MDI Return Loss Limit

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Prior Discussions on MDI Return Loss Mask

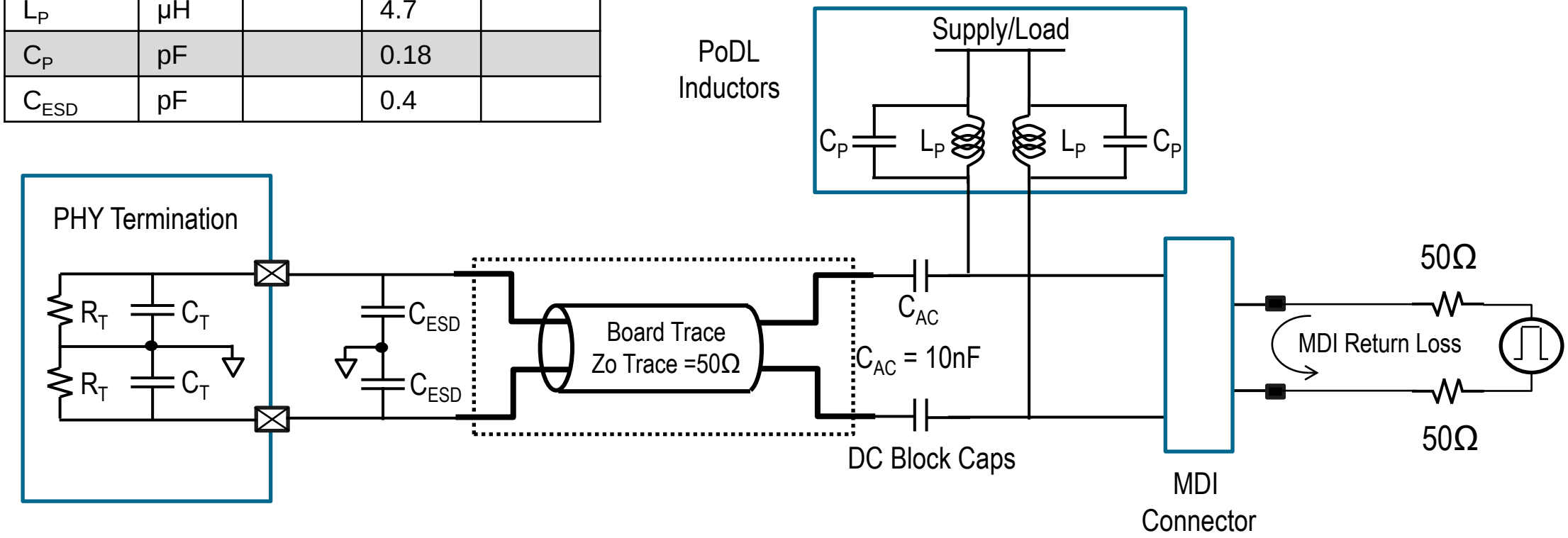
- D2.0 mask originally adopted from
  - http://www.ieee802.org/3/ch/public/nov18/bhagwat_3ch_01a_1118.pdf
- Analysis including practical implementation requirements
  - http://www.ieee802.org/3/ch/public/jan19/feyh_3ch_01a_0119.pdf
- Recent contributions addressing the MDI return loss mask
  - http://www.ieee802.org/3/ch/public/adhoc/stewart_3ch_01a_0719.pdf
  - http://www.ieee802.org/3/ch/public/adhoc/DenBesten_3ch_01_0719.pdf
- There are renewed interests in revisiting the MDI return loss mask.

MDI Return Loss Limit and Impedance Variation

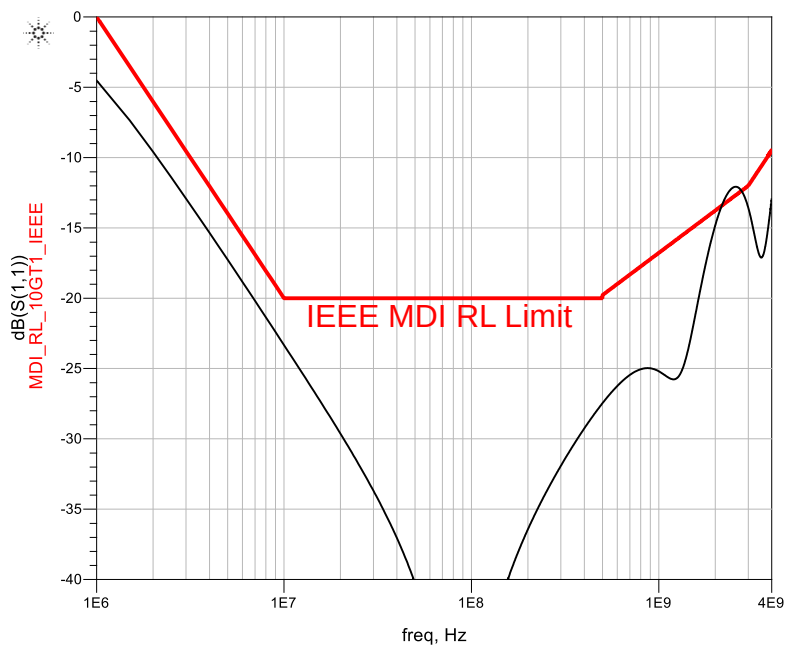
- The contribution of the following common elements have been considered:
  - PHY termination impedance and variation (+/-10% and +/-5% considered)
  - Board trace impedance and variation (+/- 10% considered)
  - Multiple board trace lengths modeled (1.5”, 3” and 4.5”)
  - External ESD clamp capacitance
  - PoDL inductance and capacitance
  - No Package model
- Considering reasonable mismatches between board traces and PHY terminations, major issue with the existing mask is evident.
- New return loss limit has been proposed.

An MDI Model for Return Loss Calculation

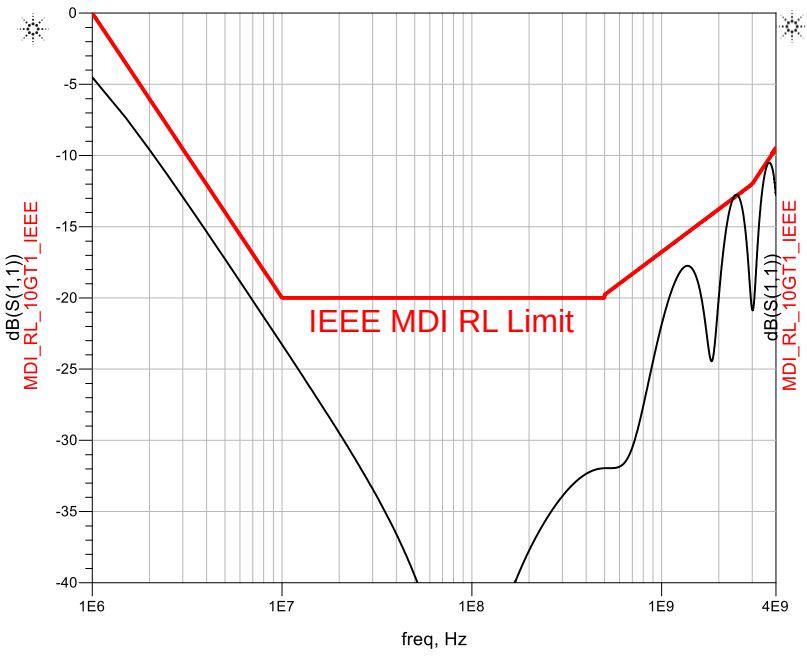
Element	unit	min	nom	max
R_T	Ω	45	50	55
Zo	Ω	45	50	55
C_T	pF		0.10	
L_P	µH		4.7	
C_P	pF		0.18	
C_{ESD}	pF		0.4	



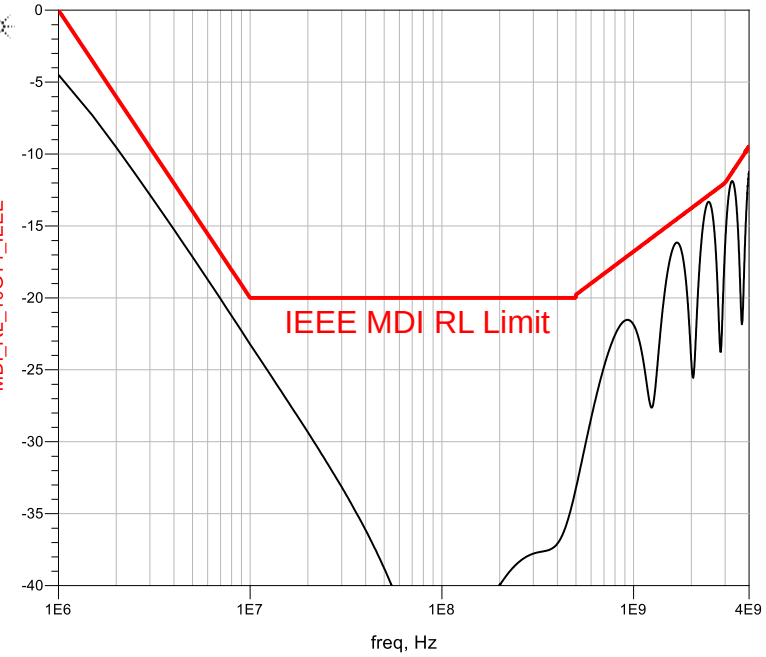
50 ohms Board Traces and 50 ohms PHY Terminations (Ideal environment)



1.5 inch trace

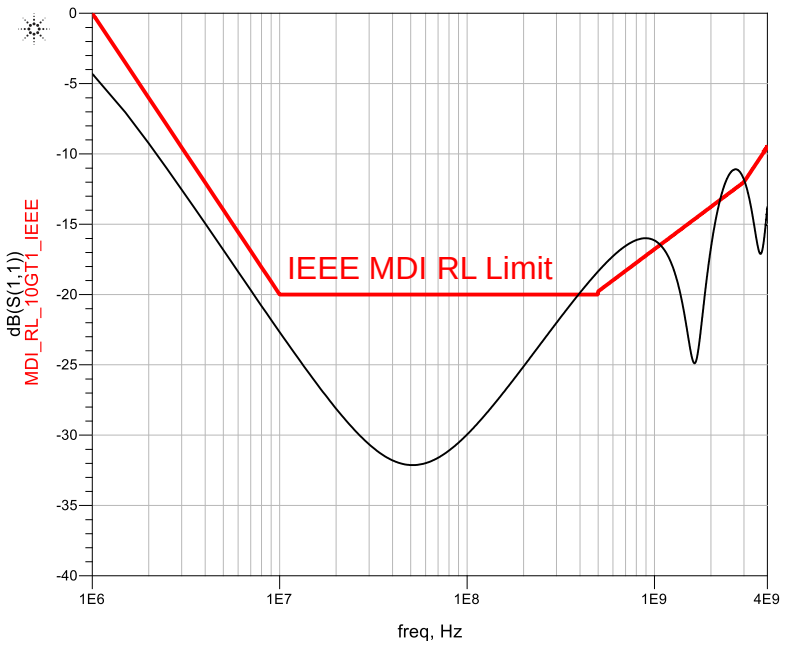


3.0 inch trace

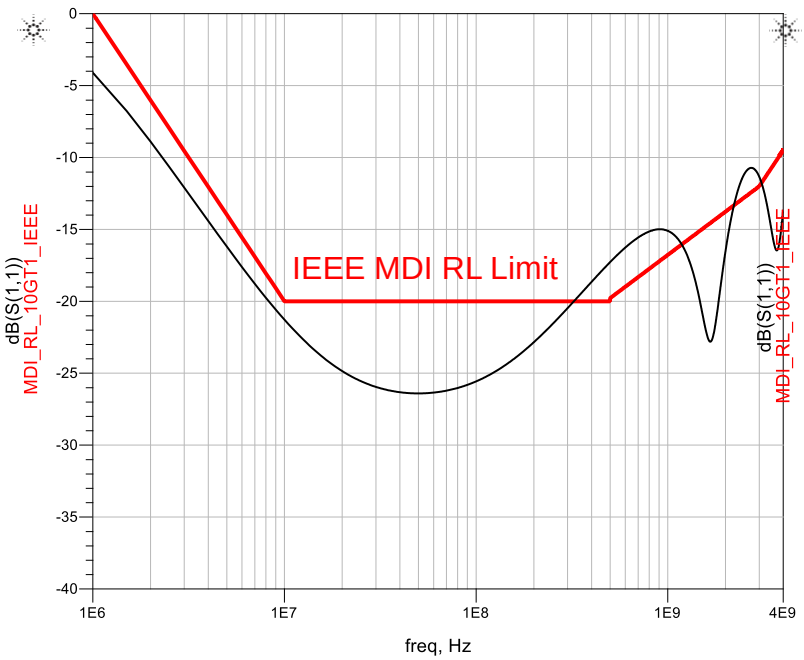


4.5 inch trace

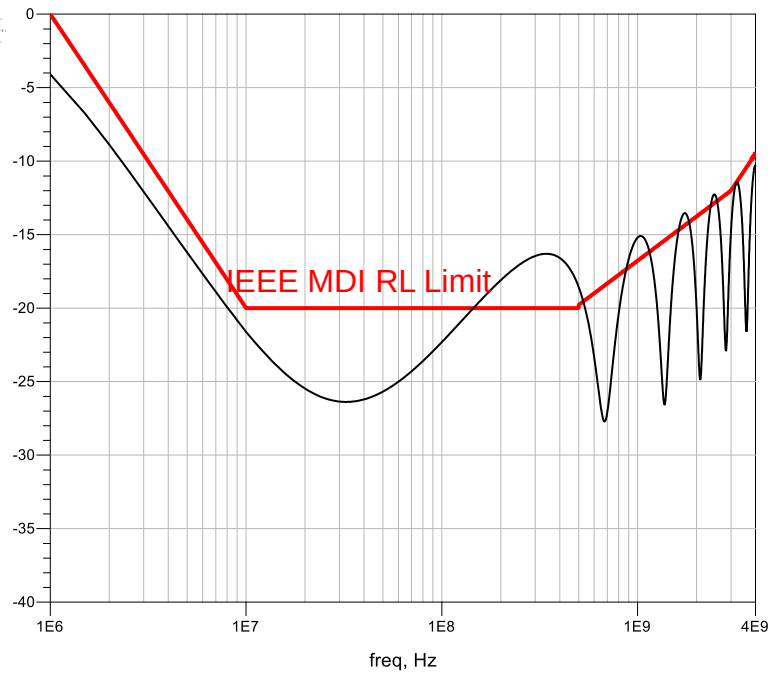
45 ohms Board Traces and 55 ohms PHY Terminations



1.5 inch trace

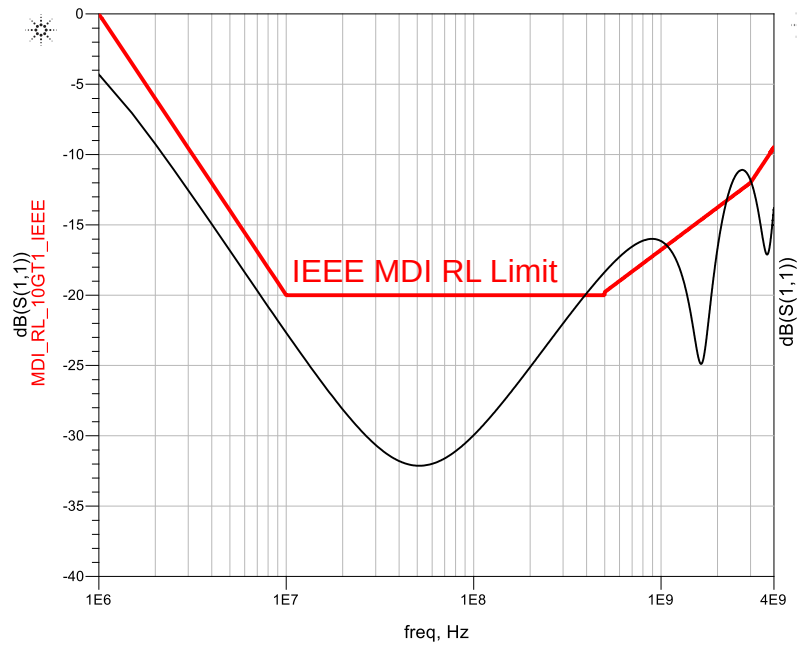


3.0 inch trace

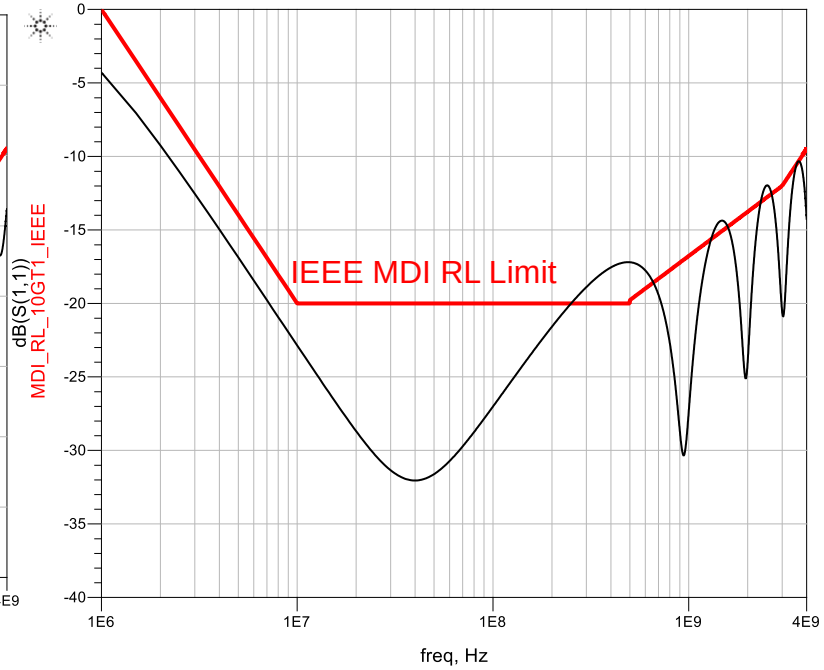


4.5 inch trace

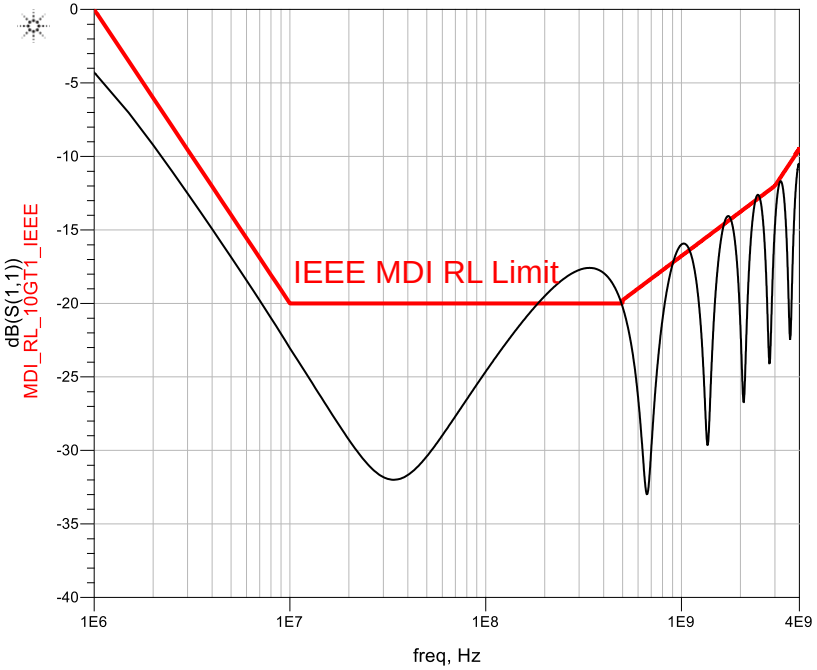
45 ohms Board Traces and 52.5 ohms PHY Terminations



1.5 inch trace

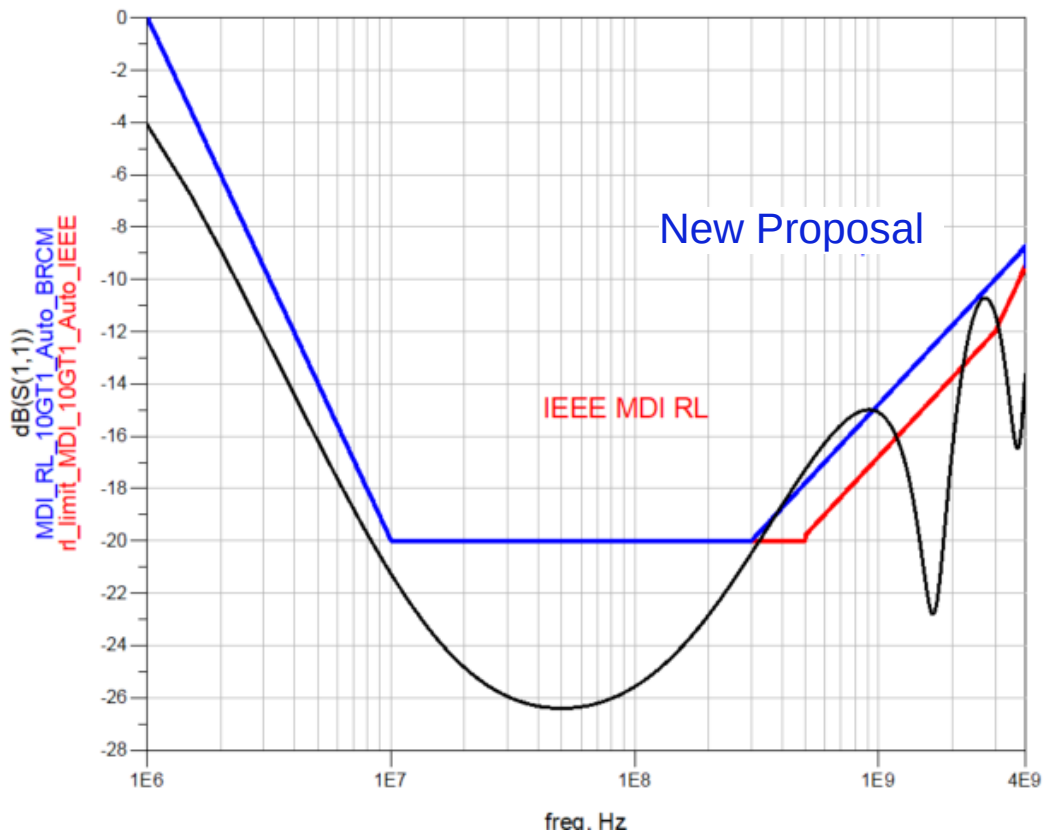


3.0 inch trace

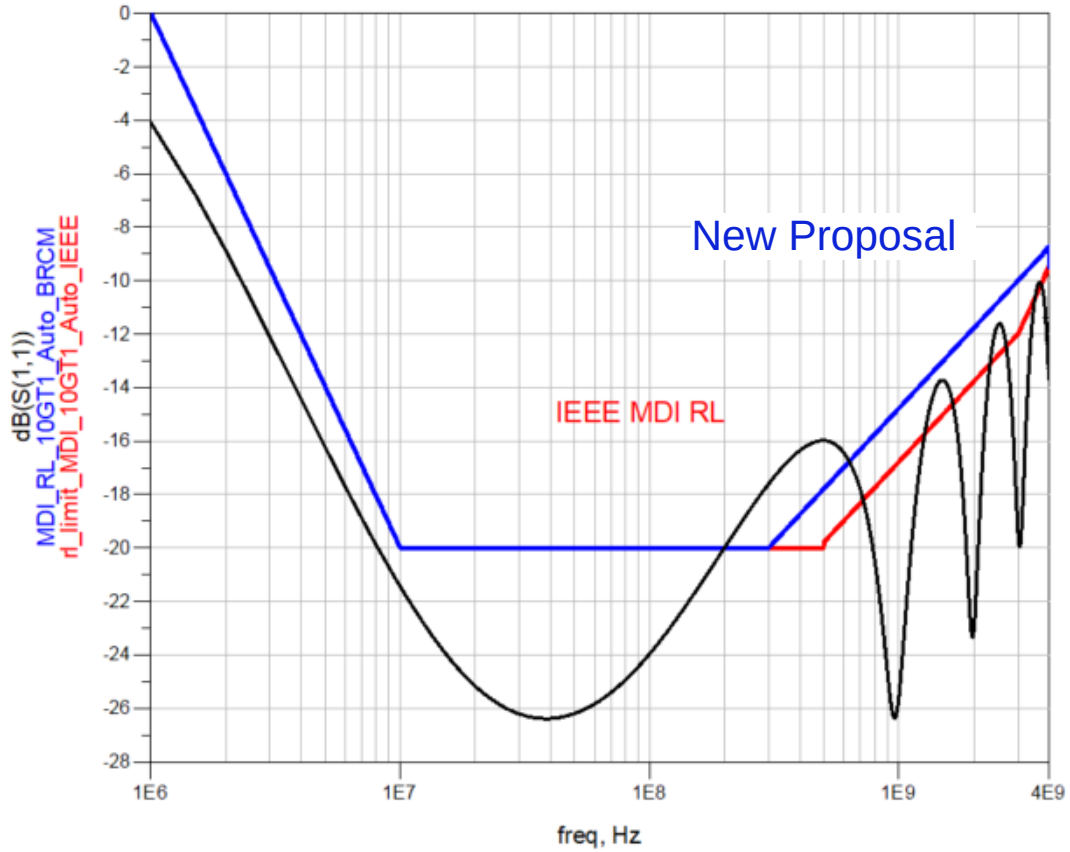


4.5 inch trace

Proposed Mask vs RT= 55 ohms

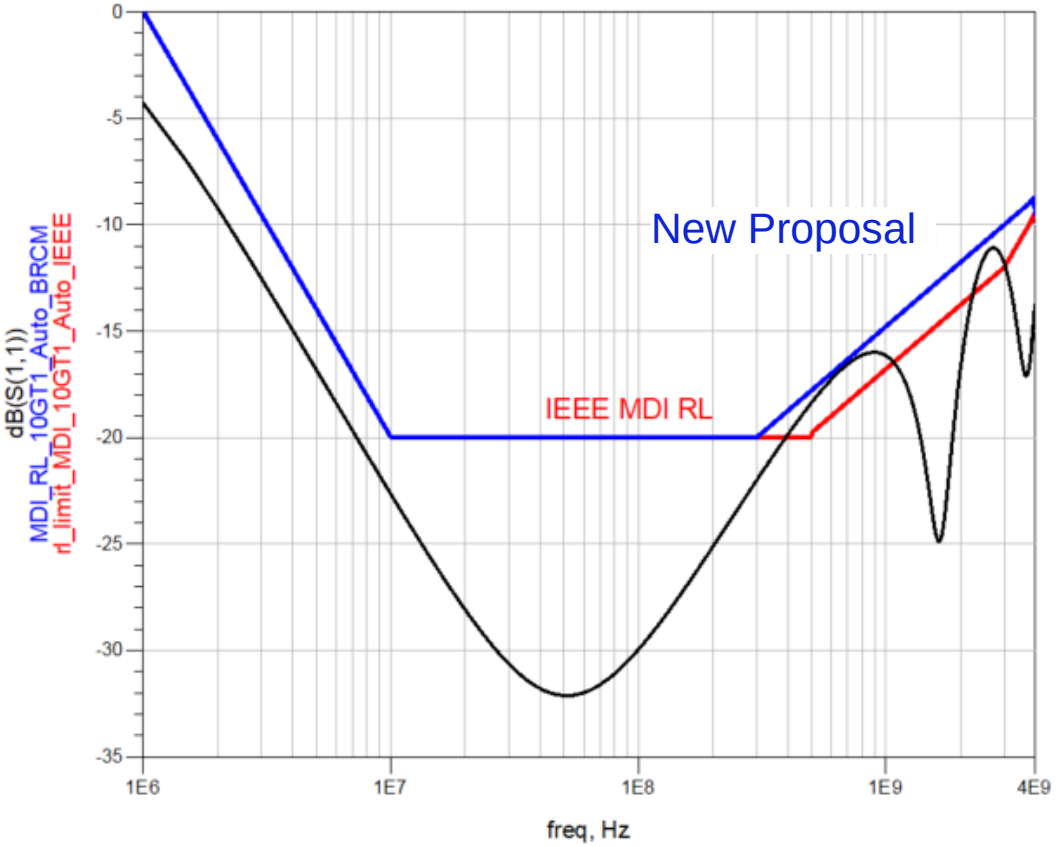


1.5 inch trace: 45 ohms
PHY Termination: 55 ohms

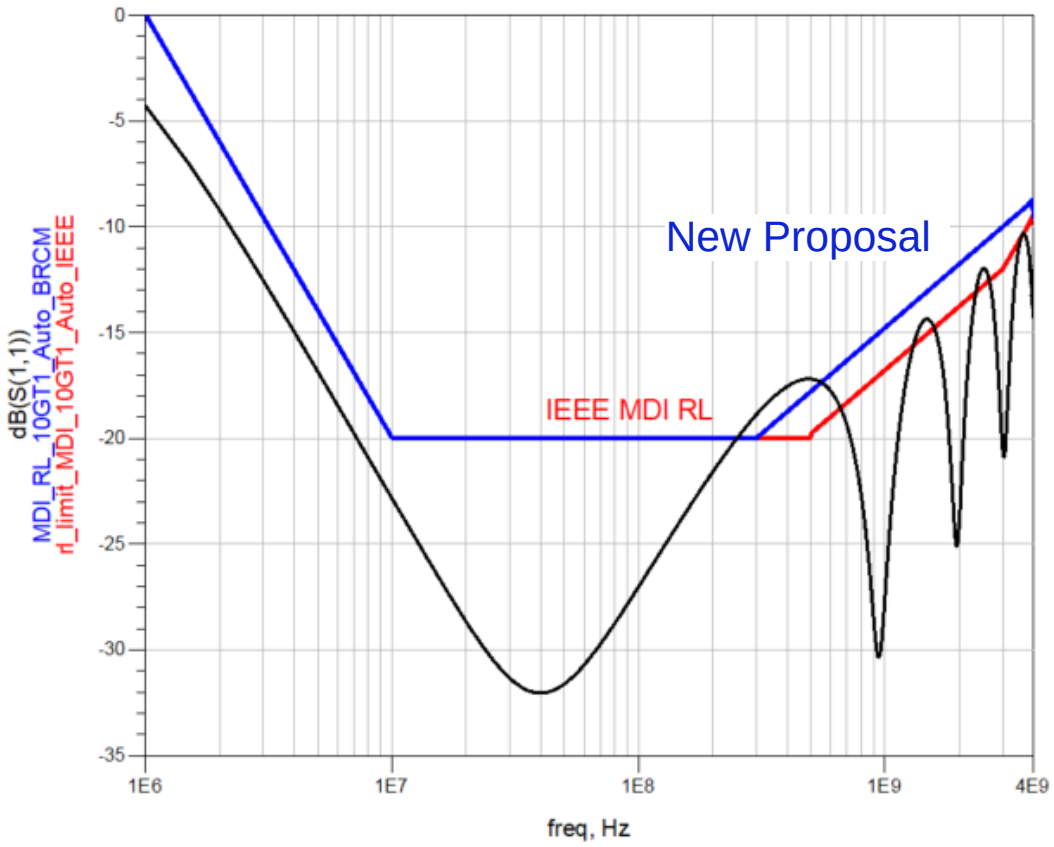


3.0 inch trace: 45 ohms
PHY Termination: 55 ohms

Proposed Mask vs RT= 52.5 ohms



1.5 inch trace: 45 ohms
PHY Termination 52.5 ohms



3.0 inch trace: 45 ohms
PHY Termination 52.5 ohms

Existing Mask vs. Proposed MDI Return Loss

IEEE 802.3ch/D2.0:

$$\text{Return Loss} = \begin{cases} 20 - 20(\log_{10}\frac{10}{f}) & 1 \le f \le 10 \\ 20 & 10 \le f \le 500 \\ 12 - 10\log_{10}(f / 3000) & 500 \le f \le 3000 \\ 12 - 20\log_{10}(f / 3000) & 3000 \le f \le 4000 \end{cases} \text{ (dB)} \qquad \text{(149-27)}$$

where

f is the frequency in MHz

New proposal:

$$\text{Return Loss} = \begin{cases} 20 - 20(\log_{10}\frac{10}{f}) & 1 \le f \le 10 \\ 20 & 10 \le f \le 300 \\ 10 - 10\log_{10}(f / 3000) & 300 \le f \le 4000 \end{cases} \text{ (dB)}$$

where

f is the frequency in MHz