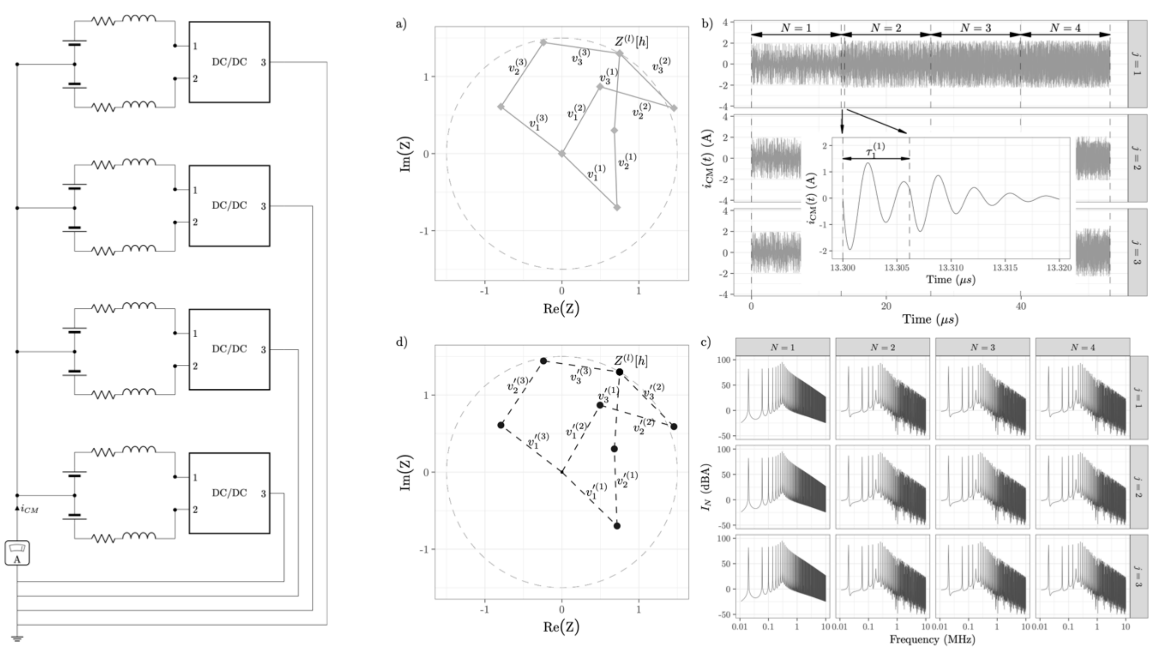
Random Walk-based modeling of Multi-Conv. setups

Bachelor thesis project



A schematic of a setup consisting of 4 PE converters, with a current probe collecting Common Mode current indicated (left), and the procedure of testing a Pearson's Random Walk approach of modelling the Common Mode current. (right), adopted from [2] with author's permission.

Summary:

Validation of a Random Walk-based modelling approach of Electromagnetic Interference in multi Power Electronic-converter setups [1], [2].

Problem definition:

Nowadays, many applications use Power Electronic converters as interfaces between electrical devices. The main function of PE converters is achieved by utilizing a switching circuit. Fast switching action of the PE converters causes electromagnetic compatibility issues. According to European Union Directive 2014/30/EU, EMC requires that devices working together in a network should operate without introducing interference which causes "substantial degradation of service when used under normal operating conditions". Moreover, clause 31 of this directive states that "where apparatus is capable of taking different configurations, the electromagnetic compatibility assessment should confirm whether the apparatus meets the essential requirements in the configurations foreseeable by the manufacturer as representative of normal use in the intended applications." To comply with these requirements, a typical procedure consists of testing PE converters in a standardized setup and validating whether the EMI exceeds levels prescribed in the standards. However, there are no standardized approaches that allow to test multiple PE converters operating together in a grid. The reason might be because there are no consensual models that allow predicting the EMI from multiple converters. The aim of the project is to validate an existing Pearson Random Walk approach to model the Electromagnetic Interference caused by the presence of multiple switching devices.

University of Twente.

Power Electronics and Electromagnetic Compatibility **PE Group**

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Method:

The student will work in a lab with an FPGA-driven multi-converter setup, and will collect and postprocess the data, in particular the Common Mode current. The student will need to analyse the data and test whether the Pearson Random Walk model allows to predict levels of EMI coming from multiple converters, based on the knowledge of EMI of one converter.

Research objectives:

The student will need to be able to program an FPGA to drive multi-converter setup. The student will need to collect Common Mode current from this setup. Finally, the student will need to postprocess the data using FFT and compare the postprocessed data with a random walk model. The student will be judged on the verification of the data with the random walk model, and confirming or disproving its usefulness for EMI prediction.

Courses and supervision:

The student should be able to program FPGA and appropriately use current and voltage probes, as well as understand the basic function of PE converters. The student should be able to work independently and consult research papers on the proposed topic. It is desirable that the student has some initial knowledge about EMC and foundational knowledge about statistics, however guidance on this can be given by the supervisors.

References:

[1] J. Bojarski, R. Smolenski, A. Kempski, and P. Lezynski, "Pearson's random walk approach to evaluating interference generated by a group of converters," *Appl Math Comput*, vol. 219, no. 12, pp. 6437–6444, 2013, doi: 10.1016/j.amc.2012.12.088.

[2] E. Ballukja, K. Niewiadomski, D. W. P. Thomas, S. Sumsurooah, M. Sumner, and J. Bojarski, "A Statistical Approach to Predict the Low Frequency Common Mode Current in Multi-Converter setups," in *2023 IEEE Symposium on Electromagnetic Compatibility and Signal/Power Integrity, EMC+SIPI 2023*, Institute of Electrical and Electronics Engineers Inc., 2023, pp. 7–12. doi: 10.1109/EMCSIPI50001.2023.10241644.

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