Fast Ethernet Consortium

100BASE-X PCS Test Suite
Version 3.3

Technical Document

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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 suite of tests has been developed to help implementers evaluate the functioning of their Clause 4 Media Access Control (MAC) based products. The tests do not determine if a product conforms to the IEEE 802.3, nor are they purely interoperability tests. Rather, they provide one method to isolate problems within a MAC device. Successful completion of all tests contained in this suite 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 well in most environments.

Organization of Tests

The tests contained in this document are organized to simplify the identification of information related to a test and to facilitate in the actual testing process. Each test contains an identification section that describes the test and provides cross-reference information. The discussion section covers background information and specifies why the test is to be performed. Tests are grouped by similar functions and further organized by technology. Each test contains the following information:

Test Number

The Test Number associated with each test follows a simple grouping structure. Listed first is the Test Group Number followed by the test's number within the group. This allows for the addition of future tests to the appropriate groups of the test suite without requiring the renumbering of the subsequent tests.

Purpose

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

References

The references section lists cross-references to the IEEE 802.3 standards and other documentation that might be helpful in understanding and evaluating the test and results.

Resource Requirements

The requirements section specifies the hardware, and test equipment that will be needed to perform the test. The items contained in this section are special test devices or other facilities, which may not be available on all devices.

Last Modification

This specifies the date of the last modification to this test.

Discussion

The discussion covers the assumptions made in the design or implementation of the test as well as known limitations. Other items specific to the test are covered here.

Test Setup
The setup section describes the configuration of the test environment. Small changes in the configuration should be included in the test procedure.

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

Observable Results
The observable results section lists specific items that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable result, this section provides a short discussion on how to interpret them. The determination of a pass or fail for a certain test is often based on the successful (or unsuccessful) detection of a certain observable result.

Possible Problems
This section contains a description of known issues with the test procedure, which may affect test results in certain situations.

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Test #24.1.1 - End of Stream Delimiter Test

Purpose: To verify that RX_ER is asserted when there is no stream termination sequence, ESD (/T/R/), following the SSD.

References:

- IEEE 802.3 Standard, 2005 - sections 22.2.1.5, 24.2.4.4.4, and Figure 24-11: Receive state diagram.

Resource Requirements:

- A testing station capable of encoding (decoding) data nibbles to (from) five-bit code groups as specified in clause 24 and sending (receiving) these code groups using the signaling method described in clause 25 or clause 26.

Last Modification: February 2, 2006

Discussion: Following detection of the SSD, the signal RX_DV is asserted. The RX_ER signal is asserted upon decoding any symbol following the SSD, which is not either, a valid data symbol or a defined stream termination sequence. Simultaneous assertion of RX_DV and RX_ER will cause the Reconciliation sublayer to force the MAC to detect a FrameCheckError. Refer to subclause 22.2.1.5 and Figure 24-11: Receive state diagram. The DUT is sent valid frames with the ESD (/T/R/) removed. The DUT is also sent frames with an invalid ESD is placed at the end of the frame. These two circumstances should cause the reception of idle symbols while RX_DV is asserted, thus causing RX_ER to occur. In the third case, a valid ESD terminates the frame and is followed by each of the 32 code groups before idle resumes. These frames should be properly accepted.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

Description of Test Frames:

NO_ESD test frame: The test frame is comprised of an SSD, a 64-byte ARP request frame with proper checksums and 32-bit CRC values, but no ESD (/T/R/).
VALID_ESD test frames: The test frames are comprised of an SSD, a 64-byte ARP request frame with proper checksums and 32-bit CRC values, a valid ESD (/T/R/) and an additional code group immediately following the frame. This is repeated to include each code group as defined by the 802.3u standard for a total of 32 frames.
INVALID_ESD test frames: The test frames are comprised of an SSD, a 64-byte ARP request frame with proper checksums and 32-bit CRC values, and an invalid ESD. The invalid ESDs are (/H/H/), (/H/J/), (/H/K/), (/H/R/), (/H/T/), (/J/H/), (/J/J/), (/J/K/), (/J/R/), (/J/T/), (/K/H/), (/K/J/), (/K/K/), (/K/R/), (/K/T/), (/R/H/), (/R/J/), (/R/K/), (/R/R/), (/R/T/), (/T/H/), (/T/J/), (/T/K/), (/T/T/). Each frame with an invalid ESD should be dropped by the DUT.

1. The testing station is instructed to transmit a properly encapsulated, valid, 64-byte ARP request frame. This will cause the DUT to transmit an ARP reply, indicating that the DUT is functioning properly.
2. The testing station is instructed to transmit the NO_ESD test frame to the DUT. The output and statistics of the DUT are observed.
3. The testing station retransmits the NO_ESD test frame to the DUT. A valid ICMP request is retransmitted minimum inter-frame gap (96 bit-times) before and after the NO_ESD test frame. The output and statistics of the DUT are observed.
4. The testing station is instructed to transmit the VALID_ESD test frames. Each of these frames is placed between two valid ICMP echo requests.
5. The testing station is instructed to transmit the INVALID_ESD test frames. Each of these frames is placed between two valid ICMP echo requests.

Observable Results:

a. The DUT should not respond to the NO_ESD test frame. The reception of either preceding or following valid frames should be unaffected.
b. The DUT should respond to each of the VALID_ESD test frames. The reception of either preceding or following valid frames should be unaffected.
c. The DUT should not respond to each of the INVALID_ESD test frames. The reception of either preceding or following valid frames should be unaffected.

Possible Problems: None.

Test #24.1.2 - Invalid Data Symbol Test

Purpose: To verify that an error (RX_ER) is detected when an invalid data symbol is sent following the transmission of the SSD (/J/K/)

References:

- IEEE 802.3 Standard, 2005 - sections 4.2.4.1.2, 4.2.4.1.3, 24.2.4.4.3, 24.2.2.1.6 and 22.2.1.4.2

Resource Requirements:

- A testing station capable of encoding (decoding) data nibbles to (from) five-bit code groups as specified in clause 24 and sending (receiving) these code groups using the signaling method described in clause 25 or clause 26. The testing stations should be capable of transmitting violation code groups.

Last Modification: February 2, 2006

Discussion: Following detection of the SSD, the signal RX_DV is asserted. The RX_ER signal is asserted upon decoding any symbol following the SSD which is not either a valid data symbol or a defined stream termination sequence. Simultaneous assertion of RX_DV and RX_ER will cause the Reconciliation sublayer to force the MAC to detect a FrameCheckError. Refer to subclause 22.2.1.5 and Figure 24-11: Receive state diagram. In this test, all valid data symbols will be replaced with all combinations of the invalid symbols. This is done to ensure that when an invalid symbol is detected, RX_ER is asserted rather than arbitrarily replacing the invalid symbols with valid data symbols.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

Test Frame Description:

In this test, the testing station sources a valid ARP request with a data field containing all valid data symbols (0 thru F). Each data symbol is individually replaced with each of the following invalid codes: 00000, 00001, 00010, 00011, 00100, 00101, 00110, 01000, 01100, 10000, 11001 as well as the 5 Control Codes /J/, /K/, /T/, /R/, and /I/. Thus, 231 different invalid frames are tested.

1. The testing station is instructed to transmit a properly encapsulated, valid, 64-byte ARP request frame. This will cause the DUT to transmit an ARP reply, indicating that the DUT is functioning properly.
2. The testing station transmits one test frame to the DUT. The output and statistics of the DUT are observed.
3. The testing station retransmits the test frame to the DUT. After a minimum inter-frame gap (96 bit-times), the valid ARP request is retransmitted. The output and statistics of the DUT is observed.
4. Steps 1 through 3 are repeated for all remaining test frames.

Observable Results:

a. The DUT should not respond to frames with an invalid symbol.
b. The reception of either preceding or following valid frames should be unaffected.
c. The DUT should report the reception of an FCS error for each test frame.

Possible Problems: None.

Test #24.1.3 - False Carrier Detect

Purpose: To verify that the device under test can detect false carrier events.

References:

- IEEE 802.3 Standard, 2005 – sections 22.2.2.6, 22.2.2.7, 22.2.2.8, Table 22-2, sections 24.2.2.1.4, 24.2.4.4.2, 24.3.4.3, and figure 24-14.

Resource Requirements:

- A testing station capable of encoding (decoding) data nibbles to (from) five-bit code groups as specified in clause 24 and sending (receiving) these code groups using the signaling method described in clause 25 or clause 26.

Last Modification: February 13, 2006

Discussion: After channel activity is detected, the Receive process first aligns the incoming code-bits on code-group boundaries for subsequent data decoding. This is achieved by scanning the rx_bits vector for a SSD (/J/K/). Detection of the SSD causes the Receive process to enter the START OF STREAM J state.

Well-formed streams contain SSD (/J/K/) in place of the first 8 preamble bits. In the event that something else is sensed immediately following the detection of carrier, a False Carrier Indication is signaled to the MII by asserting the RX_ER and setting RXD to 1110 while RX_DV remains deasserted.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station transmits a valid frame to ensure that the stations are functioning properly.
2. Let bad_ssd be a vector of 10 code-bits and let bad_ssd[0] be fixed at ZERO. Initialize bad_ssd[9:2] to the code-bit pattern “1111110”. Command the testing station to send bad_ssd (most significant bit first) followed by the remainder of a valid test frame (excluding the SSD). The testing station will monitor transmit activity from the device under test.
3. Shift bad_ssd[9:2] left one code-bit, discarding the carry bit and setting bad_ssd[2] to ONE. Command the testing station to send bad_ssd followed by the remainder of a valid test frame (excluding the SSD). The testing station will monitor transmit activity from the device under test.
4. Repeat step 2 until bad_ssd[9:2] contains the pattern “11111111”.
5. Set bad_ssd[9:5] to the /J/ code group and set bad_ssd[4:0] to the code-bit pattern “00000”. Command the testing station to send bad_ssd followed by the remainder of a valid frame (excluding the SSD). The testing station will monitor transmit activity from the device under test.

6. Increment bad_ssd[4:0]. Command the testing station to send bad_ssd followed by the remainder of a valid frame (excluding the SSD). The testing station will monitor transmit activity from the device under test.
7. Repeat step 5 until bad_ssd[4:0] exceeds "11111". Skip the iteration in which bad_ssd[4:0] equals "10001" as this is the /K/ code-group (this makes bad_ssd[9:0] /J/K/, the valid start of stream delimiter).
8. Various valid frames separated by the minimum inter-frame gap are sent preceding and following each one of the Test Frames to ensure that the reception of a false carrier event does not affect the reception of valid frames.

Observable Results:

a. The DUT should not reply to each of the Test Frames.
b. The reception of a valid frame preceding or following each of the test frames should not be affected.

Possible Problems: None.

ANNEX A (informative) Table of Definitions

(informative)

Table of Acronym Definitions

8802-3	ISO/IEC 8802-3 (IEEE Std 802.3)
ANSI	American National Standards Institute
ASIC	application-specific integrated circuit
ASN.1	abstract syntax notation one as defined in ISO/IEC 8824: 1990
MDI, AUI	attachment unit interface
BER	bit error ratio
BPSK	binary phase shift keying
BR	bit rate
BT	bit time
CAT3	Category 3 balanced cable
CAT4	Category 4 balanced cable
CAT5	Category 5 balanced cable
CD0	clocked data zero
CD1	clocked data one
CMIP	common management information protocol as defined in ISO/IEC 9596-1: 1991
CMIS	common management information service as defined in ISO/IEC 9595: 1991
CMOS	complimentary metal oxide semiconductor
CRC	cyclic redundancy check
CRV	code rule violation
CS0	control signal zero
CS1	control signal one
CVH	clocked violation high
CVL	clocked violation low
CW	continuous wave
DA	Destination Address
DTE	data terminal equipment
DUT	Device Under Test
EIA	Electronic Industries Association.
ELFEXT	equal-level far-end crosstalk
EMB	effective modal bandwidth
EMI	Electromagnetic Interference
EPD	End_of_Packet Delimiter
ESD	end of stream delimiter
FCS	Frame Check Sequence
FC-PH	Fibre Channel - Physical and Signaling Interface
FOTP	fiber optic test procedure
GMII	Gigabit Media Independent Interface
IEC	International Electrotechnical Commission
IFG	interFrameGap
IFSP1	inter-frame spacing part 1

IFSP2	inter-frame spacing part 2
IH	intermediate hub
IRL	inter-repeater link
ISI penalty	intersymbol interference penalty
ISO	International Organization for Standardization
LAN	local area network
LLC	logical link control
LSDV	link segment delay value
MAC	medium access control
MAU	medium attachment unit
MC	message code
MDELFEXT	multiple-disturber equal-level far-end crosstalk
MDFEXT	multiple-disturber far-end crosstalk
MDI	medium dependent interface
MDNEXT	multiple-disturber near-end crosstalk
MIB	management information base
MII	media independent interface
MMF	multimode fiber
MP	message page
NEXT	near-end crosstalk
NLP	normal link pulse
NPA	next page algorithm
NRZI	non return to zero and invert on ones
OFL	overfilled launch
OFSTP	optical fiber system test procedure
PCS	physical coding sublayer
PDV	path delay value
PHY	Physical Layer entity sublayer
PICS	protocol implementation conformance statement
PLS	physical signaling sublayer
PMA	physical medium attachment
PMD	physical medium dependent
PMI	physical medium independent
PPD	peak-to-peak differential
PVV	path variability value
RD	running disparity
RFI	Radio Frequency Interference
RIN	relative intensity noise
ROFL	radial overfilled launch
RS	reconciliation sublayer
RX_DV	An MII Signal (see IEEE 802.3 section 22.2.2.6)
RX_ER	An MII Signal (see IEEE 802.3 section 22.2.2.8)
SA	Source Address
SDV	segment delay value
SFD	start-of-frame delimiter
SMF	singlemode fiber
SPD	Start_of_Packet Delimiter
SR	symbol rate

SSD	start-of-stream delimiter
ST	symbol time
STE	station management entity
STP	shielded twisted pair (copper)
SVV	segment variability value
TDR	Time Domain Reflectometer
TIA	Telecommunications Industry Association
UCT	unconditional transition
UP	unformatted page
UTP	unshielded twisted pair
WCMB	worst case modal bandwidth