

Keysight Technologies

N5399C, N5399D HDMI Electrical Performance Validation and Compliance Software

For Infiniium Series Oscilloscopes

Data Sheet



Unlocking Measurement Insights

Complete Physical Layer Testing for HDMI 1.4 and HDMI 2.0

The Keysight Technologies, Inc. N5399C and N5399D HDMI electrical performance validation and compliance software is the complete test execution environment for validating and troubleshooting the electrical performance of HDMI 1.4 and HDMI 2.0 source devices. It operates on the Keysight industry-performance-leading Infiniium oscilloscope family, and extends and improves the N5399B HDMI compliance test software already well-established through the world's HDMI Authorized Test Centers (ATCs).

Though its primary application is to be the standard of HDMI physical layer measurements in HDMI ATCs worldwide in executing the HDMI electrical tests, the package is designed to flexibly handle development tasks where your characterization and troubleshooting efforts may dwarf those of the final required testing for a passing device at the conclusion of the project. Keysight has designed this product to get you there faster.

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. Certification requirements for the physical layer are documented in the HDMI 2.0 Compliance Test Specification, or CTS. The CTS defines the tests that must be run on one or more of the four high-speed TMDS (transition minimized differential signaling) lanes at each of the various resolution settings for both specifications (HDMI 1.4b and HDMI 2.0). 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.

Features

The HDMI EPVC software is a full-featured product to simplify the validation of HDMI designs and includes:

- Specification selections (HDMI 1.4b and 2.0)
- Complete test suites for HDMI: TMDS test, direct attach devices, HEAC (Ethernet/Audio return channel)
- Device capability entry using resolution and timing descriptors, video identifier codes (VIC)
- Varied connection models including differential, single ended, switch network
- Automated test sequencing using either manual or automated connection models
- Guided connection and instructions throughout the test process if in manual mode
- Test report including system and connection details, summary table, which is hotlinked to ancillary test result data, and screen shots of the test processes
- Tabular final results page with statistical analysis
- Pass/fail margin analysis
- Transfer function generation for the complex test requirements for HDMI 2.0 and for extended analysis
- Scripting for complex testing or cycling requirements
- Remote user interface
- Programmability of all operations available in the application
- Backward compatibility to N5399B users
- Test algorithm control through configurable parameters
- Test selection to support one test, many tests, or all tests
- Testplan flow control

HDMI EPVC software is easy to use

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 walks you quickly and logically through the steps required to define device capability, test selections, and test connection as well as performing the tests and providing convenient viewing of results, giving you the level of detail you need. The user is allowed to choose high level test parameters (specification, test suite) to suit test process objectives and then can proceed to select one category of tests or to specify individual tests. During the sequencing of tests in an overall test plan, should the connection or bit rate require a change, a prompt screen conveniently guides users to make the changes required. In automation modes, the testing continues without waiting for operator input. When the requested test procedure is complete, an HTML report is generated that allows viewing all the key information, and a tabular view (reports tab) is available as well. The project file can be saved for continuing testing later, and if the resume testing mode is selected, a test procedure will continue where it left off.

HDMI EPVC software saves you time

The HDMI software guides you through the whole process from setup to the point where you need to analyze the results. This graphical user interface for this process is intended to be intuitive so that you know exactly where you should be and are not mystified by what the next step is. From years of supporting these applications, Keysight knows that eliminating confusion is an instant productivity bump. The test algorithms represent much development time and optimization over the last 10 years and are certified so you don't need to develop your own software and can use confidently. In HDMI 2.0, new 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 for you automatically.

HDMI 2.0: What is Different from HDMI 1.4?

The high definition multimedia interface

HDMI is a 19-pin interface (see Figure 1) that is favored in the industry for the transmission of digital video to high resolution displays. To accomplish this, four high-speed differential lanes are used: one that serves as a clock (Ck) and three others (D0, D1, D2) for the pixel data. These four lanes are referred to as the TMDS lanes (transition minimized differential signaling). The data lanes are encoded with an 8b/10b overlay that minimizes the transitions (different from the ANSII 8b/10b, which seeks to maximize the transitions). The TMDS system makes use of a divided forwarded clock, which is referred to as the 'TMDS clock.' For HDMI 2.0, the divisor is 40 while the divisor is 10 for HDMI 1.4b and earlier. Prior to HDMI 2.0, the maximum composite bit rate was 10.2 Gbs (three data lanes at 3.4 Gbs per lane); now with HDMI 2.0, the maximum composite bit rate has been increased to 17.8 Gbs (three data lanes at 5.94 Gbs).

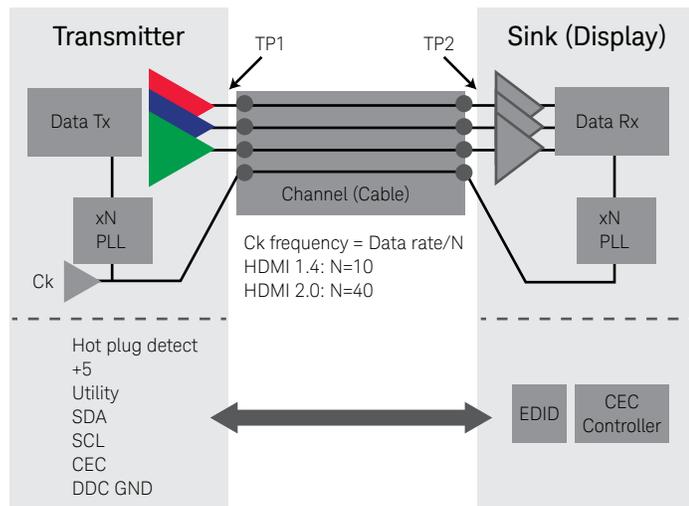


Figure 1. HDMI Interface.

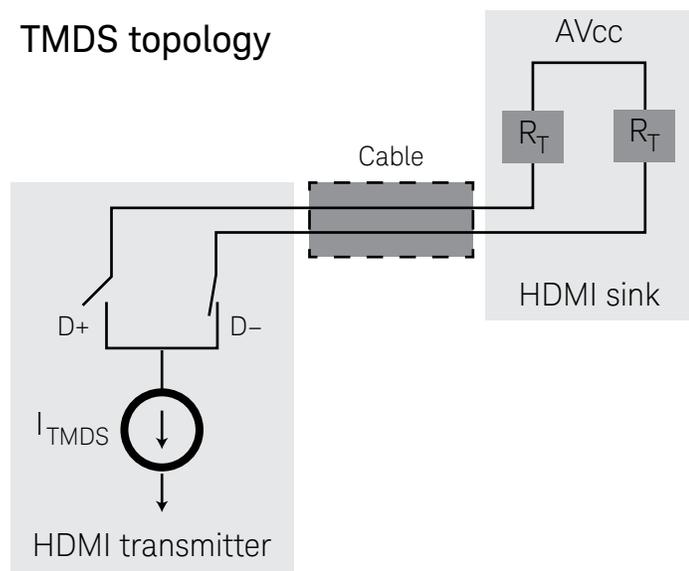


Figure 2. Differential lane topology of transition minimized differential signaling used in HDMI. (Originally from specification 1.3.)

Testing HDMI transmitters

To test a digital transmitter of any sort, the test equipment must be connected to an interface. The interface is usually not a coaxial design, so it is imperative that a test point access adapter (TPA) that breaks out the test signals to a coaxial design is used. TPAs you can use with the Keysight HDMI compliance software are presented in Table 3c. An illustration of how HDMI signals are accessed by the measurement system is shown in Figure 3. It is not commonly the case that all HDMI TMDS signals can be connected to the measurement system at the same time, so the test process will likely include reconnection of signals, which the software will guide you through.

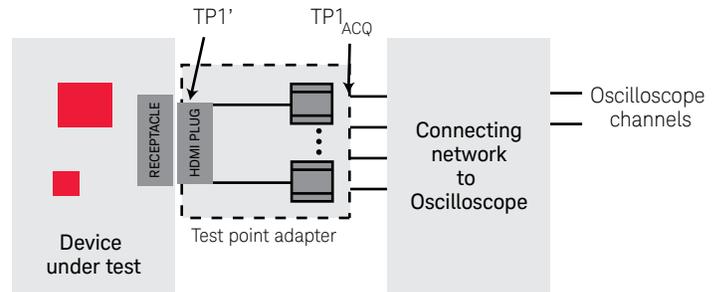


Figure 3. Test point adapter breaking out signals to the oscilloscope through cable network.

In HDMI, there are tests that measure single-ended parameters as well as differential parameters. When single-ended parameters are being measured, the waveform for a single line of the differential lane is being analyzed – for example, D0+. If this single line is compared with another line such as D0- (as in intra-pair skew testing), then the D0- signal will be routed to one oscilloscope channel and the D0+ will be routed to another. If a differential test is being performed, then the two single-ended signals are subtracted from one another in the oscilloscope (performing a Math function, for instance), and 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 3, and the oscilloscope connection must behave according to the topology requirements shown in Figure 2 for the HDMI sink connection.

New HDMI Transmitter Test Requirements for HDMI 2.0

While many of the tests remain similar for HDMI 2.0, 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 'complex mathematical 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 worst-case cable. In the figure below, we have an idealized HDMI link with HDMI transmitter, sink and cable between them.

To validate a transmitter (at test point 1), we must access the signals of the transmitter with a test point adapter and analyze with an oscilloscope. This is shown in the middle portion of the figure. The HDMI 2.0 required processing functions are depicted below the oscilloscope block. These functions include: 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 (loss vs. frequency); adding worst-case skew to either side of the differential pair (one signal at a time); and modeling the minimum equalization an HDMI receiver will have (the HDMI reference equalizer). The HDMI EPVC software generates all of these transfer functions and enables any combination of them. Further, the implementation is performed automatically in hardware by real-time convolution subsequent to the acquisition. The result is the fastest waveform processing available for HDMI 2.0 electrical testing.

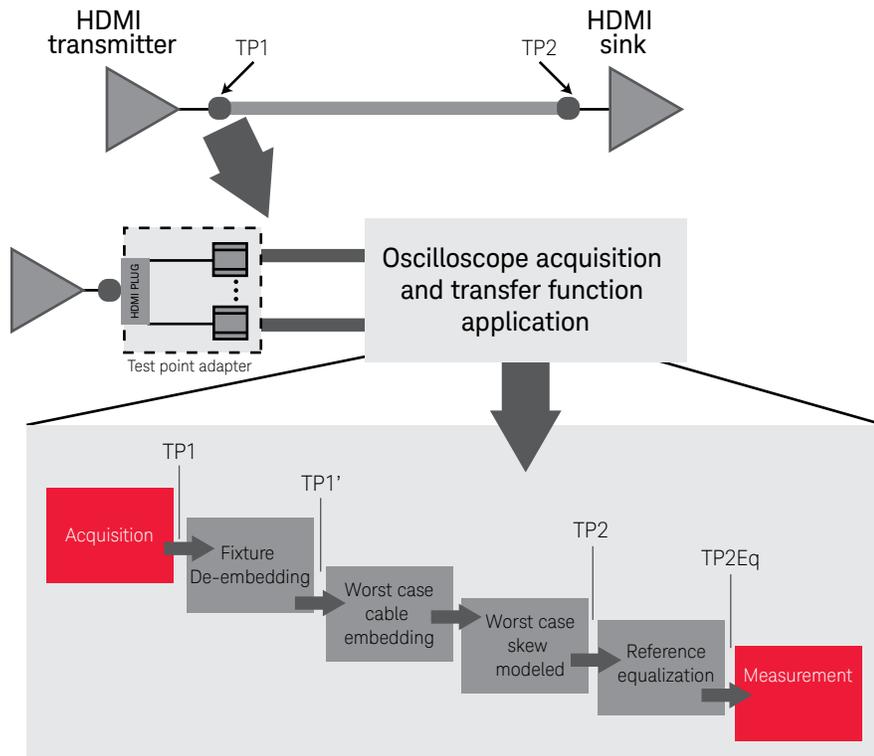


Figure 4. Test point 1 acquisition with test point adaptor with subsequent mathematical processing functions available.

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 5.) The user will know the device type (which determines the test suite) and which specification applies (HDMI 1.4b or HDMI 2.0). Though the specifications for HDMI 2.0 and HDMI 1.4b are different, the selection of HDMI 2.0 will reveal both 1.4b and 2.0 tests, as seen in Figure 8.

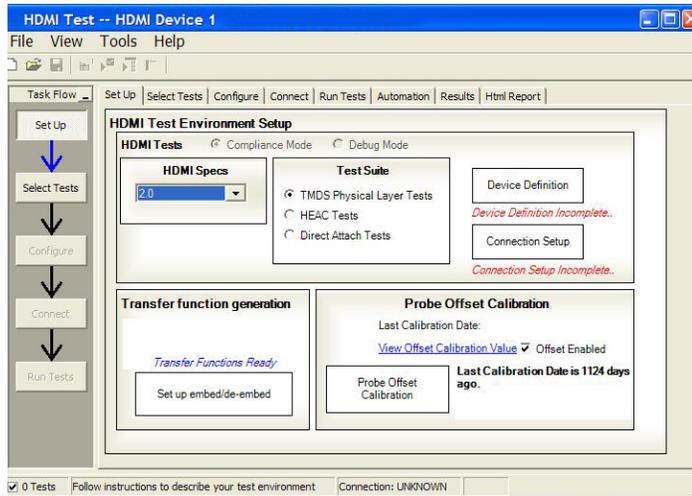


Figure 5. Entry screen for HDMI software.

New to the Keysight HDMI validation software are the device definition and connection setup tabs in the setup screen. As seen in Figure 5, upon start up, these tabs are labeled with a red status, which indicates that the user has to complete some actions before proceeding. Also included in the setup screen are 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 and 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, the filters, or transfer functions, that are required are already provided and the user does not have to create any.

Device Definition

The device definition screen lets users enter the full functionality of the device for the purpose of creating the test plan. A test plan is important in order to guide the test process to test at the specific data rates and test configurations (single-ended vs. differential) that are required.

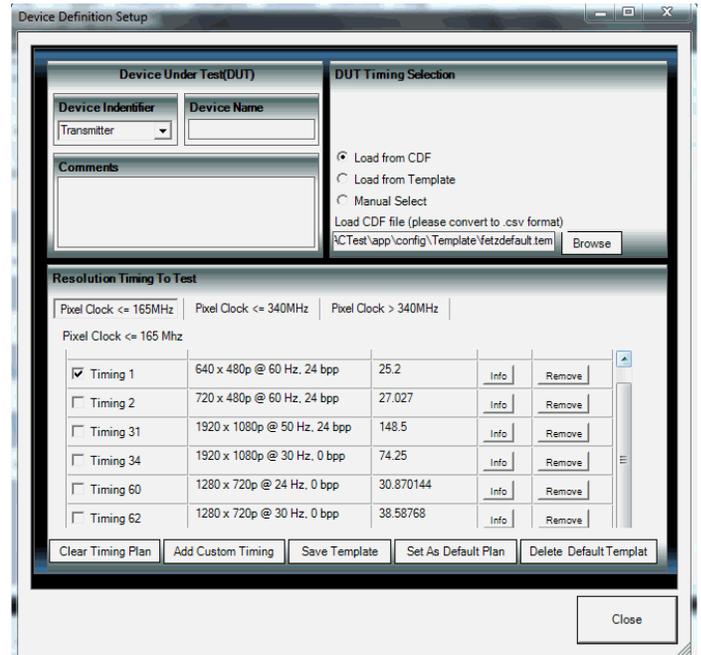


Figure 6. Device definition screen with timings and resolutions table.

This screen enables the standard DUT identification and test comments, however, the new key feature is the ability to define the timings/resolutions at which to 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 are the test fixture (or test point adapter (TPA)), the probe heads that connect to the high speed TMDS lanes, and an optional switch matrix for automated testing. Lastly, the application allows varied connections such as 2 vs. 4 probes and single-ended vs. differential connections. While the recommended use model is four probes with single-ended connection (one data lane), these others are allowed for reduced capital outlay in test solutions or to facilitate specific testing in the device characterization stage.

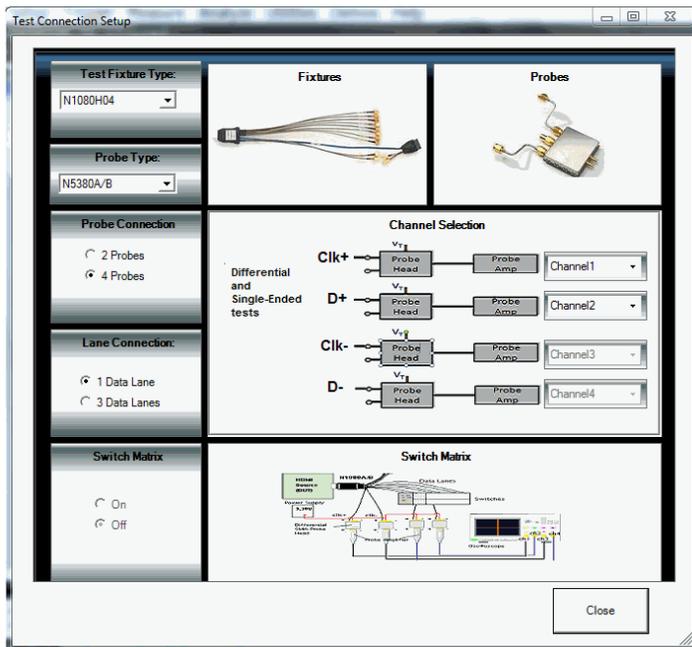


Figure 7. Test connection setup screen.

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.

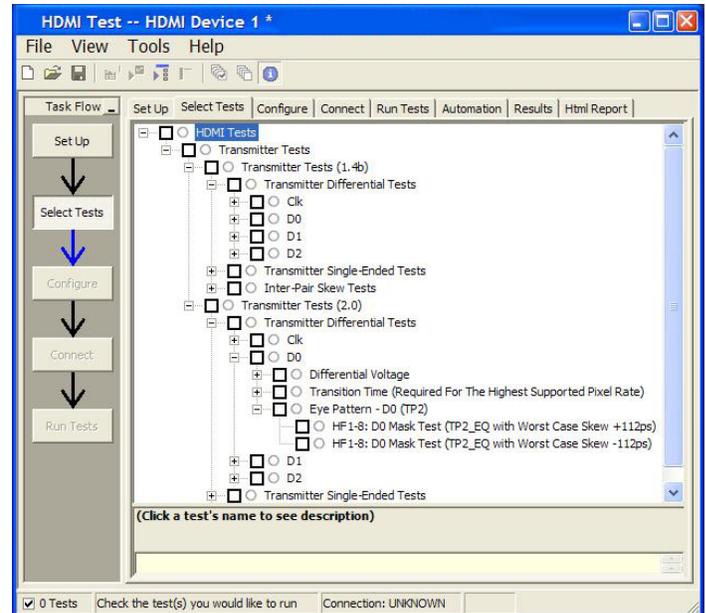


Figure 8. Test selection in the HDMI compliance software.

In Figure 8, you can see that there are two test suites for transmitter tests: HDMI 1.4b and HDMI 2.0. For a device that can perform HDMI 2.0 data rates as well as HDMI 1.4b, the HDMI 2.0 test suite will be shown while the lower data rates (< 3.4 Gbs) only the HDMI 1.4b tests will be in play. 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 will naturally 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 9 illustrates the connection diagram for the recommended 4-channel single-ended connection.

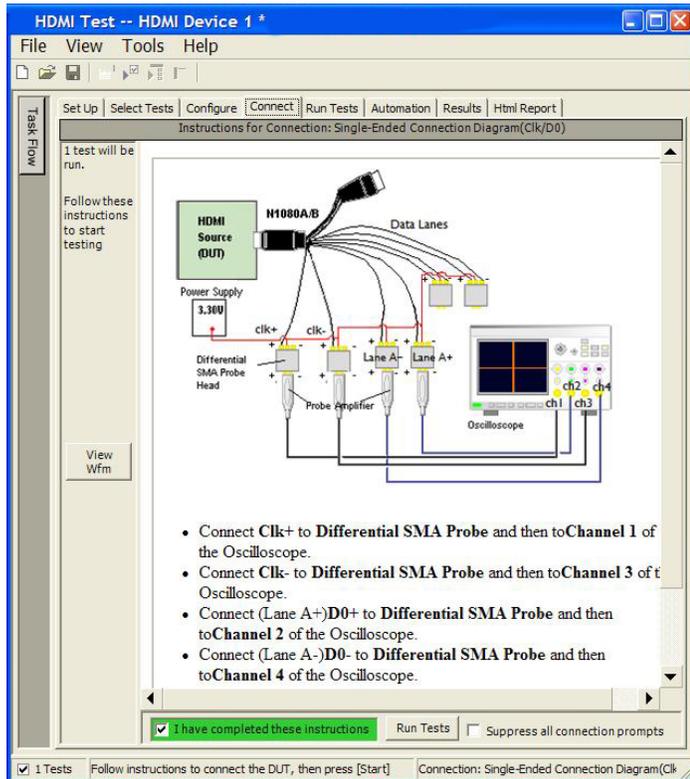


Figure 9. Test connection screen displaying the connection required and the detailed instructions for connection.

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 your 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.

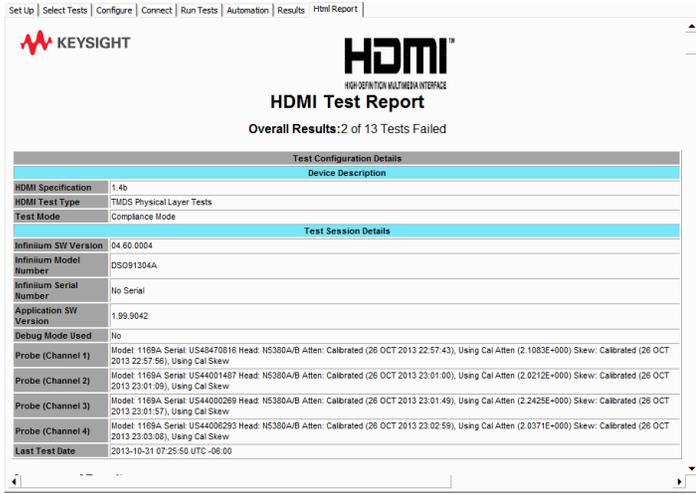


Figure 10a. The HDMI software generates a summary report where you can see the total test results for your device quickly and clearly. This is the title page illustrating the important session information regarding the connection, device and measurement equipment.

Summary of Results

Pass	# Failed	# Trials	Test Name	Worst Actual	Worst Margin	Spec Range
✓	0	2	7-9: Clock Jitter	94 mTbit	62.4 %	VALUE <= 250 mTbit
✓	0	1	7-4: Clock Rise Time	220.277 ps	193.7 %	VALUE >= 75.000 ps
✓	0	1	7-4: Clock Fall Time	198.156 ps	164.2 %	VALUE >= 75.000 ps
✓	0	1	7-8: Clock Duty Cycle(Minimum)	50.890	27.2 %	>=40%
✓	0	1	7-8: Clock Duty Cycle(Maximum)	51.360	14.4 %	<=60%
✗	2	2	7-10: D0 Mask Test	162.000	162E+02 %	No Mask Failures
✓	0	2	7-10: D0 Data Jitter	180 m	40.0 %	<=0.3Tbit
✓	0	2	7-2: VL Clock +	2.628 V	9.3 %	2.600 V <= VALUE <= 2.900 V
✓	0	2	7-2: VL Clock -	2.630 V	10.0 %	2.600 V <= VALUE <= 2.900 V
✓	0	1	7-7: Intra-Pair Skew - Clock	-27 mTbit	41.0 %	-150 mTbit <= VALUE <= 150 mTbit
✗	1	2	7-2: VL D0+	2.585 V	5.0 %	2.600 V <= VALUE <= 2.900 V
✓	0	2	7-2: VL D0-	2.608 V	2.7 %	2.600 V <= VALUE <= 2.900 V
✓	0	1	7-7: Intra-Pair Skew - Data Lane 0	91 mTbit	19.7 %	-150 mTbit <= VALUE <= 150 mTbit

Figure 10b. 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 11. 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 providing you with measurement results, the HDMI 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 HDMI compliance test specification for a given test assertion.

Margin is calculated:

Single-sided specification:

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

Double-sided specification:

Margin = 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%
DD - RiseTime	[75.00ps to 246.50ps]	146.90ps	42.0%
DD - FallTime	[75.00ps to 246.11ps]	150.43ps	44.1%
Raw Clock - FallTime	[75.00ps to 247.64ps]	237.02ps	6.1%
DD/D1 - Skew	[-0.20000 Tpixel to 0.20000 Tpixel]	-0.01345 Tpixel	46.6%
DD - Over/Undershoot	Overshoot & Undershoot	1.041666e+001% & 1.041667e+001%	
Clock Duty Cycle	Tduty(MIN) & Tduty(MAX)	5.117493e+001% & 5.219292e+001%	

Figure 12. 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

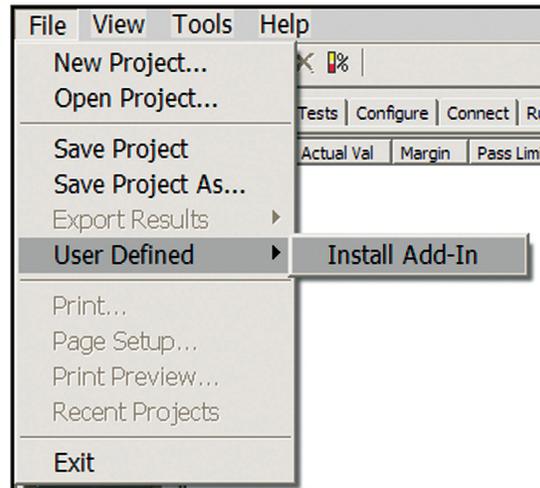


Figure 13. Importing a UDA Add-In into your test application.

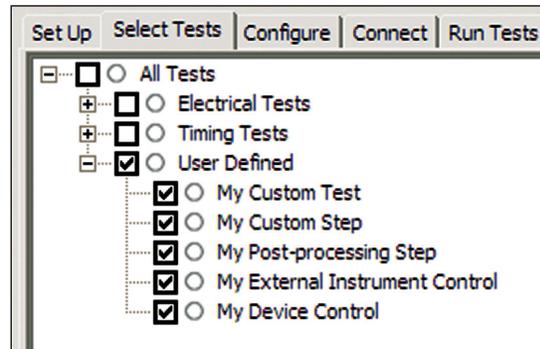


Figure 14. UDA Add-In tests and utilities in your test application.

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 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 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.

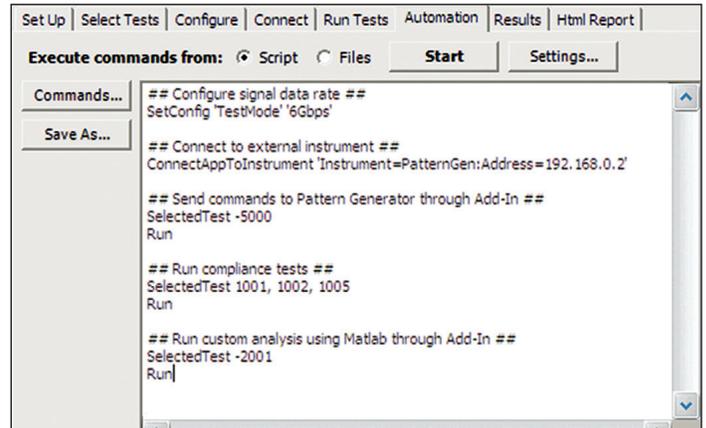


Figure 15. Remote Programming script in the Automation tab.

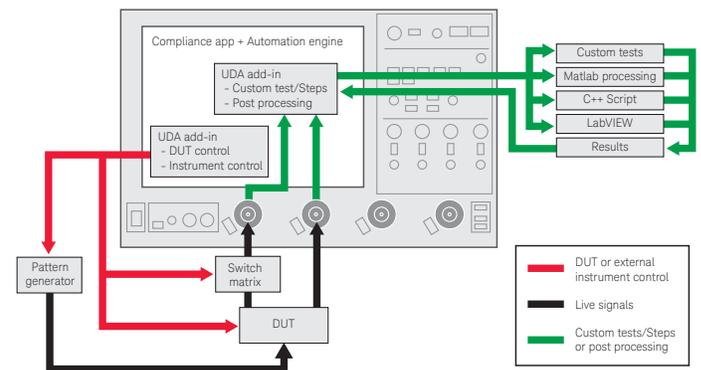


Figure 16. Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive.

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.



Figure 17. Automated testing for multi-lane digital bus interface through switching solution.

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

Measurement Requirements

To use the HDMI electrical performance validation and compliance software, you will need an HDMI TPA fixture and at least two 13 GHz or higher 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 TMDS signals are accessible for testing silicon devices, you will need to use a solder-in differential probe head for low loading probing.

Manual interconnection time can be minimized for the key performance tests by using four InfiniiMax probes to measure all three differential data lanes (D0, D1, D2) and clock without having to reposition or reconnect probes. This is called the 'four probe connection' and is selectable (for HDMI 1.4b testing) in the connection setup screen: choose four channel and three data links.

Oscilloscope compatibility

The HDMI electrical performance validation and compliance software is compatible with Keysight Infiniium Series oscilloscopes with operating software revision 4.20 or higher. For oscilloscopes with earlier revisions, free upgrade software is available here: www.keysight.com/find/scope-apps-sw.

Recommended oscilloscopes

Table 1. Recommended oscilloscope series and bandwidth.

HDMI specification	Minimum bandwidth	Number of channels	Compatible oscilloscopes
HDMI 1.4b HDMI 2.0	13 GHz	4	Infiniium 90000A, V-Series, 90000 X-, V-Series, and Z-Series
HDMI 1.4b	8 GHz	2	Infiniium S-Series

Tests Performed

The HDMI electrical performance validation and compliance software performs the following tests as per the HDMI Compliance Test Specifications (CTS 1.4 and 2.0) as documented in the respective base specifications.

Table 2. HDMI electrical transmitter tests performed by the HDMI EPVC software.

Test description	HDMI 1.4b assertion no.	HDMI 2.0 assertion no.
Transmitter tests	Section 7.0	Section HF 1.0
TMDS V_L	Test ID 7.2	Test ID HF 1.1
TMDS V_{OFF}	Test ID 7.3	–
TMDS T_{Rise} and T_{Fall}	Test ID 7.4	Test ID HF 1.2
TMDS inter-pair skew	Test ID 7.6	Test ID HF 1.3
TMDS intra pair skew	Test ID 7.7	Test ID HF 1.4
TMDS differential voltage	–	Test ID HF 1.5
TMDS clock duty cycle	Test ID 7.8	Test ID HF 1.6
TMDS clock jitter	Test ID 7.9	Test ID HF 1.7
TMDS data eye diagram	Test ID 7.10	Test ID HF 1.8

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 methodologies and test fixturing. For DVI, Keysight offers the N5394A DVI electrical performance validation and compliance software.

Ordering Information

To purchase the HDMI software with a new or existing Infiniium Series oscilloscope, order the following options.

Compliance software options

Table 3a. HDMI Compliance Test Software options

Application	License type		Infiniium V-Series/Z-Series	Infiniium 90000A/90000 X-Series	Infiniium S-Series
HDMI EPVC software HDMI 1.4b and 2.0	Fixed	Factory-installed	N5399C-1FP	DSO90000A-077 or DSOX90000-077	-
		User-installed	N5399C-1FP	N5399C-1NL	-
	Floating	Transportable	N5399C-1TP	N5399C-1TP ^{1,2}	-
		Server-based	N5435A-070	N5435A-070	-
HDMI EPVC software HDMI 2.0 upgrade	Fixed	Factory-installed	-	-	-
		User-installed	N5399C-2FP	N5399C-2NL	-
	Floating	Transportable	-	-	-
Server-based		-	-	-	
HDMI EPVC software HDMI 1.4b	Fixed	Factory-installed	N5399C-3FP	DSO90000A-023	N5399D-3FP
		User-installed	N5399C-3FP	N5399C-3NL	N5399D-3FP
HDMI switch matrix support (optional) ³	Fixed	Factory-installed	N8890-1FP	N8890-1FP	N8890-1FP
		User-installed	N8890-1FP	N8890-1FP	N8890-1FP
	Floating	Transportable	N8890-1TP	N8890-1TP	N8890-1TP
		Server-based	N5435A-124	N5435A-124	N5435A-124
PrecisionProbe (recommended)	Fixed	Factory-installed	N2809A-1FP	DSO90000A-001 or DSOX90000-001	N2808A-1FP
		User-installed	N2809A-1FP	N2809A-1NL	N2808A-1FP
	Floating	Transportable	N2809A-1TP	N2809A-1TP ^{1,2}	N2808A-1TP
		Server-based	N5435A-003	N5435A-003	-
200 Mpt memory (required for HDMI 2.0 only)		Factory-installed	DSOV000-200/ DSOZ000-200	DSO90000A-200/ DSOX90000-200	-
		Upgrade	N2810A -50M, -100, -200 (based on initial scope acquisition memory)	N5472A/B/C/D (based on initial scope acquisition memory)/N2810A -50M, -100, -200 (based on initial scope acquisition memory)	-

1. Requires software 5.00 and above.

2. Software 4.30 or above requires Windows 7. N2753A Infiniium Windows XP to 7 OS upgrade kit (oscilloscope already has M890 motherboard). N2754A Infiniium Windows XP to 7 OS and M890 motherboard upgrade kit (oscilloscope without M890 motherboard). Verify the M890 motherboard using the procedure found in the Windows 7 upgrade kit datasheet, publication number: 5990-8569EN.

3. For full switch configuration, please refer to www.keysight.com/find/switching or the brochure Automated Switching Solution for oscilloscopes, literature number: 5991-2413EN.

Ordering Information (Continued)

Probes

Table 3b. Recommended Probes per Infiniium scope family

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

- Quantity 2 for HDMI 1.4b testing is allowed.
- N5380B probe heads may be used as terminations as well.
- N7010A Active Termination Adapters require no differential probe head.

Optional software

Table 3c. Optional measurement software

Application	License type		Infiniium V-Series/Z-Series	Infiniium 90000A/90000 X-Series	Infiniium S-Series
EZJIT Plus jitter	Fixed	Factory-installed	N5400A-1FP	DSO90000-004/DSX90000-004	N5400B-1FP
		User-installed	N5400A-1FP	N5400A-1NL	N5400B-1FP
	Floating	Transportable	N5400A-1TP	N5400A-1TP	N5400B-1FP
		Server-based	N5435A-001	N5435A-001	N5435A-001
Equalization	Fixed	Factory-installed	N5461A-1FP	DSO90000-012/DSX90000-012	N5461B-1FP
		User-installed	N5461A-1FP	N5461A-1NL	N5461B-1FP
	Floating	Transportable	N5461A-1TP	N5461A-1TP	N5461B-1TP
		Server-based	N5435A-025	N5435A-025	N5435A-025
InfiniiSim (recommended)	Fixed	Factory-installed	N5465A-1FP	DSO90000-014/DSX90000-014	N5465B-1FP
		User-installed	N5465A-1FP	N5465A-1NL	N5465B-1FP
	Floating	Transportable	N5465A-1TP	N5465A-1TP	N5465B-1TP
		Server-based	N5435A-027	N5435A-027	N5435A-027

Ordering Information (Continued)

For physical connections to an HDMI device to perform tests with the N5399C HDMI compliance test software, order the following:

Connection accessories

Table 3d. HDMI Test Adapter and termination ordering information.

Description	Model number	Quantity	Comments
Type A connector plug TPA	Select one:		
	– Keysight N1080B H04	1	Not recommended for edge rates < 70 ps
	– HDMI-TPA-P	1	Available from Wilder Technologies
	– BIT-1010-0200-0	1	Available from Bitifeye GmbH
Low frequency DDC/CEC/EDID test adapter fixture	Select one:		
	– VTF-501 FlexEDID	1	Vprime (www.vprime.com) – recommended
	– Keysight N1080B H06	1	
	– HDMI-TPA-E	1	Wilder Technologies (www.wilder-tech.com)
	– BIT-1010-0004-0	1	Available from Bitifeye GmbH
Type D connector plug TPA	BIT-1010-0100-0	1	Order from Bitifeye GmbH
Type E connector plug TPA	BIT-1010-0150-0	1	Order from Bitifeye GmbH
Power supply	Keysight E3630A or 3640A power supply	1	Or suitable alternative
Power distribution	Bitifeye BIT-1003-0000-0	1	Unit supplies DC power to 5 components
Termination	Select one:		
	– Wilder HDMI TPA-T	1	HDMI lanes should be terminated to 3.3 V through
	– Keysight N5380B	1, 2, or 3	50 Ω resistors when not being tested
	– MiniCircuits ZX85-12G-S+	1 to 6	

Note: Bitifeye GmbH is a preferred Keysight integrator.

For HEC and ARC testing using the HDMI test software, order the following:

Table 3e. HEAC solution ordering information.

Model number	Description	Quantity
N1080B H04	HDMI plug test adapter	1
81150AU-EHD	HEC/ARC test fixture	1
E2678A	Differential socketed probes (used with 81150AU-EHD)	2
1130A	Probe amplifiers	2 (Optional)
E2697A	High impedance adaptor	2 (Optional)
81150A	Arbitrary waveform generator	2 (Optional)
N5990A opt 351	HEAC test software option to N5990A factory automation software	1 (Optional)
BIT-HDMI-HEAC	Stand-alone HEAC receiver physical layer and audio protocol test software	1 (Optional)

Measurement and Test Accessories

To complete your test setup, Keysight provides a wide range of cables, adapters, terminations, etc.

Table 4. 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
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 corporation. www.Bitifeye.com
BIT-GEN-SCK-0010	Snap on connector kit from Bitifeye corporation. www.Bitifeye.com
BIT-HDMI-HEHD-0001	HEC and ARC test accessory kit

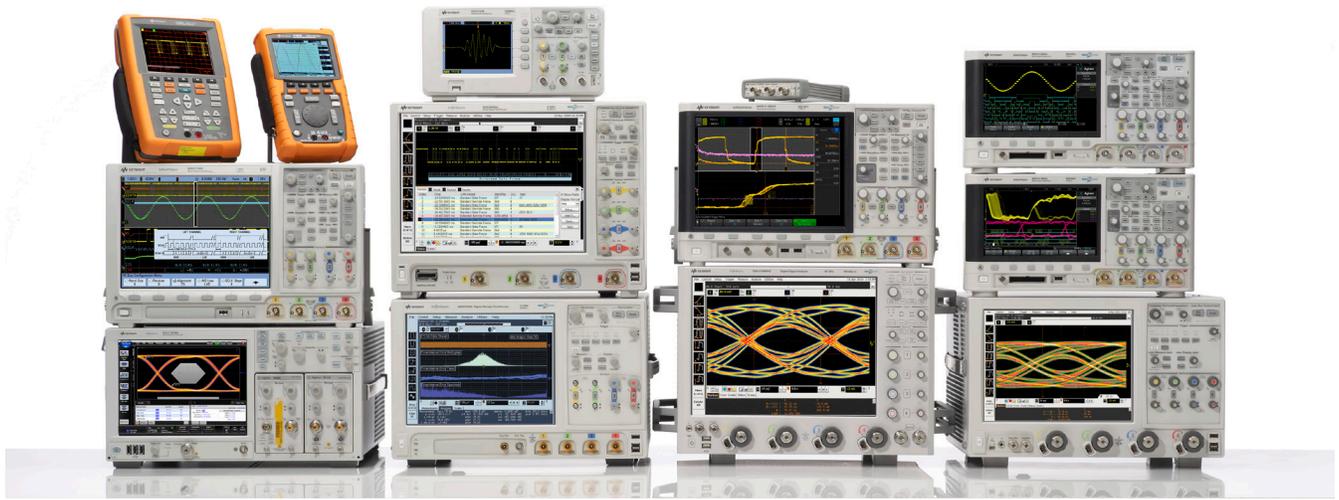
Related literature

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Publication title	Publication number
<i>Infiniium 90000 Series Oscilloscopes - Data Sheet</i>	5989-7819EN
<i>Infiniium 80000 Series Oscilloscopes and 1160 Series Probes - Data Sheet</i>	5989-4604EN
<i>N1080B HDMI Test Point Access Fixtures - Data Sheet</i>	5989-5118EN
<i>N5990A Factory Automation Software - Data Sheet</i>	5989-5483EN
<i>Infiniium 90000 X-Series Oscilloscopes - Data Sheet</i>	5990-5271EN

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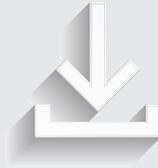
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