50, 100, 200 AND 400 GIGABIT ETHERNET TESTING SERVICE

Annex 120D
200GAUI-4 and 400GAUI-8 PMD Test Plan
Version 1.0
Technical Document

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200 and 400 Gigabit Ethernet Testing Service

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MODIFICATION RECORD

April 1, 2019 Version 1.0

Mike Klempa: Published version of test plan.

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INTRODUCTION

The University of New Hampshire's InterOperability Laboratory (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 particular test plan has been developed to help implementers evaluate the functionality of the Physical Medium Dependent (PMD) sublayer of their 200GAUI-4 and 400GAUI-8 products.

These tests are designed to determine if a product conforms to specifications defined in Annex 120D of the IEEE Std 802.3-2018. Successful completion of all tests contained in this plan does not guarantee that the tested device will operate with other devices. However, combined with satisfactory operation in the IOL's interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function properly in many 200GAUI-4 and 400GAUI-8 environments.

The tests contained in this document are organized in such a manner as to simplify the identification of information related to a test, and to facilitate in the actual testing process. Tests are organized into groups, primarily in order to reduce setup time in the lab environment, however, the different groups typically also tend to focus on specific aspects of device functionality. A three-part numbering system is used to organize the tests, where the first number indicates the clause of the IEEE 802.3 standard on which the test plan is based. The second and third numbers indicate the test's group number and test number within that group, respectively. This format allows for the addition of future tests to the appropriate groups without requiring the renumbering of the subsequent tests.

The test definitions themselves are intended to provide a high-level description of the motivation, resources, procedures, and methodologies pertinent to each test. Specifically, each test description consists of the following sections:

Purpose

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

References

This section specifies source material *external* to the test plan, including specific subclauses pertinent to the test definition, or any other references that might clarify the test methodology and/or test results. External sources are always referenced by number when mentioned in the test description. Any other references not specified by number are stated with respect to the test plan document itself.

Resource Requirements

The requirements section specifies the test hardware and/or software needed to perform the test. This is generally expressed in terms of minimum requirements, however in some cases specific equipment manufacturer/model information may be provided.

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 initial configuration of the test environment. Small changes in the configuration should not be included here, and are generally covered in the test procedure section, below.

Test Procedure

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

Observable Results

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

Possible Problems

This section contains a description of known issues with the test procedure, which may affect test results in certain situations. It may also refer the reader to test plan appendices and/or whitepapers that may provide more detail regarding these issues.

GROUP 1: TRANSMITTER ELECTRICAL SIGNALING REQUIREMENTS

Overview:

The tests defined in this section verify the transmitter's electrical signaling characteristics of the Physical Medium Dependent (PMD) layer defined in Annex 120D of the IEEE Std. 802.3-2018.

Test 120D.1.1 – Signaling Speed

Purpose: To verify that the baud rate of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, subclause 93.8.1.1 – Transmitter Test fixture

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for the signaling speed which states that the signaling speed should be 26.5625 Gbaud +/- 100 ppm per lane. This translates to 26.5625 Gbaud +/- 2.65625 Mbaud, with a nominal Unit Interval (UI) of 37.647 ps.

In this test, the signaling speed is measured while the DUT is connected to the test fixture defined in [2], or its functional equivalent. The signal being transmitted by the DUT may be any valid 200GAUI-4 and 400GAUI-8 signal.

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send a valid signal or test pattern.
2. Connect the DUT's transmitter to the DSO.
3. Measure the average TX signaling speed.
4. Repeat steps 1-3 for each transmit lane.

Observable Results:

a. The signaling speed should be within 26.5625 Gbaud +/- 100 ppm per lane.

Possible Problems: None.

Test 120D.1.2 – Differential Output Amplitude

Purpose: To verify that the differential output amplitude of the DUT transmitter is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, subclause 93.8.1.3 – Signal Levels
[3] IEEE Std. 802.3-2018, subclause 93.8.1.1 – Transmitter Test fixture
[4] IEEE Std. 802.3-2018, subclause 93.7.6 – Transmit disable function
[5] IEEE Std. 802.3-2018, subclause 93.7.7 – Lane by lane disable function

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for the differential output amplitude defined in [2].

In this test, the maximum differential peak-to-peak output voltage is measured while the DUT is connected to the test fixture defined in [3], or its functional equivalent. The signal being transmitted by the DUT will be PRBS13Q as defined in [2].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send PRBS13Q.
2. Connect the DUT's transmitter to the DSO.
3. Measure the maximum peak-to-peak differential output voltage.
4. Disable the transmitter and measure the peak-to-peak output voltage.
5. Repeat steps 1-4 for each transmit lane.

Observable Results:

a. The maximum differential peak-to-peak output voltage should be less than 1200 mV, regardless of equalization setting.
b. The transmitter output voltage should be less than or equal to 30 mV peak-to-peak when disabled as defined in [4] and [5].

Possible Problems: None.

Test 120D.1.3 – Common Mode Output Voltage

Purpose: To verify that the DC common mode output voltage of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, subclause 93.8.1.3 – Signal Levels
[3] IEEE Std. 802.3-2018, subclause 93.8.1.1 – Transmitter Test fixture

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for the common mode output voltage defined in [2].

In this test, the DC common mode output voltage is measured while the DUT is connected to the test fixture defined in [3], or its functional equivalent. The signal being transmitted by the DUT shall be PRBS13Q as defined in [2].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send PRBS13Q.
2. Connect the DUT’s transmitter to the DSO.
3. Measure the common mode output voltage of SL<p> and SL<n>.
4. Repeat steps 1-3 for each transmit lane.

Observable Results:

a. The common mode output voltage should be between 0 V and 1.9 V with respect to the signal shield.

Possible Problems: None.

Test 120D.1.4 – Common-mode AC output voltage RMS

Purpose: To verify that the maximum AC common-mode output voltages are within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, subclause 120.5.11.2.1 – PRBS13Q test pattern
[3] IEEE Std. 802.3-2018, subclause 93.8.1.1 – Transmitter Test fixture

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for maximum output AC common-mode voltage defined in [2].

In this test, the differential amplitude is measured while the DUT is connected to the DSO. The common mode voltage can be found by averaging the signal+ and signal- at any time. RMS AC common-mode voltage may be calculated by applying the histogram function over 1 UI to the common mode signal. The signal being transmitted by the DUT will be PRBS13Q as defined in [2].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send PRBS13Q.
2. Connect the DUT's transmitter to the DSO.
3. Apply a histogram function over 1 UI of the common mode signal.
5. Measure the common mode RMS amplitude.
6. Repeat steps 1-5 for each transmit lane.

Observable Results:

a. The maximum output AC common-mode voltage should be no greater than 30 mV.

Possible Problems: None.

Test 120D.1.5 – Transmit Jitter

Purpose: To verify that the transmit jitter of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120D.3.1.8 – Output Jitter
[3] IEEE Std. 802.3-2018, Table 120D-4 – PRBS13Q pattern symbols used for jitter measurement
[4] IEEE Std. 802.3-2018, Annex 120D.3.1.8.2 – Even Odd Jitter
[5] IEEE Std. 802.3-2018, Annex 120D.3.1.8.1 – J4u and J_{RMS} Jitter

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for even-odd jitter, J4u jitter and J_{RMS} jitter.

In this test, there are three components of jitter that are measured. Jitter is measured while the DUT is transmitting PRBS13Q and is performed on 12 specific transitions detailed in [2] and [3]. J4u jitter and J_{RMS} jitter are also measured on a PRBS13Q pattern. The procedure is performed as defined in [5]. All measurements will be performed with the DUT connected to the test fixture defined in [2] or its functional equivalent.

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT so that it is sourcing a PRBS13Q pattern.
2. Connect the DUT's transmitter to the DSO.
3. Find the specific transitions detailed in [3].
4. Measure the Even-Odd jitter, J4u jitter and J_{RMS} jitter.
5. Repeat steps 1-5 for each transmit lane.

Observable Results:

a. The Even-Odd Jitter value should not exceed 0.019 UI.
b. The J_{RMS} value should not exceed 0.023 UI.
c. The J4u value should not exceed 0.118 UI.

Possible Problems: None.

GROUP 2: TRANSMITTED WAVEFORM

Overview:

The tests defined in this section verify the transmitted waveform characteristics of the Physical Medium Dependent (PMD) layer defined in Annex 120D of the IEEE Std. 802.3-2018. In order to correctly characterize the effects of the coefficient changes, the intrinsic effects of the channel need to be accounted for. These tests eliminate the channel that connects the chip to the transmitter. Each test in this group, besides Test 120D.2.1, must be run ‘N’ times, where ‘N’ is the number of possible coefficient combinations.

Test 120D.2.1 – Transmitter Output Waveform

Purpose: To verify that the transmitter output waveform of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120D.3.1.4 – Steady-state voltage and linear fit pulse peak
[3] IEEE Std. 802.3-2018, subclause 85.8.3.3 – Transmitter output waveform
[4] IEEE Std. 802.3-2018, subclause 72.6.10.2.3.1 – Preset
[5] IEEE Std. 802.3-2018, subclause 120.5.11.2.1 – PRBS13Q test pattern

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for the transmitter output waveform related to transmitter steady state voltage defined in [2].

In this test, the DUT's equalizer is manipulated to every coefficient combination, including preset as specified in [4]. For each combination one complete cycle of the PRBS13Q test pattern, specified in [5], is captured. This data is then post-processed using the procedure defined in [3] to compute the least mean square fit of the captured waveform. Additional parameters such as the steady state voltage and linear fit pulse response are derived from captured data and the fitting process.

Test Setup: See Appendix I.

Test Procedure:

1. Force the DUT transmitter equalizer to preset.
2. Configure the DUT so that it is sourcing a PRBS13Q pattern.
3. Capture at least one complete cycle of the test pattern using the acquisition settings defined in [5].
4. Calculate the linear fit pulse response p(k).
5. Repeat steps 1-4 for all combination of equalizer coefficients.
6. Repeat steps 1-5 for each transmit lane.

Observable Results:

a. The transmitter's level separation mismatch ratio shall be greater than 0.95.
b. The transmitter's steady state voltage, the sum of p(k) divided by M, should be no less than 0.4 V and not exceed 0.6 V.
c. The peak of p(k) should be no less than the transmitter steady state voltage multiplied by 0.76.

Possible Problems: None.

Test 120D.2.2 – Pre-cursor Equalization

Purpose: To verify that the change in the normalized amplitude of the pre-cursor tap is monotonic and is within the conformance limits when responding to an increment or decrement request.

References:

[1] IEEE Std. 802.3-2018, Annex 120D.3.1.5 – Transmitter Equalization Settings
[2] IEEE Std. 802.3-2018, Annex 120D.3.1 – Transmitter Characteristics
[3] IEEE Std. 802.3-2018, Figure 120D-7 – Transmitter Equalization Functional Model

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200G GAUI-8 and 400G GAUI-16 devices. Pre-cursor equalization is required to compensate for the frequency-dependent loss of the channel and to facilitate data recovery at the receiver. This specification includes conformance requirements for the weight of the pre-cursor tap c(-1) defined in [2].

In this test, the ratio of c(-1) is measured at valid weights as defined in [3]. The weight at each value from register settings 0:3 shall meet the requirements specified in [1]. The c(-1) ratio is defined as:

$$\frac{c(-1)}{|c(-1)| + |c(0)| + |c(1)|}$$

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT so that it is sourcing a low frequency test pattern.
2. Connect the DUT's transmitter to the DSO.
3. Set c(-1) to a valid value in the MDIO.
4. Measure c(-1), c(0), and c(1).
5. Repeat steps 3 and 4 for all valid values.
6. Repeat steps 1-7 for each transmit lane.

Observable Results:

a. The weight of the coefficient tap at each *Local_eq_cm1* value shall meet the requirements in [3].

Possible Problems: None.

Test 120D.2.3 – Post-cursor Equalization

Purpose: To verify that the change in the normalized amplitude of the post-cursor tap is monotonic and is within the conformance limits when responding to an increment or decrement request.

References:

[1] IEEE Std. 802.3-2018, Annex 120D.3.1.5 – Transmitter Equalization Settings
[2] IEEE Std. 802.3-2018, Annex 120D.3.1 – Transmitter Characteristics
[3] IEEE Std. 802.3-2018, Figure 120D-7 – Transmitter Equalization Functional Model

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200G GAUI-8 and 400G GAUI-16 devices. Post-cursor equalization is required to compensate for the frequency-dependent loss of the channel and to facilitate data recovery at the receiver. This specification includes conformance requirements for the weight of the post-cursor tap c(1) defined in [2].

In this test, the ratio of c(1) is measured at valid weights as defined in [3]. The weight at each value from register settings 0:5 shall meet the requirements specified in [1]. The c(1) ratio is defined as:

$$\frac{c(1)}{|c(-1)| + |c(0)| + |c(1)|}$$

Test Setup: See Appendix I

Test Procedure:

1. Configure the DUT so that it is sourcing a low frequency test pattern.
2. Connect the DUT's transmitter to the DSO.
3. Set c(1) to a valid value in the MDIO.
4. Measure c(-1), c(0), and c(1).
5. Repeat steps 3 and 4 for all valid values.
6. Repeat steps 1-7 for each transmit lane.

Observable Results:

a. The weight of the coefficient tap at each *Local_eq_c1* value shall meet the requirements in [3].

Possible Problems: None.

Test 120D.2.4 – Signal to Noise and Distortion Ratio

Purpose: To verify that the transmit signal to noise ratio of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120D.3.1.6 – Transmitter output noise and distortion

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for signal to noise and distortion ratio (SNDR).

In this test, the RMS deviation error will be measured while each lane is sourcing PRBS13Q as defined in [2]. The RMS deviation from the mean voltage will be measured over the run of at least 6 consecutive identical bits for each level. The average of the four measurements is denoted as σn. The peak value of the linear interpolated waveform will also be used in this measurement. SNDR is found with Equation 92-9:

$$SNDR = 10\log_{10}\frac{pmax^2}{\sigma e^2+\sigma n^2} \qquad \text{Eq. 92-9}$$

Test Setup: See Appendix I.

Test Procedure:

1. From the linear fit pulse response, find the peak of the interpolated waveform as well as the RMS standard deviation error.
2. Configure the DUT to source PRBS31Q on all lanes not under test with the same equalization settings as the lane under test.
3. Configure the DUT to source PRBS13Q on the lane under test.
4. Connect the DUT to the DSO.
5. Measure the RMS deviation on at least six consecutive identical bits in a single pattern.
6. Use equation 92-9 to calculate SNDR.

Observable Results:

a. The SNDR shall be greater than 31.5 dB regardless of transmitter equalization setting.

Possible Problems: None.

Test 120D.2.5 – Transmitter Output residual ISI

Purpose: To verify that the transmit output intersymbol interference of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120D.3.1.7 – Transmitter output residual ISI

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-4 and 400GAUI-8 devices. This specification includes conformance requirements for Transmitter output residual ISI (SNR_{ISI}).

In this test, the ISI cursors are calculated from the linear fit pulse response after applying the reference receiver equalizer.

$$SNR_{ISI} = 20\log_{10}\frac{pmax}{\sqrt{\sum(ISIcursors^2)}}$$ Eq. 120D-9

Test Setup: See Appendix I.

Test Procedure:

1. From the linear fit pulse response, apply the reference receiver equalizer.
2. Calculate the ISI cursor values.
3. Use equation 120D-9 to find SNR_{ISI}.

Observable Results:

a. The SNR_{ISI} shall be greater than 34.8 dB regardless of transmitter equalization setting.

Possible Problems: None.

GROUP 3: IMPEDANCE REQUIREMENTS

Overview:

The tests defined in this section verify the impedance characteristics of the Physical Medium Dependent (PMD) layer defined in Annex 120D of the IEEE Std. 802.3-2018.

Test 120D.3.1 – Differential Output Return Loss

Purpose: To verify that the differential output return loss of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018., Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018., Annex 120D.3.1.1 – Transmitter differential output return loss

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200 GAUI-4 and 400 GAUI-8 devices. This specification includes conformance requirements for the differential output return loss, which are specified in [2].

For the purpose of this test, the differential output return loss is defined as the magnitude of the reflection coefficient expressed in decibels of the DUT's transmitter. The reflection coefficient is the ratio of the voltage in the reflected wave to the voltage in the incident wave. The differential output return loss of the driver should exceed (120D-2). The reference impedance for differential return loss measurements shall be 100 Ω.

$$Return\_loss(f) \geq \begin{Bmatrix} 14.25 - f & 0.05 \leq f \leq 6 \\ 8.7 - 0.075f & 6 \leq f \leq 19 \end{Bmatrix} (dB) \qquad (120D-2)$$

Test Setup: See Appendix I.

Test Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT's transmitter to the VNA.
3. Measure the differential output return loss of the DUT.
4. Repeat steps 1-3 for each transmit lane.

Observable Results:

a. The differential output return loss should exceed the limits described by (120D-2).

Possible Problems: None.

Test 120D.3.2 – Common Mode Output Return Loss

Purpose: To verify that the common mode output return loss of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018., Table 120D-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018., subclause 93.8.1.4 – Transmitter output return loss

Resource Requirements: See Appendix I.

Last Modification: July 17, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200 GAUI-4 and 400 GAUI-8 devices. This specification includes conformance requirements for the differential output return loss, which are specified in [2].

For the purpose of this test, the common mode output return loss is defined as the magnitude of the reflection coefficient expressed in decibels of the DUT's transmitter. The reflection coefficient is the ratio of the voltage in the reflected wave to the voltage in the incident wave. The common mode output return loss of the driver should exceed (93-4). The reference impedance for common mode return loss measurements shall be 25 Ω.

$$Return\_loss(f) \geq \begin{Bmatrix} 9.05 - f & 0.05 \leq f \leq 6 \\ 3.5 - 0.075f & 6 \leq f \leq 19 \end{Bmatrix} (dB) \qquad (93-4)$$

Test Setup: See Appendix I.

Test Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT's transmitter to the VNA.
3. Measure the common mode output return loss of the DUT.
4. Repeat steps 1-3 for each transmit lane.

Observable Results:

a. The differential output return loss should exceed the limits described by (93-4).

Possible Problems: None.

Test 120D.3.3 – Differential Input Return Loss

Purpose: To verify that the differential output return loss of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018., Table 120D-5 – Receiver Characteristics
[2] IEEE Std. 802.3-2018., Annex 120D.3.1.1 – Differential output return loss

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the receiver characteristics for 200 GAUI-4 and 400 GAUI-8 devices. This specification includes conformance requirements for the differential input return loss, which are specified in [2].

For the purpose of this test, the differential input return loss is defined as the magnitude of the reflection coefficient expressed in decibels of the DUT's receiver. The reflection coefficient is the ratio of the voltage in the reflected wave to the voltage in the incident wave. The differential input return loss of the driver should exceed (120D-2). The reference impedance for differential return loss measurements shall be 100 Ω.

$$Return\_loss(f) \geq \left\{ \begin{matrix} 14.25 - f & 0.05 \leq f \leq 6 \\ 8.7 - 0.075f & 6 \leq f \leq 19 \end{matrix} \right\} (dB) \qquad (120D - 2)$$

Test Setup: See Appendix I.

Test Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT's transmitter to the VNA.
3. Measure the differential input return loss of the DUT.
4. Repeat steps 1-3 for each transmit lane.

Observable Results:

a. The differential input return loss should exceed the limits described by (120D-2).

Possible Problems: None.

Test 120D.3.4 – Differential to Common Mode Return Loss

Purpose: To verify that the common mode output return loss of the DUT is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018., Table 120D-5 – Receiver Characteristics
[2] IEEE Std. 802.3-2018., subclause 93.8.1.4 – Receiver input return loss

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the receiver characteristics for 200 GAUI-4 and 400 GAUI-8 devices. This specification includes conformance requirements for the differential to common mode return loss, which are specified in [2].

For the purpose of this test, the differential to common mode return loss is defined as the magnitude of the reflection coefficient expressed in decibels of the DUT's receiver. The reflection coefficient is the ratio of the voltage in the reflected wave to the voltage in the incident wave. The differential to common mode return loss of the driver should exceed (93-4).

$$Return\_loss(f) \geq \begin{Bmatrix} 25 - 1.44f & 0.05 \leq f \leq 6.95 \\ 15 & 6.95 \leq f \leq 19 \end{Bmatrix} (dB) \qquad (93-5)$$

Test Setup: See Appendix I.

Test Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT's receiver to the VNA.
3. Measure the differential to common mode return loss of the DUT.
4. Repeat steps 1-3 for each transmit lane.

Observable Results:

a. The differential to common mode return loss should exceed the limits described by (93-5).

Possible Problems: None.

GROUP 4: RECIEVER ELECTRICAL SIGNALING REQUIREMENTS

Overview:

The tests defined in this section verify the receiver's electrical signaling characteristics of the Physical Medium Dependent (PMD) layer defined in Annex 120D of the IEEE Std. 802.3-2018.

Test 120D.4.1 – Receiver Interference Tolerance

Purpose: To verify that the bit error ratio (BER) of the DUT's receiver is within the conformance limits while communicating over a lossy channel with coupled interference.

References:

[1] IEEE Std. 802.3-2018, Table 120D-5 Receiver characteristics
[2] IEEE Std. 802.3-2018, Annex 120D.3.2.1 - Receiver interference tolerance
[3] IEEE Std. 802.3-2018, Annex 93C – Interference Tolerance Setup
[4] IEEE Std. 802.3-2018, Table 120D-6 - Receiver interference tolerance parameters
[5] IEEE Std. 802.3-2018, Annex 93A.2 - Test channel calibration
[6] IEEE Std. 802.3-2018, Table 120D-8 - Channel Operating Margin parameters

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [2] specifies the receiver tolerance characteristics for 200GAUI-4 and 400GAUI-8 devices. A major problem in the communication of multi-channel transceivers is interference. The interfering signal can come from a variety of sources including: a) Crosstalk from other data channels running the same kind of signals as the channel of interest. This type of interference is usually subdivided into: 1) Far-end crosstalk (FEXT) coming from data traveling in the same general direction as the channel of interest. 2) Near-end crosstalk (NEXT) originating from a channel with a transmitter near the receiver of the channel of interest. b) Self interference caused by reflections due to impedance discontinuities, stubs, etc. This is a form of intersymbol interference (ISI) that is beyond what a reasonable equalizer can compensate. c) Alien crosstalk which is defined to be interference from unrelated sources such as clocks, other kinds of data, power supply noise, etc. For the channel to work, the receiver must be able to extract correct data from the lossy channel in the presences of interference. The ability of the receiver to extract data in the presence of interference is an important characteristic of the receiver and needs to be measured. This ability is called interference tolerance.

In this test, BER is measured while the DUT is subjected to an input victim signal with far-end crosstalk disturber interference as specified in [3]. Reference [4] specifies four sets of test values which describe the setup parameters for the test. The test channel will be calibrated using COM as described in [5] and [6].

Test Setup: See Appendix I.

Test Procedure:

1. Calibrate the channel and output of the pattern generator according to [2] and [3].
2. Configure the victim, far end and near end pattern generator output to transmit a jittered PRBS31Q waveform.
3. Connect the lane under test's transmitter to an error detector.
4. Enable an externally facing loopback on the DUT.
5. Transmit at least $3x10^5$ bits from the victim pattern generator and calculate the PCS FEC Symbol error rate from the number of errors on the error detector.
6. Repeat steps 1-4 for all test values in [4].
7. Repeat steps 1-5 with signaling speed of 26.5625 Gbd ± 100 ppm
8. Repeat steps 1-8 for each receive lane.

Observable Results:

a. The receiver shall operate with a PCS FEC Symbol error ratio of 10^{-5} or better.

Possible Problems: None.

Test 120D.4.2 – Receiver Jitter Tolerance

Purpose: To verify that the RS-FEC symbol error ratio of the DUT's receiver is within the conformance limits while communicating over a lossy channel.

References:

[1] IEEE Std. 802.3-2018, Table 120D-5 - Receiver characteristics
[2] IEEE Std. 802.3-2018, Annex 120D.3.2.2 - Receiver jitter tolerance
[3] IEEE Std. 802.3-2018, Figure 93-12 – Jitter Tolerance Setup
[4] IEEE Std. 802.3-2018, Table 93- 6 Receiver interference tolerance parameters
[5] IEEE Std. 802.3-2018, Table 94 – 17 COM parameter values
[6] IEEE Std. 802.3-2018, Table 120D – 7 Receiver jitter tolerance parameters

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [2] specifies the receiver tolerance characteristics for 200GAUI-4 and 400GAUI-8 devices. A major problem in the communication of multi-channel transceivers is jitter. The ability of the receiver to extract data in the presence of low frequency interference is an important characteristic of the receiver and needs to be measured.

In this test, the RS-FEC symbol error ratio is measured while the DUT is subjected to a channel as specified in [3]. Reference [2] specifies test value four will be used to describe the setup parameters for the test in reference [4]. The test will be run for all cases as described in [6].

Test Setup: See Appendix I.

Test Procedure:

1. Calibrate the channel and output of the pattern generator according to [2] and [3].
2. Configure the victim, far end and near end pattern generator output to transmit a jittered PRBS31Q waveform.
3. Connect the lane under test's transmitter to an error detector.
4. Enable an externally facing loopback on the DUT.
5. Transmit at least $3x10^5$ bits from the victim pattern generator and calculate the PCS FEC Symbol error rate from the number of errors on the error detector.
6. Repeat steps 1-4 for all test values in [6].
7. Repeat steps 1-5 with signaling speed of 26.5625 Gbd ± 100 ppm
8. Repeat steps 1-6 for each receive lane.

Observable Results:

a. The receiver shall operate with a RS-FEC symbol error rate of 10^{-5} or better for each case.

Possible Problems: None.

APPENDICES

Overview:

Test plan appendices are intended to provide additional low-level technical detail pertinent to specific tests contained in this test plan. 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 plan. Appendix topics may also include discussion regarding a specific interpretation of the standard (for the purposes of this test plan), for cases where a particular specification may appear unclear or otherwise open to multiple interpretations.

Scope:

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

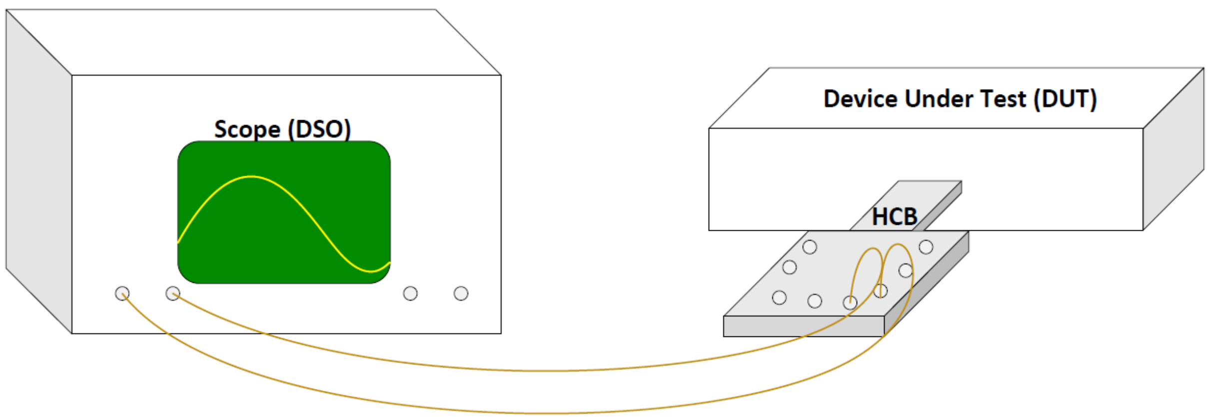
Appendix I – Test Fixtures and Setups

Purpose: To specify the test equipment and setup used to test all electrical characteristic as well as waveform characteristics in this test plan.

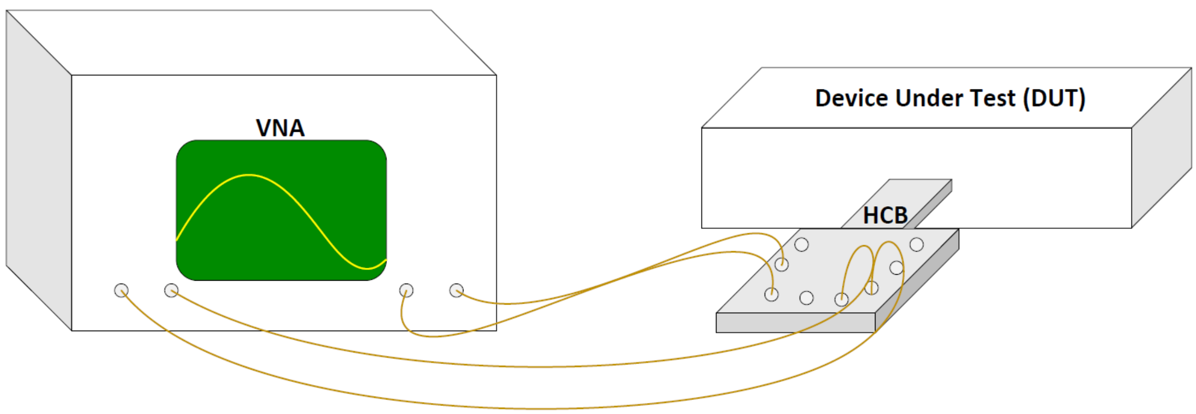
Last Modification: May 23, 2014

Equipment List:

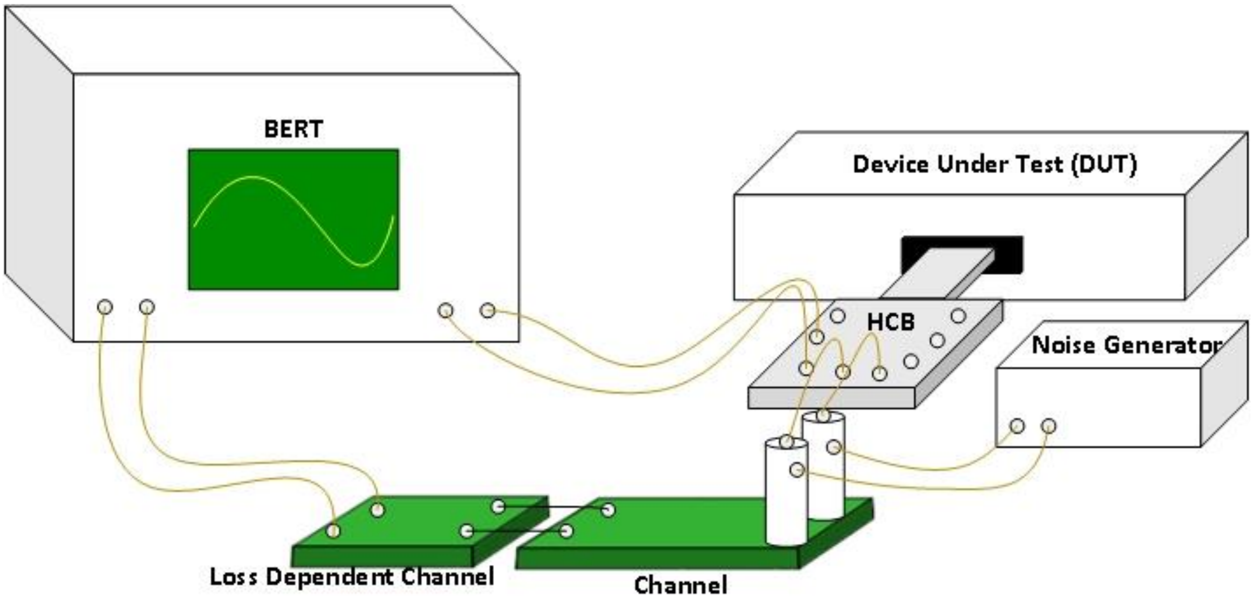
1. Digital Storage Oscilloscope, 50 GHz bandwidth (minimum)
2. Vector Network Analyzer, capable of measuring up to 19 GHz (minimum)
3. Bit Error Rate Tester (BERT)
4. 50 Ω matched coax cables
5. Host compliance board (HCB)



93.I – 1: Setup used for Group 1 and 2: Transmitter Electrical testing



93.I – 2: Setup used for Group 3: Impedance Requirements testing



93.I – 3: Setup used for Group 4: Receiver Electrical Requirements testing