

IEEE 802.3 NEA “802.3 Ethernet for AI” Assessment – “Fiber for AI” Workshop

Specifying the optical channel for Ethernet optical PMDs

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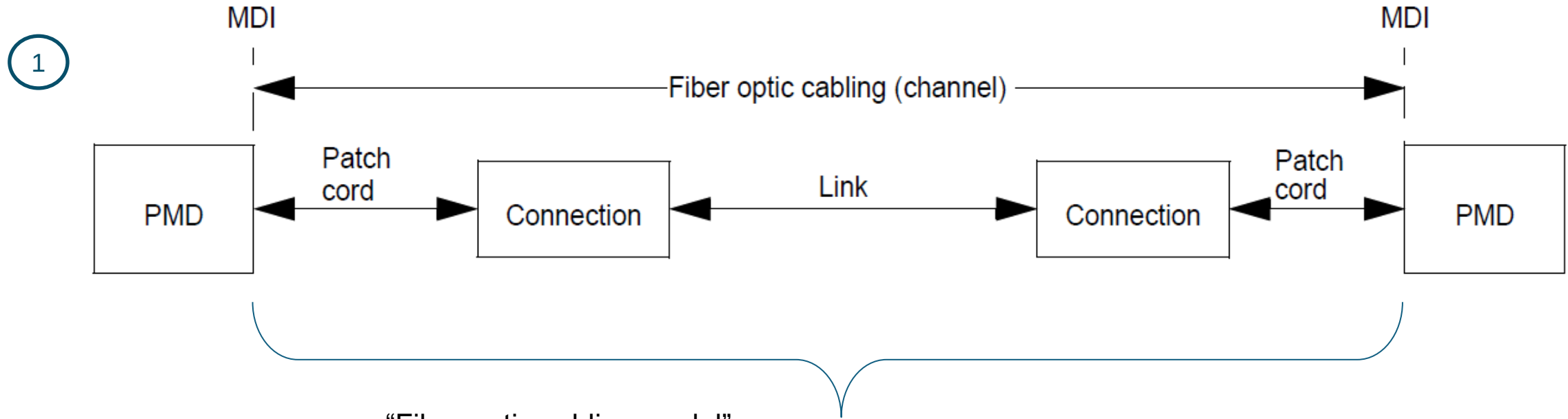
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24 Feb 2026

Introduction

- Currently, there are no industry specifications addressing multi-core or hollow-core fiber
 - Considered to be another “type” of SMF fiber
- There is growing industry interest observed in using both fiber types for high speed optical links, and they could be suggested for future IEEE 802.3 projects defining Ethernet optical PMDs
- Development of IEEE 802.3 optical PMD specifications is based on a normative channel, not optical fiber specifications
- This presentation will provide an overview of the IEEE 802.3 specification methodology for optical PMDs / channels
- SMF Ethernet optical PMDs typically range from 500m to 40km, based on either IMDD or Coherent technologies.

It Starts with the Channel



“Fiber optic cabling model”

- “Fiber optic cabling” is the channel

Individual aspects of the channel are not normative

- i.e. patch cord, connection, link, fiber, connector or splices and their specifications

Today – IEEE 802.3 Approach: An example from CL180

Table 180–10—Optical channel characteristics

Description	200GBASE-DR1	400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	Unit
Operating distance (max)	500		m
Channel insertion loss ^{a,b} (max)	See Table 180–12		dB
Channel insertion loss (min)	0		dB
Positive dispersion ^b (max)	0.65		ps/nm
Negative dispersion ^b (min)	−0.85		ps/nm
DGD_max ^c	2.24		ps
Optical return loss (min)	27	37	dB

^a These channel insertion loss values include cable, connectors, and splices.

^b The dispersion specifications are based on the statistical link design methodology documented in Appendix I of Recommendation ITU-T G.652 (08/2024), over the wavelength range 1304.5 nm to 1317.5 nm.

^c Differential Group Delay (DGD) is the time difference at reception between the fractions of a pulse that were transmitted in the two principal states of polarization of an optical signal. DGD_max is the maximum differential group delay that the system is required to tolerate.

Table 180–12—Maximum channel insertion loss versus number of discrete reflectances

Maximum channel insertion loss (dB)		Number of discrete reflectances > −55 dB and ≤ −45 dB								
		0	1	2	3	4	5	6	7	8
Number of discrete reflectances > −45 dB and ≤ −35 dB	0	3	3	3	3	3	3	2.9	2.9	2.9
	1	3	3	3	2.9	2.9	2.9	2.9	2.8	2.8
	2	2.9	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.7
	3	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.6	2.6
	4	2.7	2.6	2.6	2.6	2.5	2.5	2.5	2.5	— ^a
	5	2.5	2.5	2.5	— ^a	— ^a	— ^a	— ^a	— ^a	— ^a
	6	— ^a	— ^a	— ^a	— ^a	— ^a	— ^a	— ^a	— ^a	— ^a

^a The indicated combination of reflectances does not provide a supported maximum channel insertion loss.

Table 180–11—Optical fiber and cable characteristics

Description	Value	Unit
Nominal fiber specification wavelength	1310	nm
Cabled optical fiber attenuation (max)	0.5 ^a	dB/km
Zero dispersion wavelength (λ_0)	$1300 \leq \lambda_0 \leq 1324$	nm
Dispersion slope (max) (S_0)	0.092	ps/(nm ² x km)

^a The 0.5 dB/km attenuation is provided for Outside Plant cable as defined in TIA 568-C.3.

Other clauses called out ITU standards, e.g. CL187

Table 180–9—Illustrative link power budget

Parameter	Value	Unit
Power budget (for max TDECQ)	6.7	dB
Operating distance	500	m
Channel insertion loss ^{a, b}	3	dB
Maximum discrete reflectance	−35	dB
Allocation for penalties ^c (for max TDECQ)	3.7	dB
Additional insertion loss allowed	0	dB

^a The channel insertion loss is calculated using the maximum distance specified in Table 180–6 and cabled optical fiber attenuation of 0.5 dB/km at 1304.5 nm plus an allocation for connection and splice loss given in 180.8.2.

^b The channel insertion loss of 3 dB shown in this illustrative link power budget is valid for a maximum MPI penalty of 0.1 dB, which depends on the number and value of discrete reflectances present in the link. This channel insertion loss may be reduced by up to 0.5 dB depending on the discrete reflectances in the link as shown in Table 180–12.

^c Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested. In this illustrative link power budget the value shown includes an allocation of 0.1 dB for MPI penalty and 0.2 dB for DGD penalty. For cases with a channel insertion loss less than 3 dB, as shown in Table 180–12, the allocation for penalties should be “6.7 – channel insertion loss”.

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Normative

Informative

Going Forward

- IEEE 802.3 is based on a normative channel approach.
 - This includes the specification of the interaction between maximum channel insertion loss and number of discrete reflectances.
- Definition of Ethernet optical PMDs can begin once the characteristics of an optical *channel* using multi-core or hollow-core fibers are available:
 - independent of the standards/specifications for the fiber
 - independent of the standards/specifications for the connector
- Emerging projects in 802.3 include:
 - 802.3ds (MMF targeting 30m and 50m)
 - March 2026 400G per lane CFI