M8091UACA Receiver Conformance Test Application for UALink

KEYSIGHT

USER GUIDE

Notices

Manual Part Number

M8070-91312

Edition

Edition 1.0, February 2026

Address

Available in electronic format only

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https://www.keysight.com/us/en/support/M8091UACA

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 M8091UACA Receiver Conformance Test Application for UALink

User Guide

1 Introduction

This chapter provides an overview of the UALink Rx Test Application and the related documents that can be consulted.

KEYSIGHT TECHNOLOGIES

Overview

The Keysight M8091UACA Receiver Conformance Test Application for UALink provides a framework for using Keysight M8000 BERT Test Solutions along with Keysight Infiniium UXR oscilloscopes to perform Receiver testing based on the calibration and test procedures defined in Annex 176C, Annex 176D, Clause 178, and Clause 179 of the *IEEE P802.3dj™/D2.0, Draft Standard for Ethernet Amendment:* Media Access Control Parameters for 1.6 Tb/s and Physical Layers and Management Parameters for 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Operation.

Copper Cable (CR) Interface

The coaxial copper cable (CR) electrical interface testing methodology in UALink is designed for Direct Attach Copper (DAC) cables, emphasizing short-reach, high-speed connectivity.

Backplane (KR) Interface

The backplane (KR) electrical interface testing methodology in UALink builds upon the principles of Channel Operating Margin (COM) and stressed signal testing, tailored for high-speed backplane environments.

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

Related Documents

- IEEE P802.3dj™/D2.0 Draft Standard for Ethernet Amendment: Media Access Control Parameters for 1.6 Tb/s and Physical Layers and Management Parameters for 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Operation.
- 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 UALink Rx Test App

As a prerequisite to installing the UALink Rx Test Application, you require the necessary hardware, along with certain installed software and licenses.

System Requirements

PC Hardware Minimum Requirements

- PC with Windows 11 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 Software Manager Utility
- M8070B System Software for M8000 series
  - M8070ADVB Advanced Measurement Package for M8000 Series
- MATLAB Compiler Runtime R2022b (9.13)
  - Installer Link: https://ssd.mathworks.com/supportfiles/downloads/R2022b/Release/10/deployment_files/installer/complete/win64/MATLAB_Runtime_R2022b_Update_10_win64.zip

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 M8091UACA 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
  - Interference source
  - UXR Oscilloscope
- Recommended accessories and fixtures
- Software configuration

Installing the Software

The installer for the Keysight M8091UACA Receiver Conformance Test Application for UALink can be downloaded from the Keysight website.

1. To obtain the M8091UACA Conformance Rx Test Application installer, go to the Keysight website: https://www.keysight.com/find/M8091UACA
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.

To install the UALink Rx Test Application,

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

2 The Setup Program for the Keysight UALink Rx Test Application appears (Figure 1).

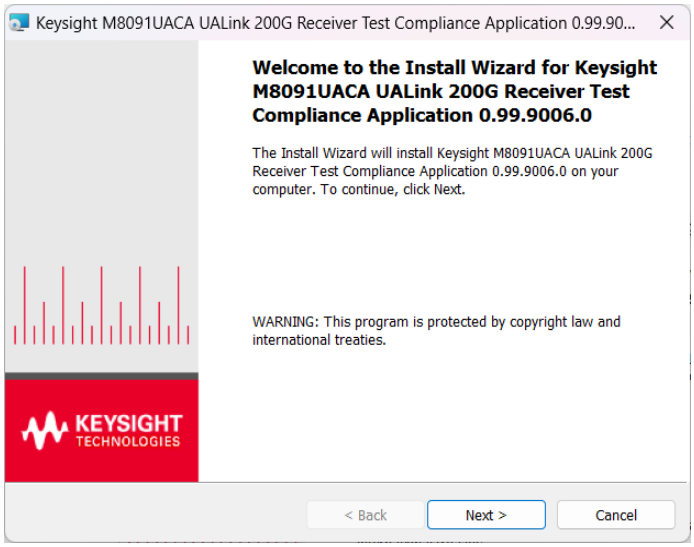


Figure 1 Setup Program for the UALink Receiver Test Compliance Application

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

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

4 Select **Agree** to accept the license agreement.

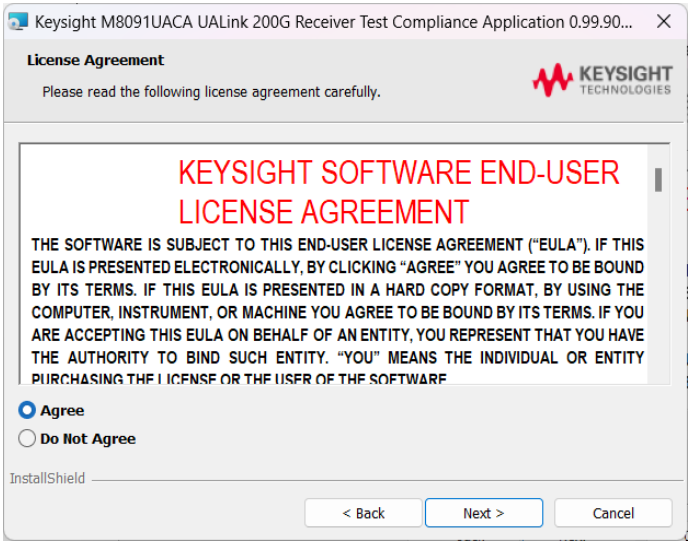


Figure 2 License Agreement window

5 Click **Next**. The **Ready to Install the Program** window appears.

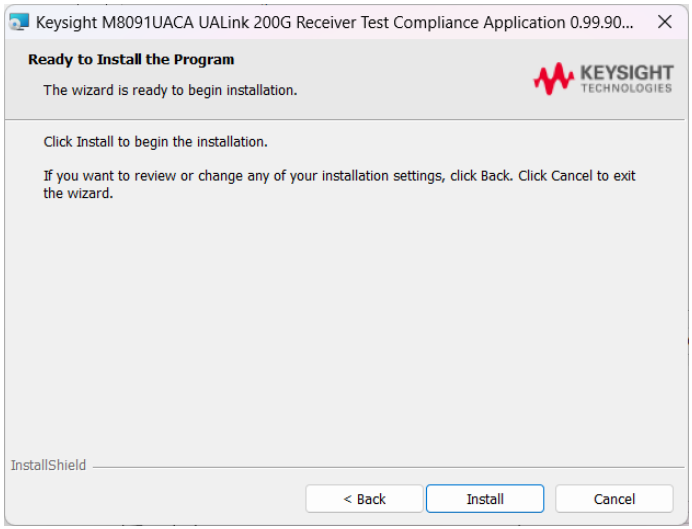


Figure 3 Begin Installation window

6 Click **Install** to begin the installation.

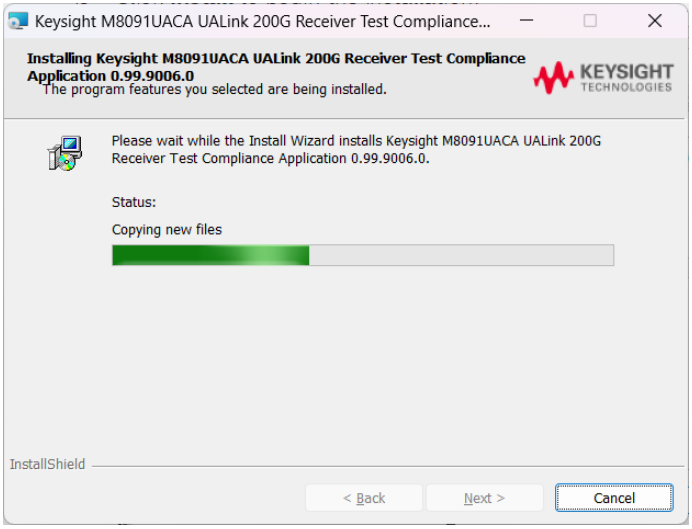
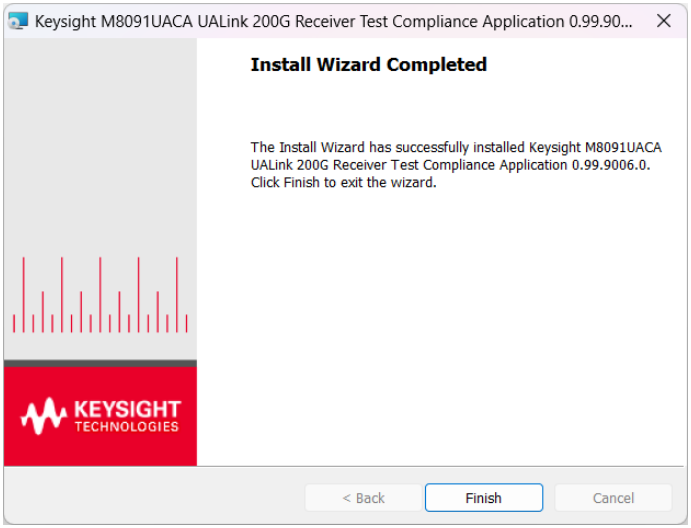


Figure 4 Installation Status window



7 Click **Finish** to complete the installation and exit the setup app.

Installing the License Key

To procure a license, you require the Ethernet Address 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 Software Manager Utility

To view and copy the Ethernet Address from Keysight Software Manager Utility:

1. Launch **Keysight Software Manager Utility** on the machine where you wish to run the Test Application and its features.
2. Copy the **Ethernet Address**, which is a set of alphanumeric values (as highlighted in Figure 5) that appears in the **Add License** tab of the application.

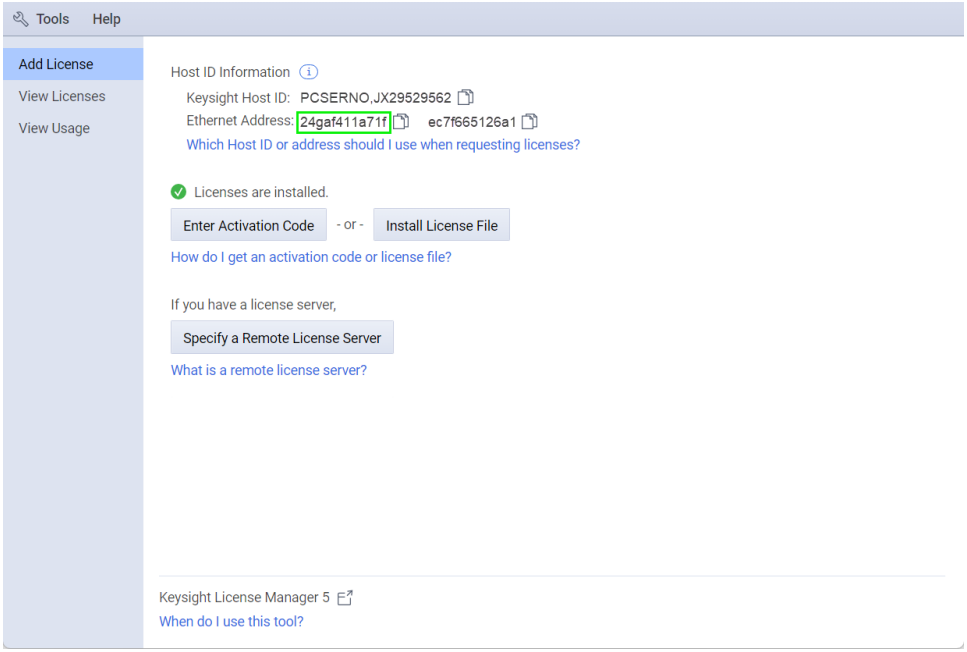


Figure 5 Viewing the Host ID

To install one of the procured licenses using the Keysight Software Manager Utility application:

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

2 Launch Keysight Software Manager Utility.

3 In the **Add License** tab (Figure 6), use one of the options to install the license file.

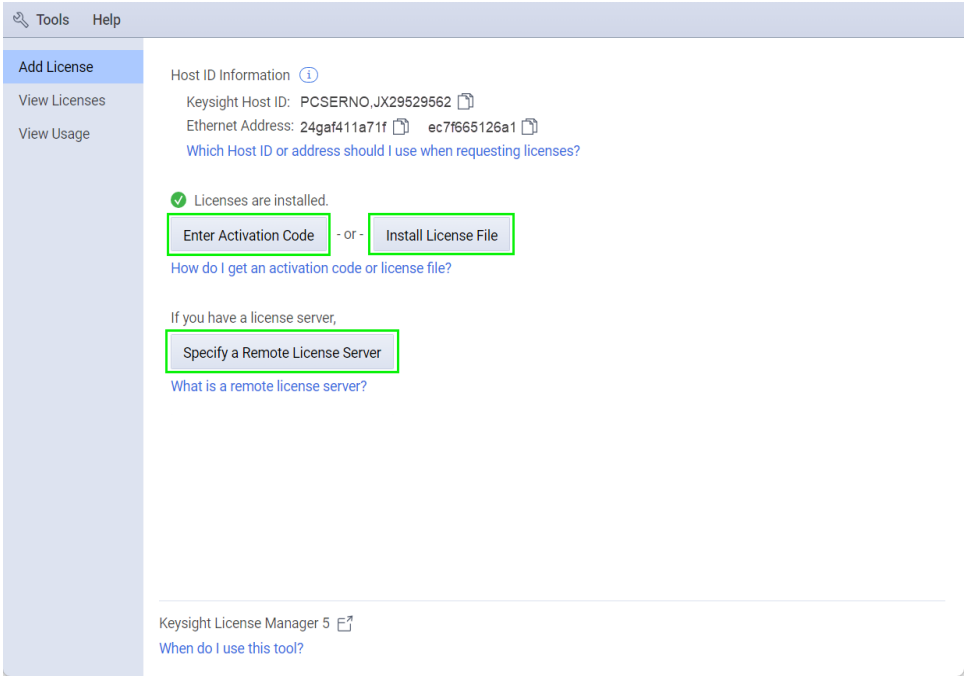


Figure 6 License installation options

For more information regarding installation of procured licenses in Keysight Software Manager Utility, refer to **Supporting Documentation** section on the Keysight Software Manager Utility web page.

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 M8091UACA Data Sheet on the keysight.com website are defined in the Keysight Connection Expert on the PC where the UALink Rx Test Application is installed.

Calibrating the Instruments

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 Keysight M8091UACA Receiver Conformance Test Application for UALink.

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

Starting the Test Application

The UALink Rx Test Application is available to be run as a standalone application on a PC, either locally or remotely.

Before you launch the UALink Rx Test Application, make sure that Keysight M8070B software or Infiniium UXR software are online and active on the respective instruments.

For calibration and tests (Draft 2.0 specification) CR standard option requires mated compliance board s-parameter files, mated compliance boards, and couplers whereas KR standard option requires ISI channel s-parameter files 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 UALink Rx Test Application is installed.

To access the UALink Rx Test Application:

1 Double-click the Keysight M8091UACA UALink Rx Test App icon on the desktop.

- The **M8091UACA UALink RX Test BERT Compliance App** banner appears.
- If a single instance of the M8070B software only is running online, the UALink Rx Test Application launches after automatically getting connected to the M8070B software.
- If the UALink 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 7).

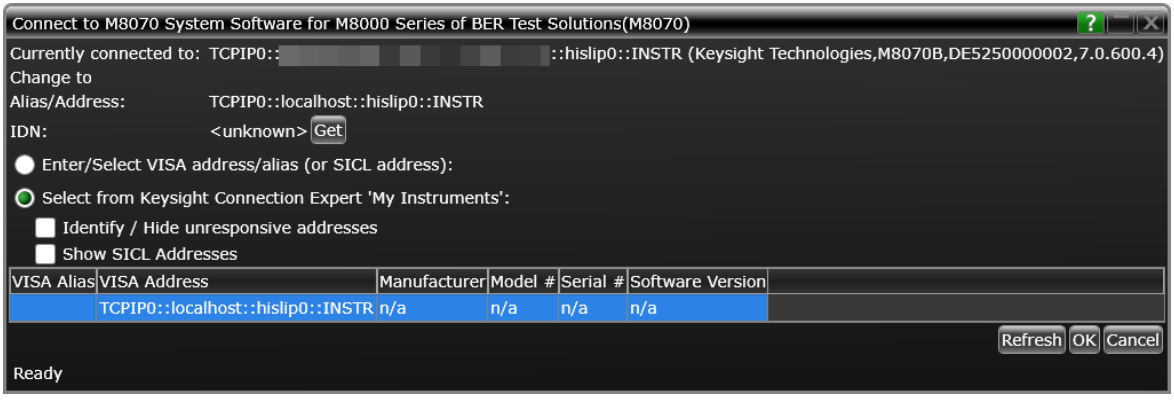


Figure 7 Connecting to M8070B if multiple instances are active

2 Perform one of the following 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 8) by clicking **Utilities > SCPI Server Information...** from the main menu of the Keysight M8070B software.

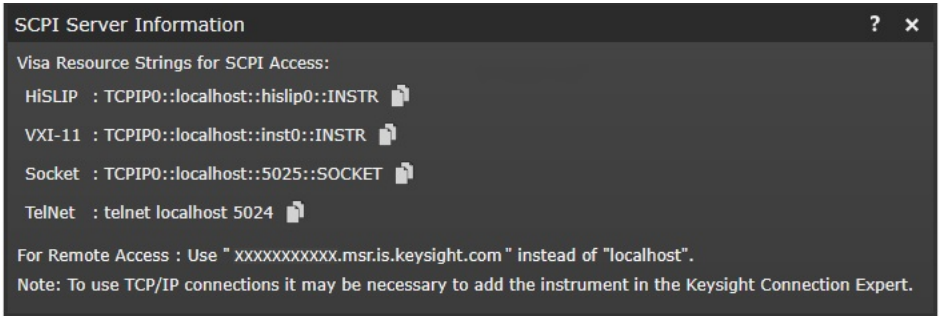


Figure 8 SCPI Server Information window on the M8070B Software

- 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 9) in the **Connect to M8070B System Software for M8000 Series of BER Test Solutions(M8070)** window. The **IDN:** field displays the instrument name.

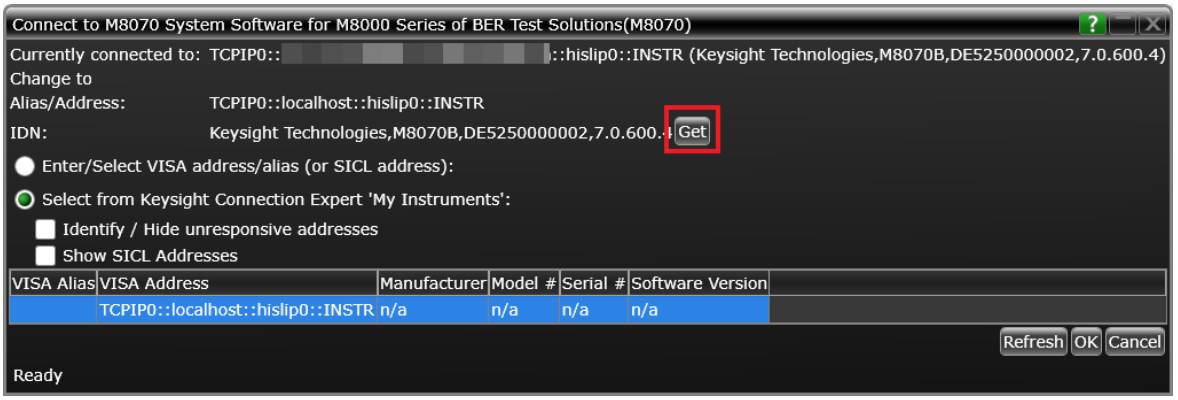


Figure 9 IDN field displaying successful connection to M8070B

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

- The UALink Rx Test Application appears with the **Set Up** tab as default (Figure 10).

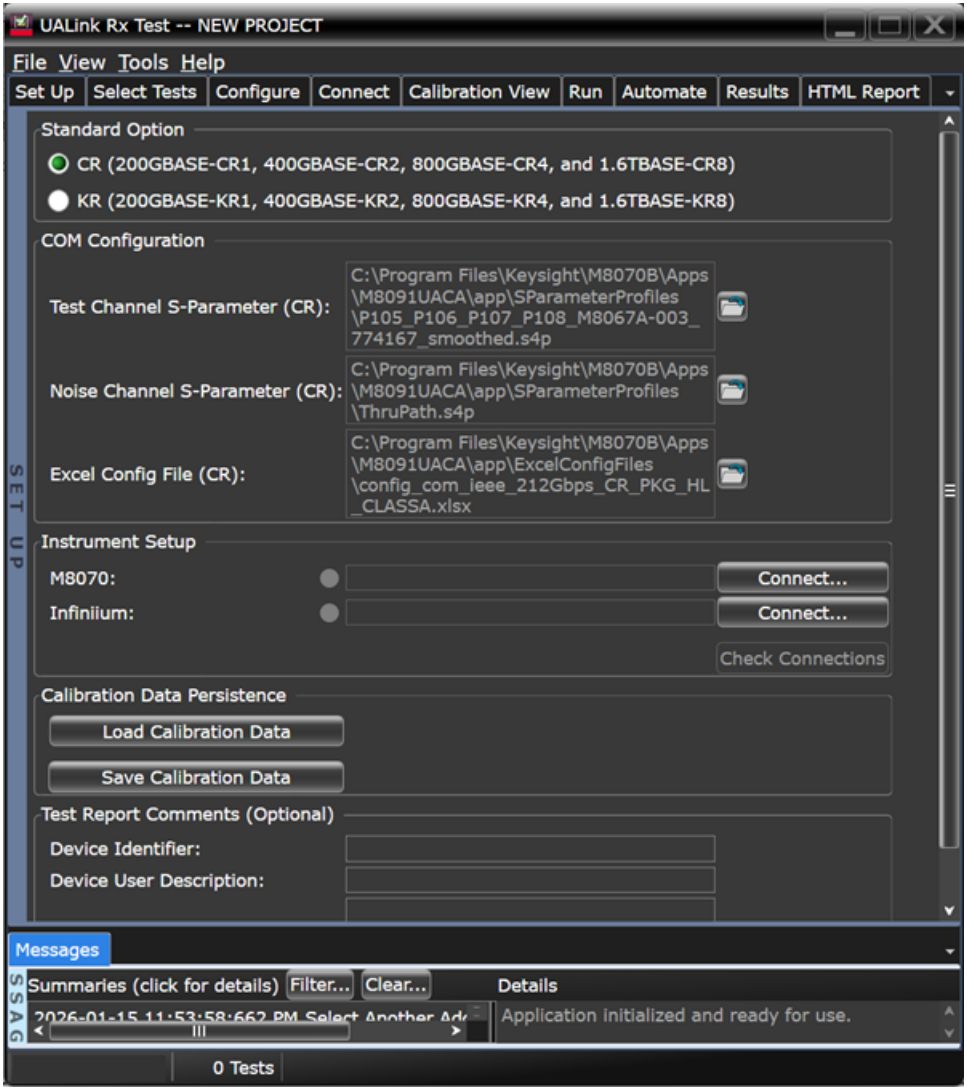


Figure 10 Default view of the UALink Rx Test App

Setting up the UALink 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 UALink calibrations, you must first set up the Test Application (Figure 11).

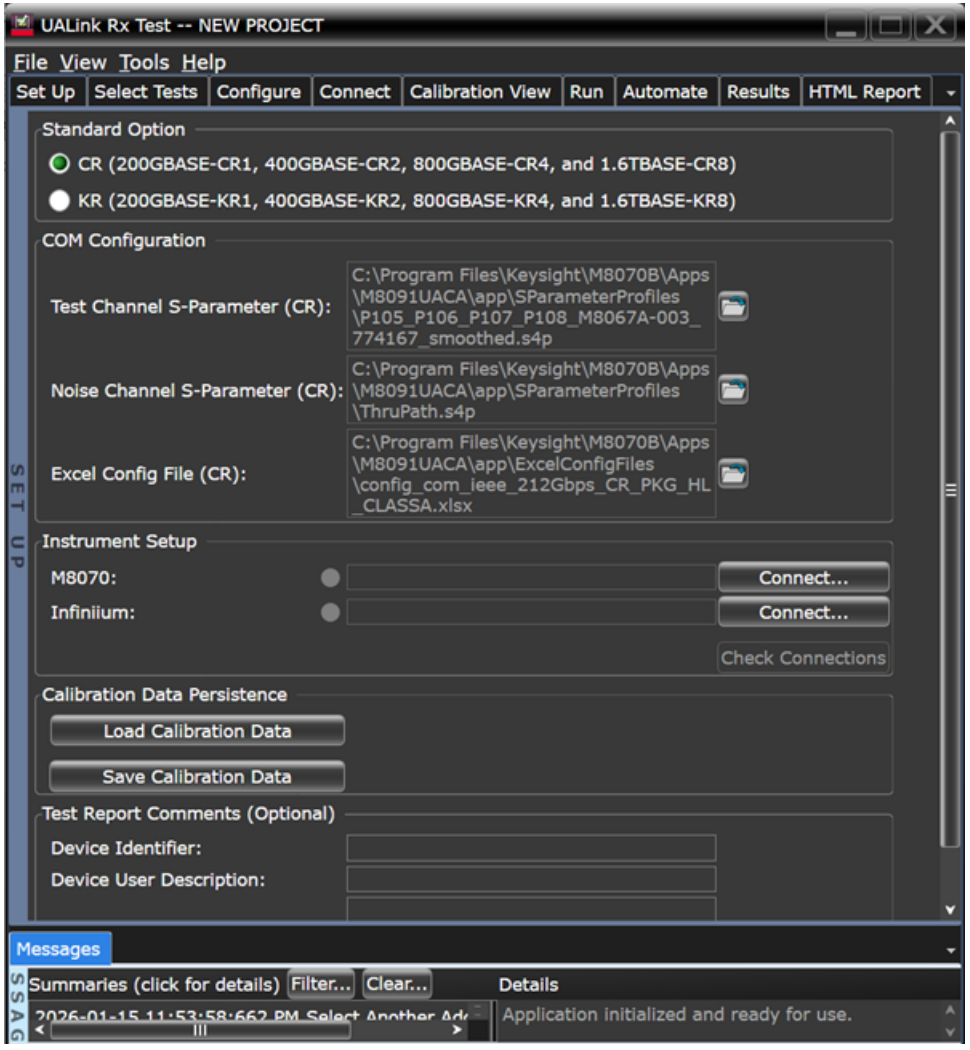


Figure 11 Setting up the UALink Rx Test App

1 Under the **Set Up** tab:

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

- CR (200GBASE-CR1, 400GBASE-CR2, 800GBASE-CR4, and 1.6TBASE-CR8)
- KR (200GBASE-KR1, 400GBASE-KR2, 800GBASE-KR4, and 1.6TBASE-KR8)

b For all standard option in the COM Configuration area, select the Test Channel S-Parameter file, the Noise Channel S-Parameter file, and the Excel Configuration file. For conformance testing, use the default EXCEL Configuration file. A different one can be specified to explore alternative scenarios.

c In the **Instrument Setup** area:

i Click **Connect...** corresponding to M8070B and Infiniium to connect to the respective instrument using the SICL/VISA address, if not connected already.

ii By default, when you start the UALink 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.

iii Click **Check Connections** to verify that M8070B and Infiniium are properly connected to the UALink Rx Test Application.

d 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 35.

e 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 Report that is 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 the *IEEE P802.3dj™/D2.0, Draft Standard for Ethernet Amendment:* Physical Layer specifications and management parameters for 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s operation.

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 or Tests.

Using the UALink 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 12).

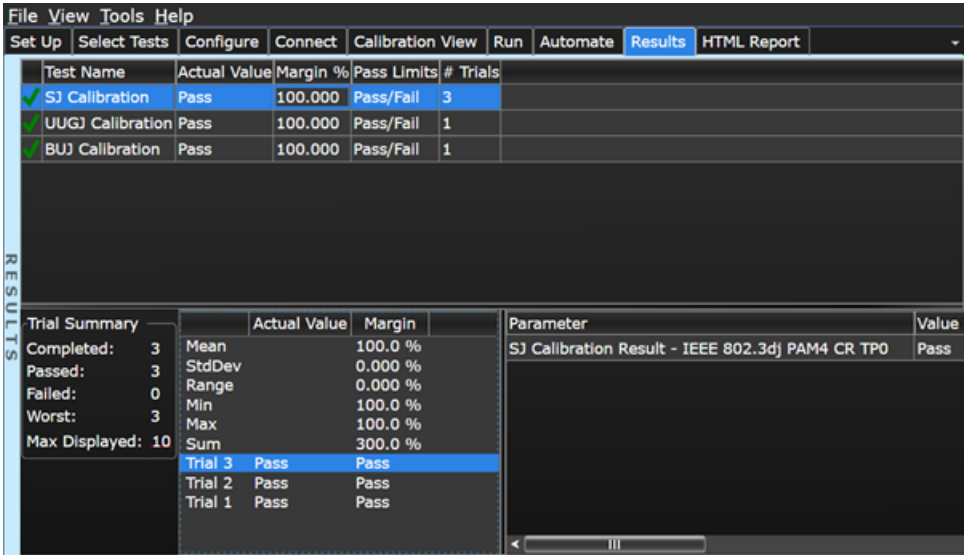


Figure 12 Example results in the Results tab

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 13) and just as pass or fail in the **Results** tab.

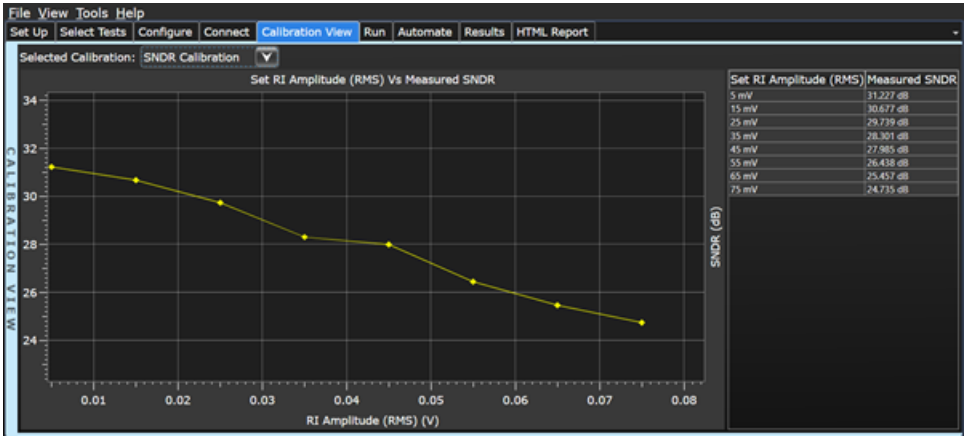


Figure 13 Example results in the Calibration View tab

For **several trials** of the same calibration or test performed directly after one another, a Trial Summary (red frame in Figure 14) is included in the results in the Results tab. The latest calibration trial will be used for the subsequent test execution.

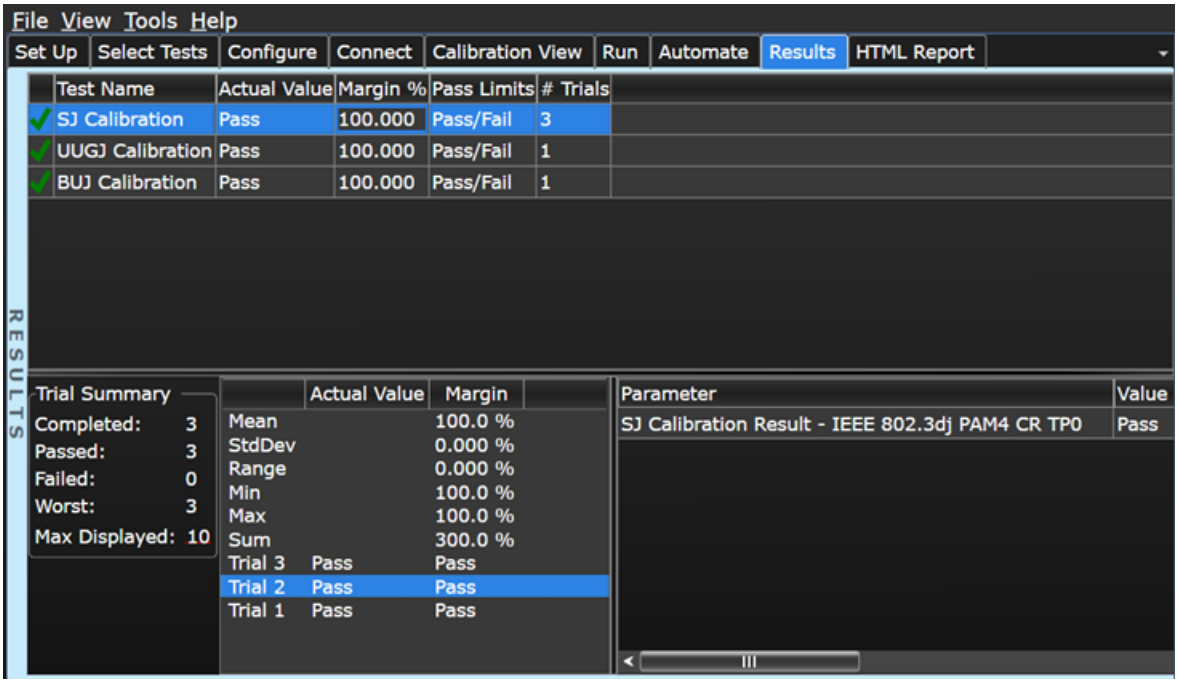


Figure 14 Example results for several trials

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 15)

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 15 Example results in the Results tab showing tags

Understanding Calibration Data Persistence

The **Calibration Data Persistence** feature (see Figure 16) of the UALink 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 UALink RX tests. The UALink Rx Test Application manages the Calibration data in the **.zip* file format.

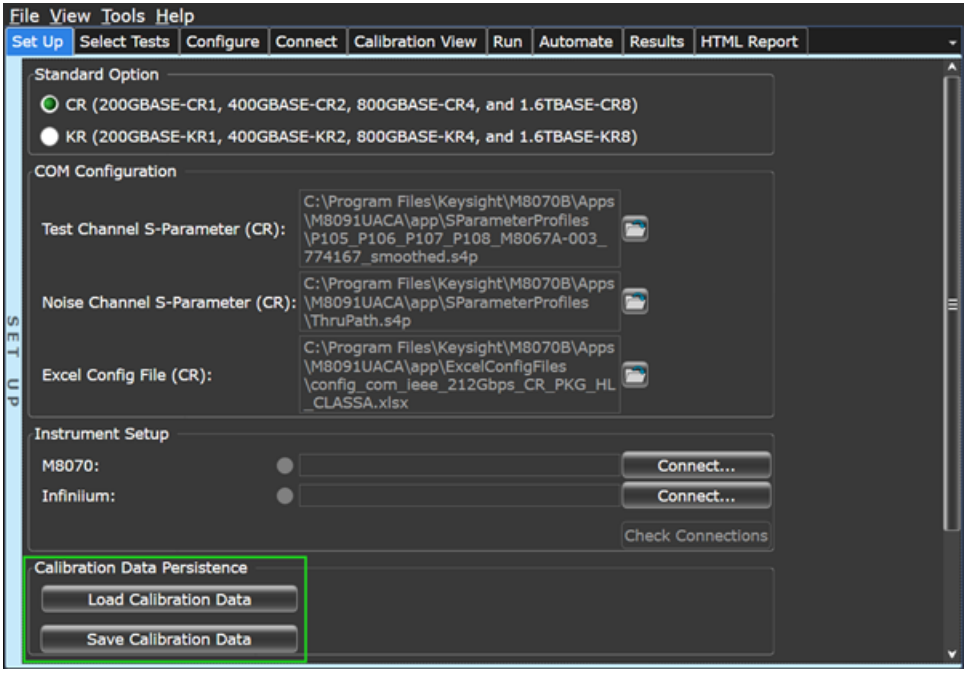


Figure 16 Calibration Data Persistence area

- To understand how to load calibration data before running UALink Tests, see Loading Calibration Data on page 36.
- To understand how to save calibration data after running UALink Calibrations, see Saving Calibration Data on page 37.

Loading Calibration Data

The UALink tests are dependent on the 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 UALink Rx Test Application indicates whether or not the calibration data was loaded successfully (Figure 17).

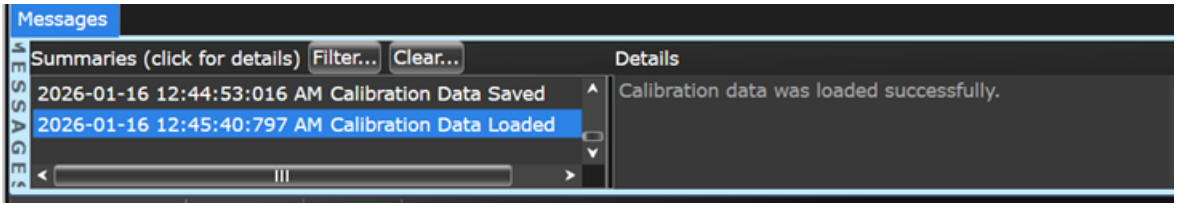


Figure 17 Messages section view after successfully loading Calibration Data

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

Saving Calibration Data

The UALink tests are dependent on the 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 UALink 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 UALink Rx Test Application indicates whether the calibration data has been saved successfully.

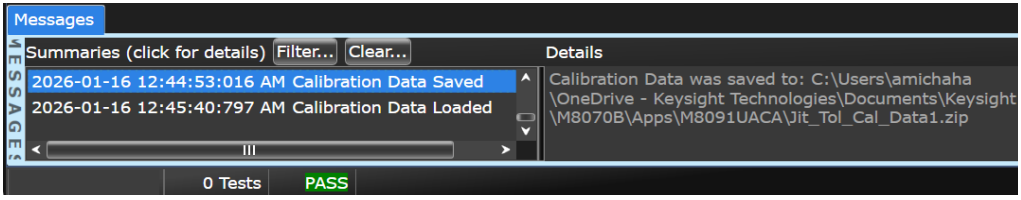


Figure 18 Messages section view after successfully saving Calibration Data

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...**.

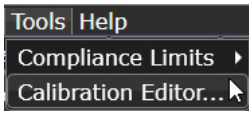


Figure 19 Launching Calibration Editor from Tools menu

2 In the **Calibration Editor** window that is displayed (Figure 20), click a standard option from the left pane.

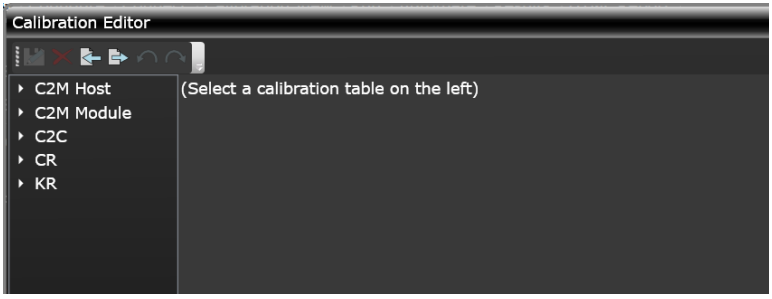


Figure 20 Calibration Editor window

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 21 displays the default calibration data for **SJ** calibration under **C2C**.

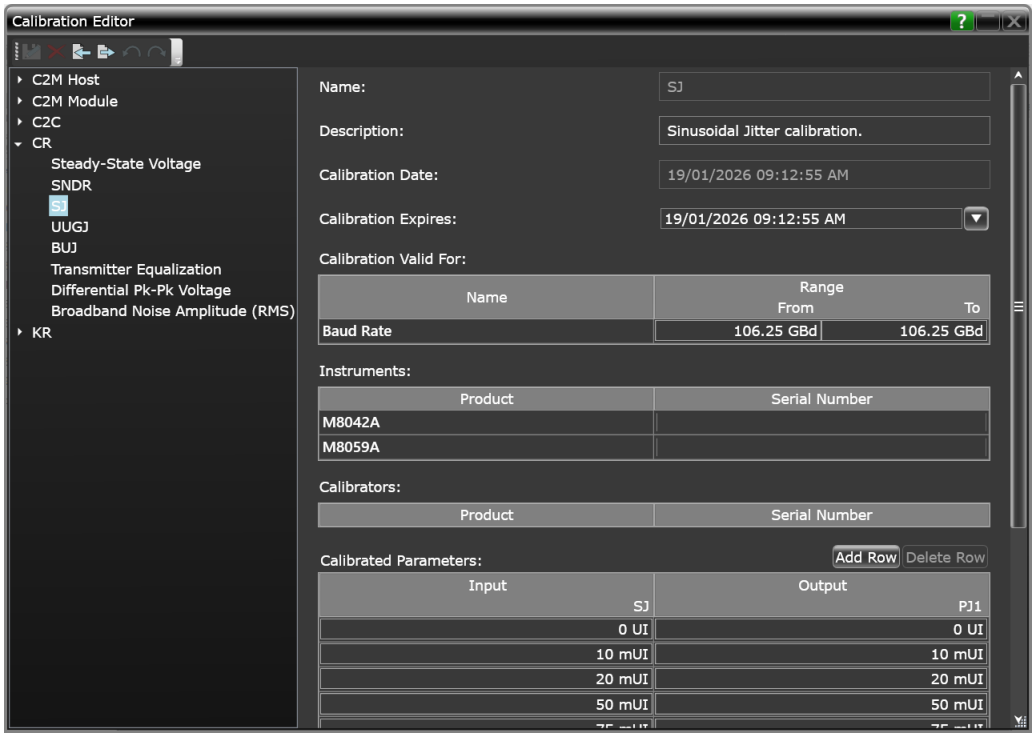


Figure 21 Default information for the selected calibration type

Figure 22 displays calibration data as it appears directly after the Test Application has performed SJ Calibration, while Figure 23 displays pre-saved calibration data (corresponding to SJ Calibration) that has been loaded.

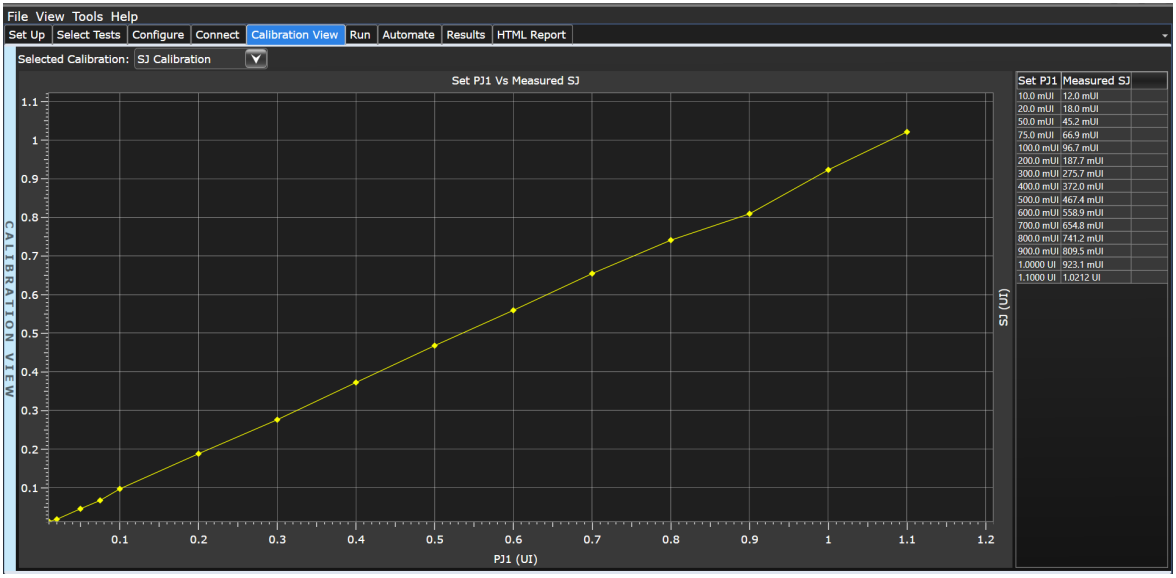


Figure 22 Plotted data in the Calibration Viewer for SJ Calibration

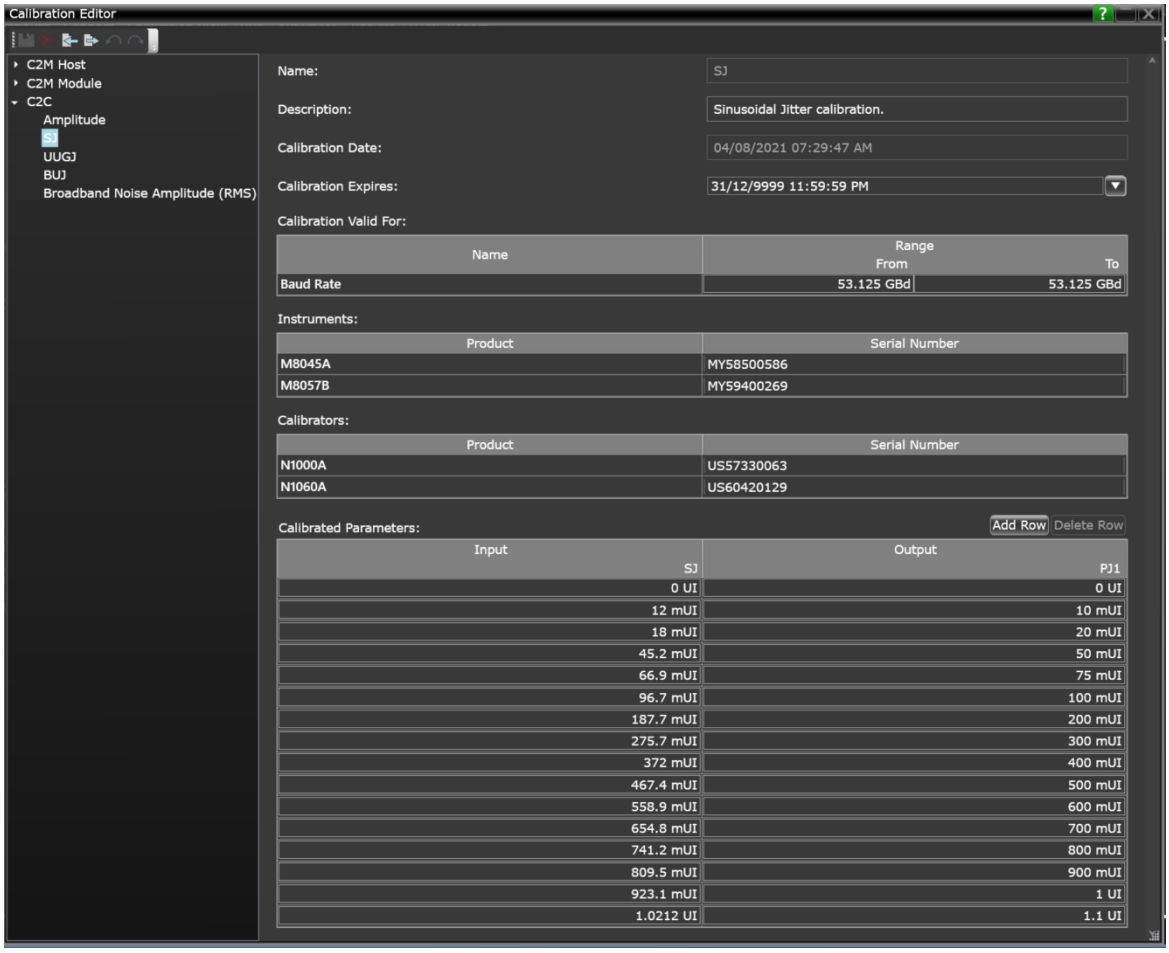


Figure 23 SJ Calibration data displayed in Calibration Editor

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 are displayed under the Output column. These correlate with the Measured value and Set value 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 M8091UACA Receiver Conformance Test Application for UALink Online Help*.

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, Inter-Symbol Interference (ISI), crosstalk, and device specifications. COM was first introduced to measure the performance margin of a channel and then extended to digital systems. The performance of digital receivers can be expressed in terms of COM requirements. COM is calculated using the test channel S-parameters as well as the noise characteristics and equalization capabilities of the actual transmitter and reference receiver. The resulting COM metric is the Signal-to-Noise Ratio (SNR) of available signal amplitude (As) to statistical noise amplitude (N) in dB. It can be calculated using the equation.

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

As refers to the signal peak amplitude observed after transmission through the complete channel, which includes the transmitter and receiver packages, the transmission medium, and any connectors. This amplitude is measured after optimal equalization performed by the reference receiver.

N is the Peak BER Noise. It is measured during a time interval depending on the target BER and accounts for the combined impact of the receiver intrinsic noise, the transmitter noise, the transmitter jitter (partially turned into amplitude noise after channel propagation), and non-compensable impairments such as crosstalk from adjacent channels, reflections, and residual ISI after the reference equalizer.

The victim channel, referred to as THRU, is affected by both near-end aggressor crosstalk (NEXT) and far-end aggressor crosstalk (FEXT). See Figure 24. For calibration and testing, the impact of NEXT and FEXT referred to as integrated crosstalk noise (ICN) is emulated using broadband noise, either injected at the transmitter (CR) or in front of the receiver test fixture (KR).

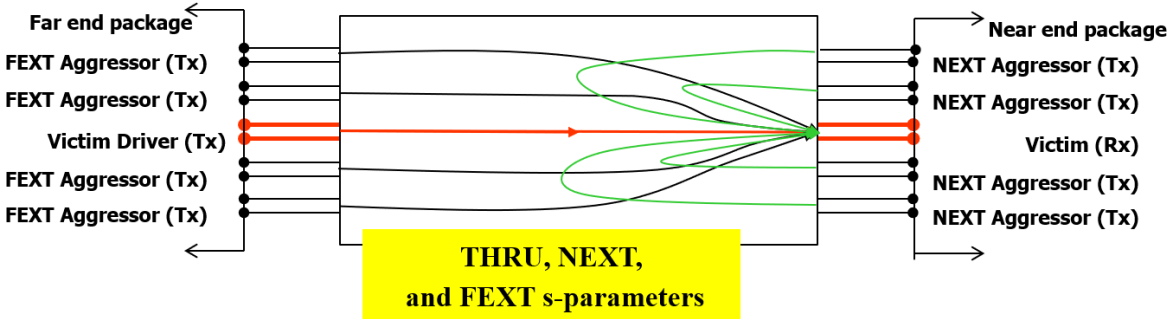


Figure 24 Channel Model for COM

COM for KR

The Backplane (KR, clause 178) test procedure defined in IEEE P802.3dj™/D2.0, rely on the Channel Operating Margin (COM) method defined initially in Annex 93C, IEEE Std 802.3bj-2014, Amendment to IEEE Std 802.3-2012: Ethernet.

The calibration and test procedures for KR consist of the following steps:

Table 2 Calibration procedure step summary

#	Procedure	Summary of steps
1	Channel Characterization	Measure S4P for Test channel (see setup from Figure 35) and verify if it meets the requirements for the considered interface.
2	Equipment Calibration	Calibrate pattern generator jitter and amplitude and the broadband noise source (see setup from Figure 26).
3	Tx Measurements	Measure key Tx characteristics (see setup from Figure 26).
4	Rx Test Calibration	Use the Matlab-based COM tool to calculate the amount of broadband noise to be injected at the receiver input to meet the target COM (3 dB), depending on Tx measurements and channel S4p (step 1&3).
5	Rx Testing	Perform interference and jitter tolerance tests.

Detailed Steps for Calibration Procedures for KR

Step#1. S4P Channel Characterization

1 Measure the scattering parameters S(tc) on the Test channel (TPt to TP5 replica) using a network analyzer as illustrated in Figure 35) or use the S4p provided with the ISI trace (see KR Configuration in the Test App / 111 for the S4p file format requirements).

2 In the application, run the "Channel Characterization using the COM tool". This will verify that the test channel COM and insertion loss meet the requirements for the targeted interface.

Step#2. Equipment Calibration

3 Calibrate the pattern generator amplitude and jitter components using the test setup shown in Figure 26.

NOTE

These measurements (especially the amplitude calibration) should be performed at the output of the coupler as shown in Figure 26. Doing so will implicitly include the coupler in the transmitter, ensuring proper accounting for the coupler loss in the system. Consequently, the test channel specified in the field (Test Channel S-parameter) should be the ISI trace without the coupler.

4 Calibrate the broadband noise source using the test setup shown in Figure 26.

NOTE

Similarly to the previous step, Keysight recommends calibrating the broadband noise at the output of the coupler as illustrated Figure 26. Consequently, the noise channel specified in the field (Noise Channel S-parameter) should be the lossless ThroughPath.s4p file available in the installation folder.

Step#3. Perform Tx Characterization

5 Adjust the pattern generator jitter components and de-emphasis. This optional step should ensure that the measured characteristics are close to those of a realistic transmitter.

NOTE

The amplitude Calibration (step 2) has to be repeated when the De-emphasis taps are adjusted.

6 Measure following transmitter metrics (**Select Tests** tab.. > **Calibrations > Channel Characterization using COM**
   - Amplitude, Transition time, SNDR, Jitter (JnU, Jrms) linearity (RLM)

NOTE This step has to be carried out for the Interference and Jitter Tolerance Tests as the initial jitter profile of the pattern generator may be different (50mUI 40MHz SJ required for jitter tolerance).

Step#4. COM-based Receiver Test Calibration:

7 In this step, the amount of noise to be injected at TP5a to reach the targeted Channel Operating margin (default 3dB) is calculated by the MATLAB - based COM tool based on the previous measurements.

Step#5. Receiver Test

8 Prior to testing the pattern generator, de-emphasis must be adjusted accordingly to optimize the receiver performance. As an alternative to Inter-Sublayer Link Training (ILT) or manual tuning, the M8070B feature "BER-based De-Emphasis Optimization" can be used. For more details, please refer to M8070ADVB User Guide.

9 The receiver is tested according to the setup displayed in Figure 33. Noise is injected for the interference test only. The BER is retrieved from the DUT internal error checkers using the M8070B DCI interface. See section DUT Control Interface / 159.

COM for CR

The coaxial copper cable (CR, clause 179) also rely on the COM approach, but in this case, the noise is injected at the transmitter side. The following differences can be mentioned:

1. The noise and test channels are the same, and the S4p files to be specified in the Set Up Tab for the Test Channel S-Parameter and Noise Channel S-parameter should be identical.
2. The Amplitude tolerance test comes in addition to the Interference and Jitter tolerance test.
3. The pattern generator amplitude is adjusted to meet a target Steady-State Voltage after the channel (TP5a) instead of the Peak-to-Peak amplitude before the channel (TP0)
4. The system configuration for receiver test is displayed in Figure 33 and Figure 34 for CR and KR, respectively.

COM for CR following IEEE P802.3dj™ Draft 1.4

The IEEE P802.3dj™/D2.0 specifies that Channel Operating Margin (COM) calculations require precise knowledge of the channel's S-parameters (S4p) to determine the appropriate amount of injected noise. However, Draft 1.4 introduces an alternative method that simplifies this process.

Instead of estimating the required amount of noise to be injected, Draft 1.4 proposes adjusting the transmitter's SNDR to achieve the target COM. In this approach, broadband noise is still added at the transmitter side to degrade SNDR, but the key difference is that SNDR and transmitter characteristics are measured after the channel. This allows for pulse response measurements post-channel, eliminating the need for the channel's S4p data.

To use this method: Navigate to the Configure tab. Enable "Debug" mode. Set the Calibration Method parameter to "Draft 1.4".

Figure 27 and Figure 30 illustrate the required setup configurations for KR and CR respectively.

These figures cover calibration procedures for:

- Jitter
- SNDR
- Steady-State Voltage
- Transmitter Characterization

This method streamlines calibration by focusing on post-channel measurements, making it especially useful when S4p data is unavailable or difficult to obtain.

Example Connection Diagrams

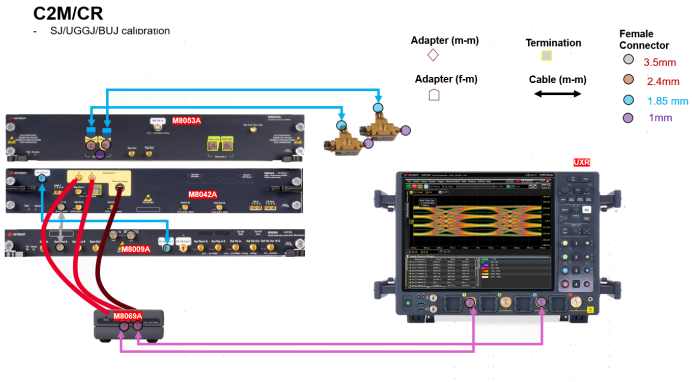


Figure 25 Connection diagram for CR SJ, UUGJ, and BUJ Calibration

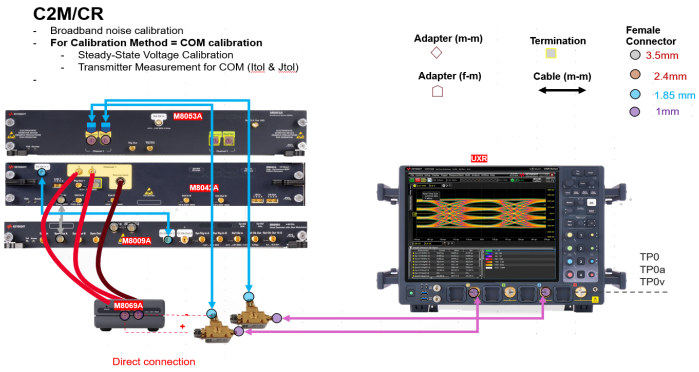


Figure 26 Connection diagram for CR COM Calibration

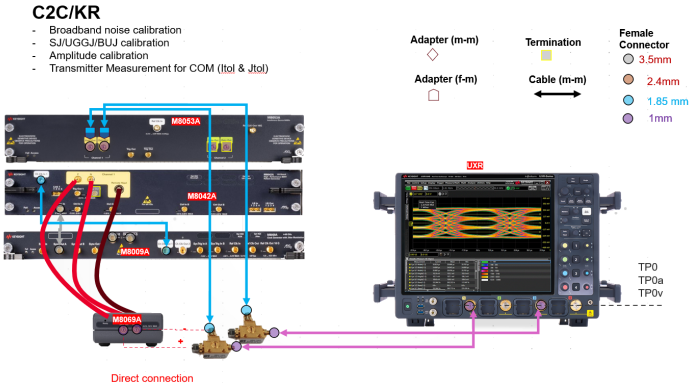


Figure 27 Connection diagram for KR Tx Measurement for COM (Itol & Jtol)

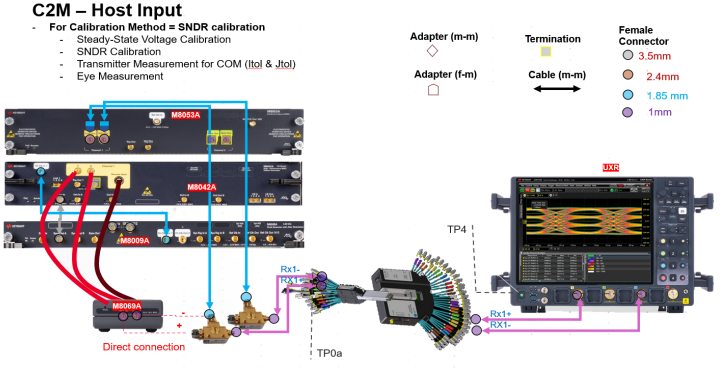


Figure 28 Connection diagram for C2M Host Input Tx Measurement for COM (Itol & Jtol) according to IEEE P802.3dj™/D1.4

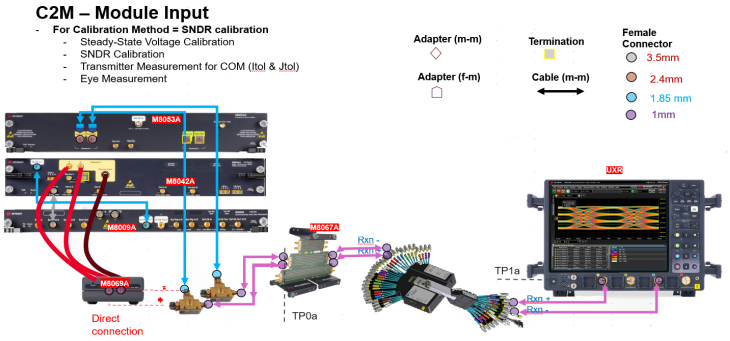


Figure 29 Connection diagram for C2M Module Input Tx Measurement for COM (Itol & Jtol) according to IEEE P802.3dj™/D1.4

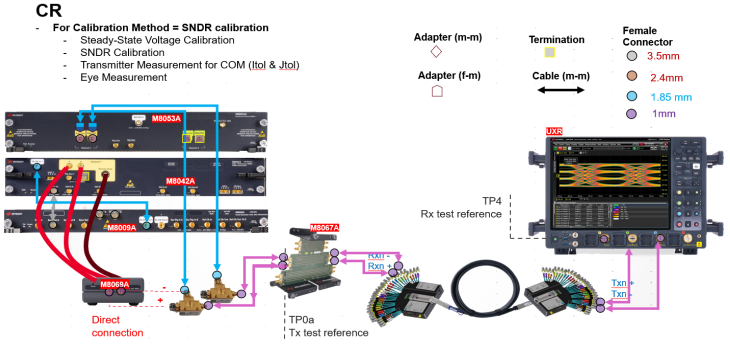


Figure 30 Connection diagram for CR Tx Measurement for COM (Itol & Jtol) according to IEEE P802.3dj™/D1.4

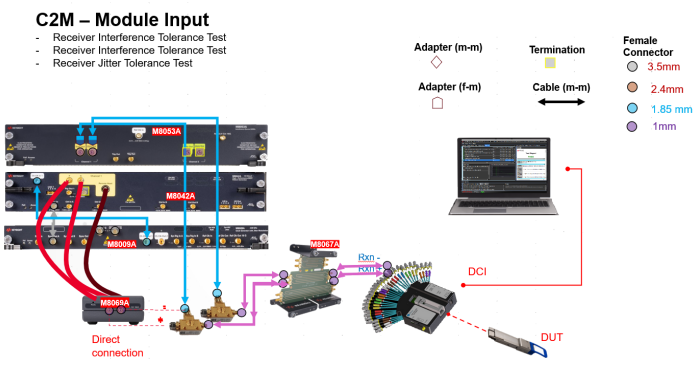


Figure 31 Connection diagram for C2M Module Input Rx Interference and Jitter Tolerance Test

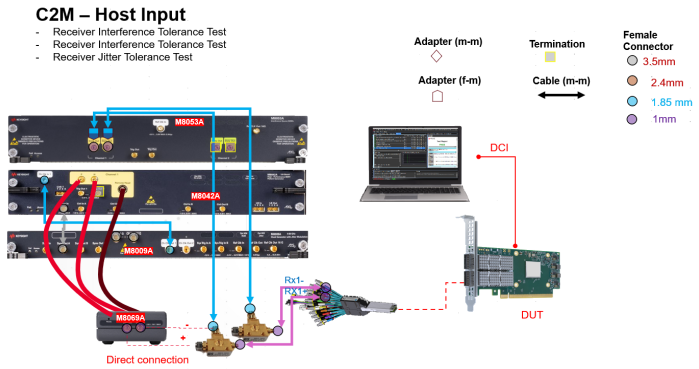


Figure 32 Connection diagram for C2M Host Input Rx Interference and Jitter Tolerance Test

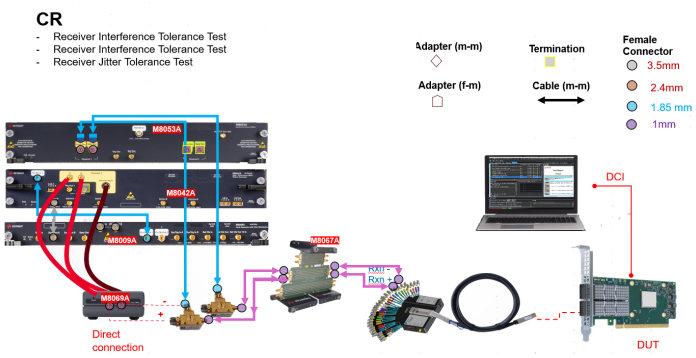


Figure 33 Connection diagram for CR Host Input Rx Interference and Jitter Tolerance Test

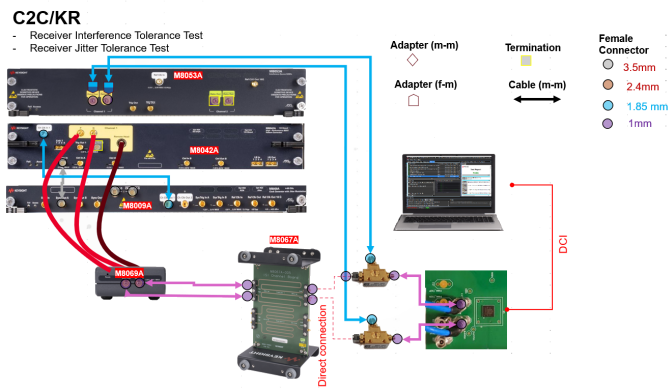


Figure 34 Connection diagram for KR Rx Interference and Jitter Tolerance Test

Calibration Channels

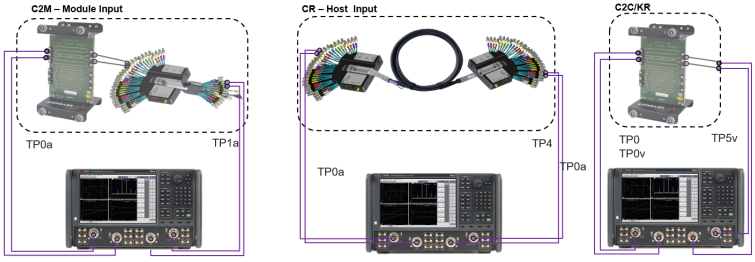


Figure 35 Connection diagram for calibration channels

4 UALink CR Calibrations

This chapter describes the calibration procedures for the UALink that are applicable to CR (200GBASE-CR1, 400GBASE-CR2, 800GBASE-CR4, and 1.6TBASE-CR8) standard.

Before performing the CR standard tests, you must calibrate all the related parameters. Perform calibrations in the order displayed in the test application.

Ensure that the UXR Infiniium Oscilloscope has been calibrated.

Calibration Parameters in Debug Mode

In the **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 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 **CR (200GBASE-CR1, 400GBASE-CR2, 800GBASE-CR4, and 1.6TBASE-CR8)** standard option, the calibration parameters listed in Table 3 are available for configuration.

Table 3 Calibration parameters in debug mode for CR standard

Calibration Parameter	Description
Parameters Common to All Calibrations	
Baud Rate	Baud Rate for testing device and for all calibrations.
Differential Channel Partner	Differential channel partner type to acquire signal.
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.
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 (3 dB max).
PAM4 Symbol 1 Level	Enter PAM4 Symbol 1 Level in percentage.
PAM4 Symbol 2 Level	Enter PAM4 Symbol 2 Level in percentage.
Amplitude	Victim Differential Amplitude.
Transmitter Cursors	Controls all the cursors equalization coefficient for Transmitter Measurements.
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. 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. This will automatically be applied to any pattern lock waveform.

Calibration Parameter	Description
Number of Averages for Waveform Acquisition	Set the number of averages used for waveform acquisition during pulse response and SNDR measurement.
Calibration Method	Draft 2.0 is the default method to use for calibration (using COM). Draft 1.4 method is using SNDR calibration.
Parameters for BUJ Calibration	
BUJ	Controls the amplitude of the BUJ jitter source.
Parameters for Steady-State Voltage Calibration	
Steady-State Voltage	Minimum Steady-State Voltage at TP1a/TP4 device must tolerate at its input without overloading its front end and causing distortion/clipping that would generate poor equalization and/or BER degradation.
Parameters for Differential Pk-Pk Voltage Calibration	
Differential Pk-Pk Voltage	Minimum Voltage device must tolerate at its input without overloading its front end and causing distortion/clipping that would generate poor equalization and/or BER degradation.
Parameters for Receiver Interference Tolerance – Transmitter Measurements for COM Model	
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 Cursors	Controls all the cursors 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 use in the 12-edge output jitter measurement.
Record Count	Set the record count used for Jnu measurement at TP0.
Pulse Response Save File	Save fitted pulse response data as two columns of time and voltage in csv format.

Calibration Parameter	Description
Parameters for Receiver Interference Tolerance – Eye Measurement	
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
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 Receiver Jitter Tolerance – Transmitter Measurements for COM Model	
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 Cursors	Controls all the cursors 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 use in the 12-edge output jitter measurement.
Record Count	Set the record count used for Jnu measurement at TP0.

CR Configuration in the Test Application

In order to obtain valid calibration data and test measurements for the CR standard option, you can select the Calibration Method offered in Configure tab (refer to Table 3):

1 Draft 1.4: Pulse response is used.

2 Draft 2.0: S-Parameter file is used.

Draft 1.4

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

The optimized equalizer settings are then used in Eye Measurement to construct Real-Time Eye for better presentation of equalized signal.

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.

Draft 2.0

Firstly, user is required to measure the test channel by using VNA to get its S-Parameter file.

The obtained S-Parameter file is required to be loaded into COM Configuration in Set Up tab.

During Rx Calibration using COM model run, transmitter profile and S-Parameter file are loaded into COM Tool to produce desired broadband noise value that met 3dB COM (this value is required by specification typically).

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 CR standard option, note the following:

1 In the current version of the test application, the S-Parameter files (low loss channel) and Excel file corresponding to the standard options are displayed by default.

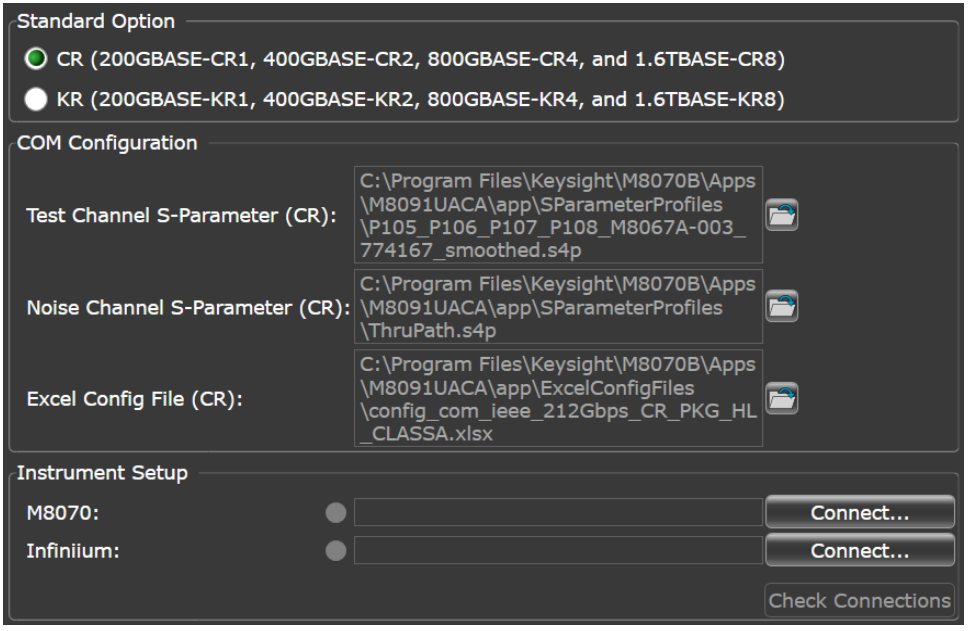


Figure 36 Configuration files for CR standard

2 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\Keysight\M8070B\Apps\M8091UACA\app\SParameterProfiles* for **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-Parameter for CR Standard

Test Channel Configuration Settings	Corresponding Rx Interference Tolerance Parameter	Target Insertion Loss	Standard Option	S-Parameter File That Can Be Selected
Low Loss (Host Low)	Test 1	15.5 dB - 16.5 dB	CR	P105_P106_P107_P108_M8067A-003_774167_smoothed.s4p
Low Loss (Host Nominal)	Test 1	15.5 dB - 16.5 dB		P105_P106_P107_P108_M8067A-003_774167_smoothed.s4p
Low Loss (Host High)	Test 1	15.5 dB - 16.5 dB		P105_P106_P107_P108_M8067A-003_774167_smoothed.s4p
High Loss (Host Low)	Test 2	36.5 dB - 37.5 dB		P105_P106_P107_P108_M8067A-005_774188_smoothed.s4p
High Loss (Host Nominal)	Test 2	31.5 dB - 32.5 dB		P105_P106_P107_P108_M8067A-005_774188_smoothed.s4p
High Loss (Host High)	Test 2	26.5 dB - 27.5 dB		P105_P106_P107_P108_M8067A-005_774188_smoothed.s4p

NOTE The default S-Parameter files are the reference only, users are required to measure their test channel's loss profile and use them for COM calculation.

3 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\Keysight\M8070B\Apps\M8091UACA\app\ExcelConfigFiles* for the **Excel Config File** configuration field.

4 From the **Open** window that appears, select the alternative S-parameter file (factory installed) for CR and click **Open**.

NOTE Currently, the test application installs a single Noise Channel S-Parameter file for the CR and KR standards and a different Excel Configuration file for each.

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: 100 GHz

Step Size: 10 MHz

No. of points: 10,000

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

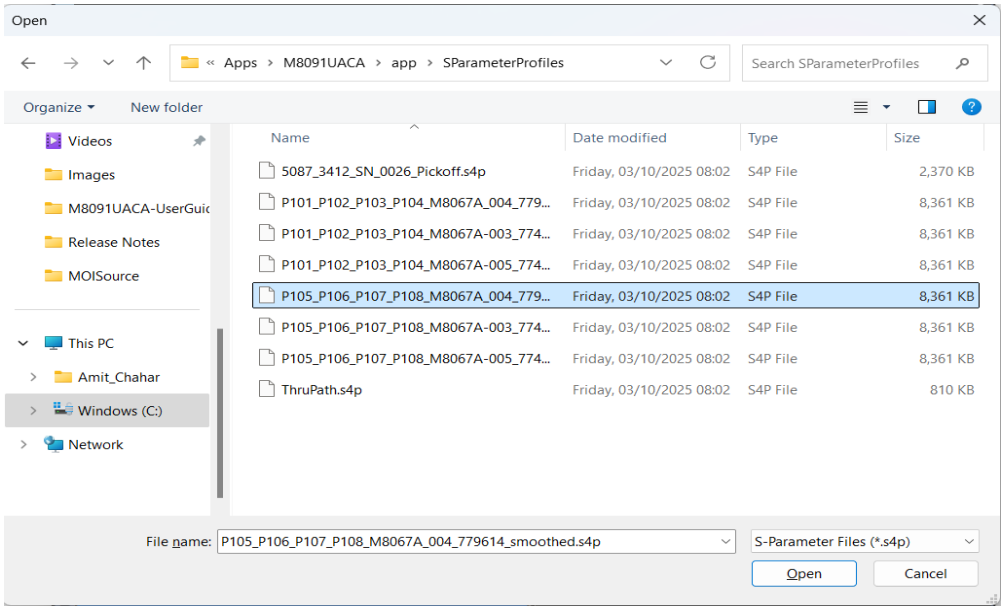


Figure 37 Selecting an S-Parameter file from the default location

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

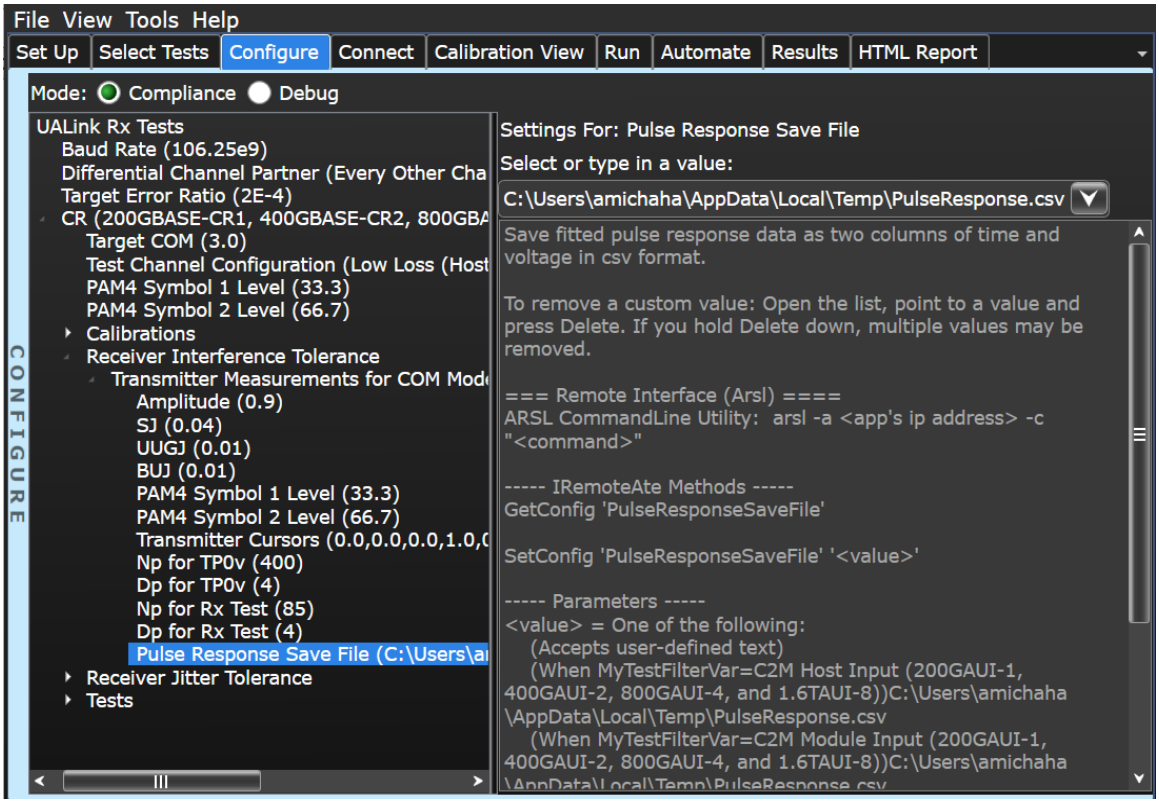


Figure 38 Pulse Response Save File Configuration Parameter

Calibration Procedure

The UALink CR receiver test calibration procedures comprises of following steps:

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

Draft 2.0 (COM Calibration)

1 Channel characterization: S-parameter measurements using a Network Analyzer for both the low loss and high loss channels. The S-parameter (refer to Table 4) should be measured from suggested Mated Test Fixture. Typical replica trace S-parameters can be generated using formula (178A–2) in Clause 93A of IEEE P802.3dj™/D2.0. The optimal amount of channel equalization at the transmitter is defined during this stage.

2 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, SNDR, transition time, and steady-state voltage).

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 level 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. For CR tests, the channel and noise s-parameter files are usually identical. The Calibration Persistence function can be used to save/recall common calibration data between the two tests.

Draft 1.4 (SNDR Calibration):

1 Stressed signal 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 COM targets. The calibration procedure requires two steps:

- Transmitter Measurements: Different transmitter profiles can be used as a starting point for the stress signal calibration. For instance, with different jitter profile (parameters **SJ**, **UUGJ**, **BUJ**) as well as rise time and SNDR (parameter Transmitter Cursors). 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 179-7 of the IEEE P802.3dj™/D2.0. 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 Signal Calibration, it is expected that the transmitter (FIR filter) and receiver (CTLE-DFE-FFE) equalizers are optimized for the given channel and transmitter profile. The amount of transmitter de-emphasis used for channel equalization are computed from the system's pulse response. Note that the resulting de-emphasis taps of the BERT pattern generator are the convolution of **Transmitter** and **Channel Eq** taps.
    The 1-tap DFE is always optimized for the actual combination of Tx de-emphasis and CTLE using the Mueller–Mueller algorithm.
    Eye Measurement: Once the equalization is optimized, the system applies the optimized equalizer and forms an eye diagram.

For the CR Module Input standard, two calibrations are required for the low-loss channel and the high-loss channel. It is also required to select the appropriate Test Channel Configuration 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).

SJ Calibration

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

Connection Diagram Connect the instruments as shown in Figure 39.

Standard Name	Test ID
CR	671102

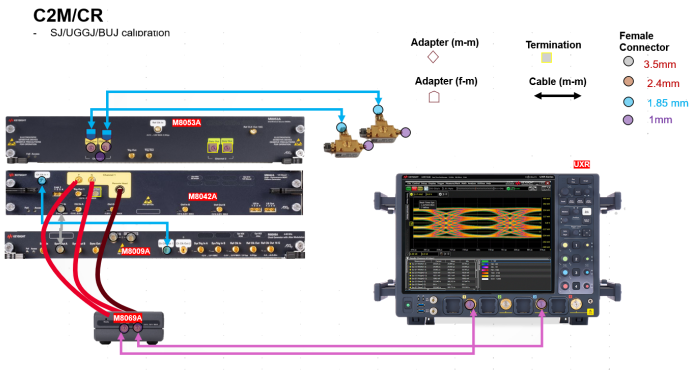


Figure 39 Connection diagram for CR - SJ, UUGJ, and BUJ Calibration

Parameters Refer to Calibration Parameters in Debug Mode on page 58.

Procedure This calibration uses the Clock/8 pattern.

The Victim Generator PJ1 is set until the desired SJ value is measured.

Results The SJ Calibration returns the results

- pass or fail in the Results tab
- measured SJ versus PJ1 in graphical and tabular formats in the Calibration View tab (Figure 41).

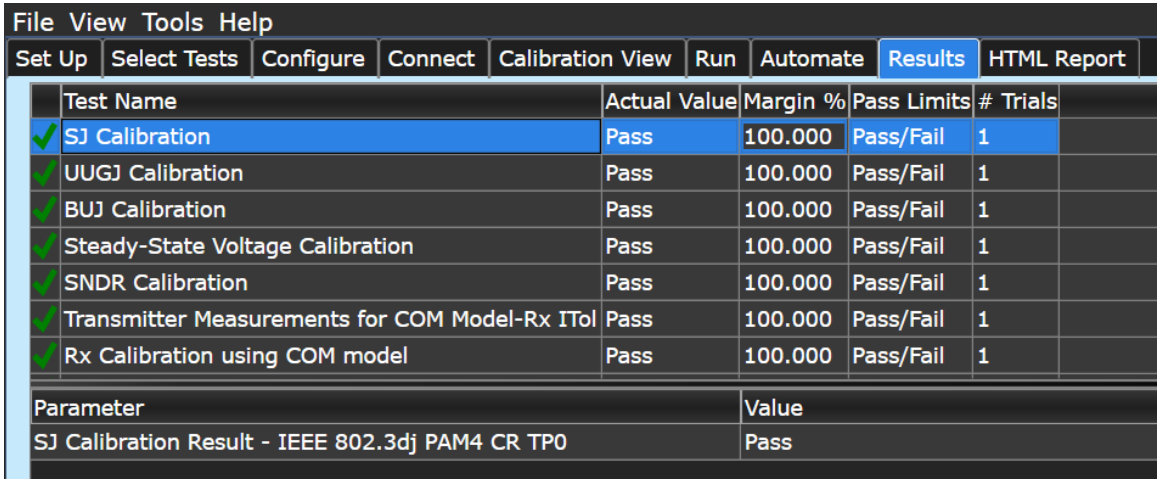


Figure 40 CR - SJ Calibration result

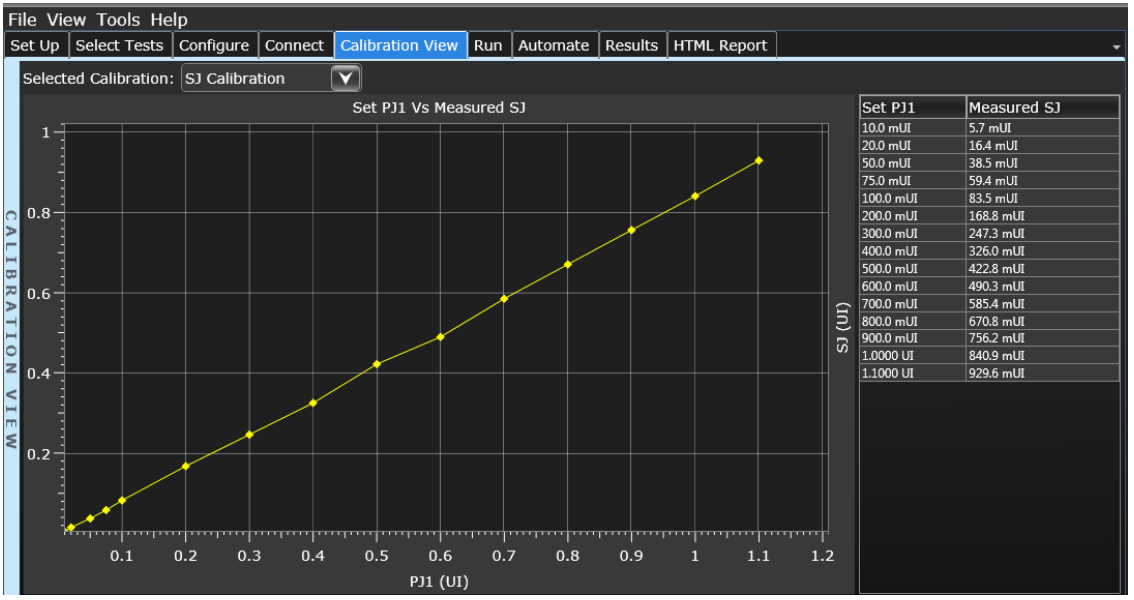


Figure 41 SJ Calibration calibrated data in Calibration View tab

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 42.

ID

Standard Name	Test ID
CR	671103

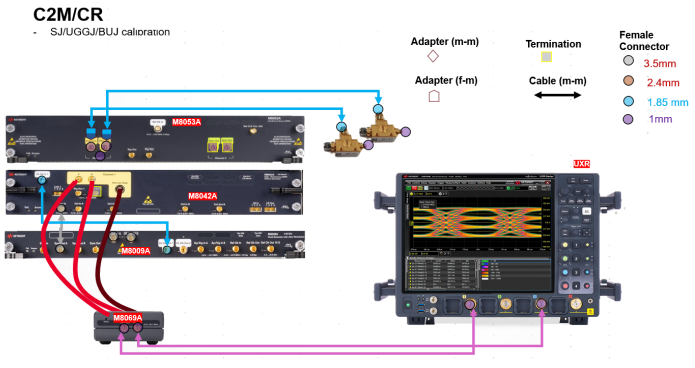


Figure 42 Connection diagram for CR - SJ, UUGJ, and BUJ Calibration

Parameters Refer to Calibration Parameters in Debug Mode on page 58.

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 44).

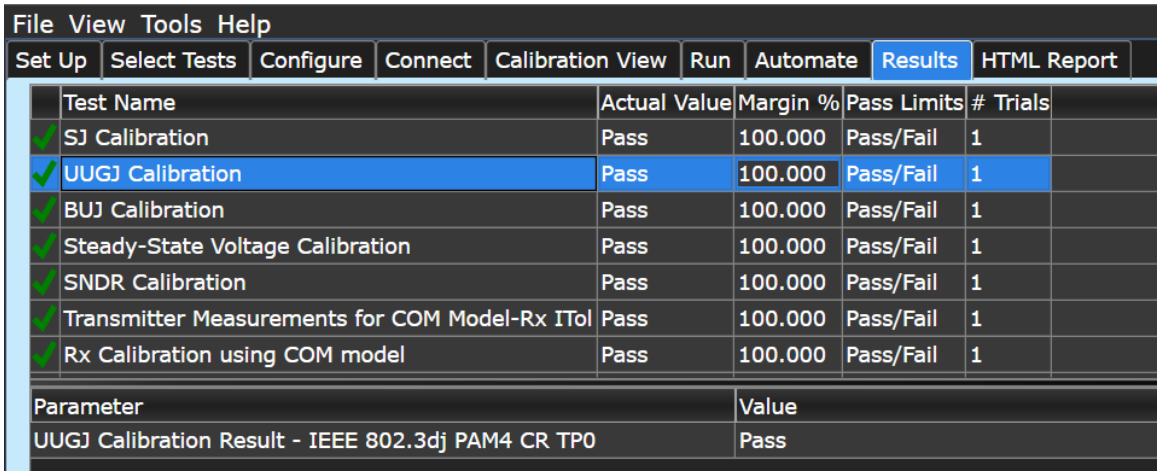


Figure 43 CR - UUGJ Calibration result

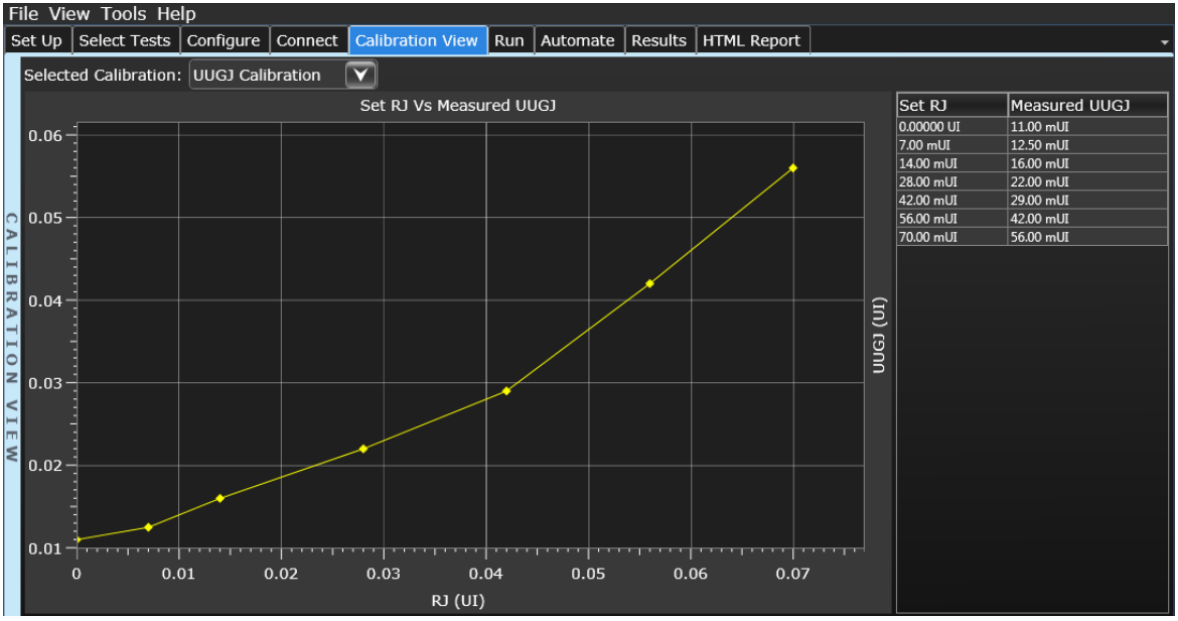


Figure 44 UUGJ Calibration calibrated data in Calibration View tab

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 45.

ID

Standard Name	Test ID
CR	671104

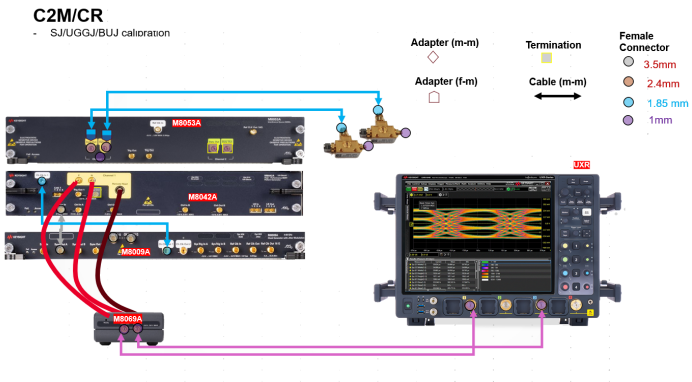


Figure 45 Connection diagram for CR - SJ, UUGJ, and BUJ Calibration

Parameters

Refer to Calibration Parameters in Debug Mode on page 58.

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 46 shows an example of the results.

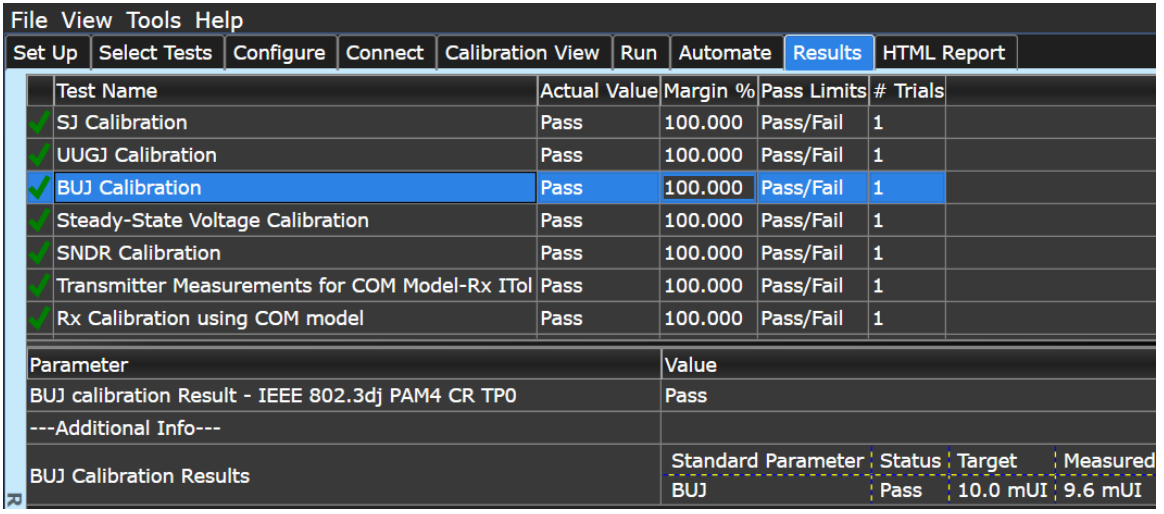


Figure 46 BUJ Calibration result in the Results tab

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 47.

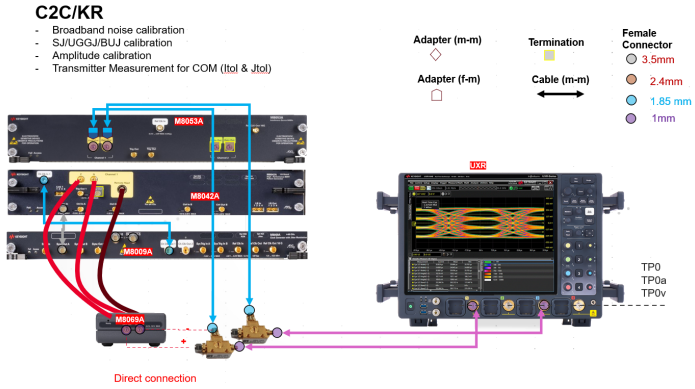


Figure 47 Connection diagram for CR Broadband Noise Calibration

ID

Standard Name	Test ID
CR	671105

Parameters Refer to Calibration Parameters in Debug Mode on page 58.

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 48 and Figure 49)

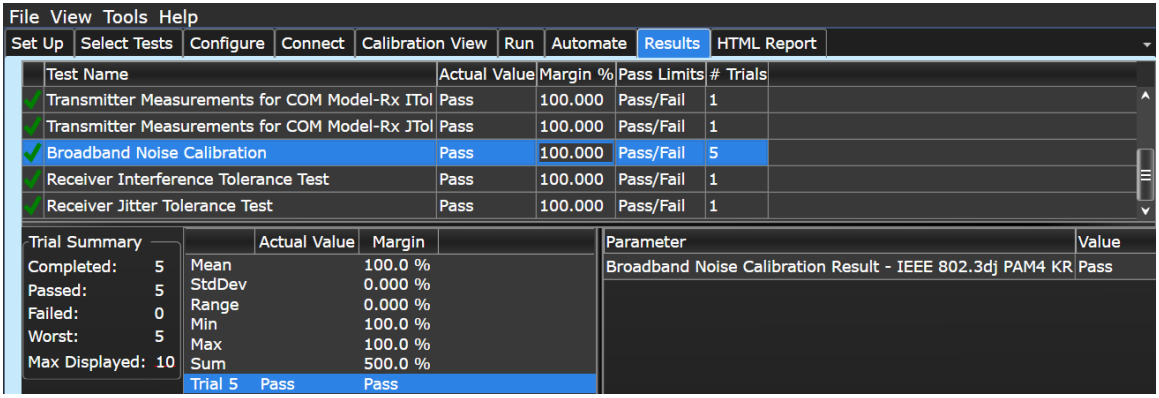


Figure 48 Broadband Noise Calibration (CR) results in the Results tab

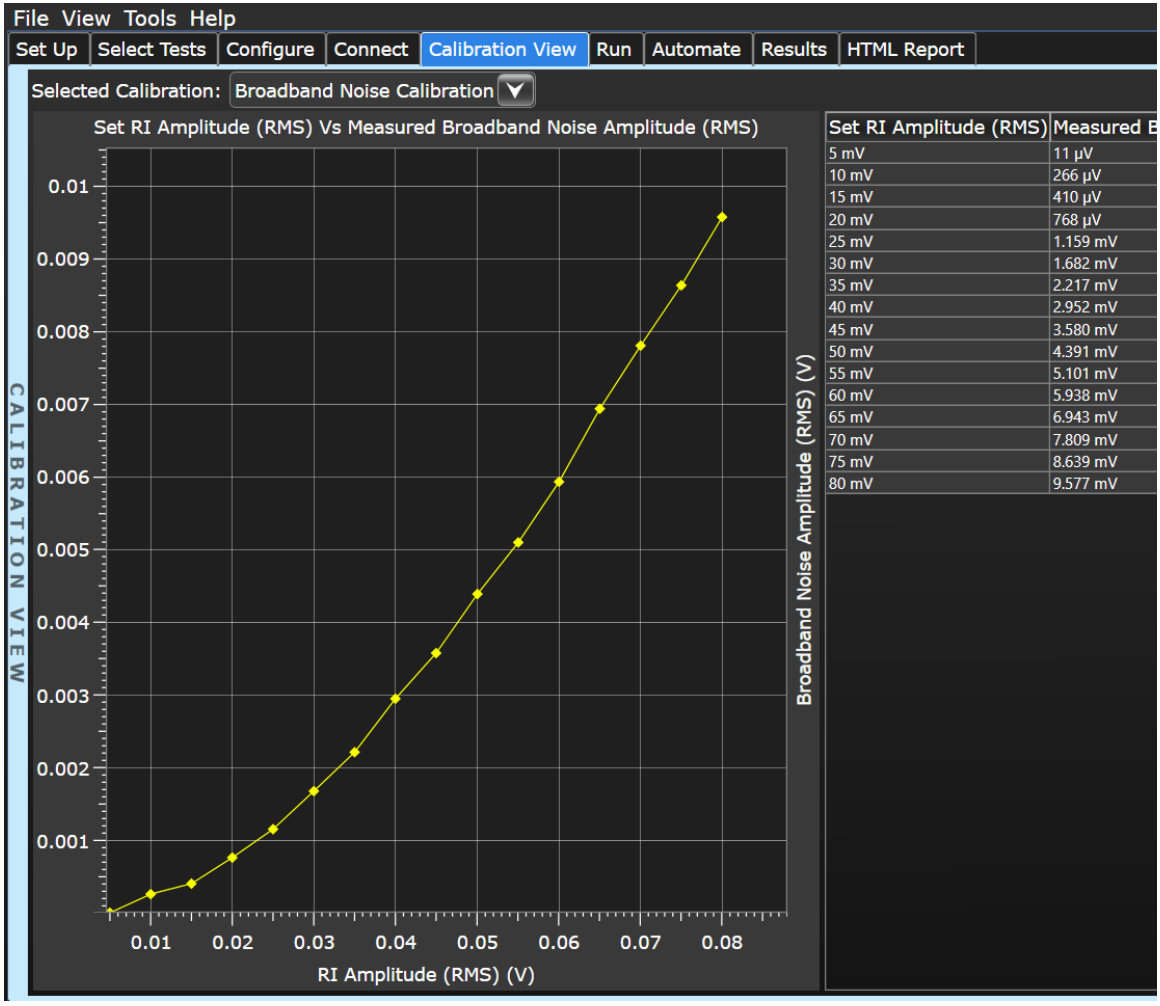


Figure 49 Broadband Noise Calibration calibrated data in Calibration View tab

Steady-State Voltage Calibration

Overview Steady-State Voltage Calibration is performed to accurately set and verify the steady-state voltage levels of a test signal.

Connection Diagram Connect the instruments as shown in Figure 50 and Figure 51.

Standard Name	Test ID
CR	672103

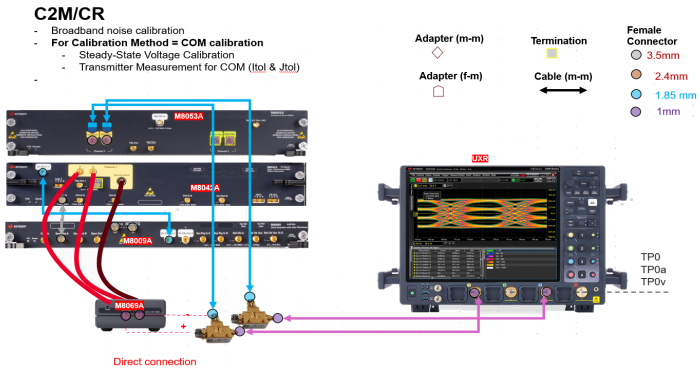


Figure 50 Connection diagram for CR Steady-State Voltage Calibration - Draft 2.0

NOTE The channel is emulated in the oscilloscope using the channel S-parameter.

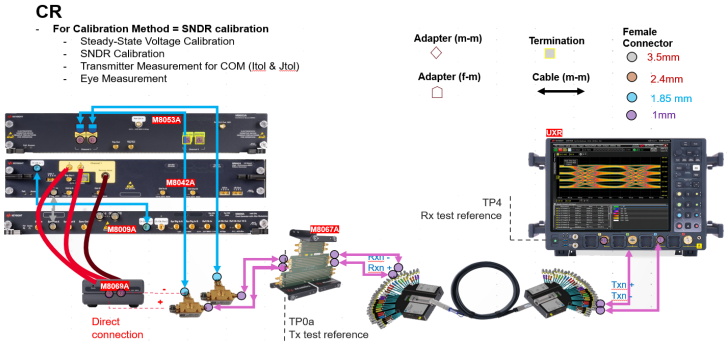


Figure 51 Connection diagram for CR Steady-State Voltage Calibration - Draft 1.4

NOTE For Draft1.4 method, the steady-state voltage is measured after the actual channel.

Parameters Refer to Calibration Parameters in Debug Mode on page 58.

Procedure This calibration uses the PRBS13Q.

With the test channel connected, linear fit pulse response is captured in the oscilloscope and steady state voltage is measured from it.

The Victim Generator Amplitude is set until the desired Steady State Voltage is measured.

Results The Steady-State Voltage Calibration returns the results

- pass or fail in the Results tab

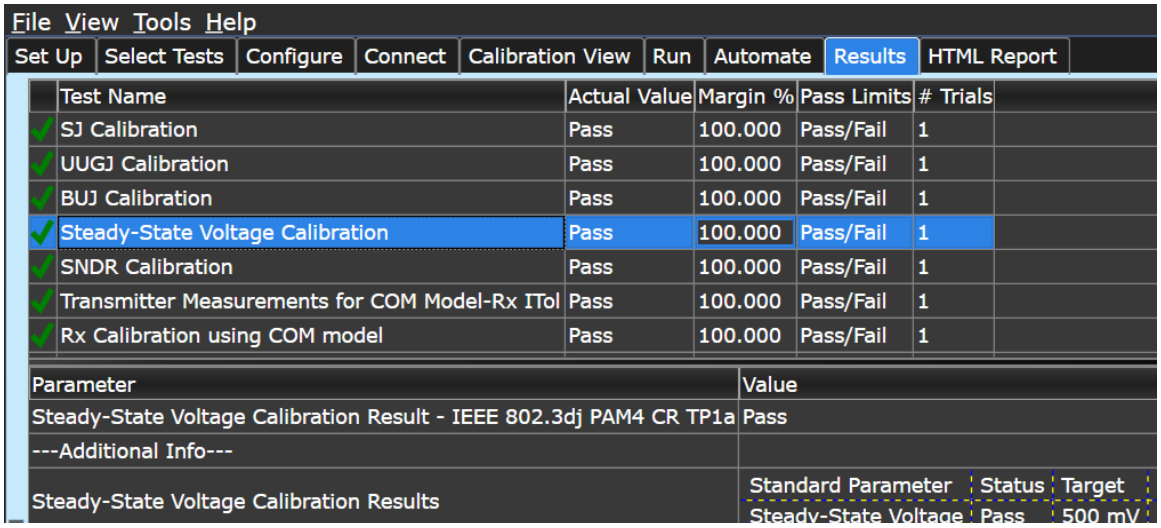


Figure 52 CR Steady-State Voltage Calibration result

Channel Characterization using COM Model

Overview

The Channel Characterization using COM Model validates the channel characteristics using COM model as per *Table 176C-5* mentioned in Annex *176C* of the *IEEE P802.3dj™/D2.0* specification. This calibration should be performed for both the low- and high-loss channel test cases.

Connection Diagram

No specific hardware connection is required.

ID

Standard Name	Test ID
CR	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-Parameter and Excel Config File, refer to CR Configuration in the Test Application on page 61.

Parameters

Refer to Calibration Parameters in Debug Mode on page 58.

Procedure

This calibration uses the PRBS13Q 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 53 shows example results.

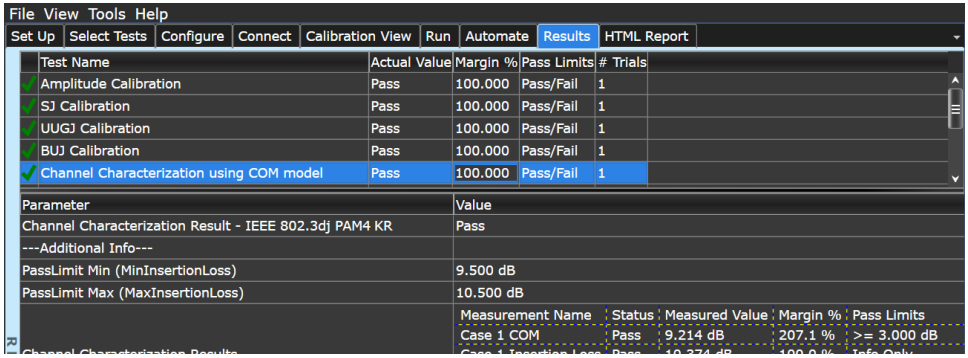


Figure 53 Channel Characterization using COM Model (CR) calibration results in the Results tab

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 179-7* mentioned in *section 179* of the *IEEE P802.3dj™/D2.0* specification.

Connection Diagram Connect the instruments as shown in Figure 54 and Figure 55.

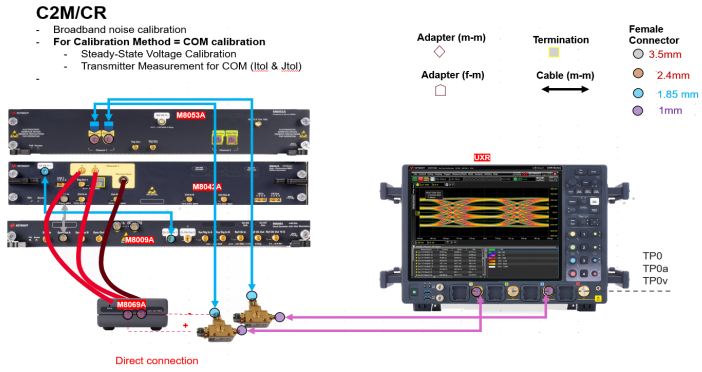


Figure 54 Connection diagram - Tx Measurement for COM Model - Rx ITol - Draft 2.0

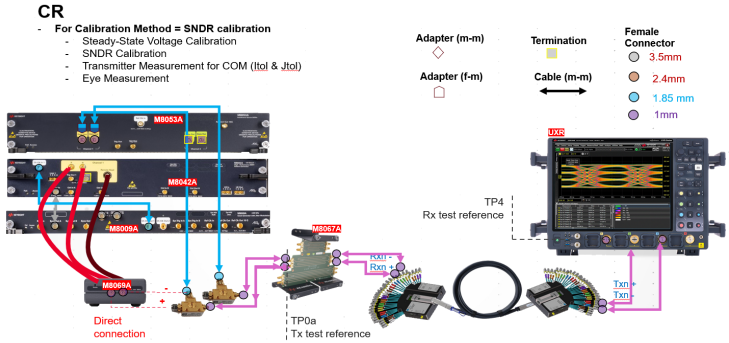


Figure 55 Connection diagram - Tx Measurement for COM Model - Rx ITol - Draft 1.4

ID

Standard Name	Test ID
CR	672101

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

- All CR calibrations performed previously:
  - SJ Calibration on page 69
  - UUGJ Calibration on page 71
  - BUJ Calibration on page 73

Parameters Refer to Calibration Parameters in Debug Mode on page 58.

Procedure This procedure uses the PRBS13Q 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 Electrical Output Specification

- Transition Time
- SNDR for Rx Test (Np = 85)
- Level Mismatch Ratio RLM
- Signal-to-Noise-and-Distortion Ratio (Np = 400)

Transmitter Output Jitter Specification

- Uncorrelated jitter RMS (Jrms) (standard deviation of the probability distribution)
- Uncorrelated Jitter (J4u) (time interval from 0.005% to 99.995% of the probability distribution)

The Output Jitter Measurement and Linear Fit Pulse Response (Np = 85) are presented as an image in the app.

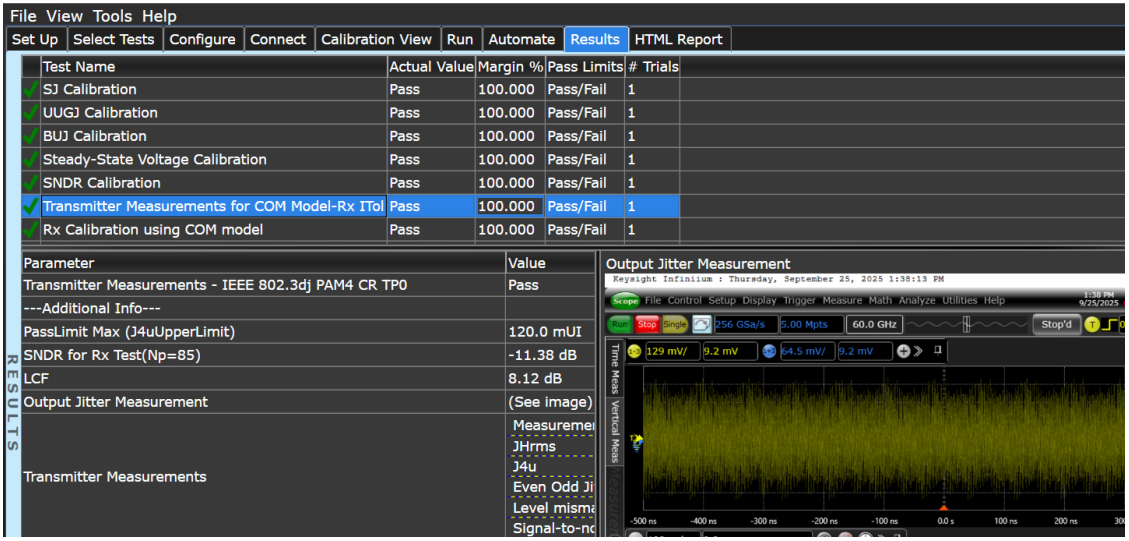


Figure 56 Transmitter Measurements for COM Model — Rx ITol Calibration results in the Results tab

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

No specific hardware connection is required.

ID

Standard Name	Test ID
CR	672102

Dependencies

This test depends on the values measured in Transmitter Measurements for COM Model — Rx ITol on page 83.

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

Parameters

Refer to Calibration Parameters in Debug Mode on page 58.

Procedure

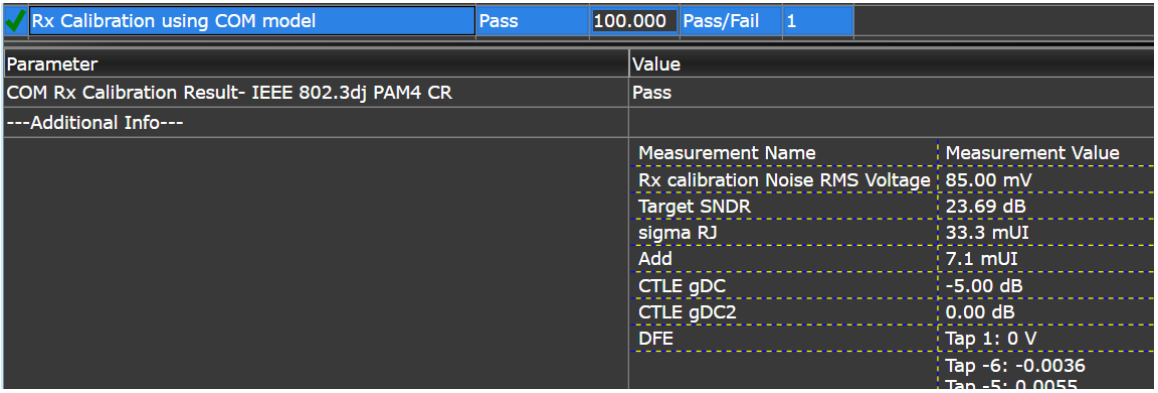
This calibration determines the Broadband Noise (RMS) value using COM calibration until the COM value begins to decrease below 3 dB.

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
- TDMODE = 0 (Calibration Method: Draft 2.0) /TMODE = 1 (Calibration Method: Draft 1.4)

Results

The calibrated value is displayed in the Results tab.



Rx Calibration using COM model	Pass	100.000	Pass/Fail	1

Parameter	Value
COM Rx Calibration Result- IEEE 802.3dj PAM4 CR	Pass
---Additional Info---	

Measurement Name	Measurement Value
Rx calibration Noise RMS Voltage	85.00 mV
Target SNDR	23.69 dB
sigma RJ	33.3 mUI
Add	7.1 mUI
CTLE gDC	-5.00 dB
CTLE gDC2	0.00 dB
DFE	Tap 1: 0 V
	Tap -6: -0.0036
	Tap -5: 0.0055

Figure 57 Rx Calibration using COM Model calibration results

Transmitter Measurements for COM Model — Rx JTol

Overview The Transmitter Measurements for COM Model — Rx JTol procedure measures transmitter parameters for the calculation of test channel COM as per Table 179-7 mentioned in section 179 of the IEEE P802.3dj™/D2.0 specification.

Connection Diagram Connect the instruments as shown in Figure 58 and Figure 59.

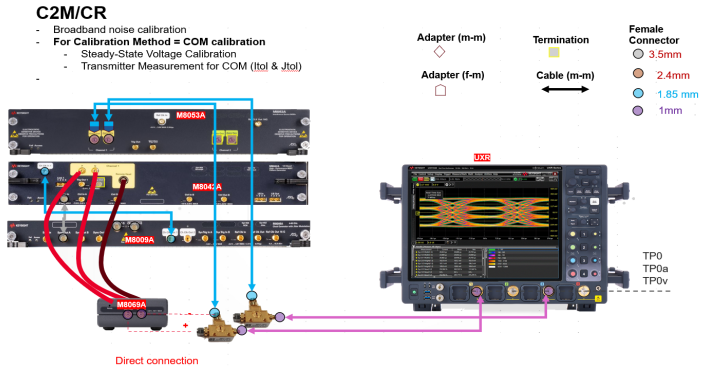


Figure 58 Connection diagram - Tx Measurement for COM Model - Rx JTol - Draft 2.0

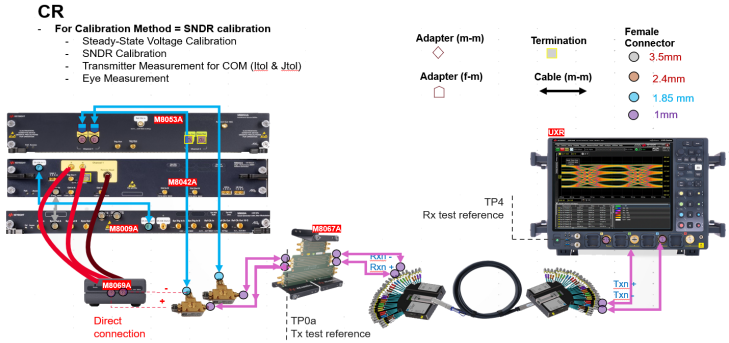


Figure 59 Connection diagram - Tx Measurement for COM Model - Rx JTol - Draft 1.4

ID

Standard Name	Test ID
CR	673100

Dependencies

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

- Excel Config File – to configure COM parameters
- Calibrated values from the following Calibrations:
  - SJ Calibration on page 69
  - UUGJ Calibration on page 71

Parameters

Refer to Calibration Parameters in Debug Mode on page 58.

Procedure

This calibration uses the PRBS13Q 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.

Transmitter Electrical Output Specification

- Transition Time
- Level Mismatch Ratio RLM
- Signal-to-Noise-and-Distortion Ratio (Np = 400)
- SNDR for Rx test (Np = 85)

Transmitter Output Jitter Specification

- Uncorrelated Jitter (J4u) (time interval from 0.005% to 99.995% of the probability distribution)
- Uncorrelated jitter RMS (Jrms) (standard deviation of the probability distribution)

The Output Jitter Measurement and Linear Fit Pulse Response (Np = 85) are presented as an image in the app.

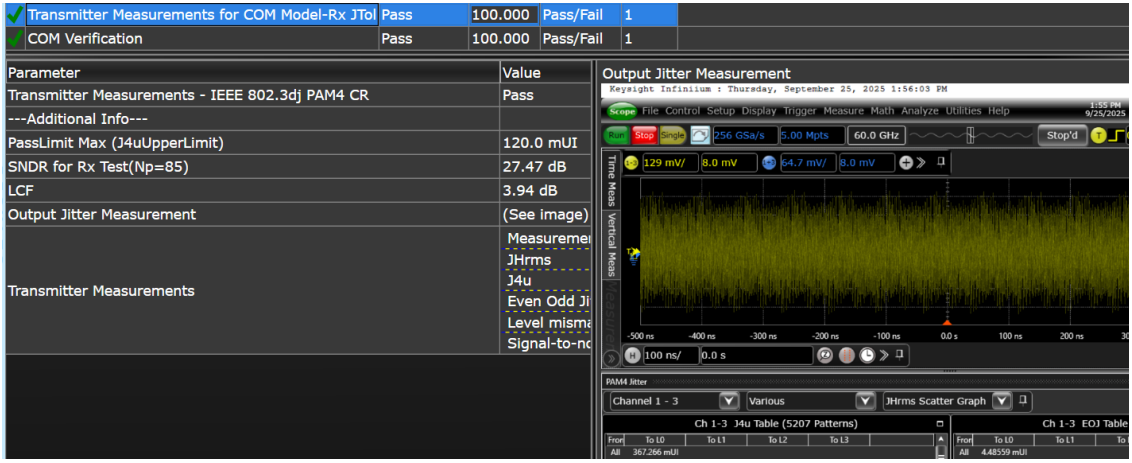


Figure 60 Transmitter Measurements for COM Model – Rx JTol Calibration results in the Results tab

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 No specific hardware connection is required.

ID

Standard Name	Test ID
CR	673101

Dependencies This procedure depends on the values measured in Transmitter Measurements for COM Model – Rx JTol on page 88.

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

Parameters Refer to Calibration Parameters in Debug Mode on page 58.

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 This calibrated values are displayed in a tabular format in the Results tab.

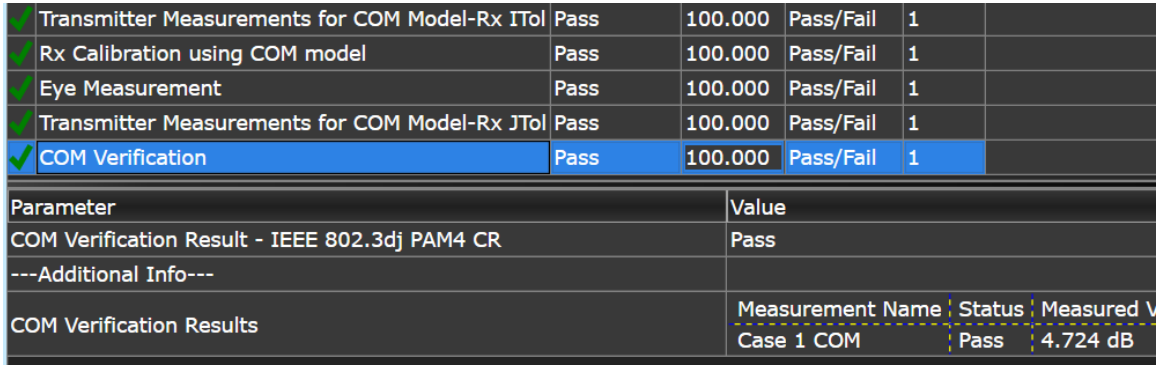


Figure 61 COM Verification Calibration results

5 UALink CR Tests

This chapter describes the procedures for the UALink Rx tests that are applicable for the CR (200GBASE-CR1, 400GBASE-CR2, 800GBASE-CR4, and 1.6TBASE-CR8) standard.

As a prerequisite, run all IEEE802.3dj CR calibrations before running tests. Ensure that the DUT is properly connected to the BERT modules and the UXR Infiniium Oscilloscope.

Test Parameters in Debug Mode

In the **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 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 CR (200GBASE-CR1, 400GBASE-CR2, 800GBASE-CR4, and 1.6TBASE-CR8) standard option, the test parameters listed in Table 5 are available for configuration.

Table 5 Test parameters in debug mode for the CR standard

Test Parameters	Description
Common Parameters	
Baud Rate	Baud Rate for testing device and for all calibrations.
Differential Channel Partner	Differential channel partner type to acquire signal.
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.
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 (3 dB max).
PAM4 Symbol 1 Level	Enter PAM4 Symbol 1 Level in percentage.
PAM4 Symbol 2 Level	Enter PAM4 Symbol 2 Level in percentage.
Common Test Parameters	
PRBS Pattern	PRBS Pattern selection for Receiver Tests.
Sync Loss Threshold	The threshold level of error ratio at which synchronization is successful.
Alignment BER Threshold	BER threshold used as pass/fail criteria during the sample point alignment.
Victim Analyzer Module	Selects the victim analyzer module for testing device.
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.

Test Parameters	Description
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	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.
Jitter Tolerance Test Parameters	
Test Mode	Test just for predefined SJ Frequencies or measure SJ Frequency.
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.
Manual Frequency List	List of Jitter frequencies separated by commas.
Minimum Jitter Amplitude Limit	Minimum Jitter Amplitude Limit.
Maximum Jitter Amplitude Limit	Maximum Jitter Amplitude Limit.

Test Parameters	Description
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 6 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* of IEEE Std 802.3bj-2014, Amendment to IEEE Std 802.3-2012: Ethernet.

Table 6 Rx test procedure step summary

#	Procedure	Test Channel Configuration	Summary of steps to be performed
1	Amplitude Tolerance Test	Perform Rx Interference Tolerance Test for both the low loss and high loss channel.	Perform Rx interference tolerance test.
2	Interference Tolerance Test	Perform Rx Interference Tolerance Test for both the low loss and high loss channel.	Perform Rx interference tolerance test.
3	Jitter Tolerance Test	Perform Rx Jitter Tolerance Test for high loss channel.	Perform Rx jitter tolerance test.

These procedures are broadly described in the following section.

Detailed Steps for Rx Test Procedures

Step#1. Rx Amplitude Tolerance Test

1. Using the test setup in Figure 62 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.
2. Configure the transmitters of the PMD under test to transmit the same test pattern, with their transmitters in the preset condition.
3. Measure the BER using the PRBS31Q pattern on the receiver under test using the built-in error counter or by activating the DUT internal loopback mode.

Step#2. Rx Interference and Jitter Tolerance Test

1. Using the test setup in Figure 62, 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.

   Use the pause during the Rx test procedure to optimize the PG

de-emphassis while keeping all other parameters constant. This step can be used using the M8070ADVB feature "BER-based De-Empahsis Optimization".

2 Measure the BER using the PRBS31Q pattern on the receiver under test using the built-in error counter or by activating the DUT's internal loopback mode, the DUT transmitter and error analyzer equalizer should be co-optimized to ensure an error-free loopback channel. Both the DUT's internal error checker and external error detectors—such as a real-time oscilloscope (e.g., UXR)—can be integrated into the compliance application via DCI (DUT Control Interface / 159

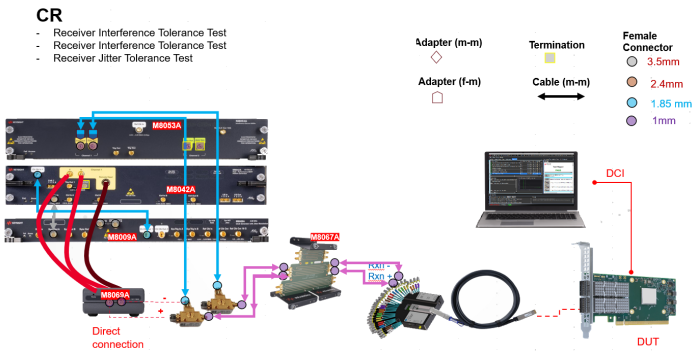


Figure 62 Connection diagram for Rx Jitter Tolerance Test without channel noise

For each case listed in Table 7, the receiver under test shall meet the BER measurements as specified in Table 176D-11 of the P802.3dj™/D2.0 specification.

Table 7 Receiver jitter tolerance parameters

Parameter	Case A	Case B	Case C	Case D	Case E	Case F	Case G	Units
Jitter frequency	0.04	0.1333	0.4	1.333	4	12	40	MHz
Jitter amplitude (peak to peak)	5	1.5	0.5	0.15	0.05	0.05	0.05	UI

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 M8070B's DCI Module with the M8070BADVB package.

Amplitude Tolerance Test

Overview

The Receiver Amplitude Tolerance Test validates that the receiver on each lane shall meet the BER requirement when subjected to calibrated variations in signal amplitude. This test ensures the receiver can operate reliably across a range of input voltage levels, simulating real-world conditions such as attenuation and channel loss. The test should be performed for both the low-loss and high-loss channel test cases, using amplitude settings derived from the COM model and calibration procedures.

Connection Diagram

Connect the instruments as shown in Figure 63.

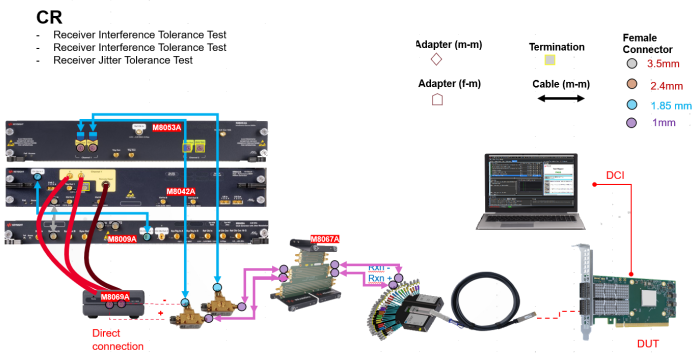


Figure 63 Connection diagram for Rx Amplitude Tolerance Test without channel noise

ID

Standard Name	Test ID
CR	675102

Dependencies

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

- SJ Calibration on page 123
- UUGJ Calibration on page 125
- BUJ Calibration on page 127
- SNDR Calibration on page 131
- Transmitter Measurements for COM Model — Rx ITol on page 133

- COM Verification on page 144

Parameters Refer to Test Parameters in Debug Mode on page 94.

Procedure This test uses the PRBS31Q pattern.

Results The Amplitude Tolerance Test attains 'Pass' value if the Rx BER is less than 1e-4, as per the *IEEE P802.3dj™/D2.0* specification.

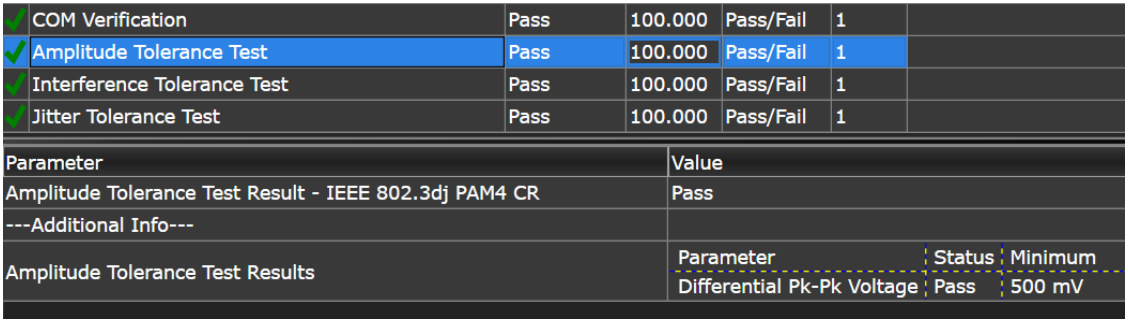


Figure 64 Rx Amplitude Tolerance Test results in tabular format

Interference Tolerance Test

Overview

The Receiver Interference Tolerance Test validates that the receiver on each lane shall meet 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.

Connection Diagram

Connect the instruments as shown in Figure 65.

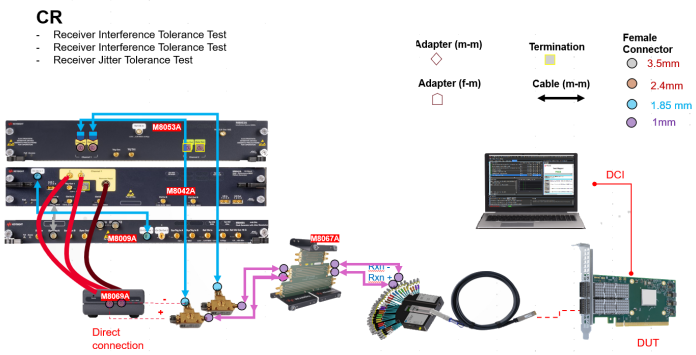


Figure 65 Connection diagram for Rx Interference Tolerance test

ID

Standard Name	Test ID
CR	675101

Dependencies

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

- Amplitude Calibration on page 116
- SJ Calibration on page 118
- UUGJ Calibration on page 120
- BUJ Calibration on page 122
- Broadband Noise Calibration on page 124
- Transmitter Measurements for COM Model – Rx ITol on page 129
- Rx Calibration using COM Model on page 132

Parameters Refer to Test Parameters in Debug Mode on page 94.

Procedure This test uses the PRBS31Q pattern.

Results The Receiver Interference Tolerance Test attains 'Pass' value if the Rx BER is less than 1e-4, as per the *IEEE P802.3dj™/D2.0* specification.

✓	Amplitude Tolerance Test	Pass	100.000	Pass/Fail	1
✓	Interference Tolerance Test	Pass	100.000	Pass/Fail	1
✓	Jitter Tolerance Test	Pass	100.000	Pass/Fail	1

Parameter	Value	
Interference Tolerance Test Result - IEEE 802.3dj PAM4 CR	Pass	
---Additional Info---		
Interference Tolerance Test Parameters	Parameter Name	Parameter Value
	BER	0.000
	Confidence Level	95.00 %
	Injected Noise	5.0 mV
	Coefficient 0	0
	Coefficient 1	0
	Coefficient 2	0
	Coefficient 3	1
	Coefficient 4	0

Figure 66 Rx Interference Tolerance Test results in tabular format

Jitter Tolerance Test

Overview

The Receiver Jitter Tolerance Test validates that the receiver bit error ratio (BER) meets the requirements for each pair of jitter frequency and peak-to-peak amplitude values as per the *IEEE P802.3dj™/D2.0* specification. This test is only required for the high loss channel test case.

Connection Diagram

Connect the instruments as shown in Figure 67.

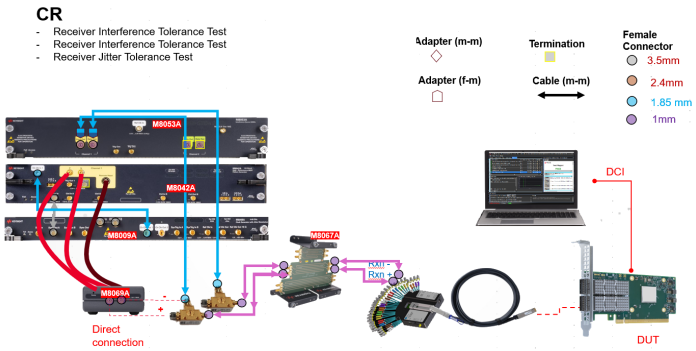


Figure 67 Connection diagram for Rx Jitter Tolerance test

ID

Standard Name	Test ID
CR	675100

Dependencies

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

- Amplitude Calibration on page 116
- SJ Calibration on page 118
- UUGJ Calibration on page 120
- BUJ Calibration on page 122
- Transmitter Measurements for COM Model – Rx JTol on page 134

Parameters

Refer to Test Parameters in Debug Mode on page 94.

Procedure

This test uses the PRBS31Q pattern.

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

Amplitude Tolerance Test	Pass	100.000	Pass/Fail	1
Interference Tolerance Test	Pass	100.000	Pass/Fail	1
Jitter Tolerance Test	Pass	100.000	Pass/Fail	1

Parameter	Value
Jitter Tolerance Test Result - IEEE 802.3dj PAM4 CR	Pass
---Additional Info---	
Jitter Tolerance Test Screenshot	(See image)

Jitter Tolerance Test Results

Parameter	Frequency	Amplitude	Status
SJ1	40.000 kHz	5.0000 UI	Pass
SJ2	133.300 kHz	1.5000 UI	Pass
SJ3	400.000 kHz	500.0 mUI	Pass
SJ4	1.333000 MHz	150.0 mUI	Pass
SJ5	4.000000 MHz	50.0 mUI	Pass
SJ6	12.000000 MHz	50.0 mUI	Pass
SJ7	40.000000 MHz	50.0 mUI	Pass

Figure 68 Rx Jitter Tolerance Test results in tabular format

6 UALink KR Calibrations

This chapter describes the test procedures for the UALink Rx Calibrations that are applicable for the KR standard options.

Before performing the UALink KR tests, you have to calibrate all the related parameters. Perform calibrations in the order displayed in the UALink 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 UALink Calibrations.

Calibration Parameters in Debug Mode

In the **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 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 **KR (200GBASE-KR1, 400GBASE-KR2, 800GBASE-KR4, and 1.6TBASE-KR8**) standard option, the calibration parameters listed in Table 8 are available for configuration.

Table 8 Calibration parameters in debug mode for the KR standard options

Calibration Parameter	Description
Parameters Common to All Calibrations	
Baud Rate	Baud Rate for testing device and for all calibrations.
Differential Channel Partner	Differential channel partner type to acquire signal: Every Other Channel or Adjacent Channel
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.
C2C (200GAUI-1, 400GAUI-2, 800GAUI-4, and 1.6TAUI-8)	
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).
PAM4 Symbol 1 Level	Controls the level of symbol 1.
PAM4 Symbol 2 Level	Controls the level of symbol 2.
Transmitter Cursors	Controls all the cursors equalization coefficient for Transmitter Measurements.
Noise Generator Channel Selection	Selects the location of the Noise Generator that shall be used for generating broadband noise.
Parameters for Common Calibrations	
Amplitude	Victim Differential Amplitude measured at the channel input.
Transmitter Cursors (Only for C2C not KR)	Controls all the cursors equalization coefficient for Transmitter Measurements.
Loop Bandwidth	Select or enter the Loop BW to be used in the clock recovery.

Calibration Parameter	Description
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.
Common – BUJ Calibration	
BUJ	Controls the amplitude of the BUJ jitter source.
Parameters for Receiver Interference Tolerance – Transmitter Measurements for COM Model	
Amplitude	Victim Differential Amplitude measured at the channel input.
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 Cursors	Controls all the cursors 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 use in the 12-edge output jitter measurement.
Record Count	Set the record count used for Jnu measurement at TP0.
Parameters for Receiver Jitter Tolerance – Transmitter Measurements for COM Model	
Amplitude	Victim Differential Amplitude measured at the channel input.

Calibration Parameter	Description
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 Cursors	Controls all the cursors 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 use in the 12-edge output jitter measurement.
Record Count	Set the record count used for Jnu measurement at TP0.

KR 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 KR standard options, note the following:

1 In the current version of the UALink Test Application, the S-Parameter files (low loss channel) and Excel file corresponding to the standard options are displayed by default.

Figure 69 Configuration files for KR standard

2 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\Keysight\M8070B\Apps\M8091UACA\app\SParameterProfiles* for **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 9. Note that Table 9 shows just an example of S-Parameter files; they may differ according to your test setup.

Table 9 Selecting Test Channel S-Parameter File for KR Standard

Test Channel Configuration Settings	Corresponding Rx Interference Tolerance Parameter	Target Insertion Loss	Standard Option	S-Parameter File That Can Be Selected
Low Loss	Test 1 (Receiver Package Class A)	14.5 dB - 15.5 dB	KR	P105_P106_P107_P108_M8067A-003_774167_smoothed.s4p
	Test 1 (Receiver Package Class B)	14.5 dB - 15.5 dB		P105_P106_P107_P108_M8067A-003_774167_smoothed.s4p
High Loss	Test 2 (Receiver Package Class A)	33.5 dB - 34.5 dB		P105_P106_P107_P108_M8067A-005_774188_smoothed.s4p
	Test 2 (Receiver Package Class B)	30 dB - 31 dB		P105_P106_P107_P108_M8067A-005_774188_smoothed.s4p

NOTE The default S-Parameter files are the reference only, users are required to measure their test channel's loss profile and use them for COM calculation.

3 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\Keysight\M8070B\Apps\M8091UACA\app\ExcelConfigFiles* for the **Excel Config File** configuration field.

4 From the **Open** window that appears, select the alternative S-parameter file (factory installed) for KR and click **Open**.

NOTE Currently, the test application installs a single Noise Channel S-Parameter file for the CR and KR standards and a different Excel Configuration file for each.

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: 100 GHz

Step Size: 10 MHz

No. of points: 10,000

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

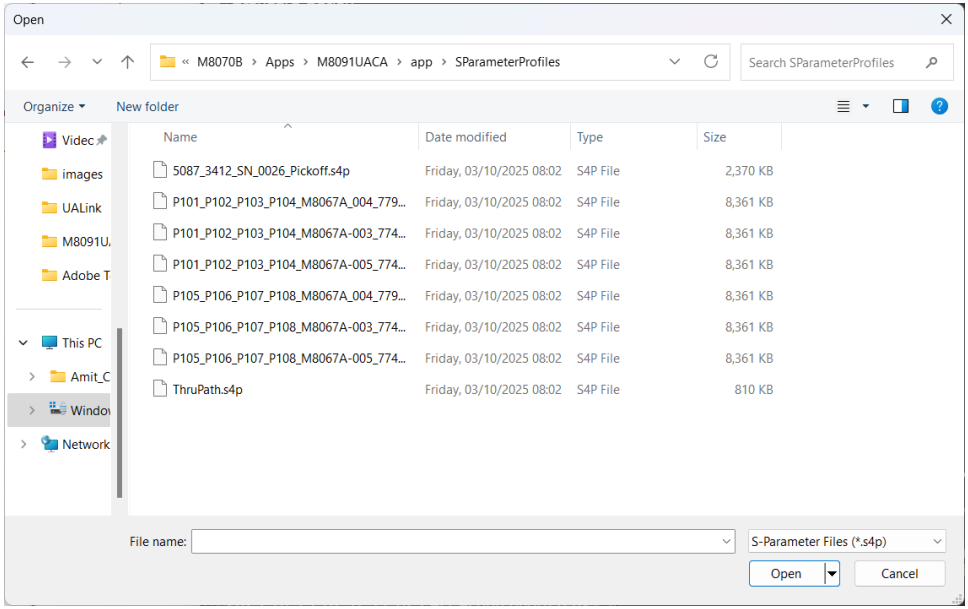


Figure 70 Selecting an S-Parameter file from the default location

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

Calibration Procedure

The UALink KR 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. Typical replica trace S-parameters can be generated using formula (178A–2) in Clause 93A of IEEE P802.3dj™/D2.0. 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 level of noise or jitter) under a specific COM (usually 3 dB).

Four COM-related calibrations are required, two for the low-loss channel and two 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 45 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*.

Amplitude Calibration

Overview The Amplitude Calibration is performed to calibrate the Victim Generator's Amplitude for the Transmitter Measurements for 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 71.

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

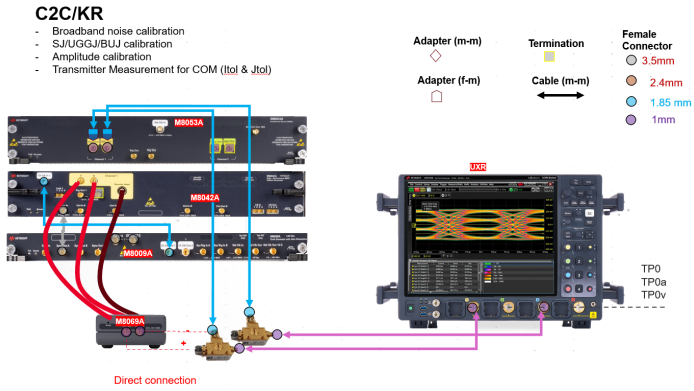


Figure 71 Connection diagram for KR Amplitude Calibration

Standard Name	Test ID
KR	871100

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

Procedure This calibration uses the PRBS13Q 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 72).

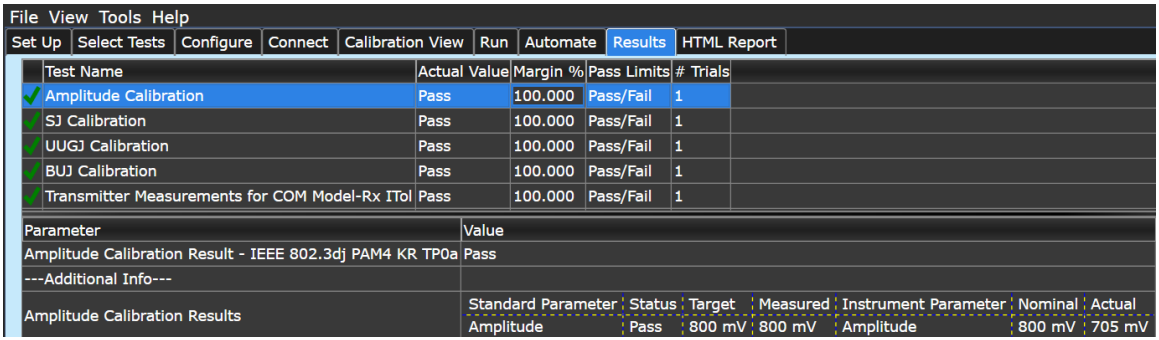


Figure 72 Amplitude Calibration (KR) results in the Results tab

SJ Calibration

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

Connection Diagram Connect the instruments as shown in Figure 73.

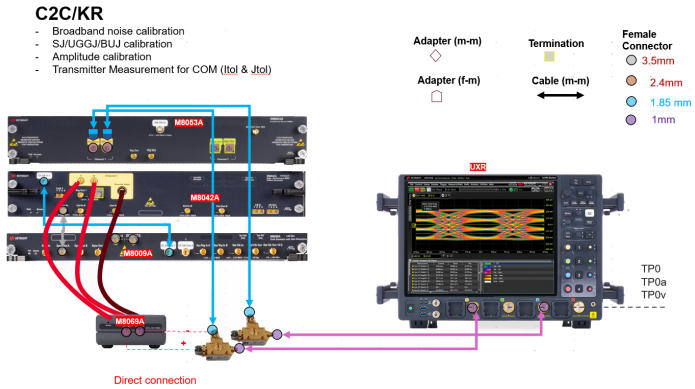


Figure 73 Connection diagram for KR SJ Calibration

ID

Standard Name	Test ID
KR	871101

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

Procedure This calibration uses the Clock/8 pattern.

The SJ is calibrated for a discrete number of points ranging from the minimum to the 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)

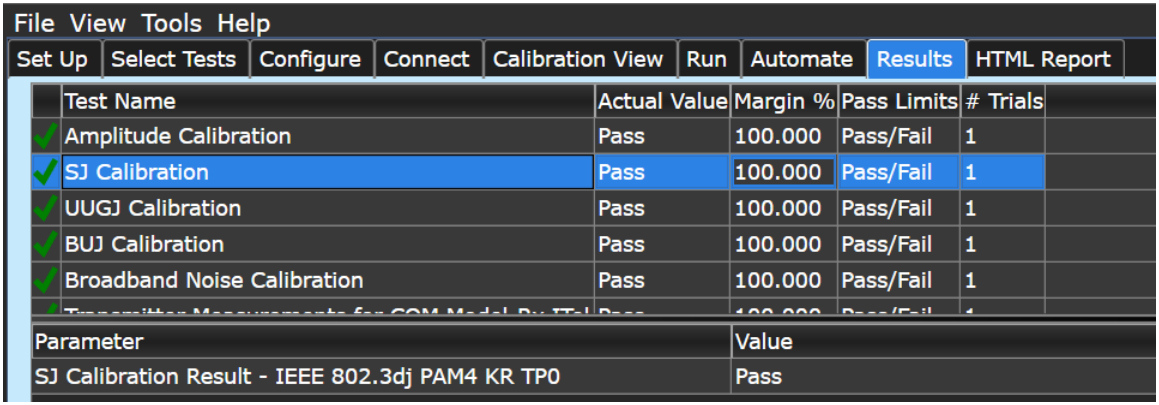


Figure 74 SJ Calibration (KR) result information in the Results tab

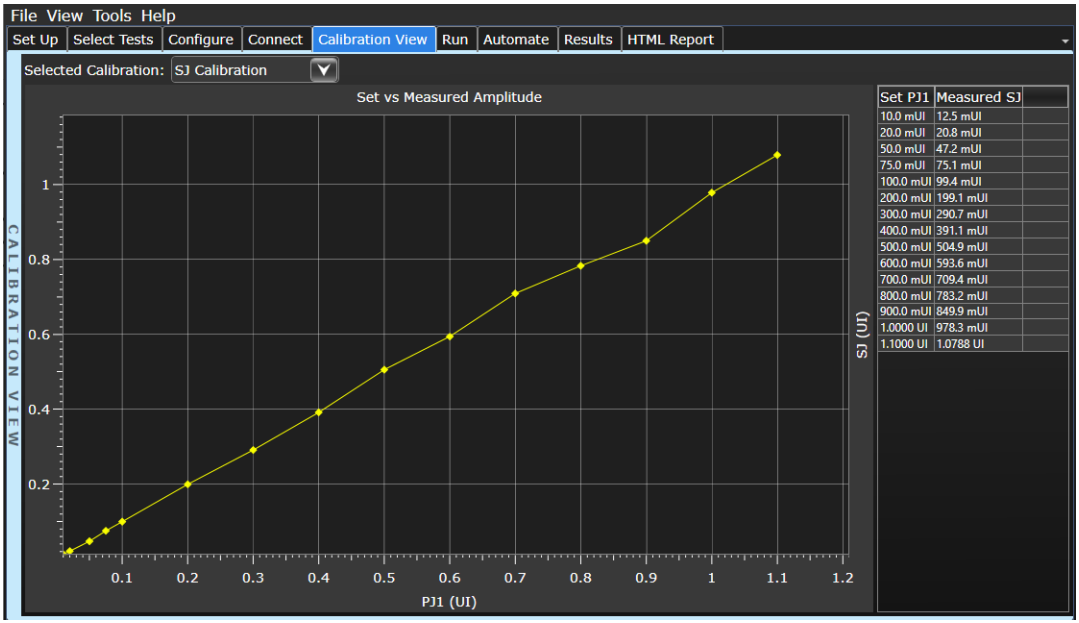


Figure 75 SJ Calibration calibrated data in Calibration View tab

UUGJ Calibration

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

Connection Diagram Connect the instruments as shown in Figure 76.

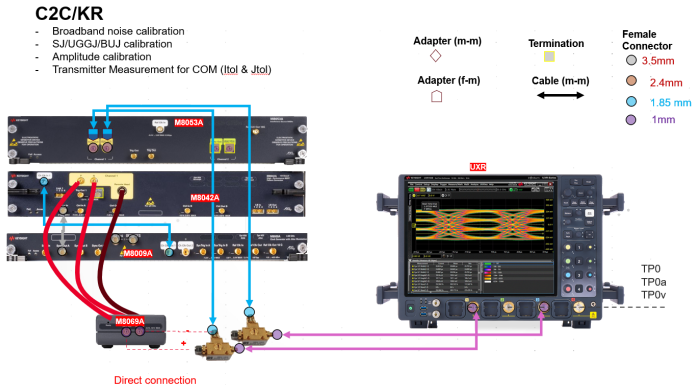


Figure 76 Connection diagram for KR UUGJ Calibration

ID

Standard Name	Test ID
CR	871102

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

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 (Figure 77)
- measured UUGJ versus set RJ in graphical and tabular formats in the Calibration View tab (Figure 78).

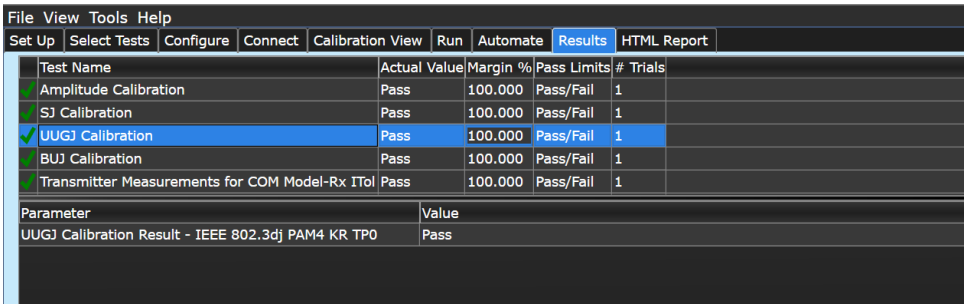


Figure 77 UUGJ Calibration (KR) result information in the Results tab

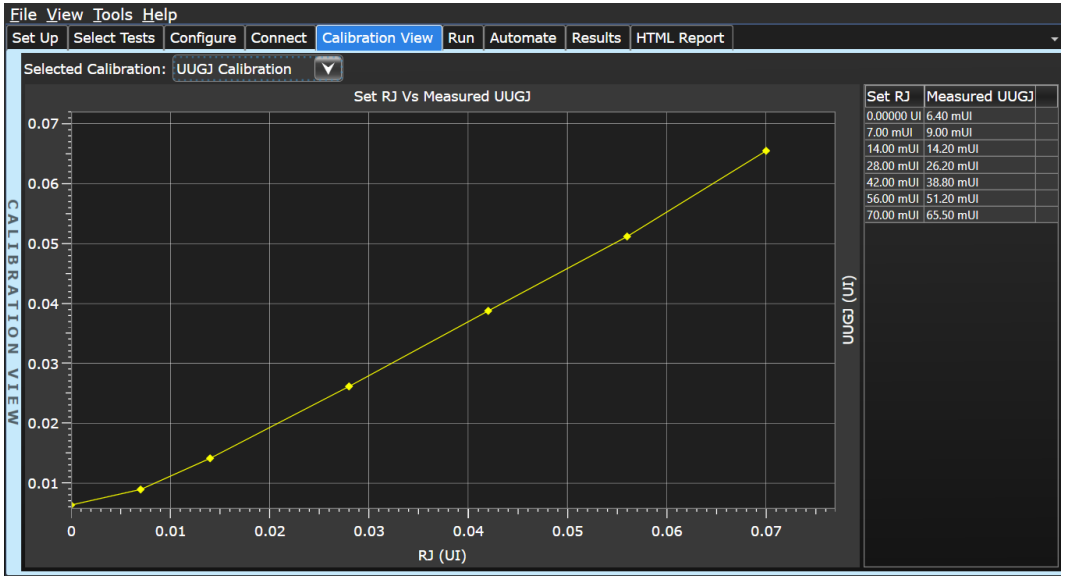


Figure 78 UUGJ Calibration calibrated data in Calibration View tab

BUJ Calibration

NOTE

The UBHPJ stress component comprises BUJ and SJ components. However, since the SJ component emulates 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 79.

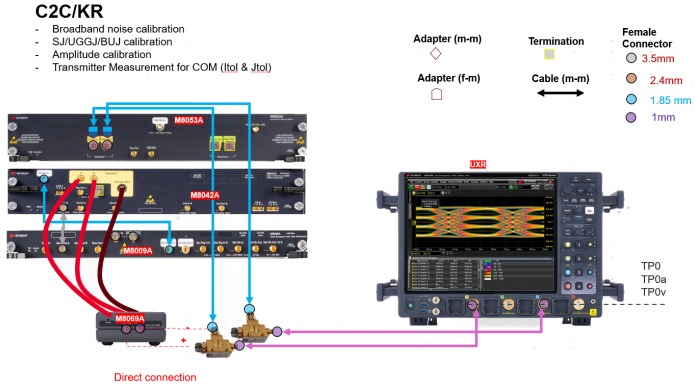


Figure 79 Connection diagram for KR BUJ Calibration

ID

Standard Name	Test ID
KR	871103

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

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 80).

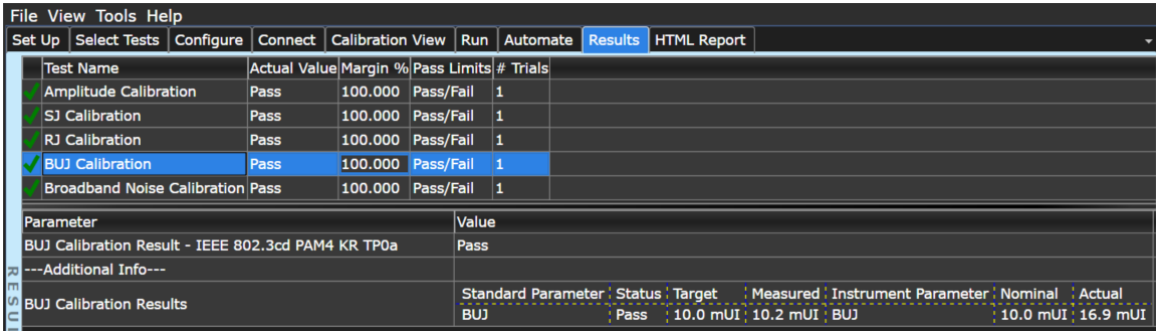


Figure 80 BUJ Calibration (KR) results in the Results tab

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 81.

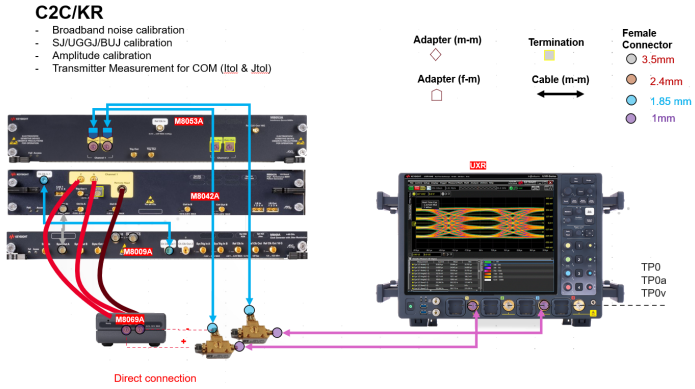


Figure 81 Connection diagram for KR Broadband Noise Calibration

ID

Standard Name	Test ID
KR	871104

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

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 82 and Figure 83)

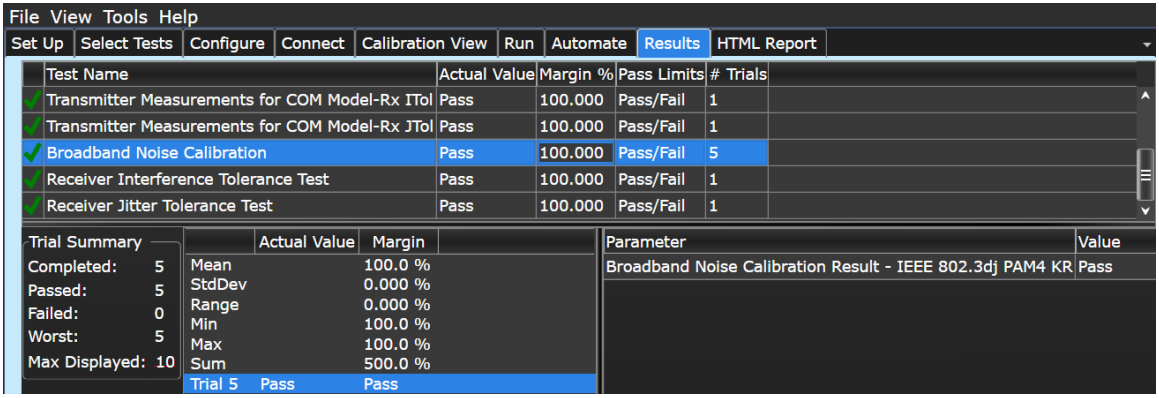


Figure 82 Broadband Noise Calibration (KR) results in the Results tab

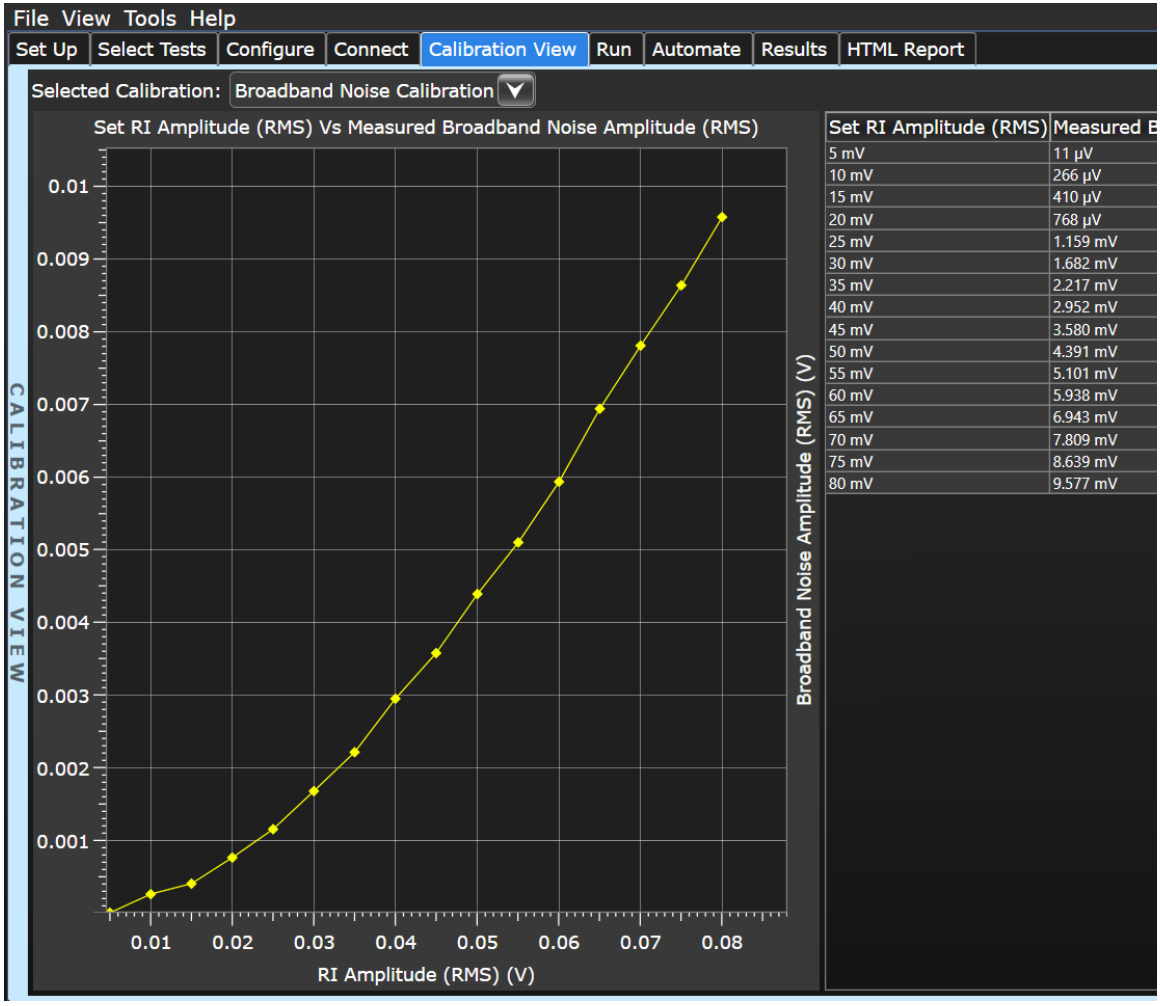


Figure 83 Broadband Noise Calibration calibrated data in Calibration View tab

Channel Characterization using COM Model

Overview

The Channel Characterization using COM Model validates the channel characteristics using COM model as per *Table 176C-5* mentioned in Annex *176C* of the *IEEE P802.3dj™/D2.0* specification. This calibration should be performed for both the low- and high-loss channel test cases.

Connection Diagram

No specific hardware connection is required.

ID

Standard Name	Test ID
KR	872100

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-Parameter and Excel Config File, refer to KR Configuration in the Test App on page 111.

Parameters

Refer to Calibration Parameters in Debug Mode on page 108.

Procedure

This calibration uses the PRBS13Q 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 84 shows example results.

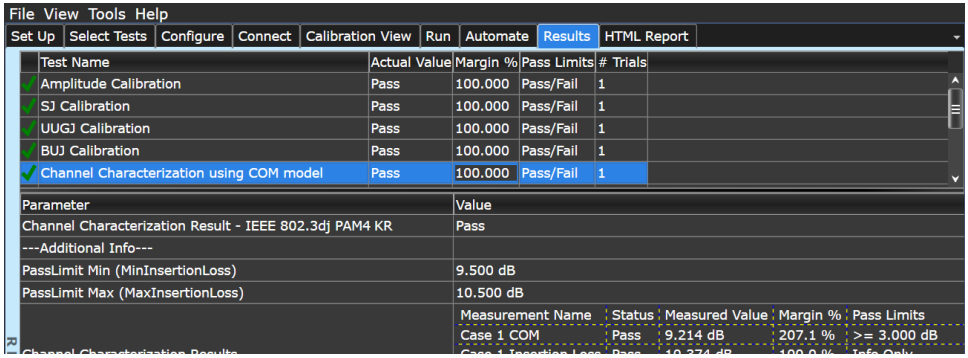


Figure 84 Channel Characterization using COM Model (KR) calibration results in the Results tab

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 the specification.

Standard Name	Spec Reference
KR	Table 178-6, Section 178.9.2, IEEE P802.3dj^{TM}/D2.0

Connection Diagram

Connect the instruments as shown in Figure 85.

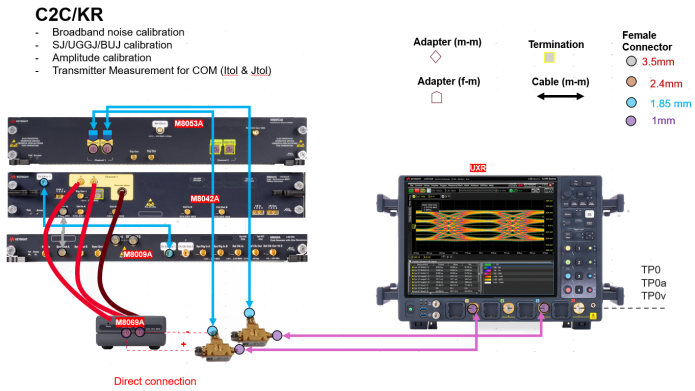


Figure 85 Connection diagram for KR Transmitter Measurements for COM Model — Rx ITol

ID

Standard Name	Test ID
KR	872101

Dependencies

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

- All C2C calibrations performed previously:
  - Amplitude Calibration on page 116
  - SJ Calibration on page 118
  - UUGJ Calibration on page 120

- BUJ Calibration on page 122
- Broadband Noise Calibration on page 124
- Channel Characterization using COM Model on page 127

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

Procedure This procedure uses the PRBS13Q 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 Electrical Output Specification

- Transition Time
- SNDR for Rx Test (Np = 55)
- Level Mismatch Ratio RLM
- Signal-to-Noise-and-Distortion Ratio (Np = 400)

Transmitter Output Jitter Specification

- Uncorrelated jitter RMS (Jrms) (standard deviation of the probability distribution)
- Uncorrelated Jitter (J4u) (time interval from 0.005% to 99.995% of the probability distribution)

The Output Jitter Measurement and Linear Fit Pulse Response (Np = 55) are presented as an image in the app.

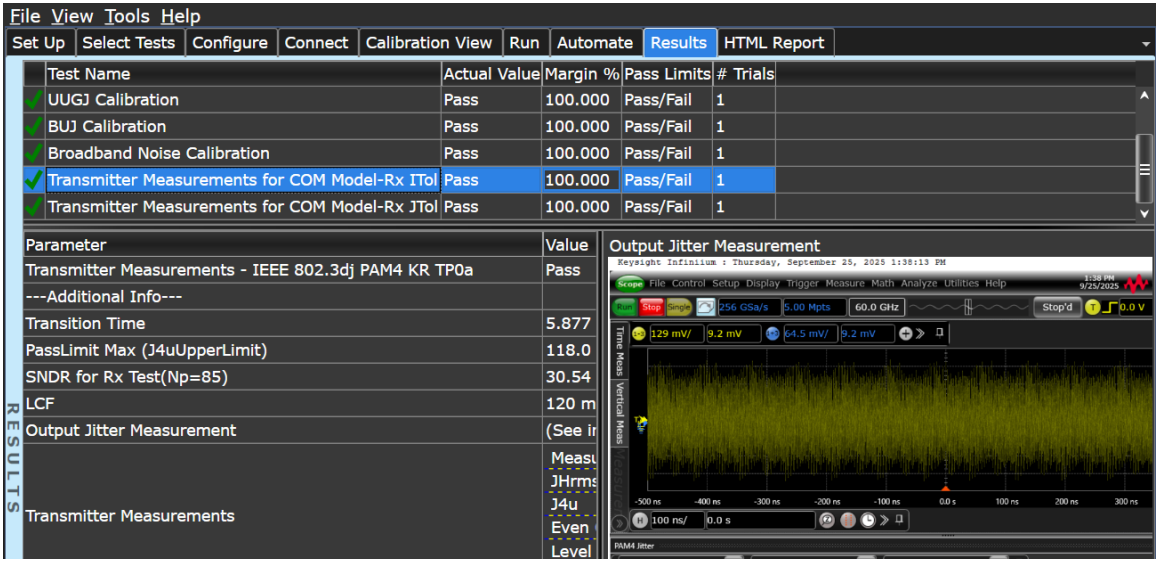


Figure 86 Overview of Tx Measurements for COM Model Rx-ITol (KR) results

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

No specific hardware connection is required.

ID

Standard Name	Test ID
KR	872102

Dependencies

This test depends on the values measured in Transmitter Measurements for COM Model — Rx ITol on page 129.

- 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 KR Configuration in the Test App on page 111.

Parameters

Refer to Calibration Parameters in Debug Mode on page 108.

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
- A_v

Results

The calibrated value is displayed in the Results tab.

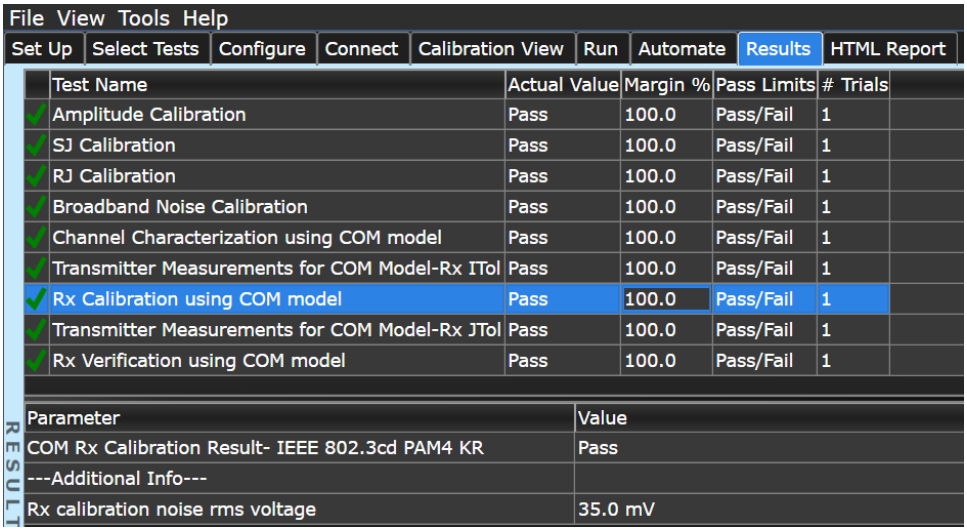


Figure 87 Rx Calibration using COM Model (KR) calibration results

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 *the specification*.

Standard Name	Spec Reference
KR	Table 178-6, Section 178.9.2, IEEE P802.3dj™/D2.0

Connection Diagram

Connect the instruments as shown in Figure 88.

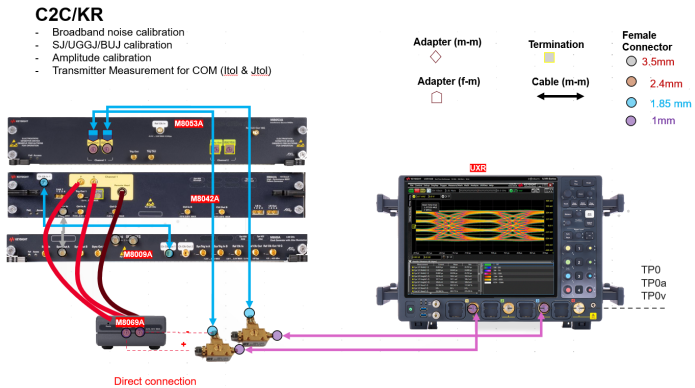


Figure 88 Connection diagram for KR Transmitter Measurements for COM Model — Rx JTol

ID

Standard Name	Test ID
KR	873100

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 KR Configuration in the Test App on page 111.

- Calibrated values from the following Calibrations:
  - Amplitude Calibration on page 116
  - SJ Calibration on page 118
  - UUGJ Calibration on page 120

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

Procedure This calibration uses the PRBS13Q 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.

Transmitter Electrical Output Specification

- Transition Time
- Level Mismatch Ratio RLM
- Signal-to-Noise-and-Distortion Ratio (Np =400)
- SNDR for Rx test (Np = 55)

Transmitter Output Jitter Specification

- Uncorrelated Jitter (J4u) (time interval from 0.005% to 99.995% of the probability distribution)
- Uncorrelated jitter RMS (Jrms) (standard deviation of the probability distribution)

The Output Jitter Measurement and Linear Fit Pulse Response (Np = 55) are presented as an image in the app.

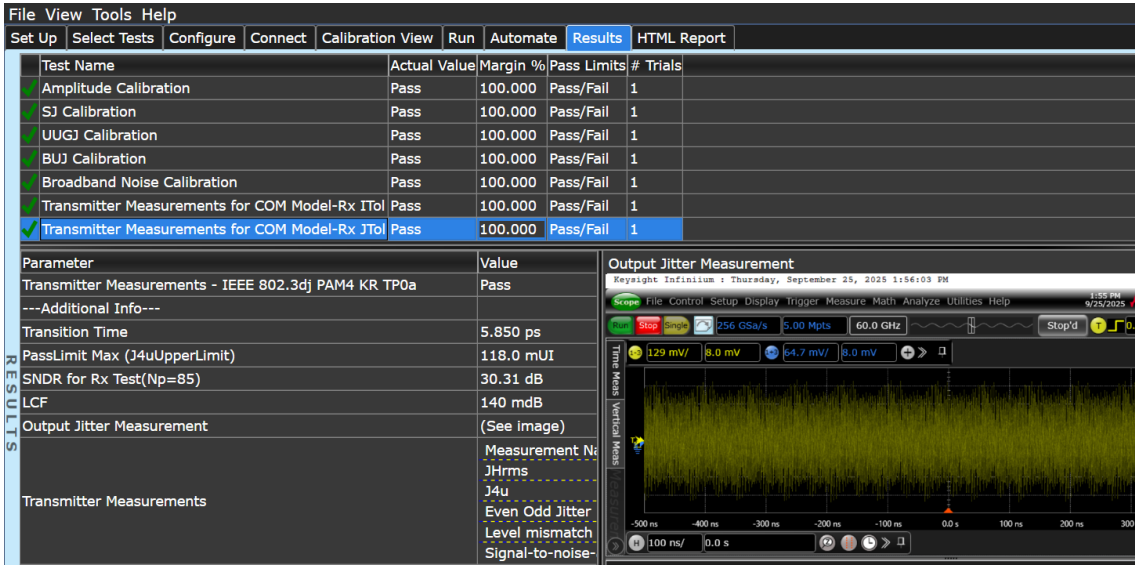


Figure 89 Transmitter Measurements for COM Model – Rx JTol (KR) Calibration results in the Results tab

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 90.

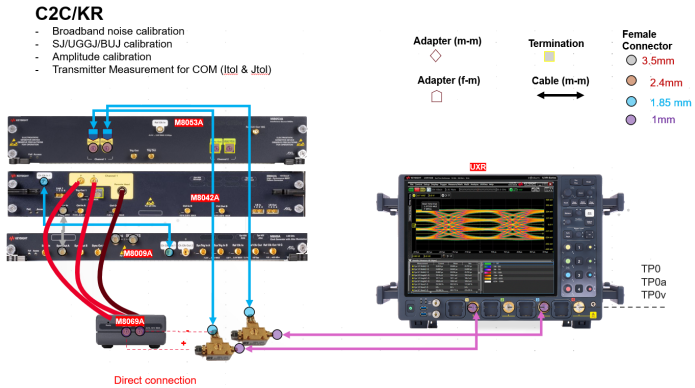


Figure 90 Connection diagram for KR Transmitter Measurements for COM Model – Rx ITol

ID

Standard Name	Test ID
KR	873101

Dependencies This procedure depends on:

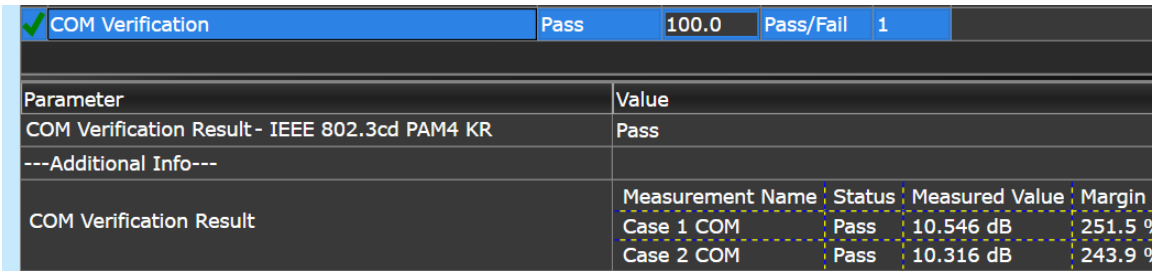
- Test Channel S-Parameter
- Noise Channel S-Parameter
- Excel Config File – containing COM parameter values after “Transmitter Measurements for COM Model” is performed

For more information on configuring Test Channel S-Parameter file, Noise Channel S-Parameter file and Excel Config File, refer to KR Configuration in the Test App on page 111.

Parameters Refer to Calibration Parameters in Debug Mode on page 108.

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 This calibrated values are displayed in a tabular format in the Results tab.



COM Verification	Pass	100.0	Pass/Fail	1

Parameter	Value			
COM Verification Result - IEEE 802.3cd PAM4 KR	Pass			
---Additional Info---				
COM Verification Result	Measurement Name	Status	Measured Value	Margin
	Case 1 COM	Pass	10.546 dB	251.5 %
	Case 2 COM	Pass	10.316 dB	243.9 %

Figure 91 COM Verification (KR) Calibration results

7 UALink KR Tests

This chapter describes the test procedures for the UALink Rx Tests that are applicable for the KR standard option.

As a prerequisite, before running KR tests:

- Run all UALink KR 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 consists of 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 and **KR (200GBASE-KR1, 400GBASE-KR2, 800GBASE-KR4, and 1.6TBASE-KR8**) standard options,, the test parameters listed in Table 10 are available for configuration.

Table 10 Test parameters in debug mode for the KR standard option

Test Parameter	Description
Parameters Common to All Tests	
Baud Rate	Baud Rate for testing device and for all calibrations.
Differential Channel Partner	Differential channel partner type to acquire signal: Every Other Channel or Adjacent Channel
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.
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 Cursors	Controls all the cursors equalization coefficient for Transmitter Measurements.
Noise Generator Channel Selection	Selects the location of the Noise Generator that shall be used for generating broadband noise.
PRBS Pattern	PRBS Pattern selection for Receiver Tests.
Sync Loss Threshold	The threshold level of error ratio at which synchronization is successful.
Alignment BER Threshold	BER threshold used as pass/fail criteria during the sample point alignment.

Test Parameter	Description
Victim Analyzer Module	Selects the victim analyzer module for testing device.
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 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.
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.
Manual Frequency List	List of Jitter frequencies separated by commas.

Test Parameter	Description
Minimum Jitter Amplitude Limit	Minimum Jitter Amplitude Limit.
Maximum Jitter Amplitude Limit	Maximum Jitter Amplitude Limit.
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 11 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* of IEEE Std 802.3bj-2014, Amendment to IEEE Std 802.3-2012: Ethernet.

Table 11 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 92). This includes the optimization of the pattern-generator de-emphasis taps prior to the actual testing.
2	Rx Jitter Tolerance Test	Perform Rx Jitter Tolerance Test for high loss channel.	Perform Rx jitter tolerance test (see setup in Figure 92).

These procedures are broadly described in the following section.

Detailed Steps for Rx Test Procedures

Step#1. Rx Interference and Jitter Tolerance Test

1 Using the test setup in Figure 92, 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.

Use the pause during the Rx test procedure to optimize the PG de-emphassis while keeping all other parameters constant. This step can be used using the M8070ADVB feature "BER-based De-Empahsis Optimization".

2 Measure the BER using the PRBS31Q pattern on the receiver under test using the built-in error counter or by activating the DUT's internal loopback mode, the DUT transmitter and error analyzer equalizer should be co-optimized to ensure an error-free loopback channel. Both the DUT's internal error checker and external error detectors—such as a real-time oscilloscope (e.g., UXR)—can be integrated into the compliance application via DCI (DUT Control Interface / 159).

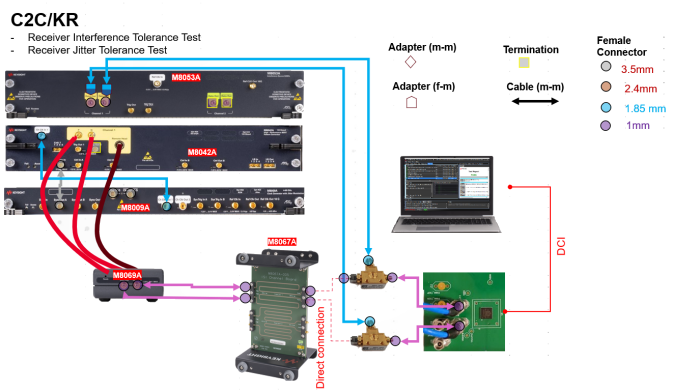


Figure 92 Connection diagram for KR Rx Interference and Jitter Tolerance Test

For each case listed in Table 12, the receiver under test shall meet the BER measurements as specified in Table 176D-11 of the P802.3dj™/D2.0 specification.

Table 12 Receiver jitter tolerance parameters

Parameter	Case A	Case B	Case C	Case D	Case E	Case F	Case G	Units
Jitter frequency	0.04	0.1333	0.4	1.333	4	12	40	MHz
Jitter amplitude (peak to peak)	5	1.5	0.5	0.15	0.05	0.05	0.05	UI

NOTE The BERs reported in the standard assume that the error statistics are sufficiently random to result in the required frame loss ratio.

Receiver Interference Tolerance Test

Overview

The Receiver Interference Tolerance Test validates that the receiver on each lane shall meet 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.

Connection Diagram

Connect the instruments as shown in Figure 93.

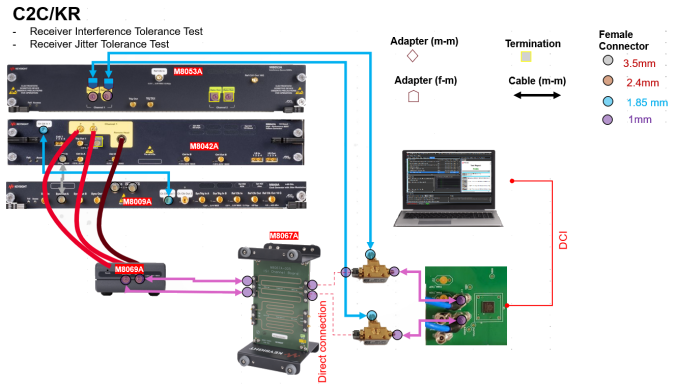


Figure 93 Connection diagram for KR Rx Interference and Jitter Tolerance Test

ID

Standard Name	Test ID
C2C	475101
KR	875101

Dependencies

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

- Amplitude Calibration on page 116
- SJ Calibration on page 118
- UUGJ Calibration on page 120
- BUJ Calibration on page 122
- Broadband Noise Calibration on page 124
- Transmitter Measurements for COM Model – Rx ITol on page 129
- Rx Calibration using COM Model on page 132

Parameters Refer to Test Parameters in Debug Mode on page 140.

Procedure This test uses the PRBS31Q pattern.

Results The Receiver Interference Tolerance Test attains 'Pass' value if the Rx BER is less than 1e-4, as per the *IEEE P802.3dj™/D2.0* specification.

✓	Receiver Interference Tolerance Test	Pass	100.000	Pass/Fail	1
✓	Receiver Jitter Tolerance Test	Pass	100.000	Pass/Fail	1

Parameter	Value	
Receiver Interference Tolerance Test - IEEE 802.3dj PAM4 C2C	Pass	
---Additional Info---		
Receiver Jitter Tolerance Test Parameters	Parameter Name	Parameter Value
	BER	0.000
	Confidence Level	95.00 %
	Injected Noise	5.0 mV
	Coefficient 0	0
	Coefficient 1	0
	Coefficient 2	0
	Coefficient 3	1
	Coefficient 4	0

Figure 94 Rx Interference Tolerance Test (C2C) results in tabular format

✓	Receiver Interference Tolerance Test	Pass	100.000	Pass/Fail	1
✓	Receiver Jitter Tolerance Test	Pass	100.000	Pass/Fail	1

Parameter	Value	
Receiver Interference Tolerance Test - IEEE 802.3dj PAM4 KR	Pass	
---Additional Info---		
Receiver Jitter Tolerance Test Parameters	Parameter Name	Parameter Value
	BER	0.000
	Confidence Level	95.00 %
	Injected Noise	5.0 mV
	Coefficient 0	0
	Coefficient 1	0
	Coefficient 2	0
	Coefficient 3	1
	Coefficient 4	0

Figure 95 Rx Interference Tolerance Test (KR) results in tabular format

Receiver Jitter Tolerance Test

Overview The Receiver Jitter Tolerance Test validates that the receiver bit error ratio (BER) meets the requirements for each pair of jitter frequency and peak-to-peak amplitude values as per the *IEEE P802.3dj™/D2.0* specification. This test is only required for the high loss channel test case.

Connection Diagram Connect the instruments as shown in Figure 96.

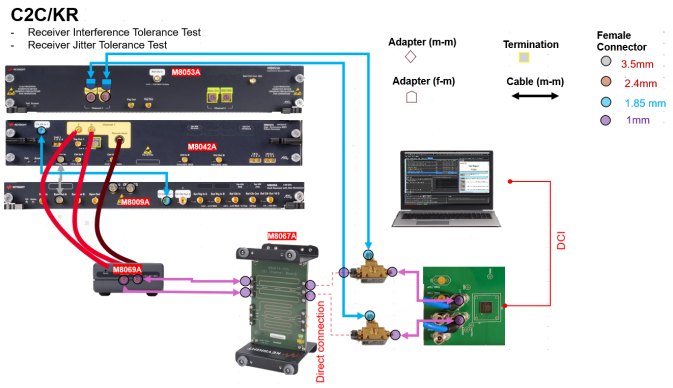


Figure 96 Connection diagram for KR Rx Interference and Jitter Tolerance Test

ID

Standard Name	Test ID
C2C	475100
KR	875100

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

- Amplitude Calibration on page 116
- SJ Calibration on page 118
- UUGJ Calibration on page 120
- BUJ Calibration on page 122
- Transmitter Measurements for COM Model — Rx JTol on page 134

Parameters Refer to Test Parameters in Debug Mode on page 140.

Procedure This test uses the PRBS31Q pattern.

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

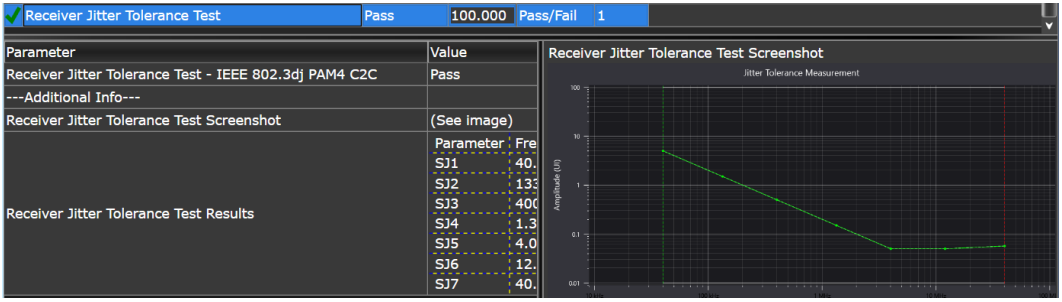


Figure 97 Rx Jitter Tolerance Test (C2C) results in tabular format

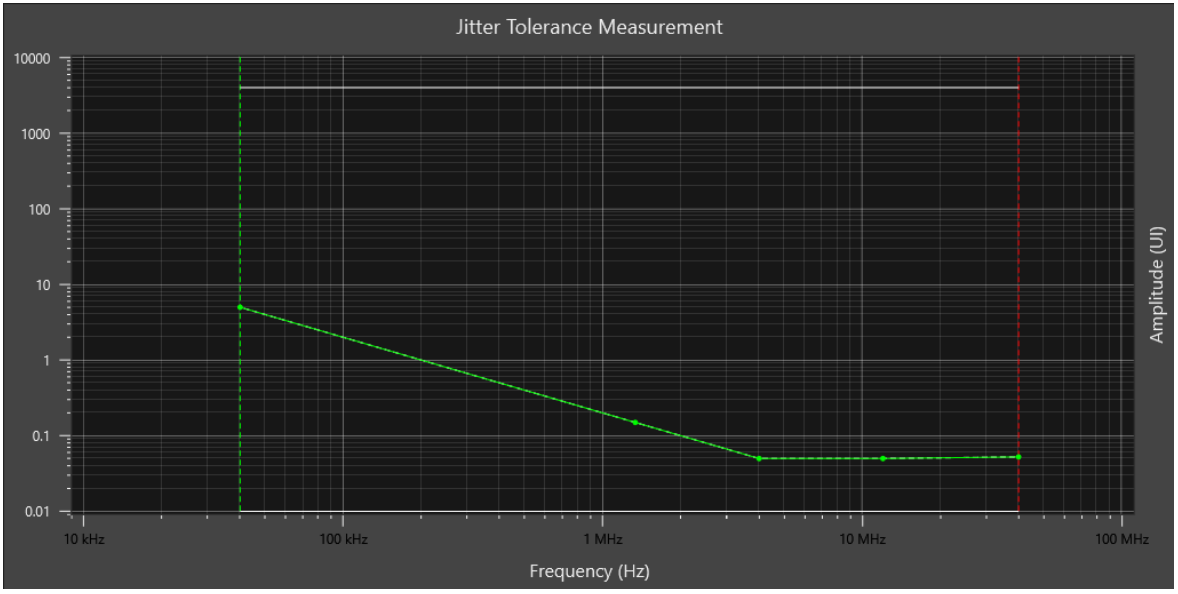


Figure 98 Rx Jitter Tolerance Test (C2C) results in graphical format

Receiver Jitter Tolerance Test	Pass	100.000	Pass/Fail	1

Parameter	Value
Receiver Jitter Tolerance Test - IEEE 802.3dj PAM4 KR	Pass
---Additional Info---	
Receiver Jitter Tolerance Test Screenshot	(See image)
Receiver Jitter Tolerance Test Results	Parameter : Frequency
	SJ1 : 40.000 kHz
	SJ2 : 133.300 kHz
	SJ3 : 400.000 kHz
	SJ4 : 1.333000 MHz
	SJ5 : 4.000000 MHz
	SJ6 : 12.000000 MHz

Receiver Jitter Tolerance Test Screenshot

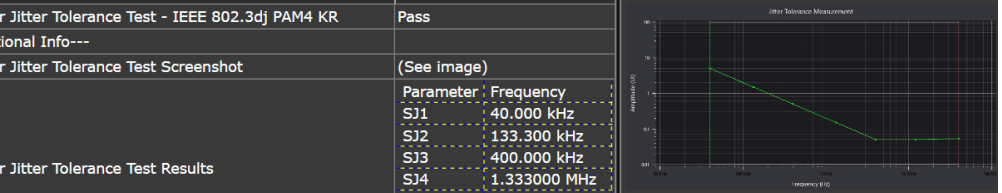


Figure 99 Rx Jitter Tolerance Test (KR) results in tabular format

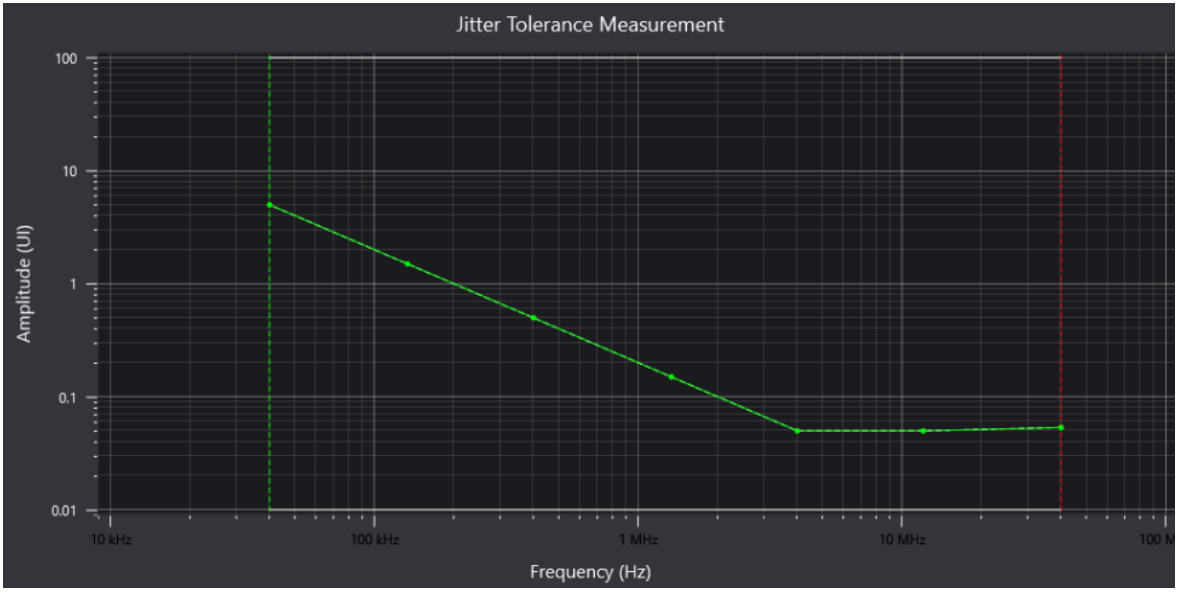


Figure 100 Rx Jitter Tolerance Test (KR) results in graphical format

Keysight M8091UACA Receiver Conformance Test Application for UALink

User Guide

8 Calibration & Test Results

This chapter describes how calibration results can be displayed in the Calibration View tab.

KEYSIGHT TECHNOLOGIES

About Calibration View

The **Calibration View** tab displays the results from the calibrations run, in both graphical and tabular format.

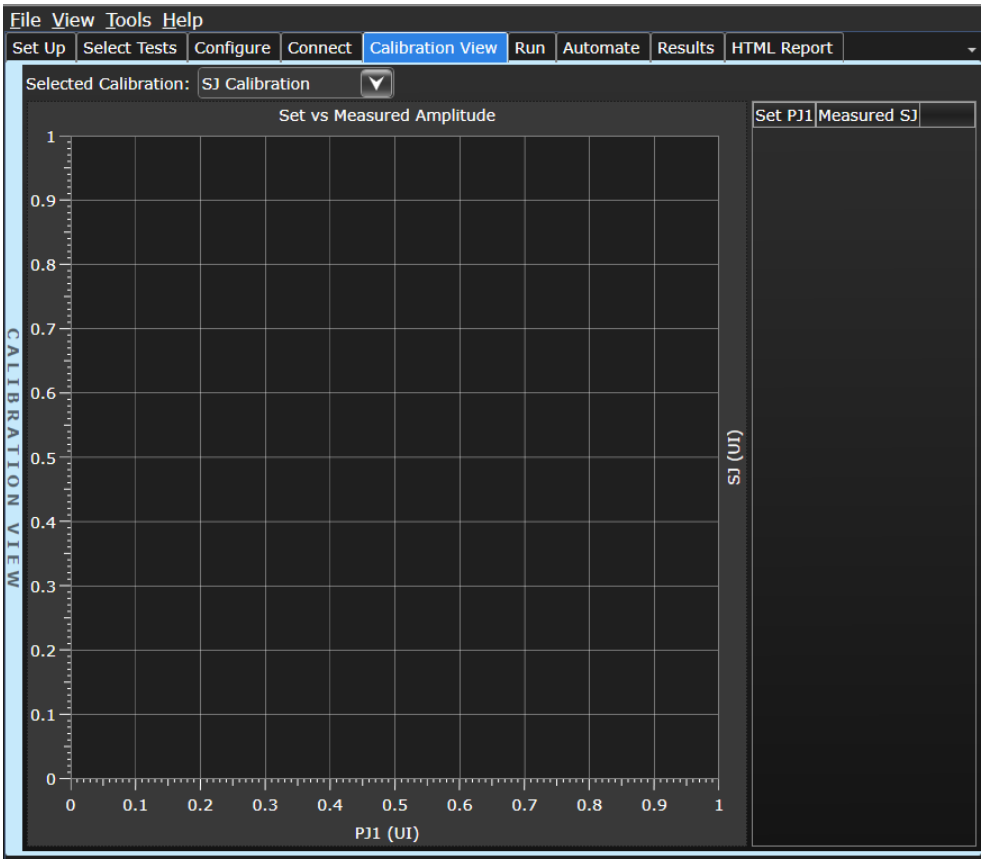


Figure 101 Default display of the Calibration View

After successful completion of the calibration run, the calibration results are reported in the **Calibration View** tab and **Results** tab.

The calibration results under the **Calibration View** tab include the following measurements:

- Set and measured values of the parameters being calibrated, in a tabular format.

- Set and measured values of the parameters being calibrated, in a graphical 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.

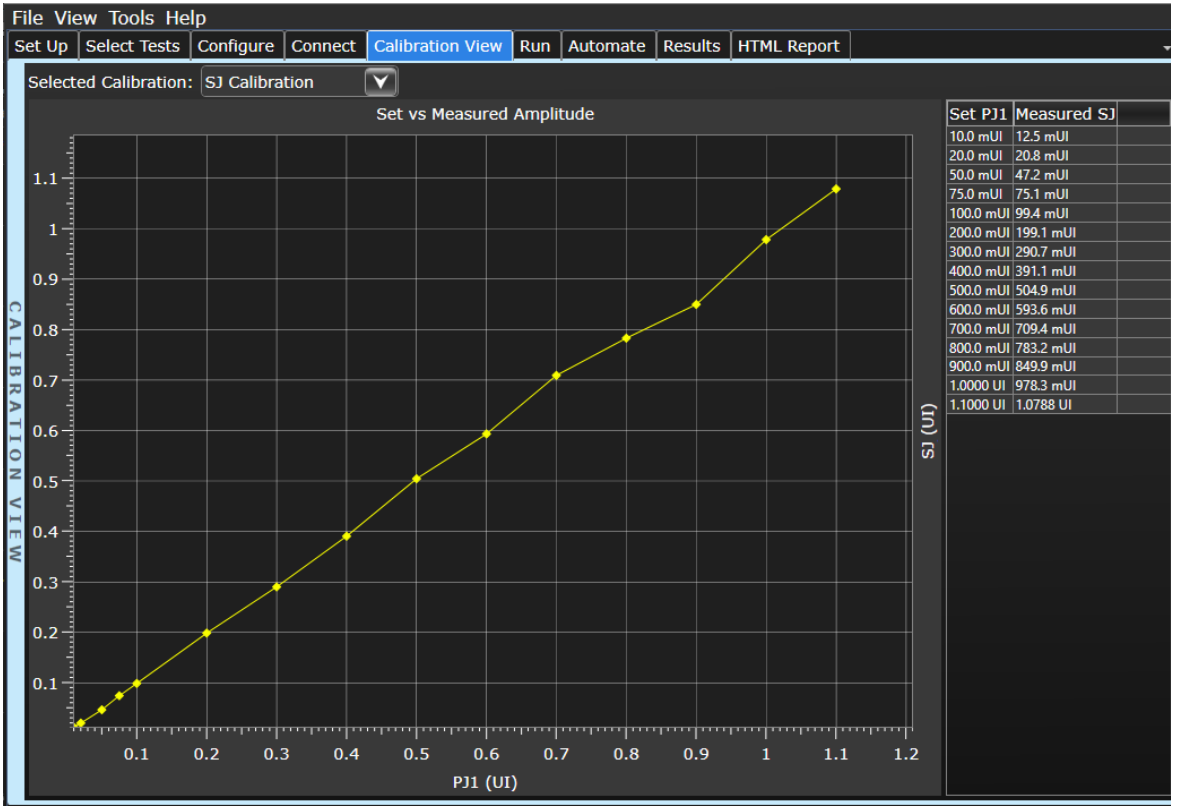


Figure 102 Display of the Calibration View after calibrations have been performed

9 Appendix

List of Acronyms

Acronym	Definition
AUI	Attachment Unit Interface
AWG	Arbitrary Waveform Generator
BER	Bit Error Ratio
BERT	Bit Error Ratio Tester
BUJ	Bounded Uncorrelated Jitter
BW	Bandwidth
C2C	Chip-to-Chip
C2M	Chip-to-Module
CDR	Clock Data Recovery
COM	Channel Operating Margin
CSV	Comma-Separated Values
CTLE	Continuous Time Linear Equalization
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
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	Input–Output
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
MCB	Module Compliance Board
N/A	Not Applicable
NEXT	Near-End Aggressor Crosstalk
Np	Linear Fit Pulse Length
NRZ	Non-Return-to-Zero
OSFP	Octal Small Form Factor Pluggable
PAM	Pulse-Amplitude Modulation
PC	Personal Computer
PCB	Printed Circuit Board
PDF	Portable Document Format
Pk–Pk	Peak to Peak
PLTS	Physical Layer Test System
PMD	Physical Medium Dependent (interface)

Acronym	Definition
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
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
UUGJ	Uncorrelated Unbounded Gaussian Jitter
VEC5	Vertical Eye Closure at 1E–5
VISA	Virtual Instrument System Architecture
WXGA+	Wide Extended Graphics Array (II)

DUT Control Interface

The **DUT Control Interface** feature allows you to control a device under test at well defined positions within the measurements of the M8070B software. It allows you to:

- Read out error count information from devices with built-in error counters.
- Read out and write devices status registers
- Import and edit of Python scripts to access DUT from M8070B system software
- Integrate devices built-in error count information in error monitoring and jitter tolerance test routines of M8070B.

NOTE

- To know more about DUT Control Interface, please refer to the **M8000 Series Bit Error Ratio Testers** product page **> Technical Support** section **> M8070ADVB Advanced Measurement Package User Guide**

The **DUT Control Interface** editor provides inserting code snippets of the supported DUT. This allows you to tailor the supported measurements in a way that the DUT is controlled at critical points during the measurement and also provide error information for the measurement. Currently, the **DUT Control Interface** supports using a DUT's built-in error counters in the following measurements:

- Error Ratio Measurement
- Jitter Tolerance Measurement

All other measurements provide callback functions as well. These are useful to tailor the measurement to the DUT (e.g. settling times in dependency of measurement parameters), or to control the device under test during the measurement.

The **DUT Control Interface** feature is enabled by the license M8070ADVB-1xx.

Using DCI within the M8091UACA Application for Manual BER Entry

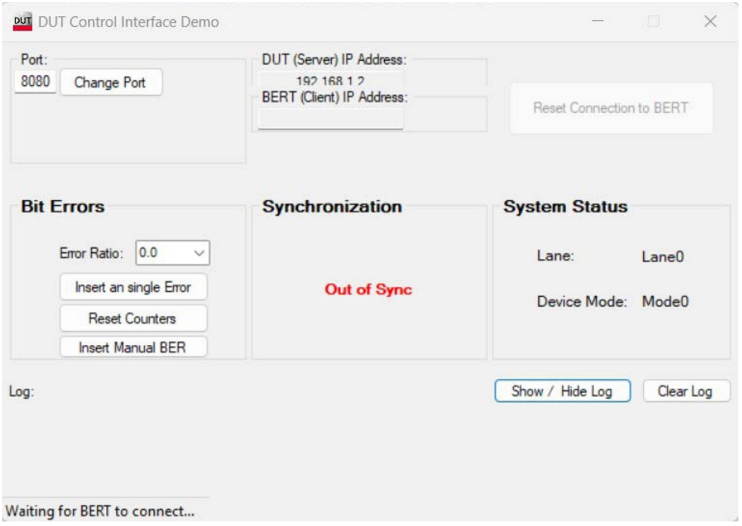
To avoid customizing the DCI script to the actual DUT API and accelerate initial testing, it is possible to manually enter the Bit Error Rate (BER) reported by the DUT's internal error checkers. To this extent, a DCI example installed with M8070B can be used consisting of an executable "Custom Virtual DUT.exe" and a python script "VirtualDUT.py"

Follow the steps below to integrate this functionality into the M8091UACA application:

1 Launch Custom Virtual DUT.exe from *C:\Program Files\ Keysight\ M8070B\Examples\DUT_Control_Interface\ CustomVirtualDut*

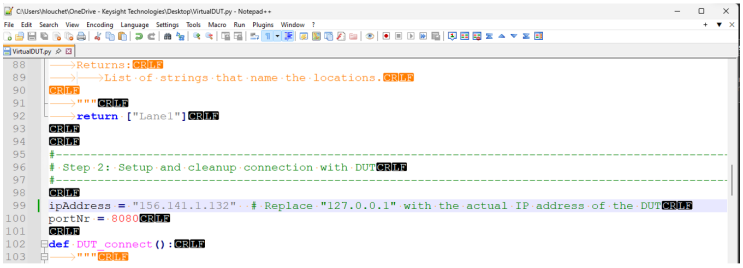
NOTE **In principle, the Custom Virtual DUT.exe can be started either on the PC running the M8091UACA application, or on the one running M8070B, or even on any other PC connected to the same network. However, Keysight recommends running on the M8070B PC to avoid limitations due to Firewalls.**

2 This opens the following tool:

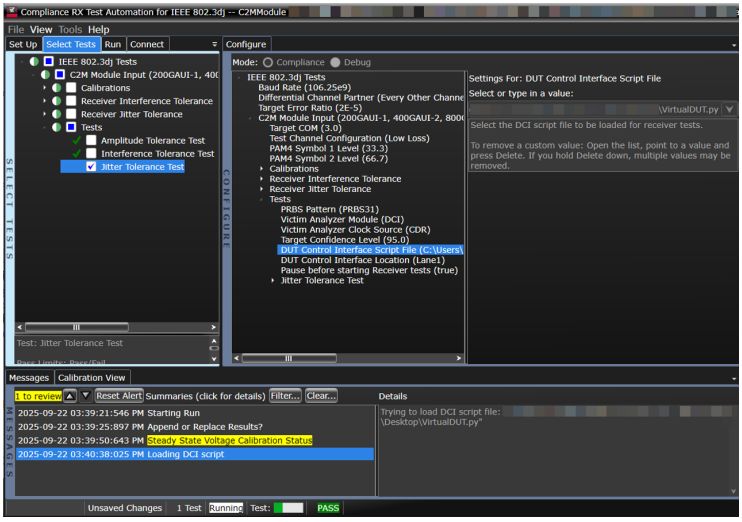


3 Copy the VirtualDUT.py file located in *C:\Program Files\Keysight\M8070B\Examples\DUT_Control_Interface\CustomVirtualDut*Script on the PC running the application. For instance, under *C:\TEMP*

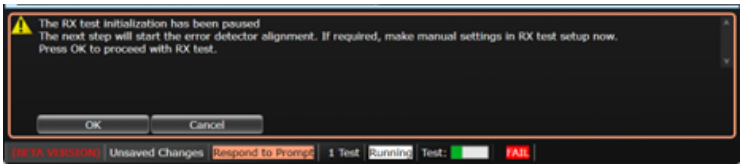
4 Edit the script with a text editor and update variables ipAddress and portNr to match those displayed in the Customer Virtual DUT executable and save the VirtualDUT.py file.



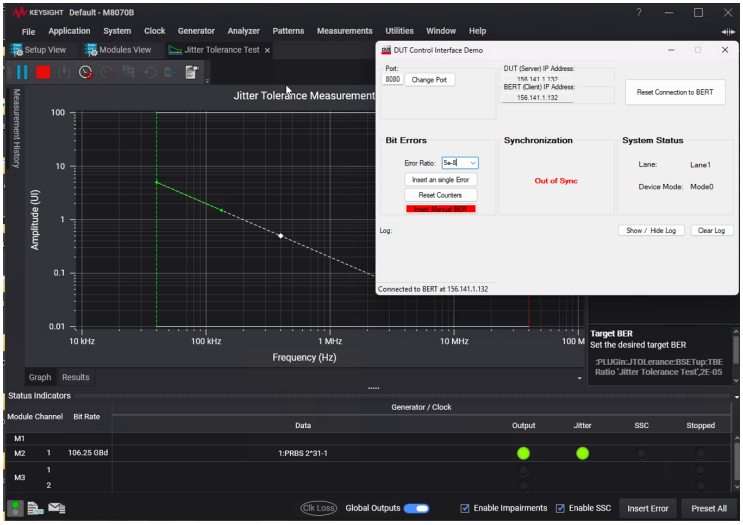
5 In the M8091UACA Application, navigate to the **Configure** Tab, expand the test menu, specify the python script path and filename in the parameter "DUT Control Interface Script File". Note that the script should be located on PC running the application.



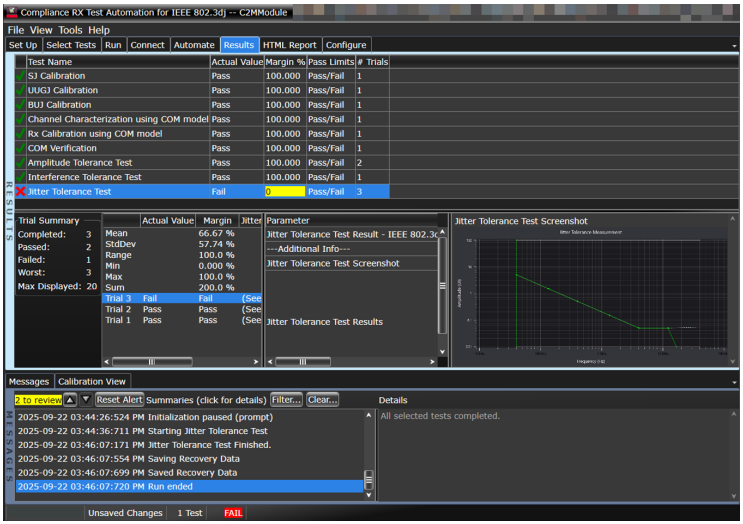
6 After it has configured the BERT for DUT testing, the application will return a prompt asking to proceed with the test. This pause is used to optimize the loopback link when using an external error detector and not required when using DCI.



7 For each measurement, the M8070B firmware will query the BER from the Custom Virtual DUT. The field "Insert Manual BER" will then turn RED. The test will not proceed until a value is entered. The default timeout is 1 minute, but can be modified inside the script. The Error ratio value can be selected from the drop-down menu or entered manually. For manual entry, ensure you use the right format "xe-y".



8 Once the test is completed, the results and screenshots are reported in the M8091UACA application.



9 Appendix

M8070-91312
Edition 1.0, February 2026
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