Automotive link segment for 10SPE

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Overview

- Goal for 10SPE automotive PHY must be to run on “CAN-like” or “FlexRay-like” cabling and connector configurations
- Bert Bergner showed measurements of 4mm pitch connectors showing the need to relax RF parameters to accommodate for 4mm pitch, see: http://www.ieee802.org/3/cg/public/July2017/DiBiaso_Bergner_01a_0717.pdf
- Another set of measurements you can find under: http://www.ieee802.org/3/bw/public/buntz_tazebay_3bw_01_0914.pdf
- Supplementing data from re-use of available “old” measurement data from RTPGE (measurement of a 100ohms FlexRay link out of a real automotive cable harness) to confirm this.

- Derive a possible set of parameters for the automotive P2P link segment

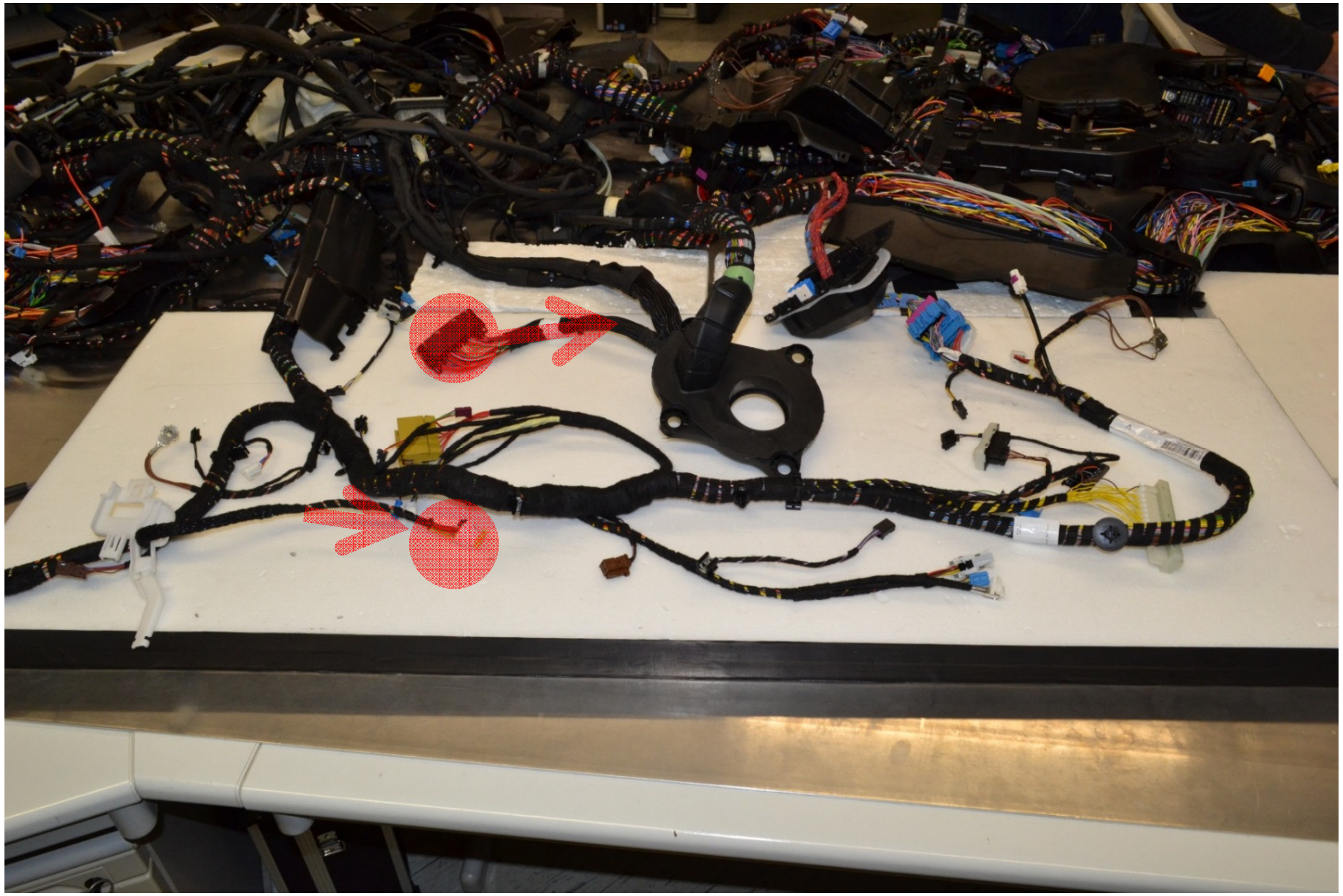
- **This presentation does only focus on the Point-2-Point link segment. However, we believe the analysis applies to the passive linear multidrop link as well. This needs to be confirmed.**

Part 1

- Re-visit of supplementing measurement data from http://www.ieee802.org/3/bw/public/buntz_tazebay_3bw_01_0914.pdf

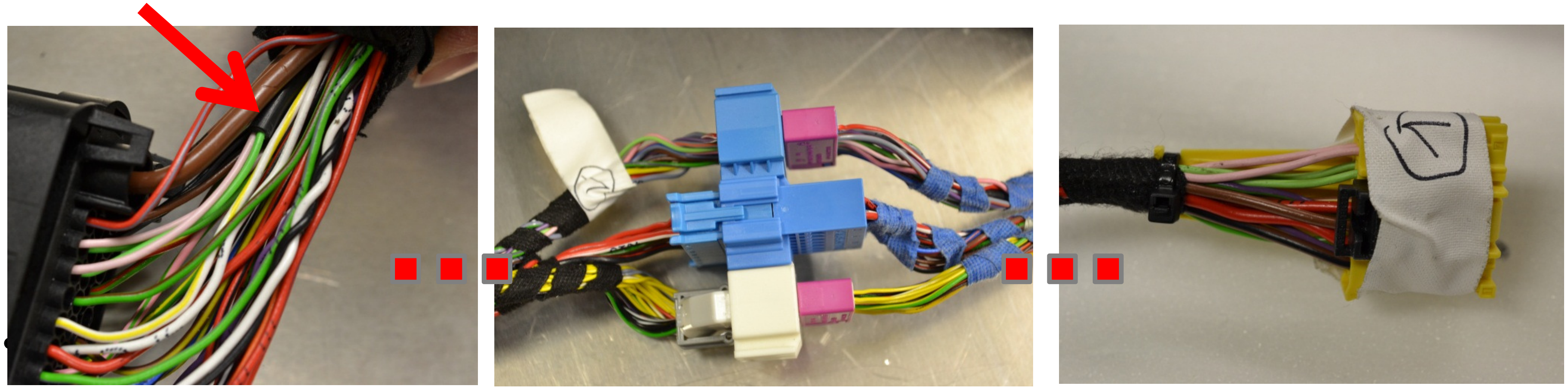
Device under test/measurement setup

- 2x0,35mm² 100 ohm jacketed cable in harness (approx. 3600mm) with inline connector (FlexRay).



Device under test/measurement setup

Connector1/jacketed cable | inline | Connector2

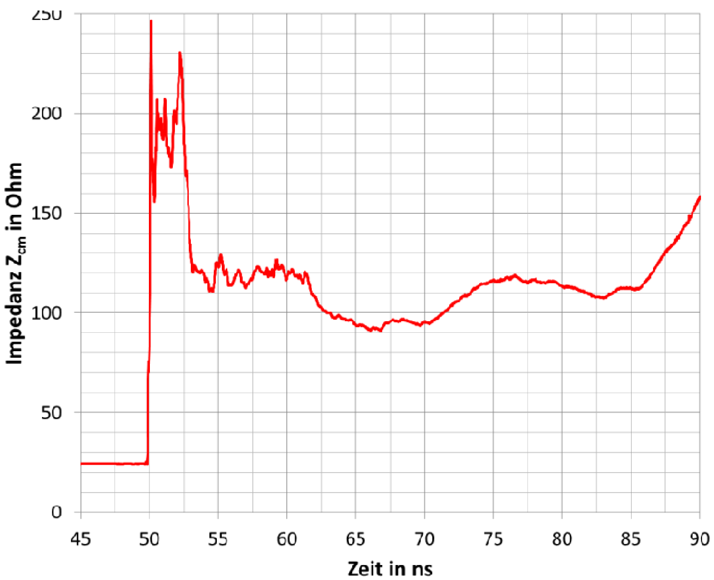


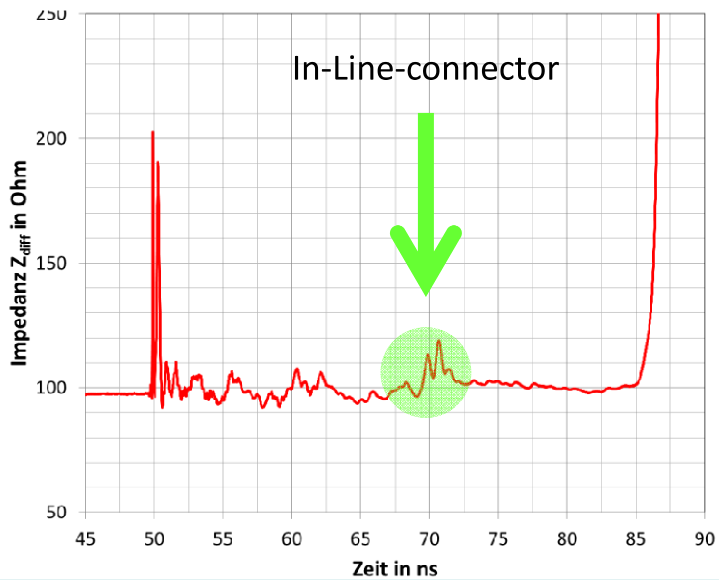
Test adapter
(as these were older measurements the test adapter is maybe not perfect…)

- Direct connection to GND plane.
- SMA heads soldered to Pins which are plugged into harness header.
- Complete harness on GND plane.
- No special treating of harness and assemblies to achieve high symmetry

TDR results Z_{cm} and Z_{diff}

- as harness is placed 50mm above GND plane Z_{CM} is nearly constant





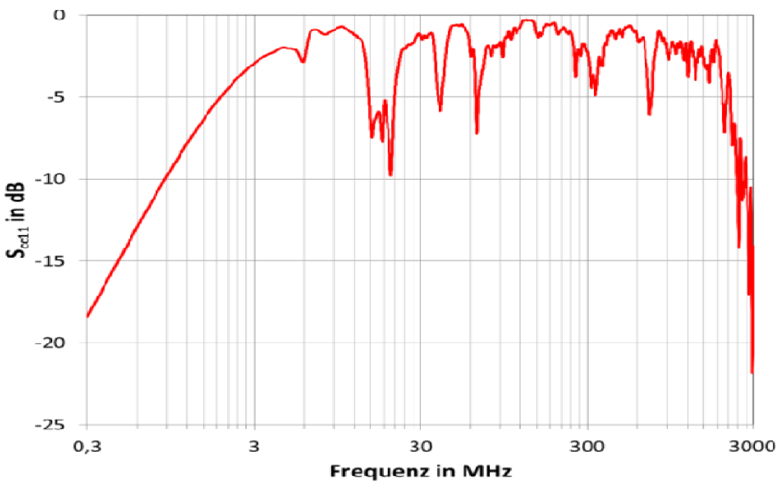
Z_{DM} may vary from 80ohms to 120ohms.
→ according RL influence to consider.

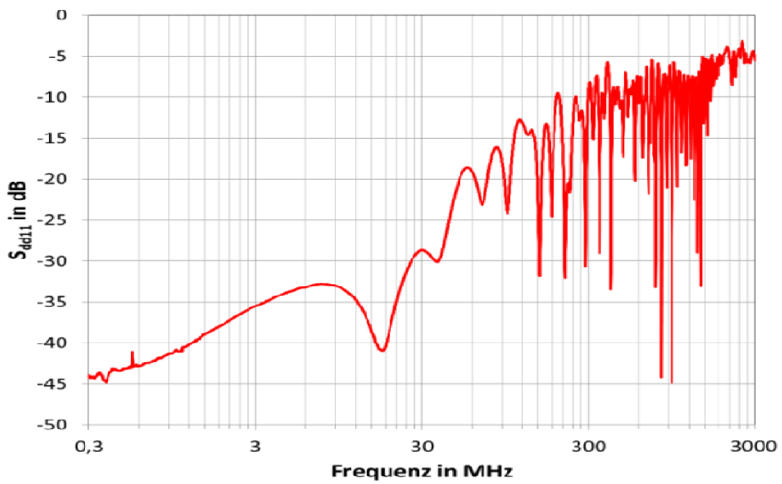
$$RL = 20 * log_{10}\left(\left|\frac{Z_2 - Z_1}{Z_2 + Z_1}\right|\right)$$

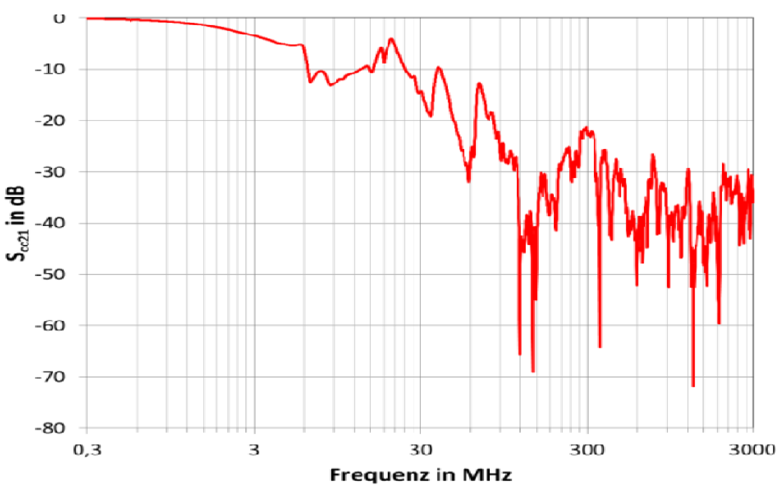
RL = 14dB (from DC)

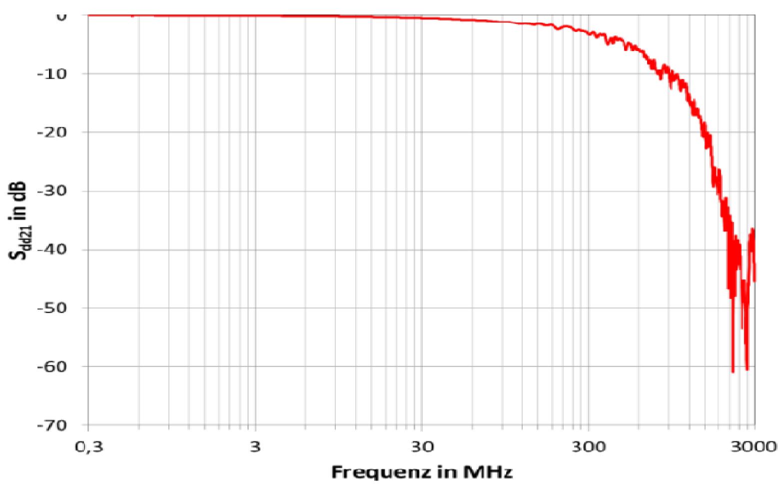
balance measurements of today’s cable harness

S_{cc11}, S_{dd11}, S_{cc21}, S_{dd21}

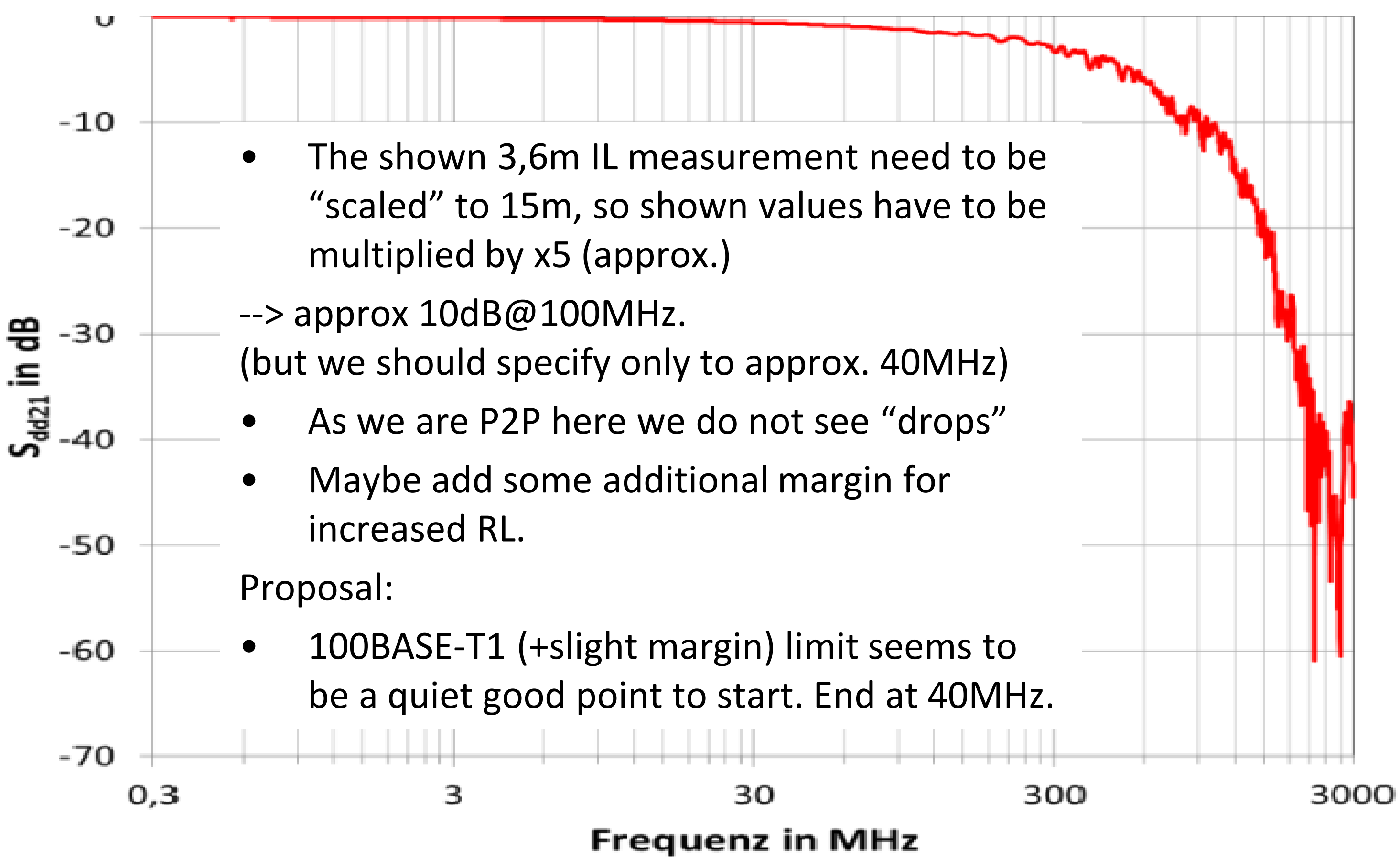








S_{dd21} (IL)



- The shown 3,6m IL measurement need to be "scaled" to 15m, so shown values have to be multiplied by x5 (approx.)

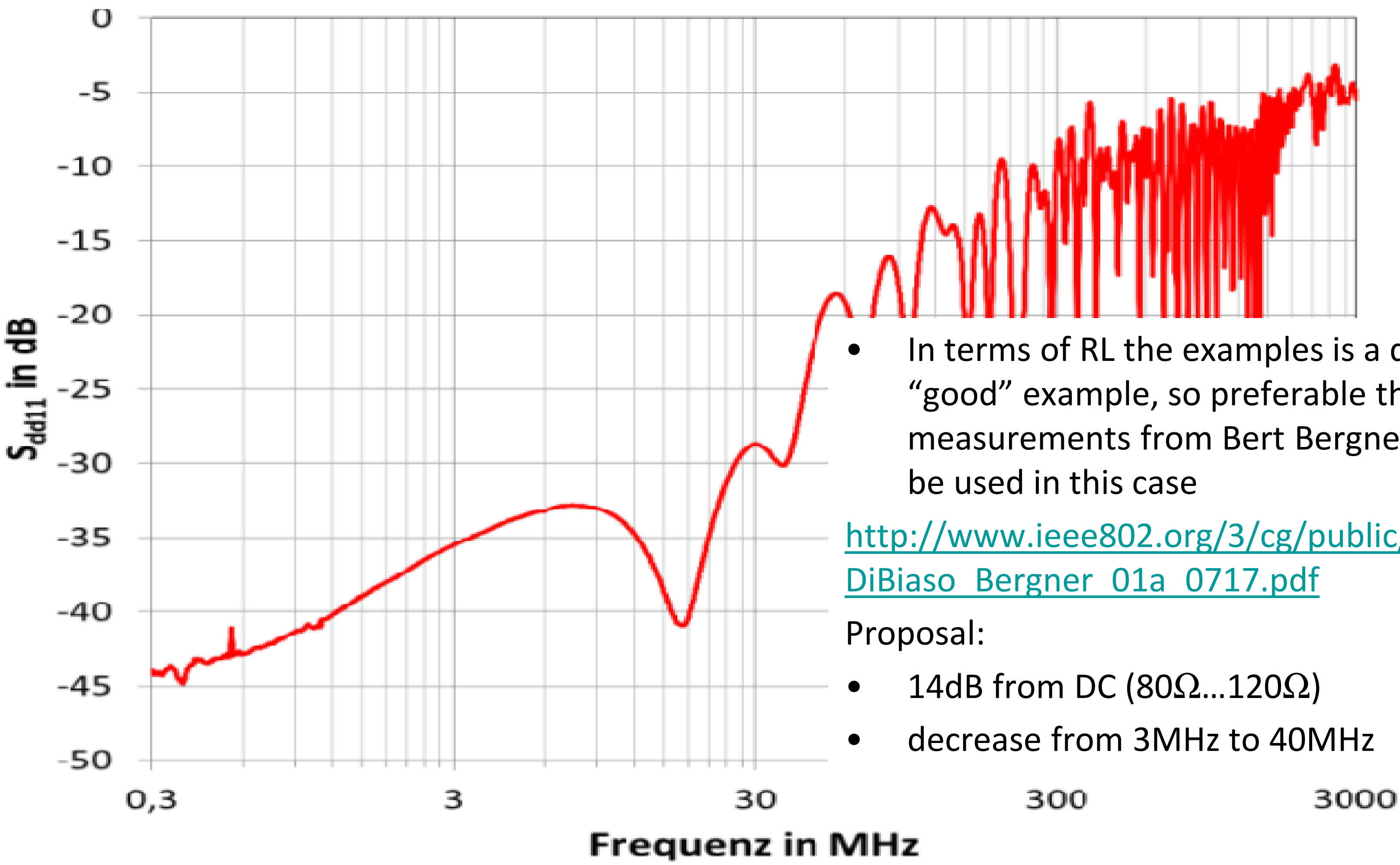
--> approx 10dB@100MHz.
(but we should specify only to approx. 40MHz)

- As we are P2P here we do not see "drops"
- Maybe add some additional margin for increased RL.

Proposal:

- 100BASE-T1 (+slight margin) limit seems to be a quiet good point to start. End at 40MHz.

S_{dd11} (RL)



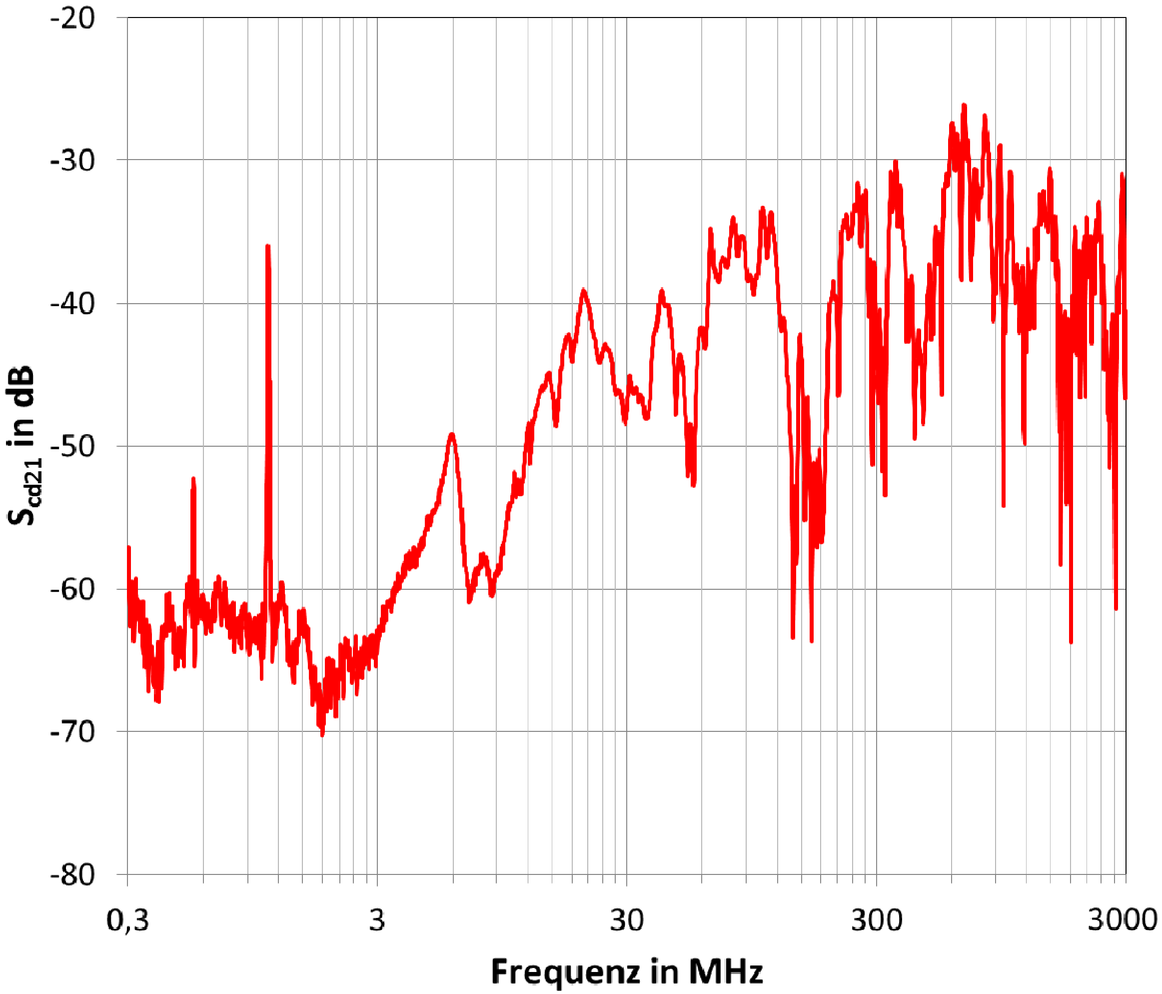
- In terms of RL the examples is a quiet "good" example, so preferable the RL measurements from Bert Bergner should be used in this case

http://www.ieee802.org/3/cg/public/July2017/DiBiaso_Bergner_01a_0717.pdf

Proposal:

- 14dB from DC (80Ω…120Ω)
- decrease from 3MHz to 40MHz

S_{cd21} (TCTL)



- This is just an example, mode conversion may not be worst case.
- Bert Bergners measurement have to be taken into account as well.

Proposal

- **30dB up 20MHz seems to give some reasonable margin.**
- **Above 20MHz decrease of MC is expected**

Part 2

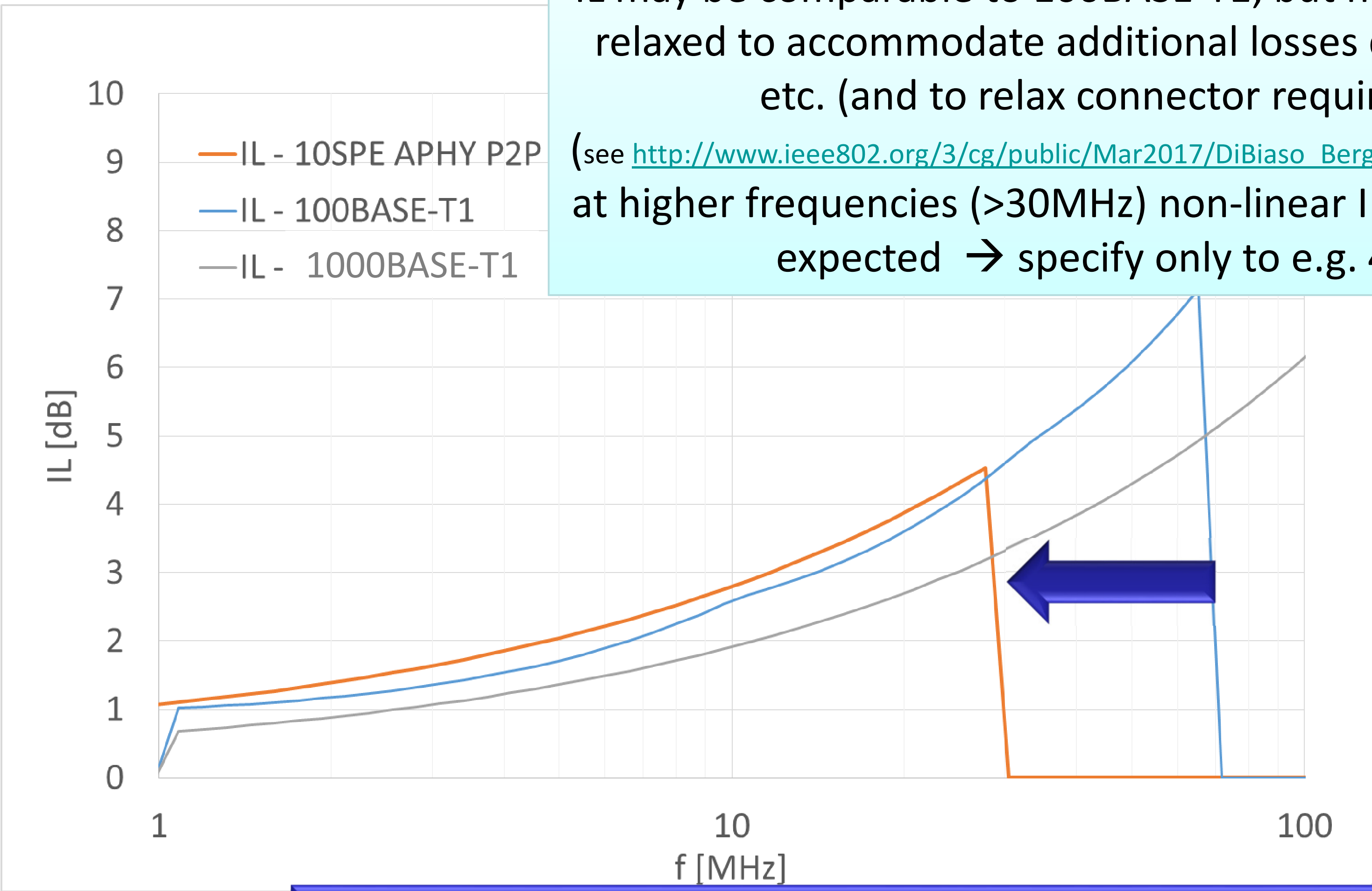
- proposal for automotive P2P link segment
- (always with comparison to 100BASE-T1/1000BASE-T1)

Look on RF parameter – comparison to 100BASE-T1/1000BASE-T1

IL may be comparable to 100BASE-T1; but needs to be slightly relaxed to accommodate additional losses due to higher RL, etc. (and to relax connector requirement)

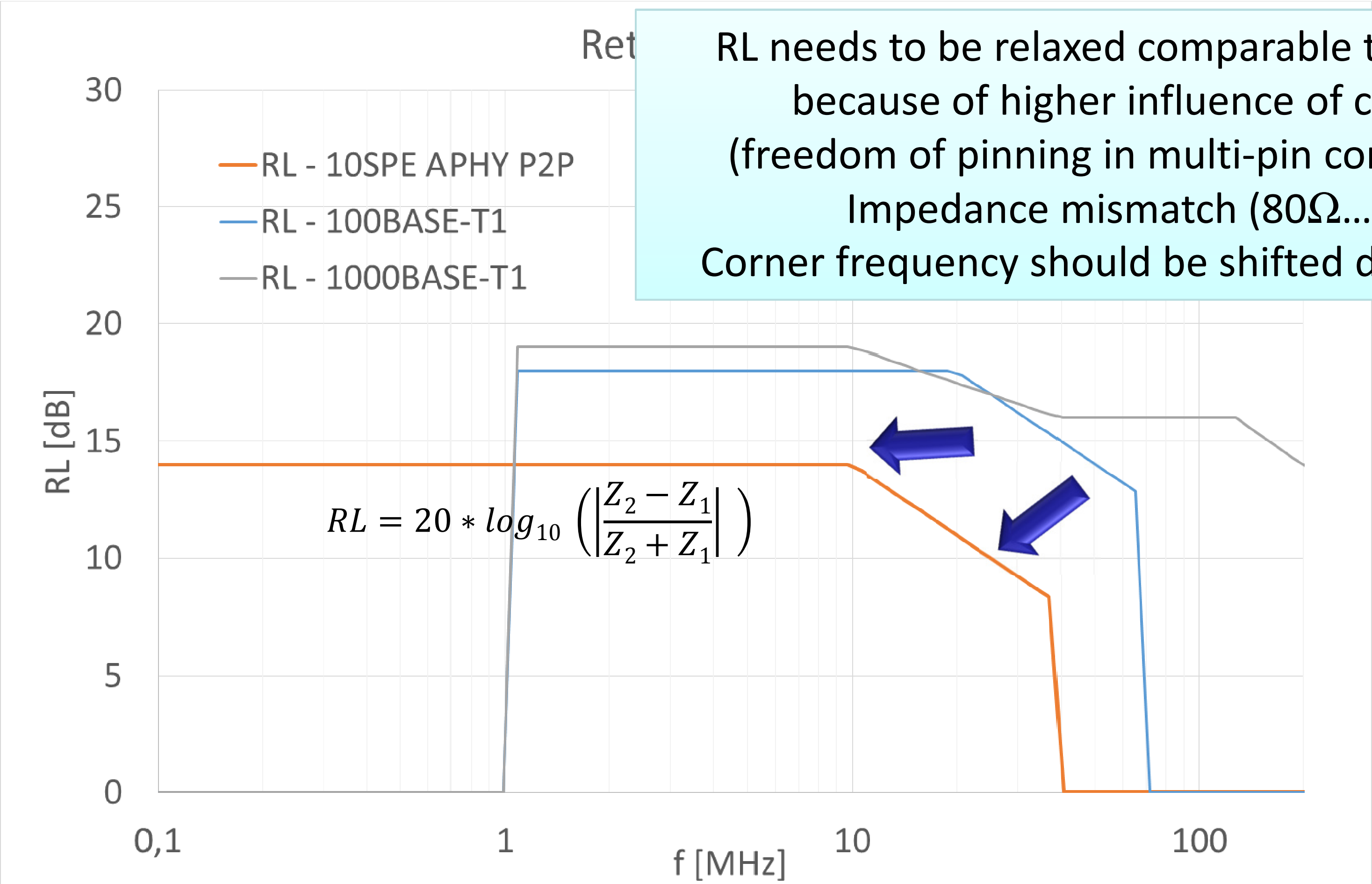
(see http://www.ieee802.org/3/cg/public/Mar2017/DiBiaso_Bergner_01a_0314.pdf, slide 3)

at higher frequencies (>30MHz) non-linear IL behavior may be expected → specify only to e.g. 40MHz



IL = 0,2 + 0,004*f + 0,8*SQRT(f) + 0,07*(1/SQRT(f))   f=0,1...40MHz

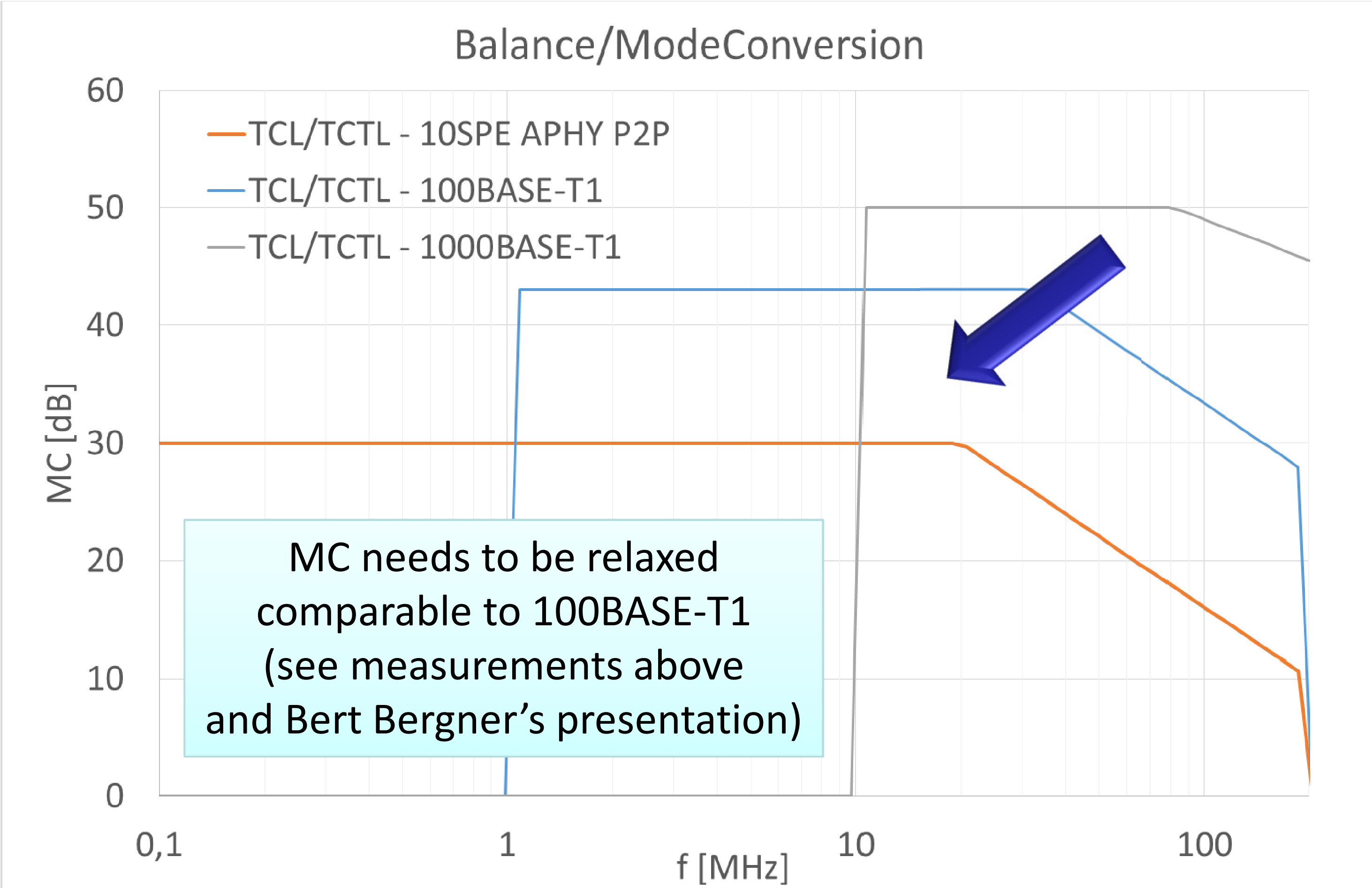
Look on RF parameter – comparison to 100BASE-T1/1000BASE-T1



RL needs to be relaxed comparable to 100BASE-T1
because of higher influence of connectors
(freedom of pinning in multi-pin connectors) and
Impedance mismatch (80Ω….120Ω)
Corner frequency should be shifted down to 10MHz

RL =	14	f=0,1...3MHz
	14-10*LOG10(f/3)	f=3...40MHz

Look on RF parameter – comparison to 100BASE-T1/1000BASE-T1



MC needs to be relaxed comparable to 100BASE-T1 (see measurements above and Bert Bergner's presentation)

MC =	30	f=0,1…20MHz
	30-20*LOG10(f/30)	f=20…200MHz

Modeling of diagrams

For information here the used formulas for the shown diagrams for a potential 10SPE automotive PHY P2P link segment:

IL =	0,2 + 0,004*f + 0,8*SQRT(f) + 0,07*(1/SQRT(f))	f=0,1…40MHz*
RL =	14	f=0,1…3MHz
	14-10*LOG10(f/3)	f=3…40MHz
MC =	30	f=0,1…20MHz
	30-20*LOG10(f/30)	f=20…200MHz

*coefficients are derived from matching to 100BASE-T1 curve

In addition, impedances of Z_{DM} = 80…120ohms are seen (this may not match to RL now…)

remark: MC = ModeConversion (in-pair) and CrossConversion (between pairs)

Conclusion

- The influence of the vehicle environment can not be neglected.
- Additional measurements of different OEMs and different connector/cable systems (which maybe are intended to be used for 10SPE automotive PHY) within a cable harness or a vehicle would be greatly appreciated to provide a better data basis.
- **Based on the available data a baseline proposal could be made next meeting cycle**

1. **This proposal is for the Point-2-Point link segment. We expect that it is suitable also for the passive linear link.**
2. **These inputs are intended to support semiconductor manufacturers in their investigations, if this indeed the case.**