An Initial Assessment of Real-Time Background Noise in 10GBASE-T Systems

Pete Cibula, Intel Corporation

Real-Time/Time-Domain Noise Measurements Purpose & Goals

- Purpose – Characterize background noise in representative systems that are candidates for 40GBASE-T PHYs
  - Support the P802.3bq PHY Baseline Proposal ad hoc's request for "…measurement results of background noise in systems, including broadband, stationary, and nonstationary narrowband sources."
  - Why? System background noise power may be a significant factor in optimizing 40GBASE-T PHY designs

- Goals - This is a follow-on assessment intended to
  - Better establish absolute system background noise levels
  - Provide examples of background noise observed on other 10GBASE-T systems (server LAN-On-Motherboard, or LOM; switch)

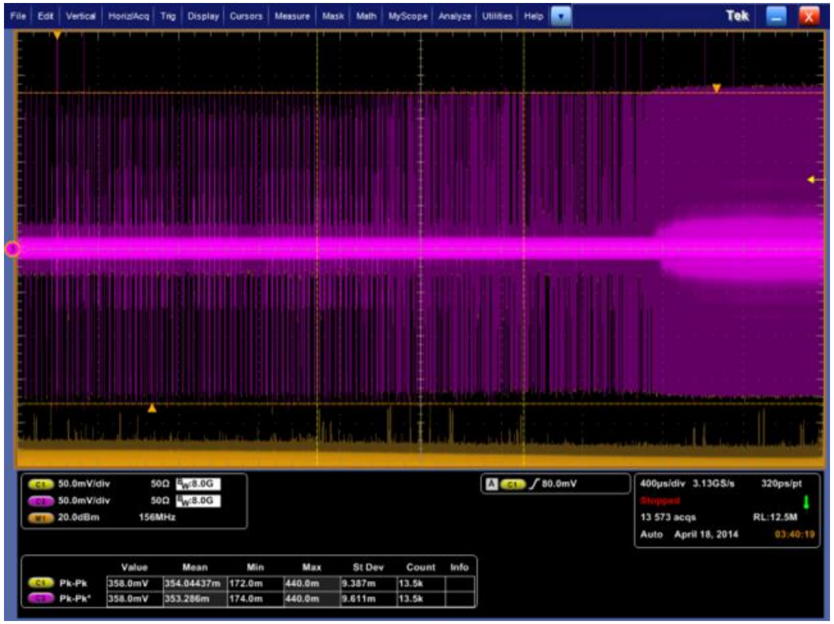
Methodology Overview

- Characterize system background noise as measured with a real-time oscilloscope
  - Measure system noise at PHY
    - PHY active but with all transmitters disabled
    - Probe as close as possible to PHY pins with DC blocks
    - Use 2 SMA inputs to capture common-mode and calculate difference-mode signals
  - Capture (image only) long-term noise and any transients over several minutes to days using Infinite persistence display mode
  - Calculate noise from FFT of time-domain acquisitions

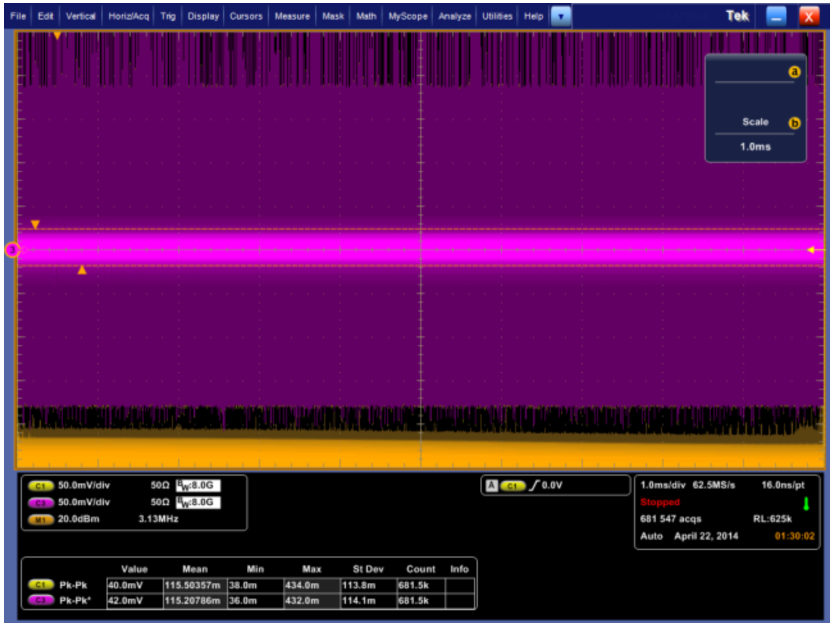
DC blocks

Signal Acquisitions

Short-term (~0.25h)



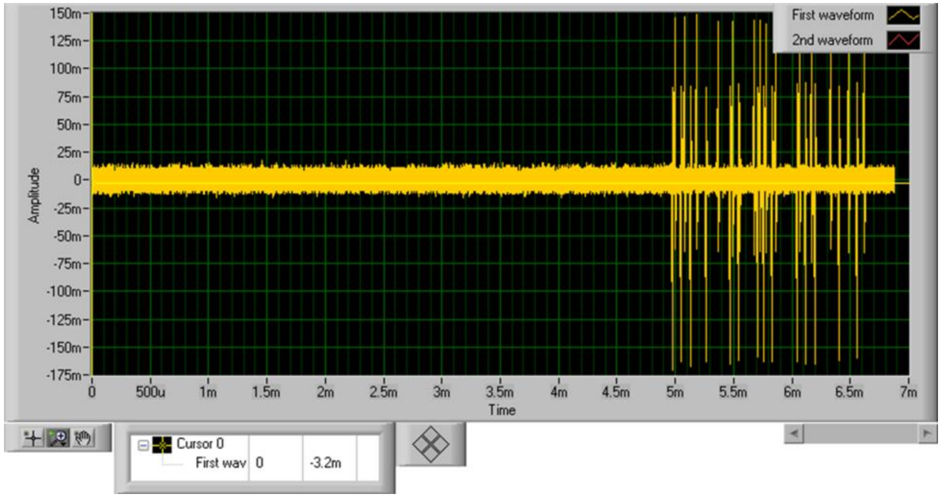
Long-term (~72h)



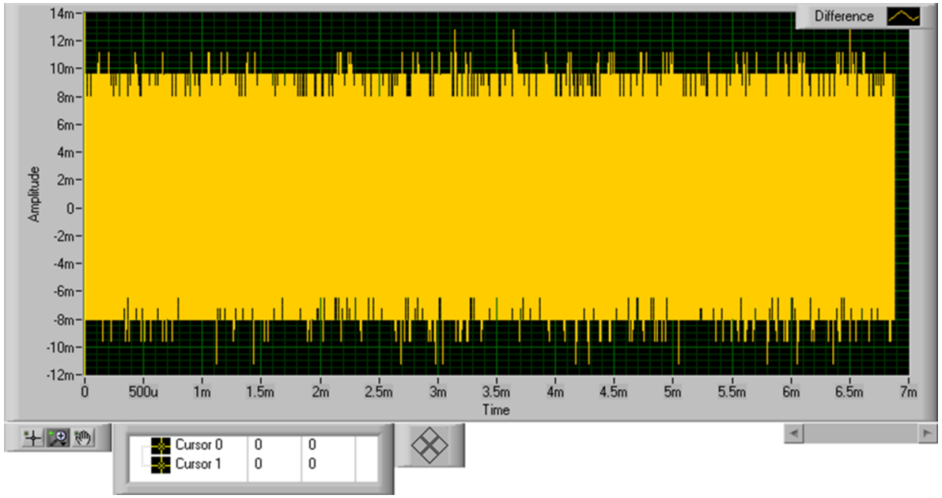
Short-term and long-term acquisitions are similar; long-term appears to be "more of the same"

Common-Mode & Difference-Mode Signals (Example)

- 7ms acquisition
  - Top is as-acquired positive & negative traces of one differential pair; ~300mV pk-pk



  - Bottom is difference signal; ~25mV pk-pk

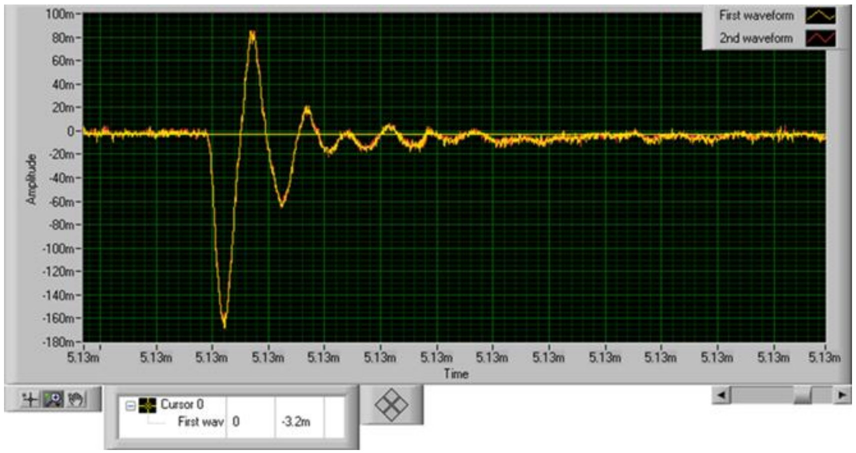


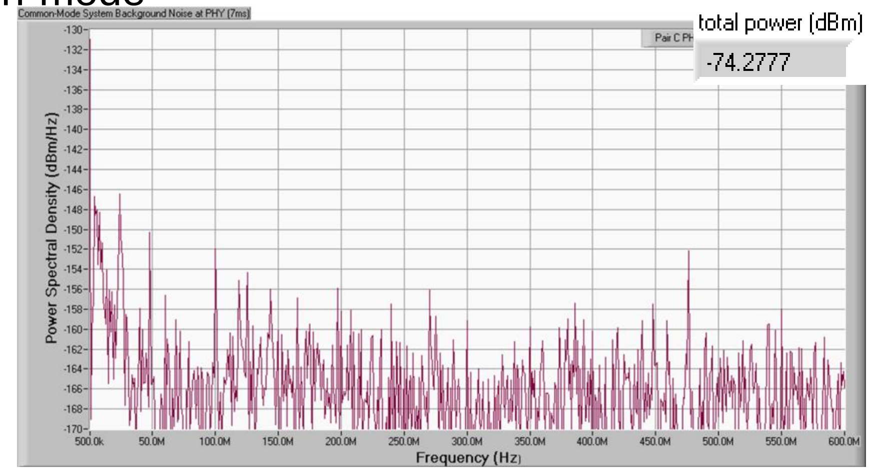
Common-Mode Acquisition Detail

- Predominant noise appears to be common-mode
  - The same signal is observed on both halves of the differential pair

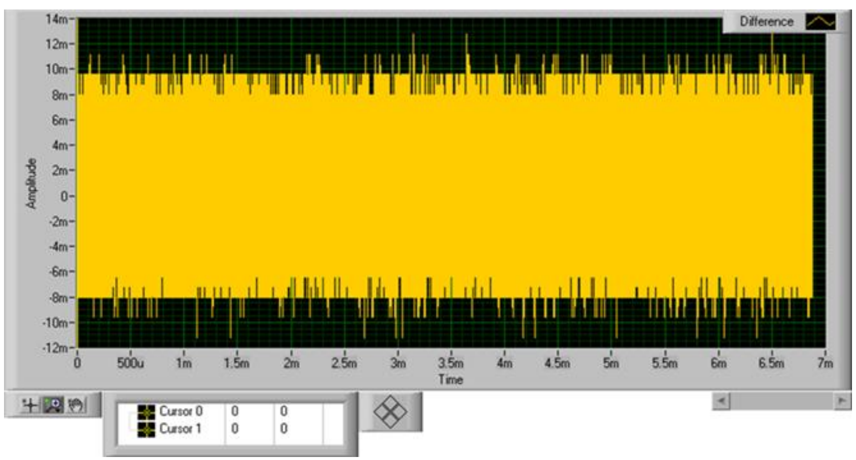
Common-mode and difference-mode noise power spectral density

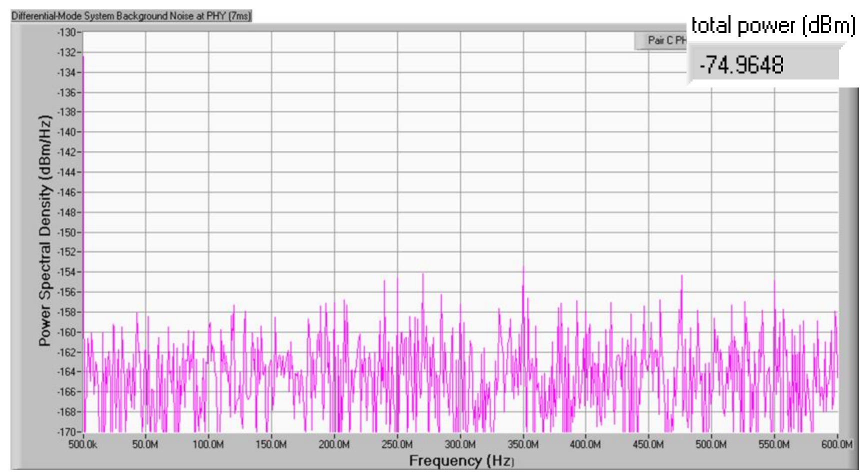
Common-mode





Difference-mode

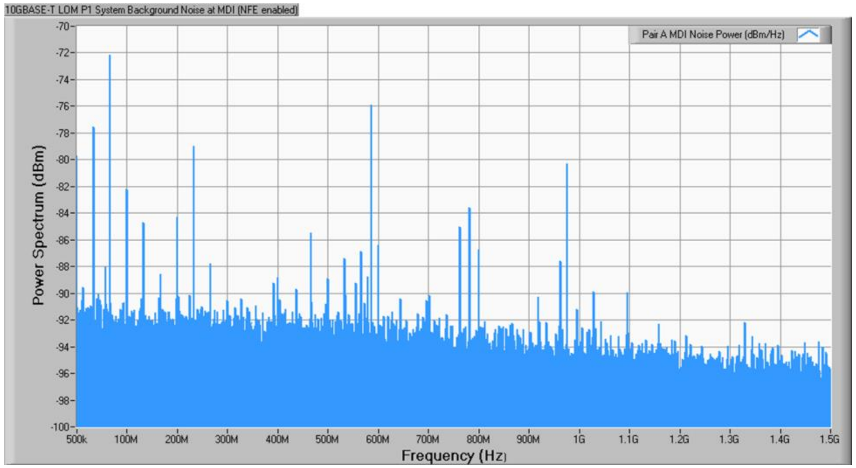




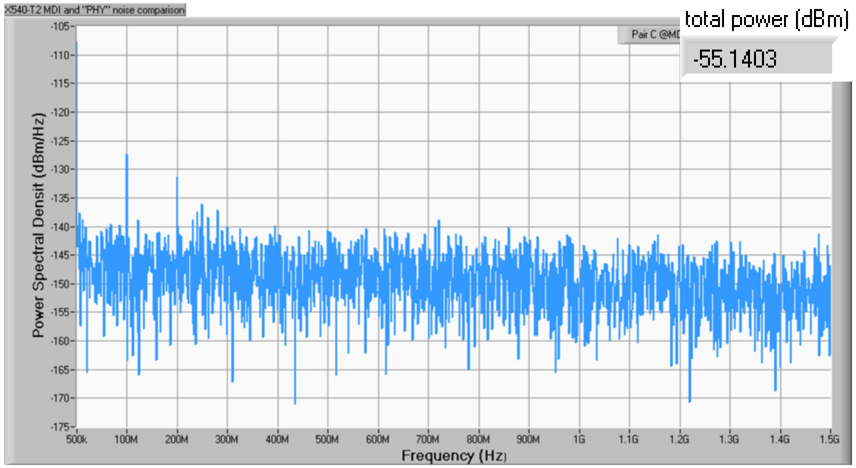
Note: Bandwidth (600MHz) is limited compared to other results

Extended Acquisition Noise & Noise Power

Power Spectrum



Noise PSD



Note: Improved bandwidth with this acquisition setting – 500kHz - 1.5GHz
Integrated noise power is ~-55.1 dBm/Hz

Conclusion

- Most “real-time” noise appears as common-mode to the PHY differential pair
- Noise power is consistent with that obtained using frequency-domain measurement techniques
  - Trending towards “Here be no dragons”

- Next steps
  - Closer examination of differential noise based on feedback from PHY ad hoc participants