Keysight U7232E
DisplayPort Electrical Performance Validation and Compliance Software
For Infiniium Series Oscilloscopes

Data Sheet
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DisplayPort Compliance Software Helps You Do The Right Job Faster

Verify and debug your DisplayPort designs more easily

Keysight Technologies, Inc. DisplayPort Electrical Performance Validation and Compliance software for Infiniium Series oscilloscopes (see Table 2) 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 and now supports the DisplayPort 1.4 specification. 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 characterization tool.

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 or through a self certification regimen defined by VESA 1 in cooperation with your company. Either way, you will want to use the DisplayPort Electrical Performance Validation and Compliance software to troubleshoot, if necessary, and then to validate the design by performing the tests before the final compliance test run.

Features

The DisplayPort electrical test software is a full-featured package to simplify the validation process of DisplayPort designs:
- Full physical layer testing high speed lanes
- Full physical layer testing of AUX channels
- USB Type-C interface control with N7018A Type-C Test Controller
- Support of 1.2b, 1.4, and DPoC CTS versions
- Selectable capture and analysis modes
- Test Status tracking
- Measurement process configurability
- Support of DualMode, or DP++
- AUX Channel Physical Layer test suite
- Test results reports with pass/fail margin analysis
- Automation control through AUX Channel Controller
- Optional switch control

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.

Save time

The DisplayPort Electrical Performance Validation and Compliance 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, defining the capabilities of the device under 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 DisplayPort software offers the electrical tests for the source as well as important tests for cable and calibration for 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 1 for a complete list of the measurements made by the DisplayPort electrical test software.

Easy test definition

The DisplayPort Electrical Performance Validation and Compliance software extends the ease-of-use advantages of Keysight’s Infiniium Series oscilloscopes to testing DisplayPort designs. The Keysight 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.

Further test process control is also provided through the automation tab of graphical user interface. This tab allows the user to tailor scripts to control external equipment such as power supplies and temperature control units, or to provide a different test flow.

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1. Video Electronics Standards Association (www.vesa.org)
2. SlimPort is a trademarked implementation of MyDP by Analogix
The DisplayPort Electrical Performance Validation and Compliance software 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 of the DisplayPort Compliance test specification (for instance, DPoC or (DisplayPort over Type-C) as shown in Figure 1) and test groupings for various DP validation tasks. These are: High speed lane physical layer testing, AUX channel and Inrush testing, and characterizations such as CTLE sweep found in Test Tools. This screen will also let you choose between exposing just normative (mandatory) tests or all tests: normative and informative. The bottom portion of the environment Set Up tab is dedicated to automation through the AUX test mode and USB Type-C interface control. After making the appropriate selections for your testing, the setup continues with DUT characteristics entry and connection specifics when the Test Setup button is selected.

The Test Setup button presents a series of screens that allow the user to enter the key test and environment information because there is a wide range of test connections and optional performance allowed for in the DisplayPort specification.

Some of this test process information is 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. The most common selection is source testing.
- **Test type**: Define whether tests will be single ended or differential. See Figure 2.
- **DUT definition**: Select the capabilities of the DUT you wish to test. See Figure 3.
- **Test fixture selection**: Select the test fixture used. See Figure 4.
- **Connection type**: Single-ended vs. differential connection: Choose between using two channels of the scope to make a differential measurement using an ‘A minus B’ technique or by using differential probe on each scope channel for each lane, see Figure 4.
- **Number of channels**: You may choose to test 1, 2, or 4 channel connection. (Note: Differential connection allows full lane selection, while single-ended can only support testing 1 or 2 lanes). See Figure 4.
- **Oscilloscope connection**: This screen allows you to assign oscilloscope channels and device lanes to test. See Figure 5.
Test Environment Setup and Test Selection (Continued)

The first setup screen is shown in Figure 2 with the Test Setup screen. This is where the project information and device specifics such as Test Device, and Connector Type are entered. The Test Type refers to whether the tests to be selected from a subsequent menu will be single ended tests only, differential tests only, or both single-ended and differential tests.

A new capability to the DP EPV&C software is to define data pattern; selections are standard DP pattern and arbitrary data pattern (shown in Figure 4). Standard DP pattern is used for compliance testing while the arbitrary data pattern can be used to evaluate actual DisplayPort signals.

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 3.
Test Connection Setup

Upon completion of the device definition, the Test Connection Setup screen is presented. This screen enables entry of parameters that affect the connection of the device to the oscilloscope. Specifically, the fixture, the type of connection and number of lanes connected. The fixture selection enables not only Keysight fixtures, but any of the current fixtures provided by various fixture vendors as well. While the de-embed files are available for fixtures, the other fixtures will have de-embed files as they are made available. The Connection Type relates to how the signal gets to the scope channel. If by differential probe, then a probe amplifier is assumed (such as the 1169A or N2800A) and the operator will then have the choice of using 1, 2, or 4 channels of test (depending on whether the appropriate number of lanes has been selected). If the Connection Type is selected is single-ended then each differential lane of the test device will have two connections to the scope. By default, these are routed to channels 1 and 3, or 2 and 4. This means only two maximum lanes may be tested this way at a time. Note: if the Test Type selection in the Start Project screen was ‘Both’ or ‘Single-Ended’, then the Connection Type will default to ‘Single ended’ and will be grayed out. The number of channels allowed will always be aware of the upstream selections so will limit the number of channels based on those inputs.

The final screen in the Test Setup loop is the Channel Assignment Setup (shown in Figure 5). It will portray the connection expected in number of channels and type of connection requested. It is editable and if there are channel assignment conflicts, the user is alerted to the fact.

Figure 4. DisplayPort EPVC software Test Connection Setup Screen.
Test Selection

After defining the test environment through the test setup loop, 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 the optional settings of pre-emphasis and levels 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.

The DP 1.4 test suite is shown in the Test Selection screen is shown in Figure 6. It is partitioned in groups of tests as a function of the pattern that is required to test. HBR (2.7 Gb/s) and RBR (1.62 Gb/s) bit rates require PRBS7 and D10.2 patterns while HBR2 (5.4 Gb/s) require special patterns such as the HBR2 compliance test pattern that has a repetition length of 2520 bits (referred to as ‘CP2520’ or ‘HBR2CPAT’). Tests may be selected independently and any number of tests may be selected for a given run. If more than one lane is possible to run (as determined by the selections in Setup) then test selection by lane is also possible. If different connections or conditions of test are required from one test to another, a splash screen is presented to the user indicating the required change. When automation mode is used with the AUX Channel Controller, the device is changed automatically and there is no need for the splash screens.

Figure 5. Channel Assignment Setup: Lane and oscilloscope assignment: Two Lane Single-ended Connection using all four scope channels.

Figure 6. Lists the tests that are selectable and their status. Status bubbles indicate successful completion, failure, or incompletion.
The DisplayPort Electrical Performance Validation and Compliance 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, 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 7 you can see the selection for various 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 conditions).

Note: For HBR2 the eye diagram testing is different from RBR and HBR as it comprehends 10⁻⁹ BER limits; so the ‘Find Margin’ capability is not available.
For HBR3, the testpoint is TP3EQ with the equalizer being a combination of CTLE and DFE. Because the DFE is computationally complex, a standard mask is used.

After you configure the test to meet your needs, the DisplayPort EPV&C software user interface displays the connection screen, which is specific to the configuration data you have selected. Figure 8 illustrates the typical connection guidance provided for a one channel “A minus B” single-ended connection model for a one lane test setup.
Margin Analysis

In addition to providing you with measurement results, the DisplayPort Electrical Performance Validation and Compliance 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 7 for example).

AUX channel and Dual Mode testing support

The DisplayPort EPV&C software also supports Dual Mode (DP++) testing for devices that are to interoperate with HDMI displays. Eye diagram and jitter tests have been ported from the HDMI software application, which is a preferred application in test labs around the world.

AUX channel testing is a different test suite selectable in the Setup screen. The tests available are shown at the bottom of Table 1.

Dual Mode and the AUX channel test suite are selected in the Setup screen shown in Figure 1 when the specification selection is DP1.2 or DP1.4.

Margin is calculated:

Single-sided specification:
Margin = \( \frac{\text{Value}_{\text{Specification}} - \text{Value}_{\text{Actual}}}{\text{Value}_{\text{Specification}}} \)

Double-sided specification:
Margin = lowest of:
\( \frac{\text{Value}_{\text{Specification_High}} - \text{Value}_{\text{Actual}}}{\text{Range}_{\text{Specification}}} \)
and
\( \frac{\text{Value}_{\text{Specification_Low}} - \text{Value}_{\text{Actual}}}{\text{Range}_{\text{Specification}}} \)

Figure 9. The DisplayPort EPVC 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 DisplayPort 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 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 10. The DisplayPort compliance 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. All are hot linked to more detailed results further in report. In addition, the margin of the result is indicated to provide further insight.

Figure 11. Summary report detail: The DisplayPort 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 DisplayPort Electrical Performance Validation and Compliance software can keep track of the status in a test plan and is visually viewable in the Test Run menu (Figures 12 and 13). In addition, you can choose to resume testing the device and the software will continue where it stopped the time before.

Figure 12. Show Test Status: Test Status selected in the Run Tests menu.

Figure 13. Test Status tracking: When all tests are complete there are no entries below ‘Remaining Permutations Summary’.
USB Type-C™ Control

The DisplayPort Electrical Performance Validation and Compliance software fully controls devices that incorporate the USB Type-C™ connector using the new Keysight N7018A Type-C Test Controller. The test controller is required to establish power delivery contracts (known as PDOs: Power Delivery Objects) as well as to place the Device Under Test into the proper alternate mode for DisplayPort. The Type-C Test Controller and power supply setup is initiated by selection of the Type-C automation control setup shown in bottom of Figure 1.

Power Delivery Contracts: the thorough testing of devices using the USB Type-C interface will require verification at all the possible power delivery settings and the DisplayPort EPV&C software handles this with ease. In the setup of the Type-C environment, the device is queried for its possible contracts and these are reflected in a PDO selection window and integrated into the test plan using the Keysight N6701C power supply which can handle both the provision and consumption of power. One or many PDOs may be selected; if more than one is selected, the test plan will repeat for each PDO.

Alternate mode: to obtain DisplayPort functionality from a Type-C device, it must be put into a DisplayPort alternate mode and two of these are defined: there is ‘DP 2+2’ mode which has 2 lanes of DP with 2 lanes dedicated to USB3, or, ‘DP 4 Lane’ operation which is standard full bandwidth DisplayPort operation. Alternate mode setting is chosen in the setup of the DisplayPort device.

Figure 14. Type-C Setup: Device is queried for PDO capability.

Figure 15. Type-C Setup: Device mode control setting.
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](http://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 16. Importing a UDA Add-In into your test application.](image1)

![Figure 17. UDA Add-In tests and utilities in your test application.](image2)
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 18. Remote Programming script in the Automation tab.

Figure 19. 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.

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.

Figure 20. Automated testing for multi-lane digital bus interface through switching solution.

Figure 21. Switch matrix software feature enabled in the compliance application.
DisplayPort Test Point Adapters

DisplayPort has added other connector forms in addition to the original standard connector. These include the Mini-DP connector (mDP) and most recently, the USB Type-C connector. The DisplayPort Electrical Performance Validation and Compliance software allows you to choose the test point adapter you want and if the file is available from the vendor, it allows you to de-embed it as well.

DisplayPort AUX channel control

The DisplayPort specification allows for automated device control through manipulation of the DPCD (DisplayPort Configuration Data) registers. Those registers are most conveniently controlled by an AUX channel controller. The choice of AUX channel controllers is shown in the ordering information section.

Measurement connections

To use the DisplayPort Electrical Performance Validation and Compliance software with any test point adaptor you will need the cables and other sundry components. The Keysight N7015A USB Type-C TPA fixture or Wilder Technologies TPAs may require extra cables to get to scope channels when connected single-ended. Order from matched cable sets in the accessories table below. Use of differential probe amplifiers and appropriate SMA probe heads is optional. However, if you want connection simplicity, consider these probes for one-time setup and complete characterization for all differential measurements.

You can minimize reconnect 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.

If you are not using a Test point adaptor but probing signals with solder-in differential probes or browsers then you will need to select the appropriate probe head for the task and the probe amplifier system you are using. For instance, if the high speed signals are only accessible through a terminated 50-Ω transmission line (for testing silicon devices for example), you will need to use solder-in differential probe heads for differential probing and select these in the scope channel setup menu.
Tests Performed

The DisplayPort Electrical Performance Validation and Compliance software performs all the anticipated required tests for the DisplayPort Compliance Test Specification 1.4 (CTS 1.4) and DPoC (DisplayPort over Type-C) CTS.

Table 1. DisplayPort electrical tests performed by the DisplayPort software

<table>
<thead>
<tr>
<th>Assertion no.</th>
<th>Test description</th>
<th>Compliance status</th>
<th>Included with DP EPVC software</th>
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</thead>
<tbody>
<tr>
<td><strong>Section 3</strong></td>
<td><strong>Source tests</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test ID 3.1</td>
<td>Data Eye Diagram</td>
<td>Normative</td>
<td>Yes</td>
</tr>
<tr>
<td>Test ID 3.2</td>
<td>Non Pre-Emphasis Level Verification</td>
<td>Normative</td>
<td>Yes</td>
</tr>
<tr>
<td>Test ID 3.3</td>
<td>Pre-Emphasis Level Verification</td>
<td>Normative</td>
<td>Yes</td>
</tr>
<tr>
<td>Test ID 3.4</td>
<td>Inter-Pair Skew</td>
<td>Normative</td>
<td>Yes</td>
</tr>
<tr>
<td>Test ID 3.5</td>
<td>Intra-Pair Skew</td>
<td>Informative</td>
<td>Yes</td>
</tr>
<tr>
<td>Test ID 3.10</td>
<td>AC Common Mode Noise</td>
<td>Informative</td>
<td>Yes</td>
</tr>
<tr>
<td>Test ID 3.11</td>
<td>Non-ISI Jitter Measurements</td>
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<td>Yes</td>
</tr>
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<td>Test ID 3.12</td>
<td>Total Jitter Measurements</td>
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<td>Test ID 3.14</td>
<td>Main Link Frequency Compliance</td>
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<td>Test ID 3.15</td>
<td>Spread Spectrum Modulation Frequency</td>
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<tr>
<td>Test ID 3.16</td>
<td>Spread Spectrum Modulation Deviation</td>
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<td>Test ID 3.18</td>
<td>Dual Mode: TMDS Clock</td>
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<td>Test ID 3.19</td>
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<td><strong>Section 8</strong></td>
<td><strong>Common tests (refer to CTS 1.2b)</strong></td>
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<tr>
<td>Test ID 8.1</td>
<td>AUX Manchester Channel Eye</td>
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<td>Test ID 8.2</td>
<td>AUX Manchester Channel Sensitivity Test</td>
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<td>Test ID 8.3</td>
<td>Aux Channel DC Test: Aux - Termination</td>
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<td>No</td>
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<td>Test ID 8.4</td>
<td>Aux Channel DC Test: Aux + Termination</td>
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<td>No</td>
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<td>Test ID 8.5</td>
<td>Inrush/Outrush Tests</td>
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<td>Test ID 8.6</td>
<td>DP_PWR DC Levels</td>
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<td>Test ID 8.7</td>
<td>DP_PWR Current</td>
<td>Normative</td>
<td>No</td>
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</tbody>
</table>

1. These tests originally included for DisplayPort CTS 1.1, omitted since CTS 1.2 and provided informationally.
2. Tests 8.3 and 8.4 are easily accomplished on a source device with use of an AUX signal breakout device such as the Wilder TPA-DP-A with external resistors, a 3.3 volt power supply and a voltmeter.
### Ordering Information

<table>
<thead>
<tr>
<th>Application</th>
<th>License type</th>
<th>Infinium V-Series and Z-series</th>
<th>Infinium 90000 Series</th>
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<td>DS090000-085</td>
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<td>U7232E-1FP 1.2</td>
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<td>Server-based</td>
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<td>Fixed Factory-installed</td>
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<td>InfiniiSim Basic (required)</td>
<td>Fixed Factory-installed</td>
<td>N5465A-3FP</td>
<td>DS090000A-013</td>
</tr>
<tr>
<td></td>
<td>User-installed</td>
<td>N5465A-3FP</td>
<td>N5465A-3NL 2 or N5465A-3FP 1.2</td>
</tr>
<tr>
<td></td>
<td>Floating Transportable</td>
<td>N5465A-3TP</td>
<td>N5465A-3TP 1.2</td>
</tr>
<tr>
<td></td>
<td>Server-based</td>
<td>N5435A-026</td>
<td></td>
</tr>
<tr>
<td>PrecisionProbe (optional)</td>
<td>Fixed Factory-installed</td>
<td>N2809A-1FP</td>
<td>DS090000A-001</td>
</tr>
<tr>
<td></td>
<td>User-installed</td>
<td>N2809A-1FP</td>
<td>N2809A-1NL 2 or N2809A-1FP 1.2</td>
</tr>
<tr>
<td></td>
<td>Floating Transportable</td>
<td>N2809A-1TP</td>
<td>N2809A-1TP 1.2</td>
</tr>
<tr>
<td></td>
<td>Server-based</td>
<td>N5435A-003</td>
<td></td>
</tr>
<tr>
<td>DisplayPort switch matrix support (optional)</td>
<td>Fixed Factory-installed</td>
<td>N8890-1FP</td>
<td>N8890-1FP</td>
</tr>
<tr>
<td></td>
<td>User-installed</td>
<td>N8890-1FP</td>
<td>N8890-1FP</td>
</tr>
<tr>
<td></td>
<td>Floating Transportable</td>
<td>N8890-1TP</td>
<td>N8890-1TP</td>
</tr>
<tr>
<td></td>
<td>Server-based</td>
<td>N5435A-124</td>
<td></td>
</tr>
<tr>
<td>InfiniiScan+ (optional)</td>
<td>Fixed Factory-installed</td>
<td>N5414B-1FP</td>
<td>DS090000A-009</td>
</tr>
<tr>
<td></td>
<td>User-installed</td>
<td>N5414B-1FP</td>
<td>N5414B-1NL 2 or N5414B-1FP 1.2</td>
</tr>
<tr>
<td></td>
<td>Floating Transportable</td>
<td>N5414B-1TP</td>
<td>N5414B-1TP 1.2</td>
</tr>
<tr>
<td></td>
<td>Server-based</td>
<td>N5435A-004</td>
<td></td>
</tr>
</tbody>
</table>

1. Requires software 5.00 and above.
2. Software 4.30 or above requires Windows 7. N2753A Infinium Windows XP to 7 OS upgrade kit (oscilloscope already has M890 motherboard), N2754A Infinium 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 data sheet with the publication number 5990-8569EN.
Recommended Oscilloscopes

The DisplayPort Electrical Performance Validation and Compliance software is compatible with all Infiniium real-time oscilloscopes with latest software revision. For oscilloscopes with earlier software revisions, free upgrade software is available at http://www.keysight.com/find/infiniium_software.

<table>
<thead>
<tr>
<th>Minimum bandwidth</th>
<th>Minimum channels</th>
<th>Oscilloscope models</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 GHz (^1)</td>
<td>4 channels</td>
<td>Infiniium 90000A, V-Series, and Z-Series</td>
</tr>
</tbody>
</table>

1. 13 GHz minimal for HBR3. 16 GHz recommended to ensure best capture of 3rd harmonic of HBR3.

Test Point Access Adapters and Probes

For physical connection to a DisplayPort device to perform tests with the DisplayPort Compliance Test Software, order one or more of the following TPAs in table below. For four lane simultaneous connection order probe amplifier and appropriate probe head from table below.

<table>
<thead>
<tr>
<th>Model number</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7015A or N7015A Option 016</td>
<td>USB Type-C Test Point Adapter</td>
<td>1</td>
</tr>
<tr>
<td>BIT-mDP-PTF-0001</td>
<td>Mini-DP Plug Test Point Access Adapter</td>
<td>1</td>
</tr>
<tr>
<td>BIT-eDP-PTF-0001</td>
<td>eDP Plug Test Point Access Adapter</td>
<td>1</td>
</tr>
<tr>
<td>BIT-DP-PTF-0003</td>
<td>Standard DisplayPort Plug Test Point Access Adapter</td>
<td>1</td>
</tr>
<tr>
<td>BIT-DP-RTF-0003</td>
<td>Standard DisplayPort Receptacle Test Point Adapter. Used in Cable Test or Sink system calibration</td>
<td>As needed</td>
</tr>
<tr>
<td>BIT-DP-CONN-0001</td>
<td>Connection Kit for Bitifeye Fixtures. Includes 2 matched sets of SMA-SMA 1 meter cables and low frequency adaptor board.</td>
<td>1</td>
</tr>
<tr>
<td>1169A, N280xA, N700xA</td>
<td>13 GHz or greater probe amplifiers (16 GHz recommended)</td>
<td>4 (optional)</td>
</tr>
<tr>
<td>N5380B, N5444A</td>
<td>SMA differential probe heads</td>
<td>4 (optional)</td>
</tr>
</tbody>
</table>

Fixtures with Prefix ‘BIT’ are procured through BitifEye Corporation (Note: TPAs available through Wilder Technologies and ICT Luxshare are also recommended).

Connections often require matched cable sets and adapters. See accessory table below for these items.
Recommended Type-C Accessories

For testing USB Type-C™ devices, the following solution elements are recommended for the purposes identified.

<table>
<thead>
<tr>
<th>Model number</th>
<th>Description</th>
<th>Quantity</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7018A</td>
<td>Type-C Test Controller</td>
<td>1</td>
<td>Control Power Delivery Contracts, Orientation and Alternate Mode</td>
</tr>
<tr>
<td>N7015A</td>
<td>Type-C Plug Test point adapter</td>
<td>1</td>
<td>Access of all Type-C signals</td>
</tr>
<tr>
<td>N7017A</td>
<td>Type-C Receptacle to Receptacle Adapter</td>
<td>1</td>
<td>For RX calibration or Type-C interface debug</td>
</tr>
<tr>
<td>N6701C</td>
<td>Power Supply Chassis</td>
<td>1</td>
<td>Power supply/Power Load for arbitrary PDIs</td>
</tr>
<tr>
<td>N6786A</td>
<td>Power Supply/Power Load</td>
<td>1 minimum</td>
<td>Power supply/Power Load for arbitrary PDIs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 optional</td>
<td></td>
</tr>
<tr>
<td>N9398C</td>
<td>DC Blocking Capacitors</td>
<td>2 minimum</td>
<td>The RX lanes of the Type-C interface do not have blocking capacitors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 recommended</td>
<td>When testing DP at least one of these will be tested for DP and will present a DC bias</td>
</tr>
<tr>
<td>5061-5311</td>
<td>3.5 mm f-f adapter</td>
<td>4 minimum,</td>
<td>Connect matched cables to break out coaxial connectors of N7015A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 recommended</td>
<td></td>
</tr>
<tr>
<td>N2823A</td>
<td>1 m matched cable set</td>
<td>2 minimum</td>
<td>Connect scope to N7015A breakouts</td>
</tr>
<tr>
<td>N5448B</td>
<td>0.25 m matched cable set</td>
<td>2 minimum</td>
<td>Connect scope to N7015A breakouts</td>
</tr>
</tbody>
</table>

AUX Channel Controller (Optional)

To purchase AUX channel controller for automated control of the device under test with the DisplayPort software, order:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unigraf DPR100</td>
<td>AUX channel controller requires hardware and software license</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: DPR-100 is available through Unigraf or its distributors - www.unigraf.fi

Other Measurement Accessories

To complete your test setup, Keysight provides a wide range of cables, adapters, terminations, etc. You may find these useful in troubleshooting, calibrations, etc.

<table>
<thead>
<tr>
<th>Model number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11667B</td>
<td>Power splitter, DC to 26.5 GHz, 3.5-mm (f) connectors</td>
</tr>
<tr>
<td>11636B</td>
<td>Power divider, DC to 26.5 GHz, 3.5-mm (f) connectors</td>
</tr>
<tr>
<td>8493B</td>
<td>Coaxial attenuator (3, 6, 10, 20, or 30 dB), DC to 18-GHz, SMA connector</td>
</tr>
<tr>
<td>5061-5311</td>
<td>3.5-mm (f - f) adapter</td>
</tr>
<tr>
<td>1250-1159</td>
<td>SMA (m - m) adapter, DC to 18 GHz</td>
</tr>
<tr>
<td>1250-1397</td>
<td>Right-angle adapter, SMA (m - m)</td>
</tr>
<tr>
<td>1250-1741</td>
<td>Right-angle adapter, SMA (f - m)</td>
</tr>
<tr>
<td>1250-1698</td>
<td>SMA tee adapter (m, f, f), DC to 12.4 GHz</td>
</tr>
<tr>
<td>1250-1694</td>
<td>SMA (m) to SMA (f) adapter</td>
</tr>
<tr>
<td>1810-0118</td>
<td>SMA (m) 50 Ω termination</td>
</tr>
<tr>
<td>33SMA-Q50-0-4</td>
<td>SMA push-on adaptors from S.M. Electronics (or equivalent)</td>
</tr>
</tbody>
</table>
Related Literature

<table>
<thead>
<tr>
<th>Publication title</th>
<th>Publication number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N5990A Test Automation Software Platform - Data Sheet</td>
<td>5989-5483EN</td>
</tr>
<tr>
<td>Infiniium 90000 Series Oscilloscopes - Data Sheet</td>
<td>5989-7819EN</td>
</tr>
<tr>
<td>Infiniium 90000 X-Series Oscilloscopes - Data Sheet</td>
<td>5990-5271EN</td>
</tr>
<tr>
<td>N5399C, N5399D HDMI Electrical Performance Validation and Compliance Software - Data Sheet</td>
<td>5990-5299EN</td>
</tr>
<tr>
<td>Infiniium Z-Series Oscilloscopes - Data Sheet</td>
<td>5991-3868EN</td>
</tr>
<tr>
<td>Infiniium V-Series Oscilloscopes - Data Sheet</td>
<td>5992-0425EN</td>
</tr>
</tbody>
</table>

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