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Efficient Control of a Bidirectional DC-DC Converter for Battery Charging and Discharging in Electric Vehicle Motor Drives

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Abstract

This paper presents a bidirectional DC-DC converter model designed for efficient battery charging and discharging in motor drive applications. The model features state-of-charge (SOC) monitoring, mode detection, and current control using Proportional-Integral (PI) regulators. Simulation results demonstrate seamless power transfer, optimized control strategies, and improved battery lifespan. The control method enhances the performance of both charging and discharging modes, maintaining voltage stability and minimizing power losses. In charging mode, the converter efficiently manages energy flow from external sources or regenerative braking, improving battery utilization. In discharging mode, it ensures a steady power supply to the motor, adapting to dynamic load conditions. The output of the model validates the effectiveness, demonstrating improved

energy efficiency, reduced ripple in torque while connected with the BLDC motor, seamless power transfer, optimized control strategies, and improved battery lifespan, making it a viable solution for energy storage management. Furthermore, the suggested configuration offers high modularity, facilitating easy integration into diverse electric vehicle architectures and scalable energy storage systems. The verification of the results for the recommended and existing models has been performed using MATLAB Simulink. © 2025 IEEE.

Author keywords

battery charging and discharging; bidirectional converter; proportional integral (PI) controller; state of charge

Indexed keywords

Engineering controlled terms

Automotive batteries; Battery management systems; Charging (batteries); DC-DC converters; Dynamic loads; Electric drives; Electric machine control; Electric motors; Electric vehicles; Energy efficiency; Energy storage; Energy transfer; Industrial electronics; MATLAB; Power control; Proportional control systems; State of charge

Engineering uncontrolled terms

Battery charging and discharging; Bidirectional converter; Bidirectional DC/DC converters; Control strategies; Energy; Lifespans; Optimized control; Power transfers; Proportional integral controllers; States of charges

Engineering main heading

Two term control systems

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Abstract

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