# OPEN Alliance Automotive Ethernet ECU Test Specification Layer 1

TC8 ECU Test

| | |
|---|---|
| Author & Company | Thomas Kirchmeier (BMW AG)<br>Georg Janker (Ruetz System Solutions GmbH)<br>All Members of the OPEN ALLIANCE TC8 Working Group |
| Title | OPEN Alliance Automotive Ethernet ECU Test Specification Layer 1 |
| Version | 3.0 |
| Date | May 8, 2020 |
| Status | final |
| Restriction Level | public |

**Version Control of Document**

| Version | Author | Description | Date |
|---|---|---|---|
| 1.0 | TC8 members | First release | 15.01.2016 |
| 1.1 | T.Kirchmeier (BMW) | Improvments regarding IPv4 test cases, see change history | 31.05.2016 |
| 1.2 | T.Kirchmeier (BMW) | Improvments regarding UDP test cases, see change history | 29.06.2016 |
| 1.3 | T.Kirchmeier (BMW) | Improvments regarding ICMPv4 test cases, see change history | 07.09.2016 |
| 1.4 | Mathias Kleinwächter (Ruetz System Solutions GmbH) | Chapter 5.6 DHCPv4 Server deleted | 19.05.2017 |
| 1.4 | Mathias Kleinwächter (Ruetz System Solutions GmbH) | Improvements regarding TCP test cases, see change history | 23.05.2017 |
| 1.4 | Mathias Kleinwächter (Ruetz System Solutions GmbH) | Added chapters<br>6.1.4 Specification of the SOMEIP TestStub Enhanced Testability Service (ETS)<br>6.1.6 Test Cases ETS<br><br>Improvements regarding ARP test cases, see change history | 24.05.2017 |
| 1.4 | Georg Janker | Update of Layer 1 and Layer2 Chapters | 24.05.2017 |
| 1.5 | Georg Janker | Update of AUTOSAR References for SOME/IP to 1.1.0 | 30.05.2017 |
| 1.5 | Georg Janker | Inserted Chapter: 3.6 Referenced TC 11 Tests | 30.05.2017 |
| 1.6 | Martin Heinzinger (Ruetz System Solutions GmbH) | Removed Port Disabling test and referenced to the corresponding TC11 Test | 07.06.2017 |
| 1.7 | Mathias Kleinwächter (Ruetz System Solutions GmbH) | Deleted invalid or duplicate Test Cases. See change history | 20.06.2017 |
| 1.8 | Frederic Garraud | Update 1.3 References | 22.06.2017 |
| 1.9 | Martin Heinzinger (Ruetz System Solutions GmbH) | Updated change history for L2 Switching | 23.06.2017 |

| | | | |
|---|---|---|---|
| 2.0 | Mathias Kleinwächter (Ruetz System Solutions GmbH) | Release of final version 2.0 | 06.09.2017 |
| 3.0 | Mathias Kleinwächter (Ruetz System Solutions GmbH) | Initial version of separate Layer 1 document. | 25.10.2019 |

**Restriction level history of Document**

| Version | Restriction Level | Description | Date |
|---|---|---|---|
| 1 | OPEN Technical Members Only | Technical Members | 25.10.2019 |

# Contents

# Foreword (Disclaimer)

### OPEN Alliance: Members Only/OPEN Internal OPEN Specification

### OPEN Alliance CONFIDENTIAL

### Copyright Notice and Disclaimer

# Introduction

This ECU and Network Test Specification is designed to determine if a product conforms to specifications defined in OPEN Specifications or related requirements. This specification is a collection of all test cases which are recommend to be considered for automotive use and should be referred by car manufacturers within their quality control processes.
Sucessful execution and passing all relevant tests gives a Device Under Test (DUT) a mimimum approval that the device's basic implementiations are done correctly.

This Test specification document is grouped in several chapters oriented on the scopes: "Automotive Ethernet", "TCP/IP Protocol Family" and "Automotive Protocols" which are described in chapter 1.3.
Tests are organized and identified with distinct IDs that relate to their scopes, and a unique enumeration. For every scope introduction chapters explain common requirements on the Device under Test, the Test Setup and parameters used by the following tests.

# 1 Scope (mandatory)

Scope Automotive Ethernet includes the following ISO/OSI layers:

- Layer 1: Physical Layer OPEN Alliance BroadR-Reach (OABR)

# 2 Normative references (mandatory)

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[1] OA_100BASE-T1 Interoperability Test Suite 1v0

[2] IEEE Std 802.3bw™ – 2015 Amendment 1: Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable (100BASE-T1)..

[3] IEEE 100BASE-T1 Physical Media Attachment Test Suite Version 1.0

[4] IEEE 100BASE-T1 Definitions for Communication Channel, Version 1.0 .

[5] IEEE 100BASE-T1 EMC Test Specification for Transceivers Version 1v0

# 3 Terms and Definitions (mandatory)

No terms and definitions are listed in this document.

# 4 Change history between version 2 and 3

| Test case ID | Change reason | Version 2 | Version 3 |
|---|---|---|---|

# 5 Test Scope Layer 1 of Automotive Ethernet

## 5.1 Interoperability Tests

### 5.1.1 General

The following test specifications are adapted from [1] to fit the general requirements of an DUT.

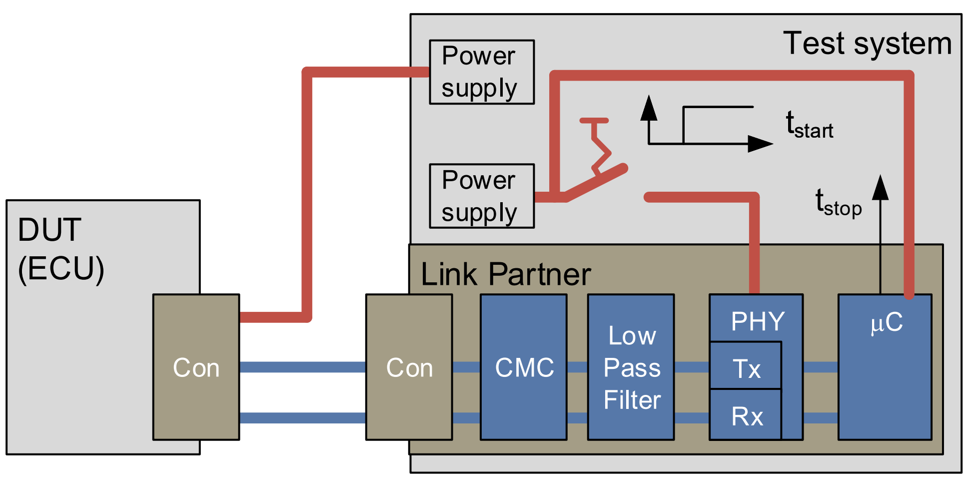
### 5.1.2 Link-up time

(based on 100BASET1_ IOP_21 and 100BASET1_ IOP_22 of [1])

3 test cycles:

- Power on Link Partner
- Power on DUT
- Wake up DUT

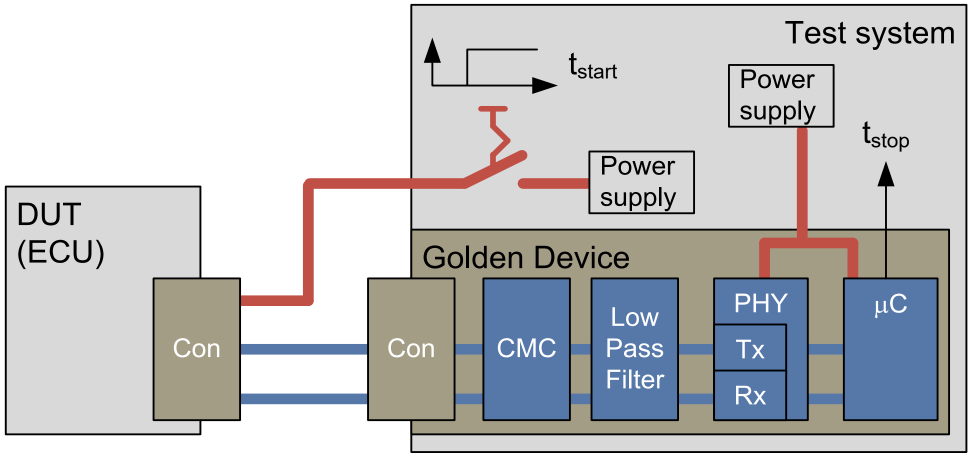
#### 5.1.2.1.1 OABR_LINKUP_01: Link-up time - Trigger: Power on Link Partner

<table>
<tr><td>Synopsis</td><td>Shall ensure that the link is established within a given time without a high time variation.</td></tr>
<tr><td>Prerequisites</td><td>1. The DUT is connected to a stable power supply.<br>2. The DUT must be operated in normal mode.<br>3. The Test System provides special awake conditions for the DUT such as a wakeup line or network management CAN messages if necessary.<br>4. If the DUT contains a switch all links have to be tested separately.<br>5. The mean start up time of the Link Partner is available: $\bar{t}_{ready}$</td></tr>
<tr><td>Test setup</td><td>The DUT must be connected to the Link Partner with opposite master/slave configuration. The polarity of the communication channel must be correct. The power supplies are controlled by the test system.<br>
</td></tr>
<tr><td>Test procedure</td><td>1. DUT shall be active and ready to build up link.<br>Repeat Step 2 to Step 5 n=100times:<br><br>2. Power on Link Partner. $t_{start}=t_{PowerOnLinkPartner}$</td></tr>
</table>

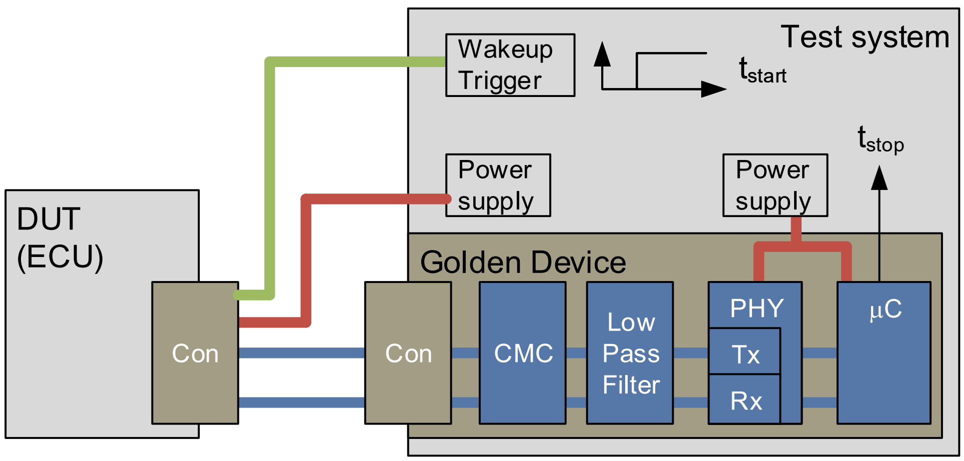
| | |
|---|---|
| | 3. Polling of Link Partner status register. If link_control= active link: $t_{stop}$=$t_{ActiveLink}$<br>4. Calculate the time $t_{up}$ between power on and link up: $t_{up}$= $t_{stop}$ - $t_{start}$<br>5. Power off Link Partner.<br>End of Repeat<br><br>6. Calculate as follows:<br>$$\bar{t} = \frac{1}{n}\sum_{i=1}^{n} t_{up}(i)$$<br>$$\sigma t = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(t_{up}(i) - \bar{t})^2}$$<br>$$\mathrm{t_{min}} = \min(t_{up}(i))$$<br>$$\mathrm{t_{max}} = \max(t_{up}(i))$$ |
| Pass criteria | $$\sigma t \leq 50\ \mathrm{ms}$$<br>$$\mathrm{t_{min}} > 10\ \mathrm{ms} + \bar{t}_{ready}$$<br>$$\mathrm{t_{max}} < 100\ \mathrm{ms} + \bar{t}_{ready}$$ |
| Notes | This test has to be performed for each port of the DUT, if it has a switch inside.<br><br>In dependency of the design of the link partner, the Test system may switch also the power supply of the µC together with the power supply of the PHY. |

#### 5.1.2.1.2 OABR_LINKUP_02: Link-up time - Trigger: Power on DUT

| | |
|---|---|
| Synopsis | Shall ensure that the link is established within a given time without a high time variation. |
| Prerequisites | 1. The Link Partner is connected to a stable power supply.<br>2. The Test System provides special awake conditions for the DUT such as a wakeup line or network management CAN messages if necessary.<br>3. The manufacturer has to provide the mean start up time of the DUT: $\bar{t}_{ready1}$ |
| Test setup | The DUT must be connected to the Link Partner with opposite master/slave configuration. The polarity of the communication channel must be correct. The power supplies are controlled by the test system. |

| | |
|---|---|
| |  |
| Test procedure | 1. Link Partner shall be active and ready to build up link.<br>Repeat Step 2 to Step 5 n=100times:<br><br>2. Power on DUT. $t_{start}=t_{PowerOnDUT}$<br>3. Polling of Link Partner status register. If link_control= active link: $t_{stop}=t_{ActiveLink}$<br>4. Calculate the time $t_{up}$ between power on and link up: $t_{up}= t_{stop} - t_{start}$<br>5. Power off DUT.<br>End of Repeat<br><br>6. Calculate as follows:<br>$$\bar{t} = \frac{1}{n}\sum_{i=1}^{n} t_{up}(i)$$<br>$$\sigma t = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(t_{up}(i) - \bar{t})^2}$$<br>$$\mathrm{t_{min}} = \min(t_{up}(i))$$<br>$$\mathrm{t_{max}} = \max(t_{up}(i))$$ |
| Pass criteria | $$\sigma t \leq 50\ \mathrm{ms}$$<br>$$\mathrm{t_{min}} > 10\ \mathrm{ms} + \bar{t}_{ready1}$$<br>$$\mathrm{t_{max}} < 100\ ms + \bar{t}_{ready1}$$ |
| Notes | This test has to be performed for each port of the DUT, if it has a switch inside. |

### 5.1.2.1.3 OABR_LINKUP_03: Link-up time - Trigger: Wake up DUT

| | |
|---|---|
| Synopsis | Shall ensure that the link is established within a given time without a high time variation. |
| Prerequisites | 1. The DUT and the Link Partner are connected to a stable power supply.<br>2. The DUT must be operated in normal mode.<br>3. Wake up message is necessary. The Test System provides special awake conditions for the DUT such as a wakeup line or network management CAN messages.<br>4. The manufacturer has to provide the value $I_{sleep}$.<br>5. The manufacturer has to provide the mean wake up time of the DUT: $\bar{t}_{ready2}$ |
| Test setup | The DUT must be connected to the Link Partner with opposite master/slave configuration. The polarity of the communication channel must be correct. The power supplies are controlled by the test system.<br> |
| Test procedure | 1. DUT shall be in sleep mode and Link Partner shall be active and ready to build up link.<br>Repeat Step 2 to Step 6 n=100times:<br><br>2. Turn on Wake up signal for DUT.<br>3. $t_{WakeUpDUT}$ if $I_{DUT} > I_{sleep}$ , $t_{start}=t_{WakeUpDUT}$<br>4. Polling of Link Partner status register. If link_control= active link: $t_{stop}=t_{ActiveLink}$<br>5. Calculate the time $t_{up}$ between wake up and link up: $t_{up}= t_{stop} - t_{start}$<br>6. Switch DUT to sleep mode.<br>End of Repeat<br><br>7. Calculate as follows:<br>$$\bar{t} = \frac{1}{n}\sum_{i=1}^{n} t_{up}(i)$$ |

| | |
|---|---|
| | $$\sigma t = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(t_{up}(i) - \bar{t})^2}$$ $$\mathrm{t_{min}} = \min(t_{up}(i))$$ $$\mathrm{t_{max}} = \max(t_{up}(i))$$ |
| Pass criteria | $$\sigma t \leq 50\ \mathrm{ms}$$ $$\mathrm{t_{min}} > 10\ \mathrm{ms} + \bar{t}_{ready2}$$ $$\mathrm{t_{max}} < 100\ ms + \bar{t}_{ready2}$$ |
| Notes | This test has to be performed for each port of the DUT, if it has a switch inside. |

### 5.1.3 Signal Quality

#### 5.1.3.1.1 OABR_SIGNAL_01: Indicated signal quality for channel with decreasing quality
(based on 100BASET1_ IOP_24a of [1])

| | |
|---|---|
| Synopsis | Shall ensure that the DUT's indicated signal quality decreases for a channel with decreasing channel quality and that there is coherence between the SQI indicated values on the DUT and the respective artificial noise injection. |
| Prerequisites | 1. The DUT and the Link Partner are connected to a stable power supply.<br>2. The DUT must be operated in normal mode.<br>3. The Test system allows varying and determining the quality of the communication channel that connects the DUT and Link Partner.<br>4. DUT must be able to monitor the signal quality indicated by the PHY. The information of the signal quality can be provided by an applicative message. To be able to obtain the DUT information of the signal quality with the respective applied channel degradation step, an additional communication channel like CAN should be available. |
| Test setup | See chapter 7.3 Artificial degradation of channel quality of [1]. |
| Test procedure | See Test procedure of 100BASET1_IOP_24a of [1] |
| Pass criteria | See Pass criteria of 100BASET1_ IOP_24a of [1] |
| Notes | This test has to be performed for each port of the DUT, if it has a switch inside. |

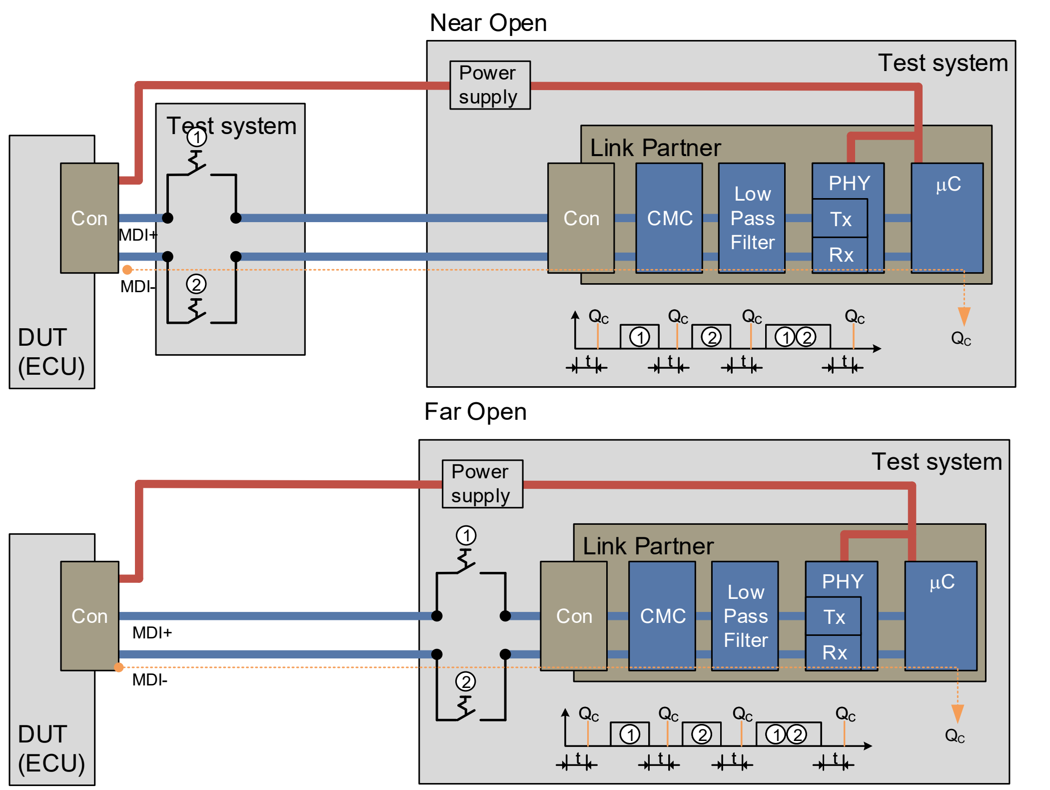
#### 5.1.3.1.2 OABR_SIGNAL_02: Indicated signal quality for channel with increasing quality
(based on 100BASET1_ IOP_24b of [1])

| | |
|---|---|
| Synopsis | Shall ensure that the DUT’s indicated signal quality increases for a channel with increasing channel quality and that there is coherence between the SQI indicated values on the DUT and the respective artificial noise injection. |
| Prerequisites | 1. The DUT and the Link Partner are connected to a stable power supply.<br>2. The DUT must be operated in normal mode.<br>3. The Test system allows varying and determining the quality of the communication channel that connects the DUT and Link Partner.<br>4. DUT must be able to monitor the signal quality indicated by the PHY. The information of the signal quality can be provided by an applicative message. To be able to obtain the DUT information of the signal quality with the respective applied channel degradation step, an additional communication channel like CAN should be available. |
| Test setup | See chapter 7.3 Artificial degradation of channel quality of [1]. |
| Test procedure | See Test procedure of 100BASET1_ IOP_24b of [1] |
| Pass criteria | See Pass criteria of 100BASET1_ IOP_24b of [1] |
| Notes | This test has to be performed for each port of the DUT, if it has a switch inside. |

### 5.1.4 Cable diagnostics

#### 5.1.4.1.1 OABR_CABLE_01: Cable diagnostics for near and far end open

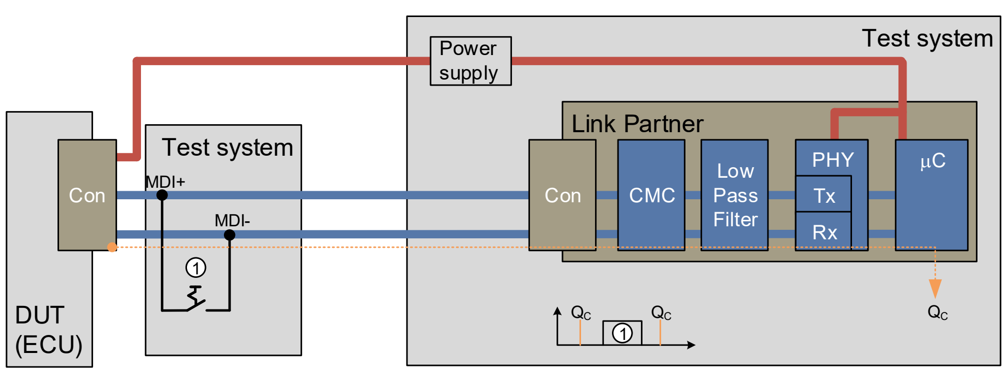
(based on 100BASET1_ IOP_32 of [1])

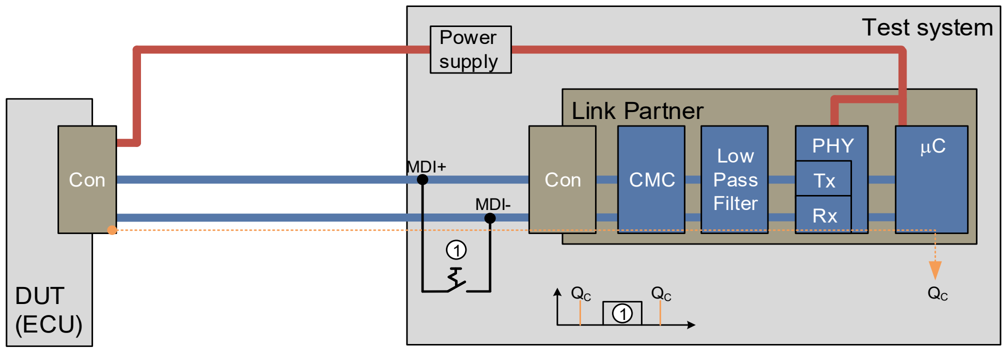
| | |
|---|---|
| Synopsis | Shall ensure that the DUT's cable diagnostic reliably detects an open of one or both of the bus lines. The test shall be performed for both a near end open at the connector of the DUT, and for a far end open at the connector of the Link Partner. |
| Prerequisites | 1. The channel should be terminated properly.<br>2. The DUT must be capable to start cable diagnostic of its PHY<br>3. The DUT must be able to detect any cable errors. This means the DUT has to provide the possibility to trigger the cable diagnostic feature. The result of the DUT's cable diagnostic can be provided by an applicative Ethernet message, an UDS communication or another communication channel like CAN. |
| Test setup |  |
| Test procedure | The following steps shall be applied to test near and far end open cable diagnostics<br><br>1. The DUT cable diagnostic feature is triggered. The DUT cable diagnostics has to be executed within $t_{error}$.<br>2. The test system creates acable error for a defined time $t_{error}$.<br>3. After the wait time t the test system reads out all identified cable errors $Q_C$ from the DUT. |

| | |
|---|---|
| | 4. Repeat step 1 to 3 for all error combinations (alternately MDI+ and/or MDI- are open). For additional information regarding the test instances, please refer to test instances Table of 100BASET1_IOP_32 of [1]. |
| Pass criteria | Each test iteration shall be classified as passed, if the DUT reports all expected cable errors. |
| Test iterations | 5 times. |
| Notes | For additional information regarding the near and far end open, please refer to Notes of 100BASET1_ IOP_32 of [1].<br><br>The results shall be reported for each 100BASE-T1 port available in the DUT. |

### 5.1.4.1.2 OABR_CABLE_02: Cable diagnostics for near and far end short

(based on 100BASET1_ IOP_33 of [1])

| | |
|---|---|
| Synopsis | Shall ensure that the DUT's cable diagnostic reliably detects a short of the bus lines. The test shall be performed for both a near end short at the connector of the DUT, and for a far end short at the connector of the Link Partner. |
| Prerequisites | 1. The channel should be terminated properly.<br>2. The DUT must be capable to start cable diagnostic of its PHY.<br>3. The DUT must be able to detect any cable errors. This means the DUT has to provide the possibility to trigger the cable diagnostic feature. The result of the DUT's cable diagnostic can be provided by an applicative Ethernet message, an UDS communication or another communication channel like CAN. |
| Test setup | Near Short<br> |

| | |
|---|---|
| | Far Short<br><br><br>DUT is connected to a properly terminated link partner. The bus wires are connected via a <= 1 Ohm resistor during following error situations:<br>• SHORT between both bus wires, far and near end.<br>• SHORT of both conductors to ground (GND) , far and near end.<br>• SHORT of both conductors to supply line (VBAT) , far and near end.<br><br>Please note that in the figures above there is presented only the 1st error situation (SHORT between both bus wires, far and near end). The 2nd and 3rd error situation, where the two wires MDI+ and MDI- are additionally connected to GND resp. VBAT, are not presented here. |
| Test procedure | The following steps shall be applied to test near and far end short cable diagnostics<br>1. The DUT cable diagnostic feature is triggered. The DUT cable diagnostics has to be executed within $t_{error}$.<br>2. The test system creates a cable error for a defined time $t_{error}$.<br>3. After the wait time t the test system requests all identified cable errors $Q_C$ from the DUT.<br>4. Repeat step 1 to 3 for all error combinations. For additional information regarding the test instances, please refer to test instances Table of 100BASET1_IOP_33 of [1]. |
| Pass criteria | Each test iteration shall be classified as passed, if the DUT reports all expected cable errors. |
| Test iterations | 5 times. |
| Notes | For additional information regarding the near and far end short, please refer to Notes of 100BASET1_ IOP_33 of [1] .<br><br>The results shall be reported for each 100BASE-T1 port available in the DUT. |

## 5.2 PMA

### 5.2.1 General

This chapter shall be used for evaluation of the Physical Layer of a 100BASE-T1 interface on DUT level. Except otherwise stated the measurements shall be conducted by room temperature (RT=23°C±5°C).

The tests shall be carried out based on the definitions of the related test specifications [2], [3], [5].

In the Synopsis the test Classification indicates if the test must be done or not in term of qualification.

Mandatory: the test is required and must be evaluated according to the specified pass/fail criterium.

Optional : the test could be executed but not required for an official qualification pass/fail criterium. Underground of the optional test is that PHY that already passed the whole test of the TC1 or parameters doubled checked do not need to be retested.

### 5.2.2 Transmitter Electrical Specifications

The following test cases specify the Requirements of the Transmitter Side (measurement point: MDI).

##### *5.2.2.1.1* OABR_PMA_TX_01: Check the Transmitter outpout droop

| | |
|---|---|
| Synopsis | Verification of the transmitter output droop.<br><br>The test case shall be executed according to the definitions in [3], Test 5.1.1.<br><br>**Test Classification: Optional** |
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into Test Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Test Mode 1. |
| Test setup | according to [3], Test 5.1.1 |
| Test procedure | according to [3], Test 5.1.1 |
| Pass criteria | according to [3], Test 5.1.1 |
| Test iterations | Accumulate min. 10 Samples to increase the Accuracy |
| Notes | The test shall be executed for each port of the DUT if it has a switch inside. |

##### *5.2.2.1.2* OABR_PMA_TX_02: Check the Transmitter Timing Jitter in MASTER Mode

| | |
|---|---|
| Synopsis | Verification of the transmitter timing jitter in MASTER mode<br><br>The test case shall be executed according to the definitions in [3], Test 5.1.3, Case 1 |

| | **Test Classification: Mandatory** |
|---|---|
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into Test Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Test Mode 2. |
| Test setup | according to [3], Test 5.1.3, Case 1 |
| Test procedure | according to [3], Test 5.1.3, Case 1 |
| Pass criteria | according to [3], Test 5.1.3, Case 1 |
| Test iterations | Accumulate min. 10 Samples to increase the Accuracy |
| Notes | The test shall be executed for each port of the DUT if it has a switch inside. |

#### 5.2.2.1.3 OABR_PMA_TX_03: Check the Transmit Clock Frequency

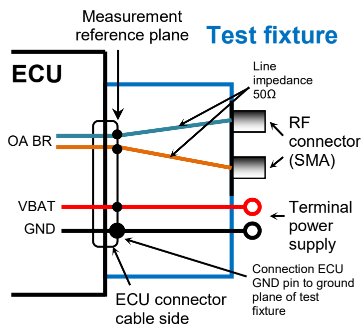
| | |
|---|---|
| Synopsis | Verification of the transmit clock frequency.<br><br>The test case shall be executed according to the definitions in [3], Test 5.1.5<br><br>**Test Classification: Mandatory** |
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into Test Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Test Mode 2. |
| Test setup | according to [3], Test 5.1.5 |
| Test procedure | according to [3], Test 5.1.5 |
| Pass criteria | according to [3], Test 5.1.5 |
| Test iterations | This test shall be conducted at all corner temperatures of the DUT<br>(e.g. -40°C/RT/105°C). Accumulate min. 10 Samples to increase the Accuracy. |
| Notes | As the test is realized on three corner temperatures use a test cable that does not influence the test result .<br><br>The test shall be executed for each port of the DUT if it has a switch inside.<br><br>The corner temperatures of the DUT for the test have to be provided by the DUT manufacturer. |

#### *5.2.2.1.4* OABR_PMA_TX_04: Check the Transmitter Power Spectral Density (PSD)

| | |
|---|---|
| Synopsis | Verification of the transmitter power spectral density.<br><br>The test case shall be executed according to the definitions in [3], Test 5.1.4<br><br>**Test Classification: Optional** |
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into Test Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Test Mode 5. |
| Test setup | according to [3], Test 5.1.4 |
| Test procedure | according to [3], Test 5.1.4 |
| Pass criteria | according to [3], Test 5.1.4 |
| Test iterations | If performing the test with a DSO, the averaging function of the scope shall be set at least to 50 times |
| Notes | The test shall be executed for each port of the DUT if it has a switch inside. |

#### 5.2.2.1.5 OABR_PMA_TX_05: Check MDI return Loss

The test case definition is based on chapter 96.8.2.1 MDI Return Loss of [2], Test 5.1.6 of [3] and the definitions in [4].

| | |
|---|---|
| Synopsis | Shall ensure that the DUT respects the limits for the Return Loss.<br><br>**Test Classification: Mandatory** |
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into SLAVE Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Slave Mode operation. |
| Test setup | The measurement of the Return Loss shall be carried out with a Network Analyzer.<br><br><br><br><br>To achieve a high degree of reliability of measurement results the use of a specific test fixture for the connection to the DUT connector MDI pins is required. A test fixture according to the diagram above and in line with definitions of [4] shall be used. The ground pin(s) of the DUT shall be directly connected to the ground plane of the test fixture. If possible the original harness connector shall be used. It shall be a fixed part of the test fixture. The calibration reference plane is defined at the beginning of the harness connector on the test fixture. The following VNA settings shall be used for the measurement:<br><br>**Parameter** / **Value**<br>Sweep $f_{Start}$ / 300 kHz<br>Sweep $f_{Stop}$ / 1 GHz<br>Sweep type / Logarithmic<br>Sweep points / 1600<br>Output power / minimum -10 dBm<br>Measurement bandwidth / 100 Hz<br>Logic Port Impedance Differential Mode / 100 Ω<br>Logic Port Impedance Common Mode / 25 Ω<br>Data calibration kit (VNA) / used kit for calibration<br>Averaging function / 16 times<br>Smoothing function / deactivated |

| | |
|---|---|
| Test procedure | 1. The DUT PHY is in SLAVE mode operation.<br>2. Use a test fixture as described in the test setup.<br>3. Connect the MDI via the test fixture to the Network Analyzer.<br>4. Measure the Value Return Loss ($S_{dd11}$)<br>5. Analyze the waveform.<br>6. Report the result with a resolution that shows: no limit Violation was detected. |
| Pass criteria | The test shall be classified as passed, if the value of the MDI Return Loss ($S_{dd11}$) fulfills the limit defined in chapter 96.8.2.1 MDI Return Loss of [2]. |
| Test iterations | Single VNA measurement with enabled averaging function set to at least 16 times. |
| Notes | The test shall be executed for each port of the DUT if it has a switch inside. |

##### 5.2.2.1.6 OABR_PMA_TX_06: Check MDI Mode conversion

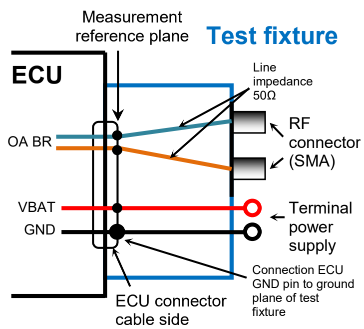
The test case definition is based on chapter 96.8.2.2 MDI mode conversion loss of [2], Test 5.1.7 of [3] and the definitions in [4].

| | |
|---|---|
| Synopsis | Shall ensure that the DUT respects the limits for the Mode conversion. Shall ensure that the DUT front end respects the appropriate symmetry requirements.<br><br>**Test Classification: Mandatory** |

| | |
|---|---|
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into SLAVE Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Slave Mode operation. |

**Test setup**

The measurement of the Mode Conversion shall be carried out with a Network Analyzer.

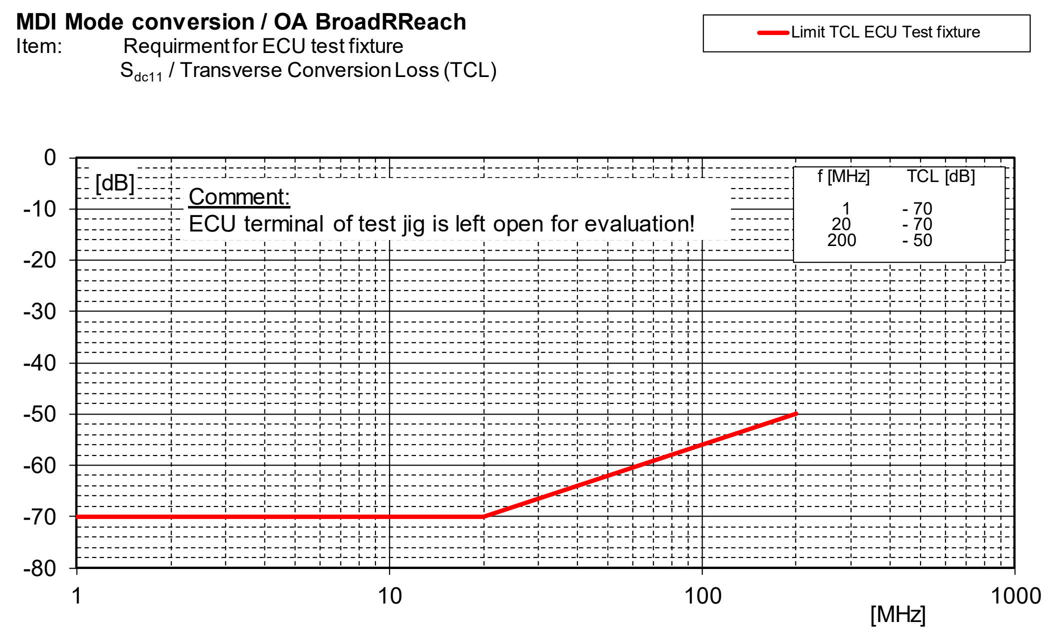


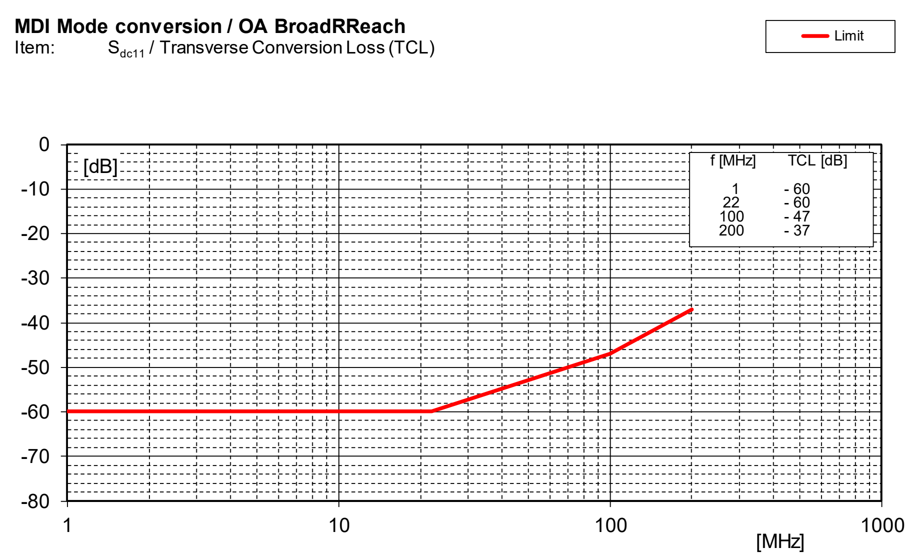

To achieve a high degree of reliability of measurement results the use of a specific test fixture for the connection to the DUT connector MDI pins is required. A test fixture according to the diagram above and in line with definitions of [4] shall be used. The ground pin(s) of the DUT shall be directly connected to the ground plane of the test fixture. If possible the original harness connector shall be used. It shall be a fixed part of the test fixture. The calibration reference plane is defined at the beginning of the harness connector on the test fixture. Additionally the used test fixture shall fulfill the limit for fixture self-conversion given below while the test fixture is not connected to the DUT (terminal left open).

The following VNA settings shall should be used for the measurement:

| **Parameter** | **Value** |
|---|---|
| Sweep $f_{Start}$ | 300 kHz |
| Sweep $f_{Stop}$ | 1 GHz |
| Sweep type | Logarithmic |
| Sweep points | 1600 |
| Output power | minimum -10 dBm |
| Measurement bandwidth | 100 Hz |
| Logic Port Impedance Differential Mode | 100 Ω |
| Logic Port Impedance Common Mode | 25 Ω |
| Data calibration kit (VNA) | used kit for calibration |
| Averaging function | 16 times |
| Smoothing function | deactivated |

**Limit for test fixture self-conversion**

<table>
<tr>
<td></td>
<td>


</td>
</tr>
<tr>
<td>Test procedure</td>
<td>
1. The DUT PHY is in SLAVE mode operation.<br>
2. Use a test fixture as described in the test setup.<br>
3. Connect the MDI via the test fixture to the Network Analyzer.<br>
4. Measure the Value Mode Conversion ($S_{dc11}$)<br>
5. Analyze the waveform.<br>
6. Report the result with a resolution that shows: no limit Violation was detected.
</td>
</tr>
<tr>
<td>Pass criteria</td>
<td>
For evaluation of MDI mode conversion measurements in the frequency range of 1 MHz to 1 GHz are required. The following limit shall be fulfilled.


</td>
</tr>
<tr>
<td>Test iterations</td>
<td>Single VNA measurement with enabled averaging function set to at least 16 times.</td>
</tr>
</table>

| | |
|---|---|
| Notes | The test shall be executed for each port of the DUT if it has a switch inside. |

### 5.2.2.1.7 OABR_PMA_TX_07: Check MDI Common Mode emission

The test case shall be executed according to the definitions in [5], Appendix D – (informative) Test method for measuring of MDI RF common mode emission of ECUs

| | |
|---|---|
| Synopsis | Measurement of the RF common mode emission at the DUT MDI.<br><br>**Test Classification: Optional** |
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into Test Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Test Mode 5. |
| Test setup | according to [5], Appendix D |
| Test procedure | according to [5], Appendix D |
| Pass criteria | The test shall be classified as passed, if the value of the MDI common mode emission fulfills the limit defined in [5], Figure D-2 |
| Test iterations | according to [5], Appendix D (see Table D1 Numbers of pass) |
| Notes | The test shall be executedexecuted for each port of the DUT if it has a switch inside.<br><br>The common mode emission is measured in a frequency range according to the definitions in [5], Appendix D – (informative) **Table D-1: Settings for measurement device for RF common mode emission measurement at MDI** . The absolute pass criteria is |

| | |
|---|---|
| | specified in the **Figure D-2: Recommended limit for MDI RF common mode emission**. In case of violations of the limit for frequencies greater than 70Mhz a warning issue or a comment shall be added in the test report. |

#### 5.2.2.1.8 OABR_PMA_TX_08: Check the Transmitter Distortion

| | |
|---|---|
| Synopsis | Verification of the transmitter distortion.<br><br>The test case shall be executed according to the definitions in [3], Test 5.1.2<br><br>**Test Classification: Optional** |
| Prerequisites | 1. The DUT is connected to a stable power supply.<br>2. Use Link Partner or an interface to set the DUT's PHY into Test Mode operation (via 100BASE-T1, Standard Ethernet, CAN, FlexRay e.g.)<br>3. DUT must be able to set its PHY into Test Mode 4. |
| Test setup | according to [3], Test 5.1.2 |
| Test procedure | according to [3], Test 5.1.2 |
| Pass criteria | according to [3], Test 5.1.2 |
| Test iterations | 10 times |
| Notes | The execution of this test is optional and not mandatory for the Compliance test.<br><br>In Case of DUT test the TX_TCLK (66.7Mhz) is not accessible. Therefore, it is necessary to recover the TX_TCLK form the signal Itself. See Appendix 1AInstead of a 100 Ω differential voltage generator, the test case may be executed also with a single-ended voltage generator and a balun. |

### 5.2.3 Appendix 1A Transmitter Distortion Test.

Transmitter Distortion test can be executed without TX_TCLK.

This part will give an overview of the test setup without TX_TCLK access, with disturber.

- The DUT is set in test mode 4 and the disturber signal of 5.4Vpp 11.111Mhz sine wave is injected on the DUT Transmitter.
- The main idea is to recover the TX_TCLK clock from the test mode 4 signal and apply the recovered timing to determine the right samples needed for [3],Test 5.1.2.

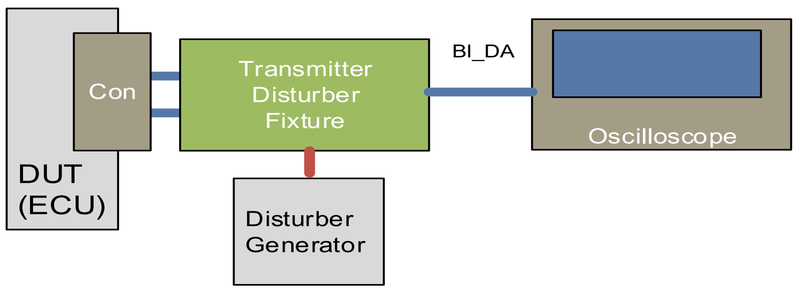



Figure 1 Transmitter Distortion Test