Temperature protection device

Chip NTC thermistor

Automotive grade, for conductive glue

NTCSP series

NTCSP10 JIS 1005 [EIA 0402]
NTCSP16 JIS 1608 [EIA 0603]
REMINDERS FOR USING THESE PRODUCTS
Before using these products, be sure to request the delivery specifications.

SAFETY REMINDERS
Please pay sufficient attention to the warnings for safe designing when using this products.
Incorrect usage may cause smoke or fire.

⚠️ REMINDERS

- Please use them within the ranges of the ratings and performance provided in the catalog and delivery specifications upon confirming the environments where they are to be used and installed.
- Do not use them outside the operating temperature range.
- Do not use them with the ratings or maximum permissible power levels exceeded.
- Do not quickly apply 5mW or more of load with the constant-voltage power supply as this may lead to staying in thermal runaway mode or the red-shorting of chips.
- Please be cautious of the applied voltage in thermistors as instruments may malfunction with the lowering of resistance due to self heating.
- With instruments that consumers can touch the thermistors with their hands, please carefully warn them not to touch the thermistors.
- Store them in locations where the temperature is 10°C to +40°C and the relative humidity is 75% or below, avoid environments where there are sudden changes in temperatures, direct sunlight, corrosive gas, grit, or dust, and keep them packed in a manner where no loading stress is applied in order to avoid deterioration and damage.
- If the storage period is exceeded, the surface of the terminal electrode may be oxidized or sulfided and the resistance value may shift.
- When sealing thermistors, please do so upon first considering the type, quantity, hardening conditions, and adhesiveness of the sealing material and confirming its reliability.
- Avoid powerful vibrations, impact (such as by dropping), pressure, etc. on thermistors that exceed the prescribed levels.
- Do not use them for long periods of time in environments with a relative humidity of over 85%. (this excludes cases where countermeasures have been taken.)
- Do not use them in the following environments. (this excludes cases where countermeasures have been taken.)
  - Corrosive gases (Cl₂, NH₃, SOx, NOx, etc.)
  - Environments with highly conductive substances (electrolytes, water, saltwater, etc.)
  - Environments with acid, alkali, or organic solvents
  - Dusty areas
- When using an alumina substrate, do a reliability test beforehand certainly, and please confirm that it's no problem (Cracks don't occur to a product.)
- Please observe the following precautions when attaching them to substrates as failure to do so may result in destruction or malfunction.
  - Do not let the substrates get warped or twisted at any time during mounting.
  - The landing size must be even on both the left and right sides.
  - Do not use items that have been dropped or detached.
  - The conductive paste is used in an appropriate amount.
- Please use a substance such as resin that does not generate hydrogen (H₂) when forming insulation film over chips.
- The products listed on this specification sheet are intended for use in general electronic equipment (AV equipment, telecommunications equipment, home appliances, amusement equipment, computer equipment, personal equipment, office equipment, measurement equipment, industrial robots) under a normal operation and use condition.
- The products are not designed or warranted to meet the requirements of the applications listed below, whose performance and/or quality require a more stringent level of safety or reliability, or whose failure, malfunction or trouble could cause serious damage to society, person or property.
- Please note that you cannot take responsibility for the damage caused by the use of this specification beyond the scope and conditions of the applications listed below or this specification sheet.
- If you plan to use this product beyond the scope and conditions of the applications listed below or this specification sheet, please consult us at advance. We will discuss the contents of the warranty in accordance with your use.

1. Aerospace/aviation equipment
2. Transportation equipment (electric trains, ships, etc.)
3. Medical equipment
4. Power-generation control equipment
5. Atomic energy-related equipment
6. Seabed equipment
7. Transportation control equipment
8. Public information-processing equipment
9. Military equipment
10. Electric heating apparatus, burning equipment
11. Disaster prevention/crime prevention equipment
12. Safety equipment
13. Other applications that are not considered general-purpose applications

When designing your equipment even for general-purpose applications, you are kindly requested to take into consideration securing protection circuit/device or providing backup circuits in your equipment.
Overview of the NTCSP series

- **CHARACTERISTICS OF NTC THERMISTORS**
  
  NTC (Negative Temperature Coefficient) thermistors are manufactured from sintered metal oxides. Each thermistor consists of a combination of two to four of the following materials: manganese, nickel, cobalt, and copper. NTC thermistors are semiconductor resistors that exhibit decreasing resistance characteristics with increasing temperature. TDK thermistors have low thermal time constants which result in extremely high rates of resistance change to accurately track the temperature.

- **FEATURES OF NTCG SERIES**
  
  - Conductive glue can mount.
  - The line-up corresponding to 150 °C.
  - AEC-Q200 compliant.

Fig.1 R-T Curve : 10kohm@25°C


Please be sure to request delivery specifications that provide further details on the features and specifications of the products for proper and safe use.

Please note that the contents may change without any prior notice due to reasons such as upgrading.
**Overview of the NTCSP series**

### PART NUMBER CONSTRUCTION

<table>
<thead>
<tr>
<th>NTC</th>
<th>SP</th>
<th>3J</th>
<th>103</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTC thermistor</td>
<td>SP</td>
<td>Corresponding to conductive glue</td>
<td>10</td>
<td>1005</td>
</tr>
</tbody>
</table>

* B constant

<table>
<thead>
<tr>
<th>B constant(K)</th>
<th>Code</th>
<th>Structure classification</th>
<th>shapes and dimensions Code (mm)</th>
<th>B constant tolerance (%)</th>
<th>Nominal resistance (Ω)</th>
<th>Nominal resistance tolerance (%)</th>
<th>Packaging style</th>
<th>TDK internal code</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A 2000 to 2050</td>
<td>3A</td>
<td>3000 to 3050</td>
<td>4A</td>
<td>10,000 (10kΩ)</td>
<td>F ±1</td>
<td>104</td>
<td>100,000 (100kΩ)</td>
<td>Taping</td>
</tr>
<tr>
<td>2B 2051 to 2100</td>
<td>3B</td>
<td>3051 to 3100</td>
<td>4B</td>
<td>4000 to 4050</td>
<td>16</td>
<td>1608</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2C 2101 to 2150</td>
<td>3C</td>
<td>3101 to 3150</td>
<td>4C</td>
<td>4051 to 4100</td>
<td>103</td>
<td>10,000 (10kΩ)</td>
<td>F ±1</td>
<td>1S</td>
</tr>
<tr>
<td>2E 2201 to 2250</td>
<td>3E</td>
<td>3201 to 3250</td>
<td>4E</td>
<td>4201 to 4250</td>
<td>47,000 (47kΩ)</td>
<td>1S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2F 2251 to 2300</td>
<td>3F</td>
<td>3251 to 3300</td>
<td>4F</td>
<td>4251 to 4300</td>
<td>150°C vehicle response</td>
<td>B constant: 25/85°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2J 2401 to 2450</td>
<td>3J</td>
<td>3401 to 3450</td>
<td>4J</td>
<td>4401 to 4450</td>
<td>4701 to 4750</td>
<td>1S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2K 2451 to 2500</td>
<td>3K</td>
<td>3451 to 3500</td>
<td>4K</td>
<td>4451 to 4500</td>
<td>4701 to 4750</td>
<td>1S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2L 2501 to 2550</td>
<td>3L</td>
<td>3501 to 3550</td>
<td>4L</td>
<td>4501 to 4550</td>
<td>4701 to 4750</td>
<td>1S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2N 2601 to 2650</td>
<td>3N</td>
<td>3601 to 3650</td>
<td>4N</td>
<td>4601 to 4650</td>
<td>4701 to 4750</td>
<td>1S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2Q 2701 to 2750</td>
<td>3Q</td>
<td>3701 to 3750</td>
<td>4Q</td>
<td>4701 to 4750</td>
<td>4701 to 4750</td>
<td>1S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2S 2801 to 2850</td>
<td>3S</td>
<td>3801 to 3850</td>
<td>4S</td>
<td>4801 to 4850</td>
<td>4701 to 4750</td>
<td>1S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**B constant calculation formula**

\[
B = \ln\left(\frac{R_1}{R_2}\right) = \frac{1}{T_1} - \frac{1}{T_2}
\]

- **B**: B constant (K)
- **T1**: Arbitrary temperature (K)
- **T2**: Arbitrary temperature different from T1 (K)
- **R1**: Zero-load resistance value at temperature T1 (Ω)
- **R2**: Zero-load resistance value at temperature T2 (Ω)

Each temperature is measured in absolute temperature. 0°C = 273.15 K

**Dimensions in mm**

<table>
<thead>
<tr>
<th>Shape symbol (JIS)</th>
<th>L</th>
<th>W</th>
<th>T</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1005</td>
<td>1.00±0.05</td>
<td>0.50±0.05</td>
<td>0.50±0.05</td>
<td>0.1min</td>
</tr>
<tr>
<td>1608</td>
<td>1.60±0.10</td>
<td>0.80±0.10</td>
<td>0.80±0.10</td>
<td>0.2min</td>
</tr>
</tbody>
</table>

**COMPATIBLE WITH CONDUCTIVE GLUE**

<table>
<thead>
<tr>
<th>Size</th>
<th>mm</th>
<th>Maximum rated power (25°C)*</th>
<th>mW</th>
<th>Dissipation factors (25°C)*</th>
<th>mW/°C</th>
<th>mW/K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1005</td>
<td>1608</td>
<td>125</td>
<td>125</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*1 Maximum rated power: Maximum power at rated temperature (25°C), maximum power that can be applied continuously

*2 Dissipation factors: powered that it is equivalent that be increased in self-heating by load power thermistor at 1°C temperature

⚠️ Please be sure to request delivery specifications that provide further details on the features and specifications of the products for proper and safe use. Please note that the contents may change without any prior notice due to reasons such as upgrading.
Chip NTC thermistor
Automotive grade, for conductive glue

NTCSP series  1005 type

SHAPE & DIMENSIONS

RECOMMENDED LAND PATTERN

COMPATIBLE WITH CONDUCTIVE GLUE (OPERATING TEMPERATURE RANGE : -55 to 150°C)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NTCSP103JF103FT1S</td>
<td>10,000</td>
<td>±1%</td>
<td>3380</td>
<td>3422</td>
<td>3435</td>
<td>3453</td>
<td>±1%</td>
<td>0.31</td>
</tr>
<tr>
<td>NTCSP104BF473FT1SX</td>
<td>47,000</td>
<td>±1%</td>
<td>4050</td>
<td>4098</td>
<td>4114</td>
<td>4137</td>
<td>±1%</td>
<td>0.14</td>
</tr>
<tr>
<td>NTCSP104KF104FT1S</td>
<td>100,000</td>
<td>±1%</td>
<td>4419</td>
<td>4468</td>
<td>4485</td>
<td>4509</td>
<td>±1%</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Product compatible with RoHS directive
Corresponding to conductive glue

Electrode material
Internal: Pd
External: Ag/Pt

Dimensions in mm

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Chip NTC thermistor
Automotive grade, for conductive glue

NTCSP series 1608 type

■SHAPE & DIMENSIONS

Electrode material
Internal:Pd
External:Ag/Pd

Dimensions in mm

■RECOMMENDED LAND PATTERN

■COMPATIBLE WITH CONDUCTIVE GLUE (OPERATING TEMPERATURE RANGE: -55 to 150°C)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NTCSP163JF103FT1S</td>
<td>10,000</td>
<td>±1%</td>
<td>3380</td>
<td>3422</td>
<td>3435</td>
<td>3453</td>
<td>±1%</td>
<td>0.31</td>
</tr>
<tr>
<td>NTCSP164BF473FT1SX</td>
<td>47,000</td>
<td>±1%</td>
<td>4050</td>
<td>4098</td>
<td>4114</td>
<td>4137</td>
<td>±1%</td>
<td>0.14</td>
</tr>
<tr>
<td>NTCSP164KF104FT1S</td>
<td>100,000</td>
<td>±1%</td>
<td>4419</td>
<td>4468</td>
<td>4485</td>
<td>4509</td>
<td>±1%</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Chip NTC thermistor
Automotive grade, for conductive glue

NTCSP series  RT table

**R-T TABLE ACQUISITION PROCEDURE**

1. Access the top page of the TDK chip NTC thermistor (protective device)

2. Click [Search by Part No.]

3. Enter the product name you want in the RT table in the box and click the Search button.
   (Example: NTCG103JF103FT1)

   ![Search Interface](image)

4. Click the displayed product name.
   (Example: NTCG103JF103FT1)

   ![Product Details](image)

5. Individual pages are displayed and click the RT table in the "Document" on the right side bar.

   ![Document List](image)

6. You can download the csv file in the 1°C step of the RT table for the product.

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Chip NTC thermistor
Automotive grade, for conductive glue

Attention in the board design

**BOARD DESIGN**
When attached to NTC substrate thermistor, amount of conductive glue has direct impact on NTC thermistor after mounting. Thus, sufficient consideration is necessary.

**Set of land dimensions**
As the stress rises in the NTC thermistor owing to the increase in silver, breakage and cracks will occur. Cause including crack, as caution on board land design, configure the shape and dimensions so that the amount of conductive glue is appropriate.

<table>
<thead>
<tr>
<th>Shape symbol</th>
<th>Symbol</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1005</td>
<td>0.6min.</td>
<td>0.35 to 0.45</td>
<td>0.50 to 0.70</td>
<td></td>
</tr>
<tr>
<td>1608</td>
<td>0.9min.</td>
<td>0.60 to 0.80</td>
<td>1.10 to 1.30</td>
<td></td>
</tr>
</tbody>
</table>

**Amount of conductive glue**
Excessive amount of conductive glue during mounting can cause electrical path formation under the chip (between the lands). In addition, when the amount of conductive glue is excessive, the terminal electrode sticking force is insufficient, causing chip falling off, which may affect the reliability of the circuit. A typical example of the amount of conductive glue is shown below.

**Application to board**
Mounting head pressure
Under suction nozzle if dead point too, during implementation, excessive force joins of NTC thermistor low, as cause causes of crack, please use with reference to something about following.
1) The bottom dead center of the suction nozzle is set on the upper surface of the substrate to adjust the excessive load to the substrate.
2) Nozzle pressure at implementation is 1N – 3N in static load, please.
Chip NTC thermistor
Automotive grade, for conductive glue

Single-part component handling

(1) To drop impact, as there is possibility that breakage and crack is entered, do not NTC thermistor that(1) NTC thermistor falls.

(2) At stacking storage after implementation and treatment of substrate, corner of boards is regarded as NTC thermistor. Please be careful, as there is the possibility that breakage and cracks will occur on impact.
Chip NTC thermistor
Automotive grade, for conductive glue

Packaging style

**REEL DIMENSIONS**

- ø180±2.0
- ø13±0.2
- ø21±0.8
- 0.8

- 2.0±0.5

Dimensions in mm

**PACKAGE QUANTITY, PRODUCT WEIGHT**

<table>
<thead>
<tr>
<th>Type</th>
<th>Package quantity (pieces/reel)</th>
<th>Individual weight (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTCSP10</td>
<td>10,000</td>
<td>1.3</td>
</tr>
<tr>
<td>NTCSP16</td>
<td>4,000</td>
<td>5.0</td>
</tr>
</tbody>
</table>

**TAPE DIMENSIONS**

<table>
<thead>
<tr>
<th>Type</th>
<th>A</th>
<th>B</th>
<th>P1</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>1005</td>
<td>0.65±0.05/0.1</td>
<td>1.15±0.05/0.1</td>
<td>2±0.05</td>
<td>0.65max.</td>
</tr>
<tr>
<td>1608</td>
<td>1.1±0.2</td>
<td>1.9±0.2</td>
<td>4.0±0.1</td>
<td>1.1max.</td>
</tr>
</tbody>
</table>

Dimensions in mm

- 160min.
- Taping
- 200min.
- 300min.

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Temperature Protection Devices

Chip NTC thermistor
Automotive grade, for conductive glue

Description and definition of terms

**INITIAL RESISTANCE**
Thermistor resistance is a function of absolute temperature as indicated by the following relationship:

\[ R = R_0 \cdot \exp\left(\frac{B}{T - T_0}\right) \] .............................. (1)

Here \( R_0 \), \( R(\Omega) \) are the respective resistance values when the surrounding temperature is \( T_0 \), \( T(K) \). B is the thermistor constant (B constant below).

**B CONSTANT**
The B constant is found from the following equation:

\[ B = \frac{2.3026(\log R - \log R_0)}{\frac{1}{T} - \frac{1}{T_0}} \] .............................. (2)

This B characteristic is indicated by the slope of the linear plot of log R-1/T inverse absolute temperature.

The B constant value is generally in the vicinity of 2500K to 5000K. B constant values of 3000K to 4000K are frequently used for measurements.

**TEMPERATURE COEFFICIENT**
The relationship between temperature coefficient \( \alpha \) and B becomes:

\[ \alpha = \frac{1}{R} \frac{dR}{dT} = -\frac{B}{T^2} \times 100(\%/^\circ C) \] .............................. (3)

The negative sign of the temperature coefficient indicates that the temperature coefficient decreases as both thermistor resistance and temperature rise. If B is taken as 3400K, the temperature coefficient found at 20°C (293.15K) becomes –4%/°C.

**HEAT DISSIPATION COEFFICIENT**
Temperature rises due to thermal energy formed as electrical current flows through the thermistor. The thermistor temperature \( T_0 \) is then related to the surrounding temperature \( T_a \) and the electrical input \( W \):

\[ W = k(T_0 - T_a) = V I \text{ (mW)} \] .............................. (4)

\[ k = \frac{W}{T_0 - T_a} \text{ (mW/°C)} \] .............................. (5)

This k value is the heat dissipation coefficient, which represents the additional electrical power (mW/°C) needed to raise the thermistor temperature by 1°C. This heat dissipation coefficient varies with changes in the measurement and environmental conditions. When a thermistor is used for temperature measurement, it is naturally important to lower the applied electrical current as much as possible in order to reduce measurement error resulting from self heating.

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20200828 / tpd_automotive_ntc-thermistor_ntcsp_en
Temperature Protection Devices

Chip NTC thermistor
Automotive grade, for conductive glue

Description and definition of terms

■ VOLTAGE - CURRENT CHARACTERISTIC

The voltage - current characteristic indicates the drop in voltage as electrical current through the thermistor is gradually increased.

Voltage-current characteristics (Fig.2)

■ HEATING TIME CONSTANT

The time period required to heat up a thermistor from a certain temperature T₀ over a target temperature rise is called the heating time constant. Various types of heating time constants are indicated by the symbols shown in Table 1 as determined by the percent change from T₀ toward the target temperature. The standard change is typically taken to be 63.2%.

Thermal time constants (Fig.3)

<table>
<thead>
<tr>
<th>Code</th>
<th>Rate of change (%) for T₀ - Ta</th>
</tr>
</thead>
<tbody>
<tr>
<td>τ</td>
<td>63.2</td>
</tr>
<tr>
<td>2τ</td>
<td>86.5</td>
</tr>
<tr>
<td>3τ</td>
<td>95.0</td>
</tr>
<tr>
<td>4τ</td>
<td>98.2</td>
</tr>
<tr>
<td>5τ</td>
<td>99.4</td>
</tr>
<tr>
<td>6τ</td>
<td>99.8</td>
</tr>
<tr>
<td>7τ</td>
<td>99.9</td>
</tr>
</tbody>
</table>

Table 1 Heating time constant and temperature change ratio

■ PERMISSIBLE OPERATING CURRENT

This is the maximum load current limit below 1°C temperature rise due to thermistor self-heating. It’s possible to express it in the following system.

Maximum allowed current [mA] = √ (Heat dissipation constant [mW/°C] ÷ Resistance [Ω])

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