MOST

Media **O**riented **S**ystems **T**ransport

Multimedia and Control
Networking Technology

Compliance Verification Procedure – Physical Layer
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MOST® COOPERATION

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SUPPORT AND FURTHER INFORMATION

For more information on the MOST technology, please contact:

MOST Cooperation
Administration
P. O. Box 4327
D-76028 Karlsruhe
Germany

Tel: (+49) (0) 721 966 50 00
Fax:(+49) (0) 721 966 50 01
E-mail: contact@mostcooperation.com
Web: www.mostcooperation.com

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Bibliography

Number	Document
[1]	MOST Specification Framework
[2]	MOST Specification
[3]	MOST High Protocol Specification
[8]	MOST FunctionCatalog
[9]	MOST Specification Of Physical Layer
[10]	MOST Compliance Test of Physical Layer
[11]	MOST Compliance Requirements

Document History

Changes

Change Ref.	Section	Changes

1 Introduction

1.1 Relevance of Compliance

Compliance in terms of Physical layer means products have to fulfill all specified parameters. In addition the Interfaces SP2 and SP3 have to fit the mechanical Interface-requirements. The process of compliance certification is not able to check all parameters considering possible input and environmental conditions. Also the number of tested devices is not sufficient to ensure product quality and stability of parameters over a product's lifetime (e.g. ISO 9000).

The requirements stated in the specification of MOST physical layer have to be guaranteed by the supplier. Therefore suppliers of devices, modules and components have to implement suitable processes like product-characterization, qualification and end-of-line-testing.

1.2 Related Documents

The ***Most Specification of Physical layer*** [9] defines parameters that are relevant for signal integrity. The parameters are related to specific interfaces SP1, SP2, SP3 and SP4. Also the mechanical interfaces at SP2 and SP3 are specified. The ***Most Compliance Test of Physical Layer*** [10] describes how to analyze these physical interfaces, in terms of fulfilling the requirements of a MOST compliant interface. These Documents are applicable for Most-devices as well as for modules and components. The process of Compliance Verification is defined in the Most document ***MOST Compliance requirements*** [11]. It describes how to achieve a compliance certification for MOST subsystems.

Terminology of naming within these documents:

MOST End Product in document [11] = Device in document [9,10]:

Any product within the bounds of scope that is offered for sale or is distributed in an unmodified form to any end user who acquires the product for such end user's personal or commercial use, alone or in combination with any other product.
Electronic Control Unit (ECU) that contains MOST modules

MOST Component in document [11] covers Module in document [9,10]:

Assembly of components that are bounded between two specification points
(e. g. EOC, OEC)

MOST Component in document [11] covers Components in document [9,10]:

Parts that are used to build up modules (e. g. Fiber Optical Transceivers (FOT), Connector, housing).
The components like FOTs can contain components itself (LED, driver – IC, etc.)

→ A component product within the bounds of Scope designed and marketed for the enabling of a complete MOST End Product, yet not being able to function as a complete MOST End Product. A MOST Component is only licensed for integration into a MOST End Product that is subsequently verified for compliance.

1.3 Location of Interfaces

SP1 describes input parameters for the EOC and properties of the EOC-input. It also describes the output parameters of a NIC, including data path between NIC and EOC.
SP2: defines the optical output signal

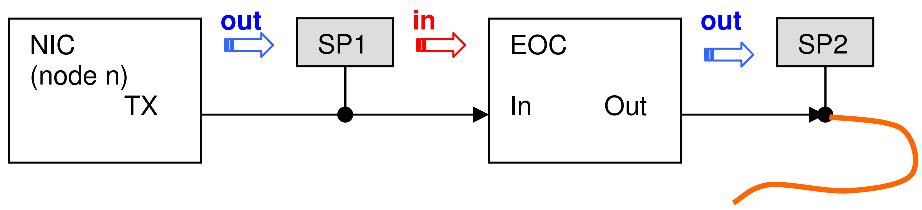

Figure 1-1: Location of specification points 1/2

SP3 defines the input parameters for the OEC. The parameters are identical with SP2 except optical power and transition times. These parameters are affected by the transmission via the optical fiber. The main effect due to the transmission line is optical attenuation.
SP4 describes the output parameters for OECs. The limitations are derived from the NICs input tolerances, therefore SP4 defines also the input section of NICs.

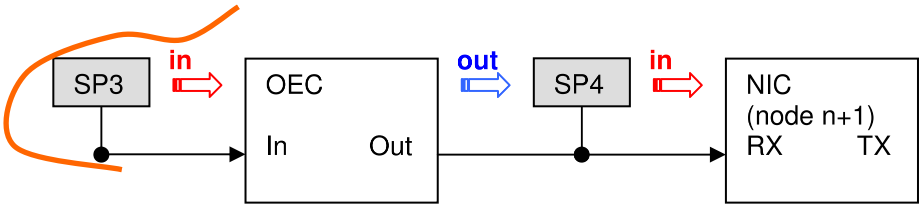

Figure 1-2: Location of specification points 3/4

Signals that fulfill the SP4-parameters can be recovered by the NIC, signals outside the ranges may cause bit-errors. On TX of the NIC (node n+1) a recovered signal is available according to SP1 requirements, timing distortion (except Phase Variation) is eliminated.

1.4 Limited access to specification points

Verification of parameter at particular SPs requires access to that particular interface. In addition for most of the Parameters a stimulation signal at the previous SP is required. Full access to all SPs is only guaranteed on Module-Level. On Device-level MCTH's do not have access to SP1 and SP2. Therefore a compliance verification on Component- and Module-level is highly appreciated. This allows to simplify the compliance verification of Devices, using the limited (access) compliance procedure. The MOST specification of ***MOST Compliance Requirements*** [11] offers the opportunity of testing components and modules according their "covered functionality". Depending on the partitioning of components within modules or Devices the respective parameters can be verified at single components. These parameters do need to be verified on higher product integration levels.

1.4.1 Example for "covered functionality"

An EOC is defined by the interfaces SP1 and SP2, including the electrical to optical conversion and the geometry of the connecting system. An EOC is compliant when all SP2-requirements are fulfilled, considering input parameter and the respective ranges at SP1.

- A light emitting source (e.g. LED) that is part of the EOC affects directly the parameters with respect to emitting wavelength. (➔ Wavelength, FWHM)
  Component
  ↓
  - An optical transmitter (e.g. FOT-TX (driver-chip & LED-Chip)) covers nearly the complete EOC-performance, (➔timing: PWV, APWD, DDJ, UJ, transition times; pulse shape: pos./neg. Overshoot, signal ripple; optical power).
    Component/Module
    ↓
    - The EOC contains the above mentioned transmitter. The optical output power is influenced by the optical transmitter and the interface geometry at SP2. (➔ optical power; interface geometry)
      Module
      ↓
      - The device contains the EOC (module). The optical output power is only influenced by the application of the EOC in the device.
        Device

2 Parameter-Overview

The following table shows all parameters of the ***Most Specification of Physical layer*** [9]. The table corresponds strictly to table 2-1 of the ***MOST Compliance Test of Physical Layer*** [10] and contains an indication about the meaning of the parameters for the interfacing components, modules and device (input, output, property). For each parameter it indicates how compliance can be achieved dependent from type (component (MOST NIC), module (EOC/OEC) and device).

	Parameter to be compliant	**MOST NIC**	**Co**	**EOC**	**Co**	**Optical link**	**Co**	**OEC**	**Co**	**Device**	**Co**
SP1											
	Bit Rate	Output	C	Input	C						
	Logic Levels	Output	C	Input	C						
	Fall- / Rise Time	Output	C	Input	C						
	Pulse-Width-Variation	Output	C	Input	C						
	Average Pulse Width Distortion	Output	C	Input	C						
	Data Dependent Link Jitter	Output	C	Input	C						
	Uncorrelated Link Jitter	Output	C	Input	C						
	Input resistance / -capacitance	1)	C	Property	C						
SP2											
	Peak wavelength			Output	C	Input	N			Output	D
	FWHM			Output	C	Input	N			Output	D
	Optical output power			Output	C	Input	S			Output	C
	Optical output power for "light off"			Output	C	Input	S			Output	C
	Extinction ratio			Output	C	Input	N			Output	D
	Fall- / rise-time			Output	C	Input	N			Output	D
	Pulse-Width-Variation			Output	C	Input	N			Output	C
	Average Pulse Width Distortion			Output	C	Input	N			Output	C
	Data Dependent Link Jitter			Output	C	Input	N			Output	C
	Uncorrelated Link Jitter			Output	C	Input	N			Output	C
	Positive /negative overshoot high level signal ripple			Output	C	Input	N			Output	D
SP3											
	Receivable optical power range for data recovery					Output	S	Input	C	Input	C
	Receivable optical power range for switching to "light off state"					Output	S	Input	C	Input	D
	Extinction ratio					Output	N	Input	C	Input	D
	Fall- / rise-time					Output	S	Input	C	Input	D
	Pulse-Width-Variation					Output	N	Input	C	Input	C
	Average Pulse Width Distortion					Output	N	Input	C	Input	C
	Data Dependent Link Jitter					Output	N	Input	C	Input	C
	Uncorrelated Link Jitter					Output	N	Input	C	Input	C
SP4											
	Bit Rate	Input	C					Output	C		
	Logic levels	Input	C					Output	C		
	Fall- / rise-time	Input	C					Output	C		
	Pulse-Width-Variation	Input	C					Output	C		
	Average Pulse Width Distortion	Input	C					Output	C		
	Data Dependent Link Jitter	Input	C					Output	C		
	Uncorrelated Link Jitter	Input	C					Output	C		
1) MOST NIC has to drive more than the input capacitance of the EOC											

Table 2-1: Compliance procedures for all parameters of specification points.

Co: Column which defines the procedures how to get compliance of specification parameters for NICs, EOCs, OECs and devices

Procedures:

C = Verification by characterization *1)

D = Verification by datasheet of the used MOST compliant components (no influence possible due to application)

S = To be verified by system integrator

N = No test necessary since not relevant

*1) The parameter needs to be characterized on the particular level (component → module → device).
If characterization data are available of components which are used in modules and if it is proved that the module (application) has no influence to that parameter the module needs not to be characterized again for this parameter. This is the same when using characterized components or modules in devices. The supplier may provide evidence for characterization/qualification process on lower level.
E.g. FWHM is characterized and guaranteed by the LED manufacturer and can not be influenced by other parameters like power supply. Therefore FOT-manufacturers or EOC-manufacturers do not need to characterize this parameter if they get characterization results of the LED from their suppliers. Device manufacturers just refer to the FOT datasheet for that parameter.

Parameters, defined in the ***Most Specification of Physical layer*** [9] are mandatory parameters for component/module datasheets. The verification of these parameters is done using the procedure of the product characterization.

3 Physical Layer Testing for Modules and Components

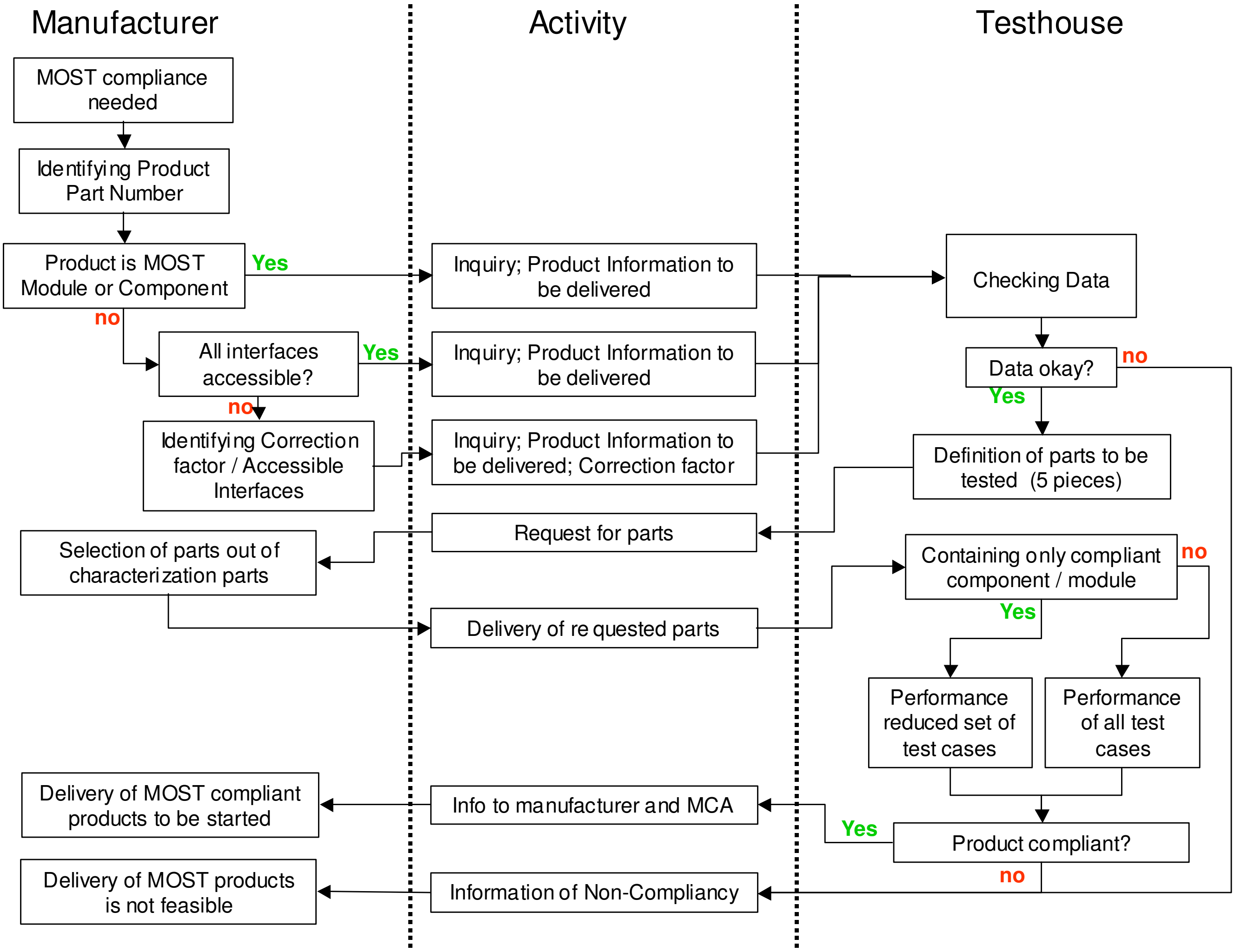

Table 3-1: Flow of compliance process for components and modules.

Definition of Terms:

MOST Module	Product between two interfaces, which are defined in the ***Most Specification of Physical layer*** [9]
Product information	for compliance needed information: construction, data sheet, application spec, list of used compliant parts, characterization information of product (covered functionality can be part of the characterization information)
Correction factor	deviation between MOST specification point and measurable point of part (optical path (example: Transmitter sending light with min. –8 dBm to achieve limit of SP2 –10 dBm)

4 Limited Physical Compliance

4.1 Overview

Generally compliance testing requires access to all specification points. In addition various test signals have to be applied to particular interface in order to check worst case performance of components and modules that are connected to that interface. The whole testing has to consider all environment conditions (e.g. specified temperature range, power supply range).
Testing devices, access to all interfaces can not be achieved without modification or opening of the device. A MCTH has only access to SP2 and SP3. Therefore variation of input parameters is only possible at SP3 (signal input of the device). Power supply of NIC, EOC and OEC is fixed by the design of the device and can not be varied. Considering these circumstances the “limited compliance” describes a simplified test procedure that uses only the accessible interfaces of a MOST-device, SP2 and SP3.

4.2 Procedure

- A test signal is applied to SP3 of the DUT
  The test signals needs to be varied in order to simulate worst case situations (=Test-Cases)
  (e.g. optical power, timing distortion, data pattern,...)
  Optical power , and timing distortion of the test signal has to be documented prior to each test sequence.
- Correct data recovery has to be checked, using diagnostic functions of function block “ET”
- The (recovered) output signal at SP2 of the DUT has to be measured (Timing and optical power)
- All tests have to be performed at room-temperature (23℃ +/-5°) / typical power supply and at the limits of the temperature range / power supply range.

The following diagram shows the required test setup.

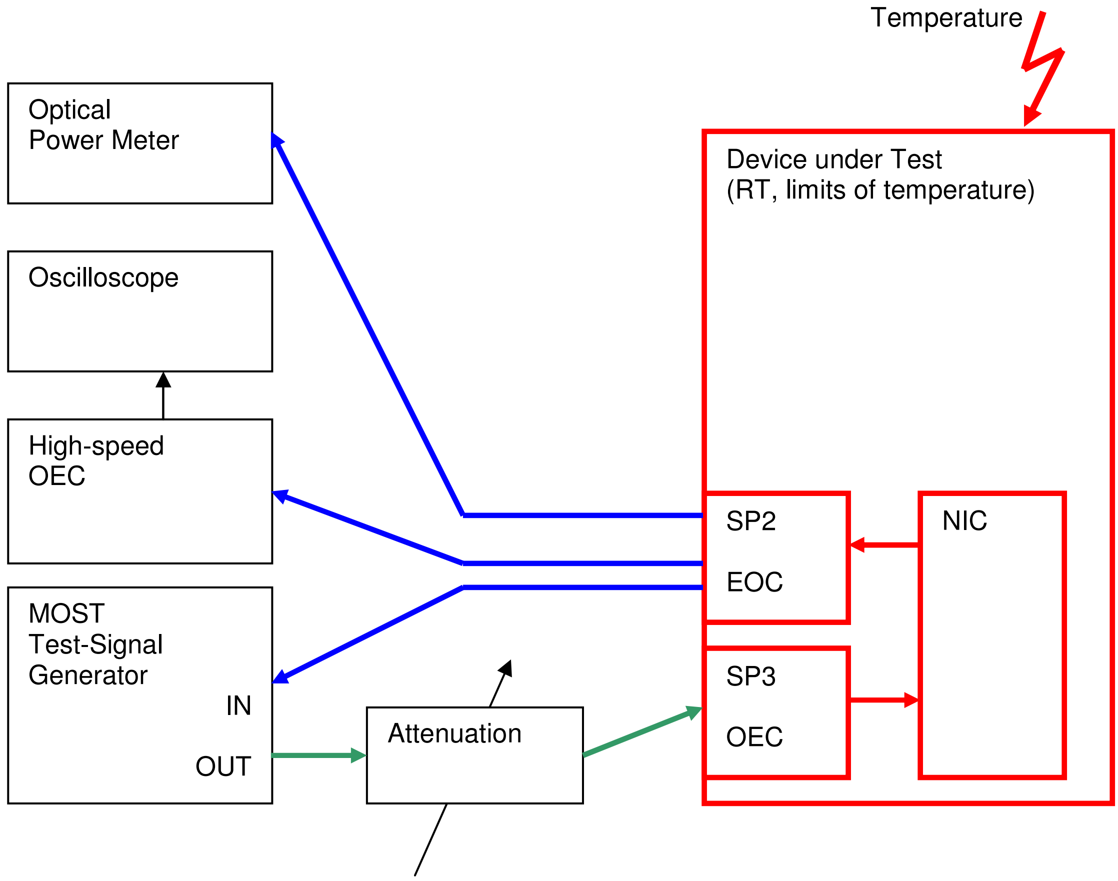

Figure 4-1: General test setup for limited compliance test

4.3 Generating test signals for the DUT Input section SP3

A test signal for testing the DUTs input section theoretically can be varied by several parameters and combinations of that parameters. These parameters are describing timing properties, optical power levels, pulse shape characteristics and emitting wavelength.
A specific Data pattern has to be generated and transferred to the DUT. The pattern contains data structures that may cause worst case response on the DUT's OEC. The parameter variation of the input signal (SP3) together with variations in the OEC's caused by the data pattern leads to a worst case output signal at SP4. For non-compliant devices/components this SP4-signal may exceed the given tolerances and cause errors in the data recovery.
Also a communication via MOST control channel between DUT and test-controller is required in order to communicate with the DUT's function block "ET". Therefore a MOST data stream containing all framing and administration information has to be used. The data pattern has to be implemented into all channels for synchronous and asynchronous data.
For testing DUT's in Slave or Master mode, the MOST test signal generator itself also needs to act as Master or Slave.
For compliance verification it is not possible to consider all possible combination of parameters. A moderate simplification and reduction to some test cases that represent realistic situations is required.

4.3.1 Variation of physical parameters

The following parameters on SP3 have most significant influence to the behavior of a device:

Optical input power at SP3	P_{opt3} (max) P_{opt3} (min)
Timing Distortion	minimum APWD (considering PWV constrains) maximum APWD (considering PWV constrains)

As a consequence the optical transmitter that is implemented into the MOST test signal generator has to correspond to the following requirements:

- The test setup has to fulfill all parameters of the MOST physical layer specification for SP3
- In addition the PWVrange (maximum – minimum PWV) has to be
 $< \{[T_{PWV2}(max) - T_{PWV2}(min)] – [T_{PWV1}(max) - T_{PWV1}(min)]\} / 2$
- The Duty Cycle of the transmitted signal has to be adjustable (range = APWDmin-max)
- At least two settings for optical power are required (P_{opt3} (min), P_{opt3} (max) @SP3)
- The geometry of the optical interface of that transmit-unit has to fit into the DUT's SP3-contact
- A fixed data (test) pattern has to be transferred

Setup	Popt @SP3	PWV@SP3	Temperature/Power Range
1	P_{opt3} (max)	APWDmin (considering PWVmin)	$T_{23°C}$ / U_{typ}
2	P_{opt3} (max)	APWDmax (considering PWVmax)	$T_{23°C}$ / U_{typ}
3	P_{opt3} (min)	APWDmin (considering PWVmin)	$T_{23°C}$ / U_{typ}
4	P_{opt3} (min)	APWDmax (considering PWVmax)	$T_{23°C}$ / U_{typ}
5	P_{opt3} (max)	APWDmin (considering PWVmin)	T_{max} / U_{min}
6	P_{opt3} (max)	APWDmax (considering PWVmax)	T_{max} / U_{max}
7	P_{opt3} (min)	APWDmin (considering PWVmin)	T_{max} / U_{min}
8	P_{opt3} (min)	APWDmax (considering PWVmax)	T_{max} / U_{max}
9	P_{opt3} (max)	APWDmin (considering PWVmin)	T_{min} / U_{min}
10	P_{opt3} (max)	APWDmax (considering PWVmax)	T_{min} / U_{max}
11	P_{opt3} (min)	APWDmin (considering PWVmin)	T_{min} / U_{min}
12	P_{opt3} (min)	APWDmax (considering PWVmax)	T_{min} / U_{max}
Note: DDJ, UJ, Rise-/Fall-times, positive overshoot, negative overshoot, high level signal ripple, extinction ratio are typical but have to fulfill the specification. Again, be aware that these settings doesn't cover all possible failure modes of a DUT. Power Range = U_{Batt} ($U_{Critical}$ .. U_{Super}, details see Most specification [2].)			

Table 4-1: Summary of Test cases.

4.3.2 Measurement of SP2 output signal of the DUT

The parameters in Table 4-2 below have to be measured for each test case showed in Table 4-1. The tests have to be performed at

1. $T_{23°C}$ / $U_{typ\ ;}$
2. T_{min} / $U_{min\ ;}$ T
3. T_{min} / $U_{max\ ;}$
4. T_{max} / $U_{min\ ;}$
5. T_{max} / $U_{max\ ;}$

while going from U_{typ} → U_{min} → U_{max}.

Measurement of the DUT-SP2 signal	Tool
Optical output power P_{opt2}	Power-Meter / SP2 measurement adapter
Timing: + PWV (t_{2pwv}) + APWD (t_{2apwd}) + rise-/fall-times ($t_{r2,}$ t_{f2})	High-Speed-OEC & Oscilloscope
Pulse shape: + Positive Overshoot within 0UI..2/3UI + Negative Overshoot within –1UI..–1/4UI + High Level Signal Ripple between 2/3UI and 3/4U + Extinction ratio $r_{e2,}$	High-Speed-OEC & Oscilloscope

Table 4-2: Summary of measurements at SP2 (DUT)

A detailed description of the measurement is given by the ***Most Compliance Test of Physical Layer*** [10].

5 Full Physical Compliance

5.1 Overview

Full physical compliance refers to MOST modules or MOST components.

	Parameter to be compliant	Phys. Layer Compliance Testing of Module	Data required (Stimulus)	Data required (Output)
SP1				
	Bit Rate	-	Speed	-
	Logic Levels	Verify	Method of input	Measure (T,U)
	Fall- / Rise Time	Verify	Method of input	Measure (T,U)
	Pulse-Width-Variation	Stimulus	Method of input	Measure (T,U)
	Average Pulse Width Distortion	Stimulus	Method of input	Measure (T,U)
	Data Dependent Link Jitter	-	Method of input	Measure (T,U)
	Uncorrelated Link Jitter	-	Method of input	Measure (T,U)
	Input resistance / -capacitance	Optional	-	Datasheet
SP2				
	Peak wavelength	Verify	-	Information of subcomponent
	FWHM	Verify	-	Information of subcomponent
	Optical output power	Measure (T,U)	-	Measure (T,U) ***Datasheet***
	Optical output power for "light off"	Measure (T,U)	-	Measure (T,U) ***Datasheet***
	Extinction ratio	Measure (T,U)	-	Measure (T,U)
	Fall- / rise-time	Measure (T,U)	-	Measure (T,U)
	Pulse-Width-Variation	Measure (T,U)	-	Measure (T,U)
	Average Pulse Width Distortion	Measure (T,U)	-	Measure (T,U)
	Data Dependent Link Jitter	Measure (T,U)	-	Measure (T,U)
	Uncorrelated Link Jitter	Verify	-	Measure (T,U)
	Positive /negative overshoot	Measure (T,U)	-	Measure (T,U)
SP3				
	Receivable optical power range for data recovery	Stimulus	Method of input **Datasheet**	Check Sleep / Operationmode
	Receivable optical power range for switching to "light off state"	Stimulus	Method of input **Datasheet**	Check Sleep / Operationmode
	Extinction ratio	Verify	Method of input	-
	Fall- / rise-time	Typical	Method of input	-
	Pulse-Width-Variation	(Stimulus)	Method of input	-
	Average Pulse Width Distortion	(Stimulus)	Method of input	-
	Data Dependent Link Jitter	Typical	Method of input	-
	Uncorrelated Link Jitter	Typical	Method of input	-

	Parameter to be compliant	Phys. Layer Compliance Testing of Module	Data required (Stimulus)	Data required (Output)
SP4				
	Bit Rate	-	Speed	-
	Logic levels	Measure (T,U)	Method of input	Measure (T,U)
	Fall- / rise-time	Measure (T,U)	Method of input	Measure (T,U)
	Pulse-Width-Variation	Measure (T,U,P_{opt3})	Method of input	Measure (T,U, P_{opt3})
	Average Pulse Width Distortion	Measure (T,U,P_{opt3})	Method of input	Measure (T,U, P_{opt3})
	Data Dependent Link Jitter	Measure (T,U,P_{opt3})	Method of input	Measure (T,U, P_{opt3})
	Uncorrelated Link Jitter	Measure (T,U,P_{opt3})	Method of input	Measure (T,U, P_{opt3})

Table 5-1: Summary of measurements at MCTH and required information of manufacturer

Legend:

Measure (T, U): Measure at min., max. and room temperature (23°C +/- 5°)
as well as with min., max. and typ. voltage.

Green: Transmitter
Yellow: Receiver
Blue: NIC

6 Direct physical measuring resolution

Direct physical measuring resolution:	
Operating voltage	± 0,1V-range for full physical compliance ± 0,25V-range for Limited Compliance / U_{Batt}
Optical power	± 0,5dB-range for setup ± 0,25dB-range for measuring equipment
Timing, optical signals	± 0,25 ns- range for setup ± 0,1ns for measuring equipment
Timing, electrical	± 0,1ns only full physical compliance
Temperature	± 2°C

Table 6-1: Summary of accuracy of measurement setup

7 General Remarks

7.1 Data Pattern

The data pattern requires two different structure elements, that are derived from WCPWV (worst case pattern for PWV) and WCDDJ (worst case pattern for DDJ). For a detailed description of generating patterns on real MOST-frames, please refer chapter 1.1.4 in ***Most Compliance Test of Physical Layer*** [10]. Figure 7-1 shows a test pattern which combines wc –scenarios for PWV and DDJ and can be used for limited compliance testing.

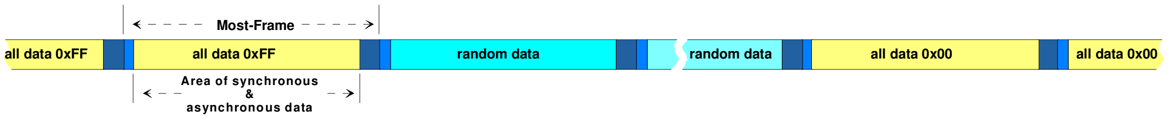

Figure 7-1: Test pattern useable for limited compliance

The following table gives an example of such a Data Pattern:
The pattern uses two MOST-frames. The first frame contains random data (respective a replacement, using static data). The second frame stimulates data dependant effects.

Frame 1								
Byte	0	1	2	3	4	5	6	7
Content	Preamble	random	random	random	random	random	random	Random
Byte	8	9	10	11	12	13	14	15
Content	Random	random	random	random	random	random	random	Random
Byte	16	17	18	19	20	21	22	23
Content	random	random	random	random	random	random	random	random
Byte	24	25	26	27	28	29	30	31
Content	random	random	random	random	random	random	random	random
Byte	32	33	34	35	36	37	38	39
Content	random	random	random	random	random	random	random	random
Byte	40	41	42	43	44	45	46	47
Content	random	random	random	random	random	random	Random	random
Byte	48	49	50	51	52	53	54	55
Content	random	random	random	random	random	random	Random	random
Byte	56	57	58	59	60	61	62	63
Content	random	random	random	random	Random	Admin.	Admin.	Admin.

Frame 2								
Byte	0	1	2	3	4	5	6	7
Content	preamble	0x00	0x00	0x00	0x00	0x00	0x00	0x00
Byte	8	9	10	11	12	13	14	15
Content	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
Byte	16	17	18	19	20	21	22	23
Content	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
Byte	24	25	26	27	28	29	30	31
Content	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0xFF
Byte	32	33	34	35	36	37	38	39
Content	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF
Byte	40	41	42	43	44	45	46	47
Content	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF
Byte	48	49	50	51	52	53	54	55
Content	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF
Byte	56	57	58	59	60	61	62	63
Content	0xFF	0xFF	0xFF	0xFF	0xFF	Admin.	Admin.	Admin.

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