DETECTING POWER GRID SYNCHRONIZATION FAILURE ON SENSING BAD VOLTAGE OR FREQUENCY

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Abstract:

The paper is designed to develop a 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 hydel, thermal, solar etc. to supply power to the load. These generating units need to supply power according to the rules of the grid. As per CENTRAL ELECTRICTYAUTHORITY OF INDIA Regulations 2010, variation of the system voltage should be of +- 5 % and make all efforts to operate at a frequency close to 50 Hz and shall not allow it to go beyond the range 49.2 to 50.3 Hz. 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 termed as islanding. This prevents 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.

Key words: Islanding, Grid, Voltage variation, Frequency variation, Active methods, Passive methods.

Introduction:

The modern society is so much dependent upon the use of electrical energy that it has become a part 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 fulfill all the three condition for synchronizations so it will get asynchronized with grid, this situation is called as 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 this can damage the grid itself or equipments connected to it and can even compromise the security of the maintenance personnel the grid. Therefore, according to IEEE1547 standard, islanding state should be identified and disconnected in 2 seconds.

1. 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 loaddemands.
- 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

2. Methodology:

There are two methods to permit islanding effect.

- Passive detection
- Active detection

In this paper we used active detection method to build the system. IOT performs major role in the system. In the proposed system we used IOT based NodeMCU to detect the frequency and Voltage variation.

2.1 Active Islanding Detection:

Active detection methods inverse 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.

2.2 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 parameter such as voltage, frequency, harmonic distortion, etc. based on the system characteristics, one or more of these parameter mar vary greatly when the system is islanded.

3. Existing methods:

- The existing system is an Arduino based application, the micro controller will be monitoring the under/over voltage which is being derived from the set point of the comparators. As the supply frequency cannot be changed, we will be using IC to produce variable frequency and for varying the voltage standard, variac is being used.
- The existing system is complex due to difficult connections and the cost of the system is also high.

4. Proposed System:

- A new power synchronization detection model that detects the abnormalities in frequency and voltage using IOT is designed.
- The proposed system consists of a NodeMCU module which has inbuilt microcontroller and WIFI module connected with smart mobile with BLYNK app monitors the frequencyand voltage which is passing to the load.

5. Arrangement Of Detecting Power Grid Synchronization Feature On Sensing Bad Voltage Or Frequency:

This system is based on IOT technology throught Node MCU to detect the frequency and voltage variations .Node MCU (ESP8266) module which has inbuilt microcontroller and self-contained ESP-12E wi-fi module is a core processor ESP8266-32bit connected with smart mobile with blynk app monitors the frequency and voltage which is passing to the load.

5.1 Block Diagram

The block diagram of the proposed system is as shown below.

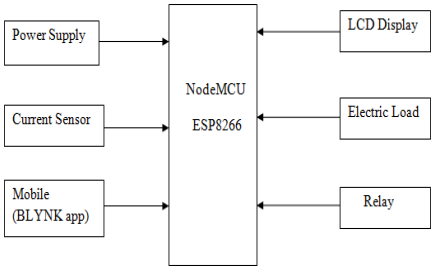

Fig 1: Block Diagram

Main components:

- Node MCU
- Relay
- Current sensor
- LCD
- Mobile (BLYNK app)
- Electric lamp load

6. 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 shutdown 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. Hence in this paper the detection of the load for synchronization and voltage, frequency detections.

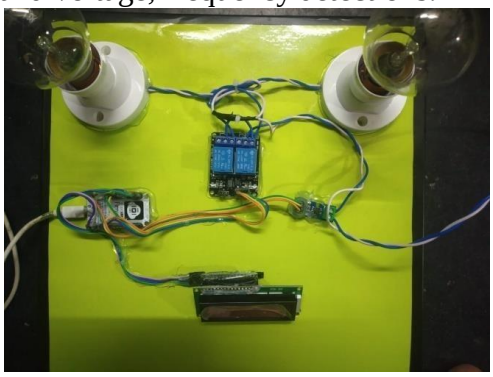

Fig 2: Hardware Representation

Figure shows the Detection of power grid synchronization failure on sensing frequency and voltage beyond acceptable range and automatic load protection by tripping. The power supply is given to the kit, the NodeMCU is powered through the adaptor it has inbuilt WIFI module and microcontroller which monitors the voltage and frequency through the Blynk app in the mobile.

When there is a change in frequency or voltage the relay receives the command from the microcontroller to disconnect the electric load from the supply. The LCD displays the power and current in the entire circuit. The current was sensed through the Current sensor.

7. Software Implementation:

7.1 ARDUINO SOFTWARE

Arduino is the world's leading open-source hardware and software ecosystem. The Company offers a range of software tools, hardware platforms and documentation enabling almost anybody to be creative with technology.

- Arduino 1.8.15 software is used in this paper.

7.2 BLYNK CLOUD

- **Blynk App** - allows to you create amazing interfaces for your papers using various widgets we

provide.

- **Blynk Server** - responsible for all the communications between the Smartphone and hardware. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- **Blynk Libraries** - for all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands.

8. Result:

Voltage detection is by done by varying the variance in Blynk app through iot 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. In the similar way frequency variation is also done.

Hence a continuous monitoring load and faults in frequency and voltage is done by using microcontroller.

8.1 Hardware Result:

Fig 3: Display Of the off loads when the frequency is low

Consider light load is connected, When supply is given light load is ON, The current sensor senses current. As the frequency is below the permissible range the load is turned off through the relay command from microcontroller.

9. Advantages:

- Here we can use, beyond the acceptable range could be used in that power houses wheredifferent supply sources are connected parallel together to fulfill the energy demand
- By using this system, the consumer load could be automatically shifted to another sourceof 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.

Conclusion:

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 economicalas compared to be the present installations. The challenge is a continuous and uninterrupted transmission which can be very well achieved with this implementation

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