

Electrically Tunable Inductor based on Core Saturation

Master thesis project

Summary:

The aim of the project is to propose an algorithm to control the inductance value of the tunable inductor based on its core saturation, considering the phenomenon of hysteresis for a specific inductor.

Problem definition:

The property of inductors to reduce inductance due to saturation of their magnetic cores is overwhelmingly seen as negative [1]. However, utilizing this feature allows for a gradual change in inductor inductance, which can be used for electrically tunable EMI filters.

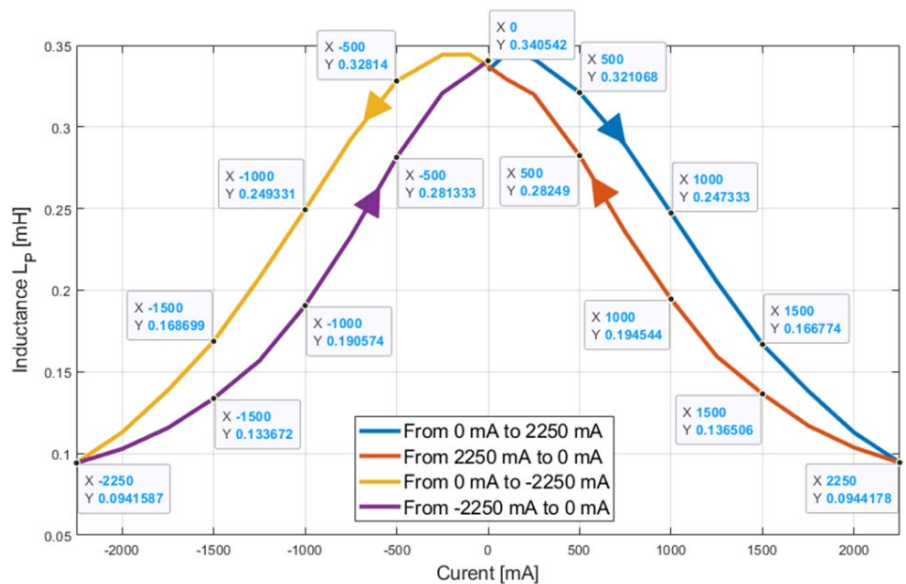
An electrically tunable inductor based on a saturated core was assembled, and its performance was tested as a part of the tunable notch filter. However, due to the hysteresis phenomenon [2], the value of the inductance depends not only on the saturation current but also on its pre-saturation value (it decreases or increases). Since predetermination is an essential parameter of the inductance tuning systems, each specific core must be characterized in terms of its behavior under saturation conditions.

Method:

A literature review on the saturation process and the hysteresis phenomenon. The impedance analyzer and the vector network analyzer in the University of Twente laboratory will be used for the characterization of the tunable inductor and EMI filter.

Research objectives:

- Comprehensive literature review on the saturation process and the hysteresis phenomenon.
- The selected inductor must be characterized in terms of the possibility of changing its inductance with the saturation of its core.
- Based on the review and analysis, the appropriate algorithm to control inductor inductance should be created and tested in the real application.
- The performance of the tunable notch filter with the designed unit should be demonstrated.
- Proposal of a method that will allow the adaption of the proposed algorithm for a different inductor depending on the requirements of the filter.



Electrically Tunable Inductor based on Core Saturation

Master thesis project

Courses and supervision:

The general knowledge in the EMC field (non-ideal passive elements, EMI filters) will be helpful.

The skills in using laboratory equipment (e.g. spectrum analyzer, oscilloscope) are required.

A good affinity with LTSpice and MATLAB is very beneficial for doing this assignment.

References:

[1] D. Nemashkalo, P. Koch, N. Moonen and F. Leferink, "Unexpected Common Mode Choke Saturation," 2023 International Symposium on Electromagnetic Compatibility – EMC Europe, Krakow, Poland, 2023, pp. 1-5, doi: 10.1109/EMCEurope57790.2023.10274369.

[2] M. F. Jaafar and M. A. Jabri, "Study and modeling of ferromagnetic hysteresis," 2013 International Conference on Electrical Engineering and Software Applications, Hammamet, Tunisia, 2013, pp. 1-6, doi: 10.1109/ICEESA.2013.6578426.

Contact:

Ivan Struzhko (Ivan.Struzhko@utwente.nl)

Tom Hartman (Tom.Hartman@utwente.nl)

University of Twente.