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Detection of Power Grid Synchronization Failure System on Depicting Sources, Line and Grid Base Analysis

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ABSTRACT: In this paper, we reflect the development of a system to trace the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage levels. There are many power generation units inter-connected to the grid such as hydel, thermal, solar etc. to supply power to the load. These generating units having responsibility to supply power according to the rules and regulation of the grid. These rules involve maintaining a voltage variation within reference limits and also the frequency. So it is convenient to have a system which give alerts the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure. This prevents in large scale brown out or black out of the grid power. So, it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid tototalgrid failure. We are planning to implement microcontroller monitors and control the under/over voltage being derived from a set of comparators and a standard Arduino or control unit is used to vary the input voltage to test the functioning grid for proper synchronization .

KEYWORDS: Current variation, Voltage variation, islanding, smart grid, LCD (liquid-crystal display).MC (microcontroller)

I. INTRODUCTION

The project is designed to findout the synchronization failure which occur in power distribution systems, the power grid station collecting supply from various feeder stations such as a thermal power generating station, a wind power generating station, a solar power generating station etc. For suitable level of transmission, the frequency and voltage of the AC supply should be within the specified limits as decided by the grid. There are lots of power generation units connected to the grid such as hydro, thermal, solar etc. to provide supply power to the load at different locations. These generating units want to supply power as per requirement need of the rules of the grid. These rules includes maintaining a voltage fluctuations within limits and also the frequency. This prevents in large scale brown out or black out of the grid power. So it is convenient to have a system which can give warning alert the grid in advance so that backup arrangements are kept on standby to avoid total grid failure. In case these limits increased by reference value and the demand for power consumption is more than the demand for supply generation , it results in grid shutdown or failure. In such type of situations, the feeder unit is completely isolated from the grid, causing islanding situation. Thus synchronization is needed amongst the grid and the feeder unit. This paper give suggestion a way to trace the fluctuations in frequency and voltage of the power supply from the feeder unit to determine the synchronization failure. Here a frequency variation in different levels detection system and a voltage variation detection system are used. For frequency fluctuation, voltage variations, and for the current variations we implement the sensors here. In case of any voltage, frequency fluctuations or variation, the lamp is switched on .of any external supply source to the power grid on sensing the abnormalities in frequency and voltage.The project can be improved by implementation of

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power electronic devices to separate the grid from the erring supply source by sensing cycle by cycle variation for more sophisticated means of detection or sensing.

Many authors and researchers discussed about the Power Grid Synchronization Failure synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage. Aman Pratap Singh[1], Vivek Kumar[2], Shreya Chaudhary[3], Prabhat Singh[4] and Chandra Shekhar Singh[5][1] discuss on passive method to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage by implementation of 8051 microcontroller.Prakhar Pandey[1] Sawan Kumar Sharma[2][2]discuss onThe microcontroller controlling methods which monitors the under/over voltage being derived from a set of comparators and a standard Arduino is used to vary the input voltage to test the functioning of the paper. A lamp load (showing a predictable blackout, brownout condition) being driven from the microcontroller in case of voltage/frequency going out of acceptable range.Inntiaz A R[1], Md Maaz[2], Jinka Varalakshmi[3], Heena Kousar[4], Hanumantha Reddy[5], Rajashekar [3]discuss ondesigning a system based on a PIC microcontroller which is the family of specialized microcontroller. The microcontroller monitors the under/over voltage using voltage sensors and is being derived from a set of comparators. The frequency of the mains supply cannot be changed, the project uses a variation in frequency generator (555- timer) for changing the frequency, otherwise a standard autotransformer is used to vary the input voltage to test the proper functioning ofthe project. Mohit Gera[1], Vikram Singh[2], Ram Kr. Pandey[3], Sonu Jaiswal[4] [4]discuss on system which can warn the grid in advance so that alternate arrangements can be kept on standby to avoid complete grid failure. Different methods of detecting islanding are grouped into three categories as a function of their operating mode.[5][1] B.Naga Sarvani, [2] B.Vineela Thulasi, [3]K.Rahul ,[4] K.Satish Kumar, [5] V.D.Sekhara Varma discuss on system is based on Arduino Uno microcontroller. The microcontroller monitors the under/over voltage being derived from a set of comparators.

A. Reasons for power grid synchronization failure

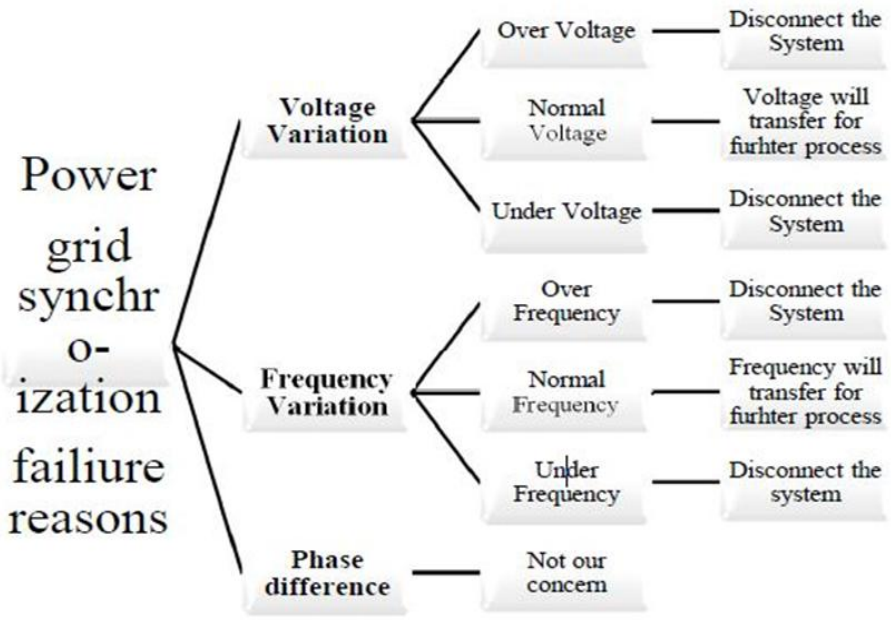

Fig. 1 Reasons for power grid synchronization failure

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B. Islanding

Islanding is a crucial and unsafe situation in which a distributed generator, like as a solar generation system, continuously provide supply power to the grid while the electric utility is shut down. This condition is arise due to an excessive use of distributed generators available in the electrical grid. Solar power generating units, wind power generating units, gas turbinesgeneration and micro generators like as fuel cells, micro turbines, etc. are all examples of distributed generators. The reality is that anyone could supply electricity return to the grid causes the problem of islanding. In which a distributed generator like solar panel or wind turbine continues to generate power and supply to the grid, even though the electricity power from the electrical utility is no longer present. Islanding is a situation in which a distributed generator continues to supply the load even when the electrical grid supply is cut off. As we know that because of usual reasons the numbers of distributed generators are increasing day by day and so is the problem of islanding. Islanding arises lots of problems, some of which are listed below:

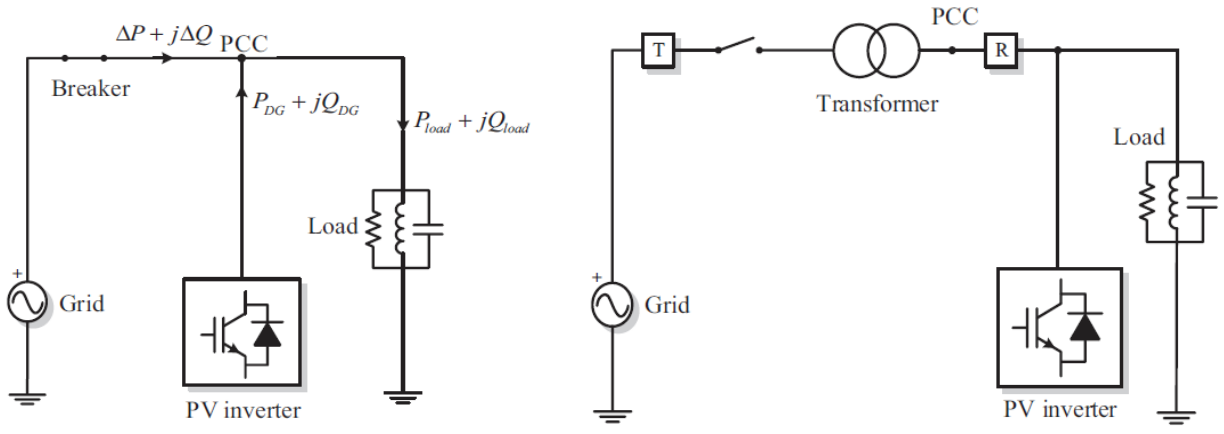

Fig. 2.Before islanding (load is fed by inverter in on-grid mode)after islanding (load is fed by inverter in off grid mode)

1) Safety Concern

Safety is the main issue related to this, as the grid may still to be powered in the event of a power outage due to electricity supplied by distributed generators, as explained previously. This may confuse the utility workers and expose them to hazards such as shocks which leads to an accident.

2) Damage to Customer's Appliances

Due to islanding and distributed generation, there may bi-directional flow of electricity. This may cause problem such as severe damage to electrical equipment, appliances and devices or equipment's. few devices are more responsive or sensitive to voltage fluctuations than others and should always be equipped with surge protectors.

3) Inverter damage

In the case of huge solar systems, many inverters are installed with the distributed generators. Islanding will be responsible problems in proper functioning of the inverters.

C. Blackout

Two severe power blackouts affected several area of northern and eastern India on 30 and 31 July 2012. The blackout on 31 July is the largest power outage in history.

Major power grid synchronization failure in history of India was in 2012.On early morning of July $30th$ the electricity supply demand balance tightened in the northern state of Uttar Pradesh. Trouble spread in chain reaction, causing blackout for entire northern grid affecting 300 million people and ending at around 7 pm on same day. Another blackout came at 1p.m on July 31 and covering northern, eastern, north-eastern grids affecting 600 million people.Transportation services were disrupted, traffic signal fails to work, and coal miners were trapped in mines as

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elevators were shut down. Direct cause of large blackouts includes electricity supply capacity failing to meet growing demand in India. Due to less rainfall hydroelectric power output was reduced and there is increase demand for electricity to pump ground water for agriculturalrrigation due to droughts and as peak summer duration electricity demand increases to power air conditioners, coolers, fans etc. Grid troubles contributed to spreading in a chain reaction national wide. It is considered as the largest power outage in history as number of people affected.

Date & Time	Transmission Element
30th July, 2012 02:33:11	400kV Bina – Gwalior-1 Line Tripped.
30th July, 2012 02:33:13	220 kV Gwalior-Malanpur 1. Zone-1 Tripped (on Power Swing) with the above events, practically all the AC links from the WR to the NR were lost.
30th July, 2012 02:33:14	400 kV Jamshedpur – Rourkela line, line-1, 2, and 3 tripped on zone 3 protection.
30th July, 2012 02:33:14	400 kV Gorakhpur-Muzaffarpur-2 tripped (on Power Swing).
30th July, 2012 02:33:15	400kVBalia – Biharsharif-2 line tripped (on power swing).

Table 1.Sequence of Outages on 29 July.

S.no.	Time	Transmission element	Reason
1	29th July 2012 15:15	220 kV Kota – Badod	Tripped due to operation of distance protection three phase Zone-1 indications at Badod end
2	29th July 2012 15:40	220 kV Bhinmal(PG) – Sirohi	Phase to earth fault.
3	29th July 2012 21:45	400 kV Bhinmal – Kankroli	Tripped due to insulator de-capping.
4	29th July 2012 22:18	400 kV Zerda – Kankroli	Emergency outage for a period of two hours to takeout one Tool &Plant which got stuck with one polymer insulator.

Table 2.Sequence of Outages on 30 July.

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Time	Transmission Element
31 July,2012 13:01:28	400 kV Kankroli-Jodhpur tripped due to dip in voltage, Wagoora-Kishenpur (1&2) (tripped due to Power Swing)
31 July,2012 13:01:30	Ballabhgarh-Gr Noida tripped, Z1, 3phase, Kanpur-Panki-1 tripped (Under voltage)
31 July,2012 13:03:18	400kV Patna-Balia-2 tripped (3-ph fault), Kankroli - Debari 220kV tripped (Under voltage protection)

Table 3.Sequence of Outages on 31 July.

II.SYSTEM MODEL AND DESIGN

In passive technique the parameters change differently which affecting the working of the grid. Any source that break the rules of grid would be immediately terminated. But the process will not stop there because only elimination is not enough, we need to know the reason of the fault i.e which parameter is showing variation is it current, voltage or any other and also we need to determine what is the location of the fault from the base of grid.. At the same time the entire faulty line is being examined for detection of the cause of the error as well as the distance of that particular fault location.The microcontroller section acts as the power grid hub.

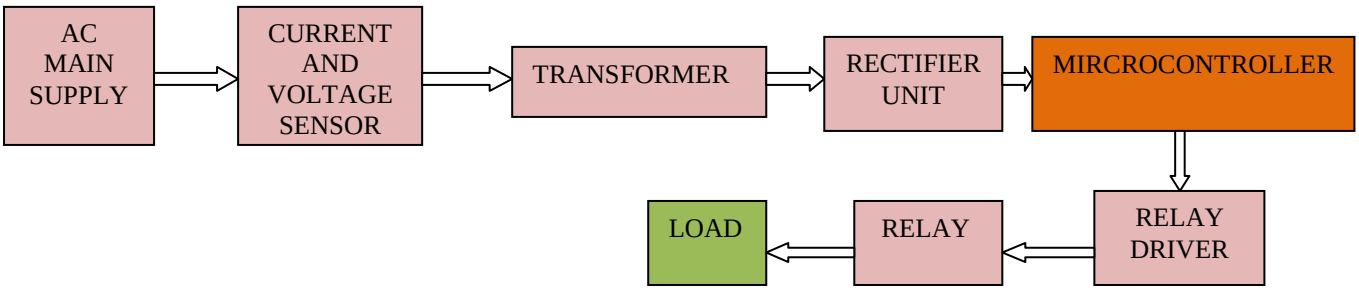

Fig. 3 Block diagram of proposed system in project

This section will continuously observed the entire system. As shown in Fig.1 different sensors have implemented in circuit. The current sensor measure the variation in current values in case a shorted or an open line and after that it forwards this information to the controller. .the project also operates in the similar fashion. Temperature is another parameter which is responsible for grid failures in case it goes beyond predefine ranges. The fault can be anywhere in the line hence it is necessary to determine the exact distance of the point where the fault has occurred and this task would add up to the effective management of the grid. For this purpose switches can be used at, say each kilometre and the on and off state of a switch. Hence calculated distance can be provided at the grid base station and physical maintenance can be start.

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III. PROPOSED CIRCUIT DIAGRAM AND HARDWARE DESIGN

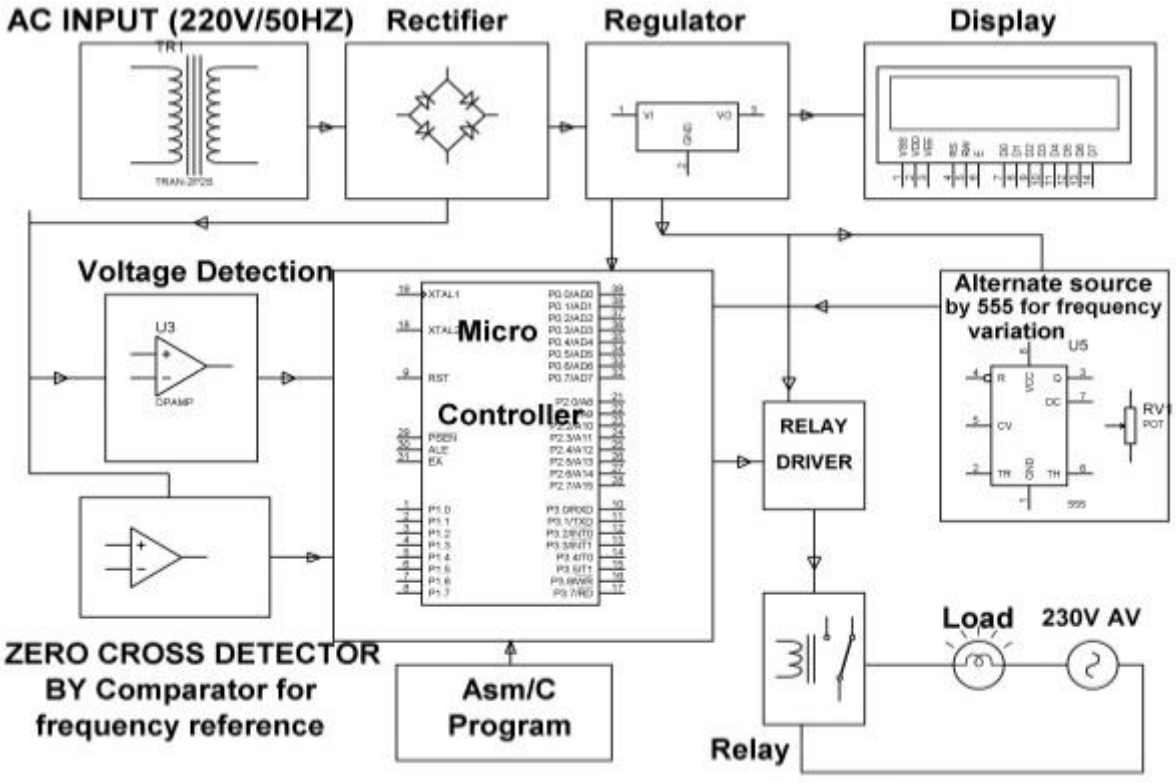

Fig. 4 Circuit diagram of proposed system in project

Microcontroller monitors which intern determines with a predetermined threshold level weather to cut off the source or not. The voltage sensor sense under/over voltage and under/over frequency condition from utility grid and the proposed value of voltage and frequency for turning on/ off the relay between a grid connected inverter and utility grid. The project use fluctuation in frequency by implementing generator using 555 timer for variation in frequency while standard variac shall be use to vary input voltage for achieving standard condition as test above. The LM398 having twoindependent unit of high gain internal frequency compensated operational amplifier which were designed specifically to operate from single power supply over wide range of voltages.Operation from split power supplies is also possible and low power supply current drain is independent of the magnitude of power supply voltage.The LM339 having of four independent precision voltage comparators. The LM339 series was specially connected to directly interface with TTL and CMOS , during its operation from both plus and minus power supplies, the LM339 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators. Islanding of grid is connected to inverter which is managing two different parameters voltage and frequency In the program it is so written that the output from 555 timer which is fed to the MC goes to be low 48KHz or above 52Hz. The related outputs of MC will be high and which will result in switching “ON or OFF” a load to which shows that the islanding has taken place. According to voltage is concerned we have taken 2 comparators. Both the comparators are output is given i.e., one for inverting input and other for non-inverting input which are given at a particular voltage. This program is that indicates two cases whether the few is low / high (or) it could be either in high / low condition the duration will be 50, 49, 48 06 greater than 52.. section however response as the grid base, taking all the important decisions regarding the safety of the grid. At the time of the controller section encounters any variation in the predetermined limits set for each of the parameters it issues a signal that is directed to the LCD section and that particular alert message is then displayed and at the same time the source that has been creating this abnormality is also

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detected and temporarily eliminated from the grid hence safeguarding the failure of whole grid. The relay unit has been implemented for the purpose of elimination of the disturbing source temporarily.

IV.CONCLUSION

A simple and cost-effective system is developed and design in this paper. This methodis used to trace fault of the power grid synchronization failure on the basis of voltage and frequency fluctuations To provide power to the load the rules of grid involve maintaining a voltage in the limits and the frequency as well. If any deviation from the range of the grid occurs then it is compulsory that the grid should automatically get disconnected. This prevents in large scale brown out or black out of the grid power by sensing abnormalities of voltage and frequency.

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