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DIFFERENT METHODS FOR DG ANTI-ISLANDING PROTECTION

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ABSTRACT

For better power quality and reliability, the power industry are focusing to distributed generations i.e. DG. New technology like photo voltaic (PV), fuel cell, wind turbine, and new innovation in power electronics generating powers but cannot provide quality and reliability and customer required both. Hence distributed generation (DG) is advance research area in the power industry due to market deregulations and environmental concerns. This paper provides the overview on existing Different methods for DG anti-islanding Protection.

KEYWORDS: Distributed Generations, Photo Voltaic (PV), Fuel Cell, Wind Turbine, Anti-Islanding.

INTRODUCTION

Distributed Generators (DG) is becoming new trade because of many benefits like small scale generation which provides to power utilities, but in this islanding detection and prevention is more critical. Islanding is the situation in which a distribution system becomes electrically isolated from the remainder of the power system, yet continues to be energized by DG connected to it or in simple word Islanding is a condition where the DG supplies power and is not under the direct control of the utility. Islanding condition creates safety hazard and may cause damage to power generation and power supply facilities. Islanding detection methods are classified into two main groups, as shown in figure 1, first one is *Active Method*, this methods interact with the system operation and this practically done by injecting a distorted current waveform, using a frequency pattern, or by varying the output power of the DG continuously and second one is *Passive Methods* techniques depend on measuring system parameters and setting thresholds for the measurable parameters. When islanding detection method fails to detect islanding is known as the non-detection zone (NDZ). Active Methods are characterized by small NDZ and include active frequency drift (AFD), output power variation and slip mode frequency shift (SMFS), and etc and commonly applied to inverter based DGs. Whereas the passive methods suffer from large NDZ, designing a passive islanding detection method is to choose the most significant parameter and its threshold value to detect islanding for almost all loadings while avoiding nuisance tripping [2]

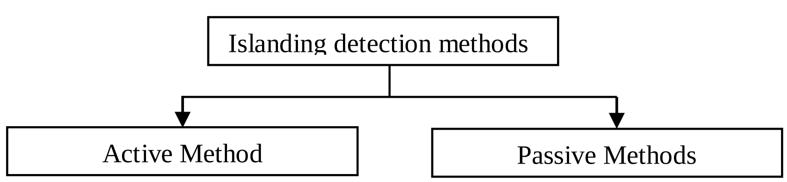

Figure 1 Islanding detection methods.

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MATERIALS AND METHODS

M. Bakhshi and R. Noroozian [4] designed reactive power based anti-islanding scheme for synchronous distributed generators. This proposed system used a new passive-based islanding detection method, which are based on measuring local parameters of DG and comparing it with preset value and also used in both traditional and smart grids i.e. the whole operations are based on digital technology. This method works according to change in ∂VDG ∂QDG index. Islanding detection methods in the distribution networks are based on passive techniques i.e. direct (itself of signal) or indirect (existing energy in the harmonics of the signal) commonly, parameters such as frequency, voltage, active power, etc. ROCOV index is nothing but the rate of change of voltage over time and it is one of the islanding detection methods for DGs in the distribution networks. In this paper proposed method has been compared with the ROCOV relay.

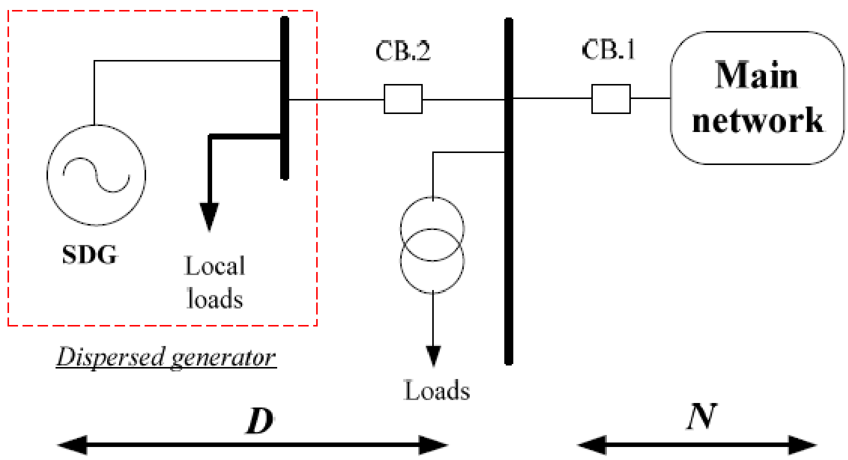

Figure 1. Overall schematic of main network and distributed generating unit [4]

As shown in the Figure 1, where *N* represents main network and *D* represents distributed generator and local loads. Aforementioned index is obtained in the normal operation, when CB1 and CB2 are normally closed and relation can be written as

$$QN + QD = -QL \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)[4]}$$

$$\frac{\partial Q_D}{\partial V_D} = \frac{\partial Q_L}{\partial V_D} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2) [4]}$$

To obtain the mentioned indicator, equation (2) should be solved in both islanding and parallel operation. If we consider the parallel operation i.e. the both sides are electrically connected so there is a load change of ∂QL occurs in *D* side. That is

$$\partial VN = k.\partial VD \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)[4]}$$

In the equation 3 main network voltage and DG voltage have proportional relation where k is constant coefficient.

$$\frac{\partial Q_D}{\partial V_D} = -\left(\frac{\partial Q_N}{\partial V_D} + \frac{\partial Q_L}{\partial V_D}\right) \Rightarrow \frac{\partial Q_N}{\partial V_D} = k\frac{\partial Q_N}{\partial V_N} \Rightarrow \frac{\partial Q_D}{\partial V_D} = -\left(k\frac{\partial Q_N}{\partial V_N} + \frac{\partial Q_L}{\partial V_D}\right) \ldots\ldots\ldots\ldots \text{(4)[4]}$$

When we compared equation (2) with (4) it is found that the same loading variations of *D* side, the computed value of ∂VD ∂QD under various situations can be different. This proposed method, monitors both voltage and reactive power of DG and calculates the detection index and detects the islanding situation. In the proposed method, signals is converted to the discrete type for this the zero order hold filter was used. In the second step discretization process, which calculate the detection index. On two different power system and under different islanding and non-islanding

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occurrences, proposed approach was successfully tested. After the testing result shows that the proposed method even though the zero percent of the reactive power mismatch whereas the ROCOV relay cannot detect this situation.

Walmir Freitas et al. [1] present a simple and reliable method for predicting the islanding detection performance of vector surge relays for Distributed Generation Applications. This paper mainly focuses on the development of analytical formulas for directly determining the behavior of vector surge relays. Vector surge relay is selected as the study subject in this paper because it is one of the most sensitive frequency-based anti-islanding devices. Figure 2 show that synchronous generator equipped with a vector surge relay VSR operating in parallel with a distribution network is depicted. Voltage drop is denoted by ΔV between the terminal voltage V_T and the generator internal voltageE_I due to the generator current I_{SG} passing through the generator reactance X_d. Consequently, there is a displacement angle Ϭ between the terminal voltage and the generator internal voltage. The simulation results of that paper validate the method proposed in this paper for the performance evaluation of vector surge relays. At the time of constant power loads the analytical formula itself can be well applied. Hence the final the formula becomes

$$t = \frac{-\left(2\omega_o K\left(\alpha-\pi\right)\right)-\sqrt{D_1}}{2K^2\left(\alpha-2\pi\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots.. \; 5[1]$$

Where, D1= $D1=\left(2\omega_o K\left(\alpha-\pi\right)\right)^2-4K^2\left(\alpha-2\pi\right)\left(\omega_o^2\alpha=2\pi^2K\right)$ and $K=\omega_o\left(\Delta P_0\right)^{(1/Pfac)}/2H$

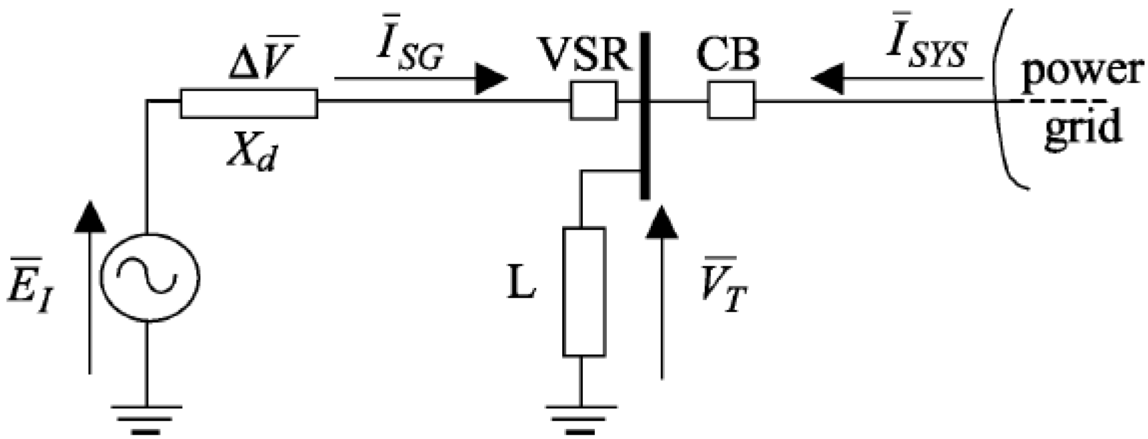

Figure 2. Equivalent circuit of a synchronous generator in parallel with utility [1].

M. R. Alam et al. [3] proposes a multifeature-based technique for islanding detection in the subcritical region, defined as a sub region of the NDZ i.e. non-detection zone. Vector surge i.e. VS relay are usually used to detect islanding but there is a non-detection zone (NDZ), which are undetectable by VS relays. In this method, features are extracted from five network variables, which are used as inputs to a support vector machine to classify the event as islanding or non-islanding. The MULTIFEATURE-BASED ISLANDING DETECTION method is worked in three sub-sections, in the first one Sub-section is the process of extraction of network variables and features associated with islanding and nonislanding events, in the second sub section SVM (Support vector machine) is used to the classification of two groups of data or variables which are extracted from the five different networks, and in the final subsection detection of islanding is presented.

In the first sub-section five variables are extraction. These are *f*: normalized frequency, $p_f = {df}/{dt}$: rate of change of frequency, θ : normalized phase angle of voltage, V : normalized voltage, and $p_f = {dV}/{dt}$ rate of change of voltage. In the second step, SVM classifier is first trained off-line by taking the input features associated with all possible scenarios of islanding and nonislanding events which may exist in DG networks, figure 3 shows Flow chart for detection of islanding and table 1 and 2 shows the islanding detection using an SVM classifier with linear kernel and different kernel respectively.

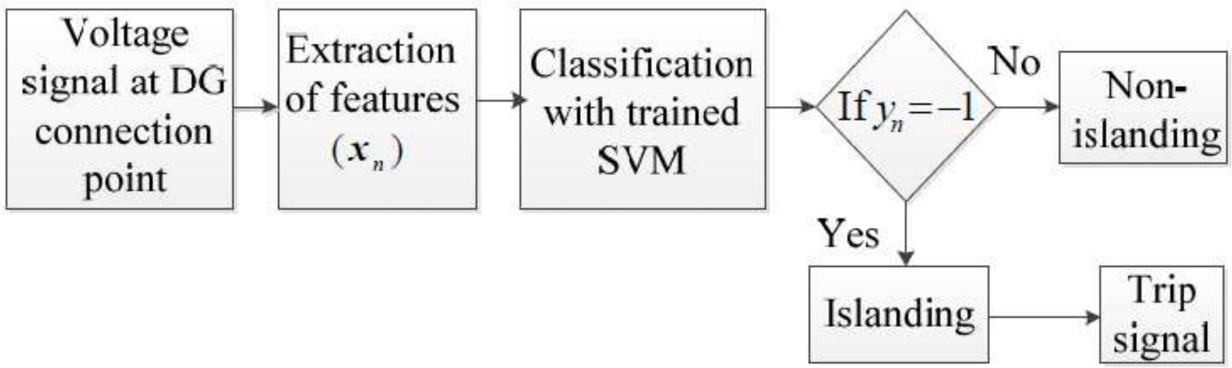

Figure 3 shows Flow chart for detection of islanding [3].

Table 1 Islanding detection using an SVM classifier with linear kernel [3]

Type of load	Deficit and excess		Detection Rate	False alarm
	ΔP(%)	ΔQ(%)		
Constant P	0-45.8	0-50	99.64%	0.63%
	0-100	0-50	99.72%	
Constant I	0-58	0-50	100%	2.5%
	0-100	0-50	100%	
Constant Z	0-66	0-55	100%	2.5%
	0-100	0-50	100%	
Constant Z, P and I	0-100	0-50	99.91%	1.88%

Table 2 Islanding Detection using SVM Classifier with Different Kernels [3]

Kernel	Parameter Value	SVs	Detection Rate	False alarm
Gaussian RBF	$\sigma = 1$	42	97.3%	0.4%

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Polynomial	$p = 2$	18	98.3%	0.2%

CONCLUSION
Anti-islanding protection is an important requirement which has to be considered prior to the integration of distributed generation into electricity grids. This paper provides the overview on existing Different methods for DG anti-islanding Protection.

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