

Design and Implementation of Iot Based Auto Phase Selection System for 3-Phase Power Line

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Abstract

In modern power systems, continuous and reliable electricity supply is crucial, especially for sensitive single-phase loads. In areas using a three-phase distribution network, failure of one or more phases often leads to power interruptions and equipment damage. This paper presents the design and implementation of an IoT-based automatic phase selection system for three-phase power lines. The proposed system automatically detects phase failure and switches to an available healthy phase to ensure continuous supply. Furthermore, using Internet of Things (IoT) technology, real-time monitoring and fault notifications are provided through a web or mobile dashboard. The system is built using an ESP32 microcontroller, voltage sensing circuits, relays, and a Wi-Fi-based IoT platform (such as Blynk or Thing Speak).

Keywords: Iot, Automatic Phase Selector, Three-Phase Supply, Relay Switching, Power Monitoring.

1. INTRODUCTION

The demand for a stable and uninterrupted power supply has increased due to widespread automation and the use of sensitive electronic equipment. In a three-phase power system, if one or two phases fail, the connected single-phase load may experience an outage or unbalanced voltage, which can cause malfunction or damage. Traditional systems use manual or GSM-based phase selection methods that require user intervention or text-based communication. However, with the emergence of the Internet of Things (IoT), it is now possible to monitor and control electrical systems remotely in real time. The IoT-based auto phase selection system proposed in this work combines automation with online monitoring.

Problem Statement: "Design and Implementation of IoT-Based Auto Phase Selection System for 3-Phase Power Lines."

The main objectives of this research work are:

To design and implement an automatic phase selection system capable of detecting and responding to phase failures in a 3-phase supply network.

To integrate IoT technology (using ESP32 or Node MCU) for real-time voltage monitoring and system status visualization through a cloud platform such as Blynk or Thing Speak.

To develop an efficient switching mechanism using relay drivers that ensure seamless transition between phases without disturbing the connected load.

To send instant notifications or alerts to users through IoT dashboards or mobile applications whenever a fault or phase change occurs.

2. LITERATURE REVIEW

The reliability of power supply systems has been a subject of extensive research, particularly in areas affected by frequent phase failures or unbalanced loads. Several researchers have proposed different methods for automatic phase selection and remote monitoring in three-phase power systems.

In [1], P. Singh et al. (2020) developed a microcontroller-based automatic phase selector that automatically switches to the next available phase when a phase failure occurs. However, the system was limited to local operation without any remote monitoring or feedback capability.

In [2], A. Kumar and R. Sharma (2021) presented a GSM-based automatic changeover system that uses

SMS alerts to notify users about phase status. Although effective in communication, the system suffered from communication delays and lack of real-time visualization due to dependence on GSM text messaging.

In [3], further research by M. Ahmed et al. (2022) introduced a smart changeover system using an Arduino controller, focusing on seamless switching with relay drivers. This design improved the transition time but did not incorporate cloud reports or IoT-based features for continuous monitoring.

In [4], with advancements in IoT technologies, IoT-enabled monitoring systems have become popular for remote energy management. N. Alvi et al. (2023) proposed an IoT-based power line monitoring system using Node MCU and Blynk platform, which enabled real-time voltage and current tracking over Wi-Fi. However, it did not address automatic phase changeover functionality.

In [5], R. Patel et al. (2023) developed an IoT-based fault detection system for three-phase lines, capable of detecting line interruptions and sending alerts via a mobile app. Although the study demonstrated effective fault identification, it lacked the implementation of an automatic corrective action mechanism, such as switching to a healthy phase.

Proposed System Diagram

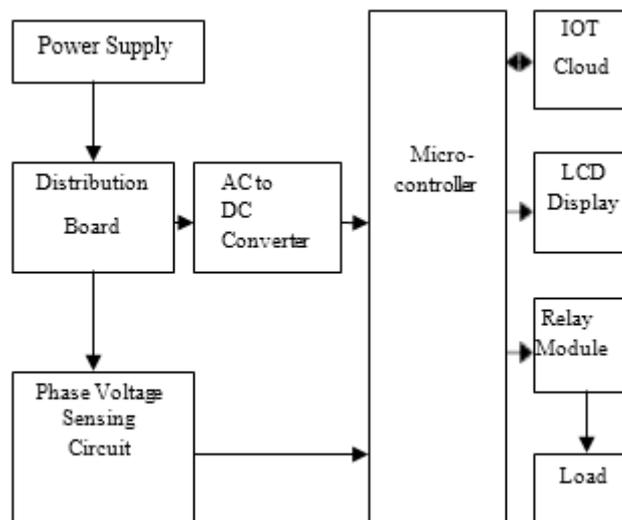


Figure.1 Block Diagram of Proposed System

Step 1: Power Supply

The power supply provides the required electrical energy for the system. In this project, the main supply is obtained from the three phase distribution line. This power is used both for monitoring the phase voltage and for operating the electronic components of the system.

Step 2: Distribution Board

The distribution board receives the three-phase input supply (R, Y, and B phases). It distributes the electrical power to different parts of the circuit, including the phase voltage sensing circuit and the AC-to-DC converter.

Step 3: Phase Voltage Sensing Circuit

The phase voltage sensing circuit continuously monitors the voltage of each phase (R, Y, and B).

If a phase is available, the circuit sends a signal to the microcontroller.

If a phase fails or the voltage drops, the circuit detects the failure and informs the microcontroller.

Step 4: AC to DC Converter

The AC-to-DC converter converts the AC supply into regulated DC voltage. This DC power is required for operating electronic components such as the microcontroller, LCD display, and relay module.

Step 5: Microcontroller

The microcontroller acts as the main control unit of the system. It receives signals from the phase voltage sensing circuit and processes the information. Based on the availability of phases, the microcontroller decides which phase should be selected for supplying power to the load.

Step 6: IoT Cloud Communication

The microcontroller is connected to the IoT cloud platform. Through IoT technology, the system can send real-time data about phase status and power conditions to the cloud. This allows remote monitoring and analysis of the power supply system.

Step 7: LCD Display

The LCD display shows important information such as: Active phase (R, Y, or B) Phase failure status System operation messages this helps users easily monitor the system status.

Step 8: Relay Module

The relay module acts as an electronic switching device. Based on the command from the microcontroller, the relay automatically switches the load to the available phase. If one phase fails, the relay switches to another healthy phase.

Step 9: Load

The load represents electrical devices such as bulbs, motors, or other equipment connected to the system. The selected phase from the relay module supplies power to the load, ensuring continuous and reliable operation even if one phase fails.

3. METHODOLOGY

1. Phase Monitoring

The three-phase input supply (R, Y, and B phases) is continuously monitored using voltage sensing circuits. These circuits detect whether the phase voltage is present or absent and send the information to the microcontroller.

2. Signal Processing

The microcontroller receives signals from the phase sensing circuit and analyzes the condition of each phase. If the selected phase fails or its voltage drops below the required level, the controller immediately identifies the failure.

3. Automatic Phase Selection

Based on the monitoring results, the microcontroller automatically selects another available phase. The switching operation is performed using relay modules connected to the controller.

4. Load Switching

When the controller detects a phase failure, it activates the relay corresponding to the healthy phase. The load is then automatically transferred to that phase, ensuring continuous power supply without manual intervention.

5. IoT Monitoring

An IoT module is integrated into the system to enable remote monitoring. The phase status and switching information can be transmitted through the internet and monitored in real time using a mobile device or web platform.

6. System Testing

The developed prototype is tested under different phase failure conditions. The results confirm that the system successfully detects phase failure and switches to the available phase quickly and reliably.

3.1 Flow Chart

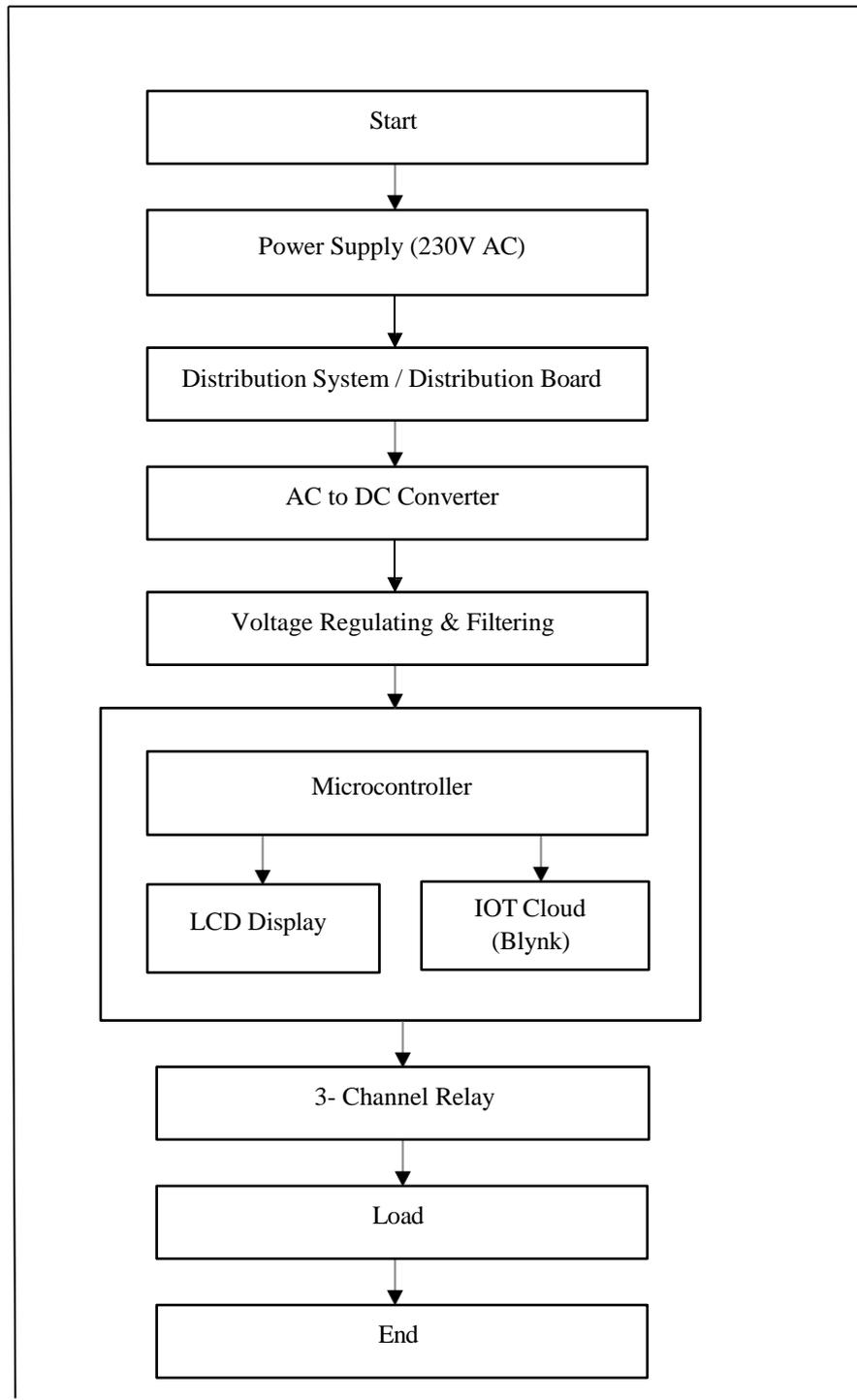


Figure 2: Flow Chart of Proposed System

4. RESULT AND DISCUSSION

The proposed IoT-based automatic phase selection system was successfully designed and implemented to ensure an uninterrupted power supply in the presence of phase failure. The system continuously monitors the availability of three phases (R, Y, and B) using the phase voltage sensing circuit.

The sensed signals are processed by the microcontroller, which automatically selects the available phase and switches the load using a relay module.

During the testing phase, different conditions were created by manually disconnecting individual phases. The system successfully detected the absence of a phase and immediately switched the load to the next available healthy phase without significant delay.

4.1 Observed Results

Table 1: Observed Result of Proposed System

Sr. No.	Test Condition	System Response
1	All phases available	R phase selected
2	R phase failure	Load switched to Y phase
3	R and Y failure	Load switched to B phase
4	All phases absent	Load turned OFF
5	IoT monitoring	Phase status updated on cloud
6	LCD display	Active phase shown correctly
7	System operation	Stable and continuous

The IoT integration allowed the system to transmit real-time data to the cloud platform. This feature enables remote monitoring of the power supply conditions and improves system reliability. The experimental setup demonstrated that the proposed system can effectively reduce manual intervention and minimize downtime caused by phase failures.

Overall, the developed system proved to be reliable, cost-effective, and suitable for residential and small industrial applications where continuous power supply is essential.

The ensured continuous power supply to the connected load. The LCD display clearly indicated the active phase and system status, make the monitoring process simple and user-friendly.

4.2 Photograph of Prototype



Figure 3. Hardware prototype of the proposed system

4.3 Result Analysis

The experimental results demonstrate that the proposed IoT-Based Automatic Phase Selection System operates effectively under different phase conditions. The phase voltage sensing circuit successfully detected the availability and failure of each phase (R, Y, and B) and transmitted the corresponding signals to the microcontroller. Based on the received signals, the microcontroller processed the information and controlled the relay module to select the appropriate phase.

During the testing process, when the primary phase failed, the system automatically switched the load to the next available phase without noticeable delay. This automatic switching ensured an uninterrupted power supply to the connected load. The LCD display provided real-time information about the active phase and system status, which helped in monitoring the operation of the system.

The overall performance of the developed system indicates that the automatic phase selection process works efficiently under different operating conditions. The sensing circuit accurately detected phase availability and transmitted reliable signals to the microcontroller. Based on these signals, the controller selected the most appropriate phase and activated the relay module to maintain power flow to the load.

The experimental setup also showed that the switching mechanism operates smoothly without causing noticeable interruption or fluctuation in the connected load. The integration of IoT technology improved system monitoring by allowing real-time updates through the cloud platform.

5. CONCLUSION

This project presents the design and implementation of an IoT-based automatic phase selection system for three-phase power lines. The system continuously monitors the availability of each phase and automatically switches the load to the available phase during a phase failure. The microcontroller, relay module, and phase sensing circuit work together to ensure a stable and uninterrupted power supply. The IoT feature also enables remote monitoring of the system status. The developed system is reliable, efficient, and suitable for applications where continuous power supply is required.

In addition, the system demonstrates the potential of combining automatic phase selection with IoT technology for modern power distribution applications. The ability to detect phase failure and automatically shift the load to an available phase improves the reliability and stability of electrical supply systems.

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