Observability of Power-Distribution Systems: State-Estimation Techniques and Approaches

Springer, cop. 2020. XV, 116 pp., illus. ISBN 978-3-030-39475-2. ISBN 978-3-030-39476-9.

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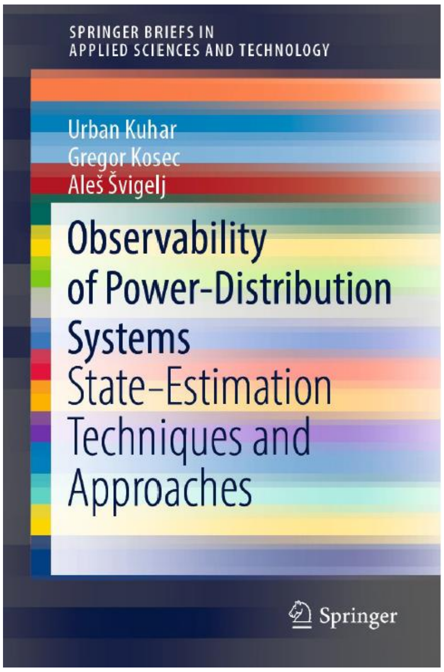

Electricity has an enormous influence on our daily lives and the economic development of society. As a result, the efficient transmission and distribution of electricity are fundamental to our health and well-being. Primarily because of the growth in distributed energy resources, the flow of electricity from utility to consumer has become a two-way street. With such a change in our power-distribution systems, we will increasingly rely on the real-time observation and control of the electricity system to ensure its safe and reliable operation in the future. A distribution system's state estimation represents a crucial part of ensuring observability in smart-grid systems. This book describes the design and implementation of a three-phase state estimation that is suitable for power-distribution networks. It gathers all relevant state-of-the-art knowledge and provides the missing pieces to offer readers a complete picture of several essential design and implementation factors and ways to address them.

The modelling of all the major power-distribution components to enable a three-phase network model's construction is described; sensitivity analyses showing how uncertain conductor lengths influence the state-estimation results are presented.

A three-phase DSSE that can incorporate heterogeneous measurement types was developed. Several different state-estimation algorithms, robust and non-robust, were reviewed and compared based on their statistical efficiency and computational speed.

The developed DSSE with all the implemented estimation norms (WLS, SHGM, and LAV) was evaluated for the sensitivity of the state variables to model and measurement uncertainties. The presented sensitivity analysis enables a sensitivity evaluation of the chosen state estimation algorithms and the measurement configuration. It was shown that this is highly desirable, as it enables an informed choice about the most suitable state-estimation algorithm based on the configuration of measurements and the accuracy of the system model The presented lower and upper interval bounds give a clear indication of the performance of the state-estimation system that can be expected with the given accuracy of the model parameters and measurements.