International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 07 | July -2017 www.irjet.net p-ISSN: 2395-0072

DETECTION OF POWER GRID SYNCHRONIZATION FAILURE ON SENSING FREQUENCY AND VOLTAGE BEYOND ACCEPTABLE RANGE AND LOAD PROTECTION

[1] B.Naga Sarvani, [2] B.Vineela Thulasi, [3] K.Rahul , [4] K.Satish Kumar, [5] V.D.Sekhara Varma

[1,2,3,4,5] Student, Dept. Of Electrical and Electronics Engineering, Pragati Engineering College, Surampalem, AP, India.

Abstract – *This paper presents the design of a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage and thereby protecting the load. There are several power generation units connected to the grid such as hydra, 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 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. This system is based on Arduino Uno microcontroller. The microcontroller 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 (indicating a predictable blackout, brownout) being driven from the microcontroller in case of voltage/frequency going out of acceptable range. GPS and GSM technologies are used to indicate the fault location.*

Key Words: Synchronization, Power Grid, Black Out, Bridge Rectifier, GSM Modem, Arduino UNO, Relay, LCD.

1. INTRODUCTION

1.1 Synchronization Detection of Failures

Power grids are vast complex networks that make up a large part of an infrastructure. Many precautions are taken, and operators hired to maintain reliability, however three fourths of power outages are caused by operator errors. These errors can be avoided by automatic adjustments based on models of the grid system. The model explored is ensuring generator synchronization within the system. Finally, not only will the grid not have destructive interference, constructive interference will occur which increases the total power the grid can produce which optimizes the grid.

The objective of this paper is to detect the failure of synchronization in power grid. This is a demonstration devised to provide such kind of a system that could detect the failure in synchronous working of the power grid in case any external supply source that is supplying to the grid is encountering any kind of abnormalities may be in frequency and voltage levels.

This detecting power grid synchronization failure system on sensing frequency or voltage beyond the acceptable range could be used in that power houses where different supply sources are connected parallel together to fulfill the energy demand.

This system could be used in home automation system, where the consumer has different energy sources such as solar or wind energy. By using this system, the consumer load could be automatically shifted to another source of energy.

1.2 Power Grid Synchronization

Synchronization means the minimization of difference in voltage, frequency and phase angle between the corresponding phases of the generator output and grid supply This system is more compact and reliable as compared to the manual system. This system is less expensive as compared to the other systems

The necessity for synchronizing and parallel generator operation is often based on the following:

- The rated generating capacity of an existing system has been exceeded by new load demands.
- Enhanced reliability (multiple generating vs. single unit generating) is to be considered.
- Operating efficiency of generator sets is a valid concern.

Conditions of synchronization are Voltage fluctuation, Voltage magnitude, Phase sequence, Frequency, Phases. Synchronization Limits are

1. Phase angle- +/-20 degrees
2. Maximum voltage difference – 7%

3. Maximum slip frequency – 0.44%

Synchronizing a generator to the power system must be done carefully. The speed (frequency) and voltage of the isolated generator must be closely matched, and the rotor angle must be close to the instantaneous power system phase angle prior to closing the generator breaker to connect the isolated generator to the power system

1.3 Black Out

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

- Inter-regional power transmission corridors due to multiple existing outages (both scheduled and forced)
- Weak High loading on 400 kV Bina–Gwalior–Agra link
- Inadequate response by State Load Dispatch Centers (SLDCs) to the instructions of Regional Load Dispatch Centers (RLDCs) .

Previous analysis summary

- Several future grid developments are expected:
- Increased use of renewable variable generation at both the bulk and distributed level;
- Profound involvement of customers in all aspects of electricity generation and uses;
- Increased penetration of automation at both the distribution and transmission level;
- More comprehensive planning strategies that will deploy risk-based techniques to cope with uncertainty.
- Physical security and Cyber security will play a never increasing role in all future grid developments.
- Advancements in the materials ranging from superconductive compounds to new nano scale structures will be a continued quest in the future. This will result in provision of societies energy needs in a way that is sustainable for the 21st century and beyond.

This system is applicable for Solar Power Plant where frequency varies; frequency and voltage parameters should match with the Power grid. Microcontroller having various applications by changing the program.

This research work seeks to design automatic and efficient fault detection and location system for both overhead and underground power transmission network system using both existing fault indicator technology and commercially proven communication technology to quickly and accurately pin point faulted sections of a transmission system.

1.4 Difficulties Faced While Synchronizing Alternators to Electrical Grid

Often electrical generators are removed from the service and connected back to the power system during variations of the load, emergency outages, maintenance, etc. Before reconnecting the generator to the system in each time, it must be synchronized with parameters of the power system network. An improper synchronization can affect the healthy power system and results in electrical and mechanical transients that can damage the prime mover, generator, transformers and other power system components.

The researchers showed that the stability of synchronized states in power grids can be enhanced by tuning generator parameters rather than modifying the entire network. Hence in this paper we are monitoring the parameters like frequency and voltage and detecting the change in the parameterizes done by using an Arduino microcontrollers and variation in frequency and voltage are sensed and send as a message to the field engineers by GSM and GPS technologies.

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

2. BLOCK DAIGRAM

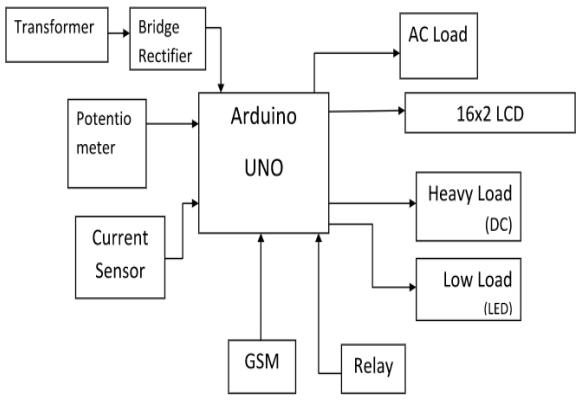

Fig -1: block diagram

Main components

- Power supply unit
- Arduino Uno Microcontroller
- LCD
- Crystal Resistors
- Capacitors
- Diodes
- Transformer
- Potentiometer
- Relay
- GSM Rectifier
- Module and GPS system
- Current Sensor
- Lamp load

3. OPERATION

The voltage, frequency must be controlled each and every time and the load share units continuously monitor the load and during low demand periods one or two generators will be shut down to save on power consumption. As demand rises again the second and third generators will be restarted, synchronized and reconnected to load and also if the combined output of all the generators cannot supply enough power then the frequency will drop for entire grid. All the generators slow down just like our car engine on a hill. Hence in this paper the detection of the load for synchronization and voltage, frequency detections.

Fig -3: Hardware Implementation

Figure shows the Detection of power grid synchronization failure on sensing frequency and voltage beyond acceptable range and automatic load protection by tripping. In this 230v power supply is given to the step down transformer. Rating of the transformer is 12v. It can be given to bride rectifier which consists of rectifier, filter and a voltage regulator. Rectifier converts the ac into dc and filter gives the pure dc signal by blocking ripples. Microcontroller receives this DC power from rectifiers. The output of the microcontroller is connected to16×2 LCD Display. In case one for proper synchronization load testing is done by connecting Heavy load lamp of 20W and for light load LED are connected. For voltage detection by using GSM and GPS interface technology a GSM module is connected to microcontroller. A Pot is connected at the input of the microcontroller. By varying pot the voltage changes after reaching the acceptable voltage the LCD displays trip voltage. The relay circuit will be opened and the lamp will be protected The frequency variation is shown before tripping. The light will flicker before it turned OFF.

4. RESULTS

4.1 Hardware Result

Voltage detection is by done by varying the potentiometer after reaching the acceptable range the LCD displays the that the voltage is EXCEED 230V and the relay will be tripped and load of AC is protected. The location of fault latitude and longitude is displays in the computer of the field engineer and a SMS is send to the mobile. The frequency detection is done before the tripping of the light load the light flicker and frequency change will be displayed on the LCD. Hence a continuous monitoring load and faults in frequency and voltage is done by using microcontroller, GSM and GPS technologies. In this case the load variation will be sensed. For varying the load in this prototype we are using LED's and dc lamp load.

Consider light load is connected, When supply is given light load is ON, The current sensor senses current. Due to light ON the display is shown as "HEAVY LOAD" And message is sent to phone through GSM. The acting Engineer in the field who receive this can restart the other generators and reconnected it to the load in order to satisfy load demand.

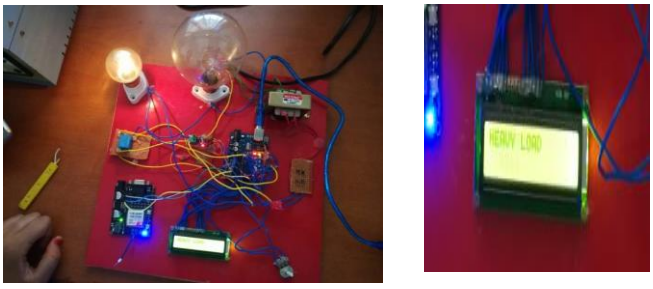

Fig -4: Display of Heavy load in LCD

4.2 Micro Controller Output

Voltage detection is by done by varying the Pot(potentiometer) after reaching the acceptable range the LCD displays the that the voltage is EXCEED 230V and the relay will be tripped and load of AC is protected. The location of fault latitude and longitude is displays in the computer of the field engineer and a SMS is send to the mobile. The frequency detection is done before the tripping of the light load the light flicker and frequency change will be displayed on the LCD. Hence a continuous monitoring load and faults in

frequency and voltage is done by using microcontroller, GSM and GPS technologies.

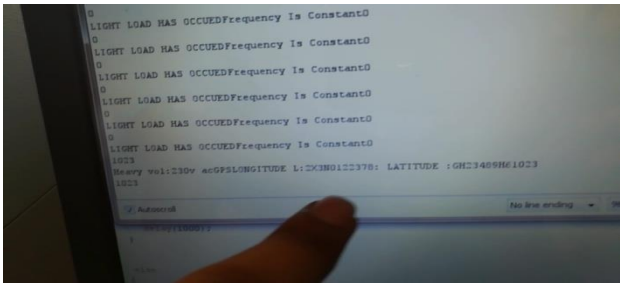

Fig -5: Display of low load in computer

5. ADVANTAGES

- Here we can use, beyond the acceptable range could be used in that power houses where different supply sources are connected parallel together to fulfill the energy demand

- By using this system, the consumer load could be automatically shifted to another source of energy.
- This system is more compact and reliable as compared to the manual system.
- It secured the power of the grid coming from different power stations by detecting the abnormal conditions of frequency and voltage beyond its acceptable
- It prevents the synchronization failure between power grid and feeder.

6. CONCULSION

A simple simulation case is studied at the end in order to give a better understanding of the overall system performance under grid faulty conditions. This work showed that the micro-grid architecture is a viable solution for including distributed generation in a power system.

This implementation concludes that it is possible to have a power grid system that is smarter, more effective as well as efficient in its operation, thus proving to be more economical as compared to be the present installations.

The challenge is a continuous and uninterrupted transmission which can be very well achieved with the implementation described by this paper and in addition to the continuous transmission several other parameters i.e. the passive parameters are being monitored regularly and any discrepancies occurring in these, are taken into account and accordingly worked upon thus making the process of management and recovery convenient and effective .This system is less expensive as compared to the other systems.

REFERENCES

[1] N. Dhaka, Developing Islanding Arrangement Automatically for Grid on Sensing Voltage or Frequency Beyond Range, IJERMT Mag., vol.2, Mar. 2015, pp. 184-187.
[2] G. F. Donald and H. W. Beatty, Standard Handbook for Electrical Engineers, Eleventh Edition, McGraw-Hill, New York, ISBN 0-07-020974-X pp. 3-64,3-65.
[3] General Electric Electric Instruments Construction and Operating Principles, General Electric Meter and Instrument Department, West Lynn, Mass. 1949, chapter 7
[4] S.N. Singh, S.C. Srivastava, Electric power industry reconstructing in India, Present Scenario and future prospects, Senior Members, IEEE.
[5] ShoreTel, Steffen Rebennack, Fred, Glover, Syst. Eng. & Opera. Res., George Mason Univ., Fairfax, VA, United States. IEEE paper on "Transmission-Capacity Expansion for Minimizing Blackout Probabilities".
[6] ATMEL 89S52 Data Sheets.
[7] Shahi Li, Julio Pronaos, Dong Zang. IEEE paper on "Micro grid power flow study in grid connected and islanding modes under converter control strategies". IEEE 2012.
[8]"Power grids.: Power restoration complete in Delhi & northeast, 50% in eastern region". The Economic Times. 31 July 2012. Retrieved 31 July 2012.
[9] "Text Book-The 8051 Microcontroller and Embedded systems" by Muhammad Ali Mazidi and Janice Gillispie Mazidi, Pearson Education.
[10] J. B Gupta's 10th edition power system part 2 "Transmission and distribution of electrical power" pg 367.
[11] M. Ali Mazidi and Janice Gillispie Mazidi,"The Microcontroller and Embedded systems", Pearson Education.,Second Edition,pp.184-244.