

## 7. Three Phase AC Motors

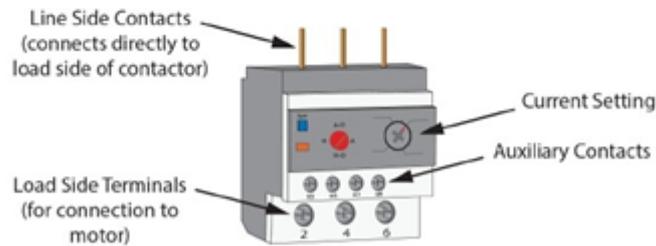
## Motor Protection Methods

There are several types of motor protection designed to protect against potentially damaging factors and conditions. Types of devices used to protect motors include the following:

- Thermal overloads
- Thermistor probe devices
- Overcurrent relays
- Circuit breakers
- HRC fuses.

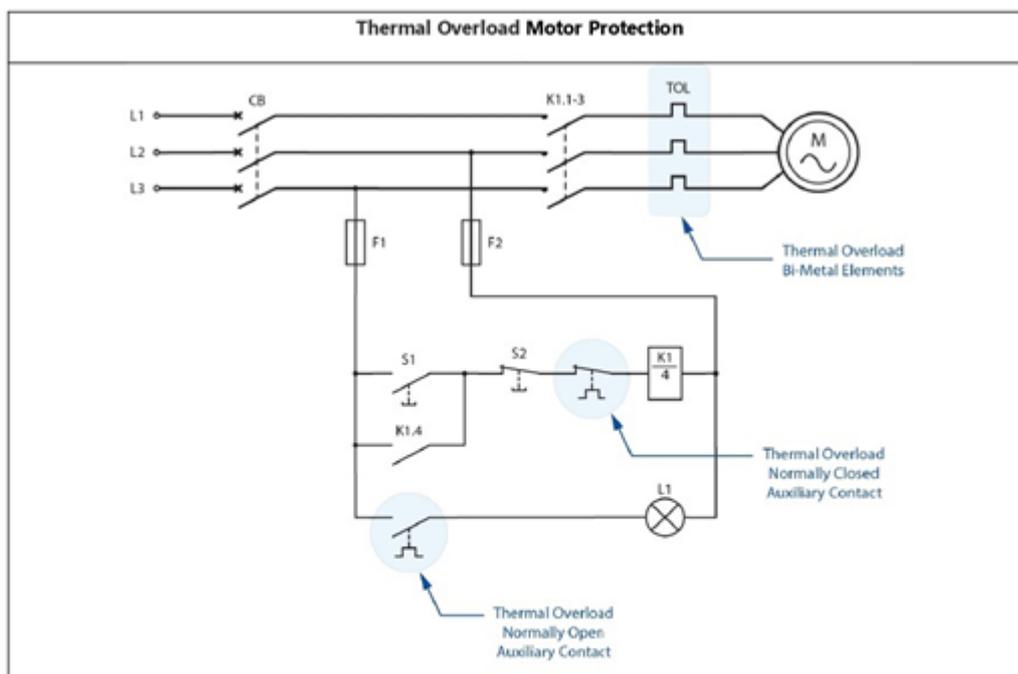
### Thermal Overloads

A thermal overload is a device used to protect motors against overload currents. They are connected into the motor supply active conductors, typically incorporated into the motor starter. The following diagram shows a typical thermal overload device that would be connected directly to the load side of a contactor supplying a motor final subcircuit.



Thermal overloads contain one or more bimetal strips. If an overload occurs, the bimetal strips bend due to the increase in temperature caused by the overload current. The bending action triggers a normally closed contact in the motor control circuit to de-energise the circuit.

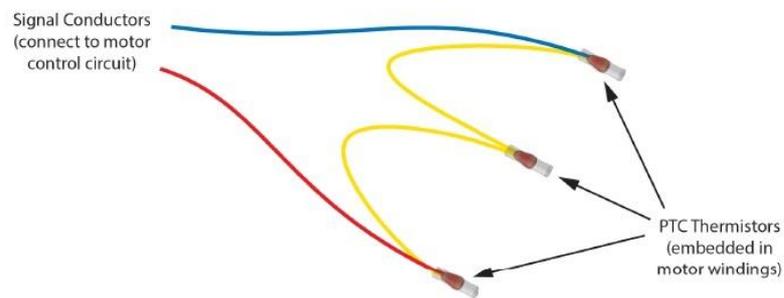
The following table explains the arrangement and operation of a thermal overload in a motor control circuit.



Normal Operating Condition	Overload Condition
<p>The normal line current is not high enough to cause the bimetal strips to bend, meaning that:</p> <ul style="list-style-type: none"> <li>The normally closed thermal overload contact will be closed, allowing current to flow to the motor contactor coil K1.</li> <li>The normally open thermal overload contact will be open.</li> <li>The overload indicator lamp L1 will be de-energised.</li> </ul>	<p>The overload current causes the bimetal strips to bend, causing the auxiliary contacts to change position, so that:</p> <ul style="list-style-type: none"> <li>The normally closed thermal overload contact opens, de-energising the motor contactor coil K1.</li> <li>The motor contacts K1.1-3 open, de-energising the motor.</li> <li>The normally open thermal overload contact will close, energising the overload indicator lamp L1.</li> </ul>

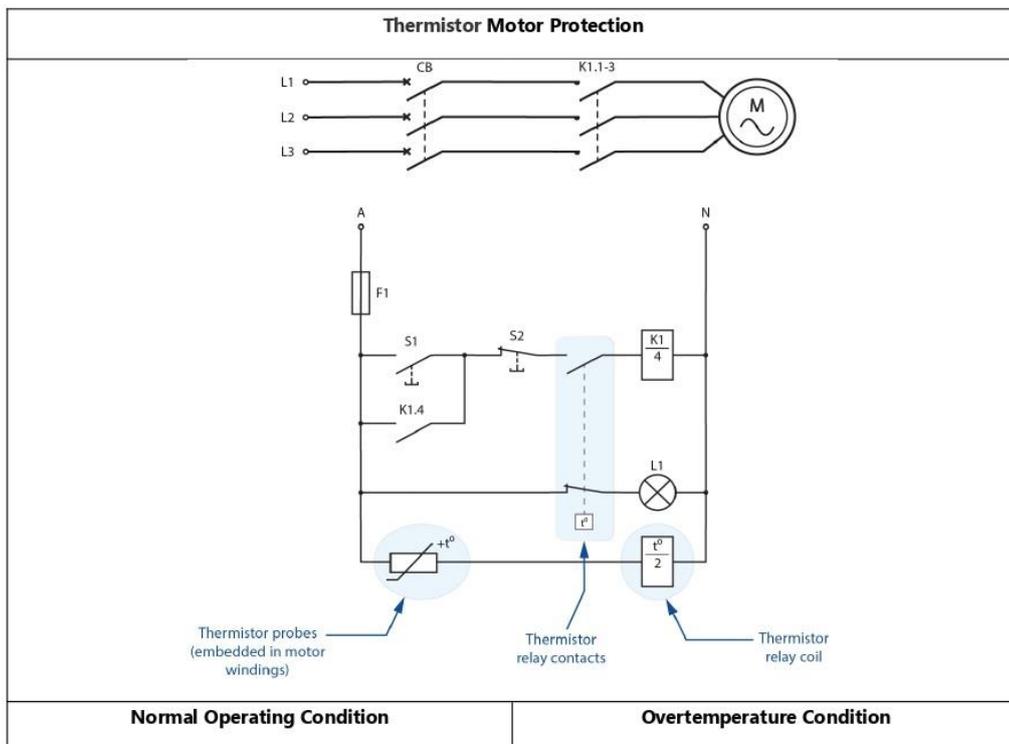
### Thermistor Probe Devices

Thermistor probes are designed to protect a motor against overtemperature. A thermistor probe device consists of a temperature dependent resistor that is embedded directly in the motor windings. This allows the temperature of the windings to be monitored independent to the value of load current. The following diagram shows the arrangement of three thermistor probes, arranged to be embedded in each phase winding of a three phase motor.



Each thermistor has a positive temperature coefficient (PTC). This means that its resistance rises slowly as temperature increases, until a specific temperature is reached when resistance rises sharply. The thermistors are not connected to the windings themselves, but rather to the external motor control circuit. If the temperature rises above the predetermined limit, the rise in thermistor resistance causes the control circuit to de-energise the motor.

The following table explains the arrangement and operation of thermistor protection in a motor control circuit.



## Direct on-line, 3 phase motor control circuit connection

The schematic circuit symbols shown below represent the components of a direct on-line motor starter.

- a. Draw the **power (main) circuit connections** from the supply ( $L_1, L_2, L_3$ ) to the 3  $\phi$  motor terminals

Correct power circuit connection

- b. On the motor terminal block, draw the **external connecting links** to operate the three phase motor in star **Y (Wye)**

Correct motor terminal links

- c. Draw the **control circuit connections** so that the motor can be **started and/or stopped using either the main controls or the remote controls**.

Correct control circuit connection

