Comment To Propose Increasing Number Of Taps Of Reference Equalizer In TDECQ Measurement For P802.3bs D3.4

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Background

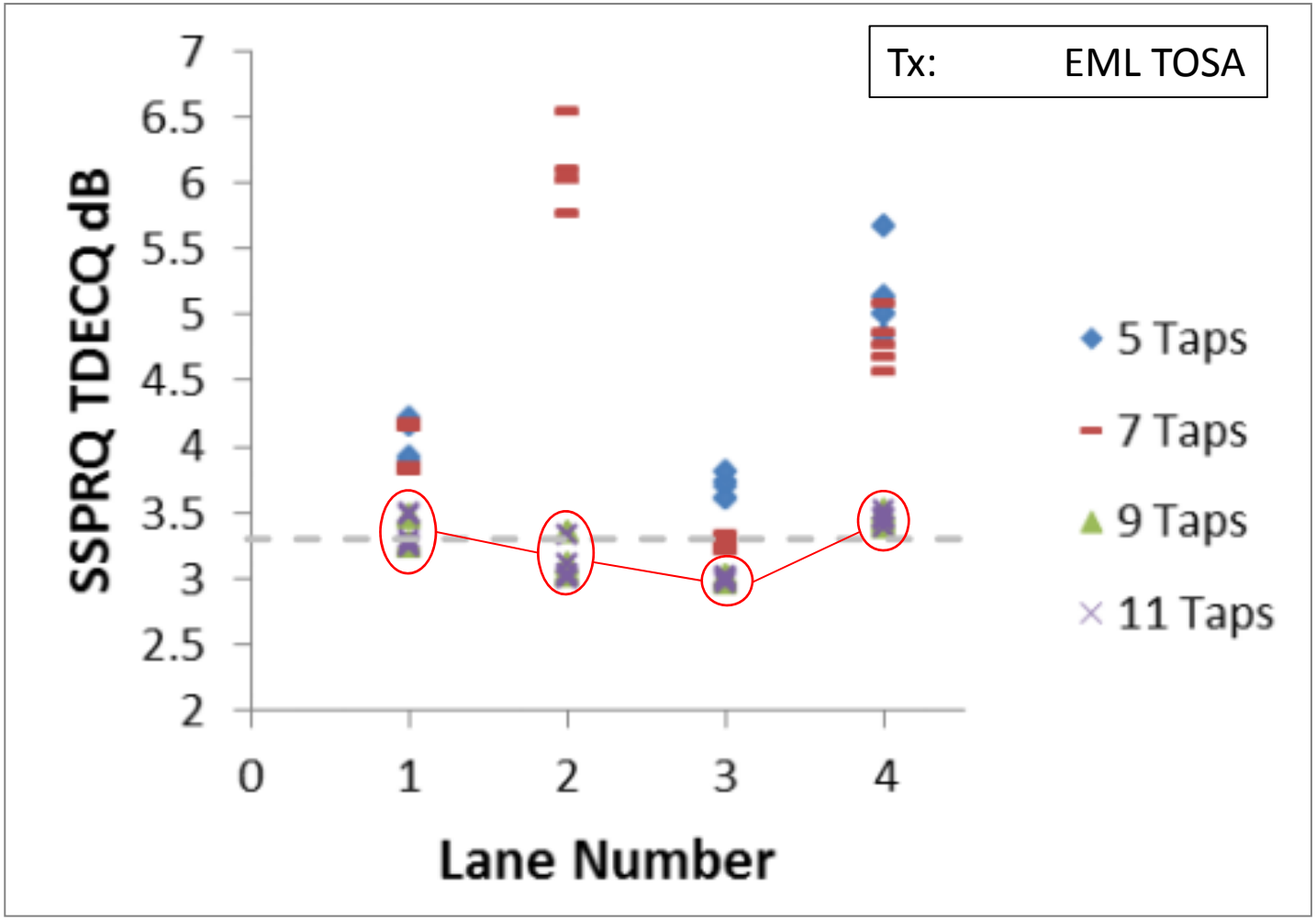
1. Several presentations raised concern that TDECQ (max) is difficult to pass with high yield.
   - way_3bs_01a_0517
   - way_3bs_01a_0717
   - chang_3cd_01a_0917
   - tamura_3bs_01a_0917

2. SSPRQ still not widely available. TDECQ measurements usually relying on PRBS15. Recent data comparing SSPRQ and PRBS15 suggests TDECQ with SSPRQ can be ~0.5 dB higher. If TDECQ with PRBS15 is marginal, difficulty will increase when SSPRQ is introduced.

3. Low transmitter yields will decrease manufacturing throughput and increase cost.

4. This presentation reports data from several different implementations that supports increasing the number of taps of the reference equalizer from 5T to 9T in order to reduce the measured values of TDECQ and improve transmitter yield.

Example 1 - TDECQ vs Number of Taps

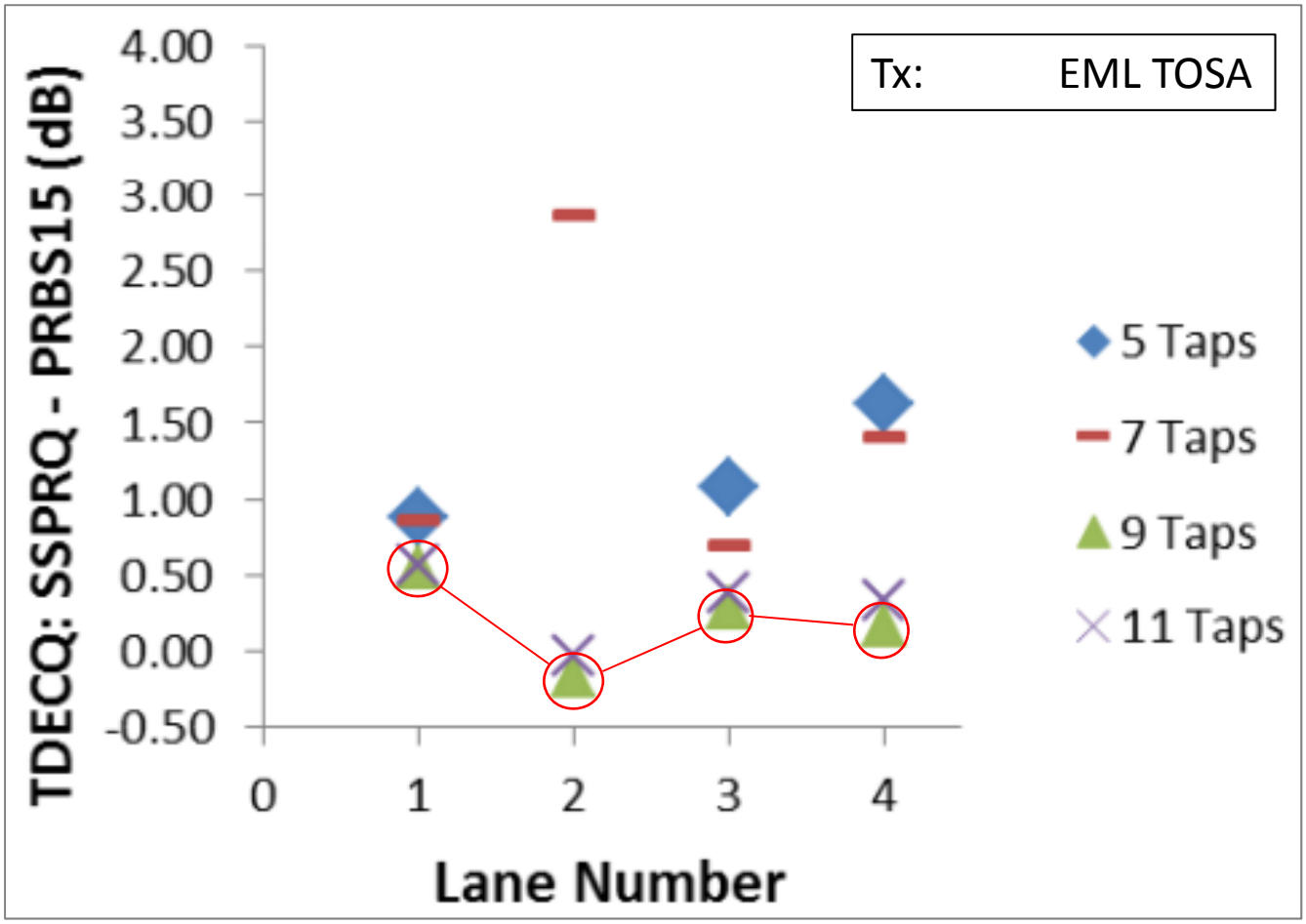


Observation:
- 9 T-spaced taps greatly improves the SSPRQ TDECQ results.

Increase taps to 9T

http://www.ieee802.org/3/bs/public/17_07/way_3bs_01a_0717.pdf

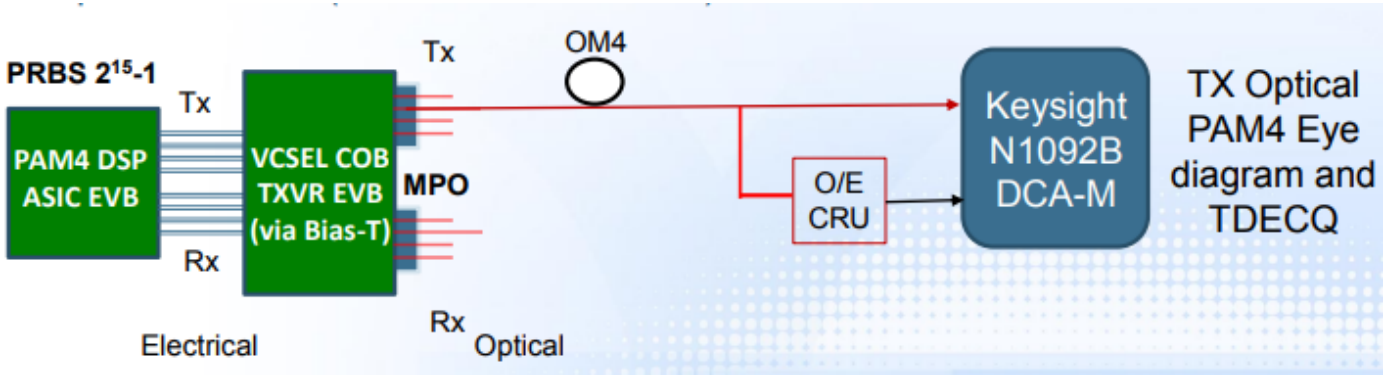
Example 1 - SSPRQ vs PRBS15



Observation:

- With 9 tap, T-spaced FFE, $TDECQ_{SSPRQ} - TDECQ_{PRBS15} \sim +0.5$ dB.

Example 2 - TDECQ vs Number of Taps



New 802.3cd D2.1 definitions (5 T-spaced at 11.2GHz)

TDECQ (dB)	Filter 11.2GHz	Filter 12.6GHz	Filter 13.28GHz (Nyquist)	Filter 15.5GHz	Filter 19.3GHz (75%)	802.3cd D2.1 specs
5 taps	5.60	5.29	4.92	4.44	5.12	<4.9dB (each lane)
7 taps	5.12	4.90	4.71	4.65	4.65	
9 taps	4.52	4.23	4.11	4.12	4.12	

Keysight Scope processing (beta version)

Observation:

- TDECQ measurement less stable at 5T.
- Only 9T measurement satisfied TDECQ (max) of 4.9 dB at specified filter bandwidth.
- PRBS15 used (SSPRQ unavailable) ➔ Expect to not pass if SSPRQ increases TDECQ by +0.5 dB.

⇨ Increase taps to 9T

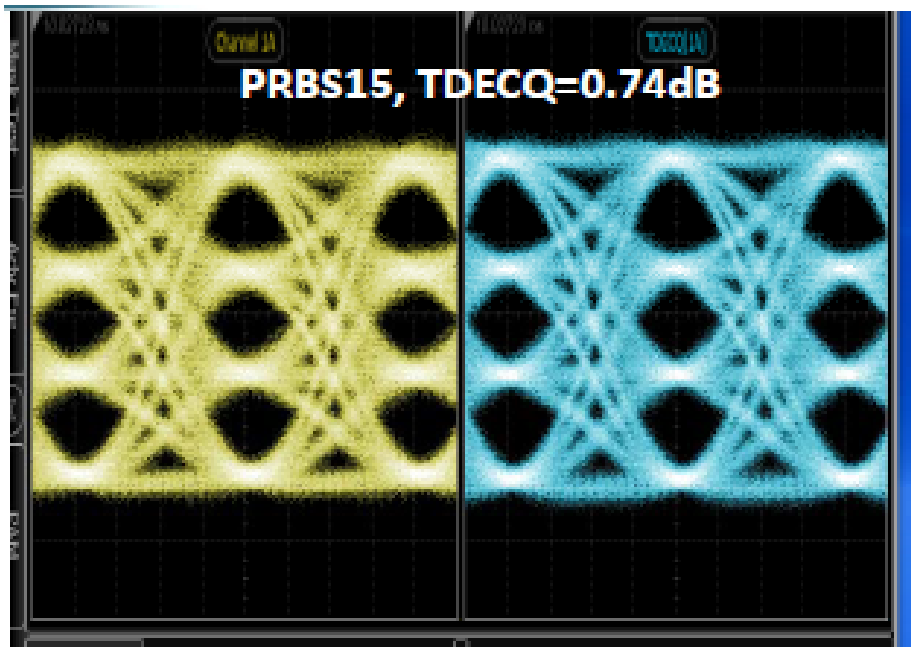
http://www.ieee802.org/3/cd/public/Sept17/chang_3cd_01a_0917.pd

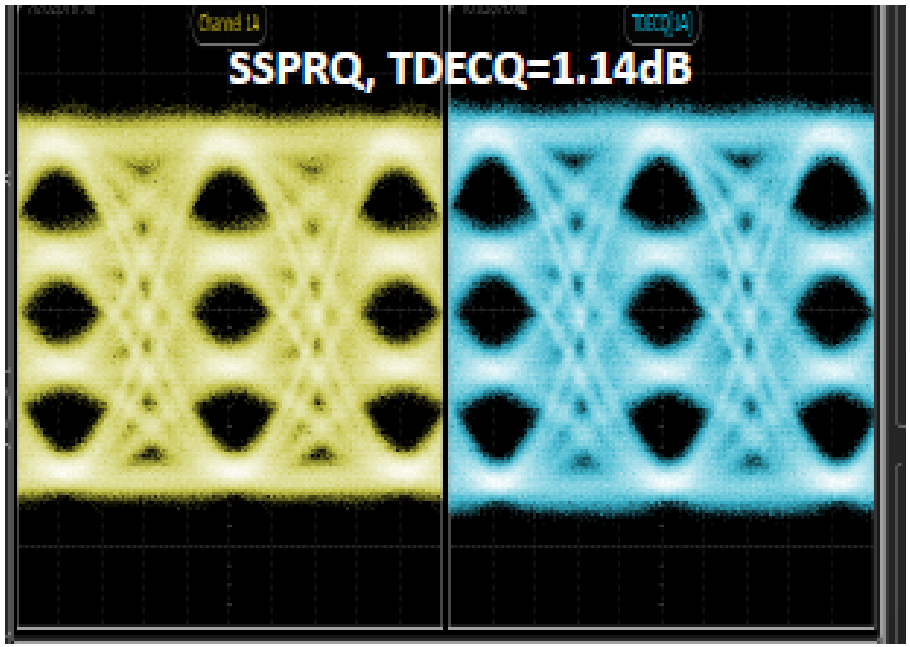
Inphi

Example 3 - SSPRQ vs PRBS15

Test conditons:

- Tx: DML TOSA
- Modulation: 53.125 Gbps PAM4
- Bias current: 45 mA
- Temperature: 25 C
- Extinction ratio: 4.5 dB

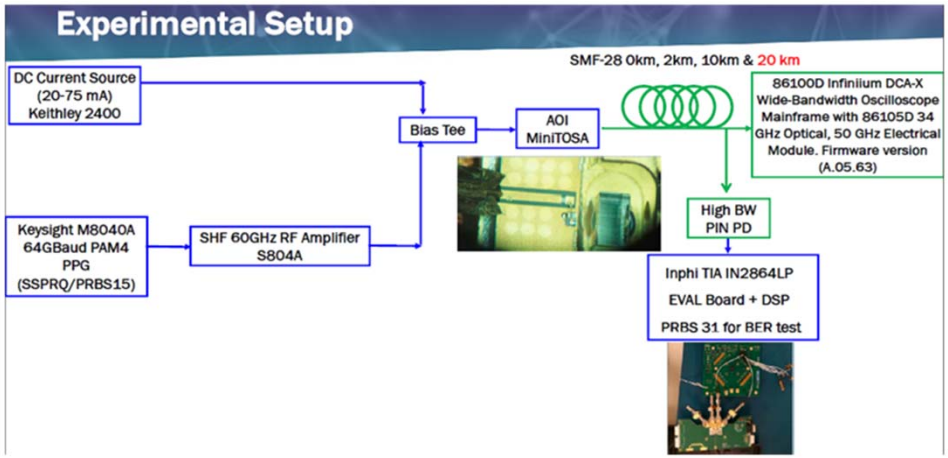




Observation:

- $TDECQ_{SSPRQ}$ - $TDECQ_{PRBS15}$ ~ +0.5 dB (max).

Example 3 - TDECQ vs Number of Taps

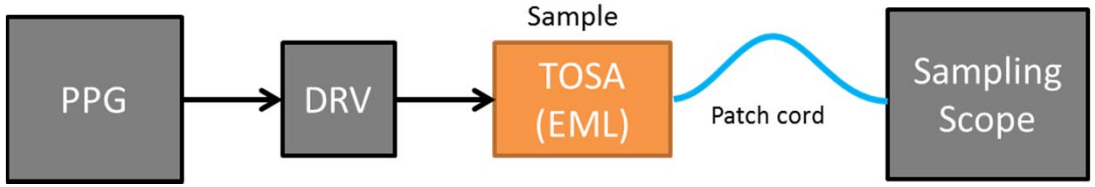


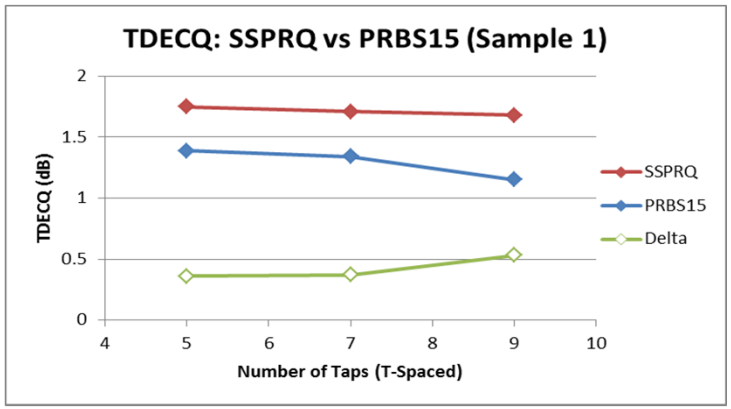
Pending

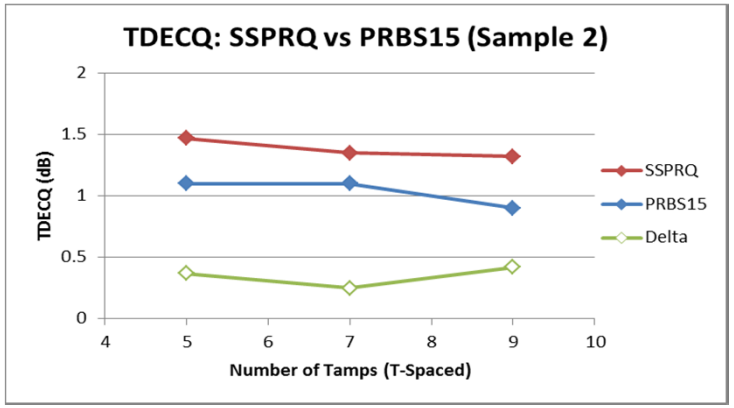
Observation:
- Pending

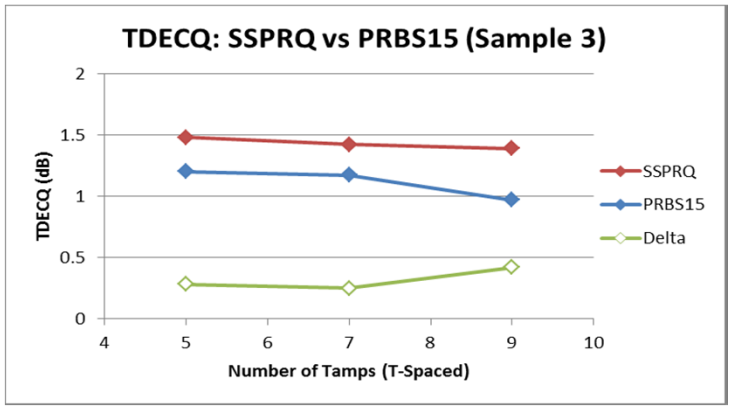
Increase taps to 9T

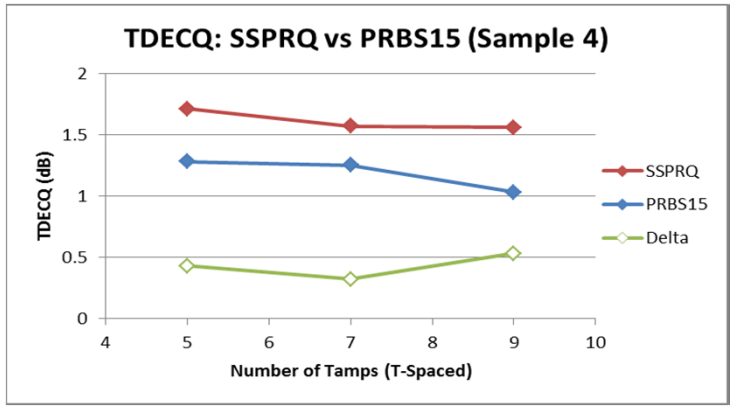
Example 4 - SSPRQ vs PRBS15







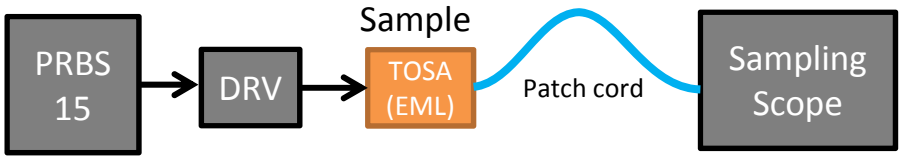




Observation:

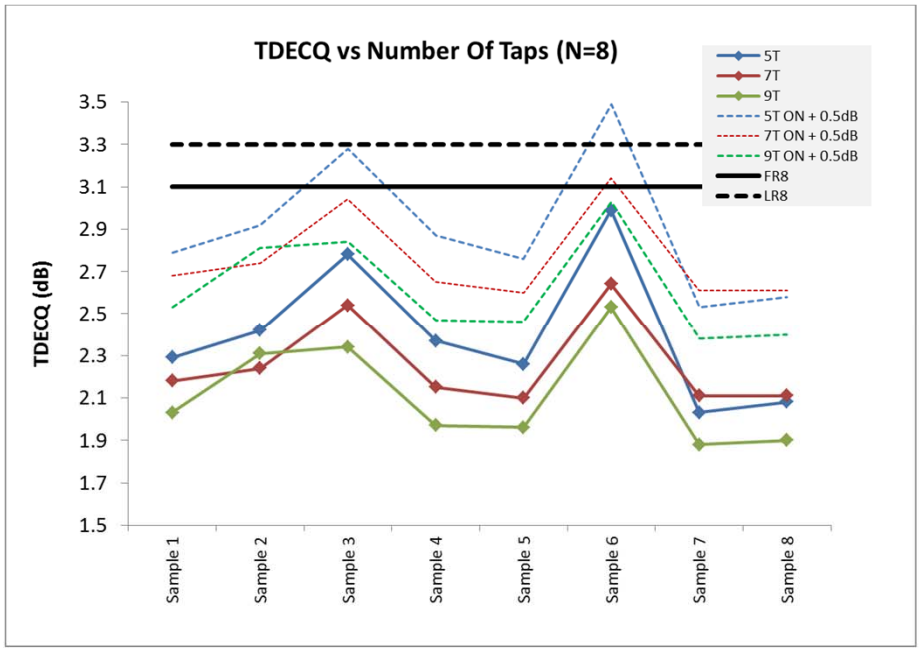
- $TDECQ_{SSPRQ} - TDECQ_{PRBS15}$ in range of +0.25 to +0.53 dB for 5T to 9T FFEs.

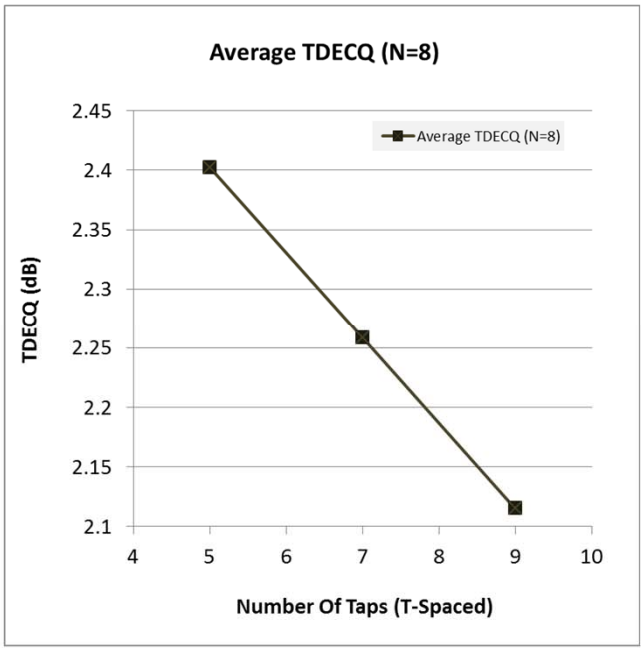
Example 4 - TDECQ vs Number Of Taps



Test conditons:

- Tx: EML TOSA
- Modulation: 53.125 Gbps PAM4
- Pattern: PRBS15
- Rx BW: 13.28125 GHz
- Test fiber: None
- Algorithm: Iterative optimization





Observation:

1. TDECQ decreases with number of taps.
2. For 5T, if +0.5 dB correction used to convert from PRBS15 to SSPRQ, samples exceeding TDECQ (max) are 2/8 for FR8 and 1/8 for LR8.
3. For 9T, 100% pass for FR8 and LR8, even after +0.5 dB correction to TDECQ.

Increase taps to 9T

Summary

1. Data from 4 sources supports concern that 5T reference equalizer has too few taps for consistently meeting TDECQ (max) for common transmitter implementations.

2. For these same implementations, data supports that 9T is much better for satisfying TDECQ (max).

3. Improved transmitter yield will lower cost.

4. Accommodating a wider variety of transmitter implementations will increase supply and further reduce cost.

Comment

- Clauses:
  - 121.8.5.4
  - 122.8.5.4

- Comment:
  - The current 5T reference equalizer has a risk of low yield in TDECQ for transmitters implementations that have longer characteristic time constants. It may preclude certain implementations, which would limit supply. These factors create risks of high costs.

- Solution:
  - Change to:

    “The reference equalizer for 200GBASE-FR4, 200GBASE-LR4, 400GBASE-FR8, and 400GBASE-LR8 is a 9 tap, T spaced feed-forward equalizer (FFE), where T is the symbol period. The sum of the equalizer tap coefficients is equal to 1.”