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Developing Islanding Detection Arrangement for Grid on Sensing Voltage or Frequency Variation

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Abstract: As distributed generators increase their importance on the electric power system, more and more parameters have to be controlled in order to assure the proper operation of the utility. One of the main problems encountered with this kind of generation is the potential formation of islands which could keep working in a normal way even if the utility grid has failed. There are several power generation units connected to the grid such as hydel, thermal, solar etc to supply power to the load. These generating units need to supply power according to the rules of the grid. These rules involve maintaining a voltage variation within limits and also the frequency. As per CENTRAL ELECTRICTY AUTHORITY OF INDIA Regulations 2010, variation of the system voltage should be of +- 5 % and make all efforts to operate at a frequency close to 50 Hz and shall not allow it to go beyond the range 49.2 to 50.3 Hz or a narrower frequency band specified in the Grid Code, except during the transient period following tripping. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding. This prevents in large scale brown out or black out of the grid power. So it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure. A large number of methods for detecting the islanding condition are used. Requirements for the performance of these methods have been spelled out by the International Electro technical Commission (IEC), the Underwriters Laboratories Inc. (UL), the Institute of Electrical and Electronics Engineers (IEEE) and several other "National Standards". Currently, the anti-islanding methods are clearly grouped into three categories as a function of their operating mode. These three categories are:

- Passive methods resident in the grid tied inverter.
- Active methods resident in the grid tied inverter.
- Methods not resident in the DG but communicating the DG and the utility.

The paper is based on passive method to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage.

Keywords: Islanding, Grid, voltage variation, frequency variation, Active method, Passive method.

I. INTRODUCTION

Since the society becomes increasingly concerned to save energy and preserve the environment, the interest toward the distributed generation systems, such as photovoltaic arrays and wind turbines, increases year after year. Other sources, such as micro-turbines and fuel cells, are also in development. But wind turbines and generally DGs will have affects in the network that one of these influences is an islanding phenomenon . Islanding state occurs when one or many sources continue to feed power to a part of the grid that is disconnected from the main utility.Islanding situations can damage the grid itself or equipments connected to the grid and can even compromise the security of the maintenance personnel that service the grid. Therefore, according to IEEE1547 standard, islanding state should be identified and disconnected in 2 seconds. There are quite a few different methods used to detect islanding. All methods have benefits and drawbacks. The methods have traditionally been divided into two subgroups; passive and active methods. In active methods, small disturbances are injected into the power system and its responses due to the injected disturbances are monitored. These methods change the balancing power between loads and generations, reduce the power quality of the power systems and are not suitable for wind farms with numerous wind turbines. Reactive power export error detection method , impedance measurement method, slip mode frequency shift algorithm (SMS), active frequency drift (AFD), active frequency drift with positive feedback (AFDPF),automatic phase-shift (APS) and adaptive logic phase shift (ALPS) are a few examples of active islanding detection methods. Passive methods continuously monitor the system parameters such as voltage, frequency, harmonic distortion, etc. Based on the system characteristics, one or more of these parameters may vary greatly when the system is islanded. The passive methods do not affect the waveform of the high voltage. This is beneficial since it does not give rise to power quality issues such as voltage dips. Setting a proper threshold can help to differentiate between an islanding and a grid connected condition. Rate of change of output power of DG , rate of change of frequency , voltage unbalance and harmonic distortion are a few examples of passive islanding detection methods. However passive methods are based on the measuring parameters of the power system and setting thresholds for the measured parameters This kind of methods lies in the inverter. They are base on the monitoring of certain characteristic parameters in the

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point of common coupling (PCC). The anti-islanding method causes the disconnection of the inverter from the utility grid under fault conditions when the parameter monitored, different for each method, gets out of the control range considered as usual during the normal operation.

The principal ones are:

- OVP/UVP (Over Voltage Protection / Under Voltage Protection) – Controls the PCC voltage value and compares it with normative limits .
- OFP/UFP (Over Frequency Protection / Under Frequency Protection) - Controls the frequency of the voltage signal at the PCC every zero crossing comparing with limits.
- Distortion detection – Checks the THD at the PCC and compares it with limits.
- Phase jump - Controls if there has been a phase jump during each cycle → Angle between V and I in PCC.

Following are some recent researches proposed and practiced by eminent researchers around world in this field,

1)Problem Of Islanding with Renewable energy sources

Connections of renewable power generators to the utility are changing the structure of the electric power system (EPS). The system is evolving from a tree structure with the generation produced by big power plants to a net structure plenty of small distributed points of generation. These distributed generators (DG) offer the possibility to combine dispersed generation with local energy storage and use, reducing the energy losses produced along the transport and distribution lines and incrementing in this way the EPS effectiveness as well as the power quality. Some technical requirements have to be established for the connection to the utility of the DG. One of the most important problems to fix is related with the potential generation of islands. As can be observed in Fig. 1, if the EPS fails and the DG keeps on working in normal operation, energizing distribution lines and local loads connected to it, an electric isolated island is formed. This problem, known as islanding operation, is to be avoided since it could involve important and serious consequences. From the EPS side, security measures have to be adopted in order to ensure the safety of the personnel working on the utility and to guarantee the reliability of the utility grid. Islanding operation keeps a region of the utility, the island connected to the DG, energized. This is hazardous for line operators who could suppose it is disconnected. Moreover, a long duration of the island could produce conflict in case the automatic reclosing of the utility protection devices. This is the case when the reconnection is done before the island has been extinguished. An island could get desynchronized during the stand alone period of operation, forcing the protections to fail again and being potentially dangerous for the electronic equipment due to the apparition of short-circuits at the moment of reconnection [1].The recently increase on DG connected to the utility makes it interesting to further analyze the anti-islanding methods. The knowledge of the problem and the ways to act against is fundamental for the future development the EPS.

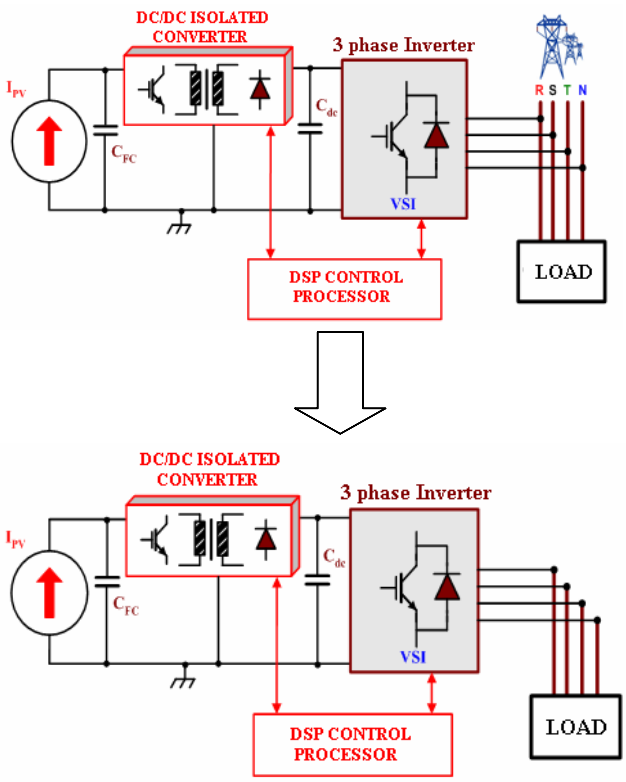

Fig. 1. Formation of an island (DG + Local loads).

2) " A Novel Islanding Detection Technique for Distributed Generation (DG) Units in Power System"

Distributed generation is a form of electric power privatization. Consumers install their own power station to supply the local loads and/or share in the utility loads. Many protective problems have been developed due to the existence of these distributed generations. However, a protective strategy should be developed to protect the system and the generator itself from different hazards. One problem with such generators is an unwanted islanding phenomenon. This paper introduces a hybrid passive method for islanding detection to minimize the non-detective zone. This method based on composed of rate of change of frequency over power under each event and rate of change of DG reactive power under each event (ROCORP). Simulation results which are carried out on software PSCAD/EMTDC shows good performance of this method.

3) "An Anti- islanding Protection Scheme for Grid- connected Distributed Power Generation"

The proposed scheme is based on an invasive current injection. An impedance estimation module in the frequency domain is introduced to estimate the equivalent impedance seen from the point of common coupling. To do so, a fast and accurate adaptive notch filter is used to extract the ambient components of the voltages and the currents. The accuracy of the proposed technique and its ability to detect islanding events even for purely resistive and nearly resonant loads are verified.

4)"Grid-connected and islanded operation of a hybrid power system

Rural area often has only one transmission line in

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connection with main power grid. The safety ofcritical load cannot be insured. Instead of adding a second transmission line,distributed generation can be installed. In this paper, a hybrid power system is analyzed. It is composed ofsolar power, windfarm ofdoublyfed induction generators (DFIG), pumped storage station,residential load and industry load. Both grid connected operation and islanded operation ofthis hybridpower system are analyzed. A control strategy is proposed to stabilize this power system under islanded condition without the necessary of central master controller. The water tower with back to back voltage source converter (VSC) is operated as a pumped storage station underislanded situation, which controls thefrequency and voltage of the islanded power system Wind farm, solar power, and loadcontribute to frequency and voltage control of the hybrid power system

5) "Variable-Frequency Grid-Sequence Detector Based on a Quasi-Ideal Low-Pass Filter Stage and a Phase-Locked Loop"

This paper proposes a filtered-sequence phase-locked loop (FSPLL) structure for detection of the positive sequence in three-phase systems. The structure includes the use of the Park transformation and moving average filters (MAF). Performance of the MAF is mathematically analyzed and represented in Bode diagrams. The analysis allows a proper selection of the window width of the optimal filter for its application in the *dq* transformed variables. The proposed detector structure allows fast detection of the grid voltage positive sequence (within one grid voltage cycle). The MAF eliminates completely any oscillation multiple of the frequency for which it is designed; thus, this algorithm is not affected by the presence of imbalances or harmonics in the electrical grid. Furthermore, the PLL includes a simple-frequency detector that makes frequency adaptive the frequency depending blocks. This guarantees the proper operation of the FSPLL under large frequency changes. The performance of the entire PLL-based detector is verified through simulation and experiment. It shows very good performance under several extreme grid voltage conditions.

6) "Overview of Control and Grid Synchronization for Distributed Power Generation Systems"

Renewable energy sources like wind, sun, and hydro are seen as a reliable alternative to the traditional energy sources such as oil, natural gas, or coal. Distributed power generation systems (DPGSs) based on renewable energy sources experience a large development worldwide, with Germany, Denmark, Japan, and USA as leaders in the development in this field. Due to the increasing number of DPGSs connected to the utility network,new and stricter standards in respect to power quality, safe running, and islanding protection are issued. As a consequence, the control of distributed generation systems should be improved to meet the requirements for grid interconnection. This paper gives an overview of the structures for the DPGS based on fuel cell, photovoltaic, and wind turbines. In addition, control structures of the grid-side converter are presented, and the possibility of compensation for low-order harmonics is also discussed. Moreover,control strategies when running on grid faults are treated. This paper ends up with an overview of synchronization methods and a discussion about their importance in the control.

Index Terms—Control strategies, distributed power generation.

7) "Anti- Islanding Today, Successful Islanding in the Future"

Distributed generation (DG) is gaining popularity in the United States and across the world. The Florida Public service Commission recently passed rules encouraging the use of renewable resources. Integrating DG with the utility network poses challenges for anti-islanding schemes. These schemes detect islanding conditions and trip the DG. Fig. 1 shows a typical network configuration for DG installations.Failure to trip islanded generators can lead to problems such as threats to personnel safety, out-of-phase reclosing, and degradation of power quality.This paper discusses a wide-area measurement-based islanding detection scheme (IDS_WA) that uses time synchronized measurements to calculate the slip frequency and acceleration between two systems to detect islanded conditions.The proposed scheme has significant advantages compared to traditional anti-islanding schemes, specifically when the power mismatch is minimal. Local-area measurement-based schemes (IDS_LA) complement the IDS_WA. The paper also discusses the use of a real-time digital simulator to model DG along with the rest of the system to validate the proposed anti-islanding scheme.The paper shows the performance of the scheme for different system configurations and load flow conditions.

8) "Microgrid Power Flow Study in Grid-Connected and Islanding Modes under Different Converter Control Strategies"

This paper presents a power flow study of a microgrid network under variable load and generation conditions during grid-tieed and islanding modes by using Power World simulator. Typical characteristics of inverter-interfaced micro Sources are considered in the paper. During the grid-tied mode, the DERs enhance the bus voltage of the MG network. But, for a bus outside the MG network, the voltage improvement is not evident. The bus voltage boost is more obvious if a DER is connected to the bus. The voltage boost depends not only on the reactive power but also on active power produced by a DER. The system loss reduction relies on how much power is generated by DERs, particularly at the peak load period.

II. CONCLUSION

This paper gives brief idea about developing a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage. There are several power generation units connected to the grid such as hydel, thermal, solar etc to supply power to the load. These generating units need to supply power according to the rules of the grid. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding. This prevents in large scale brown out or black out of the grid power. So it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure.

REFERENCES

1) Hèctor Beltran, Francisco Gimeno, Salvador Seguí-Chilet and Jose M. Torrelo Instituto de Tecnología Eléctrical Av. Juan de la Cierva, 24 - Parc Tecnològic 46980 Paterna, València (Spain) paper on "Review of the Islanding Phenomenon Problem for Connection of Renewable Energy Systems"
2) Amin Safari paper on "A Novel Islanding Detection Technique for Distributed Generation (DG) Units in Power System". February, 2013 International Journal of Advanced Science and Technology Vol. 51
3) A. Moallem, Student Member, IEEE, D. Yazdani, Member, IEEE, A. Bakhshai,Senior Member, IEEE, and P. Jain, Fellow, IEEE paper on " An Anti- islanding Protection Scheme for Grid-connected Distributed Power Generation Systems".
4) Y. Zhou, J. A. Ferreira, P. Bauer Department of Electrical Power Engineering, Delft University of Technology Mekelweg 4, 2628CD, Delft, the Netherlands. IEEE paper on "Grid-connected and islanded operation of a hybrid power system" 16-20 July 2007, IEEE PES Power Africa Conference & Exposition Johannesburg, South Africa.
5) Eider Robles, Salvador Ceballos, Josep Pou, Member, IEEE, Jos´e Luis Mart´ın, Member,IEEE, Jordi Zaragoza, Student Member, IEEE, and Pedro Iba˜nez,Member, IEEE paper on "Variable-Frequency Grid-Sequence Detector Based on A Quasi-Ideal Low-Pass Filter Stage and a Phase-Locked Loop".OCTOBER 10VOL.25, NO. 10, IEEE TRANSACTIONS ON POWER ELECTRONICS.
6) Frede Blaabjerg, Fellow, IEEE, Remus Teodorescu, Senior Member, IEEE, Marcro Liserre, Member, IEEE, and Adrian V. Timbus, Student Member, IEEE Paper on "Overview of Control and Grid Synchronization for Distributed Power Generation Systems" OCTOBER 2006, VOL. 53, NO. 5, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS.
7) John Mulhausen and Joe Schaefer, Florida Power & Company Mangapathirao Mynam, Armando Guzmán, and Marcos Donolo, Schweitzer Engineering Laboratories, Inc. IEEE paper on "Anti-Islanding Today Successful Islanding in the Future" 2010 Texas A&M Conference for Protective Relay Engineers.
8) Shuhui Li, Senior Member,IEEE, Julio Proano, and Dong Zhang, An IEEE paper on Microgrid Power Flow Study in Grid-Connected and Islanding Modes under different Converter Control Strategies" 2012 IEEE.

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