DESIGNING A FAST FOURIER TRANSFORM BASED ISLANDING DETECTION METHOD FOR DC MICROGRIDS

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Degree of Master of Science by Research

Department of Electrical Engineering

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgment any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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ABSTRACT

The scarcity of the natural resources, environmental issues and rising population in the world, demands for innovative concepts, such as microgrids to the modern power system. Nowadays, microgrids are becoming very popular and the most appropriate options to enrich the power system with renewable generation. In addition to that, rapid growth in the DC nature of the loads within the power system is apparent due to the popularity of power electronic devices and recent trends in electrified transportation systems. Hence, researchers are introducing direct current microgrid concepts to the power system, and it has become a highly emerging and trending research area at present. DC microgrids can operate under two main operating modes: grid-connected and islanded operation. The main difficulties of implementing the concept in this concept are the lack of proper international standards, safety features, and protection issues within the systems. Islanding detection is the most challenging and vital requirement in microgrid protection to ensure the safety of the personnel and microgrid equipment and to maintain a smooth and reliable operation of the DCMG. Islanding detection is used to detect the disconnection of the DC microgrid from the utility and switch to proper controls to serve critical loads in the power island.

This thesis presents a novel method of islanding detection for DC microgrids by using Fast Fourier Transform based analysis of DC-link voltage. Further, testing was carried out adopting a 10-kW low voltage DC microgrid with a single-phase bidirectional inverter interface. In addition, a DC microgrid consisting of photovoltaic model with maximum power point tracking, DC loads, AC loads and a battery module with state-of-charge based multi-mode battery management system was modeled. All the modeling and simulations were carried out considering several network configurations and network conditions with the EMTDC/PSCAD v4.2 environment. Simulations were evaluated according to the IEEE 1547-2018 standard. The probabilistic approach was applied to show the robustness of the experimental results of the proposed method.

Keywords: *Battery Management System, DC microgrid, Islanding Detection, Maximum Power Point Tracking.*

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ACRONYMS

BEMS-Battery Energy Management System

DCMG-DC microgrid

DES-Distributed Energy Storages

DQ-Direct and Quadrature axis

EMS-Energy Management System

EPS-Electrical Power System

FFT-Fast Fourier Transform

GWN-Gaussian White Noise

IDM-Islanding Detection Method

IEEE- Institute of Electrical and Electronics Engineers

IoT-Internet of Things

LPF-Low Pass Filter

MPPT-Maximum Power Point Tracking

NDZ-Non-Detection Zone

OSG-Orthogonal Signal Generator

PCC-Point of Common Coupling

PFC-Power Factor Correction

PLCC-Power Line Carrier Communication Method

PLL-Phase Lock Loop

PV-Photo Voltaic

PWM-Pulse Width Modulation

P&O-Perturb & Observe

ROCC-Rate of Change in Current

ROCV-Rate of Change in Voltage

SCADA- supervisory control and data acquisition method

SNR-Signal to Noise Ratio

SoC-Stata of Charge

SPD-Signal Produce by Disconnection

SPWM -Sinusoidal Pulse Width Modulation

TT-Transfer Trip Method

VSC-Voltage Source Converters