

Items from the 100G MMF Link Baseline

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Ad Hoc Teleconference

Baseline Specifications

- Baseline proposal for 50m and 100m OM4 reach (and equivalent reach OM3 and OM5) presented on Dec. 17, 2020.

[murty 3db adhoc 01b 121720.pdf](#)

- The following discussion and presentations have highlighted the test methodology, and various parameters in the specifications.

[le cheminant 3db adhoc 01 121720.pdf](#)

[lin 3db adhoc 01 121720.pdf](#)

[lin 3db 01 0121.pdf](#)

- Today, review the parameter specifications that have been brought up in discussion.

Key parameters noted in discussion

Extinction ratio

RIN_{12} OMA

MPN penalty

TECQ

Error Floor

Potential TBDs

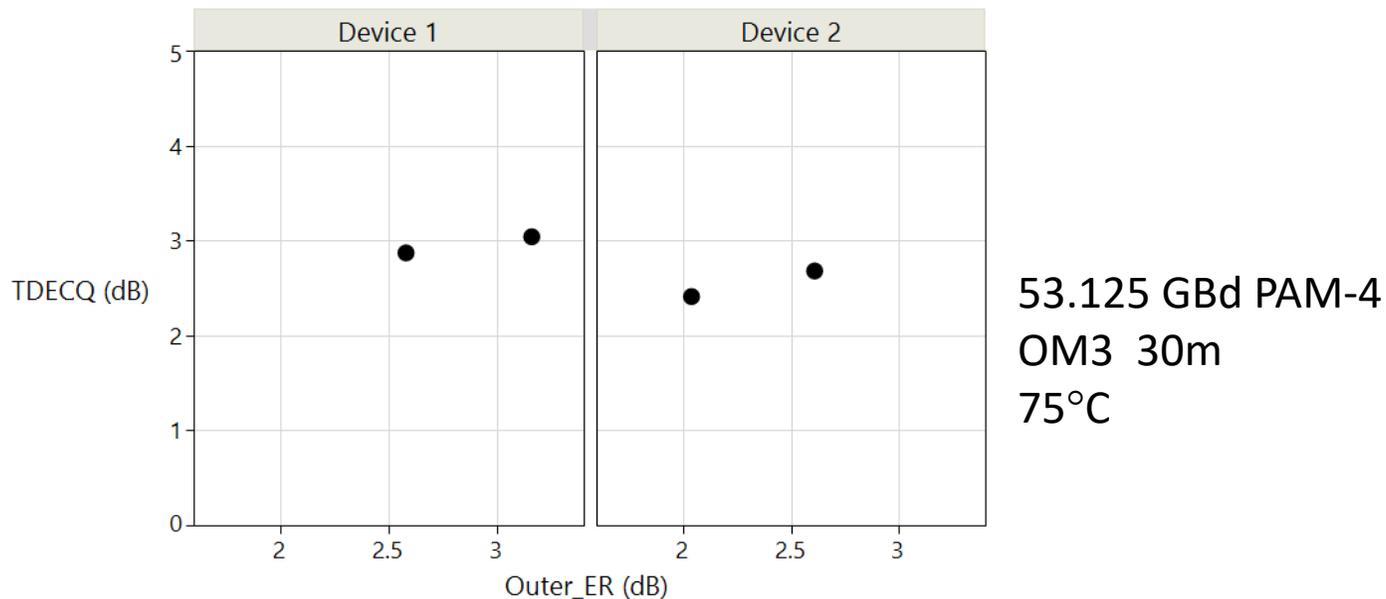
Rx FFE

Extinction Ratio

Minimum ER in 802.3 MMF Link Standards			
802.3ba 10G NRZ	802.3bm 25G NRZ	802.3cd and 802.3cm 50G PAM-4	802.3db 100G PAM-4 Proposed
3 dB	2 dB	3 dB	2.5 dB

Lin and Zheng, [lin_3db_01_0121.pdf](#), showed a significant increase in TDECQ with ER of 2.5 dB using numerical calculations and suggested setting a higher value.

➤ Measurements do not show the large increase in TDECQ when ER is reduced from 3 to 2.5 dB.



RIN₁₂OMA

Maximum RIN ₁₂ OMA in 802.3 MMF Link Standards			
802.3ba 10G NRZ	802.3bm 25G NRZ	802.3cd and 802.3cm 50G PAM-4	802.3db 100G PAM-4 Proposed
—	—	-128 dB/Hz	-131 dB/Hz

Lin and Zheng, [lin 3db adhoc 01 121720.pdf](#), suggested setting a lower value with a comparison to SMF links.

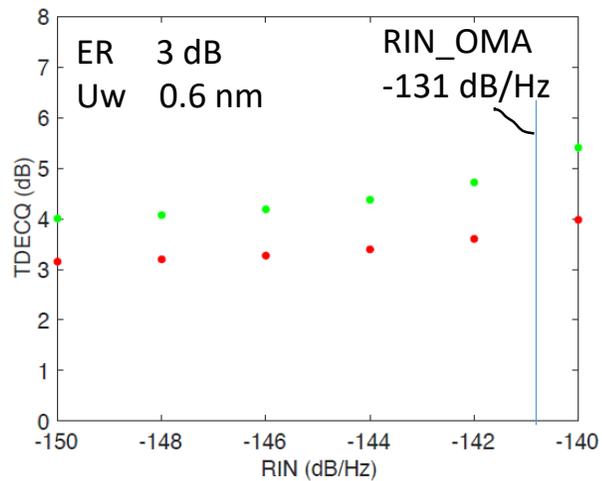
- We note that the proposed value for 100G PAM-4 link is 3 dB/Hz lower than the corresponding value for 50G PAM-4 link (see 802.3cd & cm).
- Link simulations presented in

Bhatt, Castro, and Thompson
Ingham and Murty

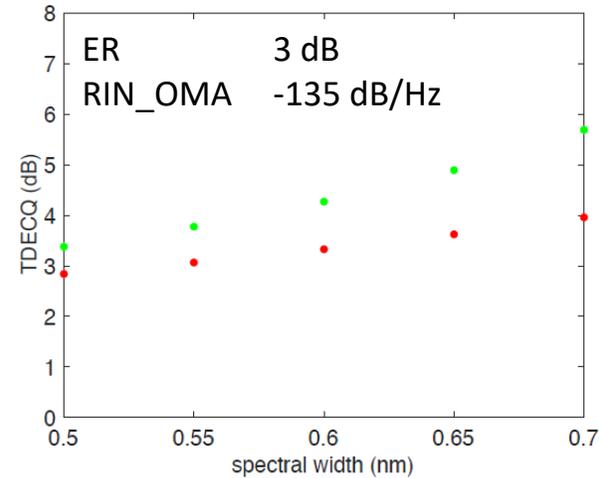
[bhatt 100GSR adhoc 01 050720.pdf](#), and
[ingham 3db adhoc 01a 062520.pdf](#)

show the feasibility of closing links with a RIN_{OMA} of -131 dB/Hz.

Link Simulations with RIN_OMA of -131 dB/Hz



TDECQ for 100 m OM4 versus RIN for 9-tap Rx FFE (green) and 23-tap Rx FFE (red)



TDECQ for 100 m OM4 versus spectral width for 9-tap Rx FFE (green) and 23-tap Rx FFE (red)

[ingham_3db_adhoc_01a_062520.pdf](#)

Simulations suggest RIN_OMA of -131 dB/Hz and Uw of 0.5 nm should lead to TDECQ below 4.5 dB with 9 tap Rx FFE.

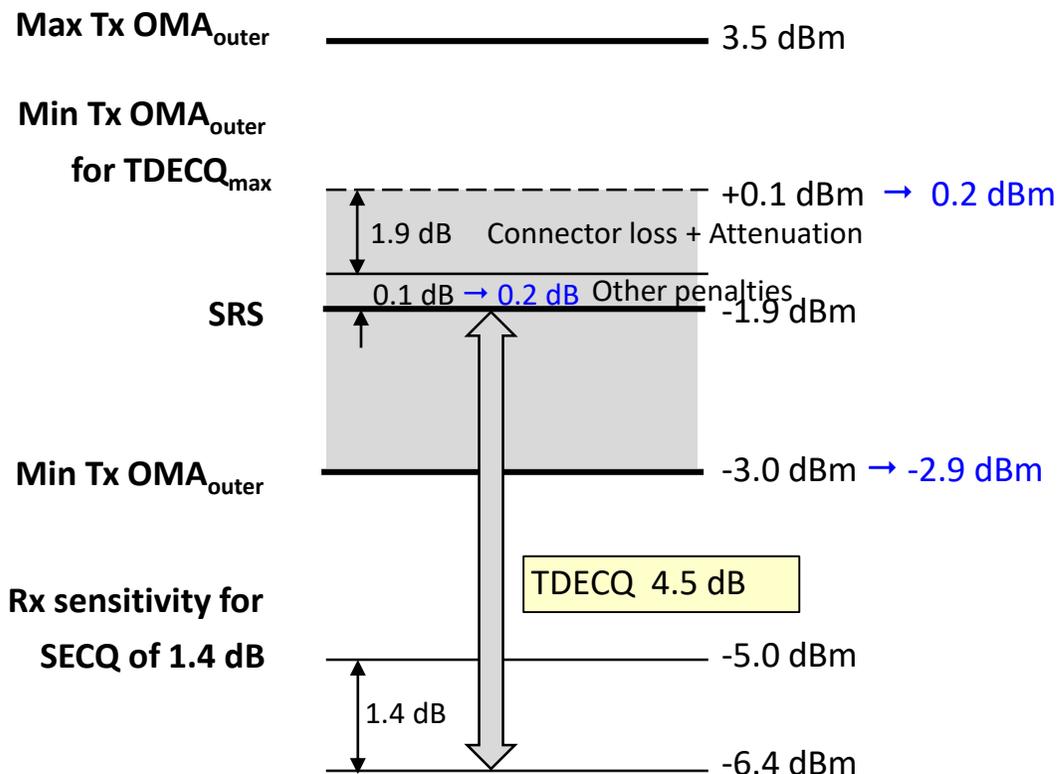
Ethernet standards are written to give flexibility to the transceiver manufacturers in choosing Tx parameters to make the link so that it meets TDECQ and other requirements.

MPN Penalty

Proposed value for Other Penalties was 0.1 dB for both 50 and 100m reach.

- Piers Dawe suggested a higher value for the 100m reach; here suggest raising the value for Other Penalties to 0.2 dB for 100m reach.

Link budget for 100m OM4



Parameter	Reach Objective B			Units
	OM3	OM4	OM5	
Effective modal bandwidth at 850 nm ^a	2000	4700		MHz.km
Power budget (for max TDECQ)	6.5 → 6.6			dB
Operating distance	0.5 to 60	0.5 to 100		m
Channel insertion loss ^b	1.7	1.9		dB
Allocation for penalties (for max TDECQ) ^c	4.6 → 4.7			dB
Additional insertion loss allowed	0.2	0		dB

^a Per IEC 60793-2-10

^b The channel insertion loss is calculated using the maximum distance specified and cabled optical fiber attenuation of 3.5 dB/km at 850 nm plus an allocation for connection and splice loss given in 138.10.2.2.1

^c Link penalties are used for link budget calculations. They are not requirements and not meant to be tested.

TECQ

Proposed by Mike Dudek to

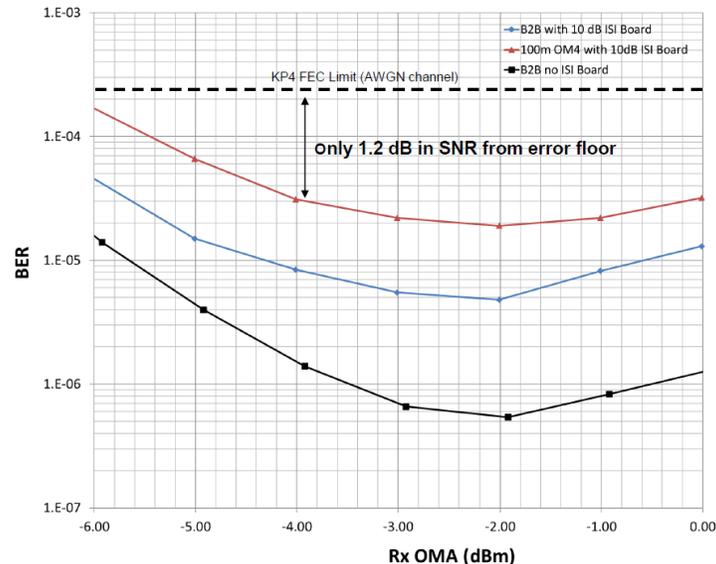
- (a) test for interoperability [Tx for 100m reach works at Rx for 50m reach], and
- (b) transceivers meet overshoot/undershoot specification at 0.5 m.

➤ Modify baseline to include TECQ specification and measurement.

Error Floor

BER specification proposed for 802.3db (same as 802.3cd and 802.3cm): “The BER when processed by the PMA shall be less than 2.4×10^{-4} provided the error statistics are sufficiently random.”

- Lin and Zheng, [lin 3db adhoc 01 121720.pdf](#), show examples of 400GBASE-FR4 links with BER of $5E-6$ (uncorrectable errors) and $1E-7$ (no uncorrectable errors) using 400GBASE-FR4 modules, and suggest a study of error floor in 802.3db, referencing the figure below reproduced from slide 5 of [lyubomirsky_3db_01_1020.pdf](#).
- The black curve does show an error floor near $5E-7$ in a B2B link for a 53.125 GBd VCSEL.
- Regarding error floors in prototype experimental setups, it is known that they may partly result from the use of discrete components, free space optical alignment on Tx and Rx may add noise, and electrical reflections at connectors.
- Considering the current stage of link testing where 100G modules are not available, suggest that demonstrated BER (and TDECQ) are sufficient to develop a Standard.



Note: The red & blue curves include 10 dB additional ISI, intended to mimic a linear interface.

[lyubomirsky_3db_01_1020.pdf](#)

Potential TBDs

50m reach

Wavelength range

Maximum TECQ and TDECQ

Overshoot/undershoot

Rx FFE

Number of taps, position of cursor, and minimum value of cursor for TDECQ and TECQ

(other TBDs are related to the above)

100m reach

Overshoot/undershoot

Rx FFE

Minimum value of cursor for TECQ

Rx FFE for 100m Reach

Proposed values for 100m reach

Number of taps on reference equalizer	9
Position of cursor	Taps 1, 2, 3, 4, or 5
Minimum value of cursor for TDECQ	0.7

➤ Following values are in the range of values discussed:

Number of taps on reference equalizer	9
Position of cursor	Taps 1, 2, 3, or 4
Minimum value of cursor for TDECQ	0.8 (same as Clause 138, 802.3cd)

Summary

- ❑ Discussed adjustments to the link parameters with the goal of driving a consensus on adopting the baseline.

Reviewed specifications for ER, RIN_{12} OMA, and MPN penalty

Added TECQ

Identified potential TBDs