EMI Suppression Ferrites

Fair-Rite Products, Wallkill, NY
PSMA Magnetics Conference 2021

Agenda

- What is Ferrite?
- Ferrite Application Areas
- Terminology
- Suppression Ferrites
  - How they work
  - Material Comparison
  - Design considerations
- Selecting the right Ferrite

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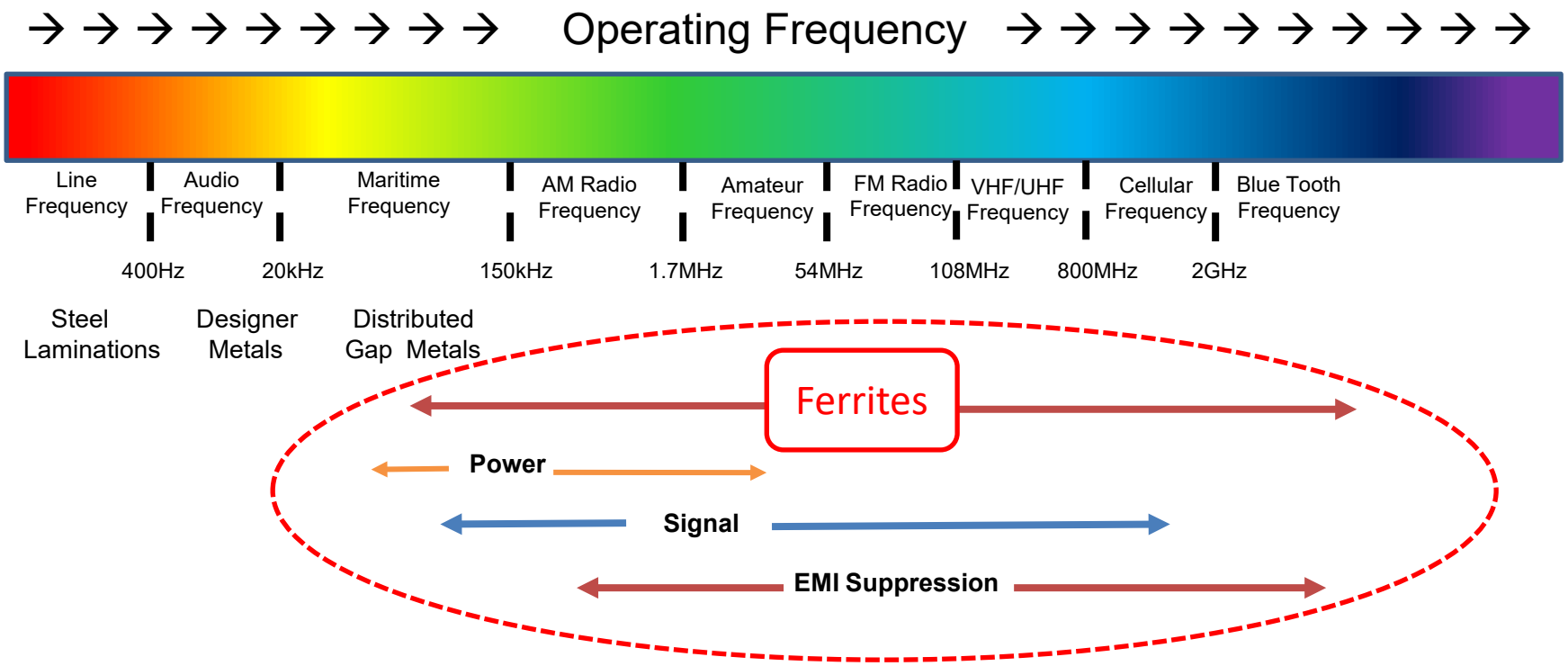
What Is Ferrite?

- Ferrite is a soft magnetic material formed by pressing and firing various metal oxides (primarily iron) into a ceramic material.
- A ‘Soft’ magnetic material is one that can be both easily magnetized and demagnetized.
- Two basic compositions: MnZn and NiZn
- Many different grades exist under these two basic types by way of altering the concentrations, adding or subtracting trace additives, and changing the processing parameters

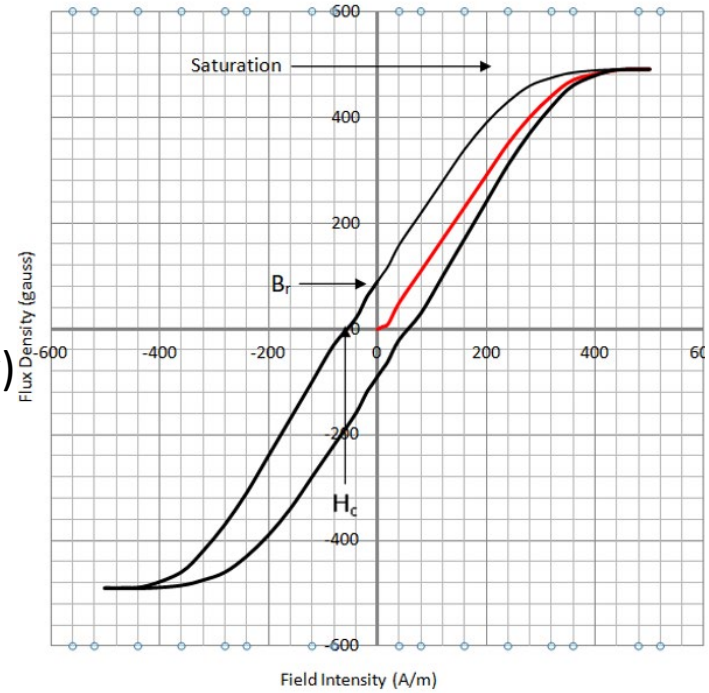
Why Ferrites?

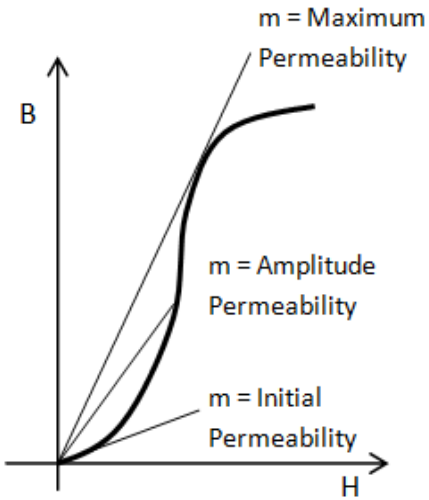


- Losses are proportional to Frequency
  - Hysteresis Losses (Magnetization)
  - Eddy Current Losses

Speak the language

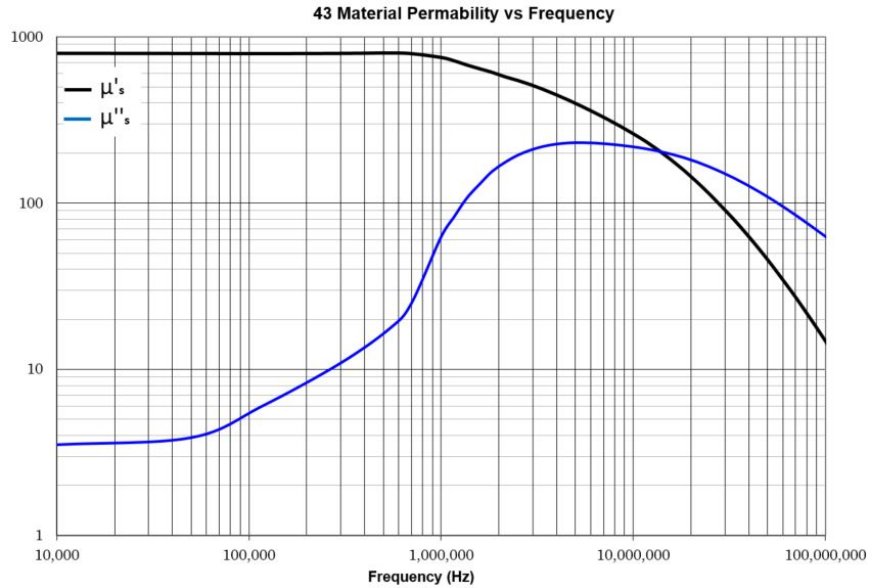
- Permeability B=μH
  - Initial (10kHz low B)
  - Incremental (μi vs DC bias)
  - Amplitude (μi vs B)
  - Effective (μi with air gap)
  - Complex (μ' μ" over frequency)
- Saturation
- Curie Temperature
- Power Loss Density

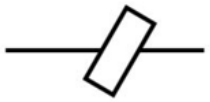




Suppression Ferrites

- Strengths
  - Lossy Core Material
  - Resistive / dissipative
- Trade Offs
  - Limited frequency band
  - DC Bias Concerns

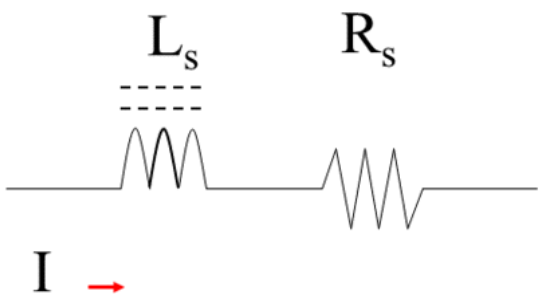




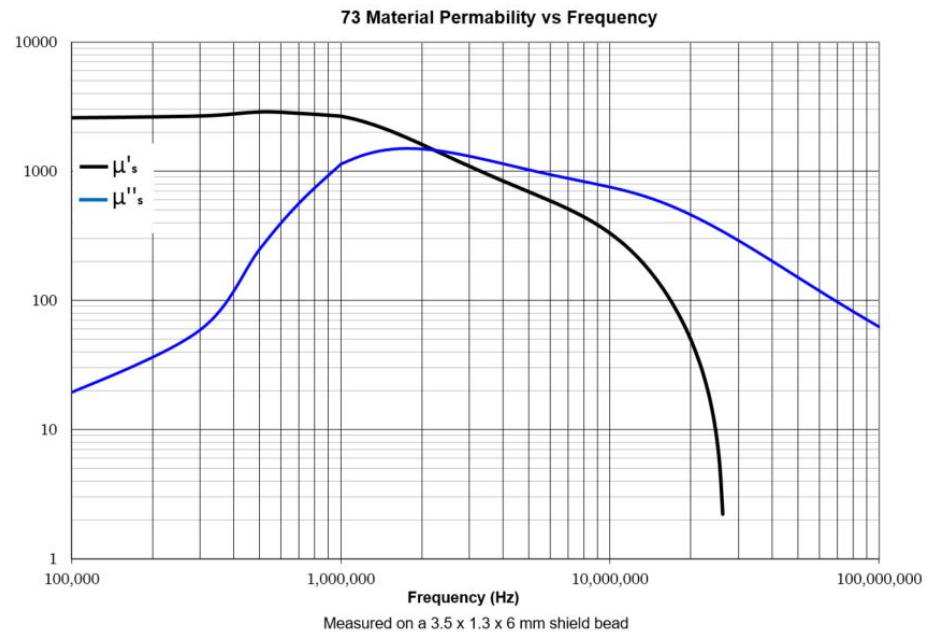
IEEE Accepted Schematic Symbol for a Ferrite Suppression Device

How do they work?

Series Model of a Ferrite Bead



A ‘perfect’ inductor in series with a resistor.
Each has an impedance.

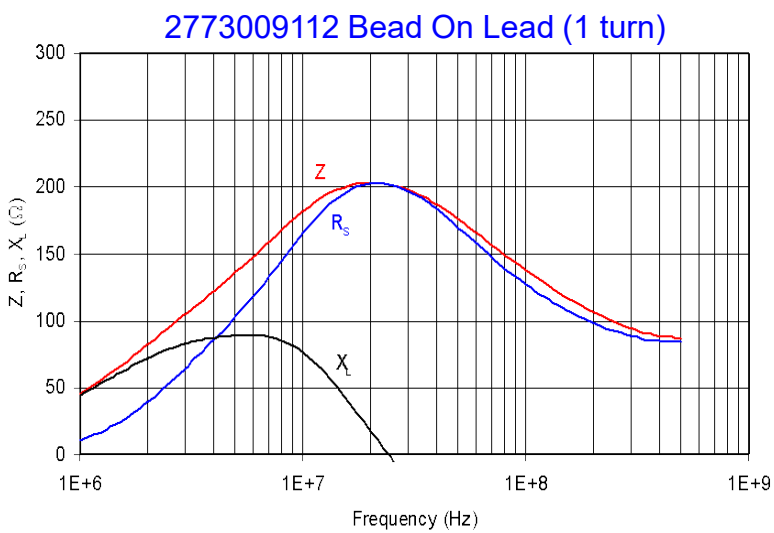


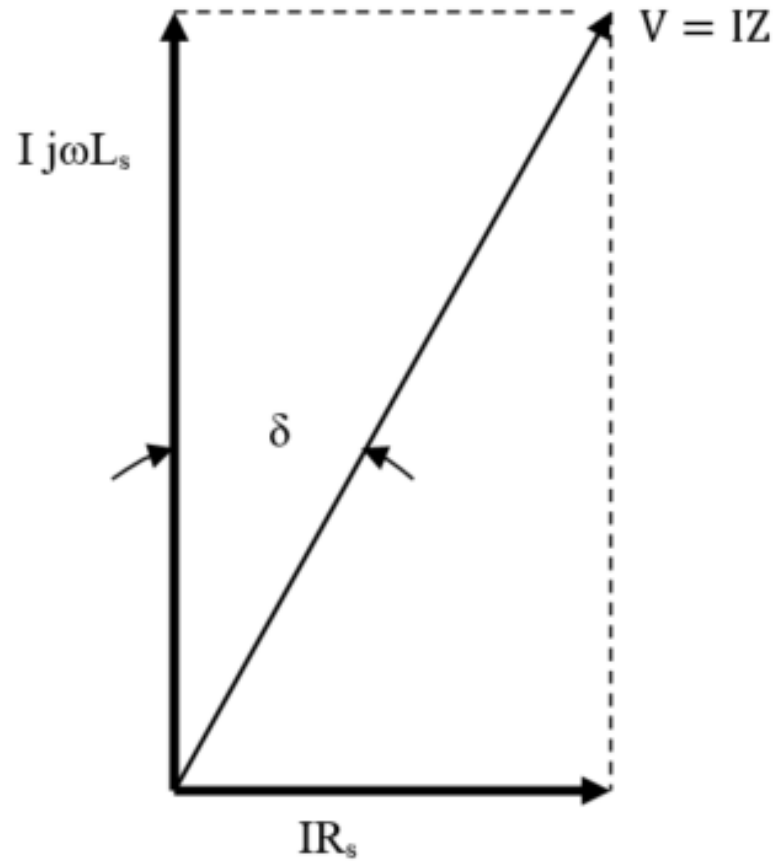
Complex Permeability Curve

Total Impedance

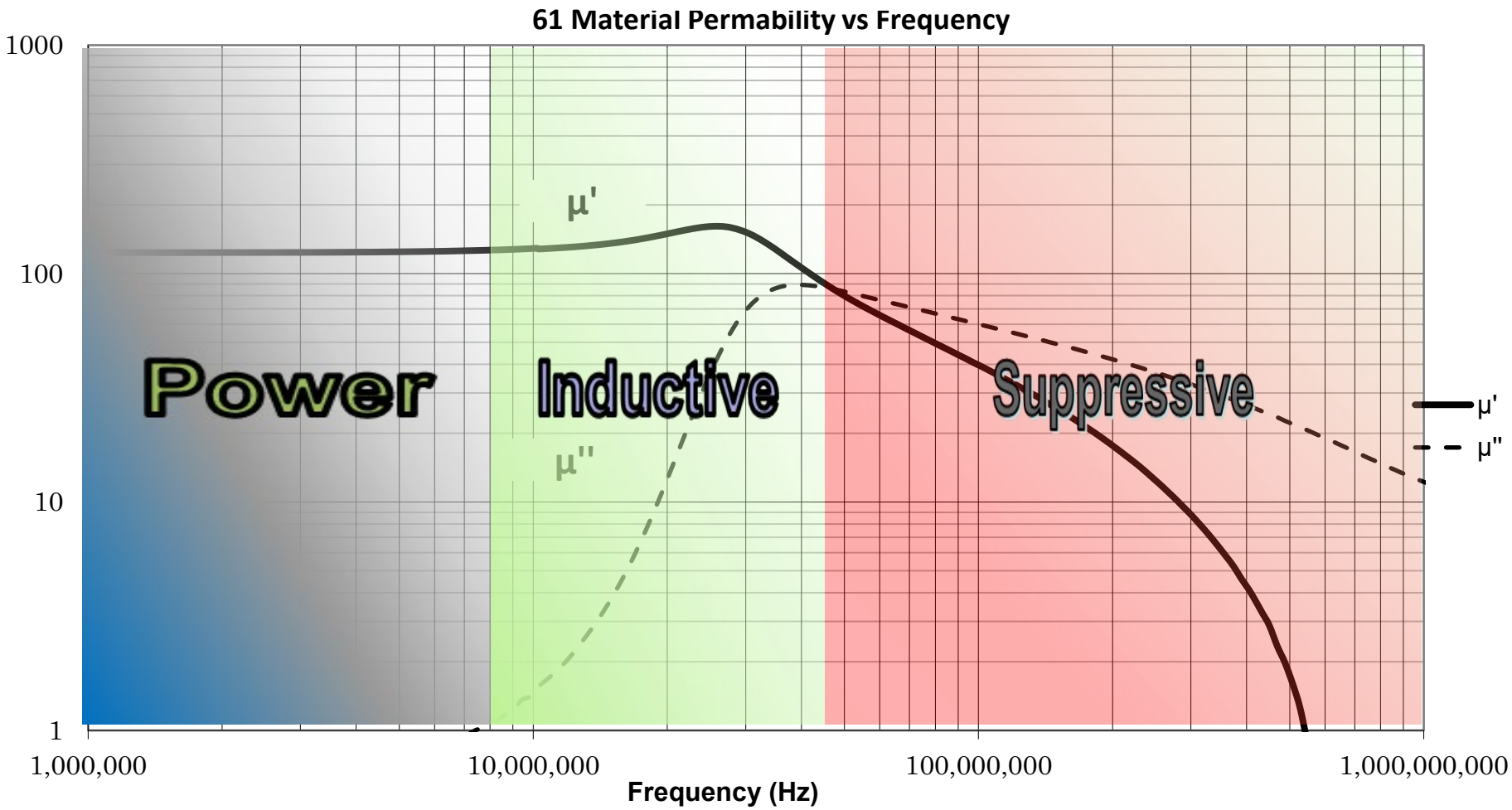
$$\tan\delta = \frac{R_s}{\omega L_s} = \frac{\mu''}{\mu'}$$

$$Z = j\omega L_0(\mu' - j\mu'')$$

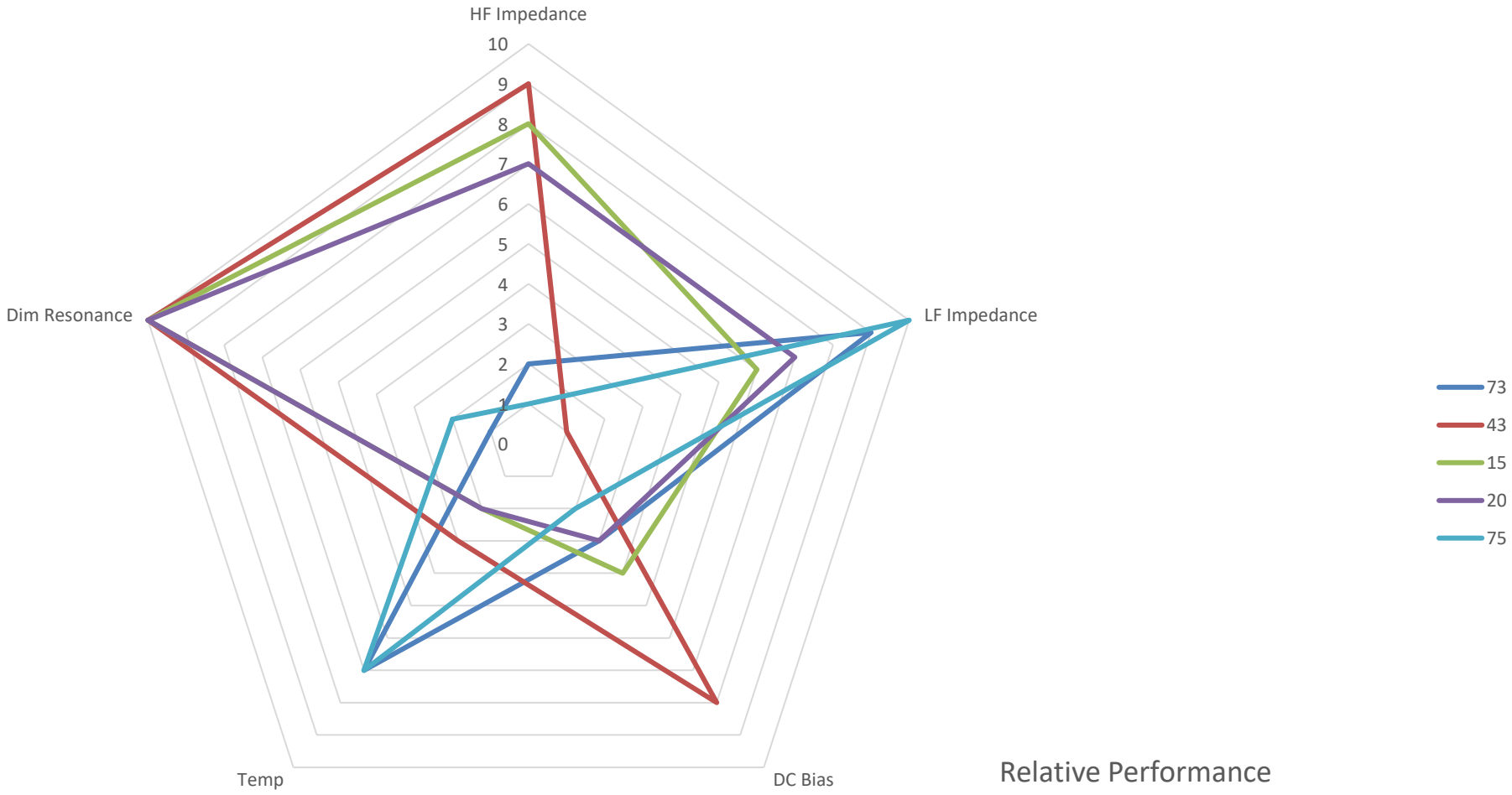




Application Areas of One Material

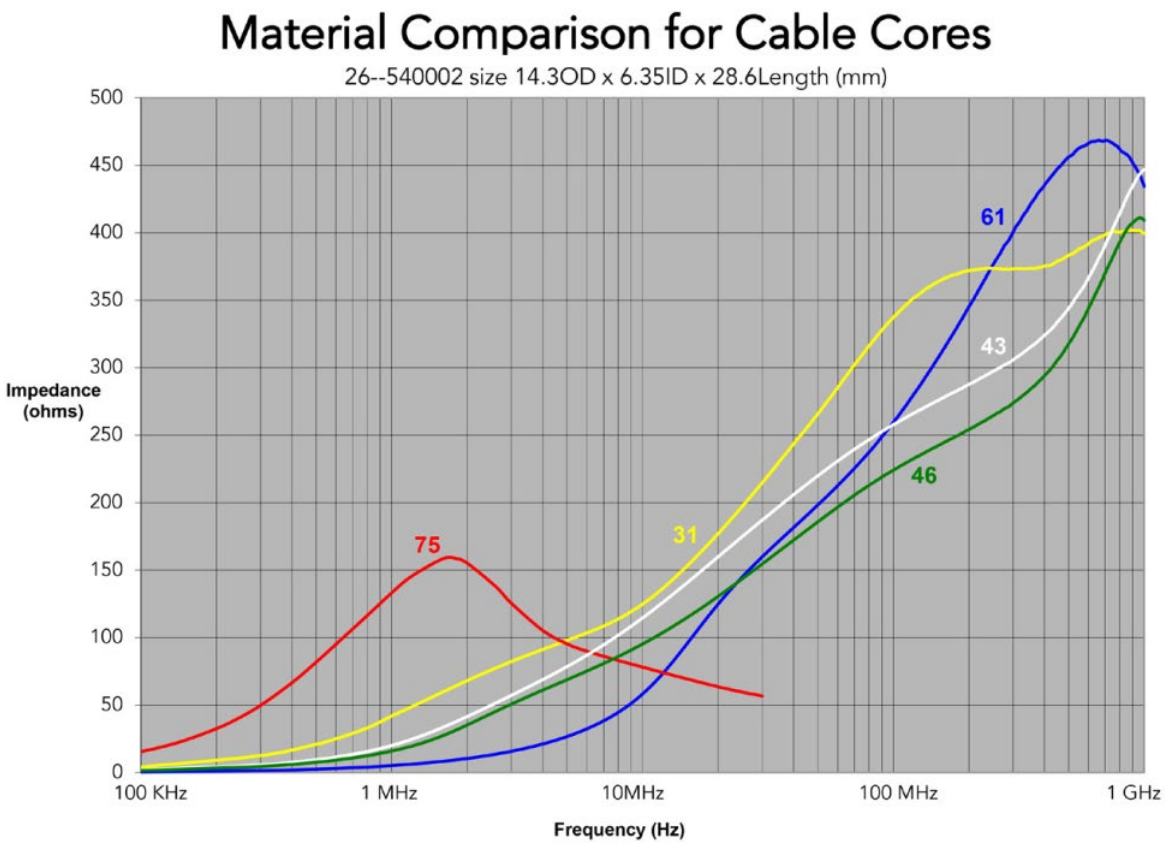


Design Considerations



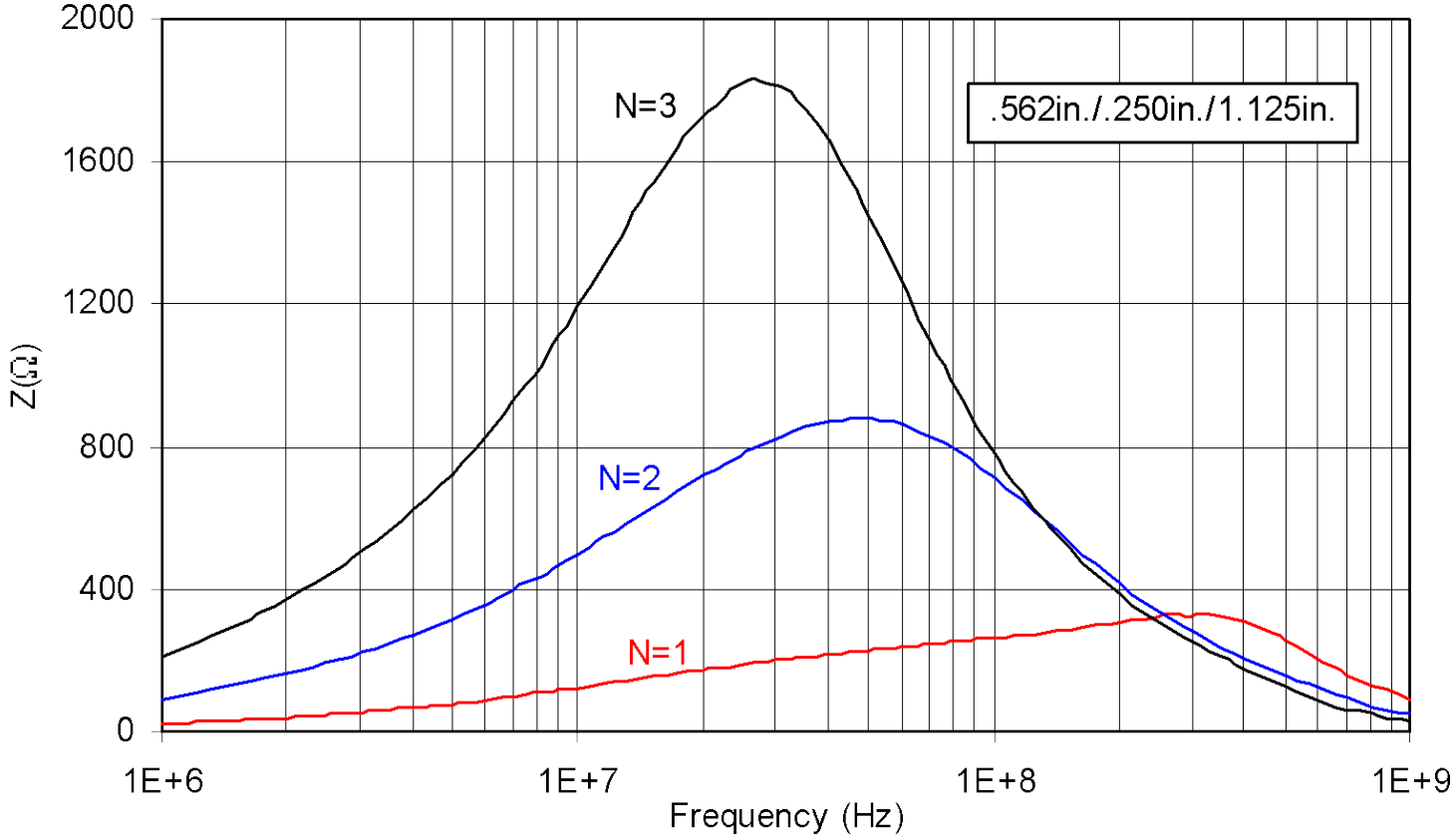
Relative Performance

EMI Suppression materials have limited frequency bands where they operate most effectively. Material should be chosen as a function of the problematic frequencies.



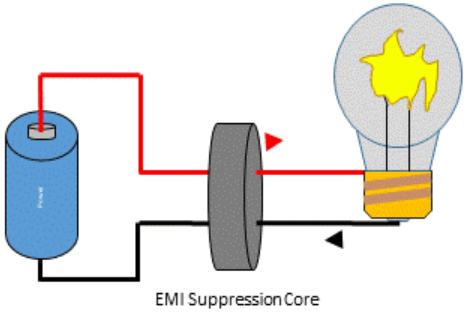
The Effect of Turns on Impedance

2643540002 Cable Bead

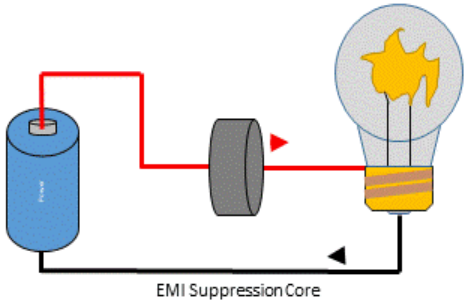


Differential Mode vs Common Mode

Common Mode Currents



Differential Mode Currents

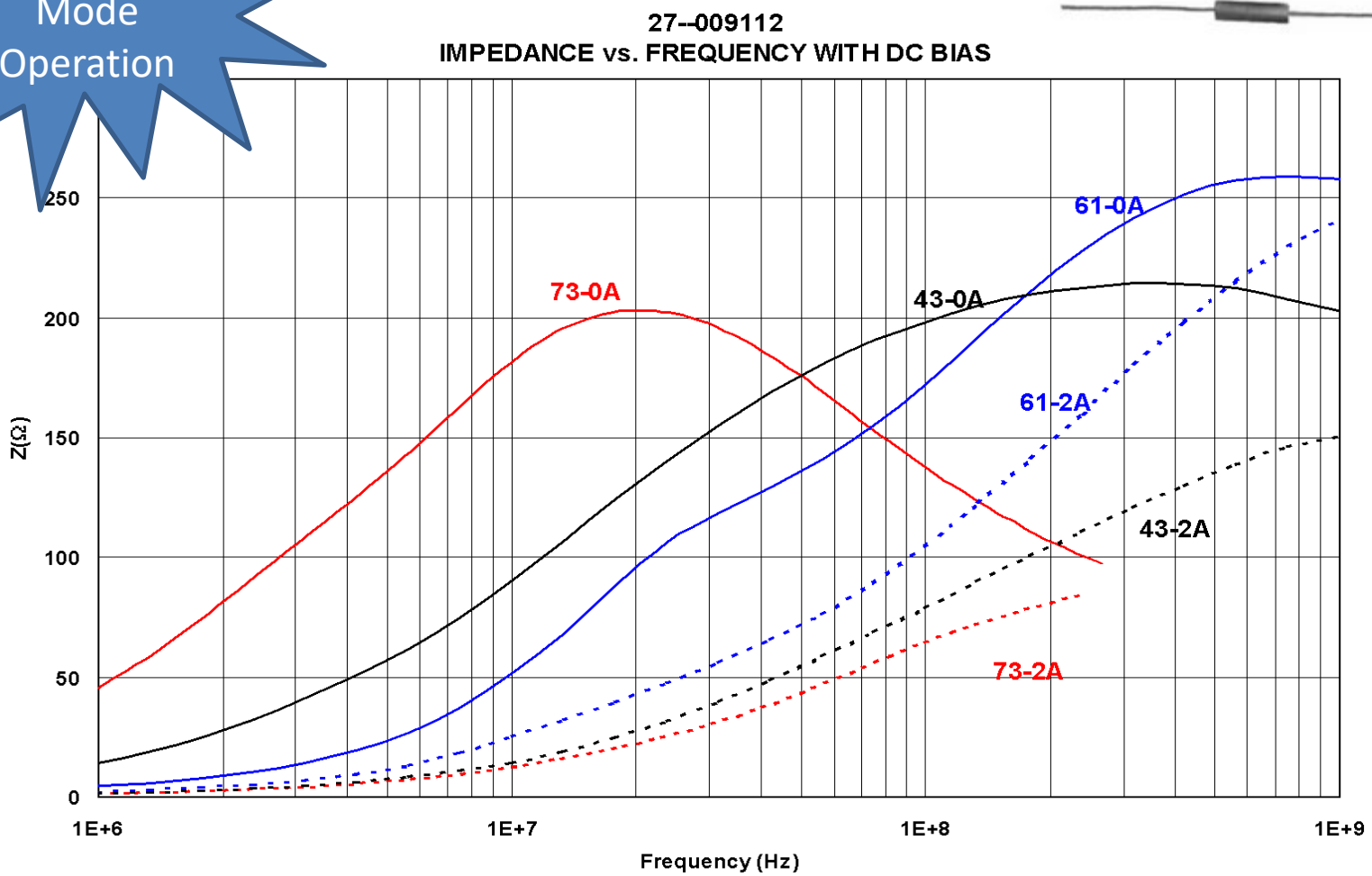


Current goes out and comes back through the suppression device.

Current travels only one way through the suppression device.

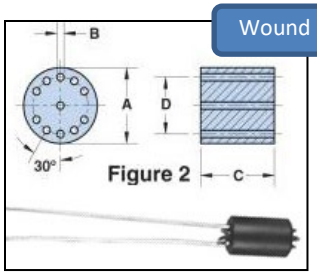
Differential Mode Operation

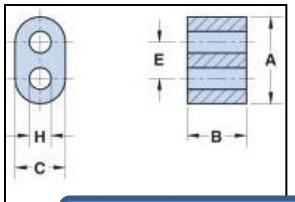
Material Comparison w/ DC Bias



Selecting the Correct Ferrite Core

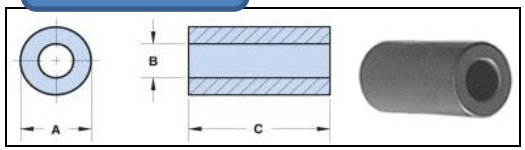
Wound Bead



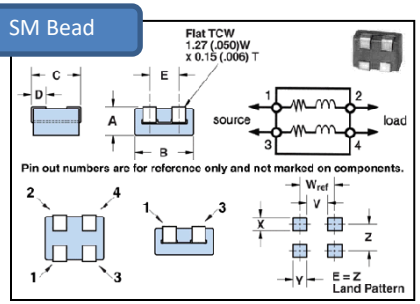


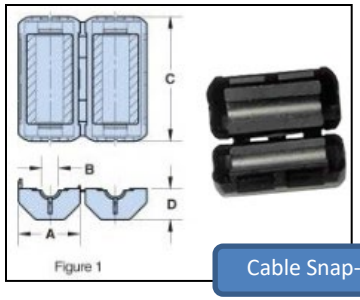
Multi-Aperture

Shield bead/ Cable Core



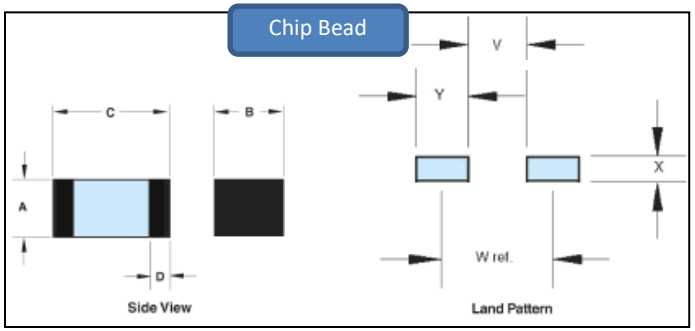
SM Bead





Cable Snap-It

Chip Bead



- *Know the source and mode*
  - *Differential or Common Mode*
- Know / Estimate the frequencies of concern
  - Best Material Selection
- *How much attenuation is required?*
  - Requires impedance of the source and load
- DC Currents
- Form factor needed
  - Cable, bead, PC mount, etc.

Summary

1. Ferrites add impedance to a circuit by imparting their reactive and resistive properties through magnetic coupling
2. Different ferrite compositions/grades are suited different bands of noise and different applications
3. Having a complete picture of the application and attenuation required will aid in selecting the best solution

Thank you!

Please check out our website at www.Fair-Rite.com

- Material and part data
- Technical papers and references
- Design tools
- Videos and presentations
- Technical forums and ask the advisor