50, 100, 200 AND 400 GIGABIT ETHERNET TESTING SERVICE

Annex 120C
200GAUI-8 and 400GAUI-16 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 2, 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-8 and 400GAUI-16 products.

These tests are designed to determine if a product conforms to specifications defined in Annex 120C 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-8 and 400GAUI-16 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: HOST TRANSMITTER ELECTRICAL SIGNALING REQUIREMENTS

Overview:

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

Test 120C.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, Annex 120C.3 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical 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-8 and 400GAUI-16 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-8 and 400GAUI-16 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 120C.1.2 – Output Amplitude

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

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical 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-8 and 400GAUI-16 devices. This specification includes conformance requirements for the differential output amplitude defined in [2] and single ended output voltage.

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 PRBS9 as defined in [2].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send PRBS9.
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 single ended output voltage should be less than 3.3 V, regardless of equalization setting.
b. The minimum single ended output voltage should be greater than -0.4 V, regardless of equalization setting.
c. The maximum differential peak-to-peak output voltage should be less than 900 mV, regardless of equalization setting.
d. The transmitter output voltage should be less than or equal to 35 mV peak-to-peak when disabled as defined in [4] and [5].

Possible Problems: None.

Test 120C.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, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical 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-8 and 400GAUI-16 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 PRBS9.
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 -0.3 V and 2.8 V with respect to the signal shield.

Possible Problems: None.

Test 120C.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, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical characteristics
[2] IEEE Std. 802.3-2018, Table 83D-1 – Transmitter Characteristics
[3] IEEE Std. 802.3-2018, subclause 93.8.1.3 – Signal Levels
[4] 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-8 and 400GAUI-16 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 PRBS9 as defined in [2].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send PRBS9.
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 17.5 mV.

Possible Problems: None.

Test 120C.1.5 – Transmit Eye

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

References:

[1] IEEE Std. 802.3-2018, Table 83E-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M host output characteristics
[3] IEEE Std. 802.3-2018, subclause 83E.3.1.6 – Host output eye width and eye height
[4] IEEE Std. 802.3-2018, subclause 83E.4.2 – Eye width and eye height measurement method
[5] IEEE Std. 802.3-2018, Figure 83E-9– Host output eye width and eye height setup

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 100G CAUI-4 devices. Reference [2] amends these specifications for 200G GAUI-8 and 400G GAUI-16 hosts.

In this test, the transmitter eye width is measured by leveraging the Dual-Dirac jitter model to estimate random jitter on a cumulative density function (CDF) created from a differential equalized signal. The DUT is instructed to transmit Pattern 4, and there should be sufficient samples to allow for a CDF to a probability of 10^{-6} without extrapolation. The CDF for the left and right edges of the eye diagram are linear fit to yield the random jitter for the left and right edges (RJR, RJL), which then uses equation 83E-7 to extrapolate the eye width from 10^{-6} probability to the desired 10^{-15} probability:

$$EW15 = EW6 - 3.19 * (RJR + RJL) \quad (83E - 7)$$

The transmitter eye height is found by finding the central 5 % of the signal at both logic 1 and logic 0. A CDF is created for each level, which are linear fit in Q-scale over the range of probabilities of 10-4 and 10-6 which yield relative noise 1 (RN1) and relative noise 0 (RN0). Equation 83E-8 is used to extrapolate the eye height from 10^{-6} probability to the desired 10^{-15} probability:

$$EH15 = EH6 - 3.19 * (RN0 + RN1) \quad (83E - 8)$$

Test Setup: See Appendix I.

Test Procedure:

1. Configure a receiver to specifications listed in [3] and connect to DUT.
2. Acquire the recommended CTLE settings from receiver.
3. Configure the DUT so that it is sourcing pattern 4 with equalization.
4. Connect the DUT's transmitter to the DSO.
5. Capture at least 4 million samples.
6. Calculate EW15 and EH15 following the procedure in [3].
7. Repeat steps 1-6 for each transmit lane.
8. Repeat steps 3-7 for with CTLE values 1 dB higher than recommended by host.
9. Repeat steps 3-7 for with CTLE values 1 dB lower than recommended by host.

Observable Results:

a. The eye width shall be at least 0.46 UI.
b. The eye height shall be at least 95 mV for case A (recommended equalization), and 80 mV for case B (+/- 1 dB of equalization to CTLE).

Possible Problems: None.

Test 120C.1.6 – Transition Time

Purpose: To verify that the DUT's transition time is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 83E-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M host output characteristics
[3] IEEE Std. 802.3bm, subclause 83E.3.1.5 – Transition Time
[4] IEEE Std. 802.3bj, Annex 86A.5.3.3 – Rise/Fall time

Resource Requirements: See Appendix I.

Last Modification: December 1, 2014

Discussion:

Reference [1] specifies the transmitter eye characteristics for 100G CAUI-4 devices. Reference [2] amends these specifications for 200G GAUI-8 and 400G GAUI-16 hosts.

In this test, the transition time is measured while the DUT is connected to the DSO. The transition times are to be measured at the 20 % and 80 % levels as defined in [3]. Reference [3] also requires that the measurement be done using the square wave test pattern, with no equalization and a run of at least eight consecutive ones.

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT so that it is sourcing a square pattern with no equalization.
2. Connect the DUT's transmitter to the DSO.
3. Capture a run of at least right consecutive ones.
4. Measure the rising and falling edge transition times.
5. Repeat steps 1-5 for each transmit lane.

Observable Results:

a. The rising and falling edge transition times value should be greater than or equal to 10 ps.

Possible Problems: None.

GROUP 2: MODULE TRANSMITTER ELECTRICAL SIGNALING REQUIREMENTS

Overview:

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

Test 120C.2.1 – Signaling Speed

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

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical 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-8 and 400GAUI-16 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-8 and 400GAUI-16 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 120C.2.2 – Output Amplitude

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

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical 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

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 200GAUI-8 and 400GAUI-16 devices. This specification includes conformance requirements for the differential output amplitude defined in [2] and single ended output voltage.

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 PRBS9 as defined in [2].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send PRBS9.
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 900 mV, regardless of equalization setting.

Possible Problems: None.

Test 120C.2.3 – 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, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical 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-8 and 400GAUI-16 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 PRBS9.
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 -0.350 V and 2.85 V with respect to the signal shield.

Possible Problems: None.

Test 120C.2.4 – 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, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 chip-to-module electrical characteristics
[2] IEEE Std. 802.3-2018, Table 83D-1 – Transmitter Characteristics
[3] IEEE Std. 802.3-2018, subclause 93.8.1.3 – Signal Levels
[4] 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-8 and 400GAUI-16 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 PRBS9 as defined in [2].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT to send PRBS9.
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 17.5 mV.

Possible Problems: None.

Test 120C.2.5 – Transmit Eye

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

References:

[1] IEEE Std. 802.3-2018, Table 83E-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M host output characteristics
[3] IEEE Std. 802.3-2018, subclause 83E.3.2.1 – Module output eye width and eye height
[4] IEEE Std. 802.3-2018, subclause 83E.4.2 – Eye width and eye height measurement method

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the transmitter characteristics for 100G CAUI-4 devices. Reference [2] amends these specifications for 200G GAUI-8 and 400G GAUI-16 modules.

In this test, the transmitter eye width is measured by leveraging the Dual-Dirac jitter model to estimate random jitter on a cumulative density function (CDF) created from a differential equalized signal. The DUT is instructed to transmit Pattern 4, and there should be sufficient samples to allow for a CDF to a probability of 10^{-6} without extrapolation. The CDF for the left and right edges of the eye diagram are linear fit to yield the random jitter for the left and right edges (RJR, RJL), which then uses equation 83E-7 to extrapolate the eye width from 10^{-6} probability to the desired 10^{-15} probability:

$$EW15 = EW6 - 3.19 * (RJR + RJL) \quad (83E - 7)$$

The transmitter eye height is found by finding the central 5 % of the signal at both logic 1 and logic 0. A CDF is created for each level, which are linear fit in Q-scale over the range of probabilities of 10-4 and 10-6 which yield relative noise 1 (RN1) and relative noise 0 (RN0). Equation 83E-8 is used to extrapolate the eye height from 10^{-6} probability to the desired 10^{-15} probability:

$$EH15 = EH6 - 3.19 * (RN0 + RN1) \quad (83E - 8)$$

The vertical eye closure is calculated using the EH15 variable and the mean value of logic 1 minus the mean value of logic 0 in the central 5% of the eye:

$$Vertical\ Eye\ Closure = 20\log\left(\frac{AV}{EH15}\right) \quad (83E - 9)$$

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT so that it is sourcing pattern 4 with optimum equalization.
2. Connect the DUT's transmitter to the DSO.
3. Capture at least 4 million samples.
4. Calculate EW15 and EH15 following the procedure in [3].
5. Repeat steps 1-6 for each transmit lane.

Observable Results:

a. The eye width shall be at least 0.57 UI.
b. The eye height shall be at least 228 mV.
c. The vertical eye close shall be less than 5.5dB.

Possible Problems: None.

Test 120C.2.6 – Transition Time

Purpose: To verify that the DUT's transition time is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 83E-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M host output characteristics
[3] IEEE Std. 802.3bm, subclause 83E.3.1.5 – Transition Time
[4] IEEE Std. 802.3bj, Annex 86A.5.3.3 – Rise/Fall time

Resource Requirements: See Appendix I.

Last Modification: December 1, 2014

Discussion:

Reference [1] specifies the transmitter eye characteristics for 100G CAUI-4 devices. Reference [2] amends these specifications for 200G GAUI-8 and 400G GAUI-16 hosts.

In this test, the transition time is measured while the DUT is connected to the DSO. The transition times are to be measured at the 20 % and 80 % levels as defined in [3]. Reference [3] also requires that the measurement be done using the square wave test pattern, with no equalization and a run of at least eight consecutive ones.

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT so that it is sourcing a square pattern with no equalization.
2. Connect the DUT's transmitter to the DSO.
3. Capture a run of at least right consecutive ones.
4. Measure the rising and falling edge transition times.
5. Repeat steps 1-5 for each transmit lane.

Observable Results:

a. The rising and falling edge transition times value should be greater than or equal to 10 ps.

Possible Problems: None.

Test 120C.2.7 – Vertical Eye Closure

Purpose: To verify that the DUT's output eye is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Table 83E-1 – Transmitter Characteristics
[2] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M host output characteristics
[3] IEEE Std. 802.3bm, subclause 83E.3.1.5 – Transition Time
[4] IEEE Std. 802.3bj, Annex 86A.5.3.3 – Rise/Fall time

Resource Requirements: See Appendix I.

Last Modification: December 1, 2014

Discussion:

Reference [1] specifies the transmitter eye characteristics for 100G CAUI-4 devices. Reference [2] amends these specifications for 200G GAUI-8 and 400G GAUI-16 hosts.

In this test, the transition time is measured while the DUT is connected to the DSO. The transition times are to be measured at the 20 % and 80 % levels as defined in [3]. Reference [3] also requires that the measurement be done using the square wave test pattern, with no equalization and a run of at least eight consecutive ones.

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT so that it is sourcing a square pattern with no equalization.
2. Connect the DUT's transmitter to the DSO.
3. Capture a run of at least right consecutive ones.
4. Measure the rising and falling edge transition times.
5. Repeat steps 1-5 for each transmit lane.

Observable Results:

a. The rising and falling edge transition times value should be greater than or equal to 10 ps.

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 120C of the IEEE Std. 802.3-2018.

Test 120C.3.1 – Differential Output Return Loss

Purpose: To verify that the differential output return loss of a module or host is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2C transmitter characteristics
[2] IEEE Std. 802.3-2018, subclause 83E.3.1.3 – Differential output return loss

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. 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 (83E-2). The reference impedance for differential return loss measurements shall be 100 Ω.

$$Return\_loss(f) \geq \begin{Bmatrix} 9.5 - 0.37f & 0.01 \leq f \leq 8 \\ 4.75 - 7.4log10(f) & 8 \leq f \leq 19 \end{Bmatrix} (dB) \qquad (83E-2)$$

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 (83E - 2).

Possible Problems: None.

Test 120C.3.2 – Differential Input Return Loss

Purpose: To verify that the differential input return loss of a module or host is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3.2 - 200GAUI-8 and 400GAUI-16 C2M receiver characteristics
[2] IEEE Std. 802.3-2018., subclause 83E.3.3.1 – Differential input return loss

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the receiver characteristics for 200G GAUI-8 and 400G GAUI-16 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 transmitter. 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 (83E-5). The reference impedance for differential return loss measurements shall be 100 Ω.

$$Return\_loss(f) \geq \left\{ \begin{matrix} 9.5 - 0.37f & 0.01 \leq f \leq 8 \\ 4.75 - 7.4log10(\frac{f}{14}) & 8 \leq f \leq 19 \end{matrix} \right\} (dB) \qquad (83E - 5)$$

Test Setup: See Appendix I.

Test Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT's 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 (83E - 5).

Possible Problems: None.

Test 120C.3.3 – Common to Differential Output Return Loss

Purpose: To verify that the output return loss of a module or host is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M transmitter characteristics

[2] IEEE Std. 802.3-2018, subclause 83E.3.1.3 – 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 to common mode return loss, which are specified in [2].

For the purpose of this test, the differential to common output 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 (83E - 3).

$$Return\_loss(f) \geq \left\{ \begin{matrix} 22 - 20\dfrac{f}{25.78} & 0.01 \leq f \leq 12.89 \\ 15 - 6\dfrac{f}{25.78} & 12.89 \leq f \leq 19 \end{matrix} \right\} (dB) \qquad (83E - 3)$$

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 (83E - 3).

Possible Problems: None.

Test 120C.3.4 – Differential to Common Mode Input Return Loss

Purpose: To verify that the input return loss of a module or host is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M receiver characteristics
[2] IEEE Std. 802.3bm., subclause 83E.3.3.1 – 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 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 to common mode input return loss of the driver should exceed (83E-6).

$$Return\_loss(f) \geq \begin{Bmatrix} 22 - 20\dfrac{f}{25.78} & 0.01 \leq f \leq 12.89 \\ 15 - 6\dfrac{f}{25.78} & 12.89 \leq f \leq 19 \end{Bmatrix} (dB) \qquad (83E-6)$$

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 (83E - 6).

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 120C of the IEEE Std. 802.3-2018.

Test 120C.4.1 – Host Receiver Stressed Input

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, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M receiver characteristics
[2] IEEE Std. 802.3-2018, Table 83E- 4 Host input characteristics
[3] IEEE Std. 802.3-2018, subclause 83E.3.3.2 – Host stressed input parameters
[4] IEEE Std. 802.3-2018, subclause 83E.3.3.2.1 – Host stressed input test procedure
[5] IEEE Std. 802.3-2018, Figure 83E-14 – Host stressed input summary
[6] IEEE Std. 802.3-2018, Annex 93A.2 - Test channel calibration
[7] IEEE Std. 802.3-2018, Table 83E-6 - COM parameter values

Resource Requirements: See Appendix I.

Last Modification: April 1, 2019

Discussion:

Reference [1] specifies the receiver tolerance characteristics for 200GAUI-8 and 400GAUI-16 devices based off [2]. 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]. The DUT's transmitter taps are set via management to provide the lowest BER and sinusoidal jitter is added to the test transmitter via a modulated clock source. 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] with the parameters as described in [6].

Test Setup: See Appendix I.

Test Procedure:

1. Configure the victim, far end and near end pattern generator output to transmit a jittered PRBS9 waveform.
2. Connect the lane under test's transmitter to an error detector.
3. Enable an externally facing loopback on the DUT.
4. Transmit at least $3x10^{12}$ bits from the victim pattern generator and calculate the BER from the number of errors on the error detector.
5. Repeat steps 1-4 for all test values in [4].
6. Repeat steps 1-5 with signaling speed of 26.5625 Gbd ± 100 ppm
7. Repeat steps 1-8 for each receive lane.

Observable Results:

a. The receiver shall operate with a BER of 10^{-6} or better.

Possible Problems: None.

Test 120C.4.2 – Module Receiver Tolerance

Purpose: To verify that the bit error ratio (BER) of the DUT's receiver is within the conformance limits.

References:

[1] IEEE Std. 802.3-2018, Annex 120C.3.1 - 200GAUI-8 and 400GAUI-16 C2M receiver characteristics
[2] IEEE Std. 802.3-2018, subc1ause 83E.3.4 - Module stressed input test
[3] IEEE Std. 802.3-2018, Table 83E - 8 – Module stressed input parameters
[4] IEEE Std. 802.3-2018, Table 83E - 9 – Pattern generator jitter characteristics
[5] IEEE Std. 802.3-2018, Table 87-13 - Applied sinusoidal jitter
[6] IEEE Std. 802.3-2018, Table 86A – 6 – Test patterns

Resource Requirements: See Appendix I.

Last Modification: April 3, 2019

Discussion:

Reference [1] specifies the compliance characteristics for 200GAUI-8 and 400GAUI-16 modules. This specification includes conformance requirements for the receiver tolerance defined in [2]. A major problem in communicating 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 a compliant input signal with interference as specified in [3]. The XLAUI/CAUI jitter tolerance test setup in Figure 83A–15 or its equivalent shall meet the receiver eye mask defined in Table 83A–2. Random jitter is added to the test signal using an interference generator which is a broadband noise source capable of producing white Gaussian noise with adjustable amplitude. The power spectral density shall be flat to ±3 dB from 50 MHz to 6 GHz with a crest factor of no less than 5. The amplitude and output jitter of the filter stress plus limiter and random jitter injection shall meet [3] and [4]. All XLAUI/CAUI lanes shall be active during jitter tolerance testing. The PRBS31 pattern defined in [5] or scrambled idle defined in 82.2.10 is used for evaluating XLAUI/CAUI jitter tolerance.

Test Setup: See Appendix I.

Test Procedure:

1. Configure the DUT so that it is sourcing test pattern 3 (PRBS31).
2. Connect the DUT's receiver to a jitter source that can operate as defined in [3].
3. Calculate the BER based on the received bits.
4. Repeat steps 1-3 for all cases in [5].
5. Repeat steps 1-4 for all lanes.

Observable Results:

a. The receiver shall operate with a BER of better then 10^{-6}.

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.

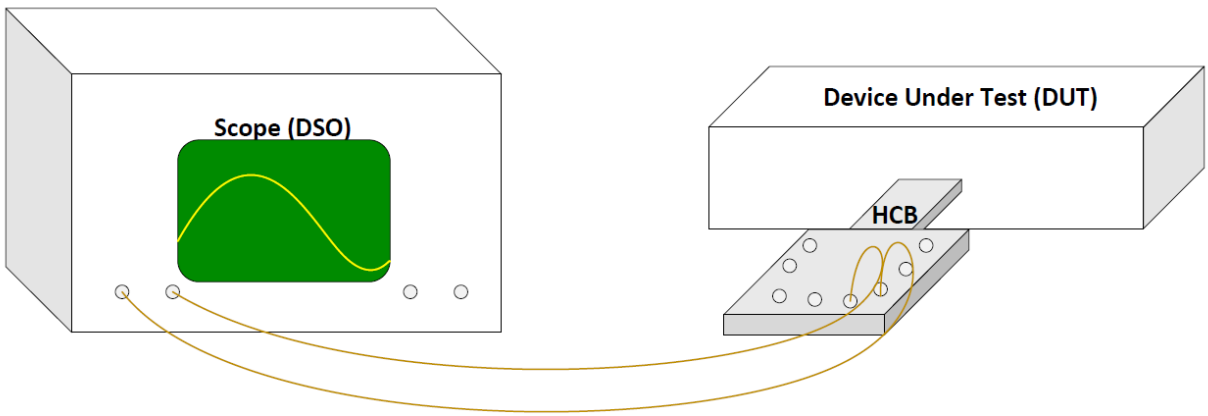
Appendix I – Test Fixtures and Setups

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

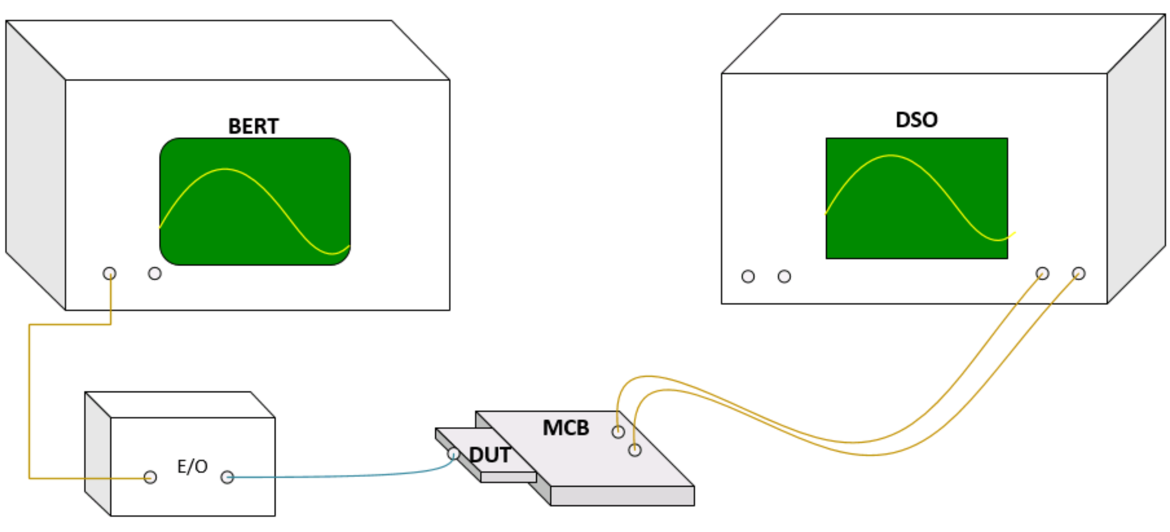
Last Modification: May 23, 2014

Equipment List:

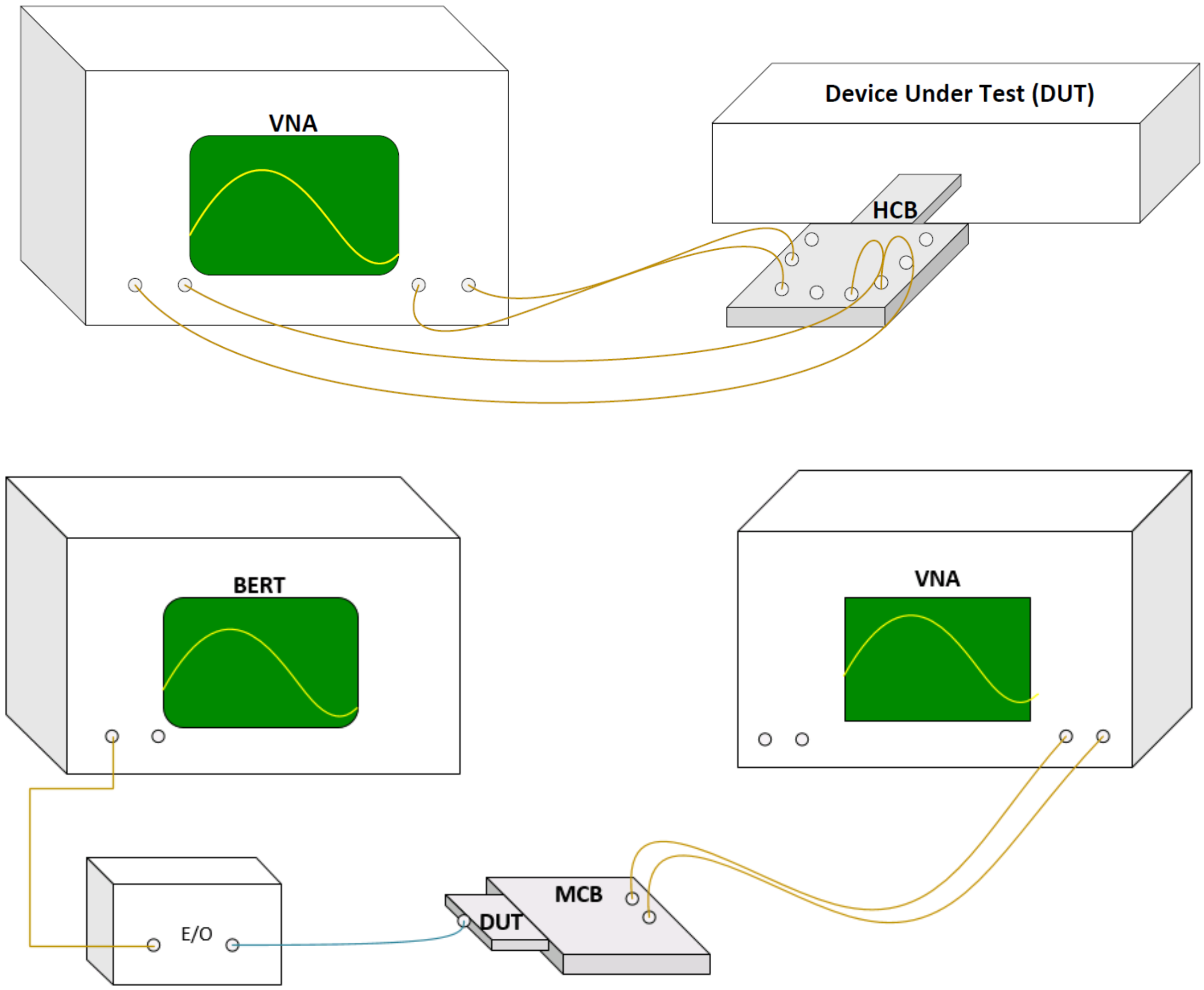
1. Digital Storage Oscilloscope, 50 GHz bandwidth (minimum)
2. Vector Network Analyzer, capable of measuring up to 19 GHz (minimum)
3. Bit Error Rate Tester (BERT)
4. 50 Ω matched coax cables
5. Host compliance board (HCB)
6. Module compliance board (MCB)



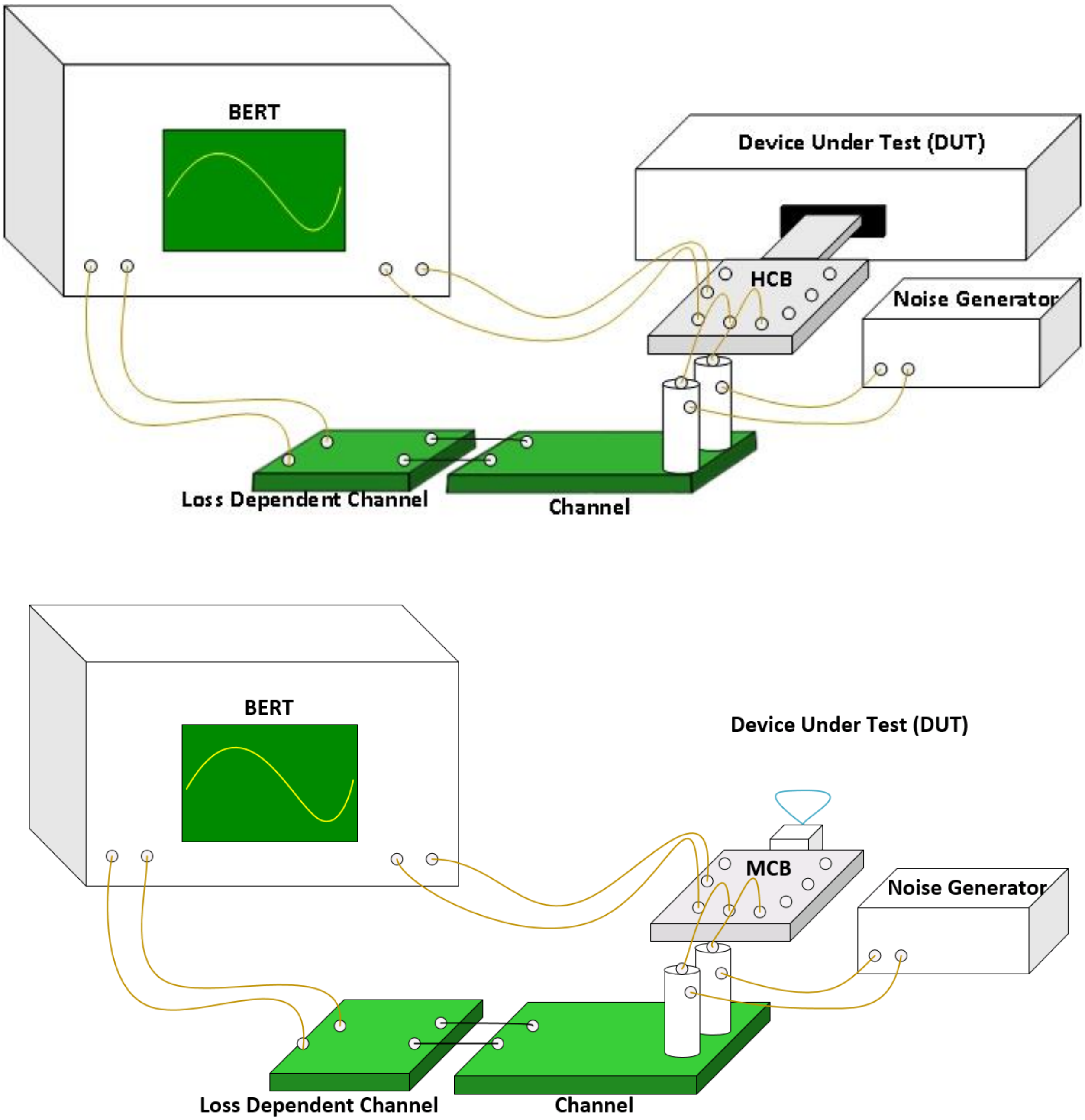
120.I – 1: Setup used for Group 1: Transmitter Electrical testing



120.I – 2: Setup used for Group 2: Transmitter Electrical testing



120.I – 3: Setups used for Group 3: Impedance Requirements testing



120 – 4: Setups used for Group 4: Receiver Electrical Requirements testing