# Islanding Detection of Wind Turbine by ROCOF and ROCOP

**Azim Ambaliya[1] Vipulkumar Jagodana[2]**
[1,2]Department of Electrical Engineering
[1,2]Marwadi Education Foundations Group of Institution, Rajkot India

*Abstract*— Recently use of renewable sources has increased, these sources include fuel cell, photo voltaic, and wind turbine. Islanding occurs when one portion of grid is isolated from remaining grid. Use of the renewable sources can provide continuous power to isolated portion in islanding condition. One of the common renewable sources is wind generation using wind turbine. Efficiency of wind generation can be increased in combination with conventional sources. When islanding occurs, few parameters change which may be frequency, voltage, active power, and harmonics. According to large change in one of these parameters islanding is detected. In this paper two passive methods Rate of Change of Frequency (ROCOF) and Rate of change of Power (ROCOP) have been implemented for islanding detection of small wind-turbine. Islanding detection of both methods have been simulated in PSCAD. Simulation results show at different islanding inception angle response of ROCOF and ROCOP

***Key words:*** islanding; adopted methods methods; PSCAD simulation

## I. Introduction

Now a day and before few year conventional sources are used for power generation. In steam power plant coal is used for power generation. It's bad effect on wheather condition of environment. Also require space for coal storage, cooling system ash disposal in conventional (steam) power plant.

Since many year, people are useing renewable source for different purpose. Now a day these renewable source used in power generation. These sources are non-conventional sources. There are many advantages of renewable sources, some of these; it is non-conventional, no bad effect on environment, no requirement of fuel storage.

Main advantages of Distributed Generation (DG), it does not effect on wheather of environment. Some renewable sources are solar energy, wind-farm, tidal energy. These sources are feed power as distributed generation (DG) to local area and grid. One problem occur when DG is islanded from grid and provide power to local area. After islanding condition some parameters are change these parameter may be voltage, frequency, current, power. Its effect occur on load side. Due to that there are some problem occur like over-heated, effect of frequency on speed of machine, effect of voltage variation.

Islanding detection is important because it's effect on load. There are some method of islanding detection are classified based on different parameters, some of them are voltage, frequency, power, current.

## II. Islanding

Islanding is defined as "a condition in which a portion of an area electric power system (EPS) is energized solely by one or more local EPSs through the associated points of common coupling (PCCs) while that portion of the area EPS is electrically separated from the rest of the area EPS" [12]

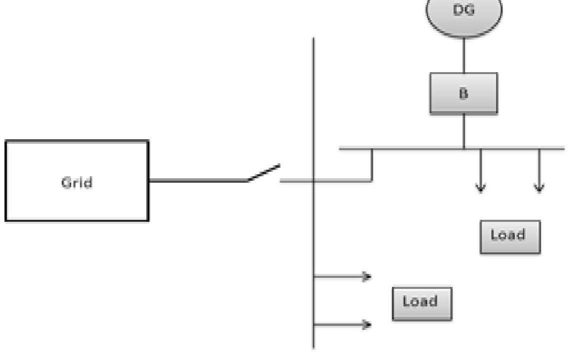


Fig. 1: Islanding

## III. Islanding Detection Techniques

The main aim of detecting islanding condition is comparing the DG output parameters with system parameters [1]. Then decide islanding situation according to change in these parameters. Islanding detection techniques can be classified into remote and local techniques. Further local techniques can be divided into passive, active and hybrid techniques as shown in figure 5.

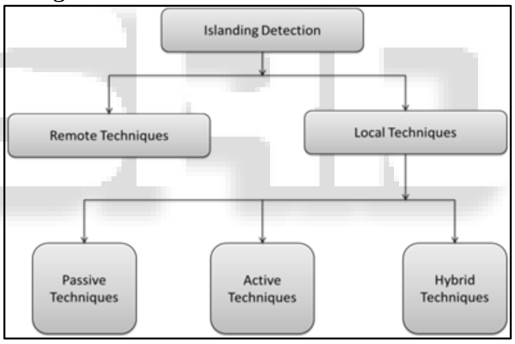


Fig. 2: Islanding detection techniques

### A. *Remote Islanding Detection Techniques:*

Remote islanding detection techniques are as communication between utilities and DGs. They may have better reliability than local techniques, they are not easy to implement and so uneconomical

### B. *Local Detection Techniques:*

Local techniques are take system parameters from PCC, some of them are frequency, voltage current for detection of islanding. It is further classified as:

### C. *Passive Detection Techniques:*

Passive Techniques work on measuring system parameters like variations in voltage, frequency, harmonic distortion, etc.[2] These parameters change when the system is islanded. Detection of an islanding and grid connected condition is based on the thresholds of parameters. Special care should take while setting the threshold value. Passive techniques are fast and they don't offer disturbance in the system. They have a large non detectable zone (NDZ) in which they fail to catch-up the islanding condition.

### *D. Active Detection Techniques:*

In the active methods directly introduce small perturbations in system [1] for islanding detection. Cause of this small perturbation will result in smallest change in system parameters when the DG is islanded, change will be negligible when the DG is connected with grid.

### *E. Hybrid Detection Schemes:*

A hybrid method is combination of both the active and passive detection techniques. The active technique is implemented after the passive technique to detect islanding.

## IV. METHODOLOGY TO BE ADOPTED

There are two methods of islanding detection of wind turbine is implemented,

- Rate Of Change Of Frequency
- Rate Of Change Of Power

These both methods are passive (local) islanding detection techniques.

### *A. Rate Of Change Of Frequency:*

The rate of change of frequency will increase when the DG is islanded.. [2, 5] The rate of change of frequency (ROCOF) can be given by

$$ROCOF, \frac{df}{dt} = \frac{\Delta p}{2HG} \times f$$

Where, ΔP is mismatch of power of the DG
H is moment of inertia for DG/system
G is the generation capacity of the DG/system
In this project ROCOF relay is work on flow chart. Different steps are below:

- First of all measure frequency from Point of Common Coupling (PCC).
- After that continuously measure rete of change of frequency. Frequency change is due to mismatch generation and load.
- If frequency variation is in desire (below than 0.33 Hz/sec) or less than desired limit than ROCOF does not detect any change in frequency.

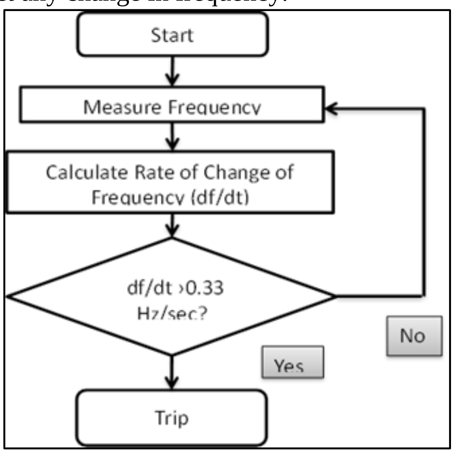


Fig. 3: flow chart of ROCOF

- If change in frequency is more than set value than it can detect that change and generate trip signal.

### *B. Rate Of Change Of Power*

If system is islanded, the rate of change of output power dP/dt, at the DG side [2], will be more than that of the rate of change of output power before the DG is removed for the same rate of load change. It has been found that this method is much effective when the distribution system with DG has generation and load is mismatch.

In this project ROCOP relay is work as upper flow chart. Different steps are below:

- First measure voltage and current from PCC.

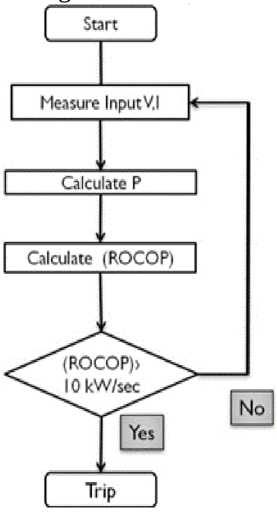


Fig. 4: flow chart of ROCOF

- Than calculate active power P from .
- After that calculate Rate of change of power of DG and grid.
- If rate of change of power is less than 10 kW/sec than no issues.
- If rate of change of power is more than 10kW/sec than ROCOP is detect that DG is isolated from main bus (grid).

## V. POWER SYSTEM SIMULATION STUDY OF ISLANDING DETECTION

### *A. Parameters:*

| | |
|---|---|
| Main Grid | 11 kV connected with 11/20 kV Transformer |
| Induction Generator | 660 V – 0.66 MVA |
| Turbine Type | Mode 2 (Three blade) |
| Self-Excitation Capacitor | 1.05 MVAR |
| Static Load | 0.707 MVA (PF=0.707) |
| Wind Generator Transformer | 0.69/20 kV – 0.8 MVA |
| Wind Speed | 15 m/s |
| Breaker Operation | 0˚, 30˚ and 90˚ |
| Method | PASSIVE (ROCOF AND ROCOP) |

 

*B. Circuit Diagram:*

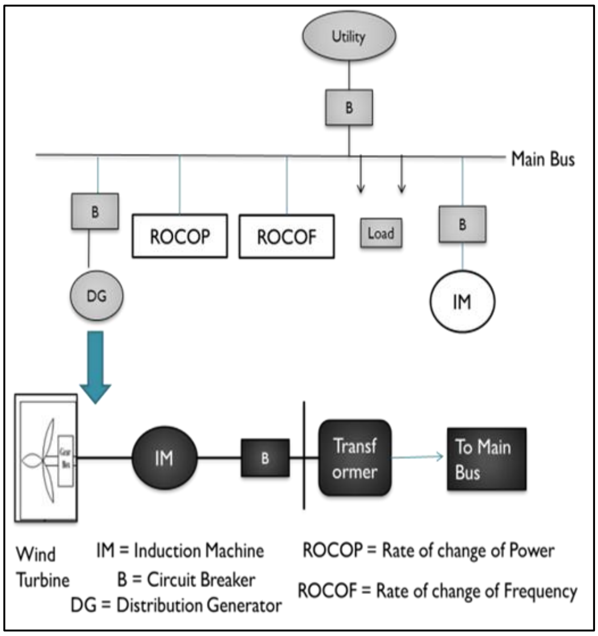


Fig. 5: block diagram

General diagram show in given figure 8. As depicted in figure wind turbine used as DG and IM connected with wind turbine. Capacitor bank connects for improvement of power factor. Transformer is connected between Grid and DG. In general working condition system frequency is 50Hz. Utility system is 20kV; 30MVA is connected to main bus. DG (wind turbine 660V; 0.8 MVA) is connected to main bus through transformer which is step up voltage from 660V to 20kV.

When circuit breaker is closed, than DG is connected to local load and power grid (figure 8), and power produced by DG is transfer to power grid and local load. When the circuit breaker is opened, DG is disconnecting with power grid. After removing DG from power grid, DG is supply power to local load only. In this condition DG is islanding so after system is recover and after DG connects with power grid through circuit breaker, before that it is supply to local load.

Now, problem is that how detect islanding. For detect the islanding condition there are two system is used here shown in figure 8.One is Rate Of Change Of Power and other one is Rate Of Change Of Power.

*C. Rocof:*

In first method there is frequency detector which checks islanding condition, utility system is remove from main bus and load on DG.

When any disturbance occur in system so some parameter change this parameter may be voltage, frequency, active power, reactive power. If system is islanded and mismatch between generation and load than frequency of grid and DG is different which is detected by ROCOF relay. If frequency change is more than desired limit than it can operate and detect system is islanded.

Here islanding occur at three point so for 0˚ angle, 30˚ and 90˚. Shown result in fig 7, fig 8, fig 9. Rate of change in frequency and detection time for ROCOF relay is shown in that figure. When islanding is occur than it can detect islanding as fast as possible. Here shown that it's detection time small. So this method is useful at which place faster islanding detection is required.

– Results of ROCOF

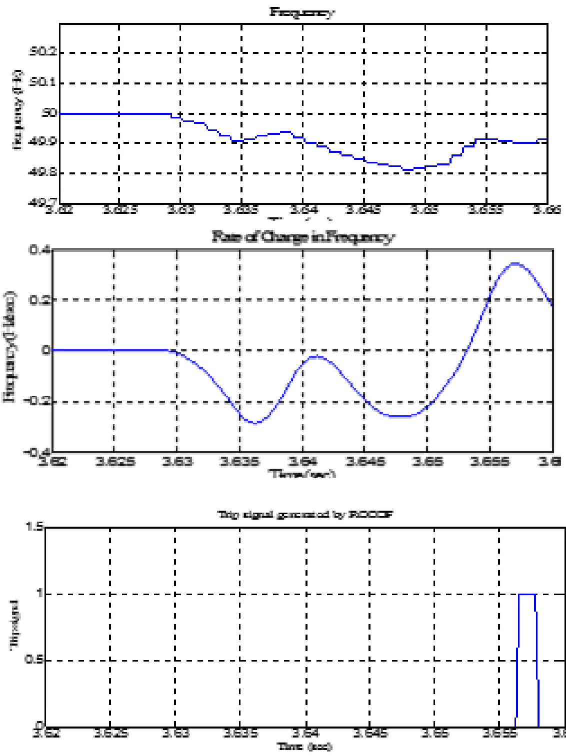


Fig. 7: ROCOF: - Islanding inception angle 0˚ (w.r.t. Phase 'A')

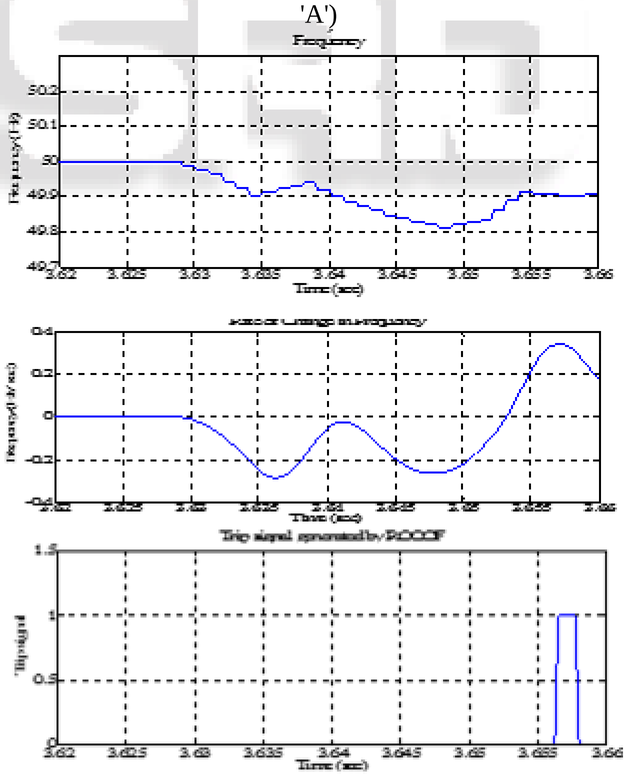


Fig. 8: ROCOF: - Islanding inception angle 30˚ (w.r.t. Phase 'A')

 

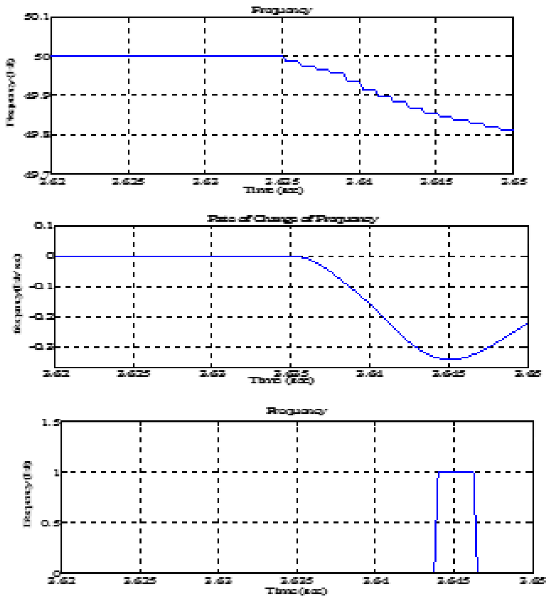

Fig. 9: ROCOF: - Islanding inception angle 90˚ (w.r.t. Phase 'A')

### *D. Rocop:*

In second method there is power change in system according to that, it check islanding condition, utility system is remove from main bus and load on DG.

If system is islanded and mismatch between generation and load than that is detected by ROCOP relay. If power change is more than desired limit than it can operate and detect system is islanded.

Response of ROCOP relay in islanding inception at three point 0˚ 30˚ and 90˚ angles are shown result in fig 10, fig 11, and fig 12

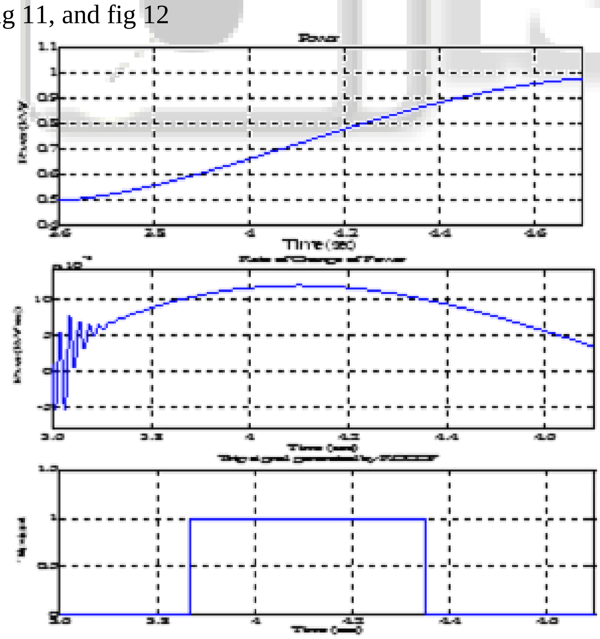

Fig. 10: ROCOP: - I1slanding inception angle 0˚ (w.r.t. Phase 'A')

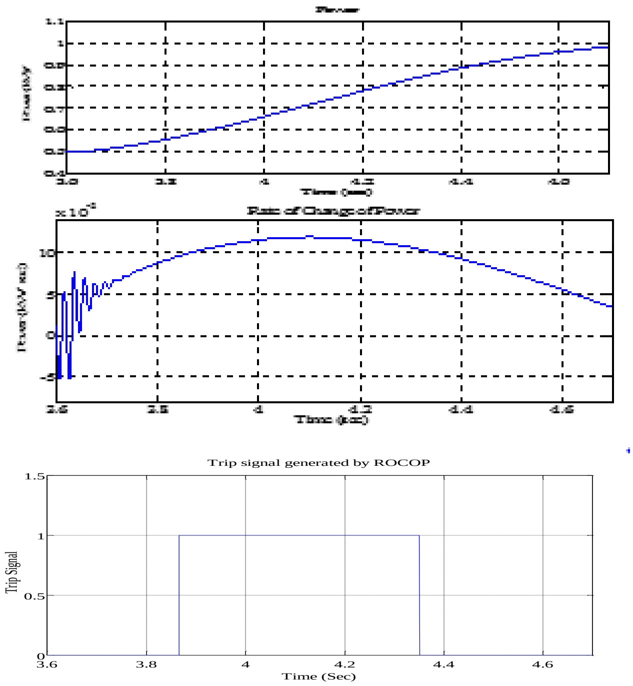


Fig. 11: ROCOP: - Islanding inception angle 30˚ (w.r.t. Phase 'A')

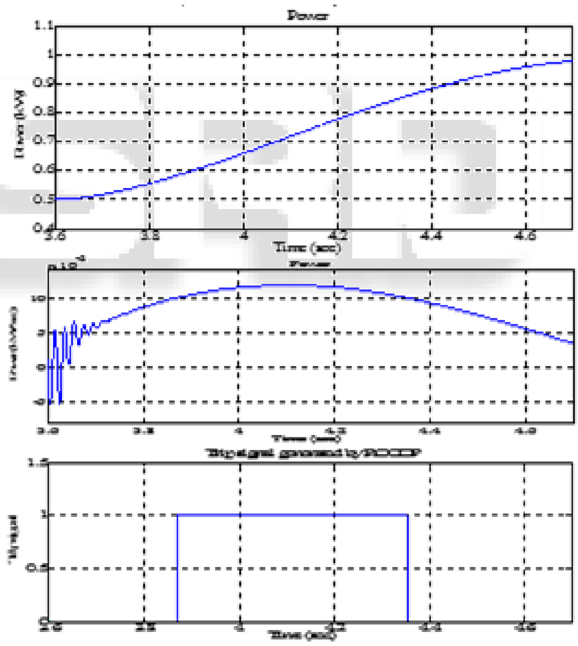

Fig. 12: ROCOP: Islanding inception angle 90˚ (w.r.t. Phase 'A')

### *E. Islanding Graph Of ROCOF And ROCOP:*

| Angle | Islanding instant | ROCOF | | ROCOP | |
|---|---|---|---|---|---|
| | | detection instant | detection duration | detection instant | detection duration |
| 0 | 3.6216 | 3.656 | 0.02 | 3.866 | 0.485 |
| 30 | 3.6234 | 3.6562 | 0.02 | 3.8662 | 0.487 |
| 90 | 3.6266 | 3.645 | 0.025 | 3.8645 | 0.488 |

Table 1: Islanding Detection and detection duration

 

### *F. Comparison of ROCOF and ROCOP Methods:*

| | ROCOF | ROCOP |
|---|---|---|
| Detection instant | Faster detection | Late detect |
| Detection duration | Less time | More time |
| Detection of islanding base on | change in frequency (df/dt) | change in Power (dP/dt) |
| Application | Islanding detection | Islanding detection |
| Detect islanding due to | Mismatch load and generation | Mismatch load and generation |
| Detection techniques | Passive (local) | Passive (local) |

Table 2: Comparison of ROCOF and ROCOP

## VI. Conclusion

Two methods are implemented for islanding detection in this work. Islanding detection of ROCOF has given fastest detection but small duration. However, islanding detection of ROCOP has given delay detection time but for large duration. So both methods we can used to detect islanding as required.

## References

[1] P. Mahat, C. Zhe, and B. Bak-Jensen, "Review of islanding detection methods for distributed generation," in Electric Utility Deregulation and Restructuring and Power Technologies, 2008. DRPT 2008. Third International Conference on, 2008, pp. 2743-2748.
[2] H. K. Kargar and J. Mirzaei, "New method for islanding detection of wind turbines," in Power and Energy Conference, 2008. PECon 2008. IEEE 2nd International, 2008, pp. 1633-1637.
[3] G. Hernandez-Gonzalez and R. Iravani, "Current injection for active islanding detection of electronically-interfaced distributed resources," Power Delivery, IEEE Transactions on, vol. 21, pp. 1698-1705, 2006.
[4] S. R. Samantaray, K. El-Arroudi, G. Joos, and I. Kamwa, "A Fuzzy Rule-Based Approach for Islanding Detection in Distributed Generation," Power Delivery, IEEE Transactions on, vol. 25, pp. 1427-1433, 2010.
[5] L. Bohan, D. Thomas, J. Ke, and M. Woolfson, "Advanced ROCOF protection Of synchronous generator," in Innovative Smart Grid Technologies (ISGT), 2011 IEEE PES, 2011, pp. 1-6.
[6] C. Wen-Yeau, "A hybrid islanding detection method for distributed synchronous generators," in Power Electronics Conference (IPEC), 2010 International, 2010, pp. 1326-1330.
[7] A. Samui and S. R. Samantaray, "Assessment of ROCPAD Relay for Islanding Detection in Distributed Generation," Smart Grid, IEEE Transactions on, vol. 2, pp. 391-398, 2011.
[8] J. C. M. Vieira, W. Freitas, X. Wilsun, and A. Morelato, "Efficient coordination of ROCOF and frequency relays for distributed generation protection by using the application region," Power Delivery, IEEE Transactions on, vol. 21, pp. 1878-1884, 2006.
[9] M. T. Hagh, N. Ghadimi, F. Hashemi, and S. J. Zebardast, "New islanding detection algorithm for wind turbine," in Environment and Electrical Engineering (EEEIC), 2011 10th International Conference on, 2011, pp. 1-5.
[10] H. H. Zeineldin and J. L. Kirtley, "A Simple Technique for Islanding Detection With Negligible Nondetection Zone," Power Delivery, IEEE Transactions on, vol. 24, pp. 779-786, 2009.
[11] M. E. Ropp, M. Begovic, and A. Rohatgi, "Analysis and performance assessment of the active frequency drift method of islanding prevention," Energy Conversion, IEEE Transactions on, vol. 14, pp. 810-816, 1999.
[12] Seyed Sohail Madani, Student Member, IEEE, Ali Abbaspour, Mojtaba Beiraghi, Payam Zamani Dehkordi, Student Member, IEEE, and Ali mohammad Ranjbar "Islanding Detection for PV and DFIG Using Decision Tree and AdaBoost Algorithm", 2012 3rd IEEE PES Innovative Smart Grid Technologies Europe (ISGT Europe), Berlin

 