Resistive Losses in a 3-D Coil

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Abstract

Introduction: Inductive sensors are widely used in the industry. It is often part of the measuring principle to determine the losses in the sensor coil. With Finite Element Analysis, it is now easy to calculate exactly axisymmetric coils in 2D, taking into account skin and proximity effects.

This presentation shows a way to calculate losses at non symmetric problems in 3D.

Computational Methods:
AC/DC Module with "Magnetic Fields" interface was applied (calculating the magnetic vector potential)
2D "Single Turn Coil Model" and 3D "Multi Turn Coil Model" have been combined.
The steel plate is modeled with a "Impedance Boundary Condition"
If inductivity is changed only slightly, the resistive losses can be added.

Results:
Simulation and measurement shows a very good correlation. Above 350kHz the measured resistance increase more then expected. This can be attributed to capacitive effects, which are not included in the "Magnetic Fields" interface.

Conclusions:
The 2D-3D method allows the calculation of 3D models in a few minutes.

Thanks to numerical simulations difficult installation situations for sensors can be tested first in theory.

Reference

Prof. Dr. J. Biela, Wirbelstromverluste in Wicklungen induktiver Bauelemente, Skriptum ETH Zürich (2012)

Figures used in the abstract

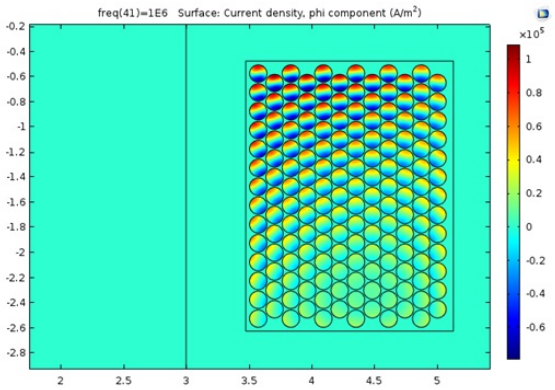

Figure 3. Proximity Effect

Figure 1: Proximity Effect

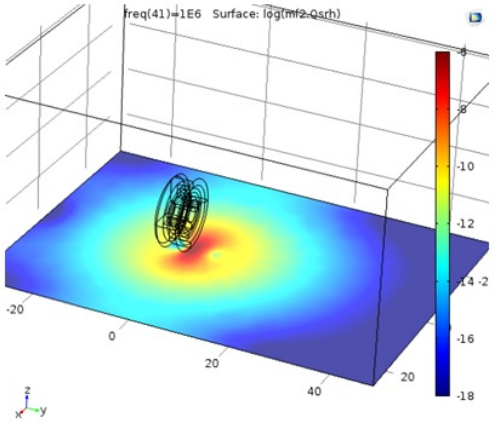

Figure 4. resistive losses

Figure 2: Resistive Losses

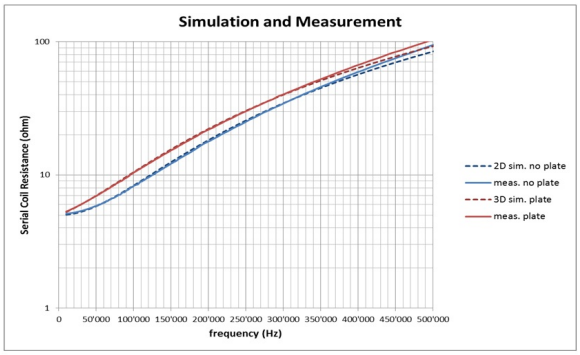

Figure 5. Coil Resistance

Figure 3: Coil Resistance