D9020DPHC
MIPI D-PHY Compliance Test Software
for Infiniium oscilloscopes

Validate and Debug Your Embedded D-PHY Data Links Quickly and Easily

Keysight Technologies, Inc. MIPI® D-PHYSM conformance test software for Infiniium oscilloscopes gives you a fast, easy way to validate and debug your embedded D-PHY data links. The D-PHY electrical test software allows you to automatically execute D-PHY electrical checklist tests for CSI-2 and DSI-2 architectures and displays the results in a flexible report format. In addition to the measurement data, the report provides margin analysis that shows how closely your product passed or failed each test. The D-PHY conformance test software performs a wide range of tests required to meet the physical layer requirements per Section 9 of the MIPI Alliance Specification for D-PHY v2.1 and below and Section 1 of the Conformance Test Suite (CTS) for D-PHY v2.1 and below. The D-PHY conformance test software helps you execute the most difficult physical layer tests for transmitters (TX tests only) that can be measured with high bandwidth real-time digital oscilloscope. Although there are not currently any requirements for physical layer compliance verification, it is highly recommended that every MIPI D-PHY link be tested against the limits of the physical layer specification to ensure that it is compliant to the specification and to minimize concerns with protocol level interoperability.

KEYSIGHT

Key Features

The D-PHY conformance test software offers several features to simplify design validation:

- Complete MIPI Alliance Specification for D-PHY v2.1 and below section 9 and CTS for D-PHY v2.1 and below section 1
- User selection of tests and configuration of data rate
- Automated scope measurement setup and programming for increased accuracy, time-savings and repeatability
- Advanced debug modes for troubleshooting
- Automated margin analysis and pass/fail conformance reporting

With the D-PHY conformance test software, you can use the same oscilloscope you use for everyday debugging to perform automated testing and margin analysis based on not only the MIPI Alliance Specification for D-PHY v2.1 but also v1.2, v1.1, v1.0 section 9 requirements and CTS for D-PHY v1.0, v1.1, v1.2 and v2.1 section 1.

Save Time with the D-PHY Conformance Application

The D-PHY conformance test software saves you time by setting the stage for automatic execution of required electrical tests. The primary difficulty of performing electrical tests for D-PHY is connecting the oscilloscope to the target device, correctly configuring the scope's measurement system for ultimate accuracy, issuing the proper commands to perform the tests and then analyzing the measured results by comparing them to limits published in the specification. The D-PHY conformance test software automates this work to provide rapid, accurate and repeatable test execution. In addition, if you discover a problem with your product, debug tools in the scope are available to aid in root-cause analysis.

Easy Test Definition

The D-PHY conformance test software extends the ease-of-use advantages of Keysight's Infiniium oscilloscopes to testing D-PHY designs. The Keysight automated test engine walks you quickly through the steps required to define and configure the tests, execute the tests, and view the test results. You can select a category of tests all at once or specify individual tests. The user interface is oriented to minimize unnecessary reconnections, which saves time and ensures accuracy and repeatability of tests. You can save tests and configurations as project files and recall them later for quick re-testing or review of previous test. Straightforward menus let you perform tests with a minimum of mouse clicks.
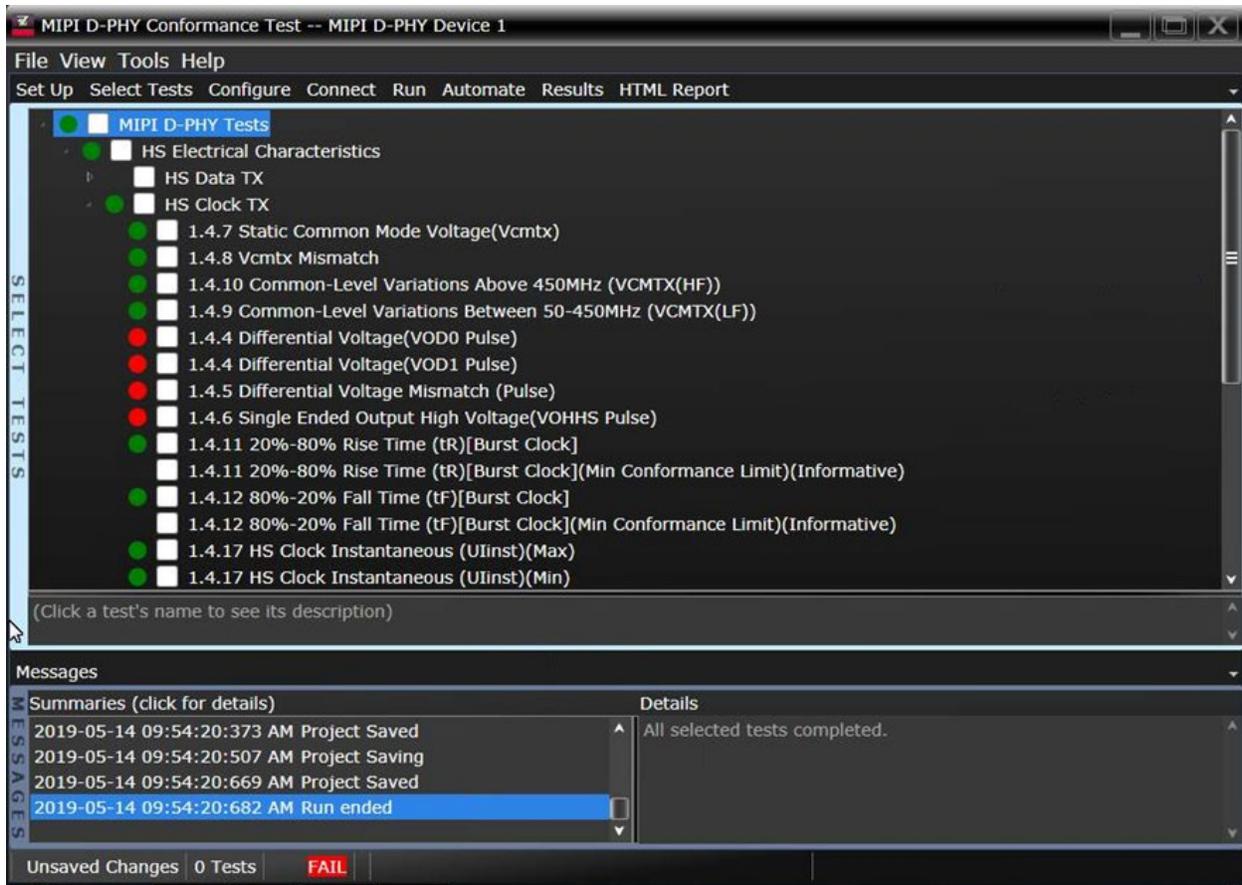
Figure 1. You can easily select individual tests or groups of tests with a mouse-click and customize your output report based on the test results you want to see.

Configurability and Guided Connections

The D-PHY conformance test software provides flexibility in your test setup. The D-PHY conformance test software provides you with user-defined controls for critical test parameters such as channel probe configurations, number of measurement observations for tests and the low-power trigger threshold. After you configure the tests to meet your needs, the D-PHY user interface will present you the connection screen that is specific to the configuration data you have selected. This includes the oscilloscope channels used for the test and the routing of any necessary probing needed to perform the tests. In some cases, a configuration change may be necessary to properly make a new set of measurements. Guided configuration diagrams will be presented when each change is needed to ensure proper configuration for the tests. The software is designed to minimize connection changes to increase the efficiency of test operation and save you time.
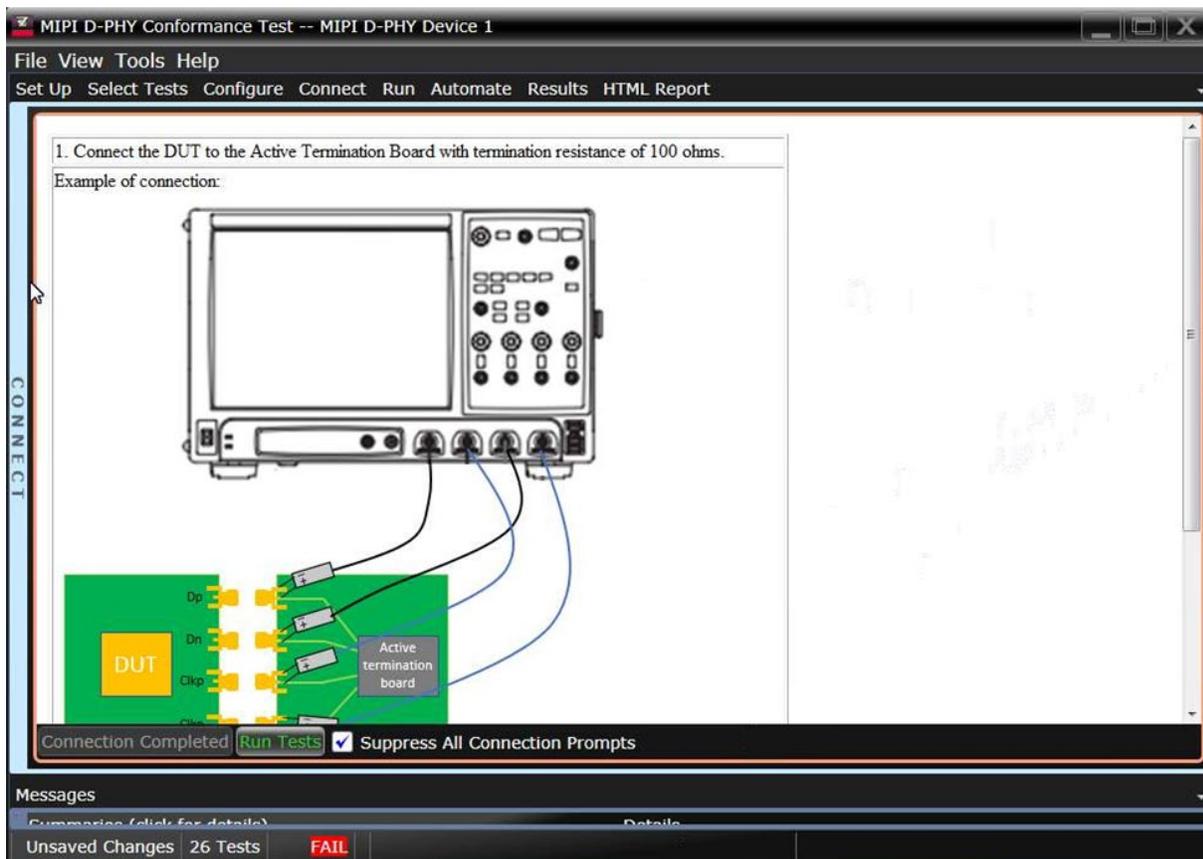
Figure 2. Guided configuration diagrams provide you with channel and probe configurations needed to properly connect to your product and accurately perform tests.

Result Reports with Margin Analysis

In addition to providing you with measurement results, the D-PHY test software provides a report format that shows you not only where your product passes or fails, but also reports how close you are to the limits specified for a particular test assertion. You select the margin test report parameter, which means you can specify the level at which warnings are issued to alert you to the electrical tests where your product is operating close to the official test limit defined by the specification for a given test assertion.
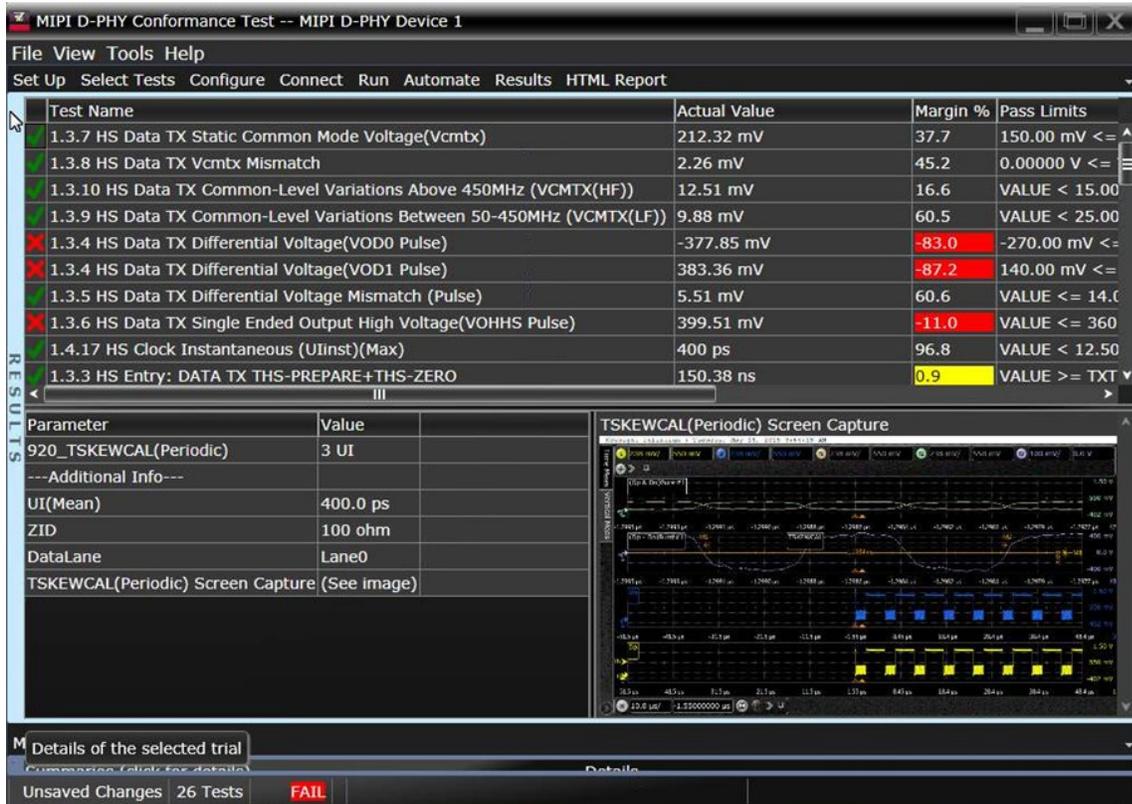
Figure 3. Results reports quickly highlight test margins versus specified limits and a summary of measurements that pass/fail or violate the margin warnings you have set.

Extensibility

You may add additional custom tests or steps to your application using the D9010UDAA User Defined Application (UDA) development tool (www.keysight.com/find/uda). Use UDA to develop functional "Add-Ins" that you can plug into your application. Add-ins may be designed as:

- Complete custom tests (with configuration variables and connection prompts)
- Any custom steps such as pre or post processing scripts, external instrument control and your own device control.

Automation

You can completely automate execution of your application's tests and Add-Ins from a separate PC using the included N5452A Remote Interface feature (download free toolkit from www.keysight.com/find/scope-apps-sw). You can even create and execute automation scripts right inside the application using a convenient built-in client.

The commands required for each task may be created using a command wizard or from "remote hints" accessible throughout the user interface.

Using automation, you can accelerate complex testing scenarios and even automate manual tasks such as:

- Opening projects, executing tests and saving results
- Executing tests repeatedly while changing configurations
- Sending commands to external instruments
- Executing tests out of order

Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive:

- Interact with your device controller to place it into desired states or test modes before test execution
- Configure additional instruments used in your test suite such as a pattern generator and probe switch matrix
- Export data generated by your tests and post-process it uses your favorite environment, such as MATLAB, Python, LabVIEW, C, C++, Visual Basic etc.
- Sequence or repeat the tests and "Add-In" custom steps execution in any order for complete test coverage of the test plan
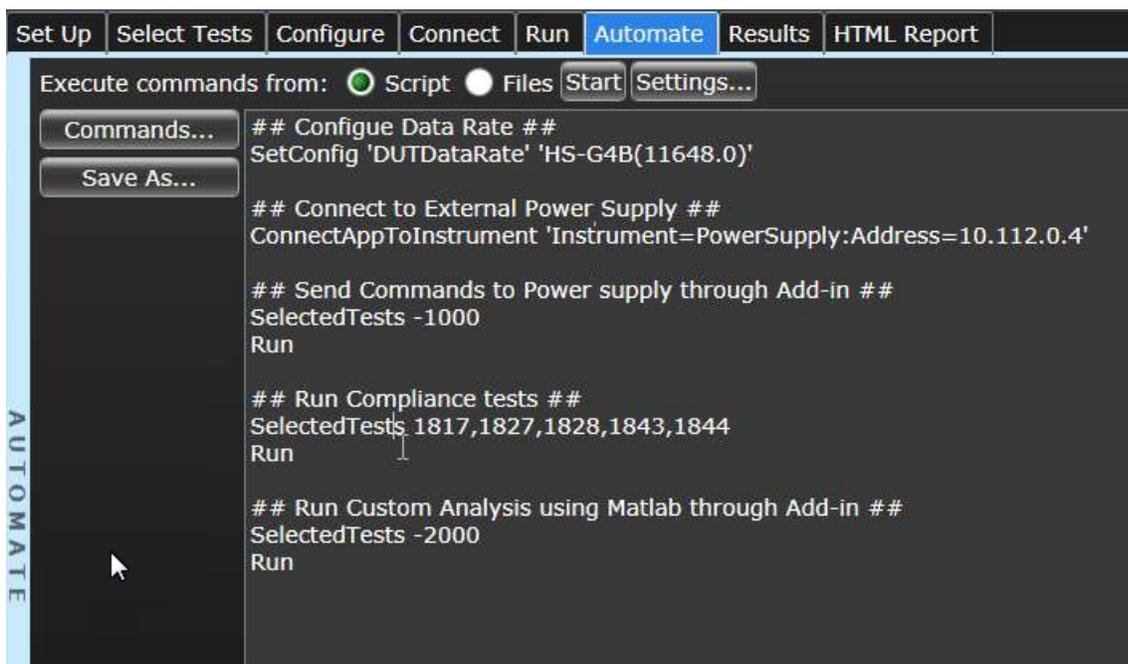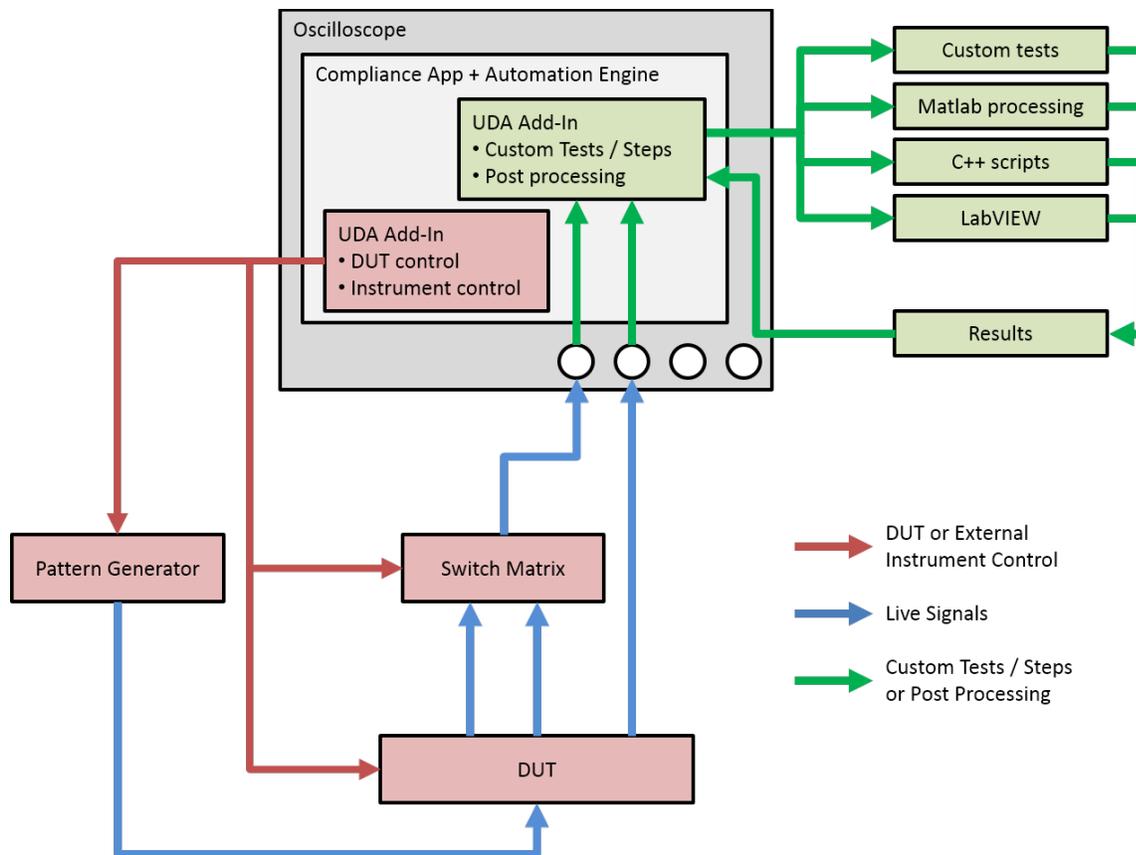

Figure 4. Remote programming script in the Automation tab.

Figure 5. Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive.

Switch Matrix

The Keysight switch matrix software option for the conformance application, used together with switch matrix hardware, enables fully automated testing for multi-lane digital bus interfaces. The benefits of this automated switching solution include:

Eliminate reconnections, which saves time and reduces errors through automating test setup for each lane of a multi-lane bus

Maintain accuracy with the use of unique PrecisionProbe or InfiniiSim features to compensate for switch path losses and skew

Customize testing by using remote programming interface and the UDA tool for device control, instrument control and test customization

More information of the switching solution and configuration visit http://www.keysight.com/find/switching and the Keysight application note with the publication number 5991-2375EN.

Figure 6. Automated testing for multi-lane digital bus interface through switching solution.

Test Coverage

HS Electrical characteristics

HS Data Tx	HS Clock Tx
Test 1.3.7 Static Common Mode Voltage (Vcmtx) Test 1.3.8 Vcmtx Mismatch Test 1.3.10 Common-Level Variations Above 450 MHz (VCMTX(HF)) Test 1.3.9 Common-Level Variations Between 50-450 MHz (VCMTX(LF)) Test 1.3.4 Differential Voltage (VOD0 Pulse) Test 1.3.4 Differential Voltage (VOD1 Pulse) Test 1.3.5 Differential Voltage Mismatch (Pulse) Test 1.3.6 Single Ended Output High Voltage (VOHHS Pulse) Test 1.3.11 20%-80% Rise Time (tR) Test 1.3.11 20%-80% Fall Time (tF)	Test 1.4.7 Static Common Mode Voltage (Vcmtx) Test 1.4.8 Vcmtx Mismatch Test 1.4.10 Common-Level Variations Above 450 MHz (VCMTX(HF)) Test 1.4.9 Common-Level Variations Between 50-450 MHz (VCMTX(LF)) Test 1.4.4 Differential Voltage (VOD0 Pulse) Test 1.4.4 Differential Voltage (VOD1 Pulse) Test 1.4.5 Differential Voltage Mismatch (Pulse) Test 1.4.6 Single Ended Output High Voltage (VOHHS Pulse) Test 1.4.11 20%-80% Rise Time (tR) Test 1.4.11 20%-80% Fall Time (tF) Test 1.4.17 HS Clock Instantaneous (UIinst) (Max) Test 1.4.17 HS Clock Instantaneous (UIinst) (Min)

Global operation

HS Data Tx (Burst mode only)	Clock Tx (Burst mode only)
Test 1.3.1 HS Entry: DATA TLPX Test 1.3.2 HS Entry: DATA TX THS-PREPARE Test 1.3.3 HS Entry: DATA TX THS-PREPARE+THS-ZERO Test 1.3.13 HS Exit: DATA TX THS-TRAIL Test 1.3.14 HS Exit: DATA TX TREOT Test 1.3.15 HS Exit: DATA TX TEOT Test 1.3.16 HS Exit: DATA TX THS-EXIT	Test 1.4.1 HS Entry: CLK TLPX Test 1.4.2 HS Entry: CLK TX TCLK-PREPARE Test 1.4.3 HS Entry: CLK TX TCLK-PREPARE+TCLK-ZERO Test 1.5.1 HS Entry: Clock TX TCLK-PRE Test 1.5.1 HS Exit: Clock TX TCLK-POST Test 1.4.13 HS Exit: CLK TX TCLK-TRAIL Test 1.4.14 HS Exit: CLK TX TREOT Test 1.4.15 HS Exit: CLK TX TEOT Test 1.4.16 HS Exit: CLK TX THS-EXIT

HS Data-clock timing

Test 1.5.3 HS Clock Rising Edge Alignment to First Payload Bit
Test 1.5.4 Data-to-Clock Skew (TSKEW(TX)) (Max,Min)
Test 1.5.4 Data-to-Clock Skew (TSKEW(TX)) (Mean)

HS Skew calibration burst (Burst mode and 1.5 Gbps above data rate)

Test 1.5.5 Initial HS Skew Calibration Burst (TSKEWCAL-SYNC)
Test 1.5.5 Initial HS Skew Calibration Burst (TSKEWCAL)
Test 1.5.6 Periodic HS Skew Calibration Burst (TSKEWCAL-SYNC)
Test 1.5.6 Periodic HS Skew Calibration Burst (TSKEWCAL)

Alternate Calibration Sequence (Burst mode, 2.5 Gbps above data rate and 100 Ω termination)

Test 1.5.8 Alternate Calibration Sequence (TALTCAL-SYNC)
Test 1.5.8 Alternate Calibration Sequence (TALTCAL)

Preamble Sequence (Burst mode, 2.5 Gbps above data rate and 100 Ω termination)

Test 1.5.9 Preamble Sequence (TEXTSYNC)
Test 1.5.9 Preamble Sequence (TPREABLE) [32 UI]
Test 1.5.9 Preamble Sequence (TPREABLE) [64 UI]
Test 1.5.9 Preamble Sequence (TPREABLE) [512 UI]

HS Spread Spectrum Clocking, Delta UI, Period Jitter (Continuous Clock, 2.5 Gbps above data rate and 100 Ω termination)

Test 1.4.18 Clock Lane HS Clock Delta UI (ΔUI)
Test 1.4.19 HS Clock SSC Modulation Rate
Test 1.4.19 HS Clock SSC Deviation (Max)
Test 1.4.19 HS Clock SSC Deviation (Min)
Test 1.4.19 HS Clock SSC df/dt
Test 1.4.20 Clock Lane HS Clock Period Jitter

HS Jitter and Eye Diagram (Continuous clock and data, 2.5 Gbps above data rate and 100 Ω termination)

Test 1.5.7 HS Clock Eye Diagram
Test 1.5.7 HS Data Eye Diagram
Data to Clock Total Jitter (Informative)
Data to Clock Deterministic Jitter (Informative)
Data to Clock Random Jitter (Informative)

LP Electrical Characteristics

LP Data Tx (Escape mode)	LP Clock Tx (Escape or ULPS mode)
Test 1.1.1 Thevenin Output High Voltage Level (VOH)	Test 1.2.1 Thevenin Output High Voltage Level (VOH)
Test 1.1.2 Thevenin Output Low Voltage Level (VOL)	Test 1.2.2 Thevenin Output Low Voltage Level (VOL)
Test 1.1.3 15%-85% Rise Time (TRLP)	Test 1.2.3 15%-85% Rise Time (TRLP)
Test 1.1.4 15%-85% Fall Time (TFLP)	Test 1.2.4 15%-85% Fall Time (TFLP)
Test 1.1.6 Pulse Width of LP TX Exclusive-OR Clock (TLP-Pulse-TX)	Test 1.2.5 Slew Rate Vs. CLoad (Max)
Test 1.1.6 Pulse Width of LP TX Exclusive-OR Clock (TLP-Pulse-TX) [Initial]	Test 1.2.5 Slew Rate Vs. CLoad (Min)
Test 1.1.7 Period of LP TX Exclusive-OR Clock (TLP-PER-TX)	Test 1.2.5 Slew Rate Vs. CLoad (Margin)
Test 1.1.5 Slew Rate Vs. CLoad (Max)	
Test 1.1.5 Slew Rate Vs. CLoad (Min)	
Test 1.1.5 Slew Rate Vs. CLoad (Margin)	

Recommended Oscilloscope

The D-PHY compliance software is compatible with Keysight Infniium Series oscilloscopes with operating software revision 6.40 or higher. For oscilloscopes with earlier revisions, free upgrade software is available here: www.keysight.com/find/scope-apps-sw.

Symbol Rate	Minimum bandwidth	Minimum channels	Compatible oscilloscopes
Up to 1 Gbps	2.5 GHz	3 Analog channels (4 Channels are recommended)	S-Series, EXR-Series, MXR-Series, V-Series, Z-Series and UXR-Series
Up to 1.5 Gbps (v1.1)	4 GHz		S-Series, EXR-Series, MXR-Series, V-Series, Z-Series and UXR-Series
Up to 2.5 Gbps (v1.2)	6 GHz		EXR-Series, MXR-Series, V-Series, Z-Series and UXR-Series
Up to 4.5 Gbps (v2.1)	12 GHz		EXR-Series, MXR-Series, V-Series, Z-Series and UXR-Series

Ordering Information

Model number	Description	Note
D9020DPHC	MIPI D-PHY Tx Compliance Software	Mandatory
D9010JITA or D9020JITA	Jitter, Vertical and Phase Noise Analysis Software for Infiniium	Mandatory
D9010SCNA or D9020SCNA	InfiniiScan Event Identification Software for Infiniium	Mandatory
D9010DMBA or D9020ASIA	De-embedding Software (PrecisionProbe, InfiiniSim Basic) Advanced Signal Integrity Software (Crosstalk)	Mandatory

Other Hardware, Probes and Accessories

Model number	Description	Note
1169B	InfiniiMax II 12 GHz differential probe amplifier	4
E2669B	Differential probe connectivity kit (contains needed probe header)	1
15443A	Matched cable pair (2 x SMA(m) to SMA(m) cable included)	2
N7010A	30 GHz Active Termination Adapter for Continuous Data and Clock test	4
RTB	MIPI D-PHY Reference Termination Board from UNH-IOL https://www.iol.unh.edu/solutions/test-tools/mipi	1
Capacitive load board	MIPI D-PHY 50pF Capacitive load board from UNH-IOL https://www.iol.unh.edu/solutions/test-tools/mipi	1

Related Literature

Type	Description / URL
Brochure	Infiniium S-Series (500 MHz to 8 GHz real time oscilloscope)
Brochure	Infiniium EXR-Series (500 MHz to 6 GHz real time oscilloscope)
Brochure	Infiniium MXR-Series (500 MHz to 6 GHz real time oscilloscope)
Brochure	Infiniium V-Series (8 GHz to 33 GHz real time oscilloscope)
Data Sheet	Infiniium Z-Series (20 GHz to 63 GHz real time oscilloscope)
Data Sheet	Infiniium UXR-Series (5 GHz to 110 GHz real time oscilloscope)

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.

Subscription – Subscription 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.

Subscription licenses include a software support subscription through the term of the license.

KeysightCare Software Support Subscription provides peace of mind amid evolving technologies.

- Ensure your software is always current with the latest enhancements and measurement standards.
- Gain additional insight into your problems with live access to our team of technical experts.
- Stay on schedule with fast turnaround times and priority escalations when you need support.

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.

Subscription-based Compliance Test Software Suites

A new ownership model of multiple Compliance Test Software Applications is now available.

With this new subscription-based model, the USB software suites bundle the Compliance Test Software Applications under a model number. Using a subscription-based ownership, you can enjoy all the test software features covered under USB across multiple generations and variants.

Software support and continuity

Under the subscription plan, software support is made available with no extra support cost. Ensuring your software always stays up to date with the latest enhancements and measurement standards while having access to our team of technical experts when you need support.

On top of that all upgrades are made available to you as the USB standards progresses with no additional costs.

Subscription-based Compliance Test Software Suites

Each suite comes with a 12, 24, or 36-month software suite subscription.

Suite license	Technology generation and variants coverage (current)
SW00MIPI MIPI Validation License	C-PHY TX Validation (D9010CPHC) D-PHY TX Validation (D9020DPHC) D-PHY TX Validation, V3.5 FCM (D9030DPHC) M-PHY TX Validation, HS-GEARs 1-4 (D9040MPHC) M-PHY TX Validation, HS-GEARs 1-5 (D9050MPHC)
SW02MIPI MIPI Full TX Test Suite	C-PHY TX Validation (D9010CPHC) D-PHY TX Validation (D9020DPHC) D-PHY TX Validation, V3.5 FCM (D9030DPHC) M-PHY TX Validation, HS-GEARs 1-4 (D9040MPHC) M-PHY TX Validation, HS-GEARs 1-5 (D9050MPHC) C-PHY and D-PHY Protocol Validation (D9010MCDP) M-PHY Protocol Validation (D9010MPMP) LowSpeed Protocol Validation (D9010MPLP)