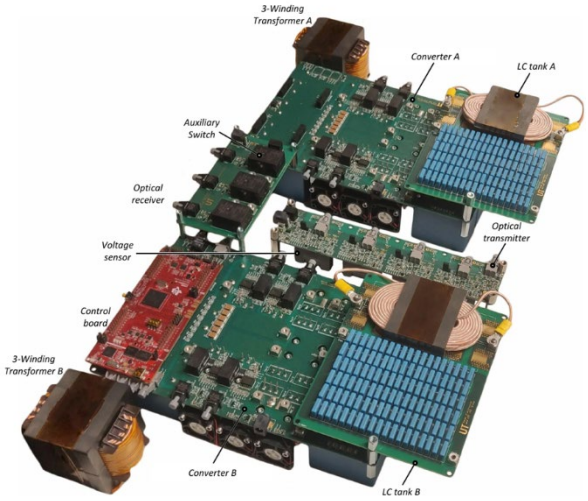
Current Balancing in Fast Chargers

Master thesis project



Summary:
The aim of this thesis is to improve the current sharing between parallel modules in an interleaved LLC resonant converter (in the picture)

Problem definition:
In order to limit current stress and alleviate thermal dissipation, fast chargers typically involve paralleling of semiconductors in the form of modules or as identical converters fed from a common voltage bus. Such an approach ensures that the current flowing through each individual semiconductor device is restricted to a safe value. However, due to the parameter mismatches in the multiple "twin" networks, current sharing is practically never identical which can lead to a circulating current instability or even a collapse of the dc voltage output in the absence of sufficient gain and phase margins. Consequently, the instability inhibits fast response and high closed-loop bandwidth. This can particularly occur in LLC resonant converters which often employ components with relatively high tolerance values in parallel networks such as series capacitance, inductances and transformer windings all of which affect the small-signal impedance and the control to output transfer function.

Method:
In this study, the experimental setup shown in the figure will be provided to the student and can be used for assessing the current-sharing performance in a relatively low-power (15 kW) back-end charging system. Closed-loop controller and hardware modifications are expected to be the source of performance improvement.

Research objectives:

- Performance a literature review of closed-loop control methods for LLC resonant converters
- Identify hardware/software-based methods for current sharing in isolated DC/DC converters
- Perform simulations and conduct experiments based on the potential improvements
- Analyze the test results and benchmark the undertaken approaches

Courses and supervision:
Knowledge in circuit theory and control systems is a pre-requisite
Knowledge in power electronics, modelling and simulation, and micro-controller programming is desirable

This thesis will form a part of a PhD research project and the PhD student will be daily supervisor with co-supervision from two faculty members within the PE group.

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