Application Engineering Bulletin

AE-1209-R1

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SINGLE PHASE MOTORS FREQUENT CAUSES OF FAILURE

An analysis of compressors returned during the warranty period consistently indicates that a large percentage of single phase motor failures need not have occurred, the most common causes of failure being miswiring or loss of refrigerant charge.

Production and service personnel often do not realize how quickly fatal damage to the motor can occur, particularly to the start winding, should the motor be miswired. Because of the fine wire used in the start winding, and the resulting high resistance, line voltage connected directly across the start winding can result in extremely high temperatures almost instantly. A motor energized with the wiring connections reversed can fail within a minute or less, and even though the wiring error is discovered and corrected after a few seconds, the start winding may be sufficiently damaged so that early field failure results. One of the most frequent sources of this type of failure is the improper installation of supplementary starting kits in the field.

In order to obtain a better understanding of how quickly a failure can occur, and the pattern of the resulting motor burn, frequently encountered types of failure have been duplicated in our engineering laboratory.

The illustrations that follow show the wiring connections schematically so that the basic wiring connections may be easily visualized. However, the wiring error need not necessarily occur at the compressor terminals, and quite probably the connections at switches, terminal boards, and contactors are more apt to be a problem.

Figure 1 illustrates first the correct wiring connection to a PSC motor with an internal protector, and shown by the broken line the connection when the "Common" and "Start" wires are interchanged. Note that when miswired, the line connections are across both the run and start windings in series, and that the protector is in the capacitor circuit and no longer senses the full line current.

When the leads were energized, the start winding failed from uniform overheating in 80 seconds but the protector did not trip. The main winding was undamaged.

Figure 2 illustrates a miswiring connection when the "Run" and "Start" wires are interchanged. Note that the line connections are directly across the start winding, and the run winding is out of the circuit.

When the leads were energized, the start winding failed in 25 seconds. The start winding was uniformly burned, while the run winding was undamaged.

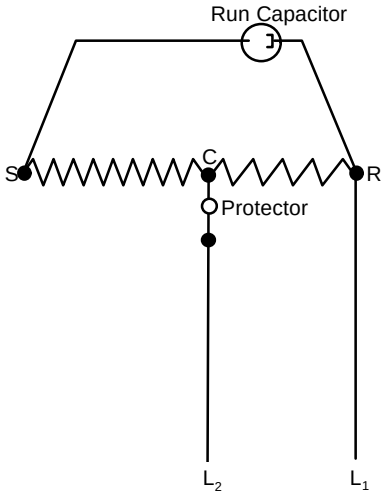
Run capacitors with identified terminals are no longer used in new equipment, however, there are still some on older equipment in the field. If you have such a capacitor it must be connected as described below.

The terminal connected to the outer foil of a run capacitor is the one most likely to short to the can and be grounded. It is identified and marked by most manufacturers of run capacitors.

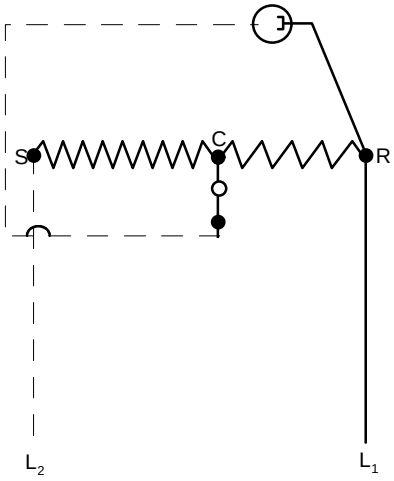
If the run capacitor is connected with the identified terminal on the line side, a grounded capacitor will result in a direct short to ground from the line. A compressor connected in this fashion as shown in Figure 3 blew a line fuse and no motor failure resulted.

If the capacitor is connected incorrectly, and the ground occurs on the start widing side of the capacitor, a short to ground exists through the start winding from either line wire. When the leads were energized, the protector tripped after 21 seconds. However a ground still existed from L_1 to ground through both run and

INTERCHANGING “COMMON” AND “START” CONNECTIONS



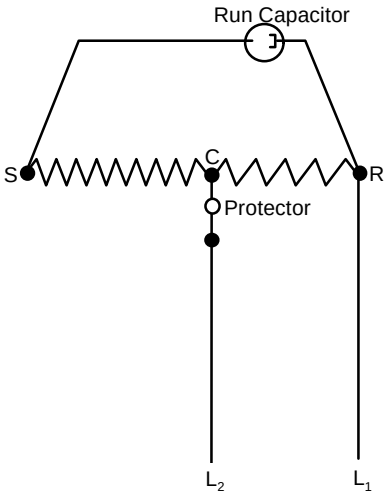
CORRECT WIRING CONNECTION



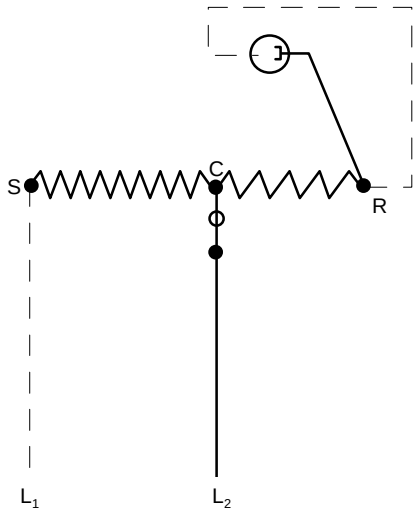
INCORRECT WIRING CONNECTION
“C” & “S” INTERCHANGED

Figure 1

INTERCHANGING “RUN” AND “START” CONNECTIONS



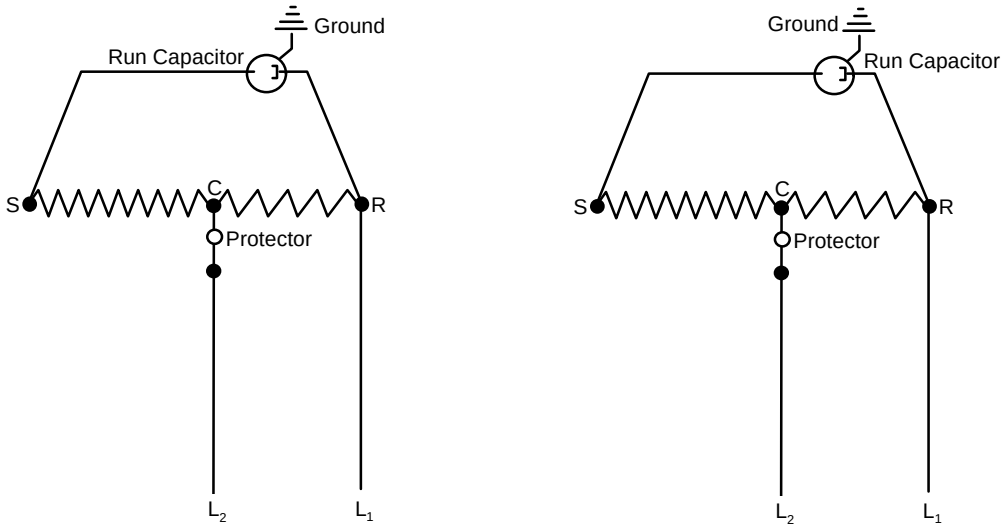
CORRECT WIRING CONNECTION



INCORRECT WIRING CONNECTION
“C” & “S” INTERCHANGED

Figure 2

SHORTED RUN CAPACITOR



RUN CAPACITOR SHORTED TO GROUND LINE SIDE OF CAPACITOR

RUN CAPACITOR SHORTED TO GROUND START WINDING SIDE OF CAPACITOR

Figure 3

start windings. The start winding failed after 30 minutes in a stalled rotor condition.

If you have such a capacitor on a compressor it should be connected as described.

Loss of Refrigerant Charge

Even though the motor may be wired correctly, a motor failure can still result from a loss of charge. An external protector normally does not protect against such a condition. Since the current drawn by the motor is abnormally low, the compressor housing temperature may control the protector, either preventing a protector trip or causing a short cycling condition because of quick cooling of the protector. In either case, a motor failure can occur in a relatively short time.

An internal protector is more directly responsive to motor heat, and once the protector trips, the "off" cycle is much longer, and the motor life can be greatly prolonged under the same loss of charge condition.

A compressor with an external protector was run with the suction tube closed and discharging to atmosphere to simulate a high side leak. The motor failed in 15 hours with severe overall heating.

Summary

A large percentage of single phase motor burns can be prevented if human error can be minimized. A convenient and dependable check of wiring connections can be easily made either on the production line or in the field by the simple ohmmeter test described in Copeland Application Engineering Bulletin AE-1193. Practically all run capacitors have the terminal connected to the outer foil identified so that proper connection is made easy. Internal protectors can extend the life of the compressor motor under loss of charge conditions so that hopefully the loss of charge condition can be discovered and corrected before failure occurs.

Copeland Corporation
Sidney, OH 45365-0669

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