Compressor Motor Protectors

Each compressor incorporates a motor protection device or system. Generally, the larger the compressor, the more sophisticated the motor protector.

It is essential that an electric motor is protected against conditions that could otherwise result in damage to the motor or to the electrical supply system. For this reason, every Kulthorn compressor is supplied with a motor protector, sometimes referred to as an overload. The more expensive the compressor, the greater is the economic justification for specifying a motor protector that has the ability to protect over a wider range of conditions.

1. External Motor Protectors

A smaller compressor (such as an AZ, AE or WJ) is fitted with an external motor protector. Most commonly, this is a compact, cylindrical device that contains a snap-action bimetallic disc. The protector is mounted in contact with the surface of the compressor housing, inside the terminal guard.

The compressor current passes through the bimetallic disc. The resistance of this disc causes the disc temperature to increase as the motor current increases. There is usually a small heater, located under the disc and connected in series with the disc itself. This heater further raises the temperature of the disc. There is also the impact of the compressor shell temperature, and a hot compressor will further increase the disc temperature. The temperature of the disc is thus influenced by the combined effects of –

- the compressor motor current
- the compressor shell temperature

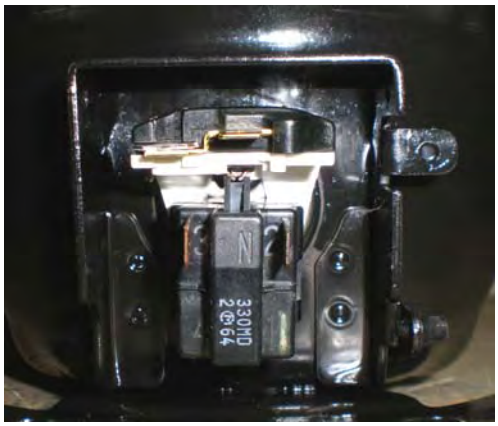
When the bimetallic disc reaches a predetermined temperature (often either 105°C or 120°C) the disc will snap open, and power supply to the compressor will be interrupted.

The compressor will cool, and at a reduced disc temperature the protector will reset and the compressor will restart, or attempt to restart. If the abnormal condition that caused the protector to trip in the first place still exists, the compressor is likely to continue to cycle on the overload until that condition is corrected.

There are two situations where a motor protector is expected to operate.

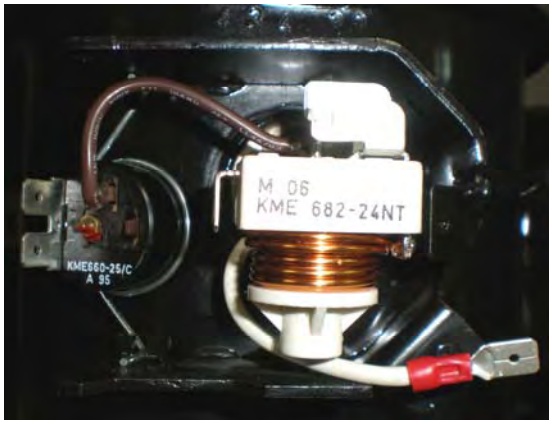
1. When the compressor is running under extreme conditions.
2. When the compressor is in a locked rotor condition. This is a situation where the compressor cannot start because the voltage is too low, the system pressures are outside the range for which the compressor is approved, there is internal damage to the compressor, or there is some other reason why the compressor is incapable of starting

An external protector has an inherent limitation. The compressor can be subjected to excessive temperatures at either high load or low load conditions. An extreme low load condition might result from loss of refrigerant from the system, or an evaporator fan failure. In such a condition the motor temperature will be high, but the motor current will be low. The motor protector senses a combination of temperature and current. If the current is very low, the protector may not trip until the motor windings are well above the specified maximum motor temperature. An external protector will not usually provide protection against 'lost gas'. It is also not likely to protect a compressor working below its approved evaporating temperature range.

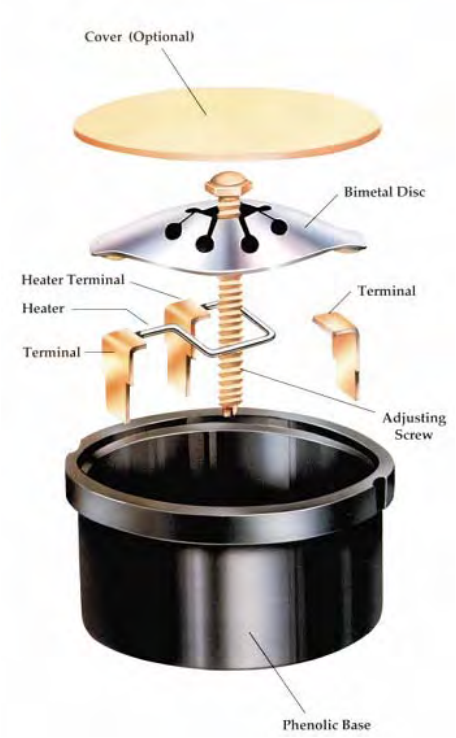


AZA refrigeration compressor with the thermal protector and relay assembled

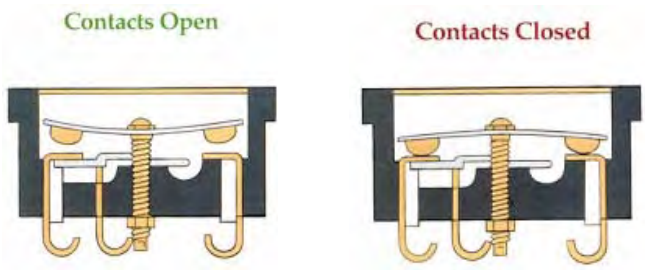
Some external protectors incorporate a PTC rather than a bimetallic disc, and these may be incorporated into combination overload / relay devices.



AE refrigeration compressor with the thermal protector and relay assembled



External 3/4" thermal protector



Bi-Metal Disc

2. Internal Motor Protectors

A motor protector that is located within the compressor is more capable of preventing the motor from reaching excessive temperatures, whether those temperatures result from extremely high loads or low loads. There are different types of internal protectors.

2.1 Internal Line-Break Motor Protectors

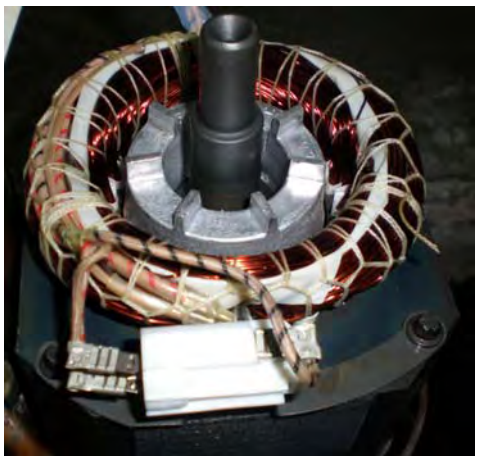
As in an external protector, the use of a bimetallic disc will interrupt the current through a compressor. While an ability to respond to compressor current is retained (this is essential for locked rotor protection of a compressor that is initially at or near ambient temperature) this type of protector responds very effectively to the temperature of the motor, usually being mounted on or close to the motor itself.

This type of line-break motor protector is available for single or three phase compressors. Three phase protectors are connected at the star point of the motor, so that the motor is stopped when the disc opens.

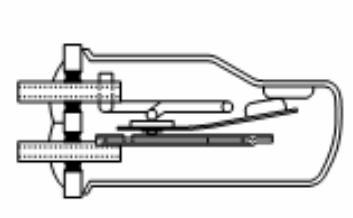
The protector is mounted inside the compressor housing, and as a result there are two obvious requirements.

- Because it is impossible to replace a faulty internal protector, it must be manufactured to a standard that is appropriate for this critical component. Failure of the motor protector means failure of the compressor.
- Since it is located in an environment of refrigerant and oil, the protector itself must be hermetically sealed.

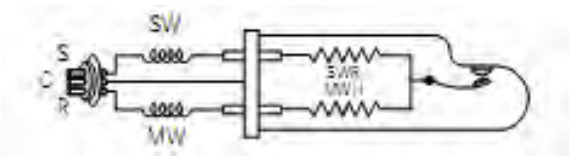
Both of these factors impact on the cost of this type of device, and it is cost that usually limits the use of this type of protector to larger compressors, such as the Kulthorn AW, KA and LA series.



AW refrigeration compressor with the internal motor protector



Internal Line-break Protector



Circuit Diagram

2.2 Internal Thermistors and External Relay

Thermistors embedded in the windings sense the motor temperature at each of their locations. Being very small and in intimate contact with the windings, they more accurately and quickly respond to fluctuations in motor temperature. The external module, or relay, trips when any thermistor exceeds its response temperature.

Various protection options are available, including phase loss and phase sequence, and the relay can be specified with mains voltage or 24V AC rating. There is normally a time delay after power is interrupted or the relay trips, before the relay will reset.

This type of system does not sense operating current, and will only provide locked rotor protection indirectly, through the resultant increase in motor temperature. Additional thermal motor protection, added to the contactor, will provide protection against excessive current.

Some Practical Considerations

Is there a preferred way to connect power to a small compressor?

Regulations may not stipulate whether the neutral or the active wire should be connected to the motor protector. Good practice suggests that the active wire should be connected to the protector. This will ensure that the compressor is electrically isolated when the protector opens, particularly important when the compressor has a 'Down To Earth' (DTE) fault. Obviously, though, the compressor will once again be "live" when the motor protector resets.

When replacing a motor protector . . . . .

The specification of an external motor protector is carefully matched to the electrical characteristics of the compressor on which it is used. When replacing a motor protector, use only the correct part, whether that is identified by the original part number or is a replacement as specified by Kulthorn Kirby.

Sometimes an external motor protector is sealed with a metal disc in its base.

Ants are attracted to some items of electrical equipment. To prevent them congregating inside a motor protector, the device is often sealed.

A compressor appears to have open circuit windings . . .

After it opens, an internal line-break motor protector may not reset for some time, typically around one hour but perhaps longer. If a compressor that utilizes an internal protector is found to be hot, and a resistance check indicates an open circuit motor, do not assume that the motor has failed. Allow sufficient time for the motor protector to reset before deciding that the compressor is faulty.

There are limits to what a motor protector can do.

We have already mentioned that an external motor protector cannot offer reliable protection against lost refrigerant charge. If this type of protection is required, a low pressure control, sensing suction pressure and adjusted to suit the characteristics of the refrigerant being used, should be fitted. If a compressor is operating outside its approved range of saturated suction temperatures (SST), or at a voltage above or below the approved range, the ability of the motor protector to perform as intended will be compromised.