10BASE-T1L Droop / Return Loss vs Power Coupling Magnetics

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ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

Droop vs Magnetics

Droop	Footprint	Volume	Cost	Photo
10%	18.3mm x 18.3mm **3.3cm²**	**4cm³**	100%	
12.6%	12.3mm x 12.3mm **1.5cm²**	**1.2cm³**	49%	
23%	12.3mm x 12.3mm **1.5cm²**	**0.9cm³**	42%	

- Arbitrarily selected magnetics vendor
- Compares droop performance at sustained 2A operation
- 2 inductor packages per power coupling network
- Measured droop values are from a sample size of 1, standard droop values will need to be margined

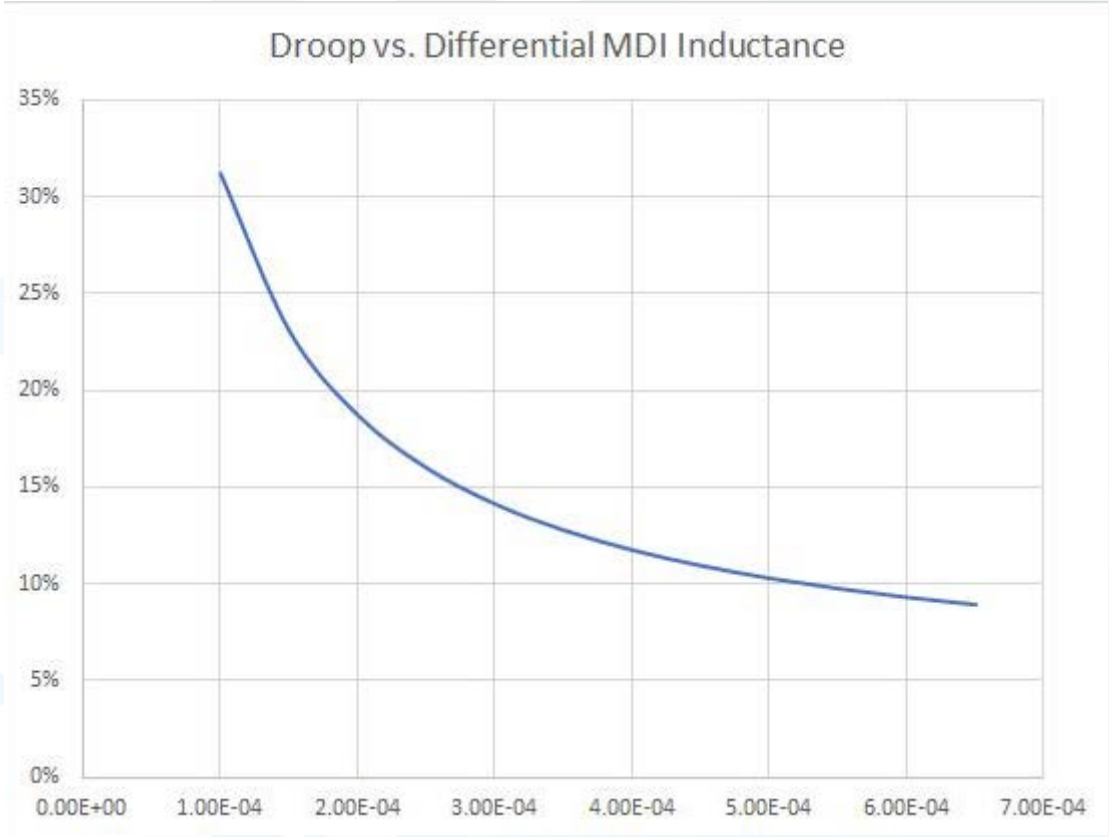
Power Coupling Network Over-specification

- Presently, Class 15 PoDL power coupling network designs have the following attributes
  - Large inductors
  - Heavy inductors
  - 33% to 50% of BOM cost per port
- State of the standard
  - Clause 146 droop requirements driven by intrinsic safety requirements not applicable to the bulk of the market

- Power coupling networks can be economized by rationalizing clause 146 requirements when paired with a Clause 104 PSE or PD
  - Droop
  - Return Loss

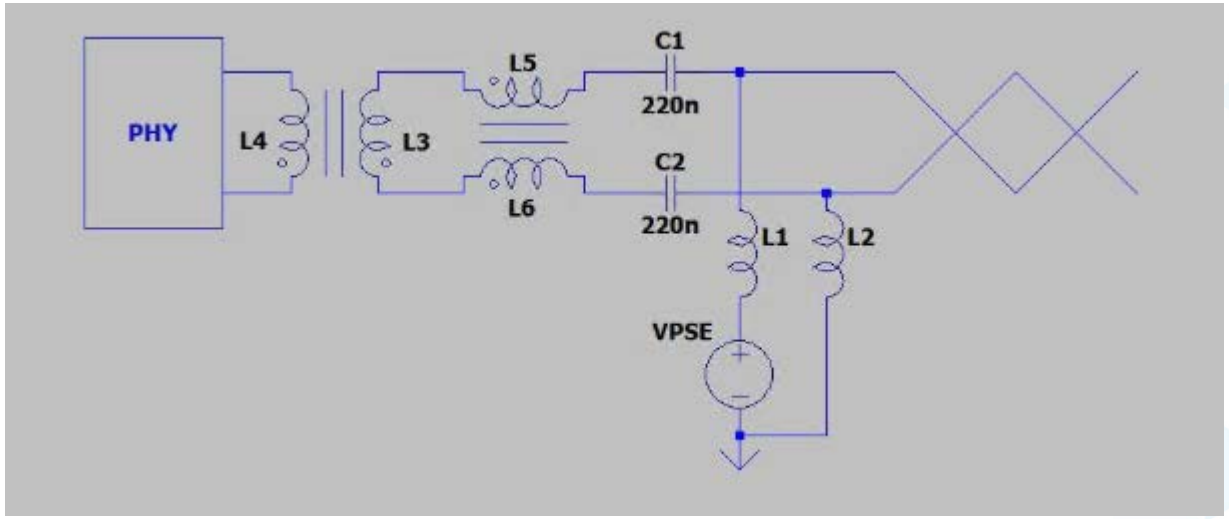
Droop vs Differential MDI Inductance

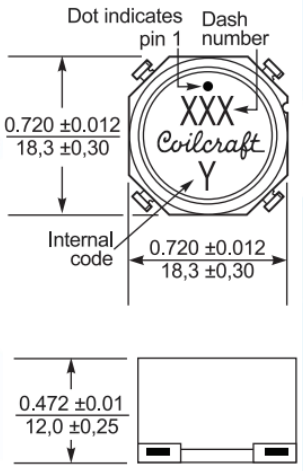
- Assumes
  - 220nF DC blocking caps
  - 10% drop for tolerance
  - 30% drop for voltage coefficient



Existing 10% Droop

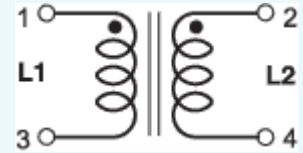
- Relative cost: **100%**



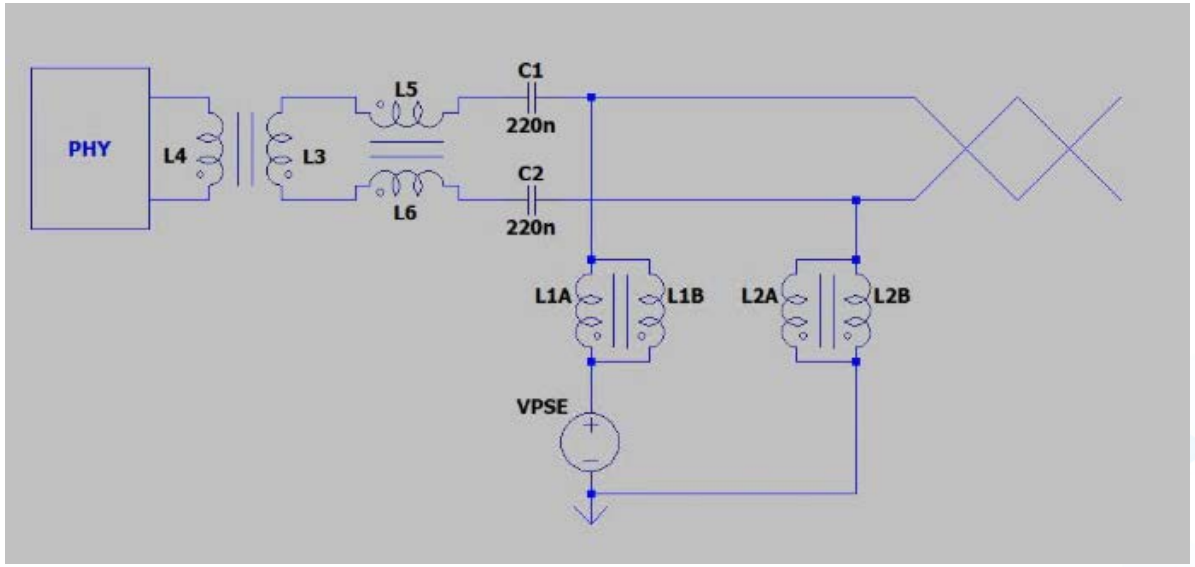


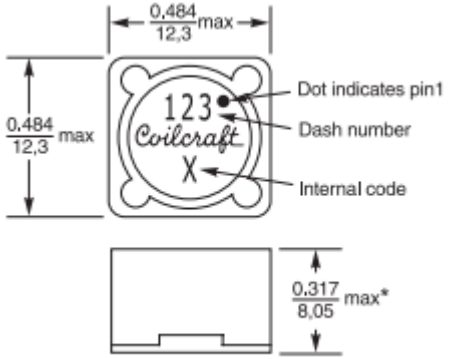
Part number 1	Inductance (µH) 2 *(Tolerance: ±10%)*	DCR (Ω) 3		SRF typ (kHz) 4	Isat (A) 5			Irms (A) 6	
		typ	max		10% drop	20% drop	30% drop	20°C rise	40°C rise
MSS1812T-474KED	470	0.200	0.230	1350.0	2.4	2.7	2.8	1.39	2.10

12.6% Droop



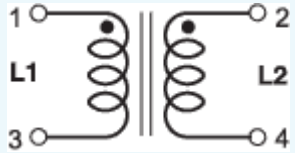
- Relative cost: **49%**



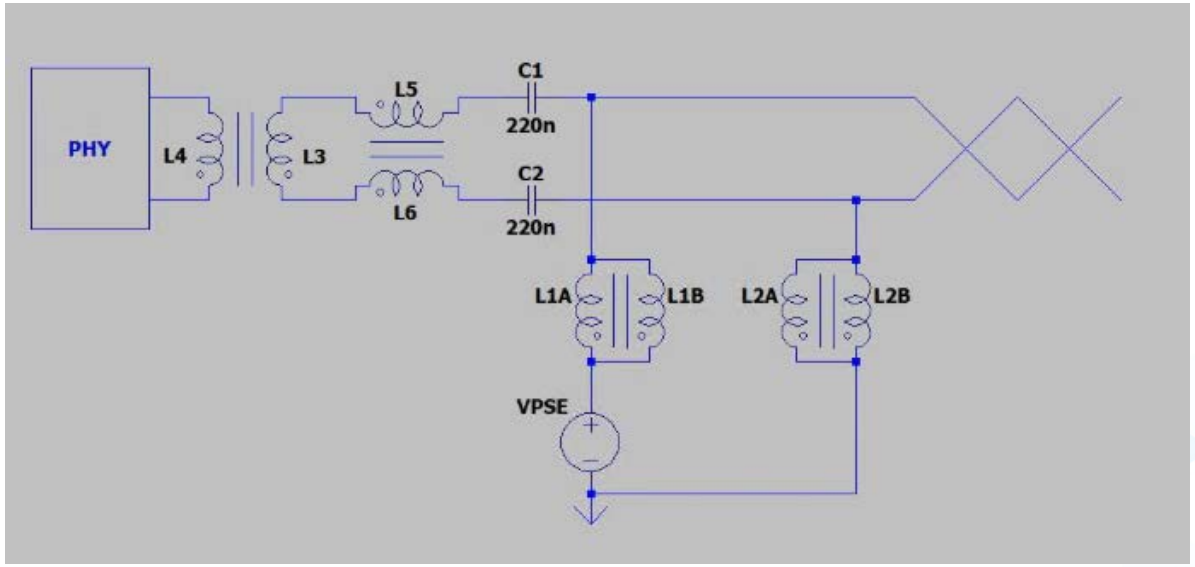


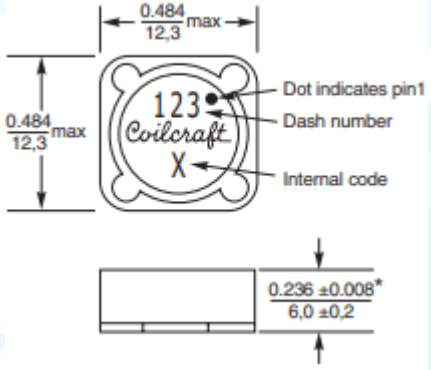
Part number 1 (Hover for schematics)	Inductance (µH) 2 *(Tolerance: ±10%)*	DCR max (Ω) 3	SRF typ (MHz) 4	Coupling coefficient	Leakage Inductance (µH) 5	Isat (A) 6			Irms (A)	
						10% drop	20% drop	30% drop	both windings 7	one winding 8
MSD1278H-184KED	180	0.47	4.2	>0.99	2.5	1.8	2.0	2.2	1.07	1.54

23% Droop



- Relative cost: **42%**





Part number 1 (Hover for schematics)	Inductance (µH) 2 *(Tolerance: ±20%)*	DCR max (Ω) 3	SRF typ (MHz) 4	Coupling coefficient	Leakage Inductance (µH) 5	Isat (A) 6	Irms (A)	
							both windings 7	one winding 8
MSD1260-104ML_	100	0.32	5.0	0.99	1.4	2.2	1.1	1.5

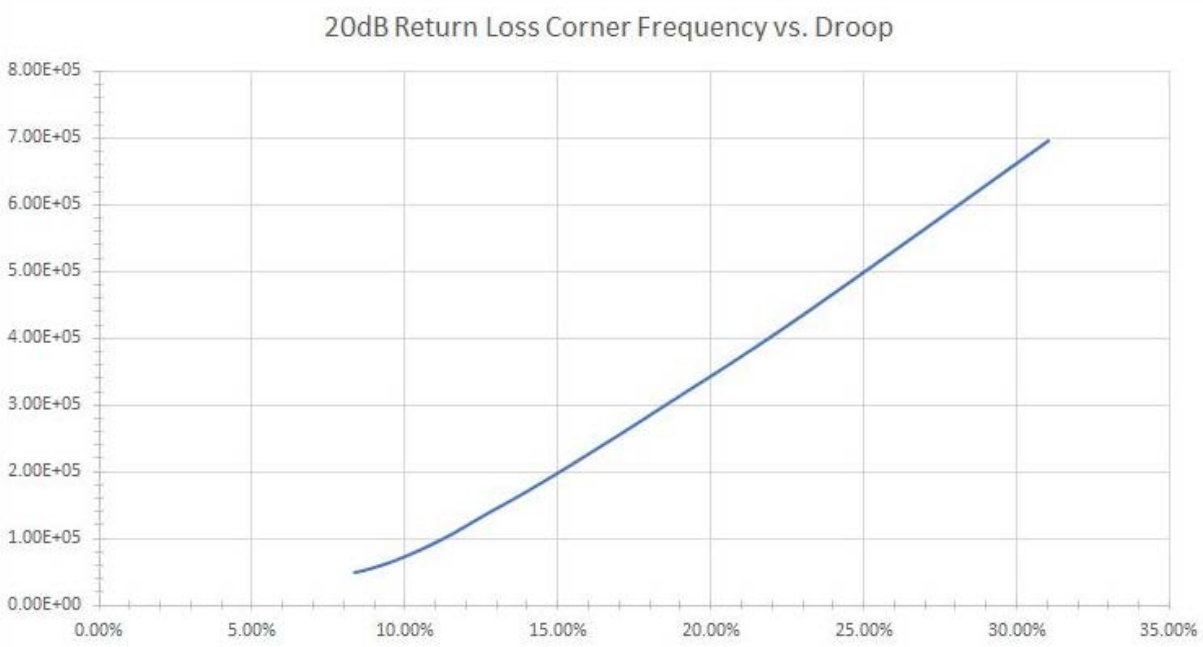
Thank You

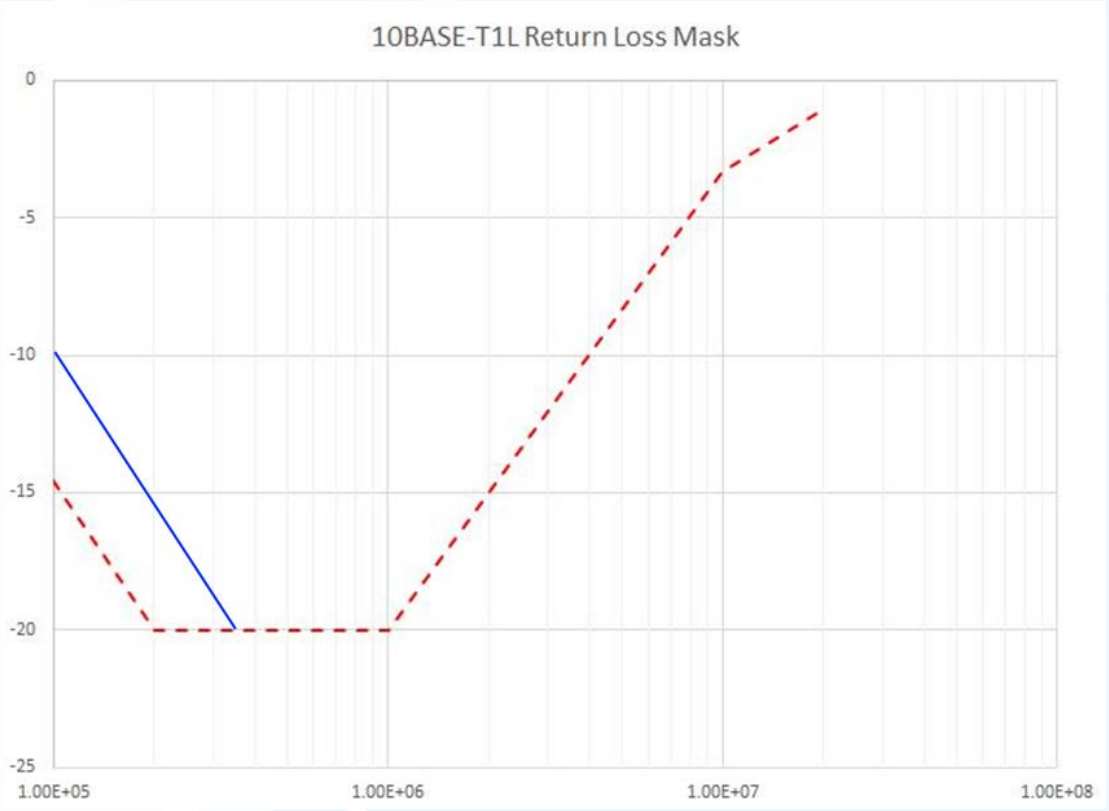
Existing Clause 146 Return Loss Requirement

- **Right:** Illustration of Return Loss
- **Bottom:** Actual Clause 146 requirement

$$\text{Return Loss}\,(f) \geq \begin{cases} 20 - 18 \times \log_{10}\left(\frac{0.2}{f}\right)\ \text{dB} & 0.1 \leq f < 0.2\ \text{MHz} \\ 20\ \text{dB} & 0.2 \leq f \leq 1\ \text{MHz} \\ 20 - 16.7 \times \log_{10}(f)\ \text{dB} & 1 < f \leq 10\ \text{MHz} \\ 3.3 - 7.6 \times \log_{10}\left(\frac{f}{10}\right)\ \text{dB} & 10 < f \leq 20\ \text{MHz} \end{cases} \qquad (146\text{–}17)$$

Return Loss for Exemplar 20% Droop





Insertion Loss vs Droop