TDECQ Reference Receiver Main Tap Location

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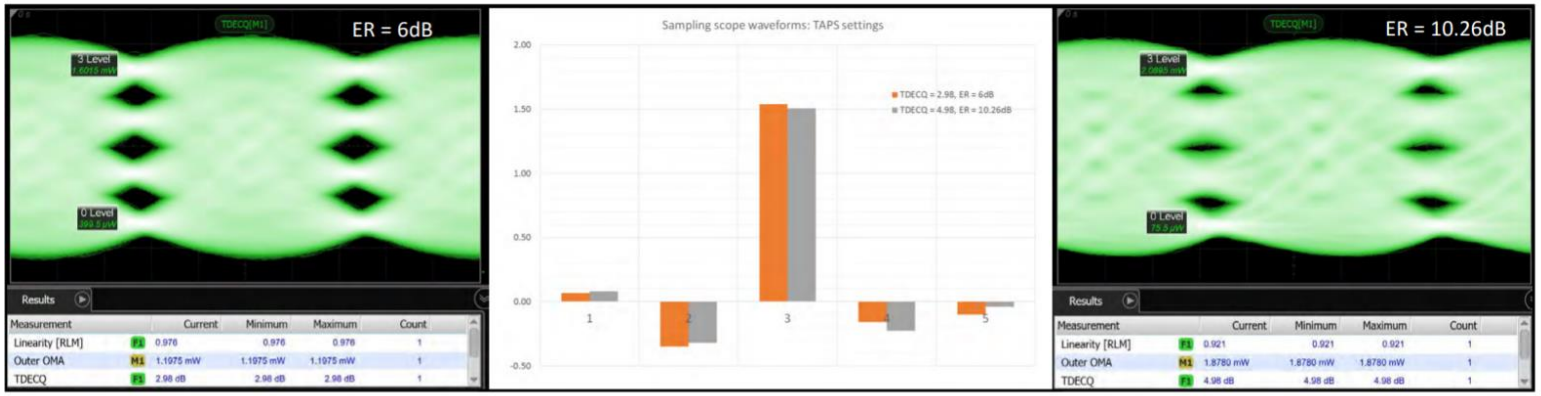
Introduction

- There are several comments related to main tap location of TDECQ reference equalizer: 94, 95, 107, 108, 116, 117, 118, 120.
- TDECQ Reference Receiver in Clause 139 and 140 is a 5 tap, T spaced FFE. It allows up to four pre-cursors. This indicates real receiver needs to support at least four pre-cursors to ensure interoperability.
- Supporting so many precursors is a big burden for real receivers. It forces real receivers to choose high power solutions and results in high module power.
- On the other hand so many precursors are only needed for pathological transmitters.
- This presentation proposes to limit the number of precursors to help screen out pathological transmitters, remove unnecessary burden on receivers to enable low power modules, and ensure interoperability.

TDECQ Measurement Results

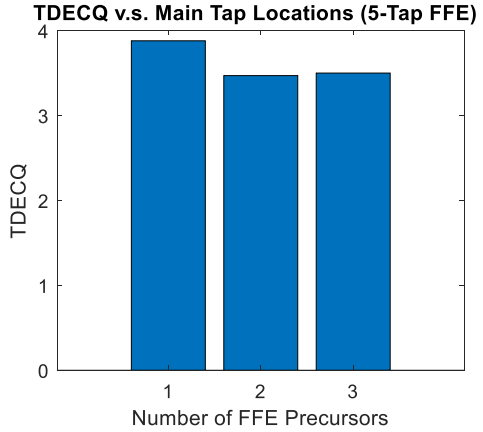
- Historically in IEEE 802.3bs project, TDECQ reference receiver was changed from 5-tap T/2 FFE to 5-tap T-spaced FFE to increase transmitter yield on TDECQ test. As a consequence, the maximum range of precursors is increased from 2 UI to 4 UI.
- Reported TDECQ measurements show 5-tap T-spaced effectively improves transmitter yield. Meanwhile no more than 2 precursors are reported to be necessary for good transmitters.
- For example, mazzini_3bs_01_0917.pdf shows main tap is optimized to tap 3 (2 precursors) for good transmitters. Precursor 2 is relatively small.

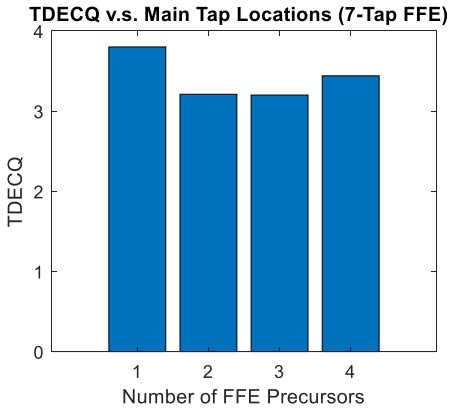
Transmitter results over two reference settings: PRBS20.



TDECQ Measurement Results

- We compared 100GBASE-DR TDECQ results for different number of FFE precursors.
- For 5-tap T-spaced FFE, FFE with two precursors give the best TDECQ results.
  - TDECQ test completely fails if using 4 FFE pre-cursors because of no post-cursors!
- We tried 7-tap T-spaced FFE to have enough coverage for post-cursors and compare the impact of the number of precursors
  - TDECQ values are almost the same for FFE with 2 or 3 pre-cursors. This is means pre3 has no obvious impact on TDECQ result.





Cost of Precursors

- In general there will be hardware and power cost to support more precursors.
- For some architectures, pre-cursors are more costly than post-cursors and may bring extra distortion. For those SERDES taking advantage of fractional (e.g. T/2) spaced FFE, more precursors are usually difficult.
- Optimizing main tap location is possible on real receiver, but at extra cost of extra hardware and power.

Proposed Changes for 50GBASE-FR and 50GBASE-LR

139.7.5.4 TDECQ reference equalizer

The reference equalizer for 50GBASE-FR and 50GBASE-LR is a 5 tap, T spaced, feed-forward equalizer (FFE), where T is the symbol period. The sum of the equalizer tap coefficients is equal to 1.

- Changes:
  The reference equalizer for 50GBASE-FR and 50GBASE-LR is a 5 tap, T spaced, feed-forward equalizer (FFE), where T is the symbol period. The sum of the equalizer tap coefficients is equal to 1. Main tap location shall not be higher than three.

Proposed Changes for 100GBASE-DR

140.7.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

The TDECQ shall be within the limits given in Table 140–6 if measured using the methods specified in 121.8.5.1, 121.8.5.2, and 121.8.5.3 using a reference equalizer as described in 121.8.5.4, with the following exceptions:

— The optical return loss of the transmitter compliance channel is 15.5 dB.

— The signaling rate of the test pattern generator is as given in Table 140–6 and uses a test pattern specified for TDECQ in Table 140–10.

— There are no interfering optical lanes and therefore the delay requirement of at least 31 UI between test pattern on one lane and any other lane, as specified in 121.8.5.1, is redundant.

— The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 26.5625 GHz.

— The normalized noise power density spectrum, $N(f)$ in Equation (121–9), is equivalent to white noise filtered by a fourth-order Bessel-Thomson response filter with a bandwidth of 26.5625 GHz.

- Changes:

  "using a reference equalizer as described in 139.7.5.4"

Conclusions

- Lacking constraints on TDECQ indicates real receivers need to support up to 4 precursors.
- Supporting up to 4 precursors is a big burden to real receiver and may allow pathological transmitters to pass TDECQ test.
- To ensure interoperability and enable low power modules, we propose to limit the number of precursors to two.

Thanks!