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Power Grid Synchronization failure Detection and Isolation using ESP8266 Microcontroller

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ABSTRACT

The project aims at developing a system capable of identifying abnormalities in voltage or frequency in order to detect a synchronization failure of a power source. Real life power grids consist of Hydro, thermal, solar etc power sources connected in synchronization to power the plant. These sources are supposed to supply power in accordance to grid rules. These rules include voltage and frequency variations within certain limits. A deviation of these limits must lead to that data source being disconnected from the grid with immediate effect. This is known as isolation. This is used to avoid a huge brown out or black out through the power grid. Our system is designed to warn the grid in advance of a power failure so that the grid may use other backup data sources when needed so as to avoid total power failure. Our system demonstrates this using a microcontroller of the 8051 family. Two Microcontroller's are used to detect the voltage and frequency from a set of detectors. Since the potentiometers are used in order to vary the input voltage and frequency in the system. A normal load/lamp is used to demonstrate a predicted black out or power failure in case of out of limit voltage/frequency variance.

KEYWORDS: Power grid synchronization, Abnormal voltage/frequency detection, Isolation, Microcontroller, Predicted blackout/power failure

1. INTRODUCTION

The project focuses on developing a system utilizing the ESP8266 microcontroller to detect and address synchronization failures in the power grid. By monitoring voltage and frequency levels, the system aims to identify deviations from acceptable limits, ensuring stable grid operation. The ESP8266 microcontroller serves as the central control unit, enabling real-time monitoring and early warning capabilities. Through timely detection and isolation of problematic power sources, the system mitigates the risk of widespread blackouts and safeguards the grid's stability and reliability.

2. METHODOLOGY

A.Introduction

The methodology involves setting up the hardware by connecting sensors to the ESP8266 microcontroller and configuring the system. Voltage and frequency are continuously monitored, and deviations from predefined limits are detected through threshold comparisons. Synchronization failures are identified, and an isolation mechanism is triggered to disconnect faulty power sources from the grid. Grid operators are

promptly alerted, enabling backup power activation. Thorough testing validates the system's performance, and ongoing optimization and refinement improve algorithms and adapt the system to real-world implementation challenges and requirements.

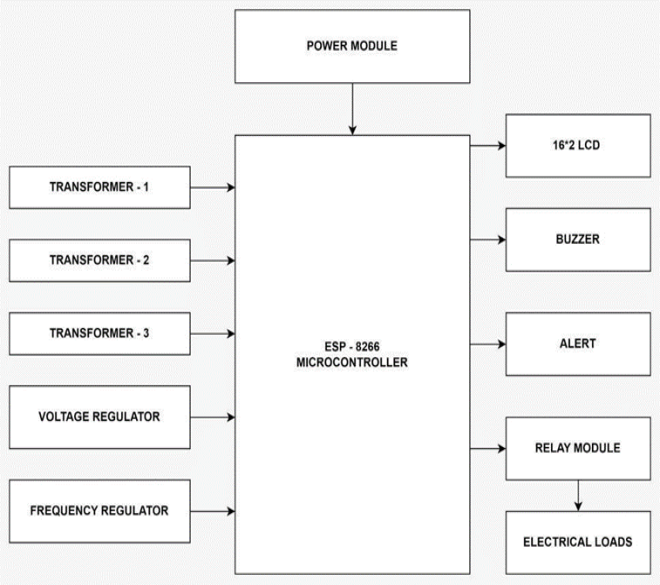
B. Existing Methods

1) Protective relays
2) Load shedding
3) Automatic generation control
4) Renewable energy integration
5) Power system modeling and simulation

C. Proposed System

1) System detects the abnormalities in voltage/frequency to prevent power outages.
2) Uses microcontroller, potentiometer, and load/lamp to monitor levels.
3) Microcontroller sends alerts if levels exceed limits.
4) System can prevent total blackout by disconnecting data source.
5) Complements existing methods and offers additional protection.
6) Simple and cost-effective solution that can be easily integrated

D. Proposed system Block diagram



E. Advantages

1) Voltage Controlled within the permissible limits.
2) Frequency Controlled.
3) Synchronization.
4) Continuity of Power Supply.
5) High Efficiency.
6) Reliability.

F. Applications

1) Real-time power grid monitoring and control.
2) Fault detection and isolation.
3) Backup power integration.
4) Preventing cascading power failures and blackouts.
5) Ensuring reliable power supply to critical infrastructure.

3. System Architecture and Design

G. Sensors

Sensors are the primary components of the system that detect voltage and frequency levels in the power grid. These sensors are connected to the ESP 8266 microcontroller and provide real-time data about the voltage and frequency levels.

H. ESP8266 Microcontroller

The microcontroller is the central processing unit of the system. It receives data from the sensors, processes it, and sends signals to other components of the system to take action in response to the data. The microcontroller is programmed to detect abnormalities in voltage and frequency levels and take necessary actions to prevent power failures.

I. Potentiometer

The potentiometer is a device used to vary the frequency and voltage levels to test the system's response. By changing the voltage and frequency levels using the potentiometer, the system can detect the variations and respond accordingly.

J. Load/Lamp

The load/lamp component is used to demonstrate a predicted blackout or power failure in case of out-of-limit voltage/frequency variance. The lamp represents a typical load connected to the power grid, and the system responds by taking action to prevent power failure in the event of voltage or frequency variations.

K. Communication module

The communication module is responsible for transmitting data about voltage and frequency levels to the power grid management system. This component communicates with the power grid management system to provide real- time data about the power grid's performance and alert the system in case of abnormalities in voltage and frequency levels.

L. Power Source

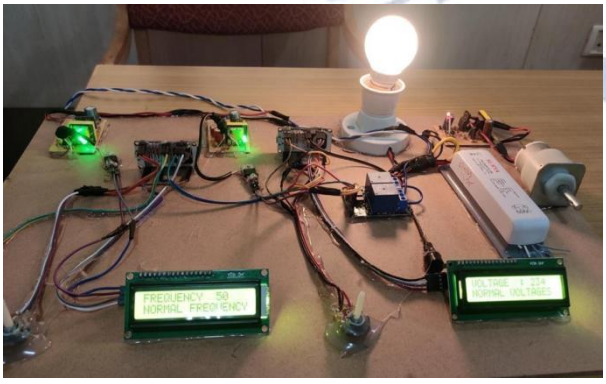
The power source is responsible for providing power to the system and keeping it running. The system requires a continuous power supply to function, and the power source ensures that the system remains operational at all times.

Overall, the power grid monitoring and control system consists of several components that work together to detect and respond to abnormalities in voltage and frequency levels. The system's sensors provide real-time data to the microcontroller, which processes the data and takes necessary actions to prevent power failures. The potentiometer and load/lamp components are used to test the system's response, while the communication module transmits data to the power grid management system. The power source ensures that the system remains operational at all times.

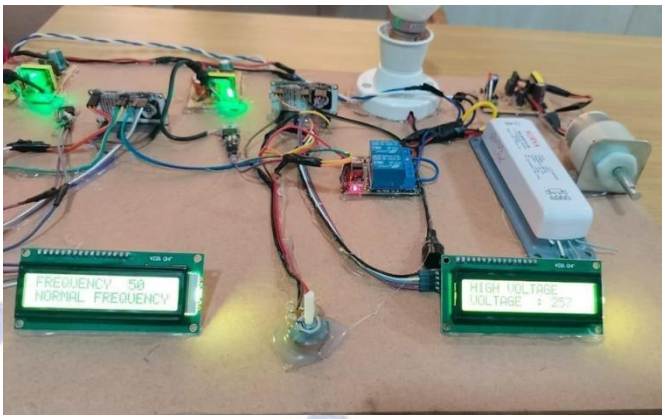
4. Experimental Results

SNO	TYPE	LAMP	DC MOTOR	CHOKE COIL
1.	V = 230 v F = 50 Hz	ON	ON	ON
2.	V = 257 v F = 50 Hz	OFF	OFF	OFF
3.	V = 230 v F = 44 Hz	OFF	OFF	OFF

M. Under Normal Condition



N. Voltage Variation



O. Frequency Variation

5. Conclusions

The system developed using the ESP 8266 microcontroller is a highly effective solution for identifying abnormalities in voltage or frequency in power sources. Real-life power grids consist of different sources such as hydro, thermal, solar, etc. that are supposed to supply power according to specific rules. The system can detect synchronization failures and alert the grid in advance, which helps avoid potential blackouts. The use of a potentiometer to vary the frequency and voltage, as well as a normal load/lamp to demonstrate a predicted blackout, makes the system easy to understand and use. The system's capability to warn the grid in advance of a power failure allows the grid to use other backup data sources when needed, avoiding a total power failure. The system has the potential to greatly improve the reliability and stability of power grids, ensuring uninterrupted power supply to the plant.

Overall, the system is a reliable and efficient solution for power grid management that has the potential to revolutionize the way we approach power grid management and ensure consistent, reliable power

supply.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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