

Reduced Twisted Pair Gigabit Ethernet EMC & Noise Ad Hoc Report

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EMC-Noise Ad Hoc Status (11/12/2013)

➤ Overview

- System EMC Testing (as previously proposed)
 - Stripline for emissions testing (using 2m 1-pair UTP cable)
 - BCI for immunity testing (using 2m 1-pair UTP cable)
- So far,
 - The EMC requirements were provided by OEMs and Tier1s
 - Egress & Ingress modeling were provided for EMC analysis yielding to a component level mode conversion limit line.
 - There has been a lot of inputs & contributions showing that the proposed component limit line is feasible for the RTPGE cables and connectors.
 - 4 different connector companies confirmed that the proposed mode conversion limit line is attainable for component level for their connectors.
 - We have two different 1-pair UTP cables which meet the component level mode conversion limit line.
- The analysis & test results were provided yielding to a baseline proposal for mode conversion of the RTPGE 15m link segment

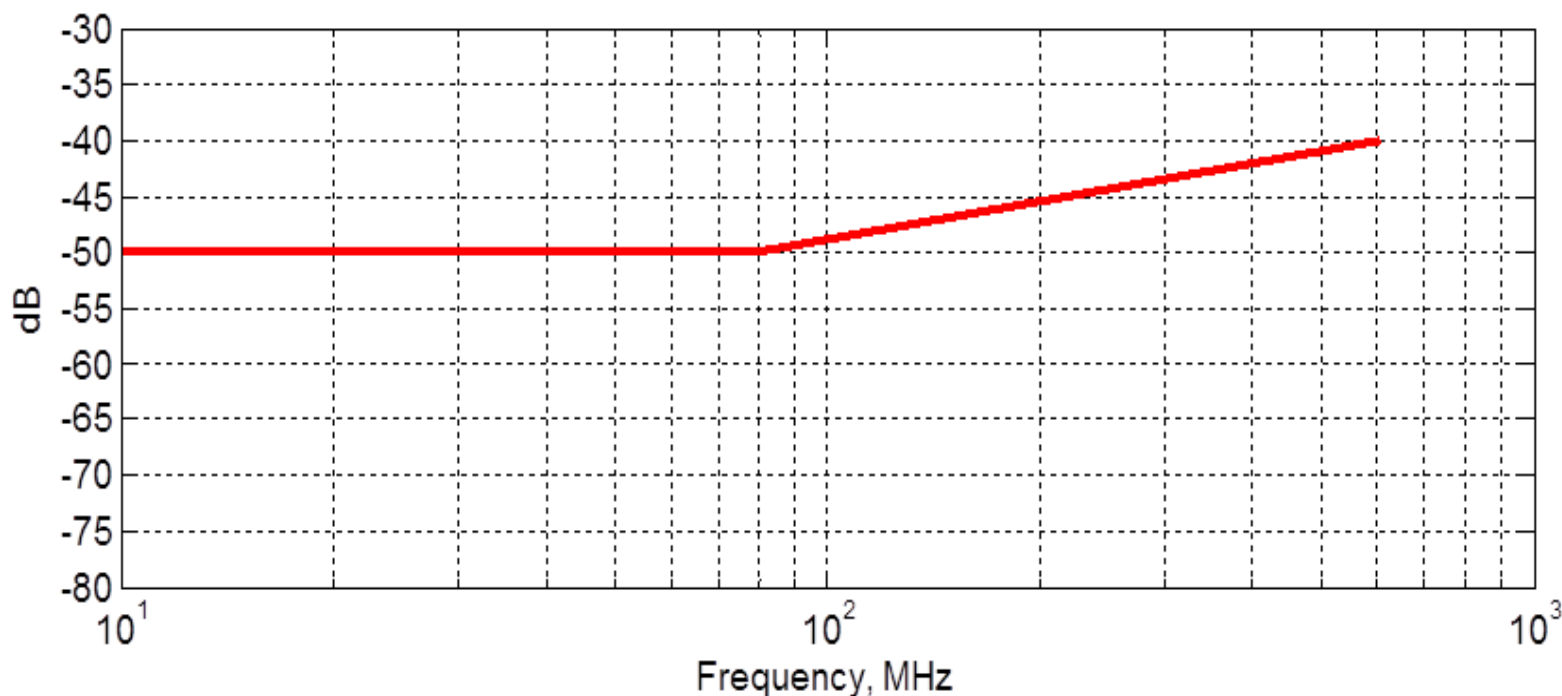
EMC Ad Hoc Status (11/12/2013)

- **Since York, we had two conference calls (10/18/2013 & 11/05/2013)**
 - Delphi showed the RTPGE link segments based on FlexRay cabling do not meet the limit line.
 - TE showed their balance results for their RTPGE connector meeting the proposed mode conversion limit line.
 - Marvell shared results showing higher noise for their EMC testing.
 - Commscope proposed a set-up and measurement method to provide consistency for RTPGE cabling testing. The documentation was provided as an input to the standard.
 - Stefan conducted a questionnaire for the existing BCI requirements and provided the input for the EMC Ad Hoc.

- **Our goal in this meeting is to adopt the baseline proposal for mode conversion parameter of RTPGE link segment in order to finish the RTPGE 15m channel definition**

Baseline Proposal for Mode Conversion

- The mode conversion limit line is proposed for a 15m UTP link segment with 4-inline connectors



$$- 50_{\text{dB}} \quad 10 < f_{\text{MHz}} < 80$$

$$[5 \log_n (f_{\text{MHz}}) - 72]_{\text{dB}} \quad 80 < f_{\text{MHz}} < 600$$

Previous Work Summary

Mehmet Tazebay, Broadcom Corporation

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RTPGE EMC & Noise Ad Hoc

- Chartered during September 2012 meeting to develop EMC & Noise models and measurements
- Conference calls & meetings held in 11/07/2012, 12/17/2012, 01/25/2013, 3/4/2013, 3/20/2013, 4/30/2013, 5/8/2013, 6/26/2013, 7/16/2013, 8/20/2013, 8/29/2013, 09/03/2013, 10/18/2013, 11/05/2013
- Communications via RTPGE/802.3bp reflector. Minutes & contributions were sent to the reflector
- Thanks to those who attended the ad hoc calls

Work-plan Summary

- **First Phase (Data Collection as of 7/14/2013)**
 - Ingress modeling
 - Define the noise sources (in-car background noise, alien XTALK, EMC noise, impulse noise, battery noise, etc.)
 - Need input for in-car broadband noise
 - Define the channel transfer function/measurement modeling methodology
 - Egress modeling
 - Block diagram for PHY emissions
 - Balance measurements of the proposed RTPGE channels were provided
 - Define emissions' mask
 - Define mode conversion limit line
 - Mode conversion data for connectors was provided on 7/16.

Work-plan Summary (cntd.)

- **Second Phase** ← **We are here**
 - Reach consensus on a baseline limit for EM emissions (emissions' mask) and based on that define the Transmit PSD mask
 - Reach consensus for mode conversion limit line
 - Build consensus of all discrete noise sources and background noise
- **Third Phase**
 - Develop text for standard

Overview

- ❑ Differential Channel Impairments
- ❑ EMC Noise & Limit Lines
- ❑ EMC Channel Transfer Function Modeling
- ❑ Alien XTALK
- ❑ In-Car Background Noise
- ❑ Impulse Noise
- ❑ Other Noise sources?

Differential Channel Impairments

- ❑ Insertion Loss (aka channel attenuation) varies as a function of length, frequency and temperature.
- ❑ Return Loss needs to be properly constrained for FDX systems and can have a direct impact on input dynamic range.
- ❑ Both of these impairments can be handled by digital equalization and echo cancellation.
- ❑ Status: Channel Ad-Hoc made progress for defining the differential parameters.

EMC Modeling & Limit Lines

- ❑ Stefan Buntz (Daimler) proposed DPI technique for component level emission & immunity testing (similar to IEC 62132-4) and provided the limit lines in http://grouper.ieee.org/groups/802/3/RTPGE/public/nov12/buntz_01_1112_rtpge.pdf
- ❑ CISPR 25 also addresses Conducted and Radiated Emissions' measurement techniques. If CISPR 25 is preferred method of testing then, **Limit lines (dBuV vs. frequency [0.1MHz–1GHz])**
- ❑ ISO 11452-2/4/5 define Radiated Immunity via Antenna, BCI and Strip Line measurement techniques. If they are preferred method of testing then, **Limit lines (dBm vs. frequency [0.1MHz–1GHz])**

EMC Channel Transfer Function

- ❑ CM-to-CM and CM-to-DM conversion transfer functions must be attained for RTPGE channels in order to compute the input-referred noise for the PHY.
- ❑ Mehmet Tazebay (Broadcom), Richard Mei (Commscope), Thomas Muller (Rosenberger) made proposals for method and techniques for attaining these transfer functions
http://www.ieee802.org/3/bp/public/jan13/tazebay_3bp_01a_0113.pdf
http://www.ieee802.org/3/bp/public/jan13/mei_3bp_01_0113.pdf
http://www.ieee802.org/3/bp/public/jan13/mueller_3bp_01_0113.pdf
- ❑ In principle, 3-port network analyzer measurements can be used to analyze the mode conversion transfer functions.
http://www.ieee802.org/3/bp/public/may13/tazebay_3bp_01_0513.pdf

Alien XTALK modeling

- ❑ Kirsten Matheus (BMW) proposed a few select cable bundle topologies based on use cases agreed-upon by participating OEMs:
http://www.ieee802.org/3/bp/public/jan13/matheus_3bp_02_0113.pdf
- ❑ Several measurements were made based on the presented topologies (Mei et al, Commscope and Donahue & Estes, UNH) using UTP channels
http://www.ieee802.org/3/bp/public/jan13/mei_3bp_01_0113.pdf
http://www.ieee802.org/3/bp/public/jul13/donahue_3bp_01_0713.pdf
- ❑ Preliminary results indicate that alien XTALK is within the limit lines for the select cables. More test results are expected with the final channel parameters.

In-Car Background Noise

- ❑ Stefan Buntz (Daimler) provided a direct measurement technique and results for BG in the car http://www.ieee802.org/3/bp/public/mar13/buntz_3bp_01_0313.pdf
- ❑ The background noise was measured as common mode noise (dBuV versus frequency [0.1MHz-1GHz]).
- ❑ The EMC channel transfer functions dictate the input-referred common mode and differential mode noise observed by the PHY.

In-Car Impulse Noise

- ❑ ISO 7637-2 lists tests for transient immunity testing (pulses 1-5) for supply lines
 - Is RTPGE with PoE expected to pass these immunity pulses?
 - Are there additional requirements in excess of ISO 7637-2?
 - What criteria is considered passing for this test?
 - Class A requires a BW of the pulse within the PSD of RTPGE!
- ❑ ISO 7637-3 lists tests for transient immunity testing for signal lines.
 - Is RTPGE MDI expected to pass these immunity transient test pulses?
 - Are there additional requirements in excess of ISO 7637-3?
 - What criteria is considered passing for this test? Is it different from the ISO 7637-3 standard?
- ❑ Thomas Hogenmuller (Bosch) made a contribution showing empirical, simulation and emulation results for in-car impulse noise. This work extensively provides information for the impulse-noise model. The mathematical parameters are provided by Mr. Hogenmuller.
<http://www.ieee802.org/3/bp/public/jul13/jul13.htm>

Other Noise Sources

- ❑ Battery Noise, PoDL considerations and etc.
- ❑ A contribution was made by Yair Darshan (Microsemi) which discussed the noise sources over a single data & power pair
http://ieee802.org/3/bp/public/may13/darshan_3bp_01_0513.pdf
- ❑ What else are we missing?

Summary

- ❑ Progress for the link segment parameters (channel ad hoc)
 - IL, RL, Alien XTALK
- ❑ EMC-Noise Ad Hoc gathered large amount of information for
 - Emissions & Immunity for 1-pair UTP cables
 - Transmit PSD
 - Mode conversion limit line
 - Impulse Noise measurements & modeling were presented for automotive environment
 - Battery Noise effect was discussed
 - The effects of temperature on the IL & RL discussed in this meeting.
 - The effects of MDI connectors for EMC performance were discussed in Geneva meeting.
 - The effects of inline connectors for EMC performance will be presented in this meeting.
- ❑ Now, based on the data that we have it is time to reach consensus on the TX PSD and mode conversion parameters so that we can start evaluating the baseline proposals.
- ❑ Questions?