Reducing TDECQ Overshoot

(Comments 252, 253, 254, 255)

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IEEE 802.3dj Plenary Meeting

Bangkok

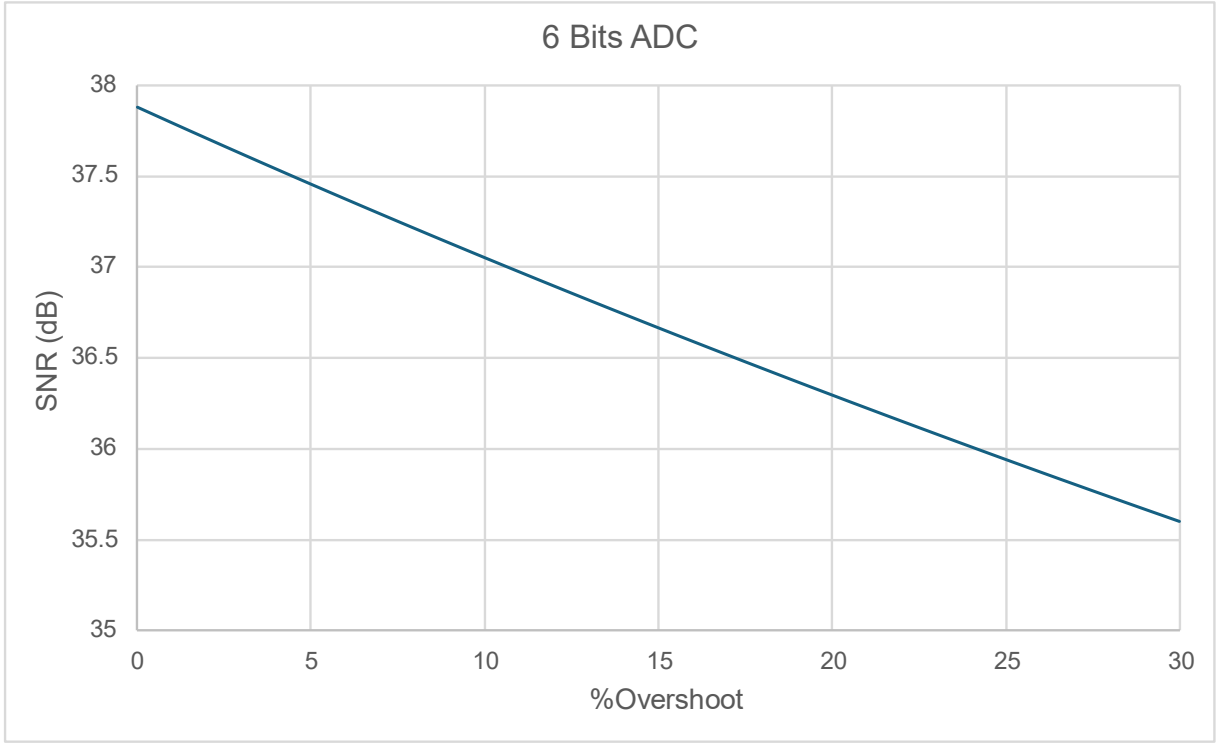
November 10, 2025

Background

- **The 802.3dj TF has been investigating how to improve optical transmitter test coverage, see ghiasi_3dj_03c_2507**
  - Task force since then has supplemented TDECQ test with following enhancements
    - Added tap limit to mitigate reported block errors issue
    - Added DFE to reduce reliance on overshoot where transmitter with less overshoot and higher TDECQ may have better BER
  - With addition of DFE to TDECQ a typical 4.7 dB FFE TDECQ transmitter has ~3.4 dB TDECQ with DFE enabled, see ghiasi_3dj_01a_2509
  - TDECQ having DFE there is less of a need using overshoot to reduce TDECQ
    - However, underlaying problem still exist if one uses the allowed max overshoot of 22% and may result in PAR (Peak to Average Ratio) and ADC clipping without TDECQ accounting for this penalty
    - Functional Receiver FRx may not identify PAR related in few seconds test and there is dependability on the FRx DSP
  - Issues with excessive overshoot were studied by rodes_3cu_adhoc_030520_v2 and ghiasi_802.3db_01_092321.

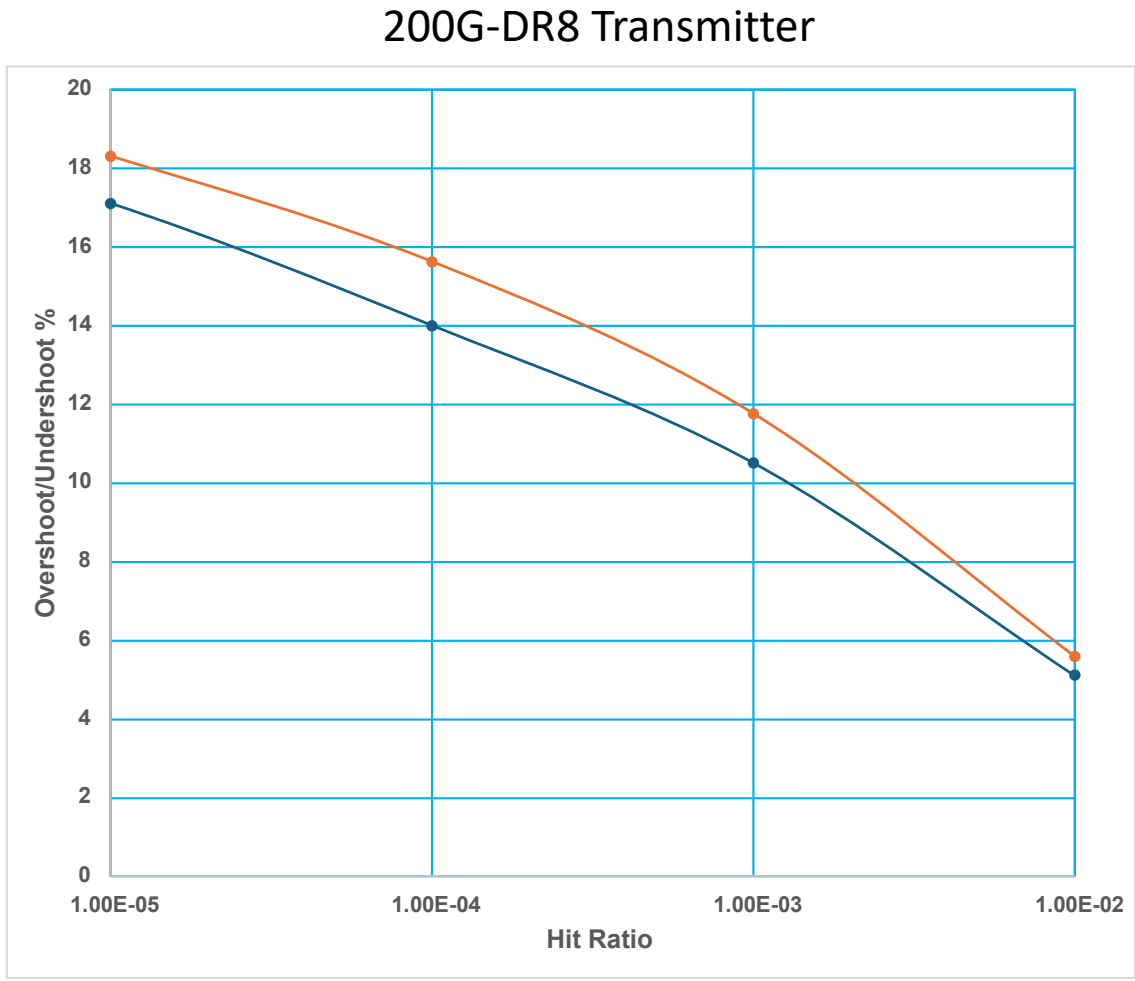
ADC SNR Definition and PAR Penalty

- **ADC SNR is defined as following in textbooks wirelesspi.com**
  - $SNR = 6.02N + 1.76 - 20log_{10}\frac{Vmax}{A}$, where N is number of ADC bits, Vmax upper range of ADC, and A is the amplitude.
    - A 6 bits ADC with zero overshoot has an SNR of 37.88 dB
    - A 6 bits ADC with 22% overshoot has an SNR of 36.15 dB or 1.7 dB of PAR (Peak to Average Ratio) penalty
  - Reducing overshoot to 12% reduces PAR penalty to 1 dB which is a good trade-off for a TDECQ with 1T DFE.



Over/under-shoot Definition

- **Over/under-shoot is defined at 10^{-2} hit ratio and maximum limit of 22%**
  - PAR penalty and ADC clipping may manifest itself at the extreme of scramblers and can be infrequently
  - Even for SSPRQ moderate size pattern (65,535 bits) overshoot triples from ~5% at hit ratio of 10^{-2} to ~15% at hit ratio of 10^{-4}
    - A typical transmitter with 15%, 20%, or 22% overshoot at 10^{-2} hit ratio can be problematic!



Summary

- **As part of effort to improve interoperability and reducing link flaps better management of overshoot/undershoot is needed**
  - Comment 261, 262, 263, and 264 recommend reducing overshoot from 22% to 12%
    - Generally 10% sufficient for DR/FR optics but one supplier does use up to ~16% for EMLs optimized for LR4 links
  - Other option that can be considered are:
    - Increase hit ratio to 10-3
    - Reduce Overshoot for all IMDD PMDs to 12% except LR4
    - Reduce Overshoot for all IMDD PMDs to 12% except LR4 and for LR4 enable Presets
    - Incorporate Peak to Average penalty into TDECQ at least at first order assuming ADC ENOB of 6 bits.

Thank You!