

D9021HDMC HDMI Tx Electrical Performance Validation and Compliance Software

For Infiniium Series Oscilloscopes



Complete Physical Layer Testing for HDMI 1.4 and HDMI 2.1

Keysight's D9021HDMC HDMI Tx electrical performance validation and compliance software offers a complete test execution environment for validating and troubleshooting the electrical performance of HDMI 1.4 and HDMI 2.1 source devices. The software, which uses a new licensing model, operates on the Keysight industry-performance-leading Infiniium oscilloscope hardware with. The D9021HDMC is functionally identical to the N5399E HDMI compliance test software, which is well-established through the world's HDMI Authorized Test Centers (ATCs).

The primary application for the HDMI EPVC software is physical layer compliance testing for HDMI sources that are performed at HDMI ATCs worldwide. The software package is also designed to flexibly handle development tasks such as characterization and troubleshooting to complement the required compliance testing.

Whether your product is a DVD player, computer, graphics card, or any of the other many product types that use the successful HDMI interface, you must submit your first article HDMI product to an HDMI ATC for certification. Requirements for compliance testing are documented in the HDMI 2.1 Generic Compliance Test Specification (GCTS) for HDMI sources.

The GCTS defines the tests that must be run on one or more of the four high-speed TMDS (transition minimized differential signaling) and FRL (fixed rate link) lanes at each of the various resolution settings for both specifications (HDMI 1.4b and HDMI 2.1). Using the HDMI Electrical Performance Validation and Compliance (EPVC) software in the development and pre-compliance steps will give you confidence in successful outcome for the test process at the HDMI ATC. Upon completion, you may become an HDMI self-certifier using your same documented test process and test equipment.

Table of Contents

- Features 4
- HDMI 2.1: What is Different from HDMI 1.4 and HDMI 2.0? 6
- Using the HDMI EPVC Software..... 10
- Tests Performed..... 20
- Ordering Information 22
- Product Web Site 25
- Flexible Software Licensing and KeysightCare Software Support Subscriptions 26

Features

The HDMI EPVC software offers a comprehensive range of features to simplify the validation of HDMI designs and includes:

- Specification selections (HDMI 1.4b, HDMI 2.1 TMDS, HDMI 2.1 Fixed Rate Link).
- Complete test suites for HDMI: HDMI 1.4, HDMI 2.1 TMDS test, HDMI 2.1 Fixed Rate Link, Direct Attach devices. HEAC (Ethernet/Audio return channel) and eARC (available through N59901A eARC software only).
- Device capability entry using resolution and timing descriptors, video identifier codes (VIC) as well as FRL features.
- Automated test sequencing for given test connection.
- Full device automation using optional switch network.
- Guided connection and instructions throughout the test process.
- Test report including system, connection details, summary table, with hotlinks to ancillary test result data, and screen shots of the test measurements.
- Tabular final results page with statistical analysis.
- Pass/fail margin analysis.
- Transfer function generation for the complex test requirements for HDMI 2.1 and for extended analysis.
- Scripting for complex testing or cycling requirements.
- Remote user interface.
- Test algorithm control through configurable parameters.
- Test selection to support one test, many tests, or all tests.
- Test plan flow control.

Easy-to-use HDMI EPVC software

The HDMI EPVC software extends the ease-of-use advantages of Keysight's Infiniium oscilloscopes to the testing of HDMI designs. The Keysight automated test engine takes you quickly and intuitively through the steps to define device capability, test selections, and test connection as well as enables you to easily perform tests and view test results. You can simply select a category of tests or specify individual tests by flexibly choosing high level test parameters (e.g. specification or test suite) that suit various test process objectives.

A prompt screen conveniently guides users to make any required connection or bit rate change during the sequencing of tests in an overall test plan. In automation modes, the testing continues without having to wait for operator input. When the requested test procedure is complete, an HTML report is generated that allows the user to view all key information. In addition, a tabular view (reports tab) is available for immediate viewing of measurement results and statistics. The project file can be saved for continued testing on the same device later. The resume testing mode allows the user to continue the test procedure where it left off.

Time-saving HDMI EPVC software

The HDMI software guides you through the whole process – from setup to analysis of results. The intuitive graphical user interface for this process allows you to select the specifics of test such as the test suite and test system connection, as well as to declare product capability that will govern the product's required test plan. The test algorithms have been certified through HDMI Forum sponsored test event qualification and are officially approved by the HDMI Forum. The need for proprietary software development is eliminated. In HDMI 2.1, filtering constructs, such as addition of skew on either signal line of a differential pair, embedding a cable model, impressing an equalization function, de-embedding a fixture, and even compensating for a lossy intervening switch network, are all handled automatically.

HDMI 2.1: What is Different from HDMI 1.4 and HDMI 2.0?

High Definition Multimedia Interface (HDMI)

HDMI is a 19-pin interface (see Figure 1), which is the preferred interface in the industry for transmission of digital video to high resolution displays. Twelve of these pins are dedicated to four highspeed differential lanes and shielding. Three pins are dedicated to i2c interface for reading EDID or SCDC channels (SCL, SDA, and GND). The CEC (Consumer Electronics Control) line is used to control connected equipment. +5 pin supplies power to devices and HPD is the Hot plug detect pin used to determine connectivity between sources and displays. The HPD and Utility line are also used as the eARC (ARC) interface for audio return channel.

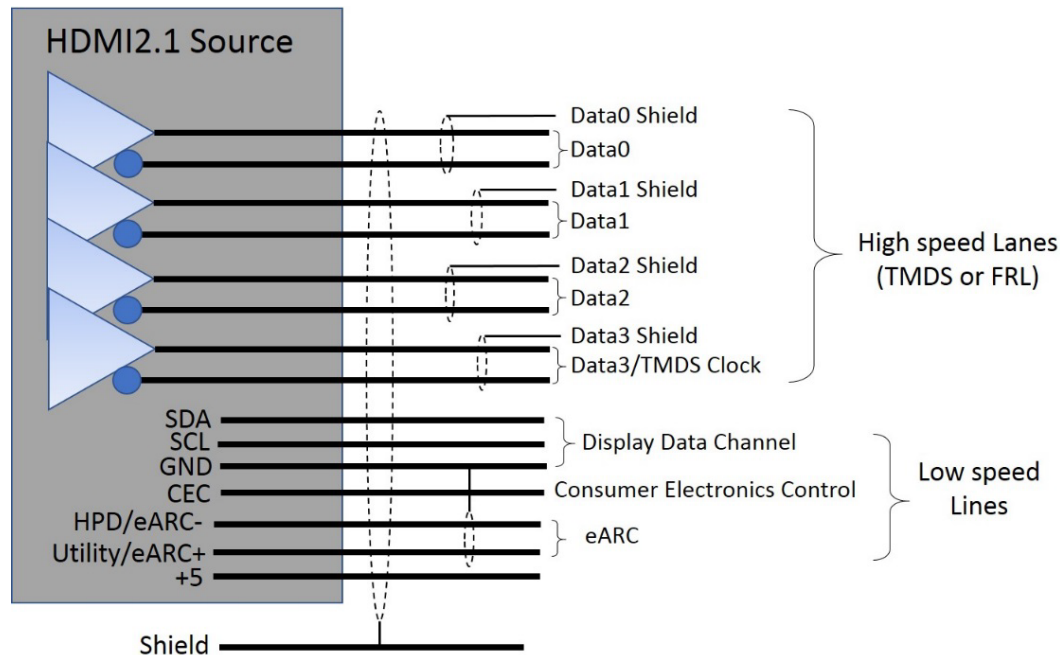


Figure 1. HDMI 2.1 source

For HDMI 1.4 and HDMI 2.0 (now referred to as 'HDMI 2.1 TMDS'), the four high speed lanes consist of an explicit clock (Ck) and three lanes for payload data (D0, D1, D2). These four lanes are referred to as the TMDS link (transition minimized differential signaling) and the data lanes are encoded with an 8b/10b overlay that minimizes the transitions. TMDS 8b/10b is different from ANSII 8b/10b, which seeks to maximize transitions in the data stream. The TMDS system makes use of a divided forwarded clock, which is referred to as the **TMDS clock**. For HDMI 2.1 TMDS, the divisor is 40, and for HDMI 1.4b the divisor is 10. For HDMI 1.4b, the maximum composite bit rate is 10.2 Gbs (three data lanes at 3.4 Gbs maximum per lane); with HDMI 2.1 TMDS, the maximum composite bit rate is increased to ~18 Gbs (three data lanes at maximum of 5.94 Gbs per lane).

The new HDMI 2.1 specification includes a dramatically different transport system called 'Fixed Rate Link' (FRL). FRL uses the four high speed lanes for data transport using 16b/18b encoding and increases the maximum data rate to 12 Gbs per lane, which nearly triples the video payload. Although HDMI products may use FRL or TMDS, FRL must be used if more than ~18 Gbs is needed for a given format.

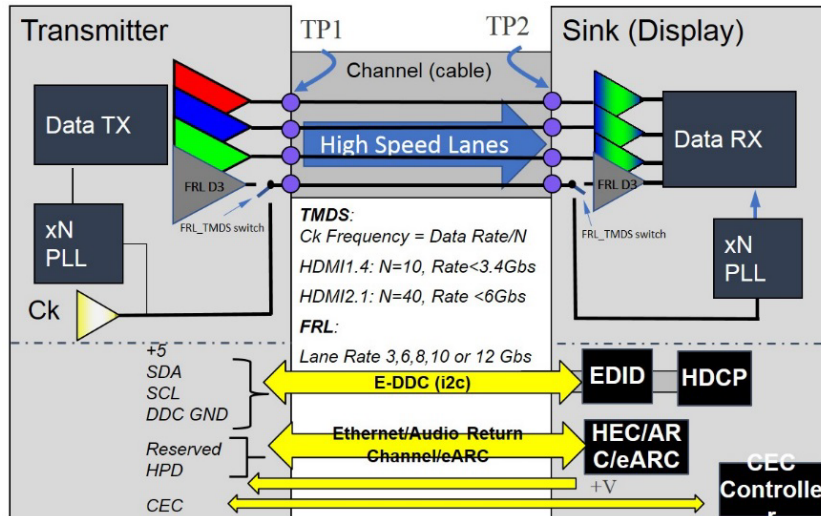


Figure 2. HDMI system

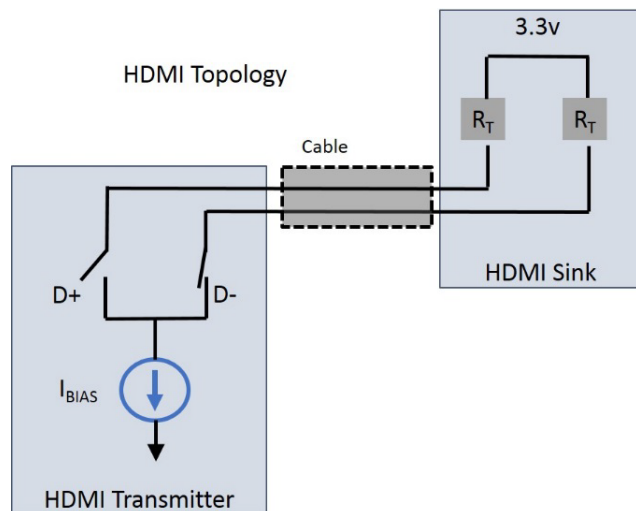


Figure 3. HDMI TMDS lane topology

Testing HDMI transmitters

To test a digital transmitter of any sort, the test equipment must be connected to an interface. Since physical layer test equipment use coaxial connectors, a test point access adapter (TPA) that breaks out the test signals from the device under test with HDMI connector to the test equipment must employ a coaxial connector.

The **Connection accessories** table below identifies the TPAs to use with the Keysight HDMI compliance software (see Figure 8 for an illustration). A simplified illustration of how HDMI signals are accessed by the measurement system is shown in Figure 4. When not all HDMI highspeed signals can be connected to the measurement system at the same time, the software will guide the user through the test process to establish a re-connection of signals when necessary. In these cases, untested lanes should be terminated properly, illustrated in Figure 3, at the sink where $R_T=50$ ohms.

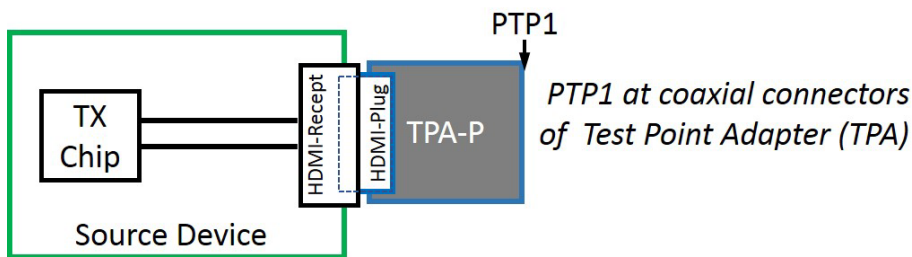


Figure 4. Updated TPA: illustrating acquisition at Practical Test Point 1 (PTP1)

In HDMI, there are tests that measure single-ended parameters as well as differential parameters. When single-ended parameters are measured, the waveform for a single line of the differential lane is analyzed. If a single line (e.g. D0+) is compared with another line (e.g. D0-, as in intra-pair skew testing), the D0- signal will be routed to one oscilloscope channel and the D0+ will be routed to another.

For tests that require differential analysis there are two cases:

- The first case is for PTP1 (output of transmitter) measurements where a differential probe may be used directly, or two single-ended measurements may be subtracted (performing a Math function, for instance).
- The second case is when a TP2 (end of cable) measurement is being made, in these cases a single-ended acquisition at PTP1 must be used to properly manifest the effects of the cable mathematically.

In either case, the resultant waveform is analyzed for the parameter of interest (level, rise time, etc.). There are times when two differential signals (two TMDS lanes) are required (data eye test being the most significant case). When performing such tests, the HDMI EPVC software can use single-ended acquisitions or can acquire the information from differentially probed lines.

In all cases, the connecting network, shown in Figure 4, and the oscilloscope connection must behave according to the topology requirements shown in Figure 3 for the HDMI sink connection.

New HDMI transmitter test requirements for HDMI 2.1

While many of the tests remain similar for HDMI 2.1 as performed in HDMI 1.4, there are many complex mathematical processes that are now required for the test processing on the oscilloscope for the data rates above 3.4 Gbs. These processes amount to filtering acquired data using transfer functions to obtain the required view. Examples of such functions are finite impulse response filters (FIRs) that can be convolved with acquisitions to accomplish de-embedding the fixture and embedding a standard-prescribed worst-case cable. In the figure below, we have an idealized HDMI link with HDMI transmitter, sink and cable between them. The use of decision feedback equalization (DFE) in the TP2Eq processing is another example of the extended requirement for HDMI 2.1 FRL products with 12 Gbs capability.

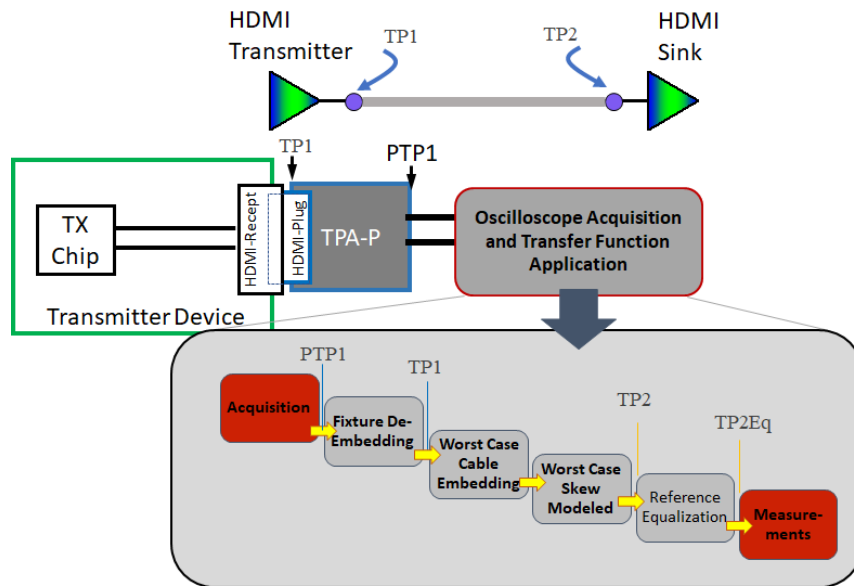


Figure 5. Test points and signal processing in HDMI

To validate a transmitter, we must access the signals of the transmitter with a test point adapter and analyze it with an oscilloscope. The HDMI 2.1 required processing functions are depicted below the oscilloscope block. These functions include the following:

- Fixture de-embedding for removing the effects of the fixture, impressing a cable model that is considered a worst-case acceptable cable in an HDMI system (the cable model includes loss vs. frequency, crosstalk and mode conversions).
- Adding worst-case skew to either side of the differential pair (one signal at a time).
- Modeling the minimum equalization an HDMI receiver will have (the HDMI reference equalizer).

The HDMI EPVC software generates all these transfer functions and enables any combination of them. It is also possible to create other transfer functions using different fixtures, cable models, and equalizers.

Using the HDMI EPVC Software

The HDMI software logically guides the user through the test process. The graphical user interface is designed to glean test process and device under test information from the user to efficiently carry out the testing. (Refer to Figure 6.) The user will know the device type (which determines the test suite) and which specification applies (HDMI 1.4b, HDMI 2.1 TMDS or HDMI 2.1 FRL). Though the specifications for HDMI 2.1 TMDS and HDMI 1.4b are different, the selection of HDMI 2.1 TMDS will reveal both 1.4b and 2.1 TMDS tests, as seen in Figure 9. HDMI 2.1 FRL tests are only shown when HDMI 2.1 FRL is selected.

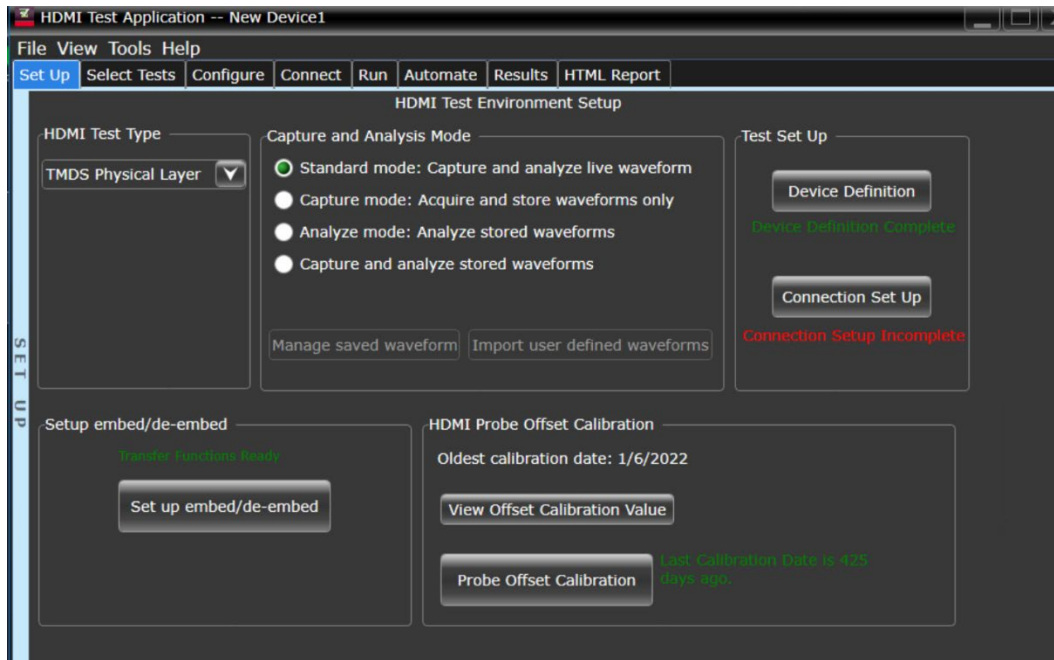


Figure 6. HDMI software application entry screen

The Keysight HDMI validation software now offers device definition and connection setup tabs in the setup screen as can be seen in Figure 6. These tabs are labeled with a colored status. The color red indicates that the user has to complete some actions before proceeding, while the color green indicates valid state and ready to test.

The setup screen also includes transfer function generation and probe offset calibration. The probe offset calibration is not new and should be run periodically to make precision measurements, particularly when measuring the eye at TP2. The offset calibration is for HDMI measurements only. If run after standard probe calibration and de-skew, it will result in the elimination of offsets in the differential measurements made by the software. The transfer function generation feature allows the user to create new filters that may be needed when performing characterizations with different cable models, different fixtures, equalization and skew. Generally, required filters, or transfer functions, are provided as part of the software package as defaults, which means the user does not have to create any.

Device definition

The information entered in the device definition screen is used to create a test plan for the device. The device definition may be limited (for example, one format given) or it may be fully defined (listing many possible formats). Logic in the software creates the minimum test procedure required. For instance, if several formats entered in TMDS have the same bit rate, only one format is tested at that bit rate. Furthermore, some tests are only run on the lowest bit rates whilst other tests are run at the highest bit rate.

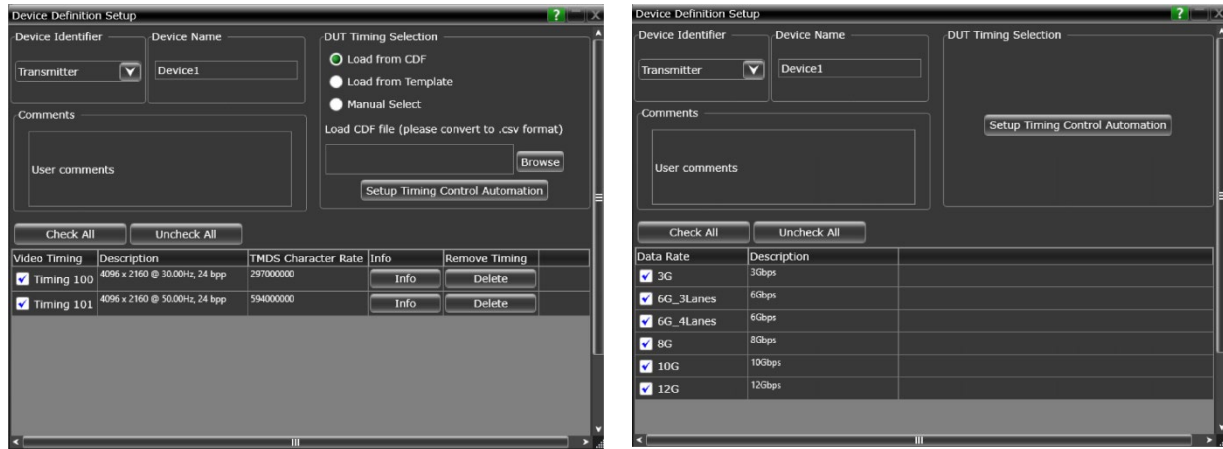


Figure 7. HDMI software application definition screens for HDMI 2.1 TMDS and HDMI 2.1 FRL

The device definition screen supports standard DUT identification and test comments. Users can now also define the timings/resolutions for each test. You can enter these resolutions by:

1. Using the capability declaration form (CDF).
2. Using a previously stored template.
3. Using the default setup (which you can define).
4. Adding your own custom timing.
5. Independently editing any of these using the check boxes in the pixel clock tabs at the top of the bottom section.

Once the resolution/timing table is defined, it can be stored as a template or as a default state. If defined as default, it will show up on all future application start-ups.

Connection setup

The connection setup screen lets you enter the details of connection from the device under test to the oscilloscope. The connection elements include the test fixture (or test point adapter, or TPA), the probe heads that connect to the high speed TMDS (or FRL) lanes, and an optional switch matrix for automated testing. The application allows different connections, including a choice of using two or four probes that are single-ended or differential. While the recommended use model is four probes with single-ended connection (one data lane), other use models are possible to reduce capital outlay in test solutions or to facilitate specific testing in the device characterization stage.

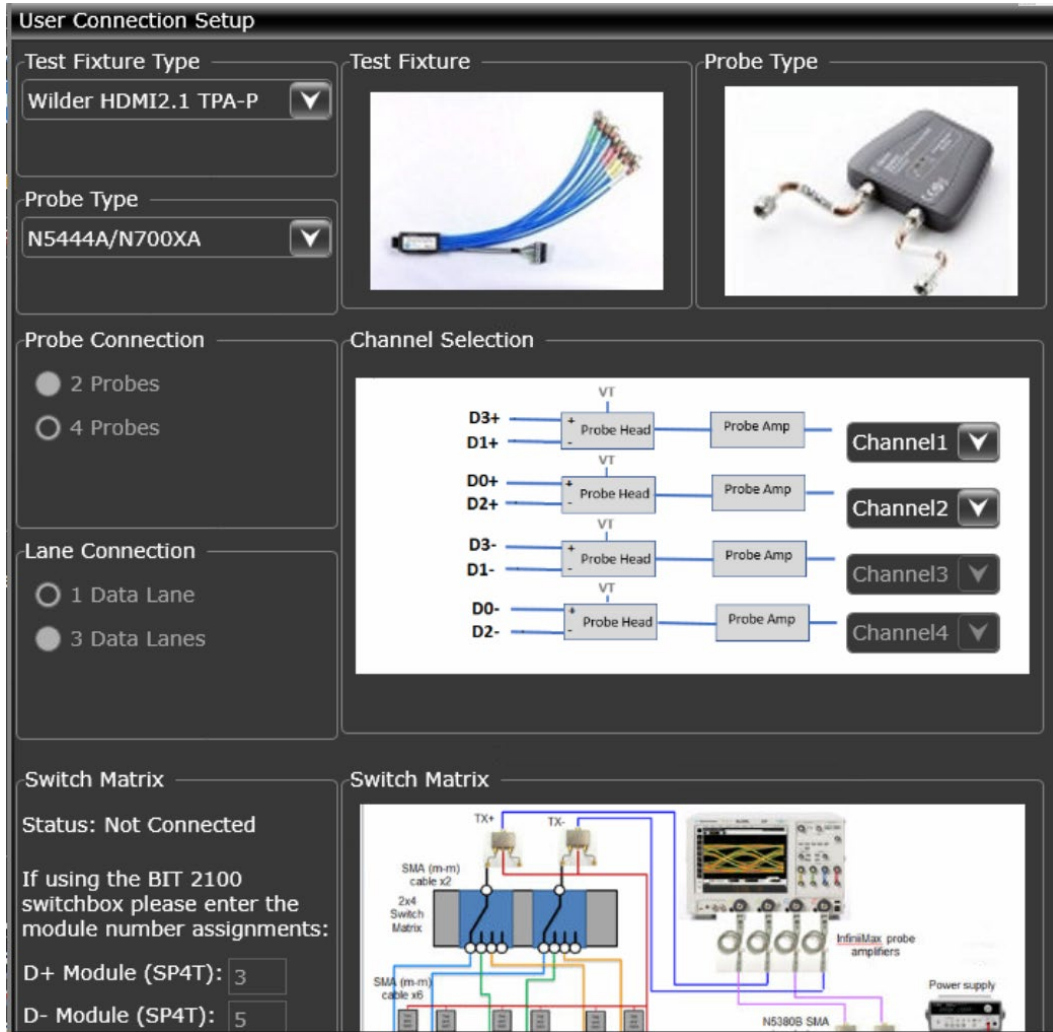


Figure 8. HDMI software application test connection screen

Test selection

After completing the DUT definition and test connection, you are ready to make test selections. By clicking on the **Select Tests** tab, you can proceed to select the tests you wish to run.

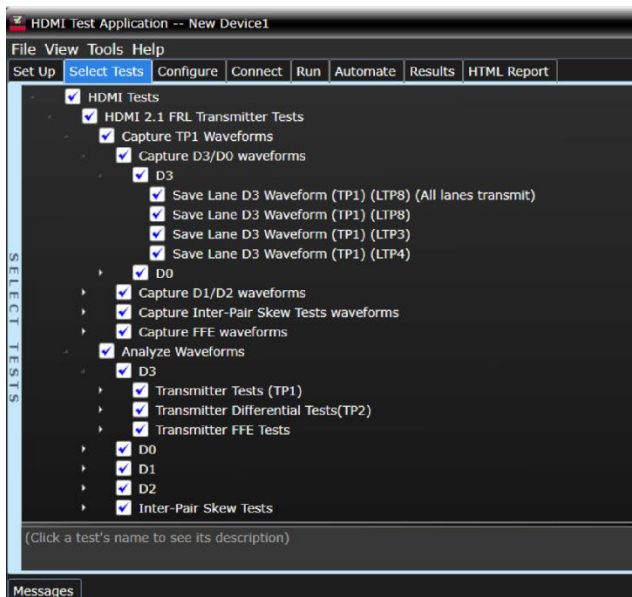
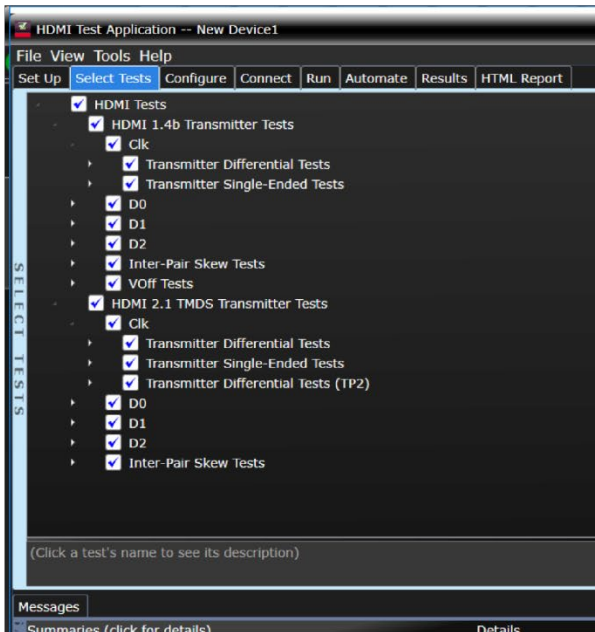


Figure 9. HDMI software application test selection screen

Figure 9 shows two test suites for transmitter tests: HDMI 1.4b and HDMI 2.1. For a device that can perform HDMI 2.1 data rates as well as HDMI 1.4b, the HDMI 2.1 test suite will be shown. If the device is limited to the lower data rates (< 3.4 Gbs), only the HDMI 1.4b tests will be available. For procedures with multiple resolutions, the test plan rules of the software will govern the tests that are run. Test procedures that are performed with only one resolution or timing format will run all tests selected.

Connection diagram and instructions

After configuring the tests according to your objectives, you then proceed to the connect tab, which gives detailed information and a pictorial view of how you should connect your device. Figure 10 illustrates the connection diagram for the recommended 4-channel single-ended connection.

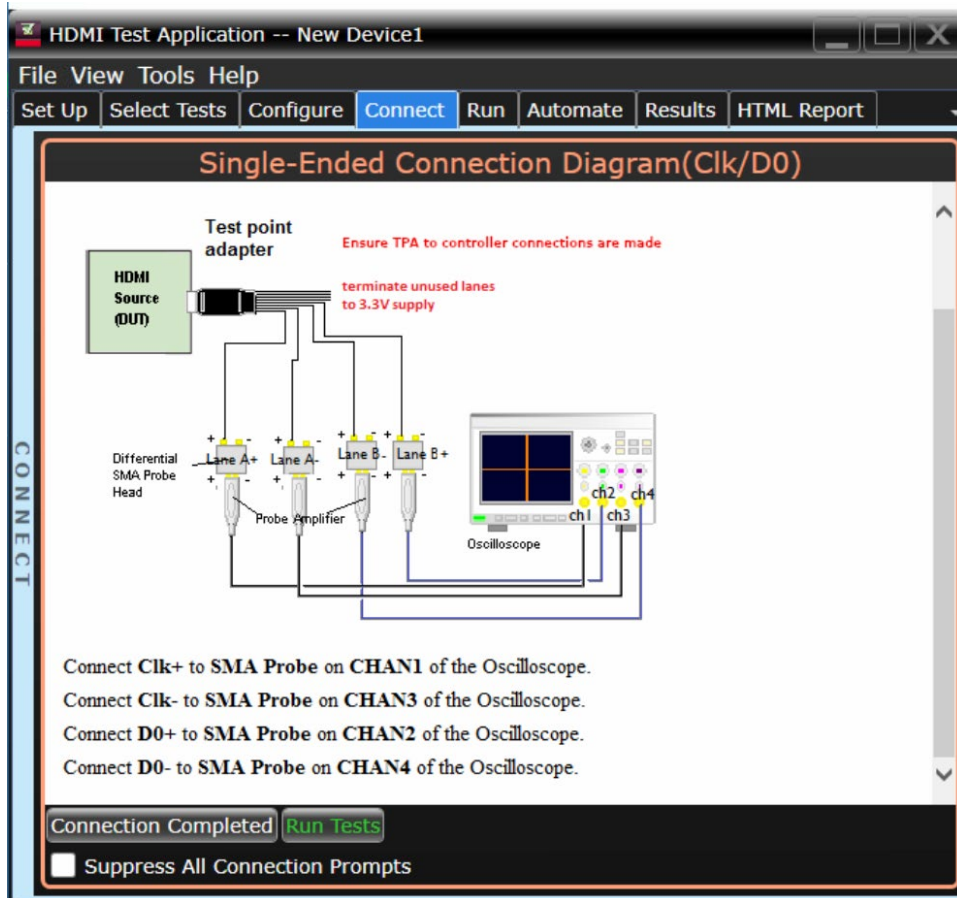


Figure 10. HDMI software application test connection screen

Thorough performance reporting

The HDMI electrical performance validation and compliance software generates thorough reports that not only capture the performance and status of the device under test, but also the screen shots of the most significant measurements for your perusal and evaluation. The first page of the report lists equipment and configuration details required in standard quality assurance programs. It also provides a hot-linked results table that will quickly get you to the measurement report section of interest.

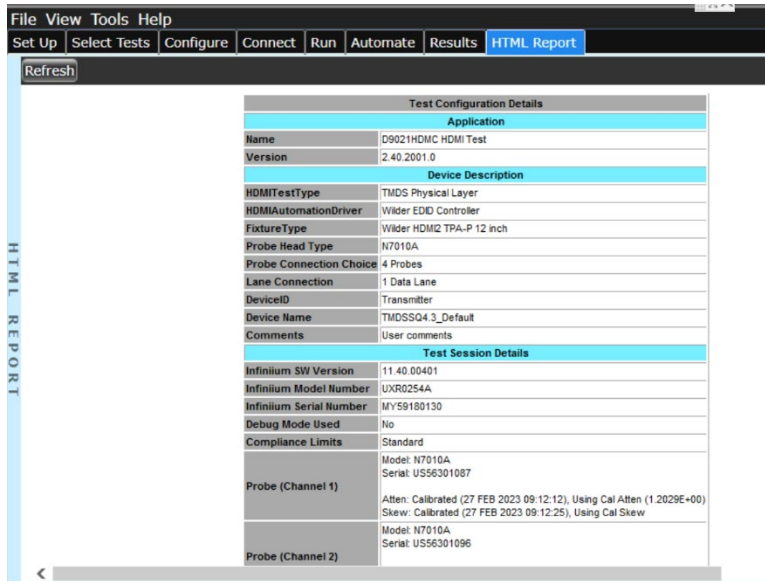


Figure 11. The HDMI software generates a summary report where you can see the total test results for your device quickly and clearly. This is the title page illustrating the important session information regarding the connection, device, and measurement equipment.

Summary of Results

Test Statistics	
Failed	6
Passed	64
Total	90

Margin Thresholds	
Warning	< 10 %
Critical	< 0 %

Pass/Fail	Test ID	Test Description	Value	Margin	Limit
✓	0	HF1-0_Clock Duty Cycle(Maximum)	50.102	16.5 %	4-62%
✓	0	HF1-0_Clock Rate	148.499745000 Mhz	2.3 %	65.000000000 Mhz << VALUE << 150.000000000 Mhz
✓	0	HF1-1_VL_Clock_+	2.901 V	37.4 %	2.300 V << VALUE << 3.100 V
✓	0	HF1-1_Clock+_VSwing	404 mV	49.0 %	200 mV << VALUE << 600 mV
✓	0	HF1-1_VL_Clock_	2.802 V	37.3 %	2.300 V << VALUE << 3.100 V
✓	0	HF1-1_Clock_-VSwing	401 mV	49.8 %	200 mV << VALUE << 600 mV
✓	0	HF1-4_Intra-Pair Skew - Clock	56 mTbt	31.3 %	:150 mTbt << VALUE << 150 mTbt
✓	0	HF1-7_Differential Clock Voltage Swing_Va (TP1)	801 mV	49.9 %	400 mV << VALUE << 1.200 V
✓	0	HF1-7_Clock Jitter (TP2_EQ with Worst Case Positive Skew)	90 mTbt	70.0 %	VALUE << 300 mTbt
✓	0	HF1-7_Clock Jitter (TP2_EQ with Worst Case Negative Skew)	100 mTbt	66.7 %	VALUE << 300 mTbt
✓	0	HF1-5_D0 Maximum Differential Voltage	473 m	39.4 %	VALUE << 700 m
✓	0	HF1-5_D0 Minimum Differential Voltage	-477 m	38.8 %	VALUE >> -700 m
✓	0	HF1-2_D0 Rise Time	83.695 ps	98.9 %	VALUE >> 42.500 ps
✓	0	HF1-2_D0 Fall Time	87.032 ps	104.8 %	VALUE >> 42.500 ps
✓	0	HF1-1_VL_D0+	2.823 V	12.8 %	2.300 V << VALUE << 2.900 V
✗	1	HF1-1_D0+_VSwing	358 mV	29.8 %	400 mV << VALUE << 600 mV
✓	0	HF1-1_VL_D0-	2.823 V	12.8 %	2.300 V << VALUE << 2.900 V
✗	1	HF1-1_D0-_VSwing	357 mV	29.8 %	400 mV << VALUE << 600 mV
✓	0	HF1-4_Intra-Pair Skew - Data Lane 0	27 mTbt	41.0 %	:150 mTbt << VALUE << 150 mTbt
✓	0	HF1-8_D0 Mask Test (TP2_EQ with Worst Case Positive Skew)	0.000	50.0 %	No Mask Failures

Figure 12. View of the test results summary table. Additional details are available for each test including the test limits, test description, and test results (including waveform captures).

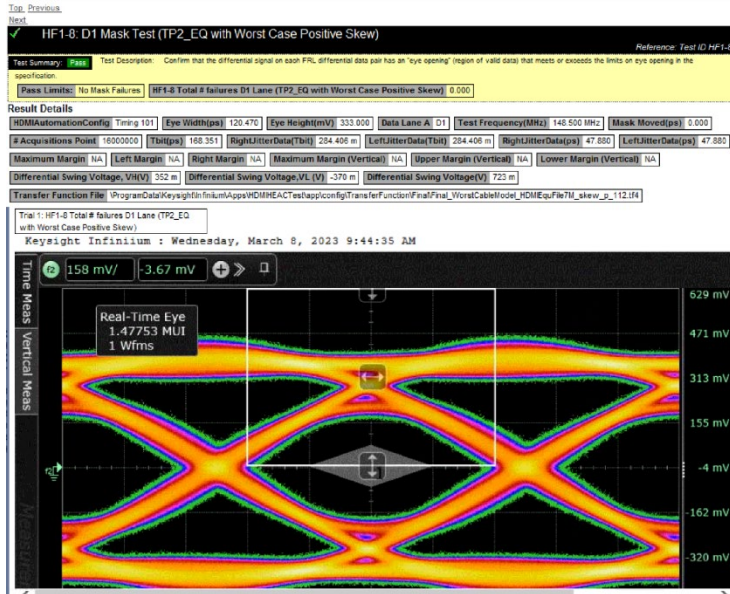


Figure 13. Summary report detail: The HDMI summary report yields all the screen shots of all the measurements that have been performed. In this figure you can see the data-eye. Observe the clear status and description at top and the measurement data just above the eye.

Margin analysis

In addition to measurement results, the HDMI test software also 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 HDMI compliance test specification for a given test assertion.

Margin is calculated as follows:

Single-sided specification

$$\text{Margin} = (\text{Value}_{\text{Specification}} - \text{Value}_{\text{actual}}) / \text{Value}_{\text{Specification}}$$

Double-sided specification

$$\text{Margin} = \text{lowest of: } (\text{Value}_{\text{Specification_High}} - \text{Value}_{\text{actual}}) / \text{Range}_{\text{Specification}}$$

and

$$(\text{Value}_{\text{Specification_Low}} - \text{Value}_{\text{actual}}) / \text{Range}_{\text{Specification}}$$

Eye margin: Another method of evaluating the eye is provided by sweeping the eye horizontally with the specified mask and determining the last locations on the left and right portions of the interior eye where there are no violations in the mask. The distance from the center mask location is a measure of design margin and is reported as eye margin if that eye mask mode is chosen in the configuration screen.

Test Name	Spec Range	Actual Val	Margin
DD - Eye Pattern	Zero Mask Failures	0	
✓ Clock - Jitter	<= 153.74ps	99.35ps	35.4%
✓ Raw Clock - RiseTime	[75.00ps to 247.21ps]	240.47ps	3.9%
✓ D0 - RiseTime	[75.00ps to 246.32ps]	146.98ps	42.0%
✓ D0 - FallTime	[75.00ps to 246.11ps]	150.43ps	44.1%
✓ Raw Clock - FallTime	[75.00ps to 247.64ps]	237.02ps	6.1%
✓ D0/D1 - Skew	[-0.20000 Tpixel to 0.20000 Tpixel]	-0.01345 Tpixel	46.6%
✓ D0 - Over/Undershoot	Overshoot & Undershoot	1.041666e+001% & 1.041667e+001%	
✓ Clock Duty Cycle	Tduty(MIN) & Tduty(MAX)	5.117453e+001% & 5.219292e+001%	

Figure 14. The HDMI software results report documents your test, indicates the pass/fail status, the test specification range, the measured values, and the margin.

Extensibility

You may add additional custom tests or steps to your application using the 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.

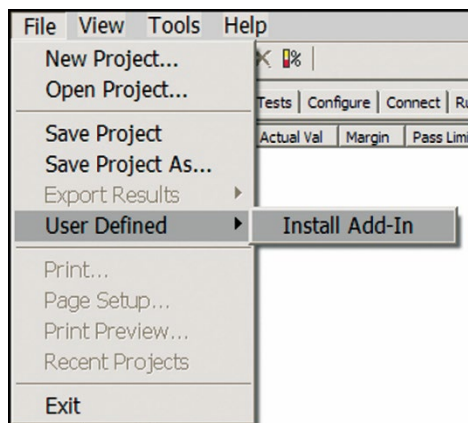


Figure 15. Importing a UDA Add-In into your test application.

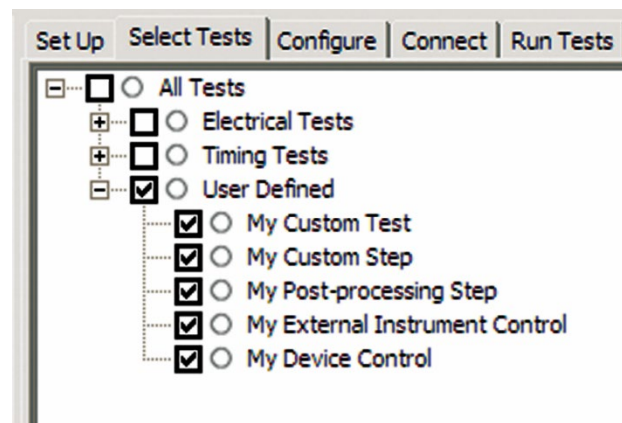


Figure 16. UDA Add-In tests and utilities in your test application.

Automation

You can completely automate execution of your application's tests and Add-Ins from a separate PC using the included remote interface feature (download the 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 the data using 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.

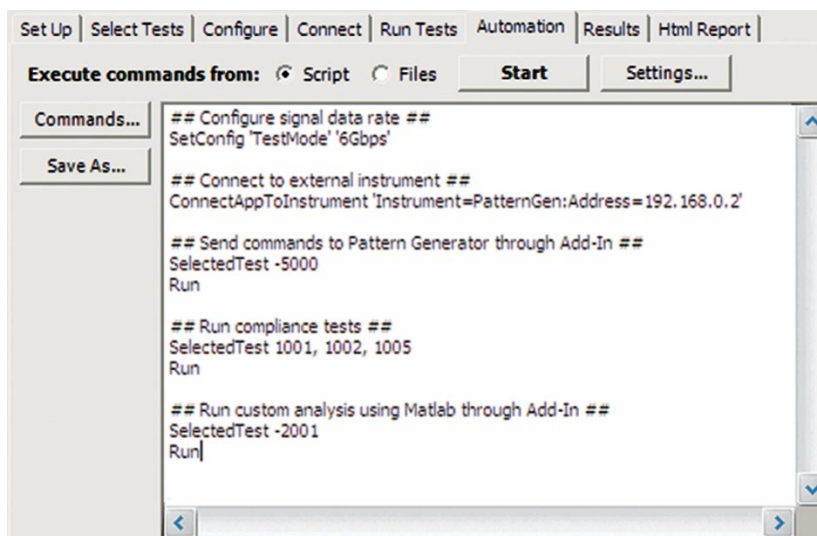


Figure 17. Remote Programming script in the Automation tab.

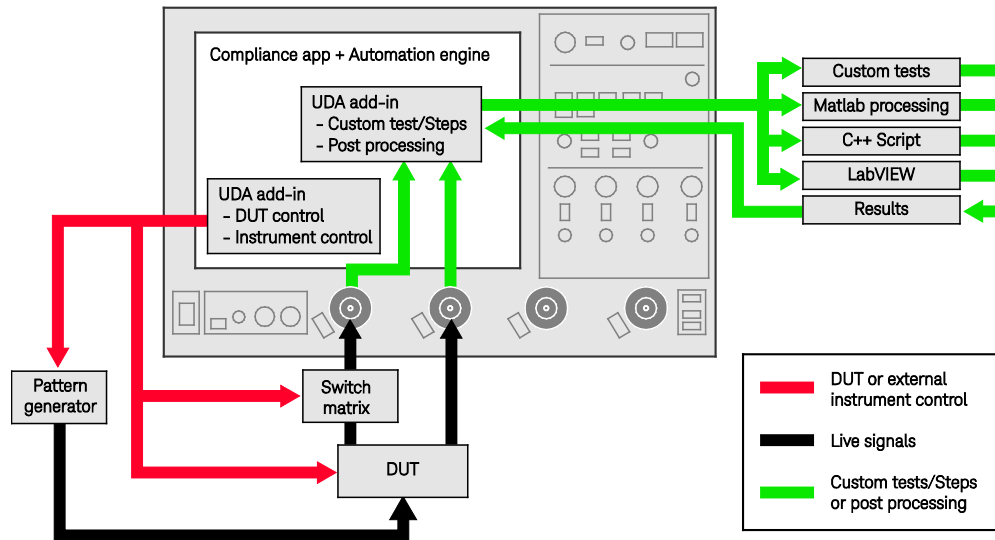


Figure 18. Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive.

Switch matrix

The Keysight switch matrix software option for the compliance 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 User-Defined Application tool for device control, instrument control, and test customization.

Keysight's recommended switch for HDMI compliance test usage is BitifEye's BIT2100 series switch. More information can be found at the BitifEye webpage by navigating to **Home > Products > Switching Solutions** and clicking on the **HDMI Source/Cable** tab.

Alternatively, you may contact your local Keysight representative for more information.

Tests Performed

The HDMI electrical performance validation and compliance software performs the following tests per the HDMI Compliance Test Specifications (CTS 1.4 and 2.1).

HDMI electrical transmitter tests performed by the HDMI EPVC software:

HDMI 1.4b Assertion No.	HDMI 2.1 TMDS Assertion No.	HDMI 2.1 FRL Assertion No.
GCTS1.4b Section 7.0	GCTS2.1 Sources Section 7.1.1	GCTS2.1 Sources Section 8.1.1
Test ID 7.2	Test ID HF 1.1	—
Test ID 7.3	—	—
Test ID 7.4	Test ID HF 1.2	Test ID HFR1-3
Test ID 7.6	Test ID HF 1.3	Test ID HFR1-4
Test ID 7.7	Test ID HF 1.4	—
—	Test ID HF 1.5	—
Test ID 7.8	Test ID HF 1.6	—
Test ID 7.9	Test ID HF 1.7	—
Test ID 7.10	Test ID HF 1.8	Test ID HFR1.7
—	—	Test ID HFR1.1
—	—	Test ID HFR1.2
—	—	Test ID HFR1.5
—	—	Test ID HFR1.6
—	—	Test ID HFR1.8
—	—	Test ID HFR1.9

NOTE: The HDMI test software can make measurements for Digital Visual Interface (DVI) 1.0 devices. However, those devices are governed by the DVI specification, which calls out different test process.

Measurement requirements

To use the HDMI electrical performance validation and compliance software, you will need an HDMI TPA fixture and at least two InfiniiMax differential probe amplifiers with appropriate SMA probe heads. If you choose to probe HDMI signals not using an HDMI TPA fixture, you will need to select the appropriate probe head for a solder-in or browsed connection. For instance, if the high-speed signals are accessible for testing on board silicon devices, you will need to use a solder-in differential probe head for low loading probing.

Keysight offers different probe connections that the user can choose to minimize cost or to minimize reconnection time. For example, the use of N7010A Active Termination Adapters will give high signal fidelity, low noise, and convenient single ended connections at a low cost, where you can evaluate two FRL lanes at a time or one TMDS data lane at a time (assuming the required TMDS clock connection is made for the eye diagram). Using a switch box to route the signals, no manual reconnections would be required.

Ordering Information

Oscilloscopes

The HDMI electrical performance validation and compliance software is compatible with Keysight Infiniium Series oscilloscopes with operating software revision 6.30 or higher. For oscilloscopes with earlier revisions, the upgrade software is available here: www.keysight.com/find/scope-apps-sw.

Recommended oscilloscope series and bandwidth:

HDMI Specification	Minimum Bandwidth	Number of Channels	Compatible Oscilloscopes
HDMI 2.1 FRL	20 GHz	4	Infiniium V, Z, and UXR Series
HDMI 2.1 TMDS and HDMI 1.4b	13 GHz	4	Infiniium V, Z, and UXR Series
HDMI 1.4b	8 GHz	2	Infiniium S-Series, V-Series, Z series

Required for Oscilloscope for HDMI 2.1 TMDS

200 MPt memory	Fixed	Factory Installed	DSOV000-200/DSOZ000-200
		User Installed	N2810A -50M, -100, -200 (based on initial scope acquisition memory)

Probes and probe amplifiers

Recommended probes per Infiniium scope family:

Probe Component	Infiniium X, V, Z, UXR-Series	Infiniium 90000A Series	Infiniium S-Series
Probe amplifiers (qty 4) ¹	N280xA, N7001/2/3A ² , MX002xA ³ or 1169B with N5442A adapters, or N7010A Active Termination Adapters ⁴	1169B	1169B
Differential SMA probe heads (qty 4)	N5444A (with N280xA or N700XA), MX0105A ⁵ (with MX002xA) or N5380B ⁶ (only with 1169B)	N5380B	N5380B

- Quantity 2 for HDMI 1.4b testing is allowed.
- For HDMI 2.1 FRL: N7003A or N7010A or N2803A is required.
- MX002xA where MX0021A/22A can be used for TMDS, MX0024A/25A can be used for FRL and TMDS. MX0023A is not recommended. Support for this family of probes will commence mid-2023.
- N7010A Active Termination Adapters require no differential probe head.
- For MX0105A with MX0021/22/24/25A probes, ensure an **internal** oscilloscope 3.3 V termination is used, and NOT an external source. Conversely, when used with the MX0023A, an **external** 3.3 V termination source should be used.
- N5380B probe heads may be used as terminations as well.

Software

To purchase the HDMI software with a new or existing Infiniium Series oscilloscope, choose from the following options:

Model Number	Description	Note
D9021HDMC	HDMI Electrical Performance, Validation and Compliance Test Software	Required
D9020JITA/ D9120JITA	Jitter, Vertical and Phase Noise Analysis Software	Required for HDMI 2.1 FRL
D9020ASIA/ D9120ASIA	Advanced Signal Integrity Software (EQ, InfiniiSim Advanced)	Required for HDMI 2.1 FRL
D9010DMBA/ D9110DMBA	De-embedding Bundle	Optional for switch path calibrations
D9020SCNA/ D9120SCNA	InfiniiScan Event Identification Software	Optional
KS6810A	Data Analytics software (1 license)	Optional

Connection accessories

HDMI test adapter and termination ordering information:

Description	Model Number	Quantity	Comments
Type A connector plug TPA	Select one:		
	HDMIA-TPA-P	1	Available from Wilder Technologies
	SP0612A	1	Available from Keysight
	BIT-1010-0420-0	1	Available from BitifEye GmbH
	BIT-1010-0400-0	1	Available from BitifEye GmbH
Low frequency DDC/CEC/EDID test adapter fixture	Select one:		
	AJSC-1 EDID/SCDC Controller		Allion (https://www.allion.com/test-fixture/hdmi-scdc-edid-controller/) – recommended
	BIT-1016-0000-0		Available from BitifEye GmbH
Power supply	Keysight E3630A or 3640A power supply	1	Or suitable alternative

Description	Model Number	Quantity	Comments
Power distribution	BitifEye BIT-1003-0001-0	1	GP Power Distribution Kit, 10 SMB Ports
Termination	Select one: Wilder HDMI TPA-T	1	HDMI lanes should be terminated to 3.3 V through 50 Ω resistors when not being tested
	Keysight N5380B	1, 2, or 3	

NOTE: BitifEye GmbH is a preferred Keysight integrator.

HEAC, ARC, and eARC solutions

Please refer to the [Keysight N5991HE1A HDMI eARC Compliance Test Software Page](#).

HDMI Rx solutions

Please refer to the [Keysight N5991HP1A HDMI 2.1 Receiver Compliance Test Software Page](#)

Test accessories

Recommended general purpose test accessories:

Model Number	Description
11667B	Power splitter, DC to 26.5 GHz, 3.5- mm (f) connectors
11636B	Power divider, DC to 26.5 GHz, 3.5-mm (f) connectors
8493B	Coaxial attenuator (3, 6, 10, 20, or 30 dB), DC to 18-GHz, SMA connector
1250-1158	SMA (f - f) adapter, DC to 18 GHz
1250-1159	SMA (m - m) adapter, DC to 18 GHz
1250-1397	Right-angle adapter, SMA (m - m)
1250-1741	Right-angle adapter, SMA (f - m)
5061-5311	3.5 mm (f - f) connector adapter
1250-1694	SMA (m) to SMA (f) Adapter

Model Number	Description
N1021-60003	2.92 mm (m) to 2.92 mm (m) phase matched cable pair, 1 m, < 5 ps
1810-0118	SMA (m) 50 Ω termination
33SMA-Q50-0-4	SMA push-on adaptors from S.M. Electronics (or equivalent)
ZX85-12G-S+	Bias tee from Mini-Circuits Corporation
BIT-HDMI-PPD-7373	Probe power distribution kit from BitifEye GmbH. www.bitifeye.com
BIT-GEN-SCK-0010	Snap on connector kit from BitifEye GmbH. www.bitifeye.com
BIT-HDMI-HEHD-0001	HEC and ARC test accessory kit

Product Web Site

For the most up-to-date and complete application and product information, please visit our product Web site at www.keysight.com/find/scope-app.

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 (e.g. 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.

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.

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.