

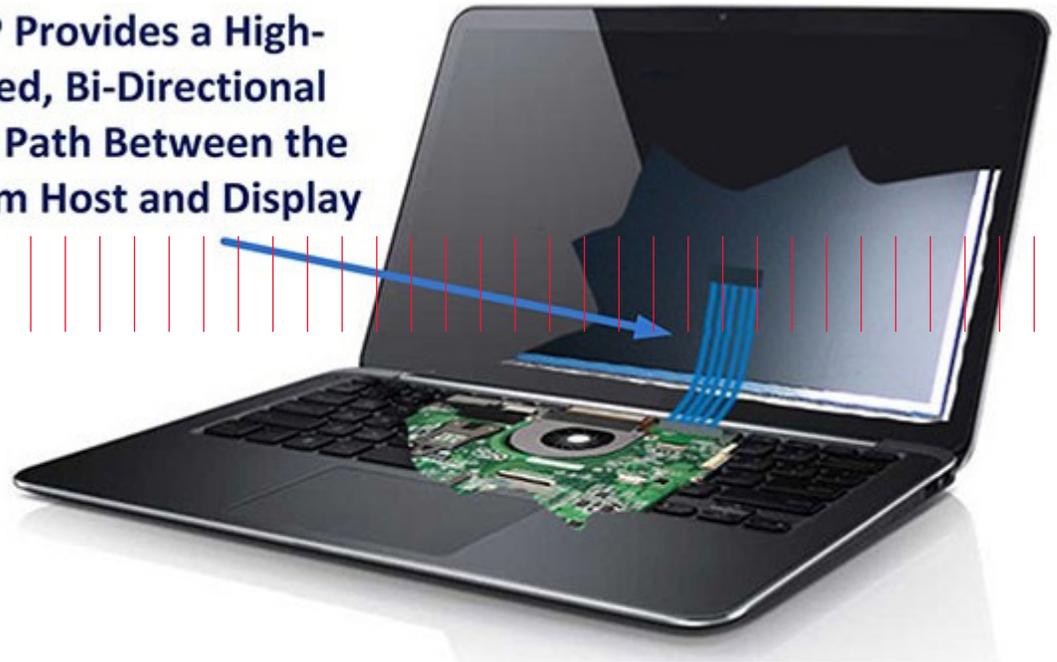
Keysight Technologies

eDP 1.4 Electrical Performance and Characterization Software

For Infiniium Series Oscilloscopes

Data Sheet

eDP Provides a High-Speed, Bi-Directional Data Path Between the System Host and Display



Verify and debug your eDP designs more easily

Keysight Technologies eDP 1.4 electrical performance and characterization software for Infiniium Series oscilloscopes (see Table 2) provides you with a fast and easy way to verify and debug your eDP interface designs for embedded systems. The eDP 1.4 electrical test software is designed to be uniquely flexible to handle the wide variety of configurations that are possible in embedded systems and pose characterization challenges. It offers the standard tests that are recommended as well as other informative tests, so it functions equally well as a validation 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 eDP 1.4 electrical performance and characterization (EP&C) software, you will also need an eDP TPA fixture for high-speed signal access as well as for AUX channel and other lines of the interface. Available fixtures are identified in Table 5.

The eDP 1.4 EP&C software is based broadly on the widely-industry-accepted Keysight DisplayPort application, which extends utility to include a wizard graphic user interface that enables test selection, parameter election, test specification entry, and test template sharing. These features are *unique* in the industry and are supported to enable ecosystem sharing of test process specifics for highly variant embedded designs.

There is no official interoperability program for eDP 1.4, though this software goes a long way to create a defacto program – if only for a specific product or family of products. The default specifications are those found in the VESA¹ test guideline eDP PHY CTG v1.0. The tests available in the eDP 1.4 EP&C software package are identified in Table 1. However, there is no limit to what tests you can have available with the Infiniium framework add-in feature, with which you can add your own tests or tests from colleagues to the test suite offered. Details of the add-in capability are covered in the *Extensibility* section below.

1. Video Electronics Standards Association (www.vesa.org)

Features

The eDP 1.4 electrical performance and characterization software offers new and unique capabilities as well as the standard features available with all Keysight Infiniium frame-work applications:

- Full physical layer testing of high-speed lanes and AUX channel
- Verification of link layer physical layer control
- Test status tracking
- Measurement process configurability
- Automated scope measurement setup
- Bit rate parameters: nominal value of bit rate, number of bit rates and test line limit for frequency accuracy
- Level parameters: nominal value of level, number of levels and test line limits for level accuracy or value of relative change between level settings
- Pre emphasis parameters: nominal value of pre-emphasis, number of pre-emphasis settings and test line limits for pre-emphasis accuracy or value of relative change between pre-emphasis settings
- Eye diagram mask testing: entry of arbitrary mask through mask files vs. bit rate
- Jitter testing: entry of arbitrary RJ, DJ, TJ values vs. bit rate
- Test plan creation: selection of device conditions to test
- Test template: create default templates for device types avoiding re-entry AND share complete test process setup with others for consistent settings for same process requirements in different locations
- Test results reports with pass/fail margin analysis
- Automation control through AUX channel controller

With the eDP 1.4 EP&C test software, you can finally solve the myriad of test issues that embedded test systems present with one application.

Easy test process definition

The eDP 1.4 electrical performance and characterization software extends the ease-of-use advantages of Keysight's Infiniium Series oscilloscopes and previous DisplayPort standard test software to testing eDP 1.4 designs.

The application will guide you through device setup and test connection with setup wizards to capture all the test process details. In doing so, you will create a tailored process to validate or characterize your device and get exactly what you need.

Using the eDP 1.4 electrical performance and characterization software

The eDP application is started from the analyze tab in the Infiniium GUI. When selected and finished loading, the screen in Figure 1 is presented. This screen looks much like other applications in the Infiniium framework. Of particular note, after selecting the standard to test (eDP 1.4) and the test suite (High-Speed Physical Layer Tests) are the *Device Definition* and *Connection Setup* buttons.

These are selected in progression, *Device Definition* first and then *Connection Setup*. If the labels below these buttons are blue, you can test with the device definition defaults (determined by the template the user can set) and with the connections defined without any further manipulations. You can proceed to *Select Tests* tab to select tests you want to run for the test session and continue to running tests.

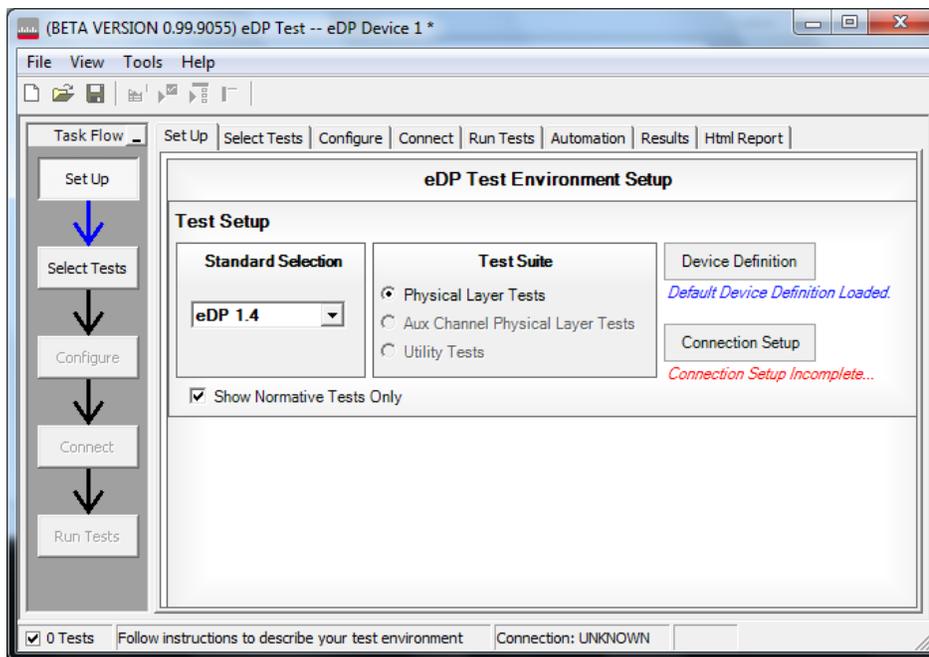


Figure 1. eDP 1.4 DisplayPort test environment setup.

Device definition

The *Device Definition* tab is where much of the eDP 1.4 EP&C software's power resides. When you click on the *Device Definition* button, you will see a sequence of windows for you to define your device's capabilities and the specifications for these. You can see in Figure 2 how much information is shown in the second tab, *Link Rate*.

The screenshot shows the 'Device Definition Wizard' window, specifically the 'Link Rate' tab. The window title is 'Device Definition Wizard' and the active tab is 'Link Rate'. The tabs at the top are: eDP Device, Link Rate, Level, Eye Diagram, Jitter, Rise/Fall Time, Inter Pair Skew, Main Link And SSC, and Intra Pair Skew. The 'Link Rate' section has a 'Specification Limit Unit Type' set to 'ppm' (radio button selected) and 'Number of Link Rates' set to '4'. There are four rows of link rate configurations:

Link Rate	Rate (Gbps)	Jitter (ps)	CTLE	Min (ppm)	Max (ppm)
Link Rate 1	1.62	617.3	RBR	-5300	300
Link Rate 2	2.7	370.4	HBR	-5300	300
Link Rate 3	3.24	308.6	HBR2	-5300	300
Link Rate 4	5.4	185.2	HBR2	-5300	300

The 'Spread Spectrum Clocking' section has a 'Spread Spectrum Clocking State' set to 'Settable'. It includes two rows of input fields:

Parameter	Value	Unit	Min	Max
SSC Modulation Frequency	32	kHz	30	33
SSC Modulation Deviation	-2500	ppm	-5000	0

At the bottom of the window are three buttons: '<< Back', 'Next >>', and 'Close'.

Figure 2. Link rate tab in Device Definition sequence.

First, note that the tabs across the top of the window cover not only the device capabilities such as link rate and level but also capture the details necessary for all the tests that can be conducted. (Example: For eye diagram testing, you can set the pattern at which to test as well as the mask file to be used.)

The fundamental issues for eDP 1.4 testing are addressed with this screen, and they are:

- The number of bit rates of which the device is capable,
- The nominal values of those bit rates,
- The manner to display the frequency accuracy of those bit rates: absolute error (bps) or ppm versus nominal link rate value. The minimum and maximum values are displayed for convenience.
- The CTLE (continuous time linear equalizer) attributes you want to use in the analysis measurements (eye diagram and jitter) to use for each bit rate. These are defaulted to the values in the eDP standard v1.0 but are easily alterable.

Finally, since spread spectrum clocking (SSC) is a favored technique in embedded systems to keep EMI low, the SSC tests parameters and specifications are selectable here. It can be set to 'Always On,' 'Always Off,' and 'Settable.'

When the entries for the *Link Rate* window are complete, you will press 'Next' and proceed to the *Eye Diagram* and *Jitter* tabs to complete the product and test requirements. Figure 3 shows attributes of the *Jitter* tab and, at the same time, illustrates a very useful construct called *Test Plan*.

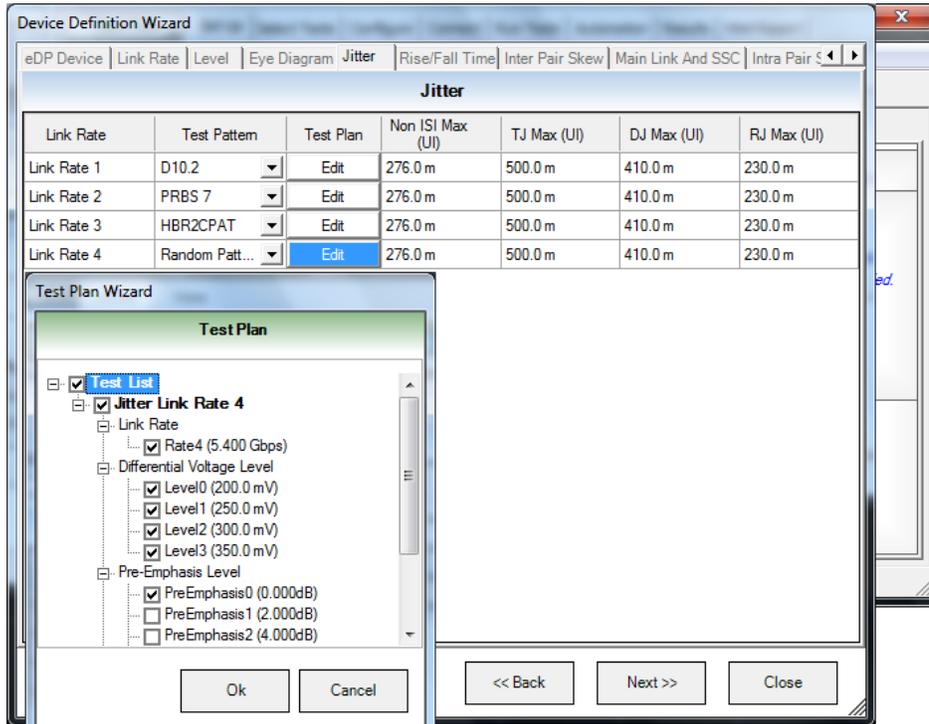


Figure 3. Jitter setup in the device definition sequence.

In the *Jitter* setup window, you will immediately see how comprehensive and flexible the software is. Firstly, it allows for all the link rates to be tested for jitter and allows for pattern type selection for the jitter measurement (selections are: PRBS7, HBR2CPAT, D10.2, random pattern). Then, you can enter the upper limits of jitter in the various components of jitter. Since the capability of your device includes different level settings and pre-emphasis settings, you might be interested in testing jitter for ALL combinations of these or just a few. By simply clicking the boxes in the *Test Plan Wizard*, you can select the device combinations to be tested.

When you have finished with the Jitter setup, you can save the setup as a template for the next time you test. Further, you can send this template to a colleague or partner so they can use the same setup, conditions and test line limits. You will see a blue label below the *Device Definition* button, and you can click on this to select another template. At this time you now click the *Connection Setup* button to enter the *Test Session* details: attributes of your work bench and test connection.

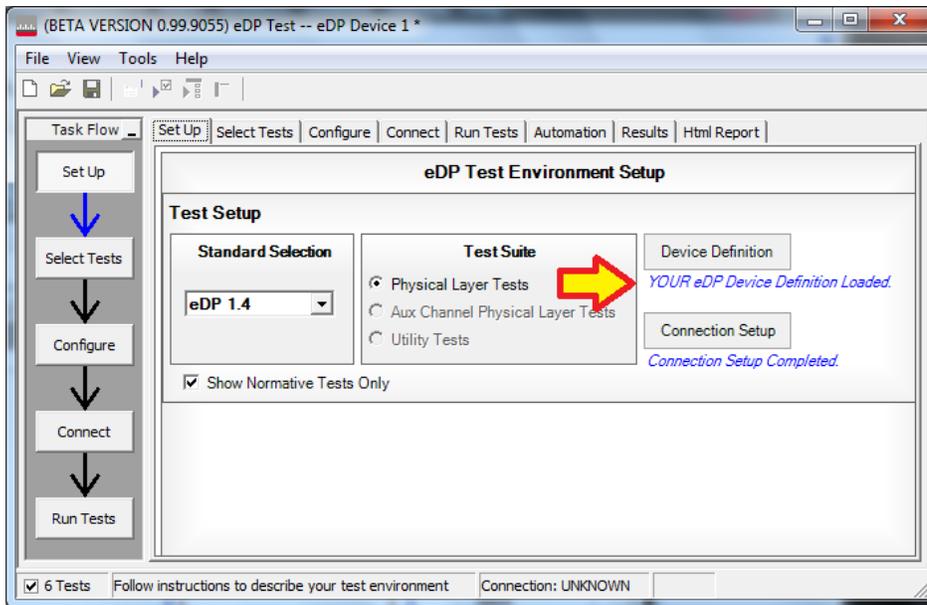


Figure 4. When finished with device setup, your specific template file is loaded.

Test session

The eDP 1.4 EP&C test session wizard is leveraged from the DisplayPort test software wizard. Its purpose is to identify the connection to the oscilloscope and enable selecting the scope of testing for your current test session – say because of troubleshooting. For example, though a device might be defined in the Device Definition wizard, to have 4 bit rates and 4 lanes, you might be interested in only one lane and the eye diagram of one bit rate for a given experiment or characterization. The session test sequence is four screens, the purpose of which is to specify connection to the oscilloscope and to select only what you need for your immediate test objectives.

Test Session Setup

The second screen of the test session sequence is the session test details screen, and it allows you to narrow in on a specific lane, bit rate or level for a focused characterization test. The screen is shown below:

The screenshot shows a dialog box titled "Test Session Setup" with a sub-section "Session Test Details". The details are organized into two rows of three columns each. The first row contains "Lane", "Bit Rate", and "Spread Spectrum Clocking". The second row contains "Differential Voltage Level", "Pre-Emphasis Level", and "Post-Cursor2 Level". At the bottom are three buttons: "<< Back", "Next >>", and "Close".

Lane	Bit Rate	Spread Spectrum Clocking
<input type="radio"/> 1 Lane <input checked="" type="radio"/> 2 Lanes <input type="radio"/> 4 Lanes	<input checked="" type="checkbox"/> Bit Rate 1 <input checked="" type="checkbox"/> Bit Rate 2 <input checked="" type="checkbox"/> Bit Rate 3 <input checked="" type="checkbox"/> Bit Rate 4	<input checked="" type="checkbox"/> SSC Enabled <input checked="" type="checkbox"/> SSC Disabled
Differential Voltage Level	Pre-Emphasis Level	Post-Cursor2 Level
<input checked="" type="checkbox"/> Swing 0 <input checked="" type="checkbox"/> Swing 1 <input checked="" type="checkbox"/> Swing 2 <input checked="" type="checkbox"/> Swing 3	<input checked="" type="checkbox"/> Pre-emphasis 0 <input checked="" type="checkbox"/> Pre-emphasis 1 <input checked="" type="checkbox"/> Pre-emphasis 2 <input checked="" type="checkbox"/> Pre-emphasis 3	<input checked="" type="checkbox"/> Level 0

Figure 5. eDP 1.4 session test details in setup.

You can select the specifics to test easily. For instance, if you just want to test 5.4 Gbs (bit rate 4), you would choose bit rate 4 and leave the other bit rates unselected. If you select all the bit rates for all the tests you selected in the test select tab, the software will run at all the bit rates you have selected.

The final screen in the test session setup sequence is the channel assignment setup. 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. In a prior screen, you can select whether you want to use direct connection to the oscilloscope or connect with oscilloscope differential probes. Direct connection is recommended; however, using differential probe heads (SMA probe heads), you can connect four lanes simultaneously and measure all the differential tests in one test connection.

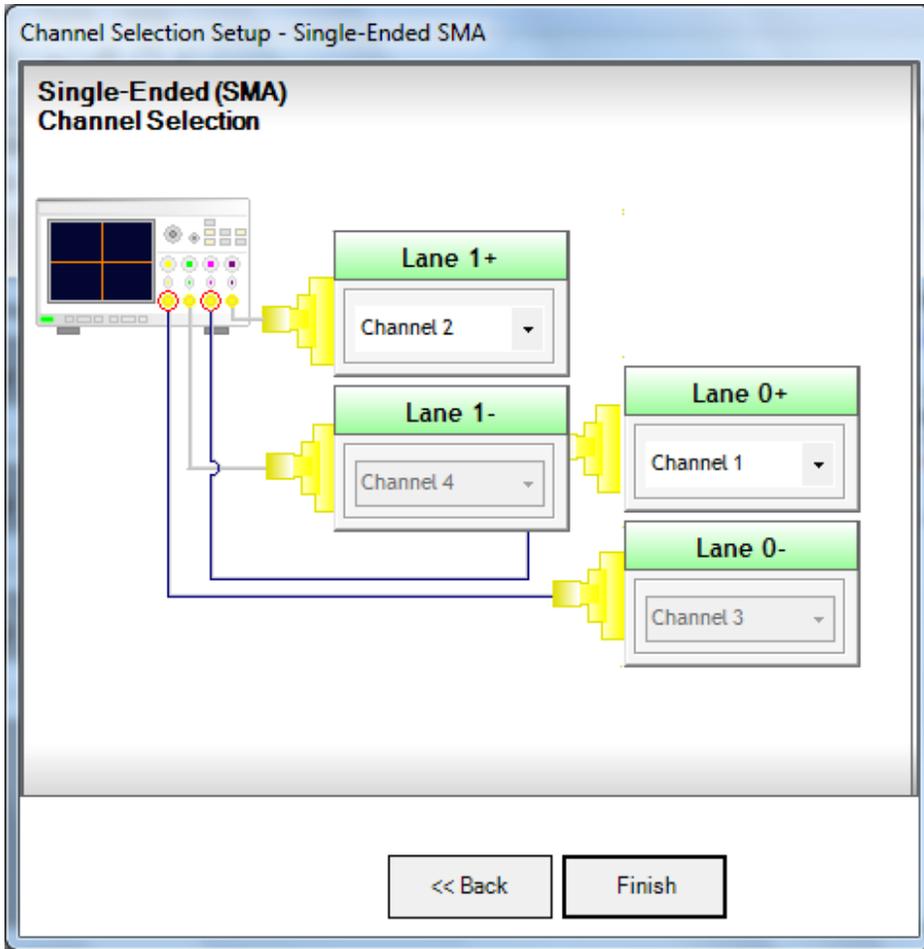


Figure 6. Channel assignment setup: lane and oscilloscope assignment: 2 lane single-ended connection using all four scope channels.

Test selection

After defining the test environment through the test setup loop, you are presented with only those tests that are appropriate for the device defined AND environment chosen. For example, if spread spectrum clocking (SSC) is not selected in the session description, then no SSC tests will appear; nor will they regardless of if the device definition setup defined the device to be SSC OFF only. A similar logic holds for pre-emphasis and levels as well. If your device definition is one lane only or 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 connection model you have chosen.

The eDP 1.4 test suite is shown in the test selection screen (see Figure 7). It is partitioned in groups of tests as a function of the pattern that is required to test. By grouping them so, the number of required test interruptions is minimized. Shown is D10.2 (clock pattern), PRBS7 (127-bit repetitive pattern), and HBR2CPAT, which is a 2520-bit repeating pattern that was defined specifically for HBR2 in DisplayPort 1.2 – it is considered a key pattern to test with in most circumstances. Other patterns that may be used are PLTPAT (divide-by-10 clock) and random pattern, which is offered for flexibility.

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.

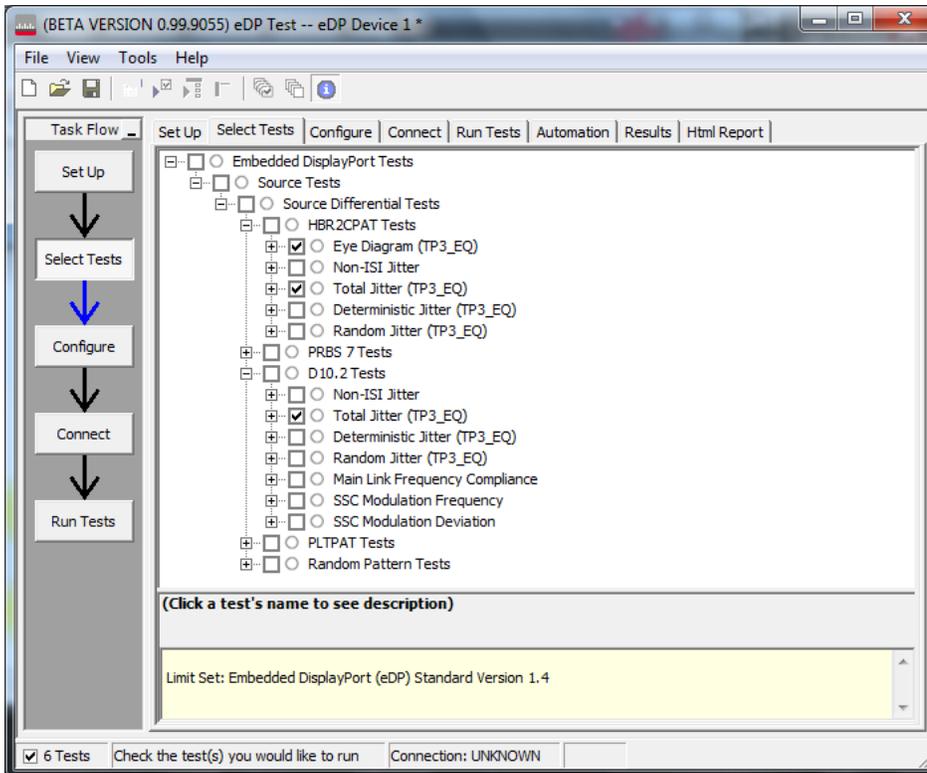


Figure 7. Lists the tests that are selectable and their status. Status bubbles indicate successful completion, failure or incompleton.

Configurability and guided connection

The eDP 1.4 electrical performance and characterization software provides further flexibility in your test setup through the configure tab and will guide you to make connection changes with hookup diagrams when the tests you select require it.

While the most configurability is afforded in the test definition sequence, the configure tab allows for further possibility of modification of the test session operation for testing debug or 'what-if' analysis. For instance, you can alter transfer function, equalization or bandwidth of the measurement. In Figure 8, you can see some of the configurable parameters that can be altered in a given test session.

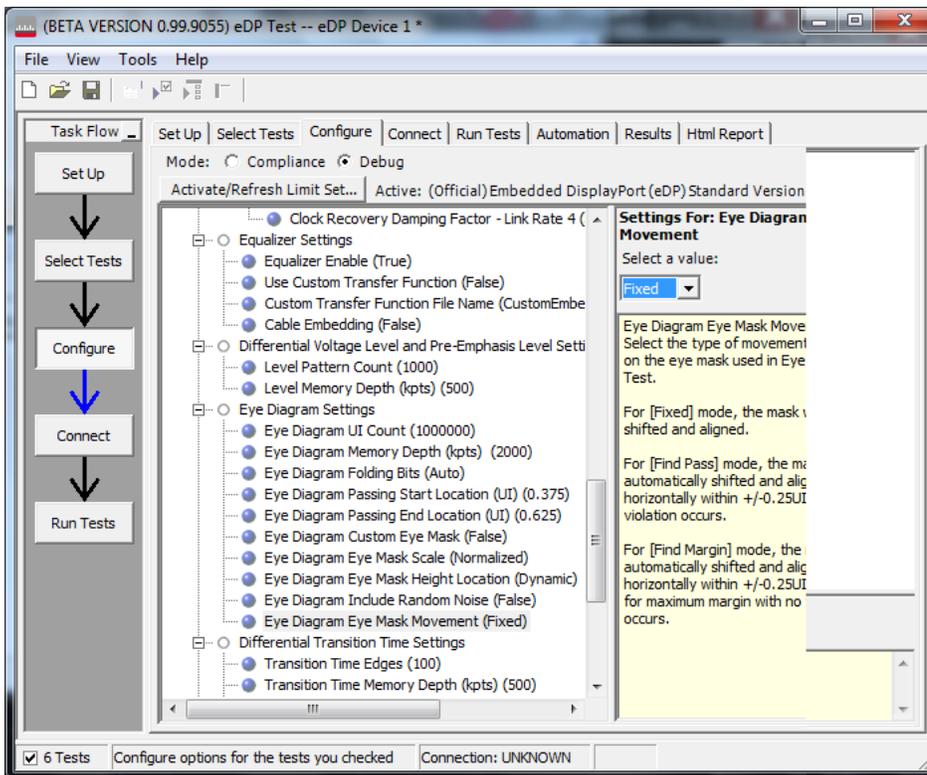


Figure 8. The eDP 1.4 configure tab enables changing measurement parameters in the 'Debug' mode to support characterization and debug activities.

After you configure the test to meet your needs, the eDP 1.4 EP&C user interface displays the connection screen, which is specific to the configuration data you have selected.

Figure 9 illustrates the typical connection guidance provided for a one-channel "A minus B" connection model for a one lane test setup.

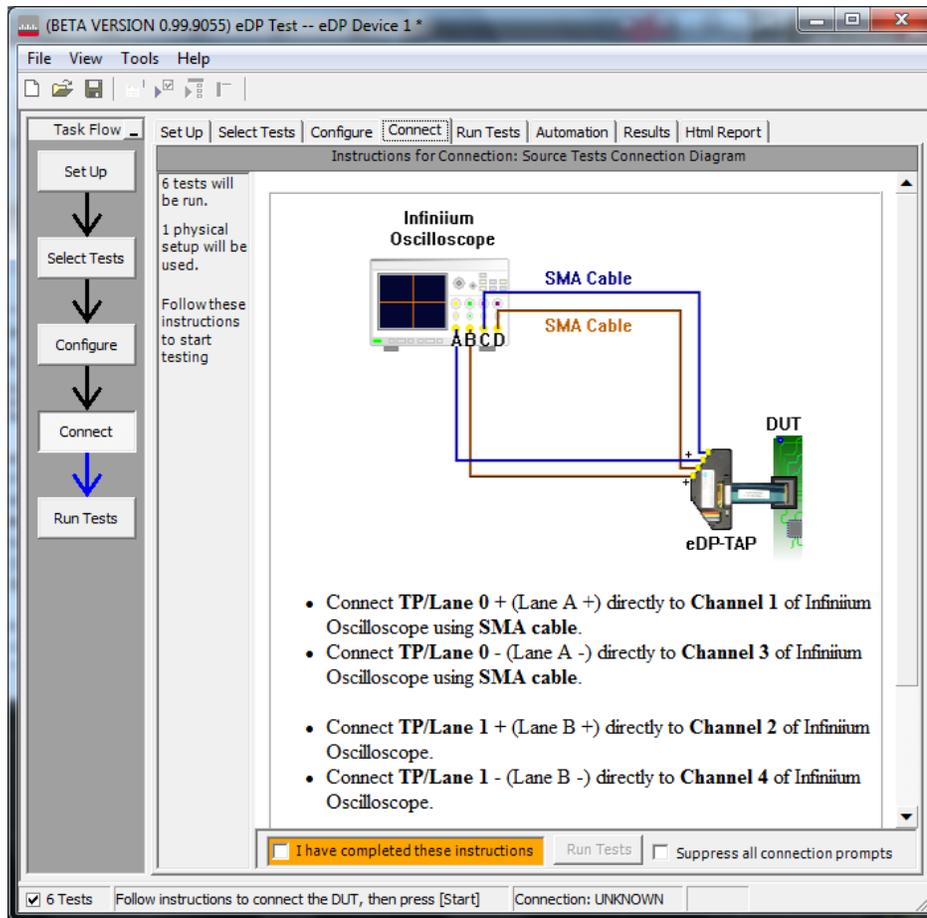


Figure 9. The final step before test is to illustrate the anticipated connection for the test.

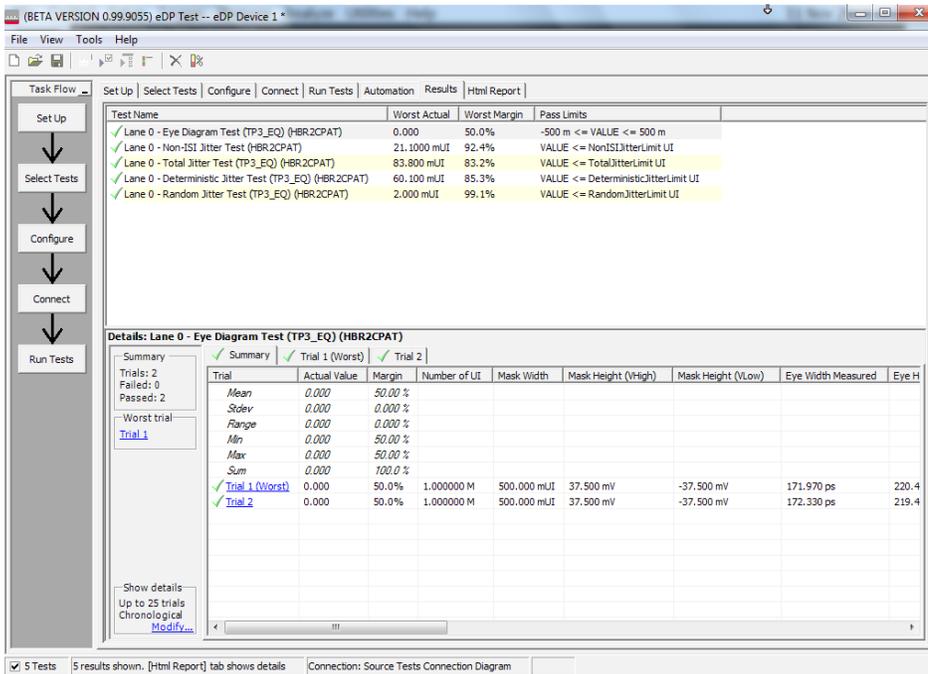


Figure 10. eDP 1.4 EP&C test software results report documents your test and indicates the pass/fail status, test specification range, measured values and margin.

Thorough performance reporting

The eDP 1.4 electrical performance and characterization software generates thorough reports that not only capture the performance and status of the device under test, but also capture 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.

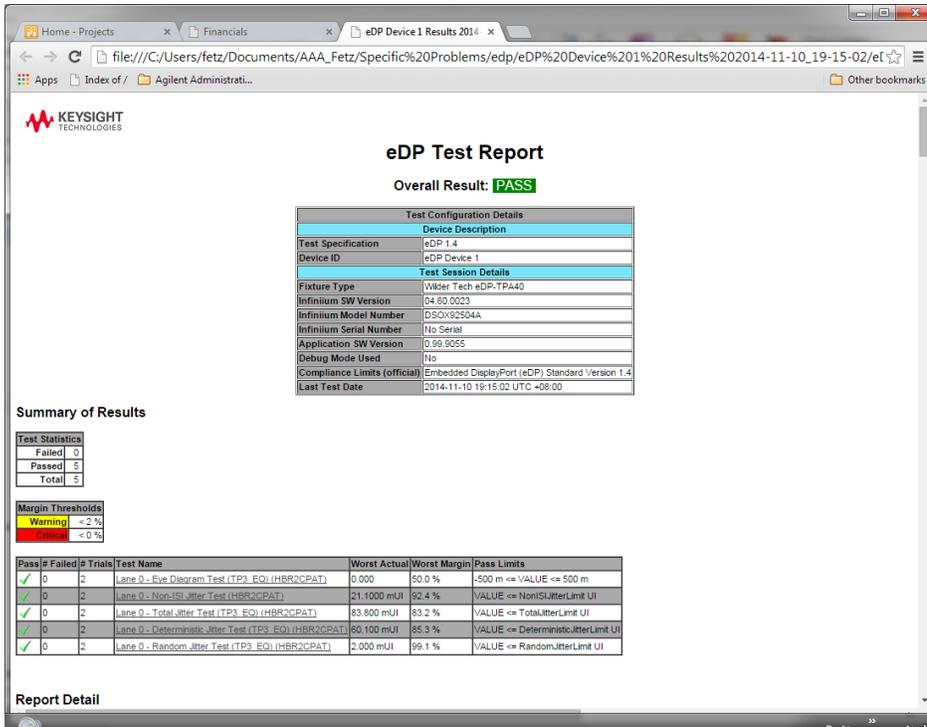


Figure 11. The eDP 1.4 software generates a summary report where you can see the total test results for your device quickly and clearly. Additional details are available for each test, including the test limits, test description and test results, including waveforms, if appropriate. All are hot-linked to more detailed results further in the report. In addition, the margin of the result is indicated to provide further insight.



Figure 12. Summary report detail: The eDP 1.4 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.

eDP test point adapters

The eDP 1.4 specification is standardized on IBEX connectors on the display panel to connect to a graphics processor board/motherboard through a ribbon-like flexible PC board.

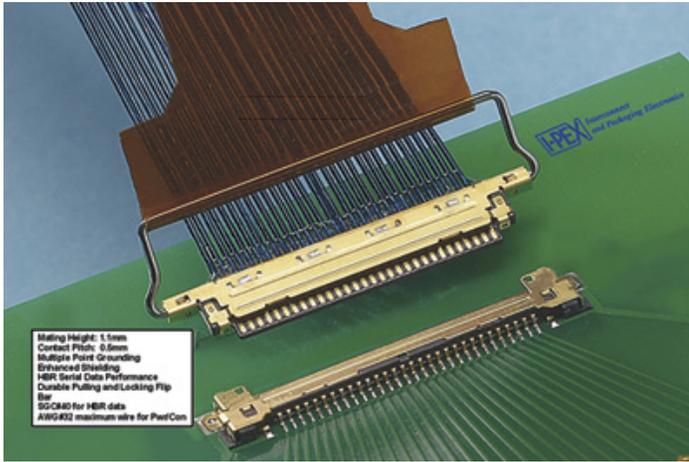


Figure 13. IBEX connector with ribbon-like flexible PC board.

By virtue of this standardization, testing for eDP 1.4 must be done at the panel connector. In DisplayPort and eDP, this point is called Testpoint 3 (or TP3 for short). TP3 necessarily includes the loss of the ribbon cable and whatever connection characteristics are at the motherboard where the ribbon connector is connected. To acquire at TP3, you will need a mating connector to your IBEX connectorized flexible PC board. Wilder Technologies makes a family of products to connect to the flexible PC board.

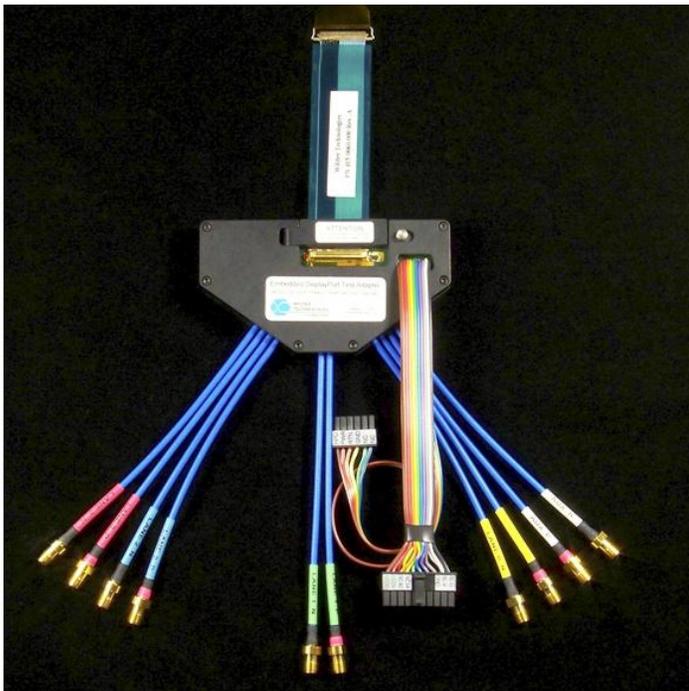


Figure 14. Wilder Technologies' eDP-TPA40L-PC test point adapter fixture.

This eDP fixture has high-speed breakout cables that terminate with SMA female connectors with an assumption that there will be cables from the oscilloscope channels to the fixture. While these cables do increase loss to the measured lines, they can be kept to a minimum to reduce their effect and can be effectively removed using PrecisionProbe software available in the Infiniium oscilloscope (see Table 4).

While TP3 will show the actual performance through a flexible PC board, it is often desired to render the acquired waveform in 'compensated' fashion to simulate a minimal correction that a receiving device might make. In DP and eDP, we call this TP3EQ (or TP3 equalized). We use CTLE (Continue Time Linear Equalizer) equalization, and the parameters for the CTLE are given in the eDP 1.4 specification. The settability of these is discussed above in *Device Definition*.

Extensibility

You may add additional custom tests or steps to your application using the N5467B/N5467C 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.

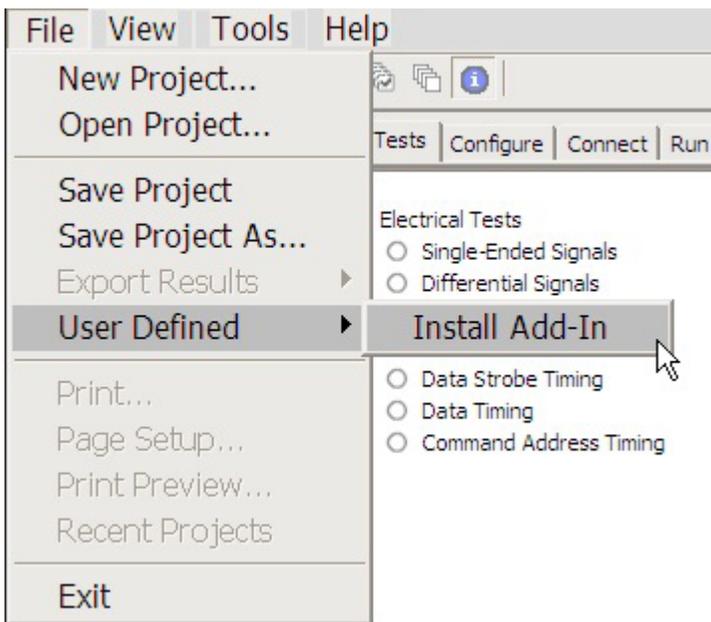


Figure 15. Importing a UDA add-in into a compliance application.

Add-ins may be designed as:

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

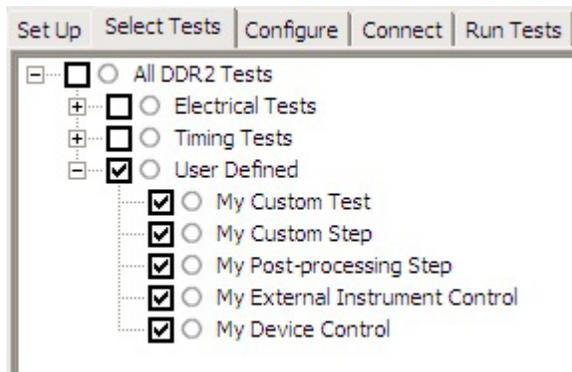


Figure 16. UDA add-in tests and utilities.

Automation

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

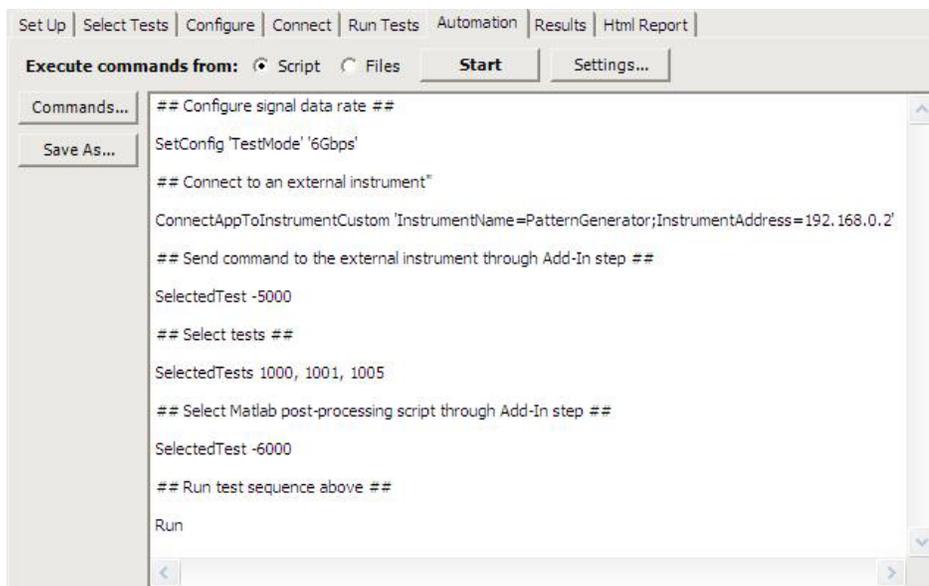


Figure 17. Remote programming script in the automation tab.

The commands required for each task may be created using a command wizard or the “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

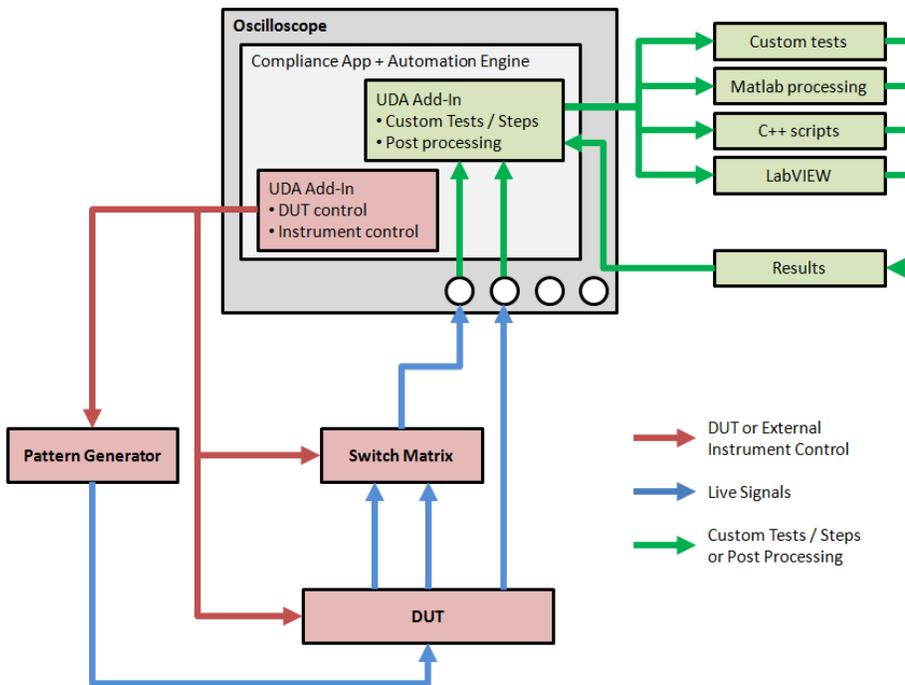


Figure 18. Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive.

Tests performed

The eDP 1.4 electrical performance and characterization software performs standard tests found in the DisplayPort electrical performance and compliance software and are provided for the specific purpose of eDP designs. Testing is assumed to be TP3 (a flexible cable from graphics processor in place) so the user needs to consider whether TP3 or TP3Eq makes sense for their application. There is nothing that prevents a Testpoint 2 measurement except test access. If a model of the flexible cable is had (S-parameter model), a transfer function can be made to undo its effects to show what the TP2 waveform looks like.

Assertion no.	Test description	Test plan	Comments
DisplayPort CTS 1.2b Section3.	Source tests	controlled	
Test ID 3.1	Data eye eiagram	Yes	Custom eye mask per data rate
Test ID 3.2	Non Pre-emphasis level verification	Yes	Referential (Level _x /Level _{x-1}) or absolute voltages
Test ID 3.3	Pre-emphasis level verification	Yes	Provided for system check. Referential or absolute
Test ID 3.4	Inter-pair skew	Yes	Pattern required
Test ID 3.5	Intra-pair skew	Yes	D10.2 pattern
Test ID 3.6	Differential transition time	Yes	Entry of thresholds
Test ID 3.10	AC common mode noise	Yes	Single-ended test connection required. DP 1.2 informative test
Test ID 3.11	Non-ISI jitter measurements	Yes	Non-equalizable jitter
Test ID 3.12	Total jitter measurements	Yes	10-9 BER
Test ID 3.14	Main link frequency compliance	Yes	D10.2 pattern preferred
Test ID 3.15	Spread spectrum modulation frequency	Yes	D10.2 pattern preferred
Test ID 3.16	Spread spectrum modulation deviation	Yes	D10.2 pattern preferred

Table 1. eDP 1.4 tests performed by the eDP 1.4 software.

Ordering information

The eDP 1.4 electrical performance and characterization software is compatible with Keysight Infiniium Series oscilloscopes with operating software revision 5.20 or higher. For oscilloscopes with earlier revisions, free upgrade software is available at www.keysight.com/find/scope-apps-sw

Recommended oscilloscopes

eDP specification	Infiniium software application	Minimum bandwidth	Compatible oscilloscopes
eDP 1.4	eDP 1.4 EP&C	13 GHz	Infiniium 90000 Series and Z-Series

Table 2. Recommended oscilloscopes.

To purchase the eDP 1.4 software with a new or existing Infiniium Series oscilloscope, order one of the following options.

eDP 1.4 software options

Application	License type		Infiniium Z-Series	Infiniium 90000 Series
eDP 1.4 EP&C software	Fixed	Factory-installed	N6469A-1FP	Option 083
		User-installed	N6469A -1FP	N6469A -1FP
	Floating	Transportable	N6469A -1TP	N6469A -1TP
		Server-based	N5435A-083	N5435A-083

Table 3. eDP 1.4 EP&C software options.

Oscilloscope measurement software

Application	License type		Infiniium Z-Series	Infiniium 90000 Series
Equalization (required)	Fixed	Factory-installed	N5400A-1FP	Option 004
		User-installed	N5400A-1FP	N5400A-1NL
	Floating	Transportable	N5400A-1TP	N5400A-1TP
		Server-based	N5435A-001	N5435A-001
Equalization (required)	Fixed	Factory-installed	N5461A-1FP	Option 012
		User-installed	N5461A-1FP	N5461A-1NL
	Floating	Transportable	N5461A-1TP	N5461A-1TP
		Server-based	N5435A-025	N5435A-025
PrecisionProbe calibration (optional)	Fixed	Factory-installed	N2809A-1FP	Option 001
		User-installed	N2809A-1FP	N2809A-1NL
	Floating	Transportable	N2809A-1TP	N2809A-1TP1,2
		Server-based	N5435A-003	n/a
InfiniiSim (optional)	Fixed	Factory-installed	N5465A-1FP	Option 014
		User-installed	N5465A-1FP	N5465A-1NL
	Floating	Transportable	N5465A-1TP	N5465A-1TP
		Server-based	N5435A-027	N5435A-027

Table 4. Infiniium measurement software.

Model number	Description
eDP-TPA40L-PC	Wilder Technologies 40 pin test point adapter
N4871A	3.5mm cables phase matched +/- 5ps
15443	SMA cable set phase matched +/-25ps

Table 5. Fixture and connection tools.

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