

**Design of Star Delta Control Circuit Work System on 3 Phase Electric Motor****Muchdar Patabo<sup>1</sup>, Hatanael Bijang<sup>2</sup>, Dostenny Kantohe<sup>3</sup>, Wellem Enoch<sup>4</sup>, Jeriko Najohan<sup>5</sup>, Heartyara Sibuea<sup>6</sup>**

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patabomuchdar@gmail.com<sup>1</sup>, natanlubii8@gmail.com<sup>2</sup>, dnkantohe@gmail.com<sup>3</sup>wellemenoch19@gmail.com<sup>4</sup>, jerikonajohan@gmail.com<sup>5</sup>, Heartyarasibuea@gmail.com<sup>6</sup>**Keywords**

Star Delta, Three Phase Electric Motor, Control Circuit

**Abstract**

Induction motors are one of the main components in the industrial world because they have several significant advantages. These advantages include a more economical price compared to other types of electric motors, relatively lighter weight, and simple construction that facilitates the maintenance process and reduces overall maintenance costs. The purpose of this research is to reduce the surge in electric current when the motor is started and increase energy efficiency. One method commonly applied in the use of induction motors is the star-delta configuration. This configuration is used primarily to save energy by reducing the energy consumption associated with high starting currents in induction motors. The star-delta method changes the motor winding connections from star to delta configuration when the motor reaches a certain speed, thereby reducing the starting current to one-third of what it would be under direct-on-line conditions. This greatly helps in reducing the stress on the power system, as well as increasing the operational life of the motor. The system has also proven to be compliant with industrial safety regulations. In this project, it can be concluded that the star delta circuit functions when pressing the star button, the motor will move slowly. Then when pressing the delta button, this circuit also has 3 buttons namely star, delta and off.

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Email: [patabomuchdar@gmail.com](mailto:patabomuchdar@gmail.com)**INTRODUCTION**

The star delta control circuit is an effective solution for operating 3-phase electric motors in various industrial applications (Jannati, Nik Idris, & Abdul Aziz, 2016). It is commonly used to reduce the high current surge that occurs when the motor is started, which can disrupt the system's stability and damage motor components (Machowski, Lubosny, Bialek, & Bumby, 2020).

A 3-phase electric motor is a type of motor that uses a 3-phase power supply to generate mechanical rotation (Diyoke, Okeke, & Aniagwu, 2016). These motors are known for their high efficiency and durability, making them a popular choice in industries. However, when the motor is started, there is a surge of current caused by the initial load capacity and the inductive nature of the motor (Portos, Garner, Parker, & Cannon, 2015). This current surge can disrupt the balance and stability of the system, as well as damage supporting equipment (Hatziargyriou et al., 2020).

To address this issue, the star delta control circuit is used for 3-phase electric motors (Hubais, Moorthy, Santiago, Masan, & Arfah, 2022). The star delta configuration allows the motor to be started in a safer star configuration with lower startup current (Azizan et al., 2021). Once the motor reaches a sufficient speed, it is switched to the delta configuration for normal operation (Singh & Chelliah, 2017).

The design of the star delta control circuit aims to optimize the performance of 3-phase electric motors. Here are the main objectives:

1. Reduce current surge: One of the main goals of this system design is to reduce the current surge that occurs when the motor is started (Shaikh, Kumar, Hakeem, & Soomar, 2022). By using the star configuration during startup, high inrush current can be avoided, reducing the load on the electrical system and protecting motor components.
2. Improve operating efficiency: Implementing the star delta control system can improve the operating efficiency of 3-phase electric motors (Sutejo, n.d.). The star configuration used during startup allows the motor to operate with lower current, reducing energy consumption and improving motor efficiency.
3. Extend motor lifespan: By reducing the current surge during motor startup, this system design can extend the lifespan of the motor (Ferreira, Baoming, & de Almeida, 2015). High current surges can cause damage to motor components, such as stator and rotor windings. By reducing the current surge, the motor experiences lower stress during startup, thereby extending its lifespan.
4. Maintain system stability: Current surges during motor startup can disrupt the balance and stability of the electrical system (Machowski et al., 2020). By using the star delta control system, the current surge can be reduced, thereby maintaining system stability and preventing disruptions to other connected equipment.
5. Enhance system reliability: By optimizing the performance of the motor through the control system, the overall reliability of the operational motor in industrial applications can be improved (Mo & Xie, 2015). Reducing the current surge during motor startup reduces excessive voltage and current on supporting equipment, thereby reducing maintenance costs and extending the motor's lifespan.

In this journal, we will provide a detailed explanation of the design of the star delta control circuit for 3-phase electric motors, including the components involved and the working principles of this control system. Our main goal is to provide a clear understanding of the implementation of this system in industrial applications and the benefits that can be obtained from its use.

Through the design of the star delta control circuit for 3-phase electric motors, it is expected to improve the efficiency and operational reliability of the motor in industrial applications. Reducing the current surge during motor startup will reduce excessive voltage and current on supporting equipment, thereby reducing maintenance costs and extending the motor's lifespan.

## RESEARCH METHODS

One of the commonly applied methods in the use of induction motors is the star-delta configuration. This configuration is used primarily to save energy by reducing the energy consumption associated with high starting currents in induction motors. The star-delta method changes the motor winding connections from a star (star) to a delta (triangle) configuration when the motor reaches a certain speed, thus reducing the starting current to one-third of the current that would occur under direct-on-line conditions. Star delta is a system in motor starting that is often used as a 3-phase induction motor starting. When the electric motor is first started, the amount of outgoing current can be reduced thanks to the delta starting circuit built into it. The star relationship (Y) is used at the beginning of the motor work and when the motor is maximized according to the speed of about 80%, the star relationship can be changed to delta relationship ( $\Delta$ ). How an electric motor works as a converter of electrical energy into mechanical energy in the form of rotating power. Electric motors have 2 most important components, namely the stator which means the stationary component and the rotor which means the rotating component. In AC motors, the rotor coil cannot receive electrical energy directly, but can be induced as occurs in the transformation of the energy coil.

## **EXPLANATION OF 3 PHASE ELECTRIC MOTORS**

### 1) 3 Phase Induction Motor

A three-phase induction motor is an electrical device that converts electrical energy into mechanical energy, where the electricity converted is 3-phase electricity. A 3-phase induction motor has a constant speed when it is at no load (zero/no-load) or at full load (full-load). The speed of a 3 phase induction motor depends on its working frequency so it is difficult to regulate the speed.

### 2) 3 Phase Induction Motor Construction

The detailed construction of an induction motor consists of two parts, namely the stator and the rotor (Bolovin, Glazyrin, & Brendakov, 2015). The stator is the stationary part of the motor which consists of the motor body, stator core, stator windings, bearings and terminal box. The rotor part is the part of the motor that rotates and consists of a cage rotor, rotor shaft. In an induction motor there is no part of the rotor that comes into contact with the stator (Tiwari, 2017). The stator and rotor are separated by an air gap. The construction of an induction motor is simpler compared to a DC motor.

### 3) Stator

The stator consists of a stack of core laminations which have grooves into which the cylindrical coils are wound. The grooves in the core laminate stack are isolated with paper. Each core laminate element is formed from iron sheet (Kaliyev, 2015). Each sheet of iron has several grooves and several fastening holes to hold the core together. Each coil is spread out in a groove called a phase winding where for a 3 Phase motor, the windings are electrically separated by 120 Degrees Celsius. The coil wire used is made of copper coated with thin insulation. Then the core stack and stator windings are placed in a cylindrical shell.

### 4) Rotor

The rotor (Squirrel Cage Rotor) is the core of an induction motor which consists of layers of conductors paired parallel to the shaft and surrounding the surface of the core. The conductor is not isolated from the core because the rotor current will naturally flow towards the smallest resistance, namely the rotor conductor (Fish, 2015). At each end of the rotor, all rotor conductors are short-circuited with the end rings so that the rotor conductors and rings rotate.

Typically, 3-phase electric motors use a voltage of 380-415 volts. This is the optimal voltage to produce large enough and efficient power in the motor.



figure 1 Phase Electric Motor

## RESULTS AND DISCUSSION

### Control System Design

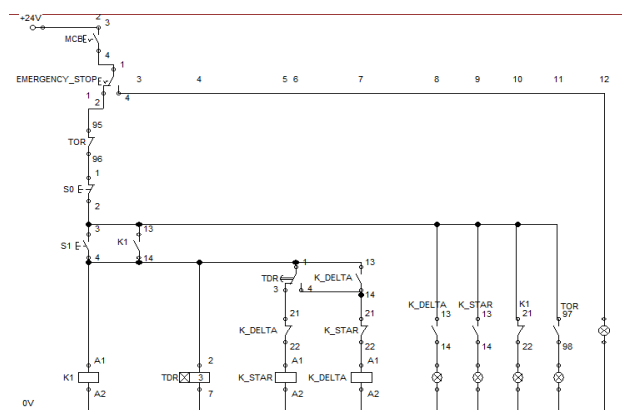


figure 2 Star-delta control system circuit (Y-Δ)



Figure 3 Star-delta control system circuit (Y-Δ)

#### A Existing components:

1. MCB 1 and 3 phase
2. Box Panel
3. NYAF Cable 1.5mm 3 Color
4. AC Contactor 3 Piece Type LC1D12
5. Thermal Overload Relay
6. Pilot Lamp 8 Pieces
7. Emergency Push Button 1 Piece
8. Timer Delay Relay
9. Push Button 2 Pieces( NC 1 Piece and NO 1 Piece)
10. 3 Phase Induction Motor

#### Working principle of star delta (Y- Δ) Circuit

First, turn on MCB 1 and 3 phases will be marked with HO indicator lights then the current goes to the emergency stop component and when there is a disturbance in the circuit, you only need to press the emergency stop and be marked with H1 indicator lights (Patil, Sonar, Karadiguddi, & Banti, 2016). Then the current goes to TOR (Thermal Overload Relay) TOR has a contact child, namely NC and NO, for NO TDR used when there is a problem in the circuit, TDR will trip and the H2 indicator light connected to the NO TDR contact child will light up. For NC TDR contact children go to So, then the current from So goes to S1. Then the current goes to the CONTACTOR component and the TIME DELAY RELAY component. To turn on the circuit then press the S1 button then CONNECTOR 1, TDR and

STAR CONNECTOR will run, STAR CONNECTOR when wrong will be marked with an indicator light H3, but here we use TIMER / TDR. To run the DELTA CONNECTOR only need to wait for the work of TIMER / TDR. For this circuit we use a TIMER with a time limit of 3 seconds and DELTA CONNECTOR will be wrong with the marked indicator light H4. To turn off the circuit only need to press the So button. But when you want to turn off the circuit with emergency conditions, you need to press the emergency stop.

Here are more details about the design of a star-delta control system for a three-phase electric motor:

1. Star Contactor
  - a) When the motor is first started, the star contacts close, connecting the motor windings in a star configuration.
  - b) Star contacts are usually equipped with special contactors designed to handle the high starting current when the motor is first started.
2. Delta Contactor
  - a) Once the motor reaches operating speed, the star contactor will open, and the delta contactor will close, changing the motor windings to a delta configuration (Hardine, Santoso, & Hadikusuma, 2022).
  - b) This helps reduce starting current and improve motor operational efficiency.
3. Relay or Timer
  - a) Control systems are usually equipped with relays or timers to regulate the transition time between star and delta.
  - b) This ensures that configuration changes are made safely and according to application requirements.
4. Motor Protection

The design must also include adequate motor protection, such as thermal or overcurrent protection, to prevent damage to the motor in the event of failure or other hazardous conditions (Proctor, 2016).
5. Circuit Diagram

A proper circuit diagram must be drawn up to visualize the relationships between contactors, relays, timers, and other parts in a star-delta control system.
6. Physical Configuration

This design also pays attention to the physical configuration of all components, including installation and placement of cables, contactors, relays, and other control equipment (Kiessling, Nefzger, Nolasco, & Kaintzyk, 2014).

By properly integrating all of these components, a star-delta control system can optimize three-phase motor performance while protecting the motor from damage caused by initial current surges.

## CONCLUSION

The working system in the star delta control circuit has proven effective in minimizing the initial current surge that occurs when the 3-phase electric motor is started. This is very helpful in reducing the stress on the power system, as well as increasing the operational life of the motor. The system has also proven to be compliant with industry safety regulations. In this project, it can be concluded that the star delta circuit functions when pressing the star button, the motor will move slowly. Then when pressing the delta button, this circuit also has 3 buttons, namely star, delta and off. Basically star delta is used to reduce the motor star current. Thus, it can be concluded in this discussion is an efficient, effective, and practical solution for controlling electric motors in various industries. And also in this project it can be concluded that the star delta circuit functions when pressing the star button, the motor will move slowly. Then when pressing the delta button, this circuit also has 3 buttons, namely star, delta and off. Basically star delta is used to reduce motor star current.

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