SECQ and its sensitivity to measurement bandwidth

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TBD

Abstract

- In 802.3cd, the measurement and the calculation of SECQ requires a calibrated signal. This signal is calibrated by an oscilloscope
- Calibration by an oscilloscope which has uneven and/or early and sharply rolled-off 4th order Bessel-Thomson roll off causes the stresses in the calibrated signal to be mis-represented – typically the signal has less stress than needed.
- This improperly less-stressed 'calibrated' signal is easier for the DUT RX to pass (even if the DUT should not pass); a false pass is the result
- There's no language in the standard today preventing this from happening even to a diligent and earnest implementer.
- We propose that in order to limit the variability of the SECQ result between different measurement tools, the Bessel-Thomson compliance should be mandated by referencing the ITU B-T tolerance as-is

Specifically: (next page)

Specification of the Optical Reference Receiver in IEEE 802.3

- 802.3ba: 100GBASE-LR4 example:
  "**88.8.8 Transmitter optical waveform (transmit eye)**"
  The filter nominal reference frequency fr is 19.34 GHz and the filter tolerances are as specified for STM-64 in ITU-T G.691. Compensation may be made for variation of the reference receiver filter response from an ideal fourth-order Bessel-Thomson response.

- Proposed new language for 802.3cd 26.56 GBd:
  The filter nominal reference frequency fr is 13.28 GHz and the filter tolerances are as specified for STM-64 in ITU-T G.691. Compensation may be made for variation of the reference receiver filter response from an ideal fourth-order Bessel-Thomson response.

Specification of the Optical Reference Receiver in IEEE 802.3

- New language for 802.3cd 56.125 GBd:
  The filter nominal reference frequency fr is 26.56 GHz and the filter tolerances are as specified for STM-64 in ITU-T G.691. Compensation may be made for variation of the reference receiver filter response from an ideal fourth-order Bessel-Thomson response.
- This proposal is to put this language into the SECQ filter definition. This is distinct from previous overall, TDECQ focused proposals.

Example instances of Bessel-Thomson in 802.3cd

- The calculation of SECQ requires the same B-T concept as does the calculation of TDECQ.

  1. "The combination of the O/E and the oscilloscope used to measure the optical waveform has a fourth-order Bessel-Thomson filter response with a bandwidth of 11.2 GHz"
     [*138.8.5 Transmitter and dispersion eye closure - quaternary (TDECQ)*,, 8023cd_D3p2]

- And the calculation of SECQ requires that:

  1. "…and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 13.28125 GHz"
     [*138.8.8 Stressed receiver sensitivity*, 8023cd_D3p2]

Terms in this paper:
symbol rate: f_{Bd};
B-T: Bessel-Thomson 4^{th} order filter.

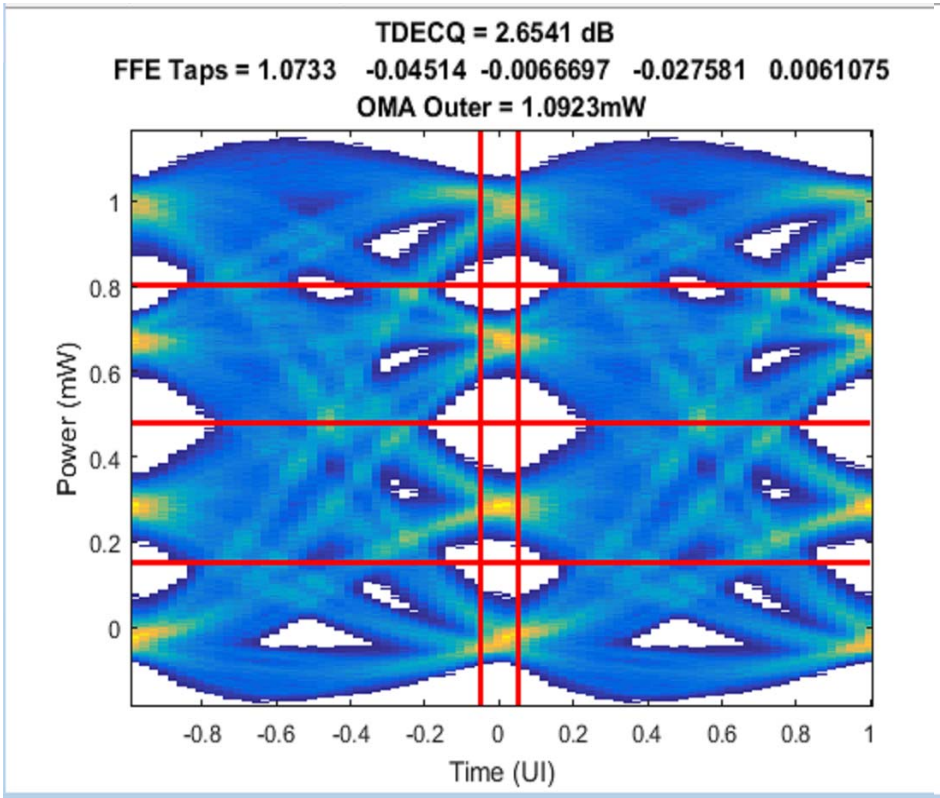
Example of the SECQ sensitivity to B-T roll-off problem

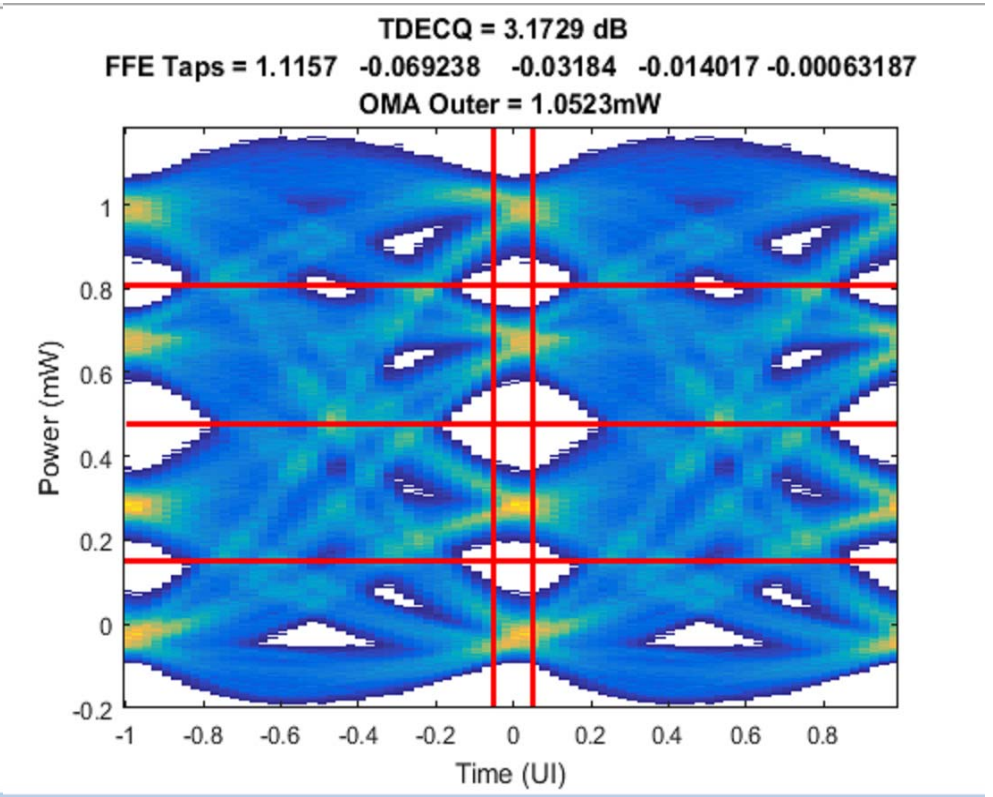
- In the following the problem is demonstrated by capturing a clean 26.56 GBd signal with an oscilloscope with same bandwidth, but two different roll-offs.

Using a 13.28 GHz B-T

SMALL DECREASE OF ROLL-OFF BW INCREASES THE MEASURED SECQ

- 18 GHz roll-off of the B-T: SECQ=2.65 dB
- 17.2 GHz roll-off of the B-T: SECQ=3.17 dB





SECQ sensitivity to the B-T roll-off

- As shown in previous slide, a small change of roll-off bandwidth from 18 GHz to 17.2 GHz added 0.51 dB of penalty to SECQ.
- That is, the same receiver measured with the 2nd signal will show 0.5 dB higher sensitivity.
- This example can be carried further; the point is, an earnest implementer can follow the standard to a ‘t’, yet under-stress their receivers, and pass bad products.

Proposed improved text

- Original text in D3.2, “138.8.8 Stressed receiver sensitivity”

The SECQ of the stressed receiver conformance test signal is measured according to 138.8.5, except that the combination of the O/E and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 13.28125 GHz, and the optical splitter and variable reflector shown in Figure 121–4 are not used.

- Improved text, improvement *in italics:*

The SECQ of the stressed receiver conformance test signal is measured according to 138.8.5, except that the combination of the O/E and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 13.28125 GHz *and the filter tolerances are as specified for STM-64 in ITU-T G.691.* Compensation may be made for variation of the reference receiver filter response from an ideal fourth-order Bessel-Thomson response.

Proposed improved text

- Original text in D3.2, “139.7.9.2 Stressed receiver conformance test signal characteristics and calibration”

The SECQ of the stressed receiver conformance test signal is measured according to 139.7.5, except that the test fiber is not used.

- Improved text, improvement *in italics:*

The SECQ of the stressed receiver conformance test signal is measured according to 139.7.5, except that the test fiber is not used, *and that the combination of the O/E and the oscilloscope has a fourth-order Bessel-Thomson filter response with the filter tolerances are as specified for STM-64 in ITU-T G.691.*

Proposed improved text

- Original text in D3.2, “140.7.9 Stressed receiver sensitivity”

The SECQ of the stressed receiver conformance test signal is measured according to 140.7.5, except that the test fiber is not used.

Improved text, improvement *in italics:*

The SECQ of the stressed receiver conformance test signal is measured according to 140.7.5, except that the test fiber is not used*, and that the combination of the O/E and the oscilloscope has a fourth-order Bessel-Thomson filter response with the filter tolerances are as specified for STM-64 in ITU-T G.691.*

Conclusion

- We show the sensitivity of the SECQ calibration process to the oscilloscope's roll-off can cause false passes RXs
- Solution: As per comment TBD, insert the language proposed here to limit this sensitivity.