Revised 100GBASE-SR4 Tx and Rx specifications

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Introduction

- TxVEC of 5 is:
- higher than any other optical PMD
- near a cliff
- higher than VECP of 4.2, and
- higher we intended

- This presentation gives revised values for TxVEC in Tx spec, and consequential changes to Tx, Rx and budget tables
- Relevant to comments 32, 70, 71, 43

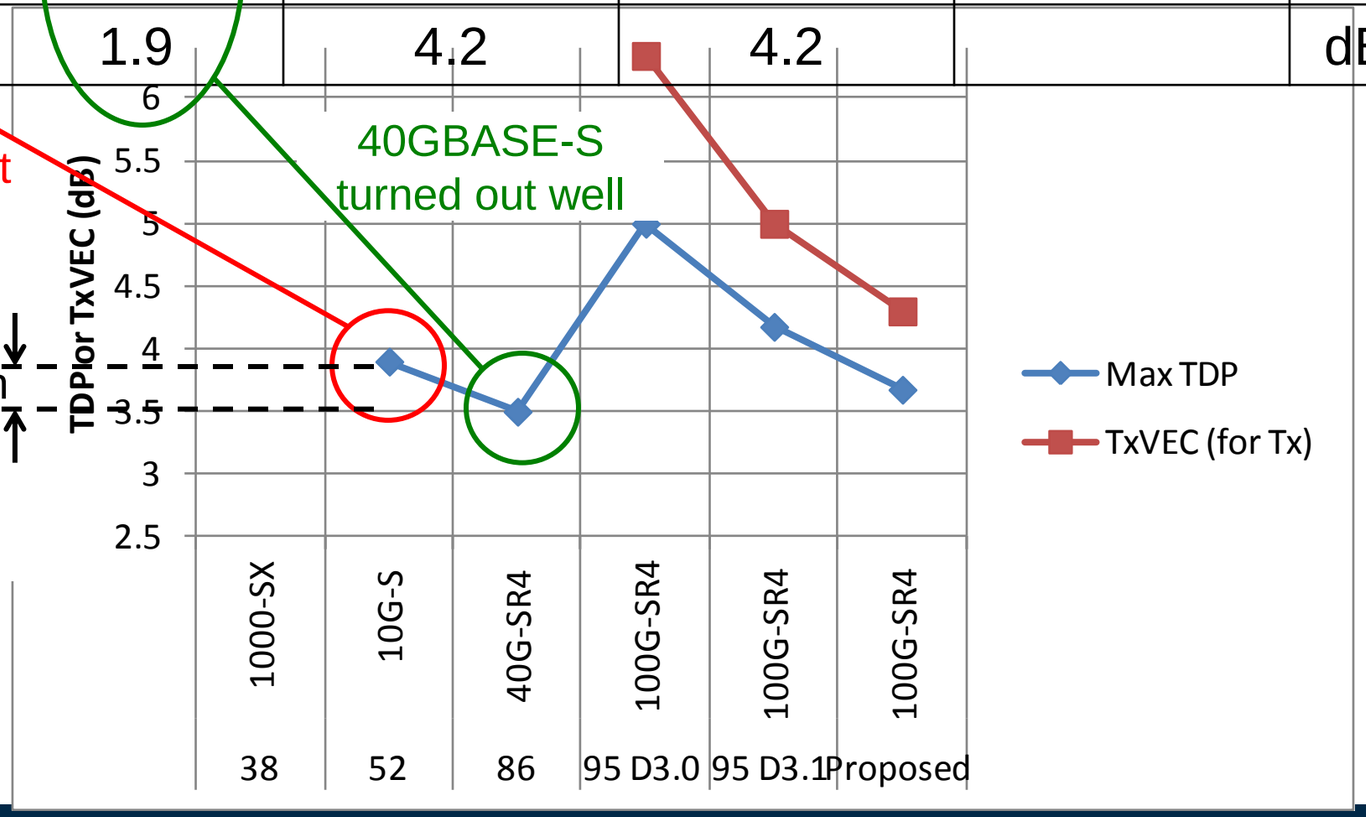
TxVEC is higher than any previous TDP

Clause	58	52	86	95 D3.0	95 D3.1	Proposed	Unit
PMD type	1000BASE-SX	10GBASE-S	40GBASE-SR4	100GBASE-SR4	100GBASE-SR4	100GBASE-SR4	
Max TDP	n/a	3.9	3.5	5	4.2	3.7	dB
Max TxVEC				6.3	5	4.3	dB
VECP (for SRS)	2.6	3.5	1.9	4.2	4.2		dB

10GBASE-S was somewhat too challenging for its time

40GBASE-S turned out well

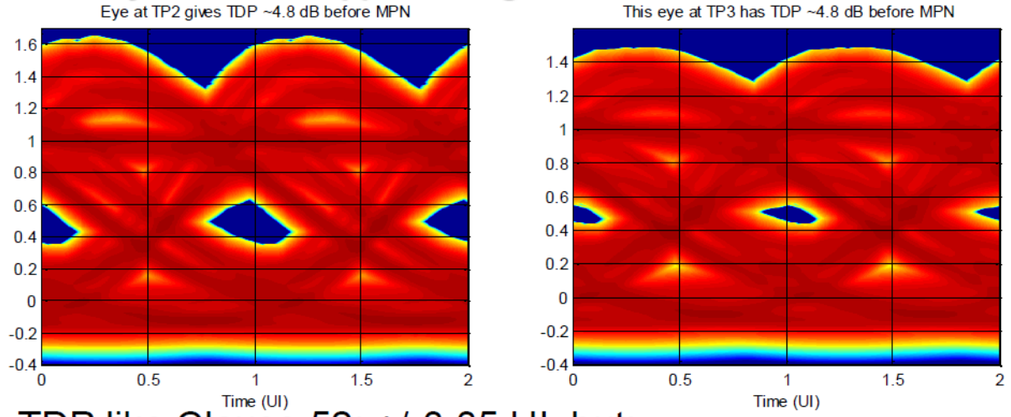
Narrow range between enough and too much



TxVEC can be much higher than TDP.
To do with estimation of MPN.
Relation between TxVEC and TDP is nonlinear, and also depends weakly on extinction ratio: these numbers are examples.

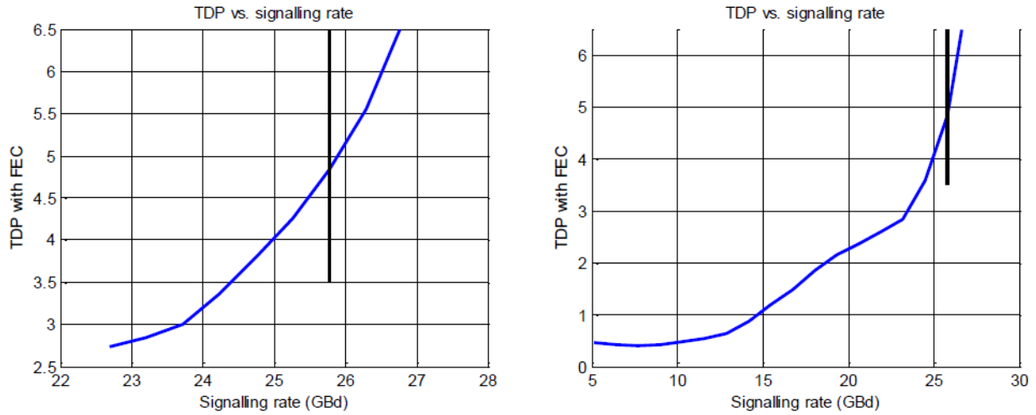
5 dB TDP is too high anyway

Simulated eye with TDP approaching 5 dB



- TDP like Clause 52: +/-0.05 UI, but:
  - BER = 5e-5
  - 100 m of OM4 modelled as a Gaussian filter, like spreadsheet model
  - Standard fourth-order Bessel-Thomson
- Includes ISI from chromatic dispersion but not MPN
- Is this on the cliff edge?

TDP vs. signalling rate



- IC bandwidths scaled with signalling rate, laser not scaled
- 2% rate change increases TDP by 0.7 dB – yes, cliff edge

- Slide 12 of dawe_02a_0114_optx, slides 4, 5 of dawe_01_0513_optx
- This eye is on the "**cliff edge**": about to collapse
- Since this work, widening the decision timing offsets and changing to TxVEC has helped
- TxVEC limit should be reduced from 5 dB

TxVEC of 5 is higher than VECP of 4.2

- Often, for the same signal, TxVEC is significantly lower than VECP
  - Whether it's TxVEC for a transmitter or a (different) TxVEC metric for a receiver
- This is partly because VECP was suitable for 1e12 BER; an indifferent signal's penalty is less at 5e-5 than 1e-12
- And also because VECP is affected by measurement noise
- The factors outweigh the decision timing offsets in TxVEC
- TxVEC for the receiver should be less than the 4.2 dB VECP in the draft
- TxVEC for the transmitter should be not much more than that

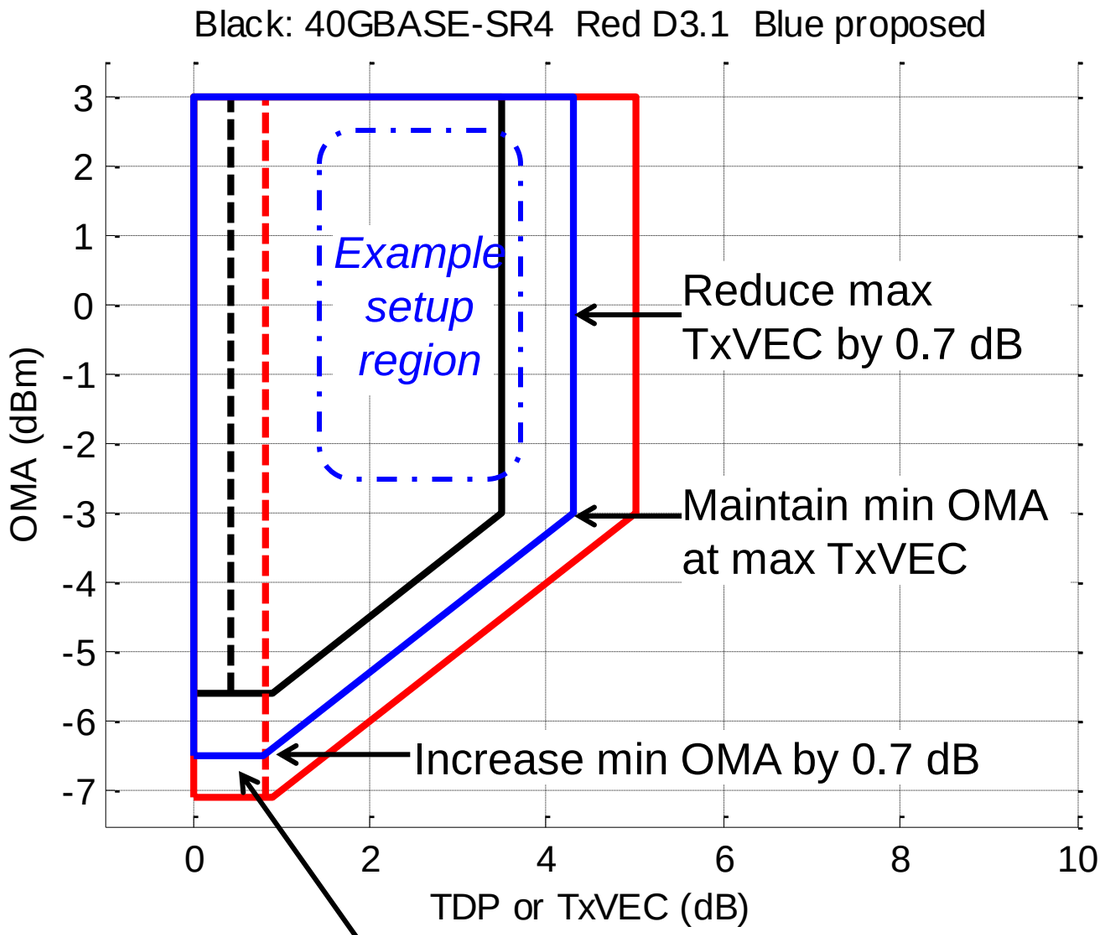
TxVEC can be measured for reasonable cost

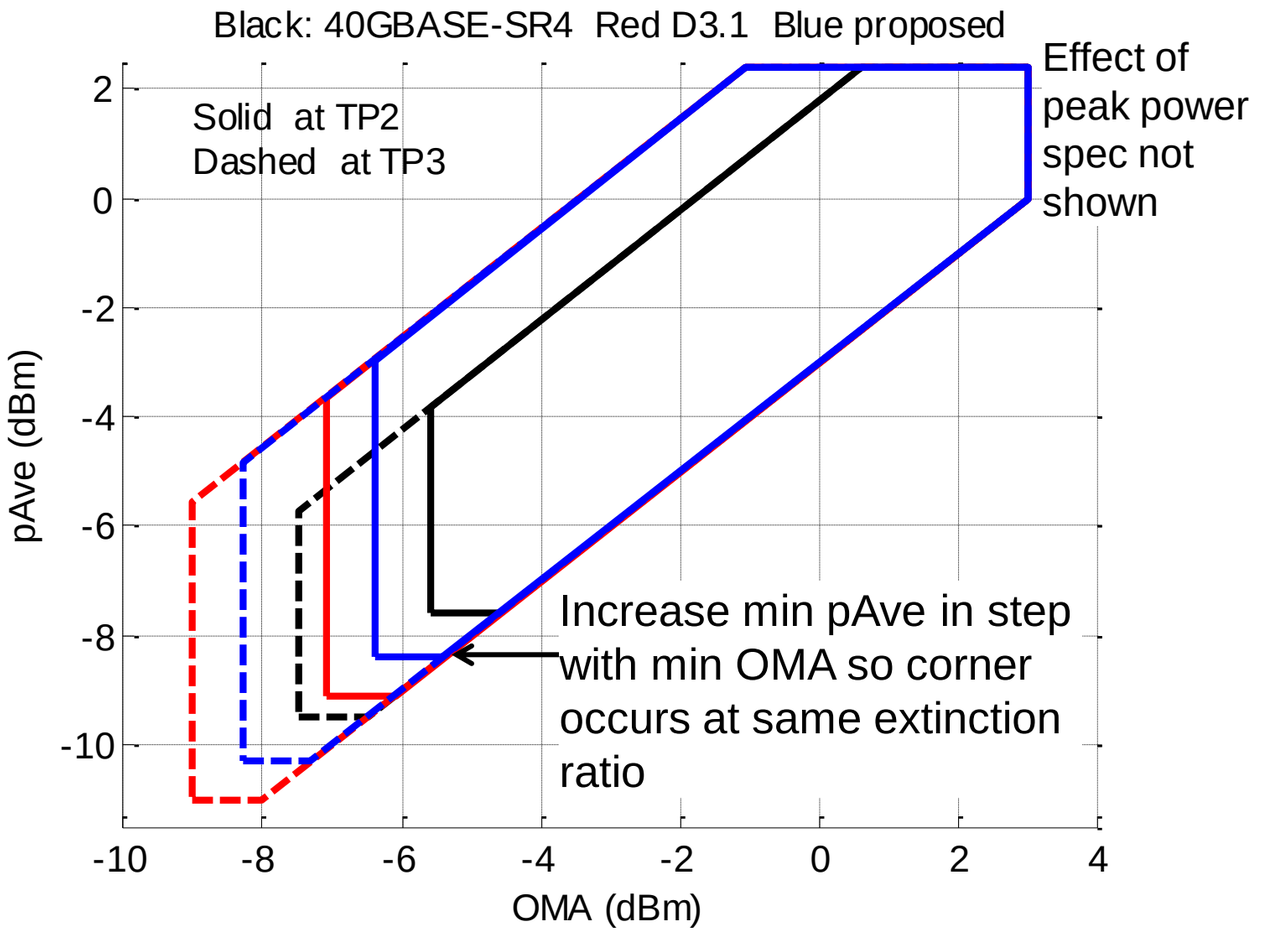
- With 10G optical lanes, implementers have been able to avoid TDP testing by building products with plenty of margin. Implementers doing TDP testing would need margin for test reproducibility. Any weaknesses in the spec would not cause any issues in the field because of this margin.

- With 25G lanes, implementers can routinely do TxVEC testing with better test reproducibility if they wish, and make valid products with less margin. Any weaknesses in the spec could be exposed.

- The TxVEC limit needs to be set closer to what reasonable products actually do (i.e. a lower limit) than was the case for TDP.

Changes to the draft - illustrated





- Effect of reducing the max Tx TxVEC by 0.7 dB
- Dashed lines on the left show the TDP or TxVEC of a fast noiseless signal without jitter or emphasis
- Transmitters with less than 0.8 dB TxVEC have more emphasis than back-to-back penalty. We don't need to outlaw them but we should not give any such transmitters of the future an OMA credit

Changes to the draft 1/3

- **Table 95–6, 100GBASE-SR4 transmit characteristics**

Average launch power, each lane (min)	-9.1	dBm
Increase in step with min OMA by 0.7 dB to	-8.4	dBm
Optical Modulation Amplitude (OMA), each lane (min)	-7.1	dBm
Increase by 0.7 dB for change in max TxVEC to	-6.4	dBm
Launch power in OMA minus TxVEC (min)	-8	dBm
Increase by decrease in max TxVEC, 0.7 dB, to	-7.3	dBm
Transmitter vertical eye closure (TxVEC), each lane (max)	5	dB
Too high, decrease by 0.7 dB to	4.3	dB

Changes to the draft 2/3

- **Table 95-7, 100GBASE-SR4 receive characteristics**
- Average receive power, each lane (min) -11 dBm
- *Increase in step with min OMA by 0.7 dB to* -10.3 dBm
- Stressed receiver sensitivity (OMA), each lane[c] (max) -5.6 dBm
- *Set to (min OMA at max TxVEC) – (max loss) – (max penalties) + (Rx TxVEC12,M=0) = -3 -1.9 -4.8 +4 =* -5.7 dBm
- Stressed eye J2 Jitter, lane under test 0.41 UI *see dawe_02_0914_optx*
- Stressed eye J4 Jitter, lane under test 0.55 UI *see dawe_02_0914_optx*
- TxVEC of stressed eye conformance signal 5 dB
- ***We can choose** a value less than the allocation for penalties, e.g.* 4 dB
  - This and next slide assume that for TxVEC of stressed eye conformance signal, noise term M is set to 0
- *This is higher than for any previous PMD – and still seems very high*

Changes to the draft 3/3

- **Table 95-8, 100GBASE-SR4 illustrative link power budget**
- Power budget (for max TxVEC) 8.2 dB
- *Change to max loss + allocation for penalties e.g. 4.8 + 1.9* = 6.7 dB
- Allocation for penalties[c] (for max TxVEC) 6.3 dB
- *Tx TxVEC + MPN not included in Tx TxVEC e.g. 4.3 +0.5* = 4.8 dB

- Need to estimate how much MPN there could be that is not included in Tx TxVEC

Conclusion

- This presentation shows a consistent set of numbers based on changing transmit TxVEC from 5 dB to 4.3 dB
- Further experience with transmit TxVEC may suggest a better optimised limit
- Decisions on the definition of TxVEC for stressed receiver conformance signal calibration may affect some numbers

Thank You