Abstract of Ph.D. Thesis
"Design, Development and Implementation of Bidirectional Battery Chargers of Light Electric Vehicles"
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The increasing demand for sustainable transportation solutions has significantly advanced research into bidirectional battery chargers for electric vehicles (EVs), with a particular focus on low-voltage battery-powered EVs, commonly referred to as light electric vehicles (LEVs). This thesis comprehensively explores various topologies and control strategies designed to enhance the efficiency and versatility of bidirectional chargers tailored specifically for LEVs.

The research begins with an extensive review of existing literature and market trends, highlighting the evolution and importance of bidirectional chargers in enabling vehicle-to-grid (V2G), vehicle-to-home (V2H), and other vehicle-to-anything (V2X) operations. It underscores state-of-the-art technologies and ongoing global projects that demonstrate the critical role bidirectional chargers play in integrating EVs with smart grids and smart homes.

Following this foundational review, the thesis delves into the design, development, and implementation of multiple bidirectional charger topologies. Key challenges addressed include ensuring wide-input voltage range operation, accommodating wide-output current range capabilities, and adapting to wide-output voltage ranges. Each topology is rigorously evaluated through detailed simulation analyses and practical hardware validations to ensure compliance with power quality standards and efficiency benchmarks. The integration of solar photovoltaic arrays with bidirectional chargers is also explored, expanding the scope of the research to address energy management challenges and promote sustainability in LEV operations. Additionally, the thesis investigates the feasibility of bridgeless bidirectional chargers, which aim to reduce component count and improve overall efficiency.

Through detailed chapters that provide theoretical insights, practical implementations, and performance evaluations, this research makes significant contributions to the advancement of bidirectional charger technology for LEVs. It highlights the adaptability and effectiveness of the developed chargers across a variety of operational scenarios.

In conclusion, the findings of this thesis underscore the efficacy and adaptability of the developed bidirectional chargers, laying a solid foundation for further research. They pave the way for optimizing the performance of bidirectional chargers, enhancing their integration into smart home ecosystems, and furthering sustainable transportation initiatives.