

Concerns with Increasing the Wavelength Range for 100GBase- FR1/LR1

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Supporters

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Considerations

- Interoperability with 100GBASE-DR, 400GBASE-DR4
- Wavelength Sensitivity of Optical Receivers
- Transmitter Performance
- Market Requirements/Trends

Current 100GBASE-DR, 400GBASE-DR4 Specs

Table 124–7—400GBASE-DR4 receive characteristics

Description	Value	Unit
Signaling rate, each lane (range)	53.125 ± 100 ppm	GBd
Modulation format	PAM4	—
Lane wavelengths (range)	1304.5 to 1317.5	nm

Table 140–7—100GBASE-DR receive characteristics

Description	Value	Unit
Signaling rate (range)	53.125 ± 100 ppm	GBd
Modulation format	PAM4	—
Wavelengths (range)	1304.5 to 1317.5	nm

Interoperability with 100GBASE-DR, 400GBASE-DR4

- 100GBASE-DR and 400GBASE-DR4 are established specifications against which products are currently shipping in high volume
- Said products have been designed/verified/qualified with the current IEEE specified wavelength range of 1304.5 to 1317.5 nm
 - Datasheets, operations guarantees/warranties are made against these test results
 - Operation outside datasheet/test limits would not be guaranteed
- Current draft includes interoperation guidelines between different PMDs
 - **Key assumption here is that attenuation is the only consideration**
- Two likely effects of adopting a new wavelength range:
 - Interoperation sections (to DR) would have to be stripped from the .3cu document or become highly complicated to accommodate wavelength considerations
 - Customers already deploying this technology would be likely to publish custom specs to restrict wavelength range to re-establish interop certainty.

802.3cu: 140.10a Requirements for interoperation between 100GBASE-DR, 100GBASE-FR1, and 100GBASE-LR1

140.10a Requirements for interoperation between 100GBASE-DR, 100GBASE-FR1 and 100GBASE-LR1

The 100GBASE-DR, 100GBASE-FR1, and 100GBASE-LR1 PMDs can interoperate with each other as described here.

140.10a.1 Requirements for interoperation between 100GBASE-FR1 and 100GBASE-DR

The 100GBASE-FR1 and 100GBASE-DR PMDs can interoperate with each other provided that the fiber optic cabling (channel) characteristics for 100GBASE-DR (see 140.10 and Table 140–12) are met and the 100GBASE-FR1 transmitter average power is greater than or equal to the value for average launch power (min) for 100GBASE-DR in Table 140–6.

802.3cu: 140.10a Requirements for interoperation between 100GBASE-DR, 100GBASE-FR1, and 100GBASE-LR1

140.10a.2 Requirements for interoperation between 100GBASE-LR1 and 100GBASE-DR

The 100GBASE-LR1 and 100GBASE-DR PMDs can interoperate with each other provided that the fiber optic cabling (channel) characteristics for 100GBASE-DR (see 140.10 and Table 140–12) are met, with the exception of the maximum and minimum channel insertion loss values, which are given in 140–15 for the two link directions separately. Attenuators may be used to achieve the required losses.

Table 140–15—Channel insertion loss requirements for interoperation between 100GBASE-LR1 and 100GBASE-DR

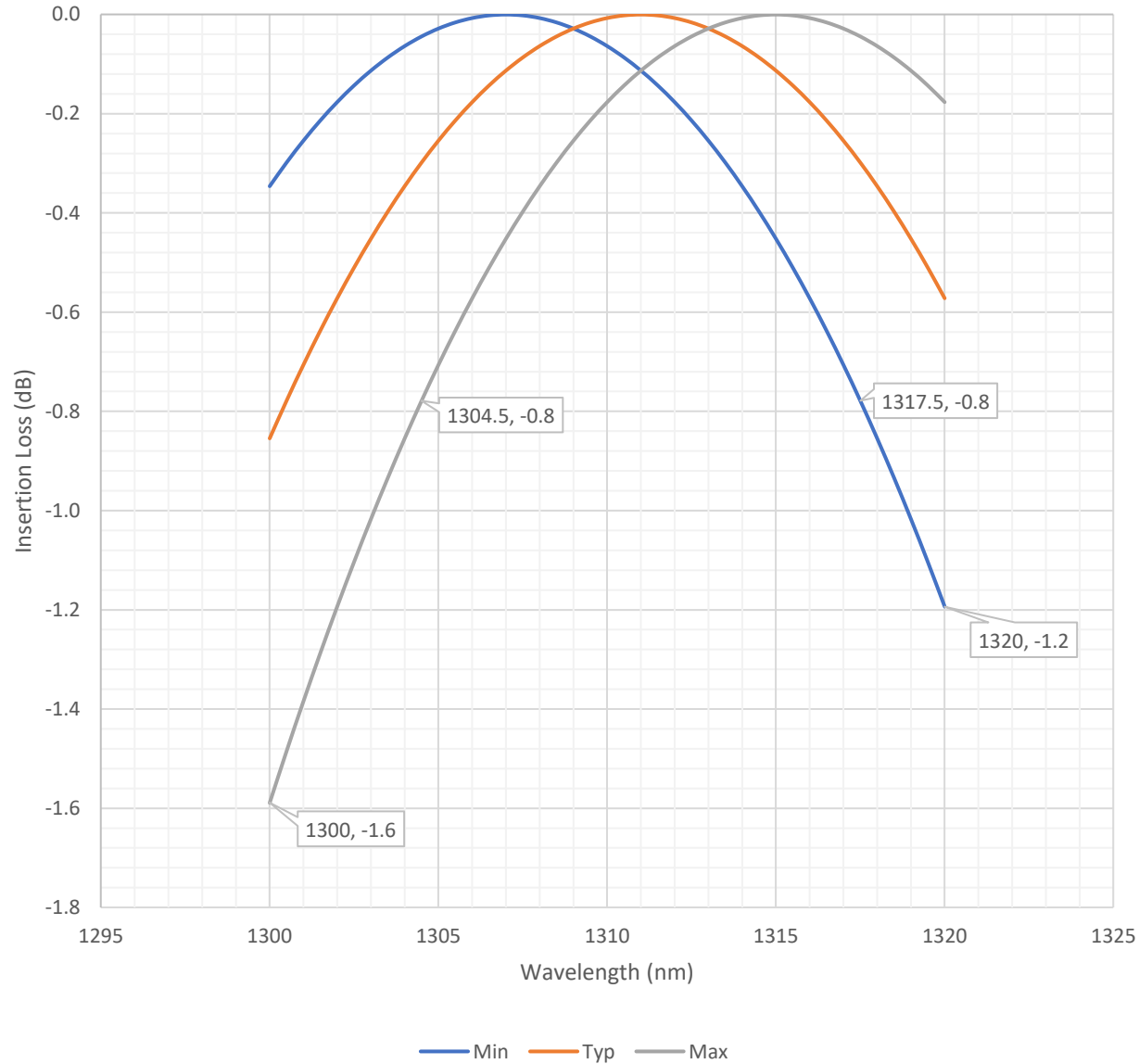
Direction	Min loss	Max loss	Unit
100GBASE-LR1 transmitter to 100GBASE-DR receiver	0.8	4	dB
100GBASE-DR transmitter to 100GBASE-LR1 receiver	0	5.2	dB

Wavelength Sensitivity of Optical Receivers

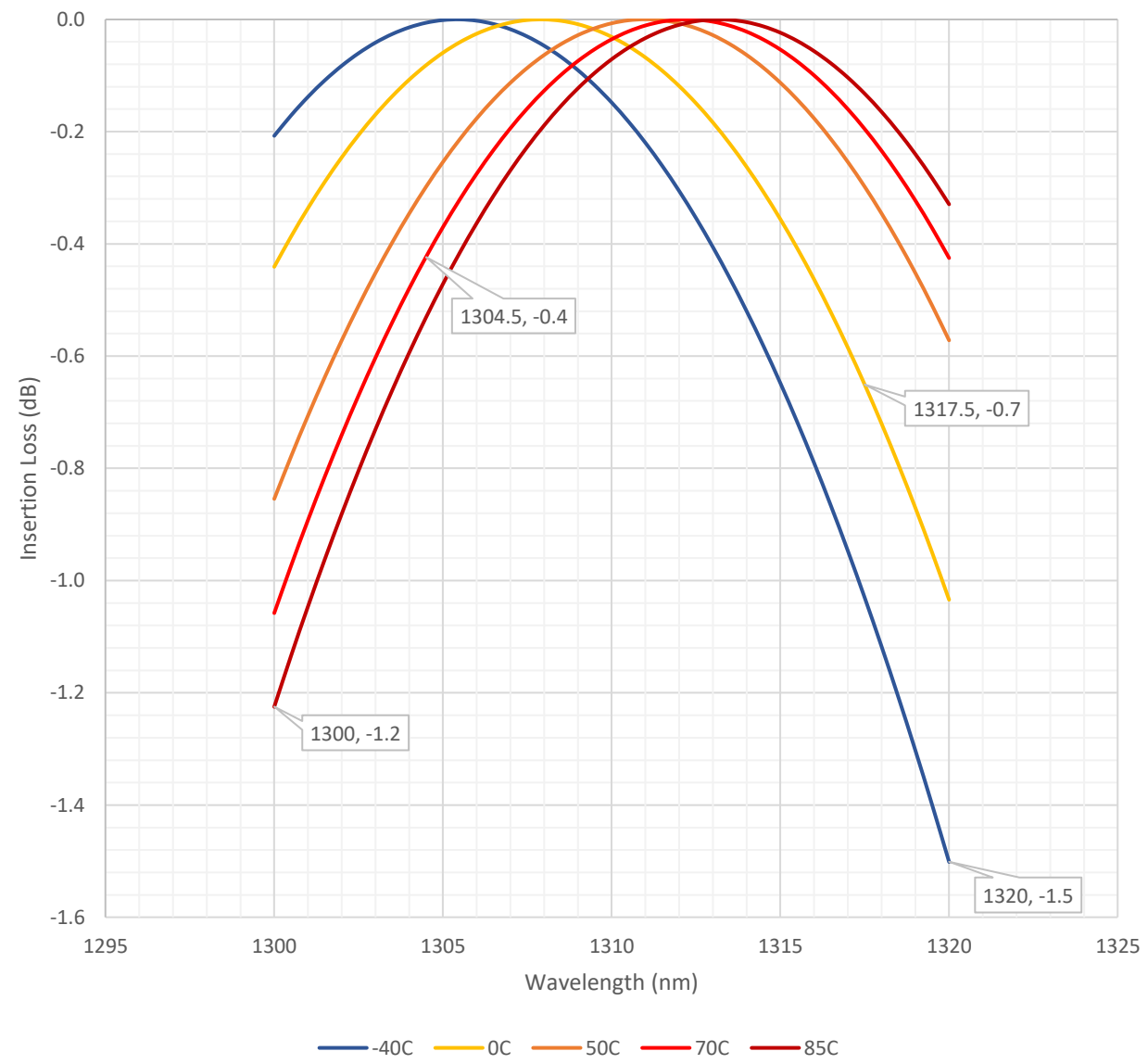
- Key assumption in [chuang_3cu_01a_091520.pdf](#) was that only the photodiode had wavelength dependency in the receiver.
- Wavelength dependence can be present in components beyond photodiode:
 - Silicon Photonic Grating Couplers
 - Discrete optics couplers (including AR coating applications)
- Degradations of $\geq 1\text{dB}$ possible if expanding from 13nm to 20nm optical bandwidths if design was optimized to IEEE specifications

Wavelength Sensitivity of Optical Receivers

Varying Grating Coupler Corner



Varying Grating Coupler Temperature



Transmitter Performance

- Key assumption in [chuang_3cu_01a_091520.pdf](#) was that there will be no significant increase in dispersion penalty and therefore no change to TDECQ and TECQ specs.
- Laser/Modulator performance could be affected by the higher temperatures under discussion
 - TDECQ of uncooled i-temp transceivers could be impacted by more than just dispersion differences
 - TECQ likely to increase at transmitter (case) temperatures of 85C → No results have been shown yet

Wavelength Range: Market Requirements/Trends

- Recent trends are toward restricting temperature and/or wavelength specifications for Ethernet Applications to improve yield/cost
 - Open Compute 100G-CWDM4-Lite: 15-55 °C
 - Open Compute 200G-FR4 OCP: 15-65 °C, 11.5nm/λ (20nm spacing)
 - 50GBASE-FR/LR (13nm)
- Even I-temp requirements of -40 to 85°C are typically only for cold start @ -40°C and have operation range of -20C to 85°C (10.5nm) after warm up time.

Summary

- Recommend to not change wavelength range for 100GBASE-FR1/LR1
- Breaks interoperability with 100GBASE-DR and 400G-BASE-FR4
- Can degrade receiver performance
- Insufficient details in proposal
 - No confirmation that additional changes won't be needed in link budgets
 - No proposal on how to change interoperation guidelines to account for wavelength aspects
- Proposed broadening to 20nm is excessive even for I-temp and against general industry trends