Reduced Twisted Pair Gigabit Ethernet
EMC & Noise Ad Hoc Report

York, England

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EMC Ad Hoc Status (9/3/2013)

- **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)
- **Since Geneva, we had one individual and one joint (w/Channel Ad Hoc) conference calls (8/20/2013 & 8/29/2013)**
  - Component level mode conversion limit line was re-iterated. BCI & Stripline Setup was discussed and the information was posted to the reflector.
  - Since 7/16/2013, new balance results were measured for RTPGE link segment (1-pair 15m UTP w/4-inline connectors) and presented to the group during Channel/EMC Ad Hoc Conference Call on 8/29/2013. These results will be re-iterated for the Task Force in this meeting.
  - 4 different connector companies confirmed that the previously 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.
- **Our goal in this meeting is to establish a baseline proposal for mode conversion parameter of RTPGE link segment**

Previous Work Summary

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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
- 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?