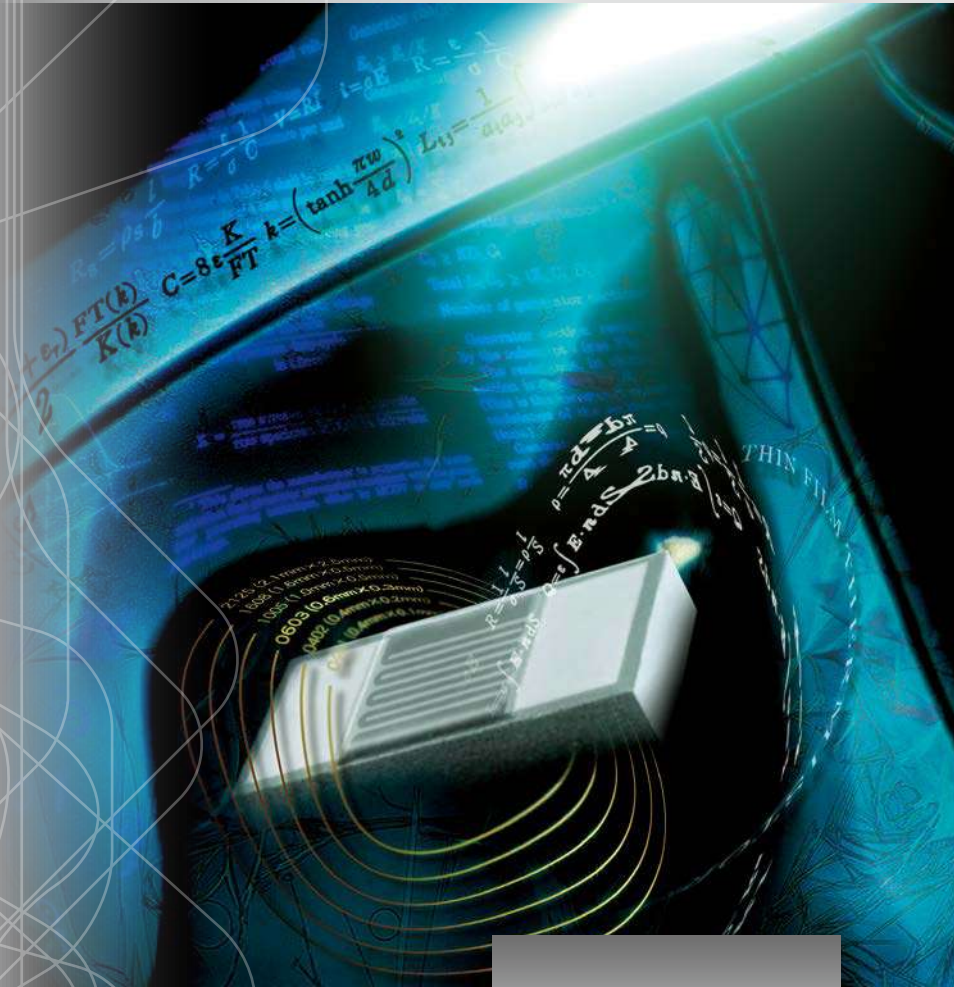


SEMITEC

SEMITEC Corporation



NTC thermistors
Circuit protection components

Cat. No. 129M

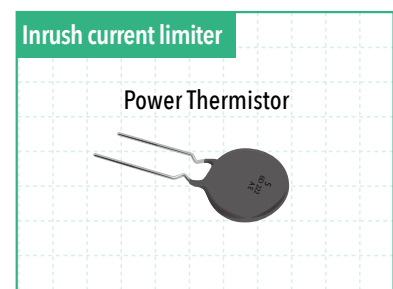
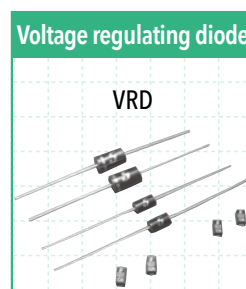
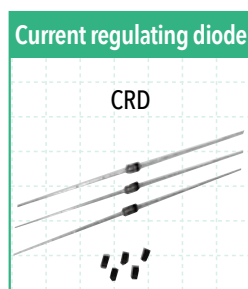
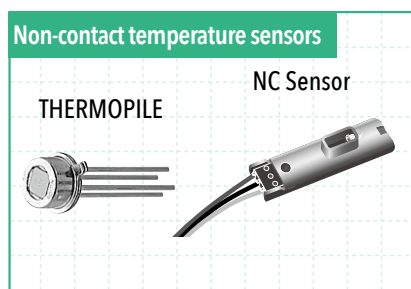
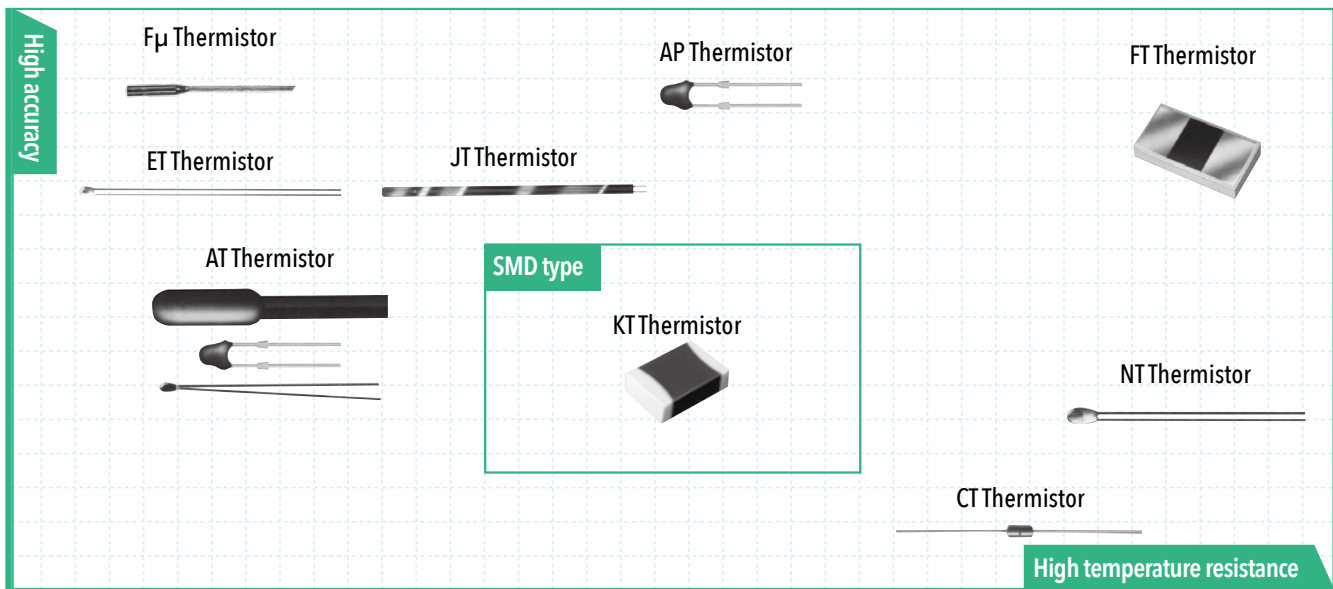
Product Catalog

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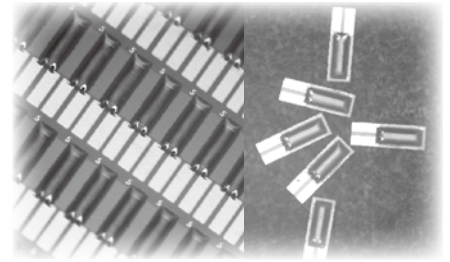


1. Application examples

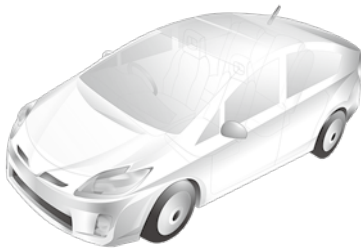
Medical and healthcare devices



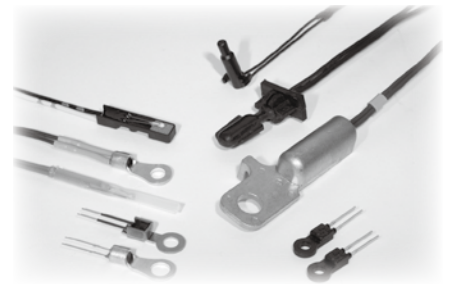
- Application
- Catheter
 - X-ray equipment
 - AED
 - MRI
 - Fluid pumps
 - Vital sign monitor
 - Electrical thermometer
 - Blood pressure measurement
 - Wearable devices



Automotive



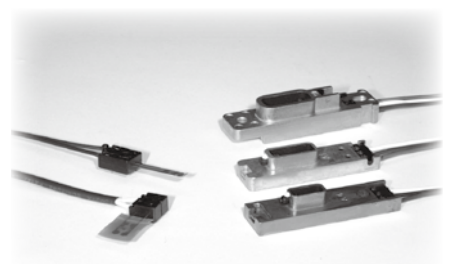
- Application
- Battery
 - Engine
 - Radiator
 - Car air conditioner
 - Car navigation
 - Seat heater
 - Inverter / converter
 - Air intake / exhaust gas
 - Capacitor
 - EV charger



Office equipment



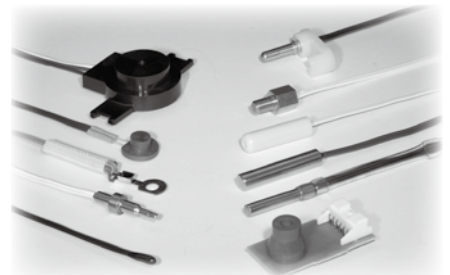
- Application
- Printer
 - Copy machine
 - Scanner
 - Projector
 - Fax machine
 - Router



Home appliances



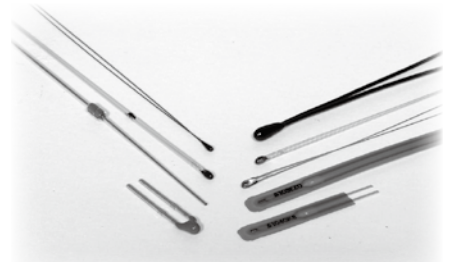
- Application
- Air conditioner
 - Refrigerator
 - Rice cooker
 - Microwave oven
 - Fan heater
 - IH cooking heater
 - Water boiler
 - Hot water toilet seat
 - Fire alarm



Consumer electronics



- Application
- PC
 - Tablet PC
 - Camera
 - Smart phone
 - Server



2. What are "NTC thermistors"?

The term "thermistor" is derived from the description "thermally sensitive resistor". NTC (Negative Temperature Coefficient) thermistors are resistors whose electrical resistance decreases with an increase of thermistor temperature. When the term "thermistor" is used, it usually means "NTC thermistor".

Thermistors are ceramic semiconductors which are manufactured by sintering metal oxide compounds at high temperatures. Controlling and planning the manufacturing method and thermistor structure makes it possible to determine the thermistor shape and electrical characteristics so that the finished product can be used in thousands of applications for temperature measurement, heat management and more.

3. Basic specifications

3-1. Resistance / temperature characteristics

Using below formula 1 the relation between the resistance and temperature values for a given temperature range can be approximated.

$$\text{Formula 1: } R_1 = R_2 \exp\left[B\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right]$$

T_1, T_2 : Absolute temperature (K)
 R_1, R_2 : Zero power resistance (Ω) at T_1, T_2
 B : B value (K)

3-2. Zero power resistance

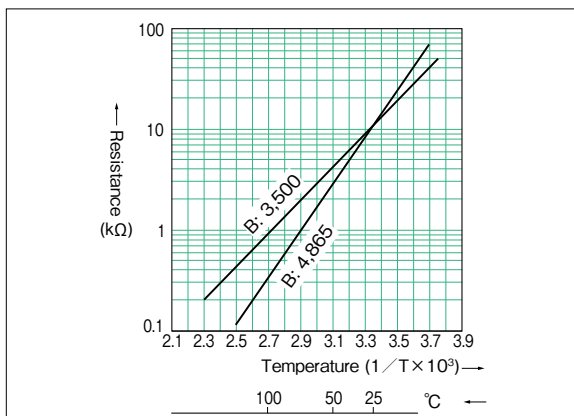
Resistance of a thermistor measured at a given temperature using electrical power low enough that sensor self heating will not noticeably affect resistance values.

3-3. B value

Constant that measures the size of the change of resistance values by using the resistance / temperature characteristics of two freely selectable points. The constant can be calculated using below formula 2.

$$\text{Formula 2: } B = \frac{\ln R_1 - \ln R_2}{\frac{1}{T_1} - \frac{1}{T_2}}$$

Using $\log R$ and $1/T$ the B value characteristics can be expressed in a graph in a straight line as below.



3-4. Resistance / temperature coefficient

Coefficient which expresses the rate of change per degree of the zero power resistance at a given temperature. The coefficient can be calculated using below formula 3.

$$\text{Formula 3: } \alpha = \frac{1}{R} \cdot \frac{dR}{dT} \times 100 = - \frac{B}{T^2} \times 100$$

α : Resistance / temperature coefficient
 T : Given absolute temperature (K)
 R : Zero power resistance (Ω) at given temperature T (K)
 B : B value (K)

3-5. Dissipation factor (JIS-C2570-1)

Constant which expresses the electrical power necessary to cause a self heating effect of 1 °C of a given thermistor in a state of thermal equilibrium.

The value of this constant can be calculated based on the ratio of electrical power and temperature increase.

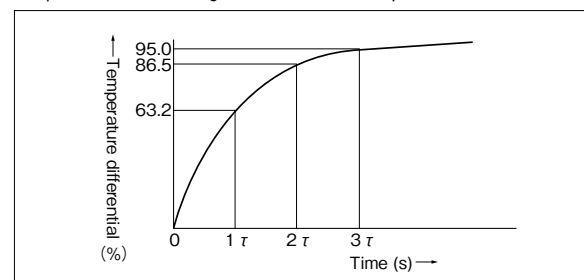
This ratio can be calculated by using formula 4 below, where P (mW) means power consumption and δ (mW / °C) means dissipation factor.

$$\text{Formula 4: } P = \delta (T_b - T_a) \\ \delta = P / (T_b - T_a) = I^2 R / (T_b - T_a)$$

P : Thermistor power consumption (mW)
 δ : Dissipation factor (mW / °C)
 T_a : Thermistor environment temperature (°C)
 T_b : Thermistor temperature at new thermal equilibrium after temperature increase
 I : Thermistor electrical current (mA)
 R : Thermistor resistance (Ω) at T_b (°C)

3-6. Thermal time constant (JIS-C2570-1)

Constant which expresses the heat response time of the thermistor. The thermal time constant is defined as the time required by a thermistor to change 63.2% of the difference between its initial and its final temperature after a change in environment temperature.



Multiples (factor n) of the thermal time constant τ result in below percentages.

$$\tau = 63.2\% \quad 2\tau = 86.5\% \quad 3\tau = 95.0\%$$

3-7. Rated maximum power dissipation

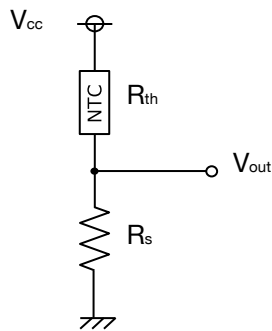
Maximum electrical power (mW) which can be applied continuously to a thermistor at a given rated temperature (usually 25 °C).

When applying electrical power to a thermistor the thermistor will self heat and reach a thermal equilibrium with the environment temperature. However, in case of excessive electrical power thermal runaway may occur which can destroy the thermistor's electrical characteristics.

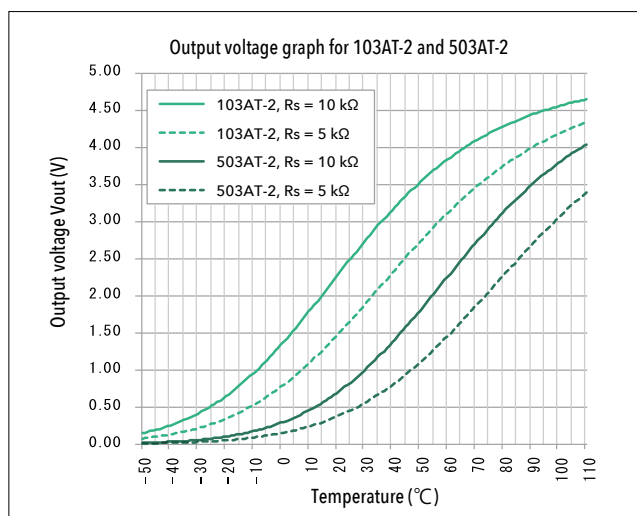
The maximum rated power value for each thermistor is determined as the value at which the thermistor self heats 5 °C.

4. How to use thermistors

The electrical resistance of NTC thermistors changes greatly when the thermistor temperature changes, which makes thermistors a popular choice for temperature sensors. However, because the resistance change of thermistors is non-linear, it is common to build a circuit with a thermistor and a resistor in order to linearize the voltage output (see also below circuit example).



Thermistor linearization circuit



The voltage output of this circuit can be expressed using formula 5 below and by using a resistance / temperature table it is possible to determine the measured temperature.

$$\text{Formula 5: } V_{\text{out}} = \frac{V_{\text{CC}}}{R_{\text{th}} + R_{\text{s}}} \times R_{\text{s}}$$

V_{cc} : Supply voltage (V)

V_{out} : Voltage output (V)

R_{th} : Thermistor resistance (Ω)

R_{s} : Resistor resistance (Ω)

It is possible to increase measurement accuracy through linearization, however the temperature range that can be linearized is limited.

The graph on the left shows the voltage output for combinations of two thermistors (SEMITEC PN: 103AT-2, 503AT-2) and two resistors (10 k Ω , 5 k Ω) as an example of this limitation.

The graph shows how the linearized temperature range changes according to each combination of thermistor and resistor.

Accordingly, we recommend using a thermistor and resistor combination after the temperature range which needs to be measured precisely is determined.

5. How to use power thermistors

Power thermistors utilize the characteristics of NTC thermistors where a device heats up when current flows through it, and this self heating causes a dramatic decrease in resistance.

A typical example for using power thermistors is a switched-mode power supply using a smoothing capacitor.

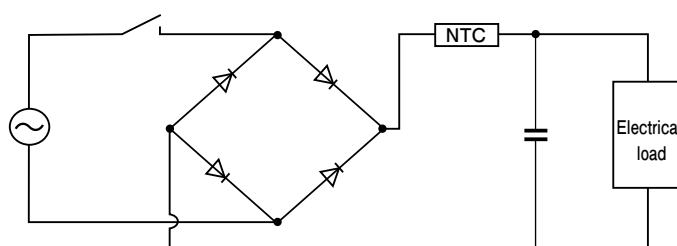
When applying an electrical current to the smoothing capacitor it will charge rapidly which is accompanied by an inrush current. The power thermistor's initial resistance limits this current and later, when the current has normalized, the power thermistor's resistance decreases due to self heating and power loss is compensated.

Power thermistors can be used as in the circuit below, however the power thermistor itself can be used both before and after rectification.

When choosing a power thermistor we recommend determining the resistance needed for the rated electrical current for your components and devices and the rated capacitance of your capacitor to determine the maximum rated current of the power thermistor.

However, please be aware, that due to power thermistor self heating or increase of environment temperature the resistance of the power thermistor will decrease and with it the maximum rated current will also decrease.

It is also important to be aware of power thermistor self heating as it may affect the circuit board or surrounding devices.



Micro thin film thermistor

FT Thermistor

FT thermistors have outclassed conventional thermistors through miniaturization, featuring quick response time, high heat resistance and excellent long term reliability.

Product number explanation

103	FT	1005	A	5P	1	-	□
<p>T: Taping¹ No marking: Untaped bulk products Electrode type: 1 = Pt 2 = Au/Ni 3 = Au Tolerance (R₂₅): 5P = 5% B value: A = 3370 K B = 3435 K D = 3969 K Size: See Fig. 1 Micro thin film thermistor Rated zero-power resistance at 25 °C E.g.: 103 = 10 x 10³ Ω</p>							

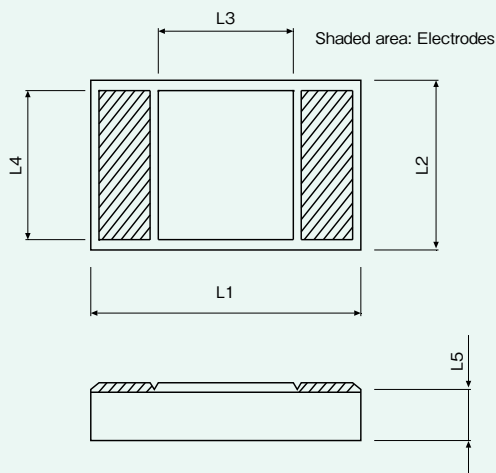
¹: Taping is currently available only for 1005 size.

Applications

High speed electrical thermometers, wearable devices, office automation, measurement instruments, medical devices, computer and mobile devices, LCDs, security devices, laser diode modules

Dimensions

Fig. 1



Size	L1	L2	L3	L4	L5 ²
1005	1.00 ± 0.05	0.50 ± 0.05	(0.50)	(0.44)	(0.15)
0603	0.60 ± 0.05	0.30 ± 0.05	(0.15)	(0.25)	(0.15)

Unit: mm

²: For thinner substrates (= smaller L5 dimension) please contact SEMITEC sales staff.

Specifications

Product number	R ₂₅ ³	R ₂₅ tolerance	B value ⁴	Dissipation factor (mw / °C)	Thermal time constant (s) ⁵	Rated power at 25 °C (mW)	Operating temperature range by electrode (°C)		
							1: Pt	2: Au/Ni	3: Au
103FT1005A5P	10.0 kΩ	± 5% ⁶	3370 K ± 1%	approx. 0.3	approx. 1.0	1.5	- 40 to 250 (350)	- 40 to 125	- 40 to 250
103FT1005B5P	10.0 kΩ		3435 K ± 1%						
103FT1005D5P	10.0 kΩ		3969 K ± 1%						
503FT1005A5P	50.0 kΩ		3370 K ± 1%						
503FT1005B5P	50.0 kΩ		3435 K ± 1%						
364FT1005A5P	360.0 kΩ		3370 K ± 1%						
New 364FT0603A5P	360.0 kΩ		3370 K ± 1%	approx. 0.2	approx. 0.5	1.0			

³: Rated zero-power resistance at 25 °C ⁴: B value calculated from rated zero-power resistance at 25 °C and 85 °C

⁵: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

⁶: If your application requires other tolerance values please contact SEMITEC sales staff.

Reliability data

Item	Electrode type	Test conditions	Criteria
Solderability	2 = Au/Ni	5 s at 260 °C	More than 90% soldered
Free fall	All	Three times natural fall to a maple board from 0.75 m height.	ΔR, ΔB ± 1%
Insulation resistance	All	100 V DC	Over 100 MΩ
Dry heat (1)	1 = Pt 3 = Au	1000 hours at 250 °C	ΔR ± 5%, ΔB ± 1%
Dry heat (2)	2 = Au/Ni	1000 hours at 125 °C	ΔR ± 3%, ΔB ± 1%
Cold	All	1000 hours at - 40 °C	ΔR ± 3%, ΔB ± 1%
Temperature cycle (thermal shock)	All	100 cycles as below: 1. - 40 °C for 30 minutes 2. Room temperature for 3 minutes 3. 125 °C for 30 minutes 4. Room temperature for 3 minutes	ΔR ± 3%, ΔB ± 1%

Mounting method recommendations

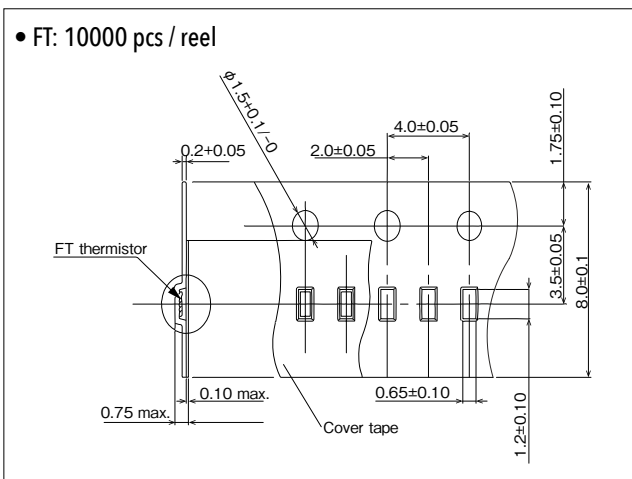
Electrode type	Recommended method
1 = Pt	Conductive resin
2 = Au/Ni	Solder
3 = Au	Wire bonding

■ Resistance / temperature characteristics

Temperature (°C)	Product number						
	103FT1005A5P	103FT1005B5P	103FT1005D5P	503FT1005A5P	503FT1005B5P	364FT1005A5P	364FT0603A5P
-40	187.9	200.7	351.0	939.3	1,002	6,763	6,763
-30	110.7	117.0	185.0	553.4	584.7	3,984	3,984
-20	67.26	70.34	100.9	336.3	351.9	2,421	2,421
-10	42.10	43.55	57.00	210.5	217.7	1,516	1,516
0	27.08	27.71	33.33	135.4	138.5	974.8	974.8
10	17.86	18.11	20.12	89.31	90.48	643.0	643.0
20	12.07	12.12	12.53	60.33	60.58	434.4	434.4
25	10.00	10.00	10.00	50.00	50.00	360.0	360.0
30	8.332	8.299	8.038	41.66	41.50	299.9	299.9
40	5.871	5.804	5.295	29.36	29.03	211.4	211.4
50	4.216	4.139	3.575	21.08	20.70	151.8	151.8
60	3.081	3.006	2.472	15.40	15.04	110.9	110.9
70	2.288	2.220	1.746	11.44	11.11	82.36	82.36
80	1.725	1.666	1.258	8.623	8.331	62.09	62.09
85	1.505	1.451	1.075	7.527	7.257	54.19	54.19
90	1.318	1.269	0.9230	6.592	6.344	47.46	47.46
100	1.021	0.9797	0.6888	5.105	4.898	36.76	36.76
110	0.8003	0.7662	0.5220	4.002	3.829	28.81	28.81
120	0.6345	0.6064	0.4012	3.172	3.029	22.84	22.84
125	0.5671	0.5418	0.3535	2.836	2.706	20.42	20.42
130	0.5084	0.4854	0.3125	2.542	2.423	18.30	18.30
140	0.4113	0.3926	0.2465	2.057	1.960	14.81	14.81
150	0.3359	0.3207	0.1969	1.680	1.601	12.09	12.09
160						9.963	9.963
170						8.274	8.274
180						6.925	6.925
190						5.837	5.837
200						4.954	4.954
210						4.232	4.232
220						3.636	3.636
230						3.142	3.142
240						2.731	2.731
250						2.385	2.385
B _{25/85}	3370 K	3435 K	3969 K	3370 K	3435 K	3370 K	3370 K

Unit: kΩ

■ Taping dimensions



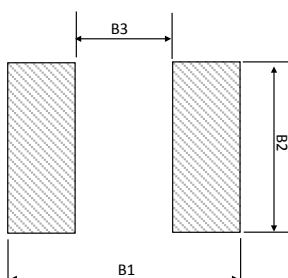
■ How to use the FT thermistor

- The FT thermistor can be used for both SMD type mounting and as a leaded thermistor (both axial and radial).
If your application requires lead wires please contact SEMITEC sales staff
- With the FT thermistor it is possible to pair two sensors (e.g. one for temperature measurement and one for compensation) with very high accuracy. If your application may require thermistor pairing please contact SEMITEC sales staff.

■ Caution

- Please contact us when choosing the mounting method.
- Please contact us when considering an application with an environment temperature exceeding 350 °C.

■ Recommended mounting pad dimensions



Size	B1	B2	B3
1005	1.20 ± 0.03	0.60 ± 0.03	0.30 ± 0.03
0603	0.72 ± 0.03	0.36 ± 0.03	0.18 ± 0.03

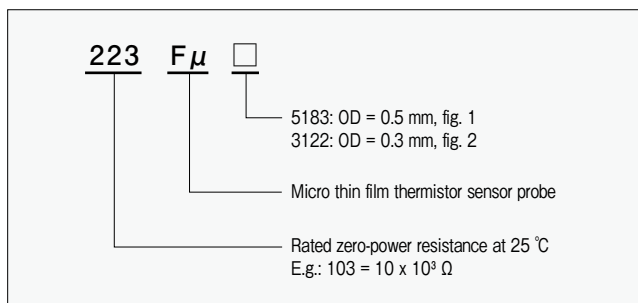
Micro thin film type sensor probe

F μ Thermistor

The F micro thin film thermistor sensor probe has been developed applying SEMITEC's proprietary thin film thermistor technology, specifically with medical purposes in mind.

It is highly suited for catheter applications with its high volume production capability, robustness, reliability, accuracy and faster response than existing thermistors.

Product number explanation



Applications

Medical catheters
Guide wires
Testing equipment
Handheld medical devices
Body temperature monitoring
Other applications that require very small probes

Resistance / temperature characteristics

Temperature (°C)	223F μ ⁵
-10	100.3
0	62.92
10	40.56
20	26.82
30	18.16
40	12.58
50	8.892
60	6.407
70	4.700

⁵: Resistance values for the thermistor chip without lead wires

Specifications

Product number	R ₃₇ ¹	R ₃₇ tolerance	B value ²	Dissipation factor (mW / °C)	Thermal time constant (ms) ³	Rated power at 25°C (mW)	Operating temperature range (°C)
223F μ 5183	14.015 kΩ	± 0.5% ⁴	3454 K ± 1%	approx. 0.35	approx. 52	1.75	- 10 to 70
223F μ 3122	14.015 kΩ	± 3% ⁴	3454 K ± 1%	approx. 0.22	approx. 20	1.1	- 10 to 70

¹: Rated zero-power resistance at 37 °C of the thermistor chip without lead wires

²: B value calculated from rated zero-power resistance at 0 °C and 50 °C without lead wires

³: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in still water.

⁴: If your application requires other tolerance values please contact SEMITEC sales staff.

Reliability data

Item	Test conditions	Criteria
Free fall	Three times natural fall to a maple board from 1 m height.	ΔR, ΔB ± 0.5%
Dry heat	1000 hours at 70 °C	
Damp heat	1000 hours at 70 °C and 90% to 95% humidity	
Temperature cycle (thermal shock)	Seven cycles as below: 1. - 20 °C for 12 hours 2. Room temperature for 1 minute 3. 55 °C for 12 hours 4. Room temperature for 1 minute	

Caution

The F micro thermistor sensor probe is manufactured using a semiconductor process. Due to its microstructure the sensor is sensitive to electrostatic discharge (ESD) in just the same way as common integrated circuits are.

In order to prevent damage to or failure of the sensor SEMITEC recommends to take appropriate precautions against ESD when handling it.

Failure to protect the sensor against ESD may also cause damage to the equipment installed with the sensor, because electrostatic discharge can cause small parametric changes, which means that the sensor may not meet its published specification.

Dimensions

Fig. 1

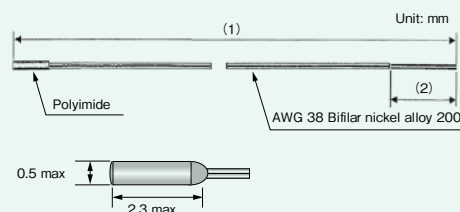
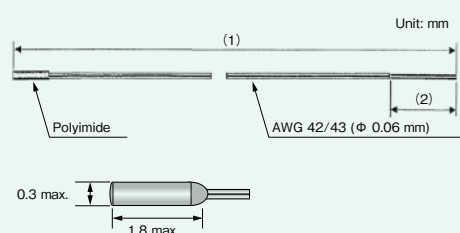


Fig. 2

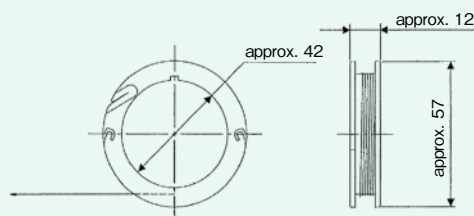


(1) Lead wire length customized according to customer requirements (max. 200 cm).
(2) Bare lead wire length customized according to customer requirements.

Please contact SEMITEC sales staff for products without resin coating on the sensor head for even smaller diameter.

Spool dimensions

Unit: mm



Connection method

The lead wire can be soldered to larger wires by winding it around the larger wire and then soldering.

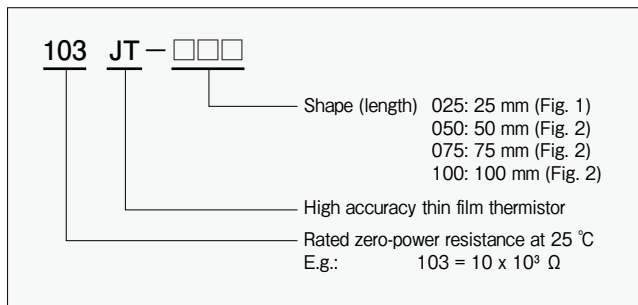
Please contact SEMITEC sales staff for customized bare lead wire lengths according to your application's requirements.

■ Thin film thermistor

JT Thermistor

The JT series thermistor features high accuracy and a thickness of less than 500 μm. The JT thermistor also has excellent electrical insulation and can be safely used in environments where it might come in contact with electrodes.

■ Product number explanation



■ Applications

Battery packs, battery chargers, IT equipment, mobile devices, LCDs, surface temperature sensors, high sensitivity air temperature sensors

■ Specifications

Product number	R ₂₅ ¹	R ₂₅ tolerance	B value ²	Dissipation factor (mw / °C)	Thermal time constant (s) ³	Rated power at 25 °C (mW)	Operating temperature range (°C)
103JT	10.0 kΩ	± 1%	3435 K ± 1%	approx. 0.7	approx. 5	3.5	- 50 to 125
104JT	100 kΩ		4390 K ± 1%				

¹: Rated zero-power resistance at 25 °C ²: B value calculated from rated zero-power resistance at 25 °C and 85 °C

³: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

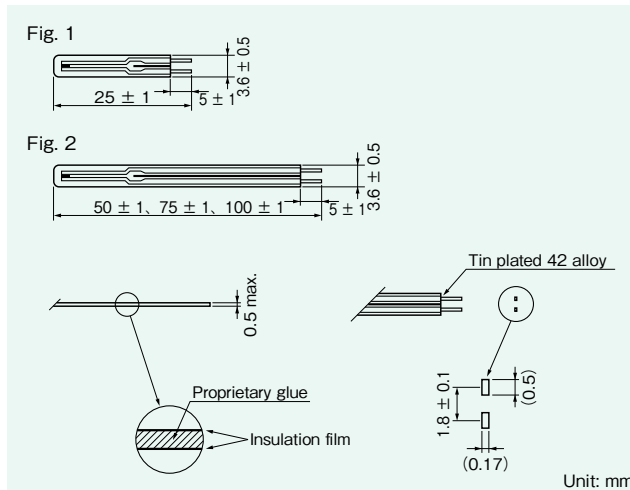
■ Reliability data

Item	Test conditions	Criteria
Resistance to soldering heat	5 s at 260 °C	ΔR, ΔB ± 1%
Solderability	2 s at 245 °C Flux material: Rosin 25%, ethyl alcohol 75%	More than 90% soldered
Tensile strength (lead wire)	10 s at 1 N (horizontal pull)	ΔR, ΔB ± 1% and visual inspection
Termination bending	2.5 N, one time, 90°	
Free fall	Three times natural fall to a maple board from 0.75 m height.	
Voltage proof	100 V AC for one minute	Less than 1 mA
Insulation resistance	100 V DC	Over 100 MΩ
Dry heat	1000 hours at 125 °C	ΔR, ΔB ± 1%
Damp heat (under electrical load)	1000 hours at 40 °C and 90% humidity Electrical load: 1 mA DC	
Temperature cycle (thermal shock)	100 cycles as below: 1. - 25 °C for 30 minutes 2. Room temperature for 3 minutes 3. 125 °C for 30 minutes 4. Room temperature for 3 minutes	

■ Caution

- If you plan pressing or pushing the thermistor against an object or inserting it into a tight space please contact SEMITEC sales staff.
- When soldering make sure to avoid contact of the hot part (over 150 °C) and the sensor, because this may melt the sensor film.
- When bending the sensor make sure to not apply force on the sensor head (minimum distance from sensor: 3 mm) when fixing it. Additionally, make sure to bend the lead wire with a minimum distance of 7 mm from the sensor head.

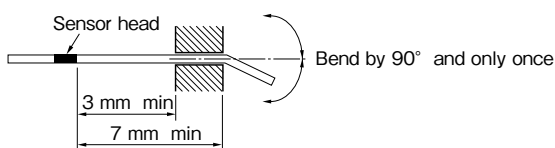
■ Dimensions



■ Resistance / temperature characteristics

Temperature (°C)	Product number	
	103JT	104JT
- 50	367.7	9584
- 40	204.7	4572
- 30	118.5	2282
- 20	71.02	1191
- 10	43.67	647.2
0	27.70	365.0
10	18.07	212.5
20	12.11	127.7
25	10.00	100.0
30	8.301	78.88
40	5.811	50.03
50	4.147	32.51
60	3.011	21.61
70	2.224	14.66
80	1.668	10.13
85	1.451	8.483
90	1.267	7.135
100	0.9753	5.111
110	0.7597	3.720
120	0.5981	2.746
125	0.5331	2.371
B _{25/85}	3435 K	4390 K

Unit: kΩ



Very high accuracy thermistor

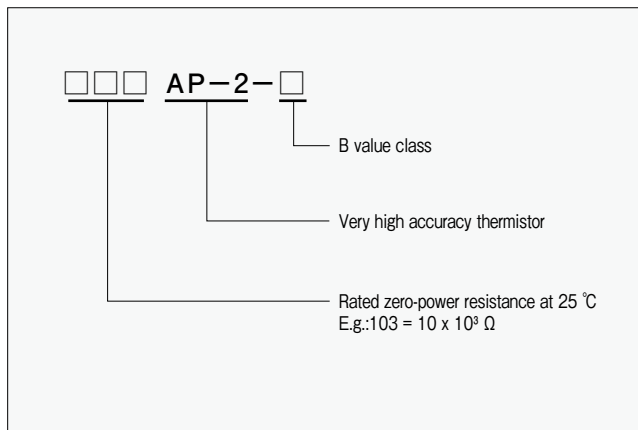
AP Thermistor

The AP series thermistor features an even higher accuracy than our high accuracy AT thermistors and is suitable for many applications.

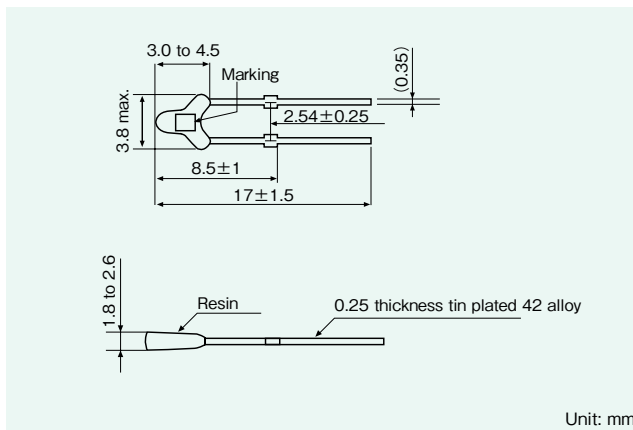
Features: - Very high accuracy with tight R_{25} and $B_{25/85}$ tolerances ($\pm 0.5\%$)

- High accuracy over a wide temperature range: 0.5% resistance tolerance from $-60\text{ }^{\circ}\text{C}$ to $+80\text{ }^{\circ}\text{C}$

Product number explanation



Dimensions



Applications

Mobile devices, battery chargers, battery packs, fan motors, automotive, office automation, home electronics, security, thermometers, measuring instruments, etc.

Specifications

Product number	R_{25}^1	R_{25} tolerance	B value ²	Dissipation factor (mw / °C)	Thermal time constant (s) ³	Rated power at 25 °C (mW)	Operating temperature range (°C)
202AP-2	2.00 kΩ	± 0.5%	3976 K ± 0.5%	approx. 1.2	approx. 15	6	- 60 to 150
232AP-2	2.252 kΩ		3976 K ± 0.5%				
502AP-2	5.00 kΩ		3976 K ± 0.5%				
103AP-2	10.0 kΩ		3435 K ± 0.5%				
103AP-2-A			3976 K ± 0.5%				
203AP-2	20.0 kΩ		3976 K ± 0.5%				
503AP-2	50.0 kΩ		4220 K ± 0.5%				
104AP-2	100 kΩ		4261 K ± 0.5%				
204AP-2	200 kΩ		4470 K ± 0.5%				

¹: Rated zero-power resistance at 25 °C ²: B value calculated from rated zero-power resistance at 25 °C and 85 °C

³: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

Reliability data

Item	Test conditions	Criteria
Resistance to soldering heat	10 s at 260 °C or 3.5 s at 340 °C	ΔR , $\Delta B \pm 0.5\%$ and visual inspection
Solderability	2 s at 245 °C Flux material: Rosin 25%, ethyl alcohol 75%	More than 90% soldered
Tensile strength (lead wire)	A load of 2 N is applied to the wire terminations in vertical direction for 10 s. (See Fig. 1)	ΔR , $\Delta B \pm 0.5\%$ and visual inspection
Termination bending	The lead wire is bent to an angle of 90 °C and then back into the original position.	
Free fall	Three times natural fall to a maple board from 1 m height.	Less than 1 mA
Voltage proof	1000 V AC for one minute	
Insulation resistance	500 V DC	Over 100 MΩ
Dry heat	1000 hours at 150 °C	ΔR , $\Delta B \pm 0.5\%$
Damp heat (under electrical load)	1000 hours at 40 °C and 90% humidity Electrical load: 1 mA DC	
Temperature cycle (thermal shock)	100 cycles as below: 1. - 60 °C for 30 minutes 2. Room temperature for 3 minutes 3. 150 °C for 30 minutes 4. Room temperature for 3 minutes	

Caution

- When bending the lead wires using for example a radio plier make sure to have a minimum distance from the sensor head of 3 mm.
- Do not apply a mechanical load of more than 2 N in the way depicted in Fig. 1 below.

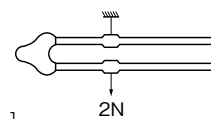


Fig. 1

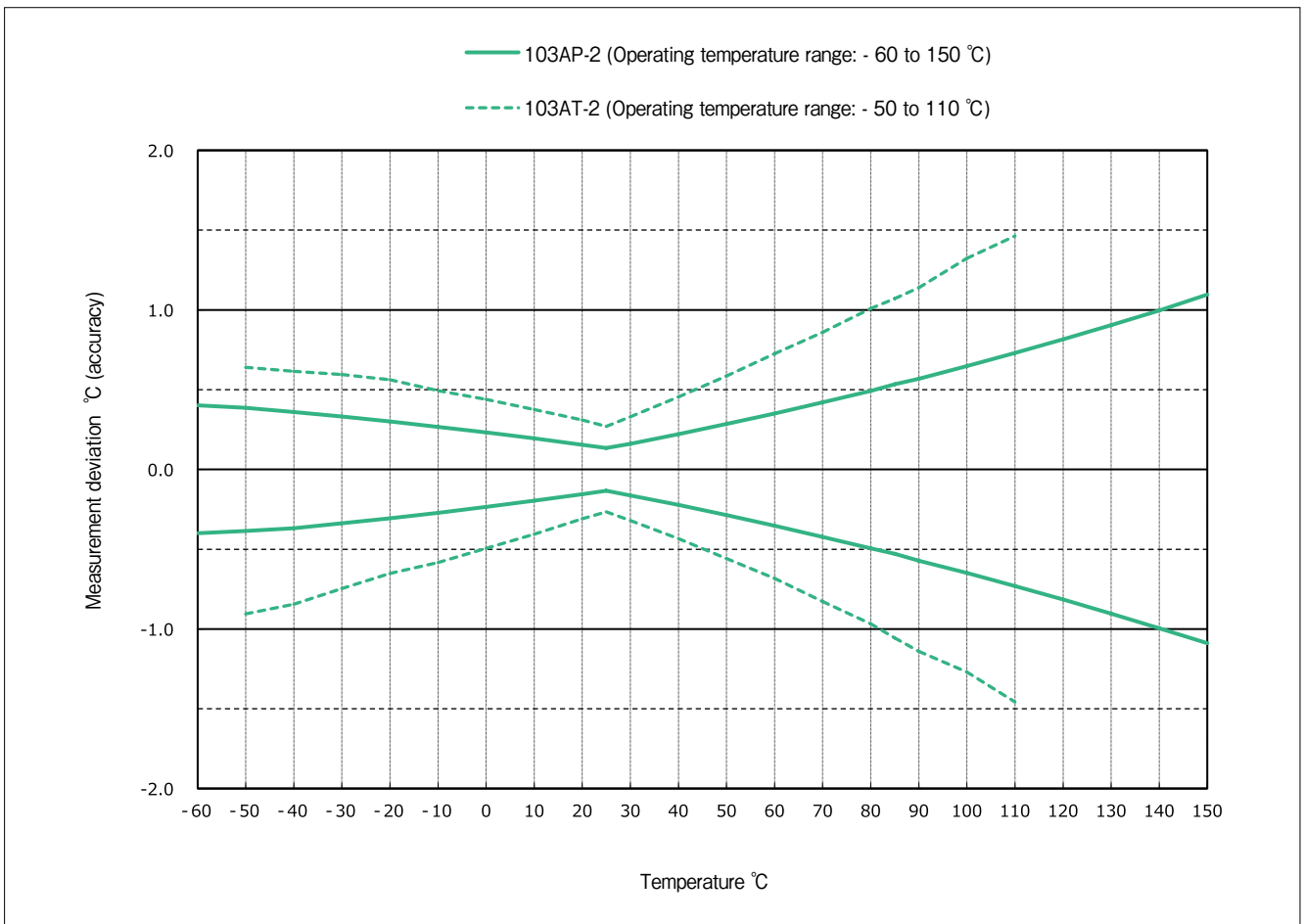
- When soldering make sure to have a minimum distance of 5 mm, use a soldering iron with 50 W and solder for maximum seven seconds at 340 °C. If you plan to cut the lead wire shorter than the above minimum distance please contact us.

■ Resistance / temperature characteristics

Temperature (°C)	Product number									
	202AP-2	232AP-2	502AP-2	103AP-2	103AP-2-A	203AP-2	503AP-2	104AP-2	204AP-2	
-60	207.1	233.2	560.2	600.6	1202	2497	7940	15510		
-50	102.6	115.5	273.7	326.9	583.4	1211	3729	7339	17830	
-40	53.94	60.73	142.2	187.4	301.2	624.9	1868	3702	8750	
-30	29.69	33.44	77.18	110.9	162.3	335.8	975.9	1943	4461	
-20	17.07	19.22	43.61	67.64	90.85	187.2	528.7	1056	2359	
-10	10.16	11.44	25.55	42.39	52.76	108.1	296.7	593.7	1291	
0	6.261	7.050	15.46	27.25	31.64	64.39	171.9	344.5	730.6	
10	3.922	4.417	9.648	17.95	19.56	39.53	102.8	205.9	426.2	
20	2.491	2.804	6.186	12.09	12.43	24.94	63.14	126.4	255.6	
25	2.000	2.252	5.000	10.00	10.00	20.00	50.00	100.0	200.0	
30	1.615	1.818	4.066	8.314	8.096	16.14	39.83	79.59	157.4	
40	1.070	1.205	2.725	5.829	5.394	10.69	25.75	51.32	99.36	
50	0.7237	0.8149	1.846	4.162	3.671	7.237	17.01	33.79	64.10	
60	0.4994	0.5624	1.270	3.022	2.546	4.998	11.48	22.72	42.26	
70	0.3513	0.3956	0.8884	2.229	1.783	3.516	7.905	15.57	28.42	
80	0.2515	0.2832	0.6314	1.669	1.265	2.516	5.539	10.86	19.47	
85	0.2142	0.2412	0.5355	1.451	1.071	2.142	4.669	9.124	16.23	
90	0.1831	0.2062	0.4558	1.266	0.9098	1.830	3.949	7.697	13.57	
100	0.1354	0.1525	0.3339	0.9737	0.6635	1.352	2.859	5.540	9.616	
110	0.1017	0.1145	0.2480	0.7576	0.4903	1.012	2.098	4.040	6.905	
120	0.07730	0.08710	0.1867	0.5961	0.3670	0.7675	1.562	2.989	5.033	
130	0.05960	0.06710	0.1422	0.4741	0.2780	0.5889	1.179	2.240	3.719	
140	0.04650	0.05230	0.1097	0.3808	0.2130	0.4570	0.8998	1.698	2.782	
150	0.03660	0.04130	0.08550	0.3087	0.1650	0.3584	0.6946	1.301	2.105	
B _{25/85}	3976 K	3976 K	3976 K	3435 K	3976 K	3976 K	4220 K	4261 K	4470 K	

Unit: kΩ

■ Measurement accuracy comparison graph



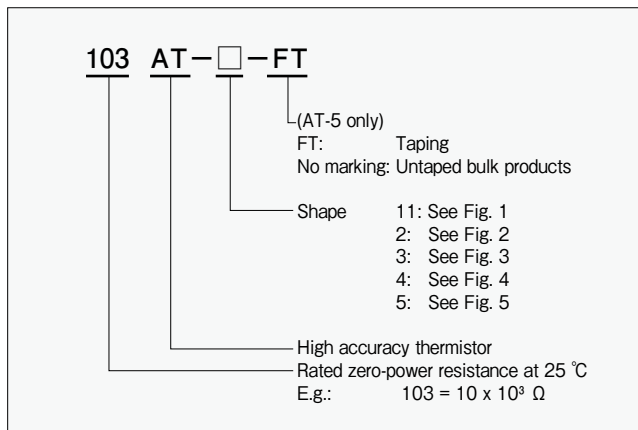
High accuracy thermistor

AT Thermistor

The AT series thermistor features high accuracy with tight resistance and B-value tolerances ($\pm 1\%$).

- Features:
- Uniform shape facilitates automated assembly
 - Long term reliability
 - Five different standard shapes available

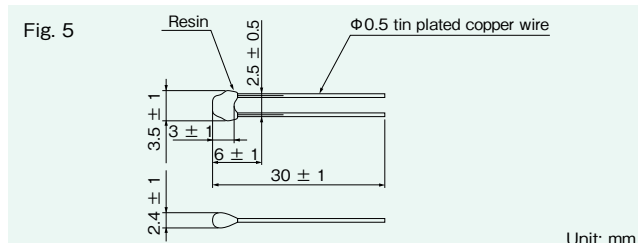
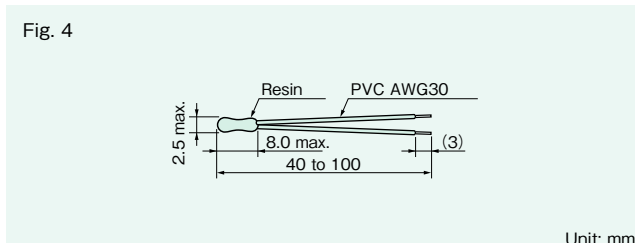
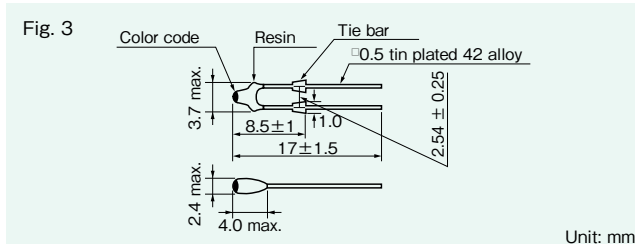
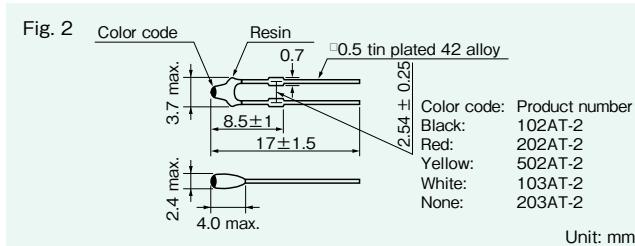
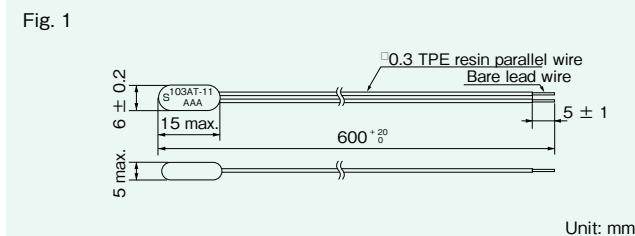
Product number explanation



Applications

Office automation, measuring instruments, controllers, mobile devices, battery chargers, battery packs, fan motors, home electronics, HVAC equipment, solar systems, security, thermometers, automotive, vending machines, refrigerated display cases, agricultural equipment

Dimensions



Specifications

Product number	R ₂₅ ¹	R ₂₅ tolerance	B value ²	Dissipation factor (mw / °C)	Thermal time constant (s) ³	Rated power at 25 °C (mW)	Operating temperature range (°C)	
102AT-11	1.00 kΩ	± 1%	3100 K ± 1%	approx. 2.6	approx. 75	13	- 50 to 90	
202AT-11	2.00 kΩ		3182 K ± 1%					
502AT-11	5.00 kΩ		3324 K ± 1%					
103AT-11	10.0 kΩ		3435 K ± 1%					
203AT-11	20.0 kΩ		4013 K ± 1%					
102AT-2	1.00 kΩ		± 1%	3100 K ± 1%	approx. 2.0	approx. 15	10	- 50 to 90
202AT-2	2.00 kΩ			3182 K ± 1%				
502AT-2	5.00 kΩ			3324 K ± 1%				
103AT-2,3	10.0 kΩ			3435 K ± 1%				
203AT-2	20.0 kΩ			4013 K ± 1%				
103AT-4	10.0 kΩ			3435 K ± 1%	approx. 10	- 30 to 90		
103AT-5	10.0 kΩ			3435 K ± 1%	approx. 2.5		approx. 15	12.5

¹: Rated zero-power resistance at 25 °C ²: B value calculated from rated zero-power resistance at 25 °C and 85 °C

³: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

Reliability data

Item	Test conditions		Criteria
Resistance to soldering heat	AT-2, 3, 4	10 s at 260 °C or 3.5 s at 350 °C	ΔR, ΔB ± 1%
	AT-5	5 s at 260 °C or 1.5 s at 350 °C	
Solderability	AT-2, 3	2 s at 245 °C. Flux material: Rosin 25%, ethyl alcohol 75%.	More than 90% soldered
	AT-4, 5	2 s at 235 °C. Flux material: Rosin 25%, ethyl alcohol 75%.	
Tensile strength (lead wire)	AT-11	10 s at 30 N (horizontal pull)	ΔR, ΔB ± 1% and visual inspection
	AT-2, 3	A load of 2 N is applied to the wire terminations in vertical direction for 10 s (see Fig. 1)	
	AT-4	60 s at 5 N (horizontal pull)	
	AT-5	A load of 2 N is applied to the wire terminations in vertical direction for 3 s (see Fig. 1)	
Termination bending	AT-11	5 N, ten times, 90°	ΔR, ΔB ± 1% and visual inspection
	AT-2, 3	One time, 90°	
	AT-4	1 N, five times, 90°	
	AT-5	2.5 N, two times, 90°	
Free fall	AT-11, 2, 3	Three times natural fall to a maple board from 1 m height.	Less than 1 mA
	AT-4	Three times natural fall to a maple board from 0.75 m height.	
	AT-5	One time natural fall to a maple board from 1 m height.	
Voltage proof	AT-11, 2, 3, 5	1000 V AC for one minute	Over 100 MΩ
	AT-4	100 V DC for one second	
Insulation resistance	AT-11, 2, 3, 5	500 V DC	ΔR, ΔB ± 1%
	AT-4	100 V DC	
Dry heat	AT-11	1000 hours at 105 °C (90 °C ⁴)	ΔR, ΔB ± 1%
	AT-2, 3, 5	1000 hours at 110 °C (90 °C ⁴)	
	AT-4	1000 hours at 90 °C	
Damp heat (under electrical load)	AT-11	1000 hours at 70 °C and 90% humidity Electrical load: 1 mA DC	ΔR, ΔB ± 1%
	AT-2, 3, 4, 5	1000 hours at 40 °C and 90% humidity Electrical load: 1 mA DC	
Temperature cycle (thermal shock)	AT-11	100 cycles as below: 1. - 55 °C for 30 minutes 2. Room temperature for 3 minutes 3. 85 °C for 30 minutes 4. Room temperature for 3 minutes	ΔR, ΔB ± 1%
	AT-2, 3	100 cycles as below: 1. - 30 °C for 30 minutes 2. Room temperature for 3 minutes 3. 90 °C for 30 minutes 4. Room temperature for 3 minutes	
	AT-4	100 cycles as below: 1. - 20 °C for 30 minutes 2. Room temperature for 1 minute 3. 70 °C for 30 minutes 4. Room temperature for 1 minute	
	AT-5	100 cycles as below: 1. - 30 °C for 30 minutes 2. Room temperature for 3 minutes 3. 90 °C for 30 minutes 4. Room temperature for 3 minutes	

⁴: Conditions for 102AT-11, 202AT-11, 102AT-2, 202AT-2

Resistance / temperature characteristics

Temperature (°C)	Product number				
	102AT	202AT	502AT	103AT	203AT
- 50	24.46	55.66	154.6	329.5	1253
- 40	14.43	32.34	88.91	188.5	642.0
- 30	8.834	19.48	52.87	111.3	342.5
- 20	5.594	12.11	32.44	67.77	190.0
- 10	3.651	7.763	20.48	42.47	109.1
0	2.449	5.114	13.29	27.28	64.88
10	1.684	3.454	8.840	17.96	39.71
20	1.184	2.387	6.013	12.09	24.96
25	1.000	2.000	5.000	10.00	20.00
30	0.8486	1.684	4.179	8.313	16.12
40	0.6189	1.211	2.961	5.827	10.65
50	0.4587	0.8854	2.137	4.160	7.181
60	0.3446	0.6587	1.567	3.020	4.943
70	0.2622	0.4975	1.168	2.228	3.464
80	0.1999	0.3807	0.8835	1.668	2.468
85	0.1751	0.3346	0.7722	1.451	2.096
90	0.1536	0.2949	0.6771	1.266	1.788
100			0.5265	0.9731	1.315
110			0.4128	0.7576	0.9807
B _{25/85}	3100 K	3182 K	3324 K	3435 K	4013 K

Unit: kΩ

Caution

AT-2, 3, 5

- When bending the lead wires using for example a radio plier make sure to have a minimum distance from the sensor head of 3 mm.
- Do not apply a mechanical load of more than 2 N in the way depicted in Fig. 1 below. The variation of the load direction should be less than 0.3 mm (see Fig. 2).

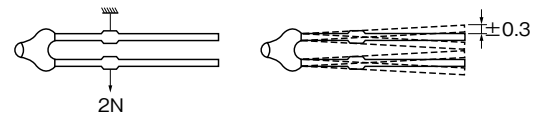


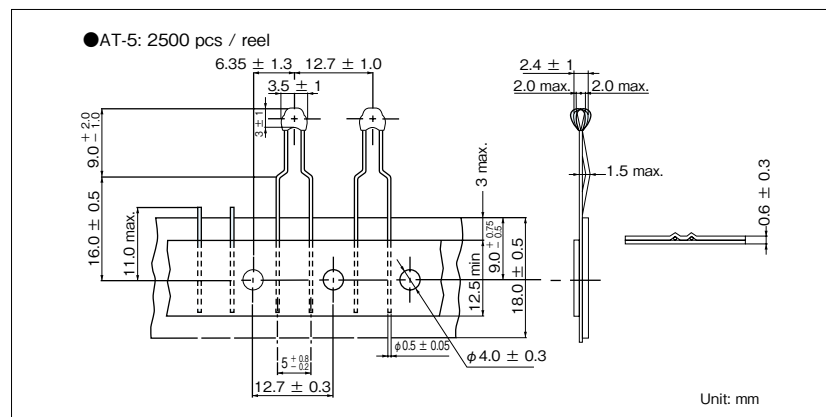
Fig. 1

Fig. 2

- When soldering make sure to have a minimum distance of 5 mm (8.5 mm), use a soldering iron with 50 W and solder for maximum 7 (2) seconds at 340 °C (350 °C). If you plan to cut the lead wire shorter than the above minimum distance please contact us.

The values in brackets are for AT-5.

Taping dimensions



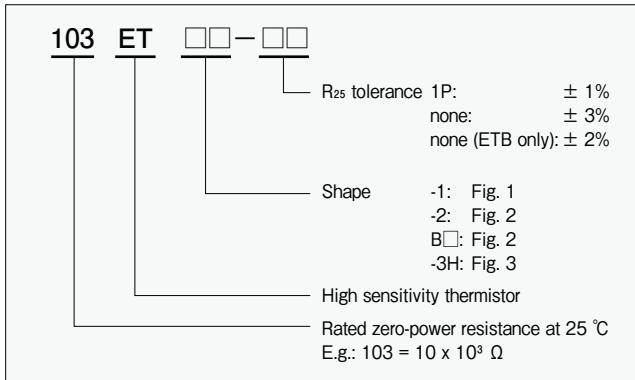
High sensitivity thermistor

ET Thermistor

The ET thermistor series features small size and high sensitivity.

- Features:
- Tight resistance and B-value tolerances; high accuracy
 - Uniform shape facilitates automated assembly
 - Long term reliability

Product number explanation



Applications

Body thermometers, thermometers, medical devices, controllers, mobile devices, battery chargers, battery packs, home electronics, toilet heaters, security, LCDs, electric vehicles

Specifications

Product number	R ₂₅ ¹	R ₂₅ tolerance	B value ²	Operating temperature range (°C)		
212ET	2.10 kΩ	± 3%	3850 K ± 1%	- 40 to 90		
402ET	4.00 kΩ		3100 K ± 1%			
582ET	5.80 kΩ		3614 K ± 1%			
103ET	10.0 kΩ		3250 K ± 1%			
203ET	20.0 kΩ		3450 K ± 1%	- 40 to 100		
303ET	30.0 kΩ		3760 K ± 1%			
403ET	40.0 kΩ		3525 K ± 1%			
503ET	50.0 kΩ		4055 K ± 1%			
833ET	83.0 kΩ		4013 K ± 1%			
104ET	100 kΩ		4132 K ± 1%			
224ET	226 kΩ		4021 K ± 1%		- 40 to 100	
234ET	232 kΩ		4274 K ± 1%			
103ETB	10.0 kΩ		± 1%, ± 2%		3435 K ± 1%	- 40 to 90

- Dissipation factor: 0.7 mW / °C
- Thermal time constant³: approx. 3.4 s (ET-1: approx. 3.2 s)
- Rated power at 25 °C: 3.5 mW
- ¹: Rated zero-power resistance at 25 °C
- ²: B value calculated from rated zero-power resistance at 25 °C and 85 °C
- ³: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

Product number	R ₃₇ ⁴	R ₃₇ tolerance	B value ⁵	Operating temperature range (°C)
503ET-3H	29.937 kΩ	± 1.08%	3944 K ± 0.5%	- 40 to 100

- Dissipation factor: 0.7 mW / °C
- Thermal time constant⁶: approx. 0.8 s
- Rated power at 25 °C: 3.5 mW
- ⁴: Rated zero-power resistance at 37 °C
- ⁵: B value calculated from rated zero-power resistance at 30 °C and 45 °C
- ⁶: Time required to reach 63.2% of temperature difference. Measured with sensor immersed in oil.

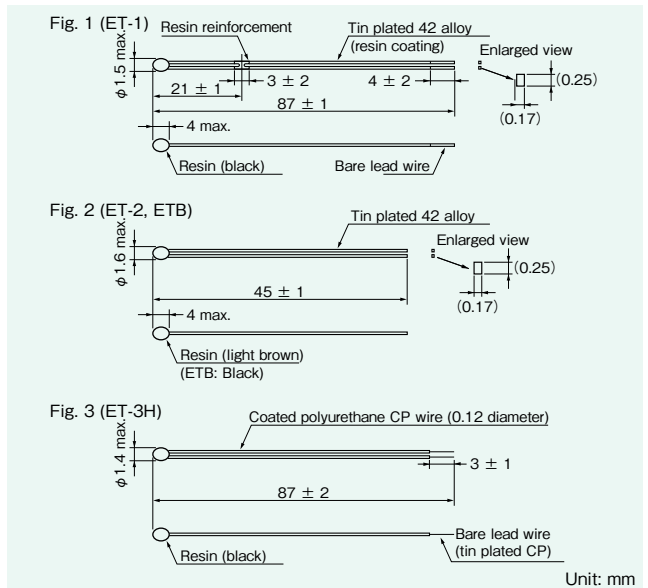
Resistance / temperature characteristics

Temperature (°C)	Product number													
	212ET	402ET	582ET	103ET	203ET	303ET	403ET	503ET	833ET	104ET	224ET	234ET	103ETB	503ET-3H
- 40	64.02	57.71	127.7	170.9	402.2	810.7	833.3	1602	2664	3325	7005	9046	204.7	1588
- 30	35.13	35.34	72.10	102.2	233.6	445.1	481.1	855.0	1421	1769	3784	4680	118.5	848.1
- 20	19.65	22.38	42.37	63.07	140.2	253.7	287.5	474.4	788.5	977.5	2116	2515	71.02	470.9
- 10	11.31	14.60	25.84	40.08	86.82	149.8	177.2	272.7	453.0	559.0	1225	1401	43.67	270.4
0	6.724	9.797	16.29	26.16	55.31	91.30	112.4	161.9	269.3	329.8	730.1	808.2	27.70	160.9
10	4.130	6.737	10.57	17.51	36.16	57.31	73.00	99.13	164.8	200.5	447.8	480.2	18.07	98.63
20	2.612	4.736	7.039	11.99	24.23	37.00	48.61	62.38	103.6	125.3	282.1	293.7	12.11	62.12
25	2.100	4.000	5.800	10.00	20.00	30.00	40.00	50.00	83.00	100.0	226.0	232.0	10.00	49.77
30	1.699	3.394	4.806	8.387	16.60	24.47	33.08	40.24	66.91	80.27	182.1	184.4	8.301	40.10
40	1.134	2.476	3.353	5.988	11.61	16.56	22.96	26.58	44.18	52.62	120.3	118.6	5.811	29.937 ⁴
50	0.7753	1.835	2.369	4.353	8.279	11.45	16.26	17.93	29.80	35.23	81.07	78.00	4.147	21.72 ⁵
60	0.5420	1.378	1.685	3.217	6.005	8.070	11.70	12.33	20.51	24.00	55.75	52.39	3.011	12.20
70	0.3867	1.049	1.214	2.414	4.425	5.791	8.569	8.588	14.37	16.59	39.01	35.87	2.224	8.449
80	0.2811	0.7997	0.8863	1.836	3.310	4.222	6.367	6.064	10.24	11.64	27.78	24.99	1.668	5.940
85	0.2413	0.7005	0.7610	1.610	2.877	3.626	5.517	5.120	8.700	9.807	23.58	21.00	1.451	5.009
90	0.2079	0.6145	0.6557	1.416	2.509	3.125	4.797	4.338	7.419	8.287	20.10	17.72	1.267	4.240
100					1.926	2.346	3.662	3.142	5.459		14.75	12.75		3.070
B _{25/85}	3850 K	3100 K	3614 K	3250 K	3450 K	3760 K	3525 K	4055 K	4013 K	4132 K	4021 K	4274 K	3435 K	3944 K ⁵

⁸: Rated zero-power resistance at 45 °C

Unit: kΩ

Dimensions



Reliability data

Item	Test conditions	Criteria
Resistance to soldering heat	10 s at 260 °C	ΔR, ΔB ± 1%
Solderability	2 s at 245 °C Flux material: Rosin 25%, ethyl alcohol	More than 90% soldered
Tensile strength (lead wire)	10 s at 1 N (horizontal pull)	ΔR, ΔB ± 1% and visual inspection
Free fall	Three times natural fall to a maple board from 1 m height.	Over 100 MΩ
Insulation resistance	100 V DC	Over 100 MΩ
Dry heat	1000 hours at 100 °C (90 °C ²)	ΔR, ΔB ± 1% (± 2%)
Damp heat (under electrical load)	1000 hours at 40 °C and 90% humidity Electrical load: 0.1 mA DC	
Temperature cycle (thermal shock)	100 cycles as below: 1. - 20 °C for 5 minutes 2. Room temperature for 3 minutes 3. 100 °C (80 °C ⁷) for 5 minutes 4. Room temperature for 3 minutes	

⁷: The value in brackets is for 212ET to 103ET, 104ET and 103ETB

Caution

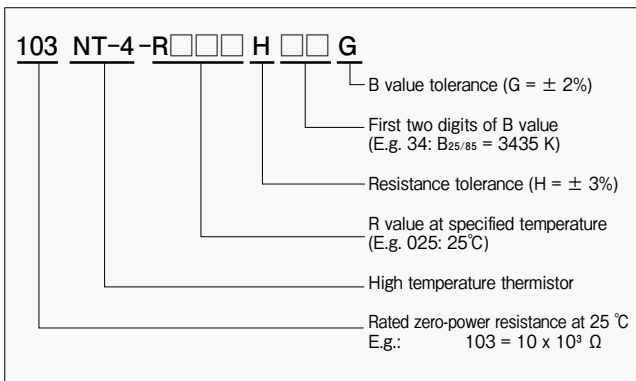
- Do not apply vertical force to the lead wires exceeding 0.3 N.
- Do not apply horizontal force to the lead wires exceeding 1 N (see drawing below).
- When soldering make sure to have a minimum distance of 5 mm from the sensor head, use a soldering iron with 50 W and solder for maximum seven seconds at 340 °C.

■ High temperature, high sensitivity, glass encapsulated thermistor

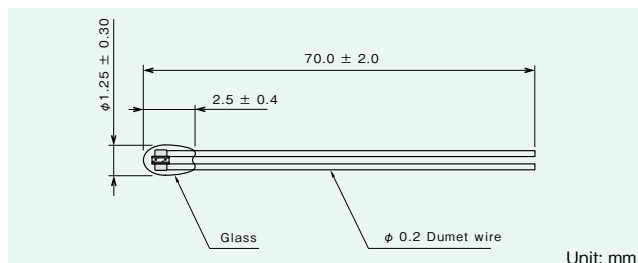
NT Thermistor

Semitec's glass encapsulated NT-4 series thermistor features high heat resistance and high sensitivity. Compared with conventional thermistors, the NT-4 thermistors are smaller, faster in response, and more reliable which makes them suitable for various applications.

■ Product number explanation



■ Dimensions



■ Applications

3D printers, HVAC equipment, water heaters, microwave ovens, home appliances, hybrid vehicles, fuel cell vehicles, automotive, medical, disaster prevention, security, office automation

■ Specifications

Product number	Rated zero-power resistance ¹			B value temperature ² (°C/100,000)	B value ²	Operating temperature range (°C)
	Temperature	Resistance	Resistance tolerance			
502NT-4-R025H39G	25 °C	5 kΩ	± 3% ³	25/85	3964 K ± 2%	- 50 to 300
852NT-4-R050H34G	50 °C	3.485 kΩ		0/100	3450 K ± 2%	
103NT-4-R025H34G	25 °C	10 kΩ		25/85	3435 K ± 2%	
103NT-4-R025H41G	25 °C	10 kΩ		25/85	4126 K ± 2%	
203NT-4-R025H42G	25 °C	20 kΩ		25/85	4282 K ± 2%	
493NT-4-R100H40G	100 °C	3.3 kΩ		0/100	3970 K ± 2%	
503NT-4-R025H42G	25 °C	50 kΩ		25/85	4288 K ± 2%	
104NT-4-R025H42G	25 °C	100 kΩ		25/85	4267 K ± 2%	
104NT-4-R025H43G	25 °C	100 kΩ		25/85	4390 K ± 2%	
204NT-4-R025H43G	25 °C	200 kΩ		25/85	4338 K ± 2%	
234NT-4-R200H42G	200 °C	1 kΩ		100/200	4537 K ± 2%	
504NT-4-R025H45G	25 °C	500 kΩ		25/85	4526 K ± 2%	
105NT-4-R025H46G	25 °C	1000 kΩ		25/85	4608 K ± 2%	

* Dissipation factor: 0.8 mw / °C • Thermal time constant⁴: approx. 6 s • Rated power at 25 °C: 4 mW
¹: Rated zero-power resistance at each temperature
²: B value calculated from rated zero-power resistance at each temperature
³: If your application requires other tolerance values please contact SEMITEC sales staff.
⁴: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

■ Reliability data

Item	Test conditions	Criteria
Resistance to soldering heat	10 s at 260 °C (wave soldering)	ΔR ± 3%, ΔB ± 1% and visual inspection
	3.5 s at 350 °C (soldering iron)	
Solderability	2 s at 245 °C Flux material: Rosin 25%, ethyl alcohol 75%	More than 90% soldered
Tensile strength (lead wire)	10 s at 1 N (horizontal pull)	ΔR ± 3%, ΔB ± 1% and visual inspection
Termination bending	0.5 N, two times, 90°	
Free fall	Three times natural fall to a maple board from 1 m height.	
Voltage proof	500 V AC for one minute	Less than 1 mA
Insulation resistance	500 V DC	Over 100 MΩ
Dry heat	1000 hours at 300 °C	ΔR ± 3%, ΔB ± 1%
Damp heat (under electrical load)	1000 hours at 85 °C and 85% humidity Electrical load: 0.1 mA DC	
Temperature cycle (thermal shock)	100 cycles as below: 1. - 30 °C for 3 minutes in fluid 2. 150 °C for 3 minutes in fluid	

■ Resistance / temperature characteristics

Temperature (°C)	502NT-4-R025H39G	852NT-4-R050H34G	103NT-4-R025H34G	103NT-4-R025H41G	203NT-4-R025H42G	493NT-4-R100H40G	503NT-4-R025H42G	104NT-4-R025H42G	104NT-4-R025H43G	204NT-4-R025H43G	234NT-4-R200H42G	504NT-4-R025H45G	105NT-4-R025H46G
-50	339.5	346.8	394.7	830.9	1931	3376	3576	8887	10090	19040	17900	52600	110900
-30	92.34	106.1	122.0	207.7	459.2	885.4	965.0	2156	2353	4524.0	4633.0	12290	25610
-10	28.48	38.02	44.09	60.87	129.3	275.5	302.8	623.2	657.0	1284.0	1393.0	3396	6979
0	16.64	23.92	27.86	34.85	72.67	162.2	175.2	354.6	368.1	724.5	804.8	1887	3849
10	10.06	15.49	18.13	20.65	42.33	98.65	104.0	208.8	213.5	423.0	479.2	1084	2195
25	5.000	8.487	10.00	10.00	20.00	49.41	50.00	100.0	100.0	200.0	232.1	500.0	1000
40	2.649	4.899	5.806	5.166	10.10	26.23	25.42	50.90	49.90	100.6	119.0	245.2	484.7
50	1.790	3.485	4.144	3.437	6.613	17.70	16.69	33.45	32.42	65.72	78.46	157.3	308.4
60	1.238	2.524	3.011	2.341	4.440	12.20	11.19	22.48	21.54	43.89	52.84	103.1	200.7
80	0.6306	1.391	1.668	1.159	2.138	6.134	5.343	10.80	10.13	20.81	25.39	47.24	90.54
85	0.3591	1.209	1.451	0.9843	1.803	5.222	4.494	9.094	8.486	17.48	21.38	39.31	75.08
100	0.3455	0.8104	0.9754	0.6189	1.112	3.300	2.741	5.569	5.122	10.61	13.06	23.27	43.96
120	0.2014	0.4952	0.5920	0.3525	0.6175	1.882	1.498	3.058	2.763	5.759	7.130	12.23	22.78
140	0.1238	0.3108	0.3679	0.2121	0.3631	1.127	0.8635	1.770	1.574	3.301	4.098	6.787	12.48
160	0.07968	0.2000	0.2365	0.1339	0.2245	0.7057	0.5225	1.074	0.9414	1.985	2.466	3.957	7.188
180	0.05341	0.1325	0.1568	0.08811	0.1448	0.4592	0.3296	0.6793	0.5873	1.244	1.544	2.406	4.322
200	0.03708	0.09036	0.1068	0.06015	0.09698	0.3092	0.2158	0.4452	0.3804	0.8098	1.000	1.519	2.703
220	0.02656	0.06329	0.07467	0.04239	0.06713	0.2145	0.1459	0.3016	0.2549	0.5442	0.6674	0.9937	1.750
240	0.01956	0.04543	0.05345	0.03072	0.04784	0.1529	0.1016	0.2104	0.1760	0.3765	0.4574	0.6712	1.168
260	0.01477	0.03337	0.03907	0.02285	0.03499	0.1117	0.07261	0.1507	0.1250	0.2676	0.3210	0.4663	0.8019
280	0.01141	0.02506	0.02912	0.01743	0.02619	0.08336	0.05319	0.1105	0.09101	0.1950	0.2302	0.3317	0.5651
300	0.00900	0.01919	0.02209	0.01361	0.02003	0.06345	0.03981	0.08278	0.06772	0.1452	0.1683	0.2410	0.4074

■ Caution

- When soldering make sure to have a minimum distance from the glass encapsulated sensor head of 5 mm.
- When working the lead wire make sure to fix the wire at a minimum distance from the glass encapsulated sensor head of 5 mm.

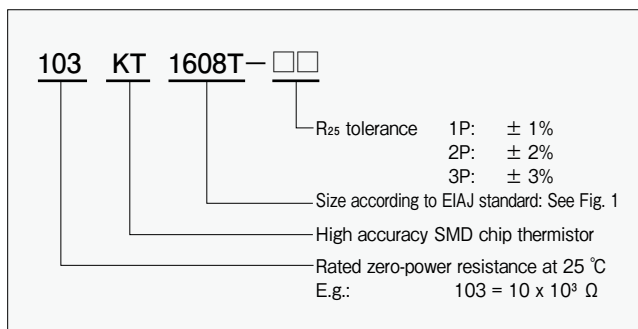
Unit: kΩ

High accuracy, SMD chip type thermistor

KT Thermistor

The KT series SMD thermistor features high accuracy with tight resistance and B-value tolerances of $\pm 1\%$, high performance, high reliability and complies with EIAJ standards (dimensions: 1005, 1608).

Product number explanation



Applications

Office automation equipment, communication equipment, IT equipment, mobile devices, battery packs, battery chargers, LCDs, hybrid ICs, AV equipment

Specifications

Product number	R_{25}^1	R_{25} tolerance	B value ²	Dissipation factor (mw / °C)	Thermal time constant (s) ³	Rated power at 25 °C (mW)	Operating temperature range (°C)
103KT1608T	10 kΩ	± 1% ± 2% ± 3%	3435 K ± 1%	approx. 0.9	approx. 5	4.5	- 40 to 125
503KT1608T	50 kΩ		4055 K ± 1%				
104KT1608T	100 kΩ		4390 K ± 1%				
103KT1005T	10 kΩ		3435 K ± 1%	approx. 0.7	approx. 2.2	3.5	

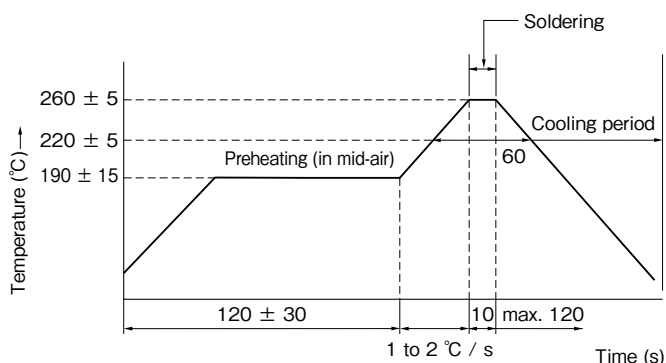
¹: Rated zero-power resistance at 25 °C. ²: B value calculated from rated zero-power resistance at 25 °C and 85 °C

³: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

Reliability data

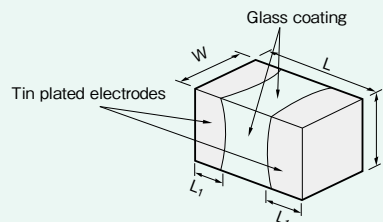
Item	Test conditions	Criteria
Resistance to soldering heat	10 s at 260 °C (wave soldering)	$\Delta R, \Delta B \pm 3\%$
Solderability	5 s at 235 °C Flux material: Rosin 25%, ethyl alcohol 75%	More than 75% soldered
Electrode connection strength vs. circuit board (horizontal)	After mounting the thermistor body is pushed horizontally with a jig with a force of 5 N for 10 s.	$\Delta R, \Delta B \pm 3\%$ and visual inspection
Electrode connection strength vs. circuit board (vertical)	After mounting the circuit board is bent from the back side to a maximum of 2 mm for 5 s.	
Strength of NTC body	A force of 10 N is applied vertically with a jig for 10 s.	$\Delta R, \Delta B \pm 3\%$
Dry heat	1000 hours at 125 °C	
Damp heat	1000 hours at 40 °C and 90% humidity	
Temperature cycle (thermal shock)	50 cycles as below: 1. - 25 °C for 30 minutes 2. Room temperature for 15 minutes 3. 100 °C for 30 minutes 4. Room temperature for 15 minutes	

Recommended temperature profile for wave soldering



Dimensions

Fig. 1



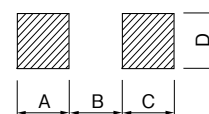
Size (Metric / EIAJ)	Size (Imperial)	L (mm)	W (mm)	T (mm)	L ₁ (mm)
1005	0402	1.00 ± 0.15	0.50 ± 0.10	0.6 max.	0.15 to 0.30
1608	0603	1.60 ± 0.15	0.80 ± 0.15	0.95 max.	0.20 to 0.50

Unit: mm

Caution

- Before and after soldering always make sure the circuit board is not bent or warped.
- The size of the soldering pad should be the same for both the left and the right side.

Recommended soldering pad size



Size (EIAJ)	A	B	C	D
1005	0.6	0.5	0.6	0.6
1608	1.0	1.0	1.0	1.2

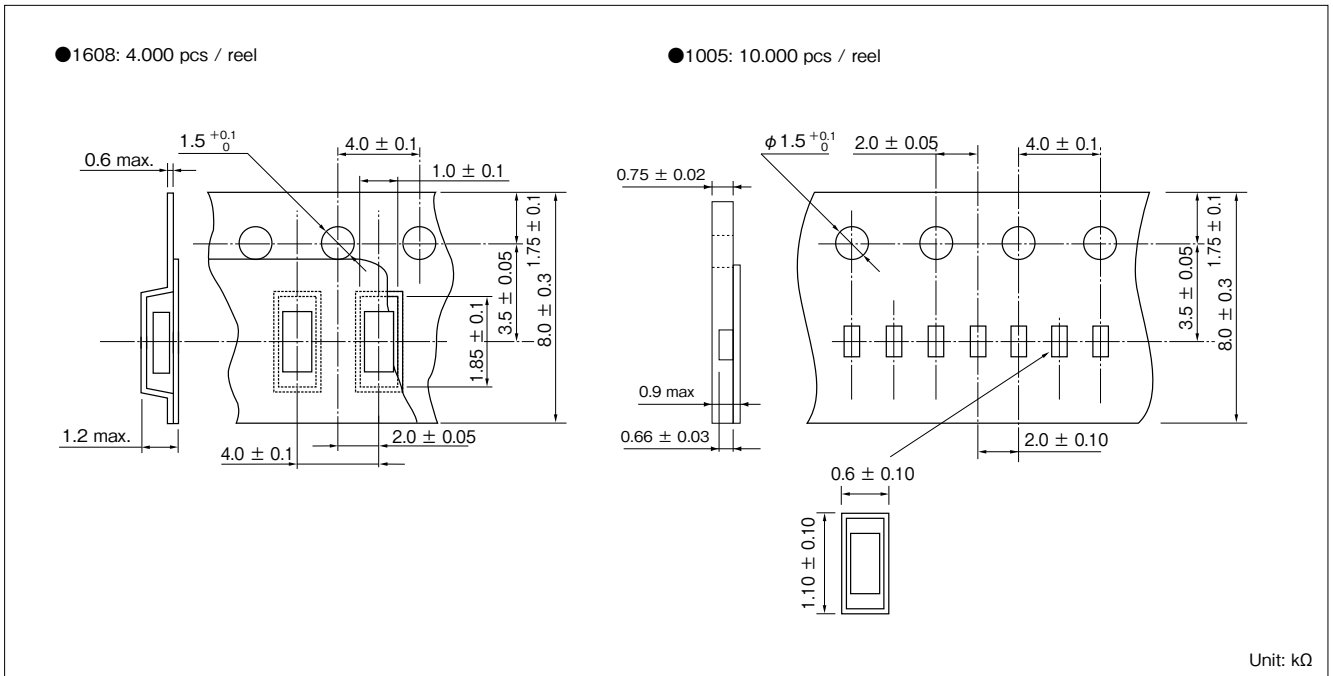
Unit: mm

Resistance / temperature characteristics

Temperature (°C)	Product number			
	103KT1608T	503KT1608T	104KT1608T	103KT1005T
- 40	221.9	1920	5218	223.9
- 30	125.1	981.8	2530	126.1
- 20	73.38	525.2	1285	73.87
- 10	44.72	293.3	682.0	44.91
0	28.16	169.7	376.8	28.22
10	18.25	101.7	216.1	18.27
20	12.14	62.90	128.3	12.15
25	10.00	50.00	100.0	10.00
30	8.283	40.05	78.55	8.282
40	5.781	26.20	49.56	5.778
50	4.120	17.56	32.13	4.119
60	2.996	12.04	21.36	2.992
70	2.214	8.431	14.53	2.212
80	1.665	6.021	10.10	1.664
85	1.451	5.122	8.487	1.451
90	1.271	4.376	7.164	1.271
100	0.9832	3.237	5.176	0.9840
110	0.7707	2.433	3.803	0.7710
120	0.6114	1.855	2.839	0.6115
125	0.5469	1.627	2.466	0.5470
B _{25/85}	3435 K	4055 K	4390 K	3435 K

Unit: kΩ

Taping dimensions



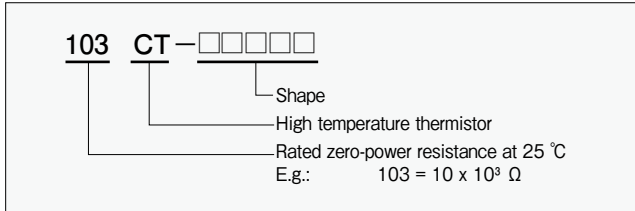
High temperature axial type thermistor

CT Thermistor

The axial glass encapsulated CT series thermistor features excellent reliability and high heat resistance.



Product number explanation



Applications

Home electronics, HVAC equipment, water heaters, kitchen appliances, solar systems, vending machines, refrigerated display cases, batteries, refrigerators

Specifications

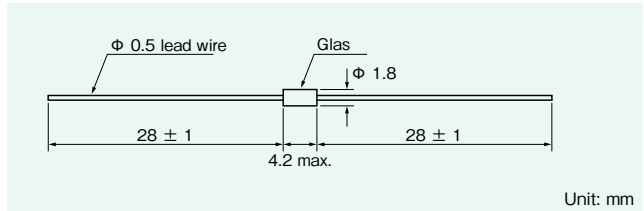
Product number	Rated zero-power resistance ¹			B value ²	Operating temperature range (°C)	Lead wire			
	Temperature	Resistance	Resistance tolerance						
252CT-4	25 °C	2.5 kΩ	± 5%	3670 K ± 2%	- 50 to 250	Nickel plating			
512CT-4		5.1 kΩ		3200 K ± 2%	- 50 to 200				
562CT-4		5.6 kΩ		3200 K ± 2%					
912CT-4		9.1 kΩ		3270 K ± 2%					
103CT-4		10 kΩ		3270 K ± 2%					
113CT-4		11 kΩ		3270 K ± 2%					
203CT-4		20 kΩ		3410 K ± 2%					
473CT-4		47 kΩ		3610 K ± 2%	- 50 to 250				
513CT-4		51 kΩ		3610 K ± 2%					
563CT-4		56 kΩ		3610 K ± 2%					
104CT-4		100 kΩ		3450 K ± 2%					
204CT-4		200 kΩ		3500 K ± 2%					
103CT-01006		25 °C		10 kΩ	± 5%		3900 K ± 2%	- 30 to 150	Tin plating
103CT-21048		25 °C		10 kΩ	± 3%		4100 K ± 2%		
503CT-91027	50 °C	19.727 kΩ	± 2.5%	3992 K ± 2%	- 40 to 150				
104CT-90113	25 °C	100 kΩ	± 5%	4070 K ± 2%					

¹ Dissipation factor: 2.1 mW / °C • Thermal time constant³: approx. 10 to 20 s

² Rated power at 25 °C: 10.5 mW

³ Rated zero-power resistance at each temperature ²: B value calculated from rated zero-power resistance at each temperature ³: Time required to reach 63.2% of temperature difference. Measured with sensor suspended in mid-air.

Dimensions



Reliability data

Item	Test conditions	Criteria
Resistance to soldering heat	10 s at 260 °C (wave soldering)	ΔR, ΔB ± 2% and visual inspection
	3.5 s at 340 °C (soldering iron)	
Solderability	2 s at 245 °C Flux material: Rosin 25%, ethyl alcohol 75%	More than 50% soldered (More than 95% soldered) ^{5, 6, 7}
Tensile strength (lead wire)	10 s at 5 N (horizontal pull)	ΔR, ΔB ± 2% and visual inspection
Termination bending	2.5 N, two times, 90°	
Free fall	Three times natural fall to a maple board from 1 m height.	
Voltage proof	500 V AC for one minute	Less than 1 mA
Insulation resistance	500 V DC	Over 100 MΩ (Over 50 MΩ) ⁵
Dry heat	1000 hours at 250 °C (200 °C) ⁴ (150 °C) ^{5, 7} (125 °C) ⁶	ΔR, ΔB ± 3%
Damp heat	1000 hours at 40 °C and 90% humidity	
Temperature cycle (thermal shock)	5 cycles as below: 1. - 30 °C for 30 minutes 2. Room temperature for 3 minutes 3. 200 °C for 30 minutes 4. Room temperature for 3 minutes (min. temp. - 40 °C, max. temp. 150 °C) ^{5, 7} (min. temp. - 25 °C to 125 °C) ⁶	

⁴: 252CT, 512CT, 562CT

⁵: 103CT-21048, 103CT-01006

⁶: 503CT-91027

⁷: 104CT-90113

Resistance / temperature characteristics

Temperature (°C)	Product number															
	252CT	512CT	562CT	912CT	103CT	113CT	203CT	473CT	513CT	563CT	104CT	204CT	103CT-21048	103CT-01006	503CT-91027	104CT-90113
- 50	120.2	137.9	151.4	278.3	305.8	336.4	604.8	1506	1634	1794	3200	6803				
- 40	65.60	81.02	88.96	159.9	175.7	193.3	350.2	867.5	941.3	1034	1863	3913	458.9		1947	
- 30	36.48	48.93	53.73	94.63	104.0	114.4	207.9	512.6	566.2	610.8	1105	2306	223.1	183.3	1010	1862
- 20	20.91	30.56	33.55	58.02	63.76	70.13	127.8	313.4	340.1	373.4	675.1	1397	114.8	98.80	547.9	1011
- 10	12.32	19.65	21.58	36.67	40.29	44.32	81.00	197.2	214.0	235.0	424.3	870.3	62.13	55.69	309.7	571.0
0	7.516	12.96	14.23	23.82	26.18	28.79	52.63	127.1	138.0	151.5	272.2	553.6	35.15	32.67	181.6	334.0
10	4.738	8.779	9.639	15.92	17.49	19.24	35.15	84.16	91.32	100.3	179.4	362.5	20.70	19.86	110.2	201.7
20	3.074	6.080	6.676	10.91	11.99	13.18	24.02	56.86	61.70	67.75	120.9	242.5	12.64	12.48	68.90	125.5
25	2.500	5.100	5.600	9.100	10.00	11.00	20.00	47.00	51.00	56.00	100.0	200.0	10.00	10.00	55.06	100.0
30	2.045	4.296	4.717	7.627	8.381	9.219	16.74	39.01	42.33	46.48	83.11	165.7	7.972	8.071	44.30	80.21
40	1.393	3.095	3.398	5.442	5.980	6.578	11.88	27.07	29.37	32.25	58.24	115.4	5.177	5.362	29.22	52.55
50	0.9698	2.267	2.489	3.952	4.342	4.777	8.570	19.05	20.68	22.70	41.52	81.91	3.453	3.649	19.73	35.23
60	0.6895	1.687	1.852	2.918	3.206	3.527	6.239	13.58	14.74	16.18	30.14	59.14	2.359	2.540	13.61	24.12
70	0.4993	1.270	1.394	2.184	2.400	2.640	4.581	9.807	10.64	11.69	22.19	43.36	1.648	1.804	9.574	16.84
80	0.3680	0.9650	1.060	1.656	1.820	2.002	3.401	7.187	7.798	8.559	16.57	32.28	1.175	1.305	6.860	11.97
85	0.3178	0.8443	0.9271	1.448	1.592	1.751	2.943	6.180	6.706	7.363	14.39	27.97	0.9988	1.118	5.844	10.16
90	0.2757	0.7402	0.8128	1.269	1.394	1.534	2.553	5.328	5.781	6.348	12.53	24.33	0.8531	0.9609	4.999	8.654
100	0.2098	0.5736	0.6298	0.9787	1.076	1.183	1.937	3.997	4.337	4.762	9.586	18.57	0.6302	0.7187	3.700	6.354
120	0.1267	0.3559	0.3908	0.5952	0.6540	0.7194	1.156	2.337	2.535	2.784	5.828	11.24	0.3601	0.4196	2.115	3.574
140	0.08028	0.2298	0.2524	0.3750	0.4121	0.4533	0.7191	1.425	1.546	1.698	3.694	7.108	0.2172	0.2577	1.127	2.115
150	0.06494	0.1870	0.2053	0.3016	0.3314	0.3646	0.5752	1.129	1.226	1.346	2.982	5.732	0.1717	0.2054	1.002	1.654
160	0.05302	0.1534	0.1684	0.2445	0.2686	0.2955	0.4638	0.9031	0.9799	1.076	2.428	4.666				
180	0.03630	0.1055	0.1158	0.1643	0.1805	0.1986	0.3091	0.5919	0.6423	0.7052	1.647	3.168				
200	0.02562	0.07445	0.08175	0.1136	0.1249	0.1374	0.2122	0.4000	0.4341	0.4766	1.150	2.216				
220				0.08063	0.08860	0.09746	0.1497	0.2780	0.3016	0.3312	0.8235	1.591				
240				0.05857	0.06436	0.07080	0.1082	0.1979	0.2148	0.2358	0.6038	1.169				
250				0.05031	0.05529	0.06082	0.09271	0.1683	0.1827	0.2006	0.5208	1.010				

Caution

- When soldering make sure to have a minimum distance from the glass encapsulated sensor head of 5 mm.
- When working the lead wire make sure to fix the wire at a minimum distance from the glass encapsulated sensor head of 5 mm.

Unit: kΩ

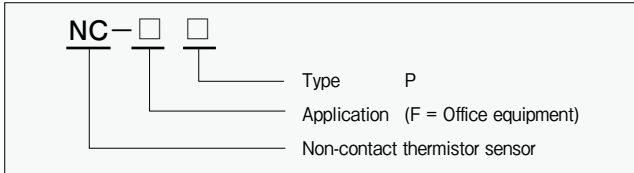
■ Non-contact (IR) temperature sensor

NC Sensor

The NC Sensor uses SEMITEC's extremely small FT thermistors as temperature sensing elements to create a robust IR sensor that can be used in many different locations and formerly impossible environments.



■ Product number explanation



■ Applications

- Office automation fuser roller applications such as LBP, PPC etc.
- Rotating parts in automotive applications
- Rotating motor parts
- Temperature measurement in high pressure environments
- Temperature measurement of drugs and chemicals

■ Specifications

Parameter	Value	Conditions
Measurement center	180 °C ± 3 °C	Blackbody temp.: 180 °C; sensor body temp.: 100 °C Roller diameter: 40 mm; distance: 5 mm
Responsivity	1.3 s ± 0.5 s	Time required to reach 63.2% of temperature difference between blackbody and sensor body.
Operating temp. range	- 10 °C to 150 °C	—
Measuring temp. range	- 20 °C to 260 °C	—
Thermistor resistance value	7 kΩ ± 3%	Rated zero-power resistance at 180 °C
Thermistor B value	3370 K ± 1%	B value determined by rated zero-power resistance at 25 °C and 85 °C

■ Reliability data

Item	Test conditions	Criteria
Dry heat	1000 hours at 150 °C	Measurement center within ± 5 °C of initial value
Dry heat under electrical load	1000 hours at 150 °C, 5 V load	
Temperature cycle (thermal shock)	5 cycles as below: 1. - 20 °C for 30 minutes 2. Room temperature for 5 minutes 3. 150 °C for 30 minutes 4. Room temperature for 5 minutes	Over 100 MΩ
Insulation resistance	500 V DC (between aluminium case and connections)	
Voltage proof	500 V AC for one minute (between aluminium case and connections)	Less than 1 mA

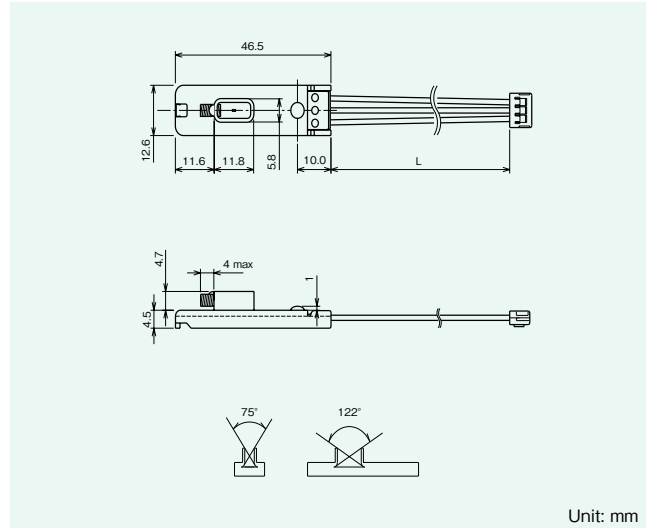
■ Data table (approx.)

		Roller temperature (°C)													
		0	20	40	60	80	100	120	140	160	180	200	220	240	260
Compensation temperature (°C)	Compensation output (Vc)	Measurement output (Vd)													
0	4.838	4.838	4.836	4.834	4.831	4.827	4.823	4.818	4.812	4.805	4.797	4.787	4.775	4.760	4.741
10	4.758		4.757	4.754	4.750	4.745	4.740	4.733	4.726	4.716	4.706	4.692	4.677	4.658	4.634
20	4.651		4.651	4.646	4.641	4.635	4.628	4.620	4.610	4.599	4.585	4.569	4.549	4.525	4.496
30	4.509			4.506	4.500	4.493	4.484	4.474	4.462	4.448	4.431	4.411	4.388	4.359	4.325
40	4.331			4.331	4.323	4.315	4.304	4.292	4.278	4.262	4.242	4.219	4.191	4.158	4.119
50	4.115				4.110	4.100	4.088	4.075	4.059	4.040	4.018	3.992	3.961	3.925	3.881
60	3.863					3.863	3.852	3.839	3.824	3.806	3.786	3.762	3.734	3.701	3.662
70	3.581						3.574	3.561	3.545	3.527	3.505	3.481	3.452	3.418	3.377
80	3.277							3.277	3.263	3.247	3.228	3.207	3.183	3.154	3.120
90	2.962								2.955	2.939	2.922	2.901	2.877	2.849	2.816
100	2.648									2.648	2.633	2.616	2.597	2.575	2.549
110	2.344										2.337	2.322	2.304	2.284	2.260
120	2.058											2.058	2.045	2.029	2.011
130	1.796												1.790	1.777	1.761
140	1.560													1.560	1.549
150	1.352														1.347

Measurement conditions
Applied voltage (E): 5 V Resistor resistance (R1, R2): 33 kΩ Blackbody roller: Φ 40 mm Installation distance: 5 mm

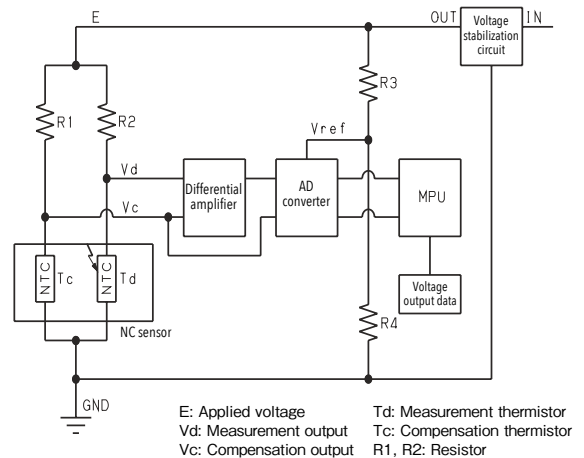
Unit: V

■ Dimensions



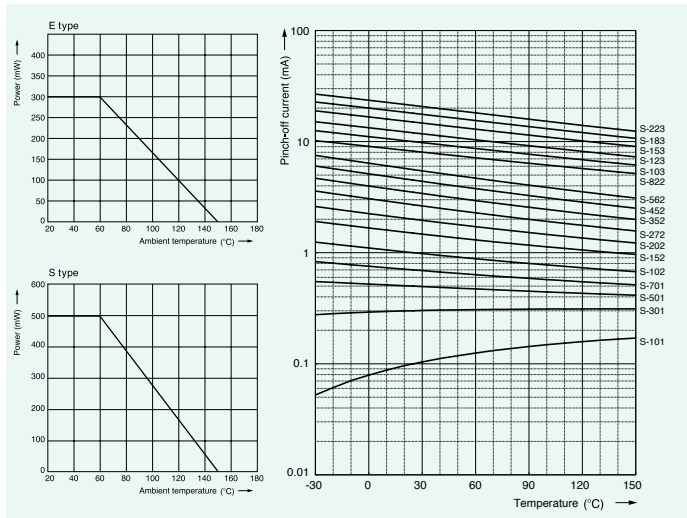
Unit: mm

■ Temperature conversion circuit example

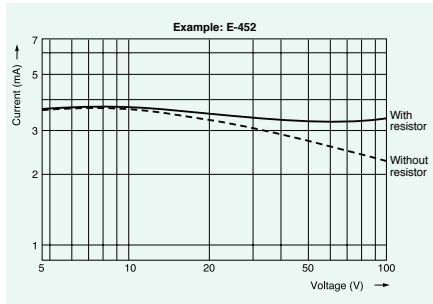


E: Applied voltage
Vd: Measurement output
Vc: Compensation output
Td: Measurement thermistor
Tc: Compensation thermistor
R1, R2: Resistor

Influence of environment temperature on power and pinch-off current rating

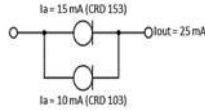


Current - voltage characteristics with and without resistor (example)



CRD for higher currents

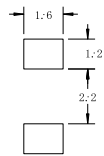
CRDs can be used in row to amplify permissible current.



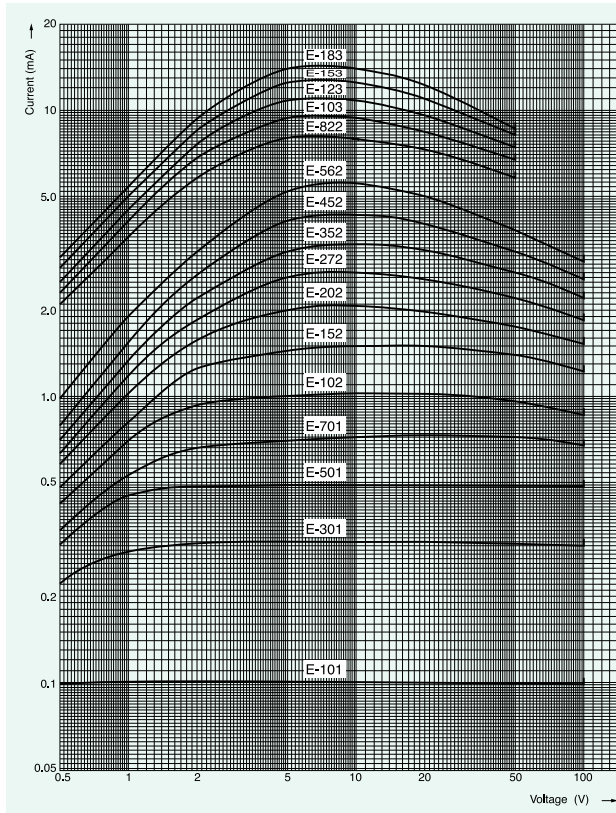
CRD for higher voltages

Using CRDs in row with Zener diodes allows the use of stable currents at higher voltage values.

Recommended mounting pad dimensions (S series only)



Dynamic characteristics (voltage - current)



How to compensate current reduction due to heat up of the CRD

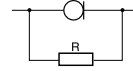
For currents of 1 mA or more resistors can be used together with CRDs to compensate for current decreases and fluctuations. The following values are typical for compensation resistors.

Rated power: 500 mW

Product number	S-102	S-152	S-202	S-272	S-352	S-452	S-562	S-822	S-103	S-123	S-153	S-183	S-223
Recommended resistance value	1.1 MΩ	430 kΩ	300 kΩ	200 kΩ	130 kΩ	91 kΩ	62 kΩ	27 kΩ	18 kΩ	15 kΩ	12 kΩ	9 kΩ	5.6 kΩ

Rated power: 300 mW

Product number	E-102	E-152	E-202	E-272	E-352	E-452	E-562	E-822	E-103	E-123	E-153	E-183
Recommended resistance value	1 MΩ	390 kΩ	240 kΩ	120 kΩ	82 kΩ	56 kΩ	39 kΩ	20 kΩ	15 kΩ	11 kΩ	9.1 kΩ	7.5 kΩ



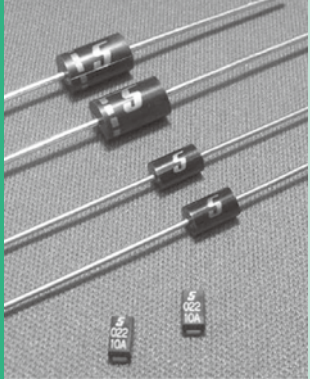
Reliability data

Item	Test conditions	Criteria
Resistance to soldering heat	10 s at 260 °C (wave soldering)	$\Delta I_p \pm 5\%$
Solderability	3 s at 245 °C Flux material: Rosin 25%, propanol 75%	More than 90% soldered
Dry heat	1000 hours at 150 °C	$\Delta I_p \pm 5\%$
Damp heat (CRD S)	1000 hours at 85 °C and 85% humidity	
Damp heat (CRD E)	1000 hours at 70 °C and 90% humidity	
Temperature cycle / thermal shock (CRD S)	10 cycles as below: 1. - 55 °C for 15 minutes 2. Room temperature for 15 minutes 3. 150 °C for 15 minutes 4. Room temperature for 15 minutes	
Temperature cycle / thermal shock (CRD E)	5 cycles as below: 1. - 25 °C for 30 minutes 2. Room temperature for 15 minutes 3. 150 °C for 30 minutes 4. Room temperature for 15 minutes	

VRD voltage regulating diode (= TVS diode)

VRD

SEMITEC's voltage regulating diode (VRD) is a transient voltage suppressor device that is designed to absorb voltage surges and spikes that occur during power initiation. Our VRD features uniform avalanche breakdown across the junction, and therefore very fast response to voltage surges. Furthermore, its control voltage is almost independent from the current which makes it a highly reliable, high performance device.



Product number explanation

Z2 033 U - 52Z

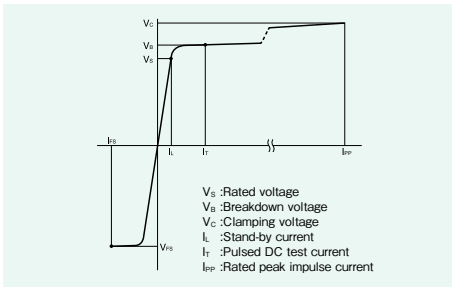
- No marking : Untaped bulk products
- 52Z : Axial taping, Z folding
- 52R : Axial taping, reel
- FT : Radial taping
- U : Unipolar
- No marking : Bipolar
- Z2 : Rated power = 1.0 W
- Z6 : Rated power = 2.0 W
- ZD : Rated power = 0.5 W; reverse blocking type

Applications

- Protection of telecommunication lines and equipment from lightning induced surges
- ESD protection
- EMP protection
- Relays, solenoids (etc.), switching surge protection
- Surge protection of fire alarms, smoke detectors, etc.
- Protection of electric circuits from abnormal voltage conditions

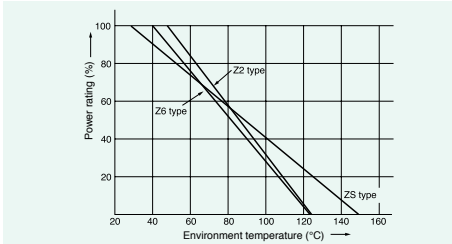
Electrical characteristics

The bipolar Z2 and Z6 types have an almost symmetrical breakdown voltage (V_{BR}). The reverse breakdown voltage of the low capacitance ZD type is 200 V or more at 10 μ A DC.



Power derating

Influence of environment temperature on power rating (%)



Taping dimensions

Axial type **Radial type**

Series	Taping method	Quantity	
Z2, Z2U	Axial taping	Reel	5000
		Z folding	2000
	Radial taping	Z folding	2000
Z6, Z6U	Axial taping	Z folding	1000

Dimensions

Symbol marks

- Bipolar
- Unipolar
- Reverse blocking

Cathode marks

- Bipolar (no cathode marking)
- Unipolar
- Reverse blocking

Item	Z2	Z6	ZD
(A)	25	24	25
(B)	6 ± 0.3	9 ± 0.5	6 ± 0.3
(C)	Φ 0.8	Φ 1.0	Φ 0.8
(D)	3.6 ± 0.3	5.3 ± 0.5	3.6 ± 0.3

Unit: mm

Specifications

Z2 / Z2U series

Product number	Stand-off voltage		Stand-by current		Breakdown voltage	Pulsed test current	Clamping voltage / rated peak impulse current			Temperature coefficient	Capacitance		
	V_S	DC	$I_{S, max}$	V_S			V_C	I_{RP}	V_C			I_{RP}	
Bipolar type	V		μ A		V	mA	V	A	V	A	% / °C	pF	
Unipolar type	V		μ A		V	mA	V	A	V	A	% / °C	pF	
- Z2008U	6.63	500	7.38	9.02	12.5 - 40	16.3	372	0.063	2400	0.071	1900	0.066	790
- Z2010U	8.10	20	9.00 - 11.0		15	33.4	19.5	311	0.071	1900	0.066	790	
Z2012	-	9.72	10.8 - 13.2		17.3	28.9	22.7	267	0.074	1580	0.075	640	
- Z2012U	-	9.72	10.8 - 13.2		17.3	28.9	22.7	267	0.074	1580	0.075	640	
Z2015	-	12.1	13.5 - 16.5		22.0	22.7	28.4	213	0.079	1280	0.079	520	
- Z2015U	-	12.1	13.5 - 16.5		22.0	22.7	28.4	213	0.079	1280	0.079	520	
Z2018	-	14.5	16.2 - 19.8		26.5	18.8	34.0	178	0.083	1040	0.083	420	
- Z2018U	-	14.5	16.2 - 19.8		26.5	18.8	34.0	178	0.083	1040	0.083	420	
Z2022	-	17.8	19.8 - 24.2		31.9	15.7	41.2	147	0.086	840	0.085	340	
- Z2022U	-	17.8	19.8 - 24.2		31.9	15.7	41.2	147	0.086	840	0.085	340	
Z2027	-	21.8	24.3 - 29.7		39.1	12.8	50.5	120	0.089	680	0.089	280	
- Z2027U	-	21.8	24.3 - 29.7		39.1	12.8	50.5	120	0.089	680	0.089	280	
Z2033	-	26.8	29.7 - 36.3		47.7	10.5	61.7	98.2	0.092	560	0.092	240	
- Z2033U	-	26.8	29.7 - 36.3		47.7	10.5	61.7	98.2	0.092	560	0.092	240	
Z2039	-	31.6	35.1 - 42.9		56.4	8.86	73.0	83.0	0.096	480	0.096	200	
- Z2039U	-	31.6	35.1 - 42.9		56.4	8.86	73.0	83.0	0.096	480	0.096	200	
Z2047	-	38.1	42.3 - 51.7		67.8	7.37	88.0	68.9	0.097	400	0.097	160	
- Z2047U	-	38.1	42.3 - 51.7		67.8	7.37	88.0	68.9	0.097	400	0.097	160	
Z2056	-	45.4	50.4 - 61.6		80.5	6.21	105	57.7	0.098	320	0.098	130	
- Z2056U	-	45.4	50.4 - 61.6		80.5	6.21	105	57.7	0.098	320	0.098	130	
Z2068	-	55.1	61.2 - 74.8		98.0	5.10	127	47.7	0.10	260	0.099	110	
- Z2068U	-	55.1	61.2 - 74.8		98.0	5.10	127	47.7	0.10	260	0.099	110	
Z2082	-	66.4	73.8 - 90.2		118	4.24	153	39.6	0.102	220	0.101	90	
- Z2082U	-	66.4	73.8 - 90.2		118	4.24	153	39.6	0.102	220	0.101	90	
Z2100	-	81	90.0 - 110		144	3.47	187	32.4	0.104	180	0.103	75	
- Z2100U	-	81	90.0 - 110		144	3.47	187	32.4	0.104	180	0.103	75	
Z2120	-	97.2	108 - 132		173	2.89	222	27.3	0.106	150	0.105	60	
- Z2120U	-	97.2	108 - 132		173	2.89	222	27.3	0.106	150	0.105	60	
Z2150	-	121	135 - 165		215	2.32	277	21.9	0.107	120	0.106	48	
- Z2150U	-	121	135 - 165		215	2.32	277	21.9	0.107	120	0.106	48	
Z2180	-	146	162 - 198		258	1.94	333	18.2	0.108	98	0.108	98	
- Z2180U	-	146	162 - 198		258	1.94	333	18.2	0.108	98	0.108	98	

*Rated peak impulse power dissipation: 500 W (10 / 1000 μ s), 6.0 kW (8 / 20 μ s)

*Rated average power dissipation: 1 W

*Operating / storage temperature: - 40 to 125 °C

Z6 / Z6U series

Product number	Stand-off voltage		Stand-by current		Breakdown voltage	Pulsed test current	Clamping voltage / rated peak impulse current			Temperature coefficient	Capacitance	
	V_S	DC	$I_{S, max}$	V_S			V_C	I_{RP}	V_C			I_{RP}
Bipolar type	V		μ A		V	mA	V	A	V	A	% / °C	pF
Unipolar type	V		μ A		V	mA	V	A	V	A	% / °C	pF
- Z6012	-	9.72	10.8 - 13.2		17.3	86.7	22.7	802	0.066	4400	0.075	3300
- Z6012U	-	9.72	10.8 - 13.2		17.3	86.7	22.7	802	0.066	4400	0.075	3300
Z6015	-	12.1	13.5 - 16.5		22	68.2	28.4	641	0.079	3600	0.079	2700
- Z6015U	-	12.1	13.5 - 16.5		22	68.2	28.4	641	0.079	3600	0.079	2700
Z6018	-	14.5	16.2 - 19.8		26.5	56.6	34.0	535	0.083	3000	0.083	2400
- Z6018U	-	14.5	16.2 - 19.8		26.5	56.6	34.0	535	0.083	3000	0.083	2400
Z6022	-	17.8	19.8 - 24.2		31.9	47.0	41.2	442	0.086	2400	0.086	1700
- Z6022U	-	17.8	19.8 - 24.2		31.9	47.0	41.2	442	0.086	2400	0.086	1700
Z6027	-	21.8	24.3 - 29.7		39.1	38.4	50.5	360	0.089	1900	0.089	1400
- Z6027U	-	21.8	24.3 - 29.7		39.1	38.4	50.5	360	0.089	1900	0.089	1400
Z6033	-	26.8	29.7 - 36.3		47.7	31.4	61.7	295	0.092	1400	0.092	1000
- Z6033U	-	26.8	29.7 - 36.3		47.7	31.4	61.7	295	0.092	1400	0.092	1000
Z6039	-	31.6	35.1 - 42.9		56.4	26.6	73.0	249	0.096	1000	0.096	720
- Z6039U	-	31.6	35.1 - 42.9		56.4	26.6	73.0	249	0.096	1000	0.096	720
Z6047	-	38.1	42.3 - 51.7		67.8	22.1	88.0	207	0.097	850	0.097	610
- Z6047U	-	38.1	42.3 - 51.7		67.8	22.1	88.0	207	0.097	850	0.097	610
Z6056	-	45.4	50.4 - 61.6		80.5	18.6	105	173	0.099	700	0.099	520
- Z6056U	-	45.4	50.4 - 61.6		80.5	18.6	105	173	0.099	700	0.099	520
Z6068	-	55.1	61.2 - 74.8		98.0	15.3	127	143	0.100	600	0.100	440
- Z6068U	-	55.1	61.2 - 74.8		98.0	15.3	127	143	0.100	600	0.100	440
Z6082	-	66.4	73.8 - 90.2		118	12.7	153	119	0.102	520	0.101	400
- Z6082U	-	66.4	73.8 - 90.2		118	12.7	153	119	0.102	520	0.101	400
Z6100	-	81.0	90.0 - 110		144	10.4	187	97.3	0.104	440	0.104	350
- Z6100U	-	81.0	90.0 - 110		144	10.4	187	97.3	0.104	440	0.104	350
Z6120	-	97.2	108 - 132		173	8.67	222	82.0	0.106	350	0.106	280
- Z6120U	-	97.2	108 - 132		173	8.67	222	82.0	0.106	350	0.106	280
Z6150	-	121	135 - 165		215	6.98	277	65.7	0.107	280	0.107	220
- Z6150U	-	121	135 - 165		215	6.98	277	65.7	0.107	280	0.107	220

*Rated peak impulse power dissipation: 1.5 kW (10 / 1000 μ s), 18.0 kW (8 / 20 μ s)

*Rated average power dissipation: 2 W

*Operating / storage temperature: - 40 to 125 °C

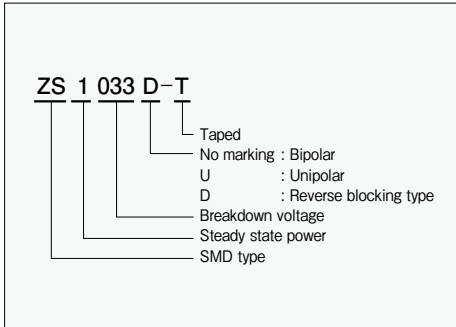
ZD series (low capacitance, reverse blocking type)

Product number	Stand-off voltage		Stand-by current		Breakdown voltage	Pulsed test current	Clamping voltage / rated peak impulse current			Temperature coefficient	Capacitance	
	V_S	DC	$I_{S, max}$	V_S			V_C	I_{RP}	V_C			I_{RP}
Bipolar type	V		μ A		V	mA	V	A	V	A	% / °C	pF
Unipolar type	V		μ A		V	mA	V	A	V	A	% / °C	pF
- ZD015	11.4	10	12.8 - 17.2		24.0	10.4	31.0	86.7	0.075	31.5	0.075	31.0
- ZD018	13.7	10	15.3 - 20.7		28.0	8.93	36.0	83.3	0.079	29.0	0.079	29.0
- ZD022	16.8	10	18.7 - 25.3		33.2	7.53	43.0	69.7	0.082	28.0	0.082	28.0
- ZD027	20.6	10	23.0 - 31.0		40.0	6.25	52.0	57.7	0.085	25.2	0.085	

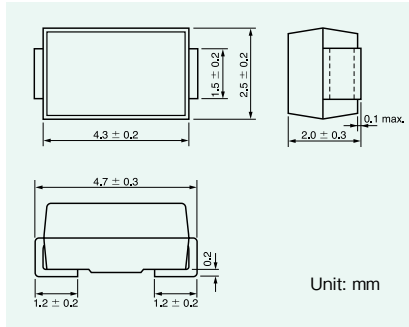
■ VRD voltage regulating diode (= TVS diode)

SMD type VRD

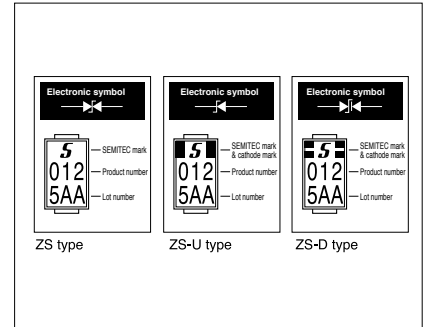
Product number



Dimensions



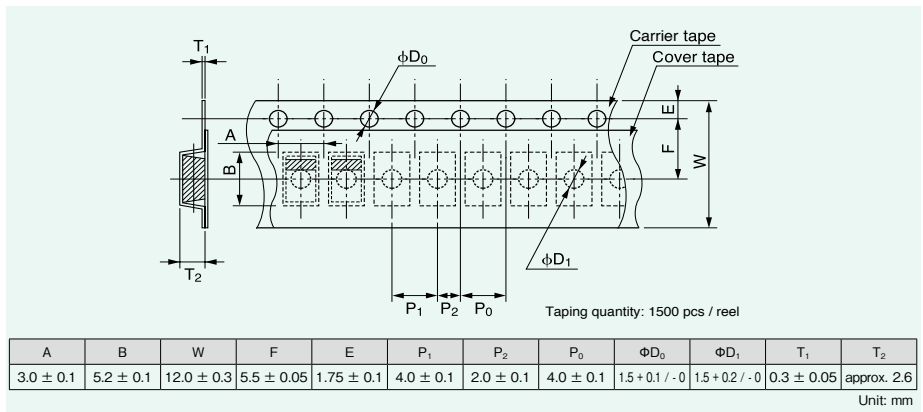
Product marking



General specifications for all types

Item	Rating
Rated average power dissipation	1.0 W
Rated peak impulse power dissipation	300 W (10 / 1000 μ s)
	1200 W (1.2 / 50 μ s)
Storage temp. range	2000 W (8 / 20 μ s)
	- 40 °C to 150 °C

Taping dimensions



Specifications

ZS type

Product number	Stand-off voltage		Stand-by current	Breakdown voltage	Clamping voltage / rated peak impulse current				Temperature coefficient	Capacitance
	V _s	I _s max			V _C max / I _{pp}		V _C max / I _{pp}			
	DC	V _S	I _s = 1 mA	10 / 1000 μ s		8 / 20 μ s		25 to 50 °C	C	
ZS1012	12 (10.8 to 13.2)	9.72	5	10	17.3	17.3	22.4	89.3	0.066	551
ZS1015	15 (13.5 to 16.5)	12.1			22.0	13.6	28.5	70.2	0.075	465
ZS1018	18 (16.2 to 19.8)	14.5			26.5	11.3	34.4	58.1	0.079	376
ZS1022	22 (19.8 to 24.2)	17.8			31.9	9.40	41.4	48.3	0.082	299
ZS1027	27 (24.3 to 29.7)	21.8			39.1	7.67	50.7	39.4	0.085	248
ZS1033	33 (29.7 to 36.3)	26.8			47.7	6.29	61.8	32.4	0.087	198
ZS1039	39 (35.1 to 42.9)	31.6			56.4	5.32	73.1	27.4	0.090	164
ZS1047	47 (42.3 to 51.7)	38.1			67.8	4.42	88.0	22.7	0.092	137

Ta = 25 °C

ZS-U type

Product number	Stand-off voltage		Stand-by current	Breakdown voltage	Clamping voltage / rated peak impulse current				Temperature coefficient	Capacitance
	V _s	I _s max			V _C max / I _{pp}		V _C max / I _{pp}			
	DC	V _S	I _s = 1 mA	10 / 1000 μ s		8 / 20 μ s		25 to 50 °C	C	
ZS1012U	12 (10.8 to 13.2)	9.72	5	10	17.3	17.3	22.4	89.3	0.066	1,102
ZS1015U	15 (13.5 to 16.5)	12.1			22.0	13.6	28.5	70.2	0.075	929
ZS1018U	18 (16.2 to 19.8)	14.5			26.5	11.3	34.4	58.1	0.079	751
ZS1022U	22 (19.8 to 24.2)	17.8			31.9	9.40	41.4	48.3	0.082	598
ZS1027U	27 (24.3 to 29.7)	21.8			39.1	7.67	50.7	39.4	0.085	497
ZS1033U	33 (29.7 to 36.3)	26.8			47.7	6.29	61.8	32.4	0.087	395
ZS1039U	39 (35.1 to 42.9)	31.6			56.4	5.32	73.1	27.4	0.090	328
ZS1047U	47 (42.3 to 51.7)	38.1			67.8	4.42	88.0	22.7	0.092	274

Ta = 25 °C

ZS-D type

Product number	Stand-off voltage		Stand-by current	Breakdown voltage	Clamping voltage / rated peak impulse current				Temperature coefficient	Capacitance
	V _s	I _s max			V _C max / I _{pp}		V _C max / I _{pp}			
	DC	V _S	I _s = 1 mA	10 / 1000 μ s		8 / 20 μ s		25 to 50 °C	C	
ZS1012D	12 (10.8 to 13.2)	9.72	5	10	17.3	17.3	22.4	89.3	0.066	30.2
ZS1015D	15 (13.5 to 16.5)	12.1			22.0	13.6	28.5	70.2	0.075	29.1
ZS1018D	18 (16.2 to 19.8)	14.5			26.5	11.3	34.4	58.1	0.079	28.2
ZS1022D	22 (19.8 to 24.2)	17.8			31.9	9.40	41.4	48.3	0.082	27.3
ZS1027D	27 (24.3 to 29.7)	21.8			39.1	7.67	50.7	39.4	0.085	26.4
ZS1033D	33 (29.7 to 36.3)	26.8			47.7	6.29	61.8	32.4	0.087	25.5
ZS1039D	39 (35.1 to 42.9)	31.6			56.4	5.32	73.1	27.4	0.090	24.8
ZS1047D	47 (42.3 to 51.7)	38.1			67.8	4.42	88.0	22.7	0.092	24.0

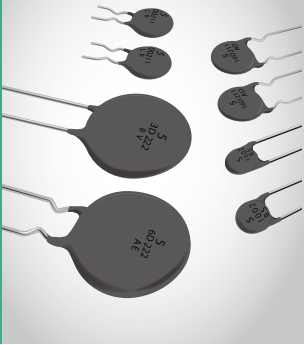
Ta = 25 °C

• Reverse voltage: 200 V DC

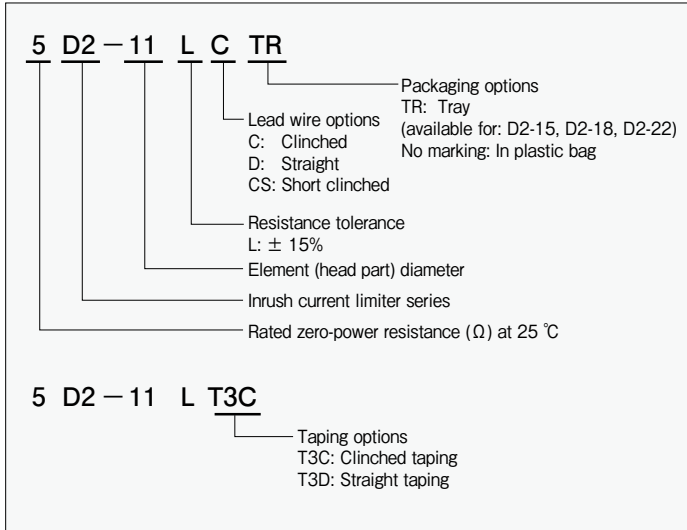
■ Inrush current limiter

Power Thermistor

Power thermistors utilize the self heating characteristic of NTC thermistors which causes a significant decrease in resistance in a short time. Power thermistors can be used instead of inrush current limiting resistors. Power thermistors have the advantage that their resistance decreases through self heating which reduces power loss and results in energy savings.
UL1434 File No. E92669 (1D2-22 excluded) certified.



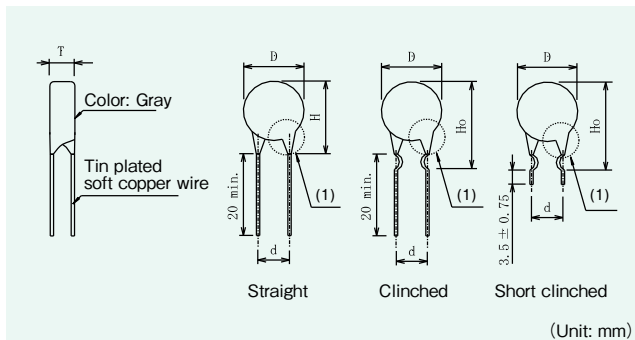
■ Product number explanation



■ Applications

Switching power supplies, adapters, LCD TVs, plasma TVs, air conditioners, DVD players, audio equipment, LCD projectors, copiers, PCs, printers, office automation equipment, gaming machine power supplies

■ Dimensions

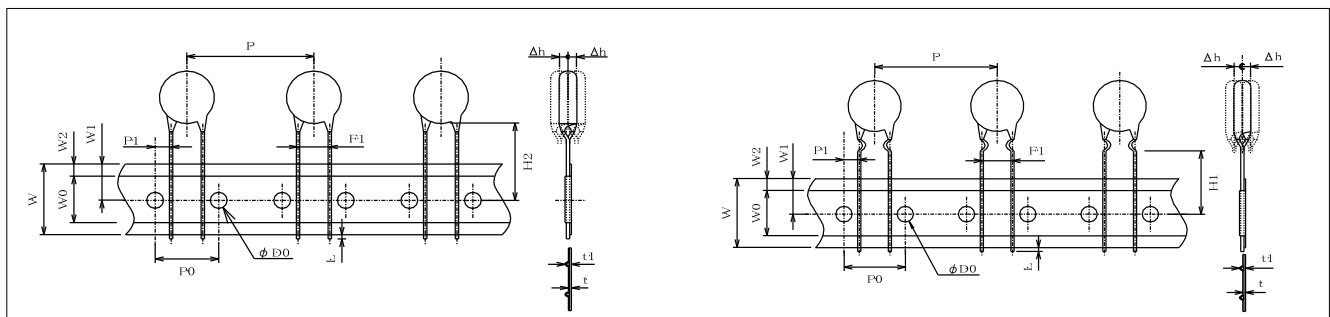


	D	T	H	H0	d	Lead wire diameter
D2-05	8.5 max.	7.0 max.	11.5 max.	15.5 max.	5.0 ± 1	Φ 0.8
D2-07	11.0 max.	9.0 max.	13.0 max.	16.0 max.		
D2-08	10.0 max.	7.0 max.	13.0 max.	17.0 max.		
D2-10	13.0 max.	9.0 max.	17.0 max.	19.5 max.		
D2-11	11.5 max.	8.0 max.	15.0 max.	18.5 max.	7.5 ± 1	Φ 1.0 (Φ 0.8)
D2-13	14.5 max.	8.0 max.	18.0 max.	21.5 max.		
D2-14	17.0 max.	9.0 max.	21.0 max.	22.5 max.		
D2-15	16.5 max.	8.0 max.	20.0 max.	23.0 max.		
D2-18	19.5 max.	8.0 max.	23.0 max.	26.0 max.	10 ± 1	Φ 1.0 (Φ 0.8)
D2-22	23.0 max.	8.5 max. (8.0 max.)	26.5 max.	29.5 max.		

1: D2-22

Unit: mm

■ Taping dimensions



	P	P0	P1	W	W0	W1	W2	H1	H2	L	F1	Φ D0	t	t1	Δh
D2-05	15.0 ± 1.0	15.0 ± 0.3	5.0 ± 0.7	17.5 to 19.0	min. 5.0	9.0 ± 0.5	max.3.0	16.0 ± 0.5	19.0 to 21.5	max. 1.0	5.0 ± 0.5	4.0 ± 0.2	0.6 ± 0.3	max. 1.5	0 ± 2.0
D2-07															
D2-08															
D2-10															
D2-11	30.0 ± 1.0		3.75 ± 0.7								7.5 ± 0.5				
D2-13															
D2-14															

• MOQ: 1000 pcs.

Unit: mm

Specifications

Product number	Zero-power resistance at 25 °C (± 15%)	B value ¹	Max. current at 25 °C	Residual resistance (Ω)	Thermal time constant ² (s)	Dissipation factor (mW / °C)	Operating temp. range (°C)	Max. capacitance				Energy surge capacity (J)
		B _{25/85}						AC				
		(± 5%)						100 V	120 V	220 V	240 V	
(Ω)	(K)	(A)	(Ω)	(s)	(mW / °C)	(°C)	100 V	120 V	220 V	240 V	(J)	
5D2-05	5.0	2650	2.0	0.48	20	15	- 50 to 150	860	600	170	150	4.3
10D2-05	10.0	2700	1.0	0.91	20	7	- 50 to 150	860	600	170	150	4.3
20D2-05	20.0	2800	0.3	1.66	20	1	- 50 to 150	860	600	170	150	4.3
5D2-07	5.0	2800	3.0	0.36	35	30	- 40 to 160	400	260	80	60	1.9
8D2-07	8.0	2800	2.0	0.58	41	30	- 40 to 160	560	360	110	90	2.6
10D2-07	10.0	2800	2.0	0.72	45	30	- 40 to 160	680	470	140	110	3.3
12D2-07	12.0	2900	1.7	0.78	41	30	- 40 to 160	380	260	80	60	1.9
16D2-07	16.0	2900	2.0	1.04	45	30	- 40 to 160	800	530	160	130	3.8
22D2-07	22.0	2900	1.0	1.43	50	30	- 40 to 160	960	630	190	150	4.5
5D2-08	5.0	2700	3.0	0.35	35	22	- 50 to 170	1260	880	260	220	6.3
10D2-08	10.0	2800	2.0	0.63	35	17	- 50 to 170	1260	880	260	220	6.3
15D2-08	15.0	2800	2.0	0.94	35	26	- 50 to 170	2880	2000	590	500	14.0
20D2-08	20.0	2900	1.0	1.13	35	8	- 50 to 170	2880	2000	590	500	14.0
2D2-10	2.0	2800	5.0	0.15	50	32	- 40 to 160	640	1100	330	270	7.9
3D2-10	3.0	2800	4.0	0.22	53	32	- 40 to 160	720	1170	350	290	8.4
5D2-10	5.0	2900	4.0	0.33	53	32	- 40 to 160	440	970	290	240	7.0
8D2-10	8.0	2900	3.0	0.52	70	32	- 40 to 160	560	1070	320	260	7.7
10D2-10	10.0	2900	3.0	0.65	75	32	- 40 to 160	1640	1100	330	270	7.9
12D2-10	12.0	3000	1.8	0.71	53	32	- 40 to 160	830	580	170	140	4.1
16D2-10	16.0	3000	1.6	0.94	70	32	- 40 to 160	830	580	170	140	4.1
2D2-11	2.0	2650	5.0	0.15	40	26	- 50 to 170	2700	1880	550	470	13.0
3D2-11	3.0	2650	4.0	0.22	40	24	- 50 to 170	4830	3360	990	840	24.0
4D2-11	4.0	2700	4.0	0.28	40	31	- 50 to 170	2880	2000	590	500	14.0
5D2-11	5.0	2700	4.0	0.35	40	39	- 50 to 170	2700	1880	550	470	13.0
8D2-11	8.0	2800	3.0	0.50	40	31	- 50 to 170	2700	1880	550	470	13.0
10D2-11	10.0	2800	3.1	0.63	40	42	- 50 to 170	2880	2000	590	500	14.0
12D2-11	12.0	2800	2.0	0.75	40	21	- 50 to 170	4030	2800	830	700	20.0
15D2-11	15.0	2950	2.5	0.80	40	34	- 50 to 170	2880	2000	590	500	14.0
16D2-11	16.0	2950	2.5	0.86	40	37	- 50 to 170	2880	2000	590	500	14.0
20D2-11	20.0	3000	2.0	1.02	40	28	- 50 to 170	2880	2000	590	500	14.0
1D2-13	1.0	2650	6.0	0.06	55	12	- 50 to 200	860	600	170	150	4.3
2D2-13	2.0	2700	6.0	0.10	55	21	- 50 to 200	860	600	170	150	4.3
4D2-13	4.0	2800	5.0	0.18	55	24	- 50 to 200	860	600	170	150	4.3
4.7D2-13	4.7	2900	5.0	0.18	55	26	- 50 to 200	2700	1880	550	470	13.0
5D2-13	5.0	2900	5.0	0.19	55	27	- 50 to 200	2700	1880	550	470	13.0
8D2-13	8.0	3000	4.0	0.27	25	25	- 50 to 200	2880	2000	590	500	14.0
10D2-13	10.0	3050	4.0	0.32	55	29	- 50 to 200	2880	2000	590	500	14.0
12D2-13	12.0	3000	4.0	0.41	55	37	- 50 to 200	4830	3360	990	840	24.0
15D2-13	15.0	3050	3.0	0.48	55	25	- 50 to 200	4830	3360	990	840	24.0
16D2-13	16.0	3050	3.0	0.51	55	26	- 50 to 200	4830	3360	990	840	24.0
2D2-14	2.0	2800	5.0	0.15	90	36	- 40 to 160	4200	2890	860	720	20.8
3D2-14	3.0	2900	5.0	0.20	80	36	- 40 to 160	3080	2110	630	520	15.2
4D2-14	4.0	2900	5.0	0.26	95	36	- 40 to 160	3400	2350	700	580	16.9
5D2-14	5.0	2900	4.0	0.33	110	36	- 40 to 160	3600	2480	740	620	17.9
8D2-14	8.0	3000	2.5	0.47	80	36	- 40 to 160	1390	970	280	240	6.9
10D2-14	10.0	3000	2.2	0.59	95	36	- 40 to 160	1790	1240	370	310	8.9
12D2-14	12.0	3000	2.0	0.71	105	36	- 40 to 160	2190	1520	450	380	10.9
16D2-14	16.0	3000	1.8	0.94	115	36	- 40 to 160	2790	1940	570	480	13.9
1D2-15	1.0	2650	8.0	0.06	70	22	- 50 to 200	6910	4800	1420	1200	34.0
1.5D2-15	1.5	2650	8.0	0.08	70	29	- 50 to 200	6910	4800	1420	1200	34.0
2D2-15	2.0	2700	8.0	0.10	70	37	- 50 to 200	6910	4800	1420	1200	34.0
3D2-15	3.0	2800	7.0	0.13	70	36	- 50 to 200	4030	2800	830	700	20.0
4D2-15	4.0	2800	7.0	0.18	70	48	- 50 to 200	4030	2800	830	700	20.0
4.7D2-15	4.7	2900	6.0	0.18	70	37	- 50 to 200	4030	2800	830	700	20.0
5D2-15	5.0	2900	6.0	0.19	70	39	- 50 to 200	4030	2800	830	700	20.0
8D2-15	8.0	3000	5.0	0.27	70	39	- 50 to 200	4030	2800	830	700	20.0
10D2-15	10.0	3000	5.0	0.34	70	49	- 50 to 200	5760	4000	1190	1000	28.0
12D2-15	12.0	3050	5.0	0.39	70	54	- 50 to 200	5760	4000	1190	1000	28.0
15D2-15	15.0	3100	4.0	0.45	70	41	- 50 to 200	5760	4000	1190	1000	28.0
16D2-15	16.0	3100	4.0	0.48	70	44	- 50 to 200	5760	4000	1190	1000	28.0
4D2-18	4.0	2900	8.0	0.16	90	59	- 50 to 200	6910	4800	1420	1200	34.0
5D2-18	5.0	2950	8.0	0.18	90	66	- 50 to 200	6910	4800	1420	1200	34.0
8D2-18	8.0	3050	6.0	0.26	90	53	- 50 to 200	6910	4800	1420	1200	34.0
10D2-18	10.0	3100	6.0	0.30	90	62	- 50 to 200	6910	4800	1420	1200	34.0
47D2-18	47.0	3450	2.0	0.94	90	21	- 50 to 200	6910	4800	1420	1200	34.0
1D2-22	1.0	2900	12.0	0.04	125	32	- 50 to 200	8200	-	1700	-	41.0
3D2-22	3.0	2800	8.0	0.13	130	48	- 50 to 200	12600	8800	2610	2200	63.0
4D2-22	4.0	2900	8.0	0.16	130	59	- 50 to 200	12600	8800	2610	2200	63.0
6D2-22	6.0	3000	6.0	0.21	130	43	- 50 to 200	12600	8800	2610	2200	63.0

¹: In part reference values ²: Reference values

Reliability data

Item	Test conditions	Criteria
Resistance to soldering heat	10 s at 260 °C 5 s at 350 °C	ΔR ± 15%
Solderability	3 s at 245 °C Flux material: Rosin 25%, ethyl alcohol 75%	More than 95% soldered
Tensile strength (lead wire)	A load of 10 N is applied to the wire terminations in vertical direction for 10 s.	ΔR ± 15%
Voltage proof	1000 V AC for one minute	Less than 1 mA
Insulation resistance	500 V DC	Over 100 MΩ
Dry heat	1000 hours at max. operating temperature for each product number	ΔR ± 20%
Damp heat	1000 hours at 40 °C and 90% humidity	
Temperature cycle (thermal shock)	10 cycles as below: 1. - 40 °C for 30 minutes 2. Room temperature for 5 minutes 3. 160 °C for 30 minutes 4. Room temperature for 5 minutes	ΔR ± 15%
Electrical load	Max. current for 1000 h at 25 °C room temperature	ΔR ± 20%

Caution

- When force is applied to the lead wire the leg connections may break or chipping may occur.
- May get hot during use. When designing the environment around the power thermistor be especially careful with lead wire connections, materials used in the direct vicinity and the layout of other electrical components.
- Do not use two or more power thermistors in a row.



■ Non-contact (IR) temperature sensor

THERMOPILE

Thermopiles are IR temperature sensors that fully utilize SEMITEC original silicon-micromachining technology.

■ Product number

10TP583T

■ Applications

Ear thermometers, IR thermometers, microwave ovens and other non-contact temperature sensing applications

■ Specifications

Parameter	Value	Conditions
Sensitive area	1.05 x 1.05 mm	Size of absorbing film
Output voltage ¹	200 μV ± 30%	—
Output voltage ²	1.00 mV ± 30%	—
Thermopile resistance	65 kΩ ± 30%	Resistance value at 25 °C
Time constant	15 ms	Typical
Operating temperature range	- 20 to 100 °C	—
Storage temperature range	- 40 to 100 °C	—
Field of view	± 50°	Incident angle to achieve 50% responsivity
Filter range	Cut on 5 μm	—
Thermistor resistance value	100 kΩ ± 3%	Rated zero-power resistance value at 25 °C
Thermistor B value	3435 K ± 0.7%	B value calculated from rated zero-power resistance at 25 °C and 85 °C

¹Test conditions

Blackbody furnace: 500 K

Sensor to blackbody distance: 100 mm

Sensor temperature: 298 K

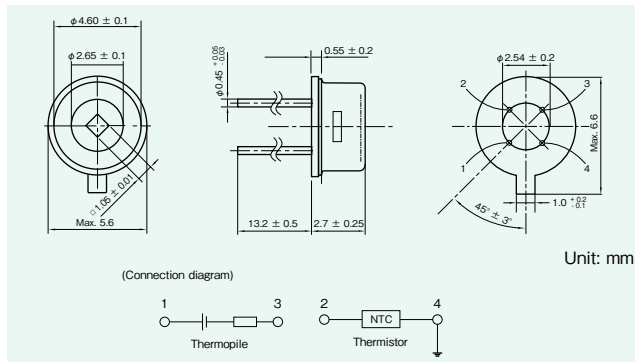
Aperture size: φ 12.7 mm

²Test conditions

Blackbody furnace: 310 K

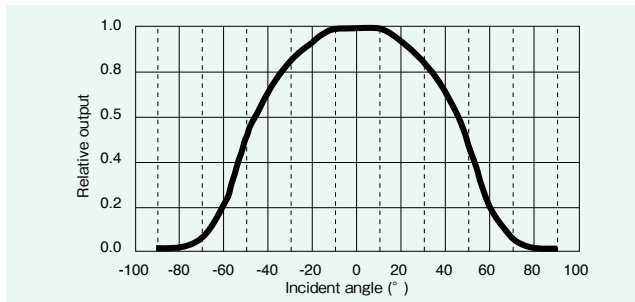
Sensor temperature: 298 K

■ Dimensions

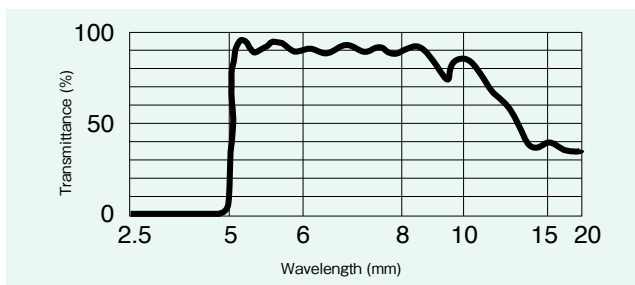


■ Optical characteristics

Field of view characteristics



Filter characteristics



■ Reliability data

Item	Test conditions	Criteria
Dry heat	1000 hours at 100 °C	Thermopile: ΔV ± 2% Thermistor: ΔR ± 0.5% Thermistor: ΔB ± 0.2%
Damp heat	1000 hours at 60 °C and 85% humidity	Thermopile: ΔV ± 2% Thermistor: ΔR ± 0.3% Thermistor: ΔB ± 0.2%
Temperature cycle (thermal shock)	10 cycles as below: 1. - 20 °C for 30 minutes 2. Room temperature for 3 minutes 3. 100 °C for 30 minutes 4. Room temperature for 3 minutes	
Resistance to soldering heat	5 s at 350 °C	
Free fall	Three times natural fall to a concrete floor from 1 m height.	

■ Data table (approx.)

		Sensor temperature (°C)									
		- 20	- 10	0	10	25	40	60	80	100	
Temperature of measured object (°C)	- 20	0.000	- 0.510	- 1.081	- 1.718	- 2.809	- 4.078	- 6.078	- 8.473	- 11.31	
	- 10	0.510	0.000	- 0.571	- 1.208	- 2.300	- 3.568	- 5.568	- 7.963	- 10.80	
	0	1.081	0.571	0.000	- 0.637	- 1.728	- 2.997	- 4.997	- 7.392	- 10.23	
	10	1.718	1.208	0.637	0.000	- 1.091	- 2.360	- 4.360	- 6.755	- 9.593	
	30	3.211	2.702	2.131	1.493	0.402	- 0.867	- 2.867	- 5.261	- 8.099	
	37	3.809	3.300	2.728	2.091	1.000	- 0.269	- 2.269	- 4.664	- 7.501	
	40	4.078	3.568	2.997	2.360	1.269	0.000	- 2.000	- 4.395	- 7.233	
	60	6.078	5.568	4.997	4.360	3.269	2.000	0.000	- 2.395	- 5.233	
	80	8.473	7.963	7.392	6.755	5.664	4.395	2.395	0.000	- 2.838	
	100	11.31	10.80	10.23	9.593	8.501	7.233	5.233	2.838	0.000	
	120	14.64	14.13	13.56	12.93	11.83	10.57	8.565	6.171	3.333	
140	18.53	18.02	17.45	16.81	15.72	14.45	12.45	10.05	7.215		
160	23.01	22.51	21.93	21.30	20.21	18.94	16.94	14.54	11.70		
180	28.17	27.66	27.09	26.45	25.36	24.09	22.09	19.70	16.86		
200	34.06	33.55	32.98	32.34	31.25	29.98	27.98	25.58	22.75		

Unit: mV



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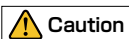
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Always consider implementing fail-safe mechanisms.

High reliability applications include:

- Medical equipment Transportation equipment (automotive, railroad, shipping, etc.) Aerospace equipment Traffic equipment
 Security equipment (Crime and Disaster Prevention) Nuclear-related equipment Military equipment Undersea equipment
 Safety devices Other equipment also requiring equally high reliability

- 2) Do not use products outside the defined specification limits or storage conditions, as reliability may be compromised.
3) Take precautions against any improper use of products that could result in heat generation, ignition, explosion, shattering, etc.
4) Some products may have sharp protrusions or edges due to their structure. Workers must therefore be adequately trained in handling products to prevent any related accidents.
5) Processing products may be accompanied by destruction, shattering, etc. of parts. Workers must therefore be adequately trained and be well versed in product material knowledge and various work conditions, to prevent any related accidents.
6) When handling products, take precautions not to apply tension, pressure or heat that exceeds the recommended specifications, as such stress may cause open or short circuits, or insulation failures that accelerate aging or impair intended performance of the products.
7) Consult Semitec sales on any uncertainties regarding application, product usage or items not mentioned herein, to avoid improper use of products.
8) Take necessary measures to prevent any damages due to accidents resulting from product failure or malfunction.
9) Semitec assumes no liability or responsibility for any accidents resulting from failure to follow the product usage guidelines mentioned above.
10) Consult Semitec sales when considering an application outside of a product's intended use. A separate, individual agreement can be concluded if necessary upon confirming application reliability.

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