Agilent U7232A DisplayPort Electrical Performance Validation and Compliance Software for Infiniium Series Oscilloscopes

Data Sheet

Verify and debug your DisplayPort designs more easily

Agilent Technologies U7232A DisplayPort electrical performance validation and compliance software for Infiniium Series oscilloscopes (see Table 1) provides you with a fast and easy way to verify and debug your DisplayPort interface designs for sink and source ICs, motherboard systems, computers and graphics cards. The DisplayPort electrical test software is designed for use in DisplayPort Authorized Compliance Test Houses, so you can confidently use it to execute DisplayPort electrical checklist tests as well as employ it as a development tool. It displays the measurement data results in a flexible report format, and the report also provides a margin analysis that shows how closely your device passed or failed each test.

To make measurements with the U7232A DisplayPort electrical test software, you may also need the W2641A DisplayPort TPA fixture for signal access.

The U7232A DisplayPort electrical test software performs a wide range of tests required to meet the DisplayPort electrical specifications for various computer system components (sink and source ICs, motherboard systems, computers and graphics cards) as documented in section 3.5.2 and 3.5.3 of the base DisplayPort specification by VESA[1]. To introduce a DisplayPort product to the market, your product must successfully pass compliance testing based on the DisplayPort specification at an approved DisplayPort test center, and you will want to have performed the tests included on the checklist before you submit your product for full compliance testing for ultimate confidence and lowest turnaround time and process cost. The U7232A software makes it easier for you to prepare for passing the certification hurdle for DisplayPort CTS1.1.

[1] Video Electronics Standards Association (**www.vesa.org**)

Agilent Technologies

U7232A saves you time

Features

The U7232A HDMI electrical test software offers several features to simplify the validation of DisplayPort designs:

- Full physical layer testing

- Verification of link layer physical layer control

- Three modes of physical layer test

- Test status tracking

- Measurement process configurability

- Automated scope measurement setup

- Test results reports with pass/fail margin analysis

With the DisplayPort electrical test software, you can use the same oscilloscope you use for everyday debugging to perform automated testing and margin analysis based on the DisplayPort-specified test checklist.

The U7232A DisplayPort electrical test software saves you time by setting the stage for automatic execution of DisplayPort electrical tests. Part of the difficulty of performing electrical tests for DisplayPort is connecting the oscilloscope to the target device, configuring the instrument for measurements, executing the test procedures, understanding what to test, and then analyzing the measured results by comparing them to limits published in the specification. The DisplayPort electrical test software does almost all of this work for you. In addition, if you discover a problem with your device, debug tools are available to aid in root-cause analysis.

The U7232A DisplayPort electrical test software offers the electrical tests for the source as well as important tests for cable and receiver tolerance testing. The software automatically configures the oscilloscope for each test, and it provides an informative results report that includes margin analysis indicating how close your product is to passing or failing that specification. Clock recovery of each lane is accomplished according to the standard by the oscilloscope using proprietary software techniques. See Table 2 for a complete list of the measurements made by the DisplayPort electrical test software.

Easy test definition

The U7232A DisplayPort electrical test software extends the ease-of-use advantages of Agilent's Infiniium Series oscilloscopes to testing DisplayPort designs. The Agilent automated test engine walks you quickly through the steps required to define the device under test, to select the tests, set up the tests, perform the tests, and view the test results. You can pick high-level test parameters to suit your test process objectives, and then you can proceed to select a category of tests all at once, or specify individual tests. The user interface is oriented to minimize reconnections, which saves you time and minimizes potential for operator error. You can save tests and configurations as project files and recall them later for quick testing and review of previous test results. Straightforward menus let you perform tests with a minimum of mouse clicks.

Test environment setup and test selection

The U7232A now allows you to define the DUT capability and select test environment variables to better suit your testing goals for speed and cost. The setup process begins with the Setup entry screen (shown in Figure 1). This screen enables selection between standard DisplayPort physical layer testing and link layer physical state change validation process. When you have selected the testing you want to perform, the setup continues as shown in Figure 2 with the 'Start project' screen where the project information, device specifics and testing template can be chosen. The template allows subsequent setup fields to have specific default values you have selected.

Since there is a wide range of setup configurations allowed for the test bench and because DisplayPort devices have a wide range of optional performance, the U7232A setup screens enable you to specify this information.
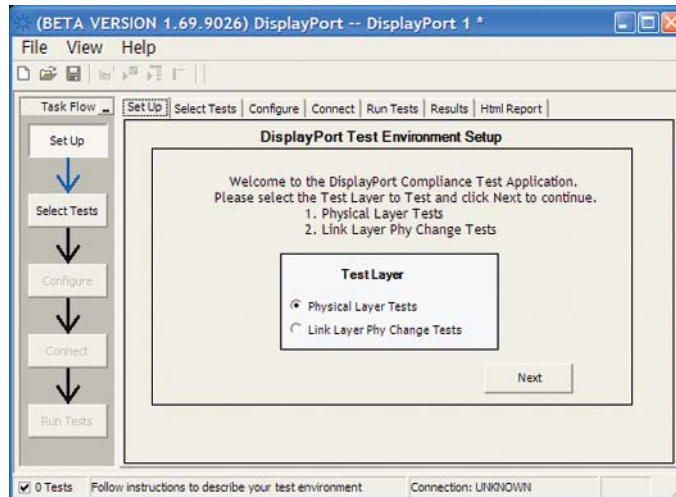

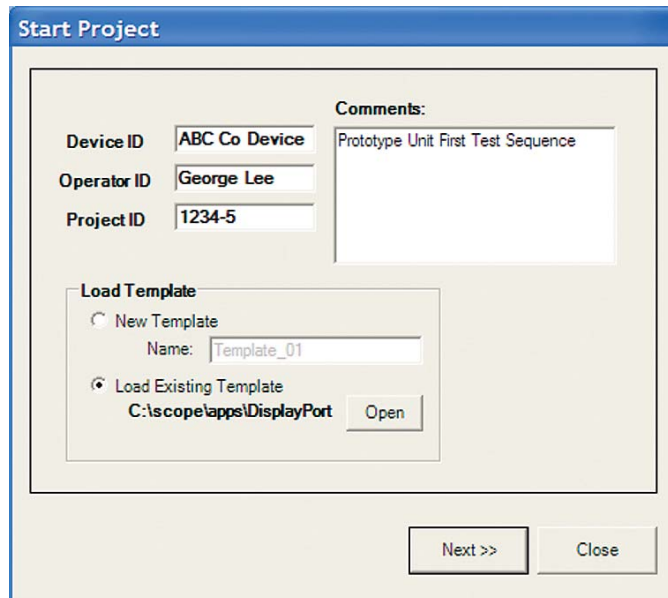**Figure 1. U7232A DisplayPort test environment setup**

Figure 2. Configuration template to enable quick selection of common settings

Test environment setup and test selection (continued)

The U7232A software guides you through selecting important test process information. These are briefly described below.

- Device ID: enter the device name and other pertinent information.

- Operator ID: for compliance test houses to identify the operator for QA process.

- Project ID: for compliance test houses that identify projects by number, this enables the report to carry a key identification number to a contract.

- Device type: allows you to select between cable test, sink test and source test suite.

- Test type: define whether tests will be single-ended or differential, see Figure 3.

- Test mode: select between compliance conditions and user-specified modes.

- DUT definition: select the capabilities of the DUT you wish to test, see Figure 4.

- Test fixture selection: select the test fixture used, see Figure 5.

- Connection type: single-ended versus differential connection: choose between using two channels of the scope to make a differential measurement using an 'A minus B' technique or by using a differential probe on each scope channel for each lane, see Figure 5.

- Number of channels: you may choose to test a 1, 2, 4 channel connection, see Figure 4. (Note: differential connection allows full lane selection, while single-ended can only support testing 1 or 2 lanes.), see Figure 5.

- Oscilloscope connection: this screen allows you to assign oscilloscope channels and device lanes to test, see Figure 8.

For convenience, these parameters can be saved in a template file. In order to execute your planned testing, the test software needs to know what you want to test and how you want to test. For instance, you have a source device and want to test the differential tests in compliance mode. This information is conveyed to the user and easily selected in the test process setup screen as shown in Figure 3.

Figure 3. U7232A Test process setup screen: select test objectives and device and test type

Test mode selection

The U7232A allows you to select a test mode that suits your goals. The selection offers the choice of compliance testing, user-defined testing and targeted characterization.

The `Compliance conditions only' mode is a test process that is controlled by a configuration control that is in accordance with the DisplayPort compliance test specification. This assures the user that measurements will only be performed on those configurations required to be tested. For instance, the data eye only need be measured for 800 mVolt setting, at both bit rates, with no pre-emphasis; only those conditions will be used for eye measurement in the `compliance conditions only' mode.

Device definition
Critical information to guide the test process will be the device capability information. This is information about the test device such as the valid levels, pre-emphasis settings, number of lanes, bit rates and whether spread spectrum clocking is enabled or not. These capabilities are identified in the DUT definition screen in Figure 4.
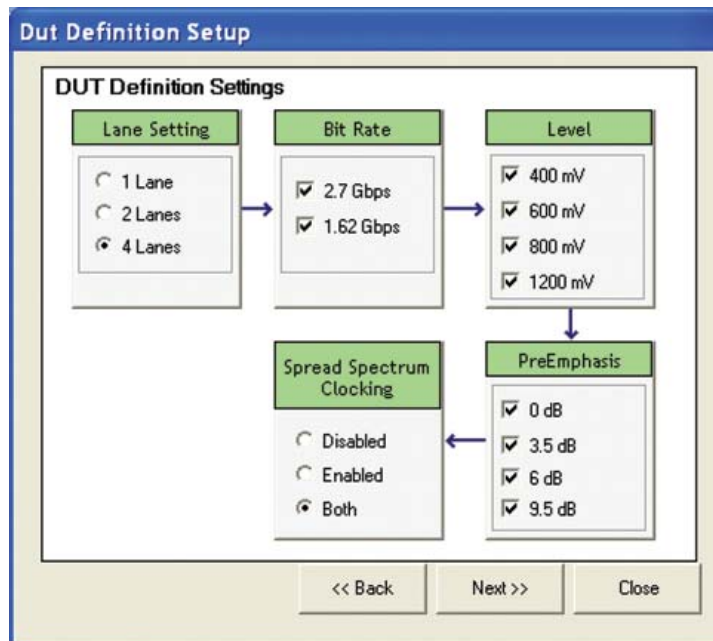

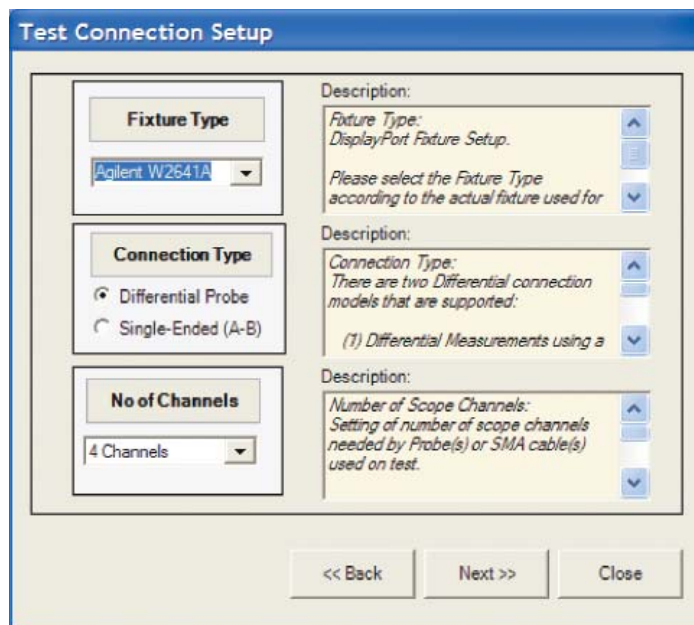**Figure 4. U7232A DUT definition entry in setup**

Figure 5. U7232A Test connection setup screen

Test mode selection (continued)

For user-defined testing, a similar configuration control as in 'Compliance conditions only' mode exists, however, the user is allowed to configure it by an additional menu called 'Manage test plans' (Figures 6 and 7.) Note the test setting checkmarks in Figure 7 indicating permutations to be tested. Note that this allows settings not formally allowed in the specification (800 mVolts with 6 dB pre-emphasis for example). The `Compliance conditions only' mode would not allow this.

The "Targeted characterization" mode is the standard mode (from version 1.0) which allows you to focus on specific device setup and specifically test that condition. This is useful for repeatability studies, troubleshooting and characterization.
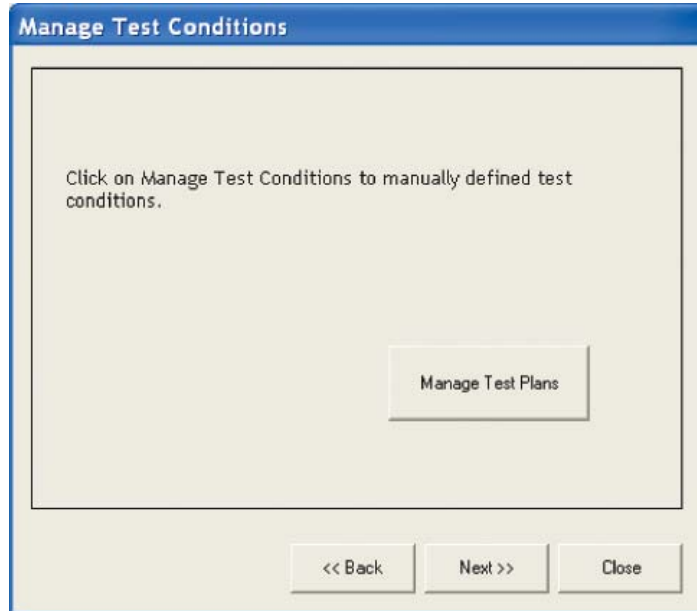

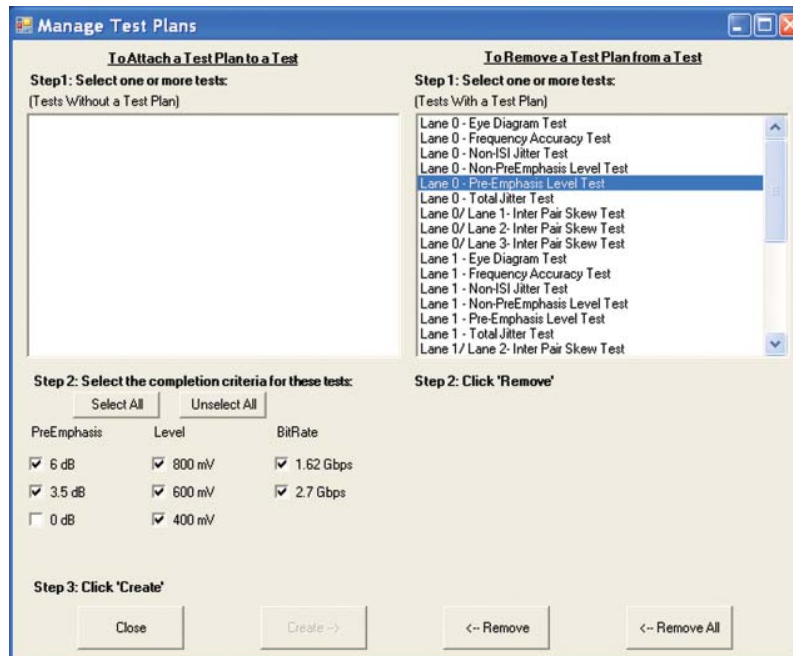**Figure 6. U7232A user defined mode enables test plans**

Figure 7. U7232A test plan management
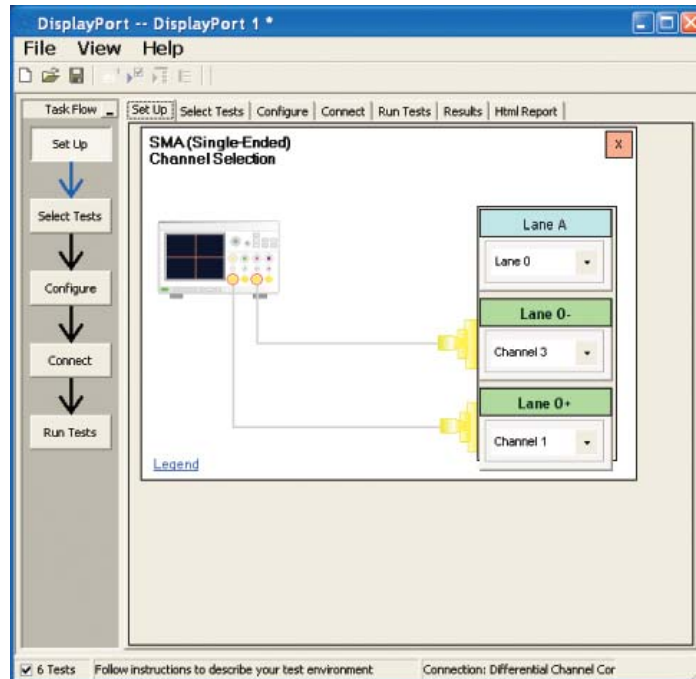
Test mode selection (continued)

Figure 8. Test environment setup: lane and oscilloscope assignment screen

Test selection

After defining the test environment you are presented with only those tests that are appropriate for the environment chosen. For instance, if spread spectrum clocking (SSC), is not enabled then no SSC tests will appear. This is the case for pre-emphasis as well. If your device definition is one lane only, or your defined device connection is one lane (one differential probe or two single-ended connections) then no inter-pair skew tests will appear in the test suite. This dynamic filtering simplifies your job by ensuring you attempt to test only what is possible for the DUT and the connection model you have chosen.
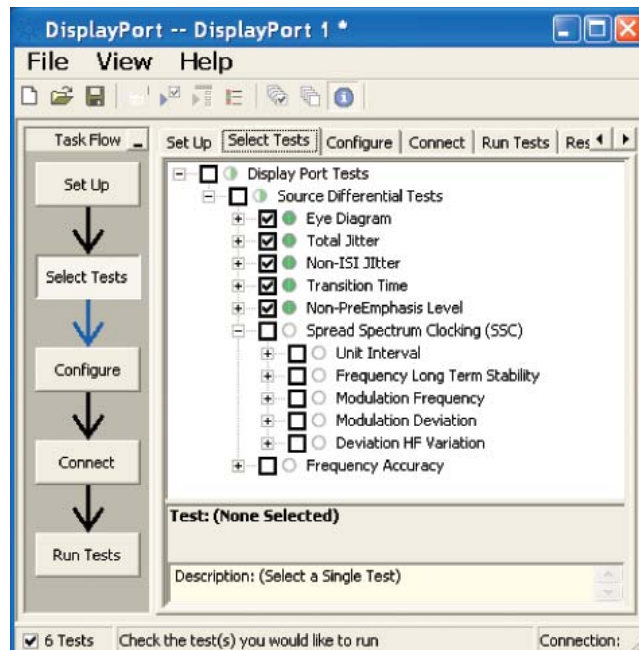

Figure 9. The Agilent automated test framework guides you quickly through selecting tests and configuring tests, setting up the connection, running the tests, and viewing the results. You can easily select individual tests or groups of tests with a mouse-click. You also can easily see the test status for the device under test.

Configurability and guided connections

The U7232A DisplayPort electrical test software provides flexibility in your test setup. It guides you to make connection changes with hookup diagrams when the tests you select require it. For test parameters such as bandwidth reduction or data channel selection, you can select appropriate values. For more critical parameters, such as mask scaling option or number of edges for analysis, default values are tied to the compliance standard; these values can only be altered in the debug screen. In Figure 10 you can see the selection for various U7232A eye mask test functions. The default for compliance mode is "Fixed" which places the mask in the center of the eye per the DisplayPort compliance test specification (shown is 'Find Margin' which will find the range of passing condition).

After you configure the test to meet your needs, the U7232A user interface displays the connection screen, which is specific to the configuration data you have selected. Figure 11 illustrates the typical connection guidance provided for differential tests for a single lane with an "A minus B" connection type.
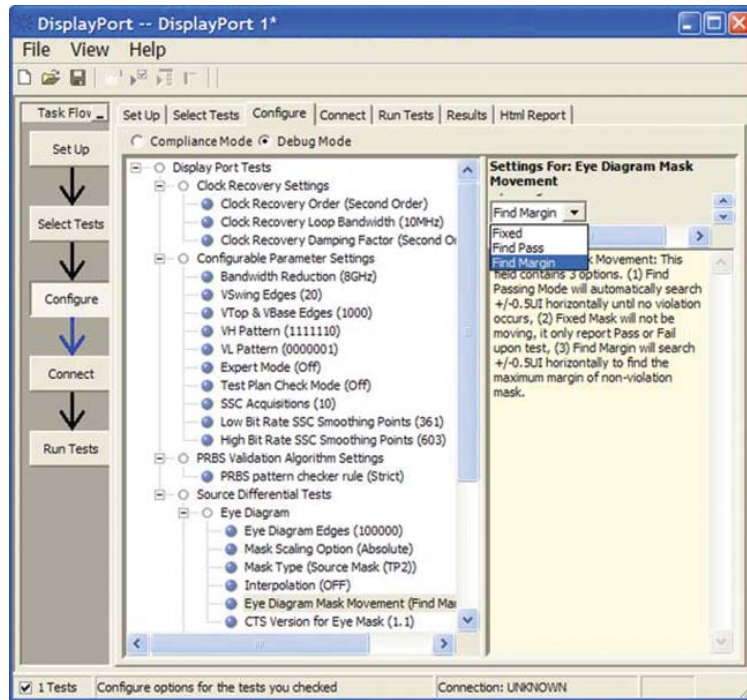

Figure 10. The U7232A configuration screen allows you to alter "soft" parameters for testing to assist in characterization and debug activities.
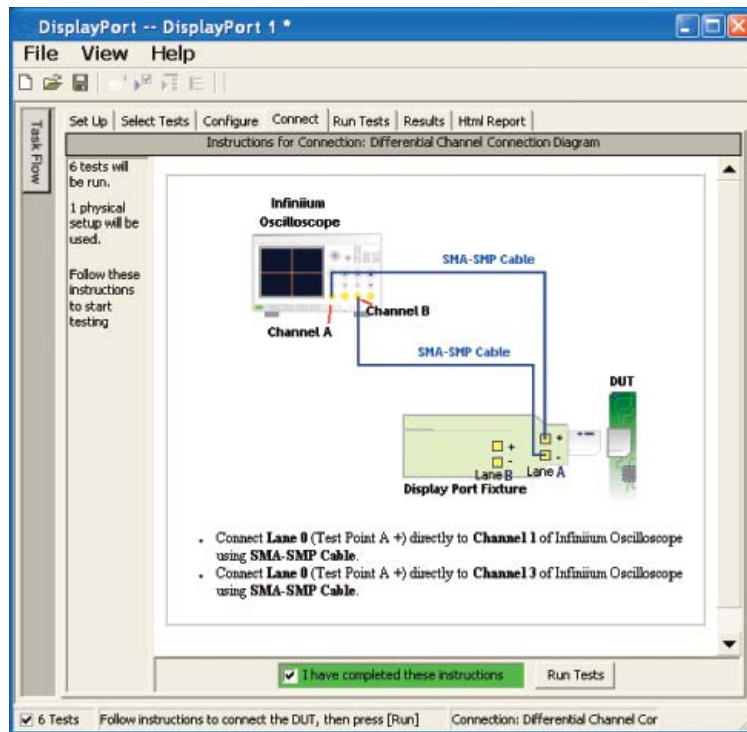

Figure 11. The final step before test is to illustrate the anticipated connection for the test.

Margin analysis

In addition to providing you with measurement results, the U7232A DisplayPort electrical 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 DisplayPort compliance test specification for a given test assertion.

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 (Eye Diagram Mask Movement: Find Margin – see Figure 10 for example.)

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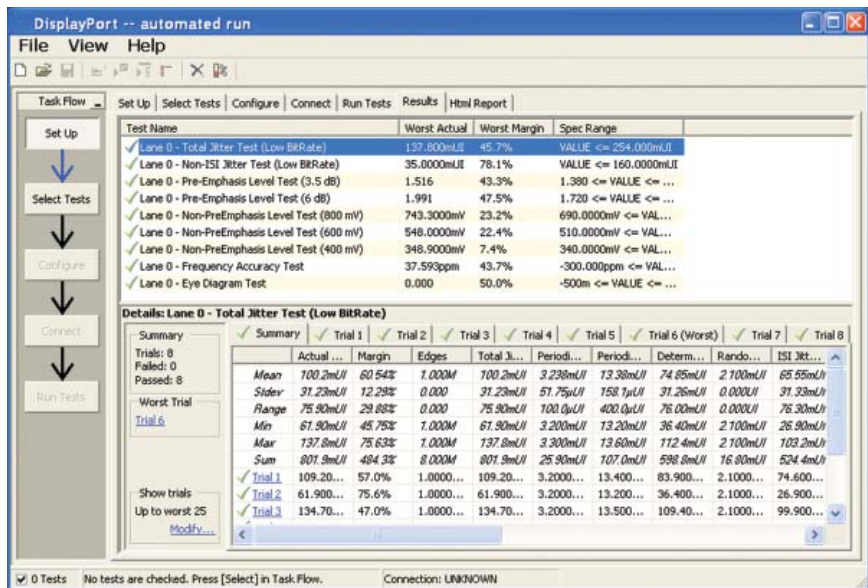

Figure 12. The DisplayPort electrical test software results report documents your test, indicates the pass/fail status, the test specification range, the measured values, and the margin.

Thorough performance reporting

The U7232A DisplayPort compliance and validation software generates thorough reports that not only capture the performance and status of the device under test, but also the screen shots of 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 13. The U7232A software generates a summary report where you can see the total test results for your device quickly and clearly. Additional details are available for each test, including the test limits, test description, and test results, including waveforms, if appropriate. In addition, the margin of the result is indicated to provide further insight.

Figure 14. Summary report detail: The U7232A software's summary report provides 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 the top and the measurement data just above the eye.

Test status tracking

The U7232A software can keep track of the status in a test plan either for `Compliance conditions only' or `User defined conditions' modes and is visually viewable in the Test run menu (Figures 15 and 16). In addition, you can choose to resume testing the device and the software where it stopped the time before.
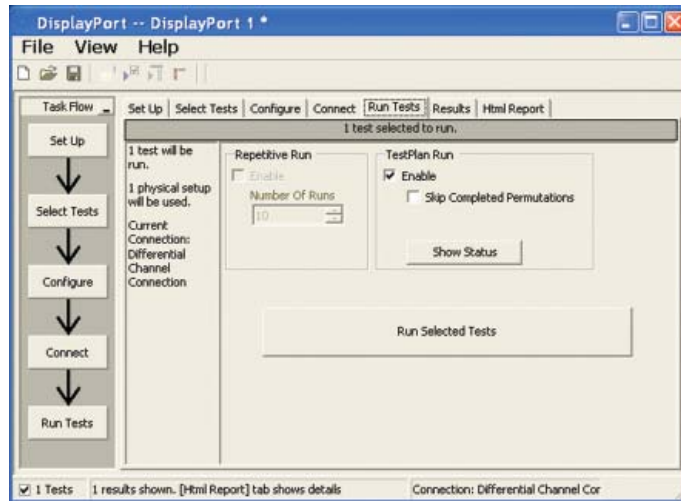

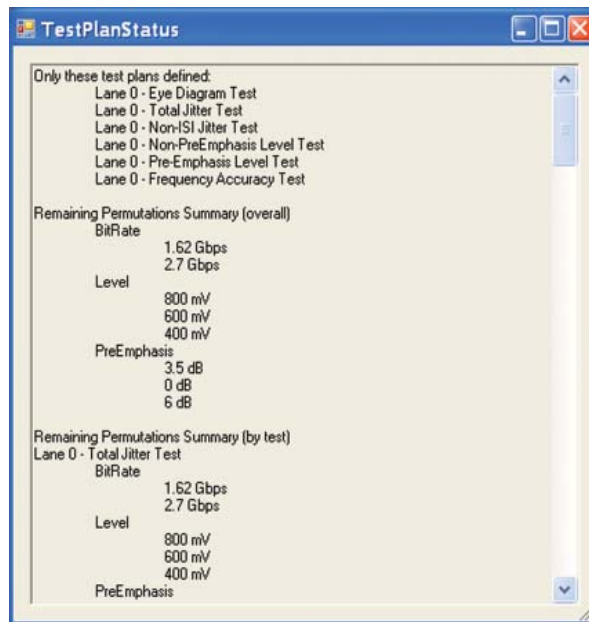**Figure 15. Show test status: test status selected in the 'Run tests' menu**

Figure 16. Test status tracking: when all tests are complete there are no entries below 'Remaining permutations summary'

DisplayPort

Cable equalization feature

The U7232A software leverages the equalization algorithms that were implemented in HDMI. Though not required in DisplayPort, these algorithms can assist in the design of receiver equalization methods by comparing against a reference model of equalization. Equalization models exist for Cat 2 cable for 2, 5, and 10 meters, assuming standard models of skin loss. Your own custom models are possible using the "User-Specified" equalization mode. Figure 17 illustrates the performance of a non-equalized DisplayPort cable versus equalization for a 5-meter cable.
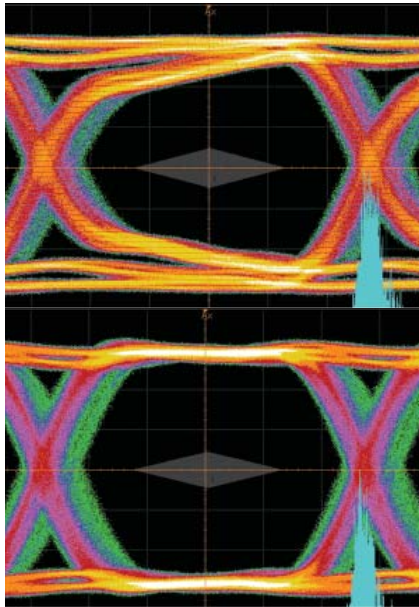

Figure 17. Cable equalization model for receiver eye or cable analysis. Top: no equalization. Bottom: 5-meter equalization model applied.

W2621A DisplayPort test point adapter

Figure 18. The Agilent W2641A DisplayPort test point adapter fixture

The W2641A DisplayPort TPA test fixture simplifies the measurement process by providing access to the electrical measurement points required for compliance tests. It breaks out the DisplayPort data lanes to pairs of SMP connectors for high-bandwidth probing with either direct connection to scope channels, or to InfiniiMax SMA differential probes through short SMP-to-SMA cables. Of course, single-ended measurements are supported as well. To support DisplayPort AUX channel for device control, two SMP connectors and a digital connector allow for direct connection to the AUX channel lane.

Measurement requirements

To use the U7232A electrical performance validation and compliance software with the Agilent W2641A DisplayPort TPA fixture, you will need at least one pair of the four SMP to SMA cable pairs provided. Use of differential probe amplifiers (1134A, 1168A, or 1169A) and appropriate SMA probe heads (N5380A) is optional. However, if you want connection simplicity, consider these probes for one-time setup and complete characterization for all differential measurements. If you are not using the W2641A test fixture, you will need to select the appropriate probe head to interface with your fixture. For instance, if the high speed signals are only accessible through a terminated 50-ohm transmission line (for testing silicon devices for example), you will need to use the E2678A socketed probe head, the E2677A, or N5381A solder-in differential probe head for high impedance probing and select these in the scope channel setup menu.

You can minimize test time by using four InfiniiMax probes to measure all four main link differential data lanes (Lane0, Lane1, Lane2, Lane3) without having to reposition or reconnect probes. To use this capability, select Connection Type: Differential Probe, Number of Channels: Four Channels in the Setup screen.

Oscilloscope compatibility

The U7232A DisplayPort electrical performance validation and compliance software is compatible with Agilent 90000 Series oscilloscopes with operating software revision 1.1 or higher or the Agilent 80000 Series oscilloscopes with operating software revision A.05.40 or higher (Windows® XP Pro). For oscilloscopes with earlier software revisions, free upgrade software is available at **http://www. agilent.com/find/infiniium_software**.

Table 1. Recommended oscilloscopes and bandwidth for the DisplayPort 1.1 specification

Agilent oscilloscopes for DisplayPort compliance test*

Suitable oscilloscopes	Recommended new purchase	Oscilloscope bandwidth
DSO80804A/B	DSO90804A or DSA90804A††	8 GHz*
DSO81004A/B		10 GHz†
DSO812004A/B	DSO91204A or DSA91204A	12 GHz†
DSO813004A/B	DSO91304A or DSA91304A	13 GHz†

*   8 GHz Bandwidth is recommended by the DisplayPort Compliance Test Specification.
†   The U7232A software will automatically control the bandwidth setting of the oscilloscope if the N5403A noise reduction software is enabled.
†† The DSO80000 and DSO90000 Series oscilloscopes are upgradable in bandwidth from 2 to 13 GHz. DSA models come with jitter and serial data analysis packages.

Tests performed

The U7232A DisplayPort electrical performance validation and compliance software performs all the required tests and many of the informative ones as listed in the DisplayPort Compliance Test Specification 1.1 (CTS1.1) as documented in section 3.5.3 of the base specification.

Note that the U7232A DisplayPort test software can make other measurements not included here, such as receiver eye measurements and equalized eye measurements as well as most of the newly omitted CTS 1.1 measurements.

Table 2. DisplayPort electrical tests performed by the U7232A software

Assertion number	Test description	Compliance status	Included with U7232A
Section 3			
Test ID 3.1	Data eye diagram	Normative	Yes
Test ID 3.2	Non pre-emphasis level verification	Normative	Yes
Test ID 3.3	Pre-emphasis level verification	Normative	Yes
Test ID 3.4	Inter-pair skew	Normative	Yes
Test ID 3.5	Intra-pair skew	Normative	Yes
Test ID 3.6	Differential transition time	Omitted*	Yes
Test ID 3.7	Single-ended rise and fall mismatch	Omitted*	Yes
Test ID 3.8	Overshoot and undershoot	Omitted*	No
Test ID 3.9	Frequency accuracy	Omitted*	No
Test ID 3.10	AC common mode noise	Normative	Yes
Test ID 3.11	Non-ISI jitter measurements	Normative	Yes
Test ID 3.12	Total jitter measurements	Normative	Yes
Test ID 3.13	Unit interval	Omitted*	Yes
Test ID 3.14	Main link frequency compliance	Omitted*	Yes
Test ID 3.15	Spread spectrum modulation frequency	Normative	Yes
Test ID 3.16	Spread spectrum modulation deviation	Normative	Yes
Test ID 3.17	Spread spectrum dF/dt	Informative	No

* These tests were defined for DisplayPort CTS 1.0 and were informative. They have been deleted for DisplayPort CTS 1.1

Ordering information

To purchase the U7232A DisplayPort source compliance test software with a new or existing Infiniium 90000 Series oscilloscope, order the following:

Model number	Description	Quantity
DSO90804A	Oscilloscope (see Table 1)	1
Option 003	High-speed serial data analysis software	1
Option 004	EZJit Plus jitter analysis software	1
1168A/1169A	10/12-GHz probe amplifiers. 1169A recommended.	4 (optional)
N5380A	12-GHz SMA probe heads for differential and single-ended measurements	4 (optional)
U7232A or DSO90000-028	DisplayPort test compliance software for Infiniium Series oscilloscopes	1

For physical connection to a DisplayPort device to perform tests with the U7232A DisplayPort compliance test software, order the following:

Model number	Description	Quantity
W2641A	DisplayPort test point access adapter (plug)	1
Standard connection		
N4235-61602	SMP to SMA cables (replacement cables)	As needed
For right angle connection (optional)		
N5460A	SMP to SMA cables right angle connector	1, 2 or 4 pairs
E4809-23801	Cable plug-in tool (recommended)	1
E4809-23802	Cable removal tool (required for right angle cables)	1
Bit-DP-RTF-0001 (BitifEye Corp).	DisplayPort receptacle test point adapter (optional) used in cable test or system calibration	1 or 2

Measurement and test accessories

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

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)
1250-1698	SMA tee adapter (m, f, f), DC to 12.4 GHz
1250-1694	SMA (m) to SMA (f) adapter
15442A	Cable kit, four 90-cm (36-inch) SMA (m - m) cables
15443A	Matched cable pair, two 90-cm (36-inch) SMA (m - m) cables, propagation delay within 25 ps
1810-0118	SMA (m) 50 Ω termination
33SMA-Q50-0-4	SMA push-on adapters from S.M. Electronics (or equivalent)

Related literature

Publication title	Publication type	Publication number
Infiniium DSO90000 and DSA90000 Series Oscilloscopes	Data sheet	5989-7819EN
N5394A DVI Electrical Performance Validation and Compliance Software	Data sheet	5989-1526EN
N5399A HDMI Electrical Performance Validation and Compliance Software	Data sheet	5989-5118EN
N5990 Automation Software	Data sheet	5989-5483EN
W2641A DisplayPort Test Point Access Adapter	Data sheet	5989-7274EN

Product Web site

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

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Finland	358 (0) 10 855 2100
France	0825 010 700*
	*0.125 €/minute
Germany	01805 24 6333**
	**0.14 €/minute
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
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