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Combining two techniques to develop a novel islanding detection method for distributed generation units

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ABSTRACT

Renewable energy is a fast-growing sector given that it does not cause the pollution produced by nuclear and fossil generation systems. The use of renewable energy for distributed generation (DG) is important worldwide not only because it increases profits but also because integrating it into utility systems ensures power supply at points of consumption even when a DG system is disconnected from the main system. Researchers continue to exert efforts in improving islanding detection methods because current detection approaches remain unsatisfactory. Accordingly, this paper presents two new islanding detection methods that are suited for single and multiple DG units. The methods are based on the rate of change in active and reactive power, frequency, and voltage angle. They are tested on single and multiple DG systems with wind turbines and simulated using the Power World Simulator software. The simulation results show that the methods effectively reduce the time spent on islanding detection and efficiently decrease non-detection zones. To verify the accuracy and speed of the proposed methods, the results are compared with those achieved by different islanding detection approaches.

1. Introduction

A distributed generation (DG) system is a small-scale unit fixed to a load unit and connected to a grid so that energy can be sold or bought. One of the major problems associated with the interconnection of DG and utility systems is islanding, which is the process in which the power supplied by an auxiliary utility system is turned off, but part of the core utility system remains operational because of the power produced by a distributed generator. The operational component is called an island. The unintentional creation of an island stems from utility system defects that result in the opening of the breaker in the upper part of a grid [1]. Current environmental problems have prompted the rapid development of energy storage technologies, with manufacturers and researchers now focusing on alternative energy sources that can serve the electrical needs of society [2]. The power generated from these sources is transmitted to various grids through the use of grid converters. In this regard, the major issue for consideration is the ability of a generator to identify an islanding situation upon connection between DG and utility systems [3].

When part of an auxiliary utility system with distributed resources and load remains in an energized state even when disengaged from the core utility system, this phenomenon is referred to as islanding [4]. In accordance with IEEE standards, all distributed generators should be disconnected immediately after an island forms [5]. Islanding can be intended or unintended; it can originate from a pre-planned event [6]. That is, in maintenance work during unintended islanding, a distributed generator is meant to be disconnected in 2 s; exceeding this period may result

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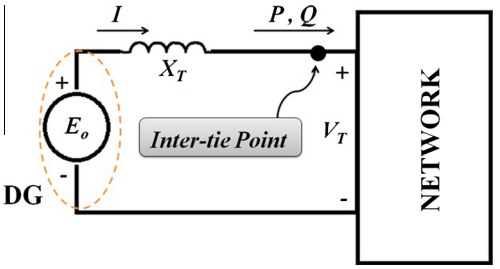

Fig. 1. Equivalent circuit of network with DG unit.

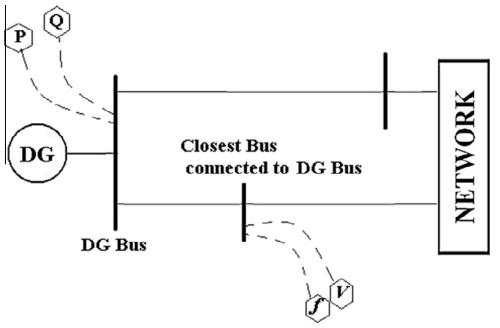

Fig. 3. Configuration of multivariable islanding detection method.

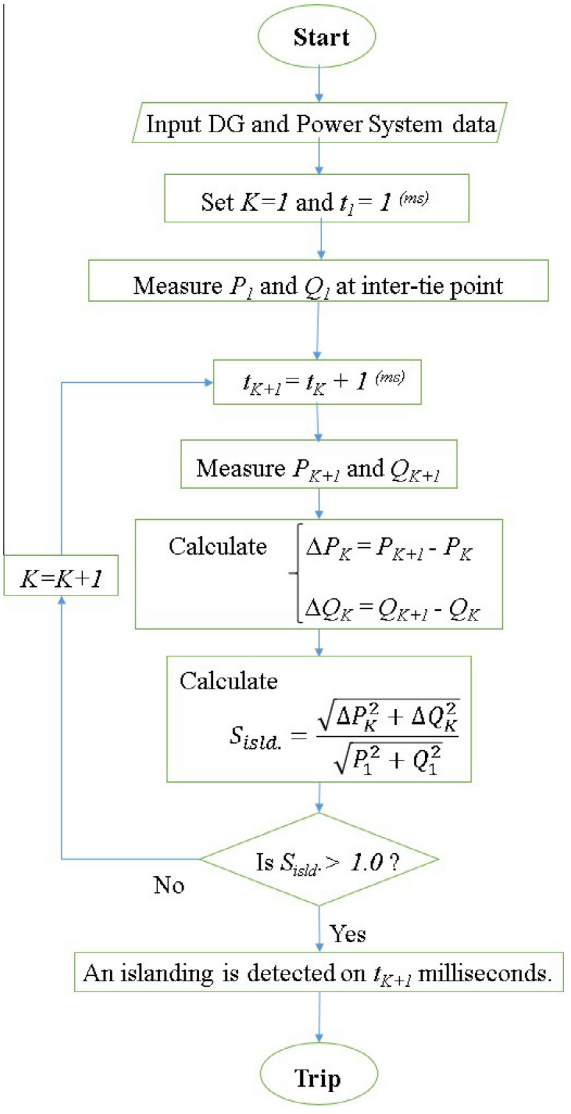

Fig. 2. Flowchart of the first proposed method for islanding detection.

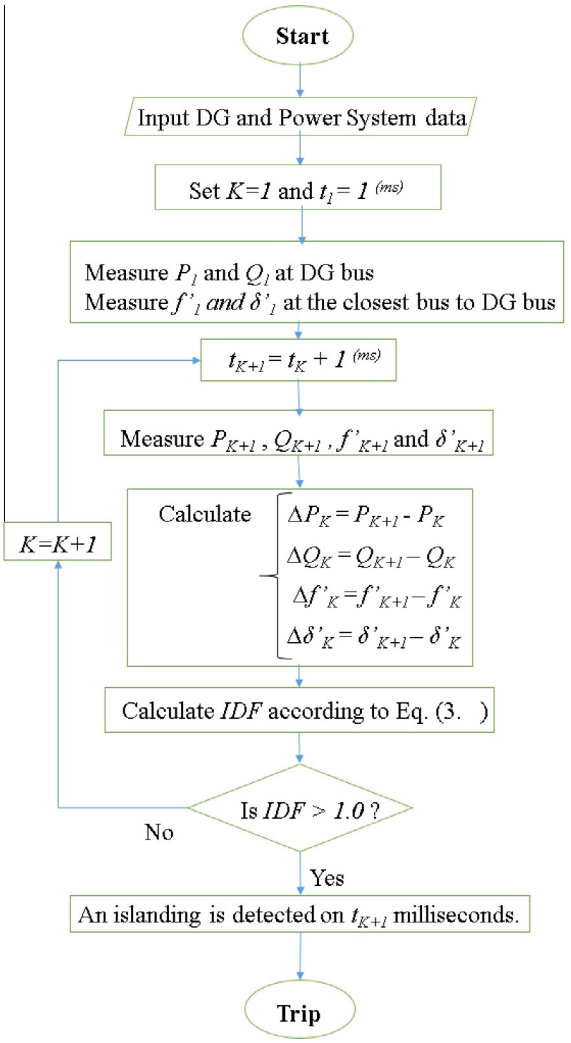

Fig. 4. Flowchart of proposed multi-variable method for islanding detection.

in grid failure [6]. The various approaches to island detection can be classified into three groups: active, passive, and hybrid methods [7].

In passive methods, alterations in voltage, frequency, phase shift, and harmonics should be examined for island formation to be detected [8]. With passive approaches,