Update on Overshoot Spec

Presentation is in support of comment #32 and 33 against 802.3cu Draft2.1

Roberto Rodes, II-VI

Greg D Le Cheminant, Keysight

Vipul Bhatt, II-VI

Background

- 802.3cu draft 2.0 introduced an overshoot transmitter spec to protect receivers from harmful transmitters. A spec limit based on minimal data, without a specific definition or measurement method was added to the draft
- At the March 17 interim meeting, we proposed an overshoot limit based on data presented in rodes_3cu_01a_031720. The Task Force voted in favor of using the overshoot limit
- After discussion with experts, the overshoot definition was changed from that used for the original analysis presented in rodes_3cu_01_032420
- Despite the change in definition, the spec limit was not updated, since more analysis had to be done to evaluate and correlate the new methodology to real device performance
- Some concerns were raised during the March 24th presentation:
  - Measurements made based on the draft 2.1 definition are dependent on sample size and observation time. The longer you observe, the higher the overshoot value becomes
  - The overshoot result is impacted by instrumentation noise, with accuracy degraded when observing small signals

In this presentation we look into:

- ❑Methodology changes to address draft 2.1 concerns: Introduce a ‘hit ratio’ based measurement
- ❑Robustness of prototyped method
- ❑Hit ratio considerations based on data
- ❑Proposed overshoot spec value based on the updated methodology

Overshoot/Undershoot Measurement methodology

Original Rodes overshoot analysis performed on a square-wave pattern

- ❑Square wave considered to allow use of common oscilloscope capability.
- ❑A benign pattern yielding lower overshoot performance that does not represent system level performance
- ❑Requires a second waveform acquisition for compliance test (inefficient)

Draft 2.1 requires SSPRQ pattern and can be performed on an eye diagram

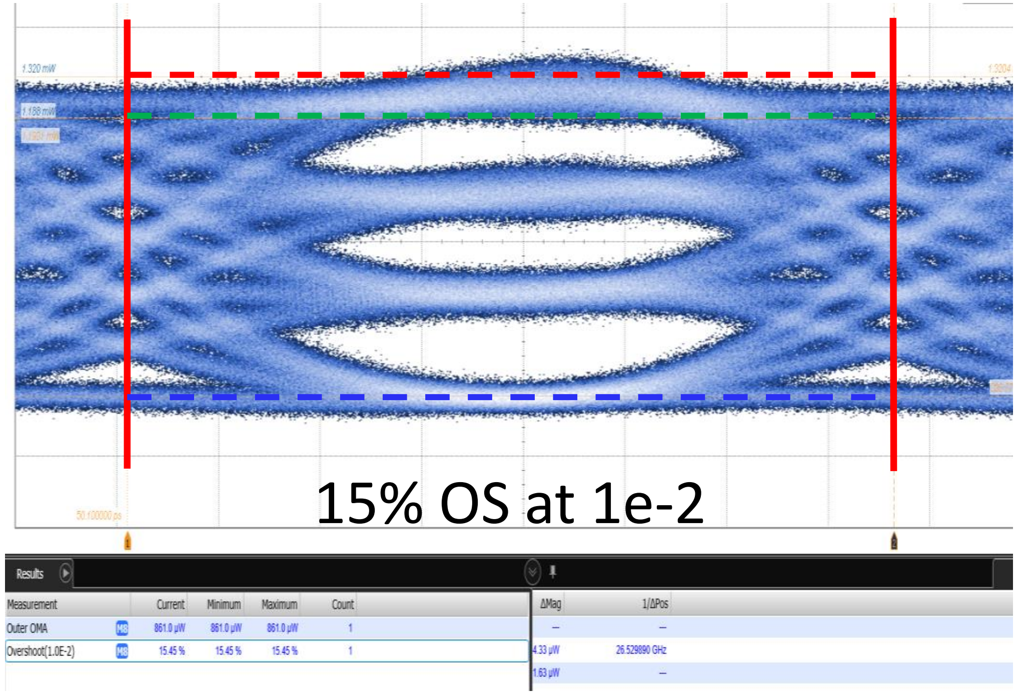
- ❑Compatible with TDECQ testing. Uses same waveform, prior to TDECQ equalization (no added test time)

Measurement method used here has been adapted to include a hit ratio strategy, similar to that used in NRZ eye mask testing

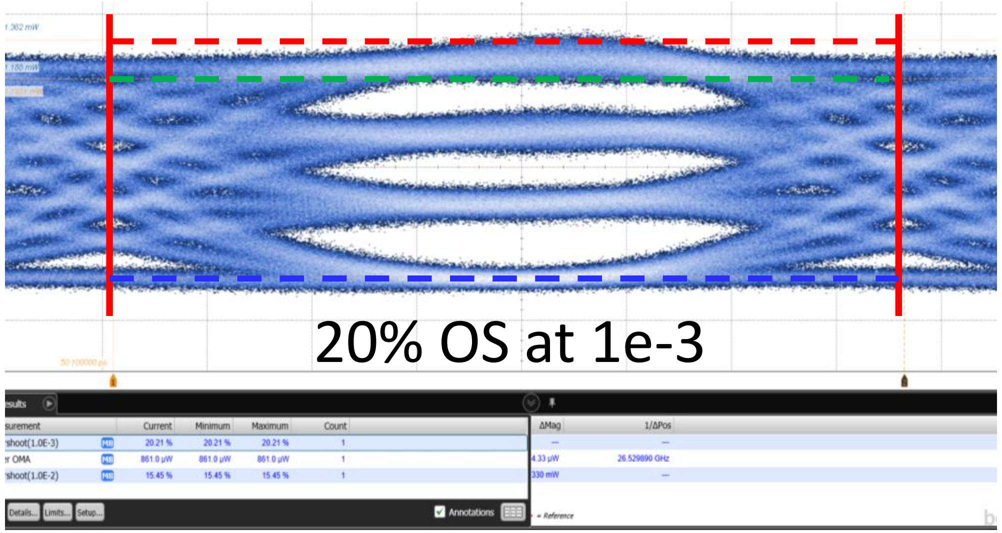
- ❑By allowing a small percentage of samples to exceed the test limit, test results are not subject to fluctuating results due to extreme outliers present with unbounded signal noise
- ❑Repeatable and effectively independent of sample size/observation time
- ❑Improved tolerance to instrument noise

Hit ratio details & Definitions

- ❑Allow a percentage of samples to reside above the overshoot value. For example, if the hit ratio is 1e-2, the test system adjusts the overshoot value lower until no more than 1% of the samples are above that limit
- ❑Exact definition of overshoot:
  - ❑OS = (Pmax – P3)/(P3-P0) x 100 where P3 and P0 come from the OMA measurement and (new text proposed:
    - ❑ Pmax: is based on a 1e-2 hit ratio, where Pmax is the smallest power level that results in the number of samples above that level not exceeding the product of hit ratio and total number of observed samples, with all samples acquired in a single unit interval eye diagram)
- ❑Undershoot defined similarly:
  - ❑US = (P0-Pmin)/(P3-P0) x 100
- ❑Same definition of Pmax and Pmin for peak-to-peak power spec



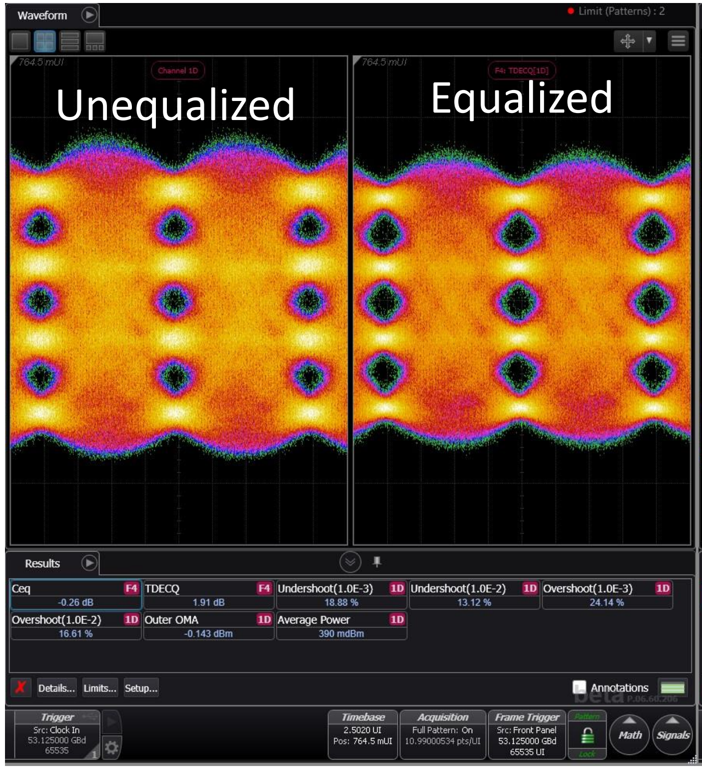
15% OS at 1e-2



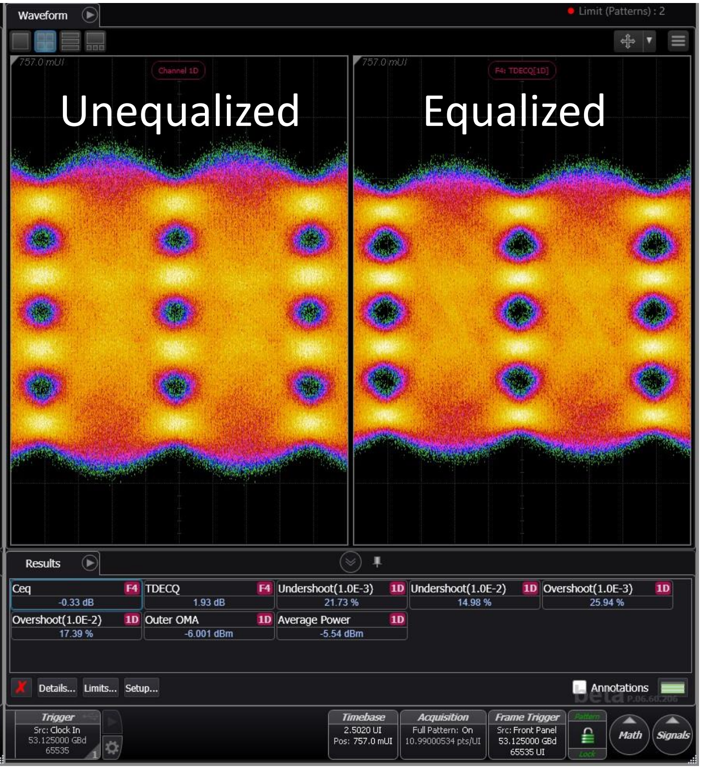
20% OS at 1e-3

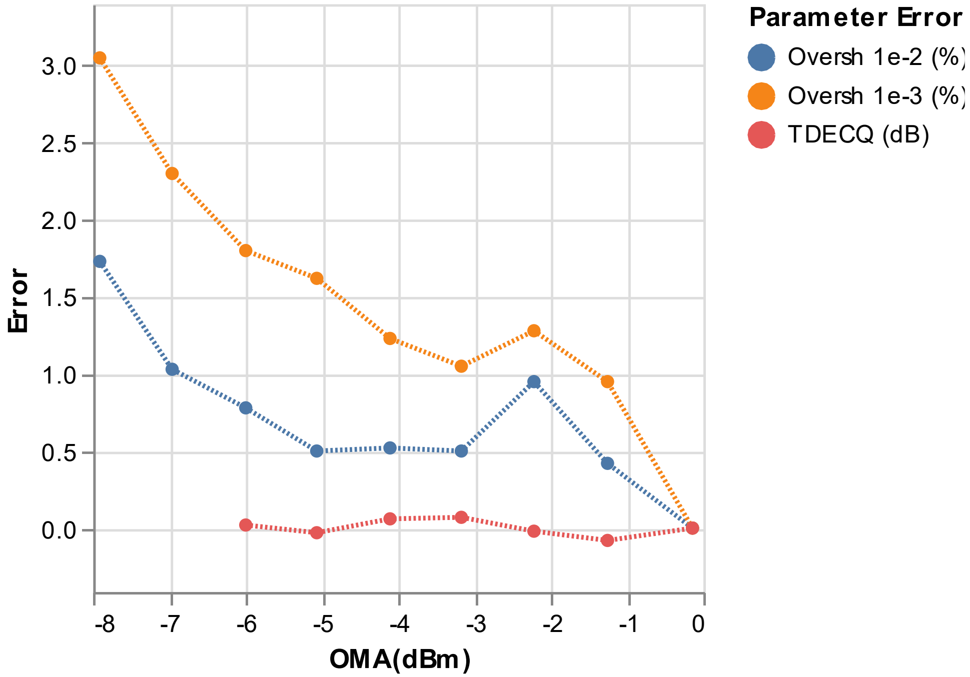
Measurement Robustness to DCA Noise

OMA -0.1 dBm



OMA -6 dBm



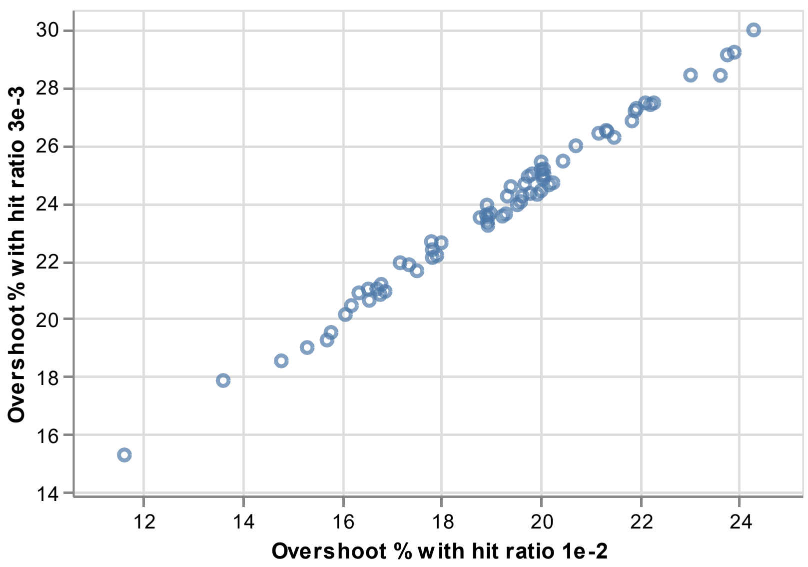


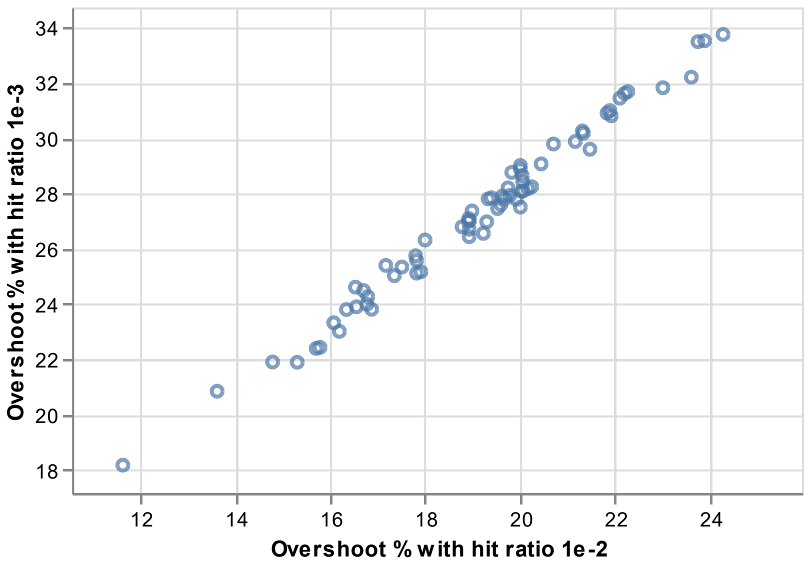
In this example, the signal is attenuated while observing TDECQ and overshoot. Below -6 dBm, the TDECQ measurement cannot be constructed, representing possible required range of measurements.

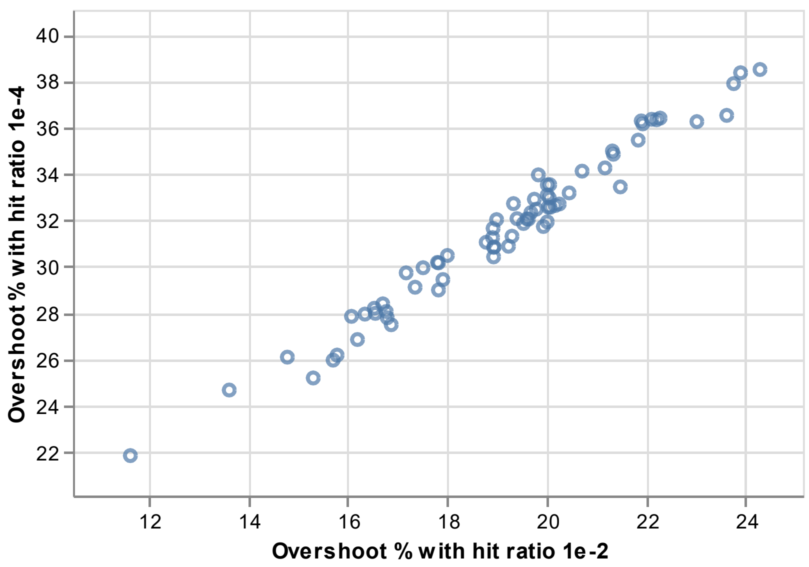
Hit ratio at 1e-2: Overshoot percentage measurement error is observed to be < 1% (16%->17%)

Hit ratio at 1e-3: the error is < 2%.

Overshoot values for different hit ratios are tightly correlated







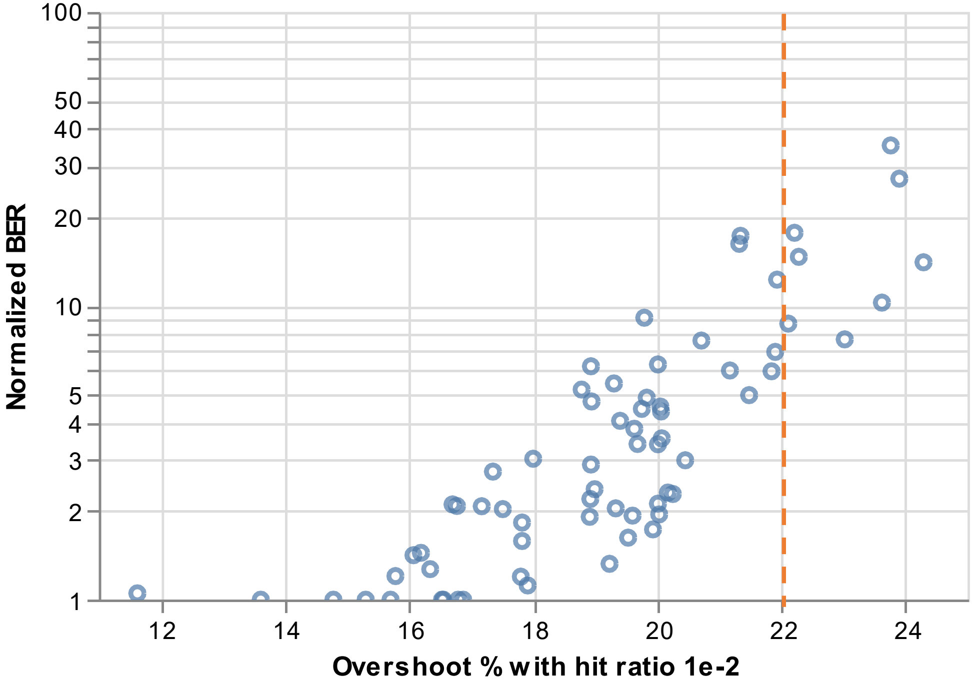
The captured data shows a tight correlation between hit ratios. A direct translation from one hit ratio to another can be done. For instance, 22% overshoot measured with 1e-2 hit ratio is equivalent to:

- ❑ 27% at 3.3e-3
- ❑ 31% at 1e-3
- ❑ 36% at 1e-4

We recommend using hit ratio 1e-2 since it shows less measurement error, and it requires less acquisition time. Lower hit ratios simply mean that the spec limit is also changed, with similar ability to differentiate good or bad

Overshoot vs BER

- ❑ Data on same 400G-FR4 module used in [rodes_3cu_adhoc_030520_v2]
- ❑ Tx equalization is changed to achieve different levels of overshoot
- ❑ Strong correlation of overshoot with mid range BER



We propose a 22% spec to limit the penalty on error floor while allowing some overshoot margin for:

- ❑ Manufacturing margin
- ❑ Measurement error
- ❑ Over temperature and dispersion penalty

Concluding Remarks

We updated overshoot spec methodology and took a new set of measurements

- SSPRQ pattern
- Probabilistic, based on hit ratio

For 400G-FR4, we recommend 22% overshoot limit with 1e-2 hit ratio

- Robust, fast testing
- Other combinations of overshoot limit and hit ratio are also possible

Further work

- LR4: impact of dispersion on overshoot limit
- Undershoot vs. overshoot: Do we need different values?
- Task Force needs to balance these considerations against schedule
- We encourage others to experiment and share results

Acknowledgment

- Thanks to David Leyba for fast prototyping of the hit ratio based overshoot measurement method to enable the experimental work