Abstract of Ph.D. Thesis

"Design and Development of Switched Reluctance Motor Drive for Low Power Applications"

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This thesis presents an in-depth examination of design, control and implementation of energy-efficient switched reluctance motor (SRM) drives tailored for low-power applications, emphasizing enhancements in power quality, cost reduction, and facilitation of sensor-less control. This research work explores significant issues related to traditional motor drive systems, focusing on their efficiency, number of components, and their ability to adapt to varying grid conditions. The research commences by elaborating on design and development of a resilient, energy-efficient SRM tailored for low-power industrial exhaust fan applications. A methodology grounded in benchmarks, bolstered by analytical calculations and validated through 2D Finite Element Method (FEM) in Ansys Maxwell, is employed to delineate an optimized motor geometry. The design is experimentally validated through fabrication of a physical prototype, demonstrating its practical feasibility in low-power SRM drive applications. Additionally, exploration of power factor correction (PFC) converter topologies aims to improve input power quality and comply with harmonic standards, specifically IEC 61000-3-2, in context of SRM drive. In order to enhance overall efficiency of the system while simultaneously minimizing expenses, bridgeless PFC converters are utilized in both single-output and dual-output arrangements for asymmetric bridge converter (ABC) and mid-point converter (MPC) powered SRM drives, respectively. Topologies including hybrid Cuk, hybrid SEPIC, integrated Zeta-Luo, and Zeta-Canonical Switching Cell (CSC) converters, are thoroughly developed to meet specific demands of SRM drives across a spectrum of load and supply conditions. These converters function in discontinuous conduction mode (DCM), thereby inherently attaining power factor correction while decreasing the necessity for numerous sensors and complex passive components. Furthermore, SRM drive system integrates a sensorless control strategy with a PFC front-end to improve energy efficiency, power quality, and reduce overall component count. By eliminating Hall-effect sensors and minimizing electrical sensing through simplified estimation algorithms using electrical feedback, system significantly lowers cost and design complexity. This approach delivers high performance while ensuring a scalable and low-cost solution, making it well-suited for low-power, cost-sensitive applications and contributing to advancement of efficient and sustainable motor drives in power electronics.