Recommended Changes to Optical PMD Proposal

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8B10B PMD sublayer: SWL optics

Table - Operating distance for each fiber type

Optical Source	62.5 μm MMF	50 μm MMF	SMF
Shortwave laser	300 m~~200 m~~	950 m~~450 m~~	N/A

Laser Safety
As written with the following changes:
- "IEC 825...." should read "IEC 825-1."
- Provide formal reference for the laser safety certification

Bit Error Ratio Objective
As written with the following changes:
- Delete the last sentence or provide as a note.

8b/10b Encoding
Reword as follows:
- The SWL optical link shall use 8b/10b encoding. 8b/10b encoding provides a balanced, DC, bit stream with a maximum run length of 5.

SWL Transmitter
As written with the following changes:
- The first paragraph needs completion
- The second paragraph on modal noise needs clarification
- The third paragraph on jitter needs clarification
- Include the transmit eye mask figure from Fibre Channel

Table - SWL transmit characteristics

Description	Unit	Value
Transmitter type		laser
Wavelength	nm	770-860
Spectral width	nm RMS	0.85 ~~4 (see note 1)~~
Effective max optical rise/fall time	ns	0.35 - 0.45 (see note 1)
Max launch power @770 nm	dBm average	-5
Max launch power @860 nm	dBm average	-4
Min launch power	dBm average	-10
Extinction ratio	dB	9
RIN (max)	dB/Hz	-117 (see note 2)
Eye opening		(see note 3)

Replace current notes with the following:

- Note 1: The effective rise/fall time is not a specification, but is provided for the purpose of calculating optical link distances. The likely value is 0.35 - 0.45 ns, 10-90%. The final value will be selected after the jitter study group completes its work. The value given provides equivalent performance to that of the transmit eye mask requirement. We have tentatively agreed that it is sufficient to specify the transmit eye mask in a way that allows the implementor to trade-off rise-time, fall-time and jitter.

- Note 2: Replace the current text with the wording in 8.2.4 of ANSI X3.230-1994 Fibre Channel

Table - SWL receive characteristics

Description	Unit	Value
Minimum receive power	dBm, avg.	-17
Maximum receive power	dBm, avg.	T.B.D. (see note 1) ?
BER	per baud	1E-12 (see note 2)
Return loss	dB, min	12
Effective max Optical rise/fall time assumed for these measurements	ns	0.75 - 0.80 (see note 3) ?

Notes as written with the following changes:

- In note 1, "PDRH and EIA 825-1" should read "CDRH and IEC 825-1"; also add the following: Setting the maximum receive power to match the current transmit limit will cause incompatibility with potentially more powerful future transmitters and in effect caps the transmit power at current levels. On the other hand, specifying a level higher than the current transmit limit increases the dynamic range requirement, potentially raising the cost of the receiver.

- Replace Note 3 with the following: The effective rise/fall time is not a specification, but is provided for the purpose of calculating optical link distances. The likely value is in the range 0.75 - 0.80 ns, 10 - 90%. The final value will be selected after the jitter study group completes its work. The value given provides equivalent performance to that of the receive eye mask requirement. We have tentatively agreed that it is sufficient to specify the receive eye mask in a way that allows the implementor to trade-off rise-time, fall-time and jitter. A worst case received eye signal is required for the purpose of testing clock recovery systems.

Delete "General note".

Table - Media characteristics for use with SWL

Description	Unit	Value	
		62.5 µm MMF	50 µm MMF
~~Guaranteed O~~operating distance (typ)	m	300* (see figure 2)~~200~~	950* (see figure 2)~~450~~
Maximum attenuation @ 850 nm	dB/km	3.5 ~~4.0~~	3.5
Minimum modal bandwidth @850 nm	MHz-km	160	500 ~~400~~
Dispersion slope	ps/km-nm^2	see figure 3 ~~0.093~~	see figure 3 ~~0.105~~
Zero~~Min~~. dispersion wavelength~~point~~	µm	see figure 3 ~~1.36~~	see figure 3 ~~1.33~~
Modal noise penalty allocation	dB	T.B.D. (see note A)	T.B.D. (see note A)
Dispersion penalty allocation	dB	T.B.D. (see note A)	T.B.D. (see note A)
Maximum link attenuation @ 850 nm	dB	T.B.D. (see note B)	T.B.D. (see note B)

* Final values for distance are dependent on jitter budget and effective optical rise/fall times.

Notes as written with the following changes:

- Delete Note 1
- Note A: Values should be provided for power penalties of the types specified for LWL media.

Note B: Must reconcile link attenuation dependent on the values for modal noise and dispersion penalties.

8B10B PMD sublayer: LWL optics

Table - Operating distance for each fiber type

Optical Source	62.5 µm MMF	50 µm MMF	SMF
Longwave laser	950 m >550 m (perhaps as much as 850 m)	950 m >550 m(perhaps as much as 850 m)	3000 m 2000 m (or more)

Laser Safety
As written with the following changes:
- "IEC 825...." should read "IEC 825-1."
- Provide formal reference for the laser safety certification

Bit Error Ratio Objective
As written with the following changes:
- Delete the last sentence or provide as a note.

8b/10b Encoding
Reword as follows:
- The LWL optical link shall use 8b/10b encoding. 8b/10b encoding provides a balanced, DC, bit stream with a maximum run length of 5.

LWL Transmitter
As written with the following changes:
- The first paragraph needs completion
- The second paragraph on modal noise needs clarification
- The third paragraph on jitter needs clarification
- Include the transmit eye mask figure from Fibre Channel

Table - LWL transmit characteristics

Description	Unit	Value
Transmitter type		laser
Wavelength	nm	1270-1355
Spectral width	nm RMS ~~nm FWHM~~	4 ~~14~~
Effective max optical rise/fall time	ns	0.35-0.45 (see note 1)
Max launch power	dBm average	-3
Min launch power	dBm average	-13
Extinction ratio	dB	9
RIN (max)	dB/Hz	-116 (see note 2)
Eye opening		see note 3

Replace current notes with the following:

- Note 1: The effective rise/fall time is not a specification, but is provided for the purpose of calculating optical link distances. The likely value is 0.35 - 0.45 ns, 10-90%. The final value will be selected after the jitter study group completes its work. The value given provides equivalent performance to that of the transmit eye mask requirement. We have tentatively agreed that it is sufficient to specify the transmit eye mask in a way that allows the implementor to trade-off rise-time, fall-time and jitter.

Note 2: Replace the current text in Note 3 with the wording in 8.2.4 of ANSI X3.230-1994 Fibre Channel for multimode fiber and 8.1.3 of ANSI X3.230-1994 Fibre Channel for single-mode fiber

Table - LWL receive characteristics

Description	Unit	Value
Min receive power	dBm average	-20
Max receiver power	dBm average	-3
BER	per baud	1E-12(see note 2)
Return loss	dB, min	12
Effective max ~~O~~ptical rise/fall-time ~~assumed~~	ns	0.75-0.80 (see note 3)

Notes as written with the following changes:

- In note 1, "PDRH and EIA 825-1" should read "CDRH and IEC 825-1".

- Replace Note 3 with the following: The effective rise/fall time is not a specification, but is provided for the purpose of calculating optical link distances. The likely value is 0.75 - 0.80 ns, 10-90%. The final value will be selected after the jitter study group completes its work. The value given provides equivalent performance to that of the receive eye mask requirement. We have tentatively agreed that it is sufficient to specify the receive eye mask in a way that allows the implementor to trade-off rise-time, fall-time and jitter. A worst case received eye signal is required for the purpose of testing clock recovery systems.

- Delete General note

Table - Media characteristics for use with LWL

Description	Unit	Value		
		62.5 μm MMF	50 μm MMF	SMF
~~Guaranteed~~ Ooperating distance	m	950* ~~550-850~~	950* ~~550-850~~	3000 ~~2000+~~
Maximum attenuation @ 1300 nm	dB/km	1.5 ~~1~~	1.5 ~~1~~	1.0 ~~<1~~
Minimum modal bandwidth @ 1300 nm	Mhz•km	500	500	N/A
Maximum dispersion slope	ps/km•nm^2	see figure 2 ~~0.093~~	see figure 2~~0.105~~	0.093
~~Zero~~Min.dispersion ~~wavelength~~point	μm	see figure 21.36	see figure 21.33	1300-1324
Dispersion (up to max. distance)	ps/nm, RMS			18 ~~12~~
Modal noise penalty allocation	dB	T.B.D.	T.B.D.	T.B.D.
Dispersion penalty allocation	dB	T.B.D.	T.B.D.	T.B.D.
Maximum link attenuation @ 1300 nm	dB	T.B.D.	T.B.D.	T.B.D.

* Final values for distance are dependent on jitter budget and effective optical rise/fall times.

Notes as written with the following changes:
- Delete Note 1
- B. Must reconcile link attenuation dependant on values for modal noise and dispersion penalties
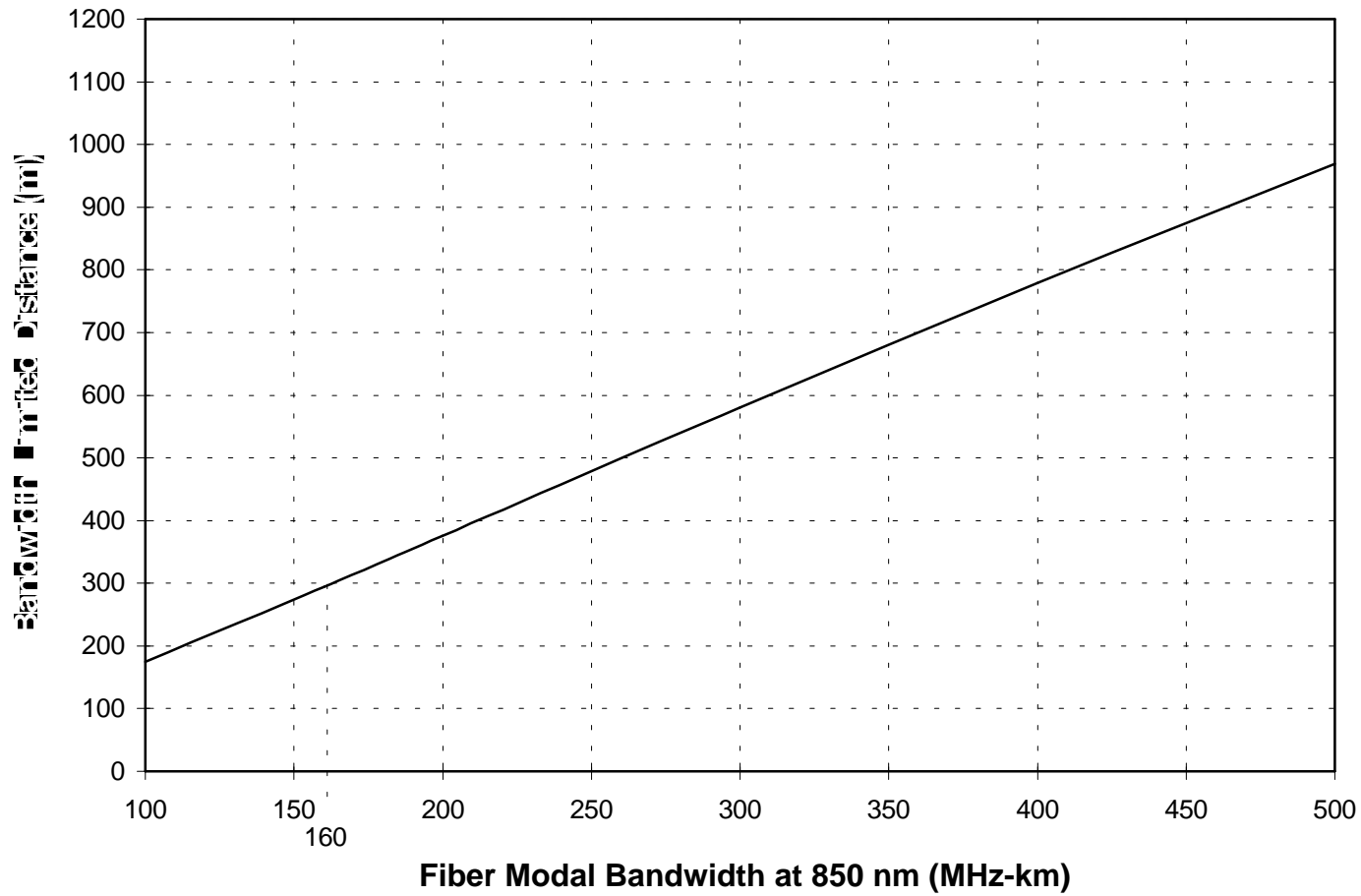
Figure 2 - SWL Operating Distance Ranges

Figure 2 - SWL Operating Distance Ranges

Y-axis: Bandwidth Limited Distance (m)
X-axis: Fiber Modal Bandwidth at 850 nm (MHz-km)

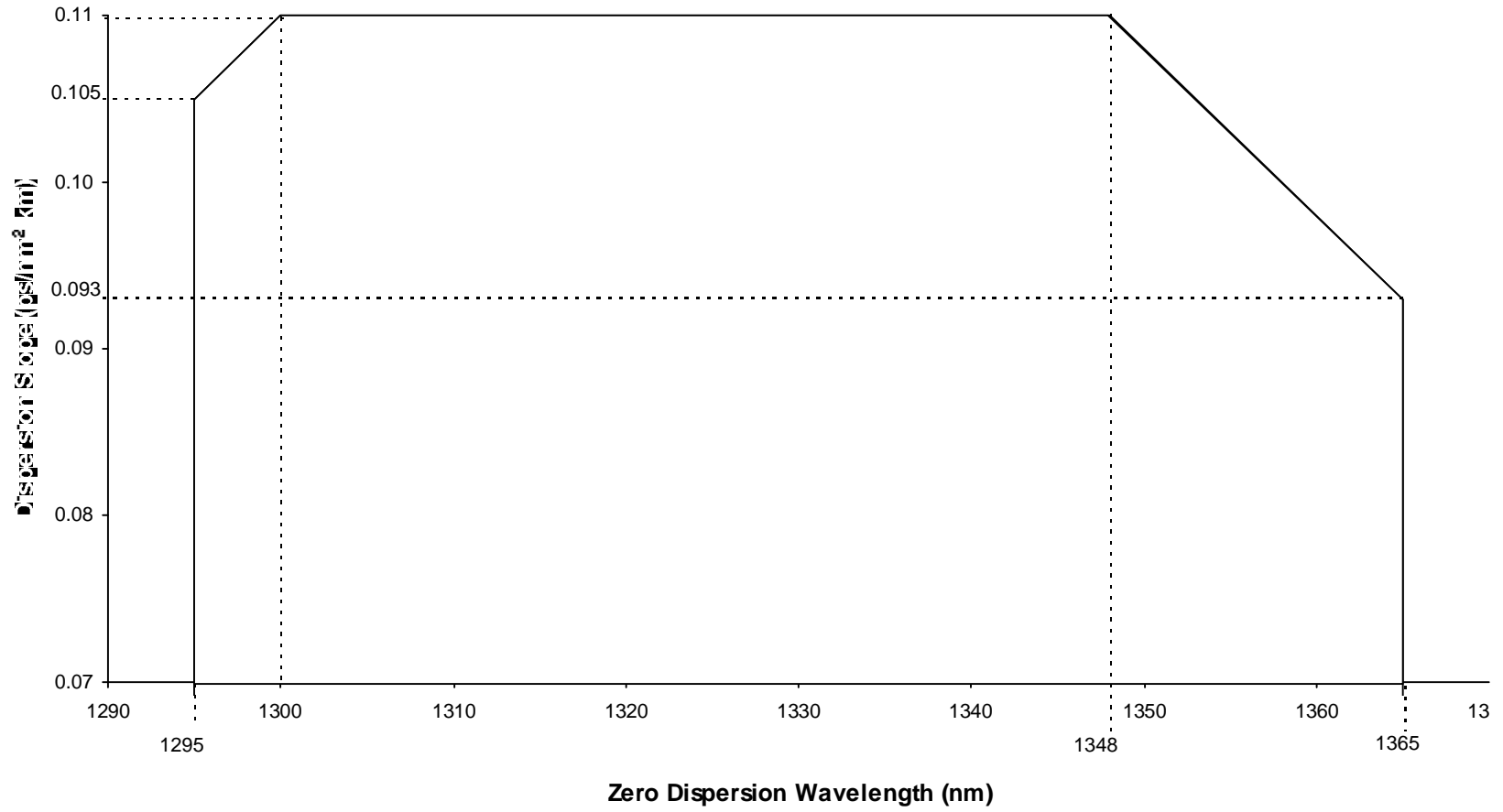**Figure 3 - Fiber Chromatic Dispersion Characteristics Template**

Figure 1F - SWL Operating Distance Ranges
for various combinations of channel input and output speeds