FAIR - RITE PRODUCTS CORP.

"Your Signal Solution"

NQA
NATIONAL QUALITY ASSURANCE, USA
QS-9000
REGISTERED COMPANY
ANSI • RAB
QMS
ACCREDITED

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Outline

1. Ferrite overview
   - What are ferrites?
   - How do they work?
2. Ferrite Applications
3. EMI Suppression Application
   - Material Characteristics
   - Selecting the Right Core
   - Material Selection / Control Performance
4. How are Ferrites Made?
5. Available Kits
6. Q & A

What Is A Ferrite?

Ferrite is a ceramic material formed by reacting metal oxides into a magnetic material.

- Soft magnetic material is one that can be both easily magnetized and demagnetized, so that it can store or transfer magnetic energy in alternating or other changing wave forms (sine, pulse, square, etc).

CHEMICAL COMPOSITION
(metal oxides) + (iron oxide)

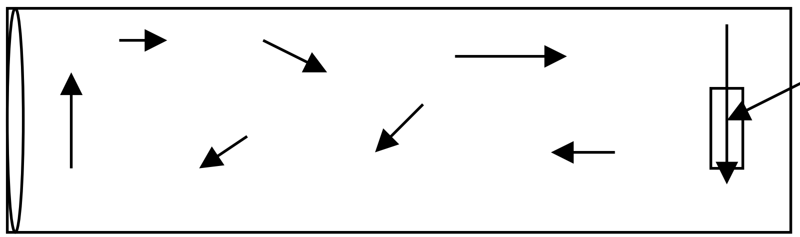
(Mn0 + Zn0) **Manganese - Zinc**

+ $(Fe_2 0_3)$ =

(Ni0 + Zn0) **Nickel - Zinc**

What Makes Ferrite Tick

– Ferrite Rod (internal structure)

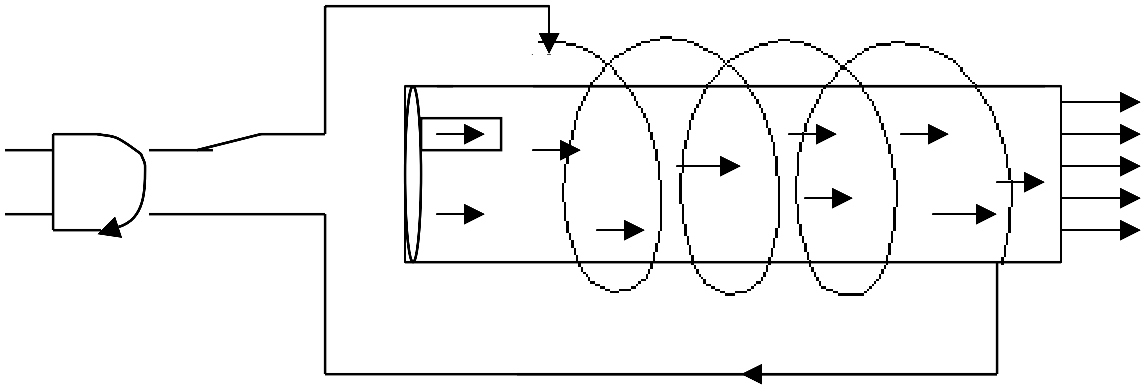


Arrows Indicate Direction of Magnetic Force

What Makes Ferrite Tick

continued

– Excitation Of Ferrites



Large Magnetic Flux

All "small magnets" are aligned in the direction of flux produced by the coil.

When & Why To Use Ferrites

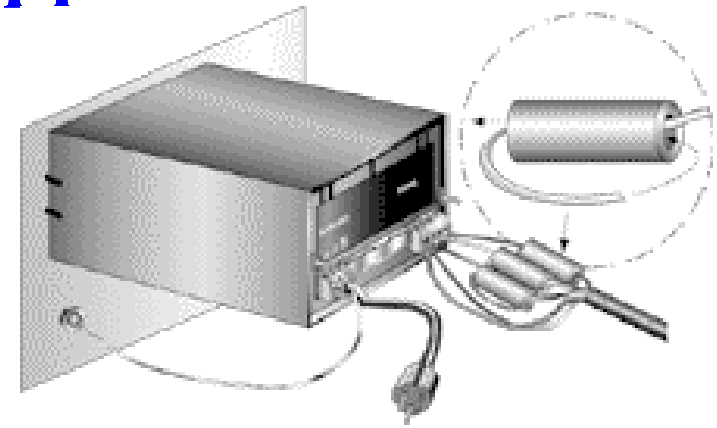
When - Frequencies above 1KHz (to 3GHz)

Why - Application Specific

Ferrites are used to process electronic signals. These signals can be filtered, transformed, absorbed or concentrated. A broad classification of the product applications are:

- EMI Suppression - High Impedance
- Power applications - Low Core Loss
- Low level signals (Sensors and antennas) – Increase Sensitivity
- Absorption of high frequencies (testing chambers & shielding)

EMI Suppression
Cable Filtering Applications



- Largest application of suppression ferrites.
- Industrial, computer, telecom, medical, aerospace applications
- Materials: #43; #44; #31; #61; #73; #51, #46
- Shield beads, snap-on cores and flat cable beads

Intrinsic Characteristics/Applications

EMI Suppression Applications

Intrinsic Characteristics

Complex Permeability [u´ & u´´]

High Impedance

Applications

Computers and peripherals

Communication Systems

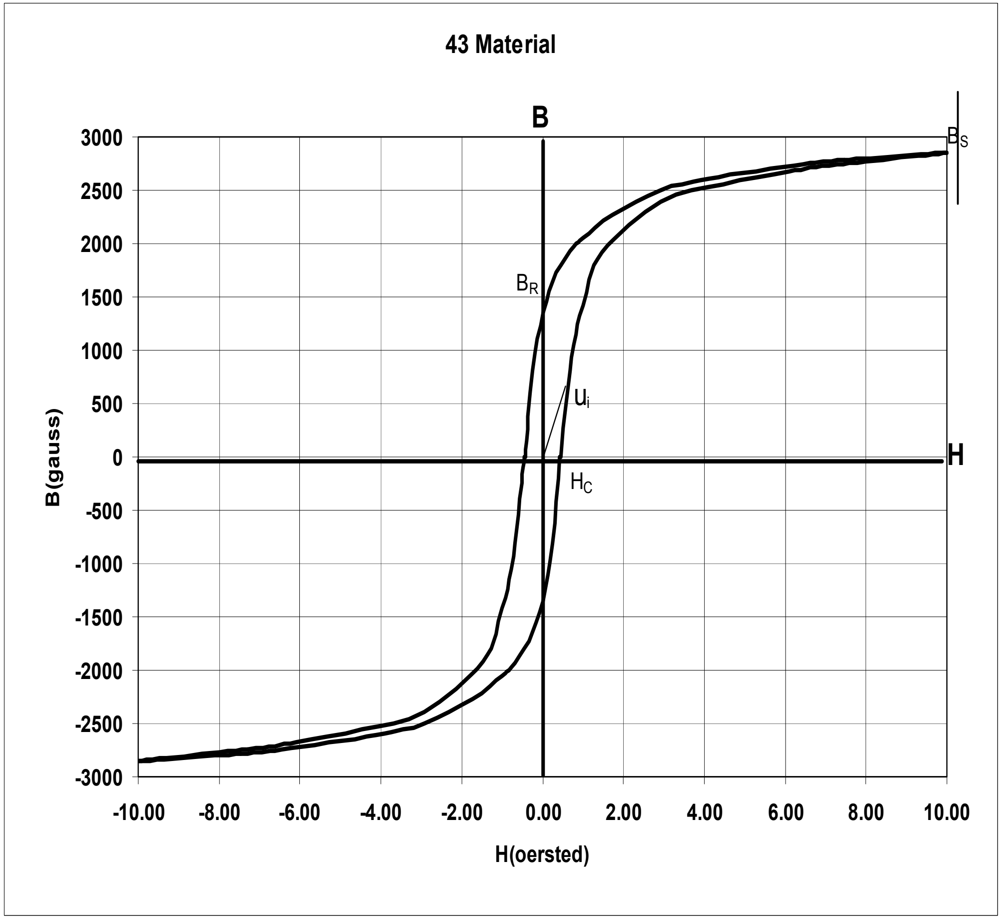
Automobiles

Switch Mode Power Supplies

dc-dc converters

ignition coils

Material Characteristics



43 Material

Property	Unit	Symbol	Value
Initial Permeability		μ_i	850
@ B < 10 gauss			
Flux Density	gauss	B	2900
@ Field Strength	oersted	H	10
Residual Flux Density	gauss	B_r	1300
Coercive Force	oersted	H_c	.45
Temperature Coefficient of	%/ C		1.25
Initial Permeability (20-70 C)			
Loss Factor	10^{-6}	$\tan\delta/\mu_i$	250
@ Frequency	MHz		1.0
Curie Temperature	°C	T_c	>130
Resistivity	Ω cm	ρ	1 10^5
Recommended Frequency Range	MHz		20 - 250
EMI Applications			

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SELECTING THE RIGHT FERRITE CORE

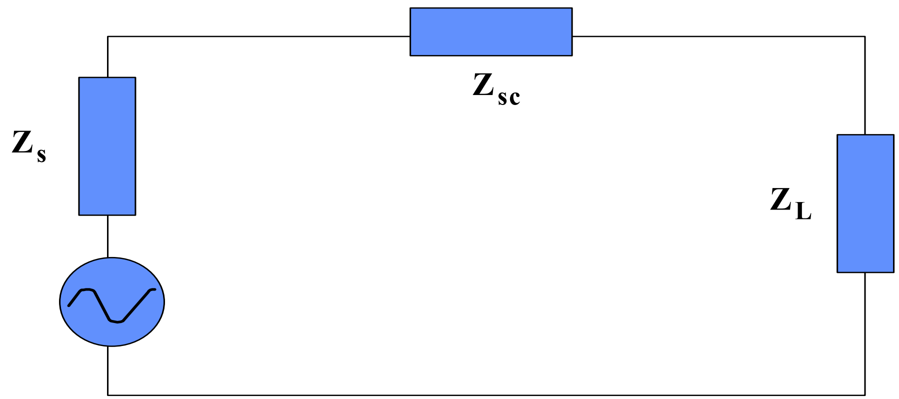
THE SOURCE of EMI

FREQUENCY of DESIRED SIGNAL VS. NOISE

CIRCUIT IMPEDANCE [LOAD AND SOURCE]

ENVIRONMENTAL CONDITIONS

ALLOWABLE SPACE



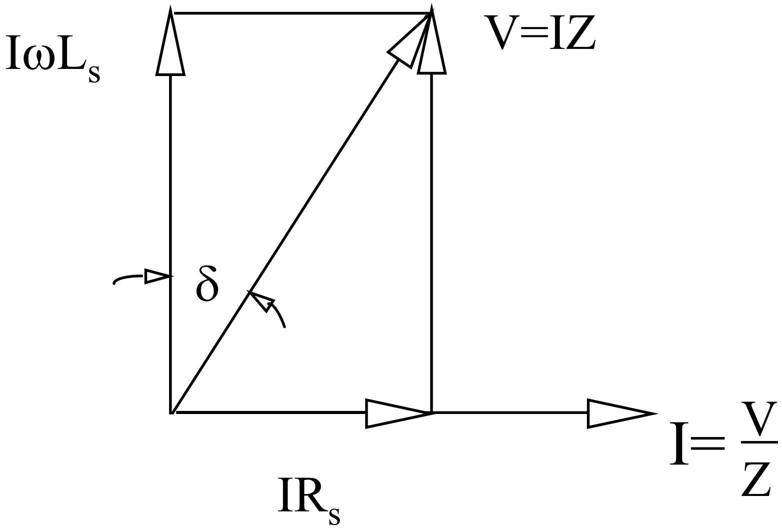
$$\text{Attenuation} = 20\log_{10}\left[\frac{(Z_S + Z_{SC} + Z_L)}{(Z_S + Z_L)}\right] \text{ dB}$$

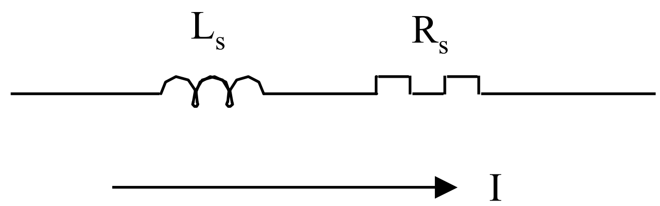
where

Z_S = **S**ource impedance

Z_{SC} = **S**uppressor **C**ore impedance

Z_L = **L**oad impedance





$$Z = R_s + j\omega L_s$$

$$Z = R_s + j\omega L_o \mu_s'$$

$$\boxed{Z = j\omega L_o(\mu_s' - j\mu_s'')}$$

$$R_s = \omega L_o \mu_s''$$

$$\omega L_s = \omega L_o \mu_s'$$

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

$$L_o = \frac{4\pi N^2 10^{-9}}{C_1} \quad [H] \qquad [C_1 \text{ - } cm^{-1}]$$

Toroidal Core $L_o = .0461\, N^2\, Ht \log_{10}\left(\frac{OD}{ID}\right) 10^{-8}\ [\,H\,]$ [Dim – mm]

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Material Parameters

μ_s' & μ_s''	Complex Permeability
ρ	Resistivity
T_c	Curie Temperature

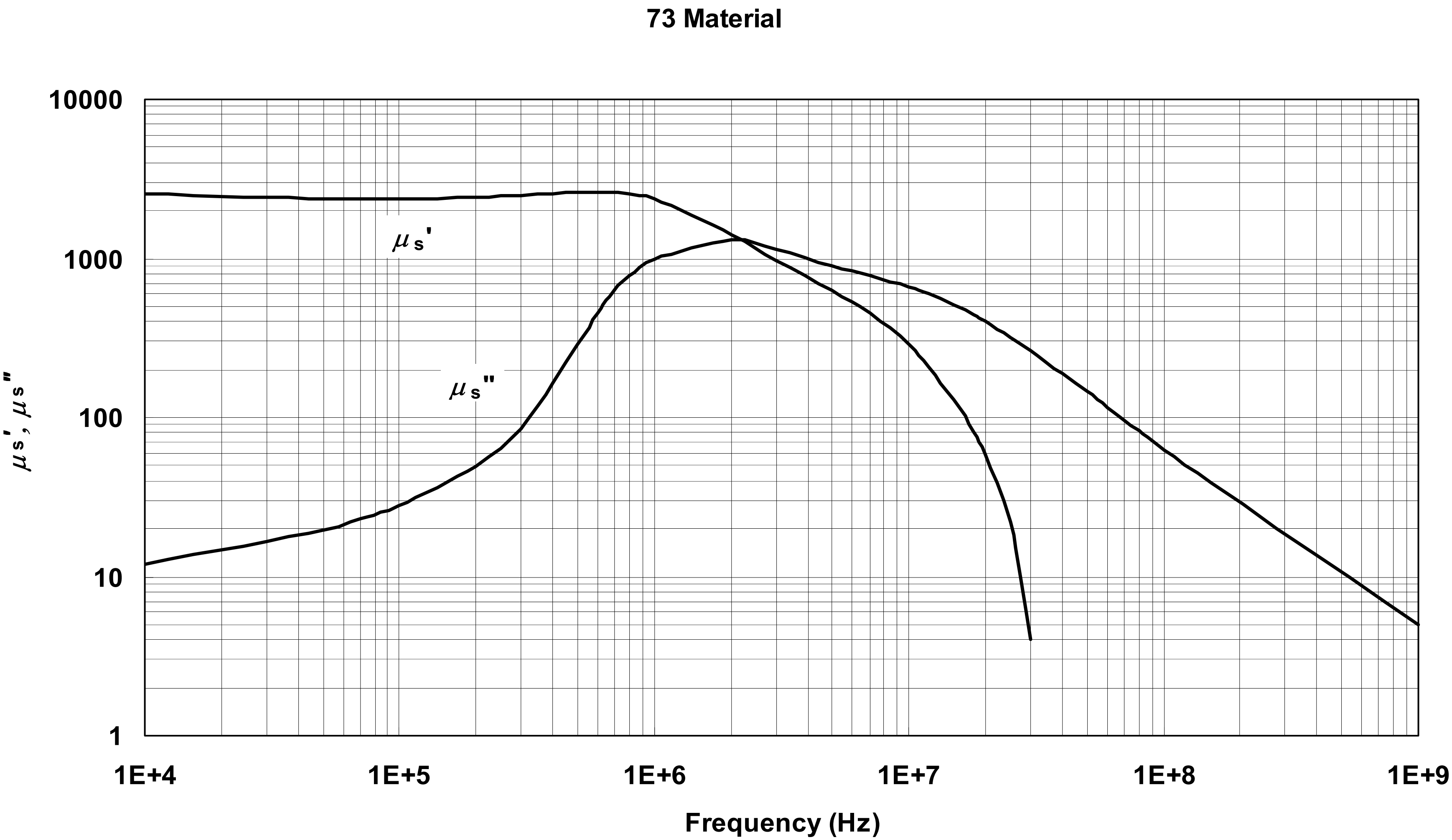
Product Parameters

C_1	Core Configuration
N^2	Number of Turns

μ_s’ & μ_s’’ ARE AFFECTED BY:

- Frequency
- DC Bias
- Temperature
- Flux Density

Complex Permeability vs. Frequency



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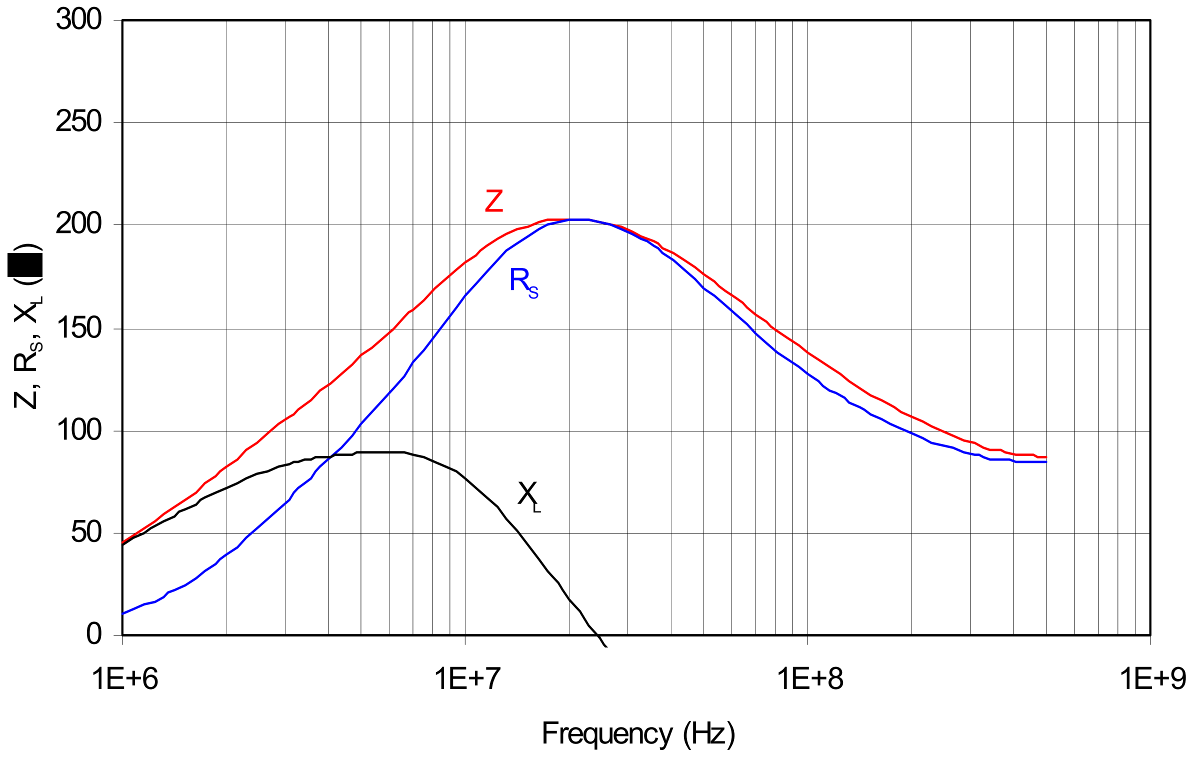
Impedance vs. Frequency

2773009112 Bead On Lead (1 turn)



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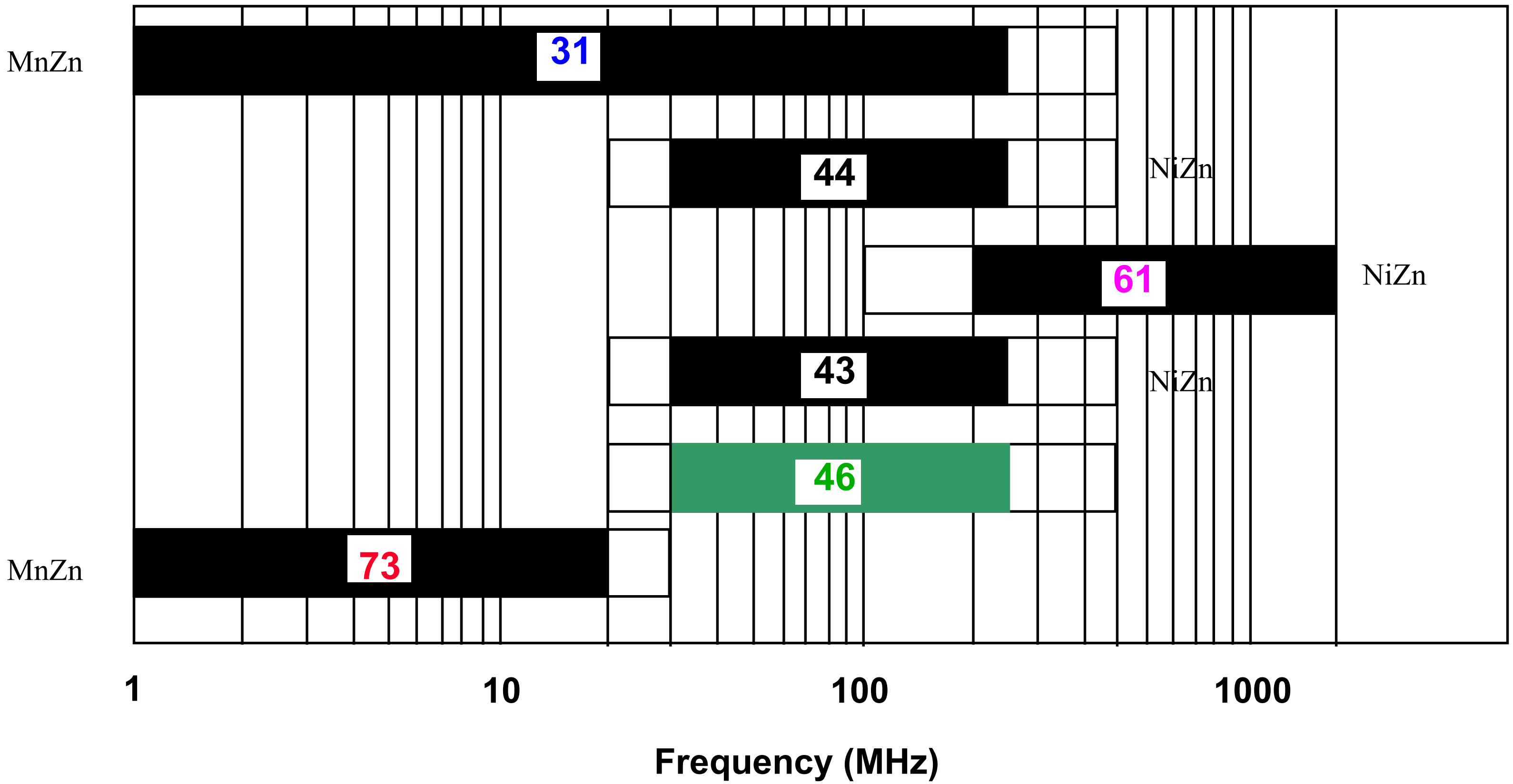
Suppression Materials Comparison



Comparison Impedance vs. Frequency

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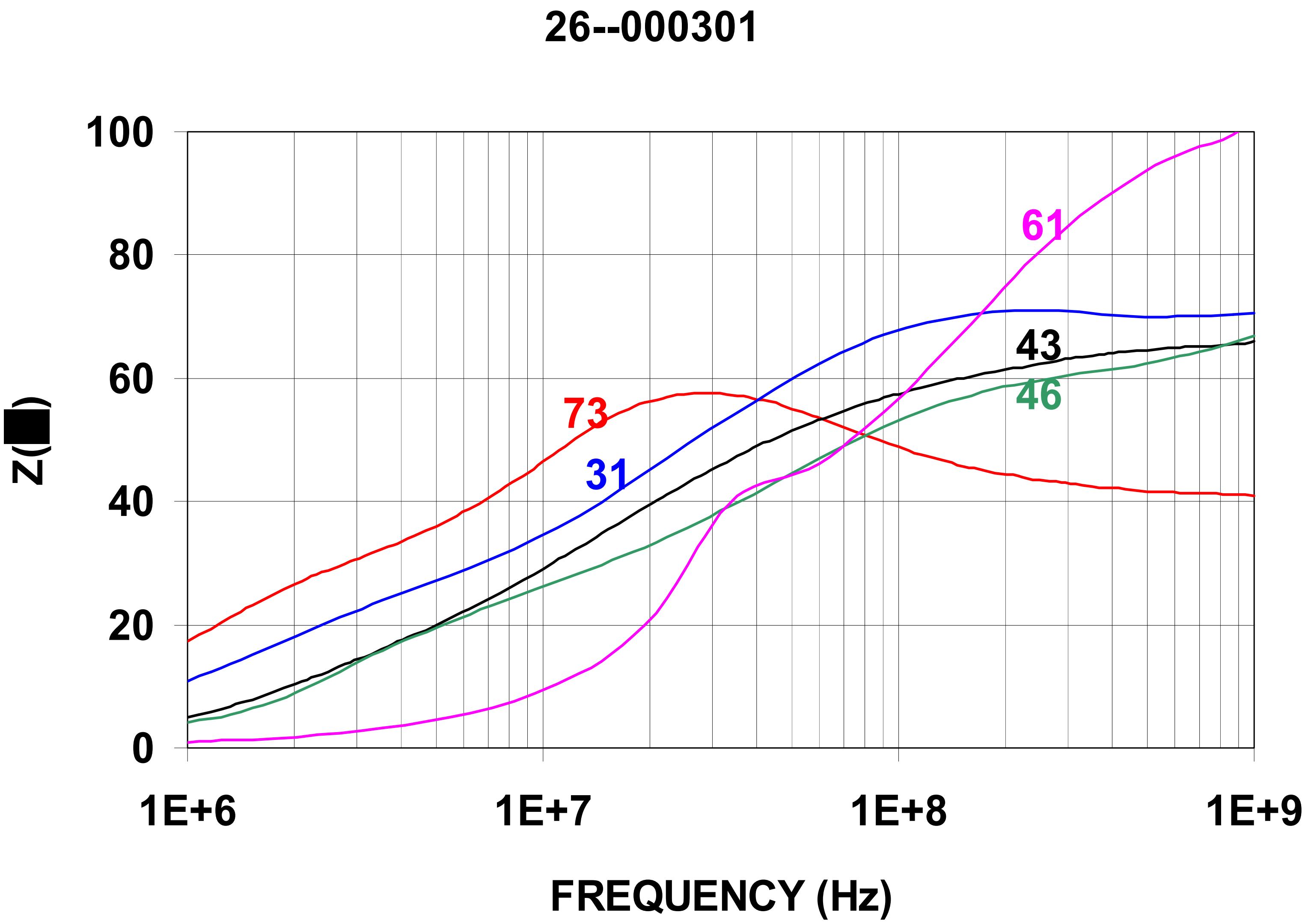

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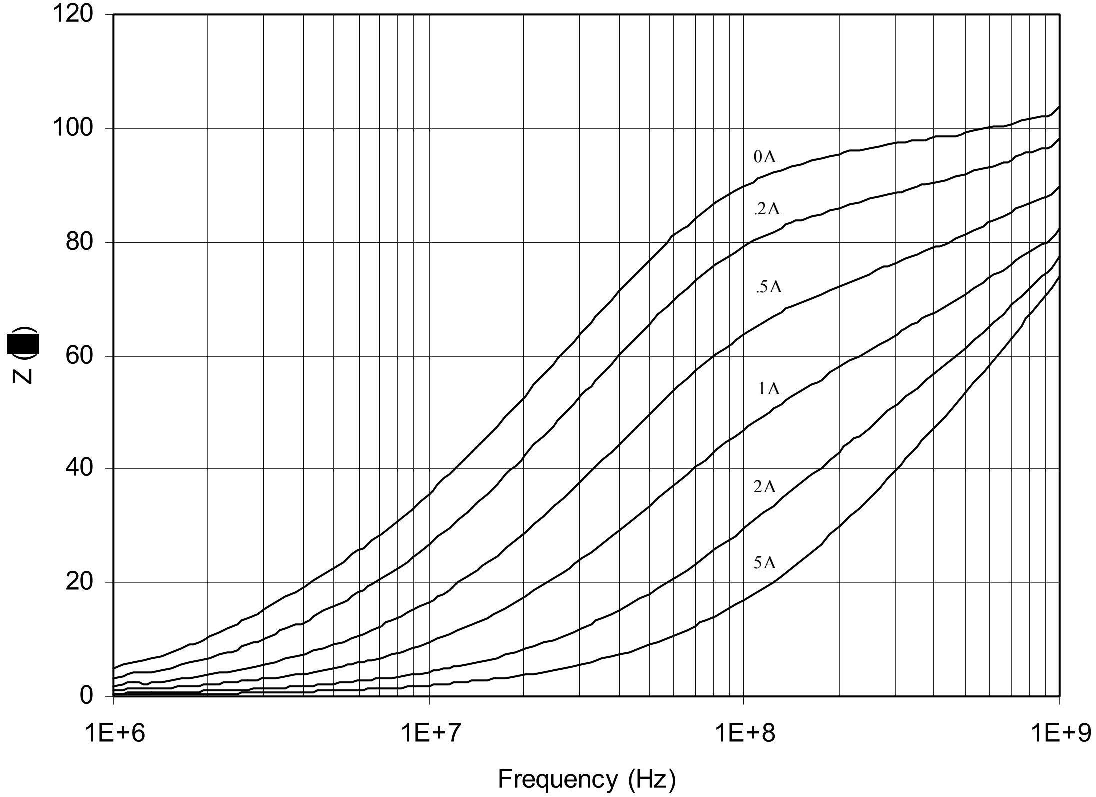
Impedance vs. Frequency with DC Bias

2743021447 Surface Mount Bead



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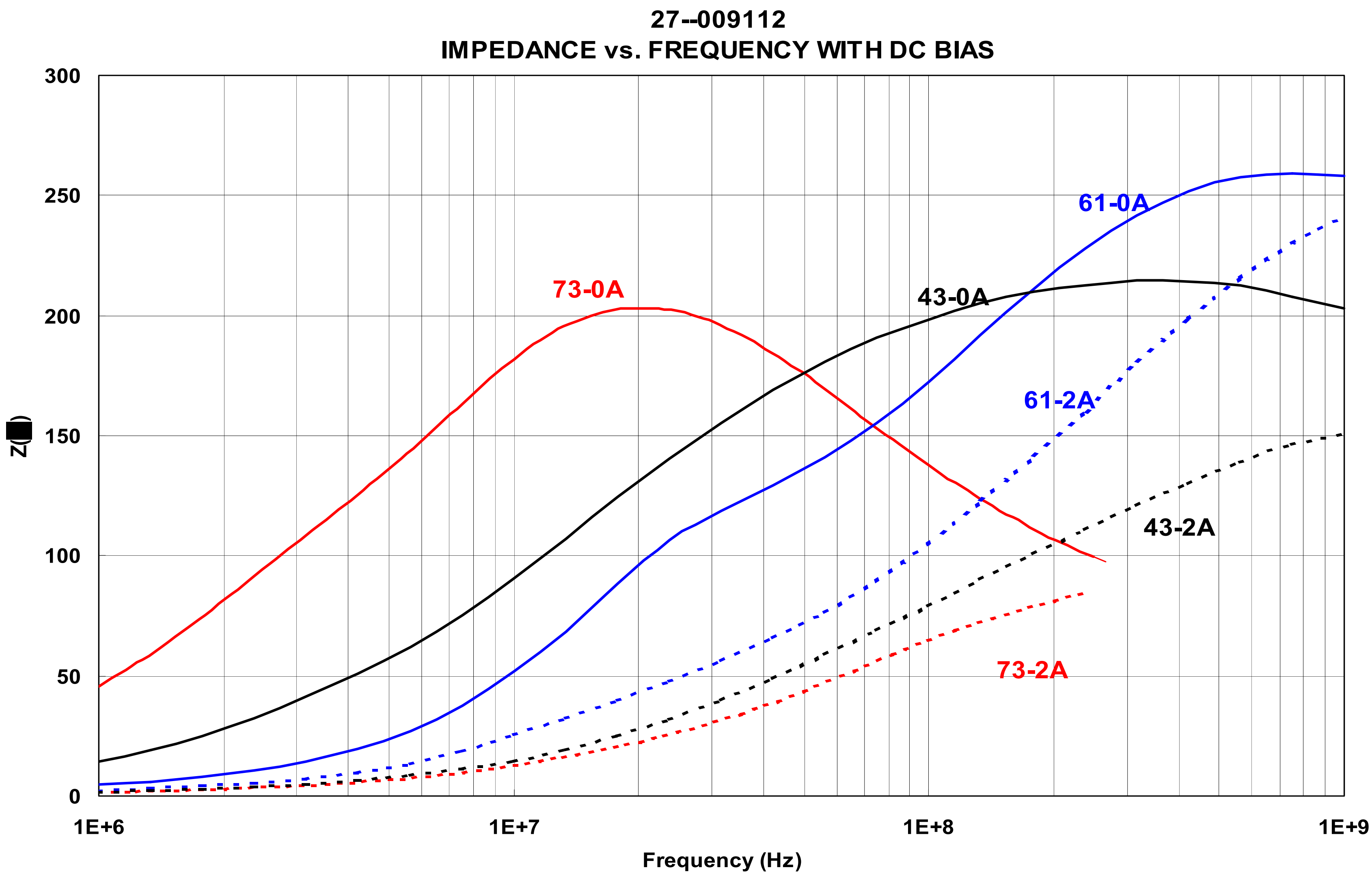
Material Comparison w/ DC Bias



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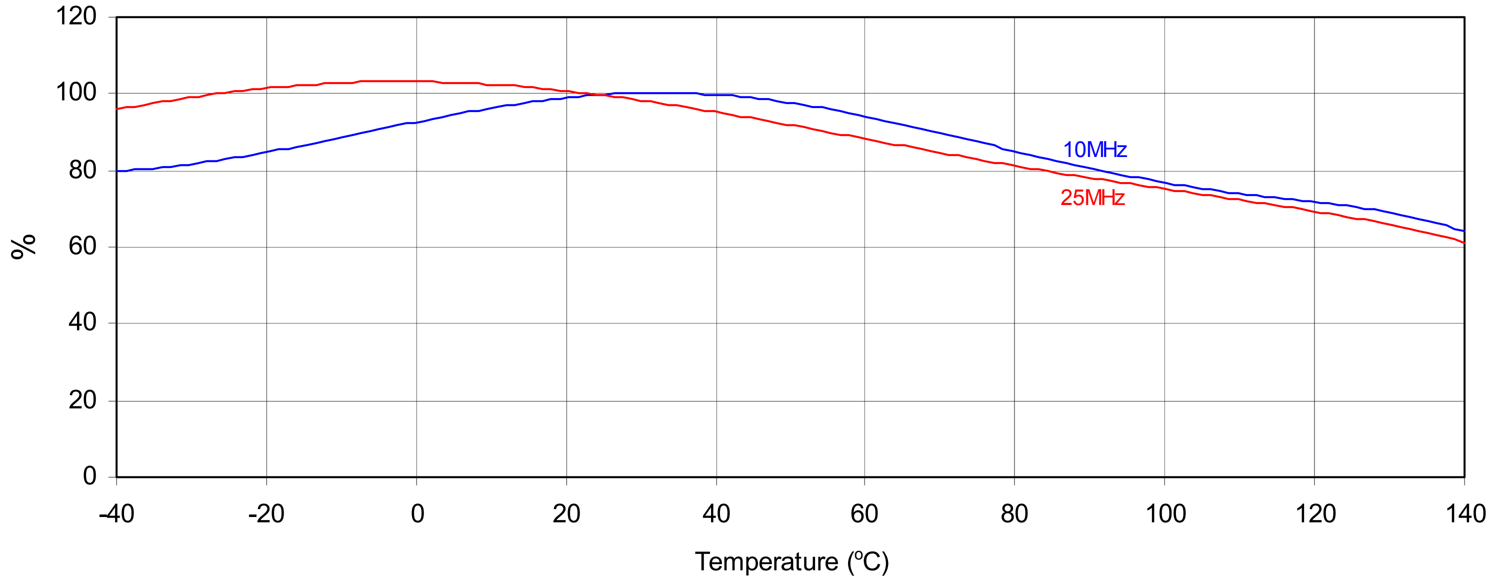
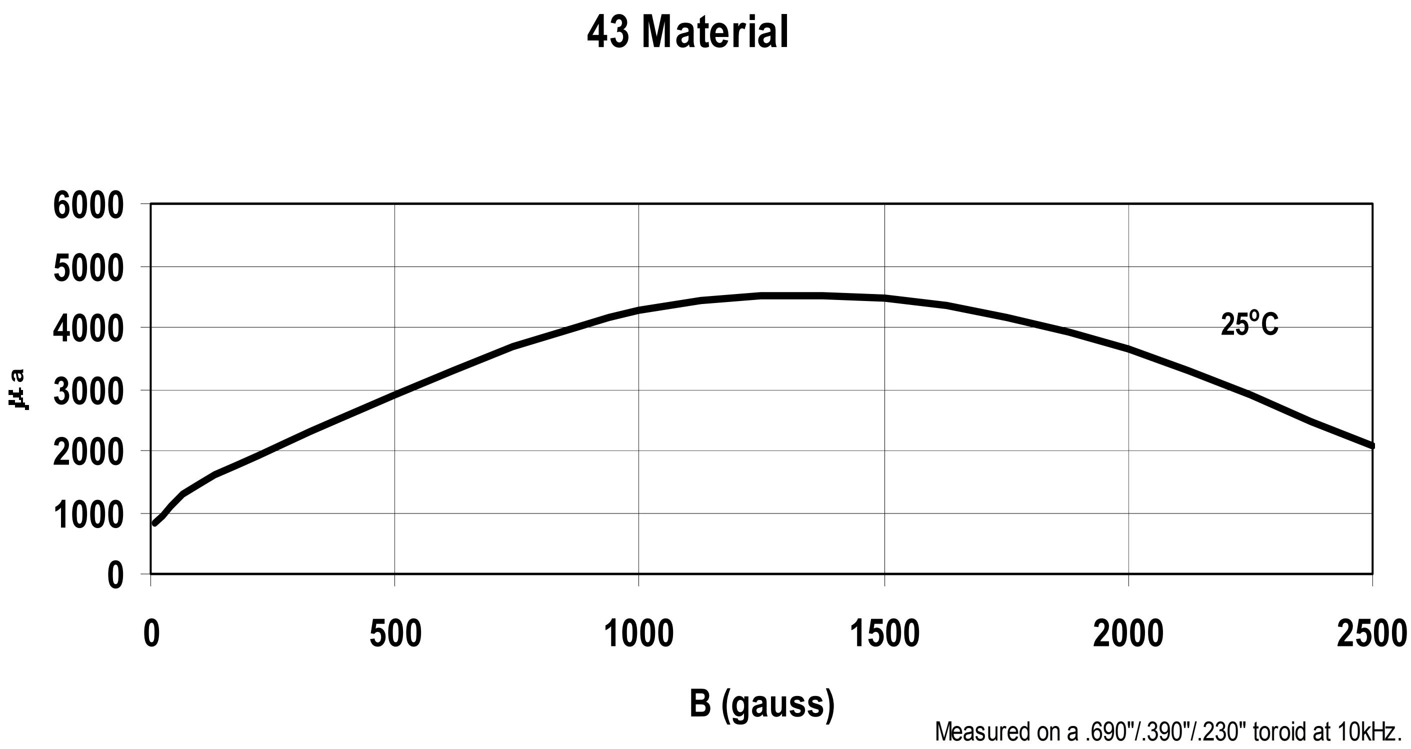
Impedance vs. Temperature Percent of Original 25ºC

73 Material



Amplitude Permeability vs. Flux Density



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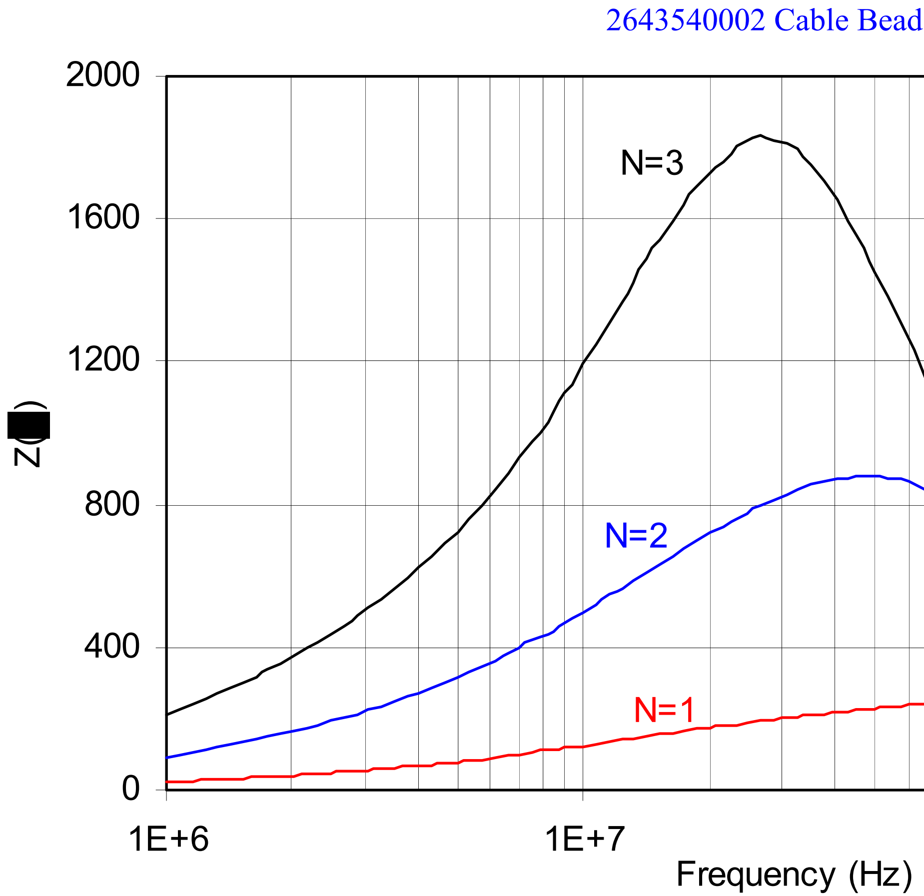
The Effect of Turns on Impedance



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Review - Desirable Material Properties For EMI Suppression

- High core loss (u”) in the intended frequency range (magnetic losses)
Note: low eddy current loss (high resistivity)

- High permeability at the low frequency range (high u’)

- Resistance to dc-bias (i.e. high incremental permeability vs. H)

- Good thermal stability (Z vs. T)

- High Curie Temperature (Tc)

- Resistance to thermal shock

Effect of Test Method on Impedance

Competitive suppliers cores, same dimensions, similar materials

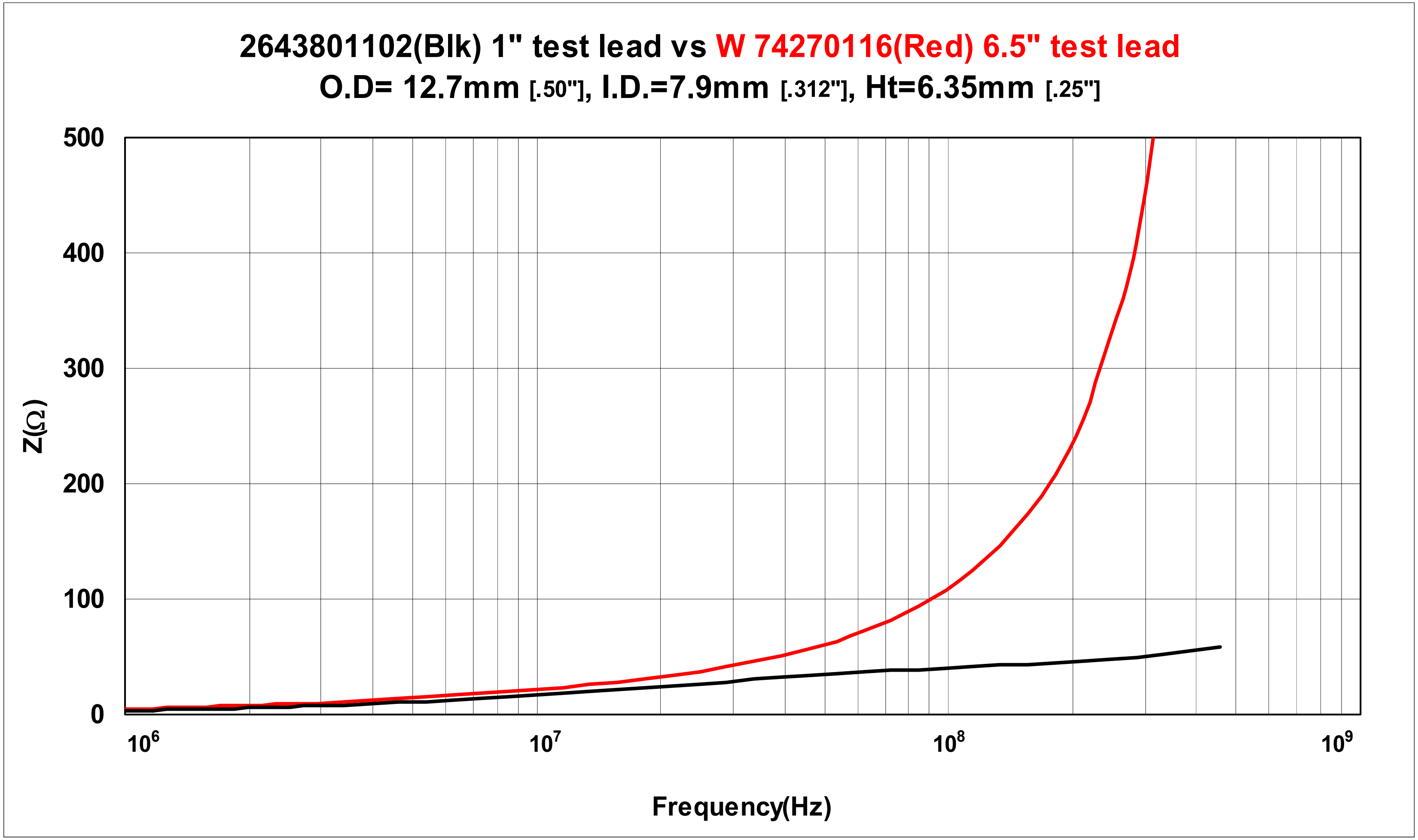
O.D.= 12.7mm [.50"], I.D.= 7.9mm [.312"], Ht= 6.35mm [.25"]

	Z @ 25MHz	Z @ 100MHz
2643801102	26	41
W 74270116	45	154

Catalog Published Data, Typical Values of Impedance

Effect of Test Method on Impedance

Competitive suppliers cores, same dimensions, similar materials



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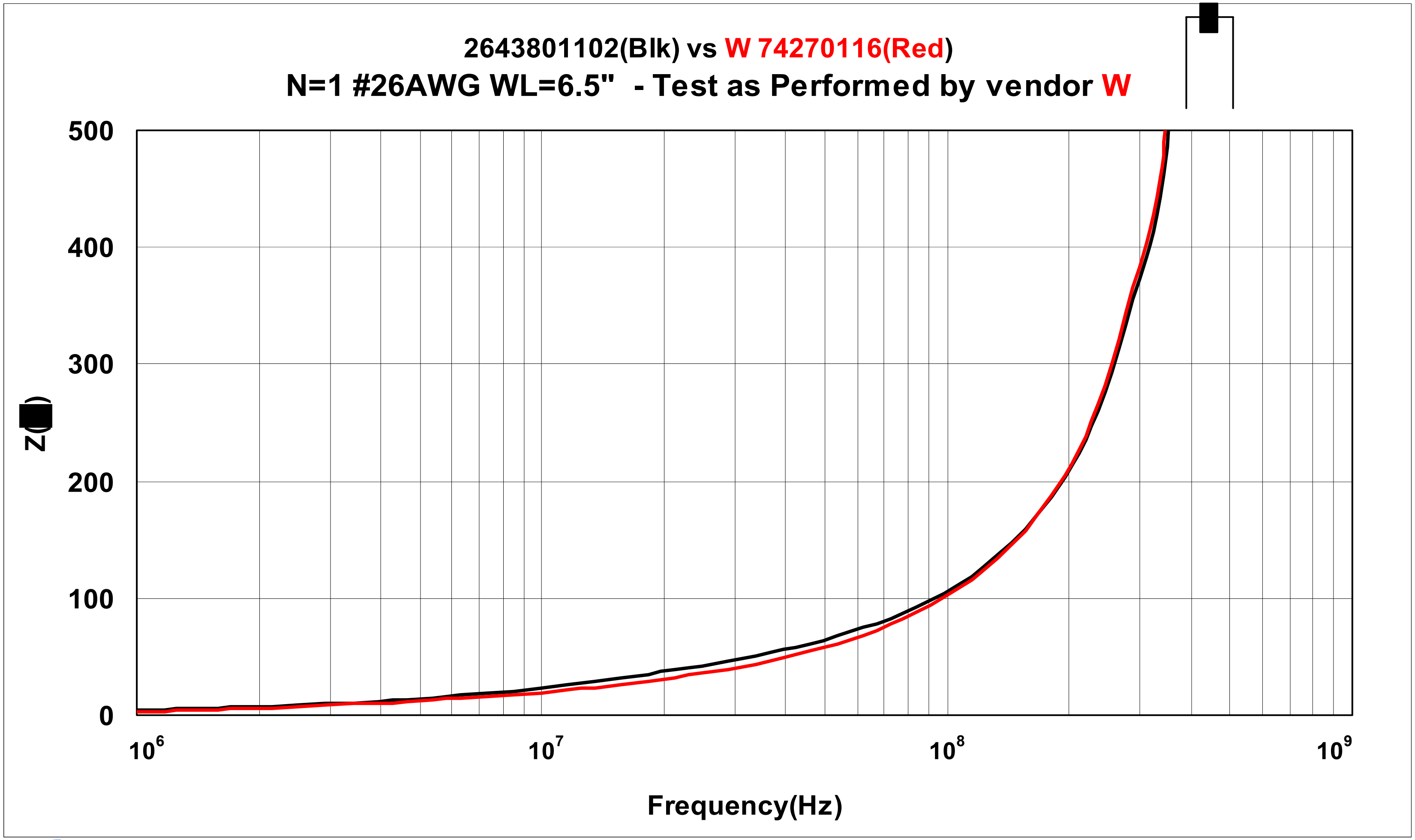

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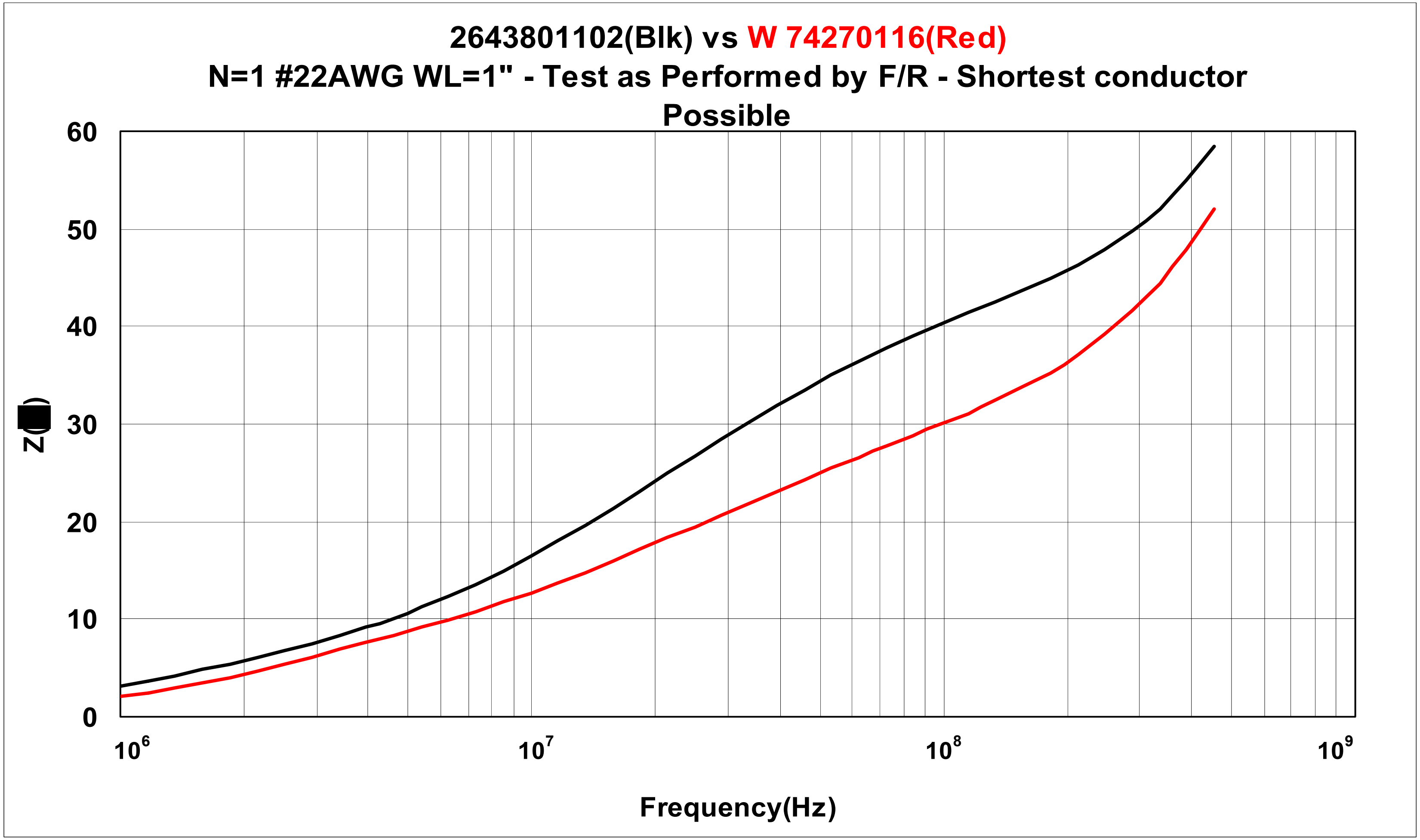

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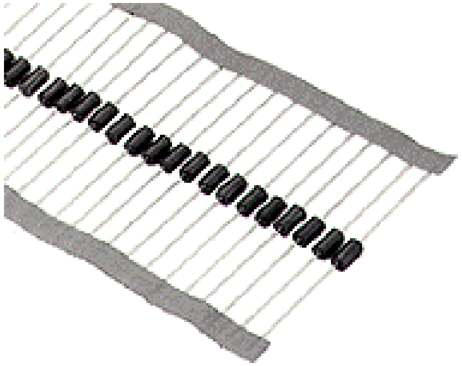

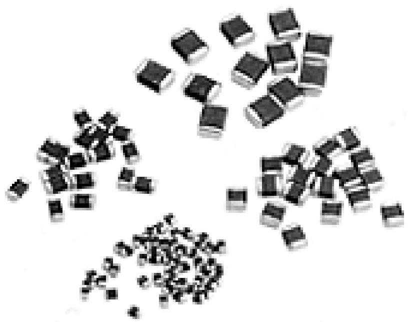

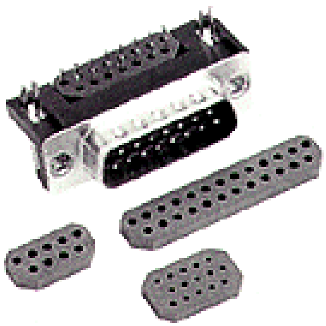

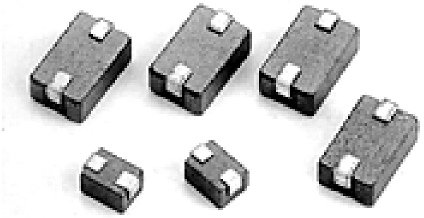

Why So Many Different Shapes?

Answer: Each shape has unique feature(s) which are required in each specific application.

- Low cost
- Simple to assemble
- Availability of standard sizes
- Easy to wind the coil
- Good magnetic shielding

Why So Many Different Materials?

Answer: Each material has unique properties which are required for a specific application

- High permeability
- Low losses (except in EMI)
- High Curie temperature
- High saturation
- Low variability (temp & time)

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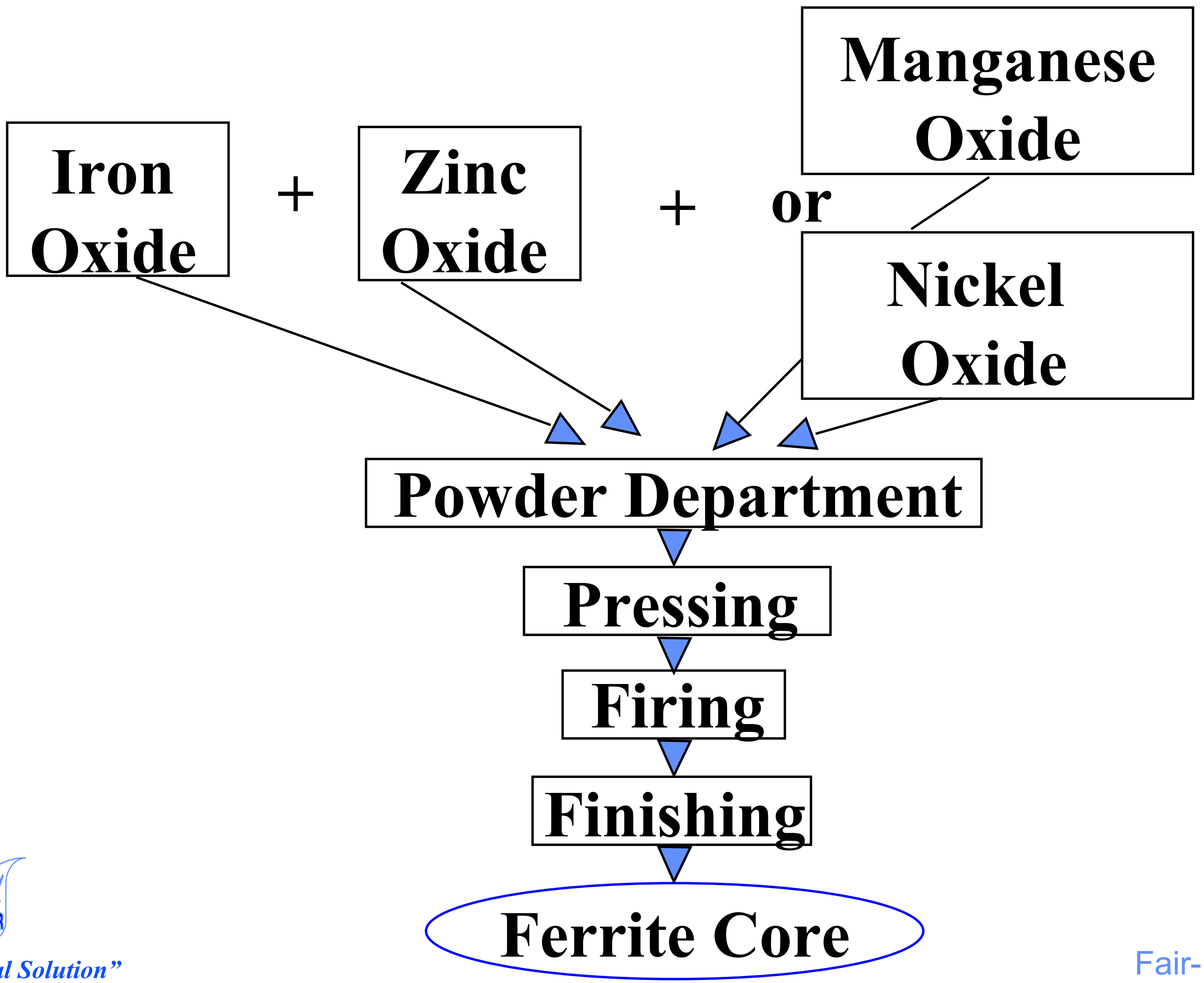
How Is Soft Ferrite Made?



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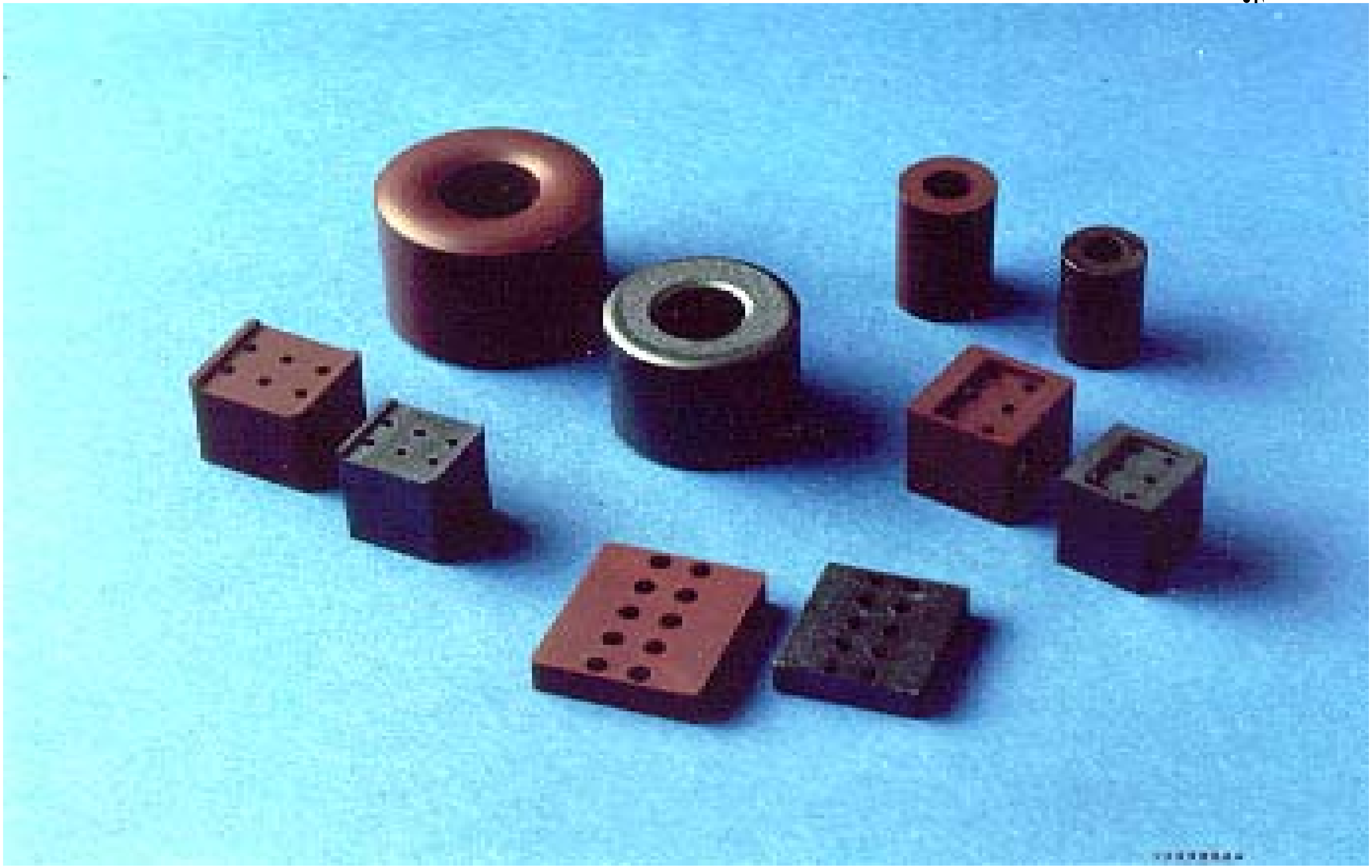

Injection Molded Ferrite Cores

51 and 78 material

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31 Material
500KHz – 500 MHz
43 Material
10 – 500 MHz
44 Mat'l
10 – 500 MHz
61 Material
100 MHz – 1 GHZ
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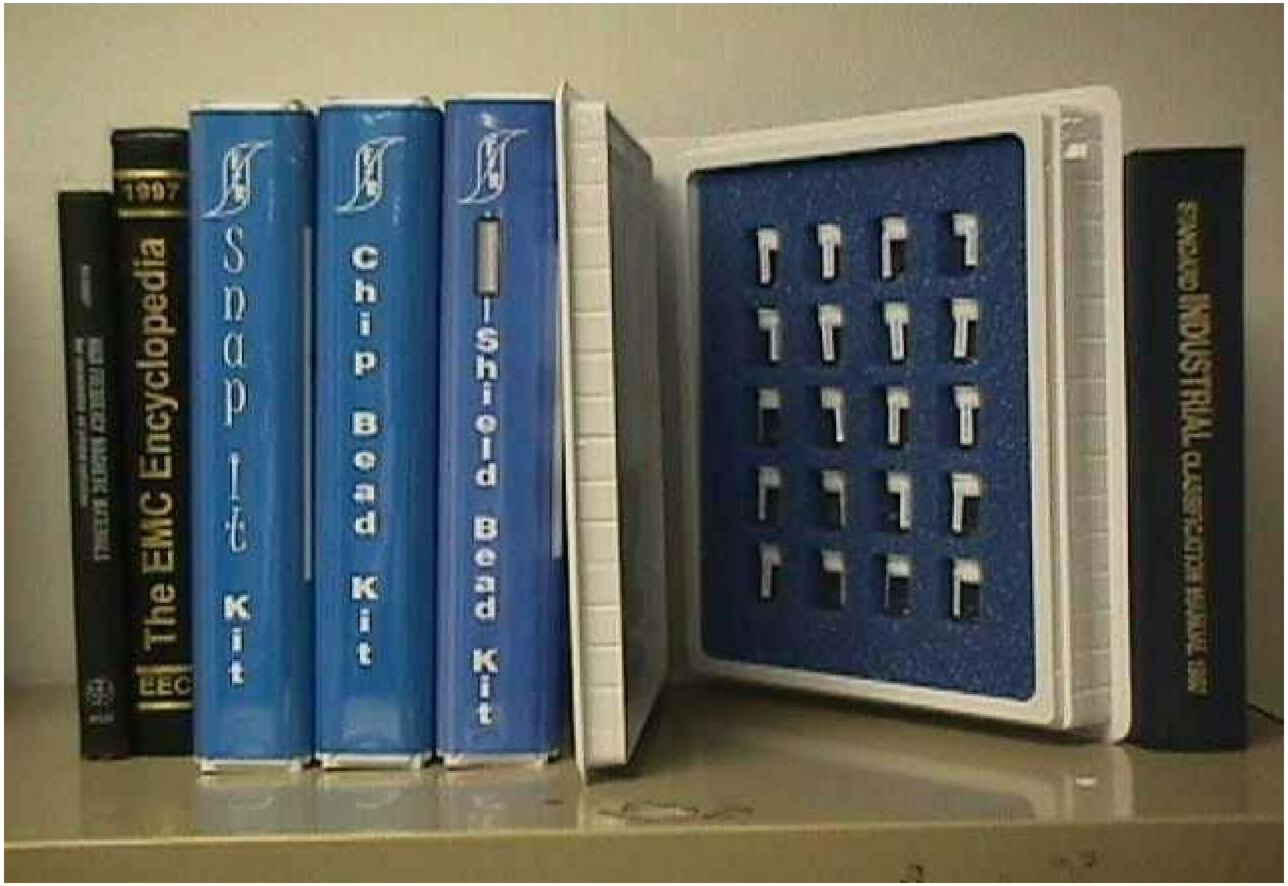
Signal Solution Kit

Engineering Evaluation - Bookshelf Kits



Bookshelf Kits for EMI Suppression

Expanded Cable and Connector EMI Suppressor Kit Part Number 0199000005

This kit provides a broad sampling of suppression cores, specifically designed to attenuate EMI between all types of cable connected systems.

Snap-It Cable Suppressor Kit Part Number 0199000017

This kit contains six sets of round cable snap-its in two of our materials; the high resistivity NiZn 44 material and the MnZn 31 material. Either material in these round cable snap-its can be used to suppress frequencies up to 500 MHz. The snap-its can accommodate round cables with dia.s from .160 to .750 inches

Chip Bead Kit Part Number 0199000018

This kit contains 20 different chip bead parts in four different EIA standard package sizes. This kit contains low current, medium and high current beads. Also included in this kit are standard and high signal speed parts.

EMI Suppression Bead Kit Part Number 0199000019

This kit contains 20 different EMI suppression beads in two different materials; 73 and 43 material. The beads range from a hole dia of 0.85mm up to 5.0 mm.

Connector Plate Kit Part Number 0199000020

This kit contains 20 different suppression plates in high resistivity NiZn 44 material.

RFID Kit Part Number 0199000024

This Kit contains 10 different sizes in materials 78 (for 125 kHz) & 61 (for 13.56 MHz) and is specifically designed for use in transponders in RFID devices.

Surface Mount Kit Part Number 0199000025

This kit contains 20 differential and common-mode surface mount beads. Supplied in several sizes and four Fair-Rite material (73, 43, 44, 61), these beads attenuate conducted EMI from 1 MHz into the GHz frequencies. these SM beads have lower dcr and higher current carrying capacities than plated beads.

Wound Bead Kit Part Number 0199000027

Contains an assortment of 6 and 11 hole beads, wound in several configurations. These beads in Fair-Rite's 44 and 61 materials, provide an impedance of hundreds of ohm over a 5 to 800 MHz frequency range, with or without a dc bias current of up to 5 ampere.

Bead-On-Lead EMI Suppressor Kit Part Number 0199000028

Three popular core sizes in materials 43, 61& 73 are included in this evaluation kit. These nine Fair-Rite engineering evaluation kits are available from Fair-Rite in Wallkill, NY. They can also be purchased from our distributors. Please refer to our web site at www.fair-rite.com for a complete list of our distributors.

Expanded Snap-It Kit Part Number 0199000034

This kit contains an assortment of snap on cores fitting cables ranging from 5mm (.196”) to 19mm (.750”) dia. In 31,43,44 & 61 mat'ls

Chip Inductor Kit Part Number 0199000035

This kit contains multi-layer SM chip inductors. Full monolithic structure on either ferrite or ceramic body. All offer excellent Q