GIGABIT ETHERNET CONSORTIUM

Clause 38
Optical PMD Test Suite
Version 0.7

Technical Document

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Gigabit Ethernet Consortium

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MODIFICATION RECORD

August 19, 2008 Version 0.7
Mike DeGaetano: Revised wavelength and average launch power measurements

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Mike DeGaetano: Revised jitter measurements

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Mike DeGaetano: Revised rise and fall times

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Eric Lynskey	UNH InterOperability Laboratory
Mike DeGaetano	UNH InterOperability Laboratory

INTRODUCTION

Overview

The University of New Hampshire InterOperability Laboratory (UNH-IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This suite of tests has been developed to help implementers evaluate the functioning of their Clause 38 optical PMD based products. The tests do not determine if a product conforms to the IEEE 802.3 standard, nor are they purely interoperability tests. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other Clause 38 capable devices. However, combined with satisfactory operation in the UNH-IOL interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function well in most environments.

Organization of Tests

The tests contained in this document are organized to simplify the identification of information related to a test and to facilitate in the actual testing process. Each test contains an identification section that describes the test and provides cross-reference information. The discussion section covers background information and specifies why the test is to be performed. Tests are grouped in order to reduce setup time in the lab environment. Each test contains the following information:

Test Number

The Test Number associated with each test follows a simple grouping structure. Listed first is the Test Group Number followed by the test's number within the group. This allows for the addition of future tests to the appropriate groups of the test suite without requiring the renumbering of the subsequent tests.

Purpose

The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level.

References

The references section lists cross-references to the IEEE 802.3 standards and other documentation that might be helpful in understanding and evaluating the test and results.

Resource Requirements

The requirements section specifies the hardware, and test equipment that will be needed to perform the test. The items contained in this section are special test devices or other facilities, which may not be available on all devices.

Last Modification

This specifies the date of the last modification to this test.

Discussion

The discussion covers the assumptions made in the design or implementation of the test as well as known limitations. Other items specific to the test are covered here.

Test Setup

The setup section describes the configuration of the test environment. Small changes in the configuration should be included in the test procedure.

Procedure

The procedure section of the test description contains the step-by-step instructions for carrying out the test. It provides a cookbook approach to testing, and may be interspersed with observable results.

Observable Results

The observable results section lists specific items that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable result, this section provides a short discussion on how to interpret them. The determination of a pass or fail for a certain test is often based on the successful (or unsuccessful) detection of a certain observable result.

Possible Problems

This section contains a description of known issues with the test procedure, which may affect test results in certain situations.

GROUP 1: Transmitter Verification

Overview:

The following group of tests pertains to the operation of the transmitter and the determination of various parametric values as defined in Std. IEEE 802.3 – 2005 Clause 38. Note, successfully passing these tests, or failing these tests, does not necessarily indicate that the device under test will, or will not, be interoperable. Devices that pass these tests are more inclined to be interoperable with not only existing products, but also future standard compliant devices.

Test 38.1.1 – Signaling speed

Purpose: To verify that the signaling speed of the device under test (DUT) is within the conformance limits specified in subclause 38.3.1 and 38.4.1.

References:

[1] IEEE Std. 802.3 – 2005, subclause 38.3.1, 38.4.1, Tables 38–3, 38–7, subclause 38.6.8

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- For LX devices, 2m – 5m single-mode patch cord or offset launch patch cord
- For SX devices, 2m – 5m multimode patch cord
- Post processing software

Last Modification: February 7, 2008

Discussion:

The 1000BASE-X Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2002. Subclause 38.3.1, and in particular, Table 38 – 3, defines the transmit characteristics for 1000BASE-SX devices (1000BASE-LX devices are covered by 38.4.1 and Table 38 – 7), the first of which is the signaling speed. The signaling speed, which is the transmitted symbol rate of a 1000BASE-X device, is specified to be 1.25Gbaud +/- 100ppm. This translates to 1.25Gbaud +/- 125kbaud, with a nominal Unit Interval (UI) of 800ps.

Test Setup: Use the fiber patch cord to connect the DUT to optical input of the DSO.

Test Procedure:

1. Configure the DUT so that it is transmitting the mixed frequency test pattern specified in 36A.3.
2. Configure the DSO to capture a suitable amount of waveform data.
3. Process the waveform data in blocks, recovering a nominal Baud rate for each block.
4. Compute the average Baud over all blocks.

Observable Results:

a. The average Baud rate over all blocks shall be 1.25GBd +/- 125kBd

Possible Problems: The DUT may not provide a mode that allows the transmission of the mixed frequency test pattern. Under these circumstances, any 8B/10B pattern will be used to perform the testing.

Test 38.1.2 – Wavelength

Purpose: To verify that the wavelength range of the device under test (DUT) is within the conformance limits specified in subclause 38.3.1 and 38.4.1.

References:

[1] IEEE Std. 802.3 – 2005, subclauses 38.3.1, 38.4.1, Tables 38–3, 38–7

Resource Requirements:

- Optical spectrum analyzer
- For LX devices, 2m – 5m single-mode patch cord or offset launch patch cord
- For SX devices, 2m – 5m multimode patch cord

Last Modification: August 19, 2008

Discussion:

The 1000BASE-X Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2005. The wavelength specifications for 1000BASE-SX devices are included in Table 38–3, and specified as 770nm to 860nm. The wavelength specifications for 1000BASE-LX devices are included in Table 38–7, and are 1270nm to 1355nm.

Test Setup: Use the fiber patch cord to connect the DUT to optical input on the spectrum analyzer.

Test Procedure:

1. Configure the DUT so that it is transmitting any valid 8B/10B data pattern.
2. Configure the optical spectrum analyzer to capture the data from the DUT.
3. Measure the wavelength range of the DUT.

Observable Results:

a. The wavelength range shall be between 770nm – 860nm for 1000BASE-SX devices or 1270nm – 1355nm for 1000BASE-LX devices.

Possible Problems: None

Test 38.1.3 – Rise and Fall Times

Purpose: To verify that the rise and fall times of the device under test (DUT) is within the conformance limits specified in subclause 38.3.1 and 38.4.1.

References:

[1] IEEE Std. 802.3 – 2005, subclauses 38.3.1, 38.4.1, Tables 38–3, 38–7, subclause 38.6.6, Figure 38 – 2

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- For LX devices, 2m – 5m single-mode patch cord or offset launch patch cord
- For SX devices, 2m – 5m multimode patch cord
- Post processing software

Last Modification: July 14, 2008

Discussion:

The 1000BASE-X Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2005. The rise and fall time specifications for 1000BASE-SX devices are included in Table 38–3, and specified as 0.26ns (max, 20% – 80% response time) when the wavelength is greater than 830nm, and 0.21ns when the wavelength is less than or equal to 830nm. The rise and fall time specifications for 1000BASE-LX devices are included in Table 38–7, and are both specified as 0.26ns. Subclause 38.6.6 states that these values must be measured on a waveform that conforms to the transmitter mask defined in Figure 38 – 2. If a filter is applied to the waveform in order to conform to the mask, then the filter response should be removed before calculating the rise and fall times.

Test Setup: Use the fiber patch cord to connect the DUT to the optical input on the DSO.

Test Procedure:

1. Configure the DUT so that it is transmitting any valid 8B/10B data pattern.
2. Configure the DSO to capture a suitable amount of waveform data.
   [1] Process the waveform data in blocks; building an eye diagram that conforms to the specified mask.
   [2] Compute the rise and fall times using 20% – 80% thresholds, removing the effects of any filters that may have been applied.

Observable Results:

a. The rise time shall be a maximum of .021ns for SX devices with a wavelength less than or equal to 830nm, or 0.26ns for SX devices with a wavelength greater than 830nm and LX devices.

b. The fall time shall be a maximum of .021ns for SX devices with a wavelength less than or equal to 830nm, or 0.26ns for SX devices with a wavelength greater than 830nm and LX devices.

Possible Problems: None

Test 38.1.4 – Average Launch Power

Purpose: To verify that the average launch power of the device under test (DUT) is within the conformance limits specified in subclause 38.3.1 and 38.4.1.

References:

[1] IEEE Std. 802.3 – 2005, subclauses 38.3.1, 38.4.1, Tables 38–3, 38–7, subclause 38.6.2

Resource Requirements:

- Optical power meter
- For LX devices, 2m – 5m single-mode patch cord or offset launch patch cord
- For SX devices, 2m – 5m multimode patch cord

Last Modification: August 19, 2008

Discussion:

The 1000BASE-X Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2005. The average launch power is defined in Tables 38–3 and 38–7 for three instances: maximum average launch power, minimum average launch power, and average launch power of the laser when turned off. The powers are shown in the table below:

	Max (dBm)	Min (dBm)	Off (dBm)
1000BASE-SX	0	-9.5	-30
1000BASE-LX	-3	-11.0/-11.5 (smf/mmf)	-30

Test Setup: Use the fiber patch cord to connect the DUT to the optical input of the DSO.

Test Procedure:

1. Configure the DUT so that it is transmitting any valid 8B/10B data pattern.
2. Measure the average launch power with the transmitter enabled.
3. Measure the average launch power with the transmitter disabled.

Observable Results:

a. The average launch power with the transmitter enabled shall be between within the limits shown in the above table for all fiber types.
b. The average launch power with the transmitter disabled shall be less than –30dBm.

Possible Problems: None

Test 38.1.5 – Extinction Ratio

Purpose: To verify that the extinction ratio of the device under test (DUT) is within the conformance limits specified in subclause 38.3.1 and 38.4.1.

References:

[1] IEEE Std. 802.3 – 2005, subclauses 38.3.1, 38.4.1, Tables 38–3, 38–7, subclause 38.6.3

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- For LX devices, 2m – 5m single-mode patch cord or offset launch patch cord
- For SX devices, 2m – 5m multimode patch cord
- Post processing software

Last Modification: February 7, 2008

Discussion:

The 1000BASE-X Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2002. The extinction ratio is defined in Tables 38–3 and 38–7 to be a minimum of 9dB. Subclause 38.6.3 states that the measurement is made with the DUT transmitting the pattern defined in 36A.2, a repeating K28.7 data pattern that generates a 125MHz square wave. The extinction ratio is defined as the ratio of the average optical energy in a ONE to the average optical energy in a ZERO.

Test Setup: Use the fiber patch cord to connect the DUT to the optical input on the DSO.

Test Procedure:

1. Configure the DUT so that it is transmitting the pattern defined in 36A.2.
2. Configure the DSO to capture a suitable amount of waveform data.
3. Process the waveform computing the extinction ratio.

Observable Results:

a. The extinction ratio shall be a minimum of 9dB.

Possible Problems: The DUT may not provide a mode that allows the transmission of the square wave test pattern. Under these circumstances, any 8B/10B pattern will be used to perform the testing.

Test 38.1.6 – Transmitter Eye Mask

Purpose: To verify that the transmitter eye of the device under test (DUT) is within the conformance limits specified in subclause 38.6.5.

References:

[1] IEEE Std. 802.3 – 2005, subclause 38.6.5, Figure 38 – 2

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- For LX devices, 2m – 5m single-mode patch cord or offset launch patch cord
- For SX devices, 2m – 5m multimode patch cord
- Post processing software

Last Modification: February 7, 2008

Discussion:

The 1000BASE-LX Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2005. The transmitter pulse shape characteristics are specified in the form of a mask of the transmitter eye diagram in Figure 38 – 2. The DUT must conform to this mask. The mask is normalized to amplitudes of 0.0 and 1.0, and should be measured after applying the specified fourth-order Bessel-Thomson filter; a 6 dB attenuator may be used at the input and/or output.

Test Setup: Use the fiber patch cord to connect the DUT to the optical input on the DSO.

Procedure:

1. Configure the DUT so that it is transmitting any valid 8B/10B data pattern.
2. Configure the DSO to capture a suitable amount of waveform data.
3. Process the waveform using the post processing software to create the eye.

Observable Results:

a. The waveform should not violate the eye mask at any point.

Possible Problems: None

Test 38.1.7 – Transmitter Jitter

Purpose: To verify that the jitter produced by the transmitter of the device under test (DUT) is within the conformance limits specified in subclause 38.5.

References:

[1] IEEE Std. 802.3 – 2005, subclause 38.5, Table 38 – 10, subclause 38.6.8

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- For LX devices, 2m – 5m single-mode patch cord or offset launch patch cord
- For SX devices, 2m – 5m multimode patch cord
- Post processing software

Last Modification: July 21, 2008

Discussion:

The 1000BASE-X Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2005. Subclause 38.5 defines the jitter budget for a 1000BASE-SX and LX devices. The total allowable jitter at is defined to be 0.431 UI (345ps) at TP2 (at the end of the patch cord), the deterministic jitter is defined to be 0.2 UI (160ps), and the random jitter is defined to be .231 UI (185ps). Jitter measurements are to be made utilizing the mixed frequency test pattern defined in 36A.3 and using a clock recovery unity with a low pass filter that has a –3dB point of 637 kHz.

Test Setup: Use the fiber patch cord to connect the DUT to the optical input on the DSO.

Test Procedure:

1. Configure the DUT so that it is transmitting the mixed frequency test pattern defined in 36A.3.
2. Configure the DSO to capture a suitable amount of waveform data.
3. Process the waveform data using the post processing software to determine the total jitter.

Observable Results:

a. The total jitter shall not exceed 0.431 UI (345ps).
b. The deterministic jitter shall not exceed 0.2 UI (160ps).
c. The random jitter shall not exceed .231 UI (185ps).

Possible Problems: The DUT may not provide a mode that allows the transmission of the mixed frequency test pattern. Under these circumstances, any 8B/10B pattern will be used to perform the testing.