

Historical perspective on optical power levels in Cl. 124, related to comments #82, #83 and #95, draft 3.0 of P802.3df

Peter Stassar, Huawei

P802.3df comment resolution meetings, September 2023

Introduction

- Comments I-82, I-83 and I-95 have been submitted to D3.0, trying to address some potential inconsistencies between minimum average transmitter optical power levels between 400GBASE-DR4/800GBASE-DR8 and 400GBASE-DR4-2 and 800GBASE-DR8-2.
- This presentation provides some historical perspective on the development of the power levels in D3.0, in relation to in-force clauses 124, 140 and 151.
- The intent is to provide the CRG with sufficient information to enable appropriate decisions on resolutions to submitted comments.
- For this issue the following parameters are relevant:
 - Transmitter average launch power, each lane, min
 - Outer Optical Modulation Amplitude (OMA_{outer}), each lane, min
 - Extinction ratio, assumption for max, while specification includes the minimum value

Overview of parameters in draft 3.0 of P802.3df

| Description | 400GBASE-DR4 | 800GBASE-DR8 | 400GBASE-DR4-2 800GBASE-DR8-2 | Unit |
|---|-------------------------------------|---------------------------|----------------------------------|------|
| Signaling rate, each lane (range) 400GBASE-DR4, 400GBASE-DR4-2 800GBASE-DR8, 800GBASE-DR8-2 | 53.125 ± 100 ppm 53.125 ± 50 ppm | | | GBd |
| Modulation format | PAM4 | | | — |
| Lane wavelength (range) | 1304.5 to 1317.5 | | | nm |
| Side-mode suppression ratio (SMSR), (min) | 30 | | | dB |
| Average launch power, each lane (max) | 4 | | | dBm |
| Average launch power, each lane ^a (min) | -2.9 | -2.9 | -3.1 | dBm |
| Outer Optical Modulation Amplitude (OMA _{outer}), each lane (max) | 4.2 | | | dBm |
| Outer Optical Modulation Amplitude (OMA _{outer}), each lane (min) ^b for TDECQ ≤ 3.4 dB for TDECQ < 1.4 dB for 1.4 dB ≤ TDECQ ≤ 3.4 dB | -0.8 — — | — -0.8 -2.2 + TDECQ | — -0.1 -1.5 + TDECQ | dBm |

- OMA_{outer} of -0.8 dBm and P_{av} of -2.9 dBm imply max ER of 10 dB
- OMA_{outer} of -0.1 dBm and P_{av} of -3.1 dBm imply max ER of ∞

- It looks a bit odd that for the 2 km versions P_{av} min is 0.2 dB lower than for the 500 m versions, while OMA_{outer} min is 0.7 dB higher.
- This presentation shows that this is related to different assumptions on max extinction for 100GBASE-DR/400GBASE-DR4 and 100GBASE-FR1

In-force 400GBASE-DR4

- The first version of 400GBASE-DR4 in Clause 124 was developed during the 802.3bs project, approved end of 2017
- OMA_{outer} , each lane, min: -0.8 dBm
- Average launch power, each lane, min: -2.9 dBm
- Implication for assumption of max Extinction Ratio
 - 10 dB for the condition that both P_{av} and OMA_{outer} at minimum value
 - Can be higher than 10 dB if either P_{av} or OMA_{outer} are not at minimum value
- Values in in-force 802.3 2022 version are still the same.

In-force 100GBASE-DR

- The first version of 100GBASE-DR in Clause 140 was developed during the 802.3cd project, approved 2018
- OMA_{outer} , each lane, min: -0.8 dBm
- Average launch power, each lane, min: -2.9 dBm
- Implication for assumption of max Extinction Ratio
 - 10 dB for the condition that both P_{av} and OMA_{outer} at minimum value
 - Can be higher than 10 dB if either P_{av} or OMA_{outer} are not at minimum value
- Values are the same as for 400GBASE-DR4
- Values in in-force 802.3 2022 version are still the same.

Draft 800GBASE-DR8

- Current P802.3df draft 3.0 for 800GBASE-DR8
- Based upon in-force 100GBASE-DR and 400GBASE-DR4
- OMA_{outer} , each lane, min: -0.8 dBm for TDECQ < 1.4 dB
- Average launch power, each lane, min: -2.9 dBm
- Implication for assumption of max Extinction Ratio
 - 10 dB for the condition that both P_{av} and OMA_{outer} at minimum value
 - Can be higher than 10 dB if either P_{av} or OMA_{outer} are not at minimum value
- Values are the same as for 400GBASE-DR4 and 100GBASE-DR

In-force 100GBASE-FR1

- The first version of 100GBASE-FR1 in Clause 140 was developed during the 802.3cu project, approved end of 2021
- $\text{OMA}_{\text{outer}}$, each lane, min: -0.1 dBm for TDECQ < 1.4 dB
- Average launch power, each lane, min: -3.1 dBm
- Implication for assumption of max Extinction Ratio
 - ∞ for the condition that both P_{av} and $\text{OMA}_{\text{outer}}$ at minimum value
- Values in in-force 802.3 2022 version are still the same.
- Additional requirement for interoperation:

140.11.1 Interoperation between 100GBASE-FR1 and 100GBASE-DR

The 100GBASE-FR1 and 100GBASE-DR PMDs can interoperate with each other provided that the fiber optic cabling (channel) characteristics for 100GBASE-DR (see 140.10 and Table 140–13) are met and the 100GBASE-FR1 transmitter average power is greater than or equal to the value for average launch power (min) for 100GBASE-DR in Table 140–6.

Draft 400GBASE-DR4-2 / 800GBASE-DR8-2

- Current P802.3df draft 3.0 for 400GBASE-DR4-2 / 800GBASE-DR8-2:
- Based upon in-force 100GBASE-FR1
- OMA_{outer} , each lane, min: -0.1 dBm for TDECQ < 1.4 dB
- Average launch power, each lane, min: -3.1 dBm
- Implication for assumption of max Extinction Ratio
 - ∞ for the condition that both P_{av} and OMA_{outer} at minimum value
- Values are the same as for 100GBASE-FR1
- Additional requirement for interoperation:

124.11a.1 Interoperation between 400GBASE-DR4 and 400GBASE-DR4-2

The 400GBASE-DR4 and 400GBASE-DR4-2 PMDs can interoperate with each other provided that the fiber optic cabling (channel) characteristics for 400GBASE-DR4 (see 124.11 and Table 124–12) are met and the 400GBASE-DR4-2 transmitter average power is greater than or equal to the value for average launch power (min) for 400GBASE-DR4 in Table 124–6.

124.11a.2 Interoperation between 800GBASE-DR8 and 800GBASE-DR8-2

The 800GBASE-DR8 and 800GBASE-DR8-2 PMDs can interoperate with each other provided that the fiber optic cabling (channel) characteristics for 800GBASE-DR8 (see 124.11 and Table 124–12) are met and the 800GBASE-DR8-2 transmitter average power is greater than or equal to the value for average launch power (min) for 800GBASE-DR8 in Table 124–6.

Issue in relation to comments

- Concerns have been raised by several comments during 802.3cu and P802.3df projects that the potential inconsistency on minimum average power between 500 m and 2 km versions may lead to issues in interoperation conditions.
- Comment I-63 to P802.3cu draft 3.0, which was rejected

Cl 140 SC 140.6.1 P41 L37 # I-63

Dawe, Piers J G Mellanox Technologies

Comment Type **TR** Comment Status **R** specifications (updated 0929)

100GBASE-DR and 100GBASE-FR1 are expected to be interoperable (whether this standard says so or not). So the 100GBASE-FR1 transmitter must not be weaker than the 100GBASE-DR one. It's not worth making a special case for 0.2 dB that most transmitters can't use anyway, without super-high extinction ratio.

SuggestedRemedy

Change 100GBASE-FR1 average launch power (min) from -3.1 to -2.9, same as for 100GBASE-DR. As a consequence, change average receive power (min) from -7.1 to -6.9 dBm.

In 140.10a.1, delete "and the 100GBASE-FR1 transmitter average power is greater than or equal to the value for average launch power (min) for 100GBASE-DR in Table 140-6."

Response Response Status **U**

REJECT.

A straw poll was taken on the 29th September 2020 IEEE P802.3cu interim meeting:

Straw poll #1:
Do you support changing the average launch power (min) from -3.1 dBm to -2.9 dBm for 100GBASE-FR1.
Y:9, N:9, Abstain: 11

There is no consensus to make the proposed change.

Issue in relation to comments, continued

- Comment #85 to P802.3df draft 2.0, which was rejected

| CI | SC | P | L | # |
|---|---------------------------------|-----------------------|----------|---------------------|
| 124 | 124.7.1 | 108 | 23 | 85 |
| Dawe, Piers | | Nvidia | | |
| <i>Comment Type</i> | TR | <i>Comment Status</i> | R | <i>launch power</i> |
| <p>The minimum OMA for 400GBASE-DR4-2 and 800GBASE-DR8-2 is 0.7 dB higher than for 400GBASE-DR4/100GBASE-DR and 800GBASE-DR8, so setting the average launch power 0.2 dB lower is not helpful. Any transmitter with an extinction ratio lower than 9.8 dB, which is very high, will exceed the 400GBASE-DR4 limit anyway. Modules will be made multi-compliant for convenience in interoperability and breakout - let us document that.</p> <p>There is a minor benefit in improving the clearance between Rx min power and Tx off max power, which should be very wide to accommodate better-than-worst receivers and intentional signal detect hysteresis.</p> | | | | |
| <i>SuggestedRemedy</i> | | | | |
| <p>Change Average launch power, each lane (min) from -3.1 to -2.9 dBm Change Average receive power, each lane (min) from -7.1 to -6.9 dBm. See another comment for interoperability text.</p> | | | | |
| <i>Response</i> | <i>Response Status</i> W | | | |
| REJECT. | | | | |
| <p>There is a historical background why the minimum average power does not seem consistent across PMD types. This is related to the assumption of an extinction ratio of 10 dB for the calculation of minimum average power from minimum OMA for 400GBASE-DR4 (and 800GBASE-DR8), while for the 400GBASE-DR4-2 and 800GBASE-DR8-2 the extinction ratio is assumed to be infinity.</p> <p>There is no interoperation issue. The requirements for interoperation are provided in 124.11a.1 and 124.11a.2.</p> <p>The following presentation was reviewed by the comment resolution group: https://www.ieee802.org/3/df/public/23_0523/dawe_3df_01_230523.pdf</p> | | | | |

Issue in relation to comments, continued 2

- Comment #19 to P802.3df draft 2.1, which was rejected

Cl 124 SC 124.11a P124 L23 # 19

Dawe, Piers

Nvidia

Comment Type ER Comment Status R

It would be bad economics to fragment the market for 400GBASE-DR4-2 modules into those that can interoperate with 400GBASE-DR4 and those that can't, when there is no cost to being interoperable. D2.0 comment 86. As 400GBASE-DR4 is well established but 400GBASE-DR4-2 is new, and as having a lower power for the higher performance PMD is counter-intuitive, the draft 400GBASE-DR4-2 should be brought into line.

SuggestedRemedy

Delete "and the 400GBASE-DR4-2 transmitter average power is greater than or equal to the value for average launch power (min) for 400GBASE-DR4 in Table 124-6." In Table 124-6, change the Average launch power, each lane (min) from -3.1 dBm to -2.9 dBm, same as 400GBASE-DR4.
Similarly for 800GBASE-DR8-2.

Response

Response Status C

REJECT.

This comment does not apply to the substantive changes between IEEE P802.3df D2.0 and D2.1 or the unsatisfied negative comments from previous drafts. Hence it is not within the scope of the recirculation ballot.

The CRG has previously considered substantively similar comments, specifically comments #85 and #86 submitted against Draft 2.0 in the initial WG Ballot. The resolution was REJECT due to insufficient evidence provided. The resolution to D2.0 comments #85 and #86 is recorded in the following comment report:

https://www.ieee802.org/3/df/comments/D2p0/8023df_D2p0_comments_final_id.pdf

However, it would be worthwhile to consider this topic further during SA ballot.

The commenter is invited to resubmit this comment during SA ballot for further consideration.

There is no consensus to make any changes at this time.

Issue in relation to comments, continued 3

- Comments I-82, I-83 and I-95 to P802.3df draft 3.0, now under consideration
- I-82 proposed remedy: Change the value of Average Launch Power, each lane (min) to -2.2dBm for the 2km reaches.
- I-83 proposed remedy: Add a footnote to Table 124-6 for Average launch power, each lane (min) based on the final determination of which ER values are used. For example "An ER value of 10dB is used to calculate the Average launch power, each lane (min)", or if different ER values are used for the different reaches this should be indicated in the footnote.
- I-95 proposed remedy: Delete "and the 400GBASE-DR4-2 transmitter average power is greater than or equal to the value for average launch power (min) for 400GBASE-DR4 in Table 124-6." In Table 124-6, change the Average launch power, each lane (min) from -3.1 dBm (the value associated with an infinite extinction ratio) to -2.9 dBm, same as 400GBASE-DR4 (associated with an unrealistically high extinction ratio for the same minimum OMA). Similarly for 800GBASE-DR8-2.

What is the specific problem with D3.0 related to this issue?

- Comment I-95 to P802.3df draft 3.0, states the following:
 - “It would be bad economics to fragment the market for 400GBASE-DR4-2 modules into those that can interoperate with 400GBASE-DR4 and those that say they can’t, when there is no cost to being interoperable. D2.0 comment 86, D2.1 comment 19. As 400GBASEDR4 is well established but 400GBASE-DR4-2 is new, and as having a lower power for the higher performance PMD is counter-intuitive, the draft 400GBASE-DR4-2 should be brought into line. This proposed change will improve paperwork costs and reduce confusion, and have no practical technical effect - it reduces the measurement guard band from 0.9 dB to 0.7 dB at 9.8 dB extinction ratio, which is higher than realistic anyway.”
- This suggests a split in interoperable and non-interoperable DRx-2 parts.
- This happens when the interoperation requirement on optical power is not met, i.e. when DRx-2 Tx P_{av} is between -2.9 dBm and -3.1 dBm, which happens when the Tx ER is higher than about 16 dB.
- Practical Extinction Ratio values are below 10 dB, making 16 dB extremely unlikely to occur, thus in practice there is no problem even when it looks odd

Options / Recommendations

- The CRG could consider to agree to increase the minimum average power of 400GBASE-DR4-2 and 800GBASE-DR8-2 from -3.1 to -2.9 dBm as proposed. However an inconsistency with in-force 100GBASE-FR1 is created.
- Option 1: agree for this modification, accepting an inconsistency with in-force 100GBASE-FR1. This could be resolved by creating a maintenance item to make the same modification to 100GBASE-FR1 in Clause 140.
- Option 2: reject this proposed modification in a similar way as for comments to previous drafts of P802.3cu and P802.3df, because an issue with interoperation between 500m and 2km PMDs only occurs, for extinction ratio's higher than 16 dB, which is highly unlikely in current technology.
- Option 3: Make no changes to the current draft and recommend that a maintenance activity addresses this as soon as P802.3df is approved.

Thanks!