# Impedance Analysis of a Pot Core Inductor

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## Abstract

This work develops a methodology based on the application of finite element method in the frequency domain, using the software COMSOL Multiphysics® with the AC/DC Module: the purpose is to evaluate electromagnetic parameters of a pot-core inductor.

This paper shows how to extract common parameters, such as the inductance (L), the equivalent series resistance (Rs), the equivalent parallel resistance (Rp) and the quality factor (Q) of a pot core inductor, which is shown in the Figure 1. The shape geometry brings many advantages such as the high Q and temperature stability. Moreover, the self-shielding geometry isolates the winding from external magnetic field and it forces the direction of the generated magnetic field. Typical applications for pot cores include: differential inductors, power inductors, proximity sensor, filters and telecom inductors.

The knowledge of the electromagnetic parameter is very important for several reasons, for example it is useful to choose the frequency where the device has the better performances or to predict the value of his inductance or simply to create a lumped equivalent circuit model to insert a more complex circuit.
We propose a simply and accurate method to evaluate these parameter taking advantage of the symmetry of the geometry, the draw of the coil and an useful command for single-turn in AC/DC Module. The study of many parameters inherent to inductance calculation, such as frequency response, magnetic losses and skin effects, could be taken into account to develop an accurate model. We have evaluated the follow electromagnetic parameter L, Rs, Rp and Q over the frequency range 100kHz - 1 MHz thanks the COMSOL Multiphysics® AC/DC Module and the Magnetic Fields interface.

We have compared the obtained results with measures taken with a precision RLC meter (Hp 4285A). The measurement are in good agreement with the simulation model. It is possible to notice that for high frequency the model isn't enough accurate due to nonlinearities of the ferrite material and other second-order effects.

## Reference

[1] L. Green, RF-inductor modeling for the 21st century", Gould-Nicolet Technologies
[2] Epcos Data book 2013, Ferrites and accessories, Epcos, www.epcos.com, 2013
[3] Ferroxcube Data handbook 2009, Soft Ferrites and Accessories, Ferroxcube, www.ferroxbube.com, 2009
[4] ACDC Module Users Guide, COMSOL, www.comsol.com

## Figures used in the abstract

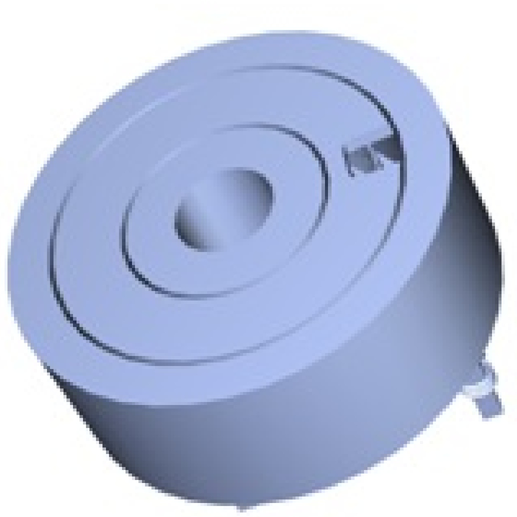

Figure 1: 3d pot core inductor.

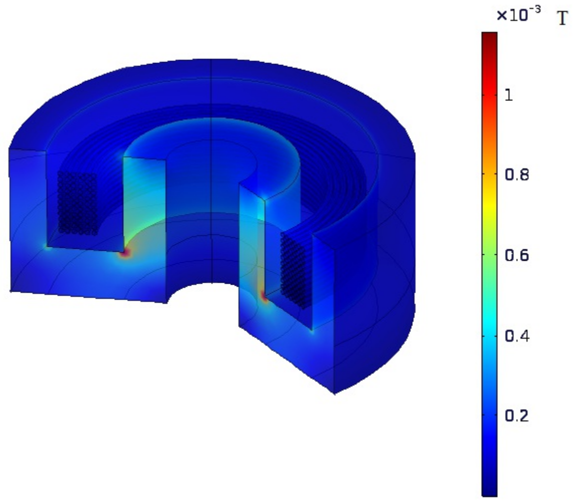


Figure 2: Simulated magnetic flux density at 500kHz.

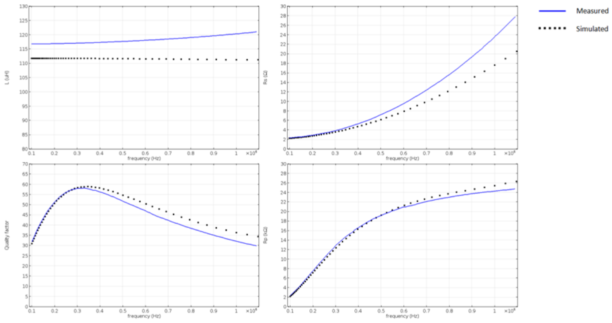


**Figure 3**: Measured vs simulated results.