[Applications]		[Series]
Room air conditioner	Room temp., External air, Outlet air, Heat exchanger	AC Series
Car air conditioner	Room temp., External air, Outlet air, Heat exchanger, Evaporator	CA Series
Surface temperature		ST Series
Hot & instant boiler	Hot water, Cool water	IB, HB Series
Microwave oven	Oven temp.	MW Series
Toilet	Toilet seat, Washing water, Drying air	WT Series

※Please contact us for detail of WT series, and other applications.

■Part number system

DTN — C 503 F 3U

① ② ③ ④ ⑤

①Thermistor
②Thermistor element
③Expressed resistance in Ω (at 25˚C). The first two digits are signficant, and the third is the number of zeros.

④Resistance tolerance ± (%)

Symbol	F	G	H	J	K	X
Resistance tolerance	±1.0	±2.0	±3.0	±5.0	±10.0	Special Tolerance

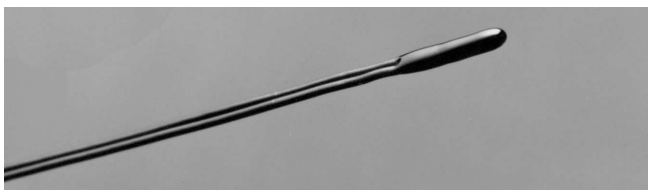
⑤B value

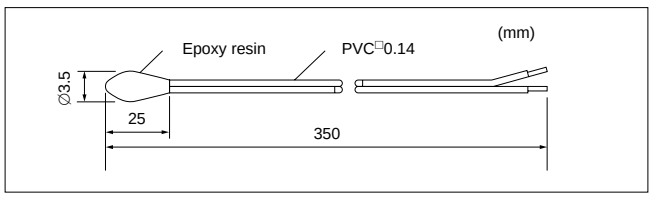
Sensor for room air conditioner

■Features

●Moisture resistant.
●Small with quick temperature response.

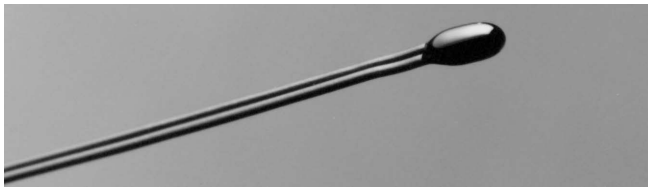
ACA-35

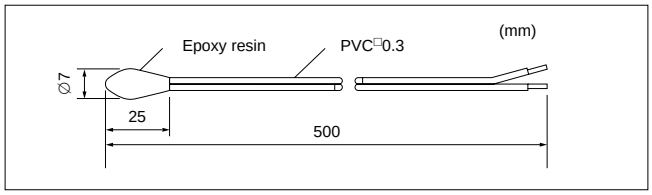




●Resistance ····· R_{25}=15kΩ±3% (Flake chip)
●B value (3T) ····· $B_{25/50}$=3950K±2%
$B_{25/85}$=3989K
●Operating temperature range ····· −30˚C～+100˚C
●Application ····· Air temperature
●Thermal time constant (in air) ····· 50sec.

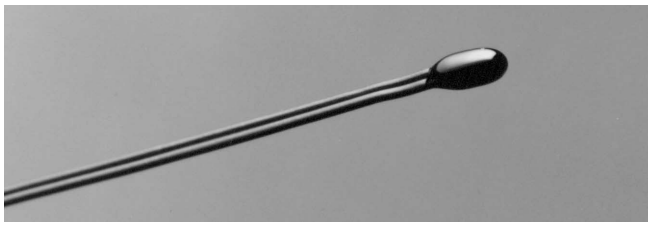
ACA-70

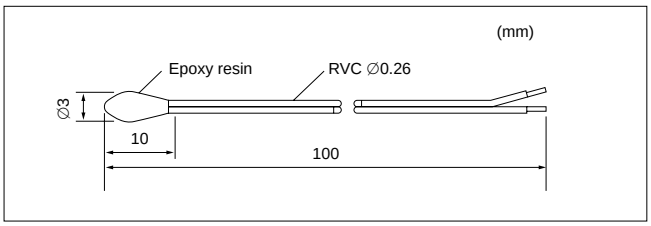




●Resistance ····· R_{25}=10kΩ±3% (Disk)
●B value (4F) ····· $B_{25/50}$=4150K±3%
$B_{25/85}$=4212K
●Operating temperature range ····· −30˚C～+80˚C
●Application ····· Air temperature
●Thermal time constant (in air) ····· 65sec.

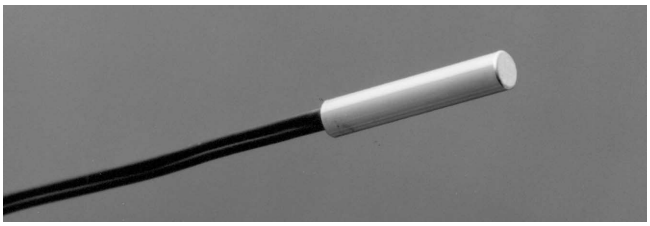
ACA-30

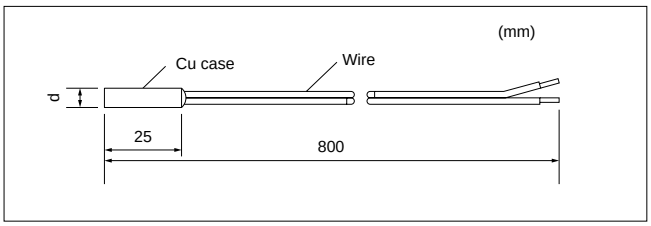




●Resistance ····· R_{25}=5kΩ±3% (Flake chip)
●B value (3T) ····· $B_{25/50}$=3950K±2%
$B_{25/85}$=3989K
●Operating temperature range ····· −30˚C~+100˚C
●Application ····· Remote control
●Thermal time constant (in air) ····· 25sec.

ACH-40 · 42 · 45

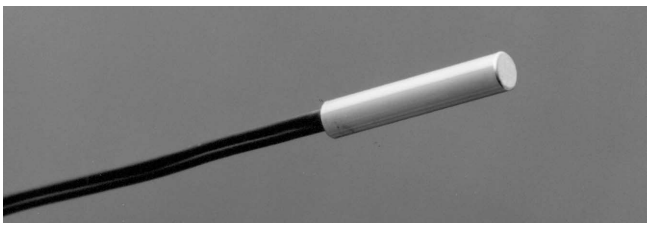


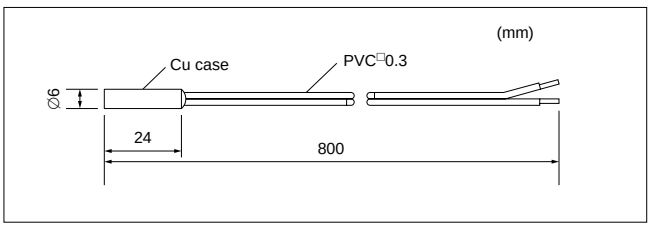


d (mm)	∅4.0	∅4.2	∅4.5
Wire	□0.14	□0.14	□0.18

●Resistance ····· R_{25}=10kΩ±3% (Flake chip)
●B value (3T) ····· $B_{25/50}$=3950K±2%
$B_{25/85}$=3989K
●Operating temperature range ····· −30˚C~+100˚C
●Application ····· Heat exchanger
●Thermal time constant (in water)···· 5sec.

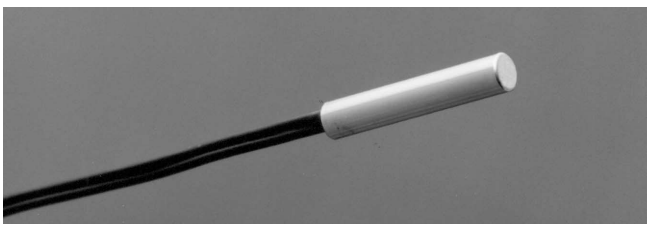
ACH-60

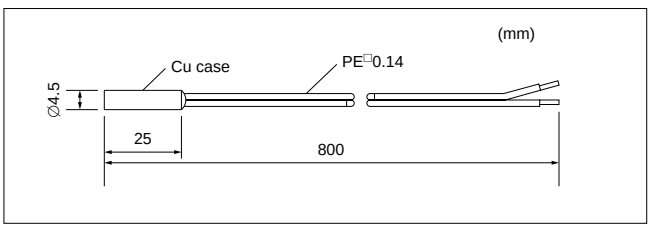




●Resistance ····· R_{25}=10kΩ±3% (Disk)
●B value (4F) ····· $B_{25/50}$=4150K±2%
$B_{25/85}$=4212K
●Operating temperature range ····· −30˚C~+80˚C
●Application ····· Heat exchanger
●Thermal time constant (in water)···· 8sec.

ACD-45

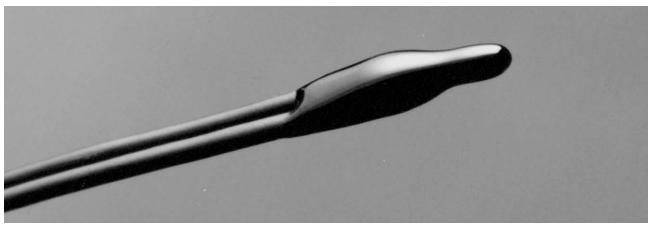


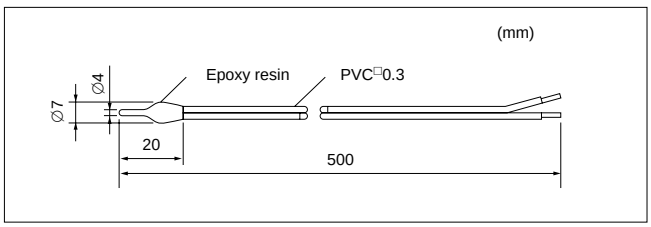


●Resistance ····· R_{90}=5kΩ±3% (Flake chip)
●B value (3U) ····· $B_{25/50}$=3950K±3%
$B_{25/85}$=4025K
●Operating temperature range ····· −30˚C~+130˚C
●Application ····· Delivery pipe
●Thermal time constant (in water)···· 5sec.

Sensor for car air conditioner

CAE-60





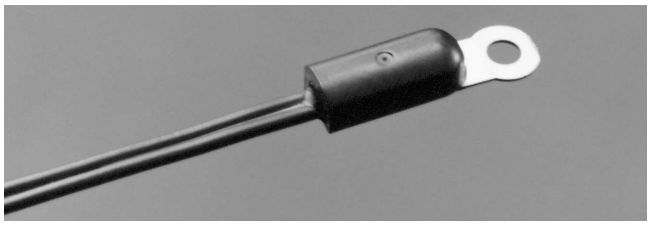
■Features

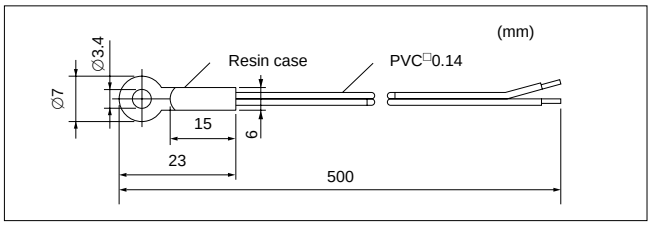
- Moisture resistant.
- Small with quick temperature response.

- Resistance ····· R_0=4.852kΩ±5% (Flake chip)
- B value (6D) ····· $B_{25/50}$=3930K±3%
  $B_{25/85}$=3941K
- Operating temperature range ····· −30˚C~+100˚C
- Application ····· Evaporator
- Thermal time constant (in water) ··· 4sec.

Sensor for measuring surface temperature

STS-60



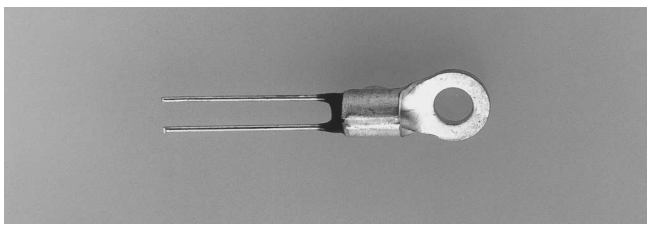


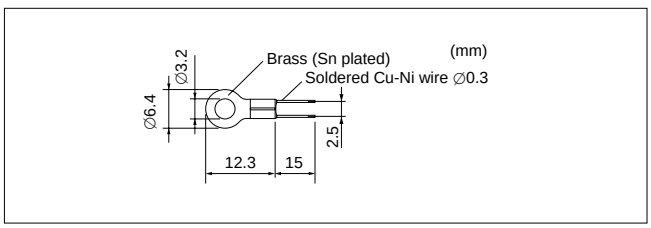
■Features

- Metal contact surface yields fast temperature response.
- Can be fastened with a screw.

- Resistance ····· R_{25}=22kΩ±3% (Flake chip)
- B value (3U) ····· $B_{25/50}$=3950K±2%
  $B_{25/85}$=4025K
- Operating temperature range ····· −30˚C~+100˚C
- Thermal time constant (in water) ·· 12sec.

STS-40

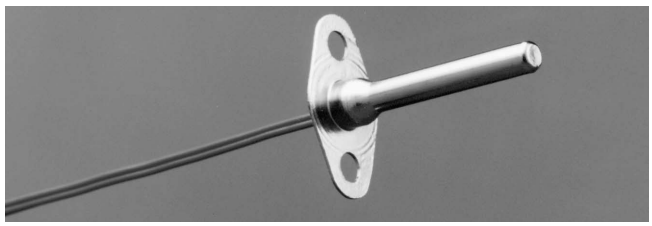


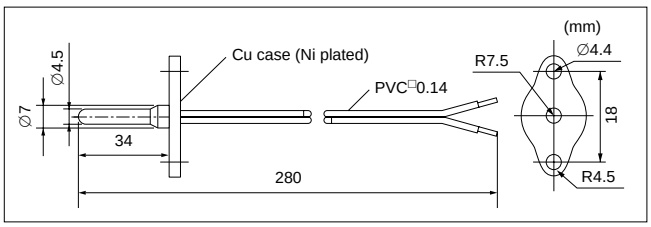


- Resistance ····· R_{25}=10kΩ±1% (Flake chip)
- B value (3H) ····· $B_{25/50}$=3450K±1%
  $B_{25/85}$=3486K
- Operating temperature range ····· −30˚C~+110˚C
- Thermal time constant (in air) ····· 35sec.

Sensor for hot boiler

HBS-45





■Features

- Moisture resistant.

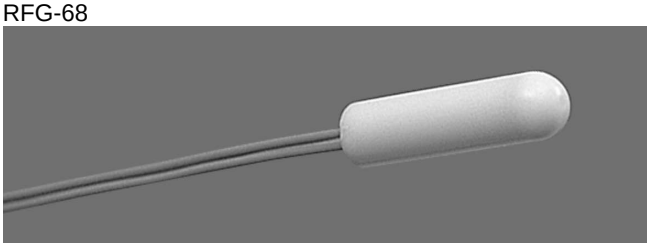
- Resistance ····· R_{25}=11kΩ±3% (Flake chip)
- B value (3T) ····· $B_{25/50}$=3950K±2%
  $B_{25/85}$=3989K
- Operating temperature range ····· −30˚C~+100˚C
- Thermal time constant (in water) ··· 8sec.

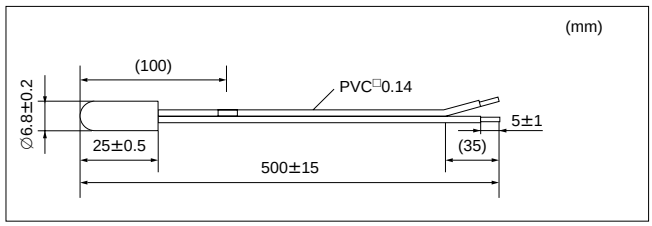
Sensor for refrigerator

■Features

●Moisture resistant.

RFG-68



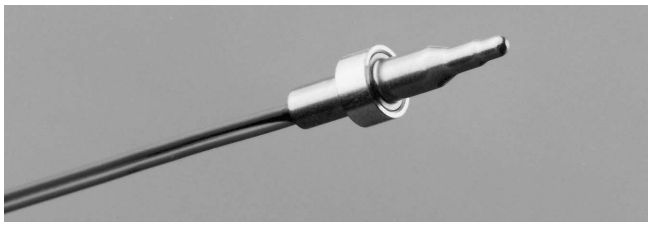


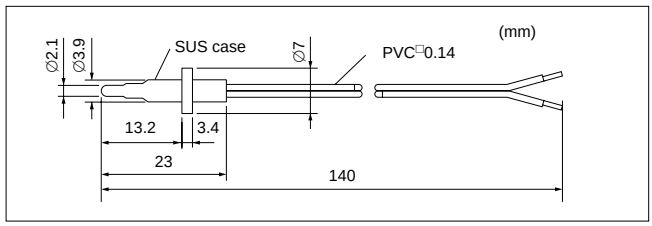
●Resistance ····· R_0=6.35kΩ±3% (Flake chip)
●B value (6W) ····· $B_{0/25}$=3823K±2%
$B_{-20/0}$=3738K
●Operating temperature range ····· −40˚C～+80˚C
Refrigerator (freezer, defroster, cold storage)
●Thermal time constant (in water) ····· 25sec.

Sensor for instant boiler

■Features

●Resistant to heat shock.
●Quick temperature response.
●Stainless steel case makes it safe to use with food.





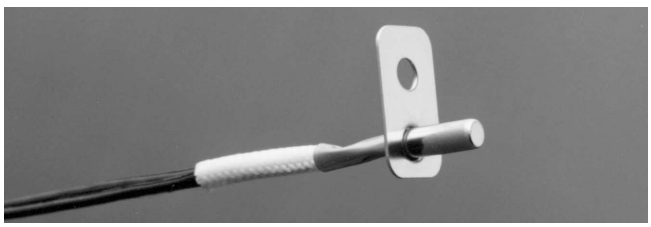
●Resistance ····· R_{50}=3.485kΩ±2.5% (GR TYPE)
●B value (6Q) ····· $B_{25/50}$=3423K±1%
$B_{25/85}$=3468K
●Operating temperature range ····· −30˚C～+105˚C
●Thermal time constant (in water) ····· 0.8sec.

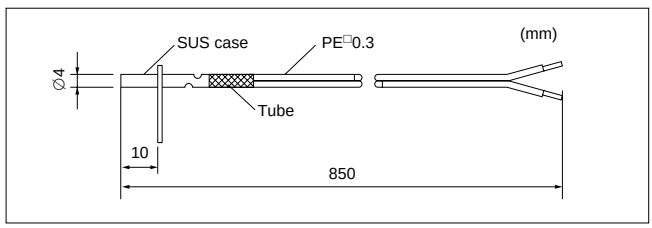
Sensor for microwave oven

■Features

●Resistant to high temperature.
●Quick temperature response.

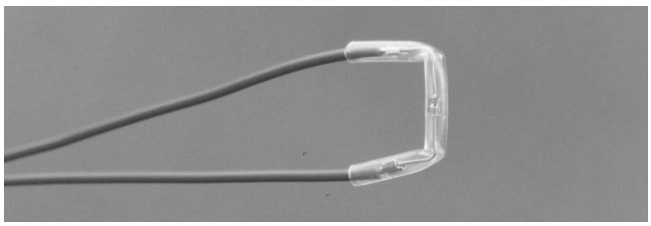
MWS-40

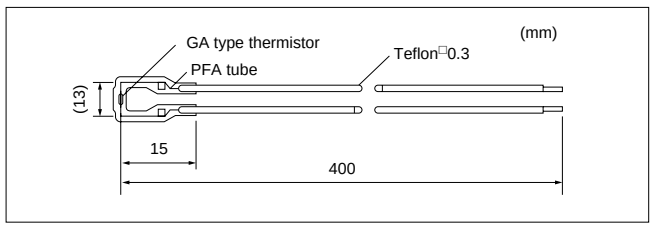




●Resistance ····· R_{200}=1kΩ±3% (GA Type)
●B value (4RG) ····· $B_{25/50}$=4050K±2%
$B_{25/85}$=4126K
●Operating temperature range ····· −30˚C～+300˚C (Sensor only)
●Thermal time constant (in water) ····· 20sec.

MWS-13





●Resistance ····· R_{200}=1kΩ±3% (GA Type)
●B value (4RG) ····· $B_{25/50}$=4050K±2%
$B_{25/85}$=4126K
●Operating temperature range ····· −30˚C～+260˚C (Sensor only)
●Thermal time constant (in water) ····· 20sec.

NTC Thermistor basic properties

Negative temperature coeffcient (NTC) thermistors are manufactured from high purity and uniform materials to achieve a construction of near-perfect theoretical density. This ensures small size, tight resistance and B-value tolerances, and fast response to temperature variations, making a highly sensitive and precision component. Thermistor is available in a wide range of types to meet your demands for small size and high reliability.

■Resistance - temperature characteristic

The resistance and temperature characteristics of a thermistor can be approximated by equation 1.

$$R = R_0 \exp\{B\,(1/T - 1/T_0)\} \quad \text{(eq1)}$$

R : resistance at absolute temperature T (K)
R_0 : resistance at absolute temperature T_0 (K)
B : B value
✻T (K) = t (˚C) +273.15

The B value for the thermistor characteristics is not fixed, but can vary by as much as 5K / ˚C according to the material composition. Therefore equation 1 may yield different results from actual values if applied over a wide temperature range.

By taking the B value in equation 1 as a function of temperature, as shown in equation 2, the difference with the actual value can be minimized.

$$B_T = CT^2 + DT + E \quad \text{(eq2)}$$

C, D, and E are constants.
The B value distribution caused by manufacturing conditions will change the constant E, but will have no effect on constants C or D. This means, when taking into account the distribution of B value, it is enough to do it with the constant E only.

●Calculation for constants C, D and E
Using equations 3~6, constants C, D and E can be determined through four temperature and resistance value data points (T_0, R_0). (T_1, R_1). (T_2, R_2) and (T_3, R_3) .
With equation 3, B_1, B_2 and B_3, can be determined from the resistance values for To and T_1, T_2, T_3 and then substituted into the equations below.

$$B_n = \frac{\ln(R_n / R_0)}{\frac{1}{T_n} - \frac{1}{T_0}} \quad \text{(eq3)}$$

$$C = \frac{(B_1 - B_2)\,(T_2 - T_3) - (B_2 - B_3)\,(T_1 - T_2)}{(T_1 - T_2)\,(T_2 - T_3)\,(T_1 - T_3)} \quad \text{(eq4)}$$

$$D = \frac{B_1 - B_2 - C\,(T_1 + T_2)\,(T_1 - T_2)}{(T_1 - T_2)} \quad \text{(eq5)}$$

$$E = B_1 - DT_1 - CT_1 \cdot T_1 \quad \text{(eq6)}$$

●Example
Using a resistance-temperature characteristic chart, the resistance value over the range of 10˚C~30˚C is sought for a thermistor with a resistance of 5kΩ and a B value deflection of 50K at 25˚C.

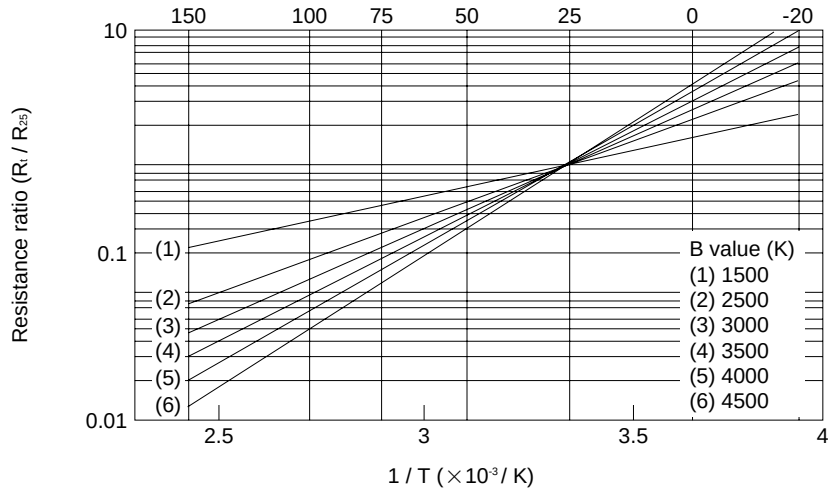
●Process
①Determine the constants C, D and E from the resistance-temperature chart.

T_0=25+273.15 T_1=10+273.15 T_2=20+273.15 T_3=30+273.15

②$B_T = CT^2 + TD + E + 50$; substitute the value into equation and solve for B_T

③$R = 5\exp\{B_T\,(1/T - 1/298.15)\}$; substitute the values into equation and solve for R
✻T : 10+273.15~30+273.15

●Results of plotting the resistance-temperature characteristics are shown figure 1



RESISTANCE-TEMPERATURE CHARACTERISTIC (Fig. 1)

■Resistance temperature coefficient

The resistance-temperature coefficient (α) is defined as the rate of change of the zero-power resistance associated with a temperature variation of 1℃ at any given temperature.
The relationship between the resistance-temperature coefficient (α) and the B value can be obtained by differentiating equation 1 above.

$$\alpha = \frac{I}{R} \cdot \frac{dR}{dT} \times 100 = -\frac{B}{T^2} \times 100 \ (\% / ℃) \cdots\cdots (2.1)$$

A negative value signifies that the rated zero-power resistance decreases

■Heat dissipation constant (JIS-C2570)

The dissipation constant (δ) indicates the power necessary for increasing the temperature of the thermistor element by 1℃ through self-heating in a heat equilibrium.
Applying a voltage to a thermistor will cause an electric current to flow, leading to a temperature rise in the thermistor. This " intrinsic heating " process is subject to the following relationship among the thermistor temperature T_1, ambient temperature T_2, and consumed power P.

$$\delta = \frac{P}{T_1 - T_2} (mW/℃) \cdots\cdots (2.2)$$

$$\ast (P = I^2 \cdot R = I \cdot V)$$

Measuring conditions for all parts in this catalog are as follows:

①Room temp is 25℃
②Axial and radial leaded parts were measured in their shipping condition.

■Power rating (JIS-C2570)

The power rating is the maximum power for a continuous load at the rated temperature.

For parts in this catalog, the value is calculated from the following formula using 25℃ as the ambient temperature.
(formula) Rated power=heat dissipation constant × (maximum operating temperature−25℃)

■Maximum operating power

Definition : The power to reach the maximum operating temperature through self heating when using a thermistor for temperature compensation or as a temperature sensor. (No JIS definition exists.) The maximum operating power, when t ˚C is the permissible temperature rise, can be calculated using the following formula.

Maximum operating power= t × heat dissipation constant··· (3.3)

■Thermal time constant for changes in surrounding temperature (JIS-C2570)

A constant expressed as the time for the temperature at the electrodes of a thermistor, with no load applied, to change to 63.2% of the difference between their initial and final temperatures, during a sudden change in the surrounding temperature.

When the surrounding temperature of the thermistor changes from T_1 to T_2, the relation between the elapsed time t and the thermistors temperature T can then be expressed by the following equation.

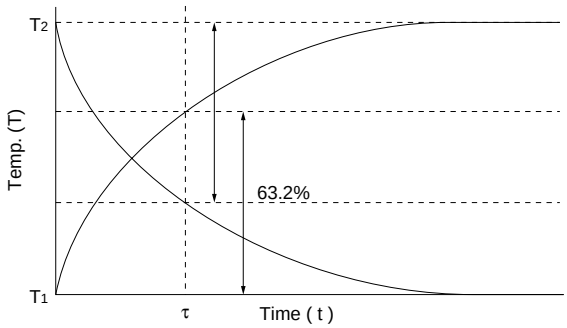
$$T=(T_1-T_2)\exp(-t/\tau)+T_2 \cdots\cdots (3.1)$$
$$=(T_2-T_1)\{\exp(-t/\tau)\}+T_1 \cdots\cdots (3.2)$$

The constant τ is called the heat dissipation constant.
If $t=\tau$, the equation becomes : $(T-T_1)/(T_2-T_1)=0.632$

In other words, the above definition states that the thermal time constant is the time it takes for the temperature of the thermistor to change by 63.2% of its initial temperatrue difference.
The rate of change of the thermistor temperature versus time is shown in table 1.

t	$\frac{T-T_1}{T_2-T_1}$
τ	63.2%
2τ	86.5%
3τ	95.0%
4τ	98.2%
5τ	99.4%

Table-1 Thermal Time Constant



Measuring conditions for parts in this catalog are as follows :

①Part is moved from a 50˚C environment to a still air 25˚C environment until the temperature of the thermistor reaches 34.2˚C.
②Axial and radial leaded parts are measured in their shipping form.

Please note, the thermal dissipation constant and thermal time constant will vary acccrding to environment and mounting conditions