LABORATOIRE D'ÉLECTROTECHNIQUE ET D'ÉLECTRONIQUE DE PUISSANCE DE LILLE

Université de Lille

L2EP Laboratoire d'électrotechnique et d'électronique de puissance de Lille

Master project, 2018-2019

– Improvement of power density by optimization of the EMC filter volume in power converters –

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Context

Electrical energy is managed by power electronics converters in a wide range of applications such as: solar charge controllers, battery chargers (e.g. mobile devices, electric vehicles), uninterruptible power supplies (e.g. data centers), actuators controls and motor drives (aircrafts, electric transportation, industrial applications). In many of these applications (especially in embedded systems), reducing volume and weight is a key challenge to process more electrical power in a smaller and lighter package.

However, all these converters operate in commutation mode which generates a large amount of parasitic electromagnetic noise such as the so-called common-mode (CM) currents that flow into the ground conductor due to capacitive coupling with the main power path. As a consequence, the power converters include noise-suppression filters (especially for CM currents reduction) that typically occupy 30 to 50 percents of the overall volume (see *Figure* below), which significantly impairs their power density.

Objectives

Improvement of power density requires to optimize the filter size, notably by selecting the appropriate materials and determining the best geometrical parameters for the realization of the CM inductor (that is usually the largest component where optimization efforts should focus). For a given electric material (toroidal core), the laboratory recently published a new method for filter optimization by determining the best possible realization of its geometrical parameters, and applied it to a DC-to-DC conversion chain to fulfill the aeronautic standards (DO-160) as shown in [1].

The proposed research work will complete this study by focusing on the selection of the best magnetic material (ferrite or nanocrystalline) that will provide the most volume reduction of the CM filter, and thereby of the power converters. The laboratory methods will be re-applied and improved to include the core material as an important optimization parameter, and finally elaborate a design tool that is capable of determining the best possible realization of the CM filter for any power converter.

Work Progress

- Understanding the power converter operation principles that are the cause of electromagnetic compatibility (EMC) issues such as CM currents. Performing a bibliographic study focused on EMC filters and on the useful characteristics of magnetic materials typically used in these filters
- Gathering information on magnetic material characteristics in a kind of database under MATLAB environment for easy information retrieval
- Becoming familiar with the filter design tools used in the laboratory, and then include the material selection as an entry point for the CM inductor optimization
- Running MATLAB simulations on a DC-to-DC power conversion system to reveal the existence of an optimal set of parameters (material + geometry)
- Validating experimentally by physically realizing the filters and performing the measurements in the laboratory

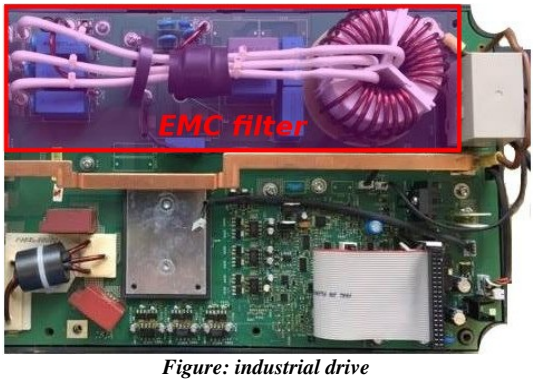

Figure: industrial drive

[1] B. Zaidi, A. Videt and N. Idir: "*Optimization method of CM inductor volume taking into account the magnetic core saturation issues,*" in IEEE Transactions on Power Electronics, 07/2018
URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8423505&isnumber=4359240