Proposed changes to SNR_TX and SNDR

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(supplement to comment I-53)

Abstract

- Commnet I-53
- The issue of equalization effect SNDR and SNR_{TX} was explored further in January 12 ad hoc presentation (ran_3ck_01_0122).
  - Thanks to Mau-Lin Wu, Rich Mellitz and Liav Ben-Artsi for their contributions.
- Following feedback in/after the ad-hoc call, this is a refined proposal.
  - Thanks to everyone who provided feedback.

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The definition of SNDR refers back to 120D which does not state what the Tx equalization should be in this measurement. Based on a previous specification in clause 92, it may be understood that the limit in Table 162–10 applies to any valid equalization setting.

Since transmitters typically have noise sources that are independent of equalization, and applying equalization reduces the pulse peak, it is expected that increasing the "strength" of Tx equalization would degrade the measured SNDR. We can assume equalization settings with c(0) close to 0.5, which would reduce the measured pulse peak by 5-6 dB; this makes the SNDR spec more difficult than it seems.

A related concern is that the noise injected in the receiver ITT is also after Tx equalization (like realistic transmitters), and it is calibrated by measuring SNDR and using the results as TX_SNR. However, TX_SNR in COM represents a white noise source _before_ the Tx equalization, since it should have the same spectrum as the victim signal.

There seems to be a mismatch between the effect of TX_SNR in COM and the effect of SNDR in real links.

This may also affect SNDR and/or SNR_TX in clause 163 and annex 120F, although the receiver test signal is calibrated differently.

SuggestedRemedy

The definition of SNDR and/or the calculation of the effect of SNR_Tx in COM may need to be changed.

A detailed presentation is planned.

Proposal (part 1)

To better account for transmitter noise introduced after equalization (σ_2):

1. For calculation of channel COM, the following Equation replaces 93A-30 (with editorial license to prevent the change from affecting previously defined clauses and annexes):

$$\sigma_{TX}^2 = \left[\frac{h^{(0)}(t_s)}{c(0)}\right]^2 10^{-\frac{SNR_{TX}}{10}}$$

   where $c(0)$ is the Tx equalizer coefficient used in the evaluation of $h^{(0)}$ (see equation 93A–21).

2. Change the definition of SNDR (Tx measured specification) in 162.9.3.3 to account for the effect of equalization on p_{max} (to match the definition above). The following equation replaces Equation 120D-7:

$$SNDR = 10\log_{10}\frac{\left(p_{max}/c(0)\right)^2}{\sigma_e^2 + \sigma_n^2}$$

   where $c(0)$ is the calculated coefficient in the linear pulse fit of the measurement (equation 162–2) from which SNDR is calculated.

   (if the measurement is done with equalization off, the equation becomes equivalent to 120D-7)

3. SNDR is defined as the maximum value across Tx equalization settings.

   (measurement with all possible settings is not feasible)

Proposal (part 2)

To prevent degradation of COM for previously analyzed channels:

1. Change SNR_{TX}
   - In Table 162–19, change the value of SNR_{TX} from 32.5 dB to 36.9 dB.
   - In Table 163–11 and Table 120F–8, change the value of SNR_{TX} from 33 dB to 37.4 dB.

   (4.4 dB increase correspond to an assumed minimum c(0) value of 0.6)
2. Change SNDR (min) specification to follow the change in SNR_{TX}.
   - In Table 162–10, change the value of SNDR (min) from 31.5 dB to 35.9 dB.
   - In Table 163–5 and Table 120F–1, change the value of SNDR (min) from 32.5 dB to 36.9 dB.

   (the tightening of the limit is partially offset by the change in the definition of SNDR in the previous slide, which will improve measured results)

Editorial license to be provided for implementing all of the above in a clean way.