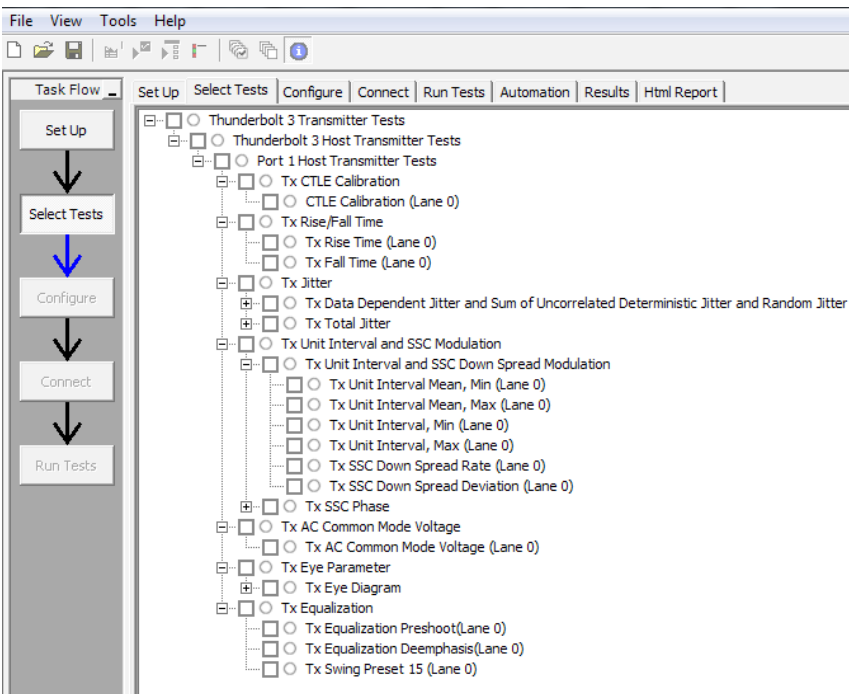


# Keysight N6470B

## Thunderbolt 3 Transmitter Compliance Test Software for Infiniium Oscilloscopes

Data Sheet



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## Verify and Debug Your Thunderbolt 3 Designs

The N6470B Thunderbolt 3 electrical test software gives you a fast and easy way to verify and debug your Thunderbolt designs for both silicon validation as well as end products like storage devices or motherboards.

The Thunderbolt 3 electrical test software allows you to automatically execute Thunderbolt 3 electrical transmitter tests and 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 N6470B Thunderbolt 3 electrical test software covers the prescribed test methods and parameters required for Thunderbolt electrical certification testing. This produces results that are consistent with those obtained during official certification at approved test labs and informational testing at plugfests.

In addition to automatic setup and execution of the transmitter tests, the N6470B Thunderbolt 3 electrical test software also provides automatic setup and control of the crosstalk generator source, a required condition for electrical testing during official certification tests.

## Features and benefits

The N6470B Thunderbolt 3 electrical test software offers several features to simplify the validation of your Thunderbolt designs:

- Full USB Type-C interface control with N7018A Type-C Test Controller integrated
- Automated test setup and execution for ease of use
- Support for simultaneous two-lane testing as well as single or dual port
- Support for cable and test fixture embedding and de-embedding to provide more accurate margin estimates
- Run tests with live or saved waveforms for easy regression testing if specification requirements change
- Support for user-defined limits and specification-specific limits for all Thunderbolt Interconnect specification revisions
- Automated test report generation and margin analysis
- Add additional custom tests, steps or automation to your application using the N5467A User-Defined Application (UDA) development tool
- Supports automated setup and control of crosstalk generator

## Applications

The N6470B Thunderbolt 3 application software provides electrical testing coverage for:

- Thunderbolt devices
  - Storage devices
  - Displays
  - Expansion bays
- Systems, hosts, motherboards
- Dongles
- Cables
- Silicon



## Easy Test Definition

The N6470B Thunderbolt 3 electrical test software extends the ease-of-use advantages of the Keysight Technologies, Inc. Infiniium V- and Z-Series oscilloscopes to testing Thunderbolt designs. The Keysight automated test engine walks you quickly through the steps required to define, set up, perform, and view the results for the tests. 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 to quickly re-test, run additional tests and review previous test results. You can also quickly verify old test results against new specification requirements using the Saved Waveform option.

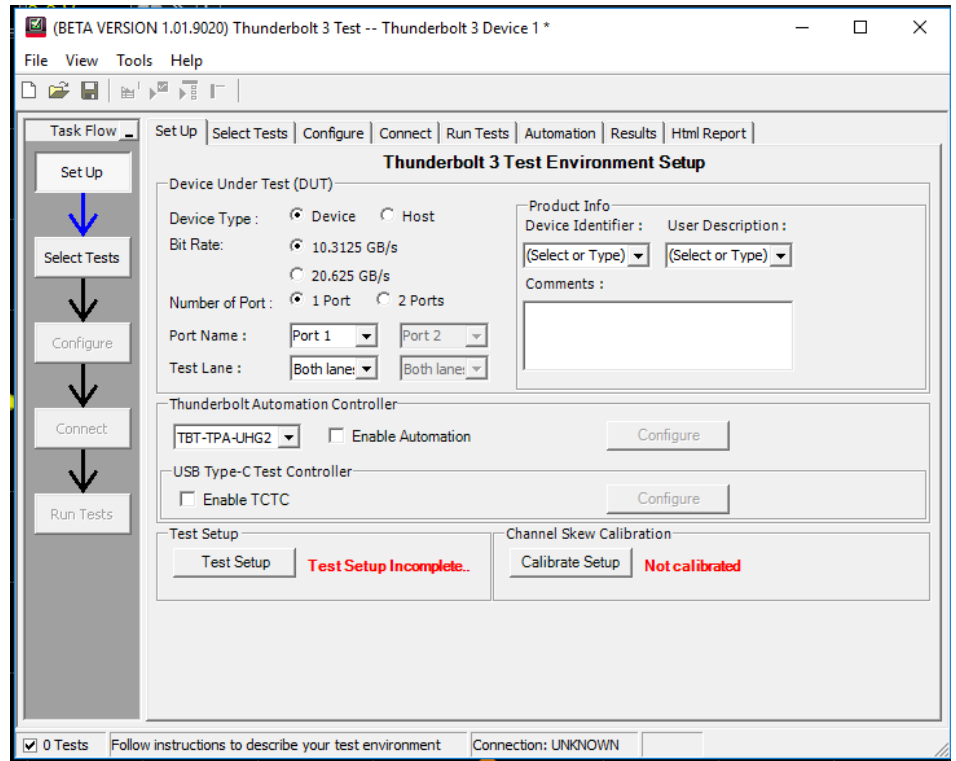


Figure 1. Setup test environment for one or two port products.

Thunderbolt transmitter testing requires active inputs to the receivers of the product under test during all electrical tests. The N6470B Thunderbolt electrical test software automates setup and control of the crosstalk source.

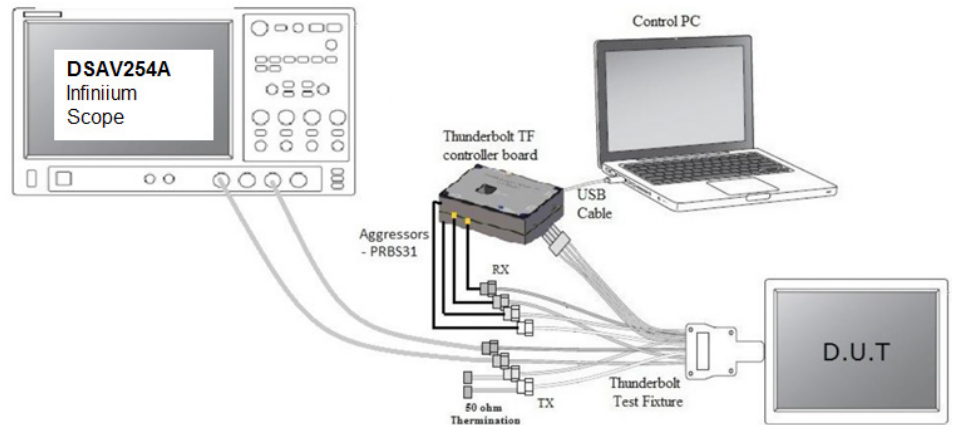


Figure 2. Automated transmitter test setup including crosstalk source.



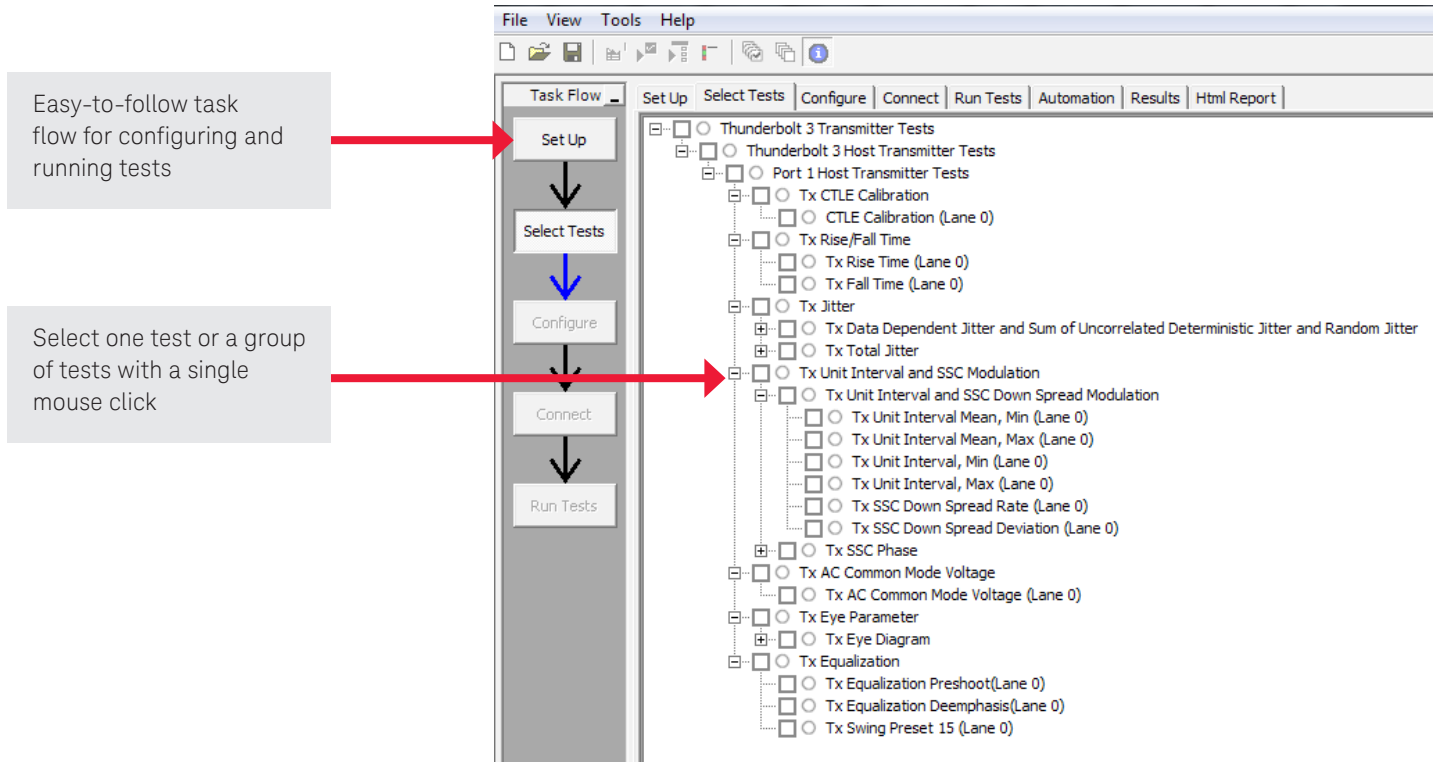


Figure 3. Thunderbolt application – select test tab.

## Configurability and Guided Connections

The Configure Tab provides flexibility in your test setup and oscilloscope settings used during tests. In configuring the tests, advanced users can specify changes to the test configuration to optimize test time versus coverage depending on validation requirements and testing goals.

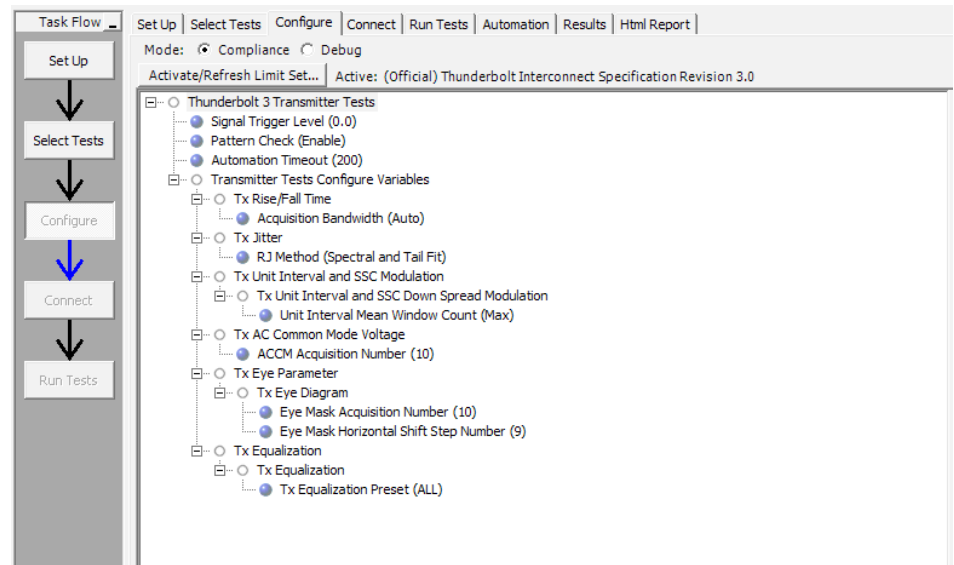


Figure 4. Thunderbolt application – configure tab.



## Reports with Margin Analysis

In addition to providing you with measurement results, The N6470B Thunderbolt electrical test software automates and provides a report format that shows you not only where your product passes or fails but also how close you are to the limits specified for a particular test parameter relative to the specification revision you are testing. 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 Thunderbolt Interconnect specification.

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

**Test Report**  
Overall Result: **PASS**

Test Configuration Details	
Device Description	
PresetNumber	P2
Bit Rate	20.625 GB/s
Specification version	Specification Rev 3.0
Test Lane Port 2	Both lanes
Test Lane Port 1	Lane 0 only
Port Number	1 Port
Port2 Name	Port 2
Port1 Name	Port 1
DUT Type	Host
Test Session Details	
Infiniium SW Version	05.60.00604
Infiniium Model Number	DSOX95004Q
Infiniium Serial Number	No Serial
Application SW Version	0.99.9022
Debug Mode Used	No
Compliance Limits (official)	Thunderbolt Interconnect Specification Revision 3.0
Bandwidth Limit	21.00 GHz
Last Test Date	2016-06-23 16:54:28 UTC -06:00

**Summary of Results**

Figure 5. Thunderbolt application – results HTML report.

Pass	# Failed	# Trials	Test Name	Actual Value	Margin	Pass Limits
①	0	1	<a href="#">Preset Calibration (Port 1, Lane 0)</a>			Pass/Fail
✓	0	1	<a href="#">1.2.1 Tx Rise Time (Port 1, Lane 0)</a>	21.043 ps	110.4 %	VALUE >= 10.000 ps
✓	0	1	<a href="#">1.2.2 Tx Fall Time (Port 1, Lane 0)</a>	21.161 ps	111.6 %	VALUE >= 10.000 ps
✓	0	1	<a href="#">1.2.3 Tx Sum of Uncorrelated Jitter (Port 1, Lane 0)</a>	158.6 mUI	48.8 %	VALUE <= 310.0 mUI
✓	0	1	<a href="#">1.2.4 Tx Sum of Uncorrelated Deterministic Jitter (Port 1, Lane 0)</a>	39.2 mUI	76.9 %	VALUE <= 170.0 mUI
①	0	1	<a href="#">CTLE Calibration (Port 1, Lane 0)</a>			Pass/Fail
✓	0	1	<a href="#">1.2.5 Tx Sum of Uncorrelated Jitter TP3EQ (Port 1, Lane 0)</a>	171.2 mUI	48.1 %	VALUE <= 330.0 mUI
✓	0	1	<a href="#">1.2.6 Tx Sum of Uncorrelated Deterministic Jitter TP3EQ (Port 1, Lane 0)</a>	39.2 mUI	76.9 %	VALUE <= 170.0 mUI
✓	0	1	<a href="#">1.1.5 Tx Total Jitter (Port 1, Lane 0)</a>	399.9 mUI	20.0 %	VALUE <= 500.0 mUI
✓	0	1	<a href="#">1.2.8 Tx Total Jitter TP3EQ (Port 1, Lane 0)</a>	536.0 mUI	18.8 %	VALUE <= 660.0 mUI
✓	0	1	<a href="#">1.2.9a Tx Unit Interval Mean_Min (Port 1, Lane 0)</a>	48.6067 ps	48.8 %	48.5917 ps <= VALUE <= 48.6210 ps
✓	0	1	<a href="#">1.2.9b Tx Unit Interval Mean_Max (Port 1, Lane 0)</a>	48.6068 ps	48.5 %	48.5917 ps <= VALUE <= 48.6210 ps
✓	0	1	<a href="#">1.2.10a Tx Unit Interval_Min (Port 1, Lane 0)</a>	48.4790 ps	3.2 %	48.4703 ps <= VALUE <= 48.7432 ps
✓	0	1	<a href="#">1.2.10b Tx Unit Interval_Max (Port 1, Lane 0)</a>	48.7339 ps	3.4 %	48.4703 ps <= VALUE <= 48.7432 ps
✓	0	1	<a href="#">1.2.11 Tx SSC Down Spread Rate (Port 1, Lane 0)</a>	36.550 kHz	22.5 %	35.000 kHz <= VALUE <= 37.000 kHz
✓	0	1	<a href="#">1.2.12 Tx SSC Down Spread Deviation (Port 1, Lane 0)</a>	513.7 m%	2.9 %	-30.0 m% <= VALUE <= 530.0 m%
✓	0	1	<a href="#">1.2.13 Tx SSC Phase Deviation (Port 1, Lane 0)</a>	15.524 ns	7.0 %	2.500 ns <= VALUE <= 16.500 ns
✓	0	1	<a href="#">1.2.14 Tx SSC Phase Slewing Rate (Port 1, Lane 0)</a>	2.743 ms/s	16.9 %	VALUE <= 3.300 ms/s
✓	0	1	<a href="#">1.2.16 Tx Eye Diagram (Port 1, Lane 0)</a>	Pass	100.0 %	Pass/Fail
✓	0	1	<a href="#">1.2.15 Tx AC Common Mode Voltage (Port 1, Lane 0)</a>	47.07 mV	52.9 %	VALUE <= ACCMLimitVar V
✓	0	1	<a href="#">1.2.17 Tx Eye Diagram TP3EQ (Port 1, Lane 0)</a>	Pass	100.0 %	Pass/Fail

Figure 6. Thunderbolt application – summary of test results.



## 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 Thunderbolt. The Type-C environment setup is initiated by selection of 'Enable TCTC' shown at the 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 Thunderbolt functionality from a Type-C device, it must be put into the Thunderbolt alternate mode. Alternate mode setting is chosen in the Type-C setup screen in the Thunderbolt Transmitter Compliance Test software.

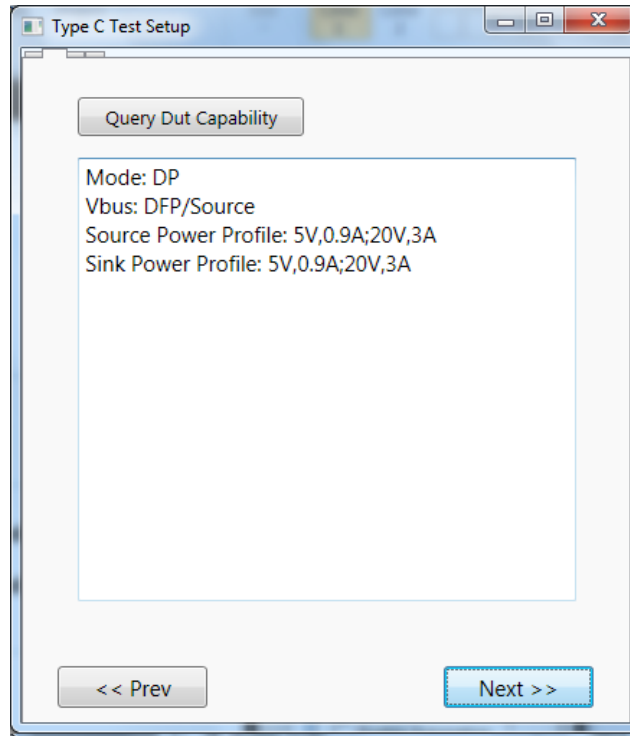


Figure 7. Type-C Setup: Device is queried for PDO capability.

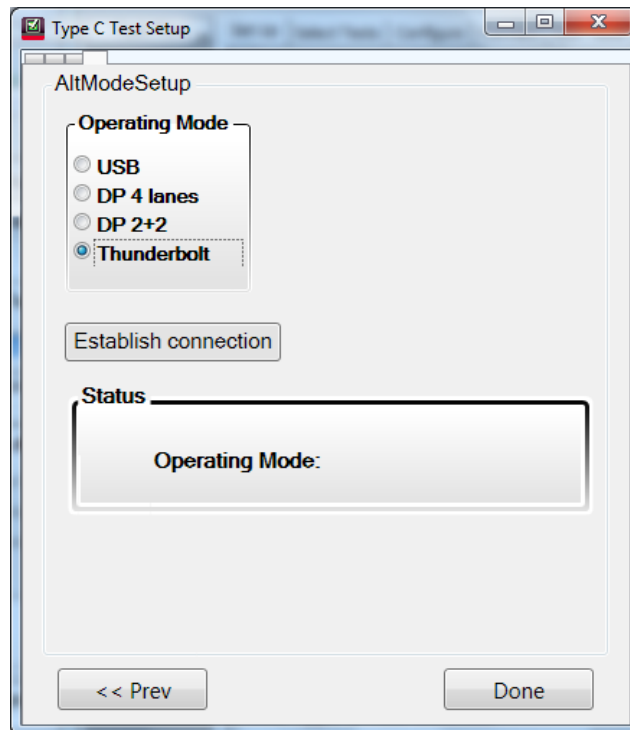


Figure 8. Type-C Setup: Device mode control setting.



## Extensibility

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

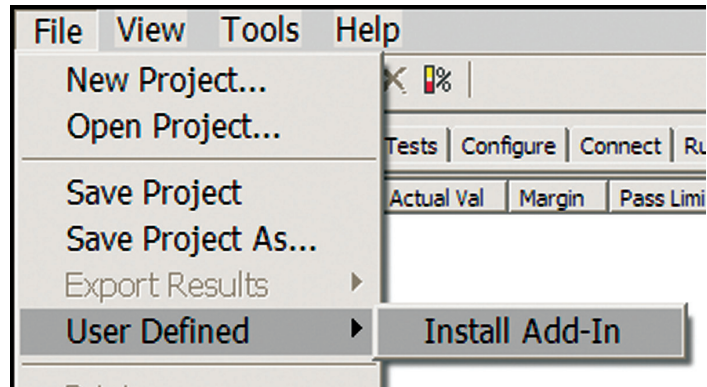


Figure 9. Importing a UDA Add-In into your test application.

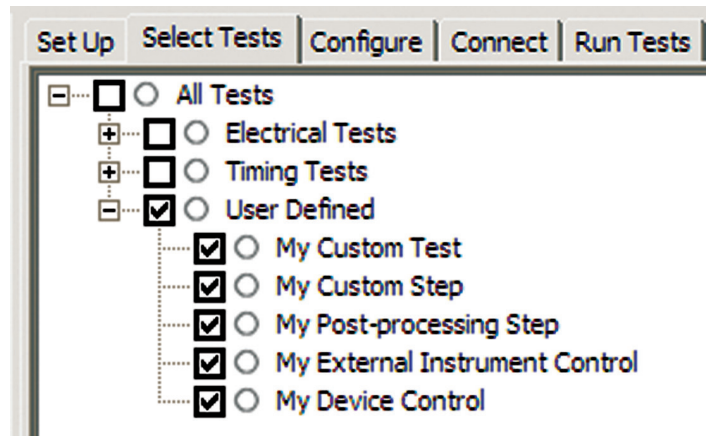


Figure 10. UDA Add-In tests and utilities in your test application.





## 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](http://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.

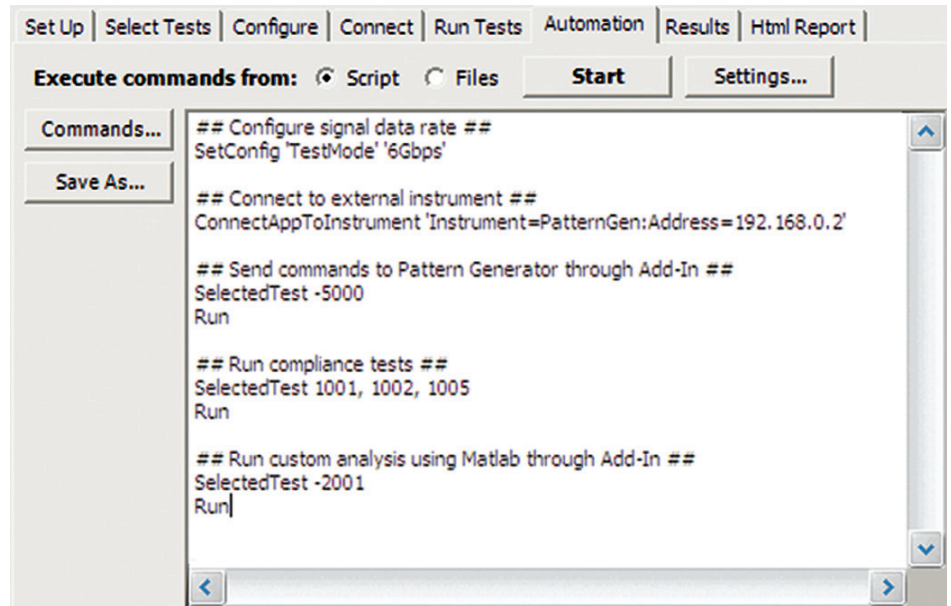


Figure 9. Remote Programming script in the Automation tab.

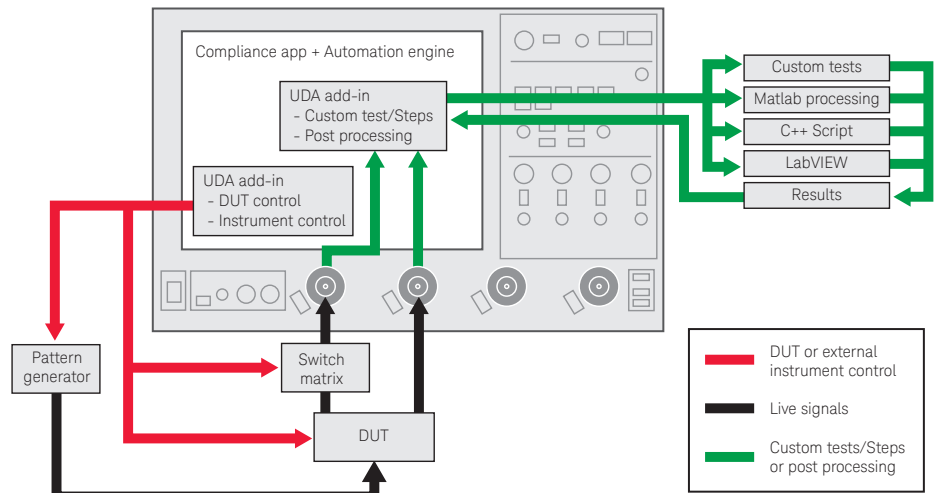


Figure 10. Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive.



## Oscilloscope Compatibility

The N6470B Thunderbolt 3 electrical test software is compatible with V- and Z-Series oscilloscopes with operation software revision 5.60 or higher. Oscilloscope bandwidth must be a minimum of 25 GHz.

Data rate	Recommended oscilloscope	Bandwidth of recommended oscilloscope
20.625 Gb/s	Infiniium V or Z Series	25 GHz or higher

## Ordering Information

You can order the N6470B as an option to your oscilloscope hardware purchase or as a separate software product. The N6470B Thunderbolt 3 electrical test software supports testing for Thunderbolt devices and hosts.

Table 1. Required SW applications.

Application	License type		Infiniium Z/V Series
Thunderbolt 3 transmitter compliance software	Fixed	Factory-installed	N6470B-1FP
		User-installed	N6470B-1FP
	Floating	Transportable	N6470B-1TP
		Server based	N5435A-104
EZJIT+ jitter analysis software	Fixed	Factory-installed	N5400A-1FP
		User-installed	N5400A-1FP
	Floating	Transportable	N5400A-1TP
		Server based	N5435A-001
Equalization emulation software	Fixed	Factory-installed	N5461A-1FP
		User-installed	N5461A-1FP
	Floating	Transportable	N5461A-1TP
		Server based	N5435A-025
InfiniiSim advanced waveform transformation software	Fixed	Factory-installed	N5465A-1FP
		User-installed	N5465A-1FP
	Floating	Transportable	N5465A-1TP
		Server based	N5435A-027
Serial data analysis/mask testing with clock recovery	Fixed	Factory-installed	E2688A-1FP
		User-installed	E2688A-1FP
	Floating	Transportable	E2688A-1TP
		Server based	N5435A-003

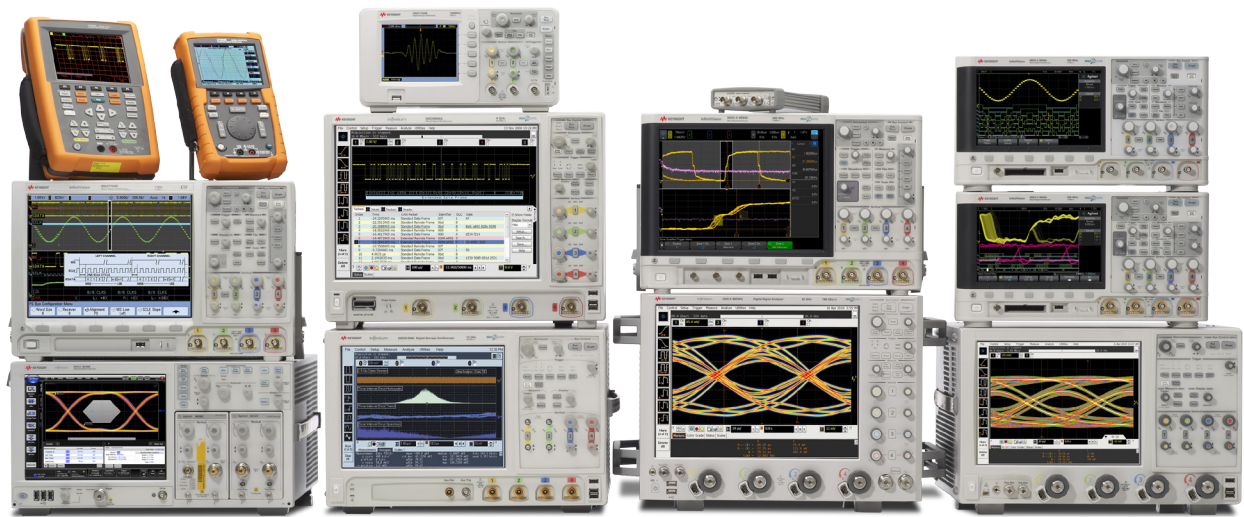
1. Requires Infiniium oscilloscope software 5.00 and above.
2. Systems running Windows 7 require Infiniium 4.60; systems running XP require Infiniium 4.20.



## 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 2 optional	Power supply/Power Load for arbitrary PDOs
N9398C	DC Blocking Capacitors	2 minimum 4 recommended	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
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



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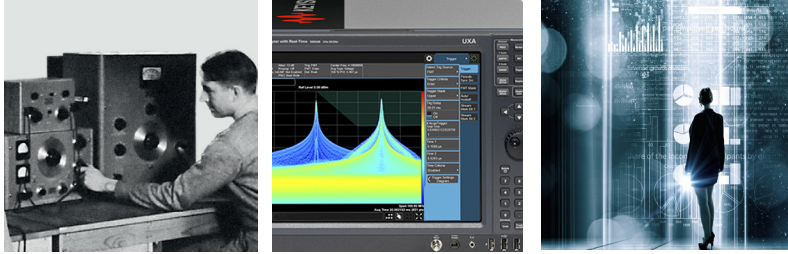
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