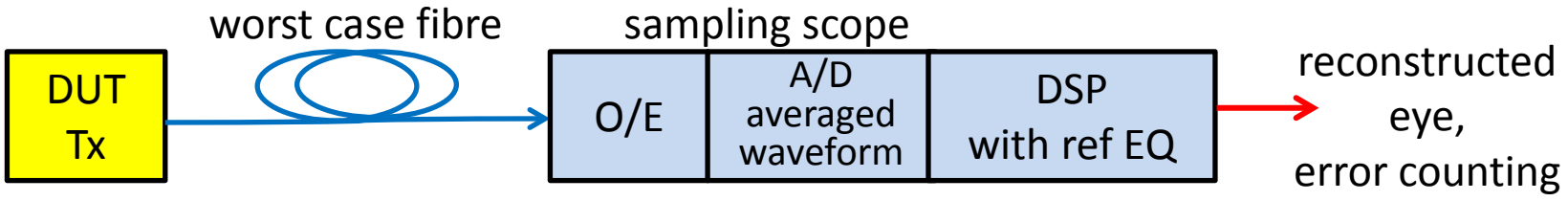
PAM4 TDEC straw-man conceptual proposal

Updated following review and 1st Dec 2015 SMF ad hoc call

Jonathan King

A straw-man conceptual proposal for PAM4 TDEC



- Measure noise of transmitter (each level?) in ref. bandwidth (0.75 x symbol rate TBC)
  - …and measure noise of transmitter (each level?) in half ref. bandwidth? (TBC)
    - might allow some accounting for spectrum of Tx noise
- Measure noise of scope in same bandwidth(s) used for Tx noise measurement(s) (TBC).
- Capture transmitter waveform, averaged pattern ($<2^{16}$) bits (e.g. PRBS13Q TBC?)
  - Ideally allow both real time or sampling scope to be used.
- Add equivalent Tx noise to averaged waveform (method TBD)
  - Assume flat noise spectrum up to symbol rate, add noise to account for ref Rx sensitivity (TBC)
- Optimize equalizer (5 tap T/2 spaced FFE; optimized with LMS/matrix inversion, TBD)
- Reconstruct eye diagram
- Determine error-ratio of reconstructed eye
  - Determine how much Rx noise can be increased and just meet required error ratio (like TDEC)
    - Compare to ideal PAM4 eye with same OMA.
  - Measure symbol error ratio at +/- 0.05 UI timing points (TBC), not across whole width of eye.
  - Assume optimized thresholds for each eye. Use same timing point for each eye.

Discussion items during 1st Dec 2015 SMF ad hoc

- Pattern
  - PRBS13Q ?
  - [*Added to capture discussion after Jonathan left:*] PRBS13Q is much less stressful than long periods of traffic or idle. A short stress pattern designed for PAM4 would be a much better choice.
- Impact of jitter
  - We need input from CDR makers on timing window requirements
- Thresholds
  - Do we optimize threshold for each eye ? or use equal spaced thresholds ?
    - Fixed thresholds would be: AC mean, and AC mean plus and minus OMA/3
    - ISI will cause optimum thresholds to move
    - Electrical track expect thresholds to be adaptive
    - Most people on call said 'adaptive'
  - Linearity test/constraint ?
  - Relative eye opening test/constraint (RLM) ?
- Reference EQ (length/complexity is TBD)
  - May be a different ref EQ for 50Gb/s and 100Gb/s – clause dependent

Received e-mail comments

- Pattern – preference was expressed for using same pattern (eg PRBS13Q) for averaged waveform and for noise measurements
  - Is PRBS13Q the right test pattern ? Are there occurrences of each modulation level wide enough to measure noise ?
- If measuring Tx noise then measure scope noise in same bandwidth(s)
- Choice of EQ: 5 tap T/2 FFE or 9 tap T/2, or something else ?
  - Clause dependent
- Measure Hit ratio, or BER, or symbol error ratio at given threshold
  - (eg threshold and timing point(s), to which increasing noise can be added, to calculate a penalty for an ideal Rx for ideal vs DUT Tx)
- Additional specs on level separation mismatch ratio (RLM), and/or eye linearity ?
- Same timing point for each eye seems realistic.