

Automatic Star Delta Starter Using Relay with an Electronic Adjustable Timer

Swapnil R. Badge¹, Nitin M. Sonune², Akshay P. Wakekar³, Hemant S. Ulmale⁴, Rugved R. Deshmukh⁵

^{1,2,3,4,5}Department of Electrical Engineering,
G. H. Raisoni College of engineering & management,
Sant Gadge Baba Amravati University, Amravati (M.H), India

Abstract: The project is designed to provide low voltage start to induction motors. This is achieved by using star to delta conversion. Star/Delta starters are probably the most common reduced voltage starters in the 50Hz industrial motor world. Star delta is used in an attempt to reduce the start current applied to the motor. Thereafter, full load current is applied to the motor. The Star/Delta starter is generally manufactured from three contactors; and electromechanical timer and a thermal overload for operating a 3 phase motor at 440 volt at ac mains supply 50 Hz. The interlocking arrangement of all the contactor coils is traditionally wired in 440 volt AC. This project uses a system to start a 3 phase motor at 440 volt AC mains supply 50 Hz with a set of 12 volt DC relays in star mode first and then to delta mode by an electronically adjustable timer. A set of relays are used to shift the motor connections from star to delta with a time delay. The timer is supplied with six lamps instead of a 3 phase motor i.e., two lamps representing each phase winding of the motor. The interlocking arrangement of the relay coils and the electronic timer are all wired in low voltage DC of 12 volt fed from an inbuilt DC power supply for safe handling of the starter during the study. It still retains its application for a 3 phase motor starting with single phasing prevention also. During star operation the lamps would glow dim indicating the supply voltage across the coils are $440/\sqrt{3}$. In delta condition after the timer operates the lamps would glow with full intensity indicating full supply voltage of 440volts. The timer comprises of a 555 in mono-stable mode the output of which is fed to a relay for changing the mains supply from 3 phase star to delta. The project also has the provision of single phasing protection since 3 phase motors get burnt if any one phase goes missing during running. The output to the lamps shall be completely cut-off in the event of any phase failure. Further the project can be enhanced by using a thyristors in firing angle control principle for soft start of the induction motor that would overcome all the drawbacks of star delta starter.

Keywords: Star Delta Starter, Contactor Relay, Timer

1. Introduction

Induction motors are popular due to their low-cost, sturdy construction, fast pick-up, low maintenance expenditure and good efficiency. The DOL (direct-on-line) starters and star/delta starters used for starting and running of induction motors provide coarse type of protections against voltage fluctuations and single phasing. Induction motors are very sensitive to low voltage and single phasing during which they draw a heavy current and can burn out unless switched off within few seconds of occurrence of such conditions. This makes the requirement of a sensitive protective device essential to avoid burning of induction motors under such conditions. The circuit of an automatic starter, incorporating the important features given below, is described here. It is meant to be used in conjunction with a DOL starter. Automatic start on resumption of proper conditions Single phasing prevention 24-hour programmable off timer (on completion of actual runtime of the motor). An induction or asynchronous motor is a type of AC motor where power is supplied to the rotor by means of electromagnetic induction, rather than a commutate or slip rings as in other types of motor. These motors are widely used in industrial drives, particularly poly-phase induction motors, because they are rugged and have no brushes. Single-phase versions are used in small appliances. Their speed is determined by the frequency of the supply current, so they are most widely used in constant-speed applications, although variable speed versions, using variable frequency drives are becoming more common. The most common type is the squirrel cage motor.

2. Literature Review

2.1 Working Principle of Star Delta Starter

There are three states of Star-Delta starters, a). Star Connected State, b). Open State, and c). Delta Connected State. During starting time Main and Star Contactors remain closed and complete Circuit. In Star Connected State, voltage applied is reduced to $1/\sqrt{3}$ of the Line Voltage across each winding. As and when motor attains good rotational speed, say about 90% of full r.p.m. after few seconds, timer connected in starter disconnects Star Contactor first and then connects Delta Contactor. Between these two, Star connected and Delta connected states, circuit becomes open and motor neither remains in Star nor in Delta State. This is called open transition switching. In Delta connected state voltage applied to windings is equal to Line Voltage. Items Required to Make Star Delta Starter Three Contactors (One Main Contactor, One Star Contactor and One Delta Contactor), Over Load Relay (or OLR) Timer, Fuse Switch Unit (or FSU), 2 Pole MCB, Fuse, Start Push Button (NO) Stop Push Button.

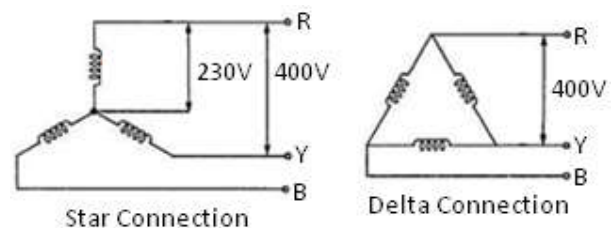


Figure 1: Simple Star & Delta Connection

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2.2 Working Conventional Type Star Delta Starter

There are two contactors that are close during run, often referred to as the main contactor and the delta contactor. These are AC3 rated at 58% of the current rating of the motor. The third contactor is the star contactor and that only carries star current while the motor is connected in star. The current in star is one third of the current in delta, so this contactor can be AC3 rated at one third of the motor rating. In operation, the Main Contactor (KM3) and the Star Contactor (KM1) are closed initially, and then after a period of time, the star contactor is opened, and then the delta contactor (KM2) is closed. The control of the contactors is by the timer (KIT) built into the starter. The Star and Delta are electrically interlocked and preferably mechanically interlocked as well. In effect, there are four states: OFF State. All Contactors are open Star State. The Main and the Star contactors are closed and the delta contactor is open. The motor is connected in star and will produce one third of DOL torque at one third of DOL current. Open State. The Main contactor is closed and the Delta and Star contactors are open. There is voltage on one end of the motor windings, but the other end is open so no current can flow. The motor has a spinning rotor and behaves like a generator. Delta State. The Main and the Delta contactors are closed. The Star contactor is open. The motor is connected to full line voltage and full power and torque are available. This type of operation is called open transition switching because there is an open state between the star state and the delta state.

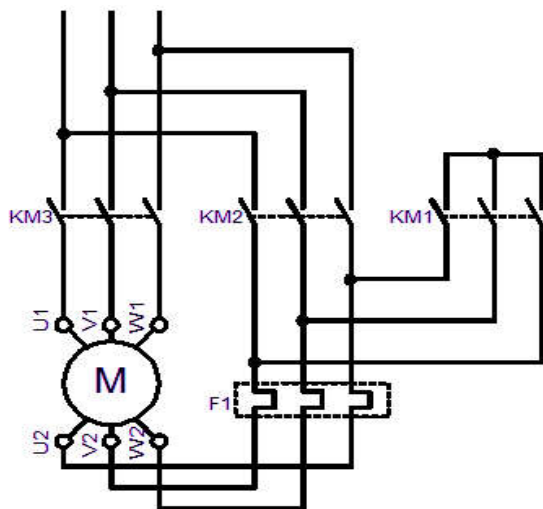


Figure 2: Working Conventional Type Star Delta Starter

2.3 Method

There are two contactors that are close during run, often referred to as the main contactor and the delta contactor. These are AC3 rated at 58% of the current rating of the motor. The third contactor is the star contactor and that only carries star current while the motor is connected in star. The current in star is one third of the current in delta, so this contactor can be AC3 rated at one third of the motor rating. In operation, the Main Contactor (KM3) and the Star Contactor (KM1) are closed initially, and then after a period of time, the

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3. System Modelling

3.1 Automatic Star Delta Starter

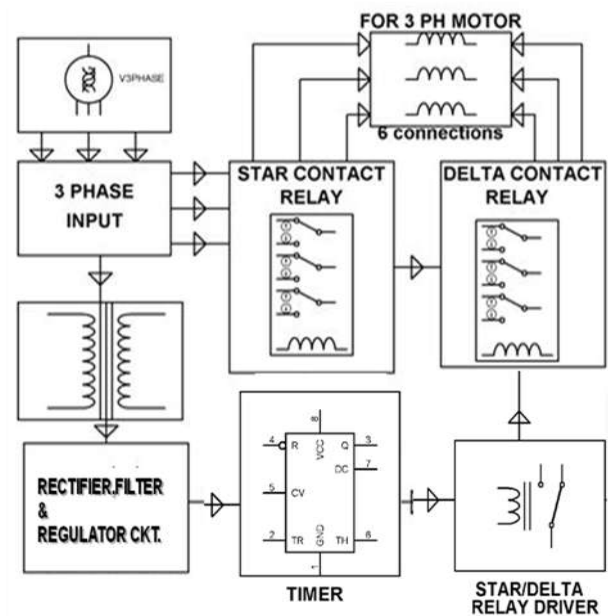


Figure 3: Block Diagram of Automatic Star Delta Starter

Due to the wide variety characteristics of the induction motor, it plays the premier role in the industrial sector. Some of those are self starting, rugged construction, high efficiency, good power factor and ease of control, etc. Squirrel cage type of induction motors are mostly used widely than the other types.

When the motor is at idle, it just look like short circuited transformer at secondary side because all the rotor bars are connected together to form a closed path. This will turn a large current flow through the rotor bars. So when the motor is started, stator draws the high current which is 8-10 times that of the motor rated current. Before starting the motor, it is necessary reduce the voltage applied to the motor.

The project is designed to provide low voltage start to induction motors. This is achieved by using star to delta conversion. Star/Delta starters are probably the most common reduced voltage starters in the 50Hz industrial motor world. Star delta is used in an attempt to reduce the start current applied to the motor then after sometime full load current is applied to the motor. Since in star connection current is same in different phases while line voltage is the root three times the phase voltage. So the voltage is reduced (results to reduce current) if motor is started as star. And also in delta connection the voltage is same as that of phase voltage so full voltage is applied if we run the motor as delta connection. The Star/Delta starter is generally obtained from three contactors; electromechanical timer and a thermal overload for operating a 3 phase motor at 440 volt at ac mains supply 50 Hz. The interlocking arrangement of all the contactor coils is traditionally wired in 440 volt AC.

The project is designed to start a 3 phase motor at 440 volt AC mains supply 50 Hz with a set of 12 volt DC relays in star mode and then to delta mode by an electronically adjustable timer. A set of relays are used to shift the motor connections from star to delta with a time delay. The project is supplied with six lamps; it will operate on 3 phase induction motor. For lamps, three lamps representing each phase winding of the motor.

starting current is reduced to one third of the direct starting current.

Reference

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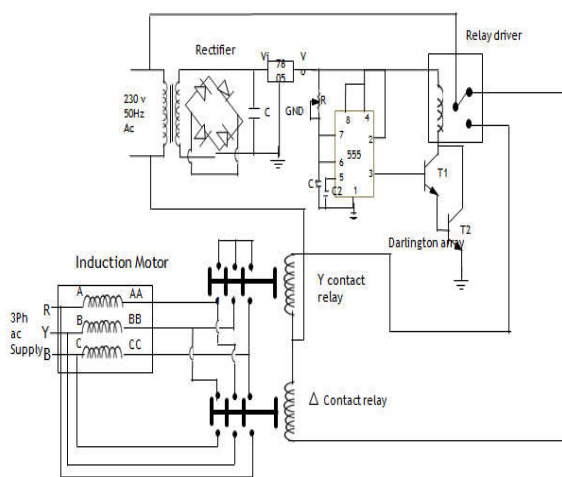


Figure 4: Circuit Diagram

4. Conclusion and Future Scope

- An automatic voltage fluctuation protector system has been implemented for protection of induction motor.
- The assembly unit is very compact and portable.
- The cost of constructing this project is relatively low as compared to its function.
- It can therefore be easily commercialized
- For star delta starter, the basic function is to enable the motor to start and the motor windings are configured in a star formation to the supply voltage. The voltage applied for star delta starter to the individual motor winding is therefore reduced by a factor of $1/\sqrt{3} = 0.58$ this connection amounts to approximately 30% of the delta values. The

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