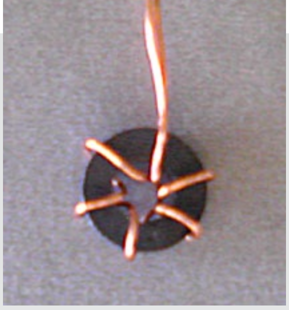

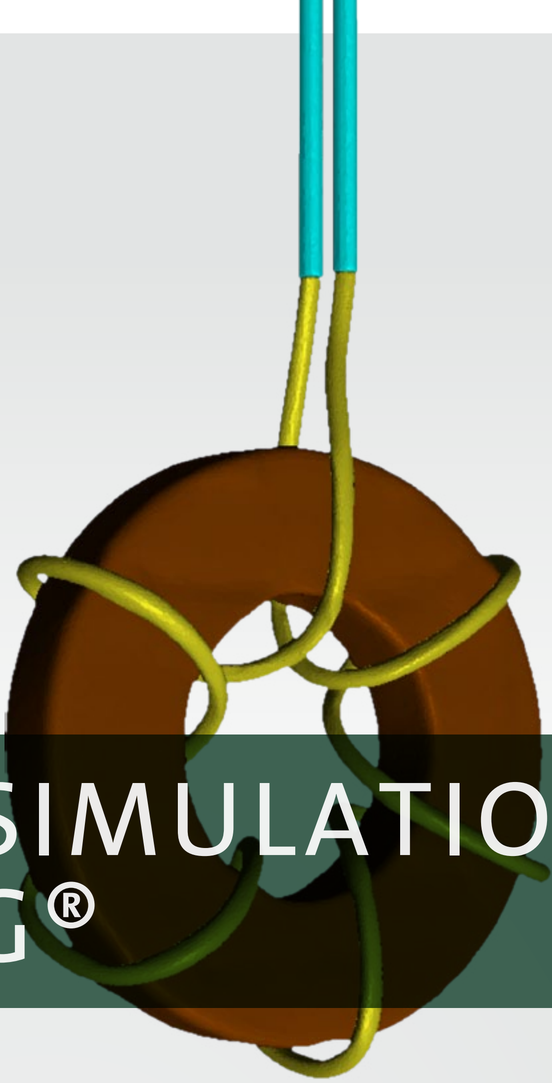

simpleware
converting 3D images into models

MAGNETIC SIMULATION USING JMAG®

Case Study

Magnetic Simulation of Toroidal Inductor using JMAG®

Toroidal inductors are electronic components constructed from a wire coiled around a magnetic (iron) core. They have a wide range of applications including high frequency coils and transformers. Toroidal inductors can also be used for measurement of magnetic characteristics, as an alternative to the solenoid coil.

This case study takes a high resolution scan of a toroidal inductor and builds a finite element mesh of the structure and surrounding air. High frequency magnetic simulations are performed to analyse the current and flux density, as well as distributions, through the inductor which cannot be observed directly. The simulation results are very useful for product verification and redesign, and it will help the development of high accuracy electromagnetic simulation.

Characteristics

» Based on micro-CT data
» Segmentation tools to aid separation of materials
» Accurate reconstruction of fine topology
» Artificial generation of wire extensions and surrounding air for analysis
» EM simulation through inductor using JMAG

Thanks to:

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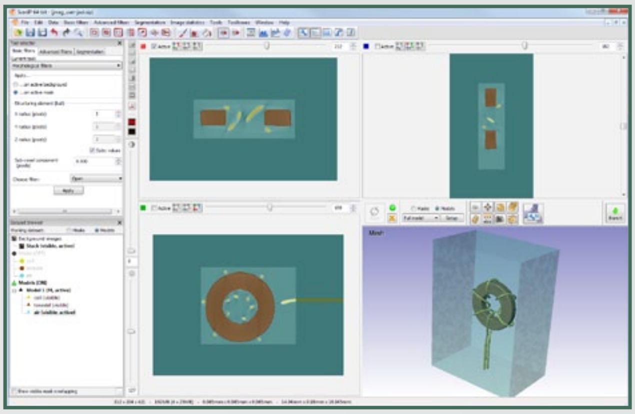
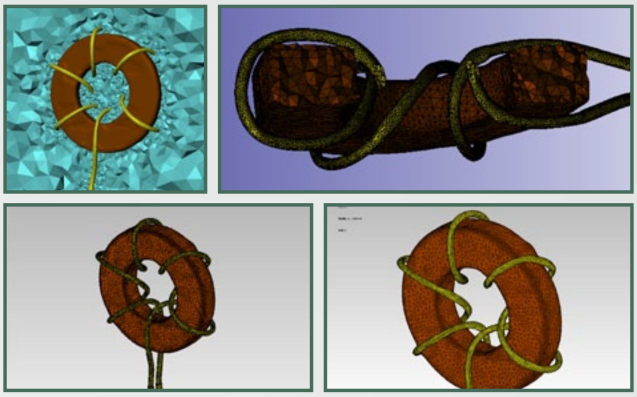
IMAGE PROCESSING

The toroidal inductor was scanned using a TUX-3200 Tohken Co.,Ltd. CT x-ray inspection machine, at a resolution of 17μm. The images were imported into ScanIP where the core and wire segmented and reconstructed. In addition, the image was padded to generate an appropriate air boundary for the later analysis. The size of the air region was configured by considering the leakage flux. In cases where magnetic flux has wide leakage it is necessary to expand the air region sufficiently. The wire was then artificially extended to the boundary, through this added layer of air.



MESH GENERATION

A smooth, high quality, conforming multipart volume mesh of the coil was created using the +FE module. Initially the default coarseness slider was used to achieve the required mesh resolution. After this, some parameters were manually adjusted to tune the mesh further. These included the maximum allowed mesh size, the internal change rate, and the number of elements across layers. This allowed meshes to be created ranging from around 100,000 to 1,000,000 elements.



SIMULATION

The generated mesh was exported in Nastran format and read directly into JMAG for simulation. In order to simulate magnetic phenomenon the material data and simulation conditions must be defined within JMAG. In this case study, a ferrite core and a copper wire were used. The permeability of ferrite and conductivity of copper were assigned. The symmetrical boundary condition was assigned at the boundaries.

From here the current density (left) and magnetic flux density (right) were predicted and visualised. The process allows the non-destructive evaluation of this small and complex component. This analysis calculates phenomena that cannot be easily measured and thus provides an insight into the operation of the coil. Conventional measurement methods have proved unsuitable for predicting the magnetic phenomena of these small components.

These results can show the effect of structure design and material characteristics on product performance in more detail. Additionally, it can verify the difference between a design and an actual product, and hopefully improve the quality of products by giving feedback about variability and performance. Thus making the analysis very useful for the evaluation of products such as small magnetic components.

Using a similar technique within JMAG the analysis can be extended to investigate many other characteristics. For example, JMAG can perform thermal and structural analyses. This technique is widely applicable to the evaluation of various electronic components.