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Hybrid Islanding Detection Method for Distributed Generators

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ABSTRACT— Distributed Generation is a dispersed generation which directly supplies power to load or injects power into the grid. Interest in distributed generation increases day by day due to environmental concerns. Unplanned islanding have various negative impacts on utility as well as consumer equipments so distributed generators should be equipped with islanding detection system. Active and passive both are the basic methods to detect islanding but both methods have some drawbacks therefore Hybrid method which is integration of basic methods of islanding detection is developed which minimizes the drawbacks of above methods. To show validness of proposed method, a system is simulated in MATLAB software and simulation results are analyse.

KEYWORDS- Dispersed Generation, Islanding detection, Hybrid method, Unplanned islanding

I. INTRODUCTION

Recently, the demand of electricity rises due to industrialization and modernization. To cope up with theses growing demand, there is need of expansion of current generating capacity as well as today's transmission and distribution network. As it is very bulky project and needs very high initial investment, distributed generator (DG) is the best solution for it [1]. Safety is the major concern in the integration of distributed generator with the grid and islanding is one of the major issues related to line maintenance worker safety and safety of the consumer as well as utility equipments [4].

Even though some portion of distribution system gets electrically isolated from utility grid, it gets power from the active source present in that islanded portion. This situation is called as Islanding [2]. Islanding may be planned or unplanned. Planned islanding is done for the purpose doing any repair or maintenance activity but unplanned islanding is the result of any fault on distribution side which is undesirable. Human and system safety point of view unplanned islanding detection is very important. According to IEEE standard 929-1988, disconnection of DG is required under system islanding condition [4]. IEEE 1547-2003 and IEC 61727 needs maximum time period of 2 sec for detection and disconnection of DG [4]. Islanding detection relays are used for disconnection of DG.

This paper is arranged into VI sections. Section I gives the general introduction. Different methods for islanding detection are listed in section II. Section III explains the methodology which is proposed in this paper. Section IV shows the effectiveness of proposed methodology by using MATLB simulation results. And finally the paper is concluded in section V.

II. LITERATURE SURVEY

Various techniques are available for detection of Islanding of DG. Some of them are reviewed in this paper. Main two categories available are remote and local. Remote techniques are also called as communication based techniques. Supervisory Control And Data Acquisition System (SCADA)[3] or Power Line Signaling Scheme is used for communication purpose [5]. This technique is reliable but very expensive. Active and passive are the basic methods which come under local islanding detection techniques.

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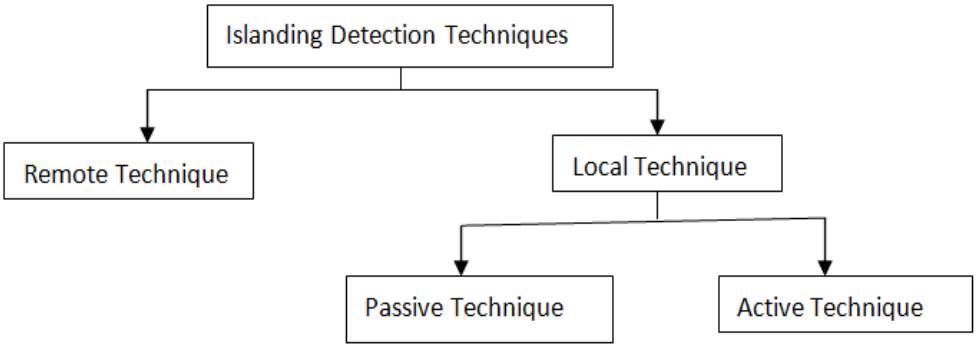

Fig. 1 Different islanding detection techniques

In passive techniques, system parameters such as system voltage, current, frequency etc are continuously monitored, measured and compared with predetermined threshold values [2]. Passive technique is very easy but has larger non-detection zone (NDZ) in which passive methods could not detect islanding [4]. One more drawback of this method is that, it fails in case if load demand and DG generation perfectly matched in islanded portion. It cannot easily discriminate between islanding and non-islanding transients [4].

To overcome the above drawbacks of passive techniques, active techniques are used. In Active techniques, the distorted wave of voltage or current is continuously injected as a disturbance signal into the system intentionally [7]. The response of that disturbance signal is used to detect islanding. It reduces NDZ. But it adversely affects on power quality of the system [4].

III. PROPOSED METHODOLOGY

DG system with current controlled voltage source inverter connected with distribution network is shown in figure.2. Photovoltaic (PV) module is used as source for DG. Parallel RLC load is connected in this system. Point of common coupling (PCC) is the point where utility grid, local load and DG connected together. Smooth sine wave of output current of inverter is obtained by connecting inductor.

System specifications are as below:

DG: 800V, 50 HZ

Transformer: 100 KVA, 25/0.4 KV

RLC Load: 80 KW, 60 KVAr

Main Grid: 25 KV, 50 HZ

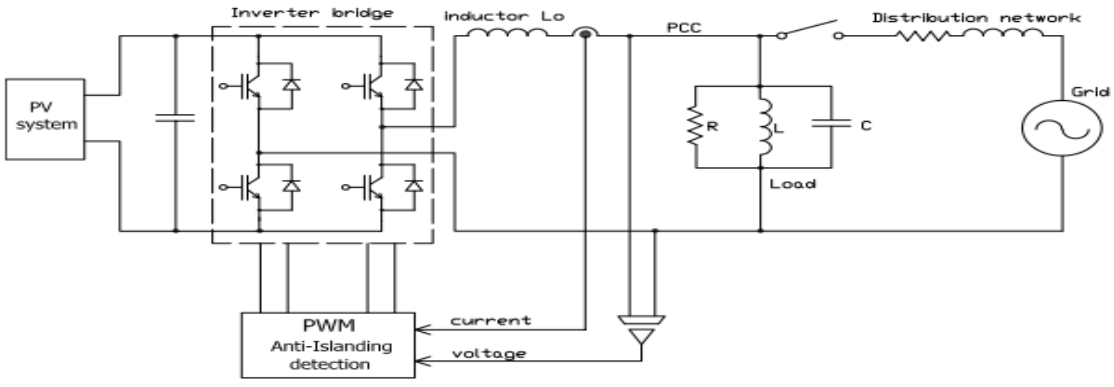

Fig. 2 Test system with DG

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Hybrid method is combination both passive and active method. It is based on rate of change of system voltage and injection of 3rd harmonic of output current of inverter.

At start, the value of system voltage is monitored and measured continuously and calculate rate of change of voltage by using equ.(1)

ROCOV= dV/dt (1)

The threshold value set for dv/dt is 2V/S. If this value exceeds predetermined threshold value, then system is suspected to be islanded because there are some non islanding conditions such as capacitor switching, Induction motor starting, sudden load change etc which causes transients in the system which may results in change in system voltage. Figure 3. shows the flow chart for the proposed methodology.

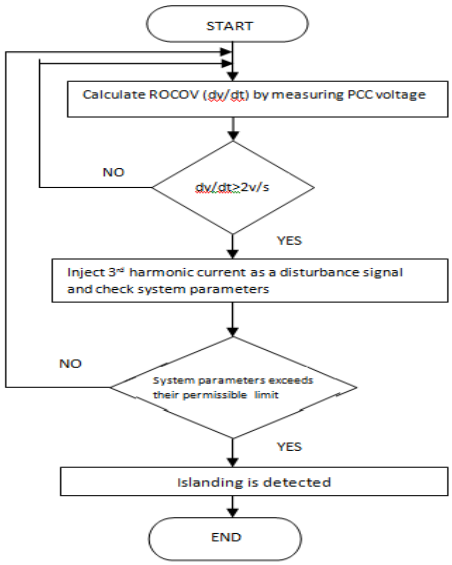

Fig.3 Flow of proposed methodology

To confirm weather system is islanded or not, inject 3rd harmonic output current of inverter as a disturbance signal through d-q current controller across d-axis. If system is grid connected then disturbance signal follows the low impedance path offered by the utility and doesn't vary the system parameter. In this case Active and reactive power consumed by the load is given by the equ. (2) and (3),

PLoad = PDG + Pgrid (2)

QLoad = QDG + Qgrid (3)

But is system is islanded disturbance signal modulates the amplitude of system voltage and frequency greatly. By using O/U voltage or O/U frequency relay islanding can be easily detected.

IV. SIMULATION RESULTS

- **Case No.1- Islanding**

Islanding occurs at time 0.7 S. Islanding is simulated by opening circuit breaker. At first we observed the value of dv/dt. As it increases above set value and reaches the 5V/S there is suspection of islanding. Inject 3rd harmonic component

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of current and monitor the system voltage and frequency. Fig. 4b shows that frequency drops down to 48.5 HZ and voltage wave is also not sinusoidal in nature so O/U frequency relay will detect islanding.

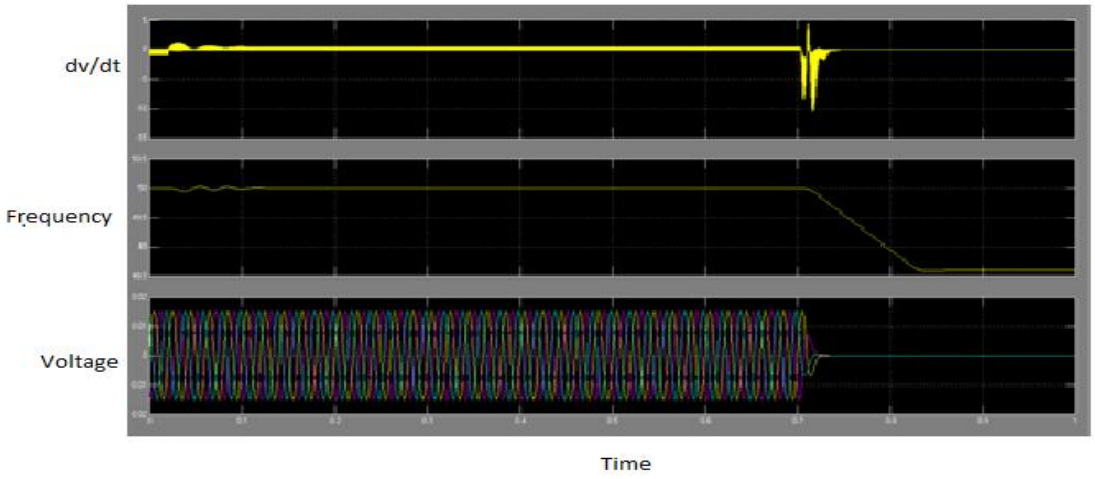

Fig. 4 a) Rate of change of b) System frequency c) System voltage

- **Case No.2-Non islanding situation- Capacitor Switching**

Capacitor bank with 35 Kvar is switched off at 0.4 S. Capacitor switching produces transients in the system which may changes the value of dv/dt above threshold value.

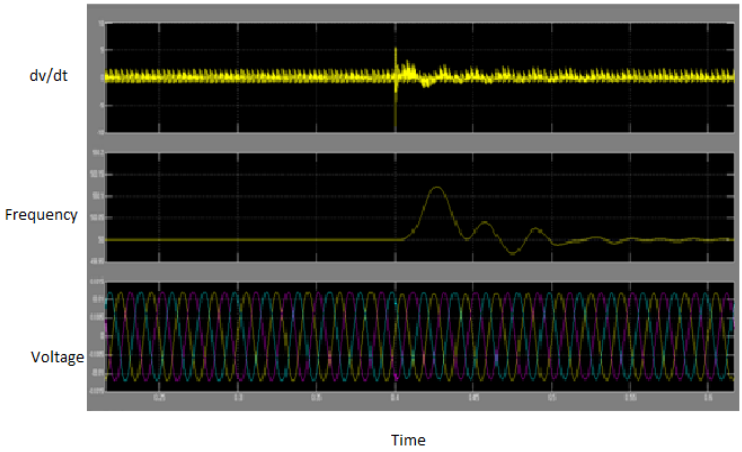

Fig. 5 a) Rate of change of voltage b) System frequency c) System voltage

Here dv/dt reaches to 3 V/S but it is not islanding. So to discriminate islanding from non islanding condition, inject disturbance signal. As it is not islanding disturbance signal does not have any significant effects on system parameters shown in
figure. 5b System frequency is within limits and system voltage is purely sinusoidal in nature.

- **Case No.3 Non-Islanding situation- Starting of Induction motor**

Starting of Induction motor causes transients. Induction motor having active power 25 KW and reactive power 40 KVAr is started at time t=0.5 sec. Due to transients dv/dt exceeds the threshold value and reaches to 3 V/S. Now due to the suspection of islanding inject third harmonic output current if inverter into the system. As it is not islanding, disturbance

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signal does not change the values of system parameters significantly. Fig. shows that system voltage has pure sinusoidal shape and frequency is also within limits.

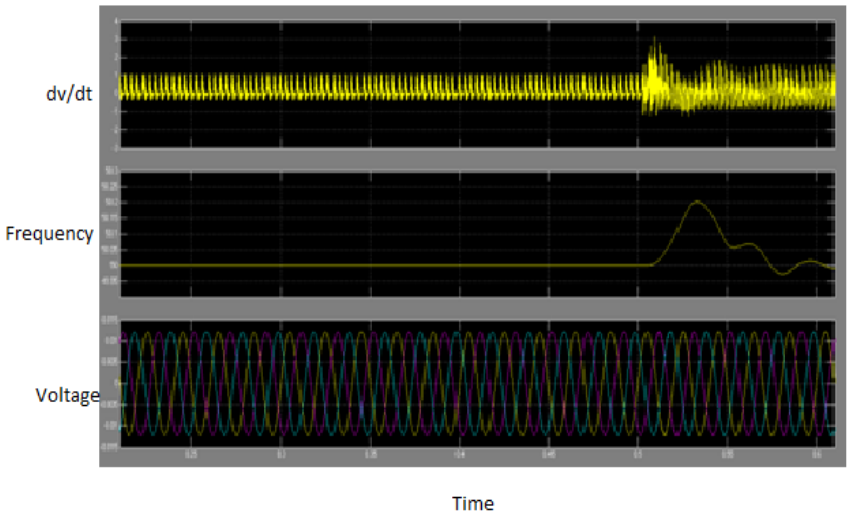

Fig. 6 a) Rate of change of voltage b) System frequency c) System voltage

V. CONCLUSION

This Hybrid method which integrates passive and active method is proposed in this paper and minimizes drawbacks of both the methods. In this method disturbance signal is injected into the system only when islanding is suspected by passive method. MATLAB/SIMULINK software is used for simulation. Proposed methodology is tested in various islanding and non-islanding conditions. A simulation result shows that this method can easily and accurately detect islanding.

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