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Voltage and Current Sensor for State Estimation in Distribution Network with Generation

C. Gouveia[1], H. Leite[1] and I. Ferreira[1]

[1] Department of Electrical Engineering
FEUP, Porto University
FEUP, Rua Dr. Roberto Frias, s/n 4200-465 Porto PORTUGAL,
e-mail: **cgouveia@fe.up.pt**, **hleite@fe.up.pt** , **imf@fe.up.pt**.

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Abstract

The penetration of Distributed Generation (DG) into the distribution networks has been increasing during the last decades. However, the increase of generation brings additional technical challenges for the Distribution Network Operators (DNOs). Thus, the integration of DG along with the improvement of the quality of service is driving the DNOs to actively control their networks. In order to achieve an effective control of the distribution network it is necessary to know the voltage across the network. Due to the lack of the real-time voltage measurers available onto the distribution network it would be necessary to estimate the voltage.

Thus, as mentioned, the implementation of a state estimation method in distribution network is challenging due to the lack of real-time measurements available. The measurements considered in the distribution state estimation methods are predominantly off-time estimations of loads and therefore named pseudo measurements. However, estimate loads at the Low Voltage Switching Board are extremely difficult.

To improve the quality of the distribution state estimation results, more real-time measurements are needed. However, the more measurements placed in the distribution networks the greater is the investment from the DNOs. Consequently, a trade-off between voltage accuracy, reliability and cost is required.

Measurement placement method can be a solution to find the optimal compromise on the number of real-time measurement and consequent voltage accuracy. New types of measuring equipment such as voltage and current sensors can also help to reduce the initial investment costs. These sensors are considered in this work and are used for both protection and measurement functions. Also, these sensors can be directly connected to the communication equipment and thus resulting in a reduction of the number of system components and wiring.

This paper presents both a method to place voltage and current sensors across the MV network and a distribution state estimation algorithm. The single-phase distribution state estimation algorithm determines the voltage magnitudes across the MV network and their associated accuracy. The state estimation algorithm integrates real-time current measurements from the current sensors at the network, the DG site and the MV busbar at the primary substation site. The distribution state estimation algorithm is based on the weighted least squares approach.

To minimize the estimated voltage inaccuracy, the placement method determines the best location for a minimum number of voltage and current sensors. The results showed that current and voltage measurement together can improve the estimated voltage magnitude accuracy.

The method to place voltage and current sensors along with the distribution state estimation algorithm may allow distribution network operators to actively control their network and thus increase the amount of generation onto their distribution networks with an improvement in power quality.