

Identifying different types of temperature detectors



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Often during the rebuild and overhaul of a piece of electrical apparatus, we are faced with the challenge to identify the type of temperature detection devices that need to be replaced. The identification process should start at the beginning of the rebuild when the apparatus starts its way through the service center.

Most major manufacturers identify the temperature detection device on a connection plate in the motor terminal box and many have a connection diagram indicating the type of device used. You can also refer to the manufacturer's catalog where they identify the type of temperature detector that has been used.

Needless to say, it is usually too late to start identifying the temperature sensor after the winding is reclaimed and the device is now dust. Because that does happen, let's look at the styles and types of winding temperature detectors.

Resistance Temperature Detector (RTD)

A RTD element consists of a wire coil or film of pure metal. See **Figure 1**. The element's resistance increases with

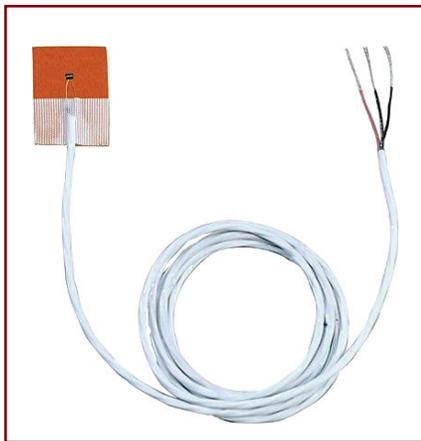


Figure 1. Resistance temperature detector (RTD)

temperature in a repeatable and known manner.

RTDs show excellent accuracy over a wide temperature spectrum. RTDs are also relatively immune to electrical noise and therefore well suited for temperature measurement in industrial environments. When necessary, RTDs are available with stainless steel shielding against electrical fields.

Here are the advantages:

- Temp range: -260° C to 850° C (-440° F to 1560° F)
- Repeatability and stability: The materials are generally platinum or copper
- Sensitivity: Larger voltage across an RTD than thermocouple
- Linearity: Platinum and copper RTDs produce a more linear response than thermocouples or thermistors

Thermocouples

A thermocouple consists of two wires of dissimilar metals joined to form a junction. See **Figure 2**. At the end of the signal wires is another junction called the "reference junction." Heating the sensing junction generates an electromotive force (EMF) potential proportional to the differences between the two dissimilar metals at the junction.

This milli-volt EMF, when compensated for the known temperature of the reference junction, indicates the tem-



Figure 2. Thermocouples

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perature at the sensing tip. Published milli-volt tables assume the reference junction is 0° C (32° F).

Thermocouples are simple and familiar; however, designing them into a system is at times complicated. The major advantage that a thermocouple offers to us is the temperature range. It can be used for a very wide range of temperatures.

Here are the advantages:

- Extremely high temperature capacity: Certain junctions can be rated as high as 1800° C (3250° F)
- Very rugged, resists shock and vibrations
- Small size, fast response
- Point sensing capacity

Thermistors

A thermistor is a resistance device composed of metal oxides formed into a bead and encapsulated in epoxy or glass. See **Figure 3**.

Thermistors typically used in electric motor windings are Positive Temperature Coefficients styles or PTC thermistors.

PTC thermistors are made of materials that

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experience an increase of resistance when temperature is raised. Sensitivity is very high.

Here are the advantages:

- Low cost: Basic PTCs are inexpensive
- High Sensitivity: Thermistors may change resistance by 100 ohms per degree versus a fraction of an ohm for RTD
- Points sensing: A thermistor bead can be made as small as a pea hook

Thermostats

Winding thermostats are basic ON/OFF switches usually inserted into the end turns of windings (usually one thermostat per phase). See **Figure 4**.

Thermostats usually have contacts that are normally closed at normal

operating temperatures. Once the temperature of the winding reaches the temperature rating for the thermostat, the contact opens and signals an external warning instrument to shut the motor off or generate an alarm. After the windings return to the normal operating temperature, the thermostat automatically resets without any external controls.

Here are the advantages:

- Switching current as high as 10 amp
- Wide temperature range: 50° C to 180° C (120° F to 355° F)
- Reasonable cost alternative
- UL rated

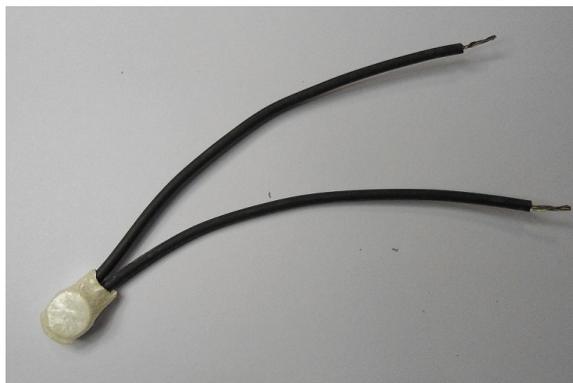


Figure 4. Thermostats

See **Table 1** for comparisons of the detectors listed above. ■



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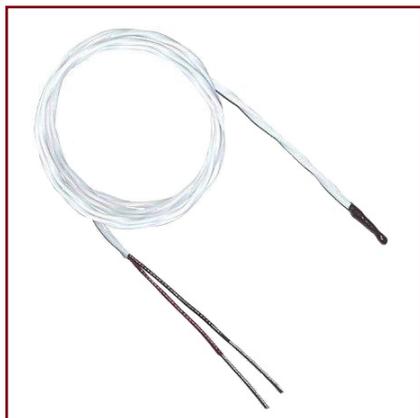


Figure 3. Thermistors

Table 1. Sensor comparisons.

	RTD	Thermocouple	Thermistor PTC	Thermostat
Temperature Range	-260° to 850° C (-440° F to 1560° F)	-270° to 1800° C (-455° F to 3250° F)	-80° to 150° C (-110° F to 300° F)	50° to 180° C (120° F to 355° F)
Sensor Cost	Moderate	Low	Low	Low
System Cost	Moderate	High	Moderate	Low
Stability	Best	Low	Moderate	Moderate
Sensitivity	Moderate	Low	Best	Best
Linearity	Best	Moderate	Poor	Moderate