TDECQ changes and consequent spec limits

802.3bs SMF ad hoc, 13th June 2017

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With data from Marco Mazzini, Cisco

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Intro: Link budget, OMA_{outer} and TDECQ

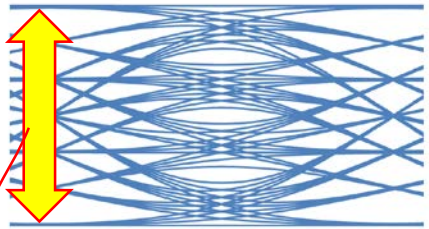
- Power budget (Tx output minus Rx stressed sensitivity) written in terms of OMA_{outer}
- TDECQ connects OMA_{outer} specs and transmitter and dispersion penalties to ensure that the OMA link budget closes
- SECQ (used to calibrate the SRS test source) is the same basic measurement as TDECQ but without the worst case channel
- Connects expected transmitter performance over a worst case channel to the stressed receiver sensitivity test

Changes to TDECQ in 802.3bs draft 3.2

- Reference EQ replaced with 5 tap T spaced FFE and a lower (~Nyquist) bandwidth reference receiver
  - More representative of expected 50Gb/s and 100Gb/s PAM4 receivers with digital EQ implementations
  - The lower bandwidth reference receiver can be thought of as anti-aliasing filter
    - It filters high frequency noise and signal components which are not addressable with a T spaced EQ
  - Precise roll off is not important (see Keysight analysis)
- The changes to TDECQ introduced in draft 3.2 will increase TDECQ values (~0.9 dB) for the same transmitter waveforms. This should be accommodated by:
  - an appropriate increase of TDECQ and SECQ specs for each PMD
  - a similar decrease in the OMA_{outer} minus TDECQ spec
    - so that min Tx OMA_{outer} at max TDECQ is the same as draft 3.1
  - no changes to the OMA_{outer} spec for SRS testing or other normative specs

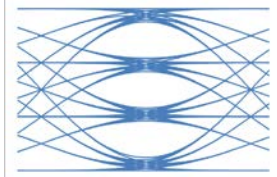
TDECQ old TDECQ new

Just compliant
Tx waveform

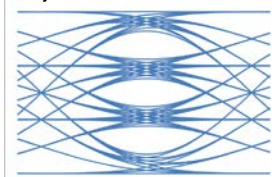


Tx OMA_{outer}

Equalized eye
5xT/2, 0.75xBaud rate



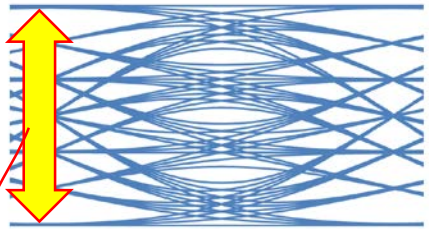
Equalized eye
5xT, 0.5xBaud rate



Changing the TDECQ methodology doesn't change the transmitter characteristics, it's the same transmitter.

TDECQ old TDECQ new

Just compliant
Tx waveform



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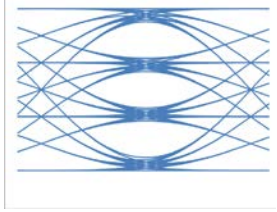

Equalized eye
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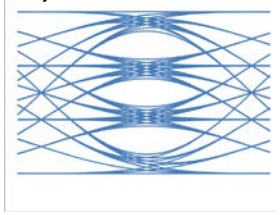


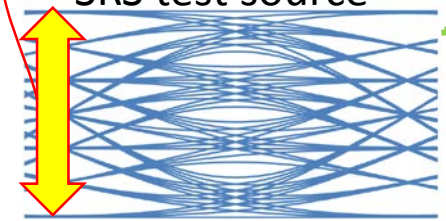
Tx OMA_{outer}

Changing the TDECQ methodology doesn't change the transmitter characteristics, it's the same transmitter.

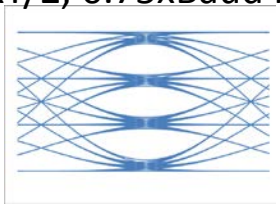
*The change to SECQ doesn't change the stress applied to the SRS test source, but the applied stress is **measured** as larger for the D3.2 SECQ.*

SRS OMA_{outer}

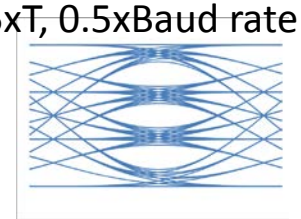
SRS test source



Calibrated SRS test eye
5xT/2, 0.75xBaud rate

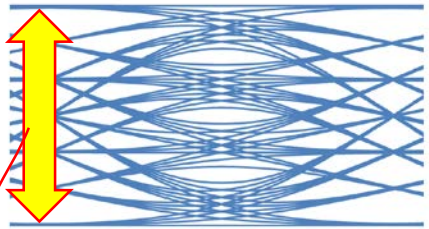


Calibrated SRS test eye
5xT, 0.5xBaud rate



TDECQ old TDECQ new

Just compliant
Tx waveform



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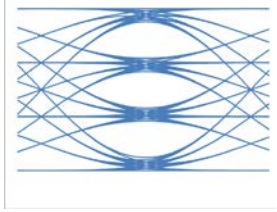

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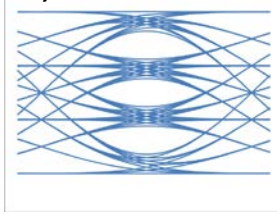


Tx OMA_{outer}

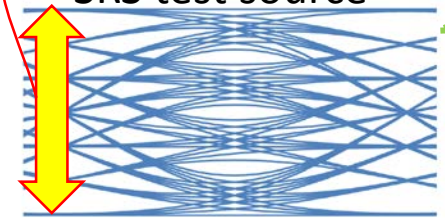
Changing the TDECQ methodology doesn't change the transmitter characteristics, it's the same transmitter.

The change to SECQ doesn't change the stress applied to the SRS test source, but the applied stress is measured as larger for the D3.2 SECQ.

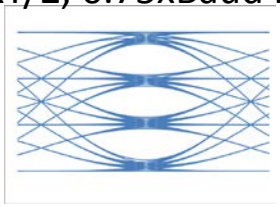
A specific receiver implementation isn't changed by the D3.2 SECQ - it's still the same receiver. If it could equalize and close the link with the SRS test source calibrated with D3.1 SECQ, it will still close link with D3.2 SECQ, without needing to change the input OMA to the receiver.

SRS OMA_{outer}

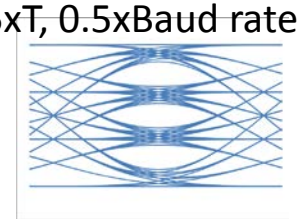
SRS test source

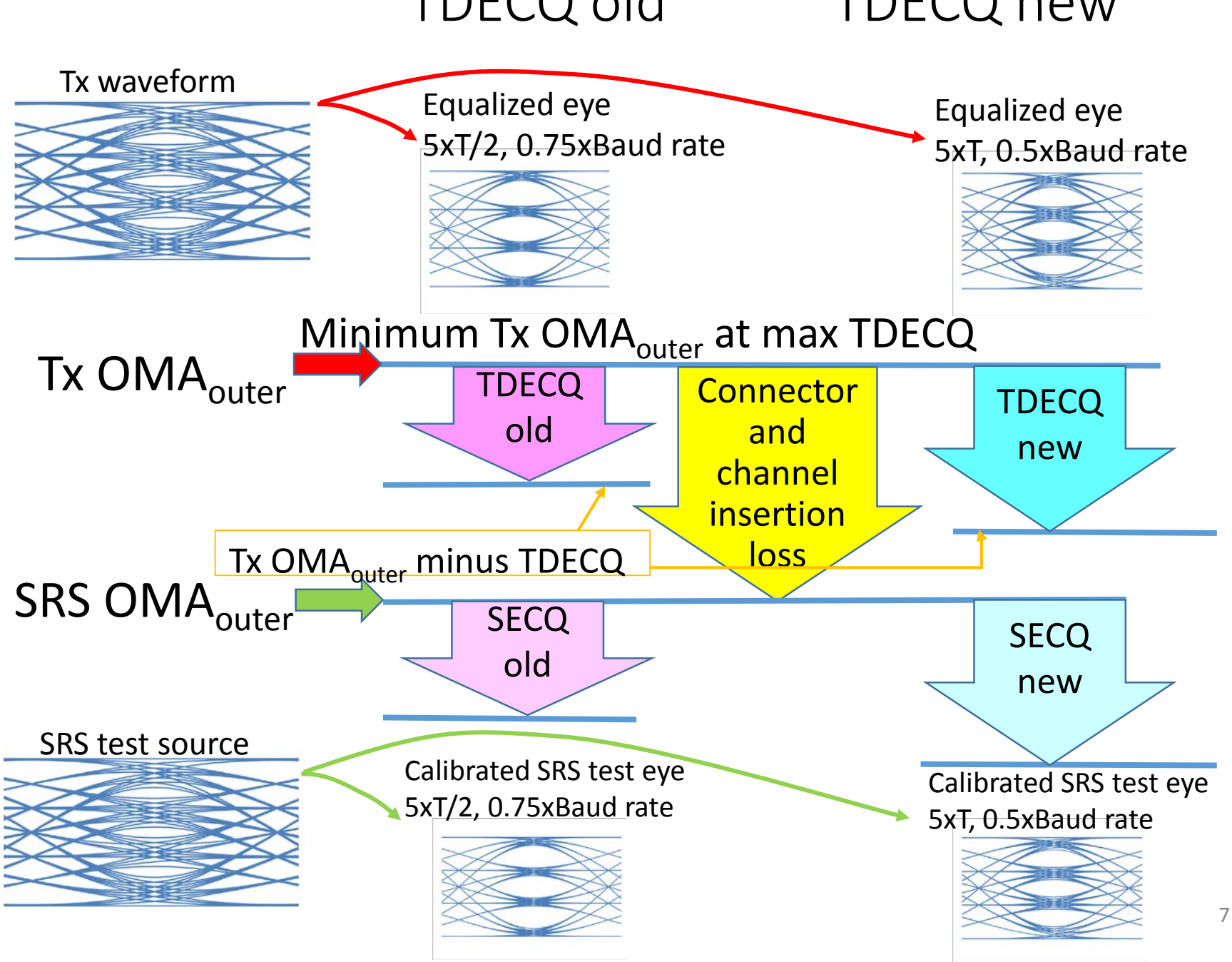


Calibrated SRS test eye
5xT/2, 0.75xBaud rate



Calibrated SRS test eye
5xT, 0.5xBaud rate




TDECQ old
TDECQ new
Tx waveform
Equalized eye
5xT/2, 0.75xBaud rate
Equalized eye
5xT, 0.5xBaud rate
Minimum Tx OMAouter at max TDECQ
Tx OMAouter
TDECQ old
Connector and channel insertion loss
TDECQ new
Tx OMAouter minus TDECQ
SRS OMAouter
SECQ old
SECQ new
SRS test source
Calibrated SRS test eye
5xT/2, 0.75xBaud rate
Calibrated SRS test eye
5xT, 0.5xBaud rate

Why no change to the SRS OMA test limit?

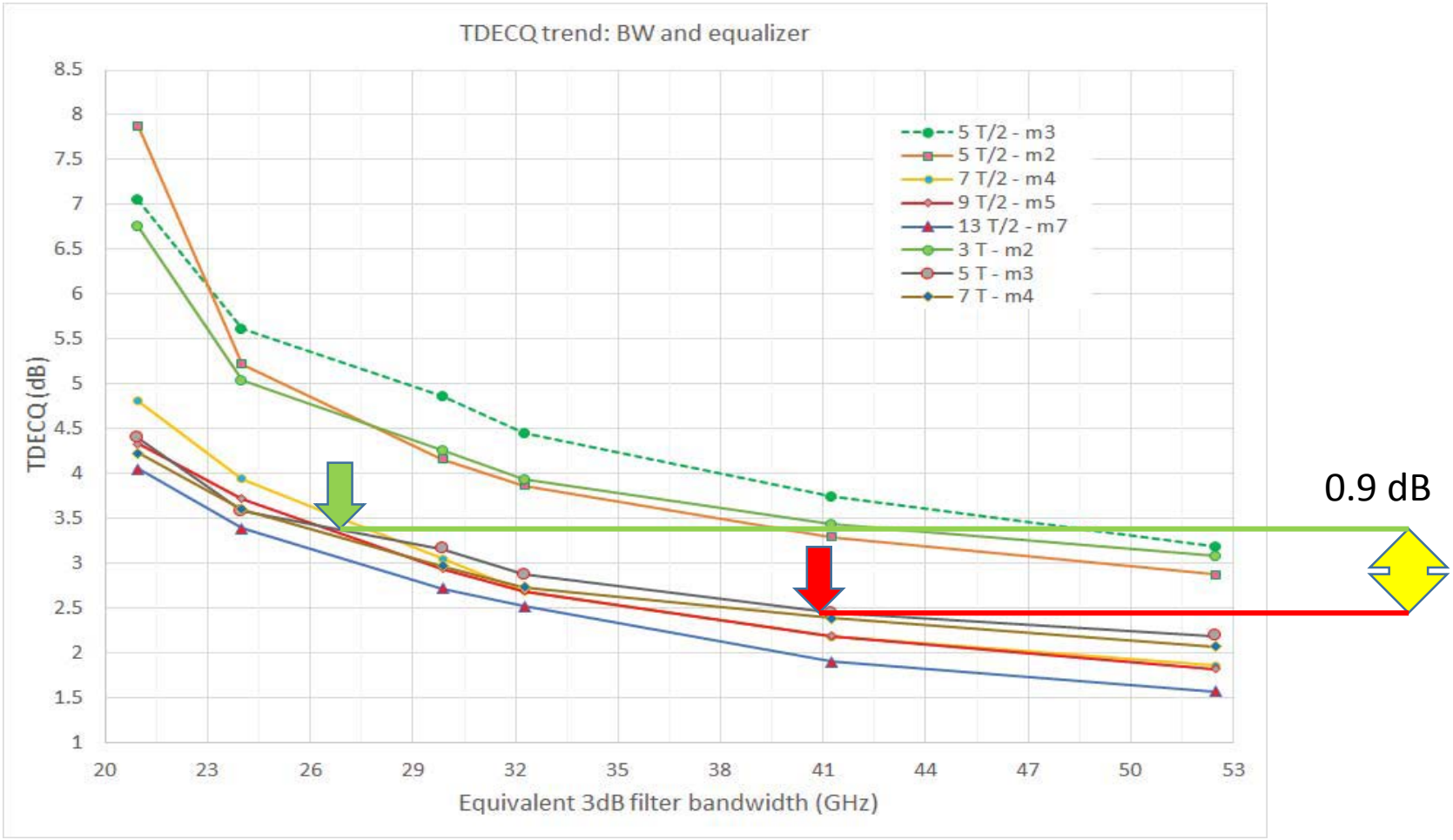
- Changing the TDECQ methodology doesn't change the transmitter characteristics, it's the same transmitter, but the penalty is *measured* as larger.
- Likewise, the change in SECQ wouldn't change the stress applied to the SRS test source, but the applied stress would be *measured* as larger for the D3.2 version of SECQ.
- And finally a specific receiver implementation isn't changed by the D3.2 SECQ - it's still the same receiver. If it could equalize and close the link with the SRS test source with D3.1 SECQ , it will still close link with D3.2 SECQ, without needing to change the input OMA to the receiver.

Summary

- The change to EQ and reference Rx bandwidth for TDECQ will increase TDECQ values (~0.9 dB) for the same transmitters.
- This should be accommodated by:
  - an increase of TDECQ and SECQ specs for each PMD
  - a similar decrease in the OMA_{outer} minus TDECQ spec
    - so that min Tx OMA_{outer} at max TDECQ is the same as draft 3.1
  - no changes to the OMA_{outer} spec for SRS test or other normative specs

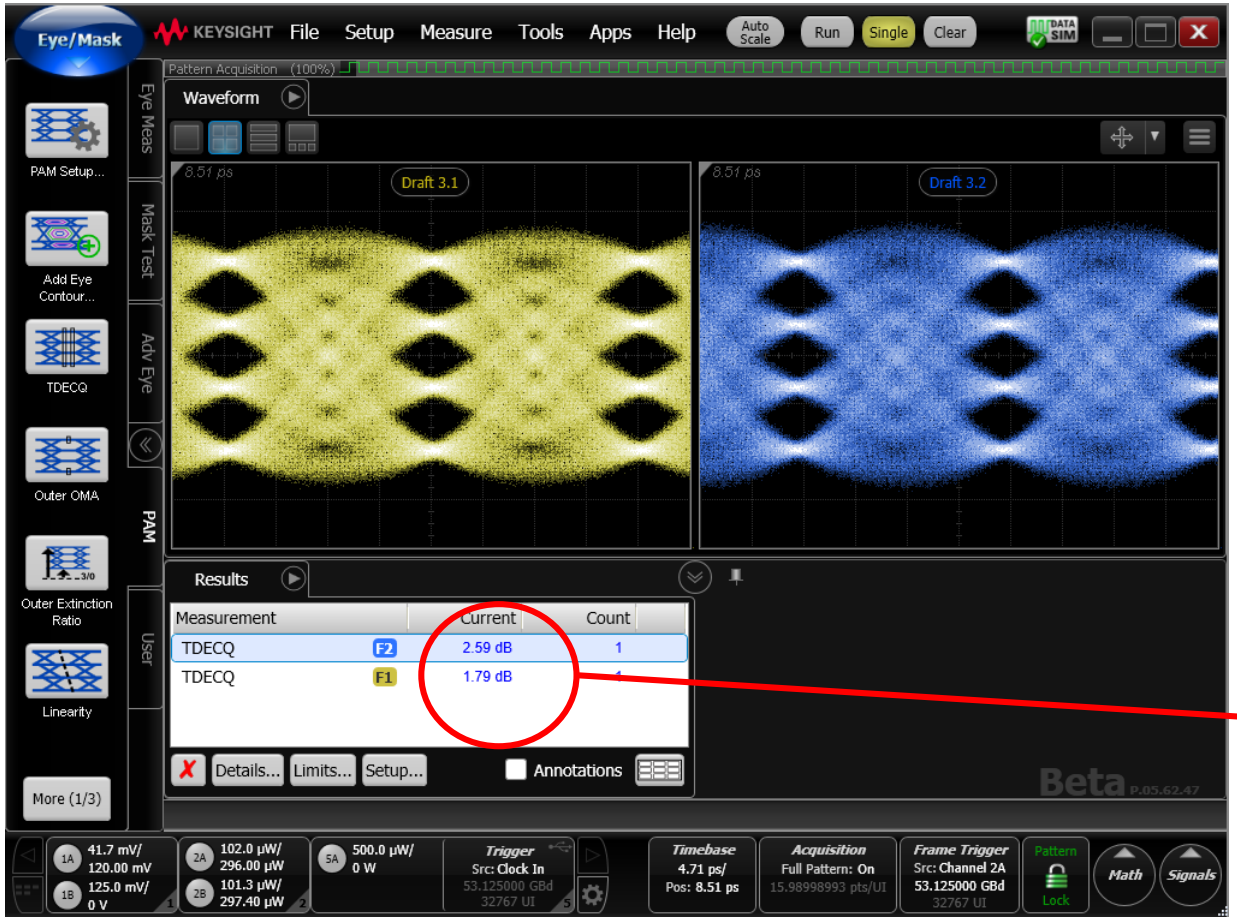
Back up

TDECQ plots from Mazzini_01a_0517_smf



Example simulated waveforms from Keysight

Result of simulated waveforms with a modest amount of ISI and RIN included. The increase of TDECQ from draft 3.1 to draft 3.2 is about 0.8 dB for this configuration.



0.8 dB difference

BER plots from Mazzini_01a_0517_smf