

# **Ethernet**

## **Clause 22, 28, and 40 Management Registers Test Suite V4.0**

*Technical Document*



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## MODIFICATION RECORD

Revision	Release Date	Author(s)	Comments
1.0.0	April 12, 2000		Initial Release
2.6	June 6, 2005	Matthew Hersh	Updated observable results and possible problems for test: <ul style="list-style-type: none"> <li>• Test #28.2.5 – Page Received Setting/Resetting</li> </ul> Updated the procedure for tests: <ul style="list-style-type: none"> <li>• Test #28.2.7 – AN Next Page Transmit Register</li> <li>• Test #28.2.11 – Link Partner Next Page Able</li> <li>• Test #40.3.1 – 1000BASE-T MASTER/SLAVE Control Register bits 9.10:8</li> <li>• Test #40.3.2 – 1000BASE-T MASTER/SLAVE Control Register bits 9.12:11</li> </ul>
2.7	June 6, 2005	Mike Henninger	Updated references to IEEE std. 802.3 - 2005
2.8	May 26, 2006	Matthew Hersh	Updated procedure for test: <ul style="list-style-type: none"> <li>• Test #28.2.8 – AN Link Partner Next Page Ability Register and Next Page Location Bits</li> </ul>
2.9	June 16, 2006	Matthew Hersh	Updated the discussion, procedure and observable results for test: <ul style="list-style-type: none"> <li>• Test #28.2.9 – mr_next_page_loaded</li> </ul>
3.0	July 20, 2006	Matthew Hersh	Updated the discussion, procedure and observable results for test: <ul style="list-style-type: none"> <li>• Test #28.2.9 – mr_next_page_loaded</li> </ul>
3.1	March 2, 2010	Matthew Senerchia	Updated the procedure and observable results for test: <ul style="list-style-type: none"> <li>• Test #28.2.11 – Link Partner Next Page Able</li> </ul>
3.2	September 14, 2012	Kathryn Dube	Updated discussion and possible problems for test: <ul style="list-style-type: none"> <li>• Test #28.2.3 – Remote Fault</li> </ul> Updated procedure and observable results for test: <ul style="list-style-type: none"> <li>• Test #28.3.3 – 1000BASE-T MASTER/SLAVE Status Register</li> </ul>
4.0	March 9, 2015	Kathryn Dube Stephen Johnson	Updated References to IEEE std. 802.3 – 2012 Added Appendix 28.A and Appendix 28.B Added “MII” to all test numbers Added the following Tests: <ul style="list-style-type: none"> <li>• Test #MII.22.1.2 – Status Register.</li> <li>• Test #MII.28.2.9 – Auto-Negotiation Link Partner Received Next Page Register</li> </ul> Updated resource requirements, discussion, test setup, procedure, observable results and possible problems for tests: <ul style="list-style-type: none"> <li>• Test #MII.22.1.1 – Main Reset</li> <li>• Test #MII.22.1.3 – Auto-Negotiation Enable</li> <li>• Test #MII.22.1.4 – Auto-Negotiation Restart</li> <li>• Test #MII.22.1.5 – Auto-Negotiation Complete</li> <li>• Test #MII.22.1.6 – Link Status</li> <li>• Test #MII.22.1.9 – Duplex Mode</li> <li>• Test #MII.28.2.1 – AN Advertisement Register</li> <li>• Test #MII.28.2.3 – Remote Fault</li> <li>• Test #MII.28.2.7 – AN Next Page Transmit Register</li> <li>• Test #MII.28.2.8 – AN Link Partner Received Next Page Storage Location.</li> </ul>

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			<p>Updated discussion, procedure and possible problems for test:</p> <ul style="list-style-type: none"> <li>• Test #MII.22.1.6 – Auto-Negotiation Ability</li> </ul> <p>Updated discussion and possible problems for test:</p> <ul style="list-style-type: none"> <li>• Test #MII.22.1.7 –Report PHY Capabilities</li> </ul> <p>Updated purpose, resource requirements, discussion, test setup procedure, observable results and possible problems for tests:</p> <ul style="list-style-type: none"> <li>• Test #MII.22.1.9 – Speed Selection</li> <li>• Test #MII.28.2.2 – AN Link Partner Ability Register</li> <li>• Test #MII.28.2.6 – Link Partner Auto-Negotiation Able</li> <li>• Test #MII.28.2.9 – mr_next_page_loaded</li> <li>• Test #MII.28.2.11 – Link Partner Next Page Able</li> </ul> <p>Updated resource requirements, test setup, procedure and possible problems for test:</p> <ul style="list-style-type: none"> <li>• Test #MII.28.2.4 – Parallel Detection Fault</li> </ul> <p>Updated purpose, resource requirements, discussion, test setup, procedure, observable results for test:</p> <ul style="list-style-type: none"> <li>• Test #MII.28.2.5 – Page Received Setting/Resetting</li> </ul> <p>Updated discussion, test setup, and procedure for test:</p> <ul style="list-style-type: none"> <li>• Test #MII.28.2.10 – Next Page Able</li> </ul> <p>Updated resource requirements, discussion, test setup, procedure and observable results for test:</p> <ul style="list-style-type: none"> <li>• Test #MII.40.3.1 – 1000BASE-T MASTER/SLAVE Control Register bits 9.10:8</li> <li>• Test #MII.40.3.2 – 1000BASE-T MASTER/SLAVE Control Register bits 9.12:11</li> </ul> <p>Updated purpose, resource requirements, test setup, procedure, observable results, and possible problems for test:</p> <ul style="list-style-type: none"> <li>• Test #MII.40.3.3 – 1000BASE-T MASTER/SLAVE Status Register</li> </ul>
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Previous versions of the test suite can be found at:  
<https://www.iol.unh.edu/testing/ethernet/ge/test-suites>

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**ACKNOWLEDGMENTS**

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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.

**MII:** Media Independent Interface.

**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 22, Clause 28, and Clause 40 Auto-Negotiation based products. 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: CLAUSE 22 MANAGEMENT FUNCTION REQUIREMENTS**

**Scope:** The following tests cover Auto-Negotiation operation specific to the management register set.

**Overview:** These tests are designed to verify that the DUT properly implements the MII register set as it pertains to the Auto-Negotiation function. Register functions explored are defined in Clause 22 (MII) of IEEE 802.3. Many of these tests are aimed at verifying the critical link between a conformant Auto-Negotiation state machine implementation and the overall system's management and control software.

**NOTE:** These tests cannot be performed if management register access is not provided.

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**Test #MII.22.1.1: Main Reset**

**Purpose:** To verify that bit 0.15 controls the resetting of the PHY and the Auto-Negotiation process.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.1.1 – Reset
- [2] IEEE Std 802.3-2012, subclause 28.2.4.1.8 – State diagram variable to MII register mapping
- [3] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [4] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram
- [5] IEEE Std 802.3-2012, Table 22-7 – Control register bit definitions
- [6] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** Bit 0.15 of the Control Register gives management the ability to reset all of the Control and Status Registers, as well as restarting the Auto-Negotiation process. The default value of bit 0.15 is zero. The default value for each bit of the Control Register should be chosen so that the initial state of the PHY upon initialization or reset is a normal operational state without management intervention.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bit 0.15

1. Initialize the DUT.
2. Read Register 0 twice.

Part b: Operational State after Main Reset

3. Set bit 0.15 to 1.
4. Read Register 0.

Part c: Auto-Negotiation State after Main Reset

5. Configure the DUT to transmit its Base Page.
6. Set bit 0.15 to one.
7. Observe transmissions from the DUT.

Part d: Resetting of the Control Register

8. Initialize the DUT.
9. Read Register 0.
10. Set Register 0 to a value that is different from the value found in the previous step.
11. Set bit 0.15 to one.

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12. Read Register 0.

Part e: Resetting of the Status Register

13. Configure the DUT to transmit its Base Page.

14. Read Register 1.

15. Send the DUT a Base Page with the Remote Fault and Acknowledge bits set to put the device into the COMPLETE ACKNOWLEDGE state. Do not read Register 1.

16. Set bit 0.15 to one.

17. Read Register 1.

**Observable Results:**

- a. The default value of bit 0.15 should be 0.
- b. After a Main Reset, the PHY should be in an operational state.
- c. The DUT should cease transmissions for break\_link\_timer, and then restart Auto-Negotiation by sending its Base Page.
- d. The DUT should set Register 0 to its default value after a Main Reset.
- e. The DUT should set Register 1 to its default value after a Main Reset.

**Possible Problems:** If the DUT improperly implements the Remote Fault function, part e cannot be performed. If the DUT does not have a default value in Register 0 and Register 1, then parts d and e cannot be performed.

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**Test #MII.22.1.2: Status Register**

**Purpose:** To verify that all bits of the Status Register (Register 1) are read only.

**References:**

[1] IEEE Std 802.3-2012, subclause 22.2.4.2 – Status Register

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** February 16, 2015

**Discussion:** Register 1 is read only, and all writes to this register should be ignored.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Read Only Status of Register 1

1. Read Register 1.
2. Set Register 1 to 0xFFFF.
3. Read Register 1.
4. Set Register 1 to 0x0000.
5. Read Register 1.

**Observable Results:**

- a. The DUT should not allow Register 1 to be written.

**Possible Problems:** None.

**Test #MII.22.1.3: Auto-Negotiation Enable**

**Purpose:** To verify that bit 0.12 controls the enabling and disabling of the Auto-Negotiation process.

**References:**

- [2] IEEE Std 802.3-2012, subclause 22.2.4.1.4 – Auto-Negotiation enable
- [3] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [4] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram
- [5] IEEE Std 802.3-2012, Table 22-7 – Control register bit definitions
- [6] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** Management has the ability to enable Auto-Negotiation by setting bit 0.12 to one and to disable Auto-Negotiation by setting bit 0.12 to zero. If the management has set bit 0.12 to zero, a link will be established using bits 0.13 and 0.6 (speed selection), and bit 0.8 (duplex mode) of the Control Register. When bit 0.12 is set to one, the DUT should transmit FLP Bursts and establish a link using the Auto-Negotiation process. The default value of bit 0.12 is one if the device supports the Auto-Negotiation process.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bit 0.12

1. Perform a Main Reset.
2. Read Register 0.

Part b: Disable Auto-Negotiation

3. Enable Auto-Negotiation.
4. Set bit 0.12 to 0.
5. Observe transmissions from the DUT.

Part c: break\_link\_timer Before Link Signaling

6. Repeat steps 3-5.
7. If present, measure the gap between the last FLP Burst and the start of link signaling.

Part d: Enable Auto-Negotiation

8. Disable Auto-Negotiation.
9. Set bit 0.12 to 1.
10. Observe transmissions from the DUT.

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**Observable Results:**

- a. If the DUT supports the Auto-Negotiation function, the default value of 0.12 should be one.
- b. The DUT should cease Auto-Negotiation and transmit appropriate link signaling (based on bits 0.6 and 0.13).
- c. **INFORMATIVE:** The DUT may wait `break_link_timer` before transmitting link signaling.
- d. The DUT should cease link signaling, wait `break_link_timer`, and then transmit its Base Page.

**Possible Problems:** If the PHY does not maintain a default value in Register 0, part a cannot be performed. If Auto-Negotiation cannot be disabled then part c cannot be performed.

**Test #MII.22.1.4: Auto-Negotiation Restart**

**Purpose:** To verify that bit 0.9 restarts Auto-Negotiation.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.1.7 – Restart Auto-Negotiation
- [2] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [3] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram
- [4] IEEE Std 802.3-2012, Table 22-7 – Control register bit definitions
- [5] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** The MII Control Register provides a means for management to restart the Auto-Negotiation process by setting bit 0.9 to 1. This is a way to restart Auto-Negotiation without resetting the entire PHY. The default value of bit 0.9 is 0.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bit 0.9

1. Perform a Main Reset.
2. Read Register 0.

Part b: Restarting the Auto-Negotiation Process

3. Enable Auto-Negotiation.
4. Set bit 0.9 to 1.
5. Observe transmissions from the DUT.

**Observable Results:**

- a. The default value of bit 0.9 should be 0.
- b. The DUT should cease transmissions, wait approximately `break_link_timer`, and then restart the Auto-Negotiation process by transmitting its Base Page.

**Possible Problems:** If the DUT does not maintain a default value in Register 0, part a cannot be performed.



**Test #MII.22.1.5: Auto-Negotiation Complete**

**Purpose:** To verify that bit 1.5 is properly set upon completion of Auto-Negotiation and entrance into the FLP LINK GOOD state.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.2.10 – Auto-Negotiation complete
- [2] IEEE Std 802.3-2012, Table 22-8 – Status register bit definitions
- [3] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [4] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [5] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** Once a link has been established, management needs to be made aware that frame transmission and reception can commence. Bit 1.5 is set when Auto-Negotiation is complete and a link has been established.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Entrance into the FLP LINK GOOD State with Auto-Negotiation Disabled

1. Disable Auto-Negotiation.
2. Send link signaling to the DUT in order to establish a link.
3. Read bit 1.5.

Part b: Entrance into the FLP LINK GOOD CHECK State with Auto-Negotiation Enabled

4. Enable Auto-Negotiation.
5. Send a Base Page to the DUT so it enters the FLP LINK GOOD CHECK state.
6. Read bit 1.5.

Part c: Entrance into the FLP LINK GOOD State with Auto-Negotiation Enabled

7. Enable Auto-Negotiation.
8. Send a Base Page to the DUT so it enters the FLP LINK GOOD CHECK state followed by link signaling in order to establish a link.
9. Read bit 1.5.

Part d: Setting Bit 1.5 to 0 in the TRANSMIT DISABLE State

10. Repeat steps 7-9.
11. Break the link and allow the DUT to enter the TRANSMIT DISABLE State.
12. Read bit 1.5.

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Part e: Establishing a Link through Parallel Detection

13. Enable Auto-Negotiation.
14. Transmit link signaling to the DUT to establish a link through Parallel Detection.
15. Read bit 1.5.

**Observable Results:**

- a. When Auto-Negotiation is disabled, the value of bit 1.5 should never be set to one.
- b. When Auto-Negotiation is enabled, the value of bit 1.5 should never be set to one before the DUT enters the FLP LINK GOOD state. The value of bit 1.5 should be zero.
- c. When Auto-Negotiation is enabled, the DUT should set bit 1.5 once it has entered the FLP LINK GOOD state. The value of bit 1.5 should be one.
- d. When the DUT enters the TRANSMIT DISABLE State bit 1.5 should be set to 0.
- e. When Auto-Negotiation is enabled, the DUT should set bit 1.5 once it has entered the FLP LINK GOOD state. The value of bit 1.5 should be one.

**Possible Problems:** None.

**Test #MII.22.1.6: Link Status**

**Purpose:** To verify that bit 1.2 of the Status Register is set when a link has been established.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.2.13 – Link Status
- [2] IEEE Std 802.3-2012, Table 22-8 – Status register bit definitions
- [3] IEEE Std 802.3-2012, subclause 28.2.6.1.1 – Semantics of the service primitive
- [4] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [5] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** Bit 1.2 of the MII Status Register indicates to management that a link has been established. When this bit is set, it indicates that the DUT has entered the FLP LINK GOOD state, regardless of whether Auto-Negotiation is enabled or disabled.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Establish a Link through Auto-Negotiation

1. Send a Base Page followed by link signaling to the DUT to establish a link.
2. Read bit 1.2.

Part b: Establish a Link through Parallel Detection

3. Restart Auto-Negotiation.
4. Send link signaling to establish link through Parallel Detection.
5. Read bit 1.2.

Part c: Establish a Link with Auto-Negotiation Disabled

6. Disable Auto-Negotiation.
7. Send the DUT link signaling to manually force a link.
8. Read bit 1.2.

Part d: Setting Bit 1.2 to 0

9. Send a Base Page followed by link signaling to the DUT to establish a link.
10. Break the link with the DUT.
11. Read bit 1.2.

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**Observable Results:**

- a-c. The DUT should not set bit 1.2 until the FLP LINK GOOD state has been entered, regardless of whether or not Auto-Negotiation has been used to establish a link.
- d. Bit 1.2 should be set to 0 once the link has been broken.

**Possible Problems:** If the device does not support 10BASE-T half duplex or 100BASE-TX half duplex, then part b cannot be performed. If Auto-Negotiation cannot be disabled, then part c cannot be performed.

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**Test #MII.22.1.7: Auto-Negotiation Ability**

**Purpose:** To verify that the DUT maintains a value of one in bit 1.3.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.2.12 – Auto-Negotiation ability
- [2] IEEE Std 802.3-2012, Table 22-8 – Status register bit definitions
- [3] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping

**Resource Requirements:** None

**Last Modification:** May 28, 2014

**Discussion:** Management is made aware that an Auto-Negotiation capable PHY is attached using the Status Register bit 1.3, regardless of the management's desire to enable or disable Auto-Negotiation. It allows for a DUT with an exposed MII to discover the Auto-Negotiation ability of an attached PHY.

**Test Setup:** Access the DUT's Management Registers.

**Procedure:**

Part a: Status of Bit 1.3

1. Disable Auto-Negotiation.
2. Read bit 1.3.
3. Enable Auto-Negotiation.
4. Read bit 1.3.

**Observable Results:**

- a. Bit 1.3 should be set to one, regardless of whether Auto-Negotiation is enabled or not.

**Possible Problems:** None.

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**Test #MII.22.1.8: Report PHY Abilities**

**Purpose:** To verify that the PHY set bits 1.15:8 and 15.15:12 appropriately for the PHY's abilities.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.2.1 – 100BASE-T4 ability
- [2] IEEE Std 802.3-2012, subclause 22.2.4.2.2 – 100BASE-X full duplex ability
- [3] IEEE Std 802.3-2012, subclause 22.2.4.2.3 – 100BASE-X half duplex ability
- [4] IEEE Std 802.3-2012, subclause 22.2.4.2.4 – 10 Mb/s full duplex ability
- [5] IEEE Std 802.3-2012, subclause 22.2.4.2.5 – 10 Mb/s half duplex ability
- [6] IEEE Std 802.3-2012, subclause 22.2.4.2.6 – 100BASE-T2 full duplex ability
- [7] IEEE Std 802.3-2012, subclause 22.2.4.2.7 – 100BASE-T2 half duplex ability
- [8] IEEE Std 802.3-2012, subclause 22.2.4.2.16 – Extended status
- [9] IEEE Std 802.3-2012, subclause 22.2.4.4.1 – 1000BASE-X full duplex ability
- [10] IEEE Std 802.3-2012, subclause 22.2.4.4.2 – 1000BASE-X half duplex ability
- [11] IEEE Std 802.3-2012, subclause 22.2.4.4.3 – 1000BASE-T full duplex ability
- [12] IEEE Std 802.3-2012, subclause 22.2.4.4.4 – 1000BASE-T half duplex ability
- [13] IEEE Std 802.3-2012, Table 22-8 – Status register bit definitions
- [14] IEEE Std 802.3-2012, Table 22-11 – Extended Status register bit definitions

**Resource Requirements:** None.

**Last Modification:** May 28, 2014

**Discussion:** Management is made aware of a PHY's signaling abilities using the Status Register bits 1.15:9. If bit 1.8 is set, then the PHY has additional abilities specified in the Extended Status Register (Register 15) bits 15.15:12.

**Test Setup:** Access the DUT's Management Registers.

**Procedure:**

Part a: PHY Abilities

1. Read bits 1.15:8 and 15.15:12.
2. Verify the DUT supports all indicated abilities.

**Observable Results:**

- a. Bits 1.15:9 and 15.15:12 should only be set if the DUT supports the ability. If the DUT is 1000BASE-T capable, bit 1.8 should be set to one and supported 1000BASE-T abilities should be contained in Register 15. If the DUT is not 1000BASE-T capable, bit 1.8 should be cleared to zero and the contents of Register 15 should be ignored.

**Possible Problems:** If the DUT does not contain a MAC, only speed and not duplex can be verified.

**Test #MII.22.1.9 Duplex Mode**

**Purpose:** To verify that the DUT will resolve a link to the highest common duplex mode according to bit 0.8 when Auto-Negotiation is disabled.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.1.3 – Speed selection
- [2] IEEE Std 802.3-2012, subclause 22.2.4.1.8 – Duplex mode
- [3] IEEE Std 802.3-2012, Table 22-7 – Control register bit definitions

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** When Auto-Negotiation has been disabled bit 0.8 controls the duplex mode. When Auto-Negotiation has been enabled, bit 0.8 can be read or written, but its state has no effect on the link configuration. If a PHY is able to operate in only one duplex mode, the value of bit 0.8 should correspond to the mode in which the PHY can operate, and any attempt to change the setting of bit 0.8 should be ignored, otherwise the default value of bit 0.8 is 0.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bit 0.8

1. Perform a Main Reset.
2. Read Register 0.

Part b: Duplex Mode with Auto-Negotiation Enabled

3. Enable Auto-Negotiation.
4. Establish a full duplex link with the DUT.
5. Transmit frames to verify that the DUT is at the correct duplex.
6. Read bit 0.8.
7. Repeat steps 3-6 with a half duplex link.

Part c: Duplex Mode with Auto-Negotiation Disabled

8. Set bit 0.12 to zero.
9. Set bit 0.8 to one.
10. Establish a full duplex link with the DUT.
11. Transmit frames to verify that the DUT is at the correct duplex.
12. Repeat steps 8 -11 with a half duplex link.

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**Observable Results:**

- a. If the PHY is able to operate in only one duplex mode, the value of bit 0.8 should correspond to the mode in which the PHY can operate, otherwise it should be 0.
- b. **INFORMATIVE:** The DUT may or may not write bit 0.8 to reflect link configuration.
- c. The DUT should resolve a full duplex link when bit 0.8 has been set, and resolve a half duplex link when bit 0.8 has been cleared.

**Possible Problems:** None.



### **Test #MII.22.1.10 Speed Selection**

**Purpose:** To verify that the DUT transmits appropriate link signaling according to bits 0.6 and 0.13 when Auto-Negotiation has been disabled.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.1.3 – Speed selection
- [2] IEEE Std 802.3-2012, Table 22-7 – Control register bit definitions

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** Link speed can be selected using either the Auto-Negotiation process, or manual speed selection. When Auto-Negotiation is disabled, bits 0.6 and 0.13 should configure the DUT based on the following table. When the DUT is configured for 1000BASE-T operation, it should transmit Base Pages advertising 1000BASE-T support only (ie. FLP Bursts advertising 8001), cease all transmissions, or transmit 1000BASE-T signaling. If the management allows bits 0.6 and 0.13 to both be set to one, the DUT should cease all transmissions. When Auto-Negotiation is enabled, bits 0.6 and 0.13 can be read or written, however, writing to these bits should have no effect on the configuration, and these bits may reflect the operating speed of the link when read. The default values of bits 0.6 and 0.13 should reflect the highest speed at which the PHY can operate according to 1.15:9 and 15.15:12. If a PHY reports via bits 1.15:9 and bits 15.15:12 that it is not able to operate at all speeds, the value of bits 0.6 and 0.13 shall correspond to a speed at which the PHY can operate, and any attempt to change the bits to an invalid setting shall be ignored.

Value of bit 0.6	Value of bit 0.13	Speed
0	0	10BASE-T
0	1	100BASE-TX
1	0	1000BASE-T
1	1	Reserved

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Values of Bits 0.6 and 0.13

1. Perform a Main Reset.
2. Read bits 0.6 and 0.13.

Part b: Supported Speed Selection with Auto-Negotiation disabled

3. Disable Auto-Negotiation.
4. Set bits 0.6 and 0.13 to a supported speed.
5. Observe transmissions from the DUT.
6. Repeat steps 3-5 with all supported combinations in the table above.

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Part c: Unsupported Speed Selection with Auto-Negotiation disabled

7. Disable Auto-Negotiation.
8. Set bits 0.6 and 0.13 to an unsupported speed.
9. Read Register 0.
10. Repeat steps 7 and 8 with all unsupported combinations in the table above.

Part d: Setting Bits 0.6 and 0.13 with Auto-Negotiation Enabled

11. Enable Auto-Negotiation
12. Establish a 100BASE-TX link with the DUT.
13. Set bit 0.6 to one and bit 0.13 to zero.
14. Repeat steps 7-9 setting bit 0.6 to zero and a bit 0.13 to one.

Part e: Indication of Link Speed

15. Enable Auto-Negotiation.
16. Establish a link at a speed not indicated by bits 0.6 and 0.13 using Auto-Negotiation.
17. Read the value of bits 0.6 and 0.13.

**Observable Results:**

- a. The default value of bits 0.6 and 0.13 should reflect the highest speed capable of the PHY.
- b. The DUT should source appropriate transmissions according to the table above.
- c. The DUT should not allow bits 0.6 and 0.13 to be set to unsupported speeds.
- d. The setting of bits 0.6 and 0.13 should not have any effect on the link configuration.
- e. **INFORMATIVE:** When Auto-Negotiation is enabled, the DUT may or may not indicate the operating speed of the link through bits 0.6 and 0.13.

**Possible Problems:** If the PHY does not maintain a default value in Register 0, part a cannot be performed.

## **GROUP 2: CLAUSE 28 MANAGEMENT REGISTERS**

**Scope:** The following tests cover Auto-Negotiation operation specific to the management register set.

**Overview:** These tests are designed to verify that the DUT properly implements the MII register set as it pertains to the Auto-Negotiation function. Register functions explored are defined in Clause 28 (Auto-Negotiation) of IEEE 802.3. Many of these tests are aimed at verifying the critical link between a conformant Auto-Negotiation state machine implementation and the overall system's management and control software.

**NOTE:** These tests cannot be performed if management register access is not provided.

## **Test #MII.28.2.1: AN Advertisement Register**

**Purpose:** To verify that the Auto-Negotiation Advertisement Register (Register 4) can be set according to Table 28-2 and is reflected in the link codewords transmitted by the DUT.

### **References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.4.1.3 – Auto-Negotiation advertisement register (Register 4) (R/W)
- [2] IEEE Std 802.3-2012, Table 28-2 – Advertisement register bit definitions
- [3] IEEE Std 802.3-2012, subclause 40.5.1.1 – 1000BASE-T use of registers during Auto-Negotiation
- [4] IEEE Std 802.3-2012, Table 40-3 – 1000BASE-T Registers
- [5] IEEE Std 802.3-2012, Annex 28A – Selector Field definitions
- [6] IEEE Std 802.3-2012, Annex 28B – IEEE 802.3 Selector Base Page definition
- [7] IEEE Std 802.3-2012, Annex 28D – Description of extensions to Clause 28 and associated annexes

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** The Auto-Negotiation Advertisement Register (Register 4) allows the management to advertise its desired abilities to its Link Partner. After the DUT is initialized, the default value of Register 4 should be as follows: a Selector Field set to 00001, a Technology Ability Field set to supported abilities found in Register 1, and the Acknowledge bit set to 0. The Selector Field bits are all read/write, however the DUT should not allow reserved Selector Field combinations to be transmitted. The DUT must allow the IEEE 802.3 Ethernet Selector Field combination to be transmitted, and the DUT may allow other non-reserved combinations to be transmitted.

The Technology Ability Field bits are all read/write, however the DUT should not allow unsupported technologies to be written or transmitted. The DUT must allow all supported technologies to be written and transmitted.

The Remote Fault bit is read/write and should be transmitted as written.

The Next Page and Extended Next Page bits should be read/write if the DUT supports the technology. If the DUT does not support the exchange of Next Pages then bit 4.15 should be set to 0. If the DUT does not support the exchange of extended Next Pages then bit 4.12 should be set to 0. If the DUT implements Annex 40C, the Next Page bit within the Base Page may be set by the 1000BASE-T or EEE add-on as displayed in Figure 40C-1. Therefore, bit 4.15 may not directly map to the DUT's transmitted link codeword.

The Acknowledge bit is read only and should not be set to 1.

The link codeword transmitted by the DUT should exactly match the value found in Register 4 with the exception of the Next Page bit if the DUT supports Annex 40C.

Management may write to Register 4 at any time, including during an Auto-Negotiation restart, so that only supported Selector Fields and technologies are advertised. This may happen in such a manner that some user values written to Register 4 are not observable.

**Test Setup: See Appendix 22.B**

**Procedure:**

Part a: Default Value of Register 4

1. Initialize the DUT.
2. Read Register 4.

Part b: Ethernet Selector Field Transmission

3. Set bits 4.4:0 to 00001.
4. Restart Auto-Negotiation.
5. Observe transmissions from the DUT.

Part c: Read/Write Ability of the Selector Field

6. Set bit 4.0 to 1.
7. Read Register 4.
8. Repeat steps 6 and 7, setting each bit of the Selector Field to 1.
9. Repeat steps 6 and 7, setting bit 4.0 to 0.

Part d: Transmission of Reserved Selector Field

10. Set bits 4.4:0 to 0.
11. Restart Auto-Negotiation.
12. Observe transmissions from the DUT.
13. Repeat steps 10-12 setting bits 4.4:0 to 1.

Part e: Transmission of Non-Reserved Selector Field Values

14. Set bits 4.4:0 to 00010.
15. Restart Auto-Negotiation.
16. Observe transmissions from the DUT.
17. Repeat steps 14-16 with the following values: 00011, 00100 and 00101.

Part f: Read/Write Ability of the Technology Ability Field and the Extended Next Page Bit

18. Set bits 4.12:5 to 1.
19. Read Register 4.
20. Repeat steps 18-19 setting bits 4.12:5 to 0.

Part g: Transmission of the Technology Ability Field and the Extended Next Page Bit

21. Set bits 4.12:5 to 1.
22. Restart Auto-Negotiation.
23. Observe transmissions from the DUT.
24. Repeat steps 21-23 setting bits 4.12:5 to 0.

Part h: Transmission of the Remote Fault Bit

25. Set bit 4.13 to 1.
26. Restart Auto-Negotiation.
27. Observe transmissions from the DUT.

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28. Repeat steps 24-26 setting bit 4.13 to 0.

Part i: Read Only Status of the Acknowledge Bit

29. Set bit 4.14 to 1.

30. Read Register 4.

Part j: Read/Write Ability of the Next Page Bit

31. Set bit 4.15 to 1.

32. Read Register 4.

33. Repeat steps 31-32 setting bit 4.15 to 0.

Part k: Transmission of Link Codewords

34. Set Register 4 to 0xFFFF.

35. Restart Auto-Negotiation.

36. Read Register 4.

37. Observe transmissions from the DUT.

38. Repeat steps 36-39 setting Register 4 to 0x0001.

**Observable Results:**

- a. Register 4 should have the following configuration:
  - The Selector field set to 00001
  - Bit 4.14 set to zero
  - The Technology Ability Field set to supported technologies based on Register 1
- b. The DUT should allow IEEE 802.3 Ethernet Selector Field code value (00001) to be transmitted.
- c. The DUT should allow bits 4.4:0 to be written.
- d. The DUT should not allow reserved Selector Field codes (00000 and 11111) to be transmitted.
- e. **INFORMATIVE:** A device may or may not allow the other defined Selector Field Codes (00010, 00011, 00100, and 00101) to be transmitted.
- f. The DUT should not allow bits 4.12:5 to be written if the DUT does not support that technology.
- g. The DUT should only allow supported abilities to be transmitted.
- h. The DUT should allow the Remote Fault bit to be transmitted.
- i. The DUT should not allow the Acknowledge Bit to be written.
- j. If the DUT supports a Next Page Exchange (bit 6.2 is set to one) then the DUT must allow bit 4.15 to be written. If bit 6.2 is set to 0 then bit 4.15 should always be zero.
- k. The link codewords transmitted by the DUT should exactly match Register 4, with the exception of the Next Page bit if the DUT supports Annex 40.C.

**Possible Problems:** During parts a, c, and f it may not be possible to read the value of Register 4 before management changes the value. If management does not allow non-Ethernet defined Selector Field combinations to be written, then part e cannot be performed.

**Test #MII.28.2.2: AN Link Partner Ability Register**

**Purpose:** To verify that the Auto-Negotiation Link Partner Ability Register is set based on the link codewords received by the DUT.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.1.2 – Link codeword encoding
- [2] IEEE Std 802.3-2012, subclause 28.2.3.1 – Parallel detection function
- [3] IEEE Std 802.3-2012, subclause 28.2.4.1.4 – Auto-Negotiation Link Partner ability register (Register 5) (RO)
- [4] IEEE Std 802.3-2012, Table 28-3 – Link partner ability register bit definitions (Base Page)
- [5] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [6] IEEE Std 802.3-2012, Annex 28A – Selector Field definitions
- [7] IEEE Std 802.3-2012, Annex 28B – 802.3 Selector Base Page definition
- [8] IEEE Std 802.3-2012, Annex 28D – Description of extensions to Clause 28 and associated annexes

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** For a device to resolve a proper link configuration, it must accurately receive its Link Partner's abilities and relay them to management. Register 5 of the MII is defined to contain these abilities. Additionally, if Parallel Detection is used to establish a link Register 5 should reflect the current link configuration. The contents of this register are not guaranteed to be valid until the DUT enters the FLP LINK GOOD state.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Storage of Received Link Codewords

1. Send a Base Page advertising 41E1 to the DUT so it enters the COMPLETE ACKNOWLEDGE state, followed by link signaling to establish a link with the DUT.
2. Read Register 5.
3. Repeat steps 1-2 sending Base Pages advertising (but not limited to) FFFF and 4101.

Part b: Read Only Status of Register 5

4. Read Register 5.
5. Set Register 5 to 0xFFFF.
6. Read Register 5.

Part c: Indication of Link Configuration When Using Parallel Detection

7. Send 10BASE-T link signaling to establish a link through Parallel Detection.
8. Read Register 5.

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9. Repeat steps 7 and 8 with 100BASE-TX and 100BASE-T4 link signaling.

**Observable Results:**

- a. The value of Register 5 should exactly match the received link codewords once the DUT has set either bit 1.5 or, if used with a Next Page Exchange, after bit 6.1 has been set.
- b. The DUT should not allow Register 5 to be written.
- c. Register 5 should reflect the technology detected by the Parallel Detection process.

**Possible Problems:** None



**Test #MII.28.2.3: Remote Fault**

**Purpose:** To verify that the DUT sets bit 1.4 upon reception of a link codeword with the Remote Fault bit set.

**References:**

- [1] IEEE Std 802.3-2012, subclause 22.2.4.2 – Status register (Register 1)
- [2] IEEE Std 802.3-2012, subclause 22.2.4.2.11 – Remote fault
- [3] IEEE Std 802.3-2012, Table 22-8 – Status register bit definitions
- [4] IEEE Std 802.3-2012, subclause 28.2.3.5 – Remote fault sensing function

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** A device that supports the MII register set must indicate the reception of a Base Page with the Remote Fault bit set by setting bit 1.4 in the Status Register. This makes management aware of a remote fault indication from a link partner. Once set, this bit should remain set until after management reads the Status Register or until successful negotiation of a link. The default value of bit 1.4 is zero.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bit 1.4

1. Perform a Main Reset.
2. Read bit 1.4.

Part b: Value of 1.4 Prior to the FLP LINK GOOD State

3. Send a Base Page with the Remote Fault bit set to 1 to put the DUT into the COMPLETE ACKNOWLEDGE state.
4. Cease transmissions to the DUT and wait until the DUT passes through the TRANSMIT DISABLE state.
5. Read bit 1.4.

Part c: Setting Bit 1.4 to 0

6. Repeat steps 3 and 4.
7. Read bit 1.4 twice.

**Observable Results:**

- a. The default value of bit 1.4 should be 0.
- b. Bit 1.4 should be set to 1 once the DUT has entered the COMPLETE ACKNOWLEDGE state.
- c. Bit 1.4 should be set to 0 after it has been read.

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**Possible Problems:** None.

**Test #MII.28.2.4: Parallel Detection Fault**

**Purpose:** To verify that the DUT sets bit 6.4 upon reception of a parallel detection fault.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.3.1 – Parallel detection function
- [2] IEEE Std 802.3-2012, subclause 28.2.4.1.5 – Auto-Negotiation expansion register (Register 6) (RO)
- [3] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [4] IEEE Std 802.3-2012, Table 28-5 – Expansion register bit definitions
- [5] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [6] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** Management is made aware that a parallel detection fault has occurred by reading bit 6.4 of the Auto-Negotiation Expansion Register (MII Register 6). Upon receiving such a fault, the DUT must set this bit. A value of 1 indicates that a fault has been detected by the Parallel Detection function. A parallel detection fault occurs if zero or more than one PMA is indicated to have link\_status=READY after a parallel detection process has started and before autoneg\_wait\_timer (500 - 1000 ms) has expired. The Parallel Detection Fault bit should be reset upon a read to the Auto-Negotiation Expansion Register.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: mr\_parallel\_detection\_fault = true during the Parallel Detection of 10BASE-T

1. Send 10BASE-T link signaling to the DUT for less than 500 ms to cause it to enter the LINK STATUS CHECK state.
2. Read Register 6.

Part b: mr\_parallel\_detection\_fault = true during the Parallel Detection of 100BASE-TX

3. Send 100BASE-TX link signaling to the DUT for less than 500 ms to cause it to enter the LINK STATUS CHECK state.
4. Read Register 6.

Part c: mr\_parallel\_detection\_fault = true during the Parallel Detection of 100BASE-T4

5. Send 100BASE-T4 link signaling to the DUT for less than 500 ms to cause it to enter the LINK STATUS CHECK state.
6. Read Register 6.

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Part d: Setting Bit 6.4 to 0

7. Send link signaling to the DUT for less than 500 ms to cause it to enter the LINK STATUS CHECK state.
8. Read Register 6 twice.

**Observable Results:**

- a-c. Bit 6.4 should be set to 1 once a Parallel Detection fault has occurred.
- d. Bit 6.4 should be set to 1 after a Parallel Detection fault and set to 0 after Register 6 has been read.

**Possible Problems:** If the DUT does not support 10BASE-T, 100BASE-TX or 100BASE-T4 then that portion of this test cannot be performed.

**Test #MII.28.2.5: Page Received Setting/Resetting**

**Purpose:** To verify that bit 6.1 is set to one when a new page is received and cleared when the Auto-Negotiation Expansion Register is read.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.4.1.5 – Auto-Negotiation expansion register (Register 6) (RO)
- [2] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [3] IEEE Std 802.3-2012, Table 28-5 – Expansion register bit definitions
- [4] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [5] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** Management is made aware of the reception of a new page by reading bit 6.1 in the Auto-Negotiation Expansion Register. If bit 6.1 is set, then management can look at the contents of the received page and act accordingly. Bit 6.1 should be reset after a read to the Auto-Negotiation Expansion Register.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Value of Bit 6.1 in the ACKNOWLEDGE DETECT State

1. Send a Base Page with the Acknowledge bit set to zero to the DUT to put it into the ACKNOWLEDGE DETECT state.
2. Read Register 6.

Part b: Value of Bit 6.1 in the COMPLETE ACKNOWLEDGE State

3. Send a Base Page with the Acknowledge bit set to one to the DUT put it into the COMPLETE ACKNOWLEDGE state.
4. Read Register 6.

Part c: Value of Bit 6.1 with Next Pages

5. Send a Base Page with the Next Page bit set to one to the DUT to put it into the COMPLETE ACKNOWLEDGE state.
6. Read bit 6.1 while the DUT is in the COMPLETE ACKNOWLEDGE state.
7. While the DUT is in the COMPLETE ACKNOWLEDGE state, send a Next Page with Acknowledge bit set to zero to the DUT to cause it to re-enter the ACKNOWLEDGE DETECT state.
8. Read bit 6.1 while the DUT is in the ACKNOWLEDGE DETECT state.

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9. While the DUT is in the ACKNOWLEDGE DETECT state, send a page identical to the ones sent in step 7 with the Acknowledge bit set to put the DUT into the COMPLETE ACKNOWLEDGE state again.
10. Read Register 6.

Part d: Setting Bit 6.1 to 0

11. Repeat step 3.
12. Read Register 6 twice.

**Observable Results:**

- a. Bit 6.1 should never be set in the ACKNOWLEDGE DETECT state.
- b. Bit 6.1 should be set to 1 in the COMPLETE ACKNOWLEDGE state.
- c. Bit 6.1 should be set to 1 in the COMPLETE ACKNOWLEDGE state and set to 0 in the ACKNOWLEDGE DETECT state.
- d. Bit 6.1 should be set to 1 in the COMPLETE ACKNOWLEDGE state and set to 0 after Register 6 has been read

**Possible Problems:** If the DUT does not support a Next Page Exchange, part c cannot be performed.

**Test #MII.28.2.6: Link Partner Auto-Negotiation Able**

**Purpose:** To verify that the DUT sets bit 6.0 to one after detection of an Auto-Negotiation capable Link Partner.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.4.1.5 – Auto-Negotiation expansion register (Register 6) (RO)
- [2] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [3] IEEE Std 802.3-2012, Table 28-5 – Expansion register bit definitions
- [4] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [5] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** A DUT's management is made aware that its Link Partner is capable of Auto-Negotiation by bit 6.0. When the DUT enters the ACKNOWLEDGE DETECT state, it sets bit 6.0 to 1. Whenever the DUT re-enters the ABILITY DETECT state bit 6.0 is set to 0.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bit 6.0

1. Initialize the DUT.
2. Read Register 6.

Part b: Value Bit 6.0 in the ACKNOWLEDGE DETECT State

3. Send a Base Page with the Acknowledge bit set to 0 to the DUT to put it in the ACKNOWLEDGE DETECT state.
4. Read Register 6.

Part c: Value of Bit 6.0 when Receiving Alternating FLP Bursts

5. Send the DUT a constant stream of FLP Bursts alternating in content and without the Acknowledge bit set, to keep the DUT in the ABILITY DETECT state.
6. Read Register 6.

Part d: Setting Bit 6.0 to 0

7. Repeat steps 3 and 4.
8. Cease transmissions to the DUT and wait until the DUT passes through the TRANSMIT DISABLE state.
9. Read Bit 6.0.

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**Observable Results:**

- a. The default value of bit 6.0 should be 0.
- b. The DUT should set bit 6.0 to 1 in the ACKNOWLEDGE DETECT state.
- c. When the DUT is in the ABILITY DETECT state, bit 6.0 should be set to 0.
- d. The DUT should set bit 6.0 to 0 in the ABILITY DETECT state.

**Possible Problems:** None.



### **Test #MII.28.2.7: AN Next Page Transmit Register**

**Purpose:** To verify that the Auto-Negotiation Next Page Transmit Register can be set according to Table 28-6 and is reflected in the Next Pages transmitted by the DUT.

#### **References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.3.4 – Next Page function
- [2] IEEE Std 802.3-2012, subclause 28.2.4.1.6 – Auto-Negotiation Next Page transmit register (Register 7) (R/W)
- [3] IEEE Std 802.3-2012, Table 28-6 – Next Page transmit register bit definitions

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** During a Next Page exchange, management must have the ability to control the contents of the pages to be transmitted. The AN Next Page Transmit Register (MII Register 7) is used for this purpose. After a device is initialized, the default value of Register 7 is 2001. The transmission of Next Pages is often controlled directly by management which prevents direct user configuration of Register 7. Optionally, devices that directly control the Next Page exchange may implement a mechanism as suggested in Annex 40C to allow for the transmission of additional Next Pages and configuration of Register 7.

**Test Setup:** See **Appendix 22.B**

#### **Procedure:**

Part a: Default Value of Register 7

1. Initialize the DUT.
2. Read Register 7.

Part b: Read/Write Ability of Register 7

3. Set Register 7 to 0xFFFF
4. Read Register 7.
5. Repeat steps 3 and 4 setting Register 7 to 0x0000.

Part c: Transmission of Next Pages

6. Configure the DUT to desire a user-controlled Next Page exchange.
7. Send a Base Page with the Acknowledge and Next Page bits set to one to the DUT to put it into the COMPLETE ACKNOWLEDGE state.
8. Set Register 7 to 0xFFFF.
9. Read Register 7.
10. Observe transmissions from the DUT.
11. Restart Auto-Negotiation.
12. Repeat steps 6 through 10 setting Register 7 to 0x0000.

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Part d: Transmission of Toggle and Acknowledge Bits

13. Configure the DUT to send multiple Next Pages.
14. Monitor the value of the transmitted Toggle and Acknowledge bits.

**Observable Results:**

- a. After a device is initialized, the value of Register 7 should be 0x2001.
- b. The DUT should allow all bits except the Toggle and Acknowledge bits to be written.
- c. The Next Pages transmitted by the DUT should have bits 7.15, 7.13, 7.12, and 7.10:0 set corresponding to the value in Register 7.
- d. The Next Pages transmitted by the DUT should have bit 7.14 set to 0, and bit 7.11 set to the opposite of the value of bit 4.11 in the initial link codeword sent by the DUT.

**Possible Problems:** If the DUT does not support a Next Page exchange, then this test cannot be performed. During part a it may not be possible to read the value of Register 7 before management changes the value.

**Test #MII.28.2.8: Received Next Page Storage Location**

**Purpose:** To verify that the DUT properly stores received Next Pages in the correct register based on bits 6.6:5.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.3.4 – Next Page function
- [2] IEEE Std 802.3-2012, subclause 28.2.4.1.5 – Auto-Negotiation expansion register (Register 6) (RO)
- [3] IEEE Std 802.3-2012, Table 28-5 – Expansion register bit definitions

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** A DUT should store received Next Pages in a location according to bits 6.6 and 6.5. If bit 6.6 is set to zero, received Next Pages may be stored in Register 5 or Register 8. If bit 6.6 is set, then received Next Pages must be stored in Register 5 if bit 6.5 is set to zero, or Register 8 if bit 6.5 is set to one. Bits 6.6:5 are read only.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Read/Write Ability of Bits 6.6:5

1. Read bits 6.6:5.
2. Set bits 6.6:5 to a different value.
3. Read Register 6.

Part b: Value of Bits 6.6:5

4. Read Register 6.

Part c: Location of Stored Next Pages

5. Send a Base Page with the Next Page bit set to one to the DUT so it enters the COMPLETE ACKNOWLEDGE state, followed by a Next Page.
6. Read Register 5 and Register 8.
7. Repeat steps 5 and 6 four more times.

**Observable Results:**

- a. The DUT should not allow bits 6.6:5 to be written.
- b. **INFORMATIVE:** The DUT may or may not set bits 6.6:5.
- c. The DUT should store the received Next Pages in the appropriate register according to bits 6.6:5. If bit 6.6 is set to 0, the DUT may store received Next Pages in either Register 5 or Register 8.

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**Possible Problems:** If the DUT does not support a Next Page exchange, then this test cannot be performed.

**Test #MII.28.2.9: Auto-Negotiation Link Partner Received Next Page Register**

**Purpose:** To verify that the DUT properly stores received Next Pages in the Auto-Negotiation Link Partner Received Next Page Register.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.3.4 – Next Page function
- [2] IEEE Std 802.3-2012, subclause 28.2.4.1.4 – Auto-Negotiation Link Partner ability register (Register 5) (RO)
- [3] IEEE Std 802.3-2012, subclause 28.2.4.1.7 – Auto-Negotiation Link Partner Received Next Page register (Register 8) (RO)
- [4] IEEE Std 802.3-2012, Table 28-4 – Link partner ability register bit definitions (Next Page)
- [5] IEEE Std 802.3-2012, Table 28-7 – Link Partner Received Next Page register bit definitions

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** For a device to resolve a proper link configuration, it must accurately receive its Link Partner's Next Page abilities and relate them to management. The Auto-Negotiation Link Partner Received Next Page Register (AN LP Received NP Register) is defined to contain these abilities and is read only.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Read/Write Ability of the AN LP Received NP Register

1. Set the AN LP Received NP Register to 0xFFFF.
2. Read the AN LP Received NP Register.

Part b: Storage of Received Next Pages

3. Send a Base Page with the Next Page bit set to one to the DUT so it enters the COMPLETE ACKNOWLEDGE state, followed by a Next Page with a value of 0xFFFF.
4. Read the AN LP Received NP Register.
5. Repeat steps 3 and 4 with Next Pages containing the following values 0x6001, 0x4000, and 0x6801.

**Observable Results:**

- a. The DUT should not allow the AN LP Received NP Register to be set.
- b. The DUT should store the Next Pages exactly as received from its Link Partner.

**Possible Problems:** If the DUT does not support a Next Page exchange, then this test cannot be performed.

**Test #MII.28.2.10: Control of mr\_next\_page\_loaded**

**Purpose:** To verify that mr\_next\_page\_loaded is set when the Auto-Negotiation Next Page Transmit Register is written, and cleared in the NEXT PAGE WAIT state and the TRANSMIT DISABLE state.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.4.1.8 – State diagram variable to MII register mapping
- [2] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [3] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [4] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** The mr\_next\_page\_loaded variable controls the transition between pages during Auto-Negotiation. The variable mr\_next\_page\_loaded is automatically set when management writes the AN Next Page Transmit Register, but should be cleared in both the TRANSMIT DISABLE and NEXT PAGE WAIT states. The DUT should continue sending its previous page with the Acknowledge bit set until mr\_next\_page\_loaded is set to true.

**Test Setup:** See **Appendix 22.A**

**Procedure:**

Part a: Continued Transmissions while in the COMPLETE ACKNOWLEDGE State:

1. Configure the DUT to desire a user-controlled Next Page exchange.
2. Send a Base Page with the Next Page and Acknowledge bits set to 1 to the DUT to cause it to enter the COMPLETE ACKNOWLEDGE state.
3. Observe transmissions from the DUT.

Part b: Setting mr\_next\_page\_loaded in the COMPLETE ACKNOWLEDGE state:

4. Restart Auto-Negotiation.
5. Send a Base Page with the Next Page and Acknowledge bits to 1 set to the DUT to cause it to enter the COMPLETE ACKNOWLEDGE state.
6. Write any value to Register 7 while the DUT is in the COMPLETE ACKNOWLEDGE state
7. Observe transmissions from the DUT.

Part c: Setting mr\_next\_page\_loaded to False in the NEXT PAGE WAIT State:

8. Restart Auto-Negotiation.
9. Send a Base Page with the Next Page and Acknowledge bits to 1 set to the DUT to cause it to enter the COMPLETE ACKNOWLEDGE state.

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10. Write any value to Register 7 while the DUT is in the COMPLETE ACKNOWLEDGE state
11. Send a Next Page with the Acknowledge and Next Page bits set to 1 to the DUT to cause it to re-enter the COMPLETE ACKNOWLEDGE state.
12. Observe transmissions from the DUT.

**Observable Results:**

- a. The DUT should remain in the COMPLETE ACKNOWLEDGE state and continue to send its Base Page with the Acknowledge bit set to 1.
- b. The DUT should start transmitting its first Next Page, with a proper Toggle bit value and the Acknowledge bit set to 0.
- c. The DUT should remain the COMPLETE ACKNOWLEDGE state and continue to send its first Next Page with the Acknowledge bit set to 1.

**Possible Problems:** If the DUT does not support Next Page exchange, then this test cannot be performed. If the DUT does not allow a user-controlled Next Page exchange, this test cannot be performed.

**Test #MII.28.2.11: Next Page Able**

**Purpose:** To verify that the DUT sets bit 6.2 if it is capable of a Next Page exchange.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.4.1.5 – Auto-Negotiation expansion register (Register 6) (RO)
- [2] IEEE Std 802.3-2012, subclause 28.2.4.1.8 – State diagram variable to MII register mapping
- [3] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [4] IEEE Std 802.3-2012, Table 28-5 – Expansion register bit definitions
- [5] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [6] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:**

- None

**Last Modification:** May 28, 2014

**Discussion:** If a DUT supports a Next Page exchange, it must indicate this capability to management by setting bit 6.2 in the Expansion Register (MII Register 6), regardless of whether a Next Page exchange is desired.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Value of Bit 6.2

1. Disable all Next Page Abilities and set bit 4.15 to 0.
2. Restart Auto-Negotiation.
3. Read bit 6.2.
4. Enable all Next Page abilities.
5. Restart Auto-Negotiation.
6. Read bit 6.2.

**Observable Results:**

- a. Bit 6.2 must be set if the DUT supports a Next Page exchange, regardless of whether a Next Page exchange is currently desired.

**Possible Problems:** None



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**Test #MII.28.2.12: Link Partner Next Page Able**

**Purpose:** To verify that the DUT sets bit 6.3 upon reception of a Base Page which has the Next Page bit set to one.

**References:**

- [1] IEEE Std 802.3-2012, subclause 28.2.4.1.5 – Auto-Negotiation expansion register (Register 6) (RO)
- [2] IEEE Std 802.3-2012, subclause 28.2.4.1.8 – State diagram variable to MII register mapping
- [3] IEEE Std 802.3-2012, subclause 28.3.1 – State diagram variables
- [4] IEEE Std 802.3-2012, Table 28-5 – Expansion register bit definitions
- [5] IEEE Std 802.3-2012, Table 28-8 – State diagram variable to MII register mapping
- [6] IEEE Std 802.3-2012, Figure 28-18 – Arbitration state diagram

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** After entering the COMPLETE ACKNOWLEDGE state, a device uses bit 6.3 to tell its management that its Link Partner is Next Page able and desires a Next Page exchange. Bit 6.3 is reset to zero whenever the DUT enters the ABILITY DETECT state. The default value of bit 6.3 is zero.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bit 6.3

1. Initialize the DUT.
2. Read bit 6.3.

Part b: Neither Device Desires a Next Page Exchange

3. Disable all Next Page Abilities and set bit 4.15 to zero.
4. Restart Auto-Negotiation.
5. Send a Base Page with the Next Page bit set to zero to the DUT to cause it to enter the COMPLETE ACKNOWLEDGE state.
6. Read bit 6.3.

Part c: Link Partner Desires a Next Page Exchange

7. Send a Base Page with the Next Page bit set to one to the DUT to cause it to enter the COMPLETE ACKNOWLEDGE state.
8. Read bit 6.3.

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Part d: Both Devices Desire a Next Page Exchange

9. Configure the DUT to desire a Next Page exchange.
10. Set bit 0.9 to one.
11. Send a Base Page with the Next Page bit set to one to the DUT to cause it to enter COMPLETE ACKNOWLEDGE state.
12. Read bit 6.3.

Part e: Setting Bit 6.3 to 0

13. Repeat step 11.
14. Cease transmissions to the DUT and wait until the DUT passes through the TRANSMIT DISABLE state.
15. Read bit 6.3.

**Observable Results:**

- a. The default value of bit 6.3 should be zero.
- b. When the DUT's Link Partner does not desire a Next Page exchange, bit 6.3 should always be zero.
- c. When the DUT's Link Partner desires a Next Page exchange, the DUT should set bit 6.3 to one once it enters the COMPLETE ACKNOWLEDGE state.
- d. When the DUT's Link Partner desires a Next Page exchange, the DUT should set bit 6.3 to one once it enters the COMPLETE ACKNOWLEDGE state.
- e. Bit 6.3 should be set to 0 when the DUT reenters the ABILITY DETECT state.

**Possible Problems:** None.

### **GROUP 3: CLAUSE 40 MANAGEMENT REGISTERS**

**Scope:** The following tests cover Auto-Negotiation operation specific to the Clause 40 management register set.

**Overview:** These tests are designed to verify that the DUT properly implements the Media Independent Interface (MII) register set as it pertains to the Auto-Negotiation function. Register functions explored are defined in Clause 40 (1000BASE-T) of IEEE 802.3. Many of these tests are aimed at verifying the critical link between a conformant Auto-Negotiation state machine implementation and the overall system's management and control software.

**NOTE:** These tests are performed on devices implementing a 1000BASE-T PMA. These tests cannot be performed if register access is not provided.

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**Test #MII.40.3.1: 1000BASE-T MASTER/SLAVE Control Register bits 9.10:8**

**Purpose:** To verify for 1000BASE-T devices that the MASTER/SLAVE Control Register bits 9.10:8 properly control the advertised Port type and duplex.

**References:**

- [1] IEEE Std 802.3-2012, subclause 40.5.1.1 – 1000BASE-T use of registers during Auto-Negotiation
- [2] IEEE Std 802.3-2012, Table 40-3 – 1000BASE-T Registers
- [3] IEEE Std 802.3-2012, Table 40-4 – 1000BASE-T Base and Next Pages bit assignments

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** In order for 1000BASE-T devices to automatically configure themselves, they must complete the exchange of a Base Page and three Next Pages during the Auto-Negotiation process. A device's management entity could control this entire exchange by writing of MII Register 4 as well as MII Register 7. However, such an approach would require each DUT's management to be capable of properly following Next Page exchange mechanism defined in Clause 28. To remove this burden from system implementers, many suppliers of 1000BASE-T PHYs also incorporate the option of having an automatic embedded Next Page exchange management entity control the process. To enable this, the embedded controller must be aware of the system's desired mode of operation for the 1000BASE-T port. The automatic exchange entity monitors the values in the MASTER/SLAVE Control Register (GMII Register 9) to control to the exchange. To specify what type of device the system is (multiport or single port) as well as the desired duplex mode for the port, the management entity writes to bits 9.10:8. Once set, the management entity can enable the port, reset the port, or restart Auto-Negotiation and the embedded Next Page exchange controller will control the exchange. If an automatic exchange entity is not present, or disabled, then the device's management entity is required to properly complete the Next Page exchange using the properly timed writing of Register 7.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: 1000BASE-T Duplex Advertisement

1. Set bits 9.8 and 9.9 to 1.
2. Restart Auto-Negotiation.
3. Send a Base Page and 1000BASE-T Next Page Sequence to the DUT.
4. Observe transmissions from the DUT.
5. Repeat steps 1-4 for all combinations of values for bits 9.9:8.

Part b: Port Type Advertisement

6. Set bit 9.10 to 1.
7. Send a Base Page and 1000BASE-T Next Page Sequence to the DUT.

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8. Observe transmissions from the DUT.
9. Repeat steps 6-8 setting bit 9.10 to 0.

**Observable Results:**

- a. Bits U3 - U4 in the second Next Page transmitted by the DUT should match the value of bits 9.9:8.
- b. Bit U2 in the second Next Page transmitted by the DUT should match the value of bit 9.10.

**Possible Problems:** If management access to GMII Register 9 (or equivalent) is not available, then this test cannot be performed.

**Test #MII.40.3.2: 1000BASE-T MASTER/SLAVE Control Register bits 9.12:11**

**Purpose:** To verify for 1000BASE-T devices that the MASTER/SLAVE Control Register bits 9.12:11 properly control MASTER/SLAVE Manual Configuration.

**References:**

- [1] IEEE Std 802.3-2012, subclause 40.5.1.1 – 1000BASE-T use of registers during Auto-Negotiation
- [2] IEEE Std 802.3-2012, Table 40-3 – 1000BASE-T Registers
- [3] IEEE Std 802.3-2012, Table 40-4 – 1000BASE-T Base and Next Pages bit assignments

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** May 28, 2014

**Discussion:** In order for 1000BASE-T devices to automatically configure themselves, they must complete the exchange of a Base Page and three Next Pages during the Auto-Negotiation process. A device's management entity could control this entire exchange by the writing of MII Register 4 as well as MII Register 7. However, such an approach would require each DUT's management to be capable of properly following Next Page exchange mechanism defined in Clause 28. To remove this burden from system implementers, many suppliers of 1000BASE-T PHYs also incorporate the option of having an automatic embedded Next Page exchange management entity control the process. To enable this, the embedded controller must be aware of the system's desired mode of operation for the 1000BASE-T port. The automatic exchange entity monitors the values in the MASTER/SLAVE Control Register (GMII Register 9) to control to the exchange. To specify that the port should be forced to be either MASTER or SLAVE, the system must set bit 9.12 to 1, and set 9.11 to either 1 or 0. Once set, the management entity can enable the port, reset the port, or restart Auto-Negotiation and the embedded Next Page exchange controller will control the exchange. If an automatic exchange entity is not present, or disabled, then the device's management entity is required to properly complete the Next Page exchange using the properly timed writing of Register 7. The default value of bits 9.12:11 is 0.

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Default Value of Bits 9.12:11

1. Initialize the DUT.
2. Read bits 9.12:11.

Part b: MASTER/SLAVE Manual Configuration Enabled

3. Set bits 9.12 and 9.11 to 1.
4. Restart Auto-Negotiation.
5. Send a Base Page and 1000BASE-T Next Page Sequence with the DUT.
6. Observe transmissions from the DUT.
7. Repeat steps 3 through 6 setting bit 9.11 to 0.

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Part c: MASTER/SLAVE Manual Configuration Disabled

8. Set bits 9.12 and 9.11 to 0.
9. Restart Auto-Negotiation.
10. Send a Base Page and 1000BASE-T Next Page Sequence with the DUT.
11. Observe transmissions from the DUT.
12. Repeat steps 8 through 11 setting bit 9.11 to 1.

**Observable Results:**

- a. The default value of bits 9.12:11 is 0.
- b. When bit 9.12 is set to 1, bits U0 & U1 in the second Next Page transmitted by the DUT should match the value of 9.12:11.
- c. **INFORMATIVE:** When bit 9.12 is set to zero, bits U0 & U1 in the second Next Page transmitted by the DUT may or may not match the value of bits 9.12:11.

**Possible Problems:** If management access to GMII Register 9 (or equivalent) is not available, then this test cannot be performed. During part a, it may not be possible to read the value of Register 9 before management changes the value.

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**Test #MII.40.3.3: 1000BASE-T MASTER/SLAVE Status Register**

**Purpose:** To verify the MASTER/SLAVE Status Register conforms to the definition in Table 40-3 for 1000BASE-T capable devices.

**References:**

- [1] IEEE Std 802.3-2012, subclause 40.5.1.1 – 1000BASE-T use of registers during Auto-Negotiation
- [2] IEEE Std 802.3-2012, Table 40-3 – 1000BASE-T Registers
- [3] IEEE Std 802.3-2012, Table 40-4 – 1000BASE-T Base and Next Pages bit assignments

**Resource Requirements:** See **Appendix 22.A**

**Last Modification:** February 3, 2015

**Discussion:** Once a 1000BASE-T device completes Auto-Negotiation, status information specific to the 1000BASE-T link must be properly represented in the MASTER-SLAVE Status Register (GMII Register 10).

**Test Setup:** See **Appendix 22.B**

**Procedure:**

Part a: Read/Write Ability

1. Read Register 10.
2. Set Register 10 to 0xFFFF.
3. Read Register 10.
4. Set Register 10 to 0x0000.
5. Read Register 10.

Part b: Value of Bits 10.11:10

6. Send a Base Page and 1000BASE-T Next Page Sequence, advertising 1000BASE-T full and half duplex support, to the DUT.
7. Read Register 10.
8. Repeat steps 6 and 7, advertising 1000BASE-T full duplex only, 1000BASE-T half duplex only and no 1000BASE-T abilities.

Part c: Value of Bit 10.14

9. Send a Base Page 1000BASE-T Next Page Sequence to the DUT so that the DUT will resolve to MASTER.
10. Read Register 10.
11. Observe transmissions from the DUT.
12. Repeat steps 9-11, changing the Next Page Sequence so that the DUT should resolve to SLAVE.



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Part d: MASTER/SLAVE Configuration Fault with Manual Configuration

13. Configure the DUT to be manual\_MASTER.
14. Send a Base Page and 1000BASE-T Next Page Sequence, advertising manual\_MASTER to the DUT.
15. Read Register 10.
16. Repeat steps 13-15, configuring the DUT and the Link Partner to be manual\_SLAVE.

Part e: MASTER/SLAVE Configuration Fault with Seed Values

17. Configure the DUT to be neither manual\_MASTER nor manual\_SLAVE.
18. Send a Base Page 1000BASE-T Next Page Sequence to the DUT, transmitting the same value for UP2 that the DUT transmits.
19. Repeat steps 17 and 18 six more times.
20. Read Register 10.

Part f: Setting Bit 10.15 to 0

21. Configure the DUT to be manual\_MASTER.
22. Send a Base Page 1000BASE-T Next Page sequence advertising manual\_MASTER to the DUT.
23. Read Register 10 twice.

Part g: Self-Clearing Function of Bit 10.15 after a Link has been Established

24. Repeat steps 21 and 22.
25. Wait until the DUT has passed through the TRANSMIT DISABLE state.
26. Establish a 1000BASE-T link with the DUT.
27. Read Register 10.

Part h: Self-Clearing Function of Bit 10.15 after Auto-Negotiation has been Restarted

28. Repeat steps 21 and 22.
29. Restart Auto-Negotiation.
30. Read Register 10.

Part i: Value of Bits 10.13:12

31. Establish a 1000BASE-T link with the DUT.
32. Read bits 10.13 and 10.12

Part j: Idle Error Count Bits

33. Establish a 1000BASE-T link with the DUT.
34. While the 1000BASE-T link is established, attempt to degrade the quality of the link between the two devices by any means, but do not break the link. The quality of the link can be degraded by either a controlled noise injection, or an uncontrolled noise injection (such as by very briefly loosening the RJ-45 plug & jack connection).
35. Read bits 10.7:0, if zero, read again. Repeat steps 33 and 34 until a non-zero value is read.

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Part k: Setting Bits 10.7:0 to 0

36. Repeat steps 33 and 34 until bits 10.7:0 return a non-zero value.
37. Read Register 10.

**Observable Results:**

- a. The DUT should not allow Register 10 to be written.
- b. The reported Link Partner duplex ability should match the ability indicated in the received UP1 Next Page.
- c. Bit 10.14 should be set to one when the DUT resolves to MASTER. Bit 10.14 should be set to 0 when the DUT resolves to SLAVE.
- d. Bit 10.15 should be set to one when a configuration fault occurs.
- e. After 7 failed attempts, the DUT should set bit 10.15.
- f. Bit 10.15 should be set to 0 after Register 10 has been read.
- g. After a 1000BASE-T link has been established, bit 10.15 should be set to 0.
- h. After Auto-Negotiation has been restarted, bits 10.15 should be set to 0.
- i. Once a link is established, bits 10.13 and 10.12 should both be set to 1.
- j. Bits 10.7:0 should indicate the number of errors (MSB is bit 7).
- k. Bits 10.7:0 should be set to 0 after being read.

**Possible Problems:** In step 33 and 34, the ability to induce errors in either a controlled or uncontrolled manner without causing a link failure may not be possible for a given device.

## **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 22.A - Resource Requirements**

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

**Last Modification:** February 6, 2013

### **Discussion:**

The reader will need the following in order to perform tests in Group 1, 2 and 3.

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 reader will need the following in order to perform test 40.3.3

1. 1000BASE-T Traffic Generator: A system capable of properly completing the 1000BASE-T Next Page exchange and establishing a valid 1000BASE-T link.

## **Appendix 22.B - Test Setup**

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

**Last Modification:** February 6, 2013

### **Discussion:**

The reader will need the following setup 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.

