Agilent Technologies N5392A Ethernet Electrical Performance Validation and Conformance Software for Infiniium Oscilloscopes

N5395B Ethernet Electrical Conformance Test Fixture

N5396A Gigabit Ethernet Jitter Test Cable

Data Sheet

Easy and accurate Ethernet design validation and debug

The Agilent Technologies N5392A Ethernet electrical performance validation and conformance software for Infiniium oscilloscopes provides you with an easy and accurate way to verify and debug your 1000BASE-T, 100BASE-TX and 10BASE-T Ethernet designs. The Ethernet electrical test software allows you to automatically execute Ethernet 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 1000BASE-T, 100BASE-TX and 10BASE-T measurements with the N5392A Ethernet electrical test software, you also need the Agilent N5395B Ethernet electrical conformance test fixture. If you want to make 1000BASE-T jitter measurements, you also need the Agilent N5396A Gigabit Ethernet jitter test cable. In addition, you can use Agilent 33250A arbitrary waveform generators as disturbing signal sources and choose from a variety of Agilent vector network analyzers to make your return loss measurements.

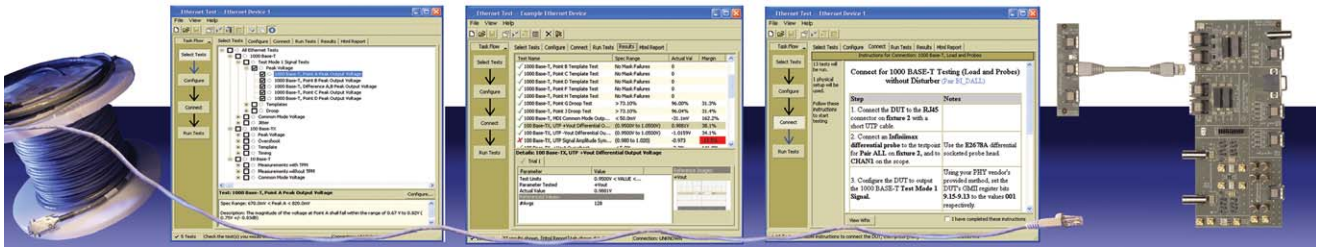
The N5392A Ethernet electrical test software performs a wide range of electrical tests required to meet the Ethernet electrical specifications for 1000BASE-T, 100BASE-TX and 10BASE-T systems as documented in the IEEE 802.3-2005 and ANSI X3.263-1995 standards. To meet signal quality requirements, your product must successfully pass conformance testing based on these specifications. Performing these tests gives you confidence in your design. The N5392A Ethernet electrical test software helps you execute a wide subset of the conformance tests that can be measured with an oscilloscope.

Features

The N5392A Ethernet electrical test software offers several features to simplify the validation of Ethernet designs:

- Setup wizard for quick and clear setup, configuration and test
- Wide range of 1000BASE-T, 100BASE-TX and 10BASE-T tests enabling standards conformance
- Disturbing signal support for 1000BASE-T Test Mode 1 and 4 tests
- Accurate and repeatable results with Agilent Infiniium oscilloscopes
- Accurate return loss measurements with supported Agilent vector network analyzers
- Automated reporting in a comprehensive HTML format with margin analysis

With the Ethernet electrical test software, you can use the same oscilloscope you use for everyday debugging to perform automated testing and margin analysis based on the Ethernet-standards.



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N5392A software saves you time

The N5392A Ethernet electrical test software saves you time by setting the stage for automatic execution of Ethernet electrical tests. Part of the difficulty of performing electrical tests for Ethernet is properly connecting to the oscilloscope, loading the proper setup files, and then analyzing the measured results by comparing them to limits published in the specification. The Ethernet electrical test software does much of this work for you.

The N5392A Ethernet electrical test 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. See Tables 3 to 5 for a complete list of the measurements made by the Ethernet electrical test software.

Easy test definition

The N5392A Ethernet electrical test software extends the ease-of-use advantages of Agilent's Infiniium oscilloscopes to testing Ethernet designs. The Agilent automated test engine walks you quickly through the steps required to define the tests you want to make, set up the tests, perform 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.

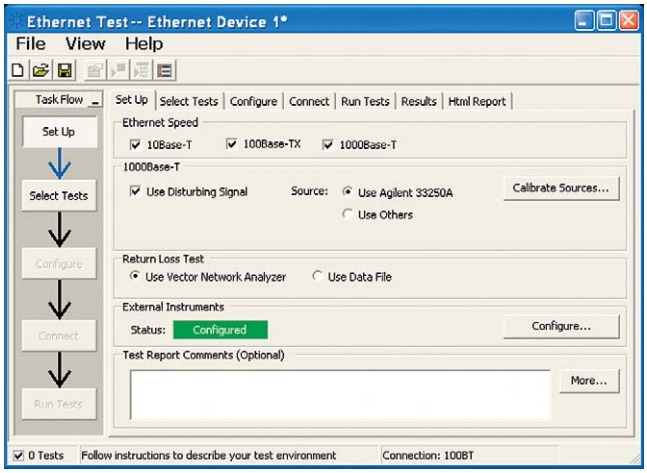


Figure 1. The clean interface of the setup page enables you to quickly make decisions and perform functions that affect the testing task.

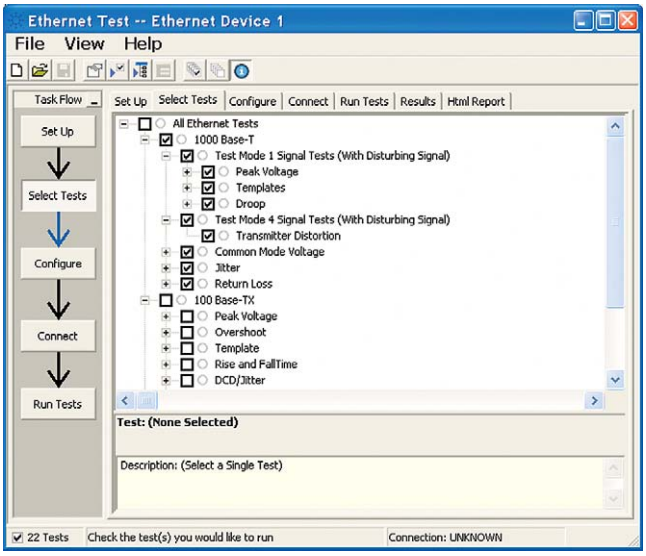


Figure 2. The Agilent automated test engine guides you quickly through selecting and configuring tests, setting up the connection, running the tests, and viewing the results. You can easily select individual tests or groups of tests with a mouse-click.

Configurability and guided connections

The N5392A 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 Ethernet electrical conformance tests you perform are based on the Agilent N5395B Ethernet electrical conformance test fixture and N5396A Gigabit Ethernet jitter test cable. You connect the oscilloscope to the conformance test fixture using Agilent InfiniiMax active differential probes, SMA cables and BNC cables. Even when you use additional instruments such as the arbitrary waveform generator as the disturbing signal source, or the vector network analyzer for return loss measurements, the N5392A will guide you through the connections with detailed instructions and diagrams.

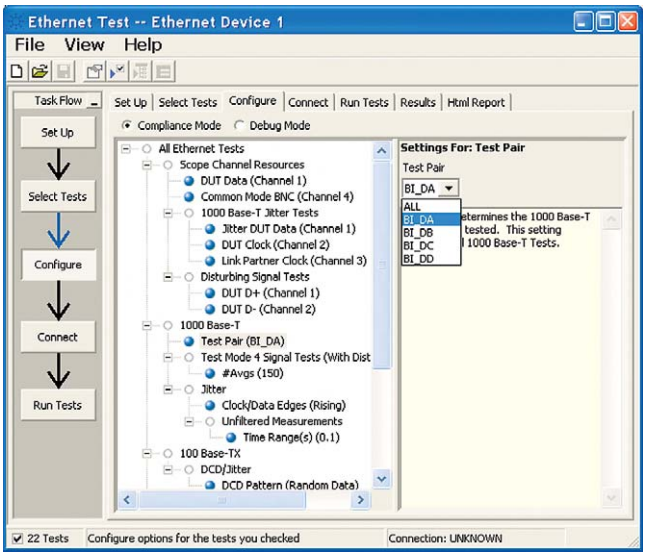


Figure 3. To set up tests, you define the device to test, its configuration, and how the oscilloscope is connected to it.

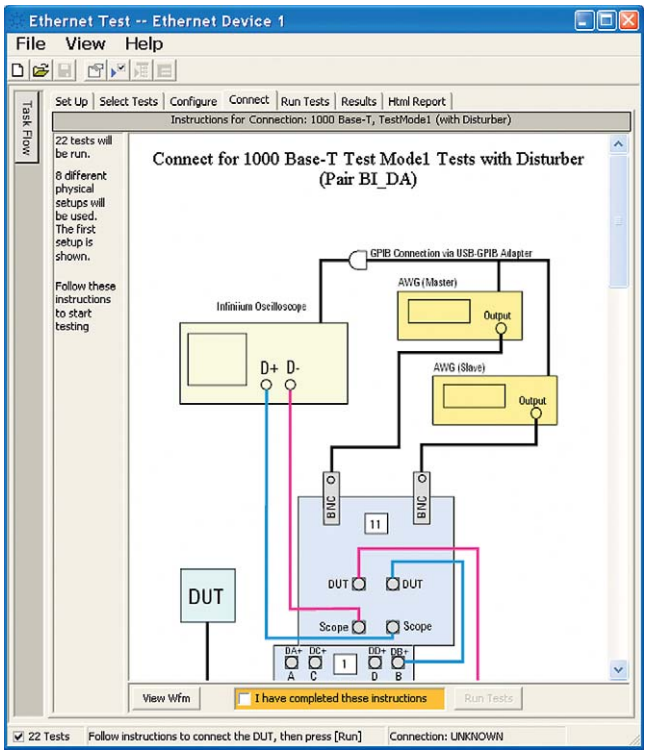


Figure 4. When you make multiple tests where the connections must be changed, the software prompts you with connection diagrams.

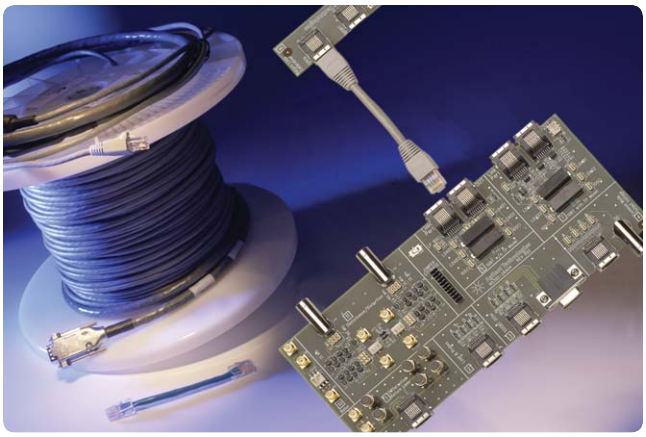


Figure 5. The N5395B Ethernet electrical conformance test fixture and N5396A Gigabit Ethernet jitter test cable.

Reports with margin analysis

In addition to providing you with measurement results, the N5392A Ethernet electrical test 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. 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 Ethernet specification.

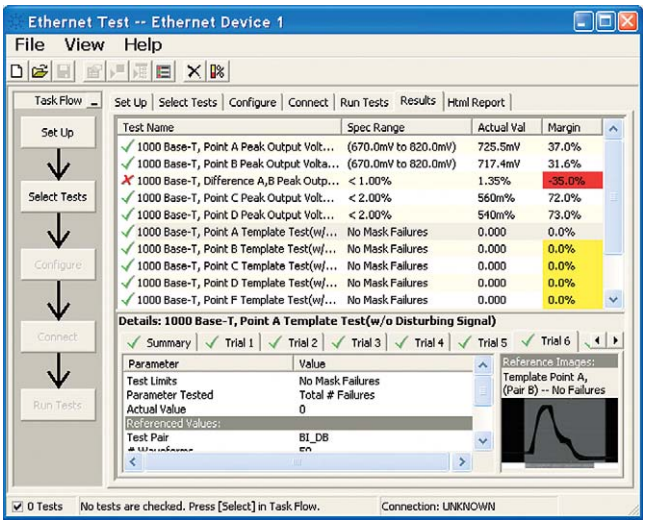


Figure 6. The Ethernet electrical test software results screen shows a summary of the tests performed, pass/fail status, and margin. Clicking on a specific test also shows the test specification and a measurement waveform, if appropriate.

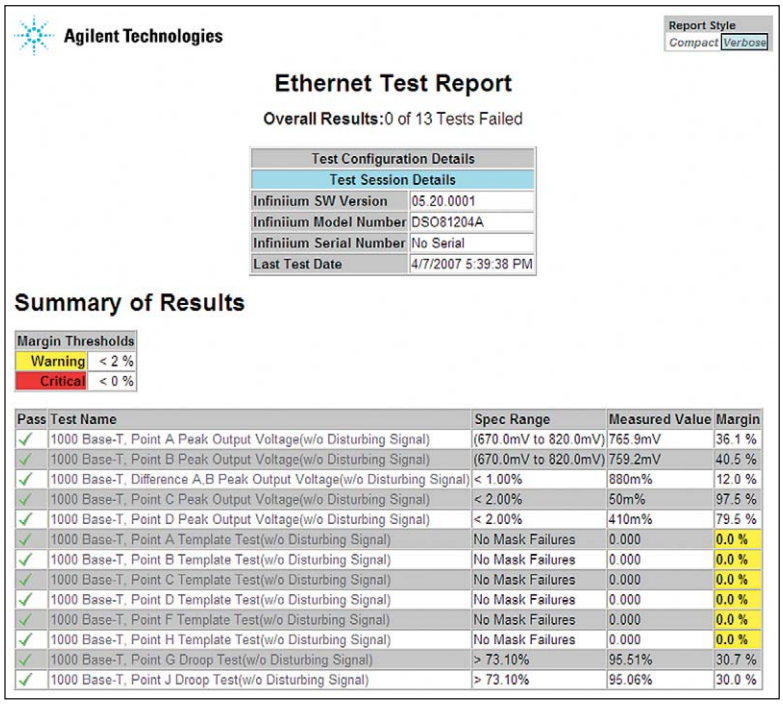


Figure 7. The Ethernet electrical test software HTML report documents your test, indicates the pass/fail status, the test specification range, the measured values, and the margin.

Reports with margin analysis (continued)

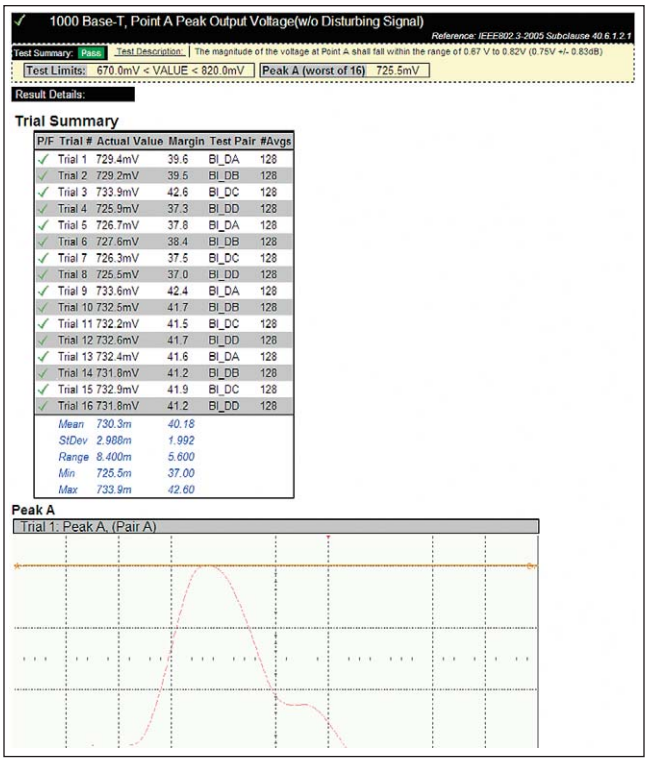


Figure 8. Additional details are available for each test, including the test limits, test description, and test results, including waveforms, if appropriate.

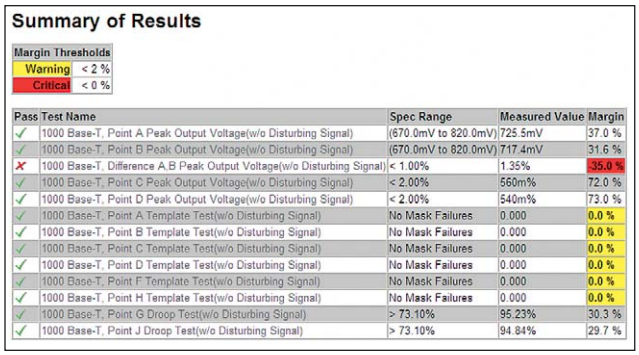


Figure 9. How close your device comes to passing or failing a test is indicated as a % in the margin field. A result highlighted in yellow or red indicates that your device has tripped the margin threshold level for a warning or failure.

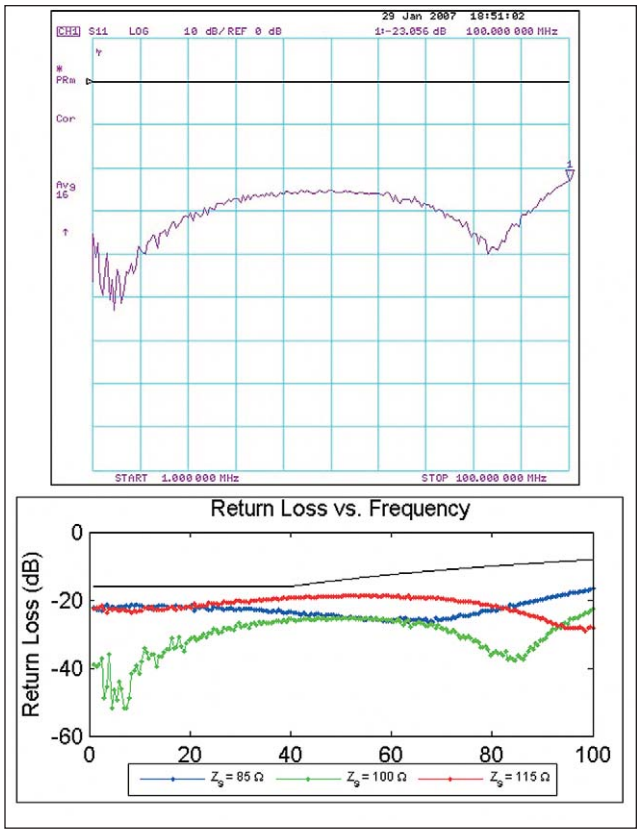


Figure 10. Make accurate and repeatable return loss measurements with a supported Agilent vector network analyzer for confident correlation to the standards. The N5392A software helps you to acquire the measurement data from your network analyzer and perform the necessary calculations.

Oscilloscope compatibility

The N5392A Ethernet Conformance software will run on:
- 8000 Series, version 5.2 or higher
- 9000 Series, version 1.0 or higher
- 90000 Series, version 1.0A or higher

These are shown in Table 1 below with minimum recommended bandwidth model and probes shown. For oscilloscopes with earlier software revisions, upgrade software is available at **http://www.agilent.com/find/infiniium_software**.

Data rate	Standard	Recommended oscilloscope	Bandwidth of recommended oscilloscope	Recommended probe	Bandwidth of recommended probe
10 Mb/s, 100 Mb/s	10BASE-T, 100BASE-TX	DSO/MSO8064A	600 MHz	1130A	1.5 GHz
		DSO/MSO8104A	1 GHz	1130A	1.5 GHz
		DSO/MSO9064A	600 MHz	1130A	1.5 GHz
		DSO/MSO9104A	1 GHz	1130A	1.5 GHz
		DSO/DSA90254A	2.5 GHz	1131A	3.5 GHz
		DSO/DSA90404A	4 GHz	1132A	5 GHz
		DSO/DSA90604A	6 GHz	1134A	7 GHz
		DSO/DSA90804A	8 GHz	1168A	10 GHz
		DSO/DSA91204A	12 GHz	1169A	12 GHz
		DSO/DSA91304A	13 GHz	1169A	12 GHz
Gigabit Ethernet (4x250 Mb/s)	1000BASE-T	DSO/MSO8104A	1 GHz	1130A	1.5 GHz
		DSO/MSO9254A	2.5 GHz	1131A	3.5 GHz
		DSO/DSA90254A	2.5 GHz	1131A	3.5 GHz
		DSO/MSO9404A	4 GHz	1132A	5 GHz
		DSO/DSA90404A	4 GHz	1132A	5 GHz
		DSO/DSA90604A	6 GHz	1134A	7 GHz
		DSO/DSA90804A	8 GHz	1168A	10 GHz
		DSO/DSA91204A	12 GHz	1169A	12 GHz
		DSO/DSA91304A	13 GHz	1169A	12 GHz

Table 1. Recommended oscilloscopes and active probes

Tests performed

The N5392A Ethernet electrical performance validation and conformance software performs the following tests as per the IEEE 802.3-2005 and ANSI X3.263-1995 standards.

Standard reference	Description
IEEE802.3.2005 Sub clause 40.6.1.2.1	Difference A, B peak output voltage*
IEEE802.3.2005 Sub clause 40.6.1.2.1	Point A peak output voltage*
IEEE802.3.2005 Sub clause 40.6.1.2.3	Point A template test*
IEEE802.3.2005 Sub clause 40.6.1.2.1	Point B peak output voltage*
IEEE802.3.2005 Sub clause 40.6.1.2.3	Point B template test*
IEEE802.3.2005 Sub clause 40.6.1.2.1	Point C peak output voltage*
IEEE802.3.2005 Sub clause 40.6.1.2.3	Point C template test*
IEEE802.3.2005 Sub clause 40.6.1.2.1	Point D peak output voltage*
IEEE802.3.2005 Sub clause 40.6.1.2.3	Point D template test*
IEEE802.3.2005 Sub clause 40.6.1.2.3	Point F template test*
IEEE802.3.2005 Sub clause 40.6.1.2.2	Point G droop test*
IEEE802.3.2005 Sub clause 40.6.1.2.3	Point H template test*
IEEE802.3.2005 Sub clause 40.6.1.2.2	Point J droop test*
IEEE802.3-2005 Sub clause 40.8.3.3	MDI common mode output voltage
IEEE802.3-2005 Sub clause 40.6.1.2.5	Jitter master filtered
IEEE802.3-2005 Sub clause 40.6.1.2.5	Jitter master unfiltered
IEEE802.3-2005 Sub clause 40.6.1.2.5	Jitter slave filtered
IEEE802.3-2005 Sub clause 40.6.1.2.5	Jitter slave filtered
IEEE802.3-2005 Sub clause 40.8.3.1	MDI return loss
IEEE802.3-2005 Sub clause 40.6.1.2.4	Transmitter distortion*

* With or without disturbing signal

Table 3. Ethernet electrical tests for 1000BASE-T performed by the N5392A software

Tests performed (continued)

Standard reference	Description
ANSI X3.263-1995, Section 9.1.3	$+V_{out}$ overshoot
ANSI X3.263-1995, Section 9.1.3	$+V_{out}$ overshoot decay
ANSI X3.263-1995, Section 9.1.3	$-V_{out}$ overshoot
ANSI X3.263-1995, Section 9.1.3	$-V_{out}$ overshoot decay
ANSI X3.263-1995, Section 9.1.6	AOI $+V_{out}$ rise time
ANSI X3.263-1995, Section 9.1.6	AOI $+V_{out}$ fall time
ANSI X3.263-1995, Section 9.1.6	AOI $+V_{out}$ rise/fall time symmetry
ANSI X3.263-1995, Section 9.1.6	AOI $-V_{out}$ rise time
ANSI X3.263-1995, Section 9.1.6	AOI $-V_{out}$ fall time
ANSI X3.263-1995, Section 9.1.6	AOI $-V_{out}$ rise/fall time symmetry
ANSI X3.263-1995, Section 9.1.8	Duty cycle distortion
ANSI X3.263-1995, Section 9.1.4	Signal amplitude symmetry
ANSI X3.263-1995, Section 9.1.9 and IEEE802.3-2005 Sub clause 25.4.5	Transmit jitter
ANSI X3.263-1995, Annex J	UTP AOI template
ANSI X3.263-1995, Section 9.1.2.2	UTP $+V_{out}$ differential output voltage
ANSI X3.263-1995, Section 9.1.2.2	UTP $-V_{out}$ differential output voltage
ANSI X3.263-1995, Section 9.1.5	Transmitter return loss
ANSI X3.263-1995, Section 9.2.2	Receiver return loss

Table 4. Ethernet electrical tests for 100BASE-TX performed by the N5392A software

Tests performed (continued)

Standard reference	Description
IEEE802.3-2005 Sub clause 14.3.1.2.5	Common mode output voltage
IEEE802.3.2005 Sub clause 14.3.1.2.1, Figure 14-9, Table 14-1	Template MAU
IEEE802.3.2005 Sub clause 14.3.1.2.1, Figure 14-10	Template TP_IDL with TPM
IEEE802.3.2005 Sub clause 14.3.1.2.1, Figure 14-10	Template TP_IDL without TPM
IEEE802.3.2005 Sub clause 14.3.1.2.1, Figure 14-12	Template Link Pulse with TPM
IEEE802.3.2005 Sub clause 14.3.1.2.1, Figure 14-12	Template Link Pulse without TPM
ANSI X3.263-1995, Section 9.1.3	Peak differential output voltage
IEEE802.3.2005 Sub clause 14.3.1.2.1	Harmonic content
IEEE802.3.2005 Sub clause 14.3.1.2.1 and Annex B.4.1 and B.4.3.3	Jitter with TPM
IEEE802.3.2005 Sub clause 14.3.1.2.1 and Annex B.4.1 and B.4.3.3	Jitter without TPM
IEEE802.3.2005 Sub clause 14.3.1.2.2 and Annex B.4.3.2	Transmitter return loss
IEEE802.3.2005 Sub clause 14.3.1.3.4 and Annex B.4.3.5	Receiver return loss

Table 5. Ethernet electrical tests for 10BASE-T performed by the N5392A software

Measurement requirements

To use the N5392A Ethernet electrical performance validation and conformance software on your Infiniium oscilloscope, you will need oscilloscope probes and probe heads, the Agilent N5395B Ethernet electrical conformance test fixture and other test accessories depending on the Ethernet standard and test suites you want to perform. For 10BASE-T and 100BASE-TX Ethernet testing, the test configurations are similar. For 1000BASE-T, the testing requirements can include jitter tests, tests with the disturbing signal, and return loss measurements, which presents a much more complex test configuration. The following section describes the fixtures and tests.

- **N5395B Ethernet electrical conformance test fixture**
  The Agilent N5395B Ethernet electrical conformance test fixture includes a main test fixture board, a short RJ-45 interconnect cable, and a small impedance calibration board (see Figure 4). The main test fixture board is subdivided into 8 fixtures which are configured specifically for the requirements of different tests. Ethernet device connection is accomplished through the short RJ 45 interconnect cable or through the N5396A Gigabit Ethernet jitter test cable. Several tests require equipment in addition to the Infiniium oscilloscope; in these cases, the connection to the test fixture is accomplished using BNC and SMA cables while the control of such equipment is accomplished by the software through the 82357A/B USB-GPIB adaptor. Some measurements require a direct SMA cable connection to channels on the oscilloscope, however, most commonly the connection is via an Agilent InfiniiMax active differential probe (1130A, 1131A, 1132A, 1134A, 1168A, or 1169A) with an E2678A socketed differential probe head.

- **N5396A Gigabit Ethernet jitter test cable and Gigabit Ethernet jitter measurement**
  The N5396A Gigabit Ethernet jitter test cable allows you to make 1000BASE-T jitter measurements with the N5395B Ethernet electrical conformance test fixture. The 103-m cable has a RJ-45 connector on one end to connect to the device under test (DUT), and a DB9 connector on the other end to connect to the N5395B Ethernet test fixture board. The 1000BASE-T jitter measurements are best made using two Agilent InfiniiMax active differential probes (1130A, 1131A, 1132A, 1134A, 1168A, or 1169A) with the E2677A/N5381A solder-in and E2678A socketed differential probe heads.

- **Return loss measurements**
  The N5392A Ethernet electrical performance validation and conformance software supports the 1000BASE-T return loss measurement which requires the N5395B Ethernet electrical conformance test fixture, 3 SMA cables and an appropriate vector network analyzer. We recommend you use one long (36") SMA cable to connect the vector network analyzer to the N5395B fixture and two short (~12") SMA cables for fixture interconnection. The software can either control the vector network analyzer to access the measurement data or read one of several vector-network-analyzer-created ASCII data files for the measurement results. Supported file formats are TouchStone and CITIFile. The software will convert the 100-ohm measured data into the 85- and 115-ohm systems as required in the specification. The network analyzer and main test fixture are calibrated using the impedance calibration board, which has separate RJ-45 connectors for an open circuit, a short circuit, and 50-ohm load.

- **1000BASE-T disturbing signal**
  There are two suites of tests that require an interfering signal referred to as the "disturbing signal:" the template test suite and the distortion test suite. The disturbing signal is created by two Agilent 33250A arbitrary waveform generators which are controlled and calibrated by the N5392A software. The disturbing signal tests require four BNC cables to connect the function generators, two short (~12") SMA cables for fixture interconnection, and two long (36") SMA cables to make direct connection to the oscilloscope for measurements.

Ordering information

The following products are used in the total solution for Ethernet testing with the N5392A:

Model number	Description
N5392A Option 021	User-installed license Factory-installed license on new 9000 or 90000 Series oscilloscopes
N5435A Option 008	Server-based license for 9000 and 90000 Series oscilloscopes
N5395B	Ethernet electrical conformance test fixture
N5396A	Gigabit Ethernet jitter test cable (for 1000BASE-T jitter test)
113XA or 116XA	InfiniiMax active differential probe
E2677A or N5381A	InfiniiMax solder-in differential probe head
E2678A	InfiniiMax socketed differential probe head
An alternative to purchasing the E2677A and E2678A is the E2669A	
E2669A	InfiniiMax connectivity kit for differential/single-ended measurements (contains one E2575A differential browser probe head, four E2677A solder-in differential probe heads, and two E2678A socketed differential probe heads)
33250A	80-MHz arbitrary waveform generator
82357A/B	USB/GPIB interface
VNA	Network analyzer that can measure in the 10-100 MHz range. Supported network analyzers: • 8752x/53x • 4395x/96x • E5070x/71x • E5061x/62x • N5230A
Accessories	
10833D	GPIB cable, 0.5 meter (other lengths available, check with your Agilent representative)
8120-1840	BNC (m) – BNC (m) cable, 48". Connects two BNC female ports.
SMA cables	4 maximum needed. Recommend two long (36") and two short (~12") cables. Suggested vendor, part number • Farnell, **8558566** (36" length) • Farnell, **1056167** (0.25 m length)
SMA push-on connectors	Aids productivity by not requiring threaded SMA connections. Order ***33SMA-Q50-0-4*** from S.M Electronics

Table 6. Products used for all 10/100/1000 tests for N5392A Ethernet solution

Ordering information (continued)

To purchase the N5392A Ethernet electrical performance validation and conformance software with a new or existing Infiniium oscilloscope, order the following:

	1000BASE-T measurements					
Model number	**Core**	**Jitter**	**Return loss**	**Disturbing signal**	**100BASE-TX measurements**	**10BASE-T measurements**
N5392A/ DSO90000A-021	1	1	1	1	1	1
N5395B	1	1	1	1	1	1
N5396A		1				
113XA/116XA	1	2			1	1
E2677A/N5381A		2				
E2678A	1	1			1	1
33250A				2		
82357A/B			1	1		
VNA			1			
GPIB cables				1 (2 if together with return loss)		
BNC cables	1	1		4		1
SMA cables			3	4		
SMA push-on connectors				6 (optional)		

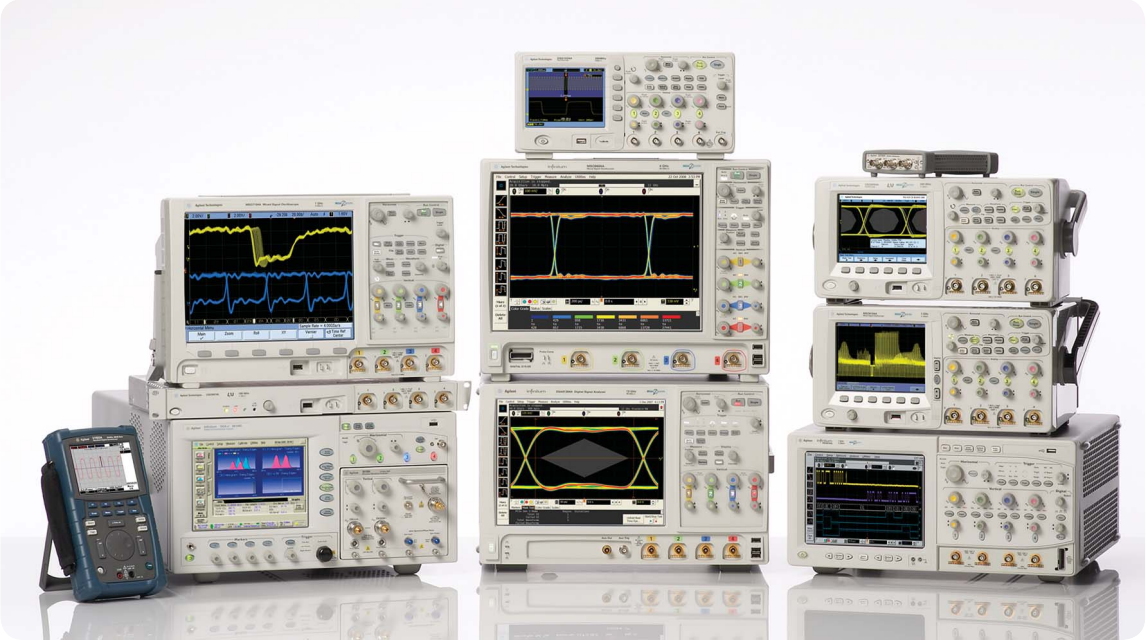
Table 7. Order guide for each Ethernet measurement standard. To determine total number of a given model number for an aggregate capability (more than one column), use highest number in row using those columns. For example, to perform all 10/100/1000 measurements, two 113XA or 116XA probe amplifiers are required.

Related literature

Publication title	**Publication type**	**Publication number**
Infiniium DSO/DSA90000A Series	Data Sheet	5989-7819EN
Infiniium Application Server License for Infiniium Oscilloscopes	Data Sheet	5989-6937EN
IInfiniium 8000 Series Oscilloscopes	Data Sheet	5989-4271EN
E2688A High-Speed Serial Data Analysis and Clock Recovery Software	Data Sheet	5989-0108EN
Infiniium 9000 Series Oscilloscopes	Data Sheet	5990-3746EN

Product Web site

For the most up-to-date and complete application and product information, please visit our product Web site at: **www.agilent.com/find/scope-apps**



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