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PMD for Fiber Optic Wake-on-LAN

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Abstract

This specification describes an implementation of sleep and wake functions for fiber optic transceivers and specifies fiber optic transceiver dimensions for automotive applications.

Keywords

Automotive, IEEE 1394, IEEE 1394b, fiber optic transceiver, FOT, hard-clad polymer fiber, HCPF, plastic optical fiber, POF, Serial Bus

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Foreword (This foreword is not part of 1394 Trade Association Specification 2004024)

This specification defines the physical medium-dependent (PMD) wake-on-LAN facilities and methods for IEEE Std 1394b-2002 fiber-optic ports for both glass and plastic optical fiber. The power states of the wake-on-LAN fiber-optic transceivers (FOTs) are mapped to corresponding IEEE 1394b port power states. The FOTs are characterized informatively in terms of architecture and mechanical design and normatively in terms of timing, control signal protocols and test procedures.

There are 4 annexes in this specification. Annexes A, B, and C and their subsections are normative and part of this specification. Annex D is informative and not part of this specification.

This specification was accepted by the Board of Directors of the 1394 Trade Association. Board of Directors acceptance of this specification does not necessarily imply that all board members voted for acceptance. At the time it accepted this specification, the 1394 Trade Association. Board of Directors had the following members:

Eric Anderson, Chair
Max Bassler, Vice-Chair
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Samsung	Jong-Wook Park

The Automotive Working Group, which developed and reviewed this specification, had the following members:

James Snider, Chair:
Bob Fust, Secretary

PMD for Fiber Optic Wake-on-LAN

1 Scope and purpose

1.1 Scope

This specification is motivated by automotive industry requirements for minimum electrical power consumption by all components within a vehicle in order to a) maximize useful battery life between recharge cycles and b) maximize fuel economy while the vehicle is operating. A fiber-optic transceiver enhanced with wake-on-LAN circuitry can enter a low-power state in which it can detect a remotely originated optical wake-up signal. This information can be communicated in turn to the fiber optic transceiver's associated Serial Bus port in order that it resumes normal operation.

The specification is not restricted to automotive applications and may be useful in any situation where minimizing power consumption is desirable.

1.2 Purpose

This specification defines physical medium-dependent (PMD) wake-on-LAN facilities and methods for IEEE Std 1394b-2002 fiber-optic ports for both glass and plastic optical fiber. The power states of the wake-on-LAN fiber-optic transceivers (FOTs) are mapped to corresponding IEEE 1394b port power states. The FOTs are characterized informatively in terms of architecture and mechanical design and normatively in terms of timing, control signal protocols and test procedures.

2 Normative references

2.1 Reference scope

The specifications and standards named in this section contain provisions, which, through reference in this text, constitute provisions of this 1394 Trade Association Specification. At the time of publication, the editions indicated were valid. All specifications and standards are subject to revision; parties to agreements based on this 1394 Trade Association Specification are encouraged to investigate the possibility of applying the most recent editions of the specifications and standards indicated below.

2.2 Approved references

The following approved specifications and standards may be obtained from the organizations that control them.

IEEE Std 1394-1995, Standard for a High Performance Serial Bus

IEEE Std 1394a-2000, Standard for a High Performance Serial Bus—Amendment 1

IEEE Std 1394b-2002, Standard for a High Performance Serial Bus—Amendment 2

1394 Trade Association Document 2001018, 1394 Automotive Specification (IDB-1394)

Optical Implementation Using IEEE 1394b, Application Report SGZA001A, March 2004, David Rekieta [Texas Instruments], http://www-s.ti.com/sc/psheets/sgza001a/sgza001a.pdf

Throughout this document, the term "IEEE 1394" shall be understood to refer to IEEE Std 1394-1995 as amended by IEEE Std 1394a-2000 and IEEE Std 1394b-2002.

2.3 Reference acquisition

The references cited may be obtained from the organizations that control them:

1394 Trade Association, 1560, East Southlake Boulevard; Editor, 1394 Trade Association; Suite 242; Southlake; TX 76092; USA. (817) 416-2200 / (817) 416-2256 (FAX); http://www.1394ta.org/

Institute of Electrical and Electronic Engineers (IEEE), 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331, USA; (732) 981-0060 / (732) 981-1721 (FAX); http://www.ieee.org/

In addition, many of the documents controlled by the above organizations may also be ordered through a third party:

Global Engineering Documents, 15 Inverness Way, Englewood, CO 80112-5776; (800) 624-3974 / (303) 792-2192; http://www.global.ihs.com/

3 Definitions and notation

3.1 Definitions

3.1.1 Conformance

Several keywords are used to differentiate levels of requirements and optionality, as follows:

3.1.1.1 expected: A keyword used to describe the behavior of the hardware or software in the design models assumed by this specification. Other hardware and software design models may also be implemented.

3.1.1.2 ignored: A keyword that describes bits, bytes, quadlets, octlets or fields whose values are not checked by the recipient.

3.1.1.3 may: A keyword that indicates flexibility of choice with no implied preference.

3.1.1.4 reserved: A keyword used to describe objects (bits, bytes, quadlets, octlets and fields) or the code values assigned to these objects in cases where either the object or the code value is set aside for future standardization. Usage and interpretation may be specified by future extensions to this or other specifications. A reserved object shall be zeroed or, upon development of a future specification, set to a value specified by such a specification. The recipient of a reserved object shall ignore its value. The recipient of an object defined by this specification as other than reserved shall inspect its value and reject reserved code values.

3.1.1.5 shall: A keyword that indicates a mandatory requirement. Designers are required to implement all such mandatory requirements to assure interoperability with other products conforming to this specification.

3.1.1.6 should: A keyword that denotes flexibility of choice with a strongly preferred alternative. Equivalent to the phrase “is recommended.”

3.1.2 Glossary

The following terms are used in this specification:

3.1.3 Abbreviations

The following are abbreviations that are used in this specification:

FOT	Fiber-optic transceiver
HPCF	Hard polymer-clad fiber
IDB	Intelligent Transportation System Data Bus
IEEE	Institute of Electrical and Electronic Engineers,
NA	Numerical aperture
OPR	Optical reference plane
PHY	Physical layer
PMD	Physical medium-dependent
POF	Plastic optical fiber
SD	Signal detect
Tx/Rx	Transmitter/receiver
WSD	Wake signal detect

3.2 Numeric values

Decimal and hexadecimal are used within this specification. By editorial convention, decimal numbers are most frequently used to represent quantities or counts. Addresses are uniformly represented by hexadecimal numbers. Hexadecimal numbers are also used when the value represented has an underlying structure that is more apparent in a hexadecimal format than in a decimal format.

Decimal numbers are represented by Arabic numerals without subscripts or by their English names. Hexadecimal numbers are represented by digits from the character set 0 – 9 and A – F followed by the subscript 16. When the subscript is unnecessary to disambiguate the base of the number it may be omitted. For the sake of legibility hexadecimal numbers are separated into groups of four digits separated by spaces.

As an example, 42 and $2A_{16}$ both represent the same numeric value.

4 Automotive Port States

4.1 Port architecture

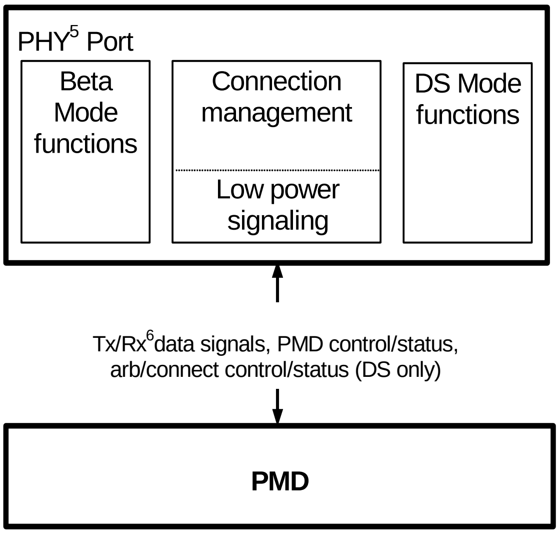


Figure 1 – Port architecture

In an automotive implementation, 'Suspend', and 'Standby' states are intermediate states which lead to the stable state called "sleep state" where power consumption is minimized

Table 1 – Automotive port states

Port state	Definition
Active	A connected enabled port that is capable of detecting serial bus signal states and participating in the reset, tree identify, self identify and normal arbitration phase
Hard disabled	A port configured in such a way that it will not transmit or receive a serial bus signal. It is prevented from signaling in any form (signal, toning, or bias). A peer port can not distinguish whether a port is off or hard disabled
Sleep	A state in which no signaling (toning, bias, signals) takes place. A bus reset is generated as a result of leaving the sleep state.
Off	Port is not powered. This occurs if a node/device is not connected to the power supply.

4.2 Sleep state characteristics

A sleep state enabled port (sleep flag set to TRUE) begins the process of transitioning to a sleep state when, while active, it is selected as a suspend initiator via a physical layer (PHY) command packet or becomes a suspend target (e.g. detects a properly framed Rx_suspend arbitration state). The sleep propagation through an active bus follows the suspend propagation mechanism described in [R7].

A port in a sleep state is characterized by:

– Low power consumption.

– No signal, toning or bias on the transmission line.
– Tone detection mechanism still operational: port is still listening for tones.
– Wake up (transition back to full electrical power consumption) from the sleep state initiates with the arrival of traffic on the bus or by internal action.
– EMI (electromagnetic interference) shall not initiate the wakeup process.

When the peer port resumes, the process of resuming will initiate toning and the port will automatically wake up (return to normal operating power consumption). The port exits from a sleep state to an active state when it executes the resume algorithm (i.e., its resume flag is set to TRUE).

4.3 Mapping of automotive port states to PHY modes

Table 2 – PHY mode mapped to automotive port states

PHY mode	Automotive device port states			
	Active	**Hard disabled/disable**	**Sleep**	**Off**
Full Power	X	X	X	
Sleep		X	X	
Ultra Low Power		X		
Power Down				X

NOTE – If not all ports of a node are in the active state, the PHY power consumption of the node can be reduced, even if the PHY is still in "full power mode".

4.4 Mapping of automotive port states to PMD modes

Table 3 – PMD mode mapped to automotive port states

PMD mode	Automotive device port state			
	Active	**Hard disabled/disable**	**Sleep**	**Off**
Full Power	X			
Low Power			X	
Ultra Low power		X (OEM-specific)		X (OEM-specific)
Off				X

5 Power consumption requirements

Table 4 – PMD power consumption

PMD power consumption	Full power	Low power	Ultra-low power	Off
Tx	60 mA (max)	20 µA (max)	0	0
Rx	80 mA (max)	20 µA (max)	20µA (max)	0

6 Plastic optical fiber (POF) and Hard-polymer clad fiber PMD specifications

This clause specifies the physical medium-dependent characteristics for plastic optical fiber (POF) and hard polymer-clad fiber (HPCF) at data rates S100β, S200β and S400β

6.1 PHY-FOT interface

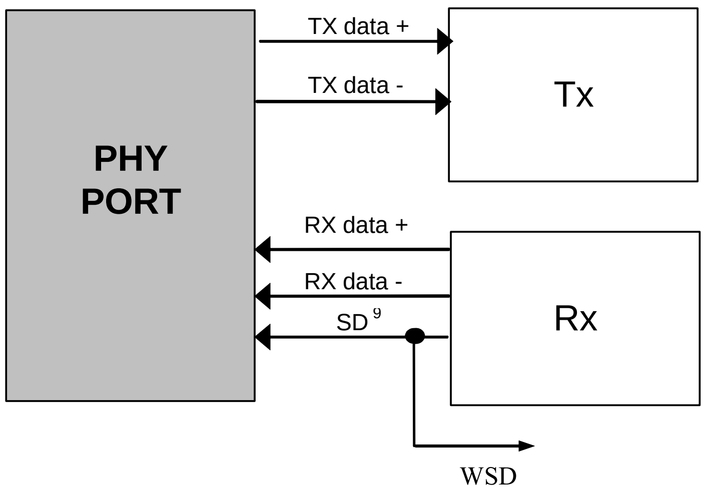


Figure 2 – PHY-FOT interface.

A signal detect (SD) terminal is connected to the TPBIAS_SD terminal of the PHY port. This signal detect input allows toning to be detected properly [R5].

When Rx is in a low power mode and the watchdog in the receiver detects an appropriate optical signal, a wake-up signal is sent via the wake signal detect (WSD) line. If required, this can be connected to other components to initiate their wake up (this is an option available for use as and when required by an OEM implementation).

In the active state the signal at the wake-up line will be ignored.

6.2 PMD wake and sleep specifications

While the Rx is in low power mode, the photo detector (PD)[11] device is continually monitored by the watchdog and if a toning signal is detected for a period of T1 ms, the receiver will resume full power operation and give a valid signal Detect (SD) output within T2 ms. If the Rx receives no optical signal from its peer port for a time greater than T3 ms, a timer circuit will put the Rx into low power mode within T4 ms, where only the watch-dog in the Rx is powered. See Figures 3, 4, 5 and 6 and Table 6 for the specifications of T1, T2, T3 and T4.

6.3 Timing requirements

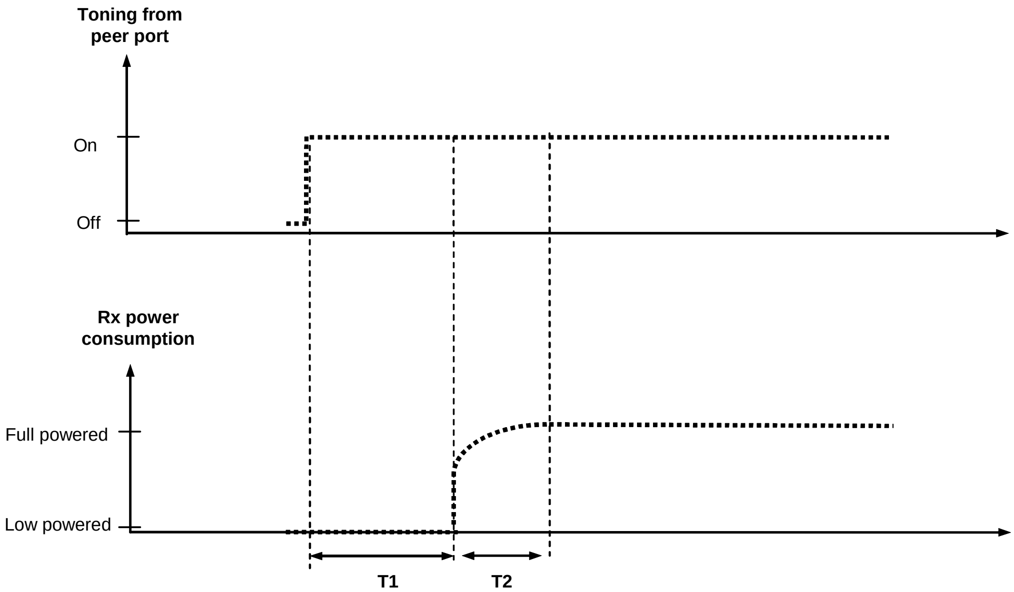


Figure 3 – Rx exiting low power

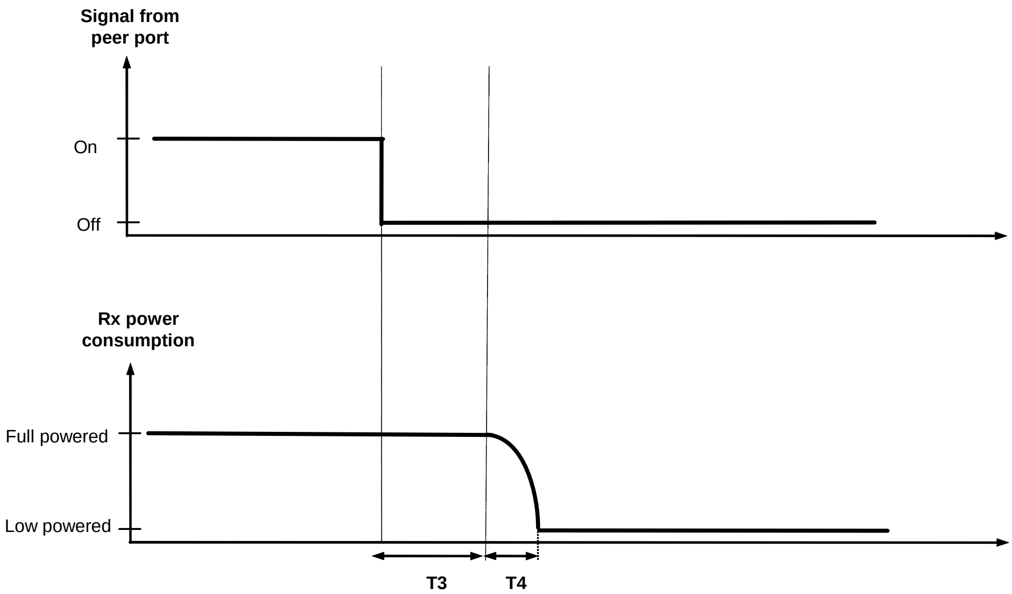


Figure 4 – Rx entering low power mode

When a Tx receives no electrical data on its Tx+/Tx- data lines during T5 ms, a timer circuit puts the emitter (Tx FOT) into low power mode, where the driver IC is not powered (may only apply to parts of the driver-IC as appropriate). When the emitter receives a fresh signal from its data line, the emitter will resume full power operation within T6 ms.

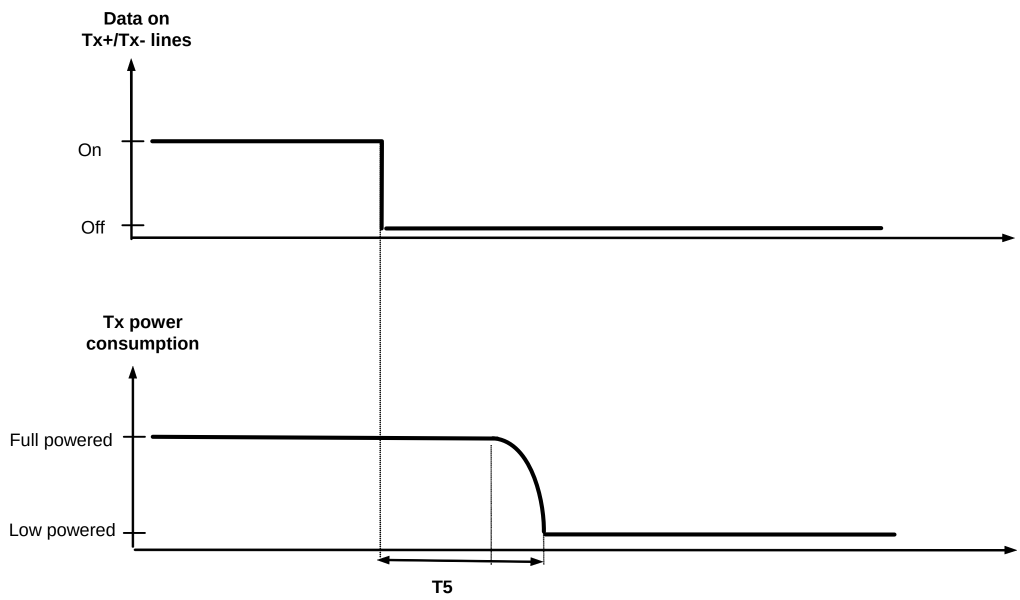


Figure 5 – TX entering Low Power mode

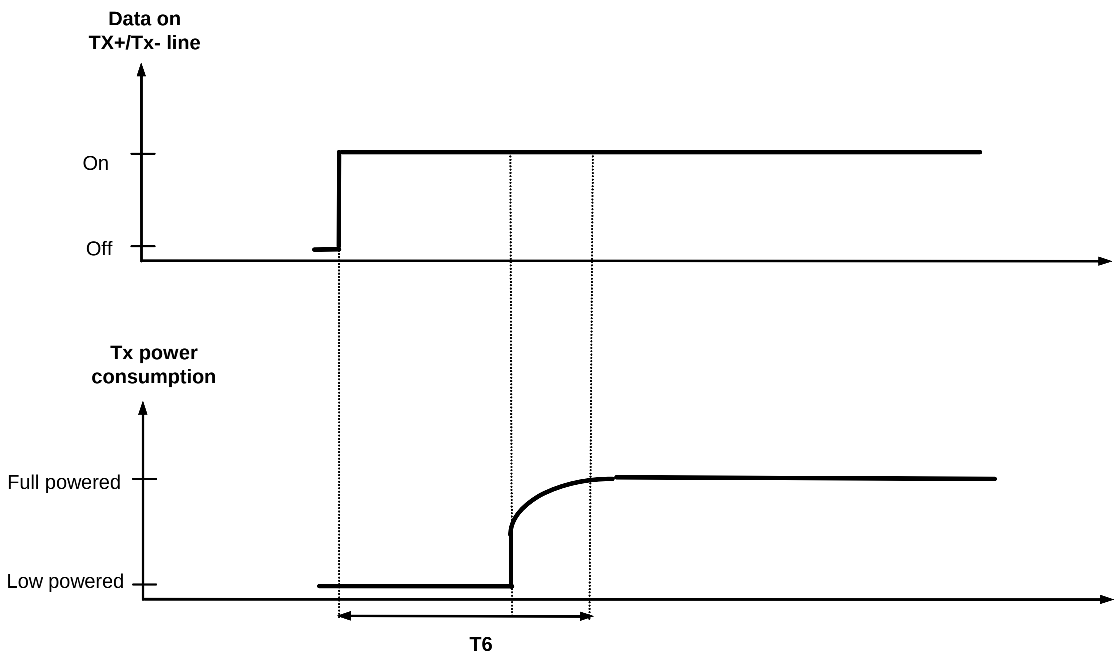


Figure 6 – TX exiting Low Power mode

Table 5 – Wake and sleep timing

Interval	Min	Max	Comments
T1+T2		128 ms	3 toning cycles (3*42.66)
T3+T4		128 ms	No toning signal for T>42.66ms
T3	50 ms		
T5		20µs	After 20µs no LED toggling is guarantied
T6		5µs	full toning interval 666,66µs desirable for wake-up

6.4 Wake Signal Detect (WSD) signal form

When the receiver detects a toning signal from its peer port, the wake signal, sent via the wake signal detect (WSD) line, could be used to switch on a power supply or other components.

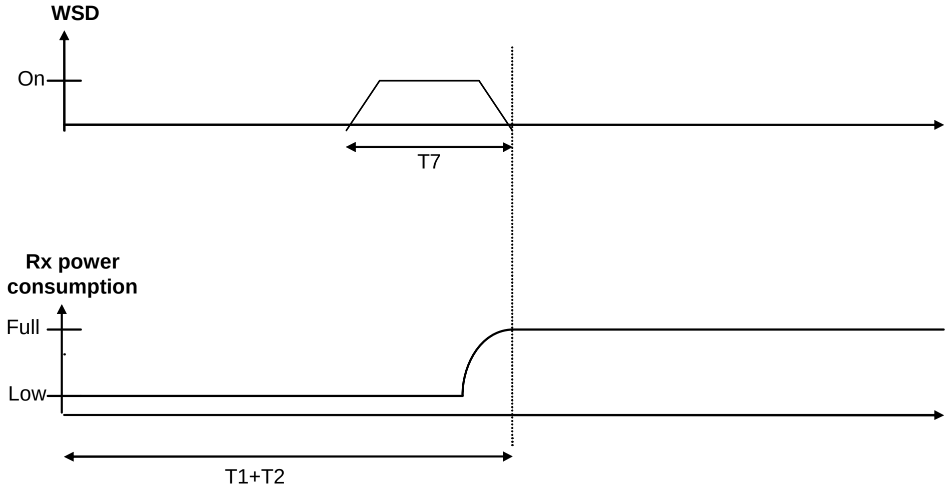


Figure 7 – Wake Signal Detect (WSD) timing.

Table 6 – Wake Signal Detect (WSD) specifications

Interval	Duration (min)	Duration (max)	Low level output	High level output	Comments
T7	2ms	4ms	0.5V	2.4V	Wake-up signal, can be used to switch power supply on

7 FOT architecture

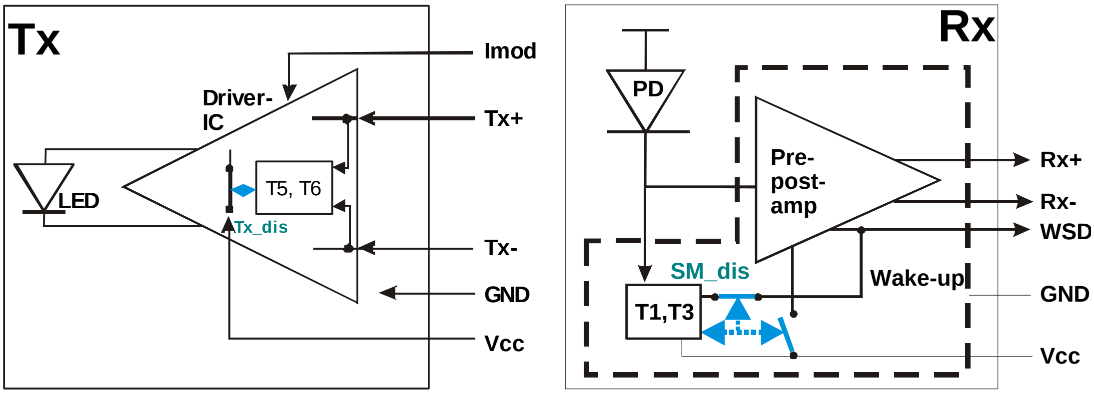


Figure 8 – FOT architecture with wake-up functionality (informative)

7.1 Footprint

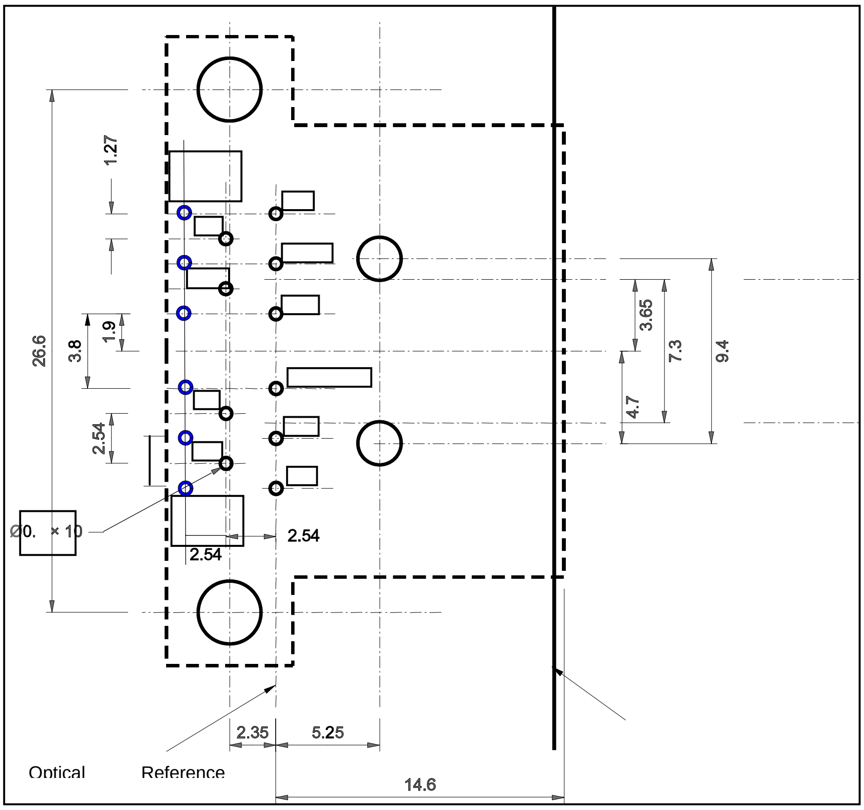


Figure 9 – Through-hole mount FOT footprint (IDB-1394 connector)

The same FOT can be used with a through hole connector technology and with a surface mount connector technology. Assembly costs are substantially lower on surface mount assembly lines with automated pick-and-place equipment, so a footprint for surface mount technology is proposed as an alternative.

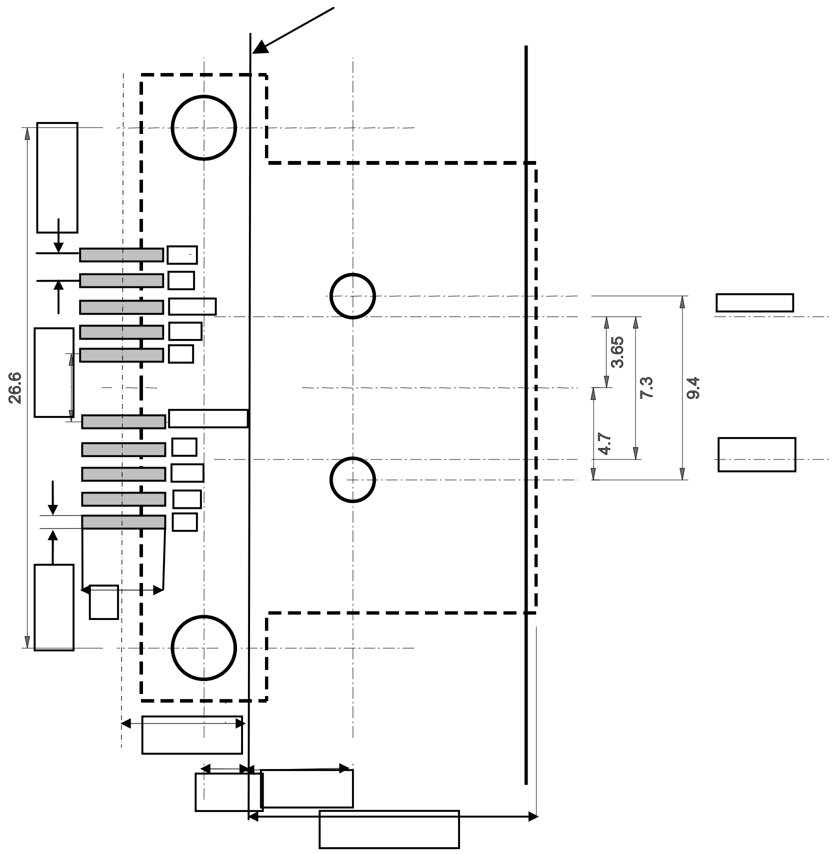


Figure 10 – Surface mount FOT footprint (IDB-1394 connector)

7.2 FOT Dimension

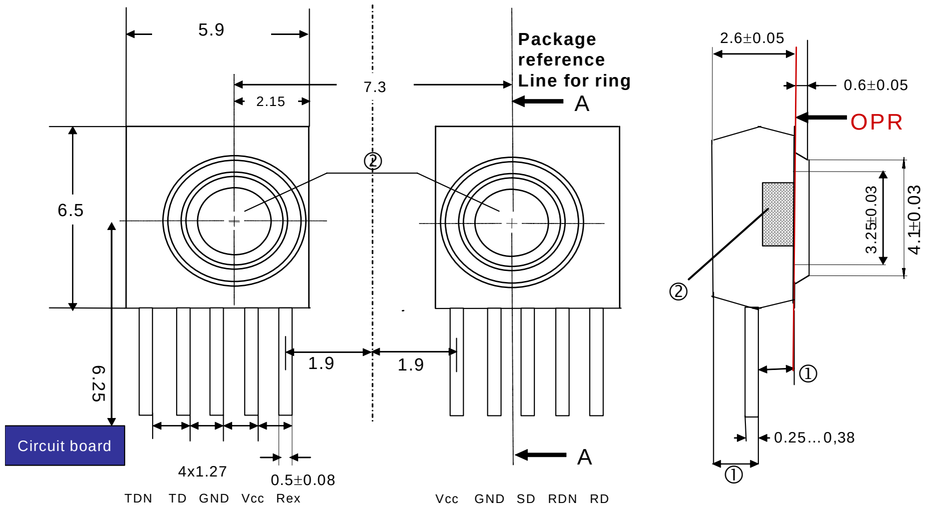


Figure 11 – : FOT dimensions (① free for design, footprint alignment by lead frame-bending offset versus straight LEAD : 2 x thickness LEAD + 0.2. ② this area is free for design). The tolerance (unless otherwise noted) is equal to ±0.1; R 0.15 max.

7.3 FOT Package

The alignment ring is the primary reference for alignment of the fiber.

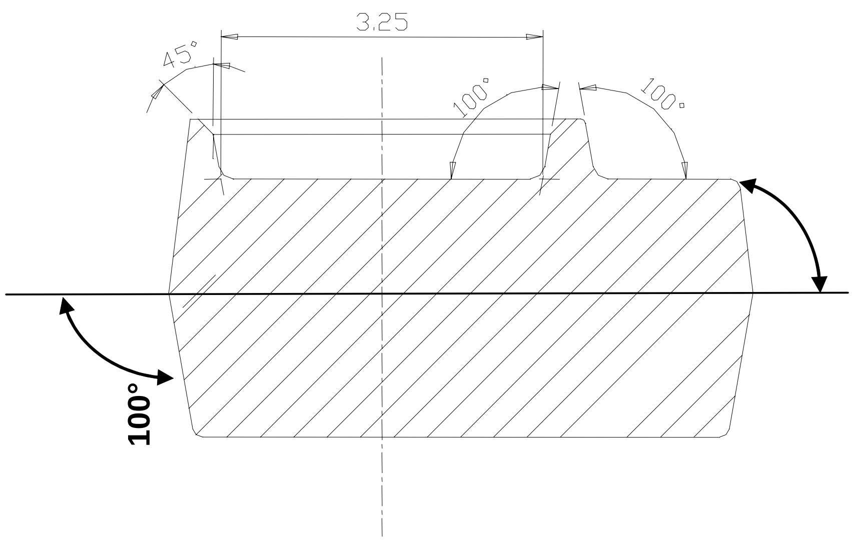


Figure 12 – FOT package side view.

8 FOT characteristics

The following FOT characteristics are relevant to applications using POF and HCPF with data-rates according to the IEEE 1394b-2002 [R3] document.

8.1 Recommended operating characteristics

Table 7 – Operating characteristics

Parameter	Min.	Typ	Max	Unit	Other requirements
Ambient temperature	-40		+85	C	
Power supply	3.15	3.3	3.5	V	
Power supply rejection ratio		30		dB	
Soldering temperature	235		260	°C	5s, minimum
DC-coupled data input differential (transmitter)	300		800	mV	100Ω termination
AC-coupled data input differential (transmitter)	400	550	800	mV	High-impedance biasing
Transmission distance			18	m	0.6 NA POF 0.37NA HPCF

NOTE – The maximum ambient temperature is specified as 85°C in this document, however, for the automotive industry this is a minimal requirement.

8.2 Transmitter characteristics

8.2.1 HPCF applications (S200-S400 transmitter)

Specification values must be met over operating temperature range and lifetime. Specification applies for both S200 and S400 unless otherwise individually specified.

Table 8 – HCPF transmitter characteristics

Parameter	Rate	Min	Typ	Max	Unit	Other requirements
Data rate	S200			250	MBd	NRZ
	S400			500		
Center wavelength		820	850	870	nm	TIA/EIA-455-127*
Spectral width				2	nm	TIA/EIA-455-127*
Launch power (50 cm)		-7		-1.7	dBm	TIA/EIA-455-95*
Launch power (transmitter off)			-43	-40	dBm	
Extinction rate		9			dB	TIA/EIA-526-4A* with K28.7 data pattern
Rise/fall time (20-80%) optical	S400			0.5	ns	TIA/EIA-526-4A with D21.5 data pattern
	S200	1.5		2		
Relative intensity noise (RIN)				-117	dB/Hz	0.5GHz BW
Overshoot			25		%	4^{th}.order Bessel-Thompson filter; f_r=937,5MHz
Systematic jitter (electrical input at TP1)	S400			203	ps	ANSI X3.230-1994 FC-PH, A.4.3 *
	S200			407		
Random jitter (electrical input at TP1)	S400			244	ps	
	S200			604		
Systematic jitter (light output at TP2)	S400			427	ps	
	S200			855		
Random jitter (light output at TP2)	S400			447	ps	
	S200			855		

8.2.2 POF applications (S100-S200 transmitter)

Specification values must be met over operating temperature range and lifetime. Specification applies for both S100 and S200 unless otherwise individually specified.

Table 9 – POF transmitter characteristics

<table>
<tr><th>Parameter</th><th>Rate</th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th><th>Other requirements</th></tr>
<tr><td rowspan="2">Data rate</td><td>S100</td><td></td><td></td><td>125</td><td rowspan="2">MBd</td><td rowspan="2">NRZ</td></tr>
<tr><td>S200</td><td></td><td></td><td>250</td></tr>
<tr><td>Center wavelength</td><td></td><td>630</td><td>650</td><td>670</td><td>nm</td><td>TIA/EIA-455-127*</td></tr>
<tr><td>Spectral width</td><td></td><td></td><td></td><td>40</td><td>nm</td><td>TIA/EIA-455-127*</td></tr>
<tr><td>Launch power
(50 cm)</td><td></td><td>-7</td><td></td><td>0</td><td>dBm</td><td>TIA/EIA-455-95*</td></tr>
<tr><td>Extinction rate</td><td></td><td>10</td><td></td><td></td><td>dB</td><td>TIA/EIA-526-4A* with K28.7 data pattern</td></tr>
<tr><td rowspan="2">Rise/fall time
(20-80%) optical</td><td>S100</td><td></td><td>2.0</td><td>3.0</td><td rowspan="2">ns</td><td rowspan="2">TIA/EIA-526-4A with D21.5 data pattern</td></tr>
<tr><td>S200</td><td></td><td>1.5</td><td>2.0</td></tr>
<tr><td>Overshoot</td><td></td><td></td><td>25</td><td></td><td>%</td><td></td></tr>
<tr><td rowspan="2">Systematic jitter
(electrical input at TP1)</td><td>S100</td><td></td><td></td><td>0.814</td><td rowspan="2">ns
(0.1 UI)</td><td rowspan="8">ANSI X3.230-1994 FC-PH, A.4.3 *</td></tr>
<tr><td>S200</td><td></td><td></td><td>0.407</td></tr>
<tr><td rowspan="2">Random jitter
(electrical input at TP1)</td><td>S100</td><td></td><td></td><td>1.208</td><td rowspan="2">ns
(0.15 UI)</td></tr>
<tr><td>S200</td><td></td><td></td><td>0.604</td></tr>
<tr><td rowspan="2">Systematic jitter
(light output at TP2)</td><td>S100</td><td></td><td></td><td>1.709</td><td rowspan="2">ns
(0.21 UI)</td></tr>
<tr><td>S200</td><td></td><td></td><td>0.855</td></tr>
<tr><td rowspan="2">Random jitter
(light output at TP2)</td><td>S100</td><td></td><td></td><td>1.709</td><td rowspan="2">ns
(0.21 UI)</td></tr>
<tr><td>S200</td><td></td><td></td><td>0.855</td></tr>
</table>

8.3 Receiver characteristics

8.3.1 HPCF applications (S200-S400 receiver)

Specification values must be met over operating temperature range and lifetime. Specification applies for both S200 and S400 unless otherwise individually specified.

Table 10 – HCPF receiver characteristics

Parameter	Rate	Min	Typ	Max	Unit	Other requirements
Data rate	S200			250	MBd	NRZ
	S400			500		
Receivable power		-23	-21	-1	dBm	BER$<10^{-10}$ measured BER$<10^{-12}$ with extrapolation
Rise/fall time (10-90%) optical				500	ps	TIA/EIA-526-4A with D21.5 data pattern
SD On output		2.4			V	
SD Off output				0.5	V	
SD assert level		-27	-24	-21	dBm	
SD deassert level		-31	-24.5	-21.5	dBm	
SD assert time				100	µs	
SD deassert time				100	µs	
High level output				1.475	V	100Ω diff. load
Low level output		0.925			V	
I Diff. output		0.25		0.4	V	
Output offset		1.125		1.275	V	
Systematic jitter (optical input at TP3)	S400			488	ps (0.24 UI)	
	S200			936		
Random jitter (optical input at TP3)	S400			464	ps (0.23 UI)	
	S200			872		
Systematic jitter (electrical output at TP4)	S400			834	ps (0.41 UI)	ANSI X3.230-1994 FC-PH, A.4.3 *
	S200			1668		
Random jitter (electrical output at TP4)	S400			500	ps (0.25 UI)	
	S200			963		

8.3.2 POF applications (S100-S200 receiver)

Specification values must be met over operating temperature range and lifetime. Specification applies for both S100 and S200 unless otherwise individually specified.

Table 11 – POF receiver characteristics

Parameter	Rate	Min	Typ	Max	Unit	Other requirements
Data rate	S100			125	MBd	NRZ
	S200			250		
Receivable power		-23		0	dBm	BER<10^{-10} measured BER<10^{-12} with extrapolation
Rise/fall time (10-90%) optical			1.5	2	ns	TIA/EIA-526-4A with D21.5 data pattern
SD On output		2.4			V	
SD Off output				0.5	V	
SD assert level		-29		-23	dBm	
SD deassert level		-33		-23.5	dBm	
SD assert time				100	µs	
SD deassert time				100	µs	
High level output				1.475	V	100Ω diff. load
Low level output		0.925			V	
I Diff. output		0.25		0.4	V	
Output offset		1.125		1.275	V	
Systematic jitter (optical input at TP3)	S100			1.872	ns (0.23 UI)	
	S200			0.936		
Random jitter (optical input at TP3)	S100			1.743	ns (0.21 UI)	
	S200			0.872		
Systematic jitter (electrical output at TP4)	S100			3.337	ns (0.41 UI)	ANSI X3.230-1994 FC-PH, A.4.3 *
	S200			1.668		
Random jitter (electrical output at TP4)	S100			1.926	ns (0.24 UI)	
	S200			0.963		

8.4 EMI characteristics

EMI requirements include four topics:

- Immunity to radiated disturbance;
- Radio frequency radiated noise;
- Resistance to electrostatic discharge; and
- Immunity to cell phone RF radiation.

See Annex A3 for test and procedures

Annex A
(normative)

PMD implementation

A.1 Low Power Mode and wake-up process

PMD enters low power mode consumption when the related port is put into a sleep state. PMD switches to full power consumption when valid optical data is detected from the receiver.

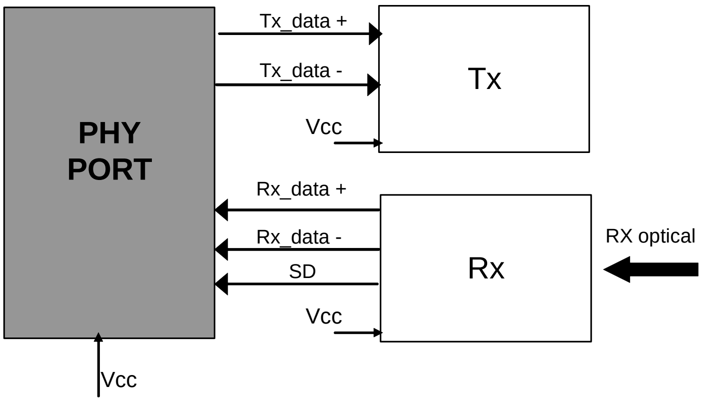


Figure A-1 PHY-FOT interface

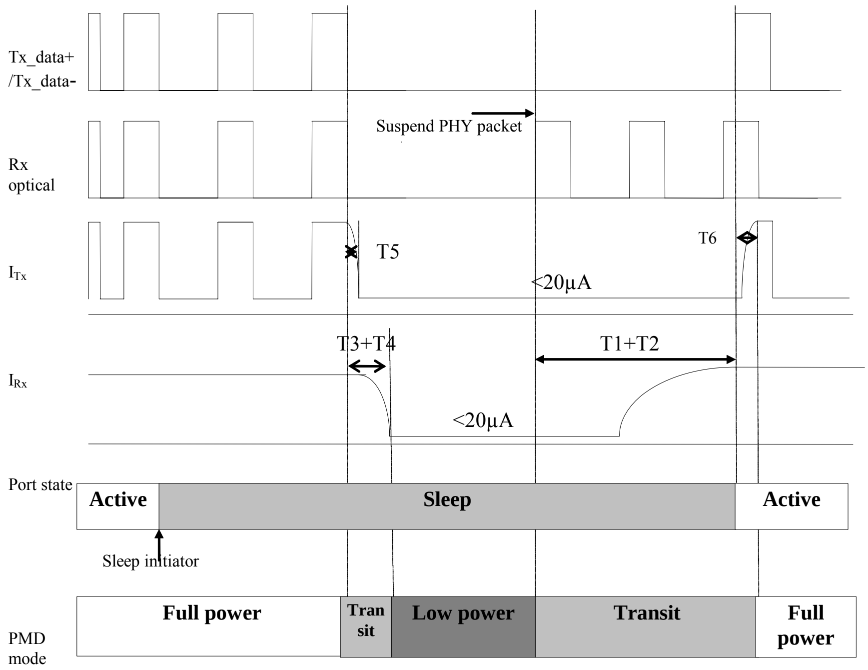


Figure A-2 Low-power mode timing diagram

NOTE – A port that enters into a sleep state shall wait 2*DISCONNECTED_TONE_INTERVAL for the peer port to cease toning [R4].

A.1 Ultra low power mode and wake up process

PMD enters ultra low power mode consumption when the related port is set to a ‘disable’ state. PMD switches to full power consumption when valid optical data is detected from the receiver.

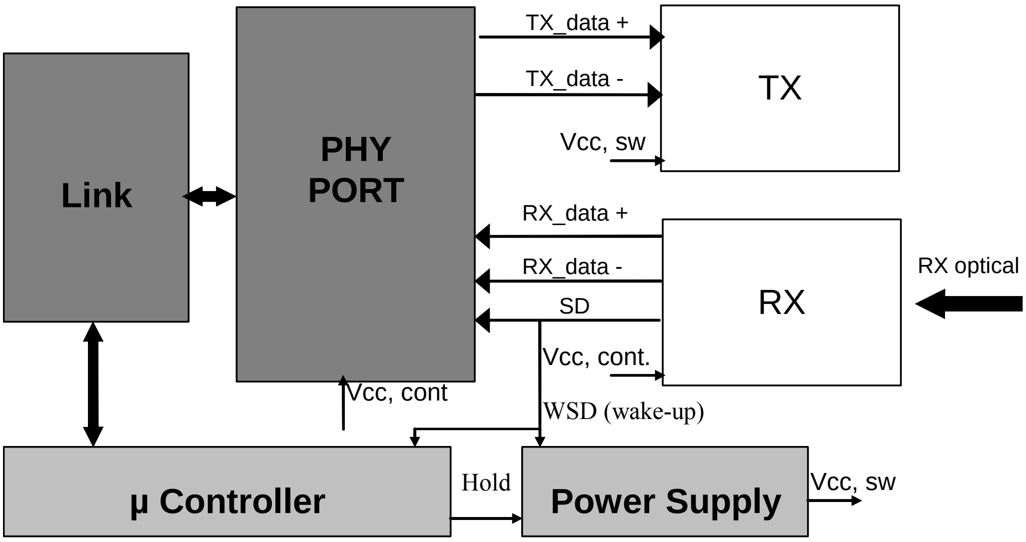


Figure A-3 PHY-FOT interface

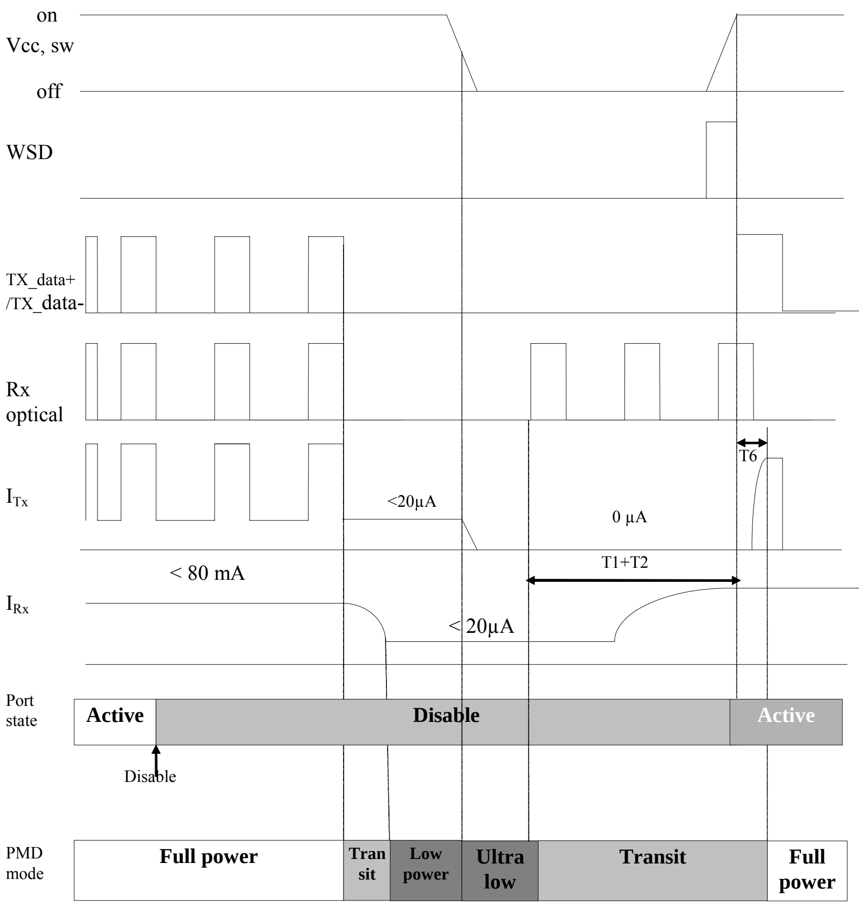


Figure A-4 PHY-FOT interface

Annex B
(normative)

EMI test procedures

B.1 Low Power Mode and wake-up process

Classification of Equipment Functional Classes

Five operating classes define the behavior of the equipment during and after certain tests described below. These classes are as follows (conforming to the “Classification of functional status” annex of ISO standard 7637-2),

Class A: All functions of a device/system perform as designed during and after exposure to disturbance.

Class B: All functions of a device/system perform as designed during exposure. However, one or more of them can go beyond specified tolerances. All functions return automatically to within normal limits after exposure is removed. Memory functions shall remain Class A.

Class C: One or more functions of a device/system * do not perform as designed during exposure but return automatically to normal operation after exposure is removed.

Class D: One or more functions of a device /system* do not perform as designed during exposure and do not return to normal operation until exposure is removed and the device system is reset by simple “operator/use” action.

Class E: One or more functions of a device/system do not perform as designed during and after exposure and cannot be returned to proper operation without repairing or replacing the device/system.

Note: * - to be specified in the EMC test plan. Unless otherwise specified in the EMC test plan, the EUT shall still conform to class A after each test.

B.2 Classification of Gravity Levels

The types of undesirable effects which may occur during and after the tests are ranked in severity by the following levels of gravity,

Levels	Effects	Definitions
0	None	n/a
1	Minor	Negligible damage and without risks for man and the environment. A slight customer inconvenience is allowed
2	Major	Without important damage or major risk for man and the environment. A significant customer inconvenience is allowed. Under no circumstances should the equipment be destroyed.

Table B-1: Classification of Gravity Levels

The system or equipment shall be designed so that no electromagnetic disturbance can be the cause of a catastrophic effect.

B.3. Immunity to radiated Disturbance Tests

B.3.1 EQ/IR 01: Immunity to radiated field (semi-anechoic or anechoic chamber)

B.3.1.1 Reference Document

This test procedure conforms to the NF R13007-5 standard.

Note: This test procedure conforms to the ISO 11452-2 standard with the following exceptions,

- PM modulation must be applied between 800 MHz and 2GHz instead of AM modulation.
- Horizontal polarization must be applied only between 400MHz and 2GHz.

B.3.1.2 Field of application

The purpose of this test is to check the immunity of equipment to electromagnetic fields within the frequency band of 200MHz to 2GHz.

The principal characteristics are as follows:

- CW within the frequency band of 200MHz to 2 GHz
- AM within the frequency band of 200MHz to 800MHz
- PM within the frequency band of 800MHz to 2GHz
- Substitution method
- Vertical polarization within the 200MHz to 2GHz frequency band
- Horizontal polarization within the 400MHz to 2 GHz frequency band
- Test on a metal earth plane

B.3.1.3 Test Facilities

- Power supply and battery
- Equipment required to check the correct operation of the EUT
- Actual (sensors, actuators) or simulated EUT environment
- 50mm thick insulating block support
- LISN conforming to publication CISPR 25 (two LISN’s for a remote earth EUT).
- 50Ω load(s)
- High frequency signal generator and broadband power amplifiers
- 50Ω coupler
- Watt meter
- Log-periodic antenna or horn antenna
- Isotropic field sensor equipped with optical fibre
- Semi-anechoic or anechoic shielded enclosure

B.3.1.4 Test Assembly

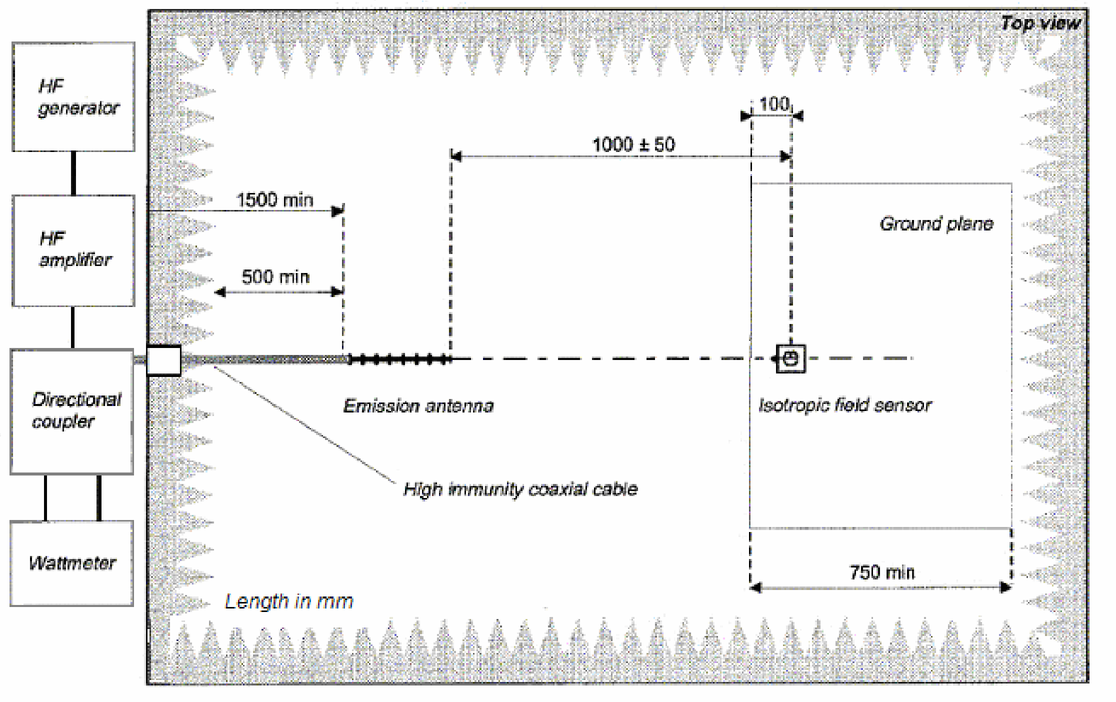


Figure B-1 A top view illustration of the test assembly setup for system calibration

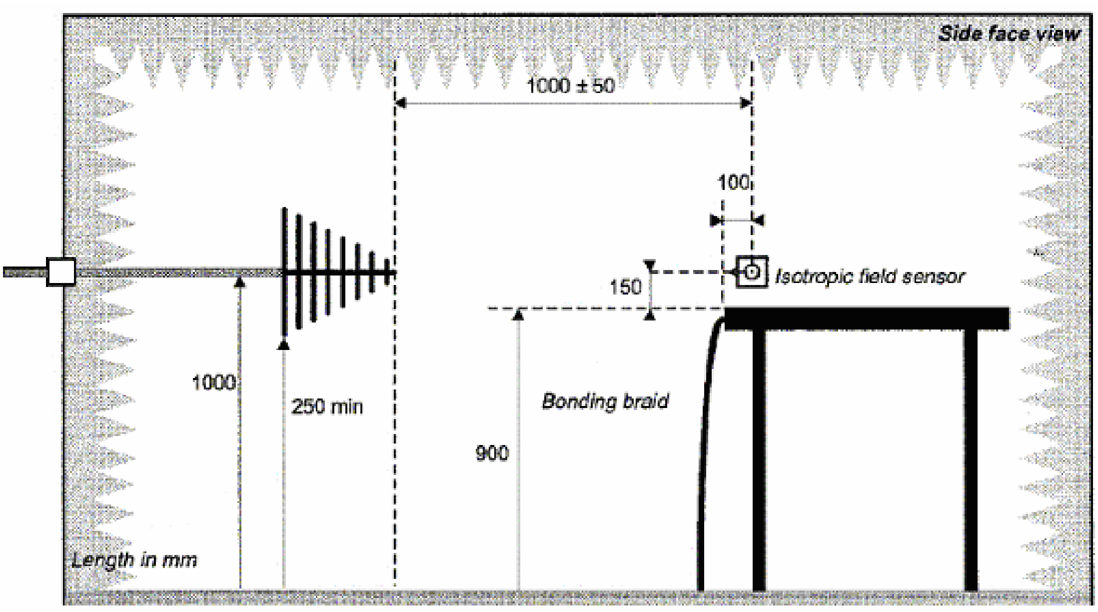


Figure B-2 A side view illustration of the test assembly setup for system calibration

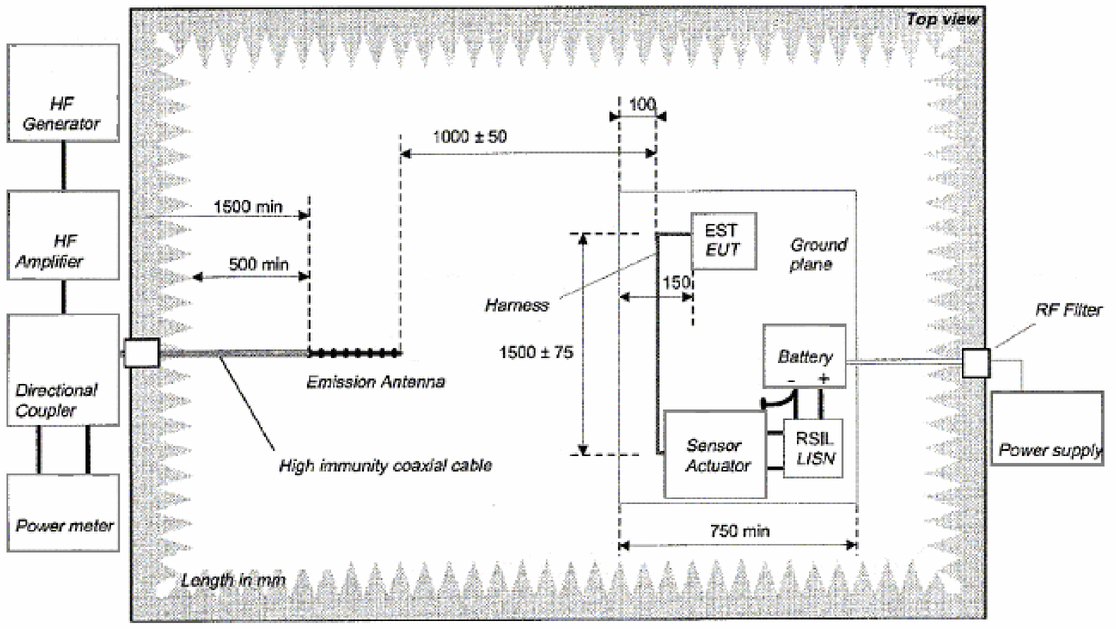


Figure B-3 A top view illustration of the test assembly setup for system test

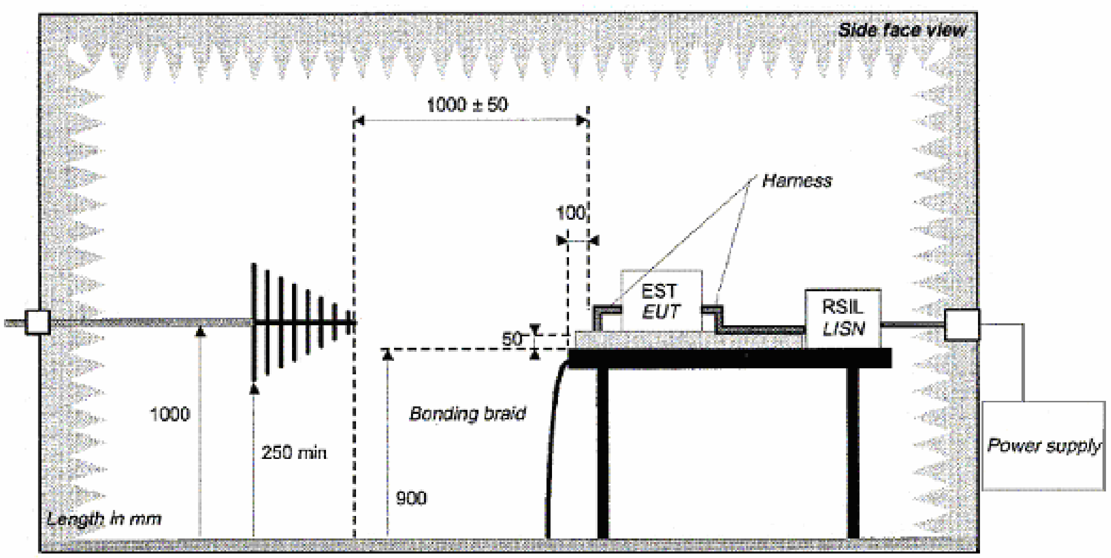


Figure B-4 A side view illustration of the test assembly setup for system test

B.3.1.5 **Procedure**

The method used is the substitution method. Unless otherwise specified, the tests shall be performed within the 200MHz to 2GHz frequency band for the vertical polarization and within the 400Mhz to 2GHz frequency band for the horizontal polarization.

The tests are carried out for three types of emission signals as follows:

- CW within the 200MHz to 2GHz frequency band
- AM within the 200MHz to 800MHz frequency band
- PM within the 800MHz to 2GHz frequency band

The three tests are carried out conserving the peak level for sine wave and modulation signals. The maximum field level envelope during the equipment test (CW, AM and PM) shall be equal to the maximum field level envelope of the CQ calibration phase.

Calibration

The calibration is carried out only in CW.

- Place the phase centre of the isotropic field sensor at a height of 150mm from the earth plane and 100mm from its edge.
- Place the tip of the antenna at a distance of 1000mm from the isotropic field sensor.
- Record the forward power $P_{calibration}$ required to generate the field specified for each frequency,

  60 V/m(rms).

  100 V/m(rms).

  200 V/m(rms).

Test

- Run the EUT for a minimum duration of 10mins.
- Place the emission antenna at the same position as during calibration, with the phase centre at a right to the centre of the cable.
- Gradually increase the forward power applied to the antenna until it reaches $P_{Calibration}$ while monitoring the EUT.
- Gradually reduce the forward power applied to the antenna and change frequency.

Test Report

Amongst other information, the test report shall include:

- Test set-up used: cable, EUT environment.
- Parameters observed and malfunctions encountered during the test.
- Required susceptibility thresholds and limits.

B.3.1.6 **Requirements**

Tests	Operating classes	Gravity Levels
60 V/m(rms)	A	0
100 V/m(rms)	B	1
200 V/m(rms)	C	2

Table B-2: A table illustrating the tests, operating classes and severity of failure gravity levels.

B.4 Radiated Noise tests

B.4.1 EQ/MR 01: Measurements of Radio Frequency Radiated Noise

B.4.1.1 Reference Document

This test procedure conforms to NF R13007-3 standard, based on Publication CISPR 25 with the following exceptions,

- Outside CISPR band disturbances (taking into account Directive 95/54/EC)
- Extension of measurements to 2GHz
- Performance of measurements in semi-anechoic chamber excluding the TEM (Transverse Electromagnetic Mode) cell method.

B.4.1.2 Field of Application

The purpose of this is to evaluate the radio frequency radiated disturbance emissions by the EUT and its wiring. The principal characteristics are as follows:

- Peak detection (average detection is used only for broadband/narrowband discrimination).
- Frequency band of 150kHz to 2 GHz
- Horizontal and Vertical polarizations
- Analysis filter bandwidth at 6dB (broadband and narrowband):

F < 30MHz : 9kHz (10kHz for spectrum analyzer)

F ≥ 30MHz : 120kHz (100kHz for spectrum analyzer) except for mobile transmitter-receiver narrowband (9kHz) (10kHz for spectrum analyzer)

Note: In practice to reduce the sweep time, measurements can be taken within the moving range from 26MHz to 87MHz and 108MHz to 2GHz with a bandwidth of 120kHz (100kHz for spectrum analyzer). If the measured value is below the narrowband limit specified in the test plan, the test is satisfactory. The value of the bandwidth used in this frequency range should be recorded in the test plan.

- The total sweep time and speed (or the number of sweeps) depends on the repetition rate of the interference emitted by the EUT. These parameters must be recorded in the test plan. Unless specified the following values should be used:
- F <3 0MHz: 100ms/MHz(BW 9kHz)
- F ≥ 30 MHz: 1ms/MHz(BW 120kHz) or 100ms/MHz(BW 9kHz)

For Low repetition frequency signals, higher values may be necessary.

- The holding time depends on the repetition rate of the interference emitted by the EUT. These parameters should be recorded in the test plan. Unless specified the following values should be used:
- F <3 0MHz: 100ms/MHz(BW 9kHz)
- F ≥ 30 MHz: 1ms/MHz(BW 120kHz) or 100ms/MHz(BW 9kHz)
- Maximum frequency step (digital receiver) of 0.9x BW

B.4.1.3 Test Facilities

- Power supply and battery
- Equipment required to check the correct operation of the EUT
- Actual sensors/actuators or simulated EUT environment
- 50mm thick insulating block support
- LISN conforming to Publication CISPR 25 (2 LISN's for a remoted earth EUT)
- 50Ω load(s)
- Spectrum analyzer or receiver conforming to CISPR 16-1 standard
- Test antennas: 1m vertical monopole, biconical and log-periodic or horn
- Semi-anechoic or anechoic chamber

B.4.1.4 Test Assembly

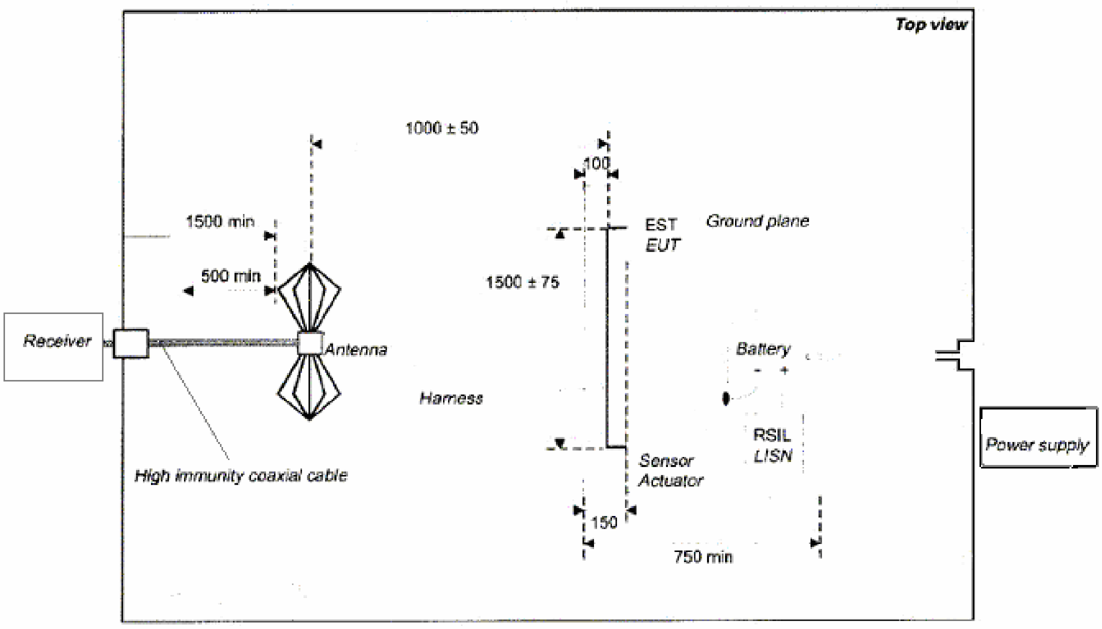


Figure B-5 Test assembly top view.

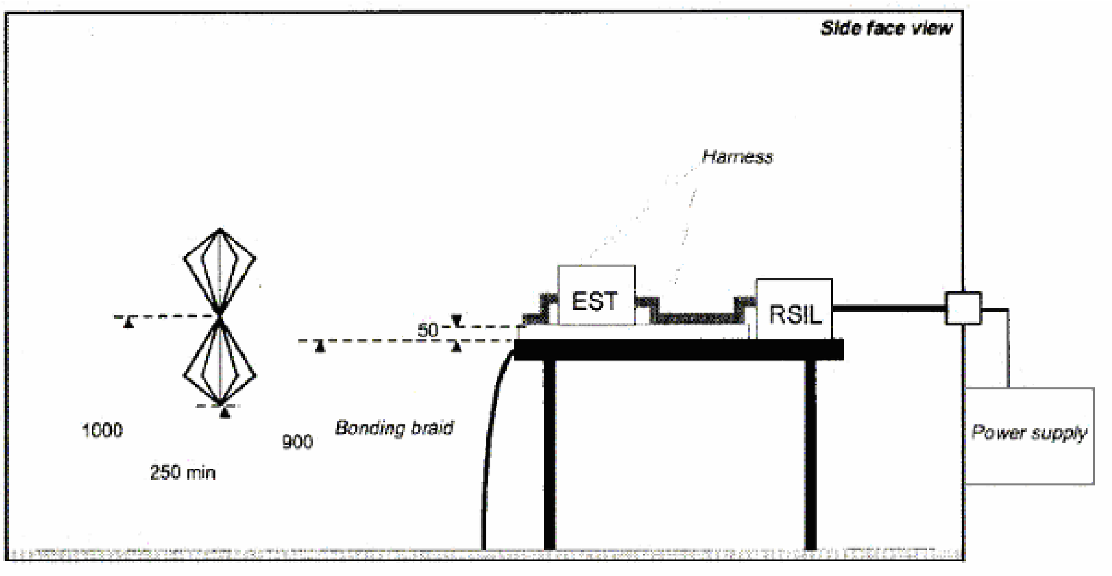


Figure B-6 Test assembly side-face view.

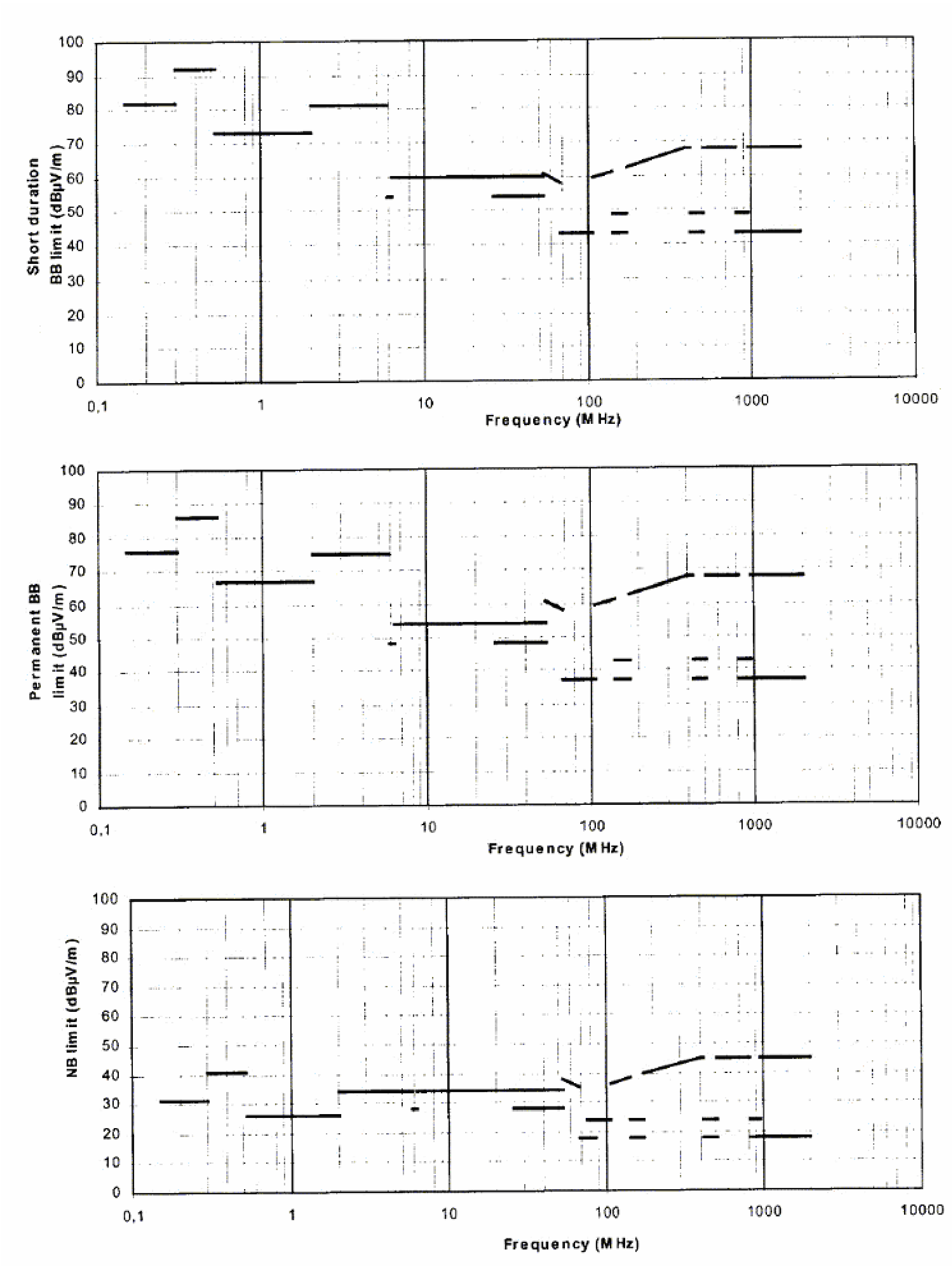
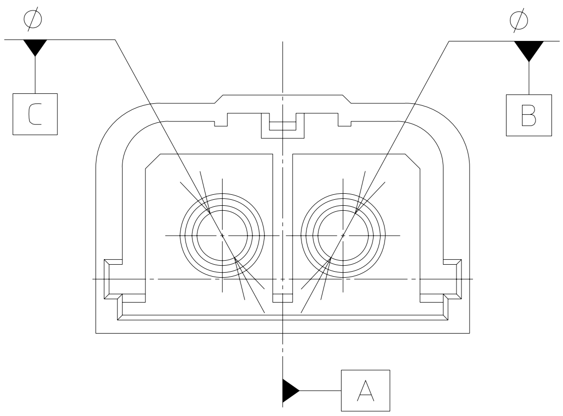


Figure B-7 A set of Graphs illustrating equipment radiated disturbance limits – peak detection.

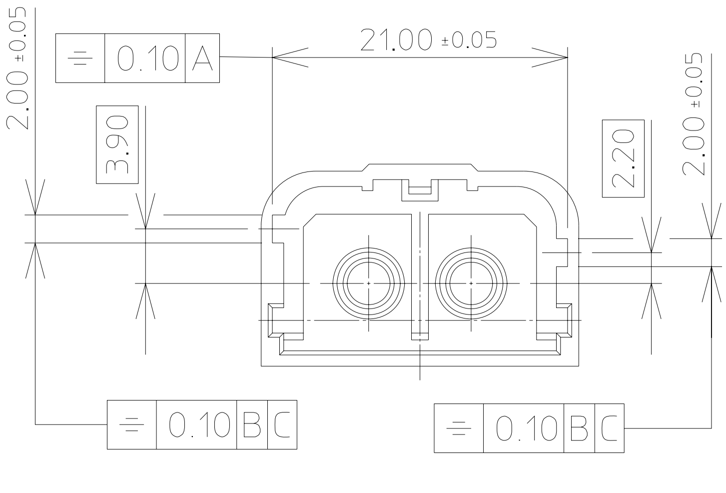
Annex C
(normative)

Keying and Color definitions

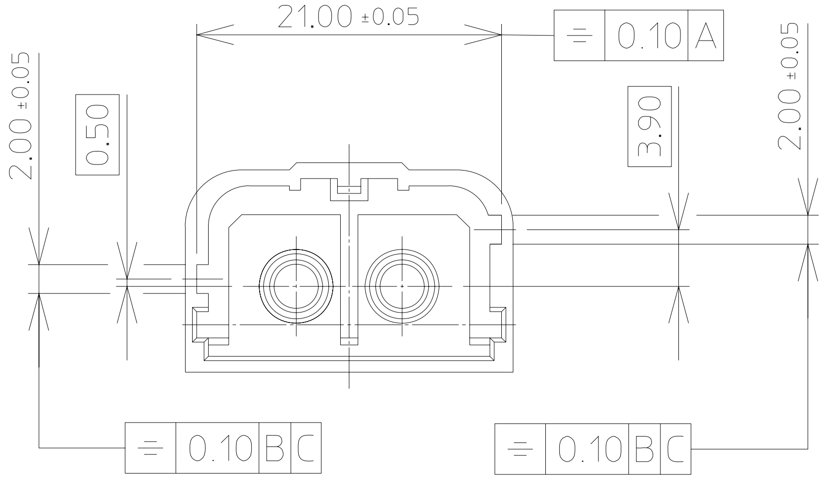
In order to distinguish the cable assembly sequence in the vehicle, four different keyings for the POF connector have been defined. Each keying is identified with a unique color code. The following drawings show the shape and dimensions of the keyings as well as the associated color.



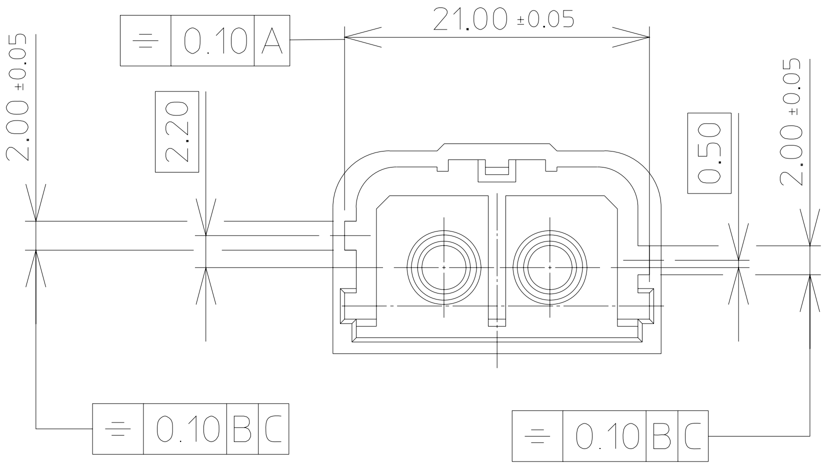
TYPE NEUTRAL: BROWN



TYPE A: BLACK



TYPE B: GREY



TYPE C: WHITE

Figure C-1 Keyings and Color codes for POF connector

Annex D
(informative)

Bibliography

[C1] IEEE Std 1212-2001, Standard for a Control and Status Registers (CSR) Architecture for microcomputer buses

[C2] IEEE Std 1394-1995, Standard for a High Performance Serial Bus

[C3] IEEE Std 1394a-2000, Standard for a High Performance Serial Bus – Amendment 1

[C4] IEEE Std 1394b-2002, Standard for a High Performance Serial Bus – Amendment 2

[C5] TA Document 2002018, 1394 Automotive Specification (IDB – 1394)

[C6] Optical Implementation Using IEEE-1394b. Ref: TI report SGZA001