Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 4, April-2017

Comparative Analysis Between Oscillation Frequency and Vector Surge Relays for Islanding Detection in Distributed Generations

Gaurang C. Kanzariya[1], Rajan K. Patel[2], Miteshkumar J. Sathvara [3]

[1]*PG student, Electrical Engineering, LDCE, Ahmedabad*
[2]*PG student, Electrical Engineering, LDCE, Ahmedabad*
[2] *Assistant Professor, Electrical Engineering, LDCE, Ahmedabad*

Abstract* — Nowadays, due to increase of renewable energy sources, Distributed Generations (DGs) is an important role in transmission & distribution systems. Due to poor voltage and frequency regulation, there is DG unintentional islanding may cause power quality (PQ) deterioration & life threatening. Due to this, islanding operation of distribution systems is not allowed and the anti-islanding protection is required for the connection of DGs at the sub-transmission & distribution networks. There is so many techniques have been proposed. Also there is new method that is based on synchronous machine oscillation frequency. Algorithm is based on the oscillation frequency of synchronous machine to distinguish from other events. Also a vector surge relay is a passive islanding detection method. In this comparison between oscillation frequency based IDM and vector surge relay based IDM is done. For the same load condition oscillation frequency take less time as compared to vector surge relay.

Keywords- Distributed generation (DG), Anti-islanding protection, Passive protection, Frequency oscillation, Synchronous generator.

I. INTRODUCTION

With the ever increasing hunger for energy, there is requirement to increased meet demand. There is gap between the production & demand. Over consumption of energy has led to frequent blackouts in many countries affecting the lives of millions. The 82 blackout in India is just an example of the same. The conventional sources are limited and it deteriorates the environment, so it is necessary to development of renewable sources on a larger scale. Many forms of renewable energy have been developed & to extract the maximum benefit, new technologies are being developed. Many countries have been identified with great wind potential & they started extracting energy from this renewable & never ending source [8]. Distributed generation is defined as the generation of power at the point of the power consumption.

One of the major challenges for distributed generation systems is detecting and fixing the potential occurrence of islands. Islanding is the condition in which Distributed generator continues to work in normal operation and feeds distribution lines when the connection of the utility grid has been interrupted [16].

There is so many techniques have been proposed. That is classified as remote & local islanding detection techniques. One of the popular method is rate of change of frequency due to its fast island detection. new method that is based on synchronous machine oscillation frequency. Algorithm is based on the oscillation frequency of synchronous machine to distinguish from other events.

II. ISLANDING

One of the major challenges for distributed generation systems is detecting and fixing the potential occurrence of islands. Islanding is the condition in which DG continues to work in normal operation and feeds distribution lines when the connection of the utility grid has been interrupted [16]. Figure1 shows the overview of islanding mode in a grid connected PV system.

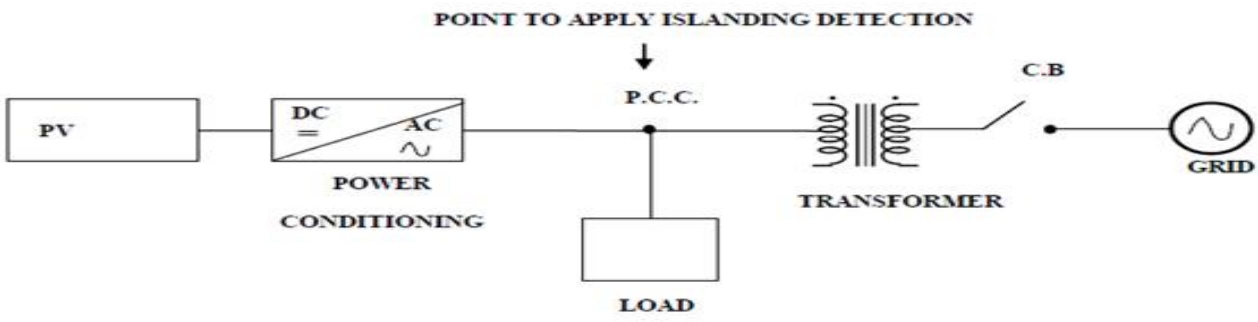

Figure 1 Overview of islanding mode in a grid connected PV system

A. Classification of Islanding Detection Method

Islanding is first classified into the remote and local methods.

1. Remote IDM
2. Local IDM

B. Remote IDM

In remote IDM, the electrical grid level where utility or network operators would monitor islanding information and control relays or distributed generation directly.

C. Local IDM

Local methods are based on traditionally, at inverter where DG use information gathered autonomously to make disconnection decisions. Local are further classified as:

1. Active IDM
2. Passive IDM

D. Active IDM

Active methods use signal injection, positive feedback, or controlled distortion to provide islanding detection indicators. These methods, generally, have smaller errors than passive methods.

E. Passive IDM

Passive methods use measured values of current, voltage, or power in various ways. Thresholds are then set against these measurements, and when these measured values exit the normal operating range, a trip relay will initiate.

III. PRICCIPLE OF OSCILLATION FREQUENCY AND VECTOR SURGE RELAYS

In this technique, measurement of oscillation frequency at distributed generator side is done for islanding detection in distributed generation. If there is large power mismatch is it is easily detect [6]. The frequency deviate for its normal value, 50 Hz, is compared with threshold 1, Oscillation frequency is to be calculated when frequency crosses threshold 1 [6]. Figure 2 shows flow chart of the proposed algorithm that is oscillation frequency based [6].

A. Oscillation Frequency

In this technique, measurement of oscillation frequency at distributed generator side is done for islanding detection in distributed generation. If there is large power mismatch is it is easily detect [6]. The frequency deviate for its normal value, 50 Hz, is compared with threshold 1, Oscillation frequency is to be calculated when frequency crosses threshold 1 [6]. Figure 2 shows flow chart of the proposed algorithm that is oscillation frequency based [6].

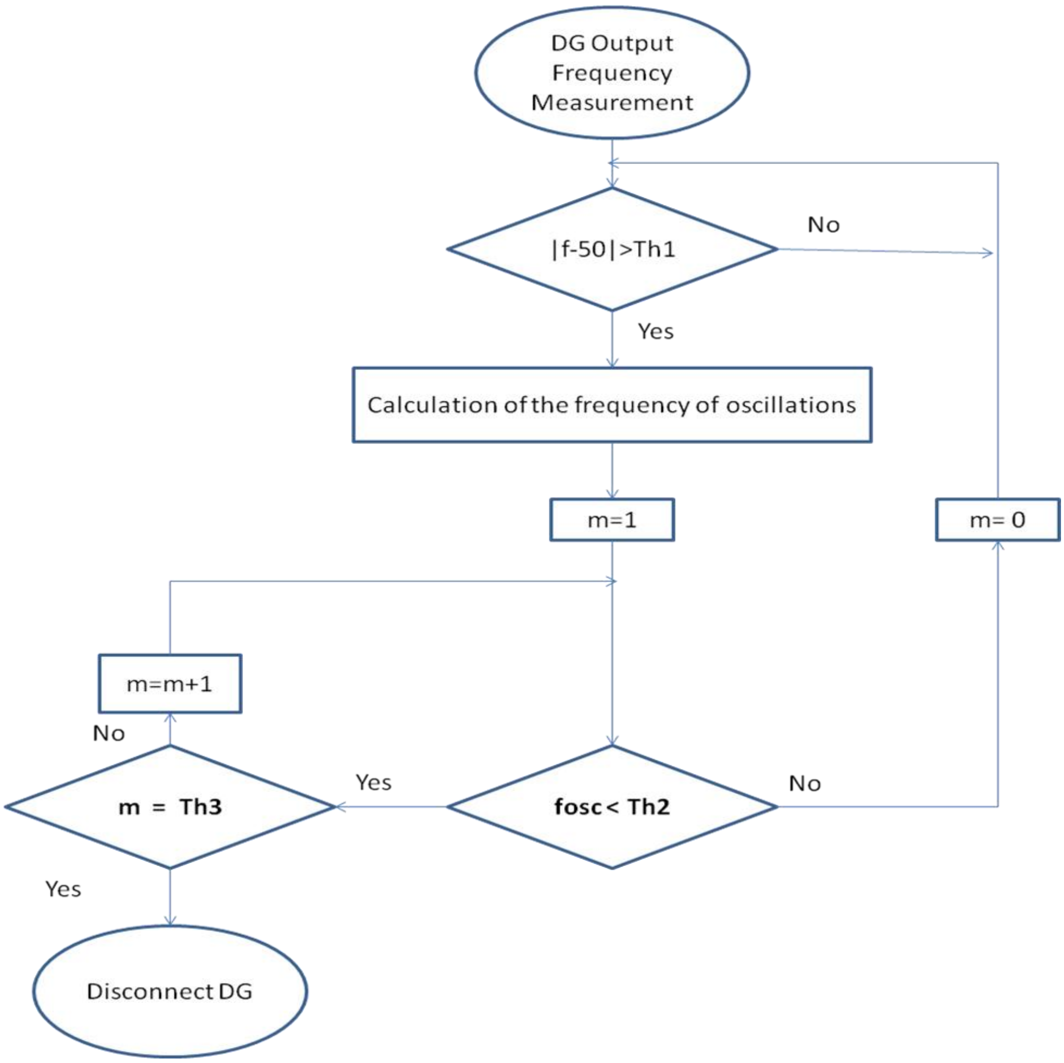

Figure 2 Flow chart of the proposed algorithm that oscillation frequency based

Usually, the frequency of interconnected electrical systems changes in plus/minus 100 mHz; in this way, Th1 is adjusted to be 200 mHz. The selection of Th2 must be less than the DG natural damped frequency of oscillation so; Th2 is selected to be 1.33 Hz. The small time delay that is introduced by Th3 is necessary to introduce more robustness to the method. In the study presented in this paper, the time delay is two cycles of 50 Hz; in other words, Th3 is 305.

The synchronous generators' oscillation frequency is usually very low, only a few hertz. The frequency oscillation estimation method proposed in this paper employs just three frequency samples to estimate [6].

$$f_{osc} = \frac{f_{\text{sample}}}{2\pi N}\cos^{-1}\left(\frac{f(k) + f(k-2N) - 2f_0}{2f(k-N) - 2f_0}\right)$$

Where f_{sample} is the sampling frequency, f_0 is the nominal frequency, acos is the arccosine, f(k) is the electrical frequency at k the instant, and N represents half of the window size

B. Vector Surge Relays

A synchronous generator equipped with a vector surge relay VSR operating in parallel with a distribution network is depicted in Fig. 3.

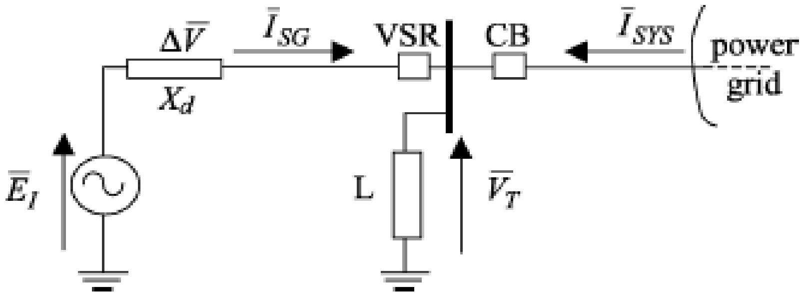

Figure 3 Equivalent circuit of a Synchronous Generator in parallel with utility.

There is a voltage drop between the terminal voltage and the generator internal voltage due to the generator current passing through the generator reactance. Consequently, there is a displacement angle between the terminal voltage and the generator internal voltage, whose phasor diagram is presented in Fig. 4(a). In Fig. 3 if the circuit breaker (CB) opens due to a fault, for example, the system composed by the generator and the load L becomes islanded.

At this instant, the synchronous machine begins to feed a larger load (or smaller) because the current provided by (or injected into) the power grid is abruptly interrupted. Thus, the generator begins to decelerate (or accelerate). Consequently, the angular difference between and is suddenly increased (or decreased) and the terminal voltage phasor changes its direction, as shown in Fig. 4(b).

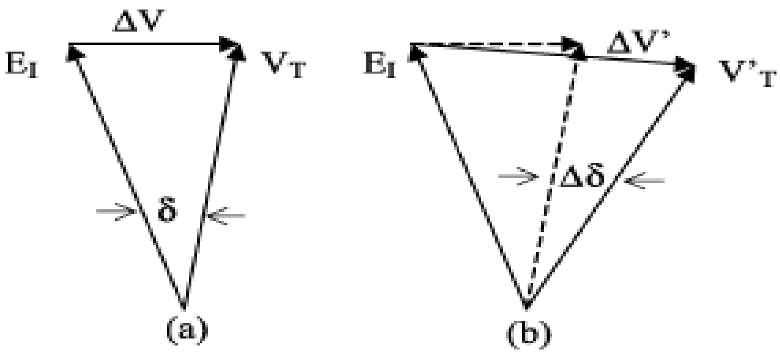

Figure 4 Internal and terminal voltage phasors: (a) before the opening of CB; (b) after the opening of CB.

The vector surge relays are simulated as follows. The generator terminal voltage angle is determined at each integration step, and a reference terminal voltage angle is computed and updated at the beginning of each cycle (i.e., it is updated cycle by cycle). The absolute variation between these two angles is calculated at each integration step and compared with the VSR angle threshold . Additionally, the root mean square (rms) value of the terminal voltage is also determined at each integration step. If the angle variation is greater than the angle threshold and the magnitude of the terminal voltage is greater than the minimum voltage setting , the vector surge relay immediately sends a trip signal to the CB. For both method test system which is to be consider is shown in Figure 5.

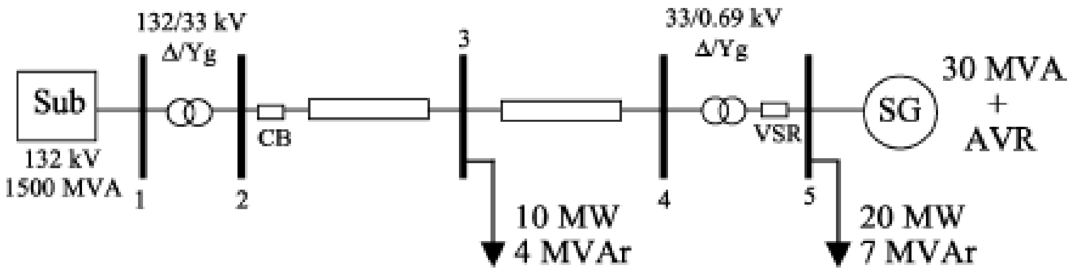

Figure 5 SLD of the Test System

The test system adopted in this paper is shown in Fig. 5. The network consists of a 132-kV, 60-Hz subtransmission system with a short-circuit level of 1500 MVA, represented by a Thévenin equivalent (Sub), which feeds a 33-kV distribution system through a 132/33-kV, Yg transformer. In this system, there is one synchronous generator with a capacity of 30 MVA connected at bus 5, which is connected to network through one 33/0.69 kV, Yg transformer.

IV. SIMULATION AND RESULTS

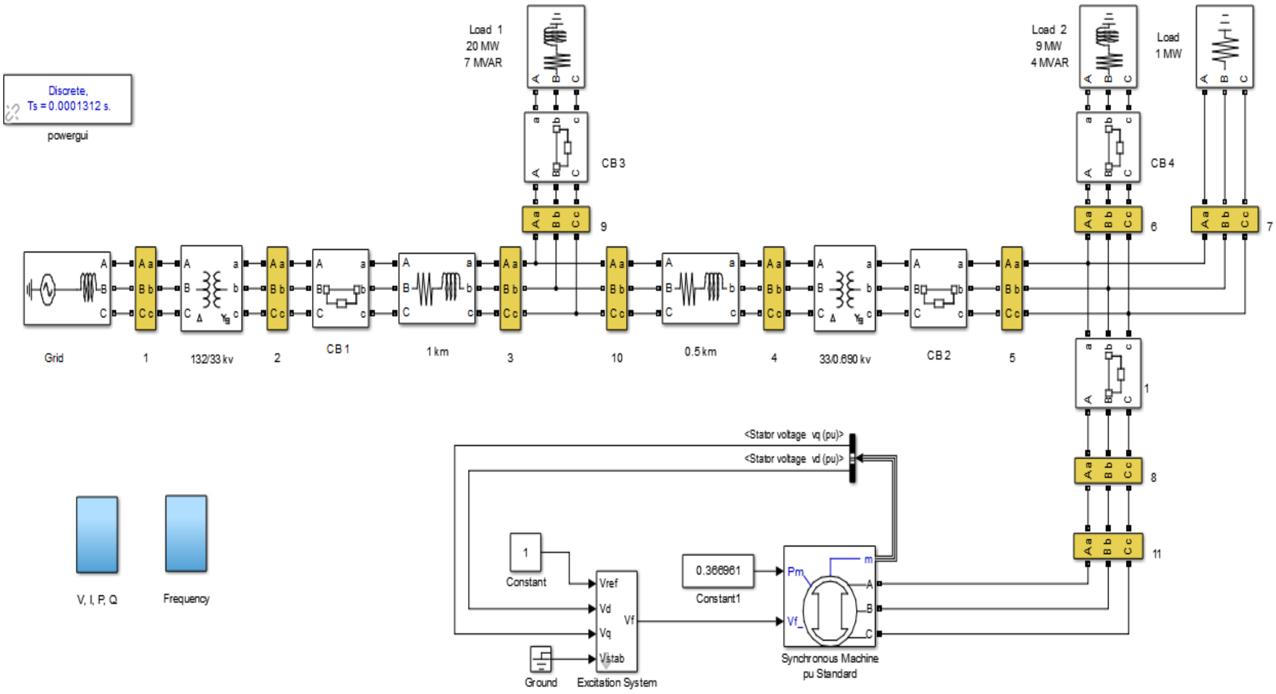

Figure 6 Main System

Figure 6 shows main system which consider. In this system utility supply distribution network. At the distribution side one synchronous generator is consider as DG. There are three load. There are two subsystem V,I,P,Q and frequency. In V,I,P,Q subsystem voltage, current, active and reactive power are to be measured at each bus. In frequency subsystem, frequency is to be measured at DG side.

A. Non-Islanding Condition

In this condition all Circuit breaker al remain in closed position so network is in normal condition. Voltages, current, active and reactive power all are normal. Figure 7 show frequency for Non-Islanding Condition.

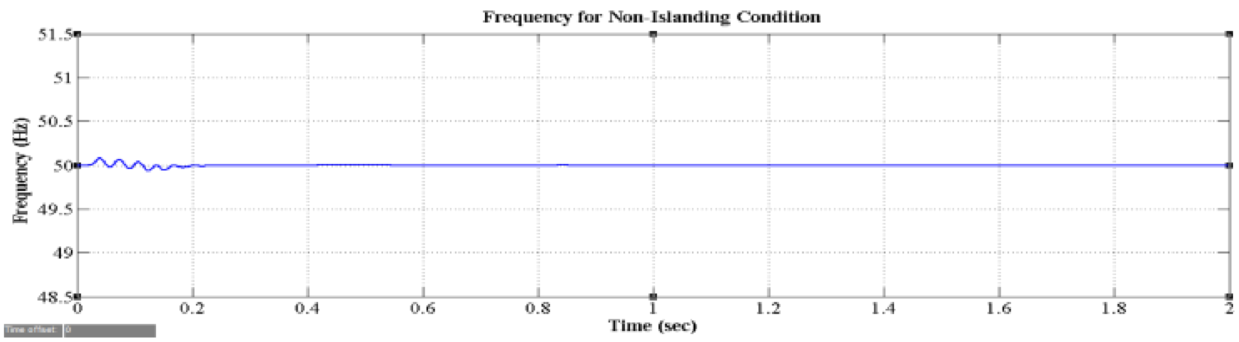

Figure 7 Frequency for Non-Islanding Condition.

B. Islanding Condition

In the islanding condition lets consider to cases, first one is power generated by DG synchronous generator is less than the total load connected to DG synchronous generator and second one is power generated by DG synchronous generator is greater than the total load connected to DG synchronous generator.

1. Generation less than total load

In this cases power generated by DG synchronous generator is less than the total load connected to the DG synchronous generator in the islanding condition. In the system CB 1 is open so DG generation is 11 MW that is less then total load that is 30 MW. Due to this system frequency is decreasing from the instant at CB 1 is open. In this CB1 is open at 0.5 sec. Figure 8 shows Frequency for Islanding condition generation less than total load.

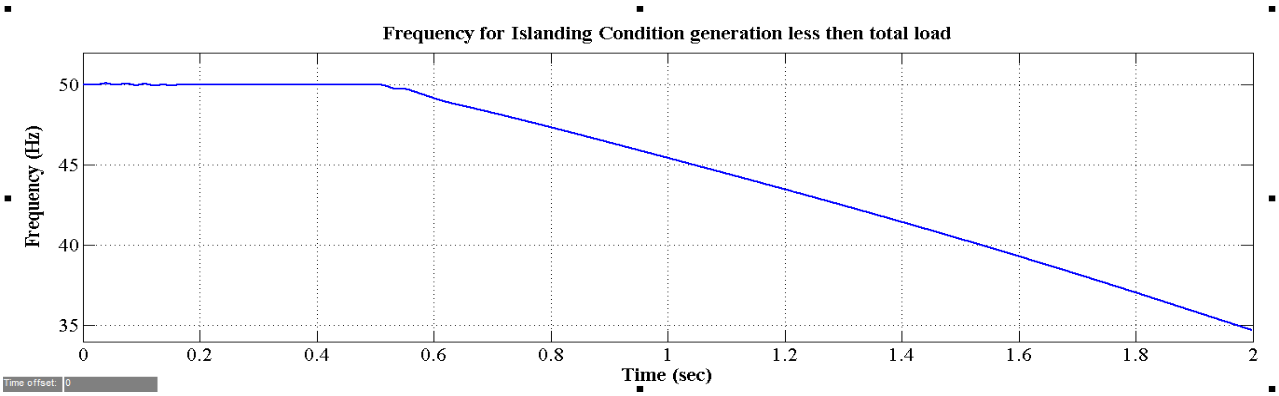

Figure 8 Frequency for Islanding Condition Generation less than total load.

2. Generation greater than total load

In this cases power generated by DG synchronous generator is greater than the total load connected to the DG synchronous generator in the islanding condition. In the system CB 2 is open so DG generation is 11 MW that is greater then total load that is 9 MW. Due to this system frequency is increasing from the instant at CB 2 is open. In this CB1 is open at 0.5 sec. Figure 9 shows Frequency for islanding condition generation greater than load.

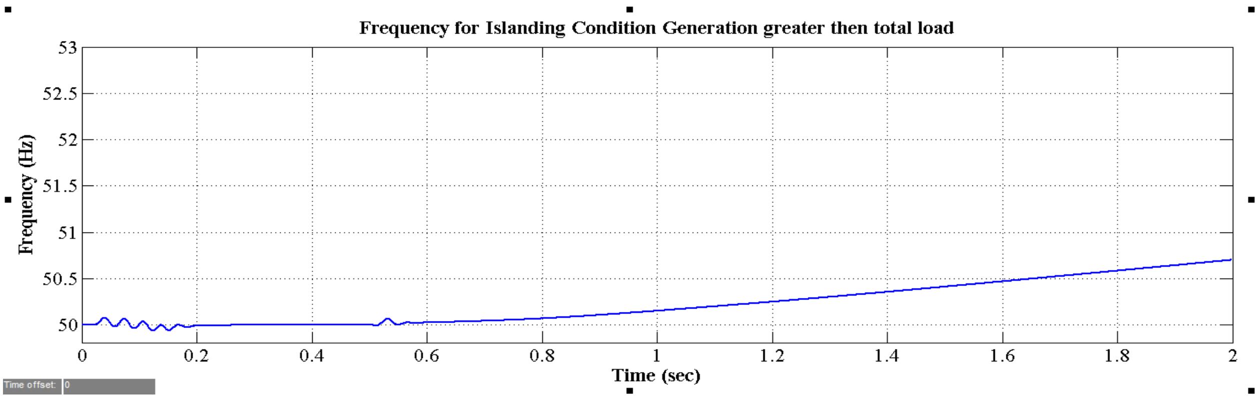

Figure 9 Frequency Signal for Islanding Condition Generation greater than total load.

C. Oscillation Frequency IDM Result

Table 1 show analysis for various loads on the DG synchronous generator for Oscillation frequency based islanding detection method

Table 1 Analysis for Various Loads

No.	Load (MW)	Frequency (Hz)	Detection Time (sec)
1.	2	56.92	0.0292
2.	4	55.50	0.0310
3.	6	53.44	0.0797
4.	8	52.33	0.1461
5.	10	50.70	0.6024
6.	12	49.22	0.5115
7.	14	47.62	0.1496
8.	16	46.00	0.0837
9.	18	44.37	0.0318
10.	20	42.74	0.0303
11.	22	41.11	0.0289
12.	24	39.48	0.0288
13.	26	37.66	0.0287
14.	28	36.25	0.0285
15.	30	34.69	0.0285

D. Vector Surge Relay IDM Result

Table 2 show analysis for various loads on the DG synchronous generator for Vector surge relay for α=5 degree based islanding detection method.

Table 2 Analysis for Various Loads (α=5 deg)

No.	Load (MW)	Frequency (Hz)	Detection Time (sec)
1.	1	57.47	0.0822
2.	2	56.78	0.1023
3.	3	56.10	0.1224

4.	**4**	**55.50**	**0.1625**
5.	**5**	**54.67**	**0.2027**
6.	**6**	**53.91**	**0.2830**
7.	**7**	**53.13**	**0.4638**
8.	**8**	**52.39**	**1.4678**
9.	**18**	**44.37**	**0.2228**
10.	**20**	**42.74**	**0.1224**
11.	**22**	**41.11**	**0.0822**
12.	**24**	**39.48**	**0.0621**
13.	**26**	**37.86**	**0.0421**
14.	**28**	**36.25**	**0.0421**
15.	**30**	**34.69**	**0.0220**

Table 3 show analysis for various loads on the DG synchronous generator for Vector surge relay for α=10 degree based islanding detection method.

Figure 1. **Table 3 Analysis for Various Loads (α=10 deg)**			
Figure 2. **No.**	Figure 3. **Load (MW)**	Figure 4. **Frequency (Hz)**	Figure 5. **Detection Time (sec)**
Figure 6. 1.	Figure 7. 1	Figure 8. 57.47	Figure 9. 0.3031
Figure 10. 2.	Figure 11. 2	Figure 12. 56.78	Figure 13. 0.3834
Figure 14. 3.	Figure 15. 3	Figure 16. 56.10	Figure 17. 0.5441
Figure 18. 4.	Figure 19. 4	Figure 20. 55.50	Figure 21. 0.9056
Figure 22. 5.	Figure 23. 22	Figure 24. 41.11	Figure 25. 0.6646
Figure 26. 6.	Figure 27. 24	Figure 28. 39.48	Figure 29. 0.3031
Figure 30. 7.	Figure 31. 26	Figure 32. 37.86	Figure 33. 0.2027
Figure 34. 8.	Figure 35. 28	Figure 36. 36.25	Figure 37. 0.1425
Figure 38. 9.	Figure 39. 30	Figure 40. 34.69	Figure 41. 0.1224

V CONCLUSION

Here, in this paper two islanding detection methods is given that is oscillation frequency based and vector surge relay. From the result of the both method it is concluded that the oscillation frequency based method take less detection time as compared to the vector surge relay based method. Also concluded that Non Detection Zone of the oscillation frequency based method is less as compared to the vector surge relay. Non detection zone of the oscillation frequency based method is 3.6%.

VI. REFERENCES

[1] Sung-II Jang, Kwang-Ho Kim "An Islanding Detection Method for Distributed Generation Using Voltage Unbalance and Total Harmonic Distortion of Current" IEEE Harmonic Distortion of Current" IEEE Transaction on power delivery, vol. 19, NO. 2, pp. 745-752, April 2004.

[2] Omar N. Faqhruldin, Ehab F. E1-Saadany, Hatem H. Zeineldin "A Universal Islanding Detection Technique for Distributed Generation Using Pattern Recognition" IEEE transaction on smart grid, vol. 5, NO. 4, pp. 1985-1992, July.

[3] Hesan Vahedi, Mehdi Karrari "Adaptivr Fuzzy Sandia Frequency-Shift Method for Islanding Protection of Inverter-Based Distributed Generation" IEEE transacttion on power delivery, Sept 2012.

[4] Hieu Thanh Do, Xing Zhang, Ngu Viet Nguyen, Shanshou Li and Tho Thi-Thanh Chu "Passive Islanding detection method using Wavelet packet Transform in grid Connected Photovoltaic Systems" IEEE transaction on power electronics, 2015.

[5] Houshang karimi, Amimaser Yazdani, Reza Travani "Negative-Sequence Current Injection for Fast Islanding Detection of a Distributed Resource Unit" IEEE transactions on power electronics, vol. 23, No.1, pp. 298-307, January 2008.

[6] Gustavo Marchesan, Matias Rossato, Ghendy Cardoso, Jr., Lenois Mariotto, and A. P. de Morais "Paasive Method for Distributed Generation Island Detection Based on Oscillation Frequency" IEEE Transaction on power delivery, vol. 31, NO. 1, pp. 138-146, February 2016.

[7] Amin Helmzadeh, Javad Sadeh and Omid Alizadeh Musavi "Anti-Islanding Protection of Distributed Generation Resources Using Negative Sequences Component of voltage" IEEE Conference paper on Power, pp. 440-443.

[8] www.gwec .net, accessed on 2nd November, 82.

[9] In-Su Bae, Jin-O Kim, Jac-Chul Kim and C.Singh "Optimal operating strategy for Distributed Generation Considering Hourly Reliability Worth" IEEE Transaction on Power System, vol. 19, NO. 1, pp.287-291, February 2004.

[10] MudathirFunshoAkorede, HashiHizam, EdrisPouresmaeil, "Distrbuted energy resources and benefits to the environment, Renewable and Sustainable enerdy reviews", vol. 14, NO. 2, pp.724-734, February.

[11] MichielHouwing , Austin N. Ajah, Petra W. Heijnen, Ivo Boxwmans, Paulien M. Herder, "Uncertainties in the Design and Operation of Distributed Enerdy resources: The case of micro-CHP Systems" Energy 33, pp. 1518-1536, 2008.

[12] Zhe Chen, FredeBlaabjerg and John K. Pedersn, " Hybrid Compensation Arragement in Dispersed Generation Systems", IEEE Transacation on power delivery, vol. 20, NO. 2, pp. 1719-1727, April 2005.

[13] J, A Pecas Lopes, N. Hatziargyriou, J. Mutale, P. Diapic, N. Jenkins, "Integrating Distributed Generation in to Electric Power Systems: A Review of drivers challenges and opportunities", Electric Power System Reseach 77, pp. 1189-1110, 2007.

[14] Sukumar. M. Brahma and Adly A. Girgis "Development of Adaptive Protection scheme for Distribution Systems with High Penetration of Distributed Generation", IEEE Transaction on power Delivery, vol. 19, no. 1, pp. 56-63, January 2004

[15] Hasham Khan, Muhammad Ahmad Choudhry and TahirMehmood, "An Algorithm to improve feeder performance at distribution level for extreme load growth scenario", Mehran university research journal of engineering and technology, vol. 27, NO. 4, pp. 377-392, 2008.

[16] Wei Yee Teoh, Chee Wei Tan "An Overview of islanding detection methods in photovoltaic systems", World Academy of scienece, Engineering and Technology 58, pp.674-682.

[17] Jose C. M. Vieira, Walmir Freitas "An investigation on the Non-Detection zones of synchronous distributed generation anti-islanding protection" IEEE Transaction on power delivery, vol. 23, NO. 2, pp. 593-600, April 2008.