

Polarisation mode dispersion values

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Introduction

The values of DGD_max for 40GBASE-LR4, 100GBASE-LR4 and 100GBASE-ER4 are “TBD” in 802.3ba Draft 1.0.

This presentation proposes appropriate values.

Table 87–13—Fiber optic cabling (channel) characteristics

| Description | 40GBASE-LR4 | Unit |
|---|-------------|-------|
| Operating distance (max) | 10 | km |
| Channel insertion loss ^a (max) | 6.7 | dB |
| Channel insertion loss (min) | 0 | dB |
| Positive dispersion (max) | 33.5 | ps/nm |
| Negative dispersion (min) | -59.5 | ps/nm |
| DGD_max ^b | TBD | ps |
| Optical return loss | TBD | dB |

Table 88–17—Fiber optic cabling (channel) characteristics

| Description | 100GBASE-LR4 | 100GBASE-ER4 | | Unit |
|---|--------------|--------------|------|-------|
| Operating distance (max) | 10 | 30 | 40 | km |
| Channel insertion loss ^a (max) | 6.3 | 18 | 18 | dB |
| Channel insertion loss (min) | 0 | 0 | | dB |
| Positive dispersion (max) | 9.5 | 28 | 36 | ps/nm |
| Negative dispersion (min) | -28.5 | -85 | -114 | ps/nm |
| DGD_max ^b | TBD | TBD | TBD | ps |
| Optical return loss | TBD | TBD | TBD | dB |

40GBASE-LR4

The DGD_max value for 10GBASE-LR in Table 52-24 is 10 ps with a max link length of 10 km.

This value came from the P802.3ae Equalization Ad Hoc [\[1\]](#) and equates to a link PMD coefficient of ~ 0.8 ps/sqrt(km) (assuming $S = 3.75$ or 2.6 sec/year above the “Max”).

This is expected to give only a small penalty at 10.3125 GBd (~ 0.1 dB). See [anslow_01_0308.pdf](#) slide 4.

Consequently, it is proposed to also set DGD_max to 10 ps for 40GBASE-LR4

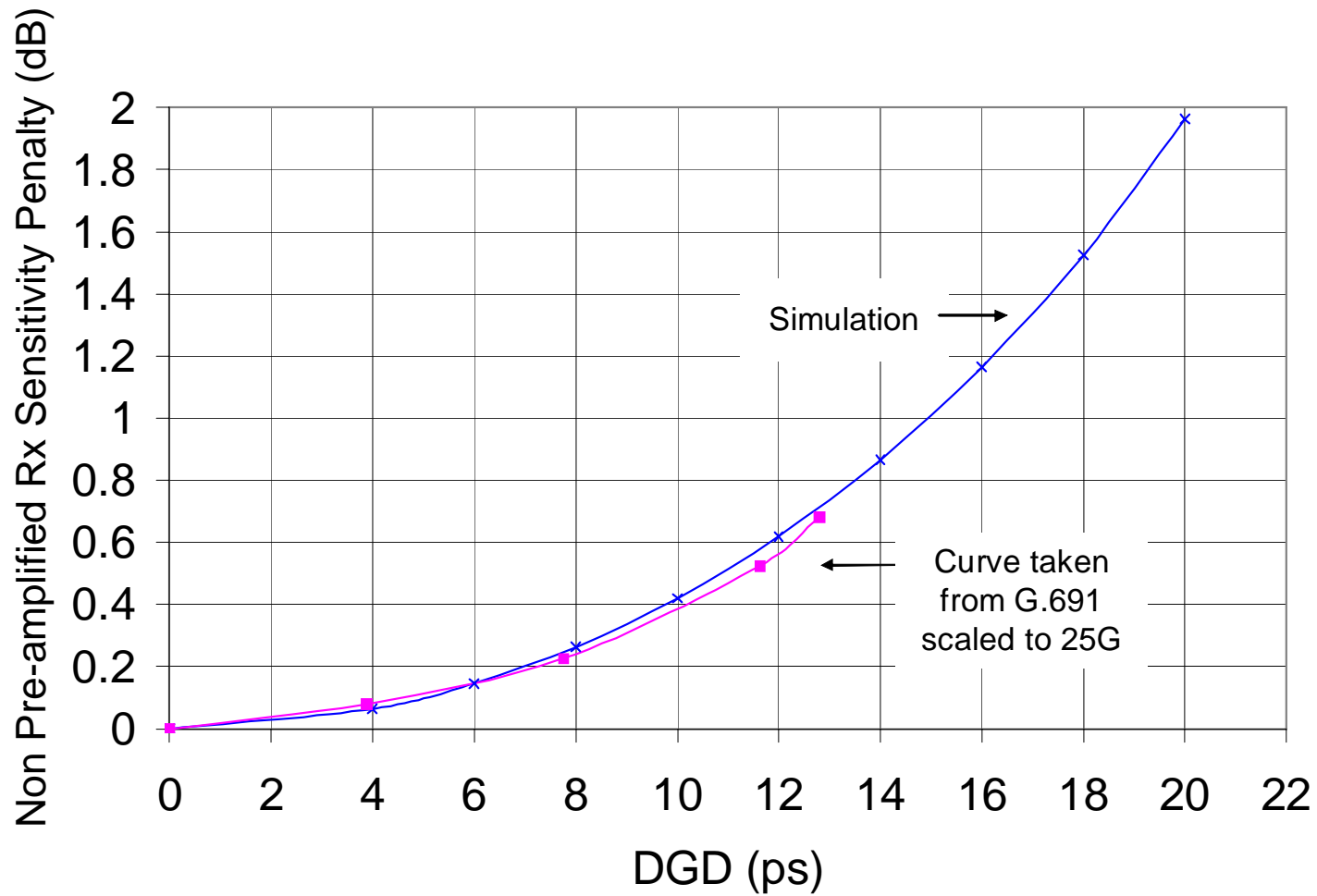
100GBASE-LR4

100GBASE-LR4 is expected to use a (non pre-amplified) PIN based receiver operating at 25.78125 GBd.

This should give a smaller penalty for a given DGD than a pre-amplified receiver. The next slide shows the expected penalty vs DGD value for this situation taken from two sources:

- Simulation of eye closure in a PIN based receiver
- Non pre-amplified curve from Fig. I.3 of G.691 [3] scaled to 25.8 GBd

25.8G PMD penalty for 100GBASE-LR4



100GBASE-LR4

As can be seen from these curves, the predicted penalty for a DGD of 10 ps is ~0.4 dB.

This value seems acceptable within the provisional 2.2 dB allocation for penalties for 100GBASE-LR4

Consequently, it is proposed to also set DGD_max to 10 ps for 100GBASE-LR4

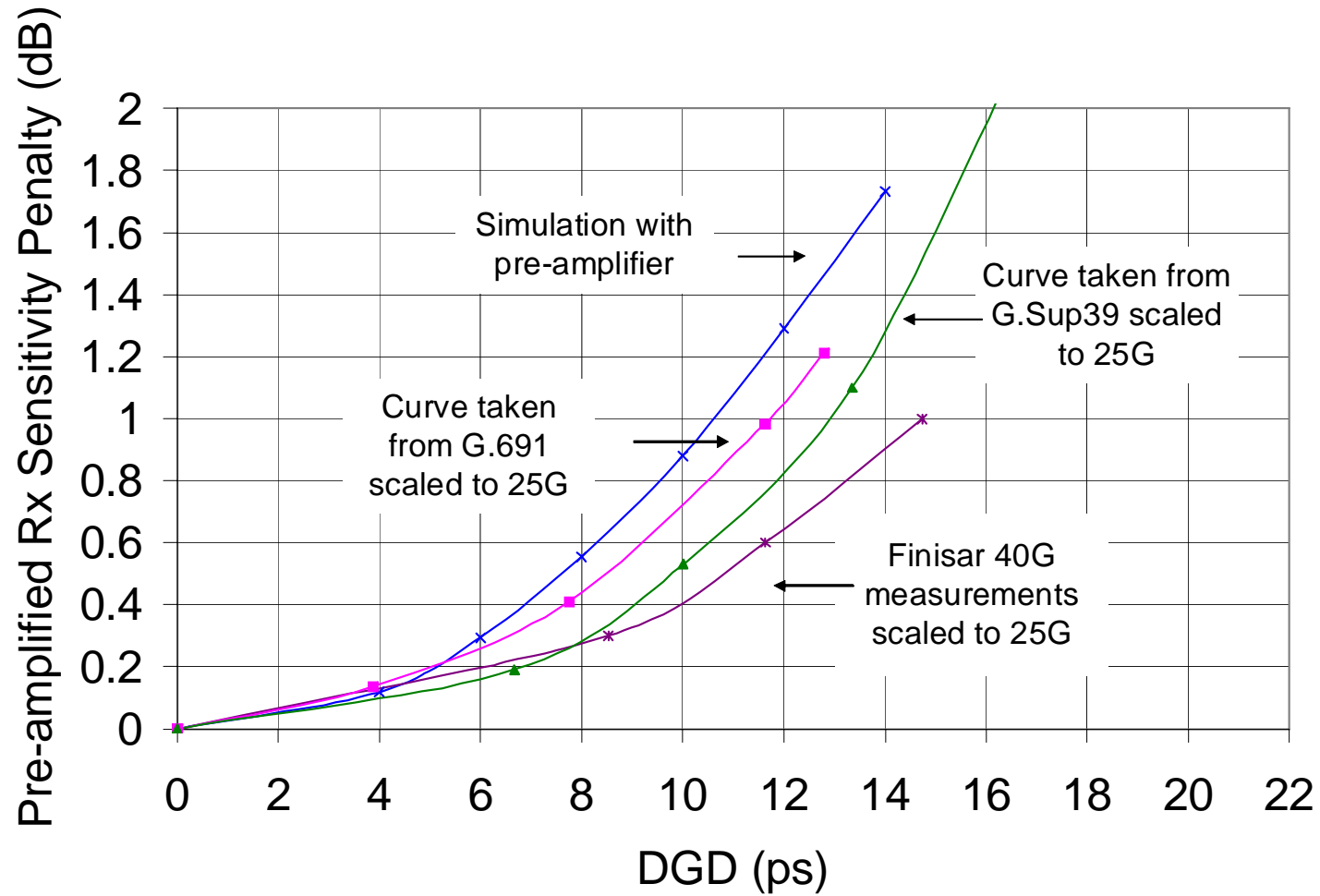
100GBASE-ER4

100GBASE-ER4 is expected to use a pre-amplified receiver operating at 25.78125 GBd.

This will give a larger penalty for a given DGD than a non pre-amplified receiver. The next slide shows the expected penalty vs DGD value for this situation taken from four sources:

- Simulation of eye closure for a pre-amplified receiver
- Pre-amplified curve from Fig. I.3 of G.691 [3] scaled to 25.8 GBd
- The NRZ curve from Fig. 7-9 of G.Sup39 [4] scaled to 25.8 GBd
- Measurements of penalty vs DGD for a pre-amplified receiver done by Finisar at 40 GBd scaled to 25.8 GBd

25.8G PMD penalty for 100GBASE-ER4



100GBASE-ER4

In Table 88-17 there are DGD_max values for 30 km and 40 km max operating distances.

For 30 km, a link PMD coefficient of 0.5 ps/sqrt(km) (assuming $S = 3.75$ or 2.6 sec/year above the “Max”) gives 10.27 ps DGD_max. Taking the worst of the curves shown on the previous slide, this gives a penalty of ~1.0 dB

This penalty value is the same as was budgeted for in [cole_02_0708](#) (the adopted baseline).

For 40 km, a link PMD coefficient of 0.5 ps/sqrt(km) gives 11.86 ps DGD_max which gives a penalty of 1.3 dB which is significantly above the budget. If we keep the 1.0 dB penalty limit, then this is equivalent to 0.434 ps/sqrt(km) ($S = 3.75$). However, for a more relaxed value of $S=3$, this is equivalent to 0.543 ps/sqrt(km)

Consequently, it is proposed to set DGD_max to 10.3 ps for 100GBASE-LR4 at both 30 km and 40 km max operating distances.

Proposal

The values of DGD_max for 40GBASE-LR4, 100GBASE-LR4 and 100GBASE-ER4 should be set as shown below.

Table 87–13—Fiber optic cabling (channel) characteristics

| Description | 40GBASE-LR4 | Unit |
|---|-------------------|-------|
| Operating distance (max) | 10 | km |
| Channel insertion loss ^a (max) | 6.7 | dB |
| Channel insertion loss (min) | 0 | dB |
| Positive dispersion (max) | 33.5 | ps/nm |
| Negative dispersion (min) | -59.5 | ps/nm |
| DGD_max ^b | TBD 10 | ps |
| Optical return loss | TBD | dB |

Table 88–17—Fiber optic cabling (channel) characteristics

| Description | 100GBASE-LR4 | 100GBASE-ER4 | | Unit |
|---|-------------------|---------------------|---------------------|-------|
| Operating distance (max) | 10 | 30 | 40 | km |
| Channel insertion loss ^a (max) | 6.3 | 18 | 18 | dB |
| Channel insertion loss (min) | 0 | 0 | | dB |
| Positive dispersion (max) | 9.5 | 28 | 36 | ps/nm |
| Negative dispersion (min) | -28.5 | -85 | -114 | ps/nm |
| DGD_max ^b | TBD 10 | TBD 10.3 | TBD 10.3 | ps |
| Optical return loss | TBD | TBD | TBD | dB |

References

- [1] Hanson T, “[Polarisation mode dispersion and related topics](#)”, IEEE P802.3ae, Equalization Ad Hoc, October 2000.
- [2] ITU-T [G.652](#), “*Characteristics of a single-mode optical fibre and cable*”
- [3] ITU-T [G.691](#), “*Optical interfaces for single channel STM-64 and other SDH systems with optical amplifiers*”
- [4] ITU-T [G.Sup39](#), “*Optical system design and engineering considerations*”