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Modeling and Analysis of EV PMSM Drive System under Regenerative Braking Operation with Fault-Tolerant Control

By

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ABSTRACT

This thesis presents modeling and analysis of an electric vehicle (EV) permeant magnet synchronous motor (PMSM) drive system under regenerative braking operation with fault-tolerant control. Accordingly, different electric motors are investigated and compared in this study to determine the merits of every motor and which one could be the best suited for EV applications. The five main types of electric motors explored are: permanent magnet synchronous motor (PMSM), brushless DC motor (BLDCM), induction motor (IM), switched reluctance motor (SRM), and brushed DC motor (DCM). From investigations, the PMSM drive system has been proven to be one of the most applicable for modern EVs. The study and analysis of the PMSM are carried out in the regenerative braking mode of operation using field-oriented control (FOC), which is used to control the bi-directional converter for operating in both motoring and braking modes. The PMSM drive system is modeled with different inverter control techniques, including adaptive hysteresis current controller (AHCC), sinusoidal pulse width modulation (SPWM), and space vector pulse width modulation (SVPWM), to investigate and compare the performance of the motor drive system for each technique.

The thesis then proposes a modified layout of the bi-directional power electronic converter operating in the EV drive system in order to maximize the possible available energy recovered during regenerative braking mode.

Also, this thesis proposes and analyzes fault-tolerant methods for the three-phase PMSM drive system with separate motor windings and independent voltage source inverters (VSI) to show the effect of the proposed technique on the EV drive system during the starting and driving cycle.

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