DESIGN AND CONSTRUCTION OF AUTOMATIC STAR-DELTA STARTER

This Report Presented in partial fulfillment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering

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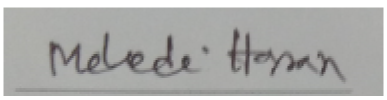
LETTER OF APPROVAL

This is to certify that this project and thesis entitled "**DESIGN AND CONSTRUCTION OF AUTOMATIC STAR-DELTA STARTER"** is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on December 2018 .

Signature of the candidates



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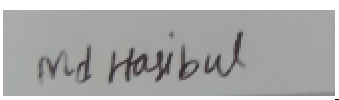

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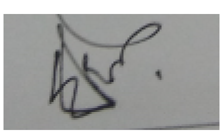

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Dedicated to

Our Parents

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MC	Magnetic Conductor
TR	Thermal Relay
HP	Horse power
FLC	Full load current
DOL	Direct Online Starting
V	Voltage
I	Current

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First of all, we give thanks to Allah. Then we would like to take this opportunity to express our appreciation and gratitude to our project and thesis supervisor **Mr. Mahmudur Rahman, AssistantProfessorof Department of EEE** for being dedicated in supporting, motivating and guiding us through this project. This project can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.

To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

The star delta starter of induction motor is designed to reduce high starting current and torque. The star delta starter is designed by three magneticcontactors, an overload relay, timer relay and circuit breaker. For Starter, a motor must be connected in delta mode position during a normal run. When induction motor is start in direct online .The motor winding flow a large amount of current .The starting high currentcan be reached in 8-10 times of the rated. So there is need to control high starting current before starting the motorTherefore, in a star connected system line current is equal to phase current but line voltage is equal to the root three times of phase voltage. For this reasons at first motor is connected to the star system and it reduce the high starting current. In delta connection, line voltage is equal to phase voltage and line current is equal to √3 times phase current.In run mode the motor connect in delta system so that the full voltage applied to the motor. The Starter is made by three magnetic contactors, timer relay, and a thermal overload relay or circuit breaker.

CHAPTER -1

INTRODUCTION

1.1 Introduction of Star-Delta Starter:

Induction motor is the most common types of electric motor in industry. This is motor very simple structure any other moving machine. But the motor is very power full and high efficiency. The most common feature of the motors are low cost, quick pick up and easy maintenance. If the induction motor start in DOL method, the motor is started with application of full voltage and the starting current will be 7-10 times of rated current. So large induction motors do not start DOL method. Another induction motor start only star system, its gives low torque and if motor start only delta method, its gives high starting current. So we need a secure protection to avoid such conditions and protect the motor. For this reason we use automatic star delta starters with help of magnetic conductor, timer relay and overload protection. This is the best protection against high current.

1.2 Problem statement:

Three phase induction motor is a self-starting electric machine. The rotating field has to be produced electromagnetic field and rotor flow the current. If the load increase on the motor, alarge amount of current flows through the rotor. For this reasons stator can draw heavy current and coil get heated up. Due to the excessive heat coil winding insulation fail and damage the motor. At the starting time the slip=1, therefore the rotor resistance become zero (Rs =R2/ (1-s). To limit this starting current we need a starter of induction motor. The voltage is reduce to one way, which in turn reduces the torque.

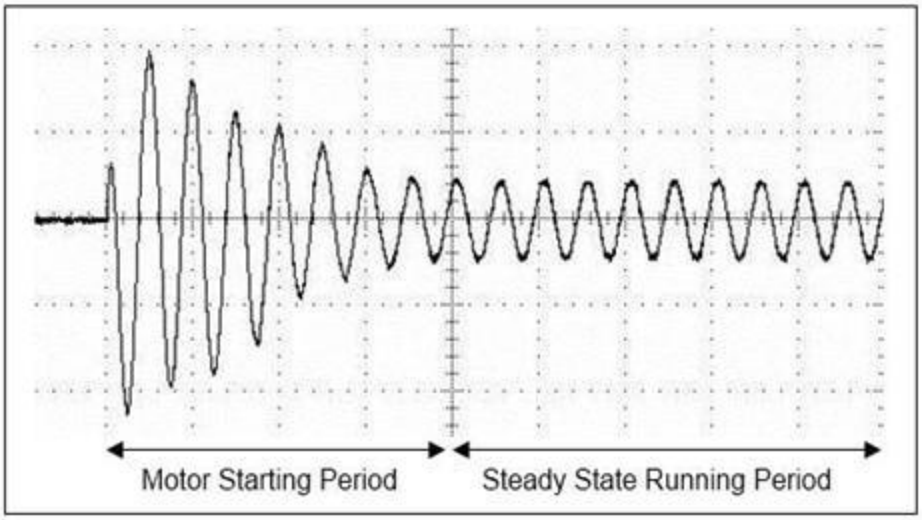


Figure-1.1: Motor starting period Vs. Steady state running period

1.3 Objective:

1. Designed a star-delta starter.
2. Implemented the design.
3. Performance and cost analysis.
4. Reduce high starting current
5. Provide over-burden and no-voltage assurance

1.3 Methodology:

1. Studied about the star-delta starter
2. Studied about the theory of induction motor
3. Constructed and Performance test of a star-delta starter

1.5 Thesis outline:

Generally this project report is divided into six chapters, where it consists of;

Chapter- 1: Introduction

Chapter- 2: Literature Review

Chapter- 3: Theoretical Model

Chapter -4: Hardware Description

Chapter -5: Result and Discussions

Chapter -6: Conclusions and recommendation

Chapter-1 is the introduction of the main idea and important of this project. In this chapter, we first explain the problem of starting of induction motor then describe the existing solution of its. After that we describe out proposed solution for starting of induction motor. Then describe the objective and working methodology.

Chapter- 2 is the Literature Review of the project. In this chapter discuses of some related system and working principle of induction motor & star delta starter.

Chapter- 3 is the Theoretical model of the project where describe the operating principle of the project.

Chapter -4 is the Hardware description of components where describe the all components that are used in the project.

Chapter -5 is the Result and Discussion where all the tested result is obtained. In this chapter also discuss the cost analysis of the project.

Chapter -6 is the Conclusions and recommendation. In this chapter we discuss about the conclusion, limitation of the project and future work of the project

CHAPTER 2

LITERATURE REVIEWS

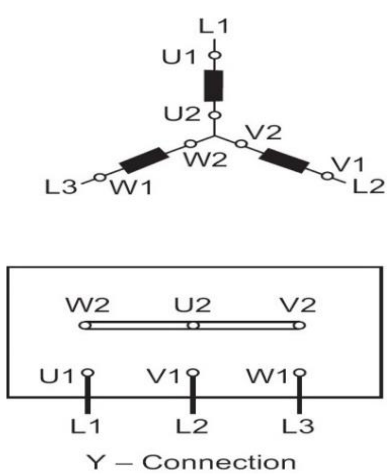
2.1 Introduction:

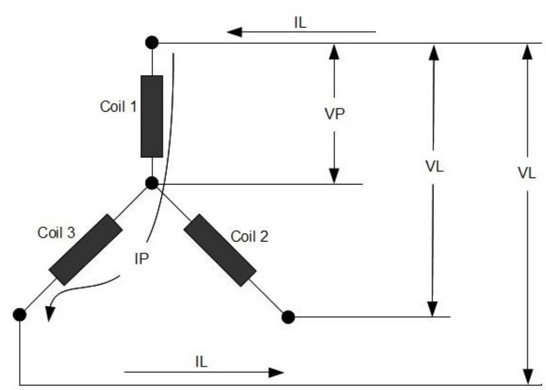
In this chapter, literature review that is to this study that is related to this study case will be identified and study. Normally, paper are interrelated by means of the subject matter induction motor starting high current reduce by means of using star-delta starter. When the motor is started, stator draws high current which is 8-10 times that of the rated current. These papers research about star delta starter that is purpose to get scientific information, analysis and study the weakness, concept and method to improve starting period of induction motor through the development of the project.

2.2 STAR-DELTA CONNECTION:

2.2.1 Star or Y-connected system:

When three coils or windings, placed 120^0 apart, are connected together at a common point as shown in below figure, they form star or Y-connected circuit. The common point is called the Neutral or Star point.





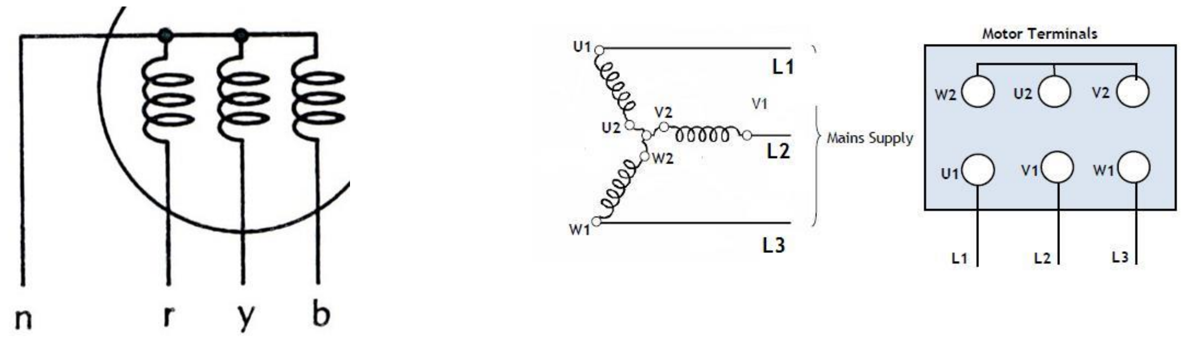


Figure 2.1: Star connected system

When only three main lines are drawn, it is said to be a 3-phase, 3-wire system. Often a neutral line is also drawn from the neutral point. In this case the system is called a 3-phase, 4 wire system.

The current flowing through each coil is called phase current and that flowing through main line is called line current. It can be seen in figure that each phase or coil is connected series with its respective main line.

Therefore, in a star connected system line current is equal to phase current i.e. the same current flows through a phase and main line connected series with it.

In a 3-phase, 4- wire system two different values of voltage are available. Each coil is connected across a main line and the neutral line as shown in figure. Therefore, voltage across a coil or phase is equal to voltage between a main line and the neutral. This voltage is called phase voltage. The voltage between any two main lines is called line voltage.

Line voltage, $V_L = \sqrt{3}V_P$

The power in a 3-phase, star connected system:

Power per phase = $V_P I_P \cos\Theta$

Hence the total power for all the three phase is given by,

$$P = 3V_P I_P \cos\Theta$$
$$= \sqrt{3}V_L I_L \cos\Theta$$

Total apparent power of the three phase = $3V_P I_P$

$$= \sqrt{3}V_L I_L \text{ (VA)}$$

Total reactive power of the three phase = $3V_P I_P \sin\Theta$

$$= \sqrt{3}V_L I_L \sin\Theta \text{ (VA) or (VAR)}$$

2.2.2 Delta or Mesh Connected Circuit:

In delta connection no neutral point is available. With this connection only three-phase, three wire system is possible.

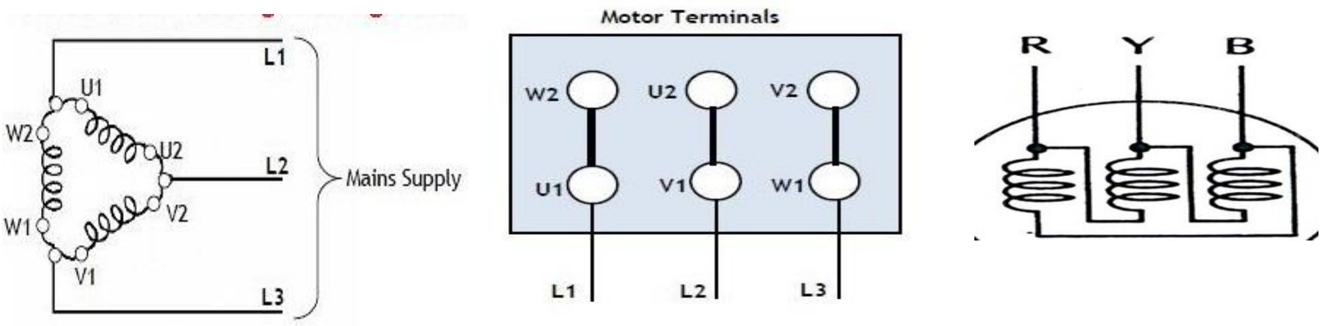


Figure 2.2: Delta connected of system

In delta or Mesh connection each coil or phase is connected across two main lines. Therefore in delta connection, line voltage is equal to phase voltage. Two different values of supply voltage cannot be obtained with this connection. In a delta connected system line current is equal to √3 times phase current.

Line current, $I_L = \sqrt{3} I_P$

The power in a 3-phase, star connected system:

Power per phase = $V_P I_P \cos\Theta$

Hence the total power for all the three phase is given by,

$$P = 3V_P I_P \cos\Theta$$
$$= \sqrt{3} V_L I_L \cos\Theta$$

Total apparent power of the three phase = $3V_P I_P$

$$= \sqrt{3} V_L I_L \text{ (VA)}$$

Total reactive power of the three phase = $3V_P I_P \sin\Theta$

$$= \sqrt{3} V_L I_L \sin\Theta \text{ (VA) or (VAR)}$$

2.3Theory of Star Delta Starter of Starting of Induction Motor:

Let,

- Istyp = startingphase current in star.
- Istyl= starting line current in star

For the star connection, line current = phase current

Therefore, Istyp=Istyl

If,

- V_1 = phase voltage
- V_L = line voltage
- IstΔl =perline current in delta.
- IstΔp =per phase current in delta.
- Ze10 = equivalent per phase impedance

$$\mathrm{Istyp} = \frac{\mathrm{V1}}{\mathrm{Ze10}} = \frac{\mathrm{VL}}{\sqrt{3}\mathrm{Ze10}}$$

$$\mathrm{Ist\Delta p} = \frac{\mathrm{VL}}{\mathrm{Ze10}}$$

For Delta connection, Line current, $I_L = \sqrt{3} I_P$.

Therefore,

$$\mathrm{Ist\Delta l} = \sqrt{3}\ \mathrm{Ist\Delta p} = \frac{\sqrt{3}\mathrm{VL}}{\mathrm{Ze10}}$$

Therefore,

$$\frac{\text{starting line current with star delta starting}}{\text{starting line current with direct switching in delta}} = \frac{\mathrm{Ist\Delta p}}{\mathrm{Ist\Delta l}}$$

$$\frac{\mathrm{VL}/\sqrt{3}\mathrm{Ze10}}{\sqrt{3}(\mathrm{VL}/\sqrt{3}\mathrm{Ze10})} = \frac{1}{3} \ \ldots\ldots(1)$$

Star delta starter, the starting current from the main supply is 1/3 in the delta switching.

Also,

$$\frac{\text{starting torque with star delta starting}}{s\text{tarting torque with direct switching in delta}} = \frac{(\mathrm{VL}/\sqrt{3})^2}{\mathrm{VL}^2} = \frac{1}{3} \;\ldots..2$$

Star delta starting, the starting torque is reduced to 1/3 of the starting torque in the delta switching.

$$\frac{\text{starting torque with star delta starting}}{s\text{tarting torque with direct switching in delta}} = \left(\frac{{\mathrm{I}_{\mathrm{styp}}}^2 \times \frac{R2}{1}}{2\pi \mathrm{ns}}\right) + \left(\frac{\left(\mathrm{I}_{\mathrm{fl}\Delta\mathrm{p}}\right)^2}{2\pi \mathrm{ns}} \times \frac{R_2}{\mathrm{s}_{\mathrm{fl}}}\right.$$

$$= \left(\frac{\mathrm{I}_{\mathrm{styp}}}{\mathrm{I}_{\mathrm{fl}\Delta\mathrm{p}}}\right)^2 \;\; x\mathrm{s}_{\mathrm{fl}}$$

Where,

$I_{fl\Delta p}$ is the full load phase current with the winding in the Delta

But,

$$\mathrm{Istyp} = \frac{\mathrm{VL}/\sqrt{3}}{\mathrm{Ze10}}$$

$$\mathrm{Ist\Delta p} \; = \frac{\mathrm{VL}}{\mathrm{Ze10}}$$

Therefore

$\mathrm{Istyp} = \frac{1}{\sqrt{3}}\mathrm{Ist\Delta p}$ And$\mathrm{Istyp}^2 = \frac{1}{3}\mathrm{Ist\Delta p}^2$

$$\frac{\text{starting torque with star delta starting}}{s\text{tarting torque with direct switching in delta}} = \left(\frac{\mathrm{I}_{\mathrm{styp}}}{\mathrm{I}_{\mathrm{fl}\Delta\mathrm{p}}}\right)^2 \;\; x\mathrm{s}_{\mathrm{fl}}$$

$$= \frac{1}{\sqrt{3}}\left(\frac{\mathrm{I}_{\mathrm{styp}}}{\mathrm{I}_{\mathrm{fl}\Delta\mathrm{p}}}\right)^2 \;\; x\mathrm{s}_{\mathrm{fl}} \ldots.3$$

Hence, the equation 3 shown above gives the starting torque of an induction motor in the star delta starting method.

2.4 Working Principle of Induction Motor & Star-Delta Starter:

The induction motor has two main parts. The input power is given to stator. Three phase induction motor when connected to the power supply the stator produceRMF. The RMF is the one which makes the rotor turn. As per law, rotor start rotating in direction and reverse flow the electric current. So the rotor is like current carrying bars immersed in a magnetic field. This will induce an electromagnetic force according to Lorentz force law and the rotor will rotate in the same direction as the RMF. This is how the induction motor works.

Electricity is induced on the rotor bars due to electromagnetic induction rather than direct connection. Initially the induction motor rotor speed is zero and gradually increase the speed. This means the rotating magnetic field will cut the rotor bar at very high rate.

As the rotor gain speed the rate of flux cut will decrease. So a high current will be induced on the bars at the start. As the rotor speed increases the current will lower the normal value. At the start stator current also must be high since the rotor and stator current are coupled due to transformer action. Due to this the stator coils will draw a huge amount of current when the motor starts.

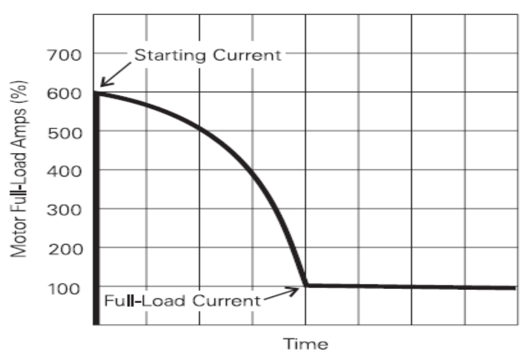


Figure 2.3: Starting current of motor

The main purpose of star-delta starter is to reduce the requirement of high starting current. Normally the starting current of an induction motor is 6 to 7 times of the full load current. This will produce a large voltage drop in the line and affect other devices when a heavy rating induction motor starts. As well as for larger motor the starting current may be so high that it may damage the stator coil or even the power cables. When we apply a three phase voltage across a star connection each coil will receive a much reduced voltage ($V_P=V_L/\sqrt{3}$).

Reduced input voltage means reduced current at the starter coil. So to overcome the high starting current need to connect of star delta starter.

2.5 Necessity of star delta starter:

Let’s consider an example: 120kW, 4 Pole, 380 Volt, Delta connected, 3 Phase, 50 Hz. First we will examine the normal running condition, i.e. when the motor is connected in Delta. The motor’s performance values are listed in table 2.1. It is crucial that we also examine the torque vs. speed and current vs. speed curves. These curves are shown in graphs.

Item	**Load**		
	Full Load	**Starting**	**Unit**
Power	120	101	kW
Voltage	380	380	V
Current	210	1530	A
	1.00	7.30	pu
Efficiency	93.9	0.0	%
Power Factor	0.87	0.10	
Speed	1491	0	rpm
Torque	769	1038	Nm
	1.00	1.35	pu

Table-2.1: 120kW motor's performance values running in delta

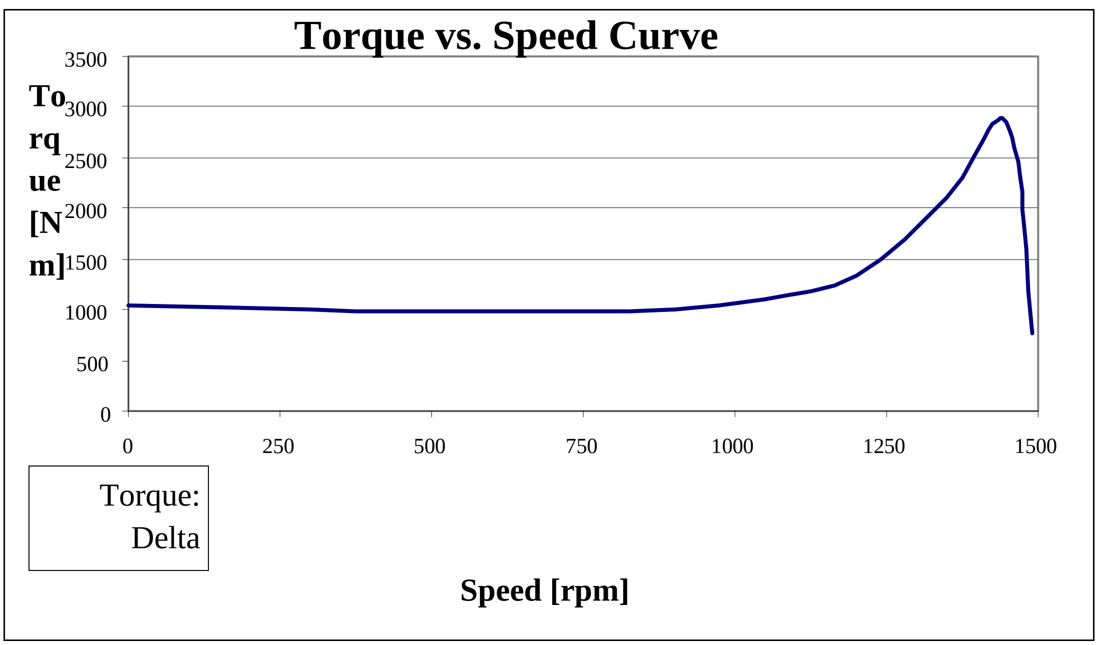


Figure-2.4: Torque vs. speed curve for Delta connection

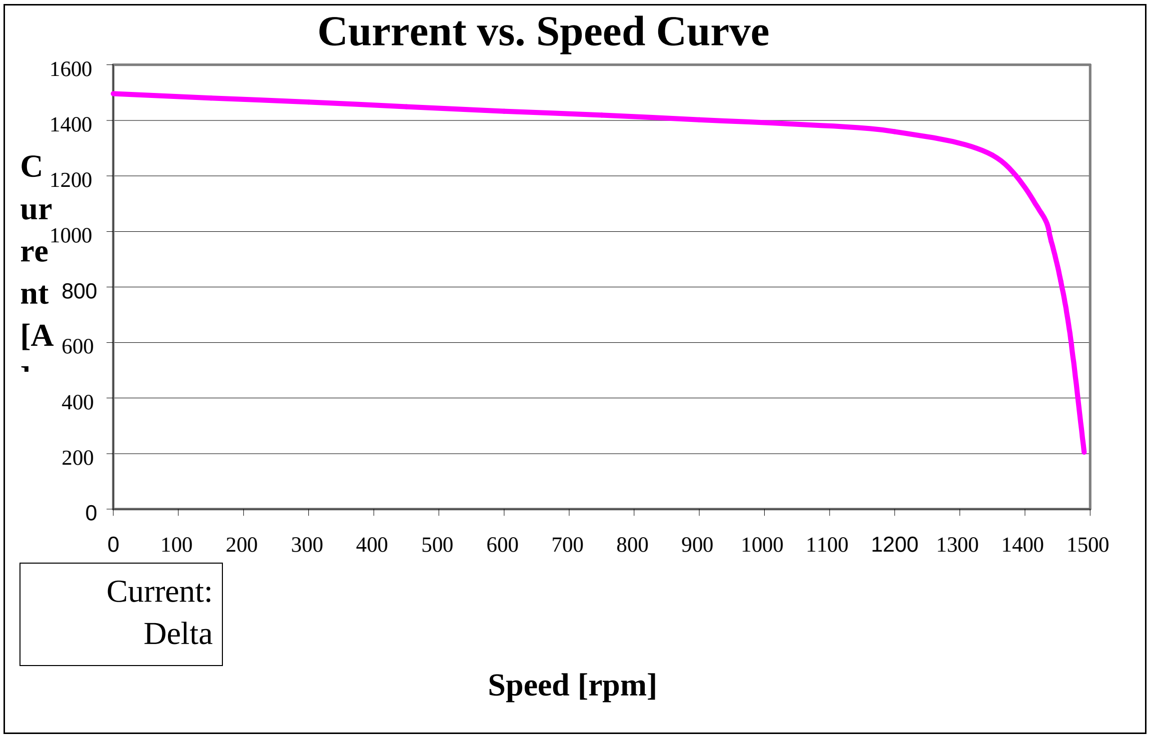


Figure-2.5:Current vs. speed curve for Delta connection

Now let's have a look what happens when the motor is connected in STAR, i.e. in the starting condition. The performance values are listed in Table 2. Graphs 3 and 4 again show the torque vs. speed and current vs. speed curves.

Item	**Load**		
	Full Load	**Starting**	**Unit**
Power	120	33	kW
Voltage	380	380	V
Current	212	500	A
	1.00	2.36	pu
Efficiency	92.3	0.0	%
Power Factor	0.86	0.10	
Speed	1469	0	rpm
Torque	780	343	Nm
	1.00	0.44	pu

Table 2.2: 120kW motor connected in star

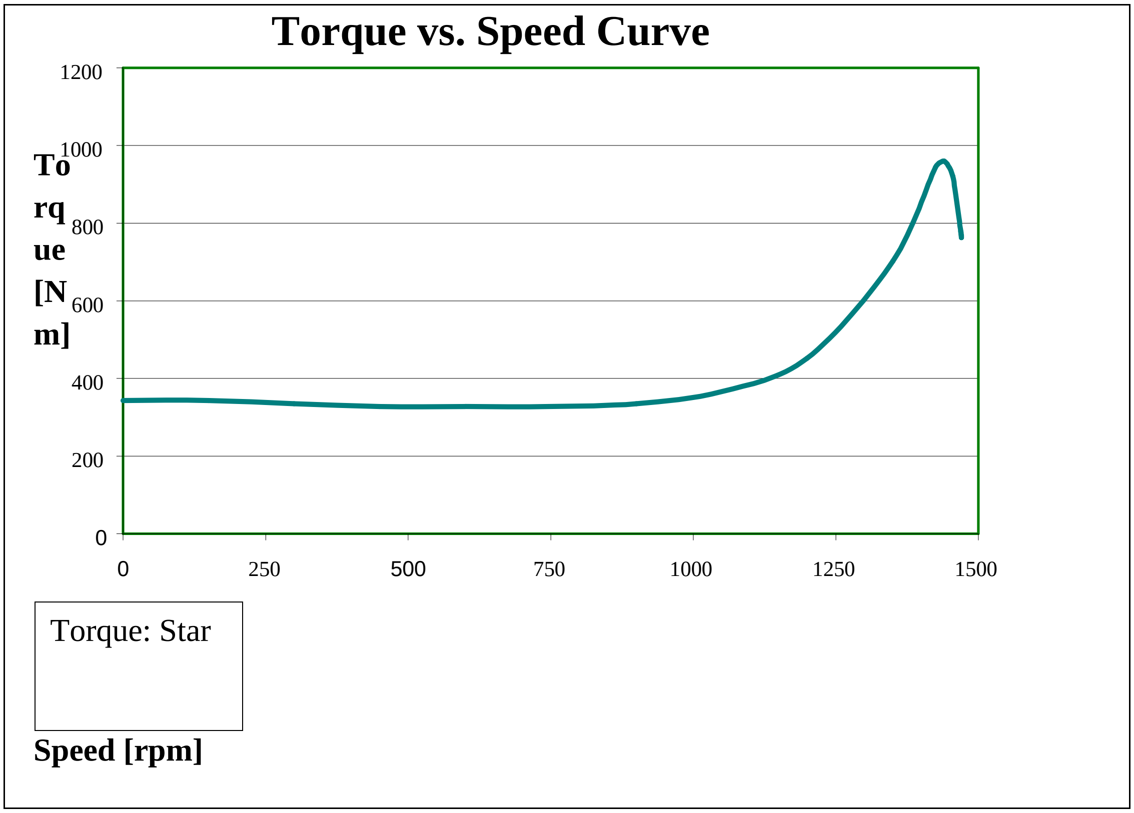


Figure-2.6: Torque vs. speed curve for Star connection

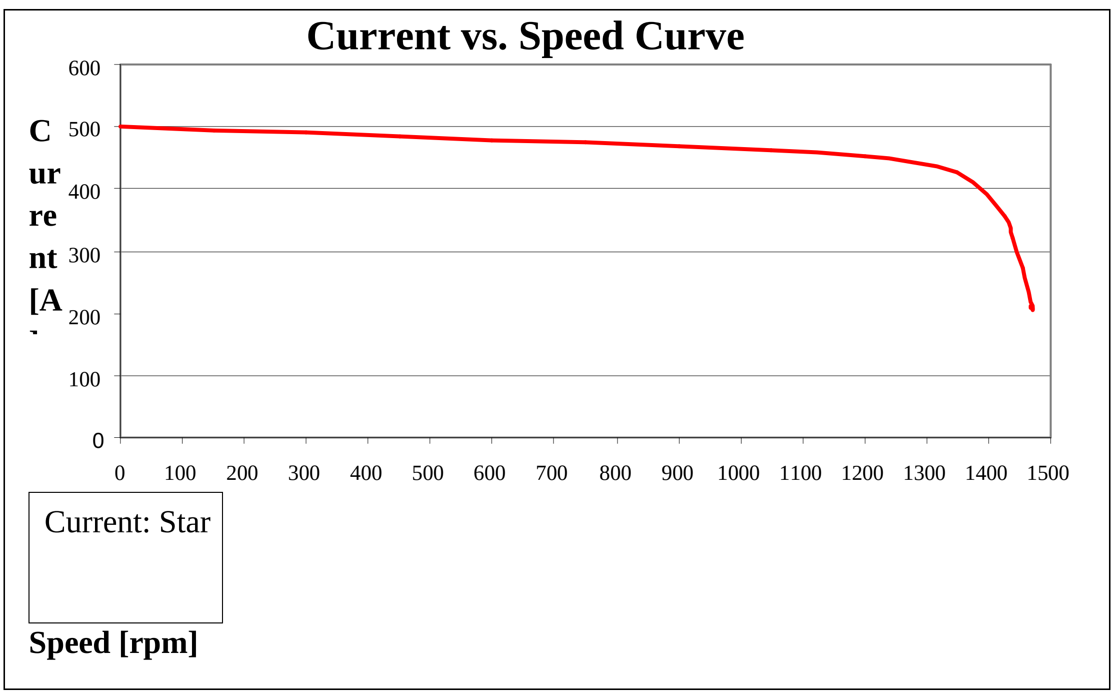


Figure2-2.7: Current vs. speed curve for Star connection

To truly grasp the differences between these two starting methods, we will list the values next to each other in table 2.3, and on graphs 2.5 and 2. 6.

	DELTA CONNECTED		**STAR CONNECTED**		
Item	**Load**		**Load**		
	Full Load	**Starting**	**Full Load**	**Starting**	**Unit**
Power	120	98	120	33	kW
Voltage	380	380	380	380	V
Current	205	1495	212	500	A
	1.00	7.30	1.00	2.36	pu
Efficiency	93.9	0.0	92.3	0.0	%
Power Factor	0.89	0.10	0.86	0.10	
Speed	1491	0	1469	0	rpm
Torque	769	1038	780	343	Nm
	1.00	1.35	1.00	0.44	pu

Table-2.3: 120kW motor performance values: Delta and Star connection comparison

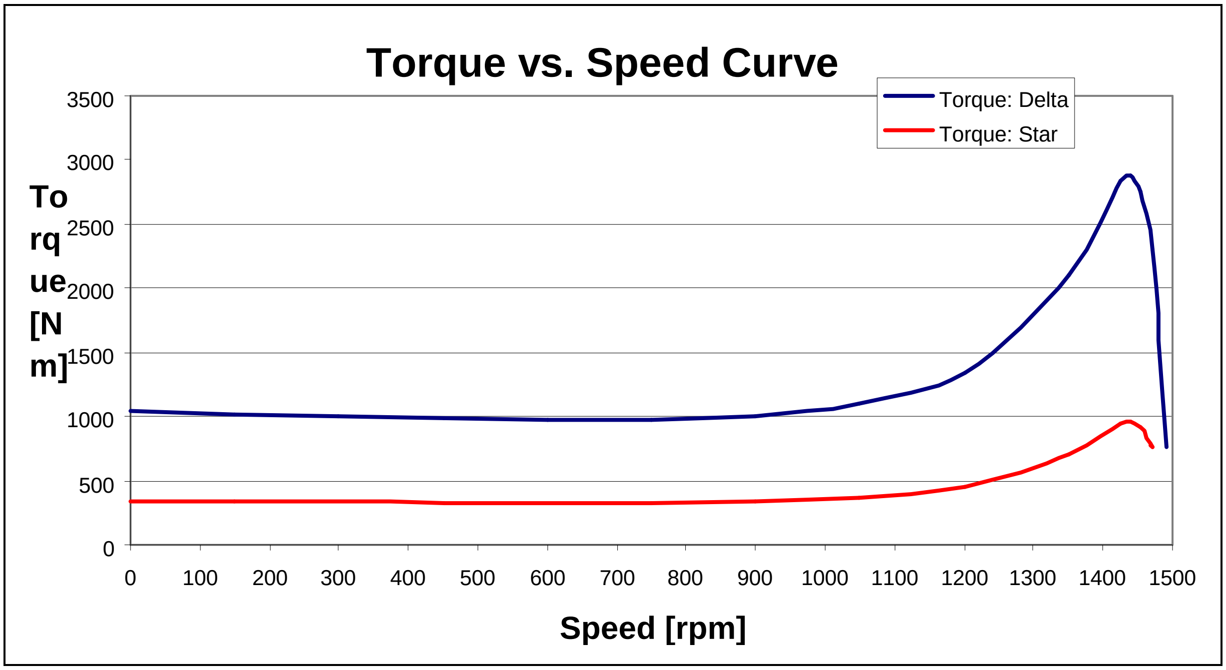


Figure-2.8-: Torque vs. speed curve: Star and Delta connections compared

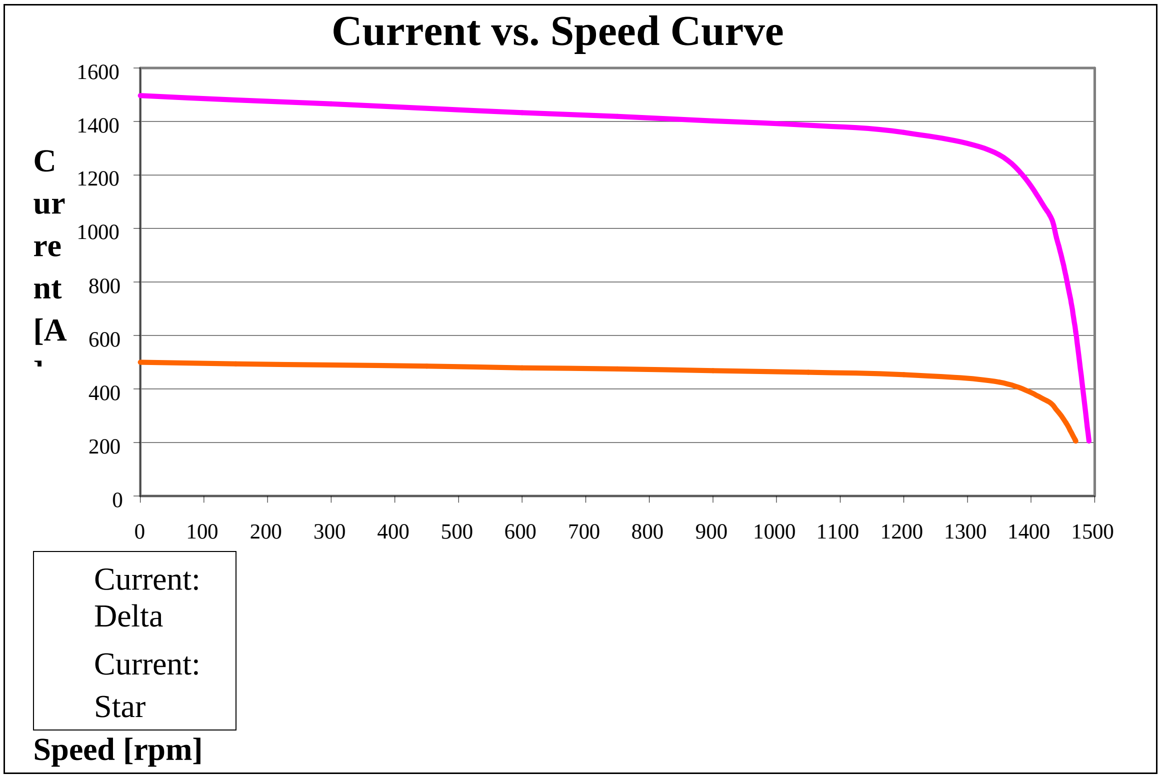


Figure-2.9: Current vs. speed curve: Star and Delta connections compared

The relations for star and delta connections are as listed in Table 2.3:

	Star	**Delta**
Voltage	$V_{Line} = \sqrt{3} \times V_{Phase}$	$V_{Line} = V_{Phase}$
Current	$I_{Line} = I_{Phase}$	$I_{Line} = \sqrt{3} \times I_{Phase}$

Table 2.4: Relation between phase and line Currents and Voltage

Thus, when the motor is started in the star connection, the phase voltage of the motor is reduced by a factor of √□3.

The reductions in starting current, starting power, and starting torques for a reduced Voltage can each be calculated by using equation 1 (This ignores other factors like saturation, etc.):

$$\text{Reduction in Value}\,[\%] = \left[1 - \left(\frac{\text{Nominal Voltage}}{\text{Reduced Voltage}}\right)^2\right] \times 100$$

Equation 1: Reduction in percentage for reduced Voltage

If we apply this equation for the star delta starting, we see from equation 2 where the 67% reduction comes from:

$$\text{Reduction} = \left[1 - \left(\frac{V_{Line\ Delta}}{V_{Line\ Star}}\right)^2\right] \times 100 = \left[1 - \left(\frac{V_{Phase}}{\sqrt{3} \times V_{Phase}}\right)^2\right] \times 100 = \left[1 - \left(\frac{1}{\sqrt{3}}\right)^2\right] \times 100 = 66.6666\%$$

Equation 2: Reduction due to star delta starting

CHAPTER- 3

Design Methodology

3.1 Introduction:

The automatic star delta starter system is designed and developed by contactor and timer relay. The induction motor havewide variety characteristics, industrially it plays the premier role. Some of those are self-starting mechanism, heavy construction, high efficiency, good power factor etc. Different types of induction motor are available.Squirrel cage induction motors are mostly used than the other types. Small and medium size induction motors are started directly on line, but when very large motors are started that way, because of large amount of current flow through the motor. To reduce the high starting current, large induction motors are started at reduced voltage and then have full supply voltage reconnected when they reached to near to the rated speed.

3.2 Block diagram of star-delta starter:

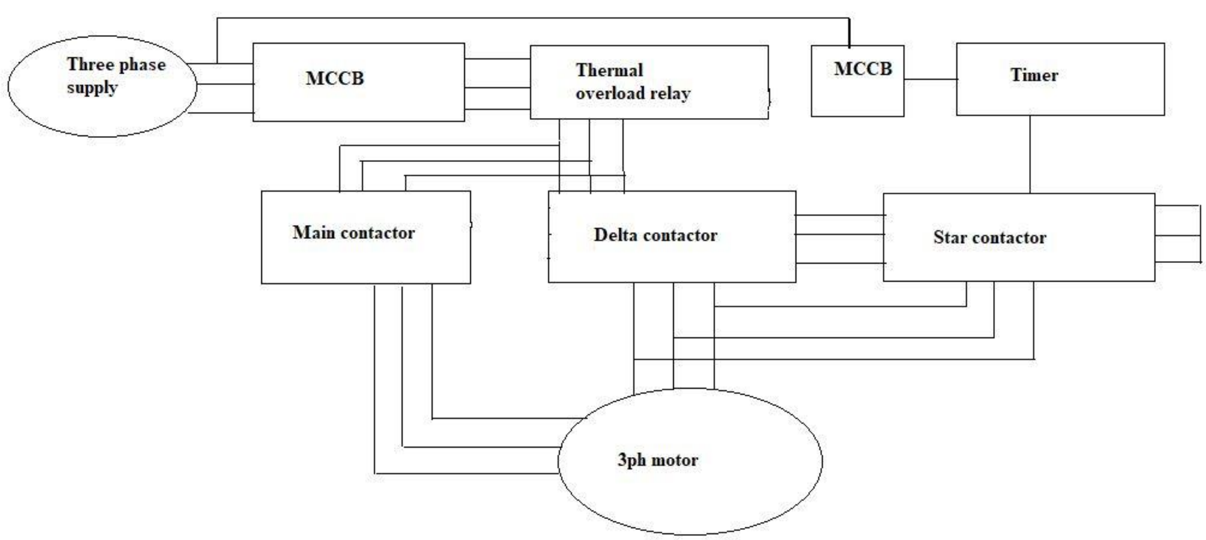


Figure 3.1: Block diagram of star-delta starter.

3.3 Flowchart:

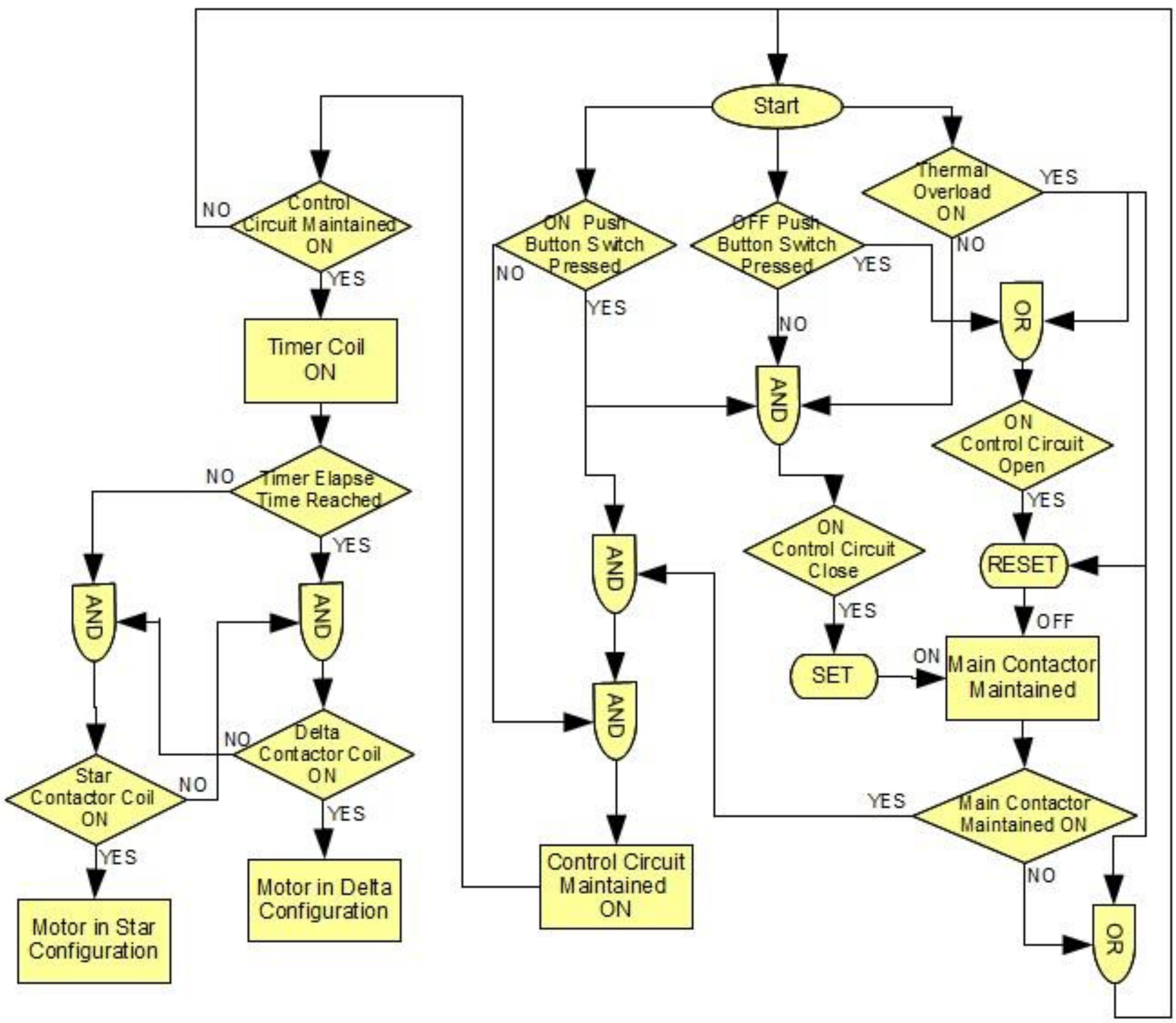


Figure-3.2: Flowchart

CHAPTER-4

Design and Implementation

4.1 Introduction:

This section illustrates the specific design of each block of the automatic star delta starter equipment along with the working of each part. Every block consists of several elements connected within the needed way to give the specified output .The comprehensive circuit illustration is provided add the end based on which the manufacture was completed .Special care was taken throughout the connection to avoid short circuit of paths during crossing of paths.

4.2 Our project consists of following hardware parts:

1. Magnetic conductor
2. Overload relay
3. Timer
4. Switch
5. Lamps
6. Board

4.2.1 Magnetic conductor:

There are three assembled contactors used for star delta starter. The ratings of contactors are about 18A 230 VAC which can work for a motor. The star and delta contactors are interlocked with a particular fixed time after which star to delta changeover in connection occurs. Below is the figure of Contactor.

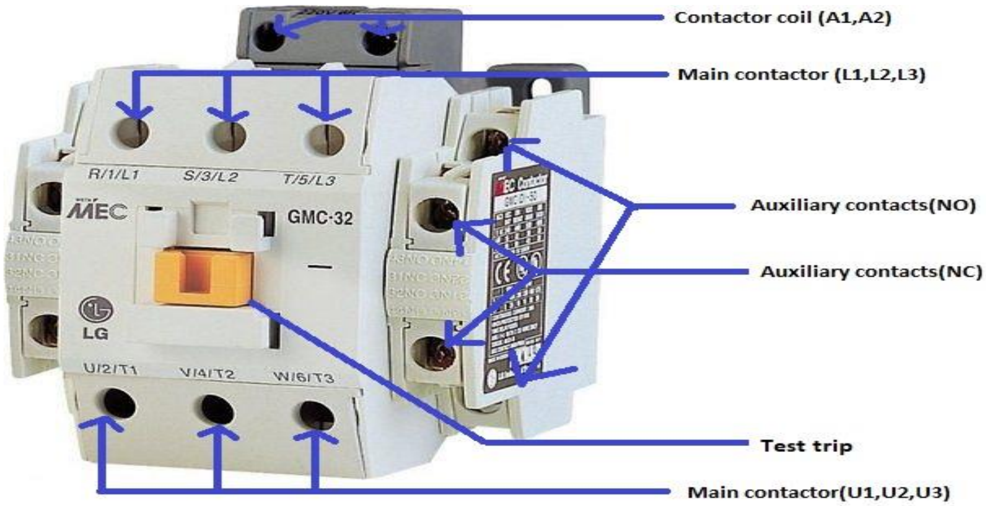


Figure 4.1: Magnetic conductor

4.2.2 Overload Relay:

Thermal overload relays are protecting devices which protect a motor against overload current and phase failure. It consists of set of indirectly heated bimetallic strips that deforms whenever the current exceeds limit. It also protect a motor against excessive heating, over-current, winding and winding insulation. It is design to stop power if the motor drawn to over current for an extended period of time. Thermal overload relays contain a normally closed (NC) relay. The ratings of overload relay are about 32A 3H which can work for a motor.

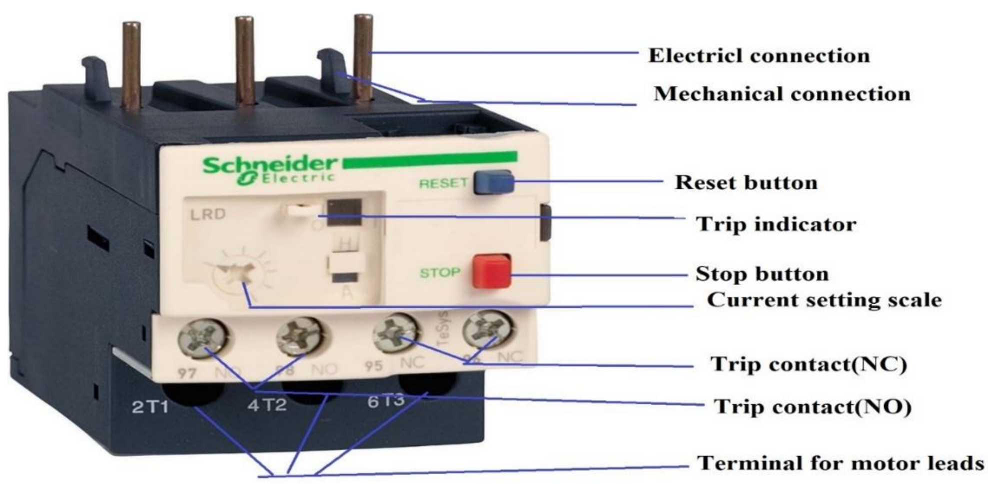


Figure 4.2: Overload relay

4.2.3 Timer Relay:

Timer is a control device which control the circuit. It is possible to construct a relay with a built in time delay device that causes the relay contacts to switch ON or switch OFF after a time delay. These type of relays are called time delay relays or Timer.

There are two basic types of time delay relay-

1.On delay timer or delay on timer.

2. Off delay timer or delay off timer.

Its rated current is 5A with 230V single phase AC supply 50Hz. The time within which star to delta changeover is done can be varied from 0 - 30 seconds. Below is the figure of Timer Box.

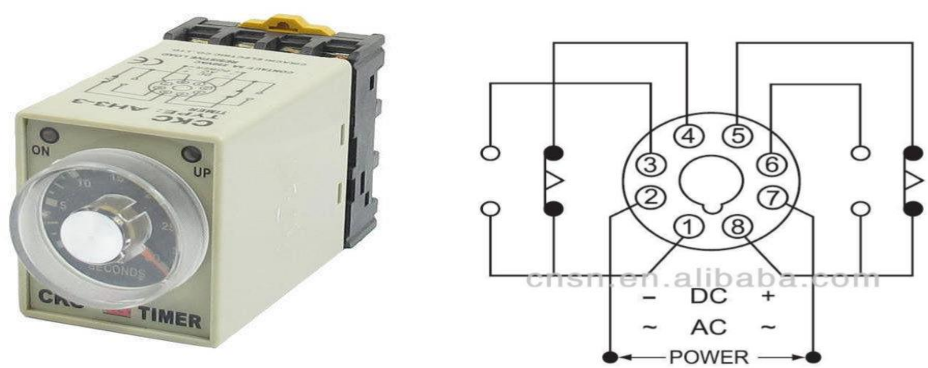


Figure 4.3: Timer & Its Connection

4.2.4 START and STOP push buttons switch:

These push buttons are based on the working principle of NO - normally open and NC - normally close type buttons. The START button here used is connected in NO type connection while for STOP button NC type connection is used. Below is the figure provided of START and STOP push buttons?

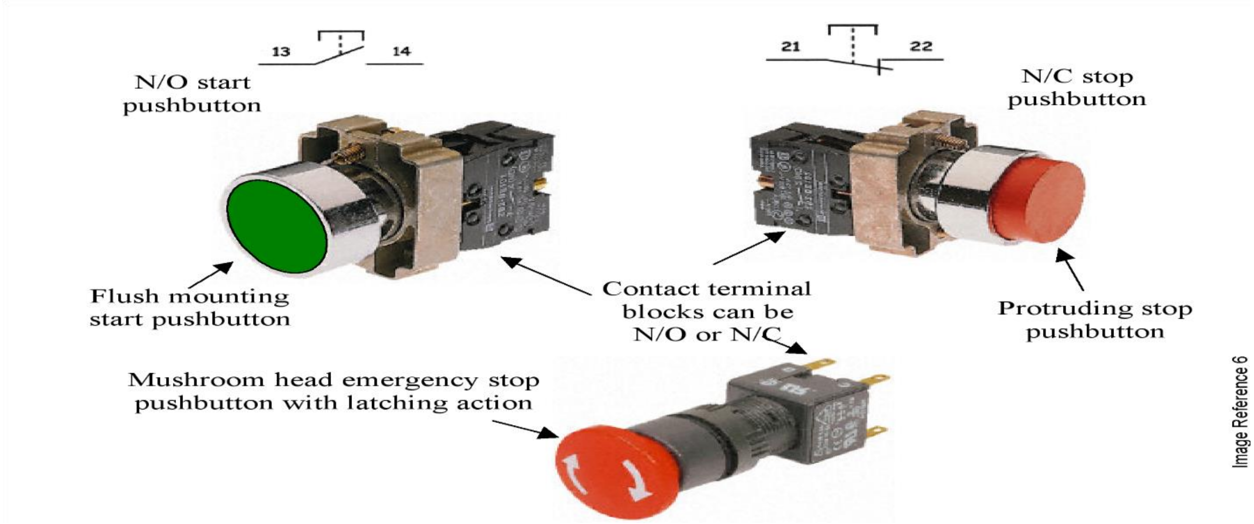


Figure 4.4: Start and stop button push switch

4.2.5 Cables:

The cables used here are of 2.5m. They can allow passing up to 15-16A of current. The resistance of 2.5 m according to resistance table provided by standard units is 8.21Ω/Km.

4.2.6 Interlock switches:

Interlock switches are safety switch which connected between star and delta contactor so that one can't activate without deactivating other contactor. For any fault if star and delta contactors are activated at the same time, the motor will be damaged.

4.3 Circuit diagram:

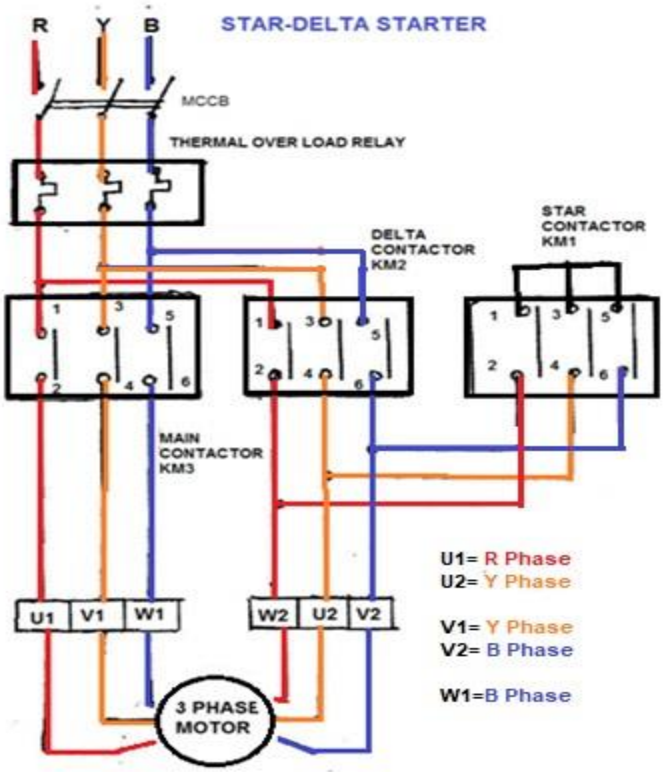


Figure 4.5**:** Power circuit diagram of automatic star delta starter

4.4 Operating principle:

The star-delta starter consists three contactor. There are main contractor, star contactor and delta contactor .The main and delta contactor are active during run mode. Then the winding of motor flow one-third of or 58% current in the line.

At the starting time, the star contactor is active until the time delay relay auxiliary contactor is open. The star contactor carries star current and the current is one third of rated current.

In run mode, the main and delta contactor are initially active and after a time, the star contactor is active until the timer contactor contact is deactivated. When the timer contactor is deactivate, the star contactor coil is open and at a time the delta contactor coil is active.The star delta changeover is done by timer relay. The two contactor star and delta are electrically interlock means one is active without other is deactivate.

Primary push the start switch and initially energized the main contactor and star contactor and timer relay contractor coil. When the star contractor coil energized and auxiliary contactor change its state normally open to close. In consequence of main contractor coil active in moment of time and its auxiliary contactor change its state normally open to close. Start switch is momentary push buttons switch. Momentary switch is switch which remains active as long as it is being compressed. The main contactor auxiliary switch NO is latched to the start switch. When the star contactor coil is active, motor run in star mode. It is active until timer auxiliary contractor change its state NC to open. While the timer is running on 5sec or reached the specified time, its auxiliary contactor change the position NC to open. At the same time the delta main contactor is active and the motor run in delta mode. Star auxiliary close contactor is connect to delta main coil and delta auxiliary close contactor is connect to star main coil. This system is called interlock. This two switches are together called interlock switch. Interlock switch one cannot active without other deactivate. When star contactor coil active, the delta contractor coil cannot be active without deactivate the star contactor coil. Similarly when delta contactor coil active, the star contactor coil cannot be active without deactivate the delta contactor coil. Stop switch is used for disconnect the circuit, when the motor needed. The overload relay is safety device which protect the motor against high current, excessive heat, phase failure, wind and wind insulation fail etc.

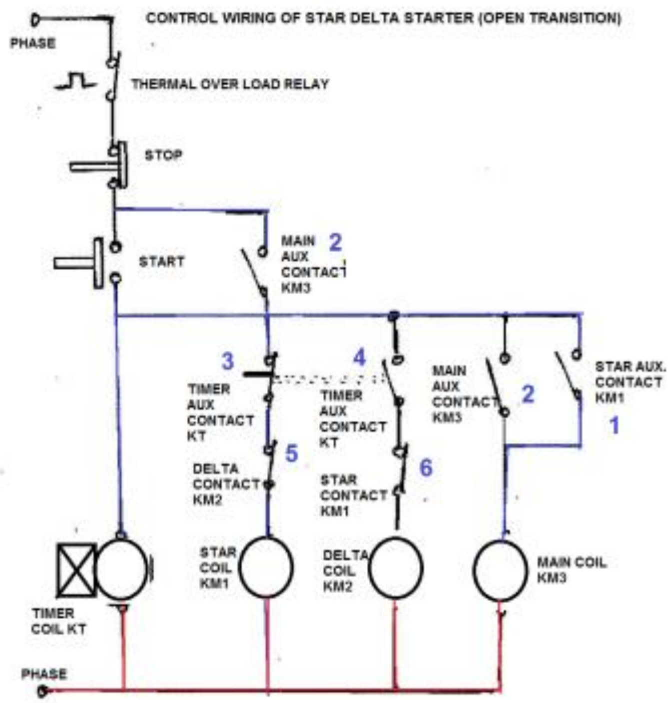


Figure 4.4: Circuit diagram of open and closed transition starter

CHAPTER-5
RESULTS AND COST ANAYLYSIS

5.1Introduction:

The value of any gadget planned must be confirmed after it is utilized and expected outcome is accomplished. In this chapter a brief description about the result and financial viability has been discussed. A cost efficient study is essential to demonstrate that the projected system will be supportive for industry to have a proficient operation and reduced energy consumption.

5.1 Result:

The presented system is planned and configured for practical use. This system is able to reduce high starting current. In this method at first motor terminal connect star system and we know start connection system line current is equal to the phase current and for this reason starting time motor achieve low starting current.After 5 second motor running delta mode operation. Delta connected system line current is root three times of phase current. So motor get full voltage and then the motor reaches its rated speed. The motor at starting is reduced to 1/3 as compared to starting current with the windings connected in delta. Finally motor run without damage. This method is used worldwide.

5.2 Three phase motor current rating for star delta starter:

Total power of the three phase motor equation is,

P=$\sqrt{3}v_l l_l \cos\emptyset$ Where, v_{ph}=240V, v_l=415V

3ph Motor rating at 400v 50HZ		STAR	DELTA
K.W	H.P	AMP	AMP
5.5	7.5	9	15.6
7.5	10	12	21
9.3	12.5	14	26
10	13.5	16.3	28
11	15	18	31
15	20	24.5	42

Figure-5.1: Three phase motor current rating for star delta

5.3 Cost sheet:

Name	**Model**	**Quantity**	**Purchase price**
Magnetic Conductor	LG	3	1800
Overload Relay	LS	1	400
Timer	TEE	1	350
Lamp	AD16	3	75
Switch	LA38	2	90
Board	Plastic	1	80
Wire	BD	1	150

Figure-5.2: Cost sheet

5.4 Cost comparison:

Star delta starter is very common types of starter and extensively used, compared to other types of starter. Motor is one of the expensive equipment in the industry. Induction Motor is very sensitive. In this project we design star delta starter which protect the motor of starting moment. It is the cheapest and safe way to start the induction motor available to other.

CHAPTER-6

CONCLUSIONS

6.1 Conclusion:

This starting method is used for medium voltage and light starting torque motors. This is one of the best way to reduce the high starting current. If the large induction motor start in direct online method, the motor can draw 5-6 times of rated current.The large amount of current can be easily reduce by the magnetic contactor, relays and the timer circuit.

The starter is designed to provide low voltage start to motors. This is achieved by using star to delta conversion. Different types of starter are available. Star/Delta starters are most common and best way to reduced voltage in the 50Hz industrial motor world.

Using the starter easily reduce the high starting current to the motor then after sometime full load current is applied to the motor. Since in star connected system line current is equal to the phase current while line voltage is the $\sqrt{3}$ times the phase voltage. If motor is started as star ,the voltage is must be reduced.

The interlocking arrangement of all the contactor coils is traditionally wired in 440-volt AC. The project is designed to provide low voltage start to induction motors. The Star-Delta starter is generally manufactured from three magnetic contactors, overload relays and timer for operating a 3-phase motor at 440 v and 50 Hz.

6.2Limitation of the work:

1. Six Terminal Motor Required.
2. The starting torque is low, it’s only 33%.
3. The application with a load torque higher than 50% of the full torque will not be able to start using the method
4. Break in supply

6.3 Future Scopes:

This is the best method to reduced high starting current and it is the very easy and cheaper than other device. But it receive large in rush currents during switching operation. Further the project can be enhanced by using a thyristor in firing angle control principle for soft start of the induction motor that would overcome all the drawbacks of star delta starter.

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Appendix

Motor Current Charts

SINGLE PHASE MOTORS

MOTOR RATING	HP	APPROX. F.L.C. AT LINE VOLTAGE		
		110V ac	220V ac	240V ac
0.07 kW	1/12	2.4	1.2	1.1
0.1 kW	1/8	3.3	1.6	1.5
0.12 kW	1/6	3.8	1.9	1.7
0.18 kW	1/4	4.5	2.3	2.1
0.25 kW	1/3	5.8	2.9	2.6
0.37 kW	1/2	7.9	3.9	3.6
0.56 kW	3/4	11	5.5	5
0.75 kW	1	15	7.3	6.7
1.1 kW	1.5	21	10	9
1.5 kW	2	26	13	12
2.2 kW	3	37	19	17
3 kW	4	49	24	22
3.7 kW	5	54	27	25
4 kW	5.5	60	30	27
5.5 kW	7.5	85	41	38
7.5 kW	10	110	55	50

THREE PHASE MOTORS

MOTOR RATING	HP	APPROX. F.L.C. AT LINE VOLTAGE 220V ac	240V ac	380V ac	415V ac	550V ac
0.1 kW	1/8	0.7	0.6	0.4	0.4	0.3
0.12 kW	1/6	1	0.9	0.5	0.5	0.3
0.18 kW	1/4	1.3	1.2	0.8	0.7	0.4
0.25 kW	1/3	1.6	1.5	0.9	0.9	0.6
0.37 kW	1/2	2.5	2.3	1.4	1.3	0.8
0.56 kW	3/4	3.1	2.8	1.8	1.6	1.1
0.75 kW	1	3.5	3.2	2	1.8	1.4
1.1 kW	1.5	5	4.5	2.8	2.6	1.9
1.5 kW	2	6.4	5.8	3.7	3.4	2.6
2.2 kW	3	9.5	8.7	5.5	5	3.5
3.0 kW	4	12	11	7	6.5	4.7
3.7 kW	5	15	13	8	8	6
4.0 kW	5.5	16	14	9	8	6
5.5 kW	7.5	20	19	12	11	8
7.5 kW	10	27	25	16	15	11
9.3 kW	12.5	34	32	20	18	14
10 kW	13.5	37	34	22	20	15
11 kW	15	41	37	23	22	16
15 kW	20	64	50	31	28	21
18 kW	25	67	62	39	36	26
22 kW	30	74	70	43	39	30
30 kW	40	99	91	57	52	41
37 kW	50	130	119	75	69	50
45 kW	60	147	136	86	79	59
55 kW	75	183	166	105	96	72
75 kW	100	239	219	138	125	95
90 kW	125	301	269	170	156	117
110 kW	150	350	325	205	189	142
130 kW	175	410	389	245	224	169
150 kW	200	505	440	278	255	192