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Baseline CD Values for 800GBASE-LR4

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Introduction

- In the November 2023 IEEE 802 plenary meeting, the baseline proposal for 800GBASE-LR4 (rodes_3dj_01a_2311) was approved, with the chromatic dispersion (CD) values of its four wavelength channels "to be specified once ITU-T statistical data gets available".

Transmitter compliance channel specifications

Dispersion								Max mean DGD
Lane0		Lane1		Lane2		Lane3		
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	0.8 ps

CD values to be specified once ITU-T statistical data gets available

- In 3dk_effenberger_2311_1, it was mentioned that "ITU-T Q2/15, Q5/15, and Q6/15 have collected data from the eight major fiber manufacturers to better understand these factors", and the probability of having zero-dispersion wavelength (ZDW) outside the specified range of [1300 1324]nm could be ~1E-4.

- In this contribution, we present the CD values of the four wavelength channels of 800GBASE-LR4 based on a reasonably conservative ZDW distribution and the statistical distribution of S_0, as done in Johnson_3dj_2307.

A reasonable choice of ZDW distribution

1) The natural choice of ZDW_{mean} is the center of [1300 1324]nm, i.e., 1312nm.
2) Ideally, the six-sigma manufacturing process leads to a sigma of 12nm/6=2nm, corresponding to a defect rate of 3.4E-6 (or 3.4 DPMO).
3) However, 3dk_effenberger_2311_1 shows that the defect rate could be as high as ~1E-4, so we have to be more conservative.
4) Assuming a simple Normal Distribution with a very conservative defect rate of 6E-4* (or 600 DPMO), we have: sigma=3.5nm.

   **Here, the defect rate of 6E-4 is calculated from erfc((12/3.5)/sqrt(2)), which represents the probability of having ZDW outside the specified range of [1300 1324]nm.*
5) So, we could conservatively assume that the ZDW follows Normal Distribution **N(mean=1312nm, sigma=3.5nm)**.

Analytical evaluation of link CD distribution

We can derive the distribution of link CD at λ using 3rd order Sellmeier equation

$$D(\lambda) = \frac{\lambda S_0}{4}\left[1 - \left(\frac{\lambda_0}{\lambda}\right)^4\right]$$

where

$$\lambda_0 \sim \mathcal{N}\left(\mu_{\lambda_0}, \sigma_{\lambda_0}^2\right)$$ truncated at 1300nm and 1324nm

$$S_0 \sim \mathcal{N}\left(\mu_{S_0}, \sigma_{S_0}^2\right)$$ (as suggested in Johnson_3dj_2307)

In the case of cable segmentations,

$$CD_M(\lambda) = \sum_{i=1}^{M} L_{Cab} D_i(\lambda)/M$$

$$where\ L_{Cab} = 10\ \text{km}\ \ \text{for 800G} - \text{LR4}$$

Numerically, $D(\lambda)$ and $CD_M(\lambda)$ are evaluated via Monte Carlo Analysis with 100M 10km-link realizations.

Baseline CD_Q values for (M=4, Q=1E-4)

Channel 1		Channel 2		Channel 3		Channel 4	
$CD_{min,Q}$ @1294.53 nm	$CD_{max,Q}$ @1296.59 nm	$CD_{min,Q}$ @1299.02 nm	$CD_{max,Q}$ @1301.09 nm	$CD_{min,Q}$ @1303.54 nm	$CD_{max,Q}$ @1305.63 nm	$CD_{min,Q}$ @1308.09 nm	$CD_{max,Q}$ @1310.19 nm
-20.34	-7.49	-16.42	-3.73	-12.52	0.03	-8.64	3.78

Baseline CD_Q values for (M=4, Q=1E-3)

Channel 1		Channel 2		Channel 3		Channel 4	
$CD_{min,Q}$ @1294.53 nm	$CD_{max,Q}$ @1296.59 nm	$CD_{min,Q}$ @1299.02 nm	$CD_{max,Q}$ @1301.09 nm	$CD_{min,Q}$ @1303.54 nm	$CD_{max,Q}$ @1305.63 nm	$CD_{min,Q}$ @1308.09 nm	$CD_{max,Q}$ @1310.19 nm
-19.40	-8.38	-15.49	-4.61	-11.61	-0.84	-7.75	2.91

Proposal

- Based on the conservative ZDW distribution of N(mean=1312nm, sigma=3.5nm), we propose the following CD values (derived with M=4 and Q=1E-4):

Transmitter compliance channel specifications

Dispersion								Max mean DGD
Lane0		Lane1		Lane2		Lane3		
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
-20.34	-7.49	-16.42	-3.73	-12.52	0.03	-8.64	3.78	0.8 ps

Thank you!