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(Revision of IEEE Std 1802.3-1991,
includes IEEE Std 1802.3d-1993)

IEEE Conformance Test Methodology for IEEE Standards for Local and Metropolitan Area Networks—

Specific Requirements—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee



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IEEE-SA Standards Board

Abstract: Abstract methods for the conformance testing of 802.3 Clause 14 (10BASE-T MAU) implementations in order to satisfy conformance requirements arising from the ISO/IEC 8802-3 (IEEE Std 802.3) specification are provided.

Keywords: AUI, compliance, conformance testing, MAC, MAU, PICS, PIXIT, PLS

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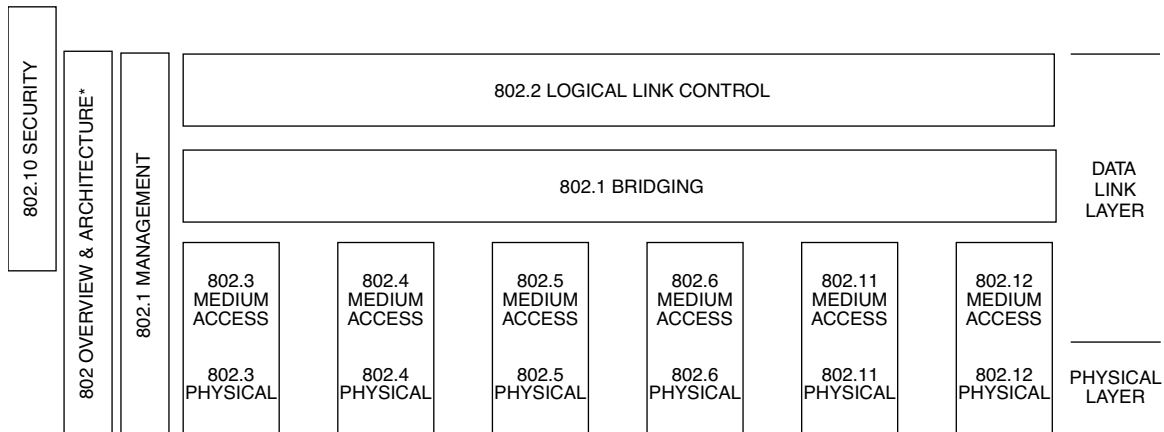
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Introduction to IEEE Std 1802.3-2001

[This introduction is not part of IEEE Std 1802.3-2001, IEEE Conformance Test Methodology for IEEE Standards for Local and Metropolitan Area Networks—Specific Requirements—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.]

This standard is part of a family of standards for local and metropolitan area networks. The relationship between the standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.)



* Formerly IEEE Std 802.1A.

This family of standards deals with the Physical and Data Link layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Basic Reference Model (ISO/IEC 7498-1: 1994). The access standards define seven types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining the technologies noted above are as follows:

- IEEE Std 802 *Overview and Architecture*. This standard provides an overview to the family of IEEE 802 Standards.
- ANSI/IEEE Std 802.1B and 802.1k [ISO/IEC 15802-2] *LAN/MAN Management*. Defines an OSI management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ANSI/IEEE Std 802.1D *Media Access Control (MAC) Bridges*. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- ANSI/IEEE Std 802.1E [ISO/IEC 15802-4] *System Load Protocol*. Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- ANSI/IEEE Std 802.1F *Common Definitions and Procedures for IEEE 802 Management Information*.
- ANSI/IEEE Std 802.1G [ISO/IEC 15802-5] *Remote Media Access Control (MAC) Bridging*. Specifies extensions for the interconnection, using non-LAN communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.
- IEEE Std 802.1H [ISO/IEC TR 11802-5] *Media Access Control (MAC) Bridging of Ethernet V2.0 in Local Area Networks*.
- ANSI/IEEE Std 802.2 [ISO/IEC 8802-2] *Logical Link Control*.

- ANSI/IEEE Std 802.3 *CSMA/CD Access Method and Physical Layer Specifications.*
- ANSI/IEEE Std 802.4 *Token Passing Bus Access Method and Physical Layer Specifications.*
[ISO/IEC 8802-4]
- ANSI/IEEE Std 802.5 *Token Ring Access Method and Physical Layer Specifications.*
[ISO/IEC 8802-5]
- ANSI/IEEE Std 802.6 *Distributed Queue Dual Bus Access Method and Physical Layer Specifications.*
[ISO/IEC 8802-6]
- ANSI/IEEE Std 802.10 *Interoperable LAN/MAN Security.*
- ANSI/IEEE Std 802.11 *Wireless LAN Medium Access Control (MAC) and Physical Layer Specifications.*
[ISO/IEC DIS 8802-11]
- ANSI/IEEE Std 802.12 *Demand Priority Access Method, Physical Layer and Repeater Specifications.*
[ISO/IEC 8802-12]

In addition to the family of standards, the following is a recommended practice for a common Physical Layer technology:

- IEEE Std 802.7 *IEEE Recommended Practice for Broadband Local Area Networks.*

Conformance test methodology

An additional standards series, identified by the number 1802, was established to identify the conformance test methodology documents for the 802 family of standards. This makes the correspondence between the various 802 standards and their applicable conformance test requirements readily apparent. Thus the conformance test document for 802.3 is numbered 1802.3.

IEEE Std 1802.3-2001

This standard, IEEE Std 1802.3-2001 is a revision of IEEE Std 1802.3-1991 and IEEE Std 1802.3d-1993. This standard provides conformance test information to satisfy requirements for certain implementations of 10BASE-T arising from ISO/IEC 8802-3: 2000 (IEEE Std 802.3, 2000 Edition). At the time this standard was approved, the complete IEEE 802.3 family of standards consisted of the following published documents:

ISO/IEC 8802-3: 2000 (IEEE Std 802.3, 2000 Edition)

Information on the current revision state of this, IEEE Std 802.3 and other IEEE 802 standards may be obtained from
Secretary, IEEE Standards Board
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IEEE Conformance Test Methodology for IEEE Standards for Local and Metropolitan Area Networks—

Specific Requirements—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

1. Introduction

1.1 Purpose

This standard defines abstract methods for the conformance testing of 802.3 Clause 14 (10BASE-T MAU) implementations in order to satisfy conformance requirements arising from ISO/IEC 8802-3¹ [IEEE Std 802.3]. Such methods will form the basis for any subsequent development of executable test cases.

1.2 Scope

The conformance test suite is intended to detect incorrect implementations of Clause 14 (10BASE-T MAU) of the ISO/IEC 8802-3 standard [IEEE Std 802.3] with the exception of the options that have been added to Clause 14 since the publication of 1996 edition of ISO/IEC 8802-3 [IEEE Std 802.3]. The Clause 14 options excluded from this conformance test suite are support for Auto-Negotiation and full-duplex operation. The test suite should demonstrate conformance to Clause 14 of the ISO/IEC 8802-3 standard [IEEE Std 802.3]. However, the user should be made aware of Section 1.3, paragraph 2, of the IEEE Standards Manual, December 1990 edition (Conformance of Products or Systems to IEEE Standards):

IEEE Standards may contain testing procedures useful in determining whether products or systems are in compliance with the standards. Compliance in itself does not necessarily imply quality or guarantee proper use. Where IEEE Standards are used as the basis of examination and/or testing of products or systems by laboratories or other agencies in the process of determining their suitability for their intended use and safe operation, the IEEE assumes no responsibility for the use or interpretation of its standards or the adequacy of the testing or certification.

The test setups and procedure described in this standard are designed to provide the implementor with a methodology for obtaining repeatable results by which conformance can be judged. However, these methodologies are by no means unique. This standard does not preclude the use of alternative methodologies provided that an equivalence between the prescribed methodology and the alternative methodology can be demonstrated.

¹Information on references can be found in 1.8.

It is acknowledged that conformance testing may need to be augmented by other testing (i.e., interoperability or development testing). Such testing is beyond the scope of this standard. It is possible, on the other hand, that an implementation may be interoperable with other implementations but not satisfy conformance testing.

Finally the reader should note that no environmental specifications appear in the test suite. A prudent vendor should ensure that the implementation operates as intended throughout the vendor's specified environmental range before claiming conformance.

1.3 Acronyms and abbreviations

ANSI	American National Standards Institute
ATS	abstract test suite
AUI	attachment unit interface
AWG	arbitrary waveform generator
BAL	balanced-unbalanced matching transformer (Balun)
BT	bit time
CI	control in circuit
CP	current probe
CO	control out circuit
CSMA/CD	carrier sense multiple access/collision detect
dB	decibels
DI	data in circuit
DIS	draft international standard
DP	differential probe
DO	data out circuit
DTE	data terminal equipment
FG	function generator
HDP	high-performance differential probe
IDL	idle signal
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
IUT	implementation under test
kHz	kilohertz
LTPG	link test pulse generator
MAC	media access control
MAU	medium attachment unit
Mb/s	megabits per second
MDI	medium dependent interface
MHz	megahertz
OSI	open systems interconnection
PG	protective ground
PICS	protocol implementation conformance statement
PIXIT	protocol implementation extra information for testing

PLS	physical signaling
RD	receive data
RM	reference model
SFD	start frame delimiter
SOI	start of idle
SQE	<i>signal_quality_error</i>
TBD	to be defined
TD	transmit data
TPG	test pattern generator
TPM	twisted-pair model
VP	voltage plus
VC	voltage common

1.4 Overview

Clause 6 of this standard is organized into two main subclauses. These subclauses are as follows:

- a) **Abstract test suite.** This is comprised of two categories of test groups. The first category involves basic interconnection testing; the second concerns capability and behavior testing. Within both categories are a number of test groups, where each group is aimed at collecting individual test cases that share some communality in features tested or test methods used. The format of this standard is meant to be consistent with guidelines for ISO Conformance Test Methodology. The reader is advised to review ISO/IEC 9646.
- b) **Test setups and adapters description.** This subclause describes the test setups, adapters, and instruments used in the abstract test suite.

1.5 Test case header description

Each test case is written in a standard format. This subclause defines the various fields of the standard format.

Test Case ID : Identification number given to the test case. See 1.6 for encoding of the test case identifications.

Test Case Name : Name assigned to the test case.

Status : Indicates level of conformance required. May be *Mandatory* or *Optional*. Mandatory requirements are to be observed in all cases. Optional requirements are to be observed when conditions set out in the standard apply.

Standard Ref. : Clause of ISO/IEC 8802-3 [IEEE Std 802.3] standard.

History : Additional reference to approved revisions to the standard.

Test Purpose : Purpose(s) of the test case.

Note : Additional information may be provided in this section.

Test Setup : This section describes the test setup. The detailed test setup is defined in each conformance test section.

Test Procedure : This section describes the test procedure.

Conformance : Statement of conformance requirement, usually quoted directly from the standard.

1.6 Numbering scheme

This is the test-case numbering scheme as used by the ISO/IEC 8802-3 [IEEE Std 802.3] conformance test specifications. Some of the evolving test suites and their corresponding numbers are given as follows:

MAC	2111
PLS	1311
AUI cable	1211
10BASE5 MAU	1111
10BASE-T MAU	1411

The form is as follows:

ABCD.EF.GH

where

A	Layer
B	Sublayer Reference
C	Class or Access Method
D	Transmission Variant or Classification
EF	Test Group Number
GH	Test Case Number

Example: 1411.07.01 refers to test case 01 in test group 07 of the test suite for the CSMA/CD physical layer testing 10BASE-T MAU component.

1411.EF.GH

where

1	=	Physical layer
4	=	10BASE-T MAU
1	=	CSMA/CD (medium independent)
1	=	10 Mb/s

1.7 Verdict assignment

It is recognized that a conformance verdict may depend on the accuracy of a test measurement and the capabilities of an instrument. The abstract test procedure does not specify accuracy requirements. An executable test suite derived from the abstract test suite shall state the accuracy of each measurement in a test case. The verdict shall be inconclusive if derived without the necessary measurement accuracy.

1.8 References

This standard shall be used with the following publications. When the following publications are superseded by an approved revision, the revision shall apply.

ISO 7498:1984, Information Processing Systems — Open Systems Interconnection — Basic Reference Model.²

ISO/IEC 9646:1994, Information processing systems — Open systems interconnection — OSI conformance testing methodology and framework.

ISO/IEC 8802-3:2000 [IEEE Std 802.3, 2000 Edition], Information Technology — Local and Metropolitan Area Networks — Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.³

IEC 60060, High-Voltage Test Techniques.⁴

IEC 60096-1:1986, Radio-Frequency Cables, Part 1: General Requirements and Measuring Methods.

IEC 600950:1991, Safety of Information Technology Equipment, Including Electrical Business Equipment.

IEC 60603-7:1999, Connectors for Frequencies Below 3 MHz for Use with Printed Boards, Part 7: Detail Specification for Connectors, 8-way, Including Fixed and Free Connectors with Common Mating Features, with Assessed Quality.

IEC 60807-2:1985 (1st Edition), Rectangular Connectors for Frequencies Below 3 MHz, Part 2: Detail Specification for a Range of Connectors with Round Contacts — Fixed Solder Contact Types.

2. MAC conformance testing

Clause 2 was originally reserved for MAC conformance testing. No further work is planned on this standard.

3. PLS conformance testing

Clause 3 was originally reserved for PLS conformance testing. No further work is planned on this standard.

4. AUI Cable conformance testing

Clause 4 originally contained information on AUI Cable conformance testing. No further work is planned on this standard.

²ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

³IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

⁴In the 2001 edition of this standard, IEC publications have been renumbered in accordance with IEC's revised numbering system. In 1997, all existing publications were issued a designation in the 60000 series. Thus IEC 60 became IEC 60060, IEC 950 became IEC 60950, etc. IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

5. 10BASE5 MAU conformance testing

Clause 5 was originally reserved for 10BASE5 MAU conformance testing. No further work is planned on this standard.

6. Type 10BASE-T MAU conformance test methodology

6.1 Scope of 10BASE-T MAU conformance test

The purpose of this clause is to define abstract methods for the conformance testing of 10BASE-T MAU implementations in order to satisfy conformance requirements arising from the 10BASE-T MAU specification (Clause 14 of ISO/IEC 8802-3) with the exception of the options that have been added to Clause 14 since the publication of 1996 edition of ISO/IEC 8802-3 [IEEE Std 802.3]. The Clause 14 options excluded from this conformance test suite are support for Auto-Negotiation and full-duplex operation however full coverage of operation at the MDI is provided. Such methods will form the basis for any subsequent development of executable test cases. This standard is applicable to the conformance testing of CSMA/CD 10BASE-T MAU (hereafter referred to as MAU) implementations that have been designed to Clause 14 of ISO/IEC 8802-3. Additional information about the implementation under test may be found in the Protocol Implementation Extra Information for Testing (PIXIT).

6.1.1 Embedded MAUs

Many of these tests do not apply to embedded MAUs where the physical AUI does not exist. In those cases, other standards may apply.

6.2 10BASE-T MAU abstract test suite

This is comprised of one category of test groups. The category relates to capability testing. Within this category are a number of test groups, where each group is aimed at collecting individual test cases together that share some commonality in features tested or test methods used. The MAU test method is Local Single as per ISO/IEC 9646. The format for the test case headers follows the outline of 1.5, with the addition of a PICS Reference: line that cross-references the test case to a particular PICS subclause/item of ISO/IEC 8802-3 [IEEE Std 802.3].

Test Suite ID	:	1411
Test Suite Name	:	10BASE-T MAU Abstract Tests
Applicable Standards	:	ISO/IEC 8802-3
OSI RM Layer	:	Physical
OSI RM Sublayer	:	Medium Attachment Unit (MAU)
Class or Access	:	CSMA/CD
Transmission Type	:	10BASE-T
Purpose	:	To assess conformance of the physical interface to applicable standards.
General Setup	:	Unless otherwise stated in individual test procedures, all tests shall start with Apply power to the MAU and bring the MAU into Link Test Pass State. In addition, all tests requiring the application of power to the MAU via the AUI shall be performed with 11.28 V applied through a 3.5 Ω 1% resistor to the VP circuit of the MAU and with 15.75 V applied through no series resistor to the VP circuit of the MAU, unless otherwise stated. For both voltage levels, all stray wiring and connection resistance for both the VP circuit and the VC circuit combined shall be limited to a maximum of 0.405 Ω excluding the resistance of conformant AUI connector connections at the source and MAU ends. All AUI applied

voltages are with reference to circuit VC.

When required, the MAU can be verified to be in a Link Test Fail state by monitoring the DI circuit for input_idle messages and the TD circuit for TD_idle messages.

6.2.1 Capability and behavior tests

6.2.1.1 Test group 1411.01 — transmit functions

Test Group ID	:	1411.01
Test Group Name	:	Transmit functions.
Test Group Purpose	:	To verify the characteristics of the Transmit function.
Test Case ID	:	1411.01.01
Test Case Name	:	Transmit signal polarity.
Status	:	MANDATORY
Standard Reference	:	14.2.1.1
PICS Reference	:	14.10.4.5.2/1, 14.10.4.5.2/2
History	:	
Test Purpose	:	To verify the polarity of the TD circuit signals in relation to the DO circuit signals.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DO circuit and the TD circuit for correct logical sense after the initial bit-loss time and before the start of idle of a packet transmission.
Conformance	:	The MAU shall receive the signals on the DO circuit and send them to the TD circuit of the MDI. A positive signal on the A lead relative to the B lead of the DO circuit shall result in a positive signal on the TD+ (Transmit Data +) lead of the MDI with respect to the TD– lead.
Test Case ID	:	1411.01.02
Test Case Name	:	Transmit start-up bit loss.
Status	:	MANDATORY
Standard Reference	:	14.2.1.1
PICS Reference	:	14.10.4.5.2/3
History	:	
Test Purpose	:	To verify the number of bits received on the DO circuit and not transmitted on the TD circuit.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DO circuit and TD circuit. Measure the number of bits received on the DO circuit and not transmitted onto the TD circuit using the Start Frame Delimiter (SFD) for reference.
Conformance	:	At the start of a packet transmission, no more than 2 bits may be received by the MAU from the DO circuit and not transmitted on the TD circuit. It is permissible for the first bit sent to contain phase violations or invalid amplitude.
Test Case ID	:	1411.01.03
Test Case Name	:	Transmit settling time.

Status	:	MANDATORY
Standard Reference	:	14.2.1.1
PICS Reference	:	14.10.4.5.2/4
History	:	
Test Purpose	:	To verify the timing and signal level of the second bit cell transmitted.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DO circuit and TD circuit. Observe the second and subsequent bits on the TD circuit.
Conformance	:	The second bit transmitted on the TD circuit shall be transmitted with the correct timing and signal levels.

Test Case ID	:	1411.01.04
Test Case Name	:	Transmit steady-state delay.
Status	:	MANDATORY
Standard Reference	:	14.2.1.1
PICS Reference	:	14.10.4.5.2/5
History	:	
Test Purpose	:	To verify the propagation delay between the DO circuit and the TD circuit.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DO circuit and TD circuit. Measure the propagation delay from a bit's zero crossing on the DO circuit to the corresponding bit's zero crossing on the TD circuit using the SFD for reference.
Conformance	:	The steady-state propagation delay between the DO circuit input and the TD circuit shall not exceed 2 bit times.

Test Case ID	:	1411.01.05
Test Case Name	:	Transmit delay variability.
Status	:	MANDATORY.
Standard Reference	:	14.2.1.1
PICS Reference	:	14.10.4.5.2/6
History	:	
Test Purpose	:	To verify the start-up delay variability between two packets.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signals 2a–f to the DO circuit of the MAU. Monitor the DO circuit and TD circuit. Measure the start-up delay (bit loss plus steady-state propagation delay) for a packet and the subsequent packet. Repeat the test 100 times to determine the largest variability.
Conformance	:	For any two packets that are separated by 9.6 μ s or less, the start-up delay (bit loss plus steady-state propagation delay) of the first packet shall not exceed that of the second packet by more than 2 bit times.

Test Case ID	:	1411.01.06
Test Case Name	:	TP_IDL, silence duration and silence voltage.
Status	:	MANDATORY
Standard Reference	:	14.2.1.1
PICS Reference	:	14.10.4.5.2/7, 14.10.4.5.2/8

History	:	
Test Purpose	:	To verify the timing of the TP_IDL signal.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the TD circuit. Measure the period of silence between the start of TP_IDL and the link test pulse. Measure the time between repeating link test pulses.
Conformance	:	Whenever data is not being transmitted on the TD circuit, an idle signal, TP_IDL, shall be transmitted on the TD circuit. TP_IDL is a start of idle as defined in 14.3.1.2.1 followed by a repeating sequence of a 16 ms $\pm$ 8 ms period of silence (the time where the differential voltage remains at 0 mV $\pm$ 50 mV) and a link test pulse (see 14.3.1.2.1).

Test Case ID	:	1411.01.07
Test Case Name	:	TP_IDL signal termination with respect to start of packet and link test pulse.
Status	:	MANDATORY
Standard Reference	:	14.2.1.1
PICS Reference	:	14.10.4.5.2/9
History	:	
Test Purpose	:	To verify correct termination of the TP_IDL signal.
Note	:	This test case is considered untestable. It is not practical to measure and is not considered critical. Even though testing for compliance is not practical, conformance to the standard, by design, is the responsibility of the manufacturer with compliance status to be noted in the PICS.
Test Setup	:	
Test Procedure	:	
Conformance	:	Transmission of TP_IDL may be terminated at any time with respect to the link test pulse. It shall be terminated such that no more than the first transmitted bit of a packet is corrupted and with no more delay than is specified for bit loss and steady-state propagation.

6.2.1.2 Test group 1411.02 — receive functions

Test Group ID	:	1411.02
Test Group Name	:	Receive Functions.
Test Group Purpose	:	To verify the characteristics of the Receive Function.

Test Case ID	:	1411.02.01
Test Case Name	:	Receive start-up bit loss.
Status	:	MANDATORY
Standard Reference	:	14.2.1.2
PICS Reference	:	14.10.4.5.3/3
History	:	
Test Purpose	:	To verify the number of bits received on the RD circuit and not transmitted on the DI circuit.
Note	:	
Test Setup	:	Test setup L.
Test Procedure	:	Apply test signal 1 to the DO circuit of the tester MAU. Monitor the RD circuit and DI circuit on the MAU under test. Measure the number of bits received on the RD circuit of the MAU under test and not transmitted on the DI circuit of the MAU under test using the SFD for reference.
Conformance	:	At the start of a packet reception from the RD circuit, no more than 5 bits

may be received from the RD circuit and not transmitted onto the DI circuit.

Test Case ID	:	1411.02.02
Test Case Name	:	Receive steady-state delay.
Status	:	MANDATORY
Standard Reference	:	14.2.1.2
PICS Reference	:	14.10.4.5.3/5
History	:	
Test Purpose	:	To verify the propagation delay from the RD circuit to the DI circuit.
Note	:	
Test Setup	:	Test setup L.
Test Procedure	:	Apply test signal 1 to the DO circuit of the tester MAU. Monitor the DI circuit and RD circuit on the MAU under test. Measure the propagation delay between a bit s zero crossing on the RD circuit of the MAU under test and the corresponding bit s zero crossing on the DI circuit of the MAU under test using the SFD for reference.
Conformance	:	The steady-state propagation delay between the RD circuit and the DI circuit shall not exceed 2 bit times.

Test Case ID	:	1411.02.03
Test Case Name	:	Receive signal polarity.
Status	:	MANDATORY
Standard Reference	:	14.2.1.2
PICS Reference	:	14.10.4.5.3/1, 14.10.4.5.3/2
History	:	
Test Purpose	:	To verify the polarity of the DI circuit signals in relation to the RD circuit signals.
Note	:	
Test setup	:	Test setup L
Test Procedure	:	Apply test signal 1 to the DO circuit of the tester MAU. Monitor the DI circuit and RD circuit signals on the MAU under test for correct logical sense after the initial bit-loss time and before the start of idle of the packet.
Conformance	:	The MAU shall receive the signals on the RD circuit of the MDI and send them to the DI circuit. A positive signal on the RD+ (Receive Data +) lead relative to the RD– lead of the MDI shall result in a positive signal on the A lead with respect to the B lead of the DI circuit.

Test Case ID	:	1411.02.04
Test Case Name	:	Receive delay variability.
Status	:	MANDATORY
Standard Reference	:	14.2.1.2
PICS Reference	:	14.10.4.5.3/6
History	:	
Test Purpose	:	To verify the start-up delay between two packets.
Note	:	
Test Setup	:	Test setup H.
Test Procedure	:	Apply test signals 24a—f to the RD circuit of the MAU under test. Monitor the DI circuit and RD circuit signals. Measure how much the start-up delay (bit loss plus steady-state propagation delay) exceeds the delay of the subsequent packet. Repeat the test 100 times and note the worst-case

	value.
Conformance	: For any two packets that are separated by 9.6 s or less, the start-up delay (bit loss plus steady-state propagation delay) of the first packet shall not exceed that of the second packet by more than 2 bit times.

Test Case ID	: 1411.02.05
Test Case Name	: Receive settling time.
Status	: MANDATORY
Standard Reference	: 14.2.1.2
PICS Reference	: 14.10.4.5.3/4
History	:
Test Purpose	: To verify the timing and signal level of the second bit transmitted.
Note	:
Test Setup	: Test setup L.
Test Procedure	: Apply test signal 1 to the DO circuit of the tester MAU. Monitor the DI circuit and RD circuit on the MAU under test. Observe the second and subsequent bits on the DI circuit of the MAU under test.
Conformance	: It is permissible for the first bit sent on the DI circuit to contain phase violations or invalid data; however all successive bits of the packet shall be sent with no more than the amount of jitter specified in 14.3.1.3.1.

6.2.1.3 Test group 1411.03 — loopback functions

Test Group ID	: 1411.03
Test Group Name	: Loopback functions.
Test Group Purpose	: To verify the functional characteristics of the Loopback function.

Test Case ID	: 1411.03.01
Test Case Name	: Loopback function when RD = idle and DO = active.
Status	: MANDATORY
Standard Reference	: 14.2.1.3
PICS Reference	: 14.10.4.5.4/1
History	:
Test Purpose	: To verify the loopback function requirements when RD is idle and DO is active.
Note	:
Test Setup	: Test setup B.
Test Procedure	: Apply test signal 1 to the DO circuit of the MAU. Monitor the DI circuit.
Conformance	: When the MAU is transmitting on the TD circuit and is not receiving RD_input messages on the RD circuit, the MAU shall transmit on the DI circuit the signals received on the DO circuit in order to provide loopback of the transmitted signal.

Test Case ID	: 1411.03.02
Test Case Name	: Loopback bit loss (DO to DI circuits).
Status	: MANDATORY
Standard Reference	: 14.2.1.3
PICS Reference	: 14.10.4.5.4/2
History	:
Test Purpose	: To verify the number of bits transmitted on the DO circuit and not received on the DI circuit.

Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DI circuit and DO circuit. Measure the number of bits received on the DO circuit and not transmitted on the DI circuit using the SFD for reference.
Conformance	:	At the start of a packet transmission on the TD circuit, no more than 5 bits of information may be received from the DO circuit and not transmitted to the DI circuit.

Test Case ID	:	1411.03.03
Test Case Name	:	Loopback steady-state delay.
Status	:	MANDATORY
Standard Reference	:	14.2.1.3
PICS Reference	:	14.10.4.5.4/4
History	:	
Test Purpose	:	To verify the propagation delay from the DO circuit to the DI circuit.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DI circuit and DO circuit. Measure the propagation delay from a bit's zero crossing on the DO circuit to the corresponding bit's zero crossing on the DI circuit using the SFD for reference.
Conformance	:	The steady-state propagation delay between the DO circuit and the DI circuit shall not exceed 1 BT.

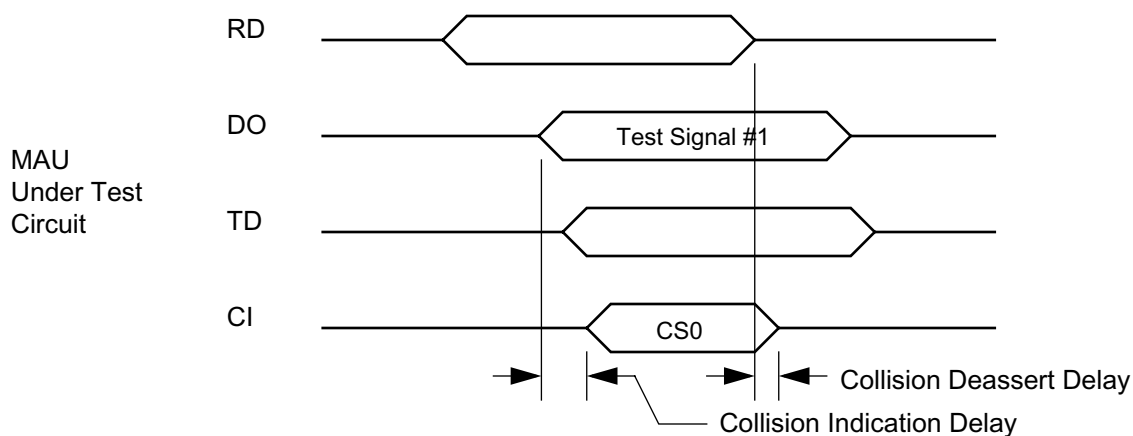
Test Case ID	:	1411.03.04
Test Case Name	:	Loopback settling time.
Status	:	MANDATORY
Standard Reference	:	14.2.1.3
PICS Reference	:	14.10.4.5.4/3
History	:	
Test Purpose	:	To verify the timing and signal level of the second bit cell transmitted.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DI circuit and DO circuit signals. Observe the second and subsequent bits of the DI circuit data.
Conformance	:	It is permissible for the first bit sent on the DI circuit to contain phase violations or invalid data; however, all successive bits of the packet shall meet the jitter specified in 14.3.1.3.1 (that is, 13.5 ns + 1.5 ns).

6.2.1.4 Test group 1411.04 — collision functions

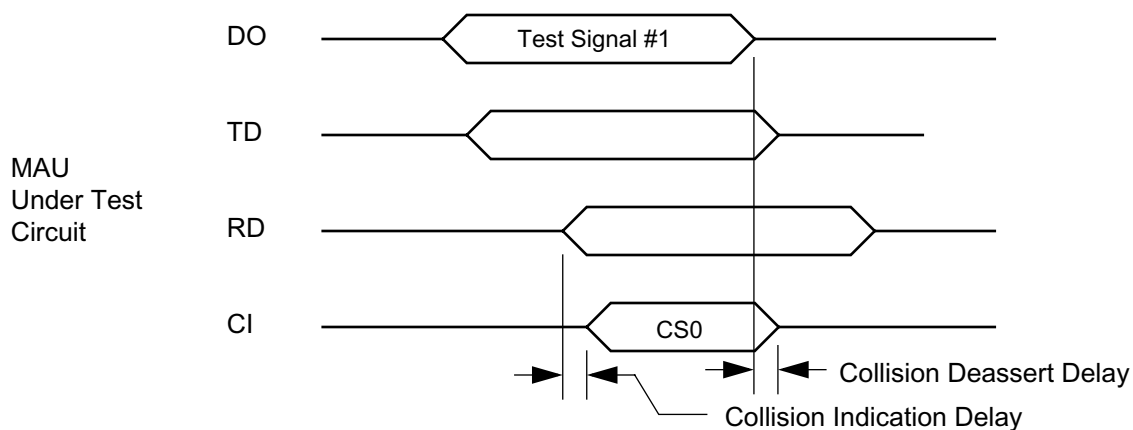
Test Group ID	:	1411.04
Test Group Name	:	Collision functions.
Test Group Purpose	:	To verify the functional characteristics of the collision function.
Test Case ID	:	1411.04.01
Test Case Name	:	No collision state.
Status	:	MANDATORY
Standard Reference	:	14.2.1.4
PICS Reference	:	14.10.4.5.5/4
History	:	
Test Purpose	:	To verify the presence and the signal characteristics of IDL on the CI circuit when there is no collision, SQE test, or jabber.
Note	:	
Test Setup	:	Test setup M.
Test Procedure	:	Monitor the CI circuit of the MAU under test. (1) Apply test signal 1 to the DO circuit of the tester MAU and IDL to the DO circuit of the MAU under test. (2) Apply test signal 1 to the DO circuit of the MAU under test and IDL to the DO circuit of the tester MAU. Verify that CI is asserting IDL while DI is active.
Conformance	:	The signal present on the CI circuit in the absence of a collision, SQE test, or jabber shall be the IDL signal.
Test Case ID	:	1411.04.02
Test Case Name	:	Collision state.
Status	:	MANDATORY
Standard Reference	:	14.2.1.4
PICS Reference	:	14.10.4.5.5/1
History	:	
Test Purpose	:	To verify the presence and the signal characteristics of CS0 on the CI circuit when there is a collision.
Note	:	
Test Setup	:	Test setup O.
Test Procedure	:	Monitor the CI circuit, DO circuit, and TD circuit of the MAU under test. (1) Apply test signal 1 to the DO circuit of the tester MAU. Apply test signal 1 to the DO circuit of the MAU under test to create a collision. Verify on the MAU under test that the signals on the DO circuit appear on the TD circuit and that CS0 is present on the CI circuit (see Figure 6-1a). (2) Apply test signal 1 to the DO circuit of the MAU under test. Apply test signal 1 to the DO circuit of the tester MAU to create a collision. Verify on the MAU under test that the signals on the DO circuit appear on the TD circuit and that CS0 is present on the CI circuit (see Figure 6-1b).
Conformance	:	While a collision is detected, a CS0 signal [see 7.3.1.2 of ISO/IEC 8802-3 (IEEE Std 802.3)] shall be sent on the CI circuit.
Test Case ID	:	1411.04.03
Test Case Name	:	Collision indication delay.

Status	:	MANDATORY
Standard Reference	:	14.2.1.4
PICS Reference	:	14.10.4.5.5/2
History	:	
Test Purpose	:	To verify the delay between the collision start and the collision presence state indicated on CI circuit.
Note	:	
Test Setup	:	Test setup O.
Test Procedure	:	Monitor the CI circuit, DO circuit, and RD circuit of the MAU under test. (1) Apply test signal 1 to the DO circuit of the tester MAU. Apply test signal 1 to the DO circuit of the MAU under test to create a collision. Measure the delay from collision start (application of the second test signal on the DO circuit of the MAU under test) to commencement of the CS0 signal on the CI circuit (see Figure 6-1a). (2) Apply test signal 1 to the DO circuit of the MAU under test. Apply test signal 1 to the DO circuit of the tester MAU to create a collision. Measure the delay from collision start (appearance of the second test signal on the RD circuit of the MAU under test) to commencement of the CS0 signal on the CI circuit (see Figure 6-1b).
Conformance	:	The CS0 signal shall be presented to the CI circuit no more than 9 bit times after the occurrence of a collision.

Test Case ID	:	1411.04.04
Test Case Name	:	Collision indication deassert delay.
Status	:	MANDATORY
Standard Reference	:	14.2.1.4
PICS Reference	:	14.10.4.5.5/3
History	:	
Test Purpose	:	To verify the cessation of the CS0 signal after the collision condition is removed.
Note	:	
Test Setup	:	Test setup O.
Test Procedure	:	Monitor the CI circuit, DO circuit, and RD circuit of the MAU under test. (1) Apply test signal 1 to the DO circuit of the tester MAU. Apply test signal 1 to the DO circuit of the MAU under test to create a collision. Monitor the CI circuit for the presence of the CS0 signal. Stop the application of the test signal on the DO circuit of the tester MAU. Measure the time from the last transition of the test signal on the RD circuit of the MAU under test until the CS0 signal on the CI circuit stops (see Figure 6-1a). (2) Apply test signal 1 to the DO circuit of the MAU under test. Apply test signal 1 to the DO circuit of the tester MAU to create a collision. Monitor the CI circuit for the presence of the CS0 signal. Stop the application of the test signal on the DO circuit of the MAU under test. Measure the time from the last transition of the test signal on the DO circuit of the MAU under test until the CS0 signal on the CI circuit stops (see Figure 6-1b).
Conformance	:	The CS0 signal on the CI circuit shall be deasserted within 9 bit times after the DO circuit or the RD circuit changes from active to idle.



a) Test signal applied to tester MAU, then MAU under test



b) Test signal applied to MAU under test, then tester MAU

Figure 6-1 — Test signal application timing for collision functions

Test Case ID	:	1411.04.05
Test Case Name	:	DI circuit source switch delay from CS0 assert.
Status	:	MANDATORY
Standard Reference	:	14.2.1.4
PICS Reference	:	14.10.4.5.5/5
History	:	
Test Purpose	:	To verify the delay between the start of collision and the presence of RD data on the DI circuit.
Note	:	
Test Setup	:	Test setup M.
Test Procedure	:	Apply test signal 19a to the DO circuit of the MAU under test. Monitor the CI circuit and DI circuit of the MAU under test. Apply test signal 19b to the DO circuit of the tester MAU at least 65 BT after the test signal on the MAU under test is applied to create a collision. Monitor the CI circuit for the presence of the CS0 signal. Measure the delay between the assertion of CS0 and commencement of input on the DI circuit corresponding to the test signal applied to the tester MAU. The signals applied to the DO circuit of the tester MAU and the DO circuit of the MAU under test are different to facilitate differentiation between DO loopback and RD.
Conformance	:	When CS0 is asserted on the CI circuit due to a collision, the data on the RD circuit shall be sent to the DI circuit within 9 bit times.

Test Case ID	:	1411.04.06
Test Case Name	:	DI circuit source switch delay from CS0 deassert.
Status	:	MANDATORY
Standard Reference	:	14.2.1.4
PICS Reference	:	14.10.4.5.5/6
History	:	
Test Purpose	:	To verify the delay between the end of collision and the presence of DO data on the DI circuit.
Note	:	
Test Setup	:	Test setup M.
Test Procedure	:	Apply the test signal 19a to the DO circuit of the MAU under test. Monitor the CI circuit, RD circuit and DI circuit of the MAU under test. Apply test signal 19b to the DO circuit of the tester MAU at least 65 BT after the test signal on the MAU under test is applied to create a collision. Monitor the CI circuit for the presence of the CS0 signal. After CS0 is asserted, stop transmitting on the DO circuit of the tester MAU. Measure the delay between idle on the RD circuit (14.2.2.5) and the presence of the DO circuit test signal on the DI circuit. The signals applied to the DO circuit of the tester MAU and the DO circuit of the MAU under test are different to facilitate differentiation between RD circuit data and DO loopback.
Conformance	:	When the RD circuit changes from active to idle and data is present on the DO circuit, the data on the DO circuit shall be sent to the DI circuit within 9 bit times.

6.2.1.5 Test group 1411.05 — SQE test functions

Test Group ID	:	1411.05
Test Group Name	:	<i>Signal_quality_error</i> Message (SQE) Test functions.
Test Group Purpose	:	To verify the functional characteristics of the SQE test functions.

Test Case ID	:	1411.05.01
Test Case Name	:	SQE_test_timer range.
Status	:	CONDITIONAL (SQE Test function shall be performed by MAUs connected to DTEs and shall not be performed for MAUs connected to repeaters).
Standard Reference	:	14.2.1.5
PICS Reference	:	14.10.4.5.6/3, 14.10.4.5.6/4
History	:	
Test Purpose	:	To verify the duration of the SQE Test state after the end of a frame transmission.
Note	:	Duration of CS0 is between first excursion outside $0\text{ mV} \pm 40\text{ mV}$ and the last positive transition.
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the CI circuit. Measure duration of the CS0 signal on the CI circuit.
Conformance	:	The MAU shall send CS0 on the CI circuit for a time SQE_test beginning a time SQE_test_wait after the last positive transition on the DO circuit. The value of SQE_test shall be $10\text{ bit} \pm 5\text{ bit times}$.

Test Case ID	:	1411.05.02
Test Case Name	:	SQE_test_wait_timer range.
Status	:	CONDITIONAL (SQE Test function shall be performed by MAUs connected to DTEs and shall not be performed for MAUs connected to repeaters).
Standard Reference	:	14.2.1.5
PICS Reference	:	14.10.4.5.6/2
History	:	
Test Purpose	:	To verify the duration of the SQE Test Wait state after the end of a frame transmission.
Note	:	Duration of CS0 is between first excursion outside $0\text{ mV} \pm 40\text{ mV}$ and the last positive transition.
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DO circuit and CI circuit. Measure time delay between the last positive transition of the data on the DO circuit and the assertion of CS0 on the CI circuit.
Conformance	:	The MAU shall send CS0 on the CI circuit beginning a time SQE_test_wait after the last positive transition of a packet on the DO circuit. The value of SQE_test_wait shall be between $0.6\text{ }\mu\text{s}$ and $1.6\text{ }\mu\text{s}$.

Test Case ID	:	1411.05.03
Test Case Name	:	SQE Test function interference.
Status	:	CONDITIONAL (SQE Test function shall be performed by MAUs connected to DTEs and shall not be performed for MAUs connected to repeaters).
Standard Reference	:	14.2.1.5
PICS Reference	:	14.10.4.5.6/1
History	:	
Test Purpose	:	To verify the effect of the SQE Test function on the TD and DI circuits.
Note	:	Extraneous signal on the TD circuit is defined to be greater than $\pm 50\text{ mV}$; extraneous signal on the DI circuit is defined to be greater than $\pm 40\text{ mV}$.
Test Setup	:	Test setup B.

Test Procedure	:	Apply test signal 1 to the DO circuit of the MAU. Monitor the DI circuit and TD circuit for 3 μ s after the end of frame transmission.
Conformance	:	This function should not introduce extraneous signals on the TD circuit or the DI circuit.

Test Case ID	:	1411.05.04
Test Case Name	:	SQE Test function in link fail state.
Status	:	CONDITIONAL (SQE Test function shall be performed by MAUs connected to DTEs and shall not be performed for MAUs connected to repeaters).
Standard Reference	:	14.2.1.5
PICS Reference	:	14.10.4.5.6/5
History	:	
Test Purpose	:	To verify that the SQE Test function does not transmit a CS0 signal when MAU is in a Link Test Fail state.
Note	:	
Test Setup	:	Test setup N.
Test Procedure	:	Apply power to the MAU under test. Monitor the AUI CI circuit of the MAU under test. Wait for 151 ms then apply test signal 1 to the DO circuit of the MAU under test. Check that the MAU is in a Link Test Fail state. Verify that CS0 is not asserted on the CI circuit for at least 3.1 μ s.
Conformance	:	The CS0 signal shall not be sent by the SQE Test function while in any of the Link Test Fail states.

6.2.1.6 Test group 1411.06 —jabber functions

Test Group ID	:	1411.06
Test Group Name	:	Jabber functions.
Test Group Purpose	:	To verify the functional characteristics of the jabber functions.

Test Case ID	:	1411.06.01
Test Case Name	:	Xmit_max_timer range.
Status	:	MANDATORY
Standard Reference	:	14.2.1.6
PICS Reference	:	14.10.4.5.7/2, 14.10.4.5.7/3
History	:	
Test Purpose	:	To verify that jabber transmission inhibit starts within the time required.
Note	:	
Test Setup	:	Test setup C.
Test Procedure	:	Apply test signal 3a to the DO circuit of the MAU. Monitor the DI circuit, TD circuit, and CI circuit. Check that the TD circuit and DI circuit signals are present up to 20 ms following the application of the input signal and that they are absent after 150 ms following the application of the input. Check that CS0 is asserted on the CI circuit after the 150 ms time period. Repeat the same procedure using test signal 3b.
Conformance	:	The MAU shall provide a window xmit_max during which time the Transmit function may continuously transmit TD_output messages to the TD circuit. The value of xmit_max shall be between 20 ms and 150 ms. If a transmission exceeds this duration, the Jabber function shall inhibit the Loopback function and the transmission of TD_output messages by the Transmit function and shall send the CS0 signal on the CI circuit.

Test Case ID	:	1411.06.02
Test Case Name	:	Jabber reset.
Status	:	MANDATORY
Standard Reference	:	14.2.1.6
PICS Reference	:	14.10.4.5.7/1, 14.10.4.5.7/4
History	:	
Test Purpose	:	To verify the jabber function reset mechanism.
Note	:	
Test Setup	:	Test setup C.
Test Procedure	:	Apply test signal 3a to the DO circuit of the MAU. Monitor the DI circuit, TD circuit, and CI circuit. When jabber is indicated (signals no longer present on the DI and TD circuits and CS0 is asserted on the CI circuit), stop the test signal. Wait 249 ms from when the test signal is stopped and verify that CS0 is still present on the CI circuit and that no signals are present on the TD circuit and DI circuit. Wait an additional 502 ms and verify that CS0 is no longer asserted on the CI circuit. Repeat the above procedure using test signal 3b.
Conformance	:	If a transmission exceeds <code>xmit_max</code> the jabber function shall inhibit the Loopback function and the transmission of TD_output messages by the Transmit function and shall send the CS0 signal on the CI circuit. This shall continue until <code>output_idle</code> has been continuously present on the DO circuit for a time <code>unjab</code> . The value of <code>unjab</code> shall be 0.5 s $\pm$ 0.25 s.

Test Case ID	:	1411.06.03
Test Case Name	:	Jabber lockup protection.
Status	:	MANDATORY
Standard Reference	:	14.2.1.6
PICS Reference	:	14.10.4.5.7/5
History	:	
Test Purpose	:	To verify the MAU jabber lockup protection.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 26 to the DO circuit of the MAU. Monitor the TD circuit. Verify that the MAU does not enter jabber by verifying that the TD circuit remains active.
Conformance	:	The MAU shall not activate its Jabber function when the repeater's MAU Jabber Lockup Protection function operates at its longest permitted time as specified in 9.6.5.

6.2.1.7 Test group 1411.07 — link integrity test functions

Test Group ID	:	1411.07
Test Group Name	:	Link Integrity Test functions.
Test Group Purpose	:	To verify the functional characteristics of the link integrity test functions.

Test Case ID	:	1411.07.01
Test Case Name	:	Link loss timer.
Status	:	MANDATORY
Standard Reference	:	14.2.1.7

PICS Reference	:	14.10.4.5.8/1
History	:	
Test Purpose	:	To verify the value of the <code>link_loss</code> timer.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply test signal 4 to the DO circuit of the MAU. Monitor the DI circuit and TD circuit. Stop applying the link test pulses to the RD circuit. Measure the time from the last link test pulse to the loss of loopback on the DI circuit.
Conformance	:	If neither <code>RD_input</code> nor a link test pulse is received for a time <code>link_loss</code> , the MAU shall enter the Link Test Fail state and cause the <code>input_idle</code> message to be sent on the DI circuit and the <code>TD_idle</code> message to be sent on the TD circuit (Figure 14-6 of ISO/IEC 8802-3 [IEEE Std 802.3]). The value of <code>link_loss</code> shall be between 50 ms and 150 ms.

Test Case ID	:	1411.07.02
Test Case Name	:	Acceptance range for consecutive link test pulses.
Status	:	MANDATORY
Standard Reference	:	14.2.1.7
PICS Reference	:	14.10.4.5.8/6, 14.10.4.5.8/7
History	:	
Test Purpose	:	To verify acceptance range for consecutive link test pulses.
Note	:	
Test Setup	:	Test setup B.
Test Procedure	:	Apply power to the MAU. Stop applying the link test pulses to the RD circuit. Check that the MAU is in a Link Test Fail state. Monitor the DO circuit and DI circuit. Apply a test signal consisting of 11 link test pulses that are spaced 7.1 ms apart to the RD circuit of the MAU. Apply test signal 1 to the DO circuit of the MAU. Verify loopback presence on the DI circuit. Repeat the test procedure with 24 ms spacing between link test pulses.
Conformance	:	Only link test pulses that occur within time <code>link_test_max</code> of each other shall be considered consecutive. The value of <code>link_test_max</code> shall be between 25 ms and 150 ms. In addition, detected pulses that occur within a time <code>link_test_min</code> of a previous pulse or packet shall be ignored while in the Link Test Pass state. In the Link Test Fail state, such pulses shall reset the counted number of consecutive link test pulses to zero. The value of <code>link_test_min</code> shall be between 2 ms and 7 ms.

Test Case ID	:	1411.07.03
Test Case Name	:	Link test pulses outside acceptance range (while in Link Test Pass state).
Status	:	MANDATORY
Standard Reference	:	14.2.1.7
PICS Reference	:	14.10.4.5.8/8
History	:	
Test Purpose	:	To verify the rejection range for consecutive link test pulses while the MAU is in the Link Test Pass state.
Note	:	This test case is considered untestable. It is not practical to measure and is not considered critical. Even though testing for compliance is not practical, conformance to the standard, by design, is the responsibility of the manufacturer with compliance status to be noted in the PICS.
Test Setup	:	