

CORNING

Extrapolation of IEC EMB guidance for OM3 to 980nm

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1. Summary

980nm has been proposed as a wavelength for VCSELS in the 802.3cz project because of improved reliability.

OM3 MM fiber has been proposed as the medium. The IEC guidance [1] developed as a consensus worst-case estimate in TIA by Corning/OFS/Prysmian/CommScope/Panduit [2] extends from 840nm to 953nm. This presentation summarizes a conservative extrapolation of that estimate to 980nm, which is consistent with independent work by Pimpinella [3] and Pérez-Aranda [4]. Because 980nm is relatively close to 953nm extrapolation is a reasonable option.

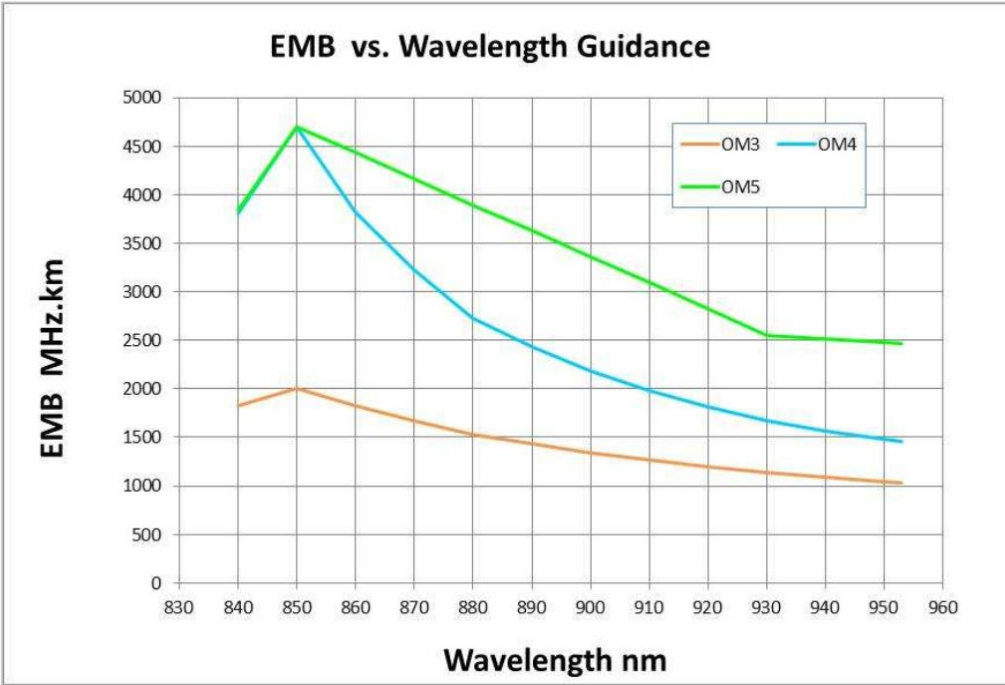
The EMB requirements for 802.3cz for 40m 25GbE and 15m 50GbE are significantly less than the estimated **946MHz.km**, so the estimate is not crucial. For other projects and/or longer distance targets the estimate should be revisited.

2a. Background of IEC guidance

The IEC guidance curves for OM3 and OM4 originated at the end of the TIA “OM5 project” and were presented as a joint contribution early in the study group phase of the IEEE802.3cz project [2] (which included BiDi at 850nm and 910nm and considered 4 wavelength WDM from 850nm to 953nm).

It is worth noting that there is a consensus understanding that the change in the mode delays with wavelength is more complicated than the linear relation assumed in the May 2003 JLT paper [5] primarily because the delays shift more rapidly near 850nm and more slowly near 1300nm (just as the optimum alpha shifts more quickly with wavelength near 850nm and more slowly near 1300nm).

2b. IEC guidance curve for OM3, OM4, OM5 [2]



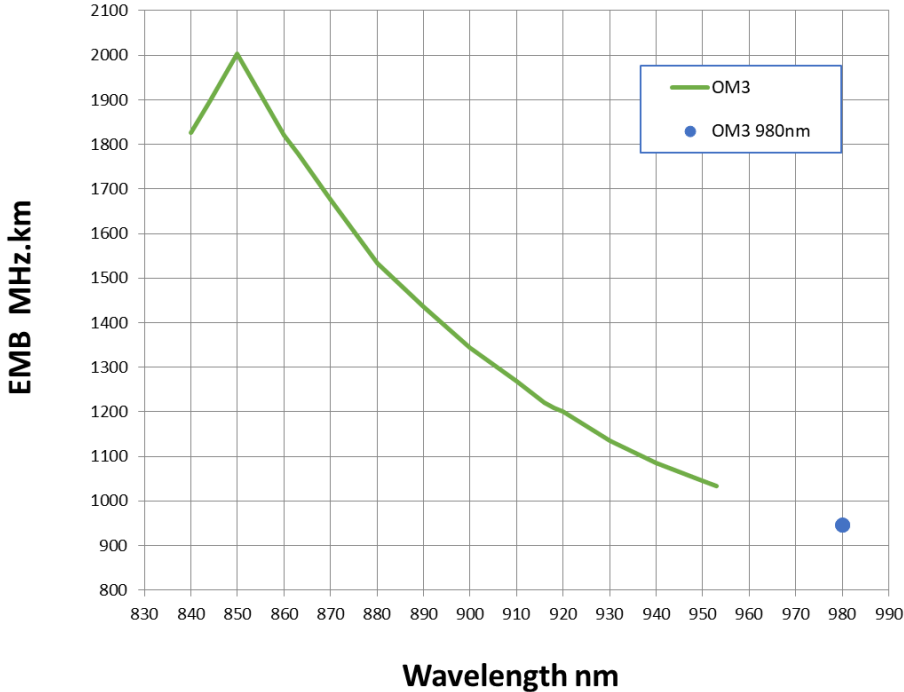
These plots are from 802.3cm study group. The curves for OM3 and OM4 represent new work.

The OM3 and OM4 curves are consensus “worst case” curves.

The $EMB(\lambda)$ of a particular OM3 fiber will lie above the OM3 guidance curve [3].

2c. IEC guidance curve for OM3

EMB vs. Wavelength Guidance



The green curve is the IEC guidance curve for OM3, consistent with the IEEE presentation [2].

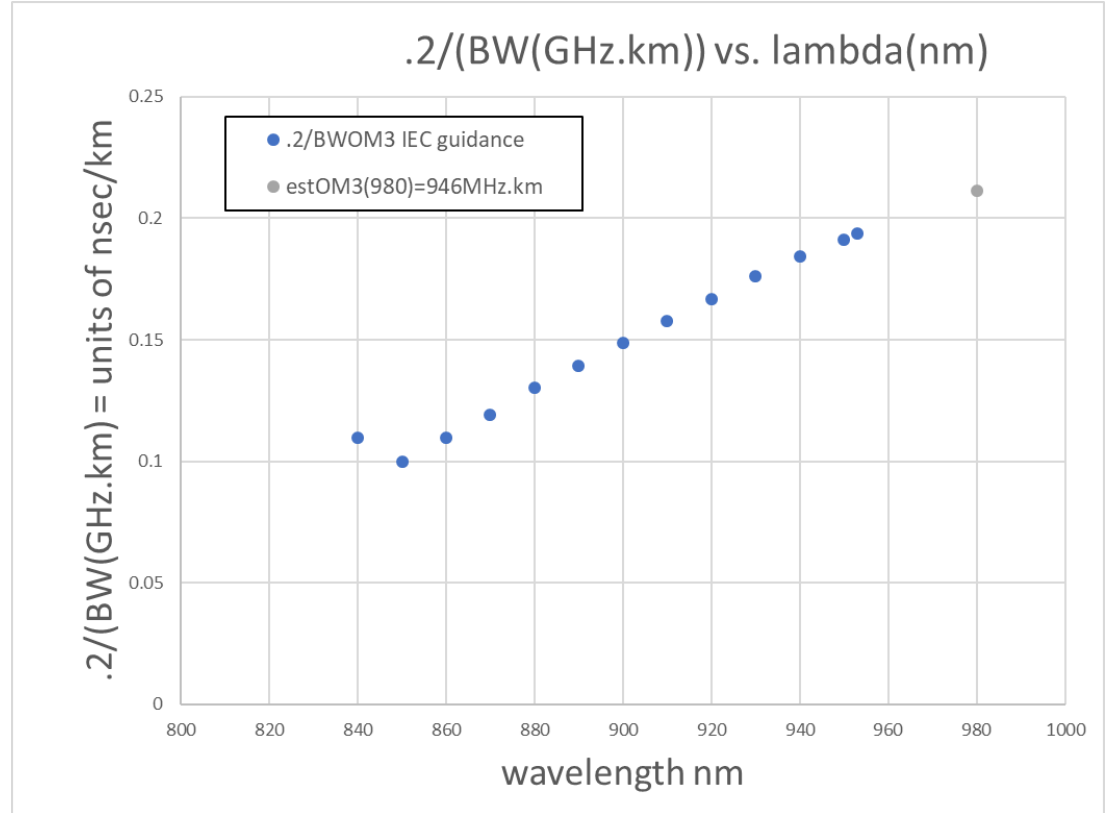
A dot marks the extrapolation to 980nm. It will be roughly 950MHz.km, with the exact value depending on details discussed in the backup slides.

3. Methodology of extrapolation

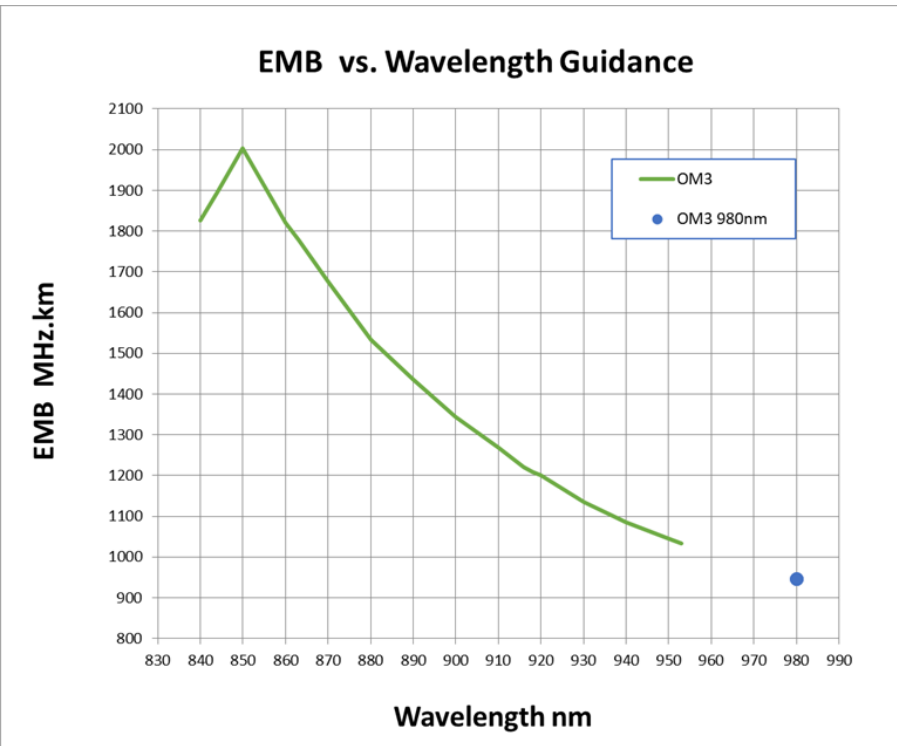
The methodology used here is to calculate an extrapolation of the $(.2/EMB)$ curve using points from the IEC guidance.

This is more linear, making extrapolation easier.

The extrapolated value converted back to MHz.km is 946MHz.km



4. Results/Discussion



The extrapolated value of 946MHz.km is meant to be used as a conservative estimate for the 802.3cz project. The purpose of using OM3 fiber is to pass along as much margin as possible to allow connectors and a reliable transceiver. The 946MHz.km appears well in excess of the BW needed in proposals so far.

Note the 2000MHz.km at 850nm is an EMB based on the EMBc method and the 946MHz.km applies to any compliant transceiver meeting the original 10GbE encircled flux specs.

5. Conclusion

An EMB in the range 946-950MHz.km has been calculated independently by different participants and looks to be a robust estimate for the purposes of the IEEE802.3cz project.

6. References

- [1] IEC document with EMB guidance curves
60793-2-10_ed7_2019.pdf
Optical fibres – Part 2-10 Product specifications – Sectional specification for category A1 multimode fibers. See Appendix E , figure E.1
- [2] IEEE NGMMF study group presentation (802.3cm study group)
https://www.ieee802.org/3/NGMMF/public/Jan18/kolesar_NGMMF_01_jan18.pdf
- [3] Pimpinella(Panduit) estimate for 980nm
https://www.ieee802.org/3/cz/public/27_oct_2020/pimpinella_3cz_01_271020.pdf
- [4] Pérez-Aranda(KDPOF) estimate for 980nm
https://www.ieee802.org/3/cz/public/27_oct_2020/perezaranda_3cz_03_271020_25G_emb_impact.pdf
- [5] May 2003 JLT paper (Pepeljugoski et al.) p.1256
“Development of System Specification for Laser-Optimized 50-um Multimode Fiber for Multigigabit Short-Wavelength LANS”
<https://www.osapublishing.org/jlt/abstract.cfm?uri=jlt-21-5-1256>

7. BACKUP

7a. Details of EMB worst-case-estimates at longer wavelengths.

OM3 fibers have two specifications:

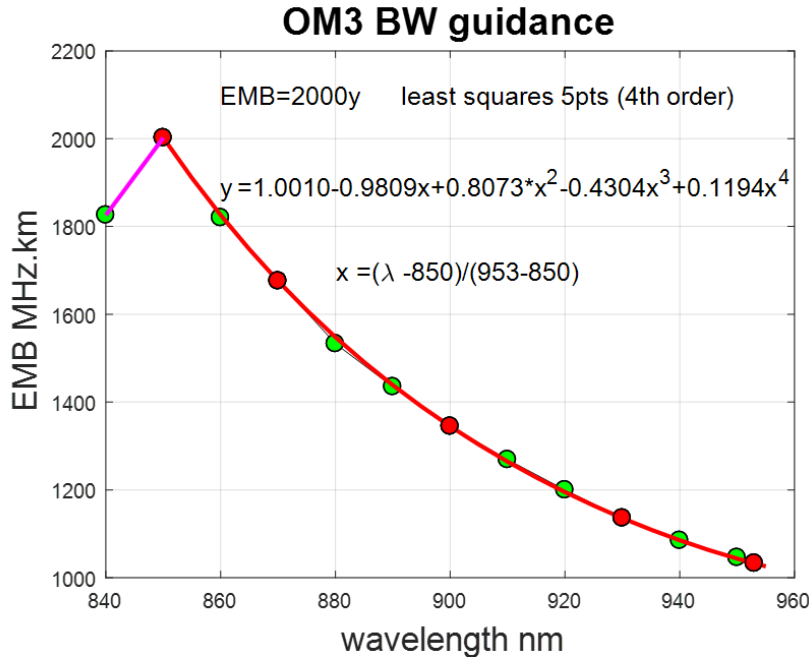
1. At 850nm $EMB = 1.13 * \min EMB_c$ at 850nm which is measured using a DMD measurement and 10 “simulated” lasers with different modal power weightings
2. At 1300nm, a legacy requirement of 500MHz.km at 1300nm with an overfilled launch (OFL BW). This is not a $\min EMB_c$ -type measurement with a DMD.

The “worst case” OM3 fibers need to also meet OFL1300 spec.

This was included in the analysis for [2] and the IEC guidance curves [1] and is implicit in the extrapolation in this presentation:

For example, (a) select 5000 ‘random’ MM fibers. (b) verify they meet OM3 specs 1 and 2 above, (c) determine the theoretical lowest $EMB = 1.13 * \min EMB_c$ at a new wavelength “X”.

7b. OM3 detail from guidance calculation and OM3/OM4 table



This plot shows the 4th order fit used in IEC 60793-2-10:2019 [1] equation E.4 and figure E.1, as well as the underlying data used for the fit.

These particular values come from the 5000 'fibers' in the Monte Carlo simulation documented in [5], using only 'fibers' meeting the OFL 1300 spec and using Sellmeir equation to accurately include the effect of the wavelength shift. These theoretical 'worst case' fibers have an extremely high EMB but at a non-850nm wavelength.

The difference between the green dots and red guidance line is within error of estimate.

lambda	OM3	OM4	OM5
840	1826	3809	3840
850	2002	4701	4700
860	1820	3817	4432
870	1676	3226	4164
880	1533	2729	3896
890	1435	2428	3628
900	1345	2179	3360
910	1269	1984	3092
920	1200	1819	2824
930	1136	1675	2556
940	1085	1566	2519
950	1046	1486	2481
953	1033	1459	2470