



# **NTC thermistors for inrush current limiting**

Leaded and coated disks

**Series/Type:** B57238  
**Date:** May 2009

**Applications**

- Switch-mode power supplies
- Soft-start motors, e.g. in vacuum cleaners

**Features**

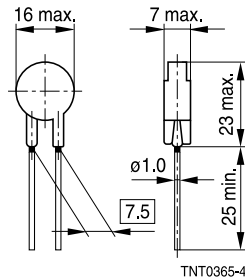
- Useable in series connections  
up to 265 V<sub>RMS</sub>
- Coated thermistor disk for line applications
- Kinked leads of tinned copper wire
- Wide resistance range
- UL approval (E69802)

**Options**

Resistance tolerance <20% and alternative lead configurations available on request

**Delivery mode**

Bulk (standard),  
cardboard tape, reeled or in Ammo pack

**Dimensional drawing**


Dimensions in mm

Approx. weight 3 g

**General technical data**

Climatic category	(IEC 60068-1)		55/170/21	
Max. power	(at 25 °C)	P <sub>max</sub>	3.9	W
Resistance tolerance		ΔR <sub>R</sub> /R <sub>R</sub>	±20	%
Rated temperature		T <sub>R</sub>	25	°C
Dissipation factor	(in air)	δ <sub>th</sub>	approx. 20	mW/K
Thermal cooling time constant	(in air)	τ <sub>c</sub>	approx. 80	s
Heat capacity		C <sub>th</sub>	approx. 1600	mJ/K

**Electrical specification and ordering codes**

R <sub>25</sub>	I <sub>max</sub> (0...65 °C)	B <sub>25/100</sub>	C <sub>test</sub> <sup>(1)</sup> 230 V	C <sub>test</sub> <sup>(1)</sup> 110 V	Param. for R(I) <sup>(1)</sup>	Param. for R(I) <sup>(1)</sup>	Ordering code
Ω	A	K	μF	μF	k	n	
2.5	8.4	2800	700	2800	0.984	-1.36	B57238S0259M000
3	7.4	2900	700	2800	1.04	-1.36	B57238S0309M000
4.7	6.6	2965	700	2800	1.20	-1.37	B57238S0479M000
5	6.4	2965	700	2800	1.23	-1.37	B57238S0509M000
7	6.0	2965	700	2800	1.34	-1.38	B57238S0709M000
8	5.5	3065	700	2800	1.40	-1.39	B57238S0809M000
10	5.0	3065	700	2800	1.50	-1.39	B57238S0100M000
15	4.4	3165	700	2800	1.67	-1.40	B57238S0150M000
16	4.0	3165	700	2800	1.69	-1.39	B57238S0160M000

1) For details on the capacitance C<sub>test</sub> as well as on the parameters k and n refer to "Application notes", chapters 1.6 and 1.7.

**Reliability data**

Test	Standard	Test conditions	$\Delta R_{25}/R_{25}$ (typical)	Remarks
Storage in dry heat	IEC 60068-2-2	Storage at upper category temperature T: 170 °C t: 1000 h	< 10%	No visible damage
Storage in damp heat, steady state	IEC 60068-2-78	Temperature of air: 40 °C Relative humidity of air: 93% Duration: 21 days	< 5%	No visible damage
Rapid temperature cycling	IEC 60068-2-14	Lower test temperature: -55 °C Upper test temperature: 170 °C Number of cycles: 10	< 10%	No visible damage
Endurance		$I = I_{\max}$ t: 1000 h	< 10%	No visible damage
Cyclic endurance		$I = I_{\max}$ , 1000 cycles On-time = 1 min Cooling time = 6 min	< 10%	No visible damage
Transient load		Capacitance = $C_{\text{test}}$ Number of cycles: 1000	< 5%	No visible damage

**Note**

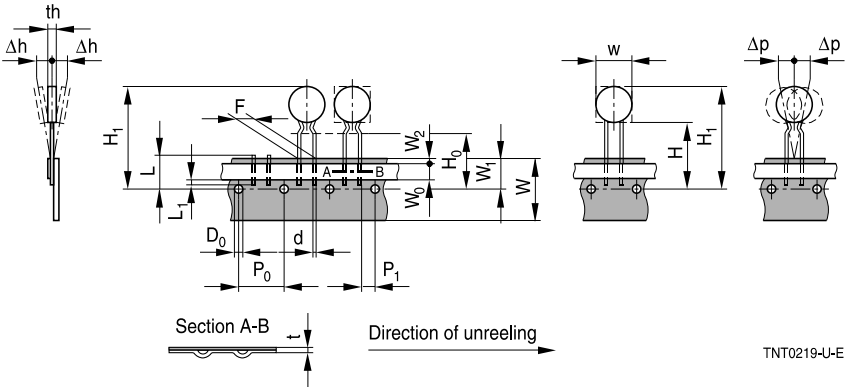
- The self-heating of a thermistor during operation depends on the load applied and the applicable dissipation factor.
- When loaded with maximum allowable current/power and the specified dissipation factor is taken as a basis, the NTC thermistor may reach a mean temperature of up to 250 °C.
- The heat developed during operation will also be dissipated through the lead wires. So the contact areas, too, may become quite hot at maximum load.
- When mounting NTC thermistors you have to ensure that there is an adequate distance between the thermistor and all parts which are sensitive to heat or combustible.

**Taping and packing**

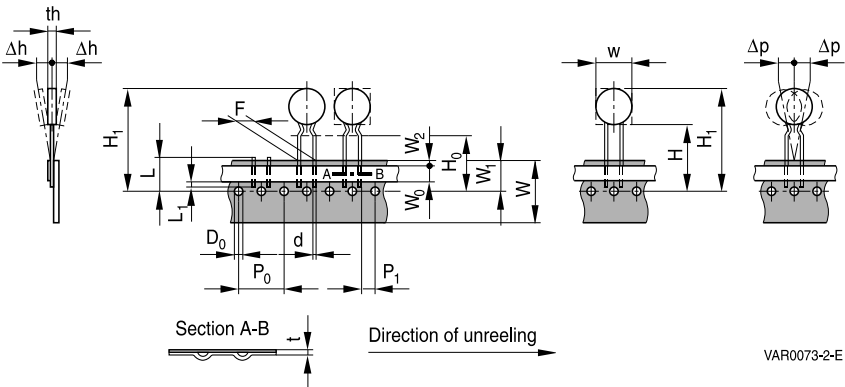
**1 Taping of radial leaded NTC thermistors**

**Dimensions and tolerances**

**Lead spacing  $F = 5.0 \text{ mm}$  (taping to IEC 60286-2)**

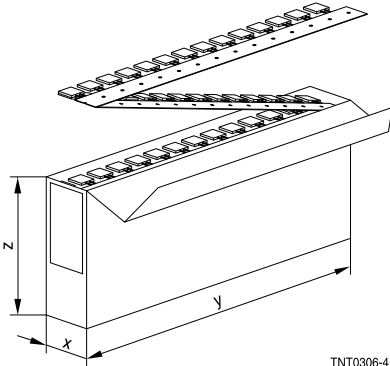


**Lead spacing  $F = 7.5 \text{ mm}$  (taping based on IEC 60286-2)**



**Dimensions (mm)**

	Lead spacing 5 mm	Tolerance of lead spacing 5 mm	Lead spacing 7.5 mm	Tolerance of lead spacing 7.5 mm	Remarks
w	11.5	max.	21	max.	
th	6.0	max.	7	max.	
d	0.5/0.6	±0.05	0.8/1.0	±0.05	
P <sub>0</sub>	12.7	±0.3	12.7	±0.3	±1 mm / 20 sprocket holes
P <sub>1</sub>	3.85	±0.7	8.95	±0.8	
F	5.0	+0.6/-0.1	7.5	±0.8	
Δh	0	±2.0	0	Depends on th	measured at top of component body
Δp	0	±1.3	0	±2.0	
W	18.0	±0.5	18.0	±0.5	
W <sub>0</sub>	5.5	min.	11.0	min.	peel-off force ≥5 N
W <sub>1</sub>	9.0	+0.75/-0.5	9.0	+0.75/-0.5	
W <sub>2</sub>	3.0	max.	3.0	max.	
H	18.0	+2.0/-0	18.0	+2.0/-0	
H <sub>0</sub>	16.0	±0.5	16.0	±0.5	
H <sub>1</sub>	32.2	max.	45.0	max.	
D <sub>0</sub>	4.0	±0.2	4.0	±0.2	
t	0.9	max.	0.9	max.	without wires
L	11.0	max.	11.0	max.	
L <sub>1</sub>	4.0	max.	4.0	max.	

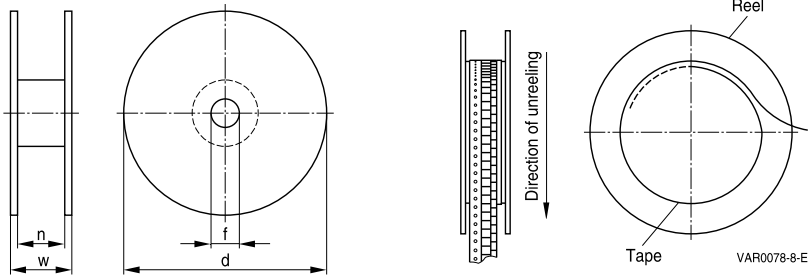
**Types of packing**
*Ammo packing*


TNT0306-4

Ammo type	x	y	z
I	80	240	210
II	56	355	355

Ammo type II only for ICL types S237 and S238

**Packing unit:** 1000 - 2000 pcs./reel

*Reel packing*


VAR0304-Q

VAR0078-8-E

**Packing unit:** 1000 - 2000 pcs./reel

**Reel dimensions (in mm)**

Reel type	d	f	n	w
I	360 max.	31 ±1	approx. 45	54 max.
II	500 max.	23 ±1	approx. 59	72 max.

*Bulk packing*

The components are packed in cardboard boxes, the size of which depends on the order quantity.

**2 Packing codes**

The last two digits of the complete ordering code state the packing mode:

Last two digits			
00	–	Bulk	–
51	Radial leads, kinked	Cardboard tape	360 or 500-mm reel packing
53	Radial leads, straight	Cardboard tape	360 or 500-mm reel packing
54	Radial leads, kinked	Cardboard tape	AMMO packing
55	Radial leads, straight	Cardboard tape	AMMO packing

Example: B57236S0160M000	Bulk
B57236S0160M051	Cardboard tape, reel
B57236S0160M054	Cardboard tape, AMMO packing

## Mounting instructions

### 1 Soldering

#### 1.1 Leaded NTC thermistors

Leaded thermistors comply with the solderability requirements specified by CECC.

When soldering, care must be taken that the NTC thermistors are not damaged by excessive heat. The following maximum temperatures, maximum time spans and minimum distances have to be observed:

	<i>Dip soldering</i>	<i>Iron soldering</i>
Bath temperature	max. 260 °C	max. 360 °C
Soldering time	max. 4 s	max. 2 s
Distance from thermistor	min. 6 mm	min. 6 mm

Under more severe soldering conditions the resistance may change.

#### **Solderability** (test to IEC 60068-2-58)

Preconditioning: Immersion into flux F-SW 32.

Evaluation criterion: Wetting of soldering areas  $\geq 95\%$ .

Solder	Bath temperature (°C)	Dwell time (s)
SnAg (3.0 ... 4.0), Cu (0.5 ... 0.9)	245 $\pm$ 3	3

#### 1.1.1 Resistance to soldering heat (test to IEC 60068-2-58)

Preconditioning: Immersion into flux F-SW 32.

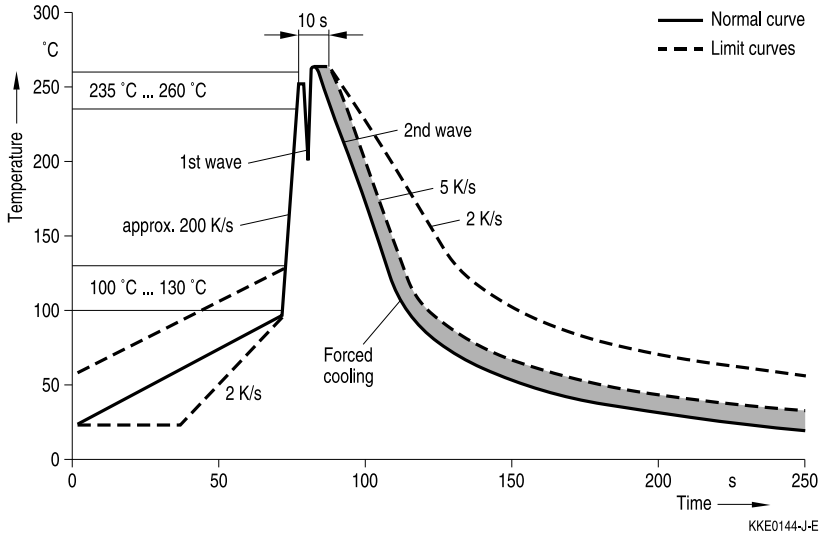
Evaluation criterion: Leaching of side edges  $\leq 1/3$ .

Solder	Bath temperature (°C)	Dwell time (s)
SnAg (3.0 ... 4.0), Cu (0.5 ... 0.9)	260 –5	10



## Wave soldering

Temperature characteristic at component terminal with dual wave soldering



## 2 Robustness of terminations

The leads meet the requirements of IEC 60068-2-21. They may not be bent closer than 4 mm from the solder joint on the thermistor body or from the point at which they leave the feed-throughs. During bending, any mechanical stress at the outlet of the leads must be removed. The bending radius should be at least 0.75 mm.

Tensile strength: Test Ua1:

Leads  $0.50 < \varnothing \leq 0.80 \text{ mm} = 10.0 \text{ N}$   
 $0.80 < \varnothing \leq 1.25 \text{ mm} = 20.0 \text{ N}$

Bending strength: Test Ub:

Two 90°-bends in opposite directions at a weight of 0.25 kg.

Torsional strength: Test Uc: severity 2

The lead is bent by 90° at a distance of 6 to 6.5 mm from the thermistor body.

The bending radius of the leads should be approx. 0.75 mm. Two torsions of 180° each (severity 2).

When subjecting leads to mechanical stress, the following should be observed:

#### *Tensile stress on leads*

During mounting and operation tensile forces on the leads are to be avoided.

#### *Bending of leads*

Bending of the leads directly on the thermistor body is not permissible.

A lead may be bent at a minimum distance of twice the wire's diameter +2 mm from the solder joint on the thermistor body. During bending the wire must be mechanically relieved at its outlet. The bending radius should be at least 0.75 mm.

#### *Twisting of leads*

The twisting (torsion) by 180° of a lead bent by 90° is permissible at 6 mm from the bottom of the thermistor body.

### **3 Sealing and potting**

When thermistors are sealed, potted or overmolded, there must be no mechanical stress caused by thermal expansion during the production process (curing / overmolding process) and during later operation. The upper category temperature of the thermistor must not be exceeded. Ensure that the materials used (sealing / potting compound and plastic material) are chemically neutral.

### **4 Cleaning**

If cleaning is necessary, mild cleaning agents such as ethyl alcohol and cleaning gasoline are recommended. Cleaning agents based on water are not allowed. Ultrasonic cleaning methods are permissible.

### **5 Storage**

In order to maintain their solderability, thermistors must be stored in a non-corrosive atmosphere. Humidity, temperature and container materials are critical factors.

The components should be left in the original packing. Touching the metallization of unsoldered thermistors may change their soldering properties.

Storage temperature:  $-25\text{ }^{\circ}\text{C}$  up to  $45\text{ }^{\circ}\text{C}$

Max. relative humidity (without condensation):  
<95%, maximum 30 days per annum

Solder the thermistors listed in this data book after shipment from EPCOS within the time specified:

Leaded components: 24 months

## Cautions and warnings

### General

See "Important notes" at the end of this document.

### Storage

- Store thermistors only in original packaging. Do not open the package before storage.
- Storage conditions in original packaging: storage temperature  $-25\text{ °C} \dots +45\text{ °C}$ , relative humidity  $\leq 75\%$  annual mean, maximum 95%, dew precipitation is inadmissible.
- Avoid contamination of thermistors surface during storage, handling and processing.
- Avoid storage of thermistor in harmful environments like corrosive gases ( $\text{SO}_x$ , Cl etc).
- Solder thermistors after shipment from EPCOS within the time specified:
  - Leaded components: 24 months

### Handling

- NTC thermistors must not be dropped. Chip-offs must not be caused during handling of NTCs.
- Components must not be touched with bare hands. Gloves are recommended.
- Avoid contamination of thermistor surface during handling.
- In case of exposure of the NTC thermistors to water, electrolytes or other aggressive media, these media can penetrate the coating and reach the surface of the ceramic. Low-ohmic or high-ohmic behavior may occur due to the formation of an electrolyte with metals (silver/lead/tin from metallization or solder). Low-ohmic behavior is caused by electrochemical migration, high-ohmic behavior by dissolving of the electrode. In either case, the functionality of the NTC thermistors can not be assured.

### Bending / twisting leads

- A lead (wire) may be bent at a minimum distance of twice the wire's diameter plus 4 mm from the component head or housing. When bending ensure the wire is mechanically relieved at the component head or housing. The bending radius should be at least 0.75 mm.
- Twisting (torsion) by  $180^\circ$  of a lead bent by  $90^\circ$  is permissible at 6 mm from the bottom of the thermistor body.

### Soldering

- Use resin-type flux or non-activated flux.
- Insufficient preheating may cause ceramic cracks.
- Rapid cooling by dipping in solvent is not recommended.
- Complete removal of flux is recommended.

## Mounting

- When NTC thermistors are encapsulated with sealing material or overmolded with plastic material, the precautions given in chapter "Mounting instructions", "Sealing and potting" must be observed.
- Electrode must not be scratched before/during/after the mounting process.
- Contacts and housings used for assembly with thermistor have to be clean before mounting.
- During operation, the inrush current limiters surface temperature can be very high. Ensure that adjacent components are placed at a sufficient distance from the thermistor to allow for proper cooling of the thermistors.
- Ensure that adjacent materials are designed for operation at temperatures comparable to the surface temperature of the thermistor. Be sure that surrounding parts and materials can withstand this temperature.
- Make sure that inrush current limiters are adequately ventilated to avoid overheating.
- Avoid contamination of thermistor surface during processing.

## Operation

- Use thermistors only within the specified operating temperature range.
- Use inrush current limiters only within the specified voltage and current ranges.
- Environmental conditions must not harm the thermistors. Use thermistors only in normal atmospheric conditions.
- Contact of NTC thermistors with any liquids and solvents should be prevented. It must be ensured that no water enters the NTC thermistor (e.g. through plug terminals). For measurement purposes (checking the specified resistance vs. temperature), the component must not be immersed in water but in suitable liquids (e.g. Galden).
- In case of exposure of the NTC thermistors to water, electrolytes or other aggressive media, these media can penetrate the coating and reach the surface of the ceramic. Low-ohmic or high-ohmic behavior may occur due to the formation of an electrolyte with metals (silver/lead/tin from metallization or solder). Low-ohmic behavior is caused by electrochemical migration, high-ohmic behavior by dissolving of the electrode. In either case, the functionality of the NTC thermistors cannot be assured.
- Be sure to provide an appropriate fail-safe function to prevent secondary product damage caused by malfunction (e.g. use a metal oxide varistor for limitation of overvoltage condition).

**Symbols and terms**

Symbol	English	German
B	B value	B-Wert
B <sub>25/100</sub>	B value determined by resistance measurement at 25 °C and 100 °C	B-Wert, ermittelt durch Widerstandsmessungen bei 25 °C und 100 °C
C <sub>test</sub>	Test capacitance	Prüfkapazität (elektrisch)
C <sub>th</sub>	Heat capacitance	Wärmekapazität
I	Current	Strom
I <sub>max</sub>	Maximum current within stated temperature range	Maximalstrom im angegebenen Temperaturbereich
I <sub>NTC</sub>	NTC current	Heißleiter-Strom
I <sub>R</sub>	Rated current	Nennstrom
I <sub>RMS</sub>	Root-mean-square value of current	Effektivwert des Stromes
k	Parameter for calculating the NTC resistance as a function of current (specified for inrush current limiters)	Konstante zur Berechnung des Heißleiterwiderstandes in Abhängigkeit von der Stromstärke (bei Einschaltstrombegrenzern angegeben)
n	Parameter for calculating the NTC resistance as a function of current (specified for inrush current limiters)	Konstante zur Berechnung des Heißleiterwiderstandes in Abhängigkeit von der Stromstärke (bei Einschaltstrombegrenzern angegeben)
P <sub>25</sub>	Maximum power at 25 °C	Maximale Leistung bei 25 °C
P <sub>diss</sub>	Power dissipation	Verlustleistung
P <sub>el</sub>	Electrical power	Elektrische Leistung
P <sub>max</sub>	Maximum power within stated temperature range	Maximale Leistung im angegebenen Temperaturbereich
R <sub>load</sub>	Load resistance	Ladewiderstand
R <sub>R</sub>	Rated resistance	Nennwiderstand
ΔR <sub>R</sub> /R <sub>R</sub>	Resistance tolerance	Widerstandstoleranz
R <sub>S</sub>	Series resistance	Serienwiderstand
R <sub>T</sub>	Resistance at temperature T (e.g. R <sub>25</sub> = resistance at 25 °C)	Widerstand bei Temperatur T (z.B. R <sub>25</sub> = Widerstand bei 25 °C)
T	Temperature	Temperatur
t	Time	Zeit
T <sub>A</sub>	Ambient temperature	Umgebungstemperatur
t <sub>a</sub>	Thermal threshold time	Thermische Ansprechzeit
T <sub>max</sub>	Upper category temperature	Obere Grenztemperatur (Kategorietemperatur)

Symbol	English	German
$T_{\min}$	Lower category temperature	Untere Grenztemperatur (Kategorietemperatur)
$T_R$	Rated temperature	Nenntemperatur
$T_{\text{surf}}$	Surface temperature	Oberflächentemperatur
$V$	Voltage	Spannung
$V_{\text{load}}$	Load voltage	Ladespannung
$V_{\text{NTC}}$	Voltage drop across an NTC thermistor	Spannungsabfall am Heißleiter
$V_{\text{RMS}}$	Root-mean-square value of voltage	Effektivwert der Spannung
$\alpha$	Temperature coefficient	Temperaturkoeffizient
$\Delta$	Tolerance, change	Toleranz, Änderung
$\delta_{\text{th}}$	Dissipation factor	Wärmeleitwert
$\tau_c$	Thermal cooling time constant	Thermische Abkühlzeitkonstante

**Abbreviations / Notes**

Symbol	English	German
*	To be replaced by a number in ordering codes, type designations etc.	Platzhalter für Zahl im Bestellnummerncode oder für die Typenbezeichnung.
+	To be replaced by a letter. All dimensions are given in mm. The commas used in numerical values denote decimal points.	Platzhalter für einen Buchstaben. Alle Maße sind in mm angegeben. Verwendete Kommas in Zahlenwerten bezeichnen Dezimalpunkte.

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The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
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