GIGABIT ETHERNET CONSORTIUM

Clause 39
Optical PMD Test Suite
Version 0.2

Technical Document

Last Updated: July 8, 2009 1:30 PM

Gigabit Ethernet Consortium

University of New Hampshire
InterOperability Laboratory

121 Technology Drive, Suite 2
Durham, NH 03824
Phone: +1-603-862-0090
Fax: +1-603-862-4181
http://www.iol.unh.edu/consortiums/ge

TABLE OF CONTENTS

The University of New Hampshire
InterOperability Laboratory

MODIFICATION RECORD

July 8, 2009	Version 0.2
Mike DeGaetano	General editing and appendix added
June 16, 2009	Version 0.1
Mike DeGaetano:	Released for internal review

The University of New Hampshire
InterOperability Laboratory

ACKNOWLEDGMENTS

The University of New Hampshire would like to acknowledge the efforts of the following individuals in the development of this test suite.

Jon Beckwith	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 39 1000BASE-CX 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 39 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 – 2008 Clause 39. 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 39.1.1 – Signaling speed

Purpose: To verify that the signaling speed of the device under test (DUT) is within the conformance limits specified in subclause 39.3.1.

References:

[1] IEEE Std. 802.3 – 2008, subclause 39.3.1, Table 39–2

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth
- Post processing software

Last Modification: June 15, 2009

Discussion:

The 1000BASE-CX Physical Medium Dependent (PMD) sublayer is defined in Clause 39 of IEEE Std. 802.3 – 2005. Subclause 39.3.1, and in particular, Table 38 – 2, defines the transmit characteristics for 1000BASE-CX devices, the first of which is the signaling speed. The signaling speed, which is the transmitted symbol rate of a 1000BASE-CX device, is specified to be 1.25Gbaud +/- 100ppm. This translates to 1.25Gbaud +/- 125kbaud, with a nominal Unit Interval (UI) of 800ps.

Test Setup: Refer to Appendix A.

Test Procedure:

1. Configure the DUT so that it is transmitting the mixed frequency test pattern specified in K28.5.
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: None.

Test 39.1.2 – Differential Output Amplitude

Purpose: To verify that the differential amplitude of the device under test (DUT) is within the conformance limits specified in subclause 39.3.1.

References:

1. IEEE Std. 802.3 – 2008, subclause 39.3.1, Table 39–2

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth
- Post processing software

Last Modification: July 8, 2009

Discussion:

The 1000BASE-CX Physical Medium Dependent (PMD) sublayer is defined in Clause 39 of IEEE Std. 802.3 – 2005. The differential amplitude specifications for 1000BASE-CX devices are included in Table 39–2, and specified as 1100mV to 2000mV.

Test Setup: Refer to Appendix A.

Test Procedure:

1. Configure the DUT so that it is transmitting any valid 8B/10B data pattern (here a K28.5 pattern is used).
2. Measure the differential amplitude of the DUT.

Observable Results:

a. The differential amplitude range shall be between 1100mV to 2000mV.

Possible Problems: None.

Test 38.1.3 – 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 39.3.3.

References:

[1] IEEE Std. 802.3 – 2008, subclause 39.3.3, Table 39 – 5

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- Post processing software

Last Modification: June 15, 2009

Discussion:

The 1000BASE-CX Physical Medium Dependent (PMD) sublayer is defined in Clause 39 of IEEE Std. 802.3 – 2008. Subclause 39.3 defines the jitter budget for 1000BASE-CX devices. The total allowable jitter at is defined to be 0.279 UI (223ps) at TP2 (at the end of the patch cord), the deterministic jitter is defined to be 0.14 UI (112ps), and the random jitter is defined to be .139 UI (111.2ps).

Test Setup: Refer to Appendix A.

Test Procedure:

1. Configure the DUT so that it is transmitting the K28.5 pattern.
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 0.279 UI (223ps).
b. The deterministic jitter shall not exceed 0.14 UI (112ps).
c. The random jitter shall not exceed .139 UI (111.2ps).

Possible Problems: The DUT may not provide a mode that allows the transmission of the mixed frequency test pattern (K28.5). Under these circumstances, any 8B/10B pattern will be used to perform the testing.

Test 39.1.4 – 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 39.3.1.

References:

[1] IEEE Std. 802.3 – 2008, subclauses 39.3.1, Tables 39–2

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- Post processing software

Last Modification: June 15, 2009

Discussion:

The 1000BASE-CX Physical Medium Dependent (PMD) sublayer is defined in Clause 39 of IEEE Std. 802.3 – 2008. The rise and fall time specifications for 1000BASE-CX devices are included in Table 38–2, and specified as 0.327ns for the 20-80% rising edge and 80-20% falling edge. Subclause 39.6.1 states that the measurement is a two-step process, first obtaining the normalized 0/1 levels from an alternating K28.5 stream, and second using the high-frequency D21.5 stream to make the rise/fall time measurement on.

Test Setup: Refer Appendix A.

Test Procedure:

1. Configure the DUT so that it is transmitting an alternating K28.5 character stream.
2. Determine the 0% and 100% levels by measuring the voltages for a logic 0 and logic 1.
3. Configure the DUT so that it is transmitting the D21.5 character stream.
4. 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.
5. Normalize this waveform relative to the 0% and 100% levels from step 2.
    [1] 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 between 85 ps and 327 ps.
b. The fall time shall be between 85 ps and 327 ps.

Possible Problems: None.

Test 39.1.5 – Differential Skew

Purpose: To verify that the maximum differential skew of the device under test (DUT) is within the conformance limits specified in subclause 39.3.1.

References:

[1] IEEE Std. 802.3 – 2008, subclauses 39.3.1, Table 39–2

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- Post processing software

Last Modification: June 15, 2009

Discussion:

The 1000BASE-CX Physical Medium Dependent (PMD) sublayer is defined in Clause 39 of IEEE Std. 802.3 – 2008. The differential skew is defined in Table 39–2 to be a maximum of 25ps. Subclause 39.6.1 states that this measurement is to be made using the normalized 50% levels as determined from an alternating K28.5 stream, and second using the high-frequency D21.5 stream to make the rise/fall measurement on.

Test Setup: Refer to Appendix A.

Test Procedure:

1. Configure the DUT so that it is transmitting an alternating K28.5 character stream.
2. Determine the 0% and 100% levels by measuring the voltages for a logic 0 and a logic 1.
3. Configure the DUT so that it is transmitting the D21.5 or K28.7 pattern.
4. Configure the DSO to capture a suitable amount of waveform data.
5. Process the waveform computing the differential skew using the normalized 50% levels.

Observable Results:

a. The differential skew shall be below 25ps.

Possible Problems: None.

Test 39.1.6 – Transmitter Eye Mask

Purpose: To verify that the transmitter eye of the device under test (DUT) is within the conformance limits specified in subclause 39.3.1.

References:

[1] IEEE Std. 802.3 – 2008, subclause 39.3.1, Table 39-3, Figure 39-3, Figure 39-4

Resource Requirements:

- Digital storage oscilloscope (DSO), 2GHz minimum bandwidth with O/E converter
- Post processing software

Last Modification: June 15, 2009

Discussion:

The 1000BASE-CX Physical Medium Dependent (PMD) sublayer is defined in Clause 38 of IEEE Std. 802.3 – 2008. The transmitter pulse shape characteristics are specified in the form of a mask of the transmitter eye diagram in Figure 39 – 3. The DUT must conform to this mask. The mask shown in figure 39-3 is normalized to amplitudes of 0.0 and 1.0 as discussed in test 39.1.4, 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: Refer to Appendix A.

Procedure:

1. Configure the DUT so that it is transmitting the alternating K28.5 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.
4. Normalize the waveform using the method discussed in test 39.1.4.
5. Create the normalized eye.

Observable Results:

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

Possible Problems: None.

APPENDICES

Overview:

Test suite appendices are intended to provide additional low-level technical detail pertinent to specific tests contained in this test suite. These appendices often cover topics that are outside of the scope of the standard, and are specific to the methodologies used for performing the measurements in this test suite. Appendix topics may also include discussion regarding a specific interpretation of the standard (for the purposes of this test suite), for cases where a particular specification may appear unclear or otherwise open to multiple interpretations.

Scope:

Test suite appendices are considered informative supplements, and pertain solely to the test definitions and procedures contained in this test suite.

Appendix A – Setup Procedure

Purpose: This section contains setup information for performing 1000BASE-CX PMD testing

References:

[1] IEEE 802.3-2008, Figure 39-1, 39-2

Last Modification: July 8, 2009

Discussion:

All tests in this section were performed using the following equipment:

1. Tektronix CSA7404
2. (2) TCA75 75 ohm BNC adapters
3. (2) 75 ohm RG179 BNC-SMA cables.

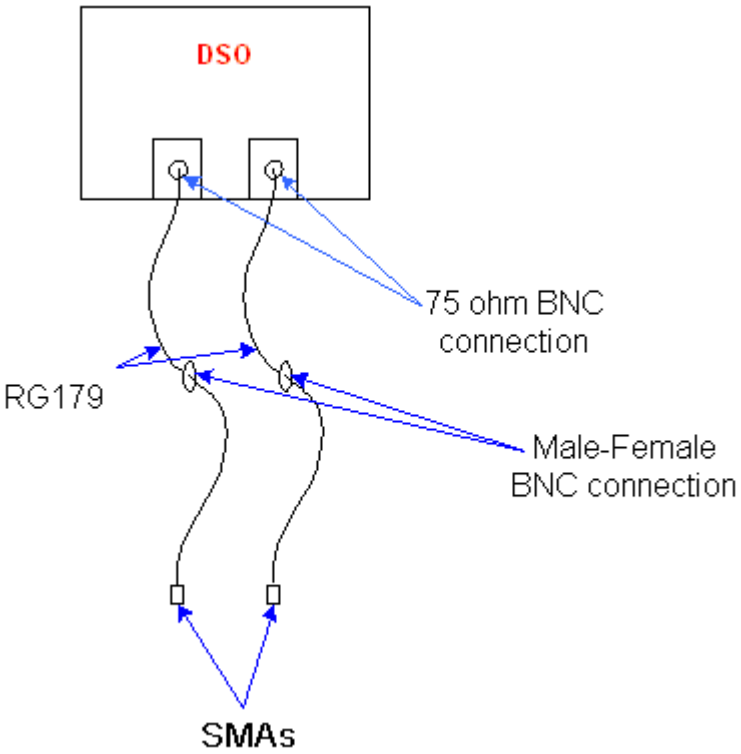

Figure A-1: Test Setup