Supporting explanations for P802.3dj draft D1.0 comments

John Johnson, Broadcom

May 13, 2024

Comments against P802.3dj draft D1.0

1. Addition of TX Channel requirements sub-clauses 180.8.5.1 and 182.8.5.1, including Transmitter compliance channel specifications tables with correct ORL requirements, rather than referencing 121.8.5.2 (D1.0 comments #001, 003)
2. Proposed values for Total average launch power (max) TBD's in Tables 181-5 and 183-6 (800GBASE-FR4-500 and -FR4) (D1.0 comments #006, 007)
3. Proposed values for Difference in launch power between any two lanes (OMAouter) (max) TBD's in Tables 181-5 and 183-6 (800GBASE-FR4-500 and -FR4) (D1.0 comments #008, 009)
4. Proposed values for Difference in receive power between any two lanes (OMAouter) (max) TBD in Tables 181-6 and 183-7 (800GBASE-FR4-500 and -FR4) (D1.0 comments #010, 011)
5. Use of max(TECQ, TDECQ) in place in Table 183-6 (800GBASE-FR4/LR4) and elsewhere in clause 183. (D1.0 comment #012)
6. Population of TBD clauses 183.7.1 and 183.7.2 with text from clauses 182.7.1 and 182.7.2. (D1.0 comments #125, 126)
7. Addition of informative MPI and DGD penalty allocation to Link power budgets in Tables 180-9 (500m DRn) and 181-7 (800GBASE-FR4-500). (D1.0 comments #127, 128)

1. TX Channel requirements

(D1.0 comments #001, 003)

180.8.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

The TDECQ of each lane shall be within the limits given in Table 180–7 if measured using the methods specified in 121.8.5.1, 121.8.5.2, and 121.8.5.3 using a reference equalizer as described in 121.8.5.4 where T is the symbol period for 200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, and 1.6TBASE-DR8 with the following exceptions:

— The signaling rate of the test pattern generator is as given in Table 180–7 and uses the test pattern specified for TDECQ in Table 180–14.

— The reference equalizer is a 15-tap, T-spaced, feed-forward equalizer (FFE), where T is the symbol period.

— The combination of the O/E converter and the oscilloscope has a 3 dB bandwidth of approximately 53.125 GHz with a fourth-order Bessel-Thomson response to at least 1.3 × 106.25 GHz, and at frequencies above 1.3 × 106.25 GHz, the response should not exceed –20 dB. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

— The normalized noise power density spectrum $N(f)$ is equivalent to white noise filtered by a fourth-order Bessel-Thomson response filter with a 3 dB bandwidth of 53.125 GHz.

Table 180–7—200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, and 1.6TBASE-DR8 transmit characteristics *(continued)*

Description	200GBASE-DR1	400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	Unit
Transmitter transition time (max)	8		ps
Average launch power of OFF transmitter, each lane (max)	–15		dBm
$RIN_{xx}OMA$[b] (max)	–139		dB/Hz
Optical return loss tolerance (max)	15.5	21.4	dB
Transmitter reflectance[c] (max)	–26		dB

121.8.5.2 Channel requirements

The transmitter is tested using an optical channel that meets the requirements listed in Table 121–11.

Table 121–11—Transmitter compliance channel specifications

PMD type	Dispersion[a] (ps/nm)		Insertion loss[b]	Optical return loss[c]	Max mean DGD
	Minimum	Maximum			
200GBASE-DR4	$0.011625\times\lambda\times[1-(1324/\lambda)^4]$	$0.011625\times\lambda\times[1-(1300/\lambda)^4]$	Minimum	21.4 dB	0.5 ps

[a] The dispersion is measured for the wavelength of the device under test (λ in nm). The coefficient assumes 500 m for 200GBASE-DR4.
[b] There is no intent to stress the sensitivity of the O/E converter associated with the oscilloscope.
[c] The optical return loss is applied at TP2.

- 180.8.5 points to 121.8.5.2 for TX channel requirements
- Table 121-11 in 121.8.5.2 lists ORL = 21.4 dB for 200GBASE-DR4
  - This ORL matches 400G/800G/1.6TBASE-DRn, but not 200GBASE-DR1, which is 15.5 dB
  - A similar issue occurs in 182.8.5 with the ORL for 200GBASE-FR1, which is 17.1 dB, not 21.4 dB.
- Proposed change:
  - Add a new exception to the list: “The optical return loss is as given in Table 180-6” (or Table 182-7, as appropriate)

2. Total average launch power (max)

(D1.0 comments #006, 007)

- Total average launch power(max) is TBD in Table 181-5 (800GBASE-FR4-500) and Table 183-6 (800GBASE-FR4)
- In 50G/L and 100G/L FR4 and LR4 PMDs, this is simply the Average launch power, each lane(max) + 6 dB.
- There is no obvious reason not to follow the same methodology for 800GBASE-FR4-500 and 800GBASE-FR4 for D1.1.
- Propose to replace the TBD's with 10.9 dBm in both tables.

PMD	Average launch power, each lane (max)	Total average launch power (max)
200GBASE-FR4	4.7	10.7
200GBASE-LR4	5.3	11.3
400GBASE-FR4	4.4	10.4
400GBASE-LR4-6	5.1	11.1
800GBASE-FR4-500	4.9	**10.9**
800GBASE-FR4	4.9	**10.9**

Values in dBm

3. Difference in launch power between any two lanes (OMAouter) (max)

(D1.0 comments #008, 009)

- Difference in launch power between any two lanes (OMAouter)(max) is TBD in Table 181-5 (800GBASE-FR4-500) and Table 183-6 (800GBASE-FR4)
- In 50G/L and 100G/L FR4 and LR4 PMDs, this is given as OMAouter(max) – OMAouter(min) or 4 dB, whichever is smaller.
- There is no obvious reason not to follow the same methodology for 800GBASE-FR4-500 and 800GBASE-FR4 for D1.1.
- Propose to replace the TBD's with 4 dB in both tables.

PMD	Outer Optical Modulation Amplitude (OMAouter), each lane (max)	Outer Optical Modulation Amplitude (OMAouter), each lane (min)	OMAouter(max) minus OMAouter(min)	Difference in launch power between any two lanes (OMAouter) (max)
200GBASE-FR4	2.8	-3	5.8	4
200GBASE-LR4	4.5	-1.2	5.7	4
400GBASE-FR4	3.7	-0.2	3.9	3.9
400GBASE-LR4-6	4.4	0.3	4.1	4
800GBASE-FR4-500	4.8	0.8	4	**4**
800GBASE-FR4	4.8	0.8	4	**4**

Values in dB, dBm

4. Difference in receive power between any two lanes (OMAouter) (max)

(D1.0 comments #010, 011)

- Difference in receive power between any two lanes (OMAouter)(max) is TBD in Table 181-6 (800GBASE-FR4-500) and Table 183-7 (800GBASE-FR4)
- In 50G/L and 100G/L FR4 PMDs, this is given as OMAouter(max) – OMAouter(min) + 0.1 or 0.2 dB.
  - The 0.1-0.2 dB presumably accounts for the difference in attenuation between the two extreme wavelengths.
- There is no obvious reason not to follow the same methodology for 800GBASE-FR4-500 and 800GBASE-FR4 for D1.1.
- Propose to replace the TBD's with 4.1 dB in both tables.

PMD	Difference in launch power between any two lanes (OMAouter) (max)	Difference in receive power between any two lanes (OMAouter) (max)
200GBASE-FR4	4	4.1
400GBASE-FR4	3.9	4.1
800GBASE-FR4-500	**4**	**4.1**
800GBASE-FR4	**4**	**4.1**

Values in dB

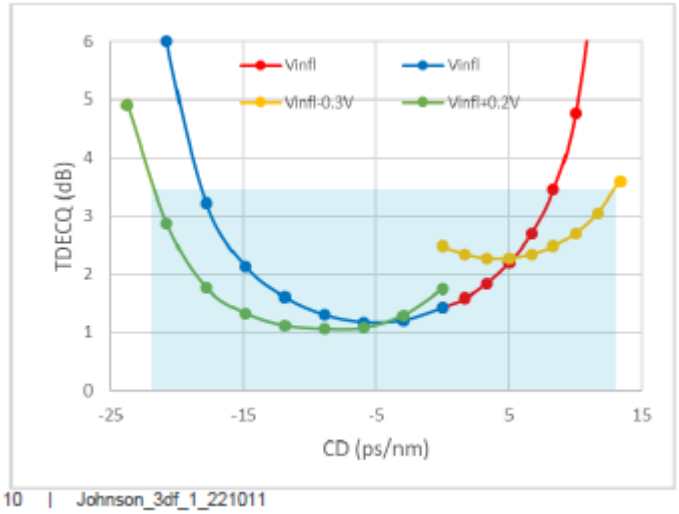
5. Use of max(TECQ, TDECQ) in Clause 183

(D1.0 comment #012)

- A TX must be compliant over the full range of fiber length (chromatic dispersion), so the use of TDECQ alone is insufficient to determine Outer Optical Modulation Amplitude (OMAouter), each lane (min) in Table 183-6 (800GBASE-FR4/LR4).
  - It's possible to bias an EAM such that TDECQ < TECQ when the EAM has non-zero chirp and the fiber has significant dispersion (Johnson_3df_01a_221011)
  - This TX spec methodology is already adopted in clauses 180, 181 and 182.
- Propose to replace TDECQ with max(TECQ, TDECQ) in Table 183-6.
  - Note that "-0.1 + max(TECQ, TDECQ)" is already in Equation 183-1 referenced in Table 183-6.
  - For consistency with clauses 180-182, replace "Equation 183-1" with "-0.1 + max(TECQ, TDECQ)" in Table 183-6, and delete Equation 183-1 on page 435, line 20. (not sure why it's there)
  - Update Figures 183-3, 183-5, 183-6 and associated descriptive text with max(TECQ, TDECQ).

Table 183–6—800GBASE-FR4 and 800GBASE-LR4 transmit characteristics

Description	800GBASE-FR4	800GBASE-LR4	Unit
Outer Optical Modulation Amplitude (OMA_{outer}), each lane (mi…			
for TDECQ <0.9 dB	0.8	–	dBm
for 0.9 dB ≤ TDECQ ≤ 3.4 dB	Equation (183–1)	–	dBm
for TDECQ <1.4 dB	–	1.9	dBm
for 1.4 dB ≤ TDECQ ≤ 3.9 dB	–	0.5+TDECQ	dBm



6. Population of clauses 183.7.1 and 183.7.2

(D1.0 comments #125, 126)

- Clause 183.7.1 Optical fiber cable is TBD.
  - The specs in this clause are simply reporting values from external fiber cabling standards.
  - There is no difference between the fiber cable specs to be used for the FR4/LR4 PMDs, and any other PMD.
  - Propose to use the same text and table as given in 182.7.1.
- Clause 183.7.2 Optical fiber connection is TBD.
  - Propose to use the same text as given in 182.7.2: "An optical fiber connection, as shown in Figure 183–7, consists of a mated pair of optical connectors."
  - Since this is a basic definition of terms, it should not be controversial.

183.7.1

~~182.7.1~~ **Optical fiber cable**

The optical fiber cable requirements are satisfied by cables containing ITU-T G.652.B (dispersion unshifted), type G.652.D (low water peak, dispersion unshifted), or type G.657.A1, or type G.657.A2 (bend insensitive) fibers, or the requirements in Table 182–11 where they differ.

183–XX

Table ~~182–11~~—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	$ps/nm^2 km$

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

183.7.2

~~182.7.2~~ **Optical fiber connection**

183–7

An optical fiber connection, as shown in Figure ~~182–3~~, consists of a mated pair of optical connectors.

7. Informative MPI and DGD power penalties

(D1.0 comments #127, 128)

- The link power budget does not explicitly say what the penalty allocation is for MPI and DGD.
  - It's only implied by the difference between Allocation for penalties (for max TDECQ) and TDECQ(max).
  - This makes it hard for average readers to understand the power budget.
- Propose to add to the footnotes on the link power budget tables an informative value for the MPI and DGD penalty
  - Table 180-9, footnote (b). Add: "This value includes an allocation of 0.1 dB for MPI and DGD penalties."
  - Table 181-7, footnote (d). Add: "This value includes an allocation of 0.5 dB for MPI and DGD penalties."

Table 180–9—Illustrative link power budget

Parameter	Value	Unit
Power budget (for max TDECQ)	6.5	dB
Operating distance	500	m
Channel insertion loss[a]	3	dB
Maximum discrete reflectance	–35	dB
Allocation for penalties[b] (for max TDECQ)	3.5	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 180.7.2.1.
[b] Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested. This value includes an allocation of 0.1 dB for MPI and DGD penalties.

Table 181–7—800GBASE-FR4-500 illustrative link power budgets

Parameter	800GBASE-FR4-500	Unit
Power budget (for maximum TDECQ)	7.6	dB
Operating distance	500	m
Channel insertion loss[a]	3.5	dB
Maximum discrete reflectance[b]	–35[c]	dB
Allocation for penalties[d] (for maximum TDECQ)	3.9	dB
Additional insertion loss allowed[e]	0	dB

[a] The channel insertion loss is calculated using the maximum distance specified in Table 181–4 and fiber attenuation of 0.5 dB/km plus an allocation for connection and splice loss given in 181.7.2.1.
[b] See 181.7.2.2 for details and specifications as a function of the number of discrete reflectances within the channel.
[c] Maximum value for each discrete reflectance with 4 discrete reflectances above –55 dB within the channel.
[d] Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested. This value includes an allocation of 0.5 dB for MPI and DGD penalties.

Thank you