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Design of a Feedback-Controlled Wireless Converter for Electric Vehicle Wireless Charging Applications

Project 1835
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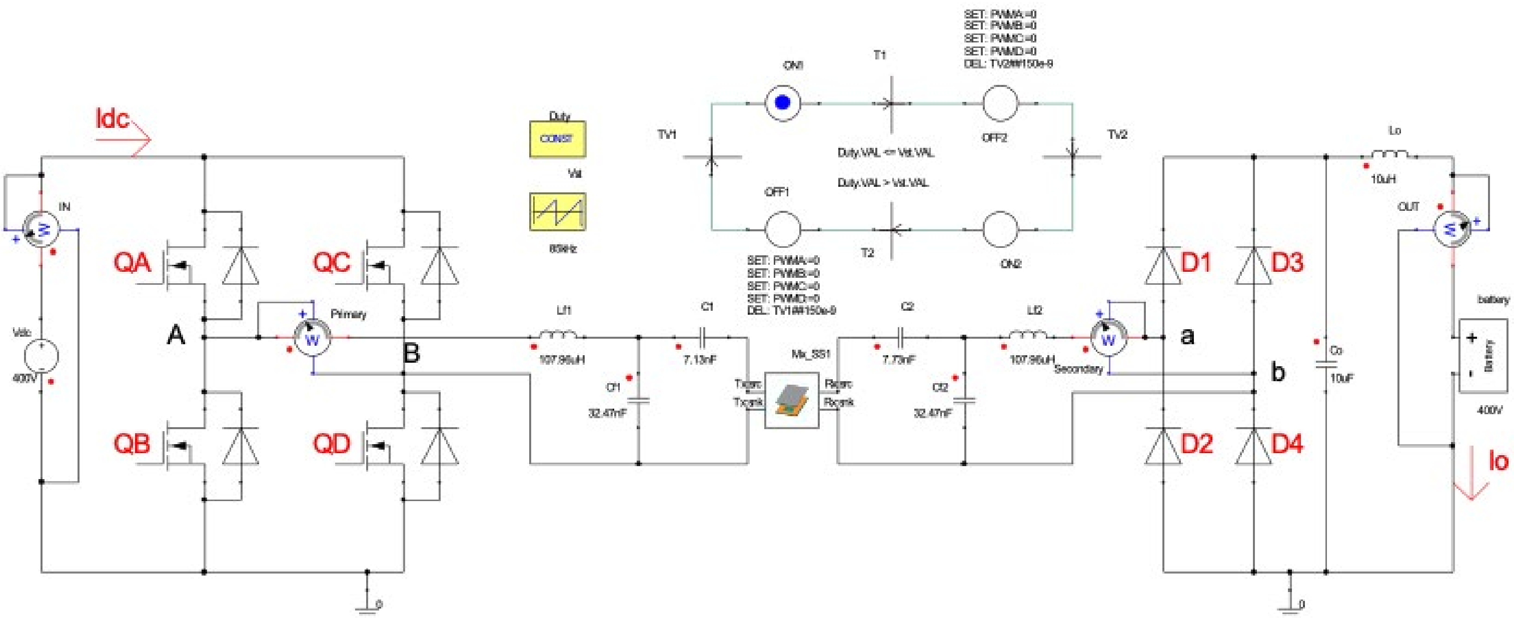

Electric vehicles (EVs) have played an important role in the modern transportation system in recent years. However, current generations of EVs face unsolved drawbacks such as short driving range, long charging time, and high cost due to expensive battery systems. Wireless Power Transfer (WPT) is a promising technology that is able to mitigate the drawbacks EVs are facing. This paper focuses on investigating and building a complete high-efficiency WPT system that is capable of efficiently charging electric vehicles. The goal is to design and apply two different configurations of compensation networks to the WPT system. In this paper, the two compensation network configurations studied are LLC and LCC. After comparing their operational characteristics and efficiencies, the most suitable configuration is proposed. Moreover, a phase-shifted controller is applied in order to regulate the power transferred through the WPT system.

Study Methods

Different simulation and analytical tools are used to analyze the performance of the proposed configurations as follows:

1. Matlab/Simulink is used to build the simulation model of the proposed configurations under ideal conditions. Additionally, it was also used to validate the control structure proposed in this project.
2. The project team used ANSYS to design the wireless coils and integrate them into the proposed configurations.
3. Altium designer software package was used to build the circuit schematics and design the printed circuit board for experimental validation.
4. Finally, the simulation results are verified experimentally using a designed printed circuit boards, and testing equipment.

Findings

A dual-sided resonant LCC converter and an LLC converter are simulated and analyzed for EV wireless charging applications. The designed converter can achieve a high system efficiency due to its soft switching features. A feedback frequency control is applied on the converter to increase the system efficiency while tracking the output power. The simulation model is fully developed and analyzed using LTspice, MATLAB, and Ansys Simplorer/Maxwell. The simulation system efficiency from a DC power source to power the electronics load is 97.48% for maximum power with coupling coefficient of 0.25. A prototype is developed to prove the system's functionality and efficient performance under different operating conditions.

Electric vehicles wireless charging systems can achieve the same efficiency levels as conductive charging using resonant converters.

Policy Recommendations

Efficient designing and implementation of wireless charging systems for electric vehicles is a practice that is directly linked to the research findings.

About the Authors

Dr. Mohamed Badawy is an Assistant Professor in the Electrical Engineering Department at San Jose State University. He joined the department in Fall 2016 as an assistant professor. Dr. Badawy is the director of the Center of Power Electronic Converters (CPEC) that he established after joining the department. The CPEC serves the research needs in the power electronics area, and it supports the power electronic classes at both the undergraduate and graduate level.

Dr. Badawy research interests span the areas of power electronic configurations and control structures for advanced applications and technologies such as: electric vehicles (EVs) and renewable energy systems.

To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/project/1835.

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