Islanding Detection of a Distributed Generation System using angle between Negative Sequence voltage and current

Javeed Bashir, Premalata Jena, Member, IEEE, Ashok Kumar Pradhan, Senior Member, IEEE

***Abstract*: This paper proposes a new passive local islanding detection technique for a distributed generation (DG) system connected to a utility grid. In the proposed method the absolute value of angle between the negative sequence components of voltage and current is estimated at the DG end and is used to recognize the islanding condition. The conventional passive methods have the drawback of non-detection zone (NDZ). The active islanding detection methods introduce disturbance in power system. A micro grid system is simulated using PSCAD/EMTDC software. Several test cases are generated to test the performance of the proposed technique.**

Keywords: Active power mismatch, distributed generation (DG), micro-grid, rate of change of frequency (ROCOF).

I. INTRODUCTION

Distributed power generation systems are becoming more common as a result of the increased demand for electricity and the requirement to reduce the impact on the environment from traditional sources of power production in which fossil fuels or nuclear fuel are commonly used. With distributed generation integration with the main utility, the main issue is the islanding situation [1]. Islanding operation occurs when DG continues to supply power to the network even if power is interrupted from the main grid [2]. Islanding is a situation in which a distribution system becomes electrically isolated from the remainder of the power system, due to a fault at upstream side or any other disturbance, and yet continues to be energized by the DG connected to it.

Several researchers have proposed many methods for islanding detection. There are four types of islanding detection techniques: 1) passive, 2) active and 3) communication based and 4) hybrid techniques. Monitoring of the different system parameters like voltage, frequency, impedance, THD at any desired location comes under the passive techniques in which these parameters are compared with the pre-specified threshold to decide about the islanding. Passive methods are preferred, since they use the information that is available on the DG without influencing the normal operation of the DG. The major demerit of passive techniques is dependency on threshold values.

For higher threshold value, islanding situations may not detected properly and for lower threshold value other non-islanding conditions may be treated as islanding condition. Various passive methods that have been presented so far are over/under voltage [4]-[5], the rate of change of frequency (ROCOF) [6], the rate of change of power (ROCOP) [7]-[8], total harmonic distortion of current [9]-[10], the rate of change of voltage (ROCOV) [11] and the phase shift method [12]. In case of active method, a small disturbance is intentionally introduced into the system and upon the feedback it can be determined whether islanding occurs or not. But a large change in the system parameters will occur in case of islanding as the main utility is absent. Active islanding methods have very small NDZ. But the quality of the power is distorted due to the injection of external disturbance. Some of the islanding methods are slip-mode frequency shift, active Frequency Drift, current injection and voltage shift method [13]-[16] in case of communication based technique, communication based islanding detection methods depend on the communication links between the DGs. This method has negligible NDZs along with the highest possible accuracy but the drawback is that it is most expensive as it requires the high speed operation.

In this paper, a passive islanding detection method is presented using the absolute value of the angle between the negative sequence voltage and current at the DG end. The voltage and current data are sampled at a sampling frequency of 1 kHz. Least square based technique is used to calculate the voltage and current phasor. The negative sequence components of voltage and current are calculated. Islanding condition is identified by estimating the absolute value of the angle between negative sequence voltage and current. The proposed method work well during zero power mismatch. Performance of the technique is tested for islanding and different non-islanding conditions like capacitor switching, load switching, etc. at the DG terminals.

II. THE SYSTEM STUDIED

A radial distribution system (25 kV, 50 Hz) as shown in Fig. 1 is considered. In this system, 10 MVA is taken as the base power. The distribution system has 4 DG units which are connected to the grid through point of common coupling (PCC). 25 kV is the operating voltage at the DG units having a distance of 20 km with transmission lines of pi sections. The description of the components of the system which are taken from the reference [20] is shown in the appendix.

III. PROPOSED TECHNIQUE

The non-islanding and islanding voltage and current data are collected at a sampling rate of 1 kHz. Phasor estimation for the voltage and current is done by the least square method. The negative sequence voltage and current after the islanding are

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