Master project, 2025-2026

Optimized PCB Design for High Frequency GaN Converters

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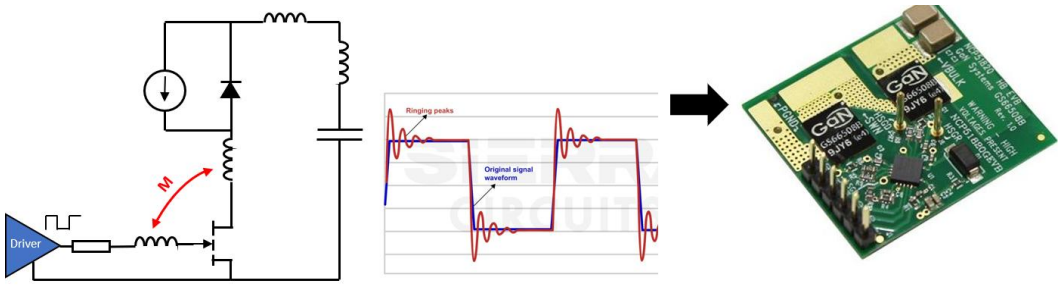
Context

Power electronic converters are essential for modern applications, from small embedded systems to electric vehicles and renewable energy systems [1]. To meet growing demands for efficiency and compactness, designers are pushing switching frequencies ever higher [2], [3]. However, parasitic effects in PCBs, such as unwanted inductances and couplings, can severely limit performance and reliability [4], [5], [6].
At Power Electronics group in L2EP, extensive research has been conducted on the impact of parasitic inductance effects in high-frequency power converters, and also proposing methods to reduce these effects [5], [6]. For example, an innovative power loop layout (vertical loop) was proposed in [6] in order to reduce the parasitic inductances and improve converter robustness. Recent studies have also shown that mutual coupling between power and control loops can significantly disturb circuit performance, leading to higher electromagnetic emissions and additional thermal losses [7]. In this context, this project offers an opportunity to join these cutting-edge developments and contribute to next-generation high-frequency power converters.



Objectives

The main objective of this project is to analyze and characterize the parasitic elements (especially parasitic inductances) present in the power and control loops of PCBs used in high-frequency switching cells. The work will also explore the mutual coupling between these loops and evaluate its impact on overall circuit performance. Advanced electromagnetic (EM) simulation tools, such as ADS Momentum®, will be employed to model and predict these parasitic effects. Experimental validation will be carried out using precise measurement equipment, including oscilloscopes and Vector Network Analyzer (VNA), to compare and refine simulation results. Ultimately, the project aims to propose an optimized PCB design strategy that effectively minimizes parasitic effects and improves the reliability and efficiency of high-frequency converters.

Schedule

The project will begin with an in-depth literature review on PCB parasitic effects and mutual coupling phenomena. Next, initial simulation work will model the parasitic inductances in the power and control loops of the PCB. These simulations will then be validated through experimental measurements using dedicated test benches (oscilloscope, VNA) to assess parasitic inductances and coupling effects.
In the second phase, the simulation models will be refined and adjusted based on the experimental data. By the end of the project, the candidate will propose an optimized PCB design strategy, derived from this study, to effectively minimize parasitic effects in high-frequency switching applications.

Application Process

Interested candidates in this project should contact email addresses with a CV and their latest academic transcripts. Shortlisted candidates will be invited for an interview to discuss the project details and their fit for the research. The internship will take place at the ESPRIT building of the University of Lille, where the candidate will have access to state-of-the-art simulation and measurement tools to carry out this work.

References

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