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Coordination Control of a Hybrid AC/DC Smart Microgrid with Online Fault Detection, Diagnostics, and Localization Using Artificial Neural Networks

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Abstract: In this paper, a solar and wind renewable energies-based hybrid AC/DC microgrid (MG) is proposed for minimizing the number of DC/AC/DC power conversion processes. High penetration rates of renewable energy increase MG instability. This instability can be mitigated by maintaining a balance between consumption demand and production levels. Coordination control is proposed in this study to address coordinated electricity flowing through both AC and DC links and to achieve system stability under variability of generation, load, and fault conditions. The MG adopts a bidirectional main converter that is controlled using a digital proportional resonant (PR) current controller in a synchronous reference frame. The PR controller plays a role as a digital filter with infinite impulse response (IIR) characteristics by virtue of its high gain at the resonant frequency, thereby reducing harmonics. Moreover, the applied PR controller quickly follows the reference signal, can adapt to changes in grid frequency, is easy to set up, and has no steady-state error. Moreover, the solar photovoltaic (PV)-based distribution generation (DG) is supported by a maximum power point tracker (MPPT)-setup boost converter to extract maximum power. Due to the usage of converter-connected DG units in MGs, power electronic converters may experience excessive current during short circuit faults. Fault detection is critical for MG control and operation since it empowers the system to quickly isolate and recover from faults. This paper proposed an intelligent online fault detection, diagnostic, and localization information system for hybrid low voltage AC/DC MGs using an artificial neural network (ANN) due to its accuracy, robustness, and quickness. The proposed scheme enables rapid detection of faults on the AC bus, resulting in a more reliable MG. To ensure the neural network's validity, it was trained on various short circuit faults. The performance of the MG was evaluated using MATLAB software. The simulation findings indicate that the suggested control strategy maintains the dynamic stability of the MG, meets the load demand, and achieves energy balance as well as properly predicts faults.

Keywords: microgrid; proportional resonant controller; artificial neural network; fault detection; fault classification; inverter control; maximum power point tracker

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1. Introduction

Environmental pollution and a slew of other issues have gained prominence in recent years as a result of widespread reliance on fossil fuels that may run out by the end of the century. To address this dilemma, environmentally friendly renewable energy is harnessed and converted into electrical energy, which not only diversifies energy consumption but also reduces reliance on fossil fuels for power generation. This energy is generated through a variety of long-term sources, including solar, wind, and other renewable sources, all of which are increasingly being used to power MGs. Among other characteristics, a