40 AND 100 GIGABIT ETHERNET CONSORTIUM

Clause 110
Cable Assembly Conformance Test Suite
Version 1.0
Technical Document

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40 and 100 Gigabit Ethernet Consortium

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MODIFICATION RECORD

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Michael Klempa: Initial version

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Curtis Donahue	UNH InterOperability Laboratory

INTRODUCTION

Overview

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 suite of tests has been developed to help implementers evaluate the standards conformance of SFP+ cable assemblies to the SFF-8431 Standard.

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 suite 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

The references section lists cross-references to the SFF-8431 standards and other documentation that might be helpful in understanding and evaluating the test and 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 suite document itself.

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 not be included here, but rather included in the procedure section below.

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 observations that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable, 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.

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 suite appendices and/or whitepapers that may provide more detail regarding these issues.

Group 1: 25GBASE-CR CABLE ASSEMBLY SPECIFICATIONS

Overview:

The tests defined in this section verify the direct attach cable's characteristics defined in Clause 110 of the IEEE Std. 802.3by. Three cable assembly types are specified, CA-N (no FEC), CA-S (BASE-R FEC) and CA-L (RS- FEC) with different requirements, due to the error correction capabilities of the three FEC cases implemented on the cable assembly.

Test 110.1 –Insertion Loss at Nyquist

Purpose: To verify that the insertion loss is within specification

References:

[1] IEEE Std. 802.3by, Table 110 - 10 – Cable Assembly Characteristics Summary

Resource Requirements: See Appendix I.

Last Modification: June 7, 2017

Discussion:

Reference [1] specifies the characteristics for Cu cable assemblies. This specification includes conformance requirements for the minimum and maximum insertion loss at 12.8906 GHz.

	CA-25G-L	**CA-25G-S**	**CA-25G-N**	**Unit**
Max.	22.48	16.48	15.5	dB
Min.	8	8	8	dB

Test Setup: See Appendix I.

Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT to the VNA.
3. Measure the insertion loss of the DUT at 12.8906 GHz.

Observable Results:

a. The insertion loss should be within the limits described by [1].

Possible Problems: None.

Test 110.2 –Return Loss at Nyquist

Purpose: To verify that the insertion loss is within specification

References:

[1] IEEE Std. 802.3by, Table 110 - 10 – Cable Assembly Characteristics Summary

Resource Requirements: See Appendix I.

Last Modification: June 7, 2017

Discussion:

Reference [1] specifies the characteristics for Cu cable assemblies. This specification includes conformance requirements for the maximum return loss at 12.8906 GHz.

	CA-25G-L	**CA-25G-S**	**CA-25G-N**	**Unit**
Max.	6	6	6	dB

Test Setup: See Appendix I.

Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT to the VNA.
3. Measure the return loss of the DUT at 12.8906 GHz.

Observable Results:

a. The return loss should be below the limit described by [1].

Possible Problems: None.

Test 110.3 –Differential Return Loss

Purpose: To verify that the differential input and out return loss is within specification

References:

[1] IEEE Std. 802.3by, Table 110 - 10 – Cable Assembly Characteristics Summary
[2] IEEE Std. 802.3bj, subclause 92.10.3 – Differential Return Loss

Resource Requirements: See Appendix I.

Last Modification: June 7, 2017

Discussion:

Reference [1] specifies the characteristics for Cu cable assemblies. This specification includes conformance requirements for the differential return loss from 50 MHz to 19 GHz.

$$\begin{Bmatrix} 16.6 - 2\sqrt{f} & 0.05 \le f < 4.1GHz \\ 14\log10(\frac{f}{5.5}) & 4.1GHz < f \le 19\ GHz \end{Bmatrix}\ (dB)$$

Test Setup: See Appendix I.

Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT to the VNA.
3. Measure the return loss of the DUT.

Observable Results:

a. The return loss should be below the limits described by [1].

Possible Problems: None.

Test 110.4 –Differential to Common Mode Return Loss

Purpose: To verify that the differential to common mode input and out return loss is within specification

References:

[1] IEEE Std. 802.3by, Table 110 - 10 – Cable Assembly Characteristics Summary
[2] IEEE Std. 802.3bj, subclause 92.10.4 – Differential to Common Mode Return Loss

Resource Requirements: See Appendix I.

Last Modification: June 7, 2017

Discussion:

Reference [1] specifies the characteristics for Cu cable assemblies. This specification includes conformance requirements for the differential to common mode return loss from 10 MHz to 19 GHz.

$$\left.\begin{cases} 22 - \left(\frac{20}{25.78}\right) f & 0.01 \le f < 12.89\ GHz \\ 15 - \left(\frac{6}{25.78}\right) f & 12.89\ GHz < f \le 19\ GHz \end{cases}\right\} (dB)$$

Test Setup: See Appendix I.

Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT to the VNA.
3. Measure the return loss of the DUT.

Observable Results:

a. The return loss should be below the limits described by [1].

Possible Problems: None.

Test 110.5 –Differential to Common Mode Conversion Loss

Purpose: To verify that the differential to common mode conversion loss is within specification

References:

[1] IEEE Std. 802.3by, Table 110 - 10 – Cable Assembly Characteristics Summary
[2] IEEE Std. 802.3bj, subclause 92.10.5 – Differential to Common Mode Conversion Loss

Resource Requirements: See Appendix I.

Last Modification: June 7, 2017

Discussion:

Reference [1] specifies the characteristics for Cu cable assemblies. This specification includes conformance requirements for the differential to common mode conversion loss from 10 MHz to 19 GHz.

$$\begin{cases} 10 & 0.01 \le f < 12.89\ GHz \\ 27 - \left(\frac{29}{22}\right) f & 12.89\ GHz < f \le 15.7\ GHz \\ 6.3 & 15.7\ GHz < f \le 19\ GHz \end{cases} \ (dB)$$

Test Setup: See Appendix I.

Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT to the VNA.
3. Measure the return loss of the DUT.

Observable Results:

a. The return loss should be below the limits described by [1].

Possible Problems: None.

Test 110.6 –Common Mode to Common Mode Return Loss

Purpose: To verify that the common mode to common mode input and out return loss is within specification.

References:

[1] IEEE Std. 802.3by, Table 110 - 10 – Cable Assembly Characteristics Summary
[2] IEEE Std. 802.3bj, subclause 92.10.6 – Differential to Common Mode Return Loss

Resource Requirements: See Appendix I.

Last Modification: June 7, 2017

Discussion:

Reference [1] specifies the characteristics for Cu cable assemblies. This specification includes conformance requirements for the common mode to common mode return loss from 20 MHz to 19 GHz.

$$\{2 \qquad 0.02 \leq f < 19\ GHz\}\ (dB)$$

Test Setup: See Appendix I.

Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT to the VNA.
3. Measure the return loss of the DUT.

Observable Results:

a. The return loss should be below the limits described by [1].

Possible Problems: None.

Test 110.7 –Channel Operating Margin (COM)

Purpose: To verify that the common mode to common mode input and out return loss is within specification.

References:

[1] IEEE Std. 802.3by, Table 110 - 10 – Cable Assembly Characteristics Summary
[2] IEEE Std. 802.3by, subclause 110.10.7.1 – Channel Operating Margin
[3] IEEE Std. 802.3bj, Annex 93A.1 – Channel Operating Margin Procedure
[4] IEEE Std. 802.3by, Table 110 - 11 – COM parameter values
[5] http://www.ieee802.org/3/by/public/channel/index.html

Resource Requirements: See Appendix I.

Last Modification: June 7, 2017

Discussion:

The cable assembly Channel Operating Margin (COM) for each lane is derived from measurements of the cable assembly signal, near-end crosstalk and far-end crosstalk paths. COM is computed using the path calculations defined in [2] and the procedure in [3]. COM parameter values for the three cable assembly types, CA-25G-L, CA-25G-S, and CA-25G-N, are provided in [4].

COM	CA-25G-L	CA-25G-S	CA-25G-N	Unit
Minimum Margin	3	3	3	dB
If the IL at Nyquist is greater than 12dB for CA-N:			2.2	dB

Test Setup: See Appendix I.

Procedure:

1. Calibrate the VNA to remove the effects of the coaxial cables.
2. Connect the DUT to the VNA.
3. Measure the Victim Lane of the DUT.
4. Measure the Near End Cross Talk of the DUT.
5. Measure the Far End Cross Talk of the DUT.
6. Run COM script using all paths captured above.
7. Record COM output.

Observable Results:

a. The channel operating margin should be above 3 dB.

Possible Problems: A cable might pass the less strenuous case CA-L or CA-S but fail CA-N. This is not a fail, as cables can be implemented in one or all scenarios. In this case, a note for any failures will be included in the report.

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 I - Setup for VNA measurements

Purpose: To specify the setup for VNA based tests in this test suite

Resource Requirements:

- Vector Network Analyzer, capable of measuring up to 19 GHz (minimum)
- Two Module Compliance Boards meeting the requirements in:
  IEEE Std. 802.3by, subclause110B.1.2 SFP28 Cable assembly test fixture

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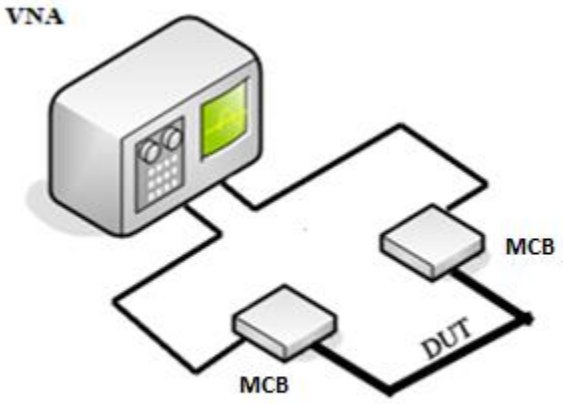
Discussion:
For the purpose of these tests, the testing equipment should be set up in the following manner:



The VNA is setup so that differential port 1 is connected to the TX side of one card while differential port 2 is attached to the RX side on the other card.

The VNA should be properly calibrated before use.