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Proposal for optical test requirements of TP2 and TP3 for 1000Base-RH

IEEE 802.3bv interim meeting in Pittsburgh

Volker Goetzfried

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Subject

- This presentation shows a proposal of test requirements for all optical parameters defined for TP2 and TP3
- Existing standards like 802.3 Ethernet 1000Base-xx were taken as a reference
- Statements (clauses) in this presentation may refer to a table [xxx] indicating the reference to min/max values which are going to be specified in the standard

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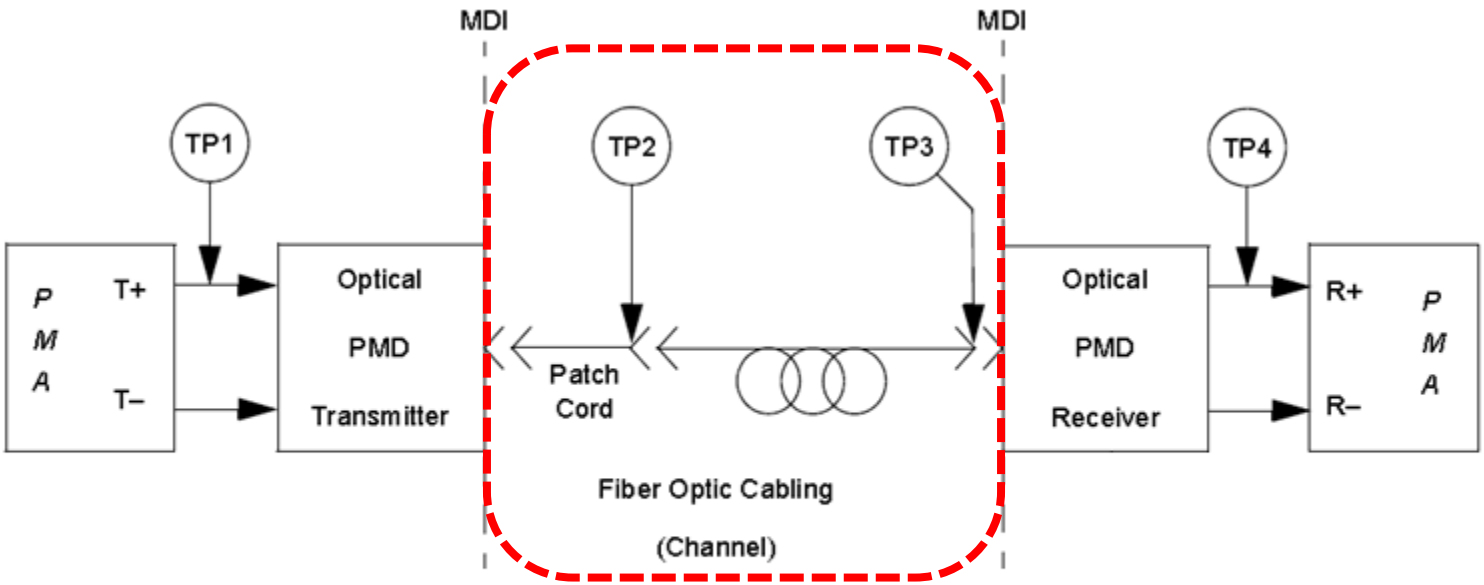
Block diagram of test points



Scope of this presentation are the parameters from the optical link of the compliance points TP2 and TP3

Source: Revision of IEEE Std 802.3-2012

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Specified parameters

TP2 Parameters		
Parameter Name	**Unit**	**Symbol**
Center Wavelength	nm	λc
Spectral Bandwidth	nm	Δλ
Average Launch Optical Power	dBm	LOP
Average Launch Power of OFF Transmitter	dBm	LOP,off
Extinction Ratio	dB	ER
Modal Power Distribution	norm	MPD
Optical Rise Time (10%/90%)	ns	tR
Optical Fall Time (90%/10%)	ns	tF
Transmitter Random Jitter	ps RMS	jR
Harmonic Distortion 2nd order	dBc	HD2
Harmonic Distortion 3rd order	dBc	HD3
Relative Intensity Noise	dB/Hz	RIN

TP3 Parameters		
Average Receiving Input Power	dBm	Pin
Average Receiving Input Power for Off State	dBm	Pin,off
Average Receiving Input Power for Wakeup	dBm	Pin,wakeup

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Optical measurement requirements

- All optical measurements at TP2 shall be made with a short fiber < 1m length.
- All optical measurements for the receiver shall be done at TP3 which is defined to be at the end of a long fiber (min. 15m length).
- The fiber shall be a plastic optical fiber with an NA of 0,5 compliant to [tbd]

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Transmitter measurements at TP2

- All timing parameters need to be acquired with an OEC (optical-to-electrical converter) and an oscilloscope having at least 3 x F_S MHz bandwidth.
- The used OEC shall exhibit a constant gain over the whole bandwidth beginning from DC in order to detect all TP2 parameters specified in table [xxx].
- All electrical parameters from the frequency domain need to be measured with a spectrum analyzer having at least 4 x F_S MHz bandwidth.

F_s – Symbol rate of System -> 312,5 / 324 MHz

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Center Wavelength & Spectral Width

Center WL is given by $\lambda_c = \frac{\sum_{i=\lambda start}^{i=\lambda end} P_i \lambda_i}{\sum_{i=\lambda start}^{i=\lambda end} P_i}$; $\lambda start = 500nm$, $\lambda end = 800nm$

Spectral width $\Delta\lambda_C = \sqrt{\frac{\sum_{i=\lambda start}^{i=\lambda end} P_i(\lambda_i - \lambda_c)^2}{\sum_{i=\lambda start}^{i=\lambda end} P_i}}$; and P_i as optical power.

The center wavelength and spectral width RMS shall be measured using an optical spectrum analyzer per [tbd].
Center wavelength and spectral width shall be measured under modulated conditions using a valid 1000Base-RH signal.

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Average Launch Optical Power*

Optical power shall be measured with a large photo detector enough to capture all light propagations coupled out of the fiber. The transmitter shall be driven under modulated conditions using a valid 1000Base-RH signal.

Average Launch Power of OFF Transmitter*

Optical power shall be measured with a large photo detector enough to capture all light propagations coupled out of the fiber. The transmitter shall be driven under modulated conditions using a valid 1000Base-RH signal.
This parameter shall be measured setting the transmitter in the OFF state defined in clause/table [xxx].

*Optical safety requirement: In any case the Transmitters output power must meet the laser class 1 requirements according to [tbd]

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Extinction Ratio (ER)

Extinction ratio (ER) shall be calculated by measuring the maximum output power P_1 and the minimum output P_0 which refers to a PAM0 and PAM15 level from a modulation point of view.

It is defined as

$$ER = 10 \times \log_{10}\left(\frac{P_1}{P_0}\right)$$ **; in dB**

In order to avoid any bandwidth limitation effect of the transmitter, a reduced modulation frequency of F_s/10 MHz shall be used comprising of a squarewave binary signal.

-> IEEE802.3 specifies in clause 38.6.3 an ER according to IEC 61280-2-2 -> This is the measurement according to a pre-defined mask which can be folded/neglected

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Optical Rise/Fall Times

The optical response time specifications are based on unfiltered waveforms. The rise/fall times shall be measured as transition time between 10%/90% and 90%/10% of the maximum amplitude utilizing a square wave PAM-2 signal at $F_s/3$ MHz.

Random Jitter (j_R)

Random jitter shall be measured as RMS value at a bit error rate (BER) of 10^{-12} The used pattern shall be a square wave PAM-2 signal at $F_s/3$ MHz. Moreover, an unjittered reference clock signal shall be used as trigger source.

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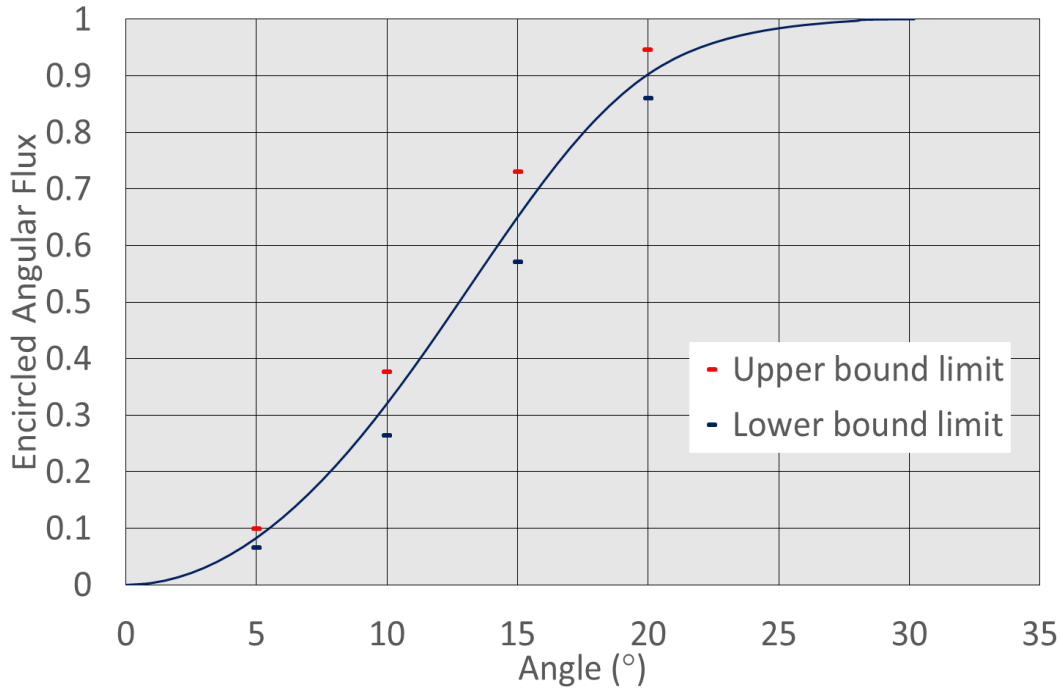
Mode Power Distribution (MPD)

As MPD test methodology the encircled angular flux (EAF) calculation shall be used as it is specified in IEC 61300-3-35 for step index plastic optical fibers according to measured far field patterns for either TP2 or TP3. Boundaries are defined in table [xxx] and are exemplarily shown below.



Source: EAF Measurement Method – TE – IEEE plenary meeting in March 2015

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Harmonic Distortions (HD)

Harmonic distortions 2nd and 3rd order shall be measured using an electrical spectrum analyzer. A single tone represented by a sinusoid with a frequency of F_s/10 MHz shall be applied to the transmitters input.

The following is defined for HD2 and HD3:

$$HDk = A_{F_1} - A_{k \times F_1} \quad \text{(dBc)}$$

Where	**HD**	**is the magnitude of harmonic distortion**
	k	**is the order**
	A	**is the magnitude at frequency**
	F_1	**is the fundamental frequency**

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Relative Intensity Noise (RIN)

This procedure describes a component test which may not be appropriate for a system level test depending on the implementation. A DC signal shall be used to drive the transmitter at its operating point.

The following equation is used to evaluate RIN:

$$RIN = 10\log_{10}\frac{P_N}{BW \times I_{oe}^2 \times R} - G \quad \text{(dB/Hz)}$$

Where	RIN	is the raltive intensity noise,
	P_N	is the electrical noise power in Watts with modulatin off,
	BW	is the low-pass bandwidth of apparatus – high-pass bandwidth of apparatus due to DC blocking capacitor,
	I_{oe}	is the photocurrent of the OEC
	R	is the effective load impedance of the OEC
	G	is the Gain in dB of any amplifier in the noise measurement path

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Receiver measurements at TP3

Receiver measurements cannot be taken with a standalone PMD component but only together with the PCS and PMA sublayers.

Average Receiving Input Power (P_{in})

P_{in} defines a minimum optical input power at TP3 where a stable communication is guaranteed for a 1000Base RH link. Sensitivity boundaries are defined under table [xxx].

Average Receiving Input Power for Off and Wakeup states

Table [xxx] defines a maximum optical input power for a receiver to get into the OFF state for reduced power consumption. Additionally, a minimum optical input power for a receiver is defined to wakeup from OFF state.

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Questions?

Thank you

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