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INVERTERS CURRENT FREQUENCY DEVIATION BASED ISLANDING DETECTION IN GRID CONNECTED PHOTOVOLTAIC SYSTEM

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ABSTRACT
The protection schemes of distribution systems are usually designed under the assumption that power flows from the substations to the end users.The utility system contains both load and generation in which part of the system is isolated from the rest of the system is the islanding condition. Power-quality problems, interference with grid protection devices, equipment damage, and even personnel safety hazards are the causes of unintentional islanding.In the proposed method, the q-axis current in the inverter is measured and the current controller is modeled with a continuous periodic Reference power from a small value. The possibility of false detection is eliminated through the affirmation of the occurrence of islanding as soon as it is suspected. DG is a islanded from the upstream system, if the frequency variation is occur in a small value due to a change in the inverter current. The proposed algorithm detects the island grid formation in the stable condition of the system. Computer simulation is done with MATLAB.

KEYWORDS: Distributed Generation, solar energy, inverter, Islanding detection, microgrid

INTRODUCTION
The risk of islanding has been an impediment to DG interconnection, particularly when the degree of DG penetration into a system becomes sufficiently large to allow a near balance between DG capacity and local off-peak load. The nature of the distribution system traditionally radial and unbalanced. Islanding occurs when a part of the distribution system is electrically isolated from the rest of the power system, continue to be excited of decentralized producers to the subsystem is isolated. This is also known as a loss of power or loss of the grid. Due to the decline in the availability of fossil fuels, there was a growing interest in the research of new energy sources[1]. DG technologies include the photovoltaic, wind power, fuel cells, micro-turbines, gas turbines and internal combustion engines, etc.Hence, DG can fulfil customer's demand in stand-alone as well as grid-connected mode as per situation requirements and the surplus power generation can be fed to the grid thereby increasing the reliability of power supply. With low penetration of DGs, the system impact might be negligible. But as penetration level increases, the impact will become significant and DG inclusion in distribution system may lead to difficulties in control, protection, harmonics, network transients, etc. Also, the undesirable environmental characteristic variations in wind speed and solar radiations make wind and PV power generation unreliable and on the other hand, create PQ problems.

There are a few issues regarding the connection of these resources for supply companies and the interconnection can be complicated many benefits with connection with electric power system. The islanding detection methods can be roughly divided into active and passive and communication on the basic techniques. Passive Methods have been proposed in the first phases when the interconnection of the DR with EPS has begun. Under/overvoltage (EIA/OVP)[7] and Under/Over Frequency (UFP/OFP) protective relays are on the distribution of allocations for various types of abnormal conditions. Phase jump detection (PJD) method includes the monitoring of the phase offset between the voltage at the PCC and the converter output current. This method is used for current source inverter [2]. In the case of voltage inverter phase shift between the current at the PCC and the converter output voltage is observed.

Detection of voltage unbalance and Total Harmonic Distortion method proposes two parameters for detecting the islanding condition of the GD: voltage unbalance and the Total Harmonic Distortion (THD) of the current[6,8]. In active methods fault signal is on certain parameters on the PCC, so that islanding condition can be detected. Active methods have a certain kind of feedback technology or control mechanism that detects changes in either the incidence or the voltage at the PCC.

Impedance method is if utility is disconnected, this variant will force detectable change in voltage at the PCC, which can be used to detect islanding condition. The method is also known as the impedance measurement method [4].The most important feature of this method is relatively small NDZ for individual inverters for all local shops. This method shows poor results when several inverters are connected.Islanding protection is the most important issues to address in DG applications. The islanding is defined as a condition in which a portion of an electric power system is solely energized and separated from the rest of the electric power system. Power utilities invest huge money for expanding transmission and distribution of power supply because of the fast growing demand of electric energy[10]. Unpredictable islanding of distributed power generation system may result in electrical damage to customer equipment, poor power quality, and even safety hazards for humans. For these reasons, it is necessary to detect the islanding condition quickly and reliably.

The paper is organized as follows. Section II presents the Grid connection of solar panel. Section III presents the proposed islanding detection method. Section IV providessimulation results that highlight the performance of the proposed islanding detection technique. Lastly, conclusions are drawn in Section V.

GRID CONNECTION OF SOLAR PANEL

Wind turbines are also distributed energy resources. These have low maintenance, low pollution, and also low costs. However, as with solar, wind energy is variable and non-dispatchable. Photovoltaic, by far the most important solar technology for distributed generation of solar power, uses solar cells assembled into solar panels to convert sunlight into electricity. It is a fast-growing technology doubling its worldwide installed capacity every couple of years. PV systems range from distributed, residential, and commercial rooftop or building integrated installations, to large, centralized utility-scale photovoltaic power stations.

The predominant PV technology is crystalline silicon, while thin-film solar cell technology accounts for about 10% of global photovoltaic deployment. PV technology has improved its sunlight to electricity conversion efficiency, reduced the installation cost per watt. As most renewable energy sources and unlike coal and nuclear, solar PV is variable and non-dispatchable, but has no fuel costs, operating pollution, mining-safety or operating-safety issues.[9].

Wind towers and generators have substantial insurable liabilities caused by high winds, but good operating safety. Inverters take DC power and invert it to AC power so it can be fed into the electric utility company grid.

The grid tie inverter must synchronize its frequency with that of the grid (e.g. 50 or 60 Hz) using a local oscillator and limit the voltage to no higher than the grid voltage. A high-quality modern GTI has a fixed unity power factor, which means its output voltage and current are perfectly lined up, and its phase angle is within 1 degree of the AC power grid. Distributed energy, also district or decentralized energy is generated or stored by a variety of small, grid-connected devices referred to as Distributed Energy Resources (DER) or distributed energy resource systems. Distributed energy resources are mass-produced, small, and less site-specific. Their development arose out of:

- Concerns over perceived externalized costs of central plant generation, particularly environmental concerns,
- The increasing age, deterioration, and capacity constraints upon T&D for bulk power;
- The increasing relative economy of mass production of smaller appliances over heavy manufacturing of larger units and on-site construction;
- Along with higher relative prices for energy, higher overall complexity and total costs for regulatory oversight, tariff administration, and metering and billing.

The inverter has an on-board computer which will sense the current AC grid waveform, and output a voltage to correspond with the grid. However, supplying reactive power to the grid might be necessary to keep the voltage in the local grid inside allowed limitations. Otherwise, in a grid segment with considerable power from renewable sources

The system composed of 3-phase, 560V, 50 Hz generating system,feeding power to the load by using above system parameters. The proposed islanding detection method is carried out using simulation. The three phase voltage is applied to the system and the corresponding waveform is shown in Fig-3. The normal three phase sine waveform is obtained. Under normal conditions, the frequency is not varied and corresponding waveform is shown in Fig-4.

Table-1 System Parameters

S. No	SYSTEM QUANTITY	SPECIFICATION
1	Source	3-phase, 560V, 50 Hz
2	Inverter specifications	MOSFET Based, 3 Arms, 6 Pulse, Carrier Frequency=1080Hz, Sampling time=5µs
3	PI controller	K_p=0.5, K_i=50, Sampling time=50µs
4	Grid	3-phase, 560V, 50 Hz
5	Load	10KW, 100VAR

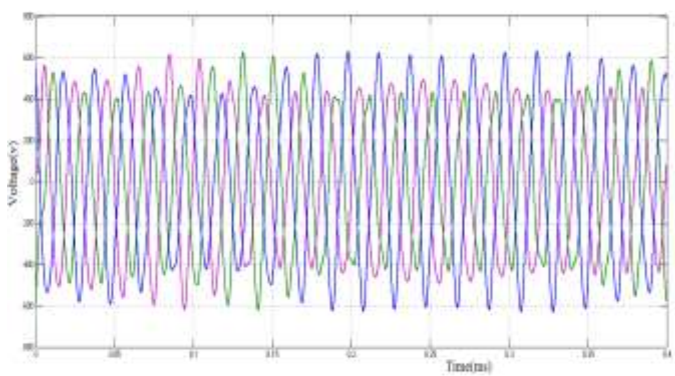

Fig-3 Voltage at PCC under Normal Condition

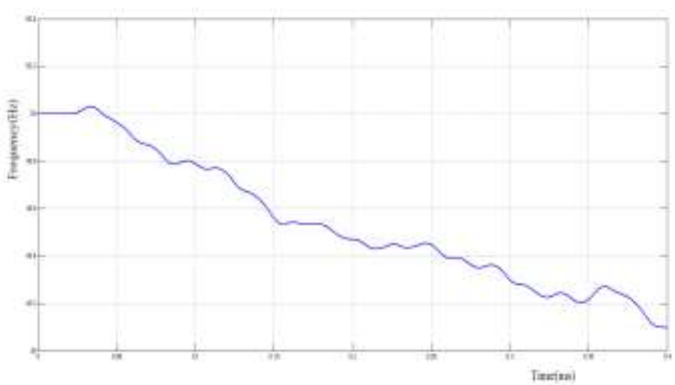

Fig-4Frequency at PCC under Normal Condition

The voltage at PCC under fault condition is varying and the corresponding waveform is shown in Fig-5. The figure shows the voltage magnitude is reduced, whereas the time period is from 0.2 to 0.23s.

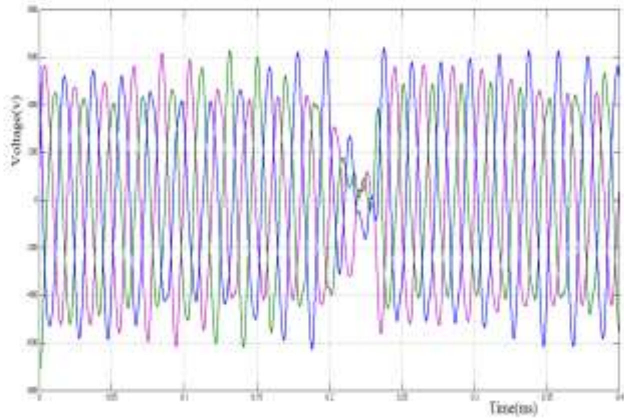

Fig-5Voltage at PCC under Fault Condition

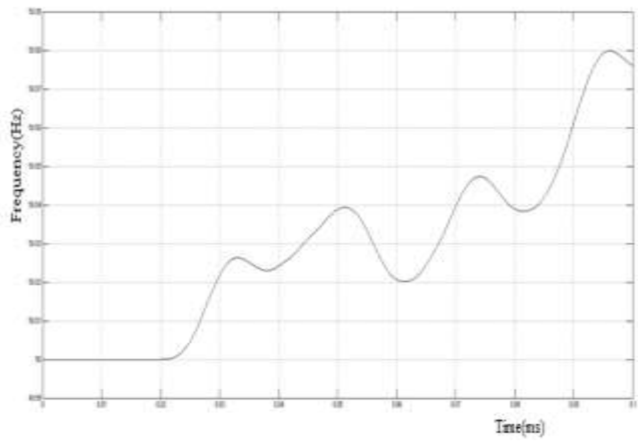

Fig-6 Frequency at PCC under Fault Condition

The frequency at PCC under fault condition is varying and the corresponding waveform is shown in Fig.-6. The above figure shows frequency deviation to 50.08 Hz. This frequency deviation is used to detect the islanding conditions.

The MATLAB tool box is used to obtain the elements required for the simulation and the corresponding parameters are given. The simulation result under normal condition and fault condition is obtained and thereby the islanding condition is detected by measuring change in frequency and compared with the threshold frequency.

CONCLUSIONS

This project deals with the detection of islanding in the distribution side.Electronically coupled distributed generators, powered by such micro sources as photovoltaic arrays, micro gas turbines, wind power systems, and fuel cells, have been gaining popularity among the industries and utilities due to their higher reliability, improved operational efficiency, and reduced greenhouse gas emission level. If power system fault happens and the islanding situation is not detected rapidly, the protection device may not behave and the grid voltage and frequency would be labile.

The utility interface operation of power converters is often used in advanced power conversion and conditioning systems such as the static VAR compensators, active power filters, Uninterruptible Power Supplies (UPS's), and grid-connected photovoltaic or wind power generation systems. If autonomous operation of an island is permitted, fast islanding detection is required for appropriate decision making to manage autonomous operation of the island. However, if these systems are not properly controlled, their connection to the utility grid can lead to grid instability or even failure.

The technique successfully detects islanding even during the worst case of islanding i.e., the perfectly matched load condition of a DG. During the stable islanding the utility loses control over the island's frequency and the island's frequency deviates with respect to the variation in the reference current. Anfrequency deviationbased algorithm is proposed for the decision making.

In case of nonislanding switching events, which may transiently impose a significant deviation in the frequency, the possibility of false detection is eliminated by reconfirming the occurrence of islanding once it is suspected. The reference current is kept to a small value to limit the degradation of the power quality and the power factor. The method prefers an absolute value, so that the average frequency deviation over a cycle during an islanding state is always a positive detectable value. The averaging of frequency deviation over 6–7 cycles reduces the possibility offalse detection. The proposed active frequency deviation technique has the ability to check the suitability of an islanded DG for a micro grid application or an islanded mode operation.

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