MDI Return Loss Limit

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Introduction

- 802.3cy D2.0 MDI return loss
  - See Equation 165-44 and Figure 165-45
  - Above 50MHz, frequency scaled by 2.5X from 802.3ch

- Question: is this a reasonable spec for practical PHY and board design?

- In this contribution, we present simulation results based on board trace and PHY MDI termination impedance models
  - Both non-PoDL and PoDL cases considered

- A new MDI return loss spec will be proposed at the end based on these results

Simulation Setup

- Board trace s4p models
  - Board trace length: 0.75 in and 1.5 in
  - Impedance variation +-10% considered
  - Board material: FR408 and Tachyon 100G
    - Simulation results are similar
    - We present mostly FR 408 results

- PHY termination impedance s4p
  - Chip package model included
  - +- 5% and +- 10% cases considered
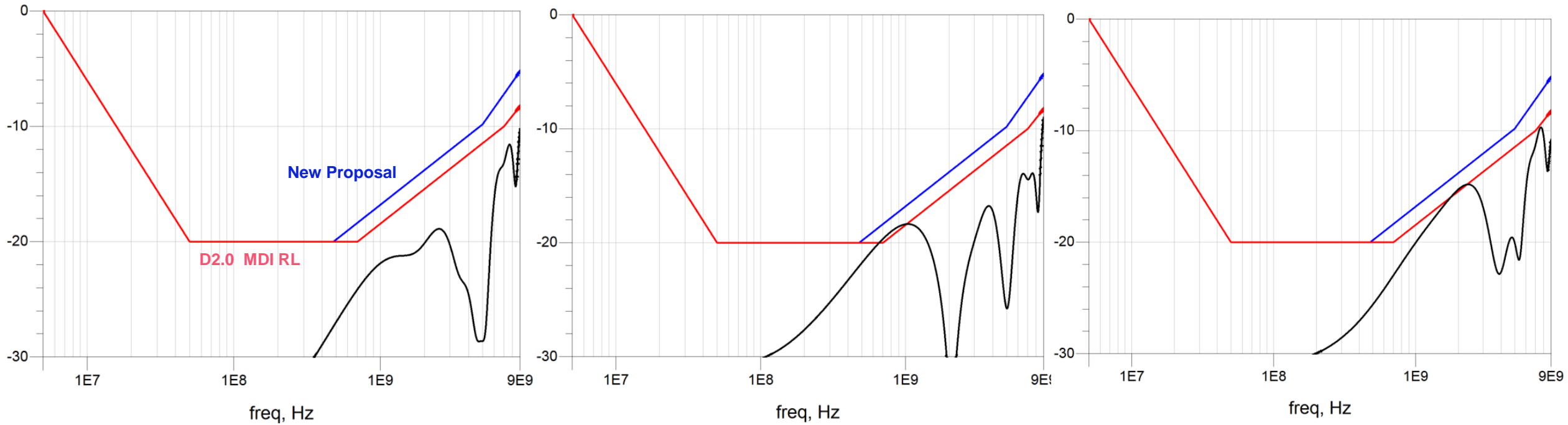

- PoDL inductance and capacitance also considered

MDI RL Simulation Model

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		0.15	
Z_o	Ω	90	100	110
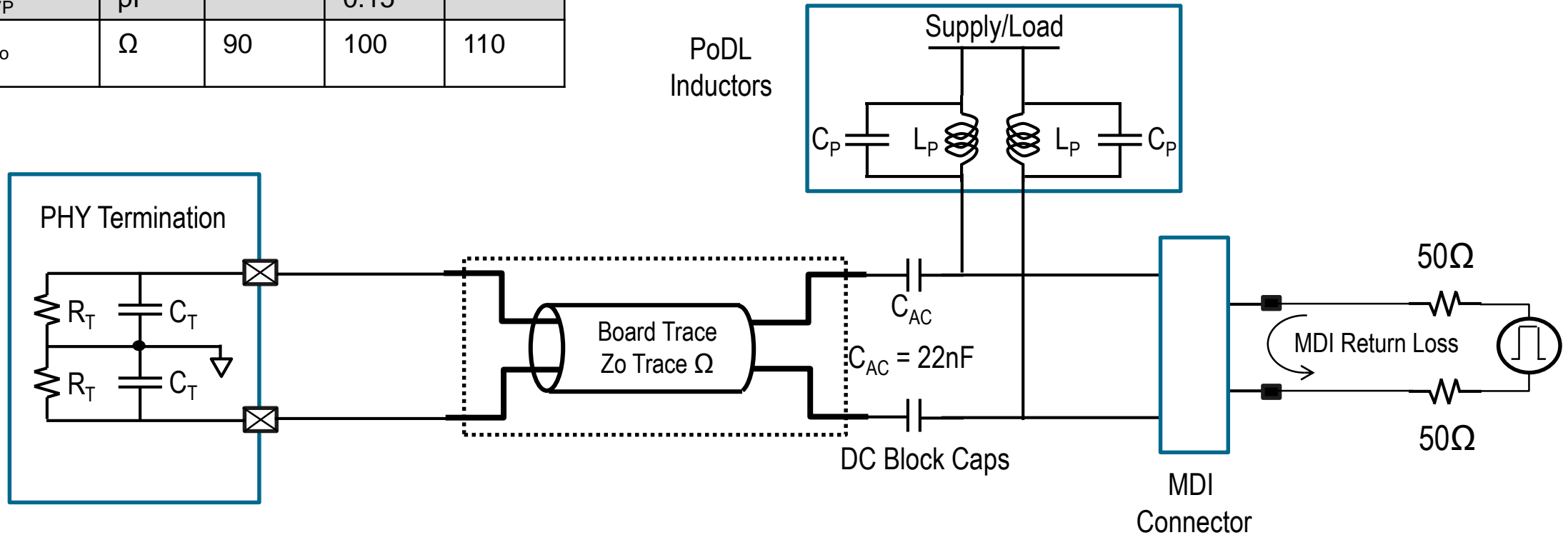
Simulation Results w/o PoDL

FR 408 with 0.75 in Traces w/o PoDL

PHY = 100 Ohm
Trace = 100 Ohm

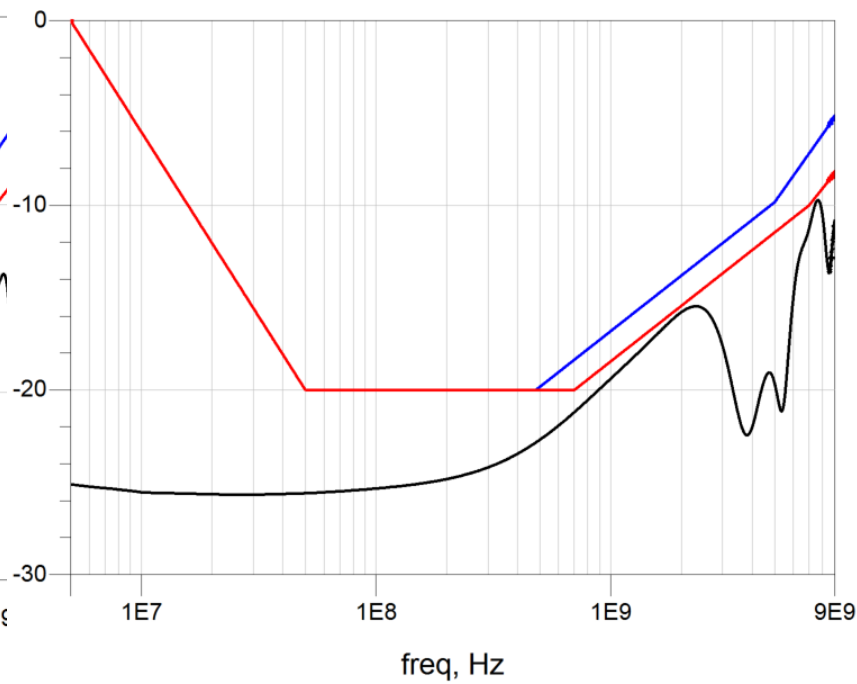PHY   = 105 Ohm
Trace =   90 Ohm

PHY   =   95 Ohm
Trace = 110 Ohm

FR 408 with 0.75 in Traces w/o PoDL (cont.)
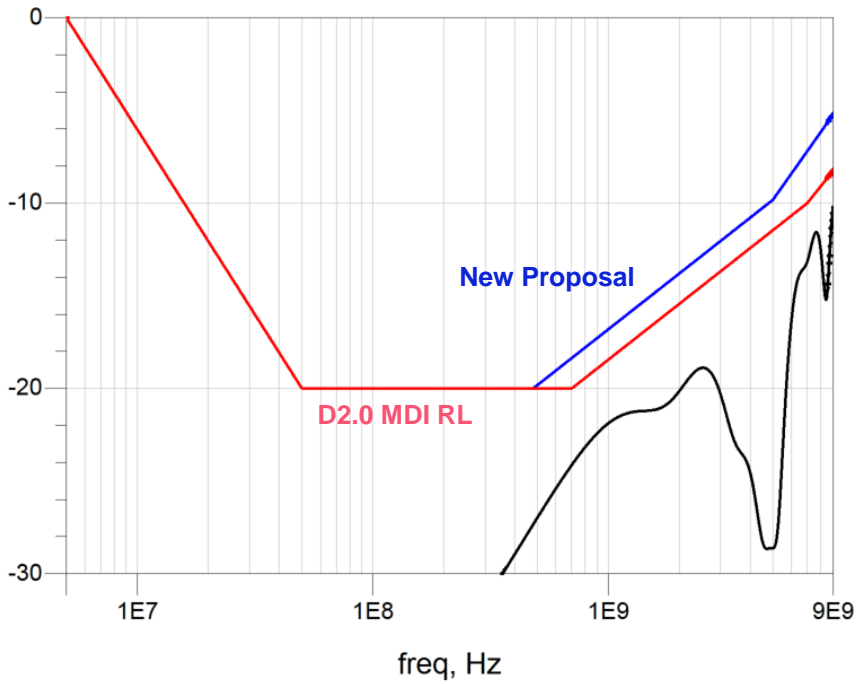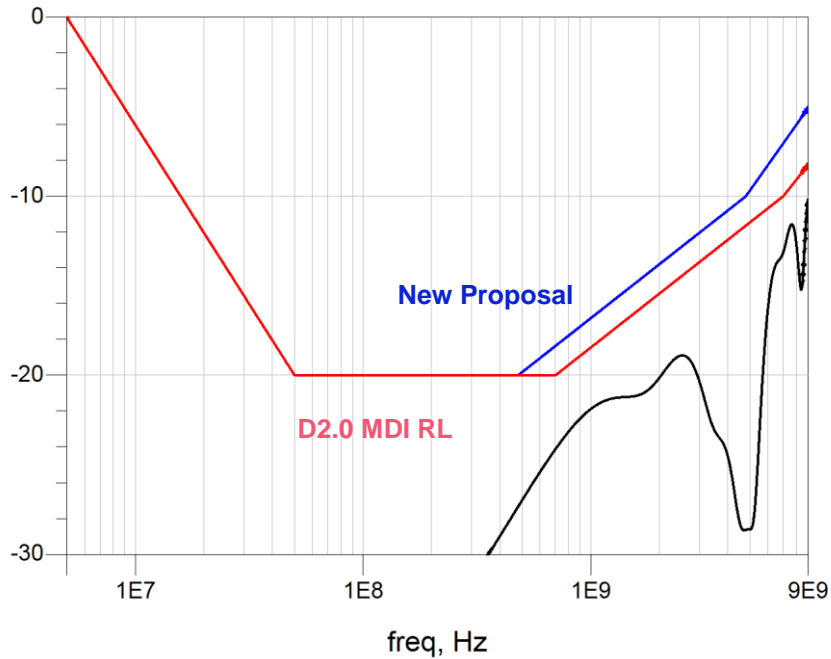

PHY = 100 Ohm
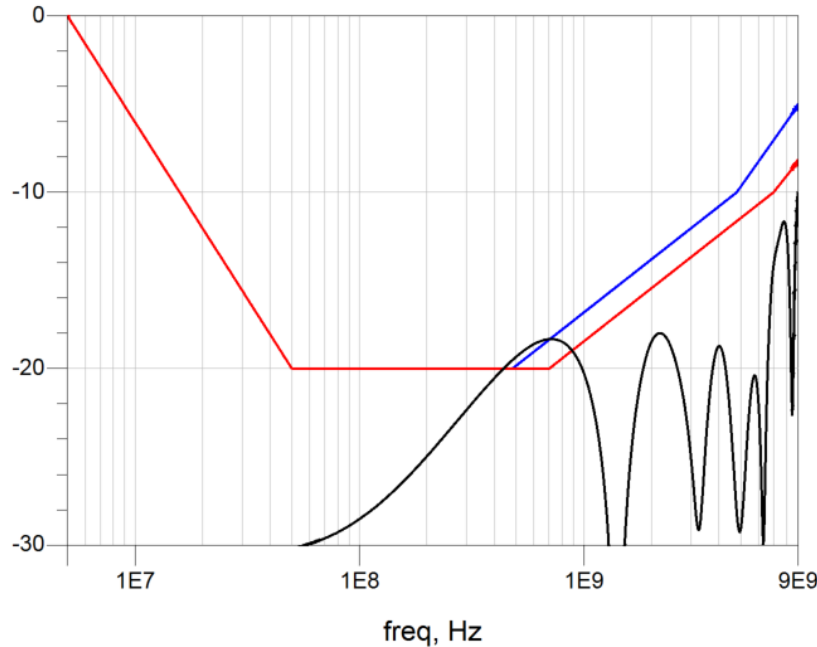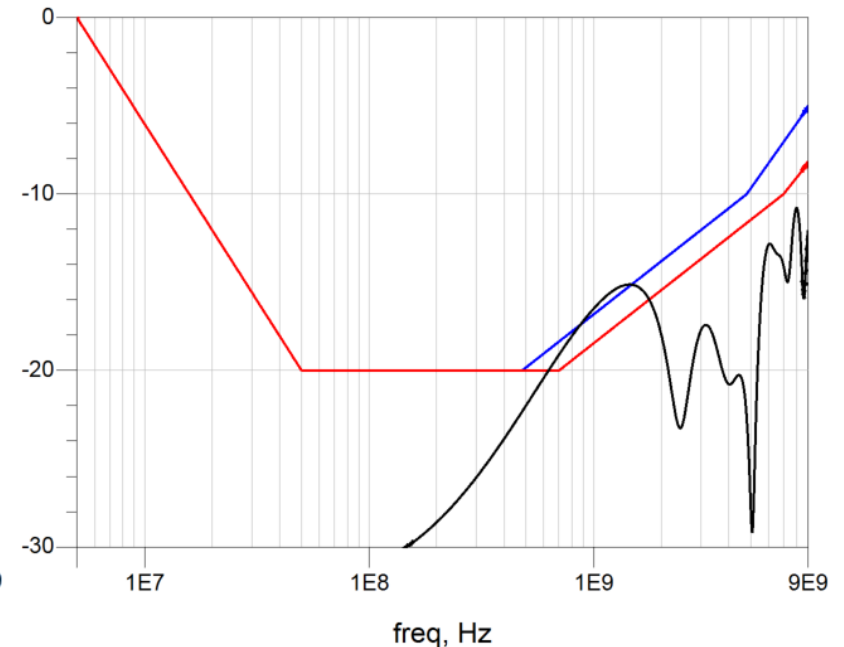Trace = 100 Ohm
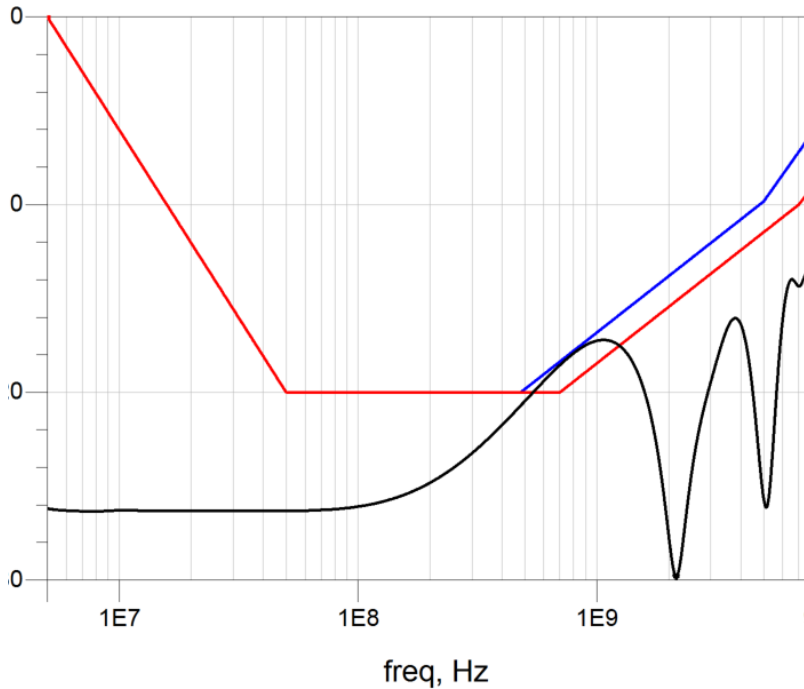
PHY = 110 Ohm
Trace =   90 Ohm

PHY =   90 Ohm
Trace = 110 Ohm

FR 408 with 1.5 in Traces w/o PoDL

PHY = 100 Ohm
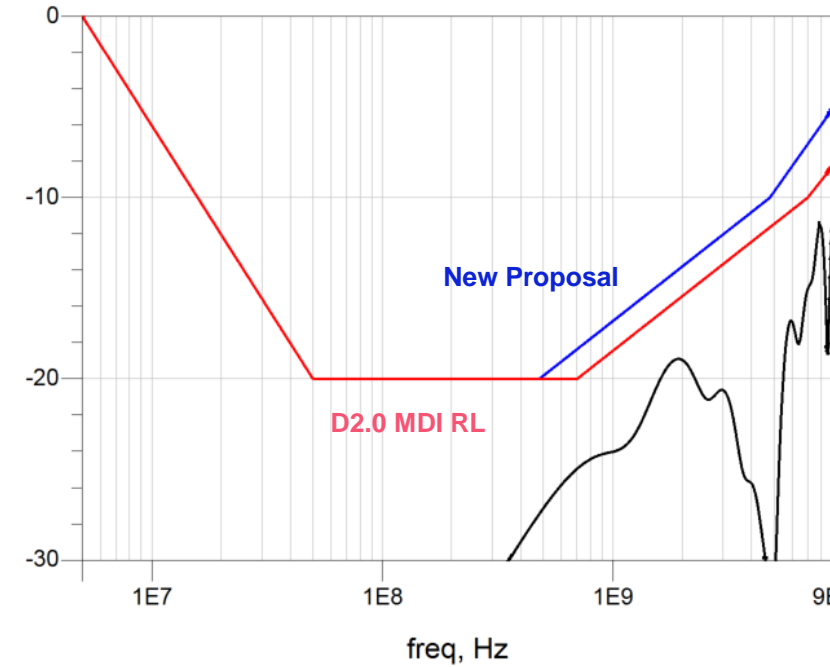Trace = 100 Ohm

PHY = 105 Ohm
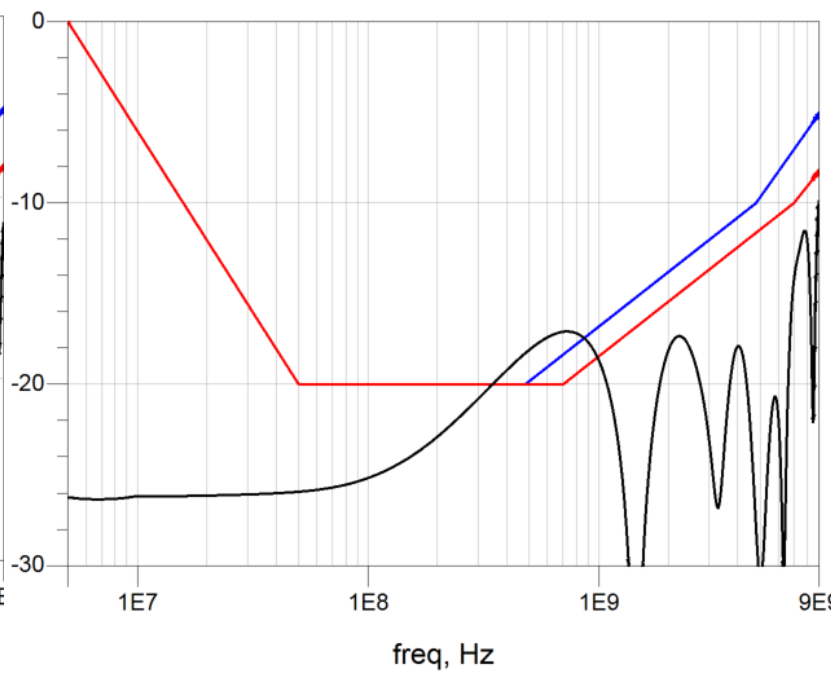Trace =   90 Ohm

PHY =   95 Ohm
Trace = 110 Ohm
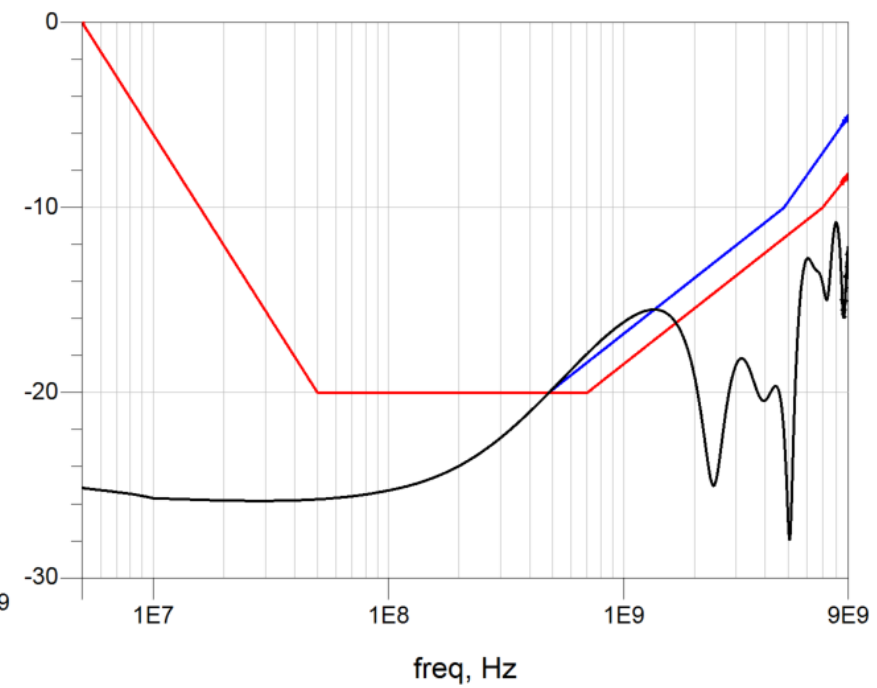
FR 408 with 1.5 in Traces w/o PoDL (cont.)

1.5 inch trace FR408

PHY = 100 Ohm
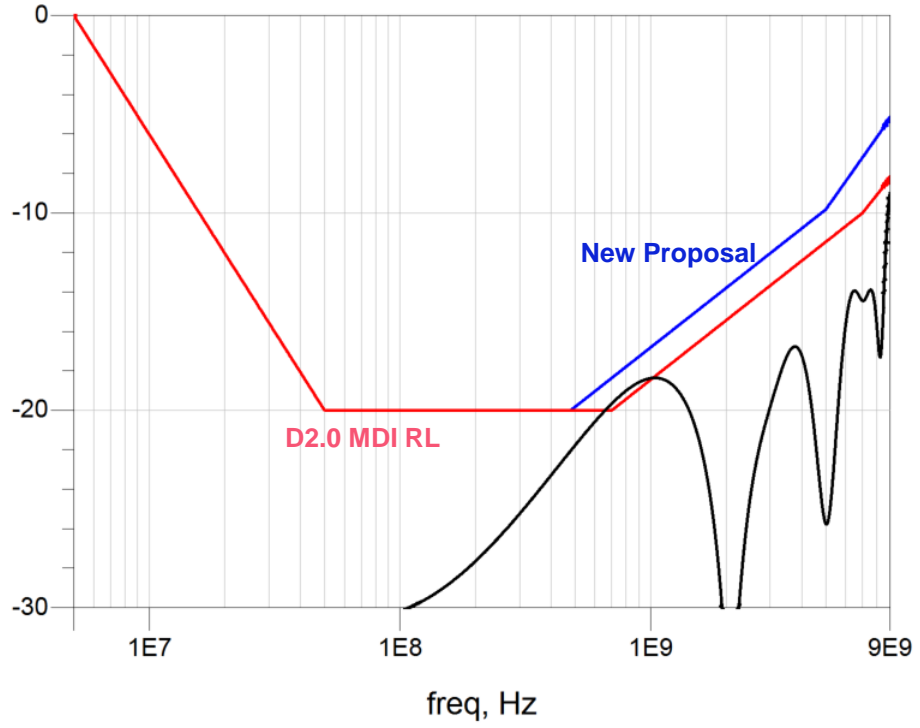Trace = 100 Ohm

PHY   = 110 Ohm
Trace =   90 Ohm
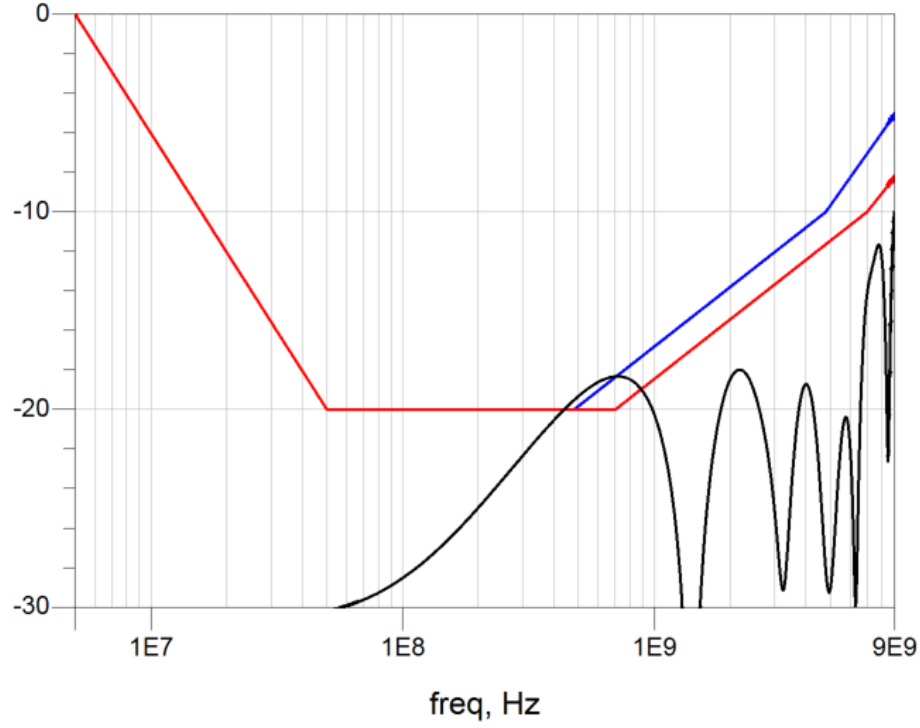
PHY   =   90 Ohm
Trace = 110 Ohm

Board Trace 0.75 in vs. 1.5 in w/o PoDL
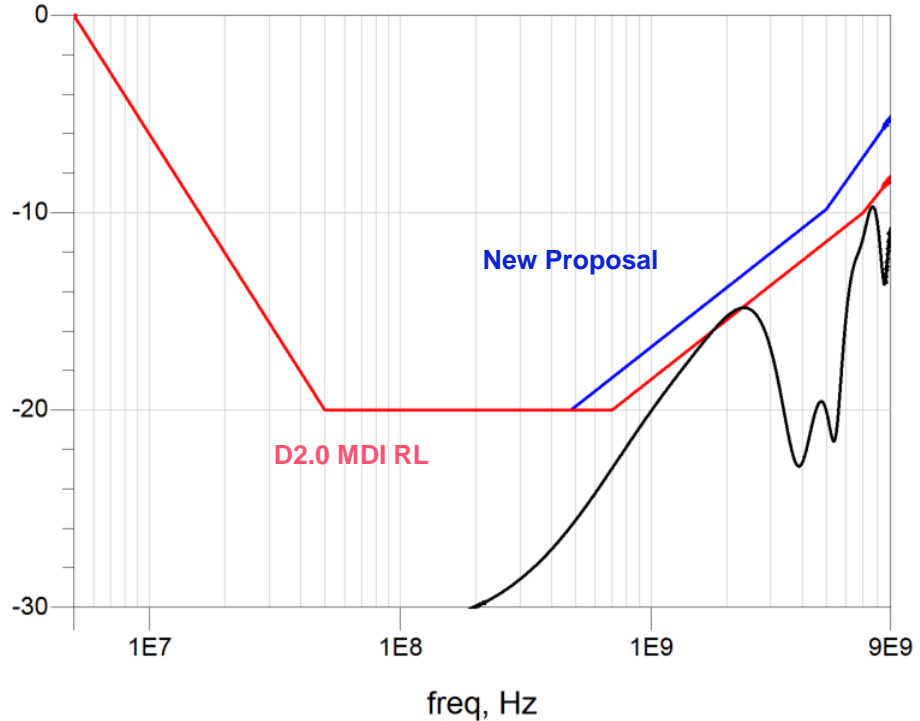# PHY = 105 ohm, Trace = 90 ohm

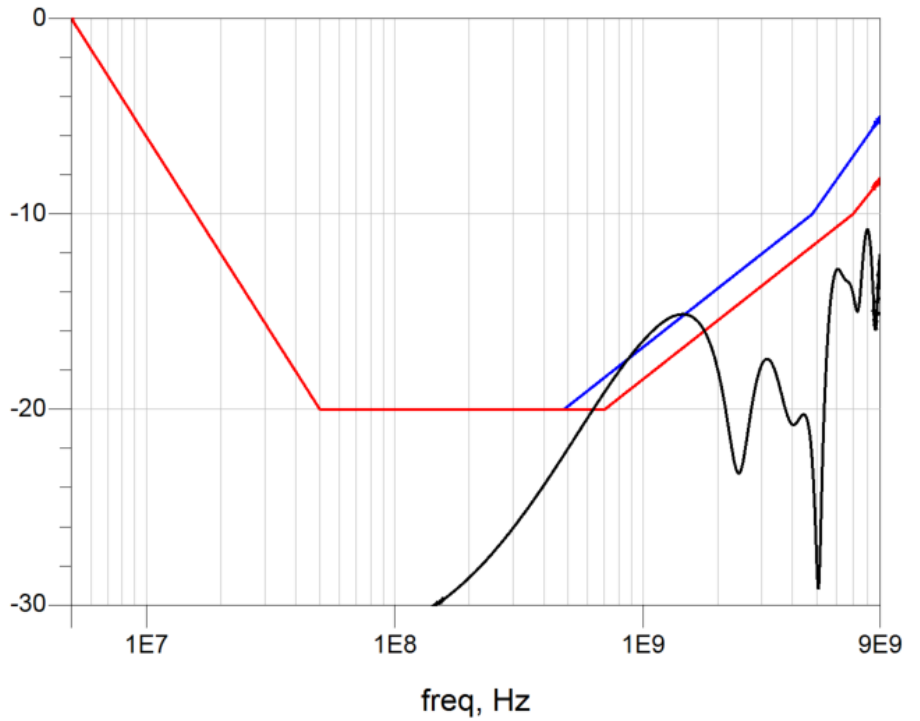**0.75 inch trace FR408**

1.5 inch trace FR408

Board Trace 0.75 in vs. 1.5 in w/o PoDL
PHY = 95 ohm, Trace = 110 ohm

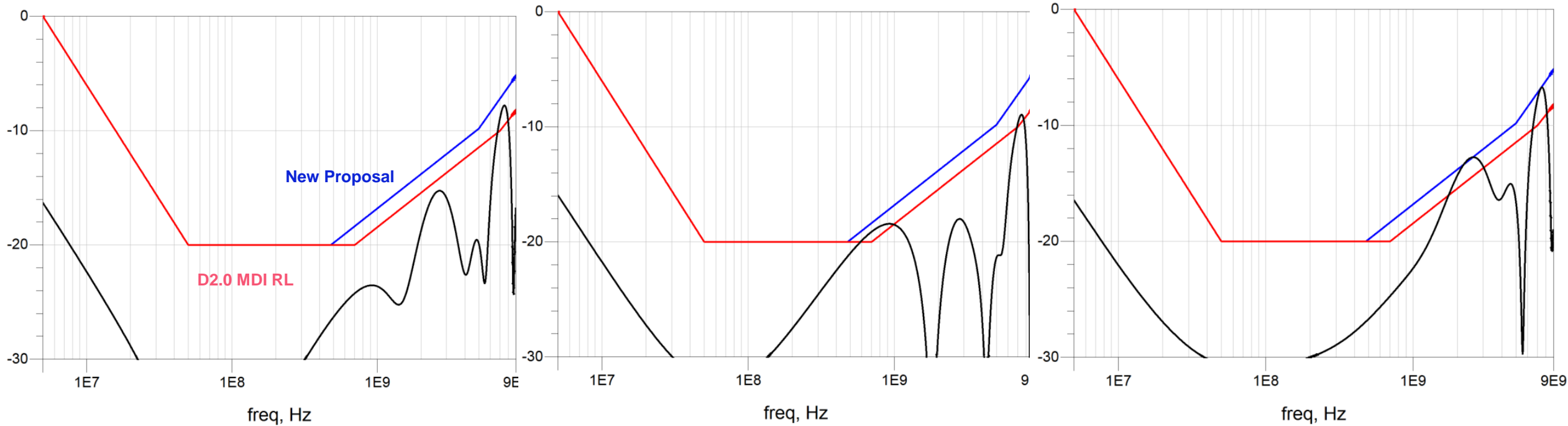**0.75 inch trace FR408**

1.5 inch trace FR408

Simulation Results with PoDL

FR 408 with 0.75 in Traces with PoDL
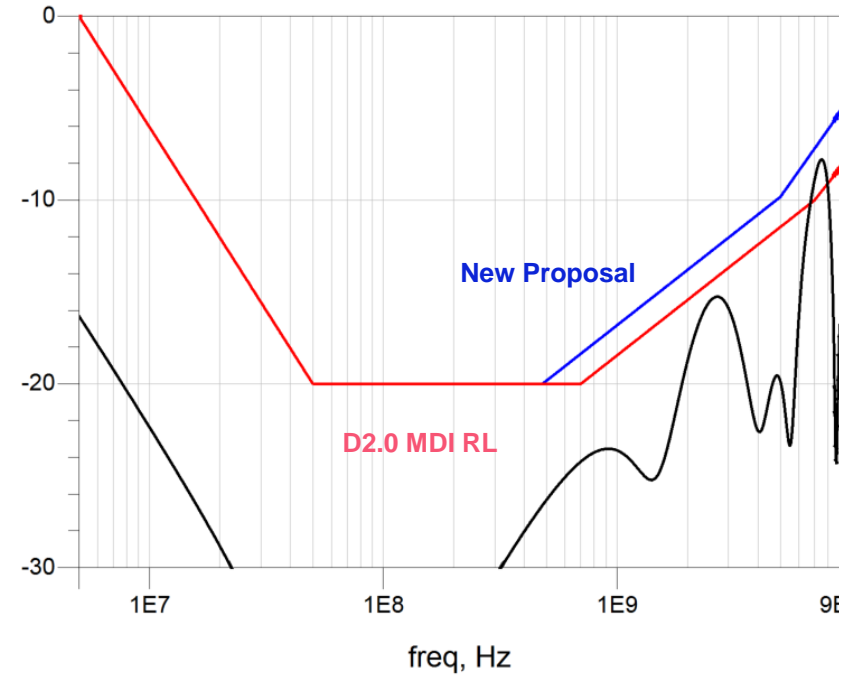

PHY   = 100 Ohm
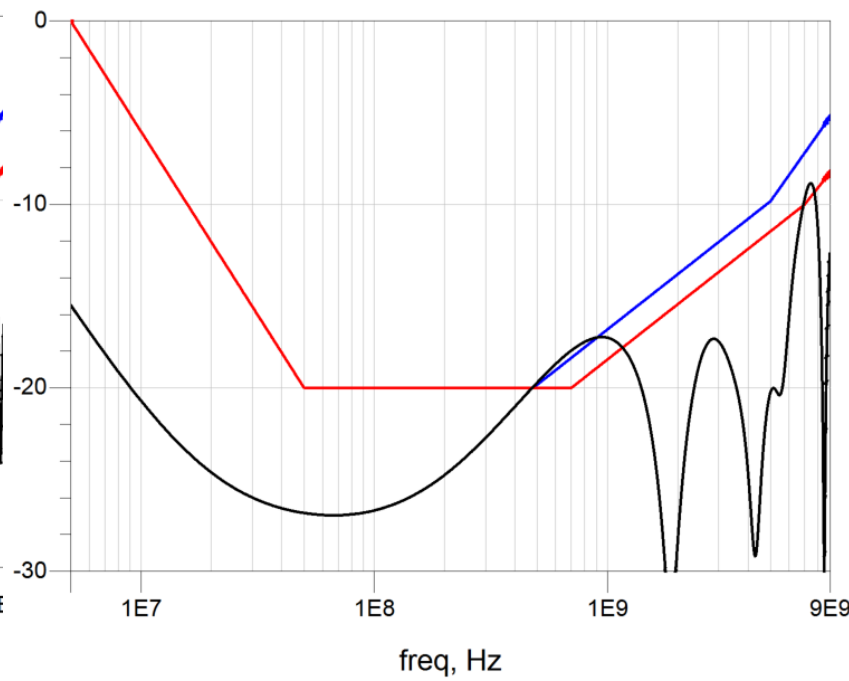Trace = 100 Ohm

PHY   = 105 Ohm
Trace =   90 Ohm

PHY   =   95 Ohm
Trace = 110 Ohm
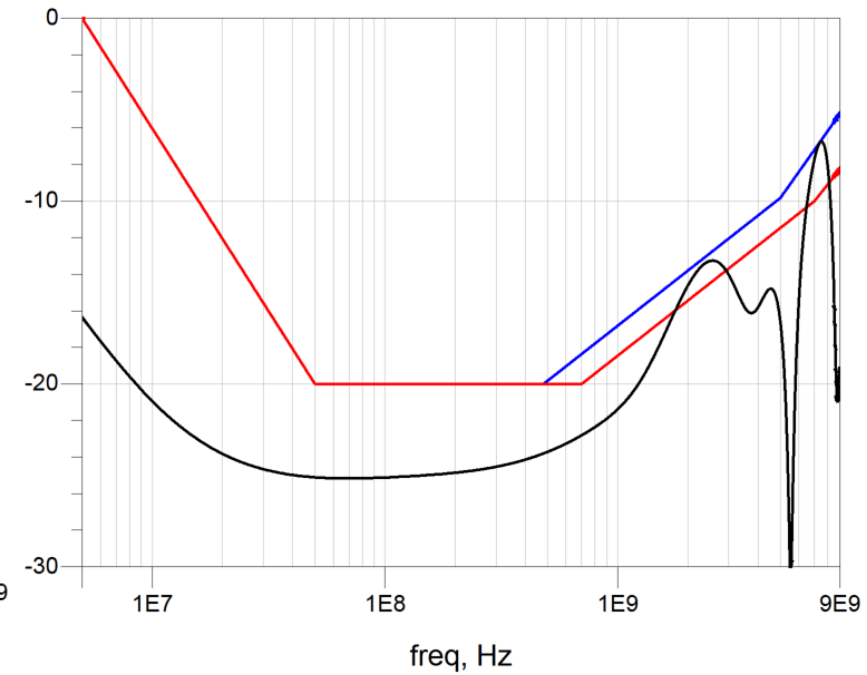
FR 408 with 0.75 in Traces with PoDL (cont.)

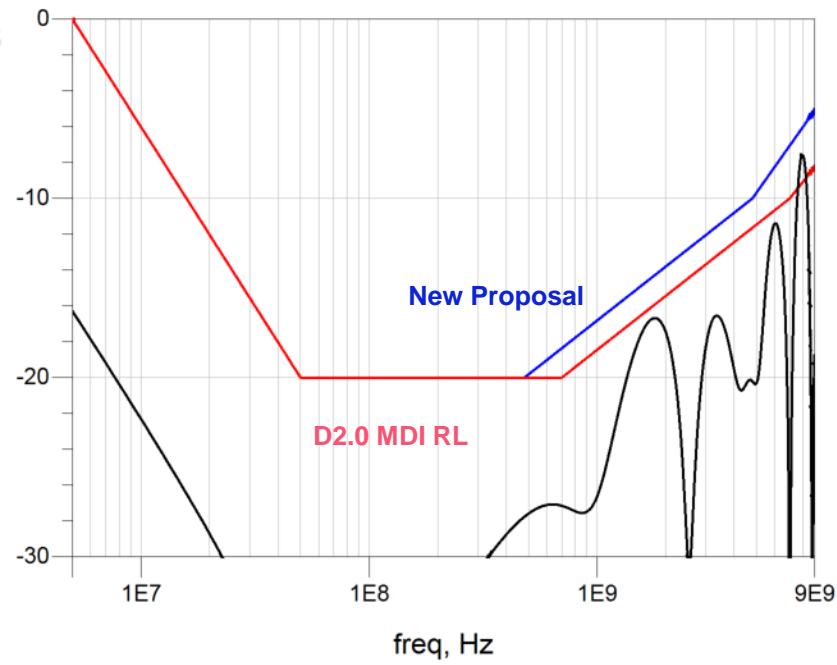PHY   = 100 Ohm
Trace = 100 Ohm

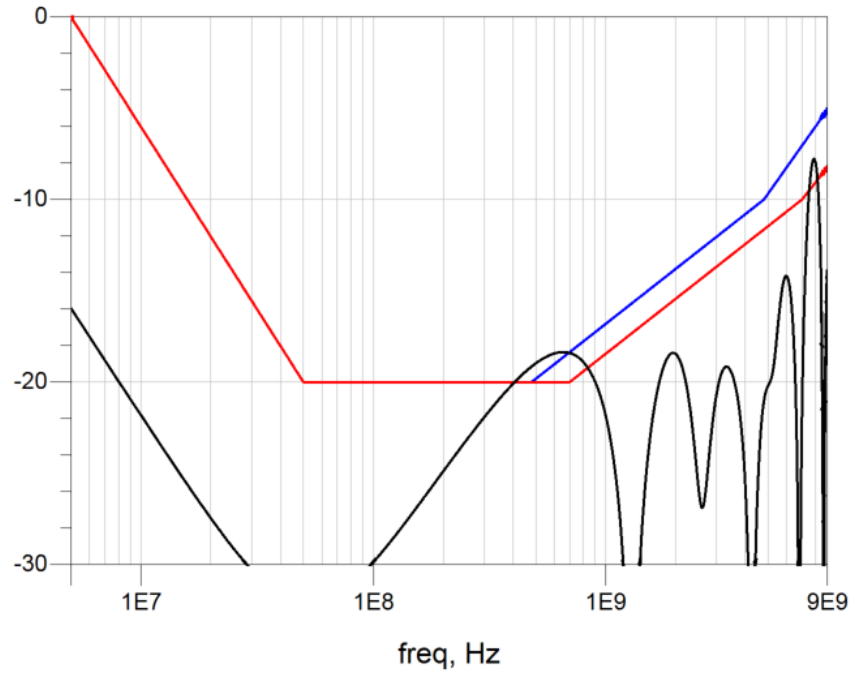PHY   = 110 Ohm
Trace =   90 Ohm

PHY   =   90 Ohm
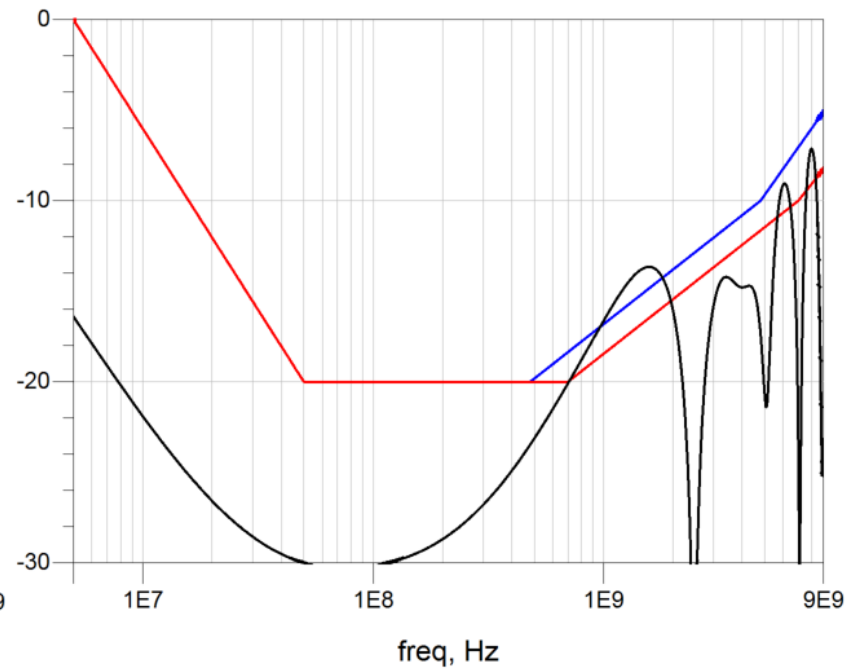Trace = 110 Ohm

FR 408 with 1.5 in Traces with PoDL

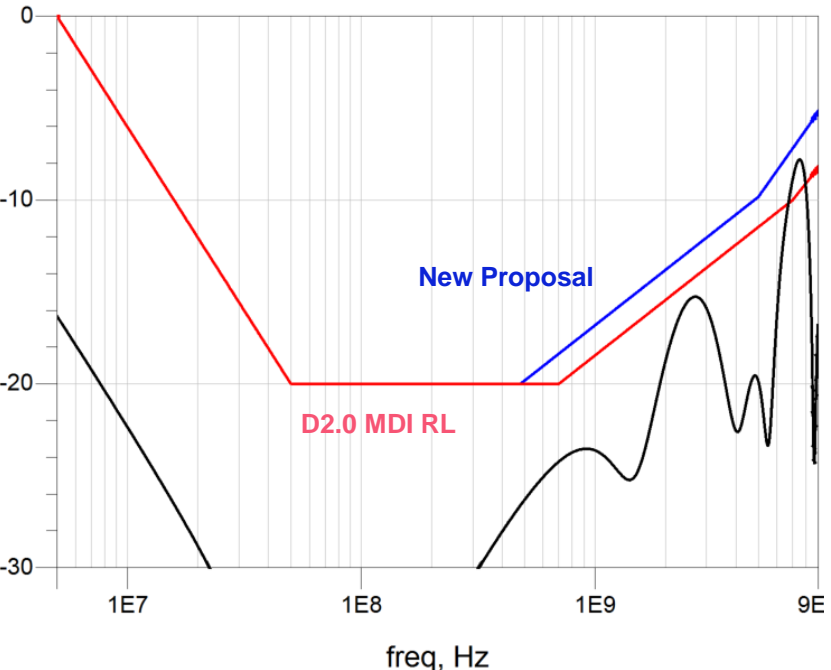PHY = 100 Ohm
Trace = 100 Ohm

PHY   = 105 Ohm
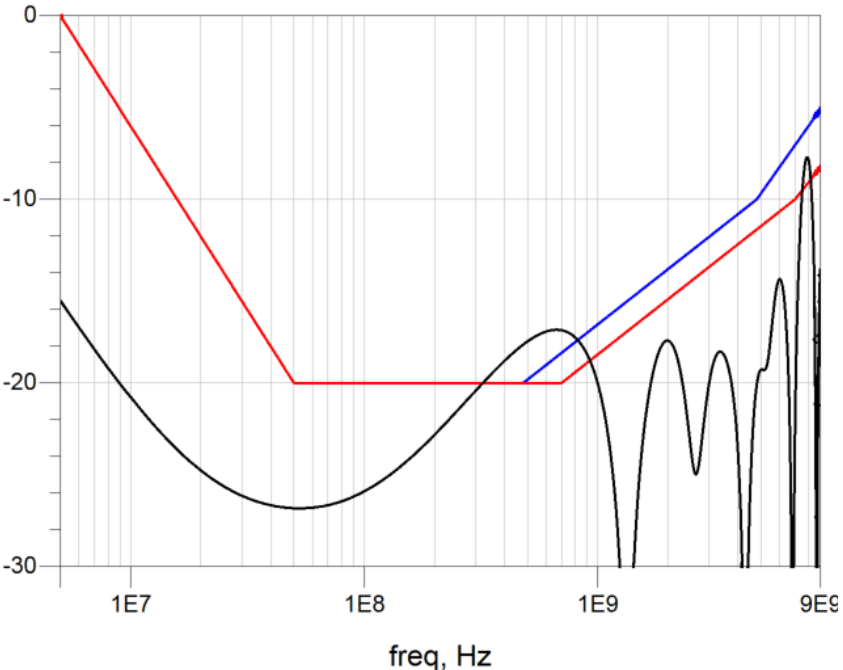Trace =   90 Ohm

PHY   =   95 Ohm
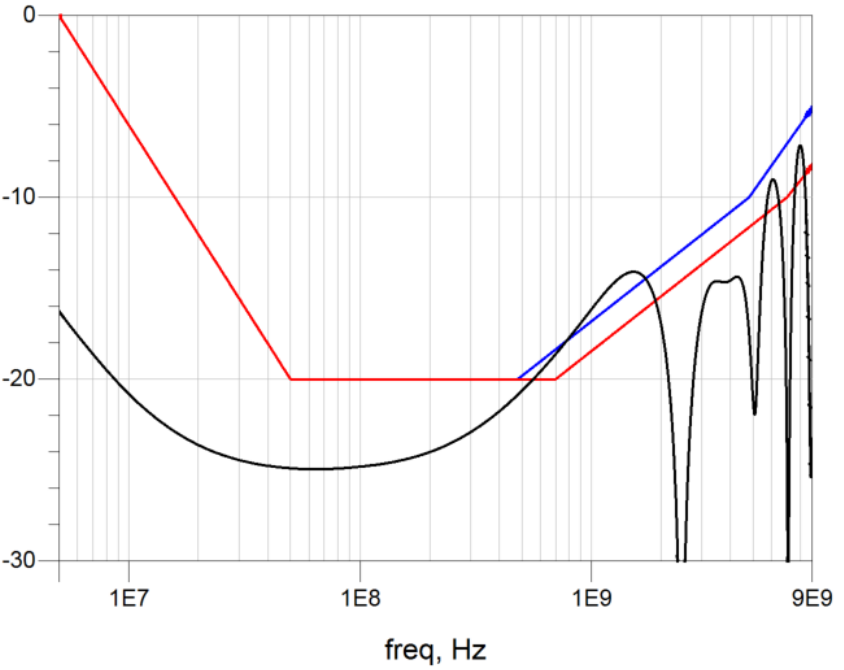Trace = 110 Ohm

FR 408 with 1.5 in Traces with PoDL (cont.)

PHY = 100 Ohm
Trace = 100 Ohm
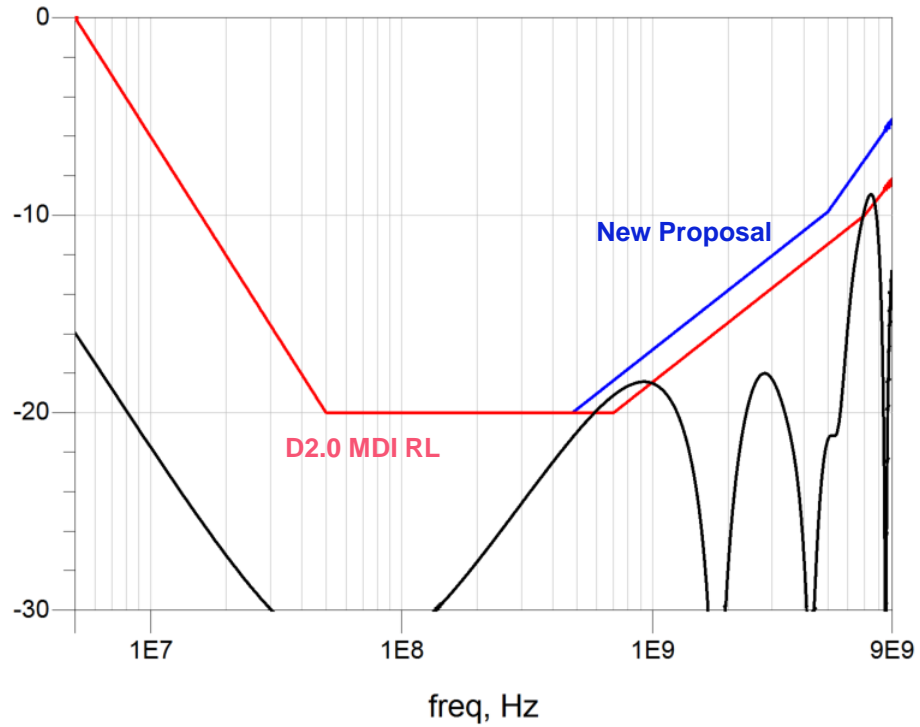
PHY = 110 Ohm
Trace =   90 Ohm
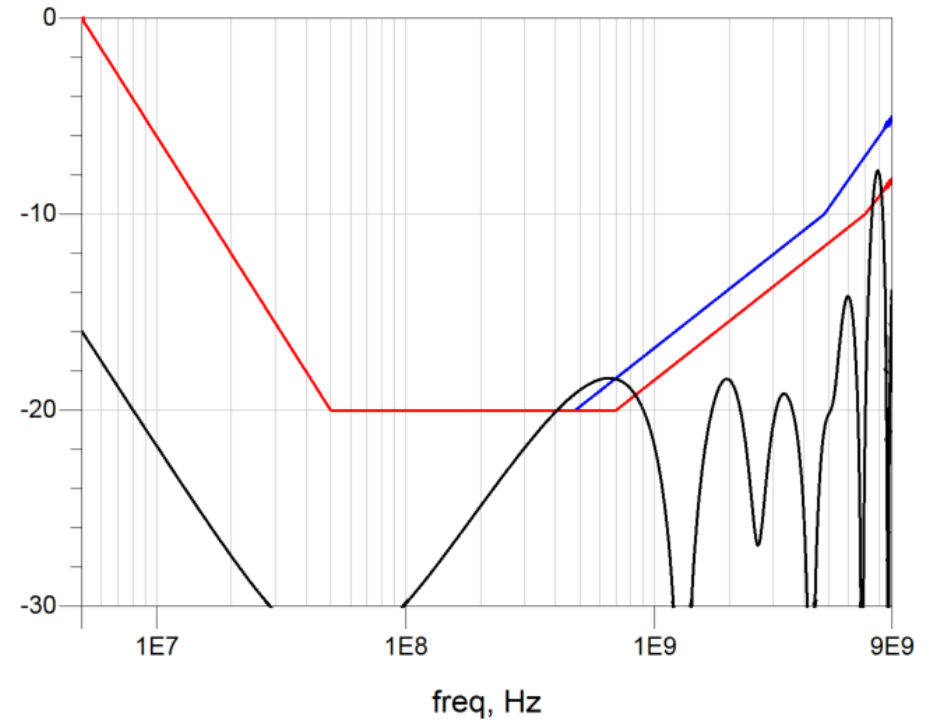
PHY =   90 Ohm
Trace = 110 Ohm

Board Trace 0.75 in vs. 1.5 in with PoDL
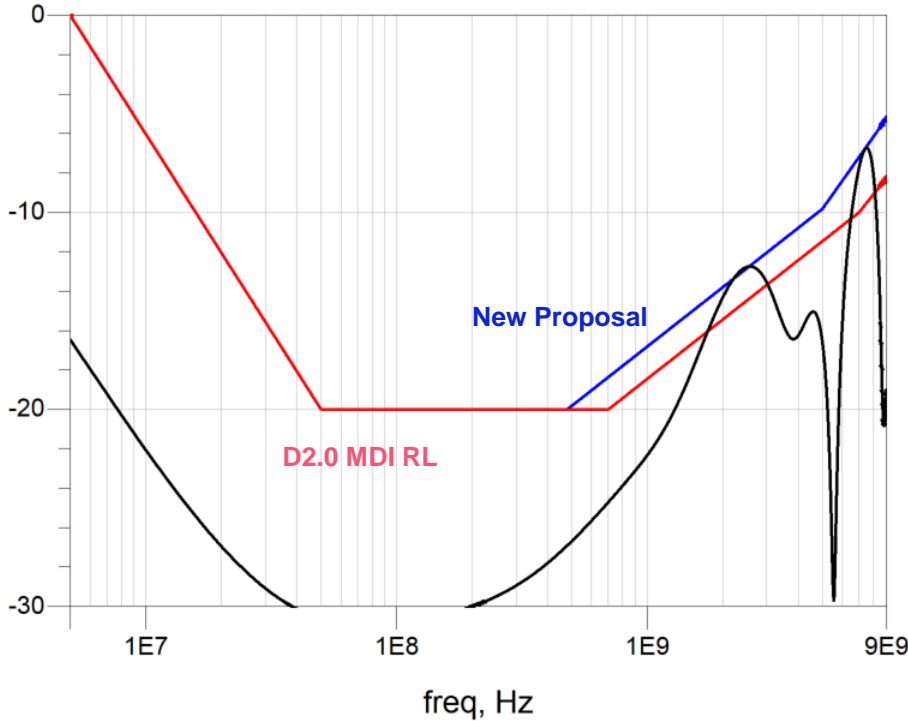# PHY = 105 ohm, Trace = 90 ohm

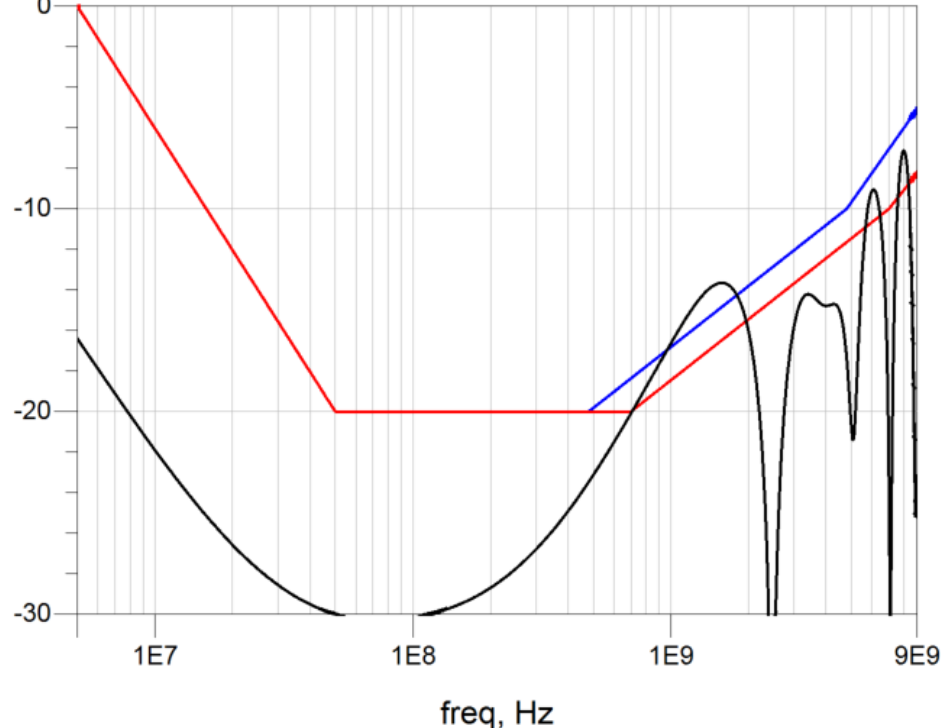
0.75 inch trace FR408

1.5 inch trace FR408

Board Trace 0.75 in vs. 1.5 in with PoDL
PHY = 95 ohm, Trace = 110 ohm

0.75 inch trace FR408

1.5 inch trace FR408

New Proposal

D2.0 MDI RL

Summary

D2.0 vs. New Proposed MDI Return Loss

D2.0 MDI RL:

$$\text{Return Loss} = \begin{cases} 20 - 20(\log_{10}\frac{50}{f}) & 5 \le f \le 50 \\ 20 & 50 \le f \le 700 \\ 20 - 10\log_{10}(f/700) & 700 \le f \le 7000 \\ 10 - 16\log_{10}(f/7000) & 7000 \le f \le 10000 \end{cases} \text{(dB)} \qquad (165\text{-}44)$$

where

f is the frequency in MHz

New Proposal:

$$\text{Return Loss} = \begin{cases} 20 - 20(\log_{10}\frac{50}{f}) & 5 \le f \le 50 \\ 20 & 50 \le f \le 480 \\ 20 - 10\log_{10}(f/480) & 480 \le f \le 4800 \\ 10 - 18\log_{10}(f/4800) & 4800 \le f \le 9000 \end{cases} \text{(dB)}$$

where

f is the frequency in MHz

Conclusion

- The D2.0 MDI return loss spec is too restrictive for practical PHY and board implementations

- A new MDI return loss is proposed

- With the new proposal, board traces between 0.75 in and 1.5 in seem to be feasible

Backup Slides

Simulation with Tachyon 100G

Board Traces and PHY Terminations without PoDL

0.75 inch trace Tachyon100G
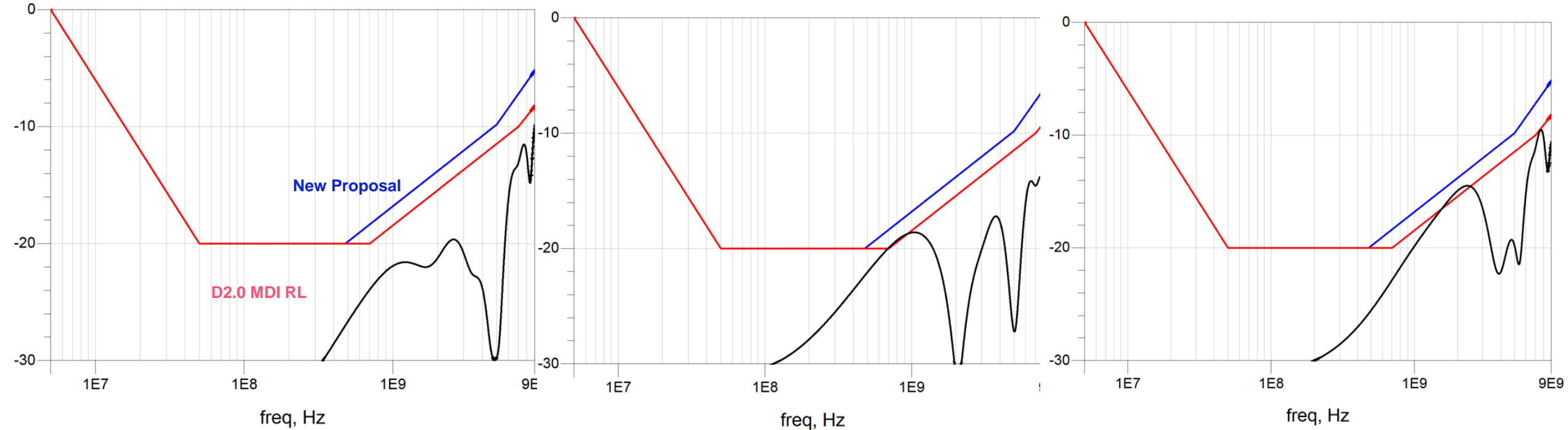
Chip = 100 Ohm
Trace = 100 Ohm

Chip   = 105 Ohm
Trace =   90 Ohm

Chip   =   95 Ohm
Trace = 110 Ohm