RMS Spectral Width

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Introduction

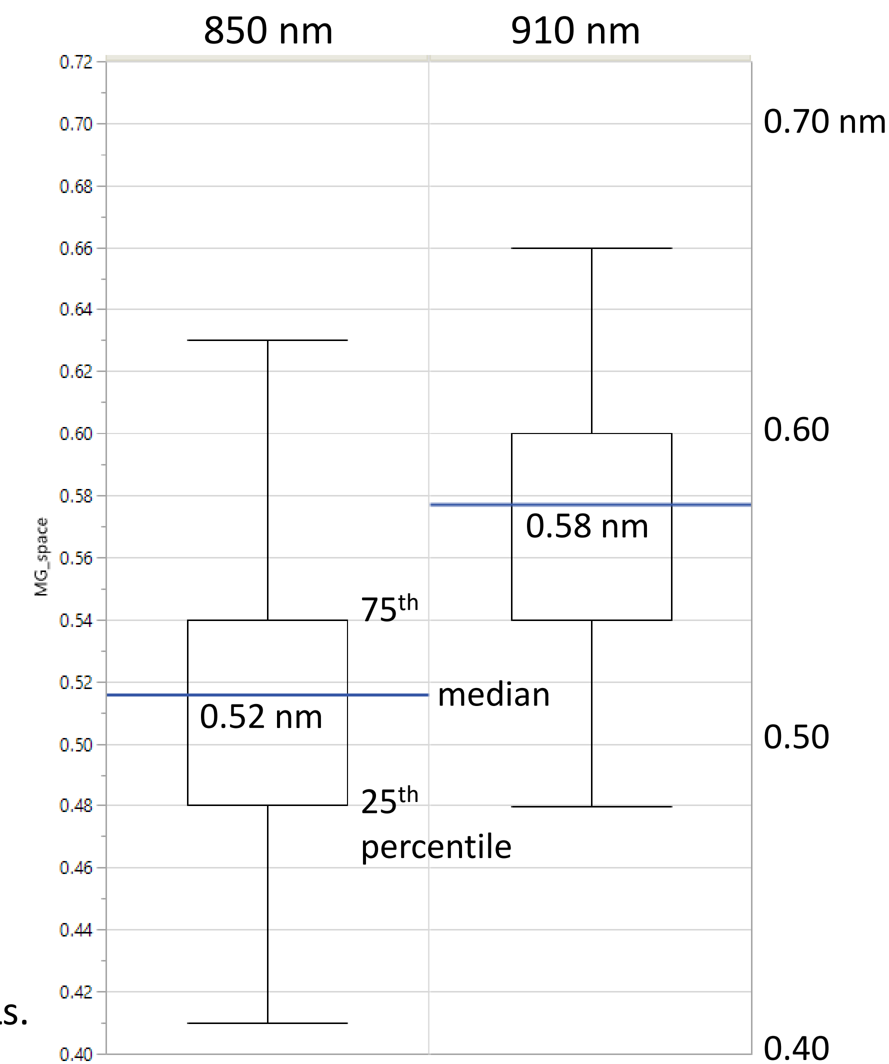
- RMS spectral width is specified as maximum 0.6 nm for both 844 – 863 nm and 900 – 918 nm channels in Table 200 – 7 of Draft 1.0.

- A maximum of 0.65 nm was suggested in king_3cm_01a_0718 for the 900 – 918 nm channel based on the lower fiber chromatic dispersion at the longer wavelength channel.

- A change from 0.60 to 0.65 nm for the maximum RMS spectral width on the 900 – 918 nm channel will promote supply assurance and reduce the manufacturing/test cost of 900 – 918 nm VCSEL arrays.

Mode Group Spacing in 850 and 910 nm VCSELs

Mode group spacing (LP01 – LP11) from wafers with aperture size within a 0.25 μm window.



Mode groups are spaced farther apart on average in VCSELs for the 900 – 918 nm channel compared to the 844 – 863 nm channel.

RMS spectral width is determined by

(a) Weighting of modes, and

(b) Mode spacing.

Same weighting of modes in 850 and 910 nm VCSELs would result in a larger spectral width for the 910 nm channel.

Maximum RMS spectral width of 0.60 and 0.65 nm for the 844 – 863 nm and 900 – 918 nm channels, respectively, is approximately the same proportion as the relative mode spacing in 850 and 910 nm VCSELs.

RMS Spectral Width

Impact of a change in RMS Spectral Width:

- Mode partition noise penalty
- TDECQ filter reference response

MPN

- The product of the fiber chromatic dispersion D and RMS spectral width U_W is a figure of merit for the mode partition noise penalty (Ogawa-Agrawal model).

- Product $D \cdot U_W$ is lower for the 900 – 918 nm channel with a max U_W of 0.65 nm when compared to the 844 – 863 nm channel with max U_W of 0.60 nm.

MMF	λ (nm)	D (ps/(nm·km)) [1]	Max U_W (nm)	Product $D \cdot U_W$ (ps/km)		P_{mpn} (dB) for 100m OM4 with k = 0.1 [2]
OM3 OM4	900	-89.8	0.60	-53.9		0.04
			0.65	-58.4	Lower at 900 nm	0.05
			0.70	-62.9		0.07
	844	-115.7	0.60	-69.4		0.09
						P_{mpn} (dB) for 150m OM5 with k = 0.1 [2]
OM5	900	-78.7	0.60	-47.2		0.10
			0.65	-51.1	Lower at 900 nm	0.13
			0.70	-55.1		0.17
	844	-101.2	0.60	-60.7		0.23

1. Fiber chromatic dispersion calculated using 10 GbE spreadsheet methodology with zero dispersion wavelength U_0 of 1320 nm and zero dispersion slope S_0 of 0.11 ps/(nm^2·km) for OM3 and OM4, and U_0 = 1328 nm and S_0 = 0.0935 ps/(nm^2·km) for OM5. Parameter values from ingham_3cm_02_0918.pdf.
2. P_{mpn} calculated with the Ogawa-Agrawal model using Q = 3.41.

TDECQ Filter Bandwidth

- TDECQ reference filter bandwidth calculated by the method described in Ref. 1.
- The TDECQ reference filter -3dBe bandwidth decreases by a negligible amount when the maximum RMS spectral width is changed from 0.60 to 0.65 nm for the 900 – 918 nm channel.

  The reference filter bandwidth of 9.0 GHz noted in Section 200.8.5 of Draft 1.0 can be used without any change.

λ (nm)	Max U_W (nm)	TDECQ Filter –3dBe BW (GHz)		
		OM3 70m	OM4 100m	OM5 150m
918	**0.60**	9.05	9.08	9.01
918	**0.65**	9.04	9.05	8.96

Calculations by Jonathan Ingham.

1. ingham_3cm_02_0918.pdf.

Summary

- Suggest maximum RMS spectral width of 0.65 nm for the 900 – 918 nm channel.

- No change to the TDECQ reference response filter -3dBe bandwidth of 9 GHz.

Appendix

Ogawa-Agrawal Model

MPN Penalty from chromatic dispersion of fiber

$$P_{mpn} = -5 \log_{10} (1 - Q^2 \sigma^2{}_{mpn})$$

$$\sigma_{mpn} = \frac{k}{\sqrt{2}} \left(1 - e^{-\beta^2}\right)$$

$$\beta = \pi \, B \, L \, (D \, U_W)$$

B	bit rate
D	fiber chromatic dispersion
L	fiber length
U_W	RMS spectral width