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Detection of Power Grid Synchronization Failure by Sensing Bad Voltage and Frequency

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Abstract - *This project developed to minimize the power grid synchronization failure and the main intention of this project is to detect the failure of power grid synchronization while sensing the voltage and frequency which are not in an acceptable range, and then stopping the power supply to the distribution system. The all the power generating unit such as thermal, hydro, wind, solar and so on connected to the power grid and all the unit follow the rules of the grid. According to the rules of the grid, these power generating units need to supply the power at permutable limits of the voltage and frequencies. Therefore, acceptable range of frequency and voltage is mandatory for the power grid. 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. This system is based on the Atmega 16 family of microcontroller which monitor the under/over voltage and frequency of the grid by using the comparator based ZCD i.e. zero crossing detection circuit and display the deviation in frequency and voltage. The main frequency cannot be change, due to this we used a variable frequency generator frequency, whereas a standard variac is used to vary the input voltage to test the functioning of the project.*

Key Words: **Grid, Synchronization, Islanding, Black out.**

1.INTRODUCTION

This project is based on the Atmega 16 family microcontroller. The system present the development of microcontroller based islanding detection for power generating unit connected to the power grid. If any kind of abnormalities on the constant working of power grid it get detected by set of comparator i.e. ZCD (Zero Crossing detection) circuit. The system used variable frequency generator using timer IC 555 for changing the frequency of supply while a standard variac used for changing supply voltage also observing test conditions by a lamp load being driven by relay driver IC ULN2003 from the microcontroller output as state above

1.1 Concept of Grid

An Electric grid is a network which can consume synchronize power from distributed generation unit and deliver or provide to the load that are connected by transmission and distribution line. Also it is network of cables or pipes for distributing high voltage power. Grid is a centre of power transmission from that power is transmitted over all the area. In a synchronous grid all the generators are connected in parallel and run not only at same frequency but also at the same phase. Grid failure or power blackout is the total loss of power to an area. Blackout which result from or result in power station tripping are particularly difficult to recover quickly. Power outage or blackout may last from a few minute to a few week depending on the nature of blackout and configuration of electric network.

1.2 Concept of Synchronization

Synchronization is the process of the closing the circuit breaker after matching the generator frequency, phase angle and voltage magnitude with grid frequency, phase angle and voltage magnitude respectively. The synchronization is not done in ac generator unless it is running at same frequency as that frequency of grid and the dc generator have to adjust its open circuit terminal voltage to synchronize with grid voltage.

1.3 Islanding

Islanding is an unsafe condition which occur on grid, in which extra feeding of power is done to grid from distributed generator unit, even though the utility of power from grid is down. Also when the islanding occur on grid feeder is get open to secure the grid from the blackout or grid failure.

2. Detection of Power Grid Failure

The basic principle of this project is to detect the grid synchronization and sensing the voltage and frequency beyond range. The system is based on a microcontroller family. The microcontroller monitors the under/over voltage derived from a set of comparators and under/over frequency from by the interrupt program for the utility grid and the processed value of voltage and frequency for turning ON/OFF the relay between a grid connected inverter and the utility grid

2.1 Block Diagram

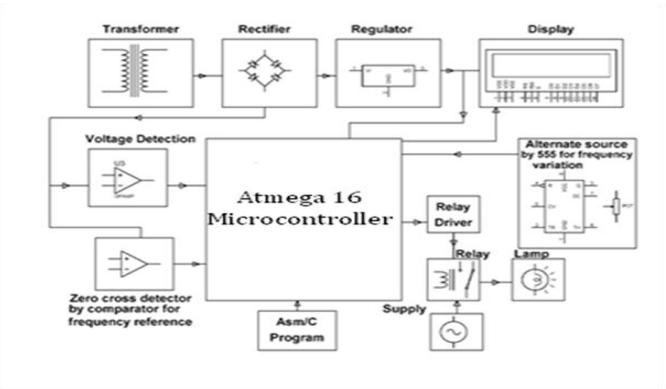

Fig -1: **Block Diagram**

2.2 Components

Hardware Requirements

- ATmega16 Microcontroller
- (Op-Amps)555 timer IC
- Resistors
- Diodes
- Voltage Regulator
- Relay Driver IC (ULN 2003)
- Lamp
- Optocoupler
- LCD
- Crystal
- Capacitors
- Transformer
- Relay
- Standard Variac
- ZCD

Software Requirements

- Keil compiler
- Language: Embedded C or Assembly.

2.3 Working

The main purpose of this project is to detect the grid synchronization by sensing the voltage and frequency which are not in an acceptable range, and then stopping the power supply towards the distribution system i.e. the supply towards the feeders. In this project we used the grid synchronizing technique is zero crossing detection.

In this system, the main supply is given to the transformer which is step down to 230v/24v then that 24v AC supply is given to the zero crossing detector through bridge rectifier and the full wave rectifier is used for the rectification purpose. After rectification is done that dc is given to the capacitor which is used as filter. Then given to voltage regulator IC LM 7805 that convert supply into 5V, 1Amp. After this total process the 5V DC supply is given to the ATmega16 microcontroller. The ZCD (zero crossing detector) used as a comparator for monitoring the under/over voltages and also monitor the natural frequency. A standard variac is used to vary the input voltage and as it is not possible to change the frequency of the mains supply so here a variable frequency generator (555timer IC) is used for varying the frequency range to test the functioning of the project.

The relay is controlled by the relay driver IC (ULN 2003), which is connected to the microcontroller. The lamp is connected to the relay contacts for indicating the predictable blackout and brownout.

3. Result And Observation

Table -1: Observation Table

Observation Table		
Parameters / Limits	Voltage (Volts)	Frequency (Hz)
Over Limits	240	52.5
Constant Limit	230	50
Under Limits	220	47.5

From the above observation table it is observed that the tolerance of voltage is ± 10 volt and tolerance of frequency is ±2.5 as per standard. Normally the range of the voltage and frequency is 230 volt and 50Hz respectively according to Indian standard. In this paper according to the results we observed the following conditions.

Condition 1: When supply is constant that is 230 volt, 50Hz then we get constant sinusoidal waveform as output which is as shown below

Voltage: (230volt), Frequency: (50Hz)

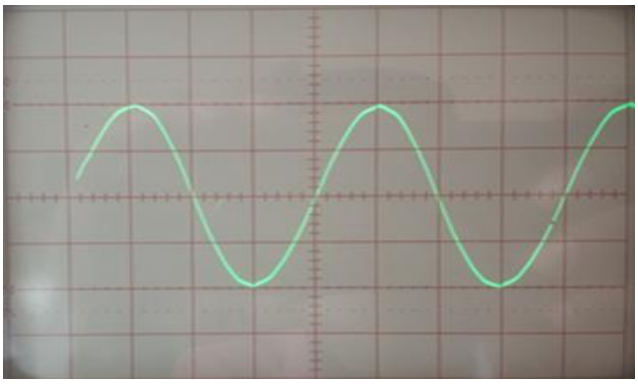

Fig-2: Stable sinusoidal waveform

Condition 2: When given supply voltage is below tolerance limit that is below 220 volt then we get the sine waveform with reducing magnitude as shown below.

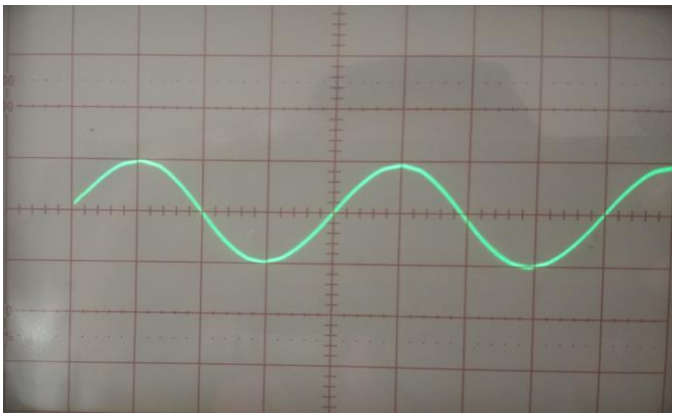

Fig-3: Sinusoidal waveform with decrease in amplitude

Condition 3: When given supply voltage is above tolerance limit that is above 240 volt then we get the sine waveform with increasing magnitude as shown below.

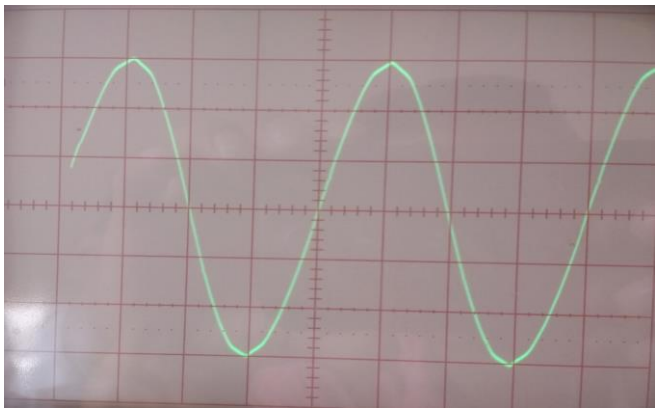

Fig-4: Sinusoidal waveform with increase in amplitude

Condition 4: Similarly when frequency is above tolerance limit we get large number of oscillation in sinusoidal waveform as shown below.

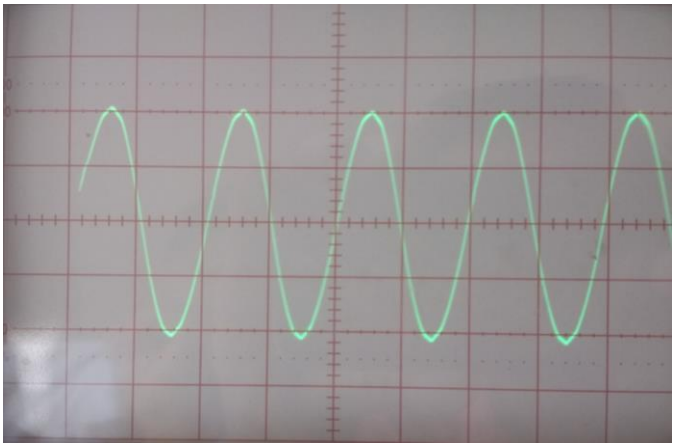

Fig-5: Sinusoidal waveform with increase in frequency

Condition 5: When frequency is below tolerance limit we get less number of oscillation in sinusoidal waveform as shown below.

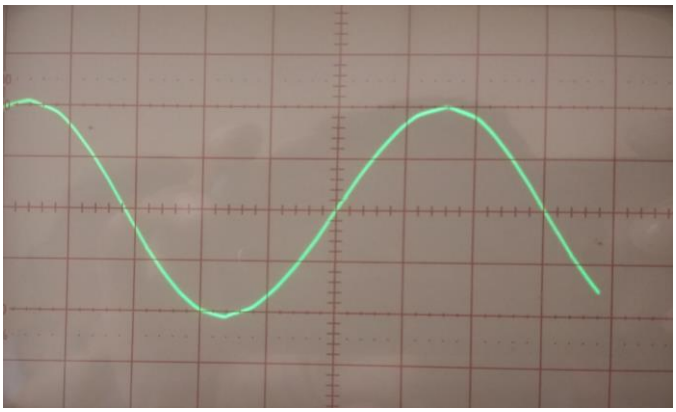

Fig-6: Sinusoidal waveform with decrease in frequency

4. CONCLUSIONS

This paper give brief idea about developing a system to detect the synchronization failure of any external supply source to the power grid on sensing the bad voltage and frequency. Number of distributed generator connected in parallel to the grid, to supply power to the load. Each generator having follow the rules of grid. These rules involve maintaining a voltage and frequency variation within limits. When any fault occur on grid and due to this grid broken a rules and deviation occur in voltage and frequency. When deviation occur in grid feeder is mandatory to open from grid and this process is term as islanding. This prevent grid failure or blackout.

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