The University of New Hampshire
InterOperability Laboratory

ETHERNET

Clause 28, 40, 55 and 78 Auto-Negotiation Management System Test Suite

v3.0

Technical Document

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Updated purpose, procedure and observable results for test:

- Test 1.1 – Auto-Negotiation On/Off

Updated title, references, discussion and procedure for tests:

- Test 1.2 – Base Page Advertisements
- Test 1.3 – Next Page and Extended Next Page Advertisements

Updated references and procedure for test:

- Test 2.1 – Speed Verification and Resolution

Updated references, procedure and observable results for test:

- Test 2.2 – Duplex Verification and Resolution

Updated discussion, procedure, observable results and possible problems for tests:

- Test 2.3 – Pause Mode Resolution
- Test 3.2 – Parallel Detection of 100BASE-TX Devices

Updated title, purpose, references, discussion, procedure, observable results and possible problems for test:

- Test 2.4 – Master-Slave Resolution

Updated references, discussion, procedure, observable results and possible problems for tests:

- Test 3.1 – Parallel Detection of 10BASE-T Devices
- Test 4.1 – Next Page Bit

Updated discussion and procedure for test:

- Test 3.3 – Parallel Detection of 100BASE-T4

Updated references, discussion, procedure and observable results for tests:

- Test 4.2 – Null Message Page Generation
- Test 6.1 – 1000BASE-T Message and Unformatted Page Transmission Order

Updated purpose, references, discussion, procedure, observable results and possible problems for test:

- Test 4.3 – Reception of Next Pages

Updated title, purpose, discussion, procedure and observable results for test:

- Test 6.2 – Content and Format of 1000BASE-T UP2

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- Test 6.3 – 1000BASE-T Unformatted Page Reception
- Test 6.4 – 1000BASE-T Message Page Reception

Updated title, purpose, discussion, procedure, observable results and possible problems for test:

- Test 6.5 – 1000BASE-T UP2 Reception

Added Tests:

- Test 2.5 – Energy Efficient Ethernet Resolution and Verification
- Test 5.1 – Extended Next Page and Next Page Bits
- Test 5.2 – Extended Null Message Page Generation
- Test 5.3 – Reception of Extended Next Pages
- Test 7.1 – 10GBASE-T Message Page Transmission
- Test 7.2 – Content and Format of 10GBASE-T Unformatted Code Field
- Test 7.3 – 10GBASE-T Unformatted Page Reception
- Test 7.4 – 10GBASE-T Message Page Reception
- Test 7.5 – 10GBASE-T Seed Value Reception
- Test 8.1 – Energy Efficient Ethernet Message and Unformatted Page Transmission Order
- Test 8.2 – Energy Efficient Ethernet Unformatted Page Reception
- Test 8.3 – Energy Efficient Ethernet Message Page Reception

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- Test 2.1 – Speed Resolution and Verification

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- Test 2.4 – 1000BASE-T Master-Slave Resolution

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- Test 3.1 – Parallel Detection of 10BASE-T Devices
- Test 3.2 – Parallel Detection of 100BASE-TX Devices
- Test 3.3 – Parallel Detection of 100BASE-T4 Devices

Added part (c) and updated procedure and observable results for:

- Test 5.4 – 1000BASE-T Message Page Reception

- September 9, 1999 Initial Version

Previous versions of the test suite can be found at:
http://www.iol.unh.edu/services/testing/fe/testsuites/

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Definitions

DUT: Device under test.

EEE: Energy Efficient Ethernet.

Link partner: The device at the opposite end of a link segment from the local station.

Page Sequence: A group of FLP Bursts containing a Message Page and its specified number of Unformatted Pages with proper Flag field bit values.

INTRODUCTION

Overview

The University of New Hampshire's InterOperability Laboratory (UNH-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 28 Auto-Negotiation based products. Though the UNH-IOL's Fast Ethernet Consortium has long been performing a Clause 28 Auto-Negotiation test suite targeting the functionality of the Auto-Negotiation state machines specified in clause 28 of the IEEE 802.3 standard, that "state machine" test suite rarely focused on system level device issues. System level issues in this context refer to interoperability problems which occur between an auto-negotiating end-user device and its link partner even though the device's Auto-Negotiation state machines and associated registers may be functioning properly. These issues typically occur as a result of a problem with the device's management, whereby the underlying Auto-Negotiation mechanism may perform properly, but then the device's management acts or reacts inappropriately. While many end-user devices utilize the same underlying Auto-Negotiation mechanism (typically embedded in a PHY), most devices have very different management and user level control. The focus of the tests within this Auto-Negotiation Management System Test Suite is to examine the functionality of the Auto-Negotiation management entity of a device.

The tests do not determine if a product conforms to the IEEE 802.3 standard, 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 UNH-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.

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GROUP 1: ABILITY ADVERTISEMENT

Scope: The following tests cover Auto-Negotiation operation specific to ability advertisements.

Overview: These tests are designed to verify that the management entity properly controls the transmission and content of FLP Bursts.

Test #Sys.1.1: Auto-Negotiation On/Off

Purpose: To verify that when management enables or disables Auto-Negotiation, that the DUT responds to management by transmitting FLP Bursts or the appropriate link signaling, respectively.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 22.2.4.1.4

Resource Requirements: See **Appendix 28.A**

Last Modification: February 27, 2014

Discussion: In some implementations, management allows the user to enable or disable Auto-Negotiation. It is recommended that the DUT's management does not automatically switch between Auto-Negotiation and a manual/fixed-speed link, without user intervention, as this may lead to sub-optimal links. If the user chooses to disable Auto-Negotiation, then the DUT should cease transmission of FLP Bursts if it has not completed the Auto-Negotiation process, wait a period of time, and start to source appropriate link signaling. If the DUT has established a link without the use of Auto-Negotiation, and then Auto-Negotiation is enabled the DUT should cease transmission, wait a period of time (at least break_link_timer), and source FLP Bursts. When a device has Auto-Negotiation enabled, it should always transmit FLP Bursts when the link is broken (it has not established a link), and it should not transmit Idle until the correct stage of the Auto-Negotiation process. Note: Some devices may choose to periodically restart Auto-Negotiation, resulting in gaps in FLP Burst transmission of at least break_link_timer in length, other devices may implement non-standard power-saving features which may interrupt FLP Burst transmission periodically.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Auto-Negotiation Enabled

1. With Auto-Negotiation disabled on the DUT, enable Auto-Negotiation using the using the DUT’s management interface.
2. Observe transmissions from the DUT.

Part b: Auto-Negotiation Disabled: Fixed Speeds

3. Using the DUT’s management interface, disable Auto-Negotiation and force the DUT to a supported speed and duplex.
4. Observe transmissions from the DUT.
5. Transmit frames to verify that the DUT is at the correct speed and duplex.
6. Repeat steps 3 through 5 for all supported speeds and duplexes.

Part c: Auto-Negotiation On/Off Transition Timing

7. With Auto-Negotiation enabled, use the DUT's management interface to disable Auto-Negotiation.
8. Observe transmissions from the DUT.
9. With Auto-Negotiation disabled, use the DUT's management interface to change the speed and duplex.
10. Observe transmissions from the DUT.

Observable Results:

a. When Auto-Negotiation is enabled, the DUT should wait break_link_timer before transmitting FLP Bursts and attempting to establish a link using the Auto-Negotiation process. The DUT should not transmit link signaling until the DUT enters the FLP LINK GOOD CHECK state.
b. The DUT should cease Auto-Negotiation and transmit link signaling.
c. INFORMATIVE: The DUT should cease Auto-Negotiation and transmit link signaling (based on management settings). The DUT may or may not pause before transmitting appropriate signaling. When changing between speeds and duplexes the DUT may or may not pause before sending link signaling.

Possible Problems: If the DUT's management does not allow Auto-Negotiation to be disabled, this test cannot be performed.

Test #Sys.1.2: Base Page Advertisements

Purpose: To verify that the DUT's management advertises valid abilities in its transmitted link codeword.

References:

[1] IEEE Std 802.3, 2012 Edition - subclauses 28.2.1.1.1, 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, 28.2.1.2.6, 28.2.3.4 Annex 28A, Annex 28B, Annex 28B.1, Annex 28B.2

Resource Requirements: See **Appendix 28.A**

Last Modification: February 27, 2014

Discussion: This test is designed to verify that the DUT transmits link codewords whose technology ability field accurately reflects the abilities of the device and the current management settings. The link codeword reflects speed abilities of the physical layer, duplex abilities of the MAC layer, and flow control abilities of the MAC control layer. A device must never advertise abilities that it does not possess. Through management, the user often has the ability to specify which abilities are desired which may further restrict the abilities advertised. In this test, the link codeword advertised by the device is verified to be within the ability set of the device, and reflects the desired mode set in management.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Modification of the Technology Ability Field

1. Using the DUT's management interface, enable Auto-Negotiation.
2. Observe transmissions from the DUT.
3. If available using the DUT's management interface, modify the desired (advertised) abilities. This may include enabling/disabling: 10BASE-T half duplex, 10BASE-T full duplex, 100BASE-TX half duplex, 100BASE-TX full duplex, 100BASE-T4, PAUSE, and ASM_DIR PAUSE.
4. Repeat steps 1 through 3 for all available abilities.

Part b: Next Page and Extended Next Page Advertisement

5. Using the DUT's management interface, enable Auto-Negotiation.
6. Observe transmissions from the DUT.
7. If available using the DUT's management interface, modify the desired (advertised) abilities such that a Next Page Exchange is desired. This may include enabling/disabling: 1000BASE-T half duplex, 1000BASE-T full duplex, 10GBASE-T, Energy Efficient Ethernet.
8. Repeat steps 5-7 for all available abilities.

Part c: Verification of Advertised Abilities

9. Verify the DUT supports all advertised abilities using results from tests #2.1 (Speed Resolution and Verification), #2.2 (Duplex Resolution and Verification) and #2.3 (Pause Mode Resolution).

Observable Results:

a. The technology ability field should advertise the proper abilities for the DUT's current management setting.
b. The Next Page and Extended Next Page bits should be set according to current management settings.
c. The DUT should not advertise any abilities that it does not possess.

Possible Problems: None.

Test #Sys.1.3: Next Page and Extended Next Page Advertisements

Purpose: To verify that the management of the DUT advertises valid Next Page and Extended Next Page abilities.

References:

[1] IEEE Std 802.3, 2012 - subclause 40.5.1.2, 55.6.1.2, Annex 28B, Annex 28B.1, Annex 28B.2, Table 40-4, Table 45-190, Table 55-15.

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: This test is designed to verify that the DUT transmits Next Pages and extended Next Pages that accurately reflect the abilities of the device and the current management settings. A device must never advertise abilities that it does not possess. Through management, the user may be able to specify which abilities are desired which further restricts the abilities advertised. The port type bit should be set appropriately for the DUT. Note: A multi-port device is considered to be any internetworking device with multiple ports, even if only one port supports 1000BASE-T or 10GBASE-T.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: 1000BASE-T Abilities

1. Complete a Next Page exchange with the DUT.
2. Observe transmissions from the DUT.
3. If available using the DUT's management interface, modify the advertised abilities. This may include enabling/disabling: 1000BASE-T half duplex, 1000BASE-T full duplex, Manual Master, Manual Slave.
4. Repeat steps 1-3 for all available abilities.

Part b: Energy Efficient Ethernet (EEE) Abilities

5. Complete a Next Page exchange with the DUT.
6. Observe transmission from the DUT.
7. If available using the DUT's management interface, modify the advertised abilities. This may include enabling/disabling: 100BASE-TX EEE, 1000BASE-T EEE, 10GBASE-T EEE.
8. Repeat steps 5-7 for all available abilities.

Part c: 10GBASE-T Abilities

9. Complete an extended Next Page exchange with the DUT.
10. Observe transmissions from the DUT.
11. If available using the DUT's management interface, modify the advertised abilities. This may include enabling/disabling: manual_Master, and manual_Slave, and LD Loop Timing.
12. Repeat steps 9-11 for all available abilities.

Observable Results:

a. UP1 should advertise appropriate abilities as indicated in Table 40-4 for the current management settings and the DUT's abilities.
b. If EEE is advertised in a standard Next Page exchange, the first EEE Unformatted Page should advertise appropriate abilities as indicated in Table 45-190 for the current management settings and the DUT's abilities. If EEE is advertised in an extended Next Page exchange, the DUT should advertise appropriate abilities in bits U24:22. The DUT should not advertise any abilities that it does not possess.
c. Bits U24:11 for the first Extended Next Page should advertise appropriate abilities as indicated in Table 55-15 for the current management settings and the DUT's abilities. The DUT should not advertise any abilities that it does not possess.

Possible Problems: None.

GROUP 2: PRIORITY RESOLUTION

Scope: The following tests cover Auto-Negotiation operation specific to Priority Resolution.

Overview: These tests are designed to verify that when a link is configured upon completion of Auto-Negotiation, it is resolved properly based on the received abilities from the link partner and the advertised abilities from the device under test (DUT).

Test #Sys.2.1: Speed Resolution and Verification

Purpose: To verify that the DUT resolves a link to the highest speed possible.

References:

[1] IEEE Std 802.3-2012: subclause 28.2.1.2.3, 28.2.3.3, 28.2.3.4, Annex 28B.3

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: Link resolution depends upon the abilities of the two devices connected and the priority of these abilities. With regards to speed, the order of priority (highest to lowest) is as follows: 10GBASE-T full duplex, 1000BASE-T full duplex, 1000BASE-T half duplex, 100BASE-T2 full duplex, 100BASE-TX full duplex, 100BASE-T2 half duplex, 100BASE-T4, 100BASE-TX half duplex, 10BASE-T full duplex, and 10BASE-T half duplex. Two devices should resolve a link to the highest common speed between the devices.

Test Setup: See **Appendix 28.B**

Procedure:

General Procedure:

1. Configure the DUT to advertise all supported technology speeds.
2. Send a Base Page advertising 10BASE-T to the DUT, so that the DUT will enter the FLP LINK GOOD CHECK state. To advertise some technologies, a Next Page exchange or extended Next Page exchange may be required.
3. Observe transmissions from the DUT.

Part a: Link Partner Advertisement of a Single Speed

4. Repeat steps 2 and 3 but modify step 2 such that each of the following speeds are advertised: 100BASE-TX, 100BASE-T4, 100BASE-T2, 1000BASE-T, and 10GBASE-T.

Part b: Link Partner Advertisement of All Speeds

5. Repeat steps 2 and 3 but modify step 2 such that all speeds are advertised.

Part c: Link Partner Advertisement of No Speeds

6. Repeat steps 2 and 3, but modify step 2 such that no speeds are advertised.

Observable Results:

a. The DUT should attempt to establish a link only when a supported speed is advertised, and should refuse a link when an unsupported speed is advertised.
b. The DUT should attempt to establish a link at the highest common speed.
c. The DUT should not establish a link with a device that does not advertise any speeds.

Possible Problems: If the DUT does not support Next Page exchange, then the 100BASE-T2, 1000BASE-T, and 10GBASE-T speeds cannot be tested.

Test #Sys.2.2: Duplex Resolution and Verification

Purpose: To verify that the DUT will resolve a link to the highest common duplex mode.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 28.2.3.3, 28.2.1.2.3, Annex 28.B3

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: Link resolution depends upon the abilities of the two devices connected and the priority of these abilities. With regards to duplex, a full duplex link takes priority over a half duplex link and devices configured for both duplexes should always establish a full duplex link.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Link Partner Advertisement of Full Duplex

1. Configure the DUT for all supported duplex settings (full and half) in all supported speeds.
2. Establish a link with the DUT by sending a Base Page advertising full duplex only at one supported speed.
3. Transmit frames to verify that the DUT is at the correct speed and duplex.
4. Repeat steps 2 and 3 for all supported speeds.
5. Repeat steps 2-4 advertising both full duplex and half duplex.

Part b: Link Partner Advertisement of Half Duplex Only

6. Repeat steps 2 and 4 advertising half duplex only.

Part c: Link Partner Advertisement of Incompatible Duplexes

7. If possible, configure the DUT to advertise only half duplex or full duplex support.
8. Attempt to establish a link with the DUT by sending a Base Page advertising an incompatible duplex
9. Repeat steps 7-8 for all supported speeds.

Observable Results:

a. The DUT should always resolve a full duplex link if both devices advertise full duplex support.
b. The DUT should resolve a half duplex link whenever both devices only support half duplex.
c. The DUT should not establish a link if there is no common duplex mode.

Possible Problems: None

Test #2.3: Pause Mode Resolution

Purpose: To verify that the DUT resolves to the proper pause mode as seen in Table 28B-3.

References:

[1] IEEE Std 802.3, 2012 Edition - Annex 28B.3, Table 28B-3

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: Link resolution depends upon the abilities of the two devices connected and the priority of these abilities. With regards to pause mode operation, pause mode should only be enabled when a full duplex link is the highest common denominator. When two devices advertise that they support flow control, they must resolve pause mode operation as specified in Table 28B-3, an expanded version of which is shown below. Note: The management interface may allow the user to change pause mode advertisements, however the transmission and response to the reception of PAUSE frames is determined by the Auto-Negotiation process and the MAC and MAC control layer operation must reflect the resolved pause mode abilities. A failure to use the resolved pause mode can create mismatched pause behavior between the two devices leading to a non-optimized link, which may include frame loss.

DUT		Link Partner		DUT Resolution		Link Partner Resolution	
PAUSE	ASM_DIR	PAUSE	ASM_DIR	Transmit PAUSE	Receive PAUSE	Transmit PAUSE	Receive PAUSE
0	0	0	0	Disable	Disable	Disable	Disable
0	0	0	1	Disable	Disable	Disable	Disable
0	0	1	0	Disable	Disable	Disable	Disable
0	0	1	1	Disable	Disable	Disable	Disable
0	1	0	0	Disable	Disable	Disable	Disable
0	1	0	1	Disable	Disable	Disable	Disable
0	1	1	0	Disable	Disable	Disable	Disable
0	1	1	1	Enable	Disable	Disable	Enable
1	0	0	0	Disable	Disable	Disable	Disable
1	0	0	1	Disable	Disable	Disable	Disable
1	0	1	0	Enable	Enable	Enable	Enable
1	0	1	1	Enable	Enable	Enable	Enable
1	1	0	0	Disable	Disable	Disable	Disable
1	1	0	1	Disable	Enable	Enable	Disable
1	1	1	0	Enable	Enable	Enable	Enable
1	1	1	1	Enable	Enable	Enable	Enable

Test Setup: See **Appendix 28.B**

Procedure:

Part a: PAUSE Frame Reception

1. If possible, configure to DUT to advertise no PAUSE abilities.
2. Establish a full duplex link with the DUT by sending a Base Page advertising no PAUSE abilities to the DUT.
3. Cause the DUT to transmit frames while using the Traffic Generator to transmit PAUSE frames to the DUT.
4. Observe transmissions from the DUT.
5. Repeat steps 2-4, with the Link Partner advertising PAUSE only, ASM_DIR only and both ASM_DIR and PAUSE abilities.
6. Repeat steps 1-5, configuring the DUT to advertise PAUSE only, ASM_DIR only and both ASM_DIR and PAUSE abilities.

Part b: Transmission of PAUSE frames

7. If possible, configure to DUT to advertise no PAUSE abilities.
8. Establish a full duplex link with the DUT by sending a Base Page advertising no PAUSE abilities to the DUT.
9. Use the Traffic Generator to transmit traffic at minimum inter-frame spacing. If possible, direct the traffic to a lower speed port, or to a congested port (by transmitting 2 line-rate streams to 1 port).
10. Observe transmissions from the DUT.
11. Repeat steps 8-10, with the Link Partner advertising PAUSE only, ASM_DIR only and both ASM_DIR and PAUSE capabilities.
12. Repeat steps 7-11, configuring the DUT to advertise PAUSE only, ASM_DIR only and both ASM_DIR and PAUSE capabilities.

Part c: Reception and Transmission of PAUSE Frames in Half Duplex

13. Configure the DUT to advertise PAUSE and ASM_DIR abilities.
14. Establish a half duplex link with the DUT by sending a Base Page advertising PAUSE and ASM_DIR to the DUT.
15. Cause the DUT to transmit frames while using the Traffic Generator to transmit PAUSE frames to the DUT.
16. Observe transmissions from the DUT.

Observable Results:

a. When appropriate the DUT should cease transmissions after receiving a PAUSE frame according to Table 28B-3.
b. When appropriate the DUT can transmit PAUSE frames according to Table 28B-3.
c. The DUT should not respond to or transmit PAUSE frames if a half duplex link has been established.

Possible Problems: There is no guaranteed method to cause a DUT to transmit a PAUSE frame.

Test # Sys.2.4: Master-Slave Resolution

Purpose: To verify that the MASTER-SLAVE configuration for 1000BASE-T and 10GBASE-T links is resolved properly according to Table 40-5 and Table 55-16.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 40.5.2, 55.6.2, Table 40-5, Table 55-16

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: Before a 1000BASE-T or 10GBASE-T link can be established between two devices, one device must resolve to be the MASTER, and the other device must resolve to be the SLAVE. During the Next Page exchange or the extended Next Page exchange, one Message Page and two Unformatted Pages or one extended Message Page are transmitted. These pages contain, among other abilities, information that is used to decide the MASTER-SLAVE configuration. Bit U2 of the first Unformatted Page or bit U13 of the extended Unformatted Code Field shows whether the device is a single-port or multiport device, and bits U1 and U0, or bits U11 and U12 of this page hold the manual configuration values for MASTER-SLAVE resolution. Loop timing support is indicated in bit U17 of the extended Unformatted Code Field. Bits U10:U0 of the second unformatted page or the extended Unformatted Code Field contain a random MASTER-SLAVE seed value. The two devices must resolve the link according to Table 40-5, the two tables below are an expanded version of this table, including resolution for Loop Timing.

One Device Advertises Loop Timing			
Local Device Type	**Remote Device Type**	**Local Device Resolution**	**Remote Device Resolution**
Loop Timing	Manual_MASTER	SLAVE	MASTER
Loop Timing	Manual_SLAVE	MASTER-SLAVE configuration fault	MASTER-SLAVE configuration fault
Loop Timing	Multi-port	SLAVE	MASTER
Loop Timing	Single-port	SLAVE	MASTER
Loop Timing Manual_MASTER	Anything	MASTER-SLAVE configuration fault	MASTER-SLAVE configuration fault
Manual_MASTER	Loop Timing	MASTER	SLAVE
Manual_SLAVE	Loop Timing	MASTER-SLAVE configuration fault	MASTER-SLAVE configuration fault
Multi-port	Loop Timing	MASTER	SLAVE
Single-port	Loop Timing	MASTER	SLAVE
Anything	Loop Timing Manaul_MASTER	MASTER-SLAVE configuration fault	MASTER-SLAVE configuration fault

Both Devices Advertise Loop Timing or Both Devices do not Advertise Loop Timing			
Local Device Type	**Remote Device Type**	**Local Device Resolution**	**Remote Device Resolution**
Manual_MASTER	Manual_MASTER	MASTER-SLAVE configuration fault	MASTER-SLAVE configuration fault
Manual_MASTER	Manual_SLAVE	MASTER	SLAVE
Manual_MASTER	Multi-port	MASTER	SLAVE
Manual_MASTER	Single-port	MASTER	SLAVE
Manual_SLAVE	Manual_MASTER	SLAVE	MASTER
Manual_SLAVE	Manual_SLAVE	MASTER-SLAVE configuration fault	MASTER-SLAVE configuration fault
Manual_SLAVE	Multi-port	SLAVE	MASTER
Manual_SLAVE	Single-port	SLAVE	MASTER
Multi-port	Manual_MASTER	SLAVE	MASTER
Multi-port	Manual_SLAVE	MASTER	SLAVE
Multi-port	Multi-port	The device with the higher SEED value is configured as MASTER, otherwise SLAVE. If the SEED values are identical, a MASTER-SLAVE configuration fault occurs.	The device with the higher SEED value is configured as MASTER, otherwise SLAVE. If the SEED values are identical, a MASTER-SLAVE configuration fault occurs.
Multi-port	Single-port	MASTER	SLAVE
Single-port	Manual_MASTER	SLAVE	MASTER
Single-port	Manual_SLAVE	MASTER	SLAVE
Single-port	Multi-port	SLAVE	MASTER
Single-port	Single-port	The device with the higher SEED value is configured as MASTER, otherwise SLAVE. If the SEED values are identical, a MASTER-SLAVE configuration fault occurs.	The device with the higher SEED value is configured as MASTER, otherwise SLAVE. If the SEED values are identical, a MASTER-SLAVE configuration fault occurs.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: 1000BASE-T MASTER-SLAVE Resolution

1. If possible, configure the DUT to advertise neither manual_MASTER nor manual_SLAVE.
2. Send a Base Page, followed by a 1000BASE-T Next Page Sequence advertising manual_MASTER, with a seed value of 000*h*.
3. Check whether the DUT has resolved the link to be MASTER or SLAVE by observing if 1000BASE-T Idle signaling is transmitted.
4. Repeat steps 2 and 3, advertising Multi-port, Single-port, and manual_SLAVE. When advertising only the same port type as the DUT, run the case three times, the second time changing the seed value in UP2 to 7FF*h*, and the third time advertising the same seed value as the DUT.
5. Repeat steps 1-4 two times, the first with the DUT advertising manual_MASTER and the second with the DUT advertising manual_SLAVE.

Part b: 10GBASE-T MASTER-SLAVE Resolution

6. Complete the following steps with the Link Partner advertising Loop Timing.
7. If possible, configure the DUT to advertise neither manual_MASTER nor manual_SLAVE.
8. Send a Base Page, followed by a 10GBASE-T extended Next Page sequence advertising manual_MASTER, and a seed value of 000*h*.
9. Observe transmissions from the DUT.
10. Repeat steps 8 and 9, with the Link Partner advertising Multi-port, Single-port, and manual_SLAVE. When advertising only the same port type as the DUT, run the case three times, the second time changing the seed value to 7FF*h*, and the third time advertising the same seed value as the DUT.
11. Repeat steps 8-10 two times, the first with the DUT advertising manual_MASTER and the second with the DUT advertising manual_SLAVE.
12. Repeat steps 6-11 with the Link Partner not advertising Loop Timing.

Observable Results:

a. The DUT should resolve the link according to Table 40-5.
b. The DUT should resolve the link according to the tables above.

Possible Problems: If the DUT does not support 1000BASE-T, then part a of this test cannot be performed. If the DUT does not support 10GBASE-T, then part b of this test cannot be performed.

Test # Sys.2.5: Energy Efficient Ethernet Resolution and Verification

Purpose: To verify that the DUT resolves an Energy Efficient Ethernet (EEE) link when appropriate.

References:
[1] IEEE Std 802.3-2012: subclause 78.3, 45.2.7.13, Table 45-190

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: During the Auto-Negotiation process, both link partners may indicate their EEE abilities. EEE operation is only resolved if both the local device and the link partner advertise the EEE ability for the resolved highest common denominator. If EEE is not supported by both devices, all EEE functionality is disabled and the Low Power Idle (LPI) client does not assert LPI.

Test Setup: See **Appendix 28.B**.

Procedure:
Part a: 100BASE-TX EEE Resolution

1. If possible, configure the DUT to not advertise 100BASE-TX EEE ability.
2. Establish a link by sending a Base Page, followed by a EEE Next Page Sequence advertising no 100BASE-TX EEE abilities, and with 100BASE-TX as the highest advertised speed.
3. Observe transmissions from the DUT.
4. Repeat steps 2 and 3, with the Link Partner advertising 100BASE-TX EEE ability.
5. Repeat steps 2-4, with a speed other than 100BASE-TX as the highest common speed.
6. Repeat steps 1-5, configuring the DUT to advertise 100BASE-TX EEE ability.

Part b: 1000BASE-T EEE Resolution

7. If possible, configure the DUT to not advertise 1000BASE-T EEE ability.
8. Establish a link by sending a Base Page, followed by a 1000BASE-T Next Page Sequence, followed by a EEE Next Page Sequence advertising no 1000BASE-T EEE ability, and with 1000BASE-T as the highest advertised speed.
9. Observe transmissions from the DUT.
10. Repeat steps 8 and 9, with the DUT advertising 1000BASE-T EEE ability.
11. Repeat steps 7-9, with a speed other than 1000BASE-T as the highest common speed.
12. Repeat steps 7-11, configuring the DUT to advertise 1000BASE-T EEE ability.

Part c: 10GBASE-T EEE Resolution

13. If possible, configure the DUT to not advertise 10GBASE-T EEE ability.
14. Establish a link by sending a Base Page, followed by a 10GBASE-T extended Next Page Sequence advertising no 10GBASE-T EEE abilities, and with 10GBASE-T as the highest advertised speed.
15. Observe transmissions from the DUT.
16. Repeat steps 14 and 15, with the Link Partner advertising 10GBASE-T EEE ability.
17. Repeat steps 13-16, with a speed other than 10GBASE-T as the highest common speed.
18. Repeat steps 13-17, configuring the DUT to advertise 10GBASE-T EEE ability.

Observable Results:

a. When both the DUT and its link partner advertise 100BASE-TX EEE ability and 100BASE-TX is their highest common speed, a 100BASE-TX EEE link should be established. Otherwise, a 100BASE-TX link should be established.
b. When both the DUT and its link partner advertise 1000BASE-T EEE ability and 1000BASE-T is their highest common speed, a 1000BASE-T EEE link should be established. Otherwise, a 1000BASE-T link should be established.
c. When both the DUT and its link partner advertise 10GBASE-T EEE ability and 10GBASE-T is their highest common speed, a 10GBASE-T EEE link should be established. Otherwise, a 10GBASE-T link should be established.

Possible Problems: The standard does not require that an LPI client asserts LPI after a EEE link has been established.

GROUP 3: PARALLEL DETECTION

Scope: The following tests cover Auto-Negotiation operation specific to Parallel Detection.

Overview: These tests are designed to verify that a capable device properly detects a fixed speed connection and establishes a link at half duplex.

Test #Sys.3.1: Parallel Detection of 10BASE-T Devices

Purpose: To verify that the DUT can properly parallel detect a fixed speed 10BASE-T link partner.

References:

[1] IEEE Std 802.3, 2012 Edition - subclauses 14.3.1.2.1, 28.2.2.2, 28.2.3.1, 28.4 Figure 28-19

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: A device 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). When a 10BASE-T device is detected, the device 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.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Reception of 10BASE-T NLPs

1. Send validly spaced NLPs to the DUT for at least 1 second.
2. Observe transmissions from the DUT.

Part b: Verification of the Link Duplex

3. Establish a 10BASE-T link by sending NLPs to the DUT.
4. Cause the DUT to transmit a frame and upon transmission, source a frame from the Traffic Generator.
5. Observe the transmission from the DUT.

Part c: Parallel Detection with Half Duplex Disabled

6. If possible disable the advertisement of 10BASE-T half duplex ability in the DUT's Base Page.
7. Send validly spaced NLPs to the DUT for at least 1 second.
8. Cause the DUT to transmit a frame and upon transmission, source a frame from the Traffic Generator.
9. Observe the transmission from the DUT.

Observable Results:

a. The DUT should establish a valid 10BASE-T link.
b. The DUT should transmit a 10BASE-T collision fragment, indicating that the DUT has properly parallel detected a half duplex connection.
c. INFORMATIVE: If the DUT allows Parallel Detection of a 10BASE-T link, the DUT must resolve to a half duplex link. Otherwise, the DUT must refuse the link.

Possible Problems: If the DUT's management does not allow 10BASE-T half duplex advertisement to be disabled, part c of this test cannot be performed. If the DUT does not support 10BASE-T, this test cannot be performed.

Test # Sys.3.2: Parallel Detection of 100BASE-TX Devices

Purpose: To verify that the DUT can properly parallel detect a fixed speed 100BASE-TX link partner.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 28.2.3.1

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: A device 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 FLP Bursts. In this case, a device 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 DUT properly handles the presence of a fixed speed 100BASE-TX device as a link partner.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Reception of 100BASE-TX Link Signaling

1. Send 100BASE-TX signaling to the DUT for more than autoneg_wait_timer.
2. Observe transmissions from the DUT.

Part b: Verification of the Link Duplex

3. Establish a link by sending 100BASE-TX signaling to the DUT.
4. Cause the DUT to transmit a frame and upon transmission send a frame from the Traffic Generator.
5. Observe transmissions from the DUT.

Part c: Parallel Detection with Half Duplex Disabled

6. If possible disable the advertisement of 100BASE-TX half duplex ability in the DUT's Base Page.
7. Send 100BASE-TX signaling to the DUT to establish a link.
8. Cause the DUT to transmit a frame and upon transmission send a frame from the traffic Generator.
9. Observe transmissions from the DUT.

Observable Results:

a. The DUT should establish a 100BASE-TX link.
b. The DUT should transmit a 100BASE-TX collision fragment, indicating that the DUT has properly parallel detected a half duplex connection.
c. INFORMATIVE: If the DUT allows Parallel Detection of a 100BASE-TX link, the DUT must resolve to a half duplex link. Otherwise, the DUT must refuse the link.

Possible Problems: If the DUT's management does not allow 100BASE-TX half duplex advertisement to be disabled, part c of this test cannot be performed. If the DUT does not support 100BASE-TX, this test cannot be performed.

Test #Sys.3.3: Parallel Detection of 100BASE-T4 Devices

Purpose: To verify that the DUT can properly parallel detect a fixed speed 100BASE-T4 link partner.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 28.2.3.1

Resource Requirements: See **Appendix 28.A**

Last Modification: January 9, 2014

Discussion: A device 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 FLP Bursts. In this case, a device 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 DUT properly handles the presence of a fixed speed 100BASE-T4 device as a link partner.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Reception of 100BASE-T4 Link Signaling

1. Send 100BASE-T4 signaling to the DUT for more than autoneg_wait_timer.
2. Observe transmissions from the DUT.

Part b: Parallel Detection with 100BASE-T4 Disabled

3. If possible disable the advertisement of the 100BASE-T4 ability in the DUT's Base Page.
4. Establish a link by sending 100BASE-T4 signaling to the DUT.
5. Observe transmissions from the DUT.

Observable Results:

a. The DUT should establish a link if the DUT supports 100BASE-T4.
b. INFORMATIVE: The DUT's management may prevent the Parallel Detection of 100BASE-T4.

Possible Problems: If the DUT's management does not allow 100BASE-T4 advertisement to be disabled, part b of this test cannot be performed. If the DUT does not support 100BASE-T4, this test cannot be performed.

GROUP 4: GENERIC NEXT PAGE FUNCTIONALITY

Scope: The following tests cover generic Auto-Negotiation operation specific to the exchange of Next Pages.

Overview: These tests are designed to verify the device's management properly controls the Next Page exchange, and that the DUT behaves appropriately upon reception of Message and Unformatted Pages, for all defined Message Codes.

Note: If the device does not support a Next Page Exchange, these tests cannot be performed.

Test #Sys.4.1: Next Page Bit

Purpose: To verify that the DUT makes proper use of the Next Page bit throughout the Next Page exchange process.

References:

[1] IEEE Std 802.3, 2012 Edition - subclauses 28.2.1.2, 28.2.1.2.6, 28.2.3.4, 28.2.3.4.1, 28.2.3.4.3, 28.2.3.4.13, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: During the exchange of Next Pages, the Next Page (NP) bit plays a simple role. It is to have the value 1 if a device has more Next Pages to transmit, and 0 if it is transmitting its last page of information. Once both a device and its link partner are transmitting Next Pages with the Next Page bit set to 0 the Next Page process should end, and a link should be established. This test is designed to verify two aspects of the Next Page process: (1) that the DUT properly sets the NP bit throughout the Next Page process, and (2) that the DUT does not transmit any Null Message Pages if its link partner finishes transmitting its Message and Unformatted Pages before DUT.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Send Same Number of Next Pages as the DUT has to Transmit

1. Send a Base Page, followed by Next Pages with NP=1 and proper toggle bit values to the DUT. Continue sending new Next Pages until the DUT sets NP=0 in its outgoing Pages.
2. Observe transmissions from the DUT. Count the number (‘n’) of Next Pages (not FLP Bursts) sent by the DUT.

Part b: Send More Next Pages than DUT has to Transmit

3. Send a Base Page followed by ‘n’ + 2 Next Pages, with proper toggle bit values to the DUT, setting NP=0 in the final Next Page.
4. Observe transmissions from the DUT.

Part c: Send Fewer Next Pages than DUT has to transmit

5. Send a Base Page and 'n' Null Message Pages with NP=0 to the DUT.
6. Observe transmissions from the DUT.

Observable Results:

a. The DUT should keep the NP bit set in all but the last page sent by the DUT.
b. The DUT should keep the NP bit set in all but the last three pages sent by the DUT.
c. The DUT should keep the NP bit set in all but the last page sent by the DUT.

Possible Problems: None.

Test #Sys.4.2: Null Message Page Generation

Purpose: To verify that the DUT transmits proper Null Message Pages if it completes sending Message and Unformatted Pages before its link partner.

References:

[1] IEEE Std 802.3, 2012 Edition - subclauses 28.2.3.4, 28.2.3.4.1, 28.2.3.4.8, 28.2.3.4.9, 28.2.3.4.13, Annex 28C, Annex 28C.2

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: Once a device has finished sending Message and Unformatted Next Pages, it is required to send Null Message Pages until its link partner is transmitting Next Pages with the Next Page bit set to zero. A Null Message Page is defined as a Message Page that contains the Null Message Code (Message Code 1). This test is designed to verify that once the DUT completes its transmission of Message and Unformatted Pages, it sends out Null Message Pages until its link partner is finished transmitting Next Pages. Alternatively, a device may solely transmit Next Pages containing Null Message codes. This would allow a device with no Next Page data to transmit to still receive Next Page information from its link partner. Although it not recommended that a device send a Null Message Page as its desired final page, it is allowed if the previous Next Page had the Next Page bit set to 1.

Test Setup: See **Appendix 28.B**.

Procedure:

Parts a & b: Send More Next Pages than DUT has to transmit

1. Send a Base Page followed by ‘n’ + 2 Next Pages with proper toggle bit and Next Page bit values to the DUT, where ‘n’ is the value in Test #4.1, part a.
2. Observe transmissions from the DUT.

Observable Results:

a. The last two Next Pages transmitted by the DUT should contain Null Message Pages.
b. INFORMATIVE: The last desired Next Page transmitted by the DUT was or was not a Null Message Page.

Possible Problems: None.

Test #Sys.4.3: Reception of Next Pages

Purpose: To verify that the DUT behaves appropriately upon reception of Message and Unformatted Pages, for all defined Message Codes.

References:

[1] IEEE Std 802.3, 2012 Edition - subclauses 28.2.1.2, 28.2.3.4, 28.2.3.4.1, 28.2.3.4.5, 28.2.3.4.8, 28.2.3.4.9, 28.2.3.4.10, 28.2.3.4.11, 28.2.3.4.13, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: A device supporting a Next Page exchange should be capable of receiving a wide variety of Next Pages from its link partner. It should properly accept all sequences of defined Message Codes and Unformatted Pages found in Annex 28C. There is no guaranteed way of confirming whether a device acts upon a received Message Code and associated Unformatted Pages, unless the Message Code contains technology abilities that the DUT is capable of. The following table contains all defined Message Codes and their corresponding number of Unformatted Pages. Message codes 9 and 11 are defined for extended Next Page use. A device may receive these Message Codes but should not act upon them.

Message Code	Message Code Definition	Number of 16-bit Unformatted Pages
1	Null Message Code	0
2	Technology Ability Extension Code 1	1
3	Technology Ability Extension Code 2	2
4	Remote Fault Number Code	1
5	OUI Tag Code	4
6	PHY Identifier Tag Code	4
7	1000BASE-T2 Technology Message Code	2
8	1000BASE-T Technology Message Code	2
9	10GBASE-T and 1000BASE-T Technology Message Code	2
10	EEE Technology Message Code	1
11	OUI Tag Message	2 or 5

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Reception of all defined Message Codes

1. Send a Base Page, followed by the first Next Page Sequence in the table above followed by enough Null Message Pages to complete the exchange with the DUT.
2. Observe transmissions from the DUT.
3. Repeat steps 1 and 2 for all Page Sequences contained within the table above.

Part b: Reception of all defined Message Codes after a 1000BASE-T Next Page sequence

4. Send a Base Page, followed by a 1000BASE-T Next Page Sequence to the DUT followed by the first Next Page Sequence in the table above followed by enough Null Message Pages to complete the exchange with the DUT.
5. Observe transmissions from the DUT.
6. Repeat steps 4 and 5 for all Page Sequences contained within the table above except for the 1000BASE-T Next Page Sequence.

Part c: Reception of all defined Message Codes after a EEE Next Page sequence

7. Send a Base Page, followed by a EEE Next Page Sequence to the DUT followed by the first Next Page Sequence in the table above followed by enough Null Message Pages to complete the exchange with the DUT.
8. Observe transmissions from the DUT.
9. Repeat steps 7 and 8 for all Page Sequences contained within the table above except for the EEE Next Page Sequence.

Observable Results:

a-c. The DUT should accept all defined combinations by properly completing the Next Page exchange and attempt to establish a highest common denominator link.

Possible Problems: There is no guaranteed way of confirming whether a device acts upon a received Message Code and associated Unformatted Pages, unless the Message Code contains technology abilities that the DUT is capable of.

GROUP 5: GENERIC EXTENDED NEXT PAGE FUNCTIONALITY

Scope: The following tests cover generic Auto-Negotiation operation specific to the exchange of extended Next Pages.

Overview: These tests are designed to verify the device's management properly controls the extended Next Page exchange, and that the DUT behaves appropriately upon reception of Message and Unformatted Pages, for all defined Message Codes.

Note: If the device does not support an extended Next Page Exchange, these tests cannot be performed.

Test #Sys.5.1: Extended Next Page and Next Page Bits

Purpose: To verify that the DUT makes proper use of the Next Page and extended Next Page bits throughout the extended Next Page exchange process.

References:

[2] IEEE Std 802.3, 2012 Edition - subclauses 28.2.1.2, 28.2.1.2.6, 28.2.3.4, 28.2.3.4.1, 28.2.3.4.2, 28.2.3.4.3, 28.2.3.4.13, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: As with Next Pages, when two devices are connected to each other, they will negotiate the usage of extended Next Pages. Extended Next Page capability is advertised in bit D12 (XNP) of the Base Page. When both devices indicate support of extended Next Page ability, then both devices will only transmit extended Next Pages. If only one device supports the extended Next page ability, or if neither device supports extended Next Page ability, then extended Next Pages will not be used.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Extended Next Page Negotiation

1. Send a Base Page with NP=1 and XNP=0 to the DUT to cause it to enter the COMPLETE ACKNOWLEDGE state.
2. Observe transmissions from the DUT
3. Repeat steps 1 and 2 setting XNP=1.
4. If possible, disable all extended Next Page abilities on the DUT.
5. Repeat steps 1 through 4.

Part b: Send Same Number of Extended Next Pages as the DUT has to Transmit

6. Send a Base Page and extended Next Pages with NP=1, XNP=1 and proper toggle bit values to the DUT. Continue sending new extended Next Pages until the DUT sets NP=0 in its outgoing Pages.
7. Observe transmissions from the DUT. Count the number (‘n’) of extended Next Pages (not FLP Bursts) sent by the DUT.

Part c: Send More Extended Next Pages than DUT has to Transmit

8. Send a Base Page and 'n’ + 2 extended Next Pages, with proper toggle bit values to the DUT, setting NP=0 in the final extended Next Page.
9. Observe transmissions from the DUT.

Part d: Send Fewer Extended Next Pages than DUT has to Transmit

10. Send a Base Pages and 'n' Null Message Pages with NP=0 to the DUT.
11. Observe transmissions from the DUT.

Observable Results:

a. The DUT should only send an extended Next Page when both the DUT and its link partner desire to send extended Next Pages; otherwise, the DUT should begin transmitting its first Next Page.
b. The DUT should keep the NP bit set in all but the last page sent by the DUT.
c. The DUT should keep the NP bit set in all but the last three pages sent by the DUT.
d. The DUT should keep the NP bit set in all but the last page sent by the DUT.

Possible Problems: None.

Test #Sys.5.2: Extended Null Message Page Generation

Purpose: To verify that the DUT transmits proper Null Message Pages if it completes sending extended Message Pages and extended Unformatted Pages before its link partner.

References:

[2] IEEE Std 802.3, 2012 Edition - subclauses 28.2.3.4, 28.2.3.4.1, 28.2.3.4.2, 28.2.3.4.8, 28.2.3.4.9, 28.2.3.4.13, Annex 28C, Annex 28C.2

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: Once a device has finished sending Message and Unformatted extended Next Pages, it is required to send Null Message Pages until its link partner is transmitting extended Next Pages with the Next Page bit set to zero. A Null Message Page is defined as a Message Page that contains the Null Message Code (Message Code 1). This test is designed to verify that once the DUT completes its transmission of Message and Unformatted Pages, it sends out valid Null Message Pages until its link partner is transmitting extended Next Pages with the Next Page bit set to zero. Alternatively, a device may solely transmit extended Next Pages containing Null Message codes. This would allow a device with no extended Next Page data to transmit to still receive extended Next Page information from its link partner. Although it not recommended that a device send a Null Message Page as its desired final page, it is allowed if the previous Next Page had the Next Page bit set to 1.

Test Setup: See **Appendix 28.B**

Procedure:

Parts a & b: Send More Extended Next Pages than DUT has to transmit

1. Send a Base Page followed by ‘n’ + 2 extended Next Pages with proper toggle bit and Next Page bit values to the DUT, where ‘n’ is the value from Test #5.1, part a.
2. Observe transmissions from the DUT.

Observable Results:

a. The last two extended Next Pages transmitted by the DUT should contain extended Null Message Pages.
b. INFORMATIVE: The last desired Next Page transmitted by the DUT was or was not a Null Message Page.

Possible Problems: None.

Test #Sys.5.3: Reception of Extended Next Pages

Purpose: To verify that the DUT behaves appropriately upon reception of extended Message Pages and extended Unformatted Pages, for all defined Message Codes.

References:

[2] IEEE Std 802.3, 2012 Edition - subclauses 28.2.1.2, 28.2.3.4, 28.2.3.4.1, 28.2.3.4.2 28.2.3.4.5, 28.2.3.4.8, 28.2.3.4.9, 28.2.3.4.10, 28.2.3.4.11, 28.2.3.4.13, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: A device supporting an extended Next Page exchange should be capable of receiving a wide variety of extended Next Pages from its link partner. It should properly accept all sequences of defined Message Codes and Unformatted Pages found in Annex 28C. There is no guaranteed way of confirming whether a device acts upon a received Message Code and associated Unformatted Pages, unless the Message Code contains technology abilities that the DUT is capable of. The following table contains all defined Message Codes and their corresponding number of Unformatted Pages.

In order to form an extended Next Page for a Message Code that is not specifically defined for extended Next Page use, three standard 16-bit Next Pages can be combined. Each extended Next Page can contain no more than one 16-bit Message Page. If the extended Next Page contains a 16-bit Message Page, it must be located in the first 16 bits of the 48-bit extended Next Page, the remaining 32 bits are an Unformatted Code Field. This Unformatted Code Field can contain up to two 16-bit standard Unformatted Next Pages, where the flag field bits must be transmitted as all zeros. If the extended Next Page does not contain a 16-bit Message page then all 48 bits are unformatted, and can contain up to three 16-bit standard Unformatted Next Pages. In this case, the first 16 bits must contain valid flag field values. Any unused bits at the end of the extended Next Page must be transmitted as zeros.

Test Setup: See **Appendix 28.B**

Message Code	Message Code Definition	Number of 16-bit Unformatted Pages
1	Null Message Code	0
2	Technology Ability Extension Code 1	1
3	Technology Ability Extension Code 2	2
4	Remote Fault Number Code	1
5	OUI Tag Code	4
6	PHY Identifier Tag Code	4
7	1000BASE-T2 Technology Message Code	2
8	1000BASE-T Technology Message Code	2
9	10GBASE-T and 1000BASE-T Technology Message Code	2
10	EEE Technology Message Code	1
11	OUI Tag Message	2 or 5

Procedure:

Part a: Reception of all defined Message Codes

1. Send a Base Page, followed by the first extended Next Page Sequence in the table above to the DUT, followed by enough extended Null Message Pages to complete the exchange with the DUT.
2. Observe transmissions from the DUT.
3. Repeat steps 1 and 2 for all Page Sequences in the table above

Part b: 10GBASE-T extended Next Page Sequence followed by all defined Message Codes

4. Send a Base Page, followed by a 10GBASE-T extended Next Page Sequence to the DUT, followed by the first extended Next Page Sequence in the table above followed by enough extended Null Message Pages to complete the exchange with the DUT.
5. Observe transmissions from the DUT.
6. Repeat steps 4 and 5 for all Page Sequences in the table above except for the 10GBASE-T, 1000BASE-T and EEE Next Page Sequences.

Observable Results:

a. and b. The DUT should accept all defined combinations by properly concluding the exchange of extended Next Pages (NP=0 in last non-Null Message Page) and attempt to establish a highest common denominator link.

Possible Problems: There is no way of confirming whether a device acts upon a received Message Code and associated Unformatted Pages, unless the Message Code contains technology abilities that the DUT is capable of.

GROUP 6: 1000BASE-T NEXT PAGE FUNCTIONALITY

Scope: The following tests cover Auto-Negotiation operation specific to the exchange of Next Pages for 1000BASE-T devices.

Overview: These tests are designed to verify the transmission and reception of 1000BASE-T Message and Unformatted Pages.

Note: If the device does not support a 1000BASE-T PMA, these tests cannot be performed

Test #Sys.6.1: 1000BASE-T Message and Unformatted Page Transmission Order

Purpose: To verify that the 1000BASE-T DUT transmits its Base Page, followed immediately by a 1000BASE-T Message Page and two Unformatted Pages.

References:

[1] IEEE Std 802.3, 2012 - subclauses 28.2.3.4.5, 28.2.3.4.8, 40.5.1.2, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: 1000BASE-T devices desiring to advertise 1000BASE-T capabilities are required to send a 1000BASE-T Message Page immediately following completion of the Base Page exchange. This Message Page should contain a Message Code #8 and the MP bit (D13) should be set to logic one. This Message Page must be followed by 2 Unformatted Pages the MP bit (D13) should be set to logic zero in these pages. This test verifies the transmission order of the pages sent from the DUT, the value of the MP bit in the transmitted pages, and the value of the Message Code Field in the Message Page.

Test Setup: See **Appendix 28.B**

Procedure:

1. Complete a Next Page exchange with the DUT.
2. Observe transmissions from the DUT.

Observable Results:

a. The DUT should transmit its Base Page, followed immediately by a 1000BASE-T Next Page Sequence.

Possible Problems: None

Test #Sys.6.2: Content and Format of 1000BASE-T UP2

Purpose: To verify that the DUT transmits random seed values in its second Unformatted Page after the 1000BASE-T Message Page.

References:

[1] IEEE Std 802.3, 2012 Edition - subclauses 40.5.1.2, Table 40-4

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: Before two 1000BASE-T devices can establish a link, a Next Page exchange must be accomplished, consisting of one Message Page and two Unformatted Pages. The content of these Unformatted Pages is defined in Table 40-4. The second Unformatted Page of a 1000BASE-T Next Page exchange contain an 11 bit (U10:0) random value. This seed value is used in the MASTER/SLAVE resolution process. This test verifies that the seed values transmitted by the DUT appear randomly generated.

Test Setup: See **Appendix 28.B**

Procedure:

1. Complete a Next Page exchange with the DUT.
2. Observe transmissions from the DUT.
3. Repeat steps 1 and 2 at least 5 times.

Observable Results:

a. The second Unformatted Page (UP2) should contain a pseudorandom integer value. The DUT should change the value transmitted here each time the Auto-Negotiation process is completed.

Possible Problems: None.

Test #Sys.6.3: 1000BASE-T Next Page Sequence Reception

Purpose: To verify that the DUT only attempts to establish a 1000BASE-T link upon reception of a 1000BASE-T Next Page Exchange where the Page Sequence is properly encoded.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 28.2.3.4.13, 40.5.1.2, Table 40-4, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: The standard requires that a device exchange a Base Page, a 1000BASE-T formatted Message Page, and two 1000BASE-T Unformatted Next Pages in sequence, without interruption. The standard does not specifically prohibit a 1000BASE-T link being established upon reception of a 1000BASE-T Message Page (Message Code #8), followed by two 1000BASE-T Unformatted Pages in sequence, without interruption not immediately after the Base Page. However, any other deviation from the required sequence of pages should result in a failure to resolve a 1000BASE-T link (though non-1000BASE-T abilities advertised, such as in the Base Page, may still be resolved).

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Null Message Page in place of 1000BASE-T UP2

1. Send a Base Page, followed by a 1000BASE-T Next Page Sequence with a Null Message Page in place of UP2 to the DUT, followed by enough additional Null Message Pages to complete the Next Page exchange.
2. Observe transmissions from the DUT.

Part b: 1000BASE-T exchange with the Message Page bit not set

3. Send a Base Page, followed by a 1000BASE-T Next Page sequence with the Message Page bit not set in the first Next Page to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
4. Observe transmissions from the DUT.

Part c: 1000BASE-T exchange with Message Page bit set in UP1

5. Send a Base Page, followed by a 1000BASE-T Next Page sequence but with the Message Page bit set in UP1 to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
6. Observe transmissions from the DUT.

Part d: 1000BASE-T exchange with Message Page bits set in UP1 and UP2

7. Send a Base Page, followed by a 1000BASE-T Next Page sequence but with the Message Page bit set in both UP1 and UP2 to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
8. Observe transmissions from the DUT.

Part e: Reception of Improper Message Codes during a 1000BASE-T Exchange

9. Send a Base Page followed by a Message Code #0 followed by two Unformatted Pages that conform to valid 1000BASE-T Unformatted Next Pages to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
10. Observe transmissions from the DUT.
11. Repeat steps 9 and 10 for all of the following Message Code values: 0x9, 0x101, 0x108, 0x109, 0x501, 0x508, 0x509, and 0x7FF.

Observable Results:

a.-d. The DUT should not attempt to establish a 1000BASE-T link when the Message Page bit is set improperly during the Next Page exchange.

e. The DUT should not establish a 1000BASE-T link with the Link Partner when the Link Partner transmitted a Message Page with a Message Code not equal to Message Code #8.

Possible Problems: None.

Test #Sys.6.4: Message Page Reception Before and Following a 1000BASE-T Exchange

Purpose: To verify that the DUT establishes a 1000BASE-T link upon reception of a properly formatted 1000BASE-T Message Page regardless of any additional pages sent after the 1000BASE-T exchange.

References:

[2] IEEE Std 802.3, 2012 Edition - subclause 40.5.1.2, Table 40-4, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: A device should only attempt to establish a 1000BASE-T link when its link partner advertises 1000BASE-T abilities using Message Code #8. The standard does not specifically prohibit a 1000BASE-T link being established upon reception of a 1000BASE-T Message Page (Message Code #8), followed by two 1000BASE-T Unformatted Pages in sequence, without interruption not immediately after the Base Page. Otherwise it should attempt to establish a link based on the received Base Page abilities. When a device receives reserved Message Codes after a valid 1000BASE-T exchange, it should complete the Next Page exchange and attempt to establish a 1000BASE-T link.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Non-Immediate 1000BASE-T exchange

1. Send a Base Page, followed by a Message Page with a Message Code #20 followed by two Unformatted Pages whose Unformatted Fields are all zero, followed by a 1000BASE-T Next Page Sequence to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
2. Observe transmissions from the DUT.

Part b: Reception of Message Codes after a 1000BASE-T Next Page Exchange

3. Send a Base Page, followed by a 1000BASE-T Next Page Sequence, followed by Message Code #0 with two Unformatted Pages to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
4. Observed transmissions from the DUT.
5. Repeat steps 3 and 4 replacing Message Code #0 with the following Message Code values: 0x9, 0x101, 0x109, 0x10A, 0x501, 0x509, 0x50A, and 0x7FF.

Observable Results:

a. INFORMATIVE: A 1000BASE-T link may be attempted upon reception of a sequence of 1000BASE-T Next Pages even though the 1000BASE-T Message Page was not received immediately after the Base Page transmission.
b. The DUT should establish a 1000BASE-T link with the Link Partner regardless of any additional Message Codes sent after the 1000BASE-T exchange.

Possible Problems: None

GROUP 7: 10GBASE-T EXTENDED NEXT PAGE FUNCTIONALITY

Scope: The following tests cover Auto-Negotiation operation specific to the exchange of extended Next Pages for 10GBASE-T devices.

Overview: These tests are designed to verify the transmission and reception of 10GBASE-T extended Message Pages.

Note: If the device does not support a 10GBASE-T PMA, these tests cannot be performed.

Test #Sys.7.1: 10GBASE-T Message Page Transmission

Purpose: To verify that the 10GBASE-T DUT transmits its Base Page, followed immediately by a properly formatted 10GBASE-T extended Message Page.

References:

[1] IEEE Std 802.3, 2012 - subclauses 28.2.3.4.5, 28.2.3.4.8, 40.5.1.2, 55.6.1.2, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: 10GBASE-T devices desiring to advertise 10GBASE-T capabilities are required to send a 10GBASE-T extended Message Page immediately following completion of the Base Page exchange. This Message Page should contain a Message Code #9 and the MP bit (D13) should be set to logic one. This test verifies the value of the MP bit in the transmitted pages, and the value of the Message Code Field in the extended Message Page.

Test Setup: See **Appendix 28.B**

Procedure:

1. Complete a 10GBASE-T extended Next Page exchange with the DUT.
2. Observe transmissions from the DUT.

Observable Results:

a. The DUT should transmit its Base Page, followed immediately by a properly formatted 10GBASE-T extended Next Page sequence.

Possible Problems: None

Test #Sys.7.2: Content and Format of 10GBASE-T Unformatted Code Field

Purpose: To verify that the DUT transmits random seed values in bits U10:0 of the 10GBASE-T extended Message Page.

References:

[1] IEEE Std 802.3, 2012 Edition - subclauses 40.5.1.2, 55.6.1.2, Table 55-15

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: Before two 10GBASE-T devices can establish a link, an extended Next Page exchange must be accomplished, consisting of one extended Message Page. The content of the Unformatted Code field in this page is defined in Table 55-15. Bits U10:0 of the Unformatted Code field of the 10GBASE-T extended Message Page contain an 11 bit (U10:0) random value. This seed value is used in the MASTER/SLAVE resolution process. This test verifies that the seed values transmitted by the DUT appear randomly generated.

Test Setup: See **Appendix 28.B**

Procedure:

1. Complete an extended Next Page exchange with the DUT.
2. Observe transmissions from the DUT.
3. Repeat steps 1 and 2 at least 5 times.

Observable Results:

a. Bits U10:0 should contain a random integer value based on Table 55-15. The DUT should change the value transmitted here each time the Auto-Negotiation process is completed.

Possible Problems: None.

Test #Sys.7.3: 10GBASE-T Page Reception

Purpose: To verify that the DUT only attempts to establish a 10GBASE-T link upon reception of a 10GBASE-T extended Next Page Exchange where the flag field is properly encoded.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 40.5.1.2, 55.6.1.2, Table 55-15, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: When attempting to establish a 10GBASE-T link using Auto-Negotiation, the transmitted Base Page must be followed immediately by a 10GBASE-T extended Message Page (Message Code #9). Any deviation from this sequence of pages should result in a failure to resolve a 10GBASE-T link (though non-10GBASE-T abilities advertised, such as in the Base Page, may still be resolved). The one exception to this would be a robust device that can receive a 10GBASE-T Message Page at any point in a Next Page exchange. Note: this ability is not a standards-based requirement.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: 10GBASE-T exchange with the Message Page bit not set

1. Send a Base Page followed by a 10GBASE-T Message Page with the Message Page bit not set to the DUT, followed by enough Null Message Pages to complete the extended Next Page exchange.
2. Observe transmissions from the DUT.

Part b: Reception of Improper Message Codes during a 10GBASE-T Exchange

3. Send a Base Page, followed by an extended Message Code #0 with an Unformatted Code Field that conforms to a valid 10GBASE-T code field to the DUT, followed by enough Null Message Pages to complete the extended Next Page exchange.
4. Observe transmissions from the DUT.
5. Repeat steps 3 and 4 for all of the following Message Code values: 0x101, 0x108, 0x109, 0x501, 0x508, 0x509, and 0x7FF.

Observable Results:

a. The DUT should not attempt to establish a 10GBASE-T link when the Message Page bit is set improperly during the extended Next Page exchange.
b. The DUT should not establish a 10GBASE-T link with the Link Partner when the Link Partner transmitted an extended Message Page with an extended Message Code not equal to Message Code #9.

Possible Problems: None.

Test #Sys.7.4: Message Page Reception Before and Following a 10GBASE-T Exchange

Purpose: To verify that the DUT only receives properly formatted extended Message Pages.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 40.5.1.2, 55.6.1.2, Table 55-15, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: A device should only attempt to establish a 10GBASE-T link when its link partner advertises 10GBASE-T abilities using Message Code #9. Otherwise it should attempt to establish a link based on the received Base Page abilities. When a device receives reserved Message Codes after a valid 10GBASE-T exchange, it should complete the extended Next Page exchange and attempt to establish a 10GBASE-T link. The one exception to this would be a robust device that can receive a 10GBASE-T Message Page at any point in a Next Page exchange.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Non-Immediate 10GBASE-T Exchange

1. Send a Base Page followed by an extended Message Page with a Message Code #20 with its Unformatted Code Field set to all zeros, followed by an extended Message Page with Message Code #9, with a valid 10GBASE-T Unformatted Code Field to the DUT, followed by enough Null Message Pages to complete the extended Next Page exchange.
2. Observe transmissions from the DUT.

Part b: Reception of Message Codes after a 10GBASE-T extended Next Page Exchange

3. Send a Base Page, followed by a 10GBASE-T extended Next Page sequence, followed by extended Message Code #0 to the DUT, followed by enough Null Message Pages to complete the extended Next Page exchange.
4. Observed transmissions from the DUT.
5. Repeat steps 3 and 4 replacing Message Code #0 with the following Message Code values: 0x101, 0x109, 0x10A, 0x501, 0x509, 0x50A, and 0x7FF.
6.

Observable Results:

a. INFORMATIVE: A 10GBASE-T link may be attempted upon reception of a valid sequence of 10GBASE-T extended Next Pages even though the 10GBASE-T extended Message Page was not received immediately after the Base Page transmission.
b. The DUT should establish a 10GBASE-T link with the Link Partner when the Link Partner transmitted a Message Page with a Message Code #9.

Possible Problems: None.

GROUP 8: ENERGY EFFICIENT ETHERNET NEXT PAGE FUNCTIONALITY

Scope: The following tests cover Auto-Negotiation operation specific to the exchange of Next Pages for Energy Efficient Ethernet (EEE) devices.

Overview: These tests are designed to verify the transmission and reception of EEE Message and Unformatted Pages.

Note: If the device does not support EEE, these tests cannot be performed.

Test #Sys.8.1: Energy Efficient Ethernet Message and Unformatted Page Transmission Order

Purpose: To verify that a EEE capable DUT transmits its Base Page, and EEE Message and Unformatted Pages immediately after its ability advertisements.

References:

[1] IEEE Std 802.3, 2012 - subclauses 28.2.3.4.5, 28.2.3.4.8, 40.5.1.2, 45.2.7.13, Table 45-190, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: EEE capable devices desiring to advertise EEE abilities are required to send a EEE Message Page and one Unformatted Page following completion of the Base Page exchange. If the DUT also desires to advertise 1000BASE-T or 10GBASE-Tabilities, the EEE Message Page shall be transmitted immediately following the 1000BASE-T Next Pages or as part of the extended 10GBASE-T exchange. This Message Page should contain a Message Code #10 and the MP bit (D13) should be set to logic one. This Message Page must be followed by 1 Unformatted Page, the MP bit (D13) should be set to logic zero in this page. This test verifies the transmission order of the pages sent from the DUT, the value of the MP bit in the transmitted pages, and the value of the Message Code Field in the Message Page.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: The DUT does not desire to advertise 1000BASE-T abilities

1. If possible, disable all 1000BASE-T abilities.
2. Complete a Next Page exchange with the DUT.
3. Observe transmissions from the DUT.

Part b: The DUT desires to advertise 1000BASE-T abilities

4. If possible, enable 1000BASE-T abilities.
5. Complete a Next Page exchange with the DUT.
6. Observe transmissions from the DUT.

Part c: The DUT desires to advertise 10GBASE-T abilities

7. If possible, enable 10GBASE-T abilities.
8. Complete an extended Next Page exchange with the DUT.
9. Observe transmissions from the DUT.

Observable Results:

a. The DUT should transmit its Base Page, followed immediately by a properly formatted EEE Next Page sequence.
b. The DUT should transmit its Base Page, followed immediately by a 1000BASE-TNext Page sequence, followed by a EEE Next Page sequence
c. The DUT should transmit its Base Page, followed immediately by a properly formatted 10GBASE-T extended Next Page sequence advertising EEE abilities.

Possible Problems: None

Test #Sys.8.2: Energy Efficient Ethernet Page Sequence Reception

Purpose: To verify that the DUT only attempts to establish a EEE link upon reception of a EEE Next Page Exchange where the Page Sequence is properly encoded.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 28.2.3.4.5, 28.2.3.4.8, 40.5.1.2, 45.2.7.13, Table 45-190, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion:
Before two EEE devices can establish a link, a Next Page exchange must be accomplished, consisting of one EEE Message Page and one Unformatted Page in sequence, without interruption. The content of the EEE Unformatted Page is defined in Table 40-4.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: EEE exchange with the Message Page bit not set

1. Send a Base Page, followed by a EEE Next Page Sequence but with the Message Page bit not set in the first page to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
2. Establish a link with a EEE capable link partner.
3. Observe transmissions from the DUT.
4. Repeat steps 1 through 3 inserting a 1000BASE-T Next Page Sequence before the EEE Next Page Sequence.

Part b: EEE exchange with Message Page bit set in UP1

5. Send a Base Page, followed by a EEE Next Page Sequence but with the Message Page bit set in UP1 to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
6. Establish a link with a EEE capable link partner.
7. Observe transmissions from the DUT.
8. Repeat steps 5 through 7 inserting a 1000BASE-T Next Page Sequence before the EEE Next Page Sequence.

Part c: Reception of Reserved Message Codes

9. Send a Base Page, followed by a Message Code #0 followed by one Unformatted Page that conforms to a EEE Unformatted Next Page to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
10. Establish a link with a EEE capable link partner.
11. Observe transmissions from the DUT.
12. Repeat steps 1 through 3 for all of the following Message Code values: 0x8, 0x9, 0x101, 0x10A, 0x501, 0x50A, and 0x7FF.

Observable Results:

a.-b. The DUT should not attempt to establish a EEE link when the Message Page bit is set improperly during the Next Page exchange.

c. The DUT should not establish a EEE link with the Link Partner when the Link Partner transmitted a Message Page with a Message Code not equal to Message Code #10.

Possible Problems: The DUT is not required to assert LPI.

Test #Sys.8.3: Energy Efficient Ethernet Message Page Reception

Purpose: To verify that the DUT only receives properly formatted Message Pages.

References:

[1] IEEE Std 802.3, 2012 Edition - subclause 28.2.3.4.5, 28.2.3.4.8, 40.5.1.2, 45.2.7.13, Table 45-190, Annex 28C

Resource Requirements: See **Appendix 28.A**

Last Modification: August 29, 2013

Discussion: A device should only attempt to establish a EEE link when its link partner advertises EEE abilities using Message Code #10. Otherwise it should attempt to establish a link based on the received Base Page abilities. When a device receives reserved Message Codes after a valid EEE exchange, it should complete the Next Page exchange and attempt to establish a link.

Test Setup: See **Appendix 28.B**

Procedure:

Part a: Non-Immediate EEE Exchange

1. If possible, disable 1000BASE-T advertisements on the DUT.
2. Send a Base Page, followed by a Message Page with Message Code #20, with two Unformatted Pages whose Unformatted Codes are all zero, followed by a EEE Next Page sequence advertising 100BASE-TX EEE to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
3. Establish a link with a EEE capable link partner.
4. Observe transmissions from the DUT.
5. If possible, enable 1000BASE-T advertisements on the DUT.
6. Repeat steps 2 through 4 inserting a 1000BASE-T Next Page Sequence after the Base Page, and advertising both 100BASE-TX EEE and 1000BASE-T EEE in the EEE Next Page Sequence.

Part b: Reception of Reserved Message Codes after a EEE Next Page Exchange

7. Send a Base Page, followed by a EEE Next Page sequence, followed by Message Code #0 with two Unformatted Pages to the DUT, followed by enough Null Message Pages to complete the Next Page exchange.
8. Establish a link with a EEE capable link partner.
9. Observed transmissions from the DUT.
10. Repeat steps 7 through 9 replacing Message Code #0 with the following Message Code values: 0x9, 0x101, 0x109, 0x10A, 0x501, 0x509, 0x50A, and 0x7FF.
11. Repeat steps 7 through 9 inserting a 1000BASE-T Next Page Sequence before the EEE Next Page Sequence.

Observable Results:

a. INFORMATIVE: A EEE link may be attempted upon reception of a sequence of EEE Next Pages even though the EEE Message Page was not received immediately after the 1000BASE-T Next Page transmissions or immediately after transmission of the Base Page.
b. The DUT should establish a EEE link with the Link Partner when the Link Partner transmitted a Message Page with a Message Code #10.

Possible Problems: The DUT is not required to assert LPI.

Appendices

Scope: Test suite appendices are considered informative supplements, and pertain solely to the test definitions and procedures contained in this test suite.

Overview: Test suite appendices are intended to provide additional low-level technical details pertinent to specific tests in this test suite. These appendices are outside the scope of the standard and are specific to the methodologies used for performing the measurements in this test suite.

Appendix 28.A – Resource Requirements

Purpose: To specify the necessary resources to complete the testing in this test suite

Last Modification: August 29, 2013

Resource Requirements:

The following equipment is required in order to perform tests in all Groups:

1. Line Monitor: A system capable of detecting, time-stamping, and recording normal link pulses (NLPs) on both the receive and transmit channels of the DUT. The channel signaling should pass through the line monitor with minimal distortion.
2. 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.

In addition to the above requirements, the following equipment is required in order to perform tests 2.2, 2.3 and GROUP 3:

1. Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) as well as valid link signaling and frames for 10/100/1000/10GBASE-T and recording received frames while connected to the receiver of the DUT.

In addition to the above requirements, the following equipment is required in order to perform tests 2.5 and GROUP 8:

1. A EEE capable link partner for verification of Low Power Idle.

Appendix 28.B – Test Setup

Purpose: To specify the test setup used to complete the testing in this test suite

Last Modification: August 29, 2013

Discussion:

The following setup is required to perform the testing in this test suite:

Using Cat 5 cords, 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 as shown below.