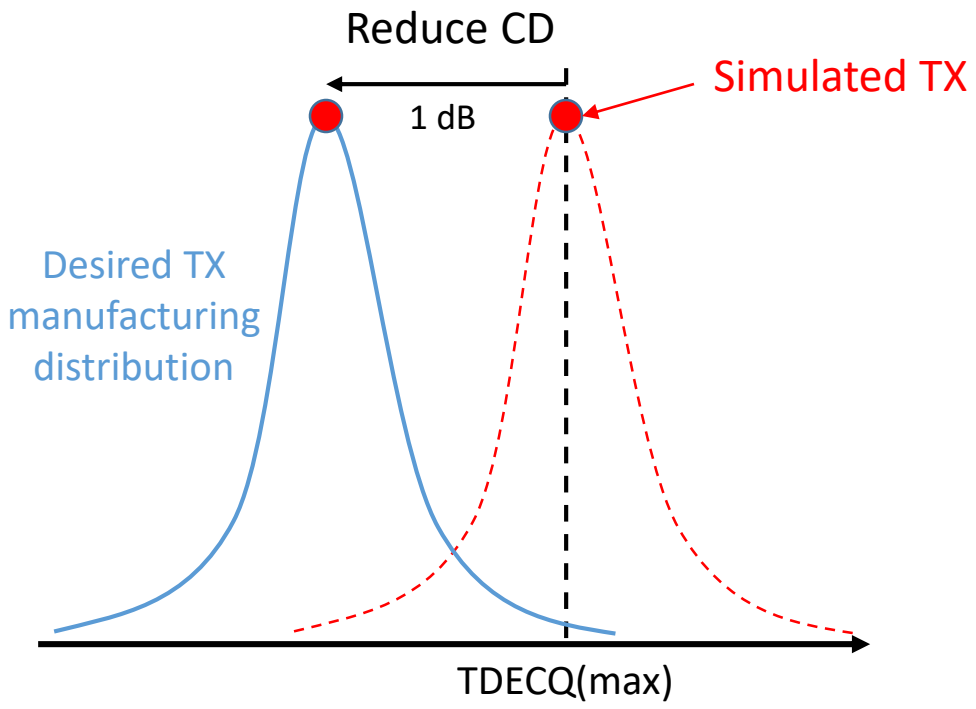
Estimating chromatic dispersion tolerance

John Johnson, Broadcom

Introduction

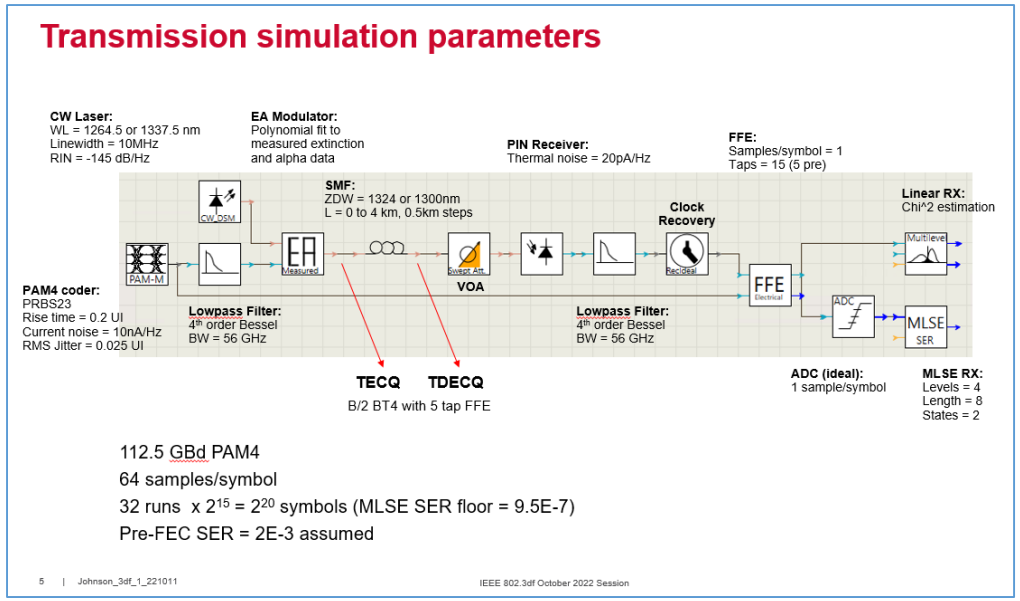
- The question has been asked: What CD specs are needed in order for 200G/L FR4 and LR4 modules to be economically feasible?
- This is a difficult way to ask the question, since the answer has many components:
  - Intrinsic technology capability (idealized simulation)
  - Practically achievable technology capability (proprietary data)
  - Manufacturing cost structure and profitability (can't go here!)
- Given the shortage of experimental data, a new approach is needed.
- One such approach is assume that simulated TX performance (with typical TX parameters) at TDECQ spec limit represents a median module's CD capability.
- The median TDECQ in manufacturing needs to be ~1 dB below the spec limit to account for manufacturing and test variation.
- The CD limits needed to meet the reduced TDECQ specs are an estimate of what is needed make FR4/LR4 TX manufacturable in practice.
- This is not a baseline CD proposal, just a method that may be used.

Analysis method



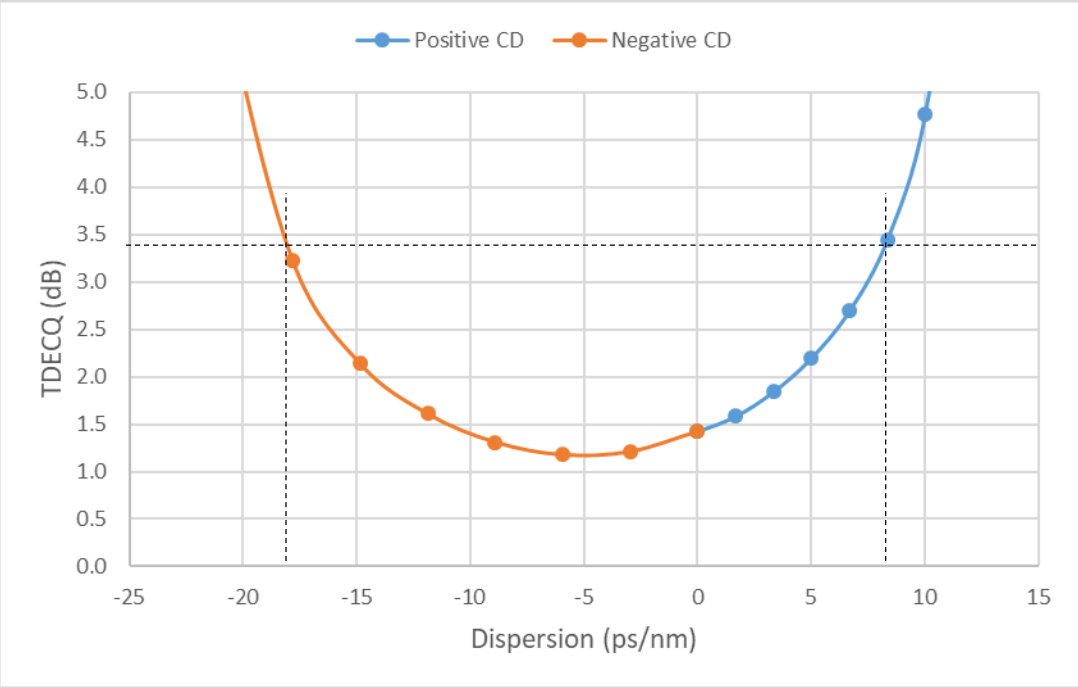
- Assume that the simulation at CD resulting in TDECQ(max) represents the capability of the median TX at the compliance limit
- Assume the median TDECQ in manufacturing needs to be 1 dB lower for economic feasibility
- Reduce the CD limits so that the simulated median TX has 1dB reduction in TDECQ
- The reduced CD limits represent the desired optical channel CD specs for high TX yield

EML transmission simulations



- The results used for this analysis were originally presented in Johnson_3df_1a_221011.
  - Symbol rate = 112.5 GBd
  - Target SER = 2E-3
  - TDECQ 15-tap FFE
  - TX/RX -3dB BW = 56 GHz (BT4 lowpass)
  - EML TX chirp = 0.6 at bias point
  - TX RINc = -145 dB/Hz
  - TX jitter = 0.025 U.I.
- This study predated consensus on inner FEC, but the conclusions will not change substantially at 113.4375 GBd and 4E-3 target SER

Simulated TDECQ vs. dispersion



Worst case G.652 CD limits	CD(min) (ps/nm)	CD(max) (ps/nm)
800G-FR4: 1264.5-1337.5nm	-11.9	6.7
800G-LR4: 1294.5-1310.2nm	-28.3	9.4

TDECQ (dB)	CD(min) (ps/nm)	CD(max) (ps/nm)
3.9	-19.3	9.2
3.4	-18.5	8.4
2.9	-17.6	7.4
2.4	-16.4	5.6
1.9	-14.5	3.4

1 dB reduction in median TDECQ needs ~ 2 ps/nm reduction from the original CD values.

- Use TDECQ(max) = 3.4 dB for FR4 (TBD in D1.0), and 3.9 dB for LR4 (per D1.0).
- CD tolerance for the “ideal” median TX at TDECQ(max) is -18.5 to +8.4 ps/nm for FR4 and -19.3 to +9.2 ps/nm for LR4.

- The FR4 CD range would need to be reduced to -16.4 to +5.6 ps/nm for 1 dB guardband to TDECQ(max).
- The LR4 CD range would need to be reduced to -17.6 to +7.4 ps/nm for 1 dB guardband to TDECQ(max).

Conclusions

- This analysis shows one method to estimate the CD limits required for manufacturable FR4 and LR4 modules.
  - Assume that the simulation at CD resulting in TDECQ(max) represents the capability of the median TX at the compliance limit
  - Assume the median TDECQ in manufacturing needs to be 1 dB lower for economic feasibility. Other assumptions are possible.
  - The resulting CD limits must be reduced by ~ 2 ps/nm on each side for 1dB reduction in TDECQ
- This analysis only addresses the TX capability. A similar analysis could be done for the RX using the sensitivity at TDECQ(max) or other metric.
  - The desired CD range would be the intersection of the TX and RX limited ranges.

Thank You