Experiment 3

Application on three phase induction motor

**Objectives:**
After successfully completing this laboratory, you should be able to:
- Use the three phase induction motor with plc for any application.
- Turn on and reverse the direction of induction motor.

**Overview:**
One of the ways of creating a rotating electromagnet is to connect a three-phase power source to a stator made of three electromagnets A, B, and C, that are placed at 120° to one another as shown in Figure 3.1.

![Figure 3.1. Three-Phase Stator Windings.](image)

When sine-wave currents phase shifted of 120° to each other, like those shown in Figure 3.2, flow in stator electromagnets A, B, and C, a magnetic field that rotates very regularly is obtained.

![Figure 3.2. Three-Phase Sine-Wave Currents Flowing in the Stator Windings.](image)
The speed of the rotating magnetic field is known as the synchronous speed (ns) and is proportional to the frequency of the ac power source. When a squirrel-cage rotor is placed inside a rotating magnetic field, it is pulled around in the same direction as the rotating field. Interchanging the power connections to two of the stator windings (interchanging A with B for example) interchanges two of the three currents and reverses the phase sequence. This causes the rotating field to reverse direction. As a result, the direction of rotation of the motor is also reversed.

The power diagram for reversing the direction of rotation of the motor and the associated control circuits are shown in Fig. 3.3.

![Diagram](image)

**Figure 3.3.** Reversing direction of rotation of a three phase induction motor
(a) Control circuit diagrams (b) Power diagram
It may be seen from 3.3 (b) that phase reversal to motor terminals has been done by Interchanging phase L2 and phase L3 leads at the upper terminals of the reverse contactor R. The forward and reverse contactor 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. Electrical interlocking has also been provided, by using control contacts.

Electrical interlocking is essential even if mechanical interlocking of contactors is provided. This is because, if the coil of contactor which is mechanically interlocked not to close, is energized, its coil gets burnt. The coil gets burnt as it draws large current due to less reactance in this case. Reactance of coil is less as reluctance to flux path increases due to large air gap between the electromagnet and the locked armature of contactor. Forward reverse starters may be designed for either Forward-Reverse Operation or Forward-Off-Reverse Operation.

Control circuit in Fig. 3.3 (a) is for direct reversing of the motor. In this circuit, for reversing there is no need to first press the STOP-push button. Direction of rotation of the motor can be changed by pressing the respective push button. This is accomplished by using interlocking through NC contacts of the push button in the coil circuits of the contactors. Assume that motor is running in forward direction when contactor F is energized through closed contact F1, NC contact of reverse push button, and normally closed contact R2 of reverse contactor R. When it is desired to reverse the motor direction, REV-push button is pressed, its NO contact closes whereas its NC contact which is in series with coil of contactor F opens. Contactor coil of F is thus de-energized and its holding circuit is also released. De-energization of F also leads to closing of its auxiliary contacts F2. The reverse contactor R is thus energized through NO contact of REV-push button, NC of FOR push button, and NC contact F2 of contactor F. The contactor R remains energized through its auxiliary contact R1. Similar action takes place when the motor is to again run in forward direction by pressing FOR-push button. Induction motors can be safely reversed by direct reversing method as the inrush current is not significantly more than when it is started direct from rest. Direct reversing is also used for bringing a motor to standstill quickly using reverse torque acting as a brake.

**Procedure:**

**Part 1**

1. Connect the circuit as shown in the Figure 3.4 on the control board and make the required wiring and connections.

![Figure 3.4. Control circuit diagrams](image-url)
2. When you are finished the connections. Starting a new project in Wpl and programming a PLC by using ladder diagram.

3. The program should satisfy the following conditions:
   - If you press on pushbutton 1, the motor should rotate to the left direction.
   - If you press on pushbutton 2, the motor should rotate to the right direction.
   - If you press on pushbutton 3, the motor should stop.

4. When you are finished the connections, check it for you and make sure that it is correct.
5. Connect the circuit to the power source.

Part 2
Control in door of garage

![Control in door of garage](image)

Figure 3.5. Control in door of garage

1. Connect the circuit as shown in the Figure 3.6 on the control board and make the required wiring and connections.
2. When you are finished the connections. Starting a new project in WPL and programming a PLC by using ladder diagram.

3. The program should satisfy the following conditions:

   - If you press on pushbutton 1, the door of garage should rotate to the left direction, and the green led becomes ON.
   - If you press on pushbutton 2, the door of garage should rotate to the right direction, and the red led becomes ON.
   - If you press on pushbutton 3, the motor should stop.
   - S4 and S5 are limit switch as shown in the figure 3.5

4. When you are finished the connections, check it for you and make sure that it is correct.

5. Connect the circuit to the power source.