DATA SHEET

D9050CEIC OIF-CEI-112G

Measurement and Conformance Application Software

Characterize CEI-112G-VSR/MR/LR Electrical Transmitter Designs using Infiniium UXR-Series Real-Time Oscilloscopes

KEYSIGHT TECHNOLOGIES

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Introduction

The Optical Internetworking Forum – Common Electrical Interface (OIF-CEI) defines a series of related 112Gb/s electrical standards supporting several interconnect channel lengths. Very Short Reach (VSR), Medium Reach (MR) and Long Reach (LR) specifications are leveraged widely in high speed optical and electrical interconnect strategies where tradeoffs in channel length, power consumption and error rate are balanced with product needs.

Several industry and standards bodies have defined specifications for 100 Gb/s high speed electrical interface using PAM4 coding. As an example, an implementation agreement (IA) developed by the Optical Internetworking Forum – Common Electrical Interface (OIF-CEI) defines 112 Gb/s operation in OIF-CEI 112G using 53b/56b PAM4 signaling (CEI-112G-VSR/MR/LR).

The Keysight D9050CEIC measurement solution offers users result accuracy and consistency in measurement techniques tracking to the OIF-CEI 112Gb/s standards. The OIF-CEI 112G standards dependency on adaptive reference equalizer demands tool automation for traversing the CTLE and DFE solutions grid in finding the optimized filter coefficients within bounds stipulated by these standards. The automation of this process along with the ability to adaptively re-configure these equalizers supports site to site measurement uniformity and significant time savings.

Keysight D9050CEIC OIF-CEI-112G software

The Keysight D9050CEIC OIF-CEI-112G software product is a measurement application for the Infiniium UXR-Series Real-Time Oscilloscopes designed to save you time and money by automating the task of performing PAM4 transmitter (TX) test measurements

Transform Complexity into Simplicity

The D9050CEIC conformance software is an easy-to-use TX test application that:

- Saves time in understanding details of unique standards measurements
- Offers site to site consistency in uniform measurement results
- Reduces the time it takes to characterize your 56Gbd PAM4 design from hours to minutes
- Helps debug your device using custom test and diagnostic configurations

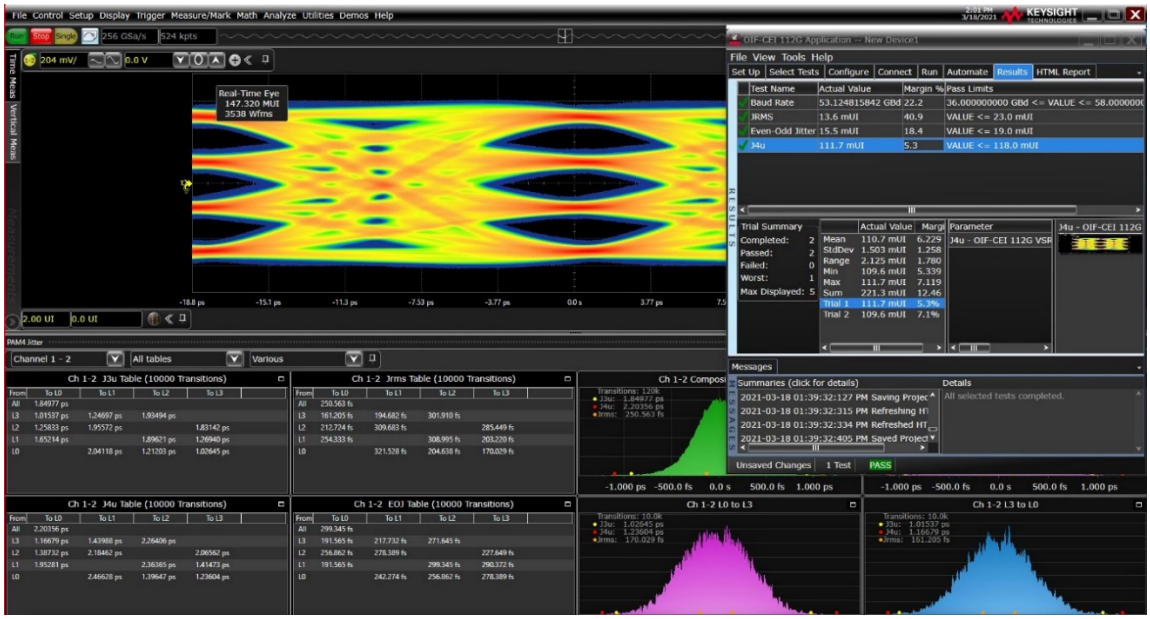

Figure 1. 53 Gbaud PAM4 eye diagram with jitter decomposition on a PRBS13Q pattern

Select Industry-leading Hardware

The D9050CEIC conformance software application is specifically designed to leverage the hardware-based equalization and filter acceleration of the Infiniium UXR-Series of real-time oscilloscopes. The Infiniium UXR-Series is highly accurate on timing/jitter related measurements and supports an exceptionally precise PLL implementations achieved with advance signal processing.

Certain CEI-112G measurements require an input referred noise floor of 1.28mV RMS which depending on the measurement signal level, can be exceeded on the Infinium UXR-Series Real-Time Oscilloscopes due to the noise sensitivity of these operations, users should be aware of the relative benefits of a N1000A DCA-X sampling oscilloscope compared to the Infiniium UXR-Series oscilloscope in interpreting the results and accuracy of these automated VSR/MR/LR measurements.

There are a broad set of date rates supported by CEI-112G specifications ranging from 36GBd to 58GBd and the measurements found in VSR, MR and LR sub-standards require a 4'th order Bessel-Thomson low-pass response (termed '4BTR') at 43GHz, tracked out to -9dB (65 GHz). This 4BTR tracking generally requires a Infinium UXR-Series with 70GHz of bandwidth to accommodate. Lower bandwidth Infiniium UXR-Series oscilloscopes can be used with a higher measurement error consideration. Higher bandwidth Infiniium UXR-Series oscilloscopes will be bandwidth constrained by digital filtering to this spec mandated 43GHz 4BTR.

Figure 2. Infiniium UXR-Series Real-Time Oscilloscopes

Recommended oscilloscope

The CEI-112G VSR/MR/LR physical layer conformance test automation measurements require an 4BTR acquisition channel response that is constrained to 65GHz (-9dB on the 4BTR). Use of an instrument with bandwidth below 60GHz for conformance measurements is not recommended.

Data Rates	Minimum Bandwidth (Brick wall)	Minimum Channels	Compatible Real-Time Oscilloscopes
58 GBd PAM4	65 GHz	2	UXR

Example of Hardware Configuration

Model number	Description	Quantity
UXR0502A UXR0504A UXR0592A UXR0592AP XR0594A UXR0594AP UXR0702A UXR0702AP UXR0704AP UXR0802A UXR0804A UXR1002A UXR1004A UXR1102A UXR1104A	60-110 GHz Infiniium UXR-series oscilloscope Recommended **70GHz** systems	1

Ordering Information

Model number	Description	Note
D9050CEIC	CEI-112G VSR/MR/LR Conformance Test Application Software	Required
D9010PAMA	Pulse Amplitude Modulation PAM-N Analysis Software	Required
D9020ASIA	Advanced Signal Integrity Software (EQ, InfiniiSim Advanced)	Required
D9020JITA	EZJIT Complete - Jitter and Vertical Noise Analysis Software	Required

Select the Desired Software Test Suite

The D9050CEIC OIF-CEI-112G TX test application covers PAM4 transmitter measurements outlined in OIF2017.346.14 (VSR), OIF2018.212.12 (LR) and OIF2019.340.05 (MR) specifications. The tests are sorted conveniently by VSR/MR/LR categories. Click on the desired test group, and the appropriate tests are offered in the Select Tests tab (factory-installed options shown)

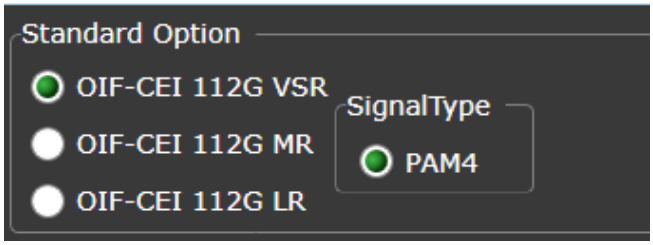

Figure 3. Standard Option that available in D9050CEIC OIF-CEI-112G TX test application

The D9050CEIC test application covers most TX tests outlined in the tables below. For a comprehensive and up-to-date list of specific tests covered by the application, download the D9050CEIC application from www.keysight.com, install it on an Infiniium UXR-Series oscilloscope, and run the application in time trial mode.

OIF-CEI-112G-VSR (oif2017.346.14 PAM4)

OIF-CEI Reference	Description
Section 23.3.2	Host-to-Module at TP1a, Table 23-1
Section 23.3.3	Module-to-Host at TP4, Table 23-4

OIF-CEI-112G-VSR (oif2017.346.14 PAM4)

OIF-CEI Reference	Description
Appendix 23.C.2	Host-to-Module at TP0a, Table 23-13

OIF-CEI-112G-MR (oif2019.340.03 PAM4)

OIF-CEI Reference	Description
Section 25.3.1	Table 25-3 and 25-4 (MR-PAM4)

OIF-CEI-112G-LR (oif2018.212.10 PAM4)

OIF-CEI Reference	Description
Section 28.3.1	Table 28-3 and 28-4 (LR-PAM4)

Configure Your Measurements

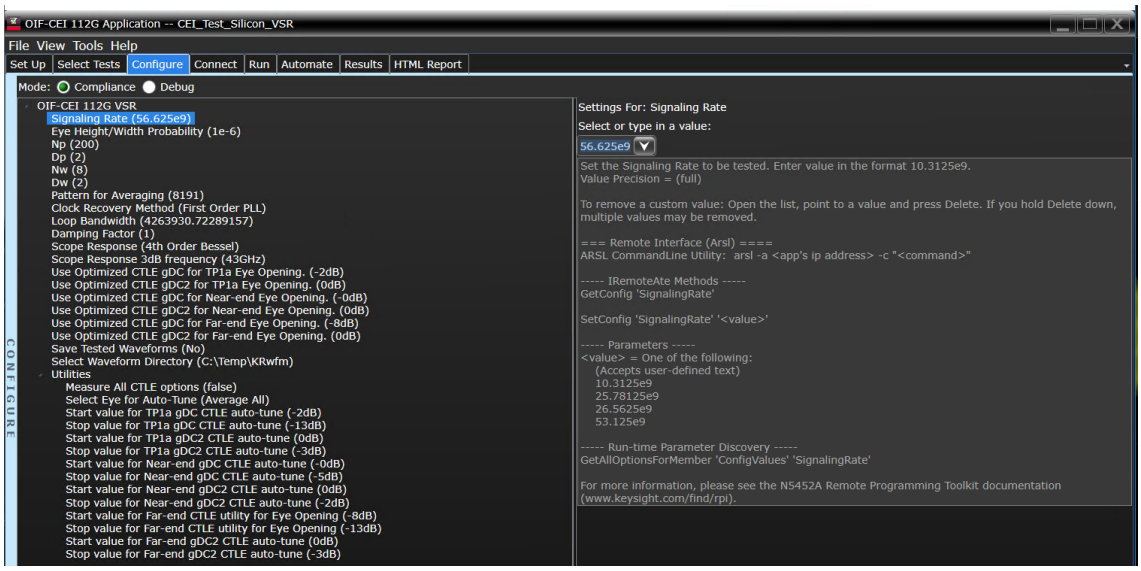

Figure 4. Configuration tab of D9050CEIC OIF-CEI-112G TX test application

Customize parameters that are specific to your setup, such as signaling rate and CTLE settings and reference equalizer search criteria and limits. Use default values or enter your own settings including filter response & bandwidth, type of pattern, and pattern symbol length, Choose Compliance mode to test within limits or choose Debug mode to test to your custom limits and adjust other test parameters.

Choose Your Tests

The D9050CEIC OIF-CEI-112G TX test application provides comprehensive coverage of most PAM4 tests that are specific to the clause you are testing. You may click on all available tests, a group of tests, or select individual tests to run. The full test name appears in the test list and is also shown in the test and reports. A description of the test and reference to the Standard is shown for each test.

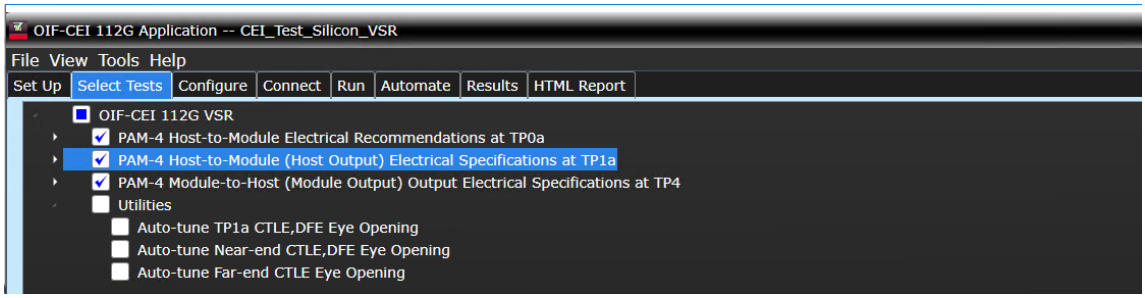

Figure 5. Available tests of D9050CEIC OIF-CEI-112G TX test application

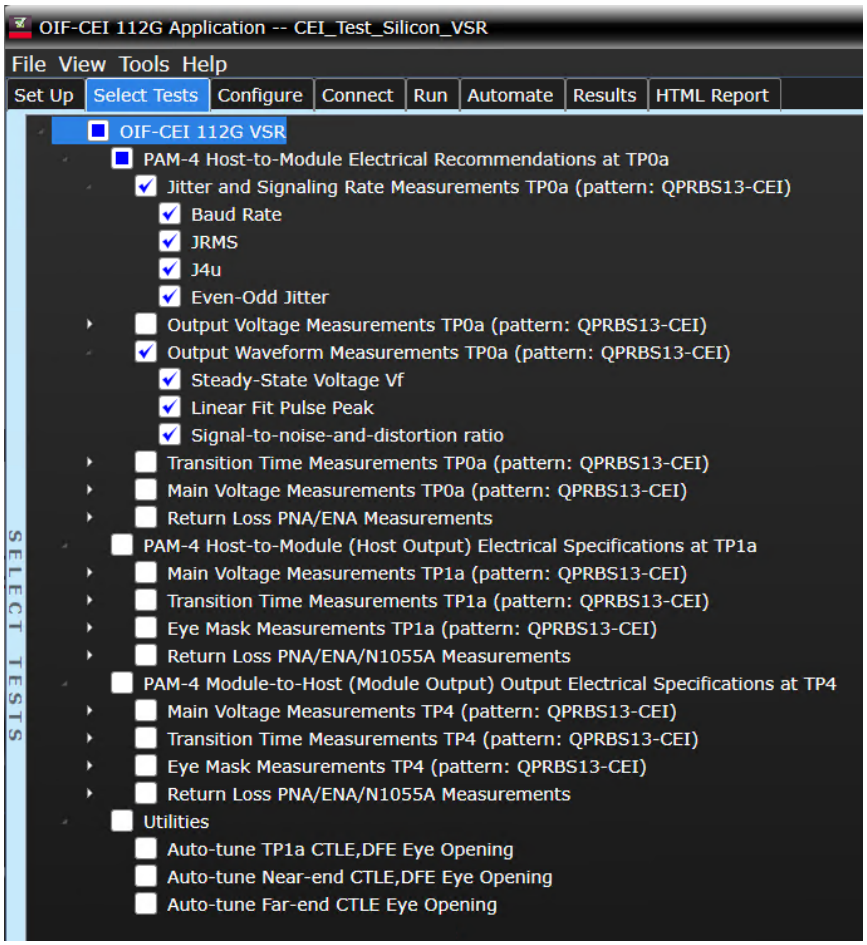

Figure 6. A group of tests were selected in D9050CEIC OIF-CEI-112G TX test application

Automated Return Loss Measurements

When used in conjunction with vector network analyzer (PNA), the D9050CEIC OIF-CEI-112G TX test application performs common mode to differential and common mode return loss measurements.

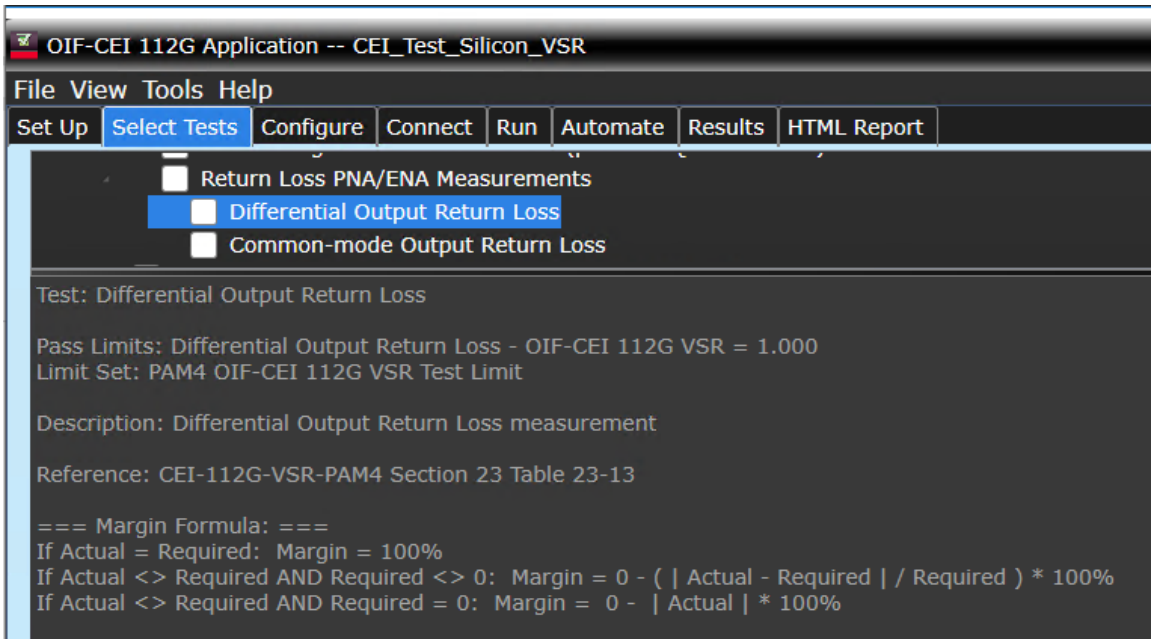

Figure 7. Return loss measurement selection of D9050CEIC OIF-CEI-112G TX test application

Automated Tuning for Optimal Eye Opening

The D9050CEIC OIF-CEI-112G TX test application provides utility test, to perform auto-tuning on the CTLE & DFE and find the optimal eye opening for eye mask measurement at TP1a & TP4 (Near-end & Far-end). Use default values or change to your own settings on the CTLE gDC and gDC2 settings in the configure tab. (shown in Figure 9)

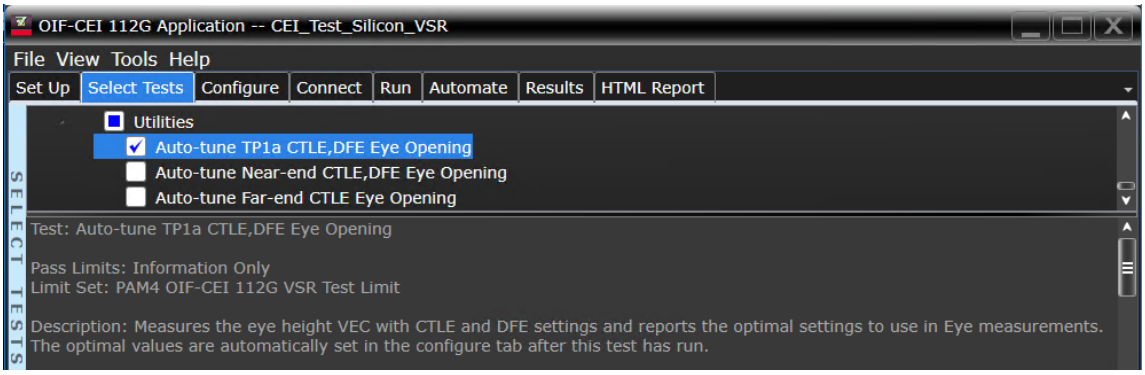

Figure 8. Automated tuning feature of CTLE and DFE for eye opening

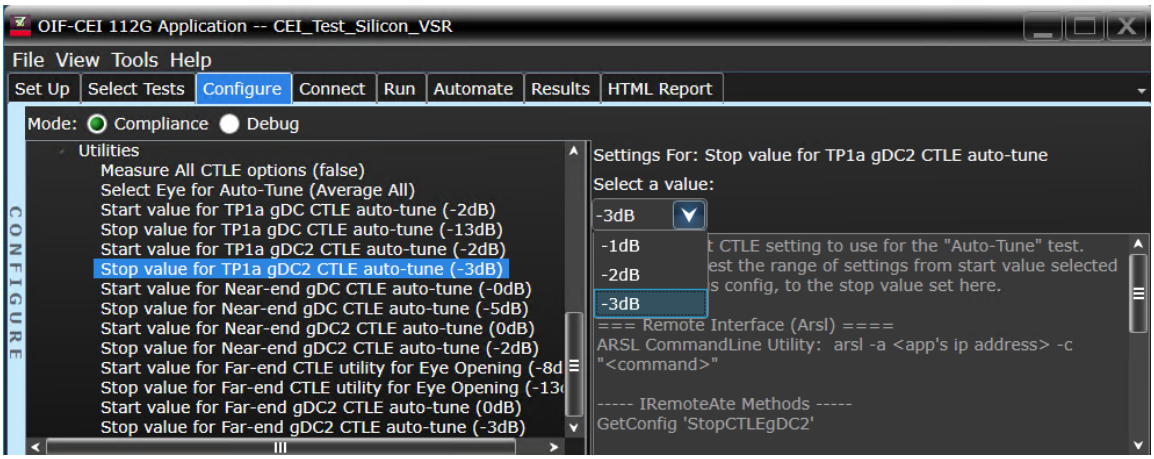

Figure 9. Settings for automated tuning in D9050CEIC OIF-CEI 112G TX test application

You can select to run all the CTLE permutations or narrow the CTLE search window to restrict the search window and improve the overall time to answer. It's recommended to leverage the COM tool and knowledge of the systems loss to compute the reference equalizer starting and end points. Default settings can take up to an hour to execute.

Parameter	Value						
---Additional Info---							
Auto-tune	gDC	gDC2	DFE taps	pulse main cursor	VEC	Eye Height	Eye Width
	-3	0	8.249E-03,-3.441E-03,-3.359E-03,7.954E-03	2.7389E-01	7.14dB	83mV	10.58ps
	-3	-1	1.3262E-02,-3.120E-03,-3.154E-03,8.015E-03	2.7278E-01	6.97dB	84.5mV	10.877ps
	-3	-2	1.0547E-02,-3.366E-03,-3.432E-03,8.092E-03	2.7323E-01	6.64dB	87.9mV	11.587ps
	-4	0	2.232E-03,-3.523E-03,-3.169E-03,8.043E-03	2.7529E-01	6.63dB	88mV	10.703ps
	-4	-1	1.609E-03,-3.224E-03,-3.092E-03,7.925E-03	2.7527E-01	6.57dB	88.7mV	11.373ps
	-5	0	1.0409E-02,-3.229E-03,-3.079E-03,7.730E-03	2.7297E-01	6.57dB	88.5mV	11.417ps
	-6	0	6.887E-03,-3.449E-03,-3.189E-03,7.913E-03	2.7382E-01	6.52dB	88.8mV	10.707ps
	-11	0	2.613E-03,-3.489E-03,-2.764E-03,7.547E-03	2.7510E-01	6.31dB	91.1mV	11.207ps
Optimal Equalizer Settings	Best gDC	Best gDC2	DFE Tap 1	DFE Tap 2	DFE Tap 3	DFE Tap 4	
	-11	0	0.002613	-0.003489	-0.002764	0.007547	

Figure 10. Auto-Tune of DFE and CTLE search grid illustrating converging on minimal VEC.

Guided Connection Diagrams for Easy Setup

Simply follow the steps to connect and configure your device under test and click Run Tests. The D9050CEIC OIF-CEI-112G TX test application automatically configures and controls your supported Infiniium UXR-Series Real-Time Oscilloscope.

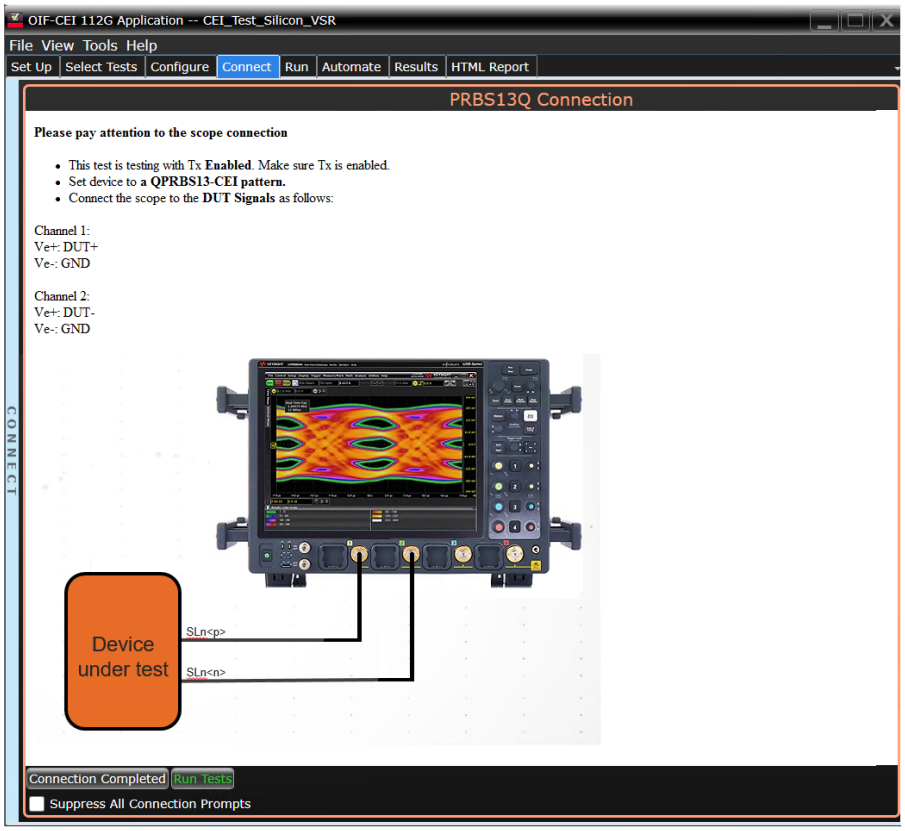

Figure 11. Connection diagram of D9050CEIC OIF-CEI-112G TX test application

More Features Streamline Development

Generate reports

Your team members and your customers are interested in the performance of your device. Share a test results report with them that shows the test conditions, summary of pass/fail, summary of all tests, and details for each test. Many include a test-specific screen shot of the measured parameter.

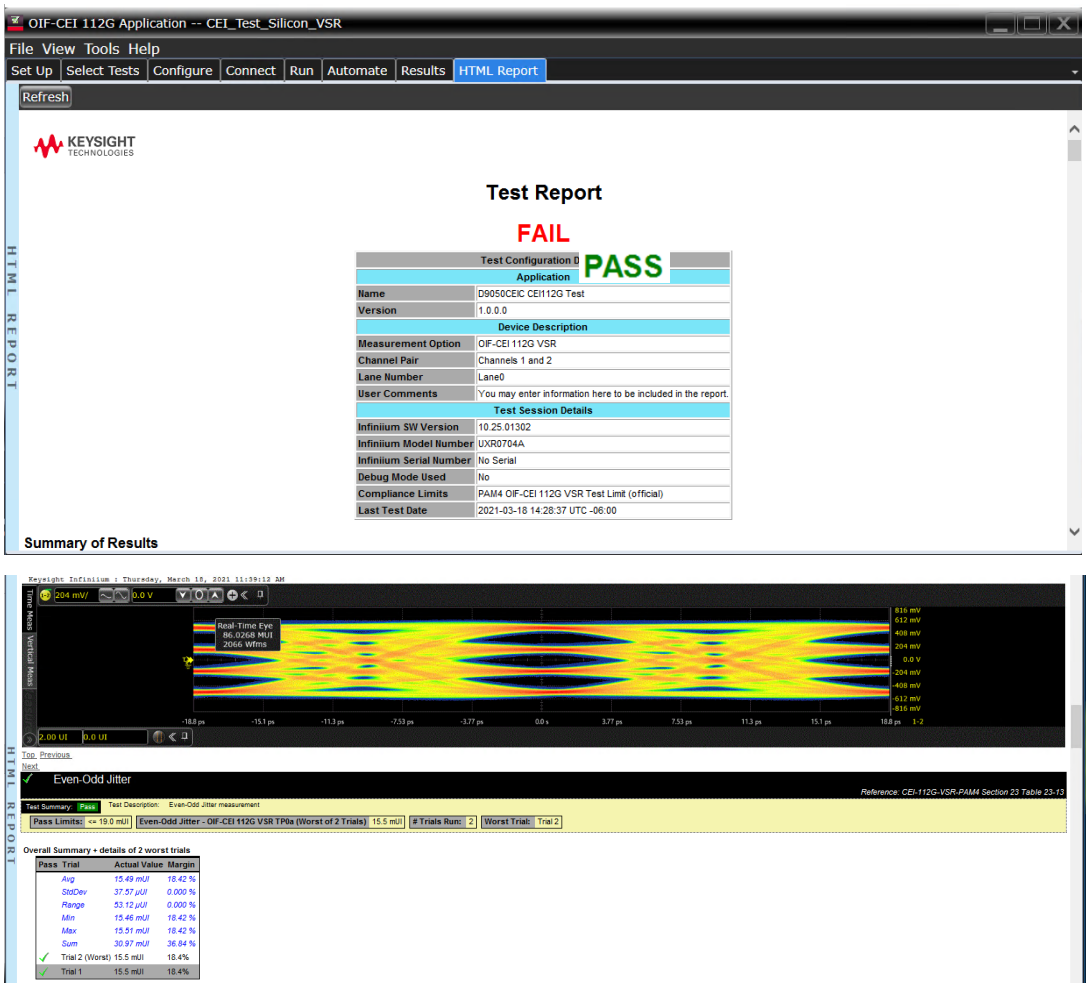

Figure 12. Test report and details

Control Your Device or Other Equipment

The Automation tab enables you to enter commands to control external devices or equipment, and to further sequence your tests or to control timing.

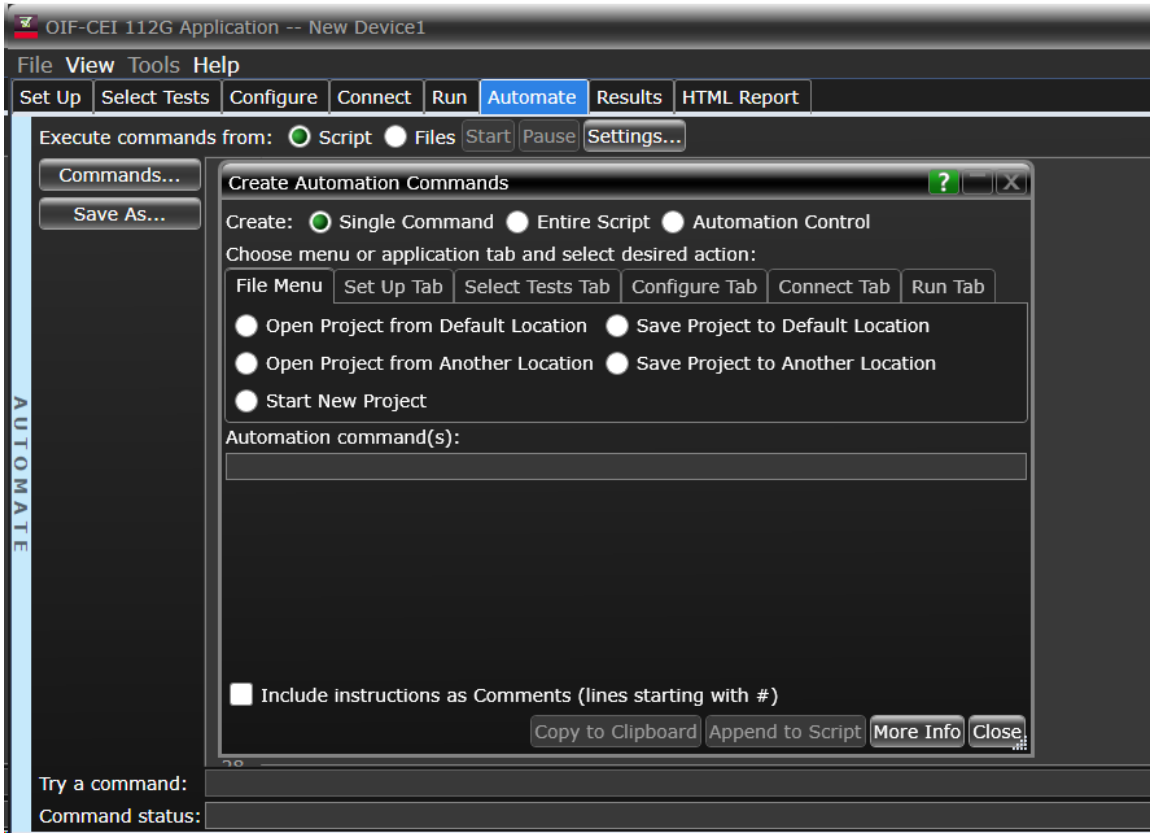

Figure 13. Automation commands in D9050CEIC OIF-CEI-112G TX test application

User-defined Test Limit Editor

At the time of publishing this datasheet, the OIF-CEI-112G project is still evolving. Various limits are still classified as TBD and others are actively being revised by the OIF CEI working groups. Users have an easy to use editor, which support field revisions to the conformal test limit pass/fail thresholds.

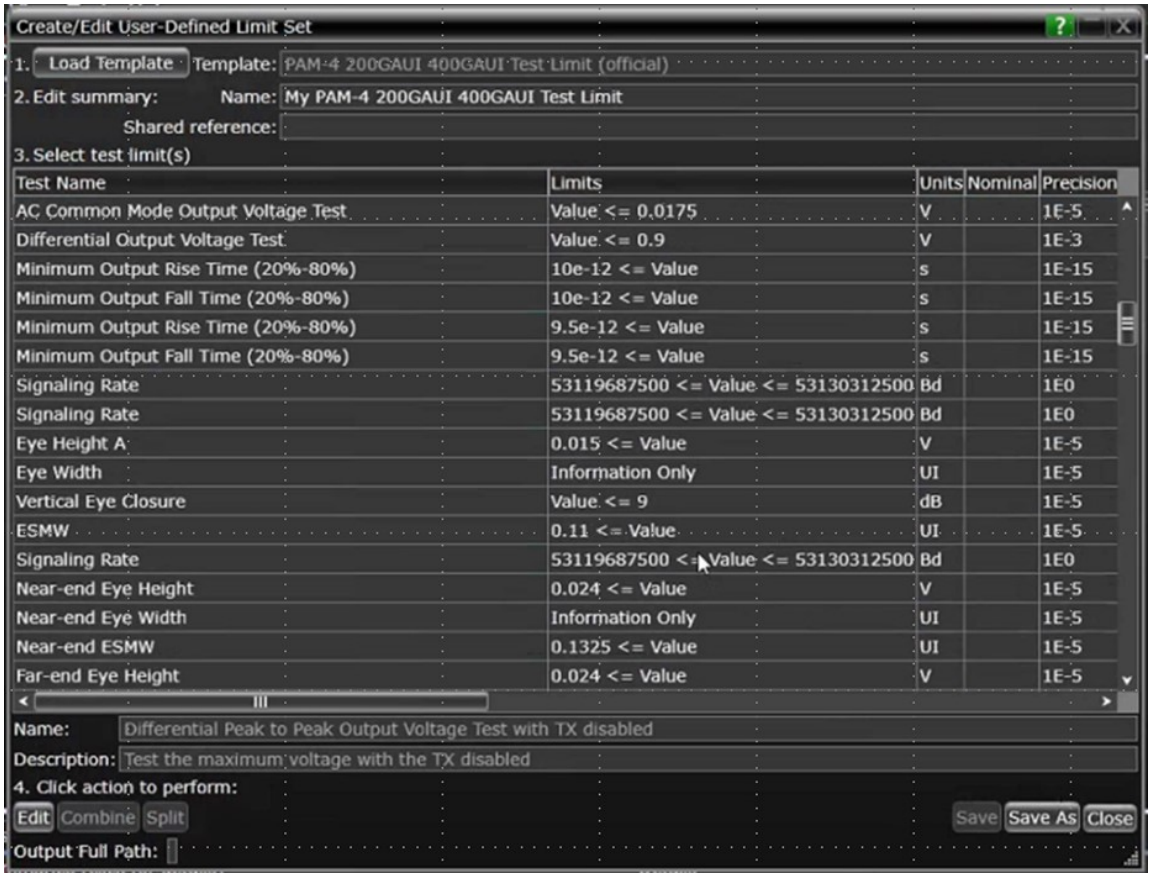

Figure 14. User-Defined limits editor

Infiniium UXR-Series Oscilloscope Firmware Version Dependencies

Advances in CTLE and DFE capabilities essential for 802.3ck reference equalization are required in UXR FW Version : 10.25.01001

Ordering Information

The D9050CEIC Electrical TX Test SW for OIF-CEI-112G may be ordered and user installed into existing licensed Infiniium UXR-Series Real-Time Oscilloscopes or ordered with factory installation with a new instrument purchase.

Flexible Software Licensing and KeysightCare Software Support Subscriptions

Keysight offers a variety of flexible licensing options to fit your needs and budget. Choose your license term, license type, and KeysightCare software support subscription.

License Terms

Perpetual – Perpetual licenses can be used indefinitely.

Time-based – Time-based licenses can be used through the term of the license only (6, 12, 24, or 36 months).

License Types

Node-locked – License can be used on one specified instrument/computer.

Transportable – License can be used on one instrument/computer at a time but may be transferred to another using Keysight Software Manager (internet connection required).

USB Portable – License can be used on one instrument/computer at a time but may be transferred to another using a certified USB dongle (available for additional purchase with Keysight part number E8900-D10).

Floating (single site) – Networked instruments/computers can access a license from a server one at a time. Multiple licenses can be purchased for concurrent usage.

KeysightCare Software Support Subscriptions

Perpetual licenses are sold with a 12 (default), 24, 36, or 60-month software support subscription. Support subscriptions can be renewed for a fee after that.

Time-based licenses include a software support subscription through the term of the license.

Selecting your license:

Step 1. Choose your software product (eg. S1234567A).
Step 2. Choose your license term: perpetual or time-based.
Step 3. Choose your license type: node-locked, transportable, USB portable, or floating.
Step 4. Depending on the license term, choose your support subscription duration.

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