M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G)

KEYSIGHT

USER GUIDE

Notices

Manual Part Number

M8092-91312

Edition

Edition 1.2, June 2025

Address

Keysight Technologies Deutschland GmbH
Herrenberger Strasse 130,
71034 Böblingen, Germany

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

U.S. Government Rights

The Software is “commercial computer software,” as defined by Federal Acquisition Regulation (“FAR”) 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement (“DFARS”) 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at http://www.keysight.com/find/sweula. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT WILL CONTROL.

Safety Notices

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Keysight Cybersecurity

Product and Solution Cybersecurity

Keysight is dedicated to ensuring the cybersecurity of its products and solutions. For detailed information,
please visit the Product and Solution Cybersecurity page.

Report a Product Cybersecurity Issue

If you encounter a cybersecurity issue with a Keysight product, please report it immediately
through our Product Cybersecurity Issue Reporting page.

Responsible Disclosure Program

Keysight encourages responsible disclosure of security vulnerabilities. For more details, please visit our Responsible Disclosure Program page.

Product Software Updates

Keysight releases periodic software updates to fix known defects, incorporate product enhancements, and address cybersecurity vulnerabilities, if any. Please ensure that your product software is always up to date.

To search for software updates for your product, please visit the Keysight Technical Support website at:
https://www.keysight.com/us/en/support/M809212CA

User Documentation

Our user documentation includes comprehensive information on features that may impact the secure deployment, use, and decommissioning of our products. This includes details on exposed network ports, the use of cryptography and authentication, and firmware security settings, if necessary.

Additional Resources

- Network Security Solutions: Learn how Keysight helps protect your network from threats.
- Creating a More Connected and Secure World: Discover Keysight's commitment to cybersecurity.

Contents

Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G)

User Guide

1 Introduction

This chapter provides an overview of the OIF-CEI-112G Rx Test Application and the related documents that can be consulted.

KEYSIGHT TECHNOLOGIES

Overview

The Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G) provides a framework for using Keysight M8000 BERT Test Solutions along with Keysight DCA and Infiniium UXR Oscilloscopes to perform Receiver testing based on the calibration and test procedures defined in the *OIF Common Electrical I/O (CEI) Electrical and Jitter Interoperability Agreements for 6G+ bps, 11G+ bps, 25G+ bps, 56G+ bps and 112G+ bps I/O (IA # OIF-CEI-05.0)* for Medium Reach and Long Reach and in *CEI-112G-VSR-PAM4 Very Short Reach Interface* (Draft) of the Physical Link Layer Working Group of the OIF for Very Short Reach.

Medium Reach and Long Reach

The Medium Reach (MR) and Long Reach (LR) test procedures are based on the Channel Operating Margin (COM) method. For the receiver interference tolerance test, broadband noise is injected into the test signal after the channel, so that the targeted COM, which the receiver is supposed to accommodate for, is achieved. The amplitude of the broadband noise depends on the transmitter and channel characteristics and must be adjusted very carefully. No broadband noise is injected for the receiver jitter tolerance test.

Very Short Reach

The Very Short Reach (VSR) test procedures are based on the stressed eye method. Characteristics of a test signal are adjusted towards specific values following a precise calibration procedure. The stressed input test signal is defined for devices on both module and host sides.

NOTE The definitions of the acronyms and abbreviations used throughout this User Guide are given in Chapter 9, Appendix: Acronyms and Abbreviations.

Related Documents

- *OIF Common Electrical I/O (CEI) Electrical and Jitter Interoperability Agreements for 6G+ bps, 11G+ bps, 25G+ bps, 56G+ bps and 112G+ bps I/O (IA # OIF-CEI-05.0)*.
- *CEI-112G-VSR-PAM4 Very Short Reach Interface* (Draft) of the Physical Link Layer Working Group of the OIF.
- M8070B documentation
  - For more information about M8070B software, refer to the M8070B documentation. To locate the M8070B documents, click **Start** > **Keysight M8070B** > **Keysight M8070B Documentation**. Alternatively, you may also visit www.keysight.com/find/M8070B to find the latest versions of the M8070B manuals.

Contacting Keysight Technologies

For more information on products, applications or services associated with Keysight Technologies, contact your local Keysight office.

The complete list is available at www.keysight.com/find/contactus.

2 Installing the OIF-CEI 5.0 (112G) Rx Test App

As a prerequisite to installing the OIF-CEI-112G Rx Test Application, you require the necessary hardware, along with certain installed software and licenses.

System Requirements

PC Hardware Minimum Requirements

- PC with Windows 10 Operating System
- Memory: 8 GB RAM
- Monitor Resolution: WXGA+ (1440 x 900)

PC Software and Instrument Firmware Requirements

- Microsoft .NET Framework
- Microsoft Office
- Keysight IO Libraries Suite
- Keysight License Manager 5 and Keysight License Manager 6
- M8070B system software for M8000 series
  - M8070ADVB Advanced Measurement Package for M8000 Series
  - M8194A Soft Front Panel or M8196A Soft Front Panel
- Flex DCA
- MATLAB Compiler Runtime R2017a (9.2)
  - Installer Link: http://ssd.mathworks.com/supportfiles/downloads/R2017a/deployment_files/R2017a/installers/win64/MCR_R2017a_win64_installer.exe
  - Updater Link: http://ssd.mathworks.com/supportfiles/downloads/R2017a/deployment_files/R2017a/installers/win64/MCR_R2017a_Update_3.exe

NOTE The exact soft- and firmware versions required are listed in the changelog or Release Notes of the relevant Receiver Conformance Test Application version. They can also be found in the corresponding data sheet on keysight.com.

PC Interfaces

- USB, LAN

Configuration and License Information

The following information can be found in the M809212CA Data Sheet on the keysight.com website.

- Equipment required for each standard option supported by the test application
- Minimum required instrument configuration for
  - M8000 BERT system
  - Error analyzer
  - Interference source
  - DCA and precision waveform analyzer
  - UXR Oscilloscope
- Recommended accessories and fixtures
- Software configuration

Installing the Software

The installer for the Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G) can be downloaded from the Keysight website.

1 To obtain the M809212CA Receiver Conformance Test Application installer, go to the Keysight website: https://www.keysight.com/us/en/products/software/application-sw/bit-error-ratio-tester-software/receiver-conformance-test-application-for-oif-cei-5-0.html

2 In the web page's **Free Trials** tab, click the **Request Free Trial** button to view instructions for downloading and installing the application software. Or skip to step 3.

3 In the web page's **Visit Technical Support** section, click **Drivers, Firmware and Software** tab to view instructions for downloading and installing the latest application software.

NOTE The name of the application "Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G)" is shortened to "Compliance RX Test Automation for OIF CEI-112G" or appears as "CEI-112G ValiFrame (M8092)" in some places.

To install the M809212CA Rx Test Application,

1 Double-click the downloaded installer file on your PC.

The Setup Program for the Keysight OIF-CEI-112G Rx Test Application appears (Figure 1).

NOTE The installer screens of your application version may differ slightly from what is displayed in the images in this section.

2 Click **Next**. The **Keysight Software End-User License Agreement** window appears.

3 Select **I accept...** to agree to the license agreement and to enable the **Next** button (Figure 2).

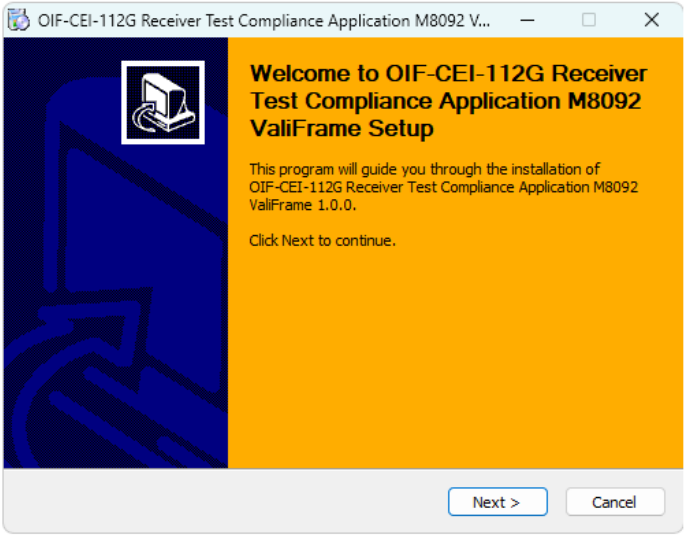


Figure 1 Setup program for the OIF-CEI-112G Receiver Test Application

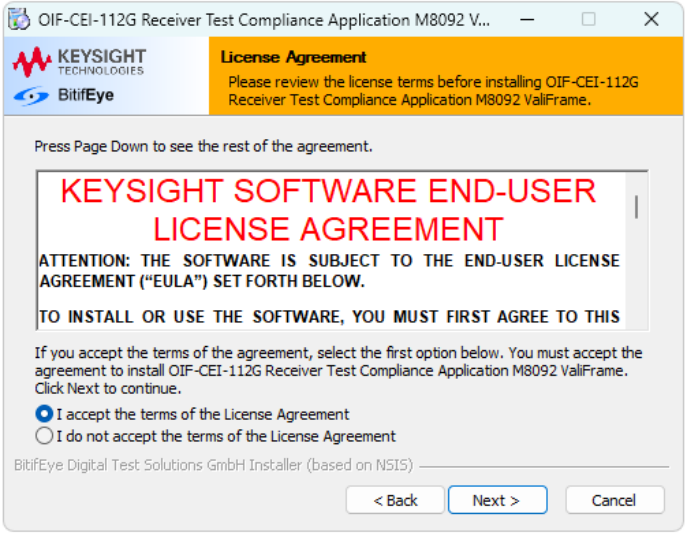


Figure 2 License Agreement window

4 Click **Next**.

a If any required software is missing, a window opens that invites you to download the software. Once you have installed the missing software, click **Reload**. Installation of the software will begin.

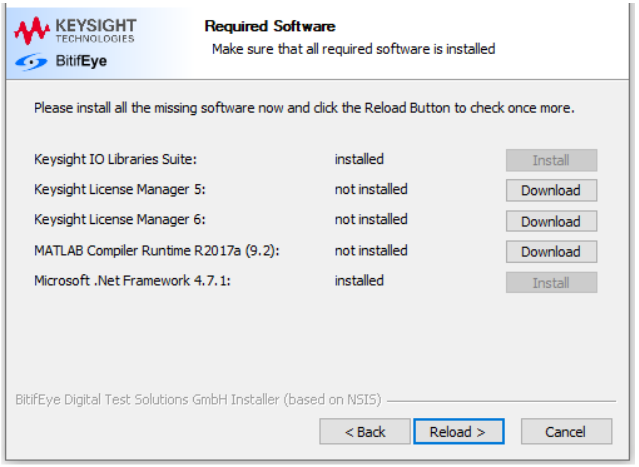


Figure 3 Required Software window

5 During the installation of the OIF-CEI-112G Rx Test Application, its status is displayed.

6 Once the installation is complete, click **Next**.

7 Click **Finish** to complete the installation and exit the setup app. If you have checked the “Show Changelog” box, the changelog file will open.

Installing the License Key

To procure a license, you require the Host ID information that is displayed in the Keysight License Manager application installed on the same machine as where you wish to install the license.

Using Keysight License Manager 5

To view and copy the Host ID from Keysight License Manager 5:

1 Launch Keysight License Manager on the machine where you wish to run the Test Application and its features.

2 Copy the Host ID that appears in the top pane of the application (Figure 4). Note that x indicates numeric values.

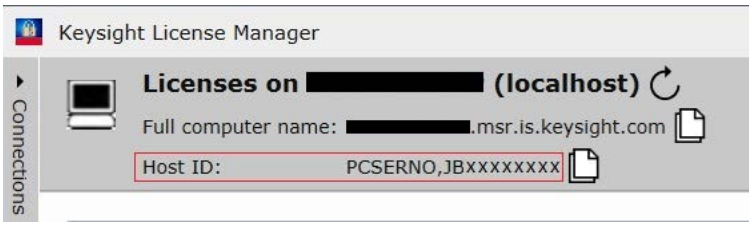


Figure 4 Viewing the Host ID information in KLM 5

To install one of the procured licenses using Keysight License Manager 5:

1 Save the license files on the machine where you wish to run the Test Application and its features.

2 Launch Keysight License Manager.

3 From the configuration menu (Figure 5), use one of the options to install each license file.

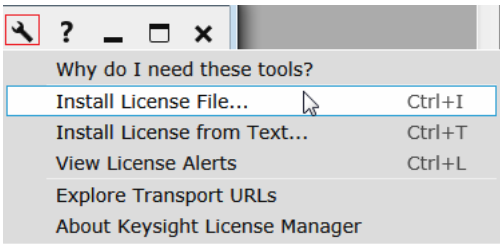


Figure 5 Configuration menu options to install licenses in KLM 5

For more information regarding installation of procured licenses on Keysight License Manager 5, refer to Keysight License Manager 5 Supporting Documentation.

Using Keysight License Manager 6

To view and copy the Host ID from Keysight License Manager 6:

1. Launch Keysight License Manager 6 on the machine where you wish to run the Test Application and its features.
2. Copy the Host ID, which is the first set of alphanumeric values (as highlighted in Figure 6) that appears in the Environment tab of the application. Note that x indicates numeric values.

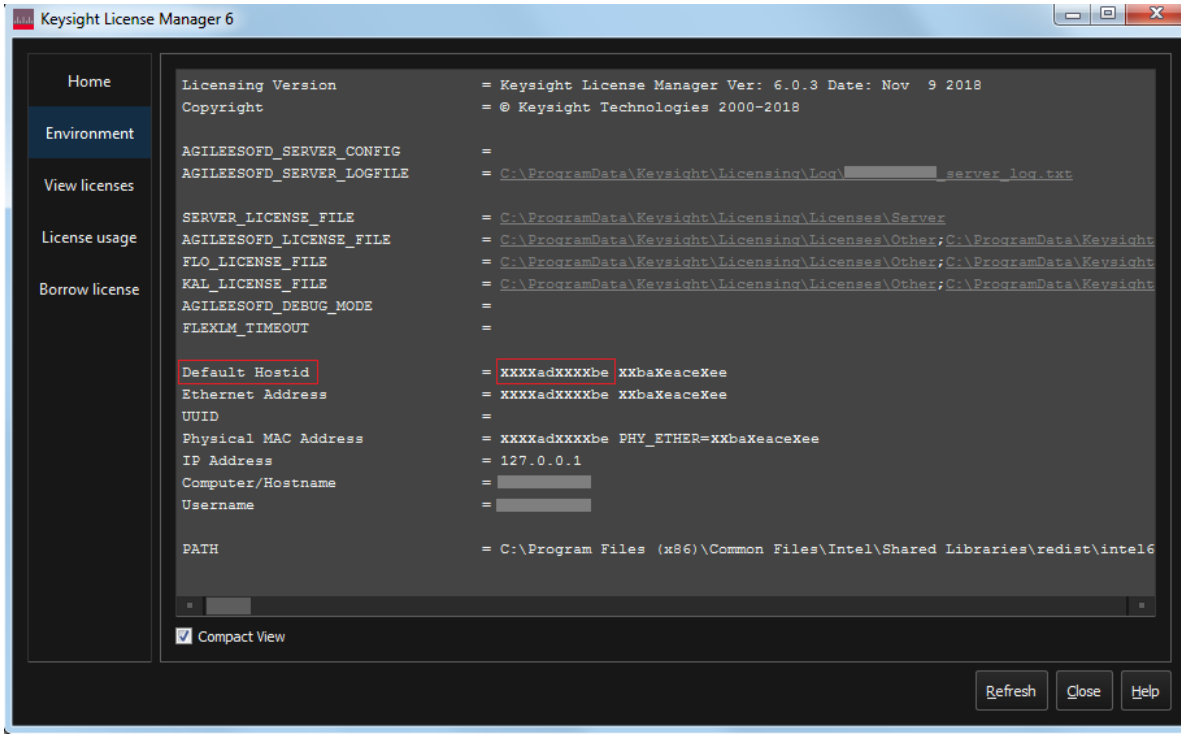


Figure 6 Viewing the Host ID information in KLM 6

To install one of the procured licenses using the Keysight License Manager 6 application:

1 Save the license files on the machine where you wish to run the Test Application and its features.

2 Launch Keysight License Manager 6.

3 From the Home tab (Figure 7), use one of the options to install each license file.

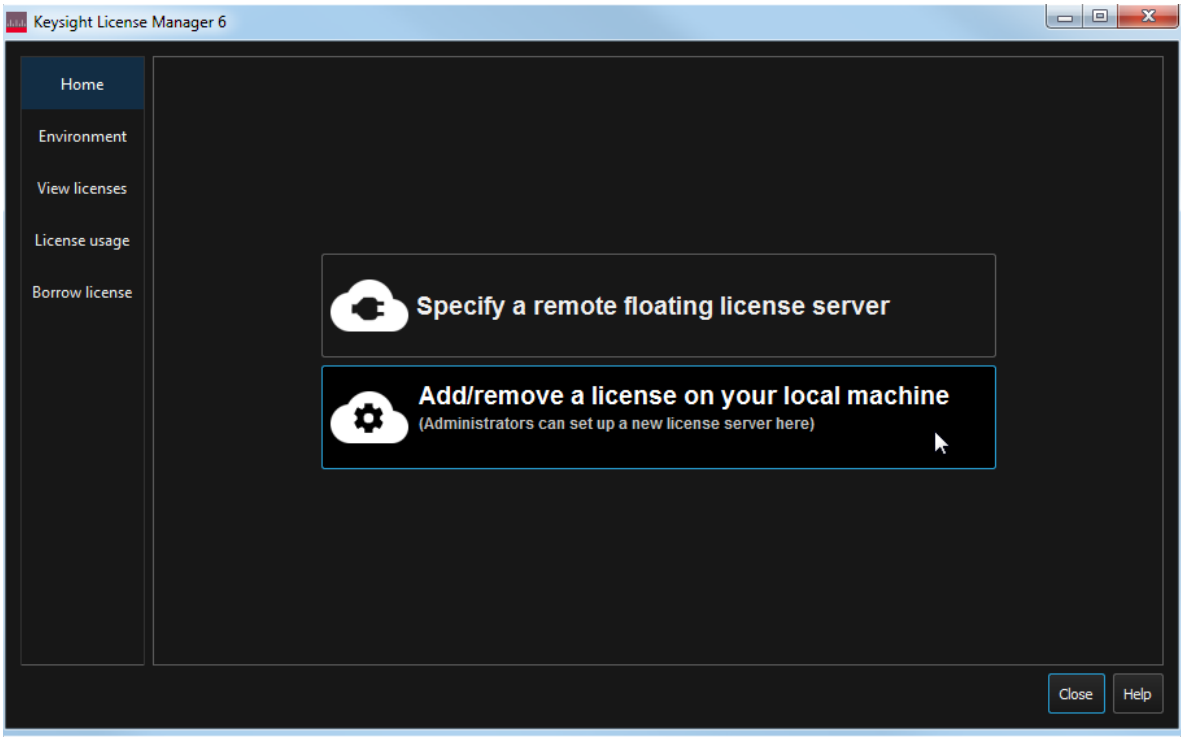


Figure 7 Home menu options to install licenses in KLM 6

For more information regarding installation of procured licenses in Keysight License Manager 6, refer to Keysight License Manager 6 Supporting Documentation.

3 Preparing to Take Measurements

This chapter details the preparations that have to be made before you can begin to take measurements with the Test App and adds some information that is useful while running the app.

NOTE Ensure that all instruments specified in the “M809212CA Data Sheet” on the keysight.com website are defined in the *Keysight Connection Expert* on the PC where the OIF-CEI-112G Rx Test Application is installed.

Calibrating the Instruments

Calibrating the FlexDCA Oscilloscope

If you have not already calibrated the FlexDCA oscilloscope, Keysight recommends calibrating the oscilloscope before performing calibrations or tests using the Receiver Conformance Test Application for OIF-CEI 5.0 (112G).

1. Disconnect all the cables that may be connected to the FlexDCA oscilloscope.
2. From the main menu of the FlexDCA N1000-Series System Software, select **Tools** > **Calibrations...** . The Calibrations dialog box will appear.
3. Follow the on-screen instructions to perform all calibrations, including the DCA module Skew calibration.

If the calibrations are not performed, warning messages are logged for each calibration performed from the M8070B software.

To learn how to perform calibrations on the oscilloscope, refer to the *DCA-X, DCA-M and FlexDCA* documentation for more details.

Calibrating the UXR Oscilloscope

If you have not already calibrated the UXR oscilloscope, Keysight recommends calibrating the oscilloscope before performing calibrations or tests using the Receiver Conformance Test Application for OIF-CEI 5.0 (112G).

If the calibrations are not performed, warning messages are logged for each calibration performed from the M8070B software.

To learn how to perform calibrations on the oscilloscope, refer to the *Keysight Infiniium UXR REal-Time Oscilloscope User's Guide* for more details.

Skew Calibration

Keysight recommends that, before you perform the OIF CEI-112G calibrations and tests, you use external Phase Trimmers to measure and remove the skew contributed by the pattern generator, fixture and cables.

NOTE First, ensure that the oscilloscope calibrations and internal skew calibration are valid.

System Calibrations

For any calibrations where the M8040A/M8050A BERT remote head is directly connected to the DCA Oscilloscope, **if the recommended M8045A-801/M8058A-801/M8059A-801 short matched cables are used, there should be no need to de-skew the data normal and data complement signals**.

If other cables are used, then the skew should be checked and, if needed, adjusted to be less than 3 ps. Insert a phase trimmer, Keysight part number N1027A-PT2, in both the data normal and data complement signal paths and adjust them until the desired skew is obtained. It should be possible to essentially zero-out the skew to just a few hundred femtoseconds. When the de-skew is complete, lock the phase trimmer adjustment, and keep the phase trimmers in the normal and complement paths throughout the entire calibration and DUT test procedures.

Figure 8 shows the example of an M8050A remote head connected directly to the DCA Oscilloscope with M8045A-801 cables, as used in VSR Amplitude, SJ, UUGJ, BUJ and Transmitter Measurements and in MR/LR Amplitude, SJ, UUGJ and Transmitter Measurements for COM Model – Rx ITol/JTol calibration steps.

Figure 8 System Calibrations

Stressed Eye Calibrations

For VSR Stressed Eye calibrations, the skew should be checked at the output of the MCB/HCB pair **for each calibration configuration** and, if necessary, adjusted to be less than 1 ps.

Insert a phase trimmer, Keysight part number N1027A-PT2, in both the data normal and data complement signal paths and adjust them until the desired skew is obtained (Figure 9 and Figure 10). It should be possible to essentially zero-out the skew to just a few hundred femtoseconds.

When the de-skew is complete, lock the phase trimmer adjustment, and keep the phase trimmers in the normal and complement paths throughout the entire calibration and DUT test procedures.

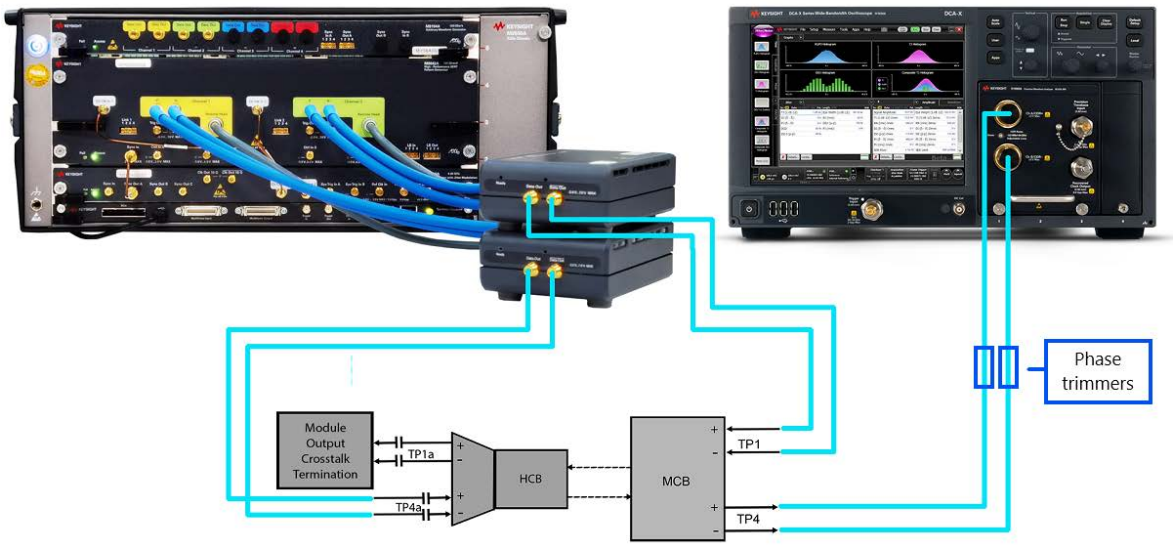


Figure 9 Stressed Eye Calibration connections for VSR Host with phase trimmers for de-skew

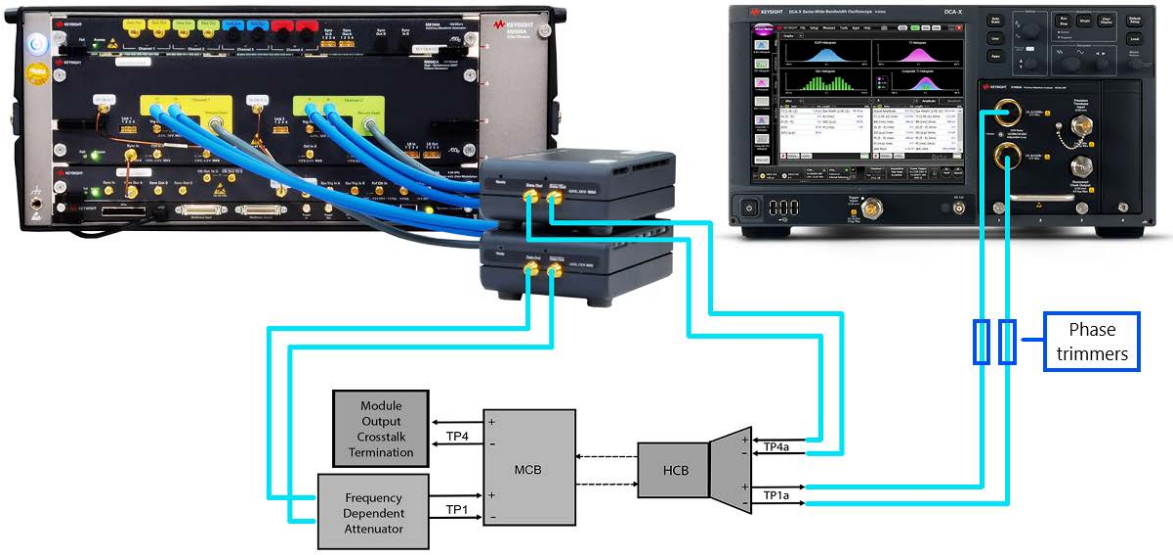


Figure 10 Stressed Eye Calibration connections for VSR Module with phase trimmers for de-skew

COM-Related Calibrations

No de-skew is required for MR/LR COM-related calibrations since they are calculated from the channel S-parameter files. However, the skew of the DUT test setup should be checked at the output of the couplers **for each calibration configuration**, and if needed, adjusted to be less than 1 ps.

Insert a phase trimmer, Keysight part number N1027A-PT2, in both the data normal and data complement signal paths and adjust them until the desired skew is obtained. It should be possible to essentially zero-out the skew to just few hundred femtoseconds.

When the de-skew is complete, lock the phase trimmer adjustment, and keep the phase trimmers in the normal and complement paths throughout the DUT test procedures (Figure 11).

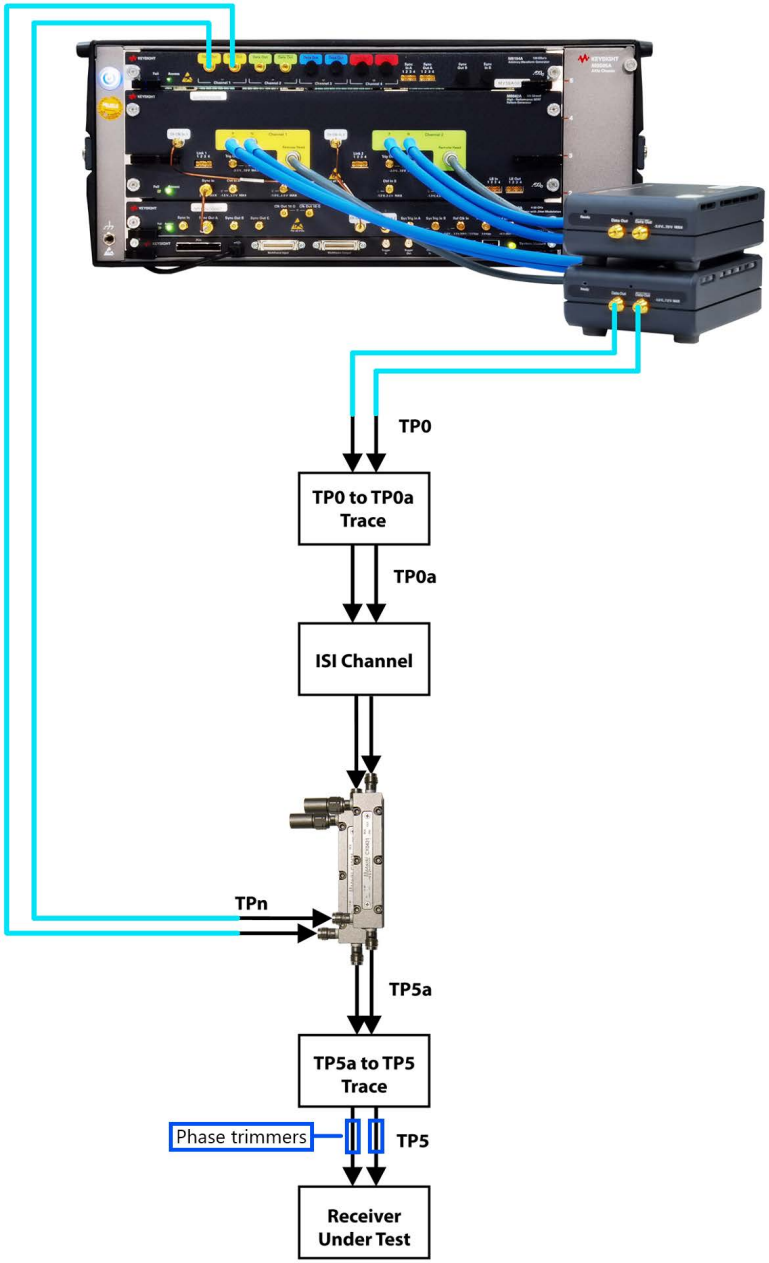


Figure 11 MR/LR Receiver Test setup with position of phase trimmers

Starting the Test Application

The OIF-CEI-112G Rx Test Application is available to be run as a standalone application on a PC, either locally or remotely.

Before you launch the OIF-CEI-112G Rx Test Application, make sure that Keysight M8070B software and FlexDCA N1000-Series System Software are online and active on the respective instruments.

For calibrations and tests, the VSR standard options require mated compliance boards and ISI channel boards, whereas the MR/LR standard options require ISI channel boards and couplers. Ensure that proper connections with the testing instruments are established and that the measurement instruments are connected on the same LAN as the remote PC where the OIF-CEI-112G Rx Test Application is installed.

To access the OIF-CEI-112G Rx Test Application,

1 Double-click the CEI-112G ValiFrame (M8092) icon on the desktop, or, from the **Start** menu of the Windows 10 OS, click **BitifEye > BitifEye CEI-112G M8092**.
For Windows 11, search for CEI-112G ValiFrame (M8092).

NOTE

If you do not see BitifEye CEI-112G M8092 listed in the **Start** menu, the OIF-CEI-112G Rx Test Application has not yet been installed on the PC.

Refer to Installing the Software on page 16 for installation instructions.

- The **M809212CA OIF CEI-112G RX Test BERT Compliance App** banner appears.
- If only a single instance of the M8070B software is running online, the OIF-CEI-112G Rx Test Application launches after automatically getting connected to the M8070B software.
- If the OIF-CEI-112G Rx Test Application detects more than one instance of the M8070B software running, the **Connect to M8070 System Software for M8000 Series of BER Test Solutions (M8070)** window appears (Figure 12).

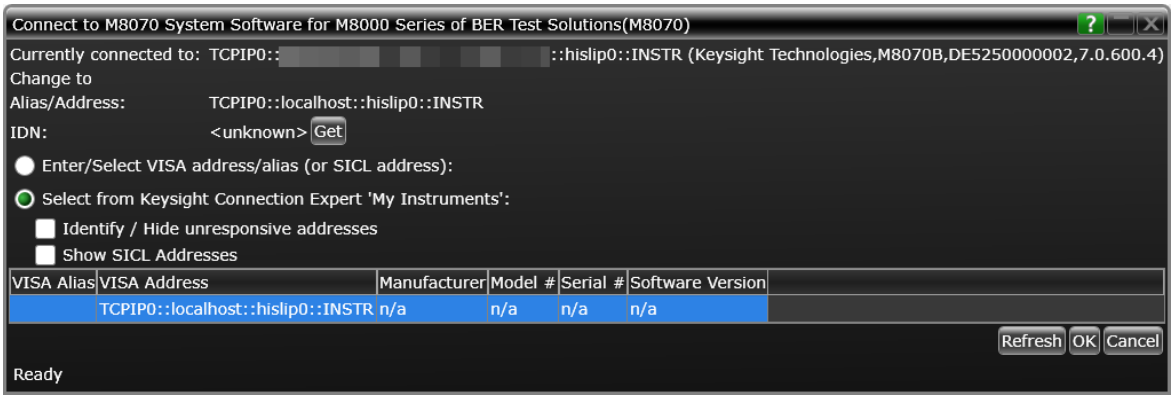


Figure 12 Connecting to M8070B if multiple instances are active

2 Perform one of the following two actions:

- In the **Enter/Select VISA address/alias (or SICL address):** text field, you can either type or copy the VISA/SICL address directly from the Keysight M8070B Software and paste it here. To verify the correct VISA address to connect to M8070B, access the **SCPI Server Information** window (Figure 13) by clicking **Utilities › SCPI Server Information...** from the main menu of the Keysight M8070B software.

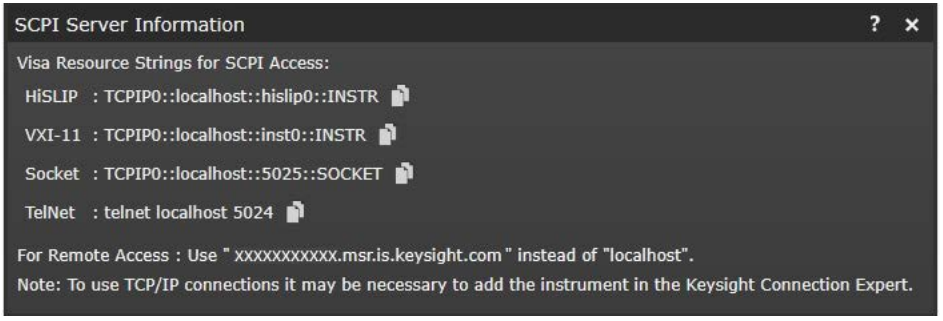


Figure 13 SCPI Server Information window on the M8070B Software

- If the BERT device is online and defined in the *Keysight Connection Expert*, click **Select from Keysight Connection Expert 'My Instruments':**. The VISA address list defined in the Keysight Connection Expert software for each online instrument is displayed. After you have verified the VISA/SICL address, select the correct VISA Address from the list.

3 Click **Get** (highlighted in Figure 14) in the **Connect to M8070B System Software for M8000 Series of BER Test Solutions(M8070)** window. The **IDN:** field displays the instrument name.

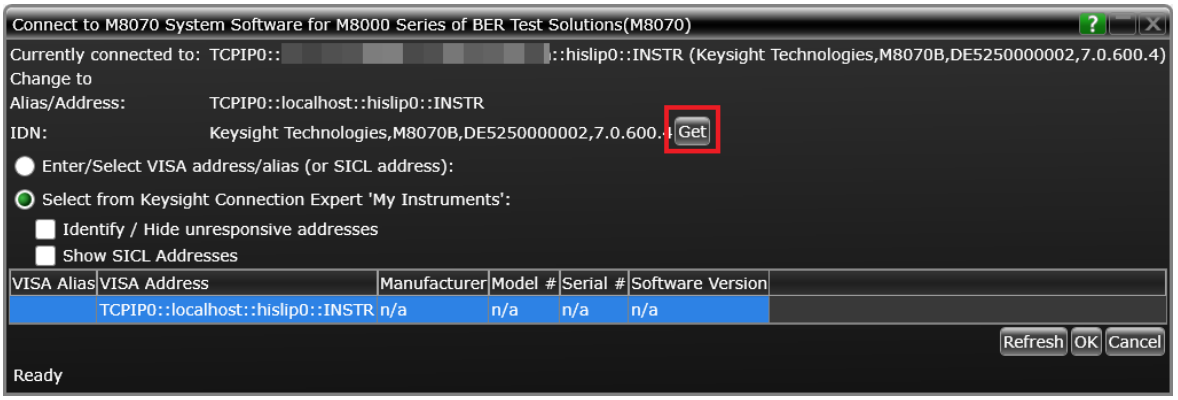


Figure 14 IDN field displaying successful connection to M8070B

4 Click **OK** (bottom right) to establish connection with M8070B and to launch the OIF-CEI-112G Rx Test Application. If a connection is not established, the application fails to launch.

- The OIF-CEI-112G Rx Test Application appears with the **Set Up** tab as default (Figure 15).

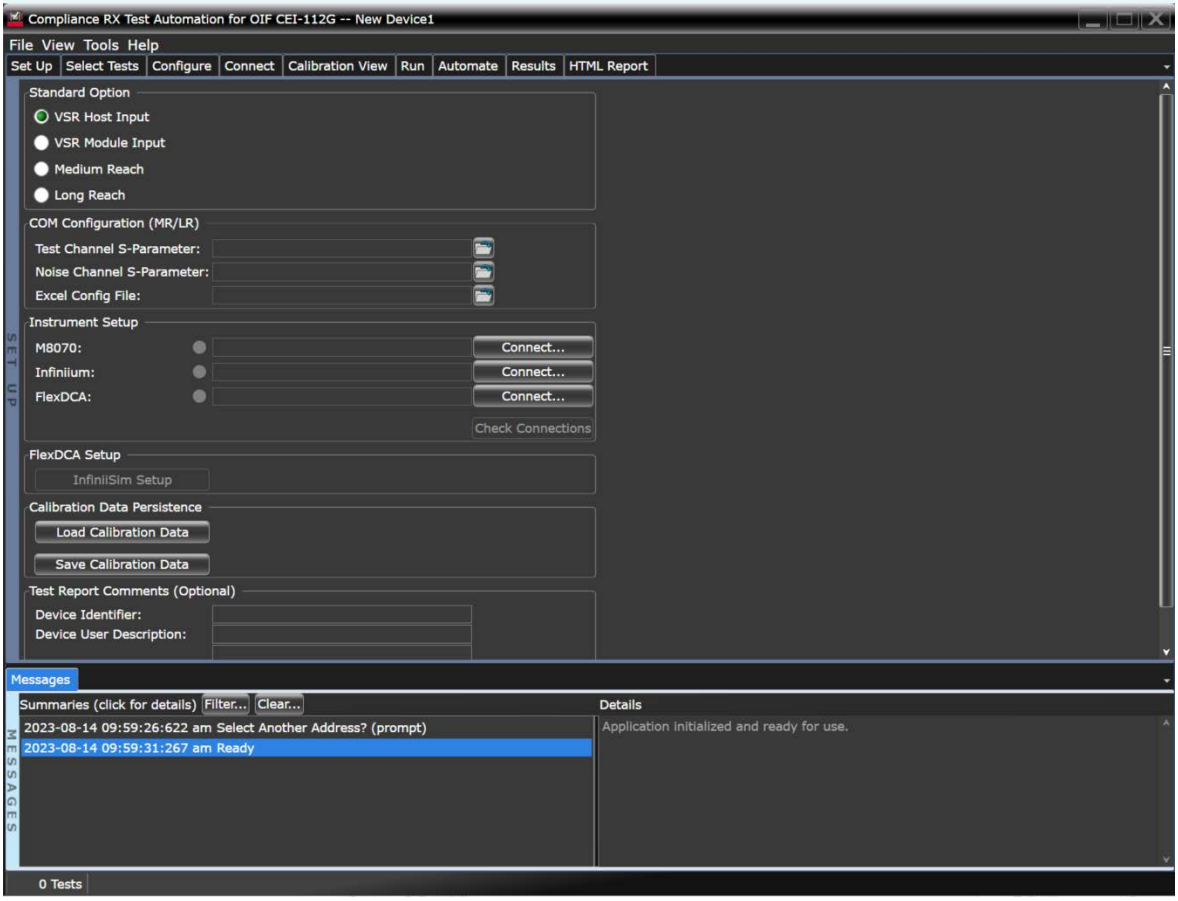


Figure 15 Default view of the OIF-CEI-112G Rx Test App

For more information about how to use the various features in the OIF-CEI-112G Rx Test Application, refer to the *Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G) Online Help*.

Setting up the OIF-CEI-112G Rx Test Application

Calibrations are performed using mated Compliance Boards, ISI channels and couplers etc., whereas the Device Under Test (DUT) is required in order to run the tests. However, before you begin performing the OIF-CEI-112G calibrations, you must first set up the Rx Test Application (Figure 16).

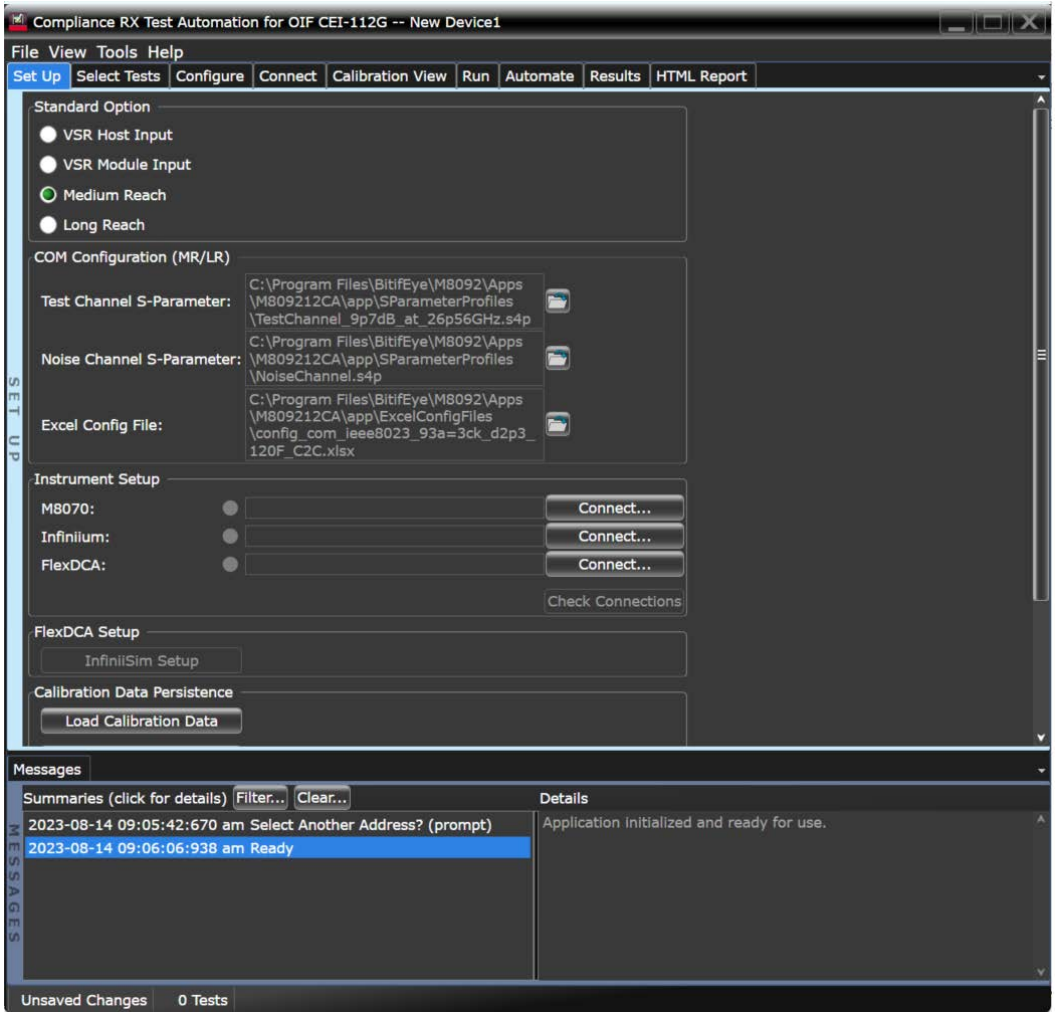


Figure 16 Setting up the OIF-CEI-112G Rx Test App

1 Under the **Set Up** tab:

a Select an option in the **Standard Option** area, to indicate the standard for which the calibrations/tests are to be performed. The available options are:

- VSR Host Input
- VSR Module Input
- Medium Reach
- Long Reach

b For the selected standard option, you must perform the respective **configuration** using the predefined configuration. In particular, in the **COM Configuration (MR/LR)** area, select the Test Channel S-Parameter file, the Noise Channel S-Parameter file and the Excel Config file. To learn more about configuring the standard option, refer to *Configuring MR/LR Standard Options* section in the *Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G) Online Help*.

c In the **Instrument Setup** area:

i Click **Connect...** corresponding to M8070B and Infiniium or FlexDCA to connect to the respective instrument using the SICL/VISA address, if not connected already. By default, when you start the OIF-CEI-112G Rx Test Application, a connection dialog is displayed to connect at least to the BERT device, else the application fails to launch. A green dot indicates that the instrument is already connected.

ii Click **Check Connections** to verify that M8070B and Infiniium or FlexDCA are properly connected to the OIF-CEI-112G Rx Test Application.

NOTE

To establish a successful connection between the OIF-CEI-112G Rx Test Application and the BERT as well as the Interference Source, you must configure the modules in the following sequence on a 5-slot AXIe chassis:

For M8050A

- M8009A in slot 1 (M1)
- M8042A in slots 2–4 (M2)
- For MR/LR: M8054A or M819xA in slot 5 (M3)
- M8046A/M8043A in another chassis connected to the same controller (M4)

d In the **FlexDCA Setup** area:

i Click **InfiniiSim Setup** to configure the Oscilloscope's FlexDCA De-embedding. The **InfiniiSim Setup** button is enabled only after a connection with the FlexDCA instrument is established. A common use is to de-embed any additional RF cables that are used to connect to the oscilloscope for calibration that will not be used when running the DUT test.

ii Once the InfiniiSim is connected and calibration is selected, the **Apply InfiniiSim (except for exempted tests)** check box will appear in the **Connect** tab. By default, this check box is selected, indicating that the InfiniiSim settings will be used in the selected calibration run. If you do not want to apply InfiniiSim (de-embedding) settings to the calibration, you can uncheck this check box.

Note that the application will not display the **Apply InfiniiSim (except for exempted tests)** check box for calibrations that do not require InfiniiSim settings. For example, the results of SJ, UUGJ, BUJ and Broadband Noise Calibrations do not change with the embedding/de-embedding. Therefore, the application automatically exempts these calibrations from the InfiniiSim settings.

If you run a group of calibrations (including exempted calibrations) with the **Apply InfiniiSim (except for exempted tests)** check box selected, then the application will ignore this check box selection for the exempted calibrations and set **InfiniiSim OFF** for them.

To learn more about configuring InfiniiSim for DCA within the Test Application, refer to the *Configuring InfiniiSim for DCA* section in the *Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G) Online Help*.

e In the **Calibration Data Persistence** area, you can save the calibration data in zip format for future use and load existing calibration data in zip format. To understand the functionality of the Calibration Data Persistence, refer to Understanding Calibration Data Persistence on page 41.

f In the **Test Report Comments (Optional)** area, enter appropriate values in the **Device Identifier:**, **Device User Description:**, and **Comments:** text fields. The content of these fields will appear in the HTML reports that are generated after test runs. Performing this step is optional. However, Keysight recommends entering these values to identify the test results for the corresponding DUT when there are a large number of DUTs to be tested.

2 Under the **Select Tests** tab, select one or more Calibrations or Tests or both options for the selected standard option.

3 Under the **Configure** tab, modify the configuration parameters based on the values defined in Clause 26 (for MR) or Clause 27 (for LR) of the *OIF Common Electrical I/O (CEI) Electrical and Jitter Interoperability Agreements for 6G+ bps, 11G+ bps, 25G+ bps, 56G+ bps and 112G+ bps I/O (IA # OIF-CEI-05.0)*. For VSR refer to *CEI-112G-VSR-PAM4 Very Short Reach Interface* (Draft) of the Physical Link Layer Working Group of the OIF.

4 In the **Connect** tab, the instructions and the connection diagram for establishing connections between the test boards and the instruments are displayed. Follow the instructions to establish the appropriate connections for each calibration/test.

5 Once the connections have been verified and the application setup is complete, click **Run** under the Run tab to start running Calibrations/Tests.

Using the OIF-CEI-112G Rx Test Application

Once you have run a procedure, you need to understand how and where the results are presented, how you can save calibrations for later and how to access the application log if something goes wrong.

Presentation of Results

The results of a calibration or test procedure are presented in the **Results tab**. The positions and dimensions of the panes of the Results tab can be changed.

In the default view, the top pane lists the procedures that have been run or are to be run while the pane underneath shows details of the procedure selected in the top pane (Figure 17).

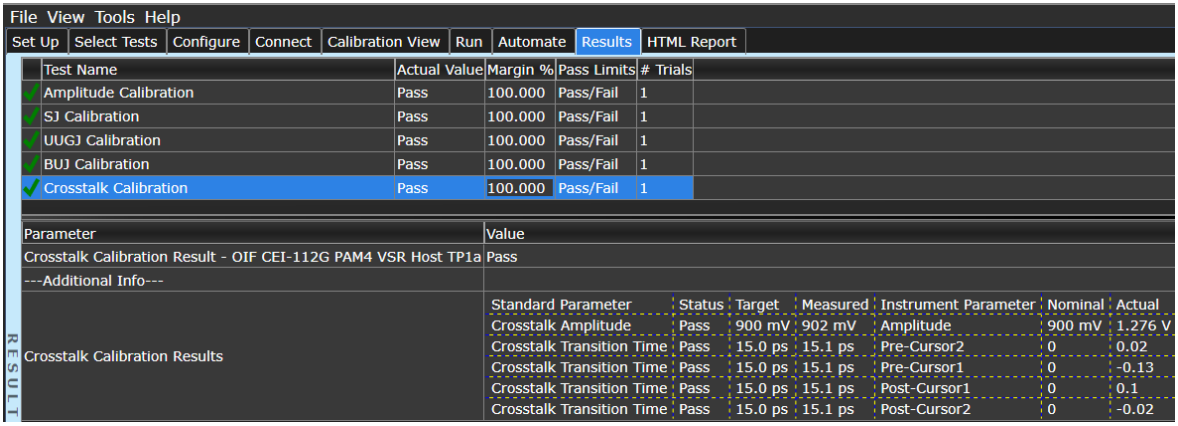


Figure 17 Example results in the Results tab

For continuous calibrations (such as SJ, UUGJ and Broadband Noise), the calibration results will be presented in graphical and tabular form in the **Calibration View tab** (Figure 18) and just as pass or fail in the Results tab. For more details, see About Calibration View on page 162.

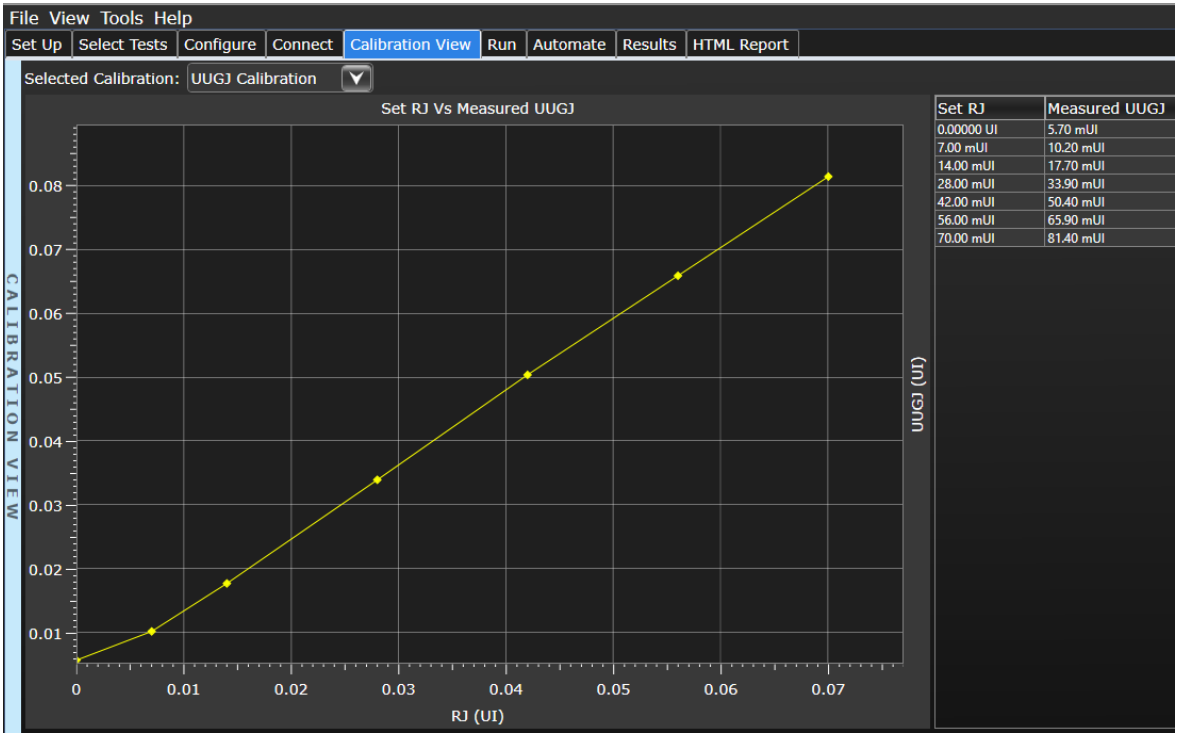


Figure 18 Example calibration results in the Calibration View tab

For **several trials** of the same calibration or test performed directly after one another, a Trial Summary (red frame in Figure 19) is included in the results in the Results tab.

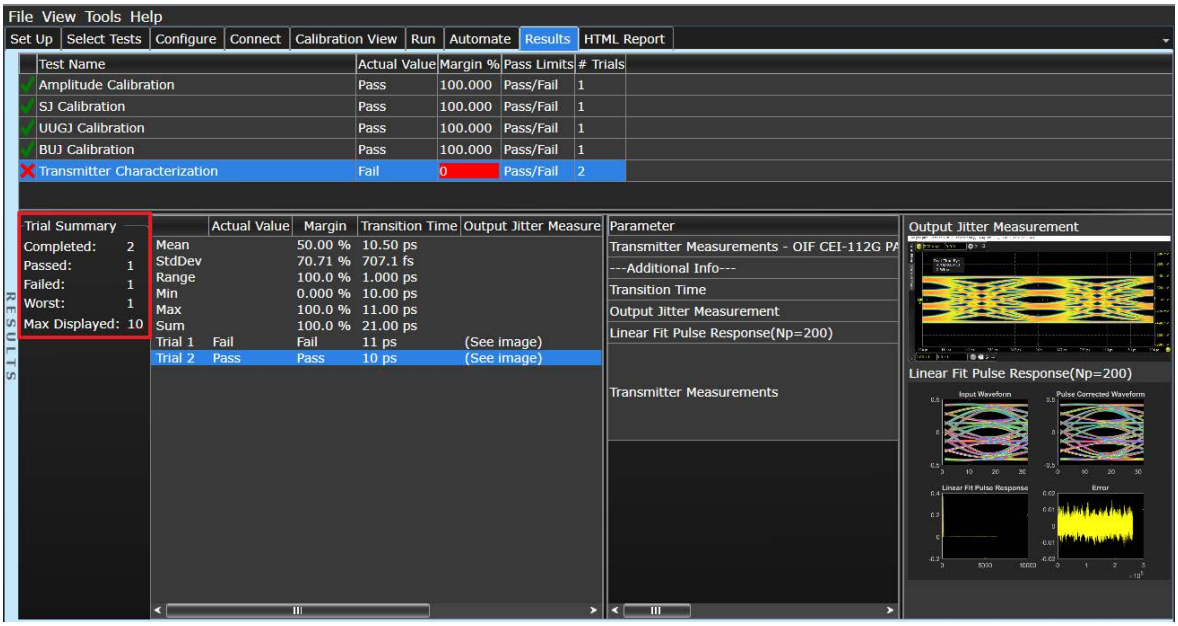


Figure 19 Example results for several trails

If any **tags** are applied to the test results, the tags will be displayed in the Additional Info section in the Results tab (see Figure 20).

Voltage Tolerance Test Result	Pass
---Additional Info---	
[Tag] Host Channel	far-short
[Tag] Amplitude	1.2 mV
[Tag] Crosstalk Amp	0.4 V
[Tag] VEC	1
[Tag] eye Height	15mV
[Tag] patch	yes
Voltage Tolerance Test Results	Parameter / Status / Minimum Differential Pk-Pk Voltage / Pass / 600 mV

Figure 20 Example results in the Results tab showing tags

NOTE

To learn more about tags, refer to the *Configuring Result Tags* section in the *Keysight M809212CA Rx Test Application for OIF-CEI 5.0 Online Help*.

Understanding Calibration Data Persistence

The **Calibration Data Persistence** feature (see Figure 21) of the OIF-CEI-112G Rx Test Application provides a way to save and load the Calibration data. The advantage of using this feature is to save time by not having to run calibrations again that are a prerequisite to running the OIF-CEI-112G RX tests. The OIF-CEI-112G Rx Test Application manages the Calibration data in the **.zip* file format.

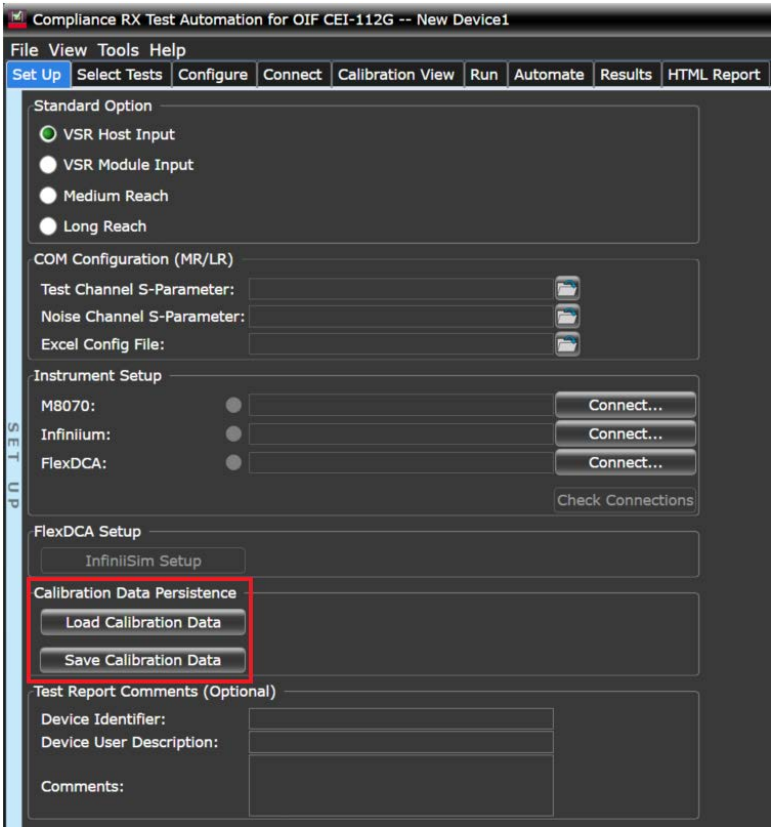


Figure 21 Calibration Data Persistence area

- To understand how to load calibration data before running OIF-CEI-112G Tests, see Loading Calibration Data on page 42.
- To understand how to save calibration data after running OIF-CEI-112G Calibrations, see Saving Calibration Data on page 43.

Loading Calibration Data

The OIF-CEI-112G tests are dependent on calibration data, which can be obtained after performing one or more Calibrations with respect to a standard option. Pre-saved calibration data can be used to run tests in the current instance of the Test Application.

To load such Calibration data into the Test Application:

1 In the **Calibration Data Persistence** area, click **Load Calibration Data**.

2 In the **Load Calibration Data** window that appears, navigate to the folder where the Calibration data file is located in *.zip* format.

3 Select the required data file and click **Open**.

4 The **Messages** area of the OIF-CEI-112G Rx Test Application indicates whether or not the calibration data was loaded successfully (Figure 22).

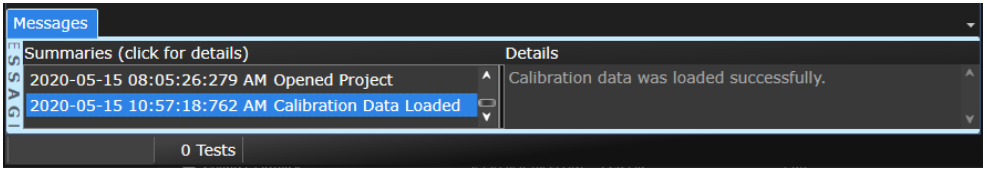


Figure 22 Set Up tab view after successfully loading Calibration Data

After you load the Calibration Data, the Test Application automatically identifies the data corresponding to the OIF-CEI-112G standard option and uses the respective data during test runs in that instance of the Test Application.

Saving Calibration Data

The OIF-CEI-112G tests are dependent on calibration data, which can be obtained after performing one or more Calibrations with respect to a standard option. Running Calibrations is time-consuming and you may be occupied for some time running each calibration (along with modifying the hardware setup for each calibration) and obtaining the required data.

The **Save Calibration Data** feature helps you save the Calibration data for future use. After you have performed all calibrations successfully, Keysight recommends that the Calibration data be saved so that you can use the calibrated values for OIF-CEI-112G tests later, if required.

To save the Calibration data:

1 In the **Calibration Data Persistence** area, click **Save Calibration Data**.

2 In the **Save As** window that appears, navigate to the folder where you wish to save the Calibration data in *.zip* file format.

3 Click **Save**.

4 The **Messages** area in the OIF-CEI-112G Rx Test Application indicates whether the calibration data has been saved successfully (Figure 23).

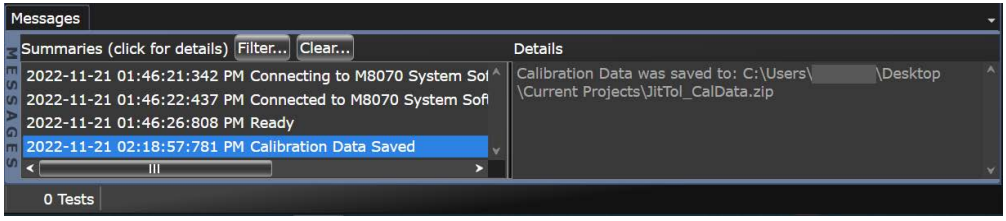


Figure 23 Set Up tab view after successfully saving Calibration Data

NOTE

The **Calibration Data Persistence** feature only lets you either save calibration data after calibrations have been performed in the Test Application or load pre-saved calibration data into the Test Application prior to running tests. If you wish to modify the calibrated data, you should use the **Calibration Editor** feature within the Test Application.

Using the Calibration Editor

The Calibration Editor feature in the Test Application offers you capabilities to view and to modify calibrated values that may have been saved using the Calibration Data Persistence feature or appear in the current instance of the Test Application after performing one or more calibrations.

1 From the main menu of the Test Application, click **Tools > Calibration Editor...**.

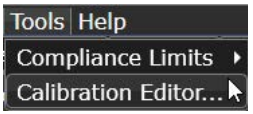


Figure 24 Launching Calibration Editor from Tools menu

2 In the **Calibration Editor** window that is displayed (Figure 25), click a standard option from the left pane.

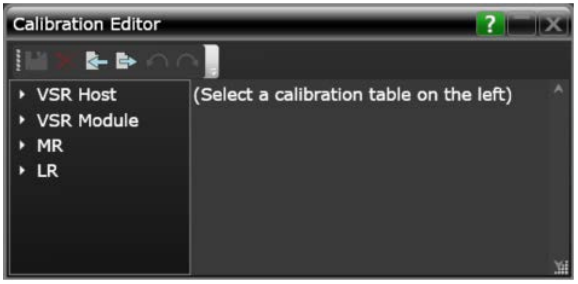


Figure 25 Calibration Editor window

3 Select a calibration type corresponding to the selected standard to view the corresponding default calibration data or the data from a recent calibration run in the current instance of the Test Application.

Figure 26 displays the default calibration data for **SJ** calibration under **Medium Reach**.

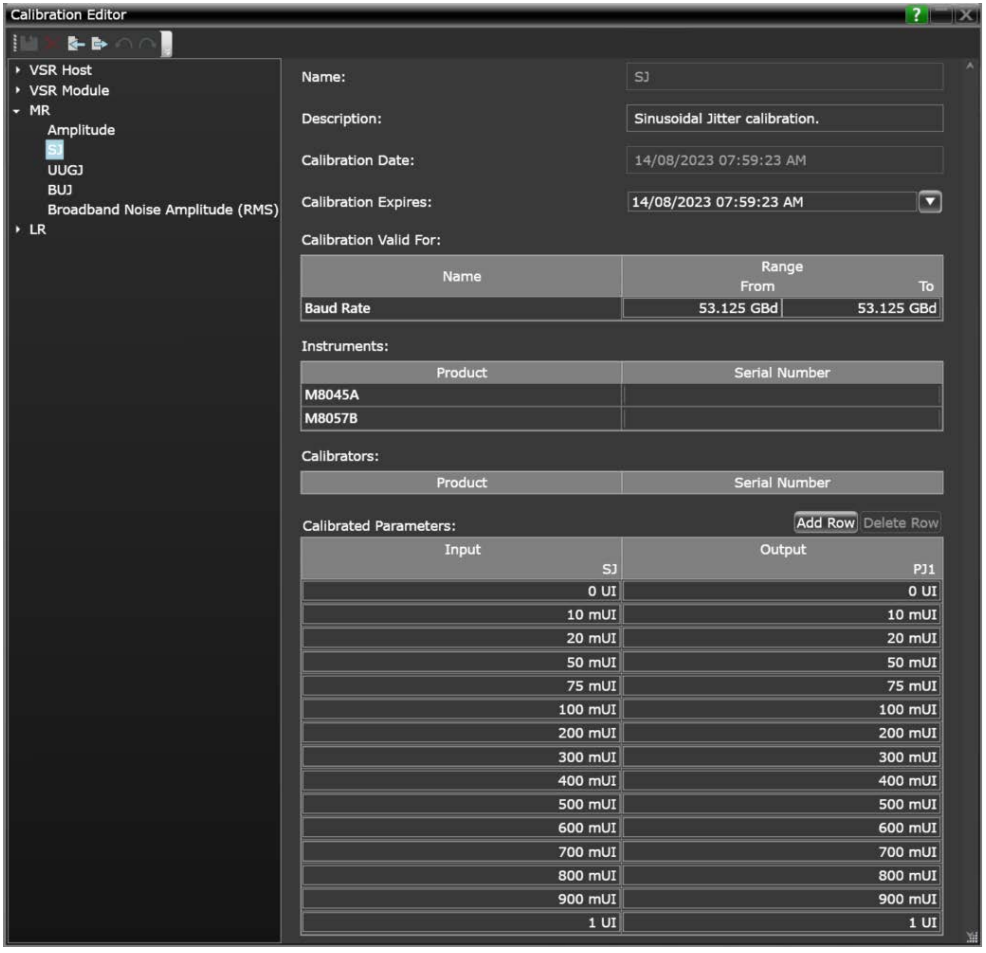


Figure 26 Default information for the selected calibration type

Figure 27 displays calibration data as it appears directly after the Test Application has performed SJ Calibration, while Figure 28 displays pre-saved calibration data (corresponding to SJ Calibration) that has been loaded.

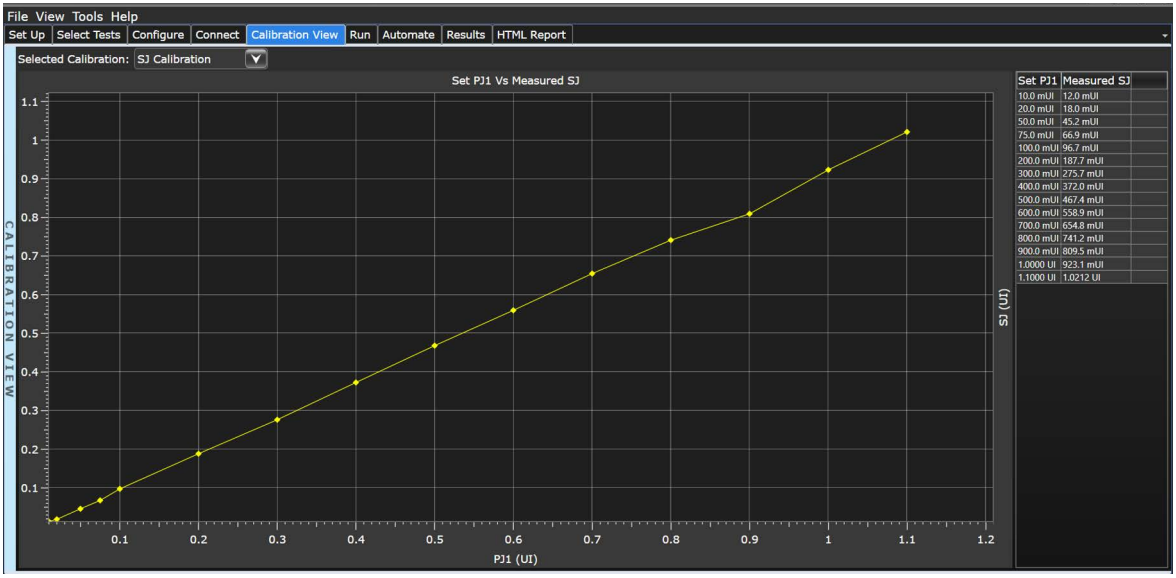


Figure 27 Plotted data in the Calibration Viewer for SJ Calibration

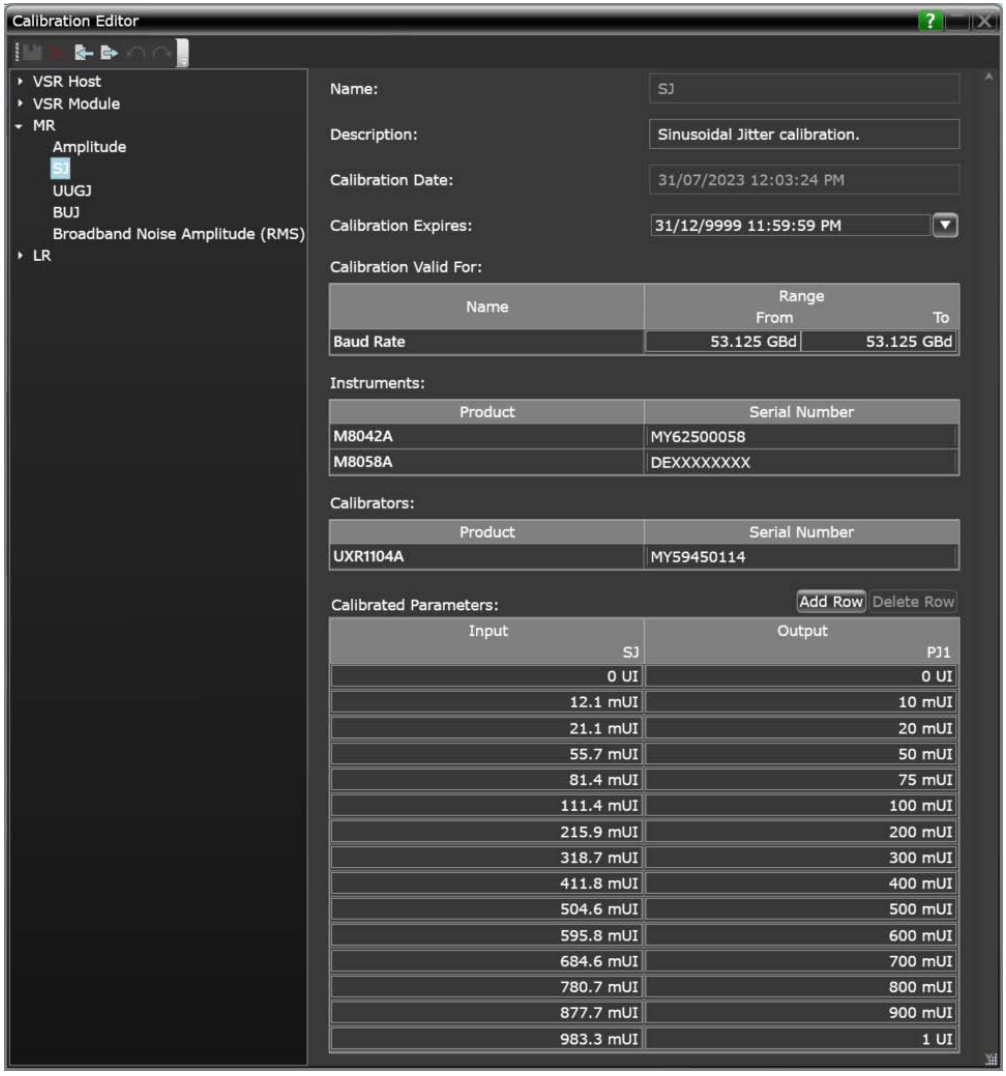


Figure 28 SJ Calibration data displayed in Calibration Editor

Table 1 lists and describes the attributes used in the calibration editor.

Table 1 Attributes in the Calibration Editor

Attribute name	Description
Name	Name of the selected calibration type.
Description	Description of the selected calibration type along with the test point where the calibration is to be performed.
Calibration Date	The date and time stamp when the selected calibration type was performed.
Calibration Expires	The date and time stamp to indicate the validity of the calibrated values for the selected calibrated type.
Calibration Valid For	The list of parameters and their range of values, which decide the validity of the calibrated values.
Instruments	The list of instruments that were used to perform the calibration and the serial number of each instrument.
Calibrators	The Oscilloscope and its modules used for the calibration.
Calibrated Parameters	The parameter values that were measured by the Oscilloscope are displayed under the Input column whereas the calibrated parameters and their values (set on the pattern generator) are displayed under the Output column. These correlate with the Measured value and Set values in the Calibration Viewer window of the Test Application. Some calibration types may have more than one output parameter.

You can use the functional features that appear in the top menu in the Calibration Editor to:

- Save any changes
- Discard all changes
- Import calibration data for editing
- Export edited calibration data into a zip file
- Undo or redo any changes in the current instance
- Modify
  - Text in the **Name** and **Description** fields
  - Date and Time stamp in the **Calibration Expires** field
  - **Range** values in **Calibration Valid For** table
  - **Serial Number** values in the **Instruments** and **Calibrators** tables
  - Both **Input** and **Output** cells in the **Calibrated Parameters** table

- Add one or more rows in the **Calibrated Parameters** table only; each new row shall display interpolated values.
- Delete one or more rows in the **Calibrated Parameters** table only.

After you have exported the modified data, you may use the **Calibration Data Persistence** feature to use the calibrated values for a specific calibration to run associated tests.

For more information on each feature that appears in the Calibration Editor, refer to *Using the Calibration Editor* section in the *Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G) Online Help*.

Viewing the Application Log

To view the application log files, navigate to the log folder:

C:\ProgramData\BitifEye\M8092\Apps\M809212CA\log

Overview of Channel Operating Margin (COM)

COM is a figure of merit (FOM) determined from a minimum reference PHY architecture and channel's S-parameters. It allows designers to explore physical design trade-offs between loss, reflection ISI, crosstalk, and device specifications.

COM is the Signal-to-Noise Ratio (SNR) of available signal amplitude (As) to statistical noise amplitude (An) in dB. It can be calculated using the equation

$$COM = 20 * \log_{10}(As/N)$$

where N = Peak BER Noise and As = Peak Signal

Both N and As are calculated based on the transmitter and channel characteristics assuming a reference receiver with optimized equalization.

A channel set contains a victim channel response called THRU and associated near-end aggressor crosstalk files (NEXT) and far-end aggressor crosstalk files (FEXT). See Figure 29.

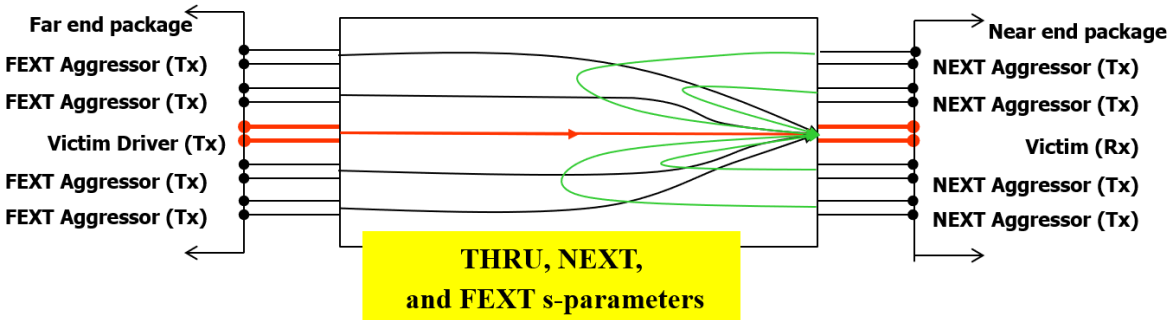


Figure 29 Channel Model for COM

The test procedures defined in Clause 26 (for MR) and Clause 27 (for LR) of *OIF Common Electrical I/O (CEI) Electrical and Jitter Interoperability Agreements for 6G+ bps, 11G+ bps, 25G+ bps, 56G+ bps and 112G+ bps I/O (IA # OIF-CEI-05.0)* rely on the Channel Operating Margin (COM) method. An informative introduction to COM can be found in Section 25.D of *IA # OIF-CEI-05.0*.

COM was first introduced to measure the performance margin of a channel and then extended to digital systems. Interoperability of digital receivers can be expressed in terms of COM requirements. COM is calculated using

channel 4-port S-parameters (for victim and aggressor lanes) as well as the noise and equalization functionality of the considered transmitter and receiver.

For the CEI-112G interfaces, COM shall be greater than or equal to 3.0 dB for each test. This minimum value allocates margin for practical limitations on the receiver implementation, the largest step size allowed for transmitter equalizer coefficients.

The COM-based receiver test workflow consists of the steps listed in Table 2. The figures mentioned there are based on those in *Annexure 93C, IEEE Std 802.3bj-2014, Amendment to IEEE Std 802.3-2012: Ethernet*.

These steps or procedures are briefly described in the following section.

Table 2 Calibration procedure step summary

#	Procedure	Summary of steps
1	Channel Characterization	Measure S4P for Test channel and Noise additional channel (see setup in Figure 32 and Figure 33).
2	Tx Equalization	Obtain a working link by adjusting Tx de-emphasis towards best Rx performance (see setup in Figure 30).
3	Equipment Calibration	Calibrate Tx jitter and amplitude (see setup in Figure 31). Note that amplitude is calibrated using optimized de-emphasis (see step 2).
4	Tx Characterization	Measure Tx characteristics (see setup in Figure 31).
5	Rx testing	Perform interference and jitter tolerance test.

Detailed Steps for Calibration Procedures

Step#1. Start with S4P Channel Characterization

1 Measure the scattering parameters, $S^{(tc)}$ on the Test Channel (TPt to TP5 replica) using the test setup shown in Figure 32.

2 Measure the scattering parameters, $S^{(nc)}$ on the Noise Channel with additional network (TPn to TP5 replica) using the test setup shown in Figure 33.

Step#2. Obtain a working link

3 Using the test setup shown in Figure 30 (that is, with Test Channel but without the noise source), initiate the Tx Equalization sequence.

- Optimize Tx de-emphasis taps towards minimum BER.
- Retain the resulting transmitter [opti Tx Eq taps] coefficients.

NOTE

The **Channel Characterization using COM model** calibration will determine the channel de-emphasis taps settings (Channel EQ Pre-cursor3/2/1 and Channel EQ Post-Cursor1) under the **Configure** tab and automatically update the channel equalization coefficients in the de-emphasis taps. For more information on Channel Characterization using COM model calibration, refer to Channel Characterization using COM Model on page 79.

Step#3. Calibrate the equipment

4 Calibrate Tx amplitude using the test setup shown in Figure 31.

- Use optimized Tx de-emphasis [opti Tx Eq taps] shown in Figure 32.

5 Calibrate Tx SJ injection using the test setup shown in Figure 31.

- Do not use de-emphasis.

6 Calibrate the broadband noise source using the test setup shown in Figure 34.

Step#4. Perform Tx Characterization

7 Measure Tx jitter parameters (Jrms and, according to the specification, J5u for MR and J3u for LR; in debug mode choose from J3u, J4u, J5u and J8u) using the test setup shown in Figure 31.
   - Do not use Channel Equalization Post/Pre-cursors.
   - Jitter injection (for example, 20 mUI SJ @40 MHz) may be required to ensure a realistic jitter profile.

8 Measure the noise parameters SNR_{TX} (or SNDR) using the test setup in Figure 31.

9 Measure the Tx transition time Trm using the test setup shown in Figure 31.
   - Do not use Channel Equalization Post/Pre-cursors.

See Transmitter Measurements for COM Model — Rx ITol on page 82.

Example Connection Diagrams

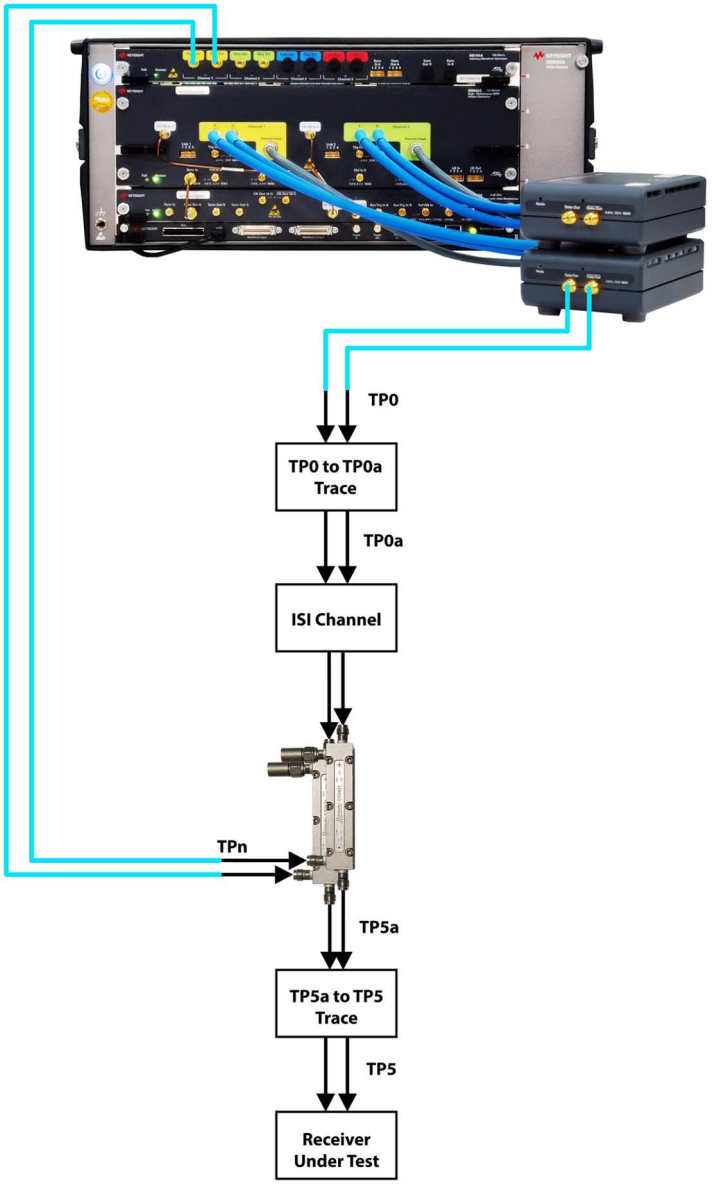


Figure 30 Interference tolerance test setup

Figure 31 Interference tolerance transmitter test setup

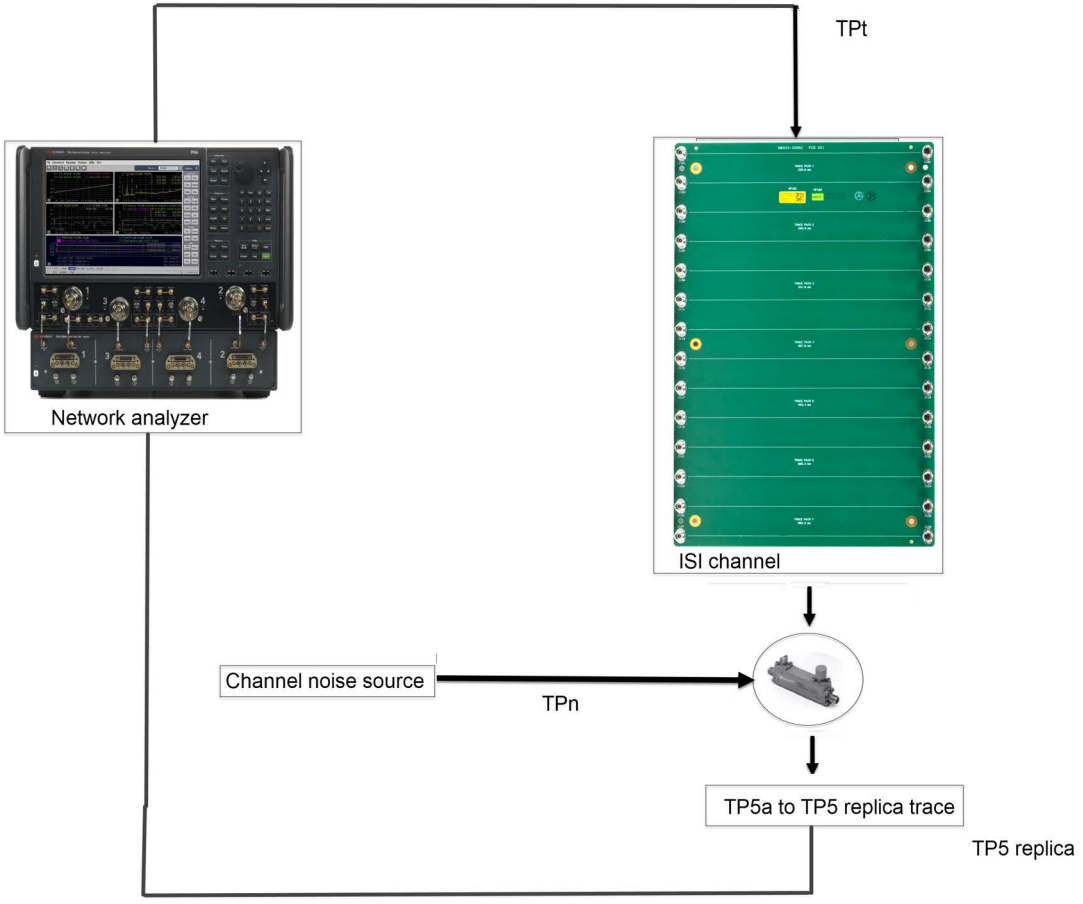


Figure 32 Interference tolerance channel S-parameter test setup

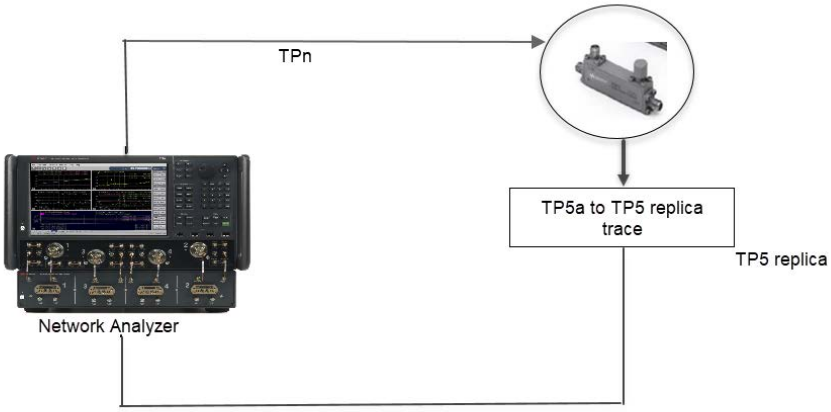


Figure 33 Interference tolerance channel noise path test setup

Figure 34 Interference tolerance channel noise level test setup

4 OIF-CEI 5.0 (112G) MR and LR Calibrations

This chapter describes the procedures for the OIF-CEI-112G Rx Calibrations that are applicable for the Medium Reach (MR) and Long Reach (LR) standard options.

Before performing the OIF-CEI-112G MR and LR tests, you have to calibrate all the related parameters. Perform calibrations in the order displayed in the OIF-CEI-112G Rx Test Application.

As mentioned earlier, ensure that the oscilloscope has been calibrated and the test channel is properly connected to the test instruments to perform OIF-CEI-112G Calibrations.

Calibration Parameters in Debug Mode

In **Debug** mode in the **Configure** tab of the Test Application, some more parameters are available to be configured, in addition to those that can be configured in **Compliance** mode. Besides, for some of the configuration options, you may enter custom values, which provides a greater flexibility in performing calibrations and tests.

For the **Medium Reach** and **Long Reach** standard options, the calibration parameters listed in Table 3 are available for configuration.

Table 3 Calibration parameters in debug mode for the MR and LR standard options

Calibration Parameter	Description
Parameters Common to All Calibrations	
Baud Rate	Baud Rate for testing device and for all calibrations.
Victim Generator PAM4 Symbol Mapping	Selects how consecutive data bits are mapped to symbols.
Victim Generator PAM4 Custom Symbol Mapping	Selects how consecutive data bits are mapped to symbols. The mapping is defined as a comma-separated list of bit sequences (e.g. 00,01,11,10). The position within this list corresponds to the symbol level. First value is for Symbol 0 and last value is for Symbol 3.
Target Error Ratio	Target Error Ratio for deciding if a test is passed or failed.
Sync Loss Threshold	The threshold level of error ratio at which synchronization is successful.
Alignment BER Threshold	BER threshold used as pass/fail criterion during the sample point alignment.
Target COM	Target COM for deciding if a test is passed or failed.
Test Channel Configuration	Specify test channel configuration that needs to be calibrated to meet COM (3dB max). Low Loss corresponds to Test1, whereas High Loss corresponds to Test2; both should be configured to meet the COM value (3 dB max).
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
Channel EQ Pre-Cursor3 for ITol	Controls the pre-cursor 3 coefficient for channel equalization for the Rx Interference Tolerance Test.
Channel EQ Pre-Cursor2 for ITol	Controls the pre-cursor 2 coefficient for channel equalization for the Rx Interference Tolerance Test.

Calibration Parameter	Description
Channel EQ Pre-Cursor1 for ITol	Controls the pre-cursor 1 coefficient for channel equalization for the Rx Interference Tolerance Test.
Channel EQ Post-Cursor1 for ITol	Controls the post-cursor 1 coefficient for channel equalization for the Rx Interference Tolerance Test.
Channel EQ Pre-Cursor3 for JTol	Controls the pre-cursor 3 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Channel EQ Pre-Cursor2 for JTol	Controls the pre-cursor 2 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Channel EQ Pre-Cursor1 for JTol	Controls the pre-cursor 1 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Channel EQ Post-Cursor1 for JTol	Controls the post-cursor 1 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Noise Generator Channel Selection	Selects the location of the Noise Generator that shall be used for generating broadband noise.
Loop Bandwidth	Select or enter the Loop BW to be used in the clock recovery.
SIRC Response for Tx Measurements	Select the SIRC response for victim transmitter measurements and crosstalk calibration. This will automatically be applied to any pattern lock waveform.
SIRC Bandwidth for Tx Measurements	Select or enter the SIRC BW for victim transmitter measurements and crosstalk calibration. This will automatically be applied to any pattern lock waveform.
Number of Averages for Waveform Acquisition	Set the number of averages used for waveform acquisition during pulse response and SNDR measurement.
CTLE Zero Frequency	Defines the continuous time filter, zero frequency.
CTLE Pole 1 Frequency	Defines the continuous time filter, pole 1 frequency.
CTLE Pole 2 Frequency	Defines the continuous time filter, pole 2 frequency.
CTLE Low-Frequency Pole/Zero	Defines the continuous time filter, low-frequency pole/zero.
Parameters for Common Calibrations	
Amplitude	Victim Differential Amplitude.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
BUJ	Controls the amplitude of the BUJ jitter source.
Parameters for Receiver Interference Tolerance	
Amplitude	Victim Differential Amplitude.
SJ	Sinusoidal Jitter at 10x receiver loop bandwidth.

Calibration Parameter	Description
UUGJ	Unbounded Uncorrelated Gaussian Jitter. This is the RMS value that is set on the BERT.
BUJ	Controls the amplitude of the BUJ jitter source.
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
Np for TP0v	Set the Np value used for linear fit pulse peak and error calculations.
Dp for TP0v	Set the Dp value used for linear fit pulse peak and error calculations.
Np for Rx Test	Set the Np value used for linear fit pulse peak and error calculations.
Dp for Rx Test	Set the Dp value used for linear fit pulse peak and error calculations.
Jnu Type	Select Jnu Type. This will select the probability used in the 12-edge output jitter measurement.
Record Count	Set the record count used for Jnu measurement at TP0.
Parameters for Receiver Jitter Tolerance	
Amplitude	Victim Differential Amplitude.
SJ	Sinusoidal Jitter at 10x receiver loop bandwidth.
UUGJ	Unbounded Uncorrelated Gaussian Jitter. This is the RMS value that is set on the BERT.
BUJ	Controls the amplitude of the BUJ jitter source.
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
Np for TP0v	Set the Np value used for linear fit pulse peak and error calculations.
Dp for TP0v	Set the Dp value used for linear fit pulse peak and error calculations.

Calibration Parameter	Description
Np for Rx Test	Set the Np value used for linear fit pulse peak and error calculations.
Dp for Rx Test	Set the Dp value used for linear fit pulse peak and error calculations.
Jnu Type	Select Jnu Type. This will select the probability used in the 12-edge output jitter measurement.
Record Count	Set the record count used for Jnu measurement at TP0.

MR and LR Configuration in the Test App

In order to obtain valid calibration data and test measurements, ensure that the Test Application is using the correct configuration parameters and corresponding values. The S-Parameter files are used for compensation losses whereas the Excel configuration file consists of Channel Operating Margin (COM) parameters.

To configure the correct S-Parameter and Excel Config File in the **Set Up** tab for the **MR** and **LR** standard options, note the following:

- In the current version of the OIF-CEI-112G Test Application, the S-Parameter files (low loss channel) and Excel file corresponding to the MR/LR standard options are displayed by default.

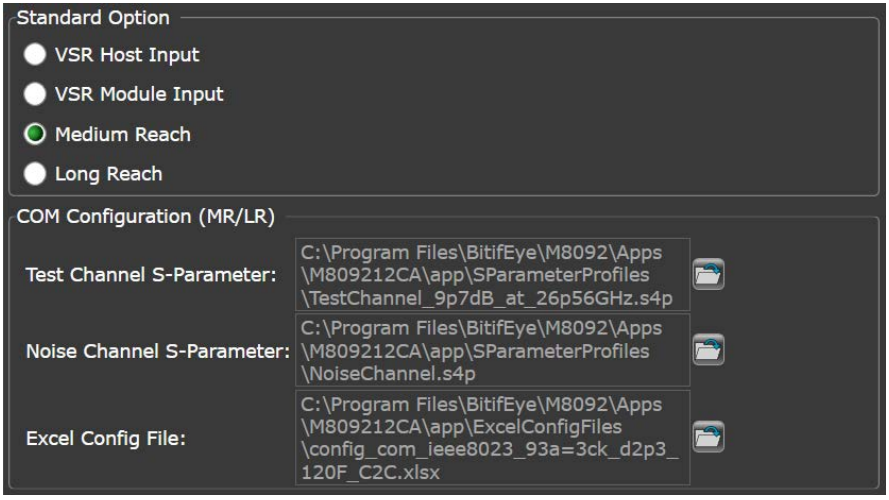


Figure 35 Configuration files for Medium Reach standard

- To define another Test Channel S-Parameter, Noise Channel S-Parameter or both files, click the respective (folder icon).

  By default, the Application installer places all S-Parameter files in the folder *C:\Program Files\BitifEye\M8092\Apps\M809212CA\app\SParameterProfiles* for the **Test Channel S-Parameter** and **Noise Channel S-Parameter** configuration fields.

From the default files available in the Test Application, you must choose the correct Test Channel S-Parameter file that correlates with the configuration parameter “Test Channel Configuration” setting as shown in Table 4. Note that Table 4 shows just an example of S-Parameter files; they may differ according to your test setup.

Table 4 Selecting Test Channel S-Parameters

Test Channel Configuration Setting	Corresponding Rx Interference Tolerance Parameter	Standard Option	S-Parameter File That Can Be Selected
Low Loss	Test 1	Medium Reach	TestChannel_9p7dB_at_26p56GHz.s4p
		Long Reach	TestChannel_13p8dB_at_26p56GHz.s4p
High Loss	Test 2	Medium Reach	TestChannel_19p8dB_at_26p56GHz.s4p
		Long Reach	TestChannel_26p4dB_at_26p56GHz.s4p

- Similarly, to define another Excel Config file, click the corresponding folder icon.

  By default, the Application installer places all Configuration files in the folder: *C:\Program Files\BitifEye\M8092\Apps\M809212CA\app\ExcelConfigFiles* for the **Excel Config File** configuration field.
- From the **Open** window that appears, select the alternative S-parameter file (factory installed) for MR/LR and click **Open**.

NOTE

While you may also load custom S-Parameter files in the Test Application for Test Channel and Noise Channel, you must ensure that these files contain measurements from exactly the same test setup. Also, the s4p file used for the Test & Noise Channels and for the replica trace must have the same attributes:

Input Ports: 1&3

Output Ports: 2&4

Start Frequency: 10 MHz

Stop Frequency: 60 GHz

Step Size: 10 MHz

No. of points: 6000

Desired formats: (DB) for dB–angle, (MA) for magnitude–angle, or (RI) for real–imaginary

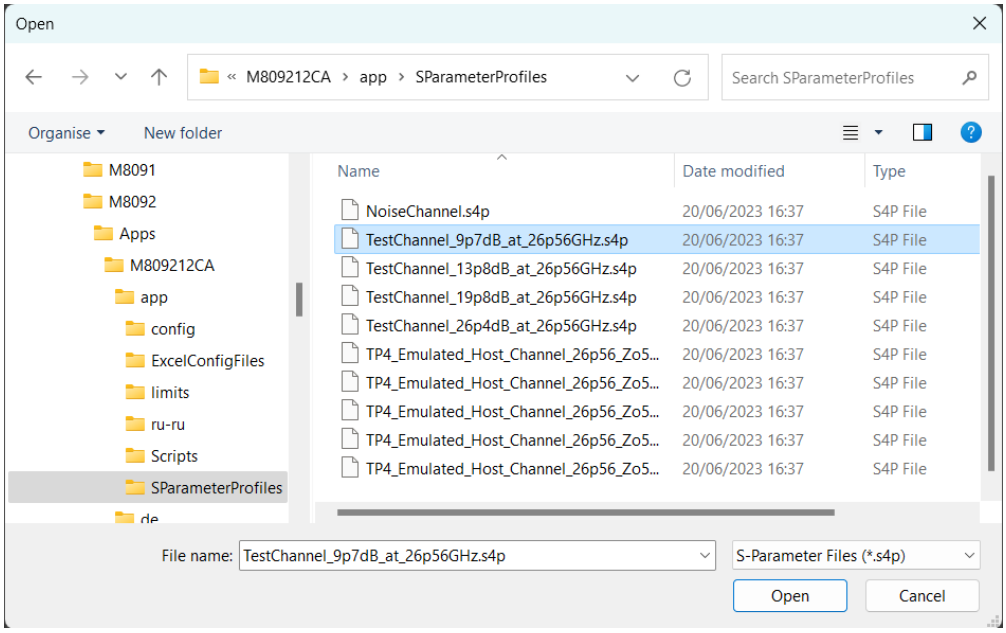


Figure 36 Selecting an S-Parameter file from the default folder

The new file location appears in the **COM Configuration** area for the corresponding Test/Noise Channel or Excel Configuration File.

NOTE

The S-parameter file for the Test Channel should include the response of the cable or PCB trace and also the receiver test fixture (referred to as "TP5a–TP5" channel, see Figure 30 on page 55). It is usually not possible to measure this. An S-parameter file combining all of this can be generated using the individual responses using a PLTS.

Default S-Parameter Files

The default S-parameter files for the Test Channel provided by the application do not include the Rx replica channel. For a proper calibration it is necessary to measure the real Test Channel that is going to be tested.

The default Test Channel files were created with the setups listed in Table 5.

Table 5 Setup used in each case to create the default S-parameter files for the Test Channel

Test Channel	Setup*
TestChannel_9p7dB	ch1 + short cable + directional coupler + short cable
TestChannel_13p8dB	ch5 + short cable + directional coupler
TestChannel_19p8dB	ch9 + adapter + directional coupler + short cable
TestChannel_26p4dB	ch4 + short cable + ch6 + adapter + directional coupler

* The channel traces correspond to the 112G Datacom ISI Board and the short cable is 1.85 mm to 1.85 mm (M8199-61610/M8045-61602).

Calibration Procedure

The OIF-112G MR/LR receiver test calibration procedures comprise three steps:

1 System calibration: Calibrate the equipment used to generate the victim transmitter and the broadband noise (once per setup configuration).

2 Channel characterization: S-parameter measurements using a Network Analyzer for both the low loss and high loss channels. The S-parameter of a “TP5a–TP5 replica trace” should be convoluted/combined with that of the ISI trace and coupler. Typical replica trace S-parameters can be generated using formula (93A-14) in Clause 93A of IEEE P802.3ck. The optimal amount of channel equalization at the transmitter is defined during this stage.

3 COM-related calibration: The following steps are performed to complete the COM model:

   a Verify channel compliance based on S-parameter analysis

   b Measure transmitter characteristics (jitter & electrical characteristics)

Finally, the COM model computes the amount of broadband noise to be injected in the noise path to test the receiver (BER measurement for different levels of noise or jitter) under a specific COM (usually 3 dB).

Two COM-related calibrations are required, one for the low-loss channel and one for the high-loss channel. As well as choosing the appropriate test channel S-parameter file, the user should also set the Test Channel Configuration parameter in the **Configure tab** to match the chosen channel loss. The Calibration Persistence function can be used to save/recall common calibration data between the two tests.

Overview of Calibration Procedures

Table 2 on page 52 shows a summary of steps for each procedure that must be performed for calibration. The figures mentioned in the steps in that table are based on those in *Annexure 93C, IEEE Std 802.3bj-2014, Amendment to IEEE Std 802.3-2012: Ethernet*.

NOTE

If you run the **Channel Characterization using COM model** calibration, it will determine the channel de-emphasis taps settings (Channel EQ Pre-cursor3/2/1 and Channel EQ Post-Cursor1) under the **Configure** tab and automatically update the channel equalization coefficients in the de-emphasis taps. For more information on Channel Characterization using COM model calibration, refer to Channel Characterization using COM Model on page 79.

Amplitude Calibration

Overview The Amplitude Calibration is performed to calibrate the Victim Generator's Amplitude for the Transmitter Measurements for the COM model.

NOTE **The amplitude calibration is dependent on the transmitter equalization setting. Please run this measurement after having specified the desired Transmitter Pre-/Post-Cursor parameters.**

Connection Diagram Connect the instruments as shown in Figure 37 (M8050A, DCA-X) and Figure 38 (M8050A, UXR).

Connect:

- Connect Victim Generator's Data Out 1 P/N to Oscilloscope CH1/CH2.
- Terminate X-Talk Generator's Data Out 2 with 50 ohms.

NOTE **TP0 to TP0a trace is not required for the calibrated instrument-grade transmitter.**

Figure 37 Amplitude Calibration connections for MR/LR (M8050A BERT and DCA-X Oscilloscope)

Figure 38 Amplitude Calibration connections for MR/LR (M8050A BERT and UXR Oscilloscope)

ID

Standard Name	Test ID
Medium Reach	471100
Long Reach	671100

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure This calibration uses the QPRBS13-CEI pattern.

The Victim Generator Amplitude is set and measured for multiple Amplitudes.

Results The Amplitude Calibration returns pass/fail and the Set Amplitude for which the Measured Amplitude was closest to the target value. Figure 39 shows an example for MR. The results for LR look similar.

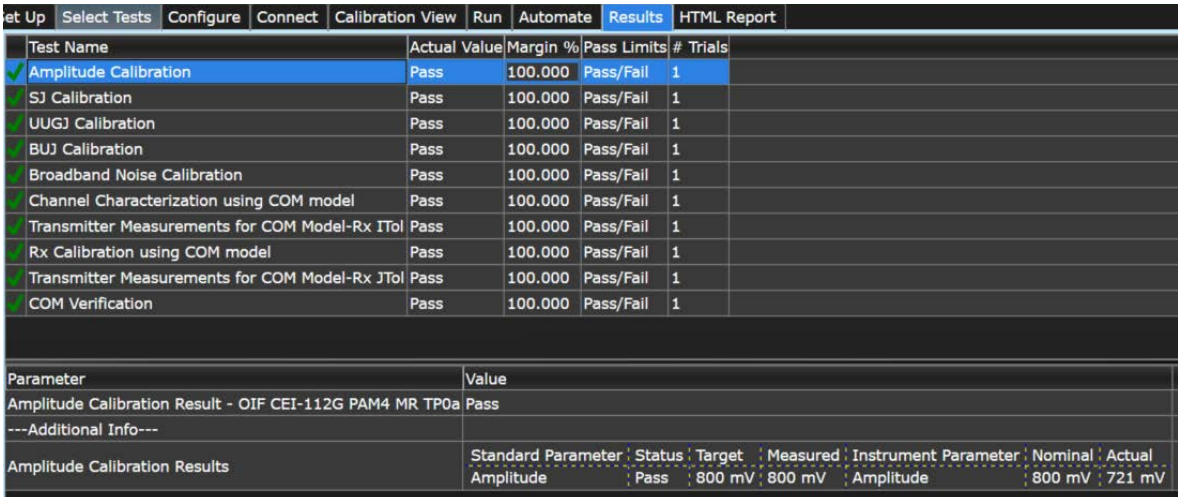


Figure 39 Amplitude Calibration results in the Results tab for MR

SJ Calibration

Overview The SJ Calibration is performed to calibrate the Sinusoidal Jitter.

Connection Diagram Connect the instruments as shown in Figure 40 (M8050A, DCA-X) and Figure 41 (M8050A, UXR).

Connect:

- Connect Victim Generator's Data Out 1 P/N to Oscilloscope CH1/CH2.
- Terminate X-Talk Generator's Data Out 2 P/N with 50 ohms.

Figure 40 SJ Calibration connections for MR/LR (M8050A BERT and DCA-X Oscilloscope)

Figure 41 SJ Calibration connections for MR/LR (M8050A BERT and UXR Oscilloscope)

ID

Standard Name	Test ID
Medium Reach	471101
Long Reach	671101

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure This calibration uses the Clock/8 pattern.

The SJ is calibrated for a discrete number of points ranging from the minimum to maximum amplitude of the Victim Generator PJ1.

Results The SJ Calibration returns the results

- pass or fail in the Results tab
- measured SJ versus the set PJ1 in graphical and tabular formats in the Calibration View tab (Figure 42)

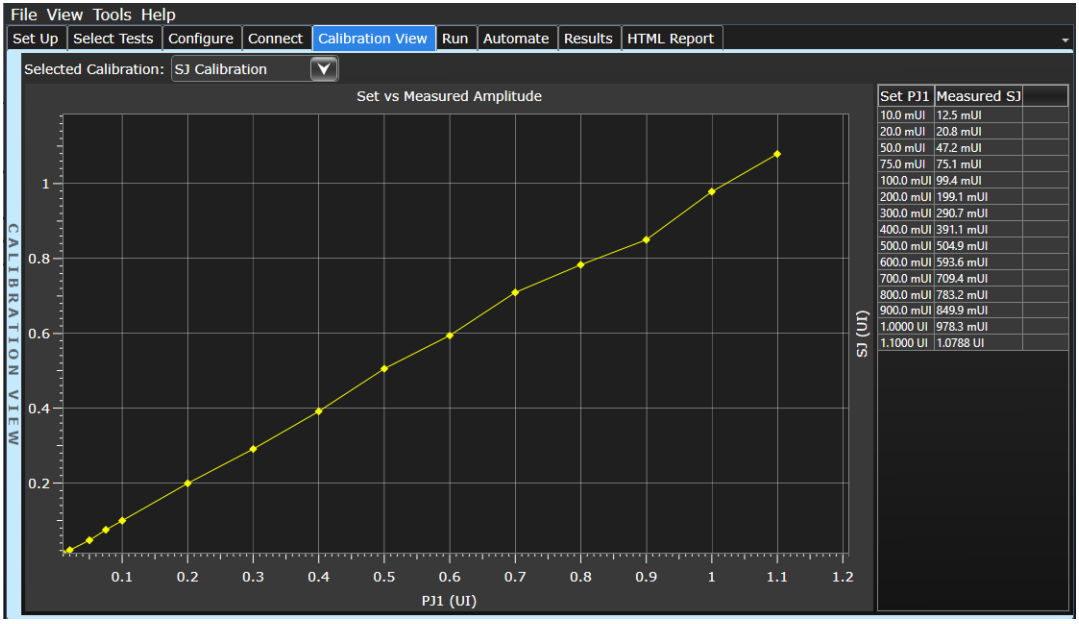


Figure 42 SJ Calibration calibrated data in Calibration View tab

UUGJ Calibration

Overview The UUGJ Calibration is performed to calibrate the Uncorrelated Unbounded Gaussian Jitter (UUGJ).

Connection Diagram Connect the instruments as shown in Figure 40 (M8050A, DCA-X) and Figure 41 (M8050A, UXR) for the SJ Calibration on page 73.

ID

Standard Name	Test ID
Medium Reach	471102
Long Reach	671102

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure This calibration uses the 1010... toggle (Clock) pattern.

The UUGJ is calibrated for a discrete number of points ranging from the minimum to maximum amplitude of the Victim Generator Random Jitter (RJ).

Results The UUGJ Calibration returns the results

- pass or fail in the Results tab
- measured UUGJ versus the set RJ in graphical and tabular formats in the Calibration View tab (Figure 43)

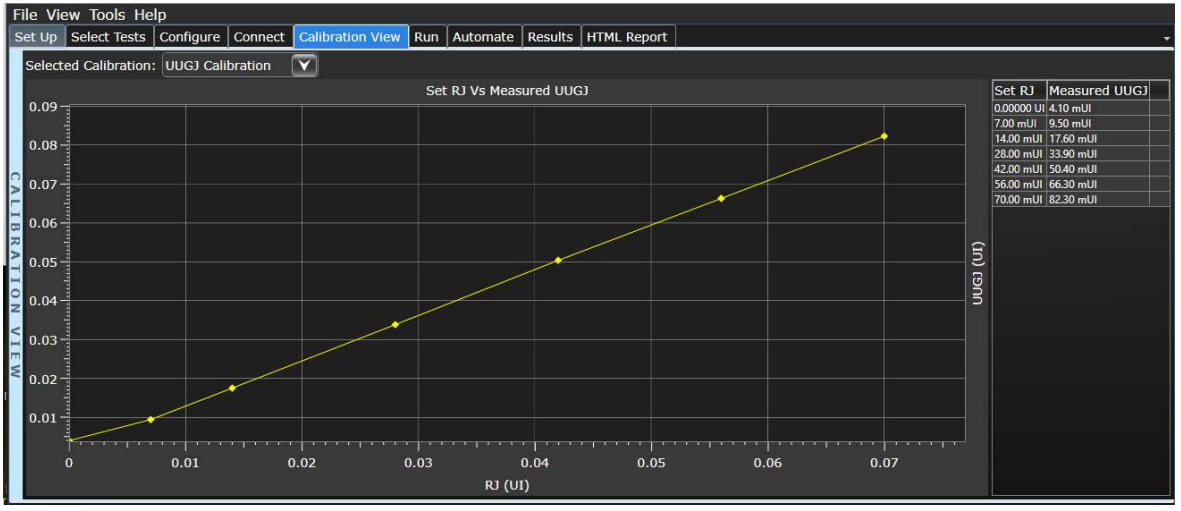


Figure 43 UUGJ Calibration calibrated data in Calibration View tab

BUJ Calibration

NOTE The UBHPJ stress component comprises BUJ and SJ components. However, since the SJ component compensates for the UBHPJ component, the BUJ component is not required for calibrations. However, if you wish a BUJ component to be included for calibration, you can set the BUJ parameter and reduce the corresponding SJ component, so that the overall UBHPJ component remains the same.

Overview The BUJ Calibration is performed to calibrate the Bounded Uncorrelated Jitter.

Connection Diagram Connect the instruments as shown in Figure 40 (M8050A, DCA-X) and Figure 41 (M8050A, UXR) for the SJ Calibration on page 73.

ID

Standard Name	Test ID
Medium Reach	471103
Long Reach	671103

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure This calibration uses the 1010... toggle (Clock) pattern.

The Victim Generator BUJ is set until the desired BUJ value is measured.

Results The BUJ Calibration returns pass/fail and the Set BUJ for which the Measured BUJ was closest to the target value. Figure 44 shows an example for MR. The results for LR look similar.

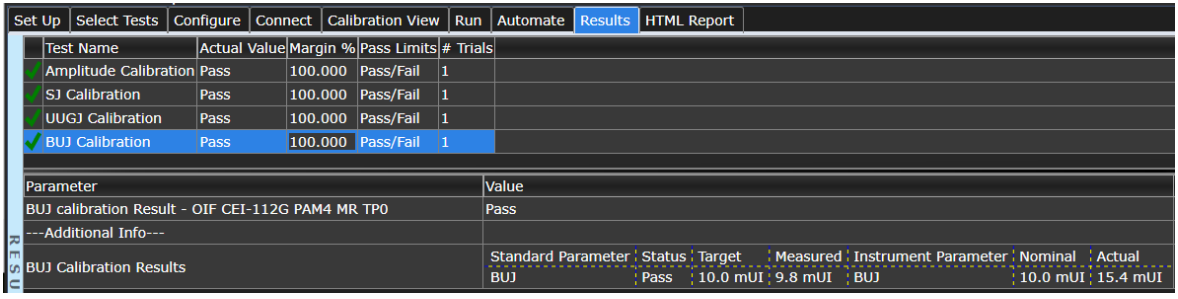


Figure 44 BUJ Calibration result in the Results tab, for MR

Broadband Noise Calibration

Overview The Broadband Noise Calibration is performed to calibrate the broadband noise in the channel.

Connection Diagram Connect the instruments as shown in Figure 45 (M8050A, DCA-X) and Figure 46 (M8050A, UXR).

Connect:

- Connect Noise Generator's Data Out 1 P/N to Oscilloscope CH1/CH2.
- Terminate Victim Generator's Data Out 1 P/N with 50 ohms.
- Terminate X-Talk Generator's Data Out 2 P/N with 50 ohms.

Figure 45 Broadband Noise Calibration connections for MR/LR (M8050A BERT and DCA-X Oscilloscope)

Figure 46 Broadband Noise Calibration connections for MR/LR (M8050A BERT and UXR Oscilloscope)

ID

Standard Name	Test ID
Medium Reach	471104
Long Reach	671104

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure A discrete number of points from the minimum to maximum amplitude of the random interference from the Noise Generator are calibrated.

Results The Broadband Noise Calibration returns the results

- pass or fail in the Results tab
- Measured Broadband Noise Amplitude (RMS) versus Set Amplitude in graphical and tabular formats in the Calibration View tab (Figure 47)

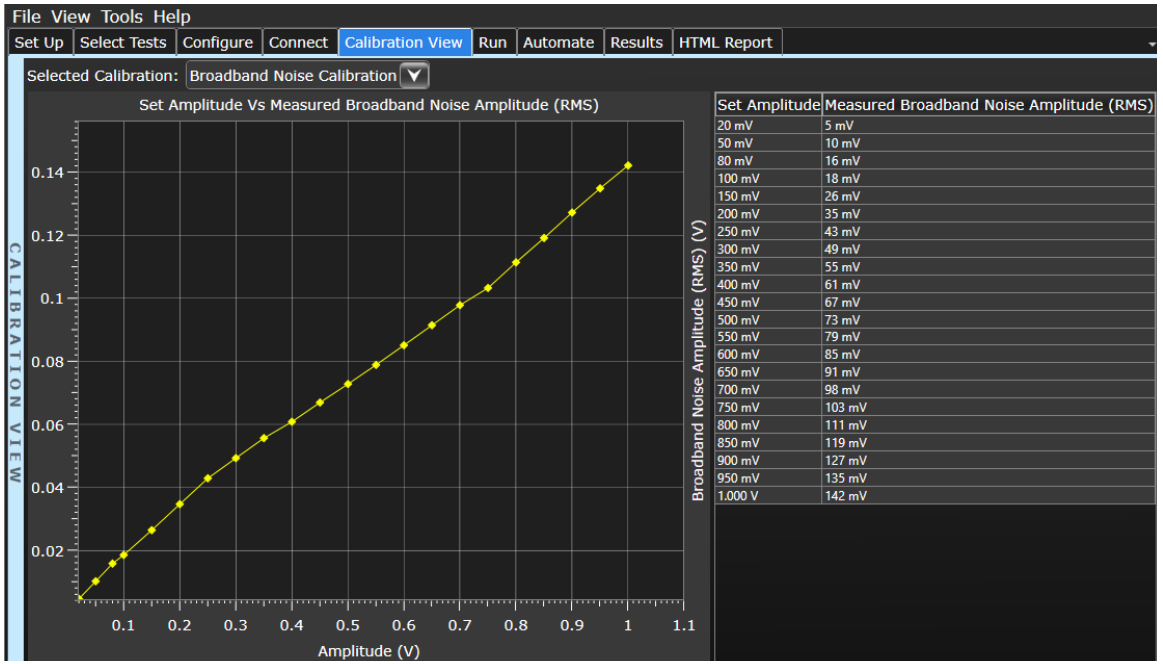


Figure 47 Broadband Noise Calibration calibrated data in Calibration View tab

Channel Characterization using COM Model

Overview The Channel Characterization using COM Model validates the channel characteristics using the COM model as per *Table_26-1 COM Parameter Values* in *Section 26.2.4.2* (for MR) and as per *Table_27-1 COM Parameter Values* in *Section 27.2.4.2* (for LR) of the *OIF Implementation Agreement OIF-CEI-05.0*. This calibration should be performed for both the low- and high-loss channel test cases.

Connection Diagram Connect the instruments as shown in Figure 48 (M8050A,).

NOTE TP0 to TP0a trace is not required for the calibrated instrument-grade transmitter.

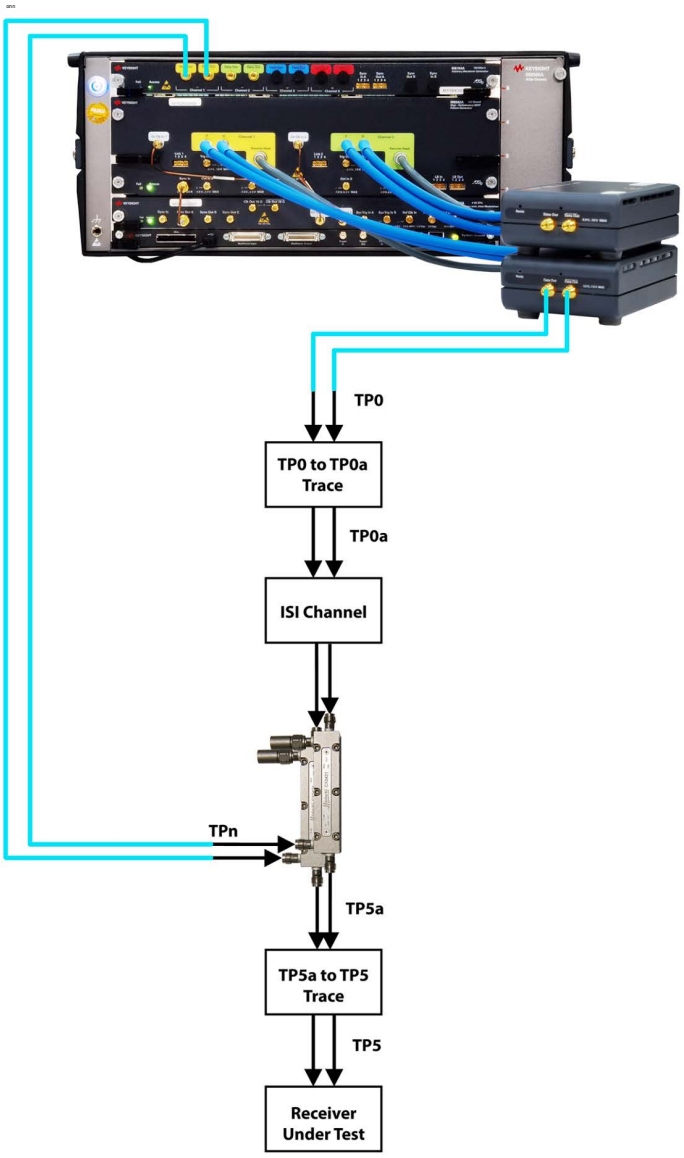


Figure 48 Connections for Channel Characterization using COM Model for MR/LR (M8050A BERT)

ID

Standard Name	Test ID
Medium Reach	472100
Long Reach	672100

Dependencies This calibration depends on the values configured for the following settings:

- Test Channel S-Parameters
- Excel Config File – to configure COM parameters

For more information on configuring Test Channel S-Parameters and the Excel Config File, refer to MR and LR Configuration in the Test App on page 64.

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure This calibration uses the Q-PRBS13-CEI pattern.

Results Channel Characterization using COM Model returns the results for all the selected Test Channel Configurations, in the Results tab.

- COM, including effects of Broadband Noise
- Insertion Loss at Nyquist

This calibration will determine the channel de-emphasis taps settings (Channel EQ Pre-cursor3/2/1 and Channel EQ Post-Cursor1) under the Configure tab and will automatically update the channel equalization coefficients in the de-emphasis taps.

Figure 49 shows example results for just one case for MR. The LR results look similar.

Parameter	Value				
Channel Characterization Result- OIF CEI-112G PAM4 MR	Pass				
---Additional Info---					
PassLimit Min (MinInsertionLoss)	0.000 dB				
PassLimit Max (MaxInsertionLoss)	10.000 dB				
Channel Characterization using COM model Results	Measurement Name	Status	Measured Value	Margin %	Pass Limits
	Case 1 COM	Pass	8.210 dB	173.7 %	>= 3.000 dB
	Case 1 Insertion Loss	Pass	9.635 dB	3.7 %	[MinInsertionLoss dB to MaxInsertionLoss dB]

Figure 49 Channel Characterization using COM Model Calibration results in the Results tab for MR

Transmitter Measurements for COM Model — Rx ITol

Overview

The Transmitter Measurements for COM Model — Rx ITol procedure measures transmitter parameters for the calculation of test channel COM as per *Table 26-4 Transmitter Output Jitter Specification* in *Section 26.3.1* (for MR) and as per *Table 27-4 Transmitter Output Jitter Specification* in *Section 27.3.1* (for LR) of the *OIF Implementation Agreement OIF-CEI-05.0*.

Connection Diagram

Connect the instruments as shown in Figure 50 (M8050A, DCA-X) and Figure 51 (M8050A, UXR).

Connect:

- Victim Generator's Data Out 1 P/N to Oscilloscope CH1/CH2.
- Terminate X-Talk Generator's Data Out 2 P/N with 50 ohms.

NOTE

TP0 to TP0a trace is not required for the calibrated instrument-grade transmitter.

Figure 50 Transmitter Measurements for COM Model — Rx ITol connections for MR/LR (M8050A BERT and DCA-X Oscilloscope)

Figure 51 Transmitter Measurements for COM Model — Rx ITol connections for MR/LR (M8050A BERT and UXR Oscilloscope)

ID

Standard Name	Test ID
Medium Reach	472101
Long Reach	672101

Dependencies This procedure depends on the values configured for the following settings:

- All MR/LR calibrations performed previously:
  - Amplitude Calibration on page 70
  - SJ Calibration on page 73
  - UUGJ Calibration on page 75
  - BUJ Calibration on page 76
  - Broadband Noise Calibration on page 77
  - Channel Characterization using COM Model on page 79

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure This procedure uses the QPRBS13-CEI pattern.

Results The procedure Transmitter Measurements for COM Model — Rx ITol returns the results for all Transmitter Electrical Output and Jitter Output parameters for the selected Test Channel Configuration.

Transmitter Output Jitter Specification

- Uncorrelated jitter RMS (Jrms) (standard deviation of the probability distribution)
- Uncorrelated Jitter (J5u) (time interval from 0.0005% to 99.9995% of the probability distribution)

Transmitter Electrical Output Specification

- Transition Time
- SNDR for Rx Test (Np = 11)
- Level Separation Mismatch Ratio RLM
- Signal-to-Noise-and-Distortion Ratio (Np = 200)

The Output Jitter Measurement and Linear Fit Pulse Response (Np = 11) are presented as an image in the app.

Figure 52 and Figure 53 show example results for MR. The LR results look similar.

Parameter	Value				
Transmitter Measurements - OIF CEI-112G PAM4 MR TP0a	Pass				
---Additional Info---					
Transition Time	9 ps				
SNDR for Rx Test(Np=11)	37.29 dB				
Output Jitter Measurement	(See image)				
Linear Fit Pulse Response(Np=11)	(See image)				
Transmitter Measurements	Measurement Name	Status	Measured Value	Margin %	Pass Limits
	Jrms	Pass	12.6 mUI	45.2 %	<= 23.0 mUI
	J5u	Pass	120.9 mUI	5.5 %	<= 128.0 mUI
	Level mismatch ratio RLM	Pass	0.96	1.1 %	>= 0.95
	Signal-to-noise-and-distortion ratio(Np=200)	Pass	40.67 dB	25.1 %	>= 32.50 dB

Figure 52 Transmitter Measurements for COM Model — Rx ITol Calibration results for MR, in Results tab

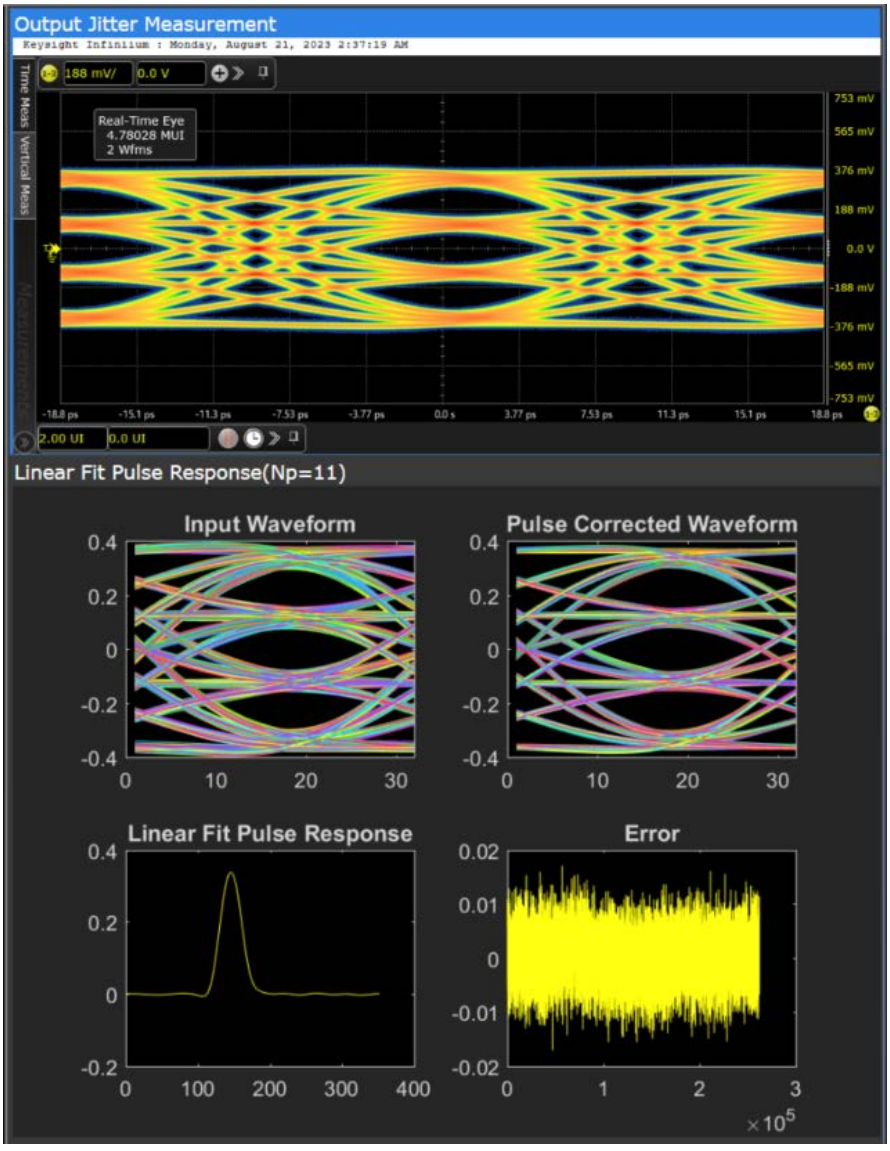


Figure 53 Transmitter Measurements for COM Model — Rx ITol calibration results, for MR. Eye diagram on oscilloscope

Rx Calibration using COM Model

Overview The Rx Calibration using COM Model prepares the calibration data as a prerequisite to performing the Receiver Interference Tolerance Test. This calibration should be performed for both the low- and high-loss channel test cases.

Connection Diagram Connect the instruments as shown in Figure 54 (M8050A).

NOTE **TP0 to TP0a trace is not required for the calibrated instrument-grade transmitter.**

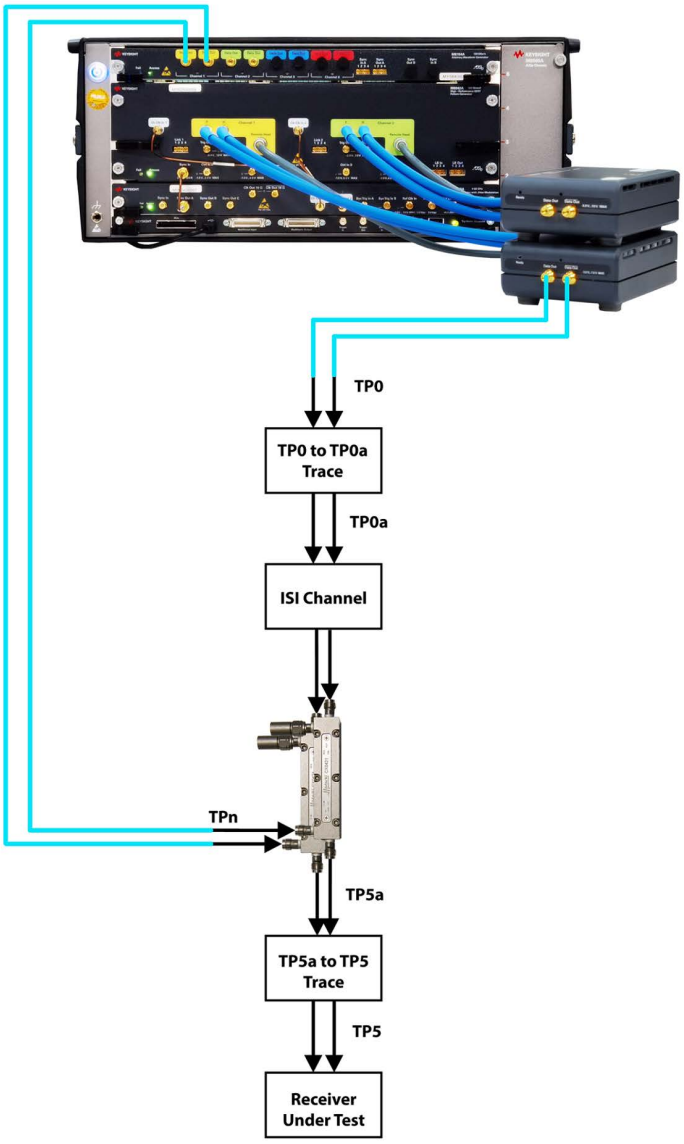


Figure 54 Rx Calibration using COM Model connections for MR/LR (M8050A BERT)

ID

Standard Name	Test ID
Medium Reach	472102
Long Reach	672102

Dependencies The Rx Calibration using COM Model depends on the values measured in Transmitter Measurements for COM Model – Rx ITol on page 82.

- Test Channel S-Parameters
- Noise Channel S-Parameters
- Excel Config File – containing COM parameter values after "Transmitter Measurements for COM Model" is performed

For more information on configuring Test Channel S-Parameters, Noise Channel S-Parameters and Excel Config File, refer to MR and LR Configuration in the Test App on page 64.

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure This calibration determines the Broadband Noise (RMS) value using COM calibration until the COM value begins to decrease below 3 dB.

The following parameters are modified automatically in the Excel Config File by the software, without any manual intervention:

- Tr
- Sigma RJ
- Add
- SNDR
- R_LM
- All parameters that are dependent on Baud Rate, such as CTLE and zeros
- RX_CALIBRATION = 1
- FORCE_TR = 1

Results The calibrated values are displayed in tabular format in the Results tab. Figure 55 shows example results for MR. The LR results look similar.

Parameter	Value	
COM Rx Calibration Result- OIF CEI-112G PAM4 MR	Pass	
---Additional Info---		
Rx Calibration using COM model Results	Measurement Name	Measurement Value
	Rx calibration Noise RMS Voltage	36.25 mV
	sigma RJ	12.3 mUI
	Add	2.6 mUI

Figure 55 Rx Calibration using COM Model Calibration results for MR

Transmitter Measurements for COM Model — Rx JTol

Overview

The procedure Transmitter Measurements for COM Model — Rx JTol measures transmitter parameters for the calculation of test channel COM as per *Table 26-4 Transmitter Output Jitter Specification* in *Section 26.3.1* (for MR) and as per *Table 27-4 Transmitter Output Jitter Specification* in *Section 27.3.1* (for LR) of the *OIF Implementation Agreement OIF-CEI-05.0*.

Connection Diagram

Connect the instruments as shown in Figure 50 (M8050A, DCA-X) and Figure 51 (M8050A, UXR) for Transmitter Measurements for COM Model — Rx ITol on page 82.

ID

Standard Name	Test ID
Medium Reach	473100
Long Reach	673100

Dependencies

This procedure depends on the values configured for the following settings:

- Excel Config File — to configure COM parameters

For more information on configuring Test Channel S-Parameter files and the Excel Config File, refer to MR and LR Configuration in the Test App on page 64.

- Calibrated values from the following calibrations:
  - Amplitude Calibration on page 70
  - SJ Calibration on page 73
  - UUGJ Calibration on page 75

Parameters

Refer to Calibration Parameters in Debug Mode on page 60.

Procedure

This calibration uses the QPRBS13-CEI pattern.

Results

The procedure Transmitter Measurements for COM Model — Rx JTol returns the results for all Transmitter Electrical Output and Jitter Output parameters for the selected Test Channel Configuration, in tabular format.

Transmitter Output Jitter Specification

- Uncorrelated jitter RMS (Jrms) (standard deviation of the probability distribution)
- Uncorrelated Jitter (J5u) (time interval from 0.0005% to 99.9995% of the probability distribution)

Transmitter Electrical Output Specification

- Transition Time
- Level Separation Mismatch Ratio
- Signal-to-Noise-and-Distortion Ratio (Np =200)
- SNDR for Rx test (Np = 11)

The Output Jitter Measurement and Linear Fit Pulse Response (Np = 11) are presented as an image in the app.

Figure 56 and Figure 57 show example results for MR. The LR results look similar.

Parameter	Value	
Transmitter Measurements - OIF CEI-112G PAM4 MR TP0a	Pass	
---Additional Info---		
Transmitter Measurements for COM Model Results	Measurement Name	Measurement Value
	Transition Time	9 ps
	Jrms	19.4 mUI
	J5u	142.2 mUI
	Level mismatch ratio RLM	0.96
	Signal-to-noise-and-distortion ratio	39.24 dB

Figure 56 Transmitter Measurements for COM Model – Rx JTol calibration results for MR in Results Tab

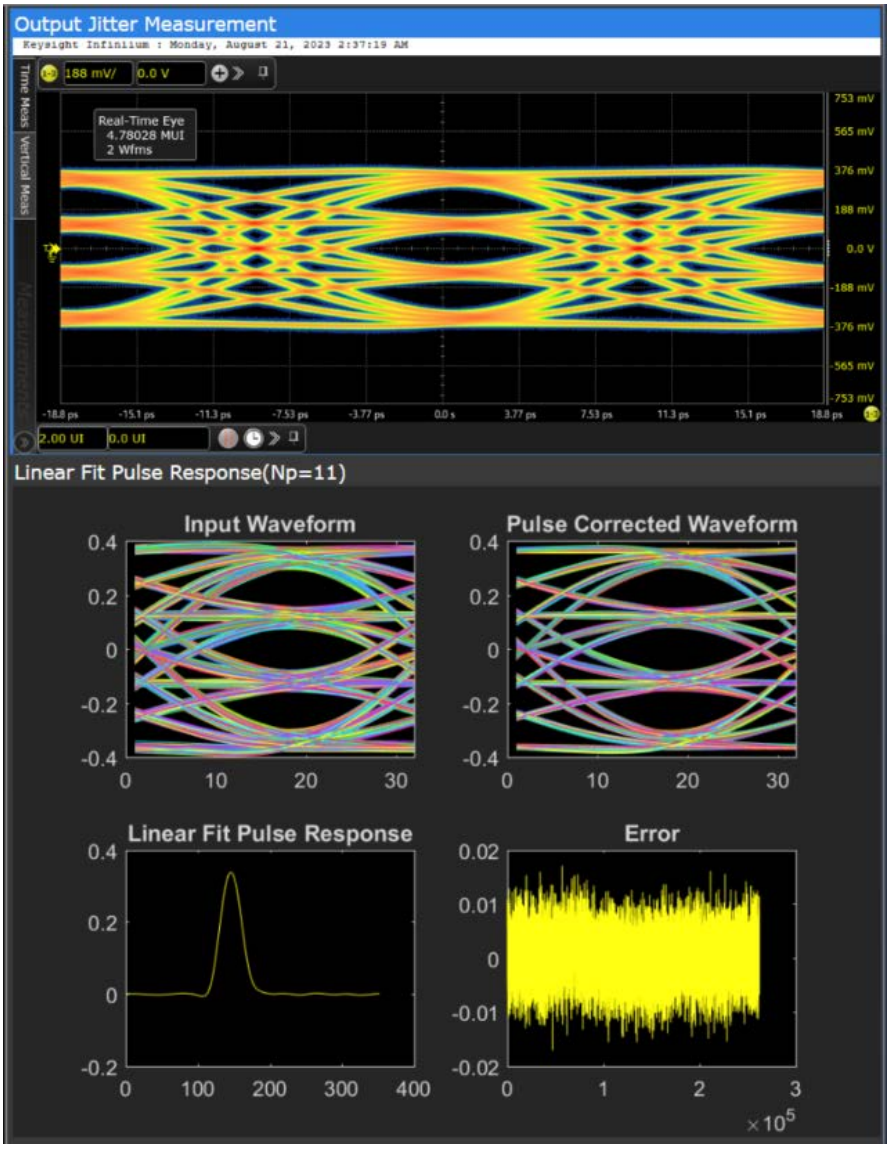


Figure 57 Transmitter Measurements for COM Model — Rx JTol calibration results for MR, graphical format

COM Verification

Overview COM Verification verifies the calibration data as a prerequisite to performing the Receiver Jitter Tolerance Test. This calibration is only required for the high-loss channel test case.

Connection Diagram Connect the instruments as shown in Figure 58 (M8050A).

NOTE TP0 to TP0a trace is not required for the calibrated instrument-grade transmitter.

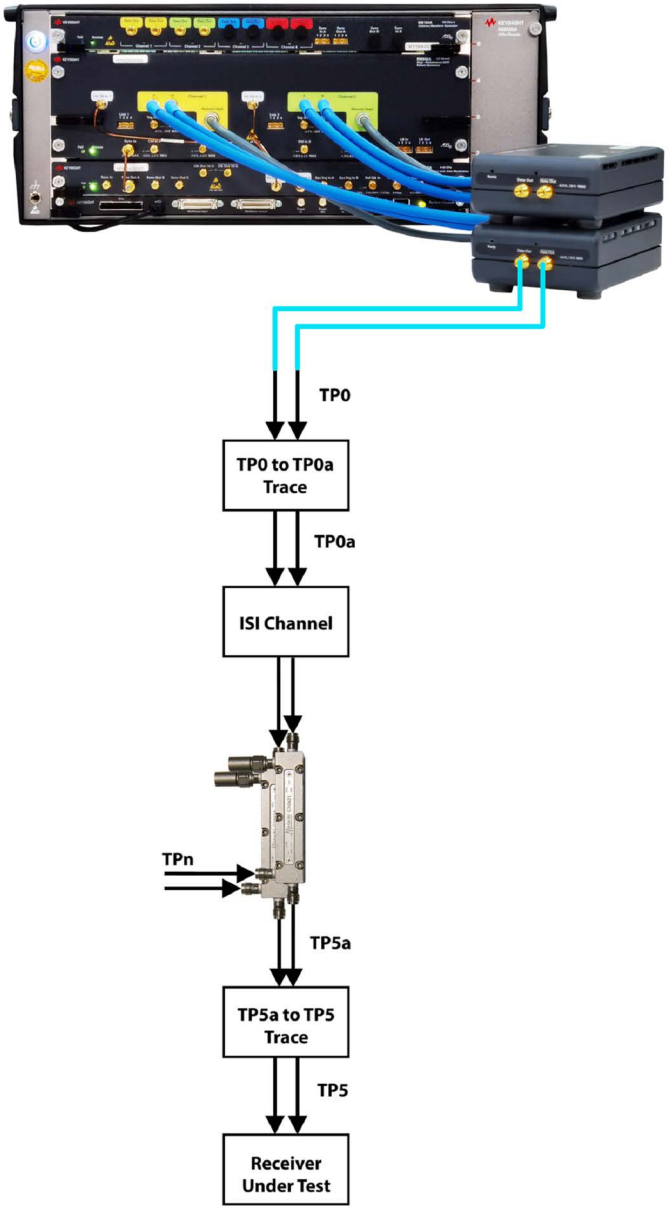


Figure 58 COM Verification connections for MR/LR (M8050A BERT)

ID

Standard Name	Test ID
Medium Reach	473101
Long Reach	673101

Dependencies This procedure depends on the values measured in Transmitter Measurements for COM Model – Rx JTol on page 89.

- Test Channel S-Parameter
- Noise Channel S-Parameter
- Excel Config File – containing COM parameter values after "Transmitter Measurements for COM Model" is performed

For more information on configuring Test Channel S-Parameter file, Noise Channel S-Parameter file and Excel Config File, refer to MR and LR Configuration in the Test App on page 64.

Parameters Refer to Calibration Parameters in Debug Mode on page 60.

Procedure The procedure COM Verification validates that the COM is above the target value when the Tx parameters are adapted for the Jitter Tolerance Test.

Results The calibrated values are displayed in tabular format in the Results tab. Figure 59 shows example results for LR. Results for MR look similar.

RESULTS

Parameter	Value				
COM Verification Result- OIF CEI-112G PAM4 LR	Pass				
---Additional Info---					
COM Verification Results	Measurement Name	Status	Measured Value	Margin %	Pass Limits
	Case 1 COM	Pass	8.479 dB	182.6 %	>= 3.000 dB

Figure 59 COM Verification Calibration results

5 OIF-CEI 5.0 MR and LR Tests

This chapter describes the test procedures for the OIF-CEI-112G (OIF-112G) Rx Tests that are applicable for the MR and LR standard options.

As a prerequisite, before running MR and LR tests:

- Run all OIF-CEI-112G MR and LR calibrations.
- Ensure that the DUT is properly connected to the BERT modules and the test channel.

Test Parameters in Debug Mode

The **Debug** mode in the **Configure** tab of the Test Application includes some parameters in addition to those that can be configured in the **Compliance** mode. Besides, for some of the configuration options, you may enter custom values, which provides a greater flexibility in performing calibrations and tests.

For the **Medium Reach** and **Long Reach** standard options, the test parameters listed in Table 6 are available for configuration.

Table 6 Test parameters in debug mode for the MR and LR standard options

Test Parameter	Description
Parameters Common to All Tests	
Baud Rate	Baud Rate for testing device and for all calibrations.
Victim Generator PAM4 Symbol Mapping	Selects how consecutive data bits are mapped to symbols.
Victim Generator PAM4 Custom Symbol Mapping	Selects how consecutive data bits are mapped to symbols. The mapping is defined as a comma-separated list of bit sequences (e.g. 00,01,11,10). The position within this list corresponds to the symbol level. First value is for Symbol 0 and last value is for Symbol 3.
Target Error Ratio	Target Error Ratio for deciding if a test is passed or failed.
Sync Loss Threshold	The threshold level of error ratio at which synchronization is successful.
Alignment BER Threshold	BER threshold used as pass/fail criterion during the sample point alignment.
Target COM	Target COM for deciding if a test is passed or failed.
Test Channel Configuration	Specify test channel configuration that needs to be calibrated to meet COM (3dB max). Low Loss corresponds to Test1, whereas High Loss corresponds to Test2; both should be configured to meet the COM value (3 dB max).
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
Channel EQ Pre-Cursor3 for ITol	Controls the pre-cursor 3 coefficient for channel equalization for the Rx Interference Tolerance Test.
Channel EQ Pre-Cursor2 for ITol	Controls the pre-cursor 2 coefficient for channel equalization for the Rx Interference Tolerance Test.

Test Parameter	Description
Channel EQ Pre-Cursor1 for ITol	Controls the pre-cursor 1 coefficient for channel equalization for the Rx Interference Tolerance Test.
Channel EQ Post-Cursor1 for ITol	Controls the post-cursor 1 coefficient for channel equalization for the Rx Interference Tolerance Test.
Channel EQ Pre-Cursor3 for JTol	Controls the pre-cursor 3 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Channel EQ Pre-Cursor2 for JTol	Controls the pre-cursor 2 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Channel EQ Pre-Cursor1 for JTol	Controls the pre-cursor 1 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Channel EQ Post-Cursor1 for JTol	Controls the post-cursor 1 coefficient for channel equalization for the Rx Jitter Tolerance Test.
Noise Generator Channel Selection	Selects the location of the Noise Generator that shall be used for generating broadband noise.
Victim Analyzer Module	Selects the victim analyzer module for testing device. ▪ If 'BERT Analyzer' is selected, manually configure the "Victim Analyzer Clock Source" parameter. ▪ If 'DCI' is selected, manually configure the "DUT Control Interface Script File" and "DUT Control Interface Location" parameters.
Victim Analyzer Clock Source	Selects the clock source for the victim analyzer module. This parameter is only applicable when BERT analyzer is selected as the Victim Analyzer Module.
Victim Analyzer PAM4 Symbol Mapping	Selects how consecutive data bits are mapped to symbols.
Victim Analyzer PAM4 Custom Symbol Mapping	Selects how consecutive data bits are mapped to symbols. The mapping is defined as a comma-separated list of bit sequences (e.g. 00,01,11,10). The position within this list corresponds to the symbol level. First value is for Symbol 0 and last value is for Symbol 3.
Target Confidence Level	Target Confidence Level for Target Error Ratio to decide if a test is passed or failed.
DUT Control Interface Script File	Select the DCI script file to be loaded for receiver tests.
DUT Control Interface Location	DCI Location to be used for receiver tests.
Pause before starting Receiver tests	Selects if a pause is made after configuring the error detector modules and before running the alignment to allow for manual changes in the settings.
Parameters for Receiver Interference Tolerance Test	
Broadband Noise Amplitude (RMS)	Specifies the amplitude of the broadband noise.
Broadband Noise Selector	Select between manual or calibrated broadband noise amplitude.
Parameters for Receiver Jitter Tolerance Test	
Test Mode	Select whether to test just for predefined SJ Frequencies ('Compliance') or to measure SJ Frequency ('Characterization').
Jitter Profile Frequency1	Defines the first corner frequency of the jitter profile.
Jitter Profile Amplitude1	Defines the jitter amplitude at first corner frequency of the jitter profile.

Test Parameter	Description
Jitter Profile Frequency2	Defines the second corner frequency of the jitter profile.
Jitter Profile Amplitude2	Defines the jitter amplitude at second corner frequency of the jitter profile.
Jitter Profile Frequency3	Defines the third corner frequency of the jitter profile.
Jitter Profile Amplitude3	Defines the jitter amplitude at third corner frequency of the jitter profile.
Frequency Relax Time	Relax time on jitter frequency changes.
Amplitude Relax Time	Relax time on jitter amplitude changes.
Algorithm	Select the measurement algorithm.
Frequency Mode	Select between Auto and Manual frequency modes.
Start Frequency	Controls the start frequency of the jitter sweep.
Stop Frequency	Controls the stop frequency of the jitter sweep.
Number of Steps	The number of steps within the jitter sweep.
Minimum Jitter Amplitude Limit	Minimum Jitter Amplitude Limit.
Maximum Jitter Amplitude Limit	Maximum Jitter Amplitude Limit.
Manual Frequency List	List of Jitter frequencies separated by commas.
JTol Step Size	Step Size for the binary algorithm of the JTol measurement.
JTol Linear Step Size	Step Size for the linear algorithm of the JTol measurement.
JTol Step Size Log	Step Size for the logarithmic algorithm of the JTol measurement.

Rx Test Procedures

Overview of Receiver Tests

Table 7 shows a summary of steps for each procedure that must be performed for Rx tests. The figures mentioned in the table and in the steps in this section are based on those in *Annexure 93C, IEEE Std 802.3bj-2014, Amendment to IEEE Std 802.3-2012: Ethernet*.

Table 7 Rx test procedure step summary

#	Procedure	Test Channel Configuration	Summary of steps to be performed
1	Rx Interference Tolerance Test	Perform Rx Interference Tolerance Test for both the low loss and high loss channel.	Perform Rx interference tolerance test (see setup in Figure 30).
2	Rx Jitter Tolerance Test	Perform Rx Jitter Tolerance Test for high loss channel.	Perform Rx jitter tolerance test (see setup in Figure 60).

These procedures are broadly described in the following section.

Detailed Steps for Rx Test Procedures

Step#1. Rx Interference Tolerance Test

1 Using the test setup in Figure 30, the transmitter taps and the channel noise as determined in the calibration procedures, configure the transmitter to transmit the test pattern specified in the PMD clause that invokes this method.

2 Configure the transmitters of the device under test to transmit the same test pattern, with their transmitters in the preset condition.

3 Measure the BER using the QPRBS31-CEI pattern on the receiver under test using the built-in error counter or by activating the DUT internal loopback mode and using a short loopback channel (IL < 10 dB for MR high loss, IL < 20 dB for MR low loss, IL < 14 dB for LR high loss, IL < 28 dB for LR low loss, @ 26.5625 GHz) to an M8046A error detector.

Step#2. Rx Jitter Tolerance Test

1 Using the test setup in Figure 60 and the transmitter taps (but without the channel noise) as determined in the calibration procedures, configure the transmitter to transmit the test pattern specified in the PMD clause that invokes this method.

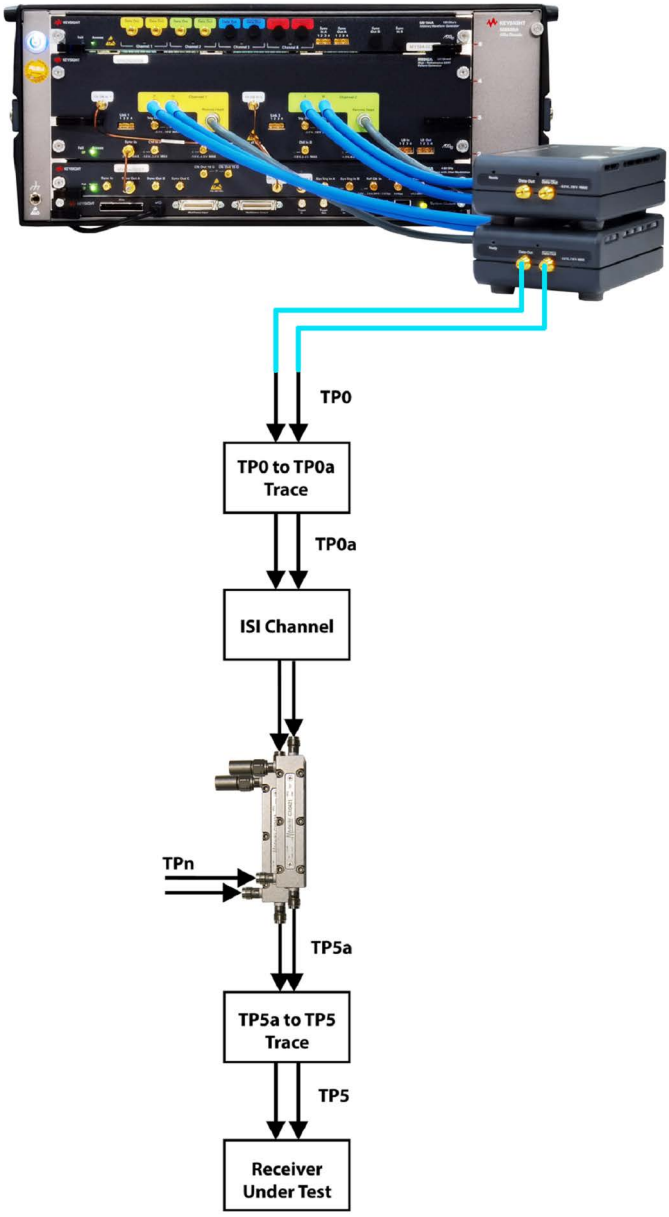


Figure 60 Test setup for Rx Jitter Tolerance Test without channel noise

2 Configure the transmitters of the device under test to transmit the same test pattern, with their transmitters in the preset condition.

3 Measure the BER using the QPRBS31-CEI pattern on the receiver under test using the built-in error counter or by activating the DUT internal loopback mode and using a short loopback channel (IL < 10 dB for MR high loss, IL < 20 dB for MR low loss, IL < 14 dB for LR high loss, IL < 28 dB for LR low loss, @ 26.5625 GHz) to an M8046A error detector.

For each case listed in Table 8, the receiver under test shall meet the tolerance parameters as specified in *Table 26-11 Receiver Jitter Tolerance Parameters* (for MR; *Table 27-11* for LR is identical to this) in *Section 26.3.2.5* of the *OIF Implementation Agreement OIF-CEI-05.0*.

Table 8 Receiver jitter tolerance parameters

Parameter	Case A	Case B	Case C	Case D	Case E	Case F	Units
Jitter amplitude (pk-pk)	5	0.5	0.15	0.05	0.05	0.05	UI
Jitter frequency for default data rate 53.125 Gbps	0.04	0.4	1.333	4	12	40	MHz
Jitter frequency for baud rate f_b [MBd]	f_b/(100*13280)	f_b/(10*13280)	f_b/(3*13280)	f_b/13280	$3*f_b$/13280	$10*f_b$/13280	MHz

NOTE The BERs reported in the standard assume that the error statistics are sufficiently random to result in the required frame loss ratio. Error statistics can be characterized using the M8046A error detector together with the M8070EDAB package.

Receiver Interference Tolerance Test

Overview

The Receiver Interference Tolerance Test validates that the receiver on each lane meets the BER requirement with channels matching the Channel Operating Margin (COM) and loss parameters for Test 1 and Test 2. This test should be performed for both the low- and high-loss channel test cases.

The Receiver Interference Tolerance Test is based on the test defined in Annex 120D.3.2.1. of IEEE Std 802.3.

Connection Diagram

Connect the instruments as shown in Figure 61 (M8050A).

Connect:

- Set Device to Loopback.
- Connect Victim Generator's Data Out 1 P/N to test point T P/N of ISI channel.
- Connect ISI channel test point T P/N to thru path of matched directional coupler pair.
- Connect Noise Generator's Data Out 1 P/N to couple path of matched directional coupler pair.
- Connect Directional Coupler's Data Out P/N to Test point T P/N of Receiver test fixture.
- Connect Receiver test fixture's Test point T P/N to Receiver under test.
- Internal CDR
  - Connect Victim Analyzer's Data In P/N to Test point of looped back signal P/N.
- External CDR
  - Connect Recovered Clock Out from Clock Recovery to Victim Analyzer's Clk In.
  - Connect Victim Analyzer's Data In P/N to Test point of looped back signal P/N via Pick-Off.
- Terminate the X-Talk Generator's Data Out 2 P/N with 50 ohms.

NOTE TP0 to TP0a trace is not required for the calibrated instrument-grade transmitter.

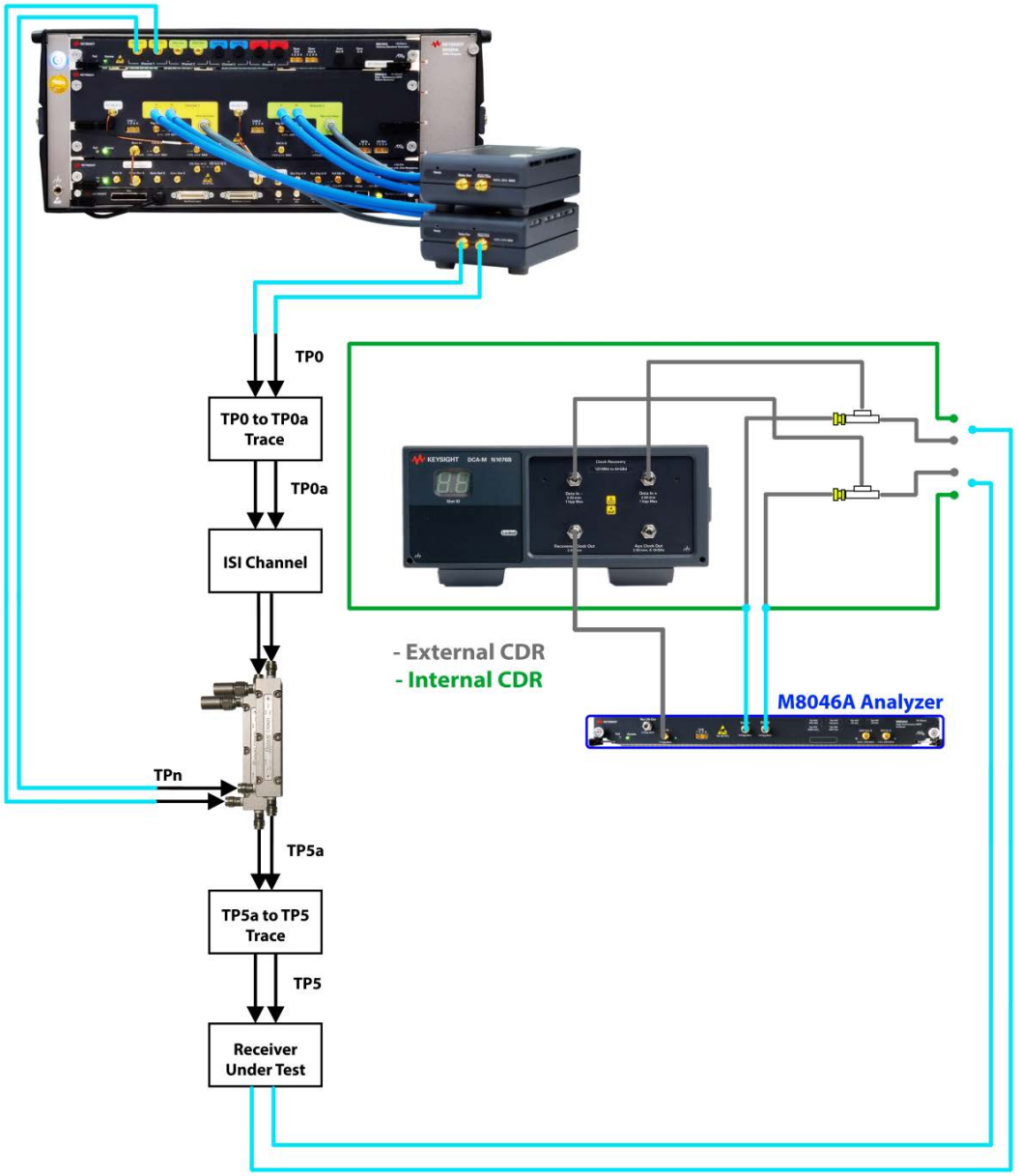


Figure 61 Rx Interference Tolerance Test connections for MR/LR (M8050A BERT)

ID

Standard Name	Test ID
Medium Reach	475100
Long Reach	675100

Dependencies The Receiver Interference Tolerance Test depends on the values configured for the following calibrations:

- Amplitude Calibration on page 70
- SJ Calibration on page 73
- UUGJ Calibration on page 75
- BUJ Calibration on page 76
- Broadband Noise Calibration on page 77
- Transmitter Measurements for COM Model – Rx ITol on page 82
- Rx Calibration using COM Model on page 86

Parameters Refer to Test Parameters in Debug Mode on page 96.

Procedure This test uses the QPRBS31-CEI pattern.

Results The Receiver Interference Tolerance Test attains 'Pass' value if the Rx BER is less than 1e-6 for MR and 1e-4 for LR, as per the *OIF-CEI 5.0* specification (Sect. 26.3.2.4, Table 26-10 and Sect. 27.3.2.4, Table 27-10).

Parameter	Value	
Receiver Interference Tolerance Test - OIF CEI-112G PAM4 MR	Pass	
---Additional Info---		
Receiver Interference Tolerance Test Screenshot	(See image)	
Receiver Interference Tolerance Test Parameters	Parameter Name	Parameter Value
	BER	2E-9
	Confidence Level	95.00 %
	Injected Noise	36.2 mV
	Coefficient 0	0
	Coefficient 1	0.019
	Coefficient 2	-0.134
	Coefficient 3	0.804
	Coefficient 4	0.043

Figure 62 Rx Interference Tolerance Test results in the results tab

Receiver Jitter Tolerance Test

Overview

The Receiver Jitter Tolerance Test validates that the receiver BER meets the requirements for each pair of jitter frequency and peak-to-peak amplitude values as per the *OIF-CEI 5.0* specification (Sect. 26.3.2.5, Table 26-11 for MR and Sect 27.3.2.5, Table 27-11 for LR). This test is only required for the high-loss channel test case.

Connection Diagram

Connect the instruments as shown in Figure 63 (M8050A).

Connect:

- Set Device to Loopback.
- Connect Victim Generator's Data Out 1 P/N to Test point T P/N of ISI channel.
- Connect ISI channel's test point T P/N to thru path of matched directional coupler pair.
- Terminate Noise Generator's Data Out_1 P/N with 50 ohms.
- Connect Directional coupler's Data Out P/N to Test point T P/N of Receiver test fixture.
- Connect Receiver test fixture's Test point T P/N to Receiver under test.
- Internal CDR
  - Connect Victim Analyzer's Data In P/N to Test point of looped back signal P/N.
- External CDR
  - Connect Recovered Clock Out from Clock Recovery to Victim Analyzer's Clk In.
  - Connect Victim Analyzer's Data In P/N to Test point of looped back signal P/N via Pick-Off.
- Terminate the X-Talk Generator's Data Out 2 P/N with 50 ohms.

NOTE TP0 to TP0a trace is not required for the calibrated instrument-grade transmitter.

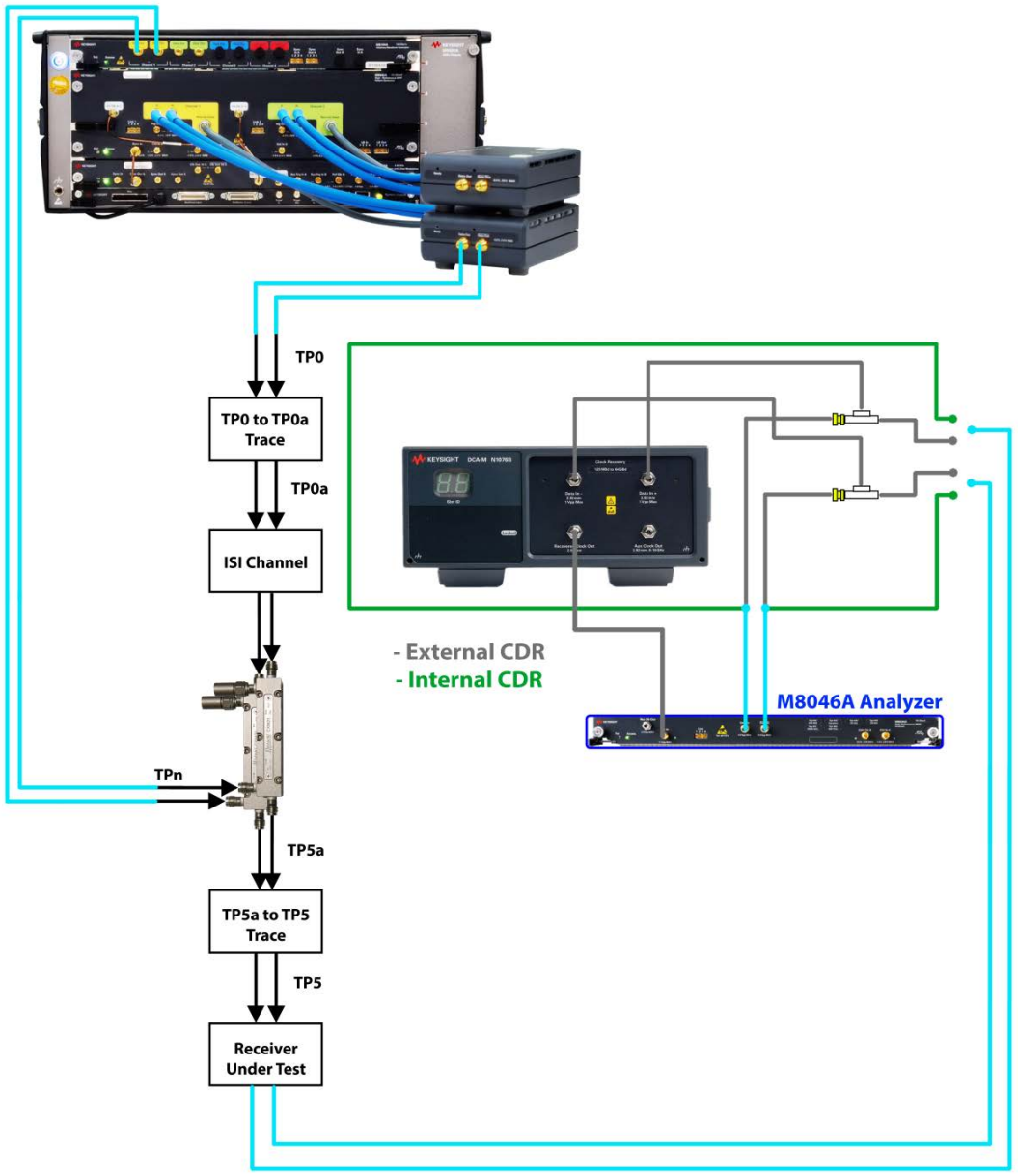


Figure 63 Rx Jitter Tolerance Test connections for MR/LR (M8050A BERT)

ID

Standard Name	Test ID
Medium Reach	475101
Long Reach	675101

Dependencies The Receiver Jitter Tolerance Test depends on the values configured for the following calibrations:

- Amplitude Calibration on page 70
- SJ Calibration on page 73
- UUGJ Calibration on page 75
- BUJ Calibration on page 76
- Transmitter Measurements for COM Model — Rx JTol on page 89

Parameters Refer to Test Parameters in Debug Mode on page 96.

Procedure This test uses the QPRBS31-CEI pattern.

Results The Receiver Jitter Tolerance Test returns Pass/Fail for each Sinusoidal Jitter Amplitude & Frequency pair point.

Parameter	Value	
Receiver Interference Tolerance Test - OIF CEI-112G PAM4 MR	Pass	
---Additional Info---		
Receiver Interference Tolerance Test Screenshot	(See image)	
Receiver Interference Tolerance Test Parameters	Parameter Name	Parameter Value
	BER	2E-9
	Confidence Level	95.00 %
	Injected Noise	36.2 mV
	Coefficient 0	0
	Coefficient 1	0.019
	Coefficient 2	-0.134
	Coefficient 3	0.804
	Coefficient 4	0.043

Figure 64 Rx Jitter Tolerance Test results in tabular format

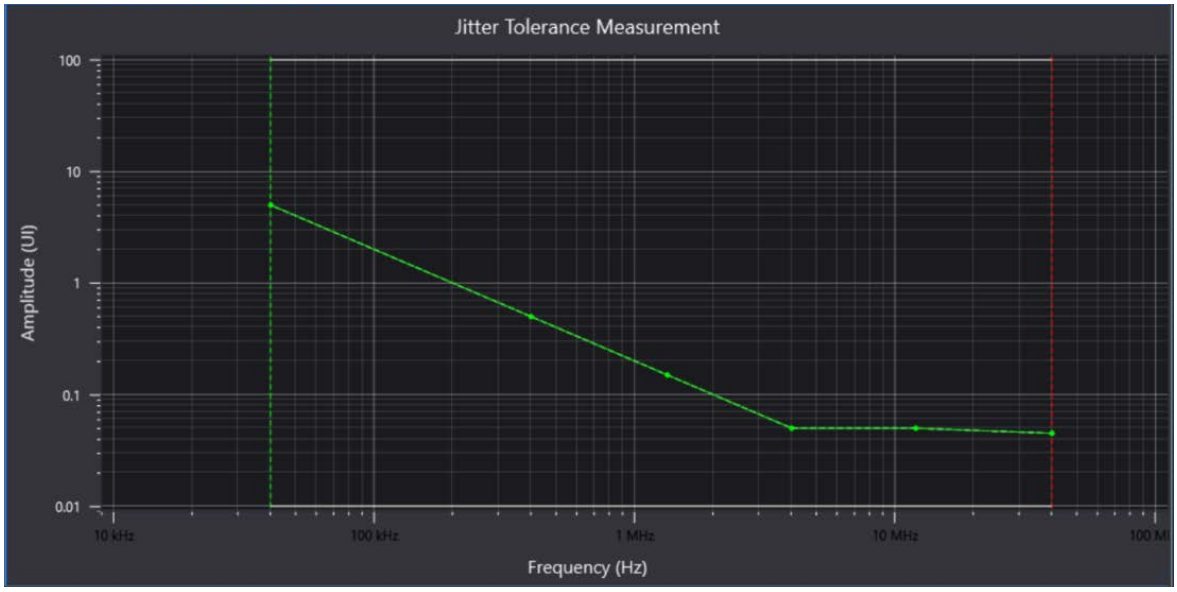


Figure 65 Rx Jitter Tolerance Test results in graphical format

6 OIF-112G VSR Calibrations

This chapter describes the procedures for the OIF-112G Very Short Range Calibrations, which are applicable for VSR Host and VSR Module standard options.

Before performing the OIF-112G VSR tests, you have to calibrate all the related parameters. Perform calibrations in the order displayed in the Keysight M809212CA Receiver Conformance Test Application for OIF-CEI 5.0 (112G).

As mentioned earlier, ensure that the FlexDCA or UXR Oscilloscope has been calibrated and the mated Compliance Board is properly connected to the test instruments to perform OIF-112G VSR Calibrations.

Calibration Parameters in Debug Mode

The Debug Mode in the Configure tab of the Test Application includes some parameters in addition to those that can be configured in the Compliance Mode. Besides, for some of the configuration options, you may enter custom values, which provides a greater flexibility in performing calibrations and tests.

For the VSR Host Input and VSR Module Input standard options, the parameters listed in Table 9 are available for configuration. Note that, other than the "Module Output Mode" and "Minimum CTLE Gain" parameters, all the parameters appear for both standard options.

Table 9 Calibration parameters in debug mode for the VSR Host Input and VSR Module Input standard options

Calibration Parameter	Description
Parameters Common to All Calibrations	
Baud Rate	Baud Rate for testing the device and for all calibrations.
Victim Generator PAM4 Symbol Mapping	Selects how consecutive data bits are mapped to symbols.
Victim Generator PAM4 Custom Symbol Mapping	Selects how consecutive data bits are mapped to symbols. The mapping is defined as a comma-separated list of bit sequences (e.g. 00,01,11,10). The position within this list corresponds to the symbol level. First value is for Symbol 0 and last value is for Symbol 3.
Target Error Ratio	Target Error Ratio for deciding if a test is passed or failed.
Sync Loss Threshold	The threshold level of error ratio at which synchronization is successful.
Alignment BER Threshold	BER threshold used as pass/fail criterion during the sample point alignment.
Host Channel	▪ For VSR Host Input: Selects between Near-end and Far-end host channel. ▪ For VSR Module Input: Selects between Low-loss and High-loss channel. The frequency-dependent attenuation is used only for the High-loss channel.
Module Output Mode	Only for VSR Host Input standard option. Selects between short and long module output mode, as requested by the host.
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.

Calibration Parameter	Description
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
Channel EQ Pre-Cursor3	Controls the pre-cursor 3 coefficient for channel equalization.
Channel EQ Pre-Cursor2	Controls the pre-cursor 2 coefficient for channel equalization.
Channel EQ Pre-Cursor1	Controls the pre-cursor 1 coefficient for channel equalization.
Channel EQ Post-Cursor1	Controls the post-cursor 1 coefficient for channel equalization.
Loop Bandwidth	Select or enter the Loop BW to be used in the clock recovery.
SIRC Response for Tx Measurements	Select the SIRC response for victim transmitter measurements and crosstalk calibration. This will automatically be applied to any pattern lock waveform.
SIRC Bandwidth for Tx Measurements	Select or enter the SIRC BW for victim transmitter measurements and crosstalk calibration. This will automatically be applied to any pattern lock waveform.
Number of Averages for Waveform Acquisition	Set the number of averages used for waveform acquisition during pulse response and SNDR measurement.
Parameters for Crosstalk Calibration	
Crosstalk Amplitude	Crosstalk Amplitude.
Crosstalk Transition Time	Crosstalk Transition Time
Parameters for Amplitude Calibration	
Amplitude	Victim Differential Amplitude.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
Parameter for BUJ Calibration	
BUJ	Controls the amplitude of the BUJ jitter source.
Parameters for Transmitter Measurements	
Amplitude	Victim Differential Amplitude.
SJ	Sinusoidal Jitter at 10x receiver loop bandwidth.
UUGJ	Unbounded Uncorrelated Gaussian Jitter. This is the RMS value that is set on the BERT.
BUJ	Controls the amplitude of the BUJ jitter source.

Calibration Parameter	Description
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
Np for TP0v	Set the Np value used for linear fit pulse peak and error calculations.
Dp for TP0v	Set the Dp value used for linear fit pulse peak and error calculations.
Jnu Type	Select Jnu Type. This will select the probability used in the 12-edge output jitter measurement.
Record Count	Set the record count used for Jnu measurement at TP0.
Parameters for Stressed Eye Calibration	
SIRC Response for Stressed Eye	Select the SIRC response for the stressed eye calibration. This will automatically be applied to any pattern lock waveform.
SIRC Bandwidth for Stressed Eye	Select or enter the SIRC BW for the stressed eye calibration. This will automatically be applied to any pattern lock waveform.
Amplitude	Victim Differential Amplitude.
SJ	Sinusoidal Jitter at 10x receiver loop bandwidth.
UUGJ	Unbounded Uncorrelated Gaussian Jitter. This is the RMS value that is set on the BERT.
BUJ	Controls the amplitude of the BUJ jitter source. Value duplicated from/to BUJ Calibration.
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Pre-Cursor3	Controls the pre-cursor 3 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor2	Controls the pre-cursor 2 equalization coefficient for Transmitter Measurements.
Transmitter Pre-Cursor1	Controls the pre-cursor 1 equalization coefficient for Transmitter Measurements.
Transmitter Post-Cursor1	Controls the post-cursor 1 equalization coefficient for Transmitter Measurements.
FFE Mode	▪ When ‘Auto’ is selected, channel equalization coefficients are computed from the measured pulse response. ▪ When ‘Manual’ is selected, the Pre-Cursor1/2/3 and Post-Cursor parameters should be specified by the user.

Calibration Parameter	Description
Channel EQ Pre-Cursor3	Controls the pre-cursor 3 coefficient for channel equalization.
Channel EQ Pre-Cursor2	Controls the pre-cursor 2 coefficient for channel equalization.
Channel EQ Pre-Cursor1	Controls the pre-cursor 1 coefficient for channel equalization.
Channel EQ Post-Cursor1	Controls the post-cursor 1 coefficient for channel equalization.
Enable Tx Deemphasis Fine Tuning	Enable or disable Tx deemphasis fine tuning.
Crosstalk Amplitude	Crosstalk Amplitude. Value duplicated from/to Crosstalk Calibration.
Crosstalk Transition Time	Crosstalk Transition Time. Value duplicated from/to Crosstalk Calibration.
Eye Height	Eye Height @ 1e-6.
Eye Height Accuracy	Defines the accuracy of the Eye Height parameter.
Vertical Eye Closure	Vertical Eye Closure @ 1e-6.
Vertical Eye Closure Accuracy	Defines the accuracy of the Vertical Eye Closure parameter.
CTLE Mode	Selects CTLE control and behavior. ▪ Optimized CTLE using COM Method: Use the optimized CTLE settings determined by the COM model. ▪ Auto-tune: Run “Auto-tune” to find the optimal CTLE settings. ▪ Manual: Manual entry of CTLE DC gain settings.
CTLE Zero Frequency	Defines the continuous time filter, zero frequency.
CTLE Pole 1 Frequency	Defines the continuous time filter, pole 1 frequency.
CTLE Pole 2 Frequency	Defines the continuous time filter, pole 2 frequency.
CTLE Low-Frequency Pole/Zero	Defines the continuous time filter, low-frequency pole/zero.
Spectral Density Noise State	Select ‘ON’ to apply Spectral Density Noise for stressed eye calibration and ‘OFF’ to disable.
Spectral Density Noise	Defines the one-sided spectral density of receiver input referred noise.
Histogram Window Shape	Select between boxcar and Gaussian window shape.
Gaussian Standard Deviation	Controls the standard deviation of the Gaussian window.
Pulse Response Save File	Save fitted pulse response data as two columns of time and voltage in csv format.
Parameters for CTLE Auto-tune	
Measure all CTLE options	For auto-tune, you can select to run all options, or to stop testing when CTLE is shown to worsen the eye.
Start value for gDC CTLE auto-tune	Select the starting CTLE DC gain setting to use for the “Auto-Tune”. Auto-Tune will use the range of settings from this start value, to the stop value set in the StopCTLE configuration.

Calibration Parameter	Description
Stop value for gDC CTLE auto-tune	Select the last CTLE DC gain setting to use for the “Auto-Tune”. Auto-Tune will use the range of settings from start value selected in the StartCTLE configuration, to the stop value set here.
Start value for gDC2 CTLE auto-tune	Select the starting CTLE DC gain 2 setting to use for the “Auto-Tune”. Auto-Tune will use the range of settings from this start value, to the stop value set in the StopCTLE configuration.
Stop value for gDC2 CTLE auto-tune	Select the last CTLE gain 2 setting to use for the “Auto-Tune”. Auto-Tune will use the range of settings from start value selected in the StartCTLE configuration, to the stop value set here.
Minimum CTLE Gain	Only for VSR Module Input standard option. Select minimum CTLE gain for module high-loss multi-lane stressed input signal calibration. Condition is gdc + gdc2 <= Minimum CTLE Gain.
Eye Measurement Maximum UI Capture Threshold	Set the maximum threshold to capture the UI used for measuring the eye.
Parameters for CTLE Manual	
Manual CTLE gDC	Specifies the CTLE DC gain setting.
Manual CTLE gDC2	Specifies the CTLE DC gain 2 setting.
Parameter for Differential Peak-Peak Voltage Tolerance Calibration	
Differential Pk-Pk Voltage	Minimum Voltage that the device must tolerate at its input without overloading its front end and causing distortion/clipping that would generate poor equalization and/or BER degradation.

VSR Configuration in the Test Application

In order to obtain valid calibration data and test measurements for the VSR standard option, the pulse response is used.

During the Stressed Eye Calibration run, the test application measures the pulse response, which is then used to optimize equalizer settings (FFE, CTLE, and DFE).

When the FFE Mode configuration variable is set to 'Auto', the channel equalization coefficients are computed from the measured pulse response; otherwise, the "Channel EQ" Pre-Cursor1/2/3 and Post-Cursor parameters should be specified by the user.

The measured pulse response data is saved by the test application as a csv file with time and voltage columns. The **Pulse Response Save File** configuration parameter shows the location of the saved pulse response csv file.

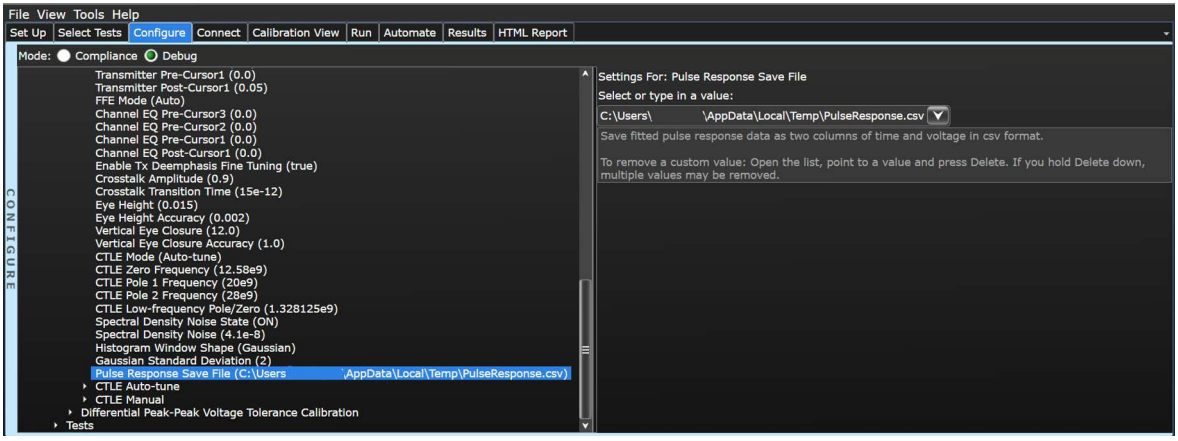


Figure 66 Pulse Response Save File Configuration Parameter

Calibration Procedure

The OIF-112G VSR receiver test calibration procedures comprise two steps:

1 System calibration: Calibrate the equipment used to generate the victim transmitter, impairments and crosstalk source (once per setup configuration).

2 Stressed Eye calibration: Calibrate the stress signal after the channel in front of the receiver under test (TP4 or TP1a) with appropriate amplitude and impairments to meet the required Eye Height and Vertical Eye Closure targets. The calibration procedure requires two steps:

- Transmitter Measurements at TP0v: Different transmitter profiles can be used as a starting point for the stressed eye calibration. For instance, with different jitter profile (parameters **SJ**, **UUGJ**, **BUJ**) as well as rise time and SNDR (parameters **Transmitter Pre-Cursor1/2/3** and **Transmitter Post-Cursor1**). (See "Transmitter Measurements" section.) It is recommended that you inject a fixed amount of BUJ (e.g. 5 or 10 mUI) to obtain a jitter profile close to one listed in *Table 23-15 Host-to-Module Electrical Recommendations at TP0a* in *Section 23.C.2* of *CEI-112G-VSR-PAM4 Very Short Reach Interface* (Draft). This comes in addition to the 50 mUI sinusoidal jitter that is required for jitter tolerance and added per default.
- Stress Signal Calibration: The calibration procedure requires the following steps:
  - Channel Equalization: For Stressed Eye Calibration, it is expected that the transmitter (FIR filter) and receiver (CTLE-DFE) equalizers are optimized for the given channel and transmitter profile. The amount of transmitter de-emphasis used for channel equalization is specified by the parameters **Channel EQ Pre-Cursor1/2/3** and **Channel EQ Post-Cursor**. When the parameter **FFE Mode** is set to Auto, these parameters are computed from the system's pulse response. Otherwise, the user should specify them manually. Note that the resulting de-emphasis taps of the BERT pattern generator are the convolution of **Transmitter** and **Channel EQ** taps. Similarly, the optimal CTLE gain can be set manually with a search or based on the pulse response measurement (parameter **CTLE mode**). The 4-tap DFE is always optimized for the actual combination of Tx de-emphasis and CTLE using the Mueller–Mueller algorithm.

Finally, an optional step can be carried out to optimize the "unstressed" VEC (parameter **Enable Deemphasis Fine Tuning**).

- Stressed eye calibration: Once the equalization is optimized, the system iteratively adjusts the amount of random jitter and signal amplitude to meet the Eye Height and Vertical Eye Closure targets (parameters **Eye Height** and **Vertical Eye Closure**). (See Stressed Eye Calibration on page 132.)

For the VSR Host Input standard a total of four calibrations are required to cover all Host Channel and Module Output Mode combinations (far-end/near-end and short/long). This is achieved by selecting the appropriate options for the Host Channel and Module Output Mode parameters in the **Configure** tab. A packaged host chip is usually tested in either near-end or far-end configuration, but both short and long modes of the module should be considered.

For the VSR Module Input standard, two calibrations are required for the low-loss channel (mated MCB/HCB) and the high-loss channel (mated MCB/HCB plus ISI board). It is also required to select the appropriate Channel choice in the **Configure** tab.

In each standard case, the Calibration Persistence function can be used to save/recall common calibration data.

BUJ calibration is only recommended if a fixed BUJ component is added to the transmitter.

The pulse response is used to optimize equalizer settings (FFE, CTLE, and DFE). The recommended setting for CTLE optimization is 'Auto-tune'.

Crosstalk Calibration

Overview The Crosstalk Calibration is performed to calibrate the crosstalk amplitude and transition time.

Connection Diagram Connect the instruments as shown in Figure 67 (Host, M8050A, DCA-X), Figure 68 (Host, M8050A, UXR), Figure 69 (Module, M8050A, DCA-X) and Figure 70 (Module, M8050A, UXR).

Connect (Host):

- MCB and HCB.
- Connect the X-Talk Generator's Data Out 2 P/N to TP1 P/N of MCB.
- Connect HCB's TP1a P/N to Oscilloscope's CH1/CH2.
- Terminate the Victim Generator's Data Out 1 P/N with 50 ohms.

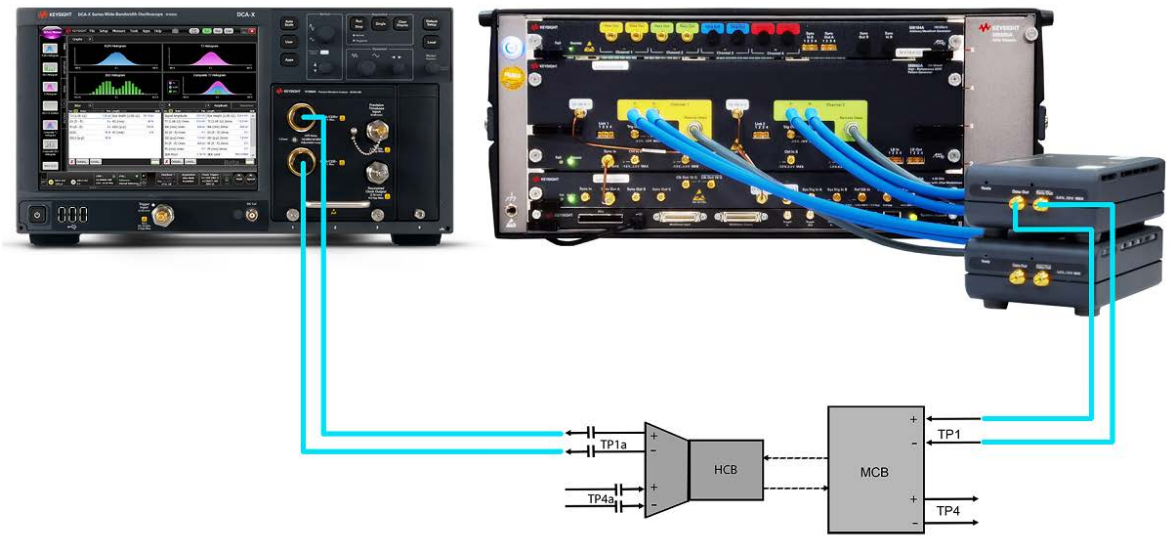


Figure 67 Crosstalk Calibration connections for VSR Host (M8050A BERT and DCA-X Oscilloscope)

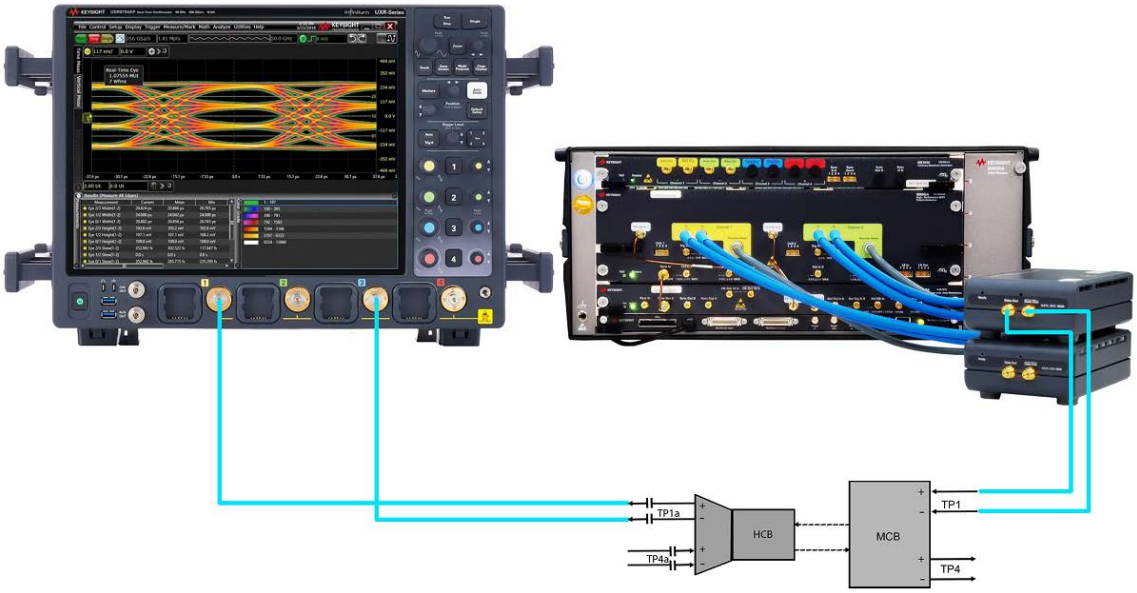


Figure 68 Crosstalk Calibration connections for VSR Host (M8050A BERT and UXR Oscilloscope)

Connect (Module):

- MCB and HCB.
- Connect the X-Talk Generator's Data Out 2 P/N to TP4a P/N of HCB.
- Connect MCB's TP4 P/N to the Oscilloscope's CH1/CH2.
- Terminate the Victim Generator's Data Out 1 P/N with 50 ohms.

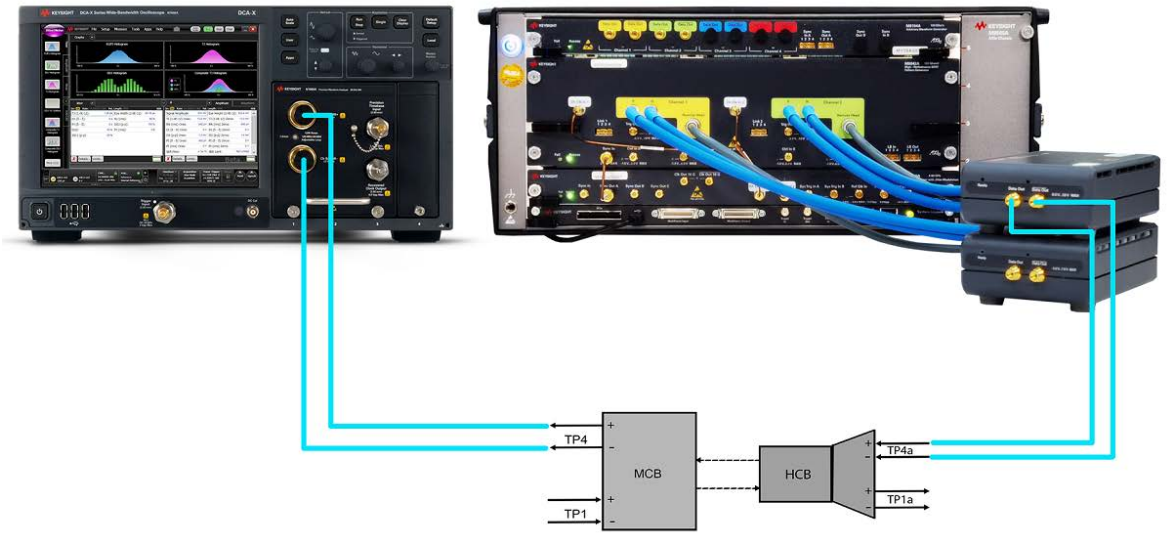


Figure 69 Crosstalk Calibration connections for VSR Module (M8050A BERT and DCA-X Oscilloscope)

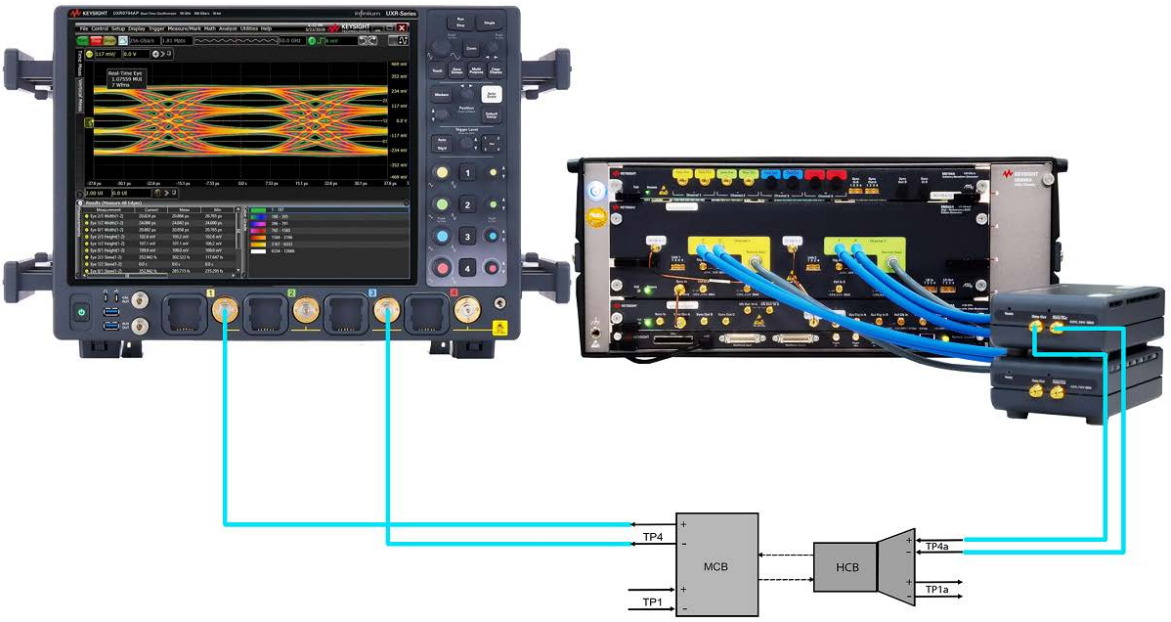


Figure 70 Crosstalk Calibration connections for VSR Module (M8050A BERT and UXR Oscilloscope)

ID

Standard Name	Test ID
VSR Host	71100
VSR Module	271100

Dependencies The Crosstalk Calibration depends on the values configured for the following settings:

- InfiniiSim-DCA 2-Port DeEmbed S-parameters for Scope Ch 1A / 2A
- InfiniiSim-DCA 4-Port DeEmbed S-parameters for Scope Ch 1A / 2A

Parameters Refer to Calibration Parameters in Debug Mode on page 110.

Procedure This calibration uses the QPRBS13-CEI pattern.

Results The Crosstalk Calibration returns the following results, in tabular format:

- Standard Parameters
  - Crosstalk Amplitude
  - Crosstalk Transition Time

- Instrument Parameters
  - Amplitude
  - De-Emphasis parameters
    - Pre-Cursor2
    - Pre-Cursor1
    - Post-Cursor1
    - Post-Cursor2

Troubleshooting steps Perform the following step if this calibration fails:

- Ensure that the cable to the oscilloscope is de-embedded.

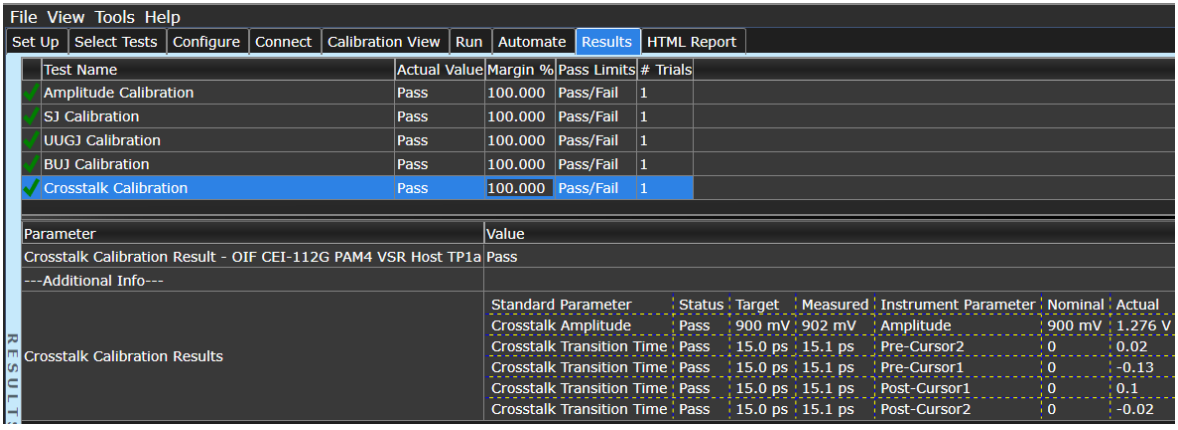


Figure 71 Crosstalk Calibration results in the Results tab for VSR Host Input

Amplitude Calibration

Overview The Amplitude Calibration is performed to calibrate the Victim Generator's Amplitude. Note that the de-emphasis configuration resulting from the Transmitter Equalization sequence must be applied during calibration.

Connection Diagram Connect the instruments as shown in Figure 72 (M8050A, DCA-X) and Figure 73 (M8050A, UXR).

Connect:

- Connect Victim Generator's Data Out 1 P/N to Oscilloscope CH1/CH2.
- Terminate X-Talk Generator's Data Out 2 with 50 ohms.

Figure 72 Amplitude Calibration connections for VSR Host & VSR Module (M8050A BERT and DCA-X Oscilloscope)

Figure 73 Amplitude Calibration connections for VSR Host & VSR Module (M8050A BERT and UXR Oscilloscope)

ID

Standard Name	Test ID
VSR Host	71101
VSR Module	271101

Parameters Refer to Calibration Parameters in Debug Mode on page 110.

Procedure This calibration uses the QPRBS13-CEI pattern.

The Victim Generator Amplitude is set and measured for multiple Amplitudes.

Results The Amplitude Calibration returns pass/fail and the Set Amplitude for which the Measured Amplitude was closest to the target value.

Figure 74 shows example results for VSR Host Input. The results for VSR Module Input look similar.

Parameter	Value						
Amplitude Calibration Result - OIF CEI-112G PAM4 VSR Host TP0	Pass						
---Additional Info---							
Amplitude Calibration Results	Standard Parameter	Status	Target	Measured	Instrument Parameter	Nominal	Actual
	Amplitude	Pass	900 mV	897 mV	Amplitude	900 mV	828 mV

Figure 74 Amplitude Calibration result in the Results tab

SJ Calibration

Overview The SJ Calibration is performed to calibrate the Sinusoidal Jitter.

Connection Diagram Connect the instruments as shown in Figure 72 (M8050A, DCA-X) and Figure 73 (M8050A, UXR) for the Amplitude Calibration on page 123.

ID

Standard Name	Test ID
VSR Host	71102
VSR Module	271102

Parameters Refer to Calibration Parameters in Debug Mode on page 110.

Procedure This calibration uses the Clock/8 pattern.

The SJ is calibrated for a discrete number of points ranging from the minimum to maximum amplitude of the Victim Generator PJ1.

Results The SJ Calibration returns the results

- pass or fail in the Results tab
- measured SJ versus the set PJ1 in graphical and tabular formats in the Calibration View tab (Figure 75)

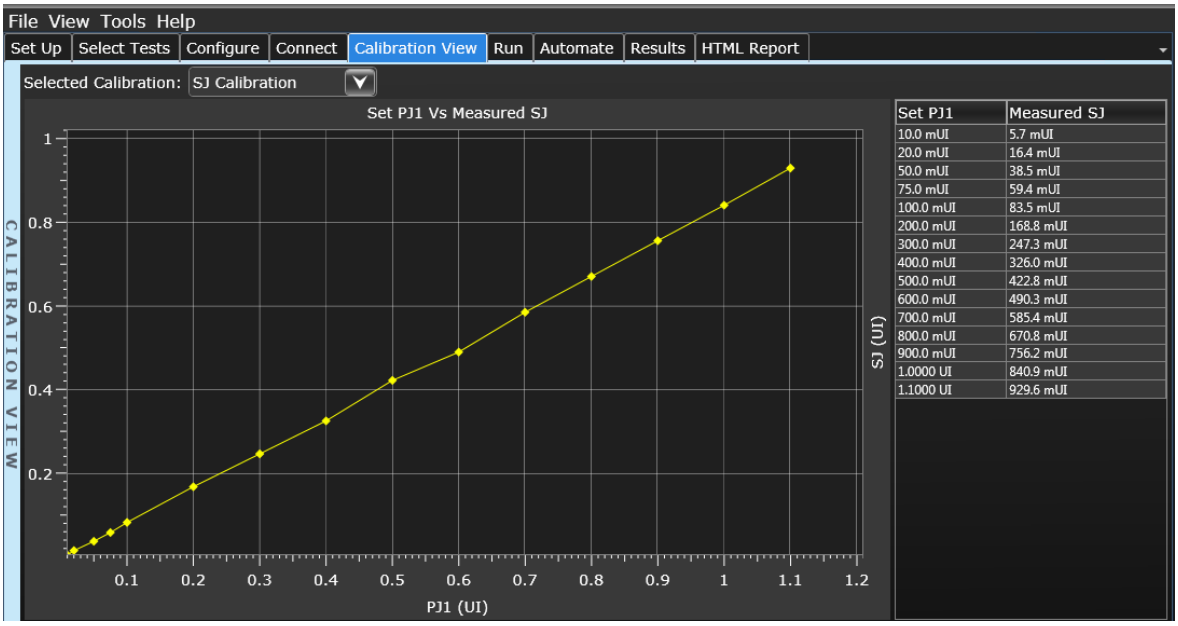


Figure 75 SJ Calibration calibrated data in Calibration View tab

UUGJ Calibration

Overview The UUGJ Calibration is performed to calibrate the Uncorrelated Unbounded Gaussian Jitter (UUGJ) at TP0a.

Connection Diagram Connect the instruments as shown in Figure 72 (M8050A, DCA-X) and Figure 73 (M8050A, UXR) for the Amplitude Calibration on page 123.

ID

Standard Name	Test ID
VSR Host	71103
VSR Module	271103

Parameters Refer to Calibration Parameters in Debug Mode on page 110.

Procedure This calibration uses the 1010... toggle (Clock) pattern.

The UUGJ is calibrated for a discrete number of set values of Victim Generator Random Jitter (RJ).

Results The UUGJ Calibration returns the results

- pass or fail in the Results tab
- measured UUGJ versus the set RJ in graphical and tabular formats in the Calibration View tab (Figure 76)

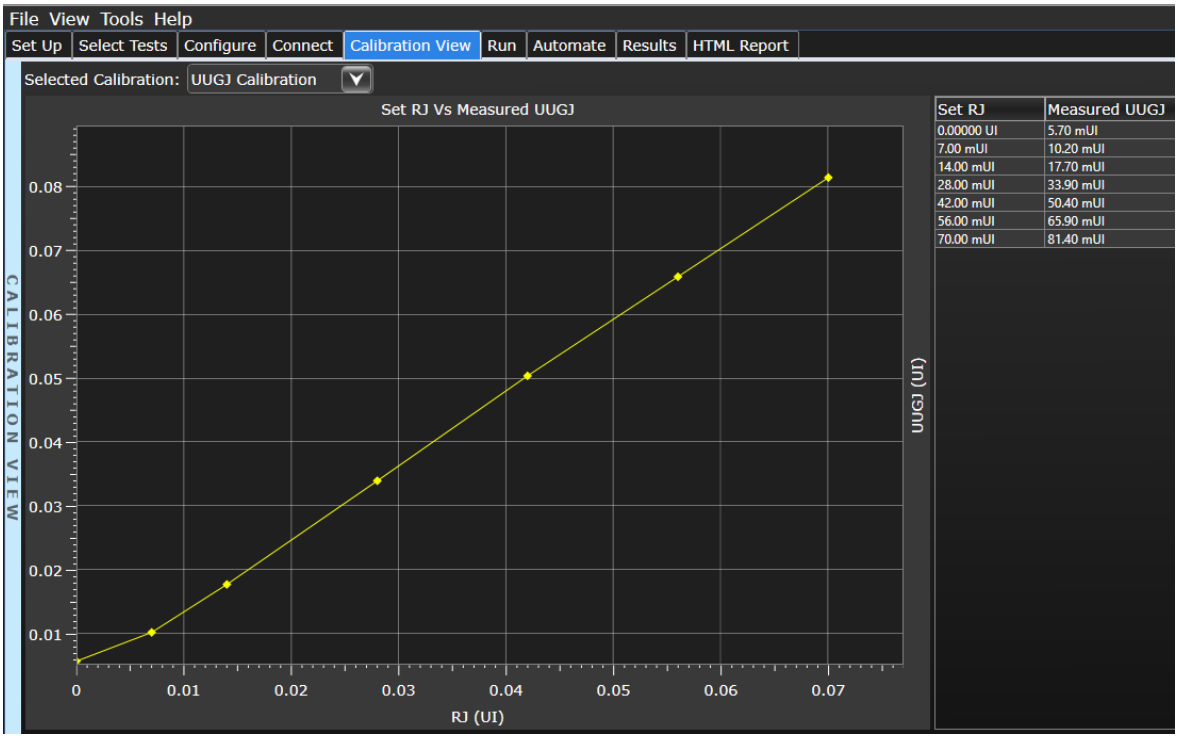


Figure 76 UUGJ Calibration calibrated data for VSR Host in Calibration View tab

BUJ Calibration

NOTE

The UBHPJ stress component comprises BUJ and SJ components. However, since the SJ component compensates for the UBHPJ component, the BUJ component is not required for calibrations. However, if you wish a BUJ component to be included for calibration, you can set the BUJ parameter and reduce the corresponding SJ component, so that the overall UBHPJ component remains the same.

Overview The BUJ Calibration is performed to calibrate the Bounded Uncorrelated Jitter.

Connection Diagram Connect the instruments as shown in Figure 72 (M8050A, DCA-X) and Figure 73 (M8050A, UXR) for the Amplitude Calibration on page 123.

ID

Standard Name	Test ID
VSR Host	71104
VSR Module	271104

Parameters Refer to Calibration Parameters in Debug Mode on page 110.

Procedure This calibration uses the 1010... toggle (Clock) pattern.

The Victim Generator BUJ is set until the desired BUJ value is measured.

Results The BUJ Calibration returns pass/fail and the Set BUJ for which the Measured BUJ was closest to the target value. Figure 77 shows an example for VSR Host. The results for VSR Module look similar.

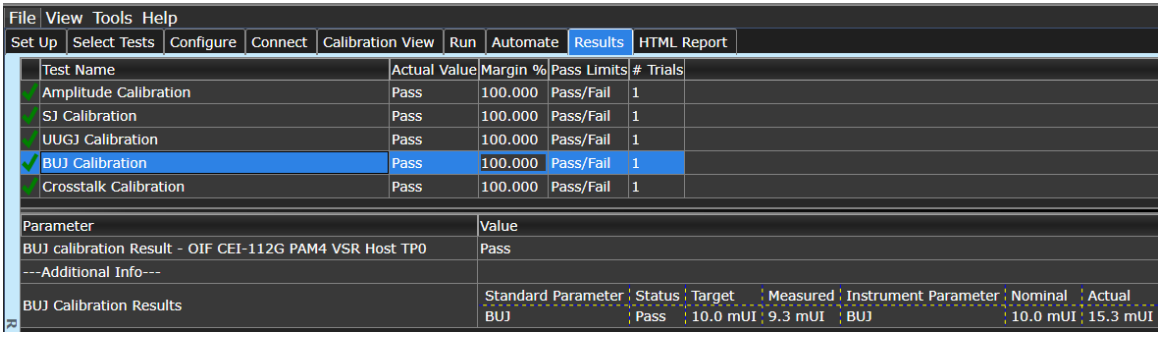


Figure 77 BUJ Calibration result in the Results tab

Transmitter Measurements

Overview

The procedure Transmitter Measurements is performed to explore different transmitters for the receiver tests. If the reference transmitter fails the transmitter measurements calibration, the following parameters can be adjusted: PAM4 Symbol 1/2 Level for RLM; Transmitter Post-Cursor1 for rise time; and SJ, UUGJ and BUJ to modify Jrms and J4u.

Note that matching the transmitter measurements targets is not required in order to proceed to the Stressed Eye Calibration step.

Connection Diagram

Connect the instruments as shown in Figure 72 (M8050A, DCA-X) and Figure 73 (M8050A, UXR) for the Amplitude Calibration on page 123.

ID

Standard Name	Test ID
VSR Host	71105
VSR Module	271105

Parameters

Refer to Calibration Parameters in Debug Mode on page 110.

Procedure

This calibration uses the QPRBS13-CEI pattern.

Results

The Transmitter Measurements procedure returns the following results, in tabular format:

- Transition Time
- Jrms
- J4u (Note that the J4u pass limit has been updated to 0.118 UI as specified in *Table 23-15 Host-to-Module Electrical Recommendations at TP0a* in *Section 23.C.2* of *CEI-112G-VSR-PAM4 Very Short Reach Interface* (Draft))
- Level mismatch ratio RLM
- Signal-to-noise-and-distortion ratio (Np = 200)

Parameter	Value				
Transmitter Measurements - OIF CEI-112G PAM4 VSR Host TP0a	Pass				
---Additional Info---					
Transition Time	10 ps				
Output Jitter Measurement	(See image)				
Linear Fit Pulse Response(Np=200)	(See image)				
Transmitter Measurements	Measurement Name	Status	Measured Value	Margin %	Pass Limits
	Jrms	Pass	15.3 mUI	33.5 %	<= 23.0 mUI
	J4u	Pass	116.8 mUI	1.0 %	<= 118.0 mUI
	Level mismatch ratio RLM	Pass	0.99	4.2 %	>= 0.95
	Signal-to-noise-and-distortion ratio(Np=200)	Pass	38.97 dB	19.9 %	>= 32.50 dB

Figure 78 Transmitter Measurements results

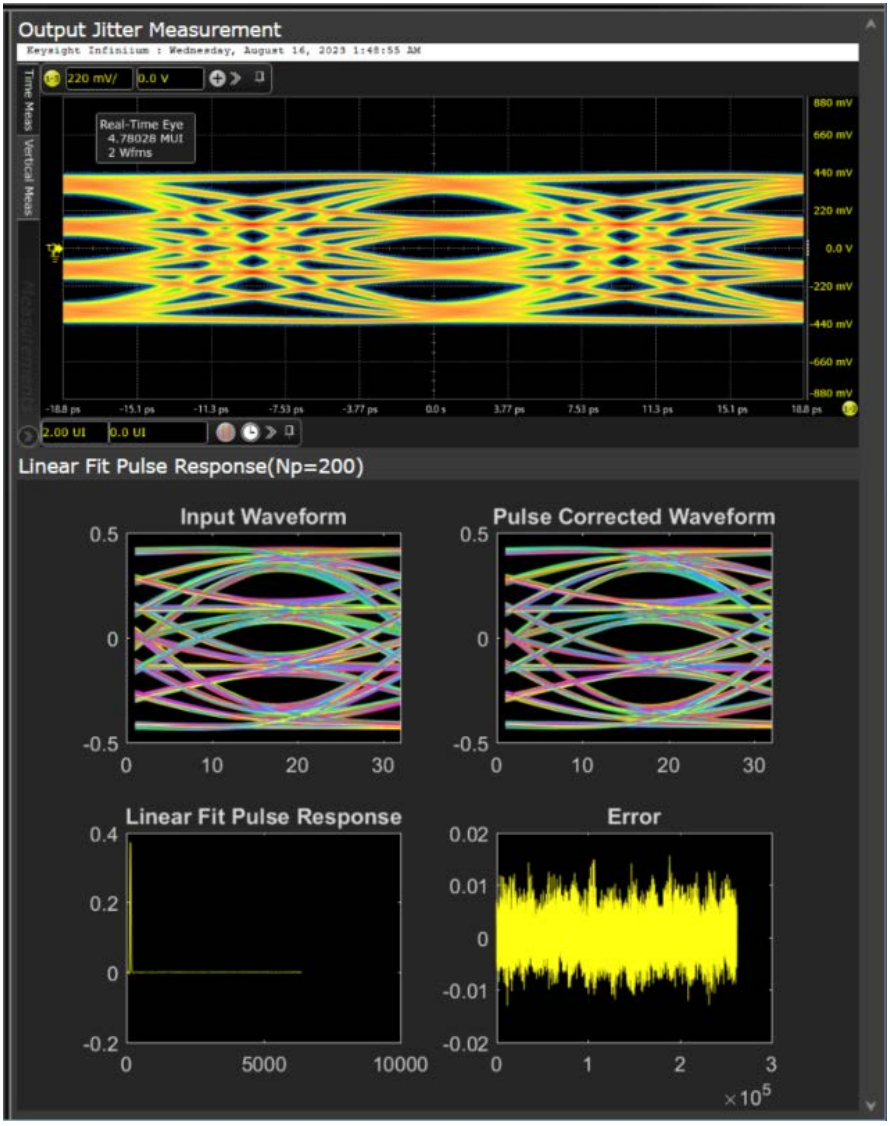


Figure 79 Transmitter Measurements, eye diagram on the oscilloscope for VSR Host Input

Stressed Eye Calibration

Overview

The Stressed Eye Calibration is performed to calibrate the stressed eye signal for the Host or Module Multi-lane Stressed Input Test. This calibration should be performed four times for the VSR Host Input standard (as shown in Table 10) and two times for the VSR Module Input standard (as shown in Table 11).

Table 10 VSR Host Input Calibration Modes

Standard Option	Host Channel	Module Output Mode	Notes
VSR Host Input	Far-end	Short	Set Host Channel and Module Output Modes in the Configure tab
		Long	
	Near-end	Short	
		Long	

Table 11 VSR Module Input Calibration Modes

Standard Option	Channel	Notes
VSR Module Input	Low Loss	Mated MCB/HCB
	High Loss	Mated MCB/HCB + Frequency-dependent attenuator

Connection Diagram

Connect the instruments as shown in Figure 80 (Host, M8050A, DCA-X), Figure 81 (Host, M8050A, UXR), Figure 82 (Module, M8050A, DCA-X) and Figure 83 (Module, M8050A, UXR).

Connect (for Host):

- MCB and HCB.
- Connect X-Talk Generator's Data Out_2 P/N to TP1 P/N of MCB.
- Terminate TP1a P/N of HCB with 50 ohms.
- Connect Victim Generator's Data Out 1 P/N to TP4a P/N of HCB.
- Connect TP4 P/N of MCB to Oscilloscope's CH1/CH2.
- Note: Host channel is embedded in Oscilloscope.

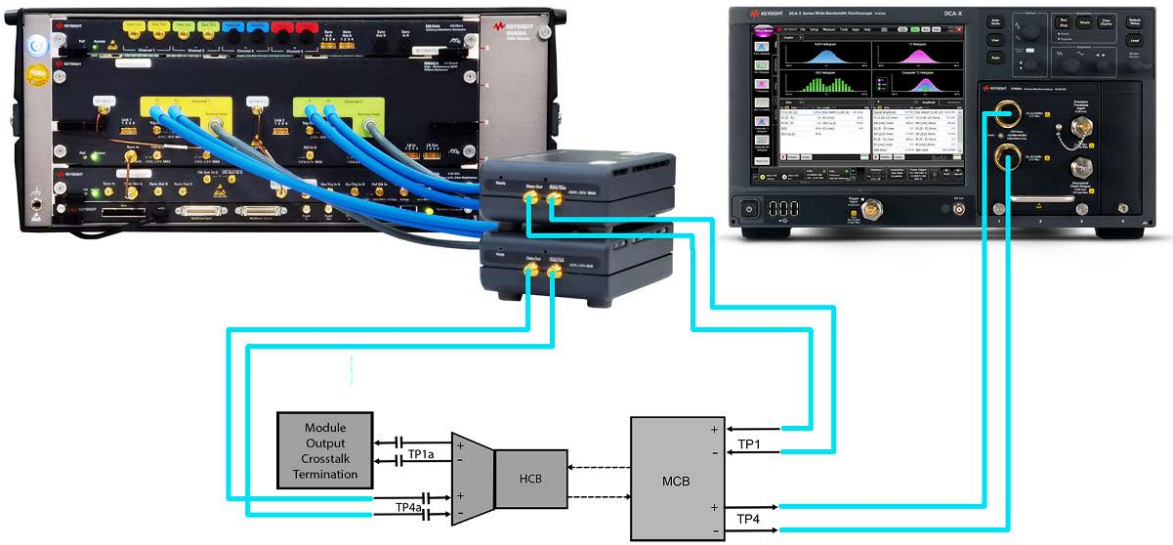


Figure 80 Stressed Eye Calibration connections for VSR Host (M8050A BERT, DCA-X Oscilloscope)

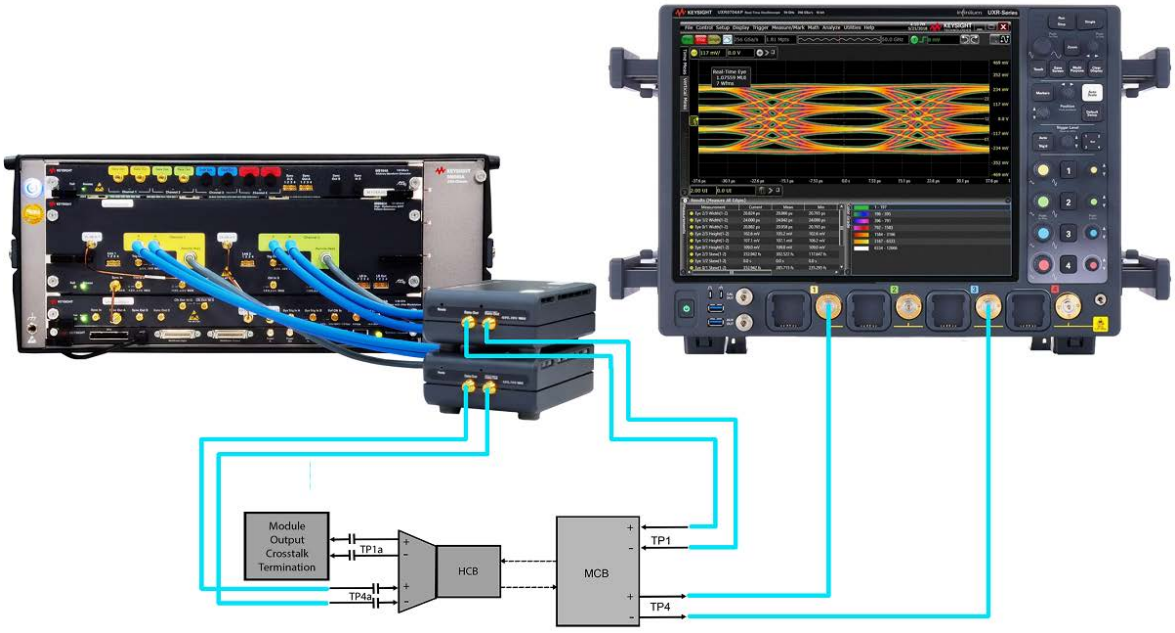


Figure 81 Stressed Eye Calibration connections for VSR Host (M8050A BERT and UXR Oscilloscope)

Connect (for Module):

- MCB and HCB.
- X-Talk Generator Data Out 2 P/N to TP4a P/N of HCB.
- Termination via 50 Ohm to TP4 of MCB.
- Victim Generator Data Out 1 P/N to Frequency-dependent attenuator.
- Frequency-dependent attenuator to TP1 P/N of MCB.
- Oscilloscope CH1/CH2 to TP1a P/N of HCB.
- Note: The Frequency-dependent attenuator is used only for the High Loss channel.

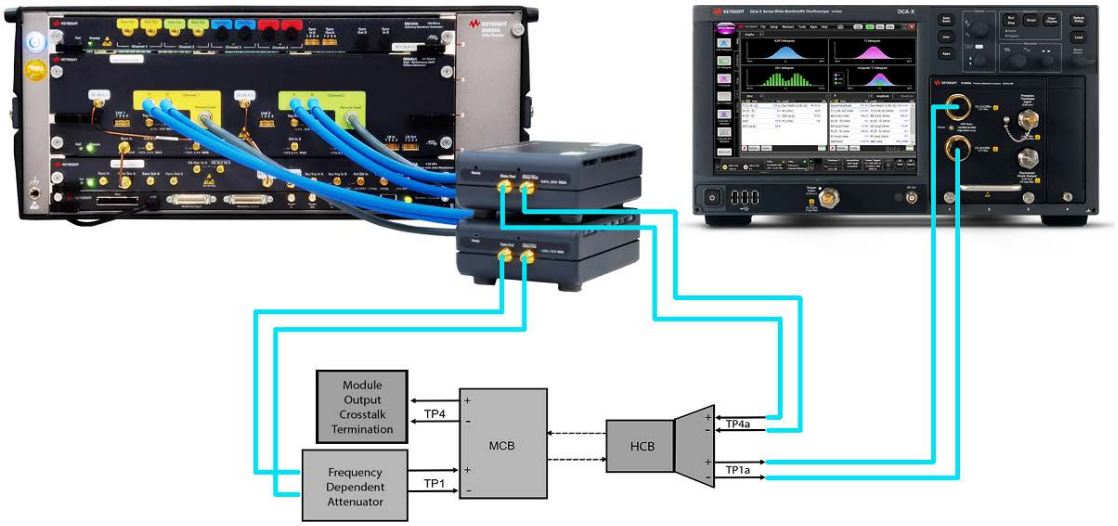


Figure 82 Stressed Eye Calibration connections for VSR Module (M8050A BERT and DCA-X Oscilloscope)

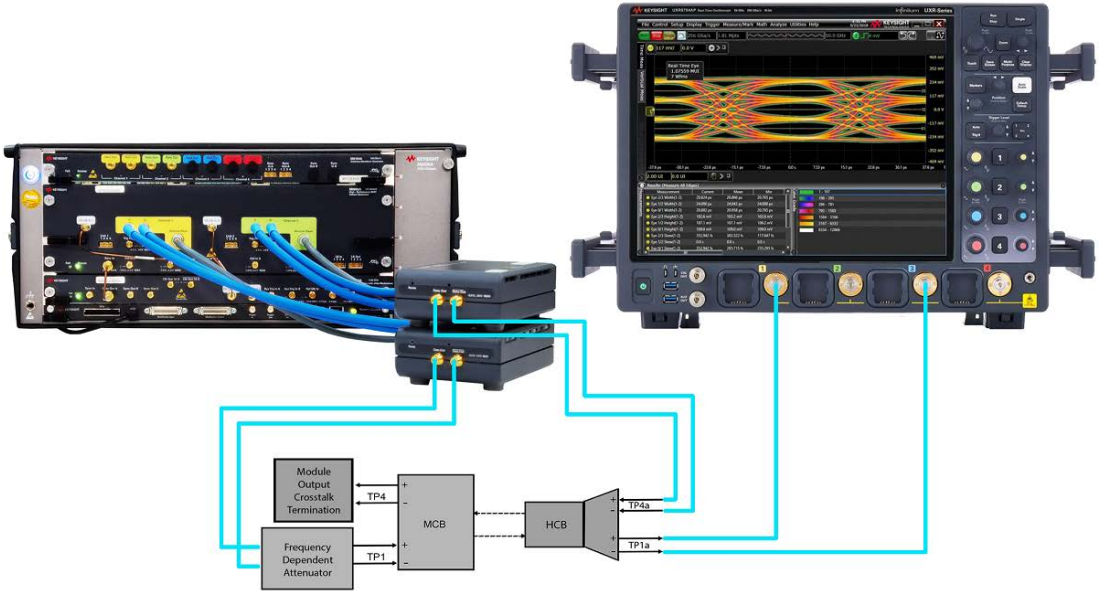


Figure 83 Stressed Eye Calibration connections for VSR Module (M8050A BERT and UXR Oscilloscope)

NOTE In the current version of the application, an ISI board is required for the high loss test case.

ID

Standard Name	Test ID
VSR Host	71106
VSR Module	271106

Dependencies The Stressed Eye Calibration depends on the values configured for the following settings:

- InfiniiSim-DCA 2-Port DeEmbed S-parameters for Scope Ch 1A / 2A
- InfiniiSim-DCA 4-Port DeEmbed S-parameters for Scope Ch 1A / 2A
- All calibrations performed previously:
  - Crosstalk Calibration on page 118
  - UUGJ Calibration on page 127
  - SJ Calibration on page 125
  - Transmitter Measurements on page 130 when FFE Mode is set to 'Auto' or CTLE Mode is set to 'Optimized CTLE using COM Method'.

Parameters Refer to Calibration Parameters in Debug Mode on page 110.

Procedure This calibration uses the QPRBS13-CEI pattern.

Results The Stressed Eye Calibration returns the following results, in tabular format:

- Standard Parameters
  - EH6
  - VEC6
  - Eye Linearity
- Instrument Parameters
  - Amplitude
  - RJ
  - Lower PAM4 Eye Level
  - Upper PAM4 Eye Level

Parameter	Value						
Stressed Eye Calibration Result - OIF CEI-112G PAM4 VSR Host TP4	Pass						
---Additional Info---							
Optimum TX Cursor Values	(0,0.04,-0.17,0.75,0.04)						
Optimum CTLE DC gain setting	-5.0 dB						
Optimum CTLE DC gain 2 setting	-2.5 dB						
Optimum DFE Taps	(0.307,-0.012,0.014,0.002)						
Stressed Eye Calibration Screenshot	(See image)						
Stressed Eye Calibration Results	Standard Parameter	Status	Target	Measured	Instrument Parameter	Nominal	Actual
	EH6	Pass	15 mV	15 mV	Amplitude	900 mV	1.092 V
	VEC6	Pass	12dB	12.2dB	RJ	0.00000 UI	8.79 mUI
	Eye Linearity	Pass	0.9	0.92	Lower PAM4 Eye Level	33%	29%
	Eye Linearity	Pass	0.9	0.92	Upper PAM4 Eye Level	67%	71%

Figure 84 Stressed Eye Calibration results for VSR Host Input

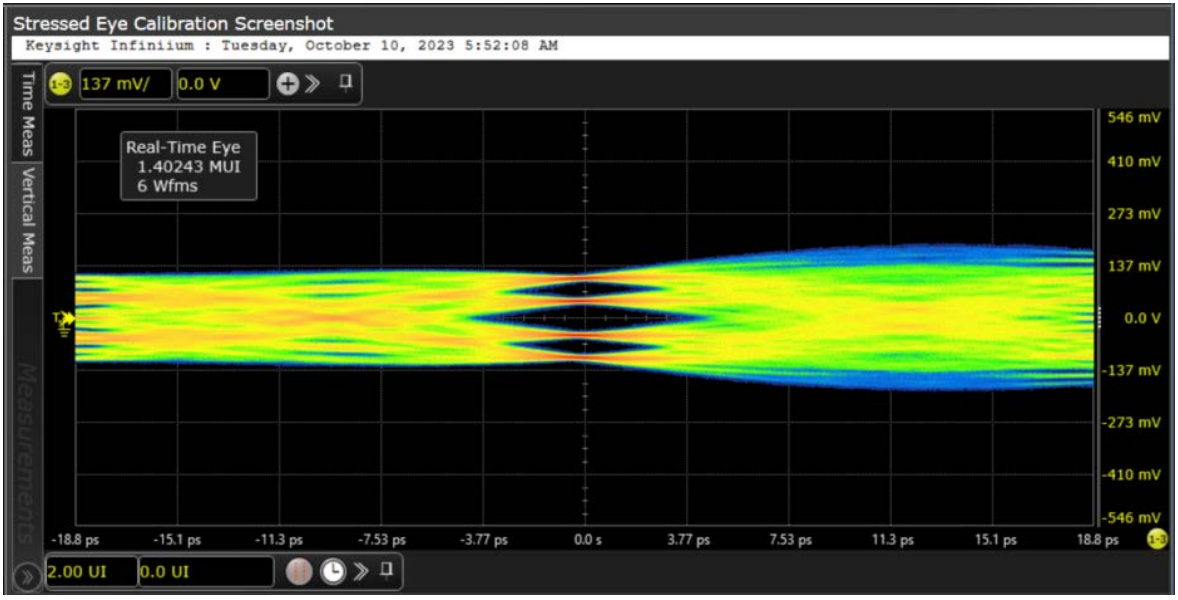


Figure 85 Stressed Eye Calibration image for VSR Host Input

Parameter	Value						
Stressed Eye Calibration Result - OIF CEI-112G PAM4 VSR Module TP1a	Pass						
---Additional Info---							
Optimum TX Cursor Values	(0,0.03,-0.17,0.7,0.1)						
Optimum CTLE DC gain setting	-10.0 dB						
Optimum CTLE DC gain 2 setting	-1.5 dB						
Optimum DFE Taps	(0.157,-0.127,-0.065,-0.015)						
Stressed Eye Calibration Screenshot	(See image)						
Stressed Eye Calibration Results	Standard Parameter	Status	Target	Measured	Instrument Parameter	Nominal	Actual
	EH6	Pass	10 mV	10 mV	Amplitude	1.200 V	750 mV
	VEC6	Pass	12dB	11.8dB	RJ	0.00000 UI	4.15 mUI
	Eye Linearity	Pass	0.9	0.91	Lower PAM4 Eye Level	33%	29%
	Eye Linearity	Pass	0.9	0.91	Upper PAM4 Eye Level	67%	71%

Figure 86 Stressed Eye Calibration results for VSR Module Input

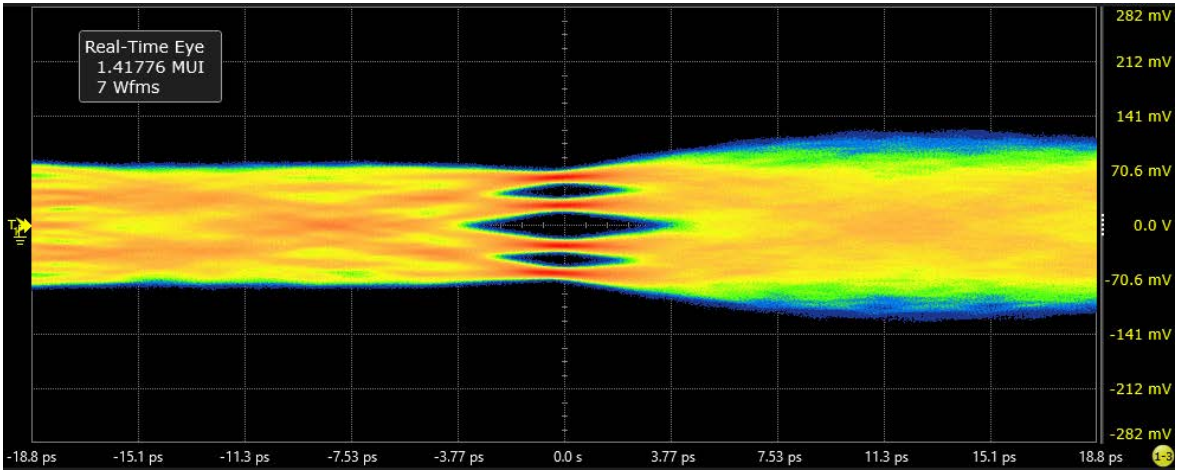


Figure 87 Stressed Eye Calibration screenshot for VSR Module Input

If the CTLE Mode is set to **Auto-tune**, then the Auto-tune results will be displayed in tabular format.

Parameter	Value
Stressed Eye Calibration Result - OIF CEI-112G PAM4 VSR Module TP1a	Pass
---Additional Info---	
Optimum TX Cursor Values	(0,0.04,-0.18,0.73,0.05)
Optimum CTLE DC gain setting	-9.0 dB
Optimum CTLE DC gain 2 setting	-1.5 dB
Optimum DFE Taps	(0.1,0.05,0.025,0.0125)
Stressed Eye Calibration Screenshot	(See image)

CTLE Auto-tune

gDC	gDC2	DFE taps	pulse main cursor	VEC Eye0	Eye Height Eye0	Eye Width Eye0	VEC Eye1	Eye Height Eye1	Eye Width Eye1	VE
-8	-2.5	1.71142E-01,-9.7951E-02,-3.5983E-02,-1.6230E-02	1.0122E-01	9.48dB	22.2mV	174mUI	7.96dB	27.8mV	216mUI	9.5
-8	-3	1.66017E-01,-1.04381E-01,-4.1074E-02,-2.0451E-02	1.0086E-01	9.26dB	22.7mV	176mUI	8.25dB	26.8mV	218mUI	9.8
-9	-1.5	1.46434E-01,-1.11559E-01,-3.6839E-02,-1.2895E-02	9.9106E-02	9.39dB	21.9mV	174mUI	8.36dB	26mV	214mUI	9.5
-9	-2	1.38875E-01,-1.18066E-01,-4.2249E-02,-1.6923E-02	9.8777E-02	9.37dB	21.9mV	172mUI	8.08dB	26.7mV	218mUI	9.6
-10	-0.5	1.22364E-01,-1.22767E-01,-3.7801E-02,-9.890E-03	9.7433E-02	9.69dB	20.8mV	166mUI	8.94dB	23.9mV	202mUI	9.3
-11	-0.5	1.00000E-01,-1.48680E-01,-4.9349E-02,-1.5766E-02	9.5040E-02	10.1dB	19.5mV	164mUI	8.93dB	23.3mV	202mUI	9.8
-12	0	1.00000E-01,-1.50000E-01,-5.0000E-02,-1.8210E-02	9.3048E-02	12.9dB	13.8mV	150mUI	10.8dB	18.5mV	188mUI	11.

Stressed Eye Calibration Results

Standard Parameter	Status	Target	Measured	Instrument Parameter	Nominal	Actual
EH6	Pass	10 mV	10 mV	Amplitude	1.200 V	704 mV
VEC6	Pass	12dB	12.5dB	RJ	0.00000 UI	7.16 mUI
Eye Linearity	Pass	0.9	0.89	Lower PAM4 Eye Level	33%	32%
Eye Linearity	Pass	0.9	0.89	Upper PAM4 Eye Level	67%	68%

Figure 88 CTLE Mode Auto-tune results

Differential Peak-Peak Voltage Tolerance Calibration

Overview The Differential Peak-Peak Voltage Tolerance Calibration is performed to calibrate the peak-to-peak voltage of the differential signal on a QPRBS13-CEI pattern. The minimum Differential Peak-Peak Voltage should be at least 750 mV at the TP1a test point (for VSR Module Input standard option) or at least 900 mV at the TP4 test point (for VSR Host Input standard option).

NOTE **Calibrate the minimum Differential Peak-Peak Voltage at TP4 and TP1a test points without using CTLE and DFE.**

As a prerequisite, this calibration will use the Transmitter Equalization values (such as Baud Rate, Transmitter Pre-Cursor3/2/1 and Transmitter Post-Cursor1) that are found in the Stressed Eye Calibration.

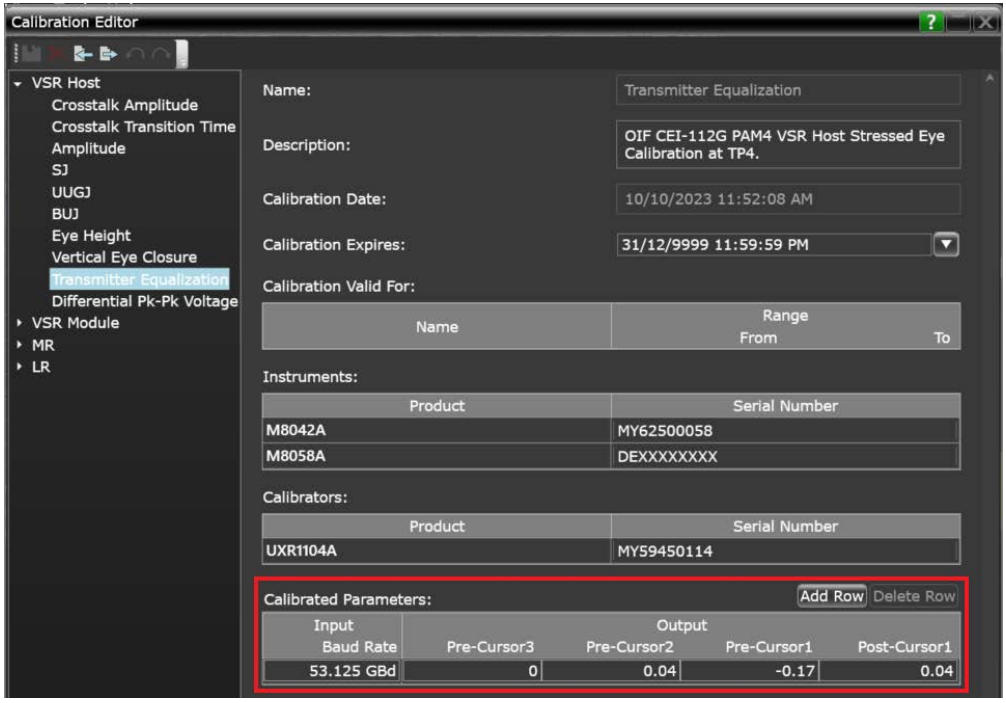


Figure 89 Example of Transmitter Equalization Values from Stressed Eye Calibration viewed in Calibration Editor

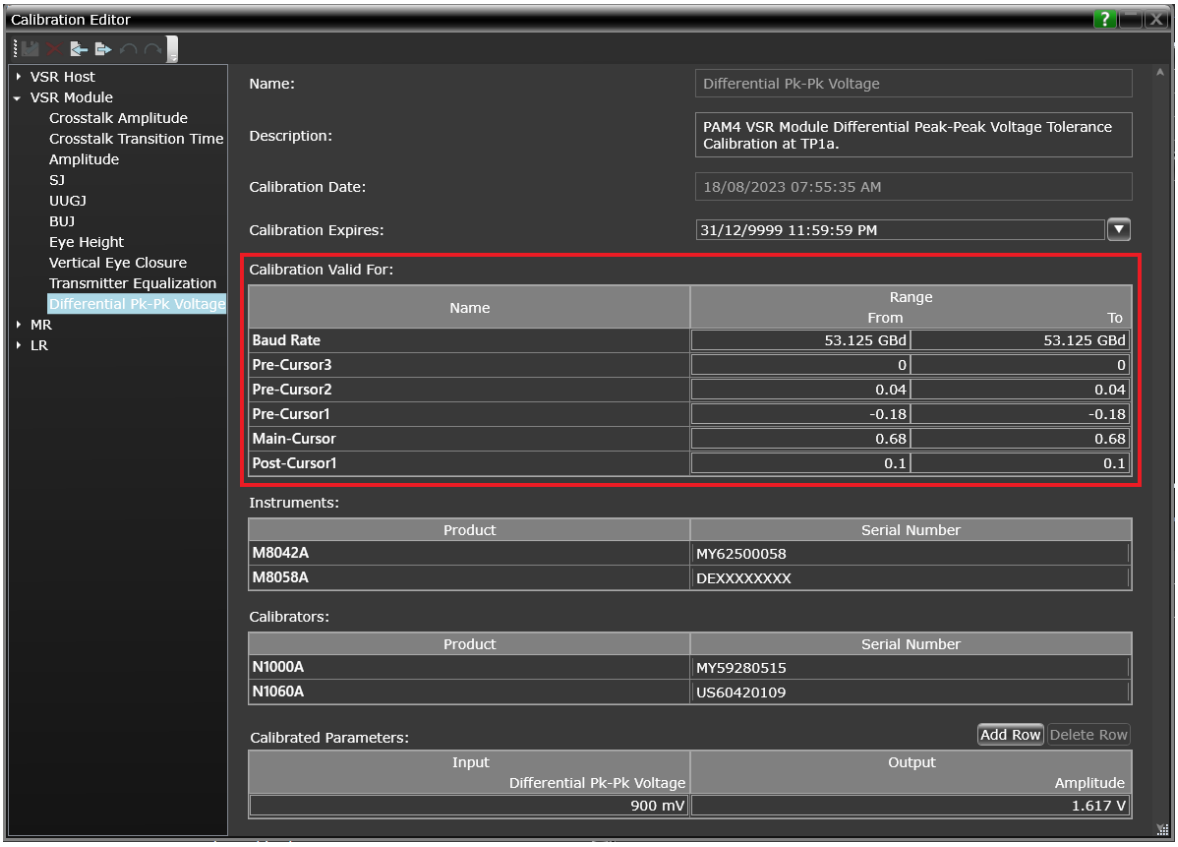


Figure 90 Differential Pk-Pk Voltage using Transmitter Equalization Values, viewed in Calibration Editor

Connection Diagram

Connect the instruments as shown in Figure 91 (Host, M8050A, DCA-X), Figure 92 (Host, M8050A, UXR), Figure 93 (Module, M8050A, DCA-X) and Figure 94 (Module, M8050A, UXR).

Connect (for Host):

- MCB and HCB.
- Connect Victim Generator's Data Out 1 P/N to TP4a P/N of HCB.
- Connect Oscilloscope's CH1/CH2 to TP4 P/N of MCB.
- Terminate X-Talk Generator's Data Out 2 P/N with 50 ohms.

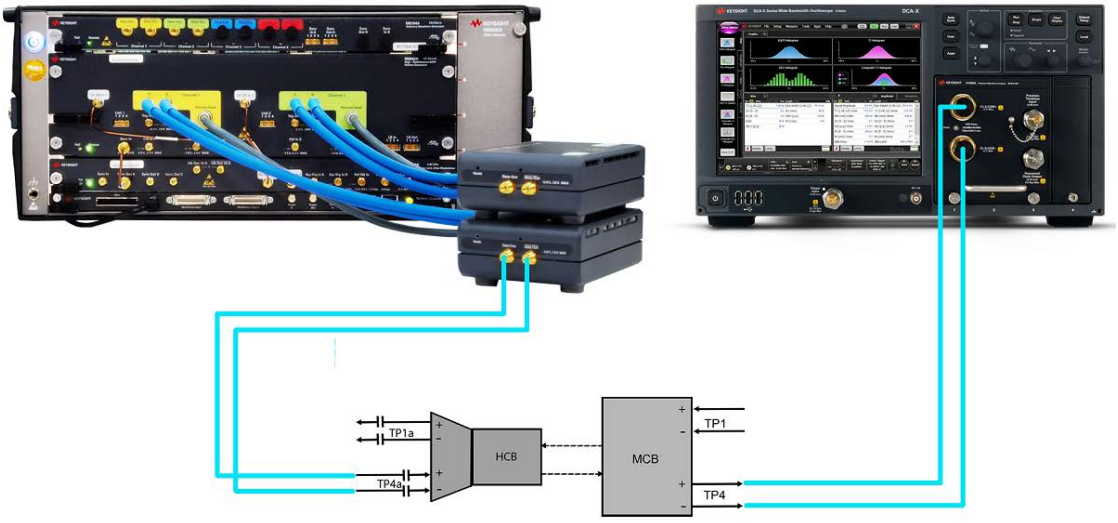


Figure 91 Differential Peak-Peak Voltage Tolerance Calibration connection for VSR Host (M8050A BERT and DCA-X Oscilloscope)

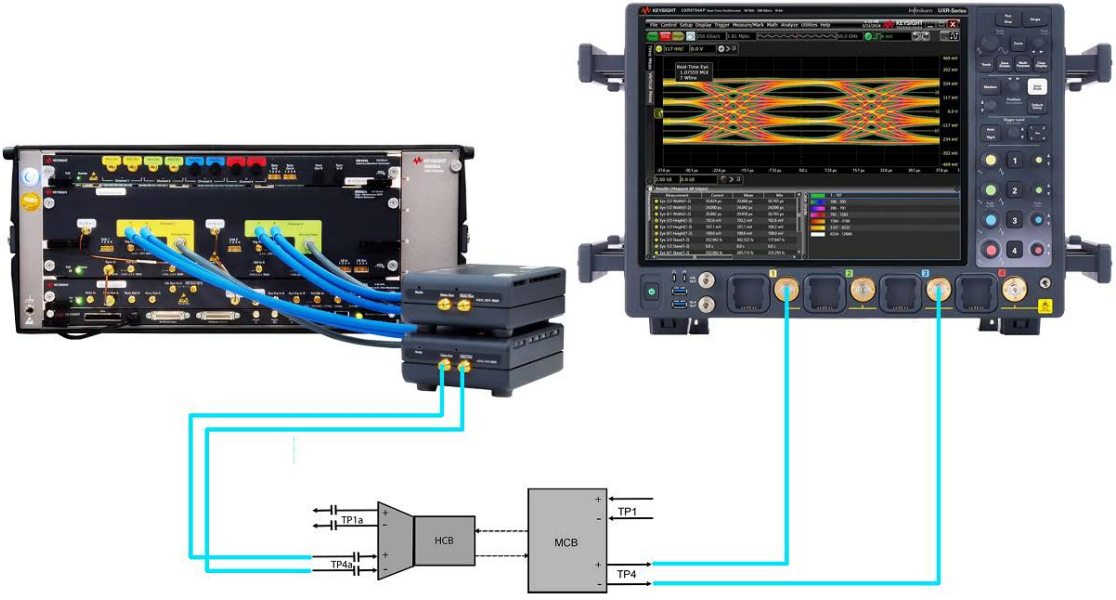


Figure 92 Differential Peak-Peak Voltage Tolerance Calibration connection for VSR Host (M8050A BERT and UXR Oscilloscope)

Connect (for Module):

- MCB and HCB.
- Connect Victim Generator's Data Out 1 P/N to Frequency-dependent attenuator.
- Connect Frequency-dependent attenuator to TP1 P/N of MCB.
- Connect Oscilloscope's CH1/CH2 to TP1a P/N of HCB.
- Terminate X-Talk Generator's Data Out 2 P/N with 50 ohms.

NOTE The Frequency-dependent attenuator is used only for the high-loss channel.

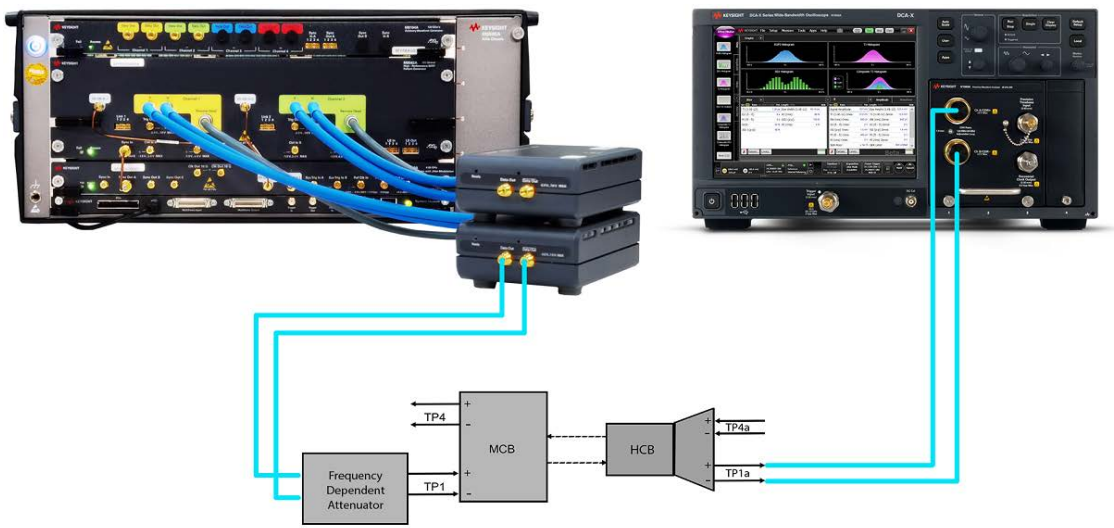


Figure 93 Differential Peak-Peak Voltage Tolerance Calibration connection for VSR Module (M8050A BERT and DCA-X Oscilloscope)

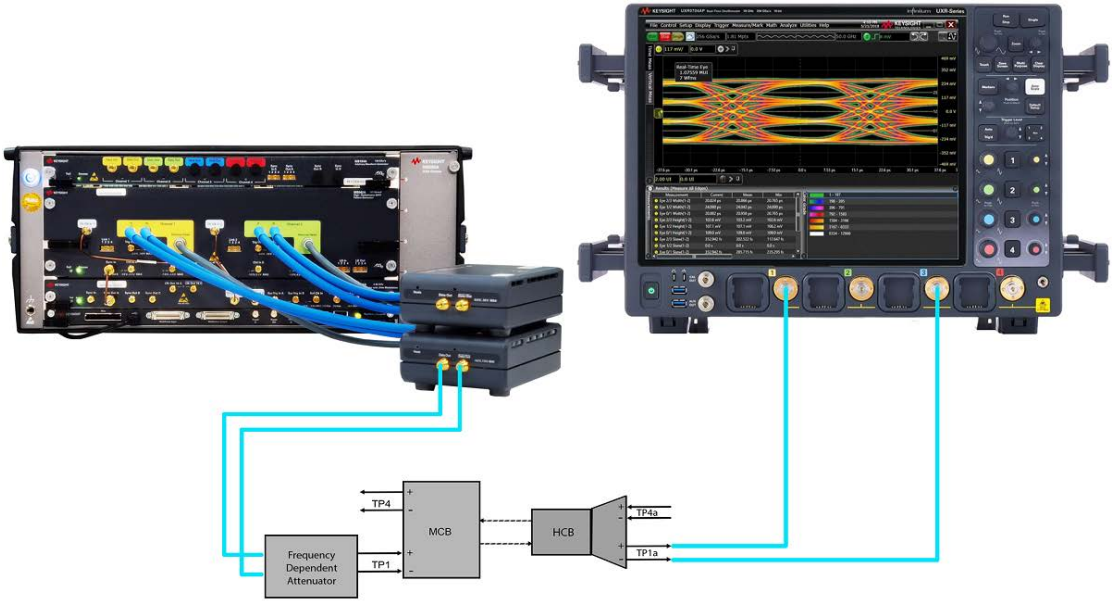


Figure 94 Differential Peak-Peak Voltage Tolerance Calibration connection for VSR Module (M8050A BERT and UXR Oscilloscope)

ID

Standard Name	Test ID
VSR Host	71107
VSR Module	271107

Dependencies The Differential Peak-Peak Voltage Tolerance Calibration depends on the Stressed Eye Calibration as it uses transmitter equalization values determined in the Stressed Eye Calibration and entered in the Transmitter Equalization calibration table (as shown in Figure 89).

Parameters Refer to Calibration Parameters in Debug Mode on page 110.

Procedure This calibration uses the QPRBS13-CEI pattern.

Results The Differential Peak-Peak Voltage Tolerance Calibration returns the following results, in tabular format:

- Standard Parameter
  - Differential Pk-Pk Voltage

- Instrument Parameter
  - Amplitude

Parameter	Value						
Differential Peak-Peak Voltage Tolerance Calibration Result - OIF CEI-112G PAM4 VSR Host TP1a	Pass						
---Additional Info---							
Differential Peak-Peak Voltage Tolerance Calibration Results	Standard Parameter	Status	Target	Measured	Instrument Parameter	Nominal	Actual
	Differential Pk-Pk Voltage	Pass	900 mV	902 mV	Amplitude	900 mV	1.584 V

Figure 95 Differential Peak-Peak Voltage Tolerance Calibration for VSR Host Input

Parameter	Value						
Differential Peak-Peak Voltage Tolerance Calibration Result - OIF CEI-112G PAM4 VSR Module TP1a	Pass						
---Additional Info---							
Differential Peak-Peak Voltage Tolerance Calibration Results	Standard Parameter	Status	Target	Measured	Instrument Parameter	Nominal	Actual
	Differential Pk-Pk Voltage	Pass	900 mV	902 mV	Amplitude	900 mV	1.617 V

Figure 96 Differential Peak-Peak Voltage Tolerance Calibration for VSR Module Input

7 OIF-112G VSR Tests

This chapter describes the test procedures for the OIF-112G VSR Tests, which are applicable for both VSR Host Input and VSR Module Input standard options.

As a prerequisite, before running VSR Host and Module tests:

- Run all OIF-112G VSR Host and VSR Module calibrations.
- Ensure that the DUT is properly connected to the BERT modules and the test channel.

Test Parameters in Debug Mode

The **Debug** Mode in the **Configure** tab of the Test Application includes some parameters in addition to those that can be configured in the **Compliance** Mode. Besides, for some of the configuration options, you may enter custom values, which provides a greater flexibility in performing calibrations and tests.

For the VSR Host Input and VSR Module Input tests, the parameters listed in Table 12 are available for configuration. Note that, other than the "Module Output Mode" parameter, all the parameters appear for both standard options.

Table 12 Test parameters in debug mode for the VSR Host Input and VSR Module Input standard options

Test Parameter	Description
Parameters Common to All Tests	
Baud Rate	Baud Rate for testing device and for all calibrations.
Victim Generator PAM4 Symbol Mapping	Selects how consecutive data bits are mapped to symbols.
Victim Generator PAM4 Custom Symbol Mapping	Selects how consecutive data bits are mapped to symbols. The mapping is defined as a comma-separated list of bit sequences (e.g. 00,01,11,10). The position within this list corresponds to the symbol level. First value is for Symbol 0 and last value is for Symbol 3.
Target Error Ratio	Target Error Ratio for deciding if a test is passed or failed.
Sync Loss Threshold	The threshold level of error ratio at which synchronization is successful.
Alignment BER Threshold	BER threshold used as pass/fail criterion during the sample point alignment.
Host Channel	▪ For VSR Host Input: Selects between Near-end and Far-end host channel. ▪ For VSR Module Input: Selects between Low-loss and High-loss channel. The frequency-dependent attenuation is used only for the High-loss channel.
Module Output Mode	Only for VSR Host Input standard option. Selects between short and long module output mode, as requested by the host. The PCB length of the host channel is listed in *Table 23-8 Emulated Host Channels* in *Section 23.C.2* of *CEI-112G-VSR-PAM4 Very Short Reach Interface* (Draft)
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Victim Analyzer Module	Selects the victim analyzer module for testing the device. ▪ If 'BERT Analyzer' is selected, manually configure the "Victim Analyzer Clock Source" parameter. ▪ If 'DCI' is selected, manually configure the "DUT Control Interface Script File" and "DUT Control Interface Location" parameters.

Test Parameter	Description
Victim Analyzer Clock Source	Selects the clock source for the victim analyzer module. This parameter is only applicable when BERT analyzer is selected as the Victim Analyzer Module.
Victim Analyzer PAM4 Symbol Mapping	Selects how consecutive data bits are mapped to symbols.
Victim Analyzer PAM4 Custom Symbol Mapping	Selects how consecutive data bits are mapped to symbols. The mapping is defined as a comma separated list of bit sequences (e.g. 00,01,11,10). The position within this list corresponds to the symbol level. First value is for Symbol 0 and last value is for Symbol 3.
Target Confidence Level	Target Confidence Level for Target Error Ratio to decide if a test is passed or failed.
DUT Control Interface Script File	Select the DCI script file to be loaded for receiver tests.
DUT Control Interface Location	DCI Location to be used for receiver tests.
Pause before starting Receiver tests	Selects if a pause is made after configuring the error detector modules and before running the alignment to allow for manual changes in the settings.
Parameters for Multi-lane Stressed Input Test	
Test Mode	Select whether to test just for predefined SJ Frequencies ('Compliance') or to measure SJ Frequency ('Characterization').
Jitter Profile Frequency1	Defines the first corner frequency of the jitter profile.
Jitter Profile Amplitude1	Defines the jitter amplitude at first corner frequency of the jitter profile.
Jitter Profile Frequency2	Defines the second corner frequency of the jitter profile.
Jitter Profile Amplitude2	Defines the jitter amplitude at second corner frequency of the jitter profile.
Jitter Profile Frequency3	Defines the third corner frequency of the jitter profile.
Jitter Profile Amplitude3	Defines the jitter amplitude at third corner frequency of the jitter profile.
Frequency Relax Time	Relax time on jitter frequency changes.
Amplitude Relax Time	Relax time on jitter amplitude changes.
Algorithm	Select the measurement algorithm.
Frequency Mode	Select between Auto and Manual frequency mode.
Start Frequency	Controls the start frequency of the jitter sweep.
Stop Frequency	Controls the stop frequency of the jitter sweep.
Number of Steps	The number of steps within the jitter sweep.
Minimum Jitter Amplitude Limit	Minimum Jitter Amplitude Limit.
Maximum Jitter Amplitude Limit	Minimum Jitter Amplitude Limit.

Test Parameter	Description
Manual Frequency List	List of Jitter frequencies separated by commas.
JTol Step Size	Step Size for the binary algorithm of the JTol measurement.
JTol Linear Step Size	Step Size for the linear algorithm of the JTol measurement.
JTol Step Size Log	Step Size for the logarithmic algorithm of the JTol measurement.
Parameters for Voltage Tolerance Test	
Differential Pk-Pk Voltage	Minimum Voltage that the device must tolerate at its input without overloading its front end and causing distortion/clipping that would generate poor equalization and/or BER degradation.

Multi-lane Stressed Input Test

Overview The Multi-lane Stressed Input Test validates the ability of the host input to tolerate sinusoidal jitter within the specified limits. The test signal is applied at TP4a using a Host Compliance Board (HCB). This test should be performed four times for the VSR Host Input standard (as shown in Table 13) and two times for the VSR Module Input standard (as shown in Table 14).

Table 13 VSR Host Input Calibration Mode

Standard Option	Host Channel	Module Output Mode	Notes
VSR Host Input	Far-end	Short	Set Host Channel and Module Output Modes in the Configure tab
		Long	
	Near-end	Short	
		Long	

Table 14 VSR Module Input Calibration Modes

Standard Option	Channel	Notes
VSR Module Input	Low Loss	Mated MCB/HCB
	High Loss	Mated MCB/HCB + Frequency-dependent attenuator

Connection Diagram

For the Multi-lane Stressed Input test, connect the instruments as shown in Figure 97 (Host, M8050A) and Figure 98 (Module, M8050A).

Connect (for Host):

- Host Device and HCB.
- Set Device to Loopback.
- Connect X-Talk Generator's Data Out 2 P/N to TP4a P/N of Lane next to Victim.
- Termination the TP1a P/N of Lane next to Victim with 50 ohms.
- Connect Victim Generator's Data Out 1 P/N to TP4a P/N.
- Internal CDR
  - Connect Victim Analyzer's Data In P/N to TP1a P/N.
- External CDR
  - Connect Recovered Clock Out from Clock Recovery to Victim Analyzer's Clk In.
  - Connect Victim Analyzer's Data In P/N to TP1a P/N via Pick-Off.

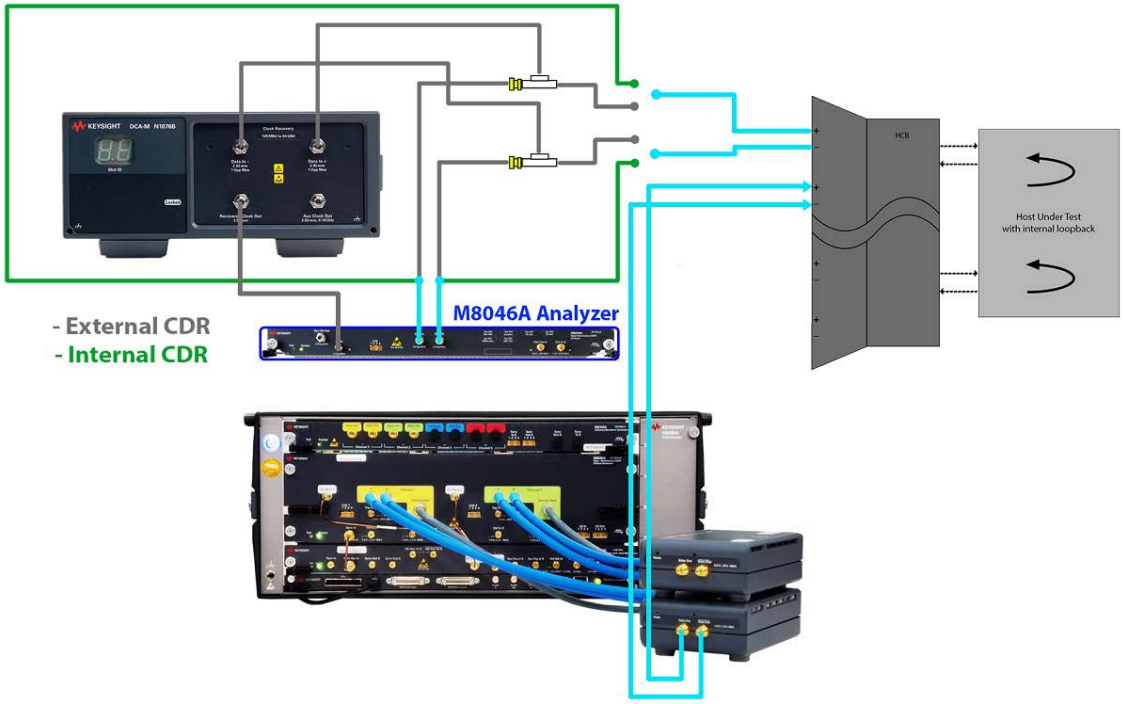


Figure 97 Multi-lane Stressed Input Test connections for VSR Host (M8050A BERT)

Connect (for Module):

- Module Device and MCB.
- Set Device to Loopback.
- Connect X-Talk Generator's Data Out 2 P/N to TP1 P/N of Lane next to Victim.
- Terminate TP4 P/N of Lane next to Victim 50 ohms.
- Victim Generator Data Out 1 P/N to Frequency-dependent attenuator.
- Connect Frequency-dependent attenuator to TP1 P/N.
- Internal CDR
  - Connect Victim Analyzer's Data In P/N to TP4 P/N.
- External CDR
  - Connect Recovered Clock Out from Clock Recovery to Victim Analyzer's Clk In.
  - Connect Victim Analyzer's Data In P/N to TP4 P/N via Pick-Off.

NOTE The Frequency-dependent attenuator is used only for the High Loss channel.

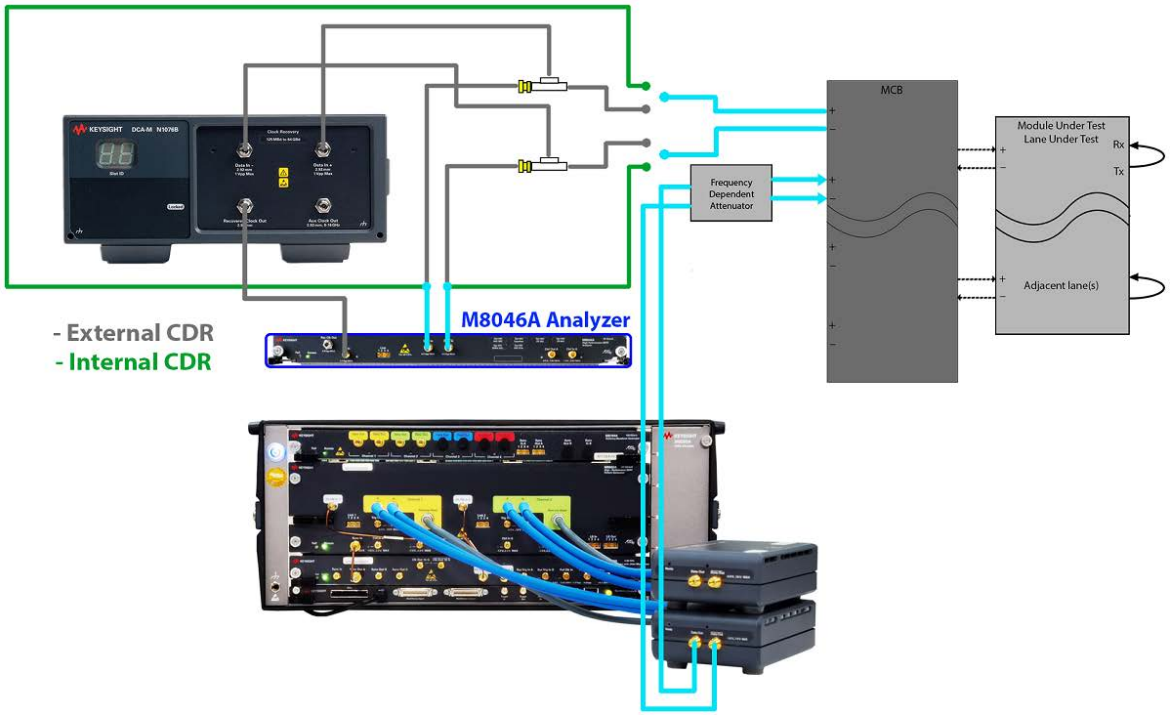


Figure 98 Multi-lane Stressed Input Test connections for VSR Module (M8050A BERT)

ID

Standard Name	Test ID
VSR Host Multi-lane	75100
VSR Module Multi-lane	275100

Dependencies

The Multi-lane Stressed Input Test depends on the values configured for the following settings:

- Crosstalk Calibration on page 118
- Amplitude Calibration on page 123
- SJ Calibration on page 125
- UUGJ Calibration on page 127
- BUJ Calibration on page 129
- Stressed Eye Calibration on page 132

Parameters Refer to Test Parameters in Debug Mode on page 148.

Procedure This test uses the QPRBS31-CEI pattern.

Results The Multi-lane Stressed Input Test returns the following results:

- Pass/Fail for each SJ Amplitude & Frequency pair point

Parameter	Value
Multi-lane Stressed Input Test Result - OIF CEI-112G PAM4 VSR Host	Pass
---Additional Info---	
Multi-lane Stressed Input Test Screenshot	(See image)
Multi-lane Stressed Input Test Results	Parameter / Frequency / Amplitude / Status SJ1 / 40.000 kHz / 5.0000 UI / Pass SJ2 / 400.000 kHz / 500.0 mUI / Pass SJ3 / 1.333000 MHz / 150.0 mUI / Pass SJ4 / 4.000000 MHz / 50.0 mUI / Pass SJ5 / 12.000000 MHz / 50.0 mUI / Pass SJ6 / 40.000000 MHz / 50.0 mUI / Pass

Figure 99 VSR Host Multi-lane Stressed Input Test Result – tabulated

Figure 100 VSR Host Multi-lane Stressed Input Test Result – graphical

Voltage Tolerance Test

Overview

The Input Voltage Tolerance Test will use the Differential Peak-Peak Voltage Tolerance Calibration on page 140 during the test. This test is carried out without stress but with an amplitude measured after the channel (TP4/TP1a) with proper de-emphasis (for example, the one found according to the VSR Stressed Eye Calibration on page 132).

This test should be performed four times for the VSR Host Input standard (as shown in Table 15) and two times for the VSR Module Input standard (as shown in Table 16).

Table 15 VSR Host Input Calibration Mode

Standard Option	Host Channel	Module Output Mode	Notes
VSR Host Input	Far-end	Short	Set Host Channel and Module Output Modes in the Configure tab
		Long	
	Near-end	Short	
		Long	

Table 16 VSR Module Input Calibration Mode

Standard Option	Channel	Notes
VSR Module Input	Low Loss	Mated MCB/HCB
	High Loss	Mated MCB/HCB + Frequency-dependent attenuator

Connection Diagram

Connect the instruments as shown in Figure 101 (Host, M8050A) and Figure 102 (Module, M8050A).

Connect (for Host):

- Host Device and HCB.
- Set Device to Loopback.
- Connect Victim Generator's Data Out 1 P/N to TP4a P/N.
- Internal CDR
  - Connect Victim Analyzer's Data In P/N to TP1a P/N.
- External CDR
  - Connect Recovered Clock Out from Clock recovery to Victim Analyzer's Clk In.
  - Connect Victim Analyzer's Data In P/N to TP1a P/N via Pick-Off.
- Terminate X-Talk Generator's Data Out 2 P/N with 50 ohms.

NOTE

Host channel is embedded in the Oscilloscope.

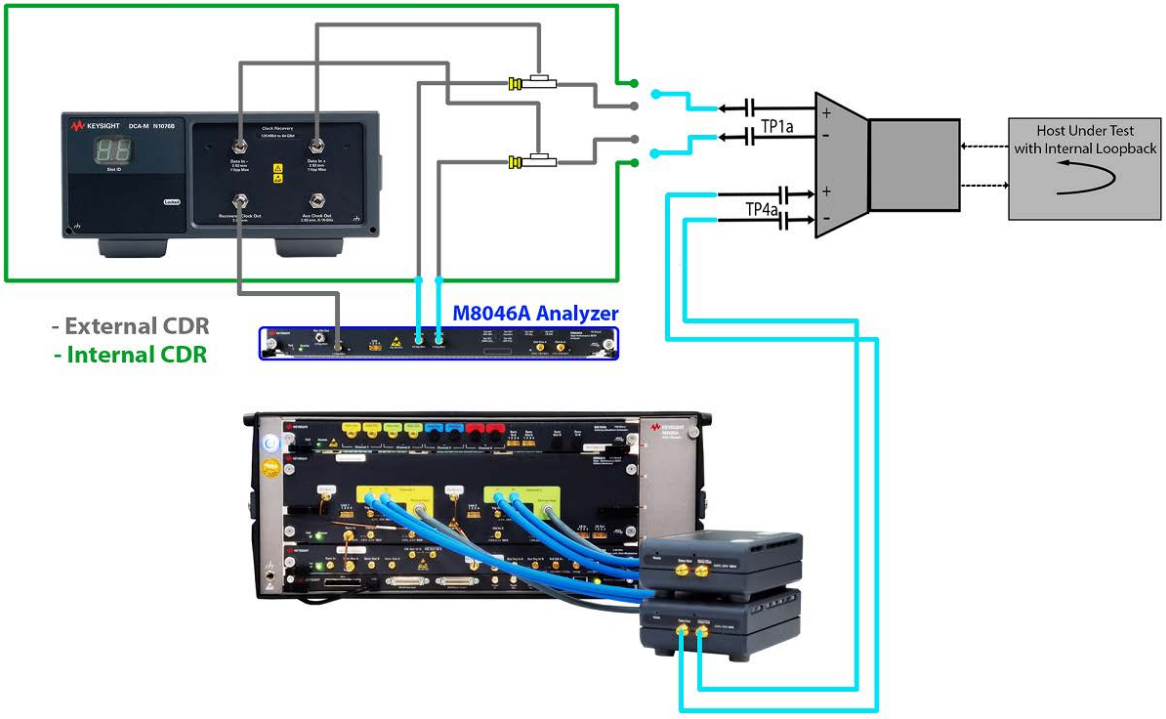


Figure 101 Voltage Tolerance Test connections for VSR Host (M8050A BERT)

Connect (for Module):

- Module Device and MCB.
- Set the Device to Loopback.
- Set Victim Generator's Data Out 1 P/N to Frequency-dependent attenuator.
- Connect Frequency-dependent attenuator to TP1 P/N.
- Internal CDR
  - Connect Victim Analyzer's Data In P/N to TP4 P/N
- External CDR
  - Connect Recovered Clock Out from Clock Recovery to Victim Analyzer's Clk In.
  - Connect Victim Analyzer's Data In P/N to TP4 P/N via Pick-Off.
- Terminate X-Talk Generator's Data Out 2 P/N with 50 ohms.

NOTE The Frequency-dependent attenuator is used only for the High Loss channel.

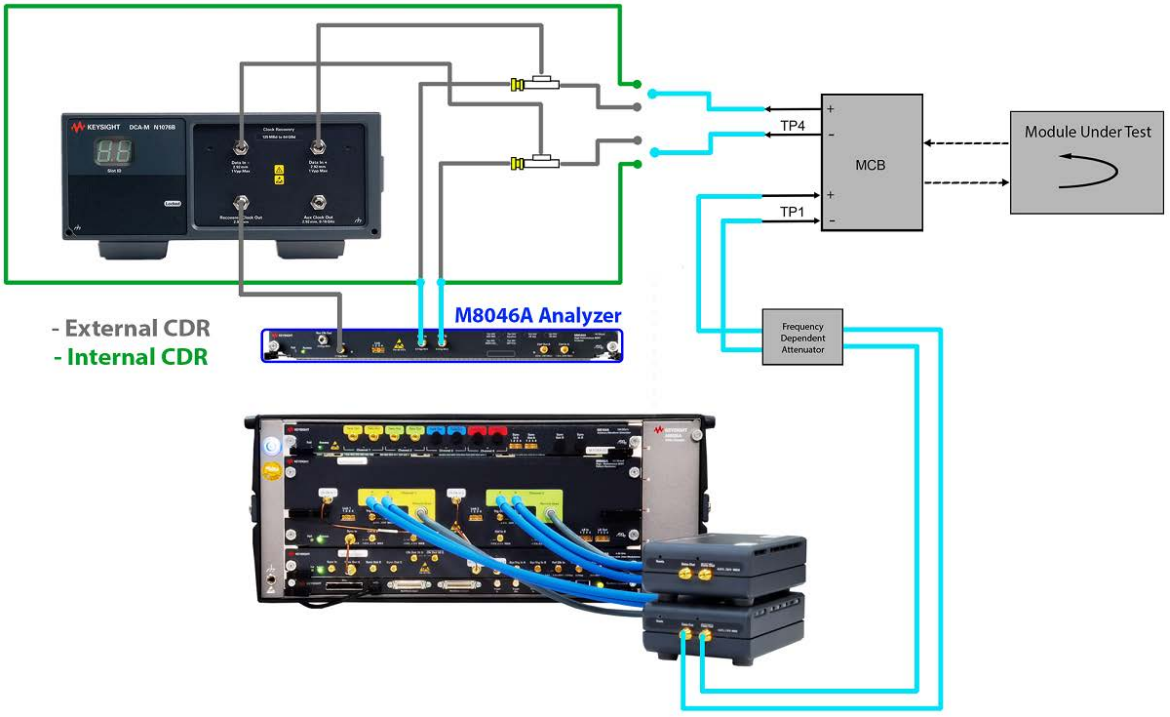


Figure 102 Voltage Tolerance Test connections for VSR Module (M8050A BERT)

ID

Standard Name	Test ID
VSR Host Multi-Lane	75102
VSR Module Multi-Lane	275102

Dependencies The Voltage Tolerance Test depends on the Differential Peak-Peak Voltage Tolerance Calibration on page 140.

Parameters Refer to Test Parameters in Debug Mode on page 148.

Procedure This test uses the QPRBS31-CEI pattern.

Results The Voltage Tolerance Test returns the following results:

- Pass/Fail for each Amplitude point

Figure 103 shows example results for VSR Host Input. The results for VSR Module Input look similar.

Parameter	Value
Voltage Tolerance Test Result - OIF CEI-112G PAM4 VSR Host	Pass
---Additional Info---	
Voltage Tolerance Test Results	Parameter / Status / Minimum Differential Pk-Pk Voltage / Pass / 900 mV

Figure 103 VSR Host Voltage Tolerance Test Result

8 Calibration & Test Results

This chapter describes how calibration results can be displayed in the Calibration View tab and how the 'Upload Results To Repository' feature facilitates making results available to collaborators anywhere in the world.

About Calibration View

The **Calibration View** tab displays the set and measured values of the parameters being calibrated, in both graphical and tabular format.

NOTE

The Calibration View only plots graphs for continuous calibrations (such as SJ, UUGJ and Broadband Noise) and not single-point calibrations such as Amplitude Calibration.

The **Calibration View** tab displays information related to calibrations only. All other results and associated information are displayed under the **Results** tab of the Test Application.

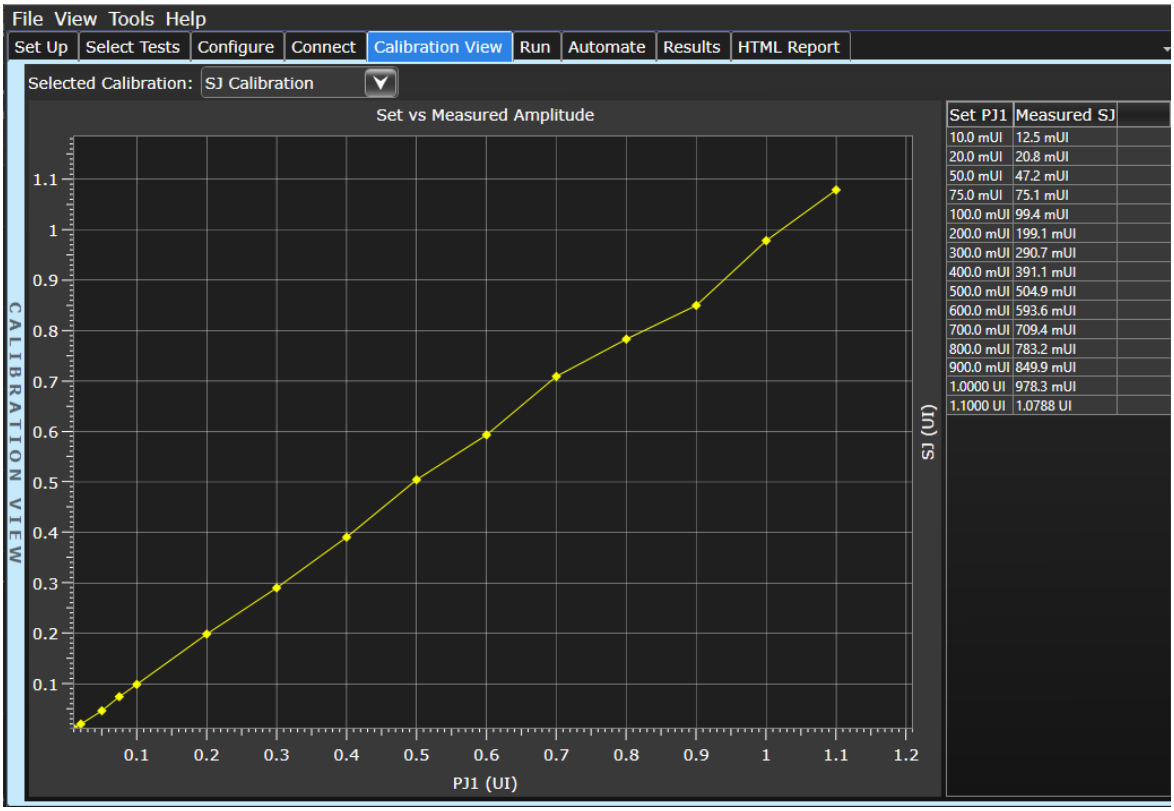


Figure 104 Example of the Calibration View after calibrations have been performed

Exporting Measurement Results to Repository

The Upload Results To Repository feature is an add-on to the Keysight Test Application, where it expands the boundaries of storing and analyzing the measurement results to a wider audience, who may be based in multiple sites across various geographical locations. Along with the feature of exporting test results from the Test Application onto your local disk in CSV, HTML or PDF file formats, you have the option to upload the test results to a Dataset on a Web Repository. Based on your requirements, you may either upload only a single measurement trial or upload huge volumes of measurement results to any Dataset.

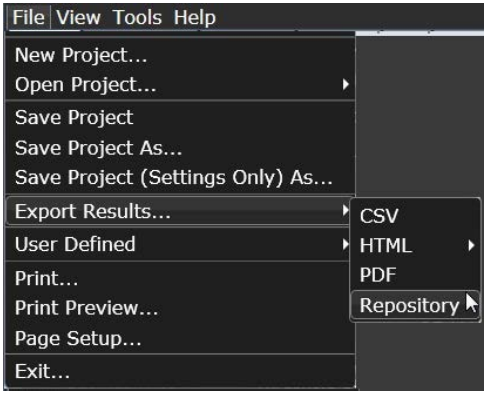
Not only can remote users with an active Internet connection access these Datasets and the corresponding test results on the Web Repository, but they have the option to add and delete Datasets on the Web Server. In the Upload Results To Repository feature, you can even modify the Dataset properties, which is helpful especially when performing a graphical analysis of the uploaded data.

In combination with the *Keysight KS6800A Series Analytics Software*, the Upload Results To Repository feature provides a comprehensive solution to export, view and perform analysis of the measurement results, thereby resulting in qualitative data to ensure that the Device Under Test (DUT) is compliant to the industry standards.

Refer to the *Keysight KS6800A Series Analytics Software Online Help* for more information about the functionality of various features in this software.

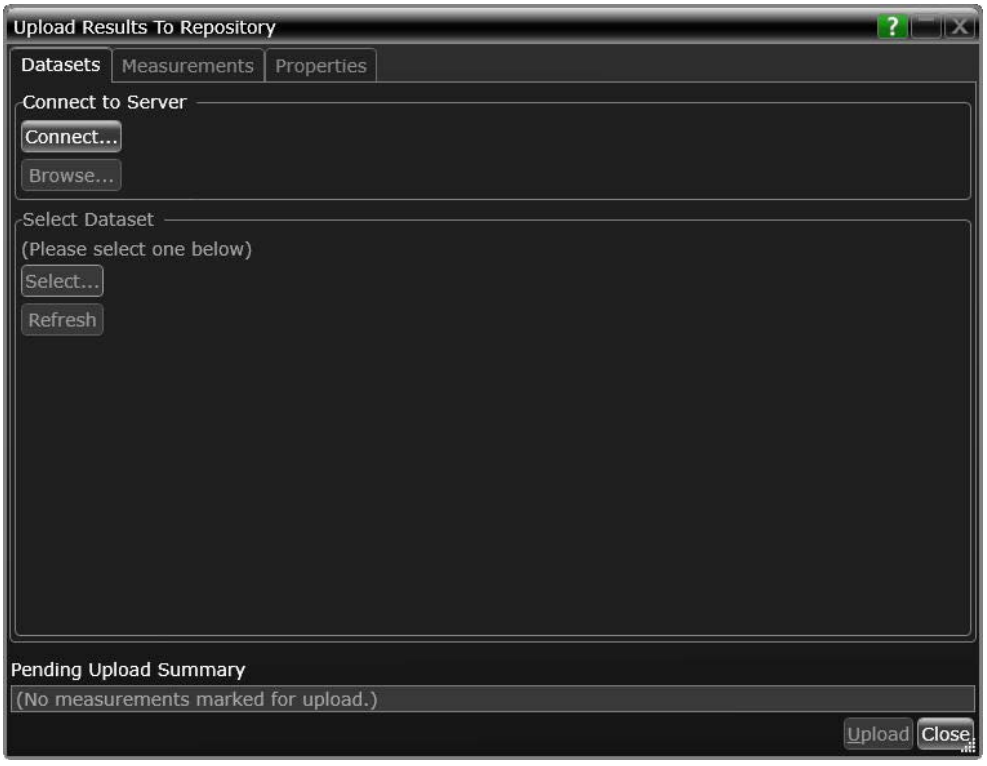
To export measurement results to the Repository after the completion of test runs:

1 From the Test Application's main menu, click **File > Export Results... > Repository**.



The **Upload Results to Repository** window appears.

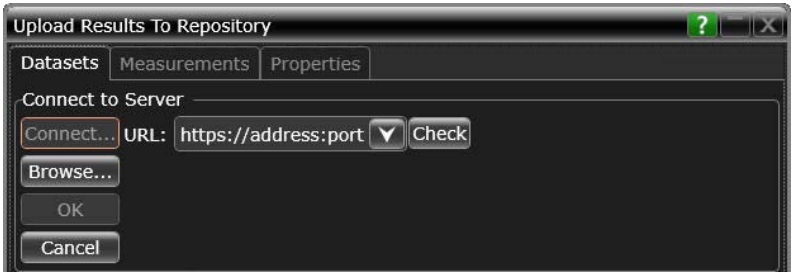
2 In the **Connect to Server** pane of the **Datasets** tab, click **Connect...** to log in to the Dataset Repository server.



3 In the URL: drop-down text field that appears, replace the default text with the actual IP address or the URL along with the port number, if applicable.

You may enter the URL of the Web Repository server, which may be a self-hosted server on your machine (http://localhost:5000/), a remote server or an authentication server. Note that all such URLs accessed via this window appear as a drop-down list in the URL: field.

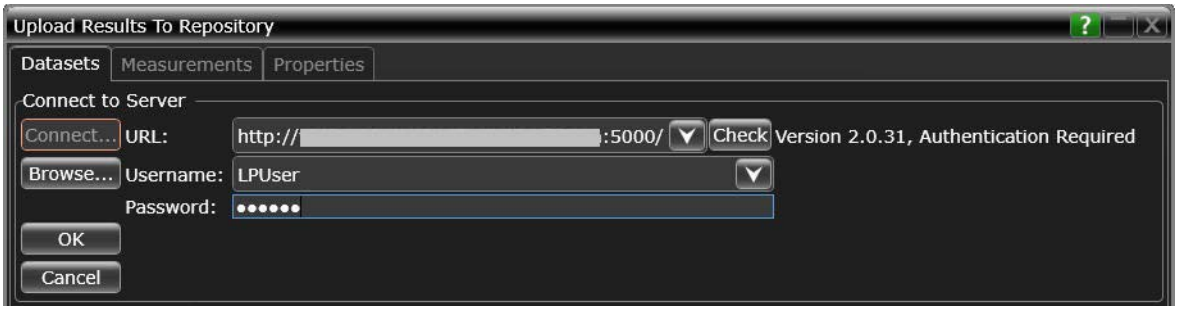
4 Click the **Check** button to verify that the KS6800A Series Analytics service is available at the specified web address. Repeat this step each time you edit the web address.



- For unrestricted access to the Repository
  - *a* If the server does not require authentication and the KS6800A Series Analytics service is found on the specified web address, the version information is displayed adjacent to the **Check** button.

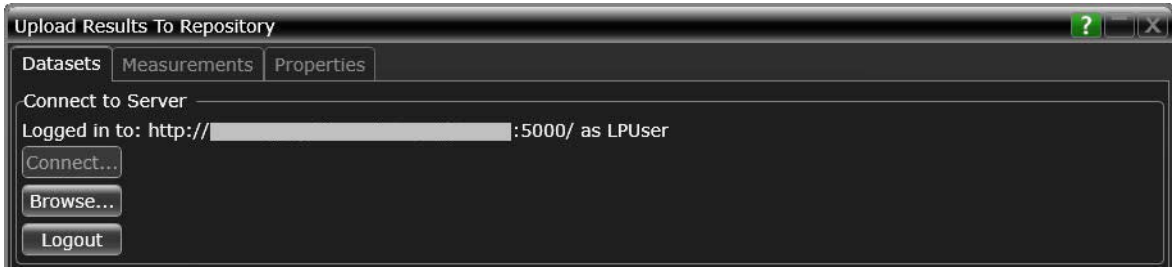
  - *b* If you click **OK**, the **Upload Results to Repository** window displays the connectivity status to the Dataset Repository.
  - *c* Click **Browse**... to navigate directly to the URL.

- For restricted access to the Repository
  - *a* If service is found on the specified URL but access to the web server is restricted based on authentication, the version information is displayed along with the text Authentication Required adjacent to the **Check** button. Also, the Username: and Password: fields appear. The **OK** button remains disabled until the authentication credentials are entered.
  - *b* Enter the user credentials in the respective fields, which are required for authentication to access those Datasets that have been created on the web server you are connecting to. For each URL that you access, the **Username:** drop-down box keeps a record and displays all user names used to access the respective URL.



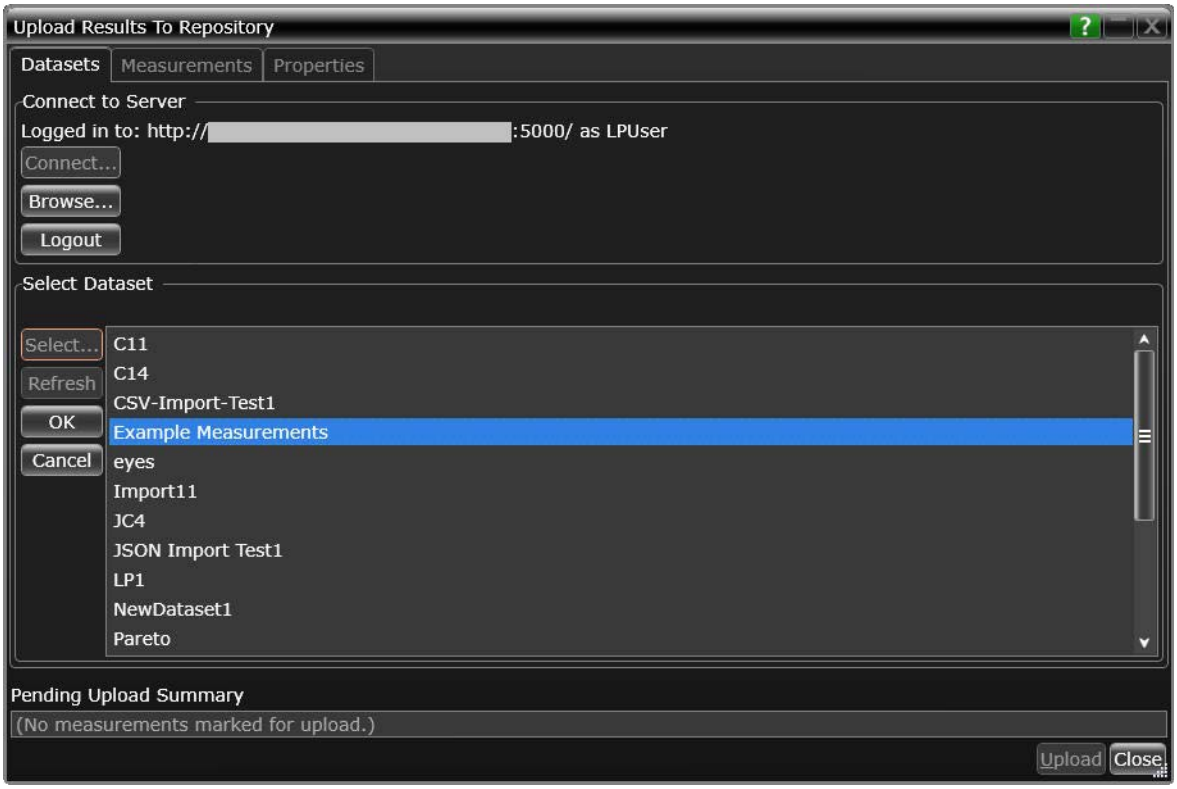
  - *c* Click **OK** to connect to the entered URL/IP address.

  The Connect to Server area displays the connection status along with the username.
  - *d* Click **Browse...** to navigate directly to the URL.

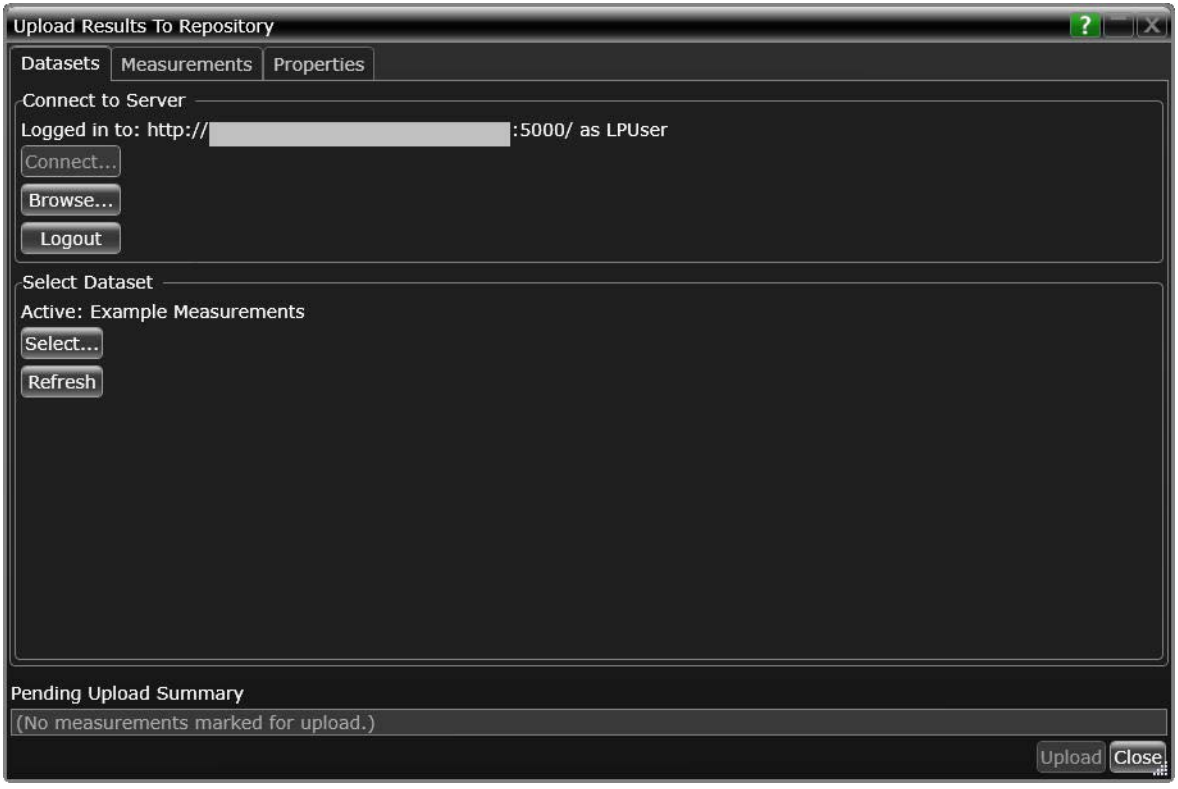


5 In the **Select Dataset** area, click **Select...** to view the list of Datasets created on the connected repository. Click **Refresh** to update the list of Datasets that appear in the Test Application's user interface.

6 Select the Dataset name where you wish to upload measurement results to. Click **OK**.

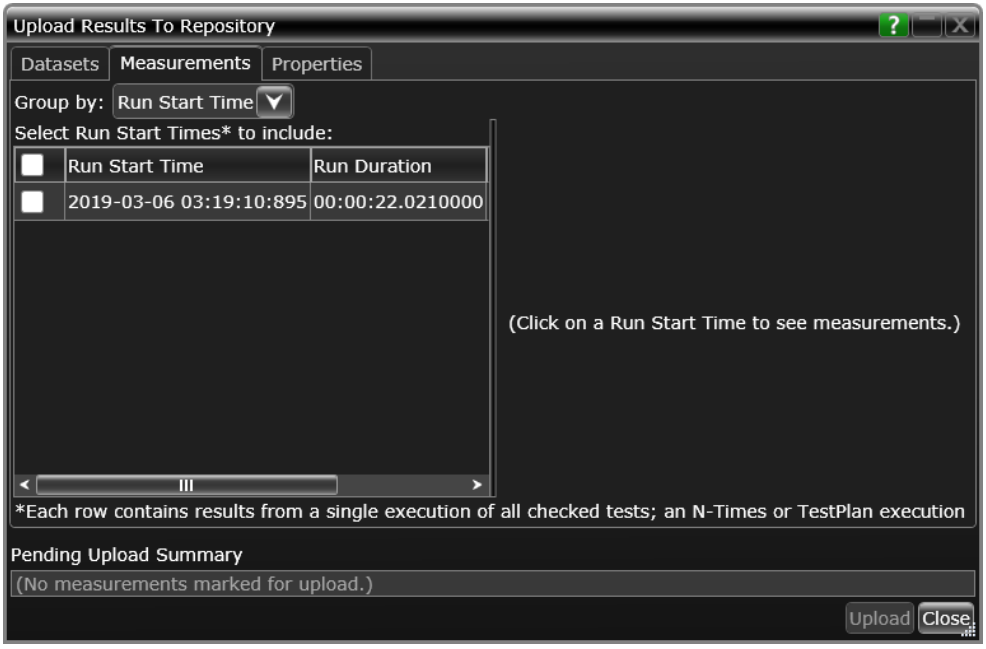


The Select Dataset area displays the selected Dataset as Active. The Measurements and Properties tabs are enabled after a Dataset is selected.



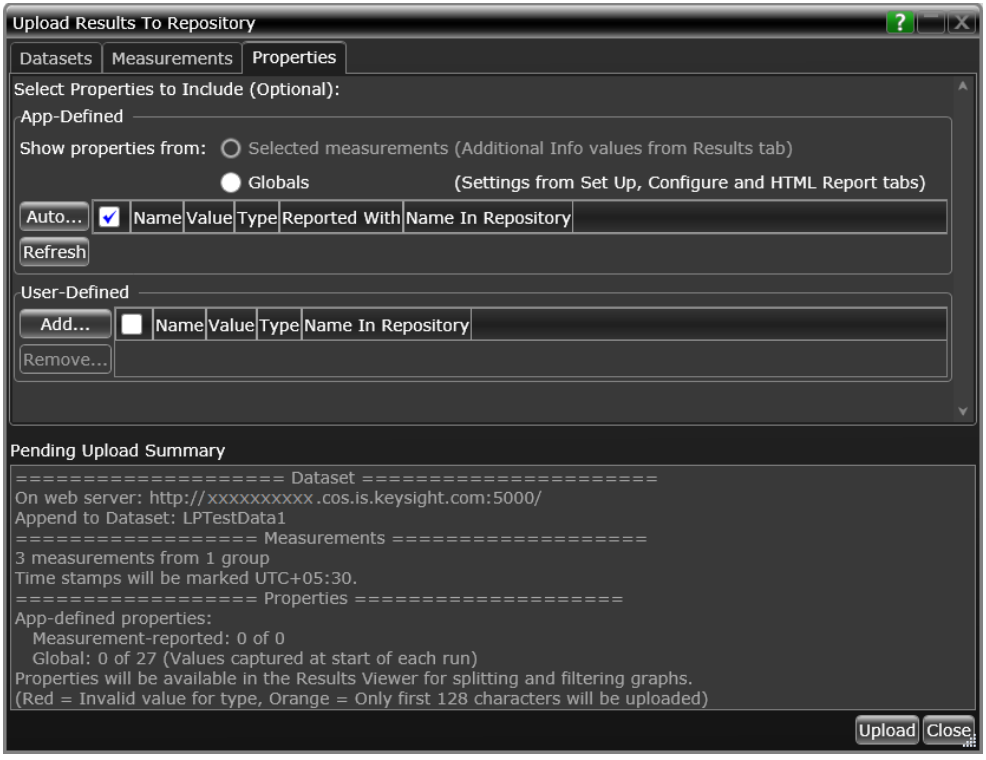
7 Click the **Measurements** tab where the test results from the last test run are displayed.

8 You may select and export multiple test results to the repository. You may change the format for the display of measurement data using the drop-down options in the **Group by:** field.

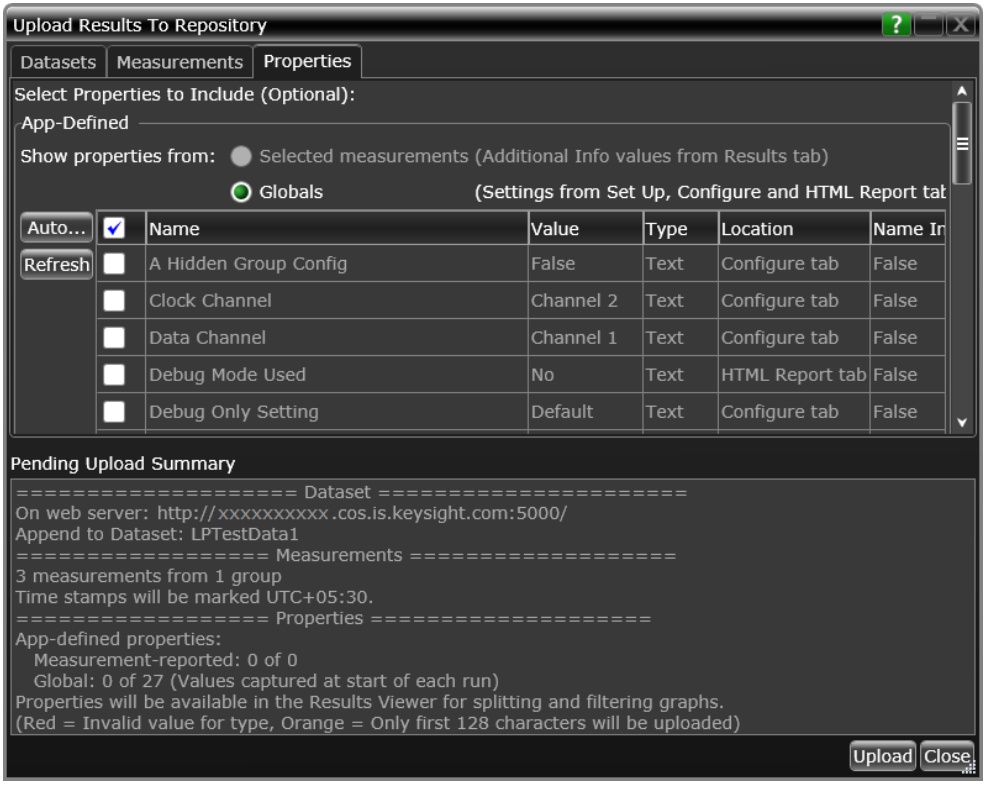


9 After selecting one or more measurements, either click **Upload** or switch to the **Properties** tab to associate one or more properties with the measurements that are being uploaded to the Web Server.

To perform an enhanced analysis on the measurement data using the *KS6800A Series Analytics Service Software*, Keysight recommends assigning properties to the measurements.



10 Click the **Properties** tab to assign properties for your measurement results that you select to upload. By default, the **App-Defined** properties are selected to be uploaded in association with the measurement data, wherein only certain aspects of the selected measurements are uploaded. However, you may switch to **Globals** to include as properties one or more options configured under the rest of the tabs of the Compliance Test Application or define one or more custom property values to be associated with the selected measurement data.



11 Click **Upload** to begin uploading measurement results.

12 Click **Close** to exit the **Upload Results to Repository** window and to return to the Compliance Test Application.

You may access the Dataset Repository using the Internet browser on your machine to view the measurement results graphically on the *KS6800A Series Analytics Service Software*.

KS6800A Series Analytics Service Software

The KS6800A Series Analytics Service software supports multiple data sources and also a wide range of data import clients. This web-based software provides various types of charts, such as Histogram, Box-and-Whisker, Line, Scatter, Eye Diagram and Constellation, each with split capability to enable data analysis. Once you upload the measurement results to a Dataset on the *KS6800A Series Analytics Service Software* via the **Upload Results to Repository** window of the Test Application, the measurement results can be viewed graphically as shown in Figure 105.

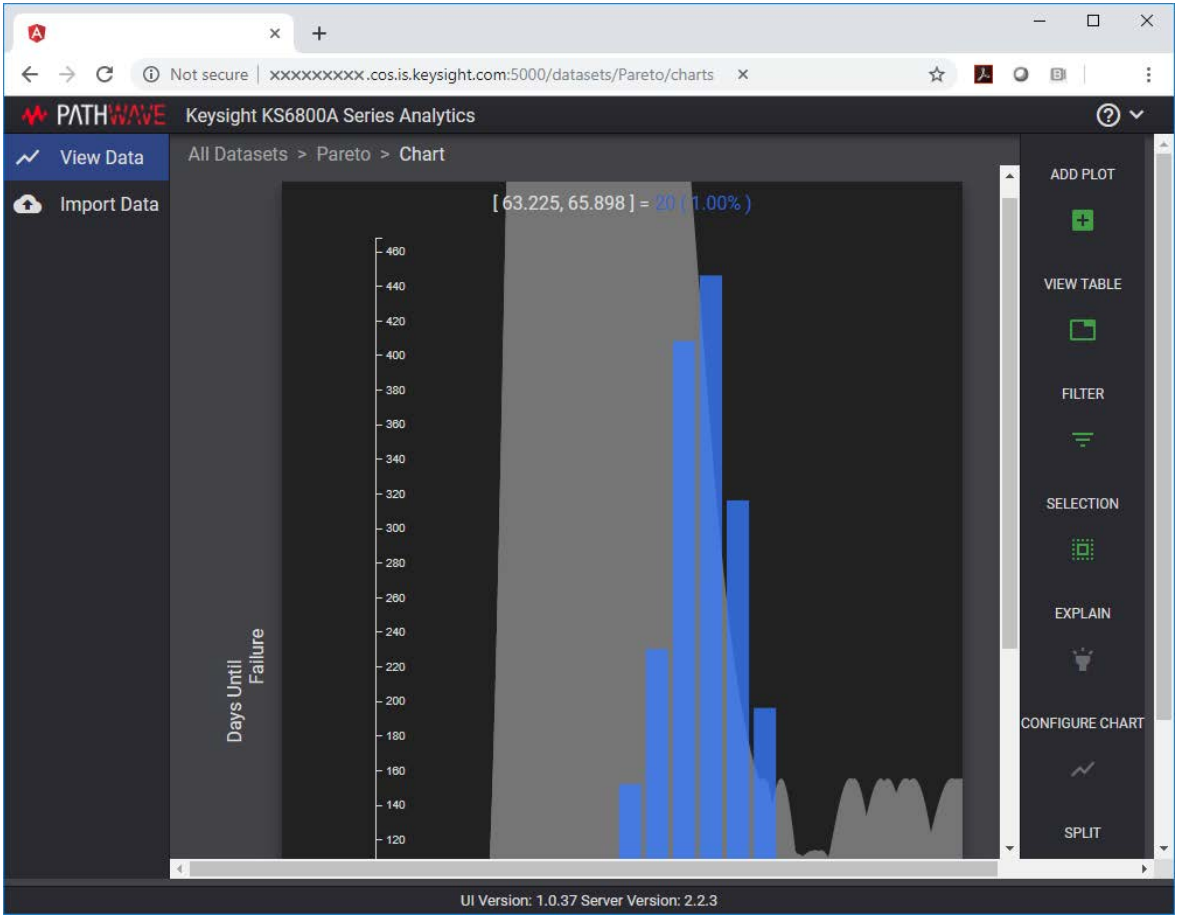


Figure 105 User interface of the KS6800A Series Analytics Service software

For more information about the Data Analytics Web Service Software, visit the KS6800A Series Analytics Service Software page on the Keysight website. You may refer to the Help manual provided within the software to understand the functionality of its features.

9 Appendix: Acronyms and Abbreviations

This chapter lists the acronyms and abbreviations used throughout this guide.

List of Acronyms

Acronym	Definition
AWG	Arbitrary Waveform Generator
BER	Bit Error Ratio
BERT	Bit Error Ratio Tester
BUJ	Bounded Uncorrelated Jitter
BW	Bandwidth
CDR	Clock Data Recovery
CEI	Common Electrical I/O Project
COM	Channel Operating Margin
CSV	Comma-Separated Values
CTLE	Continuous Time Linear Equalization
DB	dB–Angle
DCA	Digital Communication Analyzer
DCI	DUT Control Interface
DFE	Decision Feedback Equalization
Dp	Linear Fit Pulse Delay
DSO	Digital Storage Oscilloscope
DUT	Device Under Test
ED	Error Detector
EH	Eye Height
EQ	Equalization
f_b	Baud Rate
FEXT	Far-End Aggressor Crosstalk
FFE	Feed Forward Equalization
FIR	Finite Impulse Response
FOM	Figure of Merit

Acronym	Definition
HCB	Host Compliance Board
HiSLIP	High-Speed LAN Instrument Protocol
HTML	HyperText Markup Language
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
IL	Insertion Loss
IO or I/O	Interface
IP	Internet Protocol
ISI	Inter-Symbol Interference
ITol	Interference Tolerance
JSA	Jitter Spectrum Analysis
JTol	Jitter Tolerance
KLM	Keysight License Manager
LAN	Local Area Network
LR	Long Reach
MA	Magnitude–Angle
MCB	Module Compliance Board
MR	Medium Reach
N/A	Not Applicable
NEXT	Near-End Aggressor Crosstalk
Np	Linear Fit Pulse Length
NRZ	Non-Return-to-Zero
OIF	Optical Internetworking Forum
OS	Operating System
OSFP	Octal Small Form Factor Pluggable
PAM	Pulse-Amplitude Modulation
PC	Personal Computer

Acronym	Definition
PCB	Printed Circuit Board
PDF	Portable Document Format
Pk–Pk	Peak to Peak
PLTS	Physical Layer Test System
PMD	Physical Medium Dependent (interface)
PRBS	Pseudorandom Binary Sequence
PTB	Precision Timebase
QSFP	Quad Small Form Factor Pluggable
RAM	Random Access Memory
RF	Radio Frequency
RI	Random Interference; Real–Imaginary
RJ	Random Jitter
RLM	Level Separation Mismatch Ratio
RMS	Root Mean Squared
Rx	Receiver
SCPI	Standard Commands for Programmable Instruments
SICL	Standard Instrument Control Library
SJ	Sinusoidal Jitter
SNR	Signal-to-Noise Ratio
SNDR	Signal to Noise-and-Distortion Ratio
SW	Software
TCP	Transmission Control Protocol
TP	Test Point
Tx	Transmitter
UBHPJ	Uncorrelated Bounded High-Probability Jitter
URL	Uniform Resource Locator
USB	Universal Serial Bus

Acronym	Definition
UUGJ	Uncorrelated Unbounded Gaussian Jitter
VEC	Vertical Eye Closure
VEC6	Vertical Eye Closure at 1E–6
VISA	Virtual Instrument System Architecture
VSR	Very Short Reach
WXGA+	Wide Extended Graphics Array (II)

M8092-91312
Edition 1.2, June 2025

www.keysight.com

KEYSIGHT
TECHNOLOGIES