Supco®
THE RIGHT CHOICE

SEALED UNIT PARTS CO., INC.
PO Box 21, 2230 Landmark Place
Allenwood, NJ 08720 USA
800-333-9125 • www.supco.com

The Benefits of
AC Hard Starts

From the Pioneer of Hard Start Technology

THE BENEFITS OF A/C HARD STARTS

Since SUPCO®'s introduction of the 2-wire hard start kit in the late 1970's, there has been a proliferation of different technologies offering various reasons and solutions to the same problems that spurred their initial development; an air conditioner that just will not start under "normal" conditions.

We will explain the need for hard starts in the first place, along with the intrinsic benefits of installing one in an air conditioning system. With several options available, guidance to choosing the right hard start for the application will be outlined. With this knowledge in hand, making the right decision for inclusion of a hard start in an air conditioning system will become clear.

Why Do We Need a Hard Start, Anyway?

Most single phase air conditioners and heat pumps use non-bleed thermostatic expansion valves (TXV's) to control refrigerant. A problem with TXV's occurs when a reciprocating compressor shuts off, refrigerant pressures don't fully equalize. Pressures do equalize in scroll compressors; which, typically do not need hard start kits for this condition. In a reciprocating compressor, the discharge pressure will drop to about 150 psig and the suction pressure will rise only to about 100 psig. When the compressor tries to start, there's too much load for the starting motor torque to overcome. This is especially true if the supply voltage is low.
To increase starting torque, a start assist device can be used. When a TXV is used, a **potential relay hard start kit** is employed. This will increase starting torque by a minimum of 300 % over using just a run capacitor. Figure one (1) shows the wiring diagram for the OEM style 3-wire hard start.

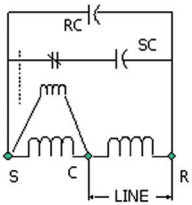


Figure 1

3 Wire Connection

The potential relay opens at 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 common wire.

A more convenient method for providing increased torque to the compressor is the 2-wire potential relay hard start device. In this case, the device can add as much starting torque as a 3-wire hard start, but installation is made simpler and cost is usually lower. Figure two (2) shows the wiring diagram for a 2-wire hard start.

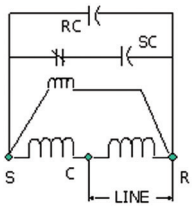


Figure 2

2 Wire Connection

Two wire hard start kits are connected in parallel with the run capacitor for Permanent Split Capacitor (PSC) type compressors; and connected to the Start and Run terminals on the compressor for Capacitor Start Induction Run(CSIR) type compressors. There is no need for a third connection to common wire.

The start relay has normally closed contacts, so when the compressor starts, both the run and start capacitors are connected to the start terminal. This causes a very high current to go through the start winding when power is first applied. This high start current increases the starting torque of the compressor motor enough that the motor will start even though the refrigerant pressures haven't equalized, or in an "under-voltage" condition.

Once the compressor begins running, the voltage across the start winding increases. This occurs because the motor acts partly like a generator and partly like a transformer. The start relay coil is connected in parallel with the start winding. When the voltage across the start winding increases above the pick-up rating on the start relay coil, the start relay contacts open. The start capacitor is then out of the circuit.

Systems with capillary tubes or fixed restrictors usually don't need a full hard start kit, unless the compressor bearings are tight. In such cases, the compressor is probably near the end of its useful life anyway.

These types of systems usually need only a start assist device that includes a **PTC (positive temperature coefficient) relay** wired in series with a start capacitor. These start assist devices are wired in parallel with the run capacitor and use only two wires. The PTC adds current to the start winding. When current passes through the PTC, it gets hot. The resistance of the PTC goes up as it gets hotter. This increases the heat output so the resistance goes up even more. The effect is that the PTC is super boosted and taken out of the circuit in a fraction of a second. The PTC needs to cool down before the start assist device can be engaged again.

There are two reasons the start capacitor can't stay in the circuit full time.

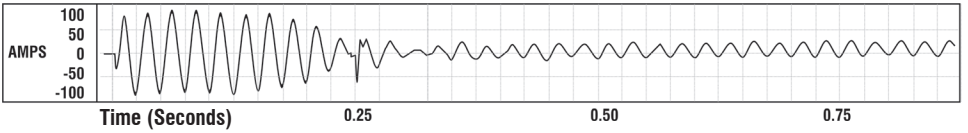
1. The start winding of the compressor can't carry such a heavy current continuously without overheating and burning out.
2. The start capacitors are made very compact and would overheat in a short while because they aren't big enough to dissipate heat as rapidly as it's generated. The plastic casing on the start capacitor also plays a role in its tendency to overheat. When a start capacitor does overheat, the little putty filled hole in the top of the capacitor blows and all the fluid inside runs out, causing the capacitor to fail.

History shows that air conditioning manufacturers agree that a start assist device is a necessary part of the equipment; all units included a starting device. They have been eliminated through the years as manufacturers reduce costs. In applications where starting every time is paramount, like refrigeration systems, start assist devices are included with each compressor.

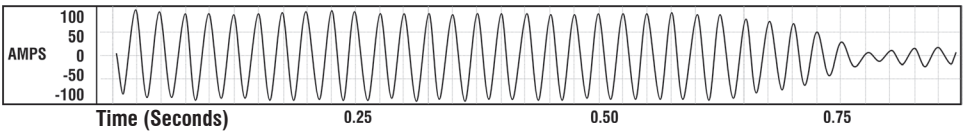
Intrinsic Benefits of Hard Starts
Along with the starting benefits of these devices, there are a few other solid reasons for incorporating their use in an air conditioning system.

With the emphasis today on **"GREEN"** products, hard start kits qualify by saving energy and lowering monthly bills. Reducing start time by as much as 50%; a system with a hard start minimizes the "in-rush" current period during startup.

In-Rush Current (Power) with SUPCO® Hard Start



In-Rush Current (Power) without SUPCO® Hard Start



Up to 10 times more power is necessary to start a compressor than to run one.
During a hot summer, an air conditioning system can start up more than 4000 times.

It can also be said that hard start kits are a ***compressor's fountain of youth.*** Compressor start is its most difficult time. The impact of increased power during startup generates more heat in the windings of the compressor. By starting a compressor up to 50% faster, stress is minimized and life expectancy increases. Also, the introduction of a start capacitor increases the power factor during startup by as much as 65%, thereby providing additional stress relief for the compressor.

When many air conditioning systems startup, usually there is a noticeable dimming of lights. This **"flicker"** is a byproduct of the increased energy necessary to start the compressor and undersized wiring in the branch circuit. By reducing the startup time by as much as 90%, the flicker is less apparent or completely eliminated.

Choosing the Right Hard Start

SUPCO®, the Pioneer of Hard Starts, offers the only complete line of hard start technologies.
- SPP Series PTC technology
- Elite Series 2-wire Electronic Potential Relay Technology
- Ultra Series 2-wire Mechanical Potential Relay Technology
- 3W Series 3-wire Mechanical Potential Relay Technology

The less informed may ask "why so many choices?" But industry veterans know that evolution of the air conditioning systems have made the various hard start advances necessary.

As previously stated, when a TXV is used, a Potential Relay Hard Start kit is recommended to provide increased torque. The choice becomes whether to install a 3-wire or 2-wire potential relay hard start kit.

The 2-wire kit is the technician's installation preference for its easy installation and proven success in the field for more than 30 years. The use of either a mechanical potential relay or electronic potential relay proves effective; with the electronic potential relay providing a backup timing safety. Both relays provide instant recycling in the event of short cycling of the air conditioning system. Short cycling may be due to a user's frequent temperature adjustments or other factors that cause the system to call for cooling very quickly. The hard start kit eliminates the strain on the compressor windings in its effort to keep pace with sudden restarts.

For applications requiring a Mechanical Potential Relay Hard Start Kit, choose from two models in the **Ultra Series** to match the application. Table 1 details the applications and competitive products.

Table 1. Ultra Series
2-Wire Mechanical Potential Relay Hard Starts

SUPCO® P/N	hp RATING	START CAP (uF; VAC)	REPLACES KICKSTART®
MPR5	1 to 3 hp	189 – 277; 330 V	TO-5
MPR1	3.5 to 5 hp	270 – 324; 330 V	KS-1

For applications where a backup safety timer is desired, choose from four models in the E Class Series Electronic Potential Relay and Hard Start Kits. Table 2 provides application details. There is no competitive device on the market.

Table 2. E Class
2-Wire Electronic Potential Relay Hard Starts

SUPCO® P/N	hp RATING	START CAP (uF; VAC)
SPP5E	1/3 to 2 hp	43 – 52; 330 V
SPP6E	1/2 to 3 hp	88 – 106; 330 V
SPP7E	1 to 4 hp	130 – 156; 330 V
SPP8E	1 to 10 hp	189 – 227; 330 V

The three-wire kit installation is more time consuming, but duplicates the OEM style inclusion. Choose from the three models available in the 3W Series three wire hard start kits to closely match the application. Table 3 outlines the applications and competitive products for this series.

Table 3. 3W Series 3 – Wire Mechanical Potential Relay Hard Starts

PART NO.	APPLICATION	VOLTAGE	CAPACITOR (330 V)	REPLACES 5-2-1
3W1	1 – 3 hp	208/ 240 VAC	88 – 108 uF	CSRU1
3W2	3.5 – 4.5 hp	208/ 240 VAC	189 – 227 uF	CSRU2
3W3	4 – 5 hp	208/ 240 VAC	270 – 324 uF	CSRU3

For systems with capillary tubes or fixed restrictors, a Positive Temperature Coefficient (PTC) hard start device is recommended. Choose from 3 models in the SPP Series to match the application. Table 4 outlines the product specifications:

Table 4. SPP Series
Positive Temperature Coefficient (PTC) Hard Starts

SUPCO® P/N	VOLTAGE (VAC)	hp RATING	TORQUE INCREASE
SPP5	90 – 277	½ - 10 hp	300%
SPP6	90 – 277	½ - 10 hp	500%
SPP7S	90 - 277	½ - 10 hp	600 %

UL/NATE

There are companies and organizations who define the benchmarks for product quality and safety. The most recognizable safety markings on products is the UL mark. There are many companies offering hard start kits that have not been tested, or have failed testing by UL. Other manufacturers use a UL recognized start capacitor, but the relay circuitry is NOT UL approved. Both the start capacitor and relay circuitry MUST be approved together as a control device. It is important to only trust a hard start kit that carries the UL mark for the device as a control device; meaning both start capacitor and relay circuitry are UL approved. By installing a non-approved device, an expensive air conditioning system is exposed to unnecessary risk. All of SUPCO's hard start kits are UL approved and carry the UL mark.

North American Technician Excellence (NATE) sets the standards for education in the HVAC/ R industry. SUPCO offers a one hour NATE Certification seminar entitled "A/C Hard Start Devices", with the objective of educating the professional on the evolution, application and selection of air conditioning hard start kits.

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

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