Breakout Magnetics: How Far Can We Take the Next Generation of Components

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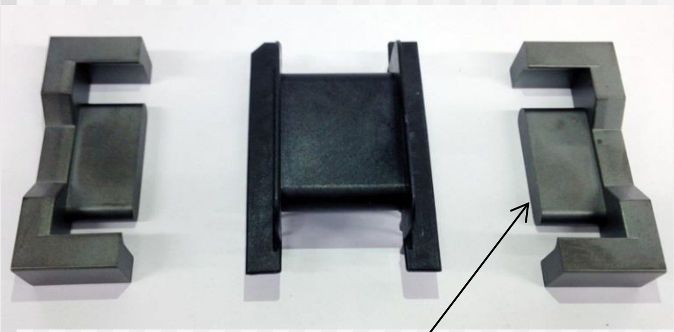
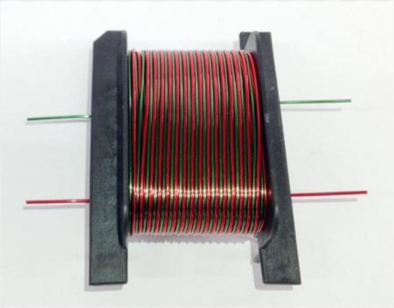
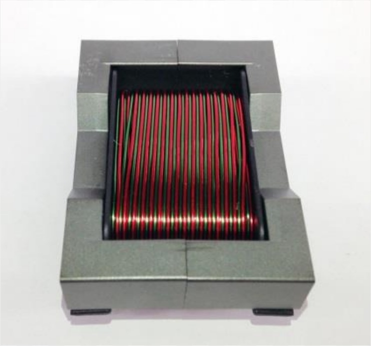
Where do Losses Come From? Typical 1500 W Transformer, 250 kHz



Core cross sectional area (Ae)





Core Loss: 4 Watts

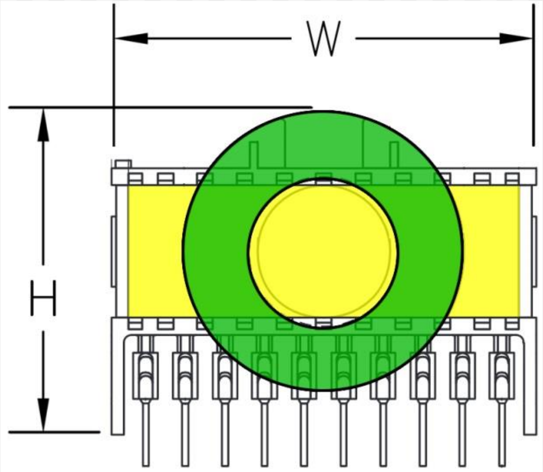
Winding Loss: 3 Watts

Total Loss: 7 Watts

Efficiency 99.5%!

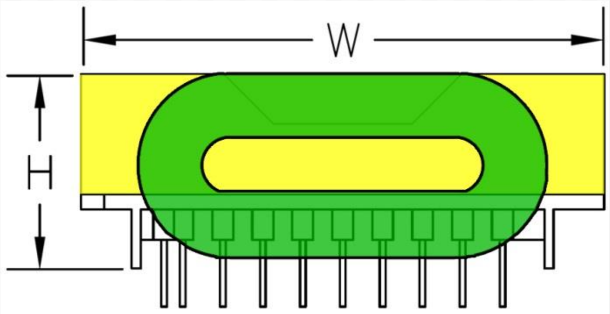
Effective Use of Available Volume

Current Typical ETD49



Full Cube = L x W x H = 101 cm3
Watts/cm3 = 11.2 *

New Design



Full Cube = L x W x H = 91 cm3
Watts/cm3 = 16.5 *

* Power rating based on constant temperature rise design same core and winding technology used for each device.

Improvement Available Today = 47%

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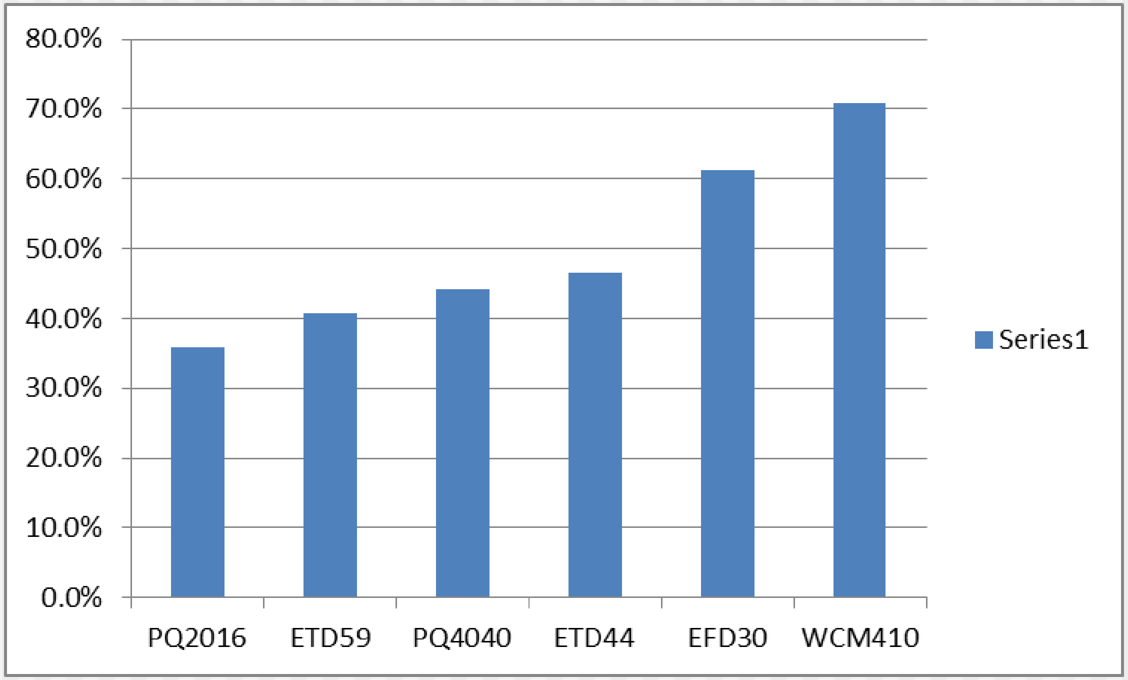
What is the Potential for Improved Packaging?

% of Total Device Cube That is Core Volume and Winding Volume Only



Improvements to 80% or higher will be possible with improved insulating materials and better use of existing materials.

Core Losses

$$B = \frac{E_{rms}(10^8)}{4.44 A_e N f}$$

Where:

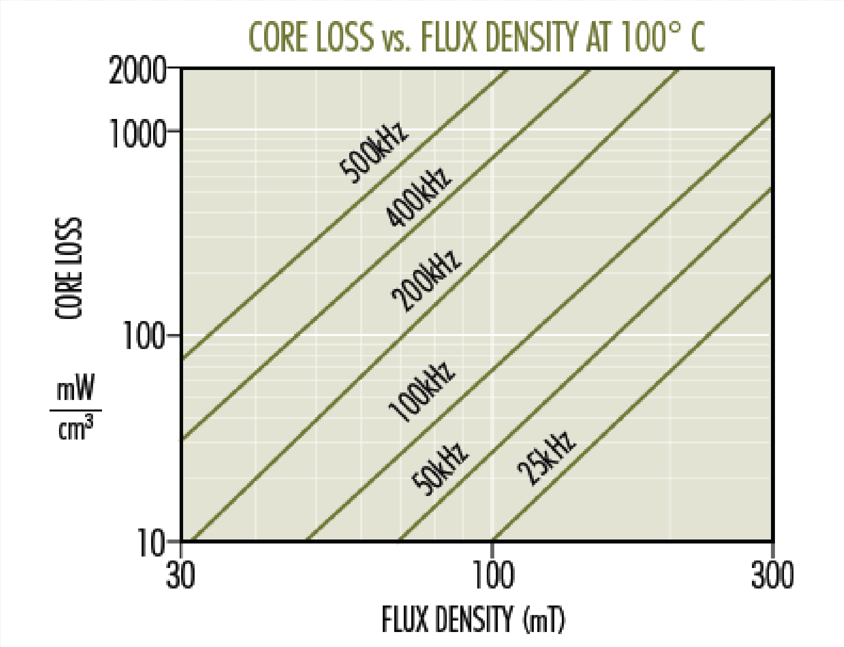
$B =$ peak AC flux density (gauss)

$E_{rms} =$ rms primary voltage

$A_e =$ core area, (cm^2)

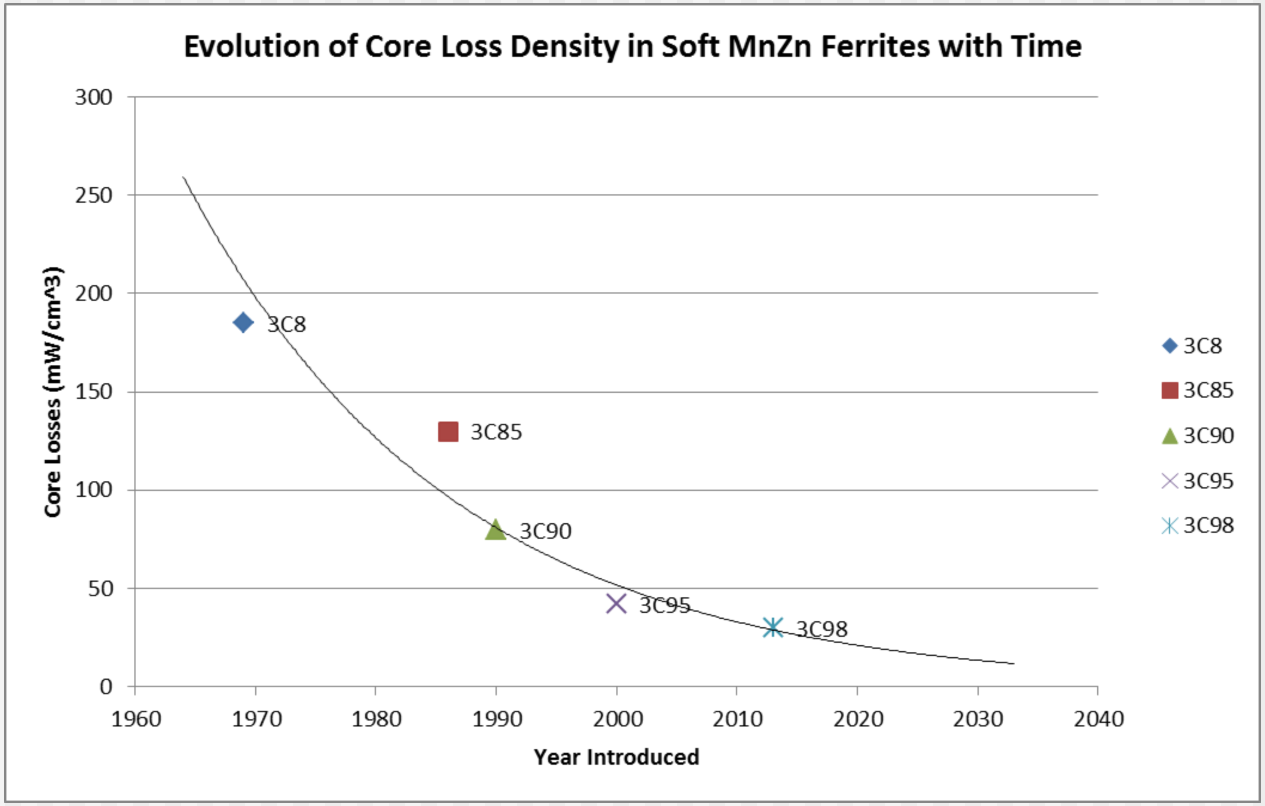
N = number of primary turns

f = operating frequency



Conclude: we want to decrease the product of Ae and N or increase the product of B and F without increasing core loss density.

What Does the Future Hold for Improved Core Materials?



4.7% avg. annual reduction in core loss from 1969 to 3C98 introduction in 2013.

Source: Ferroxcube, Core Loss at 1 kGauss, 100 kHz

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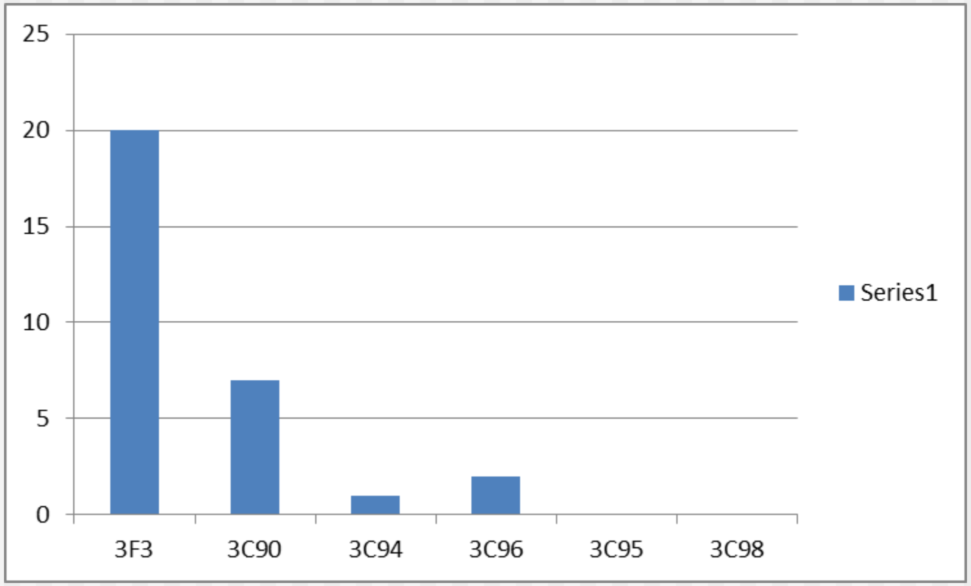
What Core Materials are Being Chosen for Today's Designs

Stocking Quantities through U.S. Distribution



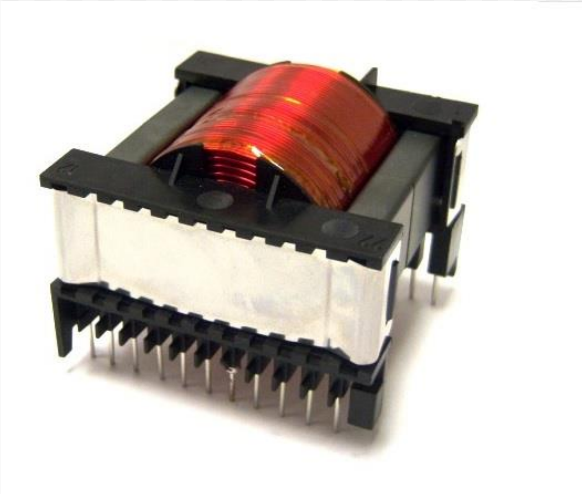
1985 1996 1998 2000 2007 2013

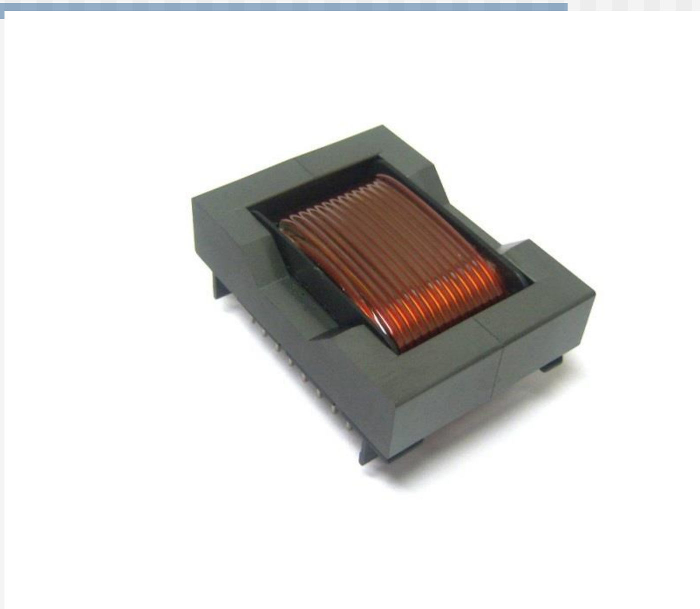
Year of Introduction

The presenter is certain that many new designs use core materials from 10+ old releases

Improvement available today: 50%

Improvement Available Today – More Efficient Packaging and Lower Loss Core





Full Cube = L x W x H = 101 cm3
Watts = 2400 at 100 kHz
Watts/cm3 = 23.7

Full Cube = L x W x H = 91 cm3
Watts = 4300 at 100 kHz
Watts/cm3 = 47.3

IMPROVEMENT 2.0 times power density

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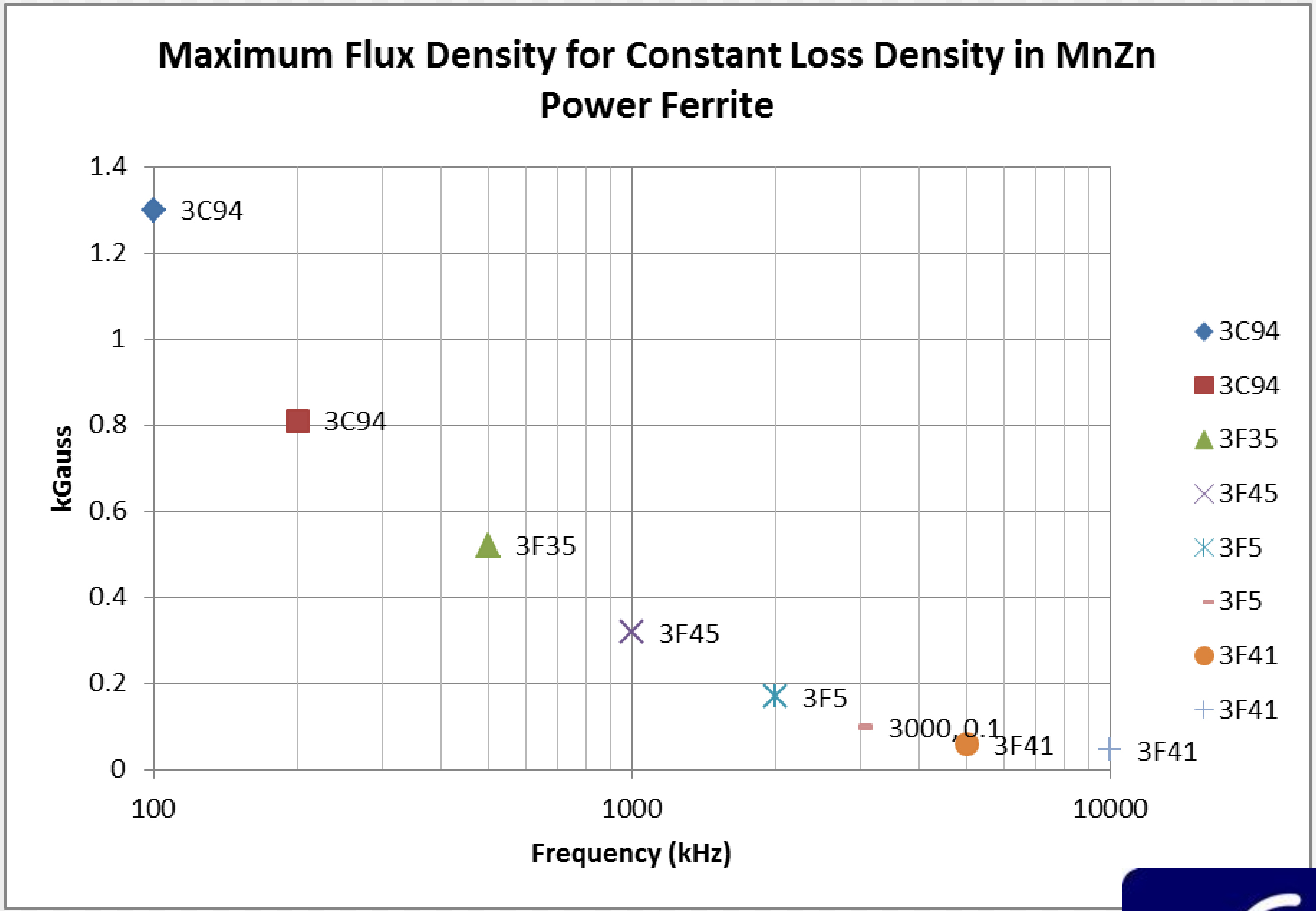
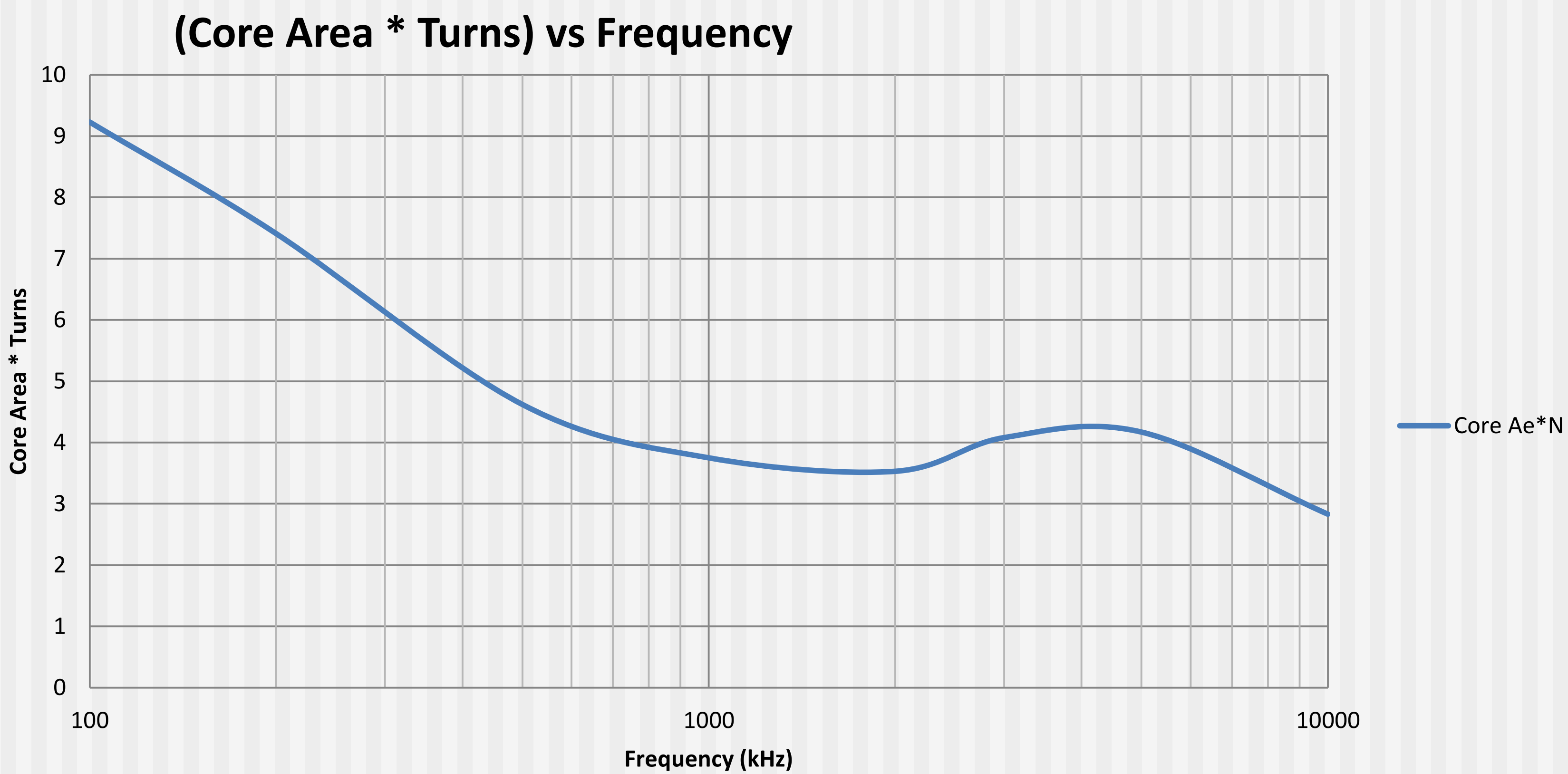
What About the Effect of Increasing the Operating Frequency?

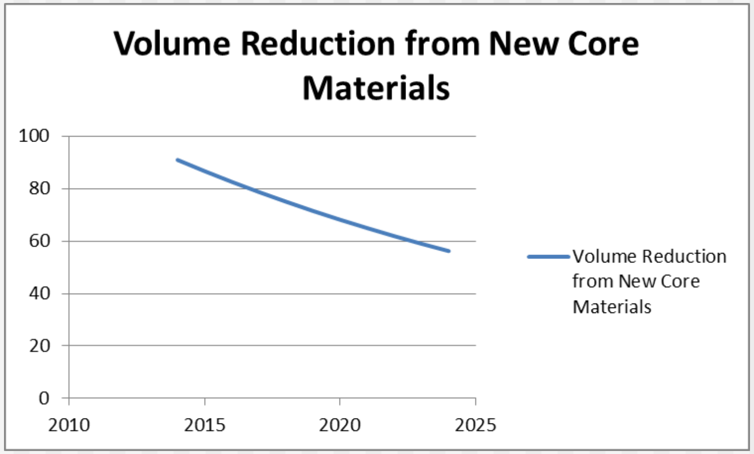


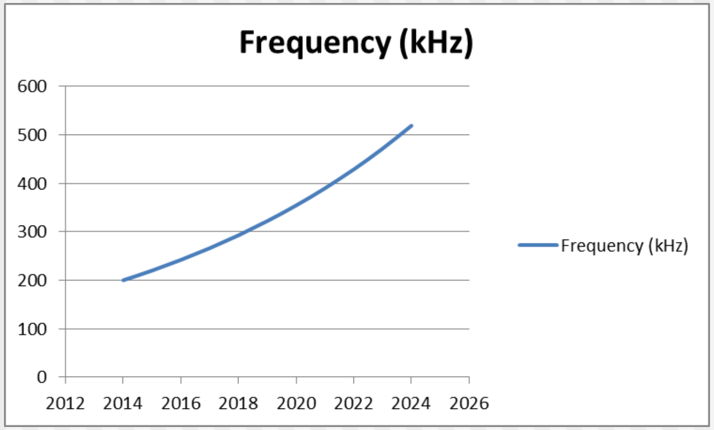
Source: Ferroxcube

Device Size vs. Frequency – State of the Art Today



10 Year Forecast





38% overall reduction in device volume

Operating frequency will increase more quickly at 10% per year. This will result in an additional 30% reduction in device volume.

Conclude: we can expect a decrease in device volume or increase in power density of at least 50% over the next 10 years as a result of better core materials and increased operating frequencies.

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Thank you for your time

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