MDI return loss proposal

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Return loss and system complexity from Ahmad Chini and Hui Pan http://www.ieee802.org/3/bp/public/jan15/pan_3bp_01_0115.pdf

- Finite RL necessitates digital echo cancellation
  – Increased signal processing complexity
- Excessive echo reduces effective ADC dynamic range
  – Lower SNR and shorter cable reach
- High freq. echo amplifies jitter to noise conversion
  – Lower SNR and shorter cable reach
  – Slower timing recovery and longer startup
- Serial reflections cause system resonance
  – Degraded driver stability
  – More DM/CM conversions

Comparison to adopted MDI return loss mask by http://www.ieee802.org/3/ch/public/nov18/bhagwat_3ch_01a_1118.pdf

- To generate the MDI return loss mask, Bhagwat considers only the parasitic capacitance of the PoDL network.
- Additionally the ESD requirements have to be considered:
  - Chip handling, HBM (Human Body Model), CDM (charge device model)
- For an implementable system, MDI return loss mask should be relaxed:
  - At the lower frequency range to allow for smaller PoDL inductors.
  - High frequency range to allow for the parasitic capacitance of ESD protection diodes.

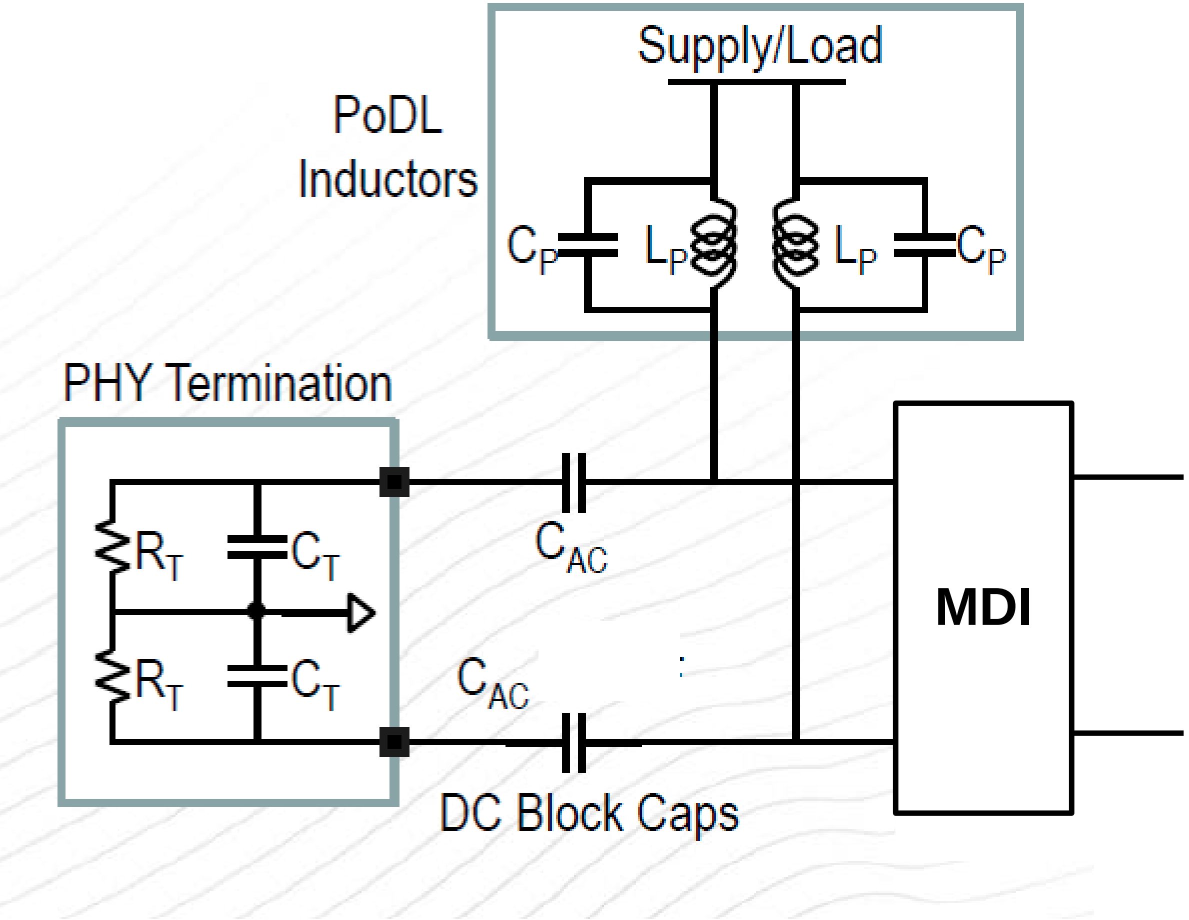
IEC 61000-4-2

- IEEE standard specifications should not preclude that the device can pass other e.g. ESD protection standards.
- Assumption: for connectors using a metallic connector shell, direct application of discharges to the pins is excluded:
  - IEC 61000-4-2, paragraph 8.3.2 Direct application of discharges to the EUT
    - The following exclusions apply:
    - d) the contacts of coaxial and multi-pin connectors which are provided with a metallic connector shell. In this case, contact discharges shall only be applied to the metallic shell of these connectors.

Considered topology and PoDL inductors

- 4 different available inductors
- Inductance lower than the 6.8uH inductance considered by bhagwat_3ch_01a_0918.pdf
- Parasitic capacitance computed from **S**elf-**R**esonant **F**requency
- $SRF = \frac{1}{2\pi\sqrt{CL}}$

Part Number	Inductance [uH]	Self-Resonant Frequency [MHz]	Parasitic Capacitance [pF]
PFL3215-222ME	2.2	250	0.184
PFL3215-332ME	3.3	190	0.180
PFL3215-472ME	4.7	170	0.184
1812DPS-222ML	2.2	175	0.376



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Single sided parasitic termination capacitance: Cterm 0.5pF to support HBM and CDM.

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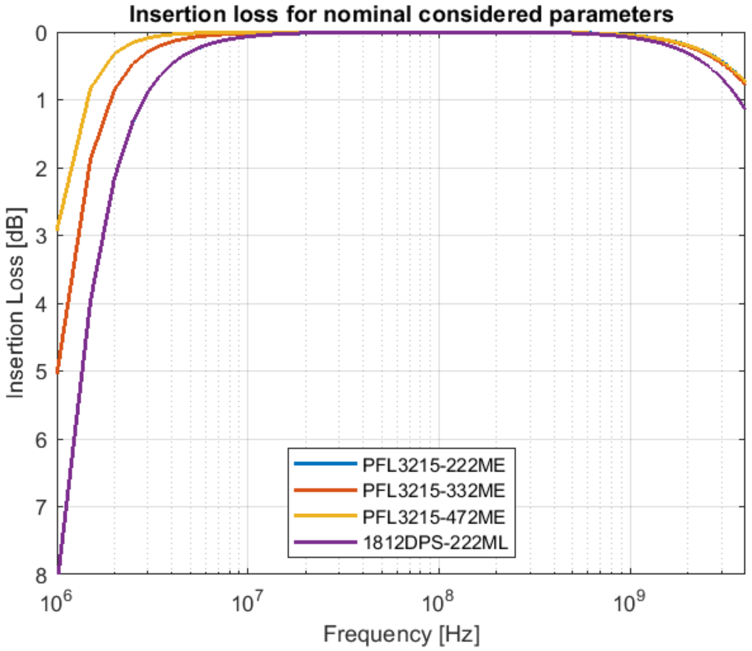

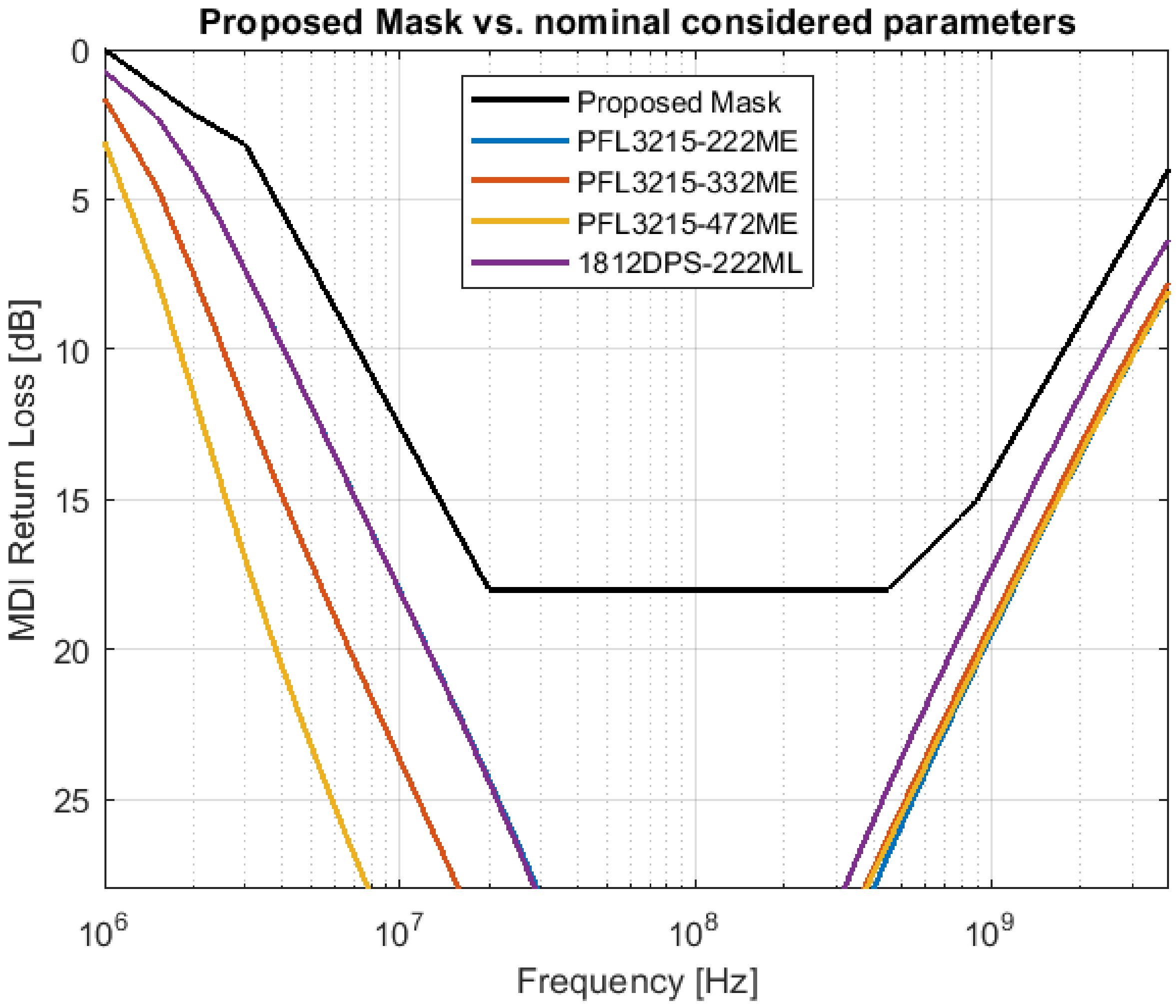

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Mask in numerical form considering single sided parasitic termination capacitance Cterm=0.5pF

$$\text{MDI return loss} = \begin{cases} 3.42+7.17\cdot\log10(f/3) & 1 \le f<3 \\ 18 + 18\cdot\log10(f/20) & 3 \le f<20 \\ 18 & 20 \le f<450 \\ 18 - 10\cdot\log10(f/450) & 450 \le f<900 \\ 15 - 17\cdot\log10(f/900) & 900 \le f<4000 \end{cases}$$

Return loss in dB, frequency in MHz

Parameter variation study

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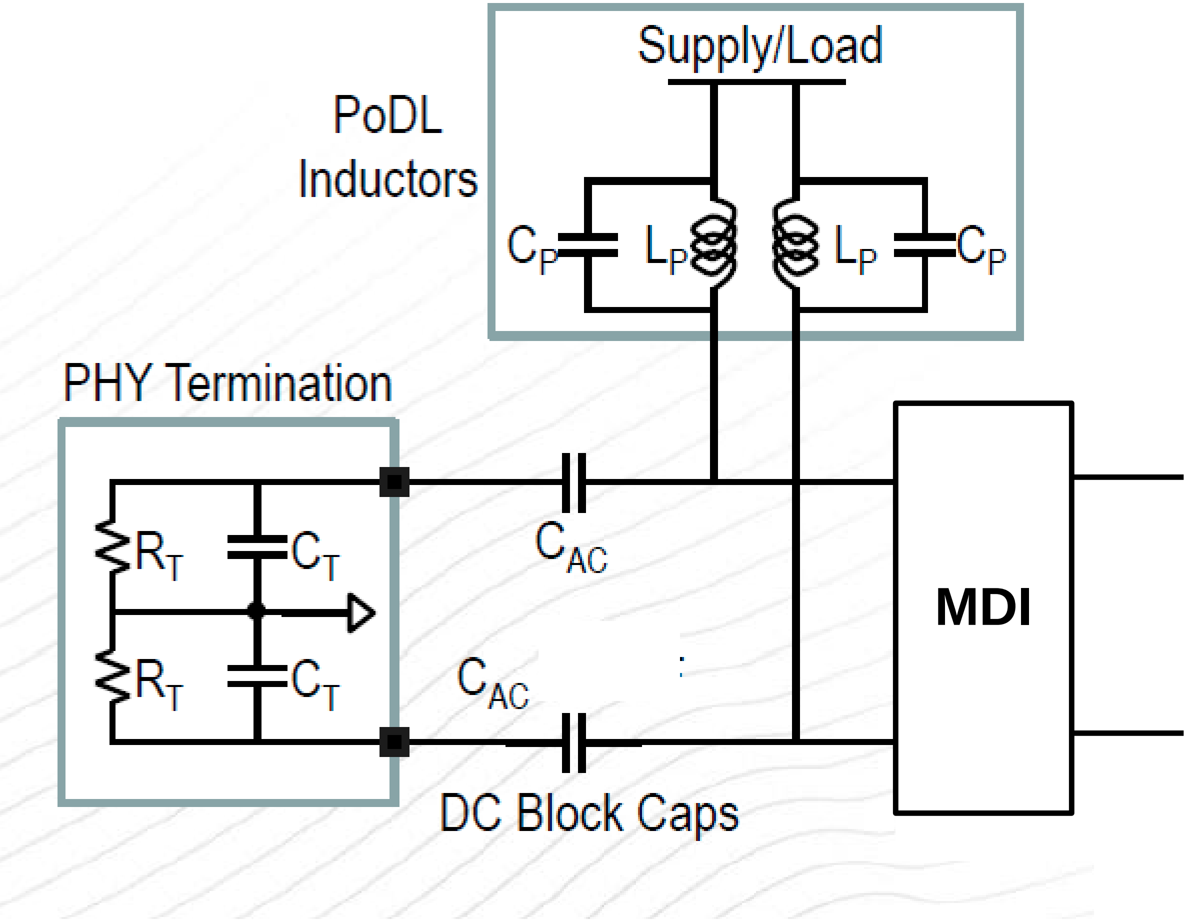
		min	nom	max
R_T	Ohm	45	50	55
C_T	pF	0.75	1.0	1.25
C_AC	nF	2.16	2.88	3.6
L_P	µH	75%	100%	125%
C_P	pF	75%	100%	125%



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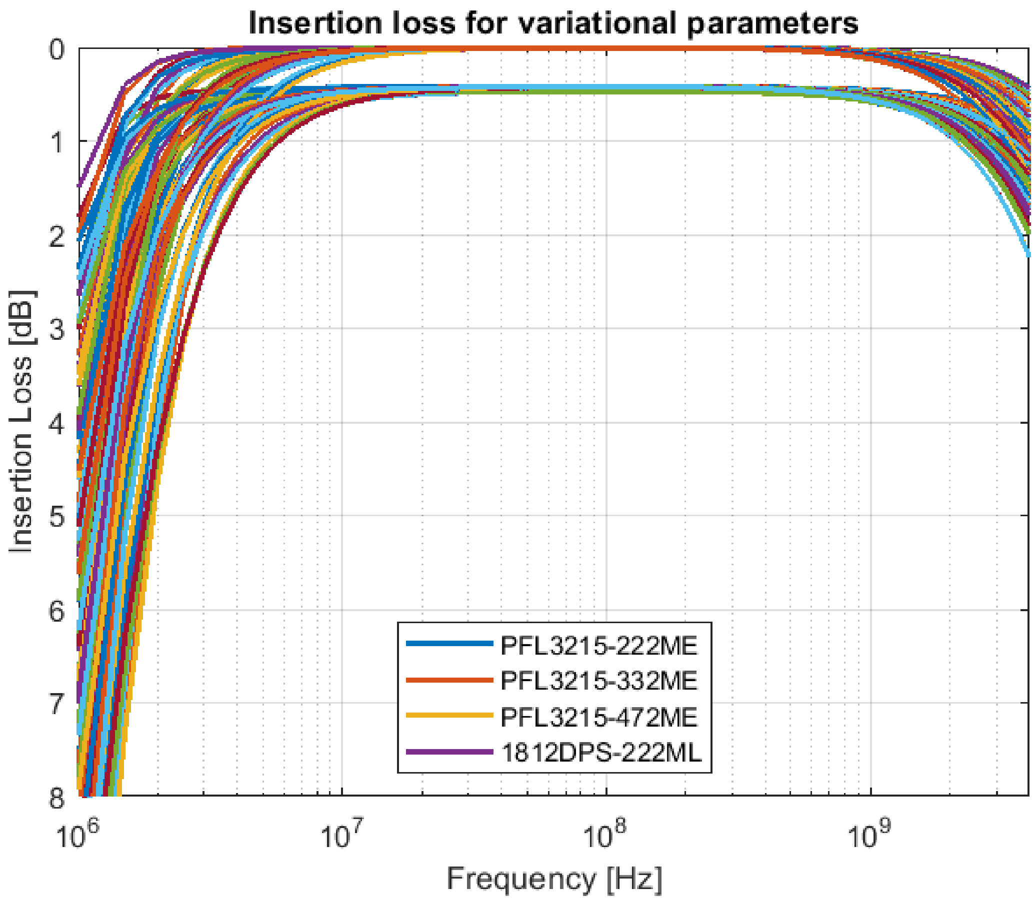
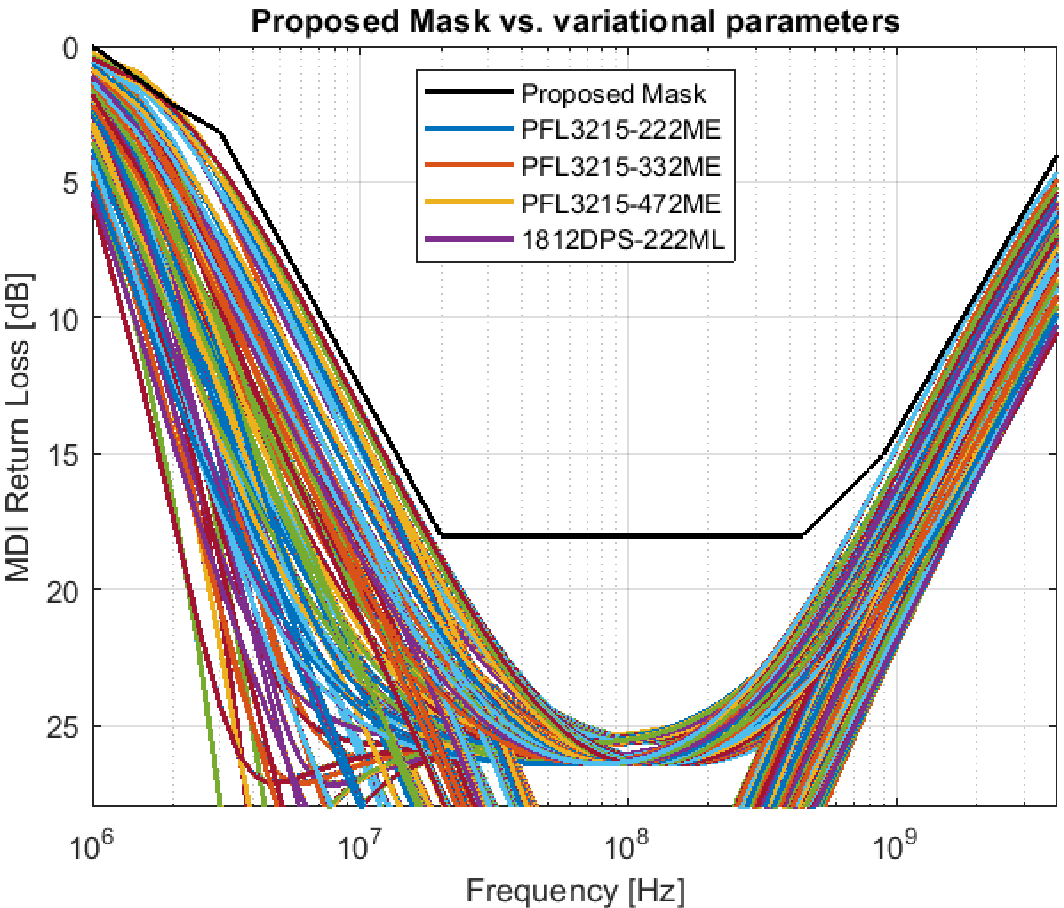
Parameter variation

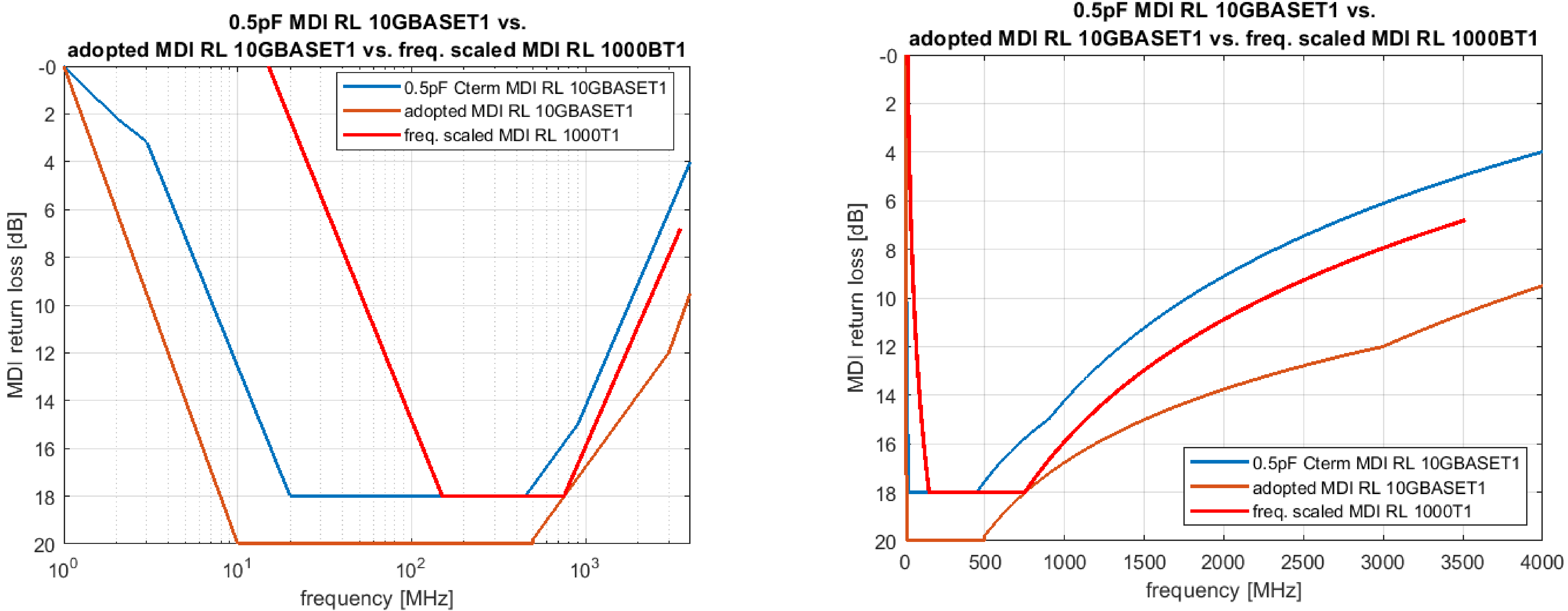
- Low PoDL inductance sets low frequency behavior f<20 [MHz]
- Termination resistor variation sets middle frequency behavior 20 ≤f<450 [MHz]
- Overall capacitance sets upper frequency behavior 450≤f<4000 [MHz]





Proposed MDI return loss mask in comparison

- Lower transition band: 1MHz to 20MHz
- Upper transition band: 450MHz to 4GHz



Conclusion

- Recommend to support both HBM and CDM requirements.
- Propose to change the MDI return loss mask to

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Return loss in dB, frequency in MHz

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