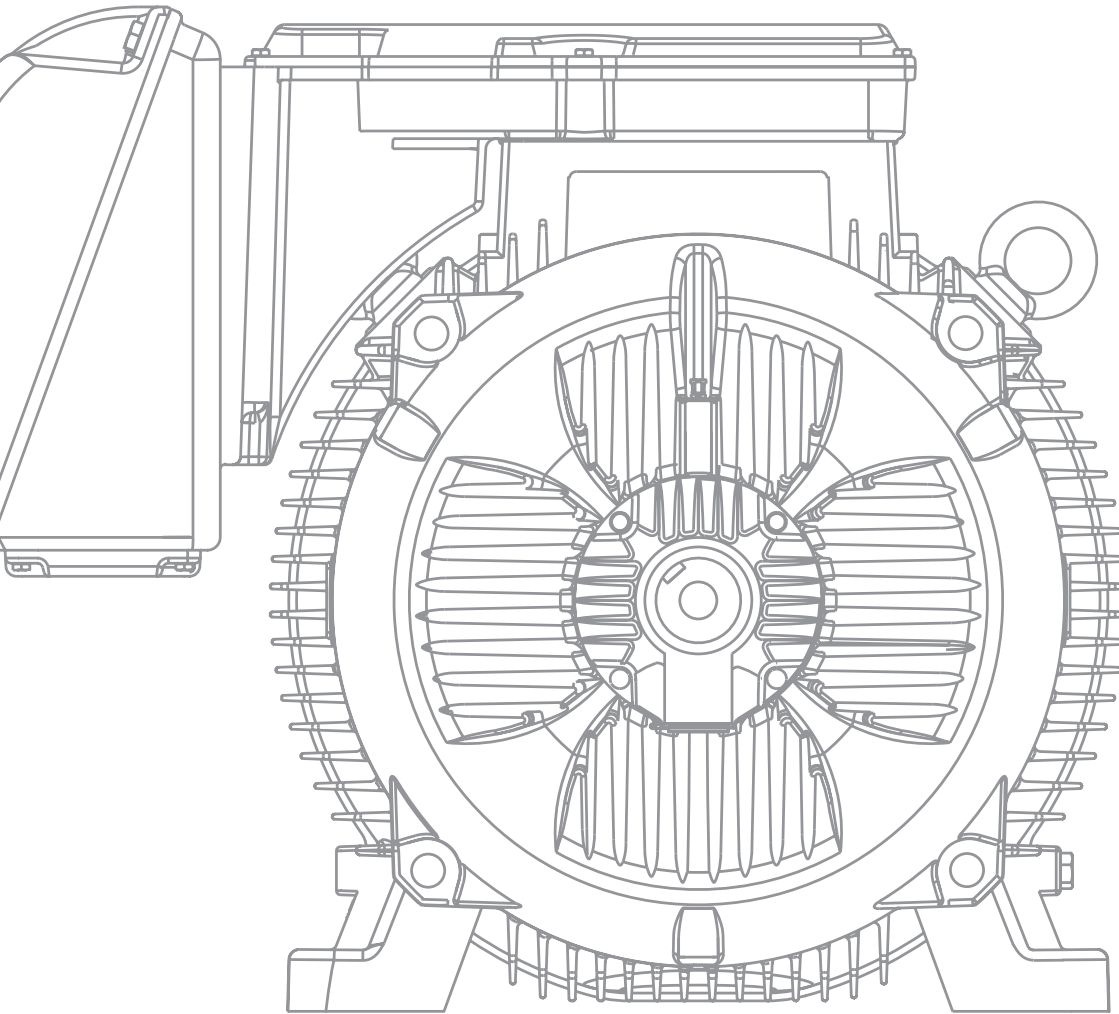
Driving efficiency and sustainability

Practical Training Guide

Electric Motor Module I

Technical and Commercial



Practical Guide to Training

Electric Motor Module I

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ELECTRIC MOTOR

The electric motor is the most widely used machine for converting electrical energy into mechanical energy, as it combines the advantages of using electrical energy (low cost, ease of transport, cleanliness, and simplicity of control) with its simple, robust, and low-cost construction, offering great versatility in adapting to a wide variety of load types.

Types:

DC Motor (Direct Current)	Direct current motors are more expensive because they require a direct current power source or a device that converts alternating current to direct current. This motor is used in special applications.
AC Motor (Alternating Current)	AC motors are the most widely used because electrical power is distributed as alternating current.

AC motors can be synchronous or asynchronous.

Synchronous	▶	Constant Speed (regardless of load variation)
Asynchronous	▶	Variable Speed (depending on load variation)

Among AC motors, we will study the **Induction Motor** whether three-phase or single-phase as it is the most widely used.

BASIC CONCEPTS

When discussing three-phase and single-phase asynchronous electric motors, it is very important to consider the most commonly used terms in order to select the electric motor best suited for the desired application.

POWER

This is the force the motor generates to drive the load at a given speed. This force is measured in HP (horsepower), cv (cavalo vapor), or kW (kilowatt).

Note:

- HP and cv are different units from kW.
- To convert power unit values, you can use the formulas below:

From	Multiply by	To get
HP and cv	0.736	kW
kW	1.341	HP and cv

Example: a 5 cv engine converted to kW:

5 cv × 0.736 = 3.68 kW

Note:
The power specified on the motor nameplate indicates the mechanical power available at the shaft end.

To determine the electrical power consumed by the motor (kW·h), divide its mechanical power by its efficiency (η).

Example: 5 cv = 3.68 kW (mechanical power)
η = 84.5% (data from the nameplate or catalog)

$$P\ (kW{\cdot}h) = \frac{3.68}{0.845} = 4.35\ kW{\cdot}h$$

ROTATION

This is the number of revolutions of the motor shaft per unit of time. Speed is typically expressed in rpm (revolutions per minute). For a frequency of 60 Hz, we have:

Motor	Synchronous rotation
2 poles	3,600 rpm
4 poles	1,800 rpm
6 poles	1,200 rpm
8 poles	900 rpm

2-pole and 4-pole motors are the best-selling models on the market.

Slip: The term "slip" is used to describe the difference between the synchronous speed and the actual speed at the motor shaft tip. Factors such as load or even fluctuations in line voltage can affect the motor's speed.

VOLTAGE

Voltage types:

Single-phase:
This is the voltage measured between phase and neutral. A single-phase motor is typically designed to be connected to a 127 V or 220 V power supply. However, there are locations where the single-phase voltage may be 115 V, 230 V, or 254 V.
In these cases, a motor specifically designed for these voltages must be used.

Three-phase:
This is the voltage measured between phases. These are the most commonly used motors, since single-phase motors have power limitations and provide lower efficiency and torque, which increases their operating costs.
In Brazil, the most commonly used three-phase voltages are 220 V, 380 V, and 440 V.

FREQUENCY

This is the number of times a given event repeats within a given time interval.
The power grid frequency used in Brazil is 60 Hz. This means that the grid voltage repeats its cycle sixty times per second.
In countries such as Paraguay, Argentina, and across Europe, the power grid operates at a frequency of 50 Hz.
Frequency is an important factor because it directly influences the rotation of an electric motor.

DEGREE OF PROTECTION

It protects the motor against the ingress of foreign objects (dust, fibers, etc.), accidental contact, and water ingress.
Thus, for example, equipment to be installed in a location subject to water jets must have an enclosure capable of withstanding such jets, under certain pressure values and angles of incidence, without water ingress that could impair the motor's operation.
The degree of protection is defined by two letters (IP) followed by two numbers. The first number indicates protection against the ingress of foreign objects and accidental contact, while the second indicates protection against water ingress.

Open Motors

They must operate in clean, sheltered environments. ▶ **MOTOR IP21 | IP23**

Enclosed Motors

Can operate in unsheltered environments. ▶ **MOTOR IP55 | IP56 | IP65 | IP66**

1st Digit	
Digit	**Designation**
0	No protection
1	Protection against the ingress of foreign objects with dimensions greater than 50 mm
2	Protection against the ingress of foreign objects with dimensions greater than 12 mm
3	Protection against the ingress of foreign objects with dimensions greater than 2.5 mm
4	Protection against the ingress of foreign objects with dimensions greater than 1.0 mm
5	Protection against the accumulation of dust harmful to the motor
6	Fully protected against dust

2nd Digit	
Digit	**Indication**
0	No protection
1	Protection against vertically falling water drops
2	Protection against vertically falling water drops when the enclosure is tilted up to 15° from the vertical
3	Protection against spraying water up to 60° from the vertical
4	Protection against splashing water from all directions
5	Protection against water jets from all directions
6	Protection against powerful water jets
7	Temporary immersion
8	Permanent immersion

Note: The W (IP55W) indicates protection against weather conditions such as rain, sea air, dew, etc.

FRAME

The frame type allows for the identification of most of its mechanical dimensions. The frame size is defined by the motor's power and speed and is identified by the letter H, which measures the distance from the motor's mounting base to the center of the shaft, in mm.
The height H is exactly equal to the motor frame size. The W22 motor series features 3 different designs for each frame size range, as shown in the figures below.

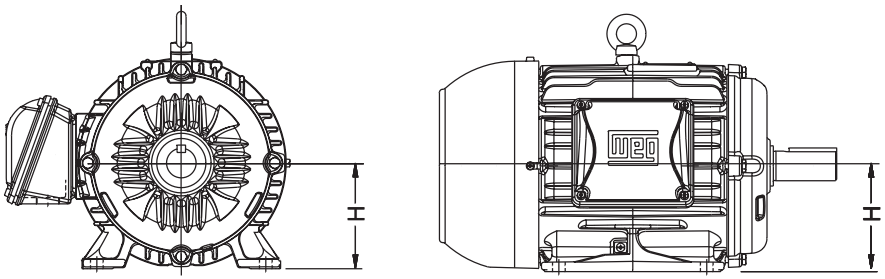


Figura 1.1: *Frames 63 to 112M*

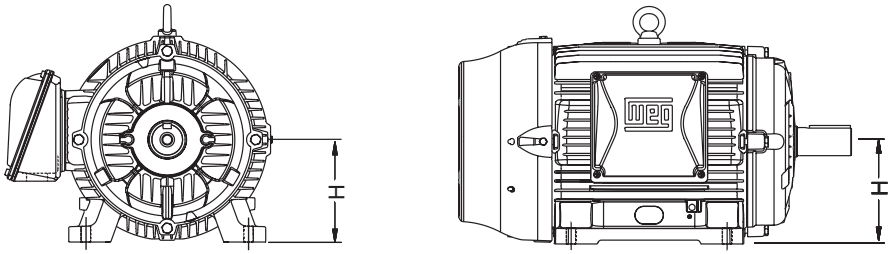


Figura 1.2: *Frame sizes 132S to 200L*

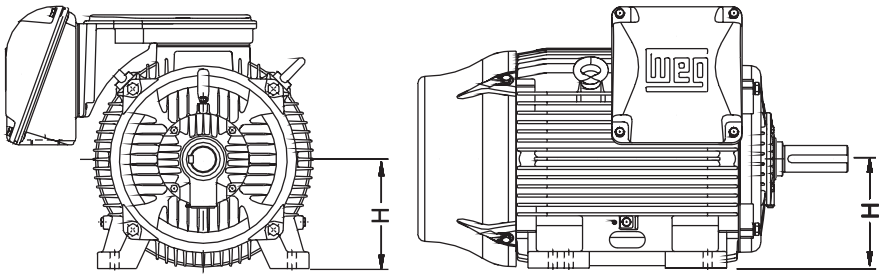
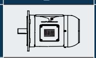
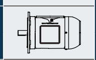
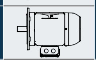
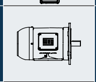
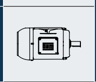
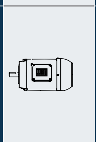
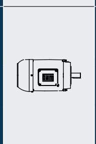
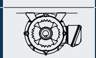
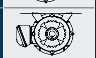
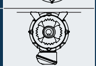
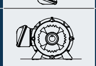
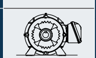
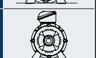
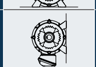
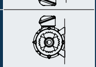
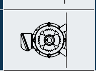
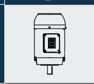
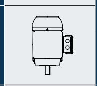
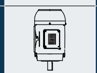
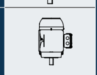
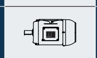
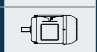
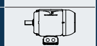
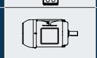
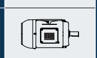
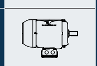
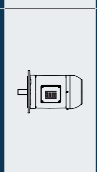
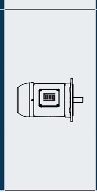
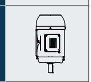
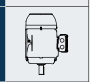
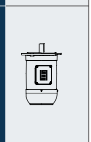
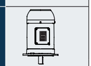
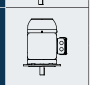
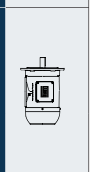
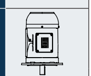
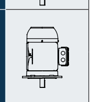


Figura 1.3: *Frame sizes 225S/M to 355*

MOUNTING CONFIGURATIONS

Mounting configurations define how the motor will be mounted and coupled to the load. Motors are generally supplied in the B3D configuration (horizontal mounting, motor with feet, right-hand shaft, as viewed from the terminal box). Other mounting configurations are listed in the table below.

Details			Construction Method	
Mounting	Axle end	Frame	Reference	Configuration
wall or FF flange	down	with legs	V15	
			V15E	
			V15T	
wall or flange FF	up	with legs	V35	
wall or v-flange			V37	
C flange	down	without legs	V18	
C flange	up	without legs	V19	
wall	forward	with legs	B6	
			B6E	
			B6T	
wall	forward	with feet	B7	
			B7E	
			B7T	
ceiling	forward	with feet	B8	
			B8E	
			B8T	
FC flange	on the right	without legs	B14D	
			B14T	
base or FC flange	left	with legs	B34E	
base or f FC flange	right	with legs	B34D	
			B34T	
wall	down	with legs	V5	
			V5E	
			V5T	
wall	up	with legs	V6	
			V6E	
			V6T	
FF flange	down	without feet	V1	
FF flange	up	without feet	V3	
base or rails	on the left	with legs	B3E	
base or rails	right	with legs	B3D	
			B3T	
FF flange	left	without legs	B5E	
FF flange	right	without legs	B5D	
			B5T	
base or FF flange	left	with legs	B35E	
base or FF flange	to the right	with feet	B35D	
			B35T	
FC flange	to the left	without feet	B14E	

INSULATION CLASSES

The insulation class specifies the thermal insulation rating. In other words, it specifies the maximum temperature that the motor windings can continuously withstand without affecting their service life. There are three insulation classes:

B	135°
F	150°
H	180°

WEG's commercial motors are standardly equipped with insulation class B, while industrial motors are supplied with insulation class F. Optionally, all motors can be manufactured with insulation class H, providing an even longer service life. These values are based on an ambient temperature of up to 40 °C.
Operating conditions above this value must be treated as special.

VENTILATION

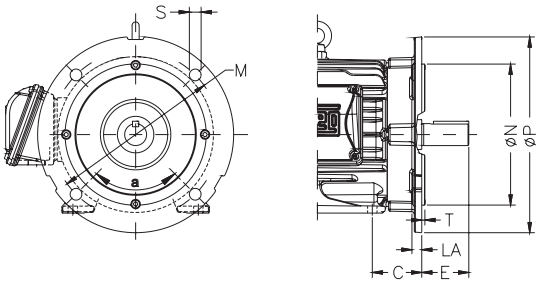
The ventilation system is responsible for cooling the motor.
IP55 motors (enclosed) are generally supplied with a TFVE ventilation system. Motors with an IP21 protection rating (open) have an internal ventilation system.

TFVE	▶	Fully enclosed with external ventilation.
OPEN	▶	Air circulates freely within the motor (internal ventilation).

FLANGES

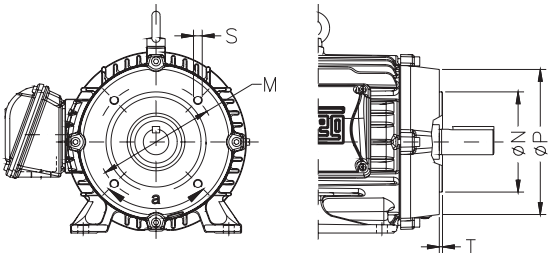
Flanges are used in situations where the motor is coupled directly to the machine.
The most commonly used flanges are types FF, FC, and FC-DIN.
The flange type defines the motor's construction type, as shown in item 7—Construction Types.

"FF" Type



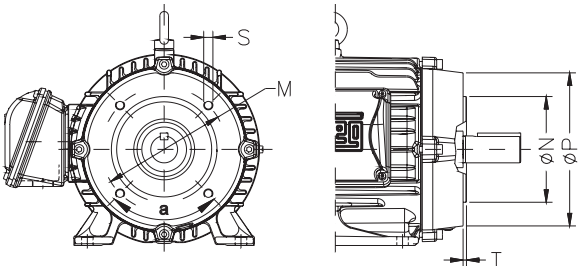
"FF" Flange									
Frame	**Flange**	**LA**	**M**	**N**	**P**	**S**	**T**	**α**	**No. of mounting holes**
63	FF-115	5.5	115	95	140	10	3	45°	4
71	FF-130	9	130	110	160		3.5		
80	FF-165		165	130	200	12			
90S / 90L		10							
100L	FF-215	12.5	215	180	250	15	4		
112M									
132S	FF-265	12	265	230	300				
132M									
132M/L									
160M	FF-300	18	300	250	350	19	5		
160L									
180M									
180L									
200L	FF-350		350	300	400				
200M									
225S/M	FF-400		400	350	450			22°30'	8
250S/M	FF-500	20	500	450	550				
280S/M		18							
315S/M	FF-600	22	600	550	660	24	6		
355M/L	FF-740		740	680	800				
355A/B									

Type “C”



“C” Flange								
Frame	Flange	M	N	P	S	T	α	No. of mounting holes
63 / 71 / 80	FC-95	95.2	76.2	143	UNC 1/4”x20	4	45°	4
90S / 90L / 100L	FC-149	149.2	114.3	165	UNC 3/8”x16			
112M / 132S / 132M / 132M/L / 160M / 160L	FC-184	184.2	215.9	225	UNC 1/2”x13	6.3		
180M / 180L / 200L / 200M	FC-228	228.6	266.7	280				
225S/M	FC-279	279.4	317.5	395	UNC 5/8”x11		22°30’	8
250S/M	FC-355	355.6	406.4	455				
280S/M								
315S/M	FC-368	368.3	419.1					
355M/L								
355A/B								

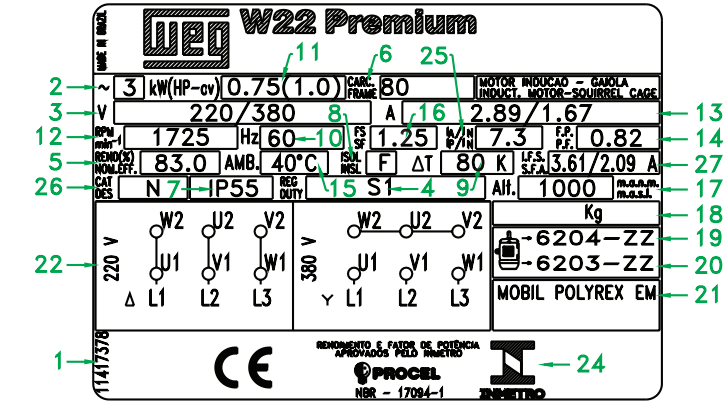
DIN Type “C”

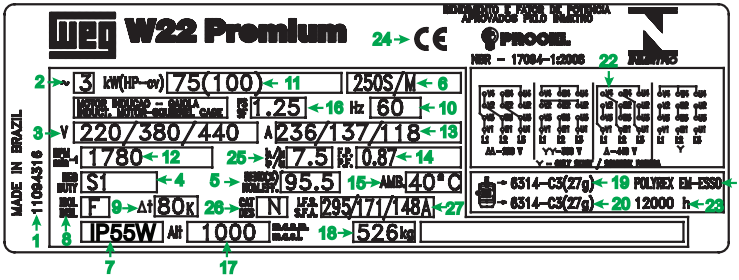


C-DIN Flange								
Frame	Flange	M	N	P	S	T	α	No. of mounting holes
63	C-90	75	60	90	M5	2.5	45°	4
71	C-105	85	70	105	M6			
80	C-120	100	80	120		3		
90S / 90L	C-140	115	95	140	M8			
100L / 112M	C-160	130	110	160		3.5		
132S / 132M/L / 132M	C-200	165	130	200	M10			

NAMEPLATE

Example of a nameplate: three-phase motor.





1. Motor code
2. Number of phases
3. Rated operating voltage
4. Duty cycle
5. Efficiency
6. Frame model
7. Degree of protection
8. Insulation class
9. Insulation class temperature
10. Frequency
11. Power
12. Rated speed per minute
13. Rated operating current
14. Power factor
15. Ambient temperature
16. Service factor
17. Altitude
18. Mass
19. Front bearing specification and amount of grease
20. Rear bearing specification and grease quantity
21. Type of grease used in the bearings
22. Wiring diagram for rated voltage
23. Motor relubrication interval (in hours)
24. Certifications
25. Starting current to rated current ratio
26. Conjugate category
27. Current at the service factor

PRODUCT LINES

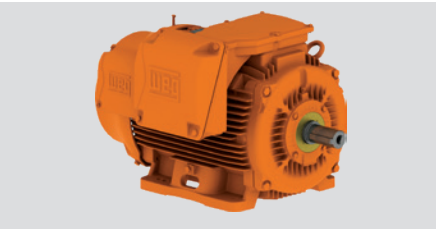
INDUSTRIAL MOTORS

W22

W80 AXgen

W23 Sync+

W23 Sync+Ultra



W22 Mining

W22 WELL

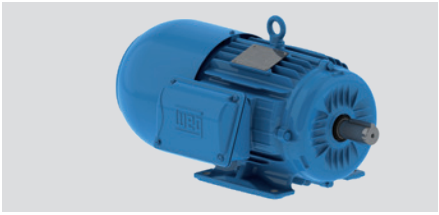
W22 Wash

Vertical High Thrust

PRODUCT LINES

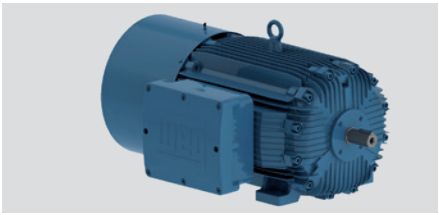
INDUSTRIAL MOTORS

Roller Table

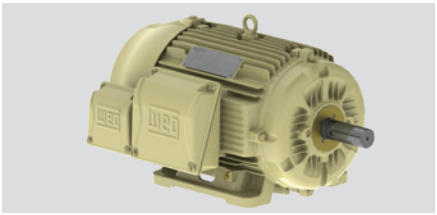


W22 Motor Brake

W22Xdb - Explosion-Proof Motor

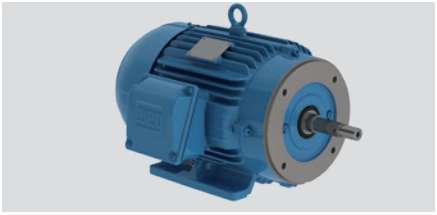


Explosion-Proof Motor Brake



W22Xtb

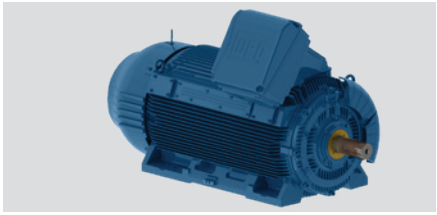
W22 Motor for Type 1 Gearbox



W22 for Monoblock Pump

Smoke

W50



W51HD

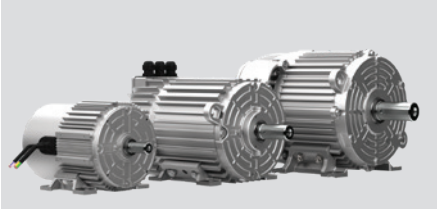
PRODUCT LINES

COMMERCIAL MOTORS

Rural

Chainsaw

W01

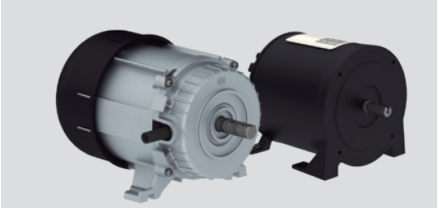


W30 Smart EC

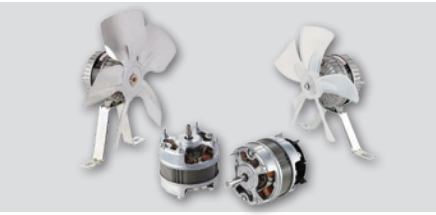
Jet Pump Motor (single-phase)

Jet Pump Motor (three-phase)

Motors for Air Conditioners



Motors for electronic gates



Motors for air movement

Motors for washing machines

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