Improved extinction ratio specifications

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Introduction

- To allow a variety of transmitter technologies for good performance, low power and cost, the extinction ratio spec should be reduced to as low as reasonable while protecting the link and the receiver
  - In March, comments bs 127,148 and 151, and cd 138, 200, 139 and 211, proposed 3 dB or 3.5 dB ER and were referred for further study and consensus building
- Recent presentations in P802.3cd ad hoc and P802.3bs SMF ad hoc explain the motivation
- http://ieee802.org/3/bs/public/adhoc/smf/17_04_25/dawe_01_0417_smf.pdf
- http://ieee802.org/3/cd/public/adhoc/archive/dawe_042617_3cd_adhoc-v3.pdf
- http://ieee802.org/3/cd/public/adhoc/archive/dawe_051017_3cd_adhoc.pdf
- This presentation shows how this can work for the six SMF PMD types in P802.3bs

Motivation

- Want to avoid excluding some transmitter technologies from future implementations
  - Directly modulated lasers (DML)
    - Well-known benefit of lower extinction ratio: less distortion in the eye
  - Electro-absorption modulators (EAM)
    - e.g. silicon photonics EAM
    - Transmitter can be shorter (faster, e.g. 10 GHz more bandwidth) and/or driven with less volts (power, cost), and deliver more output OMA

Limitations

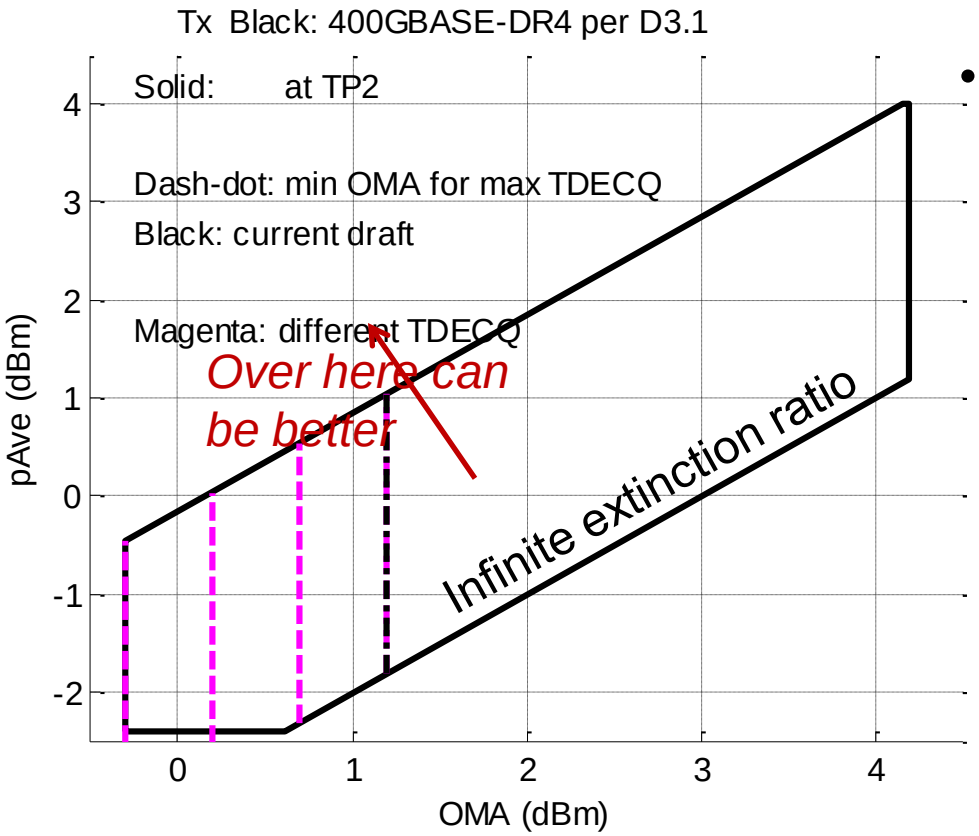
- Multi-path interference (MPI) is affected by the extinction ratio
- Reducing the extinction ratio doesn't hurt a PAM4 link budget much, because the extinction ratio is low anyway for the upper eye
- But the small difference can be quantified
  - http://ieee802.org/3/bs/public/adhoc/smf/16_01_07/king_01a_0116_smf.pdf
  - http://ieee802.org/3/bs/public/adhoc/smf/16_01_07/king_02a_0116_smf.7z

200GBASE-DR4 and 400GBASE-DR4

- Because 200GBASE-DR4 and 400GBASE-DR4 work over parallel-fibre cable plant, which has low reflection connectors, the expected multipath interference penalty is so small that the budget is unchanged
  - For 200GBASE-DR4, Table 121–15, Maximum value of each discrete reflectance
  - For 400GBASE-DR4, Table 124–13, Maximum value of each discrete reflectance
  - Both say:

Number of discrete reflectances above –55 dB	Maximum value for each discrete reflectance
1	–37 dB
2	–42 dB
4	–45 dB
6	–47 dB
8	–48 dB
10	–49 dB

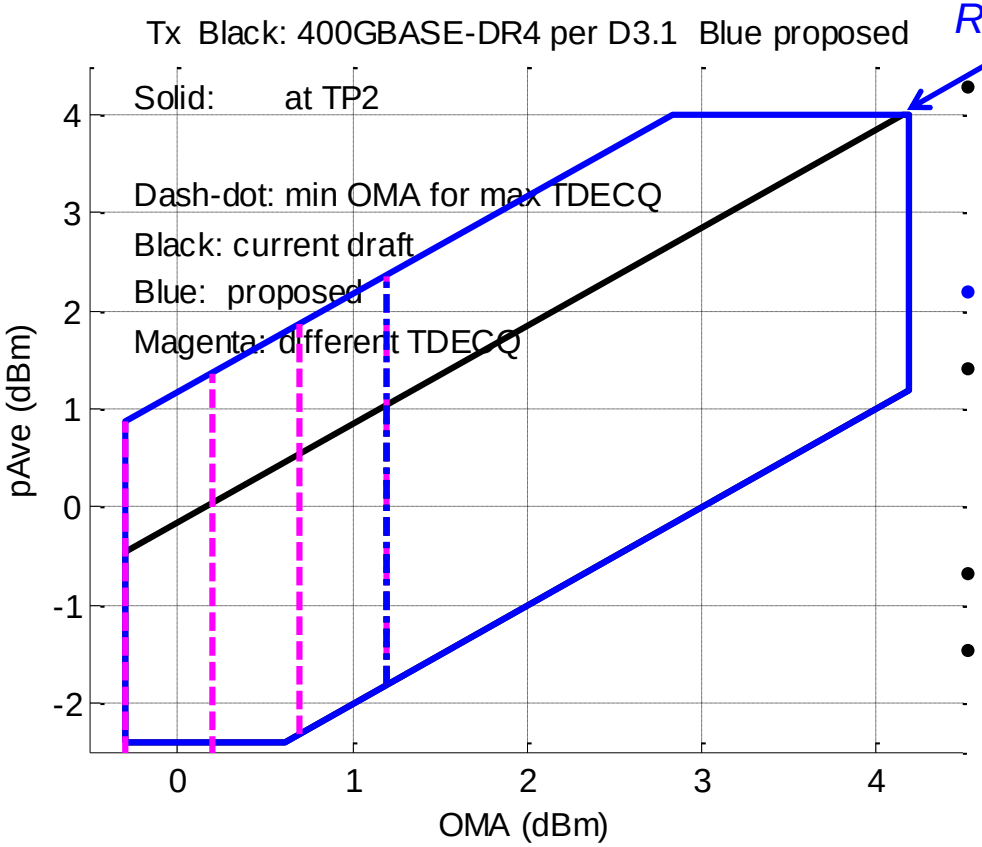
Transmitter setup map: 400GBASE-DR4



- Black polygon: Tx spec in D3.1, with 5 dB min. extinction ratio

- A single Tx waveform measurement is used to find TDECQ, OMA, mean power, and extinction ratio

400GBASE-DR4 setup map: proposal

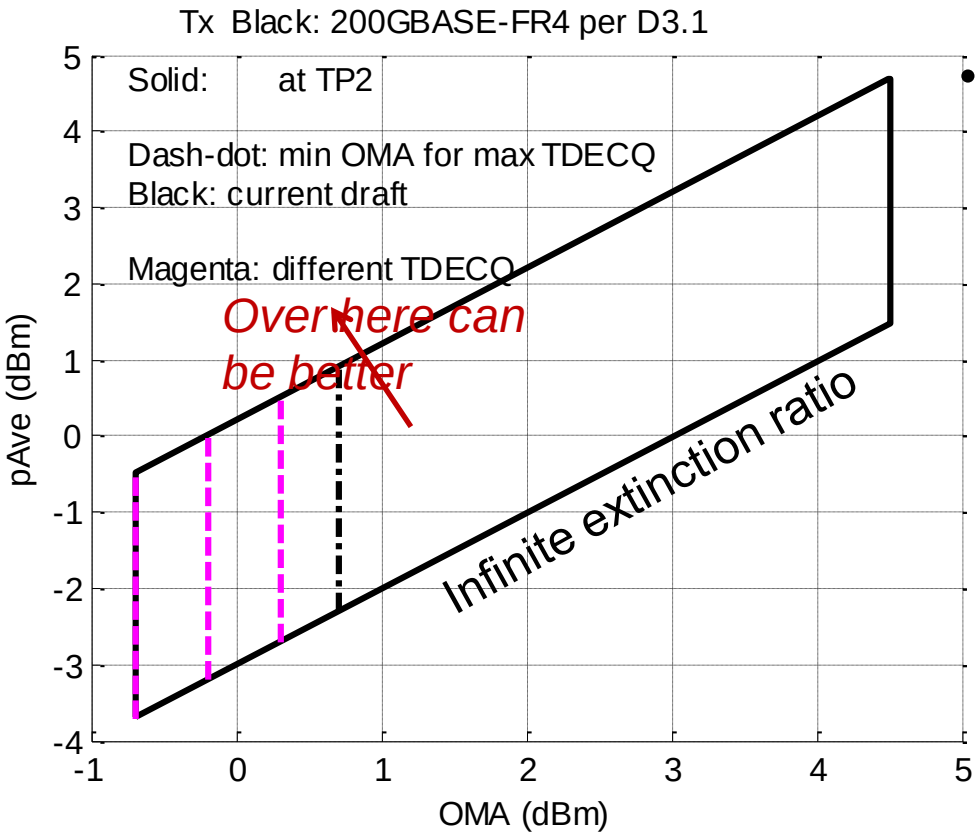


Receiver overload is unchanged for all PMDs

- Black polygon (partly hidden under blue one): Tx spec in D3.1, with 5 dB min. extinction ratio
- Blue polygon: proposal: 3.5 dB
- The expected multipath interference penalty is so small that the budget is unchanged
- Tx spec becomes easier
- Channel, connectors and receivers don't change

- A single Tx waveform measurement is used to find TDECQ, OMA, mean power, and extinction ratio

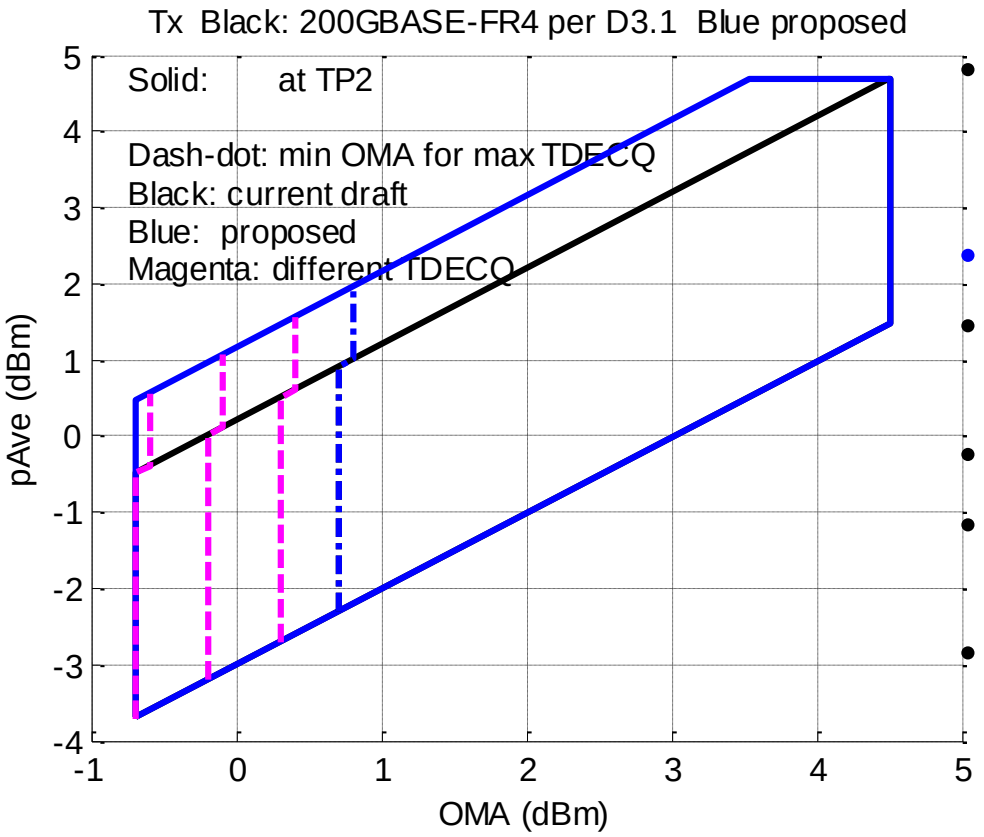
Transmitter setup map: 200GBASE-FR4



- Black polygon: Tx spec in D3.1, with 4.5 dB min. extinction ratio

- A single Tx waveform measurement is used to find TDECQ, OMA, mean power, and extinction ratio

200GBASE-FR4 setup map: one option



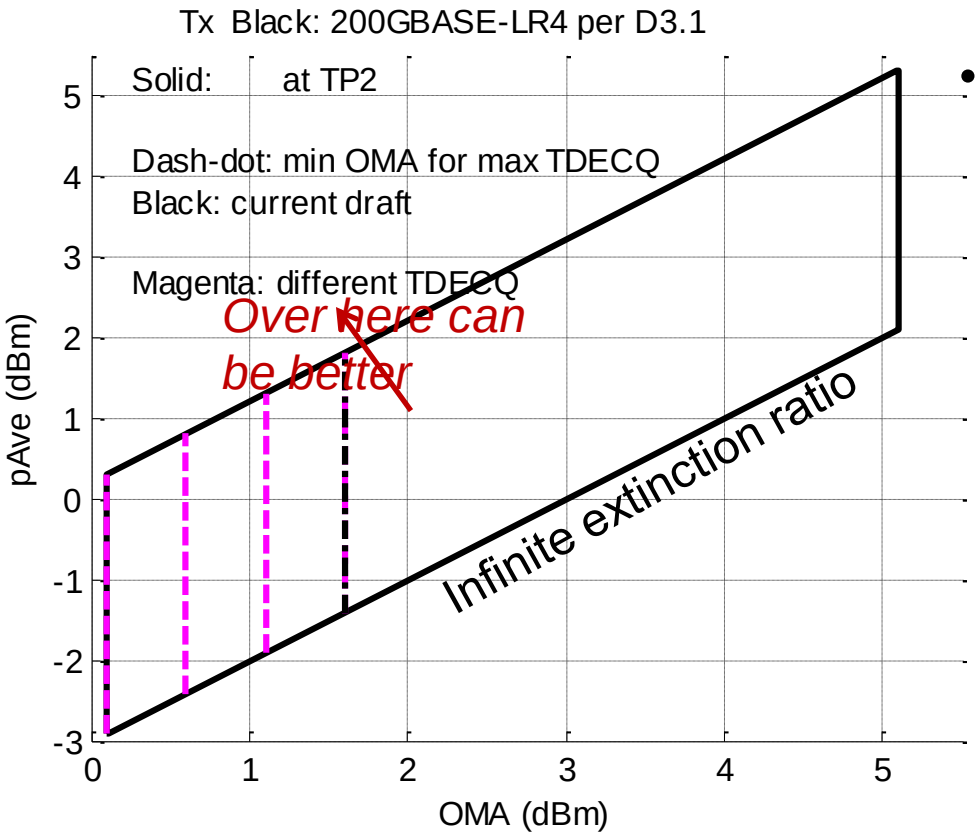
- A single Tx waveform measurement is used to find TDECQ, OMA, mean power, and extinction ratio

- Black polygon (partly hidden under blue one): Tx spec in D3.1, with 4.5 dB min. extinction ratio
- Blue polygon: proposal: 3.5 dB
- Including an extra 0.1 dB for multipath interference penalty
- Tx spec becomes easier
- Channel, connectors and receivers don't change
- **Other options include:**
  - Improve Rx sensitivity, and stressed sensitivity, and increase budget, by 0.1 dB for any extinction ratio
  - Tighten Tx minimum OMA (and minimum average power if wished), and increase budget, by 0.1 dB for any extinction ratio
  - Include MPI in TDECQ

200GBASE-FR4 and 400GBASE-FR8

- The extinction ratio and MPI considerations are the same for 200GBASE-FR4 and 400GBASE-FR8: same extinction ratio limit and discrete reflectance (Table 122–19)
  - This table might be re-optimised, about the pivot of **4** connectors at -35 dB
- However, the balance of transmitter and receiver difficulty may differ between 200GBASE-FR4 and 400GBASE-FR8

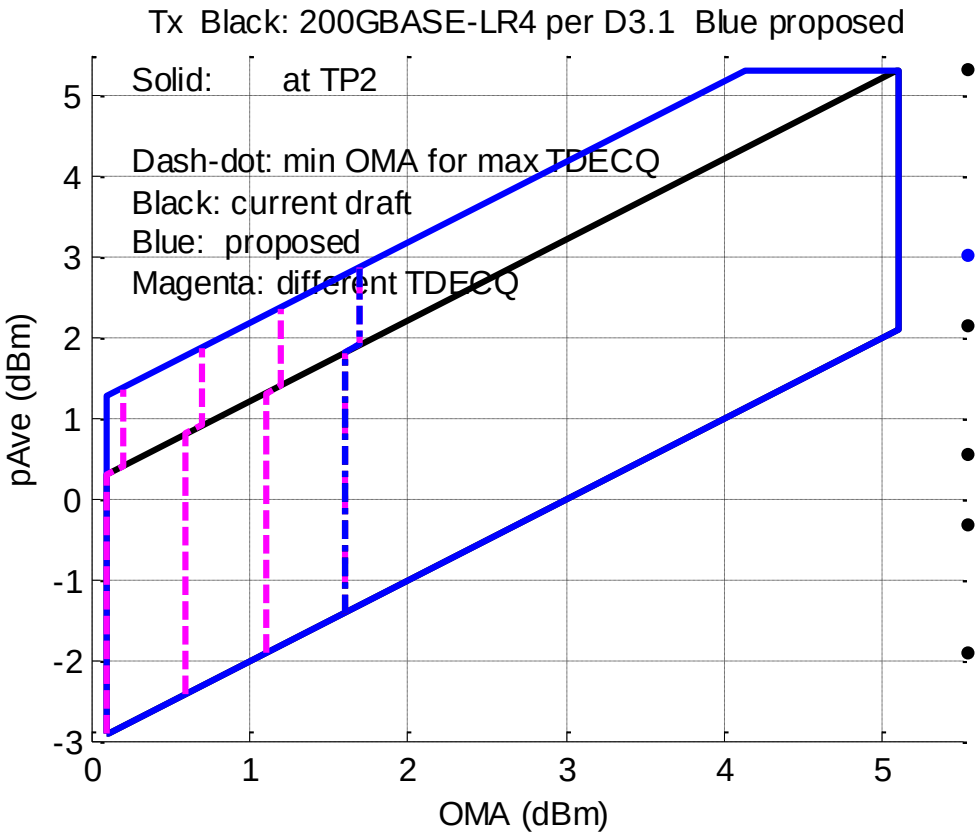
Transmitter setup map: 200GBASE-LR4



- Black polygon: Tx spec in D3.1, with 4.5 dB min. extinction ratio

- A single Tx waveform measurement is used to find TDECQ, OMA, mean power, and extinction ratio

200GBASE-LR4 setup map: one option



- A single Tx waveform measurement is used to find TDECQ, OMA, mean power, and extinction ratio

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  - Tighten Tx minimum OMA (and minimum average power if wished), and increase budget, by 0.1 dB for any extinction ratio
  - Include MPI in TDECQ

200GBASE-LR4 and 400GBASE-LR8

- The extinction ratio and MPI considerations are the same for 200GBASE-LR4 and 400GBASE-LR8: same extinction ratio limit and discrete reflectance (Table 122–19)
  - This table might be re-optimised, about the pivot of **6** connectors at -35 dB
- However, the balance of transmitter and receiver difficulty may differ between 200GBASE-LR4 and 400GBASE-LR8

Conclusion

- A lower extinction ratio limit should be applied to all SMF PMDs in P802.3bs

- Looking forward to reduced cost and power

Backup

Table 122-19, for 200GBASE-FR4, 200GBASE-LR4, 400GBASE-FR8, and 400GBASE-LR8

Number of discrete reflectances above –55 dB	Maximum value for each discrete reflectance	
	200GBASE-FR4 or 400GBASE-FR8	200GBASE-LR4 or 400GBASE-LR8
1	–25 dB	–22 dB
2	–31 dB	–29 dB
4	–35 dB	–33 dB
6	–38 dB	–35 dB
8	–39 dB	–37 dB
10	–40 dB	–38 dB