Ethernet

Clause 40
Auto-Crossover Test Suite
V2.1

Technical Document

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Ethernet Consortium

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MODIFICATION RECORD

- July 27, 2006, 2006 Version 2.1
  Matthew Hersh:
  Updated possible problems for test:
  - Test 40.1.3 – Range of sample_timer
- February 8, 2006 Version 2.0
  Matthew Hersh:
  Updated discussion, procedure, observable results and possible problems for test:
  - Test 40.1.1 – Setting and Resetting of Link_Det with Auto-Negotiation Enabled

  Updated discussion and possible problems for test:
  - Test 40.1.2 – Setting and Resetting of Link_Det with Auto-Negotiation Disabled

  Updated discussion for test:
  - Test 40.1.4 – Implementation of A_timer
- August 23, 2004 Version 1.0 Initial Release

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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 22, Clause 28, and Clause 40 Auto-Negotiation 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 an Auto-Negotiating device. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other Auto-Negotiating 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 Auto-Negotiating 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 in order to reduce setup time in the lab environment. 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 observables 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.

TABLE OF CONTENTS

GROUP 1: CLAUSE 40 AUTO-CROSSOVER FUNCTION REQUIREMENTS

Scope: The following tests cover Auto-Negotiation operation specific to the Auto-Crossover function.

Overview: These tests are designed to verify that the device under test properly implements the Auto-Crossover function as it pertains to Auto-Negotiation. Auto-Crossover functions explored are defined in Clause 40 of IEEE 802.3. Many of these tests are aimed at verifying a conformant Auto-Crossover state machine implementation.

NOTE: THESE TESTS ARE PERFORMED FOR BOTH FAST ETHERNET AND GIGABIT ETHERNET CONSORTIUMS. THESE TESTS CANNOT BE PERFORMED IF THE DUT DOES NOT IMPLEMENT AUTO-CROSSOVER.

Test #40.1.1: Setting and Resetting of Link_Det with Auto-Negotiation Enabled

Purpose: To verify that the device under test properly sets, resets, and keeps Link_Det=TRUE when Auto-Negotiation is enabled.

References:

[1] IEEE Std 802.3, 2005 Edition: Subclauses 40.4.5.1, 40.4.5.2, and 40.4.6.2.1 *Figure 40-17 Auto-Crossover State Diagram*

Resource Requirements

- Line Monitor: A system capable of detecting and recording Fast Link Pulse bursts (FLPs) on both the receive and transmit channels of the DUT. The monitor should allow the FLPs to pass through while minimally impacting the channel.
- Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) while connected to the receiver of the DUT.

Last Modification: February 8, 2006

Discussion: When the DUT receives transmission from a Link Partner, it should set Link_Det=TRUE. Once Link_Det is set to TRUE, it will remain TRUE until sample_timer expires. When sample_timer expires, Link_Det will be set to FALSE. While the DUT is receiving a link pulse from the Link Partner, linkpulse=true. While the DUT is establishing or maintaining a link, link_status=READY or OK, respectively. While transmitting using the Auto-Crossover function, Link_Det is constantly polling the value of these variables. Once sample_timer has commenced, and linkpulse=true or link_status=READY or OK, Link_Det=TRUE and will remain so until sample_timer has completed. This test is designed to verify the DUT properly sets, resets, and keeps the Link_Det variable appropriately.

Test Setup: Using Cat 5 cables, connect the DUT and the Traffic Generator to the Line Monitor such that the traffic generator's signaling will be seen by the DUT's receiver. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

Part A: Reception of Alternating FLPs

1. Enable Auto-Negotiation on the DUT.
2. Establish a connection (not a link) to the DUT.
3. Use a Traffic Generator to send the DUT FLP bursts without the ACK bit set and with alternating content for at least 20 s, such that the DUT does not enter the ACKNOWLEDGE DETECT state spaced at 16 ms apart to set Link_Det=TRUE.
4. Observe if the DUT stays on the opposite channel from the Traffic Generator.
5. Cease transmitting FLPs.
6. Observe if the DUT begins transmitting on the channel originally occupied by the traffic generator and then continues implementing Auto-Crossover.
7. Repeat steps 1-6 on the opposite pair from step 3.

Part B: Reception of Consistent FLPs

8. Repeat part A using a Traffic Generator to send the DUT FLPs with consistent content instead of FLPs with alternating content. The Acknowledge bit should not set.

Part C: Reception of Consistent FLPs with the Acknowledge bit set

9. Repeat part B using a Traffic Generator to send the DUT enough FLP bursts with the Acknowledge bit set to put the DUT through the COMPETE ACKNOWLEDGE state as defined in the Clause 28 State Machine Test Suite test 28.2.3 - Consistency Match, part b.
10. Observe if the DUT commences transmission of link signaling on the same channel as the last transmitted FLP by the DUT.

Part D: Reception of Next Pages

11. Repeat part C using a Traffic Generator to send the DUT enough FLP bursts with the Acknowledge and Next Page bits set to put the DUT through the COMPLETE ACKNOWLEDGE state.
12. If the DUT uses an unmanaged Next Page Exchange, write a value to Register 7 to force the DUT to transmit its first Next Page.

Part E: Reception of 10BASE-T Signaling

13. Repeat part B sending 10BASE-T link signaling instead of FLPs.

Part F: Reception of 100BASE-TX Signaling

14. Repeat part B sending 100BASE-TX link signaling instead of FLPs.

Observable Results:

- In all cases, once the DUT has set Link_Det=TRUE the DUT should remain transmitting on the same channel until sample_timer expires without the DUT receiving signaling of any kind. For parts A, B, C and D if A_timer expires immediately after sample_timer expires between two FLPs while the DUT is transmitting in MDI-X mode, it is possible for A_timer to force the DUT to switch back to MDI mode. This is possible if sample_timer had just expired, thus setting Link_Det=FALSE. Link_Det will remain FALSE until the first pulse of the next FLP is received. The DUT should then continue the Auto-Crossover process. Additionally, the DUT should sustain a link for all supported speeds on both channels.
- For parts B, D, E and F, upon cessation of received signaling, the DUT should cease transmission for break_link_timer, and restart the Auto-Negotiation and Auto-Crossover processes.
- For part C, the DUT should enter the COMPLETE ACKNOWLEDGE state, cease FLP transmission, and begin transmitting link signaling on the opposite channel from which it was receiving. Once the DUT has commenced transmitting link signaling, the link signaling may auto-crossover if no signaling is being received.

Possible Problems: This test cannot be performed if the DUT does not implement the Auto-Crossover function.

Test #40.1.2: Setting and Resetting of Link_Det with Auto-Negotiation Disabled

Purpose: To verify that the device under test properly sets, resets, and keeps Link_Det=TRUE when Auto-Negotiation is disabled.

References:

[1] IEEE Std 802.3, 2005 Edition: Subclauses 40.4.5.1, 40.4.5.2, and 40.4.6.2.1 *Figure 40-17 Auto Crossover State Diagram*

Resource Requirements

- Line Monitor: A system capable of detecting and recording Fast Link Pulse bursts (FLPs) on both the receive and transmit channels of the DUT. The monitor should allow the FLPs to pass through while minimally impacting the channel.
- Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) while connected to the receiver of the DUT.

Last Modification: February 8, 2006

Discussion: When the DUT receives supported idle transmissions from a Link Partner, it should set Link_Det=TRUE whether or not Auto-Negotiation is enabled. When sample_timer expires, Link_Det is immediately set to FALSE. Once sample_timer commences, the value of link_status is checked. While a link is maintained, link_status=OK. Therefore, Link_Det will be immediately set to TRUE once sample_timer has commenced, forcing the DUT to remain on the opposite channel from which it is receiving. Once sample_timer has expired after the link has been broken, Link_Det will be set to FALSE. Link_Det will remain FALSE until the appropriate link signaling is received. While Link_Det=FALSE, the Auto-Crossover process should continue.

Test Setup: Using Cat 5 cables, connect the DUT and the Traffic Generator to the Line Monitor such that the DUT's receiver will see the traffic generator's signaling. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

Part A: Reception of 10BASE-T Signaling

1. Disable Auto-Negotiation on the DUT.
2. Establish a connection (not a link) to the DUT.
3. Use a Traffic Generator to send the DUT enough NLPs spaced at 16 ms apart to set Link_Det=TRUE.
4. Observe whether the DUT stays on the opposite channel from the Traffic Generator.
5. Cease transmitting NLPs.
6. Observe if the DUT restarts the Auto-Crossover function.
7. Repeat steps 1-6 on the opposite pair from step 3.

Part B: Reception of 100BASE-TX Signaling

8. Repeat part A sending 100BASE-TX link signaling instead of 10BASE-T link signaling.

Observable Results:

- INFORMATIVE: In all cases, once the DUT has set Link_Det=TRUE the DUT should continue transmitting on one channel only until link is broken. The DUT should then restart the Auto-Crossover Process. Also, the DUT should sustain a link for all supported speeds on both channels.

Possible Problems: This test cannot be performed if the DUT does not implement the Auto-Crossover function when Auto-Negotiation is disabled, or if the DUT does not have settings to disable Auto-Negotiation and set certain speeds.

Test #40.1.3: Range of sample_timer

Purpose: To verify that the device under test transmits FLPs on a specified channel for a time within sample_timer or a multiple of sample_timer.

References:

[1] IEEE Std 802.3, 2005 Edition: Subclauses 40.4.5.2, and 40.4.6.2.1 *Figure 40-17 Auto Crossover State Diagram*

Resource Requirements

- Line Monitor: A system capable of detecting and recording Fast Link Pulse bursts (FLPs) on both the receive and transmit channels of the DUT. The monitor should allow the FLPs to pass through while minimally impacting the channel.

Last Modification: July 27, 2006

Discussion: When a device is within the MDI mode or the MDI-X mode states and A-timer has not expired, it should stay within that state for a multiple of sample_timer. The acceptable range is defined to be 62 ± 2 ms. Since there are 11 bits within the Linear Feedback Shift Register (LFSR), the DUT could possibly transmit on one channel for any multiple of sample_timers up to 11.

Test Setup: Using a Cat 5 cable, connect the DUT and the Line Monitor such that the DUTs signaling will be seen by the Line Monitor. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

Part A: Timer Within Acceptable Range Channel A

1. Enable Auto-Negotiation on the DUT.
2. Establish a connection (not a link) to the DUT.
3. Measure the duration of transmission of FLP bursts on the DUT's MDI mode.

Part B: Timer Within Acceptable Range Channel B

4. Repeat step 3 on the DUT's MDI-X mode.

Part C: Occurrences of sample_timer

5. Repeat step 3 on the DUT's MDI and MDI-X modes.

Observable Results:

a. While in Auto-Crossover mode, the lowest observed duration the DUT should transmit FLPs while in MDI mode is 62 ± 2 ms.
b. INFORMATIVE: While in Auto-Crossover mode, the lowest observed duration the DUT should transmit FLPs while in MDI-X mode is 62 ± 2 ms provided A_timer has not expired.
c. While in Auto-Crossover mode, the DUT should transmit for all possible multiples of sample_timer.

Possible Problems: Often times an exact value of sample_timer cannot be determined because sample_timer may not always expire at the same time as transmit_link_burst_timer. Therefore, the observed duration of FLP transmission on a single channel may vary by up to twice the transmit_link_burst_timer minus the space between the last pulse in an FLP burst before the minimum value of sample_timer has been reached plus 4 ms but never exceeding 64 ms. If an exact value of sample_timer cannot be determined, this test will result in a Refer to Comments. Also, this test cannot be performed if the DUT does not implement the Auto-Crossover function.

Test #40.1.4: Implementation of A_timer

Purpose: To verify that the device under test properly implements A_timer.

References:

[1] IEEE Std 802.3, 2005 Edition: Subclauses 40.4.5.2, and 40.4.6.2.1 *Figure 40-17 Auto Crossover State Diagram*

Resource Requirements

- Line Monitor: A system capable of detecting and recording Fast Link Pulse bursts (FLPs) on both the receive and transmit channels of the DUT. The monitor should allow the FLPs to pass through while minimally impacting the channel.

Last Modification: February 8, 2006

Discussion: A_timer is an asynchronous (to the Auto-Crossover State Machine) free-running timer that provides for a relatively arbitrary reset of the state machine to its initial state. This timer is used to reduce the probability of a lock-up condition where both the DUT and its link partner have the same identical seed initialization at the same point in time. During the Auto Crossover process, when A_timer expires and A_timer_done is set to TRUE, the DUT should restart the Auto-Crossover process, revert to the MDI channel and restart sample_timer.

Test Setup: Using a Cat 5 cable, connect the DUT and the Line Monitor such that the DUTs signaling will be seen by the Line Monitor. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

Part A: Range of A_timer

1. Enable Auto-Negotiation on the DUT.
2. Establish a connection (not a link) to the DUT.
3. Monitor a significant number of FLP transmissions.
4. Search for two transmissions of FLPs on the MDI-X channel that are less than sample_timer long.
5. Measure the time from the end of the first FLP transmission to the beginning of the second FLP transmission.
6. Verify that the spacing between the two transmissions is within the range of A_timer.
7. Verify that the DUT uses more than one value of A_timer.

Part B: Implementation of A_timer_done=TRUE

8. Make sure that on the MDI channel, FLPs are occasionally transmitted for longer than sample_timer, and on the MDI-X channel, FLPs are occasionally transmitted for less than sample_timer.
9. Make sure that FLPs are always transmitted on the MDI channel for at least sample_timer.

Observable Results:

a. The DUT's A_timer should be within the range of 1300 ± 325 ms.
b. The DUT should revert to the MDI channel anytime A_timer_done=TRUE whether or not sample_timer has expired. (Sometimes in the middle of an FLP.) Also, if already transmitting on the MDI channel, and the DUT resets its sample_timer, the result of this would be a transmission of longer than sample_timer on the MDI channel.

Possible Problems: This test cannot be performed if the DUT does not implement the Auto-Crossover function.

Test #40.1.5: Maximum Channel Transmit Time

Purpose: To verify that the device under test transmits FLPs on a certain channel for less than the maximum of 704 milliseconds.

References:

[1] IEEE Std 802.3, 2005 Edition: Subclauses 40.4.4.2, 40.4.5.2, and 40.4.6.2.1 *Figure 40-17 Auto-Crossover State Diagram*

Resource Requirements

- Line Monitor: A system capable of detecting and recording Fast Link Pulse bursts (FLPs) on both the receive and transmit channels of the DUT. The monitor should allow the FLPs to pass through while minimally impacting the channel.

Last Modification: February 3, 2006

Discussion: When a device is within the MDI mode or the MDI-X mode states, it should stay within that state for no longer than 704 ms. A device is required to remain on one channel for a minimum of 62 ± 2 ms., thus the maximum of sample_timer is 64 ms. Since there are 11 bits within the Linear Feedback Shift Register (LFSR), the DUT could possibly transmit the MDI-X channel for up to 11 sample_timers, which yields a maximum of (64 ms X 11 bits), or 704 ms, for the maximum amount of time a device can transmit on one channel. Since an LFSR is used it is only possible for the DUT to transmit for 10 sample_timers (64 ms X 10 bits), or 640 ms, on the MDI channel. However it is possible for A_timer to cause the DUT to stay on the MDI channel for an additional sample_timer, which makes the maximum transmit time 704 ms.

Test Setup: Using a Cat 5 cable, connect the DUT and the Line Monitor such that the DUTs signaling will be seen by the Line Monitor. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

Part A: Timer Within Acceptable Range Channel A

1. Enable Auto-Negotiation on the DUT.
2. Establish a connection (not a link) to the DUT.
3. Measure the duration of transmission of FLP bursts on the DUT"s MDI mode.

Part B: Timer Within Acceptable Range Channel B

4. Repeat step 3 on the DUT's MDI-X mode.

Observable Results:

- While in Auto Crossover mode, the maximum amount of time the DUT should transmit FLPs in MDI mode is 704 ms. The DUT may transmit MDI mode for up to 640 ms, however, if A_timer expires after the DUT has transmitted for 10 sample_timers on the MDI channel, it will transmit for a maximum of one additional sample_timer in MDI mode.
- While in Auto Crossover mode, the maximum amount of time the DUT should transmit FLPs in MDI-X mode is 704 ms.

Possible Problems: This test cannot be performed if the DUT does not implement the Auto-Crossover function.