versions are '3.0', '3.1' and '3.2'.
Connector	The Connector options are filtered based on the selected options for DUT Type and Spec Version. The available Connector options are: ▪ Std-B ▪ Std-A ▪ Micro-B ▪ Type-C ▪ Tethered Std-A ▪ Tethered Type-C
Test Method	For the USB3.2 version, when the DUT is an Active Cable or a Comp. Retimer, there are two possible test methods: Passthrough and Golden Host. In Passthrough, the data goes through the retimer using the BERT on both ports. In Golden Host, the data goes through the retimer to the host and back.
Description	Text field for describing the product.
Test Parameters	
User Name	User name text field.
Comment	Text field for user 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.

Parameter name	Description
Compliance Mode	Tests are conducted as mandated by the CTS. The parameters that are shown in the calibrations and test procedures cannot be modified by the user.
Expert Mode	Calibration and tests can be conducted beyond the limits and constraints of the CTS. The parameters that are shown in the calibrations and test procedures can be modified by the user.
Speed Class	When the “Spec Version” option is selected as: ▪ 3.0–the available option for USB Speed Class is ‘5 GB/s’. ▪ 3.1–the available options for USB Speed Class are ‘5 GB/s’ and ‘10 GB/s’. ▪ 3.2–the available options for USB Speed class are 5 Gb/s (Gen 1x1), 10 Gb/s (Gen 2x1), 10 Gb/s (Gen 1x2), and 20 Gb/s (Gen 2x2), depending on the Connector selected.

USB3.2 Parameters

In the **Configure DUT** window (see Figure 9), click the **Parameters** button. The **Test Parameters** window is displayed (see Figure 10) where the tabs are filtered according to the “Speed Class” options selected. The first four parameters can be found under the **Common** tab in this window. The others are under the **USB Speed class** tabs. The USB3.2 parameters are listed in Table 2.

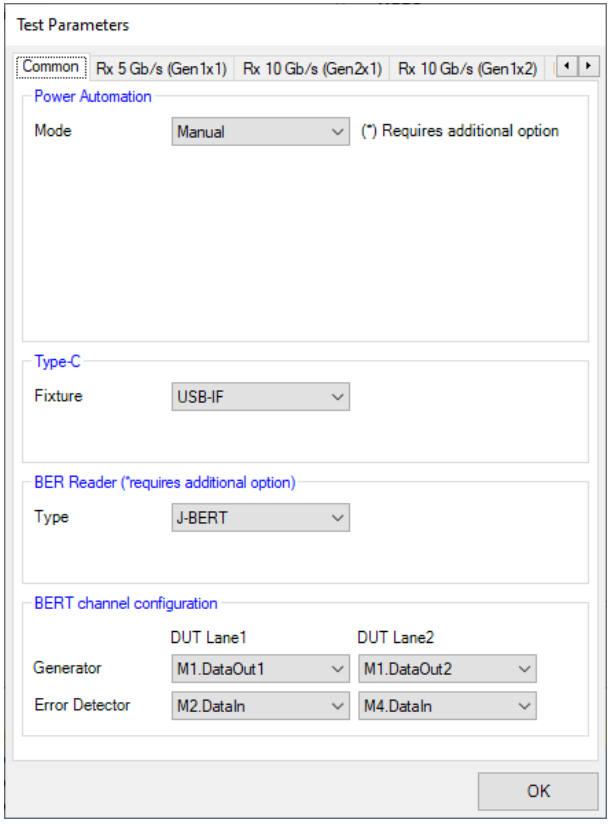


Figure 10 USB3.2 parameters configuration

Table 2 List of USB3.2 parameters

Parameter name	Description
Power Automation	Mode: There are three available modes: ▪ Manual–The user must manually set up the power supply to the DUT and perform its power-cycling. ▪ Power Switch–If you select 'None' in the "Station Configuration" window, the Power Switch Mode does not appear in the Power Automation mode. ▪ Power Supply–If you select 'None' in the "Station Configuration" window, the Power Supply Mode does not appear in the Power Automation mode. If you select one of the last two options listed above, the power is supplied automatically. Then, you may configure the following parameters: ▪ Component–The component that is used to either power up the DUT or enable the DUT's USB bus. The options are either 'Main Power' or 'VBus'. ▪ Channel–This option sets the channel number of either the power supply or the switch model that is connected to the DUT. The number of channels available depends on the power supply/switch model selected. ▪ Off–On duration: This is the time interval between switching the DUT off and then switching it on again. ▪ Settling time–This is the wait time after the DUT is switched on and before the test continues with loopback training. ▪ Power-cycle retries–Maximum number of times that ValiFrame will try to train the DUT into loopback mode. If training is not possible within the specified number of tries, the software aborts the test automatically. When the option "Power Switch Automation" is unchecked, ValiFrame prompts the user to retry each time the loopback fails.
Type-C	For Type-C testing, select the fixture either as 'USB-IF' or 'Keysight N7015A'.
BER Reader	There are three available options: ▪ J-BERT ▪ Offline BER Reader–For Offline BER Reader, you must specify the address. ▪ Custom BER Reader–For this case, you must use the *UsbCustomBerReader.dll* file to define the Custom BER Reader.
BERT Channel Configuration	Select the channels of the J-BERT that shall be used as "Data Output" and "Data Input".

Parameter name	Description
Calibration	The available options are: ▪ Scope Connection–This allows you to select Differential Ch1–Ch3 or Differential Ch2–Ch4 (Direct Connect) ▪ Use Transfer Function–Embed a custom transfer function for calibrations.
Loopback Training	The available options are: **1** Method–Determines how the loopback training is performed. The available link training methods are 'WarmReset', 'PowerOnReset' and 'Vendor Specific'. Additionally, both the M8020A and M8040A J-BERT configurations with option '0S3' or 'US3' support interactive link training with methods 'WarmReset LTSSM' and 'PowerOnReset LTSSM'. For the option 'Vendor Specific', select the sequence file. This file should only contain the loopback pattern for the Generator and the Analyzer. When Vendor Specific is selected, you are responsible for setting the DUT in loopback mode. If any option other than 'Vendor Specific' is selected, you may configure one or more of the following options: ▪ LFPS Idle–The signal applied between the LFPS bursts. ▪ LFPS Trigger Threshold–Detection level for LFPS signals sent by the DUT. This parameter is available only if the option 'PowerOnReset' is selected as the 'Method' for "Loopback Training". ▪ Use Link Training Suite Script–If you are testing with spec 3.2, this is automatically set to True. If you have a license to test with spec 3.0 or 3.1, you can select True or False. If it is set to 'False', you can configure the link training directly in ValiFrame: ▪ Burst Length–The burst length for 'WarmReset' method. ▪ Delay After Reset–Time span between the 'Reset' state and 'Configure LFPS' used during loopback training. ▪ LFPS count–Number of bursts that are sent to the DUT. ▪ TS1 count–Number of TS1 Ordered Sets that are sent to the DUT. ▪ TS2 count–Number of TS2 Ordered Sets that are sent to the DUT. ▪ TSEQ count–Number of TSEQ Ordered Sets that are sent to the DUT. If set to 'True', you can specify the Link Training Suite script file, which will be loaded, depending on the 'Method' for 'Loopback Training' selected: ▪ Warm Reset Link Training Suite Settings File ▪ Power On Reset Link Training Suite Settings File **2** Differential Voltage for loopback training–Specify the voltage used during the loopback training for short channel and long channel. If the option "Use voltage settings from Rx tests" is checked, then the voltage will be the same as that set for the receiver tests.
Error Detector	This sets the following CDR settings: ▪ Loop bandwidth–sets the loop bandwidth in MHz. ▪ Transition density–sets the Transition Density as a percentage (%). ▪ Peaking–sets the peaking in dB. ▪ Equalization–sets the equalization to 'Off' or to a specific value. ▪ Sensitivity–select either 'Normal' or 'High'. ▪ Auto-align timeout–sets the maximum duration taken to perform auto-align.

3 Using the Software

Introduction

Once the DUT has been configured, click **OK** in the **Configure DUT** Panel. All calibration and test procedures are included in the respective groups in a manner similar to how they are organized in the specifications (see Figure 11).

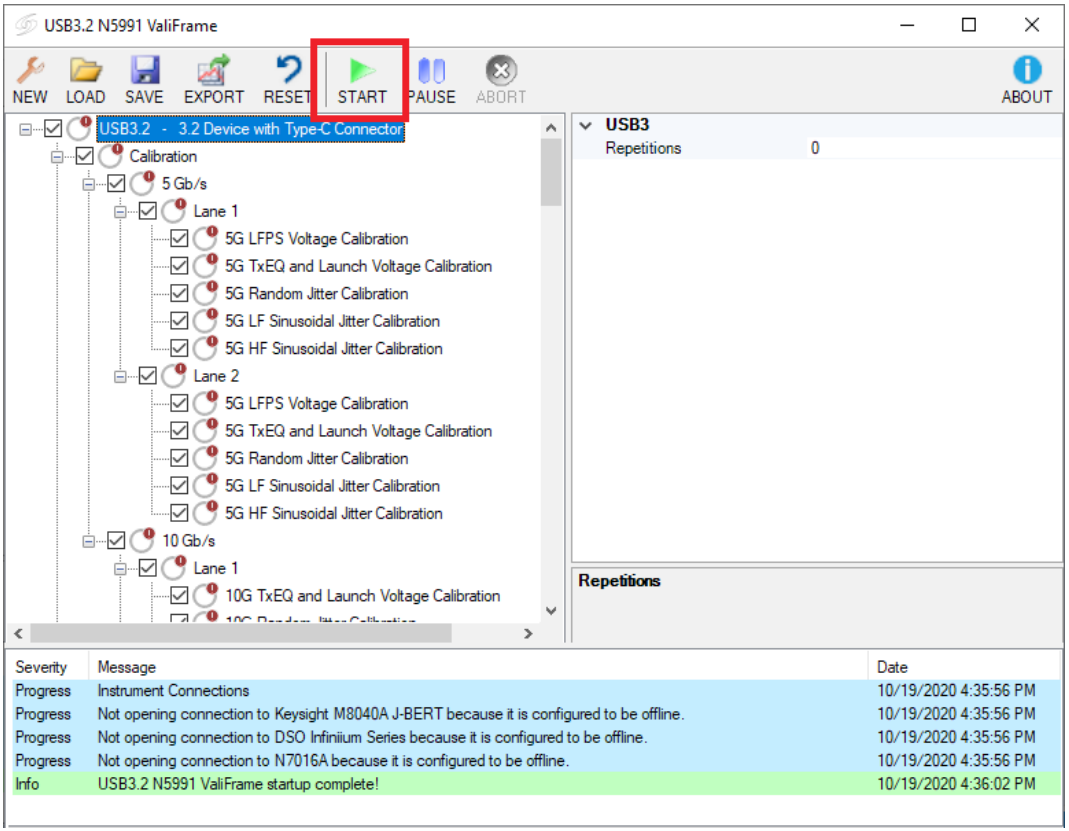


Figure 11 USB3.2 main window

The parameter grid on the right side of the window shows the parameters which are related to the selected procedures.

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

To start one or more procedures, select the corresponding check box. The Start button is enabled and turns green in color. Click **Start** to run the selected procedures.

Once all the procedures are run, the N5991 configuration can be stored as a single *'.vfp'* file using the **Save** button and recalled using the **Load** button without the need to configure the DUT again.

CAUTION

Before executing the calibration or test procedures, ensure that the USB3.2 Station Configuration is configured properly with all necessary instruments, such as the Infiniium oscilloscope, set to "online". All calibrations can be run in offline mode, that is, without any instrument connected. The offline mode is intended for product demonstrations with simulated data. CALIBRATIONS RUN IN OFFLINE MODE DO NOT GENERATE VALID CALIBRATION DATA.

Selecting, Modifying and Running Tests

Selecting Procedures

The calibration, receiver, and transmitter test procedure groups can be selected globally by selecting the check box at the top of the group. Alternatively, an individual test procedure can be selected by checking the corresponding check box. Click **Start** to run the selected test procedures.

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, almost all the parameters can be modified. First, select a specific calibration or test procedure or one of the groups contained in the N5991 procedure tree, as shown in Figure 12. The parameters are displayed in a property list on the right side of the window. These parameters can be configured only before the selected procedure subgroup or procedure is started. All selected test parameters are listed in the MS Excel/HTML test results worksheets. Note that even in Expert Mode, some of the parameters can only be changed during DUT configuration.

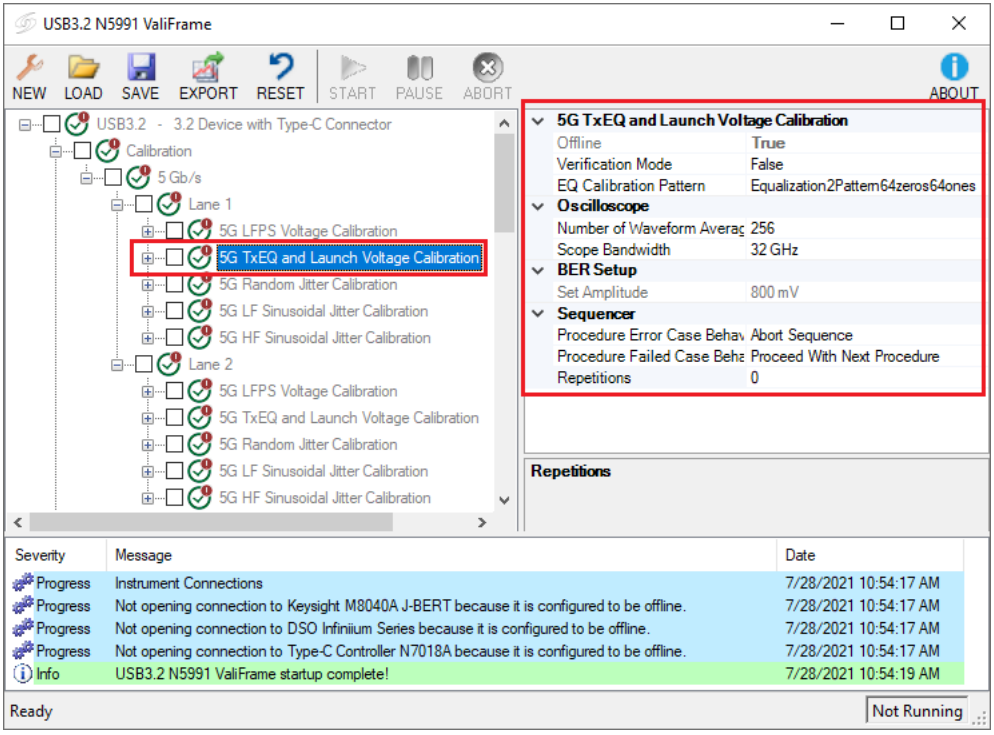


Figure 12 Modifying parameters

Running Procedures

To run the selected procedures, click the **Start** icon on the toolbar (see Figure 11). The procedures are run sequentially in the order shown in the procedure selection 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 prior to running the calibration/test procedures. To view the connection diagram, right-click the desired test or calibration. From the right-click menu, select **Show Connection...**.

Results

Runtime 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.

The results window that is opened during the procedure run closes once the specific procedure is finished. As long as the N5991 software is running, the results window for each procedure can be reopened with a double-click on the respective procedure. However, the individual results will be lost when the N5991 main window is closed, unless you have saved them.

Exporting Results

For your convenience, all individual results are collected together at the end of the test run. All calibration and test data results can be saved together by clicking the **Export** button on the toolbar of the USB3.2 N5991 Test Automation window. Keysight recommends performing this action at least once at the end of each N5991 procedure run to avoid any data loss. If the calibration and test procedures are conducted several times during the same N5991 run, the different sets of results are exported together. If a test procedure is conducted without prior execution of calibration procedures in the same test run, only the test results will be exported.

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 sub-folder “*Results/USB3 Station*” contains the Excel files of the final results measured at each calibration and test procedure. In addition to the calibration data worksheets, 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\USB3\ Calibrations*’ and saved manually in any folder before rerunning the calibrations.

Icon Representation

Once the selected procedures are run successfully, the icons that appear for individual procedures in the ValiFrame main window indicate the result (Pass / Fail / Incomplete) as described in Table 3.

Table 3 Result icon description

Icon	Description
	NotRun. The procedure has not been run yet.
	NotRun–Iterative. The procedure is going to be run more than once.
	Running. The procedure is running. **Note**: This icon is animated.
	Running–Iterative. The procedure is running with several repetitions. **Note**: This icon is animated.
	Pass. The procedure passed successfully.
	Pass–Imported. The procedure (result "pass") has been imported.
	Pass–Iterative. The procedure was run for several repetitions and passed successfully.

Icon	Description
	Fail. The procedure failed.
	Fail–Imported. The procedure (result "fail") has been imported.
	Fail–Iterative. The procedure was run for several repetitions and failed.
	Incomplete. The procedure was aborted/interrupted.
	Incomplete–Imported. The imported procedure was aborted/interrupted.
	Incomplete–Iterative. The procedure was run for several repetitions and they were incomplete.

Icon	Description
Additional States	
	CalMissing. This icon appears on the lower right portion of the main icon. For example:  It is specific to calibration procedures. It indicates that the calibration data is missing, and therefore is not available to be used in the Rx tests.
	Offline. This icon appears on the upper right portion of the main icon. For example:  It indicates that the procedure was run (or will be run) in offline mode.
	Both states can occur at the same time. For example:  It indicates that the calibration was run offline and that the offline calibration data is not available.

USB3.2 Parameters

The USB3.2 parameters are of three types:

- Sequencer Parameters
- Common Parameters
- Procedure Parameters

Sequencer Parameters

The sequencer parameters control the flow of the test sequencer, not the behavior of individual procedures. They are identical across all versions of ValiFrame. One of them, Repetitions, is available for all procedures and groups in the procedure tree. The others are only available for procedures. Like all other parameters, the sequencer parameters are shown on the right side of the ValiFrame user interface and you may manually change them, as illustrated in Figure 13.

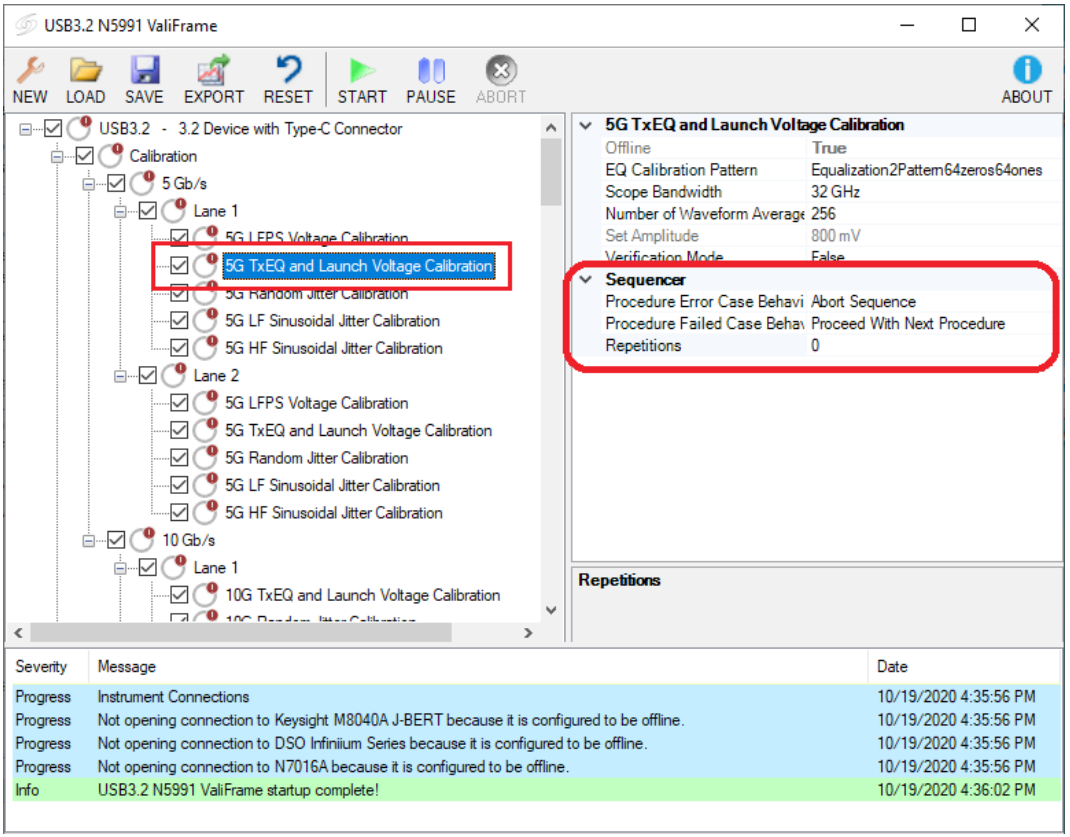


Figure 13 USB3.2 sequencer parameters

All sequencer parameters are listed in alphabetical order in Table 4.

Table 4 USB3.2 sequencer parameters

Parameter Name	Parameter Description
Procedure Error Case Behavior	▪ "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	▪ "Proceed With Next Procedure": If the current test or calibration procedure fails, continue by running the next procedure in the sequence. ▪ "Abort Sequence": Abort further running of the sequence.
Repetitions	The number of times the group or procedure is going to be repeated. If the value is '0', it runs only once.

Common Parameters

The 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 USB3.2 Receiver Test Software has some group parameters (in addition to "Repetitions") on the top-level entry of the USB3.2 calibration and receiver test tree. These are common for all ValiFrame calibration and receiver procedures respectively.

All common parameters are listed in alphabetical order in Table 5.

Table 5 USB3.2 Common receiver parameters

Parameter Name	Parameter Description
Instrument Channels	
J-BERT Generator	Defines the JBERT Channel used as Data Output signal.
J-BERT Error Detector	Defines the JBERT Channel used as Error Detector Input signal.
Power Automation	
Power Automation	If set to 'Manual', the software prompts you to power cycle the DUT. If set to 'Power Supply' or 'Power Switch', the power cycle is automated.
Power Component	The component which is used to power up the DUT and/or enable the DUT's USB bus.
Power Channel	The channel of the power supply or power switch which is connected to the DUT.
Power Cycle Off-On Duration	The timespan between switching the DUT off and switching it back on.
Power Cycle Settling Time	The timespan after the DUT is powered on and the continuation of the test.
Power Cycle max. retries for LB Training	The maximum number of loopback training retries. The following BER test shall be considered as 'Failed' after this number of retries has been exhausted.
Loopback Training	
Force Retraining	If enabled, the software prompts you to retrain the DUT after every test, even if it is still in loopback.
CDR during Loopback Training	If True, the CDR is enabled during Loopback Training.
LFPS Idle	The signal applied between the LFPS bursts.
LFPS Trigger Threshold	Detection level for LFPS signals sent by the DUT. This parameter is available only if PowerOnReset is selected as the Loopback Training Method.

Parameter Name	Parameter Description
Loopback Training Method	This method determines the way Loopback Training is performed.
User Link Training Suite	Use a Link Training Suite script file to set the generator and analyzer sequences.
Training Suite Settings File	The path where the link training script file is saved.
User Instrument Scrambler	Enables the instrument to scramble the pattern.
Use Voltage Settings from Rx Tests for Loopback Training	Set to 'True', if the voltage settings (eye-height and de-emphasis), which can be changed at each receiver test, are used for loopback training.
Training Voltage for Loopback Training	If "Use Voltage Settings from Rx Tests for Loopback Training" is set to 'True', the voltage for the loopback training is the same as that used for the Rx tests. Otherwise, the voltage for the loopback training can be defined in this field.
Short Channel Differential Voltage	The differential voltage used in the loopback training for short channel tests.
Error Detector	
CDR Symbol Rate	Use this parameter to specify the centered data rate of the DUT. By default it is set to 5000 ppm – downspread SSC, i.e., 4.975 Gb/s (5 Gb/s – 25 Mb/s). If the DUT does not transmit with SSC, the data rate should be set to the nominal, e.g., 5G. The maximum deviation allowed is ±3000 ppm. The M8046A error detector CDR is very sensitive to this parameter. If the CDR does not lock here, although the DUT is in loopback, the centered data rate has to be measured with an oscilloscope.
CDR Loop Bandwidth	Range of the CDR jitter transfer function loop bandwidth.
CDR Transition Density	Ratio of the number of transitions in the incoming data and the total number of bits transmitted.
CDR Peaking	Allowed value of Jitter peaking.
Analyzer CTLE	The equalization presets available that depend on the BERT's factory calibration.
Input Sensitivity	BERT's error detector sensitivity level.

Parameter Name	Parameter Description
Auto-align Timeout	The auto-alignment is aborted after the specified duration.
Error Detector Operation Mode	If 'Differential' is selected, the DUT's transmitted signal must be split with power dividers (or similar). If 'SingleEnded' is selected, no additional items are required.
Input Polarity Inverted	If set to 'True', the positive and negative BERT analyzer channels are inverted.

Procedure Parameters

The Procedure Parameters are all such parameters that are not part of any 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. Procedures often have parameters with the same name, but pre-configured settings always apply to the selected procedure and the meaning may differ slightly between procedures.

Table 6 and Table 7 contain descriptions of some procedure parameters that are repeated in several tests.

Table 6 USB3.2 calibration parameters

Parameter Name	Description
EQ Calibration Pattern	The pattern used for the TxEQ and Launch Voltage Calibration.
Scope Bandwidth	Bandwidth selected in the oscilloscope
Number of Waveforms Averaged	Number of waveforms that are averaged during the oscilloscope acquisition. This will lower the noise floor.
Verification Mode	If this is set to False, the procedure behaves as a normal calibration and the results are saved as usual. If it is set to True, the procedure uses a previous calibration to set the calibrated parameter. In this case, the purpose of the procedure is to verify that the available calibration is valid and the desired values can be achieved.
CLB Trace Length	The selected Compliance Load Board trace length causes the receiver eye-height to be closest to the target eye-height specified.

Parameter Name	Description
Pre-Shoot	Pre-Shoot used for the calibration
De-Emphasis	De-Emphasis used for the calibration
Differential Voltage	Differential voltage of the data signal
Random Jitter	The amount of RJ added to the signal.
Sinusoidal Jitter	The amount of sinusoidal jitter added to the test signal.
Target Eye-Height	The calibration will be performed to achieve this target eye-height.
Target Eye-Width	The calibration will be performed to achieve this target eye-width.
Number of Averages	The number of averages (SigTest measurements) for one jitter measurement.

Table 7 USB3.2 receiver parameters

Parameter Name	Description
Specification	
SSC Deviation	The spread spectrum clock (SSC) modulation depth with respect to the data rate (down-spread).
SSC Frequency	The frequency of the spread spectrum clock (SSC) added to the signal.
Target Eye-Height	The corresponding calibration is performed to achieve this target eye-height.
Target Eye-Width	The corresponding calibration is performed to achieve this target eye-width.

Parameter Name	Description
Eye Height	The value of eye-height configured for the receiver test.
Eye Width	The value of eye-width configured for the receiver test.
Eye Height Margin	The eye-height margin added to the differential voltage.
Pre-shoot	The pre-shoot value configured for receiver tests.
De-emphasis	The de-emphasis value configured for receiver tests.
Differential Voltage	The differential voltage amplitude of the test signal.
Random Jitter	The amount of calibrated RJ added to the signal.
Random Jitter Margin	The margin added to the random jitter.
Sinusoidal Jitter Frequency	The frequency of the sinusoidal jitter component.
Sinusoidal Jitter	The amount of sinusoidal jitter added to the test signal.
Sinusoidal Jitter Margin	The margin added to the sinusoidal jitter.
SJ Reduction for Eye-Width Adjustment	Amount of sinusoidal jitter at the frequency specified, which is subtracted for eye-width adjustment.
Second Tone SJ for Eye-Width Adjustment	Amount of sinusoidal jitter at 87 MHz of frequency, which is added for eye-width adjustment.
t_{Period}	The time period of an LFPS cycle.
t_{Burst}	The duration for which LFPS cycles are sent to form a single LFPS burst.

Parameter Name	Description
t_{Repeat}	The duration between the start of two adjacent LFPS bursts.
Duty Cycle	The duty cycle within t_{Period}.
Loopback Training	
Retrain at each jitter frequency	If set to 'True', the DUT is trained into loopback mode at each SJ frequency (test point).
Train with Jitter	Jitter can be enabled or disabled for Loopback Training.
Sinusoidal Jitter Variation	
Frequency Mode	Select one of the options: ▪ Compliance Frequencies ▪ Equally Spaced Frequencies ▪ User Defined Frequencies ▪ Single Frequency
Jitter Frequencies	List of frequencies to be tested. For 'Compliance' mode, they are read-only; whereas, for 'Editor' mode, they can be edited.
Start Frequency value	The minimum value of jitter frequency to be tested. Only available for 'Equally Spaced Frequencies' mode.
Stop Frequency value	The maximum value of jitter frequency to be tested. Only available for 'Equally Spaced Frequencies' mode.
Number of Frequency Steps	The number of different jitter frequencies that are tested. The distribution of frequencies between minimum and maximum is equidistant on a logarithmic or linear scale. Only available for 'Equally Spaced Frequencies' mode.
Frequency sweep scale	Select either 'Linear' or 'Logarithmic' scale. Only available for 'Equally Spaced Frequencies' mode.
Start jitter amplitude	The initial value of the SJ amplitude tested in the search algorithm.
Use fixed number of steps	The range of jitter amplitudes to be tested at each frequency starts with the defined "Start jitter amplitude" and ends with the jitter capability of the data generator. If this parameter is 'True', the range is divided into a fixed number of steps. If set to 'False', the steps are defined by the step size.

Parameter Name	Description
Number of jitter steps	The number of jitter points used in the search algorithm.
Jitter linear step size	Increase in jitter value at each step of the search algorithm.
Show Min Failed Points	If set to 'True', the result will show the first SJ amplitude that did not pass the BER test at each frequency
Differential Voltage Variation	
Start Differential Voltage	First value of differential voltage that shall be tested.
Differential Voltage Step Size	Interval between two consecutive differential voltage steps.
Data Rate Variation	
Deviation Mode	Set the data rate deviation range that shall be tested. Select one of the options: ▪ Pre Defined Deviations ▪ Equally Spaced Deviations ▪ User Defined Deviations ▪ Single Deviation
Min Data Rate Deviation	First data rate deviation that shall be tested. Only available for 'Equally Spaced Deviations' mode.
Max Data Rate Deviation	Last data rate deviation that shall be tested. Only available for 'Equally Spaced Deviations' mode.
Number of Deviation Steps	Number of steps for the data rate deviation sweep to be performed. Only available for 'Equally Spaced Deviations' mode.
Data Rate Deviation Points	User-defined data rate deviation points. Only available for 'User Defined Deviations' mode.
Data Rate Deviation	The single data rate deviation that will be tested. Only available for 'Single Deviation' mode.

Parameter Name	Description
Script Variation	
LFPS Loop Count	Sets the LFPS Loop Count.
Number of Idle	Sets the number of electrical Idle blocks in front of the sequence
Duty Cycle Variation	
Start Duty Cycle	The start duty cycle of the LFPS burst.
Stop Duty Cycle	The stop duty cycle of the LFPS burst.
Duty Cycle Step Size	The amount the duty cycle is increased by one step.
t_{Repeat} Variation	
Start t_{Repeat}	The start t_{Repeat} value of the LFPS signal.
Stop t_{Repeat}	The stop t_{Repeat} value of the LFPS signal.
t_{Repeat} Step Size	The duration by which the t_{Repeat} value is increased by one step.

4 USB3.2 Calibrations

Before any receiver test procedure can be run, the USB3.2 receiver test system must be calibrated.

Calibrations Overview

The ValiFrame calibration plane is given by the DUT input ports. The receiver test signal characteristics such as the USB3.2 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 actual values of the relevant signal output parameters from the set values over the required parameter range.

All calibration procedures required for USB3.2 receiver testing are included in the ValiFrame software. The ValiFrame calibration procedures are implemented such that the calibration process is conducted as fast as possible and is automated as much as possible, for example, by minimizing the number of re-configurations of the hardware connections.

Common Parameters for Calibrations

The parameters for the calibration group depend on the DUT type, test method, and connector. They may include:

- **Amplitude Imbalance Check**—This parameter enables or disables the amplitude imbalance check during calibration.
- **Scope Cal Connection**—Connection to the Oscilloscope used for calibrations. The available choices include ‘Differential Ch1-Ch3’ and ‘Differential Ch2-Ch4’.
- **J-BERT Generator**—The output of the data generator used for the calibrations.

5G Calibration Procedures

Common Parameters That Are Lane Specific

- **Scope Cal Connection**: Connection to the oscilloscope used for calibrations. The available choices are:
  - Differential Ch1-Ch3
  - Differential Ch2-Ch4
  - Differential Ch1-Ch3 + Differential Ch2-Ch4 (Available when the system has two analyzers connected)
- **J-BERT Generator**: The output of the data generator used for the calibrations.

5G LFPS Voltage Calibration

Availability Condition

This calibration is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure calibrates the differential voltage for low-frequency periodic signaling.

The data generator sends an LFPS pattern. The test automation sets twelve equally spaced differential voltages from 100 mV to 1200 mV in the data generator. The differential amplitude is measured with the oscilloscope.

Connection Diagram

Please refer to Figure 14 when only one lane is being tested (non-Type-C connectors and Type C for spec below 3.2) and to Figure 15 when two lanes are being tested (Type C for spec 3.2) with the M8040A data generator.

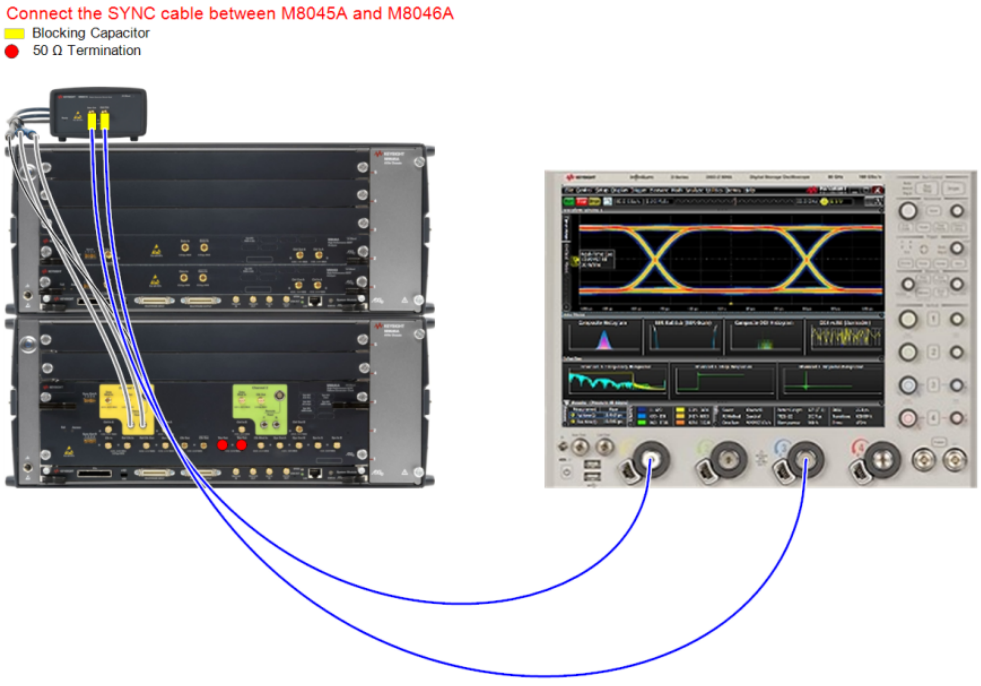


Figure 14 For 5G non-channel calibration (1 lane)

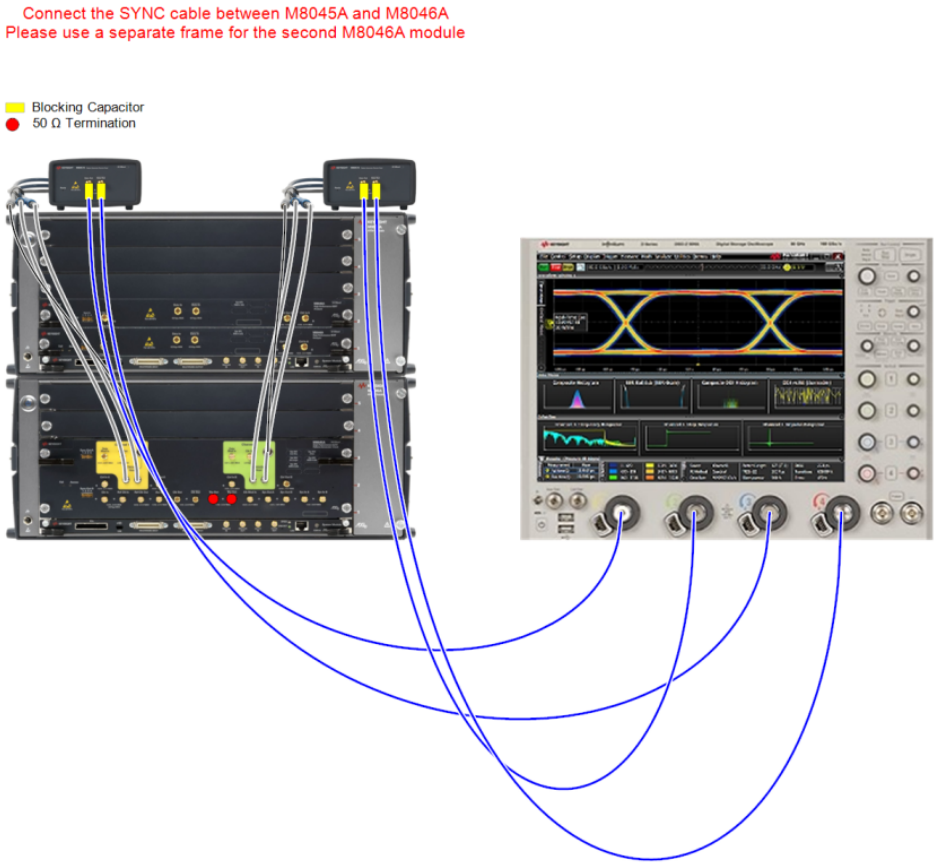
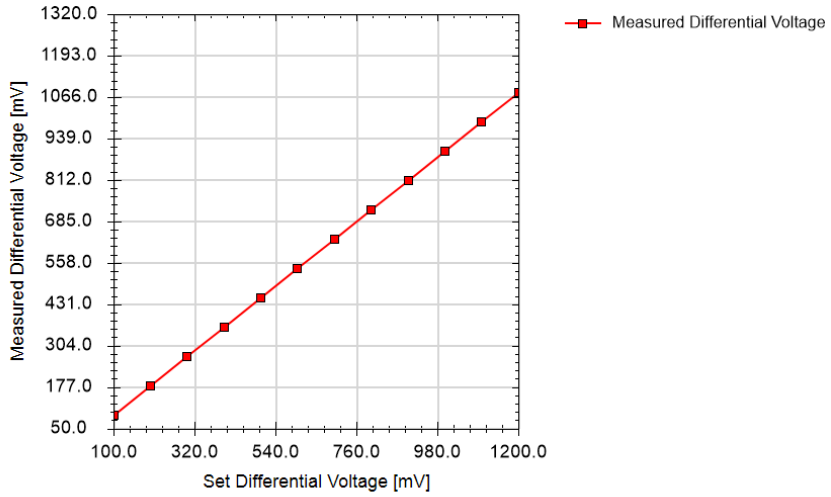


Figure 15 For 5G non-channel calibration (2 lanes)

Result Description

Cal_5G_L1_LFPS_Volt

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Keysight M8040A J-BERT	Keysight M8040A J-BERT, Keysight M8040A J-BERT, SN: Unknown
Keysight DSO	Keysight DSO, DSO Infiniium Series, SNo: Unknown
Amplitude Imbalance Check	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set Differential Voltage [mV]	Measured Differential Voltage [mV]
100	90
200	180
300	270
400	360
500	450
600	540
700	630
800	720
900	810
1000	900
1100	990
1200	1080

Figure 16 Example result for 5G LFPS voltage calibration

- **Set Differential Voltage**: The differential voltage set in the instrument.
- **Measured Differential Voltage**: The actual amplitude measured in the oscilloscope.

5G TxEQ and Launch Voltage Calibration

Availability Condition

This calibration is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure calibrates the De-Emphasis, Pre-shoot and Differential Voltage amplitude.

The pattern generator sends an equalization pattern to the oscilloscope and performs a sweep of the whole equalization range.

First, the pre-cursor is set to the initial value (–0.28). For that value, the post-cursor is swept from –0.28 to 0.02 with linear steps of 0.02. For each post-cursor value, the de-emphasis, pre-shoot and differential voltage are measured with the oscilloscope. Then, the pre-cursor is increased with a step size of 0.02 and the process is repeated until 0.02 is attained. The Launch Voltage is always fixed at 800 mV.

NOTE

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

Connection Diagram

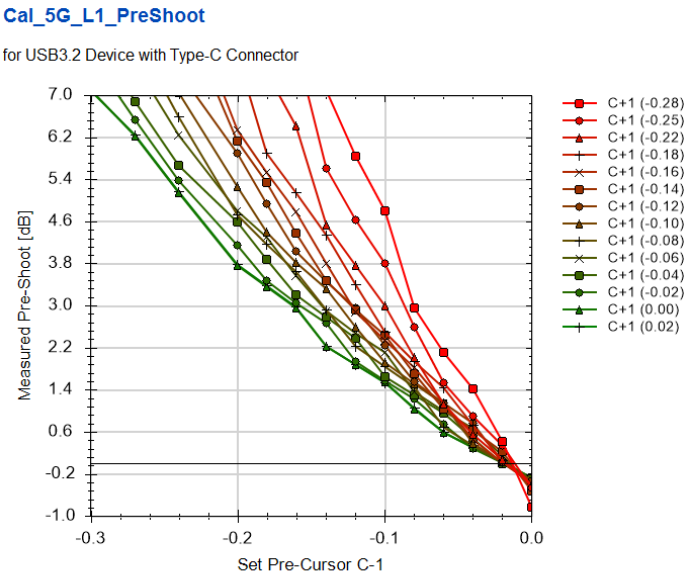
Please refer to Figure 14 when only one lane is being tested (non-Type-C connectors and Type C for spec below 3.2) and to Figure 15 when two lanes are being tested (Type C for spec 3.2) with the M8040A data generator.

Parameters in Expert Mode

- Verification Mode
- EQ Calibration Pattern
- Number of Waveform Averages
- Scope Bandwidth
- Set Amplitude

For more details of the parameters, please refer to Table 6.

Result Description



Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
EQ Calibration Pattern	Equalization2Pattern64zeros64ones
Scope Bandwidth	32 GHz
Number of Waveform Averages	256
Set Amplitude	814 mV
Verification Mode	False
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3
ProcedureName	10G Pre-Shoot Calibration

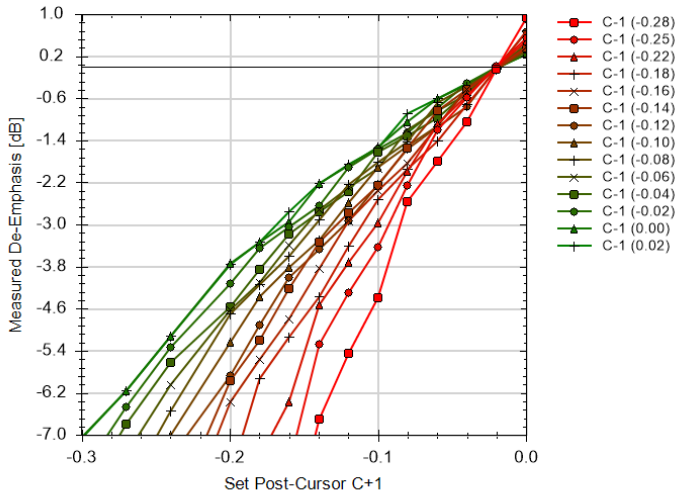
Set Pre-Cursor C-1 []	C+1 (-0.28) [dB]	C+1 (-0.25) [dB]	C+1 (-0.22) [dB]	C+1 (-0.18) [dB]	C+1 (-0.16) [dB]	C+1 (-0.14) [dB]	C+1 (-0.12) [dB]	C+1 (-0.10) [dB]	C+1 (-0.08) [dB]	C+1 (-0.06) [dB]	C+1 (-0.04) [dB]	C+1 (-0.02) [dB]	C+1 (0.00) [dB]	C+1 (0.02) [dB]
-0.28	NaN	NaN	NaN	NaN	15.94	13.30	11.59	10.71	9.99	8.79	8.29	7.78	7.10	7.09
-0.25	NaN	NaN	NaN	13.23	11.90	11.08	9.30	8.70	8.15	7.61	6.87	6.53	6.22	6.24
-0.22	NaN	NaN	14.20	10.10	9.24	8.76	7.46	7.05	6.59	6.24	5.67	5.37	5.15	5.17
-0.18	NaN	11.12	8.70	7.78	6.33	6.12	5.90	5.26	4.72	4.80	4.58	4.15	3.76	3.77
-0.16	12.60	9.37	7.45	5.89	5.52	5.34	4.93	4.39	4.16	4.30	3.87	3.47	3.35	3.37
-0.14	9.39	7.94	6.41	5.14	4.77	4.38	4.02	3.83	3.64	3.57	3.21	3.05	2.96	2.97
-0.12	7.10	5.61	4.54	4.33	3.79	3.48	3.46	3.32	2.92	2.90	2.77	2.66	2.22	2.22
-0.10	5.84	4.62	3.76	3.39	2.87	2.92	2.95	2.59	2.23	2.48	2.38	1.93	1.87	1.87
-0.08	4.80	3.80	2.99	2.50	2.33	2.43	2.24	1.92	1.84	2.10	1.64	1.58	1.54	1.54
-0.06	2.95	2.59	2.02	1.93	1.83	1.70	1.55	1.51	1.45	1.35	1.29	1.22	1.03	1.04
-0.04	2.11	1.53	1.13	1.44	1.15	1.03	1.14	1.12	0.69	1.00	0.95	0.74	0.60	0.60
-0.02	1.41	0.89	0.56	0.73	0.45	0.62	0.75	0.39	0.35	0.67	0.48	0.29	0.30	0.31
0.00	0.41	0.33	0.07	0.05	0.02	0.22	0.01	0.04	0.02	0.16	0.00	0.01	0.03	0.02
0.02	-0.82	-0.47	-0.42	-0.38	-0.37	-0.53	-0.34	-0.36	-0.31	-0.47	-0.28	-0.27	-0.28	-0.27

Figure 17 Example result for 5G TxEQ & launch voltage calibration (pre-shoot)

- **Set Pre-Cursor C–1**: The pre-cursor value set on the instrument.
- **C+1 (X) [dB]**: The entries in the table give the actual pre-shoot value in dB measured at the oscilloscope for the particular combination of pre-cursor (C–1, given in the first column) and post-cursor (C+1, given in the column heading) values.

Cal_5G_L1_DeEmphasis

for USB3.2 Device with Type-C Connector



Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
EQ Calibration Pattern	Equalization2Pattern64zeros64ones
Scope Bandwidth	32 GHz
Number of Waveform Averages	256
Set Amplitude	814 mV
Verification Mode	False
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3
ProcedureName	10G De-Emphasis Calibration

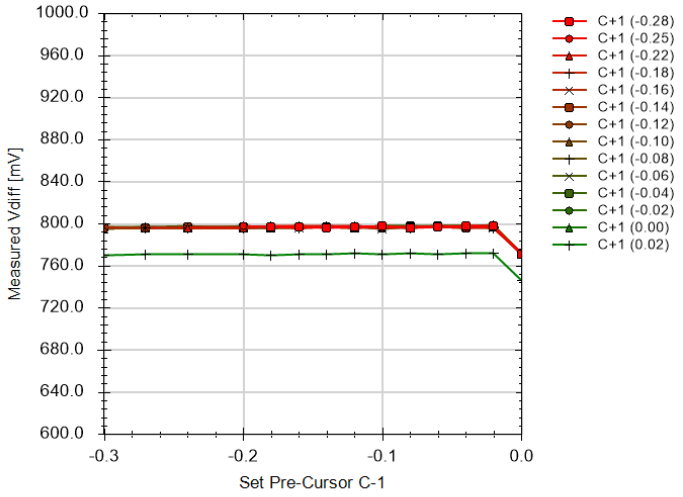
Set Post-Cursor C+1 []	C-1 (-0.28) [dB]	C-1 (-0.25) [dB]	C-1 (-0.22) [dB]	C-1 (-0.18) [dB]	C-1 (-0.16) [dB]	C-1 (-0.14) [dB]	C-1 (-0.12) [dB]	C-1 (-0.10) [dB]	C-1 (-0.08) [dB]	C-1 (-0.06) [dB]	C-1 (-0.04) [dB]	C-1 (-0.02) [dB]	C-1 (0.00) [dB]	C-1 (0.02) [dB]
-0.28	NaN	NaN	NaN	NaN	-15.95	-13.13	-11.57	-10.67	-9.93	-8.58	-8.23	-7.74	-7.05	-7.06
-0.25	NaN	NaN	NaN	-13.23	-11.89	-10.87	-9.24	-8.61	-8.07	-7.37	-6.79	-6.46	-6.15	-6.17
-0.22	NaN	NaN	-14.20	-10.09	-9.25	-8.60	-7.43	-7.01	-6.55	-6.04	-5.62	-5.34	-5.13	-5.12
-0.18	NaN	-10.76	-8.67	-7.78	-6.36	-5.97	-5.87	-5.23	-4.70	-4.62	-4.56	-4.12	-3.73	-3.75
-0.16	-12.19	-9.04	-7.42	-5.93	-5.56	-5.20	-4.91	-4.37	-4.13	-4.11	-3.85	-3.45	-3.33	-3.34
-0.14	-8.97	-7.59	-6.36	-5.13	-4.79	-4.22	-4.01	-3.82	-3.61	-3.38	-3.18	-3.05	-2.95	-2.75
-0.12	-6.70	-5.28	-4.52	-4.37	-3.83	-3.33	-3.46	-3.30	-2.92	-2.71	-2.75	-2.65	-2.21	-2.22
-0.10	-5.46	-4.29	-3.72	-3.41	-2.92	-2.77	-2.94	-2.59	-2.23	-2.30	-2.38	-1.91	-1.86	-1.86
-0.08	-4.40	-3.42	-2.97	-2.53	-2.36	-2.26	-2.24	-1.91	-1.82	-1.93	-1.63	-1.57	-1.53	-1.54
-0.06	-2.56	-2.26	-1.98	-1.94	-1.83	-1.55	-1.56	-1.51	-1.43	-1.19	-1.32	-1.26	-1.05	-0.89
-0.04	-1.79	-1.20	-1.09	-1.41	-1.12	-0.84	-1.15	-1.12	-0.69	-0.84	-0.97	-0.77	-0.60	-0.61
-0.02	-1.05	-0.58	-0.55	-0.72	-0.44	-0.44	-0.76	-0.39	-0.38	-0.52	-0.49	-0.31	-0.33	-0.32
0.00	-0.05	0.00	-0.01	-0.04	-0.03	-0.05	-0.03	-0.04	-0.04	-0.04	-0.03	-0.01	-0.04	-0.04
0.02	0.94	0.55	0.48	0.68	0.38	0.36	0.67	0.33	0.30	0.44	0.42	0.24	0.25	0.24

Figure 18 Example result for 5G TxEQ & launch voltage calibration (de-emphasis)

- **Set Post-Cursor C+1**: The post-cursor value set on the instrument.
- **C–1 (X) [dB]**: The entries in the table give the actual de-emphasis value in dB measured at the oscilloscope for the particular combination of post-cursor (C+1, given in the first column) and pre-cursor (C–1, given in the column heading) values.

Cal_5G_L1_GenOutVolt

for USB3.2 Device with Type-C Connector



Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
EQ Calibration Pattern	Equalization2Pattern64zeros64ones
Scope Bandwidth	32 GHz
Number of Waveform Averages	256
Set Amplitude	814 mV
Verification Mode	False
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3
ProcedureName	10G Generator Outout Voltage Calibration

Set Pre-Cursor C-1 []	C+1 (-0.28) [mV]	C+1 (-0.25) [mV]	C+1 (-0.22) [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	NaN	NaN	NaN	NaN	797.00	796.00	796.00	796.00	796.00	795.00	796.00	797.00	795.00	770.00
-0.25	NaN	NaN	NaN	796.00	796.00	796.00	796.00	797.00	796.00	797.00	796.00	797.00	797.00	771.00
-0.22	NaN	NaN	796.00	796.00	796.00	797.00	797.00	796.00	797.00	798.00	796.00	796.00	796.00	771.00
-0.18	NaN	798.00	796.00	796.00	796.00	797.00	797.00	797.00	796.00	796.00	796.00	798.00	796.00	771.00
-0.16	797.00	797.00	798.00	797.00	797.00	796.00	797.00	796.00	797.00	796.00	796.00	797.00	797.00	770.00
-0.14	797.00	796.00	798.00	796.00	798.00	797.00	797.00	797.00	797.00	796.00	797.00	796.00	797.00	771.00
-0.12	796.00	797.00	798.00	798.00	797.00	797.00	797.00	797.00	797.00	797.00	797.00	797.00	797.00	771.00
-0.10	797.00	797.00	797.00	798.00	796.00	796.00	797.00	796.00	798.00	797.00	797.00	797.00	797.00	772.00
-0.08	798.00	796.00	796.00	797.00	797.00	798.00	797.00	798.00	797.00	795.00	798.00	797.00	798.00	771.00
-0.06	796.00	797.00	797.00	797.00	796.00	797.00	797.00	797.00	796.00	797.00	798.00	797.00	798.00	772.00
-0.04	797.00	797.00	797.00	798.00	798.00	797.00	797.00	797.00	798.00	798.00	798.00	797.00	797.00	771.00
-0.02	798.00	797.00	796.00	797.00	797.00	798.00	796.00	797.00	798.00	798.00	798.00	798.00	797.00	772.00
0.00	798.00	797.00	797.00	796.00	797.00	798.00	796.00	798.00	797.00	796.00	797.00	799.00	797.00	772.00
0.02	771.00	772.00	772.00	772.00	771.00	771.00	771.00	771.00	772.00	772.00	772.00	772.00	772.00	746.00

Figure 19 Example result for 5G TxEQ & launch voltage calibration (differential voltage)

- **Set Pre-Cursor (C–1)**: The pre-cursor value set on the instrument.
- **C+1 (X) [mV]**: The entries in the table give the actual differential voltage value in mV measured at the oscilloscope for the particular combination of pre-cursor (C–1, given in the first column) and post-cursor (C+1, given in the column heading) values.

5G Random Jitter Calibration

Availability Condition

This calibration is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure calibrates the Random Jitter (RJ).

The pattern generator sends the CP1 pattern and adds random jitter to the signal. It sets eleven equally spaced RJ values (from 0 to 250 mUI). The jitter is measured with a real-time oscilloscope using the SigTest software.

Connection Diagram (for Type-C Connectors)

Please refer to Figure 14 when only one lane is being tested (Type C for spec below 3.2) and to Figure 15 when two lanes are being tested (Type C for spec 3.2) with the M8040A data generator.

Connection Diagram (for other connectors)

For other connectors a long-channel calibration is done, as shown in Figure 20 and Figure 21.

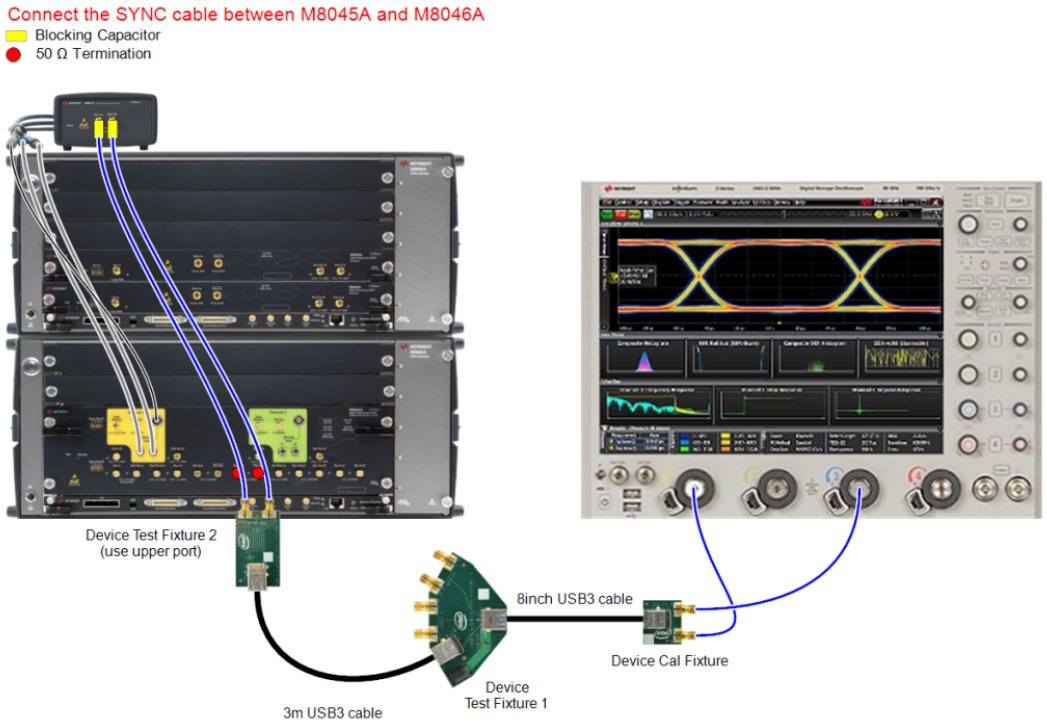


Figure 20 For 5G long-channel calibration (lane 1 – device – non type C)

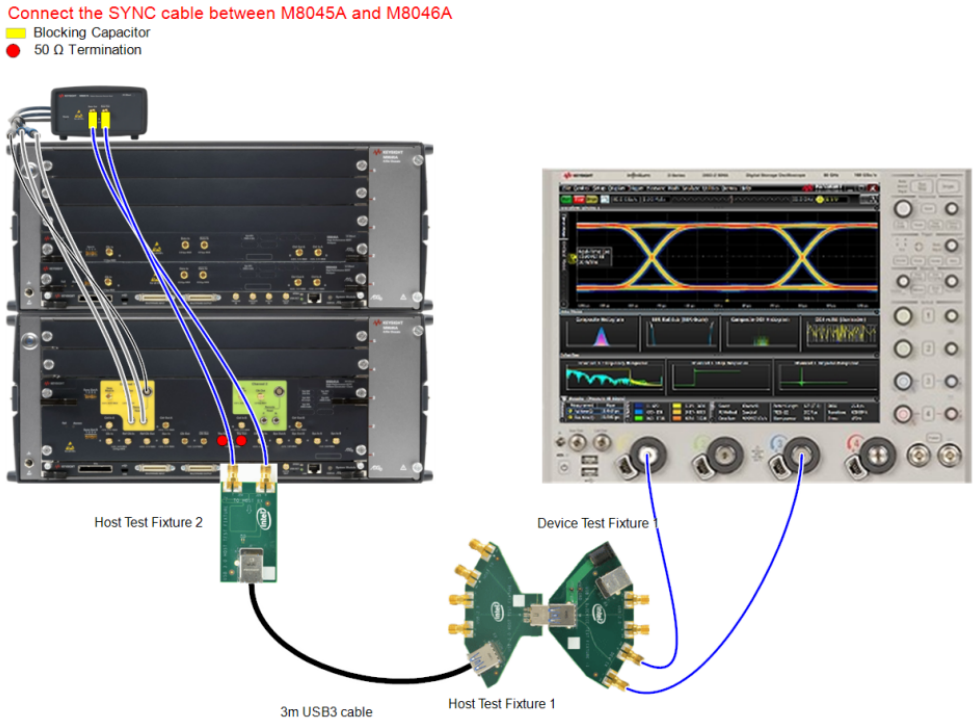


Figure 21 For 5G long-channel calibration (lane 1 – host – non type C)

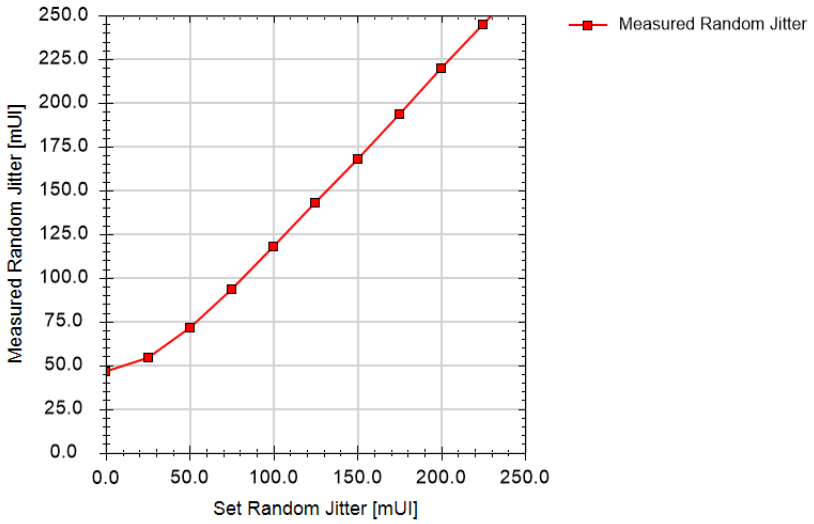
Parameters in Expert Mode

- SigTest version

Result Description

Cal_5G_L1_RJ

for USB3.2 Device with Type-C Connector



Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	3.2.11.3
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set Random Jitter [mUI]	Measured Random Jitter [mUI]
0	47
25	54
50	72
75	94
100	118
125	143
150	168
175	194
200	220
225	245
250	271

Figure 22 Example result for 5G random jitter calibration

- **Set Random Jitter**: The random jitter set at the data generator.
- **Measured Random Jitter**: The actual random jitter measured with the oscilloscope.

5G LF Sinusoidal Jitter Calibration

Availability Condition

This calibration is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure calibrates the sinusoidal jitter for low frequencies (from 100 kHz to 1 MHz).

The data generator sends the CP0 pattern during this calibration. It performs a sweep of the sinusoidal jitter amplitude for five different frequencies. At each step, the actual sinusoidal jitter amplitude is measured with the oscilloscope using the SigTest software.

The test automation checks that the measured jitter amplitude values are consistent across jitter frequencies. Deviations larger than 2.5% between the measured jitter amplitudes for the same set jitter amplitude at different frequencies are not allowed. In the case of a larger deviation, the point is re-measured up to three times.

Connection Diagram

For Type C refer to Figure 14 and Figure 15. Refer to Figure 20 and Figure 21 for other connectors.

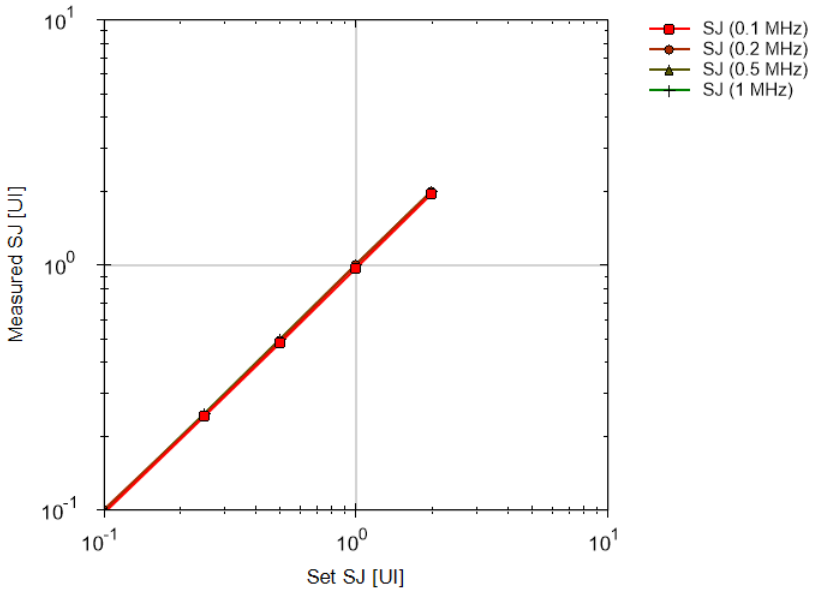
Parameters in Expert Mode

- SigTest version

Result Description

Cal_5G_L1_LF_SJ

for USB3.2 Device with Type-C Connector



Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	3.2.11.3
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set SJ [UI]	SJ (0.1 MHz) [UI]	SJ (0.2 MHz) [UI]	SJ (0.5 MHz) [UI]	SJ (1 MHz) [UI]
0.100	0.096	0.099	0.097	0.099
0.250	0.242	0.244	0.246	0.247
0.500	0.481	0.492	0.493	0.494
1.000	0.965	0.992	0.994	0.993
2.000	1.936	1.987	1.991	1.990

Figure 23 Example result for 5G LF sinusoidal jitter calibration

- **Set SJ [UI]**: The sinusoidal jitter amplitude set on the instrument.
- **SJ (x MHz) [UI]**: The actual sinusoidal jitter amplitude measured on the oscilloscope for the frequency 'x' MHz.

5G HF Sinusoidal Jitter Calibration

Availability Condition

This calibration is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure calibrates the sinusoidal jitter for high frequencies (from 2 MHz to 50 MHz). The method is the same as that for 5G LF Sinusoidal Jitter Calibration. However, in this case, the maximum allowed deviation is 5%.

The data generator sends the CP0 pattern during this calibration. It performs a sweep of the sinusoidal jitter amplitude for five different frequencies. At each step, the actual sinusoidal jitter amplitude is measured with the oscilloscope using the SigTest software.

Connection Diagram

For Type C refer to Figure 14 and Figure 15. Refer to Figure 20 and Figure 21 for other connectors.

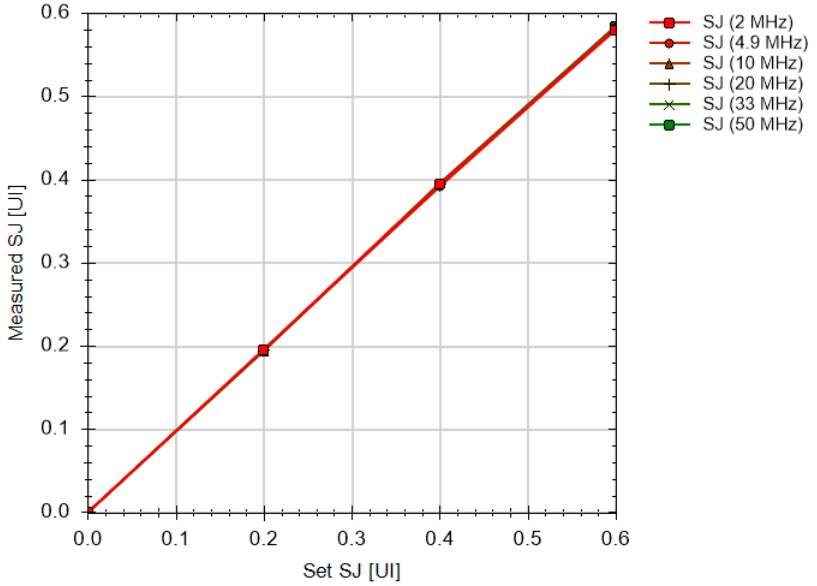
Parameters in Expert Mode

- SigTest version

Result Description

Cal_5G_L1_HF_SJ

for USB3.2 Device with Type-C Connector



Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	3.2.11.3
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set SJ [UI]	SJ (2 MHz) [UI]	SJ (4.9 MHz) [UI]	SJ (10 MHz) [UI]	SJ (20 MHz) [UI]	SJ (33 MHz) [UI]	SJ (50 MHz) [UI]
0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.200	0.195	0.195	0.195	0.195	0.194	0.194
0.400	0.394	0.392	0.394	0.395	0.396	0.394
0.600	0.579	0.581	0.582	0.583	0.584	0.584

Figure 24 Example result for 5G HF sinusoidal jitter calibration

- **Set SJ [UI]**: The sinusoidal jitter amplitude set in the instrument.
- **SJ (x MHz) [UI]**: The actual sinusoidal jitter amplitude measured on the oscilloscope for the frequency 'x' MHz.

5G Eye Height Calibration

Availability Condition

This calibration is available for all such connectors that are neither Type-C nor Tethered Type-C.

Purpose and Method

This procedure calibrates the eye height.

The data generator sends the CP0 pattern. The test automation sets several differential voltage amplitudes and measures the corresponding eye height with the oscilloscope. The measurements are performed using the SigTest software.

Connection Diagram

Please refer to Figure 20 and Figure 21.

Parameters in Expert Mode

- SigTest version

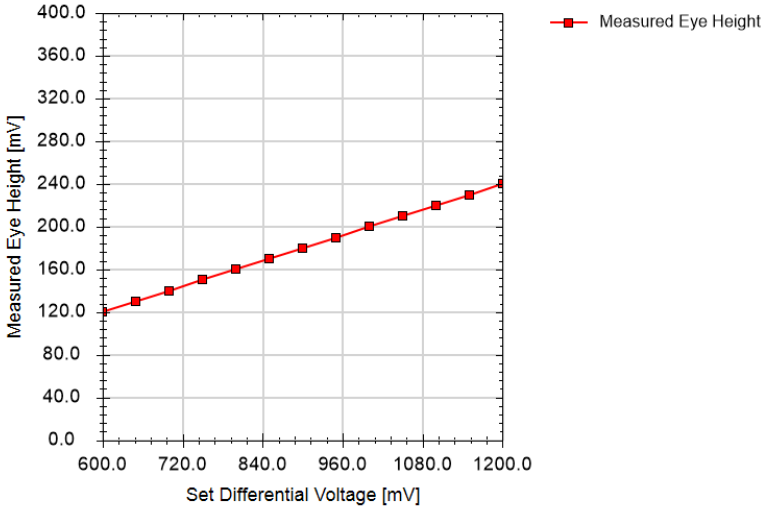
Prerequisite Calibrations

- 5G TxEQ and Launch Voltage Calibration
- 5G Random Jitter Calibration
- 5G LF Sinusoidal Jitter Calibration
- 5G HF Sinusoidal Jitter Calibration

Result Description

Cal_5G_L1_EyeHeight

for USB3.0 Device with Micro-B Connector



BERT System	Keysight M8020A J-BERT, Keysight M8020A J-BERT, SN: Unknown
Offline	True
Oscilloscope	DSO Infiniium Series, SN: Unknown, FW rev.: Unknown
SigTest version	3.2.11.3
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set Differential Voltage [mV]	Measured Eye Height [mV]
600	120
650	130
700	140
750	150
800	160
850	170
900	180
950	190
1000	200
1050	210
1100	220
1150	230
1200	240

Figure 25 Example result for 5G eye height calibration

- **Set Differential Voltage [mV]**: The differential voltage set on the instrument.
- **Measured Eye Height [mV]**: The Eye Height measured on the oscilloscope.

5G Eye Height Verification

Availability Condition

This calibration is available for all such connectors that are neither Type-C nor Tethered Type-C.

Purpose and Method

This test verifies the possibility to meet the eye height specifications with the existing calibration data and setup.

The pattern generator sends the CP0 pattern to the oscilloscope. The Random Jitter and Sinusoidal Jitter are set to the values specified in the USB Compliance Test Specification. The differential output voltage amplitude is set to the specified value plus a small margin defined with the 'Eye Height Margin' parameter. Finally, the eye height is measured with the oscilloscope using the SigTest software.

Connection Diagram

Please refer to Figure 20 and Figure 21.

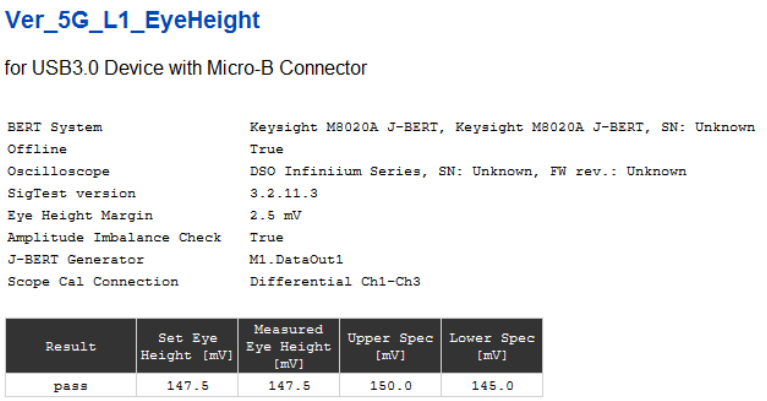
Parameters in Expert Mode

- SigTest version
- Eye Height Margin: Differential voltage added to the value specified in the CTS

Prerequisite Calibrations

- 5G TxEQ and Launch Voltage Calibration
- 5G Random Jitter Calibration
- 5G LF Sinusoidal Jitter Calibration
- 5G HF Sinusoidal Jitter Calibration
- 5G Eye Height Calibration

Result Description



Ver_5G_L1_EyeHeight

for USB3.0 Device with Micro-B Connector

BERT System	Keysight M8020A J-BERT, Keysight M8020A J-BERT, SN: Unknown
Offline	True
Oscilloscope	DSO Infiniium Series, SN: Unknown, FW rev.: Unknown
SigTest version	3.2.11.3
Eye Height Margin	2.5 mV
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Result	Set Eye Height [mV]	Measured Eye Height [mV]	Upper Spec [mV]	Lower Spec [mV]
pass	147.5	147.5	150.0	145.0

Figure 26 Example result for 5G eye height verification

- **Result**: (Pass/Fail) The verification will be considered as 'Pass' when the measured eye height is within the specification limits.
- **Set Eye Height [mV]**: The eye height that is set using the existing calibrations.
- **Measured Eye Height [mV]**: The eye height measured on the oscilloscope.
- **Upper Spec [mV]**: The maximum permissible eye height to pass the Specification limits.
- **Lower Spec [mV]**: The minimum permissible eye height to pass the Specification limits.

5G Total Jitter Verification

Availability Condition

This calibration is available for all such connectors that are neither Type-C nor Tethered Type-C.

Purpose and Method

This test verifies the possibility to meet the total jitter specifications with the existing calibration data and setup.

The differential output voltage amplitude is set to the value specified in the USB Compliance Test Specification. Random jitter and Sinusoidal Jitter are set to the specified values along with a small margin defined for the 'Random Jitter Margin' and 'Sinusoidal Jitter Margin' parameters. Finally, the Total Jitter is measured with the oscilloscope using the SigTest software.

Connection Diagram

Please refer to Figure 20 and Figure 21.

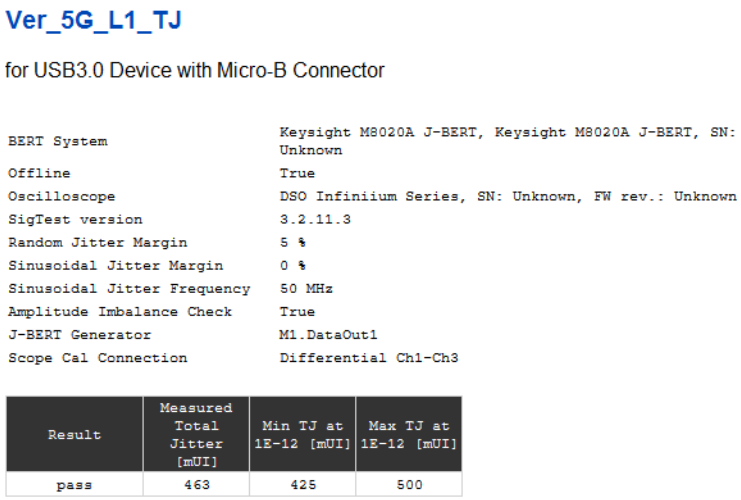
Parameters in Expert Mode

- SigTest version
- Random Jitter Margin: Percentage added to the specified RJ amplitude value
- Sinusoidal Jitter Margin: Percentage added to the specified SJ amplitude value
- Sinusoidal Jitter Frequency: The frequency of the sinusoidal jitter component

Prerequisite Calibrations

- 5G TxEQ and Launch Voltage Calibration
- 5G Random Jitter Calibration
- 5G LF Sinusoidal Jitter Calibration
- 5G HF Sinusoidal Jitter Calibration

Result Description



Ver_5G_L1_TJ

for USB3.0 Device with Micro-B Connector

BERT System	Keysight M8020A J-BERT, Keysight M8020A J-BERT, SN: Unknown
Offline	True
Oscilloscope	DSO Infiniium Series, SN: Unknown, FW rev.: Unknown
SigTest version	3.2.11.3
Random Jitter Margin	5 %
Sinusoidal Jitter Margin	0 %
Sinusoidal Jitter Frequency	50 MHz
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Result	Measured Total Jitter [mUI]	Min TJ at 1E-12 [mUI]	Max TJ at 1E-12 [mUI]
pass	463	425	500

Figure 27 Example result for 5G total jitter verification

- **Result**: (Pass/Fail) The verification will be considered as ‘Pass’ when the measured eye height is within the specification limits.
- **Measured Total Jitter [mUI]**: The Total Jitter measured on the oscilloscope.
- **Min TJ at 1E-12 [mUI]**: The maximum permissible Total Jitter to pass the Specification limits.
- **Max TJ at 1E-12 [mUI]**: The minimum permissible Total Jitter to pass the Specification limits.

10G Calibration Procedures

Common Parameters That Are Lane Specific

- **Scope Cal Connection**: Connection to the oscilloscope used for calibrations. The available choices are:
  - Differential Ch1-Ch3
  - Differential Ch2-Ch4
  - Differential Ch1-Ch3 + Differential Ch2-Ch4 (Available when the system has two analyzers connected)
- **J-BERT Generator**: The output of the data generator used for the calibrations

Common Parameters That Are Channel Specific

Specification

- SSC Type
- SSC Deviation
- SSC Frequency

10G TxEQ and Launch Voltage Calibration

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This procedure calibrates the De-Emphasis, Pre-shoot and Differential Voltage amplitude.

The pattern generator sends an equalization pattern to the oscilloscope and performs a sweep of the whole equalization range.

First, the pre-cursor is set to the initial value (–0.28). For that value, the post-cursor is swept from –0.28 to 0.02 with linear steps of 0.02. For each post-cursor value, the de-emphasis, pre-shoot and differential voltage are measured on the oscilloscope. Then, the pre-cursor is increased with a step size of 0.02 and the process is repeated until 0.02 is attained. The Launch Voltage is always fixed at 800 mV.

NOTE

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

Connection Diagram

Please refer to Figure 28 when only one lane is being tested (non-Type-C connectors and Type C for spec below 3.2) and to Figure 29 when two lanes are being tested (Type C for spec 3.2) for the M8040A.

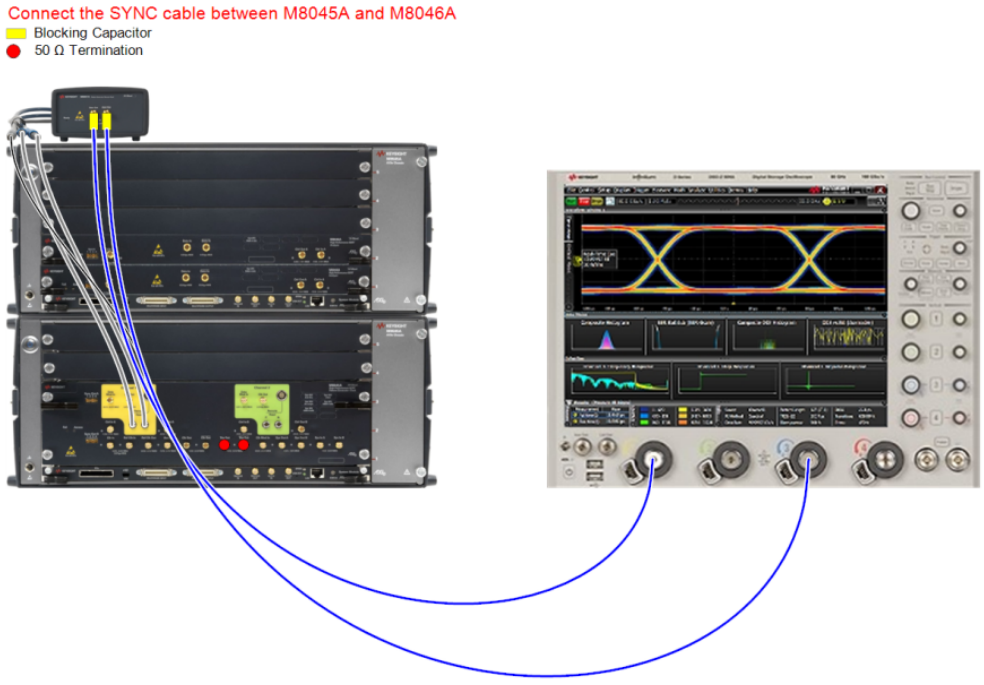


Figure 28 For 10G non-channel calibration (1 lane)

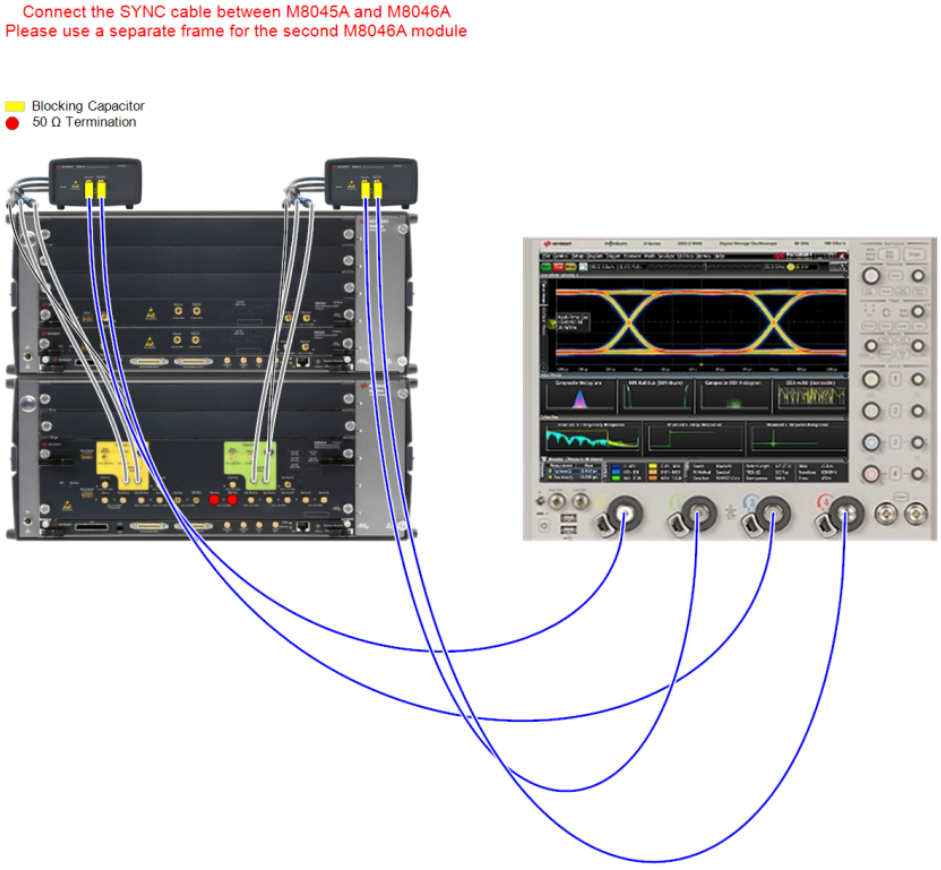


Figure 29 For 10G non-channel calibration (2 lanes)

Parameters in Expert Mode

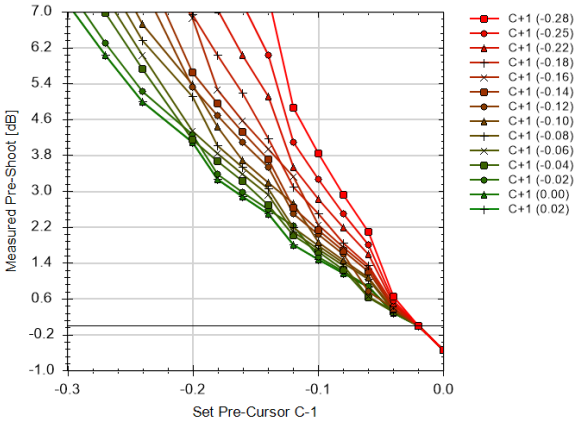
- Verification Mode
- EQ Calibration Pattern
- Number of Waveform Averages
- Scope Bandwidth
- Set Amplitude

For more details of the parameters, please refer to Table 6.

Result Description (similar to that for 5G Calibrations)

Cal_10G_L1_PreShoot

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Keysight M8040A J-BERT	Name: Keysight M8040A J-BERT ; Company: Keysight Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ; FW rev.: Unknown ; Description: M8040 with integrated jitter sources for SER tests ; Calibrated Instrument
Keysight DSO	Name: Keysight DSO ; Company: Keysight Technologies ; Model: DSO Infiniium Series ; SN: Unknown ; FW rev.: Unknown ; Description: Real Time Scope needed for system calibration ; Measurement Instrument
Verification Mode	False
EQ Calibration Pattern	EQ Two Pattern, 64 zeros, 64 onces
Amplitude Imbalance Check	True
----Oscilloscope----	
Number of Waveform Averages	256
Scope Bandwidth	32 GHz
----BER Setup----	
Set Amplitude	800 mV
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

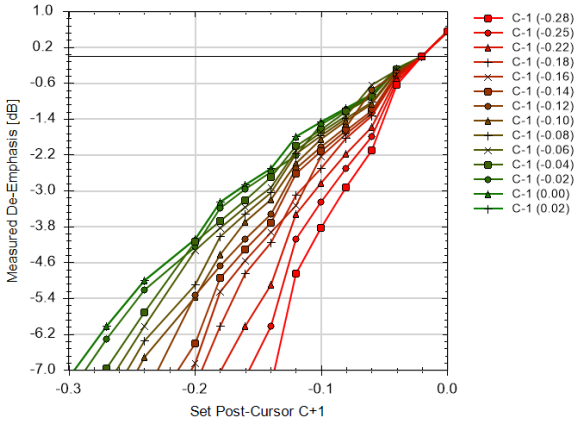
Set Pre-Cursor C-1 []	C+1 (-0.28) [dB]	C+1 (-0.25) [dB]	C+1 (-0.22) [dB]	C+1 (-0.18) [dB]	C+1 (-0.16) [dB]	C+1 (-0.14) [dB]	C+1 (-0.12) [dB]	C+1 (-0.10) [dB]	C+1 (-0.08) [dB]	C+1 (-0.06) [dB]	C+1 (-0.04) [dB]	C+1 (-0.02) [dB]	C+1 (0.00) [dB]	C+1 (0.02) [dB]
-0.28	NaN	NaN	NaN	NaN	14.81	13.26	12.04	10.24	9.54	8.94	8.42	7.55	7.18	7.18
-0.25	NaN	NaN	NaN	13.98	11.29	10.33	9.54	8.30	7.80	7.36	6.97	6.31	6.02	6.02
-0.22	NaN	NaN	13.06	10.46	8.79	8.15	7.60	6.72	6.35	6.02	5.73	5.22	5.00	5.00
-0.18	NaN	12.04	9.54	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	8.52	7.04	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	7.18	6.02	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	5.11	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	4.08	3.52	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	3.25	2.83	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	2.50	2.18	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	1.80	1.58	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	0.56	0.50	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
0.02	-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

Figure 30 Example result for 10G TxEQ & launch voltage calibration (pre-shoot)

- **Set Pre-Cursor C–1**: The pre-cursor value set on the instrument.
- **C+1 (X) [dB]**: The entries in the table give the actual pre-shoot value in dB measured at the oscilloscope for the particular combination of pre-cursor (C–1, given in the first column) and post-cursor (C+1, given in the column heading) values.

Cal_10G_L1_DeEmphasis

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Keysight M8040A J-BERT	Name: Keysight M8040A J-BERT ; Company: Keysight Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ; FW rev.: Unknown ; Description: M8040 with integrated jitter sources for SER tests ; Calibrated Instrument
Keysight DSO	Name: Keysight DSO ; Company: Keysight Technologies ; Model: DSO Infiniium Series ; SN: Unknown ; FW rev.: Unknown ; Description: Real Time Scope needed for system calibration ; Measurement Instrument
Verification Mode	False
EQ Calibration Pattern	EQ Two Pattern, 64 zeros, 64 onces
Amplitude Imbalance Check	True
----Oscilloscope----	
Number of Waveform Averages	256
Scope Bandwidth	32 GHz
----BER Setup----	
Set Amplitude	800 mV
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

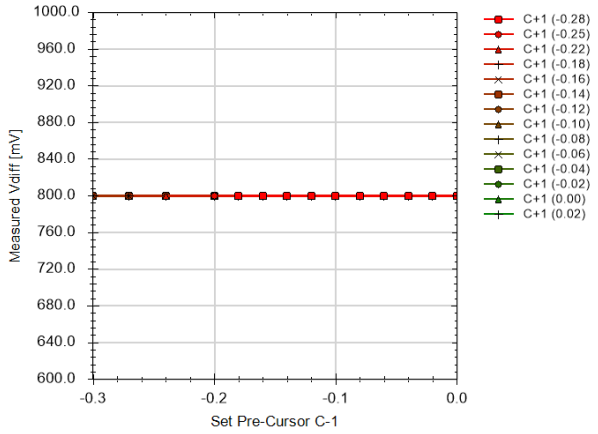
Set Post-Cursor C+1 []	C-1 (-0.28) [dB]	C-1 (-0.25) [dB]	C-1 (-0.22) [dB]	C-1 (-0.18) [dB]	C-1 (-0.16) [dB]	C-1 (-0.14) [dB]	C-1 (-0.12) [dB]	C-1 (-0.10) [dB]	C-1 (-0.08) [dB]	C-1 (-0.06) [dB]	C-1 (-0.04) [dB]	C-1 (-0.02) [dB]	C-1 (0.00) [dB]	C-1 (0.02) [dB]
-0.28	NaN	NaN	NaN	NaN	-14.81	-13.26	-12.04	-10.24	-9.54	-8.94	-8.42	-7.55	-7.18	-7.18
-0.25	NaN	NaN	NaN	-13.98	-11.29	-10.33	-9.54	-8.30	-7.80	-7.36	-6.97	-6.31	-6.02	-6.02
-0.22	NaN	NaN	-13.06	-10.46	-8.79	-8.15	-7.60	-6.72	-6.35	-6.02	-5.73	-5.22	-5.00	-5.00
-0.18	NaN	-12.04	-9.54	-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	-8.52	-7.04	-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	-7.18	-6.02	-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	-5.11	-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	-4.08	-3.52	-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	-3.25	-2.83	-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	-2.50	-2.18	-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	-1.80	-1.58	-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	-0.56	-0.50	-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
0.02	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

Figure 31 Example result for 10G TxEQ & launch voltage calibration (de-emphasis)

- **Set Post-Cursor (C+1)**: The post-cursor value set on the instrument.
- **C–1 (X) [dB]**: The actual De-Emphasis value measured at the oscilloscope for the particular combination of pre-cursor and post-cursor values.The entries in the table give the actual de-emphasis value in dB measured at the oscilloscope for the particular combination of post-cursor (C+1, given in the first column) and pre-cursor (C–1, given in the column heading) values.

Cal_10G_L1_GenOutVolt

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Keysight M8040A J-BERT	Name: Keysight M8040A J-BERT ; Company: Keysight Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ; FW rev.: Unknown ; Description: M8040 with integrated jitter sources for SER tests ; Calibrated Instrument
Keysight DSO	Name: Keysight DSO ; Company: Keysight Technologies ; Model: DSO Infiniium Series ; SN: Unknown ; FW rev.: Unknown ; Description: Real Time Scope needed for system calibration ; Measurement Instrument
Verification Mode	False
EQ Calibration Pattern	EQ Two Pattern, 64 zeros, 64 onces
Amplitude Imbalance Check	True
----Oscilloscope----	
Number of Waveform Averages	256
Scope Bandwidth	32 GHz
----BER Setup----	
Set Amplitude	800 mV
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set Pre-Cursor C-1 []	C+1 (-0.28) [mV]	C+1 (-0.25) [mV]	C+1 (-0.22) [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	NaN	NaN	NaN	NaN	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.25	NaN	NaN	NaN	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
-0.22	NaN	NaN	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	NaN	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
-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
-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
-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
-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
-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
-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
-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
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
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

Figure 32 Example result for 10G TxEQ & launch voltage calibration (differential voltage)

- **Set Pre-Cursor (C–1)**: The pre-cursor value set on the instrument.
- **C+1 (X) [mV]**: The entries in the table give the actual differential voltage value in millivolts measured at the oscilloscope for the particular combination of pre-cursor (C–1, given in the first column) and post-cursor (C+1, given in the column heading) values.

10G Random Jitter Calibration

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This procedure calibrates the Random Jitter (RJ) directly at the generator output.

The pattern generator sends the CP0 pattern and adds random jitter to the signal. It sets ten equally spaced RJ values (from 0 to 5ps). At each step, the jitter is measured with a real-time oscilloscope using the SigTest software.

Connection Diagram

Refer to Figure 28 when only one lane is being tested (non-Type-C connectors and Type C for spec below 3.2) and to Figure 29 when two lanes are being tested (Type C for spec 3.2) for the M8040A.

Parameters in Expert Mode

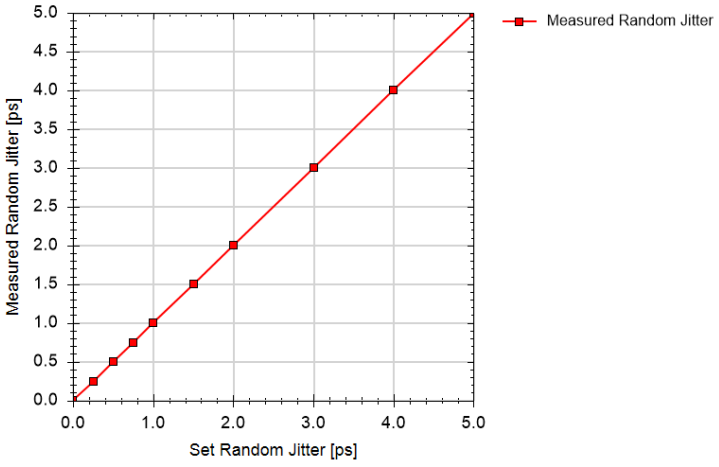
- SigTest version
- Number of Averages

For more details of the parameters, please refer to Table 6.

Result Description (similar to that for 5G Calibrations)

Cal_10G_L1_RJ

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Keysight M8040A J-BERT	Name: Keysight M8040A J-BERT ; Company: Keysight Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ; FW rev.: Unknown ; Description: M8040 with integrated jitter sources for SER tests ; Calibrated Instrument
Keysight DSO	Name: Keysight DSO ; Company: Keysight Technologies ; Model: DSO Infiniium Series ; SN: Unknown ; FW rev.: Unknown ; Description: Real Time Scope needed for system calibration ; Measurement Instrument
SigTest version	4.0.23.2
Number of Averages	2
Amplitude Imbalance Check	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set Random Jitter [ps]	Measured Random Jitter [ps]
0.00	0.000
0.25	0.250
0.50	0.500
0.75	0.750
1.00	1.000
1.50	1.500
2.00	2.000
3.00	3.000
4.00	4.000
5.00	5.000

Figure 33 Example result for 10G random jitter calibration

- **Set Random Jitter [ps]**: The random jitter set at the Data Generator.
- **Measured Random Jitter [ps]**: The actual random jitter measured with the oscilloscope.

10G LF Sinusoidal Jitter Calibration

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This procedure calibrates the Sinusoidal Jitter for low frequencies (from 200 kHz to 500 kHz) directly at the generator output.

The data generator sends the CP9 compliance pattern during this calibration. It performs a sweep of the sinusoidal jitter amplitude for five different frequencies. At each step, the actual sinusoidal jitter amplitude is measured with the oscilloscope using the SigTest software. SigTest is the standard method to measure Eye Height and Jitter. It is the only valid option available for compliance testing.

The test automation checks for consistency in the measured jitter amplitude values across jitter frequencies. Deviations larger than 2.5% between the measured jitter amplitudes are not allowed for the same set jitter amplitude at different frequencies. For deviations more than 2.5%, the point is re-measured up to three times.

Connection Diagram

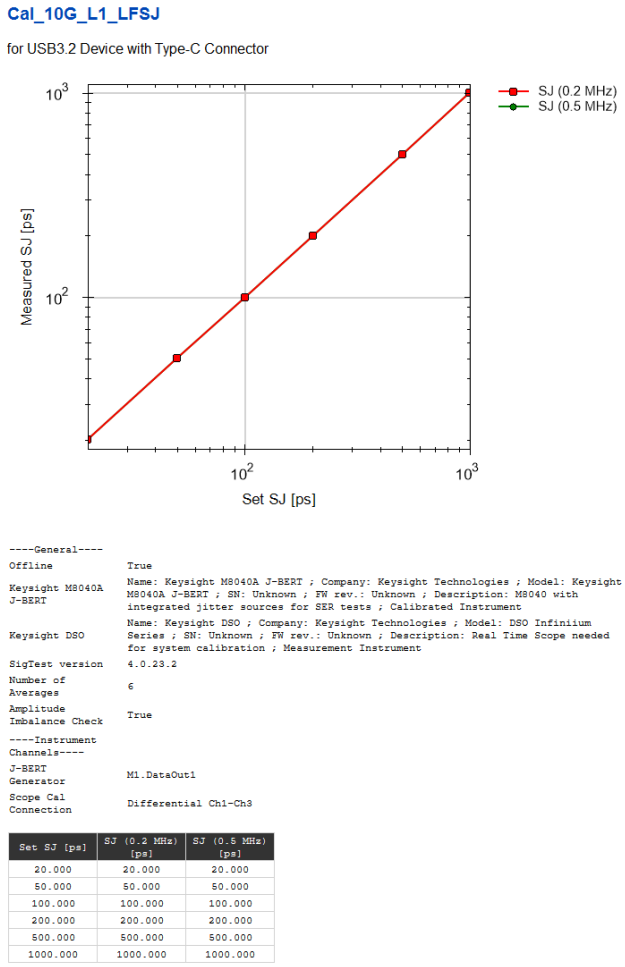
Refer to Figure 28 when only one lane is being tested (non-Type-C connectors and Type C for spec below 3.2) and to Figure 29 when two lanes are being tested (Type C for spec 3.2) for the M8040A.

Parameters in Expert Mode

- SigTest version
- Number of Averages

For more details of the parameters, please refer to Table 6.

Result Description (similar to that for 5G Calibrations)



----General----	
Offline	True
Keysight M8040A J-BERT	Name: Keysight M8040A J-BERT ; Company: Keysight Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ; FW rev.: Unknown ; Description: M8040 with integrated jitter sources for SER tests ; Calibrated Instrument
Keysight DSO	Name: Keysight DSO ; Company: Keysight Technologies ; Model: DSO Infiniium Series ; SN: Unknown ; FW rev.: Unknown ; Description: Real Time Scope needed for system calibration ; Measurement Instrument
SigTest version	4.0.23.2
Number of Averages	6
Amplitude Imbalance Check	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set SJ [ps]	SJ (0.2 MHz) [ps]	SJ (0.5 MHz) [ps]
20.000	20.000	20.000
50.000	50.000	50.000
100.000	100.000	100.000
200.000	200.000	200.000
500.000	500.000	500.000
1000.000	1000.000	1000.000

Figure 34 Example result for 10G LF sinusoidal jitter calibration

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

10G HF Sinusoidal Jitter Calibration

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This procedure calibrates the sinusoidal jitter for high frequencies (from 1 MHz to 100 MHz).

The data generator sends the CP9 pattern during this calibration. It performs a sweep of the sinusoidal jitter amplitude for five different frequencies. At each step, the actual sinusoidal jitter amplitude is measured on the oscilloscope using the SigTest software. SigTest is the standard method to measure Eye Height and Jitter. It is the only valid option available for compliance testing.

The test automation checks for consistency in the measured jitter amplitude values across jitter frequencies. Deviations larger than 5% between the measured jitter amplitudes are not allowed for the same set jitter amplitude at different frequencies. For deviations more than 5%, the point is re-measured up to three times.

Connection Diagram

Refer to Figure 28 when only one lane is being tested (non-Type-C connectors and Type C for spec below 3.2) and to Figure 29 when two lanes are being tested (Type C for spec 3.2) for the M8040A.

Parameters in Expert Mode

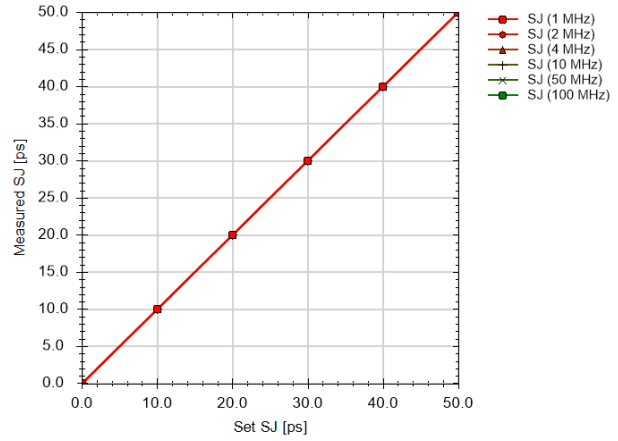
- SigTest version
- Number of Averages

For more details of the parameters, please refer to Table 6.

Result Description (similar to that for 5G Calibrations)

Cal_10G_L1_HFSJ

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Keysight M8040A J-BERT	Name: Keysight M8040A J-BERT ; Company: Keysight Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ; FW rev.: Unknown ; Description: M8040 with integrated jitter sources for SER tests ; Calibrated Instrument
Keysight DSO	Name: Keysight DSO ; Company: Keysight Technologies ; Model: DSO Infiniium Series ; SN: Unknown ; FW rev.: Unknown ; Description: Real Time Scope needed for system calibration ; Measurement Instrument
SigTest version	4.0.23.2
Number of Averages	6
Amplitude Imbalance Check	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set SJ [ps]	SJ (1 MHz) [ps]	SJ (2 MHz) [ps]	SJ (4 MHz) [ps]	SJ (10 MHz) [ps]	SJ (50 MHz) [ps]	SJ (100 MHz) [ps]
0.00	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.000	10.000	10.000	10.000	10.000	10.000
20.00	20.000	20.000	20.000	20.000	20.000	20.000
30.00	30.000	30.000	30.000	30.000	30.000	30.000
40.00	40.000	40.000	40.000	40.000	40.000	40.000
50.00	50.000	50.000	50.000	50.000	50.000	50.000

Figure 35 Example result for 10G HF sinusoidal jitter calibration

- **Set SJ [ps]**: The sinusoidal jitter amplitude set in the instrument.
- **SJ (x MHz) [ps]**: The actual sinusoidal jitter amplitude measured on the oscilloscope for the frequency ‘x’ MHz.

10G Compliance Load Board Selection

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This procedure determines the optimal CLB to be used in the setup for further calibrations.

The data generator sends the CP9 compliance pattern. The procedure measures the eye height with nominal stress settings (refer to the non-editable parameters for this test) of all three CLBs. Then, the software selects the CLB for which the measured eye height is closest to 70 mV.

NOTE You are not required to repeat this calibration for lane 2 except for the passthrough test method.

Connection Diagram

Refer to Figure 36 to Figure 39 for lane 1 calibration.

NOTE For lane 2 the setup is the same but using the second channel of the data generator and differential Ch2-Ch4 of the oscilloscope.

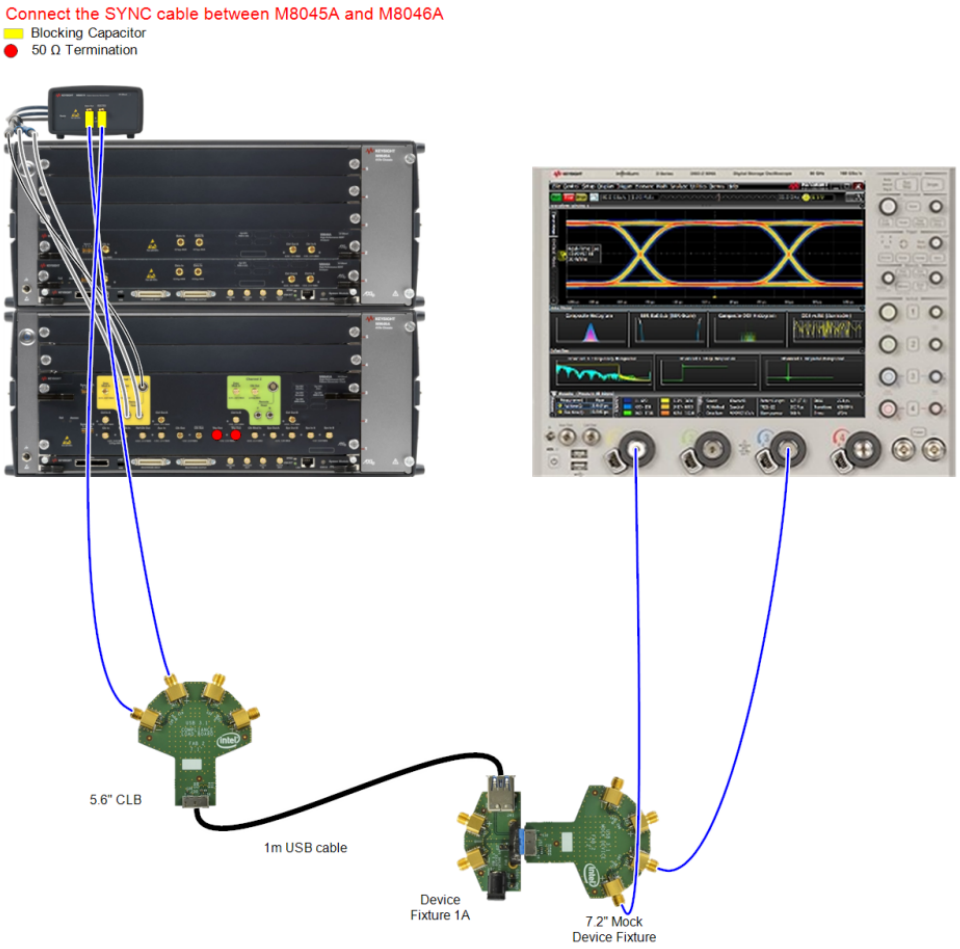


Figure 36 For 10G long channel calibration (device – non type C)

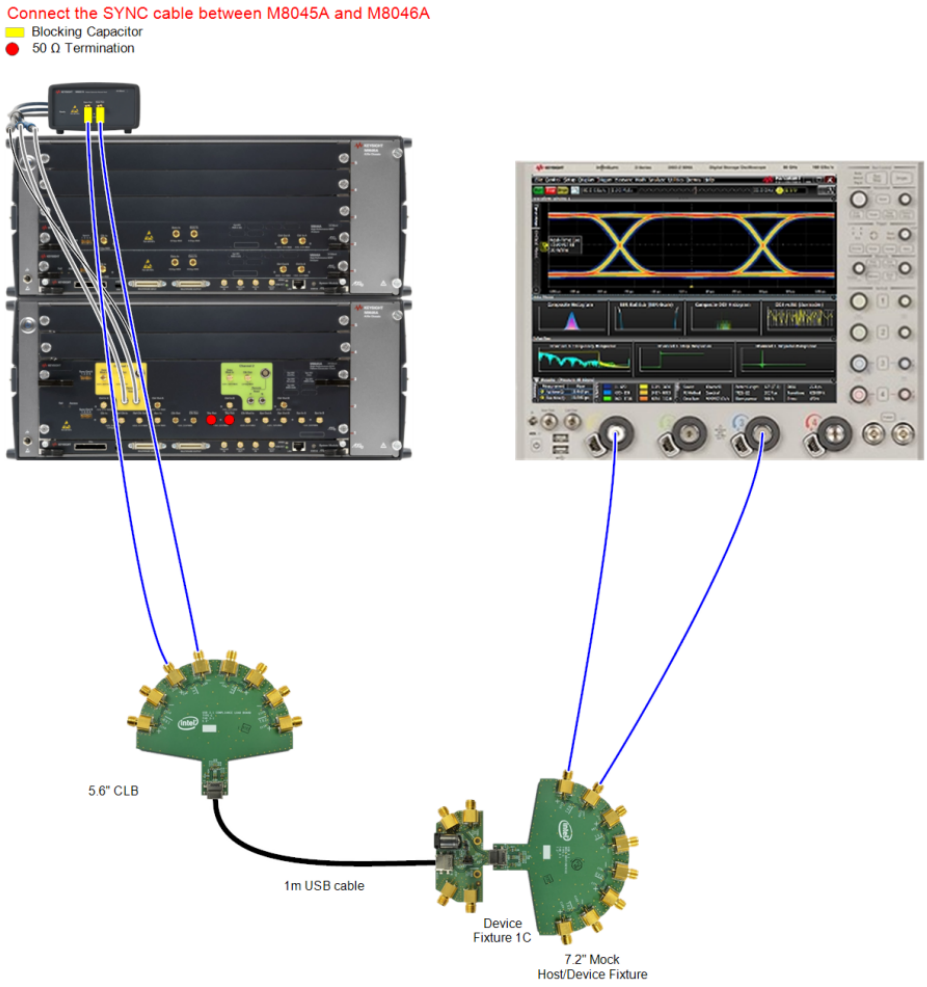


Figure 37 For 10G long channel calibration (device – type C)

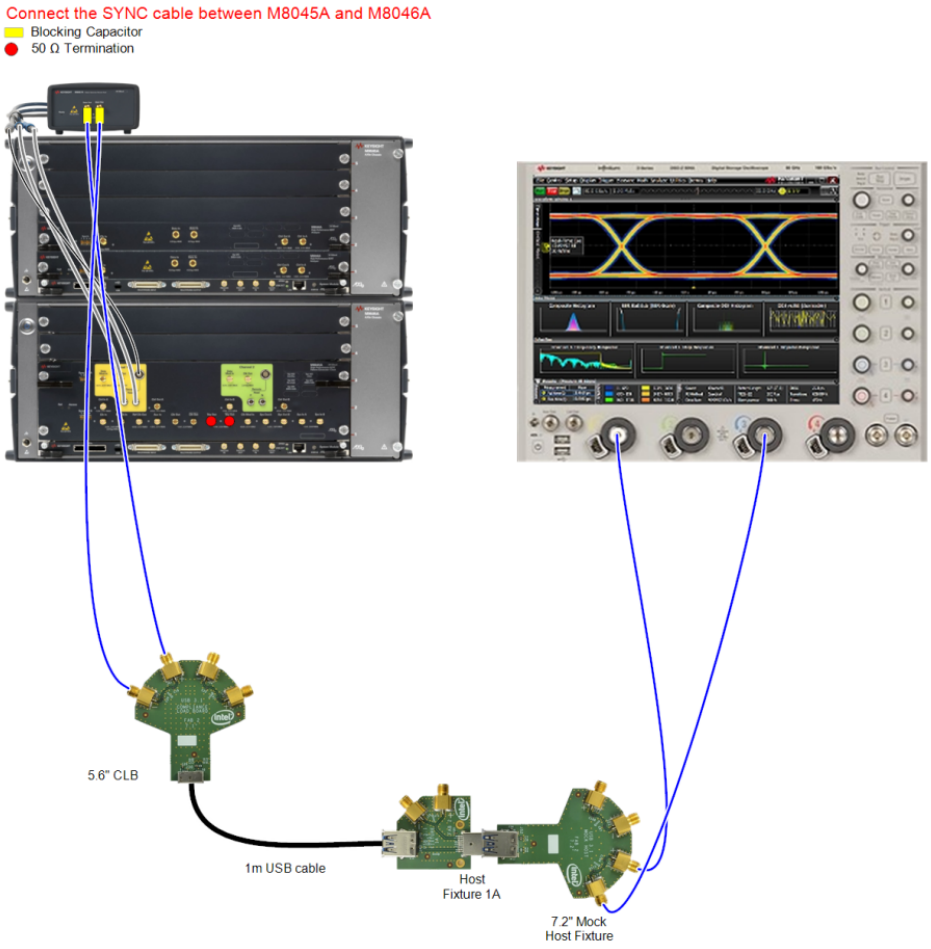


Figure 38 For 10G long channel calibration (host – non type C)

NOTE Ensure that another fixture kit is used for Passthrough test method Lane 2 calibration than that used for Lane 1 calibration.

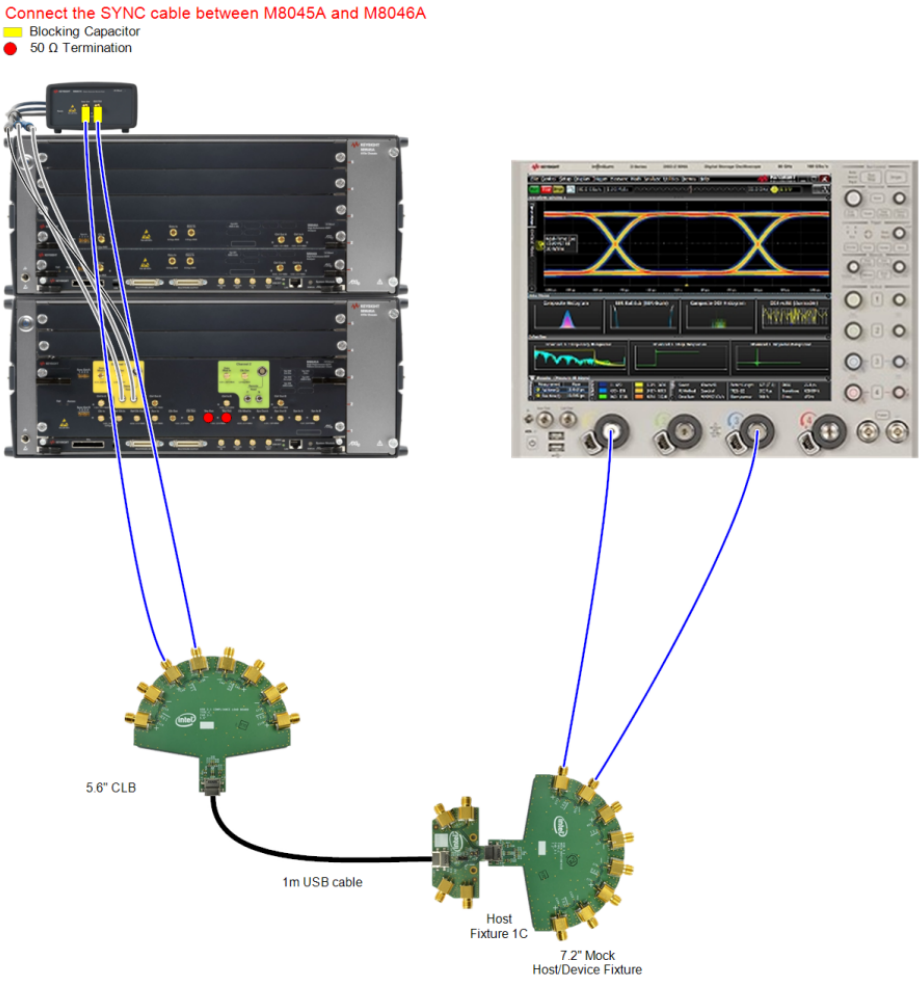


Figure 39 For 10G long channel calibration (host, active cable, or comp. retimer – type C)

Parameters in Expert Mode

- SigTest version
- SSC Deviation
- Pre-Shoot
- De-Emphasis

- Differential Voltage
- Random Jitter
- Sinusoidal Jitter
- Number of Averages

For more details of the parameters, please refer to Table 6.

Prerequisite Calibrations

- 10G TxEQ and Launch Voltage Calibration
- 10G Random Jitter Calibration
- 10G LF Sinusoidal Jitter Calibration
- 10G HF Sinusoidal Jitter Calibration

Result Description

Cal_10G_L1_CLB

for USB3.2 Device with Type-C Connector

Type-C Fixture	USB_IF
Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	4.0.23.2
SSC Deviation	5000 ppm
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Differential Voltage	800 mV
Random Jitter	1 ps
Sinusoidal Jitter	17 ps
Number of Averages	5
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3
ProcedureName	10G Compliance Load Board Selection

CLB Length [inch]	Measured Eye Height [mV]
5.6	86.71
7.1	76.78
8.1	70.33

Figure 40 Example result for 10G compliance load board selection

- **CLB Length [inch]**: The optimal CLB selected after the test.
- **Measured Eye Height [mV]**: The eye height measured with the optimal CLB.

10G Eye Width Pre Calibration

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This procedure calibrates the eye width depending on the de-emphasis.

The data generator sends the CP9 compliance pattern. The procedure performs a sweep over several de-emphasis settings to discover the optimal de-emphasis setting that helps generate the eye width closest to the target specification value.

Connection Diagram

The connection diagram is the same as for 10G Compliance Load Board Selection (refer to Figure 36 to Figure 39 for lane 1 calibration) but with the optimal CLB.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator and differential Ch2-Ch4 of the oscilloscope.**

Parameters in Expert Mode

- SigTest version
- CLB Trace Length
- SSC Deviation
- Pre-Shoot
- Differential Voltage
- Random Jitter
- Sinusoidal Jitter
- Number of Averages

For more details of the parameters, please refer to Table 6.

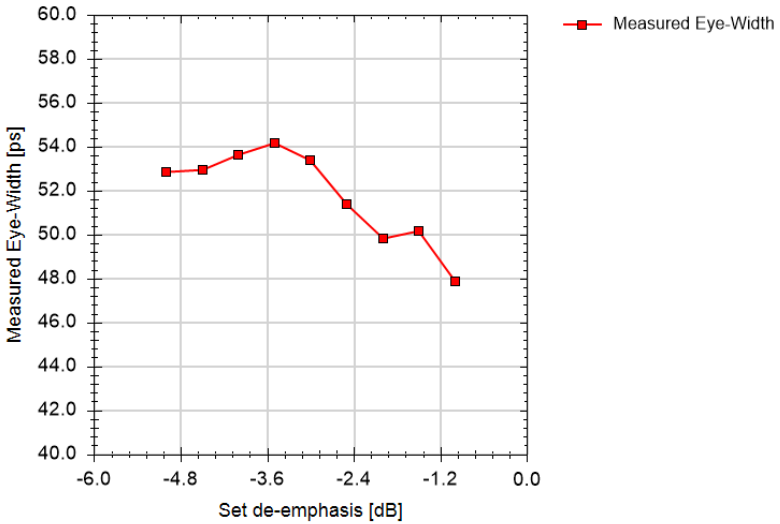
Prerequisite Calibrations

- 10G TxEQ and Launch Voltage Calibration
- 10G Random Jitter Calibration
- 10G LF Sinusoidal Jitter Calibration
- 10G HF Sinusoidal Jitter Calibration

Result Description

Cal_10G_L1_PreEyeWidth

for USB3.2 Device with Type-C Connector



Type-C Fixture	USB_IF
Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	4.0.23.2
CLB Trace Length	8.1
SSC Deviation	5000 ppm
Pre-Shoot	2.2 dB
Differential Voltage	800 mV
Random Jitter	1 ps
Sinusoidal Jitter	17 ps
Number of Averages	2
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

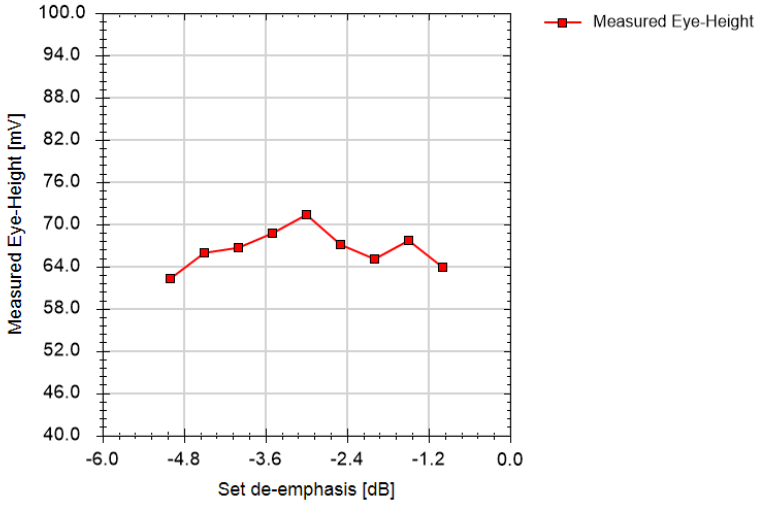
Set de-emphasis [dB]	Measured Eye-Width [ps]
-5.00	52.83
-4.50	52.97
-4.00	53.63
-3.50	54.18
-3.00	53.37
-2.50	51.37
-2.00	49.83
-1.50	50.15
-1.00	47.87

Figure 41 Example result for 10G eye width pre calibration

- **Set de-emphasis [dB]**: The de-emphasis set at each step.
- **Measured Eye-Width [ps]**: The eye width measured at each step.

Cal_10G_L1_PreEyeHeight

for USB3.2 Device with Type-C Connector



Type-C Fixture	USB_IF
Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	4.0.23.2
CLB Trace Length	8.1
SSC Deviation	5000 ppm
Pre-Shoot	2.2 dB
Differential Voltage	800 mV
Random Jitter	1 ps
Sinusoidal Jitter	17 ps
Number of Averages	2
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Set de-emphasis [dB]	Measured Eye-Height [mV]
-5.00	62.23
-4.50	65.95
-4.00	66.65
-3.50	68.75
-3.00	71.41
-2.50	67.10
-2.00	65.12
-1.50	67.72
-1.00	63.86

Figure 42 Example result for 10G eye height pre calibration

- **Set de-emphasis [dB]**: The de-emphasis set at each step.
- **Measured Eye-Height [mV]**: The eye height measured at each step.

10G Eye Height and Width Calibration

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This procedure calibrates the eye with respect to the differential voltage and sinusoidal jitter.

The data generator sends the CP9 compliance pattern. The procedure sets different combinations of differential voltage (700 mV and 900 mV) and sinusoidal jitter (12 ps and 22 ps) and measures the eye height and eye width.

The calibration data generates a stress Rx eye with a defined eye height and width.

Connection Diagram

The connection diagram is the same as for 10G Compliance Load Board Selection (refer to Figure 36 to Figure 39 for lane 1 calibration) but with the optimal CLB.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator and differential Ch2-Ch4 of the oscilloscope.**

Parameters in Expert Mode

- SigTest version
- CLB Trace Length
- Pre-Shoot
- De-Emphasis
- Random Jitter
- Target Eye-Height
- Target Eye-Width
- Number of Averages

For more details of the parameters, please refer to Table 6.

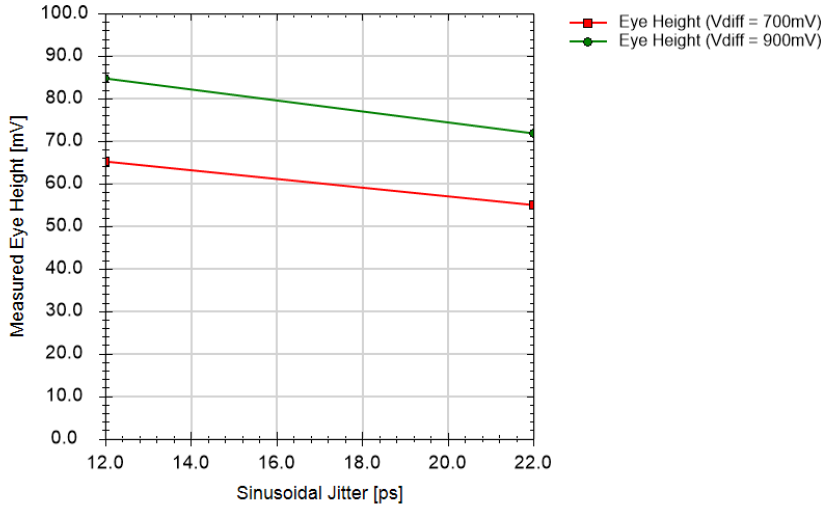
Prerequisite Calibrations

- 10G TxEQ and Launch Voltage Calibration
- 10G Random Jitter Calibration
- 10G LF Sinusoidal Jitter Calibration
- 10G HF Sinusoidal Jitter Calibration

Result Description

Cal_10G_L1_EH_Cal

for USB3.2 Device with Type-C Connector



Type-C Fixture	USB_IF
Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	4.0.23.2
CLB Trace Length	8.1
SSC Deviation	5000 ppm
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Random Jitter	1 ps
Target Eye-Height	71.5 mV
Target Eye-Width	48.5 ps
Number of Averages	5
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3
ProcedureName	10G Eye Height and Width Calibration

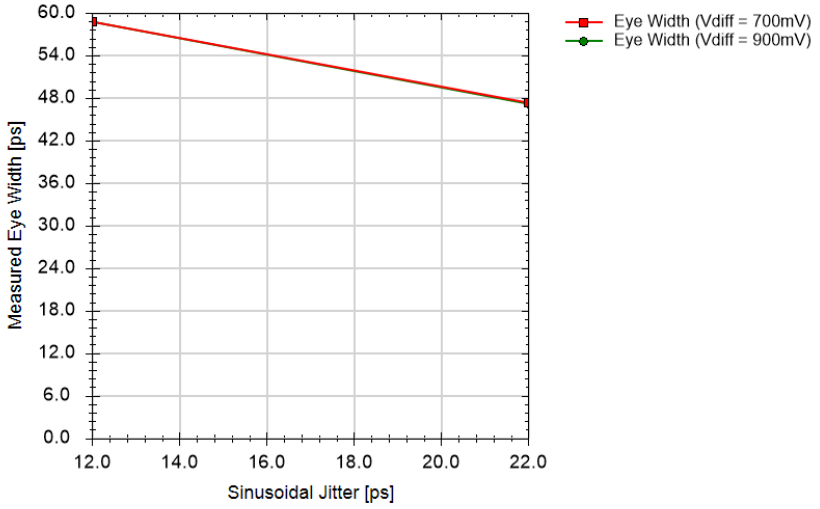
Set SJ [ps]	Eye Height (Vdiff = 700mV) [mV]	Eye Height (Vdiff = 900mV) [mV]
12.00	65.24	84.77
22.00	55.05	71.92

Figure 43 Example result for 10G eye height calibration

- **Set SJ [ps]**: The sinusoidal jitter added to the signal at each step.
- **Eye Height (Vdiff = x mV) [mV]**: The eye height measured on the oscilloscope for x mV differential voltage on the signal.

Cal_10G_L1_EW_Cal

for USB3.2 Device with Type-C Connector



Type-C Fixture	USB_IF
Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	4.0.23.2
CLB Trace Length	8.1
SSC Deviation	5000 ppm
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Random Jitter	1 ps
Target Eye-Height	71.5 mV
Target Eye-Width	48.5 ps
Number of Averages	5
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3
ProcedureName	10G Eye Height and Width Calibration

Set SJ [ps]	Eye Width (Vdiff = 700mV) [ps]	Eye Width (Vdiff = 900mV) [ps]
12.00	58.71	58.79
22.00	47.26	47.25

Figure 44 Example result for 10G eye width calibration

- **Set SJ [ps]**: The sinusoidal jitter that is added to the signal at each step.
- **Eye Width (Vdiff = x mV) [ps]**: The eye width measured on the oscilloscope for x mV differential voltage on the signal.

10G Compliance Eye Calibration

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

The procedure searches for the optimal combination of sinusoidal jitter and differential voltage that helps achieve the compliance eye.

The data generator transmits the CP9 compliance pattern. The procedure starts by setting the differential voltage and the sinusoidal jitter to the nominal values and measures the EH and EW for that combination. If the measured EH and EW are within the optimal range (71 mV – 73 mV for EH and 48.2 ps – 49 ps for EW), the procedure ends. If not, a new combination of SJ and Vdiff is calculated by using the current measurement results and the Eye Height and Width calibration. Then, the process is repeated until an eye within the optimal range is obtained or until the maximum number of search steps is reached.

If the maximum number of search steps is reached, the calibration result will be the measured pair of SJ and differential voltage that helps achieve an eye closer to the specification value. If the closest eye is out of specification limits, a manual search (where the user sets the sinusoidal jitter and differential voltage) will be required to pass the test.

The eye measurements are done on the oscilloscope using the SigTest software.

Connection Diagram

The connection diagram is the same as for 10G Compliance Load Board Selection (refer to Figure 36 to Figure 39 for lane 1 calibration) but with the optimal CLB.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator and differential Ch2-Ch4 of the oscilloscope.**

Parameters in Expert Mode

- SigTest version
- CLB Trace Length
- Pre-Shoot
- De-Emphasis

- Random Jitter
- Target Eye-Height
- Target Eye-Width
- Number of Averages
- Max number of search steps: After this number of steps, the search for optimum Vdiff and SJ values is aborted.

For more details of the parameters, please refer to Table 6.

Prerequisite Calibrations

- 10G TxEQ and Launch Voltage Calibration
- 10G Random Jitter Calibration
- 10G LF Sinusoidal Jitter Calibration
- 10G HF Sinusoidal Jitter Calibration

Result Description

Cal_10G_L1_CompEye

for USB3.2 Device with Type-C Connector

Type-C Fixture	USB_IF
Offline	False
Keysight M8040A J-BERT	M8070B, SN: DE56700053, FW rev.: 6.7.500.6
Keysight DSO	DSAV334A, SN: MY56110106, FW rev.: 06.50.01004
SigTest version	4.0.23.2
CLB Trace Length	8.1
SSC Deviation	5000 ppm
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Random Jitter	1 ps
Target Eye-Height	71.5 mV
Target Eye-Width	48.5 ps
Number of Averages	5
Max Number of Search Steps	8
Amplitude Imbalance Check	True
J-BERT Generator	M1.DataOut1
Scope Cal Connection	Differential Ch1-Ch3

Vdiff [mV]	SJ [ps]	Eye-Height [mV]	Eye-Width [ps]
900.2	21.02	72.7	48.7

Figure 45 Example result for 10G compliance eye calibration

- **Vdiff [mV]**: The differential voltage amplitude for which the optimal eye is obtained.
- **SJ [ps]**: The sinusoidal jitter amplitude for which the optimal eye is obtained.
- **Eye-Height [mV]**: The optimal eye height value measured on the oscilloscope.
- **Eye-Width [ps]**: The optimal eye width value measured on the oscilloscope.

10G Compliance Eye Verification

Availability Condition

This calibration is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This test verifies the possibility to meet the eye height and eye width specifications with the existing calibration data and setup.

The pattern generator sends the CP9 pattern to the oscilloscope The sinusoidal jitter and the differential voltage are set to the values for which the optimal eye is obtained using the Compliance Eye calibration results.

The eye height and eye width are measured with the oscilloscope using the SigTest software. The test is considered as 'Pass' if the measured eye is within the specification limits.

Connection Diagram

The connection diagram is the same as for 10G Compliance Load Board Selection (refer to Figure 36 to Figure 39 for lane 1 calibration) but with the optimal CLB.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator and differential Ch2-Ch4 of the oscilloscope.**

Parameters in Expert Mode

- SigTest version
- CLB Trace Length
- Pre-Shoot
- De-Emphasis
- Differential Voltage
- Random Jitter
- Sinusoidal Jitter
- Number of Averages

For more details of the parameters, please refer to Table 6.

Prerequisite Calibrations

- 10G TxEQ and Launch Voltage Calibration
- 10G Random Jitter Calibration
- 10G LF Sinusoidal Jitter Calibration
- 10G HF Sinusoidal Jitter Calibration

Result Description

Ver_10G_L2_Component_CompEye

for USB3.2 - Retimer Device with SRIS Component Retimer with Type-C Connector

Type-C Fixture	USB_IF
Offline	True
Oscilloscope	DSO Infiniium Series, SN: Unknown, FW rev.: Unknown
SigTest version	4.0.23.2
CLB Trace Length	5.6
SSC Deviation	5000 ppm
Pre-Shoot	2.2 dB
De-Emphasis	-1 dB
Differential Voltage	800 mV
Random Jitter	1 ps
Sinusoidal Jitter	17 ps
Number of Averages	6
J-BERT Generator	M1.DataOut2
Scope Cal Connection	Differential Ch2-Ch4
Amplitude Imbalance Check	True

Result	Measured Eye Height [mV]	Min Eye Height [mV]	Max Eye Height [mV]	Measured Eye Width [ps]	Min Eye Width [ps]	Max Eye Width [ps]
pass	71.50	70.00	75.00	48.50	48.00	50.00

Figure 46 Example result for 10G compliance eye verification

- **Result**: (Pass/Fail) If the measured eye height and width are within the min. and max. specification values, the test is considered as 'Pass'.
- **Measured Eye Height [mV]**: The eye height value measured on the oscilloscope.
- **Min Eye Height [mV]**: The permissible minimum eye height according to the specification limits.
- **Max Eye Height [mV]**: The permissible maximum eye height according to the specification limits.
- **Measured Eye Width [ps]**: The eye width value measured on the oscilloscope.
- **Min Eye Width [ps]**: The permissible minimum eye width allowed according to the specification limits.
- **Max Eye Width [ps]**: The permissible maximum eye width allowed according to the specification limits.

5 USB3.2 Receiver Tests

Once the USB3.2 receiver test system has been calibrated, receiver tests can be run.

USB3.2 Receiver Tests Overview

The basic principle of all USB3.2 receiver tests is:

- Train the DUT into the 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

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

NOTE For Rx tests, you do not require a real-time oscilloscope.

Common Parameters for Receiver Tests

NOTE

Some of the following parameters will not be listed in ValiFrame if Power Switch or Power Supply is set to None in the USB3.2 Station Configurator. The selections made for DUT Type, Test Method, and Connector Type under Configure DUT in ValiFrame will also affect the set of properties and test procedures and thus the common parameters that are listed in ValiFrame.

Power Automation

- Power Automation
- Power Component
- Power Channel
- Power Cycle Off-On Duration
- Power Cycle Settling Time
- Power Cycle Max. Retries for LB Training

Loopback Training

- Force Retraining

5G (Gen1x1) Rx Tests

In this section, the test procedures are organized in three different groups:

- Long Channel Tests
- Short Channel Tests
- LFPS Tests

For connectors Type-C and Tethered Type-C, the receiver tests are duplicated for each lane. The abbreviations Rx1 and Rx2 are added to each procedure name in the software, meaning Lane 1 and Lane 2, respectively.

NOTE **Both lanes must be tested for a valid compliance test.**

Common Parameters That Are Data Rate Specific

Loopback Training

- CDR during Loopback Training
- LFPS Idle
- LFPS Trigger Threshold
- Loopback Training Method
- Use Link Training Suite
- Warm Reset / Power On Reset Link Training Suite Settings File

Error Detector

- CDR Symbol Rate
- CDR Loop Bandwidth
- CDR Transition Density
- CDR Peaking
- Analyzer CTLE
- Input Sensitivity
- Auto-align Timeout
- Error Detector Operation Mode
- Input Polarity inverted

Refer to Table 5 for the description of the mentioned parameters.

Long Channel Tests

Common Parameters That Are Channel Specific

Loopback Training

- Use Voltage Settings from Rx Tests for Loopback Training
- Training Voltage for Loopback Training

Common Parameters That Are Lane Specific

Instrument Channels

- J-BERT Generator
- J-BERT Error Detector

Refer to Table 5 on page 44 for the description of the mentioned parameters.

5G Rx Compliance Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This test determines if the DUT meets the receiver Compliance Test Specification.

The procedure measures the number of symbol errors when all jitter types and the eye height are set to their specification limit values (maximum for jitter, minimum for eye height). This is done for several predefined jitter frequencies.

For this measurement, it is necessary to train the DUT into loopback mode. To achieve that, the data generator sends a training sequence to the DUT. The training sequence is generated based on the Loopback Training parameter settings, such as, PowerOnReset or WarmReset.

The loopback training must be performed with the same physical stress parameters as the measurements. This allows the DUT receiver to optimize its equalizer for the test signal during loopback training.

NOTE

For non Type-C connectors, the signal is defined with the minimum Eye-Height value (145 mV). For Type-C connectors, the signal is defined with the minimum differential voltage amplitude (800 mV).

For non Type-C connectors, a margin is applied to the eye height, random jitter and sinusoidal jitter components. For Type-C connectors, no such margins are applied.

Connection Diagram

Please refer to Figure 47 to Figure 54, depending on the DUT type, Connector and Test Method.

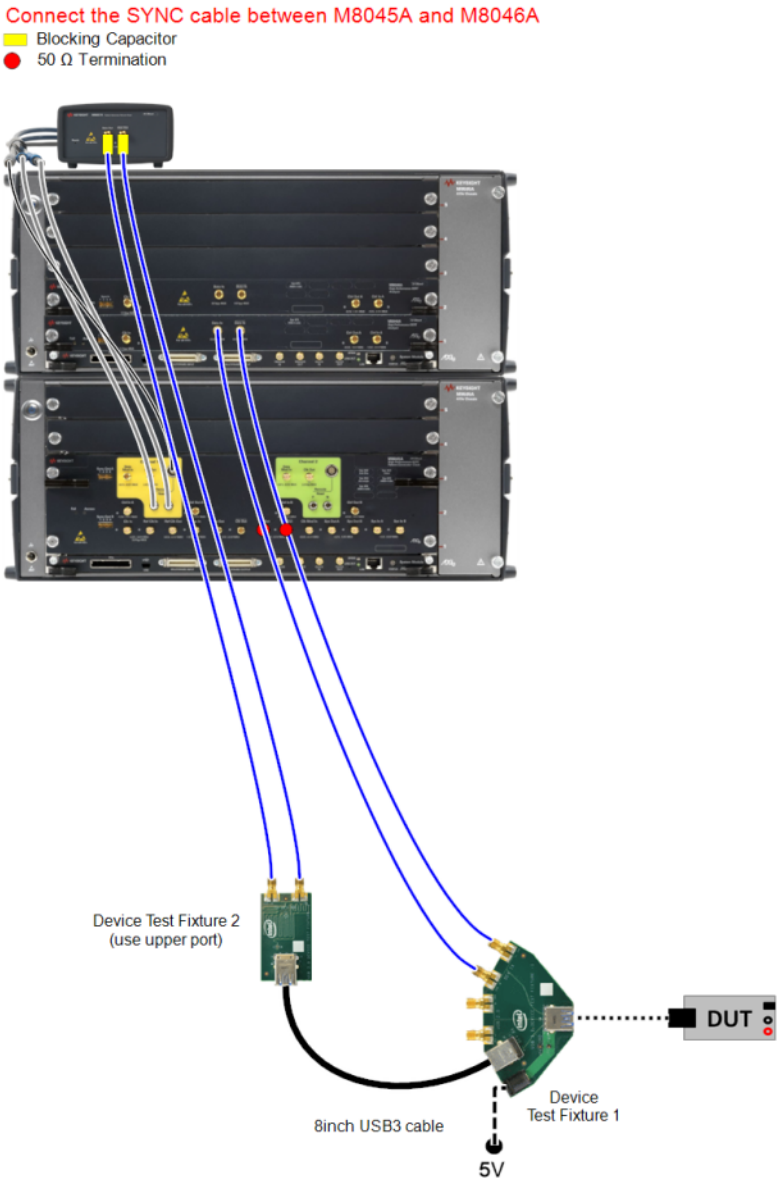


Figure 47 For 5G Rx long channel tests (device – non type C)

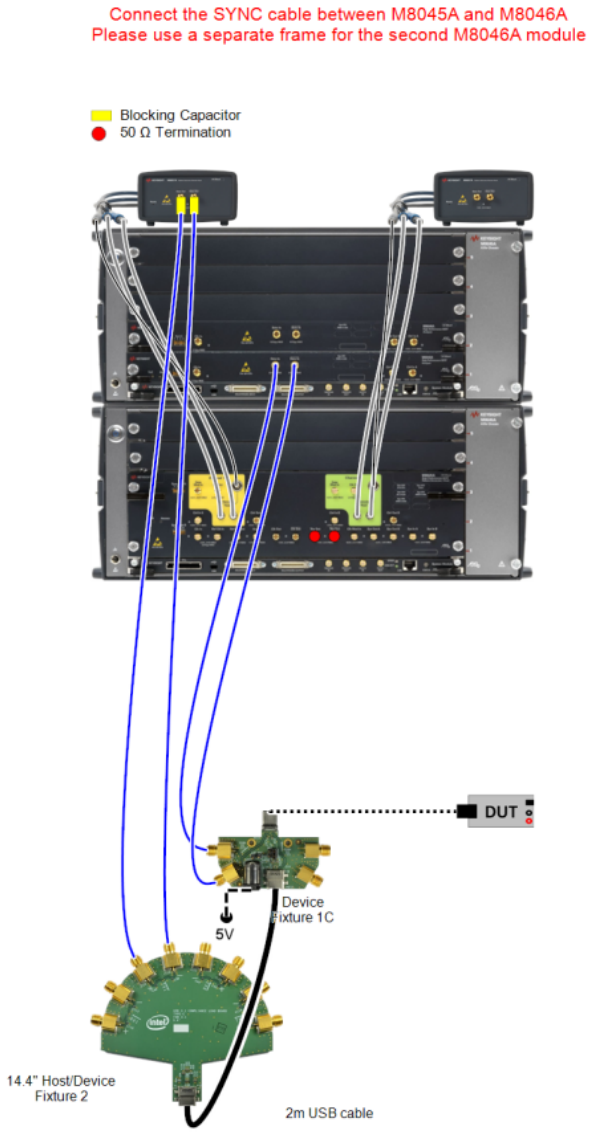


Figure 48 For 5G Rx1 long channel tests (device - type-C)

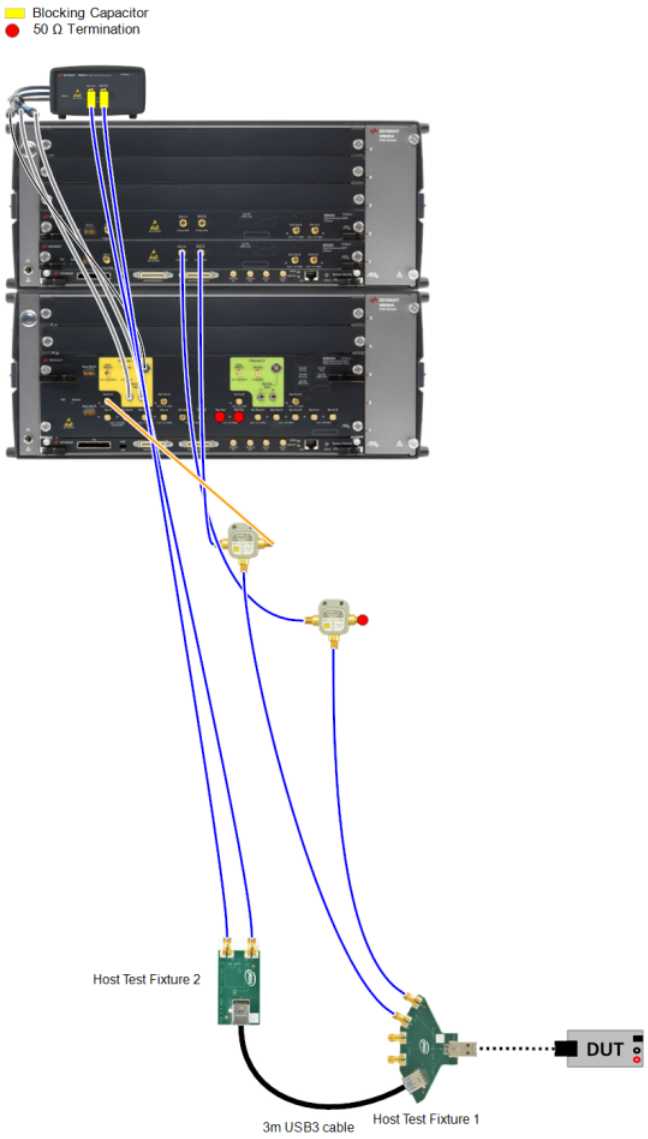


Figure 49 For 5G Rx long channel tests (host - non type-C)

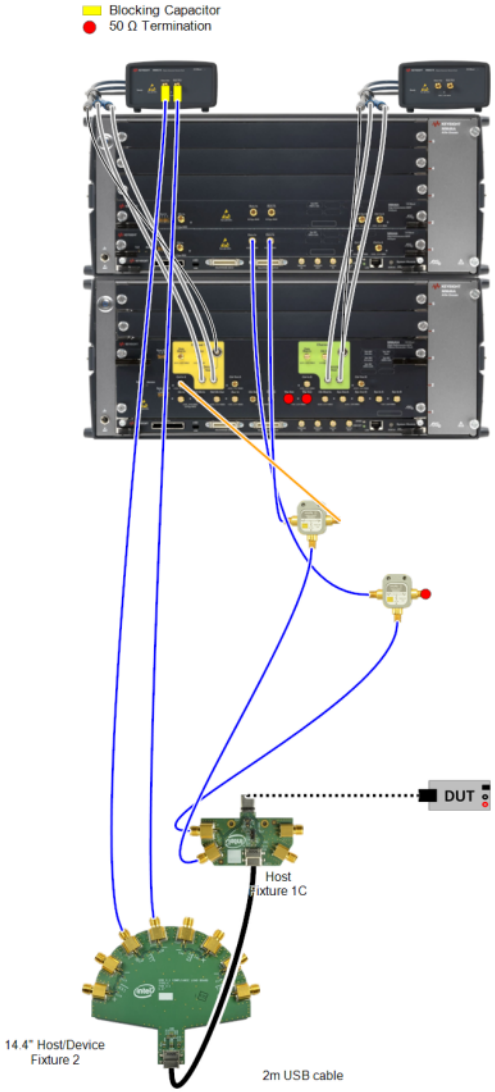


Figure 50 For 5G Rx1 long channel tests (host - type C)

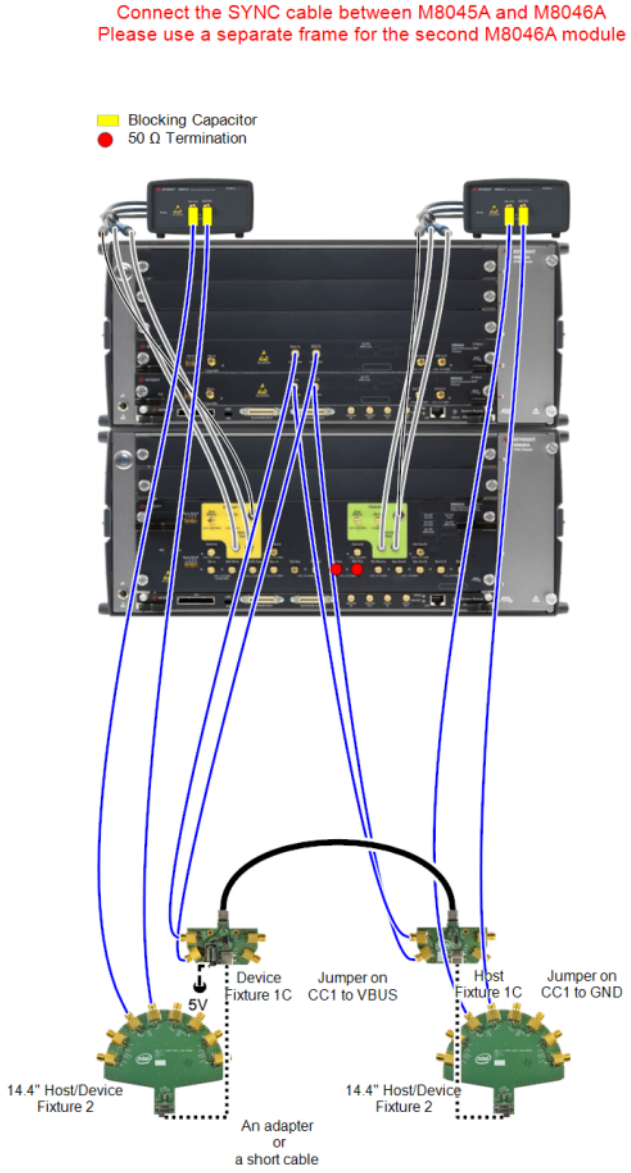


Figure 51 For 5G Rx1 long channel tests (active cable – passthrough)

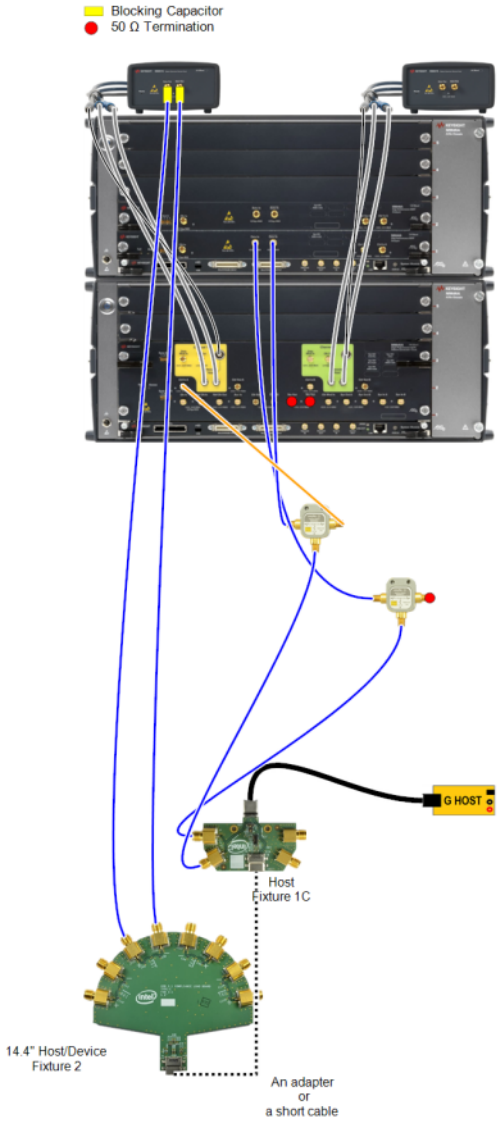


Figure 52 For 5G Rx1 long channel tests (active cable – golden host)

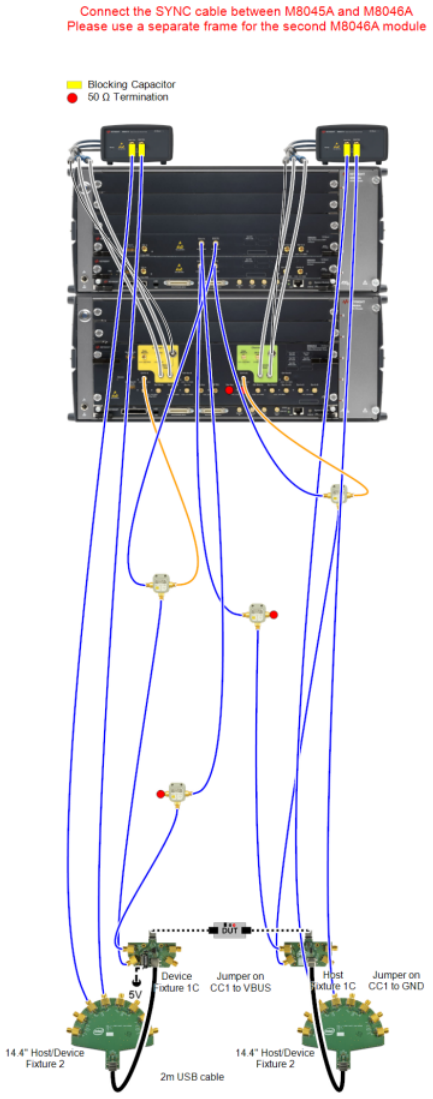


Figure 53 For 5G Rx1 long channel tests (retimer – passthrough)

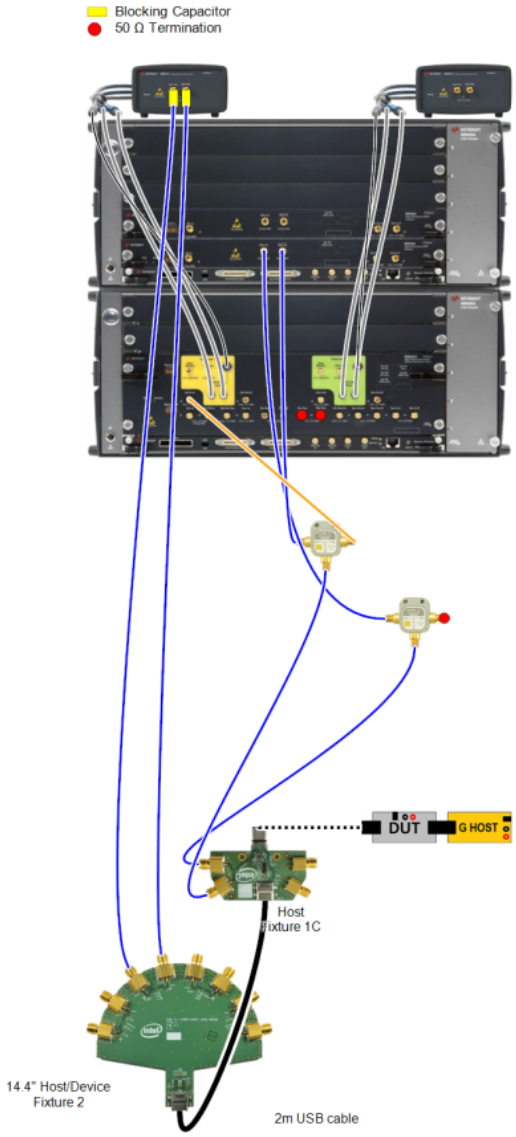


Figure 54 For 5G Rx1 long channel tests (retimer – golden host)

Parameters in Expert Mode

Specification

- Eye Height (only for non Type-C)
- Eye Height Margin (only for non Type-C)
- Differential Voltage (only for Type-C)
- Random Jitter
- Random Jitter Margin (only for non Type-C)
- Sinusoidal Jitter Margin (only for non Type-C)

Loopback Training

- Retrain at each jitter frequency
- Train with Jitter

BER Setup

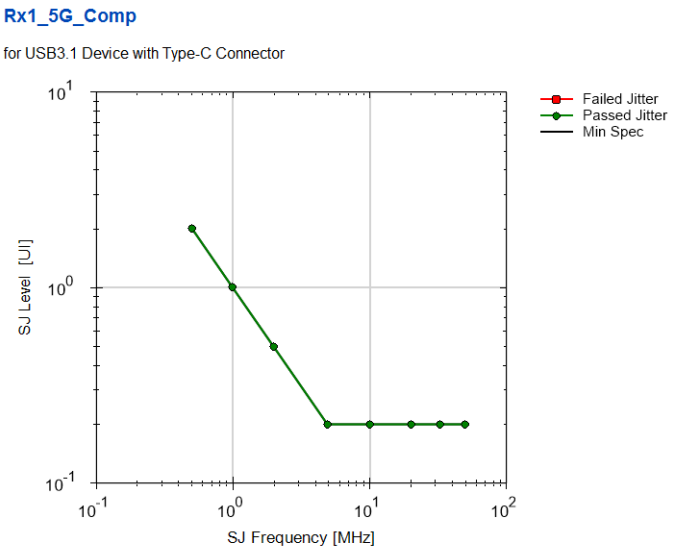
- Target BER
- BER Test Duration
- Allowed Errors
- PJ Frequencies for Test
- Relax time for BER Measurement

For more details about the parameters, please refer to Table 7.

Prerequisite Calibrations

- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description



Retrain at each jitter frequency	False
Train with Jitter	True
Relax time for BER Measurement	5 s
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M1.DataIn1
Use Voltage Settings from Rx Tests for Loopback Training	True
Loopback Training Method	WarmReset
LFPS Idle	M8020A Idle
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\
CDR Loopbandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	USB 5Gb/s -3.5dB
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
Power Automation	Power Switch
Power Component	VBus
Power Channel	1
Power Cycle Off On Duration	3 s
Power Cycle Settling Time	3 s
Power Cycle max. Retries for LB Training	1

Result	SJ Frequency [MHz]	Failed Jitter [UI]	Passed Jitter [UI]	Min Spec [UI]	Symbol Errors
pass	50.000		0.20	0.20	0
pass	33.000		0.20	0.20	0
pass	20.000		0.20	0.20	0
pass	10.000		0.20	0.20	0
pass	4.900		0.20	0.20	0
pass	2.000		0.50	0.50	0
pass	1.000		1.00	1.00	0
pass	0.500		2.00	2.00	0

Figure 55 Example result for 5G Rx compliance test

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Failed Jitter [UI]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Passed Jitter [UI]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [UI]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Symbol Errors**: Number of errors during the test.

5G Rx Constant Parameter Stress Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This test determines if the DUT meets the receiver specifications for a specific jitter frequency.

The procedure is similar to 5G Rx Compliance Test but it measures the number of symbol errors at a single sinusoidal jitter frequency (by default, this frequency is set to 4.9 MHz).

Note that this procedure is not categorized as a compliance test.

NOTE

For non Type-C connectors, the signal is defined with the minimum Eye Height value (145 mV). For Type-C connectors, the signal is defined with the minimum differential voltage amplitude (800 mV).

For non Type-C connectors, a margin is applied to the eye height, random jitter and sinusoidal jitter components. For Type-C connectors, no such margins are applied.

Connection Diagram

Please refer to Figure 47 to Figure 54, depending on the DUT type, Connector, and Test Method.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator.**

Parameters in Expert Mode

Specification

- Eye Height (only for non Type-C)
- Eye Height Margin (only for non Type-C)
- Differential Voltage (only for Type-C)
- Random Jitter
- Random Jitter Margin (only for non Type-C)
- Sinusoidal Jitter Frequency
- Sinusoidal Jitter
- Sinusoidal Jitter Margin (only for non Type-C)

Loopback Training

- Train with Jitter

BER Setup

- Target BER
- Allowed Errors

For more details of the parameters, please refer to Table 7.

Prerequisite Calibrations

- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description

Rx1_5G_ConstStress

for USB3.2 Device with Type-C Connector

----General----	
Offline	True
Specification	Electrical Compliance Test Specification Enhanced Super USB 1.0
Test Properties:	
----Loopback Training----	
Train with Jitter	True
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
Loopback Training Method	WarmReset
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_5G_WarmReset.txt
Force Retraining	True
----Specification----	
Differential Voltage	800 mV
Random Jitter	170 mUI
Sinusoidal Jitter Frequency	4.9 MHz
Sinusoidal Jitter	200 mUI
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----BER Setup----	
Target BER	100E-12
Allowed Errors	1
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loop bandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	Bit Errors
pass	0

Figure 56 Example result for 5G Rx constant parameter stress test

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **Bit Errors**: Number of errors during the test.

5G Rx Jitter Tolerance Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This test characterizes how much jitter a DUT can tolerate at different sinusoidal jitter frequencies.

For each sinusoidal jitter frequency, the jitter amplitude is increased in equally-spaced steps until the number of measured symbol errors is larger than the value set for “Allowed Errors”.

Note that this receiver test is not categorized as a compliance test.

NOTE

For non Type-C connectors, the signal is defined with the minimum Eye Height value (145 mV). For Type-C connectors, the signal is defined with the minimum differential voltage amplitude (800 mV).

For non Type-C connectors, a margin is applied to the eye height, random jitter and sinusoidal jitter components. For Type-C connectors, no such margins are applied.

Connection Diagram

Please refer to Figure 47 to Figure 54, depending on the DUT type, Connector, and Test Method.

NOTE

For lane 2 the setup is the same but using the second channel of the data generator.

Parameters in Expert Mode

Specification

- Eye Height (only for non Type-C)
- Eye Height Margin (only for non Type-C)
- Differential Voltage (only for Type-C)
- Random Jitter
- Random Jitter Margin (only for non Type-C)

- Sinusoidal Jitter Margin (only for non Type-C)

Loopback Training

- Retrain at each Jitter Frequency
- Train with Jitter

Sinusoidal Jitter Variation

- Frequency Mode

If Compliance Frequencies, User Defined Frequencies or Single Frequency are selected:

  - Jitter frequencies
  - Start jitter amplitudes

If Equally Spaced Frequencies is selected:

  - Start frequency value
  - Stop frequency value
  - Number of Frequency Steps
  - Frequency sweep scale

- Use fixed number of steps
  - If True:
    - Number of jitter steps
  - If False
    - Jitter step sizes or factors
- Show Min Failed Points

BER Setup

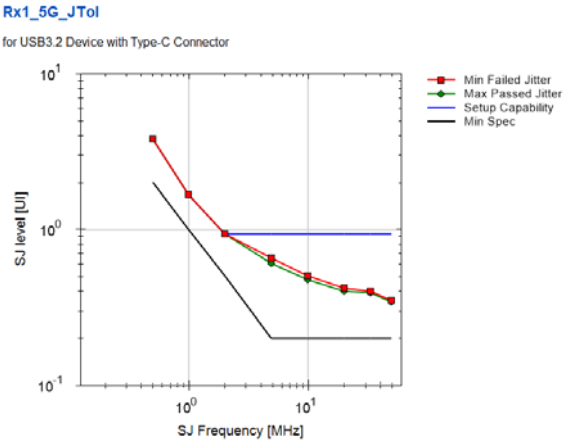
- Target BER
- Allowed Errors
- Relax Time

For more details of the parameters, please refer to Table 7.

Prerequisite Calibrations

- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description



----General----		
Offline		True
Specification		Electrical Compliance Test Specification
----Specification----		
Differential Voltage		800 mV
Random Jitter		170 mUI
SSC Type		Downspread
SSC Deviation		5000 ppm
SSC Frequency		33 kHz
----Loopback Training----		
Force retraining on each frequency		False
Train with Jitter		False
Use Voltage Settings from Rx Tests for Loopback Training		True
CDR during Loopback Training		False
LFPS Idle		M8040A Idle
LFPS Trigger Threshold		60 mV
Loopback Training Method		PowerOnReset
Power On Reset Link Training Suite Settings File		C:\ProgramData\BitifEye\ValiFrameM1\USB3
Force Retraining		True
----Sinusoidal Jitter Variation----		
Frequency mode		Compliance Frequencies
Use fixed number of steps		False
Show min failed points		True
----BER Setup----		
Target BER		1E-5
Allowed Errors		1
----Instrument Channels----		
J-BERT Generator		M1.DataOut1
J-BERT Error Detector		M2.DataIn
----Error Detector----		
CDR symbol rate	4.9875 GBit/s	
CDR Loopbandwidth	9.9 MHz	
CDR Transition Density	61.2 %	
CDR Peaking	1 dB	
Analyzer CTLE	65	
Input Sensitivity	High	
Auto-align Timeout	60 s	
Error Detector Operation Mode	Differential	
Input Polarity inverted	False	
----Power Automation----		
Power Automation	Manual	

Result	SJ Frequency [MHz]	Min Failed Jitter [UI]	Max Passed Jitter [UI]	Setup Capability [UI]	Min Spec [UI]	Margin [%]
pass	0.50	3.82	3.82	4	2.00	91.0
pass	1.00	1.66	1.66	2	1.00	66.0
pass	2.00	0.93	0.93	1	0.50	86.0
pass	4.90	0.65	0.60	1	0.20	200.0
pass	10.00	0.50	0.48	1	0.20	137.5
pass	20.00	0.42	0.40	1	0.20	100.0
pass	33.00	0.40	0.39	1	0.20	95.0
pass	50.00	0.35	0.34	1	0.20	70.0

Figure 57 Example result for 5G Rx jitter tolerance test

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Min Failed Jitter [UI]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Max Passed Jitter [UI]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Setup Capability [UI]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [UI]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Margin [%]**: The margin between the min spec and the test result.

5G Rx Sensitivity Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This test searches for the minimum eye height that a DUT can tolerate.

The procedure starts with an eye height value of “Start Eye Height” and decreases it with steps of “Step Size” value. The minimum passed value is the last test point that did not return more errors than specified in the “Allowed Errors” parameter. For DUTs which do not support disconnect (incapability to step down and drop out of loopback), it is necessary to train the DUT in every step.

Note that this receiver test is not categorized as a compliance test.

NOTE

For non Type-C connectors, the signal is defined with Eye Height values. For Type-C connectors, the signal is defined with differential voltage amplitude values.

For non Type-C connectors, a margin is applied to the eye height, random jitter and sinusoidal jitter components. For Type-C connectors, no such margins are applied.

Connection Diagram

Please refer to Figure 47 to Figure 54, depending on the DUT type, Connector, and Test Method.

NOTE

For lane 2 the setup is the same but using the second channel of the data generator.

Parameters in Expert Mode

Specification

- Random Jitter
- Random Jitter Margin (only for non Type-C)
- Sinusoidal Jitter Frequency

- Sinusoidal Jitter
- Sinusoidal Jitter Margin (only for non Type-C)

Eye Height Variation (only for non Type-C)

- Start Eye Height
- Eye Height Step Size

Differential Voltage Variation (only for Type-C)

- Start Differential Voltage
- Differential Voltage Step Size

For more details of the parameters, please refer to Table 7.

Prerequisite Calibrations

- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description

Rx1_5G_Sens

for USB3.2 Device with Type-C Connector

----General----	
Offline	True
Specification	Electrical Compliance Test Specification
Test Properties:	
----Specification----	
Random Jitter	170 mUI
Sinusoidal Jitter Frequency	4.9 MHz
Sinusoidal Jitter	200 mUI
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----Differential Voltage Variation----	
Start Differential Voltage	900 mV
Differential Voltage Step Size	20 mV
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Loopback Training----	
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	50 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3\
Force Retraining	True
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loopbandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	Min Passed Differential Voltage [mV]	Min Spec [mV]	Margin [%]
pass	120	800	85.0

Figure 58 Example result for 5G Rx sensitivity test

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **Min Passed Differential Voltage [mV]**: The minimum differential voltage amplitude where the tested point passes.
- **Min Spec [mV]**: Minimum differential voltage amplitude that the DUT must tolerate.

- **Margin [%]**: The margin between the min spec and the test result.

5G Rx Data Rate Deviation Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This test checks the range of data rate deviation within which the DUT works properly.

The procedure sets the specified values for eye height, jitter and SSC and measures the number of symbol errors for every tested deviation. The test is considered to be successful when all deviations between -300 ppm and 300 ppm pass the error test.

Note that this receiver test is not categorized as a compliance test.

NOTE

For non Type-C connectors, the signal is defined with the minimum Eye Height value (145 mV). For Type-C connectors, the signal is defined with the minimum differential voltage amplitude (800 mV).

For non Type-C connectors, a margin is applied to the eye height, random jitter and sinusoidal jitter components. For Type-C connectors, no such margins are applied.

Connection Diagram

Please refer to Figure 47 to Figure 54, depending on the DUT type, Connector, and Test Method.

NOTE

For lane 2 the setup is the same but using the second channel of the data generator.

Parameters in Expert Mode

Specification

- SSC Frequency
- Eye Height (only for non Type-C)
- Eye Height Margin (only for non Type-C)
- Differential Voltage (only for Type-C)

- Random Jitter
- Random Jitter Margin (only for non Type-C)
- Sinusoidal Jitter Frequency
- Sinusoidal Jitter
- Sinusoidal Jitter Margin (only for non Type-C)

Data Rate Variation

Deviation Mode

- For equally spaced Deviations:
  - Min. Data Rate Deviation
  - Max. Data Rate Deviation
  - Number of Deviation Steps
- For User Defined Deviations:
  - Data Rate Deviation Points
- For Single Deviation:
  - Data Rate Deviation

BER Setup

- Target BER
- Allowed Errors
- Relax Time

For more details of the parameters, please refer to Table 7.

Prerequisite Calibrations

- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description

Rx1_5G_DataRateDev

for USB3.2 Device with Type-C Connector

----General----	
Offline	True
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
----Data Rate Variation----	
Deviation Mode	Pre Defined Deviations
----Specification----	
Differential Voltage	800 mV
Random Jitter	170 mUI
Sinusoidal Jitter Frequency	4.9 MHz
Sinusoidal Jitter	200 mUI
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----BER Setup----	
Target BER	1E-9
Allowed Errors	5
Relax Time	1 s
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Loopback Training----	
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
Loopback Training Method	WarmReset
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_5G_WarmReset.txt
Force Retraining	True
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loop bandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	Deviation [ppm]	Data Rate [GBit/s]	Errors []	Comment
pass	-600	4.997000	0	Below min spec (-300 ppm). Does not affect the overall test result.
pass	-300	4.998500	0	Min spec. Affects the overall test result.
pass	0	5.000000	0	Nominal datarate. Affects the overall test result.
pass	300	5.001500	0	Max spec. Affects the overall test result.
pass	600	5.003000	0	Above max spec (300 ppm). Does not affect the overall test result.
pass	2500	5.012500	0	Above max spec (300 ppm). Does not affect the overall test result. This point corresponds to SSC centerspread at 5Gbit/s.

Figure 59 Example result for 5G Rx data rate deviation test

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **Deviation [ppm]**: The tested data rate deviation at each step.
- **Data Rate [GBit/s]**: The data rate given by the current deviation.
- **Errors**: Number of errors during the test.

Short Channel Tests

The list of tests for Short Channel is the same as that for Long Channel. The procedures behave in the same manner. The only differences are the connection setups and that the differential voltage amplitude of the signal is set to 1.2 V instead of 800 mV.

NOTE Short channel tests should be run at the maximum differential voltage, 1.2 V, to stress the DUT. The default value is kept as 800 mV to avoid accidental damage to DUTs that cannot support such a high voltage. You can manually adjust this value yourself.

Common Parameters That Are Channel Specific

Loopback Training

- Short Channel Differential Voltage for Loopback Training

Common Parameters That Are Lane Specific

Instrument Channels

- J-BERT Generator
- J-BERT Error Detector

Refer to Table 5 on page 44 for the description of the mentioned parameters.

5G Rx Short Channel Compliance Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This test determines if the DUT meets the receiver Short Channel Compliance Test Specification.

The procedure measures the number of symbol errors when all jitter types and the eye height are set to their specification limit values (maximum for jitter, minimum for eye height). This is done for several predefined jitter frequencies.

For this measurement, it is necessary to train the DUT into loopback mode. To achieve that, the data generator sends a training sequence to the DUT. The training sequence is generated based on the Loopback Training parameter settings, such as, PowerOnReset or WarmReset.

The loopback training must be performed with the same physical stress parameters as the measurements. This allows the DUT receiver to optimize its equalizer for the test signal during loopback training.

NOTE

For non Type-C connectors, the signal is defined with the minimum Eye Height value (145 mV). For Type-C connectors, the signal is defined with the minimum differential voltage amplitude (1.2 V).

For non Type-C connectors, a margin is applied to the eye height, random jitter and sinusoidal jitter components. For Type-C connectors, no such margins are applied.

Connection Diagram

Refer to Figure 60 to Figure 67, depending on the DUT type, Connector and Test Method.

NOTE

For lane 2 the setup is the same but using the second channel of the data generator.

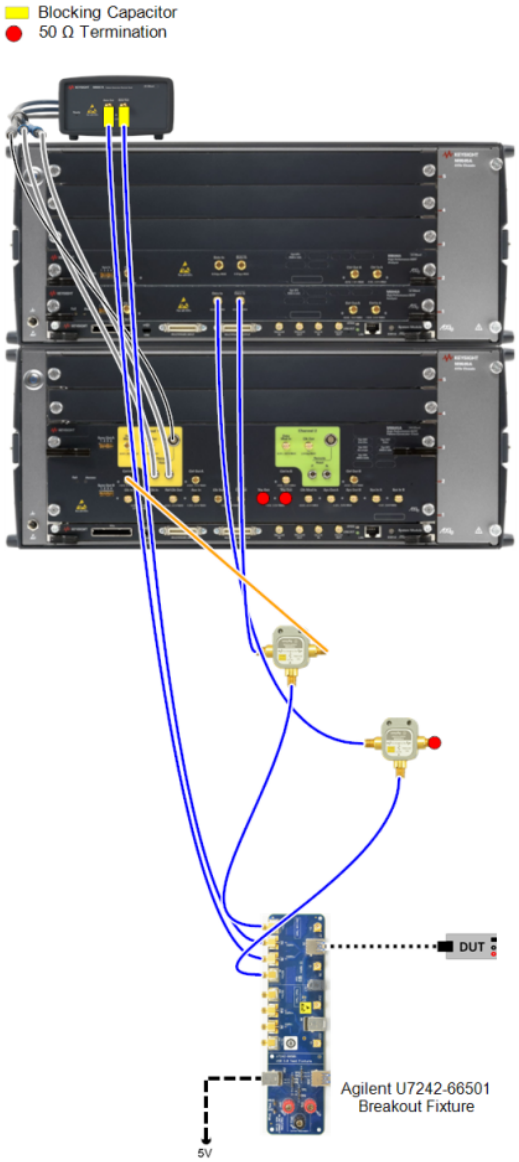


Figure 60 For 5G Rx short channel tests (device - non type-C)

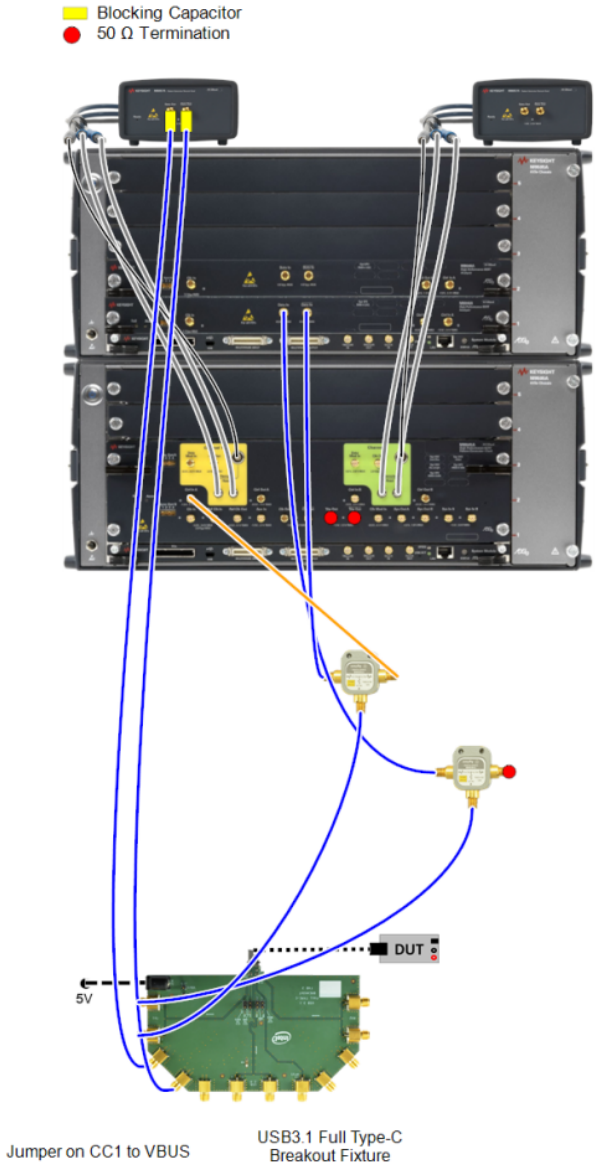


Figure 61 For 5G Rx1 short channel tests (device - type-C)

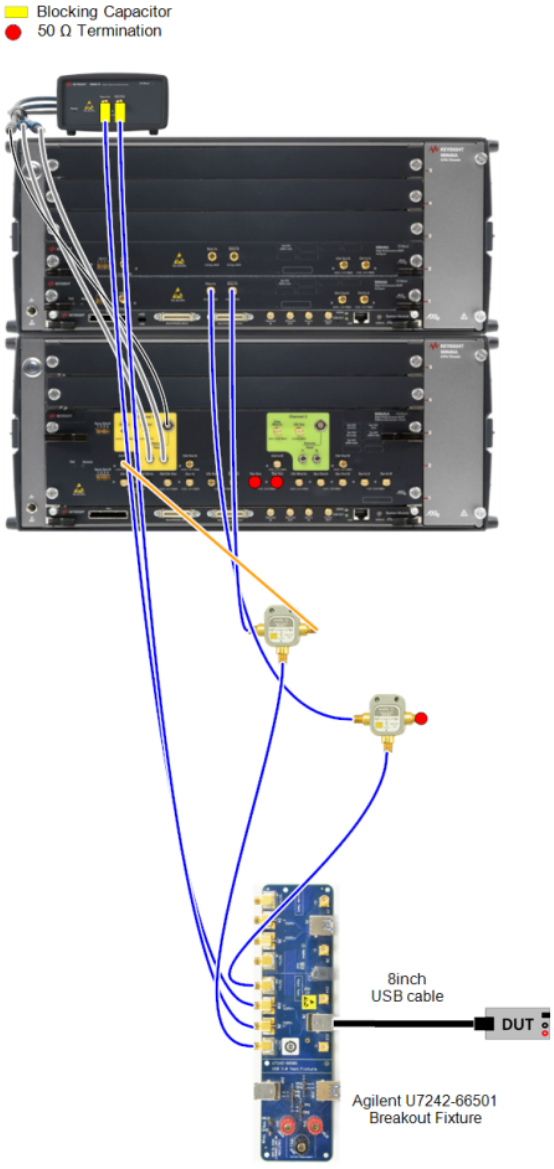


Figure 62 For 5G Rx1 short channel tests (host - non type-C)

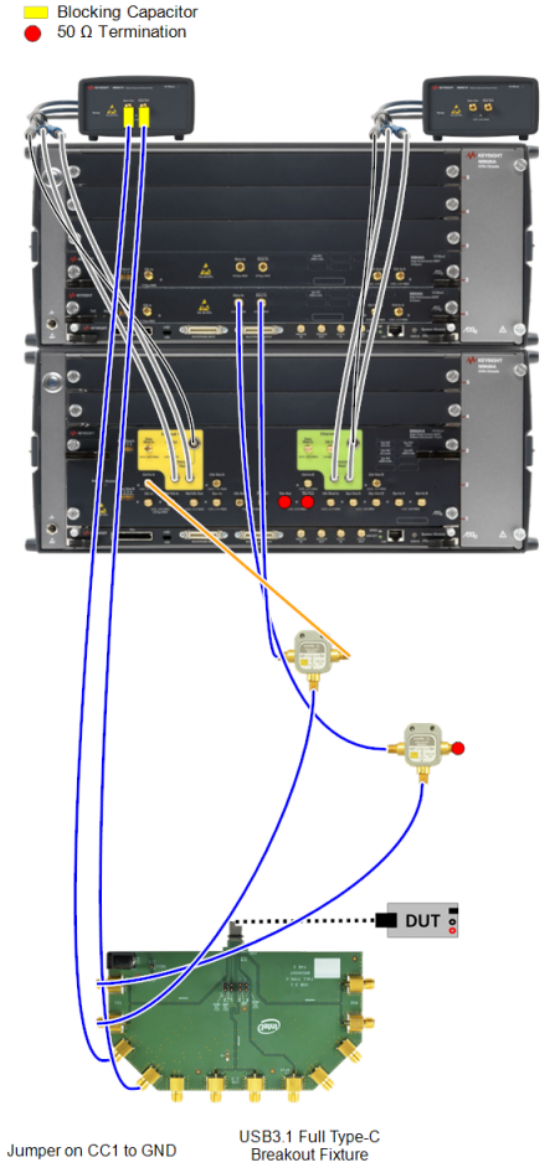


Figure 63 For 5G Rx1 short channel tests (host – type C)

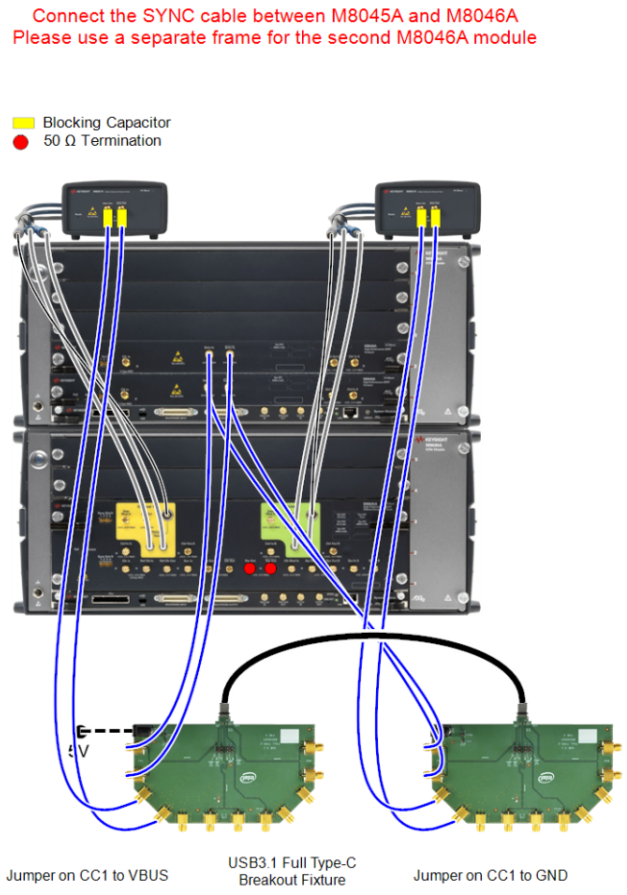


Figure 64 For 5G Rx1 short channel tests (active cable – passthrough)

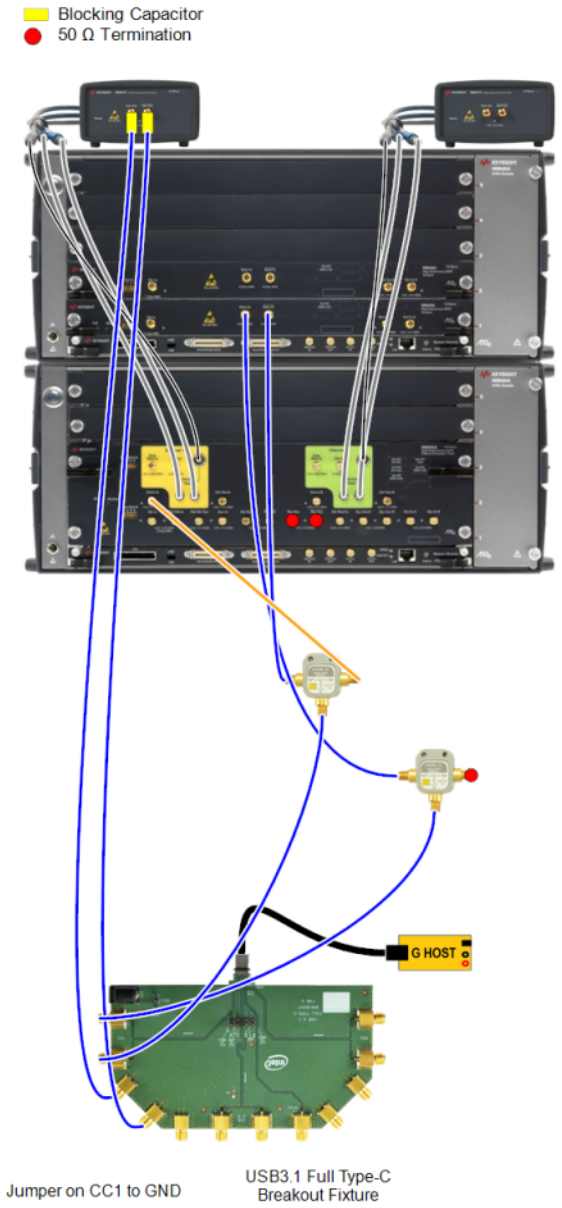


Figure 65 For 5G Rx1 short channel tests (active cable – golden host)

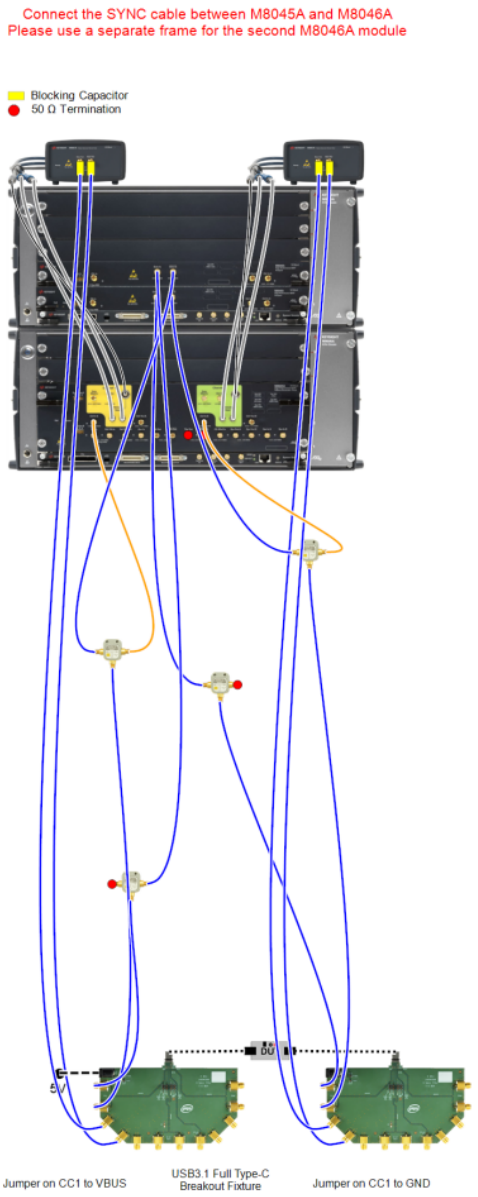


Figure 66 For 5G Rx1 short channel tests (retimer – passthrough)

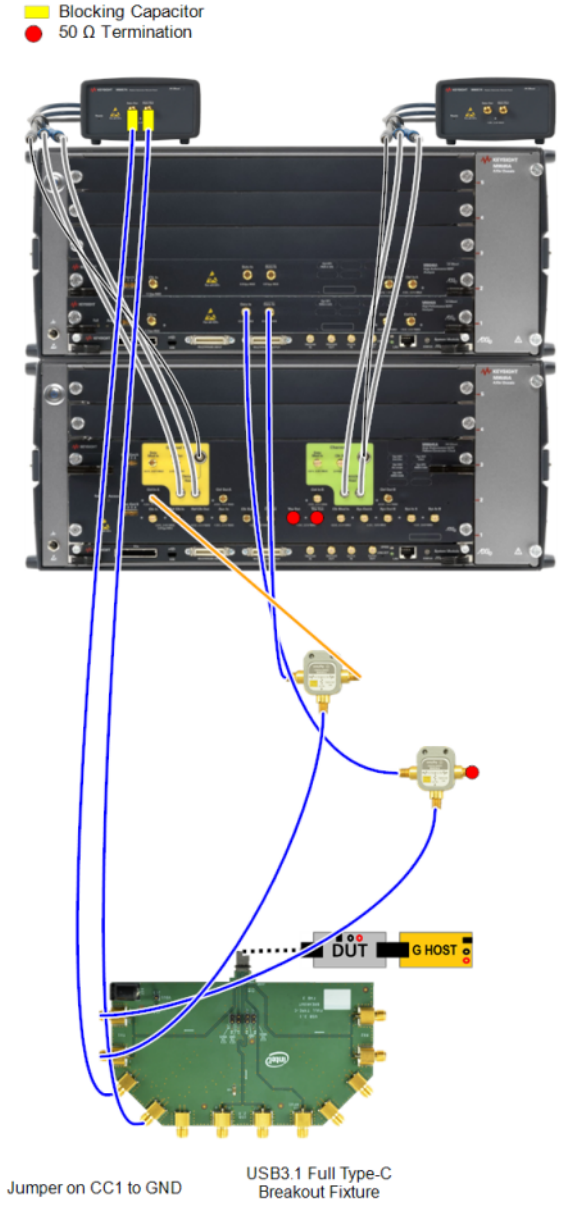


Figure 67 For 5G Rx1 short channel tests (retimer – golden host)

Parameters in Expert Mode

Specification

- Eye Height (only for non Type-C)
- Eye Height Margin (only for non Type-C)
- Differential Voltage (only for Type-C)
- Random Jitter
- Random Jitter Margin (only for non Type-C)
- Sinusoidal Jitter Margin (only for non Type-C)

Loopback Training

- Retrain at each jitter frequency
- Train with Jitter

BER Setup

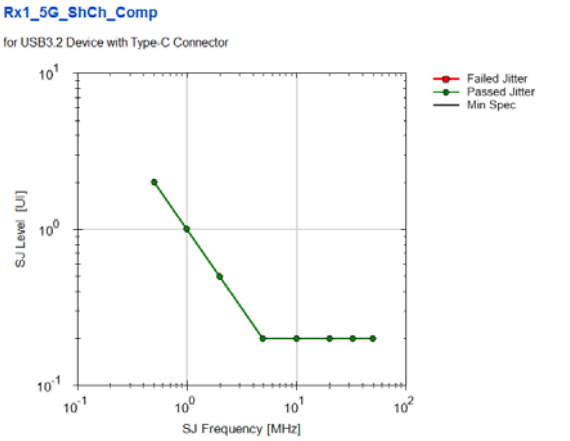
- Target BER
- BER Test Duration
- Allowed Errors
- PJ Frequencies for test
- Relax time for BER Measurement

Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

Prerequisite Calibrations

- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description (similar to that for Long Channel tests)



----General----	
Offline	True
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
----Specification----	
Differential Voltage	1.2 V
Random Jitter	170 mUI
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----BER Setup----	
Target BER	100E-12
BER Test Duration	6 s
Allowed Errors	1
Relax time for BER Measurement	5 s
----Loopback Training----	
Retrain at each jitter frequency	False
Train with Jitter	True
Short Channel Differential Voltage for Loopback Training	800 mV
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
Loopback Training Method	WarmReset
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_5G_WarmReset.txt
Force Retraining	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Error Detector----	
CDR symbol rate	4.9975 GBit/s
CDR Loop bandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	6%
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	SJ Frequency [MHz]	Failed Jitter [UI]	Passed Jitter [UI]	Min Spec [UI]	Symbol Errors
pass	50.000		0.20	0.20	0
pass	33.000		0.20	0.20	0
pass	20.000		0.20	0.20	0
pass	10.000		0.20	0.20	0
pass	4.900		0.20	0.20	0
pass	2.000		0.50	0.50	0
pass	1.000		1.00	1.00	0
pass	0.500		2.00	2.00	0

Figure 68 Example result for 5G Rx short channel compliance test

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Failed Jitter [UI]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Passed Jitter [UI]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [UI]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Symbol Errors**: Number of errors during the test.

5G Rx Short Channel Constant Parameter Stress Test

This procedure is similar to the 5G Rx Constant Parameter Stress Test / 138.

5G Rx Short Channel Jitter Tolerance Test

This procedure is similar to the 5G Rx Jitter Tolerance Test / 141.

5G Rx Short Channel Sensitivity Test

This procedure is similar to the 5G Rx Sensitivity Test / 145.

5G Rx Short Channel Data Rate Deviation Test

This procedure is similar to the 5G Rx Data Rate Deviation Test / 149.

LFPS Tests

Common Parameters for LFPS Tests

- **Send TSEQ after LFPS**: Crystal-less devices need a TSEQ pattern after LFPS for their CDR.
- **Trigger Delay after LFPS**: Time between the last LFPS burst sent by the pattern generator and the start of the oscilloscope acquisition to detect TSEQ sent by the DUT.
- **Trigger Threshold Level**: Detection threshold of the LFPS signal sent by the DUT.

5G Rx LFPS Compliance Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This test verifies that the DUT recognizes LFPS signaling at the limit allowed as per the specification.

The procedure generates a sequence consisting of an LFPS pattern looped 16 times. The sequence is downloaded to the J-BERT and sent to the DUT. The procedure checks if the DUT responds with TSEQ using a real-time oscilloscope. This procedure is repeated for a set of differential voltage and duty cycle compliance combinations.

The test passes if the DUT responds to LFPS signals with a differential voltage range:

- DUT must respond to LFPS with amplitude above 300 mVpp
- DUT must not respond to LFPS with amplitude below 100 mVpp

Connection Diagram

Please refer to Figure 69 to Figure 74 depending on the DUT type, Connector and Test Method.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator and Ch2 of the oscilloscope.**

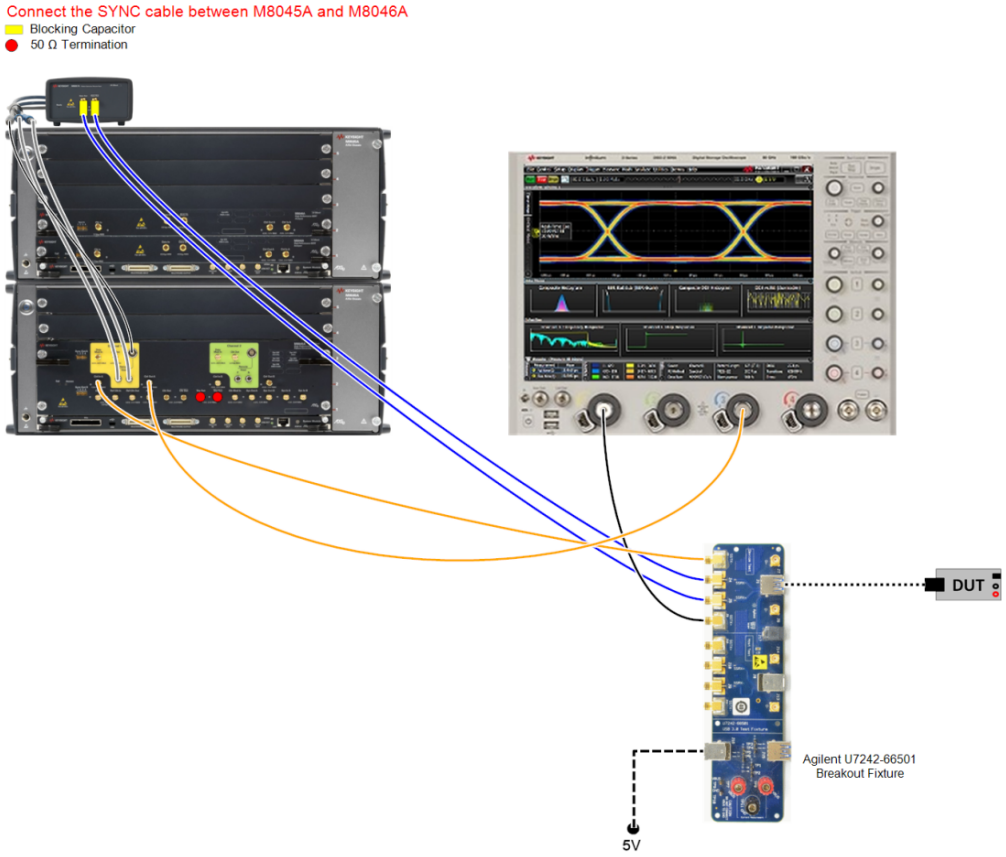


Figure 69 For 5G Rx LFPS tests (device - non type-C)

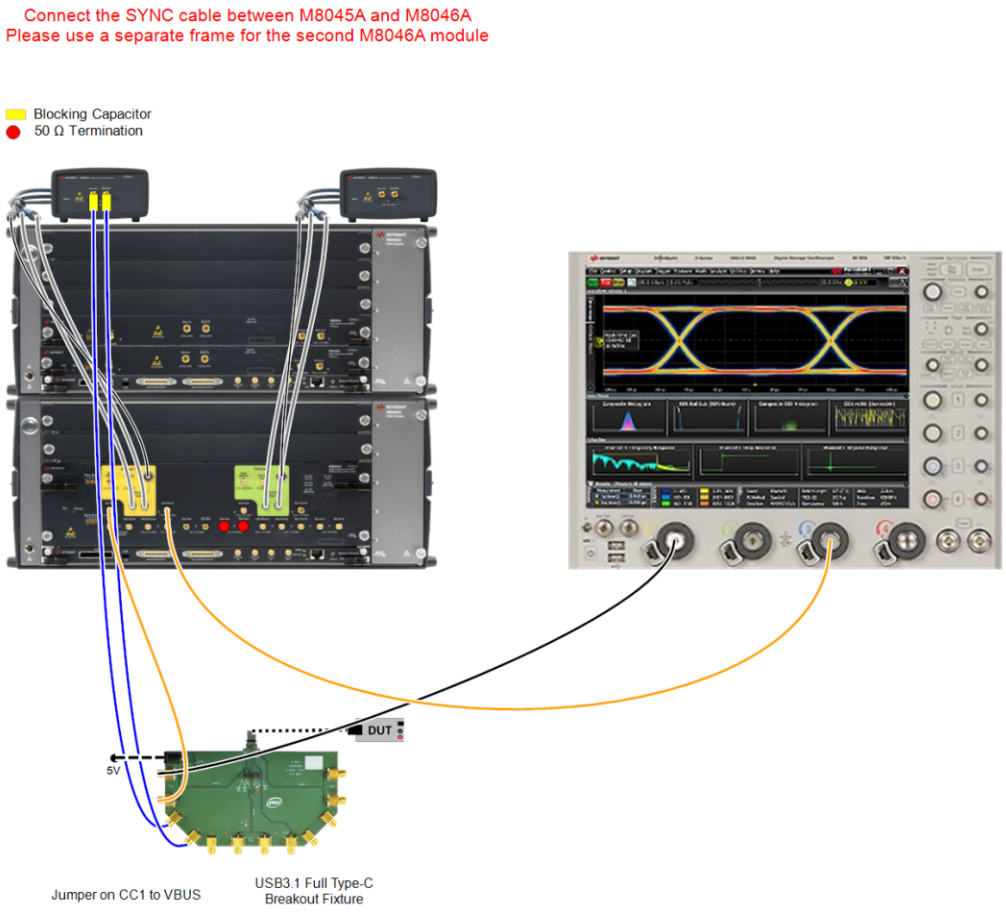


Figure 70 For 5G Rx1 LFPS tests (device - type-C)

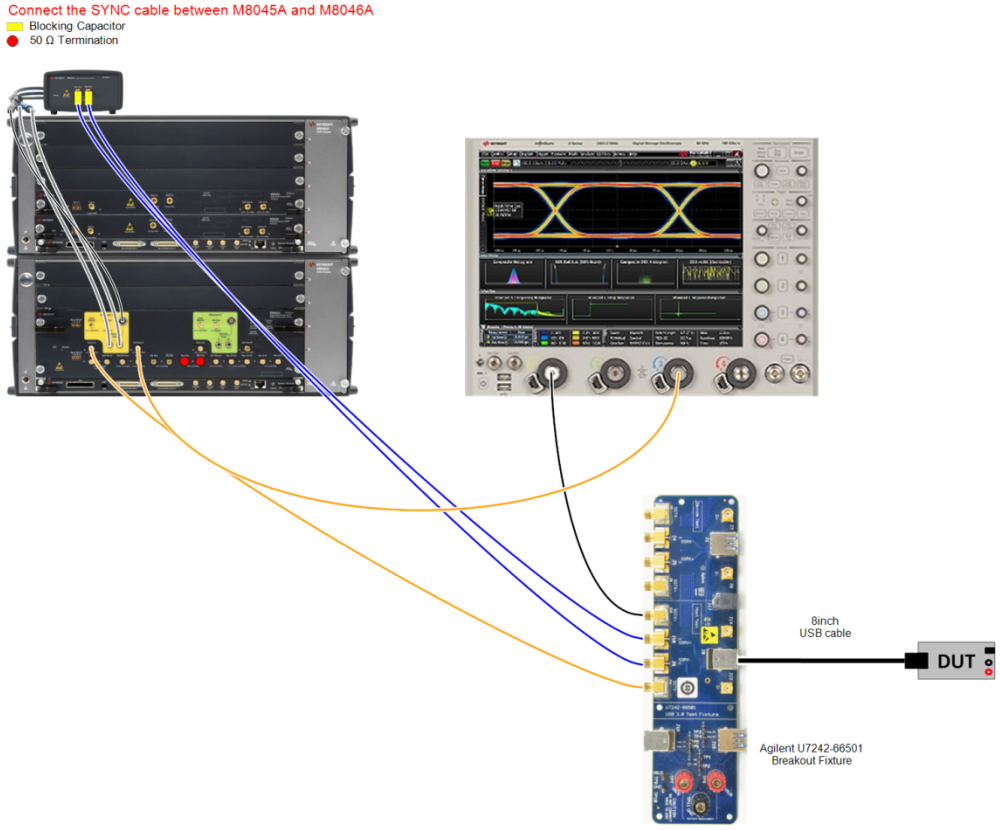


Figure 71 For 5G Rx LFPS tests (host - non type-C)

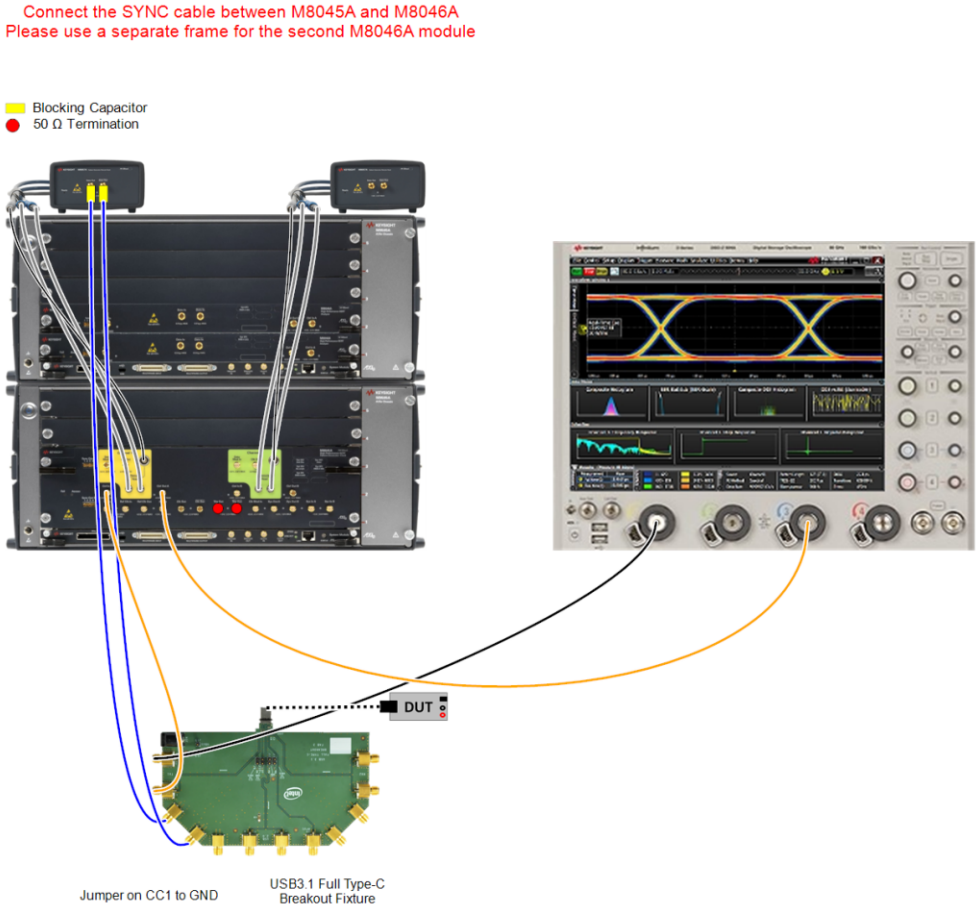


Figure 72 For 5G Rx1 LFPS tests (host – type C)

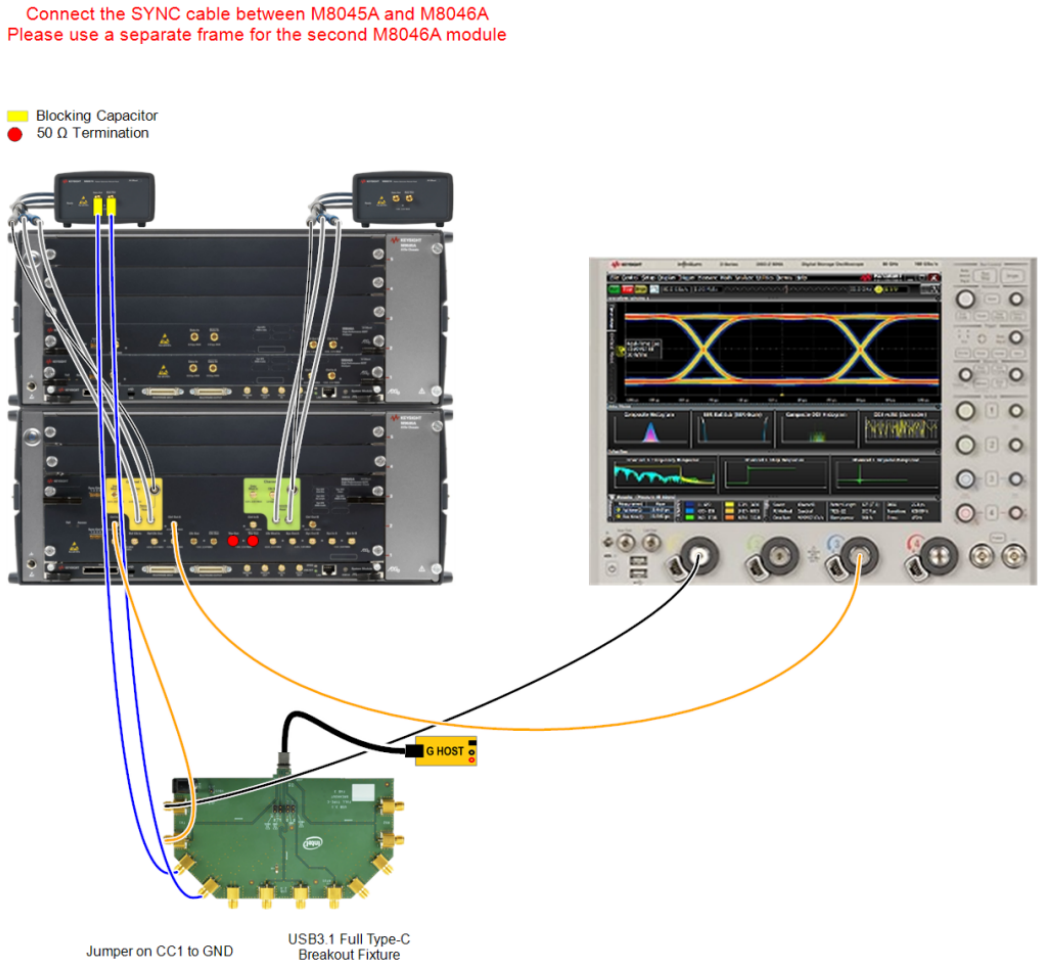


Figure 73 For 5G Rx1 LFPS tests (active cable – golden host)

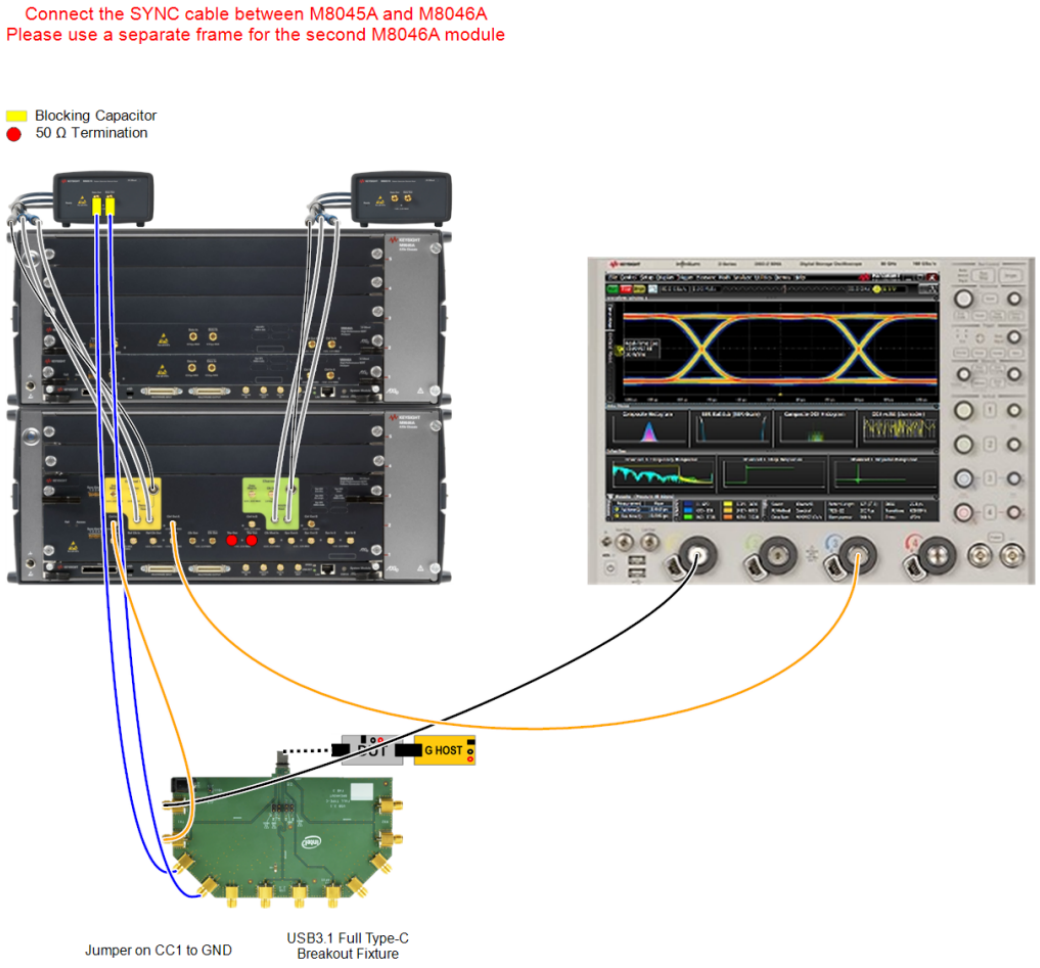


Figure 74 For 5G Rx1 LFPS tests (retimer – golden host)

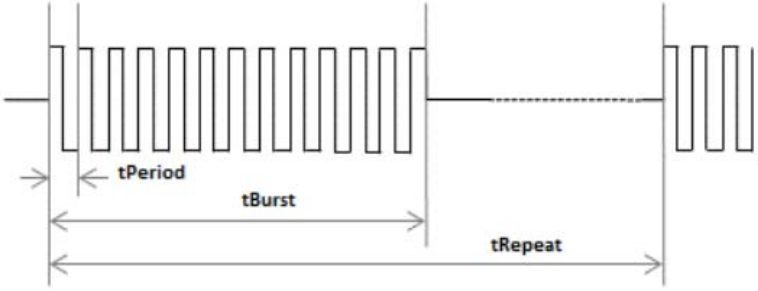
Parameters in Expert Mode

Script Variation

- LFPS Loop Count
- Number of Idle

Specification

- t_{Period}
- t_{Burst}
- t_{Repeat}



Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

Prerequisite Calibrations

- 5G LFPS Voltage Calibration

Result Description

Rx1_5G_LFPS_Comp

for USB3.2 Device with Type-C Connector

----General----	
Offline	True
Send TSEQ after LFPS	True
Trigger Delay after LFPS	150 us
Trigger Threshold Level	100 mV
Specification	Electrical Compliance Test Specification Enh
Test Properties:	
----Specification----	
tPeriod	50 ns
tBurst	1 us
tRepeat	10 us
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----Script Variation----	
LFPS Loopcount	16
Number of Idle	5
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Loopback Training----	
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	50 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3\Set
Force Retraining	True
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loopbandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	Dut Responded	Diff Volt pp [mV]	Duty Cycle [%]	Description
pass	True	800	50	DUT must respond
pass	True	1200	50	DUT must respond
pass	True	1000	40	DUT must respond
pass	True	1000	60	DUT must respond
pass	True	300	50	DUT must respond
pass	True	200	50	DUT may respond
pass	True	100	50	DUT may respond
pass	False	90	50	DUT must not respond

Figure 75 Example result for 5G Rx LFPS compliance test

- **Result**: (Pass / Fail), if the DUT responds correctly to the LFPS, the value is “Pass” otherwise “Fail”.
- **DUT Responded**: True if the DUT responds to the LFPS, False if it does not respond.
- **Diff Volt pp [mV]**: The differential voltage amplitude applied to the test signal.
- **Duty Cycle [%]**: The duty cycle applied to the test signal.
- **Description**: Specifies whether the DUT must respond or not to pass the step.

5G Rx LFPS Sensitivity Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure characterizes the minimum differential LFPS amplitude at which the DUT still responds to the LFPS signal.

The data generator sends LFPS signals of various differential voltage amplitudes. It starts with the selected Start Differential Voltage value and decreases with a step size defined by the Differential Voltage Coarse Step Size parameter. When the Step Size Switching Point (default 400 mV) is reached, the step size is changed to the defined Differential Voltage Fine Step Size and the amplitude is decreased with this step size until 90 mV is reached. Each step is passed if the DUT sends the TSEQ pattern upon detecting the LFPS signal. The test is passed if the DUT responded to LFPS signals with a differential voltage range within the specs:

- DUT must respond to LFPS with amplitude above 300 mVpp
- DUT must not respond to LFPS with amplitude below 100 mVpp

Connection Diagram

Please refer to Figure 69 to Figure 74, depending on the DUT type, Connector, and Test Method.

Parameters in Expert Mode

Script Variation

- LFPS Loop Count
- Number of Idle

Specification

- t_{Period}
- t_{Burst}
- t_{Repeat}
- Duty Cycle

Differential Voltage Variation

- Start Differential Voltage
- Stop Differential Voltage
- Differential Voltage Coarse Step Size
- Differential Voltage Fine Step Size

- Step Size Switching Point

For more details of the parameters, please refer to Table 7.

Prerequisite Calibrations

- 5G LFPS Voltage Calibration

Result Description

Rx1_5G_LFPS_Sens

for USB3.2 Device with Type-C Connector

Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
Offline	True
tPeriod	50 ns
tBurst	1 us
LFPS Loopcount	16
Number of Idle	5
tRepeat	10 us
Duty Cycle	50 %
Start Differential Voltage	1.2 V
Stop Differential Voltage	90 mV
Differential Voltage Start Step Size	50 mV
Differential Voltage End Step Size	20 mV
Step Size Switching Point	400 mV
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
Send TSEQ after LFPS	True
Trigger Delay after LFPS	150 us
Trigger Threshold Level	100 mV
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
Loopback Training Method	WarmReset
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_5G_WarmReset.txt
CDR symbol rate	4.9875 GBit/s
CDR Loopbandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
Power Automation	Manual
Force Retraining	True

Result	Min Passed Diff Volt pp [mV]	Min Failed Diff Volt pp [mV]	Max Failed Diff Volt pp [mV]	Min Spec [mV]	Max Spec [mV]	Description
pass	105	90	90	100	300	The test fails if the DUT reacts to voltages below "Min Spec" or does not react to voltages above "Max Spec"

Figure 76 Example result for 5G Rx LFPS sensitivity test

- **Result**: (Pass / Fail), if the DUT responds correctly to the LFPS, the value is “Pass” otherwise “Fail”.
- **Min Passed Diff Volt pp [mV]**: The minimum differential voltage amplitude applied to the test signal where the test passes. This value must not be lower than 100mVpp.

- **Min Failed Diff Volt pp [mV]**: The minimum differential voltage amplitude applied to the test signal where the test fails. It must be lower than 100mVpp.
- **Max Failed Diff Volt pp [mV]**: The maximum differential voltage amplitude applied to the test signal where the test fails. This value has to be lower than 300mVpp.
- **Min Spec**: The minimum differential voltage allowed by the specifications.
- **Max Spec**: The maximum differential voltage allowed by the specifications.

5G Rx LFPS Duty Cycle Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure characterizes the LFPS duty cycle range that the DUT detects.

The data generator sends LFPS signals, varying the duty cycle in each test step. Each step is considered as passed if the DUT sends the TSEQ pattern upon detecting the LFPS signal. The test passes if the DUT responds to LFPS signals with a duty cycle between 40% and 60%.

Connection Diagram

Please refer to Figure 69 to Figure 74, depending on the DUT type, Connector, and Test Method.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator and Ch2 of the oscilloscope.**

Parameters in Expert Mode

Script Variation

- LFPS Loop Count
- Number of Idle

Specification

- t_{Period}
- t_{Burst}
- t_{Repeat}
- Differential Voltage

Duty Cycle Variation

- Start Duty Cycle
- Stop Duty Cycle
- Duty Cycle Step Size

For more details of the parameters, please refer to Table 7.

Prerequisite Calibrations

- 5G LFPS Voltage Calibration

Result Description

Rx1_5G_LFPS_DCycle

for USB3.2 Device with Type-C Connector

----General----	
Offline	True
Send TSEQ after LFPS	True
Trigger Delay after LFPS	150 us
Trigger Threshold Level	100 mV
Specification	Electrical Compliance Test Specification Enhanc
Test Properties:	
----Specification----	
tPeriod	50 ns
tBurst	1 us
tRepeat	10 us
Differential Voltage	800 mV
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----Script Variation----	
LFPS Loopcount	16
Number of Idle	5
----Duty Cycle Variation----	
Start Duty Cycle	20 %
Stop Duty Cycle	80 %
Duty Cycle Step Size	10 %
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Loopback Training----	
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	50 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3\Settings\M8(
Force Retraining	True
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loopbandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	Duty Cycle [%]	Min Spec [%]	Max Spec [%]	Comment
pass	20	40	60	Below min spec (40 %). Does not affect the overall test result.
pass	30	40	60	Below min spec (40 %). Does not affect the overall test result.
pass	40	40	60	Within spec range. Affects the overall test result.
pass	50	40	60	Within spec range. Affects the overall test result.
pass	60	40	60	Within spec range. Affects the overall test result.
pass	70	40	60	Above max spec (60 %). Does not affect the overall test result.
pass	80	40	60	Above max spec (60 %). Does not affect the overall test result.

Figure 77 Example result for 5G Rx LFPS duty cycle test

- **Result**: (Pass / Fail), if the DUT responds correctly to the LFPS, the value is “Pass” otherwise “Fail”.
- **Duty Cycle [%]**: The duty cycle applied to the test signal at each step.
- **Min Spec [%]**: The minimum duty cycle allowed by the specifications.
- **Max Spec [%]**: The maximum duty cycle allowed by the specifications.

5G Rx LFPS t_{Repeat} Test

Availability Condition

This test is available for all Spec Versions: 3.0, 3.1, and 3.2.

Purpose and Method

This procedure determines whether the DUT responds to LFPS signals with different t_{Repeat} values.

The data generator sends LFPS signals while varying the t_{Repeat} value at each test step. Each step is considered as passed if the DUT sends the TSEQ pattern upon detecting the LFPS signal. The test passes if the DUT responds to LFPS signals with a t_{Repeat} between 6 µs and 14 µs.

Connection Diagrams

Please refer to Figure 69 to Figure 74, depending on the DUT type, Connector, and Test Method.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator and Ch2 of the oscilloscope.**

Parameters in Expert Mode

Script Variation

- LFPS Loop Count
- Number of Idle

Specification

- t_{Period}
- t_{Burst}
- Differential Voltage
- Duty Cycle

t_{Repeat} Variation

- Start t_{Repeat}
- Stop t_{Repeat}
- t_{Repeat} Step Size

For more details of the parameters, please refer to Table 7.

Prerequisite Calibrations

- 5G LFPS Voltage Calibration

Result Description

Rx1_5G_LFPS_tRep

for USB3.2 Device with Type-C Connector

----General----	
Offline	True
Send TSEQ after LFPS	True
Trigger Delay after LFPS	150 us
Trigger Threshold Level	100 mV
Specification	Electrical Compliance Test Specification Enhanced Su
Test Properties:	
----Specification----	
tPeriod	50 ns
tBurst	1 us
Differential Voltage	800 mV
Duty Cycle	50 %
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----Script Variation----	
LFPS Loopcount	16
Number of Idle	5
----tRepeat Variation----	
Start tRepeat	2 us
Stop tRepeat	18 us
tRepeat Step Size	2 us
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Loopback Training----	
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	50 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3\Settings\M8040
Force Retraining	True
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loopbandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	tRepeat [us]	Min Spec [us]	Max Spec [us]	Comment
pass	2	6	12	Below min spec (6 us). Does not affect the overall test result.
pass	4	6	12	Below min spec (6 us). Does not affect the overall test result.
pass	6	6	12	Within spec range. Affects the overall test result.
pass	8	6	12	Within spec range. Affects the overall test result.
pass	10	6	12	Within spec range. Affects the overall test result.
pass	12	6	12	Within spec range. Affects the overall test result.
pass	14	6	12	Above max spec (12 us). Does not affect the overall test result.
pass	16	6	12	Above max spec (12 us). Does not affect the overall test result.
pass	18	6	12	Above max spec (12 us). Does not affect the overall test result.

Figure 78 Example result for 5G Rx LFPS t_{Repeat} test

- **Result**: (Pass / Fail), if the DUT responds correctly to the LFPS, the value is “Pass” otherwise “Fail”.
- **tRepeat [µs]**: The t_{Repeat} value applied to the test signal at each step.
- **Min Spec [µs]**: The minimum t_{Repeat} allowed by the specifications.
- **Max Spec [µs]**: The maximum t_{Repeat} allowed by the specifications.

10G (Gen1x2) Rx Tests

This section is only available for spec 3.2 and when the gen1 multi-lane operation is selected (“10 Gb/s (Gen 1x2)” option in the Configure DUT dialog).

In this section, the test procedures are organized into two different groups:

- Long Channel Tests
- Short Channel Tests

For any x2 Rx test, both lane 1 (config lane) and lane 2 (non-config lane) are tested in parallel.

NOTE The user can decide which lane is lane 1 (config lane) and which lane is lane 2 (non-config lane) in Configure DUT > Test Parameters > BERT Channel Configuration.

Common Parameters That Are Data Rate Specific

Loopback Training

- CDR during Loopback Training
- LFPS Idle
- LFPS Trigger Threshold
- Loopback Training Method
- Warm Reset / Power On Reset Link Training Suite Settings File
- Non Config Warm Reset / Power On Reset Link Training Suite Settings File

Error Detector

- CDR Symbol Rate
- CDR Loop Bandwidth
- CDR Transition Density
- The 2nd Order CDR Loop Setting
- Analyzer CTLE
- Input Sensitivity
- Auto-align Timeout
- Error Detector Operation Mode
- Input Polarity inverted

Refer to Table 5 on page 44 for the description of the mentioned parameters.

Long Channel Tests

Common Parameters That Are Channel Specific

Loopback Training

- Use Voltage Settings from Rx Tests for Loopback Training
- Training Voltage for Loopback Training

Instrument Channels

- J-BERT Generator
- J-BERT Generator non config lane
- J-BERT Error Detector
- J-BERT Error Detector non config lane

Refer to Table 5 on page 44 for the description of the mentioned parameters.

5Gx2 Rx Long Channel Compliance Test

Availability Condition

This test is available for Spec Version: 3.2.

Purpose and Method

This test determines if the DUT meets the receiver Compliance Test Specification (long channel).

The procedure measures the number of symbol errors when all jitter types and the eye height are set to their specification limit values (maximum for jitter, minimum for eye height). This is done for several predefined jitter frequencies.

For this measurement, it is necessary to train the DUT into loopback mode. To achieve that, the data generator sends a training sequence to the DUT. The training sequence is generated based on the Loopback Training parameter settings, such as, PowerOnReset or WarmReset.

The loopback training must be performed with the same physical stress parameters as the measurements. This allows the DUT receiver to optimize its equalizer for the test signal during loopback training.

Connection Diagram

Please refer to Figure 79 to Figure 82, depending on the DUT type and Test Method.

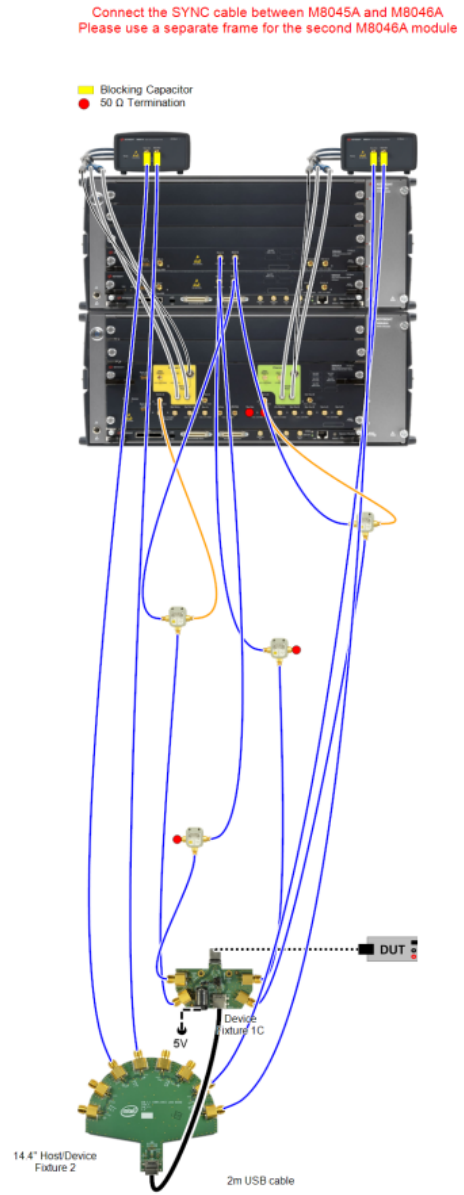


Figure 79 For 5Gx2 Rx1 long channel tests (device - type-C)

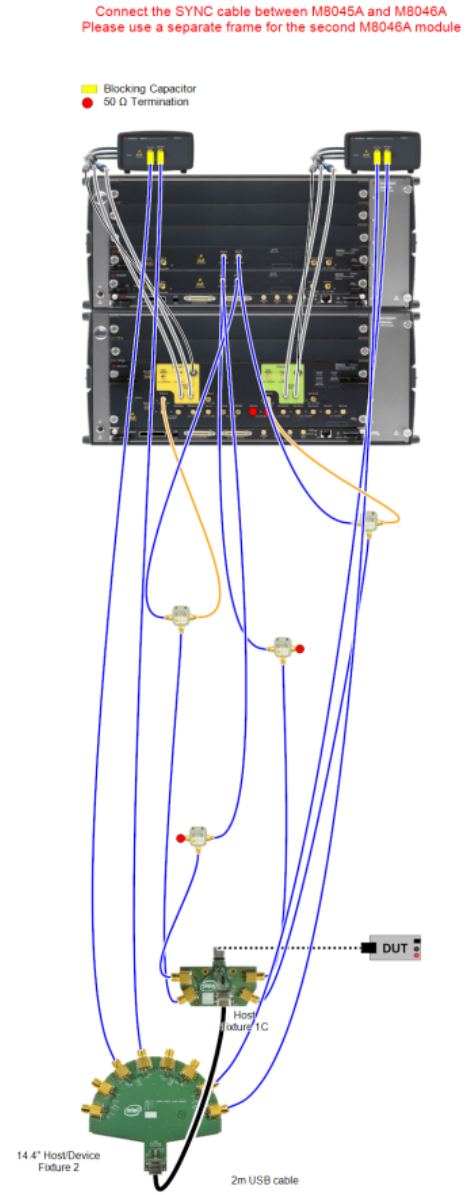


Figure 80 For 5Gx2 Rx1 long channel tests (host - type-C)

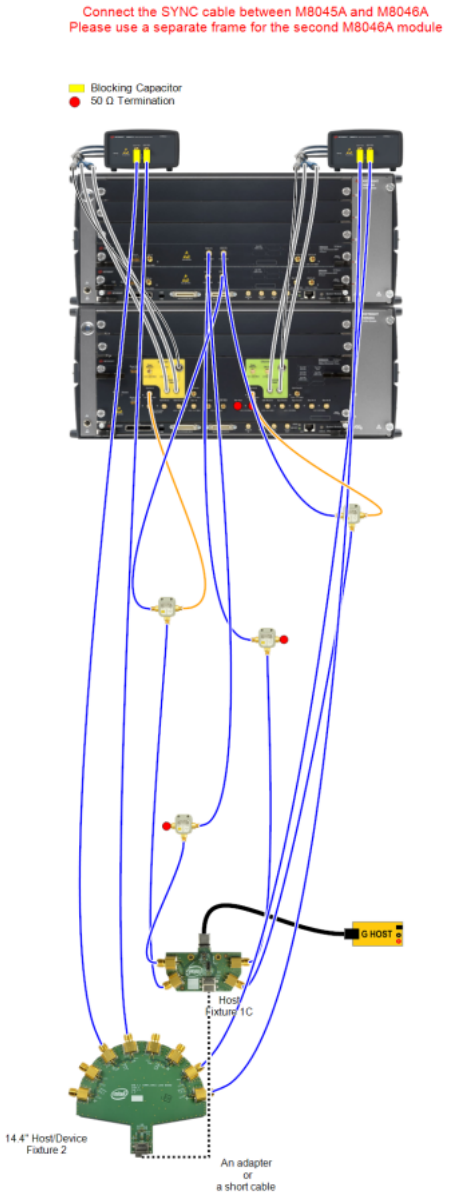


Figure 81 For 5Gx2 Rx1 long channel tests (active cable - golden host)

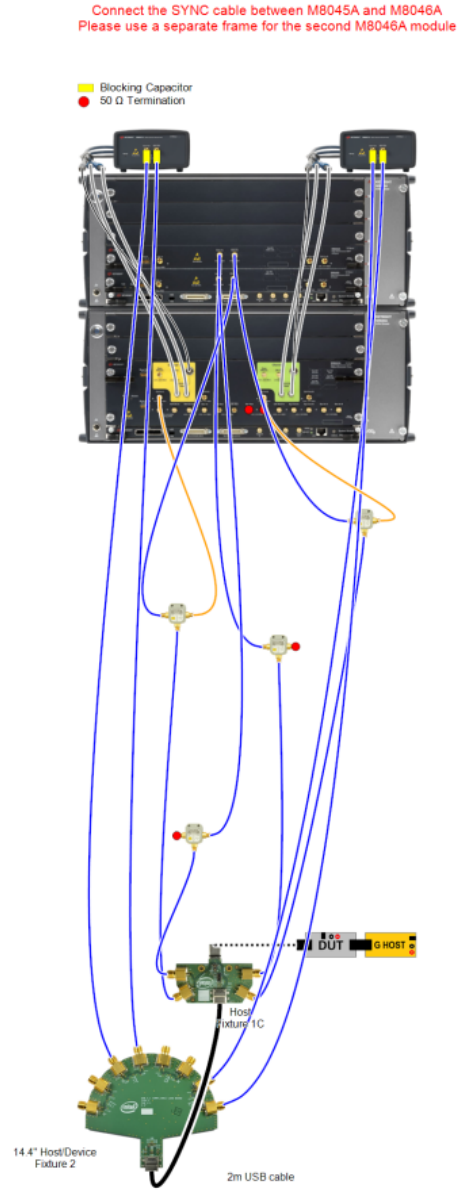


Figure 82 For 5Gx2 Rx1 long channel tests (retimer - golden host)

Parameters in Expert Mode

Specification

- Differential Voltage
- Random Jitter

Loopback Training

- Retrain at each Jitter Frequency
- Train with Jitter

BER Setup

- Target BER
- BER Test Duration
- Allowed Errors
- PJ Frequencies for Test
- Relax Time for BER Measurement

Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

Prerequisite Calibrations

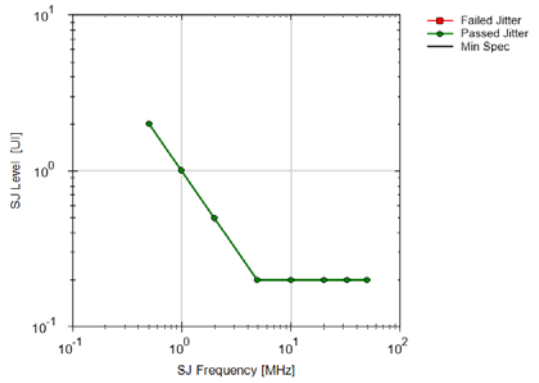
- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description

Two pages of results are produced, one for the configured channel and one for the non-configured channel. Only one is shown here.

Rx_5Gx2_Comp_ConfigLane

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
----Specification----	
Differential Voltage	800 mV
Random Jitter	170 mUI
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----BER Setup----	
Target BER	100E-12
BER Test Duration	6 s
Allowed Errors	1
Relax time for BER Measurement	5 s
----Loopback Training----	
Retrain at each jitter frequency	False
Train with Jitter	True
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
Loopback Training Method	WarmReset
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_Doubled5G_WarmReset.txt
Force Retraining	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Generator non config lane	M1.DataOut2
J-BERT Error Detector	M2.DataIn
J-BERT Error Detector non config lane	M4.DataIn
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loop bandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	SJ Frequency [MHz]	Failed Jitter [UI]	Passed Jitter [UI]	Min Spec [UI]	Symbol Errors
pass	50.000		0.20	0.20	0
pass	33.000		0.20	0.20	0
pass	20.000		0.20	0.20	0
pass	10.000		0.20	0.20	0
pass	4.900		0.20	0.20	0
pass	2.000		0.50	0.50	0
pass	1.000		1.00	1.00	0
pass	0.500		2.00	2.00	0

Figure 83 Example result for 5Gx2 Rx compliance test (long channel)

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Failed Jitter [UI]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Passed Jitter [UI]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [UI]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Symbol Errors**: Number of errors during the test.

5Gx2 Rx Long Channel Constant Parameter Stress Test

This procedure is similar to the 5G Rx Constant Parameter Stress Test / 138, except that two reports will be produced, one for each lane, and the Connection Diagram is given by Figure 79 to Figure 82, depending on the DUT Type and Test Method.

5Gx2 Rx Long Channel Jitter Tolerance Test

This procedure is similar to the 5G Rx Jitter Tolerance Test / 141, with the exception that two reports will be produced, one for the configured lane (config lane) and one for the non-configured lane (non config lane). The procedure used to characterize the lanes is displayed in Table 8.

Test result: Pass/Fail. Pass if both lanes pass. Fail if either lane fails (or both lanes fail).

Table 8 Jitter tolerance test procedure for double data rates (two lanes tested in parallel)

Result	Procedure for Config Lane	Procedure for Non Config Lane
Loss of synchrony on one lane (retrain it)	Goes to next frequency	Goes to next frequency
Errors on just one lane	Jitter is increased	Jitter is increased
Errors on both lanes	Goes to next frequency	Goes to next frequency
No errors	Jitter is increased	Jitter is increased

5Gx2 Rx Long Channel Sensitivity Test

This procedure is similar to the 5G Rx Sensitivity Test / 145, except that two reports will be produced, one for each lane, and the Connection Diagram is given by Figure 79 to Figure 82, depending on the DUT Type and Test Method.

Short Channel Tests

The list of tests for Short Channel is the same as that for Long Channel. The procedures behave in the same manner. The only differences are the connection setups and that the differential voltage amplitude of the signal is set to 1.2 V instead of 800 mV.

NOTE Short channel tests should be run at the maximum differential voltage, 1.2 V, to stress the DUT. The default value is kept as 800 mV to avoid accidental damage to DUTs that cannot support such a high voltage. You can manually adjust this value yourself.

Common Parameters That Are Channel Specific

Loopback Training

- Short Channel Differential Voltage for Loopback Training

Instrument Channels

- J-BERT Generator
- J-BERT Generator non config lane
- J-BERT Error Detector
- J-BERT Error Detector non config lane

Refer to Table 5 on page 44 for the description of the mentioned parameters.

5Gx2 Rx Short Channel Compliance Test

Availability Condition

This test is available for Spec Version: 3.2.

Purpose and Method

This test determines if the DUT meets the receiver Compliance Test Specification (short channel).

The procedure measures the number of symbol errors when all jitter types and the eye height are set to their specification limit values (maximum for jitter, minimum for eye height). This is done for several predefined jitter frequencies.

For this measurement, it is necessary to train the DUT into loopback mode. To achieve that, the data generator sends a training sequence to the DUT. The training sequence is generated based on the Loopback Training parameter settings, such as, PowerOnReset or WarmReset.

The loopback training must be performed with the same physical stress parameters as the measurements. This allows the DUT receiver to optimize its equalizer for the test signal during loopback training.

Connection Diagram

Please refer to Figure 84 to Figure 87, depending on the DUT type and Test Method.

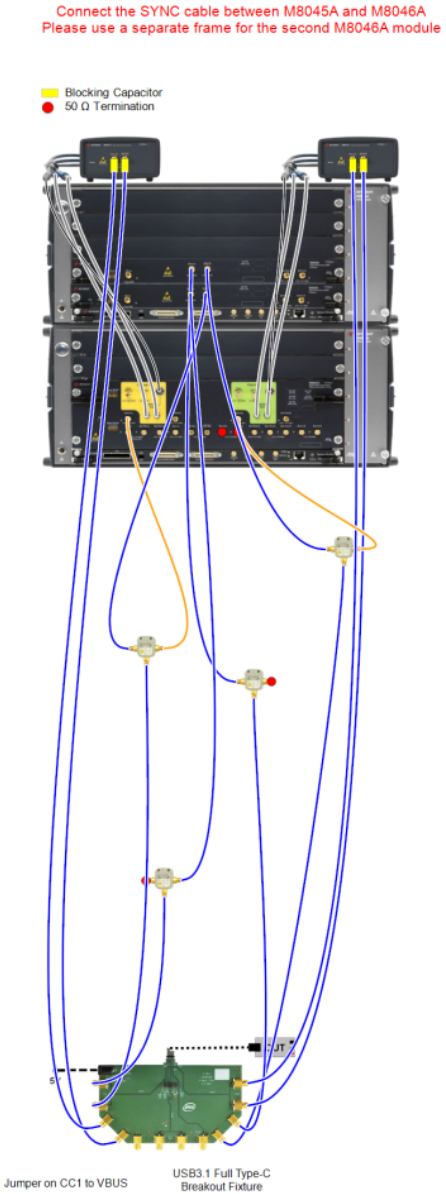


Figure 84 For 5Gx2 Rx1 short channel tests (device - type-C)

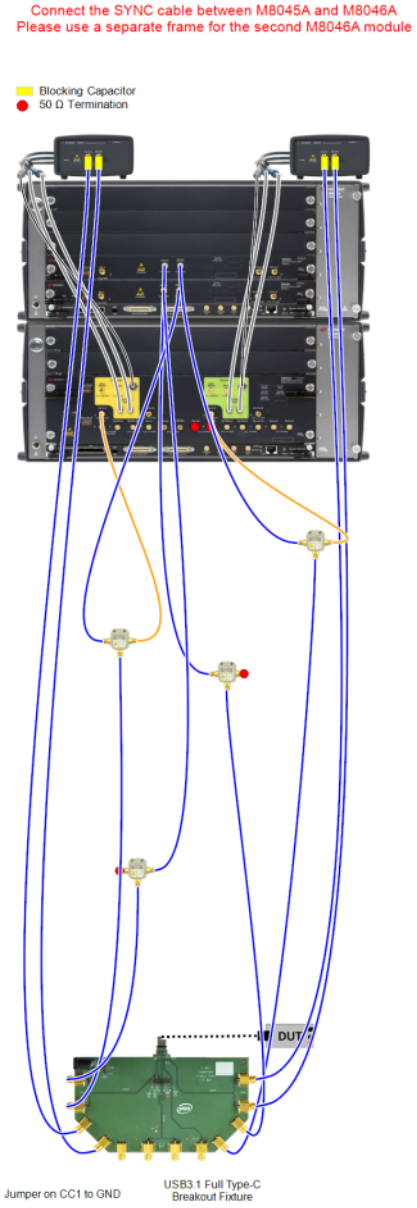


Figure 85 For 5Gx2 Rx1 short channel tests (host - type-C)

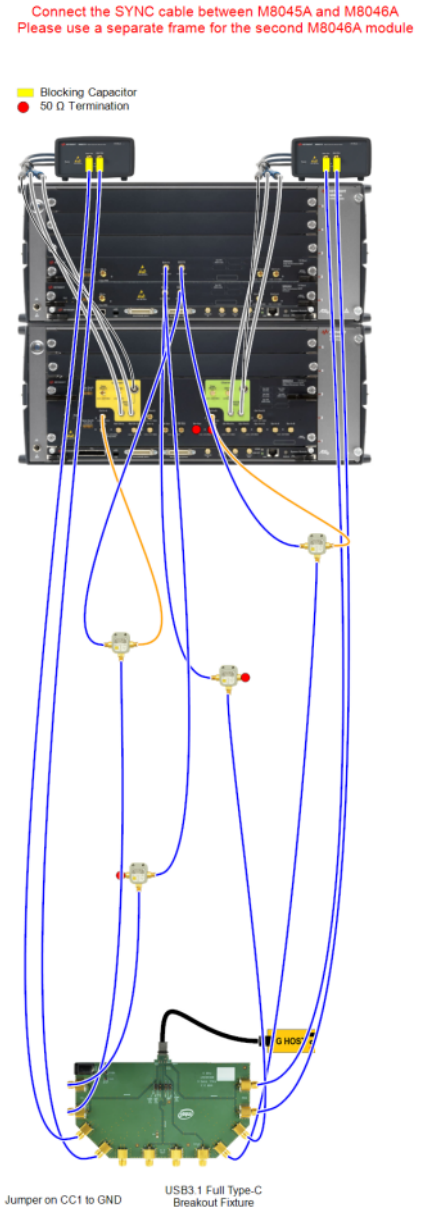


Figure 86 For 5Gx2 Rx1 short channel tests (active cable - golden Host)

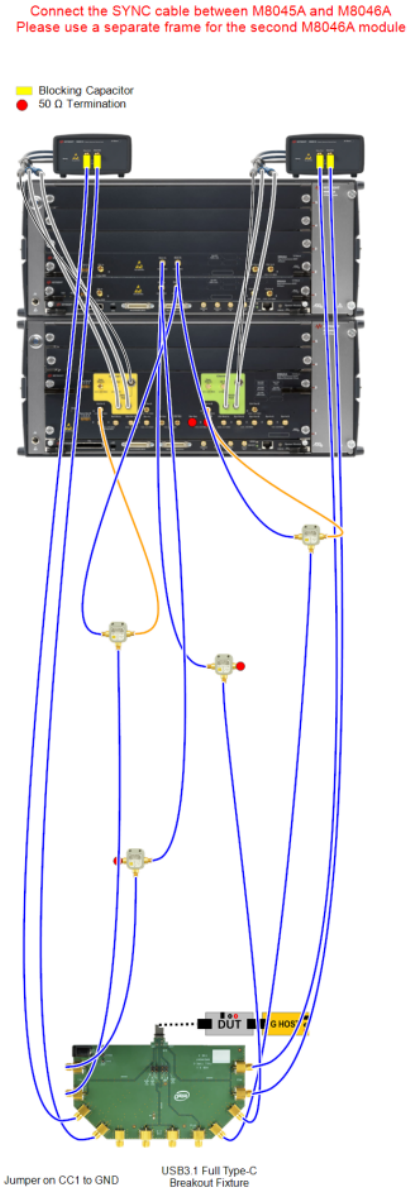


Figure 87 For 5Gx2 Rx1 short channel tests (retimer - golden host)

Parameters in Expert Mode

Specification

- Differential Voltage
- Random Jitter

Loopback Training

- Retrain at each jitter frequency
- Train with Jitter

BER Setup

- Target BER
- BER Test Duration
- Allowed Errors
- PJ Frequencies for Test
- Relax time for BER Measurement

Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

Prerequisite Calibrations

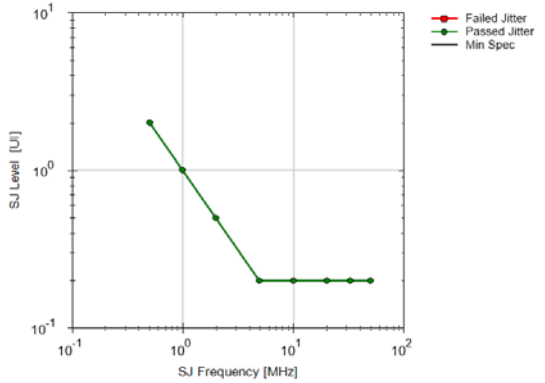
- All 5G calibrations except the 5G LFPS Voltage Calibration.

Result Description (similar to that for Long Channel tests)

Two pages of results are produced, one for the configured channel and one for the non-configured channel. Only one is shown here.

Rx_5Gx2_Comp_ConfigLane

for USB3.2 Device with Type-C Connector



----General----	
Offline	True
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
----Specification----	
Differential Voltage	1.2 V
Random Jitter	170 mUI
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----BER Setup----	
Target BER	100E-12
BER Test Duration	6 s
Allowed Errors	1
Relax time for BER Measurement	5 s
----Loopback Training----	
Retrain at each jitter frequency	False
Train with Jitter	True
Short Channel Differential Voltage for Loopback Training	800 mV
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
Loopback Training Method	WarmReset
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameX1\USB3 \Settings\M8040A\M8040A_USB32_Doubled5G_WarmReset.txt
Force Retraining	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Generator non config lane	M1.DataOut2
J-BERT Error Detector	M2.DataIn
J-BERT Error Detector non config lane	M4.DataIn
----Error Detector----	
CDR symbol rate	4.9875 GBit/s
CDR Loop bandwidth	9.9 MHz
CDR Transition Density	61.2 %
CDR Peaking	1 dB
Analyzer CTLE	65
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	SJ Frequency [MHz]	Failed Jitter [UI]	Passed Jitter [UI]	Min Spec [UI]	Symbol Errors
pass	50.000		0.20	0.20	0
pass	33.000		0.20	0.20	0
pass	20.000		0.20	0.20	0
pass	10.000		0.20	0.20	0
pass	4.900		0.20	0.20	0
pass	2.000		0.50	0.50	0
pass	1.000		1.00	1.00	0
pass	0.500		2.00	2.00	0

Figure 88 Example result for 5Gx2 Rx compliance test (short channel)

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Failed Jitter [UI]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Passed Jitter [UI]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [UI]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Symbol Errors**: Number of errors during the test.

5Gx2 Rx Short Channel Constant Parameter Stress Test

This procedure is similar to the 5G Rx Constant Parameter Stress Test / 138, except that two reports will be produced, one for each lane, and the Connection Diagram is given by Figure 84 to Figure 87, depending on the DUT Type and Test Method.

5Gx2 Rx Short Channel Jitter Tolerance Test

This procedure is similar to the 5G Rx Jitter Tolerance Test / 141, except that two reports will be produced, one for each lane (refer to 5Gx2 Rx Long Channel Jitter Tolerance Test / 205), and the Connection Diagram is given by Figure 84 to Figure 87, depending on the DUT Type and Test Method.

5Gx2 Rx Short Channel Sensitivity Test

This procedure is similar to the 5G Rx Sensitivity Test / 145, except that two reports will be produced, one for each lane, and the Connection Diagram is given by Figure 84 to Figure 87, depending on the DUT Type and Test Method.

10G (Gen2x1) Rx Tests

In this section, the test procedures are organized in two different groups:

- Long Channel Tests
- Short Channel Tests

For connectors Type-C and Tethered Type-C, the receiver tests are duplicated for each lane. The abbreviations Rx1 and Rx2 are added to each procedure name in the software, meaning Lane 1 and Lane 2, respectively.

NOTE **Both lanes must be tested for a valid compliance test.**

Common Parameters That Are Data Rate Specific

Loopback Training

- CDR during Loopback Training
- LFPS Idle
- LFPS Trigger Threshold
- Loopback Training Method
- Warm Reset / Power On Reset Link Training Suite Settings File
- Use Instrument Scrambler

Error Detector

- CDR Symbol Rate
- CDR Loop Bandwidth
- CDR Transition Density
- The 2nd order CDR loop setting
- Analyzer CTLE
- Input Sensitivity
- Auto-align Timeout
- Error Detector Operation Mode
- Input Polarity inverted

Refer to Table 5 on page 44 for the description of the mentioned parameters.

Long Channel Tests

Common Parameters That Are Channel Specific

Loopback Training

- Use Voltage Settings from Rx Tests for Loopback Training
- Training Voltage for Loopback Training

Common Parameters That Are Lane Specific

Instrument Channels

- J-BERT Generator
- J-BERT Error Detector

Refer to Table 5 on page 44 for the description of the mentioned parameters.

10G Rx Compliance Test

Availability Condition

This test is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This test determines if the DUT meets the receiver Compliance Test Specification.

The procedure measures the number of symbol errors when all jitter types and the eye height are set to their specification limit values (maximum for jitter, minimum for eye height). This is done for several predefined jitter frequencies.

For this measurement, it is necessary to train the DUT into loopback mode. To achieve that, the data generator sends a training sequence to the DUT. The training sequence is generated based on the Loopback Training parameter settings, such as PowerOnReset or WarmReset.

The loopback training must be performed with the same physical stress parameters as that of the measurements. This allows the DUT receiver to optimize its equalizer for the test signal during loopback training.

Connection Diagram

Refer to Figure 89 to Figure 96, depending on the DUT Type, Connector and Test Method.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator.**

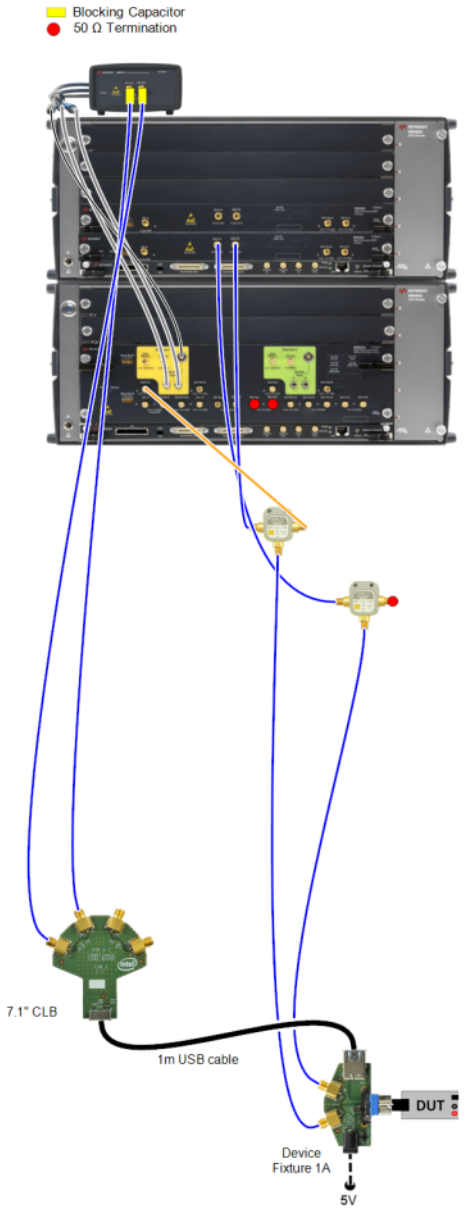


Figure 89 For 10G Rx long channel tests (device - non type-C)

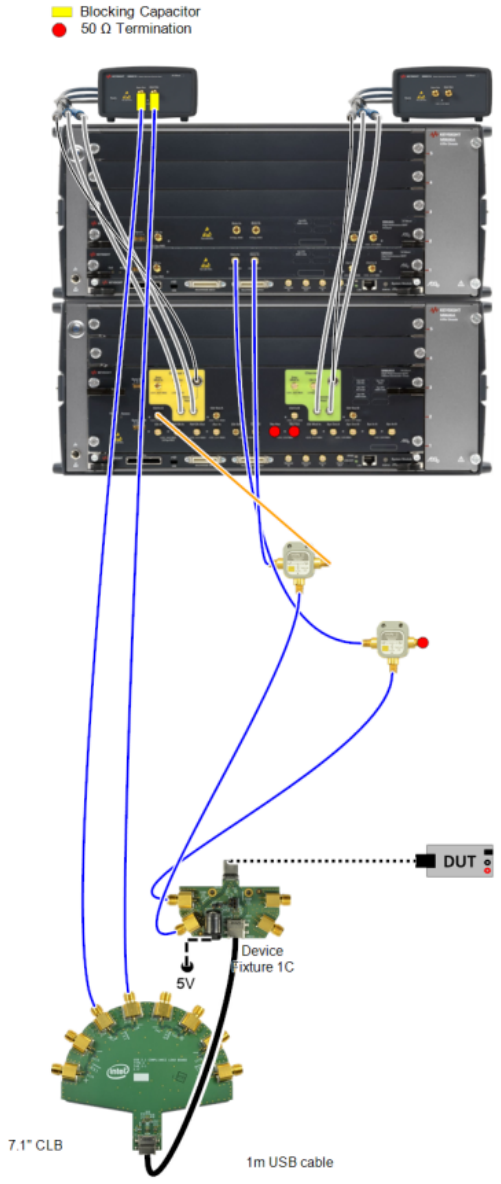


Figure 90 For 10G Rx1 long channel tests (device - type-C)

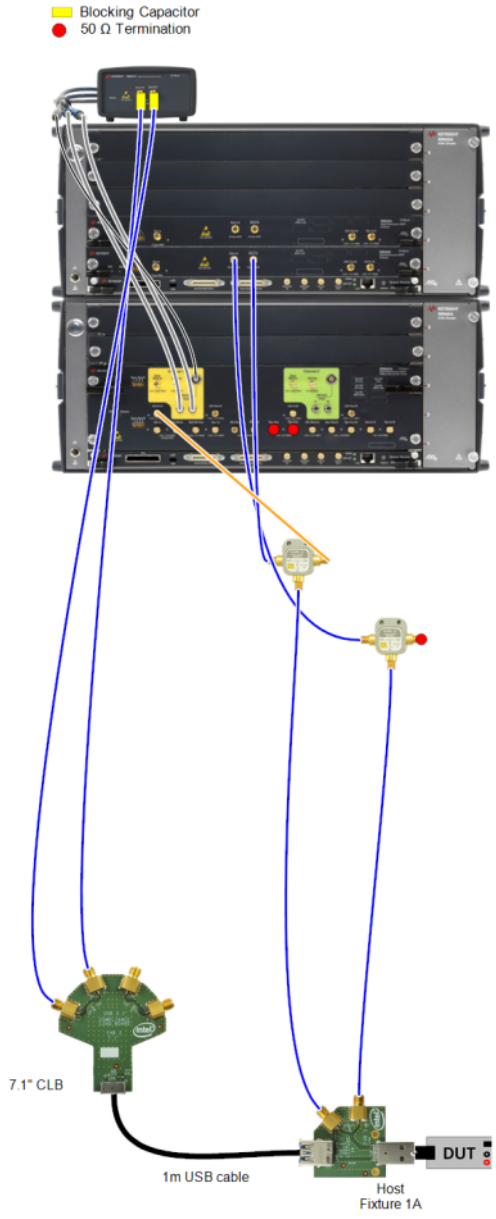


Figure 91 For 10G Rx long channel tests (host - non type-C)

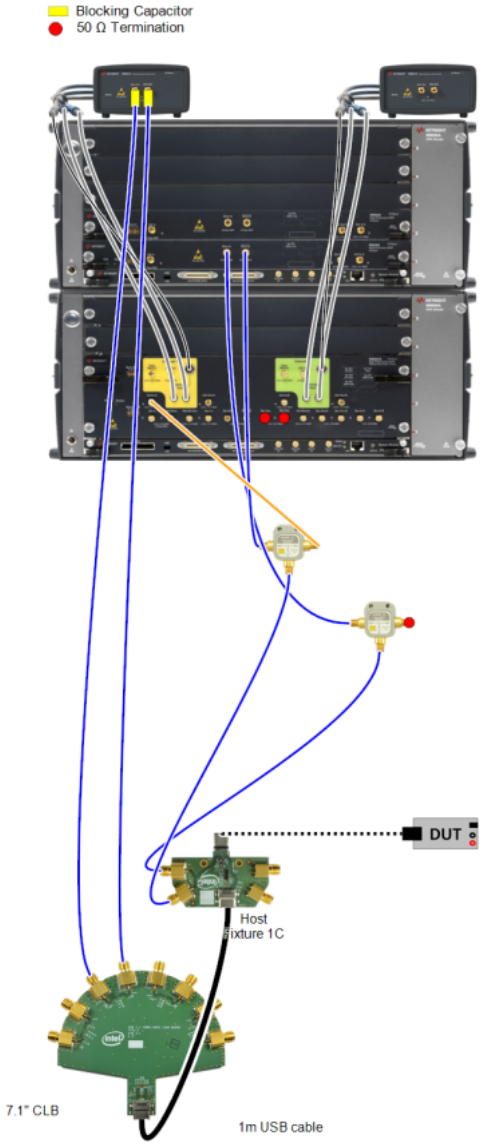


Figure 92 For 10G Rx1 long channel tests (host – type C)

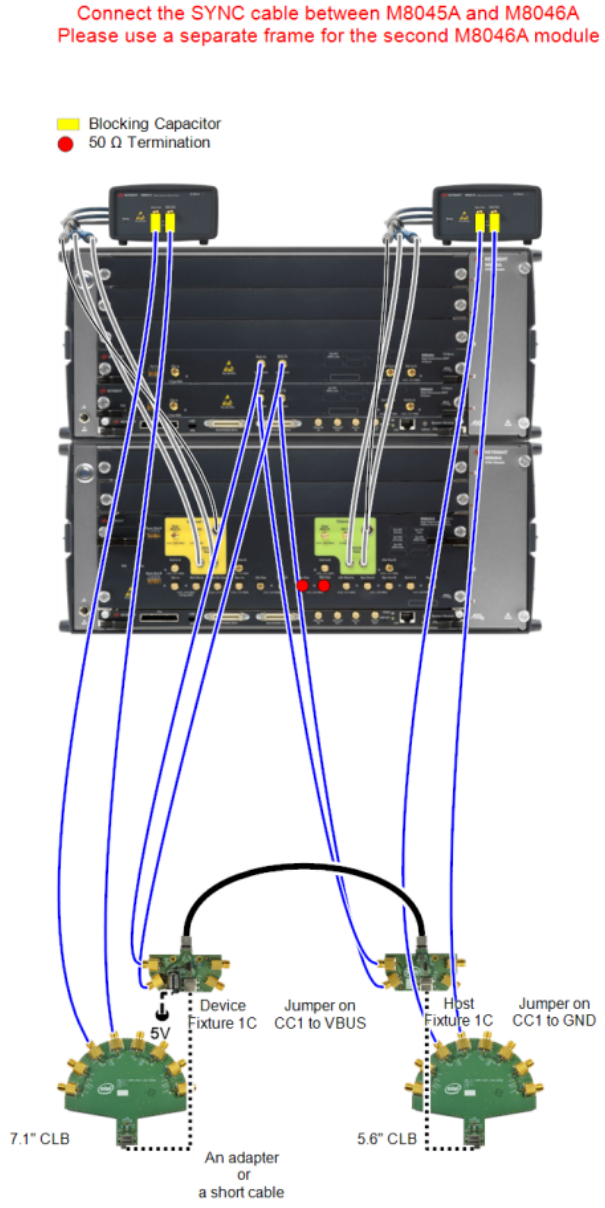


Figure 93 For 10G Rx1 long channel tests (active cable - passthrough)

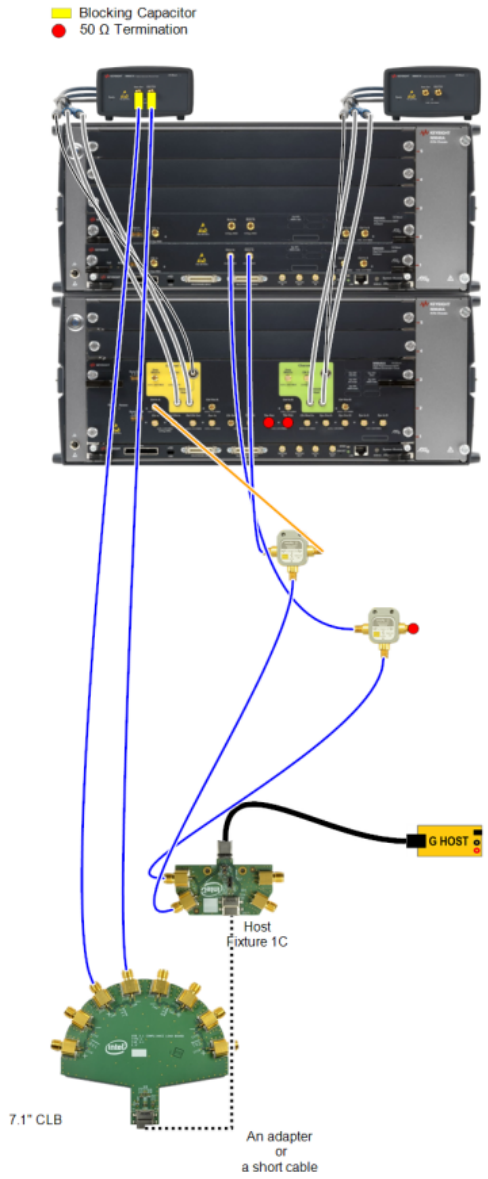


Figure 94 For 10G Rx1 long channel tests (active cable – golden host)

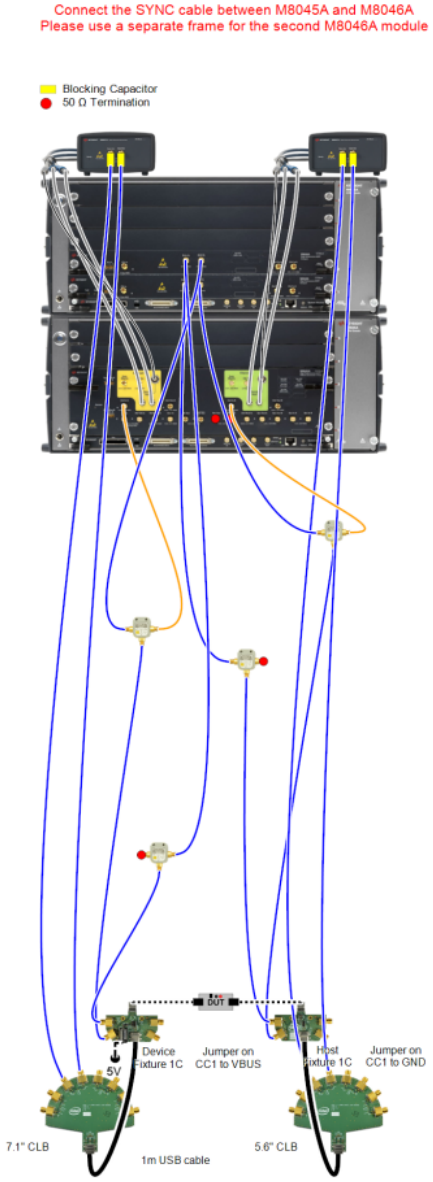


Figure 95 For 10G Rx1 long channel tests (retimer - paasthrough)

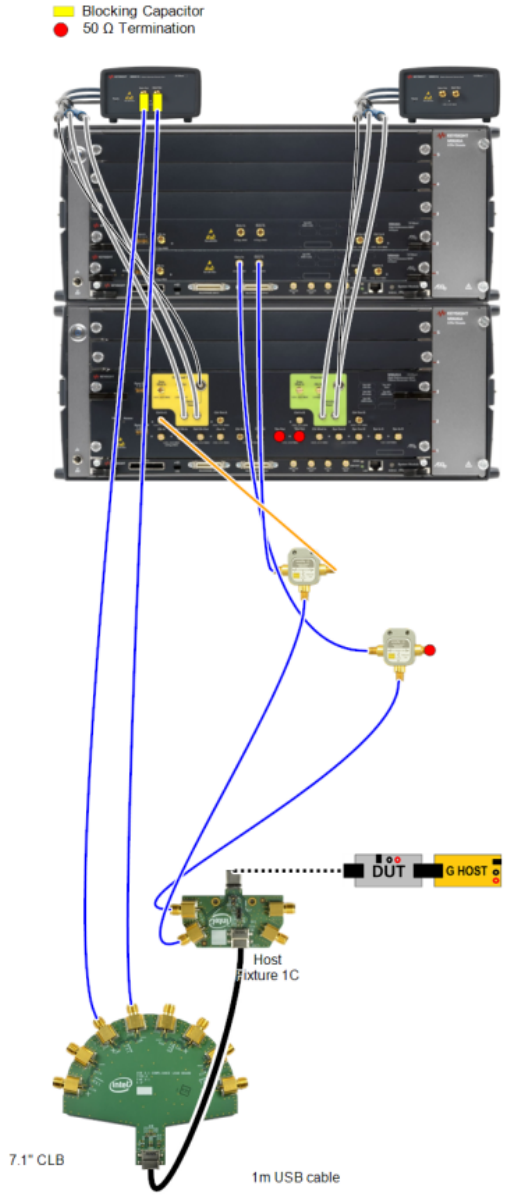


Figure 96 For 10G Rx1 long channel tests (retimer – golden host)

Parameters in Expert Mode

Specification

- Target Eye-Height
- Target Eye-Width
- Eye-Height
- Eye-Width
- Pre-shoot
- De-emphasis
- Differential Voltage
- Random Jitter
- SJ Reduction for Eye-Width Adjustment
- Second Tone SJ for Eye-Width Adjustment

Loopback Training

- Retrain at each jitter frequency
- Train with Jitter

BER Setup

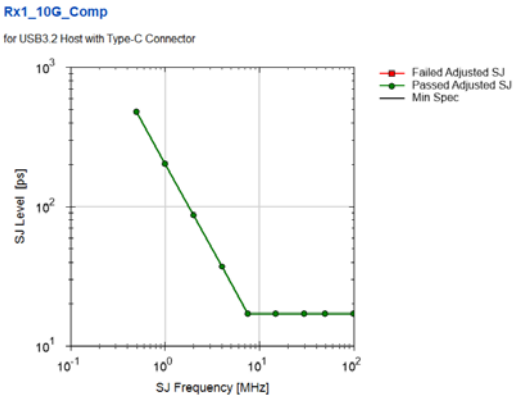
- PJ Frequencies for test
- BER Test Duration
- Allowed Errors
- Relax time for BER Measurement

Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

Prerequisite Calibrations

- All 10G calibrations

Result Description



----General----	
Offline	True
Type-C Fixture	USB_IF
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
CLB Trace Length	7.1
----Specification----	
Eye-Height	70 mV
Eye-Width	48 ps
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Differential Voltage	800 mV
Random Jitter	1 ps
SJ Reduction for Eye-Width Adjustment	0 s
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----BER Setup----	
BER Test Duration	120 s
Allowed Errors	1
Relax time for BER Measurement	5 s
----Loopback Training----	
Retrain at each jitter frequency	False
Train with Jitter	True
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	60 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_10G_PowerOnReset.txt
Use Instrument Scrambler	False
Force Retraining	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Error Detector----	
CDR symbol rate	9.975 GBit/s
CDR Loop bandwidth	15 MHz
CDR Transition Density	60 %
CDR Peaking	1 dB
Analyzer CTLE	0
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	SJ Frequency [MHz]	Failed Adjusted SJ [ps]	Passed Adjusted SJ [ps]	Min Spec [ps]	Nominal SJ [ps]	Errors []
pass	100.000		17.00	17.00	17.00	0
pass	50.000		17.00	17.00	17.00	0
pass	30.000		17.00	17.00	17.00	0
pass	15.000		17.00	17.00	17.00	0
pass	7.500		17.00	17.00	17.00	0
pass	4.000		97.00	97.00	97.00	0
pass	2.000		97.00	97.00	97.00	0
pass	1.000		203.00	203.00	203.00	0
pass	0.500		476.00	476.00	476.00	0

Figure 97 Example result for 10G Rx compliance test (long channel)

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Failed Adjusted SJ [ps]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Passed Adjusted SJ [ps]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [ps]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Nominal SJ [ps]**: Sinusoidal jitter amplitude at the frequency specified that is set to achieve the target eye-width.
- **Errors**: Number of errors during the test.

10G Rx Constant Parameter Stress Test

Availability Condition

This test is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This test determines if the DUT meets the receiver specifications for a specific jitter frequency.

The procedure is similar to 10G Rx Compliance Test but it measures the number of symbol errors at a single sinusoidal jitter frequency (by default, this frequency is set to 4.9 MHz).

Note that this procedure is not categorized as a compliance test.

Connection Diagram

Please refer to Figure 89 to Figure 96, depending on the DUT type, Connector, and Test Method.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator.**

Parameters in Expert Mode

Specification

- Pre-Shoot
- De-Emphasis
- Differential Voltage
- Random Jitter
- Nominal SJ
- Sinusoidal Jitter Frequency
- SJ Reduction for Eye-Width Adjustment
- Second Tone SJ for Eye-Width Adjustment
- Adjusted SJ

Loopback Training

- Train with Jitter

BER Setup

- BER Test Duration
- Allowed Errors
- Relax Time for BER Measurement

For more details about the parameters, please refer to Table 7.

Prerequisite Calibrations

- All 10G calibrations

Result Description

Rx1_10G_ConstStress

for USB3.2 Host with Type-C Connector

----General----	
Offline	True
Type-C Fixture	USB_IF
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
CLB Trace Length	7.1
----Specification----	
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Differential Voltage	800 mV
Random Jitter	1 ps
Nominal SJ	17 ps
Sinusoidal Jitter Frequency	100 MHz
SJ Reduction for Eye-Width Adjustment	0 s
Second Tone SJ for Eye-Width Adjustment	0 s
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----Sequencer----	
Enable multiple test runs	False
----Loopback Training----	
Train with Jitter	True
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	50 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_10G_PowerOnReset.txt
Use Instrument Scrambler	False
Force Retraining	True
----BER Setup----	
BER Test Duration	120 s
Allowed Errors	1
Relax time for BER Measurement	5 s
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Error Detector----	
CDR symbol rate	9.975 GBit/s
CDR Loop bandwidth	15 MHz
CDR Transition Density	50 %
CDR Peaking	1 dB
Analyzer CTLE	0
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	Pre-Shoot [dB]	De-Emphasis [dB]	Differential Voltage [mV]	Random Jitter [ps]	Nominal SJ [ps]	SJ Frequency [MHz]	Adjusted SJ [ps]	Second Tone SJ [ps]	Errors []
pass	2.20	-3.10	800.0	1.00	17.00	100.00	17.00	0.00	0

Figure 98 Example result for 10G Rx1 constant parameter stress test (long channel)

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **Pre-Shoot [dB]**: The pre-shoot value of the tested signal.
- **De-Emphasis [dB]**: The de-emphasis value of the tested signal.
- **Differential Voltage [mV]**: The differential voltage amplitude of the tested signal.
- **Random Jitter [ps]**: The amount of random jitter added to the signal.
- **Nominal SJ [ps]**: Sinusoidal jitter amplitude at the frequency specified that is set to achieve the target eye-width.
- **SJ Frequency [MHz]**: The frequency of the sinusoidal jitter component.
- **Adjusted SJ [ps]**: The amount of SJ added to the signal.
- **Second Tone SJ [ps]**: The SJ amplitude of the second tone component.
- **Errors**: The number of errors during the measurement.

10G Rx Jitter Tolerance Test

Availability Condition

This test is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This test characterizes how much jitter a DUT can tolerate at different sinusoidal jitter frequencies.

For each sinusoidal jitter frequency, the jitter amplitude is increased in equally-spaced steps until the measured bit-error rate is larger than the value set for “Target BER”.

Note that this receiver test is not categorized as a compliance test.

Connection Diagram

Please refer to Figure 89 to Figure 96, depending on the DUT type, Connector, and Test Method.

NOTE For lane 2 the setup is the same but using the second channel of the data generator.

Parameters in Expert Mode

Specification

- Target Eye-Height
- Target Eye-Width
- Eye-Height
- Eye-Width
- Pre-Shoot
- De-Emphasis
- Differential Voltage
- Random Jitter
- SJ Reduction for Eye-Width Adjustment
- Second Tone SJ for Eye-Width Adjustment

Loopback Training

- Train with Jitter
- Force retraining on each frequency

Sinusoidal Jitter Variation

- Frequency Mode

If Compliance Frequencies, User Defined Frequencies or Single Frequency are selected:

  - Jitter frequencies

If Equally Spaced Frequencies is selected:

  - Start frequency value
  - Stop frequency value
  - Number of Frequency Steps
  - Frequency sweep scale

- Start jitter amplitude
- Use fixed number of steps
  - Number of jitter steps
  - Jitter step size or factor
- Show Min Failed Points

BER Setup

- Target BER
- Relax Time for BER Measurement
- Allowed Errors

Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

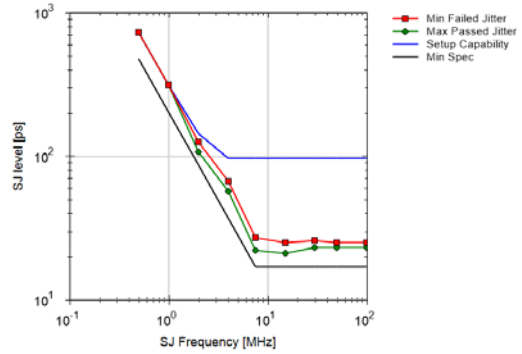
Prerequisite Calibrations

- All 10G calibrations

Result Description

Rx1_10G_JTol

for USB3.2 Host with Type-C Connector



----General----	
Offline	True
Type-C Fixture	USB_IF
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
CLB Trace Length	7.1
----Specification----	
Eye-Height	70 mV
Eye-Width	48 ps
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Differential Voltage	800 mV
Random Jitter	1 ps
SJ Reduction for Eye-Width Adjustment	0 s
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----Sinusoidal Jitter Variation----	
Frequency mode	Compliance Frequencies
Use fixed number of steps	False
Show min failed points	True
----Loopback Training----	
Train with Jitter	False
Force retraining on each frequency	False
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	50 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3\Settings\M8040A\M8040A_USB32_10G_PowerOnReset.txt
Use Instrument Scrambler	False
Force Retraining	True
----BER Setup----	
Target BER	100E-12
Relax time for BER Measurement	1 s
Allowed Errors	1
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Error Detector----	
CDR symbol rate	9.975 GBit/s
CDR Loop bandwidth	16 MHz
CDR Transition Density	50 %
CDR Peaking	1 dB
Analyzer CTLE	0
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual
----Instruments----	
Measurement Instrument 1	Name: Keysight M8040A J-BERT ; Company: Keysight Technologies ; Model: Keysight M8040A J-BERT ; SN: Unknown ; FW rev.: Unknown ; Description: M8040 with integrated jitter sources for BER tests ; Measurement Instrument

Result	SJ Frequency [MHz]	Min Failed Jitter [ps]	Max Passed Jitter [ps]	Setup Capability [ps]	Min Spec [ps]	Margin [%]
pass	0.50	728.00	728.00	728.0	476.00	52.9
pass	1.00	314.00	314.00	314.0	202.86	54.8
pass	2.00	125.50	107.00	144.0	86.45	23.8
pass	4.00	67.00	57.00	96.0	36.84	54.7
pass	7.50	27.00	22.00	96.0	17.00	29.4
pass	15.00	25.00	21.00	96.0	17.00	23.5
pass	30.00	26.00	23.00	96.0	17.00	35.3
pass	50.00	25.00	23.00	96.0	17.00	35.3
pass	100.00	25.00	23.00	96.0	17.00	35.3

Figure 99 Example result for 10G Rx1 jitter tolerance test (long channel)

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Min Failed Jitter [ps]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Max Passed Jitter [ps]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Setup Capability [ps]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [ps]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Margin [%]**: The margin between the min spec and the test result.

10G Rx Sensitivity Test

Availability Condition

This test is available for Spec Versions: 3.1 and 3.2.

Purpose and Method

This test searches for the minimum eye height that a DUT can tolerate.

The procedure starts with an eye height value of “Start Eye Height” and decreases it with steps of “Step Size” value. The minimum passed value is the last test point that did not return more errors than specified in the “Allowed Errors” parameter. For DUTs that do not support disconnect (incapability to step down and drop out of loopback), it is necessary to train the DUT in every step.

Note that this receiver test is not categorized as a compliance test.

Connection Diagram

Please refer to Figure 89 to Figure 96, depending on the DUT type, Connector, and Test Method.

NOTE **For lane 2 the setup is the same but using the second channel of the data generator.**

Parameters in Expert Mode

Specification

- Pre-Shoot
- De-Emphasis
- Random Jitter
- Nominal SJ
- Sinusoidal Jitter Frequency
- SJ Reduction for Eye-Width Adjustment
- Second Tone SJ for Eye-Width Adjustment
- SCC Deviation
- Adjusted SJ

Loopback Training

- Train with Jitter

Eye Height Variation

- Start Eye Height
- Eye Height Step Size

BER Setup

- Target BER
- Relax Time for BER Measurement

Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

Prerequisite Calibrations

- All 10G calibrations

Result Description

Rx1_10G_Sens

for USB3.2 Host with Type-C Connector

----General----	
Offline	True
Type-C Fixture	USB_IF
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
CLB Trace Length	7.1
----Specification----	
Eye-Height	70 mV
Eye-Width	48 ps
Pre-Shoot	2.2 dB
De-Emphasis	-3.1 dB
Differential Voltage	800 mV
Random Jitter	1 ps
SJ Reduction for Eye-Width Adjustment	0 s
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----Loopback Training----	
Train with Jitter	True
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
LFPS Trigger Threshold	50 mV
Loopback Training Method	PowerOnReset
Power On Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameK1\USB3 \Settings\M8040A\M8040A_USB32_10G_PowerOnReset.txt
Use Instrument Scrambler	False
Force Retraining	True
----BER Setup----	
Target BER	100E-12
Relax time for BER Measurement	1 s
----Eye Height Variation----	
Start Eye Height	70 mV
Eye Height Step Size	2.5 mV
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Error Detector	M2.DataIn
----Error Detector----	
CDR symbol rate	9.975 GBit/s
CDR Loop bandwidth	15 MHz
CDR Transition Density	50 %
CDR Peaking	1 dB
Analyzer CTLE	0
Input Sensitivity	High
Auto-align Timeout	60 s
Error Detector Operation Mode	Differential
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	Min Passed Eye Height [mV]	Min Spec [mV]	Margin [%]
pass	38	70	46.4

Figure 100 Example result for 10G Rx1 sensitivity test (long channel)

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **Min Passed Eye Height [mV]**: The minimum eye height where the tested point passes.
- **Min Spec [mV]**: Minimum eye height that the DUT must tolerate.
- **Margin [%]**: The margin between the min spec and the test result.

Short Channel Rx Tests

The list of tests for Short Channel is the same as that for Long Channel. The procedures behave in the same manner. The only differences are the connections setups and that the differential voltage amplitude of the signal is set to 1.2 V instead of 800 mV.

NOTE Short channel tests should be run at the maximum differential voltage, 1.2 V, to stress the DUT. The default value is kept as 800 mV to avoid accidental damage to DUTs that cannot support such a high voltage. You can manually adjust this value yourself.

Common Parameters That Are Channel Specific

Loopback Training

- Short Channel Differential Voltage for Loopback Training

Common Parameters That Are Lane Specific

Instrument Channels

- J-BERT Generator
- J-BERT Error Detector

Refer to Table 5 on page 44 for the description of the mentioned parameters.

10G Rx Short Channel Compliance Test

This procedure is similar to the 10G Rx Compliance Test / 222. The connection diagrams are the same as in 5G Rx Short Channel Compliance Test / 154.

10G Rx Short Channel Constant Parameter Stress Test

This procedure is similar to the 10G Rx Constant Parameter Stress Test / 234. The connection diagrams are the same as in 5G Rx Short Channel Compliance Test / 154.

10G Rx Short Channel Jitter Tolerance Test

This procedure is similar to the 10G Rx Jitter Tolerance Test / 238. The connection diagrams are the same as for the 5G Rx Short Channel Compliance Test / 154.

10G Rx Short Channel Sensitivity Test

This procedure is similar to the 10G Rx Sensitivity Test / 243. The connection diagrams are the same as for the 5G Rx Short Channel Compliance Test / 154.

20G (Gen2x2) Rx Tests

This section is only available for spec 3.2, for connectors Type-C and Tethered Type-C, and when the gen2 multi-lane operation is selected (20 Gb/s (Gen 2x2) option in the Configure DUT dialog).

In this section, the test procedures are organized into two different groups:

- Long Channel Tests
- Short Channel Tests

For any x2 Rx test, lane 1 (config lane) and lane 2 (non config lane) are tested in parallel.

The result of the tests will depend on the sequencer parameter “Fail if Non Config Lane is failing”. This parameter is set to false by default, which means that the test result only depends on the result of the config lane. However, if it is set to true, the result of both lanes will decide the overall pass/fail (to pass, both lanes must pass, otherwise the test fails).

NOTE **The user can decide which lane is lane 1 (config lane) and which lane is lane 2 (non config lane) in Configure DUT > Test Parameters > BERT Channel Configuration.**

Common Parameters That Are Data Rate Specific

Loopback Training

- CDR during Loopback Training
- LFPS Idle
- LFPS Trigger Threshold
- Loopback Training Method
- Warm Reset / Power On Reset Link Training Suite Settings File
- Use Instrument Scrambler

Error Detector

- CDR Symbol Rate
- CDR Loop Bandwidth
- CDR Transition Density
- The 2nd order CDR loop setting
- Analyzer CTLE
- Input Sensitivity

- Auto-align Timeout
- Error Detector Operation Mode
- Input Polarity inverted

Refer to Table 5 on page 44 for the description of the mentioned parameters.

Long Channel Tests

Common Parameters That Are Channel Specific

Loopback Training

- Use Voltage Settings from Rx Tests for Loopback Training
- Training Voltage for Loopback Training

Instrument Channels

- J-BERT Generator
- J-BERT Generator non config lane
- J-BERT Error Detector
- J-BERT Error Detector non config lane

Refer to Table 5 on page 44 for the description of the mentioned parameters.

10Gx2 Rx Compliance Test

This procedure is similar to the 10G Rx Compliance Test / 222.

Connection Diagram

Refer to Figure 101 to Figure 104, depending on the DUT Type and Test Method.

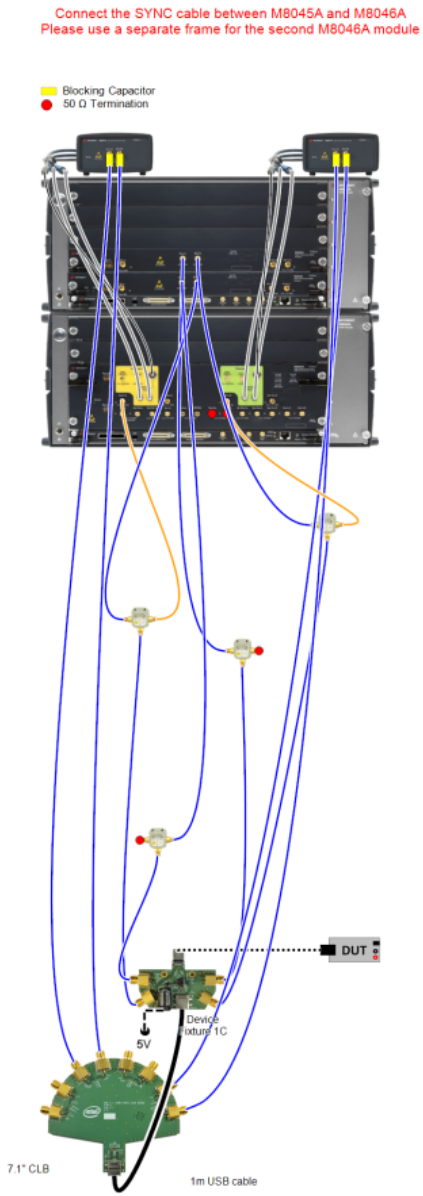


Figure 101 For 10Gx2 Rx long channel tests (device - type-C)

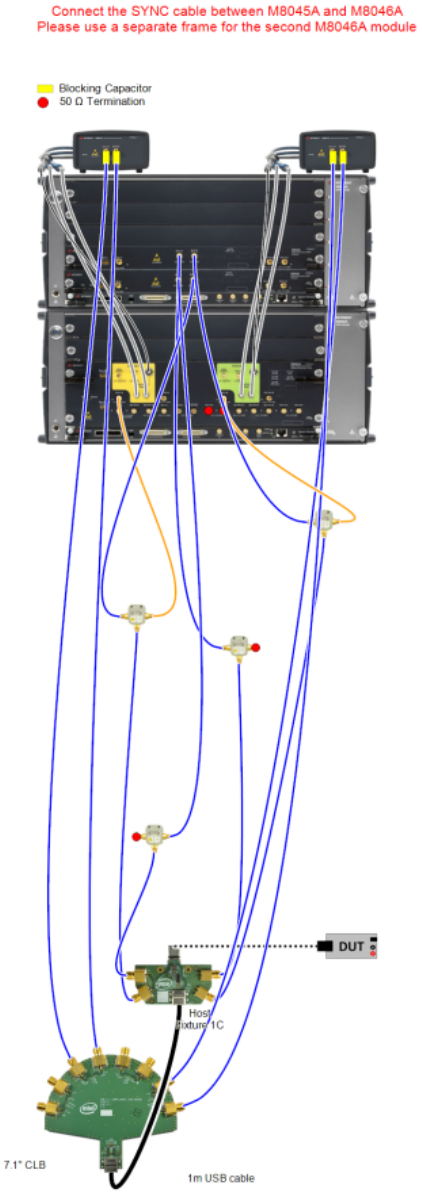


Figure 102 For 10Gx2 Rx long channel tests (host - type-C)

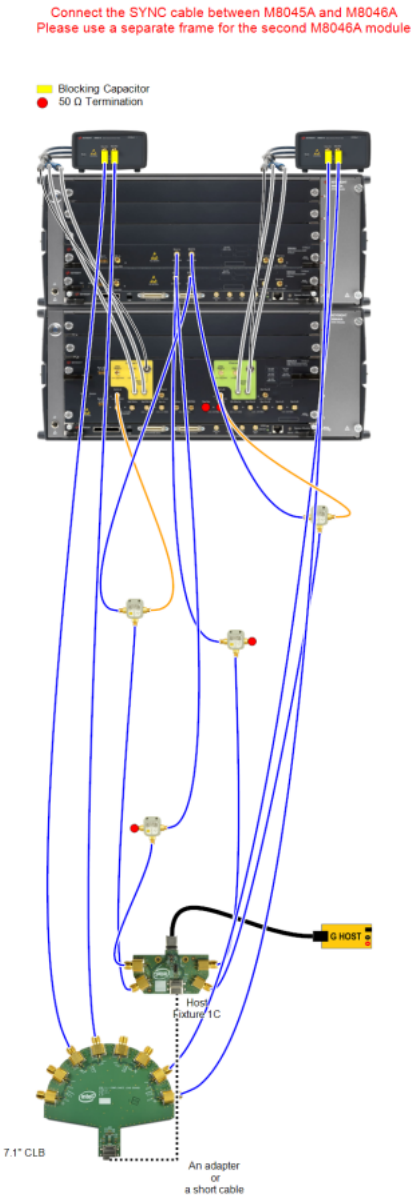


Figure 103 For 10Gx2 Rx long channel tests (active cable - golden host)

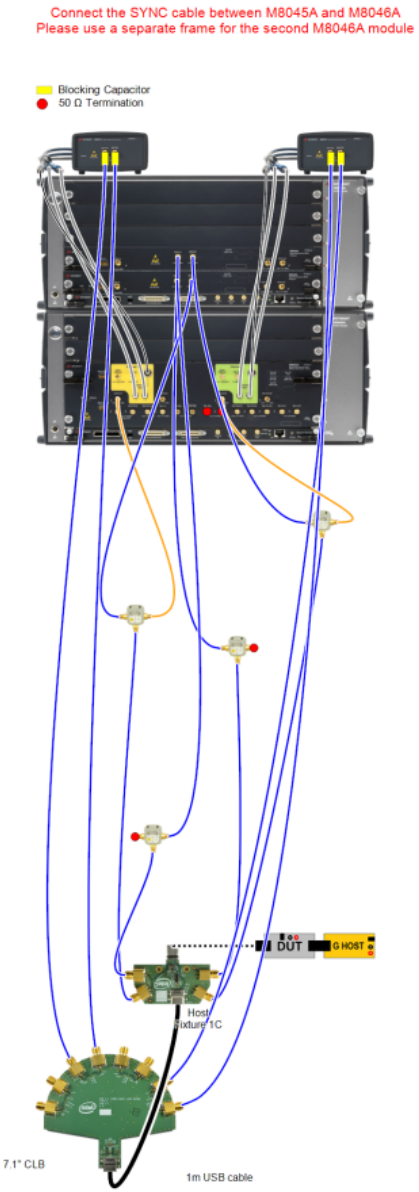


Figure 104 For 10Gx2 Rx long channel tests (retimer - golden host)

Parameters in Expert Mode

Specification

- Target Eye-Height
- Target Eye-Width
- Eye-Height
- Eye-Width
- Eye-Height Complement Lane
- Eye-Width Complement Lane
- Pre-Shoot
- Pre-Shoot Complement Lane
- De-Emphasis
- De-Emphasis Complement Lane
- Differential Voltage
- Differential Voltage Complement Lane
- Random Jitter
- SJ Reduction for Eye-Width Adjustment
- SJ Reduction for Eye-Width Adjustment Complement Lane
- Second Tone SJ for Eye-Width Adjustment
- Second Tone SJ for Eye-Width Adjustment Complement Lane

Loopback Training

- Retrain at each jitter frequency
- Train with Jitter

BER Setup

- PJ Frequencies for test
- BER Test Duration
- Allowed Errors
- Relax time for BER Measurement

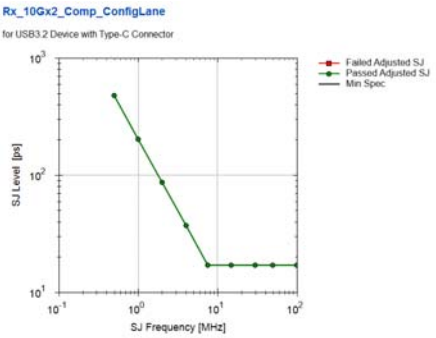
Refer to Table 5 on page 44 and Table 7 on page 47 for the description of the mentioned parameters.

Prerequisite Calibrations

- All 10G calibrations

Result Description

Two pages of results are produced, one for the configured channel and one for the non-configured channel. Only one is shown here.



----General----	
Offline	True
Type-C Fixture	USB_IF
Specification	Electrical Compliance Test Specification Enhanced SuperSpeed USB 1.0
Test Properties:	
CLB Trace Length	6.6
----Specification----	
Eye-Height	71.5 mV
Eye-Width	46.5 ps
Eye-Height Complement Lane	71.5 mV
Eye-Width Complement Lane	46.5 ps
Pre-Shoot	2.2 dB
Pre-Shoot Complement Lane	2.2 dB
De-Emphasis	-1 dB
De-Emphasis Complement Lane	-1 dB
Differential Voltage	800 mV
Differential Voltage Complement Lane	800 mV
Random Jitter	1 ps
SJ Reduction for Eye-Width Adjustment	0 s
SJ Reduction for Eye-Width Adjustment Complement Lane	0 s
SSC Type	Downspread
SSC Deviation	5000 ppm
SSC Frequency	33 kHz
----BER Setup----	
BER Test Duration	120 s
Allowed Errors	1
Relax time for BER Measurement	5 s
----Loopback Training----	
Retrain at each jitter frequency	False
Train with Jitter	True
Use Voltage Settings from Rx Tests for Loopback Training	True
CDR during Loopback Training	False
LFPS Idle	M8040A Idle
Loopback Training Method	WarmReset
Warm Reset Link Training Suite Settings File	C:\ProgramData\BitifEye\ValiFrameM1\USB3 \Settings\M8040A\M8040A_USB32_Doubled100_WarmReset.txt
Use Instrument Scrambler	False
Force Retraining	True
----Instrument Channels----	
J-BERT Generator	M1.DataOut1
J-BERT Generator non config lane	M1.DataOut2
J-BERT Error Detector	M2.DataIn
J-BERT Error Detector non config lane	M4.DataIn
----Error Detector----	
CDR symbol rate	9.975 GBit/s
CDR Loop bandwidth	15 MHz
CDR Transition Density	50 %
CDR Peaking	1 dB
Analyzer CTLE	0
Input Sensitivity	High
Auto-align Timeout	60 s
Input Polarity inverted	False
----Power Automation----	
Power Automation	Manual

Result	SJ Frequency [MHz]	Failed Adjusted SJ [ps]	Passed Adjusted SJ [ps]	Min Spec [ps]	Nominal SJ [ps]	Errors ()
pass	100.000		17.00	17.00	17.00	0
pass	60.000		17.00	17.00	17.00	0
pass	30.000		17.00	17.00	17.00	0
pass	15.000		17.00	17.00	17.00	0
pass	7.500		17.00	17.00	17.00	0
pass	4.000		37.00	37.00	37.00	0
pass	2.000		87.00	87.00	87.00	0
pass	1.000		203.00	203.00	203.00	0
pass	0.500		474.00	474.00	474.00	0

Figure 105 Example result for 10Gx2 Rx compliance test (long channel)

- **Result**: (Pass / Fail), if the BER test at a specific frequency is passed, the value is “Pass” otherwise “Fail”.
- **SJ Frequency [MHz]**: The frequency value of the SJ that is applied to the test signal.
- **Failed Adjusted SJ [ps]**: The minimum sinusoidal jitter amplitude where the tested point fails.
- **Passed Adjusted SJ [ps]**: The maximum sinusoidal jitter amplitude where the tested point passes.
- **Min Spec [ps]**: Minimum sinusoidal jitter amplitude that the DUT must tolerate.
- **Nominal SJ [ps]**: Sinusoidal jitter amplitude at the frequency specified that is set to achieve the target eye-width.
- **Errors**: Number of errors during the test.

10Gx2 Rx Constant Parameter Stress Test

This procedure is similar to the 10G Rx Constant Parameter Stress Test / 234, except that two reports will be produced, one for each lane.

For the Connection Diagram, please refer to Figure 101 to Figure 104, depending on the DUT type and Test Method.

10Gx2 Rx Jitter Tolerance Test

This procedure is similar to the 10G Rx Jitter Tolerance Test / 238, except that two reports will be produced, one for each lane (refer to 5Gx2 Rx Long Channel Jitter Tolerance Test / 205).

For the Connection Diagram, please refer to Figure 101 to Figure 104, depending on the DUT type and Test Method.

10Gx2 Rx Sensitivity Test

This procedure is similar to the 10G Rx Sensitivity Test / 243, except that two reports will be produced, one for each lane.

For the Connection Diagram, please refer to Figure 101 to Figure 104, depending on the DUT type and Test Method.

10Gx2 Short Channel Rx Tests

The list of tests for Short Channel is the same as that for Long Channel. The procedures behave in the same manner. The only differences are the connections setups and that the differential voltage amplitude of the signal is set to 1.2 V instead of 800 mV.

NOTE Short channel tests should be run at the maximum differential voltage, 1.2 V, to stress the DUT. The default value is kept as 800 mV to avoid accidental damage to DUTs that cannot support such a high voltage. You can manually adjust this value yourself.

Common Parameters That Are Channel Specific

Loopback Training

- Short Channel Differential Voltage for Loopback Training

Instrument Channels

- J-BERT Generator
- J-BERT Generator non config lane
- J-BERT Error Detector
- J-BERT Error Detector non config lane

Refer to Table 5 on page 44 for the description of the mentioned parameters.

10Gx2 Rx Short Channel Compliance Test

This procedure is similar to the 10G Rx Compliance Test / 222, except that two reports will be produced, one for each lane.

The connection diagrams are the same as for 5Gx2 Rx Short Channel Compliance Test / 208.

10Gx2 Rx Short Channel Constant Parameter Stress Test

This procedure is similar to the 10G Rx Constant Parameter Stress Test / 234, except that two reports will be produced, one for each lane.

The connection diagrams are the same as for 5Gx2 Rx Short Channel Compliance Test / 208.

10Gx2 Rx Short Channel Jitter Tolerance Test

This procedure is similar to the 10G Rx Jitter Tolerance Test / 238, except that two reports will be produced, one for each lane (refer to 5Gx2 Rx Long Channel Jitter Tolerance Test / 205).

The connection diagrams are the same as for 5Gx2 Rx Short Channel Compliance Test / 208.

10Gx2 Rx Short Channel Sensitivity Test

This procedure is similar to the 10G Rx Sensitivity Test / 243.

The connection diagrams are the same as for 5Gx2 Rx Short Channel Compliance Test / 208.

6 Appendix: Acronyms and Abbreviations

This Appendix contains a list of acronyms and abbreviations used in the Keysight N5991 U32A USB3.2 Test Automation Software Platform User Guide.

Acronym	Definition
BER	Bit Error Ratio
BERT	Bit Error Ratio Tester
BW	Bandwidth
CDR	Clock Data Recovery
CLB	Compliance Load Board
CTLE	Continuous Time Linear Equalization
CTS	Compliance Test Specification
DSO	Digital Storage Oscilloscope
DUT	Device Under Test
EQ	Equalization
GPIB	General Purpose Interface Bus
HF	High Frequency
IO	Input–Output
IP	Internet Protocol
J-BERT	Jitter Bit Error Ratio Tester
LAN	Local Area Network
LF	Low Frequency
LFPS	Low Frequency Periodic Signaling
LTS	Link Training Suite
LTSSM	Link Training and Status State Machine
PC	Personal Computer
PDO	Power Data Object
RJ	Random Jitter
Rx	Receiver
SJ	Sinusoidal Jitter

Acronym	Definition
SSC	Spread Spectrum Clocking
TSEQ	Training Sequence
TTC	Transition Time Converter
Tx	Transmitter
UI	Unit Interval

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