Keysight U7243C

USB 3.1 – 5 Gbps and 10 Gbps Transmitter Compliance Software

For the Infiniium Series Oscilloscopes

Data Sheet

KEYSIGHT
TECHNOLOGIES

Table of Contents

Verify and Debug your USB 3.1 Designs More Easily

Keysight Technologies Inc. U7243C USB 3.1 validation and compliance software provides you with a fast and easy way to verify and debug your USB 3.1 products.

The USB 3.1 transmitter compliance software allows you to automatically execute USB 3.1 transmitter compliance, and it displays the results in a flexible report format. In addition to the measurement data, the report provides a margin analysis that shows how closely your device passed or failed each test.

The U7243C USB 3.1 transmitter compliance software utilizes the prescribed test methods and algorithms as defined in the USB 3.1 rev 1.0 specification and compliance test specification.

By incorporating the USB-IF SigTest utility the U7243C USB 3.1 transmitter compliance software will provide you with consistent lab compliance test results with those generated at USB-IF workshops or test labs that use the stand-alone USB-IF SigTest tool for transmitter compliance verification. The advanced eye pattern and jitter analysis capabilities provided by the SDA electrical test option will allow product developers to quickly perform advanced eye and jitter analysis and debug to the jitter component level.

The USB 3.1 electrical performance validation and compliance software performs a wide range of electrical tests, including both normative and informative requirements, as per the USB 3.1 specification and the USB 3.1 transmitter compliance test specification.

Features

The U7243C USB 3.1 transmitter compliance software offers several features to simplify the validation of USB 3.1 designs:

- Automated 1M (Gen 1 (5 Gbps)) or 2M (Gen 2 (10 Gbps)) Unit Interval (or greater) testing for highest accuracy
- Results consistent with USB-IF SigTest software utility
- Test setup wizard for ease-of-use
- Wide range of electrical tests
- USB Type-C interface control with N7018A Type-C Test Controller
- USB 3.1 SigTest clock recovery algorithm
- Automated scope measurement setup
- Test results report generation
- Pass/fail margin analysis
- TP1 eye pattern compliance test mask
- Gen 1 CTLE (5 Gbps) signal correction for TP1 tests
- Gen 2 CTLE (10 Gbps) RX EQ transfer function computation
- Gen 2 SCDx/LBPM tests
- Gen 2 preshoot/de-emphasis tests

With the USB 3.1 transmitter compliance software, you can use the same oscilloscope you use every day to perform automated testing and margin analysis based on the USB-IF specified tests.

USB 3.1 compliance testing

To pass signal quality testing at a USB-IF-sponsored compliance workshop, your product must successfully pass "Gold Suite" testing, based on the USB-IF SigTest application. The SigTest application tests your device against the minimum signal-quality performance requirements for USB 3.1. If you are developing receivers and transmitters for devices and system motherboards, the USB 3.1 transmitter compliance software helps you execute all the SigTest tests and additional oscilloscope already completed tests.

While SigTest tests provide a good overview of USB 3.1 electrical signal quality, they address only a small subset of the electrical compliance measurements specified in the USB 3.1 specification. The SigTest application also provides minimal reporting capability with pass/fail indication and measurement values, and has limited debugging capabilities to decipher eye mask violations or excessive jitter.

For USB 3.1 measurements, the U7243C software automatically calculates deterministic jitter and total jitter at 10^{-12} BER. Random jitter is also reported for completeness and a voltage margin "eye" diagram is included in the final HTML report. DJ and TJ values are specified in the USB 3.1 specification and are required for compliance verification.

Benefits

U7243C benefits

The U7243C USB 3.1 transmitter compliance software saves you time by setting the stage for automatic execution of USB 3.1 electrical tests. Part of the difficulty of performing electrical tests for USB 3.1 is hooking up the oscilloscope, loading the proper setup files, and then analyzing the measured results by comparing them to limits published in the specification. The USB 3.1 transmitter compliance software does much of this work for you. In addition, if you discover a problem with your device, robust debug tools are available to aid in root-cause analysis. These debug tools are provided by the Keysight *E2688A high-speed serial data analysis software* and N5400A EZJIT Plus jitter analysis software. These tools are included in the USB 3.1 transmitter compliance software for debug and analysis using the specific clock recovery parameters from the specification. If you need to change the settings, you will need the full versions installed on your scope.

The U7243C USB 3.1 transmitter compliance software offers many more electrical tests than the SigTest application. Unlike the SigTest application, the U7243C USB 3.1 transmitter compliance 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 a particular test assertion. Table 1 shows a side-by-side comparison of the capabilities of the USB-IF SigTest application and the Keysight U7243C electrical test software.

Table 1. Comparison of capabilities of the Keysight USB 3.1 transmitter compliance software and the USB 3.1 SigTest application.

Capability	Keysight U7243C	USB 3.1 SigTest
Number of measurement assertions	> 50	—
Automated oscilloscopes setup for each measurement	Yes, guided	No, single setup
Measurement results	Pass/fail with margin analysis	Pass/fail with measured value
USB 3.1 test specification based measurements methodology	Yes	Yes
Clock recovery method	USB-IF SigTest or 1st/2nd order PLL	USB-IF SigTest
Custom HTML report generation	Yes	No
Selectable number of tests performed	Yes	No
Multi-trial run support	Yes	No
Debug mode for "what if" analysis	Yes	No

Easy Test Definition

The U7243C USB 3.1 transmitter compliance software extends the ease-of-use advantages of Infiniium Series oscilloscopes to testing USB 3.1 designs. The Keysight automated test engine walks you quickly through the steps required to define the tests, set up the tests, perform the tests, and view the test results. You can select a category of tests all at once, or specify individual tests. 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.

Pick the product type you want to test

Choose the test point you are probing with your oscilloscope

Test with SSC enabled (for compliance) or with a clean clock

Choose USB-IF SigTest or Keysight SDA

Type-C environment setup

Figure 1. The Keysight U7243C allows you to easily specify the test point you want to use to test the compliance of your device. This makes test setup easy as only the appropriate tests for the test point you pick are shown on later test selection pages.

Easy Test Definition (Continued)

Easy to follow task flow for configuring and running tests

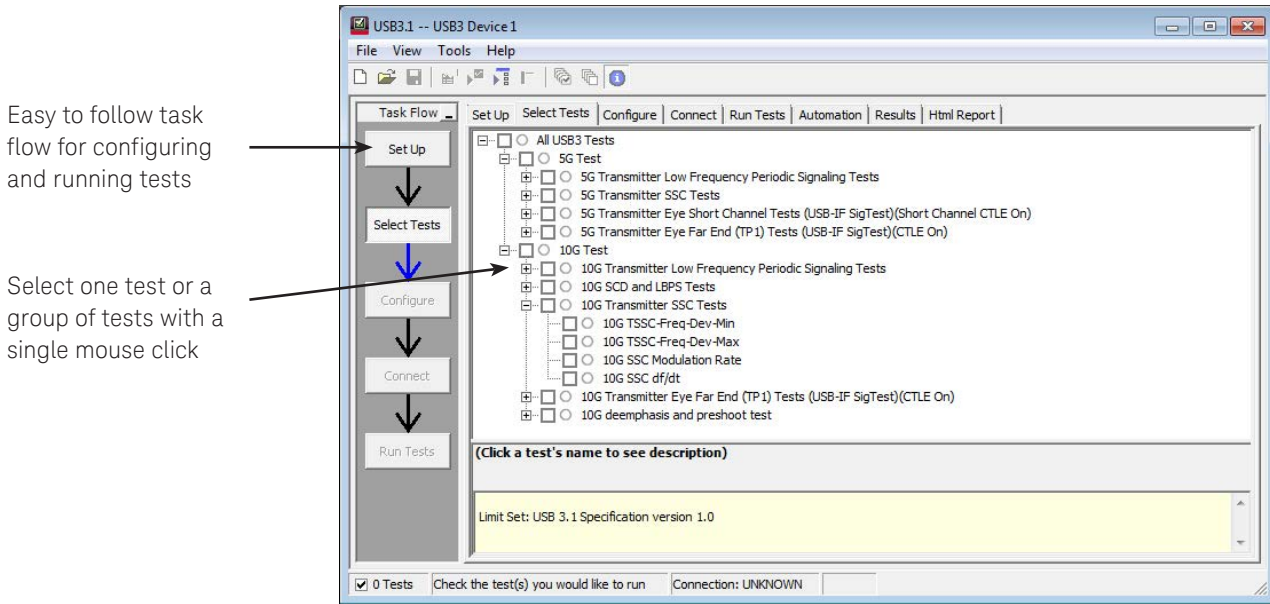Select one test or a group of tests with a single mouse click

Figure 2. The Keysight automated test engine guides you quickly through selecting tests, configuring tests, setting up the connection, running the tests, and viewing the results. Individual tests or groups of tests are easily selected with a mouse click.

Configurability and Guided Connections

The U7243C USB 3.1 transmitter 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.
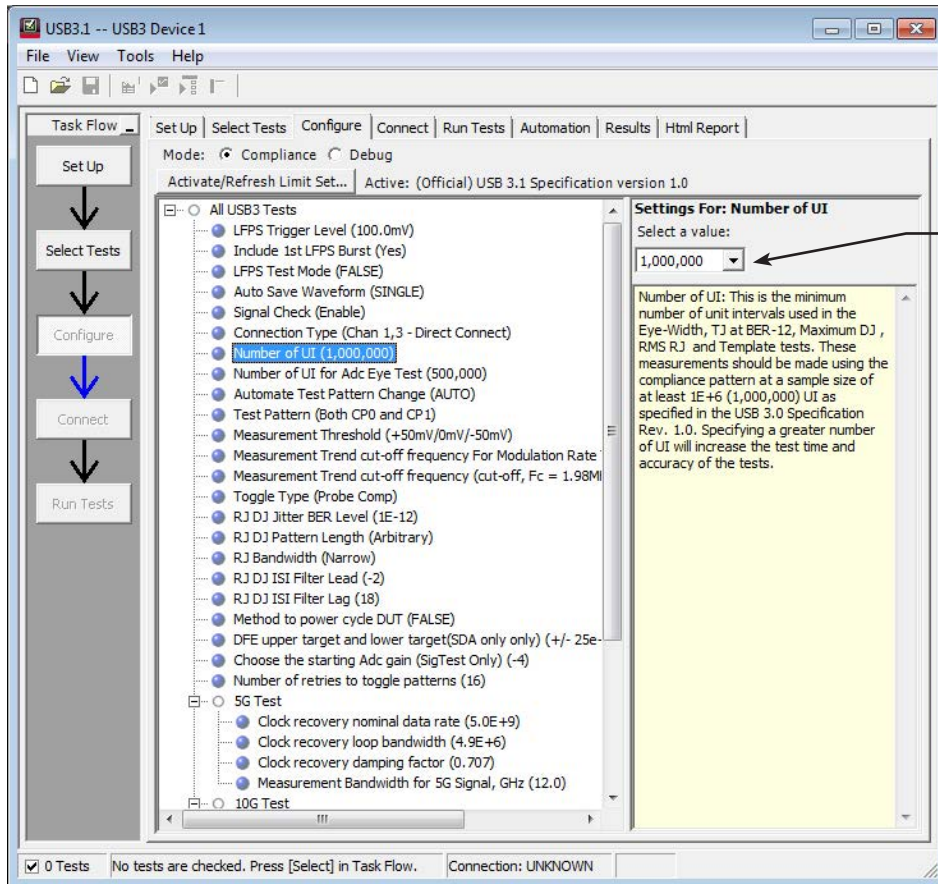
Specify 1 million UI (or more) for your jitter measurements

Figure 3. In configuring the tests, you specify the device to test, its configuration, and how the oscilloscope is connected.

Configurability and Guided Connections (Continued)

If more than one test setup connection is required, you will be notified

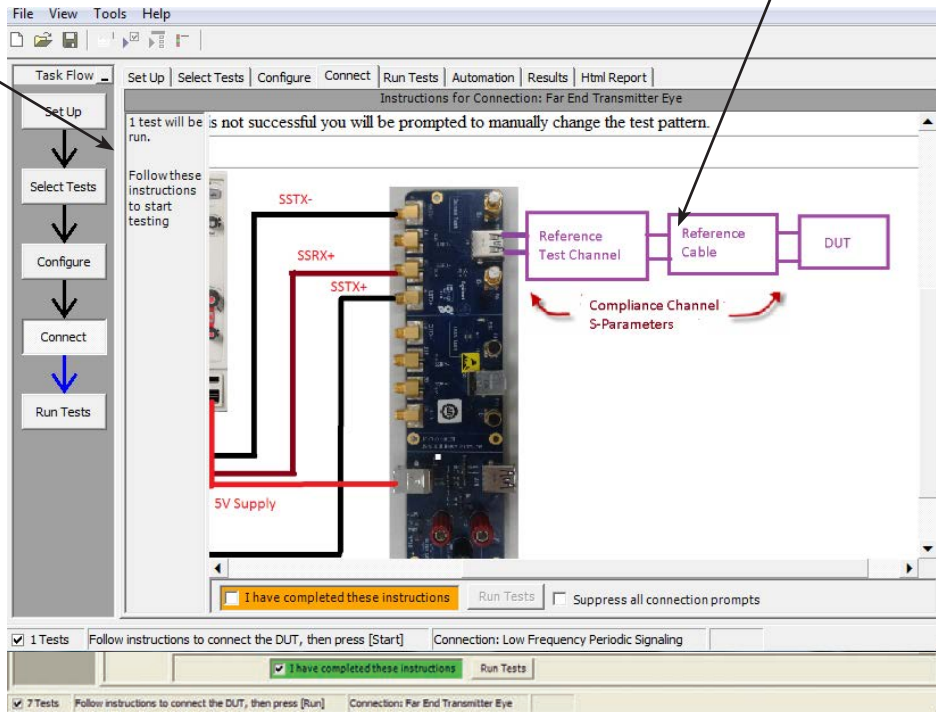You are prompted to make the appropriate connections for the set of tests

Figure 4. When you make multiple tests where the connections must be changed, you are prompted with connection diagrams and/or photographs.

Reports with Margin Analysis

In addition to providing you with measurement results, the U7243C USB 3.1 transmitter 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 can select the margin test report parameter, which means you can specify the level at which warnings are issued to alert you to electrical tests where your product is operating close to the official test limit defined by the USB 3.1 specification.

Test results in an easy-to-read HTML formatted report

Overall test description

Summary test results
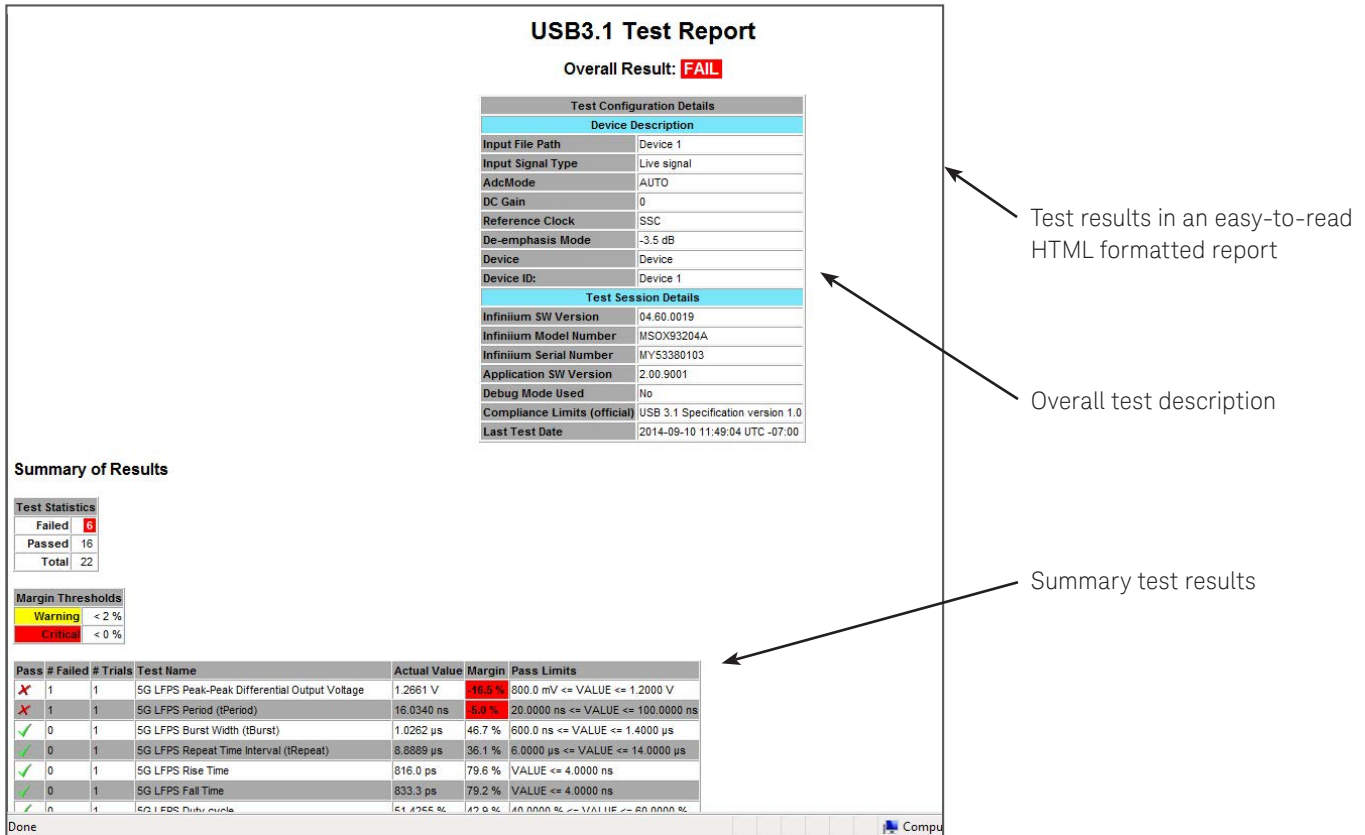
Figure 5. The USB 3.1 transmitter compliance software results report documents your test, indicates the pass/fail status, the test specification range, the measured values, and shows how much margin you have.

Reports with Margin Analysis (Continued)

Test setup conditions

Voltage margin results presented in identical format used by SigTest
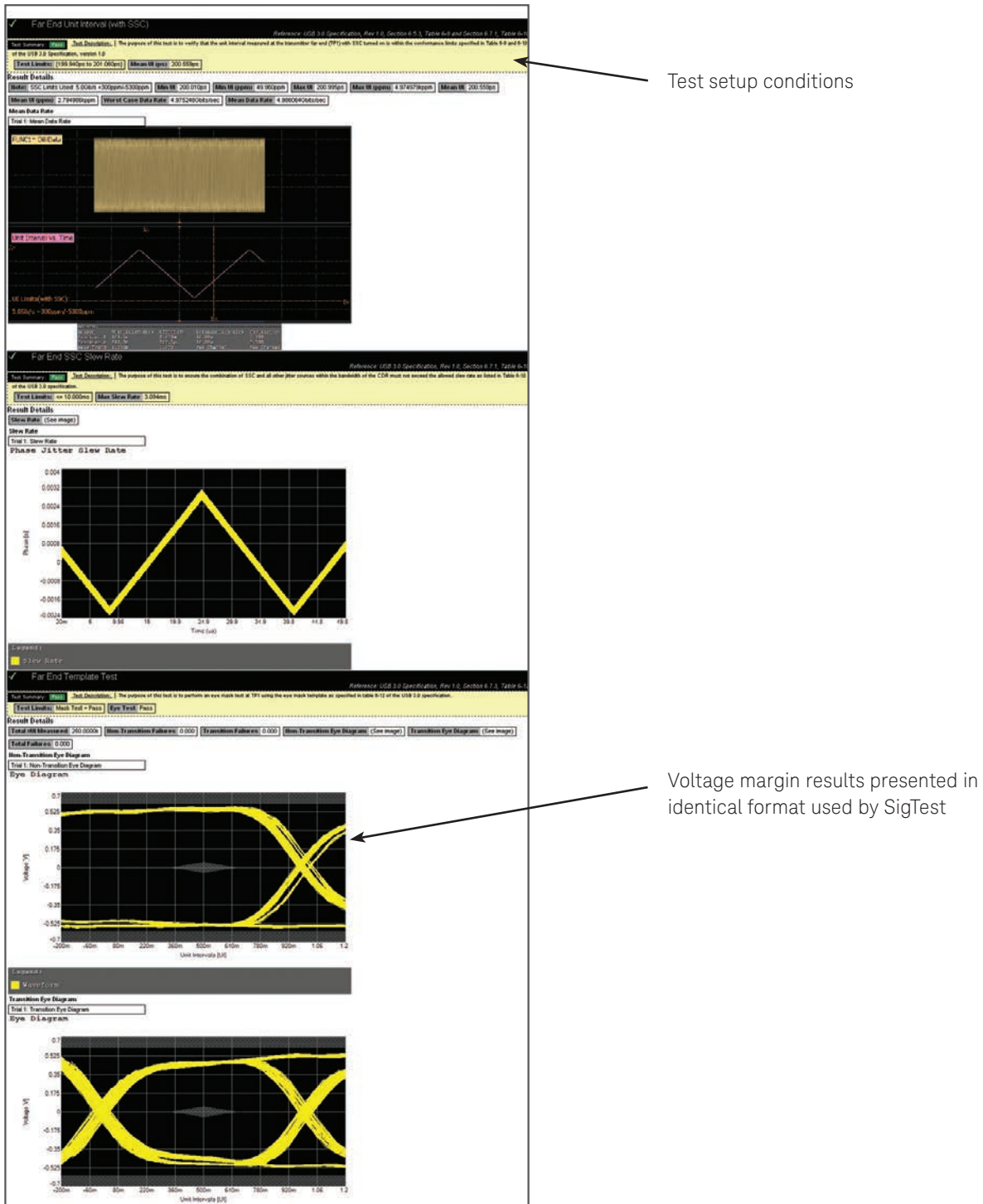
Figure 6. The HTML report provides additional details including test setup conditions, graphical results, and test limits (where appropriate).

Reports with Margin Analysis (Continued)
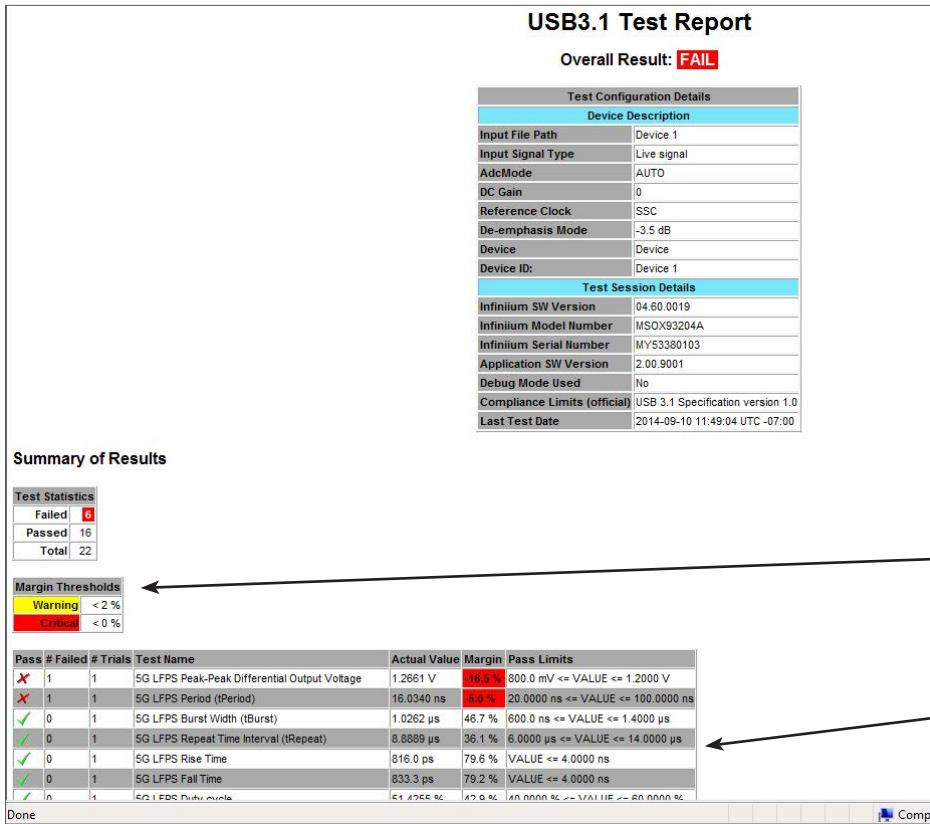
User set margin thresholds for warning and failure indicators

Margin values indicate when the results are approaching test limits. Warnings and failures are highlighted

Figure 7. How close you are to passing or failing a test is indicated as a % in the margin field. A result highlighted in yellow or red indicates that the margin threshold level for a warning or failure was detected.

USB Type-C™ Control

The USB 3.1 Transmitter 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 and Thunderbolt. It can also be used to control a USB3.1 transmitter through Low Frequency Periodic Signaling (LFPS). The Type-C environment setup is initiated through the selection to the TCTC 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 USB3.1 Transmitter Compliance software handles this with ease. In the setup of the Type-C environment, the device under test is queried for it's declared valid 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.

LFPS: the controller can be used to send LFPS pings for the purpose of controlling a transmitter in the compliance mode. It further can be used to initiate link training to start LBPM (LFPS Based Pulse Width Modulation Messaging) for capability declaration to measure electrical parameters in that signaling.
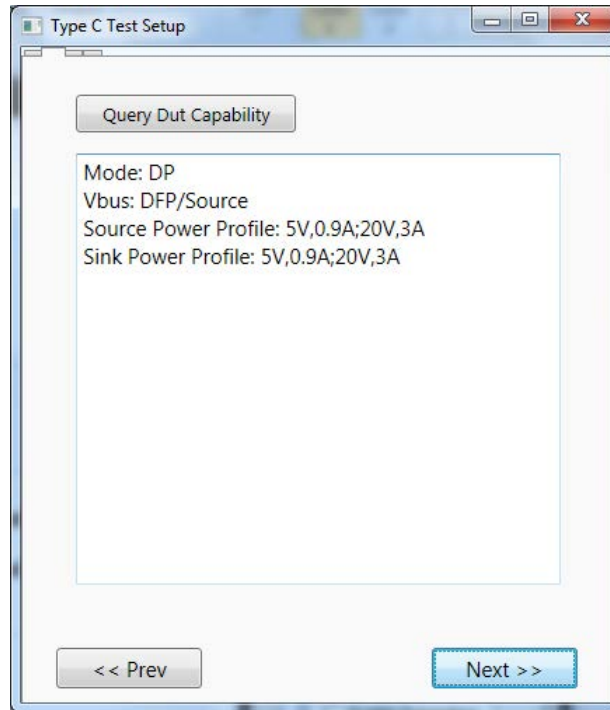
Figure 8. Type-C Setup: Device is queried for PDO capability.
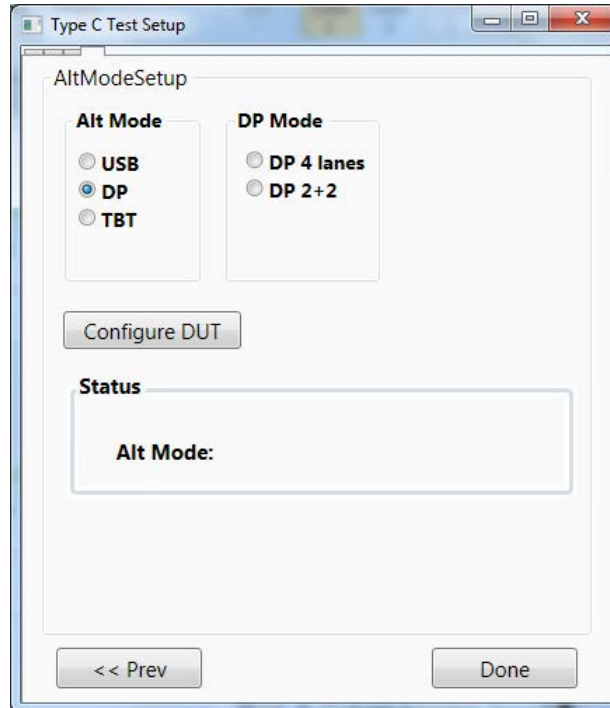
Figure 9. Type-C Setup: Device mode control setting.

Extensibility

You may add additional custom tests or steps to your application using the N5467A User Defined Application (UDA) development tool (**www.keysight.com/find/uda**). Use UDA to develop functional "Add-Ins" that you can plug into your application.

Add-ins may be designed as:
– Complete custom tests (with configuration variables and connection prompts)
– Any custom steps such as pre or post processing scripts, external instrument control and your own device control

Figure 10. Importing a UDA Add-In into your test application.

Figure 11. UDA Add-In tests and utilities in your test application.

Automation

You can completely automate execution of your application's tests and Add-Ins from a separate PC using the included N5452A 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.
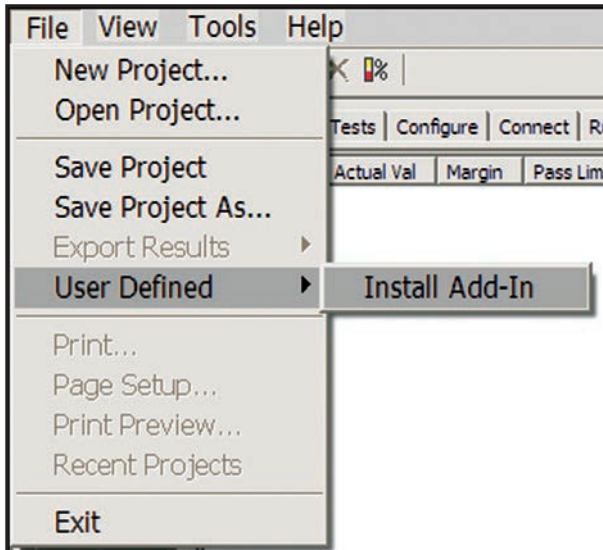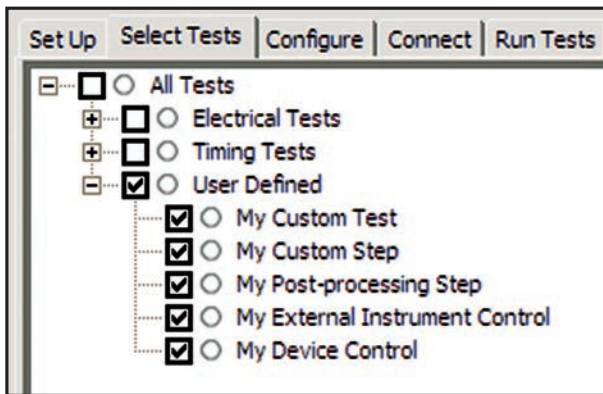
The commands required for each task may be created using a command wizard or from "remote hints" accessible throughout the user interface.

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.
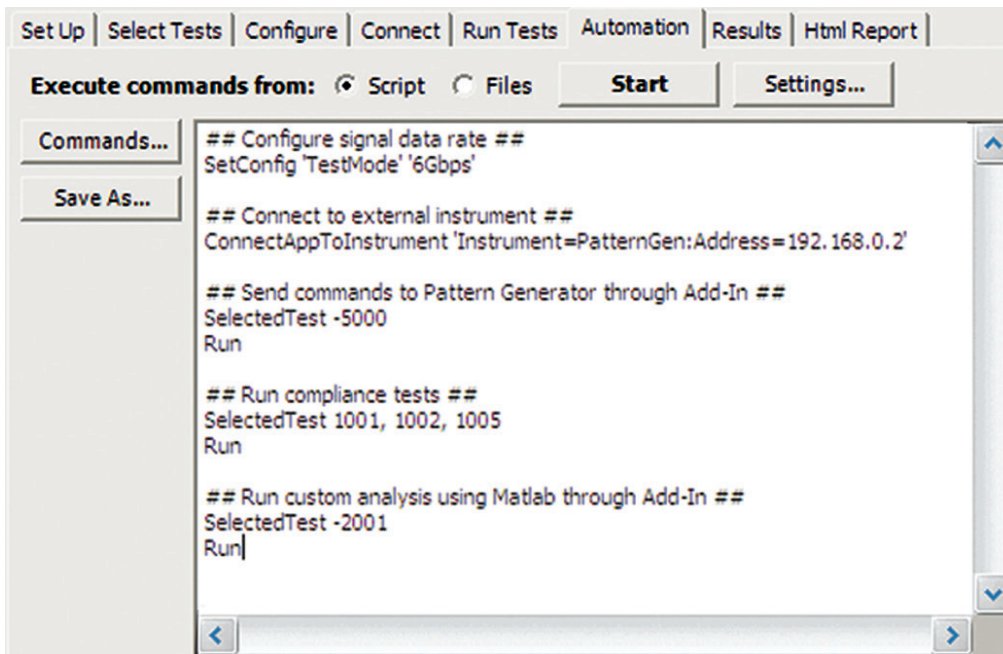

Figure 12. Remote Programming script in the Automation tab.

Automation (Continued)
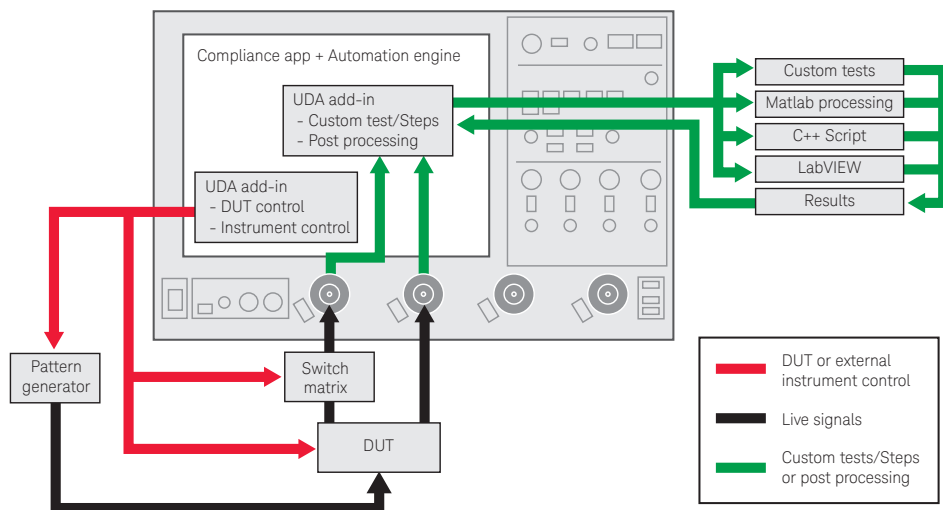
Figure 13. Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive.

Additional Applications

With the U7243C USB 3.1 license, you are able to run all the tests in Compliance Mode without other application licenses. With the exception that InfiniiSim (N5465A) is required if you want to apply a custom transfer function created using models or S-Parameter files. An example would be to de-embed the effects of a custom test fixture.

In debug mode the following are required:

InfiniiSim (N5465A): Not required unless a custom transfer function needs to be created.

Equalization (N5461A): This is required for the Far End Template Test (CTLE ON), it is used to open the eye by equalization. But it is not required for the Near End Template Test.

Serial Data Analysis (E2688A): This is required for the Far End Template Test (CTLE ON). It provides clock recovery and is necessary to perform eye measurements. It is highly recommended for general purpose debug of the USB 3.1 signals.

EZJIT+ (N5400A) - the tests listed below require EZJIT+:
– 5G Far End Random Jitter (CTLE ON)
– 5G End Maximum Deterministic Jitter (CTLE ON)
– 5G End Total Jitter at BER-12 (CTLE ON)

Note: DSA scopes includes SDA and EZJIT+.

Recommended Oscilloscopes

The software is compatible with Keysight Infiniium Series oscilloscopes with operating software revision 4.60 or higher. For oscilloscopes with earlier revisions, upgrade software is available at: **www.keysight.com/find/scope-apps-sw**.

Table 2. Recommended oscilloscopes. Bandwidth dependent on expected rise times. For rise times < 28 ps (10/90) consider >= 20 GHz

USB specification	Minimum bandwidth	Compatible oscilloscopes
Gen 1 (5 Gbps)	13 GHz	Infiniium 90000A, V-Series, 90000 X- and Z-Series
Gen 2 (10 Gbps)	16 GHz	Infiniium V-Series and Z-Series

Additional Equipment

Stimulus

The AUX or CAL OUT of the scope can be used to toggle 5 Gbps compliance patterns on most but not all DUTs. Pattern generators can be used to toggle compliance patterns in DUTs and are required for the 10G LFPS, SCD, and LBPM tests. They will toggle compliance patterns more reliably than using the Scope outputs. Any combination of pattern generator options will work for this application. For instance, only one channel is required for all tests. The following is a matrix of instruments and what tests they support:

Table 3. Stimulus support matrix

Stimulus	Compliance pattern toggling	5G LFPS test (warm reset)	10G LFPS tests	SCD/LBPM tests
Aux/Cal out	Supported 5G only	Not support	Not support	Not support
33250A	Supported DC block	Supported DC block	Not support	Not support
81134A	Supported DC block	Supported DC block	Supported 2ea, DC blocks	Supported 2ea, DC blocks
81150A	Supported BNC/SMA	Supported BNC/SMA	Supported 2ea, BNC/SMA	Supported 2ea, BNC/SMA
81160A	Supported BNC/SMA	Supported BNC/SMA	Supported 2ea, BNC/SMA	Supported 2ea, BNC/SMA
N4903B	Supported DC block	Supported DC block	Supported 2ea, DC blocks	Supported 2ea, DC blocks
M8020A	Supported DC block	Supported DC block	Supported 2ea, DC blocks	Supported 2ea, DC blocks
N7018A	Supported DC block	Supported DC block	Supported 2ea, DC blocks	Supported 2ea, DC blocks

Power supply (Optional)

The E3631A can be used to power the device. This is normally done through the U7242A fixture. This will further automate tests like the LFPS tests.

For power supply and power supply contracts with devices implementing the USB Type-C connector, see Recommended Type-C Accessories table

Ordering Information

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

Table 4.

Application	License type		Infiniium V-Series and Z-Series	Infiniium 90000 A/X-Series
USB 3.1: 5 and 10 Gbps transmitter compliance software	Fixed	Factory-installed	U7243C-1FP	DSO90000-081
		User-installed	U7243C-1FP	U7243C-1FP [1]
	Floating	Transportable	U7243C-1TP	U7243C-1TP [1]
		Server-based	N5435A-118	N5435A-118
USB 3.1: Upgrade 5 to 10 Gbps transmitter compliance software	Fixed	Factory-installed	–	–
		User-installed	U7243C-2FP	U7243C-2FP [1]
	Floating	Transportable	–	–
		Server-based	–	–
USB 3.1: 5 Gbps only transmitter compliance software	Fixed	Factory-installed	U7243C-3FP	DSO90000A-041
		User-installed	U7243C-3FP	U7243C-3FP [1]
	Floating	Transportable	U7243C-3TP	U7243C-3TP [1]
		Server-based	N5435A-030	N5435A-030

1. Requires Infiniium oscilloscope software 5.00 and above.

The following are required to run some of the tests in the Debug mode of the U7243C Software. For more details see the Additional Applications section on page 15.

Table 5.

Application	License type		Infiniium V-Series and Z-Series	Infiniium 90000 A/X-Series
EZJIT+ jitter analysis software	Fixed	Factory-installed	N5400A-1FP	DSO90000A-004
		User-installed	N5400A-1FP	N5400A-1FP [1]
				N5400A-1NL [2]
	Floating	Transportable	N5400A-1TP	N5400A-1TP [1]
		Server-based	N5435A-001	N5435A-001
Equalization emulation software	Fixed	Factory-installed	N5461A-1FP	DSO90000A-012
		User-installed	N5461A-1FP	N5461A-1FP [1]
				N5461A-1NL [2]
	Floating	Transportable	N5461A-1TP	N5461A-1TP [1]
		Server-based	N5435A-025	N5435A-025
InfiniiSim advanced waveform transformation software	Fixed	Factory-installed	N5465A-1FP	DSO90000A-014
		User-installed	N5465A-1FP	N5465A-1FP [1]
				N5465A-1NL [2]
	Floating	Transportable	N5465A-1TP	N5465A-1TP [1]
		Server-based	N5435A-027	N5435A-027
SDA (serial data analysis)	Fixed	Factory-installed	E2688A-1FP	DSO90000A-003
		User-installed	E2688A-1FP	E2688A-1FP [1]
				E2688A-1NL [2]
	Floating	Transportable	E2688A-1TP	E2688A-1TP [1]
		Server-based	N5435A-003	N5435A-003

1. Requires Infiniium oscilloscope software 5.00 and above.
2. Systems running Windows 7 require Infiniium 4.60. Systems running XP require Infiniium 4.20.

Ordering Information (Continued)

Table 6. Accessories

| Model number	Description
U7242A	USB 3.0 test fixture
N7015A	Type-C High-Speed Test Fixture
N2823A	2.92 mm cables phase-matched pair > 40 GHz, 1 m
N5448B	2.92 mm cables phase-matched pair > 40 GHz, 25 cm
N9398C	Blocking capacitor, 50 kHz to 26.5 GHz

Recommended Type-C Accessories

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

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

Related Literature

Publication title	Publication number
E2688A, N5384A High-Speed Serial Data Analysis and Clock Recovery Software for Infiniium Oscilloscopes - Data Sheet	5989-0108EN
EZJIT Plus Jitter Analysis Software for Infiniium Oscilloscopes - Data Sheet	5989-0109EN
Infiniium 90000 Series Oscilloscopes - Data Sheet	5989-7819EN
N5461A Serial Data Equalization Software for Infiniium Series Oscilloscopes - Data Sheet	5990-3330EN
N5465A InfiniiSim Waveform Transformation Toolset for Infiniium Oscilloscopes - Data Sheet	5990-4059EN
U7242A USB 3.0 Transmitter and Receiver Test Fixture - Data Sheet	5990-4118EN
EZJIT Complete Jitter and Vertical Noise Analysis Software for Infiniium Oscilloscopes - Data Sheet	5991-0523EN
Infiniium Z-Series Oscilloscopes - Data Sheet	5991-3868EN
Infiniium V-Series Oscilloscopes - Data Sheet	5992-0425EN
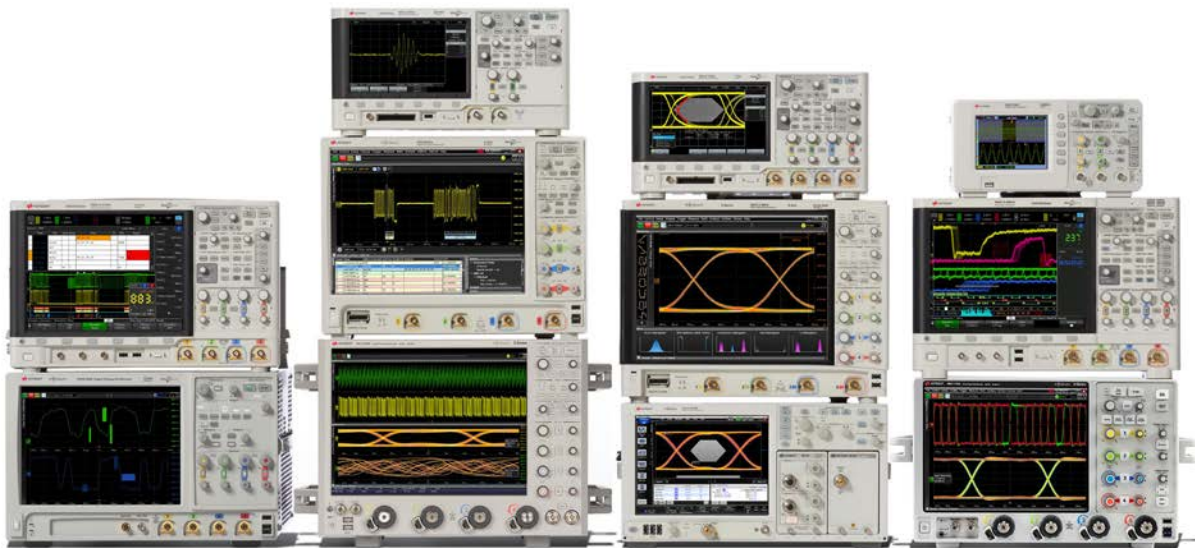
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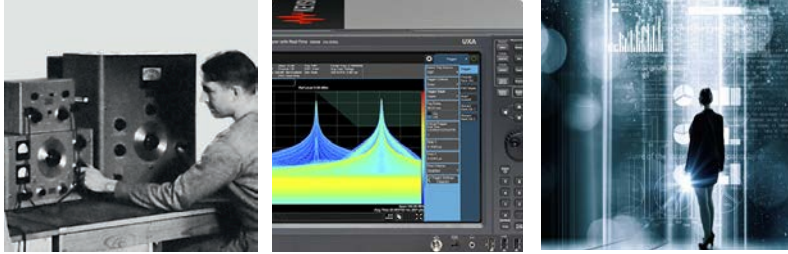www.keysight.com/find/software

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