Abstract

This doctoral dissertation proposes an innovative solution for protecting medium-voltage microgrids, particularly those operating as controlled islands. According to the technical requirements of individual polish distribution system operators, the islanded operation of generating units connected to the public grid is currently prohibited. However, with advancements in renewable energy sources, this approach may change in the future. In the aspect of islanding, particularly with inverter-based generation sources (e.g., photovoltaic or wind farms), ensuring the proper operation of power system protection devices can be challenging. These challenges are mainly related to low fault current levels, variability in fault current flow directions, and the ambiguity of the response of inverter-based distributed generation sources to disturbances in network parameters (voltage, frequency). As a result, the existing, well-established protection criteria cannot operate effectively under these conditions, leading to failures in detecting faults. Therefore, the primary goal of this study was to develop protection criteria specifically tailored to function in these unique scenarios. The research focused on adaptive power system protection, a technique that automatically adjusts settings and active protection criteria based on the microgrid's topology. Key factors include whether the microgrid is connected to the power system and the number and types of distributed generation sources it contains. Modern protection criteria were developed using simulation models of medium-voltage networks. These models were based on real parameters and represented a fragment of an actual network. Control algorithms for distributed generation sources were also created. These algorithms enabled the simulation of disturbances in microgrids, both when connected to the power system and when operating as controlled islands. Based on the conducted research, an adaptive protection algorithm was developed along with detailed guidelines for its implementation.

Keywords: microgrids, distributed generation, island operation, power system protection, adaptive protection, setting banks.