OMEGA's Precision Interchangeable Thermistors

What Are Thermistors?

Thermistors, derived from the term THERMally sensitive resISTORS, are a very accurate and cost-effective method for measuring temperature. Available in 2 types, NTC (negative temperature coefficient) and PTC (positive temperature coefficient), it is the NTC type thermistor that is commonly used to measure temperature.

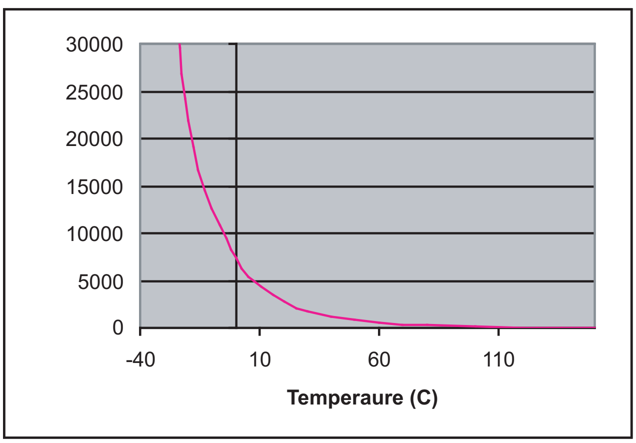
How Do They Compare to RTDs?

In contrast to RTDs that change resistance in a nearly linear way, NTC thermistors have a highly non-linear change in resistance and actually reduce their resistance with increases in temperature (See Figure 1).

The reasons that thermistors continue to be popular for measuring temperature is:

- Their higher resistance change per degree of temperature provides greater resolution
- High level of repeatability and stability (±0.1°C)
- Excellent Interchangeability
- A small size means fast response to temperature changes

Figure 1: Thermistor Curve



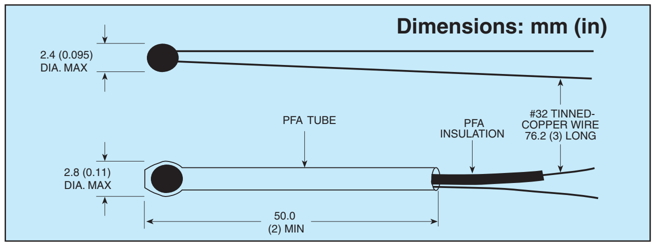
Thermistor Basics

Thermistors are made using a mixture of metals and metal oxide materials. Once mixed, the materials are formed and fired into the required shape. The thermistors can then be used "as-is" as disk-style thermistors, or further shaped and assembled with lead wires and coatings to form bead-style thermistors.

Coatings typically include:

- Epoxy coatings for lower temperature use [typically -50 to 150°C (-58 to 316°F)]
- Glass coatings for higher temperature applications [typically -50 to 300°C (-58 to 572°F)

These coatings are used to mechanically protect the thermistor bead and wire connections while providing some protection from humidity and or corrosion. It is the epoxy bead-type thermistor that is used in Omega's thermistor temperature sensor products.



Thermistors are typically supplied with very small diameter (#32AWG or 0.008" diameter) solid copper or copper alloy wires as shown above. Many times, these wires are tinned for easy soldering.

What Thermistor is Best for My Application?

Whether you are replacing an existing thermistor, or selecting one for a new application, there are 3 key pieces of information needed to obtain the desired result. These are:

1. Select the right base resistance for your new application, or correctly specify the base resistance of the thermistor needing to be replaced
2. Specify a resistance vs. temperature relationship ("curve"), or for replacement applications, make sure you know the existing thermistor information
3. Thermistor size or sensor package style

Base Resistance

NTC thermistors drop in resistance with increased temperature. This is also true of the amount of resistance change per degree the thermistor will provide. Relatively low temperature applications (-55 to approx 70°C) generally use lower resistance thermistors (2252 to 10,000 Ω). Higher temperature applications generally use the higher resistance thermistors (above 10,000 Ω) to optimize the resistance change per degree at the required temperature.

Thermistors are available in a variety of resistances and "curves". Resistances are normally specified at 25°C (77°F) , and the most common include:

- 2252 Ω
- 3000 Ω
- 5000 Ω
- 10,000 Ω
- 30,000 Ω
- 50,000 Ω
- 1 MΩ (1,000,000)

Table 1.1 shows how the resistance at 25°C (77°F) affects the amount of resistance change at a higher temperature.

Resistance vs. Temperature Curve

Unlike RTDs and thermocouples, thermistors do not have standards associated with their resistance vs. temperature characteristics or curves. Consequently, there are many different ones to choose from.

Each thermistor material provides a different resistance vs. temperature "curve". Some materials provide better stability while others have higher resistances so they can be fabricated into larger or smaller thermistors.

Table 1.1

Thermistor Model No.	Resistance @ 25°C (77°F)	Resistance Change per °C at 50°C
44004	2252 Ω	30.7 Ω
44005	3000 Ω	42 Ω
44007	5000 Ω	70 Ω
44006	10000 Ω	140 Ω
44008	30000 Ω	420 Ω

Many manufactures list a Beta (β) constant between 2 temperatures (Example: β 0/50 = 3890). This, along with the resistance at 25°C (77°F) can be used to identify a specific thermistor curve. See pages Z-236 and Z-237 for Omega's thermistor curves.

Size or Sensor Package Style

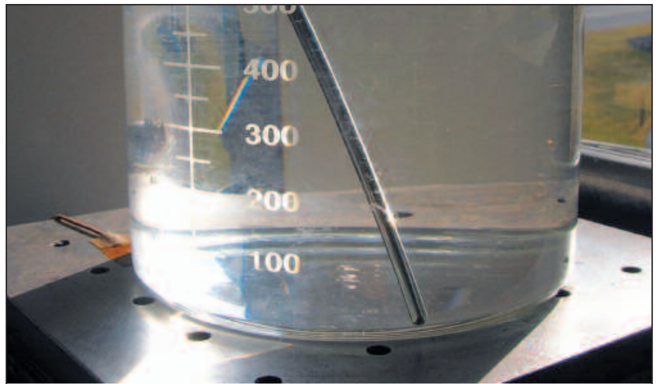
Once the right resistance and "curve" are established, the user should consider how the thermistor will be used. When selecting the right size or packaging for the sensor, it helps to remember that like any other sensor, a thermistor only measures its own temperature.

Thermistor beads are generally not designed for direct immersion into a process. They are small devices that change temperature very quickly since the only thing between them and the environment is a thin coating of epoxy. At Omega, offer a comprehensive line of sensors that protect the thermistor while allowing it to be used in a wide variety of applications. Below are a sampling of some of these styles.

ON-950, $43. See page D-18 for more information.

General Purpose

General purpose sensor designs are those that can be adapted to a wide variety of uses. Ranging from electronic equipment to structures, processes and design and reliability testing applications, these sensors are easy to install and monitor. The Omega ON-950 is an example of this type of construction. A small SST housing with #8-32 threaded stud can be installed into any #8-32 threaded hole, taking up a very small amount of space.



ON-403-PP, $70.
See page D-19 for more information.

Liquid Immersion Measurement

When exposed to liquids, thermistors need to be protected from corrosion as well as positioned into the fluid so it will come to the needed temperature. This is typically achieved using closed ended tubes and specially designed housings. Care must be taken to make sure that there is a good thermal path to the thermistor, and that thermal mass is as small as possible.

ON-909-44004-40, $49.
See page D-20 for more information.

Surface Sensing

A simple but effective sensor design for monitoring surface temperature is the ON-409 attachable surface sensor. This design includes a thin, round metal stamping into which the thermistor is epoxied. The metal stamping can then be attached to a surface using an epoxy or other method to measure surface temperature.

There are many thermistor options presented in the following pages. If you don't find the right sensor for your application, or have questions concerning your application, please give our Customer Service Engineers a call. Additional information can also be found on our Website **omega.com/tmistor.**

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