

Module 4

# AC MOTOR CONTROL

Lecture 1

## STARTING OF AN INDUCTION MOTOR

Shameer A Koya

### Introduction

- Induction motors at starting may draw 5 to 10 times the full load current.
- Small squirrel cage motors started directly from the line without the help of starters.
- 5 hp and above motors require some kind of starter.
- The function of a starter is to reduce the starting voltage impressed to the stator at the starting so that the starting current is not excessive.
- Methods of starting are:
  1. Full voltage starter
  2. Reduced Voltage Starting
    - A. Primary resistance starting
    - B. Autotransformer starting
    - C. Star-delta starting
    - D. Solid state starting
    - E. Rotor (Secondary) resistance starting - WRIM

## Full Voltage Starter

- motor is connected directly to the supply line through a manual or magnetic starter

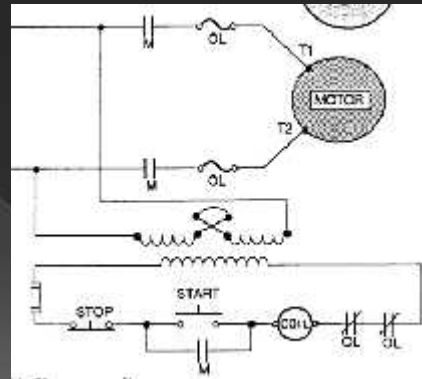
➤ When the **START** button is pressed, the control circuit is completed and the operating coil, M, energizes and closes all its contacts.

➤ The motor starts.

➤ The START button may be released and the circuit will be maintained by the **auxiliary contact** in the control circuit.

➤ Pressing the **STOP** button will de-energize the coil and all M contacts will open.

➤ The motor is disconnected from the line.

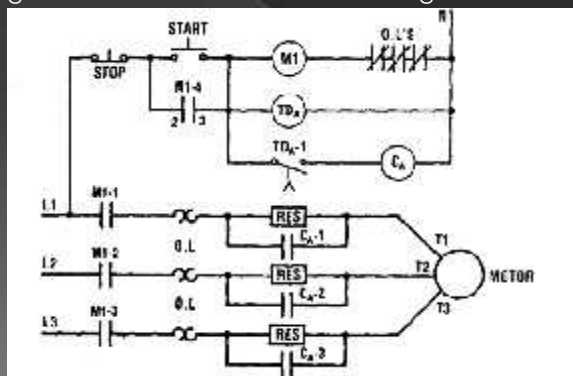


## Stator Resistance Starting

- Primary resistor type starters are used for starting motors at reduced voltage
- a resistor is connected in series, between the line and the motor
- The resistor is disconnected (manual or automatic) when the motor reaches a certain speed so that the motor runs on full line voltage
- These starters are used to start squirrel cage motors where a limited torque is required, to avoid damage to machinery due to shock of sudden acceleration.
- Automatic primary resistor starters can include one or more steps of acceleration, depending upon the motor size

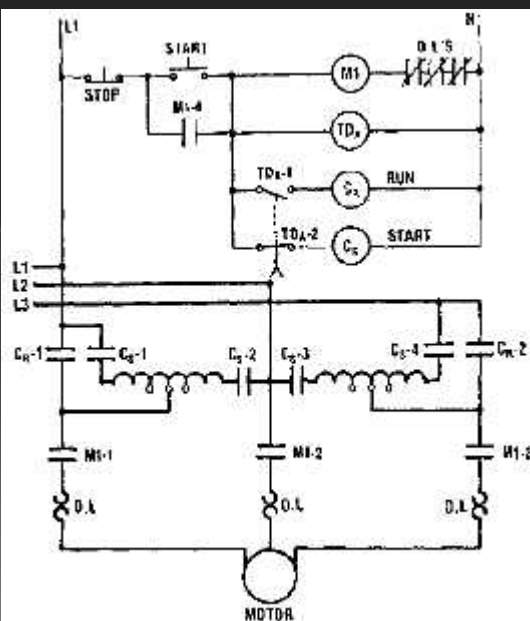
## Primary Resistance Starting

- When the start button is pressed, coil (M1) is energized, closing the line contacts (M1-1 to M1-3) and holding contact (M1-4)
- Since the resistors are connected in series with the motor, the motor starts on reduced voltage.
- The time delay relay coil is also energized.
- After a preset time contact (TD<sub>A</sub>-1) closes, energizing the contactor coil (C<sub>A</sub>). This will close all (C<sub>A</sub>) contacts which short circuit the resistors, connecting the motor across the full line voltage.



## Autotransformer Starting

- An autotransformer type starter generally has two autotransformers connected in open delta
- Taps are provided on autotransformer to start the motor at 50, 60 or 80 of the line voltage.
- An adjustable time-delay relay controls the transfer from reduced voltage condition to full voltage.
- Working refer book

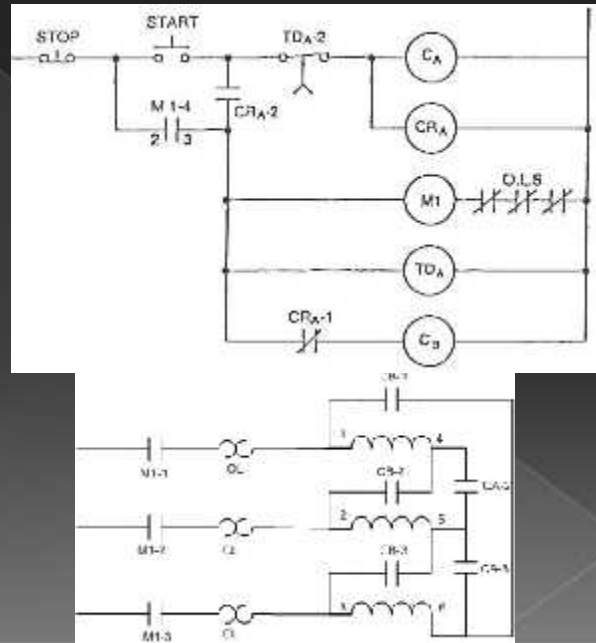


## Star-Delta Starters

- ◉ Commonly used method to reduce inrush currents without the need of external device is star-delta motor starting.
- ◉ both ends of each of the three windings are brought out to the terminals.
- ◉ Using contacts the motor can be started in star and then switched to delta connection.
- ◉ The current drawn & the torque developed by the motor are reduced to only 1/3 of their full voltage value.
- ◉ Wye-delta motors are used for driving centrifugal loads such as fans, blowers and where a reduced starting torque is necessary.
- ◉ These motors are also used where a reduced starting current is required.

- ◉ Two methods
  - > open transition starting
  - > closed transition starting.
- ◉ When open transition starting is used, the motor circuit is opened briefly during the transition from star to delta.
  - > starter momentarily disconnects the motor and then reconnects it in delta.
- ◉ In closed transition, the circuit remains closed through resistors during the transition.
  - > used in some installations to prevent power line disturbances

## Open transition start star/delta starter



## Solid State Starter

- no moving parts and provides an efficient method of controlling voltage & currents in a machine.
- two thyristors connected anti-parallel to allow ac current.
- the output voltage is adjusted by controlling the conduction period of the thyristors.
- firing angle  $\alpha$ , can be varied from nearly  $180^\circ$  to give low voltage as the motor starts up to  $0^\circ$  to give full voltage.
- Motor protection function can be easily added to a starter using digital logic.

