ANALOG DEVICES

# Optimized Power Coupling Inductance Day 2

Michael Paul

# Adjustments after 1st day of conference

# Text Modification to allow variable Lpodl

In clause 189.6, insert new section 189.6.1 MPI Return Loss with text:

“When the MPI is a TCI, the TCI return loss at TC1 and TC2 shall meet the values determined using Equation (188–7) with the other trunk TC (i.e., TC2 or TC1, respectively) terminated in 100 /OHMS with a DTE or simulated DTE load present at the TCI, plus 10*log10(N_load), where N_load is the maximum number of unit loads for the DTE. (where /OHMS is the symbol for Ohms)”

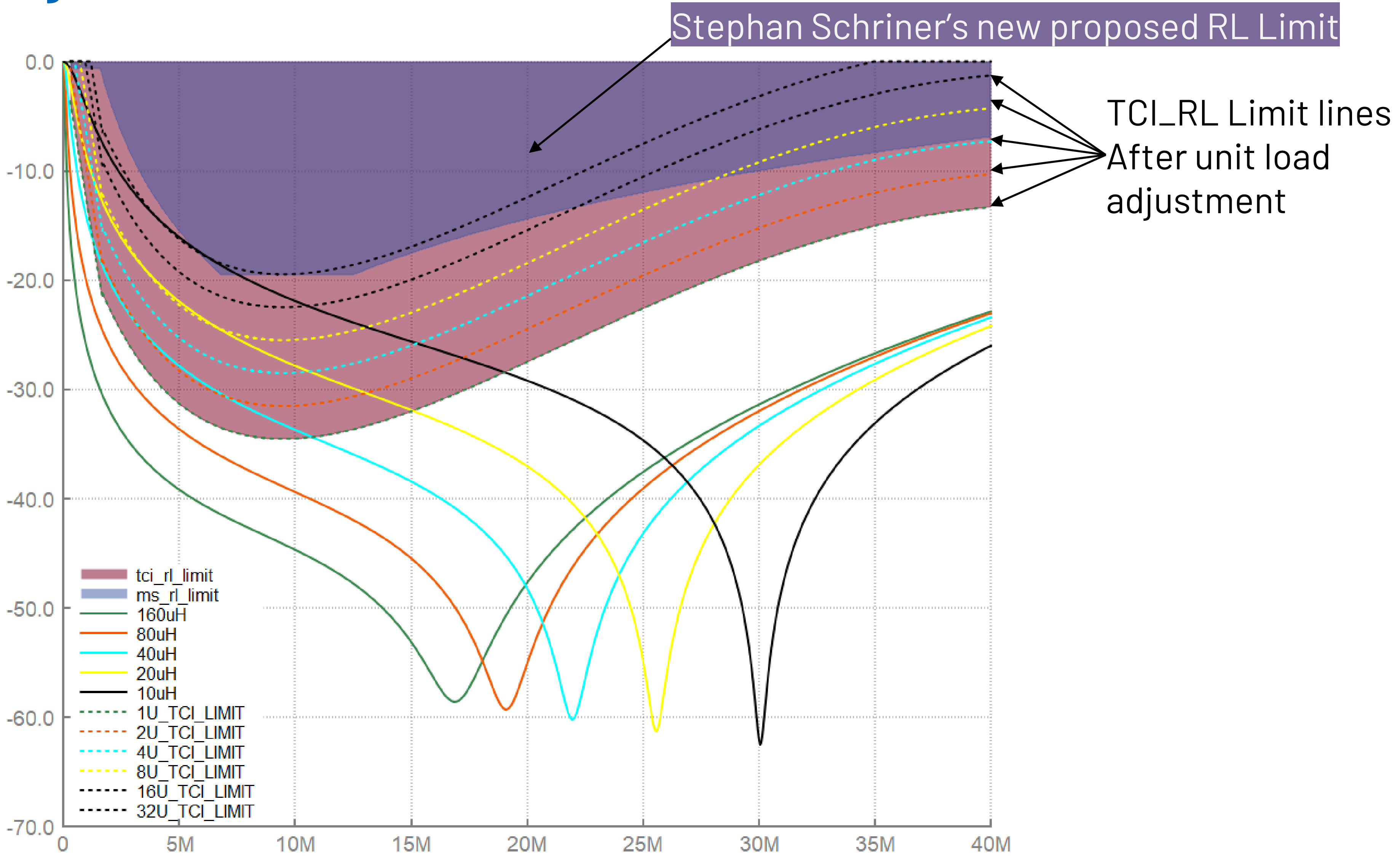
In clause 188.9.2, insert a new first sentence

“When the TCI is also an MPI, the return loss of the TCI complies with the return loss of 189.6.1.” Change the beginning of the following sentence to read, “When the TCI is not an MPI, the TCI return loss at TC1 and TC2 shall meet the values determined using Equation (188–7) with the other trunk TC (i.e., TC2 or TC1, respectively) terminated in 100 /OHMS with a DTE or simulated DTE load present at the TCI.” (where /OHMS is the symbol for Ohms)

**Credit to George Zimmerman for Text Proposal and Math**

# GZ Proposed Adjustable Limits

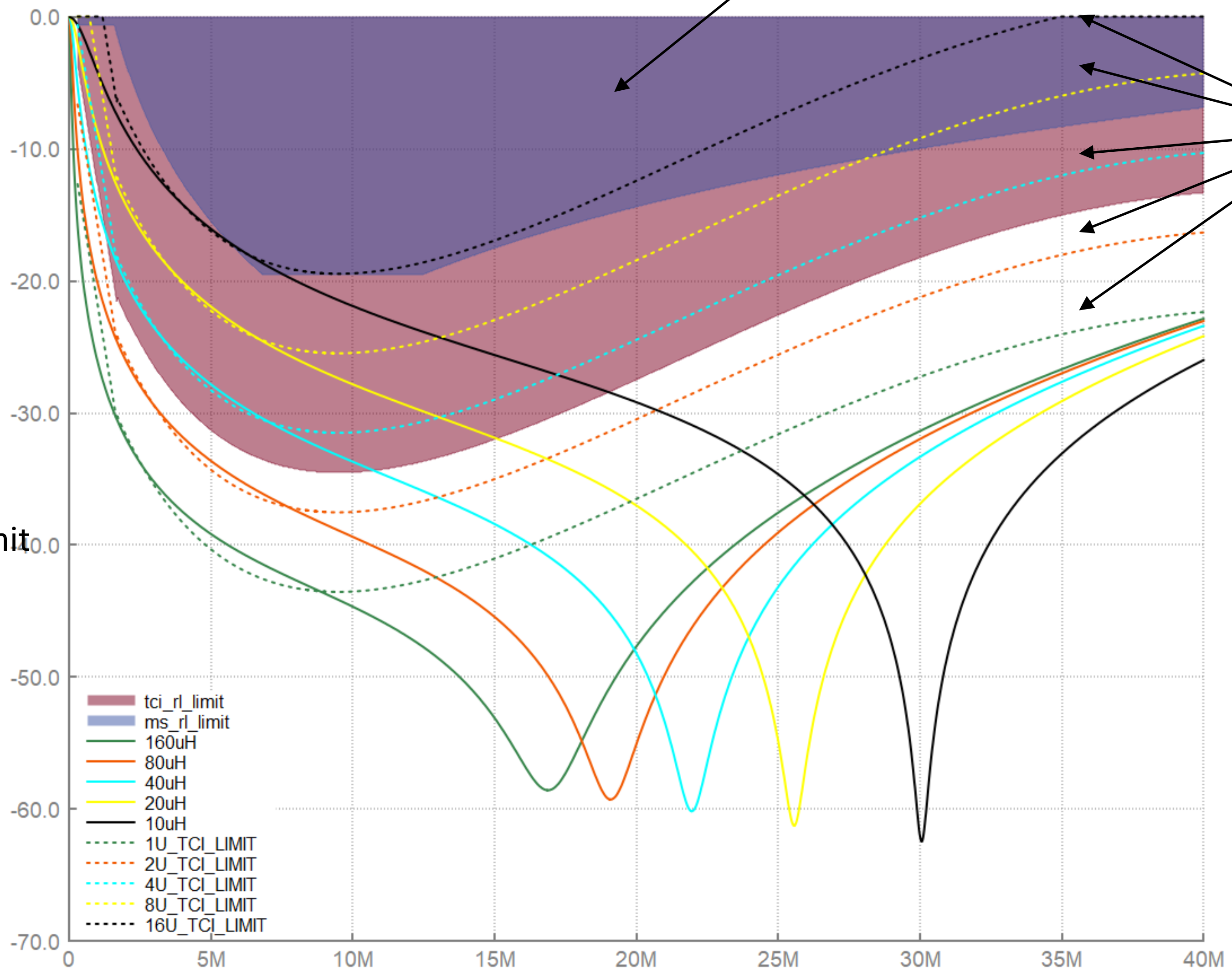
Equation (188–7) …
plus 10*log10(N_load),



# Unit Load Adjustable Limits

Stephan Schriner's new proposed RL Limit

TCI_RL Limit lines
After unit load
adjustment

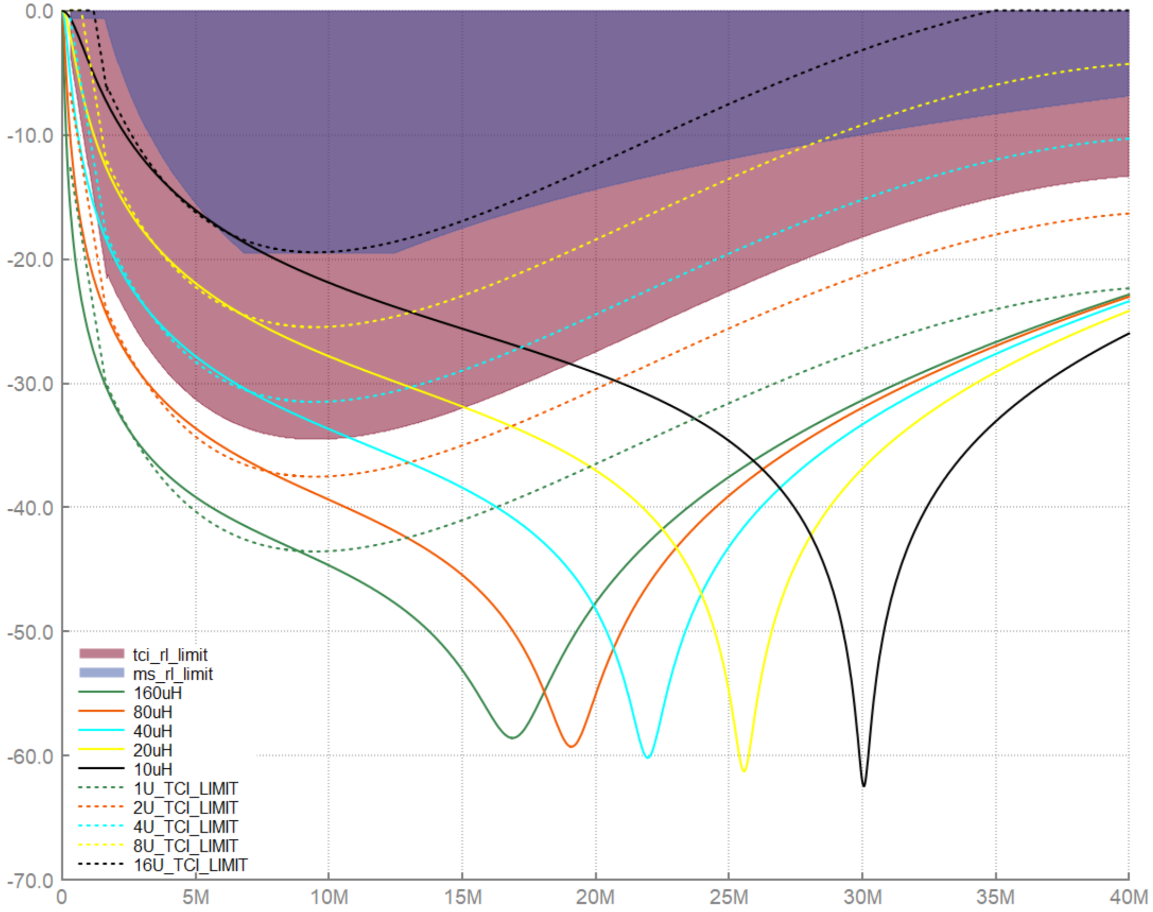


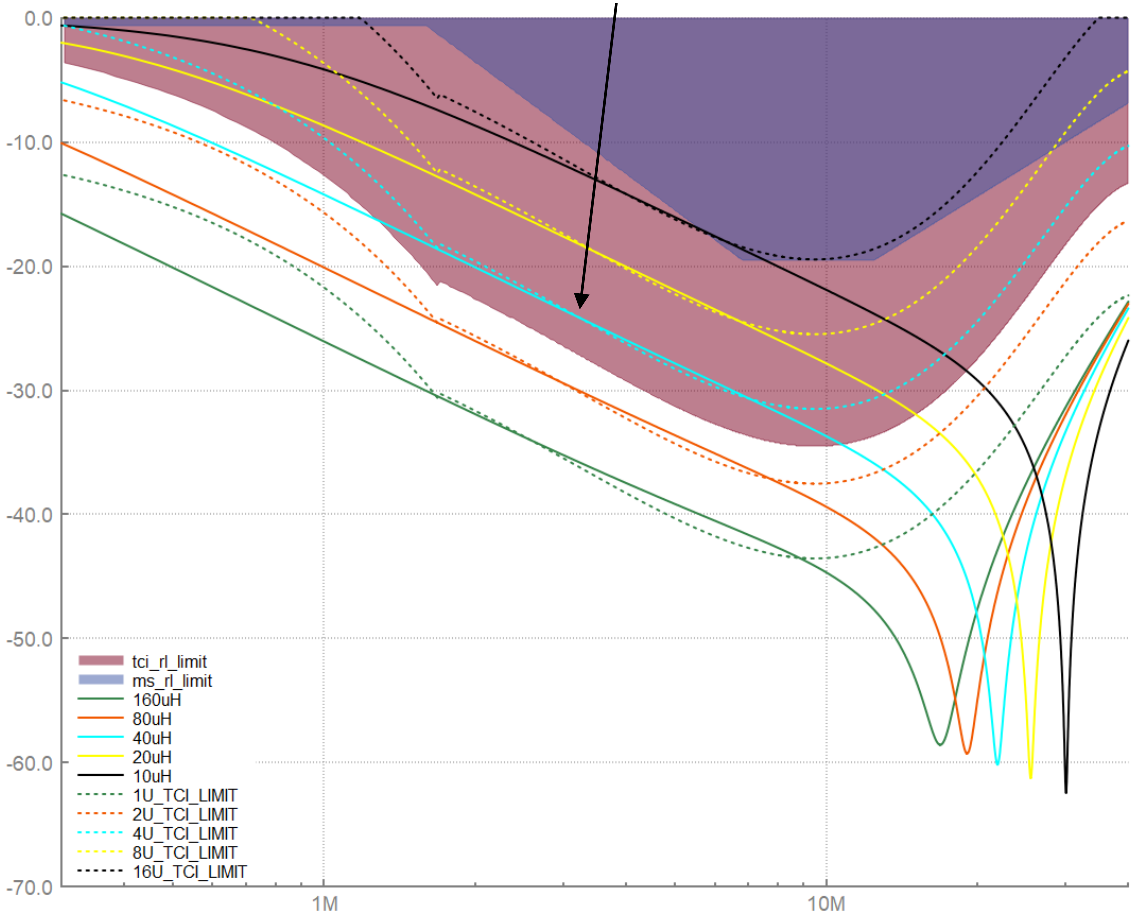

Equation (188–7) … plus
10*log10(N_load^2 / 8),

Lines fit better, but 1U device limit
Dropped by ~10dB

# Comparing linear and log X scales

Inductors have -20dB / decade characteristic




**Todo:**
**Analyze how to move the low frequency line without affecting the high frequency RL**
**Comment against D2.1 with update**

# Previously Presented on Jan 20, 2025

# Introduction

When we defined unit loads, one of the goals was to optimize power coupling inductance based on load current

- A mixing segment has a power coupling inductance budget
- Exceeding the minimum budget causes data droop

Power coupling inductors 'sum' in parallel

- Data integrity calculations assumed an even distribution of inductance across the nodes:
  - 17 nodes (1 MPSE, 16 MPDs), with 85uH power coupling inductance each
  - 85uH / 17 = 5uH minimum parallel inductance

**This presentation discusses:**

**1) A more optimal way to distribute Power Coupling Inductance**

**2) Required changes to the TCI return loss specifications to allow PCI optimization**

# Power Coupling Inductance Budget

The mixing segment power coupling inductance budget is linked to each node's power budget

- Fewer high unit load devices can coexist on a mixing segment
  - Therefore, higher unit load MPDs can absorb more of the power coupling inductor budget
- Doing this allows high current device to use smaller power coupling inductance value
  - This optimizes cost and size
- This was proposed in November 2023: Paul_02_da_2023_11_13.pdf, slide 3

# Power Coupling Inductance Optimization

| Unit Load | Old Distribution (uH) | New Distribution (uH) |
|---|---|---|
| 1U | 80 | 160 |
| 2U | 40 | 80 |
| 4U | 20 | 40 |
| 8U | 10 | 20 |
| 16U | 5 | 10 |
| MPSE | 80 | 10 |

The new distribution distributes Amps per Henry evenly across the unit load types and the MPSE

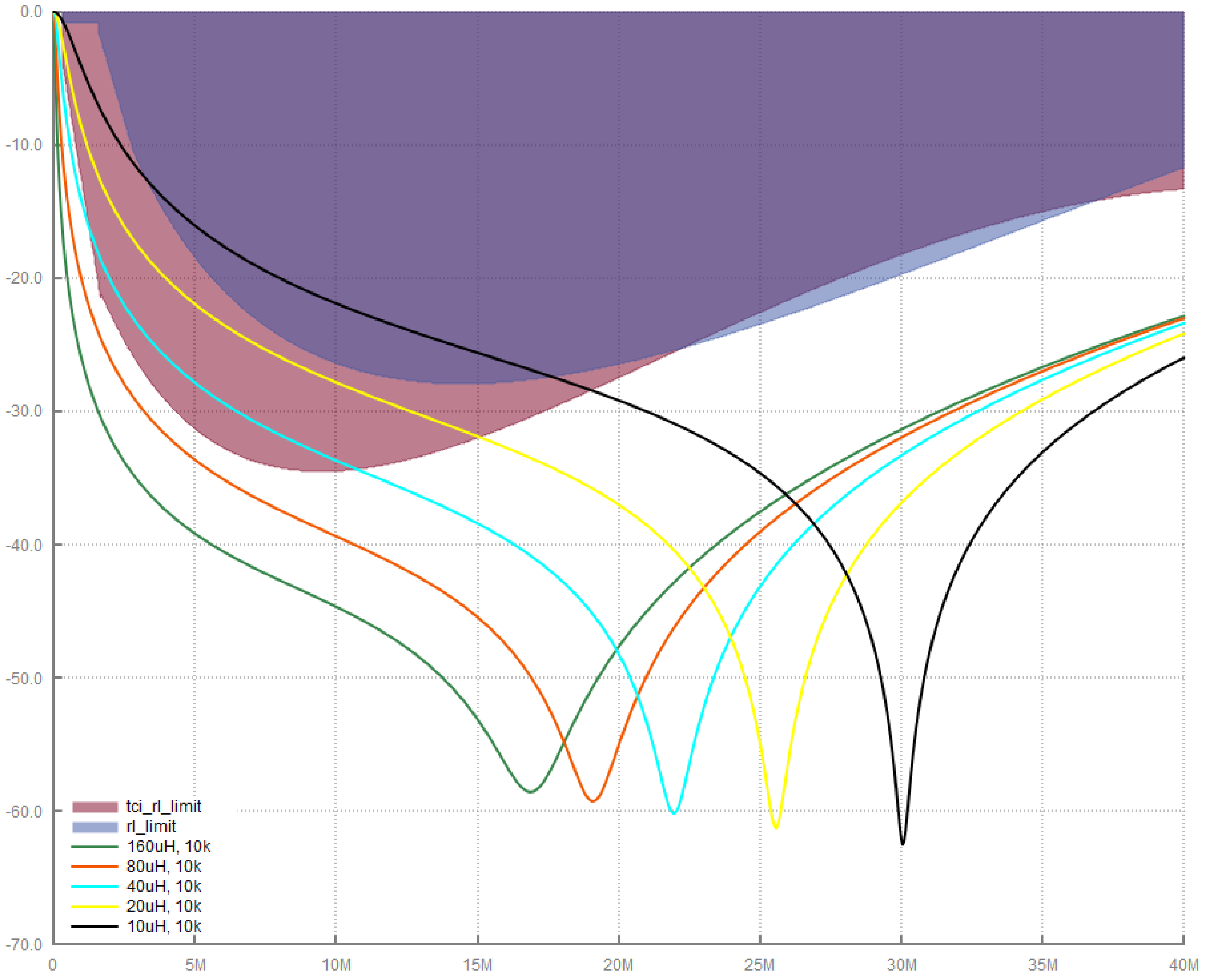
The new distribution provides a drastic improvement on the MPSE economics and has little to no effect on the MPD economics

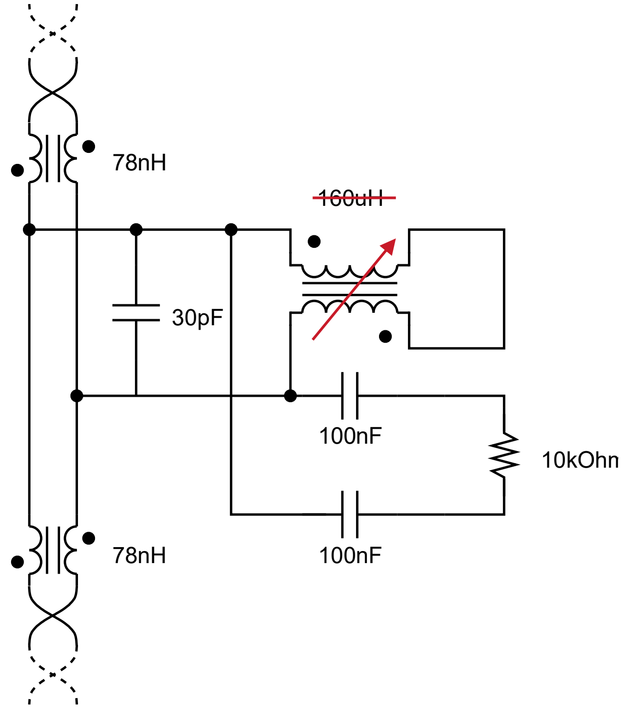
# Power Coupling Inductance Compliance

In 802.3da Draft 2.0, the power coupling inductance is limited by the TCI Return Loss limit specified in clause 188

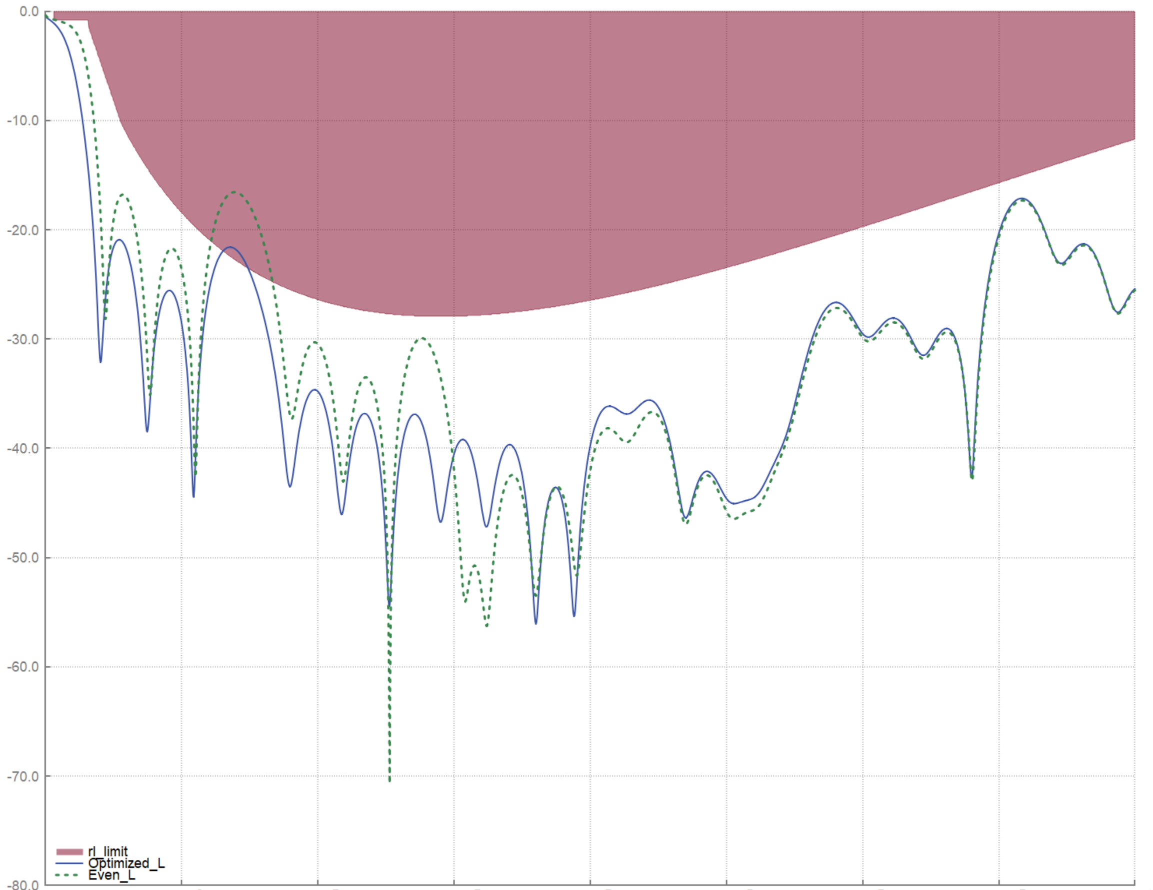
- The TCI return loss limit is calculated for nodes with ~80uH power coupling inductance
- We need it to accommodate ~10uH for 16U devices and 160U for 1U devices

# Return Loss with Different Power Coupling Inductors



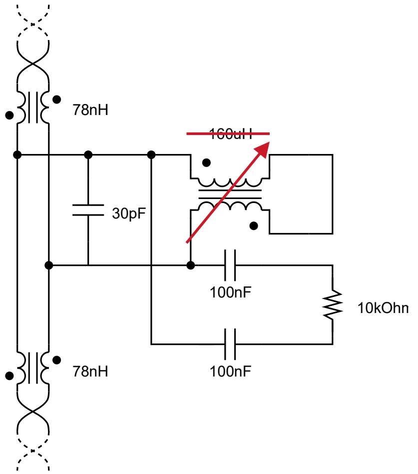
# Mixing Segment RL – Looking at Mixing Segment from Transmitter



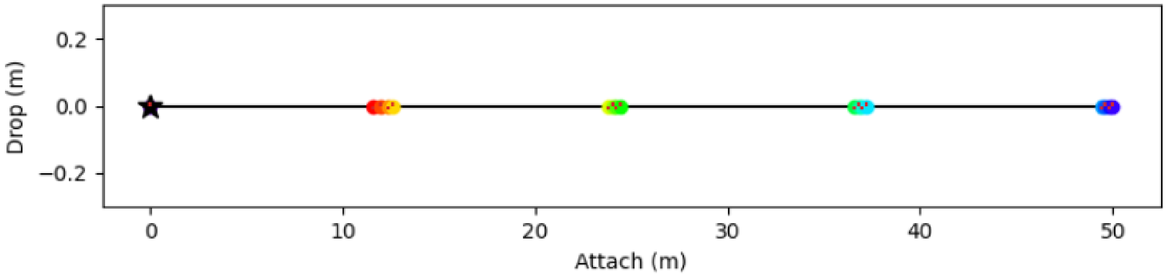

Even_L -> 85uH All 17 Nodes

Optimized_L -> 10uH Transmitter, 160u * 16 PDs

Node Configuration:




Network Configuration: 4 Clumps, 4nodes per clump



# Conclusion

I am requesting a 'Task Force To Do' on this topic

Is there consensus on the new power coupling inductance distribution?

I need help changing the Clause 188 return loss specifications to accommodate the power coupling inductance distribution

# Appendix