ELECTROMECHANICAL EQUIPMENT PERATION AND MAINTENANCE

NTQF Level III

Learning Guide-15

Unit of Competence: - Maintain Induction Motor Functions

Module Title: - Maintaining Induction Motor Functions

LG Code:- EIS EME3 M05 0219LO-01-15

TTLM Code: - EIS EME3 M05 0219TTLM-V1

LO-01: - Identifying types of starting motor

Instruction Sheet	Learning Guide #02

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Introduction to Induction motor and its components
- Types of Induction Motor starting and its Components
  - Dol (direct on line)
  - forwarded and reversed
  - Star- Delta
  - Auto Transformer
  - Soft starter methods

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Identify components of direct on line
- Know components of forward and reverse starting method
- Identify components of Star-delta starting method
- Identify components of auto transformer starting method
- Know method of starting soft star starter

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 10
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1” in page 8

5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.
8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2” in page 18.
10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished

Information Sheet-1	Introduction to Induction motor and its components

1. Introduction

Induction motors are basically asynchronous AC motor where power is supplied to the rotating device by means of electromagnetic induction. They can operate on either single phase or three phase ac supply, however the single phase induction motors are suitable only for few applications. almost 85% applications the three phase induction motors are preferred. Depending on the type of rotor, the induction motor are classified into two types, slip ring induction motors and squirrel cage induction motors type.

1.1. Construction of three phase induction motors

. A 3-phase induction motor has two main parts (i) stator and (ii) rotor. The rotor is separated from the stator by a small air-gap which ranges from 0.4 mm to 4 mm.

Shaft- for transmitting the torque to the load. This shaft is made up of steel.

Bearings:- for supporting the rotating shaft.

Fan :-used for cooling purpose

Terminal box:-.used for receiving external electrical connection

Air gap:- the small distance between stator and rotor approximately varies from 0.4mm to 4 mm.

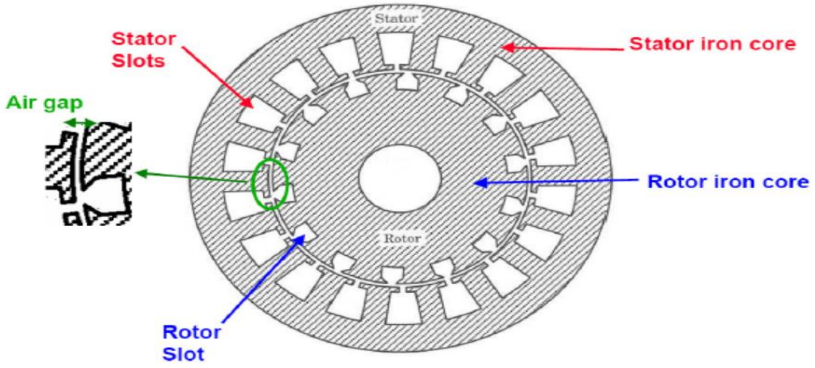


Figure 1.1. part of induction motor

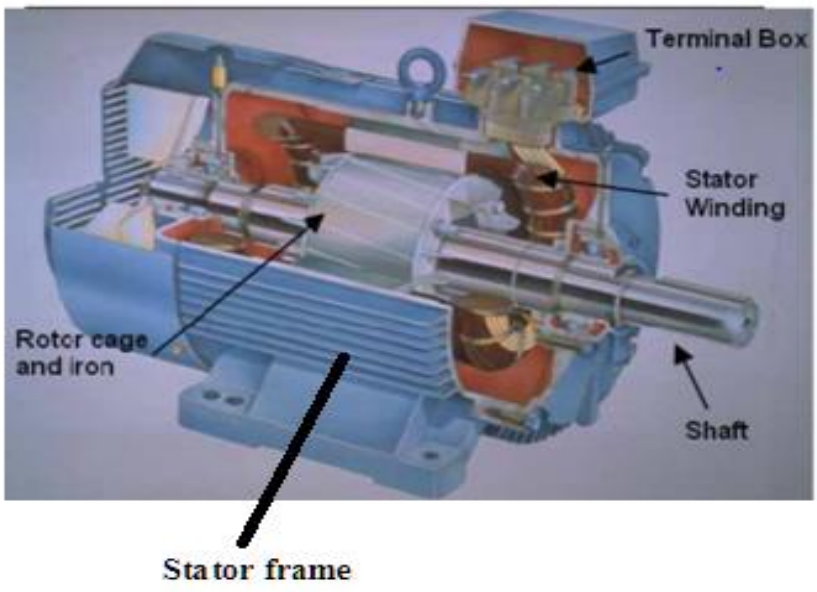


Figure1.2 Sectional view of three phase induction motor stator and rotor

Stator: As its name indicates stator is a stationary part of induction motor. It is made up of number of stampings in which different slots are cut to receive 3 phase winding circuit which is connected to 3 phase AC supply

Slots: - is the house of the conductor in which rotating magnetic field is produced after AC supply is given to them.

A stator winding: - is placed in the stator of induction motor and the three phase supply is given to it. The three phases of the winding are connected either in star or delta depending upon which type of starting method is used. The windings are wound for a definite number of poles depending upon the speed requirement, as speed is inversely proportional to the number of poles, given by the formula: Ns= 120f/p

Where Ns= synchronous speed f = Frequency p = no. of pols

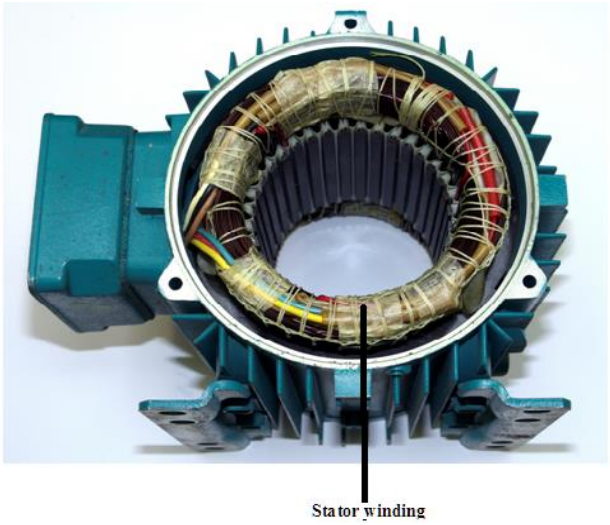


Figure 1.3. stator and its windings

Stator Frame

It is the outer most part of the three phase induction motor. Its main function is to support the stator core and the field winding. It acts as a covering and it provide protection and mechanical strength to all the inner parts of the induction motor.

Stator Core

The main function of the stator core is to carry the alternating flux. In order to reduce the eddy current loss, the stator core is laminated. These laminated types of structure are made up of stamping which is about 0.4 to 0.5 mm thick

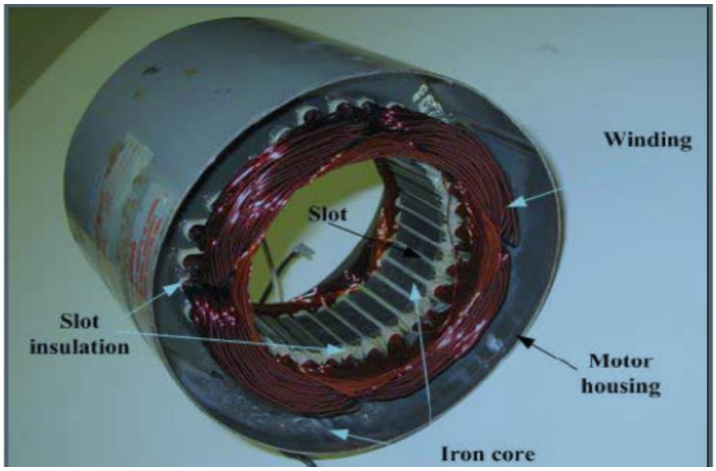
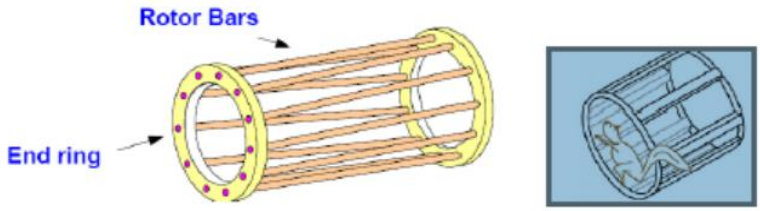


Figure 1.4. The internal components three phase motors

Rotor

The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft. Rotor consists of cylindrical laminated core with parallel slots that carry conductor bars. Conductors are heavy copper or aluminum bars which fits in each slots. The slots are not exactly made parallel to the axis of the shaft but are slotted a little skewed for the following reason, they reduces magnetic hum or noise and They avoid stalling of motor.



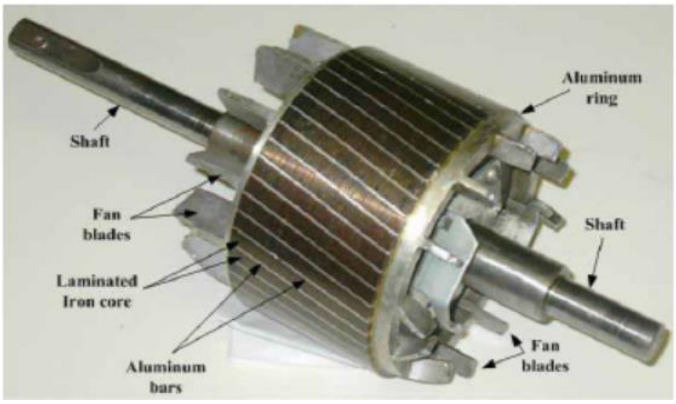


Figure 1.4 squirrel cage rotor

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is induction motor? (2pts)
2. Write the difference between stator frame and yoke? (2pts)
3. List construction parts induction motors parts (6pts)

Note: **Satisfactory rating - 10points** **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Answer sheet

1. ----------
2. ----------
3. ----------

Information Sheet-2	Types of Induction Motor starting and its Components

1. Introduction

A 3-phase induction motor is theoretically self-starting. The stator of an induction motor consists of 3-phase windings, which when connected to a 3-phase supply creates a rotating magnetic field. The magnetic field created by the rotor will interact with the rotating magnetic field in the stator and produce rotation. Therefore, 3-phase induction motors employ a starting method not to provide a starting torque at the rotor, but because of the following reasons; There are various methods of starting of an induction motor:

1.1. Direct on line starting (DOL)
1.2. Star – Delta starting
1.3. Forwarded and Reversed
1.4. Auto transformer starting
1.5. Soft-start

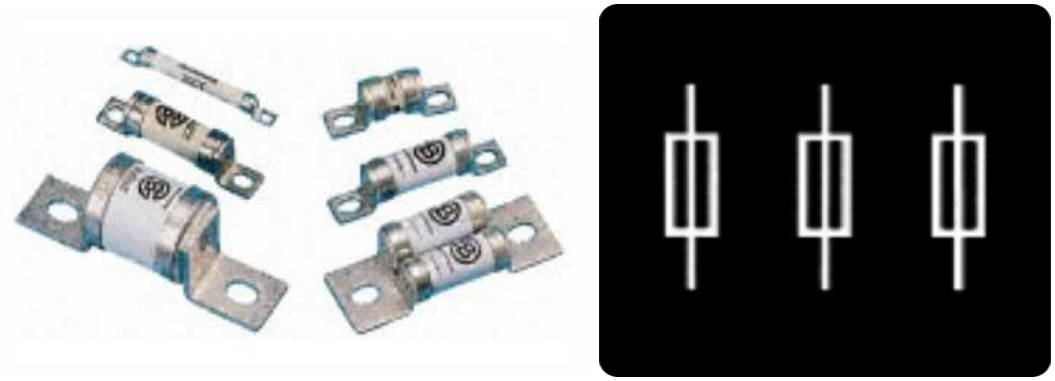
2.1. Direct on line starting (DOL)

The Direct On-Line (DOL) starter is the simplest and the most inexpensive of all starting methods and is usually used for squirrel cage induction motors. It directly connects the contacts of the motor to the full supply voltage. The starting current is very large, normally 6 to 8 times the rated current. The starting torque is likely to be 0.75 to 2 times the full load torque. In order to avoid excessive voltage drops in the supply line due to high starting currents, the DOL starter is used only for motors with a rating of less than 5KW.

2.1.1 Components of direct on line (DoL)

Fuse or circuit breaker, Contactors, Over Load Relay (Overload protection), Pushing Start Button, Release Start Button and Pushing Stop Button

Fuse :-is over current protective device this means that it blows the current is above the rated value .



(a) (b)

Figure 2.1 (a) Shows fuse electrical device and b shows electrical symbol

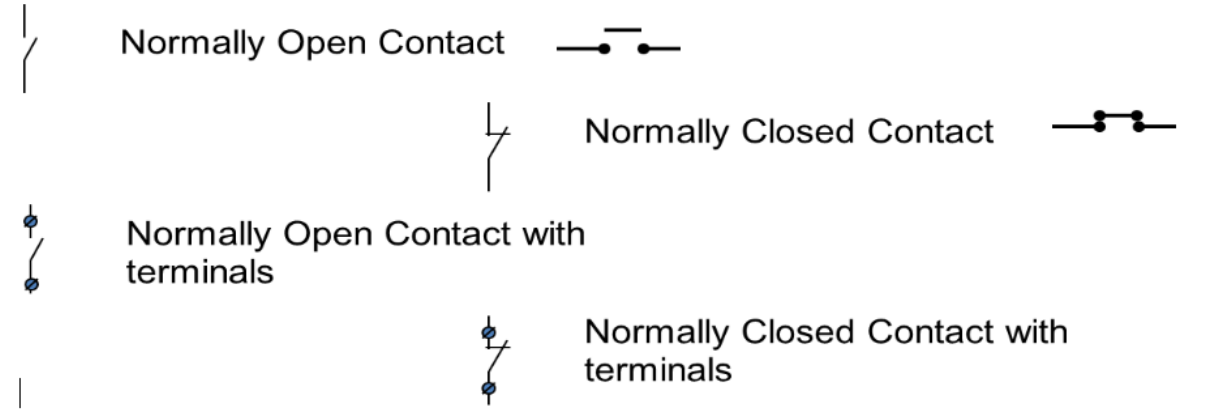
Circuit breaker (CB):- is an electrical device used to interrupt the circuit during fault condition automatically.

(a) (b)

Figure 2.2 (a) and (b) shows electrical and symbols of circuit breaker respectively

Magnetic Contactor :- is a control device that uses a small control current to energize or de-energize the load connected to it. This means that it makes the circuit while energized and break s a circuit when de energized

Contacts Symbols



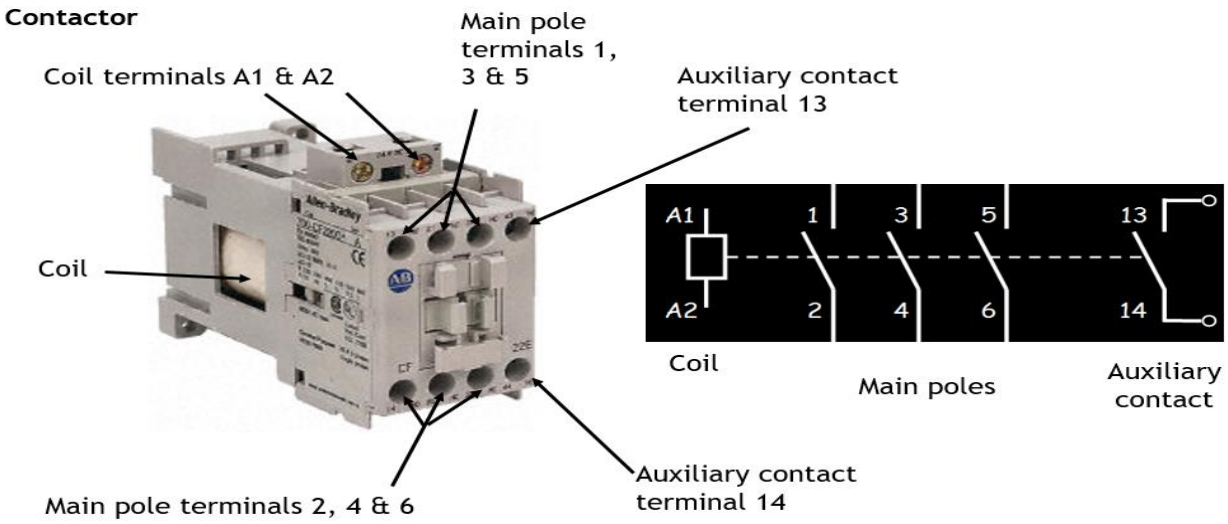


Figure 2.3 . contactor electrical device and its components

An Auxiliary contactor: -is a regular (low-power) relay - but built like a regular contactor and when used together with another contactor it is called auxiliary contactor to clarify that it is not used for switching loads but has an activation/deactivation the system it is operated by power supply of ac 220v. it has normally closed and open terminals for more information see figure 2.3 above

Thermal overload relay :- are protective devices. They are designed to cut power if the motor draws too much current for an extended period of time.

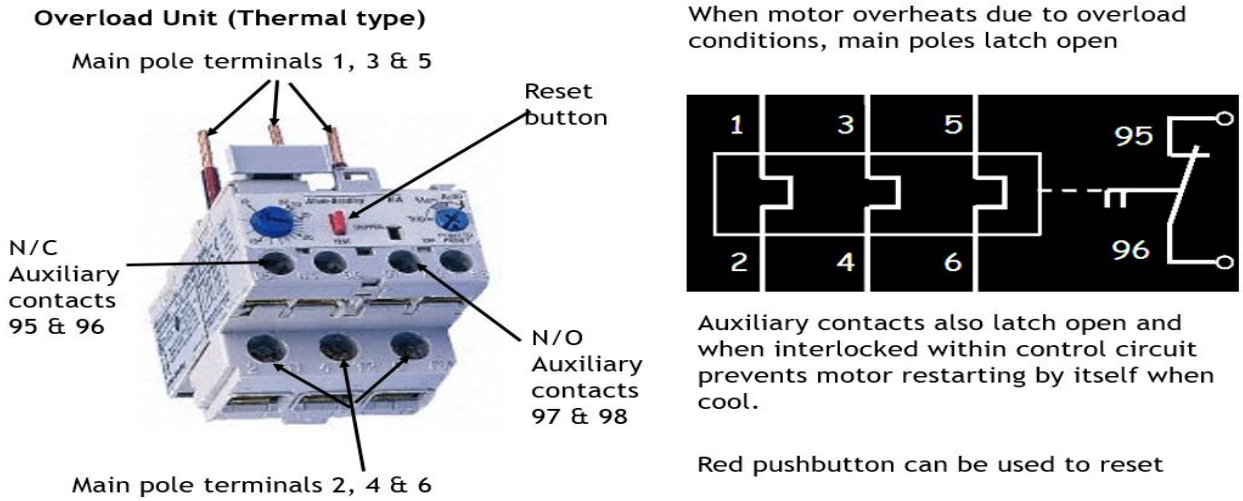
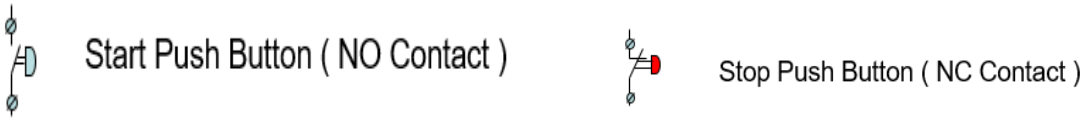


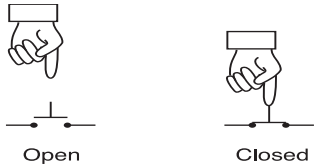
Figure 2.4. parts of thermal overload relay and its symbols

Push button :-is an electrical device used to make and break the power supply pushing on the device there are start and stop push button.

Electrical symbol



- Normally open
  - ❖ electrical contact is made when button is pressed
- Normally closed
  - ❖ electrical contact is broken when button is pressed
- Internal spring returns button to its un-pressed state



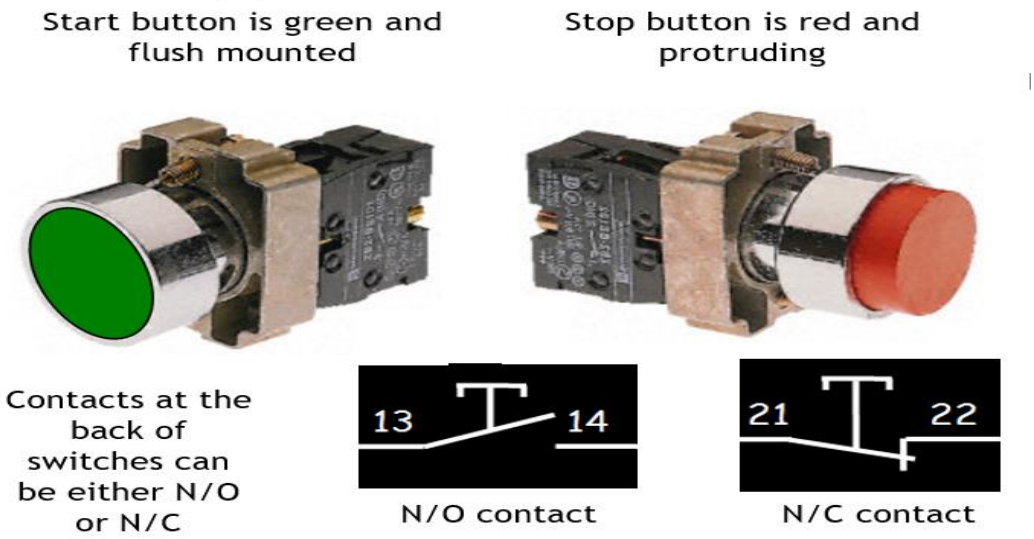


Figure 2.5 Electrical device and symbol of start and stop push button

Selector switch selector :- an electrical or a mechanical electronic device for making or breaking or changing the connections in a circuit.

Figure 2.6 Selector switch device

2.2. Star –Delta starting method

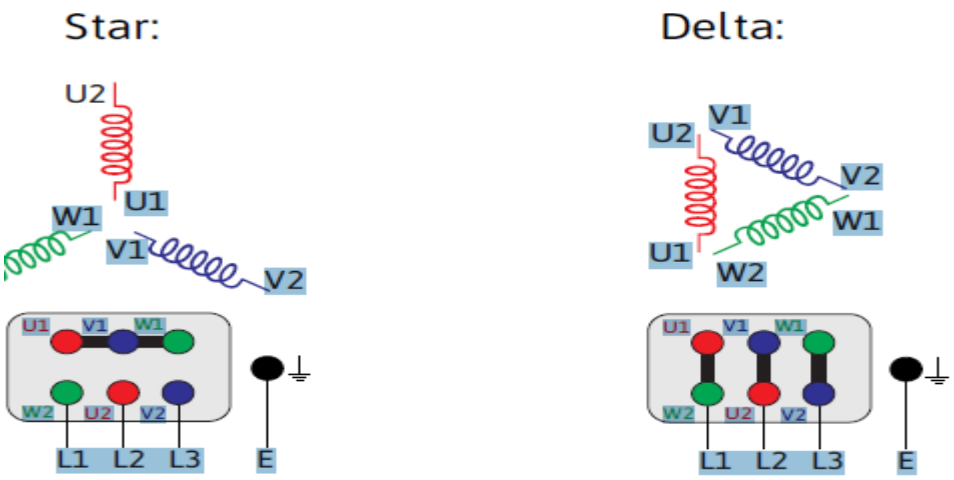


Figure 2.2.1. shows the terminal connection of star and delta

The voltage between phase to phase in star or delta connection is

V1-u1= 380v/400v v1-w1=380v/400v u1-w1=380v/400v

But the voltage between phase and neutral is 220v/250v

The star delta starting is a very common type of starter and extensively used, compared to the other types of the starters.

This method used reduced supply voltage in starting.it achieves low starting current by first connecting the stator winding in star configuration, and then after the motor reaches a certain speed, throw switch changes the winding arrangements from star to delta configuration. By connecting the stator windings, first in star and then in delta, the line current drawn by the motor at starting is reduced to one-third as compared to starting current with the windings connected in delta. At the time of starting when the stator windings are start connected, each stator phase gets voltage $\mathrm{VL}/\sqrt{3}$ where VL is the line voltage. Since the torque developed by an induction motor is proportional to the square of the applied voltage, star- delta starting reduced the starting torque to one – third that

obtainable by direct delta starting. its components are the same as to listed in section 2.1 except timer

Time delay relay switch:- also called a timer switch, or simply timer) is a timer that operates an electric switch controlled by the timing mechanism. The switch may be connected to an electric circuit operating from mains power, including via a relay or contactor; or low voltage

It has different pin in its base example 8-pin, 10- pin etc

Figure 2.2.2 Time delay relay device

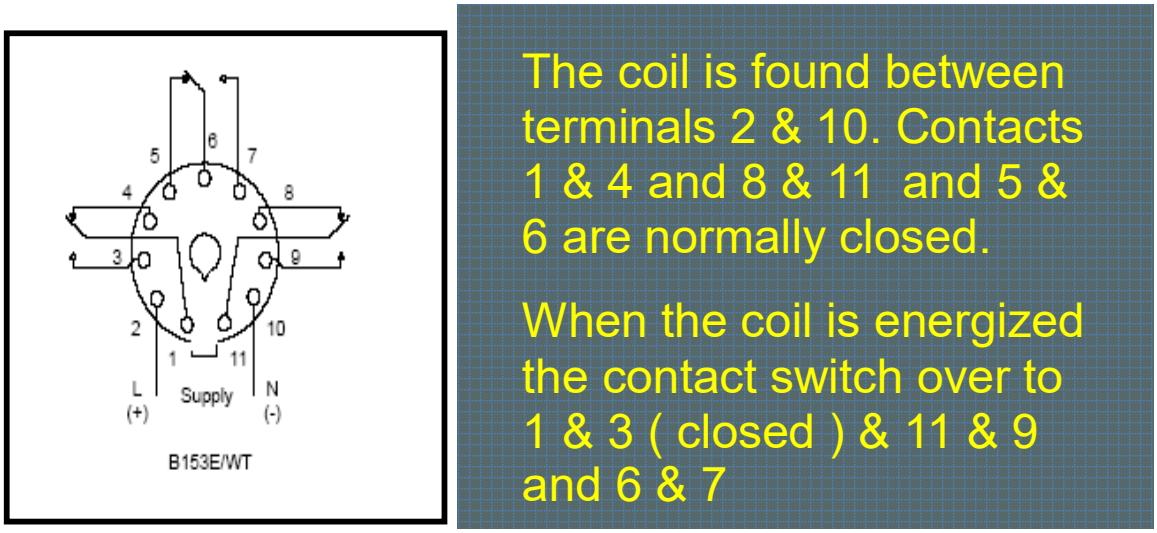


Figure 2.2.3 11-pin timer base format configuration

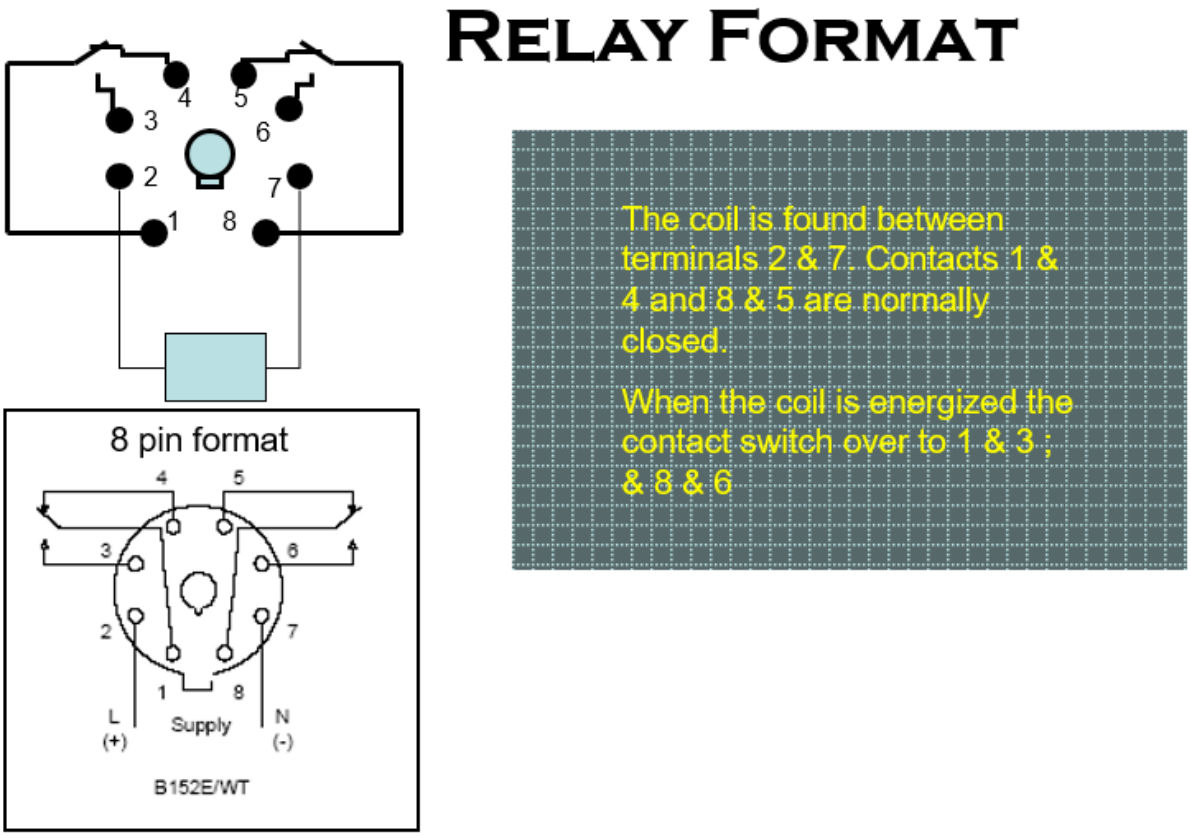


Figure 2.2.2 8- pin –time relay format

2.3. Forward and Reverse motor starting: -is used in system where forward and backward or upward and down ward movement or rotation in the system needed. To change the direction of the rotation, in three phase induction machine two of its phases needs to be exchanged, thus changing the phase sequence form, say ABC to CBA. This can be accomplished by using two contactors, one for the forward or CW rotation and one for the reverse or CCW rotation. The forward and reverse contactors are mechanically interlocked i.e., if one of them is closed the other cannot close. This is done to avoid dead short circuit in case both the contactors closing simultaneously.it components are the components listed in section 2.1 and 2.2 above see them carefully

2.4. Auto transformer starting: -The autotransformer reduced-voltage starter places the motor on the secondary of the autotransformer while starting. The taps on the autotransformer limit the voltage applied to the motor to 50%, 65% or 80% of the nominal voltage. The operation principle of auto transformer method is similar to the star delta starter method. The starting current is limited by (using a three phase auto transformer) reduce the initial stator applied voltage.

The auto transformer starter is more expensive, more complicated in operation and bulkier in construction when compared with the star – delta starter method. But an auto transformer starter is suitable for both star and delta connected motors, and the starting current and torque can be adjusted to a desired value by taking the correct tapping from the auto transformer

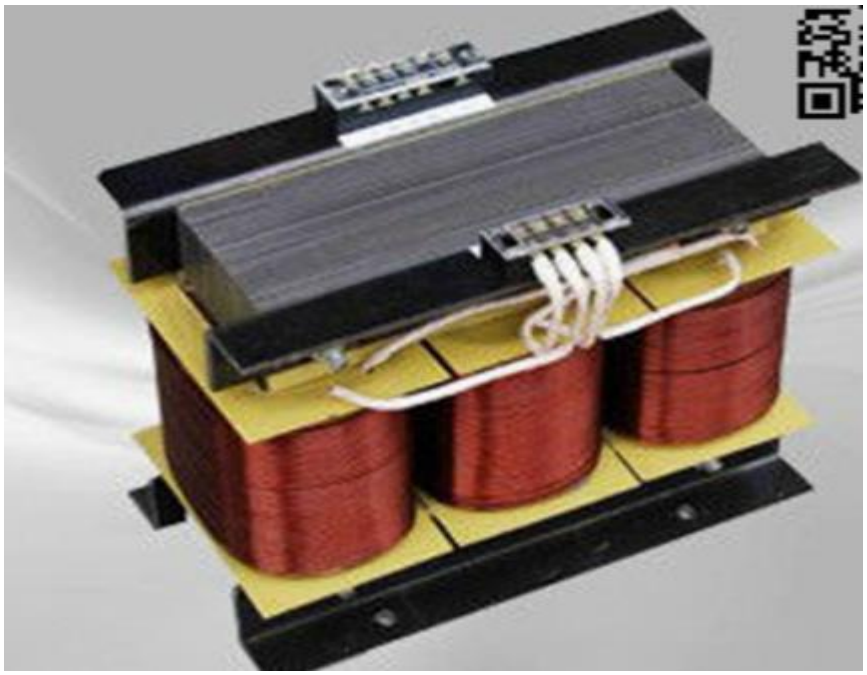


Figure2.4 Auto-transformer device

Refer ……

www.youtube.com/watch?v=ZJ-pAJBv09w

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the starting components of Dol (4pts)
2. Write the constructional components of induction motors (4pts)
3. What makes difference the starting components of star-delta from Dol (2pts)
4. List three phase induction motor starting method (5)

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Answer sheet

1. ----------
2. ----------
3. ----------
4. ----------

List of Reference Materials

www.youtube.com/watch?v=ZJ-pAJBv09w