Additional PAM4 transmitter constraints
(comments 52, 54, 57, 59, 27)

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Introduction

- Several comments against earlier drafts have expressed concern that TDECQ alone does not sufficiently constrain transmitter characteristics, and that SECQ alone allows too broad range of test sources for SRS testing.
  - Concerns are outlined in (for example)
    - *http://ieee802.org/3/cd/public/adhoc/archive/dawe_041818_3cd_adhoc-v2.pdf*
    - *http://www.ieee802.org/3/cd/public/Jan18/schube_3cd_01a_0118.pdf*
    - *Comments against D3.2: 52, 54, 57, 59, 27*
- There is some support for excluding very slow transmitters and very noisy transmitters
  - Exclude very slow transmitters to ensure that the range of permitted transmitters is compatible with low power equalizers and to ease interoperability
  - Change SRS definitions to exclude very noisy SRS test sources, to reflect the range of compliant transmitters
- Two changes to the draft optical clauses are proposed here:
  - Add maximum rise fall time spec
  - Add an exception to the SRS description that limits it's RIN to same value as the transmitter, and a RIN spec for MMF

Transmitter transition time spec

- Avoids specifying an indirect characteristic such as EQ tap weights
- Allows simple, practical measurements at sub-component level which directly relate to the spec

- For a Nyquist bandwidth Tx, with ideal raised cosine response Tx
  - $T_{10\text{-}90}$ ~ 0.75 UI out of the transmitter
    - When seen through a Nyquist bandwidth receiver this becomes ~1 UI
    - This class of transmitter should not be ruled out
- Simulations in dawe_051618_3cd_adhoc.pdf
  - proposes a limit of 27 to 30 ps for 26.5625 GBaud

- Proposal:
  - For SMF PMDs specify max $T_{20\text{-}80}$ = 0.8 UI (or equivalent ps value ?)
  - For 50 Gb/s MMF PMDs specify max $T_{20\text{-}80}$ = 0.9 UI (or equivalent ps value ?)

SRS changes

- The draft 3.2 definition of the SRS test source allows up to half of the SECQ to be produced by added Gaussian noise.
- This may result in a SRS test source which has a much higher RIN than the specifications allow for a PAM4 transmitter – this is not a realistic test of receiver performance, as described in
  - *http://www.ieee802.org/3/cd/public/Jan18/schube_3cd_01a_0118.pdf*
- Proposal: to limit the amount of added Gaussian noise such that the RIN of the SRS test source is no greater than the RIN allowed by the transmitter specs
  - For clause 138, a RIN_{12}OMA spec would be needed

Specific changes to 802.3cd

Changes needed to introduce transition time spec

- For 138, 139, 140
- Add sub-clause for definition of transmitter transition time
- Add transition time spec to transmitter characteristics
- Add PAM4 square wave test pattern for transmitter transition time

Possible transition time definition for 802.3cd

- New sub-clause after 138.8.6, for example

138.8.7 Transmitter transition time

The transmitter transition time of each lane shall be within the limits given in Table 138–8 if measured using the test pattern specified for transmitter transition time in Table 138–12.

Transmitter transition time (rise and fall times) is defined as the slowest of the time interval of the transition between 20% of OMA_{outer} to 80% of OMA_{outer}, or 80% of OMA_{outer} to 20% of OMA_{outer}, of the rising and falling edges respectively, as measured through an optical to electrical converter (O/E) and oscilloscope with a combined frequency response of a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 13.28125 GHz. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

The 0% level and the 100% level are as defined by the OMA_{outer} measurement procedure (138.8.4).

Changes needed to introduce noise limit for SRS

- Add RIN spec to transmit characteristics in clause 138
- Add test pattern for RIN to clause 138, 139, 140
- Either
  - Add an exception to Stressed Receiver Sensitivity sub-clause (e.g. 138.8.8), e.g.
    - With the sinusoidal jitter and sinusoidal interferer turned off, the RIN_OMA max of the SRS test source should be no greater than the RIN_{12}OMA specified for the transmit characteristics in Table 139-8.

  or

  - Add a RIN_OMA spec under ‘Conditions of SRS test’ in Table 138-9, and add a sentence to refer to the RIN_OMA spec for the SRS test source in the appropriate sub-clause

Back up

Example of transition time spec in 802.3

86A.5.3.3 Transition time

In this annex, transition times (rise and fall times) are defined as the time between the 20% and 80% times, or 80% and 20% times, respectively, of isolated edges.

If the test pattern is the square wave with eight ones and eight zeros, the 0% level and the 100% level are as defined by the OMA measurement procedure (see 68.6.2).

If the test pattern is PRBS9, the transitions within sequences of five zeros and four ones, and nine ones and five zeros, respectively, are measured. These are bits 10 to 18 and 1 to 14, respectively, where bits 1 to 9 are the run of nine zeros. In this case, the 0% level and the 100% level may be estimated as ZeroLevel and ZeroLevel + MeasuredOMA in the TWDP code (see 68.6.6.2), or by the average signal within windows from –3 UI to –2 UI and from 2 UI to 3 UI relative to the edge.

For electrical signals, the waveform is observed through a 12 GHz low-pass filter response (such as a Bessel-Thomson response).

NOTE—This definition is not the same as the rise and fall times typically reported by an oscilloscope from an eye diagram, which take all the edges into account.