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Editorial

Protection and Communication Techniques in Modern Power Systems

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The protection systems of modern grids are facing new challenges and opportunities due to the development of future Smart Grids. The complexity of the system increases when the share of distributed renewable energy sources increases. Simultaneously, the new communication technologies enable new kinds of solutions for protection. Modern society is becoming increasingly dependent on the continuous supply of electricity. For this reason, it is essential that the faults in the system are detected, located, and isolated as soon as possible to enable the continuation of the power supply to the healthy parts of the system. This is enabled by intelligent electronic devices (IEDs) supported by fault indicators and other types of devices providing information about the system status. In the Smart Grid context, this means that also various information and communication systems are involved, forming also a critical layer for the overall system.

This Special Issue includes five papers with a wide variety of topics related to protection, fault location, and communication techniques applied in modern grids. In what follows, the papers in this Special Issue are briefly summarized.

Differential protection is perhaps the most efficient protection method, enabling a high speed and absolute selectivity. Considering the Smart Grid environment, a clear benefit is also the capability to handle the multi-directional flow of fault currents. However, when implementing the line differential protection, a high-speed communication network is needed. The design aspects of the communication network applied in line current differential protection (LCDP) are discussed in [1], including the communication mode, topology, communication protocol, and synchronization. The paper also studies the impact of the communication network to the transmission quality criteria (speed, jitter, etc.). Furthermore, some interesting simulation studies are presented applying a co-simulation environment.

Earth fault location in non-effectively earthed medium-voltage distribution networks is as challenging task due to a relatively small fault current. Paper [2] proposes two new methods for locating the single-phase to earth faults applicable in both neutral isolated networks and networks using the Petersen coil. The methods are developed utilizing the theory of symmetrical components, and the performance of the methods is demonstrated by the simulations.

The fault detection and location are especially difficult, with high impedance faults. A solution for this problem is introduced in paper [3]. The proposed method uses overcurrent relays for detecting the faulted section and fault recordings from data loggers placed in the network to define the accurate fault location. The method is based on travelling waves, and for processing the measured data, discrete wavelet transform is applied.

Many of the fault location methods require the accurate information of the network, especially the line parameters. A parameter-free solution for faulted section detection is presented in [4]. The proposed method applies an advanced deep learning-based method. The method requires a large number of fault scenarios for training the neural network, and those can be generated by simulations. According to the results presented in the paper, the proposed methods appear to be robust, but at the end, only one test network was used for validating the performance.

The challenges of overcurrent protection in networks containing renewable energy sources are discussed in [5]. It focuses on a case where the local grid of the energy community is connected to the main grid via a single medium-voltage line. The paper claims that

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there is the possibility of a delayed operation of the relays when the connecting line has an initially very low current. This is illustrated by simulation studies employing a detailed model of digital protection relay.

As a summary, the papers in this Special Issue clearly focused on a few specific problems arising in modern power systems. There seems to still be a need for better and more accurate methods to detect and locate the fault, especially in cases where the fault current itself is very low. It also appears that the challenges arising from the introduction of local renewable generation provide good opportunities for new protection solutions. In general, it is also evident that many of the proposed solutions require collecting data from different locations, which means that suitable communication solutions are required. In this field, there is still a lot of room for further studies.

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