NTC Thermistors

Description

Through traditional craftsmanship and engineering excellence, the Zettler name has symbolized quality and reliability in electrical components for over 100 years in demanding applications such as telecommunications systems, computer peripherals, office automation equipment, home appliances, security systems, test and measurement devices, and industrial controls.

We also bring that same commitment to the HVAC/R market with an offering of relays, transformers, contactors, heat sequencers, temperature sensors, and fan centers. This group of products is used by the HVAC/R industry in both residential and commercial applications.

We welcome application challenges, stock over one million units, deliver quick turnaround, and understand demanding service requirements. Our unique combination of 100% quality testing, first-class sales and technical support, cost-effective product design, and outstanding product availability offer a highly dependable and responsive resource for fulfilling all your HVAC/R Components needs.
NTC Thermistors

Characteristics

Continuous Temperature Sensing

Zettler NTC Thermistor Sensors offer economical, accurate and reliable solutions to those applications requiring more extensive sensing than one or two temperature points. NTC thermistor sensors provide a change in resistance with temperature when combined with an electronic circuit and provide a means of continuously measuring temperature over a wide range.

NTC Thermistor Sensor Features

• Economical
• Long-term stability
• Custom sensors to fit customer requirements
• Custom sensor housings to fit customer requirements
• A wide variety of packaging options available

Operating Principles of NTC Thermistor Sensor

An NTC thermistor is a ceramic semiconductor made with various metal oxides. Their electrical resistance decreases with increasing temperature. This resistance is processed by an electronic circuit to provide temperature measurement. The thermistor itself does not provide any control over heating elements, relays, etc. The thermistor is strictly a sensor and any electrical control would need to be implemented by the circuit utilizing the thermistor.
NTC Thermistors

Terminology

Negative Temperature Coefficient (NTC)

An NTC thermistor is one in which the zero-power resistance decreases with an increase in body temperature.

Zero-Power Resistance (RT)

The zero-power resistance is the DC resistance value of a thermistor measured at a specified temperature with power dissipated by the thermistor low enough that any further decrease in power will result in not more than 0.1 % (or one-tenth of the specified measurement tolerance, whichever is smaller) change in resistance.

Rated zero power resistance (R25)

The zero power resistance is measured under the standard temperature of 25°C.

B Value (unit: K)

B value is a constant describing the physical characteristic of the NTC thermistor material, also called thermistor coefficient.
That is: \[ B = \ln\left(\frac{R_1}{R_2}\right) \left(\frac{1}{T_1} - \frac{1}{T_2}\right) \]
R1-Resistance at Temperature T1
R2-Resistance at Temperature T2
B value is usually determined by zero-power resistance at 25°C / 85°C in American market and 25°C / 50°C in Asia market.
Maximum Operating Temperature

The maximum operating temperature of a thermistor is the maximum body temperature at which the thermistor will operate for an extended period of time with acceptable stability of its characteristics. This temperature can be the result of internal or external heating, or both, and should not exceed the maximum value specified.

Maximum Power Rating

The maximum power rating of a thermistor is the maximum power which a thermistor will dissipate for an extended period of time with acceptable stability of its characteristics.

Dissipation Constant

The dissipation constant is the ratio, (expressed in milliwatts per degree C) at a specified ambient temperature, of a change in power dissipation in a thermistor to the resultant body temperature change.

Thermal Time Constant

The thermal time constant is the time required for a thermistor to change 63.2 % of the total difference between its initial and final body temperature when subjected to a step function change in temperature under zero-power conditions.
Zero-Power Temperature Coefficient Of Resistance

Zero-power temperature coefficient of resistance is the slope of the R-T curve at any given temperature is used to express the point. It is a measure of the rate of change in resistance of the thermistor at a specific temperature. Alpha is expressed in -%/°C. As the R-T curve is not linear, alpha is greater at lower temperatures than at higher temperatures.

\[ \alpha_T = \frac{1}{R_T} \frac{(D R_T)}{(D T)} \]

Alpha is useful for determining what tolerances are required for an application. For example, the alpha value at 25°C for a particular NTC was -4.0%/°C, if the application requires a temperature accuracy ±0.5°C, then the NTC zero-power resistance at 25°C tolerance would need to specified as ±2.0%. (4.0%*0.5)

Tolerance on Resistance

This is a method of measuring precision in NTC thermistors. Tolerance is the percentage of variation in resistance at a specific temperature. Tolerance is always stated as a percentage at a specified temperature. The industry standard is to use 25°C as the base temperature, unless another temperature is specified.

Important Notice

The user must determine the suitability of our products for the application and assumes all risk and liability associated therewith.
NTC Thermistors

Thermistor Sensor Typical Applications

**HVAC/R appliance**
- Air conditioners
- Boiler heating system
- Washing machines
- Clothes dryers
- Electric water heaters
- Toasters
- Micro-wave oven
- Electronic thermometers
- Fire detectors
- Home weather stations
- Oven temperature controls
- Dishwashers
- Pool and spa controls
- Refrigerator and freezer temperature controls
- Electric blanket controls
- Small appliance controls
- Electrical thermostat
- Solar collector controls

**Automotive**
- Audio amplifiers
- Automatic climate controls
- Coolant sensors
- Electric coolant fan temperature controls
- Emission controls
- Engine oil temperature sensors
- Transmission oil temperature sensors
- Seat heating system control
- Intake air temperature sensors
- Water level sensors
- Outside air temperature sensors
- Engine block temperature sensors
- Oil level sensors

**Industrial Electronics**
- Commercial vending machines
- Gas flow indicators
- HVAC equipment
- Industrial process controls
- Microwave power measurement
- Photographic processing equipment
- Plastic laminating equipment
- Solar energy equipment
- Thermoplastic molding equipment
- Thermostats
- Water purification equipment
- Welding equipment

**Food Handling And Processing**
- Coffee makers
- Deep fryers
- Fast food processing
- Temperature controlled food storage systems
- Thermometers for use in food preparation
Zettler NTS Thermistor sensor is designed according to UL 1434 or customer custom requirements. All components have excellent reliability and are RoHS compliant. Precision range term 1%, 2%, 3%, or 5%.

**Thermistor sensor benefits include:**
- Engineered to specific application requirements
- Thermally responsive
- Increased performance of the overall system in terms of energy consumption and ease of use
- Reduced assembly cost and increased reliability
- Rugged performance and long-term stability

**Plastic over-molded sensor features and benefits include:**
- Plastic provides a much higher protection against moisture over time
- Plastic probes can be made into more application-specific shapes
- Plastic probes can eliminate multiple-part assemblies for customers and reduce their labor and combined material cost
- Lower weight content than metal probes can benefit transportation costs
- Piece price is typically more economical than metal-based probes
Sensor Varieties

Zettler designed thermistor sensors use a variety of sensor types to further enhance their use in applications. The most common sensor is the axial glass encapsulated NTC thermistor which can be supplied with tight tolerances at multiple temperatures.

Standard Plastic Materials

Standard plastic materials selections are based on use, probe shape, response time and cost. The most commonly used plastics are General Electric's Valox and Chevron Phillips Chemical's Ryton. The advantages of plastic are low cost, design shape flexibility and excellent moisture protection. Other protection methods are epoxy potted-metal housings and shrink tubing. Metal housings are typically brass, stainless steel or aluminum.

The following are the most commonly used plastics. Customer-specified plastics can also be used.

- Valox - inexpensive, acceptable for use with food products
- Polypropylene - very inexpensive, low temperature rating
- Ryton - high temperature rating, good thermal conductivity, relatively expensive, harder but also more brittle than Valox or polypropylene.

Zettler can use all major brands of wire terminals and connector housings. The photos show just a small sampling of our capabilities. Please contact a Zettler Controls Applications Engineer for assistance in selecting the wire terminations and housings for your application.

Temperature sensor typical package types: Plastic housing sealed, Metal housing sealed, Combined housing sealed, Simple housing packaged.

Plastic housing sealed temperature sensor housing materials include Valox PBT, Ryton PPS, PP, Nylon, Ultem. Use proper plastic material according to customer different shape, thermal time constant, cost and application requirements etc. Economical, shape complexity, moisture resistance, performance stability and light weight are the advantages of this kind of sensors. Normal material sealed sensors can be used in -40°C to +125°C environment, special plastic sealed sensors can be used up to +200°C.
The NTC can be sealed completely in a plastic housing or can be exposed, this will be determined by customer's applications thermal response and dielectric strength requirement.

Metal housing sealed temperature sensor housing material options include: Brass (copper), Stainless Steel, Aluminium, etc., quick thermal response, strong construction, easy to fasten and high application environment temperature are the advantages. Some types can be used in -40°C to +250°C environment.

Combined housing sealed temperature sensor is normally housed by metal and plastic material together. It has the advantage of plastic housing sealed and metal housing sealed sensors, quick thermal response, strong construction, easy to have complex shape, easy to fasten, etc. to +250°C environment.
Simple housing packaged temperature sensor, the NTC normally is packaged by Teflon or PVC heat shrink sleeve or sealed by epoxy. This kind of sensor has simple construction, is economical and has good thermal response. They normally can be used in a clean application environment without strict environment conditions.
# NTC Thermistors

Widely used temperature sensing technologies performance comparison

<table>
<thead>
<tr>
<th>SENSOR TYPE</th>
<th>NTC THERMISTOR</th>
<th>PLATINUM RESISTOR</th>
<th>THERMOCOUPLE</th>
<th>L.C. SENSOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARAMETER</td>
<td>Resistance vs. Temperature</td>
<td>Resistance vs. Temperature</td>
<td>Voltage vs. Temperature</td>
<td>Voltage or Current vs. Temperature</td>
</tr>
<tr>
<td>ADVANTAGES</td>
<td>Large Change in Resistance vs. Temperature</td>
<td>Linear</td>
<td>Wide Operating Temperature Range</td>
<td>Linear High Output vs. Temperature</td>
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<tr>
<td></td>
<td>Fast Time Response</td>
<td>High Stability</td>
<td>Simple</td>
<td>Inexpensive</td>
</tr>
<tr>
<td></td>
<td>High Resistance Eliminates the Need for Four Wire Measurement</td>
<td>Wide Operating Temperature Range</td>
<td>Inexpensive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small Size</td>
<td>Interchangeable Over Wide Temperature Range</td>
<td>Rugged</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inexpensive</td>
<td></td>
<td>No External Power Supply Required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Stability</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>Interchangeable to Tight Tolerance</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DISADVANTAGES</td>
<td>Non-Linear</td>
<td>Small Change in Resistance vs. Temperature</td>
<td>Non-Linear</td>
<td>Limited Operating Temperature Range</td>
</tr>
<tr>
<td></td>
<td>Operating Temperature Limited to Approximately -60 to +300 Degrees Celsius</td>
<td>Relatively Slow Time Response</td>
<td>Relatively Low Stability</td>
<td>Current Source Required</td>
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<tr>
<td></td>
<td>Interchangeable Over Relatively Narrow Temperature Ranges</td>
<td>Low Resistance Requires Three or Four Wire Measurement</td>
<td>Low Sensitivity</td>
<td>Subject to Self-Heating</td>
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<tr>
<td></td>
<td>Current Source Required</td>
<td>Sensitive to Shock and Vibration</td>
<td>Low Voltage Output Can Be Affected By RFI and EMI</td>
<td>Limited Configurations</td>
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<tr>
<td></td>
<td>Current Source Required</td>
<td>Reference Junction Compensation Required</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expensive</td>
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</table>
## NTC Thermistors

### Widely used temperature sensing technologies performance comparison

<table>
<thead>
<tr>
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<tr>
<td>NTS110001</td>
<td>50K</td>
<td>3934</td>
<td>-40°C to 125°C</td>
<td>NTS023001</td>
<td>5K</td>
<td>3470</td>
<td>-40°C to 105°C</td>
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<td>10K</td>
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<td>10K</td>
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<td>-40°C to 200°C</td>
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<td>NTS220004</td>
<td>23K</td>
<td>4200</td>
<td>-40°C to 125°C</td>
</tr>
</tbody>
</table>

### Notes:

1. Custom orders are welcome!

2. If the model required is not listed, please submit the following information so our engineers can determine the correct product for you:
   - Operating temperature range, working criteria and dielectric requirements for the sensor (i.e.: air, water, oil, etc.)
   - Required temperature reaction time (thermal time constant)
   - Outline size (include drawing)

3. For your convenience, we have our own processing equipment for the terminations. Interface terminals can be processed and the guard sleeve can be assembled to your requirements.

4. We can develop temperature sensors with different types of specifications and outlines to meet your needs.

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