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WIRELESS 3 PHASE STAR TO DELTA AND DELTA TO STAR CONVERSIOY USING CONTACTOR AND MOBILE APPLICATION

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Abstract – *Three-phase induction motors are extensively Used in industrial and commercial applications due to their Robustness, high efficiency, and low maintenance Requirements. However, high inrush current during startup Remains a significant challenge, causing mechanical stress The motor and electrical disturbances in the supply network.*

Conventional methods, such as manual or timer-based Star delta starters, have been widely implemented to mitigate Starting current, but they suffer from limitations including Lack of real-time control, inflexibility, and increased Dependence on human intervention. Previous research has Explored advanced methods such as soft starters and Programmable logic controllers (PLCs) for better motor Control, but these solutions often involve higher cost and Complexity. This paper proposes a wireless 3-phase star-delta and delta-star conversion system using contactors controlled Via a mobile application. The proposed system enables Remote operation, real-time monitoring, and enhanced Safety by minimizing manual interaction. Additionally, it Provides reliable motor control, reduces energy loss during Startup, and offers a cost-effective alternative to Conventional and automated solutions. Experimental results Demonstrate the system's effectiveness in reducing starting Current, improving operational flexibility, and facilitating User-friendly control, making it suitable for modern Industrial automation applications.

Key Words: **Three-phase induction motor, Star-Delta starter, Contactor, Wireless control, Mobile application**

1. INTRODUCTION

Three-phase induction motors are widely used in industries Due to their simple construction, high reliability, and low Maintenance requirements. However, starting these motors Directly using Direct-On-Line (DOL) methods generates high Inrush currents, which can damage motor windings, reduce the Lifespan of connected equipment, and cause electrical Disturbances. To address this issue, star-delta starters are commonly employed to limit the starting current. Traditional Star-delta starters are either manual or time-based, requiring Operators to be physically present near the motor panel, which Can be inconvenient and unsafe in many industrial Environments. With recent advancements in wireless Communication and mobile technologies, motor control can Now be performed remotely, providing flexibility, safety, and Real-time monitoring. This project proposes a wireless 3-phase Star-delta and delta-star conversion system using contactors Controlled through a mobile application. The system enables Remote operation, reduces human effort, improves operational Safety, and ensures efficient and reliable motor performance, offering a modern and cost-effective solution for industrial Motor control.

2. Literature Review:

Several researchers have studied motor Starting techniques And automation Methods: conventional manual star-delta Starters are simple but prone to human error and unsafe Operation. Automatic star-delta starters using timers reduce human Intervention but lack flexibility and monitoring.PLC-based Motor control systems Provide accurate control but are costly and complex for small industries. Recent studies show that Wireless Technologies such as Bluetooth, GSM and Wi-Fi are increasingly used for motor control and monitoring using Mobile applications. However, most existing systems do not focus on wireless Bidirectional conversion between star and delta using Contactors. Therefore, a need exists for a low-cost, simple, and wireless-controlled star-delta system.

1.1Manual Star-Delta Starters:

Manual star-delta starters are among the earliest and simplest Techniques for reducing the high starting current of induction Motors. In this method, the motor initially starts in a star (Y) Configuration, which reduces the voltage applied to each Phase to $1/\sqrt{3}$ of the line voltage, thus limiting the starting Current to approximately one-third of the direct-on-line (DOL) value. After a certain period, the connection is manually changed to delta (Δ) for normal operation, allowing. The motor to run at full line voltage. While cost-effective, this Method is prone to human error, timing mistakes, and unsafe operation, especially in industrial environments with large Motors. Improper switching can cause mechanical stress, Overheating, or even motor failure.

Timer-Based Automatic Star-Delta Starters:
Timer-based automatic star-delta starters were developed to Reduce human intervention while controlling the high starting Current of induction motors. In this system, the motor initially starts in the star configuration, which reduces the voltage across each winding to $1/\sqrt{3}$ of the Line voltage and limits the starting current to approximately one-Third of the direct-on-line (DOL) value. This eliminates the need For manual intervention, Reduces human error, and ensures More consistent startup performance.

However, timer-based starters have inherent limitations. The Fixed switching time is calculated for nominal load conditions and cannot adapt to varying operational loads or supply Voltage fluctuations. If the motor is lightly loaded, the transition from star to delta May occur too late, resulting in unnecessary energy loss and Mechanical stress. Conversely, under heavy load, switching Too early can cause high inrush current, potentially damaging The motor and connected equipment.

Moreover, these systems do not provide real-time monitoring, fault detection, or Remote control, which limits flexibility and makes them less Suitable for modern industrial automation. Despite these limitations, timer-based automatic starters Remain widely used in small and medium-scale industries due To their low cost, simplicity, and reliability. They serve as a Foundation for more advanced automated systems, including PLC-based and wireless control solutions.

PLC-Based Motor Control Systems:
Programmable Logic Controller (PLC)-based starters provide A modern and flexible solution for controlling three-phase Induction motors. A PLC is an industrial digital computer designed to perform Control functions in real-time. In motor starting applications, PLCs can manage the sequence of star-delta switching, Monitor motor parameters such as current, voltage, and Temperature, and implement safety interlocks to prevent faults Or damage.
Unlike timer-based systems, PLCs allow adaptive Control based on real-time operating conditions. For example, the PLC can adjust the star-to-delta transition Time according to motor load, preventing unnecessary Mechanical stress or high inrush current. PLCs can also Integrate with sensors and feedback devices, enabling Automatic fault detection, overload protection, and system Diagnostics.

Additionally, PLC-based control can be integrated with SCADA (Supervisory Control and Data Acquisition) systems Or HMI (Human-Machine Interface) panels, providing Centralized monitoring, logging, and remote operation. This Enhances safety, reliability, and efficiency in industrial Operations. The main limitations of PLC-based starters are higher cost, Hardware complexity, and programming requirements. Small-Scale industries often find PLC systems expensive and technically demanding compared to conventional or timer-Based starters.
Nevertheless, PLC-based solutions are highly effective for Large-scale or automated industrial environments, offering precise control, flexibility, and advanced monitoring Capabilities that manual and timer-based systems cannot provide

Wireless Motor Control Systems:
Recent advances in wireless technologies, including Bluetooth, GSM, Wi-Fi, and IoT platforms, have enabled Remote motor operation and monitoring via mobile Applications. Wireless control minimizes operator presence Near high-voltage panels, enhancing safety and convenience. It also allows real-time feedback, operational alerts, and Energy monitoring. Previous research has implemented single-Direction wireless motor starters, but most systems do not provide bidirectional star-delta and delta-star switching using Contactors, which is essential for flexible industrial Applications.

Theory of Star-Delta Switching and Contactors:
Star-delta conversion is achieved using contactors, which are Electromechanical switches designed to handle high currents. During startup, the star contactor closes, connecting the motor Windings in star configuration and reducing starting current. After the timer or controller triggers the transition, the star Contactor opens and the delta contactor closeTheory of Star-Delta Switching and Contactors:

After the timer or controller triggers the transition, the star Contactor opens and the delta contactor closes, applying full Line voltage. Proper sequencing and interlocking of contactors Are critical to prevent short circuits and ensure safe operation. Wireless control of these contactors enables remote switching, Monitoring, and safety interlocks

Research Gap:

Although conventional, automatic, and PLC-based starters Have been widely studied, there is a lack of low-cost, wireless Systems capable of bidirectional star-delta conversion with Real-time monitoring via mobile applications. Such a system would combine the benefits of reduced starting current, Operational flexibility, safety, and ease of use at a reasonable Cost.

Conclusion: An effective motor starting system should be Simple, reliable, low-cost, and support wireless remote Operation. This motivates the development of a wireless star-Delta and delta-star conversion system using contactors and A mobile application, addressing limitations of previous Methods while meeting modern industrial needs.

Wireless 3 Phase Star To Delta And Delta To Star Conversion Usiing Contactor And Mobile Application:

Block diagram:

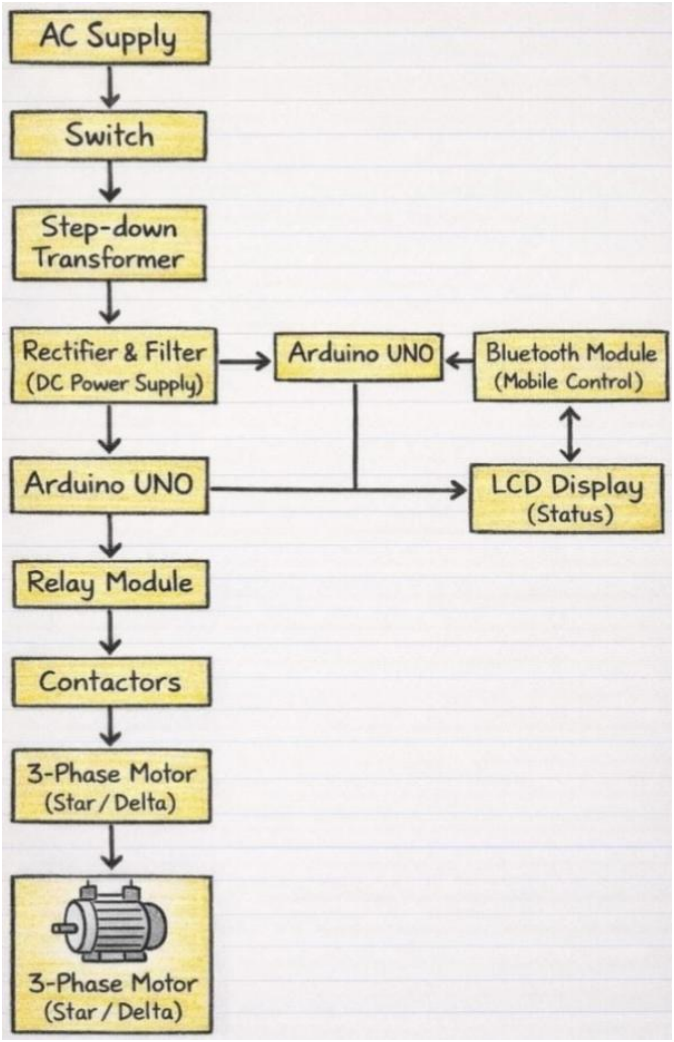


Fig. 1. Block Diagram of Wireless Star–Delta and Delta–Star Conversion System

This project deals with the wireless conversion of 3-phase Induction motors from star to delta and vice versa using Contactors controlled through a mobile application. In Conventional systems, high starting current can cause electrical Stress and reduce motor life. To prevent this, the motor initially Operates in a star configuration, limiting the starting current, and then switches to a delta configuration for normal Operation. The mobile application allows remote control and Real-time monitoring, making the system convenient, safe, and Efficient. Overall, this approach enhances motor performance, Reduces energy losses, and improves operational reliability.

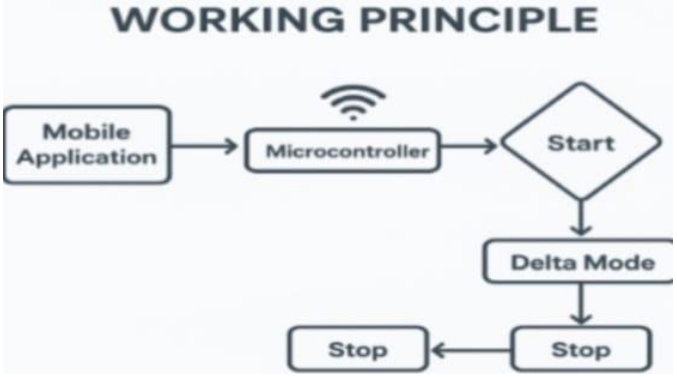
Working principle: The project is divided into two main Sections:

• **Power Section**: Manages the main 3-phase supply and The motor through contactors.
• **Control Section:** The microcontroller receives Commands wirelessly via Bluetooth

Working Principle of Wireless Star-Delta & Delta-Star Conversion by power section:

The mobile application sends commands wirelessly to the Micro controller. When the START button is pressed, the Star contactor is energized. The motor starts in Star mode, reducing the starting Current.After a preset time or when the DELTA button is pressed, the Star contactor turns off and the Delta contactor turns on.

The Motor then runs at full speed and full power. Pressing the STOP button turns off all contactors, ensuring the Motor stops safely.Delta-to-Star switching can also be performed remotely if required.



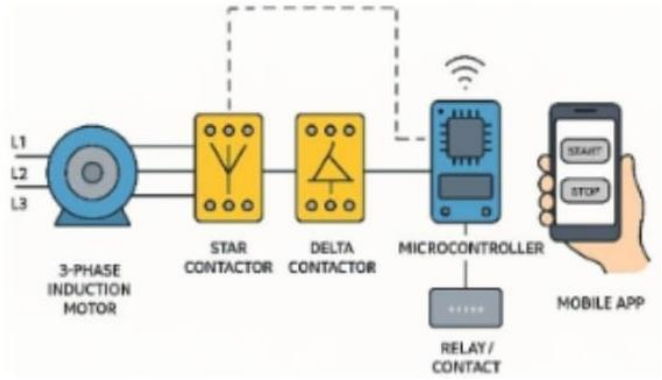
Power circuit:

The power circuit is used to control the 3-phase induction Motor with the help of Star and Delta contactors.

The 3-phase AC supply is first passed through an MCB / Circuit Breaker, which protects the motor from overload and Short-circuit faults.
From the MCB, the supply is given to both Star and Delta Contactors.

When the Star contactor is energized, the motor starts in star Connection, resulting in reduced starting Current.After the starting period, the Delta contactor is energized, allowing the motor to run at full voltage and rated speed. Electrical interlocking is provided to ensure that the Star and Delta contactors do not operate at the same time.

Finally, power from the contactors is supplied to the motor Terminals U, V, and W for proper motor operation.



Advantages:

- Wireless Motor Control: Enables remote start, stop, And Star–Delta switching through a mobile Application.
- Reduced Starting Current: Limits inrush current during motor startup, protecting windings and Connected equipment.
- Enhanced Safety: Reduces human interaction with High-voltage systems, minimizing accident risks.
- Automation and Ease of Operation: Eliminates manual switching and provides smooth, automatic Motor control.
- Cost-Effective Implementation: Built using easily Available and low-cost components such as Arduino, Relays, and contactors.
- Improved Motor Life: Controlled starting and proper Switching increase the lifespan of the motor.
- Scalable and Upgradable: The system can be expanded With IoT integration, fault detection, and real-time monitoring in the future.

Disadvantages:

• Limited Wireless Range: Bluetooth or Wi-Fi Communication may not cover long distances in large Industrial areas.

• Dependence on Continuous Power Supply: The Microcontroller and communication modules require a Stable power source for proper functioning.

• Risk of Incorrect Switching: Faulty interlocking logic May cause simultaneous operation of Star and Delta Contactors, leading to electrical damage.

• No Feedback in Basic Version: Motor status such as Speed, load, or running condition is not available without additional sensors.

• Interference Issues: Wireless communication may be Affected by electromagnetic interference in industrial Environments.

• Security Concerns: Unauthorized access is possible if Proper authentication is not implemented in the wireless System.

• Initial Setup Complexity: Proper programming and Circuit configurations are required, which may need Technical expertise.

CONCLUSION:

This work presents the design and implementation of a Wireless Star–Delta and Delta–Star conversion system for a 3-phase induction motor using contactors and a Mobile application. The proposed system effectively reduces the high starting current by initially operating The motor in star configuration and later switching to Delta mode for normal running conditions. Wireless control Through Bluetooth or Wi-Fi minimizes manual intervention And enhances operational safety.

The use of a microcontroller-based control circuit ensures Accurate switching, proper interlocking, and reliable motor Operation the system is cost effective
Easy to implement, And suitable for small- and medium-scale industrial Applications. Overall, the proposed approach improves motor Life, operational efficiency, and user convenience, making it A practical solution for modern motor control systems.

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