TDECQ update: Comments on proposals to add threshold adjustment

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- TDECQ background
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- Recommendations

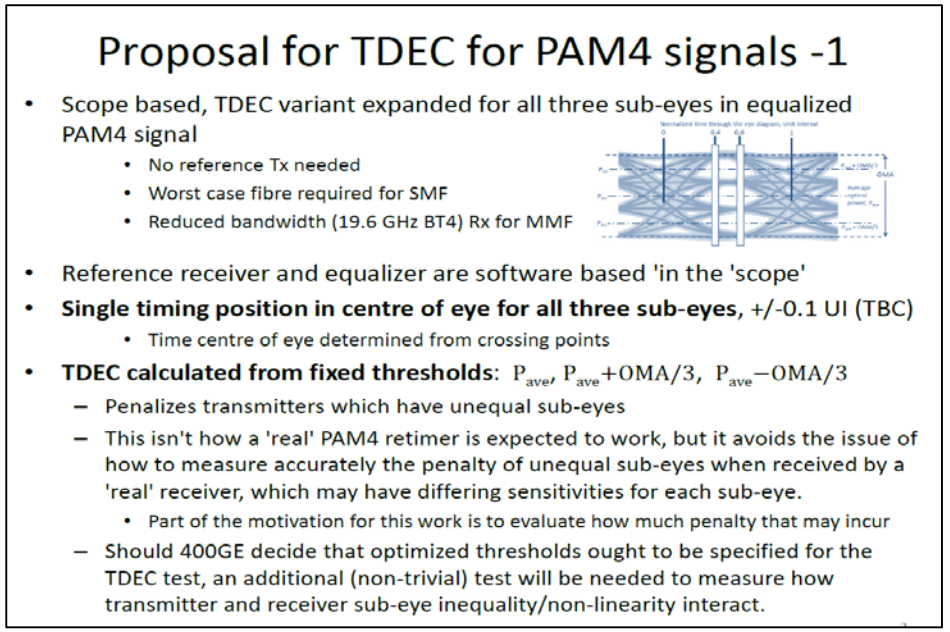
*Related to comments against 802.3cd Draft 3.1: 97, 98, 99, 102, 104

TDECQ background

- The basic principles of the TDECQ D3.0 definition were laid out about two years ago in king_01a_0416_smf.pdf *

Our duty-of-care

- 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

TDECQ background -2

Two important items for any changes to TDECQ :

- 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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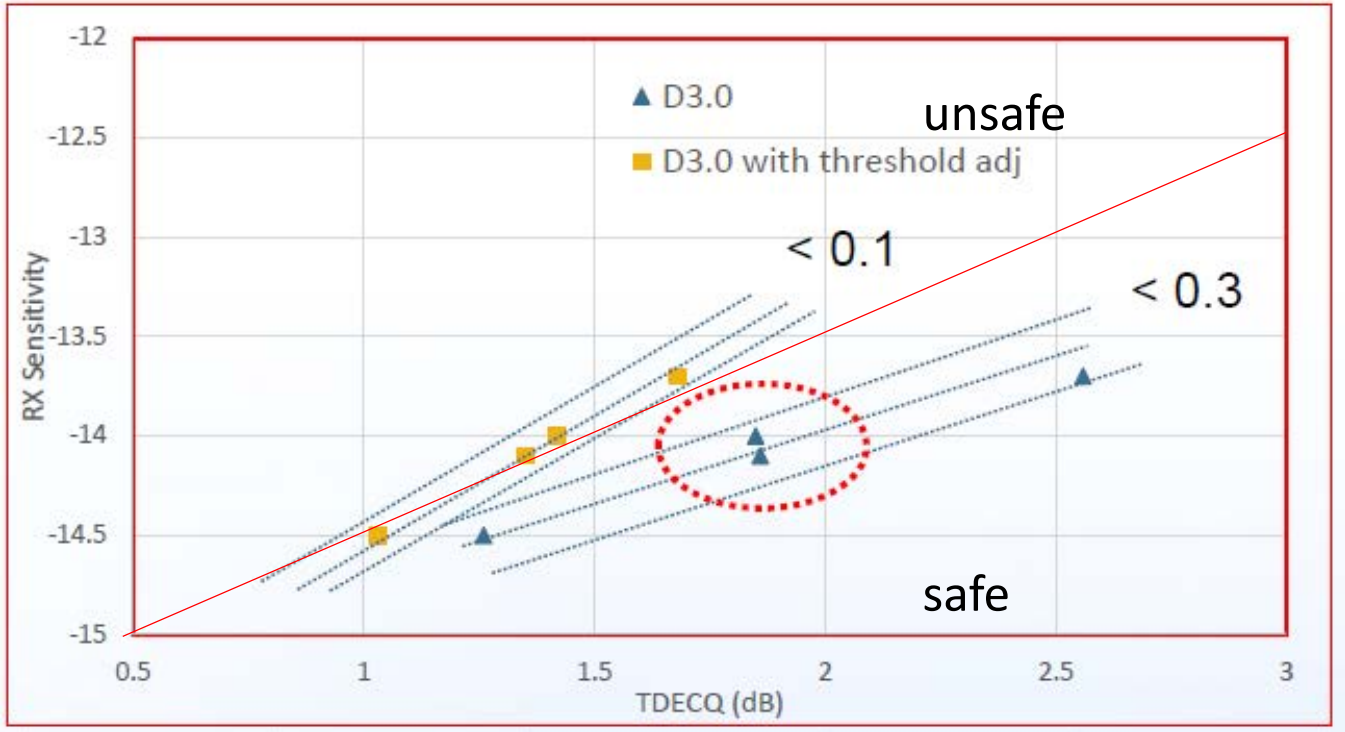
- Refers to a hole in the current draft but talks about guard bands.

- 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'

Slide 13 data

- 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)



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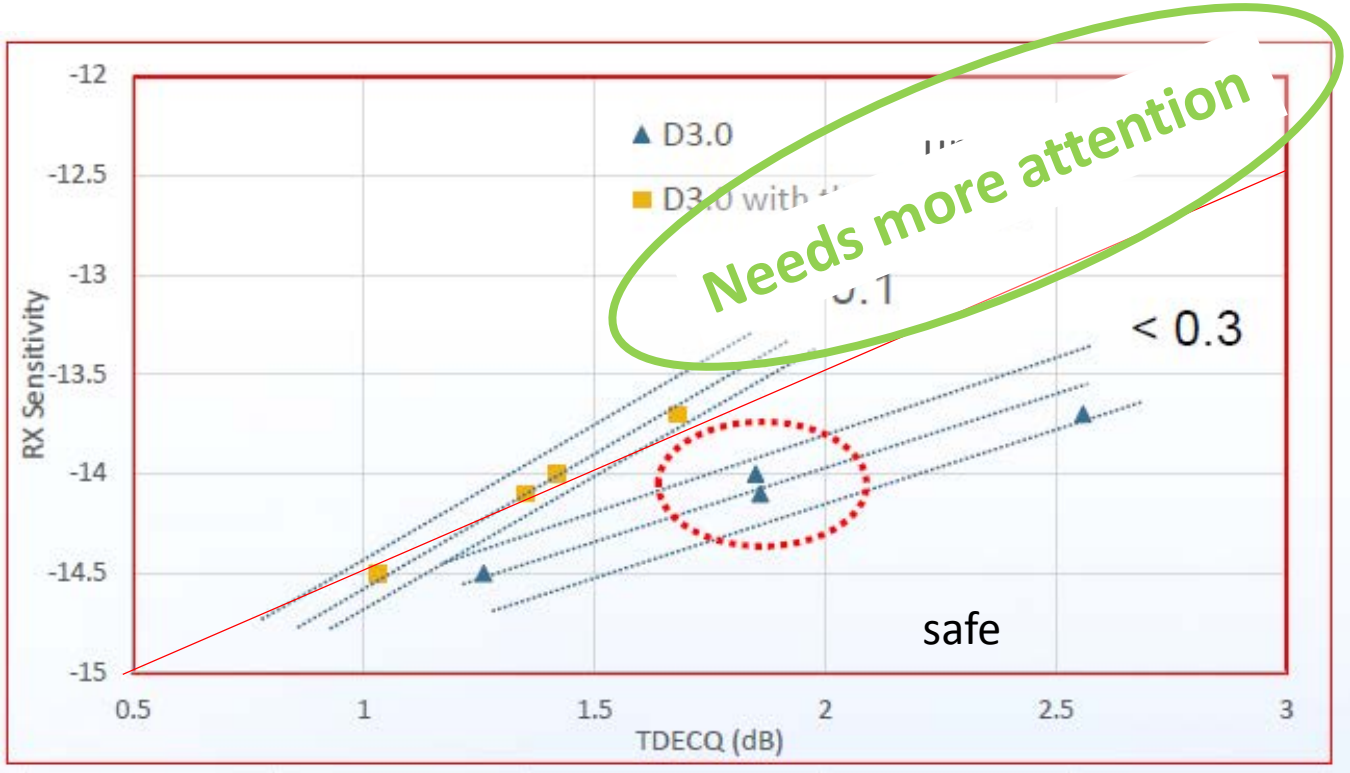
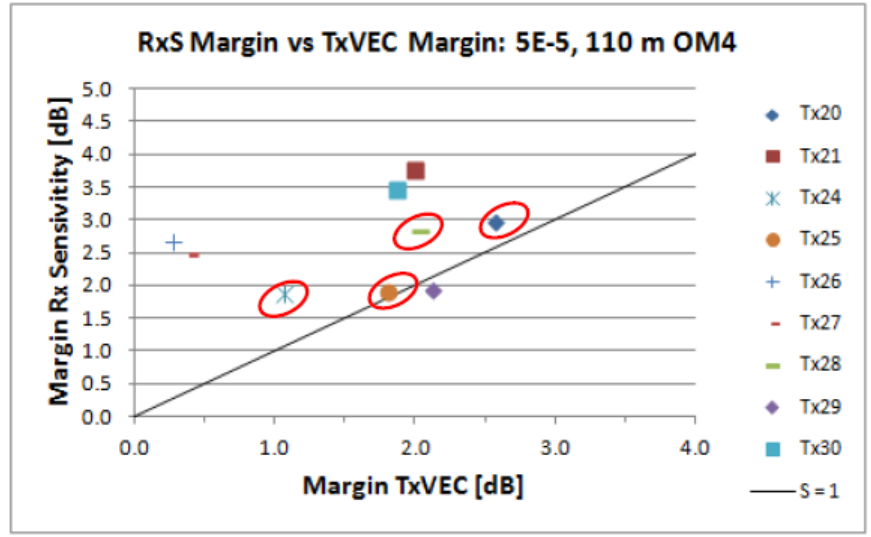


Compare with TDEC, 100GBASE-SR4

- 802.3b task force developed a new scope based transmitter metric, TDEC, to replace TDP.
- TDEC guarantees a working link because transmitter TDEC is equal to or greater than 'real' receiver sensitivity penalties.
  - Measurements with a wide range of transmitters confirmed this.
- Undoubtedly, some transmitters could fail TDEC, but still close link with a particular receiver.
- It's the price of interoperability

Validation in 802.3bm: TDEC vs measured sensitivity



- During 802.3bm, a wide range of Tx eyes were shown to have TDEC ≥ measured sensitivity penalty: ***TDEC guarantees a working link***
- TDEC closely matches receiver sensitivity for the more symmetric eyes, and overestimates eye closure for asymmetric eyes: ***1 dB of OMA margin compensates for ≥ 1dB of TDEC***
- For the more symmetric eyes: ***1 dB of sensitivity margin compensates for 1 dB of SEC shortfall***

Extract from http://www.ieee802.org/3/bm/public/mmfadhoc/meetings/may15_14/petrilla_01_0515_mmf.pdf

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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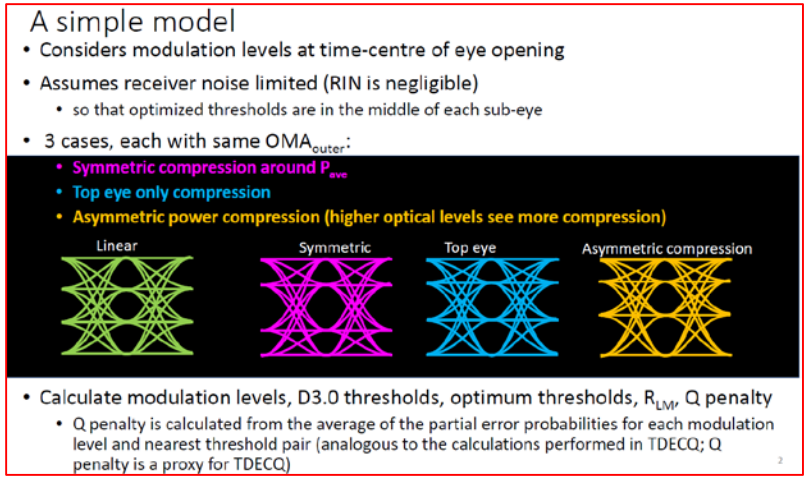
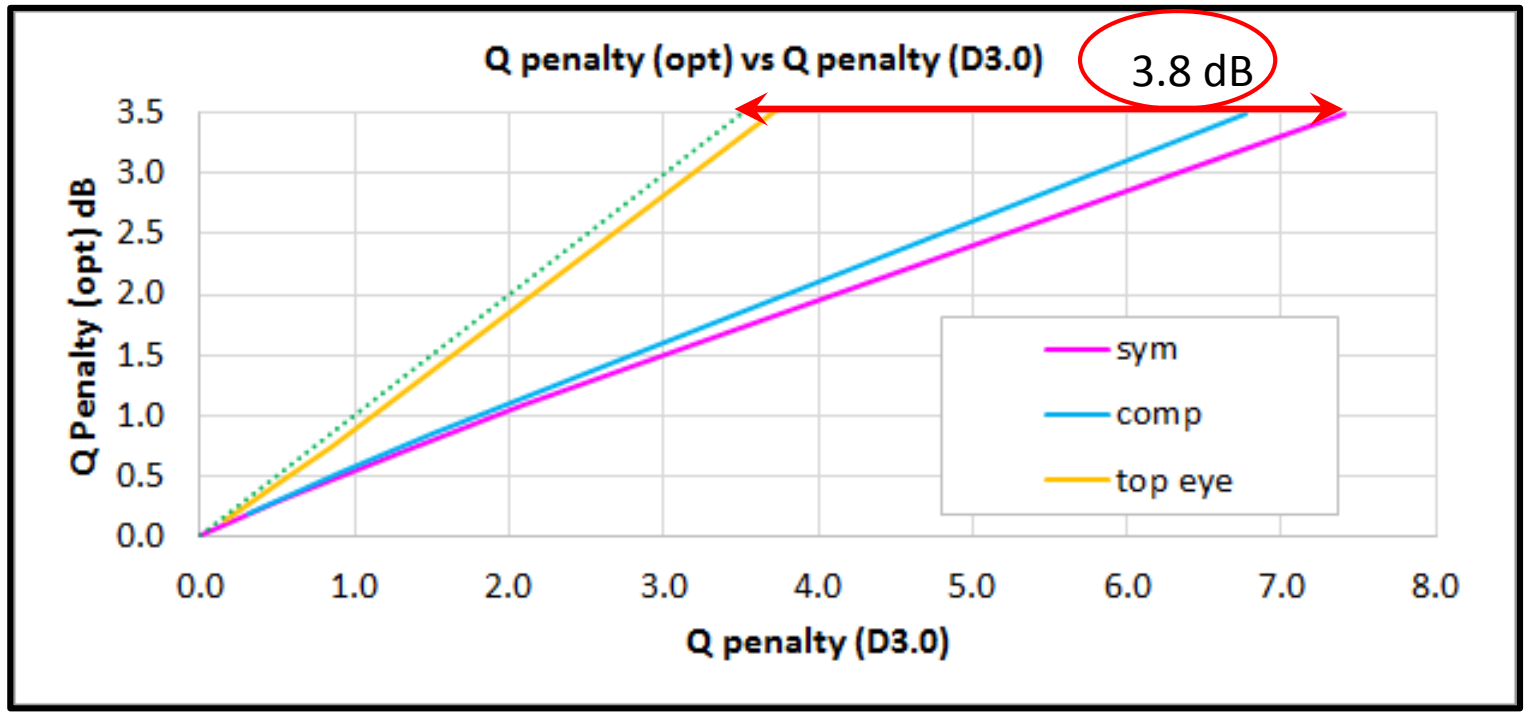
- Adding threshold adjust allows higher levels of inner eye inequality for the same values of TDECQ
- The data in chang_021418_3cd_adhoc-v2.pdf shows that adding threshold adjust to TDECQ underestimates the system penalty, even for a receiver implementation that has a longer EQ than the reference.
  - 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

TDECQ threshold adjust: impact on allowed sub-eye inequality

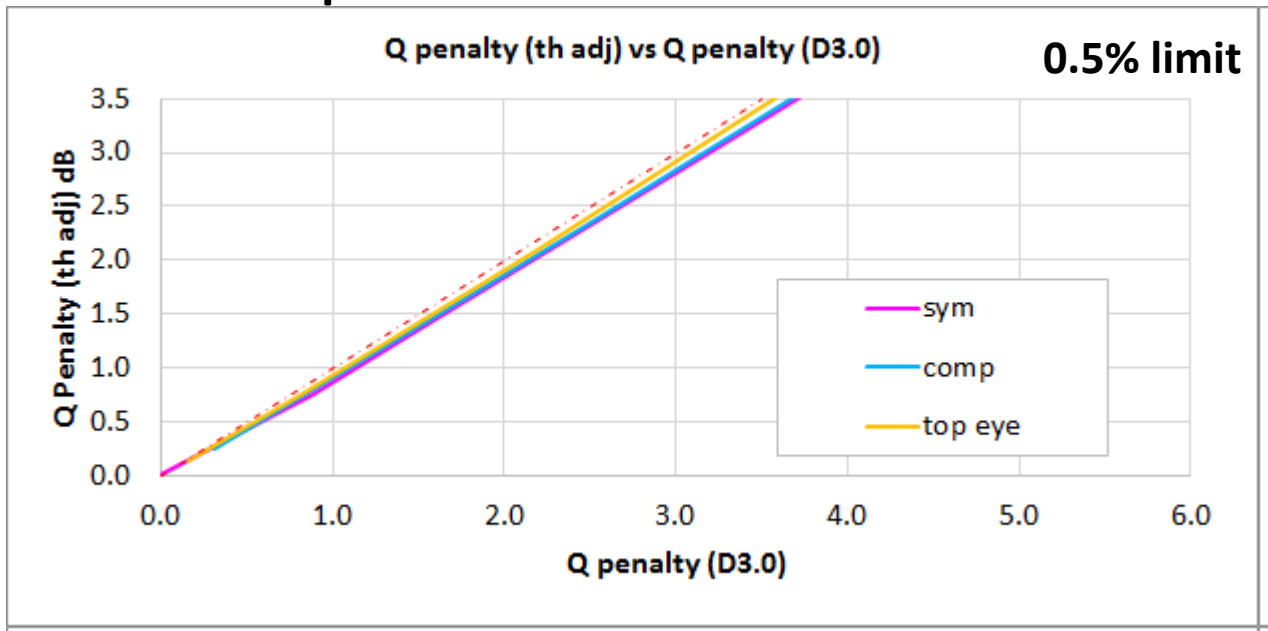
- Same model as *king_3cd_01_0118_adhoc*; with limit to threshold adjust added
  - **Unlimited** threshold adjust ~ doubles the allowed sub eye nonlinearity within the TDECQ limit

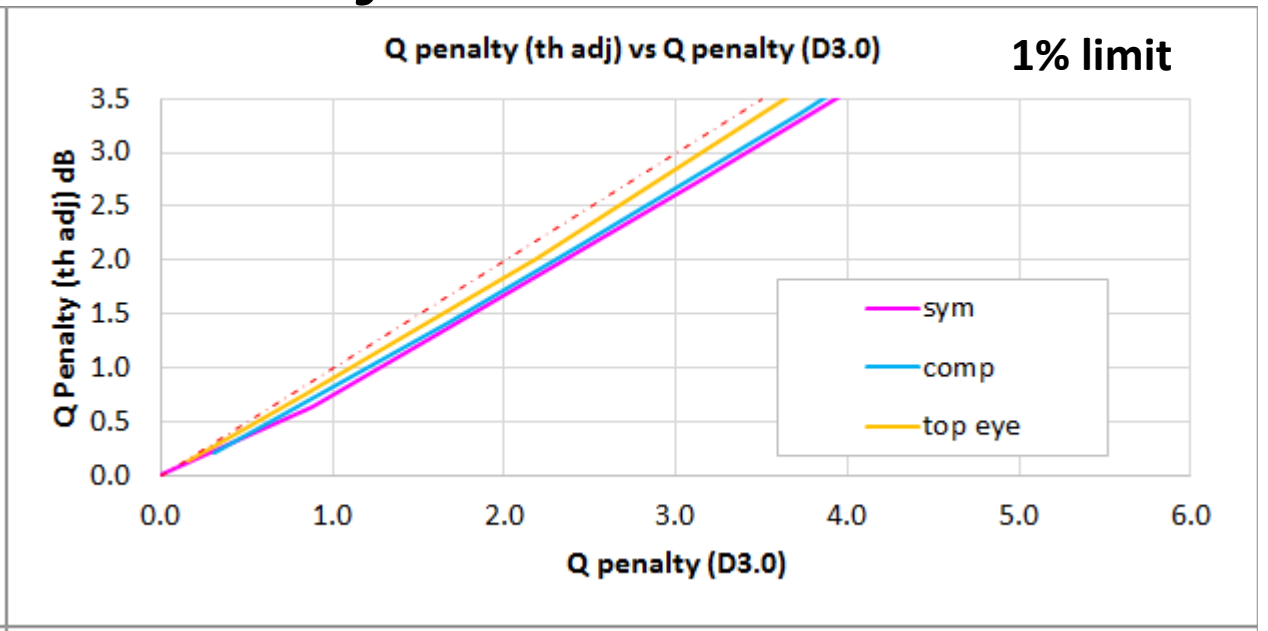


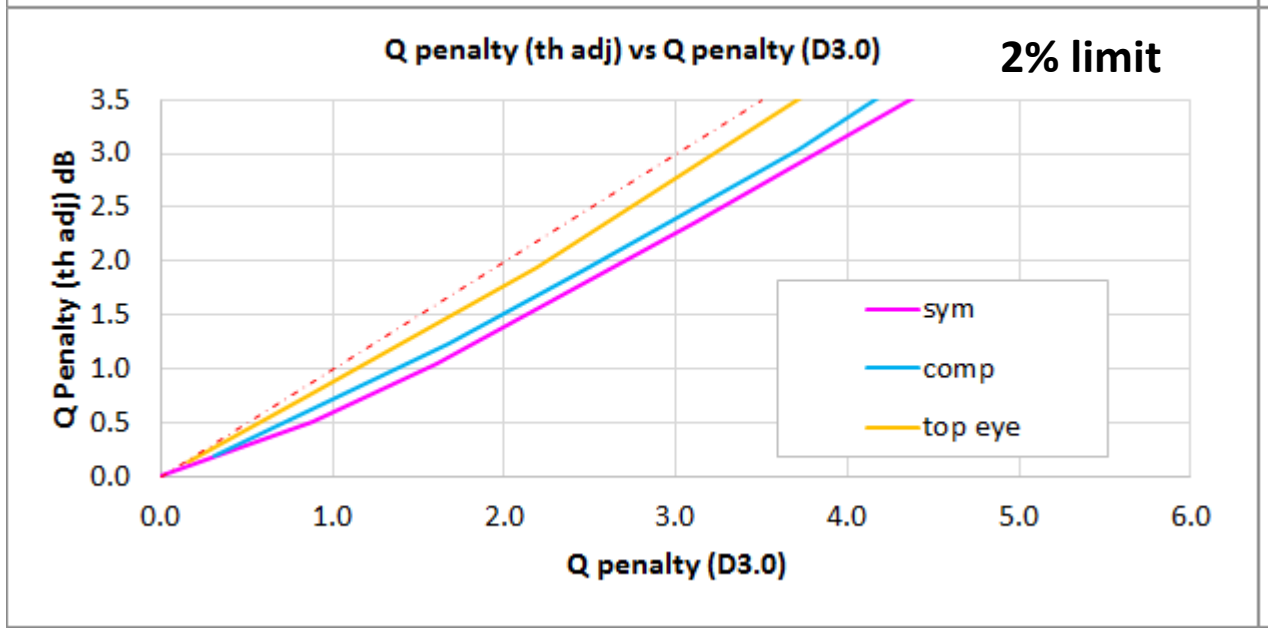


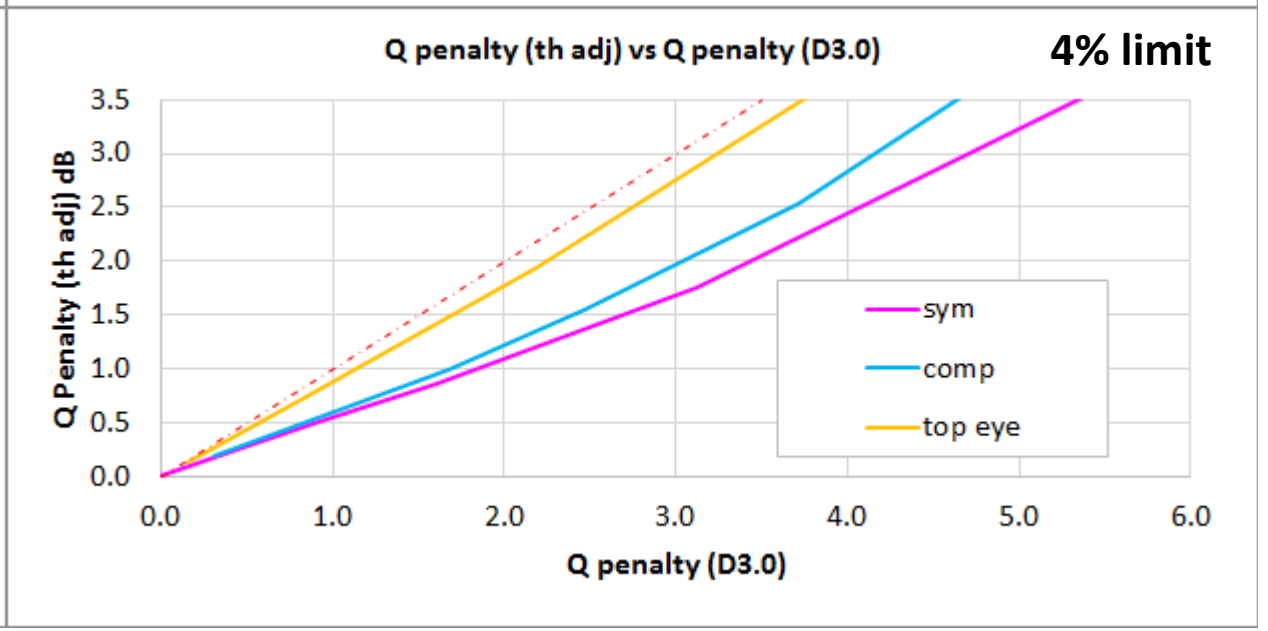
http://www.ieee802.org/3/cd/public/adhoc/archive/king_011018_3cd_adhoc.pdf

Impact of **limited** threshold adjust



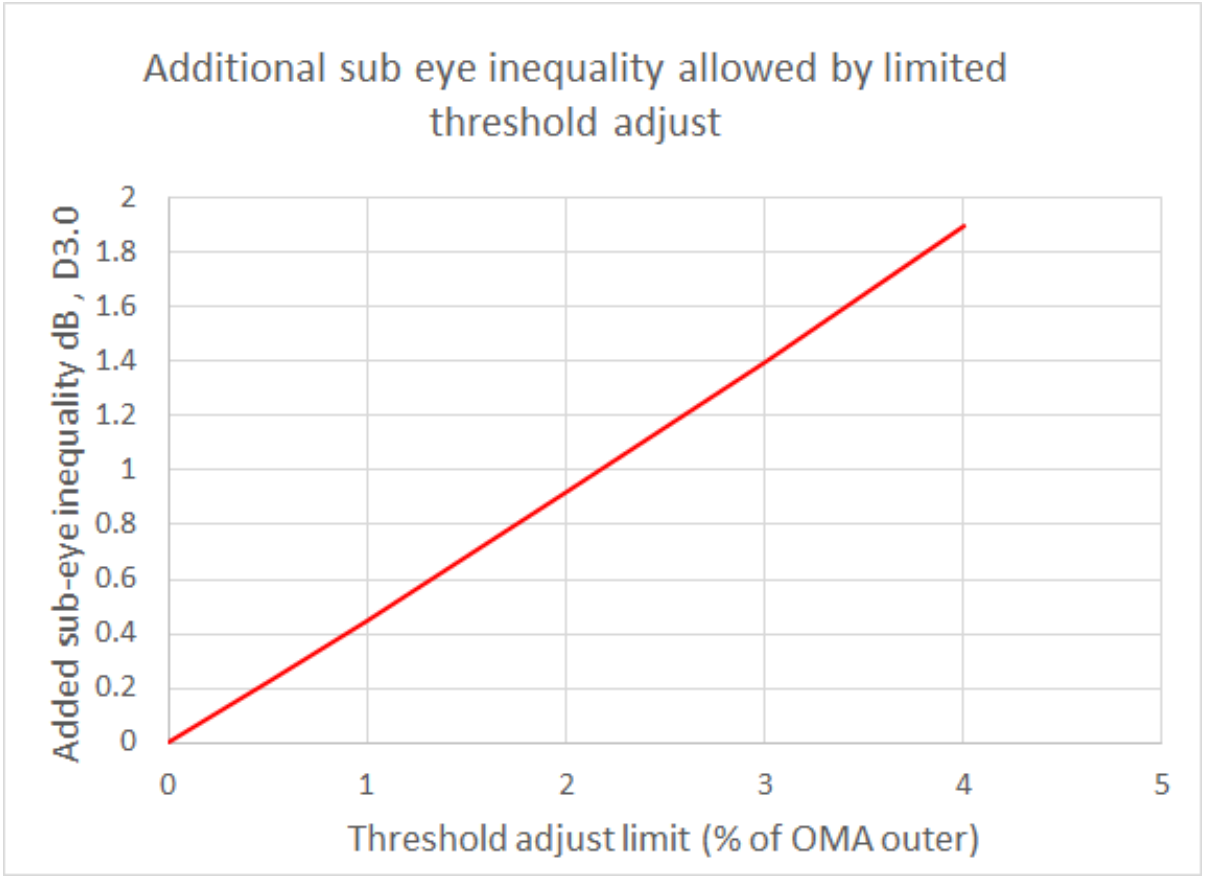






Impact of TDECQ threshold adjustment on allowed sub-eye inequality

- Limited threshold adjustment significantly increases the allowed sub-eye inequality



Concluding notes

- Don’t add threshold adjustment to TDECQ unless due diligence is completed satisfactorily:
  - 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.