

NTC THERMISTOR-INRUSH CURRENT LIMITING DEVICES

Joyin NTC Thermistor(JNR)devices are made of a specially formulated metal oxide ceramic material which is capable of suppressing high inrush current surges.

JNR devices,being of relatively high resistance,shall limit the inrush current for 1~2 seconds during which time the device decreased 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.

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 can not be used in parallel since one unit will tend to conduct nearly all the current available.Thus,JNR 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 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 JNR thermistor to the circuit.

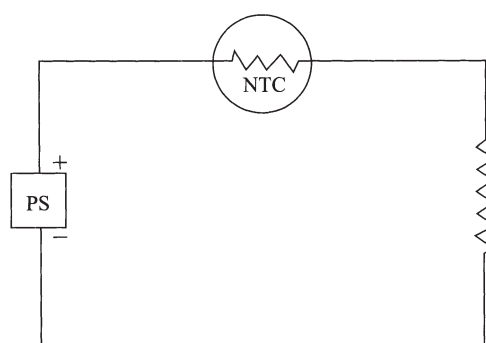


Fig.B

NTC THERMISTOR CHARACTERISTICS

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

Temperature-Resistance Characteristic:

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

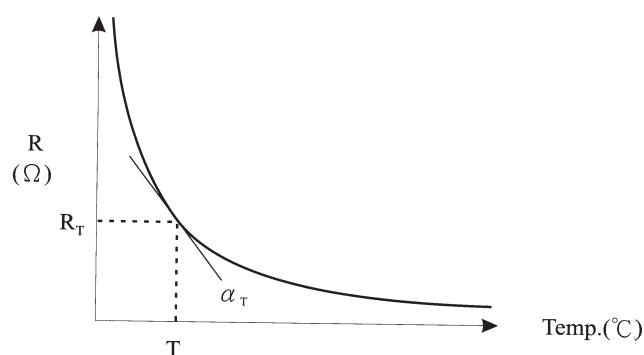
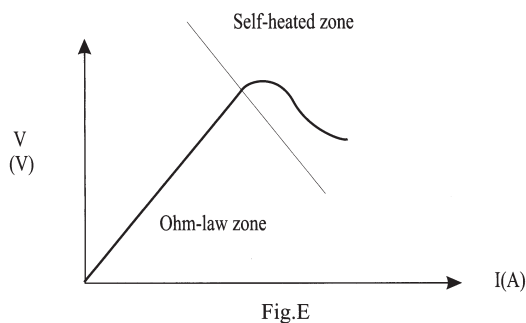


Fig.D

- Nominal resistance at 25°C (Ω) R_{25}
- Zero-power resistance (Ω) R_T
- Tolerance on the resistance nominal
 $\Delta R_{25}/R_{25}=15\%(L), 20\%(M)$
- Material constant (Sensitivity index) ($^{\circ}\text{K}$) β
- Temperature coefficient of resistance ($\%/^{\circ}\text{C}$) α_T

Voltage-Current Characteristic:

When operating in small current(see fig.E),due to very low power 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."



- Thermal dissipation coefficient($\text{mW}/^{\circ}\text{C}$) δ
- Maximum steady-state current(A) I_{max} .
- Resistance at maximum current(Ω) $R_{I_{\text{max}}}$.

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 ($\delta (T-T_0)dt$) by the component ($-HdT$)is equal to the energy dissipated by it.

$$-HdT = \delta (T-T_0)dt$$

This equation yields: $T-T_1=(T_0-T_1) \times e^{-t/\tau}$, $\tau = H/\delta$

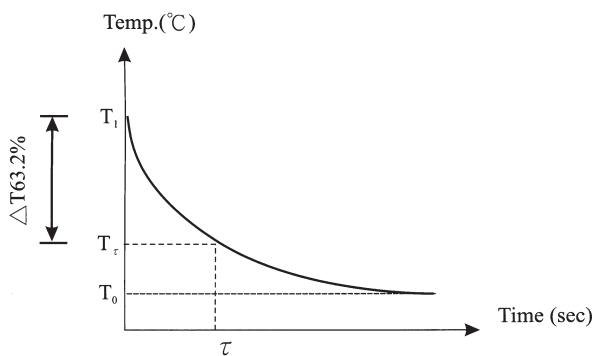
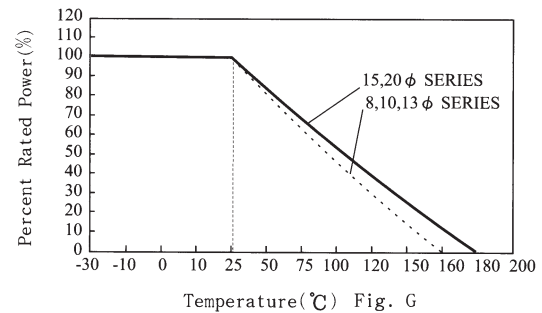


Fig.F

DERATING CURVE OF SURGE CURRENT LIMITING THERMISTOR

The maximum power of thermistor will decrease with the change of ambient temperature.

(See Fig.G)



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.JOYIN inrush current limiter(JNR)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($R_{I_{\text{max}}}$.)

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($\text{mW}/^\circ\text{C}$), at a specified ambient temperature, of a change in power dissipation in a thermistor to the resultant body temperature change. ($\delta = \Delta P / \Delta T$)

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.

Material constant(β)

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($^\circ\text{K}$). The reference temperature used in this formula for determining material constant rating of JOYIN thermistor is 298.15°K and 323.15°K . $\beta = \ln(R_1/R_2) / (\frac{1}{T_1} - \frac{1}{T_2})$

Temperature coefficient of resistance(α)

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($\%/^\circ\text{C}$). $\alpha = 1/R \cdot dR/dT$

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 range within $\pm 10\%$. This energy varies with voltage and capacitance.

Storage temperature range: -40 to $+125^\circ\text{C}$

Operating temperature range: -30 to $+125^\circ\text{C}$

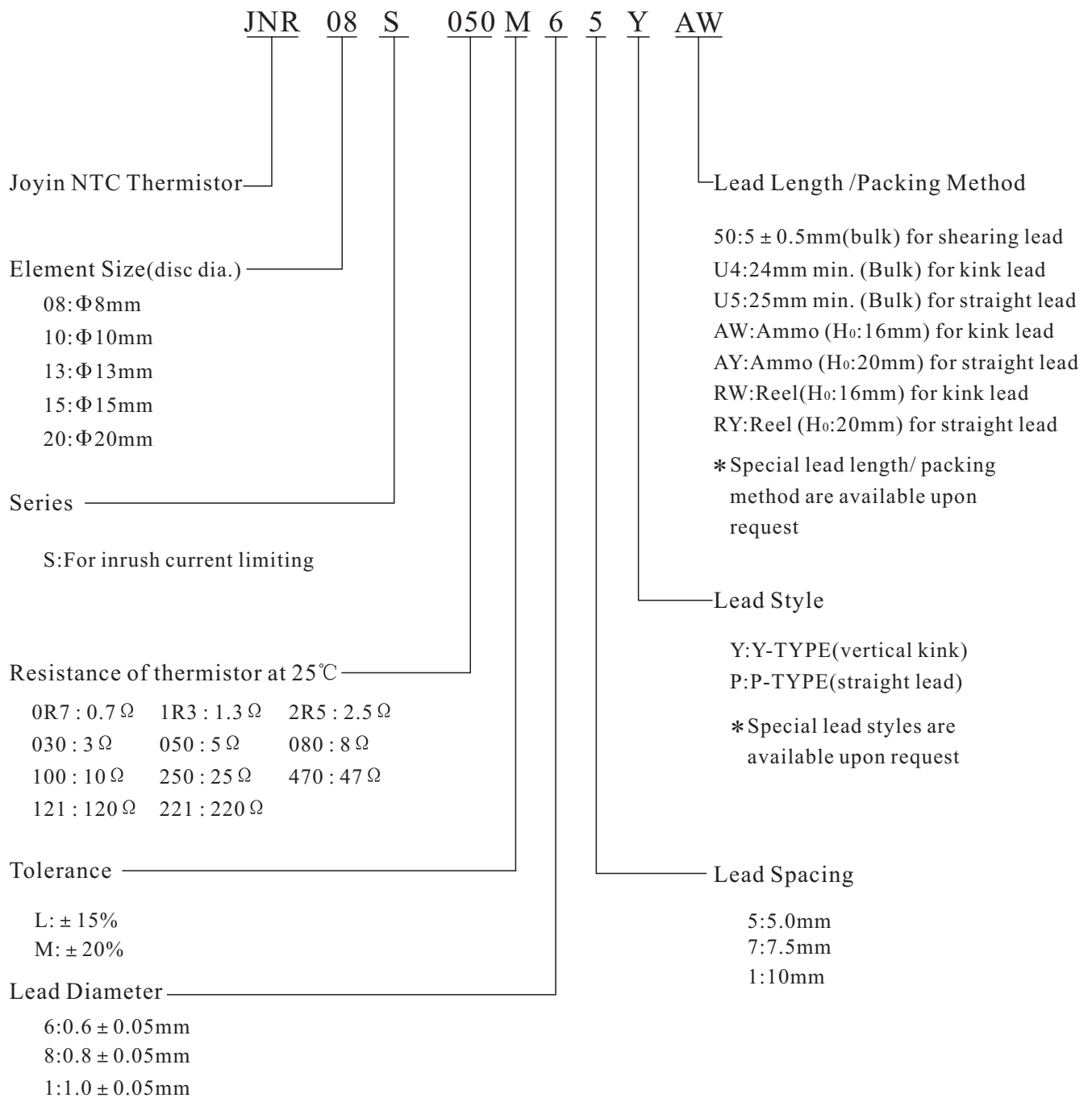
NOTE: "WARNING"

- The JNR thermistor shall not be touched by hand at the large power consumption for preventing burns.
- The JNR thermistor shall not be operated beyond the specified "Maximum Current" in the catalog.
- The JNR thermistor shall not be operated and stored under following environmental condition.
- a. To be exposed directly to water or drop of water.
- b. To be exposed directly to oil, gasoline or organic

solvent and/or atmospheres of them.

c. Under condition of deoxidized or corrosive atmospheres such as chlorine, hydrogen sulfide, sulphur oxide and cracked gas from vinyl chloride.....etc.

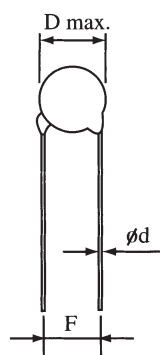
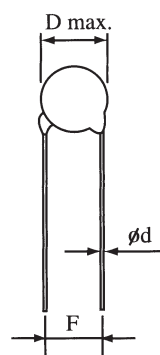
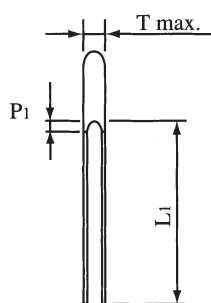
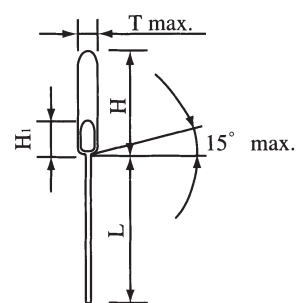
HOW TO ORDER BY PART NUMBER:



Dimension Table

unit:mm

| Diameter | 8Φ | 10Φ | 13Φ | 15Φ | 20Φ |
|----------|------|---------|------|------|----------|
| D max | 10 | 12 | 15 | 17.5 | 23 |
| d±0.05 | 0.6 | 0.6/0.8 | 0.8 | 0.8 | 0.8/0.1 |
| F±1.0 | 5.0 | 5.0/7.5 | 7.5 | 7.5 | 7.5/10.0 |
| H max. | 13.5 | 17 | 20 | 22.5 | 28.0 |
| H1max | 3.5 | 5 | 5 | 5 | 5 |
| L1min | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| p1max | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| L min | 24.0 | 24.0 | 24.0 | 24.0 | 24.0 |

**P Type (straight leads)****Y Type (vertical kink)**

Max.Thickness (T)

| Part No. | 8Φ | 10Φ | 13Φ | 15Φ | 20Φ |
|----------|-----|-----|-----|-----|-----|
| 0R7M | -- | -- | -- | -- | 5.0 |
| 1R3M | -- | -- | -- | 5.0 | 5.5 |
| 2R5M | -- | -- | 5.0 | 5.0 | 5.0 |
| 030M | -- | 5.0 | -- | 6.0 | -- |
| 040M | -- | 5.0 | -- | 5.0 | 6.0 |
| 050M | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 |
| 060L | 4.0 | 5.0 | 5.0 | 5.0 | 6.5 |
| 070L | -- | 5.5 | 5.0 | 5.0 | -- |
| 080L | 4.5 | 6.0 | 5.0 | 6.0 | 5.0 |
| 100L | 5.0 | 5.0 | 5.5 | 6.5 | 5.5 |
| 120L | -- | 5.0 | 6.0 | 7.0 | -- |
| 150L | 4.0 | 5.0 | -- | 5.0 | -- |
| 160L | -- | 5.0 | 6.5 | 5.0 | -- |
| 180L | 5.0 | -- | -- | -- | -- |
| 200L | 5.0 | 6.0 | 5.0 | 5.0 | -- |
| 220L | 5.0 | 6.0 | -- | -- | -- |
| 250L | -- | 6.0 | 5.0 | 5.5 | -- |
| 400L | -- | -- | -- | 6.0 | -- |
| 470L | -- | -- | -- | -- | -- |
| 500L | -- | 5.0 | -- | 5.0 | -- |
| 800L | -- | 5.5 | -- | 5.0 | 6.0 |
| 121L | -- | 6.5 | -- | 5.5 | -- |
| 221L | -- | -- | -- | -- | -- |

RATING AND CHARACTERISTICS

Φ8mm

| Part Number | Resistance at 25°C | | I _{max.} | R _I max. | Thermal dissipation coefficient | Thermal time constant | Material constant β (±10%) |
|-----------------|--------------------|-----------|-------------------|---------------------|---------------------------------|-----------------------|----------------------------|
| | (Ohms) | Tolerance | (Amps) | (Ω) | (mW/°C) | (sec.) | (°K) |
| JNR08S050M65□△△ | 5 | ±20% | 3.0 | 0.200 | 9 | 36 | 2750 |
| JNR08S060L65□△△ | 6 | ±15% | 3.0 | 0.210 | 9 | 36 | |
| JNR08S080L65□△△ | 8 | | 3.0 | 0.245 | 9 | 36 | |
| JNR08S100L65□△△ | 10 | | 3.0 | 0.270 | 9 | 38 | |
| JNR08S150L65□△△ | 15 | | 2.0 | 0.505 | 12 | 36 | 3000 |
| JNR08S180L65□△△ | 18 | | 2.0 | 0.550 | 12 | 36 | |
| JNR08S200L65□△△ | 20 | | 2.0 | 0.600 | 12 | 36 | |
| JNR08S220L65□△△ | 22 | | 2.0 | 1.110 | 12 | 36 | |

• For application required ratings not shown, contact application engineering.

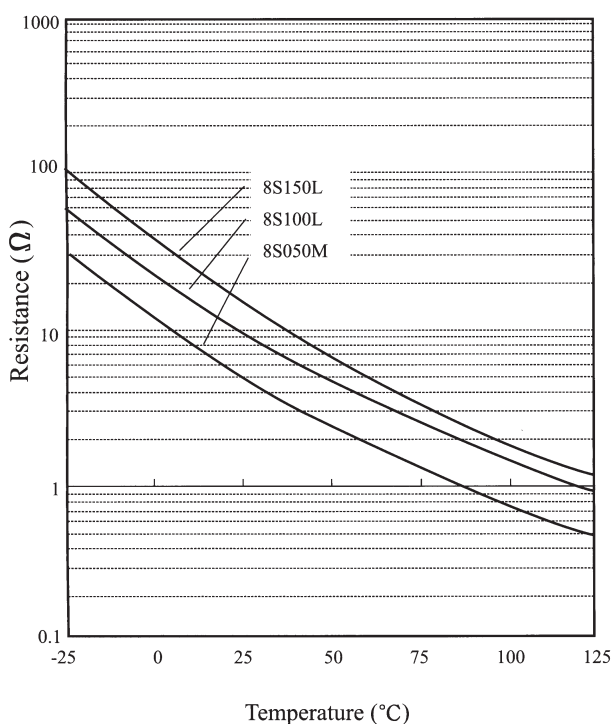
□ :Lead Style (please refer to page 140)

Y: vertical kink (standard)

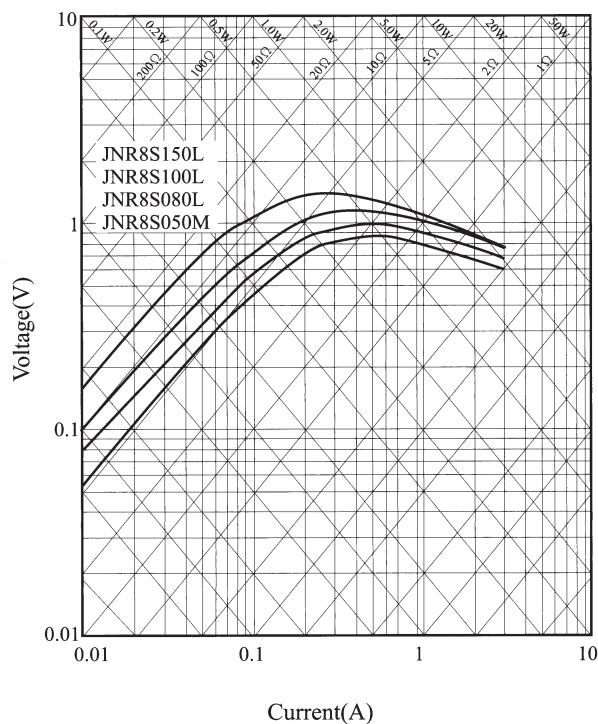
P: straight leads

△△:Lead Length / Packing Method (Please refer to page 139 for the detail codes)

R-T CHARACTERISTIC CURVE-8Φ



V-I CHARACTERISTIC CURVE-8Φ



RATING AND CHARACTERISTICS

Φ10mm

| Part Number | Resistance at 25℃ | | I _{max} . | R _I max. | Thermal dissipation coefficient | Thermal time constant | Material constant β (±10%) |
|-----------------|-------------------|-----------|--------------------|---------------------|---------------------------------|-----------------------|----------------------------|
| | (Ohms) | Tolerance | (Amps) | (Ω) | (mW/℃) | (sec.) | (°K) |
| JNR10S2R5M87□△△ | 2.5 | ±20% | 5.0 | 0.100 | 10 | 41 | 2750 |
| JNR10S030M87□△△ | 3 | | 5.0 | 0.130 | 10 | 41 | |
| JNR10S040M87□△△ | 4 | | 4.0 | 0.153 | 10 | 43 | |
| JNR10S050M87□△△ | 5 | | 4.0 | 0.176 | 10 | 45 | |
| JNR10S060L87□△△ | 6 | ±15% | 3.0 | 0.243 | 10 | 45 | 3000 |
| JNR10S070L87□△△ | 7 | | 3.0 | 0.290 | 11 | 45 | |
| JNR10S080L87□△△ | 8 | | 3.0 | 0.303 | 10 | 43 | |
| JNR10S100L87□△△ | 10 | | 3.0 | 0.270 | 11 | 45 | |
| JNR10S120L87□△△ | 12 | | 2.0 | 0.340 | 11 | 48 | |
| JNR10S160L87□△△ | 16 | | 2.0 | 0.400 | 12 | 50 | |
| JNR10S200L87□△△ | 20 | | 2.0 | 0.615 | 12 | 53 | |
| JNR10S250L87□△△ | 25 | | 2.0 | 0.635 | 12 | 53 | |
| JNR10S500L87□△△ | 50 | | 2.0 | 0.708 | 10 | 47 | |
| JNR10S800L87□△△ | 80 | | 1.0 | 2.070 | 12 | 49 | 3300 |
| JNR10S121L87□△△ | 120 | | 1.0 | 2.295 | 10 | 51 | 3600 |

- For application required ratings not shown, contact application engineering.

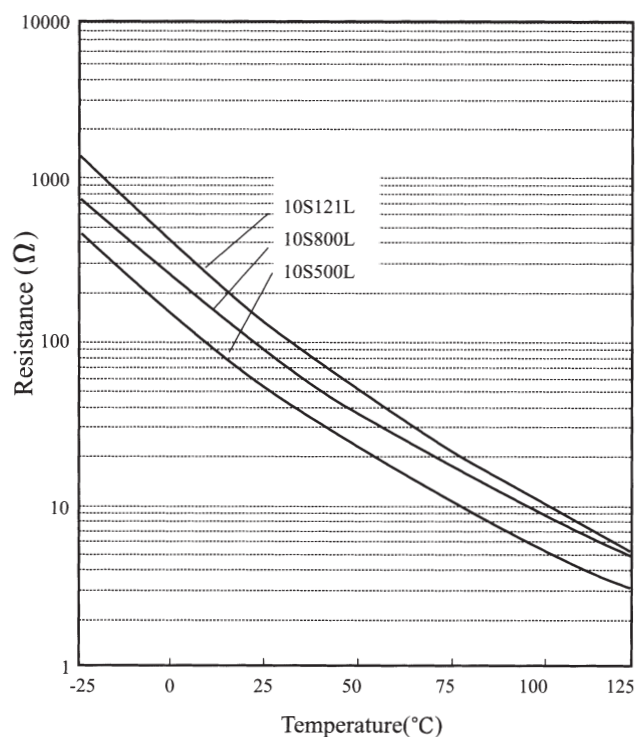
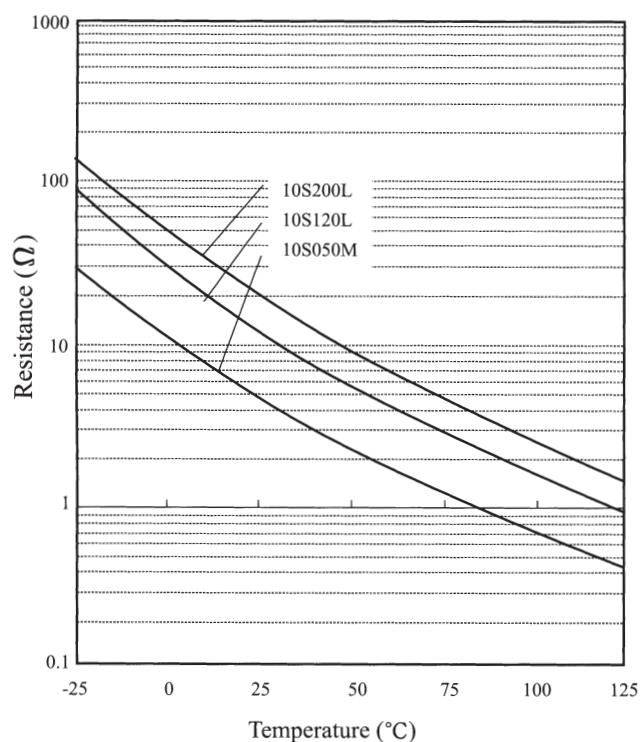
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Y: vertical kink (standard)

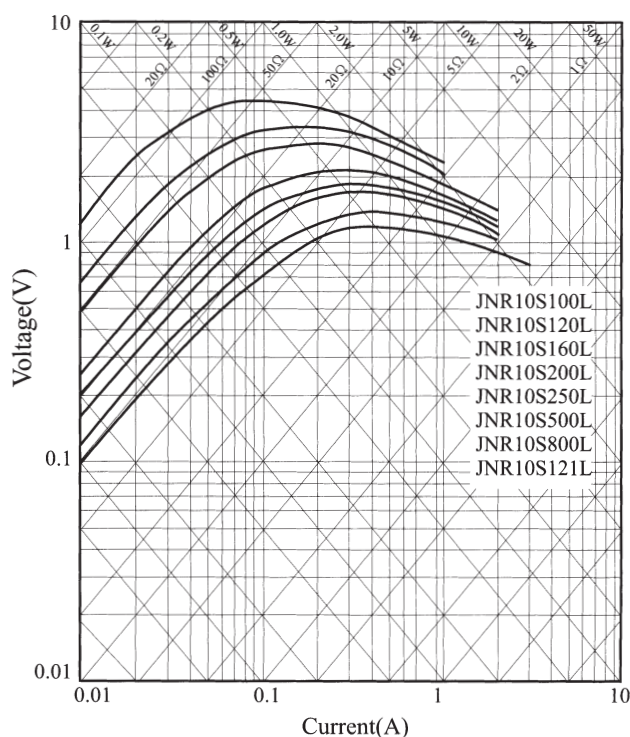
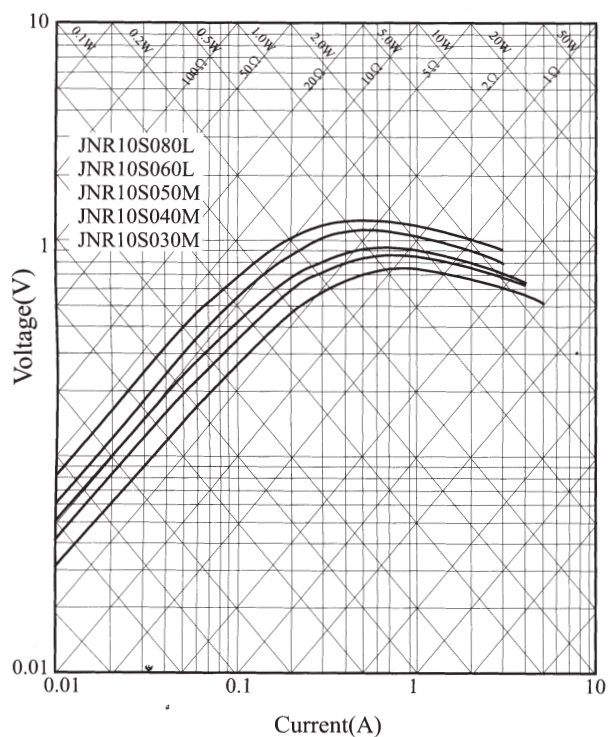
P: straight leads

△△:Lead Length / Packing Method (Please refer to page 139 for the detail codes)

R-T CHARACTERISTIC CURVE-10Φ



V-I CHARACTERISTIC CURVE-10Φ



RATING AND CHARACTERISTICS

Φ13mm

| Part Number | Resistance at 25℃ | | I _{max} . | R _I max. | Thermal dissipation coefficient | Thermal time constant | Material constant β (±10%) |
|-----------------|-------------------|-----------|--------------------|---------------------|---------------------------------|-----------------------|----------------------------|
| | (Ohms) | Tolerance | (Amps) | (Ω) | (mW/℃) | (sec.) | (°K) |
| JNR13S2R5M87□△△ | 2.5 | ±20% | 6.0 | 0.094 | 14 | 65 | 2750 |
| JNR13S050M87□△△ | 5 | | 5.0 | 0.115 | 13 | 63 | |
| JNR13S060L87□△△ | 6 | ±15% | 5.0 | 0.142 | 13 | 64 | |
| JNR13S070L87□△△ | 7 | | 4.0 | 0.173 | 13 | 64 | |
| JNR13S080L87□△△ | 8 | | 4.0 | 0.188 | 14 | 65 | |
| JNR13S100L87□△△ | 10 | | 4.0 | 0.210 | 15 | 65 | |
| JNR13S120L87□△△ | 12 | | 3.0 | 0.353 | 16 | 66 | |
| JNR13S160L87□△△ | 16 | | 3.0 | 0.386 | 16 | 68 | |
| JNR13S200L87□△△ | 20 | | 3.0 | 0.313 | 14 | 65 | 3300 |
| JNR13S250L87□△△ | 25 | | 2.0 | 0.368 | 15 | 68 | |

• For application required ratings not shown, contact application engineering.

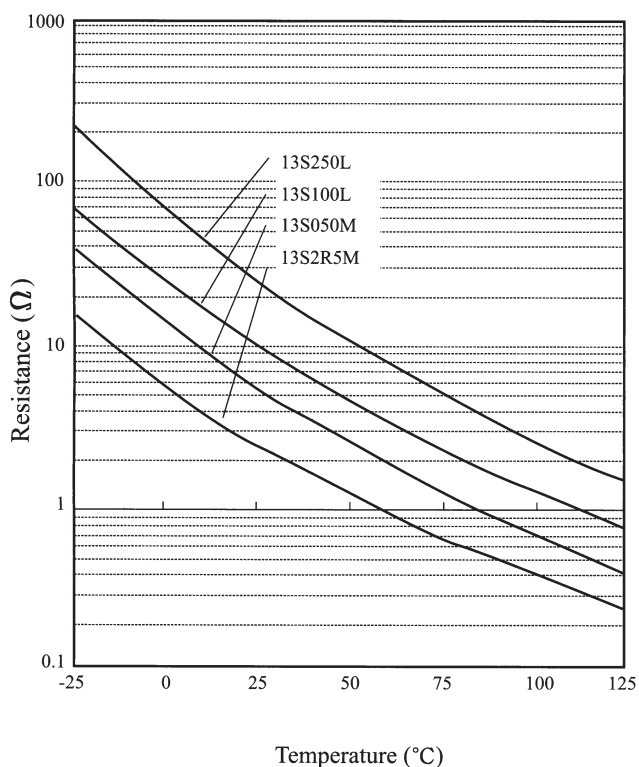
□ :Lead Style (please refer to page 140)

Y: vertical kink (standard)

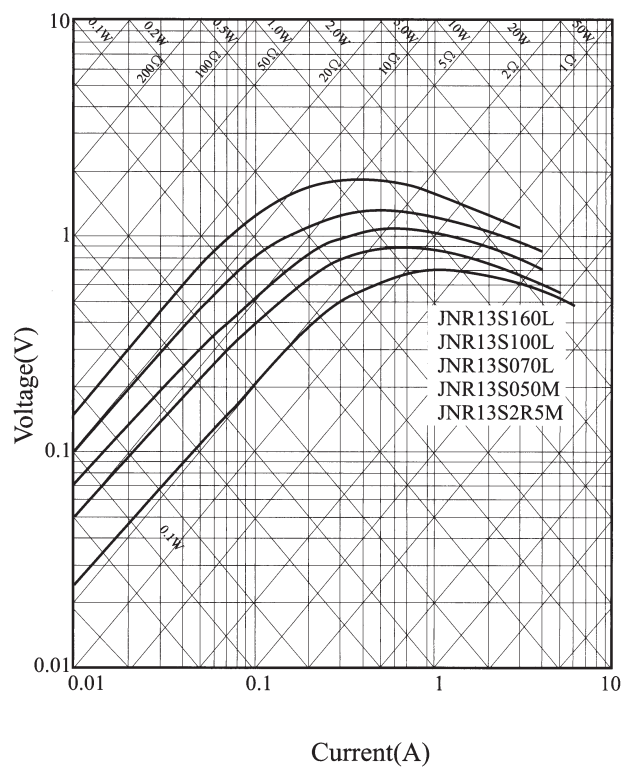
P: straight leads

△△:Lead Length / Packing Method (Please refer to page 139 for the detail codes)

R-T CHARACTERISTIC CURVE-13Φ



V-I CHARACTERISTIC CURVE-13Φ



RATING AND CHARACTERISTICS

Φ15mm

| Part Number | Resistance at 25℃ | | I _{max} . | R _I max. | Thermal dissipation coefficient | Thermal time constant | Material constant β (±10%) |
|-----------------|-------------------|-----------|--------------------|---------------------|---------------------------------|-----------------------|----------------------------|
| | (Ohms) | Tolerance | (Amps) | (Ω) | (mW/℃) | (sec.) | (°K) |
| JNR15S1R3M87□△△ | 1.3 | ±20% | 8.0 | 0.061 | 20 | 55 | 2750 |
| JNR15S2R5M87□△△ | 2.5 | | 8.0 | 0.083 | 18 | 58 | |
| JNR15S030M87□△△ | 3 | | 7.0 | 0.107 | 18 | 62 | |
| JNR15S040M87□△△ | 4 | | 6.0 | 0.112 | 18 | 70 | |
| JNR15S050M87□△△ | 5 | | 6.0 | 0.125 | 19 | 72 | |
| JNR15S060L87□△△ | 6 | ±15% | 5.0 | 0.139 | 19 | 74 | 3000 |
| JNR15S070L87□△△ | 7 | | 5.0 | 0.148 | 19 | 76 | |
| JNR15S080L87□△△ | 8 | | 5.0 | 0.156 | 20 | 78 | |
| JNR15S100L87□△△ | 10 | | 5.0 | 0.178 | 20 | 80 | |
| JNR15S120L87□△△ | 12 | | 4.0 | 0.238 | 21 | 82 | |
| JNR15S150L87□△△ | 15 | | 4.0 | 0.190 | 17 | 74 | 3300 |
| JNR15S160L87□△△ | 16 | | 4.0 | 0.231 | 17 | 74 | |
| JNR15S200L87□△△ | 20 | | 4.0 | 0.290 | 20 | 76 | |
| JNR15S250L87□△△ | 25 | | 3.0 | 0.368 | 21 | 77 | |
| JNR15S400L87□△△ | 40 | | 3.0 | 0.437 | 22 | 82 | |
| JNR15S470L87□△△ | 47 | | 3.0 | 0.483 | 23 | 85 | |
| JNR15S800L87□△△ | 80 | | 2.5 | 0.684 | 18 | 75 | 3600 |
| JNR15S121L87□△△ | 120 | | 2.0 | 1.106 | 19 | 81 | |
| JNR15S221L87□△△ | 220 | | 1.0 | 3.020 | 20 | 103 | |

- For application required ratings not shown, contact application engineering.

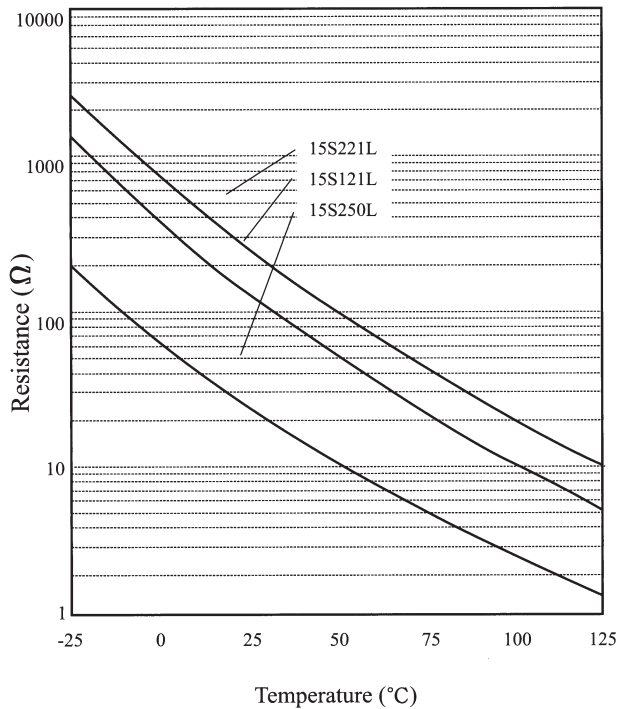
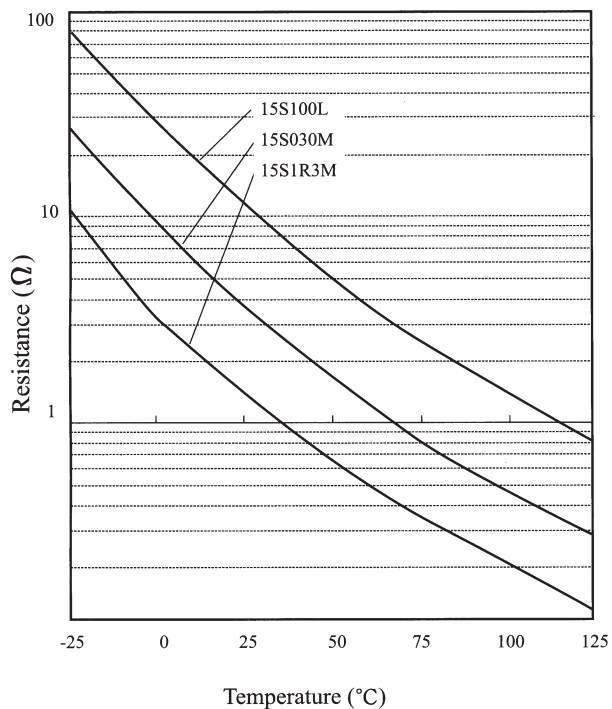
□ :Lead Style (please refer to page 140)

Y: vertical kink (standard)

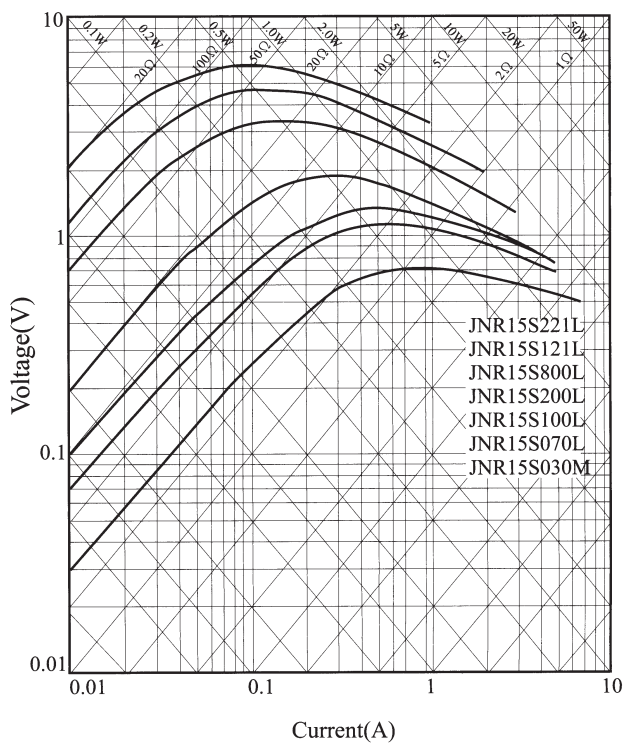
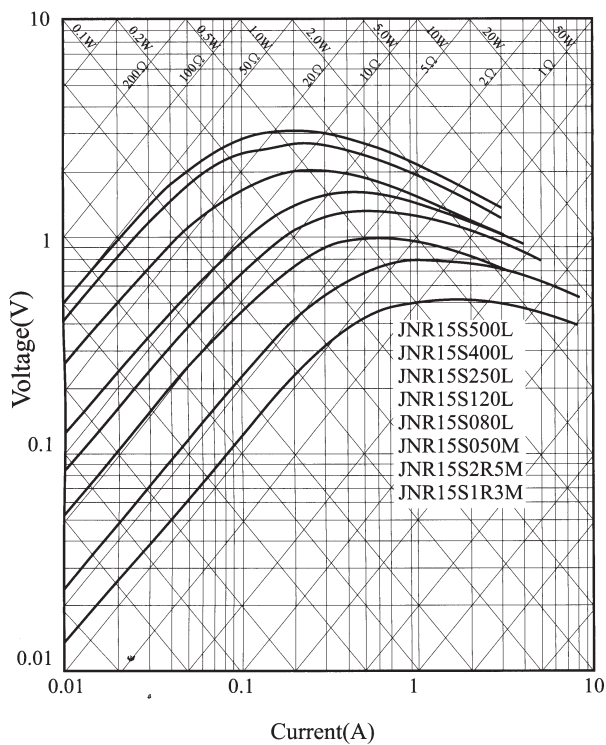
P: straight leads

△△:Lead Length / Packing Method (Please refer to page 139 for the detail codes)

R-T CHARACTERISTIC CURVE-15 Φ



V-I CHARACTERISTIC CHART-15 Φ



RATING AND CHARACTERISTICS

Φ20mm

| Part Number | Resistance at 25°C | | Imax. | RImax. | Thermal dissipation coefficient | Thermal time constant | Material constant β ($\pm 10\%$) |
|-----------------|--------------------|------------|--------|--------------|---------------------------------|-----------------------|--|
| | (Ohms) | Tolerance | (Amps) | (Ω) | (mW/°C) | (sec.) | ($^{\circ}\text{K}$) |
| JNR20S0R7M11□△△ | 0.7 | $\pm 20\%$ | 12.0 | 0.032 | 25 | 98 | 2750 |
| JNR20S1R3M11□△△ | 1.3 | | 8.0 | 0.061 | 25 | 104 | |
| JNR20S2R5M11□△△ | 2.5 | | 10.0 | 0.063 | 20 | 98 | |
| JNR20S050M11□△△ | 5 | | 7.0 | 0.108 | 24 | 112 | |
| JNR20S060L65□△△ | 6 | $\pm 15\%$ | 6.0 | 0.141 | 24 | 115 | 3000 |
| JNR20S100L65□△△ | 10 | | 6.0 | 0.136 | 23 | 98 | |
| JNR20S120L65□△△ | 12 | | 5.0 | 0.174 | 25 | 98 | |
| JNR20S121L65□△△ | 120 | | 2.0 | 1.215 | 24 | 103 | |
| | | | | | | | |
| | | | | | | | 3300 |
| | | | | | | | 3600 |

• For application required ratings not shown, contact application engineering.

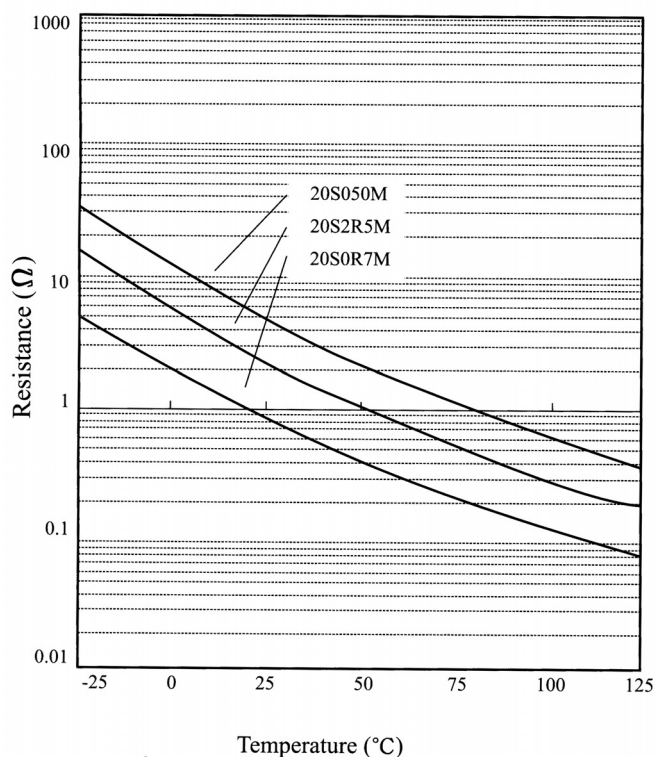
□ :Lead Style (please refer to page 140)

Y: vertical kink (standard)

P: straight leads

△△:Lead Length / Packing Method (Please refer to page 139 for the detail codes)

R-T CHARACTERISTIC CURVE-20Φ



V-I CHARACTERISTIC CURVE-20Φ

