POWER THERMISTOR

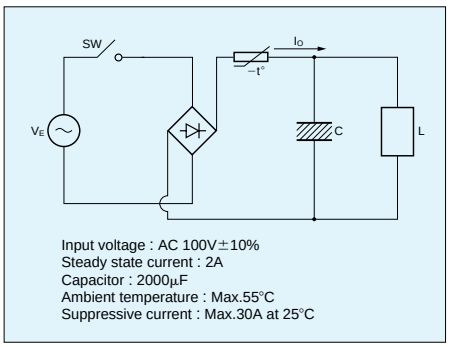
The POWER THERMISTOR is a device for suppressing inrush current to an electric circuit. Circuits including electric bulbs or capacitors induce a inrush current more than 100 times the normal current when the circuit switch is turned on. The POWER THERMISTOR in the circuits protects electric equipments from being damaged by limiting the inrush current.

MARK Ⅱ is a NEW POWER THERMISTOR featuring smaller size and larger energy capacity to meet severe requirements in inrush current suppression.
There is the tendency of miniturization in low power switching power supply, and MARK Ⅱ is effectively applicable for the needs, though the camparatively larger sized fixed resistors (ceramic coat) are used now.

Application

The power thermistor will suppress inrush current which is caused by a capacitor, filament for a bulb, inverter for fluorescent lamp, a heater and etc., also will control fan motor speed of cooler for electric circuit.
Especially MARKⅡ was developed to use for power supply of TV, VCR instead of cement resistor.

How to use the power thermistor



Input voltage : AC 100V±10%
Steady state current : 2A
Capacitor : 2000μF
Ambient temperature : Max.55°C
Suppressive current : Max.30A at 25°C

The most suitable power thermistor for the above circuit is required to fulfill the following terms and conditions.

1. The permissible current at ambient temperature of 55°C should be over 2A.
2. The thermistor resistance for suppressive current which becomes below 30A should be over 4.2 ohm from the under-mentioned formula.

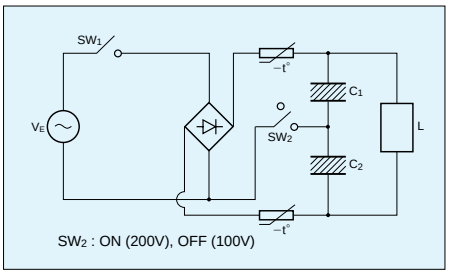
$$\frac{\sqrt{2}\ V_E \times 1.1}{R_C + R_{25}} \leqq 30$$

R_C : Intial resistance value in the circuit is 1 ohm (100V/100A)
R_{25} : Rated zero-power resistance at 25°C

3. Max. capacitance shall be over 2000μF at AC 100V.

Accordingly, suitable thermistors are 6D-22, 5D-18 and 8D-18, and if we consider in the points of small time constant which means a small size and large effect for suppressive current which means large rated zero-power resistance, 8D-18 is the most suitable one.

Use the following circuit in the power supply for 100V and 200V.



SW2 : ON (200V), OFF (100V)

Thermal time constant

If ambient temperature of a thermistor is changed to T_1 from T_2 suddenly, temperature of the thermistor changes slowly.
The time constant means the time when temperature of the thermistor reaches 63% of the temperature difference.

Residual resistance

If current is flowed through a thermistor, any heat will be generated in the thermistor by which its resistance will be decreased, however, a decrease of a resistance will be stabilized at a saturation resistance value which is determined by impressed electric power and a dissipation constant. The residual resistance value means maximum satulation resistance value when the maximum permissible current is flowed through the thermistor.

Temperature coefficient

The temperature coefficient of a thermistor is expressed by the following equation ;

$$-\frac{B}{T_2}\ (\%/^\circ C)$$

Dissipation factor

If small voltage is applied to a thermistor, small current will flow which produce enough heat in the thermistor. Dissipation factor is electric power which make 1°C raise by heat in a thermistor.

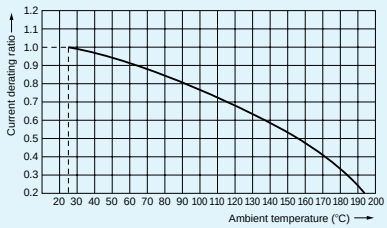
$$\delta = \frac{P}{\Delta t}\ (mW/^\circ C)$$

P is applied electric power.
Δt is rised temperature of the thermistor.

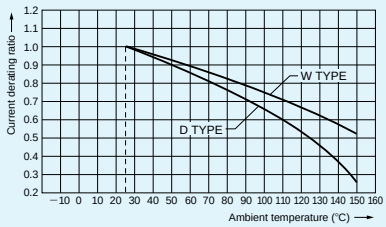
Maximum permissible current

If the maximum permissible current flows to a thermistor at 25°C, temperature of the thermistor rises to 200°C, (160°C). When ambient temperature is above 25°C, the maximum permissible current shall be over reduced as the maximum permissible current reduction curve.

New Power Thermistor MARKⅡ



Power Thermistor



Reliability tests

MARKⅡ

Dry heat test

Test sample is exposed in air at 200°C for 1,000 hours. ΔR25/R25≦±20%

Damp heat test

Test sample is exposed in atmosphere of 95%RH at 40°C for 1,000 hours. ΔR25/R25≦±10%

Load test

Test sample is applied the maximum rating current in air at 25°C for 1,000 hours. ΔR25/R25≦±20%

Change of temperature

Test sample is given 10 times of the following temperature cycle,
→ −40°C for 30 minutes → room temperature for 5 minutes →
→ 200°C for 30 minutes → room temperature for 5 minutes.
ΔR25/R25≦±10%

POWER THERMISTOR

Dry heat test

Test sample is exposed in air at 160°C for 1,000 hours. ΔR25/R25≦±10%

Damp heat test

Test sample is exposed in atmosphere of 95%RH at 40°C for 1,000 hours. ΔR25/R25≦±10%

Load test

Test sample is applied the maximum rating current in air at 25°C for 1,000 hours. ΔR25/R25≦±10%

Change of temperature

Test sample is given 10 times of the following temperature cycle,
→ −30°C for 30 minutes → room temperature for 5 minutes →
→ 160°C for 30 minutes → room temperature for 5 minutes.
ΔR25/R25≦±10%

Resistance-temperature characteristics

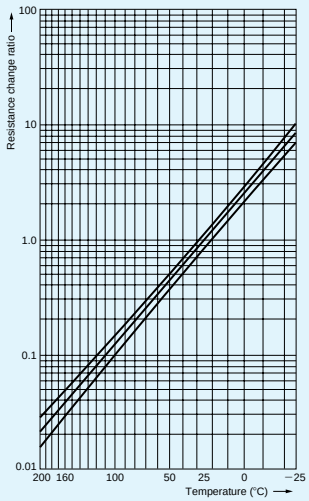
The theoretical characteristics of a thermistor is expressed by following equation.

$$R_1 = R_2 \exp\left\{B\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right\}$$

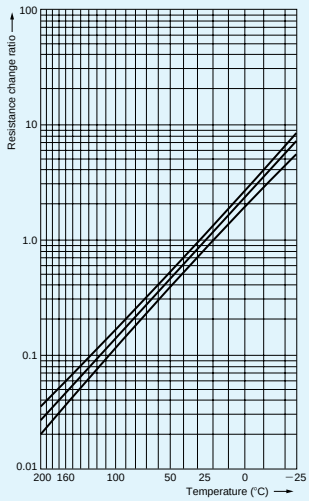
R_1 is the zero-power resistance at absolute temperature T_1
R_2 is the zero-power resistance at absolute temperature T_2

B is constant which depends on the material used to make the thermistor. Unless otherwise specified, all values of B are determined from measurements made at 25°C and 85°C.

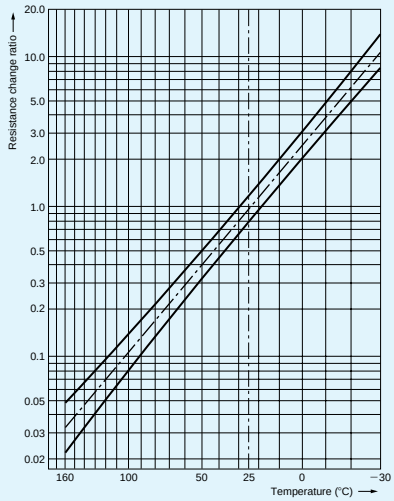
MARK Ⅱ B : 3150K



MARK Ⅱ B : 2900K



Power Thermistor B : 3250K



Specifications (Disk type)

Part No.	R_{25} *1 (Ω)	B value *2 $B_{25/85}$ (K)	Maximum enegy J (W-s)	Maximum rating current at 25°C (A)	Residual *3 resistance (Ω)	Dissipation factor (mW/°C)	Thermal *4 time constant (s)	Rating temp (°C)	Maximum capacitance (μF)			
									AC100V	AC120V	AC220V	AC240V
3D-22	3±15%	3250±5%	40.0	5.4	0.137	29.8	130	−30~160	8,500	5,900	1,700	1,470
4D-22	4±15%	3250±5%	50.0	4.7	0.182	30.7	160	−30~160	11,000	7,600	2,200	1,900
6D-22	6±15%	3250±5%	80.0	3.9	0.274	32.4	220	−30~160	17,000	11,800	3,500	2,950
4D-18	4±15%	3250±5%	9.0	4.1	0.182	22.8	100	−30~160	2,000	1,350	410	340
5D-18	5±15%	3250±5%	11.0	3.8	0.228	24.6	120	−30~160	2,500	1,700	510	430
8D-18	8±15%	3250±5%	18.0	3.1	0.365	27.2	150	−30~160	4,100	2,800	840	710
10D-18	10±15%	3250±5%	22.0	2.8	0.456	28.2	150	−30~160	5,000	3,400	1,030	860
5D-13	5±15%	3250±5%	4.0	3.4	0.228	20.1	55	−30~160	900	620	180	150
8D-13	8±15%	3250±5%	6.0	2.7	0.365	20.3	65	−30~160	1,400	970	280	240
16D-13	16±15%	3250±5%	12.0	1.9	0.730	21.4	105	−30~160	2,800	1,900	570	480
5D-11	5±15%	3250±5%	4.0	3.3	0.228	19.0	50	−30~160	900	620	180	150
8D-11	8±15%	3250±5%	6.0	2.6	0.365	19.8	70	−30~160	1,400	970	280	240
10D-11	10±15%	3250±5%	7.0	2.4	0.456	20.1	75	−30~160	1,800	1,250	370	310
10D-9	10±15%	3250±5%	2.0	2.2	0.456	17.2	40	−30~160	510	350	100	80
16D-9	16±15%	3250±5%	4.0	1.7	0.730	17.4	50	−30~160	820	560	160	140
22D-7	22±15%	3250±5%	1.0	1.4	1.003	15.7	30	−30~160	310	210	60	50

Specifications (Washer type)

Part No.	R_{25} *1 (Ω)	B value *2 $B_{25/85}$ (K)	Maximum enegy J (W-s)	Maximum rating current at 25°C (A)	Residual *3 resistance (Ω)	Dissipation factor (mW/°C)	Thermal *4 time constant (s)	Rating temp (°C)	Maximum capacitance (μF)			
									AC100V	AC120V	AC220V	AC240V
6W-22	6.0±15%	3250±5%	80	6.1	0.153	34.0	220	−30~200	17,000	11,800	3,500	2,950
4W-25	4.0±15%	3250±5%	50	7.8	0.102	36.2	160	−30~200	11,000	7,600	2,200	1,900

*1 R_{25} : Rated zero-power resistance value at 25°C.
*2 B value : determined by rated zero-power resistance at 25°C and 85°C.
*3 Residual resistance is the maximum value when maximum rating current is applied.
*4 Time when thermistor temperature reaches 63.2% of the temperature difference. The value is measured in the air.

Part number

Disk type

5 D-11 T3C (F2)

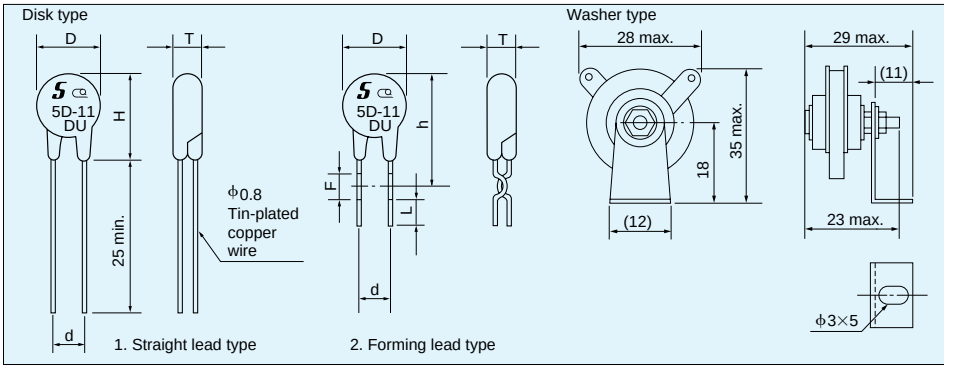
- (F2) Forming lead
- T3C Taping
- D-11 Element diameter : ϕ11
- D Shape D : Disk type
- 5 Resistance at 25°C : 5Ω

Washer type

4 W-25

- W-25 Element diameter : ϕ25
- W Shape W : Washer type
- 4 Resistance at 25°C : 4Ω

Dimensions



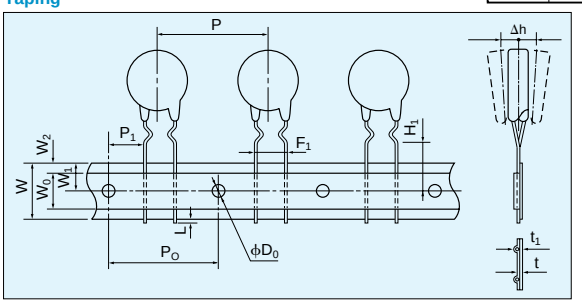
- UL approved (Disk type)
  File No. E92669
  Thermistor type device
- Canadian Standards (Disk type)
  File No. CA97673-1
  Class 7950 30 NTC Thermistor

	D	T	H	h	F	L	d
D-7	9.5max.	5max.	13max.	15max.	3±0.2	3.5±0.5	6±1
D-9	11max.	6max.	15max.	17max.			7.5±1
D-11	14max.		18max.	20max.			
D-13	16max.	8max.	20max.	22max.			
D-18	21max.	9max.	26max.	28max.			10±1
D-22	25max.	8max.	30max.	32max.			

Taping

	P	P_0	P_1	W	W_0	W_1	W_2	H_1	L	F_1	ϕD_0	t	t_1	Δh
D-7	15±1	15±0.3	3.75±0.7	$18^{+1.0}_{-0.5}$	5min.	9±0.5	3max.	16±0.5	1max.	7.5±0.5	4±0.3	0.6±0.3	1.6max.	0±2
D-9														
D-11														
D-13	30±1													

Taping

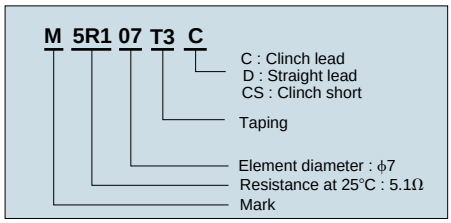


Specifications (Disk type)

Part No.	R_{25} *1 (Ω)	B value*2 $B_{25/85}$ (K)	Maximum enegy J (W·s)	Maximum rating current at 25°C (A)	Residual*3 resistance (Ω)	Dissipation factor (mW/°C)	Thermal *4 time constant (s)	Rating temp (°C)	Maximum capacitance (μF)			
									AC100V	AC120V	AC220V	AC240V
M5R107	5.1±10%	2900±5%	2.0	4.6	0.18	17.0	20	−40~200	400	270	80	60
M8R207	8.2±10%	2900±5%	2.8	3.6	0.30	17.2	25	−40~200	560	380	110	90
M10007	10.0±10%	2900±5%	3.4	3.3	0.36	17.2	30	−40~200	680	470	140	110
M12007	12.0±10%	3150±5%	3.6	3.6	0.24	17.5	25	−40~200	560	380	110	90
M16007	16.0±10%	3150±5%	4.0	3.1	0.43	17.8	30	−40~200	800	550	160	130
M22007	22.0±10%	3150±5%	4.8	2.6	0.59	18.0	40	−40~200	960	660	190	160
M2R210	2.2±10%	2900±5%	8.2	7.4	0.08	18.9	40	−40~200	1,460	1,130	330	280
M3R010	3.0±10%	2900±5%	8.6	6.4	0.11	19.2	45	−40~200	1,720	1,190	350	290
M3R910	3.9±10%	2900±5%	8.0	5.6	0.11	19.5	45	−40~200	1,880	1,300	380	320
M5R110	5.1±10%	3150±5%	7.2	5.7	0.14	19.2	40	−40~200	1,440	1,000	290	250
M8R210	8.2±10%	3150±5%	7.8	4.5	0.22	19.9	50	−40~200	1,560	1,080	320	270
M10010	10.0±10%	3150±5%	8.2	4.1	0.27	20.1	60	−40~200	1,640	1,130	330	280
M1R014	1.0±10%	2900±5%	18.0	11.9	0.04	22.0	65	−40~200	3,720	2,580	760	640
M2R014	2.0±10%	2900±5%	21.0	8.6	0.07	23.4	90	−40~200	4,200	2,900	860	720
M3R014	3.0±10%	3150±5%	15.0	8.3	0.08	23.6	80	−40~200	3,080	2,130	630	530
M3R914	3.9±10%	3150±5%	17.0	7.4	0.08	24.5	95	−40~200	3,400	2,360	700	590
M5R114	5.1±10%	3150±5%	18.0	6.5	0.14	24.7	110	−40~200	3,600	2,500	740	620

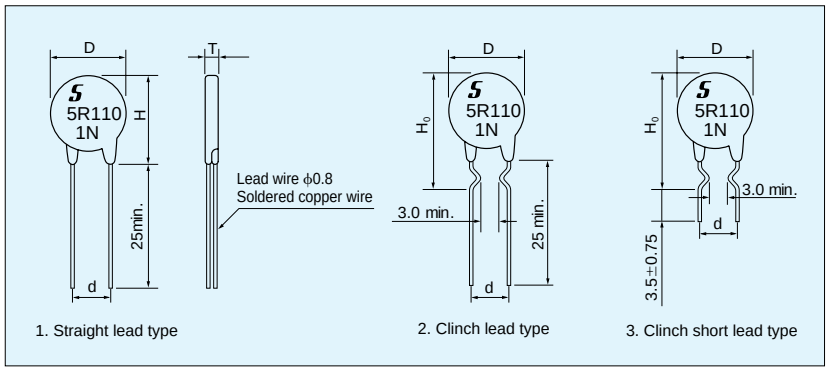
★1 R_{25} : Rated zero-power resistance value at 25°C.
★2 B value : determined by rated zero-power resistance at 25°C and 85°C.
★3 Residual resistance is the maximum value when maximum rating current is applied.
★4 Time when thermistor temperature reaches 63.2% of the temperature difference. The value is measured in the air.

Part number

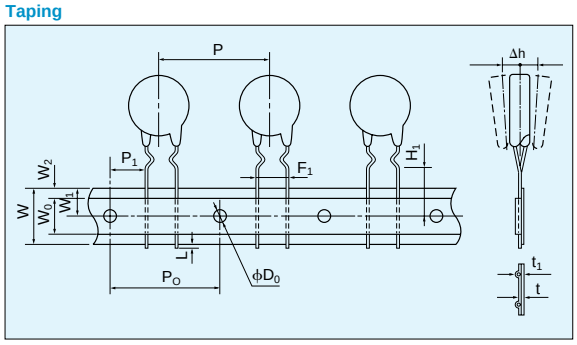


●UL approved
File No. E92669
Thermistor type devices

Dimensions



Taping



	D	T	H	H0	d
M···07	9.5max.	6max.	12max.	15max.	7.5±1
M···10	13max.		17max.	19.5max.	
M···14	17max.		20.5max.	22.5max.	

Taping

	P	P0	P1	W	W0	W1	W2	H1	L	F1	ϕD0	t	t1	Δh
M···07	15±1	15±0.3	3.75±0.7	$18^{+1.0}_{-0.5}$	5min.	9±0.5	3max.	16±0.5	1max.	7.5±0.5	4±0.2	0.6±0.3	1.5max.	0±2
M···10														
M···14	30±1													