Influence of air-gap length and cross-section on magnetic circuit parameters
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Agenda

1. Introduction
2. Computational methods
3. Use of Comsol Multiphysics
4. Results
5. Conclusions
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Introduction

- Magnetic inductors and transformers are the fundamental components for PE devices (high frequency filters, EMC chokes, energy storages, galvanic insulations)
- Air-gap significantly modifies the parameters of magnetic circuit
- The optimal selection of shape and dimensions of air-gap is very important from designing point of view
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Computational methods

- AC/DC module was applied for the calculations.
- By varying cross-section and air-gap optimal solutions for this kind of magnetic circuit are proposed.
- The magnetic flux in the core is produced by external vector of magnetic field - additional boundary condition to surfaces of model ($H_x=0; H_y = 0; H_z = 1000 \text{ A/m}$).
- Determination of total magnetic flux amount in the magnetic core cross-section compare to the magnetic flux in the air-gap area with the same cross-section as magnetic core - $F_{FR}$ (factor of magnetic fluxes ratio).
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Use of Comsol Multiphysics

<table>
<thead>
<tr>
<th>Minimum</th>
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<tr>
<td>Time</td>
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<tr>
<td>Physical memory</td>
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<tr>
<td>Virtual memory</td>
<td>13.60 GB</td>
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<tr>
<td>Degrees of freedom</td>
<td>157 162</td>
</tr>
</tbody>
</table>
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Results

Magnetic flux distribution for exemplary cases of FEM analyses:

a) base case with given ratio of cross-section and given length of air-gap,

b) case with the same (as case “a”) ratio of cross-section and bigger length of air-gap, c) case with different ratio of cross-section and the same length of air-gap (as case “a”).
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Conclusions

- COMSOL Multiphysics® software is a useful software for electromagnetic calculations of complex and sophisticated geometries
- FEM analyses allows to determine optimal dimensions of magnetic core cross-section, magnetic core dimensions ratio and level of fringing flux
- FEM calculation allows to optimise the magnetic circuit for specific requirements of applications (no fringing flux, strictly defined fringing flux, etc.)
- Determining of optimal length of air gap and dimension ratio of magnetic core cross-section is a one of the most crucial aspects in a designed process of optimised inductors
- Obtained results are useful for design engineers in the optimisation process of inductors and transformer designs
Thank you very much for your attention!

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