Importance of using scaled data as opposed to limit lines in modeling channel impacts

Contribution to IEEE 802.3bq 40G-BASE-T Task Force

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George Zimmerman, Ph.D., CME Consulting

Supporters

- Mike Grimwood, Broadcom
- Paul Kish, Belden
- Wayne Larsen, Commscope
- Sterling Vaden, OCC

Overview

- Motivation

- Models

- Limits vs. Measurements

- Observations & Recommendations

Motivation

- PHY power estimation exercises have shown sensitivity to small variations in impairment levels

  - Modeling efforts have generally used limit lines for impairment power

  - Power estimates are based on receiver dynamic range, and hence total integrated power

- Limit lines are designed so that impairments touch them in few places

  - Previous 802.3 standards have recognized averaging effects in PHYs and adjusted models accordingly

Models

- Receiver dynamic range will be driven by impairments on maximum length channel
- Actual channel measurements will generally have margin to limits by design
  - Shift entire measurement to touch limit at worst point (0dB margin) (pessimistic)
- Measure total power using simplified transmit model to remove filter dependencies
  - Transmit PSD will weight the integrated power result but doesn't qualitatively alter the impact of using limit lines vs. measured channels
- For reference, use flat PSD to evaluate differences
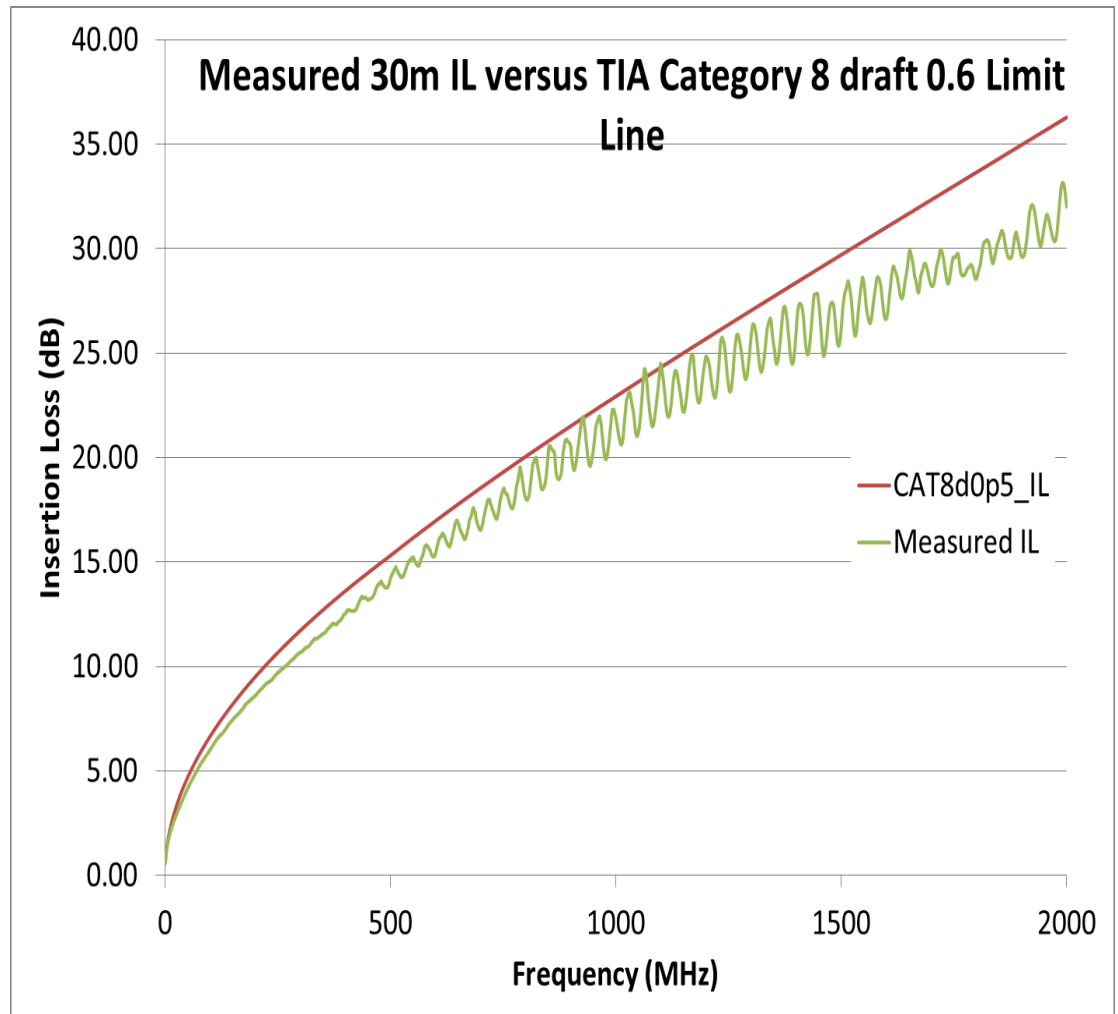 - -90 dBm/Hz to 2GHz = 3dBm

Limits vs. Measurements - RL

- 30m channel (3m-24m-3m, 1.25 dB margin @ 1995 MHz)

- Integrated Power:
  - Limits: -3.90 dBm
  - Measured: -10.72 dBm
  - 0dB Margin shifted measurement: -9.47dBm

- 6.82 dB native difference

- 5.57 dB difference when adjusted to 0dB margin

Measured 30m RL versus TIA Category 8 draft 0.6 Limit Line
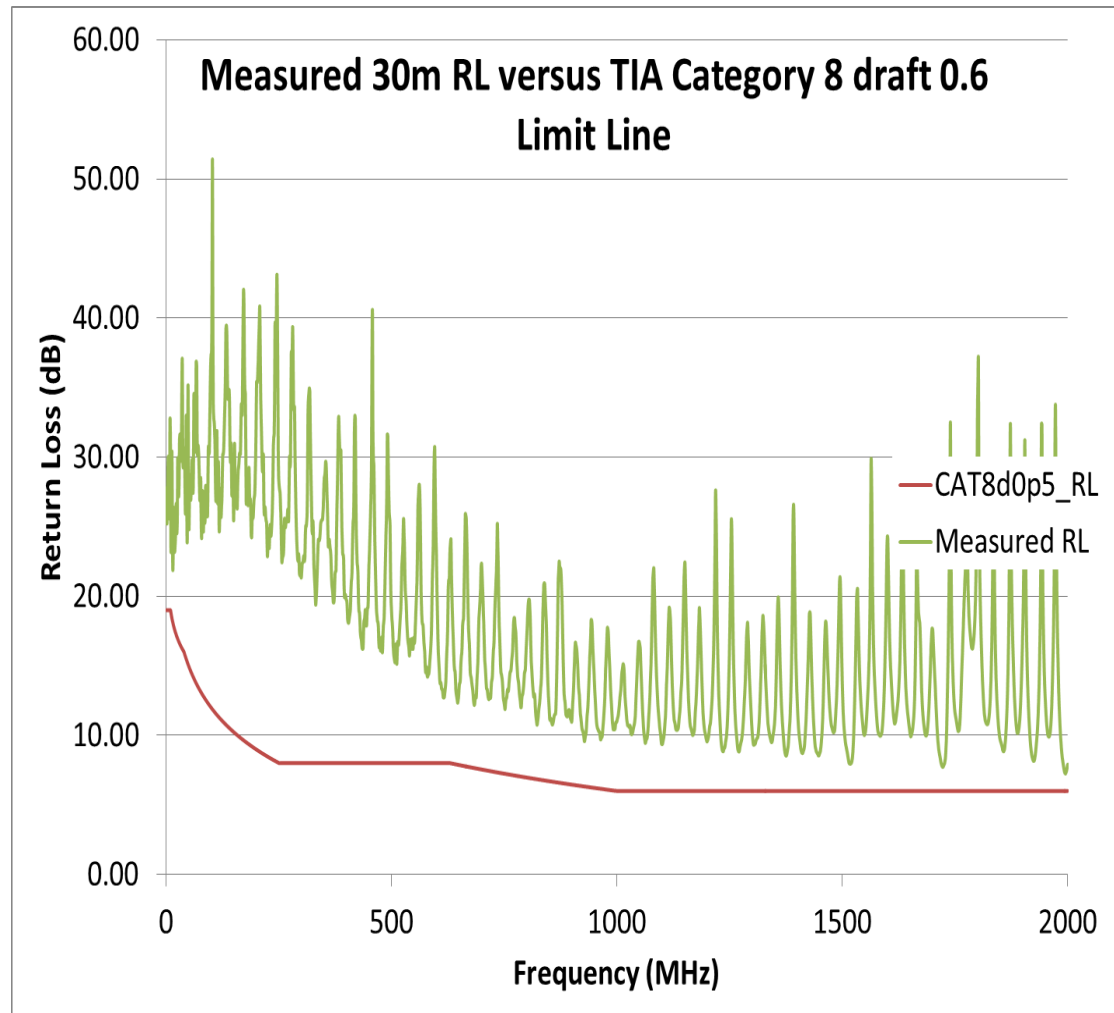
Limits vs. Measurements - IL

- 30m channel (3m-24m-3m, -0.43 dB margin @ 1063 MHz)
- Integrated Power:
  - Limits: -10.23dBm
  - Measured: -10.97dBm
  - 0dB Margin shifted measurement:
    -10.55dBm
- Only 0.74 dB native difference
- 0.32 dB difference when adjusted to 0dB margin

Measured 30m IL versus TIA Category 8 draft 0.6 Limit Line

X-axis: Frequency (MHz); Y-axis: Insertion Loss (dB)

Legend: CAT8d0p5_IL, Measured IL

Limits vs. Measurements - PSNEXT

- 30m channel (3m-24m-3m, 10.22 dB margin @ 1063 MHz)

- Integrated Power:
  - Limits: -11.71 dBm
  - Measured: -20.12 dBm
  - 0dB Margin shifted measurement:
    -9.89dBm

- 8.40 dB native difference

- 1.82 dB difference when adjusted to 0dB margin

Measured 30m PSNEXT versus TIA Category 8 draft 0.6 Limit Line
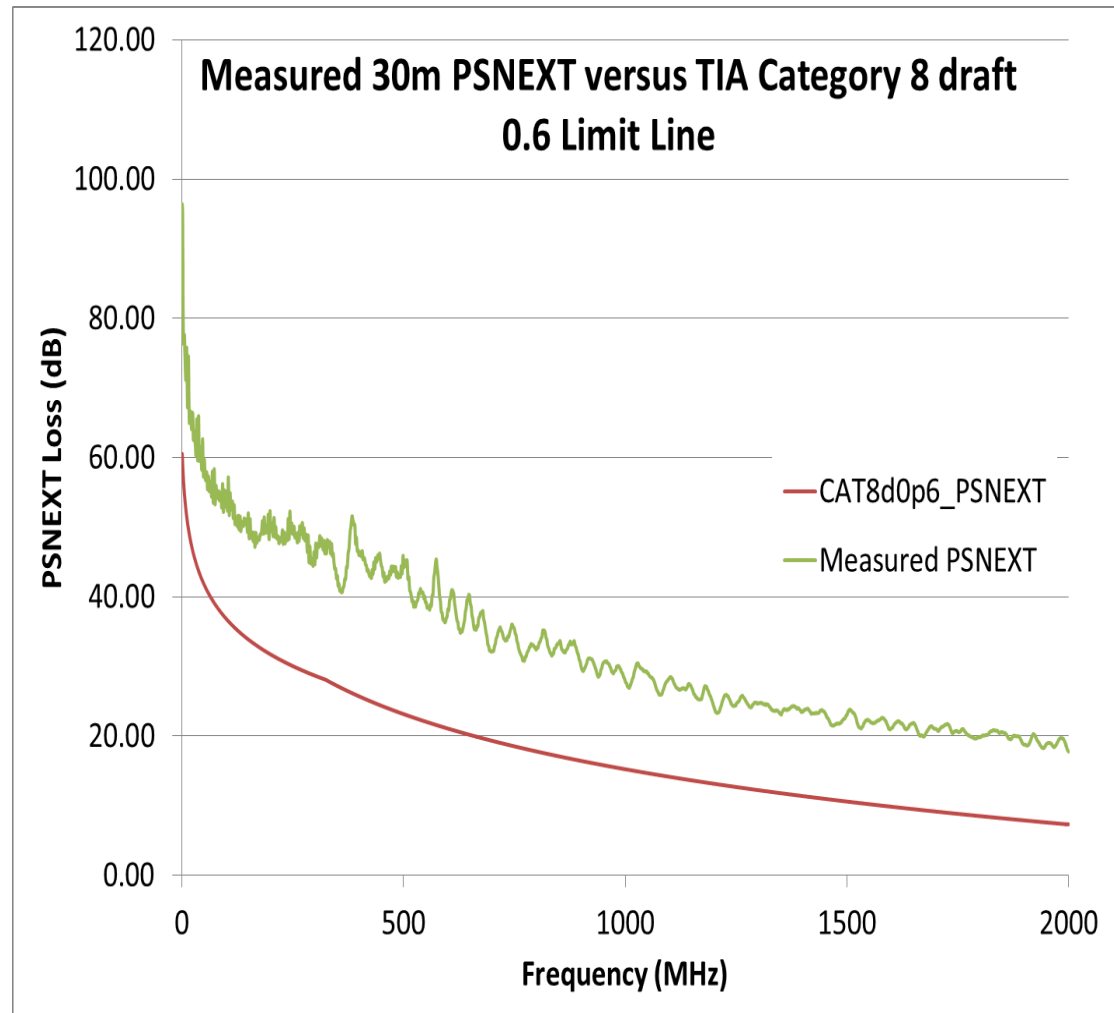
Observations

- Using scaled measurements causes large differences in power for peaky impairments such as RL or pair-to-pair XT
- Using scaled measurements causes significant, but smaller differences in smoothed measurements (PS XT)
- Using scaled measurements causes little difference in IL due to its smoothness

Recommendations and Discussion

- PHY modeling should use scaled measurements for RL & Crosstalk where possible
  - Significant differences impact channel modeling and PHY power trades
- TF should consider whether and how to best specify relying on this 'frequency averaged' behavior
  - Not ready for decision yet
  - If specified, should be liaised to TIA & ISO