TDECQ/TECQ/SECQ Comments

Brian Welch

Supporters

- David Leyba (Keysight)
- Ahmad El-Chayeb (Keysight)
- Mark Kimber (Semtech)

Related Comments

Category	Page	Sub-clause	Line #	Comment	Proposed Change
Technical	452	182.7.1	43	Current TDECQ (max) value is "TBD"	Update TDECQ (max) and Target PAM4 symbol error ratio to 3.4 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1124
Technical	452	182.7.1	45	Current TECQ (max) value is "TBD"	Update TECQ (max) and Target PAM4 symbol error ratio to 3.4 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1125
Technical	452	182.7.1	47	Current |TDECQ - TECQ| (max) value is "TBD"	Update |TDECQ-TECQ| (max) and Target PAM4 symbol error ratio to2.5 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1125
Technical	454	182.7.2	27	Current SECQ value is "TBD"	Update SECQ and Target PAM4 symbol error ratio to 3.4 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1125
Technical	465	182.9.5	9	Current Target PAM4 symbol error ratio is 9.6 x 10^-3	Update Target PAM4 symbol error ratio to 4.8 x 10^-4 per welch_3dj_01_1124
Technical	480	183.7.1	34	Current TDECQ (max) value is "TBD"	Update TDECQ (max) and Target PAM4 symbol error ratio to 3.4 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1124
Technical	480	183.7.1	37	Current TECQ (max) value is "TBD"	Update TECQ (max) and Target PAM4 symbol error ratio to 3.4 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1125
Technical	480	183.7.1	38	Current |TDECQ - TECQ| (max) value is "TBD"	Update |TDECQ-TECQ| (max) and Target PAM4 symbol error ratio to2.5 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1125
Technical	482	183.7.2	30	Current SECQ value is "TBD"	Update SECQ and Target PAM4 symbol error ratio to 3.4 dB **and** 4.8 x 10^-4 (both must be changed), respectively per welch_3dj_01_1125
Technical	489	183.9.5	48	Current Target PAM4 symbol error ratio is 9.6 x 10^-3	Update Target PAM4 symbol error ratio to 4.8 x 10^-4 per welch_3dj_01_1124

Overview

- TDECQ/TECQ is generally considered as a transmitter specification, where higher TDECQ/TECQ values and/or target SER allow for more transmitter degradation.

- However, TDECQ/TECQ are also receiver specs, where SECQ = TDECQ (max), mandating that the worst allowable transmitter be created for receiver compliance testing. This requires that:
  - The SECQ value can be created by a reference transmitter + channel (generally with variations on SECQ composition).
  - The SECQ value is something a receiver can pass while complying with other datasheet specifications.

Background

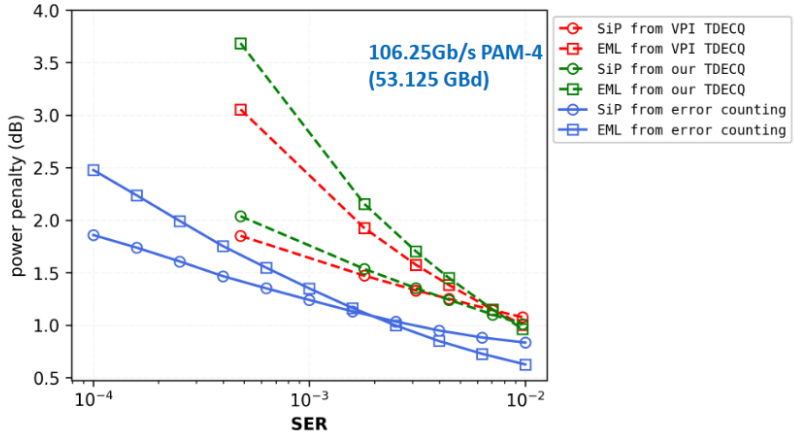
- **In lebya_3dj_optx_01a_230629 TDECQ/TECQ values were observed to converge to a very low value (approaching 1 dB) for high target SER.**
- **This work was replicated (via simulation) in liu_3dj_optx_01a_230829**

Some observations of measured TDECQ versus SER for real transmitters

- 100G transmitters
- Two SiP and one EML
- One waveform acquired for each transmitter
- 5 tap FFE in TDECQ virtual reference receiver
- SER limit varied from 4.8 e-4 to 9.7e-3
- For the three transmitters a 1.1 dB separation in TDECQ penalty values is observed at common 4.8e-4 SER, but TDECQ converges to very similar values at high SER

KEYSIGHT 4

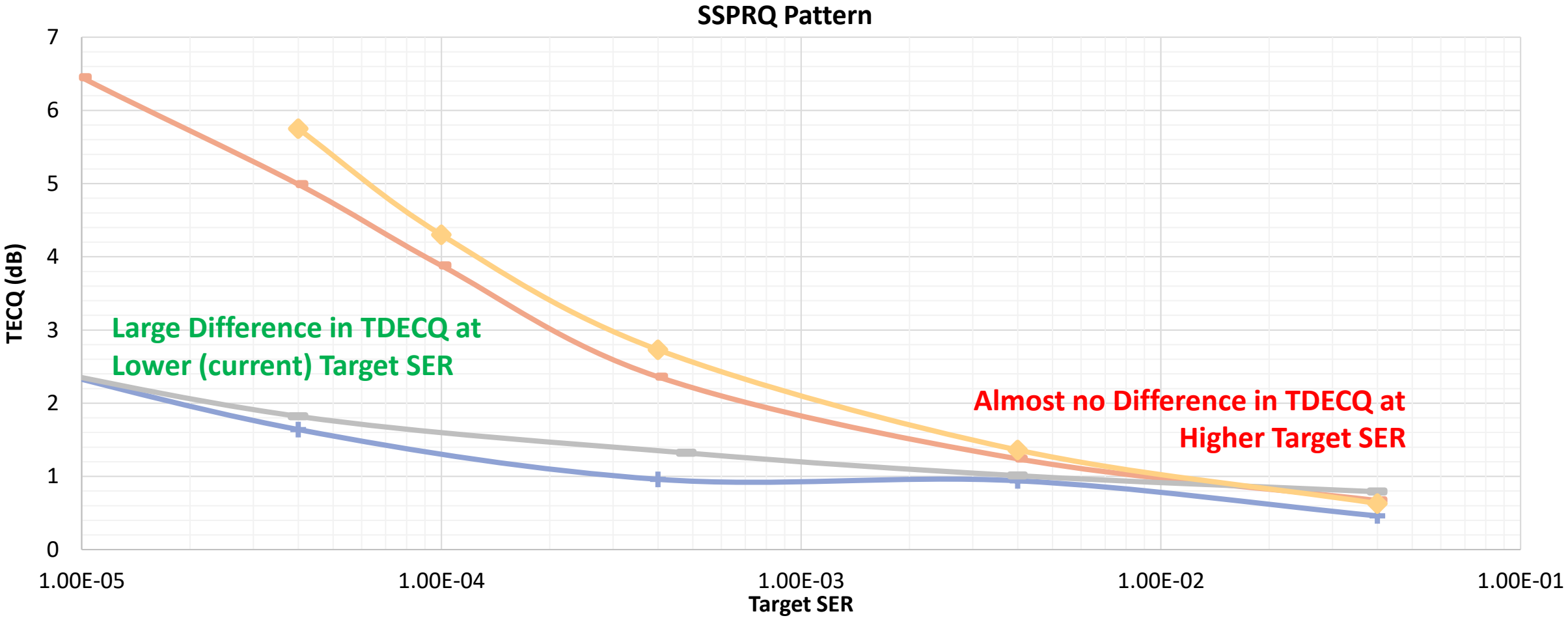
Our simulation results (6): TDECQ vs. direct-error-counting



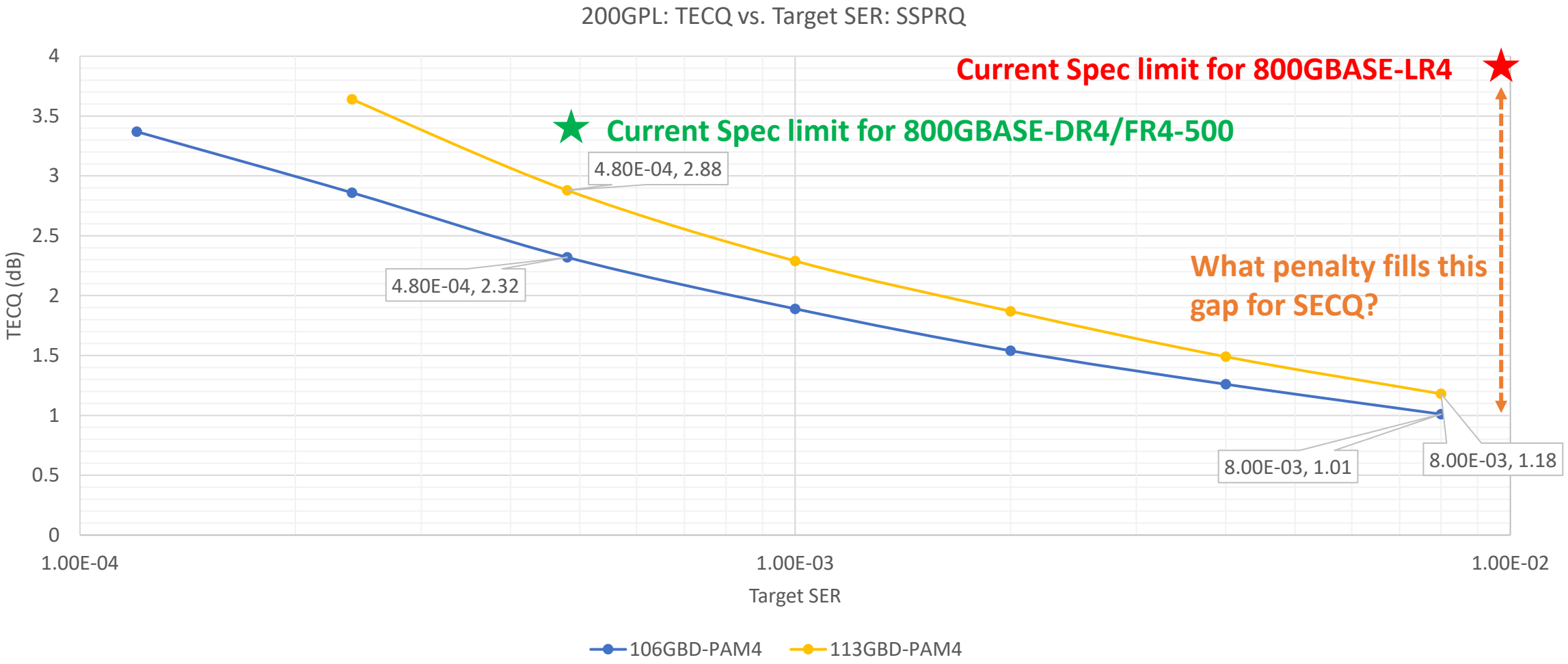
- ✓ At high SER, TDECQ penalty still represents the receiver sensitivity penalty observed.
- ✓ A "worse" transmitter at low SER can become a "better" transmitter at high SER.
- ✓ The physical reason is because of different nonlinear distortion, ISI, and EQ-induced noise enhancement behaviors of these two types of transmitters.

IEEE P802.3dj 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force 13

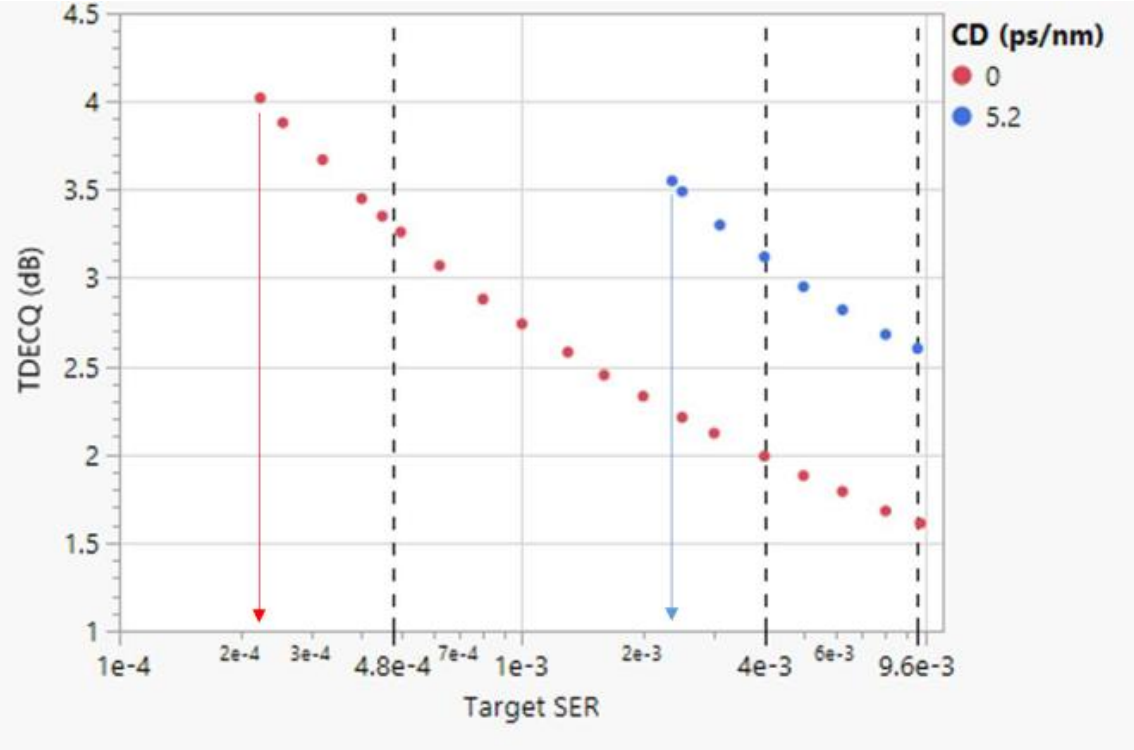
New Experiments – 100G (Four Transmitter Types)



New Experiments – 200G (Two Rates)



Other Results – High Dispersion



johnson_3dj_optx_01_241031.pdf

fan_3dj_01a_2407.pdf

Discussion

- At high target SER values TECQ values converge to < 1.5 dB
  - This is essentially independent of the behavior of the transmitter at lower target SER values.
- TDECQ values of around 2.5 dB have been observed for transmitters under extreme dispersion corners
- Does dispersion need to be part of a stressed receiver compliance test (SECQ)? If so, what are the reference transmitter conditions (ie, chirp, etc.)? Reference channel?
  - Does receiver sensitivity need to be defined as a function of TDECQ instead of TECQ?
- **Proposals have been made for SECQ values up to 3.9 dB, considerably beyond what has been demonstrated (TP2 need or TP3 compliance).**

Discussion

- SECQ at target_SER = 4.8e-4 is an understood calibration/test for SRS compliance testing
  - However, it is not a perfect test as different SECQ compositions can yield different post RS-FEC results.

- SECQ at target_SER = 9.6e-3 is an unknown, and SECQ composition for SRS compliance testing has not been demonstrated.
  - Pushing for a high/unseen SECQ value without test data likely to contribute new interop challenges, beyond those that we experienced with 100GPL.

- **If SECQ limits are not realistically defined, we will repeat the experience of 100GPL where receiver compliance is not determined by the 802.3 standard but requires broad interop testing with other optics modules to enable customer deployment.**

End

Questions ?