Wavelength Consideration of 100GBASE-FR1 and 100GBASE-LR1 for Uncooled DFB Laser Operation over Industrial Temperature

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Proposed changes

Suggest to change the wavelength of 100GBASE-FR1 and 100GBASE-LR1 from “1304.5 to 1317.5” to “1300 to 1320” nm. If this proposal was adopted, a maintenance request could possibly be used to fix it in 100GBASE-DR.

Table 140–6—100GBASE-DR, 100GBASE-FR1, and 100GBASE-LR1 transmit characteristics

Description	~~Value~~ 100GBASE-DR	100GBASE-FR1	100GBASE-LR1	Unit
Signaling rate (range)	53.125 ± 100 ppm			GBd
Modulation format	PAM4			—
Wavelength (range)	1304.5 to 1317.5			nm

1300 to 1320 for 100GBASE-FR1 and 100GBASE-LR1

Table 140–7—100GBASE-DR, 100GBASE-FR1, and 100GBASE-LR1 receive characteristics

Description	~~Value~~ 100GBASE-DR	100GBASE-FR1	100GBASE-LR1	Unit
Signaling rate (range)	53.125 ± 100 ppm			GBd
Modulation format	PAM4			—
Wavelengths (range)	1304.5 to 1317.5			nm

1300 to 1320 for 100GBASE-FR1 and 100GBASE-LR1

Background

Reason for the requested change is “to enable uncooled DFB laser application for industrial temperature operation.” The current wavelength range of +/-6.5nm is 13nm. The DFB Laser wavelength drift of 0.1nm/C over 125C temp range is 12.5nm, and thus there is only 0.5nm left (or +/-0.25nm) to produce the DFB laser, which is not cost effective. The typical CWDM DFB laser wavelength spec is +/-3nm, while higher cost LWDM DFB is specified as +/-1nm.

Additional changes in chromatic dispersion

The positive and negative dispersions will be changed accordingly, when the wavelength range is increased for uncooled DFB laser operation over industrial temperature. For 100GBASE-LR1 example, the chromatic dispersion range will be changed from "-18.6 to 16" to "-22.95 to 18.18" ps/nm.

Table 140–11—Fiber optic cabling (channel) characteristics

Description	100GBASE-DR	100GBASE-FR1	100GBASE-LR1	Unit
Operating distance (max)	500	2 000	10 000	m
Channel insertion loss[a,b] (max)	See Table 140–12	4	6.3	dB
Channel insertion loss (min)	0	0	0	dB
Positive dispersion[b] (max)	0.8	3.2 3.64	16 18.18	ps/nm
Negative dispersion[b] (min)	–0.93	–3.7 -4.59	–18.6 -22.95	ps/nm
DGD_max[c]	2.24	2.3	5	ps
Optical return loss (min)	27	25	22	dB

[a]These channel insertion loss values include cable, connectors, and splices.
[b]Over the wavelength range 1304.5 nm to 1317.5 nm 1300 to 1320 for 100GBASE-FR1 and 100GBASE-LR1
[c]Differential Group Delay (DGD) is the time difference at reception between the fractions of a pulse that were transmitted in the two principal states of polarization of an optical signal. DGD_max is the maximum differential group delay that the system must tolerate.

No change to dispersion penalty

As the dispersion range is increased by the proposed wavelength relaxation for single wavelength, could the dispersion penalty spec of |TDECQ-TECQ| be met for the power budget consideration?

- There is no significant impact to dispersion penalty according to the studies summarized in next slide. Propose no change to the dispersion penalty specification

Table 140–6—100GBASE-DR, 100GBASE-FR1, and 100GBASE-LR1 transmit characteristics
(continued)

Description	~~Value~~ 100GBASE-DR	100GBASE-FR1	100GBASE-LR1	Unit
TECQ (max)	—	3.4	3.4	dB
| TDECQ - TECQ | (max)	—	2.5	2.5	dB

Remain unchanged

Dispersion Penalty Specification of |TDECQ - TECQ|<=2.5 dB

The dispersion penalty |TDECQ-TECQ| of =<2.5 dB could be met with sufficient margin for 100GBASE-LR1 after the wavelength range relaxation.

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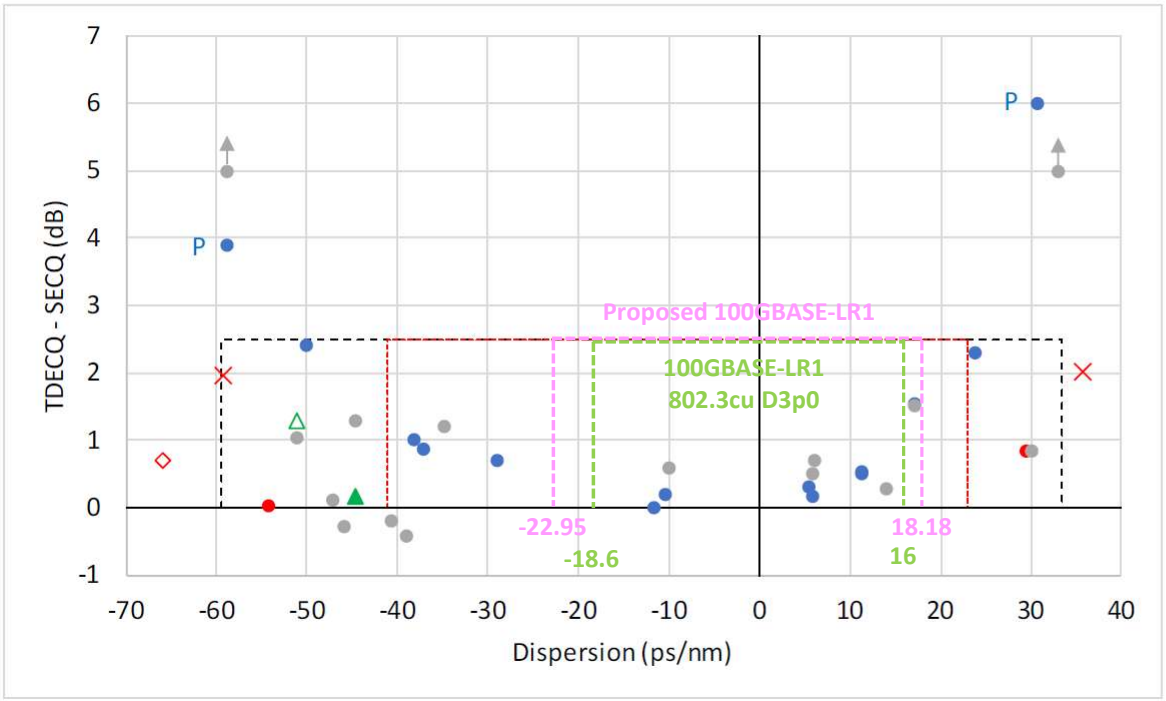

Interoperability with deployed specifications

Interop the revised Tx specification with current and the previously deployed Rx specification could be of concern

The link budget is essentially dependent on TDECQ and Rx sensitivity performance. As we are not changing the TDECQ nor the dispersion penalty specification, there should be no concern on interoperability issue from TDECQ.

Also, there is negligible impact on the receiver sensitivity from the wavelength range change as illustrated by two typical implementation of photo detectors below, one is surface normal type InGaAs PD while the other is edge coupled Ge PD. The data indicates the wavelength dependence of relative response from the Rx showing less than 0.05dB variation between the current and proposed ranges.