

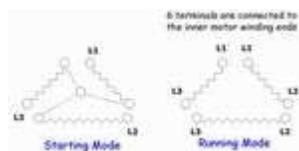
## Part Winding Start Motors for Semi-hermetics offer Significant Advantages

Copeland has developed motors for semi-hermetic compressors, which have been proven to give reliable starting and at the same time offer significant current surge reduction. The latest of these motors, developed specially for the largest 8-cylinder models ensures acceptability in most locations without the need for expensive external starting devices.

### Inrush Current

The simplest way of starting a three-phase motor is to simply connect it to the supply using a contactor. This is termed direct on line (DOL) starting.

DOL starting can cause problems due to the current inrush because until the rotor is turning at speed, very high currents will flow through the windings. In many locations this causes an unacceptable network voltage reduction and a solution such as star-delta starting is frequently used. A motor designed for normal running with delta connection can be connected for either star or delta as shown in **Fig 1** and started in star. An additional contactor is used. When connected in star, considerably less current is drawn – and less torque is available. A problem associated with this method is the need to instantaneously disconnect to motor from the supply while the changeover is made. This is termed “open transition”. Even assuming there is sufficient torque to attain full speed in star, a compressor will start to slow down rapidly as soon as the motor is disconnected. If there is any load on the compressor the speed can be significantly reduced before the voltage is applied again to the delta connections.



This results in a tendency for a peak current to exist during the transition, and the value of this peak current can approach that of the peak which would exist were the motor started directly in delta, reference **figure 2**. To overcome this a closed transition can be used. With this method the supply can be connected via resistors before the star contact is opened and the delta contact finally closed. An additional set of contactors is required and the value for the resistors has to be carefully chosen if high peak currents are still to be avoided.



### The 50/50 or Dual Voltage Motor

Part winding start motors present much better opportunities for reducing starting currents. These motors are effectively the two motors in one. Each pair of three windings is essentially a separate motor. The first of such motors to be developed was the 50/50 motor and it has two sets of identical windings. Starting with one winding only and bringing in the second when the compressor is up to speed results in a good starting characteristic. Unfortunately the torque available with half a motor is frequently insufficient to enable full speed to be attained even if the compressor is unloaded. In this situation there will be a current surge similar to the DOL current surge when the second winding is switched in. One reason that 50/50 motors are still used is that with the 230V 60Hz version there is the option to connect each pair of windings in series. Then each winding pair behaves as one long winding and the motor can be used for 460 volts, 60 Hz (380V 50Hz). For this reason the 50/50 motor is sometimes termed a dual voltage motor.

### The Copeland Solution

The Copeland part winding start motors overcome the problems with the DOL start and 50/50 start. By using a winding ratio of two-thirds and one third there is sufficient torque start the compressor (normally unloaded), give a very good reduction of current inrush on starting, and no high current peak on the transition. The starting current would typically be reduced to 75% of its DOL value. A typical characteristic is shown in **figure 3**.



For the eight-cylinder compressors Copeland has developed a very special motor which has a winding division of 3/5 and 2/5. There are nine windings in the motor and the compressor may be started without pre-unloading. In this mode the starting current is reduced to just below 70% of its DOL value. An alternative connection allows the starting current to be reduced to 54% of its DOL value when the compressor is pre-unloaded.