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Detecting Power Grid Synchronization Failure by Sensing Voltage and Frequency on Acceptable Range

Neeraj Tiwari [1], Balveer Singh [2], Abhay Nath Dubey [3], Tanveer Singh [4]
Department of Electrical Engineering,
Poornima College of Engineering, Jaipur

ABSTRACT: The system is designed 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, but our prime focus is synchronizing the non-conventional sources for remote area supply. 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 variation in between frequency range. If any deviation from the specified value will occur then it 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 and can automatically disconnect it to avoid complete grid failure. This system is based on a microcontroller of 8051 family. The microcontroller AT89S52 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 has been used, which is connected to the supply and a relay. If microcontroller detects any deviation from the specified voltage and frequency range then it sends a signal to the relay and the load automatically gets disconnected from the supply.

Keywords: *Frequency, Grid, Power, synchronization, Voltage*

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I. INTRODUCTION

Detection of Synchronization Failure;

Power grids are vast complex networks that make up a large part of an infrastructure. Many precautions are taken by 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, the grid will not have destructive interference; constructive interference will occur which increases the total power the grid can produce which optimizes the 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.

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 manually operated system and less expensive.

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

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

Difficulties Faced While Synchronizing Alternators to Electrical Grid;

Today's era we are more focused towards distributed energy generation. If excess power is generated by these units, it is to be transmitted to grid. Before connecting this system to the grid, 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 measurement of frequency is a tedious task. We have done it by converting the analog signal into digital signal and set the micro-controller accordingly such that whenever frequency and voltage goes beyond acceptable range, it get disconnected from the system. It has been observed that the stability of synchronized states in power grids can be enhanced by tuning generator parameters rather than modifying the entire network.

II. 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 blackout are:-

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

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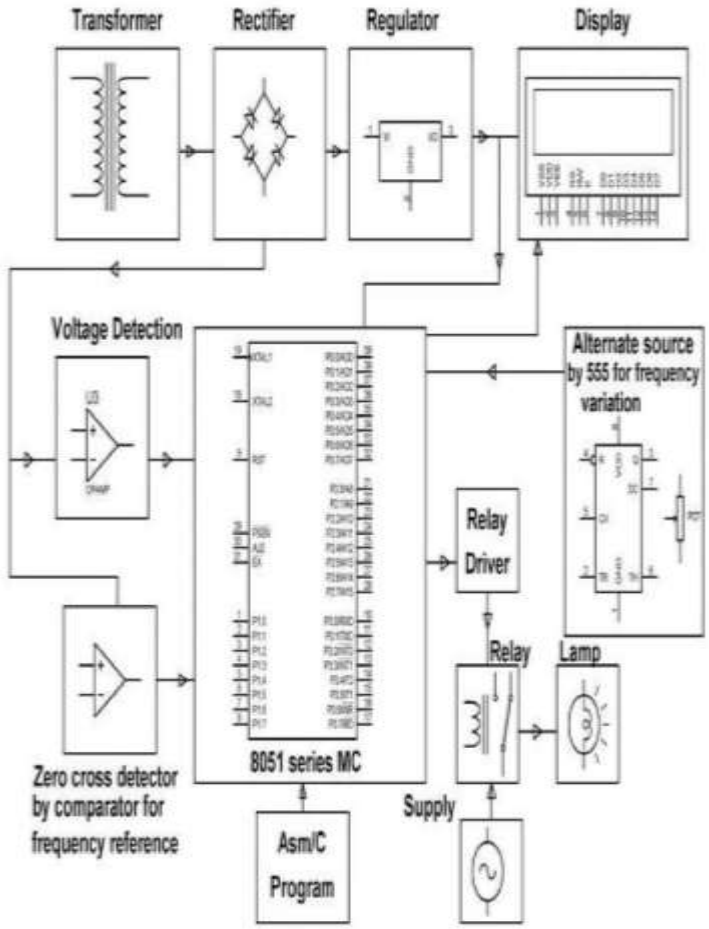
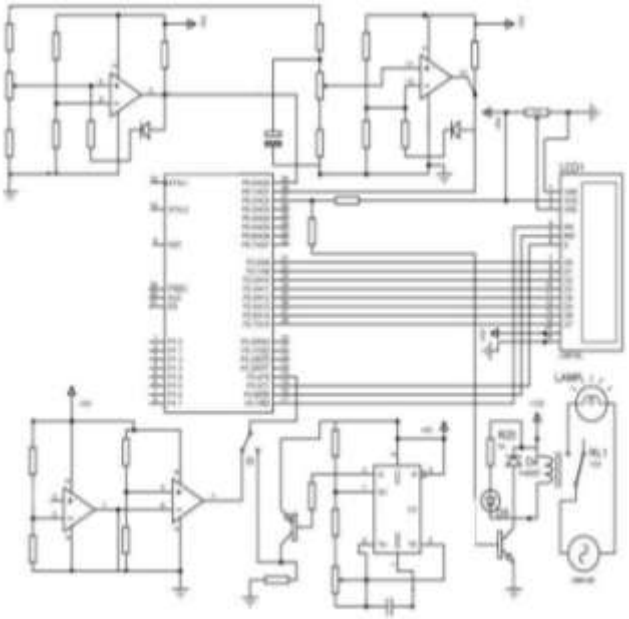
BLOCK DIAGRAM:



In this system firstly the input supply goes to the transformer, which is step-down transformer. It converts the 220V AC input into 12 volt AC output. Here we have designed a circuit to calculate the input frequency, which is done in micro-controller. The micro-controller calculates the frequency of digital signal instead of sinusoidal signal. So a rectifier circuit is inserted in between the transformer and micro-controller. The micro-controller and liquid crystal display operates at 5 Volt DC signals, while the signal DC received may not be +5 Volts that's why we have used a voltage regulator IC 7805 here to regulate this voltage to get +5 Volts DC. This 5 Volts DC is input for micro-controller, LM 339 IC, Liquid crystal display as well as for 555 Timer IC and amplifier 358. The rectified output of rectifier is send to Voltagecomparator IC LM339N.

CIRCUIT DIAGRAM:



III. WORKING

In this system firstly the input supply goes to the transformer, which is step-down transformer. It converts the 220V AC input into 12 volt AC output here we have designed a circuit to calculate the input frequency, which is done in micro- controller. The micro-controller calculates the frequency of digital signal instead of sinusoidal signal. So a rectifier circuit is inserted in between the transformer and micro-controller. The micro-controller and liquid crystal display operates at 5 Volt DC signals, while the signal DC received may not be +5 Volts DC. That's why we have used a voltage regulator IC 7805 here to regulate this voltage to get +5 Volts DC. This 5 Volts DC is input for micro-controller, LM339 IC, Liquid crystal display as well as for 555 timer IC and amplifier 358.

The rectified output of rectifier is send to voltage Comparator IC LM339N. The LM339N is a quad differential comparator in 14 pin DIP package. This device consists of four independent voltage comparators that are designed to operate from single power supply over wide range of voltages. LM339N can operate with dual power supply as long as difference between two supplies is 2V to 36V and VCC is at least 1.5V more positive than input common mode voltage the output of voltage comparator and IC 358 goes to the microcontroller for further process. The micro-controller is programmed in such a way that if the frequency of the input signal is below 48 Hz or greater than 52Hz, it generates low signal to relay. Hence relay does not operate in this case. It also checks for the voltage level that the voltage is stable and in between the specified range, i.e. not too much high or low. If the voltage as well as the frequency is in between the specified range then only the micro-controller gives high pulse to the relay to connect the load. The micro-controller is also conned to the LCD, which consist of seven segment display. It shows the value of input frequency and voltage. The input is connected to the load lamp through the N.O. terminal of the relay. If the voltage and frequency is in

between the acceptable range, the micro-controller generated the high pulse output signal to the relay and its coil gets energized. In this case the N.O. terminal of the load gets connected to the supply.

IV. RESULTS

Hardware Result:

Voltage detection is by done by varying the potentiometer after reaching the acceptable range the LCD displays that the voltage is stable or not and the relay will be tripped and load is protected, if voltage is unstable. The frequency detection is done before the tripping of the light load the light flicker and frequency change will be displayed. Hence a continuous monitoring load and faults in frequency and voltage is done by using microcontroller.

Micro Controller Output:

Micro-controller AT89S52 has been programmed in such a manner that it detects the variation in frequency. The measurement of frequency is done by Crystal Oscillator. The output of zero crossing detector and crystal is send as input and micro-controller detects its acceptable range. If it is in acceptable then only it sends high signal to the relay which connected supply to the load.

V. CONCLUSION

As a conclusion this project includes the combination of transformer, timer IC, relays, microcontroller and rectifier etc. to build a network which can be implemented for synchronization of supply from source. The two main objective of this project is that the use of a coded microcontroller which shows us the accurate frequency and voltage of our network and other is the knowledge about the recent topic of synchronization which is a part of our curriculum. Seeing its future aspects in India, synchronizing of two or more sources on a common gird will be a great achievement in terms of fulfilling the energy demand because in a country like India where a large section of our population is based either on agriculture or on industrial sector. We are able to meet the industrial need but sometimes failing in meeting the farming needs because it is costly for government to establish a transmission line from the generating station or the nearby grid substation to that particular area which we sometimes considered as remote area. So having a non-conventional source of energy there for fulfilling needs. In these areas mostly there are two or more non-conventional sources to supply because a single source is not sufficient to do that so there comes the need of synchronization. This thing is completely new in India and those hybrid grids in India are currently using the foreign technology. Indians are working to have this technology by their own. The hardware of this project has been successfully integrated and worked to meet the requirements.

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