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# Detecting Power Grid Synchronization Failure on Sensing Bad Voltage or Frequency Documentation

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**Abstract**—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.

In this paper we present the development 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. For feasible transmission, the frequency and voltage of the AC supply should be within the limits as decided by the grid, depending upon the demand of the power supply. As per CENTRAL ELECTRICTY AUTHORITY OF INDIA Regulations 2010, variation of the system voltage should be of +- 5 % and that for frequency close to 50 Hz and shall not allow it to go beyond the range 49.2 to 50.3 Hz or a narrower frequency band specified in the Grid Code, except during the transient period following tripping. In case these limits are exceeded and the demand for power is more than the demand for supply, it results in grid failure. In such situations, the feeder unit is completely disconnected from the grid, causing islanding situation. Thus synchronization is needed between the grid and the feeder unit, so as to prevent the large scale brown out or black out of the grid power. In this paper, we are presenting a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure. Methods of detecting islanding are clearly grouped into three categories as a function of their operating mode. These three categories are:

-  Active methods resident in the grid tied inverter
-  Passive methods resident in the grid tied inverter
-  Methods not resident in the DG but communicating the DG and the utility

This paper is based 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.

**Keywords**—Islanding, Grid, Voltage Variation, Frequency Variation, Active methods, Passive methods

**INTRODUCTION**

Energy provides the power to progress. Availability of sufficient energy and its proper use in the country can result in its people rising from subsistence level to highest standard of living. Energy exists in different forms in nature but the most important form is the electrical energy. 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. Increasing electrical energy demand, modern lifestyles and energy usage patterns have made the world fully dependant on power systems thus the need of a reliable and stable power system grid. However, the power system is a highly nonlinear system, which changes its operations continuously. Therefore, it is very challenging and uneconomical to make the system be stable for all disturbances. At present, the interest toward the distributed generation systems, such as photovoltaic arrays and wind turbines, increases year after year. But wind turbines and generally DGs will have affects in the power system network that one of these influences is an islanding phenomenon. 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 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. According to IEEE1547 standard, islanding state should be identified and disconnected in 2 seconds. This leads to idea of Automatic detection of Grid synchronization failure concept. Thus, the main consideration in our paper is to detect islanding in a grid.

**ISLANDING**

Islanding is a critical and unsafe condition in which a distributed generator, such as a solar system, continues to supply power to the grid while the electric utility is down. This condition is caused due to an excessive use of distributed generators in the electrical grid. Solar power generators, wind generators, gas turbines and micro generators such as fuel cells, micro turbines, etc. are all examples of distributed generators. The fact that anyone could supply electricity back to the grid causes the problem of islanding. It is a condition in which a distributed generator like solar panel or wind turbine continues to generate power and feed the grid, even though the electricity power from the electrical utility is no longer present. 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.

To avoid this problem, it is recommended that all distributed generators shall be equipped which devices to prevent islanding. The act of preventing islanding from happening is also called anti-islanding. Islanding causes many problems, some of which are listed below:

- **Safety Concern:** Safety is the main concern, as the grid may still be powered in the event of a power outage due to electricity supplied by distributed generators, as explained earlier. This may confuse the utility workers and expose them to hazards such as shocks.
- **Damage to customer's appliances:** Due to islanding and distributed generation, there may a bi-directional flow of electricity. This may cause severe damage to electrical equipment, appliances and devices. Some devices are more sensitive to voltage fluctuations than others and should always be equipped with surge protectors.
- **Inverter damage:** In the case of large solar systems, several inverters are installed with the distributed generators. Islanding could cause problems in proper functioning of the inverters.

**WAYS TO DETECTS AND RESOLVE ISLANDING**

There are many ways to detect islanding. These are categorized as under:

- **Active islanding detection:** Active detection methods involve the technique of constantly sending a signal back and forth between the distributed generator and the grid to ensure the status of electrical supply. In active methods, small disturbances are injected into the power system and its responses due to the injected disturbances are monitored. These methods change the balancing power between loads and generations, reduce the power quality of the power systems and are not suitable for wind farms with numerous wind turbines. Reactive power export error detection method , impedance measurement method, slip mode frequency shift algorithm (SMS), active frequency drift (AFD), active frequency drift with positive feedback (AFDPF),automatic phase-shift (APS) and adaptive logic phase shift (ALPS) are a few examples of active islanding detection methods.
- **Passive islanding detection:** Passive detection methods, on the other hand, make use of transients in the electricity (such as voltage, current, frequency, etc.) for detection. Passive methods continuously monitor the system parameters such as voltage, frequency, harmonic distortion, etc. Based on the system characteristics, one or more of these parameters may vary greatly when the system is islanded. The passive methods do not affect the waveform of the high voltage. This is beneficial since it does not give rise to power quality issues such as voltage dips. Setting a proper threshold can help to differentiate between an islanding and a grid connected condition. Rate of change of output power of DG, rate of change of frequency, voltage unbalance and harmonic distortion are a few examples of passive islanding detection methods.
- **Methods not resident in the DG but communicating the DG and the utility:** Methods not resident in the DG side but implemented on the EPS side are much complicated and expensive. The most important ones can be summarized as:
  - **Introduction of impedance** –Small impedance, normally capacitive, is placed after the PCC on the EPS side. It only gets connected when the breaker DG-EPS is opened, unbalancing the local load.
  - **PLC Communication** – Uses the "Power Line Communications Carrier" technology to test if the DG is working isolated. SCADA Systems – With the help of a Supervisory Control and Data Acquisition System the EPS is checked and the potential islands detected.

The quickest and easy way to prevent any problems is to shut off the distributed generator when requested by the utility.

## ARRANGEMENT FOR DETECTING POWER GRID SYNCHRONIZATION FAILURE ON SENSING BAD VOLTAGE OR FREQUENCY

The block diagram shown in fig.1.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, the project uses a variable frequency generator (555-timer) for changing the frequency, while a standard variac is used to vary the input voltage to test the functioning of the project. A lamp load (indicating a predictable blackout, brownout) is being driven from the microcontroller in case of voltage/frequency going out of acceptable range. Further the project can be enhanced by using power electronic devices to isolate the grid from the erring supply source by sensing cycle by cycle deviation for more sophisticated means of detection.

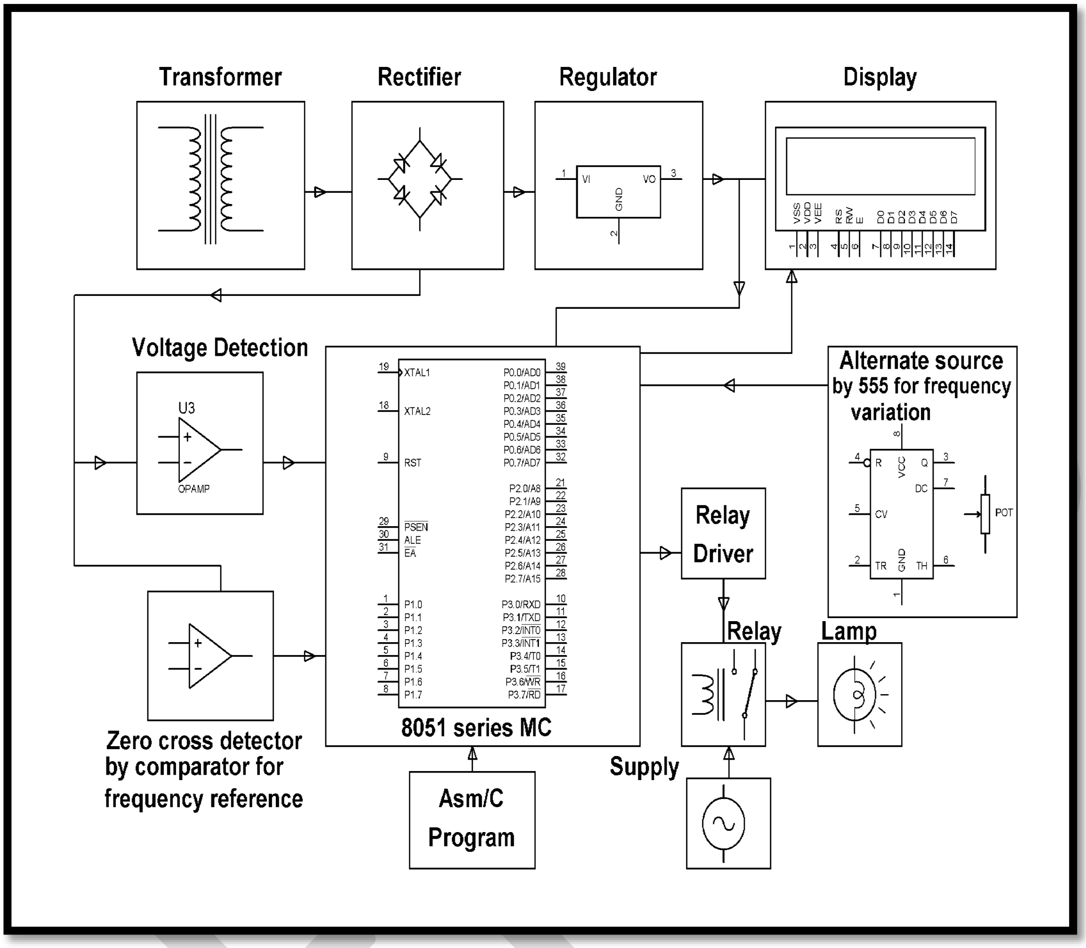


Fig.1- Block diagram

The components required are as follows: Microcontroller (At89s52/At89c51),Power Supply,555 Timer, Lm358, Lm339, Relays, Bc547, Liquid Crystal Display, Led, In4007, Resistors, Capacitors.

## VOLTAGE SENSING PART

The microcontroller is connected to the zero voltage sensing circuit to ensure the frequency of the supply is at normal frequency of 50Hz. A Voltage Regulator is used to get variable voltage. Initially both the presets are adjusted such that both the output pins of the OPAMP IC are at normal low and normal high level. At this point the lamp is glowing as the voltage is in the range. The Voltage Regulator is adjusted so as to get the input AC voltage more than the normal value. Now the normally high pin of the OPAMP IC will go low, giving an interruption pulse to the pin of the microcontroller. The microcontroller accordingly sends a high logic pulse to switch off the relay driver, which in turn de-energizes the relay driver making the lamp to turn off. Similarly when the Variable Regulator is adjusted so as to get input AC voltage less than the normal value, at some point, the normally low pin of the OPAMP IC goes high and the microcontroller on receiving this interruption, sends a high logic signal to the relay driver to switch off the relay and hence the lamp which stops glowing

## FREQUENCY SENSING PART

The Voltage Regulator is adjusted such that the AC input voltage is at its normal value. The microcontroller pin is connected to the output of the 555 timer through a PNP transistor. The timer works in a stable mode to produce signals at frequencies which can be adjusted using the variable frequency. This output is connected to the internal timer of the microcontroller which accordingly calculates the frequency of the frequency, the relay driver is triggered, which in turn energizes the relay and the AC supply is given to the lamp which turns off once the frequency of the pulses goes beyond the normal frequency or less than the normal.

## ACTUAL VIEW OF PROJECT

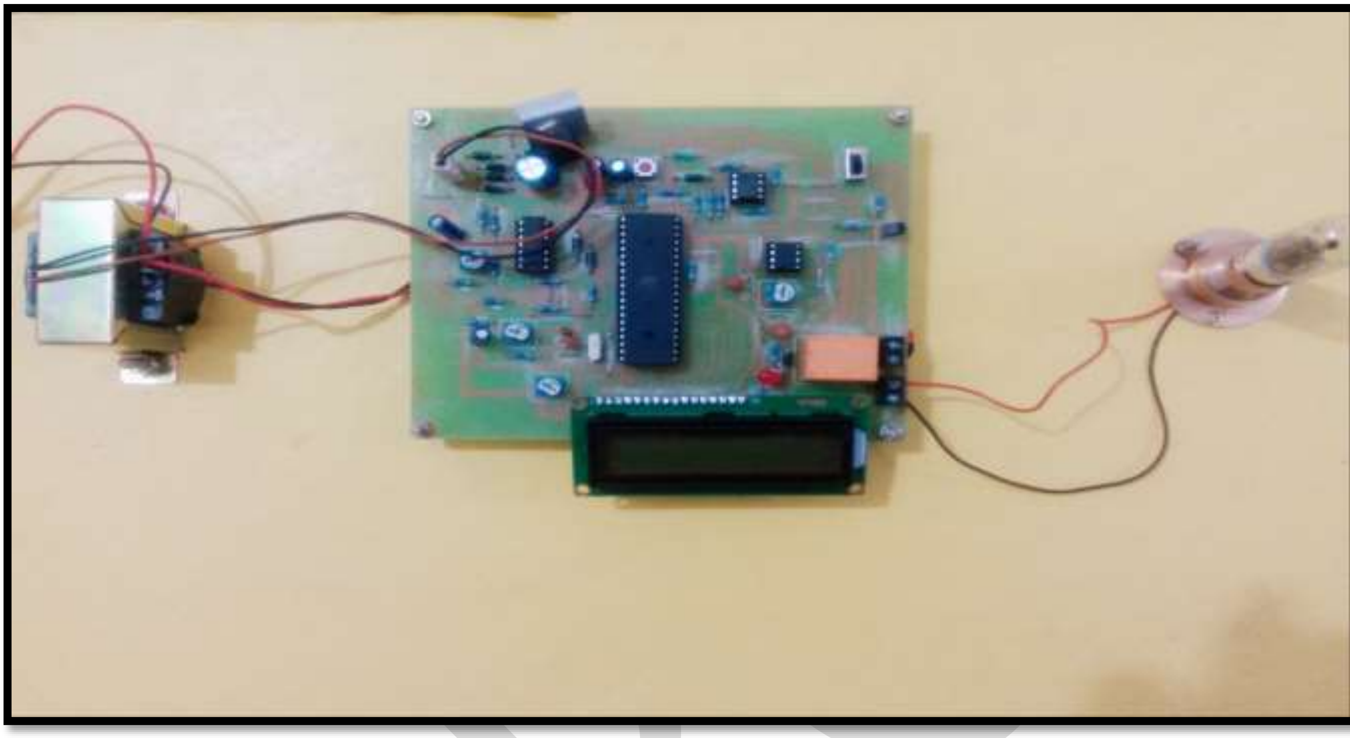

Fig.2 Actual View of Project

## CONCLUSION

This paper gives brief idea about indicator which senses the abnormalities in voltage as well as in frequency so as to detect the synchronization failure of any external supply source to the power grid. This type of indicators are much needed in most crowded EHV substations where number of voltage levels, number of sources, number of power transformers and number of load lines are existing. In short it will be beneficial in case of complicated substation because at present the facility available is FTR i.e. Frequency Trip Relay and UFR i.e. Under Frequency Relay which performance function of directly disconnection of particular feeder which may cause sudden rise of voltage on system bus. Also there is a chance for the power system to get imbalance in the absence of such indications and automatic disconnection i.e. islanding.

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