Universität Stuttgart
Institut für Robuste
Leistungshalbleitersysteme

Dominik Koch
dominik.koch@ilh.uni-stuttgart.de
+49 (0)711 / 685 68699

Forschungsarbeit
Masterarbeit

Leistungs-elektronik

Multi-Domänen und Multi-Ziel Optimierung für hochkompakte Schaltwandler

Abstract

Aufgrund immer steigender Leistungsdichte, Anzahl an Bauelementen und der Verwendung von Wide-Bandgap Halbleitern werden leistungselektronische Systeme immer kompakter und komplexer. Um dabei bei immer größer werdender Leistungsdichte eine maximale Effizienz zu erreichen, müssen alle möglichen Optionen des (diskreten) Lösungsraum betrachtet werden. Der Lösungsraum definiert sich bspw. durch mögliche Halbleiter und Passivas oder das Schaltungsträgerdesign.

Um diesen Lösungsraum abzubilden wird sich dabei computergestützten Optimierungsmethoden bedient, welche das Optimum (Pareto-Front) bestimmen.

Ziel dieser Arbeit ist es, einen Workflow für die Bestimmung dieser Pareto-Front mit multidimensionaler Simulation für einen DC/DC-Wandler zu implementieren und den Wandler ggf. aufzubauen und zu charakterisieren.

Zeitplan

- Einarbeitung & Literaturrecherche (10%)
- Implementierung Multi-Domänen Optimierung (50%)
- Aufbau und Charakterisierung Wandler (25%)
- Ausarbeitung & Vortrag(20%)

Vorkenntnisse

- Erfahrungen in 3D-FEM hilfreich
- Kenntnisse in Leistungselektronik
- Sicherer Umgang mit MATLAB o.ä.

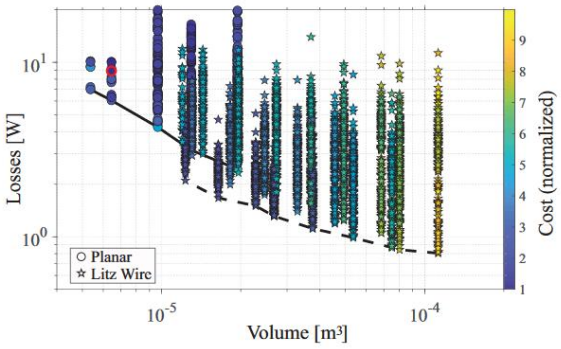

Figure 4 η-ρ Pareto-front of boost PFC inductors for planar (solid line) and litz wire (dashed line) inductors. The costs of all designs are normalized to the value of the cheapest design (red circle).

Effizienz-Volumen Pareto Front für unterschiedliche PFC-Induktivitäten [1]

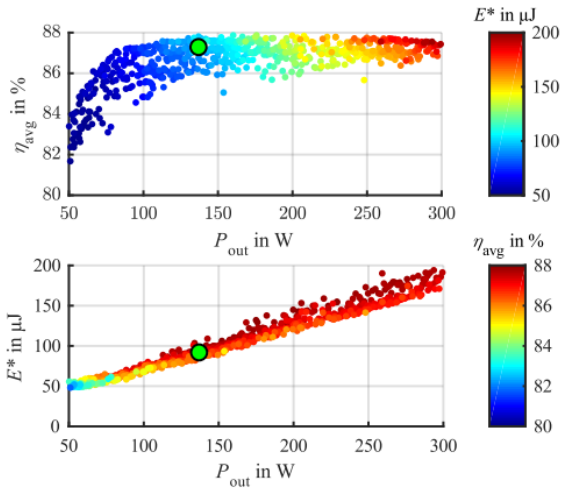

Fig. 2. Results of the multi-objective optimization. The selected design is highlighted

Effizienz-Ausgangsleistung multi-Ziel Optimierung für unterschiedliche Parameter [2]

[1] M. J. Kasper, L. Peluso, G. Deboy, G. Knabben, T. Guillod and J. W. Kolar, "Ultra-high Power Density Server Supplies Employing GaN Power Semiconductors and PCB-Integrated Magnetics," *CIPS 2020; 11th International Conference on Integrated Power Electronics Systems*, Berlin, Germany, 2020, pp. 1-8.
[2] D. Bura, T. Plum and R. W. De Doncker, "A Pareto-Optimized, Capacitively Isolated SEPIC Converter for Wide Load Ranges and High Frequency Power Conversion," *2019 IEEE Applied Power Electronics Conference and Exposition (APEC)*, Anaheim, CA, USA, 2019, pp. 1661-1667, doi: 10.1109/APEC.2019.8721997.

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Research thesis
Masterthesis

Power electronics

Multi-Domain and Multi-Goal Optimization of ultra-compact power converters

Abstract

Due to ever increasing power densities, number of devices and the use of wide-bandgap semiconductors, power electronic systems are getting more complex and compact. To still achieve a maximum efficiency, all solutions of the (discrete) solution space must be investigated. The solution space is defined by e.g. suitable semiconductors and passives or the PCB-design.

To map this solution space, the aid of computer-based methods is necessary, which are calculating the optimal point of the so called pareto-front.

Goal of this thesis is to implement a workflow for such a pareto-front optimization with a multi-dimensional simulation for a compact DC/DC-converter and, if applicable, to construct and characterize this converter.

Time plan

- Literature research (10%)
- Implementation multi-domain optimization (50%)
- Setup and characterization of the converter (25%)
- Written thesis & talk (20%)

Preliminary experience

- Experience in 3D-FEM helpful
- Knowledge in power electronics
- Good knowledge of MATLAB or similar

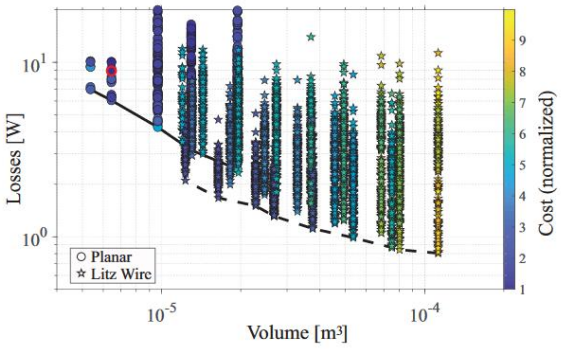

Figure 4 η-ρ Pareto-front of boost PFC inductors for planar (solid line) and litz wire (dashed line) inductors. The costs of all designs are normalized to the value of the cheapest design (red circle).

Efficiency-volume pareto front for different PFC-inductances [1]

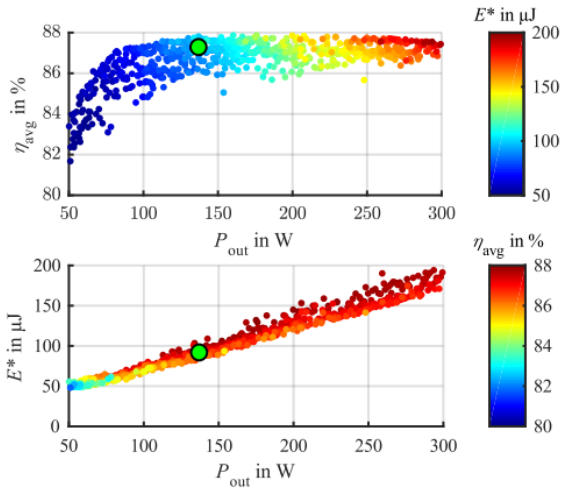

Fig. 2. Results of the multi-objective optimization. The selected design is highlighted

Efficiency over output power for different multi-objective optimizations [2]

[1] M. J. Kasper, L. Peluso, G. Deboy, G. Knabben, T. Guillod and J. W. Kolar, "Ultra-high Power Density Server Supplies Employing GaN Power Semiconductors and PCB-Integrated Magnetics," *CIPS 2020; 11th International Conference on Integrated Power Electronics Systems*, Berlin, Germany, 2020, pp. 1-8.
[2] D. Bura, T. Plum and R. W. De Doncker, "A Pareto-Optimized, Capacitively Isolated SEPIC Converter for Wide Load Ranges and High Frequency Power Conversion," *2019 IEEE Applied Power Electronics Conference and Exposition (APEC)*, Anaheim, CA, USA, 2019, pp. 1661-1667, doi: 10.1109/APEC.2019.8721997.