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DETECTION OF POWER GRID SYNCHRONIZATION FAILURE ON SENSING FREQUENCY AND VOLTAGE

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Abstract: Grid synchronization failure can cause complete black out. So, there is always a need for a system that can sense any abnormalities and take actions accordingly to prevent black outs. A grid is connected with several power generating units like thermal, nuclear, wind etc. to deliver power to the load. In India, the generating units have to deliver power according to the Indian Electricity Grid Code, 2010 which states that the variation in voltage should be within the limit of ±5% and that for the frequency should be within ±3%. If any value higher/lower is detected, then that particular feeder should be disconnected from the grid temporarily in order to protect the grid. In this paper, we will be discussing about a system based on the microcontroller, that will be used to monitor the variation in voltage and frequency of the any external supply source, and automatically disconnects the supply source from the load.

1. INTRODUCTION

1.1 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 fulfil 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.

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.

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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 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 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.

1.4 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.
- 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.

2. LITERATURE REVIEW

1. Laukik S. Raut, Shahrukh B. Pathan, Gaurav N. Pawar, Mandar V. Pathak,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

2 Karan Gupta, Shreyas Gupta, KummadVerma, Anil Singh, Abhimanou Sharma, gave an idea of Detecting Power Grid Synchronization Failure on Sensing Bad Voltage or Frequency Documentation in which they described in modern power

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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.

3. BLOCK DAIGRAM

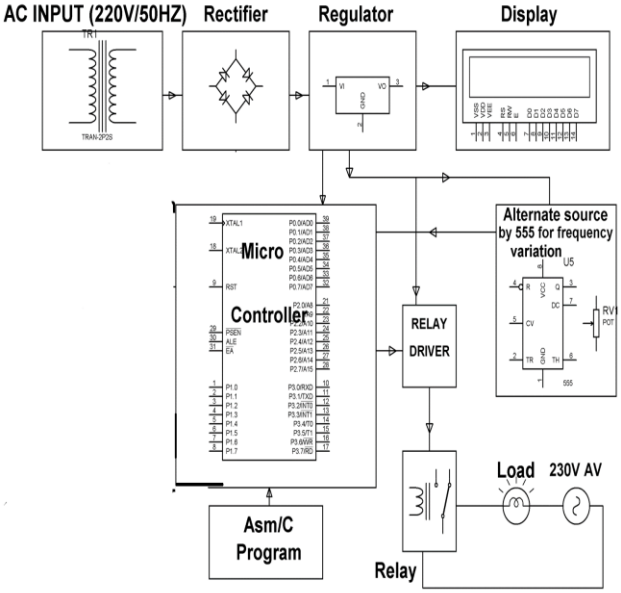

Fig -1: Block diagram

Main components

- Power supply unit
- Arduino Uno Microcontroller
- LCD
- Capacitors
- Diodes
- Transformer
- Potentiometer
- Relay
- Lamp load

4. OPERATION

The input supply voltage to the system is 220V AC but, the voltage requirement of the most of the electronic components is much smaller than the supply voltage here . So, a step-down transformer here is used to step-down the voltage to 12V DC, via a rectifier. The microcontrollers of 8051 family requires 5V input for their operation and thus, a voltage regulator regulates the 12V into 5 V DC . The microcontroller is interfaced with the LCD display, relay driver and voltage, frequency detectors. The voltage of the system is varied by using voltage potentiometer and variable frequency is produced using IC 555- timer. The voltage and frequency detector senses for any abnormalities in the supply through a reference value and returns the sensed data to the microcontroller which analyses the data to generate output signals for other devices and perform tripping action through relay driver, according to the higher/lower value sensed. The lamp is used to indicate the synchronization failure of the supply. Whenever there is a synchronization failure of the source (i.e. abnormal voltage or frequency), the relay circuit is triggered and the lamp stops glowing which gives indication of the synchronization failure.

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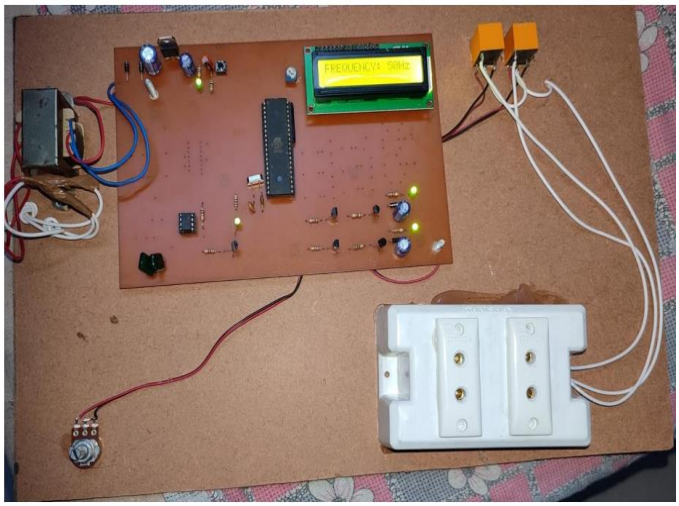

Fig -3: Hardware Implementation

FREQUENCY SENSING

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, 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. For varying the input frequency, IC 555-timer is used . The voltage of the system is kept at normal value via a regulator. The output of the IC 555-timer is connected to the pin of the microcontroller through a PNP transistor. The IC 555-timer works in astable mode to produce signals at frequencies that can be adjusted using the variable frequency This output is connected to the internal timer of the microcontroller which then calculates the frequency of the frequency accordingly . For frequency value lower/higher than the normal, the relay circuit is triggered, the relay driver is switched off and lamp stops glowing, giving an indication for the synchronization failure due to abnormalities in supply frequency.

4. RESULTS

It is observed that the tolerance of voltage is ± 10 volt and tolerance of frequency is ±2.0 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 :- When supply is constant that is 230 volts, 50Hz then we get constant sinusoidal waveform as output. (230volt), Frequency: (50Hz) These Parameters Limits Voltage (Volts) Frequency (H z) Over Limits 240 52.5 Constant Limit 230 50 Under Limits 220 47.5 38 Stable sinusoidal waveform When frequency is below tolerance limit we get less number of oscillation in sinusoidal waveform. Sinusoidal waveform with decrease in frequency. These outputs are obtained in the PC or in the lab oscilloscope and can verify the result.

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 and cost-effective system is developed and design in this paper. This method is used to trace fault of the power grid synchronization failure on the basis of frequency fluctuations To provide power to the load the rules of grid involve maintaining a voltage in the limits and the frequency as well. If any deviation from the range of the grid occurs then it is

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compulsory that the grid should automatically get disconnected. This prevents in large scale brown out or black out of the grid power by sensing abnormalities of voltage and frequenc

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