400GBASE-DR4-2 compliance to 400GBASE-DR4 and interoperability

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Problem statement

- 400GBASE-DR4-2 is supposed to be a more capable 400GBASE-DR4
- They should be completely interoperable on all 400GBASE-DR4 channels
- According to 124.11a.1, this is not quite the case: there is an extra rule that the 400GBASE-DR4-2 transmitter average power is at least the minimum for 400GBASE-DR4 in Table 124–6.
- This is because there are slightly different minimum average powers (and signal detect max) at the receivers
- The difference has no technical value but causes costs in paperwork and confusion
- The numbers should be tweaked so that 400GBASE-DR4-2 is a true superset of 400GBASE-DR4 (comment 95)

Present situation

- The 400GBASE-DR4-2 minimum transmitter average power is *lower* than the 400GBASE-DR4 minimum, although the OMA and OMA-TDECQ minima are *higher*
- In practice, the 400GBASE-DR4-2 transmitter will comply anyway, because PAM4 transmitters don't have very high extinction ratios
  - The limit should be moved up
- The 400GBASE-DR4 signal detect max is higher than the minimum average power from a 100GBASE-FR1 after a 400GBASE-DR4 channel
  - (often, quad or octal modules are built that can be used as 100GBASE-FR1 and 400GBASE-DR4-2)
- In practice, one would not set the signal detect assert level at the max in the spec; the product works, the paperwork doesn't
- Some signal detect limits should be revised down so that relevant signals are detected – see slide 5

Extinction ratio

- For 400GBASE-DR4, the minimum average power is based on minimum OMA at 10 dB extinction ratio
  - 0.9 dB above the min. average power based on infinite extinction ratio
- In practice, a highest ext. ratio below 8 dB is more reasonable
  - 0.5 dB above the minimum average power for 10 dB extinction ratio (1.4 dB above infinite)
  - So there is more than 0.5 dB margin for a different measurement error between average power and OMA measurement (errors from MDI connector loss would correlate)
- For 100GBASE-FR1 (in force) and 400GBASE-DR4-2 (draft), the minimum average power is based on infinite extinction ratio
  - Writing down a realistic minimum helps network diagnostics based on portable average power meters. We get to choose it
  - Comment 95 proposes changing 400GBASE-DR4-2 and 800GBASE-DR8-2 from -3.1 to -2.9, aligning to 400GBASE-DR4
  - Comment 82 proposes changing 400GBASE-DR4-2 and 800GBASE-DR8-2 from -3.1 to -2.2, aligning the assumed extinction ratio at 10 dB
  - Either way, remove the exception in 124.11a.1
- *None of this limits a product's extinction ratio*

Explanation in the standard

- Comment 83 asks for a footnote added in the Tx tables to provide the value of ER max used to calculate the minimum Tx Power
- Normative or informative or say nothing?
- Give a reason or just state facts? Our motivation might be a choice of extinction ratio, aligning extinction ratio, a choice of extinction ratio penalty (to allow room for measurement error) or alignment with another PMD – to be decided
- Examples (covering both options on slide 4; keep relevant text as appropriate):
- NOTE—An OMA of -0.8 dBm corresponds to an average power of -2.9 dBm and an extinction ratio of 10 dB, an OMA of -0.1 dBm corresponds to an average power of -3.1 dBm and an extinction ratio of 29 dB, an OMA of -0.1 dBm corresponds to an average power of -2.2 dBm and an extinction ratio of 10 dB
  - avoiding calling the ER "max"
- NOTE—The minimum average power is the same for 400GBASE-DR4, 400GBASE-DR4-2, 800GBASE-DR8 and 800GBASE-DR8-2

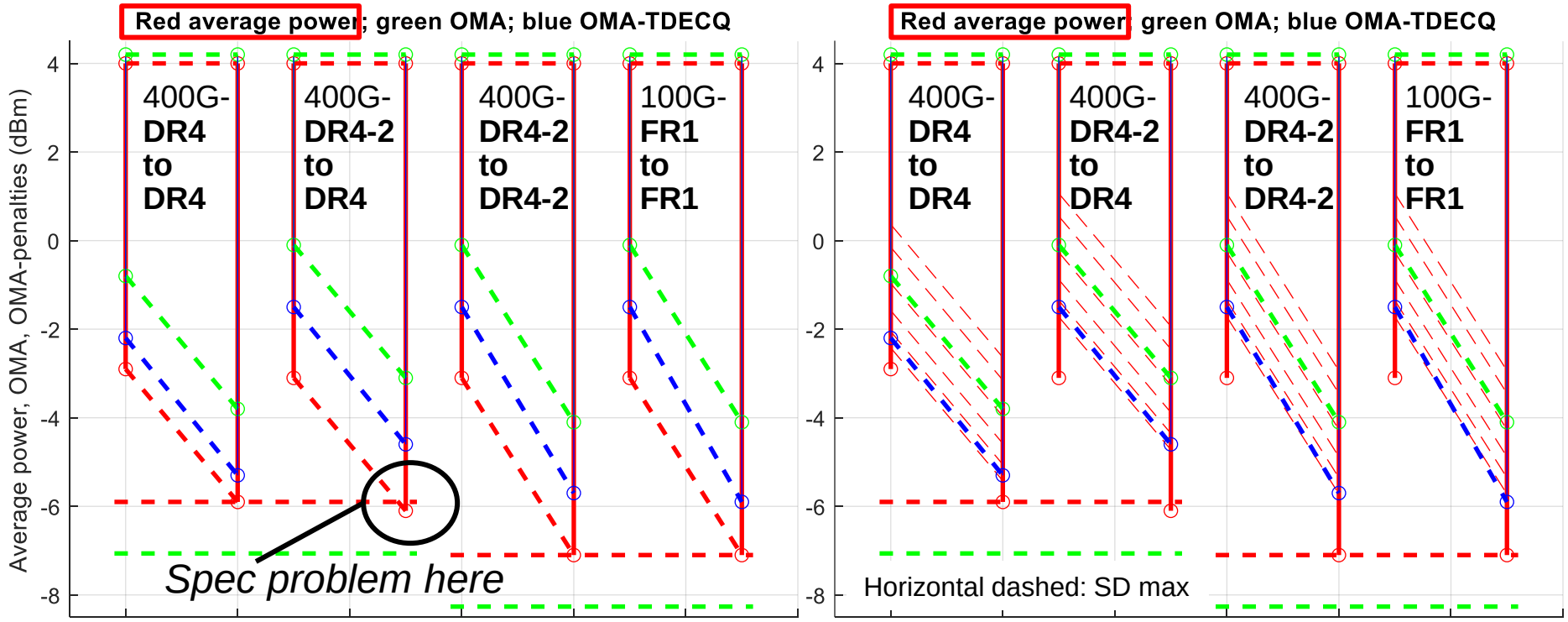
Signal detect

- The signal detect should detect all relevant compliant signals
  - Higher layers will determine whether a signal on one lane is 100GBASE-FR1, 400GBASE-DR4(-2) or 800GBASE-DR8(-2)
- So the signal detect max should be set at or below the weakest of all these, which is -7.1 dBm. It will never happen on a compliant link, but the SD assert level should be lower than the minimum compliant power anyway and there is plenty of room to lower this
  - Change the limit for 800GBASE-DR8, 400GBASE-DR4-2 and 800GBASE-DR8-2 from "average receive power, each lane (min) in Table 124–7)" (which is -5.9, -7.1, -7.1 dBm), to -7.1 dBm
    - This should apply to 800GBASE-DR4 and 800GBASE-DR4-2 in P802.3dj too

Signal detect - aside

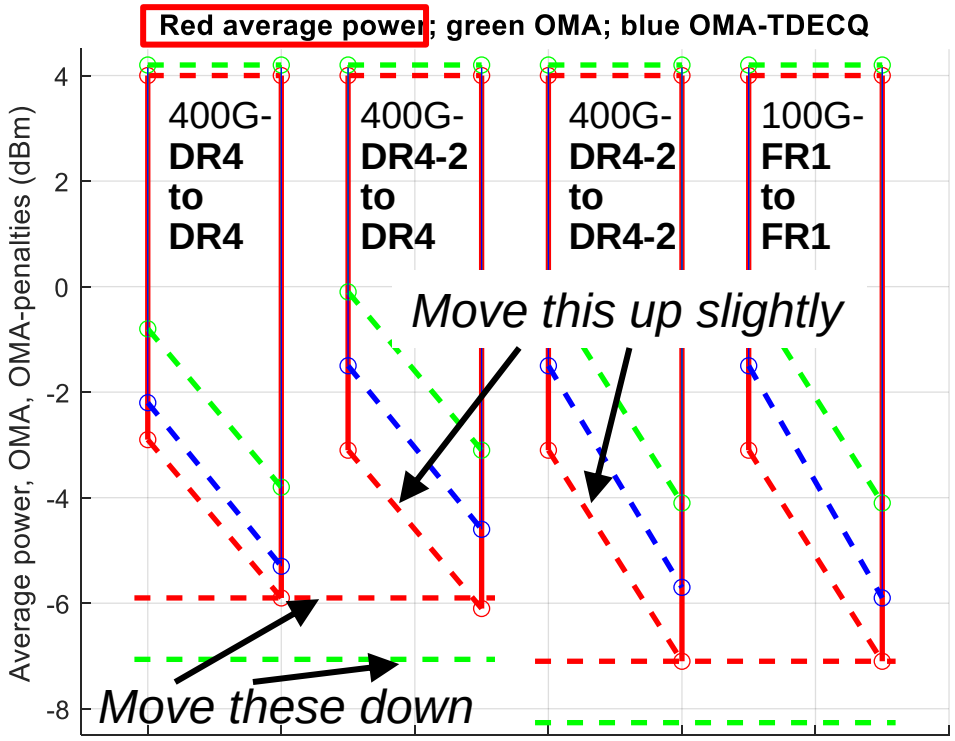
- The way the spec is written, an OMA-based signal detect has to be set noticeably lower because the limit is average power based
- Is this OK?

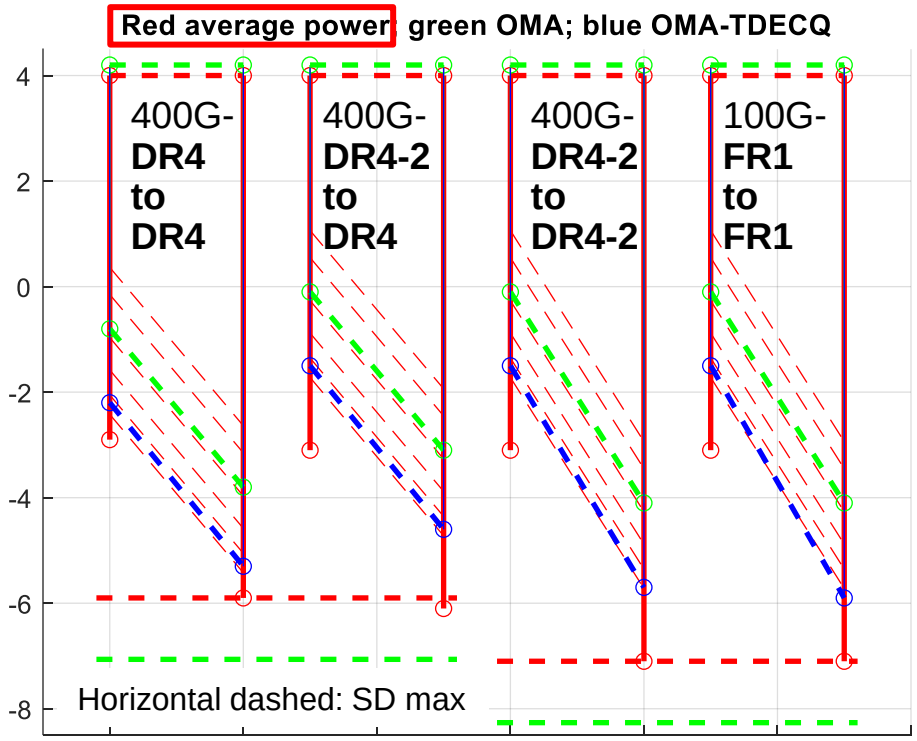
Spec limits and range of likely worst cases



- Left: spec limits Right: 3.5, 4:8 dB ext. ratio
- Assumes that comment 15 (400GBASE-DR4-2 and 800GBASE-DR8-2, change the allocation for penalties) is accepted

Solutions





- Left: spec limits
- Right: 3.5, 4:8 dB ext. ratio
- Increase 400GBASE-DR4-2, 800GBASE-DR8-2 average power for 400GBASE-DR4 compliance
- Reduce 400GBASE-DR4-2, 800GBASE-DR8-2 SD max for 100GBASE-FR1 compatibility

Some references

- DR family interoperability signal detect and average power limits
- Piers Dawe, Nvidia
- https://ieee802.org/3/df/public/23_0523/dawe_3df_01_230523.pdf

- 100GBASE-DR, FR1, and LR1 Average Power Min specs
- Eric Maniloff, Ciena
- https://ieee802.org/3/cu/public/March20/maniloff_3cu_01_040720.pdf