# 1000BASE-T1 Interoperability Test Suite

## Interoperability Test Suite Specification


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|---|---|
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1000BASE-T1 Interoperability Test Suite. This document aims to be a guide to implement and carry out the necessary procedures to test the grade of interoperability between devices with 1000BASET1 capabilities.

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# 2 Introduction

## 2.1 Overview

The goal of this document is to define a set of tests that on one hand ensure interoperability between multiple devices that use 1000BASE-T1 capable PHYs. In particular, this requires each PHY to be able to establish a stable link within a given time limit, to be able to reliably monitor and signal the current link status to an upper layer and to be able to transmit data with an upper bit error rate limit.

Being in line with [9], following options are not considered within the framework of this specification:

- Communication systems using Power over data line (PoDL) or system implementation using STP cables.
- Energy efficiency functionalities of 1000BASE-T1 PHYs.
- Topics related with transmission speed change from 1Gb/s to 100Mb/s or vice versa are out of the scope of this document. If Auto-Negotiation is supported by the DUT, this option must be disabled.

Furthermore, on the other hand, this document addresses a set of test cases that verify the reliability of important supported features of an automotive Ethernet PHY (often also called transceiver), e.g. for diagnostic purposes for automotive Ethernet PHY's. In particular, signal quality index (SQI) and harness defects detection.

This document shall provide all the necessary technical aspects and detail descriptions in order to guarantee that the same outcome from test cases will be obtained even when running the test suite in different test systems, provided that the particular test suite and the test system are compliant to the content of this document.

**Note: The tests do not solely cover the respective PHYs, but also take into account PHY configuration and an external filter, if applicable. The results of the Interoperability Test Suite will not only depend on the PHY, but also on the general configuration of implementation under test; the Link Partner, the chokes and the communication channel conditions.**

## 2.2 Normative References


[1] IEEE P802.3bp™: Physical Layer Specifications and Management Parameters for 1 Gb/s Operation over a Single Twisted Pair Copper Cable

[2] IEEE P802.3bw™ Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable (100BASE-T1)

[3] IEEE P802.3-2015 IEEE Standard for Ethernet

[4] OPEN ALLIANCE: 1000BASE-T1 PHY Control Test Suite – Revision 1.0

[5] OPEN ALLIANCE: 1000BASE-T1 Physical Media Attachment Test Suite – Revision 1.3

[6] OPEN ALLIANCE: 1000BASE-T1 Physical Coding Sublayer Test Suite – Revision 1.0

[7] OPEN ALLIANCE: 1000BASE-T1 EMC Measurement Specification for Transceivers – Revision 2.1

[8] OPEN ALLIANCE: 1000BASE-T1 EMC Test Specification for Common Mode Chokes – Revision 2.0

[9] OPEN ALLIANCE: 1000BASE-T1 System Implementation Specification – Revision 1.6

[10] OPEN ALLIANCE: Advanced diagnostic features for 1000BASE-T1 automotive Ethernet PHYs – Revision 2.2

[11] OPEN ALLIANCE: Sleep/Wake-up Specification – Revision 1.0

[12] OPEN ALLIANCE: Channel and Components Requirements for 1000BASE-T1 Link Segment Type A (UTP) – Revision 2.3

## 2.3 Abbreviations and definitions

*ID:* 1000BASET1_L1_IOP_1

Type: Information

| Abbreviation | Glossary term | Glossary definition |
|---|---|---|
| CRC | Cyclic Redundancy Check | |
| ISO/OSI | | Layer model of communication systems |
| MAC | Media Access Control | Abbreviation for the sub layer of the data link layer (layer 2) of the OSI model or for the physical device that implements the Media Access Control functions. |
| MDI | Media dependent interface | |
| PHY | Physical Layer | Abbreviation for the physical layer (layer 1) of the OSI model or for the device that implements layer 1 of the OSI model. |
| DUT | Device under test | Combination of PHY, PHY configuration and filter that is being tested. |
| LP | Link partner | see list of definitions (1000BASET1_L1_IOP_2). |
| ETH_N | | Negative MDI pin or cable connected to a PHY's negative MDI pin. |
| ETH_P | | Positive MDI pin or cable connected to a PHY's positive MDI pin. |
| SQI | Signal quality indicator | The PHY's estimated signal quality of the channel or a comparable value from which a quality indicator for the communication channel can be derived. |
| CIDM | Characteristic Impedance Differential Mode | |
| IL | Insertion Loss | |
| RL | Return Loss | |
| OAM | Operations, Administration and Management | As defined in IEEE 802.3bp [1] |

| Abbreviation | Glossary term | Glossary definition |
|---|---|---|
| t0 | Timer | A timer which counts upwards from zero for measuring elapsed time.<br>In test case IOP_19, the timer t0 is incremented until the DUT's PHY indicated link status changes from link-up to link-drop.<br>In test cases IOP_20 and IOP_21, the timer t0 is incremented until the DUT's PHY indicates an active link |

Table 1: List of Abbreviations.

*ID:* 1000BASET1_L1_IOP_2

*Type:* Information

| Glossary term | Glossary definition |
|---|---|
| MAY | This word or the adjective "OPTIONAL", mean that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same way an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.) |
| MUST | This word, or the terms "REQUIRED" or "SHALL", mean that the definition is an absolute requirement of the specification. |
| MUST NOT | This phrase or the phrase "SHALL NOT", mean that the definition is an absolute prohibition of the specification. |
| SHOULD | This word, or the adjective "RECOMMENDED", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course. |
| SHOULD NOT | This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label. |
| Link status | The link state that is indicated via a PHY's status registers. The link state can be a combination of various PHY status bits. |
| Link partner | Device that is connected to a Device under Test to perform the interoperability tests. A link partner must use a well-known PHY, PHY configuration and external PHY filter (if necessary). |
| External PHY filter or external filter. | Additional circuit that is connected directly to the PHY and filters the in- and outgoing physical layer signaling. The PHY vendor typically provides a reference filter design. |

| Glossary term | Glossary definition |
|---|---|
| PHY configuration | Variable settings that affect the PHY's behavior (e.g., sensitivity of internal equalizers, or shaping of outgoing physical layer signaling). The PHY configuration could be set by an upper layer (e.g., by software) or could be hardcoded, e.g., via dedicated PHY configuration pins. |
| Test case | Description of one or more test steps and a set of conditions that define whether the observed behavior when executing the test steps matches the expected results. |
| Test iteration | The execution of all test steps of a given test case. |
| Test instance | A test instance defines different test parameters for a given test case, such as the DUT's PHY MASTER/SLAVE configuration, or used cable to connect the link partner. The test case itself is not altered. |
| Soft reset | Reset of a PHY by software, usually triggered by writing to a control register. |
| Hard reset | Reset of a PHY via a dedicated reset-pin, or by toggling the PHYs power supply. |
| Channel | Synonym for physical layer communication channel (see [4]). |

Table 2: List of Definitions.

## 2.4 Organization of Tests

In this chapter the main structure of the test cases as well as the elementary test cases structure will be introduced.

### 2.4.1 Elementary test structure

The main structure description of a test case is shown in Table 3. A brief description about the meaning of each field is provided.

| | |
|---|---|
| **Synopsis** | A short description of the purpose of the test case is given here. |
| **Prerequisites** | A list of requirements and capabilities needed for a proper test conduction |
| **Test Setup** | The respective test environment setup is specified (e. g. if different test case sequences will require different test system configuration) |
| **Test procedure** | The first note here describes the total sum of test case executions due to setup variations to give the test implementer a first impression of the specific test case.<br><br>As the second part of the test case execution, the test steps are described dealing with the setup being applied and what is observed and measured at each execution etc.<br><br>All actions of the test environment shall be described explicitly in this item. |
| **Pass criteria** | In this response cell, a description is given about what is expected as the result.<br><br>The Pass criteria are also specified in this point. |
| **Test iterations** | Amount of test repetitions. See Appendix - 7.1 Suggested Iterations |
| **Notes** | When necessary a note will be added complementing the information of the test case. |

**Table 3 - Main test structure**

### 2.4.2 Test case instances structure

Together with the test definition and all its parameters, the test case instances will also be defined that are part of each test case.

A test case instance can be defined as a repetition of the same test case modifying certain configurations of the DUT and the test environment without losing focus on the test purpose.

| Instance Test Case # | | Parameter 1 | Parameter 2 | Parameter 3 | … | Parameter N |
|---|---|---|---|---|---|---|
| | **Parameter A** | 1000BASET1_ IOP_X | | | … | |
| | **Parameter B** | | 1000BASET1_ IOP_Y | | … | |
| … | … | … | … | … | … | … |
| | **Parameter Z** | | | 1000BASET1_ IOP_Z | … | |

**Table 4 - Test case instances definition**

An example definition of a test case is shown in Table 5. In this case, first the behavior of the DUT will be tested when acting as a MASTER with the conditions established by the corresponding test case. Next, the test will be performed with the DUT acting as a SLAVE.

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| X.X.X.# | **DUT as MASTER** | 1000BASET1_ IOP_XX_SR_M_S | |
| X.X.X.# | **DUT as SLAVE** | | 1000BASET1_ IOP_XX_SR_S_M |

**Table 5 - Example of test case instances**

# 3 Layer 1 Interoperability

## 3.1 General Requirements

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*ID:* 1000BASET1_L1_IOP_3

*Type:* Information

A Device under Test (DUT) consists of the PHY (identified by its manufacturer, model and revision number), the external filter (if required by the PHY vendor) and PHY configuration.

---

*ID:* 1000BASET1_L1_IOP_4

*Type:* Requirement

The PCB layout of the DUT shall adhere to PHY vendor’s reference design. In particular, this includes schematic and specific parts installed, power supply, power decoupling and interface between the PHY and microcontroller.

---

*ID:* 1000BASET1_L1_IOP_5

*Type:* Requirement

The PHY configuration and software interface used for the IOP tests shall adhere to the specification of the PHY vendor. This requires the PHY vendor to define which registers shall be used, e.g., to evaluate the PHY’s link status or estimated signal quality.

Only if PHY is configured according to available datasheet and application notes a "PASS" shall be noted (and the used versions shall be documented). If further register changes are made, a "PASS with REMARK" shall be noted, including the description of what is changed in the registers.

---

*ID:* 1000BASET1_L1_IOP_6

*Type:* Requirement

All monitoring activities (e.g. register readout for active link) shall be done by an interrupt or periodic polling. To ensure valid results, the polling period must be chosen according to the timing requirements of the test case (e.g., much lower than the timing requirement).

---

*ID:* 1000BASET1_L1_IOP_7

*Type:* Requirement

For all Layer 1 Interoperability test cases defined in chapter 3, the DUT shall be tested against a defined set of link partners, unless explicitly defined otherwise in the test case description. A link partner is defined by the same requirements that apply to the DUT. If multiple qualified link partners are available, the test against multiple link partners is mandatory

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*ID:* 1000BASET1_L1_IOP_8

*Type: Requirement*

For all PHY feature set tests defined in chapter 5, the DUT must be tested against a known link partner. The link partner is defined by the same requirements that apply to the DUT. The link partner configuration must be included in the test results. Tests against additional link partners are optional.

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*ID:* 1000BASET1_L1_IOP_9

*Type:* Requirement

For each test case, the test results shall be documented individually for each combination of DUT and link partner, for each variation point and for each test instance.

---

*ID:* 1000BASET1_L1_IOP_10

*Type:* Information

The tests do not necessarily aim at qualifying a single DUT, but the combination of DUT and link partner. This also means that if a test fails, not the DUT's PHY, but the combination of DUT and link partner is faulty. Other DUT/link partner combinations might be free from defects and may qualify.

---

*ID:* 1000BASET1_L1_IOP_11

*Type:* Requirement

A link-up condition is defined in terms of the following bits:

- Local receiver status (LRS);
- Remote receiver status (RRS);
- Link status bit (LS)

And the PHY status

- PHY_Status (send_data, send_idle,…) - PCS Status of IEEE 802.3 Fig 40-16a

- Link-up-> (LRS==1 AND RRS==1 AND LS==1) AND  PHY_Status==send_data

---

*ID:* 1000BASET1_L1_IOP_12

*Type:* Requirement

A link down condition is defined in terms of the following bits:

- Local receiver status (LRS);
- Remote receiver status (RRS);
- Link status bit (LS)

Link down-> (LRS==0 or RRS==0 or LS==0)

---

*ID:* 1000BASET1_L1_IOP_13

*Type:* Requirement

Auto-Negotiation option must be disabled, if it is supported by the DUT, during the conduction of all test cases defined in this specification.

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## 3.2 Test coverage / variation points

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*ID*: 1000BASET1_L1_IOP_14

*Type*: Requirement

The tests shall be performed with channels types as defined in section 3.3.

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*ID*: 1000BASET1_L1_IOP_15

*Type*: Requirement

The tests shall be performed at an ambient temperature of - 40°C, at room temperature and at an ambient temperature of either + 105° C or + 125° C, according to the maximum ambient operating temperature specified in the DUT datasheet.

---

*ID*: 1000BASET1_L1_IOP_16

*Type*: Requirement

A test instance of a test case shall be considered as passed, if no test iteration failed. The number of suggested test iterations is defined in chapter 7.1 .

## 3.3 Channels definition

This definition shall be used for defining a test wiring harness that simulates various communication channels according to the channel definitions of IEEE Std. 802.3bp [1] for interoperability tests of 1000BASE-T1 transceivers.

### 3.3.1 Channel Type A.1

*ID*: 1000BASET1_L1_IOP_17

*Type*: Requirement

The parameters of the type A.1 channel are derived from the limit definition for a communication channel according to [1] and [12]. For setting up a real test harness upper and lower limits are added for each parameter. The type A.1 channel implementation shall fulfill these limits at (23±2)°C ambient temperature (RT = Room Temperature).

**NOTE**: For cable type reference, *within the body* of this document: “Type A.1” cable refers to automotive grade unshielded twisted pair (UTP) cable, with jacketing considered as a requirement for 1000BASE-T1 Ethernet.

The parameter and limits are defined in section 8.2 of [9].

### 3.3.2 Channel Type A.2

*ID*: 1000BASET1_L1_IOP_18

*Type*: Requirement

The Type A.2 channel is derived from a **5m** link segment scaled from the type A.1 cable.

The parameter and limits are defined in section 8.3 of [9].

### 3.3.3 Channel Type A.3

*ID*: 1000BASET1_L1_IOP_19

*Type*: Requirement

The Type A.3 channel is derived from a **1.5m** link segment scaled from the type A.1 cable.

The parameter and limits are defined in section 8.4 of [9].

## 3.4 Multiple Link Partners

This section describes a concept to adopt multiple link partners, increasing the coverage in terms of diversity of interoperability in the ecosystem without necessarily increasing the test periods and efforts.

---

*ID:* 1000BASET1_L1_IOP_20

*Type:* Requirement

Each device having passed the tests listed below could be considered as potential link partner candidate

a) Conformance Tests
   1. OA- PHY Control Test Suite
   2. OA- Physical Media Attachment Test Suite
   3. OA- Physical Coding Sub-layer Test Suite

b) Interoperability Tests
   1. OA- Interoperability Test Suite - At least all test cases in groups #1 and # 2; disregarding the *PHY features set tests* chapter (SQI + Diagnostic)

---

*ID:* 1000BASET1_L1_IOP_21

*Type:* Requirement

The respective silicon vendors should provide enough samples to be placed in the test system as link partners

---

*ID:* 1000BASET1_L1_IOP_22

*Type:* Requirement

Following information will be logged during the test execution with a resolution of up to 1ms between each signal change:

- *Link-up*
- *loc_rcvr_status*
- *rem_rcvr_status*
- *PCS Status of IEEE 802.3 (Fig 40-16a)*

This information shall be available with no restrictions from LP and DUT side in order to provide additional information when a failure is observed.

*ID:* 1000BASET1_L1_IOP_23

*Type:* Requirement

The respective silicon vendors must commit to provide support if interoperability issues are identified and the root cause is unclear for their part to be considered as a link partner for this testing.

---

*ID:* 1000BASET1_L1_IOP_24

*Type:* Requirement

A matrix with all LP combination shall be added at the beginning of the report document with a Pass / Fail for each combinations.

---

# 4 Interoperability Test Cases

*ID:* 1000BASET1_L1_IOP_25

Type: Requirement

The test cases defined in this section are mandatory for all 1000BASE-T1 PHYs.

## 4.1 Group 1, Link status

*ID:* 1000BASET1_L1_IOP_26

*Type:* Information

The test cases defined in this section shall ensure that the PHY signals the correct link state to upper layers. In particular, a PHY must not signal an active link when no data can be transmitted.

### 4.1.1 Reliability of indicated link status directly after link-up / PHY reset

*ID:* 1000BASET1_IOP_16

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the data can be transmitted as soon as the PHY signals an active link. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHY.<br>2. DUT must be able to detect a link-up within 1ms after the PHY indicates an active link via its status registers.<br>3. DUT must be able to send frames, for that a xMII interface must be available on the DUT:<br>a. if *Comm_ready* is supported (see [10]) within 1ms after *comm ready status* is met, otherwise<br>b. within 2ms after detecting a link-up<br>and is able to send a new frame each 1ms. This includes any processing time by the DUT's application software and networking stack.<br>4. DUT and link partner must be able to detect any lost frames by the networking stack or by the application.<br>5. DUT and link partner must be able to detect a link down during a test iteration.<br>6. Link partner, or device that is connected to the link partner, must be able to receive all frames sent by the DUT. |
| **Test Setup** | DUT must be connected to an active link partner with opposite MASTER/SLAVE configuration. Depending on the test instance, the link partner is either connected with correct, or with swapped polarity (i.e., DUT ETH_N ⇔ LP ETH_P and DUT ETH_P⇔ LP ETH_N). |
| **Test procedure** | 1. Link partner shall be active and ready to receive frames.<br>2. DUT shall soft reset and reconfigure its PHY. |

| | |
|---|---|
| | 3. If required by PHY vendor: DUT must wait until PHY has accepted MASTER/SLAVE configuration.<br>4. The DUT's PHY configuration must be finished within 20ms after reset.<br>5. DUT shall set an internal *counter* variable to 0.<br>6. If supported, DUT shall wait until the PHY indicates a PHY ready status (*Comm_ready* or *loc_phy_ready* and *rem_phy_ready*) otherwise until indicates an active link (e.g., by polling the link state or by using an interrupt).<br>7. DUT shall send out a frame with the current counter value 1ms after , *Comm_ready* condition is met, if it is supported, otherwise 1ms after link-*up* is met.<br>8. Every subsequent 1ms, the DUT shall increment its counter variable and send out a frame with the new counter.<br>9. Repeat step 8 until the link partner receives the first frame by the DUT or the link goes down.<br>10. The link partner must store the *counter* value of the first received frame. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled:<br>○ Link partner receives the first frame sent by DUT (*counter* == 0).<br>○ Link did not go down after test step 5, i.e., link stayed active for the whole iteration. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | Test instance 1000BASE-T1_IOP_16_SR_S_M_P are mandatory in 1000BASE-T1 since automatic polarity detection and correction should be supported when configured as SLAVE. |

Table 6: Main test structure of 1000BASET1_IOP_16

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER | LP is MASTER, LP connected with swapped polarity of ETH_N and ETH_P |
|---|---|---|---|---|
| 4.1.1.1 | **DUT as SLAVE** | | 1000BASE-T1_IOP_16_SR_S_M | |
| 4.1.1.2 | **DUT as SLAVE** | | | 1000BASE-T1_IOP_16_SR_S_M_P |
| 4.1.1.3 | **DUT as MASTER** | 1000BASE-T1_IOP_16_SR_M_S | | |

Table 7: Test case instances of 1000BASET1_IOP_16

### 4.1.2 Reliability of indicated link status when connected to link partner with same MASTER/SLAVE configuration

*ID:* 1000BASET1_IOP_17

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY does not signal an active link when connected to a link partner with equal MASTER/SLAVE configuration. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHY.<br>2. DUT is able to detect a link-up |
| **Test Setup** | DUT must be connected to an active link partner with equal MASTER/SLAVE configuration. |
| **Test procedure** | 1. Link partner shall be active.<br>2. DUT shall soft reset and reconfigure its PHY.<br>3. If required by PHY vendor: DUT must wait until its PHY has accepted MASTER/SLAVE configuration.<br>4. The DUT's PHY configuration must be finished within 20ms after reset.<br>5. DUT shall monitor for an indicated link-up for at least 750ms. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled:<br>o DUT does not detect a link-up. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | - |

Table 8: Main test structure of 1000BASET1_IOP_17

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 4.1.2.1 | **DUT as SLAVE** | 1000BASE-T1_ IOP_17 _SR_S_S | |
| 4.1.2.2 | **DUT as MASTER** | | 1000BASE-T1_ IOP_17 _SR_M_M |

Table 9: Test case instances of 1000BASET1_IOP_17

### 4.1.3 Revoke of link status after link-down

*ID:* 1000BASET1_IOP_19

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY does detect and signal a link down within a given time limit after the link has been interrupted, e.g., by a reset or power-down of the link partner.<br><br>The DUT must be tested against at least one known link partner. A test against a complete set of link partners is optional. The link partner configuration must be included in the test results. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHY.<br>2. DUT must be able to read the current link status. |
| **Test Setup** | DUT must be connected to an active link partner with opposite MASTER/SLAVE configuration. |
| **Test procedure** | 1. Link partner shall be active.<br>2. DUT shall soft reset and reconfigure its PHY.<br>3. If required by PHY vendor: DUT must wait until its PHY has accepted MASTER/SLAVE configuration.<br>4. The DUT's PHY configuration must be finished within 20ms after reset.<br>5. Wait until the DUT's PHY signals an active link.<br>6. Apply in the link partner a permanent hard reset condition and start timer t0.<br>7. Wait until the DUT's PHY indicated link status changes from link-up to link-down and stop timer t0. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled.<br><br>o DUT detected the link-down within 5ms. (t0 <= 5ms). |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | - |

Table 10: Main test structure of 1000BASET1_IOP_19

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 4.1.3.1 | **DUT as SLAVE** | | 1000BASE-T1_ IOP_19 _SR_S_M |
| 4.1.3.2 | **DUT as MASTER** | 1000BASE-T1_ IOP_19 _SR_M_S | |

Table 11: Test case instances of 1000BASET1_IOP_19

## 4.2 Group 2, Link-up

*ID:* 1000BASET1_L1_IOP_27

*Type:* Information

The test cases defined in this section shall ensure that the PHY is able to establish an active link after reset and reconfiguration of itself, or of the link partner's PHY.

### 4.2.1 Link-up after PHY-reset

*ID:* 1000BASET1_IOP_21

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY is able to establish a link after being reset and reconfigured within a given time limit. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHY.<br>2. DUT is able to detect a link-up within 0.5ms after the PHY indicates an active link via its status registers. |
| **Test Setup** | DUT is connected to an active link partner with opposite MASTER/SLAVE configuration. Depending on the test instance, the link partner is either connected with correct, or with swapped polarity (i.e., DUT ETH_N ⇔ LP ETH_P and DUT ETH_P ⇔ LP ETH_N). |
| **Test procedure** | 1. DUT shall soft-/hard reset and reconfigure its PHY.<br>2. The DUT's PHY configuration must be finished within 20ms after reset.<br>3. After finished configuration, the DUT shall start timer t0.<br>4. DUT shall wait until the PHY indicates an active link and stop timer t0.<br>5. If [LQ.LTT] register, as defined in [10], is supported, once PHY indicates an active link read the Linkup Total Time from [LQ.LTT] register; (lcl_rcv AND rem_rcv).<br>6. DUT shall monitor whether the link status remains active for at least 750ms after initial link-up. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled. |

| | |
|---|---|
| | ○ DUT's PHY achieved link-up within 100ms after finished configuration (t0 <= 100ms).<br>○ If [LQ.LTT] register is supported, the obtained value should be correlated with t0 counted by the test system.<br>○ Link did not go down after test step 4.<br><br>Additionally, for the test instances 1000BASE-T1_IOP_21_SR_S_M_P and 1000BASE-T1_IOP_21_HR_S_M_P<br><br>○ DUT indicates swapped polarity is indicated by status register |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | Test instances 1000BASE-T1_IOP_21_SR_S_M_P and 1000BASE-T1_IOP_21_HR_S_M_P are mandatory in 1000BASE-T1 since automatic polarity detection and correction should be supported when configured as SLAVE. |

Table 12: Main test structure of 1000BASET1_IOP_21

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER | LP is MASTER, LP connected with swapped polarity of ETH_N and ETH_P |
|---|---|---|---|---|
| 4.2.1. | **DUT is SLAVE; PHY is soft reset** | | 1000BASE-T1_ IOP_21 _SR_S_M | |
| 4.2.1. | **DUT is SLAVE; PHY is soft reset** | | | 1000BASE-T1_ IOP_21 _SR_S_M_P |
| 4.2.1. | **DUT is MASTER PHY is soft reset** | 1000BASE-T1_ IOP_21 _SR_M_S | | |
| 4.2.1. | **DUT is SLAVE; PHY is hard reset** | | 1000BASE-T1_ IOP_21 _HR_S_M | |
| 4.2.1. | **DUT is SLAVE; PHY is hard reset** | | | 1000BASE-T1_ IOP_21 _HR_S_M_P |
| 4.2.1. | **DUT is MASTER PHY is hard reset** | 1000BASE-T1_ IOP_21 _HR_M_S | | |

Table 13: Test case instances of 1000BASET1_IOP_21

### 4.2.2 Link-up after reset of link partner

*ID:* 1000BASET1_IOP_22

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY is able to establish a link after the link partner's PHY has been reset and reconfigured within a given time limit. |
| **Prerequisites** | 1. Link partner with the capability to reset and configure its PHY.<br>2. DUT must be able to trigger the PHY reset of the link partner or must be able to detect the time of the LP's PHY reset.<br>3. DUT must be able to detect a link-up within 0.5ms after the PHY indicates an active link via its status registers. |
| **Test Setup** | DUT must be connected to an active link partner with opposite MASTER/SLAVE configuration. |
| **Test procedure** | 1. DUT shall wait until the PHY indicates an active link.<br>2. DUT shall trigger a soft-/hard reset of the link partner's PHY or wait until the link partner has reset its PHY.<br>3. DUT shall start timer t0 directly after the reset of the LP's PHY.<br>4. The link partner must configure its PHY within 20ms after the reset.<br>5. DUT must ignore any indicated active links within 25ms after the reset.<br>6. 25ms after LP's reset: DUT shall wait until the PHY indicates an active link and stop timer t0. The lowest possible indicated link-up time can be 25ms, even if the actual link-up was established quicker.<br>7. DUT shall monitor whether the link status remains active for at least 750ms after initial link-up. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled.<br>○ DUT's PHY reported link-up within 120ms after reset of the LP's PHY (t0 <= 120ms).<br>○ Link did not go down after test step 5.<br>Additionally, for the test instances 1000BASE-T1_IOP_22_SR_S_M_P and 1000BASE-T1_IOP_22_HR_S_M_P<br>○ DUT indicates swapped polarity is indicated by status register |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | Test instances IOP_22_SR_S_M_P and IOP_22_HR_S_M_P are mandatory in 1000BASE-T1 since automatic polarity detection and correction should be supported when configured as SLAVE. |

Table 14: Main test structure of 1000BASET1_IOP_22

| Instance Test Case # | DUT / LP configuration | LP is SLAVE; PHY is soft reset | LP is MASTER; PHY is soft reset | LP is SLAVE; PHY is hard reset | LP is MASTER; PHY is hard reset |
|---|---|---|---|---|---|
| 4.2.2. | **DUT is SLAVE** | | 1000BASE-T1_ IOP_22 _SR_S_M | | |
| 4.2.2. | **DUT is SLAVE** | | | | 1000BASE-T1_ IOP_22 _HR_S_M |
| 4.2.2. | **DUT is SLAVE, LP connected with swapped polarity of ETH_N and ETH_P** | | 1000BASE-T1_ IOP_22 _SR_S_M_P | | |
| 4.2.2. | **DUT is SLAVE, LP connected with swapped polarity of ETH_N and ETH_P** | | | | 1000BASE-T1_ IOP_22 _HR_S_M_P |
| 4.2.2. | **DUT is MASTER** | 1000BASE-T1_ IOP_22 _SR_M_S | | | |
| 4.2.2. | **DUT is MASTER** | | | 1000BASE-T1_ IOP_22 _HR_M_S | |

Table 15: Test case instances of 1000BASET1_IOP_22

# 5 1000BASE-T1 PHY features set tests

*ID*: 1000BASET1_L1_IOP_28

*Type*: Information

The test cases defined in this chapter shall ensure that optional PHY features, such as an estimation of the channel quality or cable diagnostics, provide expected and comparable results under known test conditions. If a PHY supports a given feature, the associated test cases are mandatory. Else, the test case shall be ignored.

## 5.1 Group 3, Signal Quality

*ID*: 1000BASET1_L1_IOP_29

*Type*: Information

The tests in this section are only applicable for 1000BASE-T1 PHYs that support an estimation of the signal quality of the communication channel. The signal quality can either be read directly from a PHY register, or may be derived based on one or more PHY register values.

### 5.1.1 Indicated signal quality for channel with decreasing quality

*ID:* 1000BASET1_IOP_24a

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY's indicated signal quality decreases for a channel with decreasing channel quality. |
| **Prerequisites** | 1. Test system that allows varying and determining the quality of the communication channel that connects the DUT and LP.<br>2. DUT must be able to monitor the signal quality indicated by the PHY. |
| **Test Setup** | DUT must be connected to an active link partner with opposite MASTER/SLAVE configuration. Test setup shall be able to apply artificial noise to communication channel. |
| **Test procedure** | 1. DUT shall soft reset and reconfigure its PHY.<br>2. Remove any artificial channel degradation, to ensure that the highest possible signal quality is reached on both the DUT and LP.<br>3. Measure the PHY's SQI value for at least 100 times. Determine and store the minimum and maximum SQI read values. Store all Forward Error Correction counters and additionally PHY Health (SNR) indicated in OAM read in parallel with the SQI values.<br>4. Increase artificial noise level by one step, i.e. by 0.1dB Gaussian noise generator output.<br>5. Repeat steps 3 and 4 for ten additional noise levels after the PHY can no longer establish a link. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled.<br>○ SQI value:<br>○ Steadily and monotonically decreased by one step each<br>○ SQI values are only valid if link-up condition is present<br>○ Link status<br>○ Link-up status remains for SQI values higher than 0<br>○ Link-up status shall be reached from the highest SQI value that corresponds to a BER<$10^{-10}$<br>○ No link instabilities with intermittently link drops should be observed between SQI values higher than 0. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | To guarantee comparability of the results, a graphic disclosing SQI value (y-axis) vs. associated noise level on the network *[ dB]* (x axis) shall be given in the test report for each test iteration. The noise level seen by the DUT is relevant; this means the noise source level weighed by the coupling factor of the differential directional |

| | |
|---|---|
| | coupler. To ensure a valid SQI value in each reading, the supplier should provide documentation regarding the required wait time between measurements or indicate that a new valid SQI value is available to be read. |

Table 16: Main test structure of 1000BASET1_IOP_24a

| Instance Test Case # | DUT / LP configuration | LP is SLAVE; PHY is soft reset | LP is MASTER; PHY is soft reset |
|---|---|---|---|
| 5.1.1. | DUT is SLAVE | | 1000BASE-T1_ IOP_24a _SR_S_M |
| 5.1.1. | DUT is MASTER | 1000BASE-T1_ IOP_24a _SR_M_S | |

Table 17: Test case instances of 1000BASET1_IOP_24a

### 5.1.2 Indicated signal quality for channel with increasing quality

*ID:* 1000BASET1_L1_IOP_24b

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY's indicated signal quality increases for a channel with increasing channel quality. |
| **Prerequisites** | 1. Test system that allows varying and determining the quality of the communication channel that connects the DUT and LP.<br>2. DUT must be able to monitor the signal quality indicated by the PHY. |
| **Test Setup** | DUT must be connected to an active link partner with opposite MASTER/SLAVE configuration. Test setup shall be able to apply artificial noise to communication channel. |
| **Test procedure** | 1. Start with the highest artificial noise channel degradation The DUT's PHY can no longer establish a link.<br>2. DUT shall soft reset and reconfigure its PHY.<br>3. Measure the PHY's SQI value at least 100 times. Determine and store the minimum and maximum SQI read values. Store all Forward Error Correction counters and additionally PHY Health (SNR) indicated in OAM read in parallel with the SQI values.<br>4. Decrease artificial noise by one step, i.e. by 0.1 dB Gaussian noise generator output.<br>5. Repeat steps 3 and 4 until no artificial noise is applied. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled.<br>○ SQI value<br>○ Steadily and monotonically increased by one step each<br>○ SQI values are only valid if link-up condition is present<br>○ Link Status<br>○ Link-up status remains for SQI values higher than 0.<br>○ Link-up status shall be reached from the lowest SQI value that corresponds to a BER<$10^{-10}$<br>○ No link instabilities with intermittently link drops should be observed between SQI values higher than 0. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | To guarantee comparability of the results, a graphic disclosing SQI value (y-axis) vs. associated noise level on the network *[ dB]* (x axis) shall be given in the test report for each test iteration. The noise level seen by the DUT is relevant; this means the noise source level weighed by the coupling factor of the differential directional coupler. To ensure a valid SQI value in each reading, the supplier |

| | |
|---|---|
| | should provide documentation regarding the required wait time between measurements or indicate that a new valid SQI value is available to be read. |

Table 18: Main test structure of 1000BASET1_IOP_24b

| Instance Test Case # | DUT / LP configuration | LP is SLAVE | LP is MASTER |
|---|---|---|---|
| 5.1.2.1 | DUT is SLAVE | | 1000BASE-T1_ IOP_24b _SR_S_M |
| 5.1.2.2 | DUT is MASTER | 1000BASE-T1_ IOP_24b _SR_M_S | |

Table 19: Test case instances of 1000BASET1_IOP_24b

## 5.2 Group 4, Cable Diagnosis

### 5.2.1 Cable diagnostics for error-free channel

*ID:* 1000BASET1_IOP_31

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY's cable diagnostic does not indicate a short or open for an error-free channel. |
| **Prerequisites** | 1. DUT must be able to trigger the PHY's cable diagnostic feature.<br>2. The link partner shall terminate the channel properly.<br>The link partner should not be transmitting any signal (typically "SEND_Z" or as SLAVE) |
| **Test Setup** | DUT is connected to a properly terminated link partner. |
| **Test procedure** | 1. DUT shall soft reset and reconfigure its PHY.<br>2. DUT shall start cable diagnostic of its PHY.<br>3. DUT shall wait until the PHY finished cable diagnostics.<br>4. DUT shall read out the indicated result. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled.<br>○ Cable diagnostic reported no errors (i.e., no short / open of the bus lines). |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | - |

Table 20: Main test structure of 1000BASET1_IOP_31

| Instance Test Case # | Error-free Channel |
|---|---|
| 5.2.1. | 1000BASE-T1_IOP_31_SR_C1__S_M |
| 5.2.1. | 1000BASE-T1_IOP_31_SR_C2__S_M |

Table 21: Main test structure of 1000BASET1_IOP_31

### 5.2.2 Cable diagnostics for near and far end open

*ID:* 1000BASET1_IOP_32

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the PHY'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 LP. |
| **Prerequisites** | 1. DUT must be able to trigger the PHY's cable diagnostic feature.<br>2. The link partner shall terminate the channel properly.<br>The link partner should not be transmitting any signal (typically "SEND_Z" or as SLAVE) |
| **Test Setup** | DUT is connected to a properly terminated link partner. One or both of the bus lines have a near or far end open. |
| **Test procedure** | 1. DUT shall soft reset and reconfigure its PHY.<br>2. DUT shall start cable diagnostic of its PHY.<br>3. DUT shall wait until the PHY finished cable diagnostics.<br>4. DUT shall read out the indicated result. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled.<br>○ Cable diagnostic reported an open of the bus line(s).<br>○ The cable fault locations shall be reported starting with a minimum distance of approx. 1 meter, with a resolution of 1 meter |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | For a near end open, one or both bus lines shall be disconnected directly at the connector of the DUT. For a far end open, one or both bus lines shall be disconnected directly at the connector of the LP. |

Table 22: Main test structure of 1000BASET1_IOP_32

| Instance Test Case # | DUT / LP configuration | Test setup | Open is on ETH_N or ETH_P | Open on both ETH_N and ETH_P |
|---|---|---|---|---|
| 5.2.2.1 | DUT is SLAVE | **Near-end open (on connector of DUT).** | 1000BASET1_IOP_32_SR_C2_O1_NEAR_S_M | |
| 5.2.2.2 | DUT is SLAVE | **Near-end open (on connector of DUT).** | | 1000BASET1_IOP_32_SR_C2_O2_NEAR_S_M |
| 5.2.2.3 | DUT is SLAVE | **Far-end open (on connector of LP).** | 1000BASET1_IOP_32_SR_C2_O1_FAR_S_M | |
| 5.2.2.4 | DUT is SLAVE | **Far-end open (on connector of LP).** | | 1000BASET1_IOP_32_SR_C2_O2_FAR_S_M |
| 5.2.2.5 | DUT is MASTER | **Near-end open (on connector of DUT).** | 1000BASET1_IOP_32_SR_C2_O1_NEAR_M_S | |
| 5.2.2.6 | DUT is MASTER | **Near-end open (on connector of DUT).** | | 1000BASET1_IOP_32_SR_C2_O2_NEAR_M_S |
| 5.2.2.7 | DUT is MASTER | **Far-end open (on connector of LP).** | 1000BASET1_IOP_32_SR_C2_O1_FAR_M_S | |
| 5.2.2.8 | DUT is MASTER | **Far-end open (on connector of LP).** | | 1000BASET1_IOP_32_SR_C2_O2_FAR_M_S |

Table 23: Test case instances of 1000BASET1_IOP_32

### 5.2.3 Cable diagnostics for near and far end short

*ID:* 1000BASET1_IOP_33

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | • Shall ensure that the PHY's cable diagnostic reliably detects a short between both bus wires. 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 LP. |
| **Prerequisites** | 1. DUT must be able to trigger the PHY's cable diagnostic feature.<br>2. The link partner shall terminate the channel properly.<br>The link partner should not be transmitting any signal (typically "SEND_Z" or as SLAVE) |
| **Test Setup** | DUT is connected to a properly terminated link partner. The bus lines are connected via a <= 1 Ohm resistor. |
| **Test procedure** | 1. DUT shall soft reset and reconfigure its PHY.<br>2. DUT shall start cable diagnostic of its PHY.<br>3. DUT shall wait until the PHY finished cable diagnostics.<br>4. DUT shall read out the indicated result. |
| **Pass criteria** | Each test iteration shall be classified as passed, if all of the following condition(s) are fulfilled.<br>○ Cable diagnostic reported a short between the bus lines.<br>○ The cable fault locations shall be reported starting with a minimum distance of approx. 1 meter, with a resolution of 1 meter |
| **Test iterations** | See suggested test iterations in Appendix – 7.1 Suggested Iterations |
| **Notes** | For a near end short, both bus lines shall be connected via a <= 1 Ohm resistor directly at the connector of the DUT. For a far end short, both bus lines shall be connected via a <= 1 Ohm resistor directly at the connector of the LP. |

Table 24: Main test structure of 1000BASET1_IOP_33

| Instance Test Case # | DUT / LP configuration | Test setup | SHORT on both ETH_N and ETH_P |
|---|---|---|---|
| 5.2.3.1 | DUT is SLAVE | **Near-end short (on connector of DUT).** | 1000BASET1_IOP_33 _SR_C2_S2_NEAR_S_M |
| 5.2.3.2 | DUT is SLAVE | **Far-end short (on connector of LP).** | 1000BASET1_IOP_33 _SR_C2_S2_FAR_S_M |
| 5.2.3.3 | DUT is SLAVE | **Near-end short (on connector of DUT).** | 1000BASET1_IOP_33 _SR_C2_S2_NEAR_GND_S_ M |
| 5.2.3.4 | DUT is SLAVE | **Far-end short (on connector of LP).** | 1000BASET1_IOP_33 _SR_C2_S2_FAR_GND_S_M |
| 5.2.3.5 | DUT is SLAVE | **Near-end short (on connector of DUT).** | 1000BASET1_IOP_33 _SR_C2_S2_NEAR_VBAT_S_ M |
| 5.2.3.6 | DUT is SLAVE | **Far-end short (on connector of LP).** | 1000BASET1_IOP_33 _SR_C2_S2_FAR_VBAT_S_M |
| 5.2.3.7 | DUT is MASTER | **Near-end short (on connector of DUT).** | 1000BASET1_IOP_33 _SR_C2_S2_NEAR_M_S |
| 5.2.3.8 | DUT is MASTER | **Far-end short (on connector of LP).** | 1000BASET1_IOP_33 _SR_C2_S2_FAR_M_S |
| 5.2.3.9 | DUT is MASTER | **Near-end short (on connector of DUT).** | 1000BASET1_IOP_33 _SR_C2_S2_NEAR_GND_M_ S |
| 5.2.3.10 | DUT is MASTER | **Far-end short (on connector of LP).** | 1000BASET1_IOP_33 _SR_C2_S2_FAR_GND_M_S |
| 5.2.3.11 | DUT is MASTER | **Near-end short (on connector of DUT).** | 1000BASET1_IOP_33 _SR_C2_S2_NEAR_VBAT_M_ S |
| 5.2.3.12 | DUT is MASTER | **Far-end short (on connector of LP).** | 1000BASET1_IOP_33 _SR_C2_S2_FAR_VBAT_M_S |

Table 25: Test case instances of 1000BASET1_IOP_33

# 6 Wake-up/Sleep

*ID:* WAKE_IOP_1

Type: Requirement

The test cases defined in this section except WAKE_IOP_8 are mandatory for all 1000BASE-T1 devices supporting the wake-up/sleep functionality defined in [11]. WAKE_IOP_8 is mandatory if the PHY supporting wakeup and sleep signaling over dedicated I/O pins.

## 6.1 Group 5, Wake-up reception and signalizing

*ID:* WAKE_IOP_2

*Type:* Information

The test cases defined in this section shall ensure that a wake-up (WUP/WUR) can be received and signalized to the upper layer as described in [11].

### 6.1.1 Reception of a wake-up pulse (WUP)

*ID:* WAKE_IOP_3

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that a DUT is able to receive a WUP over a passive link, signalize the wake-up event and upon this to establish a link within an expected time.<br><br>Parameters to be measured:<br><br>• *t_wkp_unpwrd: Time between wake-up request on the LP and DUT wake-up signalization.*<br>• *t_wkp_link-up: Time between DUT wake-up signalization and link-up.*<br>• *Link stability after a wake-up condition.* |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHYs.<br>2. DUT with the capability to set its PHYs into sleep mode.<br>3. Link partner, or device that is connected to the DUT, shall be able to send a wake-up pulse (WUP).<br>4. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT shall be connected to a link partner (LP1) with a passive link with opposite MASTER/SLAVE configuration.<br>• DUT shall be in sleep state.<br>• LP1 including LP1_P1 shall be powered and connected to the DUT with a passive link. |

| | |
|---|---|
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a wake-up request on LP1<br>3. Start timer $t_0$<br>4. Wait until the DUT signalizes a wake-up condition<br>5. Readout timer value (*t_wkp_unpwrd* = $t_0$)<br>6. Configuration of the DUT must be finished within 20ms after wake-up.<br>7. Wait until DUT signalizes a link-up condition<br>8. Readout timer value (*t_wkp_link-up* = $t_0$ - *t_wkp_unpwrd – 20ms (configuration time)*)<br>9. Monitor the link status for additional 750ms |
| **Pass criteria** | For all the executed iterations the following pass criterion shall be fulfilled:<br>• *t_wkp_unpwrd* < TWU_Link_Passive + T_Powersupply_Stable + T_PHY_Initialization<br>*t_wkp_unpwrd* < 17 ms<br>• *t_wkp_link-up* ≤ 100 ms<br>• No link drop is observed after link-up condition has been reached. |
| **Test iterations** | See suggested test iterations in Appendix- 7.1 Suggested Iterations |
| **Notes** | |

Table 26: Main test structure of WAKE_IOP_3

| **Instance Test Case #** | **DUT / LP configuration** | **LP as SLAVE** | **LP as MASTER** | **LP is MASTER, LP connected with swapped polarity of ETH_N and ETH_P** |
|---|---|---|---|---|
| 6.1.1.1 | DUT as SLAVE | | WAKE_IOP_3_S_M | |
| 6.1.1.2 | DUT as MASTER | WAKE_IOP_3_M_S | | |
| 6.1.1.3 | DUT as SLAVE | | | WAKE_IOP_3_S_M_P |

Table 27: Test case instances of WAKE_IOP_3

### 6.1.2 Reception of a wake-up request (WUR)

*ID:* WAKE_IOP_4

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that DUT is able to receive a WUR over an active link and to signalize it.<br><br>Parameter to be measured:<br><br>• *TWU_Link_active*: Wake-up transmission time over an active link.<br>• Link stability during and after WUR event. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHYs.<br>2. Link partner, or device that is connected to the DUT, shall be able to send a wake-up request (WUR).<br>3. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT shall be connected to an active link partner (LP1) with opposite MASTER/SLAVE configuration.<br>• A stable link-up condition shall be present at the moment of starting the test execution. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a wake-up request on LP1<br>3. Start timer $t_0$<br>4. Wait until the DUT signalizes a wake-up condition<br>5. Readout timer value (*TWU_Link_active* = $t_0$)<br>6. Monitor the link status for additional 750ms |
| **Pass criteria** | For all the executed iterations the following pass criterion shall be fulfilled:<br><br>• *TWU_Link_active* < 2 ms<br>• No link drop is observed during the test execution. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 28: Main test structure of WAKE_IOP_4

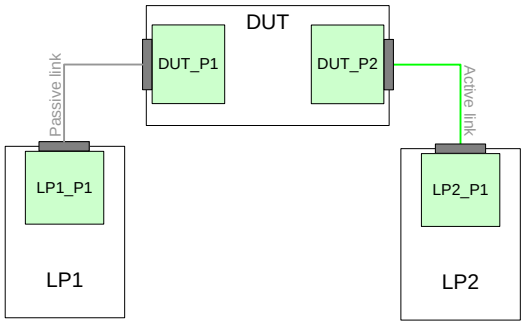
| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 6.1.2.1 | DUT as SLAVE | | WAKE_ IOP_4_S_M |
| 6.1.2.2 | DUT as MASTER | WAKE_ IOP_4_M_S | |

Table 29: Test case instances of WAKE_IOP_4

### 6.1.3 Reception of a wake-up pulse (WUP) on an already active DUT

*ID:* WAKE_IOP_5

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that a DUT is able to receive a WUP over a passive link, signalize the wake-up event and upon this to establish a link while another DUT´s port link is already established.<br><br>Parameters to be measured:<br><br>• *TWU_Link_passive*: Wake-up transmission time over a passive link.<br>• *t_wkp_link-up*: Time between DUT wake-up signalization and link-up.<br>• Link stability after a wake-up condition. |
| **Prerequisites** | 1. DUT shall have more than one port.<br>2. DUT with the capability to reset and configure its PHYs.<br>3. DUT with the capability to set its PHYs into sleep mode.<br>4. Link partner, or device that is connected to the DUT, shall be able to send a wake-up pulse (WUP).<br>5. Link partner shall have local wake-up input available.<br>6. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT ports shall be connected to their LPs with opposite MASTER/SLAVE configuration.<br>• DUT port *DUT_P1* shall be connected to LP1.<br>• LP1 including LP1_P1 shall be powered and the link between DUT_P1 and LP1_P1 shall be passive at the moment of starting the test execution.<br>• DUT port *DUT_P2* shall be connected to LP2.<br>• LP2 shall be in normal mode and the link between DUT_P2 and LP2_P1 shall be active at the moment of starting the test execution. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a wake-up request on LP1<br>3. Start timer $t_0$<br>4. Wait until the DUT signalizes a wake-up condition<br>5. Readout timer value (*TWU_Link_passive* = $t_0$)<br>6. Configuration of the DUT must be finished within 20ms after wake-up.<br>7. Wait until DUT signalizes a link-up condition |

| | |
|---|---|
| | 8. Readout timer value (*t_wkp_link-up* = $t_0$ - *TWU_Link_passive – 20ms (configuration time)*)<br>9. Configuration of the DUT must be finished within 20ms after wake-up.<br>10. Monitor the link status for additional 750ms |
| **Pass criteria** | For all the executed iterations the following pass criterion shall be fulfilled:<br>• *TWU_Link_passive* < 2 ms<br>• *t_wkp_link-up* ≤ 100 ms<br>• No link drop is observed after link-up condition has been reached. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | Test can be skipped for DUTs with one port. |

Table 30: Main test structure of WAKE_IOP_5

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 6.1.3.1 | DUT as SLAVE | | WAKE_IOP_5_S_M |
| 6.1.3.2 | DUT as MASTER | WAKE_IOP_5_M_S | |

Table 31: Test case instances of WAKE_IOP_5

## 6.2 Group 6, Wake-up transmission

*ID:* WAKE_IOP_6

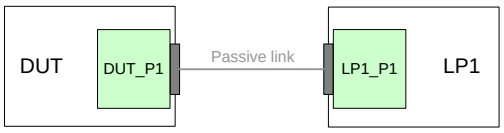
*Type:* Information

The test cases defined in this section shall ensure that a wake-up (WUP/WUR) can be transmitted and signaled to the upper layer as described in [11].

### 6.2.1 Transmission of a wake-up pulse (WUP)

*ID:* WAKE_IOP_7

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the DUT is able to send a WUP over a passive link within an expected time and to properly signalize the action.<br><br>Parameters to be measured:<br><br>• TWU_forward_passive: Time between local wake-up event on the DUT and LP1 wake-up signalization.<br>• *t_wkp_link-up*: Time between DUT wake-up signalization and link-up.<br>• Link stability after a wake-up condition. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHYs.<br>2. DUT with the capability to set its PHYs into sleep mode.<br>3. Link partner, or device that is connected to the DUT, shall be able to receive a wake-up pulse (WUP).<br>4. DUT implementation shall have local wake-up input available.<br>5. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT shall be connected to a link partner (LP1) with a passive link with opposite MASTER/SLAVE configuration.<br>• LP1 including LP1_P1 shall be powered and connected to the DUT with a passive link.<br>• DUT including DUT_P1 shall be powered and connected to the LP1 with a passive link. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a wake-up request on DUT<br>3. Start timer $t_0$<br>4. Wait until LP1 signalizes a wake-up condition<br>5. Readout timer value (TWU_link_passive = $t_0$) |

| | |
|---|---|
| | 6. Configuration of the DUT must be finished within 20ms after wake-up.<br>7. Wait until DUT signalizes a link-up condition<br>8. Readout timer value (*t_wkp_link-up* = $t_0$ - TWU_link_passive– *20ms (configuration time)*)<br>9. Monitor the link status for additional 750ms |
| **Pass criteria** | For all the executed iterations the following pass criterion shall be fulfilled:<br>• TWU_link_passive < 2 ms<br>• *t_wkp_link-up* ≤ 100 ms<br>• No link drop is observed after link-up condition has been reached. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 32: Main test structure of WAKE_IOP_7

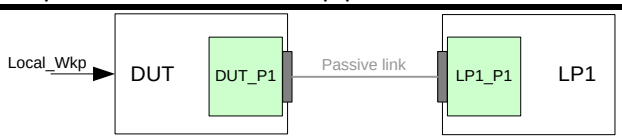
| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER | LP is MASTER, LP connected with swapped polarity of ETH_N and ETH_P |
|---|---|---|---|---|
| 6.2.1.1 | DUT as SLAVE | | WAKE_IOP_ 7_S_M | |
| 6.2.1.2 | DUT as MASTER | WAKE_IOP_ 7_M_S | | |
| 6.2.1.3 | DUT as SLAVE | | | WAKE_IOP_ 7_S_M_P |

Table 33: Test case instances of WAKE_IOP_7

### 6.2.2 Transmission of a wake-up pulse after local wake-up (WUP)

*ID:* WAKE_IOP_8

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the DUT is able to send a WUP over a passive link within an expected time and to properly signalize the action.<br><br>Parameters to be measured:<br><br>• *t_wkp_unpwrd*: Time between local wake-up event on the DUT and LP1 wake-up signalization.<br>• *t_wkp_link-up*: Time between DUT wake-up signalization and link-up.<br>• Link stability after a wake-up condition. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHYs.<br>2. DUT with the capability to set its PHYs into sleep mode.<br>3. Link partner, or device that is connected to the DUT, shall be able to receive a wake-up pulse (WUP).<br>4. DUT implementation shall have local wake-up input available.<br>5. The test system shall be able of providing time measurement capabilities synchronized with the test steps events.<br>6. The DUT provides a local wake-up pin. |
| **Test Setup** |  <br>• DUT shall be connected to a link partner (LP1) with a passive link with opposite MASTER/SLAVE configuration.<br>• DUT shall be in sleep state.<br>• LP1 including LP1_P1 shall be powered and connected to the DUT with a passive link. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Apply a local wake pulse to DUT for at least 50us<br>3. Start timer $t_0$<br>4. Wait until LP1 signalizes a wake-up condition<br>5. Readout timer value (*t_wkp_unpwrd* = $t_0$)<br>6. Configuration of the DUT must be finished within 20ms after wake-up.<br>7. Wait until DUT signalizes a link-up condition<br>8. Readout timer value (*t_wkp_link-up* = $t_0$ - *t_wkp_unpwrd* – *20ms (configuration time)*)<br>9. Monitor the link status for additional 750ms |
| **Pass criteria** | For all the executed iterations the following pass criterion shall be fulfilled:<br><br>• *t_wkp_unpwrd* < TWU_WakeIO + TWU_Link_passive + (T_Powersupply_Stable + T_PHY_Initialization)<br>*t_wkp_unpwrd* < 1ms + 2ms + (15ms)<br>*t_wkp_unpwrd* < 18 ms<br>• *t_wkp_link-up* ≤ 100 ms |

| | |
|---|---|
| | • No link drop is observed after link-up condition has been reached. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 34: Main test structure of WAKE_IOP_8

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 6.2.2.1 | DUT as SLAVE | | WAKE_IOP_8_S_M |
| 6.2.2.2 | DUT as MASTER | WAKE_IOP_8_M_S | |

Table 35: Test case instances of WAKE_IOP_8

### 6.2.3 Transmission of a wake-up request (WUR)

*ID:* WAKE_IOP_9

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the DUT is able to send a WUR over an active link.<br><br>Parameters to be measured:<br><br>• *TWU_Link_active*: Wake-up transmission time over an active link.<br>• Link stability after a wake-up condition. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHYs.<br>2. Link partner, or device that is connected to the DUT, shall be able to receive a wake-up request (WUR).<br>3. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT shall be connected to an active link partner (LP1) with opposite MASTER/SLAVE configuration.<br>• A link-up condition shall be present at the moment of starting the test execution. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a WUR on the DUT<br>3. Start timer $t_0$<br>4. Wait until the LP1 signalizes a wake-up condition<br>5. Readout timer value (*TWU_Link_active* = $t_0$) |
| **Pass criteria** | For all the executed iterations the following pass criterion shall be fulfilled:<br><br>• *TWU_Link_active* < 2 ms |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 36: Main test structure of WAKE_IOP_9

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 6.2.3.1 | DUT as SLAVE | | WAKE_ IOP_9_S_M |
| 6.2.3.2 | DUT as MASTER | WAKE_IOP_9_M_S | |

Table 37: Test case instances of WAKE_IOP_9

## 6.3 Group 7, Wake-up forwarding

*ID:* WAKE_IOP_10

*Type:* Information

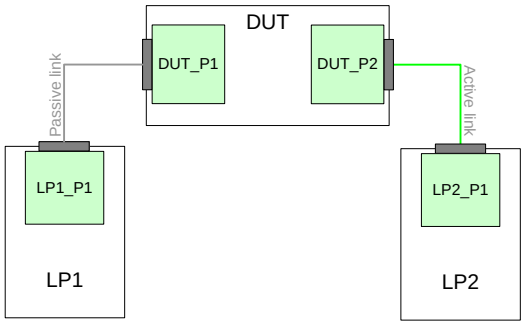
The test cases defined in this section shall ensure that a wake-up request can be forwarded as described in [11].

This section applies for multi-port DUTs.

### 6.3.1 Forwarding wake-up request from active to passive link

ID: WAKE_IOP_11

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that a wake-up request received by a DUT over an active link can be forwarded within the expected time to a LP via a passive link.<br><br>Parameters to be measured:<br><br>• *t_wkp_fwd*: Time between triggering the WUR on LP2 and LP1 wake-up signalization. |
| **Prerequisites** | 1. DUT shall have more than one port.<br>2. DUT with the capability to reset and configure its PHYs.<br>3. DUT with the capability to set its PHYs into sleep mode.<br>4. Link partner, or device that is connected to the DUT, shall be able to send and receive a wake-up pulse (WUP).<br>5. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT ports shall be connected to their LPs with opposite MASTER/SLAVE configuration.<br>• DUT port *DUT_P1* shall be connected to LP1.<br>• LP1 including LP1_P1 shall be powered and the link between DUT_P1 and LP1_P1 shall be passive at the moment of starting the test execution.<br>• DUT port *DUT_P2* shall be connected to LP2.<br>• LP2 shall be in normal mode and the link between DUT_P2 and LP2_P1 shall be active at the moment of starting the test execution. |

| | |
|---|---|
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a WUR on LP2<br>3. Start timer $t_0$<br>4. Wait until the LP1 signalizes a wake-up condition<br>5. Readout timer value ($t\_wkp\_fwd = t_0$) |
| **Pass criteria** | Each test iteration shall be classified as pass, if all of the following condition(s) are fulfilled:<br>• $t\_wkp\_fwd$ < TWU_Link_active + TWU_Forwarding + TWU_Link_passive<br>$t\_wkp\_fwd$ < 2ms + 1ms + 2ms<br>$t\_wkp\_fwd$ < 5ms |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 38: Main test structure of WAKE_IOP_11

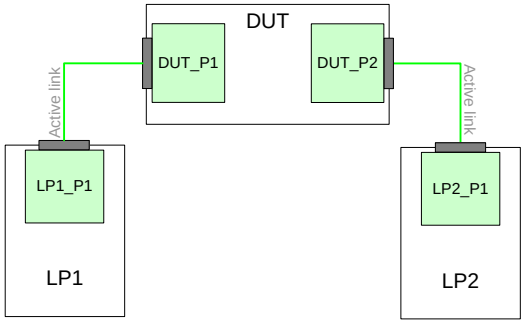
| **Instance**<br>**Test Case #** | **DUT / LP**<br>**configuration** | **LP1 as SLAVE, LP2 as SLAVE** | **LP1 as MASTER, LP2 as MASTER** | **LP1 as MASTER, LP2 as SLAVE** | **LP1 as SLAVE, LP2 as MASTER** |
|---|---|---|---|---|---|
| | DUT_P1 as SLAVE, DUT_P2 as MASTER | | | WAKE_ IOP_11_SM_MS | |
| | DUT_P1 as MASTER,<br>DUT_P2 as SLAVE | | | | WAKE_ IOP_11_MS_SM |
| | DUT_P1 as MASTER,<br>DUT_P2 as MASTER | WAKE_ IOP_11_MM_SS | | | |
| | DUT_P1 as SLAVE, DUT_P2 as SLAVE | | WAKE_ IOP_11_SS_MM | | |

Table 39: Test case instances of WAKE_IOP_11

### 6.3.2 Forwarding a wake-up request from active to active link

*ID:* WAKE_IOP_12

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that a wake-up request received by a DUT over an active link can be forwarded within the expected time to a LP via an active link.<br><br>Parameters to be measured:<br><br>• *t_wkp_fwd*: Time between triggering the WUR on LP2 and LP1 wake-up signalization. |
| **Prerequisites** | 6. DUT shall have more than one port.<br>7. DUT with the capability to reset and configure its PHYs.<br>8. DUT with the capability to set its PHYs into sleep mode.<br>9. Link partner, or device that is connected to the DUT, shall be able to receive a wake-up request (WUR).<br>10. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT ports shall be connected to their LPs with opposite MASTER/SLAVE configuration.<br>• DUT port *DUT_P1* test shall be connected to LP1.<br>• LP1 shall be powered and the link between DUT_P1 and LP1_P1 shall be active at the moment of starting the test execution.<br>• DUT port *DUT_P2* test shall be connected to LP2.<br>• LP2 shall be in normal mode and the link between DUT_P2 and LP2_P1 shall be active at the moment of starting the test execution. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a WUR on LP2<br>3. Start timer $t_0$<br>4. Wait until the LP1 signalizes a wake-up condition<br>5. Readout timer value ($t\_wkp\_fwd = t_0$) |
| **Pass criteria** | Each test iteration shall be classified as pass, if all of the following condition(s) are fulfilled:<br><br>• *t_wkp_fwd* < TWU_Link_active + TWU_Forwarding + TWU_Link_active<br>*t_wkp_fwd* < 2ms + 1ms + 2ms |

| | |
|---|---|
| | *t_wkp_fwd* < 5ms |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 40: Main test structure of WAKE_IOP_12

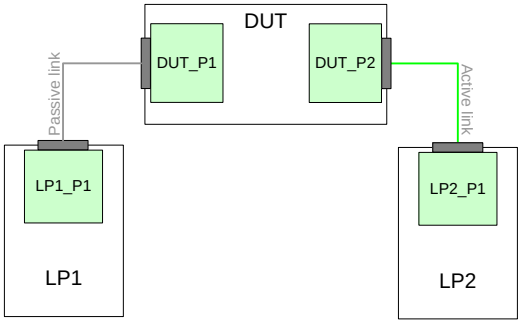
| **Instance**<br><br>**Test Case #** | **DUT / LP**<br><br>**configuration** | **LP1 as SLAVE, LP2 as SLAVE** | **LP1 as MASTER, LP2 as MASTER** | **LP1 as MASTER, LP2 as SLAVE** | **LP1 as SLAVE, LP2 as MASTER** |
|---|---|---|---|---|---|
| | DUT_P1 as SLAVE, DUT_P2 as MASTER | | | WAKE_ IOP_12_SM_MS | |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as SLAVE | | | | WAKE_ IOP_12_MS_SM |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as MASTER | WAKE_ IOP_12_MM_SS | | | |
| | DUT_P1 as SLAVE, DUT_P2 as SLAVE | | WAKE_ IOP_12_SS_MM | | |

Table 41: Test case instances of WAKE_IOP_12

### 6.3.3 Forwarding a wake-up request from passive to active link

*ID:* WAKE_IOP_13

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that a wake-up request received by a DUT over a passive link can be forwarded within the expected time to a LP via an active link.<br><br>Parameters to be measured:<br><br>• *t_wkp_fwd*: Time between triggering the WUR on LP1 and LP2 wake-up signalization. |
| **Prerequisites** | 1. DUT shall have more than one port.<br>2. DUT with the capability to reset and configure its PHYs.<br>3. DUT with the capability to set its PHYs into sleep mode.<br>4. Link partner, or device that is connected to the DUT, shall be able to receive a wake-up request (WUR).<br>5. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT ports shall be connected to their LPs with opposite MASTER/SLAVE configuration.<br>• DUT port *DUT_P1* test shall be connected to LP1.<br>• LP1 including LP1_P1 shall be powered and the link between DUT_P1 and LP1_P1 shall be passive at the moment of starting the test execution.<br>• DUT port *DUT_P2* test shall be connected to LP2.<br>• LP2 shall be in normal mode and the link between DUT_P2 and LP2_P1 shall be active at the moment of starting the test execution. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a wake-up request on LP1<br>3. Start timer $t_0$<br>4. Wait until the LP2 signalizes a wake-up condition<br>5. Readout timer value ($t\_wkp\_fwd = t_0$) |
| **Pass criteria** | Each test iteration shall be classified as pass, if all of the following condition(s) are fulfilled:<br><br>• *t_wkp_fwd* < TWU_Link_passive + TWU_Forwarding + TWU_Link_active<br>*t_wkp_fwd* < 2ms + 1ms + 2ms |

| | |
|---|---|
| | *t_wkp_fwd* < 5ms |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 42: Main test structure of WAKE_IOP_13

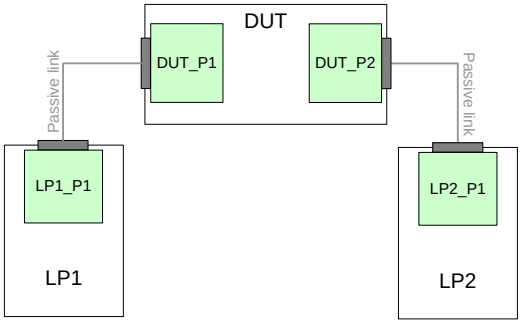
| **Instance**<br><br>**Test Case #** | **DUT / LP**<br><br>**configuration** | **LP1 as SLAVE, LP2 as SLAVE** | **LP1 as MASTER, LP2 as MASTER** | **LP1 as MASTER, LP2 as SLAVE** | **LP1 as SLAVE, LP2 as MASTER** |
|---|---|---|---|---|---|
| | DUT_P1 as SLAVE, DUT_P2 as MASTER | | | WAKE_ IOP_13_SM_MS | |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as SLAVE | | | | WAKE_ IOP_13_MS_SM |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as MASTER | WAKE_ IOP_13_MM _SS | | | |
| | DUT_P1 as SLAVE, DUT_P2 as SLAVE | | WAKE_ IOP_13_SS_MM | | |

Table 43: Test case instances of WAKE_IOP_13

### 6.3.4 Forwarding a wake-up request from passive to passive link

*ID:* WAKE_IOP_14

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that a wake-up request received by a DUT over a passive link can be forwarded within the expected time to a LP via a passive link.<br><br>Parameters to be measured:<br><br>• *t_wkp_fwd*: Time between triggering the WUR on LP1 and LP2 wake-up signalization. |
| **Prerequisites** | 1. DUT shall have more than one port.<br>2. DUT with the capability to reset and configure its PHYs.<br>3. DUT with the capability to set its PHYs into sleep mode.<br>4. Link partner, or device that is connected to the DUT, shall be able to receive a wake-up pulse (WUP).<br>5. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT ports shall be connected to their LPs with opposite MASTER/SLAVE configuration.<br>• DUT port *DUT_P1* test shall be connected to LP1.<br>• LP1 including LP1_P1 shall be powered and the link between DUT_P1 and LP1_P1 shall be passive at the moment of starting the test execution.<br>• DUT port *DUT_P2* test shall be connected to LP2.<br>• LP1 including LP1_P2 shall be powered and the link between DUT_P1 and LP1_P1 shall be passive at the moment of starting the test execution. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a wake-up request on LP1<br>3. Start timer $t_0$<br>4. Wait until the LP2 signalizes a wake-up condition<br>5. Readout timer value ($t\_wkp\_fwd = t_0$) |
| **Pass criteria** | Each test iteration shall be classified as pass, if all of the following condition(s) are fulfilled:<br><br>• *t_wkp_fwd* < TWU_Link_passive + TWU_Forwarding + TWU_Link_passive<br>*t_wkp_fwd* < 2ms + 1ms + 2ms |

| | |
|---|---|
| | *t_wkp_fwd* < 5 ms |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 44: Main test structure of WAKE_IOP_14

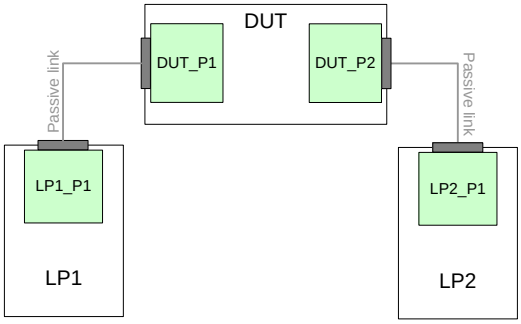
| **Instance**<br><br>**Test Case #** | **DUT / LP**<br><br>**configuration** | **LP1 as SLAVE, LP2 as SLAVE** | **LP1 as MASTER, LP2 as MASTER** | **LP1 as MASTER, LP2 as SLAVE** | **LP1 as SLAVE, LP2 as MASTER** |
|---|---|---|---|---|---|
| | DUT_P1 as SLAVE, DUT_P2 as MASTER | | | WAKE_ IOP_14_SM_MS | |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as SLAVE | | | | WAKE_ IOP_14_MS_SM |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as MASTER | WAKE_ IOP_14_MM _SS | | | |
| | DUT_P1 as SLAVE, DUT_P2 as SLAVE | | WAKE_ IOP_14_SS_MM | | |

Table 45: Test case instances of WAKE_IOP_14

### 6.3.5 Forwarding a wake-up request from passive to passive link, DUT in sleep

*ID:* WAKE_IOP_15

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that a wake-up request received by a DUT over a passive link can be forwarded within the expected time to a LP via a passive link.<br><br>Parameters to be measured:<br><br>• *t_wkp_fwd*: Time between triggering the WUR on LP1 and LP2 wake-up signalization. |
| **Prerequisites** | 1. DUT shall have more than one port.<br>2. DUT with the capability to reset and configure its PHYs.<br>3. DUT with the capability to set its PHYs into sleep mode.<br>4. Link partner, or device that is connected to the DUT, shall be able to receive a wake-up pulse (WUP).<br>5. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT ports shall be connected to their LPs with opposite MASTER/SLAVE configuration.<br>• DUT port *DUT_P1* test shall be connected to LP1.<br>• LP1 including LP1_P1 shall be powered and the link between DUT_P1 and LP1_P1 shall be passive at the moment of starting the test execution.<br>• DUT port *DUT_P2* test shall be connected to LP2.<br>• LP1 including LP1_P2 shall be powered and the link between DUT_P1 and LP1_P1 shall be passive at the moment of starting the test execution. |
| **Test procedure** | 1. Reset timer $t_0$<br>2. Trigger a wake-up request on LP1<br>3. Start timer t0<br>4. Wait until the LP2 signalizes a wake-up condition<br>5. Readout timer value (t_wkp_fwd = t0) |
| **Pass criteria** | Each test iteration shall be classified as pass, if all of the following condition(s) are fulfilled:<br><br>• *t_wkp_fwd* < TWU_Link_Passive + (T_Powersupply_Stable + T_PHY_Initialization) + TWU_Forwarding + TWU_Link_Passive |

| | |
|---|---|
| | *t_wkp_fwd* < 2ms + (15ms) + 1ms + 2ms<br>*t_wkp_fwd* < 20 ms |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 46: Main test structure of WAKE_IOP_15

| **Instance**<br><br>**Test Case #** | **DUT / LP**<br><br>**configuration** | **LP1 as SLAVE, LP2 as SLAVE** | **LP1 as MASTER, LP2 as MASTER** | **LP1 as MASTER, LP2 as SLAVE** | **LP1 as SLAVE, LP2 as MASTER** |
|---|---|---|---|---|---|
| | DUT_P1 as SLAVE, DUT_P2 as MASTER | | | WAKE_ IOP_15_SM_MS | |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as SLAVE | | | | WAKE_ IOP_15_MS_SM |
| | DUT_P1 as MASTER,<br><br>DUT_P2 as MASTER | WAKE_ IOP_15_MM_SS | | | |
| | DUT_P1 as SLAVE, DUT_P2 as SLAVE | | WAKE_ IOP_15_SS_MM | | |

Table 47: Test case instances of WAKE_IOP_15

## 6.4 Group 8, Sleep

*ID:* WAKE_IOP_16

*Type:* Requirement

The test cases defined in this section shall ensure that the PHY is able to make the transition to sleep as requested.

### 6.4.1 Sleep request after link-up

*ID:* WAKE_IOP_17

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the DUT is able to enter the sleep mode and remain in this state after link-up was established when the sleep request is issued on the DUT side. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHYs.<br>2. DUT with the capability to set its PHYs into sleep mode.<br>3. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT shall be connected to an active link partner (LP1) with opposite MASTER/SLAVE configuration.<br>• A stable link-up condition shall be present at the moment of starting the test execution. |
| **Test procedure** | 1. Trigger a sleep request on the DUT<br>2. Start timer $t_0$<br>3. Wait until the DUT signalizes a sleep condition<br>4. Readout timer value ($t\_sleep = t_0$)<br>5. DUT and LP shall monitor whether the sleep condition remains for at least 750ms. |
| **Pass criteria** | Each test iteration shall be classified as pass, if all of the following condition(s) are fulfilled:<br>• $t\_sleep < sleep\_req\_timer$<br>$t\_sleep$ < 16ms<br>• Both the DUT and the LP must not leave the sleep condition after the SLEEP state has been entered. |

| | |
|---|---|
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 48: Main test structure of WAKE_IOP_17

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 6.4.1.1 | DUT as SLAVE | | WAKE_IOP_17_S_M |
| 6.4.1.2 | DUT as MASTER | WAKE_IOP_17_M_S | |

Table 49: Test case instances of WAKE_IOP_17

### 6.4.2 Remote sleep request after link-up

*ID:* WAKE_IOP_18

*Type:* Requirement

| | |
|---|---|
| **Synopsis** | Shall ensure that the DUT is able to enter the sleep mode and remain in this state after link-up was established when the sleep request is issued on the LP side. |
| **Prerequisites** | 1. DUT with the capability to reset and configure its PHYs.<br>2. DUT with the capability to set its PHYs into sleep mode.<br>3. The test system shall be able of providing time measurement capabilities synchronized with the test steps events. |
| **Test Setup** |  <br>• DUT shall be connected to an active link partner (LP1) with opposite MASTER/SLAVE configuration.<br>• A stable link-up condition shall be present at the moment of starting the test execution. |
| **Test procedure** | 1. Trigger a sleep request on the LP1<br>2. Start timer $t_0$<br>3. Wait until the DUT signalizes a sleep condition<br>4. Readout timer value ($t\_sleep = t_0$)<br>5. DUT and LP shall monitor whether the sleep condition remains for at least 750ms. |
| **Pass criteria** | Each test iteration shall be classified as pass, if all of the following condition(s) are fulfilled:<br>• *t_sleep < sleep_req_timer + sleep_ack_timer*<br>*t_sleep < 16ms + 8ms*<br>*t_sleep* < 24ms<br>• Both the DUT and the LP shall not leave the sleep condition after the SLEEP state has been entered. |
| **Test iterations** | See suggested test iterations in Appendix - 7.1 Suggested Iterations |
| **Notes** | |

Table 50: Main test structure of WAKE_IOP_18

| Instance Test Case # | DUT / LP configuration | LP as SLAVE | LP as MASTER |
|---|---|---|---|
| 6.4.2.1 | DUT as SLAVE | | WAKE_IOP_18_S_M |
| 6.4.2.2 | DUT as MASTER | WAKE_IOP_18_M_S | |

Table 51: Test case instances of WAKE_IOP_18

# 7 Appendix

## 7.1 Suggested Iterations

### 7.1.1 Nomenclature

The following parameters are to describe the test environment and if applicable the kind of stress and its location.

| Reference name | Description |
|---|---|
| 1000BASE-T1_IOP_XX | Test reference |
| SR | Soft Reset |
| HR | Hard Reset |
| O1 | Open is on ETH_N or ETH_P |
| O2 | Open on both ETH_N and ETH_P |
| S2 | Short on both ETH_N and ETH_P |
| NEAR | Open/Short near to DUT |
| FAR | Open/Short near to LP |
| M | MASTER |
| S | SLAVE |
| P | Swapped Polarity |
| C1 | Type A.3 Channel |
| C2 | Type A.1 Channel or a combination of Type A.2 and A.3 Channels |
| T1 | Room Temperature |
| T2 | -40°C |
| T3 | 105°C /125°C |

Table 52: Nomenclature of test enviroment variables

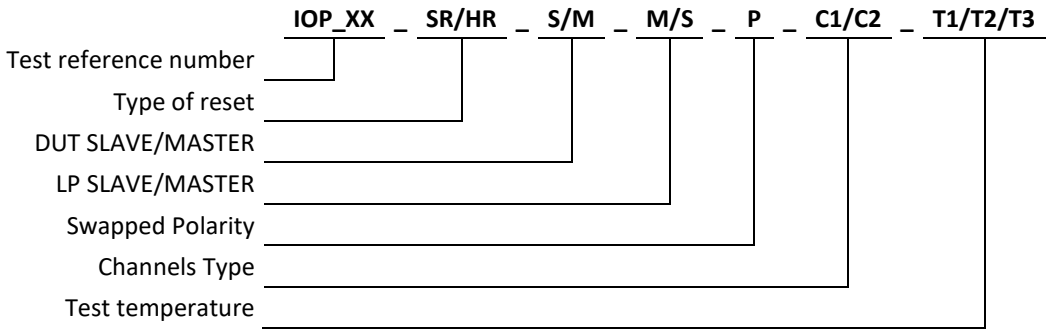



Figure 1: Groups 1 to 3 nomenclature

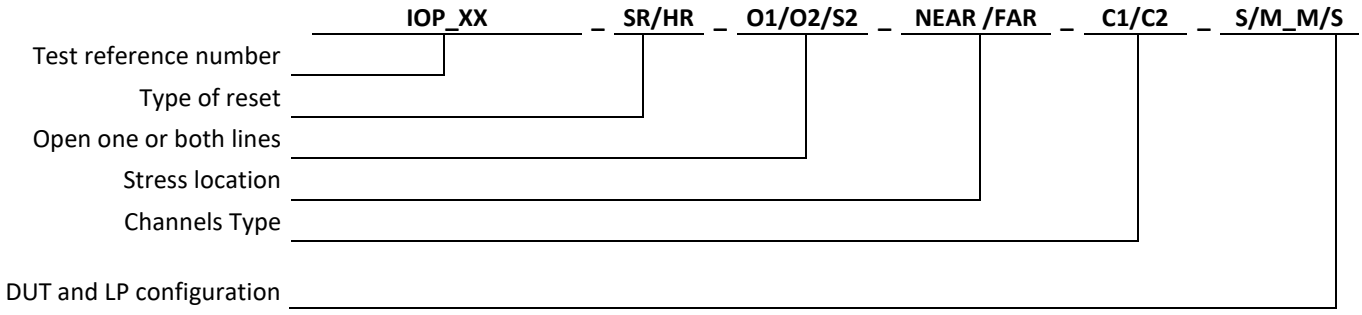


Figure 2: Group 4 nomenclature

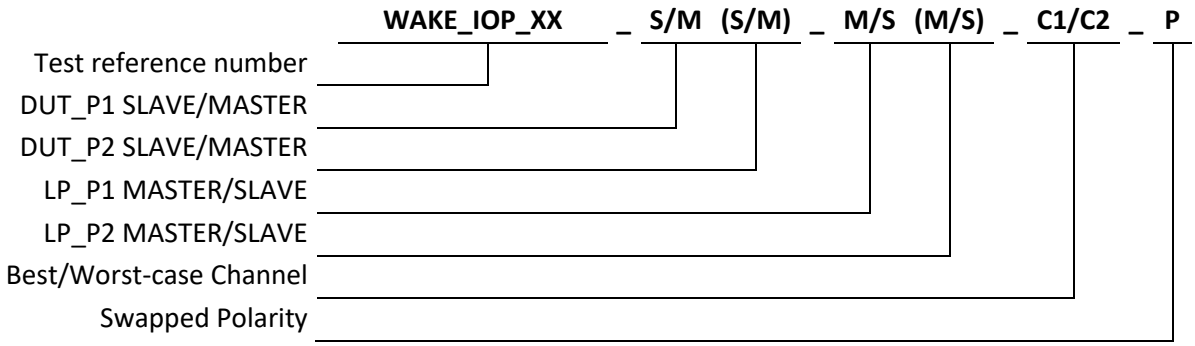



Figure 3: Group 5-8 nomenclature

### 7.1.2 Group 1 test cases iterations

| Group | Test Case | Minimal amount of iterations per LP* |
|---|---|---|
| Group 1: Link Status | IOP_16_SR_M_S_C1_T1 | 500.000 |
| | IOP_16_SR_M_S_C2_T1 | 500.000 |
| | IOP_16_SR_S_M_C1_T1 | 500.000 |
| | IOP_16_SR_S_M_P_C1_T1 | 8.000 |
| | IOP_16_SR_S_M_C2_T1 | 500.000 |
| | IOP_16_SR_S_M_P_C2_T1 | 18.000 |
| | IOP_17_SR_M_M_C2_T1 | 50.000 |
| | IOP_17_SR_S_S_C2_T1 | 50.000 |
| | IOP_19_SR_M_S_C2_T1 | 125.000 |
| | IOP_19_SR_S_M_C2_T1 | 125.000 |

Table 53: Group 1 test cases suggested iterations

**When considering multiple link partners tests.*

### 7.1.3 Group 2 test cases iterations

| Group | Test Case | Minimal amount of iterations per LP* |
|---|---|---|
| Group 2:<br><br>Link-Up | IOP_21_HR_M_S_C1_T1 | 200 |
| | IOP_21_HR_M_S_C1_T2 | 25 |
| | IOP_21_HR_M_S_C1_T3 | 25 |
| | IOP_21_HR_M_S_C2_T1 | 1.800 |
| | IOP_21_HR_M_S_C2_T2 | 225 |
| | IOP_21_HR_M_S_C2_T3 | 225 |
| | IOP_21_HR_S_M_C1_T1 | 200 |
| | IOP_21_HR_S_M_C1_T2 | 25 |
| | IOP_21_HR_S_M_C1_T3 | 25 |
| | IOP_21_HR_S_M_C2_T1 | 1.800 |
| | IOP_21_HR_S_M_C2_T2 | 225 |
| | IOP_21_HR_S_M_C2_T3 | 225 |
| | IOP_21_HR_S_M_P_C1_T1 | 200 |
| | IOP_21_HR_S_M_P_C1_T2 | 25 |
| | IOP_21_HR_S_M_P_C1_T3 | 25 |
| | IOP_21_HR_S_M_P_C2_T1 | 1.800 |
| | IOP_21_HR_S_M_P_C2_T2 | 225 |
| | IOP_21_HR_S_M_P_C2_T3 | 225 |
| | IOP_21_SR_M_S_C1_T1 | 250.000 |
| | IOP_21_SR_M_S_C1_T2 | 25.000 |
| | IOP_21_SR_M_S_C1_T3 | 25.000 |
| | IOP_21_SR_M_S_C2_T1 | 500.000 |
| | IOP_21_SR_M_S_C2_T2 | 25.000 |
| | IOP_21_SR_M_S_C2_T3 | 25.000 |
| | IOP_21_SR_S_M_C1_T1 | 250.000 |
| | IOP_21_SR_S_M_C1_T2 | 24.750 |
| | IOP_21_SR_S_M_C1_T3 | 24.750 |
| | IOP_21_SR_S_M_C2_T1 | 500.000 |
| | IOP_21_SR_S_M_C2_T2 | 25.000 |
| | IOP_21_SR_S_M_C2_T3 | 25.000 |
| | IOP_21_SR_S_M_P_C1_T1 | 8.000 |
| | IOP_21_SR_S_M_P_C1_T2 | 250 |
| | IOP_21_SR_S_M_P_C1_T3 | 250 |
| | IOP_21_SR_S_M_P_C2_T1 | 72.000 |
| | IOP_21_SR_S_M_P_C2_T2 | 2.250 |
| | IOP_21_SR_S_M_P_C2_T3 | 2.250 |
| | IOP_22_HR_M_S_C1_T1 | 800 |
| | IOP_22_HR_M_S_C1_T2 | 25 |
| | IOP_22_HR_M_S_C1_T3 | 25 |
| | IOP_22_HR_M_S_C2_T1 | 7.200 |

| Group | Test Case | Minimal amount of iterations per LP* |
|---|---|---|
| | IOP_22_HR_M_S_C2_T2 | 225 |
| | IOP_22_HR_M_S_C2_T3 | 225 |
| | IOP_22_HR_S_M_C1_T1 | 800 |
| | IOP_22_HR_S_M_C1_T2 | 25 |
| | IOP_22_HR_S_M_C1_T3 | 25 |
| | IOP_22_HR_S_M_C2_T1 | 7.200 |
| | IOP_22_HR_S_M_C2_T2 | 225 |
| | IOP_22_HR_S_M_C2_T3 | 225 |
| | IOP_22_HR_S_M_P_C1_T1 | 800 |
| | IOP_22_HR_S_M_P_C1_T2 | 25 |
| | IOP_22_HR_S_M_P_C1_T3 | 25 |
| | IOP_22_HR_S_M_P_C2_T1 | 7.200 |
| | IOP_22_HR_S_M_P_C2_T2 | 225 |
| | IOP_22_HR_S_M_P_C2_T3 | 225 |
| | IOP_22_SR_M_S_C1_T1 | 20.000 |
| | IOP_22_SR_M_S_C1_T2 | 625 |
| | IOP_22_SR_M_S_C1_T3 | 625 |
| | IOP_22_SR_M_S_C2_T1 | 180.000 |
| | IOP_22_SR_M_S_C2_T2 | 5.625 |
| | IOP_22_SR_M_S_C2_T3 | 5.625 |
| | IOP_22_SR_S_M_C1_T1 | 20.000 |
| | IOP_22_SR_S_M_C1_T2 | 625 |
| | IOP_22_SR_S_M_C1_T3 | 625 |
| | IOP_22_SR_S_M_C2_T1 | 180.000 |
| | IOP_22_SR_S_M_C2_T2 | 5.625 |
| | IOP_22_SR_S_M_C2_T3 | 5.625 |
| | IOP_22_SR_S_M_P_C1_T1 | 4.000 |
| | IOP_22_SR_S_M_P_C1_T2 | 125 |
| | IOP_22_SR_S_M_P_C1_T3 | 125 |
| | IOP_22_SR_S_M_P_C2_T1 | 36.000 |
| | IOP_22_SR_S_M_P_C2_T2 | 1.125 |
| | IOP_22_SR_S_M_P_C2_T3 | 1.125 |

Table 54: Group 2 test cases suggested iterations

**When considering multiple link partners tests.*

### 7.1.4 Group 3 test cases iterations

| Group | Test Case | Suggested amount of iterations | Minimal amount of iterations per LP* |
|---|---|---|---|
| Group 3: Signal Quality | IOP_24a_SR_M_S_C1_T1 | 1 | n.a. |
| | IOP_24a_SR_S_M_C1_T1 | 1 | n.a. |
| | IOP_24b_SR_M_S_C1_T1 | 1 | n.a. |
| | IOP_24b_SR_S_M_C1_T1 | 1 | n.a. |

Table 55: Group 3 test cases suggested iterations

*When considering multiple link partners tests.*

### 7.1.5 Group 4 test cases iterations

| Group | Test Case | Suggested amount of iterations | Minimal amount of iterations per LP* |
|---|---|---|---|
| Group 4: Cable Diagnostics | IOP_31_SR_C1_T1** | 50 | 50 |
| | IOP_31_SR_C2_T1** | 450 | 450 |
| | IOP_32_SR_O1_FAR_M_C2_T1 | 500 | n.a. |
| | IOP_32_SR_O1_FAR_S_C2_T1 | 500 | n.a. |
| | IOP_32_SR_O1_NEAR_M_C2_T1 | 500 | n.a. |
| | IOP_32_SR_O1_NEAR_S_C2_T1 | 500 | n.a. |
| | IOP_32_SR_O2_FAR_M_C2_T1 | 500 | n.a. |
| | IOP_32_SR_O2_FAR_S_C2_T1 | 500 | n.a. |
| | IOP_32_SR_O2_NEAR_M_C2_T1 | 500 | n.a. |
| | IOP_32_SR_O2_NEAR_S_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_FAR_M_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_FAR_S_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_NEAR_M_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_NEAR_S_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_FAR_GND_M_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_FAR_GND_S_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_NEAR_GND_M_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_NEAR_GND_S_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_FAR_VBAT_M_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_FAR_VBAT_S_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_NEAR_VBAT_M_C2_T1 | 500 | n.a. |
| | IOP_33_SR_S2_NEAR_VBAT_S_C2_T1 | 500 | n.a. |

Table 56: Group 4 test cases suggested iterations

*When considering multiple link partners tests.*
***Only Diagnostic test case (IOP 31)*

### 7.1.6 Group 5 test cases iterations

| Group | Test Case | Suggested amount of iterations |
|---|---|---|
| Group 5:<br><br>Wake-up reception and signalizing | WAKE_IOP_3_S_M_C1 | 2500 |
| | WAKE_IOP_3_M_S_C1 | 2500 |
| | WAKE_IOP_3_S_M_C2 | 2500 |
| | WAKE_IOP_3_M_S_C2 | 2500 |
| | WAKE_IOP_3_S_M_C1_P | 2500 |
| | WAKE_IOP_4_S_M_C1 | 5000 |
| | WAKE_IOP_4_M_S_C1 | 5000 |
| | WAKE_IOP_5_S_M_C1 | 2500 |
| | WAKE_IOP_5_M_S_C1 | 2500 |
| | WAKE_IOP_5_S_M_C2 | 2500 |
| | WAKE_IOP_5_M_S_C2 | 2500 |

Table 57: Group 5 test cases suggested iterations

### 7.1.7 Group 6 test cases iterations

| Group | Test Case | Suggested amount of iterations |
|---|---|---|
| Group 6:<br><br>Wake-up transmission | WAKE_IOP_7_M_S_C1 | 2500 |
| | WAKE_IOP_7_S_M_C1 | 2500 |
| | WAKE_IOP_7_M_S_C2 | 2500 |
| | WAKE_IOP_7_S_M_C2 | 2500 |
| | WAKE_IOP_7_M_S_C1_P | 2500 |
| | WAKE_IOP_8_S_M_C1 | 2500 |
| | WAKE_IOP_8_M_S_C1 | 2500 |
| | WAKE_IOP_8_S_M_C2 | 2500 |
| | WAKE_IOP_8_M_S_C2 | 2500 |
| | WAKE_IOP_9_S_M_C1 | 5000 |
| | WAKE_IOP_9_M_S_C1 | 5000 |

Table 58: Group 6 test cases suggested iterations

### 7.1.8 Group 7 test cases iterations

| Group | Test Case | Suggested amount of iterations |
|---|---|---|
| Group 7:<br><br>Wake-up forwarding | WAKE_IOP_11_MM_SS_C1 | 5000 |
| | WAKE_IOP_11_SS_MM_C1 | 5000 |
| | WAKE_IOP_11_MS_SM_C1 | 5000 |
| | WAKE_IOP_11_SM_MS_C1 | 5000 |
| | WAKE_IOP_12_MM_SS_C1 | 5000 |
| | WAKE_IOP_12_SS_MM_C1 | 5000 |
| | WAKE_IOP_12_MS_SM_C1 | 5000 |
| | WAKE_IOP_12_SM_MS_C1 | 5000 |
| | WAKE_IOP_13_MM_SS_C1 | 5000 |
| | WAKE_IOP_13_SS_MM_C1 | 5000 |
| | WAKE_IOP_13_MS_SM_C1 | 5000 |
| | WAKE_IOP_13_SM_MS_C1 | 5000 |
| | WAKE_IOP_14_MM_SS_C1 | 5000 |
| | WAKE_IOP_14_SS_MM_C1 | 5000 |
| | WAKE_IOP_14_MS_SM_C1 | 5000 |
| | WAKE_IOP_14_SM_MS_C1 | 5000 |
| | WAKE_IOP_15_MM_SS_C1 | 5000 |
| | WAKE_IOP_15_SS_MM_C1 | 5000 |
| | WAKE_IOP_15_MS_SM_C1 | 5000 |
| | WAKE_IOP_15_SM_MS_C1 | 5000 |

Table 59: Group 7 test cases suggested iterations

### 7.1.9 Group 8 test cases iterations

| Group | Test Case | Suggested amount of iterations |
|---|---|---|
| Group 8:<br><br>Sleep | WAKE_IOP_17_S_M_C1 | 5000 |
| | WAKE_IOP_17_M_S_C1 | 5000 |
| | WAKE_IOP_18_S_M_C1 | 5000 |
| | WAKE_IOP_18_M_S_C1 | 5000 |

Table 60: Group 8 test cases suggested iterations

## 7.2 Artificial degradation of channel quality

### 7.2.1 Description

Figure 4 shows an example approach to artificially reduce the quality of the communication channel with a differential directional coupler whose parameters are defined in Table 61.

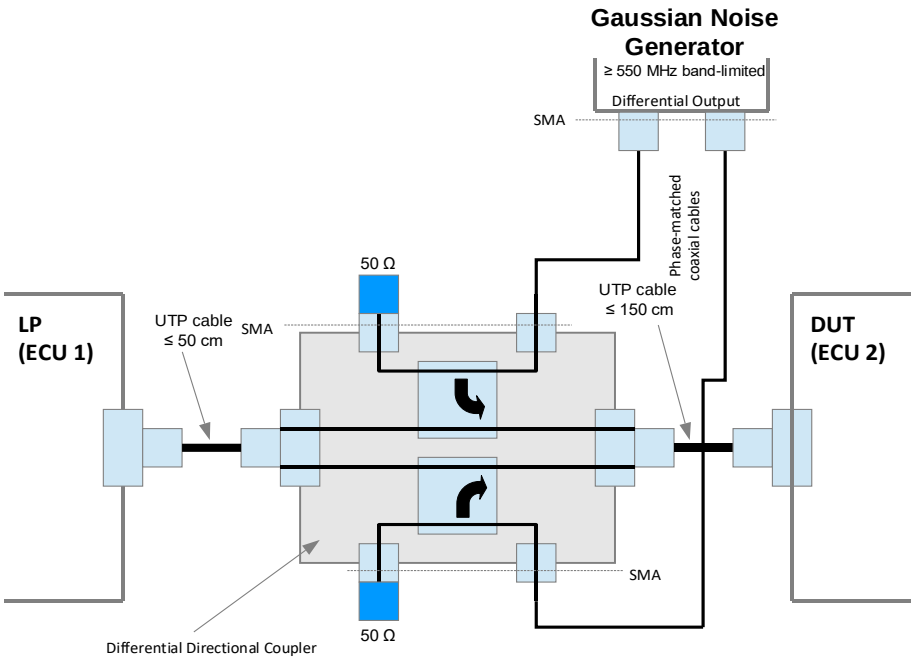



Figure 4: Example for artificial degradation of channel quality

| Differential Directional Coupler | | |
|---|---|---|
| **Parameter** | **Value** | **Frequency** |
| Insertion Loss | ≤ 1 dB | 1 – 600 MHz |
| Return Loss | $\geq \begin{pmatrix} 19 & 1 \leq f < 10 \\ 24 - 5\log f & 10 \leq f < 40 \\ 16 & 40 \leq f < 130 \\ 37 - 10\log f & 130 \leq f < 400 \\ 11 & 400 \leq f \leq 600 \end{pmatrix} dB$ | 1 – 600 MHz |
| Coupling Flatness | ± 1 dB | 1 – 600 MHz |
| Coupling Attenuation Forward | 20 dB ± 1 dB | |
| Coupling Attenuation Backward | 21 dB ± 1 dB | |

Table 61: Example for Differential Directional Coupler Parameters

## 7.3 Exemplar xGMII/SMI Pinout Interface for testing purposes.

Following figure shows an example of an xGMII/SMI Pinout Interface for PHY Board used for testing purposes. The aim of this example is the benefits of 'requiring' PHY silicon vendors to support similar pinout interface for testing with xGMII/MDIO access, due to the re-use factor if this pinout interface is aligned between different test houses. This example in particular covers the requirements for interoperability testing, it may be the case that other testing services, like conformance or EMC, require additional signals, if these have been omitted, any test house is free to enhance this pinout interface -- for example, TX_TCLK is not currently present on this example, this signal could be added (at least optionally).

| Pin | Signal | Signal | Pin |
|---|---|---|---|
| 1 | GND | VCC (3.3V) | 2 |
| 3 | GND | VCC (3.3V) | 4 |
| 5 | GND | GND | 6 |
| 7 | GND | MDC | 8 |
| 9 | GND | MDIO | 10 |
| 11 | IN1 | GND | 12 |
| 13 | GND | NC | 14 |
| 15 | GND | NC | 16 |
| 17 | INH | GND | 18 |
| 19 | GND | RGMII_RXD3 | 20 |
| 21 | GND | RGMII_RXD2 | 22 |
| 23 | GND | RGMII_RXD1 | 24 |
| 25 | GND | RGMII_RXD0 | 26 |
| 27 | OUT1 | GND | 28 |
| 29 | GND | RGMII_RXC | 30 |
| 31 | GND | RGMII_RX_CTL | 32 |
| 33 | WAKE | GND | 34 |
| 35 | GND | RGMII_TXC | 36 |
| 37 | SGMII_RXN | GND | 38 |
| 39 | SGMII_RXP | RGMII_TXD3 * | 40 |
| 41 | GND | RGMII_TXD2 * | 42 |
| 43 | GND | RGMII_TXD1 * | 44 |
| 45 | SGMII_TXN | RGMII_TXD0 * | 46 |
| 47 | SGMII_TXP | GND | 48 |
| 49 | GND | RGMII_TX_CTL | 50 |
| 51 | GND | GND | 52 |
| 53 | SPI_MOSI | TX_ER | 54 |
| 55 | SPI_MISO | RX_ER | 56 |
| 57 | SPI_CS1 | GND | 58 |
| 59 | SPI_CLK | RESET | 60 |
| BOTTOM | | TOP | |

Table 62: Example for xGMII / SMI Pinout

### 7.3.1 Connector description

**Manufacturer:** Samtec

**Description:** Conn Edge Rate Socket Strip SKT 60 POS 0.8mm Solder ST Edge Mount T/R

**Part number:** ERF8-030-01-L-D-EM2

## 7.4 List of tables

## 7.5 List of figures