40GBASE-T link segment and PHY channel: Modelling and measurements

IEEE 802.3bq Indian Wells 2014

LEONI

Alexander Franck
M.Eng.
R&D

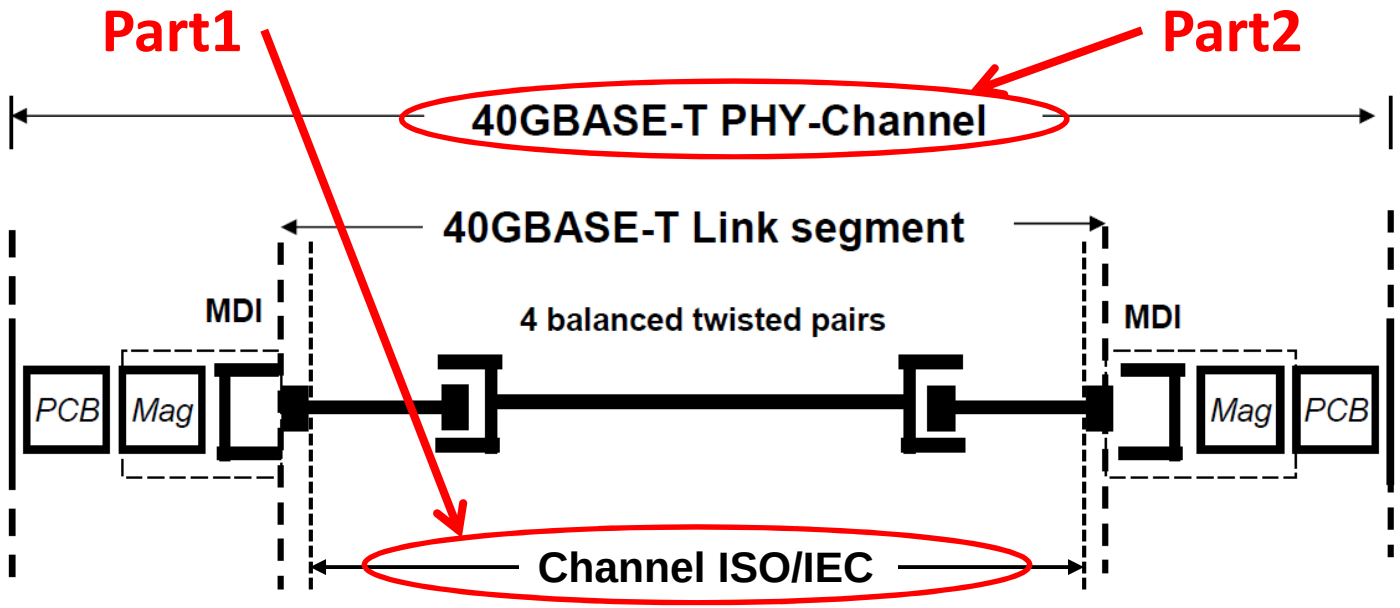
LEONI Kerpen GmbH
Zweifaller Straße 275-287
52224 Stolberg - Germany
alexander.franck@leoni.com

Authors

- Y. Engels, LEONI Kerpen
- A. Franck, LEONI Kerpen
- A. Oehler, Reutlingen University
- D. Schicketanz, Consultant

Supporters

Content



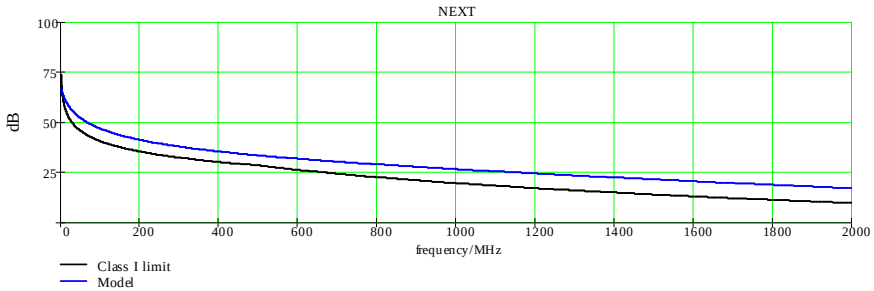
- **Part 1**: Modelling and measurement of long and short ISO/IEC Channel I and Channel II
- **Part 2**: Impact of PCB and MDI on the PHY Channel

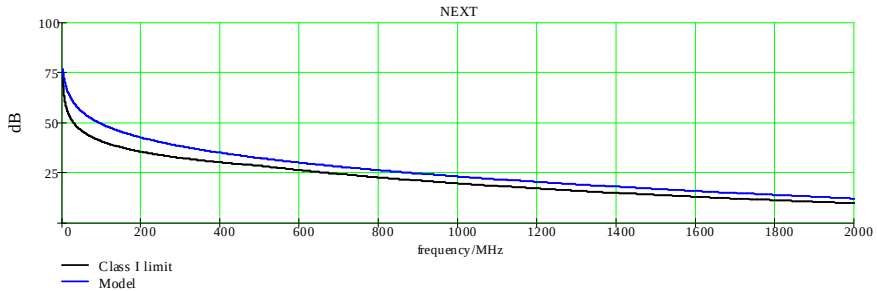
Part 1: Modelling and measurements of link segments (ISO/IEC cabling channels)

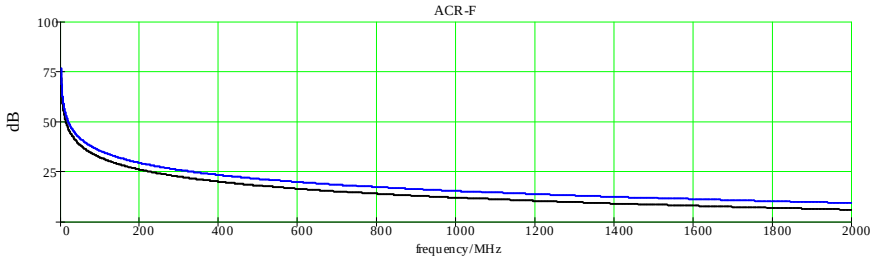
- Limit line model applied to ISO/IEC class I and class II and comparison to measurements class II
  - The limit line model is under work in ISO/IEC and a proposal for a technical report (WD 11801-99-3) is in process (ISO/IEC JTC 1 N 11897). The concept is to use the component limit lines without phase and process them with the help of the matrix approach.
  - Since not all component values are fixed and in order to reduce complexity at the moment, only the 4x4 S-Matrix is used and the provisional IEC component specifications are taken.

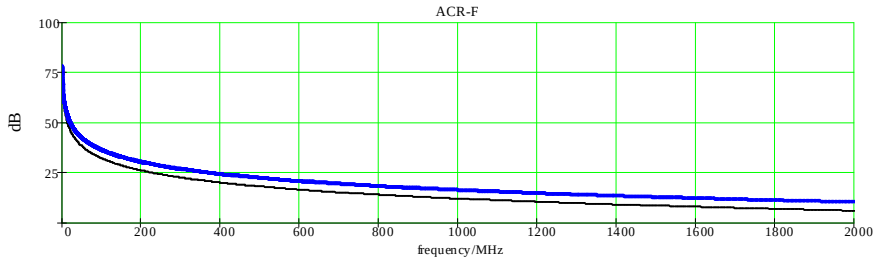
Class I Channel (similar to TIA cat8)

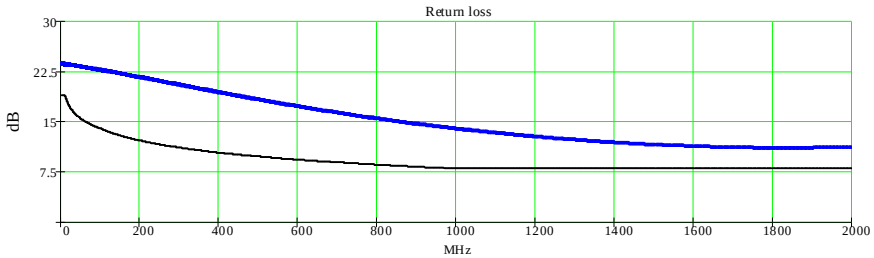
long: 2m-26m-2m short: 0.5m-3m-0.5m

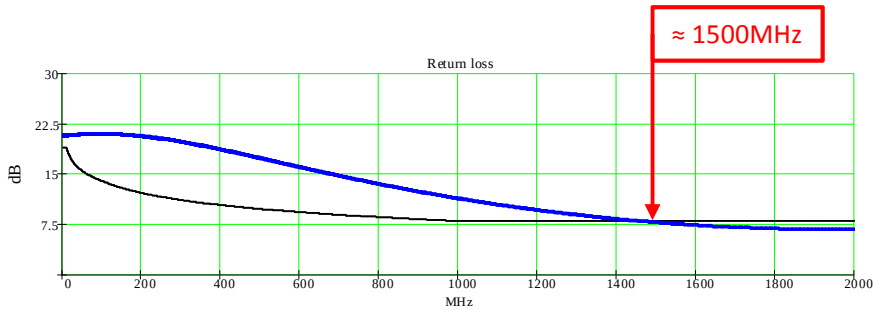








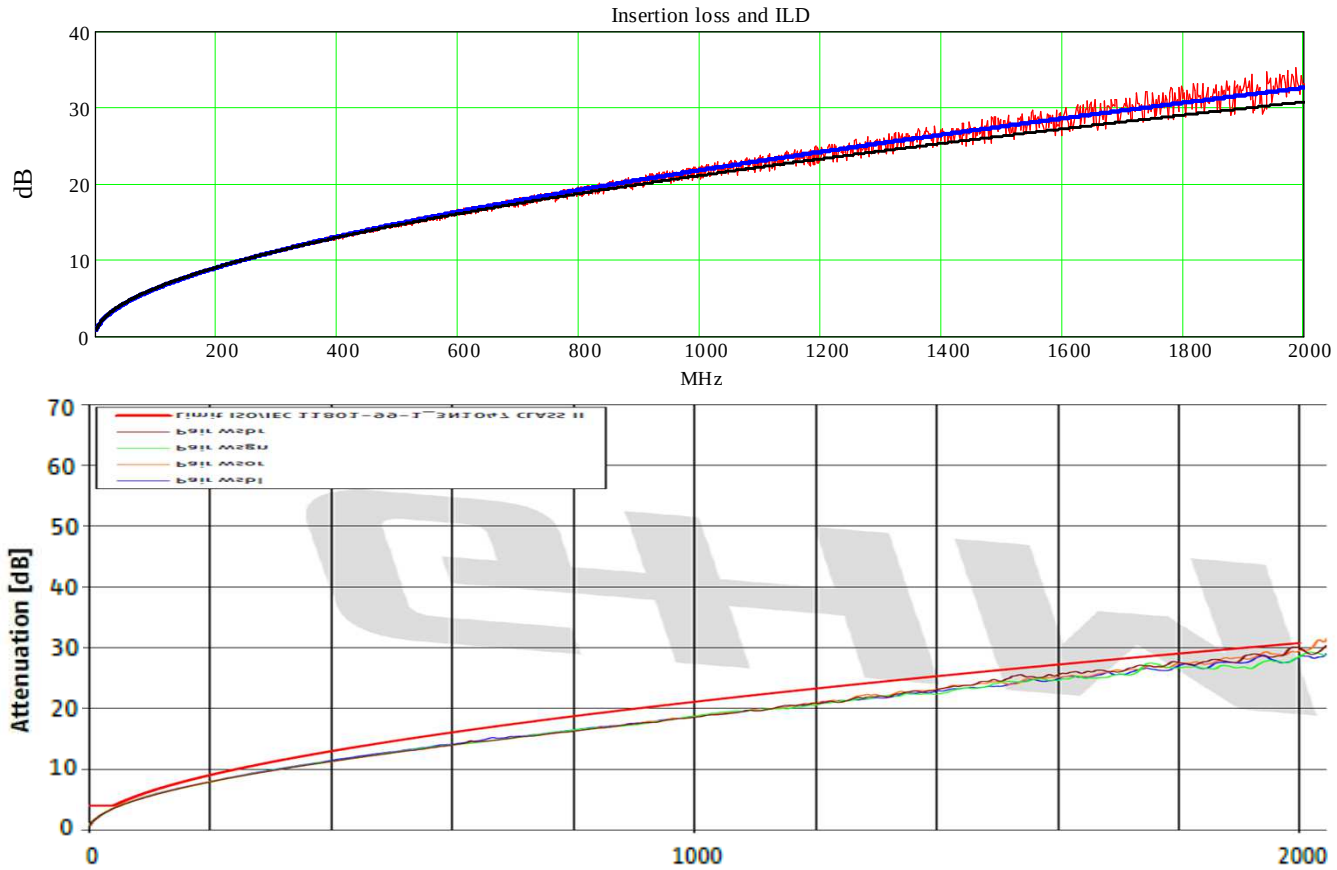




- Model – **ISO/IEC 11801-99-1 DTR N 2238 Class I Limits**

Class II Channel Insertion loss

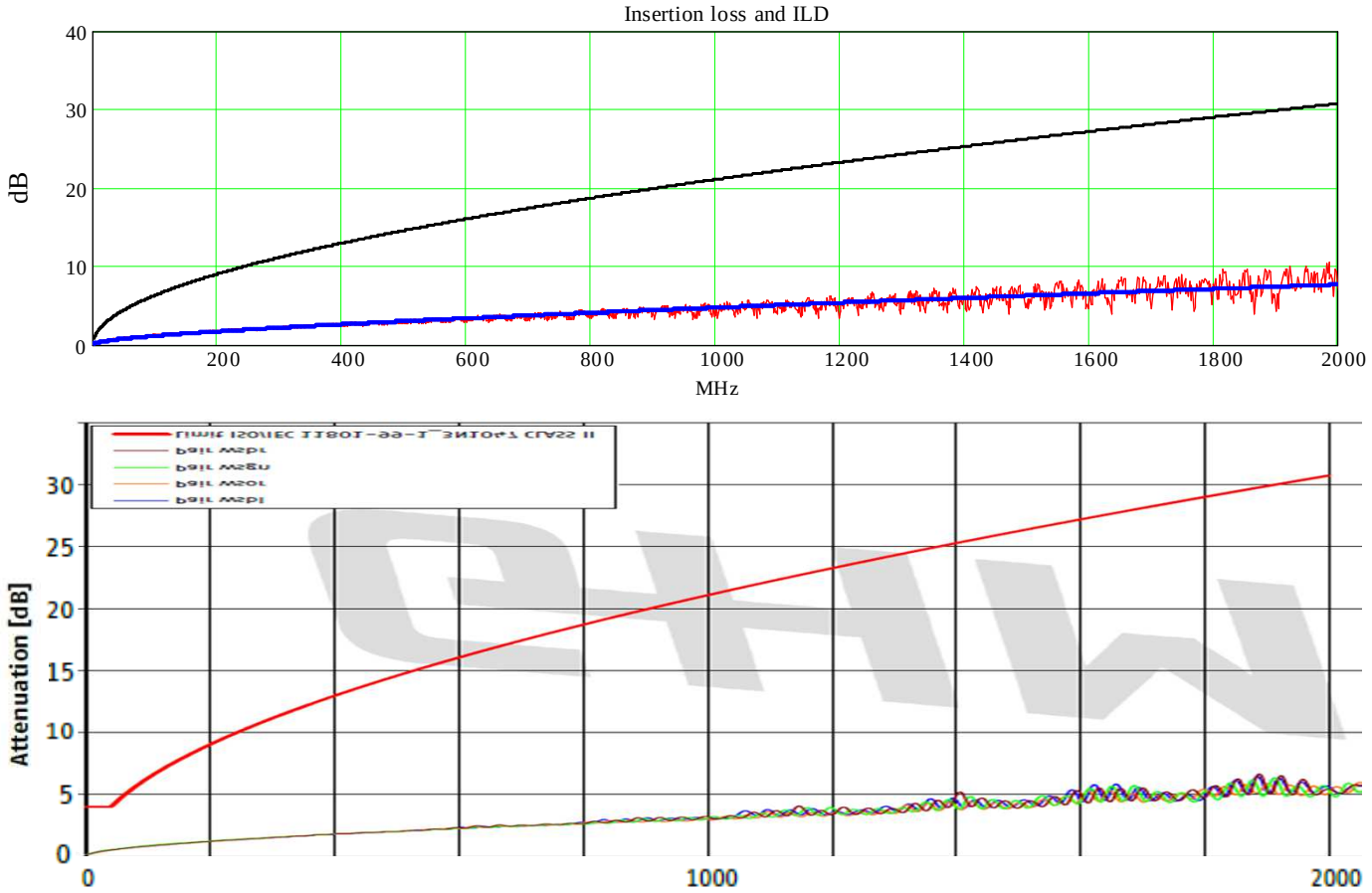
long: 2m-26m-2m



– ISO/IEC 11801-99-1 DTR N 2238 Class I Limits – ISO/IEC 11801-99-1 DTR N 2238 Class II Limits measurments – Model

Class II Channel Insertion loss

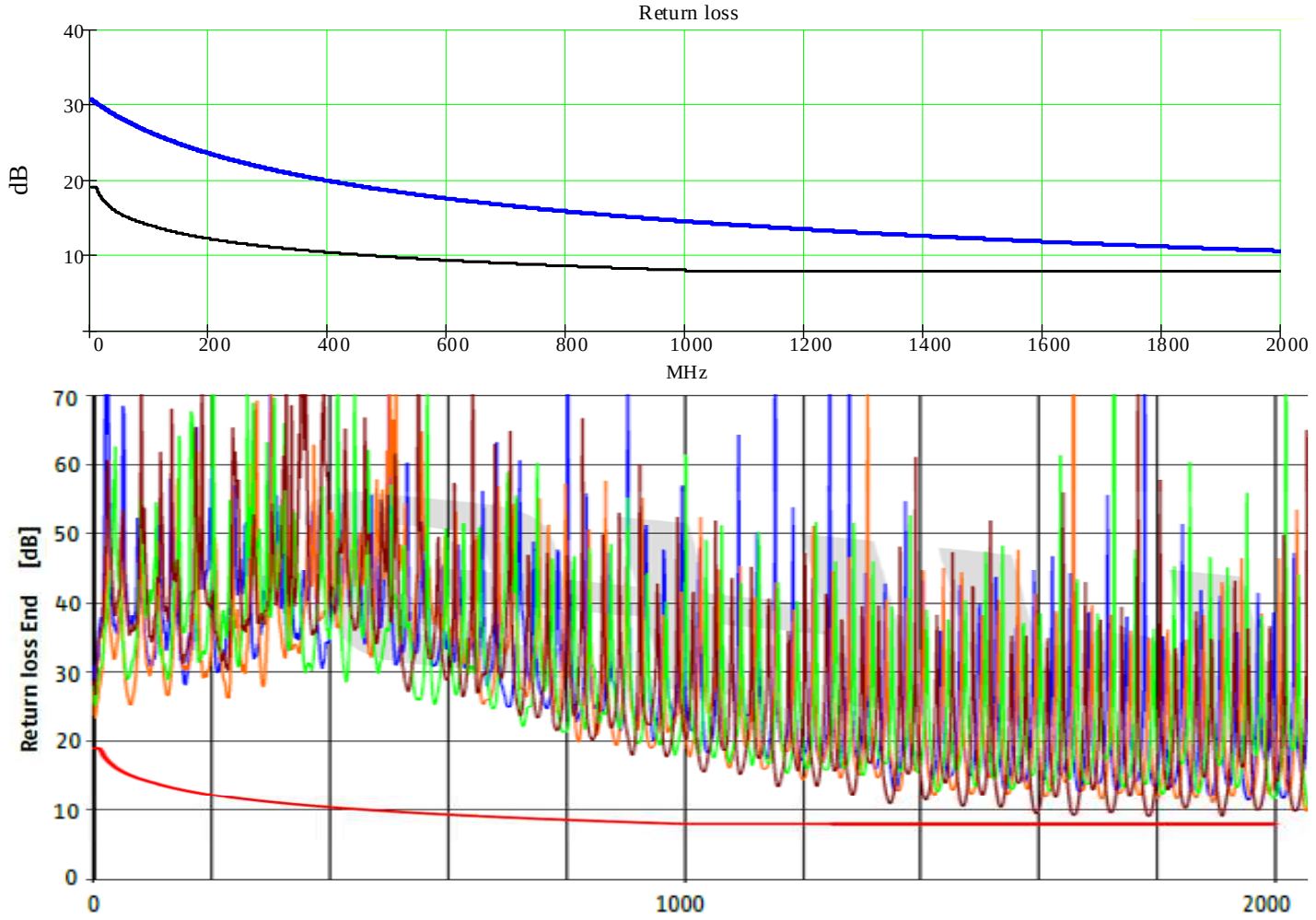
short: 0.5m-3m-0.5m



– ISO/IEC 11801-99-1 DTR N 2238 Class I Limits – ISO/IEC 11801-99-1 DTR N 2238 Class II Limits measurments – Model

Class II Channel Return loss

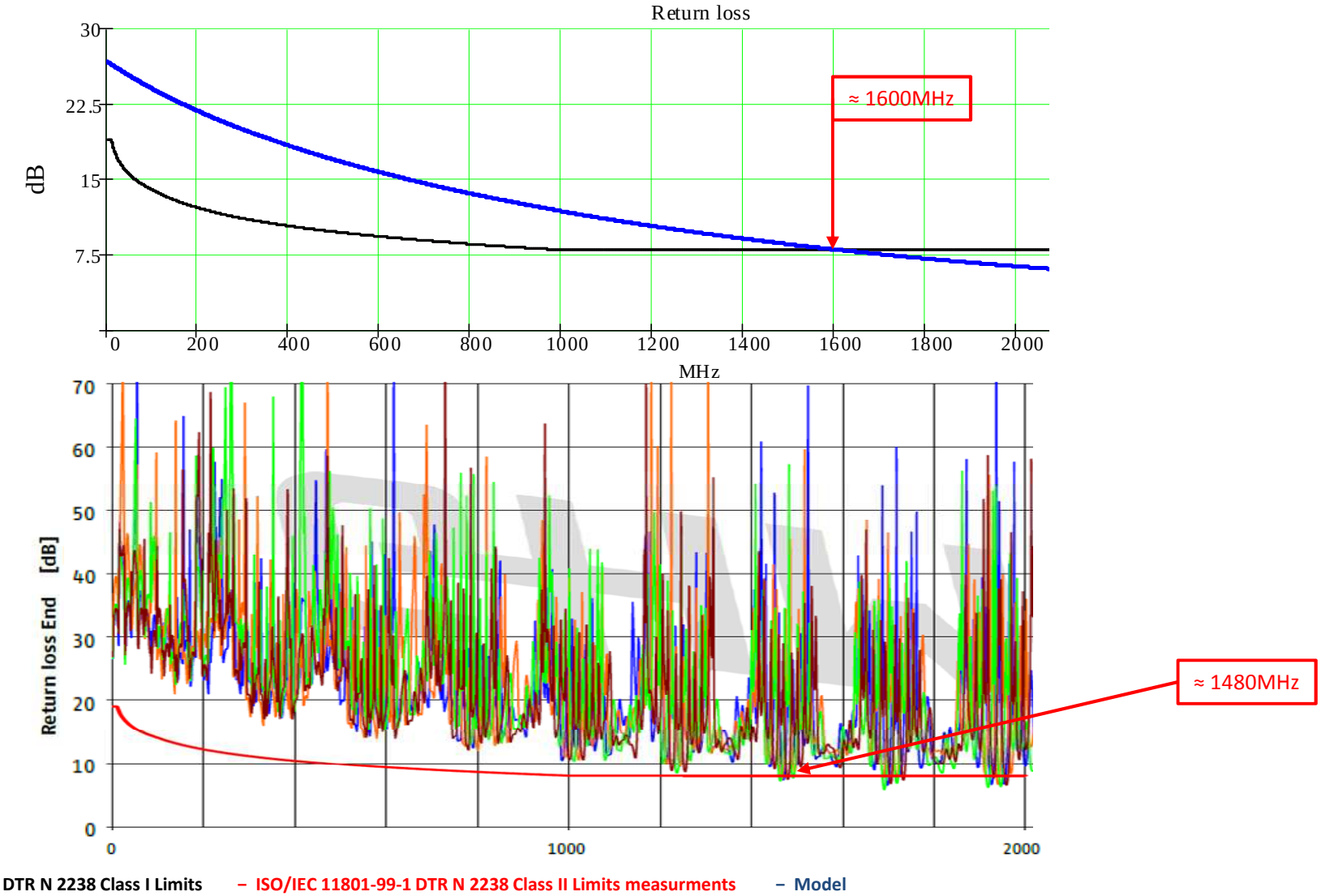
long: 2m-26m-2m



– ISO/IEC 11801-99-1 DTR N 2238 Class I Limits – ISO/IEC 11801-99-1 DTR N 2238 Class II Limits measurments – Model

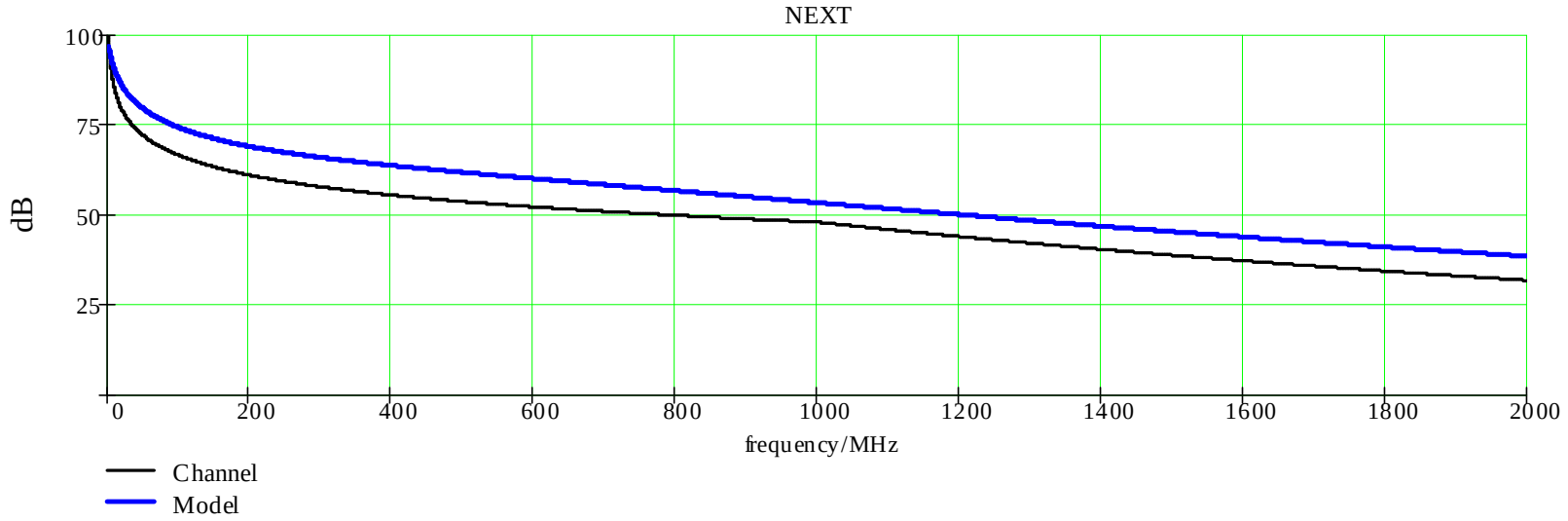
Class II Channel Return loss

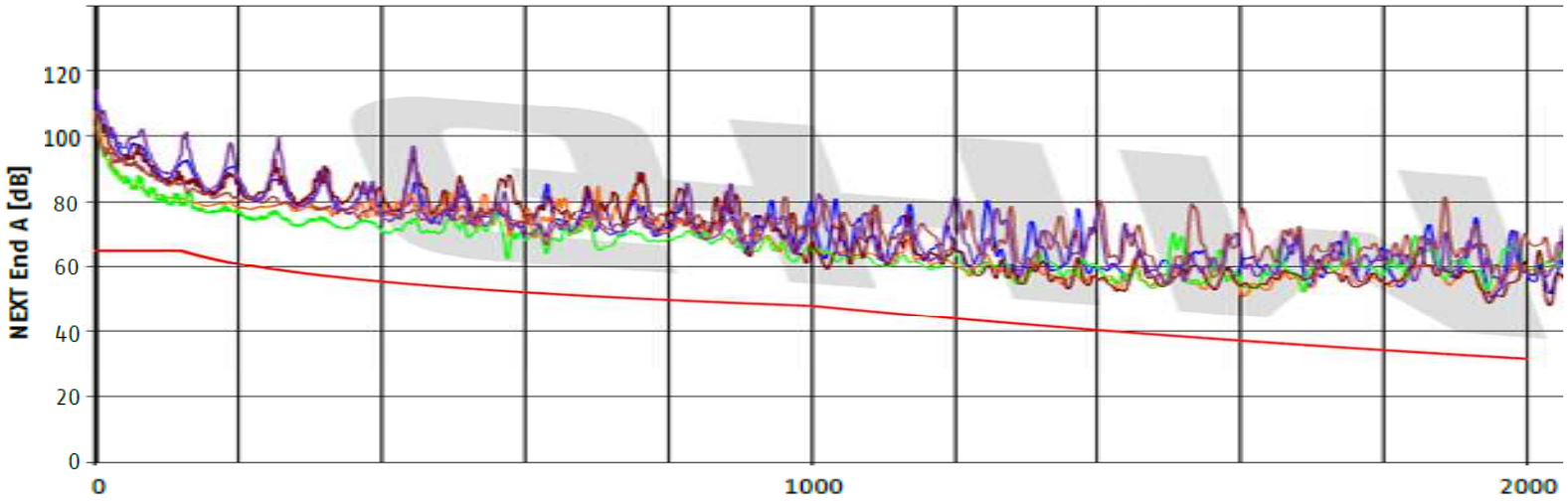
short: 0.5m-3m-0.5m



Class II Channel NEXT

long: 2m-26m-2m

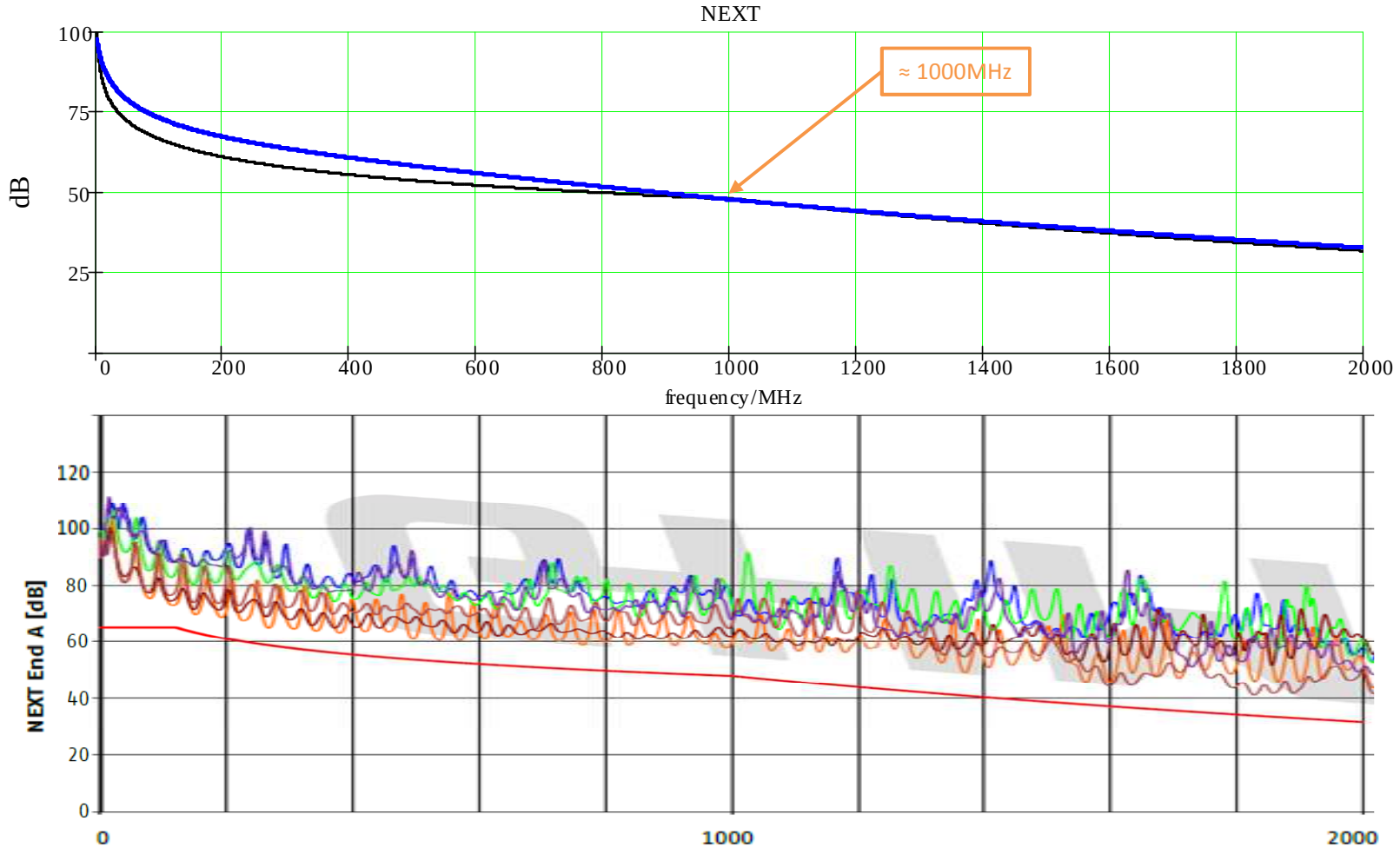




– ISO/IEC 11801-99-1 DTR N 2238 Class I Limits – ISO/IEC 11801-99-1 DTR N 2238 Class II Limits measurments – Model

Class II Channel NEXT

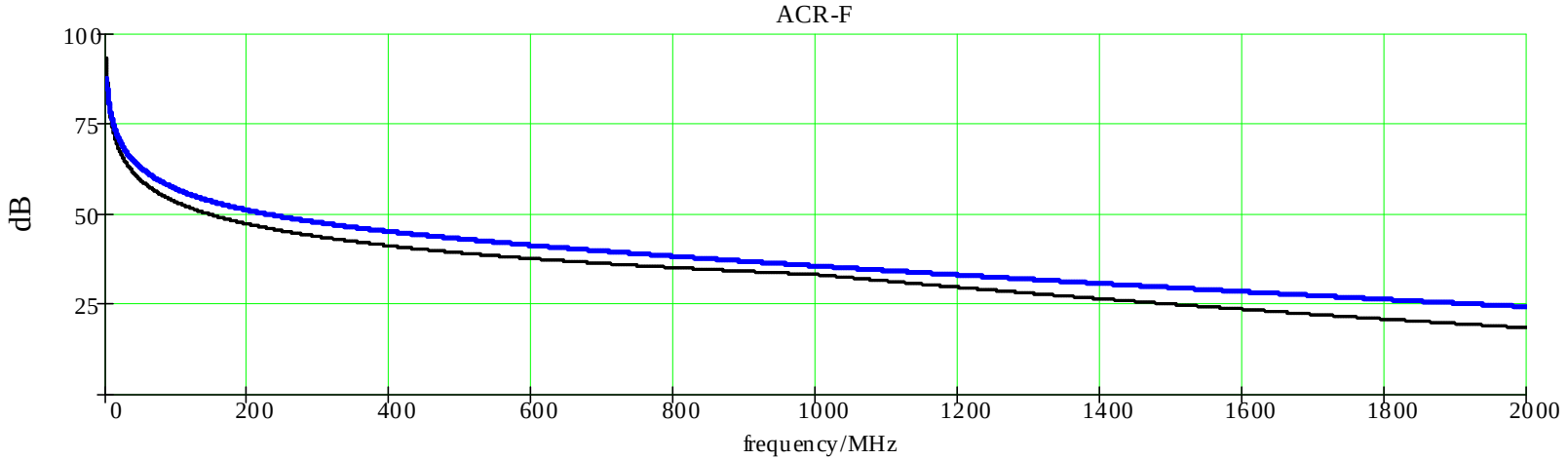
short: 0.5m-3m-0.5m

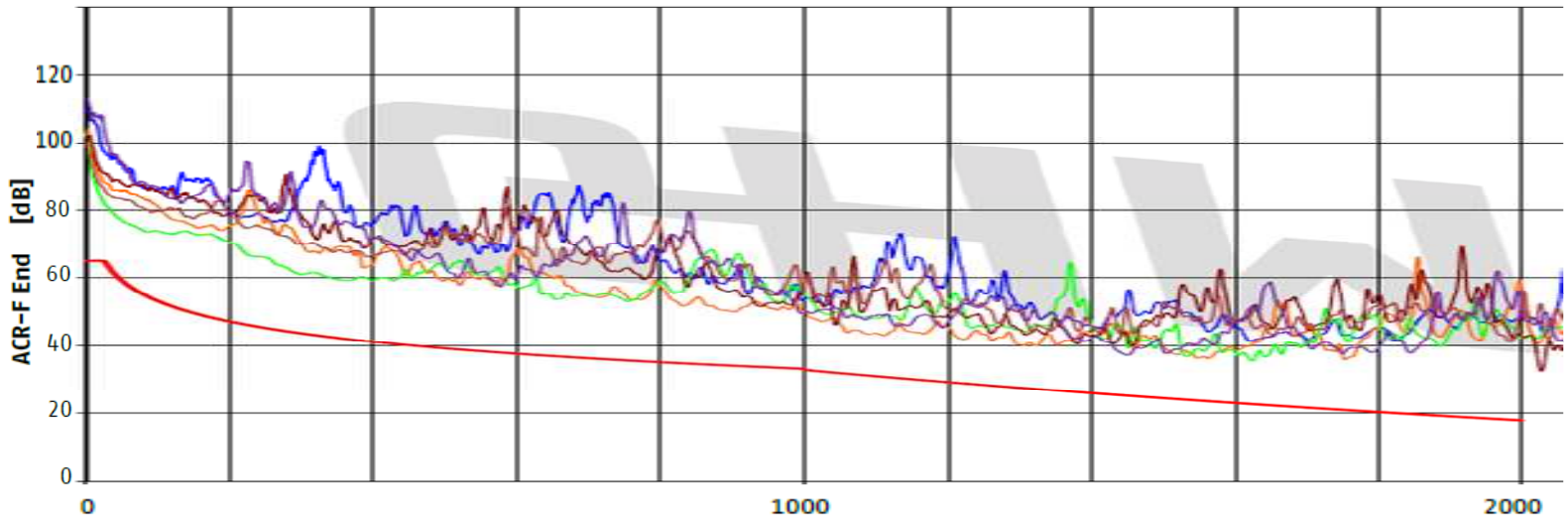


– ISO/IEC 11801-99-1 DTR N 2238 Class I Limits – ISO/IEC 11801-99-1 DTR N 2238 Class II Limits measurements – Model

Class II Channel ACR-F

long: 2m-26m-2m

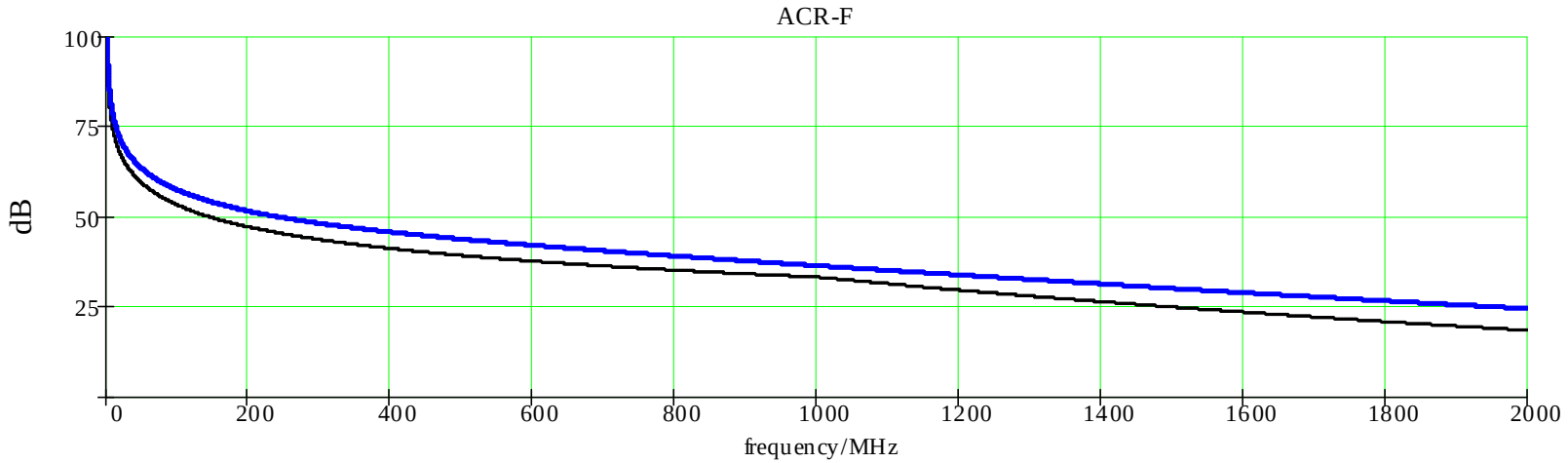


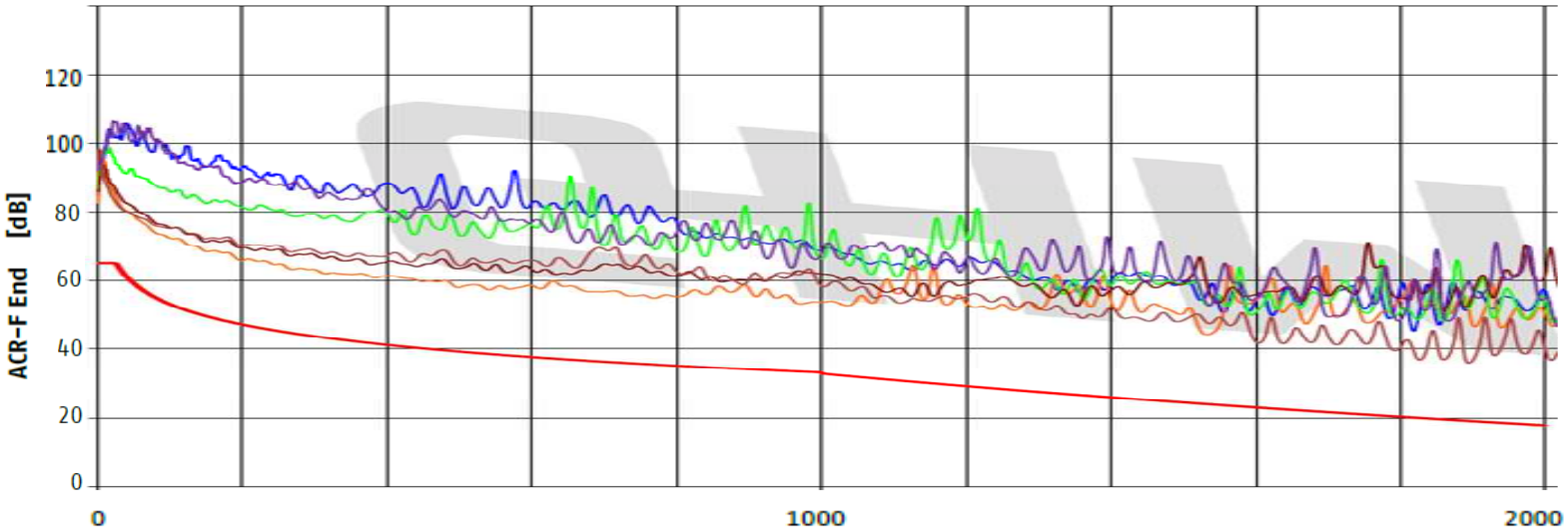


– ISO/IEC 11801-99-1 DTR N 2238 Class I Limits – ISO/IEC 11801-99-1 DTR N 2238 Class II Limits measurments – Model

Class II Channel ACR-F

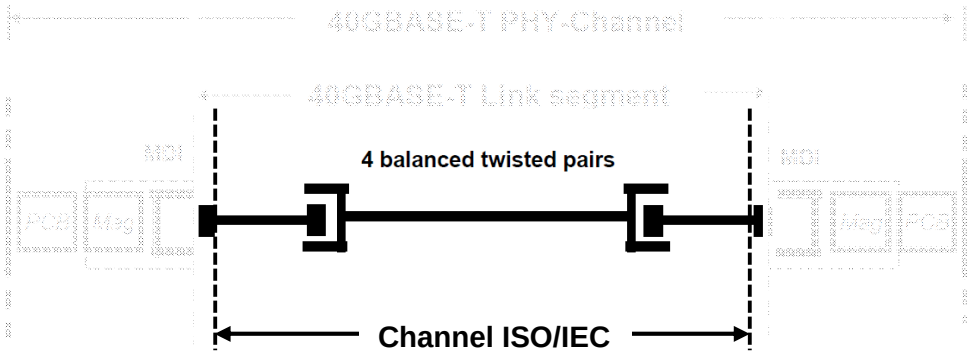
short: 0.5m-3m-0.5m





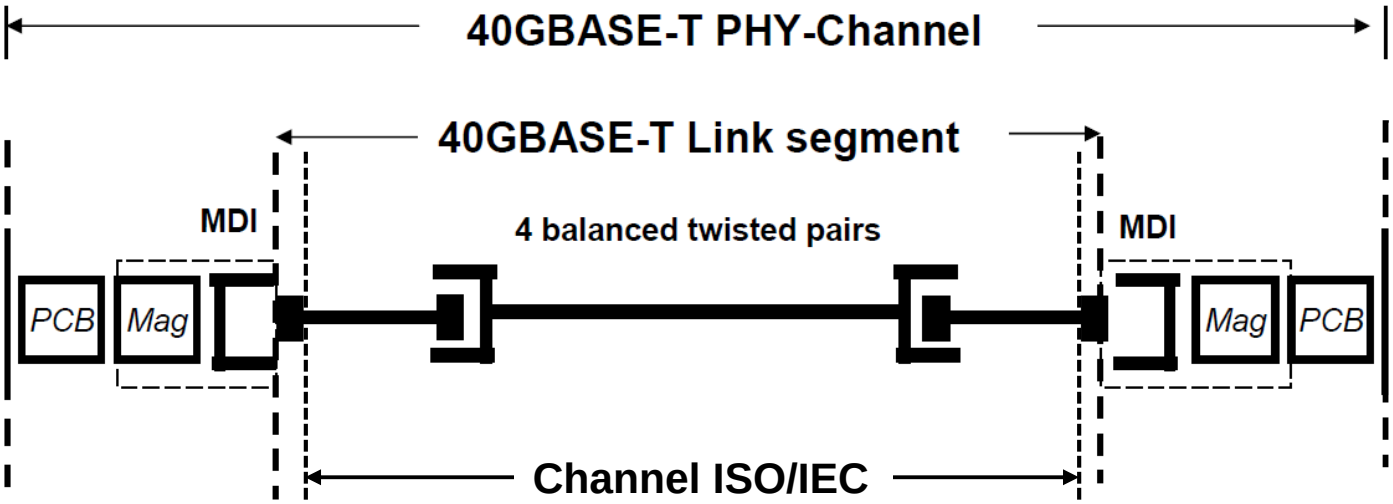
– ISO/IEC 11801-99-1 DTR N 2238 Class I Limits – ISO/IEC 11801-99-1 DTR N 2238 Class II Limits measurments – Model

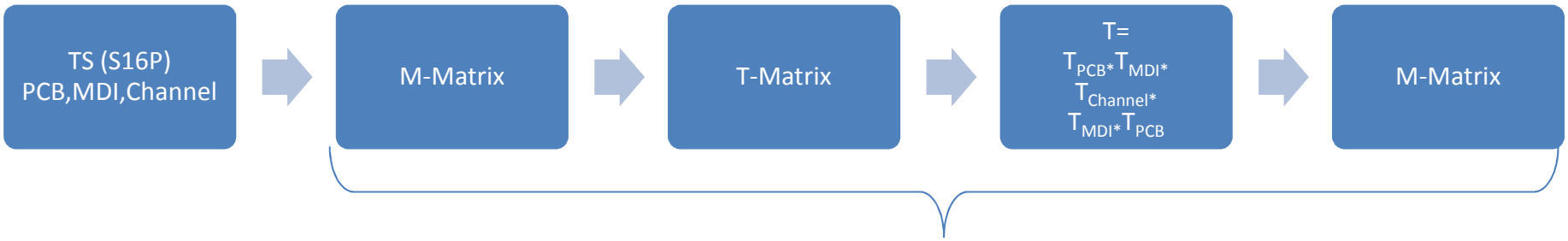
Conclusions Part 1



- ISO/IEC model works and mirrors actual measurements
- Up to 1600 MHz the limit lines for RL are sufficient even for very short Class I and Class II channels
- Measurements show capabilities to achieve Class II for short and long channels
- The model can be used to calculate PHY channels

Part 2: Modelling of PHY Channels with touchstone data





ITG Paper: Impact of the common mode on high data rate transmission over balanced cabling

Part 2: Modelling of PHY Channels with touchstone data

- In a first step 8x8 matrices were processed but 6 cases could be seen for each result

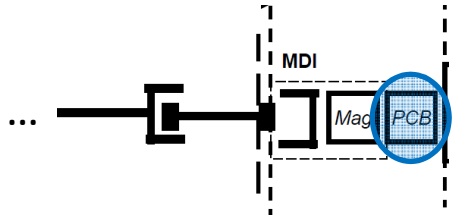
Physical pair pins	Pair naming	Insertion loss pair	Result labelling	NEXT pairs	FEXT pairs	
12	1	1	Case 1	1-2	1-2	
36	2	2	Case 2	2-3	2-3	worst case
45	3	3	Case 3	3-4	3-4	
78	4	4	Case 4	4-1	4-1	best case
78	4	4	Case 5	2-4	2-4	
78	4	4	Case 6	1-3	1-3	

The following Touchstone-Files were used:

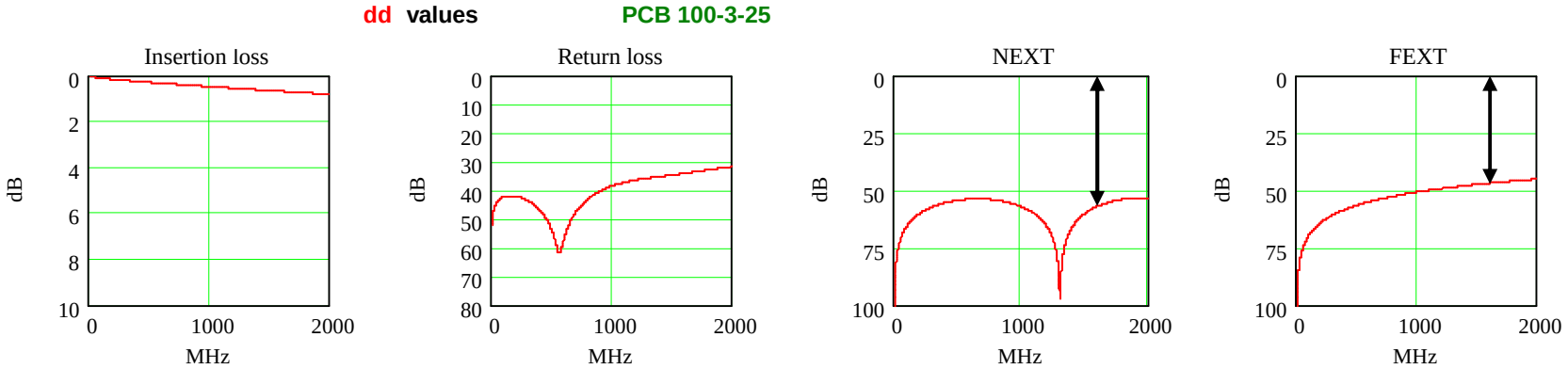
PCB = Intel
MDI = Bel
Channel = Nexans, Commscope

PCB Intel:

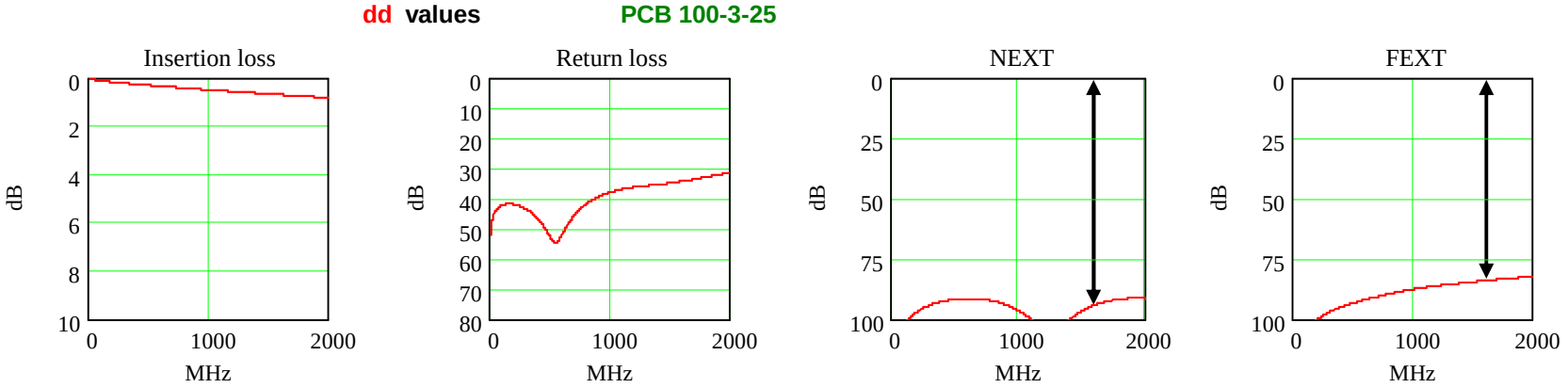
(100Ω_3in_25mils)



- Case 2: Adjacent microstrip traces (worst case)



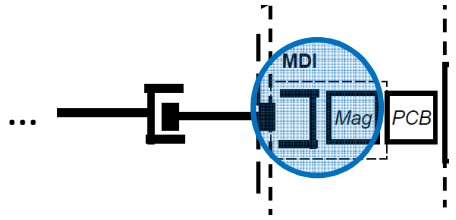
- Case 4: widely separated microstrip traces (best case)



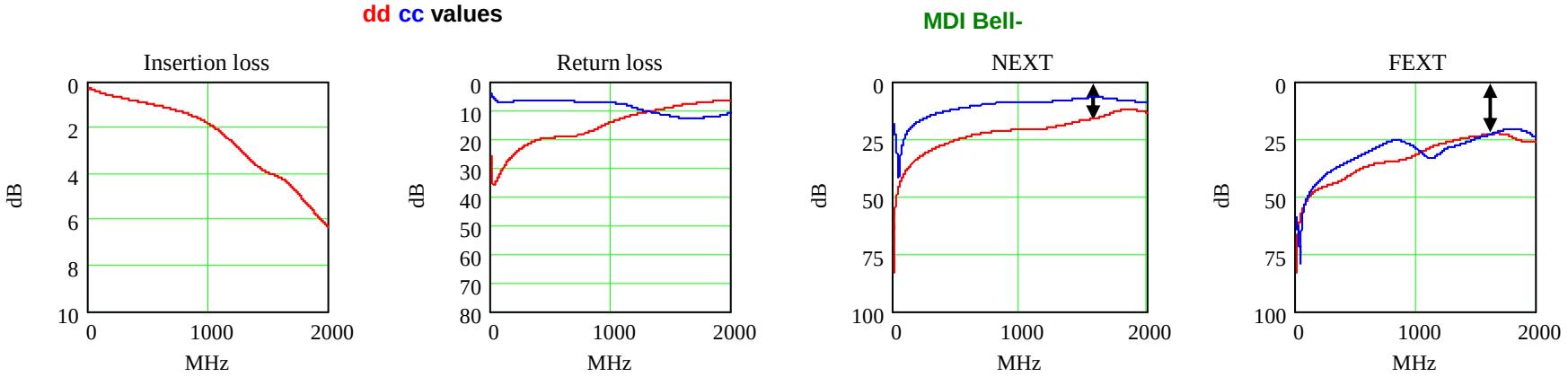
➢ PCB shows good NEXT margins (Case2: ≈54dB, Case4: >80 dB)@1.6GHz

MDI Bell :

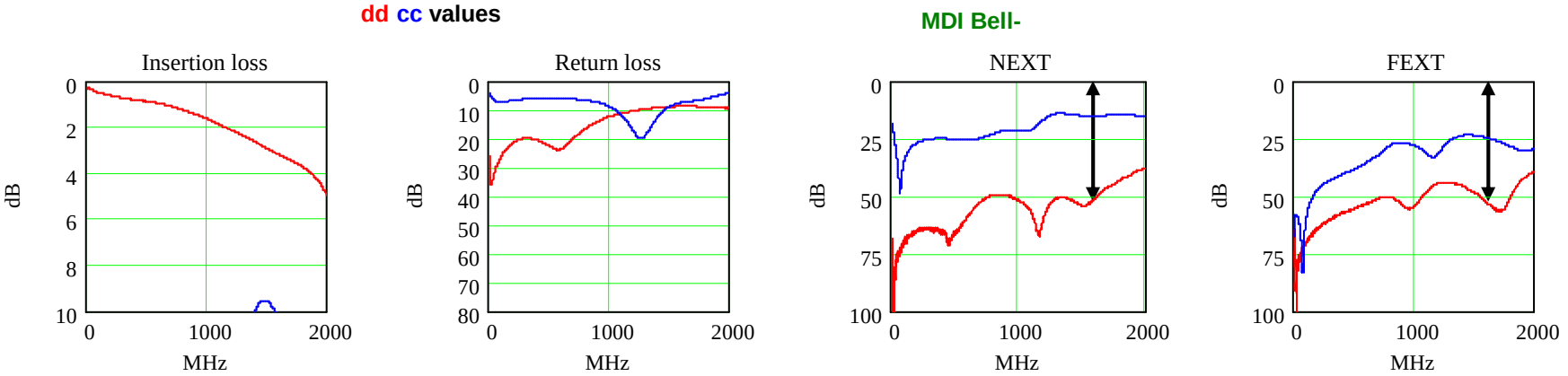
(BellCM2, incl. magnetics)



- Case 2: Worst case



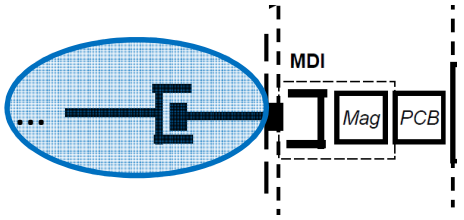
- Case 4: Best case



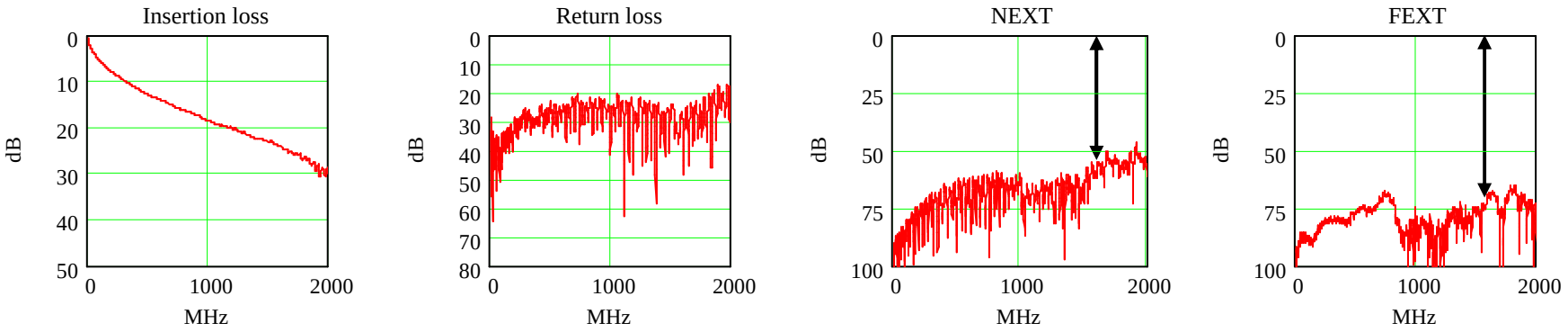
➢ MDI shows significant difference in bad combinations
NEXT margins (Case2: ≈17dB, Case4: ≈50 dB)@1.6GHz

Channel Class II Nexans:

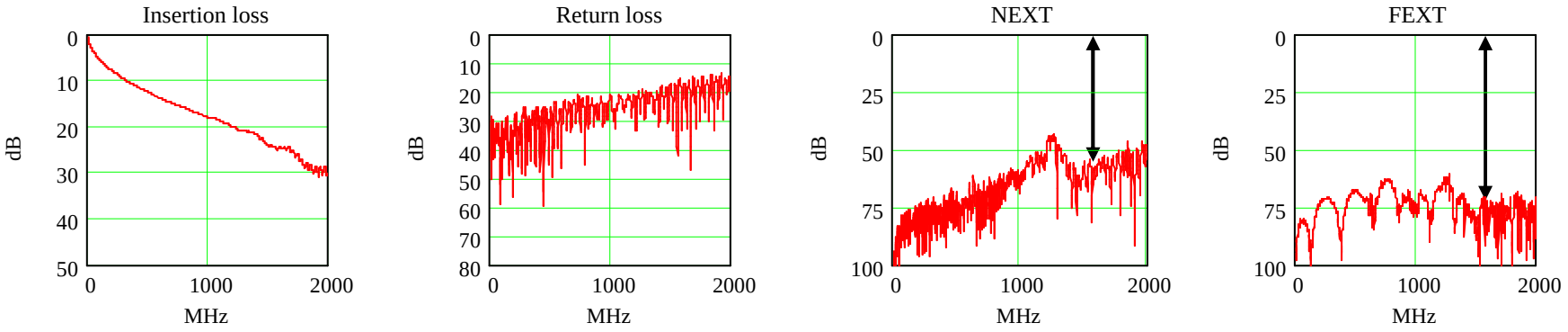
long: 3m-24m-3m (3_24_3_Nexans2)



dd values **Nexans 30m**



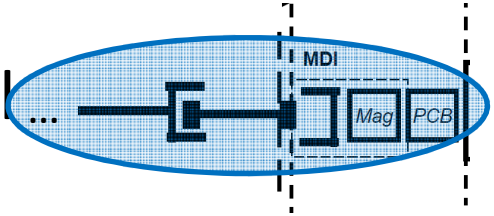
dd values **Nexans 30m**



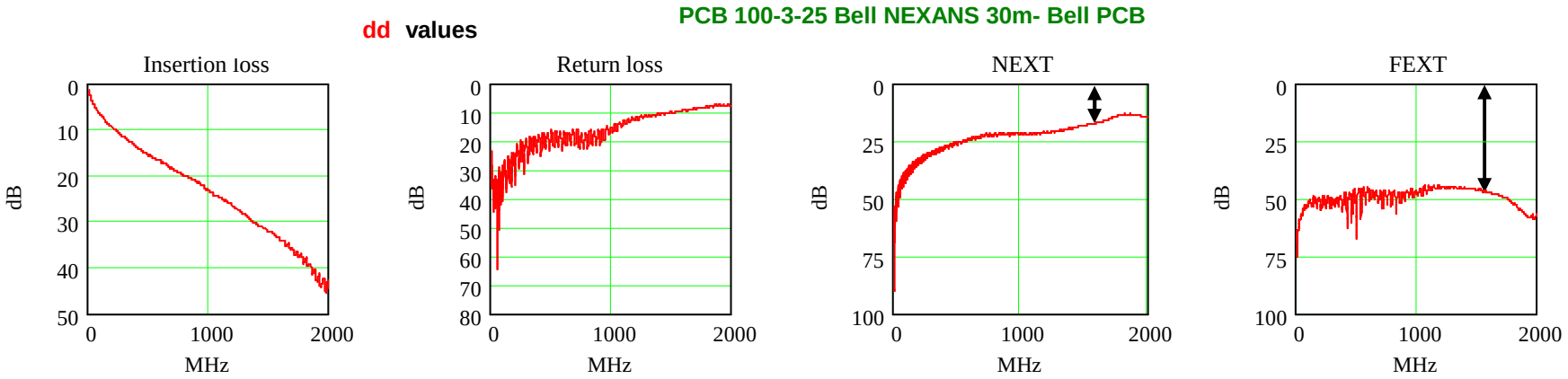
- Channel Class II NEXT margins (Case2: >50dB, Case4: >50 dB)@1.6GHz

Channel Class II Nexans + **MDI** Bell + **PCB** Intel

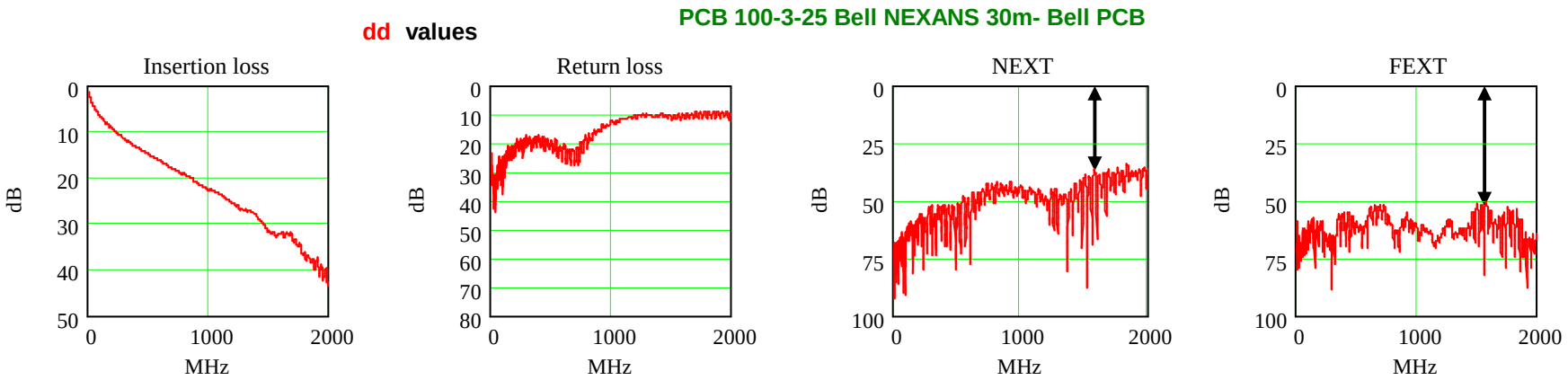
long: 3m+24m+3m + MDI(incl. magnetics) + PCB(100Ω_3in_25mils)



- Case 2: Worst case



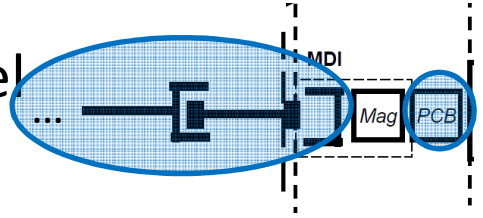
- Case 4: Best case



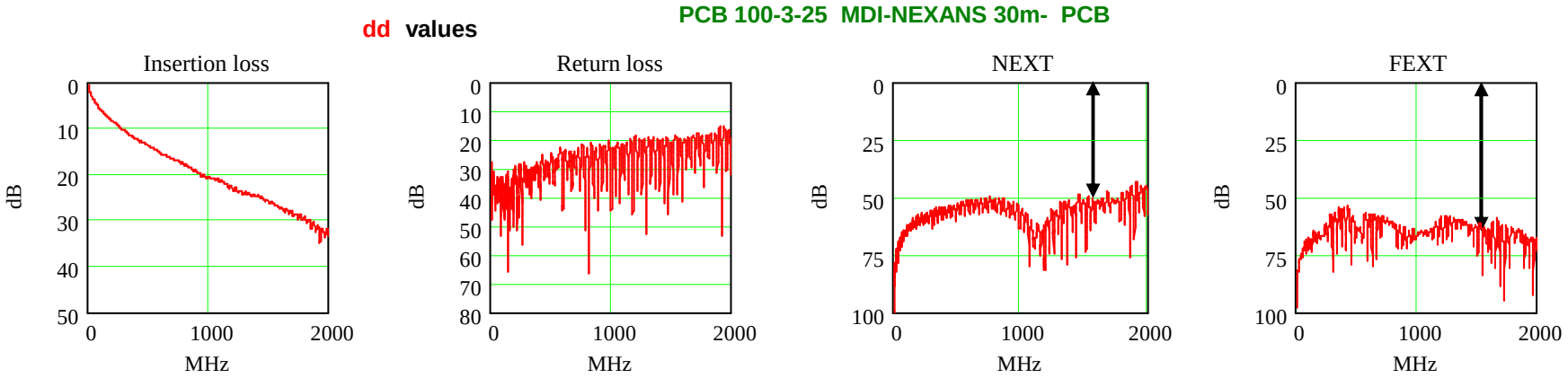
- The magnetics disturb in both cases
- Decreasing NEXT margin (Case2: ≈15dB, Case4: ≈37 dB)@1.6GHz

Channel Class II Nexans + w/o Magnetics + **PCB** Intel

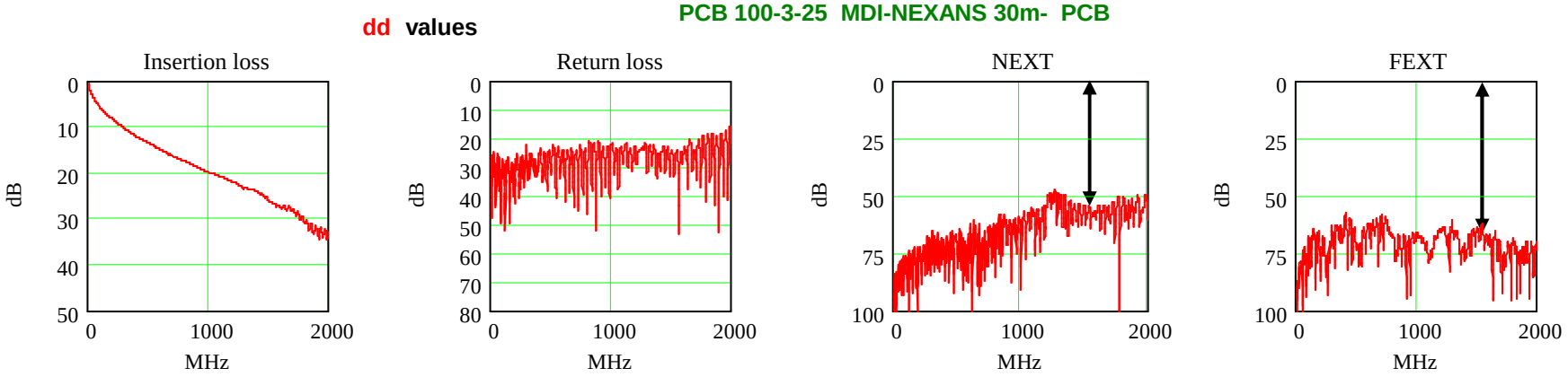
long: 3m+24m+3m(3_24_3_Nexans2) + PCB (100Ω_3in_25mils)



- Case 2: Worst case



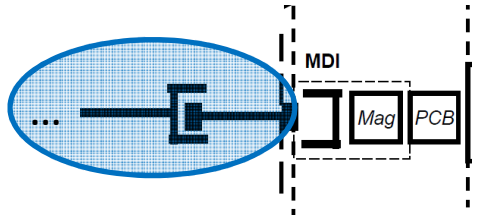
- Case 4: Best case



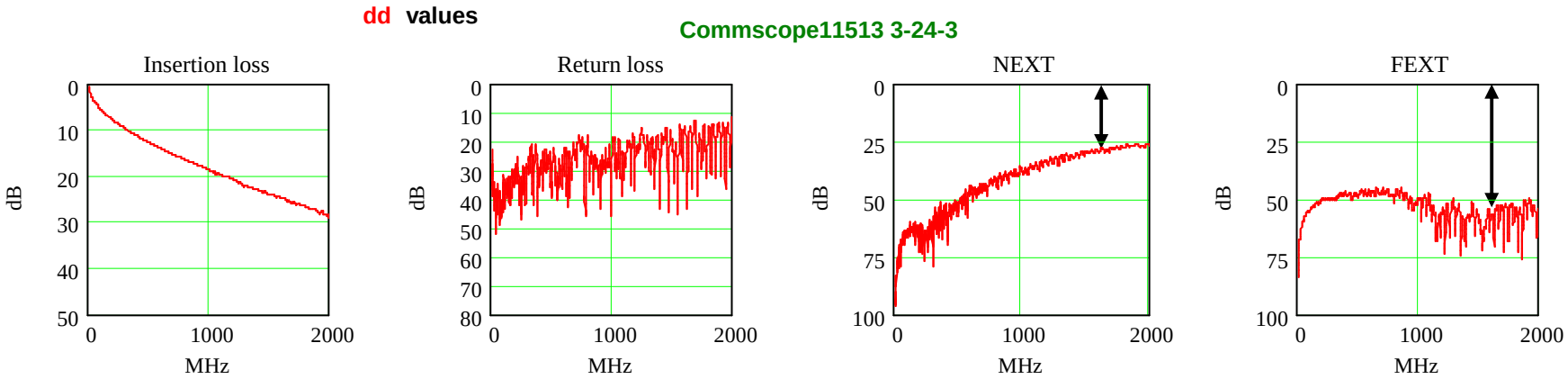
➢ Channel Class II without MDI shows good margins (Case2: 50dB, Case4: >50dB)@1.6GHz

Channel Class I Commscope:

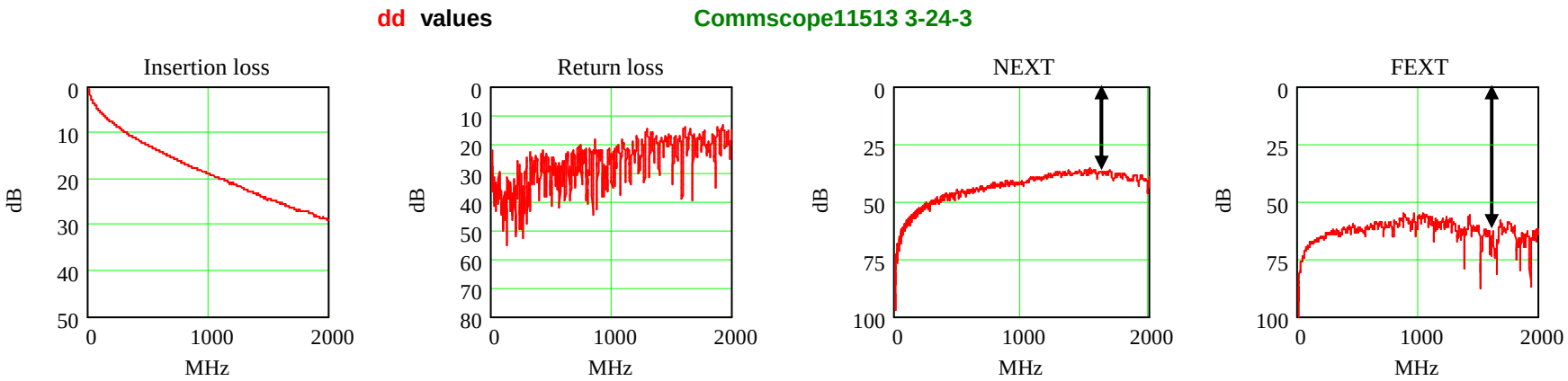
long: 3m-24m-3m (11513_3_24_3)



- Case 2: Worst case



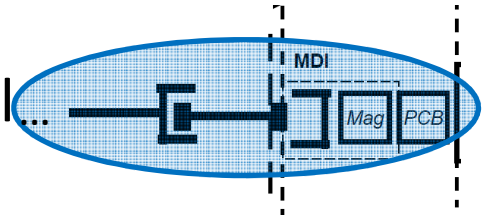
- Case 4: Best case



➢ Channel Class I NEXT margin (Case2: ≈26dB, Case4: ≈37dB)@1.6GHz

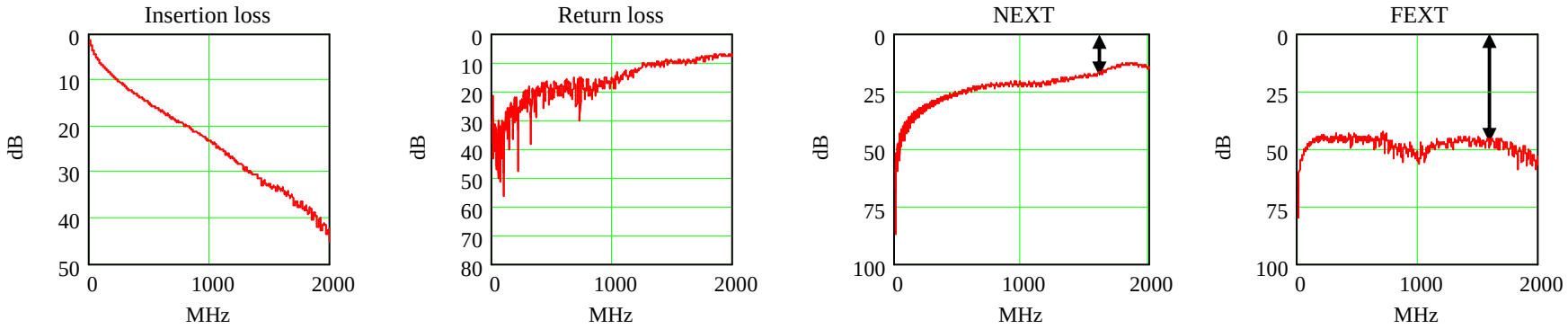
Channel Class I Commscope + MDI Bell + PCB Intel…

long: 3m+24m+3m + MDI(incl. magnetics)+PCB (100Ω_3in_25mils)



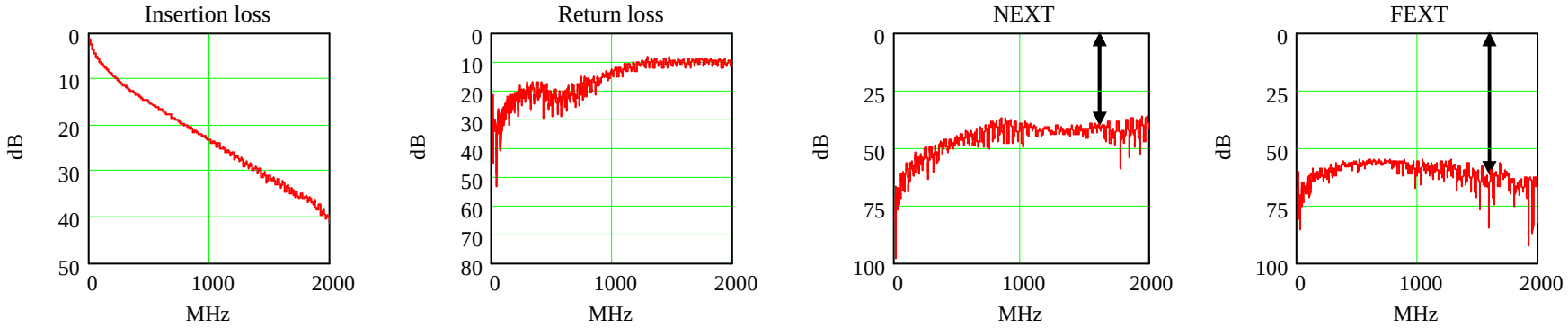
- Case 2: Worst case

dd values PCB 100-3-25 MDI Bell- Commscope11513 3-24-3 MDI Bell- PCB 100-3-25



- Case 4: Best case

dd values PCB 100-3-25 MDI Bell- Commscope11513 3-24-3 MDI Bell- PCB 100-3-25



- The magnetics disturb in both cases
- Decreasing NEXT margin (Case2: ≈15dB, Case4: ≈37 dB)@1.6GHz

Conclusion Part 2

- PCB layout
  - The choosen layout (3inch - 25mils) has already good transmission performance and does not derate the cabling performance
  - It is important to choose a layout that does not derate the cabling performance
- Magnetics on MDI
  - The presented cases demonstrate some very good pair combinations results and some moderate pair combination results.
  - At the moment the magnetics reduce the cabling channels dramatically even for class I as already known
- The model can be used for the impact regarding future improvement for MDI and/or PCB
- Channel II configurations shows more NEXT & FEXT margin then channel I configurations

Thank you

Any questions?