D9010EAPC 10GBASE-KR and 40GBASE-KR4 Compliance Test Application

KEYSIGHT

Methods of Implementation

Notices

© Keysight Technologies 2022

No part of this manual may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Keysight Technologies as governed by United States and international copyright laws.

Software Version

Version 3.20.0.0

Edition

November 2022

Keysight Technologies.
1900 Garden of the Gods Road
Colorado Springs, CO 80907 USA

Warranty

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

Technology Licenses

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

Restricted Rights Legend

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as "Commercial computer software" as defined in DFAR 252.227-7014 (June 1995), or as a "commercial item" as defined in FAR 2.101(a) or as "Restricted computer software" as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Keysight Technologies' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

Safety Notices

CAUTION

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

WARNING

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

10GBASE-KR Compliance Test Application—At a Glance

The Keysight D9010EAPC 10GBASE-KR Compliance Test Application is an Ethernet test solution that covers the electrical timing parameters for 10GBASE-KR and 40GBASE-KR4 specification (IEEE 802.3ap).

The 10GBASE-KR Compliance Test Application:

- Lets you select individual or multiple test to run.
- Lets you identify the device being tested and its configuration.
- Shows you how to make oscilloscope connections to the device under test.
- Automatically checks for proper oscilloscope configuration.
- Automatically sets up the oscilloscope for each test.
- Allows you to determine the number of trials for each test.
- Provides detailed information of each test that has been run. The result of maximum 25 worst trials can be displayed at any one time.
- Creates a printable HTML report of the tests that have been run. This report includes pass/fail limits, margin analysis, and screen shots.

Required Equipment and Software

In order to run the 10GBASE-KR automated tests, you need the following equipment and software:

- For the minimum version of Infiniium oscilloscope software, see the D9010EAPC release notes.
- D9010EAPC 10GBASE-KR Compliance Test Application software and license.
- For differential probing (minimum 25 GHz):
  - N2802A 25 GHz InfiniiMax III Series probe amplifier.
  - N2803A 30 GHz InfiniiMax III Series probe amplifier.
  - N2836A InfiniiMax III 26 GHz solder-in probe head.
- For single-ended probing:
  - SMA cables that are able to support the 10 Gb speed.
- Infiniium oscilloscope:
  - DSA-X 90000 Q-Series oscilloscope
  - DSA-X 90000A Series oscilloscope
  - DSO-X 90000 Q-Series oscilloscope
  - DSO-X 90000A Series oscilloscope
  - UXR Series oscilloscope

Contents

10GBASE-KR Compliance Test Application–At a Glance / 4

1 Installing the 10GBASE-KR Compliance Test Application

Installing the Software / 10

Installing the License Key / 11

Using Keysight License Manager 5 / 11

Using Keysight License Manager 6 / 12

2 Preparing to Take Measurements

Calibrating the Oscilloscope / 16

Starting the 10GBASE-KR Compliance Test Application / 17

3 Setting Up to Test 40GBASE-KR4 with Switch Matrix

Overview / 20

Enabling Switch Matrix / 21

Establishing Connection to the Switch Drivers / 22

Establishing connection to the Switch Drivers – Automatically / 22

Establishing connection to the Switch Drivers – Manually / 26

Configuring Signal Paths / 30

Configuring Signal Paths with Automatic Selection / 30

Configuring Signal Paths with Manual Selection / 30

Response Correction / 32

4 Main Voltage Measurements

Differential Peak-to-Peak Output Voltage Test with TX Disabled / 39

Common Mode Voltage Test / 40

Differential Peak-to-Peak Output Voltage Test / 41

5 Jitter and Data Rate Measurements

Data Rate / 46

Jitter (Random Jitter, Deterministic Jitter, Duty Cycle Distortion, and Total Jitter) / 47

6 Transmitter Output Waveform Measurements

Transition Time - Rising Edge / 52

Transition Time - Falling Edge / 53

7 Transmitter Output Waveform - Coefficient Update Measurements

Coefficient Update c_1 inc c_0 hold c_1 hold / 59

Coefficient Update c_1 dec c_0 hold c_1 hold / 60

Coefficient Update c_1 hold c_0 inc c_1 hold / 61

Coefficient Update c_1 hold c_0 dec c_1 hold / 62

Coefficient Update c_1 hold c_0 hold c_1 inc / 63

Coefficient Update c_1 hold c_0 hold c_1 dec / 64

8 Transmitter Output Waveform - Coefficient Status Measurements

Coefficient Status c_1 dis c_0 min c_1 dis / 69

Coefficient Status c_1 dis c_0 max c_1 dis / 70

Coefficient Status c_1 min c_0 min c_1 dis / 71

Coefficient Status c_1 dis c_0 min c_1 min / 72

9 Transmitter Output Waveform “Information Only” Measurements

Transmitter Output Waveform “Information Only” Measurements / 76

10 DME/EEE Waveform Measurements

DME Differential Peak-to-Peak Output Voltage Test / 81

DME T1-Transition Position Spacing (Period) Test / 82

DME T2-Clock Transition to Clock Transition Test / 83

DME T3-Clock Transition to Data Transition Test / 84

EEE Differential Peak-to-Peak Output Voltage Test with TX Disabled / 85

EEE Differential Peak-to-Peak Output Voltage Test / 86

EEE Common Mode Deviation Voltage Test / 87

11 Debug Mode

12 Exporting Measurement Results to Repository

Exporting Measurement Results to Repository / 92

KS6800A Series Analytics Service Software / 100

A Calibrating the Infiniium Oscilloscope and Probe

Oscilloscope Internal Calibration / 104

Required Equipment for Oscilloscope Calibration / 104

Running the Oscilloscope Internal Calibration / 105

Probe Calibration / 109

Required Equipment for Probe Calibration / 109

Connecting the Probe for Calibration / 109

Verifying the Connection / 111

Running the Probe Calibration and Deskew / 113

Verifying the Probe Calibration / 115

Index

1 Installing the 10GBASE-KR Compliance Test Application

Installing the Software / 10
Installing the License Key / 11

If you purchased the D9010EAPC 10GBASE-KR Compliance Test Application separate from your Infiniium oscilloscope, you need to install the software and license key.

Installing the Software

1. Make sure you have the minimum version of Infiniium oscilloscope software (see the D9010EAPC release notes) by choosing **Help > About Infiniium...** from the main menu.
2. To obtain the 10GBASE-KR Compliance Test Application, go to Keysight website: http://www.keysight.com/find/D9010EAPC
3. The link for 10GBASE-KR Compliance Test Application will appear. Double-click on it and follow the instructions to download and install the application software.

Installing the License Key

For the list of licenses required to run this application, refer to the Data Sheet.

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

Using Keysight License Manager 5

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

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

2 Copy the Host ID that appears on the top pane of the application. Note that x indicates numeric values.

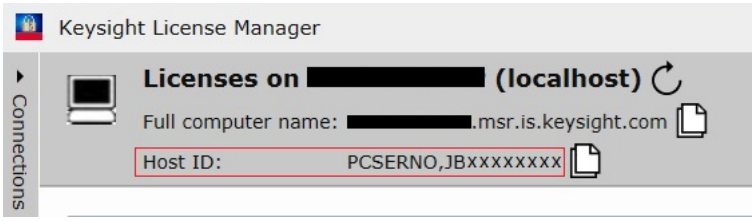


Figure 1 Viewing the Host ID information in Keysight License Manager 5

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

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

2 Launch Keysight License Manager.

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

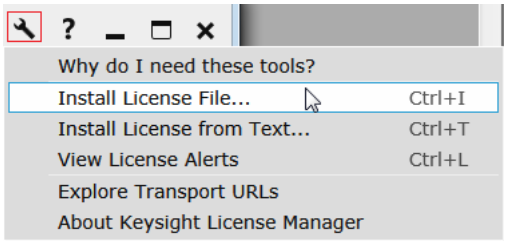


Figure 2 Configuration menu options to install licenses on Keysight License Manager 5

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

Using Keysight License Manager 6

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

1. Launch Keysight License Manager 6 on your machine, where you wish to run the Test Application and its features.
2. Copy the Host ID, which is the first set of alphanumeric value (as highlighted in Figure 3) that appears in the Environment tab of the application. Note that x indicates numeric values.

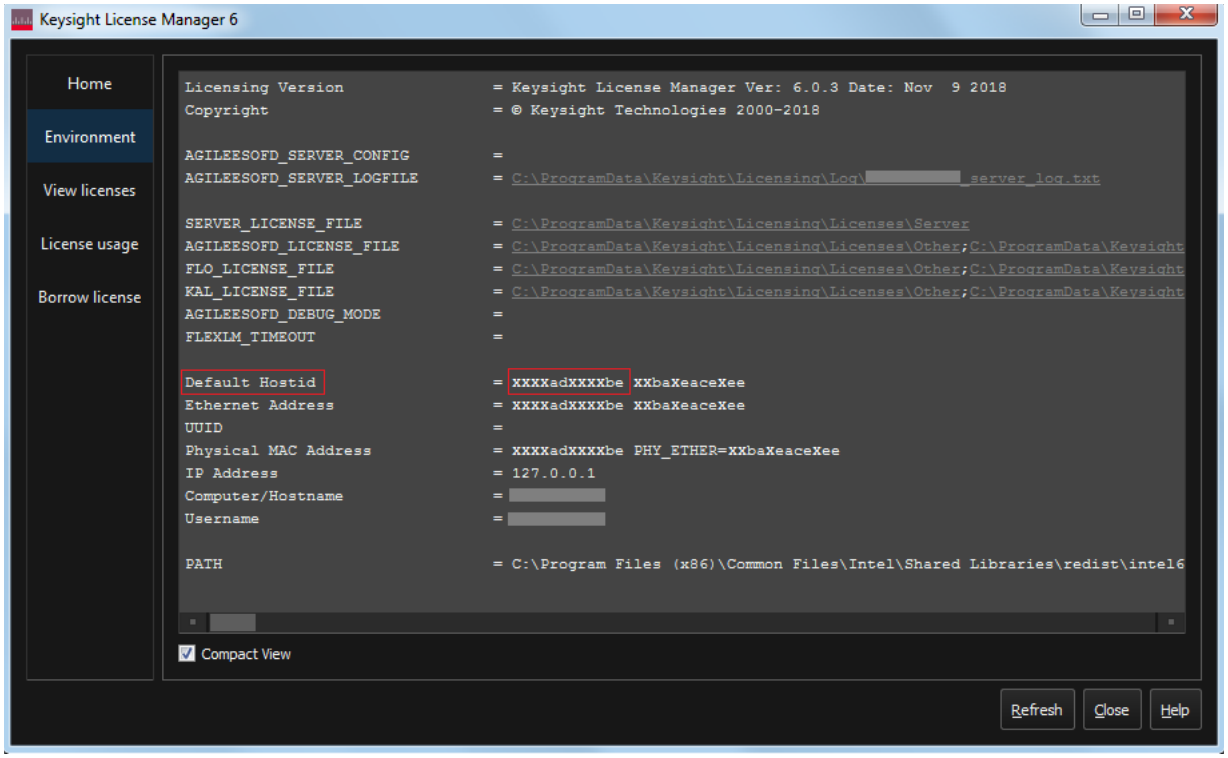


Figure 3 Viewing the Host ID information in Keysight License Manager 6

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

1. Save the license files on the machine, where you wish to run the Test Application and its features.
2. Launch Keysight License Manager 6.
3. From the Home tab, use one of the options to install each license file.

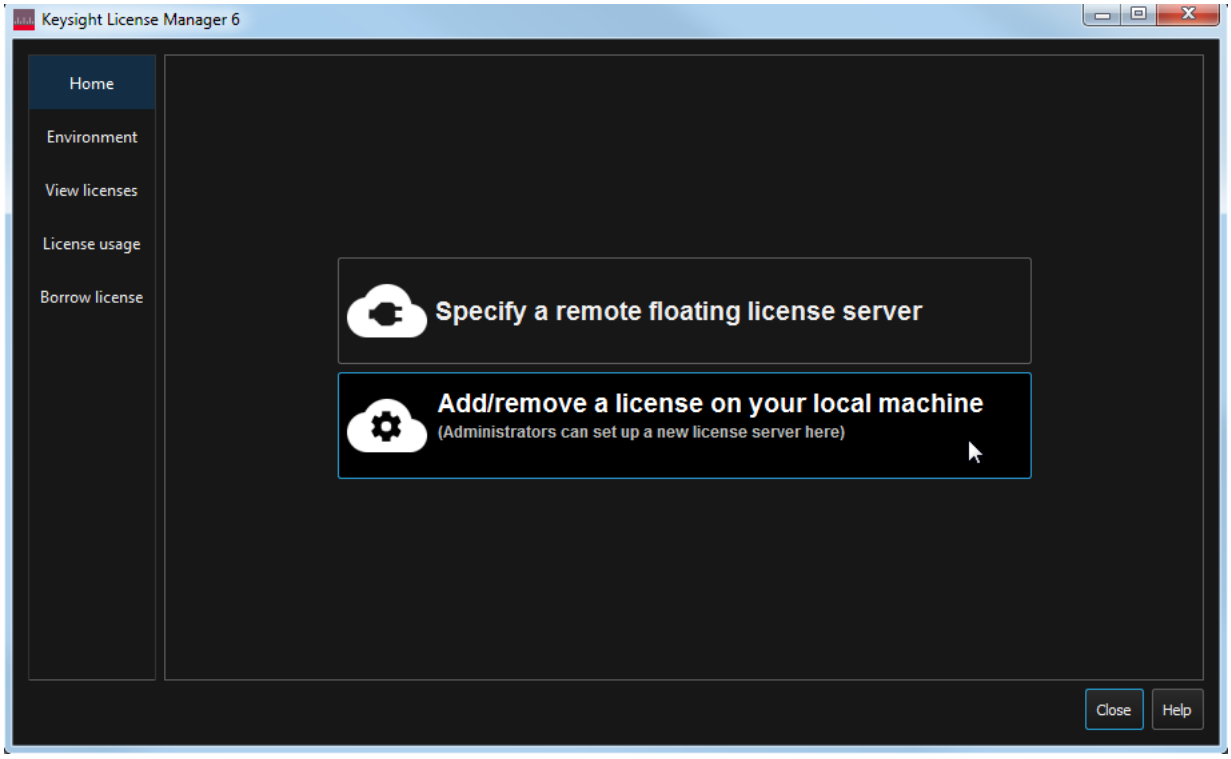


Figure 4 Home menu options to install licenses on Keysight License Manager 6

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

2 Preparing to Take Measurements

Calibrating the Oscilloscope / 16
Starting the 10GBASE-KR Compliance Test Application / 17

Before running the 10GBASE-KR and 40GBASE-KR4 automated tests, you should calibrate the oscilloscope and probe. No test fixture is required for this application. After the oscilloscope and probe have been calibrated, you are ready to start the 10GBASE-KR Compliance Test Application and perform the measurements.

Calibrating the Oscilloscope

If you haven't already calibrated the oscilloscope, see Appendix A, “Calibrating the Infiniium Oscilloscope and Probe,” starting on page 103.

NOTE If the ambient temperature changes more than 5 degrees Celsius from the calibration temperature, internal calibration should be performed again. The delta between the calibration temperature and the present operating temperature is shown in the **Utilities > Calibration** menu.

NOTE If you switch cables between channels or other oscilloscopes, it is necessary to perform cable and probe calibration again. Keysight recommends that, once calibration is performed, you label the cables with the channel on which they were calibrated.

Starting the 10GBASE-KR Compliance Test Application

1 Ensure that the Device Under Test (DUT) is operating and set to desired test modes.

2 To start the 10GBASE-KR Compliance Test Application: From the Infiniium oscilloscope's main menu, choose **Analyze > Automated Test Apps > D9010EAPC 10GKR 40GKR Test App**.

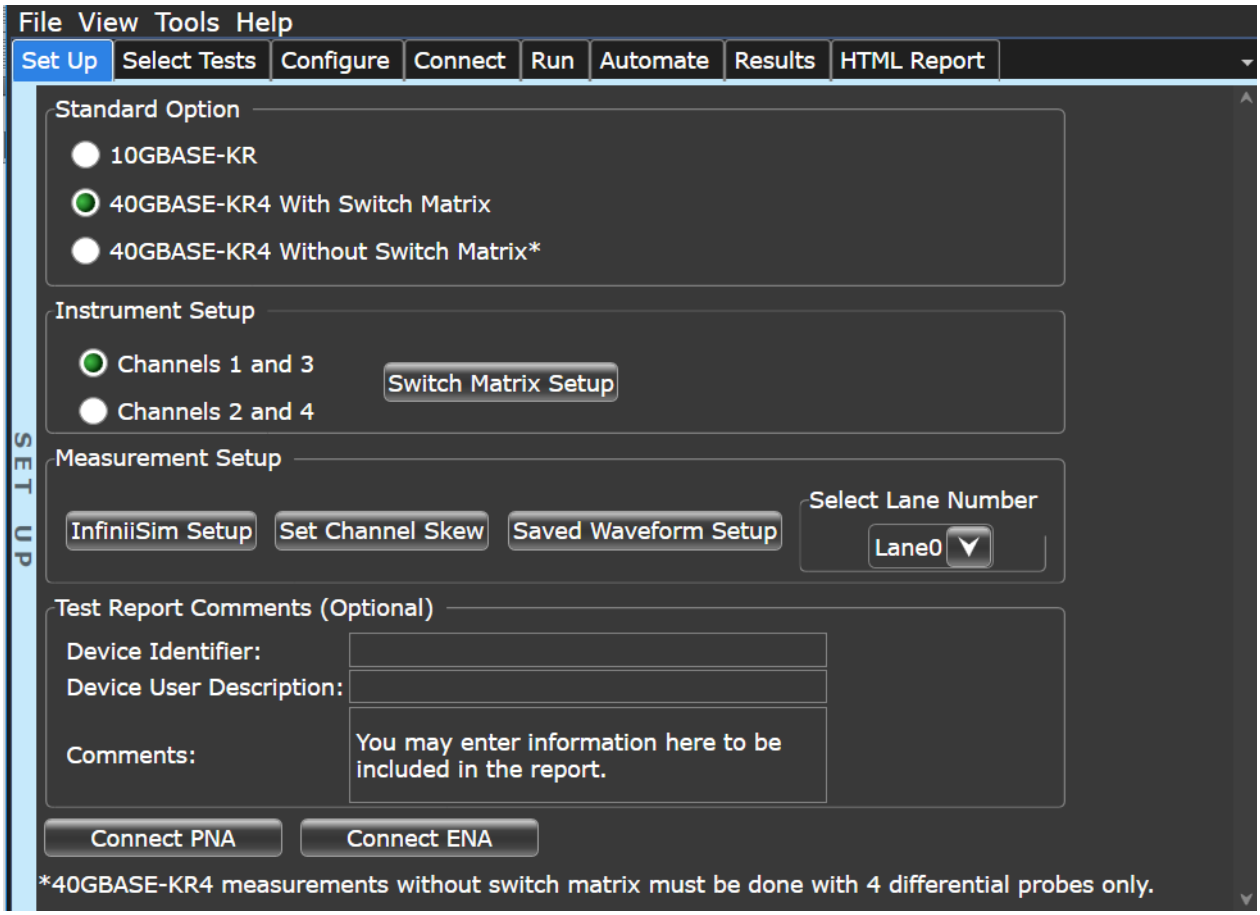


Figure 5 10GBASE-KR Compliance Test Application Main Window

The tabs in the main pane show the steps you take in running the automated tests:

Set Up	Lets you identify and set up the test environment, including information about the device under test. The **Instrument Setup** section enables you to configure switch matrix. Set up InfiniiSim with the **InfiniiSim Setup** button. With the **Set Channel skew** button, the channels can be visually adjusted and skewed. The **Saved Waveform Setup** button enables easy setup of saved waveforms. When waveforms are set up, the application will make all measurements on the saved waveforms. The **Device Identifier**, **User Description**, and **Comments** are all printed in the final HTML report.
Select Tests	Lets you select the tests you want to run. The tests are organized hierarchically so you can select all tests in a group. After tests are run, status indicators show which tests have passed, failed, or not been run, and there are indicators for the test groups.
Configure	Lets you configure test parameters (for example, channels used in test, Number of UI to test, scope bandwidth, etc.).
Connect	Shows you how to connect the oscilloscope to the device under test for the tests that are to be run.
Run Tests	Starts the automated tests. If the connections to the device under test need to be changed while multiple tests are running, the tests pause, show you how to change the connection, and wait for you to confirm that the connections have been changed before continuing.
Automation	Lets you construct scripts of commands that drive execution of the application.
Results	Contains more detailed information about the tests that have been run. You can change the thresholds at which marginal or critical warnings appear.
HTML Report	Shows a compliance test report that can be printed.

3 Setting Up to Test 40GBASE-KR4 with Switch Matrix

Overview / 20
Enabling Switch Matrix / 21
Establishing Connection to the Switch Drivers / 22
Configuring Signal Paths / 30
Response Correction / 32

40GBASE-KR4 tests can run with the switch matrix using four dual single-ended connections or without the switch matrix using four differential probe connections. Without switch matrix requires the Infiniimax III probe: N2802A or N2803A.

Both options are fully automated to switch across the four lanes. Switch Matrix requires either the Keysight U3020A S26 or the BitifEye BIT2100.

If differential Infiniimax III probes are used, 40GBASE-KR4 tests can be run without the switch matrix. The four lanes can be connected to channels 1 through 4.

This chapter describes the switch matrix feature and steps for configuring the switch matrix in the Keysight D9010EAPC 10GBASE-KR and 40GBASE-KR4 Compliance Test Application.

Overview

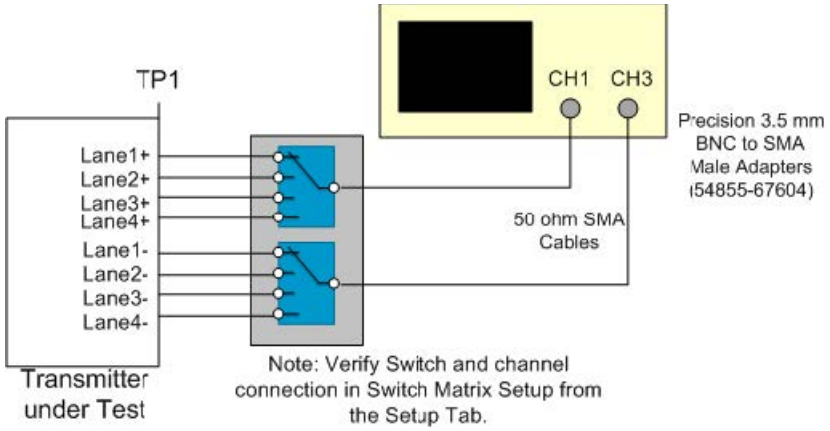
An Oscilloscope has only four Channels to run tests. The limited number of channels may, at times, limit the testing of some multi-lane standards. Also, it may prove to be a hindrance to run test procedures for multi-port devices or simultaneous testing of multiple devices. The Switch Matrix feature on the Infiniium Oscilloscope overcomes such limitations.

The purpose of the 'Switch Matrix' feature is to ease the testing procedure, make it more feasible and to reduce the overall time. Using this feature, you can connect multiple lanes of the source devices to the correct switches and to obtain an accurate signal path whenever required.

Keysight recommends the following switches to be used with the Test Application:

- Keysight U3020A S26
- BitifEye BIT-2100

The following figure shows the connection setup for 40GBASE-KR4 tests with the switch matrix.

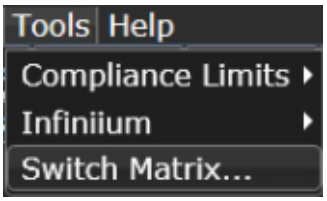


Enabling Switch Matrix

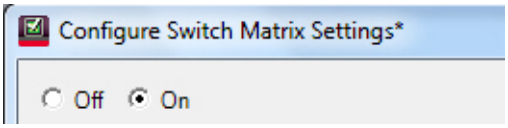
Before you begin the testing of multiple lane pairs of the source devices simultaneously, you must enable the Switch Matrix feature.

To enable the switch matrix feature:

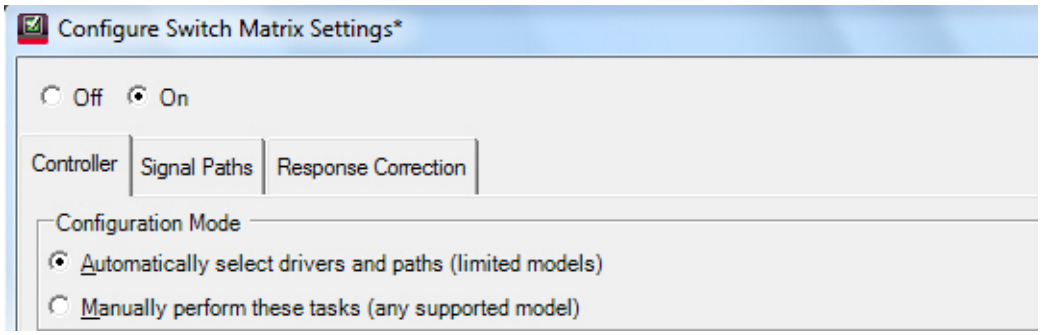
1 Click **Tools>Switch Matrix....**



2 In the **Configure Switch Matrix Settings** dialog box, click **On** to enable the Switch Matrix feature.



Enabling the Switch Matrix feature also enables the automated switch control. The option **Automatically select drivers and paths (limited models)** in the **Configuration Mode** section of the **Controller** tab is selected by default.

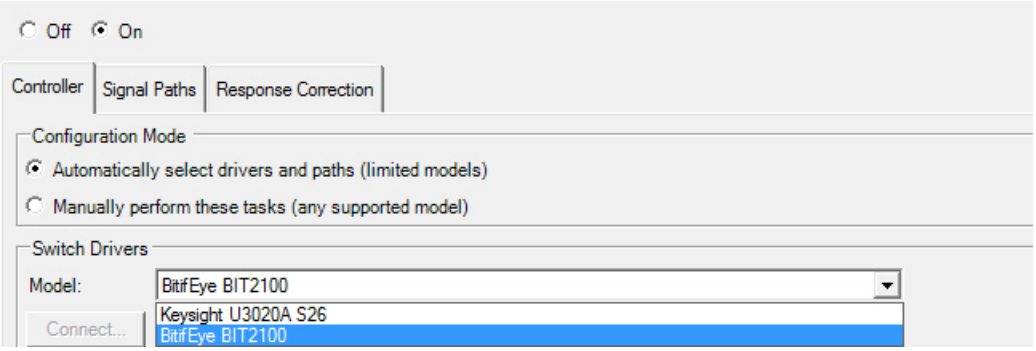


Establishing Connection to the Switch Drivers

Establishing connection to the Switch Drivers – Automatically

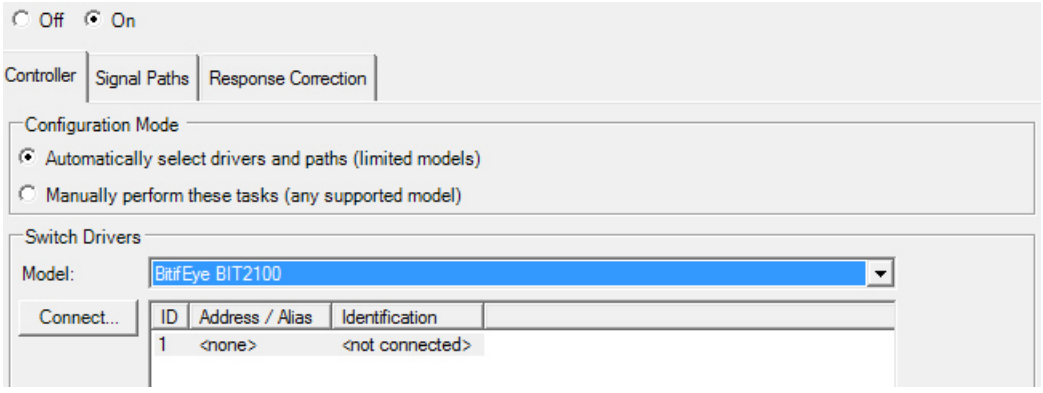
In the **Configure Switch Matrix Settings** dialog, under the **Controller** tab:

1 From the **Switch Drivers** section, select the switch model from the **Model**: drop-down options.



NOTE The switch settings and the response correction for all paths are reset if you toggle between switch models.

2 Click the **Connect** button to be able to connect the selected switch driver to a physical switch instrument.

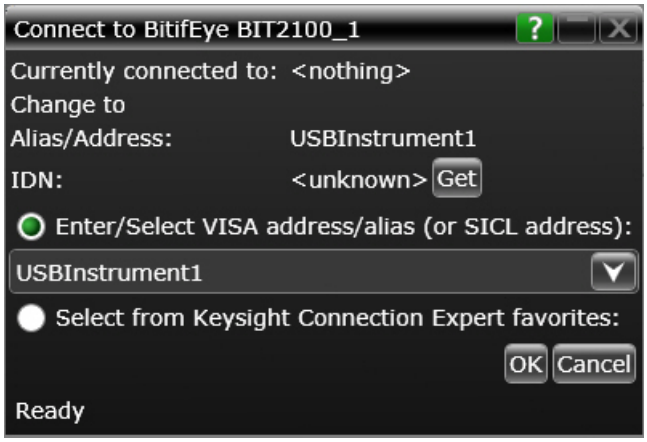


3 A **Connect to** <*switch-model*> dialog appears, which gives you two options to establish a connection to the selected switch models.

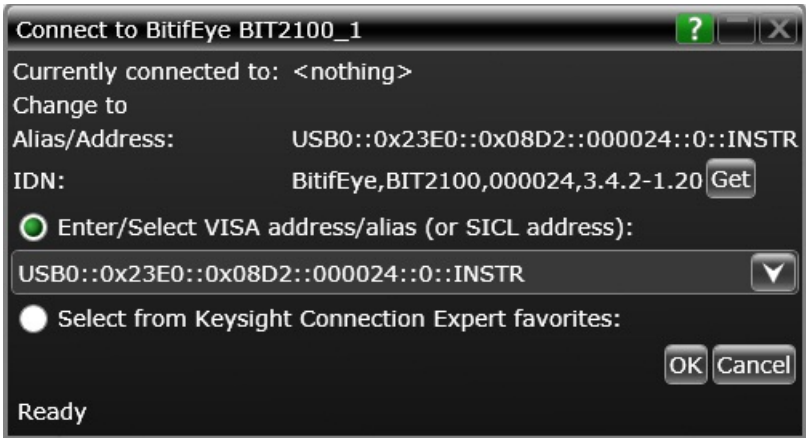
4 Select one of the options to establish connection:

Selecting Enter/Select VISA address/alias

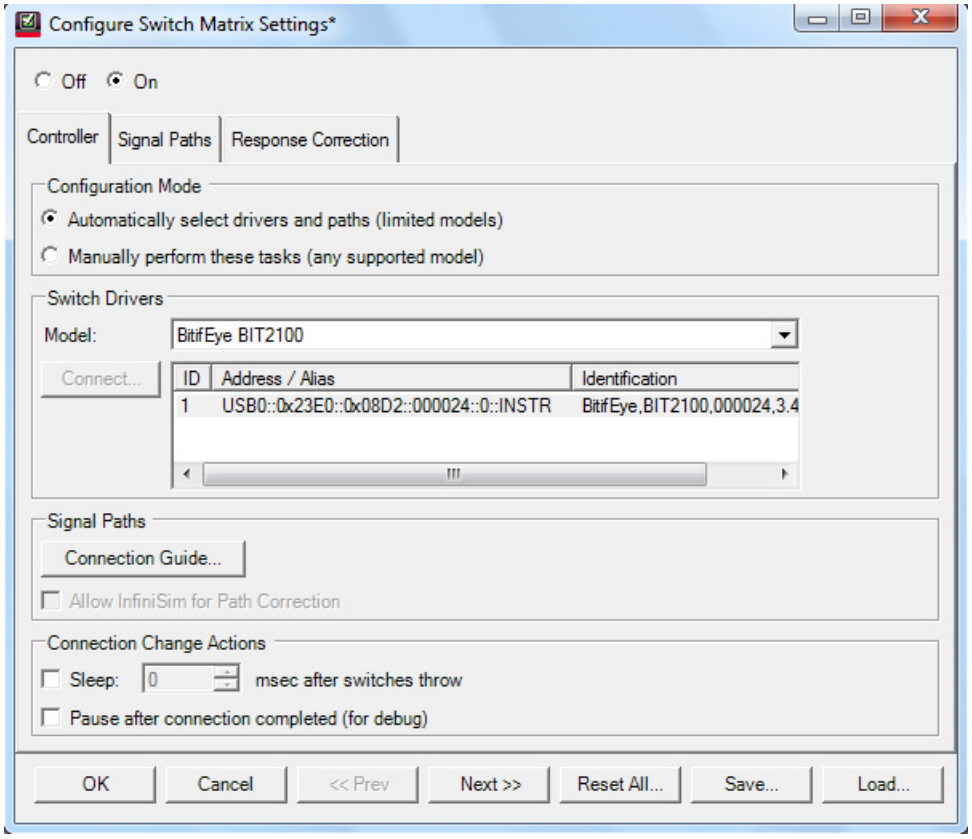
1 Select **Enter/Select VISA address/alias** to type the complete SICL or VISA address of the switch driver. By default, this option is selected.



2 Click the **Get** button to identify the instrument at the specified address or alias and to view the current status of the instrument that is connected to the switch driver.



3 Click **OK** to return to the **Configure Switch Matrix Settings** dialog. The connection to the selected switch is displayed.

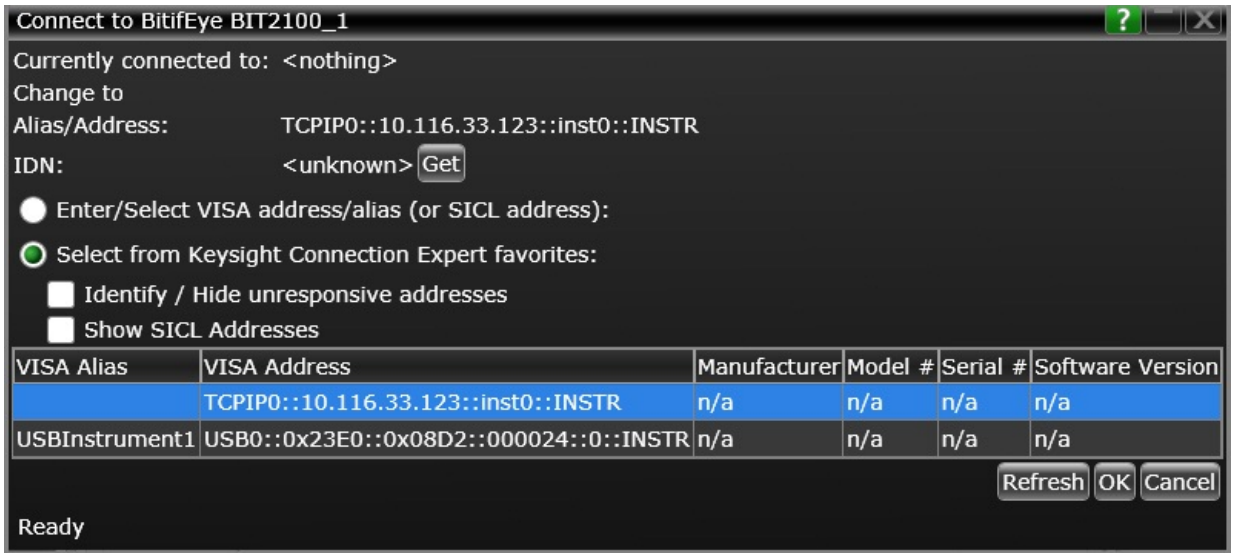


4 Click **OK** to save the settings and return to the test environment.

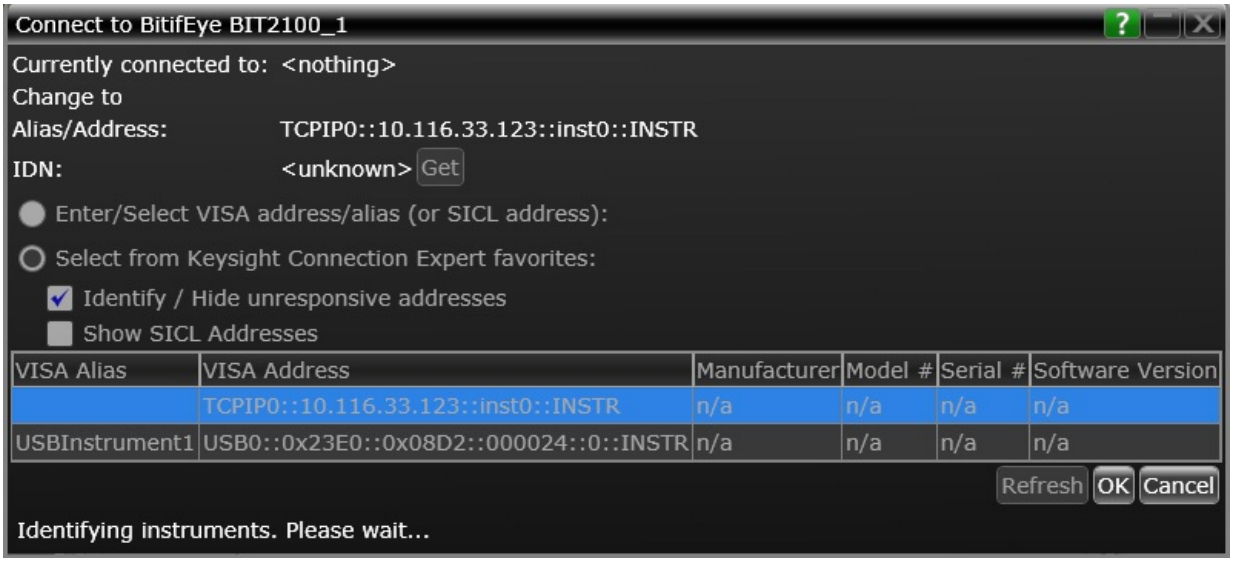
Selecting from Keysight Connection Expert favorites

1 Choose **Select from Keysight Connection Expert favorites** to control the application with the help of remote PC. Upon selecting this option, the application starts seeking device information from the Keysight Connection Expert.

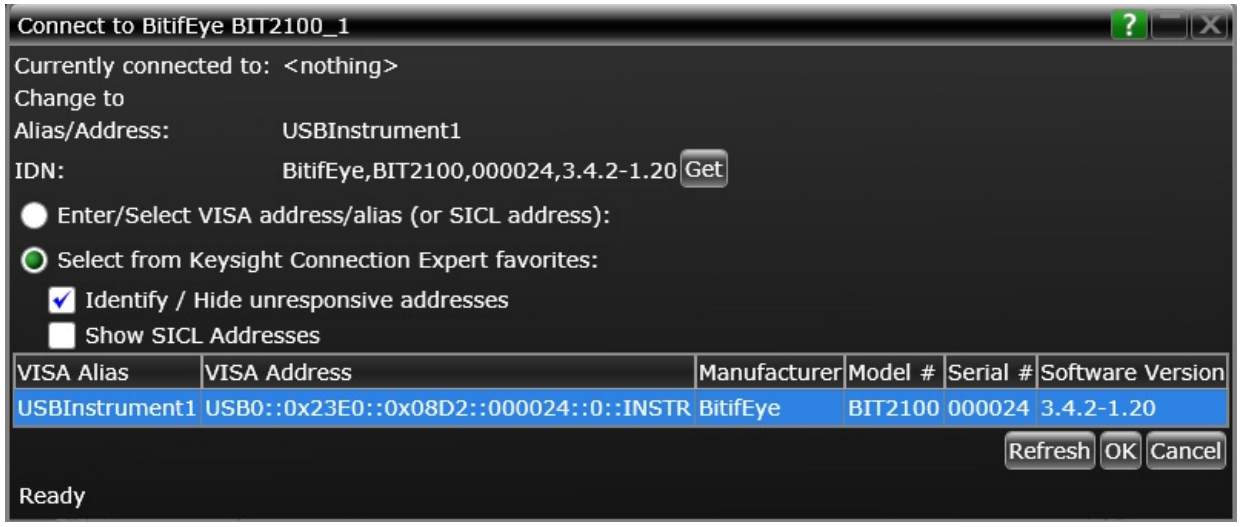
If remote access of the device is enabled, the **Connect to** <*switch-model*> dialog displays the list of active instruments.



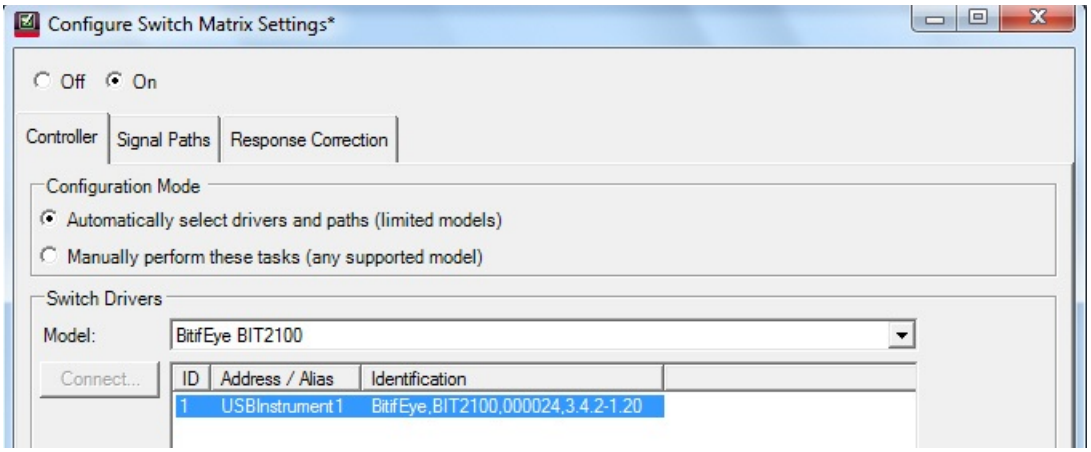
2 Click to select the I**dentify / Hide unresponsive addresses** check box to run an IDN query to every instrument in the list and search for the active instruments, if any.



3 If any active instruments are found, the **Connect to** <*switch-model*> dialog lists out such instruments. Select the required instrument from the list.



4 Click **OK** to return to the **Configure Switch Matrix Settings** dialog. The connection to the selected switch is displayed.



5 Click **OK** in the **Configure Switch Matrix Settings** dialog to save the settings and return to the test environment.

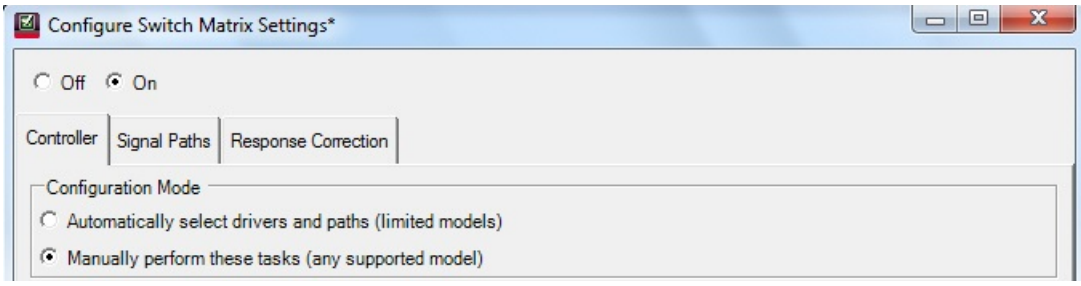
NOTE The **Select from Keysight Connection Expert** favorites option is available only when the device is powered on and enabled for remote access.

Establishing connection to the Switch Drivers – Manually

The **Manually perform these tasks (any supported model)** option allows you to decide how many drivers to use and how to route the signal paths. It enables the use of any supported switch model.

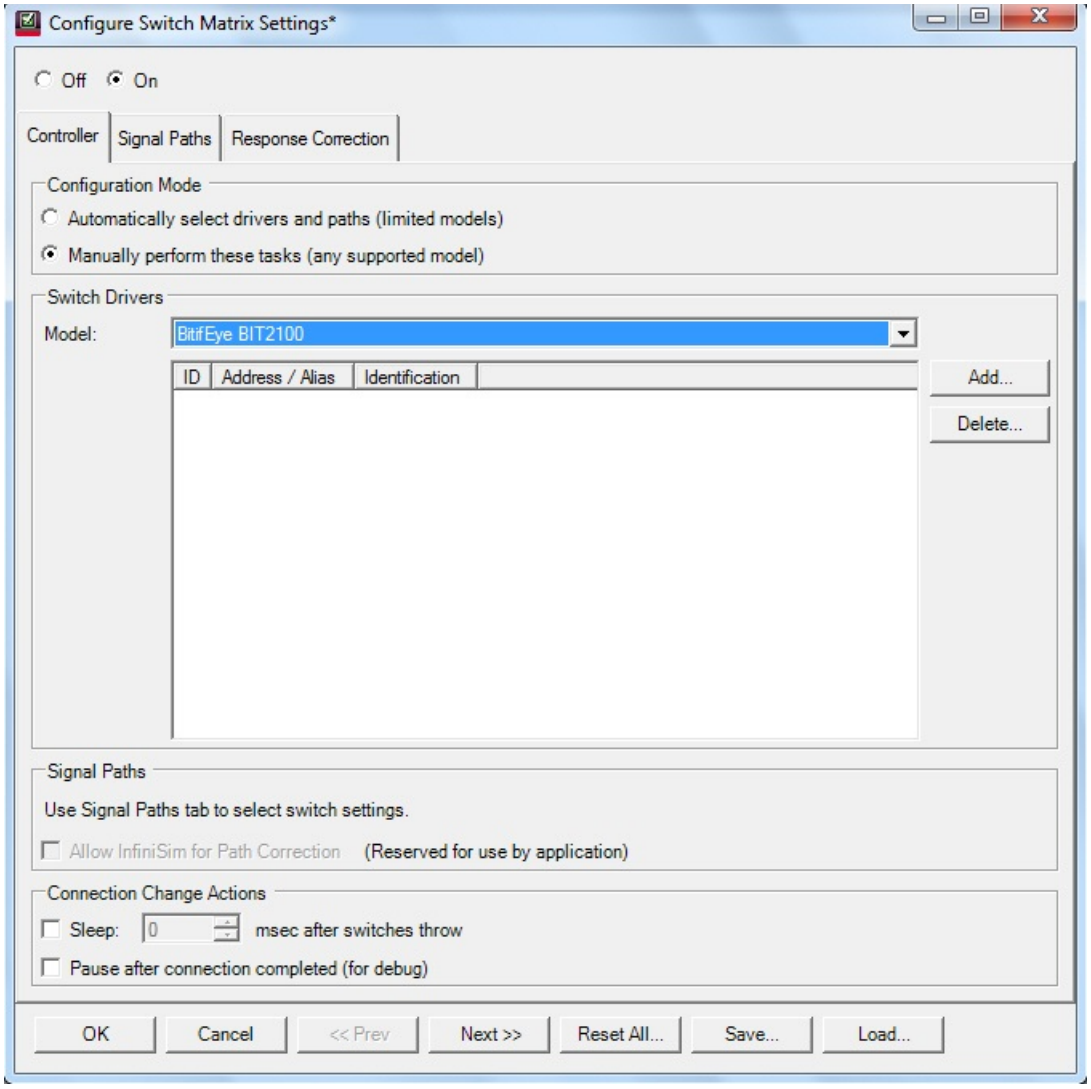
In the **Configure Switch Matrix Settings** dialog:

1 Click to select the **Manually perform these tasks (any supported model)** radio button in the **Configuration Mode** section.

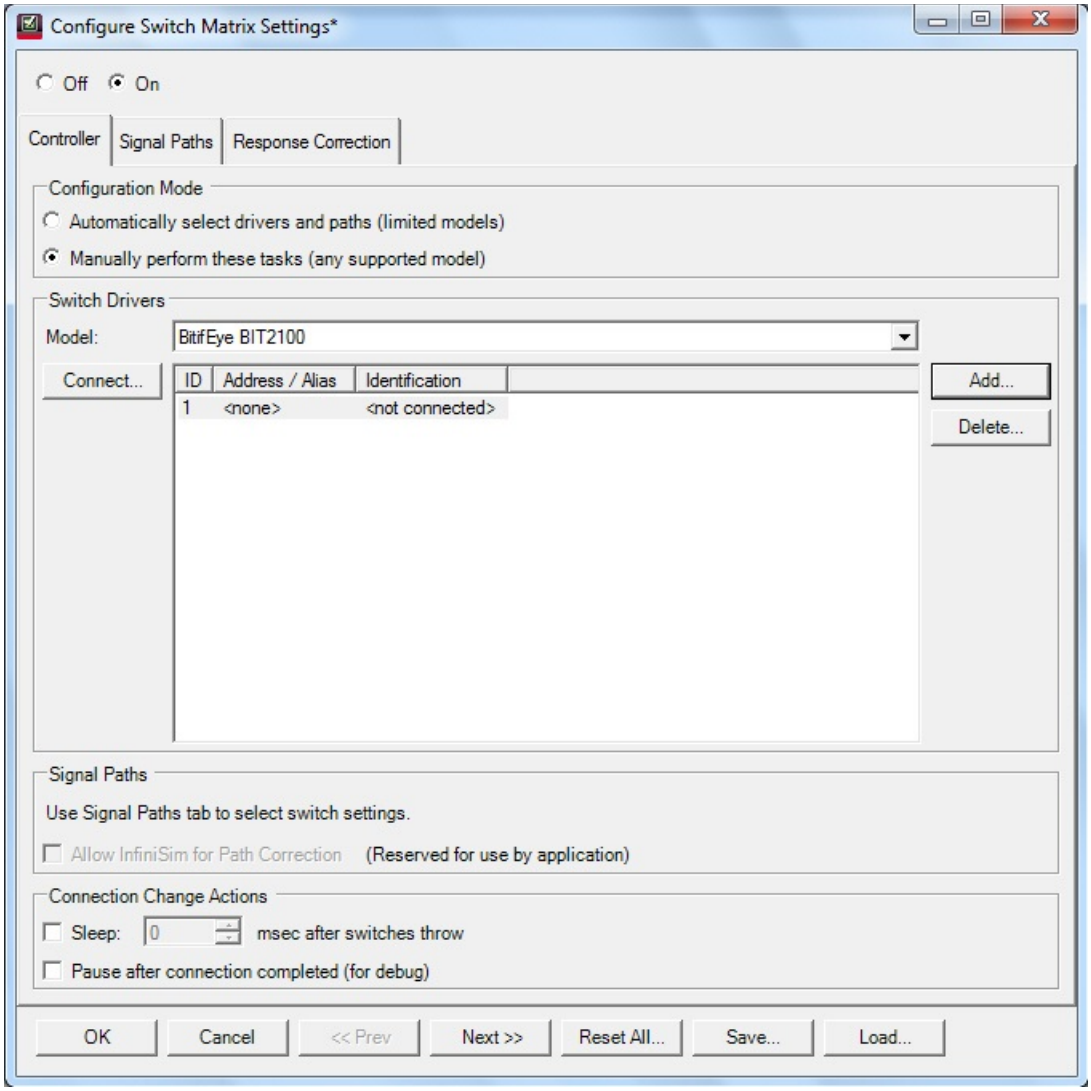


2 From the **Switch Drivers** section, select the switch model from the **Model:** drop-down options.

3 In the **Switch Drivers** section, you may use the **Add** button to append the list of any additional drivers, which require a connection to an instrument. Use the Delete button to remove a selected driver from the list. Removing the driver from the list dissociates any signal paths that may have been assigned to it earlier.


Configure Switch Matrix Settings*
Off
On
Controller
Signal Paths
Response Correction
Configuration Mode
Automatically select drivers and paths (limited models)
Manually perform these tasks (any supported model)
Switch Drivers
Model:
BitifEye BIT2100
ID
Address / Alias
Identification
Add...
Delete...
Signal Paths
Use Signal Paths tab to select switch settings.
Allow InfiniSim for Path Correction
(Reserved for use by application)
Connection Change Actions
Sleep:
0
msec after switches throw
Pause after connection completed (for debug)
OK
Cancel
<< Prev
Next >>
Reset All...
Save...
Load...

4 When you click the **Add**... button, the **Connect**... button appears so that you can establish connectivity to the selected Switch.



5 The rest of the steps for establishing a connection to the switch model remains the same as described in the previous section. The only difference between automatic and manual modes is that you can add/delete and select switch drivers (any supported model) as per your requirements and preferences in the manual mode.

Configuring Signal Paths

Once you have enabled the Switch Matrix feature and set up connections to the switch drivers, you must configure signal paths. The options to configure the signal paths vary depending upon whether you have selected **Automatically select drivers and paths (limited models)** or **Manually perform these tasks (any supported model)** in the **Controller** tab of the **Configure Switch Matrix Settings** dialog.

Refer to the connection diagram before configuring signal paths either for Automatic or Manual selection. Under the Controller tab, click the **Connection Guide** button to access the Connection Diagram dialog.

Configuring Signal Paths with Automatic Selection

When you have selected **Automatically select drivers and paths (limited models)** in the **Controller** tab of the **Configure Switch Matrix Settings** dialog:

1. Click the **Signal Paths** tab. The **Path Assignment** table lists the connection matrix of the device with the Switch modules.
2. Scroll down to view the automatic connections that have been established.

At runtime, when the Switch Matrix module is on and when a connection prompt occurs, two events occur:

- The framework suppresses the prompts.
- The Switch Matrix module detects the new connection and then throw switches, as indicated in the Switch column, taking into account the current value of the configuration variable (if any) associated with the connection.

Configuring Signal Paths with Manual Selection

When you have selected **Manually perform these tasks (any supported model)** in the **Controller** tab of the **Configure Switch Matrix Settings** dialog:

1. Click the **Signal Paths** tab in the **Configure Switch Matrix Settings** dialog.
2. Select the channel or switch module in one of the drop-down options. Manually select the alternative channel or driver module from the other drop-down option.
3. Optionally, you may change the lane assignments and the corresponding Switch modules.
4. Click the **View Connections...** button to view the signal path mapping, to understand how the signal path maps to the connection diagrams being used by the application.
5. The **Signal Paths Connection View** dialog is displayed. Select any one of the available options in the **Connection**: drop-down.

6 The **Path Assignment & Response Correction** area displays the connections configured for the corresponding connection diagrams in the **Connection:** drop-down.

7 Select an entry in the **Path Assignment & Response Correction** area to view the corresponding test information.

8 Click the **Tests...** button to view information about the tests that use the selected connection to perform automated tests.

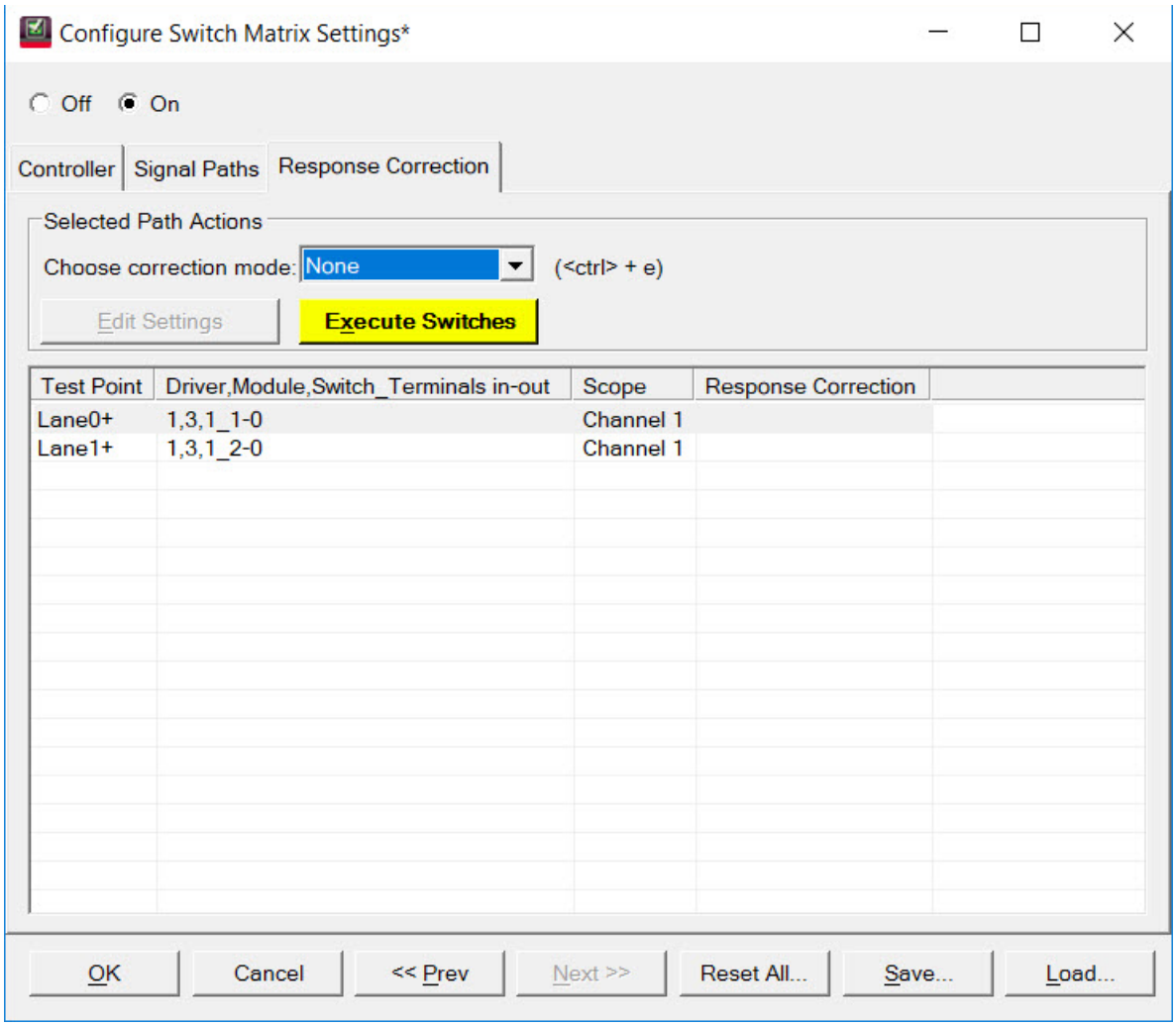
9 Click the **Close** button to exit and return to the **Configure Switch Matrix Settings** dialog to finish the signal path configuration.

10 If required, use the **Reset Paths...** button to clear all switch and response correction settings for all paths. Click **OK** if you wish to proceed.

11 Also, if needed, use the **Load Preconfigured Settings...** button to set switches for all paths as per the recommended settings. Click **OK** if you wish to proceed.

Response Correction

You must specify the response correction after you finish configuring the signal paths. Configuring this area is vital as it impacts the measurement accuracy, credibility and performance of the Oscilloscope. The purpose of response correction is to correct the channel frequency response of the oscilloscope.

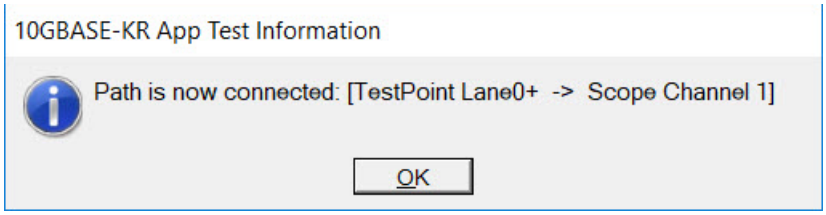


For each scope channel that you select, the default response correction method is None, which turns off normalization for the specified path.

You may use the **Edit Settings** button or double-click the selected row to access the corresponding configuration dialog, if you wish to make further changes to a specific scope channel configuration.

Use the **Execute Switches** button to establish a connection between the selected test point and scope channel. The color of this button corresponds to the Oscilloscope Channel where the Switch is connected to.

In the following example, the application displays the prompt indicating that a connection is established when you click **Execute Switches** after selecting the first row. Click **OK** to close the prompt.



Once you have finished response corrections for all connections, click **OK** in the **Configure Switch Matrix Settings** dialog. The application redirects you to the test environment.

4 Main Voltage Measurements

Differential Peak-to-Peak Output Voltage Test with TX Disabled / 39
Common Mode Voltage Test / 40
Differential Peak-to-Peak Output Voltage Test / 41

This section provides the Methods of Implementation (MOIs) for the Main Voltage Measurements using a Keysight Infiniium oscilloscope and the D9010EAPC 10GBASE-KR Compliance Test Application.

Probing and Connection for the Bus Signal Level Tests

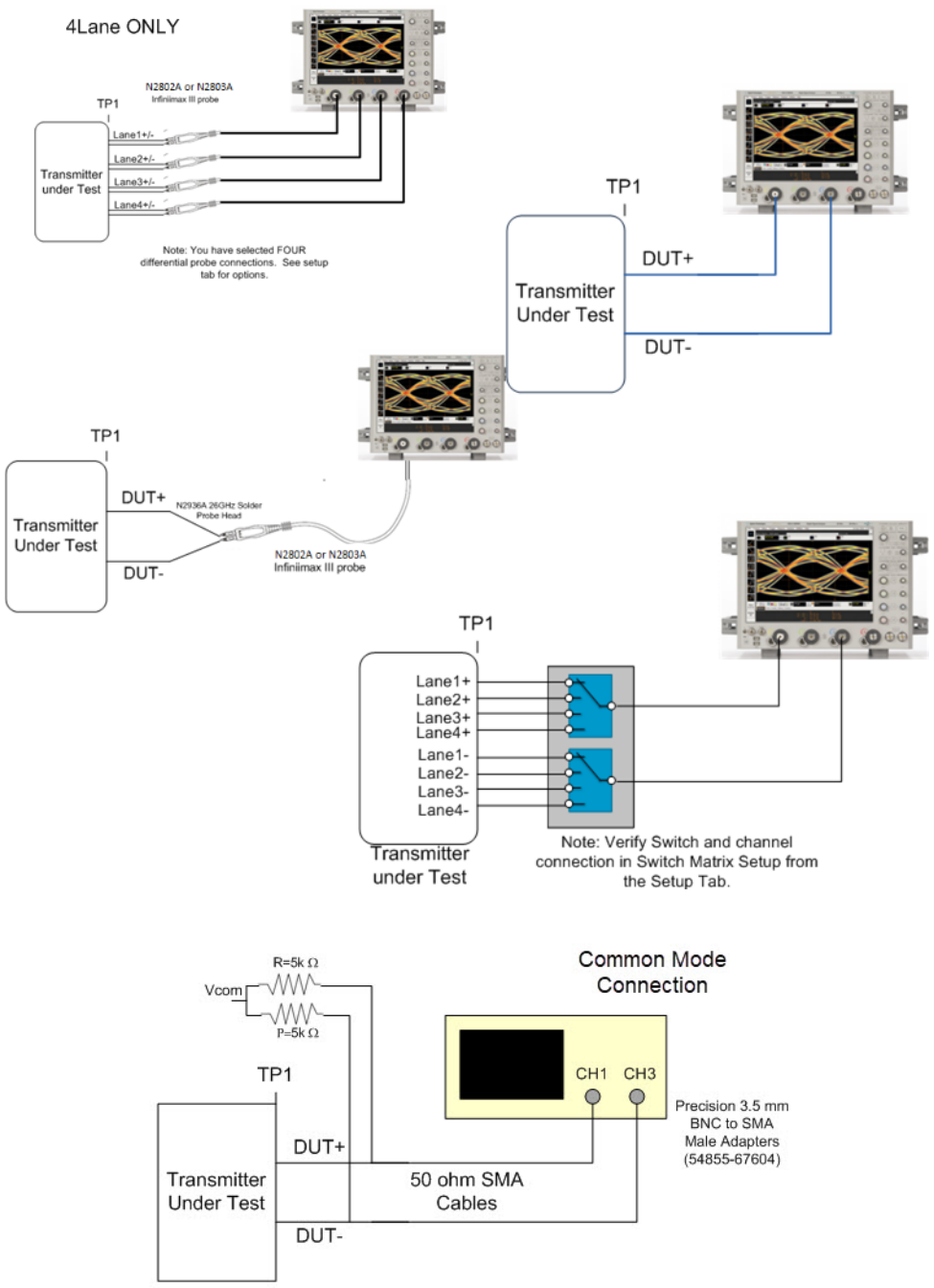


Figure 6 Probing for Main Voltage Measurements

You can use any of the oscilloscope channels as the signal source channel. You can identify the channels used for the measurement signal in the **Configuration** tab of the 10GBASE-KR Compliance Test Application. (The channels shown in the previous figure are just an example.)

Test Procedure

1 Start the automated test application as described in "Starting the 10GBASE-KR Compliance Test Application" on page 17.

2 Connect the probes to the signals on the DUT.

3 Connect the oscilloscope probes or cables to the channel(s) of the oscilloscope that you have set up in the **Configuration** tab.

4 In the 10GBASE-KR Test application, click on the **Set Up** tab.

5 Set up InfiniiSim if needed.

6 Type in or select the **Device Identifier** as well as the **User Description** from the drop-down list. Enter your comments in the **Comments** text box.

7 Click the **Select Tests** tab and check the tests you want to run. Check the parent node or group to check all the available tests within the group.

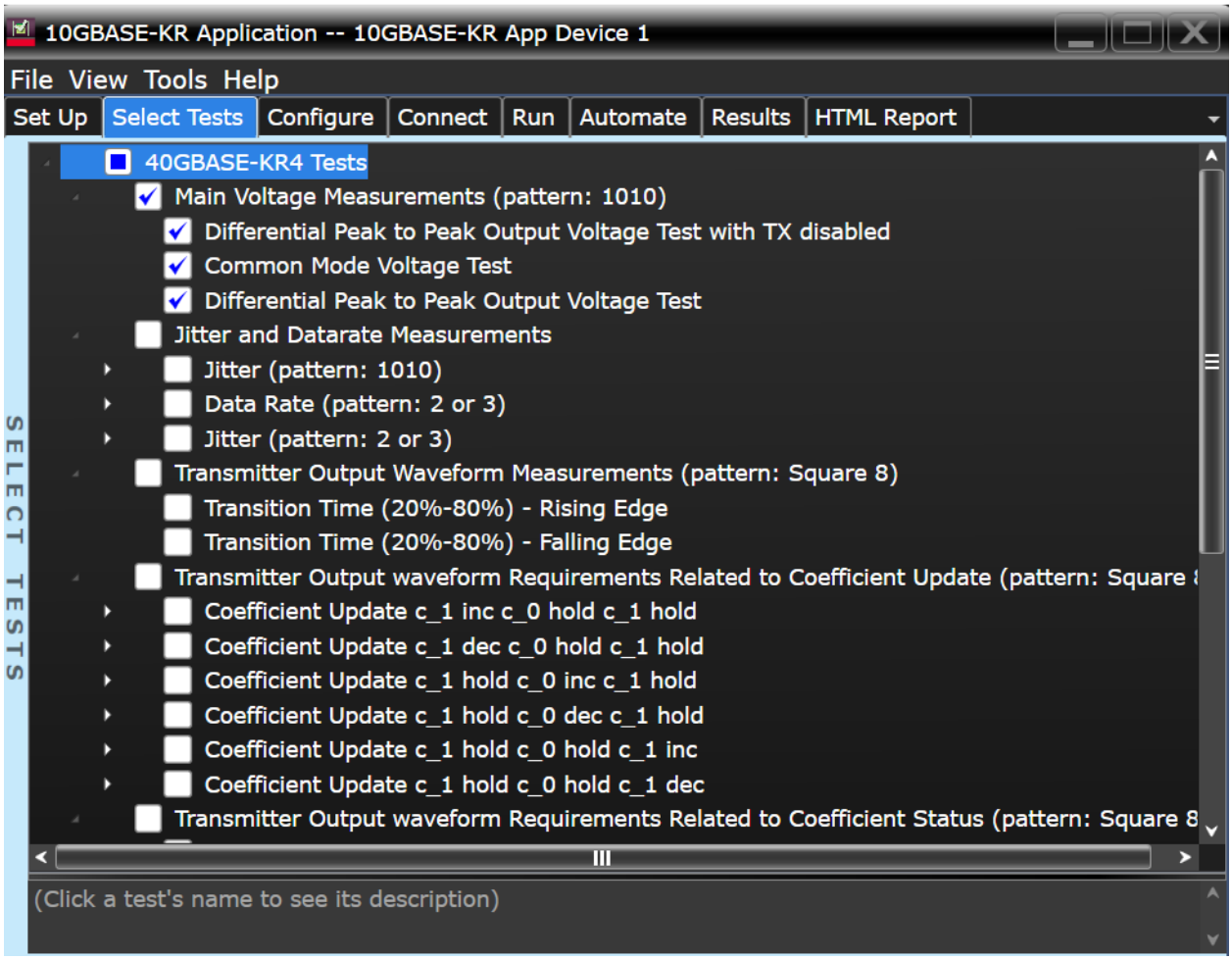


Figure 7 Selecting Main Voltage Measurement Tests

Main Voltage Specifications

The 10GBASE-KR and 40GBASE-KR4 specifications can be found in IEEE 802.3ap section 72.7.1.

- Differential Peak-to-Peak Output Voltage with TX disabled (max 30 mV).
- Common Mode Voltage (0-1.9 V).
- Differential Peak-to-Peak Output Voltage (max 1200 mV).

Differential Peak-to-Peak Output Voltage Test with TX Disabled

The purpose of this test is to verify that when TX is disabled the peak-to-peak voltage is less than 30 mV.

PASS Condition

The max peak-to-peak voltage is less than 30 mV.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is truly disabled (no valid data transitions).
3. Measure peak-to-peak voltage of the signal.
4. Compare the max peak-to-peak voltage to 30 mV.

Common Mode Voltage Test

The purpose of this test is to verify that the common mode signal of the differential pair is between 0-1.9 V.

NOTE This measurement can be done only with dual-single ended connection; it cannot be done with a differential probing connection.

PASS Condition The signal is between 0-1.9 V.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Verify that there is a signal and that the connection is dual-single ended.
3. Measure the Vmin and Vmax of the addition of the channel 1 and 3 or channel 2 and 4.
4. Compare the worst result measurement to 0-1.9 V.

Differential Peak-to-Peak Output Voltage Test

The purpose of this test is to verify that the peak-to-peak voltage of the differential signal on a 1010 pattern is less than 1200 mV.

PASS Condition

The differential signal max peak-to-peak voltage on a 1010 pattern is less than 1200 mV.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Verify that there is a signal is connected and has a 1010 pattern.
3. Measure the peak-to-peak voltage of the differential signal of DUT+ and DUT-.
4. Compare the max peak-to-peak voltage to 1200 mV.

5 Jitter and Data Rate Measurements

Data Rate / 46
Jitter (Random Jitter, Deterministic Jitter, Duty Cycle Distortion, and Total Jitter) / 47

This section provides the Methods of Implementation (MOIs) for the Jitter and Data Rate Measurements using a Keysight Infiniium oscilloscope and the D9010EAPC 10GBASE-KR Compliance Test Application.

Probing and Connection for the Bus Signal Level Tests

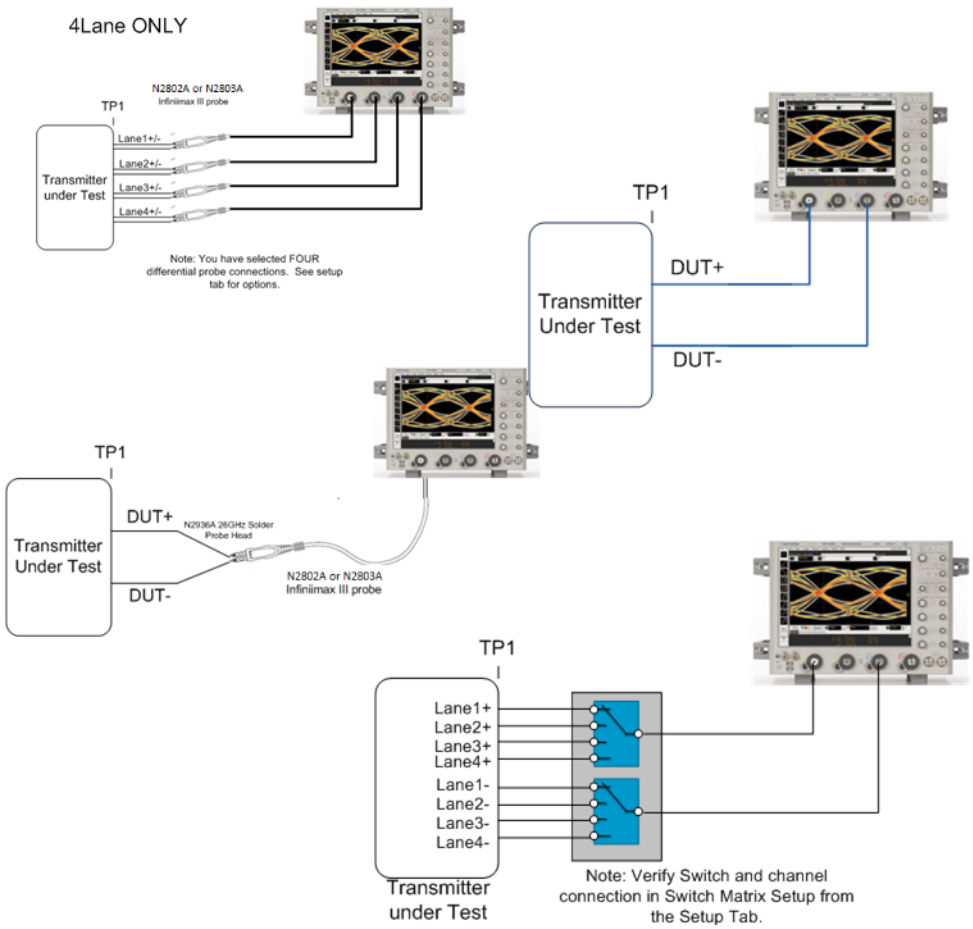


Figure 8 Probing for Jitter and Data Rate Measurements

You can use any of the oscilloscope channels as the signal source channel. You can identify the channels used for the measurement signal in the **Configuration** tab of the 10GBASE-KR Compliance Test Application. (The channels shown in the previous figure are just an example.)

Test Procedure

1. Start the automated test application as described in "Starting the 10GBASE-KR Compliance Test Application" on page 17.
2. Connect the probes to the signals on the DUT.
3. Connect the oscilloscope probes or cables to the channel(s) of the oscilloscope that you have set up in the **Configuration** tab.
4. In the 10GBASE-KR and 40GBASE-KR4 Test application, click on the **Set Up** tab.
5. Set up InfiniiSim if needed.
6. Type in or select the **Device Identifier** as well as the **User Description** from the drop-down list. Enter your comments in the **Comments** text box.

7 Click the **Select Tests** tab and check the tests you want to run. Check the parent node or group to check all the available tests within the group.

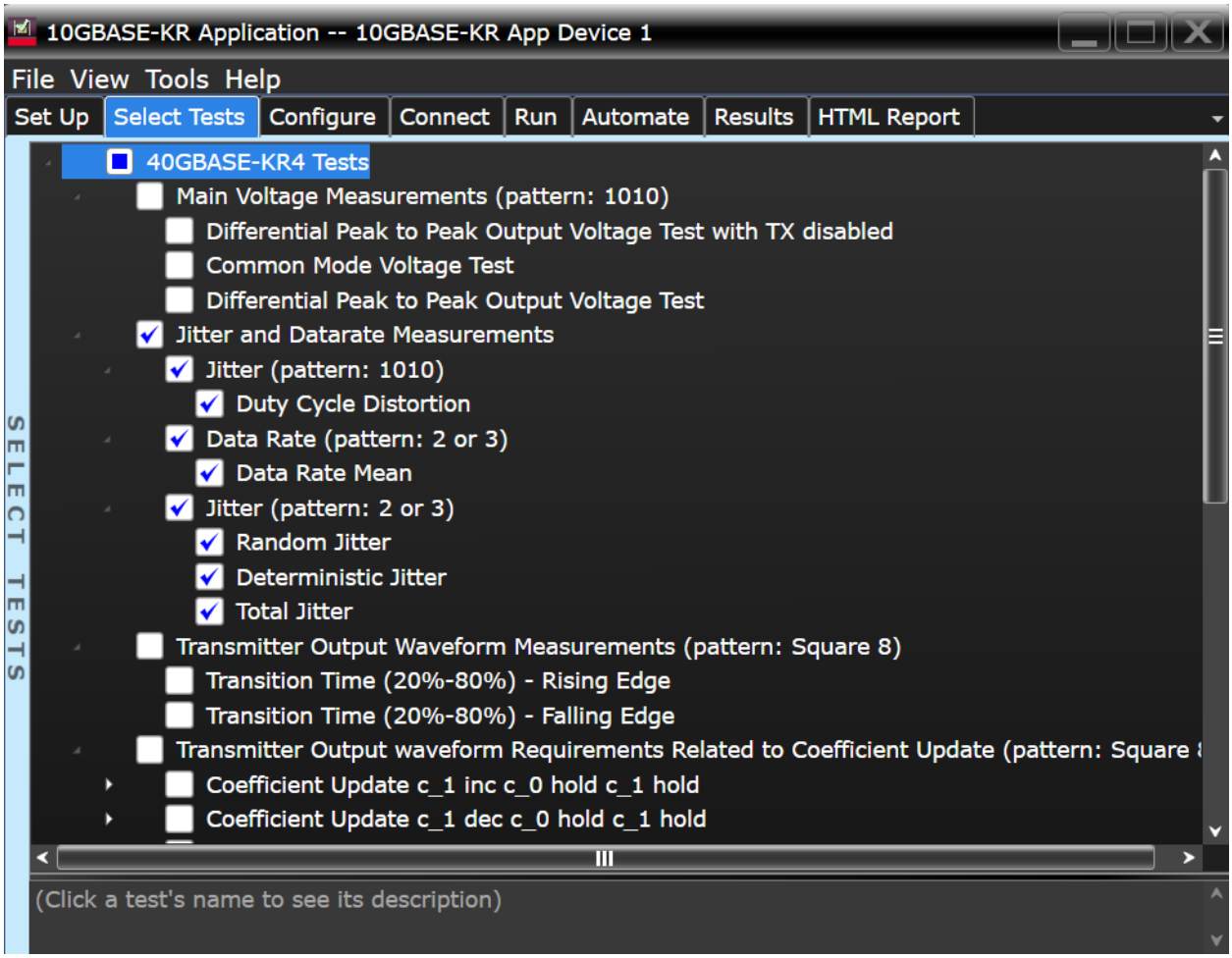


Figure 9 Selecting Jitter and Data Rate Tests

Transmitter Output Waveform Specifications

The 10GBASE-KR and 40GBASE-KR4 specifications can be found in IEEE 802.3ap section 72.7.1.

- Data Rate (10.3125 ±100 ppm GBd).
- Max output jitter (max peak-to-peak).
  - Random Jitter (max 150 mUI).
  - Deterministic Jitter (max 150 mUI).
  - Duty Cycle Distortion (max 35 mUI).
  - Total Jitter (max 280 mUI).

Data Rate

The purpose of this test is to verify that the data rate mean is between 10.3125 ±100 ppm.

PASS Condition The mean data rate is between 10.3125 ±100 ppm.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (pattern 2 or 3 must be used for this test).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Set data rate measurement to semi-automatic 10.3125 Gb/s.
5. Measure min, max, mean data rate.
6. Report min and max values.
7. Compare and report the mean data rate value to 10.3125 ±100 ppm GBd.

Jitter (Random Jitter, Deterministic Jitter, Duty Cycle Distortion, and Total Jitter)

The purpose of this test is to verify that differential signal's Random Jitter is less than 150 mUI, Deterministic Jitter is less than 150 mUI, Duty Cycle Distortion is less than 35 mUI, and Total Jitter is less than 280 mUI. If all tests are selected, all tests are run on a single measurement. Each test can be run individually by selecting any or some of the tests.

PASS Conditions

- Random Jitter rms is less than 150 mUI.
- Deterministic p-p jitter is less than 150 mUI.
- Duty Cycle Distortion is less than 35 mUI.
- Total Jitter at BER of 10E-12 is less than 280 mUI.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (pattern 2 or 3 must be used for all the tests other than Duty Cycle Distortion. For Duty Cycle Distortion, pattern 1010 must be used).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Set clock recovery to OJTF First Order PLL with Nominal Data Rate 10.3125 Gb/s and Loop Bandwidth to 4 MHz.
5. Using EZJIT, measure Random Jitter, Deterministic Jitter, Duty Cycle Distortion, and Total Jitter at BER of 10E-12.
6. Compare and report the values to their respective maximum specification.

6 Transmitter Output Waveform Measurements

Transition Time - Rising Edge / 52
Transition Time - Falling Edge / 53

This section provides the Methods of Implementation (MOIs) for the Transmitter Output Waveform Measurements for Transition Time using a Keysight Infiniium oscilloscope and the D9010EAPC 10GBASE-KR Compliance Test Application.

Probing and Connection for the Bus Signal Level Tests

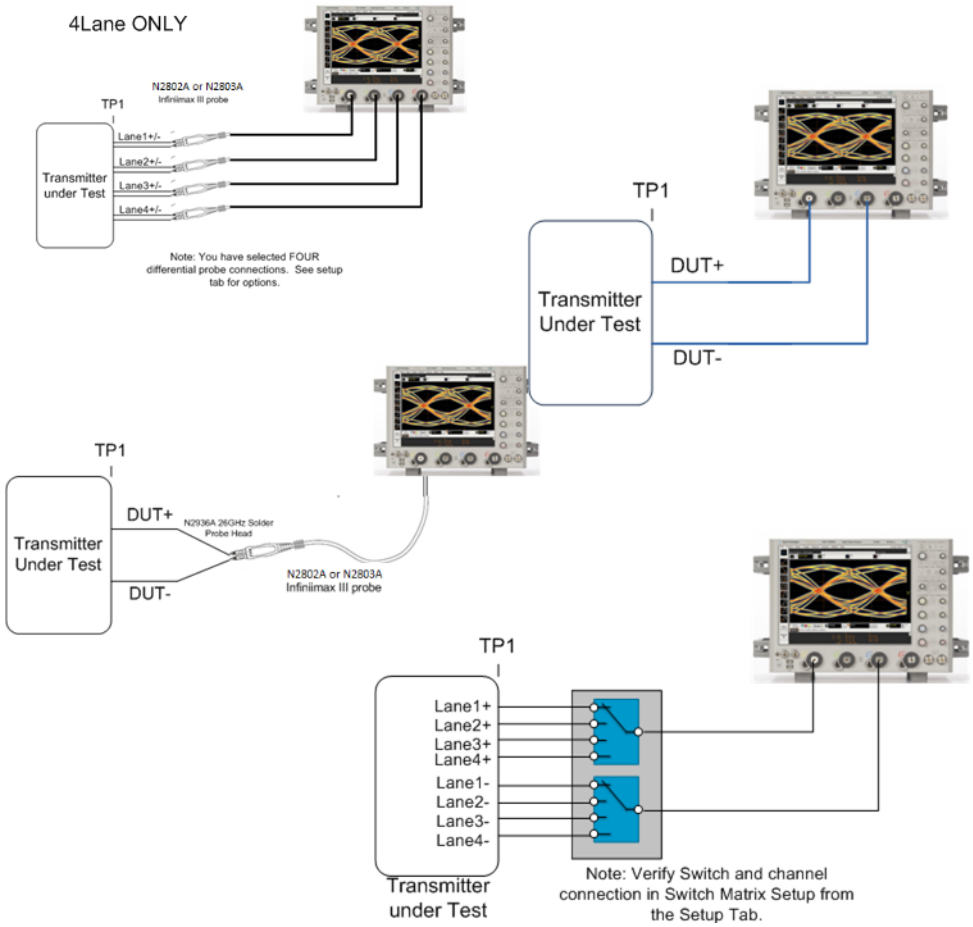


Figure 10 Probing for Transmitter Output Waveform Measurements

You can use any of the oscilloscope channels as the signal source channel. You can identify the channels used for the measurement signal in the **Configuration** tab of the 10GBASE-KR Compliance Test Application. (The channels shown in the previous figure are just an example.)

Test Procedure

1. Start the automated test application as described in "Starting the 10GBASE-KR Compliance Test Application" on page 17.
2. Connect the probes to the signals on the DUT.
3. Connect the oscilloscope probes or cables to the channel(s) of the oscilloscope that you have set up in the **Configuration** tab.
4. In the 10GBASE-KR Test application, click on the **Set Up** tab.
5. Set up InfiniiSim if needed.
6. Type in or select the **Device Identifier** as well as the **User Description** from the drop-down list. Enter your comments in the **Comments** text box.

7 Click the **Select Tests** tab and check the tests you want to run. Check the parent node or group to check all the available tests within the group.

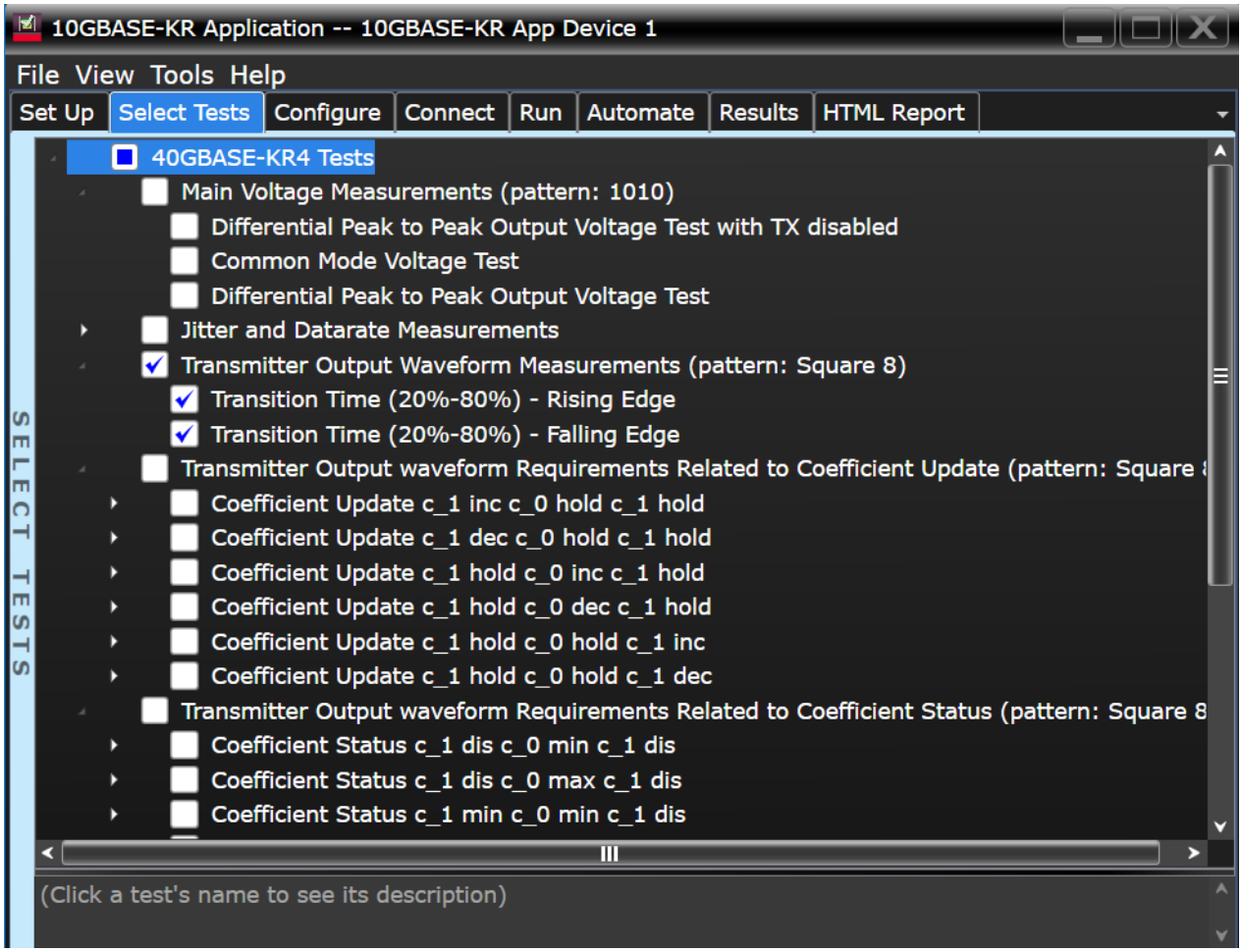


Figure 11 Selecting Transmitter Output Waveform Test

Data Rate and Jitter Specifications

The 10GBASE-KR and 40GBASE-KR4 specifications can be found in IEEE 802.3ap section 72.7.1.

- Transition Time (20%-80%) – Rising Edge (24-47 ps).
- Transition Time (20%-80%) – Falling Edge (24-47 ps).

Transition Time - Rising Edge

The purpose of this test is to verify that the rising edge of the differential signal is between 24 to 47 ps.

PASS Condition The min and max rise time of the signal are between 24 to 47 ps.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure min and max rise time of the entire signal.
5. Compare and report the min and max values to the valid range of 24-47 ps.

Transition Time - Falling Edge

The purpose of this test is to verify that the falling edge of the differential signal is between 24 to 47 ps.

PASS Condition The min and max fall time of the signal are between 24 to 47 ps.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure min and max fall time of the entire signal.
5. Compare and report the min and max values to the valid range of 24-47 ps.

7 Transmitter Output Waveform – Coefficient Update Measurements

Coefficient Update c_1 inc c_0 hold c_1 hold / 59
Coefficient Update c_1 dec c_0 hold c_1 hold / 60
Coefficient Update c_1 hold c_0 inc c_1 hold / 61
Coefficient Update c_1 hold c_0 dec c_1 hold / 62
Coefficient Update c_1 hold c_0 hold c_1 inc / 63
Coefficient Update c_1 hold c_0 hold c_1 dec / 64

This section provides the Methods of Implementation (MOIs) for the Transmitter Output Waveform Coefficient Update Measurements using a Keysight Infiniium oscilloscope and the D9010EAPC 10GBASE-KR Compliance Test Application.

Probing and Connection for the Bus Signal Level Tests

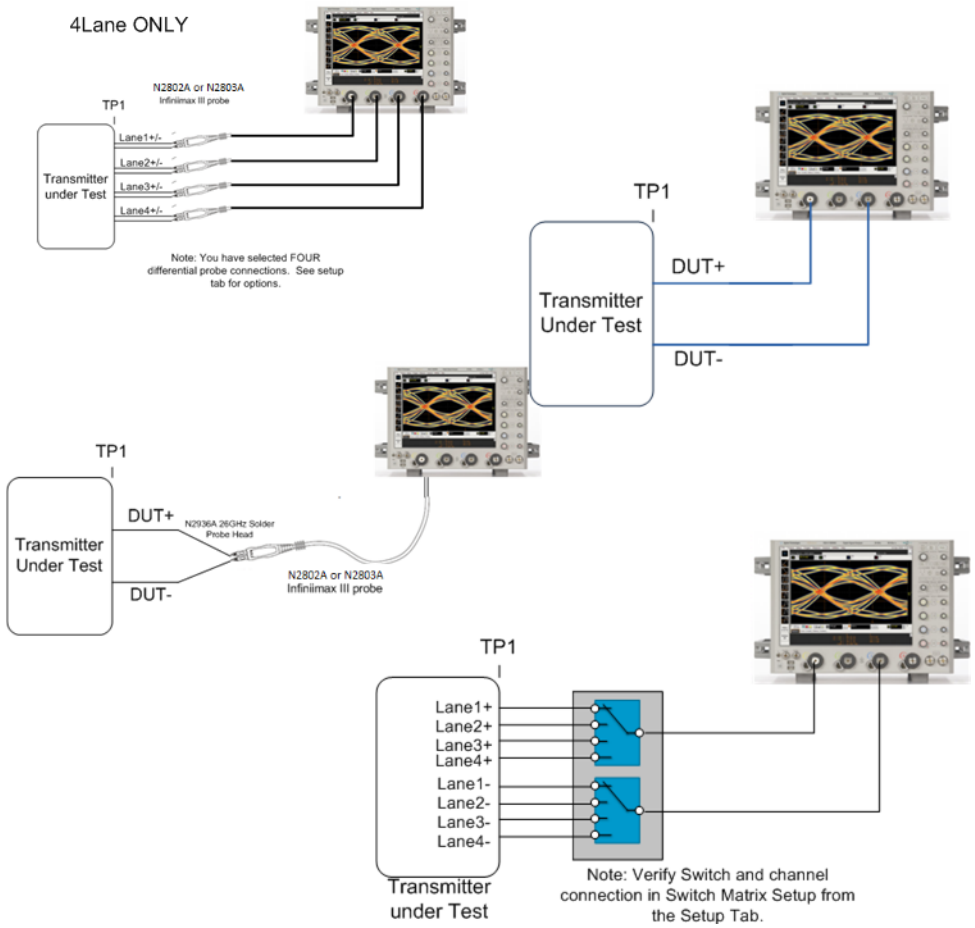


Figure 12 Probing for Transmitter Output Waveform – Coefficient Update Measurements

You can use any of the oscilloscope channels as the signal source channel. You can identify the channels used for the measurement signal in the **Configuration** tab of the 10GBASE-KR Compliance Test Application. (The channels shown in the previous figure are just an example.)

Test Procedure

1. Start the automated test application as described in "Starting the 10GBASE-KR Compliance Test Application" on page 17.
2. Connect the probes to the signals on the DUT.
3. Connect the oscilloscope probes or cables to the channel(s) of the oscilloscope that you have set up in the **Configuration** tab.
4. In the 10GBASE-KR Test application, click on the **Set Up** tab.
5. Set up InfiniiSim if needed.
6. Type in or select the **Device Identifier** as well as the **User Description** from the drop-down list. Enter your comments in the **Comments** text box.

7 Click the **Select Tests** tab and check the tests you want to run. Check the parent node or group to check all the available tests within the group.

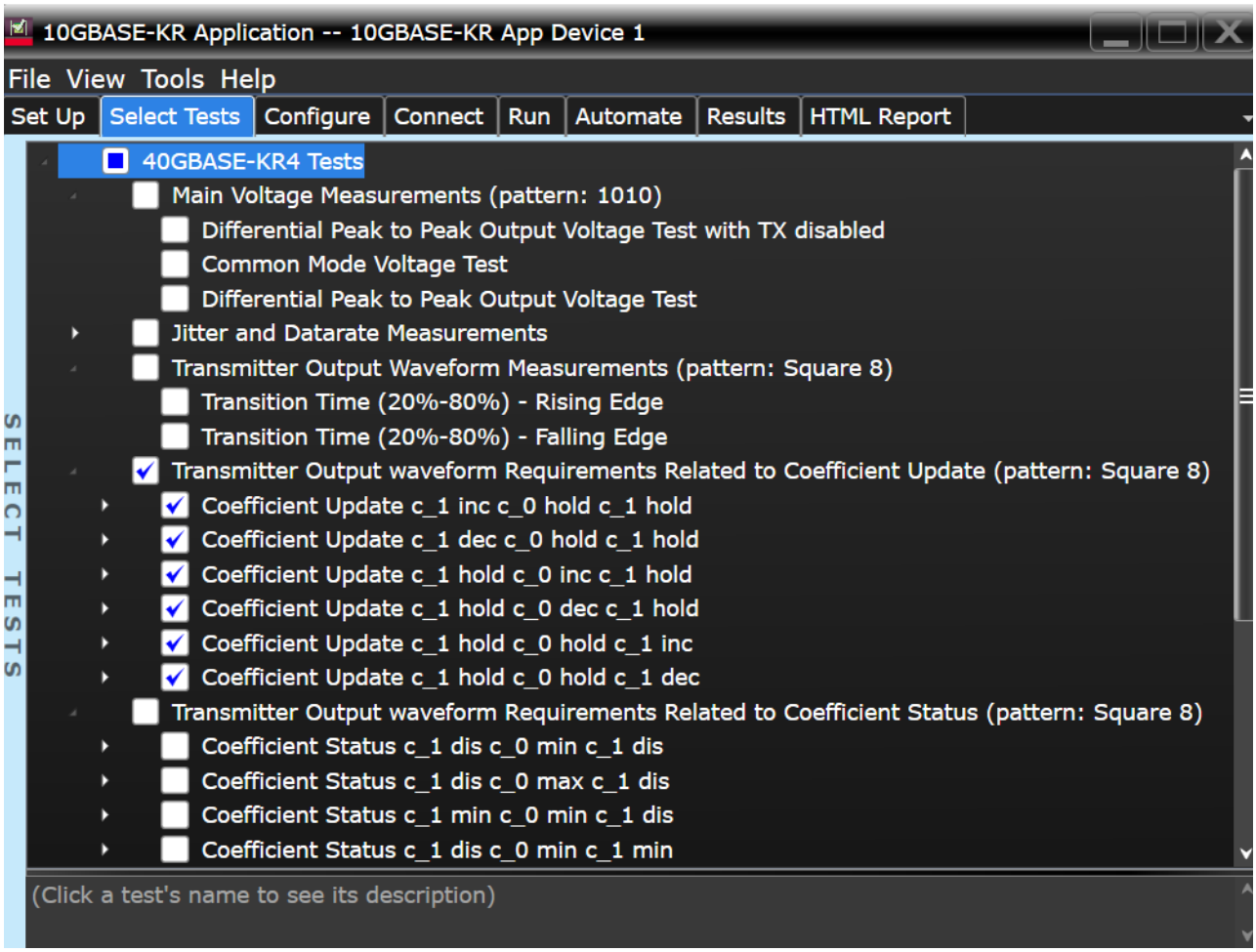


Figure 13 Selecting Transmitter Output Waveform – Coefficient Update Test

Coefficient Update Specifications

The 10GBASE-KR and 40GBASE-KR4 specifications can be found in IEEE 802.3ap section 72.7.1.11 – Table 72-7.

Coefficient Update			Requirements		
c(1)	c(0)	c(-1)	v1(k) – v1(k – 1) (mV)	v2(k) – v2(k – 1) (mV)	v3(k) – v3(k – 1) (mV)
increment	hold	hold	–20 to –5	5 to 20	5 to 20
decrement	hold	hold	5 to 20	–20 to –5	–20 to –5
hold	increment	hold	5 to 20	5 to 20	5 to 20
hold	decrement	hold	–20 to –5	–20 to –5	–20 to –5

Coefficient Update			Requirements		
c(1)	c(0)	c(–1)	v1(k) – v1(k – 1) (mV)	v2(k) – v2(k – 1) (mV)	v3(k) – v3(k – 1) (mV)
hold	hold	increment	5 to 20	5 to 20	–20 to –5
hold	hold	decrement	–20 to –5	–20 to –5	5 to 20

Coefficient Update c_1 inc c_0 hold c_1 hold

The purpose of this test is to verify that the difference in v1, v2, and v3 between coefficient updates, falls between the specified values in table 72-7 of IEEE 802.3ap.

PASS Condition

The difference in the coefficient update when c(1) is incremented to the previous state for v1, v2, and v3 are within the specified values.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
5. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
6. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
7. Save v1, v2, v3 as v1(k-1), v2(k-1), and v3(k-1) values.
8. Pop up to ask user to Increment c(1). OK pressed.
9. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
10. Measure v2 – set the measurement to measure Pulse Top with Pulse width of 50%.
11. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
12. Subtract v1(k) – v1(k-1), v2(k)-v2(k-1), and v3(k)-v3(k-1).
13. Compare and report the values from step 12 to their respective value ranges in table 72-7 of IEEE 802.3ap.

Coefficient Update c_1 dec c_0 hold c_1 hold

The purpose of this test is to verify that the difference in v1, v2, and v3 between coefficient updates, falls between the specified values in table 72-7 of IEEE 802.3ap.

PASS Condition

The difference in the coefficient update when c(1) is decremented to the previous state for v1, v2, and v3 are within the specified values.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
5. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
6. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
7. Save v1, v2, v3 as v1(k-1), v2(k-1), and v3(k-1) values.
8. Pop up to ask user to decrement c(1). OK pressed.
9. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
10. Measure v2 – set the measurement to measure Pulse Top with Pulse width of 50%.
11. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
12. Subtract v1(k) – v1(k-1), v2(k)-v2(k-1), and v3(k)-v3(k-1).
13. Compare and report the values from step 12 to their respective value ranges in table 72-7 of IEEE 802.3ap.

Coefficient Update c_1 hold c_0 inc c_1 hold

The purpose of this test is to verify that the difference in v1, v2, and v3 between coefficient updates, falls between the specified values in table 72-7 of IEEE 802.3ap.

PASS Condition

The difference in the coefficient update when c(0) is incremented to the previous state for v1, v2, and v3 are within the specified values.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
5. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
6. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
7. Save v1, v2, v3 as v1(k-1), v2(k-1), and v3(k-1) values.
8. Pop up to ask user to Increment c(0). OK pressed.
9. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
10. Measure v2 – set the measurement to measure Pulse Top with Pulse width of 50%.
11. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
12. Subtract v1(k) – v1(k-1), v2(k)-v2(k-1), and v3(k)-v3(k-1).
13. Compare and report the values from step 12 to their respective value ranges in table 72-7 of IEEE 802.3ap.

Coefficient Update c_1 hold c_0 dec c_1 hold

The purpose of this test is to verify that the difference in v1, v2, and v3 between coefficient updates, falls between the specified values in table 72-7 of IEEE 802.3ap.

PASS Condition

The difference in the coefficient update when c(0) is decremented to the previous state for v1, v2, and v3 are within the specified values.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
5. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
6. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
7. Save v1, v2, v3 as v1(k-1), v2(k-1), and v3(k-1) values.
8. Pop up to ask user to decrement c(0). OK pressed.
9. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
10. Measure v2 – set the measurement to measure Pulse Top with Pulse width of 50%.
11. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
12. Subtract v1(k) – v1(k-1), v2(k)-v2(k-1), and v3(k)-v3(k-1).
13. Compare and report the values from step 12 to their respective value ranges in table 72-7 of IEEE 802.3ap.

Coefficient Update c_1 hold c_0 hold c_1 inc

The purpose of this test is to verify that the difference in v1, v2, and v3 between coefficient updates, falls between the specified values in table 72-7 of IEEE 802.3ap.

PASS Condition

The difference in the coefficient update when c(-1) is incremented to the previous state for v1, v2, and v3 are within the specified values.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
5. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
6. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
7. Save v1, v2, v3 as v1(k-1), v2(k-1), and v3(k-1) values.
8. Pop up to ask user to increment c(-1). OK pressed.
9. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
10. Measure v2 – set the measurement to measure Pulse Top with Pulse width of 50%.
11. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
12. Subtract v1(k) – v1(k-1), v2(k)-v2(k-1), and v3(k)-v3(k-1).
13. Compare and report the values from step 12 to their respective value ranges in table 72-7 of IEEE 802.3ap.

Coefficient Update c_1 hold c_0 hold c_1 dec

The purpose of this test is to verify that the difference in v1, v2, and v3 between coefficient updates, falls between the specified values in table 72-7 of IEEE 802.3ap.

PASS Condition

The difference in the coefficient update when c(-1) is decremented to the previous state for v1, v2, and v3 are within the specified values.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
5. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
6. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
7. Save v1, v2, v3 as v1(k-1), v2(k-1), and v3(k-1) values.
8. Pop up to ask user to decrement c(-1). OK pressed.
9. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
10. Measure v2 – set the measurement to measure Pulse Top with Pulse width of 50%.
11. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
12. Subtract v1(k) – v1(k-1), v2(k)-v2(k-1), and v3(k)-v3(k-1).
13. Compare and report the values from step 12 to their respective value ranges in table 72-7 of IEEE 802.3ap.

8 Transmitter Output Waveform – Coefficient Status Measurements

Coefficient Status c_1 dis c_0 min c_1 dis / 69
Coefficient Status c_1 dis c_0 max c_1 dis / 70
Coefficient Status c_1 min c_0 min c_1 dis / 71
Coefficient Status c_1 dis c_0 min c_1 min / 72

This section provides the Methods of Implementation (MOIs) for the Transmitter Output Waveform Coefficient Status Measurements using a Keysight Infiniium oscilloscope and the D9010EAPC 10GBASE-KR Compliance Test Application.

Probing and Connection for the Bus Signal Level Tests

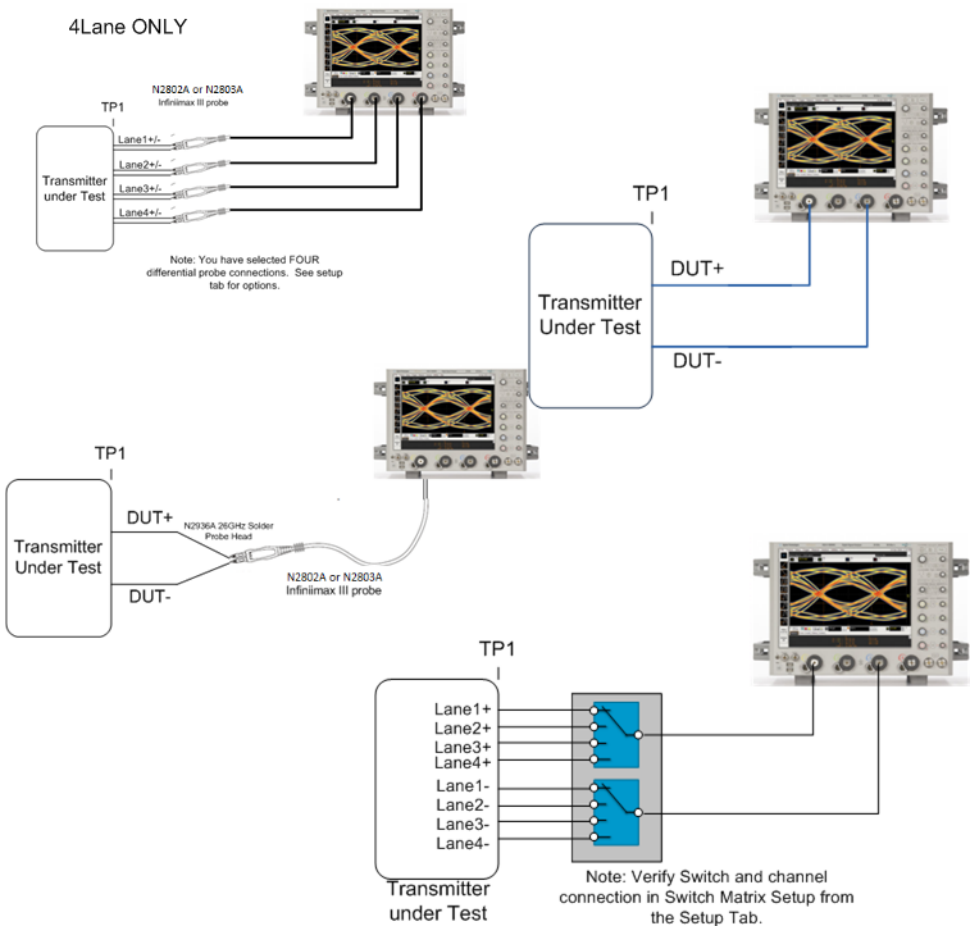


Figure 14 Probing for Transmitter Output Waveform – Coefficient Status Measurements

You can use any of the oscilloscope channels as the signal source channel. You can identify the channels used for the measurement signal in the **Configuration** tab of the 10GBASE-KR and 40GBASE-KR4 Compliance Test Application. (The channels shown in the previous figure are just an example.)

Test Procedure

1. Start the automated test application as described in "Starting the 10GBASE-KR Compliance Test Application" on page 17.
2. Connect the probes to the signals on the DUT.
3. Connect the oscilloscope probes or cables to the channel(s) of the oscilloscope that you have set up in the **Configuration** tab.
4. In the 10GBASE-KR Test application, click on the **Set Up** tab.
5. Set up InfiniiSim if needed.
6. Type in or select the **Device Identifier** as well as the **User Description** from the drop-down list. Enter your comments in the **Comments** text box.

7 Click the **Select Tests** tab and check the tests you want to run. Check the parent node or group to check all the available tests within the group.

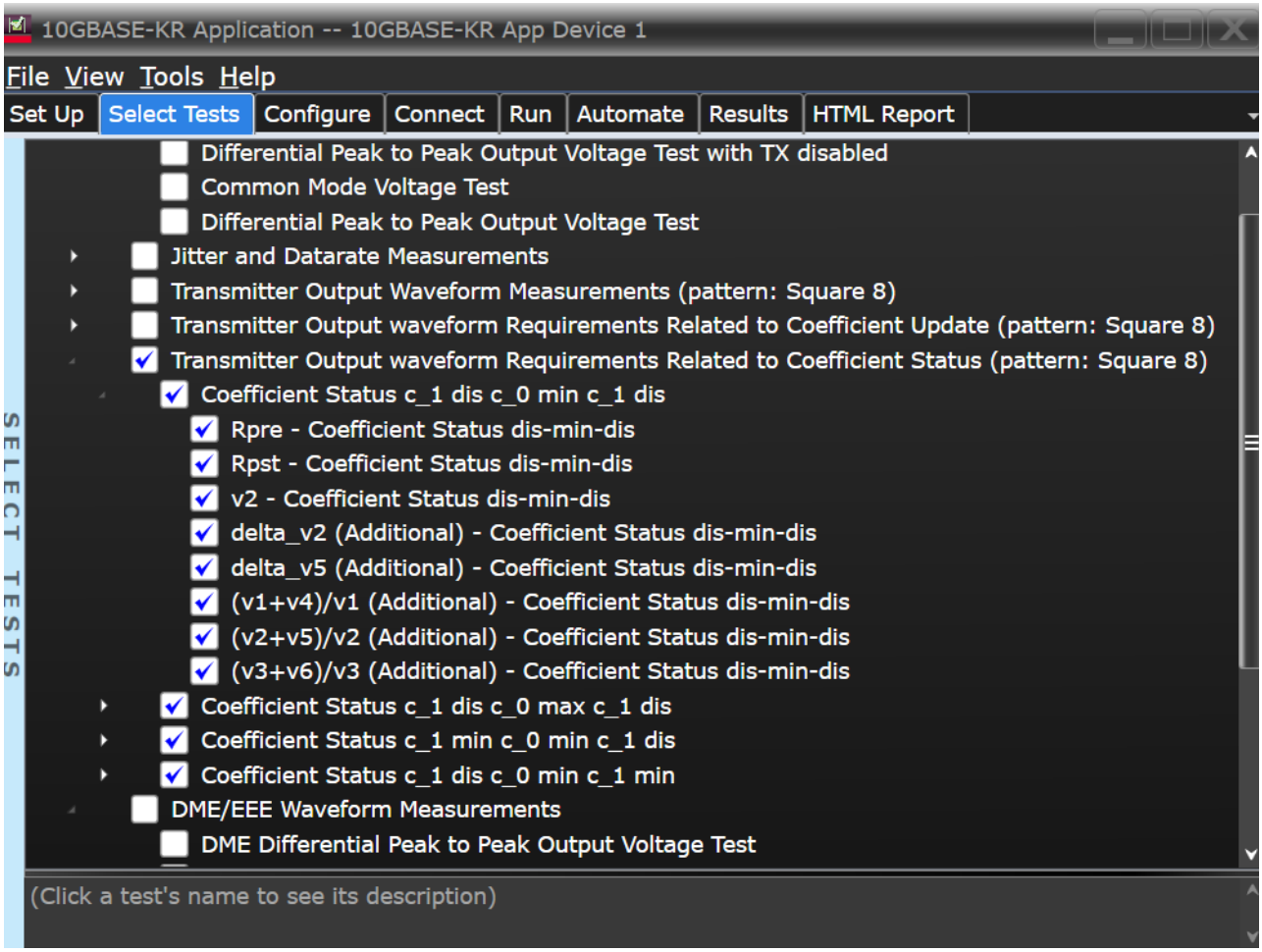


Figure 15 Selecting Transmitter Output Waveform – Coefficient Status Test

Coefficient Status Specifications

The 10GBASE-KR and 40GBASE-KR4 specifications can be found in IEEE 802.3ap section 72.7.1.11 Table 72-8.

- Δv2 and Δv5 (max 40 mV peak-to-peak).
- (v1+v4)/v1, (v2+v5)/v2, and (v3+v6)/v3 shall not exceed 0.05.
- v2 as not defined in table 72-8 <= 40 mV.

Coefficient Status			Requirements		
c(1)	c(0)	c(-1)	R_{pre}	R_{pst}	v_2 (mV)
disabled	minimum	disabled	0.90 to 1.10	0.90 to 1.10	220 to 330
disabled	maximum	disabled	0.95 to 1.05	0.95 to 1.05	400 to 600

Coefficient Status			Requirements		
c(1)	c(0)	c(–1)	R_{pre}	R_{pst}	v_2 (mV)
minimum	minimum	disabled	–	4.00 (min)	–
disabled	minimum	minimum	1.54 (min)	–	–

Coefficient Status c_1 dis c_0 min c_1 dis

The purpose of this test is to verify Rpre, Rpst, and v2 are within specification as defined in table 72-8 of IEEE 802.3ap. Additionally, to verify that Δv2 and Δv5 are less than 40 mV. Additionally, (v1+v4)/v1, (v2+v5)/v2, and (v3+v6)/v3 cannot exceed 0.05.

PASS Condition

Rpre, Rpst, v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3, Δv2 and Δv5 are within the respective defined specifications when c(1) is disabled, c(0) is at its minimum value, and c(-1) is disabled.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Pop up to ask user to change c(0) to minimum. OK pressed.
5. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
6. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
7. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
8. Measure v4 – set measurement to measure Voltage Overshoot on the falling edge.
9. Measure v5 – set measurement to measure Voltage Base with pulse width of 50%.
10. Measure v6 – set measurement to measure Voltage Preshoot on the rising edge.
11. Calculate Rpre = v3/v2, Rpst = v1/v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3.
12. Measure Δv2 – trigger on rising edge. Scale and center high pulse of the square pattern. Place histogram left limit at t1+2T and right limit t2-2T (t1, t2, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
13. Calculate Δv2 = v2(max) – v2(min) as measured in step 12 histogram.
14. Measure Δv5 – trigger on falling edge. Scale and center low pulse of the square pattern. Place histogram left limit at t2+2T and right limit t3-2T (t2, t3, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
15. Calculate Δv5 = v5(max)-v5(min as measured in step 14 histogram.
16. Compare and report the values from steps 11, 13, and 15 to their respective specification values.

Coefficient Status c_1 dis c_0 max c_1 dis

The purpose of this test is to verify Rpre, Rpst, and v2 are within specification as defined in table 72-8 of IEEE 802.3ap. Additionally, to verify that Δv2 and Δv5 are less than 40 mV. Additionally, (v1+v4)/v1, (v2+v5)/v2, and (v3+v6)/v3 cannot exceed 0.05.

PASS Condition

Rpre, Rpst, v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3, Δv2 and Δv5 are within the respective defined specifications when c(1) is disabled, c(0) is at its maximum value, and c(-1) is disabled.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Pop up to ask user to change c(0) to maximum. OK pressed.
5. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
6. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
7. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
8. Measure v4 – set measurement to measure Voltage Overshoot on the falling edge.
9. Measure v5 – set measurement to measure Voltage Base with pulse width of 50%.
10. Measure v6 – set measurement to measure Voltage Preshoot on the rising edge.
11. Calculate Rpre = v3/v2, Rpst = v1/v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3.
12. Measure Δv2 – trigger on rising edge. Scale and center high pulse of the square pattern. Place histogram left limit at t1+2T and right limit t2-2T (t1, t2, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
13. Calculate Δv2 = v2(max) – v2(min) as measured in step 12 histogram.
14. Measure Δv5 – trigger on falling edge. Scale and center low pulse of the square pattern. Place histogram left limit at t2+2T and right limit t3-2T (t2, t3, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
15. Calculate Δv5 = v5(max)-v5(min as measured in step 14 histogram.
16. Compare and report the values from steps 11, 13, and 15 to their respective specification values.

Coefficient Status c_1 min c_0 min c_1 dis

The purpose of this test is to verify Rpst and v2 are within specification as defined in table 72-8 of IEEE 802.3ap. Additionally, to verify that Δv2 and Δv5 are less than 40 mV. Additionally, (v1+v4)/v1, (v2+v5)/v2, and (v3+v6)/v3 cannot exceed 0.05.

PASS Condition

Rpst, v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3, Δv2 and Δv5 are within the respective defined specifications when c(1) is at its minimum, c(0) is at its minimum value, and c(-1) is disabled.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Pop up to ask user to change c(1) and c(0) to minimum. OK pressed.
5. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
6. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
7. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
8. Measure v4 – set measurement to measure Voltage Overshoot on the falling edge.
9. Measure v5 – set measurement to measure Voltage Base with pulse width of 50%.
10. Measure v6 – set measurement to measure Voltage Preshoot on the rising edge.
11. Calculate Rpst = v1/v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3.
12. Measure Δv2 – trigger on rising edge. Scale and center high pulse of the square pattern. Place histogram left limit at t1+2T and right limit t2-2T (t1, t2, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
13. Calculate Δv2 = v2(max) – v2(min) as measured in step 12 histogram.
14. Measure Δv5 – trigger on falling edge. Scale and center low pulse of the square pattern. Place histogram left limit at t2+2T and right limit t3-2T (t2, t3, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
15. Calculate Δv5 = v5(max)-v5(min as measured in step 14 histogram.
16. Compare and report the values from steps 11, 13, and 15 to their respective specification values.

Coefficient Status c_1 dis c_0 min c_1 min

The purpose of this test is to verify Rpre and v2 are within specification as defined in table 72-8 of IEEE 802.3ap. Additionally, to verify that Δv2 and Δv5 are less than 40 mV. Additionally, (v1+v4)/v1, (v2+v5)/v2, and (v3+v6)/v3 cannot exceed 0.05.

PASS Condition

Rpre, v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3, Δv2 and Δv5 are within the respective defined specifications when c(0) is at its minimum, c(-1) is at its minimum value, and c(-1) is disabled.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Pop up to ask user to change c(0) and c(-1) to minimum. OK pressed.
5. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
6. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
7. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
8. Measure v4 – set measurement to measure Voltage Overshoot on the falling edge.
9. Measure v5 – set measurement to measure Voltage Base with pulse width of 50%.
10. Measure v6 – set measurement to measure Voltage Preshoot on the rising edge.
11. Calculate Rpre = v3/v2, (v1+v4)/v1, (v2+v5)/v2, (v3+v6)/v3.
12. Measure Δv2 – trigger on rising edge. Scale and center high pulse of the square pattern. Place histogram left limit at t1+2T and right limit t2-2T (t1, t2, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
13. Calculate Δv2 = v2(max) – v2(min) as measured in step 12 histogram.
14. Measure Δv5 – trigger on falling edge. Scale and center low pulse of the square pattern. Place histogram left limit at t2+2T and right limit t3-2T (t2, t3, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
15. Calculate Δv5 = v5(max)-v5(min as measured in step 14 histogram.
16. Compare and report the values from steps 11, 13, and 15 to their respective specification values.

9 Transmitter Output Waveform “Information Only” Measurements

Transmitter Output Waveform “Information Only” Measurements / 76

This section provides the Methods of Implementation (MOIs) for the Transmitter Output Waveform “Information Only” Measurements using a Keysight Infiniium oscilloscope and the D9010EAPC 10GBASE-KR Compliance Test Application.

Probing and Connection for the Bus Signal Level Tests

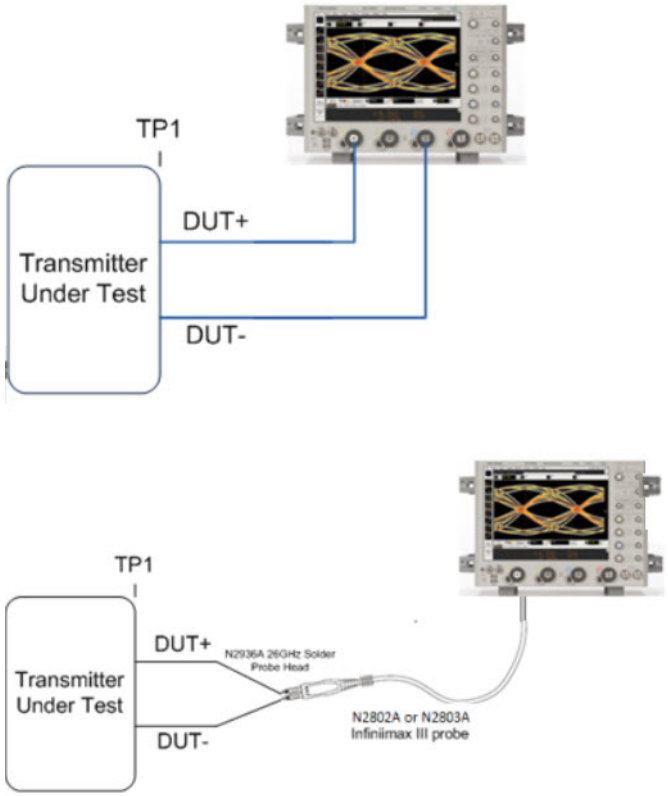


Figure 16 Probing for Transmitter Output Waveform Manual Measurements

You can use any of the oscilloscope channels as the signal source channel. You can identify the channels used for the measurement signal in the **Configuration** tab of the 10GBASE-KR Compliance Test Application. (The channels shown in the previous figure are just an example.)

Test Procedure

1. Start the automated test application as described in "Starting the 10GBASE-KR Compliance Test Application" on page 17.
2. Connect the probes to the signals on the DUT.
3. Connect the oscilloscope probes or cables to the channel(s) of the oscilloscope that you have set up in the **Configuration** tab.
4. In the 10GBASE-KR Test application, click on the **Set Up** tab.
5. Set up InfiniiSim if needed.
6. Type in or select the **Device Identifier** as well as the **User Description** from the drop-down list. Enter your comments in the **Comments** text box.
7. Click the **Select Tests** tab and check the tests you want to run. Check the parent node or group to check all the available tests within the group.

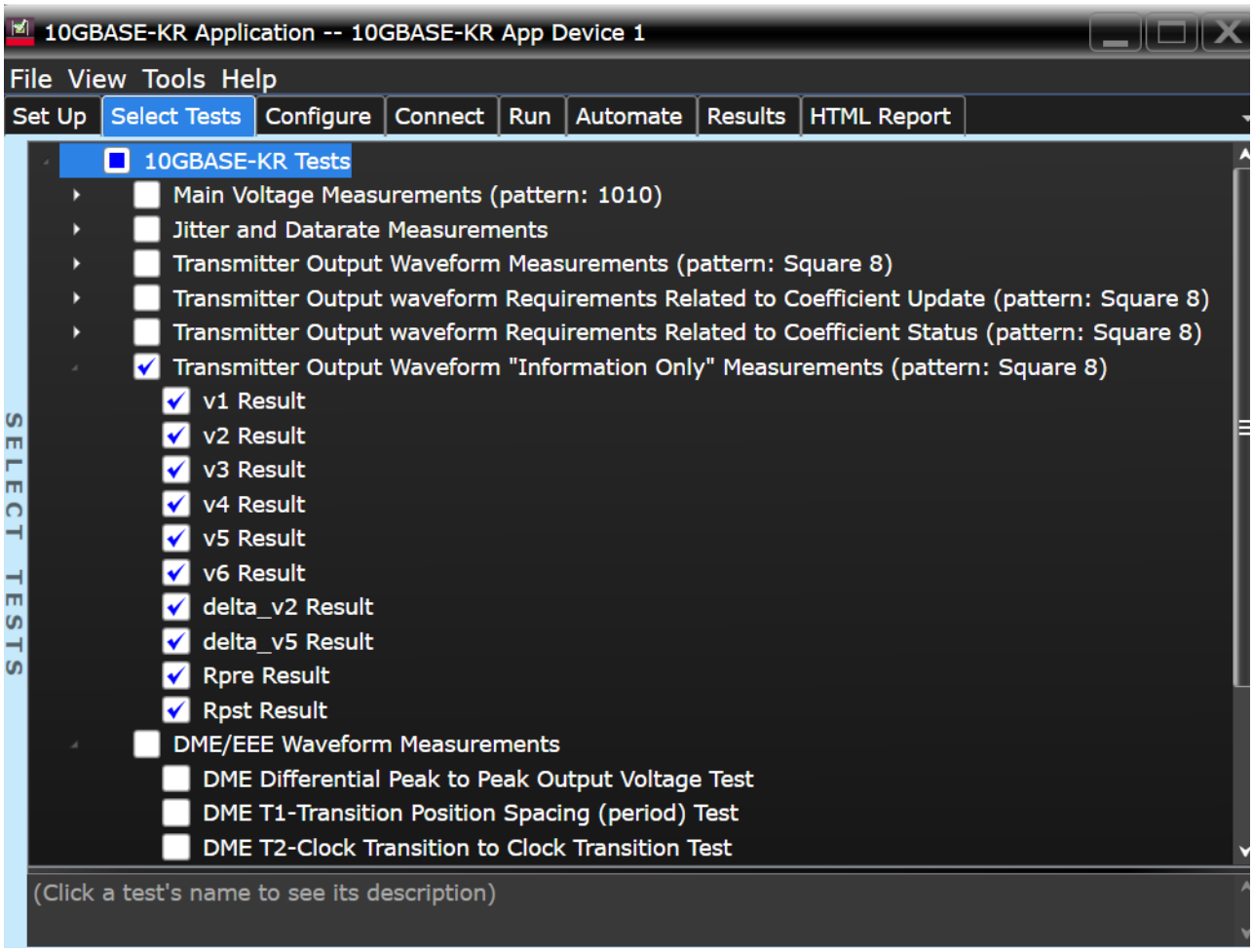


Figure 17 Selecting Transmitter Output Waveform Manual Test

Manual Measurement Specifications

These tests are information only tests to show the values of v1..v6, Δv2, Δv5, Rpre, and Rpst at any status, update, etc., that you would like to measure.

Transmitter Output Waveform “Information Only” Measurements

The purpose of these tests is information only, to show the values of v1..v6, Δv2, Δv5, Rpre, and Rpst at any status, update, etc., that you would like to measure.

PASS Condition Information only. No pass/fail criteria.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Check that the signal is connected and data pattern exists (square 8 pattern).
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Measure v1 – set measurement to measure Voltage Overshoot on the rising edge.
5. Measure v2 – set measurement to measure Pulse Top with Pulse width of 50%.
6. Measure v3 – set measurement to measure Voltage Preshoot on the falling edge.
7. Measure v4 – set measurement to measure Voltage Overshoot on the falling edge.
8. Measure v5 – set measurement to measure Voltage Base with pulse width of 50%.
9. Measure v6 – set measurement to measure Voltage Preshoot on the rising edge.
10. Calculate Rpre = v3/v2, Rpst = v1/v2.
11. Measure Δv2 – trigger on rising edge. Scale and center high pulse of the square pattern. Place histogram left limit at t1+2T and right limit t2-2T (t1, t2, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
12. Calculate Δv2 = v2(max) – v2(min) as measured in step 12 histogram.
13. Measure Δv5 – trigger on falling edge. Scale and center low pulse of the square pattern. Place histogram left limit at t2+2T and right limit t3-2T (t2, t3, and T defined in IEEE 802.3ap section 72.7.1.11 Figure 72-12).
14. Calculate Δv5 = v5(max)-v5(min as measured in step 14 histogram.
15. Report the values from steps 11, 13, and 15.

10 DME/EEE Waveform Measurements

DME Differential Peak-to-Peak Output Voltage Test / 81
DME T1-Transition Position Spacing (Period) Test / 82
DME T2-Clock Transition to Clock Transition Test / 83
DME T3-Clock Transition to Data Transition Test / 84
EEE Differential Peak-to-Peak Output Voltage Test with TX Disabled / 85
EEE Differential Peak-to-Peak Output Voltage Test / 86
EEE Common Mode Deviation Voltage Test / 87

This section provides the Methods of Implementation (MOIs) for the DME and EEE Waveform Measurements using a Keysight Infiniium oscilloscope and the D9010EAPC 10GBASE-KR Compliance Test Application.

Probing and Connection for the Bus Signal Level Tests.

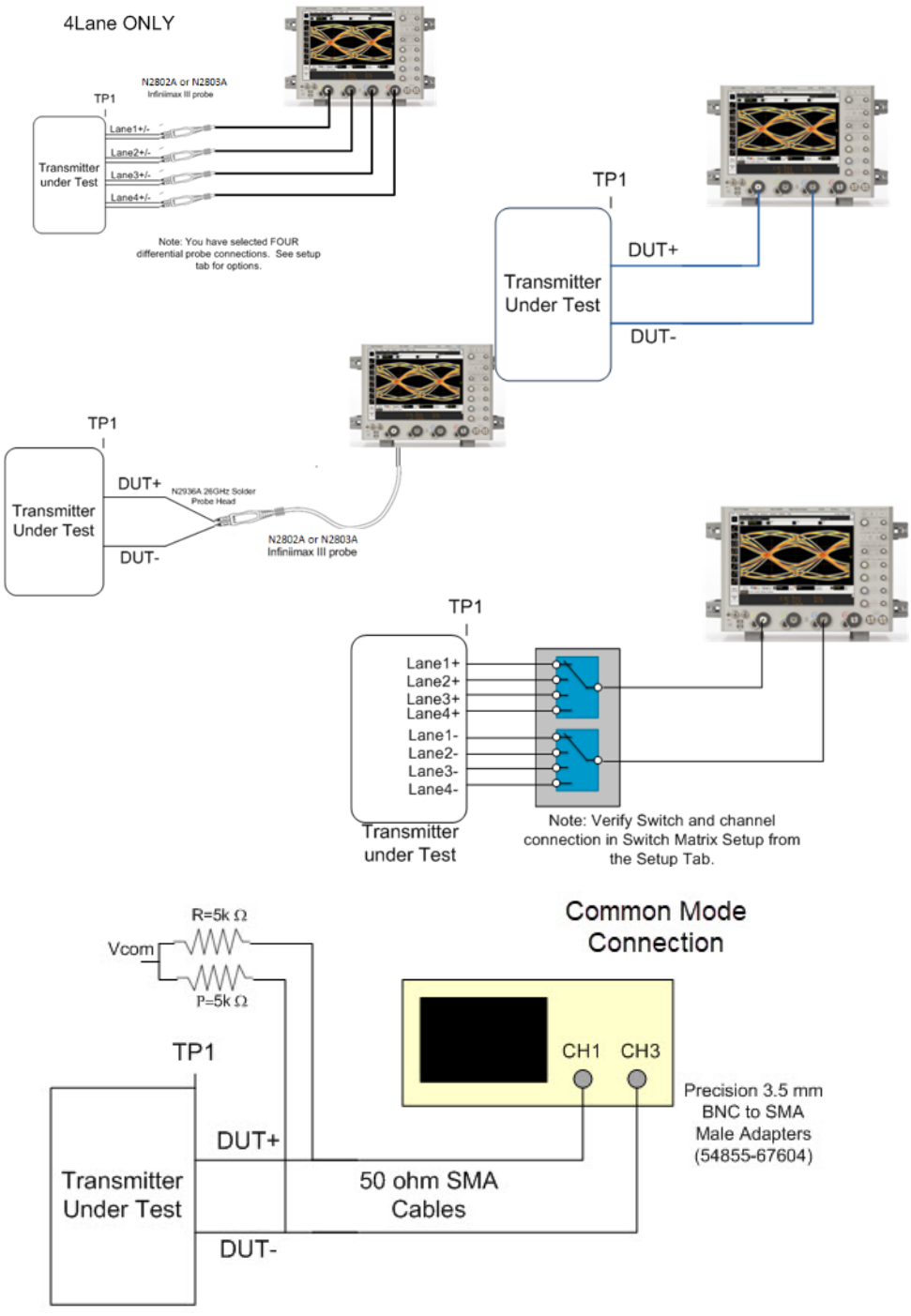


Figure 18 Probing for DME/EEE Waveform Measurements

You can use any of the oscilloscope channels as the signal source channel. You can identify the channels used for the measurement signal in the **Configuration** tab of the 10GBASE-KR Compliance Test Application. (The channels shown in the previous figure are just an example.)

Test Procedure

1 Start the automated test application as described in "Starting the 10GBASE-KR Compliance Test Application" on page 17.

2 Connect the probes to the signals on the DUT.

3 Connect the oscilloscope probes or cables to the channel(s) of the oscilloscope that you have set up in the **Configuration** tab.

4 In the 10GBASE-KR Test application, click on the **Set Up** tab.

5 Set up InfiniiSim if needed.

6 Type in or select the **Device Identifier** as well as the **User Description** from the drop-down list. Enter your comments in the **Comments** text box.

7 Click the **Select Tests** tab and check the tests you want to run. Check the parent node or group to check all the available tests within the group.

Figure 19 Selecting DME/EEE Waveform Tests

DME/EEE Waveform Specifications

The 10GBASE-KR and 40GBASE-KR4 DME specifications can be found in IEEE 802.3ap section 73.5.1 Table 73-1 and section 73.5.3 Table 73-2. The 10GBASE-KR and 40GBASE-KR4 EEE specifications can be found in section 72.7.1 Table 72-6.

- DME Differential Peak-to-Peak Output Voltage (0.6-1.2 V).
- DME T1 (3.2 ns-0.01% to 3.2 ns+0.1%).
- DME T2 (6.2 ns-6.6 ns).
- DME T3 (3.0 ns-3.4 ns).
- EEE Differential Peak-to-Peak Output Voltage with TX disabled (max 30 mV).
- EEE Differential Peak-to-Peak Output Voltage with TX enabled (min 720 mV).
- EEE Common Mode Voltage Deviation (±150 mV).

DME Differential Peak-to-Peak Output Voltage Test

The purpose of this test is to verify that the peak-to-peak voltage of the differential signal on a 1010 pattern is less than 1200 mV.

PASS Condition

The differential signal max peak-to-peak voltage on a 1010 pattern is less than 1200 mV.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Verify that there is a signal is connected and has a 1010 pattern.
3. Measure the peak-to-peak voltage of the differential signal of DUT+ and DUT-.
4. Compare the min and max peak-to-peak voltage to be within 0.6 to 1.2 V.

DME T1–Transition Position Spacing (Period) Test

The purpose of this test is to verify that transition spacing of the DME signal is 3.2 ns ±0.01%.

PASS Condition The mean period is between 3.2 ns ±0.01%.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Verify that there is a signal is connected.
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Request DUT in DME mode.
5. Measure the unit interval of the differential DME signal – set UI measurement to SEMI, 3.2e-9.
6. Compare the mean measurement to 3.2 ns ±0.01%.

DME T2-Clock Transition to Clock Transition Test

The purpose of this test is to verify clock to clock transition is 6.2 ns to 6.6 ns.

PASS Condition The mean period is between 6.2 ns to 6.6 ns.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Verify that there is a signal is connected.
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Request DUT in DME mode.
5. Measure the rising to rising edge.
6. Compare the min and max values to measurement to 6.2 ns to 6.6 ns.

DME T3-Clock Transition to Data Transition Test

The purpose of this test is to verify clock to data transition is 3.0 ns to 3.4 ns.

PASS Condition The min and max UI time is between 3.0 ns to 3.4 ns.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Verify that there is a signal is connected.
3. Set memory depth to capture the number or UI set in the configuration tab.
4. Request DUT in DME mode.
5. Measure the unit interval of the differential DME signal – set UI measurement to SEMI, 3.2e-9.
6. Compare the min and max values to measurement to 3.0 ns to 3.4 ns.

EEE Differential Peak-to-Peak Output Voltage Test with TX Disabled

The purpose of this test is to verify that when TX is disabled the peak-to-peak voltage is less than 30 mV.

PASS Condition

The max peak-to-peak voltage is less than 30 mV.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Request DUT to be EEE mode.
3. Check that the signal is truly with TX disabled (no valid data transitions).
4. Measure peak-to-peak voltage of the signal.
5. Compare the max peak-to-peak voltage to 30 mV.

EEE Differential Peak-to-Peak Output Voltage Test

The purpose of this test is to verify that the peak-to-peak voltage of the differential signal on a 1010 pattern is greater or equal to 720 mV.

PASS Condition

The differential signal max peak-to-peak voltage on a 1010 pattern is greater than or equal to 720 mV.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Request DUT in EEE mode.
3. Verify that there is a signal is connected and has a 1010 pattern.
4. Measure the peak-to-peak voltage of the differential signal of DUT+ and DUT-.
5. Compare the min voltage to be greater than or equal to 720 mV.

EEE Common Mode Deviation Voltage Test

The purpose of this test is to verify that the common mode signal of the differential pair of the pre-LPI signal and the LPI signal is within ±150 mV.

PASS Condition

The signal voltage change between pre and post LPI is within 150 mV change.

Measurement Algorithm

1. Obtain sample or acquire signal data.
2. Verify that there is a signal and that the connection is dual-single ended.
3. Request DUT to be pre-LPI.
4. Measure the peak-to-peak voltage of the addition of the channel 1 and 3 or channel 2 and 4.
5. Request DUT to be in LPI.
6. Measure the peak-to-peak voltage of the addition of the channel1 and 3 or channel 2 and 4.
7. Calculate Vpp(post)-Vpp(pre).
8. Compare the result from step 8 to ±150 mV.

11 Debug Mode

Debug mode can be selected to enable the ability to change jitter measurement options. In the **Configuration** tab, select the **Debug** radio button. This will add the following options:

- **Rj Bandwidth** – Choose the Rj Filter. Options are Narrow (Pink) or Wide (White). This changes the amount of DC jitter in the Rj measurement.
- **Jitter Pattern Length** – Choose Periodic or Arbitrary. Periodic is used for data patterns that are periodic and repeat through the scope memory. Arbitrary is used for random data patterns or long data patterns (for example, PRBS31) that do not repeat through the scope memory. If Arbitrary is selected, set the ISI filters.
- **ISI Filter Lead** – When using Arbitrary mode for the Jitter Pattern Length, set the Leading ISI filter coefficient. To help select the correct ISI filter, see "Application Note 1574: Choosing the ISI Filter Size for EZJIT Plus Arbitrary Data Jitter Analysis" (at www.keysight.com, literature part number 5989-4974EN).
- **ISI Filter Lag** – When using Arbitrary mode for the Jitter Pattern Length, set the Lagging ISI filter coefficient. Again, to help select the correct ISI filter, see "Application Note 1574: Choosing the ISI Filter Size for EZJIT Plus Arbitrary Data Jitter Analysis".

12 Exporting Measurement Results to Repository

Exporting Measurement Results to Repository / 92

This section describes the Upload Measurement Results To Repository feature of the Keysight D9010EAPC 10GBASE-KR and 40GBASE-KR4 Compliance Test Application.

Exporting Measurement Results to Repository

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

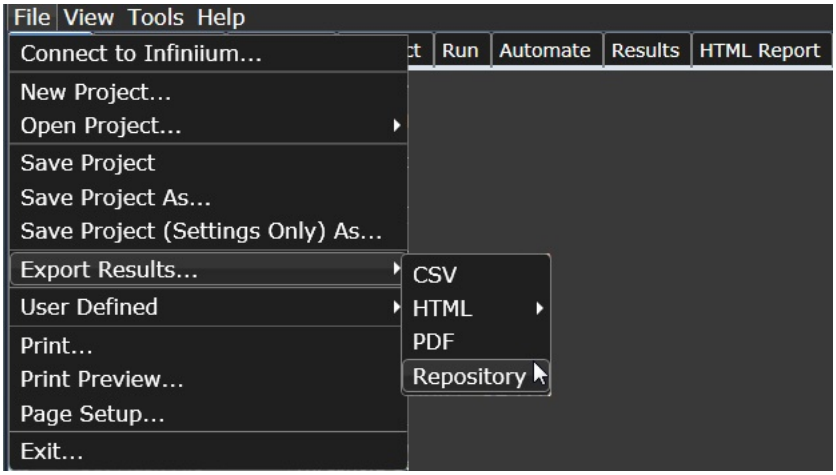
Not only can remote users with an active Internet connection access these Datasets and the corresponding test results on the Web Repository, but they have the option to add and delete Datasets on the Web Server. In the Upload Results To Repository feature, you can even modify the Dataset properties,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

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

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

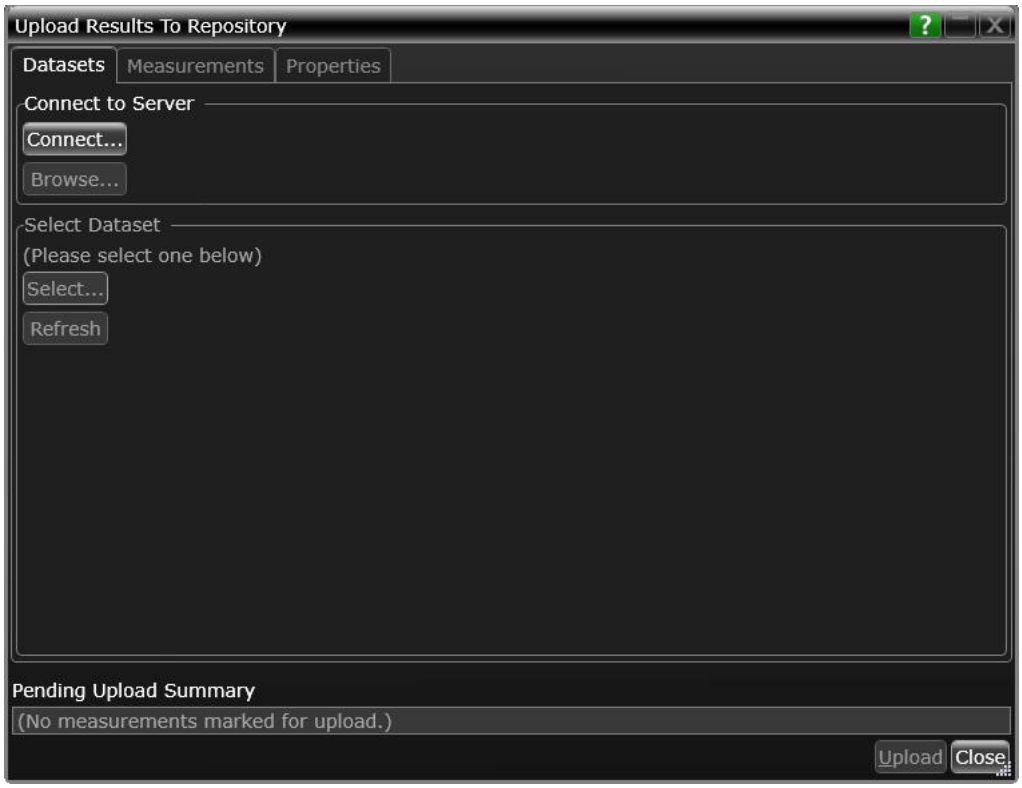
To export measurement results to the Repository after the completion of test runs,

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



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

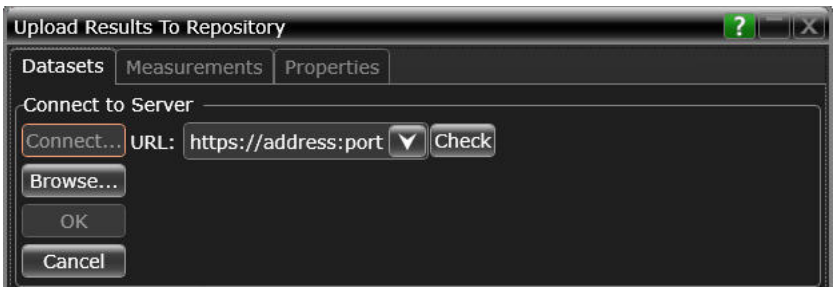
2 In the **Connect to Server** pane of the **Datasets** tab, click **Connect...** to login to the Dataset Repository server.



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

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

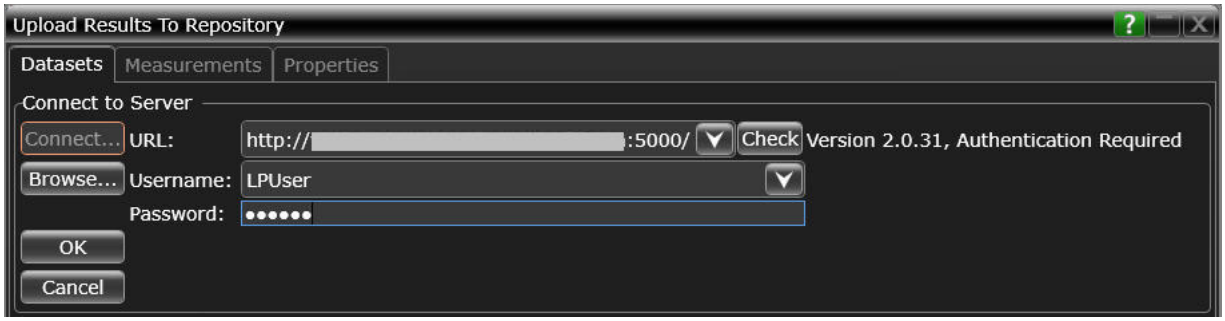
4 Click the **Check** button to verify that the KS6800A Series Analytics service is available on the specified web address. Repeat this step each time you edit the web address.



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

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

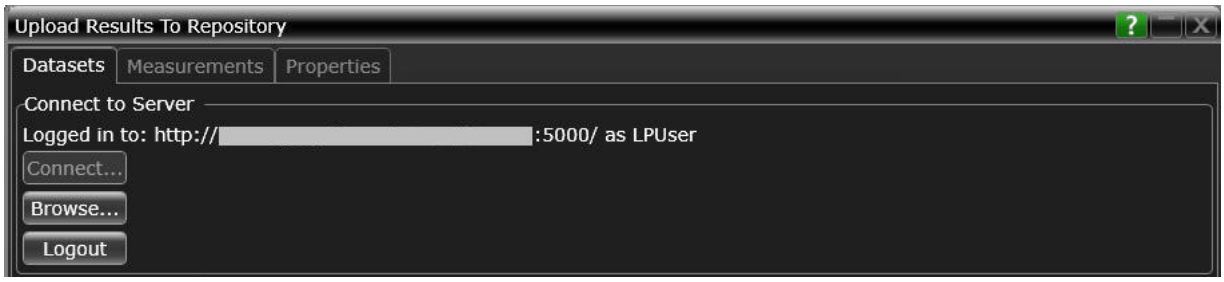
- For restricted access to the Repository
  - **a** If service is found on the specified URL but access to the web server is restricted based on authentication, the version information is displayed along with the text Authentication Required adjacent to the **Check** button. Also, the **Username**: and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



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

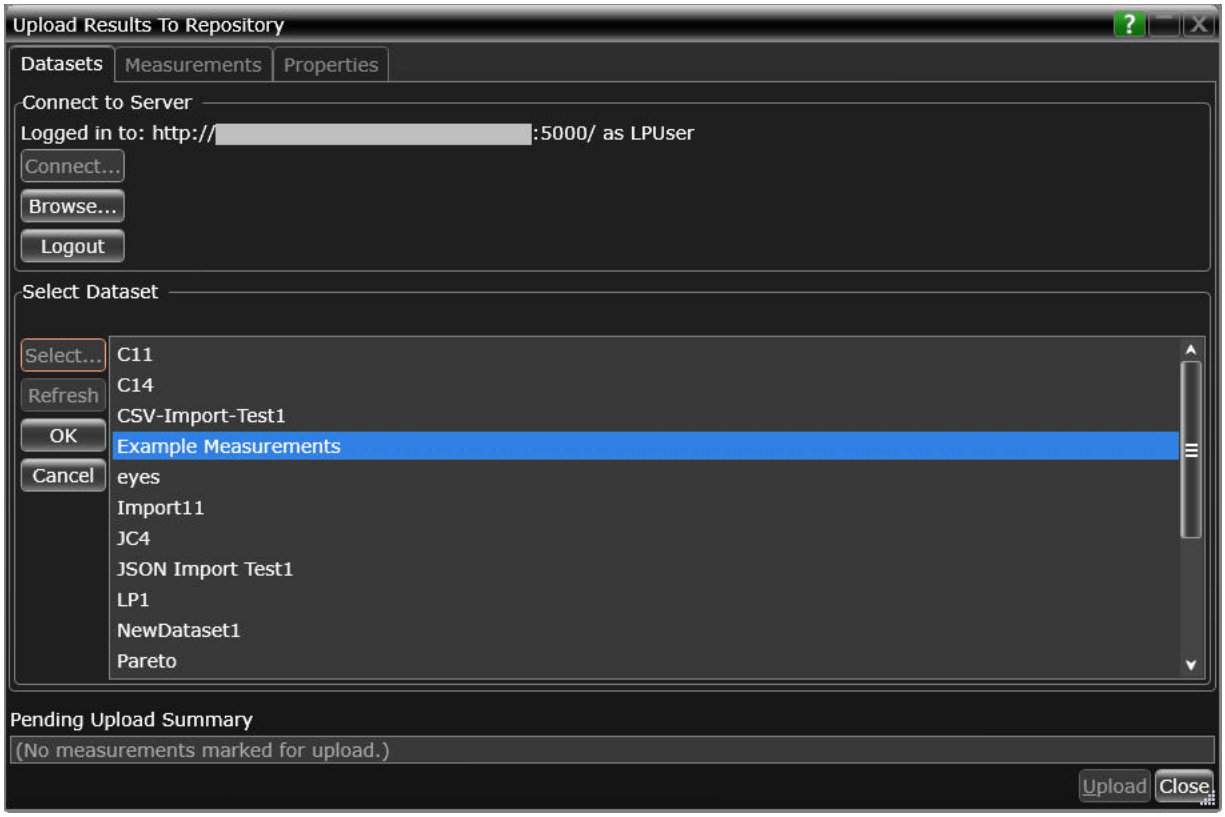
The **Connect to Server** area displays the connection status along with the username.

d Click **Browse**... to navigate directly to the URL.

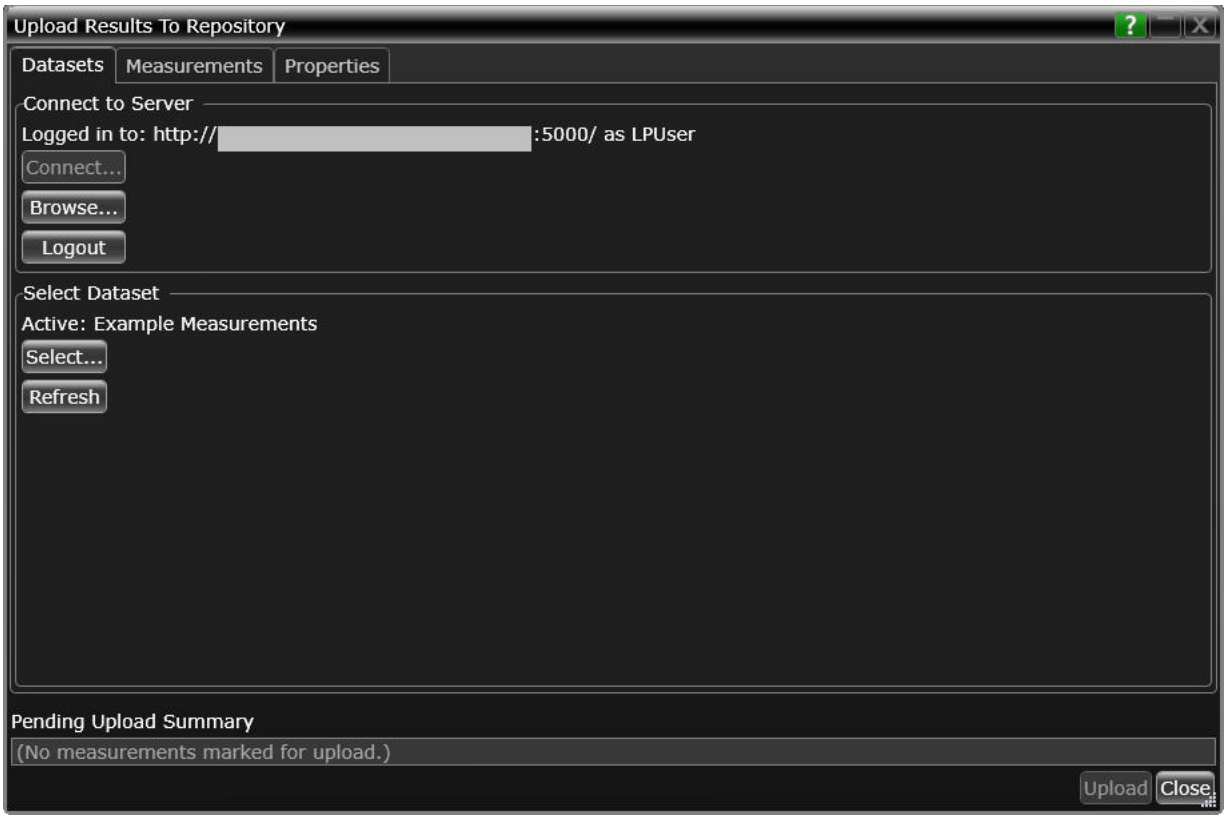


5 In the **Select Dataset** area, click **Select**... to view the list of Datasets created on the connected repository. Click **Refresh** to update the list of Datasets that appear in the Test Application's user interface.

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

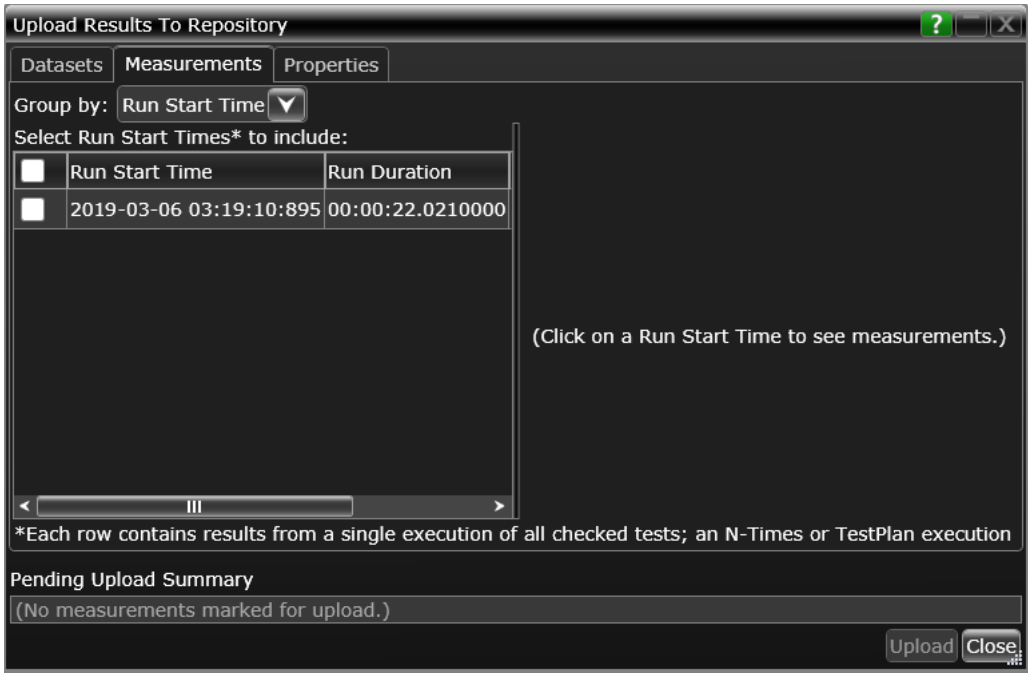


The **Select Dataset** area displays the selected Dataset as Active. The **Measurements** and **Properties** tabs are enabled after a Dataset is selected.



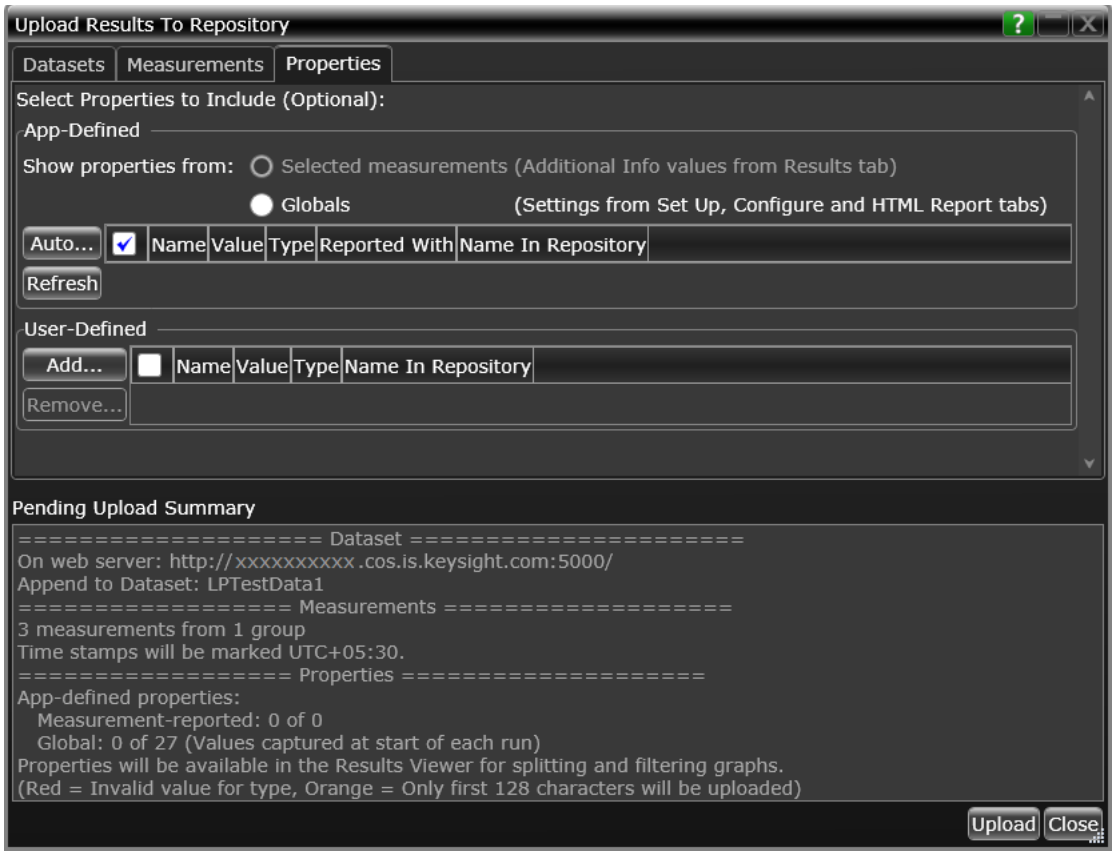
7 Click the **Measurements** tab where the test results from the last test run are displayed.

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

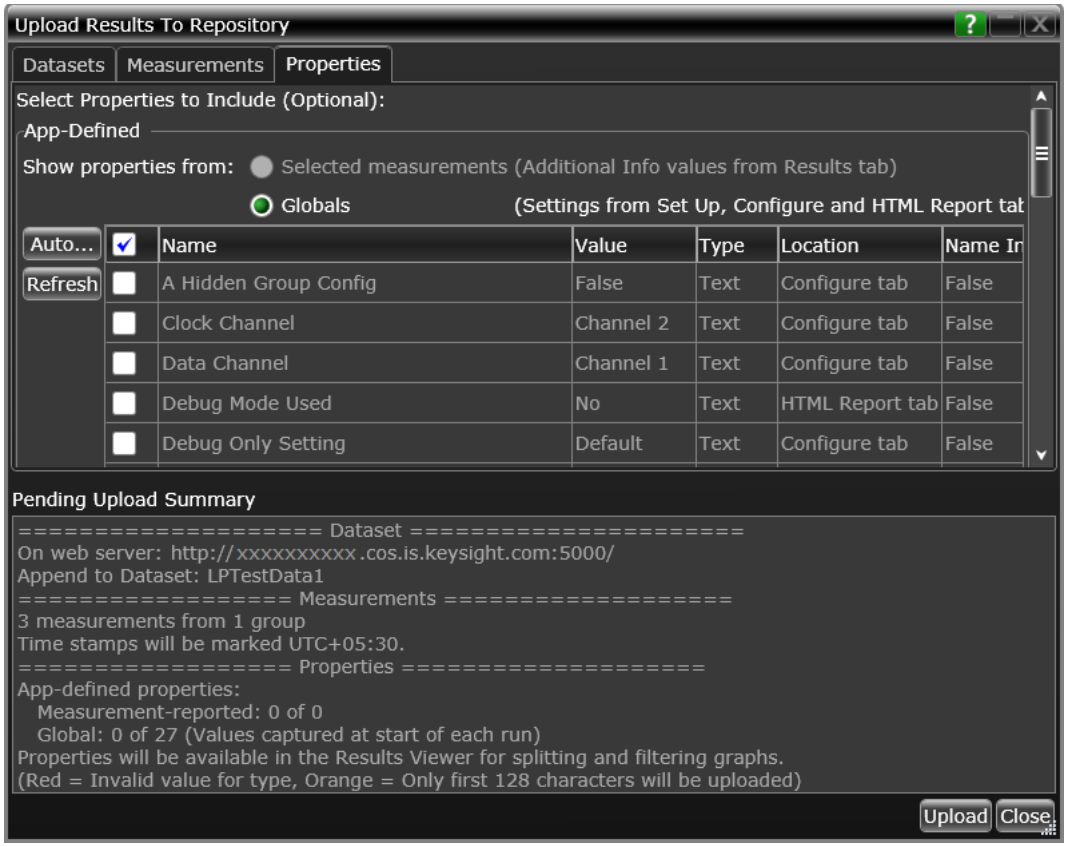


9 After selecting one or more measurements, either click **Upload** or switch to the **Properties** tab to associate one or more properties to the measurements that are being uploaded to the Web Server.

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



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



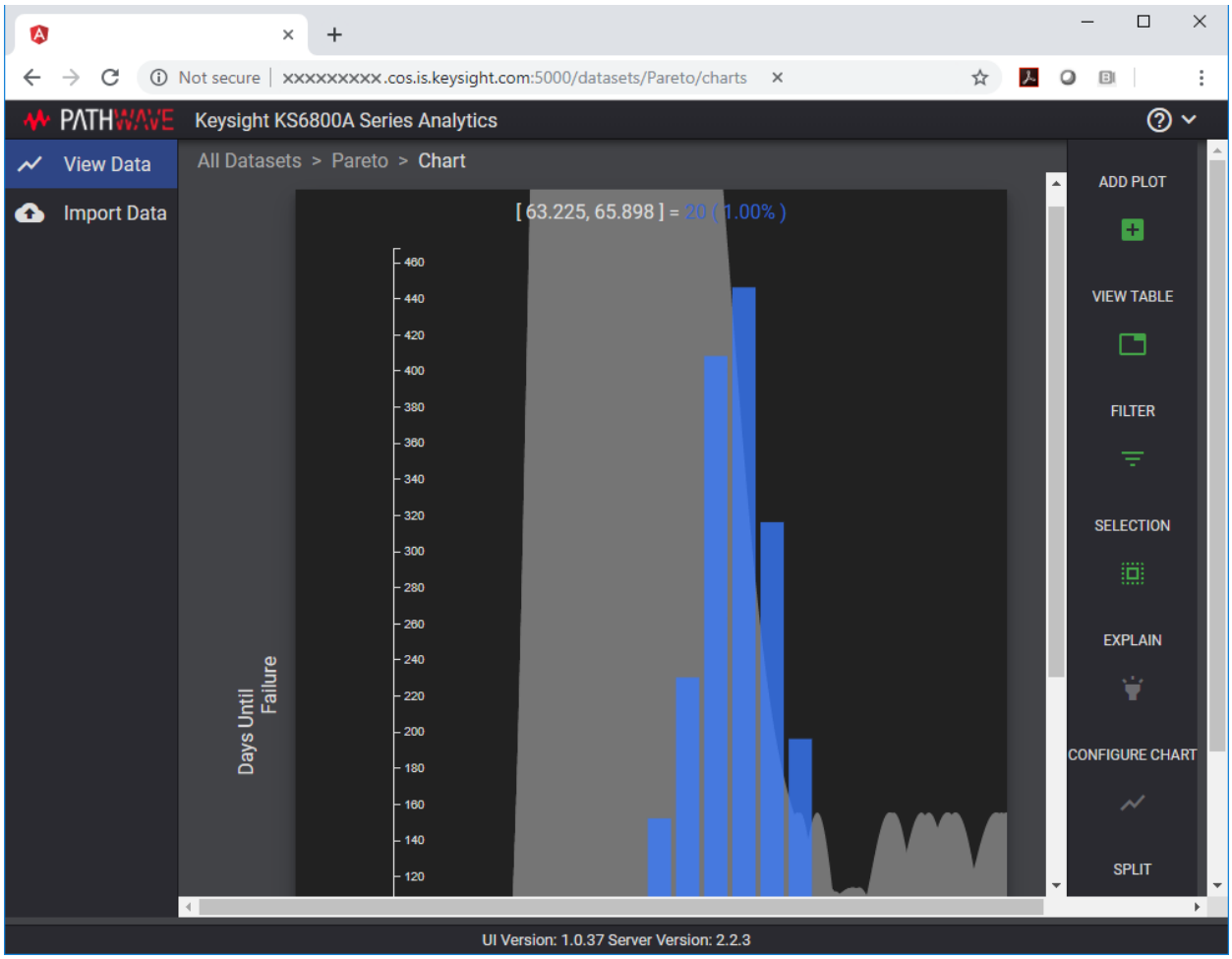
11 Click **Upload** to begin uploading measurement results.

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

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

KS6800A Series Analytics Service Software

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



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

A Calibrating the Infiniium Oscilloscope and Probe

Oscilloscope Internal Calibration / 104
Probe Calibration / 109

This section describes the Keysight Infiniium digital storage oscilloscope calibration procedures.

Oscilloscope Internal Calibration

This will perform an internal diagnostic and calibration cycle for the oscilloscope. For the Keysight oscilloscope, this is referred to as Calibration.

Required Equipment for Oscilloscope Calibration

To calibrate the Infiniium oscilloscope in preparation for running the 10GBASE-KR and 40GBASE-KR4 automated tests, you need the following equipment:

- Keyboard, qty = 1, (provided with the Keysight Infiniium oscilloscope).
- Mouse, qty = 1, (provided with the Keysight Infiniium oscilloscope).
- Precision 3.5 mm BNC to SMA male adapter, Keysight p/n 54855-67604, qty = 2 (provided with the Keysight Infiniium oscilloscope).
- Calibration cable (provided with Keysight Infiniium oscilloscopes). Use a good quality 50 Ω BNC cable.
- BNC shorting cap.

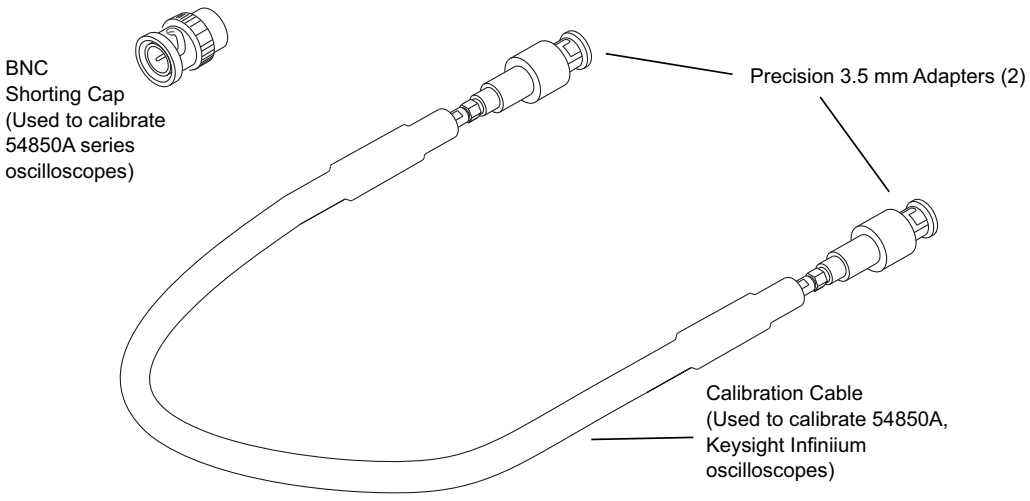


Figure 20 Accessories Provided with the Keysight Infiniium Oscilloscope

Running the Oscilloscope Internal Calibration

This Calibration will take about 20 minutes. Perform the following steps:

1. Set up the oscilloscope with the following steps:
   - **a** Connect the keyboard, mouse, and power cord to the rear of the oscilloscope.
   - **b** Plug in the power cord.
   - **c** Turn on the oscilloscope by pressing the power button located on the lower left of the front panel.
   - **d** Allow the oscilloscope to warm up at least 30 minutes prior to starting the calibration procedure in step 3 below.
2. Locate and prepare the accessories that will be required for the internal calibration:
   - **a** Locate the BNC shorting cap.
   - **b** Locate the calibration cable.
   - **c** Locate the two Keysight precision SMA/BNC adapters.
   - **d** Attach one SMA adapter to the other end of the calibration cable – hand tighten snugly.
   - **e** Attach another SMA adapter to the other end of the calibration cable – hand tighten snugly.

3 Referring to the following figure, perform the following steps:

a Click the **Utilities > Calibration...** menu to open the Calibration dialog box.

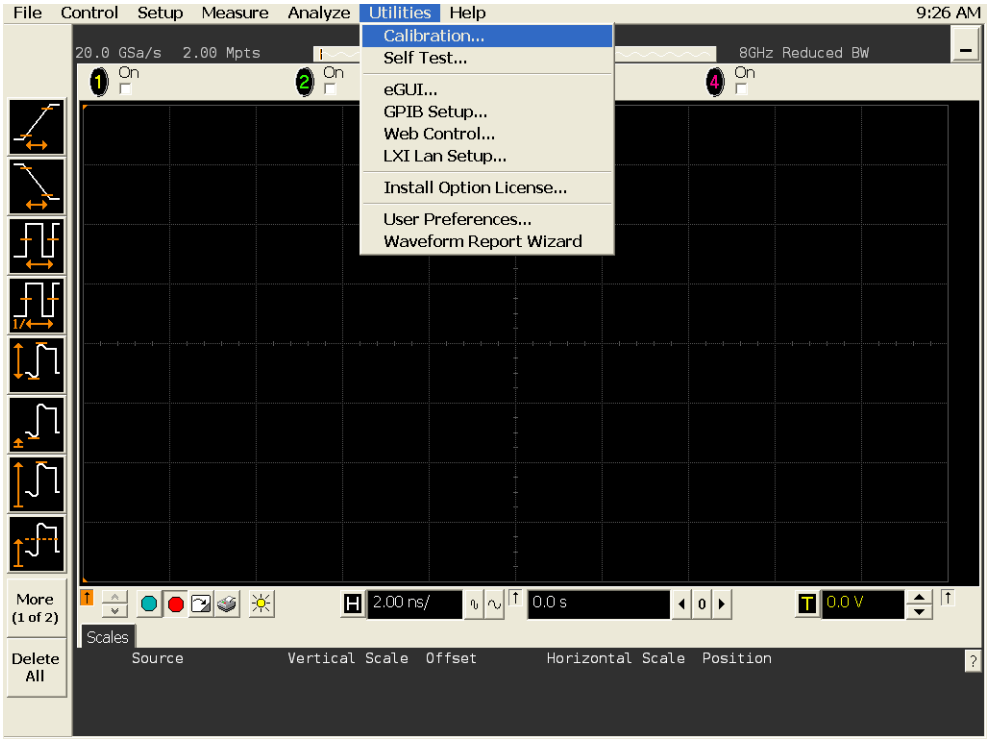


Figure 21 Accessing the Calibration Menu

4 Referring to the following figure, perform the following steps to start the calibration:

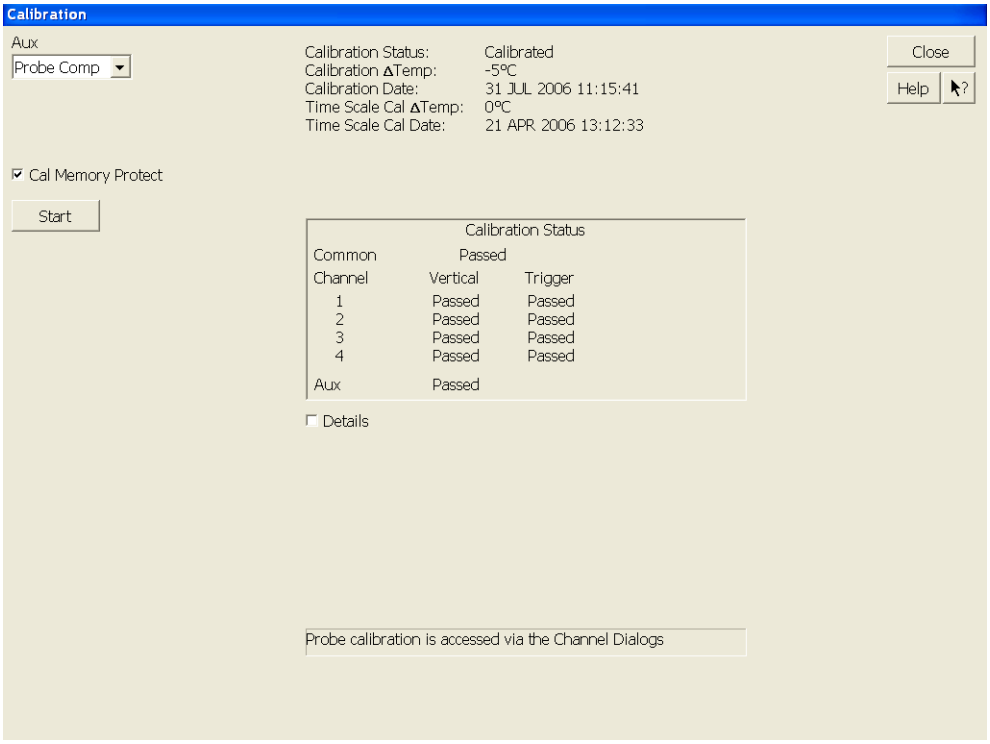


Figure 22 Oscilloscope Calibration Window

a Uncheck the **Cal Memory Protect** checkbox.

b Click the **Start** button to begin the calibration.

c During the calibration of channel 1, if you are prompted to perform a **Time Scale Calibration**, as shown in the following figure, click the **Std+Dflt** button to continue the calibration, using the Factory default calibration factors.

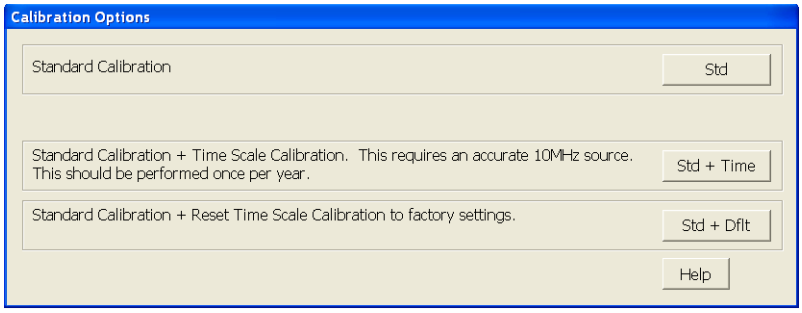


Figure 23 Time Scale Calibration Dialog Box

d When the calibration procedure is complete, you will be prompted with a Calibration Complete message window. Click the **OK** button to close this window.

e Confirm that the Vertical and Trigger Calibration Status for all Channels passed.

f Click the **Close** button to close the calibration window.

g The internal calibration is completed.

NOTE These steps do not need to be performed every time a test is run. However, if the ambient temperature changes more than 5 degrees Celsius from the calibration temperature, this calibration should be performed again. The delta between the calibration temperature and the present operating temperature is shown in the **Utilities > Calibration...** menu.

Probe Calibration

Before performing 10GBASE-KR and 40GBASE-KR4 tests, you should calibrate the probes. Calibration of the solder-in probe heads consist of a vertical calibration and a skew calibration. The vertical calibration should be performed before the skew calibration. Both calibrations should be performed for best probe measurement performance.

Required Equipment for Probe Calibration

The calibration procedure requires the following parts.

- BNC (male) to SMA (male) adapter.
- Deskew fixture.
- 50 Ω SMA terminator.

Connecting the Probe for Calibration

For the following procedure, refer to the following figure.

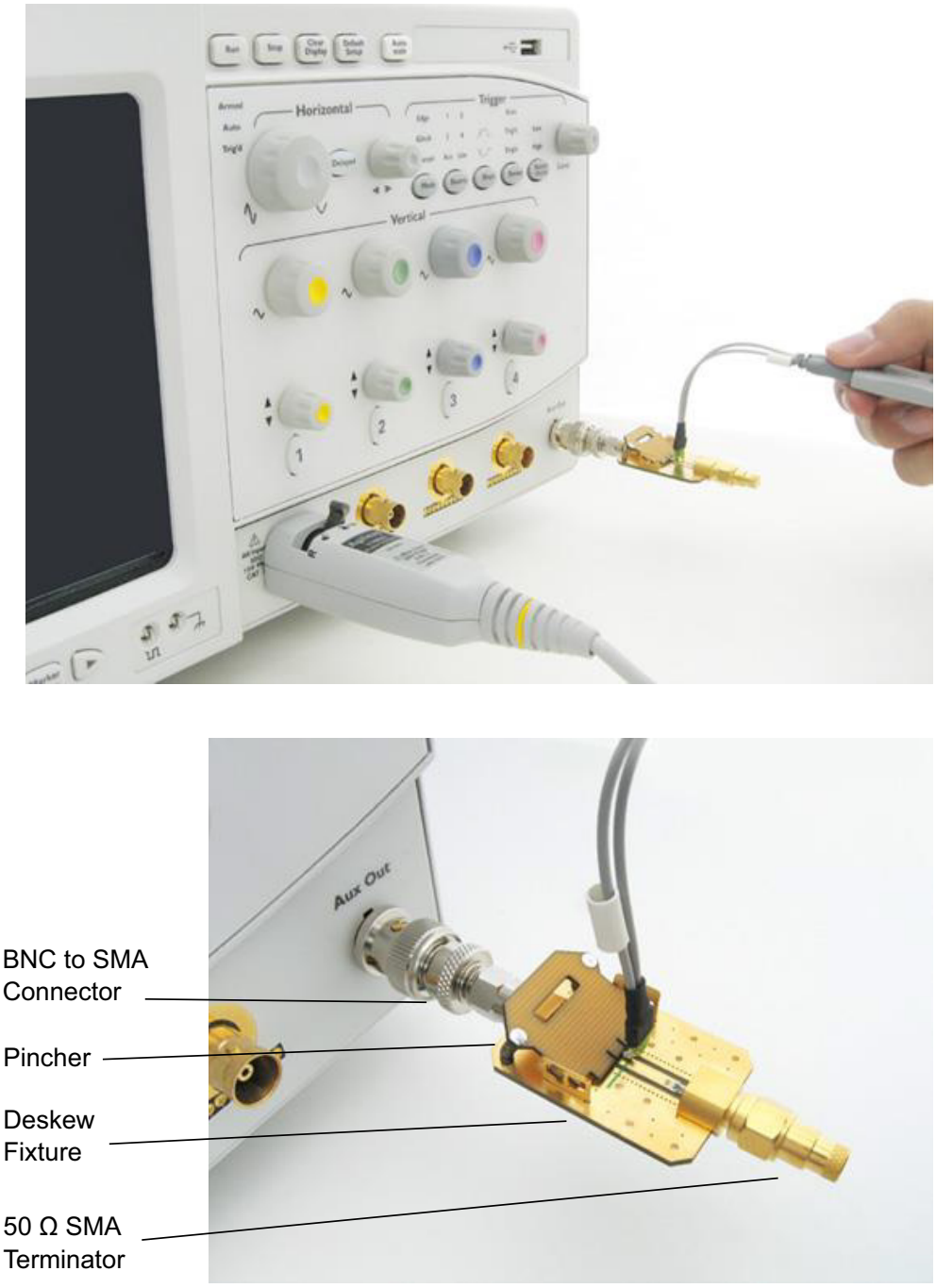


Figure 24 Solder-in Probe Head Calibration Connection Example

1 Connect BNC (male) to SMA (male) adapter to the deskew fixture on the connector closest to the yellow pincher.

2 Connect the 50 Ω SMA terminator to the connector farthest from yellow pincher.

3 Connect the BNC side of the deskew fixture to the Aux Out BNC of the Infiniium oscilloscope.

4 Connect the probe to an oscilloscope channel.

5 To minimize the wear and tear on the probe head, it should be placed on a support to relieve the strain on the probe head cables.

6 Push down the back side of the yellow pincher. Insert the probe head resistor lead underneath the center of the yellow pincher and over the center conductor of the deskew fixture. The negative probe head resistor lead or ground lead must be underneath the yellow pincher and over one of the outside copper conductors (ground) of the deskew fixture. Make sure that the probe head is approximately perpendicular to the deskew fixture.

7 Release the yellow pincher.

Verifying the Connection

1 On the Infiniium oscilloscope, press the **[Auto Scale]** key on the front panel.

2 Set the volts per division to **100 mV/div**.

3 Set the horizontal scale to **1.00 ns/div**.

4 Set the horizontal position to approximately **3 ns**. You should see a waveform similar to that in the following figure.

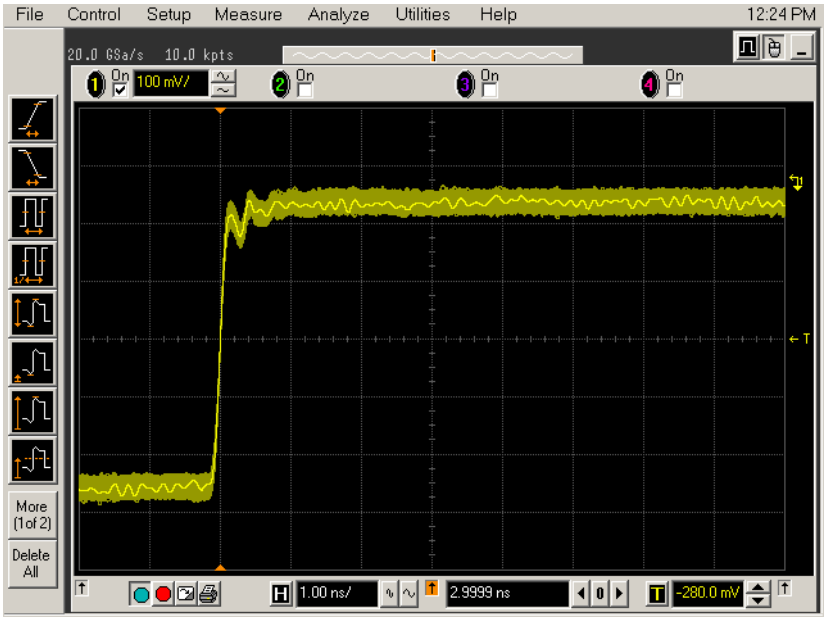


Figure 25 Good Connection Waveform Example

If you see a waveform similar to that of the following figure, then you have a bad connection and should check all of your probe connections.

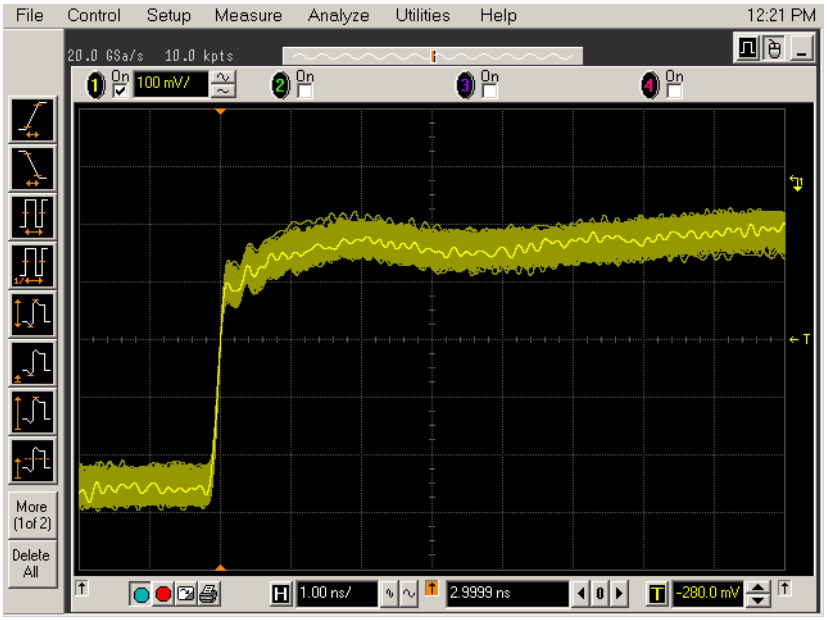


Figure 26 Bad Connection Waveform Example

Running the Probe Calibration and Deskew

1 On the Infiniium oscilloscope in the **Setup** menu, select the channel connected to the probe, as shown in the following figure.

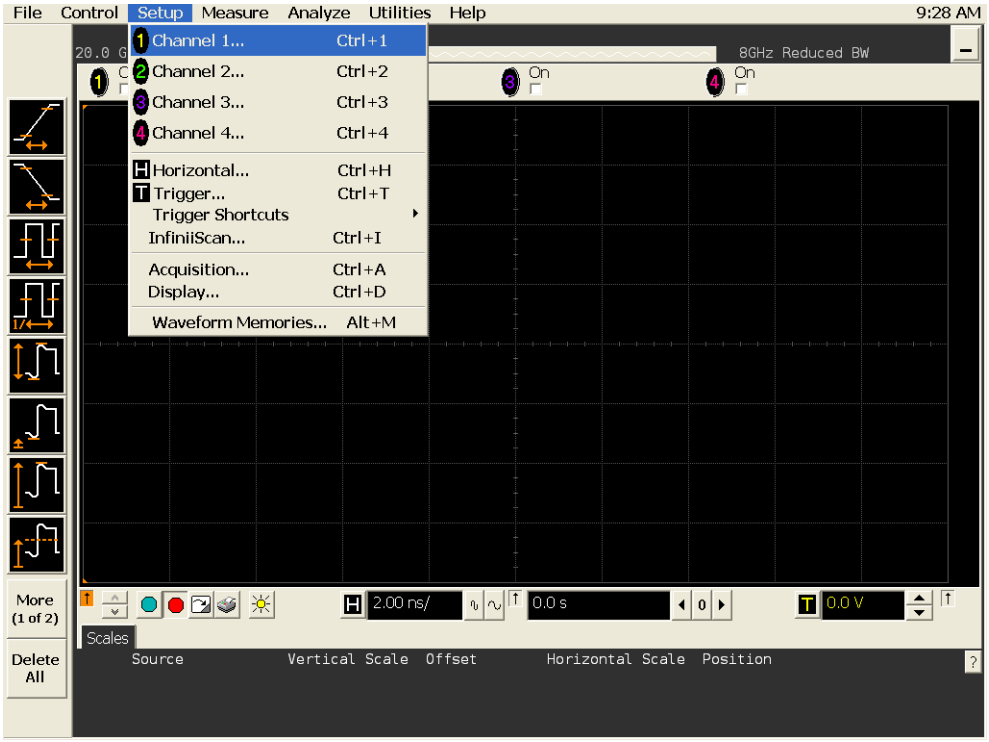


Figure 27 Channel Setup Window

2 In the Channel Setup dialog box, select the **Probes...** button, as shown in the following figure.

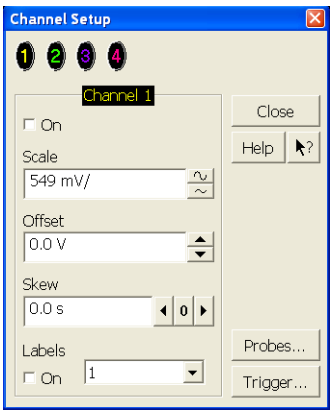


Figure 28 Channel Dialog Box

3 In the Probe Setup dialog box, select the **Calibrate Probe...** button.

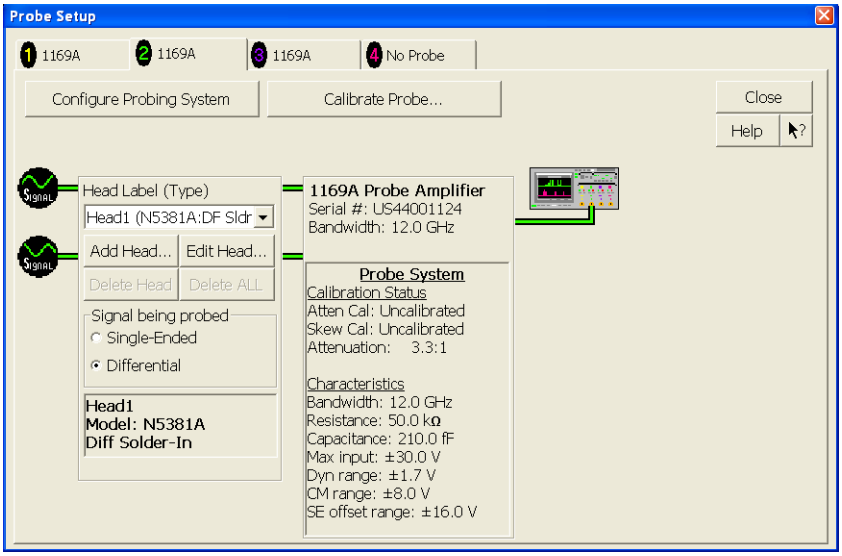


Figure 29 Probe Setup Window

4 In the Probe Calibration dialog box, select the **Calibrated Atten/Offset** radio button.

5 Select the **Start Atten/Offset Calibration...** button and follow the on-screen instructions for the vertical calibration procedure.

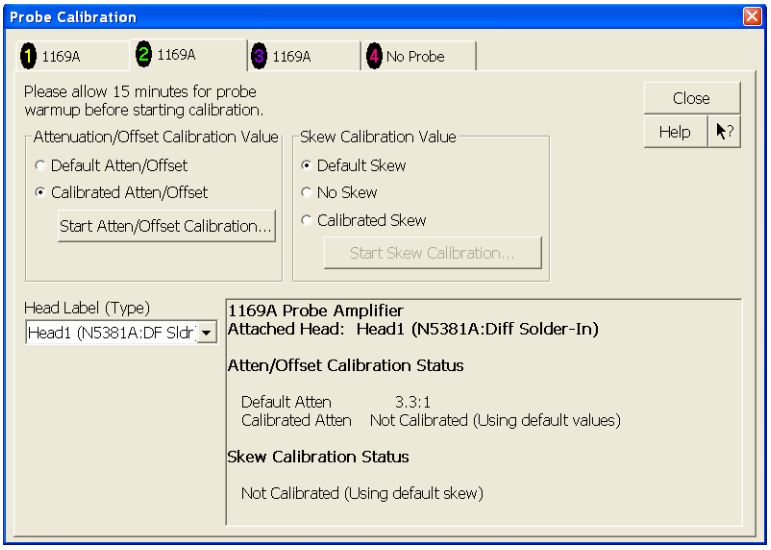


Figure 30 Probe Calibration Window

6 Once the vertical calibration has successfully completed, select the **Calibrated Skew...** button.

7 Select the **Start Skew Calibration...** button and follow the on-screen instructions for the skew calibration.

At the end of each calibration, the oscilloscope will prompt you if the calibration was or was not successful.

Verifying the Probe Calibration

If you have successfully calibrated the probe, it is not necessary to perform this verification. However, if you want to verify that the probe was properly calibrated, the following procedure will help you verify the calibration.

The calibration procedure requires the following parts:

- BNC (male) to SMA (male) adapter.
- SMA (male) to BNC (female) adapter.
- BNC (male) to BNC (male) 12 inch cable such as the Keysight 8120-1838.
- Keysight 54855-61620 calibration cable (Infiniium oscilloscopes with bandwidths of 6 GHz and greater only).
- Keysight 54855-67604 precision 3.5 mm adapters (Infiniium oscilloscopes with bandwidths of 6 GHz and greater only).
- Deskew fixture.

For the following procedure, refer to the following figure.

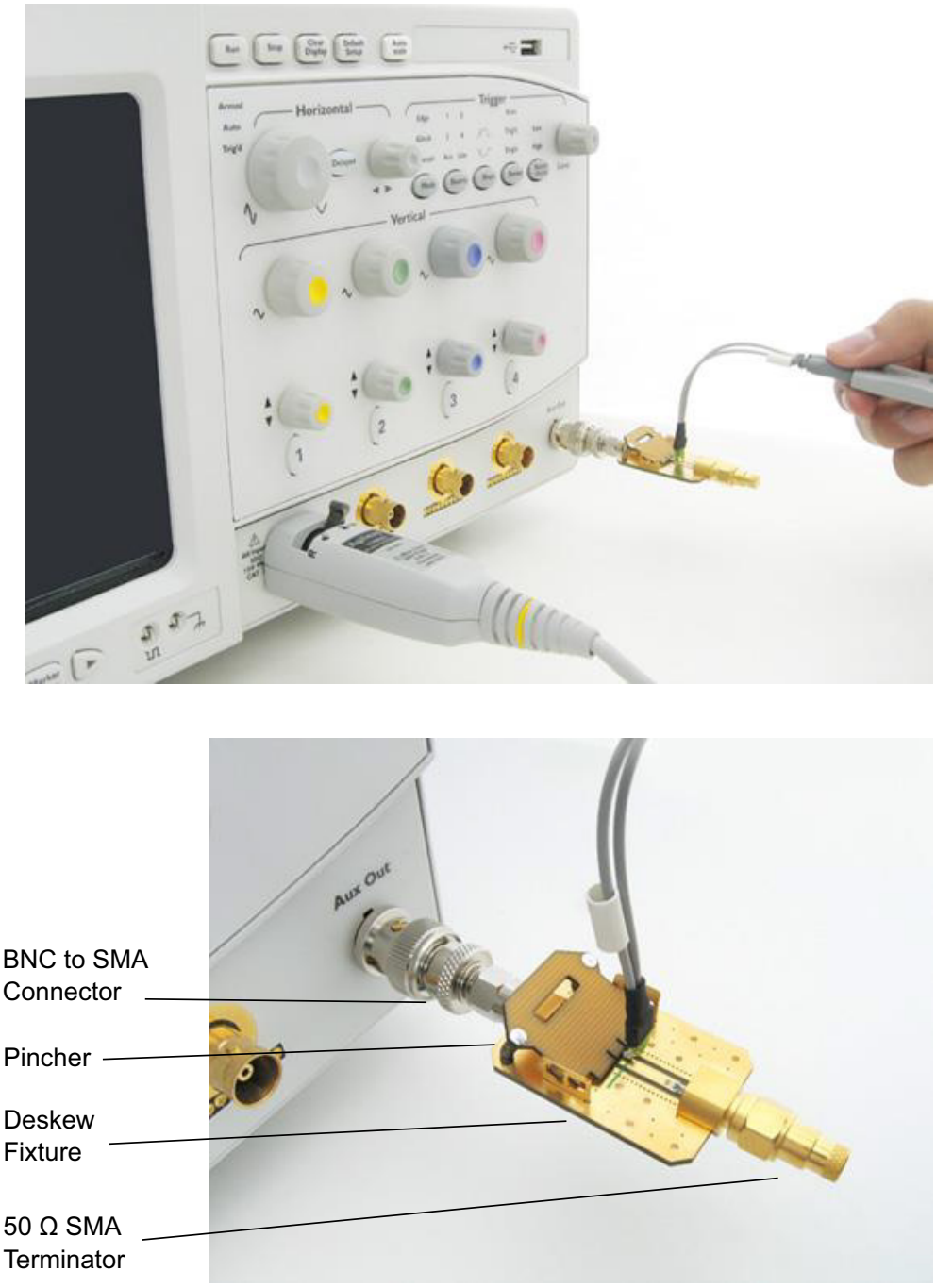


Figure 31 Probe Calibration Verification Connection Example

1 Connect BNC (male) to SMA (male) adapter to the deskew fixture on the connector closest to the yellow pincher.

2 Connect the SMA (male) to BNC (female) to the connector farthest from the yellow pincher.

3 Connect the BNC (male) to BNC (male) cable to the BNC connector on the deskew fixture to one of the unused oscilloscope channels. For infiniium oscilloscopes with bandwidths of 6 GHz and greater, use the 54855-61620 calibration cable and the two 54855-64604 precision 3.5 mm adapters.

4 Connect the BNC side of the deskew fixture to the Aux Out BNC of the Infiniium oscilloscope.

5 Connect the probe to an oscilloscope channel.

6 To minimize the wear and tear on the probe head, it should be placed on a support to relieve the strain on the probe head cables.

7 Push down on the back side of the yellow pincher. Insert the probe head resistor lead underneath the center of the yellow pincher and over the center conductor of the deskew fixture. The negative probe head resistor lead or ground lead must be underneath the yellow pincher and over one of the outside copper conductors (ground) of the deskew fixture. Make sure that the probe head is approximately perpendicular to the deskew fixture.

8 Release the yellow pincher.

9 On the oscilloscope, press the autoscale button on the front panel.

10 Select Setup menu and choose the channel connected to the BNC cable from the pull-down menu.

11 Select the **Probes...** button.

12 Select the **Configure Probe System** button.

13 Select **User Defined Probe** from the pull-down menu.

14 Select the **Calibrate Probe...** button.

15 Select the **Calibrated Skew** radio button.

16 Once the skew calibration is completed, close all dialog boxes.

17 Select the **Start Skew Calibration...** button and follow the on-screen instructions.

18 Set the vertical scale for the displayed channels to **100 mV/div**.

19 Set the horizontal range to **1.00 ns/div**.

20 Set the horizontal position to approximately **3 ns**.

21 Change the vertical position knobs of both channels until the waveforms overlap each other.

22 Select the Setup menu choose **Acquisition...** from the pull-down menu.

23 In the Acquisition Setup dialog box enable averaging. When you close the dialog box, you should see waveforms similar to that in the following figure.

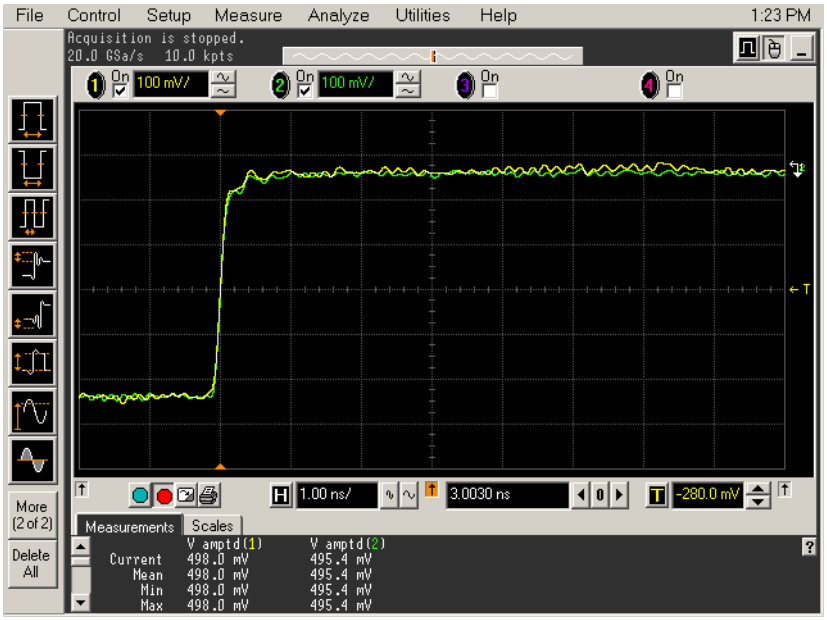


Figure 32 Calibration Probe Waveform Example

NOTE

Each probe is calibrated with the oscilloscope channel to which it is connected. Do not switch probes between channels or other oscilloscopes, or it will be necessary to calibrate them again. It is recommended that the probes be labeled with the channel on which they were calibrated.

Index

Numerics

10GBASE-KR and 40GBASE-KR4 compliance test application, 4

A

application software, installing, 10
application software, starting, 17
Automation tab, 18

B

BNC shorting cap, 104
BNC to SMA male adapter, 104

C

calibrating the oscilloscope, 16, 20, 103
calibration cable, 104
Coefficient Status c_1 dis c_0 max c_1 dis, 70
Coefficient Status c_1 dis c_0 min c_1 dis, 69
Coefficient Status c_1 dis c_0 min c_1 min, 72
Coefficient Status c_1 min c_0 min c_1 dis, 71
coefficient status measurements, 65
coefficient status specifications, 67
Coefficient Update c_1 dec c_0 hold c_1 hold, 60
Coefficient Update c_1 hold c_0 dec c_1 hold, 62
Coefficient Update c_1 hold c_0 hold c_1 dec, 64
Coefficient Update c_1 hold c_0 hold c_1 inc, 63
Coefficient Update c_1 hold c_0 inc c_1 hold, 61
Coefficient Update c_1 inc c_0 hold c_1 hold, 59
coefficient update measurements, 55
coefficient update specifications, 57
Common Mode Voltage Test, 40
Configure tab, 18
Connect tab, 18

D

data rate, 46
data rate and jitter measurements, 43
data rate specifications, 51
Debug Mode, 89
deskew and probe calibration, running, 113
deterministic jitter, 47
Differential Peak-to-Peak Output Voltage Test, 41
Differential Peak-to-Peak Output Voltage Test with TX Disabled, 39
DME Differential Peak-to-Peak Output Voltage Test, 81
DME T1-Transition Position Spacing (Period) Test, 82
DME T2-Clock Transition to Clock Transition Test, 83
DME T3-Clock Transition to Data Transition Test, 84
DME/EEE waveform measurements, 77
DME/EEE waveform specifications, 80
duty cycle distortion, 47

E

EEE Common Mode Deviation Voltage Test, 87
EEE Differential Peak-to-Peak Output Voltage Test, 86
EEE Differential Peak-to-Peak Output Voltage Test with TX Disabled, 85
equipment required for calibration, 104
equipment required for probe calibration, 109

H

HTML Report tab, 18

I

installation, 9
ISI Filter Lag, 89
ISI Filter Lead, 89

J

jitter, 47
jitter and data rate measurements, 43
Jitter Pattern Length, 89
jitter specifications, 51

K

keyboard, 104

L

license key, installing, 11

M

main voltage measurements, 35
main voltage specifications, 38
manual measurement specifications, 75
manual measurements, 73
measurements, preparing, 15, 19
mouse, 104

N

notices, 4

O

oscilloscope calibration, 16, 20
oscilloscope internal calibration, 104
oscilloscope internal calibration, running, 105

P

precision 3.5 mm BNC to SMA male adapter, 104
probe calibration, 109
probe calibration and deskew, running, 113
probe calibration connection, verifying, 111
probe calibration, connecting, 109
probe calibration, verifying, 115

R

random jitter, 47
Results tab, 18
Rj Bandwidth, 89
Run Tests tab, 18

S

Select Tests tab, 18
Set Up tab, 18
specifications, coefficient status, 67
specifications, coefficient update, 57
specifications, data rate, 51
specifications, DME/EEE waveform, 80
specifications, jitter, 51
specifications, main voltage, 38
specifications, manual measurement, 75
specifications, transmitter output, 45

T

total jitter, 47
transition time, falling edge, 53
transition time, rising edge, 52
transmitter output specifications, 45
transmitter output waveform manual measurements, 76
transmitter output waveform measurements, 49