Panasonic

2015

CATALOG

Thermal Management Solutions

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Thermal Management Solutions CONTENTS

All products in this catalog comply with the RoHS Directive.

The RoHS Directive is "the Directive (2011/65/EU) on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment " and its revisions.

The NTC Thermistors

NTC Thermistors is a negative temperature coefficient resistor that significantly reduces its resistance value as the heat/ambient temperature rises. Thermistors is sintered in high-temperature (1200 °C to 1500 °C), and manufactured in various shapes. It's comprised of 2 to 4 kinds of metal oxides: iron, nickel, cobalt, manganese and copper.

Features

- Temperature Coefficient of Resistance is negative, and it's extremely large (–2.8 to –5.1 [%/°C]).
- Various shapes, especially compact size components are available.
- Selection of resistance vale is comparatively free, it's available from several tens Ω to several hundred kΩ.

Recommended Applications

- For temperature measurement or temperature detection : Thermometer, temperature controller
- For temperature compensation : Transistor, transistor circuit, quarts oscillation circuit, and measuring instruments

Physical Characteristics of NTC Thermistors

Thermistor is a resistor sensitive to temperature that is utilizing the characteristic of metal oxide semiconductor having large temperature coefficient.
And its temperature dependency of resistance value is indicated by the following equation :

$$R=R_0 \exp\left[B\left(\frac{1}{T}-\frac{1}{T_0}\right)\right] \quad \cdots\cdots(1)$$

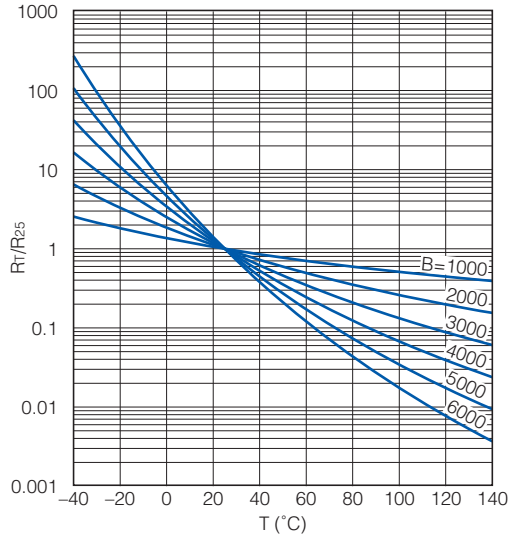
T_0 : Standard Temperature 298.15 K(25 °C)
R_0 : Resistance at T_0 [K]
B : Thermistor Constant [K]

Temperature coefficient (α) in general meaning is indicated as follows :

$$\alpha=-\frac{B}{T^2} \quad \cdots\cdots(2)$$

Since the change by temperature is considerably large, α is not appropriate as a constant. Therefore, B value (constant) is generally used as a coefficient of thermistors.

Fig. 1



Major Characteristics of NTC Thermistors

The relation between resistance and temperature of a thermistor is linear as shown in Fig. 2. The resistance value is shown in vertical direction in a logarithmic scale and reciprocal of absolute temperature (adding 273.15 to centigrade) is shown in horizontal direction.
The B value (constant) determines the gradient of these straight lines. The B value (constant) is calculated by using following equation.

$$B=\frac{\ell nR_1-\ell nR_2}{\frac{1}{T_1}-\frac{1}{T_2}} \quad \cdots\cdots(3)$$

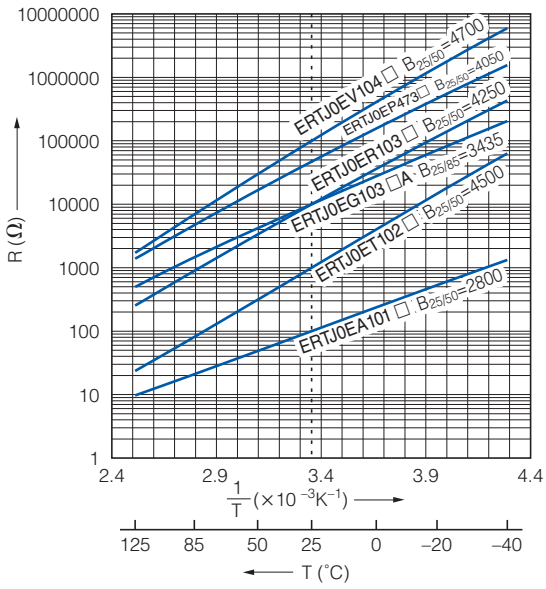
R_1: Resistance at T_1 K
R_2: Resistance at T_2 K

When you calculate this equation, you'll find that B value is not exactly constant. The resistance is expressed by the following equation :

$$R = AT^{-C} \exp D/T \quad \cdots\cdots(4)$$

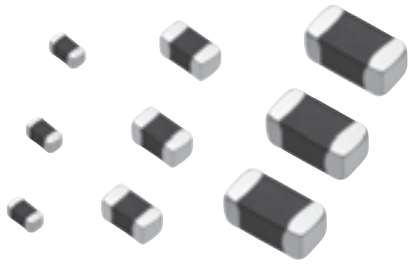
In (4), C is a small positive or negative constant and quite negligible except for use in precision temperature-measuring device, therefore, the B value can be considered as constant number.
In Fig. 1, the relation between the resistance ratio R_T/R_{25} (R_{25} : Resistance at 25 °C, RT : Resistance at T °C) and B Value is shown with T °C, in the horizontal direction.

Fig. 2



Multilayer NTC Thermistors

Series: **ERTJ**



Features

- Surface Mount Device (0201, 0402, 0603)
- Highly reliable multilayer / monolithic structure
- Wide temperature operating range (–40 to 125 °C)
- Environmentally-friendly lead-free
- RoHS compliant

Recommended Applications

- Mobile Phone
  - · Temperature compensation for crystal oscillator
  - · Temperature compensation for semiconductor devices
- Personal Computer and Peripheral Device
  - · Temperature detection for CPU and memory device
  - · Temperature compensation for ink-viscosity (Inkjet Printer)
- Battery Pack (secondary battery)
  - · Temperature detection of battery cells
- Liquid Crystal Display
  - · Temperature compensation of display contrast
  - · Temperature compensation of display backlighting (CCFL)

Explanation of Part Numbers

1	2	3	4	5	6	7	8	9	10	11	12	
E	R	T	J	0	E	G	1	0	3	J	A	(Example)

Common Code

Product Code		Type Code	
ERT	NTC Thermistors	J	Chip Type (SMD) Multilayer Type

Size Code

Z	"0201"
0	"0402"
1	"0603"

Packaging Style Code

E	"0201", "0402" Pressed Carrier Taping Punched Carrier Taping (Pitch : 2 mm)
V	"0603" Punched Carrier Taping (Pitch : 4 mm)

B Value Class Code

A	2701 to 2800
G	3301 to 3400
M	3801 to 3900
P	4001 to 4100
R	4201 to 4300
S	4301 to 4400
T	4401 to 4500
V	4601 to 4700

Nominal Resistance R_{25} (Ω)

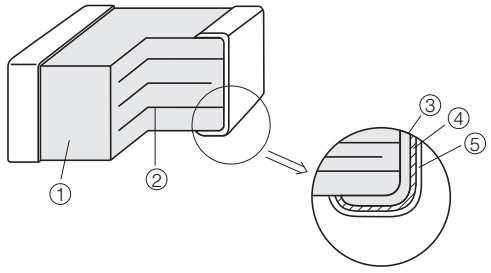
The first two digits are significant figures of resistance and the third one denotes the number of zeros following them.

Resistance Tolerance Code

F	±1%	Narrow Tolerance Type
G	±2%	
H	±3%	Standard Type
J	±5%	

Special Specification

Construction



No.	Name	
①	Semiconductive Ceramics	
②	Internal electrode	
③	Terminal electrode	Substrate electrode
④		Intermediate electrode
⑤		External electrode

Ratings

Size code (EIA)	Z(0201)	0(0402)	1(0603)
Operating Temperature Range	−40 to 125 °C		
Rated Maximum Power Dissipation*1	33 mW	66 mW	100 mW
Dissipation Factor*2	Approximately 1 mW/°C	Approximately 2 mW/°C	Approximately 3 mW/°C

*1 Rated Maximum Power Dissipation : The maximum power that can be continuously applied at the rated ambient temperature.
·The maximum value of power, and rated power is same under the condition of ambient temperature 25 °C or less. If the temperature exceeds 25 °C, rated power depends on the decreased power dissipation curve.
·Please see "Operating Power" for details.
*2 Dissipation factor : The constant amount power required to raise the temperature of the Thermistor 1 °C through self heat generation under stable temperatures.
·Dissipation factor is the reference value when mounted on a glass epoxy board (1.6 mmT).

Part Number List of Narrow Tolerance Type (Resistance Tolerance : ±2 %, ±1 %)

● 0201(EIA)

Part Number	Nominal Resistance at 25 °C	Resistance Tolerance	B Value at 25/50(K)	B Value at 25/85(K)
ERTJZEG103□A	10 kΩ	±1 %(F) or ±2 %(G)	(3380 K)	3435 K±1%
ERTJZEP473□	47 kΩ		4050 K±1 %	(4100 K)
ERTJZER683□	68 kΩ		4250 K±1 %	(4300 K)
ERTJZER104□	100 kΩ		4250 K±1 %	(4300 K)
ERTJZET104□	100 kΩ		4500 K±1 %	(4550 K)
ERTJZEV104□	100 kΩ		4700 K±1 %	(4750 K)

□ : Resistance Tolerance Code

● 0402(EIA)

Part Number	Nominal Resistance at 25 °C	Resistance Tolerance	B Value at 25/50(K)	B Value at 25/85(K)
ERTJ0EG103□A	10 kΩ	±1 %(F) or ±2 %(G)	(3380 K)	3435 K±1 %
ERTJ0EP333□	33 kΩ		4050 K±1 %	(4100 K)
ERTJ0EP473□	47 kΩ		4050 K±1 %	(4100 K)
ERTJ0EP683□	68 kΩ		4050 K±1 %	(4100 K)
ERTJ0ES104□	100 kΩ		4330 K±1 %	(4390 K)
ERTJ0EV104□	100 kΩ		4700 K±1 %	(4750 K)

□ : Resistance Tolerance Code

● 0603(EIA)

Part Number	Nominal Resistance at 25 °C	Resistance Tolerance	B Value at 25/50(K)	B Value at 25/85(K)
ERTJ1VG103□A	10 kΩ	±1 %(F) or ±2 %(G)	(3380 K)	3435 K±1 %
ERTJ1VS104□A	100 kΩ		(4330 K)	4390 K±1 %

□ : Resistance Tolerance Code

Part Number List of Standard Type (Resistance Tolerance : ±5 %, ±3 %)

● 0201(EIA)

Part Number	Nominal Resistance at 25 °C	Resistance Tolerance	B Value at 25/50(K)	B Value at 25/85(K)
ERTJZET202□	2.0 kΩ	±3 %(H) or ±5 %(J)	4500 K±2 %	(4450 K)
ERTJZET302□	3.0 kΩ		4500 K±2 %	(4450 K)
ERTJZET472□	4.7 kΩ		4500 K±2 %	(4450 K)
ERTJZEG103□A	10 kΩ		(3380 K)	3435 K±1 %
ERTJZEP473□	47 kΩ		4050 K±2 %	(4100 K)
ERTJZER683□	68 kΩ		4250 K±2 %	(4300 K)
ERTJZER104□	100 kΩ		4250 K±2 %	(4300 K)
ERTJZET104□	100 kΩ		4500 K±2 %	(4550 K)
ERTJZEV104□	100 kΩ		4700 K±2 %	(4750 K)

□ : Resistance Tolerance Code

● 0402(EIA)

Part Number	Nominal Resistance at 25 °C	Resistance Tolerance	B Value at 25/50(K)	B Value at 25/85(K)
ERTJ0EA220☐	22 Ω	±3 %(H) or ±5 %(J)	2750 K±3 %	(2700 K)
ERTJ0EA330☐	33 Ω		2750 K±3 %	(2700 K)
ERTJ0EA400☐	40 Ω		2750 K±3 %	(2700 K)
ERTJ0EA470☐	47 Ω		2750 K±3 %	(2700 K)
ERTJ0EA680☐	68 Ω		2800 K±3 %	(2750 K)
ERTJ0EA101☐	100 Ω		2800 K±3 %	(2750 K)
ERTJ0EA151☐	150 Ω		2800 K±3 %	(2750 K)
ERTJ0ET102☐	1.0 kΩ		4500 K±2 %	(4450 K)
ERTJ0ET152☐	1.5 kΩ		4500 K±2 %	(4450 K)
ERTJ0ET202☐	2.0 kΩ		4500 K±2 %	(4450 K)
ERTJ0ET222☐	2.2 kΩ		4500 K±2 %	(4450 K)
ERTJ0ET302☐	3.0 kΩ		4500 K±2 %	(4450 K)
ERTJ0ER332☐	3.3 kΩ		4250 K±2 %	(4300 K)
ERTJ0ET332☐	3.3 kΩ		4500 K±2 %	(4450 K)
ERTJ0ET472☐	4.7 kΩ		4500 K±2 %	(4450 K)
ERTJ0ER472☐	4.7 kΩ		4250 K±2 %	(4300 K)
ERTJ0ER682☐	6.8 kΩ		4250 K±2 %	(4300 K)
ERTJ0EG103☐A	10 kΩ		(3380 K)	3435 K±1 %
ERTJ0EM103☐	10 kΩ		3900 K±2 %	(3970 K)
ERTJ0ER103☐	10 kΩ		4250 K±2 %	(4300 K)
ERTJ0ER153☐	15 kΩ		4250 K±2 %	(4300 K)
ERTJ0ER223☐	22 kΩ		4250 K±2 %	(4300 K)
ERTJ0EP333☐	33 kΩ		4050 K±2 %	(4100 K)
ERTJ0ER333☐	33 kΩ		4250 K±2 %	(4300 K)
ERTJ0ET333☐	33 kΩ		4500 K±2 %	(4580 K)
ERTJ0EP473☐	47 kΩ		4050 K±2 %	(4100 K)
ERTJ0EV473☐	47 kΩ		4700 K±2 %	(4750 K)
ERTJ0EP683☐	68 kΩ		4050 K±2 %	(4100 K)
ERTJ0ER683☐	68 kΩ		4250 K±2 %	(4300 K)
ERTJ0EV683☐	68 kΩ		4700 K±2 %	(4750 K)
ERTJ0ER104☐	100 kΩ		4250 K±2 %	(4300 K)
ERTJ0ES104☐	100 kΩ		4330 K±2 %	(4390 K)
ERTJ0ET104☐	100 kΩ		4500 K±2 %	(4580 K)
ERTJ0EV104☐	100 kΩ		4700 K±2 %	(4750 K)
ERTJ0ET154☐	150 kΩ		4500 K±2 %	(4580 K)
ERTJ0EV154☐	150 kΩ		4700 K±2 %	(4750 K)
ERTJ0EV224☐	220 kΩ		4700 K±2 %	(4750 K)
ERTJ0EV334☐	330 kΩ		4700 K±2 %	(4750 K)
ERTJ0EV474☐	470 kΩ		4700 K±2 %	(4750 K)

☐ : Resistance Tolerance Code

● 0603(EIA)

Part Number	Nominal Resistance at 25 °C	Resistance Tolerance	B Value at 25/50(K)	B Value at 25/85(K)
ERTJ1VA220☐	22 Ω	±3 %(H) or ±5 %(J)	2750 K±3 %	(2700 K)
ERTJ1VA330☐	33 Ω		2750 K±3 %	(2700 K)
ERTJ1VA400☐	40 Ω		2800 K±3 %	(2750 K)
ERTJ1VA470☐	47 Ω		2800 K±3 %	(2750 K)
ERTJ1VA680☐	68 Ω		2800 K±3 %	(2750 K)
ERTJ1VA101☐	100 Ω		2800 K±3 %	(2750 K)
ERTJ1VT102☐	1.0 kΩ		4500 K±2 %	(4450 K)
ERTJ1VT152☐	1.5 kΩ		4500 K±2 %	(4450 K)
ERTJ1VT202☐	2.0 kΩ		4500 K±2 %	(4450 K)
ERTJ1VT222☐	2.2 kΩ		4500 K±2 %	(4450 K)
ERTJ1VT302☐	3.0 kΩ		4500 K±2 %	(4450 K)
ERTJ1VT332☐	3.3 kΩ		4500 K±2 %	(4450 K)
ERTJ1VR332☐	3.3 kΩ		4250 K±2 %	(4300 K)
ERTJ1VR472☐	4.7 kΩ		4250 K±2 %	(4300 K)
ERTJ1VT472☐	4.7 kΩ		4500 K±2 %	(4450 K)
ERTJ1VR682☐	6.8 kΩ		4250 K±2 %	(4300 K)
ERTJ1VG103☐A	10 kΩ		(3380 K)	3435 K±1%
ERTJ1VR103☐	10 kΩ		4250 K±2 %	(4300 K)
ERTJ1VR153☐	15 kΩ		4250 K±2 %	(4300 K)
ERTJ1VR223☐	22 kΩ		4250 K±2 %	(4300 K)
ERTJ1VR333☐	33 kΩ		4250 K±2 %	(4300 K)
ERTJ1VP473☐	47 kΩ		4100 K±2 %	(4150 K)
ERTJ1VR473☐	47 kΩ		4250 K±2 %	(4300 K)
ERTJ1VV473☐	47 kΩ		4700 K±2 %	(4750 K)
ERTJ1VR683☐	68 kΩ		4250 K±2 %	(4300 K)
ERTJ1VV683☐	68 kΩ		4700 K±2 %	(4750 K)
ERTJ1VS104☐A	100 kΩ		(4330 K)	4390 K±1%
ERTJ1VV104☐	100 kΩ		4700 K±2 %	(4750 K)
ERTJ1VV154☐	150 kΩ		4700 K±2 %	(4750 K)
ERTJ1VT224☐	220 kΩ		4500 K±2 %	(4580 K)

☐ : Resistance Tolerance Code

● Temperature and Resistance value (the resistance value at 25 °C is set to 1)/ Reference values

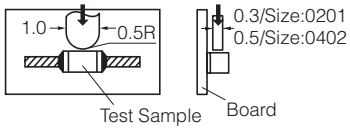
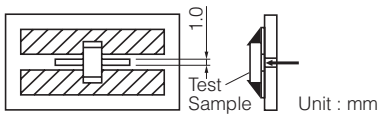
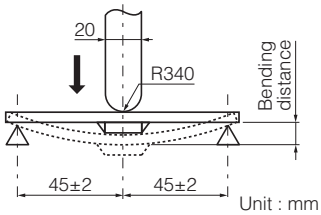
	ERTJ□□A~		ERTJ□□G~	ERTJ□□M~	ERTJ□□P~	ERTJ□□R~	ERTJ0ES~	ERTJ1VS~	ERTJ□□T~	ERTJ0ET104□	ERTJ□□V~
$B_{25/50}$	2750 K	2800 K	(3375 K)	3900 K	4050 K	4250 K	4330 K	(4330 K)	4500 K	4500 K	4700 K
$B_{25/85}$	(2700 K)	(2750 K)	3435 K	(3970 K)	(4100 K)	(4300 K)	(4390 K)	4390 K	(4450 K)	(4580 K)	(4750 K)
T(°C)									✻1	✻2	
-40	13.05	13.28	20.52	32.11	33.10	43.10	45.67	45.53	63.30	47.07	59.76
-35	10.21	10.40	15.48	23.29	24.03	30.45	32.08	31.99	42.92	33.31	41.10
-30	8.061	8.214	11.79	17.08	17.63	21.76	22.80	22.74	29.50	23.80	28.61
-25	6.427	6.547	9.069	12.65	13.06	15.73	16.39	16.35	20.53	17.16	20.14
-20	5.168	5.261	7.037	9.465	9.761	11.48	11.91	11.89	14.46	12.49	14.33
-15	4.191	4.261	5.507	7.147	7.362	8.466	8.743	8.727	10.30	9.159	10.31
-10	3.424	3.476	4.344	5.444	5.599	6.300	6.479	6.469	7.407	6.772	7.482
-5	2.819	2.856	3.453	4.181	4.291	4.730	4.845	4.839	5.388	5.046	5.481
0	2.336	2.362	2.764	3.237	3.312	3.582	3.654	3.650	3.966	3.789	4.050
5	1.948	1.966	2.227	2.524	2.574	2.734	2.778	2.776	2.953	2.864	3.015
10	1.635	1.646	1.806	1.981	2.013	2.102	2.128	2.126	2.221	2.179	2.262
15	1.380	1.386	1.474	1.567	1.584	1.629	1.642	1.641	1.687	1.669	1.710
20	1.171	1.174	1.211	1.247	1.255	1.272	1.277	1.276	1.293	1.287	1.303
25	1	1	1	1	1	1	1	1	1	1	1
30	0.8585	0.8565	0.8309	0.8072	0.8016	0.7921	0.7888	0.7890	0.7799	0.7823	0.7734
35	0.7407	0.7372	0.6941	0.6556	0.6461	0.6315	0.6263	0.6266	0.6131	0.6158	0.6023
40	0.6422	0.6376	0.5828	0.5356	0.5235	0.5067	0.5004	0.5007	0.4856	0.4876	0.4721
45	0.5595	0.5541	0.4916	0.4401	0.4266	0.4090	0.4022	0.4025	0.3874	0.3884	0.3723
50	0.4899	0.4836	0.4165	0.3635	0.3496	0.3319	0.3251	0.3254	0.3111	0.3111	0.2954
55	0.4309	0.4238	0.3543	0.3018	0.2881	0.2709	0.2642	0.2645	0.2513	0.2504	0.2356
60	0.3806	0.3730	0.3027	0.2518	0.2386	0.2222	0.2158	0.2161	0.2042	0.2026	0.1889
65	0.3376	0.3295	0.2595	0.2111	0.1985	0.1832	0.1772	0.1774	0.1670	0.1648	0.1523
70	0.3008	0.2922	0.2233	0.1777	0.1659	0.1518	0.1463	0.1465	0.1377	0.1348	0.1236
75	0.2691	0.2600	0.1929	0.1504	0.1393	0.1264	0.1213	0.1215	0.1144	0.1108	0.1009
80	0.2417	0.2322	0.1672	0.1278	0.1174	0.1057	0.1011	0.1013	0.09560	0.09162	0.08284
85	0.2180	0.2081	0.1451	0.1090	0.09937	0.08873	0.08469	0.08486	0.08033	0.07609	0.06834
90	0.1974	0.1871	0.1261	0.09310	0.08442	0.07468	0.07122	0.07138	0.06782	0.06345	0.05662
95	0.1793	0.1688	0.1097	0.07980	0.07200	0.06307	0.06014	0.06028	0.05753	0.05314	0.04712
100	0.1636	0.1528	0.09563	0.06871	0.06166	0.05353	0.05099	0.05112	0.04903	0.04472	0.03939
105	0.1498	0.1387	0.08357	0.05947	0.05306	0.04568	0.04340	0.04351	0.04198	0.03784	0.03308
110	0.1377	0.1263	0.07317	0.05170	0.04587	0.03918	0.03708	0.03718	0.03609	0.03218	0.02791
115	0.1270	0.1153	0.06421	0.04512	0.03979	0.03374	0.03179	0.03188	0.03117	0.02748	0.02364
120	0.1175	0.1056	0.05650	0.03951	0.03460	0.02916	0.02734	0.02742	0.02702	0.02352	0.02009
125	0.1091	0.09695	0.04986	0.03470	0.03013	0.02527	0.02359	0.02367	0.02351	0.02017	0.01712

✻1 Applied to the product except for ERTJ0ET104□ in $B_{25/50}$=4500 K.
✻2 Applied only to ERTJ0ET104□.

$$B_{25/50}=\frac{\ell n\ (R_{25}/R_{50})}{1/298.15-1/323.15} \qquad B_{25/85}=\frac{\ell n\ (R_{25}/R_{85})}{1/298.15-1/358.15}$$

R_{25}=Resistance at 25.0±0.1 °C
R_{50}=Resistance at 50.0±0.1 °C
R_{85}=Resistance at 85.0±0.1 °C

Specification and Test Method

Item	Specification	Test Method
Rated Zero-power Resistance (R_{25})	Within the specified tolerance.	The value is measured at a power that the influence of self-heat generation can be negligible (0.1mW or less), at the rated ambient temperature of 25.0±0.1°C.
B Value	Shown in each Individual Specification. ✻ Individual Specification shall specify $B_{25/50}$ or $B_{25/85}$.	The Zero-power resistances; R_1 and R_2, shall be measured respectively at T_1 (deg.C) and T_2 (deg.C). The B value is calculated by the following equation. $B_{T_1/T_2} = \frac{\ell n\ (R_1) - \ell n\ (R_2)}{1/(T_1+273.15) - 1/(T_2+273.15)}$ | | T_1 | T_2 | | $B_{25/50}$ | 25.0 ±0.1 °C | 50.0 ±0.1 °C | | $B_{25/85}$ | 25.0 ±0.1 °C | 85.0 ±0.1 °C |
Adhesion	The terminal electrode shall be free from peeling or signs of peeling.	Applied force : Size 0201 : 2 N Size 0402, 0603 : 5 N Duration : 10 s Size : 0201, 0402  Size : 0603 
Bending Strength	There shall be no cracks and other mechanical damage. R_{25} change : within ±5 %	Bending distance : 1 mm Bending speed : 1 mm/s 
Resistance to Soldering Heat	There shall be no cracks and other mechanical damage. Nallow Tol. type / Standard type R_{25} change : within ±2 % / within ±3 % B Value change : within ±1 % / within ±2 %	Soldering bath method Solder temperature : 270 ±5 °C Dipping period : 4.0 ±1 s Preheat condition : | Step | Temp (°C) | Period (s) | | 1 | 80 to 100 | 120 to 180 | | 2 | 150 to 200 | 120 to 180 |
Solderability	More than 95 % of the soldered area of both terminal electrodes shall be covered with fresh solder.	Soldering bath method Solder temperature : 230 ±5 °C Dipping period : 4 ±1 s Solder : Sn-3.0Ag-0.5Cu

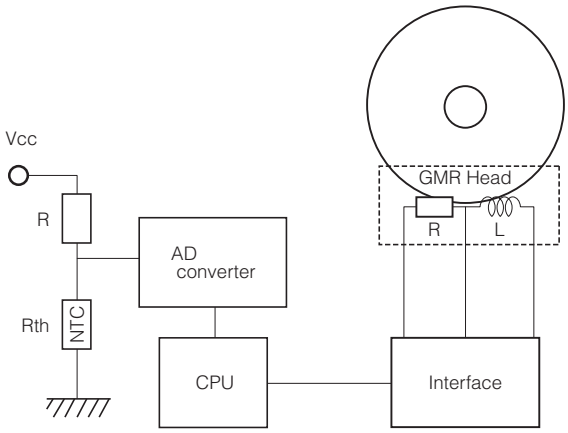
Specification and Test Method

Item	Specification	Test Method
Temperature Cycling	Nallow Tol. type / Standard type R_{25} change : within ±2 % / within ±3 % B Value change : within ±1 % / within ±2 %	Conditions of one cycle Step 1 : –40 °C, 30±3 min Step 2 : Room temp., 3 min max. Step 3 : 125 °C, 30±3 min. Step 4 : Room temp., 3 min max. Number of cycles: 100 cycles
Humidity	Nallow Tol. type / Standard type R_{25} change : within ±2 % / within ±3 % B Value change : within ±1 % / within ±2 %	Temperature : 85 ±2 °C Relative humidity : 85 ±5 % Test period : 1000 +48/0 h
Biased Humidity	Nallow Tol. type / Standard type R_{25} change : within ±2 % / within ±3 % B Value change : within ±1 % / within ±2 %	Temperature : 85 ±2 °C Relative humidity : 85 ±5 % Applied power : 10 mW(D.C.) Test period : 500 +48/0 h
Low Temperature Exposure	Nallow Tol. type / Standard type R_{25} change : within ±2 % / within ±3 % B Value change : within ±1 % / within ±2 %	Specimens are soldered on the testing board shown in Fig.2. Temperature : –40 ±3 °C Test period : 1000 +48/0 h
High Temperature Exposure	Nallow Tol. type / Standard type R_{25} change : within ±2 % / within ±3 % B Value change : within ±1 % / within ±2 %	Specimens are soldered on the testing board shown in Fig.2. Temperature : 125 ±3 °C Test period : 1000 +48/0 h

Typical Application

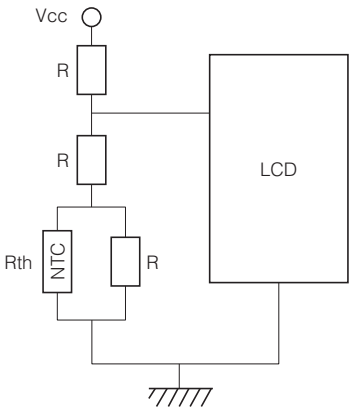
● Temperature Detection

Writing current control of HDD



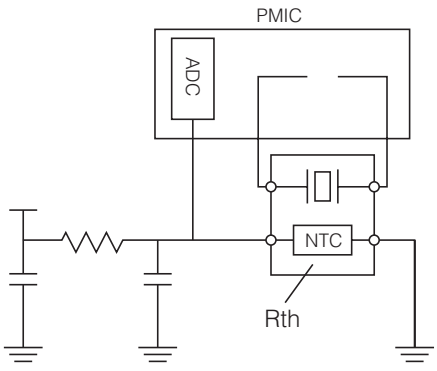
● Temperature Compensation (Pseudo-linearization)

Contrast level control of LCD

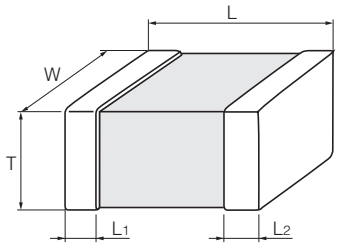


● Temperature Compensation (RF circuit)

Temperature compensation of TCXO



Dimensions in mm (not to scale)



(Unit : mm)

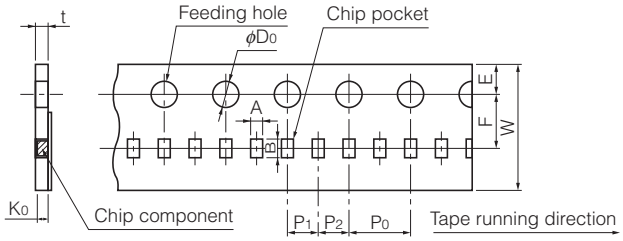
Size Code (EIA)	L	W	T	L_1, L_2
Z(0201)	0.60±0.03	0.30±0.03	0.30±0.03	0.15±0.05
0(0402)	1.0±0.1	0.50±0.05	0.50±0.05	0.25±0.15
1(0603)	1.60±0.15	0.8±0.1	0.8±0.1	0.3±0.2

Packaging Methods

● Standard Packing Quantities

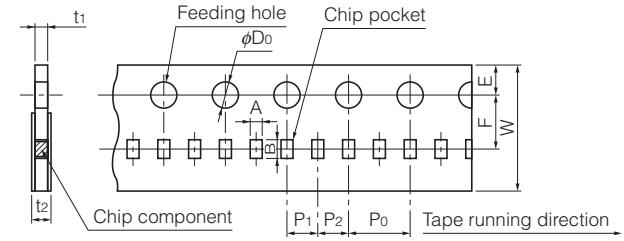
Size Code	Thickness (mm)	Kind of Taping	Pitch (mm)	Quantity (pcs./reel)
Z(0201)	0.3	Pressed Carrier Taping	2	15,000
0(0402)	0.5	Punched Carrier Taping	2	10,000
1(0603)	0.8		4	4,000

● Pitch 2 mm (Pressed Carrier Taping) : Size 0201



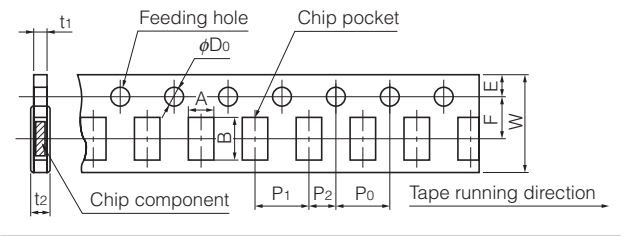
Symbol	A	B	W	F	E	P_1	P_2	P_0	ϕD_0	t	K_0
Dim. (mm)	0.36 ±0.03	0.66 ±0.03	8.0 ±0.2	3.50 ±0.05	1.75 ±0.10	2.00 ±0.05	2.00 ±0.05	4.0 ±0.1	$1.5^{+0.1}_{0}$	0.55 max.	0.36 ±0.03

● Pitch 2 mm (Punched Carrier Taping) : Size 0402



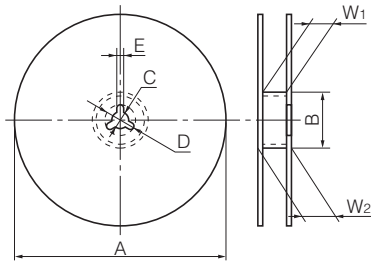
Symbol	A	B	W	F	E	P_1	P_2	P_0	ϕD_0	t_1	t_2
Dim. (mm)	0.62 ±0.05	1.12 ±0.05	8.0 ±0.2	3.50 ±0.05	1.75 ±0.10	2.00 ±0.05	2.00 ±0.05	4.0 ±0.1	$1.5^{+0.1}_{0}$	0.7 max.	1.0 max.

● Pitch 4 mm (Punched Carrier Taping) : Size 0603



Symbol	A	B	W	F	E	P_1	P_2	P_0	ϕD_0	t_1	t_2
Dim. (mm)	1.0 ±0.1	1.8 ±0.1	8.0 ±0.2	3.50 ±0.05	1.75 ±0.10	4.0 ±0.1	2.00 ±0.05	4.0 ±0.1	$1.5^{+0.1}_{0}$	1.1 max.	1.4 max.

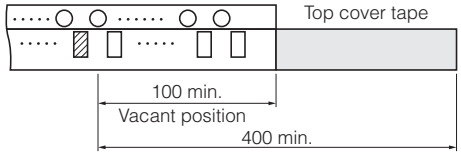
● Reel for Taping



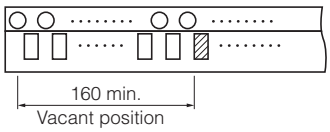
Symbol	φA	φB	C	D	E	W_1	W_2
Dim. (mm)	180^{0}_{-3}	$60.0^{+1.0}_{0}$	13.0±0.5	21.0±0.8	2.0±0.5	$9.0^{+1.0}_{0}$	11.4±1.0

● Leader Part and Taped End

Leader part



Taped end



(Unit : mm)

Minimum Quantity / Packing Unit

Part Number (Size)	Minimum Quantity / Packing Unit	Packing Quantity in Carton	Carton L×W×H (mm)
ERTJZ (0201)	15,000	300,000	250×200×200
ERTJ0 (0402)	10,000	200,000	250×200×200
ERTJ1 (0603)	4,000	80,000	250×200×200

Part No., quantity and country of origin are designated on outer packages in English.

Multilayer NTC Thermistors

Series: **ERTJ**

Handling Precautions

⚠Safety Precautions

Multilayer NTC Thermistors (hereafter referred to as "Thermistors") should be used for general purpose applications found in consumer electronics (audio/visual, home, office, information & communication) equipment.
When subjected to severe electrical, environmental, and/or mechanical stress beyond the specifications, as noted in the Ratings and Specified Conditions section, the Thermistors' performance may be degraded, or become failure mode, such as short circuit mode and open-circuit mode. If you use under the condition of short-circuit, heat generation of thermistors will occur by running large current due to application of voltage. There are possibilities of smoke emission, substrate burn-out, and, in the worst case, fire.
For products which require higher safety levels, please carefully consider how a single malfunction can affect your product. In order to ensure the safety in the case of a single malfunction, please design products with fail-safe, such as setting up protecting circuits, etc.

- For the following applications and conditions, please contact us for product of special specification not found in this document.
  - · When your application may have difficulty complying with the safety or handling precautions specified below.
  - · High-quality and high-reliability required devices that have possibility of causing hazardous conditions, such as death or injury (regardless of directly or indirectly), due to failure or malfunction of the product.
    - ① Aircraft and Aerospace Equipment (artificial satellite, rocket, etc.)
    - ② Submarine Equipment (submarine repeating equipment, etc.)
    - ③ Transportation Equipment (motor vehicles, airplanes, trains, ship, traffic signal controllers, etc.)
    - ④ Power Generation Control Equipment (atomic power, hydroelectric power, thermal power plant control system, etc.)
    - ⑤ Medical Equipment (life-support equipment, pacemakers, dialysis controllers, etc.)
    - ⑥ Information Processing Equipment (large scale computer systems, etc.)
    - ⑦ Electric Heating Appliances, Combustion devices (gas fan heaters, oil fan heaters, etc.)
    - ⑧ Rotary Motion Equipment
    - ⑨ Security Systems
    - ⑩ And any similar types of equipment

Operating Conditions and Circuit Design

1. Circuit Design

1.1 Operating Temperature and Storage Temperature

When operating a components-mounted circuit, please be sure to observe the "Operating Temperature Range", written in delivery specifications. Please remember not to use the product under the condition that exceeds the specified maximum temperature.
Storage temperature of PCB after mounting Thermistors, which is not operated, should be within the specified "Storage Temperature Range" in the delivery specifications.

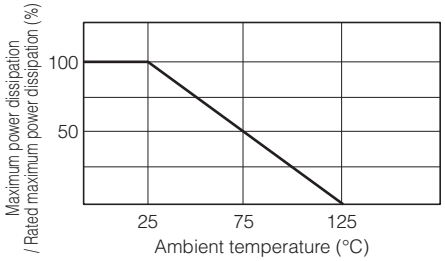
1.2 Operating Power

The electricity applied to between terminals of Thermistors should be under the specified maximum power dissipation.
There are possibilities of breakage and burn-out due to excessive self-heating of Thermistors, if the power exceeds maximum power dissipation when operating.
Please consider installing protection circuit for your circuit to improve the safety, in case of abnormal voltage application and so on.
Thermistors' performance of temperature detection would be deteriorated if self-heating occurs, even when you use it under the maximum power dissipation.
Please consider the maximum power dissipation and dissipation factor.

[Maximum power dissipation]

· The Maximum power that can be continuously applied under static air at a certain ambient temperature. The Maximum power dissipation under an ambient temperature of 25 °C or less is the same with the rated maximum power dissipation, and Maximum power dissipation beyond 25 °C depends on the Decreased power dissipation curve below.

Decreased power dissipation curve



[Dissipation factor]

· The constant amount power required to raise the temperature of the Thermistor 1 °C through self heat generation under stable temperatures.
Dissipation factor (mW/°C) = Power consumption of Thermistor / Temperature rise of element

1.3 Environmental Restrictions

The Thermistors shall not be operated and/or stored under the following conditions.

(1) Environmental conditions
  (a) Under direct exposure to water or salt water
  (b) Under conditions where water can condense and/or dew can form
  (c) Under conditions containing corrosive gases such as hydrogen sulfide, sulfurous acid, chlorine and ammonia

(2) Mechanical conditions
  The place where vibration or impact that exceeds specified conditions written in delivery specification is loaded.

1.4 Measurement of Resistance

The resistance of the Thermistors varies depending on ambient temperatures and self-heating. To measure the resistance value when examining circuit configuration and conducting receiving inspection and so on, the following points should be taken into consideration:

① Measurement temp : 25±0.1 °C
  Measurement in liquid (silicon oil, etc.) is recommended for a stable measurement temperature.

② Power : 0.10 mW max.
  4 terminal measurement with a constant-current power supply is recommended.

2. Design of Printed Circuit Board

2.1 Selection of Printed Circuit Boards

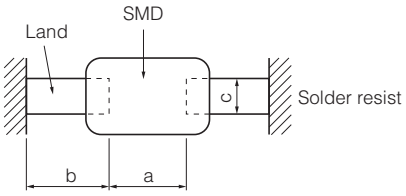
There is a possibility of performance deterioration by heat shock (temperature cycles), which causes cracks, from alumina substrate.

Please confirm that the substrate you use does not deteriorate the Thermistors' quality.

2.2 Design of Land Pattern

(1) Recommended land dimensions are shown below. Use the proper amount of solder in order to prevent cracking. Using too much solder places excessive stress on the Thermistors.

Recommended Land Dimensions

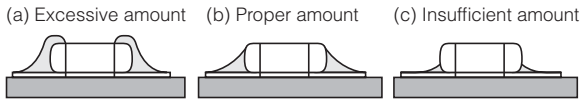


Unit (mm)

Size Code (EIA)	Component dimensions			a	b	c
	L	W	T			
Z(0201)	0.6	0.3	0.3	0.2 to 0.3	0.25 to 0.30	0.2 to 0.3
0(0402)	1.0	0.5	0.5	0.4 to 0.5	0.4 to 0.5	0.4 to 0.5
1(0603)	1.6	0.8	0.8	0.8 to 1.0	0.6 to 0.8	0.6 to 0.8

(2) The land size shall be designed to have equal space, on both right and left sides. If the amount of solder on both sides is not equal, the component may be cracked by stress, since the side with a larger amount of solder solidifies later during cooling.

Recommended Amount of Solder



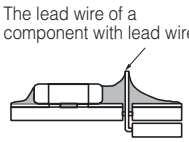
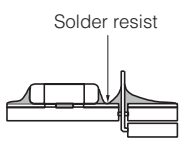
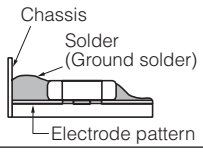
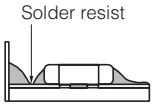
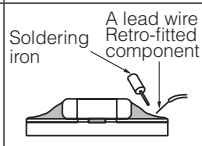
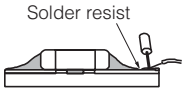
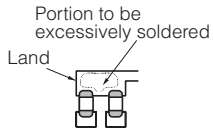
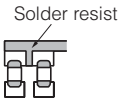
2.3 Utilization of Solder Resist

(1) Solder resist shall be utilized to equalize the amounts of solder on both sides.

(2) Solder resist shall be used to divide the pattern for the following cases;
  · Components are arranged closely.
  · The Thermistor is mounted near a component with lead wires.
  · The Thermistor is placed near a chassis.

Refer to the table below.

Prohibited Applications and Recommended Applications

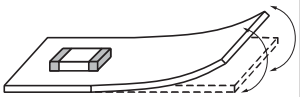
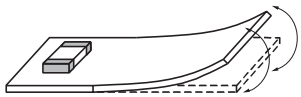
Item	Prohibited applications	Improved applications by pattern division
Mixed mounting with a component with lead wires		
Arrangement near chassis		
Retro-fitting of component with lead wires		
Lateral arrangement		

2.4 Component Layout

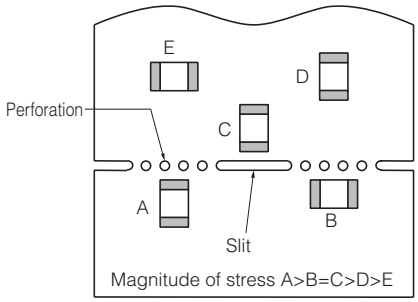
To prevent the crack of Thermistors, try to place it on the position that could not easily be affected by the bending stress of substrate while mounting procedures or procedures afterwards.

Placement of the Thermistors near heating elements also requires the great care to be taken in order to avoid stresses from rapid heating and cooling.

(1) To minimize mechanical stress caused by the warp or bending of a PC board, please follow the recommended Thermistors' layout below.

Prohibited layout	Recommended layout
	 Layout the Thermistors sideways against the stressing direction

(2) The following layout is for your reference since mechanical stress near the dividing/breaking position of a PC board varies depending on the mounting position of the Thermistors.



(3) The magnitude of mechanical stress applied to the Thermistors when dividing the circuit board in descending order is as follows:
push back < slit < V-groove < perforation.
Also take into account the layout of the Thermistors and the dividing/breaking method.

(4) When the Thermistors are placed near heating elements such as heater, etc., cracks from thermal stresses may occur under following situation:
· Soldering the Thermistors directly to heating elements.
· Sharing the land with heating elements.

If planning to conduct above-mentioned mounting and/or placement, please contact us in advance.

2.5 Mounting Density and Spaces

Intervals between components should not be too narrow to prevent the influence from solder bridges and solder balls. The space between components should be carefully determined.

Precautions for Assembly

1. Storage

(1) The Thermistors shall be stored between 5 to 40 °C and 20 to 70 % RH, not under severe conditions of high temperature and humidity.

(2) If stored in a place where humidity, dust, or corrosive gasses (hydrogen sulfide, sulfurous acid, hydrogen chloride and ammonia, etc.) are contained, the solderability of terminal electrodes will be deteriorated.
In addition, storage in a places where the heat or direct sunlight exposure occur will cause mounting problems due to deformation of tapes and reels and components and taping/reels sticking together.

(3) Do not store components longer than 6 months. Check the solderability of products that have been stored for more than 6 months before use

2. Chip Mounting Consideration

(1) When mounting the Thermistors/components on a PC board, the Thermistor bodies shall be free from excessive impact loads such as mechanical impact or stress due to the positioning, pushing force and displacement of vacuum nozzles during mounting.

(2) Maintenance and inspection of the Chip Mounter must be performed regularly.

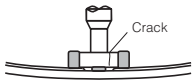
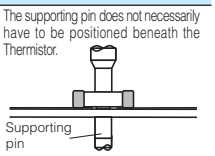
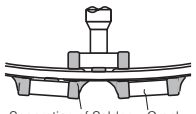
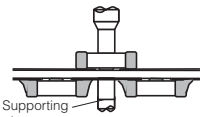
(3) If the bottom dead center of the vacuum nozzle is too low, the Thermistor will crack from excessive force during mounting.

The following precautions and recommendations are for your reference in use.

(a) Set and adjust the bottom dead center of the vacuum nozzles to the upper surface of the PC board after correcting the warp of the PC board.

(b) Set the pushing force of the vacuum nozzle during mounting to 1 to 3 N in static load.

(c) For double surface mounting, apply a supporting pin on the rear surface of the PC board to suppress the bending of the PC board in order to minimize the impact of the vacuum nozzles. Typical examples are shown in the table below.

Item	Prohibited mounting	Recommended mounting
Single surface mouting	 Crack	 The supporting pin does not necessarily have to be positioned beneath the Thermistor. Supporting pin
Double surface mounting	 Separation of Solder Crack	 Supporting pin

(d) Adjust the vacuum nozzles so that their bottom dead center during mounting is not too low.

(4) The closing dimensions of the positioning chucks shall be controlled. Maintenance and replacement of positioning chucks shall be performed regularly to prevent chipping or cracking of the Thermistors caused by mechanical impact during positioning due to worn positioning chucks.

(5) Maximum stroke of the nozzle shall be adjusted so that the maximum bending of PC board does not exceed 0.5 mm at 90 mm span. The PC board shall be supported by an adequate number of supporting pins.

3. Selection of Soldering Flux

Soldering flux may seriously affect the performance of the Thermistors. The following shall be confirmed before use.

(1) The soldering flux should have a halogen based content of 0.1 wt% (converted to chlorine) or below. Do not use soldering flux with strong acid.

(2) When applying water-soluble soldering flux, wash the Thermistors sufficiently because the soldering flux residue on the surface of PC boards may deteriorate the insulation resistance on the Thermistors' surface.

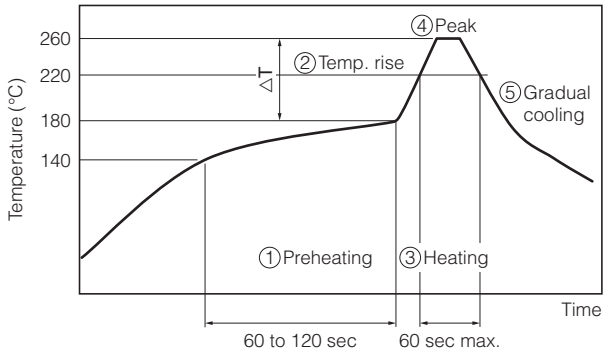
4. Soldering

4.1 Reflow Soldering

The reflow soldering temperature conditions are composed of temperature curves of Preheating, Temp. rise, Heating, Peak and Gradual cooling. Large temperature difference inside the Thermistors caused by rapid heat application to the Thermistors may lead to excessive thermal stresses, contributing to the thermal cracks. The Preheating temperature requires controlling with great care so that tombstone phenomenon may be prevented.

Item	Temperature	Period or Speed
①Preheating	140 to 180 °C	60 to 120 sec
②Temp. rise	Preheating temp to Peak temp.	2 to 5 °C /sec
③Heating	220 °C min.	60 sec max.
④Peak	260 °C max.	10 sec max.
⑤Gradual cooling	Peak temp. to 140 °C	1 to 4 °C /sec

Recommended profile of Reflow soldering (EX)



△T : Allowable temperature difference △T ≦ 150 °C

The rapid cooling (forced cooling) during Gradual cooling part should be avoided, because this may cause defects such as the thermal cracks, etc.
When the Thermistors are immersed into a cleaning solvent, make sure that the surface temperatures of the devices do not exceed 100 °C.
Performing reflow soldering twice under the conditions shown in the figure above [Recommended profile of Reflow soldering (EX)] will not cause any problems. However, pay attention to the possible warp and bending of the PC board.

4.2 Hand Soldering

Hand soldering typically causes significant temperature change, which may induce excessive thermal stresses inside the Thermitors, resulting in the thermal cracks, etc. In order to prevent any defects, the following should be observed.

- The temperature of the soldering tips should be controlled with special care.
- The direct contact of soldering tips with the Thermistors and/or terminal electrodes should be avoided.
- Dismounted Thermistors shall not be reused.

(1) Condition 1 (with preheating)

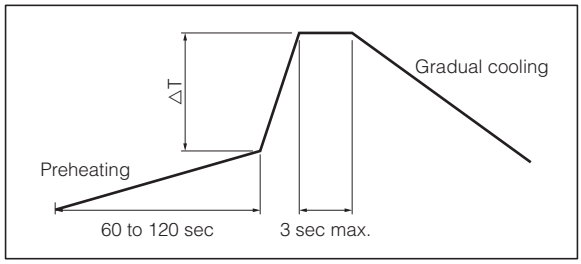
(a) Soldering:
Use thread solder (ϕ1 mm or below) which contains flux with low chlorine, developed for precision electronic equipment.

(b) Preheating:
Conduct sufficient pre-heating, and make sure that the temperature difference between solder and Thermistors' surface is 150 °C or less.

(c) Temperature of Iron tip: 300 °C max.
(The required amount of solder shall be melted in advance on the soldering tip.)

(d) Gradual cooling:
After soldering, the Thermistors shall be cooled gradually at room temperature.

Recommended profile of Hand soldering (EX)



△T : Allowable temperature difference △T ≦ 150 °C

(2) Condition 2 (without preheating)
Hand soldering can be performed without preheating, by following the conditions below:

(a) Soldering iron tip shall never directly touch the ceramic and terminal electrodes of the Thermistors.

(b) The lands are sufficiently preheated with a soldering iron tip before sliding the soldering iron tip to the terminal electrodes of the Thermistors for soldering.

Conditions of Hand soldering without preheating

Item	Condition
Temperature of Iron tip	270 °C max.
Wattage	20 W max.
Shape of Iron tip	ϕ3 mm max.
Soldering time with a soldering iron	3 sec max.

5. Post Soldering Cleaning

5.1 Cleaning solvent

Soldering flux residue may remain on the PC board if cleaned with an inappropriate solvent. This may deteriorate the electrical characteristics and reliability of the Thermistors.

5.2 Cleaning conditions

Inappropriate cleaning conditions such as insufficient cleaning or excessive cleaning may impair the electrical characteristics and reliability of the Thermistors.

(1) Insufficient cleaning can lead to:

(a) The halogen substance found in the residue of the soldering flux may cause the metal of terminal electrodes to corrode.

(b) The halogen substance found in the residue of the soldering flux on the surface of the Thermistors may change resistance values.

(c) Water-soluble soldering flux may have more remarkable tendencies of (a) and (b) above compared to those of rosin soldering flux.

(2) Excessive cleaning can lead to:

(a) When using ultrasonic cleaner, make sure that the output is not too large, so that the substrate will not resonate. The resonation causes the cracks in Varistors and/or solders, and deteriorates the strength of the terminal electrodes. Please follow these conditions for Ultrasonic cleaning:

Ultrasonic wave output : 20 W/L max.
Ultrasonic wave frequency : 40 kHz max.
Ultrasonic wave cleaning time : 5 min. max.

5.3 Contamination of Cleaning solvent

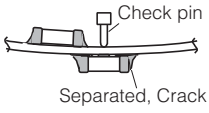
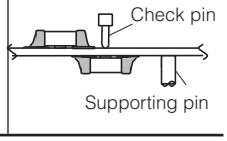
Cleaning with contaminated cleaning solvent may cause the same results as insufficient cleaning due to the high density of liberated halogen.

6. Inspection Process

The pressure from measuring terminal pins might bend the PCB when implementing circuit inspection after mounting Thermistors on PCB, and as a result, cracking may occur.

(1) Mounted PC boards shall be supported by an adequate number of supporting pins on the back with bend settings of 90 mm span 0.5 mm max.

(2) Confirm that the measuring pins have the right tip shape, are equal in height, have the right pressure, and are set in the correct positions.
The following figures are for your reference to avoid bending the PC board.

Item	Prohibited setting	Recommended setting
Bending of PC board		

7. Protective Coating

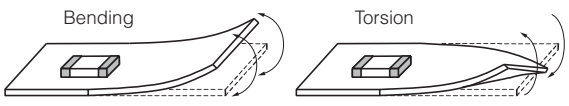
When the surface of a PC board on which the Thermistors have been mounted is coated with resin to protect against moisture and dust, it shall be confirmed that the protective coating does not affect the performance of Varistors.

(1) Choose the material that does not emit the decomposition and/or reaction gas. The Gas may affect the composing members of the Varistors.

(2) Shrinkage and expansion of resin coating when curing may apply stress to the Varistors and may lead to occurrence of cracks.

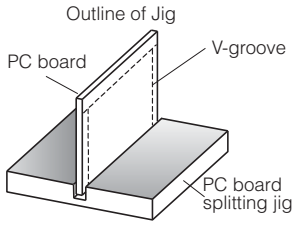
8. Dividing/Breaking of PC Boards

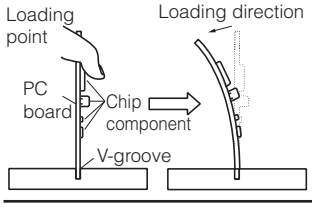
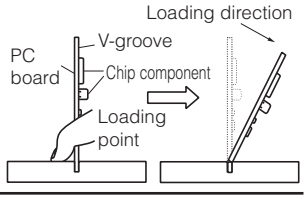
(1) Please be careful not to stress the substrate with bending/twisting when dividing, after mounting components including Varistors. Abnormal and excessive mechanical stress such as bending or torsion shown below can cause cracking in the Thermistors.



(2) Dividing/Breaking of the PC boards shall be done carefully at moderate speed by using a jig or apparatus to protect the Thermistors on the boards from mechanical damage.

(3) Examples of PCB dividing/breaking jigs:
The outline of PC board breaking jig is shown below. When PC boards are broken or divided, loading points should be close to the jig to minimize the extent of the bending
Also, planes with no parts mounted on should be used as plane of loading, in order to prevent tensile stress induced by the bending, which may cause cracks of the Thermistors or other parts mounted on the PC boards.

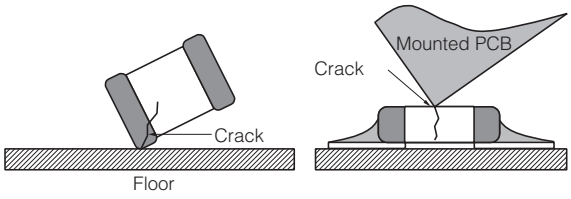


Prohibited dividing	Recommended dividing
	

9. Mechanical Impact

(1) The Thermistors shall be free from any excessive mechanical impact.
The Thermistor body is made of ceramics and may be damaged or cracked if dropped.
Never use a Thermistor which has been dropped; their quality may be impaired and failure rate increased.

(2) When handling PC boards with Thermistors mounted on them, do not allow the Thermistors to collide with another PC board.
When mounted PC boards are handled or stored in a stacked state, the corner of a PC board might strike Thermistors, and the impact of the strike may cause damage or cracking and can deteriorate the withstand voltage and insulation resistance of the Thermistor.

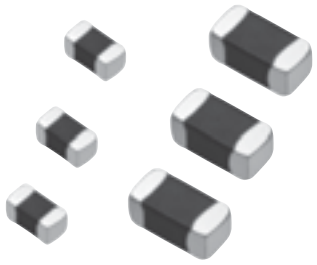


Other

The various precautions described above are typical. For special mounting conditions, please contact us.

Multilayer NTC Thermistors

Series: **ERTJ**



Features

- Surface Mount Device (0402, 0603)
- Highly reliable multilayer / monolithic structure
- Wide temperature operating range (–40 to 150 °C)
- Environmentally-friendly lead-free
- RoHS compliant

Recommended Applications

- For car audio system
- For ECUs
- For electric pumps and compressors
- For LED lights
- For batteries
- For temperature detection of various circuits

Explanation of Part Numbers

1	2	3	4	5	6	7	8	9	10	11	12	
E	R	T	J	0	E	G	1	0	3	F	M	(Example)

Common Code

Product Code		Type Code	
ERT	NTC Thermistors	J	Chip Type (SMD) Multilayer Type

Size Code

0	"0402"
1	"0603"

Packaging Style Code

E	"0402" Pressed Carrier Taping Punched Carrier Taping (Pitch : 2 mm)
V	"0603" Punched Carrier Taping (Pitch : 4 mm)

B Value Class Code

A	2701 to 2800
G	3301 to 3400
M	3801 to 3900
P	4001 to 4100
R	4201 to 4300
S	4301 to 4400
T	4401 to 4500
V	4601 to 4700

Nominal Resistance R_{25} (Ω)

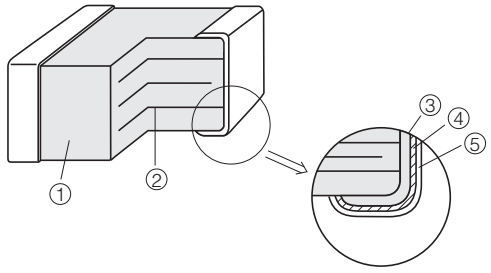
The first two digits are significant figures of resistance and the third one denotes the number of zeros following them.

Resistance Tolerance Code

F	±1%	Narrow Tolerance Type
G	±2%	
H	±3%	Standard Type
J	±5%	

M	Automotive component

Construction



No.	Name	
①	Semiconductive Ceramics	
②	Internal electrode	
③	Terminal electrode	Substrate electrode
④		Intermediate electrode
⑤		External electrode

Ratings

Size code (EIA)	0(0402)	1(0603)
Operating Temperature Range	–40 to 150 °C	
Rated Maximum Power Dissipation*1	66 mW	100 mW
Dissipation Factor*2	Approximately 2 mW/°C	Approximately 3 mW/°C

*1 Rated Maximum Power Dissipation : The maximum power that can be continuously applied at the rated ambient temperature.
·The maximum value of power, and rated power is same under the condition of ambient temperature 25 °C or less. If the temperature exceeds 25 °C, rated power depends on the decreased power dissipation curve.
·Please see "Operating Power" for details.
*2 Dissipation factor : The constant amount power required to raise the temperature of the Thermistor 1 °C through self heat generation under stable temperatures.
·Dissipation factor is the reference value when mounted on a glass epoxy board (1.6 mmT).

Part Number List

● 0402(EIA)

Part Number	Nominal Resistance at 25 °C	B Value at 25/50(K)	B Value at 25/85(K)
ERTJ0EG103□M	10 kΩ	3380 K±1 %	3435 K±1 %
ERTJ0EP473□M	47 kΩ	4050 K±1 %	(4100 K)
ERTJ0ER104□M	100 kΩ	4250 K±1 %	(4300 K)
ERTJ0EV104□M	100 kΩ	4700 K±1 %	(4750 K)

□ : Resistance Tolerance Code (F : ±1%, G : ±2%, H : ±3%, J : ±5%)

● 0603(EIA)

Part Number	Nominal Resistance at 25 °C	B Value at 25/50(K)	B Value at 25/85(K)
ERTJ1VG103□M	10 kΩ	3380 K±1 %	3435 K±1 %
ERTJ1VP473□M	47 kΩ	4100 K±1 %	(4150 K)
ERTJ1VV104□M	100 kΩ	4700 K±1 %	(4750 K)

□ : Resistance Tolerance Code (F : ±1%, G : ±2%, H : ±3%, J : ±5%)

● Temperature and Resistance value (the resistance value at 25 °C is set to 1)/ Reference values

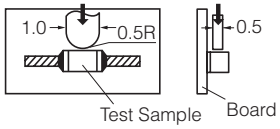
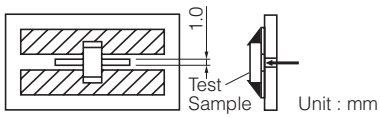
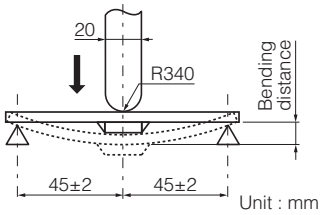
	ERTJ□□G~	ERTJ□□P~	ERTJ□□P~	ERTJ□□R~	ERTJ□□V~
$B_{25/50}$	(3380 K)	4050 K	4100 K	4250 K	4700 K
$B_{25/85}$	3435 K	(4100 K)	(4150 K)	(4300 K)	(4750 K)
T(°C)					
-40	20.52	33.10	34.56	42.40	59.76
-35	15.48	24.03	24.99	29.96	41.10
-30	11.79	17.63	18.26	21.42	28.61
-25	9.069	13.06	13.48	15.50	20.14
-20	7.037	9.761	10.04	11.33	14.33
-15	5.507	7.362	7.546	8.370	10.31
-10	4.344	5.599	5.720	6.244	7.482
-5	3.453	4.291	4.369	4.699	5.481
0	2.764	3.312	3.362	3.565	4.050
5	2.227	2.574	2.604	2.725	3.015
10	1.806	2.013	2.030	2.098	2.262
15	1.474	1.584	1.593	1.627	1.710
20	1.211	1.255	1.258	1.271	1.303
25	1	1	1	1	1
30	0.8309	0.8016	0.7994	0.7923	0.7734
35	0.6941	0.6461	0.6426	0.6318	0.6023
40	0.5828	0.5235	0.5194	0.5069	0.4721
45	0.4916	0.4266	0.4222	0.4090	0.3723
50	0.4165	0.3496	0.3451	0.3320	0.2954
55	0.3543	0.2881	0.2837	0.2709	0.2356
60	0.3027	0.2386	0.2344	0.2222	0.1889
65	0.2595	0.1985	0.1946	0.1831	0.1523
70	0.2233	0.1659	0.1623	0.1516	0.1236
75	0.1929	0.1393	0.1359	0.1261	0.1009
80	0.1672	0.1174	0.1143	0.1054	0.08284
85	0.1451	0.09937	0.09658	0.08843	0.06834
90	0.1261	0.08442	0.08189	0.07457	0.05662
95	0.1097	0.07200	0.06969	0.06316	0.04712
100	0.09563	0.06166	0.05957	0.05371	0.03939
105	0.08357	0.05306	0.05117	0.04585	0.03308
110	0.07317	0.04587	0.04415	0.03929	0.02791
115	0.06421	0.03979	0.03823	0.03378	0.02364
120	0.05650	0.03460	0.03319	0.02913	0.02009
125	0.04986	0.03013	0.02886	0.02519	0.01712

$$B_{25/50}=\frac{\ell n\ (R_{25}/R_{50})}{1/298.15-1/323.15}$$

$$B_{25/85}=\frac{\ell n\ (R_{25}/R_{85})}{1/298.15-1/358.15}$$

R_{25}=Resistance at 25.0±0.1 °C
R_{50}=Resistance at 50.0±0.1 °C
R_{85}=Resistance at 85.0±0.1 °C

Specification and Test Method

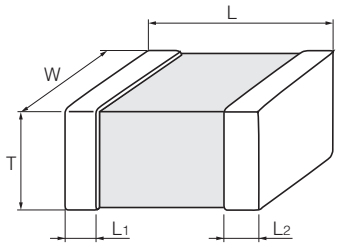
Item	Specification	Test Method
Rated Zero-power Resistance (R_{25})	Within the specified tolerance.	The value is measured at a power that the influence of self-heat generation can be negligible (0.1mW or less), at the rated ambient temperature of 25.0±0.1°C.
B Value	Shown in each Individual Specification. ✻ Individual Specification shall specify $B_{25/50}$ or $B_{25/85}$.	The Zero-power resistances; R_1 and R_2, shall be measured respectively at T_1 (deg.C) and T_2 (deg.C). The B value is calculated by the following equation. $B_{T_1/T_2} = \frac{\ell n\ (R_1) - \ell n\ (R_2)}{1/(T_1+273.15) - 1/(T_2+273.15)}$ T_1 / T_2: $B_{25/50}$ 25.0 ±0.1 °C / 50.0 ±0.1 °C; $B_{25/85}$ 25.0 ±0.1 °C / 85.0 ±0.1 °C
Adhesion	The terminal electrode shall be free from peeling or signs of peeling.	Applied force : Size 0402, 0603 : 5 N Duration : 10 s Size : 0402  Size : 0603 
Bending Strength	There shall be no cracks and other mechanical damage. R_{25} change : within ±5 %	Bending distance : 2 mm Bending speed : 1 mm/s 
Resistance to Vibration	There shall be no cracks and other mechanical damage. R_{25} change : within ±2 % B Value change : within ±1 %	Solder samples on a testing substrate, then apply vibration to them. Acceleration : 5 G Vibrational frequency : 10 to 2000 Hz Sweep time : 20 minutes 12 cycles in three directions, which are perpendicular to each other
Resistance to Impact	There shall be no cracks and other mechanical damage. R_{25} change : within ±2 % B Value change : within ±1 %	Solder samples on a testing substrate, then apply impacts to them. Pulse waveform : Semisinusoidal wave, 11 ms Impact acceleration : 50 G Impact direction : X-X', Y-Y', Z-Z' In 6 directions, three times each

Specification and Test Method

<table>
<tr><th>Item</th><th>Specification</th><th>Test Method</th></tr>
<tr><td>Resistance to Soldering Heat</td><td>There shall be no cracks and other mechanical damage.

R_{25} change : within ±2 %
B Value change : within ±1 %</td><td>Soldering bath method
Solder temperature : 260 ±5 °C, 270 ±5 °C
Dipping period : 3.0 ±0.5 s, 10.0 ±0.5 s
Preheat condition :
<table><tr><th>Step</th><th>Temp (°C)</th><th>Period (s)</th></tr><tr><td>1</td><td>80 to 100</td><td>120 to 180</td></tr><tr><td>2</td><td>150 to 200</td><td>120 to 180</td></tr></table></td></tr>
<tr><td>Solderability</td><td>More than 95 % of the soldered area of both terminal electrodes shall be covered with fresh solder.</td><td>Soldering bath method
Solder temperature : 230 ±5 °C
Dipping period : 4 ±1 s
Solder : Sn-3.0Ag-0.5Cu</td></tr>
<tr><td>Temperature Cycling</td><td>R_{25} change : within ±2 %
B Value change : within ±1 %</td><td>Conditions of one cycle
Step 1 : –55±3 °C, 30±3 min.
Step 2 : Room temp., 3 min. max.
Step 3 : 125±5 °C, 30±3 min.
Step 4 : Room temp., 3 min. max.
Number of cycles: 2000 cycles</td></tr>
<tr><td>Humidity</td><td>R_{25} change : within ±2 %
B Value change : within ±1 %</td><td>Temperature : 85 ±2 °C
Relative humidity : 85 ±5 %
Test period : 2000 +48/0 h</td></tr>
<tr><td>Biased Humidity</td><td>R_{25} change : within ±2 %
B Value change : within ±1 %</td><td>Temperature : 85 ±2 °C
Relative humidity : 85 ±5 %
Applied power : 10 mW(D.C.)
Test period : 2000 +48/0 h</td></tr>
<tr><td>Low Temperature Exposure</td><td>R_{25} change : within ±2 %
B Value change : within ±1 %</td><td>Temperature : –40 ±3 °C
Test period : 2000 +48/0 h</td></tr>
<tr><td>High Temperature Exposure 1</td><td>R_{25} change : within ±2 %
B Value change : within ±1 %</td><td>Temperature : 125 ±3 °C
Test period : 2000 +48/0 h</td></tr>
<tr><td>High Temperature Exposure 2</td><td>R_{25} change : within ±3 %
B Value change : within ±2 %</td><td>Temperature : 150 ±3 °C
Test period : 1000 +48/0 h</td></tr>
</table>

Dimensions in mm (not to scale)



(Unit : mm)

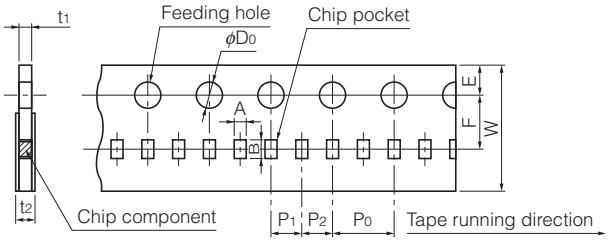
Size Code (EIA)	L	W	T	L_1, L_2
0 (0402)	1.0±0.1	0.50±0.05	0.50±0.05	0.25±0.15
1 (0603)	1.60±0.15	0.8±0.1	0.8±0.1	0.3±0.2

Packaging Methods

● Standard Packing Quantities

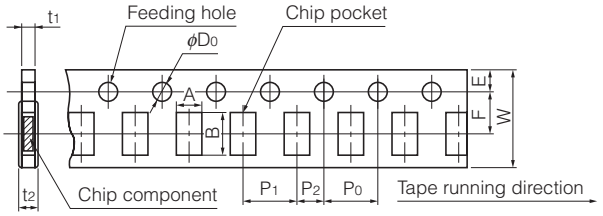
Size Code	Thickness (mm)	Kind of Taping	Pitch (mm)	Quantity (pcs./reel)
0 (0402)	0.5	Punched Carrier Taping	2	10,000
1 (0603)	0.8		4	4,000

● Pitch 2 mm (Punched Carrier Taping) : Size 0402



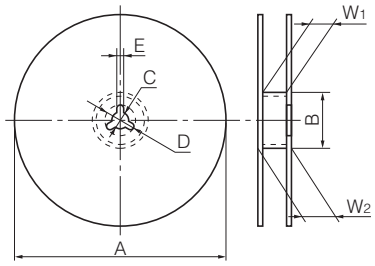
Symbol	A	B	W	F	E	P_1	P_2	P_0	ϕD_0	t_1	t_2
Dim. (mm)	0.62 ±0.05	1.12 ±0.05	8.0 ±0.2	3.50 ±0.05	1.75 ±0.10	2.00 ±0.05	2.00 ±0.05	4.0 ±0.1	$1.5^{+0.1}_{0}$	0.7 max.	1.0 max.

● Pitch 4 mm (Punched Carrier Taping) : Size 0603



Symbol	A	B	W	F	E	P_1	P_2	P_0	ϕD_0	t_1	t_2
Dim. (mm)	1.0 ±0.1	1.8 ±0.1	8.0 ±0.2	3.50 ±0.05	1.75 ±0.10	4.0 ±0.1	2.00 ±0.05	4.0 ±0.1	$1.5^{+0.1}_{0}$	1.1 max.	1.4 max.

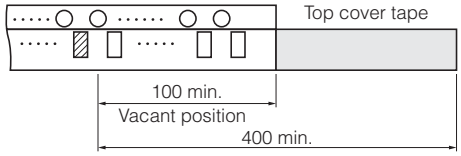
● Reel for Taping



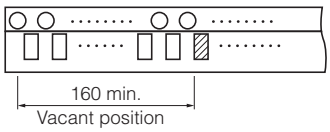
Symbol	φA	φB	C	D	E	W_1	W_2
Dim. (mm)	180^{0}_{-3}	$60.0^{+1.0}_{0}$	13.0±0.5	21.0±0.8	2.0±0.5	$9.0^{+1.0}_{0}$	11.4±1.0

● Leader Part and Taped End

Leader part



Taped end



(Unit : mm)

Minimum Quantity / Packing Unit

Part Number (Size)	Minimum Quantity/ Packing Unit	Packing Quantity in Carton	Carton L×W×H (mm)
ERTJ0 (0402)	10,000	200,000	250×200×200
ERTJ1 (0603)	4,000	80,000	250×200×200

Part No., quantity and country of origin are designated on outer packages in English.

Multilayer NTC Thermistors

Series: **ERTJ**

Handling Precautions

⚠Safety Precautions

The NTC Thermistors for automotive devices (chip type), hereafter referred to as Thermisotrs, is designed for use in automotive devices. When subjected to severe electrical, environmental, and/or mechanical stress beyond the specifications, as noted in the Ratings and Specified Conditions section, the Thermistors' performance may be degraded, or become failure mode, such as short circuit mode and open-circuit mode. If you use under the condition of short-circuit, heat generation of thermistors will occur by running large current due to application of voltage. There are possibilities of smoke emission, substrate burn-out, and, in the worst case, fire.

For products which require higher safety levels, please carefully consider how a single malfunction can affect your product. In order to ensure the safety in the case of a single malfunction, please design products with fail-safe, such as setting up protecting circuits, etc.

● For the following applications and conditions, please contact us for product of special specification not found in this document.

· When your application may have difficulty complying with the safety or handling precautions specified below.

· High-quality and high-reliability required devices that have possibility of causing hazardous conditions, such as death or injury (regardless of directly or indirectly), due to failure or malfunction of the product.

① Aircraft and Aerospace Equipment (artificial satellite, rocket, etc.)
② Submarine Equipment (submarine repeating equipment, etc.)
③ Transportation Equipment (airplanes, trains, ship, traffic signal controllers, etc.)
④ Power Generation Control Equipment (atomic power, hydroelectric power, thermal power plant control system, etc.)
⑤ Medical Equipment (life-support equipment, pacemakers, dialysis controllers, etc.)
⑥ Information Processing Equipment (large scale computer systems, etc.)
⑦ Electric Heating Appliances, Combustion devices (gas fan heaters, oil fan heaters, etc.)
⑧ Rotary Motion Equipment
⑨ Security Systems
⑩ And any similar types of equipment

Operating Conditions and Circuit Design

1. Circuit Design

1.1 Operating Temperature and Storage Temperature

When operating a components-mounted circuit, please be sure to observe the "Operating Temperature Range", written in delivery specifications. Please remember not to use the product under the condition that exceeds the specified maximum temperature.

Storage temperature of PCB after mounting Thermistors, which is not operated, should be within the specified "Storage Temperature Range" in the delivery specifications.

1.2 Operating Power

The electricity applied to between terminals of Thermistors should be under the specified maximum power dissipation.

There are possibilities of breakage and burn-out due to excessive self-heating of Thermistors, if the power exceeds maximum power dissipation when operating.

Please consider installing protection circuit for your circuit to improve the safety, in case of abnormal voltage application and so on.

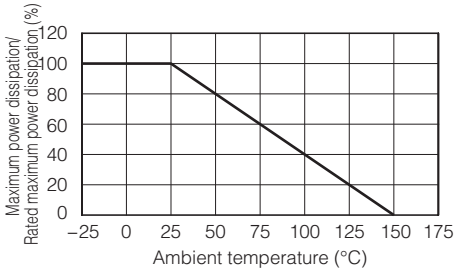
Thermistors' performance of temperature detection would be deteriorated if self-heating occurs, even when you use it under the maximum power dissipation.

Please consider the maximum power dissipation and dissipation factor.

[Maximum power dissipation]

· The Maximum power that can be continuously applied under static air at a certain ambient temperature. The Maximum power dissipation under an ambient temperature of 25 °C or less is the same with the rated maximum power dissipation, and Maximum power dissipation beyond 25 °C depends on the Decreased power dissipation curve below.

Decreased power dissipation curve



[Dissipation factor]

· The constant amount power required to raise the temperature of the Thermistor 1 °C through self heat generation under stable temperatures.

Dissipation factor (mW/°C) = Power consumption of Thermistor / Temperature rise of element

1.3 Environmental Restrictions

The Thermistors shall not be operated and/or stored under the following conditions.

(1) Environmental conditions
  (a) Under direct exposure to water or salt water
  (b) Under conditions where water can condense and/or dew can form
  (c) Under conditions containing corrosive gases such as hydrogen sulfide, sulfurous acid, chlorine and ammonia

(2) Mechanical conditions
  The place where vibration or impact that exceeds specified conditions written in delivery specification is loaded.

1.4 Measurement of Resistance

The resistance of the Thermistors varies depending on ambient temperatures and self-heating. To measure the resistance value when examining circuit configuration and conducting receiving inspection and so on, the following points should be taken into consideration:

① Measurement temp : 25±0.1 °C
  Measurement in liquid (silicon oil, etc.) is recommended for a stable measurement temperature.

② Power : 0.10 mW max.
  4 terminal measurement with a constant-current power supply is recommended.

2. Design of Printed Circuit Board

2.1 Selection of Printed Circuit Boards

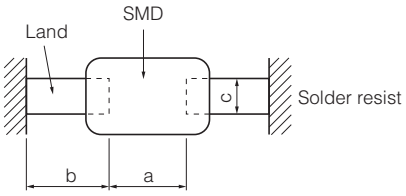
There is a possibility of performance deterioration by heat shock (temperature cycles), which causes cracks, from alumina substrate.

Please confirm that the substrate you use does not deteriorate the Thermistors' quality.

2.2 Design of Land Pattern

(1) Recommended land dimensions are shown below. Use the proper amount of solder in order to prevent cracking. Using too much solder places excessive stress on the Thermistors.

Recommended Land Dimensions

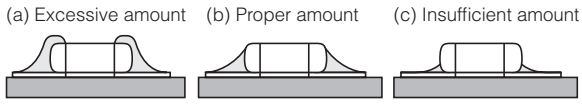


Unit (mm)

Size Code (EIA)	Component dimensions			a	b	c
	L	W	T			
0(0402)	1.0	0.5	0.5	0.4 to 0.5	0.4 to 0.5	0.4 to 0.5
1(0603)	1.6	0.8	0.8	0.8 to 1.0	0.6 to 0.8	0.6 to 0.8

(2) The land size shall be designed to have equal space, on both right and left sides. If the amount of solder on both sides is not equal, the component may be cracked by stress, since the side with a larger amount of solder solidifies later during cooling.

Recommended Amount of Solder



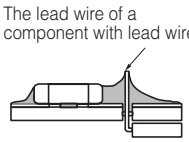
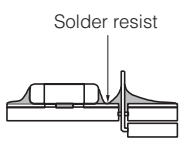
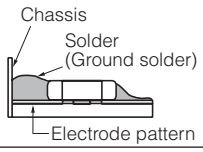
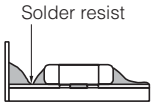
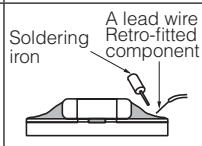
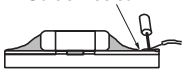
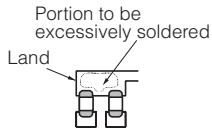
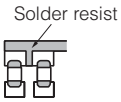
2.3 Utilization of Solder Resist

(1) Solder resist shall be utilized to equalize the amounts of solder on both sides.

(2) Solder resist shall be used to divide the pattern for the following cases;
  · Components are arranged closely.
  · The Thermistor is mounted near a component with lead wires.
  · The Thermistor is placed near a chassis.

Refer to the table below.

Prohibited Applications and Recommended Applications

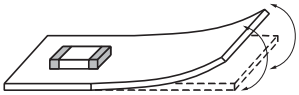
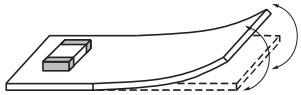
Item	Prohibited applications	Improved applications by pattern division
Mixed mounting with a component with lead wires		
Arrangement near chassis		
Retro-fitting of component with lead wires		
Lateral arrangement		

2.4 Component Layout

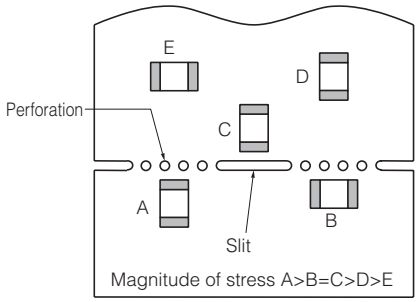
To prevent the crack of Thermistors, try to place it on the position that could not easily be affected by the bending stress of substrate while mounting procedures or procedures afterwards.

Placement of the Thermistors near heating elements also requires the great care to be taken in order to avoid stresses from rapid heating and cooling.

(1) To minimize mechanical stress caused by the warp or bending of a PC board, please follow the recommended Thermistors' layout below.

Prohibited layout	Recommended layout
	 Layout the Thermistors sideways against the stressing direction

(2) The following layout is for your reference since mechanical stress near the dividing/breaking position of a PC board varies depending on the mounting position of the Thermistors.



(3) The magnitude of mechanical stress applied to the Thermistors when dividing the circuit board in descending order is as follows:
push back < slit < V-groove < perforation.
Also take into account the layout of the Thermistors and the dividing/breaking method.

(4) When the Thermistors are placed near heating elements such as heater, etc., cracks from thermal stresses may occur under following situation:
· Soldering the Thermistors directly to heating elements.
· Sharing the land with heating elements.

If planning to conduct above-mentioned mounting and/or placement, please contact us in advance.

2.5 Mounting Density and Spaces

Intervals between components should not be too narrow to prevent the influence from solder bridges and solder balls. The space between components should be carefully determined.

Precautions for Assembly

1. Storage

(1) The Thermistors shall be stored between 5 to 40 °C and 20 to 70 % RH, not under severe conditions of high temperature and humidity.

(2) If stored in a place where humidity, dust, or corrosive gasses (hydrogen sulfide, sulfurous acid, hydrogen chloride and ammonia, etc.) are contained, the solderability of terminal electrodes will be deteriorated.
In addition, storage in a places where the heat or direct sunlight exposure occur will cause mounting problems due to deformation of tapes and reels and components and taping/reels sticking together.

(3) Do not store components longer than 6 months. Check the solderability of products that have been stored for more than 6 months before use

2. Chip Mounting Consideration

(1) When mounting the Thermistors/components on a PC board, the Thermistor bodies shall be free from excessive impact loads such as mechanical impact or stress due to the positioning, pushing force and displacement of vacuum nozzles during mounting.

(2) Maintenance and inspection of the Chip Mounter must be performed regularly.

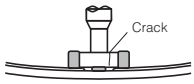
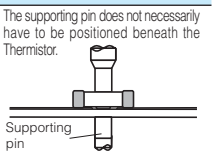
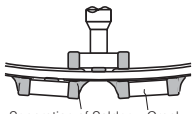
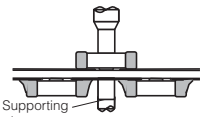
(3) If the bottom dead center of the vacuum nozzle is too low, the Thermistor will crack from excessive force during mounting.

The following precautions and recommendations are for your reference in use.

(a) Set and adjust the bottom dead center of the vacuum nozzles to the upper surface of the PC board after correcting the warp of the PC board.

(b) Set the pushing force of the vacuum nozzle during mounting to 1 to 3 N in static load.

(c) For double surface mounting, apply a supporting pin on the rear surface of the PC board to suppress the bending of the PC board in order to minimize the impact of the vacuum nozzles. Typical examples are shown in the table below.

Item	Prohibited mounting	Recommended mounting
Single surface mouting	 Crack	 The supporting pin does not necessarily have to be positioned beneath the Thermistor. Supporting pin
Double surface mounting	 Separation of Solder Crack	 Supporting pin

(d) Adjust the vacuum nozzles so that their bottom dead center during mounting is not too low.

(4) The closing dimensions of the positioning chucks shall be controlled. Maintenance and replacement of positioning chucks shall be performed regularly to prevent chipping or cracking of the Thermistors caused by mechanical impact during positioning due to worn positioning chucks.

(5) Maximum stroke of the nozzle shall be adjusted so that the maximum bending of PC board does not exceed 0.5 mm at 90 mm span. The PC board shall be supported by an adequate number of supporting pins.

3. Selection of Soldering Flux

Soldering flux may seriously affect the performance of the Thermistors. The following shall be confirmed before use.

(1) The soldering flux should have a halogen based content of 0.1 wt% (converted to chlorine) or below. Do not use soldering flux with strong acid.

(2) When applying water-soluble soldering flux, wash the Thermistors sufficiently because the soldering flux residue on the surface of PC boards may deteriorate the insulation resistance on the Thermistors' surface.

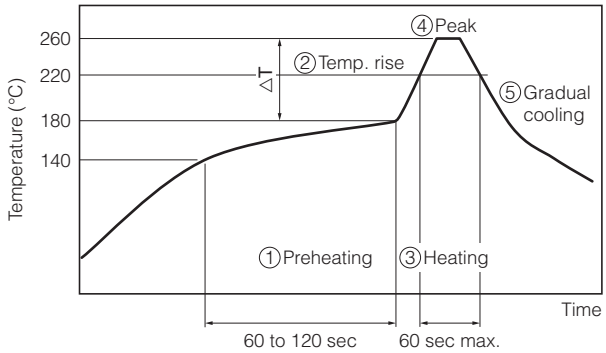
4. Soldering

4.1 Reflow Soldering

The reflow soldering temperature conditions are composed of temperature curves of Preheating, Temp. rise, Heating, Peak and Gradual cooling. Large temperature difference inside the Thermistors caused by rapid heat application to the Thermistors may lead to excessive thermal stresses, contributing to the thermal cracks. The Preheating temperature requires controlling with great care so that tombstone phenomenon may be prevented.

Item	Temperature	Period or Speed
①Preheating	140 to 180 °C	60 to 120 sec
②Temp. rise	Preheating temp to Peak temp.	2 to 5 °C /sec
③Heating	220 °C min.	60 sec max.
④Peak	260 °C max.	10 sec max.
⑤Gradual cooling	Peak temp. to 140 °C	1 to 4 °C /sec

Recommended profile of Reflow soldering (EX)



△T : Allowable temperature difference △T ≦ 150 °C

The rapid cooling (forced cooling) during Gradual cooling part should be avoided, because this may cause defects such as the thermal cracks, etc.
When the Thermistors are immersed into a cleaning solvent, make sure that the surface temperatures of the devices do not exceed 100 °C.
Performing reflow soldering twice under the conditions shown in the figure above [Recommended profile of Reflow soldering (EX)] will not cause any problems. However, pay attention to the possible warp and bending of the PC board.

4.2 Hand Soldering

Hand soldering typically causes significant temperature change, which may induce excessive thermal stresses inside the Thermitors, resulting in the thermal cracks, etc. In order to prevent any defects, the following should be observed.

- The temperature of the soldering tips should be controlled with special care.
- The direct contact of soldering tips with the Thermistors and/or terminal electrodes should be avoided.
- Dismounted Thermistors shall not be reused.

(1) Condition 1 (with preheating)

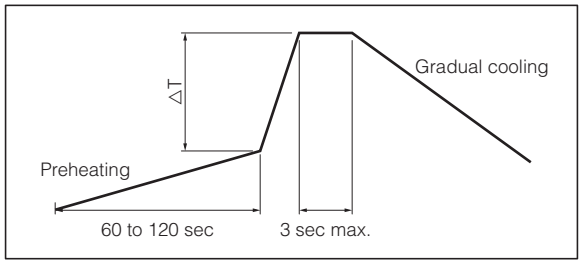
(a) Soldering:
Use thread solder (ϕ1 mm or below) which contains flux with low chlorine, developed for precision electronic equipment.

(b) Preheating:
Conduct sufficient pre-heating, and make sure that the temperature difference between solder and Thermistors' surface is 150 °C or less.

(c) Temperature of Iron tip: 300 °C max.
(The required amount of solder shall be melted in advance on the soldering tip.)

(d) Gradual cooling:
After soldering, the Thermistors shall be cooled gradually at room temperature.

Recommended profile of Hand soldering (EX)



△T : Allowable temperature difference △T ≦ 150 °C

(2) Condition 2 (without preheating)
Hand soldering can be performed without preheating, by following the conditions below:

(a) Soldering iron tip shall never directly touch the ceramic and terminal electrodes of the Thermistors.

(b) The lands are sufficiently preheated with a soldering iron tip before sliding the soldering iron tip to the terminal electrodes of the Thermistors for soldering.

Conditions of Hand soldering without preheating

Item	Condition
Temperature of Iron tip	270 °C max.
Wattage	20 W max.
Shape of Iron tip	ϕ3 mm max.
Soldering time with a soldering iron	3 sec max.

5. Post Soldering Cleaning

5.1 Cleaning solvent

Soldering flux residue may remain on the PC board if cleaned with an inappropriate solvent. This may deteriorate the electrical characteristics and reliability of the Thermistors.

5.2 Cleaning conditions

Inappropriate cleaning conditions such as insufficient cleaning or excessive cleaning may impair the electrical characteristics and reliability of the Thermistors.

(1) Insufficient cleaning can lead to:

(a) The halogen substance found in the residue of the soldering flux may cause the metal of terminal electrodes to corrode.

(b) The halogen substance found in the residue of the soldering flux on the surface of the Thermistors may change resistance values.

(c) Water-soluble soldering flux may have more remarkable tendencies of (a) and (b) above compared to those of rosin soldering flux.

(2) Excessive cleaning can lead to:

(a) When using ultrasonic cleaner, make sure that the output is not too large, so that the substrate will not resonate. The resonation causes the cracks in Varistors and/or solders, and deteriorates the strength of the terminal electrodes. Please follow these conditions for Ultrasonic cleaning:

Ultrasonic wave output : 20 W/L max.
Ultrasonic wave frequency : 40 kHz max.
Ultrasonic wave cleaning time : 5 min. max.

5.3 Contamination of Cleaning solvent

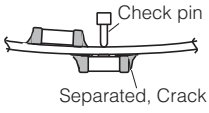
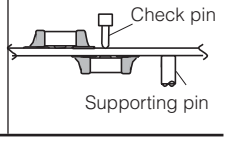
Cleaning with contaminated cleaning solvent may cause the same results as insufficient cleaning due to the high density of liberated halogen.

6. Inspection Process

The pressure from measuring terminal pins might bend the PCB when implementing circuit inspection after mounting Thermistors on PCB, and as a result, cracking may occur.

(1) Mounted PC boards shall be supported by an adequate number of supporting pins on the back with bend settings of 90 mm span 0.5 mm max.

(2) Confirm that the measuring pins have the right tip shape, are equal in height, have the right pressure, and are set in the correct positions.
The following figures are for your reference to avoid bending the PC board.

Item	Prohibited setting	Recommended setting
Bending of PC board		

7. Protective Coating

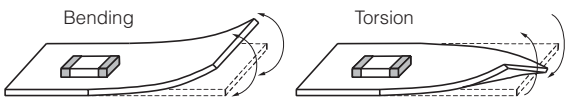
When the surface of a PC board on which the Thermistors have been mounted is coated with resin to protect against moisture and dust, it shall be confirmed that the protective coating does not affect the performance of Varistors.

(1) Choose the material that does not emit the decomposition and/or reaction gas. The Gas may affect the composing members of the Varistors.

(2) Shrinkage and expansion of resin coating when curing may apply stress to the Varistors and may lead to occurrence of cracks.

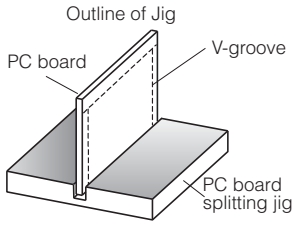
8. Dividing/Breaking of PC Boards

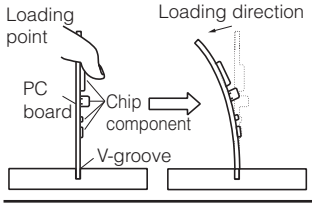
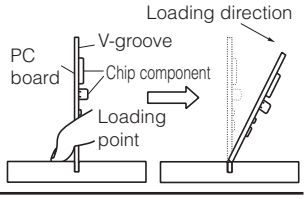
(1) Please be careful not to stress the substrate with bending/twisting when dividing, after mounting components including Varistors. Abnormal and excessive mechanical stress such as bending or torsion shown below can cause cracking in the Thermistors.



(2) Dividing/Breaking of the PC boards shall be done carefully at moderate speed by using a jig or apparatus to protect the Thermistors on the boards from mechanical damage.

(3) Examples of PCB dividing/breaking jigs:
The outline of PC board breaking jig is shown below. When PC boards are broken or divided, loading points should be close to the jig to minimize the extent of the bending
Also, planes with no parts mounted on should be used as plane of loading, in order to prevent tensile stress induced by the bending, which may cause cracks of the Thermistors or other parts mounted on the PC boards.

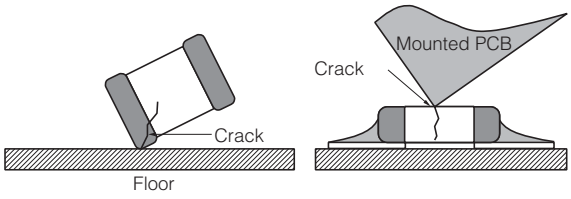


Prohibited dividing	Recommended dividing
	

9. Mechanical Impact

(1) The Thermistors shall be free from any excessive mechanical impact.
The Thermistor body is made of ceramics and may be damaged or cracked if dropped.
Never use a Thermistor which has been dropped; their quality may be impaired and failure rate increased.

(2) When handling PC boards with Thermistors mounted on them, do not allow the Thermistors to collide with another PC board.
When mounted PC boards are handled or stored in a stacked state, the corner of a PC board might strike Thermistors, and the impact of the strike may cause damage or cracking and can deteriorate the withstand voltage and insulation resistance of the Thermistor.

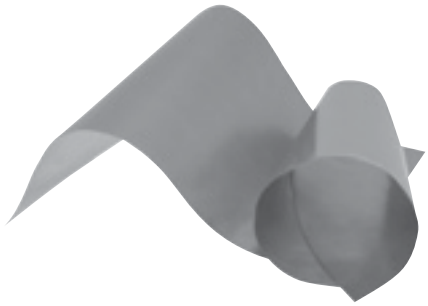


Other

The various precautions described above are typical.
For special mounting conditions, please contact us.

"PGS" Graphite Sheets

Type: EYG



PGS (Pyrolytic Graphite Sheet) is a thermal interface material which is very thin, synthetically made, has high thermal conductivity, and is made from a higly oriented graphite polymer film. It is ideal for providing thermal management/heat-sinking in limited spaces or to provide supplemental heat-sinking in addition to conventional means. This material is flexible and can be cut into customizable shapes.

Features

- Excellent thermal conductivity : 700 to 1950 W/(m·K)
  (2 to 5 times as high as copper, 3 to 8 time as high as aluminum)
- Lightweight: Specific gravity : 0.85 to 2.13 g/cm^3
  (1/4 to 1/10 of copper, 1/1.3 to 1/3 of aluminum in density)
- Flexible and easy to be cut or trimmed. (withstands repeated bending)
- Low thermal resistance
- RoHS compliant

Recommended applications

- Smart phones, Mobile phones, DSC, DVC, Tablet PCs, PCs and peripherals, LED Devices
- Semiconductor manufacturing equipment (Sputtering, Dry etching, Steppers)
- Optical communications equipment

Explanation of Part Numbers

- PGS only (EYGS******)

1	2	3	4	5	6	7	8	9	10
E	Y	G	S	0	9	1	2	1	0

Product Code

Style	
S	PGS only

Dimension	
0912	90 mm × 115 mm
1218	115 mm × 180 mm
1823	180 mm × 230 mm

PGS Thickness*	
10	100 µm
07	70 µm
05	50 µm
04	40 µm
03	25 µm

* PGS thickness of 17 µm, 10 µm does not support as single item.

- Taping (EYGA********)

1	2	3	4	5	6	7	8	9	10	11	12
E	Y	G	A	0	9	1	2	1	0	D	M

Product Code

Style	
A	Taping

Dimension**	
0912	90 mm × 115 mm
1218	115 mm × 180 mm

** Please contact us for other dimensions other than those above.

PGS Thickness	
10	100 µm
07	70 µm
05	50 µm
04	40 µm
03	25 µm
02	17 µm
01	10 µm

Suffix	
A	Lamination type * Please refer to Composition example.
M	
F	
PA	
PM	
DM	
DF	
V	
RV	
KV	

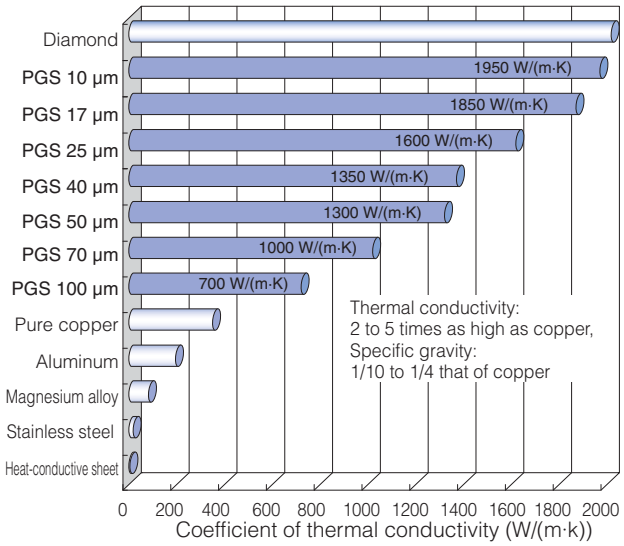
Characteristics

Thickness		100 µm	70 µm	50 µm	40 µm
		0.10±0.03 mm	0.07±0.015 mm	0.050±0 .015 mm	0.040±0 .012 mm
Density		0.85 g/cm^3	1.21 g/cm^3	1.70 g/cm^3	1.80 g/cm^3
Thermal conductivity	a-b plane	700 W/(m·K)	1000 W/(m·K)	1300 W/(m·K)	1350 W/(m·K)
Electrical conductivity		10000 S/cm	10000 S/cm	10000 S/cm	10000 S/cm
Extensional strength		20.0 MPa	20.0 MPa	20.0 MPa	25.0 MPa
Expansion coefficient	a-b plane	9.3×10^{-7} 1/K	9.3×10^{-7} 1/K	9.3×10^{-7} 1/K	9.3×10^{-7} 1/K
	c axis	3.2×10^{-5} 1/K	3.2×10^{-5} 1/K	3.2×10^{-5} 1/K	3.2×10^{-5} 1/K
Heat resistance*		400 °C			
Bending(angle 180,R5)		10000 cycles			

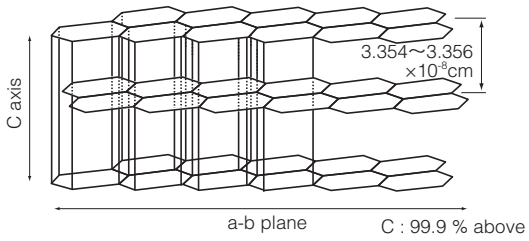
Thickness		25 µm	17 µm	10 µm
		0.025±0 .010 mm	0.017±0 .005 mm	0.010±0 .002 mm
Density		1.90 g/cm^3	2.10 g/cm^3	2.13 g/cm^3
Thermal conductivity	a-b plane	1600 W/(m·K)	1850 W/(m·K)	1950 W/(m·K)
Electrical conductivity		20000 S/cm	20000 S/cm	20000 S/cm
Extensional strength		30.0 MPa	40.0 MPa	40.0 MPa
Expansion coefficient	a-b plane	9.3×10^{-7} 1/K	9.3×10^{-7} 1/K	9.3×10^{-7} 1/K
	c axis	3.2×10^{-5} 1/K	3.2×10^{-5} 1/K	3.2×10^{-5} 1/K
Heat resistance*		400 °C		
Bending(angle 180,R5)		10000 cycles		

* Withstand temperature refers to PGS only.
(Lamination material such as PET tape etc. is not included)
** Values are for reference, not guaranteed.

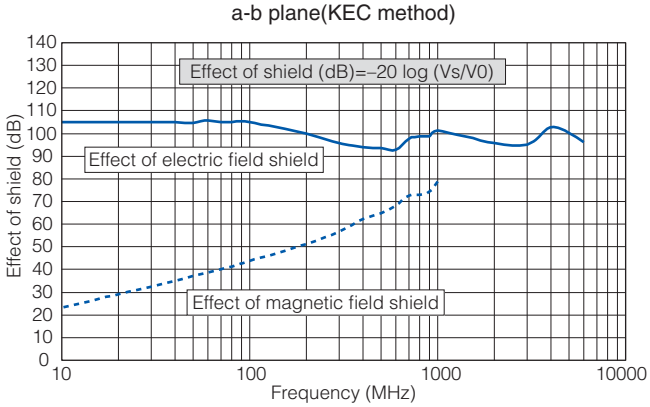
Comparison of thermal conductivity (a-b plane)



Layered structure of PGS



Electric field shield performance



Lamination type/Composition example

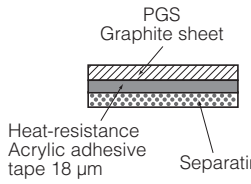
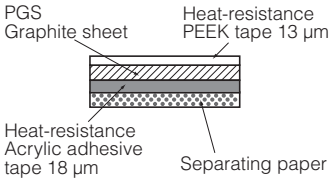
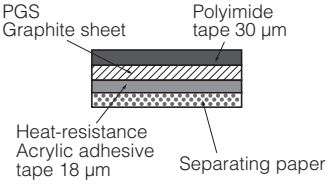
● Standard series (PGS 100, 70, 50, 40, 25, 17, 10 µm)

Type		PGS Only	Adhesive Type		
		S type	A-A type	A -M type	A -F type
Front face		–	–	–	–
Rear face		–	Insulative adhesion type 30 µm	Insulative thin adhesion type 10 µm	Insulative thin adhesion type 6 µm
Structure		PGS Graphite sheet	PGS Graphite sheet / Acrylic Adhesive tape 30 µm / Separating paper	PGS Graphite sheet / Acrylic Adhesive tape 10 µm / Separating paper	PGS Graphite sheet / Acrylic Adhesive tape 6 µm / Separating paper
Features		· High Thermal Conductivity High Flexibility · Low Thermal Resistance · Available up to 400 °C · Conductive Material	· With insulation material on one side · With strong adhesive tape for putting chassis · Withstanding Voltage : 2 kV	· With insulation material on one side · Low thermal resistance comparison with A-A type · Withstanding Voltage : 1 kV	· With insulation material on one side · Low thermal resistance comparison with A-A type
Withstand temperature		400 °C	100 °C	100 °C	100 °C
Standard Size		115 × 180 mm	90 × 115 mm	90 × 115 mm	90 × 115 mm
Maximam size		180 × 230 mm (25 µm to)	115 × 180 mm	115 × 180 mm	115 × 180 mm
100 µm	Part No.	EYGS121810	EYGA091210A	EYGA091210M	EYGA091210F
	Thickness	100 µm	130 µm	110 µm	106 µm
70 µm	Part No.	EYGS121807	EYGA091207A	EYGA091207M	EYGA091207F
	Thickness	70 µm	100 µm	80 µm	76 µm
50 µm	Part No.	EYGS121805	EYGA091205A	EYGA091205M	EYGA091205F
	Thickness	50 µm	80 µm	60 µm	56 µm
40 µm	Part No.	EYGS121804	EYGA091204A	EYGA091204M	EYGA091204F
	Thickness	40 µm	70 µm	50 µm	46 µm
25 µm	Part No.	EYGS121803	EYGA091203A	EYGA091203M	EYGA091203F
	Thickness	25 µm	55 µm	35 µm	31 µm
17 µm	Part No.	–	EYGA091202A	EYGA091202M	EYGA091202F
	Thickness	–	47 µm	27 µm	23 µm
10 µm	Part No.	–	EYGA091201A	EYGA091201M	EYGA091201F
	Thickness	–	40 µm	20 µm	16 µm

Type		Laminated type (Insulation & Adhesive)			
		A-PA type	A-PM type	A-DM type	A-DF type
Front face		Polyester tape standard type 30 µm	Polyester tape standard type 30 µm	Polyester tape thin type 10 µm	Polyester tape thin type 10 µm
Rear face		Insulative adhesion type 30 µm	Insulative thin adhesion type 10 µm	Insulative thin adhesion type 10 µm	Insulative thin adhesion type 6 µm
Structure		PGS Graphite sheet / Polyester(PET) tape 30 µm / Acrylic Adhesive tape 30 µm / Separating paper	PGS Graphite sheet / Polyester(PET) tape 30 µm / Acrylic Adhesive tape 10 µm / Separating paper	PGS Graphite sheet / Polyester(PET) tape 10 µm / Acrylic Adhesive tape 10 µm / Separating paper	PGS Graphite sheet / Polyester(PET) tape 10 µm / Acrylic Adhesive tape 6 µm / Separating paper
Features		· With insulation material on both side · Withstanding Voltage PET tape : 4 kV Adhesive Tape : 2 kV	· With insulation material on both side · Withstanding Voltage PET tape : 4 kV Adhesive Tape : 1 kV	· With insulation material on both side · Withstanding Voltage PET tape : 1 kV Adhesive Tape : 1 kV	· With insulation material on both side · Withstanding Voltage PET tape : 1 kV
Withstand temperature		100 °C	100 °C	100 °C	100 °C
Standard Size		90 × 115 mm	90 × 115 mm	90 × 115 mm	90 × 115 mm
Maximam size		115 × 180 mm	115 × 180 mm	115 × 180 mm	115 × 180 mm
100 µm	Part No.	EYGA091210PA	EYGA091210PM	EYGA091210DM	EYGA091210DF
	Thickness	160 µm	140 µm	120 µm	116 µm
70 µm	Part No.	EYGA091207PA	EYGA091207PM	EYGA091207DM	EYGA091207DF
	Thickness	130 µm	110 µm	90 µm	86 µm
50 µm	Part No.	EYGA091205PA	EYGA091205PM	EYGA091205DM	EYGA091205DF
	Thickness	110 µm	90 µm	70 µm	66 µm
40 µm	Part No.	EYGA091204PA	EYGA091204PM	EYGA091204DM	EYGA091204DF
	Thickness	100 µm	80 µm	60 µm	56 µm
25 µm	Part No.	EYGA091203PA	EYGA091203PM	EYGA091203DM	EYGA091203DF
	Thickness	85 µm	65 µm	45 µm	41 µm
17 µm	Part No.	EYGA091202PA	EYGA091202PM	EYGA091202DM	EYGA091202DF
	Thickness	77 µm	57 µm	37 µm	33 µm
10 µm	Part No.	EYGA091201PA	EYGA091201PM	EYGA091201DM	EYGA091201DF
	Thickness	70 µm	50 µm	30 µm	26 µm

✻ Please contact us for other lamination type product.
✻✻ Withstanding Voltages are for reference, not guaranteed.

● High heat resistance series (PGS 100, 70, 50, 40, 25, 17, 10 μm)

Type		High heat resistance type		
		A-V type	A-RV type	A-KV type
Front face		–	High heat resistance and insulation type 13 μm	High heat resistance and insulation type 30 μm
Rear face		High heat resistance and insulation adhesion type 18 μm	High heat resistance and insulation adhesion type 18 μm	High heat resistance and insulation adhesion type 18 μm
Structure				
Features		· With high heat resistance and insulation tape on one side · Withstanding Voltage Adhesive tape : 2 kV	· With high heat resistance and insulation tape on both side · Withstanding Voltage PEEK tape : 2 kV Adhesive tape : 2 kV	· With high heat resistance and more insulated tape on both side · Withstanding Voltage PI tape : 5 kV Adhesive tape : 2 kV
Withstand temperature		150 °C	150 °C	150 °C (Polyimide : 180 °C)
Standard Size		90 × 115 mm	90 × 115 mm	90 × 115 mm
Maximam size		115 × 180 mm	115 × 180 mm	115 × 180 mm
100 μm	Part No.	EYGA091210V	EYGA091210RV	EYGA091210KV
	Thickness	118 μm	131 μm	148 μm
70 μm	Part No.	EYGA091207V	EYGA091207RV	EYGA091207KV
	Thickness	88 μm	101 μm	118 μm
50 μm	Part No.	EYGA091205V	EYGA091205RV	EYGA091205KV
	Thickness	68 μm	81 μm	98 μm
40 μm	Part No.	EYGA091204V	EYGA091204RV	EYGA091204KV
	Thickness	58 μm	71 μm	88 μm
25 μm	Part No.	EYGA091203V	EYGA091203RV	EYGA091203KV
	Thickness	43 μm	56 μm	73 μm
17 μm	Part No.	EYGA091202V	EYGA091202RV	EYGA091202KV
	Thickness	35 μm	48 μm	65 μm
10 μm	Part No.	EYGA091201V	EYGA091201RV	EYGA091201KV
	Thickness	28 μm	41 μm	58 μm

✻ Please contact us for other lamination type product.
✻✻ Withstanding Voltages are for reference, not guaranteed.

Minimum order

Item	Type	Part No.	Size	Minimum order
PGS Graphite Sheet Only	S type 100 µm	EYGS091210	90×115 mm	20
		EYGS121810	115×180 mm	10
		EYGS182310	180×230 mm	10
	S type 70 µm	EYGS091207	90×115 mm	20
		EYGS121807	115×180 mm	10
		EYGS182307	180×230 mm	10
	S type 50 µm	EYGS091205	90×115 mm	20
		EYGS121805	115×180 mm	10
		EYGS182305	180×230 mm	10
	S type 40 µm	EYGS091204	90×115 mm	20
		EYGS121804	115×180 mm	10
		EYGS182304	180×230 mm	10
	S type 25 µm	EYGS091203	90×115 mm	20
		EYGS121803	115×180 mm	10
		EYGS182303	180×230 mm	10
PGS 70, 25, 17 µm Adhesive Type [Standard series]	A-A type 70 µm	EYGA091207A	90×115 mm	20
		EYGA121807A	115×180 mm	10
	A-A type 25 µm	EYGA091203A	90×115 mm	20
		EYGA121803A	115×180 mm	10
	A-A type 17 µm	EYGA091202A	90×115 mm	20
		EYGA121802A	115×180 mm	10
	A-M type 70 µm	EYGA091207M	90×115 mm	20
		EYGA121807M	115×180 mm	10
	A-M type 25 µm	EYGA091203M	90×115 mm	20
		EYGA121803M	115×180 mm	10
	A-M type 17 µm	EYGA091202M	90×115 mm	20
		EYGA121802M	115×180 mm	10
PGS 70, 25, 17 µm Laminated Type (Insulation & Adhesive) [Standard series]	A-PA type 70 µm	EYGA091207PA	90×115 mm	20
		EYGA121807PA	115×180 mm	10
	A-PA type 25 µm	EYGA091203PA	90×115 mm	20
		EYGA121803PA	115×180 mm	10
	A-PA type 17 µm	EYGA091202PA	90×115 mm	20
		EYGA121802PA	115×180 mm	10
	A-PM type 70 µm	EYGA091207PM	90×115 mm	20
		EYGA121807PM	115×180 mm	10
	A-PM type 25 µm	EYGA091203PM	90×115 mm	20
		EYGA121803PM	115×180 mm	10
	A-PM type 17 µm	EYGA091202PM	90×115 mm	20
		EYGA121802PM	115×180 mm	10
	A-DM type 70 µm	EYGA091207DM	90×115 mm	20
		EYGA121807DM	115×180 mm	10
	A-DM type 25 µm	EYGA091203DM	90×115 mm	20
		EYGA121803DM	115×180 mm	10
	A-DM type 17 µm	EYGA091202DM	90×115 mm	20
		EYGA121802DM	115×180 mm	10

* Only S type supports 180×230 mm size.
(PGS thickness of 17 µm, 10µm does not support as single item)
** PGS of 10 µm, 40 µm, 50 µm type is also possible to be made as lamination type.
*** The above-listed part number is sample part number for testing.
**** Please contact us about your request of custom part number which will be arranged separately.
***** Please contact us if quantity is below Minimum Order Quantity.

Item	Type	Part No.	Size	Minimum order
PGS 70, 25, 17 µm [High heat resistance type]	A-V type 70 µm	EYGA091207V	90×115 mm	20
		EYGA121807V	115×180 mm	10
	A-V type 25 µm	EYGA091203V	90×115 mm	20
		EYGA121803V	115×180 mm	10
	A-V type 17 µm	EYGA091202V	90×115 mm	20
		EYGA121802V	115×180 mm	10
	A-RV type 70 µm	EYGA091207RV	90×115 mm	20
		EYGA121807RV	115×180 mm	10
	A-RV type 25 µm	EYGA091203RV	90×115 mm	20
		EYGA121803RV	115×180 mm	10
	A-RV type 17 µm	EYGA091202RV	90×115 mm	20
		EYGA121802RV	115×180 mm	10
	A-KV type 70 µm	EYGA091207KV	90×115 mm	20
		EYGA121807KV	115×180 mm	10
	A-KV type 25 µm	EYGA091203KV	90×115 mm	20
		EYGA121803KV	115×180 mm	10
	A-KV type 17 µm	EYGA091202KV	90×115 mm	20
		EYGA121802KV	115×180 mm	10

* Only S type supports 180×230 mm size.
(PGS thickness of 17 µm, 10µm does not support as single item)
** PGS of 10 µm, 40 µm, 50 µm type is also possible to be made as lamination type.
*** The above-listed part number is sample part number for testing.
**** Please contact us about your request of custom part number which will be arranged separately.
***** Please contact us if quantity is below Minimum Order Quantity.

"PGS" (Pyrolytic Graphite Sheet) Heat sink sheet

Handling Precautions

⚠ Safety Precautions

- When using our products, no matter what sort of equipment they might be used for, be sure to make a written agreement on the specifications with us in advance. The design and specifications in this catalog are subject to change without prior notice.
- Do not use the products beyond the specifications described in this catalog.
- This catalog explains the quality and performance of the products as individual components. Before use, check and evaluate their operations when installed in your products.
- Install the following systems for a failsafe design to ensure safety if these products are to be used in equipment where a defect in these products may cause the loss of human life or other significant damage, such as damage to vehicles (automobile, train, vessel), traffic lights, medical equipment, aerospace equipment, electric heating appliances, combustion/gas equipment, rotating equipment, and disaster/crime prevention equipment.

✻ Systems equipped with a protection circuit and a protection device
✻ Systems equipped with a redundant circuit or other system to prevent an unsafe status in the event of a single fault

PGS (Pyrolytic Graphite Sheet) Heat sink sheet (hereafter referred to as PGS) may result in accidents or trouble when subjected to severe conditions of electrical, environmental and /or mechanical stress beyond the specified "Rating" and specified "Conditions" found in the Specifications. Please follow the recommendations in "Safety Precautions" and "Application Notes". Contact our engineering staff or the factory with any questions.

1. ⚠Safety Precautions

1.1 The PGS shall be used within the specified operating temperature range.
1.2 The PGS is soft, do not rub or touch it with rough materials to avoid scratching it.
1.3 Lines or folds in the PGS may affect thermal conductivity.
1.4 The PGS shall not be used with acid.
The PGS shall not be used in contact with a soldering iron at 400 °C or more
1.5 The PGS shall not be exposed to salt water or direct sunlight during use. The PGS shall not be used in corrosive gases (hydrogen sulfide, sulfurous acid, chlorine, ammonia etc.).
1.6 Our PGS has been developed for general industry applications. Prior to using the PGS for special applications such as medical, work please contact our engineering staff or the factory.
1.7 Never touch a PGS during use because it may be extremely hot.

2. Application notes

2.1 Use protective materials when handling and/or applying the PGS, do not use items with sharp edges as they might tear or puncture the PGS.
2.2 The PGS does not work properly if overheated.
2.3 Thermal conductivity is dependant on the way it is used.
Test the adaptability of PGS to your application before use.
2.4 The PGS has conductivity.
If required, the PGS should be provided insulation.
2.5 Long term storage
- The PGS shall not be stored under severe conditions of salt water, direct sunlight or corrosive gases (hydrogen sulfide, sulfurous acid, chlorine, ammonia etc.).
- The PGS shall not be stored near acid.

<Package markings>
Package markings include the product number, quantity, and country of origin.
In principle, the country of origin should be indicated in English.

CAUTION AND WARNING

1. The electronic components contained in this catalog are designed and produced for use in home electric appliances, office equipment, information equipment, communications equipment, and other general purpose electronic devices.
   Before use of any of these components for equipment that requires a high degree of safety, such as medical instruments, aerospace equipment, disaster-prevention equipment, security equipment, vehicles (automobile, train, vessel),
   please be sure to contact our sales representative.
2. When applying one of these components for equipment requiring a high degree of safety, no matter what sort of application it might be, be sure to install a protective circuit or redundancy arrangement to enhance the safety of your equipment. In addition, please carry out the safety test on your own responsibility.
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● Please contact

● Factory

Device Solutions Business Division
Automotive & Industrial Systems Company
Panasonic Corporation
1006 Kadoma, Kadoma City, Osaka 571-8506,
JAPAN

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