

TDECQ update:
Comments on proposals to add
threshold adjustment

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Contents: notes on the proposals to add threshold adjustment to TDECQ*

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*Related to comments against 802.3cd Draft 3.1: 97, 98, 99, 102, 104

TDECQ background

- The basic principles of the TDECQ D3.0 definition were laid out about two years ago in [king_01a_0416_smf.pdf](http://www.ieee802.org/3/bs/public/adhoc/smf/16_04_19/king_01a_0416_smf.pdf) *

- It's late in the 802.3cd project, any changes to the standard should be demonstrated to:

- Be a significant improvement over draft 3.1 specs
- Not introduce new issues

- The current definition (D3.1) is complete and sufficient. It already allows some transmitter inner-eye inequality but requires that a higher inequality penalty be compensated with higher Tx OMA through the Tx_OMA minus TDECQ spec.

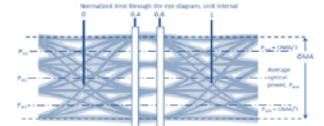
- Measurement data to date has shown TDECQ (D3.0 definition) vs receiver sensitivity correlating approximately dB:dB with an RMS error of about 0.3 dB, with a tendency to overestimate receiver sensitivity penalty for high TDECQ values.

* http://www.ieee802.org/3/bs/public/adhoc/smf/16_04_19/king_01a_0416_smf.pdf

Proposal for TDEC for PAM4 signals -1

- Scope based, TDEC variant expanded for all three sub-eyes in equalized PAM4 signal

- No reference Tx needed
- Worst case fibre required for SMF
- Reduced bandwidth (19.6 GHz BT4) Rx for MMF



- Reference receiver and equalizer are software based 'in the 'scope'
- **Single timing position in centre of eye for all three sub-eyes, +/-0.1 UI (TBC)**
 - Time centre of eye determined from crossing points
- **TDEC calculated from fixed thresholds: P_{ave} , $P_{ave} + OMA/3$, $P_{ave} - OMA/3$**
 - Penalizes transmitters which have unequal sub-eyes
 - This isn't how a 'real' PAM4 retimer is expected to work, but it avoids the issue of how to measure accurately the penalty of unequal sub-eyes when received by a 'real' receiver, which may have differing sensitivities for each sub-eye.
 - Part of the motivation for this work is to evaluate how much penalty that may incur
 - Should 400GE decide that optimized thresholds ought to be specified for the TDEC test, an additional (non-trivial) test will be needed to measure how transmitter and receiver sub-eye inequality/non-linearity interact.

TDECQ background -2

Two important items for TDECQ changes:

- Show threshold adjustment doesn't result in the SRS test source having too high a stress for the receiver, test with a fully stressed receiver (ie including baseline wander and sinusoidal jitter) so that the tracking/optimization algorithms are exercised;
- Show threshold adjustment significantly improves correlation between TDECQ and measured receiver sensitivity.
 - For example, a 'significant improvement' would be reducing RMS error to below 0.1 dB across a range of transmitters and receivers

Comments on chang_021418_3cd_adhoc-v2.pdf : 'Hole in spec'

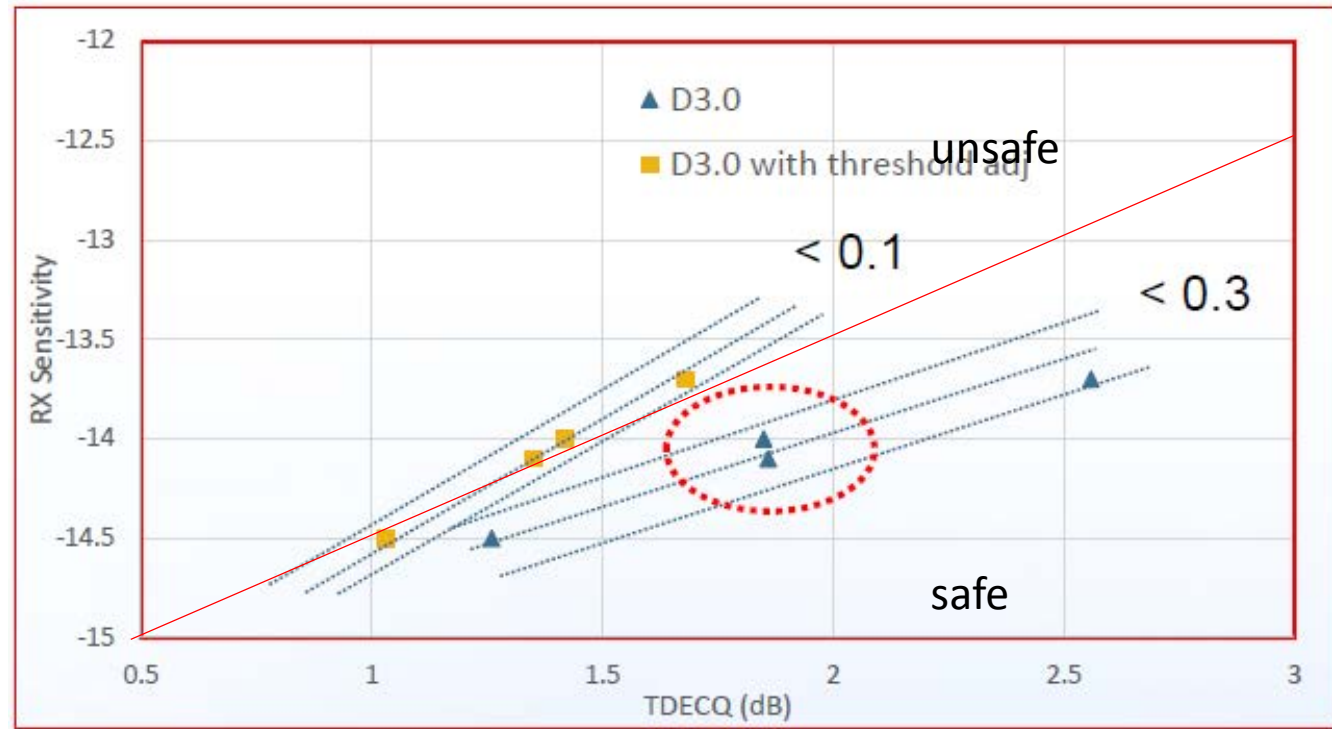
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- Refers to a hole in the current draft but talks about guard bands.
- It should be noted that IEEE never specifies guard bands, since these would be specific to a particular implementation, the parameter being measured, and the measurement set up.
 - There is no hole in the P802.3cd spec.
- To be compliant, a transceiver must meet specifications over its entire operating range (e.g. over temperature and supply voltage). Guard bands are the responsibility of the manufacturer.

Comments on chang_021418_3cd_adhoc-v2.pdf : 'Rx penalty prediction'

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- When thresholds are optimized the slope of Rx sensitivity vs TDECQ is >1
 - This really would be a hole in the spec
- i.e. TDECQ with threshold adjustment underestimates receiver penalty, even though the receiver used has a much longer EQ (10 tap FFE) than the reference EQ
- In contrast, a reference EQ which is representative of the worst case receiver should tend to over-estimate sensitivity penalty (slope of receiver sensitivity vs TDECQ should be ≤ 1)



Comments on chang_021418_3cd_adhoc-v2.pdf : SRS

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- The SRS test results show two stressed test sources with substantially equal inner-eye heights.
- Adding threshold adjustment to TDECQ allows more unequal inner-eye heights.
- In order to show the SRS test is not going to over-burden receivers with excess non-linearity, the SRS test should explore the range of inner-eye inequality when threshold adjust is implemented.
 - This is not shown in chang_021418_3cd_adhoc-v2.pdf

Comments on chang_021418_3cd_adhoc-v2.pdf : recommendations

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- Adding threshold adjust allows higher levels of inner eye inequality for the same values of TDECQ
- The data in chang_021418_3cd_adhoc-v2.pdf shows that adding threshold adjust to TDECQ underestimates the system penalty, even for a receiver implementation that has a longer EQ than the reference.
 - This is a risk to link closure and interoperability, and does not improve the draft !
- It should be demonstrated that any changes significantly improve the draft, and do not over-burden receivers with excess non-linearity.
 - This has not been shown

Discussion...