# Motor basics

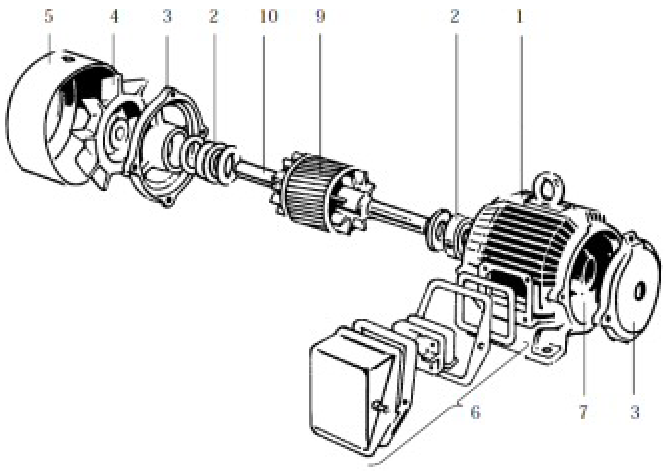



*Illustration of exploded motor*

Asynchronous motors are the most widely used and require practically no maintenance. In mechanical terms, they are virtually standard units, so suitable suppliers are always nearby.

There are several types of asynchronous motors, all of which work according to the same basic principle.

The two main components of this kind of motor are the stator (stationary element) and the rotor (rotating element).

## Stator

The stator is a fixed part of the stationary motor. It consists of a stator housing (1), ball-bearings (2) that support the rotor (9), bearing blocks (3) for positioning of the bearings and as a finish for the stator housing, fan (4) for motor cooling and valve casing (5) as protection against the rotating fan. A box for electrical connections (6) is located on the side of the stator housing.

An iron core (7) is in the stator housing made from thin (0.3 to 0.5 mm) iron sheets. These iron sheets have punched-out sections for the three-phase windings. The phase windings and the stator core generate the magnetic field. The number of pairs of poles (or poles) determines the speed at which the magnetic field rotates. If a motor is connected to its rated frequency, the speed of the magnetic field is called the synchronous speed of the motor (n0).

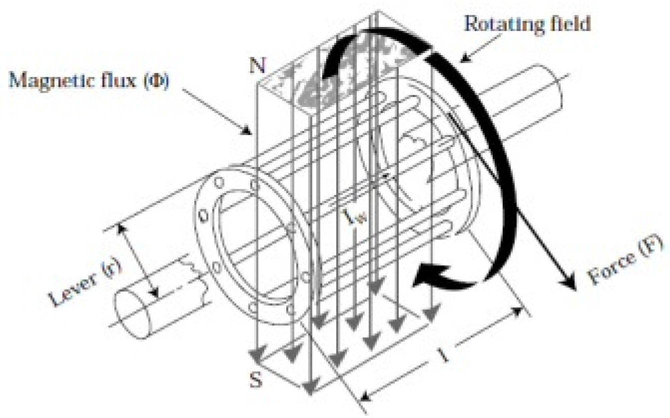
| Pole pairs (p) | 1 | 2 | 3 | 4 | 6 |
|---|---|---|---|---|---|
| Number of poles | 2 | 4 | 6 | 8 | 12 |
| $n_0$ [1/min] | 3000 | 1500 | 1000 | 750 | 500 |

## Rotor

The rotor (9) is mounted on the motor shaft (10). Like the stator, the rotor is made of thin iron sheets with gaps punched through them. There are two main types of rotor: slipring motors and short-circuit motors – the difference being determined by changing the windings in the gaps.

Slip ring rotors, like the stator, have wound coils placed in the gaps and there are coils for each phase coming to the slip rings. After a short-circuit of the slip rings, the rotor will function as a short-circuit rotor.

Short-circuit rotors have cast-in aluminium rods in the gaps. An aluminium ring is used at each end of the rotor to short-circuit the rods. The short-circuit rotor is the more frequently used of the two. Since the two rotors principally work in the same way, only the short-circuit rotor will be described.



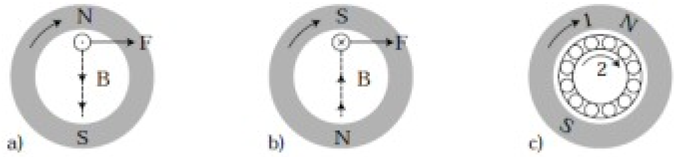

When a rotor bar is placed in the rotating field, a magnetic pole runs through the rod. The magnetic field of the pole induces a current (Iw) in the rotor bar which is only influenced by force (F).

This force is determined by the flux density (Φ), the induced current (Iw), the length (l) of the rotor and the angle (Θ) between the force and the flux density: **F = Φ x Iw x l x sin Θ**

If Θ is assumed to be = 90°, the force is: **F = Φ x Iw x 1**

The next pole that goes through the rotor bar has the opposite polarity. This induces a current in the opposite direction. Since the direction of the magnetic field has also changed, the force acts in the same direction as before.

When the full rotor is placed in the rotating field, the rotor bars are affected by forces that turn the rotor. The speed (2) of the rotor does not reach that of the rotating field (1), since at the same speed no currents are induced in the rotor bars.




*Rotor bar induction*

*Source: Danfoss - Facts Worth Knowing About 3 ph Inverters*