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PoDL Considerations for MDI Return Loss Mask

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Objectives

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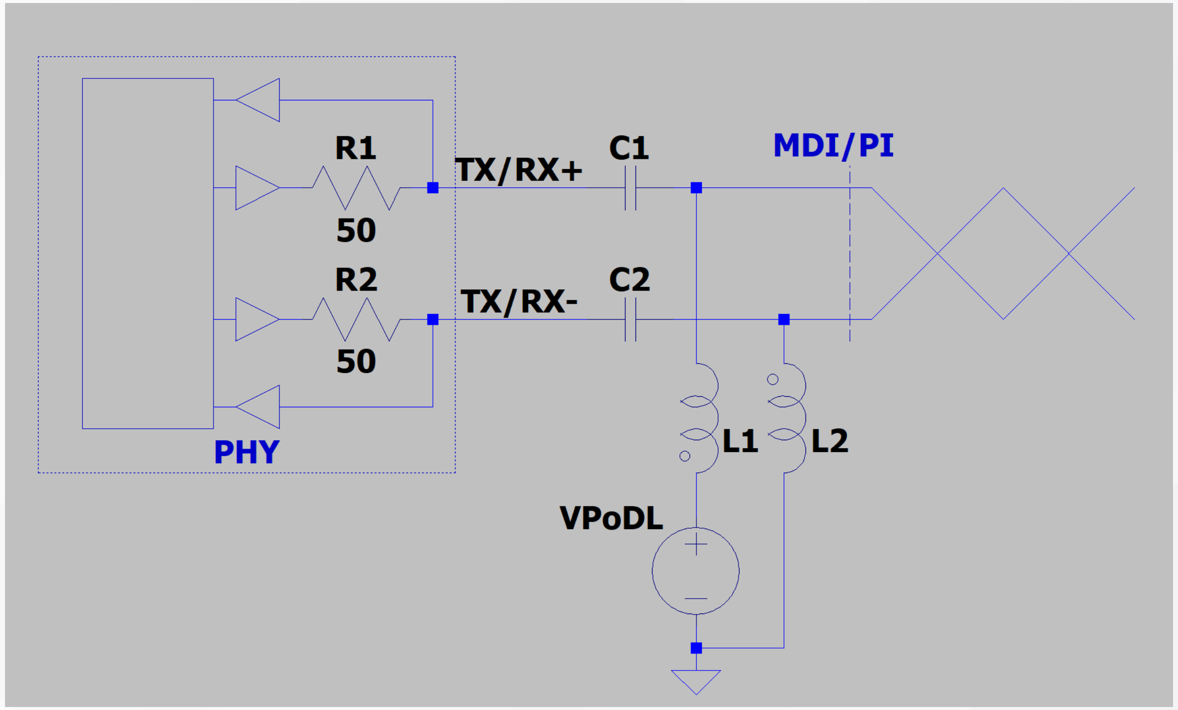
- Review basic PoDL MDI/PI architecture
- Discuss limitations on PoDL inductors
- Review some data from bhagwat_3ch_02a_0718.pdf
- Propose next steps

Basic PoDL MDI/PI

- Low frequency return loss a function of :
  - DC blocking capacitors C1/C2
  - PoDL inductors L1/L2
- Low frequency return loss dominated by L1/L2 when the MDI/PI is over-damped:

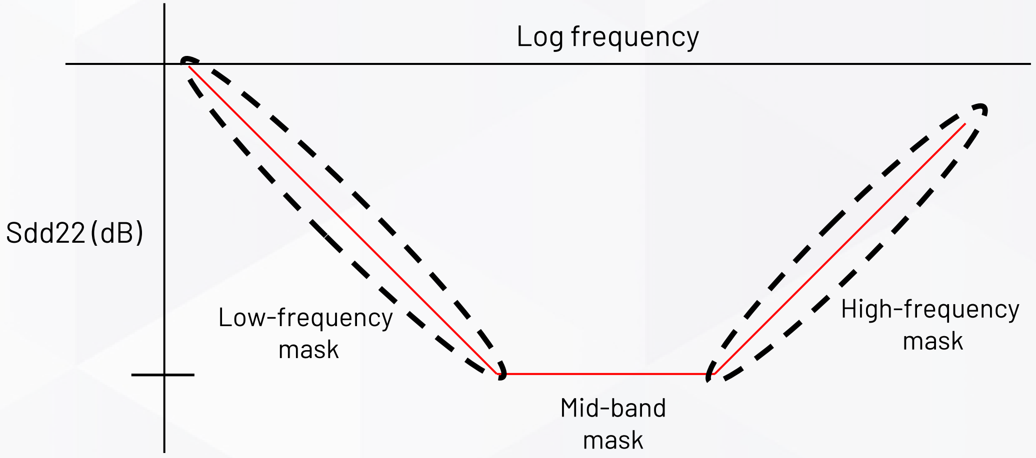
$$C \gg \frac{L}{(50\Omega)^2}$$



PoDL Inductor Constraints

- PoDL inductor selection is a balancing act
  - Size and cost goes as
    - Open-circuit inductance (OCL)
    - Square of ampacity, e.g. doubling ampacity quadruples size and cost
  - Low-frequency RL mask constrains OCL
    - OCL also constrained by droop
  - High-frequency RL mask constrains inductor self-resonant frequency (SRF)
  - Mid-band RL constrains inductor core-loss and use of snubber resistors and/or common-mode terminations

Typical MDI Return Loss Mask



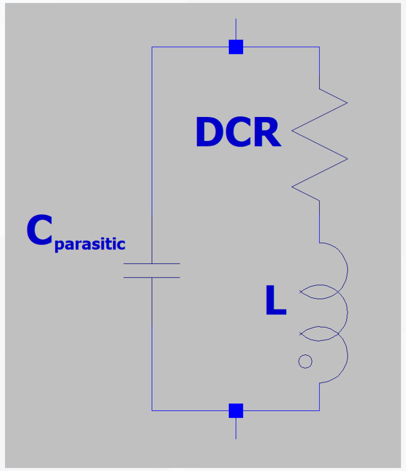
Note: Sdd22 and RL are used interchangeably here even though RL is a positive quantity while Sdd22 is negative

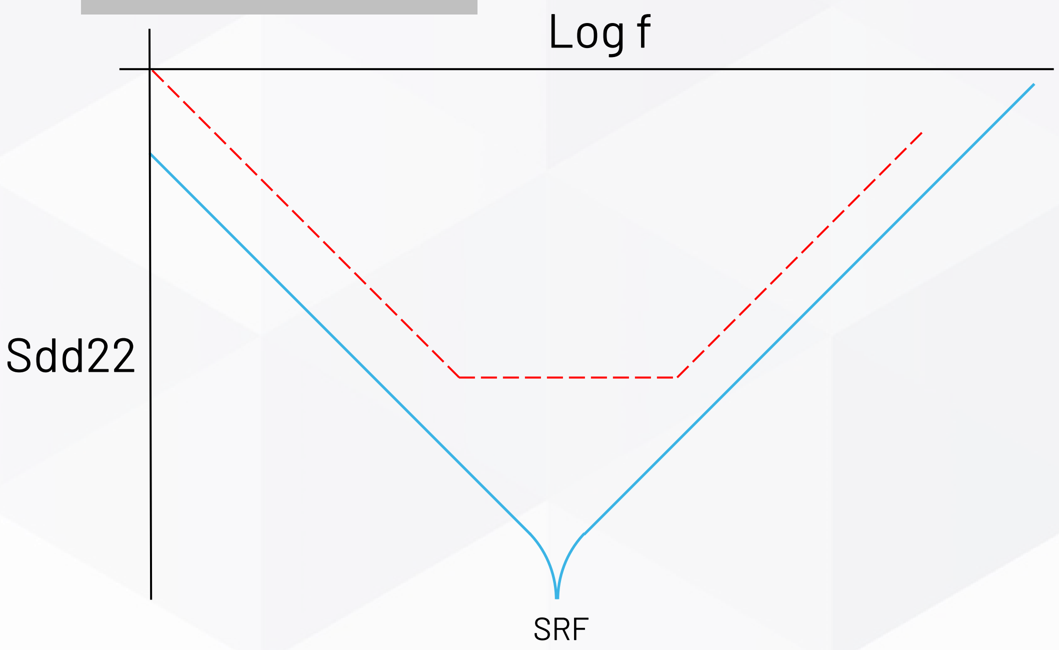
Inductor SRF

- Parasitic capacitance between inductor terminals limits high frequency impedance
- Maximum inductor impedance occurs at:

$$SRF = \frac{1}{2 * \pi\sqrt{L * C_{parasitic}}}$$

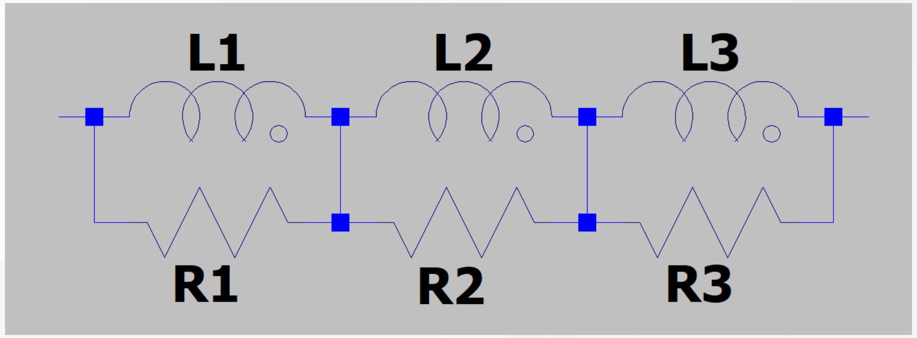
- SRF manifests itself as a 'V' in the observed RL
- Bigger inductors and inductors with higher OCL have lower SRF
- Core-loss can also cause inductor impedance to drop off at high frequencies

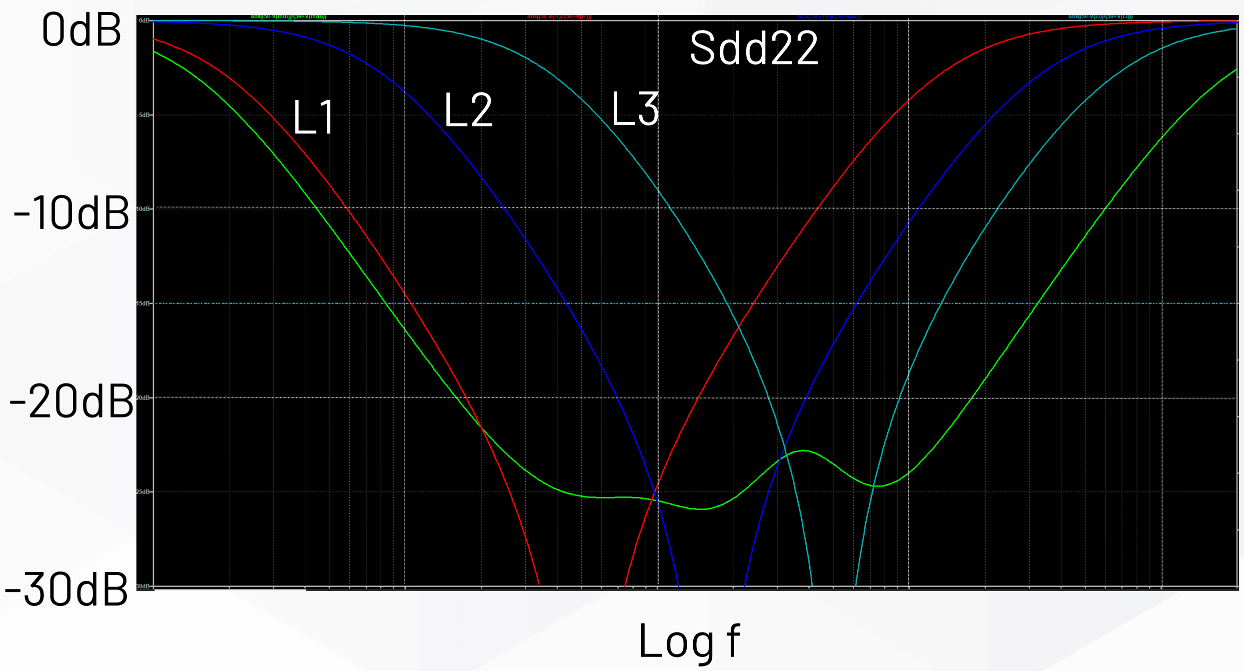




Inductor Cascades

- What happens if SRF fails to meet high frequency RL mask?
  - Inductor cascades can be employed to extend return loss
  - Cascade inductors are smaller relative to first inductor, but cost and complexity increase can be significant
  - Meeting 20dB mid-band RL may be problematic depending on snubber resistor R1/R2/R3 requirements and core-loss

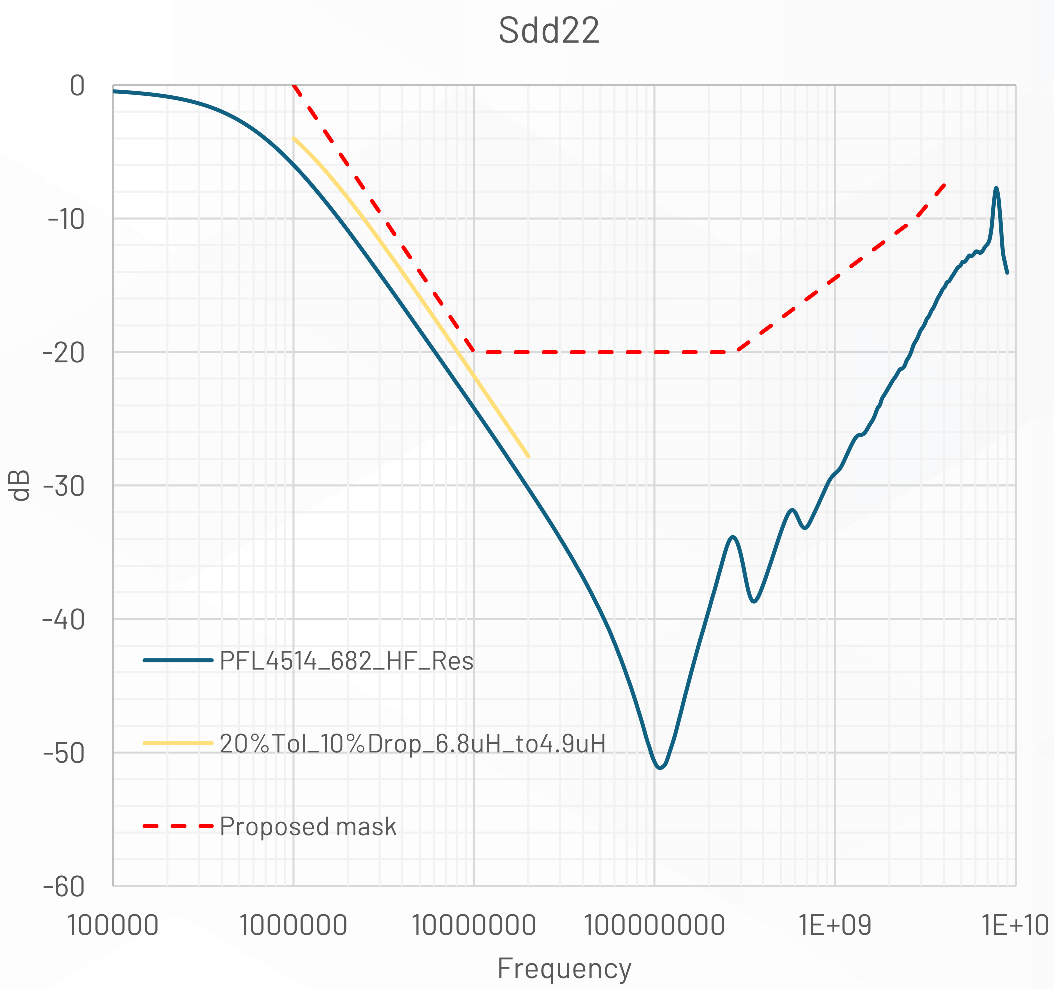


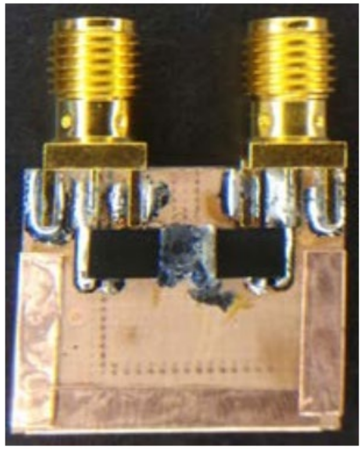


Mode Conversion Considerations

- PoDL inductors can be a source of mode conversion at the MDI
- Low frequency mode conversion is a function of L1/L2 OCL matching
  - Can be mitigated with PoDL power path CMC
  - Some newer inductors offer improved matching specs
- Larger footprint inductors tend to have poor high-frequency mode conversion loss
  - High-frequency mode conversion may be mitigated with cascades

RL Data for Off-the-Shelf Inductor





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- Data originally presented in bhagwat_3ch_02a_0718.pdf
- RL data does not include effects of PHY and other MDI components
- 3.4mm x 4.9mm x 1.4mm footprint
- D/S ampacity: 0.86A DC at 105C ambient

Next Steps

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- Identify inductor ampacity requirements
- Design and Build test fixtures
  - Measure RL and mode conversion with VNA
  - Evaluate ampacity
- Present results and propose MDI RL mask modifications as needed