Fault-Tolerant Control of Permanent Magnet Synchronous Motor Drive under Open-Phase Fault

By

Nada Sayed Abd ELGayed

A thesis submitted in partial fulfillment
Of
The requirements for the degree of

Master of Science

In

Electrical Power and Machines

Department of Electrical Engineering

Faculty of Engineering, Fayoum

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ABSTRACT

This thesis presents an integrated solution for a fault-tolerant three-phase permanent magnet synchronous motor (PMSM) field-oriented control (FOC) drive subjected to open-phase fault (OPF). The proposed solution is integrated with an effective fault-tolerant detection methodology. Fast and accurate methods of detection and fault-tolerance are urgently needed to detect, isolate the fault early, and avoid the destruction of the whole system. The fault detection methodology proposed here is based on model predictive current control (MPCC), which is easy to apply, detects OPF in a range of microseconds, and robust under-speed or load transients. On the other hand, the fault-tolerant compensation technique is based on a neutral point connection together with stator current regulation to maintain the magneto-motive force (MMF) unchanged under open-phase failure. Controlling the motor phase currents in the post-fault condition ensures a rotating magnetic field similar to that produced during healthy conditions thus, reducing the saturation impact and ensuring the reliability of the control operation. In this work, the FOC PMSM drive system with the proposed fault detection and fault-tolerant techniques is validated using MATLAB simulation. The obtained results ensure the effectiveness of the proposed method in steady state and during transients under different loading and rotor speed conditions.