

NTC Thermistors

NTC 熱敏電阻器



NTC Thermistor of Inrush Current Limiting

抑制突波電流用熱敏電阻器

TP Type



■ Introduction

TP Type NTC Thermistor devices are made of a specially formulated metal oxide ceramic material which is capable of suppressing high current surges.

TP type NTC devices, being of relatively high resistance, shall limit the inrush current for 1~2 seconds during which time the device decreases in resistance substantially to a point where its voltage drop is negligible. The devices are especially useful in power supplies (see FigA) because of the extremely low impedance of the capacitor being charged, of which the bridge is usually subjected to an exceedingly high current surge at turn-on point.

■ Features

- High inrush current restriction effect.
- Small power loss in stationary state. (Normally 1W or less than 50W power.)
- High thermal and electrical stability.
- Wide selection of electrical characteristics.
- Special coating material: green silicone.

■ Application

As shown in Fig. B, the current surge can be eliminated by Placing a NTC thermistor in series with a filament string. Yet, if the resistance of one NTC thermistor does not provide sufficient inrush current limiting functions for your application, two or more may be used in series or in separate legs of the supply circuit (Fig.A). Be noticed, the thermistor cannot be used in parallel since one unit will tend to conduct nearly all the current available. Thus, TP type thermistor may be used in the AC (point A1 or A2) or the DC (point D1 or D2) locations in the circuit. (See Fig. A)

The resistance of NTC thermistor is designed higher than the total resistance of filaments when the circuit is turned on. As current begins flowing, the thermistor shall immediately "self-heat". Then, in 1~2 seconds, its resistance will be reduced to a minimum and become insignificant to the total resistance of a circuit. With the same concept, current surges in electric motors can be held to minimum. Fig. C shows a typical DC motor's turn on surge before and after the application of a TP type thermistor to the circuit.

■ 簡介

TP 系列熱敏電阻器系由特殊配制的金屬氧化物陶瓷材料制成。它可用來抑制高的突波電流。相對於受保護電路，TP熱敏電阻器具有較高的電阻；因此會抑制突波電流約1~2秒，在這一段時間內TP的電阻將因溫度升高而下降，直至熱敏電阻兩端壓降到可被忽略的電阻值為止。如圖A以電源供應器為例，在電源開的瞬間，電容器一般阻抗極低，橋式整流器通常承受很大的電流，故TP系列熱敏電阻器特別適用於保護電源供應器。

■ 特質

- 有效抑制突波電流。
- 穩定狀態下功率損耗極小(通常僅有1W或小于50W)。
- 熱及電特性穩定性高。
- 寬廣的電性規格可供選擇。
- 使用特殊的塗裝材料：綠色矽膠

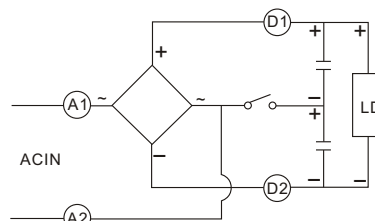


Fig.A

■ 應用概述

如圖B所示，將一NTC熱敏電阻與一白熱燈絲串聯時，可以消除突波電流。若一只NTC熱敏電阻無法提供足夠之突流限制功能時，二只或更多的熱敏電阻可用于串聯電路上或供應電路的各個分路上(如圖A)。但要注意的是NTC熱敏電阻，不可並聯於電路上，因為其中一只NTC就可能傳導幾乎所有的電流。TP系列熱敏電阻最好用于圖A所示AC電路的A1或A2處，或是DC電路D1或D2處。在設計上，當電路剛被打開的瞬間，NTC熱敏電阻的阻值高于電路上所有白熱燈絲的總電阻值。當電流開始通過時，熱敏電阻隨即產生「自熱」現象，并在1到2秒內，阻值會降到幾可忽略。以同樣的構想來看電動馬達的突波電流，亦可以被抑制到最低限度。圖C表示應用TP系列熱敏電阻保護直流馬達前后突波電流的差異。

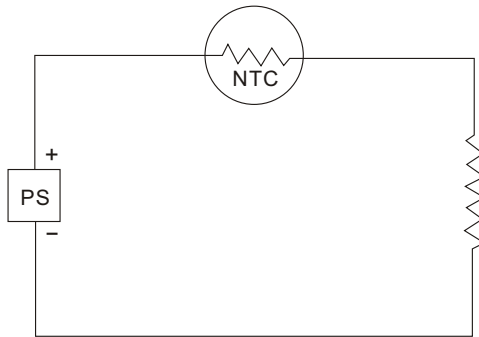


Fig.B

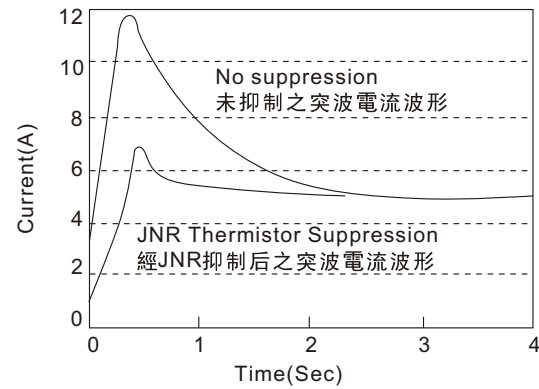


Fig.C

■NTC Thermistor Characteristics

To choose for application or take as referable parameters, the NTC thermistors are usually decided by the following three fundamental characteristics:

●Theperature-Resistance Characteristic:

The resistance value of NTC thermistor is decreased while the ambient temperature or itself temperature is increased. (See Fig.D)

■NTC熱敏電阻之特性

應用上NTC元件的參數，通常由下列三種基本特性決定：

●溫度-電阻特性：

當NTC熱敏電阻之環境溫度或它本身的溫度上升時，NTC的電阻值隨之減小(如圖D)。

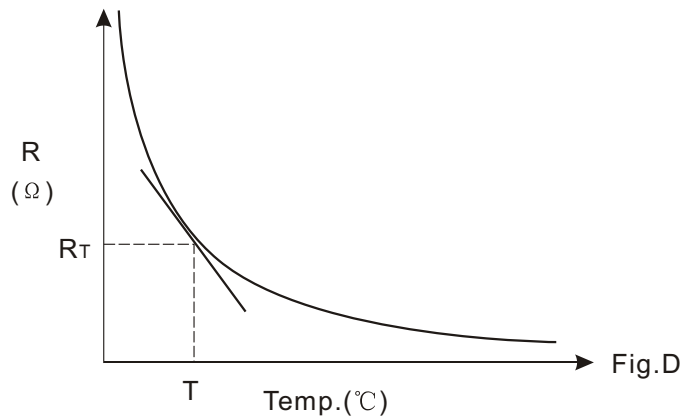


Fig.D

◎Nominal resistance at 25°C(Ω)

◎Zero-power resistance(Ω)

◎Tolerance on the resistance nominal
 $\Delta R_{25}/R_{25}=15\%(L), 20\%(M)$

◎Material constant(Sensibility index)(K)

◎Temperature coefficient of resistance(%°C)

R₂₅

R_T

B

at

* 25°C時之電阻值(Ω)

*零功率電阻值(Ω)

*電阻值之容許差 $\Delta R_{25}/R_{25}=15\%(L), 20\%(M)$

*材料常數(敏感度指數)(°K)

*電阻溫度係數(%°C)

R₂₅

R_T

B

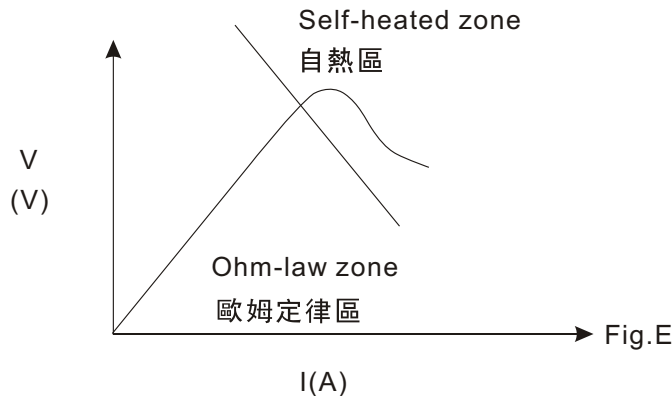
at

●Voltage-Current Characteristic:

When operating in small current(see Fig. E),due to very low pwer is unable to make the NTC thermistor self-heated, so its resistance value is thus maintained constant and displayed with a linear curve(in conformity with Ohm-law $V/R=I$).If the current is increased, the NTC thermistor will follow Joule-efficiency($P=V \times I$) and make itself self-heated that results in a resistance value decreasing and thus displays with a status of “Voltage descending while current increased.”

●電壓-電流特性:

當NTC熱敏電阻在小電流下工作時(如圖E),由于功率太低,其電阻值保持固定而表現綫性關係(符合歐姆定律 $V/R=I$)。如果電流增加,NTC熱敏電阻就會產生焦耳效應($P=V \times I$)而使自己發熱,其電阻值隨即減小表現「電流增加,電壓下降」的狀態。



- ◎Thermal dissipation coefficient($mW/^\circ C$)
- ◎Maximum steadystate current(A)
- ◎Resistance at maximum current(Ω)

δ
I_{max.}
R_{imax.}

- ◎熱散逸系數($mW/^\circ C$)
- ◎最大穩定電流(A)
- ◎最大電流時之電阻(Ω)

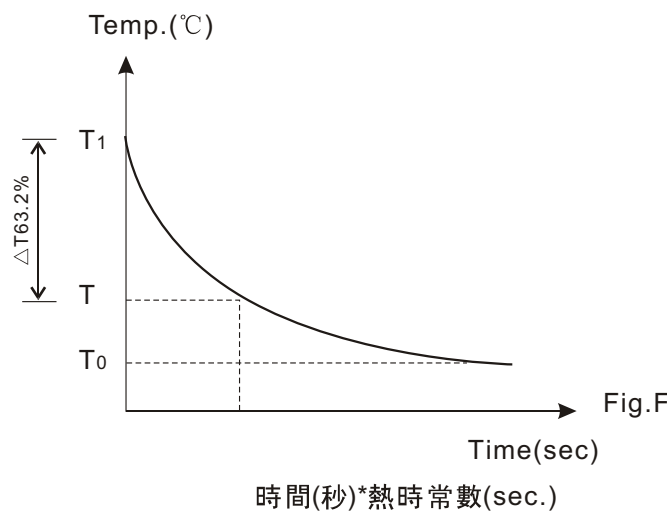
δ
I_{max.}
R_{imax.}

●Temperature-Time Characteristic:

As shown in Fig. F which explains the time needed to reach the thermal equilibrium of NTC components with the environment. This Characteristic depends on two important parameters. If a step change in temperature is applied to a component e.g. From high (T_1) to low (T_0) temperature, the energy lost by the component ($-HdT$) is equal to the energy dissipated by it ($\delta (T-T_0)dt$).
 $-Hdt = \delta (T-T_0)dt$
 This equation yields: $T_0 - T_1 = (T_0 - T_1) \times e^{-t/\tau}$, $\tau = H/\delta$

●溫度-時間特性:

(如圖F),說明NTC元件與環境達成熱平衡所需的時間。主要決定于材料熱容量(H)及散熱系數(δ)。當元件溫度由 T_1 降到 T_0 ,則可得到下列平衡式:
 $-Hdt = \delta (T-T_0)dt$ 其中 $-Hdt$ =元件熱損失
 $(\delta (T-T_0)dt)$: 元件散熱量
 積分后可得溫度與時間關係式: $T_0 - T_1 = (T_0 - T_1) \times e^{-t/\tau}$,
 其中 $\tau = H/\delta$



Parameters Definition

● Thermistor

A thermistor is a thermally sensitive resistor of which its primary function is to exhibit a change in resistance accompanying with a change in itself temperature.

● Negative temperature coefficient(NTC) thermistor

NTC thermistor is a thermistor of which the zero-power resistance decreases while itself temperature is increased.

● Inrush current

Inrush current is the initial surge of current that results when power is firstly applied to a load having a low starting impedance, such as a discharged capacitor, a cold lamp filament, or a stopped motor, etc.

● Inrush current limiter

Specially designed and constructed NTC thermistor may be used as an inrush current limiter. WMEC inrush current limiter(WTR) is available in a wide range of current handling and zero-power resistance value combinations.

● Zero-power resistance(R_0)

The zero-power resistance is the direct current resistance value of a thermistor measured at a specified temperature "T" with a power dissipation by the thermistor low enough that any further decrease in power will result in less than 0.1 percent change in resistance.

● Maximum steady-state current(I_{max})

The maximum steady-state current is the rating of the maximum current, normally expressed in amperes(A), allowable to be conducted by an inrush limiting NTC thermistor for an extended period of time.

● Resistance at maximum current($R_{I_{max}}$)

The resistance at maximum current is the approximate resistance of an inrush current limiting thermistor, expressed in ohms(Ω), when it is conducting its rated maximum steady-state current.

● Thermal dissipation coefficient(δ)

The thermal dissipation coefficient is the ratio, normally expressed in milliwatts per degree C($mW/^\circ C$), at a specified ambient temperature, of a change in power dissipation in a thermistor to the resultant body temperature change. ($\delta = VXI/\Delta T$)

● Thermal time constant(τ)

The thermal time constant is the time required for a thermistor to change 63.2 percent of total difference between its initial and final body temperature when subjected to a step function change in ambient temperature under zero-power condition and is normally expressed in second.

參數定義

● 熱敏電阻

熱敏電阻是一種對熱敏感的電阻器，其電阻值隨元件本身溫度變化而改變。

● 負溫度系數(NTC)熱敏電阻

NTC熱敏電阻是零功率電阻隨本身溫度上升而下降的電阻。

● 突波電流(沖擊電流)

譬如已放電的電容器，已冷卻的燈絲，或者一個靜止的馬達等等。有極低的起始阻抗，當負載的初期有較高的初始電流稱為沖擊電流。

● 突波電流抑制器

經過特殊設計和制造的NTC熱敏電阻就是一種突波電流抑制器。制造的突波電流抑制器(WTR)有寬廣的電流及零功率電阻範圍可供搭配選擇。

● 零功率電阻(R_0)

在特定溫度(T)下，熱敏電阻所消耗之功率極低時所量到的直流電阻值。該電功率消耗低到如果電功率的再次下降，電阻值變化率仍小於0.1%。

● 最大穩定電流(I_{max})

NTC熱敏電阻能允許長時間通過的最大電流值，通常以安培(A)表示。

● 最大電流電阻($R_{I_{max}}$)

NTC熱敏電阻通過額定最大穩定電流時的殘余電阻，以歐姆(Ω)表示。

● 熱散逸系數 (δ)

在一特定的環境溫度下，熱敏電阻電功率消耗對本體溫度變化量的比值，通常以 $mW/^\circ C$ 表示。

($\delta = VXI/\Delta T$)

● 熱時常數(τ)

在零功率條件下，熱敏電阻之溫度依照「步級函數」下降到其最初溫度與最終溫度差之63.2%時所需的時間，通常以秒數(Sec.)表示。參考(圖F)。

●Material constant(B)

The material constant of a NTC thermistor is a measure of its resistance at one temperature compared to its resistance at a different temperature. Its value may be calculated by the formula shown below and is expressed in degrees kelvin(^oK). The reference temperature used in this formula for determining material constant of WMEC thermistor is 298.15^oK and 323.^oK $B=Ln(R_1/R_2)/(-\frac{1}{T_1} - \frac{1}{T_2})$

●Temperature coefficient of resistance(α_T)

The temperature coefficient of resistance is the ratio at a specified temperature, T, of the rate of change of zero-power resistance with temperature to the zero-power resistance of the thermistor. The temperature coefficient is commonly expressed in percent per degree C (%/^oC) $\alpha = 1/R \cdot dR/dT$

●Surge energy:

Surge energy is the maximum energy of pulses The thermistor is capable of tolerating surge energy more than 1000 times with the resistance changing rate within $\pm 10\%$. This energy varies with voltage and capacitance.

●材料常數(B)

材料常數又稱貝他常數，即NTC熱敏電阻在某一溫度之電阻與另一溫度之電阻的比較值，可由下面的公式計算得到，並以卡氏溫度 (K) 表示之。
 $B=Ln(R_1/R_2)/(-\frac{1}{T_1} - \frac{1}{T_2})$

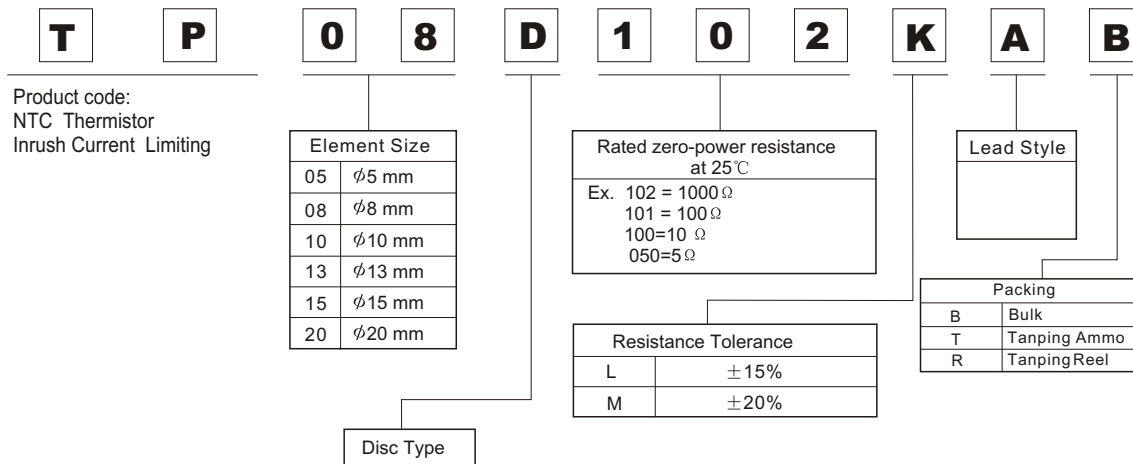
●電阻之溫度系數(α_T)

熱敏電阻在某一特定溫度(T),零功率電阻對溫度變化率及零功率電阻之比值，通常以(%/^oC)表示。
 $\alpha = 1/R \cdot dR/dT$

●突波能量:

熱敏電阻能承受最少1000次而電阻變化率在 $\pm 10\%$ 以內之突波能量。此能量與所加之電壓及電容值有關。可經由V-1圖形積分而得。

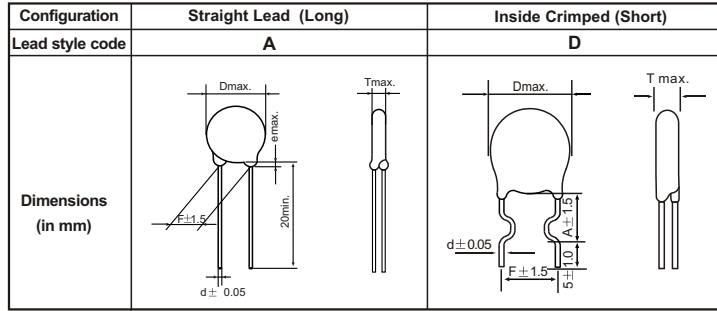
■ Explanation of part Numbers



05D Series



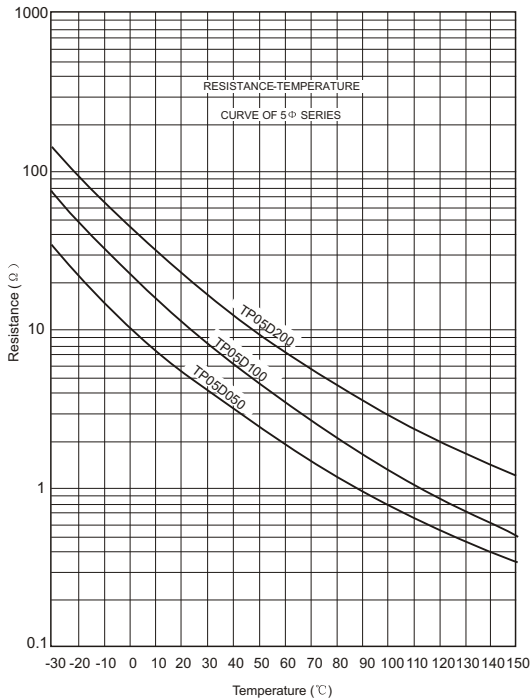
Dimensions



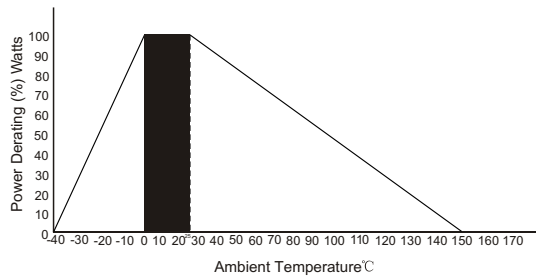
Specification

Part No.	Zero Power Rated Resistance at (25°C) (Ω)	Max. steady State Current at (25°C) (A)	Approx. Resistance at Max. Current at (25°C) (Ω)	Thermal Dissipation Constant mW/°C	Thermal Time Constant (S)	Operating Temperature °C	Dimensions (Unit: mm)			
							D (Max)	F ± 1.5	T (Max)	∅ d ± 0.05
TP05D050	5	2	0.429	14	18	-40 ~ +150	8.0	5.0	5.0	0.6
TP05D080	8	1	0.485	14	18	-40 ~ +150	8.0	5.0	5.0	0.6
TP05D100	10	1	0.694	14	22	-40 ~ +150	8.0	5.0	5.0	0.6
TP05D120	12	0.7	0.734	14	23	-40 ~ +150	8.0	5.0	5.0	0.6
TP05D160	16	0.7	0.903	14	23	-40 ~ +150	8.0	5.0	5.0	0.6
TP05D200	20	0.3	0.997	14	23	-40 ~ +150	8.0	5.0	5.0	0.6

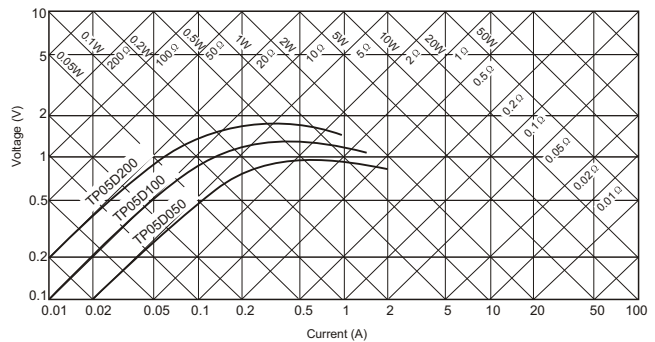
Resistance vs. Temperature Characteristic



Power Derating Curve



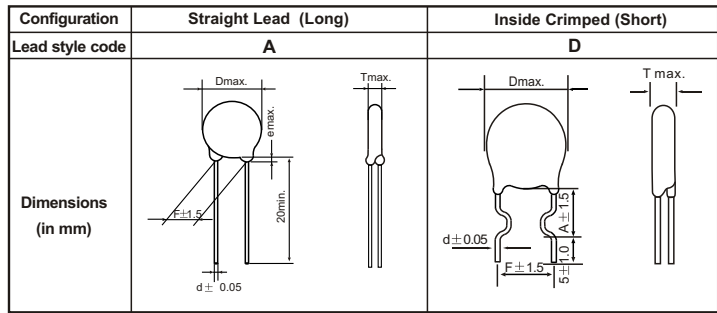
Current vs. Voltage Characteristic



08D Series



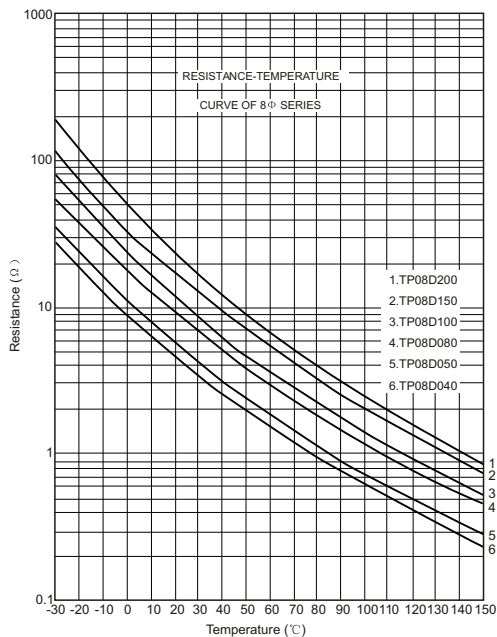
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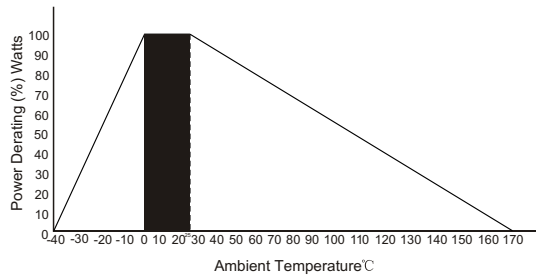
Specification

Part No.	Zero Power Rated Resistance at (25°C)	Max. steady State Current at (25°C)	Approx. Resistance at Max. Current at (25°C)	Thermal Dissipation Constant	Thermal Time Constant	Operating Temperature	Dimensions(Unit:mm)			
							D	F	T	∅ d
	(Ω)	(A)	(Ω)	mW/°C	(S)	°C	(Max)	±1.5	(Max)	±0.05
TP08D030	3	4	0.230	15	28	-40 ~ +170	10	5.0	5.0	0.6
TP08D040	4	3	0.237	15	28	-40 ~ +170	10	5.0	5.0	0.6
TP08D050	5	3	0.227	15	28	-40 ~ +170	10	5.0	5.0	0.6
TP08D060	6	3	0.234	15	29	-40 ~ +170	10	5.0	5.0	0.6
TP08D080	8	2	0.360	15	28	-40 ~ +170	10	5.0	5.0	0.6
TP08D100	10	2	0.412	15	30	-40 ~ +170	10	5.0	5.0	0.6
TP08D120	12	2	0.587	15	30	-40 ~ +170	10	5.0	5.0	0.6
TP08D160	15	2	0.722	15	30	-40 ~ +170	10	5.0	5.0	0.6
TP08D200	20	1	0.724	15	31	-40 ~ +170	10	5.0	5.0	0.6
TP08D220	22	1	0.855	15	30	-40 ~ +170	10	5.0	5.0	0.6
TP08D300	30	1	0.920	15	30	-40 ~ +170	10	5.0	5.0	0.6
TP08D330	33	1	1.012	15	31	-40 ~ +170	10	5.0	5.0	0.6
TP08D500	50	1	1.250	15	31	-40 ~ +170	10	5.0	5.0	0.6

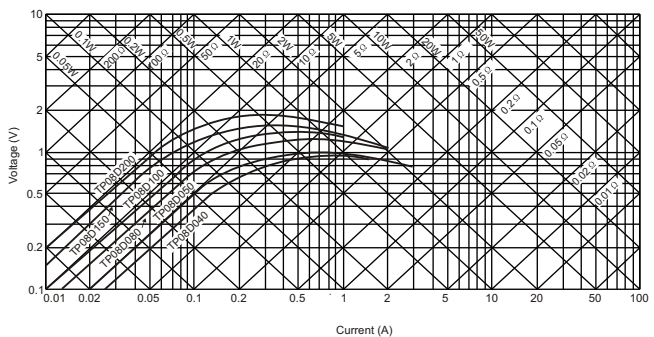
Resistance vs. Temperature Characteristic



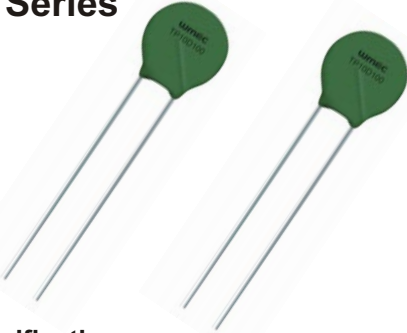
Power Derating Curve



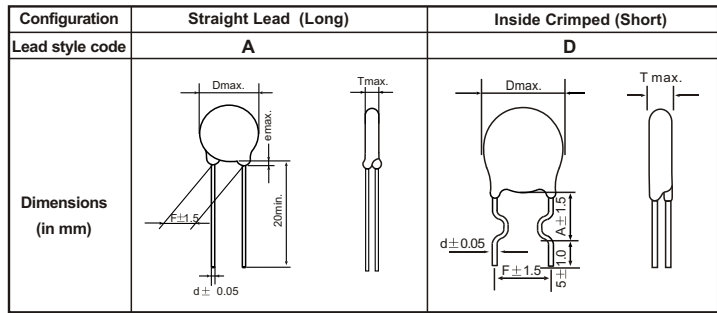
Current vs. Voltage Characteristic



10D Series



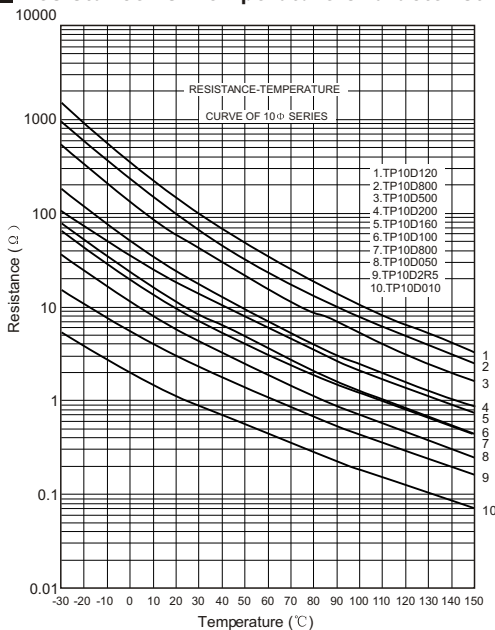
■ Dimensions



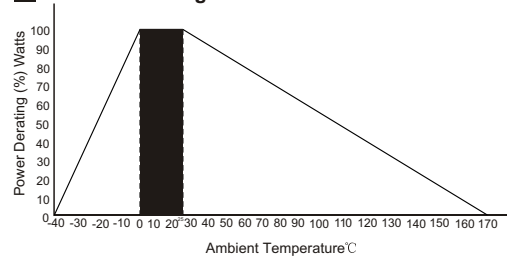
■ Specification

Part No.	Zero Power Rated Resistance at (25°C)	Max. steady State Current at (25°C)	Approx. Resistance at Max. Current at (25°C)	Thermal Dissipation Constant	Thermal Time Constant	Operating Temperature	Dimensions(Unit:mm)			
	(Ω)	(A)	(Ω)	mW/°C	(S)	°C	D (Max)	F ±1.5	T (Max)	∅d ±0.05
TP10D010	1	5.0	0.090	17	37	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D1R5	1.5	5.0	0.101	17	37	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D2R5	2.5	5.0	0.120	18	43	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D030	3	5.0	0.119	18	43	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D040	4	4.0	0.163	16	45	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D050	5	4.0	0.180	17	45	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D060	6	3.0	0.250	17	45	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D070	7	3.0	0.290	17	45	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D080	8	3.0	0.303	17	43	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D100	10	3.0	0.270	17	45	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D120	12	2.0	0.340	18	48	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D160	16	2.0	0.40	18	50	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D200	20	2.0	0.615	17	53	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D250	25	2.0	0.635	17	53	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D300	30	2.0	0.700	17	53	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D500	50	2.0	0.708	18	47	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D600	60	1.5	1.094	18	50	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D800	80	1.2	1.742	17	50	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8
TP10D120	120	1.0	2.335	19	50	-40 ~+170	12.5	5.0/7.5	5.0	0.6/0.8

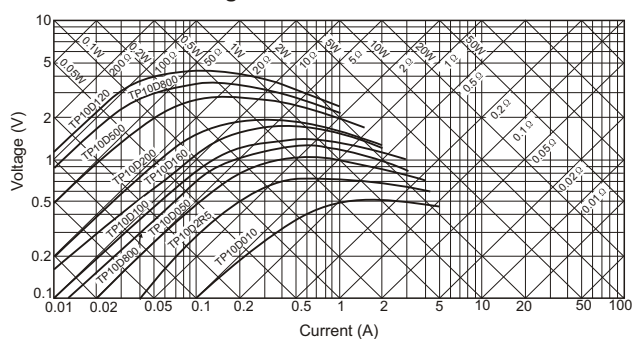
■ Resistance vs. Temperature Characteristic



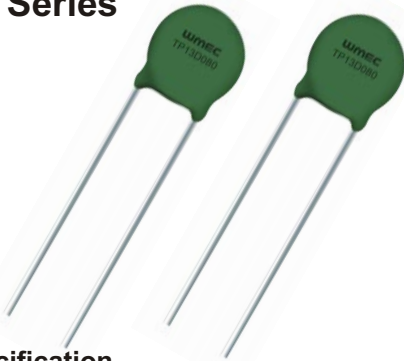
■ Power Derating Curve



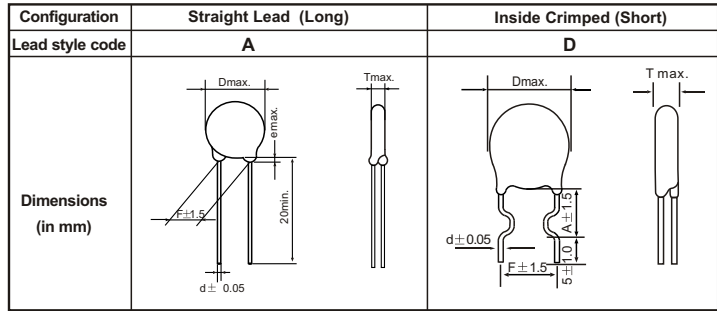
■ Current vs. Voltage Characteristic



13D Series



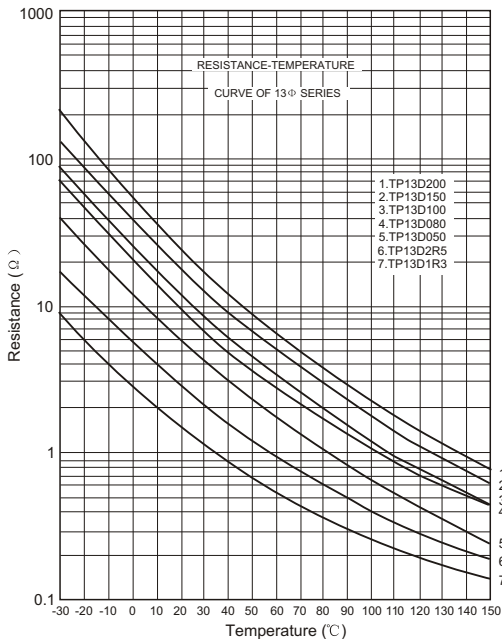
Dimensions



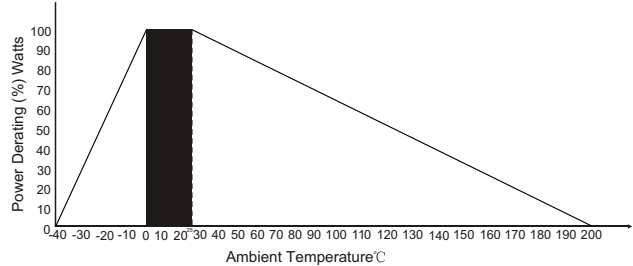
Specification

Part No.	Zero Power Rated Resistance at (25°C)	Max. steady State Current at (25°C)	Approx. Resistance at Max. Current at (25°C)	Thermal Dissipation Constant	Thermal Time Constant	Operating Temperature	Dimensions(Unit:mm)			
	(Ω)	(A)	(Ω)	mW/°C	(S)	°C	D (Max)	F ± 1.5	T (Max)	ϕ d ± 0.05
TP13D1R3	1.3	7	0.056	18	60	-40 ~ +200	15	7.5	6.0	0.8
TP13D1R5	1.5	7	0.066	18	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D2R5	2.5	6	0.079	18	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D030	3	6	0.083	18	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D040	4	5	0.108	20	63	-40 ~ +200	15	7.5	6.0	0.8
TP13D050	5	5	0.113	20	64	-40 ~ +200	15	7.5	6.0	0.8
TP13D060	6	4	0.153	20	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D070	7	4	0.169	20	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D080	8	4	0.175	20	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D100	10	4	0.185	20	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D120	12	4	0.284	21	63	-40 ~ +200	15	7.5	6.0	0.8
TP13D150	15	3	0.303	21	63	-40 ~ +200	15	7.5	6.0	0.8
TP13D160	16	3	0.304	21	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D200	20	3	0.335	21	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D300	30	2.5	0.465	21	62	-40 ~ +200	15	7.5	6.0	0.8
TP13D470	47	2.0	0.729	21	63	-40 ~ +200	15	7.5	6.0	0.8
TP13D121	120	1.5	1.912	21	63	-40 ~ +200	15	7.5	6.0	0.8

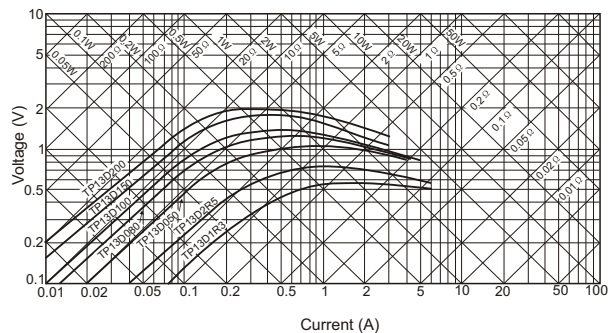
Resistance vs. Temperature Characteristic



Power Derating Curve



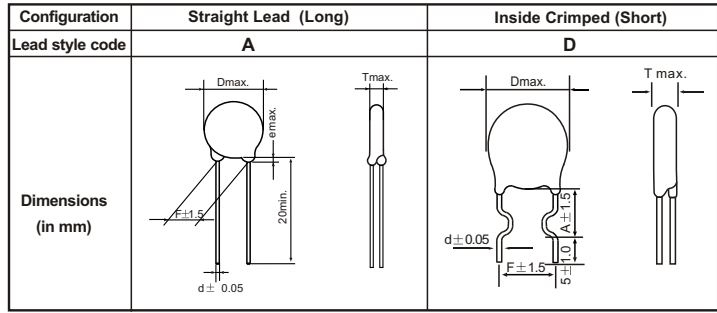
Current vs. Voltage Characteristic



15D Series



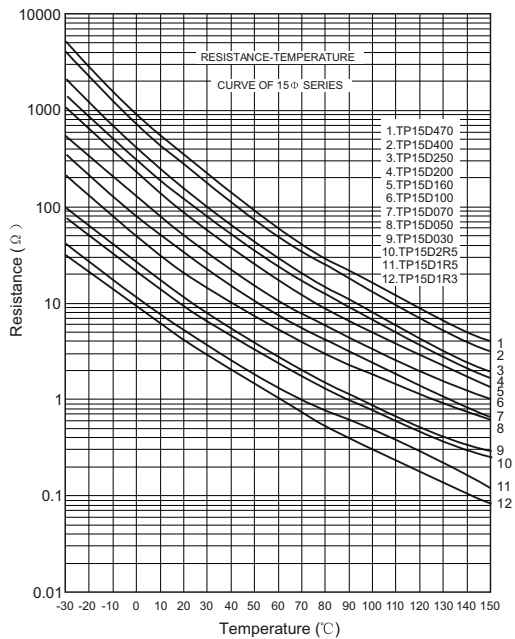
Dimensions



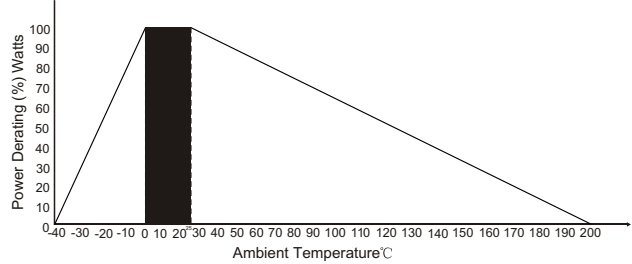
Specification

Part No.	Zero Power Rated Resistance at (25°C)	Max. steady State Current at (25°C)	Approx. Resistance at Max. Current at (25°C)	Thermal Dissipation Constant	Thermal Time Constant	Operating Temperature	Dimensions(Unit:mm)			
							D	F	T	∅d
	(Ω)	(A)	(Ω)	mW/°C	(S)	°C	(Max)	±1.5	(Max)	±0.05
TP15D1R3	1.3	8	0.043	25	76	-40 ~+200	17.5	7.5	6.0	0.8
TP15D1R5	1.5	8	0.067	25	76	-40 ~+200	17.5	7.5	6.0	0.8
TP15D2R5	2.5	8	0.068	25	76	-40 ~+200	17.5	7.5	6.0	0.8
TP15D030	3	7	0.101	25	80	-40 ~+200	17.5	7.5	6.0	0.8
TP15D040	4	6	0.140	25	81	-40 ~+200	17.5	7.5	6.0	0.8
TP15D050	5	6	0.156	25	82	-40 ~+200	17.5	7.5	6.0	0.8
TP15D060	6	5	0.140	25	82	-40 ~+200	17.5	7.5	6.0	0.8
TP15D070	7	5	0.156	25	80	-40 ~+200	17.5	7.5	6.0	0.8
TP15D080	8	5	0.160	25	78	-40 ~+200	17.5	7.5	6.0	0.8
TP15D100	10	5	0.162	25	75	-40 ~+200	17.5	7.5	6.0	0.8
TP15D120	12	4	0.225	25	84	-40 ~+200	17.5	7.5	6.0	0.8
TP15D150	15	4	0.234	25	83	-40 ~+200	17.5	7.5	6.0	0.8
TP15D160	16	4	0.248	25	83	-40 ~+200	17.5	7.5	6.0	0.8
TP15D200	20	4	0.259	25	83	-40 ~+200	17.5	7.5	6.0	0.8
TP15D250	25	3	0.394	25	83	-40 ~+200	17.5	7.5	6.0	0.8
TP15D400	40	3	0.496	25	84	-40 ~+200	17.5	7.5	6.0	0.8
TP15D470	47	3	0.517	25	84	-40 ~+200	17.5	7.5	6.0	0.8
TP15D800	80	2.5	0.718	25	84	-40 ~+200	17.5	7.5	6.0	0.8
TP15D121	120	2	1.159	25	85	-40 ~+200	17.5	7.5	6.0	0.8

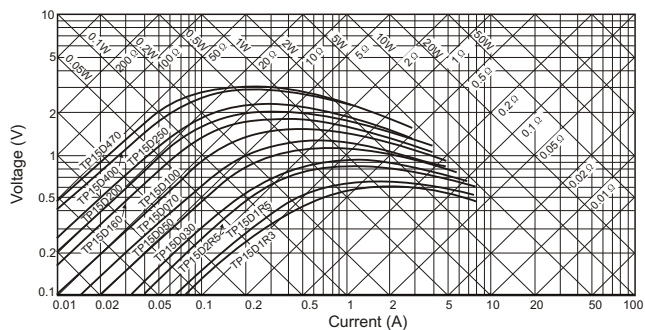
Resistance vs. Temperature Characteristic



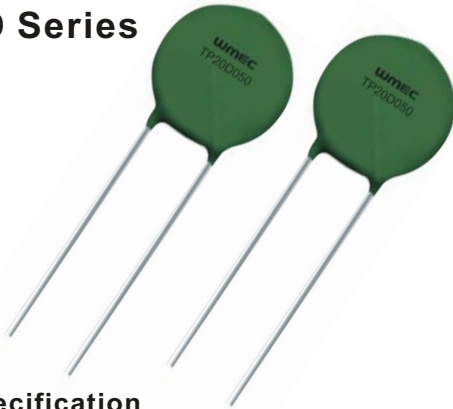
Power Derating Curve



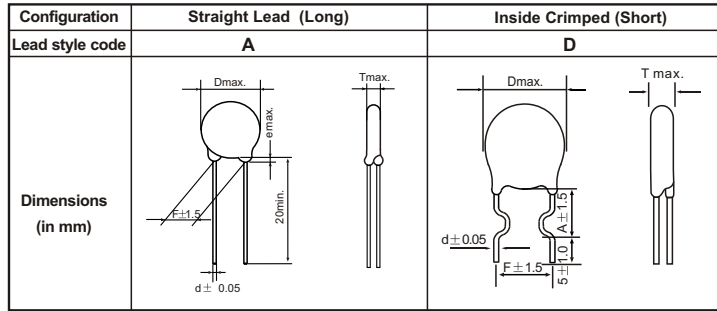
Current vs. Voltage Characteristic



20D Series



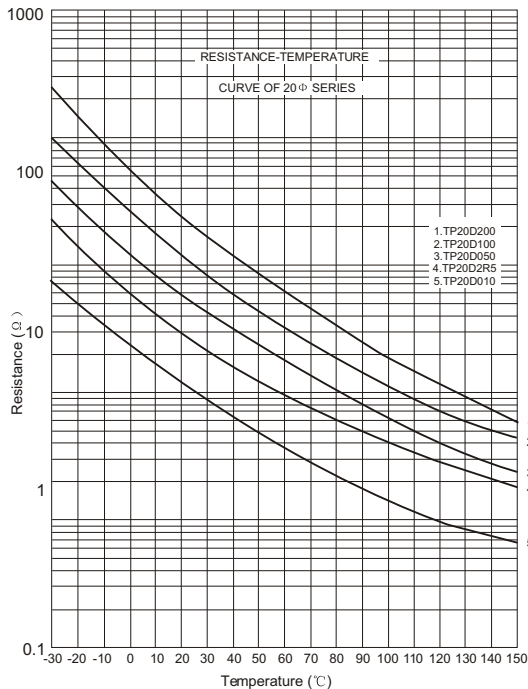
Dimensions



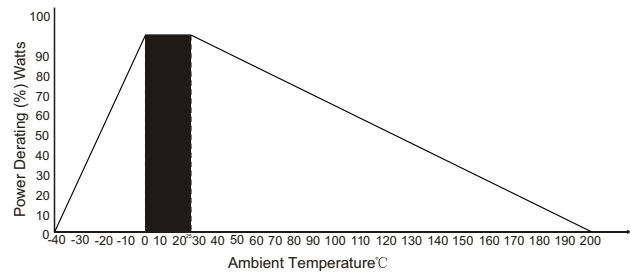
Specification

Part No.	Zero Power Rated Resistance at (25°C)	Max. steady State Current at (25°C)	Approx. Resistance at Max. Current at (25°C)	Thermal Dissipation Constant	Thermal Time Constant	Operating Temperature	Dimensions(Unit:mm)			
							D	F	T	ød
	(Ω)	(A)	(Ω)	mW/°C	(S)	°C	(Max)	±1.5	(Max)	±0.05
TP20D0R7	0.7	12	0.020	31	85	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D1R3	1.3	9	0.033	31	104	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D020	2	8	0.043	31	104	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D2R5	2.5	8	0.046	31	118	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D030	3	8	0.049	31	102	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D040	4	8	0.076	31	103	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D050	5	7	0.078	30	103	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D060	6	6	0.102	30	100	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D070	7	6	0.125	30	102	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D080	8	6	0.128	30	97	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D100	10	6	0.146	30	97	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D120	12	5	0.176	30	98	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D150	15	5	0.190	30	98	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D160	16	5	0.191	30	98	-40 ~+200	23	7.5/10	6.0	0.8/1.0
TP20D200	20	6	0.191	30	107	-40 ~+200	23	7.5/10	6.0	0.8/1.0

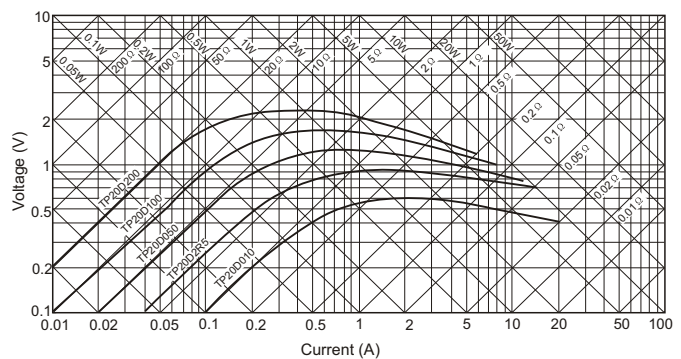
Resistance vs. Temperature Characteristic



Power Derating Curve



Current vs. Voltage Characteristic



NTC Thermistor of Temperature Measurement

溫度補償用熱敏電阻器

TM Type

Application

Temperature compensation
Temperature measurement
Temperature control

Features

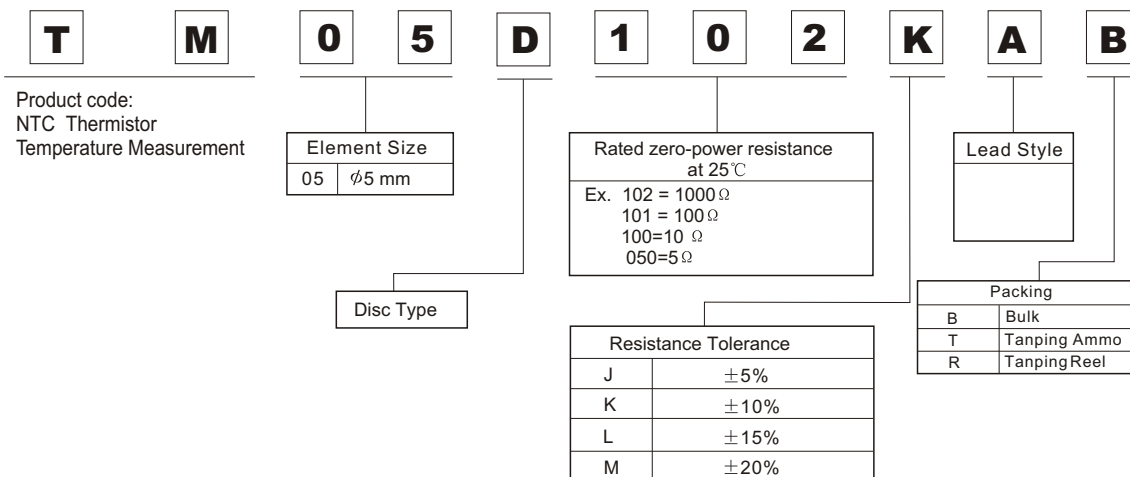
Wide resistance range
Cost-effective
Lacquer-coated thermistor disk
Tinned copper leads
Lead spacing 5.0 mm
Marked with resistance and tolerance



Dimensions

Configuration	Straight Lead (Long)	Inside Crimped (Short)
Lead style code	A	D
Dimensions (in mm)		

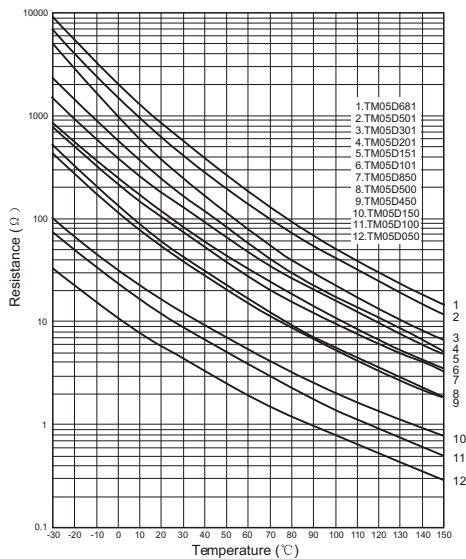
Explanation of part Numbers



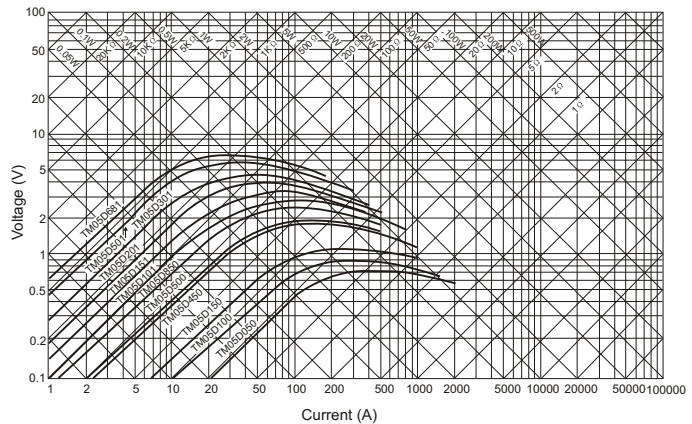
■ Specification

Part No.	Zero Power Rated Resistance at (25°C)	B-Constance	Max. Permissible Current at (25°C)	Thermal Dissipation Constant	Thermal Time Constant	Operating Temperature
	(Ω)		(mA)			
TM05D030	3	2200	770	9	16	-30~+125
TM05D050	5	2400	610	9	16	-30~+125
TM05D070	7	2500	570	9	19	-30~+125
TM05D100	10	2600	450	9	22	-30~+125
TM05D150	15	2800	250	8	19	-30~+125
TM05D200	20	2800	250	9	25	-30~+125
TM05D250	25	2900	250	8	19	-30~+125
TM05D400	40	3100	250	9	21	-30~+125
TM05D450	45	3100	250	9	23	-30~+125
TM05D500	50	3100	250	9	19	-30~+125
TM05D600	60	3100	220	9	21	-30~+125
TM05D850	85	3100	180	9	22	-30~+125
TM05D101	100	3100	170	9	19	-30~+125
TM05D121	120	3100	145	8	20	-30~+125
TM05D131	130	3300	140	8	17	-30~+125
TM05D151	150	3200	140	9	19	-30~+125
TM05D181	180	3500	135	8	20	-30~+125
TM05D201	200	3500	130	9	17	-30~+125
TM05D221	220	3500	125	9	20	-30~+125
TM05D251	250	3500	120	9	21	-30~+125
TM05D301	300	3500	150	9	22	-30~+125
TM05D351	350	3500	100	9	22	-30~+125
TM05D471	470	3500	95	9	28	-30~+125
TM05D501	500	3800	95	9	22	-30~+125
TM05D681	680	3800	75	9	18	-30~+125
TM05D701	700	3800	75	8	17	-30~+125
TM05D901	900	3800	70	9	22	-30~+125
TM05D102	1000	3800	70	9	22	-30~+125
TM05D152	1500	3900	55	8	22	-30~+125

■ Resistance vs. Temperature Characteristic



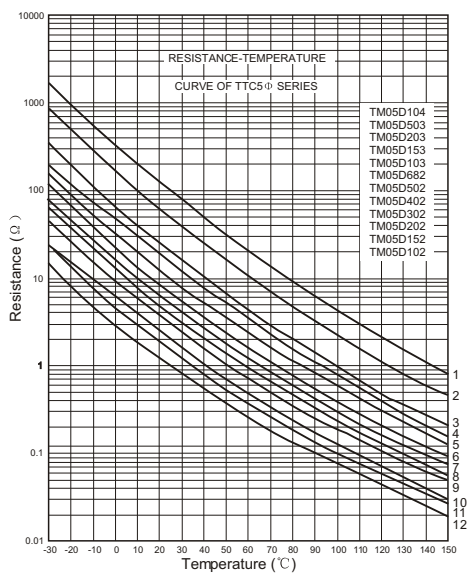
■ Current vs. Voltage Characteristic



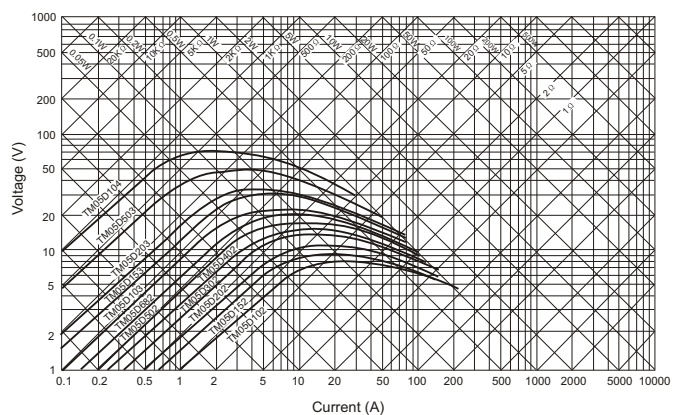
■ Specification

Part No.	Zero Power Rated Resistance at (25°C)	B-Constance	Max. Permissible Current at (25°C)	Thermal Dissipation Constant	Thermal Time Constant	Operating Temperature
	(Ω)		(mA)			
TM05D192	1900	3900	55	9	22	-30~+125
TM05D202	2000	3900	50	9	21	-30~+125
TM05D222	2200	4000	50	9	21	-30~+125
TM05D252	2500	4000	50	9	21	-30~+125
TM05D302	3000	4000	40	9	20	-30~+125
TM05D332	3300	4000	35	9	19	-30~+125
TM05D352	3500	4000	35	9	16	-30~+125
TM05D402	4000	4000	35	8	20	-30~+125
TM05D472	4700	4000	30	8	21	-30~+125
TM05D502	5000	3950	30	9	21	-30~+125
TM05D602	6000	4050	30	8	22	-30~+125
TM05D682	6800	4000	25	9	20	-30~+125
TM05D802	8000	4050	25	8	23	-30~+125
TM05D103	10000	4050	20	8	21	-30~+125
TM05D123	12000	4050	20	8	18	-30~+125
TM05D153	15000	4150	20	9	22	-30~+125
TM05D203	20000	4250	20	9	23	-30~+125
TM05D253	25000	4250	20	9	25	-30~+125
TM05D303	30000	4250	15	9	26	-30~+125
TM05D403	40000	4250	15	9	20	-30~+125
TM05D473	47000	4300	15	9	20	-30~+125
TM05D503	50000	4300	10	9	17	-30~+125
TM05D683	68000	4300	10	10	17	-30~+125
TM05D104	100000	4400	10	8	24	-30~+125
TM05D154	150000	4500	5	8	17	-30~+125
TM05D204	200000	4600	5	9	15	-30~+125
TM05D334	330000	4600	4	9	16	-30~+125
TM05D404	400000	4600	4	8	15	-30~+125
TM05D474	470000	4600	3	9	14	-30~+125

■ Resistance vs. Temperature Characteristic



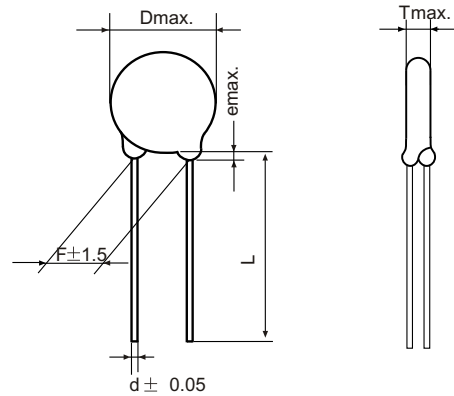
■ Current vs. Voltage Characteristic



Available Standard Lead Configurations

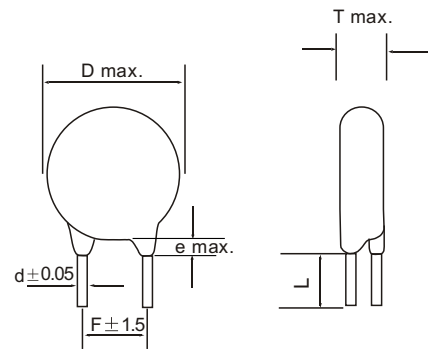
Type 1- Straight long leads (Lead style code : A)

Lead code	A1	A2	A3	A4	A5
F	2.5	5	7.5	10	12.5
L	20 mm min				
d	0.5 or 0.6 or 0.8				
e	Max. 4.0mm				



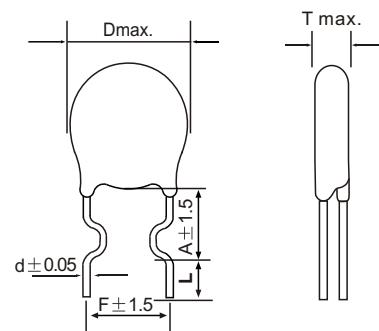
Type 2- Straight short leads (Lead style code : B)

Lead code	B1	B2	B3	B4	B5
F	2.5	5	7.5	10	12.5
L	5 ± 1 mm				
d	0.5 or 0.6 or 0.8				
e	Max. 3.0mm				



Type 3 - inside crimped short lead (Lead style code : C)

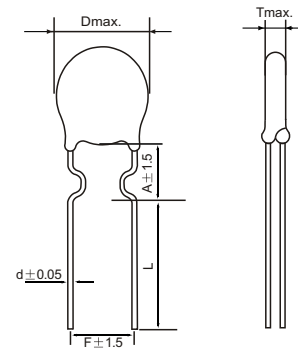
Lead code	C2	C3	C4	C5
F	5	7.5	10	12.5
A	4 ± 1.5	4 ± 1.5	5 ± 1.5	6 ± 1.5
L	5 ± 1 mm			
d	0.5 or 0.6 or 0.8			



Available Standard Lead Configurations

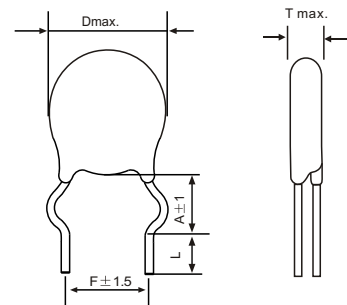
Type 4 - inside crimped long lead (Lead style code : D)

Lead code	D2	D3	D4	D5
F	5	7.5	10	12.5
A	4 ± 1.5	4 ± 1.5	5 ± 1.5	6 ± 1.5
L	20 mm min			
d	0.5 or 0.6 or 0.8			



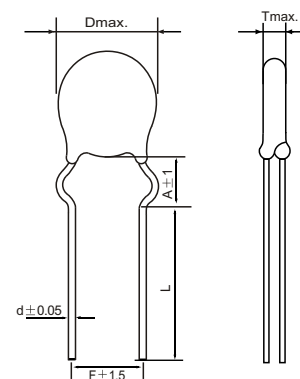
Type 5- Outside crimped short lead (Lead style code : E)

Lead code	E2	E3	E4	E5
F	5	7.5	10	12.5
A	4 ± 1.5	4 ± 1.5	5 ± 1.5	6 ± 1.5
L	5 ± 1 mm			
d	0.5 or 0.6 or 0.8			



Type 5- Outside crimped Long lead (Lead style code : F)

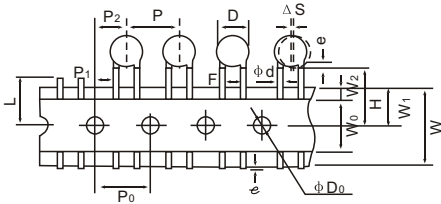
Lead code	D2	D3	D4	D5
F	5	7.5	10	12.5
A	4 ± 1.5	4 ± 1.5	5 ± 1.5	6 ± 1.5
L	20 mm min			
d	0.5 or 0.6 or 0.8			



■ Taping Specification

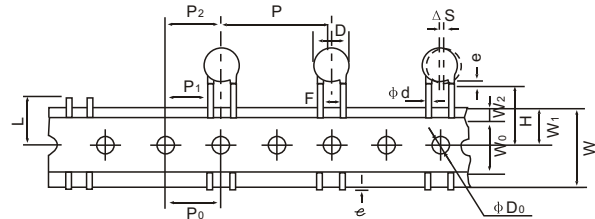
● Straight leads

A2 : 12.7mm pitch/ lead spacing 5 mm taping



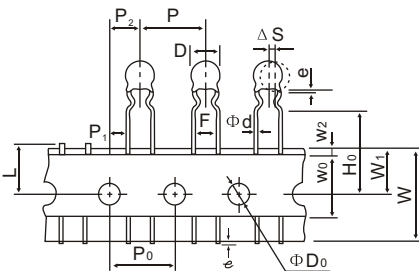
● Straight leads

A3, A4: 25.4mm pitch/ lead spacing 7.5,10 mm taping



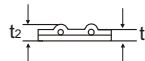
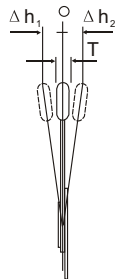
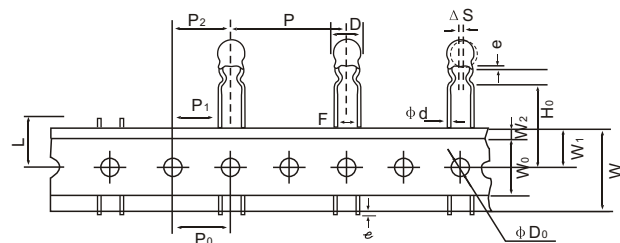
● Inside crimped leads

D2 : 12.7mm pitch/ lead spacing 5 mm taping



● Inside crimped leads

D3, D4: 25.4mm pitch/ lead spacing 7.5,10 mm taping



Item	Code	A2	A3	A4	D2	D3	D4
Pitch of component	P	12.7	25.4	25.4	12.7	25.4	25.4
Pitch of sprocket hole	P ₀	12.7±0.3	12.7±0.3	12.7±0.3	12.7±0.3	12.7±0.3	12.7±0.3
Lead spacing	F	5.0 ^{+0.8} _{-0.2}	7.5±1.0	10±1.0	5.0 ^{+0.8} _{-0.2}	7.5±1.0	10±1.0
Length from hole center to component center	P ₂	6.35±1.3	12.7±1.3	12.7±1.3	6.35±1.3	12.7±1.3	12.7±1.3
Length from hole center to lead	P ₁	3.85±0.7	8.95±1.0	7.7±1.0	3.85±0.7	8.95±1.0	7.7±1.0
Body diameter	D	See the individual product specification					
Deviation along tape, left or right	ΔS	0±2.0					
Carrier tape width	W	18.0±0.5					
Position of sprocket hole	W ₁	9.0±0.5					
Lead distance between reference and bottom planes	H	20.0±1.5			—		
	H ₀	—			16.0±0.5		
Protrusion length	e	+0.5 to -1.0					
Diameter of sprocket hole	φD ₀	4.0±0.2					
Lead diameter	φd	0.6±0.05					
Total tape thickness	t ₁	0.6±0.3					
Total thickness, tape and lead wire	t ₂	2.0 max.					
Body thickness	T	See the individual product specification					
Portion to cut in case of defect	L	11.0 max.					
Hold down tape width	W ₀	11.5 min.					
Hold down tape position	W ₂	1.5±1.5					
Coating extension on lead	E	3.0 max.			Up to the end of crimp)		
Deviation across tape	Δh ₁	2.0 max.					
	Δh ₂						

(in mm)

