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Detection of Power Grid Synchronization Failure on Sensing Frequency and Voltage beyond Acceptable Range

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ABSTRACT:The project is designed to develop a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage. There are several power generation units connected to the grid such as hydel, thermal, solar etc. to supply power to the load. These generating units need to supply power according to the rules of the grid. As per CENTRAL ELECTRICTY AUTHORITY OF INDIA Regulations 2010, variation of the system voltage should be of +- 5 % and make all efforts to operate at a frequency close to 50 Hz and shall not allow it to go beyond the range 49.2 to 50.3 Hz. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding. 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 complete grid failure.

KEYWORDS: Islanding, Grid, voltage variation, frequency variation,active method, passive method.

I.INTRODUCTION

In India we have five national grids, Western grid, Eastern grid, North-East grid, Southern grid, Northern grid. Northern grid, Eastern grid, North-East grid, Western grid are synchronized with each other and southern grid is asynchronized.The modern society is so much dependent upon the use of electrical energy that it has become a part and parcel of our life. Several new trends have already employed in the electricity infrastructure. It includes the expansion of the existing grid with micro grids and mega grids, extensive sensors, data processing, visualization tools, etc. For synchronization of all power generating station with State as well as National power grid we have selected three parameters voltage, frequency and phase angle between voltage and current if any of these parameters is violated due to any abnormality or fault the power station will not be able to fulfill all the three condition for synchronizations so it will get a synchronized with grid and its called situation of ISLANDING. Islanding state occurs when one or many sources continue to feed power to a part of the grid that is disconnected from the main utility. Islanding situations can damage the grid itself or equipments connected to the grid and can even compromise the security of the maintenance personnel that service the grid. Therefore, according to IEEE1547 standard, islanding state should be identified and disconnected in 2 seconds. There are quite a few different methods used to detect islanding.

II. ISLANDING

Islanding refers to the condition in which a distributed generator (DG) continues to power a location even though electrical grid power from the electric utility is no longer present. Islanding can be dangerous to utility workers, who may not realize that a circuit is still powered, and it may prevent automatic re-connection of devices. Solar power generators, wind generators, gas turbines and micro generators such as fuel cells, micro turbines, etc. are all examples

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of distributed generators. Also it exposes utility workers to life critical dangers of shocks and burns, who may think that there is no power once the utility power is shut down, but the grid may still be powered due to the distributed generators.

III. RELATED WORK / LITERATURE REVIEW

(a) Zongjie Liu, Lifeng Zhu, Li Deng, Lijun Qin, Feng Jiao[1],proposed a methodology ofIslanding Detectionabout the Photovoltaic Grid-Connected GenerationSystemas a the photovoltaic grid-connected generation system is rapidly developed and applied due to the cleaning, renewable and wide distribution of solar. This paper is to solve the problem about islanding detection brought by the photovoltaic grid-connected generation system. First of all, it analyses the reason happened and potential hazards of the Islanding and introduces the existing detection method and islanding detection. Then, in view of the insufficiency of the existing method, it put forward a new solution that combined the negative sequence voltage positive feedback voltage with active power positive feedback to the islanding detection. The amount of change of the frequency and the voltage is introduced to the voltage - active power positive feedback, which can effectively and fast detect the island.

(b) Karan Gupta, Shreyas Gupta, KummadVerma, Anil Singh, Abhimanou Sharma[2], gave an idea of Detecting Power Grid Synchronization Failure on Sensing Bad Voltage or Frequency Documentationin which they described in modern power system, electrical energy from the generating station is delivered to the ultimate consumers through a huge network of transmission and distribution. There are several power generation units connected to the grid such as hydro, thermal, solar, wind etc to supply power to the load. Thus, for satisfactory operation of loads, it is desirable that consumers are supplied with substantially constant voltage and frequency.

(c) Laukik S. Raut, Shahrukh B. Pathan, Gaurav N. Pawar, Mandar V. Pathak[3],gave an idea of Detecting Power Grid Synchronization Failure on Sensing Frequency or Voltage beyond Acceptable Range. The system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage. There are several power generation units connected to the grid such as tidal, thermal, solar etc to supply power to the load. These generating units need to supply power according to the rules of the grid. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation will occurs then automatically disconnect the grid line. 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 complete grid failure. This system is based on a microcontroller of 8051 family. The microcontroller monitors the under/over voltage being derived from a set of comparators. As the frequency of the mains supply cannot be changed, so by using variable frequency generator (555-timer) frequency can changed. A lamp load (indicating a predictable blackout, brownout) being driven from the microcontroller in case of voltage/frequency going out of acceptable range.

(d) Rohan Solanki, Divyesh Patel, Yuvraj Gharia, Daivik Sailor, Bhumit Patel, AshishChaudhari[4],generated Detection And Protection of power grid synchronisation failure system in which they gave the idea if any deviation from the acceptable range limit of the grid it is mandatory that the some feeder should automatically get disconnected from the grid which in termed as islanding, these prevent in large scale brownout or blackout 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 complete grid failure.

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IV.CIRCUIT DIAGRAM & ITS EXPLANATION

We have designed this circuit diagram in LT-Spice software.

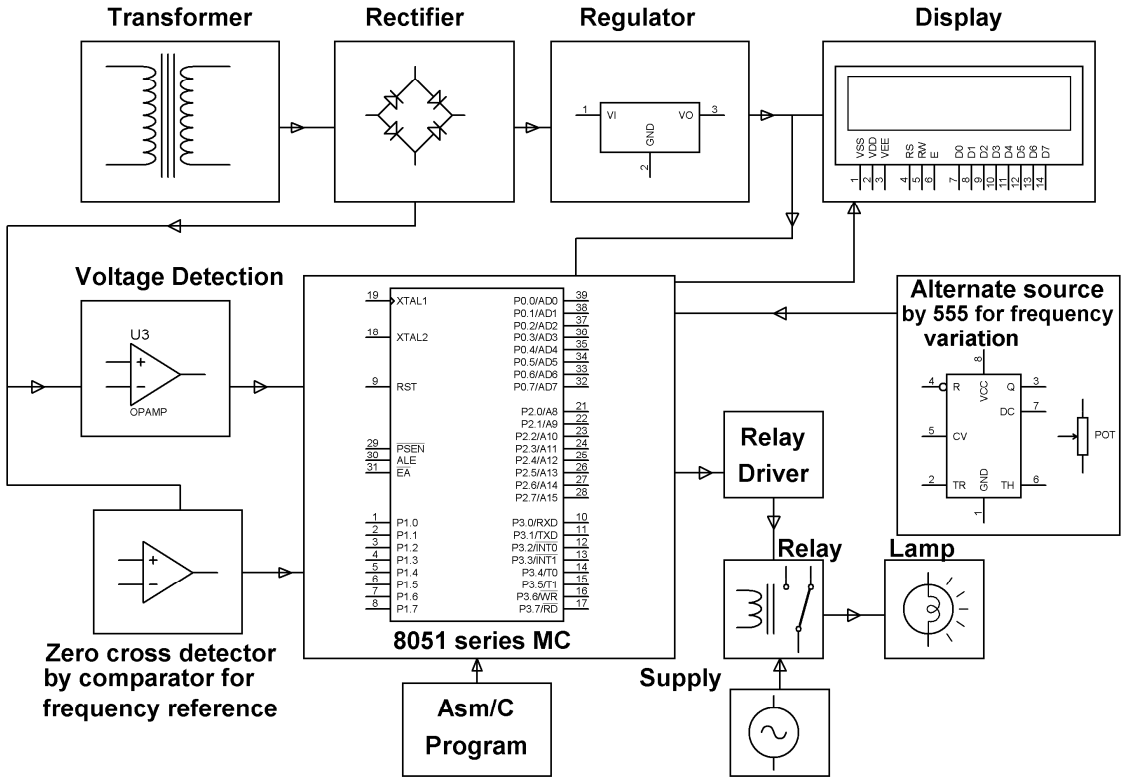

Fig 1: Circuit Diagram

CIRCUIT EXPLANATION-Islanding of grid is basically to manage two parameters. One parameter is voltage and other parameter is frequency. Since we cannot change the frequency we have taken a 555 timer in a free running astable mode, the frequency of which can be varied by R. . This is the reason why we use a 555 timer for giving precisely 52Hz or 50 KHz or 49 KHz which has to be tested by the program. In the program it is so written that if the output from 555 timer which is fed to the MC goes to be low 48 KHz or above 52Hz the corresponding outputs of MC will go high , which will result in switching "ON or OFF" a load to indicate that the islanding has taken place. (frequency related).

NORMAL SITUATION-In normal situation the led and lamp do not glow indicating 50Hz and stable voltage. In any deviation from voltage range or frequency range the led and lamp glow indicating failure of grid synchronization.This program is also written that in either of these cases whether the frequency is low / high (or) the voltage could be either in high / low condition , through the microcontroller they are all displayed in the LCD display and the output is connected to a relay to switch ON or OFF a load.

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VI. OBSERVATION &RESULT

After completion of the hardware and software, we observed following calculations:
After using the system we have observed the voltage stable and unstable state on particular voltage ranges

Voltage (V)	LCD Display	LAMP Indication
<240	Low Voltage	ON
240-250	Stable Voltage	OFF
>250	High Voltage	ON

After using the system we have observed the lamp indication based on frequency of the above frequency range

Frequency (Hz)	LCD Display	LAMP Indication
<48	Display frequency	ON
48-52	Display Frequency	OFF
>52	Display Frequency	ON

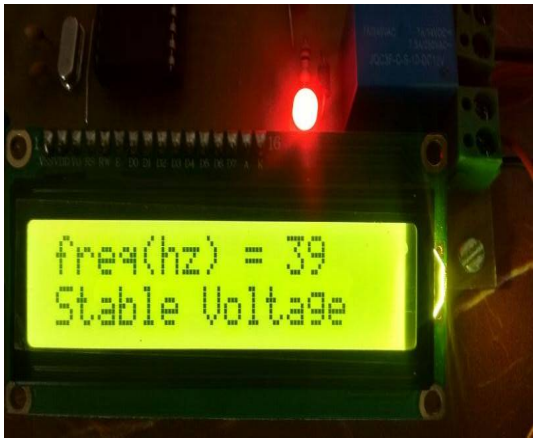

Fig 2(a): Low Frequency Condition

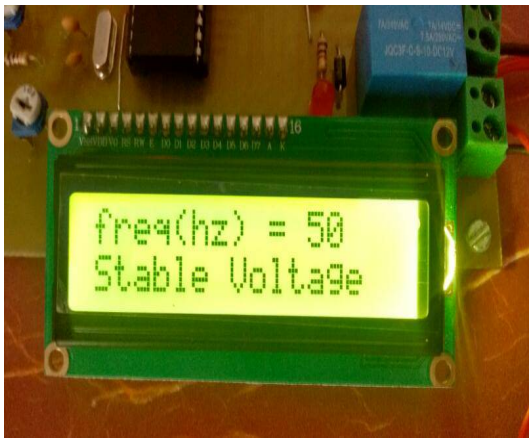

Fig 2(b): Normal Frequency Condition

Fig2(c): High Frequency Condition

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Fig 2(d): Low voltage condition

Fig 2(e): High voltage condition

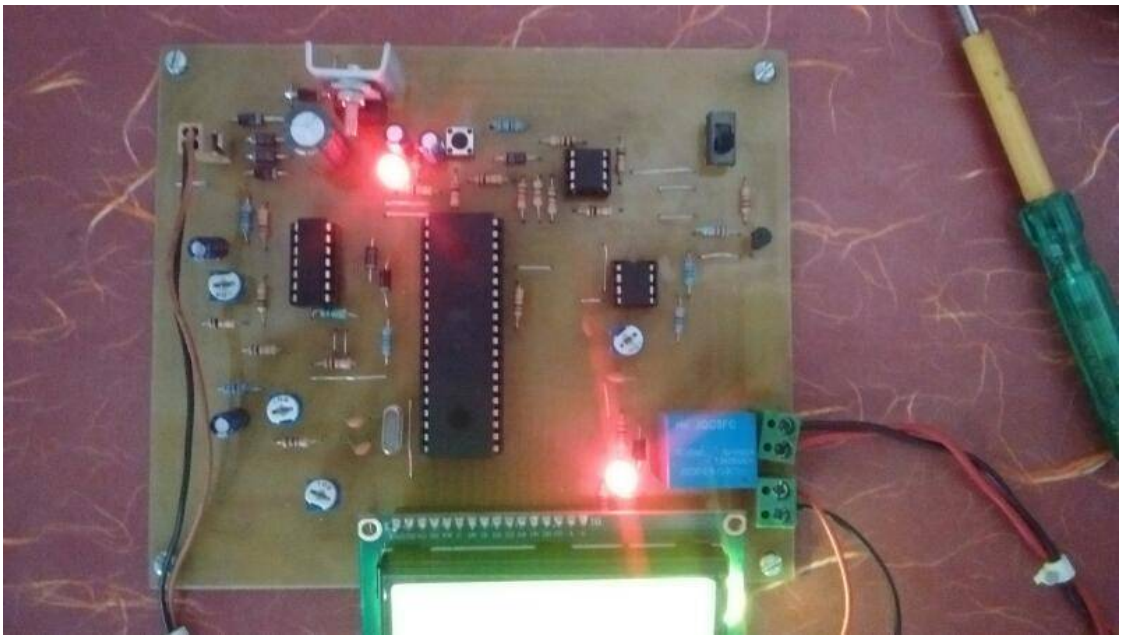

Fig 2(f): Designed hardware's image

We have implemented the circuit successfully. As we open(ON) the power supply the transformer steps down from 240v to 12v. This 12V is now fed to the rectifier circuit producing the variable dc. 12V variable dc is also send to the 7805 voltage regulator for supplying the 5V to various components of the circuitry. This variable dc is send to the voltage and frequency comparator for sensing three respective parameters. These sensed parameters are than send to microcontroller for calculations and processing.

For changing parameters we have to switch the sliding switch to manual position. By varying the POT (variable resistance) we can achieve the different voltage and frequency levels. LCD displays the corresponding frequency level and voltage is stable for not (for stable voltage, voltage level must be in between 220V to 250V) and lamp glows on abnormal conditions (undesirable conditions).

V.CONCLUSION

In this way, to develop a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage. There are several power generation units connected to the grid such

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as hydro thermal, solar etc. To supply power to the load. The rules of grid involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder 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. This seminar is based on the microcontroller 8051.that are having lot of advantages by changing programming. So that alternate arrangements are kept on standby to avoid complete Grid Failure.

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