

**AUTOMOTIVE  
ETHERNET CONSORTIUM**

**Clause 96**  
**100BASE-T1 PHY Control Test Suite**  
*Version 1.0*  
*Technical Document*



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## **INTRODUCTION**

The University of New Hampshire's InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This particular suite of tests has been developed to help implementers evaluate the functionality of the PMA sublayer of their 100BASE-T1 products.

These tests are designed to determine if a product conforms to specifications defined in the IEEE 802.3bw 100BASE-T1 Standard. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other devices. However, combined with satisfactory operation in the IOL's interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function properly in many 100BASE-T1 automotive environments.

The tests contained in this document are organized in such a manner as to simplify the identification of information related to a test, and to facilitate in the actual testing process. Tests are organized into groups, primarily in order to reduce setup time in the lab environment, however the different groups typically also tend to focus on specific aspects of device functionality. A three-part numbering system is used to organize the tests, where the first number indicates the section of the IEEE 100BASE-T1 Standard on which the test suite is based. The second and third numbers indicate the test's group number and test number within that group, respectively. This format allows for the addition of future tests to the appropriate groups without requiring the renumbering of the subsequent tests.

The test definitions themselves are intended to provide a high-level description of the motivation, resources, procedures, and methodologies pertinent to each test. Specifically, each test description consists of the following sections:

### **Purpose**

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

### **References**

This section specifies source material *external* to the test suite, including specific subsections pertinent to the test definition, or any other references that might be helpful in understanding the test methodology and/or test results. External sources are always referenced by number when mentioned in the test description. Any other references not specified by number are stated with respect to the test suite document itself.

### **Resource Requirements**

The requirements section specifies the test hardware and/or software needed to perform the test. This is generally expressed in terms of minimum requirements, however in some cases specific equipment manufacturer/model information may be provided.

### **Last Modification**

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

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**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 initial configuration of the test environment. Small changes in the configuration should not be included here, and are generally covered in the test procedure section, below.

**Test Procedure**

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

**Observable Results**

This section lists the specific observables that can be examined by the tester in order to verify that the DUT is operating properly. When multiple values for an observable are possible, this section provides a short discussion on how to interpret them. The determination of a pass or fail outcome for a particular test is generally based on the successful (or unsuccessful) detection of a specific observable.

**Possible Problems**

This section contains a description of known issues with the test procedure, which may affect test results in certain situations. It may also refer the reader to test suite appendices and/or whitepapers that may provide more detail regarding these issues.

## Device Under Test (DUT) Requirements

For the purposes of this test suite, the DUT is one port of a 100BASE-T1 capable device that includes a 100BASE-T1 PHY mounted on a PCB with an MDI connector and any necessary circuitry such as a low pass filter or common mode choke. All tests will be performed at the MDI connector of the DUT.

Please see the additional requirements listed in the following table:

<b>Test Number and Name</b>	<b>Required Capabilities</b>
<b>Group 1: PHY Control and Timers</b>	
Test 96.1.1 – PMA Reset	Access to PMA Reset Access to link_status <sup>2</sup> Ability to set master/slave configuration
Test 96.1.2 – Value of minwait_timer	Ability to set master/slave configuration
Test 96.1.3 – Value of maxwait_timer	Access to link_status <sup>2</sup> Ability to set master/slave configuration
Test 96.1.4 – Value of stabilize_timer	Access to link_status <sup>2</sup> Ability to set master/slave configuration
<b>Group 2: PHY Control State Diagram</b>	
Test 96.2.1 – PHY Control State Diagram - DISABLE TRANSMITTER State	Access to PMA Reset Ability to set master/slave configuration
Test 96.2.2 – PHY Control State Diagram - SLAVE SILENT State	Ability to set master/slave configuration
Test 96.2.3 – PHY Control State Diagram - TRAINING State	Ability to set master/slave configuration The ability to send and receive frames <sup>1</sup>
Test 96.2.4 – PHY Control State Diagram - SEND IDLE State	Ability to set master/slave configuration The ability to send and receive frames <sup>1</sup>
Test 96.2.5 – PHY Control State Diagram - SEND IDLE OR DATA State	Ability to set master/slave configuration The ability to send and receive frames <sup>1</sup> Access to the MII signals
<b>Group 3: Link Monitor State Diagram</b>	
Test 96.3.1 – Link Monitor State Diagram	Access to link_status <sup>2</sup> Ability to set master/slave configuration

<sup>1</sup> This can be accomplished through a loopback, responding to ICMP requests, or by forwarding traffic through two ports.

<sup>2</sup> Due to the nature of testing, the link\_status signal must update as quickly as possible and have the ability to be probed by an oscilloscope or logic analyzer.

## **GROUP 1: PHY Control and Timers**

### **Overview:**

This section verifies the integrity of the IEEE 100BASE-T1 PHY Control functions and related timers.



## **Test 96.1.1 – PMA Reset**

**Purpose:** To verify that the PMA properly initializes upon receipt of a reset request from the management entity.

### **References:**

- [1] IEEE Std. 802.3bw, subclause 96.4.1 – PMA Reset function

### **Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** March 9, 2016 (Version 1.0)

### **Discussion:**

Reference [1] states that the PMA is reset upon power on or the receipt of a reset request from management entity. The PMA Reset function causes the PHY Control State Diagram to transition to the DISABLE TRANSMITTER state. After exiting the DISABLE TRANSMITTER state while configured as master, the DUT should immediately transition from the SLAVE SILENT state to the TRAINING state and transmit Idle with tx\_mode=SEND\_I. After exiting the DISABLE TRANSMITTER state while configured as slave, the DUT should remain in the SLAVE SILENT state until it has set scr\_status=OK.

The PMA Reset function also causes the Link Monitor State Diagram to transition to the LINK DOWN state. Here the DUT should set link\_status=FAIL.

**Test Setup:** Connect the Device Under Test (DUT) to the Link Partner via the line tap or to the Test Station.

### **Procedure:**

1. Configure the DUT as master.
2. Establish a valid link with the DUT.
3. Monitor the transmissions from the DUT and cause the management to request a PMA Reset while simultaneously ceasing transmissions from the test station.
4. Configure the DUT as slave and repeat steps 1-3.

### **Observable Results:**

- a. In step 3, the DUT should stop transmitting with tx\_mode=SEND\_N and start transmitting with tx\_mode=SEND\_I.
- b. In step 3, the DUT should set link\_status=FAIL.
- c. In step 4, the DUT should stop transmitting.
- d. In step 4, the DUT should set link\_status=FAIL.

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**Possible Problems:** If the ability to control the PMA Reset request is not available, this test cannot be performed. Parts b and d cannot be completed if access to link\_status is not available. Some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested. If it is not possible to synchronize asserting PMA Reset and ceasing transmissions from the test station, care must be taken to ensure that the test station does not transmit a sequence that would cause the DUT to set scr\_status=OK or loc\_rcvr\_status=OK.

## **Test 96.1.2 – Value of minwait\_timer**

**Purpose:** To verify that the device under test (DUT) properly implements a minwait\_timer of 1.8 us +/- 0.18 us.

### **References:**

- [1] IEEE Std. 802.3bw, subclause 96.4.7.2 – Timers
- [2] IEEE Std. 802.3bw, Figure 96-18 PHY Control state diagram
- [3] IEEE Std. 802.3bw, Figure 96-19 Link Monitor state diagram

### **Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** March 9, 2016 (Version 1.0)

### **Discussion:**

Reference [1] defines minwait\_timer as 1.8 us +/- 0.18 us. This timer is used to ensure that the devices transmit the training pattern for enough time to ensure that the link partner can recover the signal and establish a link.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

### **Procedure:**

#### *Case 1: minwait\_timer in TRAINING*

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
3. Start transmitting a valid training signal from the transmit station as soon as the DUT restarts the training process. If the DUT is a master then the Transmit station should begin transmissions with loc\_rcvr\_status = OK. If the DUT is a slave then the Transmit station should not set loc\_rcvr\_status = OK until after the DUT starts transmitting the Idle training pattern.
4. Monitor how long the DUT sends the Idle training pattern in the TRAINING state before transitioning to the SEND IDLE OR DATA state.
5. Repeat steps 2-4 with the DUT configured as slave.

#### *Case 2: minwait\_timer in SEND IDLE OR DATA*

6. Configure the DUT as master.
7. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
8. Establish a valid link with the DUT, but stop transmitting from the test station as soon as the DUT enters the SEND IDLE OR DATA state.
9. Monitor how long the DUT transmits with tx\_mode=SEND\_N before restarting training.
10. Repeat steps 7-9 with the DUT configured as slave.

#### *Case 3: minwait\_timer between SEND IDLE to SEND IDLE OR DATA*

11. Configure the DUT as master.

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12. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
13. Establish a valid link with the DUT.
14. Instruct the Test station to transmit with tx\_mode=SEND\_I with loc\_recvr\_status = OK.
15. As soon as the DUT begins transmitting with tx\_mode=SEND\_N, instruct the test station to transmit with loc\_recvr\_status=NOT\_OK for less than minwait\_timer.
16. As soon as the DUT begins transmitting with tx\_mode=SEND\_I, instruct the test station to transmit with loc\_recvr\_status=OK.
17. Observe how long the DUT remains in the SEND\_I state.
18. Repeat steps 12-14 with the DUT configured as slave.

*Case 4: minwait\_timer between SEND\_IDLE OR DATA to SEND\_IDLE*

19. Configure DUT as master.
20. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
21. Establish a valid link with the DUT.
22. Instruct the test station to transmit with tx\_mode=SEND\_I with loc\_recvr\_status=NOT\_OK.
23. As soon as the DUT begins transmitting with tx\_mode=SEND\_I, instruct the test station to transmit with loc\_recvr\_status=OK.
24. As soon as the DUT begins transmitting with tx\_mode=SEND\_N, instruct the test station to transmit with loc\_recvr\_status=NOT\_OK.
25. Observe how long the DUT remains in the SEND\_N state.
26. Repeat steps 18-22 with the DUT configured as slave.

**Observable Results:**

- a. In step 4, the DUT should transmit the Idle training pattern for 1.8 us +/- 0.18 us.
- b. In step 5, the DUT should transmit the Idle training pattern for 1.8 us +/- 0.18 us.
- c. In step 9, the DUT should transmit with tx\_mode=SEND\_N for 1.8 us +/- 0.18 us.
- d. In step 10, the DUT should transmit with tx\_mode=SEND\_N for 1.8 us +/- 0.18 us.
- e. In step 17, the DUT should transmit with tx\_mode=SEND\_I for 1.8us +/- 0.18 us.
- f. In step 18, the DUT should transmit with tx\_mode=SEND\_I for 1.8us +/- 0.18 us.
- g. In step 22, the DUT should transmit with tx\_mode=SEND\_N for 1.8us +/- 0.18us.
- h. In step 23, the DUT should transmit with tx\_mode=SEND\_N for 1.8us +/- 0.18us.

**Possible Problems:** Some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested. Case 1 cannot be tested as master if the DUT takes longer than minwait\_timer to set loc\_recvr\_status. Case 2 cannot be tested if the DUT takes longer than minwait\_timer to drop loc\_recvr\_status.

### **Test 96.1.3 – Value of maxwait\_timer**

**Purpose:** To verify that the device under test (DUT) properly implements a maxwait\_timer of 200 ms +/- 2 ms.

**References:**

- [1] IEEE Std. 802.3bw, subclause 96.4.7.2 – Timers
- [2] IEEE Std. 802.3bw, Figure 96-18 PHY Control state diagram
- [3] IEEE Std. 802.3bw, Figure 96-19 Link Monitor state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** March 9, 2016 (Version 1.0)

**Discussion:**

Reference [1] defines maxwait\_timer as 200 ms +/- 2 ms. This timer is used to limit the amount of time the devices spend in the SLAVE SILENT and TRAINING states.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

*Case 1: Value of maxwait\_timer*

1. Configure the DUT as master.
2. Establish a link and ensure that link\_status=OK.
3. Monitor the transmissions and link\_status from the DUT.
4. Stop transmitting signaling to the DUT.
5. Determine when the DUT sets tx\_mode≠SEND\_N and mark this as TIME A.
6. Determine when the DUT sets link\_status=FAIL and mark this as TIME B.
7. Measure max\_wait\_timer as the difference between TIME A and TIME B.
8. Repeat steps 2-7 with the DUT configured as slave.

**Observable Results:**

- a. In step 7, the DUT should implement a max\_wait\_timer of 200 ms +/- 2 ms when configured as master.
- b. In step 8, the DUT should implement a max\_wait\_timer of 200 ms +/- 2 ms when configured as slave.

**Possible Problems:** This test cannot be completed if access to link\_status is not available. Also, some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.

## **Test 96.1.4 – Value of stabilize\_timer**

**Purpose:** To verify that the device under test (DUT) properly implements a stabilize\_timer of 1.8 us +/- 0.18 us.

**References:**

- [1] IEEE Std. 802.3bw, subclause 96.4.7.2 – Timers
- [2] IEEE Std. 802.3bw, Figure 96-19 Link Monitor state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** September 18, 2014 (Version 1.3)

**Discussion:**

Reference [1] defines stabilize\_timer as 1.8 us +/- 0.18 us. This timer is used to ensure that the device is receiving a valid signal for the duration stabilize\_timer before setting link\_status=OK.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
3. Start transmitting a valid training signal from the transmit station as soon as the DUT restarts the training process.
4. After the DUT sets loc\_rcvr\_status = OK, continue to send the valid signal for less than stabilize\_timer, then stop transmitting.
5. Check the value of link\_status.
6. Repeats steps 2-5, increasing the duration that the test station sends a valid signal in step 4 until the DUT reports link\_status = OK. This is the value for stabilize\_timer.
7. Repeat steps 2-6 with the DUT configured as slave.

**Observable Results:**

- a. In step 6, the value of stabilize\_timer should be 1.8 us +/- 0.18 us when configured as master.
- b. In step 7, the value of stabilize\_timer should be 1.8 us +/- 0.18 us when configured as slave.

**Possible Problems:** This test cannot be performed if real-time access to link\_status is not available. Also, some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.

## **GROUP 2: PHY Control State Diagram**

### **Overview:**

The tests defined in this section verify the PHY Control State Diagram for 100BASE-T1 capable PHYs.

## **Test 96.2.1 – PHY Control State Diagram - DISABLE TRANSMITTER State**

**Purpose:** To verify that the device under test (DUT) properly disables the transmitter while in the DISABLE TRANSMITTER state.

**References:**

[1] IEEE Std. 802.3bw, Figure 96-18 PHY Control state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** June 25, 2014 (Version 1.2)

**Discussion:**

Reference [1] states that the transmitters should be disabled when the PHY Control State Diagram transitions to the DISABLE TRANSMITTER state.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and cause the management to request a PMA Reset.
3. Observe if the DUT disables the transmitter upon entering the DISABLE TRANSMITTER state.
4. Configure the DUT as Slave and repeat steps 2 and 3.

**Observable Results:**

- a. In step 3, the DUT should disable the transmitter upon entering the DISABLE TRANSMITTER state when configured as master.
- b. In step 4, the DUT should disable the transmitter upon entering the DISABLE TRANSMITTER state when configured as slave.

**Possible Problems:** If the ability to control the PMA Reset request is not available, this test cannot be performed. Some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.



## **Test 96.2.2 – PHY Control State Diagram - SLAVE SILENT State**

**Purpose:** To verify that the device under test (DUT) properly does not transmit while in the SLAVE SILENT state and that the DUT properly transitions out of this state.

**References:**

[1] IEEE Std. 802.3bw, Figure 96-18 PHY Control state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** June 25, 2014 (Version 1.2)

**Discussion:**

Reference [1] states that the DUT should be in `tx_mode = send_z` when it enters the SLAVE SILENT State. Devices configured as master transition out of this state immediately, but devices configured as slave stay in this state until `loc_rcvr_status = OK`.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

*Part A: DUT is master*

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and restart the training process on the DUT by sending invalid Ternary Codes after the DUT has established a link.
3. Observe that the DUT immediately transitions out of the SLAVE SILENT state without waiting for `loc_rcvr_status = OK`.

*Part B: DUT is slave*

4. Configure the DUT as slave.
5. Monitor the transmissions from the DUT and restart the training process on the DUT by sending invalid Ternary Codes after the DUT has established a link.
6. Do not immediately send a valid Idle training pattern.
7. Send a valid Idle training pattern and observe that the DUT begins transmitting a valid Idle training pattern.

**Observable Results:**

- a. In step 3, the DUT should transition out of the SLAVE SILENT state without waiting for `loc_rcvr_status = OK`.
- b. In step 7, the DUT should not transition out of the SLAVE SILENT state until it receives a valid Idle training pattern.

**Possible Problems:** Some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.

### **Test 96.2.3 – PHY Control State Diagram - TRAINING State**

**Purpose:** To verify that the device under test (DUT) properly exits from the TRAINING state.

**References:**

[1] IEEE Std. 802.3bw, Figure 96-18 PHY Control state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** June 25, 2014 (Version 1.2)

**Discussion:**

The Reference [1] states that the device will remain in the TRAINING state until it has loc\_rcvr\_status=OK and minwait\_timer has finished. If the link partner does not have loc\_rcvr\_status=OK then the device will transition to the SEND IDLE state. If the link partner does have loc\_rcvr\_status=OK then the device will transition to the SEND IDLE OR DATA state. The link partner's value for rem\_rcvr\_status is determined based on the scrambler sequence transmitter by the link partner.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

*Case 1 - DUT remains in the TRAINING state*

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
3. Do not transmit a valid Idle training pattern to the DUT, observe that the DUT continues to transmit a valid Idle pattern with tx\_mode=SEND\_I and the scrambler for loc\_rcvr\_status = NOT OK.
4. Configure the DUT as slave
5. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
6. Transmit a valid Idle training pattern to the DUT, then stop transmitting as soon as the DUT begins transmitting.
7. Observe that the DUT does not exit the training state and continues to transmit a valid Idle pattern with tx\_mode=SEND\_I and the scrambler for loc\_rcvr\_status = NOT OK.

*Case 2 - DUT transitions to the SEND IDLE state*

8. Configure the DUT as master.
9. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
10. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = NOTOK.
11. Observe that the DUT continues transmitting with tx\_mode=SEND\_I.
12. Configure the DUT as slave and repeat steps 9-11.

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*Case 3 - DUT transitions to the SEND IDLE OR DATA state*

13. Configure the DUT as master.
14. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
15. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = OK.
16. Observe that the DUT establishes a link and is capable of sending and receiving frames.
17. Configure the DUT as slave and repeat steps 14-16.

**Observable Results:**

- a. In step 6, the DUT should continue transmitting a valid Idle training pattern with tx\_mode=SEND\_I and loc\_rcvr\_status = NOT OK when configured as master.
- b. In step 7, the DUT should continue transmitting a valid Idle training pattern with tx\_mode=SEND\_I and loc\_rcvr\_status = NOT OK when configured as slave.
- c. In step 11, the DUT should continue transmitting a valid Idle training pattern with tx\_mode=SEND\_I and loc\_rcvr\_status = OK when configured as master.
- d. In step 12, the DUT should continue transmitting a valid Idle training pattern with tx\_mode=SEND\_I and loc\_rcvr\_status = OK when configured as slave.
- e. In step 16, the DUT should establish a valid link and be capable of transmitting and receiving frames when configured as master.
- f. In step 17, the DUT should establish a valid link and be capable of transmitting and receiving frames when configured as slave.

**Possible Problems:** Some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.

## **Test 96.2.4 – PHY Control State Diagram - SEND IDLE State**

**Purpose:** To verify that the device under test (DUT) properly exits from the SEND IDLE state.

**References:**

[1] IEEE Std. 802.3bw, Figure 96-18 PHY Control state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)

**Last Modification:** June 25, 2014 (Version 1.2)

**Discussion:**

Reference [1] states that the device will remain in the SEND IDLE state while it has `loc_rcvr_status=OK` and `rem_rcvr_status = NOT_OK`. The DUT will transition to the SEND IDLE OR DATA state once `rem_rcvr_status=OK` or to the SLAVE SILENT state if `loc_rcvr_status=NOT_OK`. The link partner's value for `loc_rcvr_status` is determined based on the scrambler sequence transmitter by the link partner.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

*Case 1 - DUT remains in the SEND IDLE state*

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
3. Send a valid Idle training pattern to the DUT with the scrambler for `loc_rcvr_status = NOT OK`.
4. Observe that the DUT continues transmitting a valid Idle training pattern.
5. Configure the DUT as slave and repeat steps 2-4.

*Case 2 - DUT transitions to the SLAVE SILENT state*

6. Configure the DUT as master.
7. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
8. Send a valid Idle training pattern to the DUT with the scrambler for `loc_rcvr_status = NOT OK` for at least `minwait_timer`.
9. Stop transmitting to the DUT.
10. Observe that the DUT transitions to the SLAVE SILENT state.
11. Configure the DUT as slave and repeat steps 7-10.

*Part C - DUT transitions to the SEND IDLE OR DATA state*

12. Configure the DUT as master.
13. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
14. Send a valid Idle training pattern to the DUT with the scrambler for `loc_rcvr_status = NOT OK` for at least `minwait_timer`, then transmit with `loc_rcvr_status = OK`.

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15. Observe that the DUT establishes a link and is capable of sending and receiving frames.
16. Configure the DUT as slave and repeat steps 13-15.

**Observable Results:**

- a. The DUT should continue transmitting a valid Idle training pattern with `loc_rcvr_status = OK` in step 4.
- b. The DUT should continue transmitting a valid Idle training pattern with `loc_rcvr_status = OK` in step 5.
- c. The DUT should transition to the SLAVE SILENT state in step 10.
- d. The DUT should transition to the SLAVE SILENT state in step 11.
- e. The DUT should establish a valid link and be capable of transmitting and receiving frames in step 15.
- f. The DUT should establish a valid link and be capable of transmitting and receiving frames in step 16.

**Possible Problems:** Some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.

## **Test 96.2.5 – PHY Control State Diagram - SEND IDLE OR DATA State**

**Purpose:** To verify that the device under test (DUT) properly exits from the SEND IDLE OR DATA state.

**References:**

[1] IEEE Std. 802.3bw Figure 96-18 PHY Control state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)
- MII Test Station

**Last Modification:** December 4, 2014 (Version 2.0)

**Discussion:**

Reference [1] states that the device will remain in the SEND IDLE OR DATA state until it has loc\_rcvr\_status=NOT\_OK and tx\_enable=FALSE. The DUT will transition to the SLAVE SILENT state if loc\_rcvr\_status=NOT\_OK while tx\_enable=FALSE. The DUT will transition to the SEND IDLE state if rem\_rcvr\_status=NOT\_OK

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

*Case 1 - DUT remains in the SEND IDLE OR DATA state*

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
3. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = OK for at least minwait\_timer.
4. Observe that the DUT establishes a valid link and is capable of transmitting and receiving frames.
5. Configure the DUT as slave and repeat steps 2-4.

*Case 2 - DUT transitions to the SLAVE SILENT state*

6. Configure the DUT as master.
7. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
8. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = OK for at least minwait\_timer.
9. Stop transmitting to the DUT.
10. Observe that the DUT transitions to the SLAVE SILENT state, or transitions to the SEND IDLE state and then to the SLAVE SILENT STATE.
11. Configure the DUT as slave and repeat steps 7-10.

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*Case 3 - DUT remains in the SEND IDLE OR DATA state while tx\_enable=TRUE*

12. Configure the DUT as master.
13. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
14. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = OK for at least minwait\_timer.
15. Force the DUT to set tx\_enable=TRUE.
16. Stop transmitting to the DUT.
17. Observe that the DUT remains in the SEND IDLE OR DATA state for maxwait\_timer if the DUT was observed to transition directly to the SLAVE SILENT state in step 10.
18. Configure the DUT as slave and repeat steps 13-17.

*Case 4 - DUT transitions to the SEND IDLE state*

19. Configure DUT as master.
20. Monitor the transmissions from the DUT and restart the training process on the DUT, either through management or by sending invalid Ternary Codes after the DUT has established a link.
21. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = OK until the DUT enters the SEND IDLE OR DATA state.
22. Send a valid idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = NOT OK.
23. Observe that the DUT transitions to the SEND IDLE state.
24. Configure the DUT as slave and repeat steps 20-23.

**Observable Results:**

- a. The DUT should establish a valid link and be capable of transmitting and receiving frames in step 4.
- b. The DUT should establish a valid link and be capable of transmitting and receiving frames in step 5.
- c. The DUT should transition to the SLAVE SILENT state, or transition to the SEND IDLE state and then to the SLAVE SILENT state in step 10.
- d. The DUT should transition to the SLAVE SILENT state, or transition to the SEND IDLE state and then to the SLAVE SILENT state in step 11.
- e. If the DUT was observed to transition directly to the SLAVE SILENT state in steps 10 and 11, the DUT should remain in the SEND IDLE OR DATA state for maxwait\_timer in step 17.
- f. If the DUT was observed to transition directly to the SLAVE SILENT state in steps 10 and 11, The DUT should remain in the SEND IDLE OR DATA state for maxwait timer in step 18.
- g. In step 23, the DUT should transition to the SEND IDLE state.
- h. In step 24, the DUT should transition to the SEND IDLE state.

**Possible Problems:** Case 3 cannot be completed if access to the MII signals is not available. Case 3 can also not be completed in the case where the DUT transitions to the SEND IDLE state and then to the SLAVE SILENT state in steps 10 and 11. This is because loc\_rcvr\_status can take longer than minwait\_timer to fall after transmissions to the DUT have ceased, and the transition tested in Case 3 will never occur. Also, some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.

### **GROUP 3: Link Monitor State Diagram**

**Overview:**

The tests defined in this section verify the Link Monitor State Diagram defined for 100BASE-T1 PHYs in subclause 96.4.5 of the IEEE 802.3bw 100BASE-T1 Specification.



## **Test 96.3.1 – Link Monitor State Diagram**

**Purpose:** To verify that the device under test (DUT) properly implements the Link Monitor State Diagram.

**References:**

[1] IEEE Std. 802.3bw, Figure 96-19 Link Monitor state diagram

**Resource Requirements:**

- 100BASE-T1 Transmit station (refer to appendix 96.A)
- 100BASE-T1 Monitor station (refer to appendix 96.A)
- Access to the link\_status signal must be provided

**Last Modification:** June 25, 2014 (Version 1.2)

**Discussion:**

The 100BASE-T1 specification provides the Link Monitor State Diagram. Devices must not set link\_status=OK until the LINK UP state.

**Test Setup:** Connect the DUT to the 100BASE-T1 Transmit station and the 100BASE-T1 Monitor station.

**Procedure:**

*Case 1 - DUT does not enter the LINK OK state*

1. Configure the DUT as master.
2. Monitor the transmissions from the DUT and restart the training process on the DUT by sending invalid Ternary Codes after the DUT has established a link.
3. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = OK for less than stabilize\_timer, then stop transmitting.
4. Observe that the DUT does not set link\_status = OK.
5. Configure the DUT as slave and repeat steps 2-4.

*Case 2 - DUT enters the LINK OK state*

6. Configure the DUT as master.
7. Monitor the transmissions from the DUT and restart the training process on the DUT by sending invalid Ternary Codes after the DUT has established a link.
8. Send a valid Idle training pattern to the DUT with the scrambler for loc\_rcvr\_status = OK for at least stabilize\_timer.
9. Observe that the DUT sets link\_status = OK.
10. Configure the DUT as slave and repeat steps 7-9.

*Case 3 - DUT exits the LINK OK state*

11. Configure the DUT as master.
12. Monitor the transmissions from the DUT and link\_status.
13. Establish a valid link with the DUT and observe that the DUT sets link\_status=OK.
14. Stop transmitting to the DUT.
15. Observe that the DUT sets link\_status = FAIL after maxwait\_timer expires.
16. Configure the DUT as slave and repeat steps 12-15.

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**Observable Results:**

- a. The DUT should not set link\_status = OK in step 4.
- b. The DUT should not set link\_status = OK in step 5.
- c. The DUT should set link\_status = OK in step 9.
- d. The DUT should set link\_status = OK in step 10.
- e. The DUT should set link\_status = OK then link\_status = FAIL in step 15.
- f. The DUT should set link\_status = OK then link\_status = FAIL in step 16.

**Possible Problems:** This test cannot be completed if access to the link\_status signal is not available. Also, some devices may not allow configuration as master or slave, in which case only the supported configuration will be tested.

## **TEST SUITE APPENDICES**

**Overview:**

The appendices contained in this section are intended to provide additional low-level technical details pertinent to specific tests defined in this test suite. Test suite appendices often cover topics that are beyond the scope of the standard, but are specific to the methodologies used for performing the measurements covered in this test suite. This may also include details regarding a specific interpretation of the standard (for the purposes of this test suite), in cases where a specification may appear unclear or otherwise open to multiple interpretations.

**Scope:**

Test suite appendices are considered informative, and pertain only to tests contained in this test suite.

## Appendix 96.A – Test Stations

**Purpose:** To provide the requirements of the test stations used during 100BASE-T1 PHY Control testing.

**Discussion:**

Two test stations will be required to perform all tests that are specified in this document. The 100BASE-T1 Receive Test Station will examine the transmissions from the DUT, and the 100BASE-T1 Transmit Test Station will transmit the necessary test patterns to test the receiver of the DUT. It is possible to combine both stations into one setup.

The 100BASE-T1 Receive Test Station will consist of an oscilloscope and software to capture and decode the transmissions from the DUT. The DUT will connect to the test station through the Line Tap as specified in appendix 3.B. The software will download the capture from the oscilloscope and decode the ternary symbols, using knowledge of the 100BASE-T1 encoding, to create the MII data stream. The test setup is shown in Figure A - 1. Note that the MII test station is mandatory for some tests, while it can be replaced with higher layers or a loopback in some tests. Other solutions, such as an FPGA that can capture the ternary symbols, are possible however the test station must not modify or affect the transmissions from the DUT in any manner.

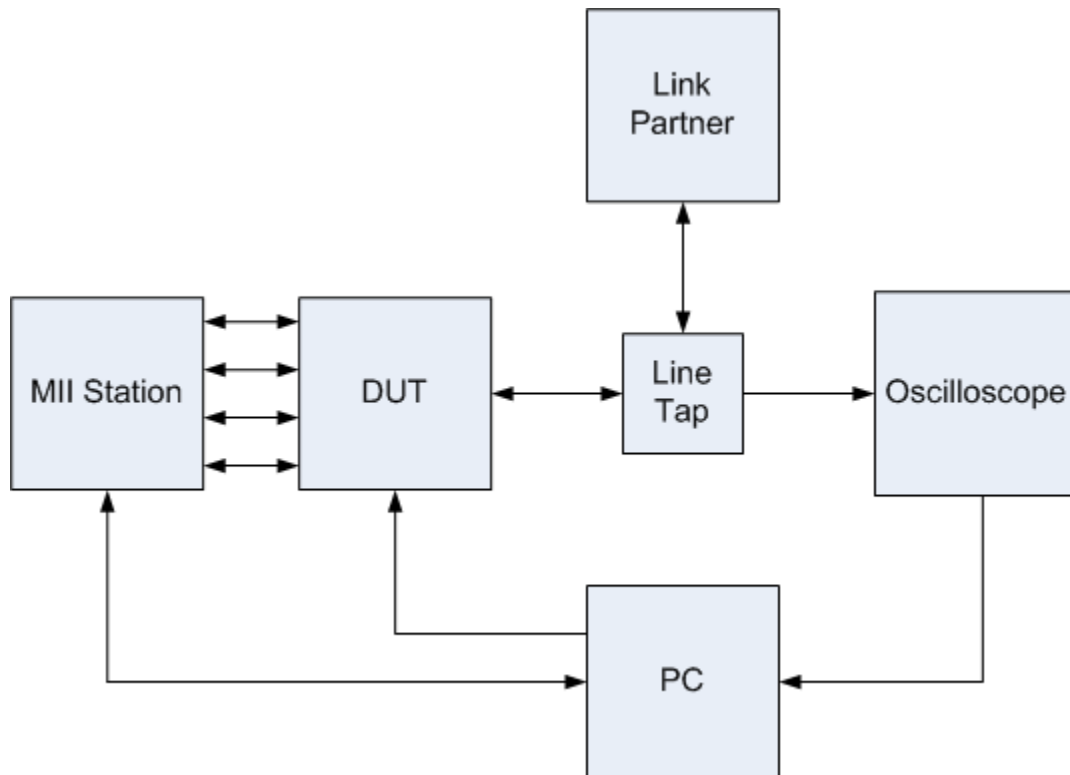
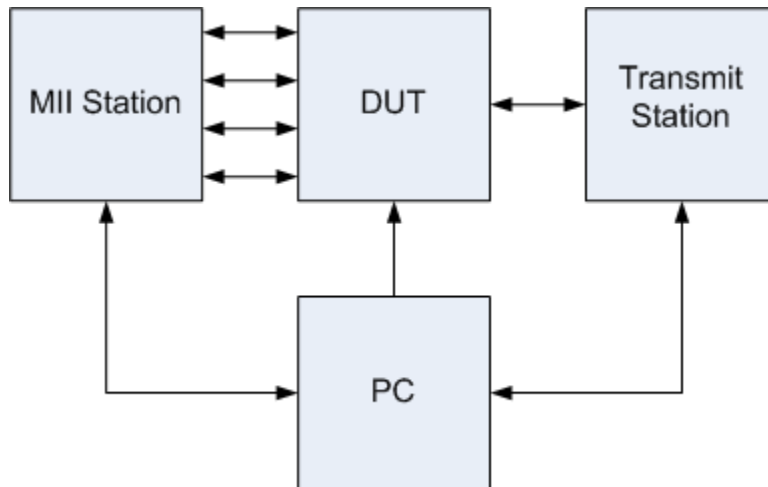


Figure A - 1: 100BASE-T1 Receive Station Setup

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The 100BASE-T1 Transmit Test Station will consist of software and hardware that is capable of transmitting arbitrary ternary symbols to the DUT. The ability to send arbitrary sequences, such as invalid transitions of the PCS Transmit State Machine, is essential to fully test the receiver of the DUT. The test setup is shown in Figure A - 2. Note that the MII test station is mandatory for some tests, while it can be replaced with higher layers or a loopback in some tests.



**Figure A - 2: 100BASE-T1 Transmit Station Setup**

## **Appendix 96.B – Line Tap**

**Purpose:** To provide the requirements of a line tap that will be used, in conjunction with an oscilloscope, to capture the transmissions from the DUT.

**Discussion:** For more information on the line tap used during 100BASE-T1 PHY Control testing, please contact the UNH-IOL.