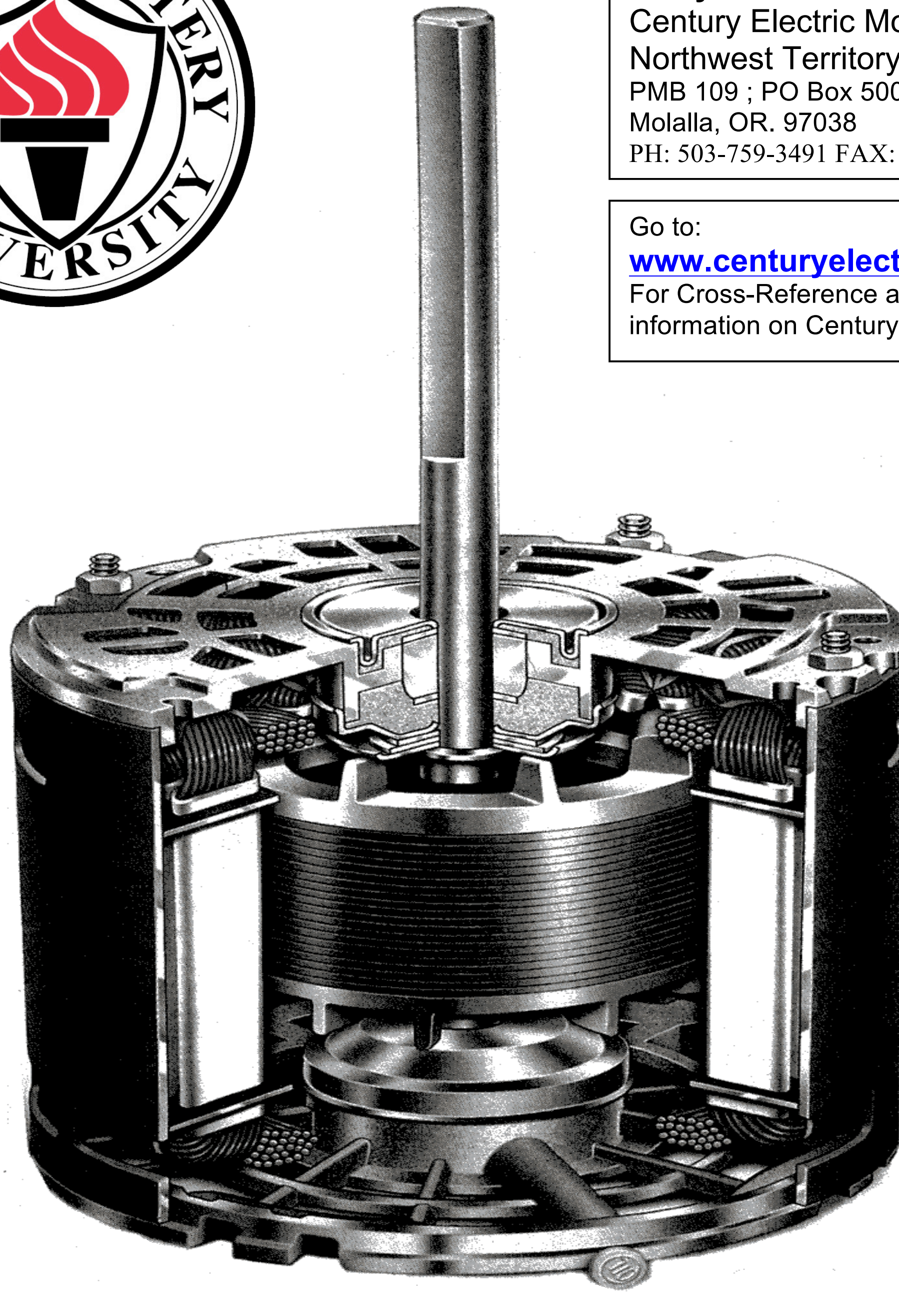
Replacement Motor Program

How to select a replacement motor



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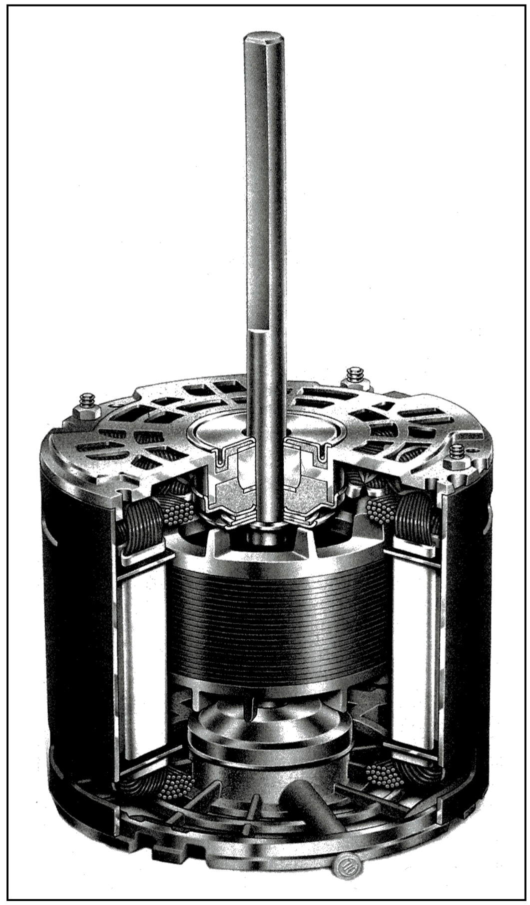
Selecting a replacement motor is not a science, there a rules, and rules of thumb, that when followed will provide you with a suitable replacement motor. It should be mentioned that the best method for selecting a replacement motor is to follow the Original Equipment Manufacturer's (OEM) recommendation and for that purpose Century has a cross reference available for some of the most popular motors used in the industry. However there are times this information is not available, or the part number is not known. Then a different approach must be taken.

It usually takes only a few minutes to select a replacement motor. Several things you should know about the original motor are:

1. Enclosure
2. Frame Size
3. Type (ex. Shaded Pole, PSC, Three Phase)
4. Volts
5. Horsepower
6. RPM
7. Capacitor
8. Number of Speeds
9. Shaft Size
10. Rotation
11. Mounting



The original motor often has this information printed on the label. On occasion, you will get a motor that has no information available. It is very important to get the customer to bring you this motor to inspect. This will enable you to identify the motor and select a suitable replacement.

Step 1. Enclosure

There are several different enclosure types for different applications. The enclosure is designed specifically to help a motor dissipate heat in any given environment. Thus, enclosures should be matched to a specific application or environment based on the **DISSIPATION OF HEAT** and the following considerations:

1. Airflow (Does air flow over the motor or not?)
2. Contaminants (Dust, dirt, rain/water etc.)
3. Combustibles (Paint fumes, Gas etc.)

The types of Enclosures are as follows:

1. **Open:** motor that has holes in the shell and end brackets to permit air to pass over and around the motor. This type of motor is typically installed in an environment with low airflow and is relatively clean. Example: Furnace Blower Motor.

2. **ODP (Open Drip-Proof):** motor that has holes in the shell and or end bells that when operated is not interfered with when drops of liquid or solid particles strike or enter the enclosure at any angle from 0 – 15 degrees downward from vertical. Example: Compressor Motors (various other belt drive applications)
3. **TEAO (Totally Enclosed Air Over):** motor that has no holes in the shell and is to be located directly in the airflow of the application of use. Typically a wet or dusty dirty environment. This motor relies on this airflow to dissipate heat. Example: Condenser Fan Motor
4. **TEFC (Totally Enclosed Fan Cooled):** a motor that has no holes in the shell and has a fan or fan blade located on the opposite drive end of the motor. This motor will have a mushroom or hood over the fan keeping contaminates from getting into the motor. This motor creates its own airflow to dissipate heat. Usually these motors will have fins or ribs that run the length of the shell, also known as heat sinks, to create additional surface area to dissipate heat.
5. **TENV (Totally Enclosed Non-Ventilated):** a motor that has no holes in the shell and relies on surface area to dissipate heat. This motor is typically located in an area where no airflow over the motor takes place and it must rely on external surface area. Typically, a motor that is TENV is longer than a comparable HP motor with other enclosures.
6. **Explosion Proof:** a motor that is constructed to withstand an explosion of a specified gas or vapor which may occur within it and to prevent the ignition of the specified gas or vapor surrounding the motor by sparks, flashes or explosions of the specified gas or vapor. **When dealing with this type of motor be advised of serious liability issues surrounding a replacement. It is advised that only certified indivuals work on or recommend these type of motors as replacements.**

Step 2. **Determine Frame Size or Shell Diameter**

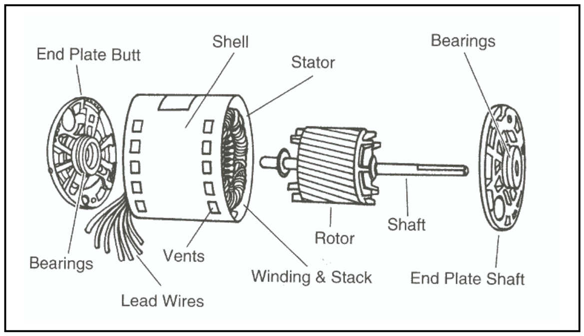
There are several frame sizes used in the Air Conditioning Industry, but NEMA 48 Frame (5-1/2”) is the most popular. Motor Frame sizes are all arbitrary values, and unfortunately, each manufacturer uses a different numbering system. Only the shell diameter and NEMA (National Electrical Manufacturer’s Association) values are common. Table 1 below, shows several common frame sizes and what some manufacturer’s refer to them as. The frame size code is generally part of the motor model number.

Table 1

Diameter Inches	NEMA*	GE	Emerson	Century	Universal
3.3”	29	_	33	33	A/3
5”	42	29	48	42	D
5-1/2”	48	39	55	48	H
6-1/2”	56	40-49	63	56	_

Each group of motors is designed with characteristics to do a specific job for its application. Shaded Pole, Permanent Split Capacitor (PSC) and Split Phase are normally air moving motors for HVAC/R and ventilating fan applications. Capacitor Start and Three Phase are larger motors used for some air movement, compressors, pumps, extreme duty and belt applications.

Step 4. **Determine Voltage**



Common voltages are 115, 208-230, 277 and 460. In the event this information is not listed on the original motor it may be necessary to get the voltage of the equipment the motor came out of, or the supply voltage to the building or facility.

Step 5. **Determine Horsepower**

Determining the Horsepower is key to proper motor selection. Several methods can be used to determine the horsepower. The best method is to read the original motor label. However if the label is gone or the horsepower rating in not legible the following procedure can be used. Table 2 shows the relationship between horsepower, stack size and amperage for 6 pole (1075 RPM) 208-230V Condenser Fan motors. Table 3 (Next Page) shows the same relationship for 6 pole (1075 RPM) Blower Motors.

Table 2 **Condenser Fan Motors**

Horsepower	Speed	Full Load Amps	Stack Range (Inches*)	Avg.
1/6	1	0.90	1.000 – 1.125	1.000
1/6	2	1.00	1.125 – 1.500	1.125
1/4	1	1.80	1.250 – 1.375	1.250
1/4	2	1.60	1.375 – 1.500	1.500
1/3	1	2.40	1.625 – 1.750	1.625
1/3	2	2.30	1.875 – 2.000	1.875
1/2	1	3.60	1.750 – 2.125	2.000
1/2	2	3.50	2.250 – 2.750	2.500
3/4	1	5.10	2.500 – 3.000	2.500
3/4	2	4.70	2.500 – 3.000	2.500

Table 3 Blower Motors

Horsepower	Speed	Volts	Full Load Amps	Stack Range (Inches*)	Avg.
1/4	1	115	4.2	1.125 – 1.250	1.125
1/4	1	208-230	2.0	1.125 – 1.250	1.125
1/4	2	115	4.2	1.125 – 1.250	1.125
1/4	2	208-230	2.0	1.125 – 1.250	1.125
1/4	3	115	4.1	1.250 – 1.375	1.250
1/4	3	208-230	2.0	1.250 – 1.375	1.250
1/3	1	115	6.2	1.500 – 1.750	1.625
1/3	1	208-230	3.1	1.500 – 1.750	1.625
1/3	2	115	6.2	1.500 – 1.750	1.625
1/3	2	208-230	3.1	1.500 – 1.750	1.625
1/3	3	115	6.2	1.625 – 1.825	1.625
1/3	3	208-230	3.0	1.625 – 1.825	1.625
1/2	1	115	9.0	2.250 – 2.500	2.250
1/2	1	208-230	4.3	2.250 – 2.500	2.250
1/2	2	115	9.0	2.250 – 2.500	2.250
1/2	2	208-230	4.3	2.250 – 2.500	2.250
1/2	3	115	9.0	2.250 – 2.500	2.500
1/2	3	208-230	4.3	2.250 – 2.500	2.500
3/4	1	115	10.3	2.250 – 2.750	2.500
3/4	1	208-230	5.0	2.250 – 2.750	2.500
3/4	2	115	10.3	2.250 – 2.750	2.750
3/4	2	208-230	5.0	2.250 – 2.750	2.750
3/4	3	115	10.3	2.250 – 2.750	2.750
3/4	3	208-230	5.0	2.250 – 2.750	2.750

***NOTE: FOR 8 POLE (850-825 RPM) MOTORS ADD (+) 0.500" TO STACK HEIGHT IN TABLES 2 AND 3.**

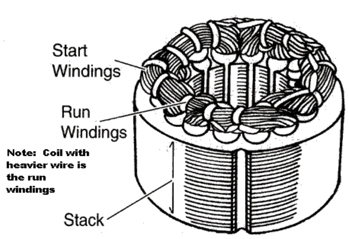


Fig. 1
PSC - 6 Pole (1,075 RPM) Motor Stator

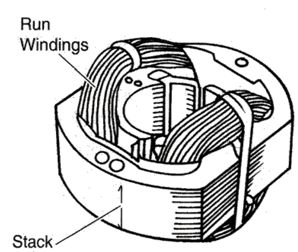


Fig. 2
Shaded Pole - 2 Pole (3,500 RPM)

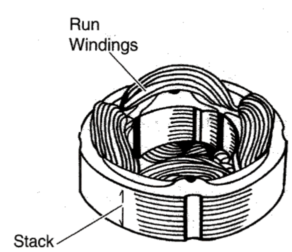


Fig. 3
Shaded Pole - 4 Pole (1,750 RPM)

The Stack height is the thickness of the metal portion of the Stator, not including the copper windings. (See Fig. 1, 2, & 3)

Usually you want to measure stack height with the motor disassembled, but for motors that are "open" it is not necessary to take the motor apart. A rod or ruler can be used to check the thickness by inserting it into the shell and marking the depth of both sides. The difference is the stack size. (See Fig. 4 & 5)

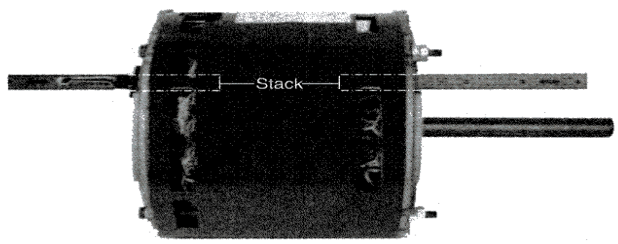


Fig. 4

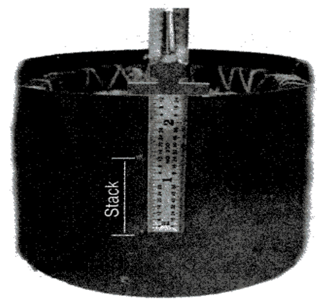


Fig. 5

Step 6 **Determining Speed (RPM)**

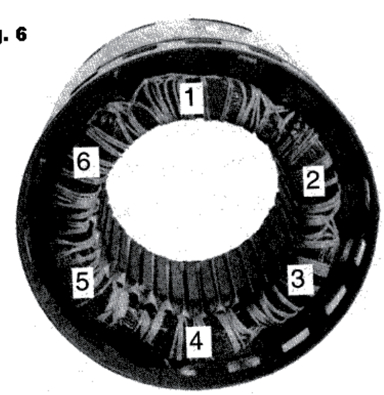
The most common speed of motors is 1200 RPM (6 pole) with a normal operating range between 1025 – 1075 RPM, for high speed. The number of poles or run windings in a motor determines it's design, "Synchronous Speed". A pole is equal to one run winding coil. Some units have 8 pole motors which have a maximum speed of 900 RPM and generally operate at about 825 – 850 RPM with normal fan or blower load. Figures 1, 2 & 3 (shown earlier) give some examples of different pole motors. Table 4 below, shows the design speed and general operating speed of most motors used today.

Table 4

# of Poles	Synchronous Speed (RPM)	Normal Operating Speed (RPM)
8 Pole	900	825 – 850
6 Pole	1200	1025 – 1075
4 Pole	1800	1725
2 Pole	3600	3450

Fig. 6 shows what to look for and how to determine the number of poles.

Fig. 6



Again the number of poles determines the "Synchronous" speed of the motor. Synchronous speed is determined by a formula:

Speed (RPM) = 3,600 CPM (Cycles Per Minute) x 2 ÷ Poles

OR

Speed (RPM) = 7,200 ÷ Poles

Example a 2 Pole motor would be:

7,200 ÷ 2 = 3600 Synchronous RPM

The 2 pole motor example would operate at 3600 Synchronous RPM but under full load it would operate around 3450 RPM. The loss or difference in speed is called the "Motor Slip"

Step 7 **Determine the Capacitor**

The most popular type of motor today is a Permanent Split Capacitor (PSC). The capacitor is an integral part of this motor. Without a capacitor, the motor will not run. When replacing a PSC motor it is recommended that the capacitor size of the replacement motor be used. Using a capacitor other than specified will affect the motor performance, decrease efficiency, increase amp draw and result in reduced motor life.

Capacitor voltages: If a motor requires a 5Mfd 370V capacitor you can use a 5Mfd 440V capacitor in a pinch. You can always use a higher voltage rated capacitor, but **never a lower voltage** rated capacitor.

The other type of motor used in the industry is a Shaded Pole motor. The shaded pole motor does not have start windings and does not require a capacitor. These motors have lower efficiency ratings than PSC type motors. You can replace a shaded pole motor with a PSC motor in most cases. PSC motors should not be replaced with a shaded pole motor.

Step 8 **Determine the Number of Motor Speeds**

Determine the number of speed settings or "Taps" of the original motor. The original motor label will usually indicate the number of speeds.

In the event you can not find the number of speeds on the motor label the following method can be used to determine the number of speeds the motor has:

1. If there are 2 brown capacitor wires (PSC MOTOR) the number of speeds is generally 3 less than the total number of wires. Example: A motor has 6 wires and 2 are brown

capacitor wires, the number of speeds is 6 – 3 or 3 speeds. If the motor has only one brown wire, the number of speeds is equal to the total number of wires less 2.

2. If the motor is a shaded pole motor (does not use a capacitor), the number of speeds is equal to the total number of wires less 1. Example: A motor has 4 wires and none of them are brown, the number of speed is 4 – 1, or 3 speeds.

Step 9 **Determine Shaft Size and Length**

The shaft width and length are easy to determine, since the shaft can be easily measured. The most popular Original Motor shaft width is .500 inch (1/2”) and the length varies from 2 to 5 inches. Most replacement motors, up to 1 HP, use a .500 (1/2”) shaft and they are generally 4 to 6 inches long, which is more than adequate. If necessary, the excess can be cut off easily by putting the motor on a bench and wiring it up. Turning the motor on and placing a hacksaw on the shaft (let the motor do the work for you). Be careful not to get the metal shavings in the motor.

Step 10 **Determine Motor Shaft Rotation**

All general purpose replacement motors, are Electrically Reversible making the rotation of the motor of little consequence.

Step 11 **Determine Type of Motor Mount**

Replacement motors can be mounted in a number of ways, Belly Band, Thru Bolts, Shell Holes and occasionally by Resilient Rings.

After you have installed the replacement Motor it is always recommended that you check the motor with an amp meter. An overloaded motor always runs hot, slow and draws more than nameplate amps. Reading the current draw with an amp meter is the most accurate method of identifying an incorrect replacement. Amp meter readings on the installed motor should be **<u>no more than 10% above or 20% below nameplate rated amps</u>**.

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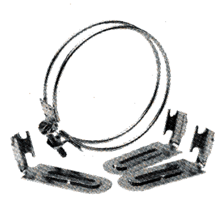

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Notes: