Switching Device Fault Analysis for Low Voltage Inverters Used in Microgrid

Abstract Submitted

by

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Abstract

This thesis examines the failure mechanisms, detection techniques, and diagnostic approaches for switching devices used in microgrid (MG) low-voltage inverters. The work is organized into many chapters, each addressing a distinct type of problem, inverter configuration, or application situation. The literature review looks at a variety of AC MG converter defect modes and existing failure detection methods, pointing out shortcomings in existing techniques and the requirement for precise, continual monitoring systems for the dynamic MG environment. The main hypothesis establishes that different statistical indicators combined with signal processing techniques like fast Fourier transform (FFT) and discrete wavelet transform (DWT) enable reliable early defect detections in inverters switching components.

The succeeding chapters present focused approaches for identifying faults in diverse inverter systems. Faults in the inverter snubber circuit resistance inside a BLDC motor drive are identified by FFT and wavelet techniques. The thesis investigates early IGBT failure in the 3-Phase voltage source converter (VSC) connected to a photovoltaic (PV) MG and accelerated IGBT switch failures in bidirectional inverters through FFT-based analysis. Additionally, the thesis examines changes in MOSFET's effective resistance in MG H-bridge inverters through FFT-based analysis. Detection of GTO switch failure in a PV-incorporated MG's 3-phase voltage source inverter is achieved through an FFT-based analysis technique. Here, a DWT-based fault detection is proposed for IGBT switch breakdown failures in 3-phase PV-integrated VSCs. An emerging defect detection in snubber circuits in SOFC-fed inverters through combined FFT and DWT-based evaluation is suggested.

This work's innovative feature is the development of fault detection algorithms customized for certain inverter topologies and device kinds. Simulation tests, laboratory evaluations, and comparison with existing methods are used to validate the algorithms' efficacy.