

*Connection & Rotational direction test of
3 – Phase induction motor with squirrel cage rotor*

Object: The object of this experiment is to make the student be familiar with the assembly, connections, braking unit and direction of rotation of a 3 – phase induction motor fitted with squirrel cage rotor at no – load.

Theory: The three – phase induction motor is the motor used most frequently for industrial drives because of its excellent reliability, its simple and thus low – cost construction and its low maintenance costs. The three – phase induction motor is also known as squirrel – cage rotor due to its construction.

The stationary part of the three – phase induction motor is known as the stator. It consists of a housing and a metal casing with grooves in which the three – phase current winding is embedded as shown in Figure (1). The winding is made up of three coils which are arranged offset to each other at 120° . The ends of the windings are fed to the terminal board in the junction box.

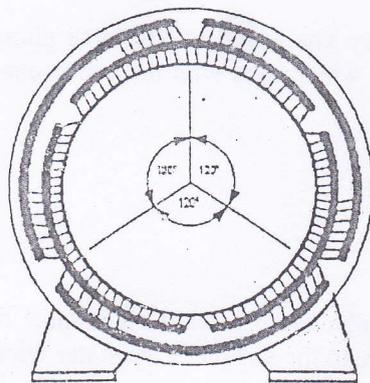


Figure (1)
Stator of a 3 – phase induction motor

The rotor also consists of a metal casing with grooves. Aluminum or copper conductor rods are drawn into these grooves or injected with die cast aluminum and connected by short – circuit rings at the front sides. The rods and short – circuit rings together form a cage and thus represent the rotor winding. The angled arrangement of the rods ensures even running. Short – circuit rings are often combined with ventilating fans for cooling the motor. The drive shaft is located in the centre of the rotor, as shown in Figure (2).

The Torque Attenuator of the Control Unit: In the Control Unit (Type 2730) an additional switch and a potentiometer are installed to reduce the brake machine torque. This is achieved by reducing the motor voltage of the brake machine. This method is applied in motors with a very stable torque – speed characteristics behavior such as in the shunt wound motor and synchronous motor.

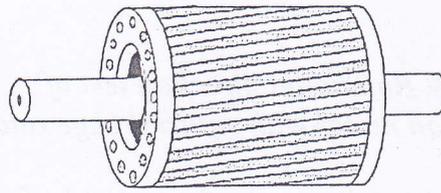


Figure (2)
Squirrel cage rotor

If a brake unit (e. g. Type 2719) is used together with the Control Unit as a load for a controlled drive, a load can be switched on or off with this switch. The braking machine rotates in the opposite direction of rotation to that displayed on the Control Unit. To ensure that the experimental machine turns to the right direction, the braking machine must turn to the opposite direction. The direction of rotation setting on the Control Unit always refers to the experimental machine. The potentiometer has no effect on the brake machine torque at the right stop. If the potentiometer is turned to the left, the torque can be reduced to zero value.

The speed of the rotating field:

When the motor windings are connected to the three phase current mains a rotary field is produced in the stator which runs with the synchronous speed or speed of the rotary field (n_0), where:

$$n_0 = fs/p$$

fs : mains frequency
 p : number of pole pairs

Number of pole pairs (p) can be understood as the number of north/south pole pairs which are formed per phase due to the design of the stator winding.

Connection of the motor: The windings of a squirrel – cage motor can be connected in star or delta circuit as shown in Figure (3).

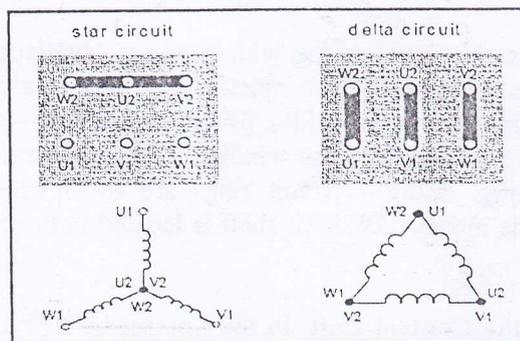


Figure (3)
Star connection and delta connection

Figure (4) shows how the terminals are connected with the windings in the motor. The current and torque in the star circuit are only a third of those in the delta circuit. The power rating plate serves as an aid when to select star or delta circuit.

Figure (5) shows the Name Plate Data of the three – phase Induction Motor (Type 2707). You will see D/Y 400/692 V which means that the motor is to be operated in star circuit at 692 V and in delta circuit at 400 V. In star circuit on the other hand the motor only emits a third of its rated power. If the rating plate carries the specification D/Y 230/400 V, the motor on the 400 V three – phase mains should only be operated in star circuit. Since the windings in this motor are designed for 230 V, they would heat up to illegal temperatures in delta circuit on 400 V. It should be appreciated that the direction of rotation of a motor can be varied simply by exchanging two of the three mains leads (terminals), as shown in Figure (6).

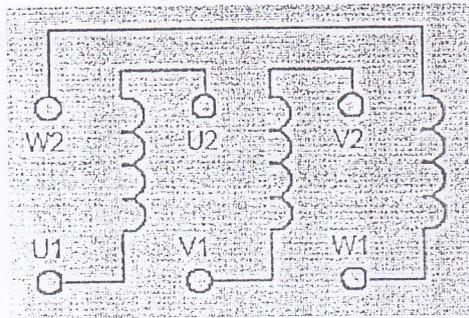


Figure (4)

The connection terminals of the windings

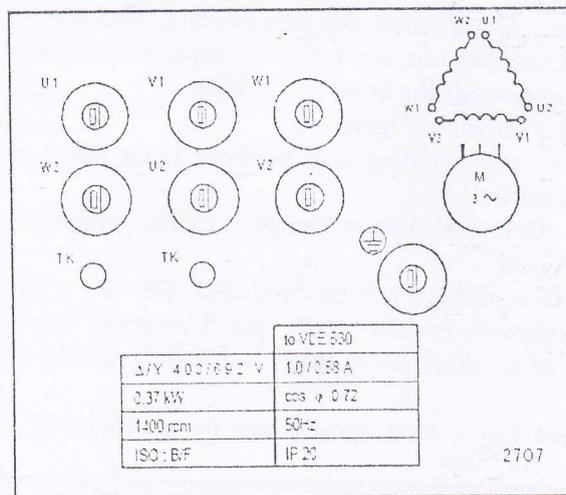


Figure (5)

Name plate data of 3 – phase induction motor (Type 2707)

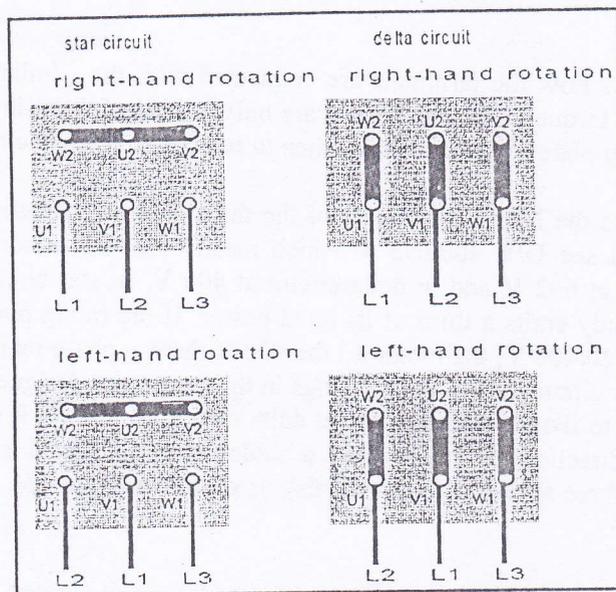


Figure (6)

Reversing the direction of rotation of a 3 – phase induction motor

Necessary equipments:

1. Three – phase induction motor (Type 2707).
2. Brake Unit (Type 2719).
3. Control Unit (Type 2730).
4. Universal Power Supply (Type 2740).

Procedure:

Run I:

1. Push the experimental machine onto the Brake Unit and couple it to the braking machine.
2. Adjust the adapter feet so that the experimental machine and the braking machine are collinear (on one axis). Fix the experimental machine by pulling the clamping lever towards the braking machine.
3. Connect the circuit shown in Figure (7).
4. Connect the motor stator winding in delta circuit to the 400 V mains.
5. Switch *ON* the Control Unit.
6. Switch *ON* the Universal Power Supply: speed, torque and direction of rotation are displayed.
7. The direction – of – rotation will be displayed. The motor should turn to the right (CW); otherwise switch *OFF* the Universal Power Supply and interchange two of the three mains leads and Switch *ON* the Universal Power Supply again.
8. Record the speed (no – load speed) and the direction of rotation in the following table:

Speed (no) / rpm	Direction of Rotation	CW(Clock Wise)	CCW(Counter Clock Wise)

9. Switch *OFF* the Universal Power Supply.

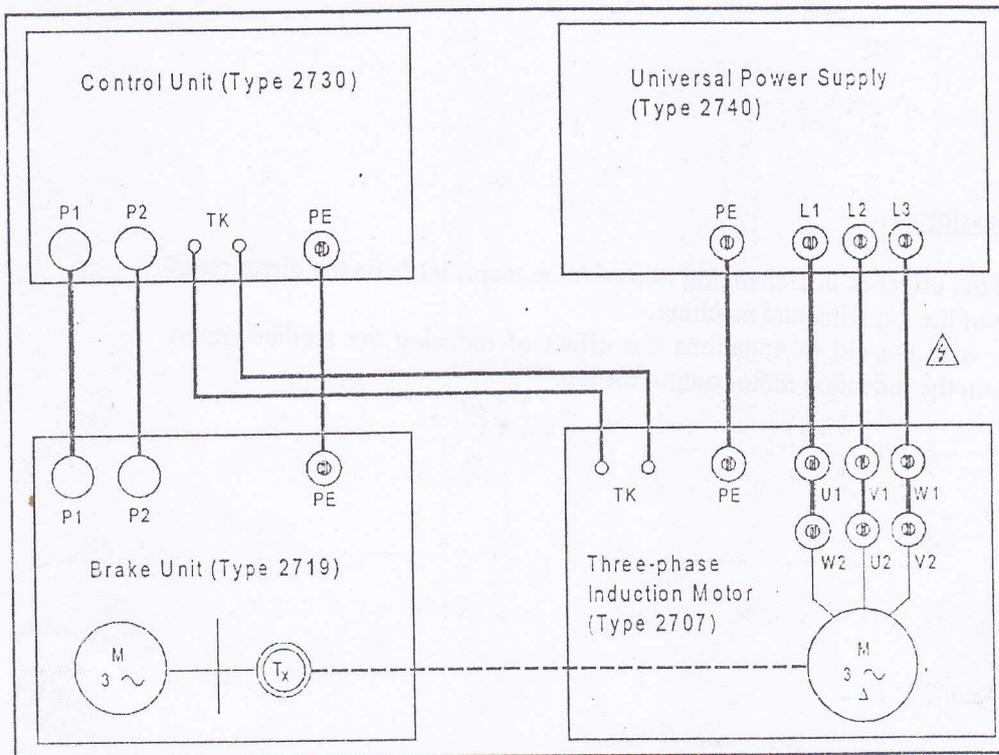


Figure (7)
Delta connection circuit diagram of 3 – phase induction motor

Run II:

Make the following settings on the Control Unit:

1. Switch the operation – mode switch to MANUAL.
2. Note the setting of the torque attenuator.
3. Set the speed – preselection switch to range of previously recorded speed (1800 or 3600 rpm).
4. Set the set point switch INT/EXT to "internal" position.
5. Set the direction – of – rotation switch to previously recorded direction of rotation.
6. Start the braking machine by briefly pressing the START/STOP key.
7. Compare the displayed speed with the previously recorded one and adjust it if necessary with the set point potentiometer.
8. Switch *ON* the Universal Power Supply. The torque should now be zero. Correct the speed with the set point potentiometer if necessary.
9. To finish the experiment first switch *OFF* the Universal Power Supply and then the Control Unit.

NOTE: For an accurate setting of speed and torque, the voltage values can be measured additionally with a multimeter at the jacks provided.

Report & discussion:

1. Explain the effect of interchanging two of three mains leads on the direction of rotation of the experimental machine.
2. Explain with the aid of equations the effect of reducing the applied mains voltage on the induction motor output torque.