Adaptive Control for Zero-Voltage Switching of a T-type Bridge in Unfolding-Based AC-DC Converter System (ASPIRE)

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Energy, Environment, & AerospaceElectrical & Computer Engineering

Abstract

A controller method for determining the minimum current and minimum time required for zero-voltage switching in a T-type bridge-based resonant AC-DC converter to maximize efficiency.

Problem

Complications to the soft-switching analysis for grid-tied AC-DC converters make it difficult to achieve zero-voltage switching. This results in loss of energy, increased cooling demands, and electromagnetic interference.

Solution

This technology adjusts the switching of the semiconductor devices to achieve optimal performance of the converter to reduce energy loss, ensure a more stable temperature, and better meet Electromagnetic Interference standards.

Value Proposition

Increased efficiency in power conversion by decreasing energy loss, minimizing space and costs of cooling. Ensures power converters better meet Electromagnetic Interference standards.

Benefit

Grid-tied AC-DC power converters are vital to the growth of renewable energy applications. Single-stage unfolding-based AC-DC converters offer important benefits of efficiency and power density because the low-frequency operation of the unfolder results in negligible switching losses. However, complications to the soft-switching analysis make it difficult to achieve zero-voltage switching.

This problem results in needless loss of energy and ties the system to taxing cooling systems to prevent overheating. The proposed control module and method seeks to address these problems.This control module and method adjusts the switching of the semiconductor devices to achieve optimal performance of the converter. By accounting for various dependent and/or varying inputs of the T-type bridge, ZVS calculations are accurately and consistently provided to the control module to reduce energy loss, ensuring a more stable temperature, and better meeting Electromagnetic Interference standards.

Commercializing this technology will provide increased efficiency in power conversion by decreasing energy loss, minimizing space needed for cooling equipment, and reducing cooling costs. In addition, this control module and method ensures power converters better meet Electromagnetic Interference standards

Market Application

This technology would be of interest to power converter manufacturers looking to increase efficiency, reduce size and cooling load, and better meet electromagnetic interference standards. It would also be of interest to electric vehicle manufacturers, roadway and transportation

departments and corporations, and other parties looking to pursue electric roadway implementation.

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Publications

- Gurudiwan, et al., Accurate ZVS Analysis of a Full-Bridge T-Type Resonant Converter for a 20-kW Unfolding-Based AC-DC Topology, IEEE Open Journal of Power Electronics, May 14, 2024.

Intellectual Property

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