

# NTC Thermistors

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## 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.

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# NTC Thermistors

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## 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 ( $R_T$ )

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 ( $R_{25}$ )

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

### B Value (unit: K)

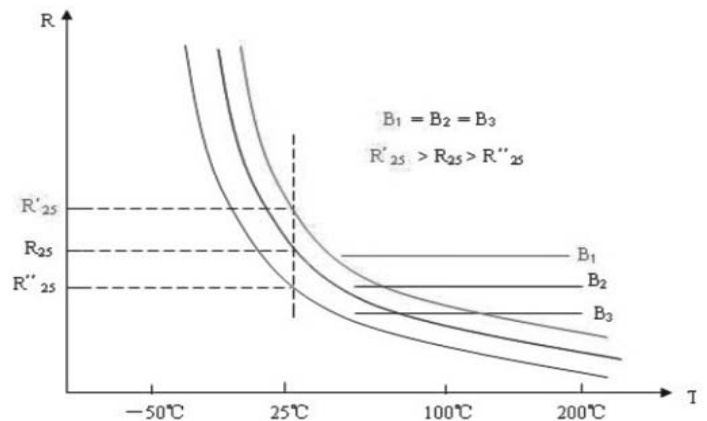
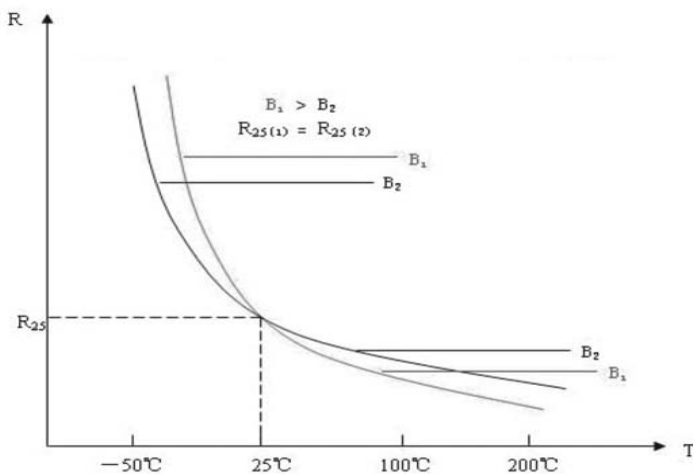
B value is a constant describing the physical characteristic of the NTC thermistor material, also called thermistor coefficient.

That is:  $B = \ln(R_1/R_2)/(1/T_1 - 1/T_2)$

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.



# NTC Thermistors

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## 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

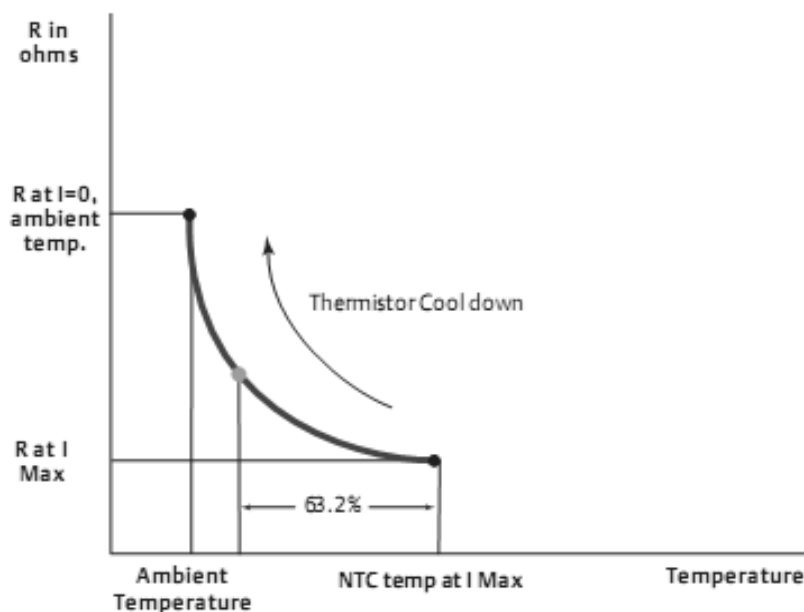
The maximum power rating of a thermistor is the maximum power which a thermistor will dissipate for an extended period of time with acceptable stability of its characteristics.

## 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.



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## 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 be 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

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## 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

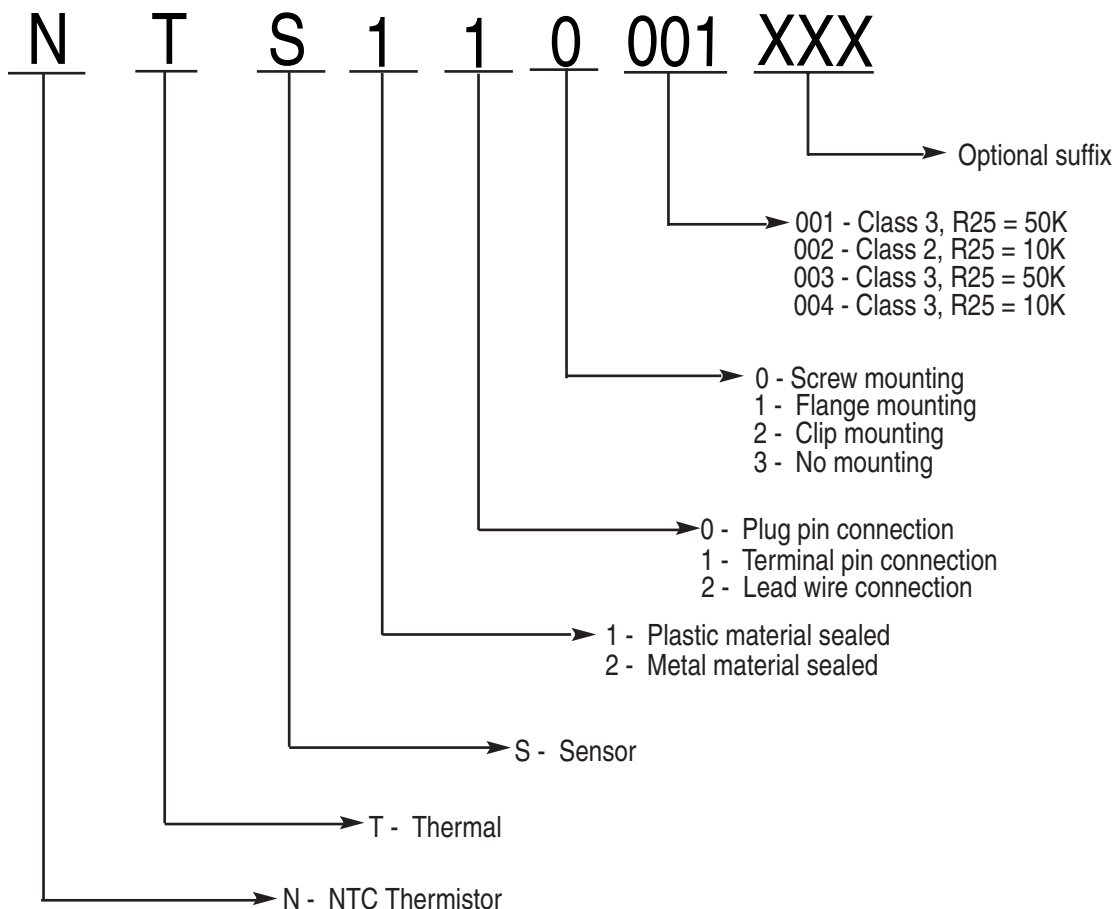
### Food Handling And Processing

Coffee makers  
Deep fryers  
Fast food processing

Temperature controlled food storage systems  
Thermometers for use in food preparation

# NTC Thermistors

## Zettler Controls Thermistor Sensor part numbering system



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

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# NTC Thermistors

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## 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.

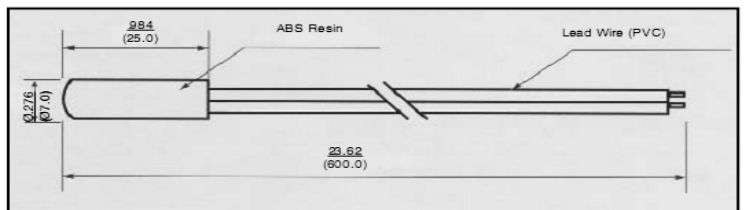
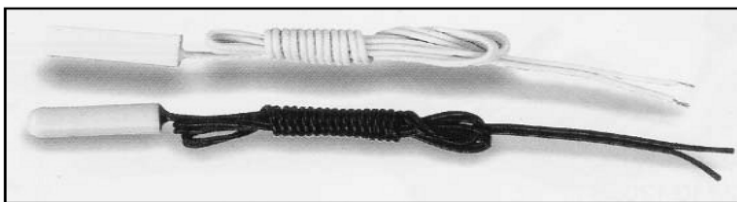
The following are the most commonly used plastics. Customer-specified plastics can also be used.

- 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.



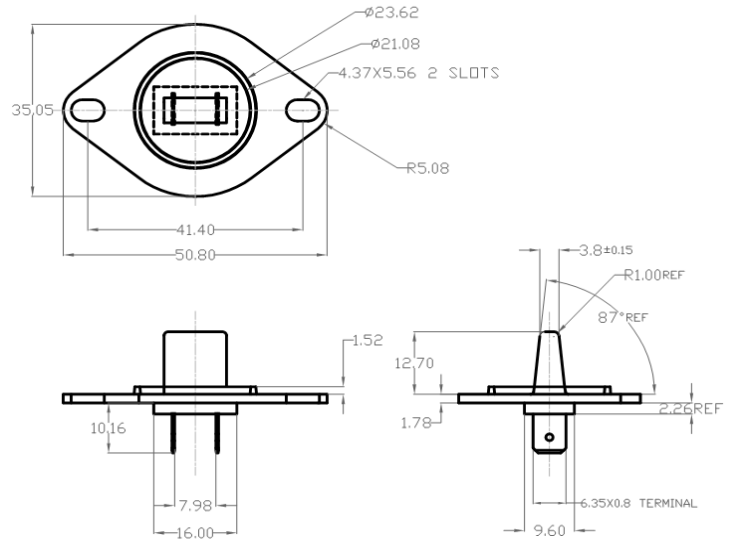
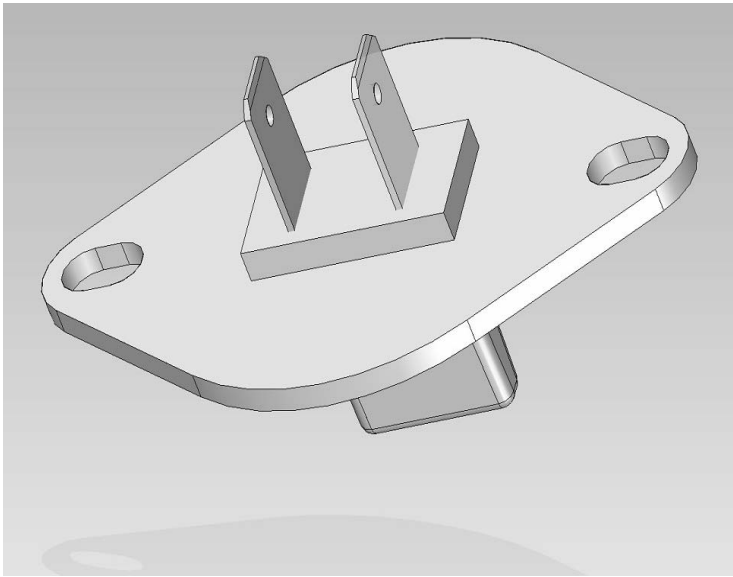
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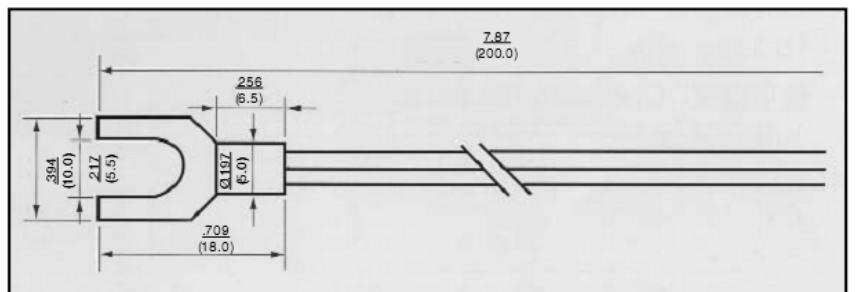
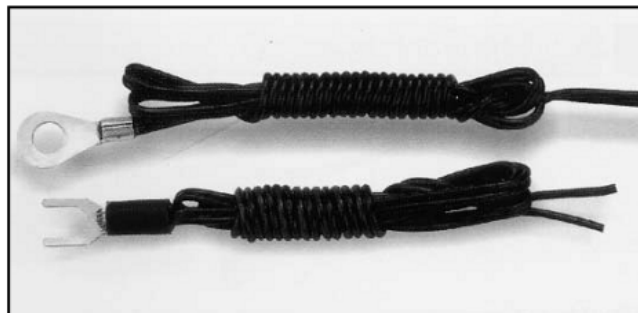
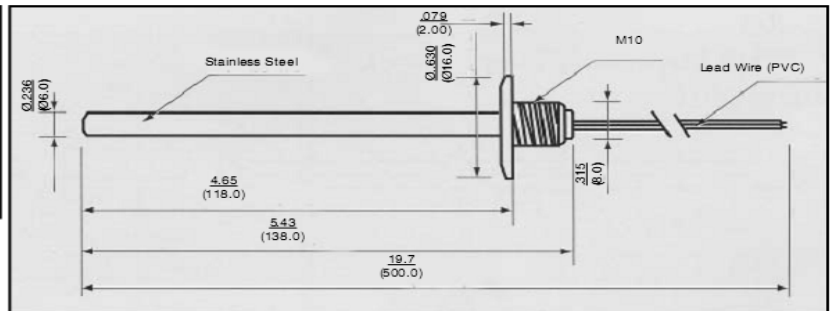
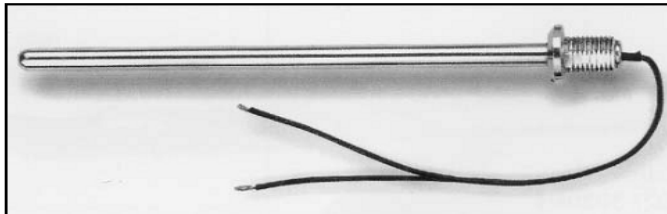


# NTC Thermistors



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.



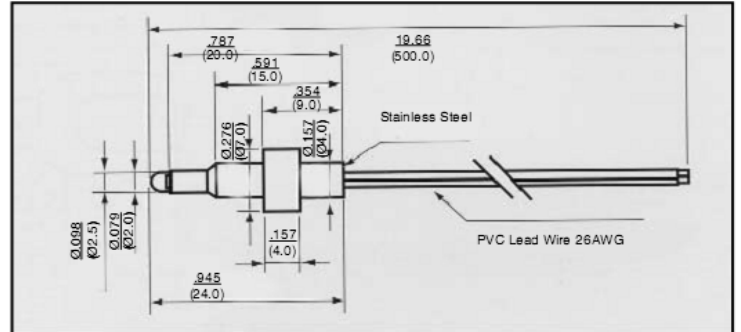
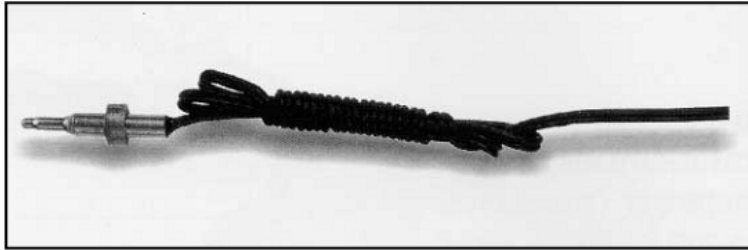
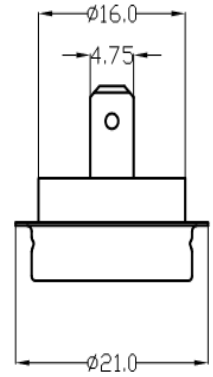
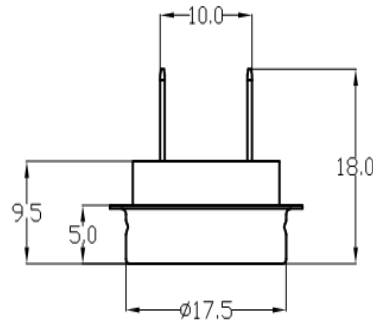
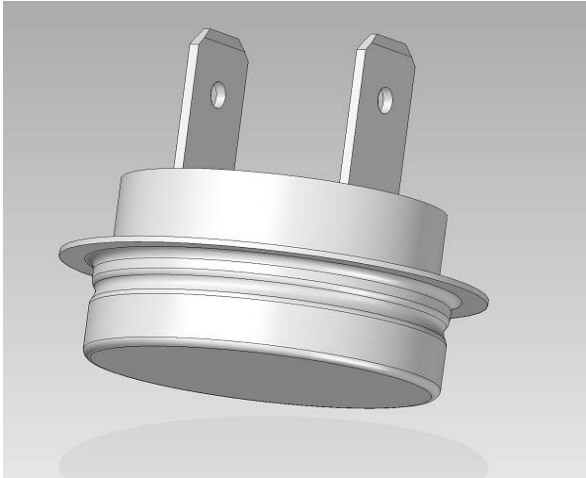
Combined housing sealed temperature sensor is normally housed by metal and plastic material together. It has the advantage of plastic housing sealed and metal housing sealed sensors, quick thermal response, strong construction, easy to have complex shape, easy to fasten, etc. to +250°C environment.

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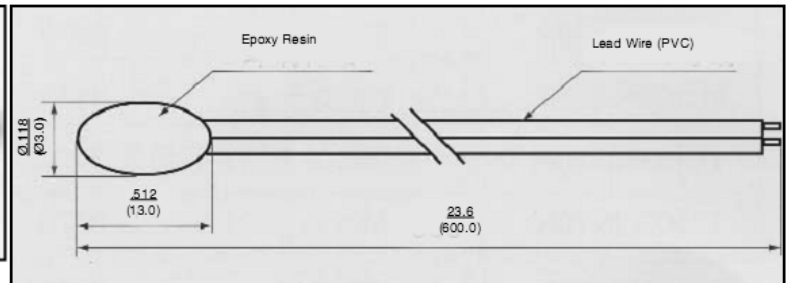
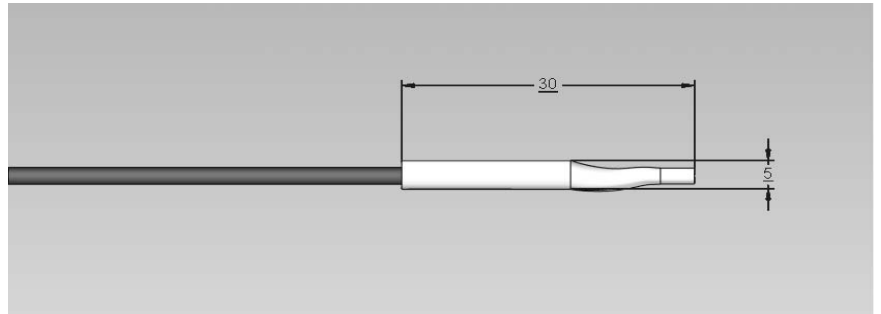
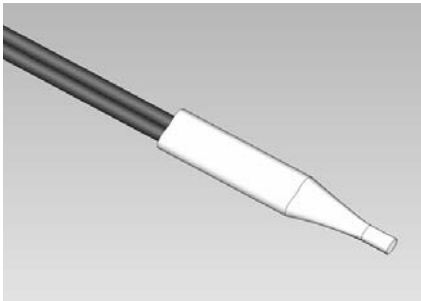
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Simple housing packaged temperature sensor, the NTC normally is packaged by Teflon or PVC heat shrink sleeve or sealed by epoxy. This kind of sensor has simple construction, is economical and has good thermal response. They normally can be used in a clean application environment without strict environment conditions.



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# NTC Thermistors

## Widely used temperature sensing technologies performance comparison

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

# NTC Thermistors

## Widely used temperature sensing technologies performance comparison

MODEL	Standard Resistance (R25) ohm	B (25/50°C)	Operating Temperature Range	US MODEL	Standard Resistance (R25) ohm	B (25/50°C)	Operating Temperature Range
NTS110001	50K	3934	-40 <sup>0</sup> to 125 <sup>0</sup> C	NTS023001	5K	3470	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS111001	50K	3934	-40 <sup>0</sup> to 125 <sup>0</sup> C	NTS123001	10K	3435	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS111002	10K	3934	-40 <sup>0</sup> to 125 <sup>0</sup> C	NTS223004	10K	3470	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS221002	50K	3950	-40 <sup>0</sup> to 200 <sup>0</sup> C	NTS223005	5K	3270	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS221003	50K	3950	-40 <sup>0</sup> to 200 <sup>0</sup> C	NTS221007	10K	3380	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS221001	40K	3950	-40 <sup>0</sup> to 200 <sup>0</sup> C	NTS221008	10K	3700	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS221007	10K	3950	-40 <sup>0</sup> to 200 <sup>0</sup> C	NTS221009	10K	3700	-40 <sup>0</sup> to 250 <sup>0</sup> C
NTS221008	10K	3950	-40 <sup>0</sup> to 200 <sup>0</sup> C	NTS123002	2K	3920	-40 <sup>0</sup> to 60 <sup>0</sup> C
NTS221006	10K	3950	-40 <sup>0</sup> to 200 <sup>0</sup> C	NTS223006	10K	3950	-40 <sup>0</sup> to 100 <sup>0</sup> C
NTS221004	10K	3934	-40 <sup>0</sup> to 105 <sup>0</sup> C	NTS221010	20K	3950	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS223001	10K	4050	-40 <sup>0</sup> to 105 <sup>0</sup> C	NTS220001	50K	3950	-40 <sup>0</sup> to 200 <sup>0</sup> C
NTS221005	10K	3380	-40 <sup>0</sup> to 105 <sup>0</sup> C	NTS220002	50K	4050	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS023002	10K	3934	-40 <sup>0</sup> to 105 <sup>0</sup> C	NTS220003	23K	4200	-40 <sup>0</sup> to 105 <sup>0</sup> C
NTS301001	50K	3934	-40 <sup>0</sup> to 200 <sup>0</sup> C	NTS123003	55K	4050	-40 <sup>0</sup> to 80 <sup>0</sup> C
NTS223003	100K	4000	-40 <sup>0</sup> to 105 <sup>0</sup> C	NTS220004	23K	4200	-40 <sup>0</sup> to 125 <sup>0</sup> C

### 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:
  - a. Operating temperature range, working criteria and dielectric requirements for the sensor (i.e.: air, water, oil, etc.)
  - b. Required temperature reaction time (thermal time constant)
  - c. 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.

Revised 3/19/12

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