



Overview To The Construction Of Single Phase Motors

MCW Hints & Tips 0011

Resistance Start

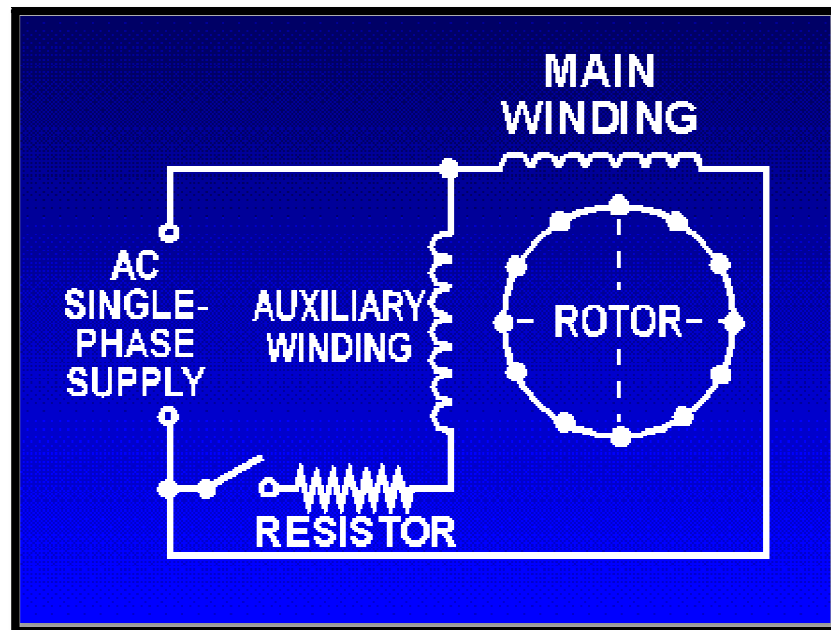
This motor has a starting winding in addition to the main winding (Auxiliary winding). The starting winding is positioned at right angles to the main winding. The electrical phase shift between the currents in the two windings is obtained by making the impedance of the windings unequal.

The main winding has a high inductance and a low resistance. The current, therefore, lags the voltage by a large angle. The starting winding (Auxiliary winding) is designed to have a fairly low inductance and a high resistance. Here the current lags the voltage by a smaller angle.

For example, suppose the current in the main winding lags the voltage by 70° . The current in the auxiliary winding lags the voltage by 40° . The currents are, therefore, out of phase by 30° . The magnetic fields are out of phase by the same amount.

Although the ideal angular phase difference is 90° for maximum starting torque, the 30° -degree phase difference still generates a rotating field. This supplies enough torque to start the motor. When the motor comes up to speed, a central fugal switch disconnects the starting winding and resistance from the line, and the motor continues to run as an induction motor. The starting torque is not as great as it is in the capacitor-start.





Split-phase

The split-phase motor, also called an induction-start/induction-run motor, is perhaps the simplest kind of single-phase motor you'll find in the plant.

It has two windings: a start and a main winding. The start winding is made with smaller gauge wire than the main winding and has much higher resistance. This results in different currents and magnetic fields in the two windings. These two magnetic fields, displaced from each other, form a rotating field that causes the rotor to turn.

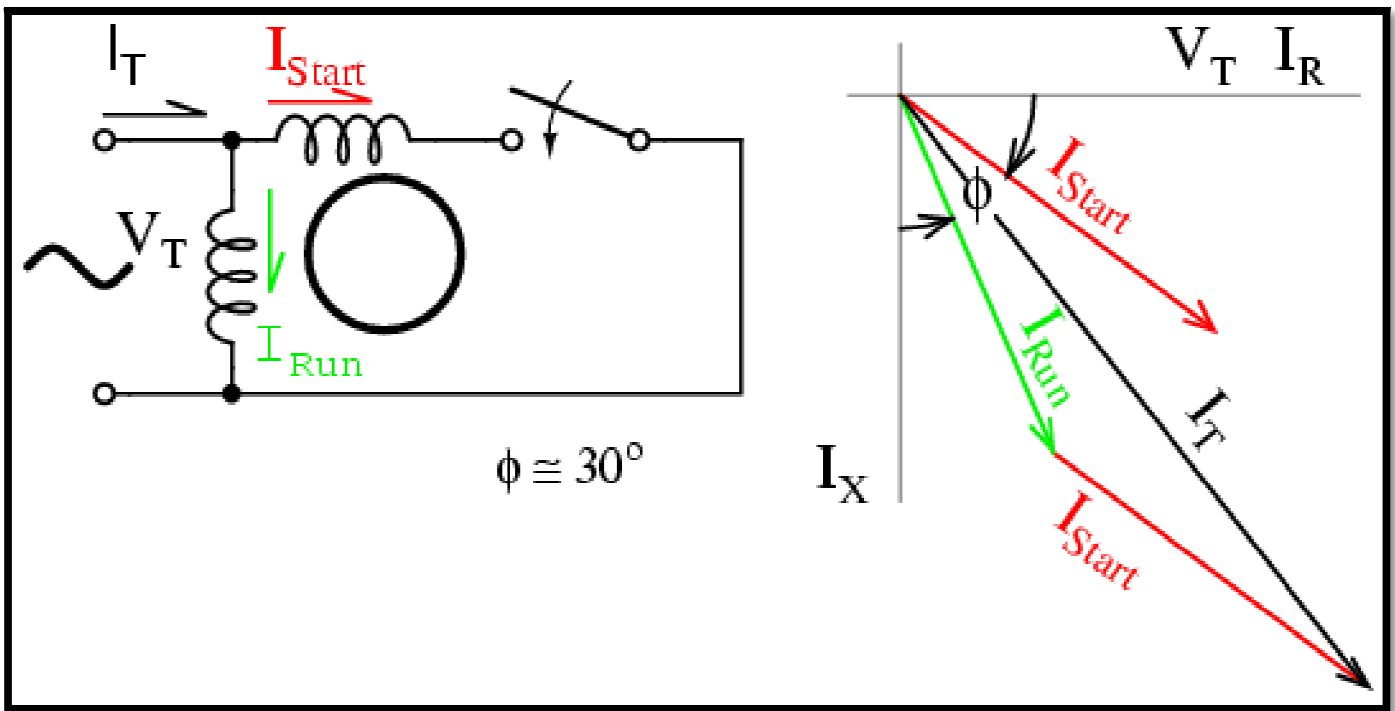
Split-phase motors use a switching mechanism that disconnects the start winding when the motor comes up to approximately 75 percent of rated speed. Thereafter, the main winding operates independently. A centrifugal switch on the motor shaft is most common.

The split-phase motor's simple design is typically less expensive than other single-phase motor types made for industrial use. However, the simplicity limits performance. Starting torque is low; 100 to 175 percent of rated load. In addition, the split-phase motor develops high starting current relative to motor horsepower, also called locked rotor current. In addition, because of the small wire used in the start winding, prolonged starting times can cause the motor to overheat and the start winding to fail. Therefore, don't use this motor if high starting torque is required.



Other split-phase motor limitations include relatively low breakdown torque (200 to 300 percent of rated load), and unreliable thermal protection due to the high locked rotor current relative to running current. Also, these motors usually are designed for single voltage, limiting application flexibility.

Good applications for split-phase motors include small grinders, small fans and blowers, and other low starting torque applications with horsepower requirements ranging from 1/20 to 1/3 hp. Avoid any applications requiring high cycle rates or high torque.



Permanent split capacitor

Permanent split capacitor (PSC) motors do not have a starting switch or a capacitor strictly for starting. Instead, permanent split capacitor motors have a run-type capacitor that is permanently connected in series with the start winding. This makes the start winding an auxiliary winding after the motor reaches running speed.

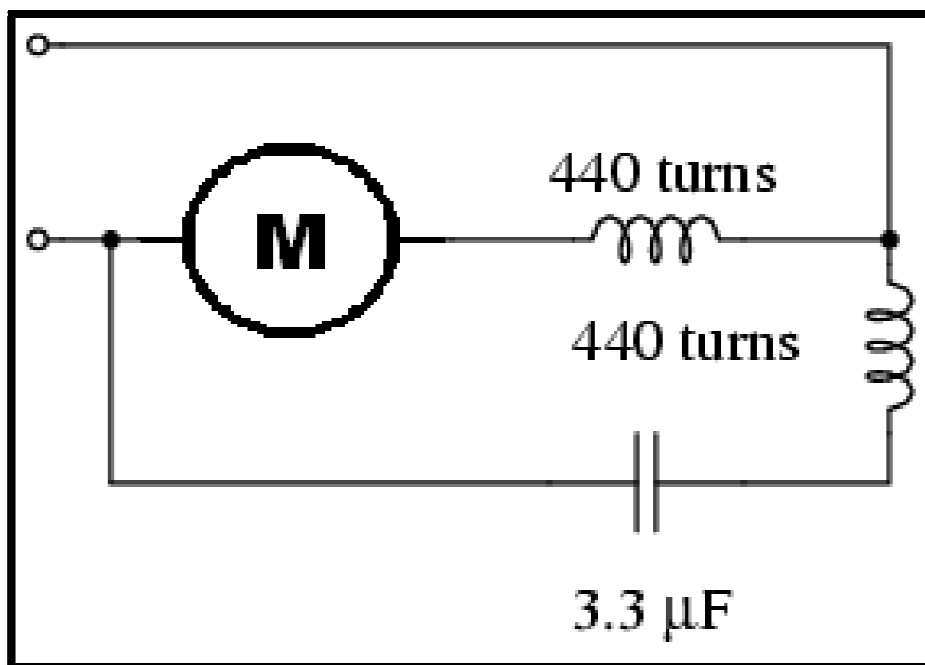
Because the run capacitor must be designed for continuous use, it cannot provide the short-term "boost" of a starting capacitor. Therefore, starting torque of a PSC motors is low, ranging from 30 to 150 percent of rated load, which makes the motors unsuitable for hard-to-start loads. However, unlike split-phase motors, PSC motors have low starting currents, usually less than 200 percent of rated full-load current, making them excellent for applications with high cycle rates.



Permanent split capacitor motors have several advantages: since they do not require a starting mechanism, they can be designed for easy reversing.

They can also be designed for optimum efficiency and high power factors at rated load. They are considered to be the most reliable single-phase motors, primarily because a starting switch is not required.

Permanent split capacitor motors have a wide variety of applications depending on the design. Examples include direct drive fans, blowers with low starting torque requirements and intermittent cycling applications such as adjusting mechanisms, valve actuators, gate operators and garage door openers, many of which also require reversing.

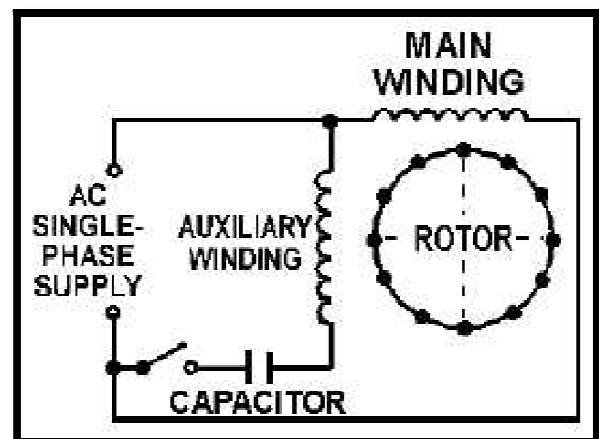
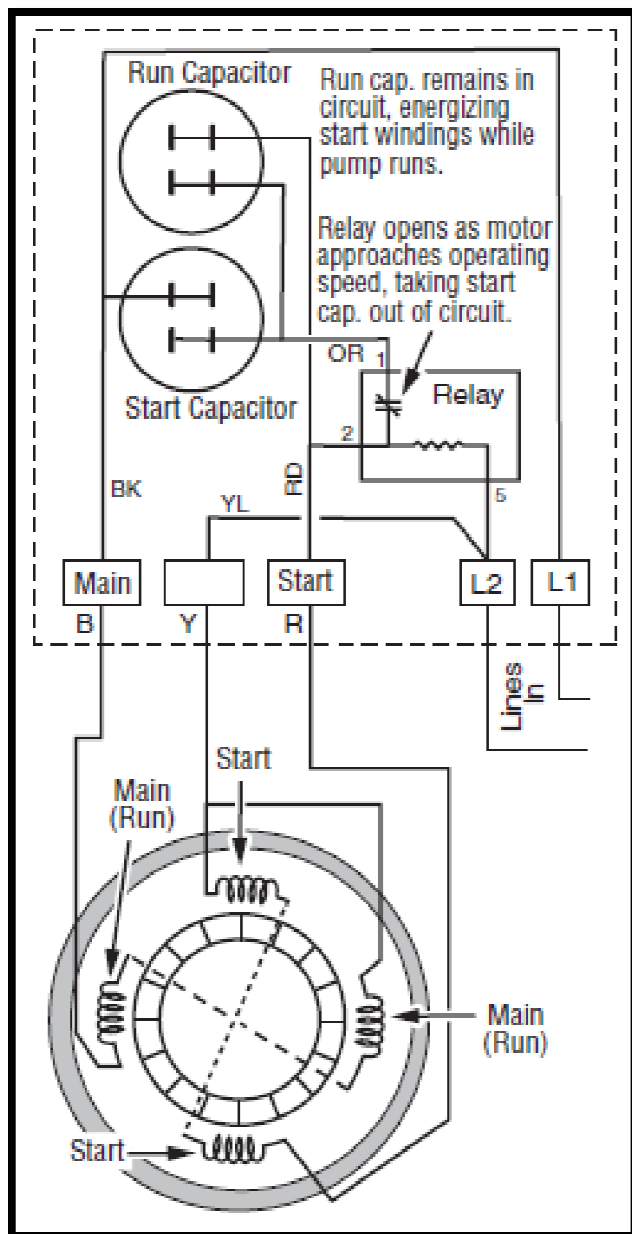


Capacitor start/capacitor run

This motor design combines the best of the capacitor-start/induction-run motor with the best of the permanent split capacitor motor. Like a capacitor-start motor, it has a start-type capacitor in series with the auxiliary winding, which produces high starting torque. Like a PSC motor, it also has a run-type capacitor in series with the auxiliary winding after the start-capacitor is switched out. Plus, because each capacitor is specific-purpose, performance is further optimized with high breakdown torque, lower full-load current and higher efficiency.



Capacitor-start/capacitor-run motors command a higher price, which is mostly the result of one or more additional capacitors (plus a starting switch). If the ultimate single-phase performance is required in demanding applications, this motor is the choice. Such applications include woodworking machinery, air compressors, high-pressure water pumps, vacuum pumps and other high-torque applications requiring up to 10 horsepower.

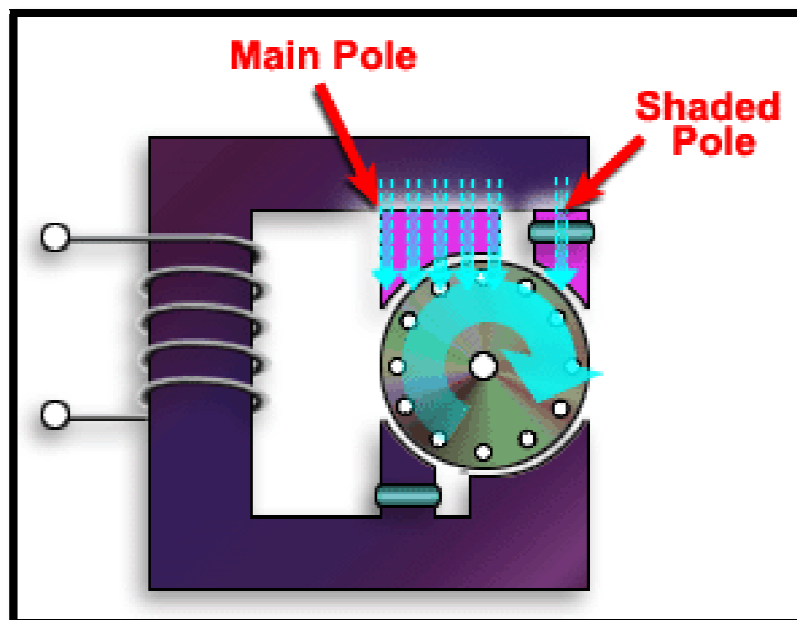


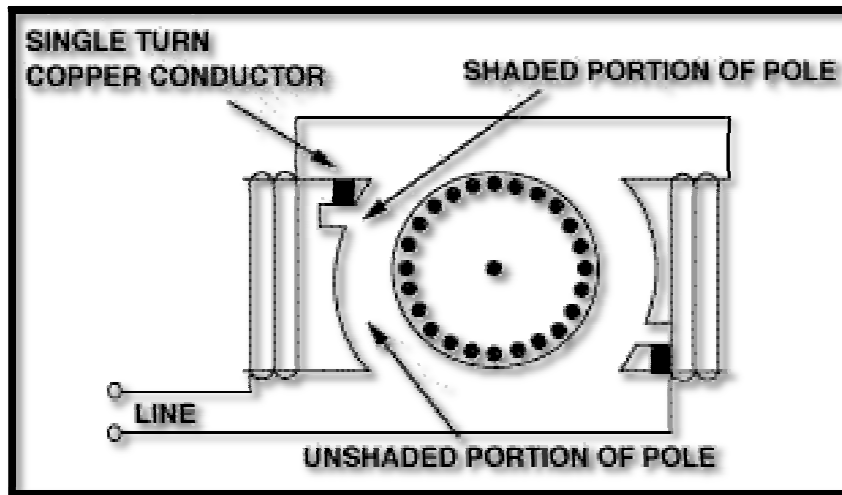
Shaded-pole

Though shaded-pole motors are more suited to household appliance use, they are appropriate for some air-moving applications in the plant.

Unlike the previous single-phase motors, shaded-pole motors have only one main winding and no start winding. Starting is accomplished through a design that uses a copper ring around a small portion of each motor pole. This "shades" that portion of the pole, causing the magnetic field in the ringed area to lag the field in the non-ringed portion. The reaction of the two fields initiates rotation.

Because it lacks a start winding, starting switch or capacitor, the shaded pole motor is electrically very simple and inexpensive. Plus, speed can be controlled merely by varying voltage (or through a multi-tap winding). These motors offer poor starting torque, typically 25 to 75 percent of rated load, and very low efficiency. But their low initial cost makes them good for small-horsepower or light-duty applications. The most common application is probably household ventilation fans.





Single Phase Motor's At A Glance

Below is a table designed to show the positive and negative points of the motors we have discussed above.

	<u>Advantages</u>	<u>Disadvantages</u>	<u>Applications</u>
Resistance Start	Higher starting torque than a shaded pole motor.	Starting torque isn't very large. Heat build up in the resistors means the motor must be allowed to cool between starts, this means starting frequency is limited and also time between starts is longer.	Household ventilation fans.
Split phase	Typically less expensive than other single-phase motor types. Good for low starting torque applications with horsepower requirements ranging from 1/20 to 1/3 hp.	Starting torque is low. Develops high starting current relative to motor horsepower. Prolonged starting times can cause the motor to overheat and the start winding to fail. Unreliable thermal protection. Usually are designed for single voltage, limiting application flexibility.	Small grinders, small fans and blowers and other low starting torque applications.



Permanent Split Capacitor	Low starting current. Can be designed for easy reversing. They can also be designed for optimum efficiency and high power factors at rated load. Considered to be the most reliable single-phase motors. No start switch.	Unsuitable for hard-to-start loads. Low starting torque.	Direct drive fans, small blowers, adjusting mechanisms, valve actuators, gate operators and garage door openers.
Capacitor Start/Capacitor Run	High efficiency. Low full load current.	Higher priced than other motors.	Wood working machinery, air compressors, high-pressure water pumps, vacuum pumps and other high torque applications.
Shaded Pole	Inexpensive. Good for small horsepower or light duty applications. No start switch.	Relatively simple electronically. Offer poor starting torque. Low efficiency.	Small horse power or light duty applications, most common is household ventilation fans.

