LABORATOIRE D'ELECTROTECHNIQUE ET D'ELECTRONIQUE DE PUISSANCE DE LILLE

Master project, 2026 - 27

— Digital Control Approach for Accurate Characterization of Soft Magnetic Materials Under Arbitrary Excitation —

Supervisors: O. Messal ; A. Benabou | oualid.messal@univ-lille.fr ; abdelkader.benabou@univ-lille.fr
L2EP – ULille

Context

As the energy transition accelerates, soft magnetic materials are becoming increasingly important in electrical energy conversion systems. To study the behavior of soft magnetic materials under conditions close to real applications (e.g., electrical machines) and to support modelling needs, experimental measurements must be performed under static and dynamic excitations, as well as with different induction waveforms (sinusoidal, sinusoidal with harmonics, triangular, etc.).

Objective

Develop a digital control system capable of regulating both the amplitude and the waveform of the magnetic induction for the accurate magnetic characterization of soft magnetic materials.

Work steps

#Literature Review

- Bibliographic review of existing digital control methods for amplitude and waveform (equivalent electric circuit, adaptive iterative feedback, model-free digital control, etc.) [1], [2].
- Identification of the approaches best suited to the specific constraints of magnetic measurements (frequency, amplitude, waveform, distortion, etc.).

#Implementation and evaluation

- Implementation of the most promising methods within a scientific computing environment (Matlab, python, etc.).
- Performance evaluation (reproducibility, stability, noise management, accuracy).

#Application to magnetic characterization of soft magnetic materials

- Integration of the validated digital control methods into the infrared (IR) thermography-based iron-loss characterization setup developed at L2EP [3], with the objective of enhancing its capabilities in the framework of Fatima Hassan's PhD thesis started in December 2025 [4].
- Evaluate the performance of the proposed digital control approach on different classes of soft magnetic materials (SiFe, NiFe, CoFe, etc.) under a wide range of induction waveforms, amplitudes, and frequencies.

Key words

Magnetic materials, digital control, amplitude control, waveform control, magnetic characterization, IEC standards.

References

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