University of New Hampshire InterOperability Laboratory
Ethernet Consortium

Superseded

As of January 27th, 1997 the Ethernet Consortium Clause # 28 Auto Negotiation State Machine Base Page Exchange Conformance Test Suite version 1.1 has been superseded by the release of the Auto Negotiation State Machine Base Page Exchange Conformance Test Suite version 2.0. This document along with earlier versions, are available on the Ethernet Consortium test suite archive page.

Please refer to the following site for both current and superseded test suites:

http://www.iol.unh.edu/testsuites/ethernet/archive.html

Fast Ethernet Consortium
Auto-Negotiation Test Suite

Revision 1.1

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Test Group 1: FLP Burst Transmission

Test #1.28: Separation of FLP Bursts

Purpose: To verify proper separation of consecutive FLP bursts.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.1.4.1, 28.2.1.1, 28.2.1.1.2

Resource Requirements:

- Line Monitor

Last Modification: August 19, 1996

Discussion: A station capable of auto-negotiation must transmit fast link pulse (FLP) bursts. Not only is the content and composition of these bursts important, but also the timing of the bursts. This test is designed to verify that the timing of the device under test's consecutive FLP bursts fall within the specified range.

Test Setup: Set up the devices as shown. Using Category 5 UTP cable, connect the DUT to a 100 Ω line termination. Connect the Line Monitor's first channel to the DUT's receive pair and second channel to the DUT's transmit pair with differential high impedance taps.

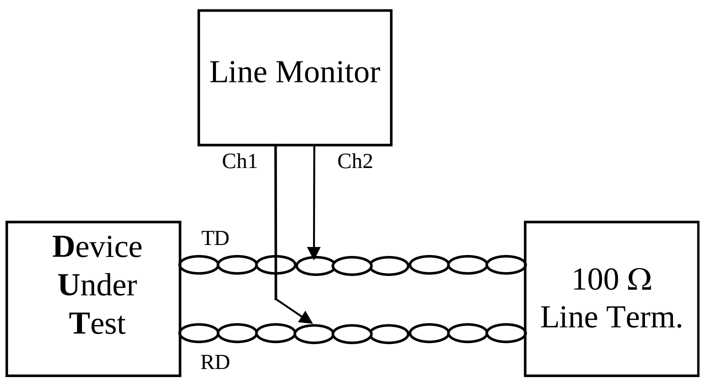

Figure 1.28-1: Test Configuration

Procedure:

1. The DUT is configured to send FLP bursts
2. Monitor the transmitted bursts
3. The separation of each burst is measured

Observable Results:

- The separation of FLP bursts should be 16±8 ms

Test #2.28: Internal Separation of FLP Bursts

Purpose: To verify that the device under test transmits FLPs with valid pulse separation.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.1.4.1, 28.2.1.1, 28.2.1.1.2

Resource Requirements:

- Line Monitor

Last Modification: August 19, 1996

Discussion: To ensure that the content of an FLP burst is interpreted accurately, the individual pulses that make up the burst must be analyzed. This test is designed to verify that the device under test sends FLP bursts whose clock and data pulses are spaced properly.

Test Setup: See Figure 1.28-1

Procedure:
1. The DUT is configured to send FLP bursts
2. Monitor the transmitted bursts
3. The spacing between clock pulses (starting with the first pulse and then every odd pulse after that) is measured
4. The spacing between clock and data pulses is measured

Observable Results:

- The spacing between clock pulses should be 125±14 μs
- The spacing between clock and data pulses should be 62.5±7 μs

Test #3.28: Number of Pulses in a Burst

Purpose: To verify that the device under test transmits the correct number of pulses in an FLP burst.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.1.1.1

Resource Requirements:

- Line Monitor

Last Modification: August 19, 1996

Discussion: In order for an FLP burst to be considered valid, it must contain a certain number of pulses, namely 17 clock pulses and up to 16 data pulses. This test is designed to verify that the device under test sends FLP bursts with a valid number of pulses.

Test Setup: See Figure 1.28-1

Procedure:

1. The DUT is configured to send FLP bursts
2. Monitor the transmitted bursts
3. The number of pulses present in the burst is measured

Observable Results:

- The number of pulses in a burst should be 17-33 (inclusive)

Test #4.28: NLP Compliance

Purpose: To verify the device under test's link pulse waveforms meet specification.

References:
- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.1.4.1, 28.2.1.1, 28.4
- ANSI/IEEE Std 802.3, 1993 Edition: Section 14.3.1.2.1, Figure 14-12

Resource Requirements:
- Oscilloscope
- Differential Voltage Probes
- TP Test Card

Last Modification: August 19, 1996

Discussion: All link pulses need to conform to the transmitter waveform specifications for Link Test Pulses defined in IEEE 802.3 Figure 14-12, including those contained in an FLP burst. This test is designed to verify that the device under test produces link pulses within specification.

Test Setup: Set up the devices as shown. Using Category 5 UTP cable, connect the DUT to the TP Test Card. Connect the Oscilloscope to the TP Test Card using Differential Voltage Probes.

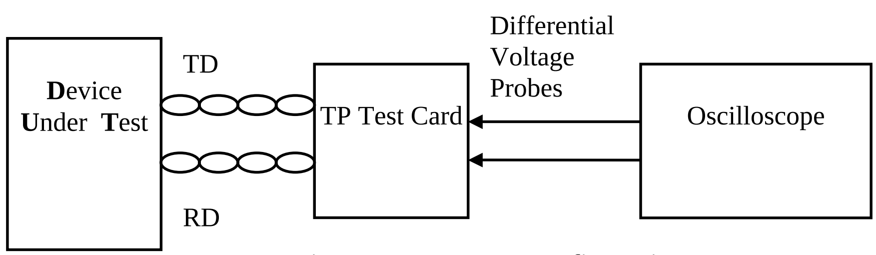

Figure 4.28-1: Test Configuration

Procedure:
1. The DUT is configured to send FLP bursts
2. Monitor the transmitted bursts
3. Observe the link pulse waveforms across each test load defined in fig. 14-11
4. Repeat procedure with loads connected through the TPM

Observable Results:
- Under each test setup, the FLP's link pulses should fit within the NLP template defined in Figure 14-12.
- After the differential output voltage drops below -50 mV, it shall remain below +50 mV.

Test #5.28: Transmitted Link Code Word (Base Page) Encoding

Purpose: To verify that the device under test transmits an acceptable selector field combination, advertises the correct abilities in the technology ability field, and transmits proper initial values for the remote fault, acknowledge, and next page bits.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.1.2, 28.2.1.2.1, 28.2.1.2.2, 28.2.1.2.3, 28.2.1.2.4, 28.2.1.2.5, Annex 28A, 28B, 28B.1, 28B.2

Resource Requirements:

- Line Monitor

Last Modification: January 3, 1997

Discussion: This test is designed to verify that the device under test transmits Link Code words with acceptable content. There are defined selector field combinations that a station is permitted to transmit in its link code word. The technology ability field of the link code word advertises a station's abilities. The final three bits in the link code word (Remote Fault bit, Acknowledge bit, Next Page bit) should all have a proper initial setting. The default value for the RF bit on a non-faulting link is zero. The Ack bit should be initially zero. The NP bit should be one if it supports Next Page exchange and zero if it doesn't or does not wish to implement a NP exchange. In this test, it is confirmed that the device under test transmits a link code word with the selector field combination corresponding to IEEE 802.3, advertises the data service abilities that it supports in its technology ability field, and has the RF, Ack, and NP bits set correctly.

Test Setup: See Figure 1.28-1

Procedure:

1. The DUT is configured to send FLP bursts
2. Monitor the transmitted bursts
3. The contents of the selector field (first five data bits), technology ability field (D[5:12]), and of the Remote Fault bit, Acknowledge bit, and Next Page bit are acquired

Observable Results:

- The selector field combination should correspond to S[4:0]=00001 as defined in table 28-9
- The technology ability field should advertise the correct abilities when referenced to table 28-10
- The DUT should not advertise any abilities that it does not possess
- The value of the Remote Fault bit should be zero
- The value of the Acknowledge bit should be zero
- The value of the Next Page bit should be one if it supports Next Page exchange and zero if it doesn't or does not wish to implement a NP exchange

Test Group 2: FLP Burst Reception

Test #6.28: Acknowledge Bit

Purpose: To verify that the device under test enters the Acknowledge Detect state upon reception of complete, consecutive and consistent FLP bursts.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.1.2, 28.1.4.2, 28.2.1.2.4

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: January 5, 1997

Discussion: Once an auto-negotiation identifies its link partner as auto-negotiation able, it will enter the Acknowledge Detect state only after it receives at least 3 complete, consecutive and consistent link code words from its link partner. Once the Acknowledge Detect state is entered, the station should send out FLP bursts containing its link code word with the Acknowledge bit (the fifteenth data pulse) set to logic one. This test is designed to verify that the device under test will set the Acknowledge bit after the reception of 3 or more complete, consecutive and consistent link code words.

Test Setup: Set up the devices as shown. Using Category 5 UTP cable, connect the DUT's transmit pair to a 100 Ω line termination, and the receive pair to a traffic generator. Connect the Line Monitor's first channel to the DUT's receive pair and second channel to the DUT's transmit pair with differential high impedance taps.

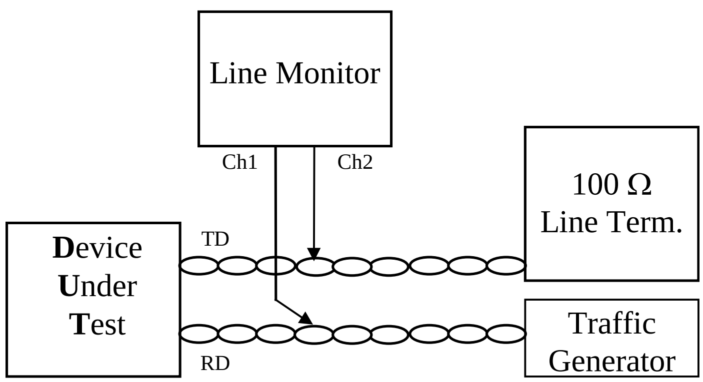

Figure 6.28-1: Test Configuration

Procedure:

Part A:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send a series of 3 FLPs
3. Monitor the FLPs sent back by the DUT and determine whether the Acknowledge bit is set
4. If it was not set, repeat the procedure with an increasing number of FLPs until the bit is set

Part B:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send enough FLPs, alternating between valid FLPs containing different advertised abilities, such that the number of FLPs would be enough to put the station into the Acknowledge Detect state
3. Monitor the FLPs sent back by the DUT and determine whether the Acknowledge bit is set

Observable Results:

Part A:

- The Acknowledge bit should be set after the reception of at least 4 complete and matching FLPs
- Record the number of FLPs required to put the DUT into the Acknowledge Detect state for use in later tests

Part B:

- The DUT should not enter the Acknowledge Detect state

Test #7.28: Refusal of Incomplete FLPs

Purpose: To verify that the device under test does not accept incomplete FLP bursts.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.2, 28.2.2.1, Figure 28-15 Receive State Diagram

Resource Requirements:

- Traffic Generator
- Line Monitor

Last Modification: August 19, 1996

Discussion: A complete FLP burst is composed of 17 to 33 pulses. This test is designed to verify that a station will not accept an incomplete FLP burst, as specified in the 802.3u standard. Also, the station should not establish a link based solely on carrier sense.

Test Setup: See Figure 6.28-1

Procedure:

Part A:

1. Establish a connection (not a link) to the DUT
2. Verify that the DUT does not establish a link based on carrier sense
3. Use a Traffic Generator to send the DUT enough incomplete FLPs consisting of only 15 pulses to put the DUT into the Acknowledge Detect state (see test #6.28)
4. Observe whether the DUT entered the Acknowledge Detect state

Part B:

5. Establish a connection (not a link) to the DUT
6. Use a Traffic Generator to send the DUT a series of the following 2 FLPs alternating at 16 ms apart:
    - a 17 pulse FLP containing the following data: 1 1 0 0 0 1 1 1 1 1 with no clock pulse after the final 1
    - an 8 pulse FLP containing the following data: 0 0 0 0 1 0 with a final clock pulse
7. Observe whether the DUT entered the Acknowledge Detect state

Observable Results:

- The DUT should not enter the Acknowledge Detect state in either case

Test #8.28: Acceptance of Long FLPs

Purpose: To verify that the device under test properly accepts FLPs that have more than 33 pulses by ignoring all but the first 16 data bits.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.2, 28.2.2.1, 28.3.3 (Rx_bit_cnt), Figure 28-15 Receive State Diagram

Resource Requirements:

- Traffic Generator
- Line Monitor

Last Modification: August 19, 1996

Discussion: An FLP burst normally consists of 17 to 33 pulses, with normally 16 data bits. However, if a device receives an FLP with more than 33 pulses, it should still accept the burst. The first 16 data bits should be kept and any additional should be ignored. This test is designed to determine whether the Device Under Test properly accepts FLPs with more than 16 data bits.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT.
2. Use a Traffic Generator to send enough valid FLPs with 5 extra pulses (3 clock pulses and 2 data pulses) attached to the end to put the DUT into the Acknowledge Detect state (see Test #6.28).
3. Observe whether the DUT enters the Acknowledge Detect state.

Observable Results:

- The DUT should enter the Acknowledge Detect state

Test #9.28: Next Page Bit

Purpose: To verify that the device under test can handle the reception of an FLP from a next page capable device.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.1.2, 28.2.1.2.5, 28.2.3.4

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: When a station is connected to a next page able device, it will receive an FLP bursts with set next page bits (the final bit of the link code words set to logic one). Regardless of whether the receiving station is next page able or not, it should still accept the link code word as valid. This test is designed to verify that the device under test is capable of receiving a flagged next page bit.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send enough FLPs with the next page bit set to a logic one to put it into the Acknowledge Detect state (see test #6.28)
3. Verify that the DUT enters the Acknowledge Detect state

Observable Results:

- The DUT should enter the Acknowledge Detect state

Test #10.28: Selector Field Reserved Combinations

Purpose: To verify that the device under test accepts FLPs with the selector field set to a reserved combination.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.1.2, 28.2.1.2.1, Annex 28A, 28B, 28B.1

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: There are combinations for the selector field that are reserved by the IEEE. A station never supposed to transmit these combinations, but there are no specifications as to the combinations that can be received. Therefore, as long as complete and consistent link code words are received, a station should accept them as valid regardless of the selector field combination. This test is designed to verify that the device under test will accept a link code word with the selector field set to a reserved combination.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send enough FLPs with the selector field combination of 0,0,1,1,1 (ordered bit S0 to S4) to put it into the Acknowledge Detect state (see test #6.28)
3. Verify that the DUT enters the Acknowledge Detect state

Observable Results:

- The DUT should enter the Acknowledge Detect state

Test #11.28: Technology Ability Field Reserved Bits

Purpose: To verify that the device under test accepts FLPs with the reserved bits of the technology ability field set to logic one.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.1.2, 28.2.1.2.2, 28.2.3.3, Annex 28B.2

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: The last three bits of the technology ability field of a link code word are reserved by the IEEE. A station is supposed to transmit these bits as logic zero, but is supposed to be able to receive these bits set to a one without a problem. This test is designed to verify that the device under test will accept a link code word with the last three bits (the reserved bits) of the technology ability field set to logic one.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send enough FLPs with the fifth, sixth, and seventh bits of the technology ability field set to logic one to put it into the Acknowledge Detect state (see test #6.28)
3. Verify that the DUT enters the Acknowledge Detect state

Observable Results:

- The DUT should enter the Acknowledge Detect state

Test #12.28: Range of NLP Timer

Purpose: To verify that the device under test accepts FLP bursts with proper spacing, and refuses those with spacing outside of the acceptable range.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.2.1, 28.3.2

Resource Requirements

- Traffic Generator
- Line Monitor

Last Modification: August 19, 1996

Discussion: As well as characteristic requirements, FLP bursts have requirements for the delay between consecutive bursts. In order to be accepted as valid, received FLP bursts must have a delay between them between "nlp_test_min_timer" and "nlp_test_max_timer." The value for "nlp_test_min_timer" must be between 5 and 7 ms. The value for "nlp_test_max_timer" must be between 50 and 150 ms. This test is to verify that the device under test accepts FLP bursts with spacing within these ranges, and refuses FLP bursts with spacing outside of these ranges.

Test Setup: See Figure 6.28-1

Procedure:

Part A: Bursts Within Acceptable Range

1. Establish a connection (not a link) to the DUT
2. Use a Traffic Generator to send the DUT enough FLP bursts spaced at 7.1 ms apart to put it into the Acknowledge Detect state (see test #6.28)
3. Observe whether the DUT entered the Acknowledge Detect state
4. Repeat using FLPs spaced at 49.9 ms

Part B: Bursts Outside Acceptable Range

5. Repeat using FLPs spaced at 4.9 ms
6. Repeat using FLPs spaced at 150.1 ms

Observable Results:

- In both cases of Part A, the DUT should enter the Acknowledge Detect state
- In both cases of Part B, the DUT should not enter the Acknowledge Detect state

Test #13.28: Identification of Link Partner as Auto-Negotiation Able

Purpose: To verify that the device under test is able to recognize its link partner as capable of auto-negotiation within specification.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.2.1

Resource Requirements:

- Traffic Generator

Last Modification: January 5, 1997

Discussion: When establishing a link, a station is required to recognize its link partner as auto-negotiation able within a certain range of pulses in an FLP burst. This test is designed to verify that the device under test adheres to this range.

Test Setup: See Figure 6.28-1.

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use a Traffic Generator to send the DUT 6 pulses spaced at 50μs, wait 16ms, then send enough valid FLP bursts to put the DUT into the Acknowledge Detect state. The proper number of FLP bursts should be one less than the value determined in #6.28 as that value includes the FLP required to identify a device as auto-negotiation able.
3. Determine whether the DUT has entered the Acknowledge Detect state
4. If the DUT did not enter the Acknowledge Detect state, repeat steps 1 through 3 increasing the number of initial pulses until the DUT enters the Acknowledge Detect state

Observable Results:

- The DUT should recognize the Link Partner as auto-negotiation able within 6 to 17 (inclusive) pulses

Test #14.28: Range of FLP Pulse Timer

Purpose: To verify that the device under test determines that its link partner is auto-negotiation able upon receiving pulses spaced within flp_test_min_timer and flp_test_max_timer, and does not recognize a device as auto-negotiation able upon receiving pulses spaced outside the acceptable range.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.2.1, 28.3.2, Figure 28-15 Receive State Diagram

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: January 5, 1997

Discussion: As well as characteristic requirements, FLP bursts have requirements for the delay between consecutive pulses within the burst. In order to be accepted as valid, received pulses must have a delay between them between "flp_test_min_timer" and "flp_test_max_timer." The value for "flp_test_min_timer" must be between 5 and 25 μs. The value for "flp_test_max_timer" must be between 165 and 185 μs. This test is to verify that the device under test accepts FLP bursts with pulses spaced within these ranges, and refuses FLPs with pulses spaced outside of these ranges.

Test Setup: See Figure 6.28-1

Procedure:

Part A: Pulses Within Acceptable Range

1. Establish a connection (not a link) to the DUT
5. Use a Traffic Generator to send the DUT enough pulses spaced at 25.1μs to identify the link partner as auto-negotiation able (refer to #13.28), wait 16ms, then send enough valid FLP bursts to put the DUT into the Acknowledge Detect state. The proper number of FLP bursts should be one less than the value determined in #6.28 as that value includes the FLP required to identify a device as auto-negotiation able.
2. Observe whether the DUT entered the Acknowledge Detect state
3. Repeat using FLPs with pulses spaced at 164.9 μs

Part B: Pulses Outside Acceptable Range

5. Repeat using FLPs with pulses spaced at 4.9 μs
6. Repeat using FLPs with pulses spaced at 185.1 μs

Observable Results:

- In both cases of Part A, the DUT should enter the Acknowledge Detect state
- In both cases of Part B, the DUT should not enter the Acknowledge Detect state

Test #15.28: Range of Data Detect Timer

Purpose: To verify that the device under test accepts data pulses with proper spacing and refuses data pulses with spacing outside the acceptable range.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.2.1, 28.3.2, Figure 28-15 Receive state diagram

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: January 5, 1997

Discussion: As well as characteristic requirements, FLP bursts have requirements for the delay between clock and data pulses within the burst. In order to be accepted as valid, received data pulses must have a delay between them and the previous clock pulse between "data_detect_min_timer" and "data_detect_max_timer." The value for "data_detect_min_timer" must be between 15 and 47 μs. The value for "data_detect_max_timer" must be between 78 and 100 μs. This test is to verify that the device under test accepts FLP bursts with data pulses spaced within these ranges, and refuses FLPs with data pulses spaced outside of these ranges. As defined in Figure 28-15, if an FLP containing the data pattern 1,0 is sent with the data 1 transmitted a time exceeding 100 μs following the clock pulse, then the data_detect_max_timer should be violated. In a conformant device, this should result in the interpretation of the data pattern as 0,1. Thus, by alternating the transmission of this test FLP with FLPs containing typical spacing, a conformant device should not enter the Acknowledge Detect state. This technique is used to test the validity of data_detect_max_timer. For data_detect_min_timer, we take a different approach. Here, we send the DUT multiple pulses before data_detect_min_timer expires. In a properly working device, these pulses should effectively be seen only as one since linkpulse would be set to true on the first and then the second would be ignored. In a non-conformant device, the second pulse would be seen as the next clock pulse, and then the FLP from that point forward would be incorrect. The device would see the next clock pulse as a data pulse, and so on and so forth. Again, by alternating the transmission of this modified FLP with FLPs containing typical spacing, a conformant device should enter the Acknowledge Detect state, whereas a non-conformant device should not.

Test Setup: See Figure 6.28-1

Procedure:

Part A: Data Pulses Within Acceptable Range

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send the DUT enough FLPs, alternating between FLPs with the data pulses spaced 47.1 μs from the clock pulses and FLPs with perfect spacing, to put it into the Acknowledge Detect state (see test #6.28)
3. Observe whether the DUT entered the Acknowledge Detect state
4. Repeat using FLPs with the data pulses spaced 77.9 μs from the clock pulses

Part B: Data Pulses Outside Acceptable Range

5. Repeat using FLPs with the data pulses spaced 100.1 μs from the clock pulses
6. Use the Traffic Generator to send the DUT enough FLPs to put it into the Acknowledge Detect state (see test #6.28) containing a 1,0 data sequence, alternating between FLPs with perfect spacing and FLPs with the following modification: after the clock pulse preceeding the 1, insert two pulses, one spaced at 5 μs and one at 14.9 μs, and have no normal data pulse

Observable Results:

- In both cases of Part A, the DUT should enter the Acknowledge Detect state
- In Step 5 of Part B, the DUT should not enter the Acknowledge Detect state
- In Step 6 of Part B, the DUT should enter the Acknowledge Detect state

Test #16.28: Consistency Match

Purpose: To verify that the device under test performs a consistency match test on received FLPs.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.3.1

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: January 2, 1997

Discussion: Upon entering the Acknowledge Detect state of the auto-negotiation process, a device must receive 3 consecutive and consistent FLPs from its link partner before it can proceed. However, these FLPs must not only be consistent amongst themselves, but also with the FLPs that the device received to put it into the Acknowledge Detect state. To ensure this, a station must perform a consistency match test. If a consistency mismatch occurs, the device should enter the Transmit Disable state and cease sending FLPs. This test is designed to verify that the device under test checks to be sure that the FLPs received in the Acknowledge Detect state are consistent (ignoring the Acknowledge bit) with the FLPs that it received to get it there.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send a series of FLPs- first some with the Acknowledge bit not set (enough to put the DUT into the Acknowledge Detect state- refer to results of test #6.28) followed by 3 with the Acknowledge bit set to logic one and bit D10 holding the opposite value as the initial 4 FLPs
3. Monitor the transmit line coming from the DUT

Observable Results:

- The DUT should cease transmitting FLPs immediately once the inconsistent FLPs are received

Test #17.28: Range of Break Link Timer

Purpose: To verify that the device under test recognizes a broken link and restarts the auto-negotiation process within the acceptable range.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.3.2, 28.3

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: January 3, 1997

Discussion: Once a device has entered the Transmit Disable state, it must wait a specified amount of time before it restarts the auto-negotiation process. This time is defined by the device's "break_link_timer," and is required to be between 1200 and 1500 ms. This test is designed to verify that the device under test restarts the auto-negotiation process after entering the Transmit Disable state within this range.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send the same series of FLP bursts as in test #16.28 to put the DUT into the Transmit Disable state
3. Verify that the DUT starts a renegotiation
4. Measure the amount of time between when the station entered the Transmit Disable and when the first FLP of the renegotiation process was transmitted, and this will be the value of break_link_timer

Observable Results:

- The DUT's break_link_timer should be in the range 1200 to 1500 ms

Test #18.28: Range of Link Fail Inhibit Timer

Purpose: To verify that the device under test will wait a specified amount of time between when it parallel detects a link partner and when it establishes that link.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.3.2, 28.3

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: January 3, 1997

Discussion: Once a device has entered the FLP LINK GOOD CHECK state, it must receive a link_status=OK message from its link partner within a specified amount of time. If this message is not received, it will enter the Transmit Disable state and wait for the duration of its break_link_timer before starting a renegotiation. This time is defined by the device's "link_fail_inhibit_timer," and is required to be between 750 and 1000 ms. This test is designed to verify that the device under test enters the Transmit Disable state from the FLP LINK GOOD CHECK state when a link_status=OK message is not received from its link partner in the acceptable range of time.

Test Setup: See Figure 6.28-1

Procedure:

5. Establish a connection (not a link) to the DUT
6. Use the Traffic Generator to put the device into the COMPLETE ACKNOWLEDGE state (see test #20.28)
7. Verify that the DUT starts a renegotiation
8. Measure the amount of time between when the station transmitted it's final FLP after entering the COMPLETE ACKNOWLEDGE state (see results of test #20.28) and when the first FLP of the renogotiation process was transmitted, and this will be the value of break_link_timer + link_fail_inhibit_timer
9. Subtract the value of break_link_timer (see results of test #17.28) from this value to acquire the value of link_fail_inhibit_timer

Observable Results:

- The DUT's link_fail_inhibit_timer should be in the range 750 to 1000 ms

Test #19.28: Range of Auto-Negotiation Wait Timer

Purpose: To verify that the implemented value of autoneg_wait_timer is within the specified range of 500 to 1000ms.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.3.2, Figure 28-16 Arbitration state diagram

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: January 5, 1997

Discussion: In order for an auto-negotiation able device to properly parallel detect a link partner, it must receive a valid single_link_ready=true signal from its link partner for a period of time before it negotiates to that link. This time is defined by the device's "autoneg_wait_timer," and is specified to be between 500 and 1000 ms. This test is designed to verify that the device under test does not parallel detect to a link before waiting a time within this range. This approach does introduce an error into the measurement, however. In order to find the point where autoneg_wait_timer is started, the point where the device ceased transmission of FLPs must be found. This point could fall between the transmission of two consecutive FLPs, in which case there is no way to find the exact point. Therefore, an error is introduced with a maximum value equal to the gap between two transmitted FLPs (see test #1.28).

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Send the station valid NLPs with valid spacing
3. Monitor the DUT's transmit line
4. Verify that the DUT establishes a 10Base-T link
5. Measure the time between when the DUT ceased transmission of FLPs and when the DUT began transmitting NLPs. This is the value of autoneg_wait_timer

Observable Results:

- The DUT's autoneg_wait_timer should be in the range of 500 to 1000 ms

Test Group 3: Establishing a Link

Test #20.28: Complete Acknowledge

Purpose: To verify that the device under test sends out a valid number of link code words after the Complete Acknowledge state has been entered.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.1.2.4

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: Well into the auto-negotiation process is the Complete Acknowledge state. A station reaches this state after first entering the Acknowledge Detect state (which is done when at least 3 complete, consecutive and consistent FLP bursts are received- see Test #6.28), and then receiving 3 complete, consecutive and consistent FLPs with the Acknowledge bit set. Once the Complete Acknowledge state has been entered, a station should send out 6 to 8 (inclusive) more FLPs containing its link code word. This test is designed to verify that the device under test sends out the 6 to 8 (inclusive) FLPs after entering the Complete Acknowledge state.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send a series of FLPs- first some with the Acknowledge bit not set (enough to put the DUT into the Acknowledge Detect state- refer to results of test #6.28) followed by 3 with the Acknowledge bit set to logic one, to put the DUT into the COMPLETE ACKNOWLEDGE state
3. Monitor the transmit line coming from the DUT and count the number of FLPs sent by the DUT after the COMPLETE ACKNOWLEDGE state has been entered

Observable Results:

- After the COMPLETE ACKNOWLEDGE state has been entered, the DUT should send out 6 to 8 (inclusive) FLPs containing its Link Code Word

Test #21.28: Parallel Detection of 10Base-T Devices

Purpose: To verify that the device under test can detect that its link partner is a fixed speed 10Base-T device.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.2.2, 28.2.3.1, 28.4
- ANSI/IEEE Std 802.3, 1993 Edition: Section 14.3.1.2.1

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: A station capable of auto-negotiation should be capable of detecting a 10Base-T device as its link partner solely on the receipt of 10Base-T normal link pulses (NLPs). This should occur before the detection of FLP bursts. When a 10Base-T device is detected, the station should either enable its 10Base-T PMA and establish a link if supported, or simply not allow a link to be established if not supported. Also, the station should be able to accept worst-case NLPs, that have one of the following characteristics (these are achieved using the setup shown in Figure 17.28-1:

1. As in Figure 14-12 in IEEE 802.3: with a peak amplitude of 585 mV, a pulse width of 0.60 BT, and a maximum undershoot.
2. As in Figure 14-12 in IEEE 802.3: with maximum allowed amplitude and pulse width.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Test Station to send the DUT a series of NLPs spaces at 16 ms apart
3. If the DUT has a 10Base-T PMA, verify that it is enabled by determining whether a link is established
4. Send the DUT a packet and see if it is accepted
5. If the DUT has no 10Base-T PMA, verify that no link is established
6. Repeat using each worst case NLP

Observable Results:

- If the DUT supports a 10Base-T PMA, a link should be established in each case. If not, a link should be refused.

Test #22.28: Parallel Detection of 100Base-TX Devices

Purpose: To verify that the device under test can properly parallel detect a fixed speed 100Base-TX link partner.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.3.1

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: A station capable of auto-negotiation should also implement the parallel detection function. This provides for the detection of a 100Base-TX fixed speed device before the detection of FLPs. In this case, a station should either enable its 100Base-TX PMA if supported and establish a link, or otherwise not allow a link to be established. This test is designed to verify that the device under test properly handles the presence of a fixed speed 100Base-TX device as a link partner.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to simulate the presence of a non-auto-negotiating 100Base-TX device
3. If the DUT has a 100Base-TX PMA, verify that it is enabled by determining whether a link is established
4. Send the DUT a packet and see if it is accepted
5. If the DUT has no 100Base-TX PMA, verify that no link is established

Observable Results:

- If the DUT supports a 100Base-TX PMA, a link should be established. If not, a link should be refused.

Test #23.28: Parallel Detection of 100Base-T4 Devices

Purpose: To verify that the device under test can properly parallel detect a fixed speed 100Base-T4 link partner.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.3.1

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: A station capable of auto-negotiation should also implement the parallel detection function. This provides for the detection of a 100Base-T4 fixed speed device before the detection of FLPs. In this case, a station should either enable its 100Base-T4 PMA if supported and establish a link, or otherwise not allow a link to be established. This test is designed to verify that the device under test properly handles the presence of a fixed speed 100Base-T4 device as a link partner.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to simulate the presence of a non-auto-negotiating 100Base-T4 device
3. If the DUT has a 100Base-T4 PMA, verify that it is enabled by determining whether a link is established
4. Send the DUT a packet and see if it is accepted
5. If the DUT has no 100Base-T4 PMA, verify that no link is established

Observable Results:

- If the DUT supports a 100Base-T4 PMA, a link should be established. If not, a link should be refused.

Test #24.28: Priority Resolution Function

Purpose: To verify that the device under test properly configures the highest common denominator (HCD) technology for the transmitted technologies in a link code word.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Sections 28.2.3.3, Annex 28B.2, 28B.3

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: Once a station has received its link partner's link code word and completed the exchange of FLP bursts, the technology at which communication is to be established must be resolved. Through the priority resolution function, the highest common denominator (HCD) technology should be found. This test is designed to verify that the device under test resolves the proper HCD for all possible technology combinations.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send a series of FLP bursts that advertise a set of abilities
3. Verify that the DUT establishes a link when it can, and refuses a link otherwise
4. Verify that the DUT resolved the highest common technology by sending a packet to the DUT in that format and determining whether it was received
5. Verify that full duplex was resolved whenever possible
6. Repeat this procedure for all possible combinations of the first five bits of the technology ability field

Observable Results:

- In every case, the DUT should resolve the highest priority possible based on the priority resolution function for the technologies advertised

Test #25.28: Failed Link for HCD

Purpose: To verify that the device under test starts a renegotiation upon the reception of a link_status=FAIL from the resolved highest common denominator (HCD) technology.

References:

- ANSI/IEEE Std 802.3u/D5 March 23, 1995 Edition: Section 28.2.3.2

Resource Requirements:

- Line Monitor
- Traffic Generator

Last Modification: July 23, 1996

Discussion: Once the highest common denominator (HCD) technology has been determined through the parallel detection function, if a station receives a link_status=FAIL message from that priority, it should cause a renegotiation. This test is designed to verify that the device under test does start a renegotiation upon the receipt of a link_status=FAIL message from the HCD technology.

Test Setup: See Figure 6.28-1

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send a series of FLP bursts that advertise a set of abilities
3. Verify the DUT resolves the HCD priority and establishes a link
4. Send the DUT a link_status=FAIL for the HCD priority
5. Verify that the DUT starts a renegotiation

Observable Results:

- The DUT should start a renegotiation upon reception of the link_status=FAIL message

Appendix A: Test Equipment

Traffic Generator

An arbitrary waveform generator (AWG) which matches the specifications in IEEE Std 1802.3d-1993 Section 6.3.4.4 with the exception that the sample resolution shall be 4 ns/point

BAL

100 Ω to 50 Ω balun impedance adapter as defined in IEEE Std 1802.3d-1993 Section 6.3.3.3

Oscilloscope

A digitizing signal analyzer which matches the specifications for an oscilloscope as defined in IEEE Std 1802.3d-1993 Section 6.3.4.8

Differential Voltage Probe

Meets specifications defined in IEEE Std 1802.3d-1993 Section 6.3.4.9

TP Test Card

A testing card with an RJ-45 interface containing the following options:

- Cross over at the input
- Cable termination with 100 Ω load, Test Load 1, or Test Load 2 (as defined in IEEE 802.3 Section 14.3.1.2.1 and Figure 14-11)
- Unshielded twisted pair model (as defined in IEEE Std 802.3 Section 14.3.1.2)
- Link test pulse generator

Line Monitor

A device capable of recording and time stamping the pulses that make up transmitted FLPs