SECQ Test Method and Calibration Improvements

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In support of comments 82-84

Supporters

- [to be added]

Background and Motivation

- The stressed receiver test outlined for PAM4 PMDs in 802.3cd specifies a stressed receiver conformance test signal (a.k.a. reference transmitter) with a given SECQ
- The reference transmitter is calibrated to the specified SECQ value by adding ISI, sinusoidal jitter (SJ), sinusoidal interference (SI), and Gaussian noise (GN)
- The current reference Tx calibration for this test outlined in 802.3cd+bs defines that half of the SECQ should be from bandwidth limitations / ISI, but does not otherwise define the makeup of the SECQ contributing stressors nor reference Tx characteristics. There are two potential issues:

1. Prior work (e.g. chang_3cd_01_1117, particularly p. 20) has shown that actual receiver performance will vary depending on the composition and ratio of the various SECQ stressors. So leaving this composition/ratio unspecified risks either:
   - **Overstressing** the receiver (e.g. if more Gaussian noise is used than the worst-case allowable transmitter) and causing unnecessary yield hit
   - **Understressing** the receiver (e.g. if less Gaussian noise is used than the worst-case allowable transmitter) and causing interoperability gaps/failures in actual deployment
2. The current text leaves room for a wide range of reference transmitter implementations which will cause further variance in stressed Rx test results for the same tested Rx, also potentially leading to interoperability issues

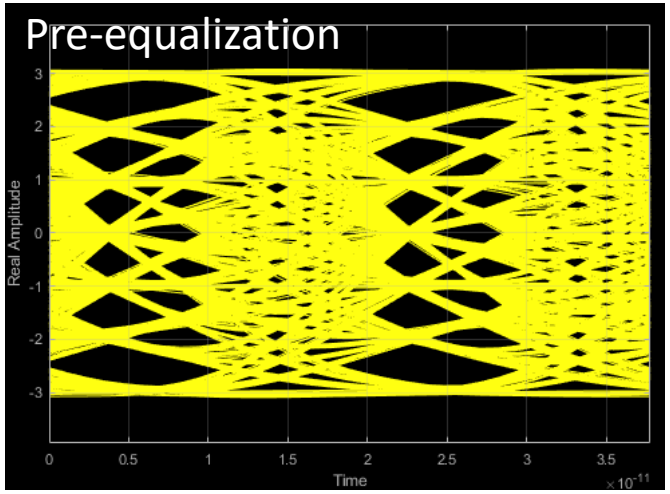
We are proposing revising the wording in the description of the stressed receiver sensitivity test (section 140.7.9) to more clearly bound test conditions and ensure interop for compliant receivers

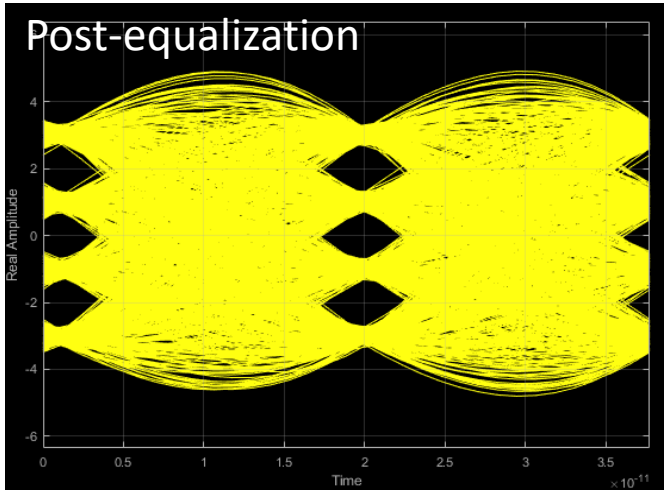
- Details on subsequent slides

Examples: 53Gbd PAM4 SRS Conformance Signals

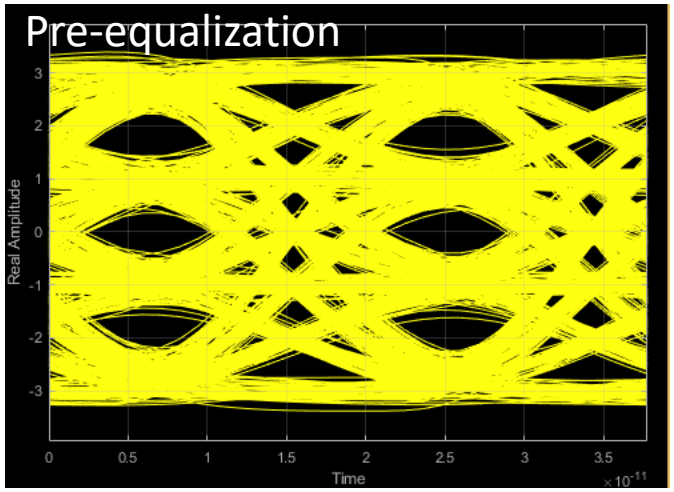
- Calibrating ISI-based “first 50%” of SECQ in accordance with draft standard gives two very different SRS conformance test waveforms
- Issue will be magnified when including allowed variance in remaining GN + SI SECQ stressors

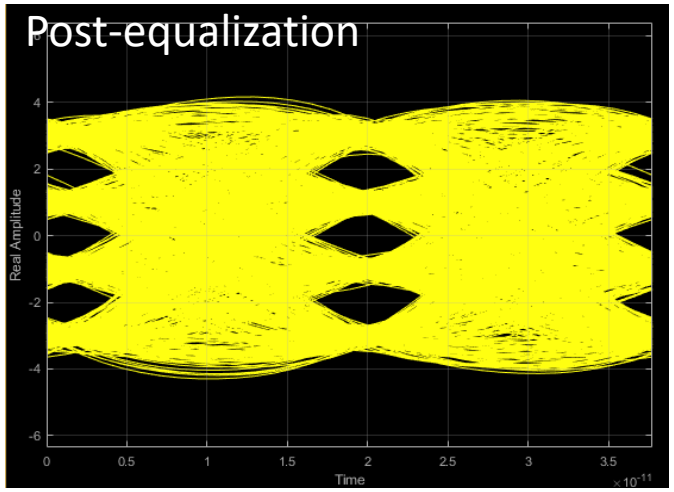
Case A SRS conformance signal
@ 1.7 dB SECQ
35 dB SNR, ~22 GHz Tx BW





Case B SRS conformance signal
@ 1.7 dB SECQ
23.5 dB SNR, ~35 GHz Tx BW





Proposed Remedy / Clarifying Language

Basic approach:

- Fix all degrees of freedom for SECQ composition except one, to get as repeatable and consistent an SRS conformance test signal as possible, rather than let everything float
- Ensure that as much as possible, various stress amounts track with actual expected values

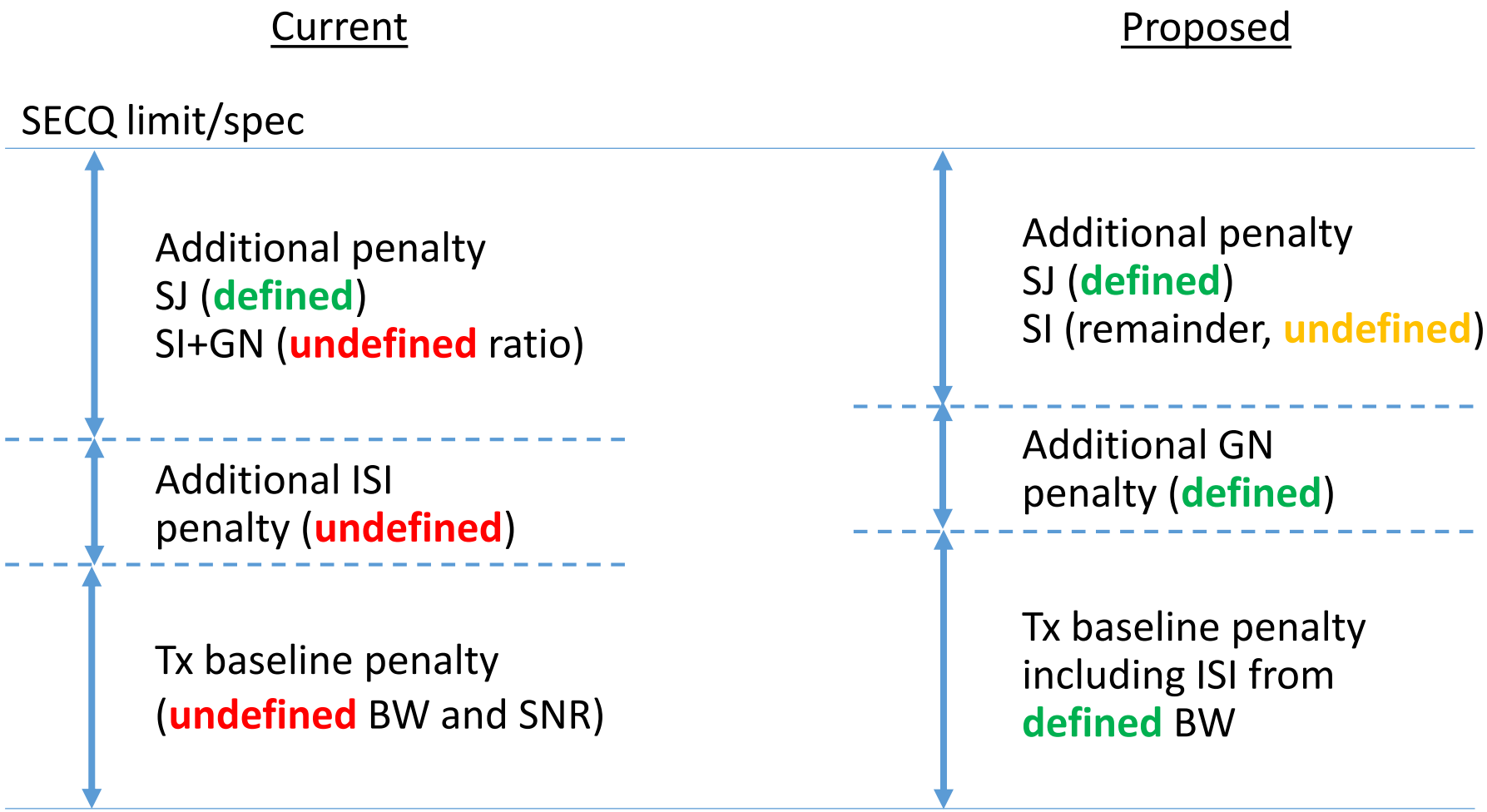
Specifically:

- Specify a Tx bandwidth (13.25G for 50G/lane PAM4, 26.5G for 100G/lane PAM4) in place of the 50% ISI requirement
- Define a specific value for Gaussian noise to be added beyond baseline reference Tx + ISI SECQ (value in process, aim to tie this back to Tx with worst-case RIN value)
- Remaining SECQ comprised of sinusoidal interference and sinusoidal jitter (already defined separately)

These changes:

- Remove ambiguity and variability of current “at least 50% ISI” guideline (no cap on max amt of ISI as % of total, actual ISI stress varies depending on baseline Tx SECQ, etc.), while not significantly changing the amount of ISI stress
- Remove ambiguity and variability of current “amount of your choice” language on Gaussian noise to avoid overstressing or understressing receiver, with amount tied back to actual random noise and RIN coming from Tx
- Keep the overall SECQ value unchanged

Proposed Changes, in Pictures



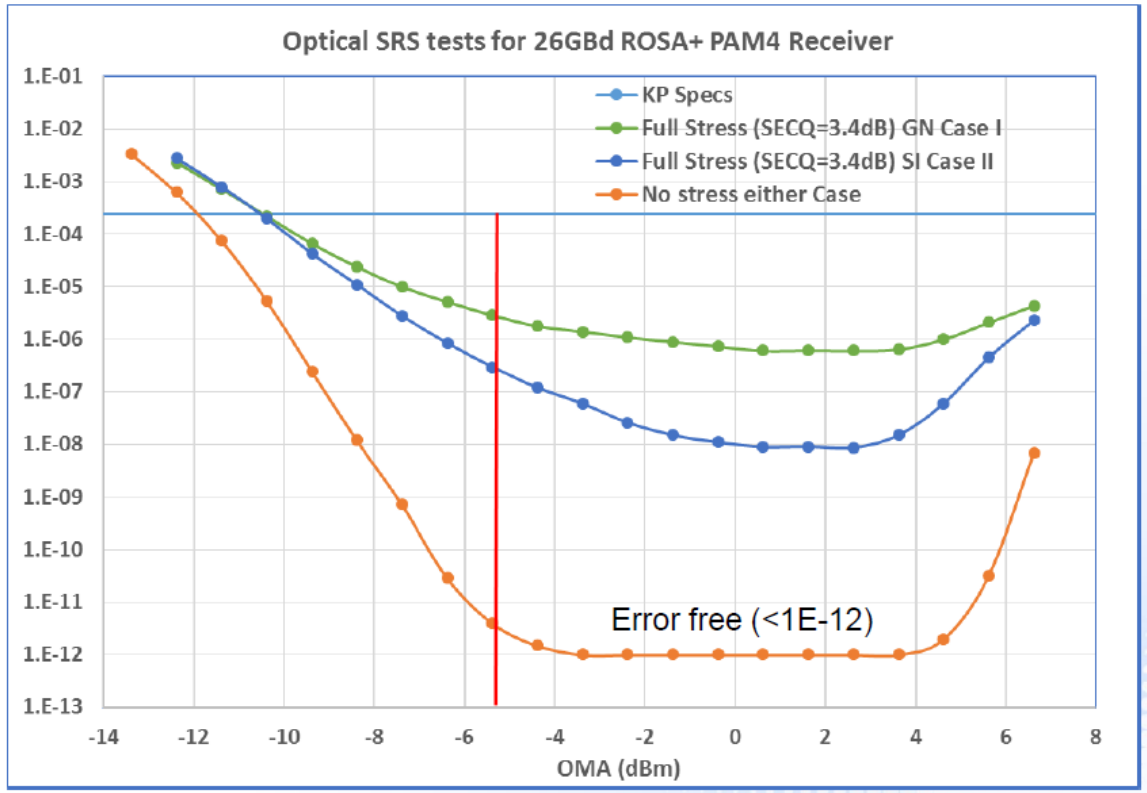
Backup

Prior Work

- Excerpt from chang_3cd_01_1117 showing performance variation with varying SI/GN stressor ratios at same SECQ
- Note that this is for 50G PAM4; 100G PAM4 will have considerably less BER margin to FEC limit

Compare Two Cases with PRBS31Q

- Same SECQ=3.4dB but with different BER behavior



Case1	S.I. dominance
	SECQ
Ideal Tx	0.87
TX+LPF	1.66
S.J. only	1.74
S.J+G.N.	1.78
S.J.+ S.I.	3.3
S.J.+ G.N.+S.I.	3.4

Case2	G.N. dominance
	SECQ
Ideal Tx	0.87
TX+LPF	1.66
S.J. only	1.74
S.J+S.I.	2.1
S.J.+ G.N.	2.75
S.J.+ G.N.+S.I.	3.4

Tx SNR / Tx BW relationship @ 1.7 dB SECQ