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New Method for Islanding Detection of Distributed Generation System

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Abstract:

This paper illustrated the new method for islanding detection of distributed generation based wind farm. Doubly fed induction generation used as generation of power in wind farm systems. All the simulations performed in Matlab/Simulink software. This paper illustrated that the negative sequence method is effective method for islanding of distributed generation based wind farm system.

Keywords: *Distributed Generation (DG), Doubly Fed Induction Generator (DFIG), Islanding*

I. INTRODUCTION

Now days, electric power utilities are concerned with distributed generators together with photovoltaic, wind farms, fuel cells, micro turbine and also internal combustion engine (ICE) or generators as a lot of good alternatives to determination the problems associated with environment and to deal with going up energy prices and power plant construction costs. Distributed generation (DG) may make a role to increase power quality of power, reduce peak loads and estimate the need for reserve margin [1-2]. Islanding operation is a condition in which a part of a network is disconnected from the reminder of power system but it remains energized by Distributed Generator (DG) units interconnected to the distribution system. Islanding of a grid-connected DG occurs when a section of the utility system containing, but the independent Distributed Generators (DGs) keep on to energize the utility lines in the isolated segment. Unintended islanding is a concern primarily because it poses a hazard to utility and customer equipment, maintenance personnel and general public.

As additional DG system become division of the power grid, there is an increased safety hazard for personnel and an increased hazard of damage to the power system. Failure to trip Distributed Generation (DG) islanding can direct to a number of problems for these resources and the connected loads, which include power quality, stability, safety and operational problems. Therefore, the current industry practice is to disconnect all distributed resources (DRs) immediately after the occurrence of island [3-4].

Detection of islanding techniques is classified as passive and active. Passive techniques make use of information available at the Distributed Generation (DG) side to determine whether the DG system is isolated from the grid. The benefit of passive techniques is that the performance does not have an impact on the normal operation of DG system. Active techniques initiate an external perturbation at the output of the inverter. These tend to have a faster reply and a very small non-detection zone (NDZ) as compared to passive approaches. However, the power quality (PQ) of inverter can be degraded by the perturbation.

II. DISTRIBUTED GENERATION SYSTEM

Distributed generation (DG) is defined electricity generation as a small scale fueled by renewable energy sources, such as wind, solar, or by low-emission energy sources, such as fuel cells and micro-turbines. Distributed Generation (DG) units are classically connected so that they work in parallel with the utility grid, and they are frequently associated in close up immediacy to the load. Distributed Generation (DG) units have not so distant been satisfactory lacking a utility grid. However, the economic advantages of utilizing DG units, coupled with the advancements in different methods for controlling these units. They have led to the definite chance of these units being operated in an self-directed mode, or what is known as a microgrid. Therefore, distribution systems with fixed DG units can function in two modes: grid-connected and autonomous. In grid-connected mode, even though the voltage and frequency are usually controlled by the grid and the Distributed Generation (DG) units are synchronized with the grid. Integrating with Distributed Generation (DG) units can have an impact on the practices used in distribution systems, such as the voltage profile, power flow, power quality, stability, reliability, and protection. As DG units have a small capacity compared to centralized power plants, the impact is negligible if the penetration level is low as the limit is nearly about 1%-5%. However, if the penetration level of DG units increases to the expected level of 20%-30%, the impact of DG units will be profound.

III. ISLANDING DETECTION METHODS

The main point of view of detecting an islanding condition is to observe the DG output parameters and system parameters and decide whether or not an islanding circumstance has occurred from change in these parameters. Islanding detection techniques can be separated into remote and local techniques and local techniques can further be separated into passive, active and hybrid techniques as shown in given below figure 1.

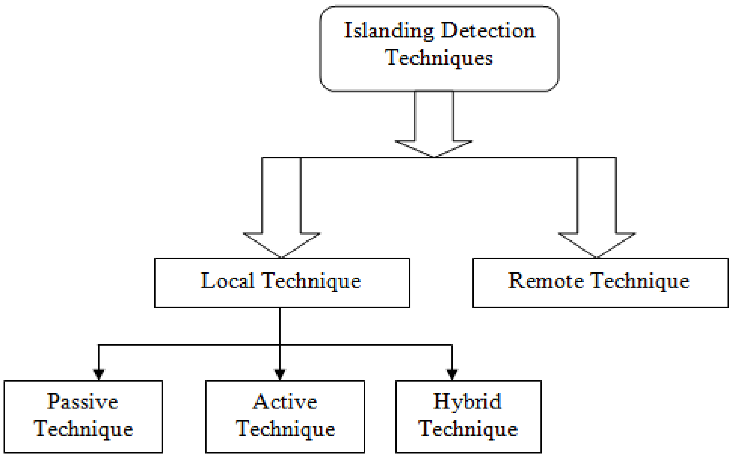

Figure 1: Techniques for Islanding Detection

To examine the performance of the different techniques during the unexpected events a simulation model is implemented. In all essential parts, it is important that the model reflects a real type signals.

ROCOF Relay

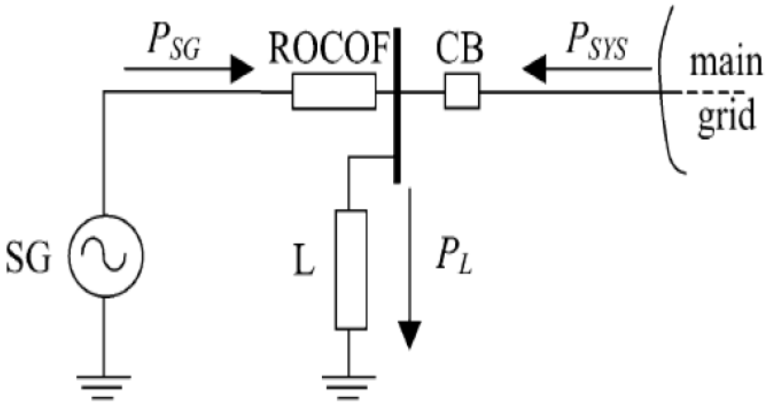

Figure 2: Equivalent circuit of synchronous generator equipped with ROCOF relay operating parallel with utility [5]

Above figure represents an equivalent circuit of a synchronous generator prepared with a ROCOF relay operating in parallel with a distribution system network. In this figure 2, the synchronous generator (SG) feeds a load (L). The difference between the electrical powers P_{SG} supplied by the synchronous generator and power P_L consumed by the load is provided by the main grid. So that frequency of the system remains stable. If the circuit breaker (CB) opens, due to a fault for instance, the system self-possessed by the generator and the load becomes islanded.

Now if we consider this case, there is an electrical power imbalance owing to the lost grid power $P_{SYS.}$ This power imbalance causes transients in the islanded system and the system frequency starts to diverge dynamically. The behavior of such system can be used to notice an islanding condition. Though, if the power imbalance in the islanded system is small, then the frequency will change slowly. Thus, the rate of change of frequency *df / dt* can be used to accelerate the islanding detection for this situation [6]. The rate of change of frequency is calculated allowing for a measure window over a few cycles which is usually between 2 and50 cycles.

This signal is process by filters and then the consequent signal is used to sense islanding condition. If the value of the rate of change of frequency is high than a threshold value, a trip signal is with no delay sent to the generator circuit breaker (CB). Typical rate of change of frequency (ROCOF) settings install in 60-Hz systems are between 0.10and 1.20 Hz/s. Another significant quality accessible in these relays is a block function by least amount terminal voltage. If the terminal voltage drop under an adjustable level V_{min}, the trip signal from the ROCOF relay is blocked. This is to avoid, for example, the actuation of the ROCOF relay throughout generators start-up or short circuit conditions.

Vector Surge Relay

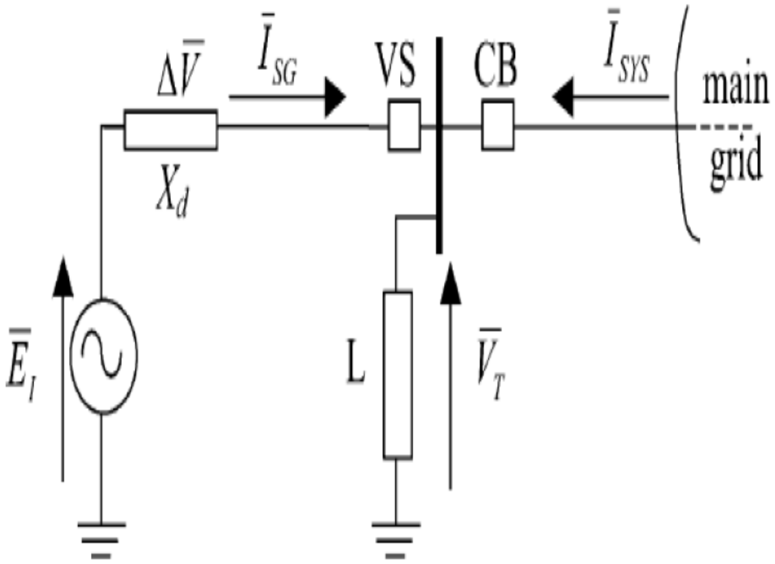

Figure 3: Equivalent circuit of synchronous generator equipped with vector surge relay operating parallel with utility [5]

A synchronous generator prepared with a VS relay operation in parallel with a distribution network is depict in Figure 3. Voltage drop V between the terminal voltage VT and the generator internal voltage EI due to the generator current ISG passing through the generator reactance Xd. As a result, there is a displacement angle between the terminal voltage and the generator internal voltage, whose phasor diagram is presented in Fig. 4(a). In Figure 3, if the circuit breaker open due to a faulty condition, for instance, the system poised by the generator and the load L becomes islanded. In this condition, the synchronous machine starts to provide a superior load (or lesser) because the current ISYS provided (or obsessive) by the power grid is abruptly interrupted. Thus, the generator begins to decelerate (or accelerate).

Due to a result, the angular difference between VT and EI is suddenly increased (or decreased) and the terminal voltage phasor changes its direction, as shown in Figure 4(b). Due to analyze such occurrence in the time domain, the instant value of the terminal voltage jumps to an additional value and the phase changes the phase position changes as depicted in Figure 4, where the point A indicates the islanding instant. In adding, the frequency of the terminal voltage also changes. This performance of the terminal voltage is called vector surge. Vector surge relays are based on such phenomenon. VS relays accessible in the market compute the duration time of an electrical cycle and begin a new measurement at each zero rising crossing of the terminal voltage.

To avoid fake operation, ROCOF and VS relays are disabling, if the terminal voltage decreases below a determined voltage threshold. Now it shown that ROCOF relays need a smaller active power imbalance stage than VS relays for successful islanding detection. On the other hand, ROCOF relays are to a great extent more susceptible to fake operation than VS relays.

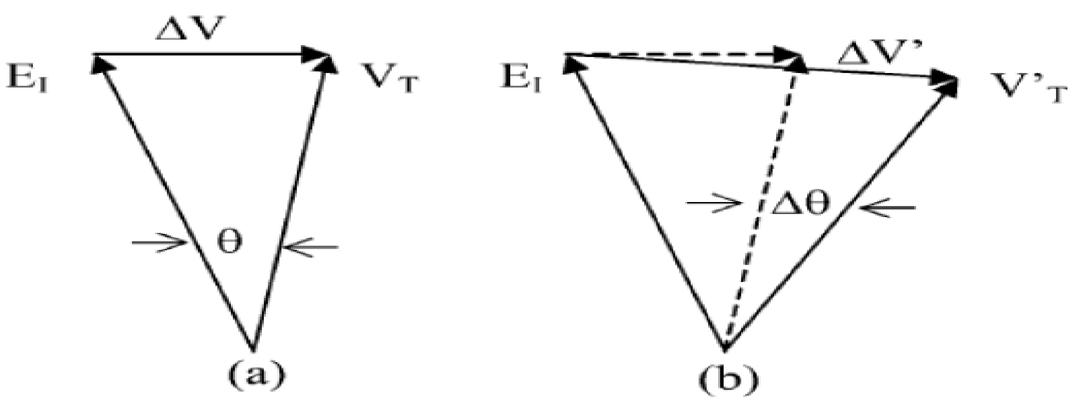

Figure 4: Internal and terminal voltage phasors (a) before opening with CB (b) after opening with CB

IV: SIMULATION & DISCUSSION

In this case the simulation model there are two sets of 9MW wind farms. Doubly-Fed induction Generators (DFIG) driven by wind turbine. Each 9MW DFIG based wind farm consists of six 1.5 MW wind turbines linked to a 120 KV grid through a 30 KM, 25 KV feeder. Doubly-fed induction generator (DFIG) wind turbine consists of a wound rotor induction generator and an also AC/DC/AC IGBT-based PWM converter. The stator winding is directly connected to the 60 Hz grid and the rotor is feed at variable frequency through the AC/DC/AC converter. The DFIG technology allows extracting maximum energy from the wind for low down wind speeds by optimizing the speed of turbine, while minimizing mechanical stresses on the turbine during gusts of wind. The wind speed is at 10m/s. The control system uses a torque controller in order to keep up the speed at 1.2 pu. The reactive power produced by the wind turbine is keeping up at 0 Mvar.

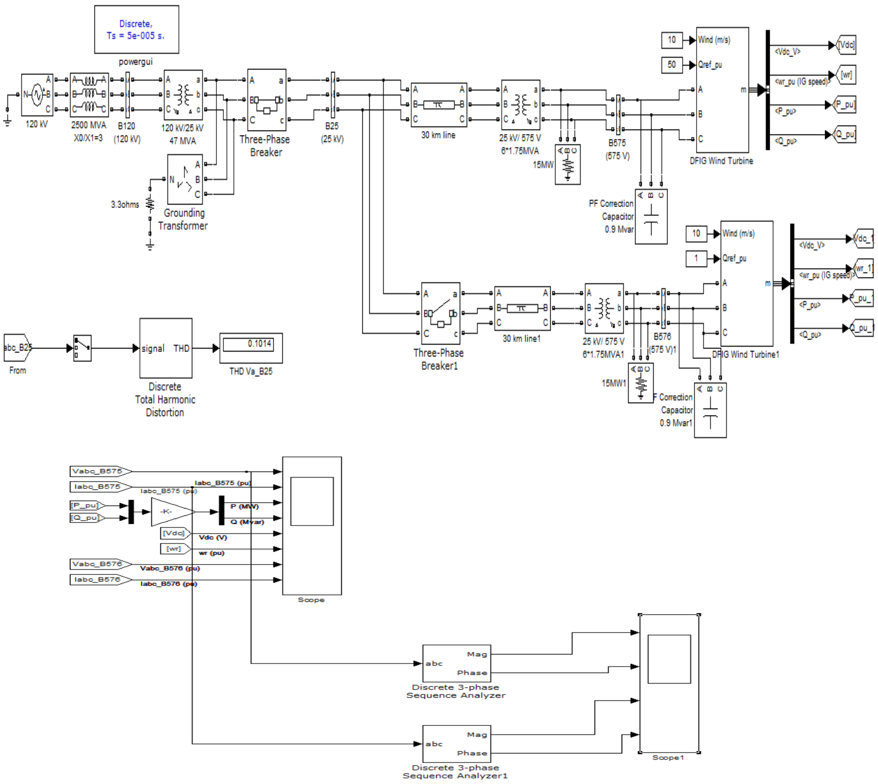

Figure 5: Matlab/Simulink model of Islanding Detection of DFIG

The positive, negative and zero sequence voltage and equivalent d1 coefficients and positive, negative and zero sequence current and corresponding d1 coefficients for different islanding and non-islanding conditions shown in the simulation results. The d1 coefficients clearly localizes the islanding event and thus helps in detecting the same and by the comparison of three techniques observed the effectiveness of detecting islanding technique.

Now figure 5 shows the voltage and current waveform at bus B_575. In the above wave- forms of voltage and current the voltage and current level at bus B-575 is nearly about 1pu.

V. SIMULATION RESULT

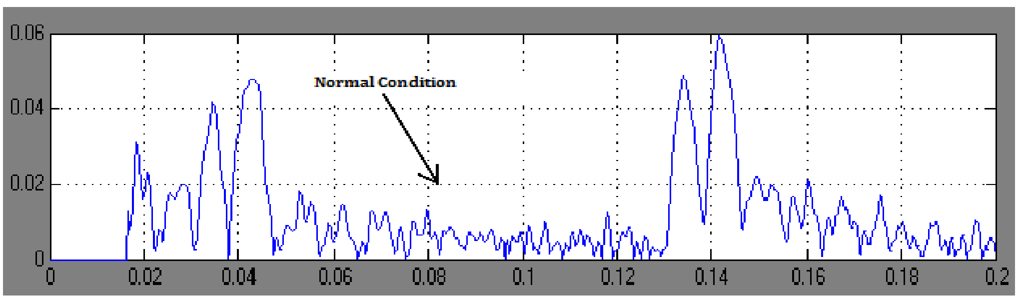

Figure: 6 (a)

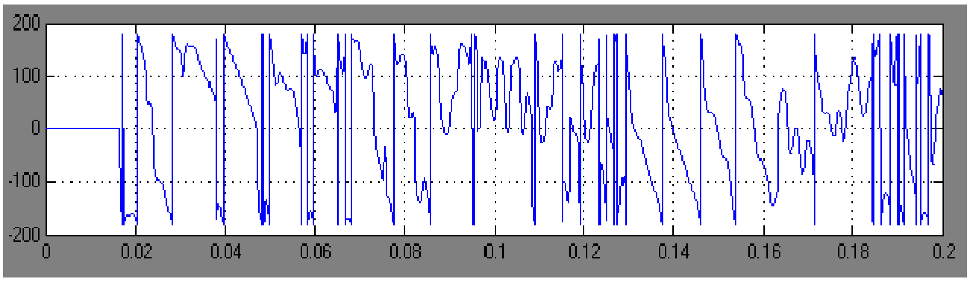

Figure: 6 (b)

Figure: 6 (a) & 6 (b) The negative sequence component of voltage and d-1 coefficient of normal condition

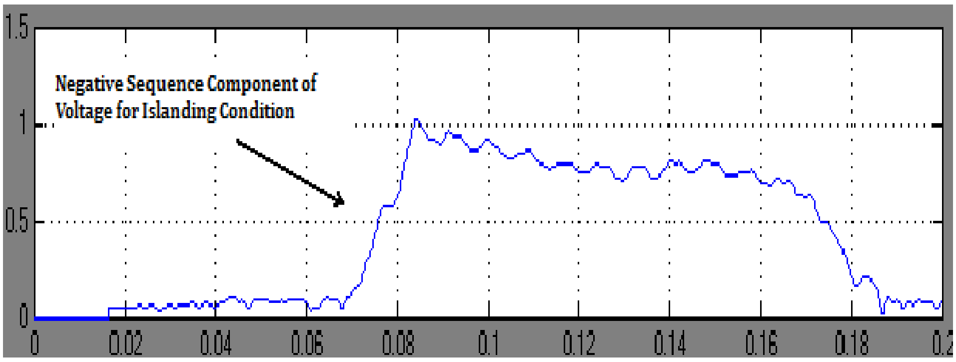

Figure: 7 (a)

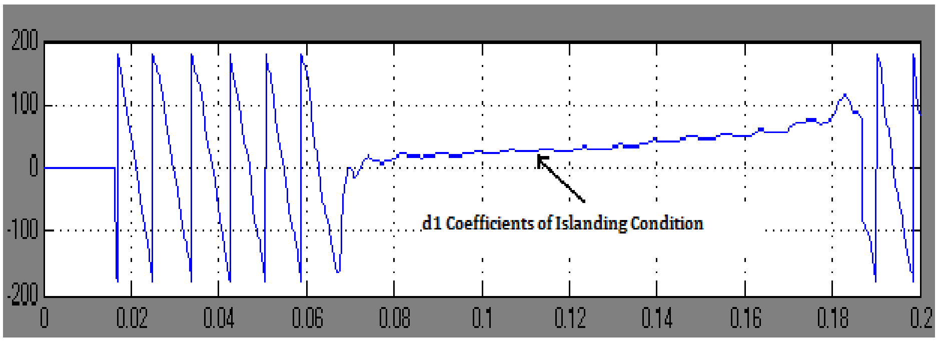

Figure: 7(b)

Figure: 7 (a) & (b): The negative sequence component of voltage and its d-1 coefficient for Islanding Condition

VI. CONCLUSION

In this paper we presented the new method for detecting the islanding condition of distributed generation based wind farm system. Here the above system is simulated with positive, negative and zero sequence method. In above simulation result, only the negative sequence component of voltage and its d-1 coefficient for normal and islanding condition are shown. From the result, it is clearly shown that the negative sequence component method is most effective method for islanding detection.

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