Shop Tech Talk June 2009

Q. What are the differences between the common over temperature protection devices used in electric motors

There are 3 common internal devices used to protect an electric motor from overheating.

1. **PTC Thermistors**
2. **Thermal Protectors (button style...Thermik)**
3. **RTDs (Resistance Temperature Detectors)**


Thermistors


Siemens Thermistor Protection Unit

PTC Thermistors:

Positive temperature coefficient (PTC) thermistors have a resistance that increases with rise in temperature, However, when the temperature reaches the nominal operating temperature of the thermistor its resistance increases rapidly. This rapid increase in resistance is sensed inside the Thermistor Protection Unit (TPU), to which the thermistors are externally connected, and is converted into a contact switching function that can be used to open the control circuit of the motor or at least indicate the over temperature fault.

Three, electrically insulated, thermistors are usually used in protecting an electric motor, one embedded in each phase of the motor's winding . These 3 are then connected in series, so 6 wire ends become 2 wire ends. These 2 wire ends are then connected to its TPU.

Some ac variable speed drives and Soft Starts can accept a thermistor input directly,all the Danfoss VLT series drives and the MCD soft starter, thus alleviating the need for a separate TPU.

The use of PTC Thermistors is highly recommended to protect any electric motor from thermal overheating. The extra work of running 2 additional wires back to the motor starter and the installation of a TPU will provide protection that will ensure the most successful operating practices over a long time.

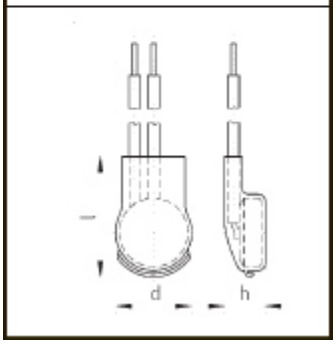
When thinking about motor overheating we invariably think about it being caused by mechanical overloading of the motor. In this particular case a good electronic motor overload connected to the starter would provide excellent protection. However if we have a situation where the motor cooling fan/ blower is impaired or broken or if we have conditions where the motor is covered with sand,rock/ gravel or lint preventing the proper cooling of the motor then even the best electronic overload protection unit will not prevent the motor overheating.....only the PTC Thermistors, with their associated TPU will do the job!

Like thermostats, thermistors have a tamper proof pre-set switch point, with a reset only after the motor cools down. Due to their small size and heat sink construction, they have fast response times. In mush wound motors, thermistors can provide locked rotor protection. Also, since the controller trips at a high resistance value, resistance variations due to long lead runs can be tolerated.

The resistance between the 2 leads of each thermistor varies with different manufacturers,usually between 20 and 250 ohm each. Each TPU will also have a spec indicating the maximum total allowed resistance of the connected thermistors. We must make sure the resistance sum of the 3 thermistors is less than the TPU max resistance allowed (usually less than 1500 ohms).

Holland Industrial, 518 West Montgomery Street, Henderson, NC., 27536
Tel: 1-800-232-7541,Fax 1-252-492-2444, E-Mail: sales @ hollandindustrial.com

Thermal Protectors



Thermik's S05 style thermal protectors, with normally closed contacts and with an insulating housing, can be used in most environments. This small device has a maximum switching current of 10 amps and temperatures ranging from a low 50°C up to 180°C in 50° increments. This protector can be used on motors up to and including class H insulation systems requirements. 2000V Insulation rating, 10A, 250 VAC Contact rating.

These thermal protectorsare fully insulated for use up to 480v cicuits and can be wired directly into the motor control circuit. No interfacing unit is necessary, the 3 thermal protectors, 1 per phase , connected in series, can be wired directly into the motor control circuit.

RTDs

On large expensive motors > 200HP and more usually with an operating voltage of 2300v, 4160v or higher, resistance temperature detectors (RTDs) are used to thermally protect the motor winding and the bearings by measuring the change of resistance of an accurately calibrated resistive sensor,usually made of copper, platinum or nickel.

Name of Sensor	Metal	Resistance at 0°C
Cu-10	Copper	10 Ω
Pt-100	Platinum	100 Ω
Ni-120	Nickel	120 Ω

The RTD device is too large to be mounted in the windings (can be up to 1" wide and 12" long and 0.125' thick) so they are installed within the stator slots at the time of manufacture.

An RTD has a linear relationship between resistance and temperature,typically 0.4 Ω / °C for a Pt-100 sensor. A very sensitive measuring instrument is required to continuously measure the small changes in the resistance of the RTD, thus the sensing unit is relatively expensive.

Because of these small changes in resistance with temperature the accuracy of the RTD measurement is affected by the series loop resistance of the extension wire between the measuring instrument and the Pt-100 sensor. This has led to the 3-wire RTDs, where a 3rd identical extension wire is connected between the instrument and the sensor. This 3rd wire provides the instrument with a way of measuring the loop resistance and subtracting it from the total measured resistance. This improves accuracy.

Precautions also have to be taken in screening the cable route because the RTD connections are susceptible to electrical interference and induced voltages.

A motor with RTDs will have two RTDs on each of the three windings plus one on each bearing.

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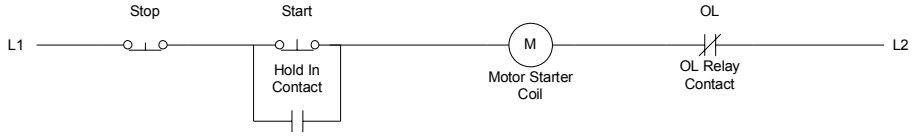
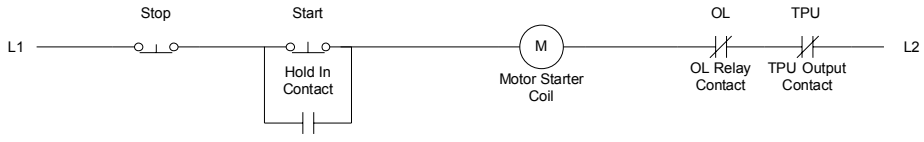
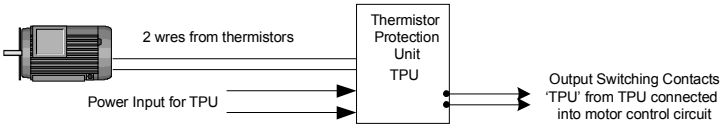
1.



1.Traditional 3 wire start stop motor control circuit with standard motor starter overload protection

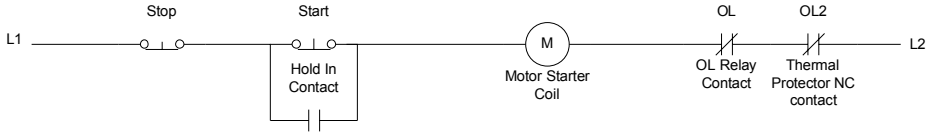
2.





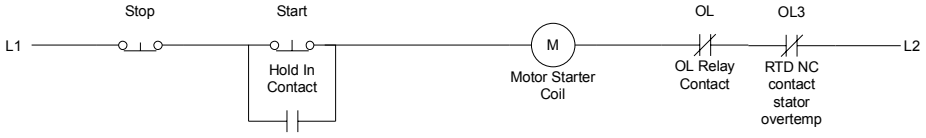
2.Traditional 3 wire start stop motor control circuit with standard motor starter overload protection and motor thermistor temperature protection

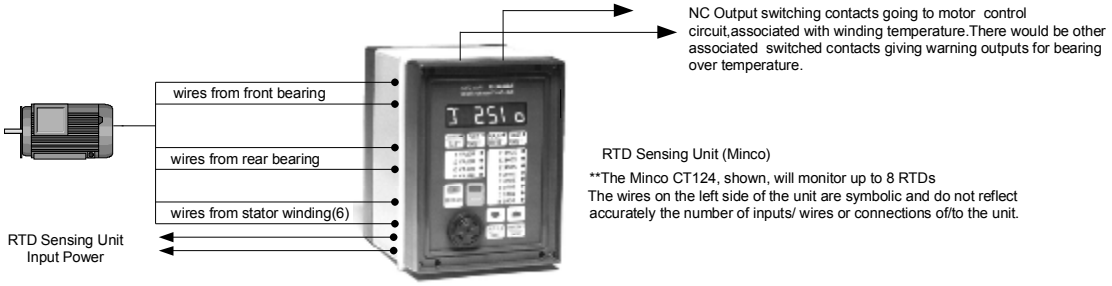
3.



3.Traditional 3 wire start stop motor control circuit with standard motor starter overload protection and motor internal thermal protector

4.





4.Traditional 3 wire start stop motor control circuit with standard motor starter overload protection and internal RTD in stator winfing

Diagrams Associated With Different Over Temperature Protection Methods