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Islanding Detection using Oscillation Frequency

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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. It use small window of 2.1ms to calculate the oscillation frequency that enables fast islanding detection. Even though the window is small, result is secure and able to detect islands when the interrupted power at the disconnected point is less than 3.6% of the DG power. The main contribution of the proposed method is speed detection improvement.

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 generatior 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.

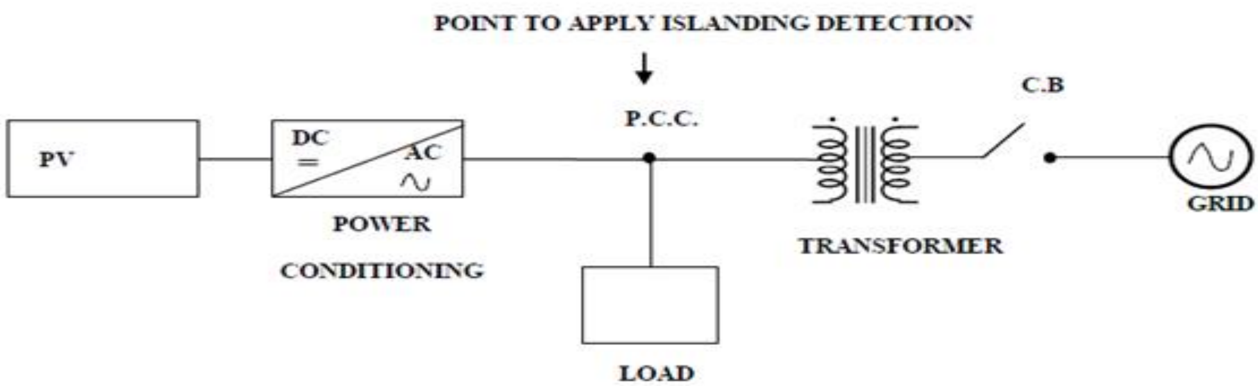


Figure 1 Overview of islanding mode in a grid connected PV system

A. *Modes of Islanding*

There are modes of islanding that intentional and unintentional islanding.

B. *Intentional Islanding*

Intentional islanding is the planned type in which Power Island is created by sectionalizing the utility system. [12]. It is carried out mainly for maintenance purposes in which the island maintains a continuous supply of power. Intentional islanding does not cause any harm to the system and total remaining loads should be less or near to the DG capacity prior to the formation of the island [12].

C. Unintentional Islanding

Unintentional islanding is the unplanned one mostly caused by fault or an accident in which the loss of connection remains undetected.

III. ISLANDING DETECTION USING 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].

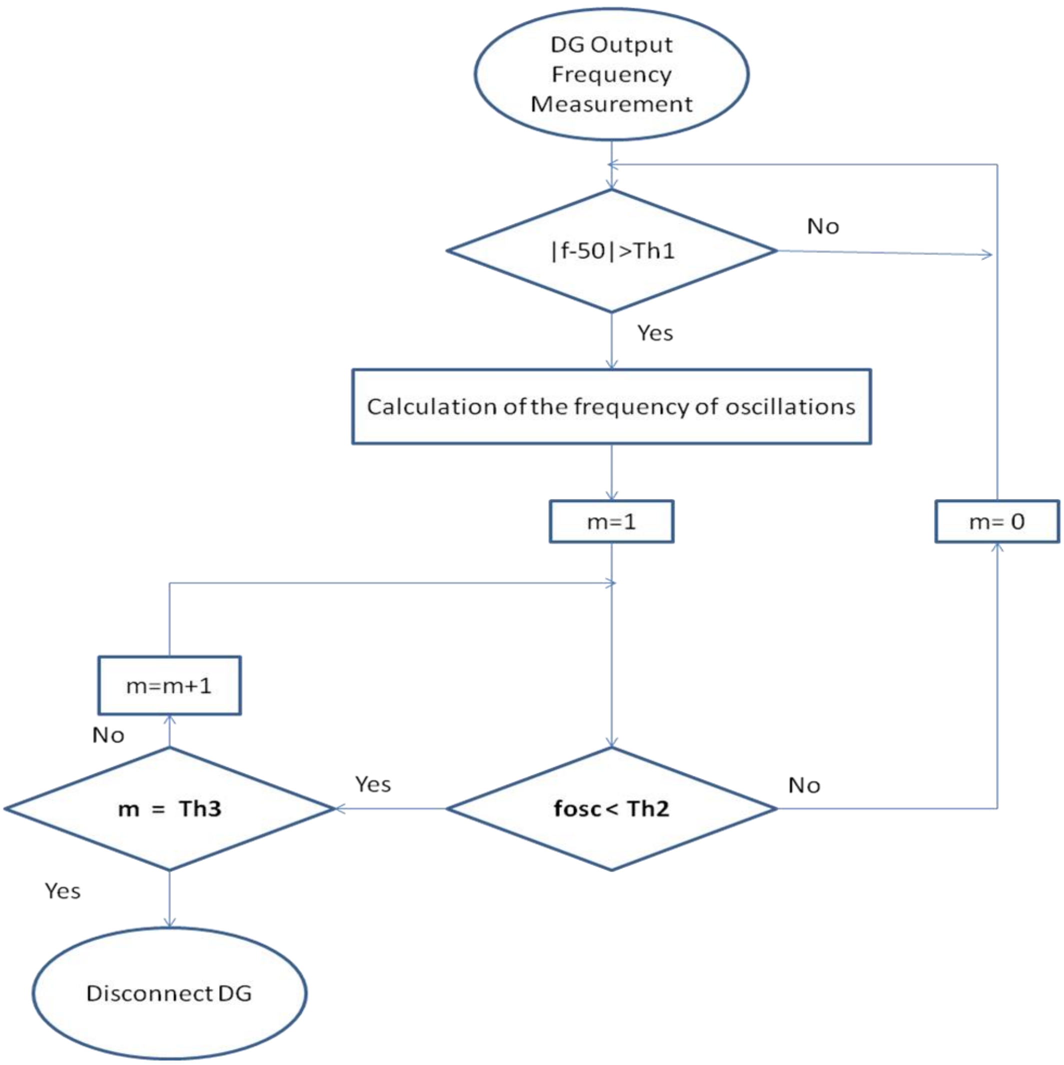


Figure 2 Flow chart of the proposed algorithm that oscillation frequency based

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.

A. Frequency Estimation

The synchronous generators' oscillation frequency is usually very low, only a few hertz. For frequency estimation of these signals, some algorithm needs a large window, such as 350 and 500 ms . Although these algorithms are accurate, the introduced delay is very large. 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. It is desirable to have the fastest possible estimation convergence. In this way, should be the lowest integer possible. On the other hand, larger gives more accuracy for the method. In the studies carried out in this paper, is set to be 8, resulting in a window length of 16 samples (2.1 ms). The window used in the proposed methodology is much smaller than the one presented by, allowing for a much faster protection function.

IV. SIMULATION AND RESULTS

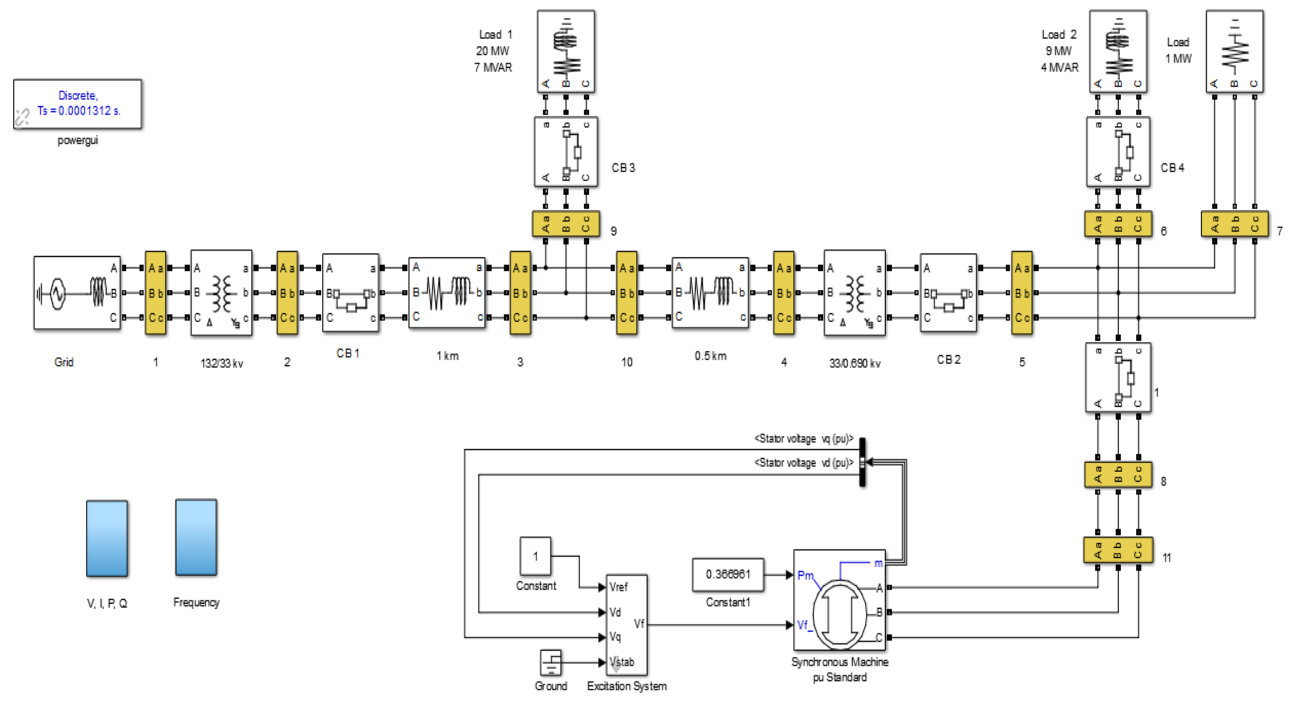
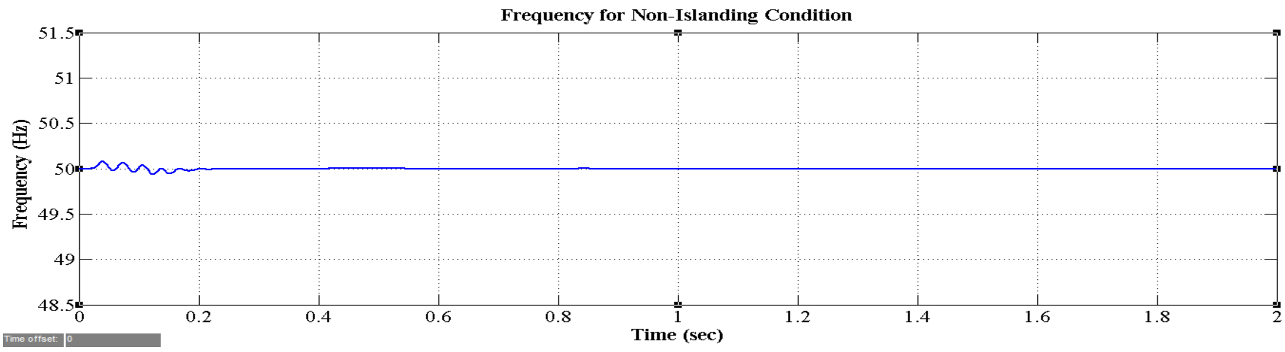


Figure 3 Main System

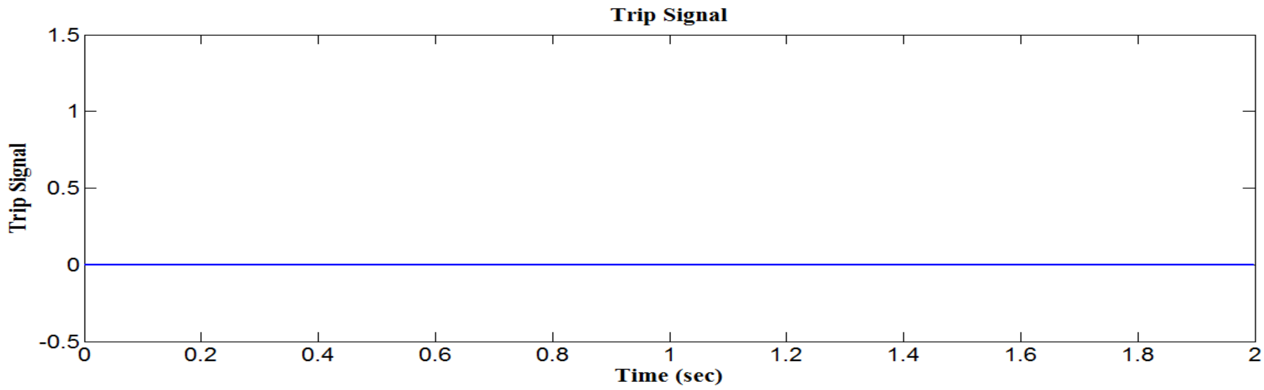
Figure 3 shows main system which consider. In this system utility supply distribution network. At the distribution side one synchronous generator is consider as DG. There are three load. There are two subsystem V,I,P,Q and frequency. In V,I,P,Q subsystem voltage, current, active and reactive power are 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. Voltage, current, active and reactive power all are normal. Figure 4 show (a) frequency of the system and (b) trip signal.



(a)



(b)

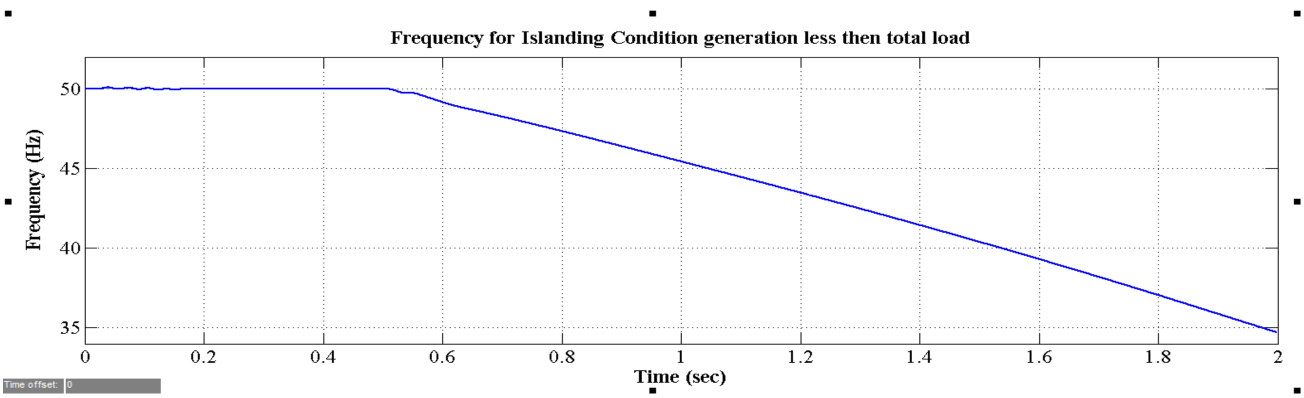
Figure 4 (a) Frequency and (b) Trip Signal for Non-Islanding Condition.

B. Islanding Condition

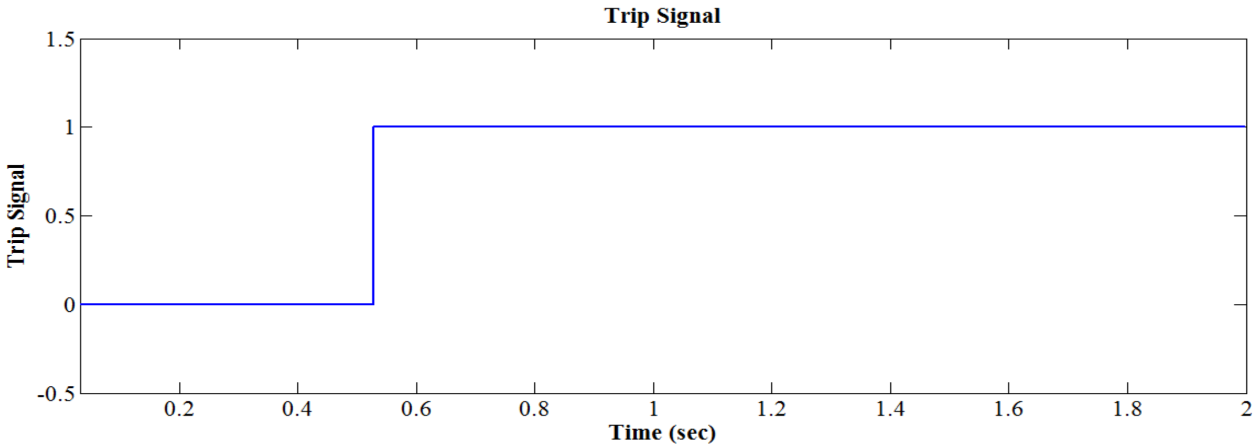
In the islanding condition lets consider to cases, first one is power generated by DG synchronous generator is less then the total load connected to DG synchronous generator and second one is power generated by DG synchronous generator is greater than the total load connected to DG synchronous generator.

C. Generation less then 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 5 shows (a) Frequency and (b) Trip Signal.



(a)

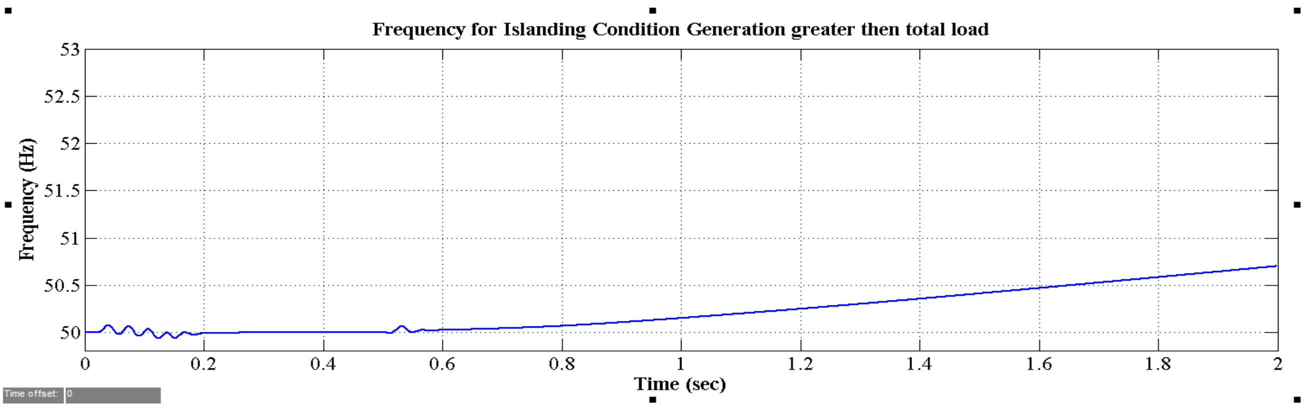


(b)

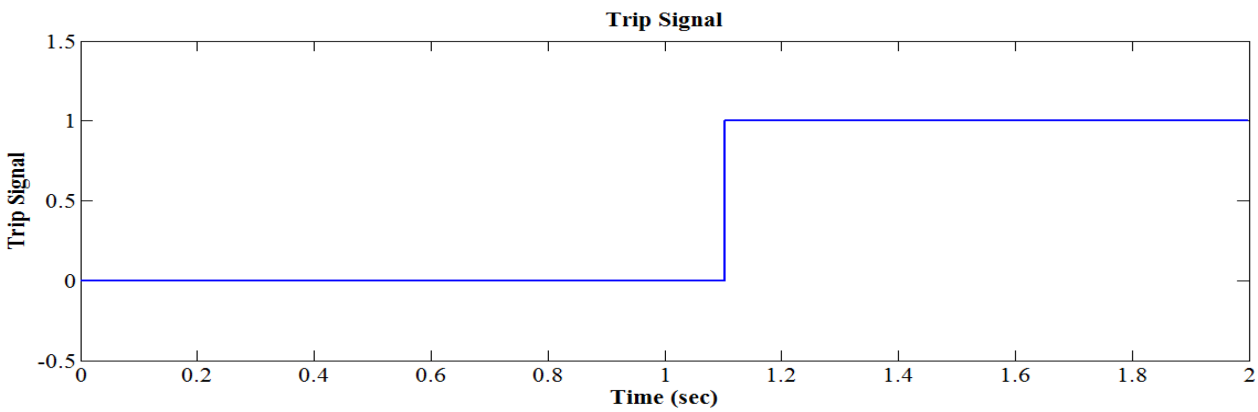
Figure 5 (a) Frequency and (b) Trip Signal for Islanding Condition Generation less than total load

D. 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 6 shows (a) Frequency and (b) Trip Signal.



(a)



(b)

Figure 6 (a) Frequency and (b) Trip Signal for Islanding Condition Generation greater than total load

E. Analysis for Various Load on DG

In this, various loads is to be taken for analysis of the proposed algorithm. In Table 1 various load is to be taken.

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

V CONCLUSION

An efficient and suitable passive island detection method for distribution generation systems with synchronous generators has been presented. From this proposed algorithm, conclude that in the islanding condition when large unbalance occur than the proposed algorithm detect it very fast.

And also, conclude that in the islanding condition when total load value is nearly equal to the DG synchronous generator value at that time the proposed algorithm take more time to detect islanding condition. The proposed algorithm is able to detect islanding in unbalance power less than 3.6%. Also, it does not detect the switching loads.

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