PO Box 21 • 2230 Landmark Place • Allenwood, NJ 08720 USA
732-223-6644 • Fax 732-223-1617
www.supco.com • info@supco.com

F290-0407

SEALED UNIT PARTS CO., INC.

SPPE

THE E CLASS ADVANTAGE

The E Class Advantage

Are Compressor Hard Start Devices Needed?

Compressor hard start devices are a luxury item for service technicians to use in rectifying a myriad of compressor start problems. It is true that the majority of hard start device applications result from the marginal voltages delivered by electric utilities during peak demand periods. As the predominant application is air conditioning, the hard start device can serve as an insurance policy for compressor starts when voltages drop to 90% of rated line conditions. The ability to ensure a compressor start under low voltage conditions can serve to minimize the number of “nuisance” service calls and allow a service contractor to focus on true problem events.

As the air conditioning industry has expanded and diversified, numerous types and models of air conditioning units and compressors have entered the marketplace. This diverse proliferation has resulted in the need to provide a one-size-fits-all compressor start device. Investigations recently undertaken by SUPCO indicate that a start device should be closely matched to the compressor, and a one size for all approach may actually cause damage to a compressor if applied incorrectly. All SUPCO technology employs the appropriate safeguards to ensure against compressor damage due to misapplied start devices. This situation does not exist for most other start device manufacturers.

General Function

It is pertinent to discuss the general application and function of a hard start device. A capacitor in conjunction with a switching device (typically a relay) is introduced across the start windings of a single-phase compressor. Figure 1. illustrates the typical wiring arrangement for a 2-wire and a 3-wire connection.

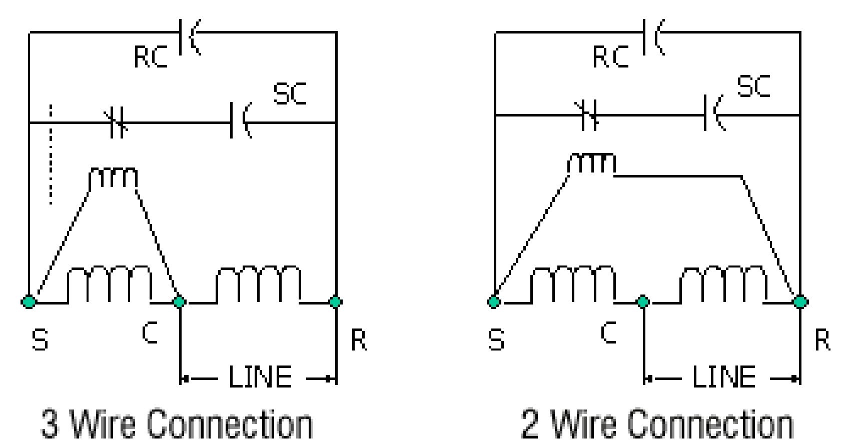


Figure 1. Wiring Configurations

When the compressor is called upon to start, the start capacitor provides a voltage boost to the start winding of the motor (effectively simulating the phasor lead/lag of a three-phase motor) and causes the motor rotor to turn. At some point, when the capacitor is released from the start winding, the motor continues to run.

In a 3 wire configuration, the potential relay opens at a manufacturer's specified voltage across the start winding of the motor, effectively removing the start capacitor from the circuit. A third wire is necessary to connect to the run winding. In a 2 wire configuration, the potential relay and start capacitor are connected across the run and start winding. The potential relay opens at a specified increment above line voltage, thus removing the start capacitor from the circuit. There is no need for a third wire.

The size of the capacitor significantly impacts the characteristics of the start winding. Figure 2. shows the generalized impedances for the compressor motor and start devices. As such, the start capacitor should be carefully matched to the specific compressor.

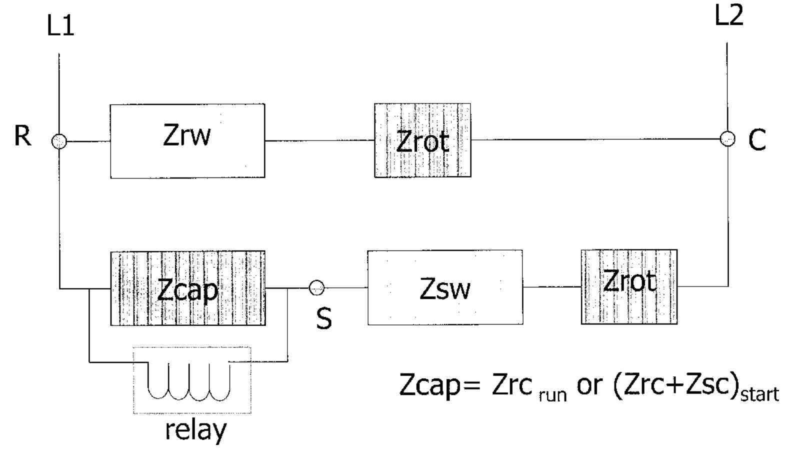


Figure 2.
2 Wire Potential Relay Equivalent Circuit

Hard Start Technology
Two main types of start devices exist in the marketplace today. SUPCO has developed a full range of products in both types to provide a customer with all applicable choices. Both types have their own desirable applications and each have specific advantages. The two types of start devices discussed below are

1. PTC – Positive Temperature Coefficient devices
2. Potential Relay devices – voltage sensing and current sensing

The E Class Advantage
Compressor start devices are available in a variety of forms. Specific applications call for specific products. SUPCO is one of very few manufacturers in the marketplace who provide a complete line of start devices to fit any application. PTC devices fulfill and will continue to fulfill specific needs in the industry. Potential relay devices can be found in a wide assortment. Care should be employed in selecting potential relay devices to ensure that all state-of-the-art developments are included in the product. The SUPCO E-Class Series comprise the most advanced developments in start device technology:

1. Voltage sensing technology that monitors for motor start (current sensing devices require internal fuse protection).
2. A 2-wire connection that simplifies installation
3. A secondary timing circuit that ensures that the capacitor is not permanently left in the start winding circuit
4. A fully electronic device – minimizing the limitations of mechanical devices and secondary fusing associated with triac devices
5. A start device matched with an appropriately sized capacitor to cover the range of compressors for the intended application (one size does not fit all)

The use of compressor start devices results from a need to ensure that a compressor (usually air conditioning) will start under voltage conditions that are less than ideal. As discussed, several options exist in the market to address compressor start concerns. Start devices exist in many forms for specific applications. SUPCO provides a full range of products in all relevant technologies to effectively match the proper start device to the application. Care should be taken to utilize a device that meets the requirements of the job. Extra caution should be observed when employing the "one-size-fits-all" and "a bigger capacitor is better" approach to applying a start device. Consult SUPCO, a manufacturer with a complete product range, to ensure the greatest success in the start device application.

A start device that fails to remove the start capacitor from the circuit has the potential to cause premature failure of the start windings in the compressor. Figure 6 shows the same compressor start using and oversized capacitor without a safety timing circuit. The run – start voltage is suppressed by the combined characteristics of the motor windings and the extra large capacitor. It never reaches the prescribed threshold voltage defined by the potential relay for removing the start capacitor from the circuit. The total supply current remains near the locked rotor value even after the motor has started (as highlighted in Figure 6).

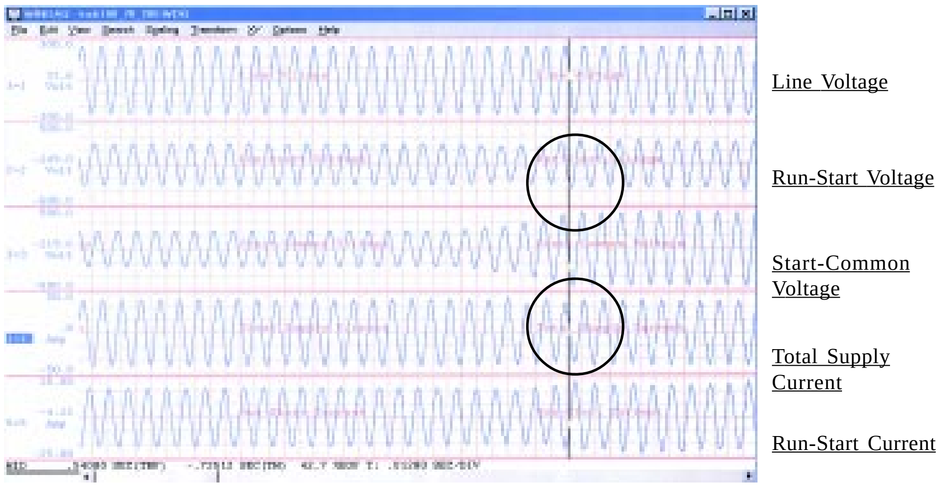


Figure 6. Start w/Oversized Capacitor Without Safety Timing Circuit

If the capacitor is never removed from the start windings, premature winding failure could occur. As such, care should be taken when selecting capacitor sizes for an application. Care should also be taken regarding products that tout a “bigger capacitor is better” approach to compressor starting. SUPCO E-Class devices provide a secondary timing safety device to ensure that the start capacitor is dropped from the circuit in a fail-safe mode. Figure 5. also shows that the start winding voltage drops appropriately after the start capacitor has been removed in a SUPCO E-Class device.

PTC Devices

The PTC device has been successfully employed in a number of applications for many years. SUPCO models SPP, SPP5, SPP6, SPP7S employ PTC technology to ensure that the start capacitor has dropped from the start circuit after an appropriate amount of time has elapsed. This device utilizes a ceramic element with a predictable thermal response to the introduction of electric current. As current is introduced across the start windings, the PTC element begins to warm. When the PTC device reaches approximately 250º F (corresponding to 0.6-0.8 seconds), the resistance in the element increases and creates an open switch that releases the start winding from the circuit. The 0.6-0.8 seconds that the PTC device allows the start windings to be engaged is generally enough time to enable the compressor to start. The advantage of this device is its simplicity. A two-wire connection between the run and start terminals on the compressor is all that is required to provide reliable starts in most cases.

However, this device has several limitations that should be considered if the application is critical.

- The PTC device has no ability to sense whether the compressor has actually started.
- The amount of time provided for a start boost is dictated solely by the temperature of the ceramic device, which has warmed due to the introduction of the starting current.
- If the compressor does not start before the temperature threshold has been reached, it will not start until the PTC device cycles through a cool-down period (usually 2 - 3 minutes). Many view this start approach as an appropriate safety measure. The PTC effectively limits the continued unsuccessful cycling of the start windings that can often result in a motor burnout. Others will argue that a start device should be able to re-cycle immediately. If this feature is desired, a PTC is not the correct start device application.

Potential Relay Devices

The Potential Relay start device has recently been the subject of considerable attention in the market place. Several manufacturers are promoting products with a variety of technologies. The primary distinction between the potential relay devices relates to a voltage sensing or current sensing capability.

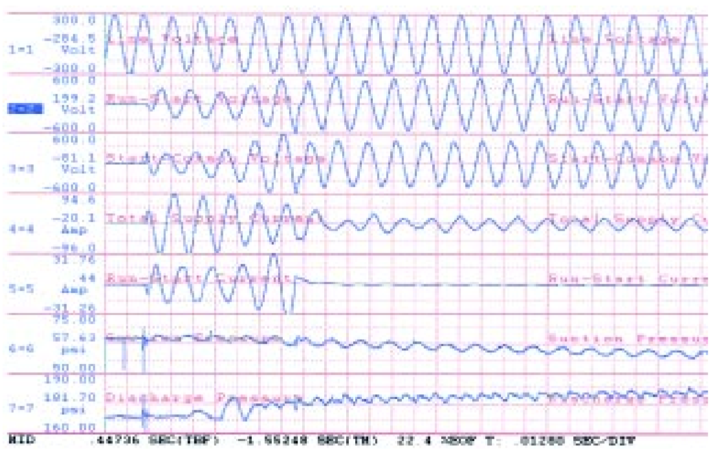
The voltage sensing method monitors start winding developed voltage and actuates a mechanical or electronic potential relay to disengage the start capacitor. The electronic potential relay is inherently more reliable and precise than the older type mechanical potential relay. SUPCO employs voltage sensing technology with an electronic potential relay.

The current sensing approach senses current through the run winding and drops the start capacitor out of the circuit based upon a threshold value. Both methods have proven effective in providing devices that are able to “sense” when a compressor has started and thus providing more reliable compressor starts in marginal conditions. However, the current sensing method must employ an internal fuse to protect the motor from potential damage and is more difficult to connect than the 2-wire voltage sensing approach.

Capacitor Size

The proliferation of potential relay type devices has resulted in the notion that one capacitor can be employed to start all compressors. That is, use the biggest capacitor and give the compressor a “big kick” to get it started. The sensing characteristic will drop the capacitor out of the start circuit when necessary and thus the compressor will not be harmed. This idea, however, is flawed. The use of a capacitor that is too large for the impedance characteristics of the windings in some compressors can actually result in significant compressor damage. Recent investigations indicate that this situation is particularly evident in voltage sensing devices.

Figure 3. shows a successful compressor start. The run-start and start-common voltages increase to a maximum value and the total supply current drops to operating conditions when the start device is dropped from the circuit. While Figure 4. shows an unsuccessful (locked rotor) compressor start. In this figure, the run-start voltage never increases to a point indicating a motor start. The total supply current remains at a maximum and the motor never starts.



Line Voltage

Run-Start Voltage

Start-Common Voltage

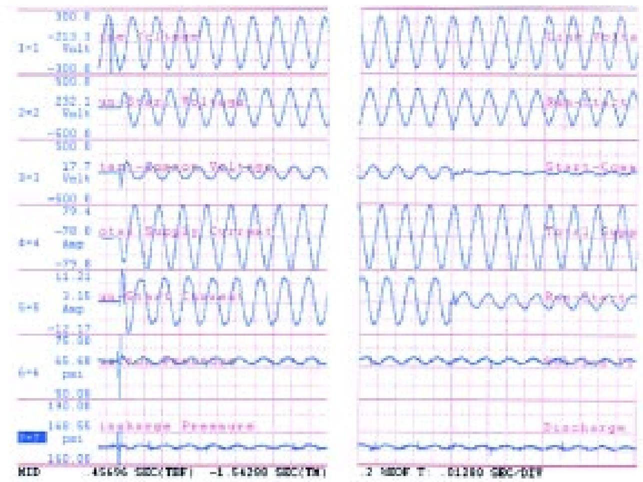
Total Supply Current

Run-Start Current

Suction Pressure

Discharge Pressure

Figure 3. Good Start



Line Voltage

Run-Start Voltage

Start-Common Voltage

Total Supply Current

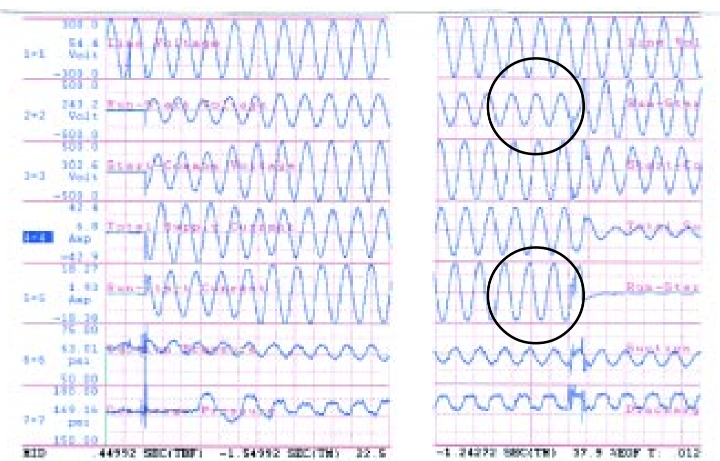
Run-Start Current

Suction Pressure

Discharge Pressure

Figure 4. No Start/Locked Rotor

If the start capacitor is too large for the application, the capacitor can actually mask the developed voltage in the start windings and keep the start capacitor in the circuit continuously. Figure 5. illustrates a compressor start with a capacitor that is too large. The motor is actually running, but the run-start voltage is suppressed below the trigger voltage of the start device. As a result, the start capacitor remains in the circuit as the motor runs. A secondary, fail-safe method is necessary to ensure that the start device is ultimately removed from the circuit. This event can be seen at the end of the time duration of the run-start current highlighted in Figure 5.



Line Voltage

Run-Start Voltage

Start-Common Voltage

Total Supply Current

Run-Start Current

Suction Pressure

Discharge Pressure

Figure 5. Start w/Oversized Capacitor With Safety Timing Circuit