



# Agilent Technologies U7236A 10GBASE-T Ethernet Electrical Conformance Application for Infiniium Oscilloscopes

## U7237A 10GBASE-T Transmitter Electrical Test Fixture

### Data Sheet

#### Fast and accurate 10GBASE-T design validation and debug

The Agilent Technologies U7236A 10GBASE-T Ethernet electrical conformance application for Infiniium oscilloscopes provides you with a fast and accurate way to verify and debug your 10GBASE-T Ethernet designs. The 10GBASE-T Ethernet electrical test software allows you to automatically execute 10GBASE-T Ethernet physical medium attachment (PMA) physical-layer (PHY) electrical tests, 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.

To make 10GBASE-T measurements with the U7236A Ethernet electrical conformance test software, you also need the Agilent U7237A Ethernet electrical conformance test fixture. The U7237A test fixture gives you easy access to confidently probe 10GBASE-T devices by bringing the signals from the RJ-45 connector out to the SMP connectors. SMP-to-SMA cables and other accessories are supplied to connect to the test instrument inputs.



The U7236A 10GBASE-T Ethernet electrical test software performs a wide range of electrical tests required to meet the Ethernet electrical specifications for 10GBASE-T, as documented in the IEEE 802.3 an-2006 standard. To meet signal quality requirements, your product should

successfully pass conformance testing based on these specifications. Performing these tests gives you confidence in your design. The U7236A 10GBASE-T Ethernet electrical test software helps you execute a wide subset of the conformance tests using an oscilloscope, spectrum analyzer and vector network analyzer.



## Features

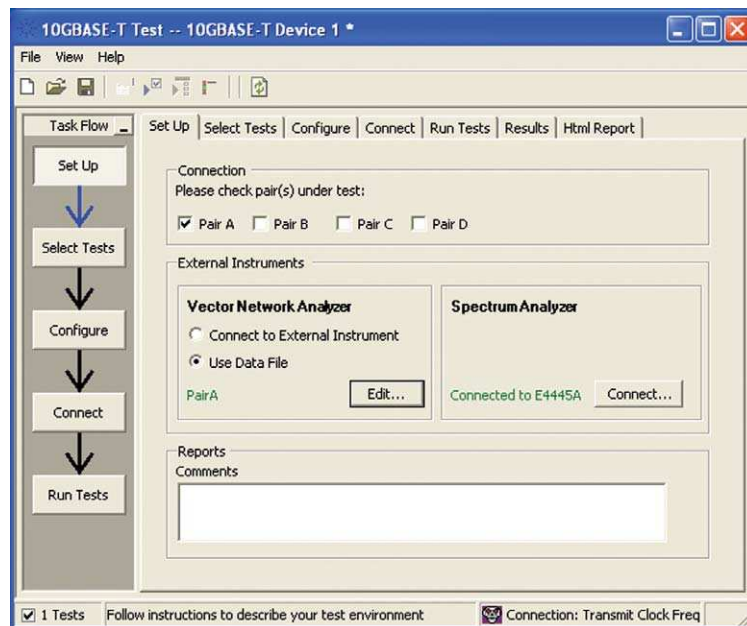
The U7236A 10GBASE-T Ethernet electrical test software offers several features to simplify the validation of Ethernet designs:

- Complete coverage of the 10GBASE-T transmitter electrical specifications as described in section 55.5.3 of IEEE 802.3an-2006.
- Accurate return loss testing performed with a supported Agilent vector network analyzer
- Automated measurement setup and programming of oscilloscope, spectrum analyzer and vector network analyzer for increased accuracy, time-savings and repeatability.
- Automated test engine with extremely user-friendly interface, allowing you to set up instruments and select and configure tests to be run, resulting in a comprehensive report of test results with margin analysis.

## U7236A saves you time

The U7236A software and U7237A fixture will save you time by setting the stage for automatic execution of 10GBASE-T Ethernet electrical tests. Part of the difficulty of performing the 10GBASE-T electrical tests is to properly set up and configure the oscilloscope, spectrum analyzer, and vector network analyzer that are used to make the required measurements. This is a time-consuming task; the U7236A takes care of the instrument control and configures the oscilloscope,

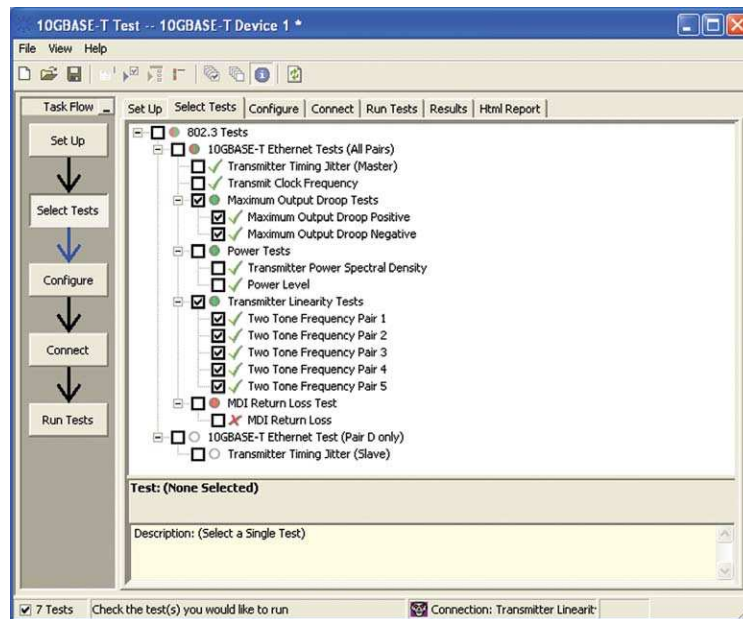
spectrum analyzer, or vector network analyzer as needed by each test to provide rapid, accurate, and repeatable test execution. See Tables 4 and 5 for the lists of supported spectrum analyzers and network analyzers. In addition, if you discover a problem with your product, debug tools in the oscilloscope are available to aid in root-cause analysis. See Table 1 for a complete list of the measurements that you can make with the U7236A software and U7237A test fixture.



**Figure 1. The clean interface of the setup page enables you to quickly make decisions and perform functions that affect the testing task. This is where you select the output pairs of the device under test and set up your additional instruments.**

## Easy test definition

The U7236A 10GBASE-T Ethernet electrical test software extends the ease-of-use advantages of Agilent's Infiniium oscilloscopes to testing 10GBASE-T Ethernet. The software installs and runs on the oscilloscope and provides you with a clean interface to quickly connect to the spectrum analyzer and vector network analyzer you are using for the tests. It then guides you quickly through the steps required to define and configure the tests, execute the tests, and view the test results. A setup page enables you to quickly make decisions from the outset regarding the choice of tests and perform functions that affect the testing task. The test selections available in the following steps are then filtered according to the choices made in the setup page. While selecting 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 for quick testing and review of previous test results. Straightforward menus let you perform tests with a minimum of mouse clicks.



**Figure 2. The Agilent automated test engine guides you quickly through selecting and configuring tests, setting up the connection, running the tests, and viewing the results. You can easily select individual tests or groups of tests with a mouse-click.**

## Configurability and guided connections

The U7236A 10GBASE-T Ethernet electrical test software provides flexibility in your test setup. It guides you to make connection changes with hookup diagrams when the tests you select require it. All 10GBASE-T Ethernet electrical tests you perform are based on the Agilent U7237A 10GBASE-T Ethernet electrical test fixture. You connect the oscilloscope to the test fixture using the supplied pair of SMP (female) to SMA (male) phase-matched cables. For additional instruments such as the spectrum analyzer, or the vector network analyzer for return loss measurements, the U7236A will guide you through the connections with detailed instructions and diagrams. The spectrum analyzer and vector network analyzer are controlled through the Agilent IO Libraries and therefore can be linked to the scope through a USB-to-GPIB connection or through the LAN.

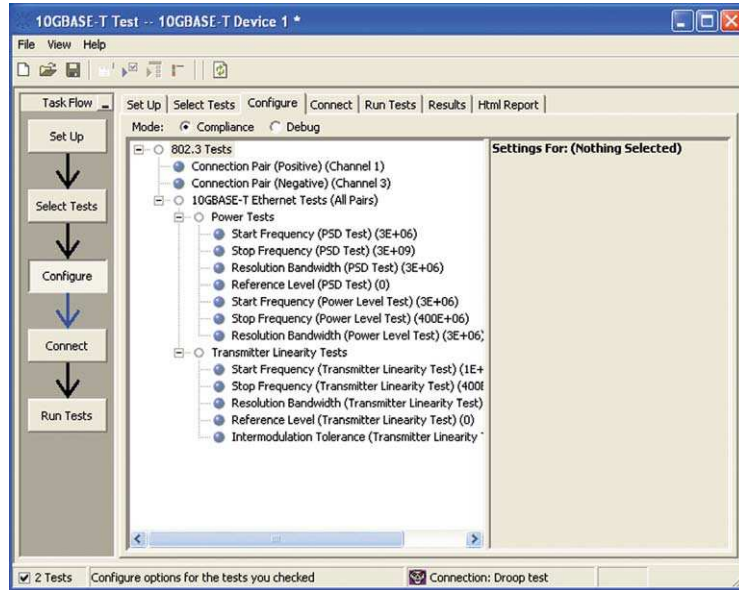


Figure 3. The configure page allows you to control additional test parameters.

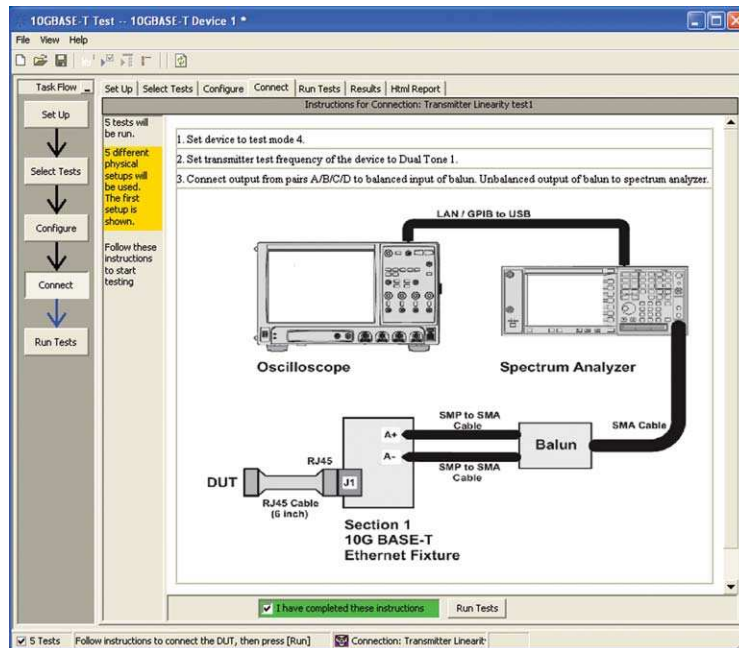
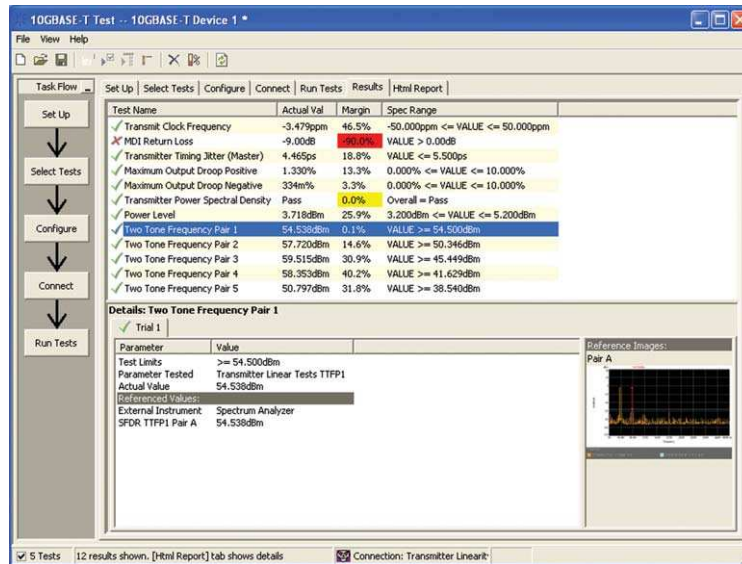


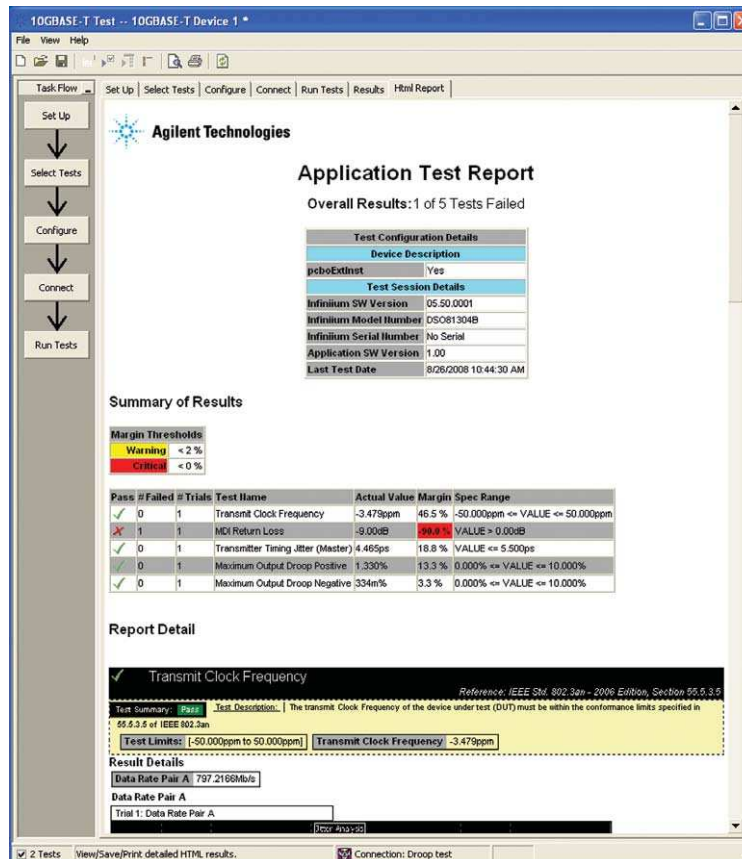
Figure 4. When you make multiple tests where the connections must be changed, the software prompts you with connection diagrams.

## Reports with margin analysis

In addition to providing you with measurement results, the U7236A 10GBASE-T Ethernet electrical test software provides a report format that shows you where your product passes or fails and reports how close you are to the limits specified for a particular test. 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 10GBASE-T Ethernet specification.



**Figure 5.** The 10GBASE-T Ethernet electrical test software results screen shows a summary of the tests performed, pass/fail status, and margin. Clicking on a specific test also shows the test specification and a measurement waveform, if appropriate.



**Figure 6.** The 10GBASE-T Ethernet electrical test software HTML report documents your test, indicates the pass/fail status, the test specification range, the measured values, and the margin.

## Extensibility

You may add additional custom tests or steps to your application using the N5467A User Defined Application (UDA) development tool ([www.agilent.com/find/uda](http://www.agilent.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

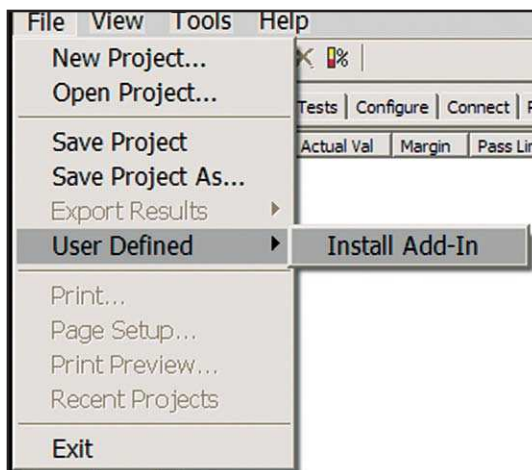


Figure 7. Importing a UDA Add-In into your test application.

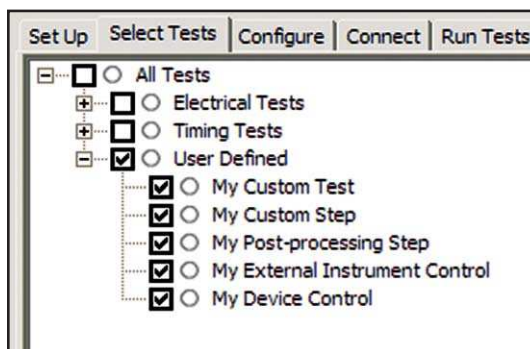


Figure 8. UDA Add-In tests and utilities in your test application.

## 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.agilent.com/find/scope-apps-sw](http://www.agilent.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.

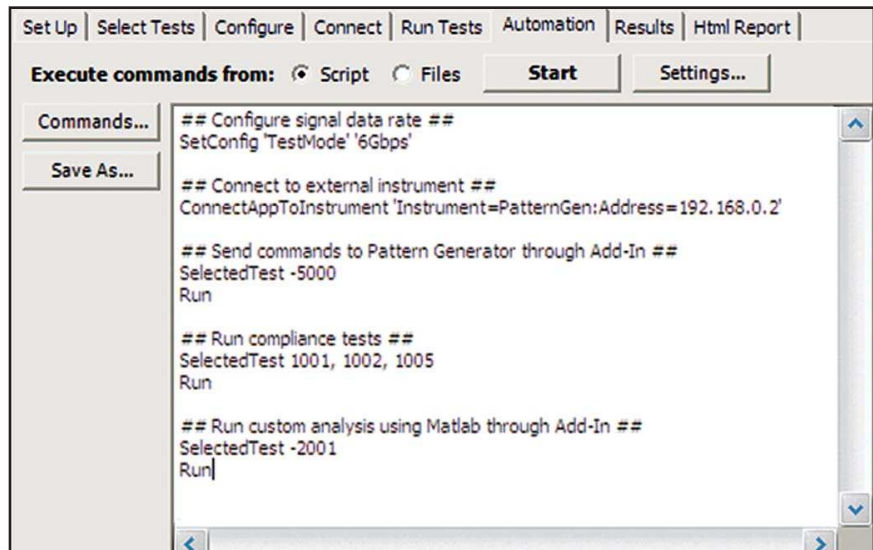


Figure 9. Remote Programming script in the Automation tab.

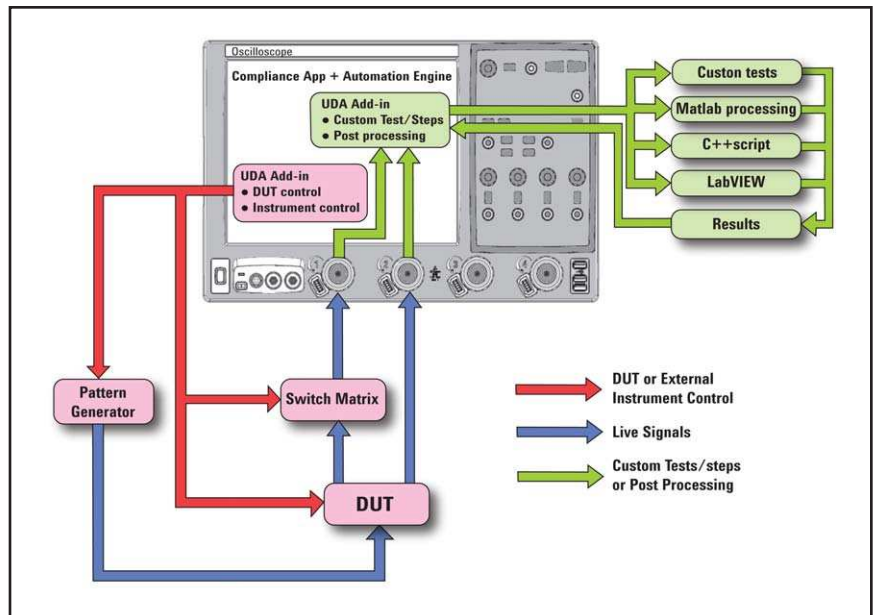


Figure 10. Combine the power of built-in automation and extensibility to transform your application into a complete test suite executive.

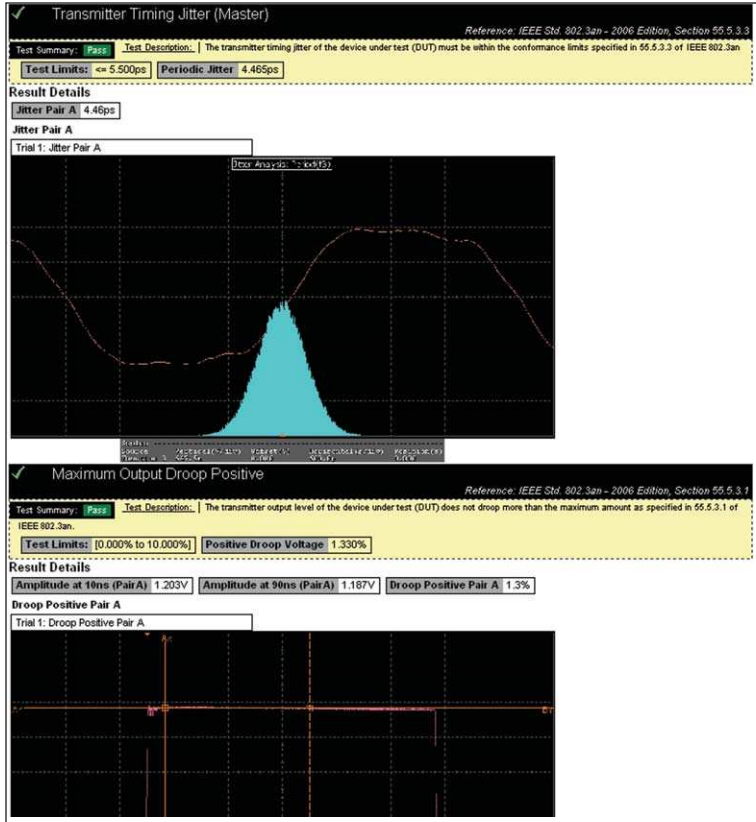


Figure 11. Additional details are available for each test, including the test limits, test description, and test results, including waveforms, if appropriate.

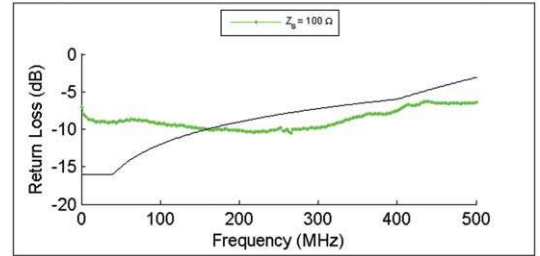
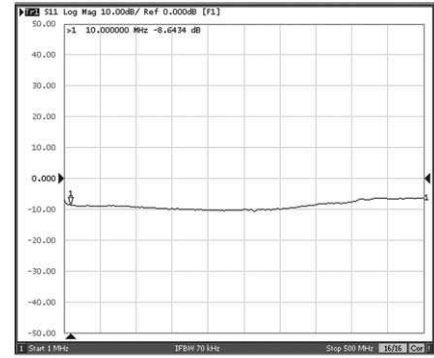


Figure 13. Make accurate and repeatable return loss measurements with a supported Agilent vector network analyzer for confident correlation to the standards. The U7236A software helps you to acquire the measurement data from your network analyzer and perform the necessary calculations.

Summary of Results

Pass	# Failed	# Trials	Test Name	Actual Value	Margin	Spec Range
✓	0	1	Transmit Clock Frequency	-3.479ppm	46.5 %	-50.000ppm $\leq$ VALUE $\leq$ 50.000ppm
✗	1	1	MDI Return Loss	-9.00dB	-90.0 %	VALUE > 0.00dB
✓	0	1	Transmitter Timing Jitter (Master)	4.465ps	18.8 %	VALUE $\leq$ 5.500ps
✓	0	1	Maximum Output Droop Positive	1.330%	13.3 %	0.000% $\leq$ VALUE $\leq$ 10.000%
✓	0	1	Maximum Output Droop Negative	334m%	3.3 %	0.000% $\leq$ VALUE $\leq$ 10.000%
✓	0	1	Transmitter Power Spectral Density	Pass	0.0 %	Overall = Pass
✓	0	1	Power Level	3.718dBm	25.9 %	3.200dBm $\leq$ VALUE $\leq$ 5.200dBm
✓	0	1	Two Tone Frequency Pair 1	54.538dBm	0.1 %	VALUE $\geq$ 54.500dBm
✓	0	1	Two Tone Frequency Pair 2	57.720dBm	14.6 %	VALUE $\geq$ 50.346dBm
✓	0	1	Two Tone Frequency Pair 3	59.515dBm	30.9 %	VALUE $\geq$ 45.449dBm
✓	0	1	Two Tone Frequency Pair 4	58.353dBm	40.2 %	VALUE $\geq$ 41.629dBm
✓	0	1	Two Tone Frequency Pair 5	50.797dBm	31.8 %	VALUE $\geq$ 38.540dBm

Figure 12. How close your device comes to passing or failing a test is indicated as a % in the margin field. A result highlighted in yellow or red indicates that your device has tripped the margin threshold level for a warning or failure).

## Tests performed

The U7236A 10GBASE-T Ethernet electrical performance validation and conformance software performs the following tests as per the IEEE 802.3an-2006 standard. The target test device must be able to provide the test modes as described in 55.5.2 of the standard in order to be tested.

Standard reference	Description
IEEE 802.3an-2006 Subclause 55.5.3.1	Maximum output droop
IEEE 802.3an-2006 Subclause 55.5.3.2	Transmitter linearity
IEEE 802.3an-2006 Subclause 55.5.3.3	Transmitter timing jitter
IEEE 802.3an-2006 Subclause 55.5.3.4	Transmitter power spectral density (PSD) and power level
IEEE 802.3an-2006 Subclause 55.5.3.5	Transmit clock frequency
IEEE 802.3an-2006 Subclause 55.8.2.1	MDI return loss

**Table 1: Electrical tests for 10GBASE-T performed by the U7236A software**

## Oscilloscope compatibility

The U7236A 10GBASE-T Ethernet conformance test software will run on several models of Agilent's Infiniium oscilloscopes with version 3.01 or higher

Recommended Agilent oscilloscope	Bandwidth of recommended oscilloscope
DSO/DSA90254A, MSO/DSO9254A	2.5 GHz
DSO/DSA90404A, MSO/DSO9404A	4 GHz
DSO/DSA90604A	6 GHz
DSO/DSA90804A	8 GHz
DSO/DSA91204A	12 GHz
DSO/DSA91304A	13 GHz
DSO/DSA-X 91604A	16 GHz
DSO/DSA-X 92504A	25 GHz
DSO/DSA-X 93204A	32 GHz

**Table 2: Recommended Oscilloscopes**

## Supported spectrum analyzers

Spectrum analyzers are used for some of the 10GBASE-T electrical tests, and those supported by the U7236A are listed below:

Supported Agilent spectrum analyzer	Description
N9020A	MXA midrange signal analyzer with frequency range options of 20 Hz to 3.6 GHz, 8.4 GHz, 13.6 GHz, or 26.5 GHz. The N9068A (phase noise measurement application) is a recommended add-on for advanced jitter analysis.
N9010A	EXA economy signal analyzer with frequency range options of 9 kHz to 3.6 GHz, 7.0 GHz, 13.6 GHz, or 26.5 GHz. The N9068A (phase noise measurement application) is a recommended add-on for advanced jitter analysis.
E4440/3/5/6/7/8A	PSA Series performance spectrum analyzer with frequency range of 3 Hz to 26.5 GHz, 6.7 GHz, 13.2 GHz, 44 GHz, 42.98 GHz, or 50 GHz. Option 226 (phase noise measurement personality) is recommended for advanced jitter analysis.
E4402/4/5/7B	ESA-E Series mid-performance spectrum analyzer with frequency range of 9 kHz to 3.0 GHz, 6.7 GHz, 13.2 GHz, or 26.5 GHz. Option 226 (Phase noise measurement personality) is recommended for advanced jitter analysis.
E4403/8B	ESA-L Series low-cost economy spectrum analyzers for basic analysis with frequency range of 9 kHz to 3.0 GHz or 26.5 GHz. These are for basic analysis only and are not recommended if advanced analysis capability is desired.

**Table 3: Supported spectrum analyzers**

## Vector network analyzers for return loss testing

The current Agilent vector network analyzers listed below are supported for return loss testing. Models listed below must be in the configuration where it can support 50 Ohms measurements in the 1-MHz to 500-MHz frequency range.

Supported Agilent vector network analyzer	Description
E5061x/62x/70x/71x	ENA Series network analyzers
4395A/96B	Combination analyzers
N5230A	PNA-L Series general-purpose network analyzer with start frequency range of 300 kHz
8752x/53x	S-parameter network analyzer [discontinued]. Supported for legacy reasons.

**Table 4: Supported vector network analyzers**

As an alternative, the U7236A software also allows you to use data files as inputs for return loss testing. These data files are saved forward reflection or S11 traces from your vector network analyzer in TouchStone or CITIFile format and should contain information in the 1-MHz to 500-MHz frequency range.

# U7237A 10GBASE-T transmitter electrical test fixture

The U7237A fixture is designed to provide functionality as described in IEEE 802.3an-2006 Subclause 55.5.2.1.

U7237A contents	Quantity	Description
10GBASE-T Ethernet test fixture PCA	1	Main test fixture PCA divided into 3 sections. <ul style="list-style-type: none"> <li>• Section 1: RJ-45 receptacle to SMP (male) connectors</li> <li>• Section 2: Slave jitter test circuitry as described in Figure 55-30 of IEEE 802.3an-2006</li> <li>• Section 3: RJ-45 short, open, and load used for return loss calibration. This section is designed to be easily separated from the main fixture PCA for use.</li> </ul>
Precision instrumentation balun	1	300-kHz to 3-GHz balun used with Section 1 of the main fixture PCA for the transmitter linearity, PSD, power level, and return loss tests
Shielded patch cord with RJ-45 plugs	2	8-inch cable to connect the DUT to the test fixture. Second cable used to connect master device during slave jitter test.
Phase-matched SMP (female) to SMA (male) cable pair (16 inch)	1	This pair of cables is used to connect from each of the SMP (male) output pairs of the main fixture PCA to the oscilloscope or balun inputs.
50 Ω terminator SMP (female)	6	These are used to terminate the unused pairs of Section 1.

Table 5: Fixture description

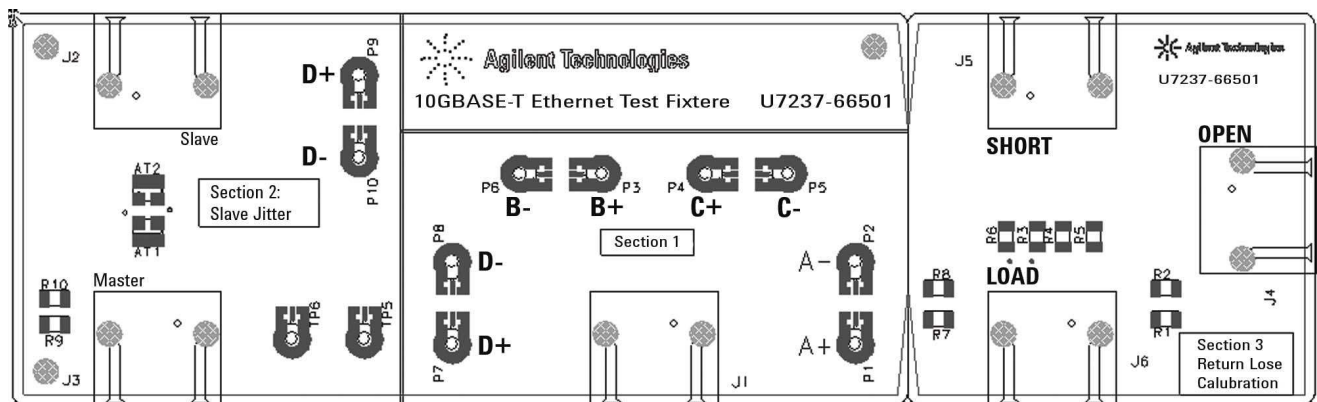


Figure 14. Top-view of the main U7237A 10GBASE-T test fixture PCA

## Ordering information

The following products are used in the total solution for 10GBASE-T Ethernet testing with the U7236A.

Model number	Description
U7236A	10GBASE-T Ethernet electrical conformance application for Infiniium oscilloscopes
U7237A	10GBASE-T transmitter electrical test fixture
Oscilloscope	Supported Infiniium oscilloscope from Table 2 or 3
Spectrum analyzer	Supported spectrum analyzer from Table 4
Vector network analyzer	Supported vector network analyzer from Table 5
82357A/B	USB/GPIB interface adapter

Additional accessories	
10833D	GPIB cable, 0.5 meter (other lengths available, check with your Agilent representative)
N4235-61604	Phase-matched SMP (female) to SMA (male) cable pair (1 m). Order if longer cable lengths are desired.

**Table 6: Product ordering information for 10GBASE-T electrical transmitter testing**



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