PTC thermistors as limit temperature sensors

SMD, EIA case sizes 0402, 0603, 0805, standard series

Series/Type:	**B59404, B59601, B59602, B59603, B59701**
Date:	April 2020

Limit temperature sensors, EIA case sizes 0402, 0603, 0805 — Standard series

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Applications

- DC/DC converters
- Home appliances
- Dimmers
- Electronic ballasts
- Over-temperature protection of power components
- Secondary protection of battery packs
- SMPS
- Notebooks

Features

- Fast and reliable response
- Suitable for reflow soldering only
- Compliant to RoHS directive 2002/95/EC
- UL approval to UL1434 for B59404A* and B59601A* (file number E69802)
- Lead-free terminations (tinned), except case size 0402

Options

- Other T_{sense} or resistance values on request

Delivery mode

- Blister tape (EIA case size 0805) or cardboard tape (EIA case sizes 0402 and 0603), 180-mm reel with 8-mm tape, taping to IEC 60286-3
- Packing unit: 4.000 pcs. for EIA case sizes 0603 and 0805, 10.000 pcs. for EIA case size 0402

General technical data

Max. operating voltage		V_{max}	32	V DC
Minimum operating temperature	($V \leq V_{max}$)	$T_{op,min}$	−40	°C
Maximum operating temperature	($V \leq V_{max}$)	$T_{op,max}$	125 °C or $T_{sense,1}$ +25 °C whichever is higher[1)]	°C

1) $T_{op,max}$ = 140 °C for B59404A0130A062

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Electrical specifications and ordering codes

EIA case sizes 0402 and 0603

R_R ($V \leq V_{max}$) Ω	ΔR_R %	$T_{sense,1}$ (@ 4.7 kΩ) °C	$T_{sense,1}$ (@ 4.7 MΩ) °C	R ($T_{sense,1}$ +10 °C) kΩ	Ordering code
EIA case size 0402, high ohmic types					
10000	±50	-	130 ±5	-	B59404A0130A062
EIA case size 0603, standard types					
470	±50	75 ±5	-	-	B59601A0075A062
470	±50	85 ±5	-	-	B59601A0085A062
470	±50	95 ±5	-	-	B59601A0095A062
470	±50	105 ±5	-	-	B59601A0105A062
470	±50	115 ±5	-	-	B59601A0115A062
470	±50	125 ±5	-	-	B59601A0125A062
470	±50	135 ±5	-	-	B59601A0135A062
EIA case size 0603, tight temperature tolerance types					
470	±50	85 ±3	-	≥ 15	B59601A0085B062
470	±50	95 ±3	-	≥ 40	B59601A0095B062
470	±50	105 ±3	-	≥ 40	B59601A0105B062
470	±50	115 ±3	-	≥ 40	B59601A0115B062
470	±50	125 ±3	-	≥ 40	B59601A0125B062

Note:
In order to limit self heating effects the electrical power during measurement should be below 2 mW for EIA case size 0402 and below 4 mW for EIA case size 0603.

Electrical specifications and ordering codes

EIA case sizes 0603 and 0805

R_R ($V \leq V_{max}$)	ΔR_R	T_{sense}	T (@ $2 \cdot R_R$)	T (typ.) (@ R_{min})	R ($T_{sense,1}$ −5°C)	R ($T_{sense,1}$ +5°C)	R ($T_{sense,1}$ +15°C)	Ordering code
Ω	%	°C	°C	°C	kΩ	kΩ	kΩ	
EIA case size 0603, tight resistance tolerance types								
110	±15	70	57 ±3	15	≤ 1.1	≥ 1.1	-	B59602A0055B062
470	±15	55	45 ±5	5	≤ 4.7	≥ 4.7	-	B59603A0055A062
470	±15	85	75 ±5	40	≤ 4.7	≥ 4.7	-	B59603A0085A062
470	±15	105	95 ±5	55	≤ 4.7	≥ 4.7	-	B59603A0105A062
EIA case size 0805, standard types								
680	±50	70	-	-	≤ 5.7	≥ 5.7	≥ 40[1)]	B59701A0070A062
680	±50	90	-	-	≤ 5.5	≥ 13.3	≥ 40	B59701A0090A062
680	±50	100	-	-	≤ 5.5	≥ 13.3	≥ 40	B59701A0100A062
680	±50	110	-	-	≤ 5.5	≥ 13.3	≥ 40	B59701A0110A062
680	±50	120	-	-	≤ 5.5	≥ 13.3	≥ 40	B59701A0120A062
680	±50	130	-	-	≤ 5.5	≥ 13.3	≥ 40	B59701A0130A062
680	±50	140	-	-	≤ 5.5	≥ 13.3	≥ 40	B59701A0140A062

Note:
In order to limit self heating effects the electrical power during measurement should be below 4 mW for EIA case size 0603 and below 6 mW for EIA case size 0805.

1) R ($T_{sense,1}$ +25 °C)

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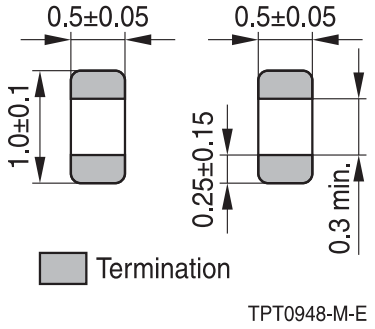
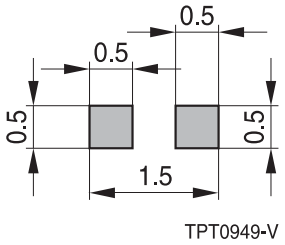
Dimensional drawings in mm

EIA case size 0402



TPT0948-M-E

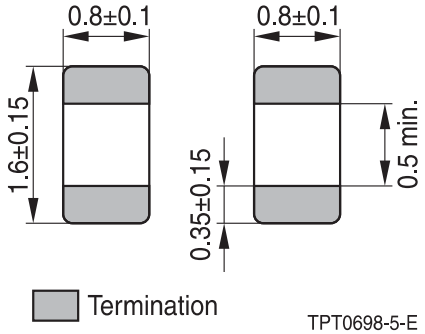
Solder pad



TPT0949-V

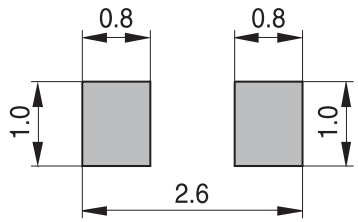
Recommended maximum dimensions (mm)

EIA case size 0603



TPT0698-5-E

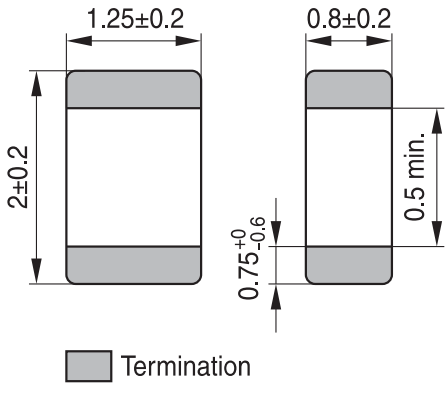
Solder pad



TPT0899-A

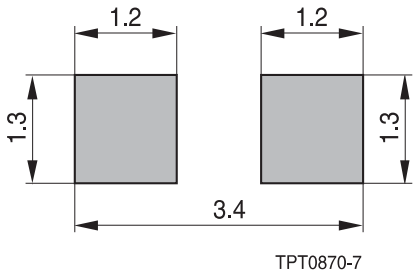
Recommended maximum dimensions (mm)

EIA case size 0805



TPT0650-F-E

Solder pad



TPT0870-7

Recommended maximum dimensions (mm)

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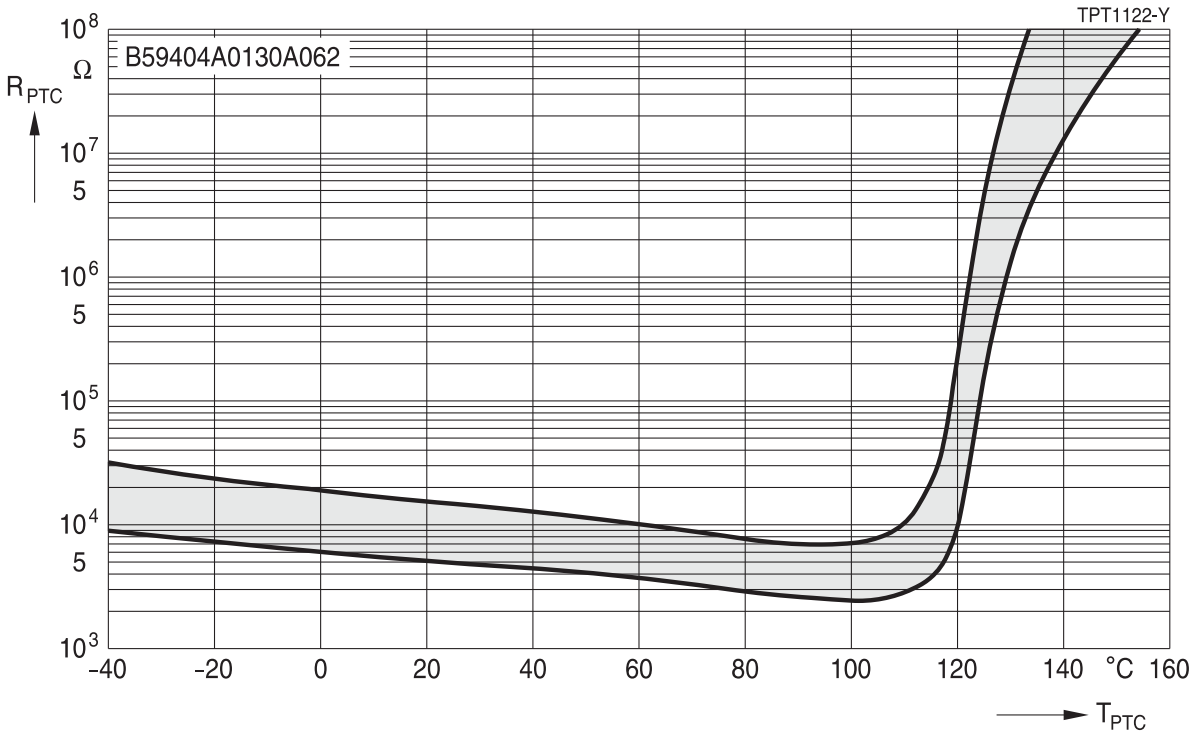
Characteristics (typical) for B59404A*, EIA case size 0402

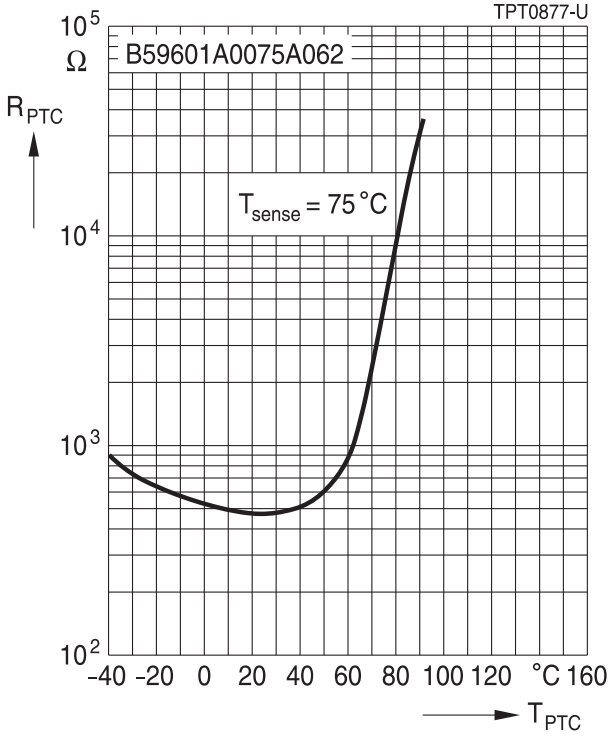
PTC resistance R_{PTC} versus PTC temperature T_{PTC} (measured at low signal voltage).
R_{min} and R_{max} values are typical values for reference only.

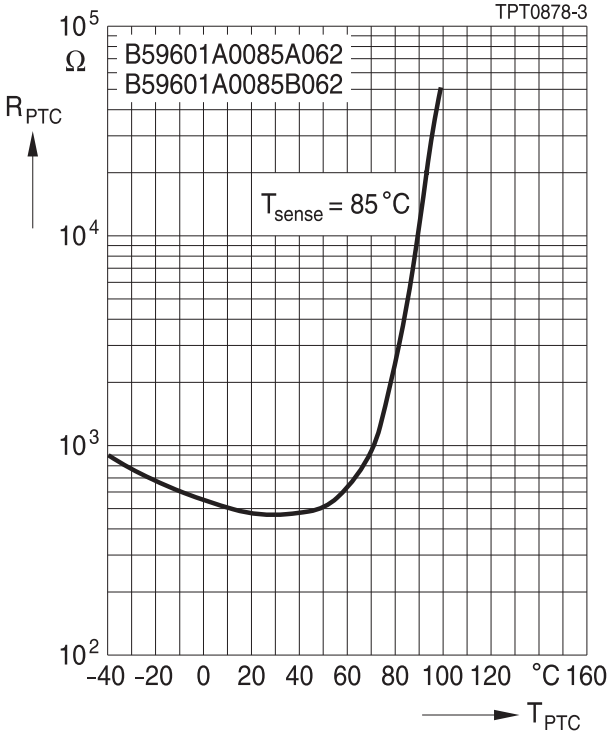


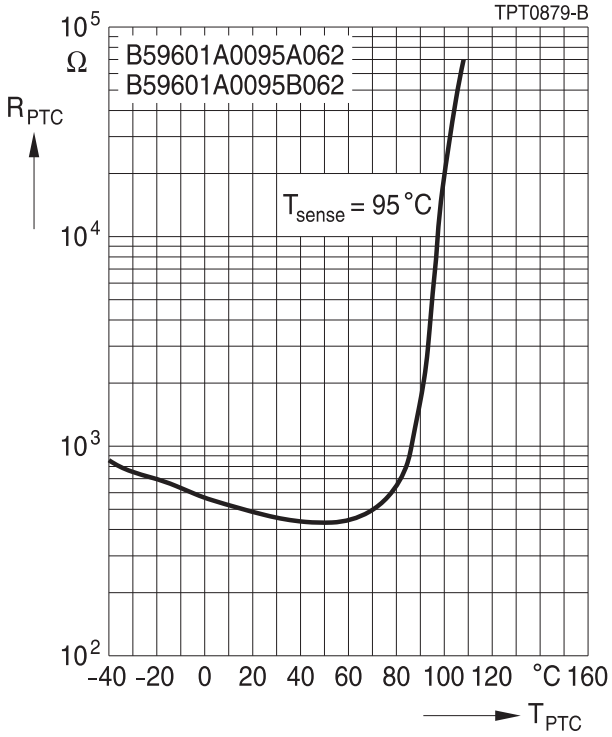
SMD

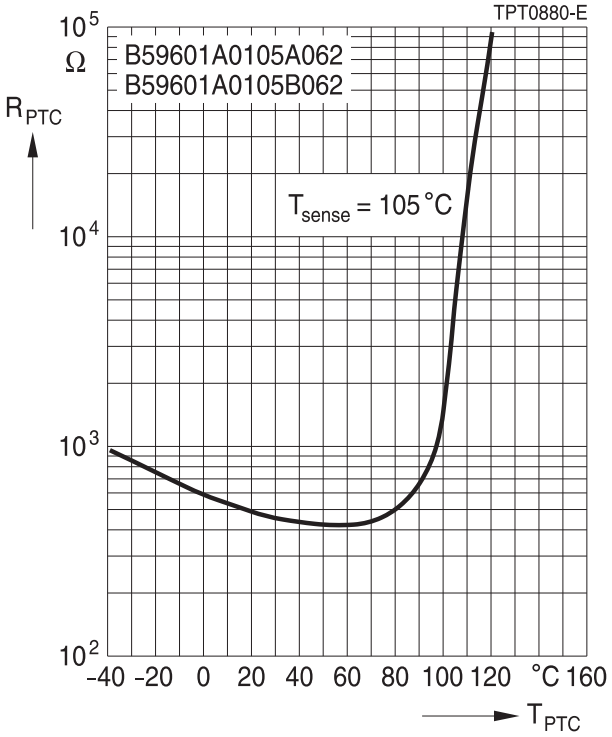
Characteristics (typical) for B59601A*, EIA case size 0603

PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)





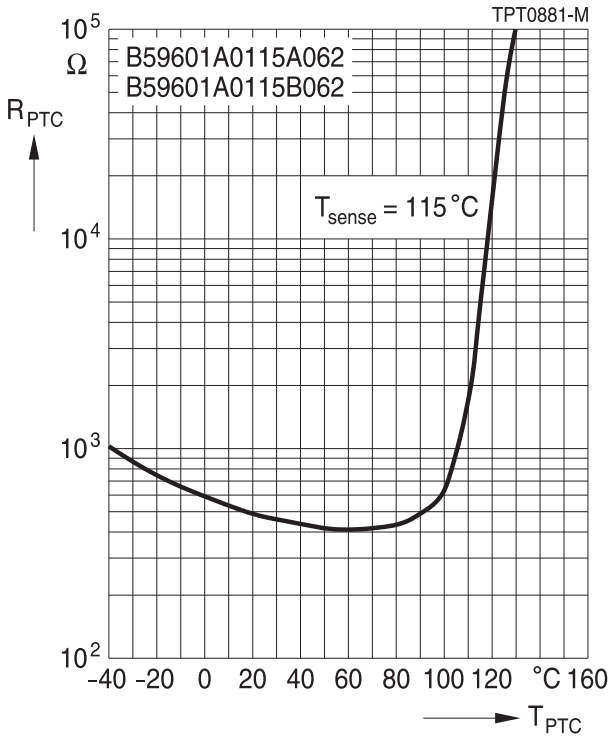


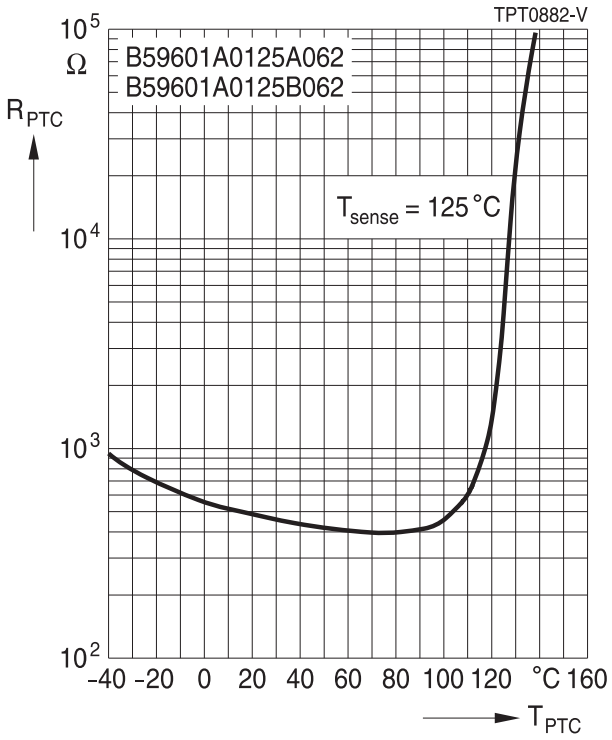


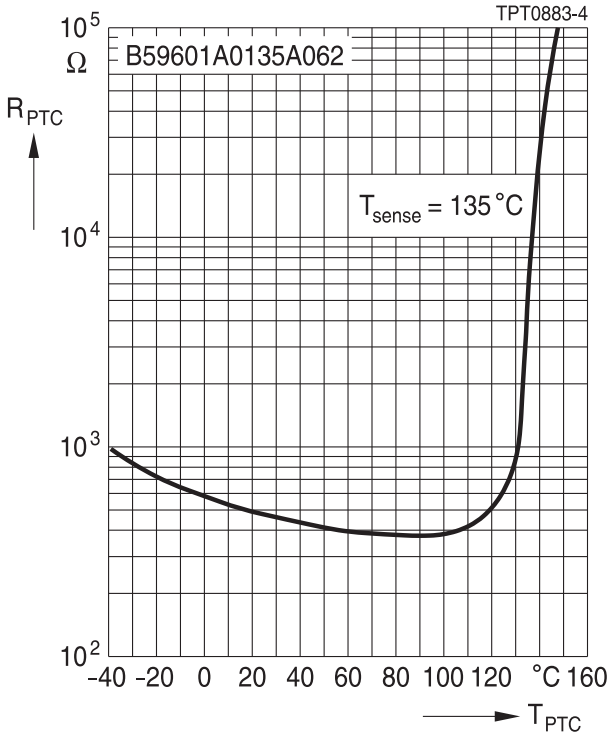
SMD

Characteristics (typical) for B59601A*, EIA case size 0603

PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)







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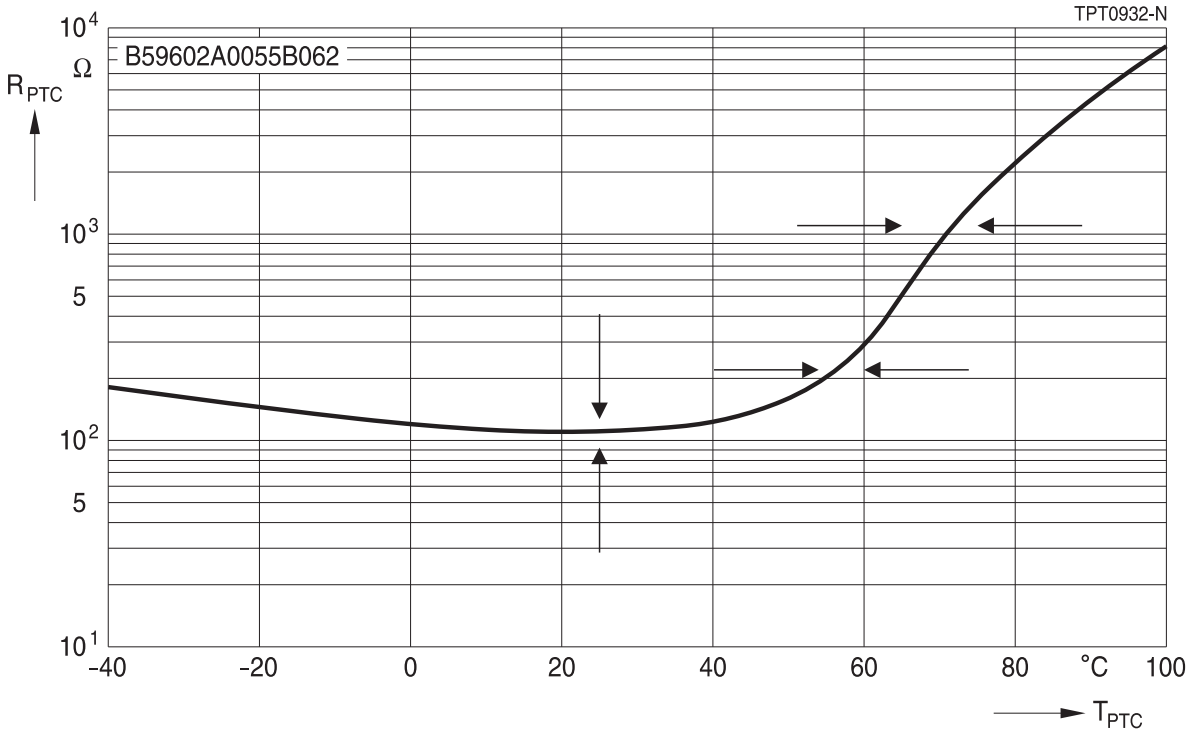
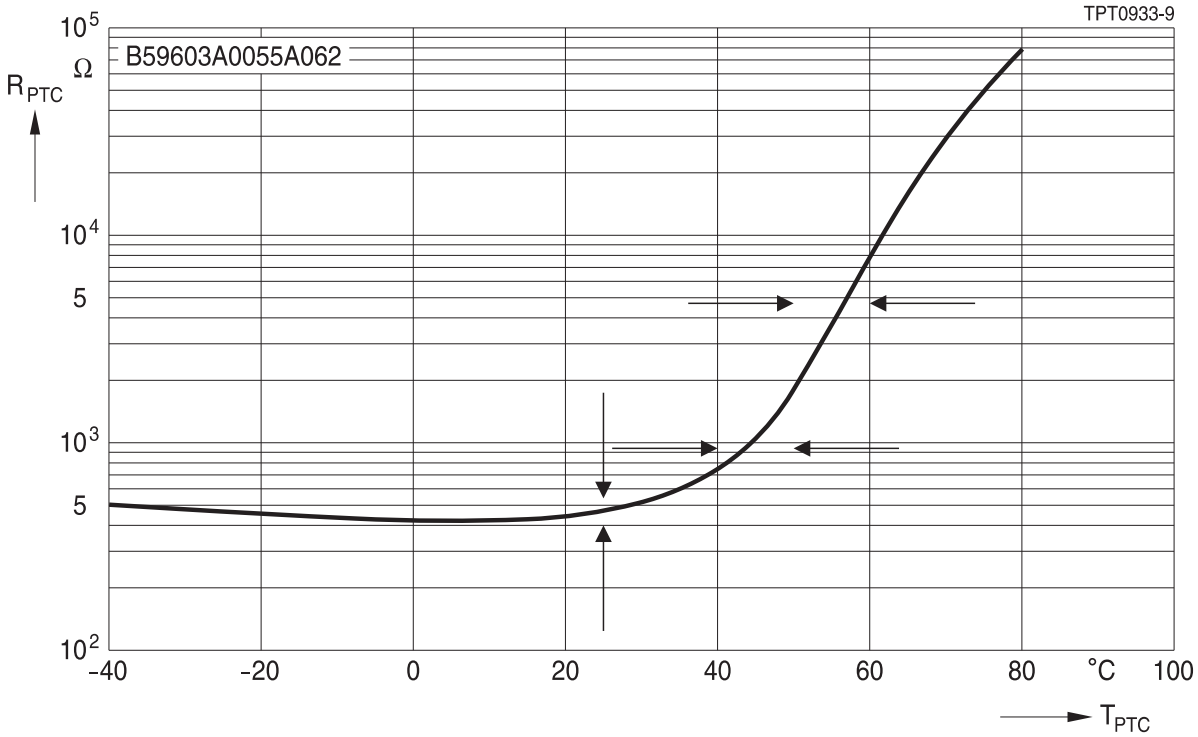
Characteristics (typical) for B59602A* and B59603A*, EIA case size 0603

PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)

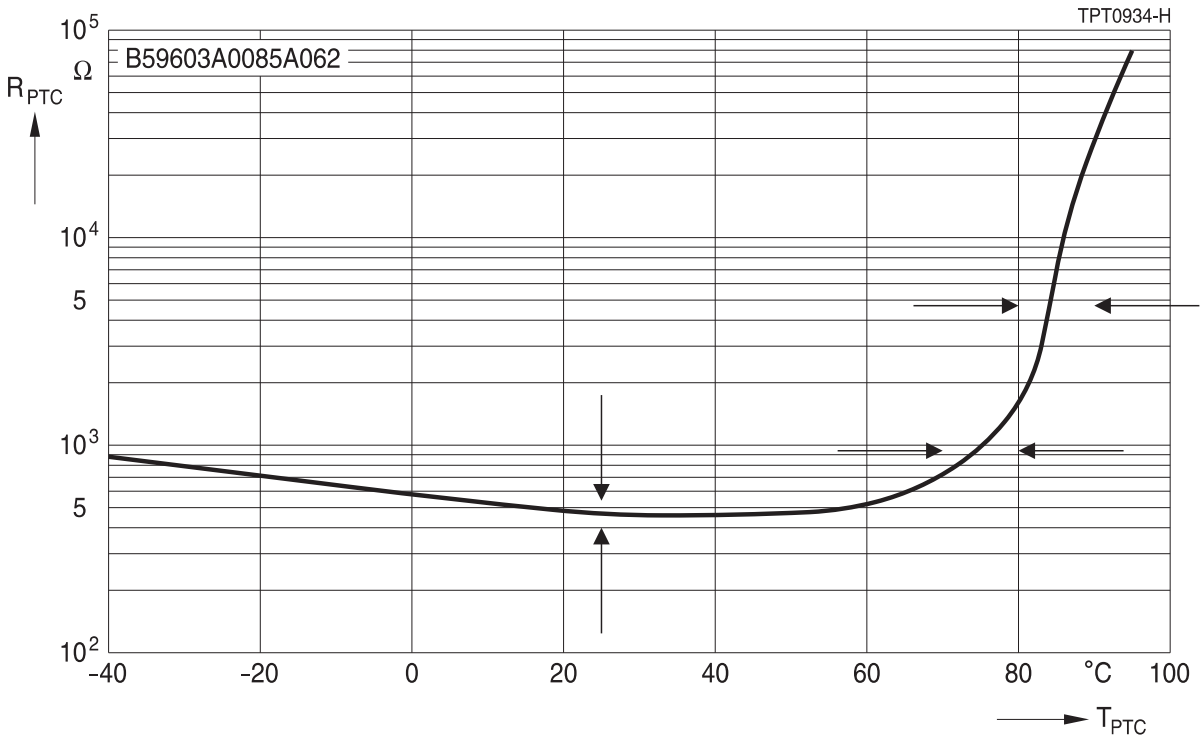


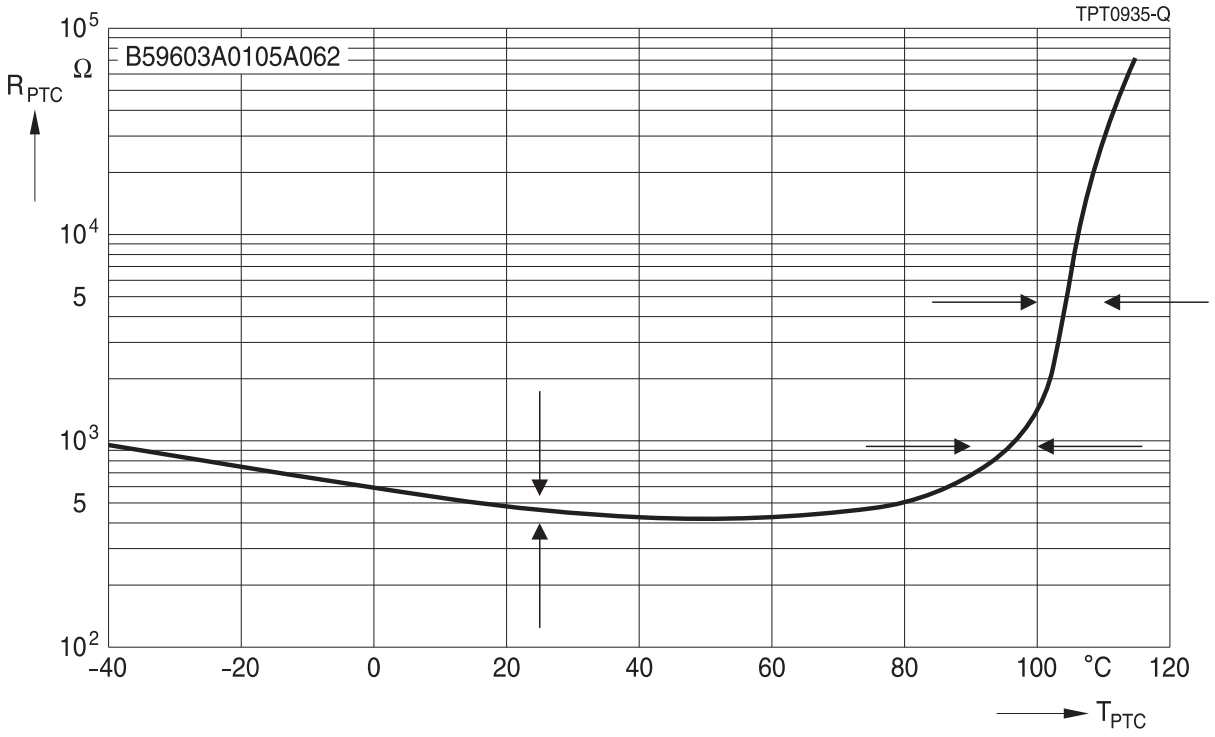


SMD

Characteristics (typical) for B59603A*, EIA case size 0603

PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)

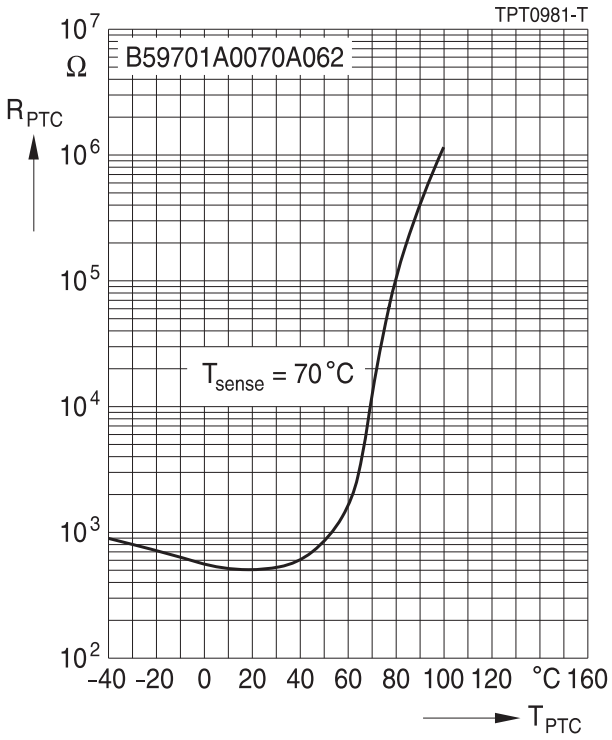


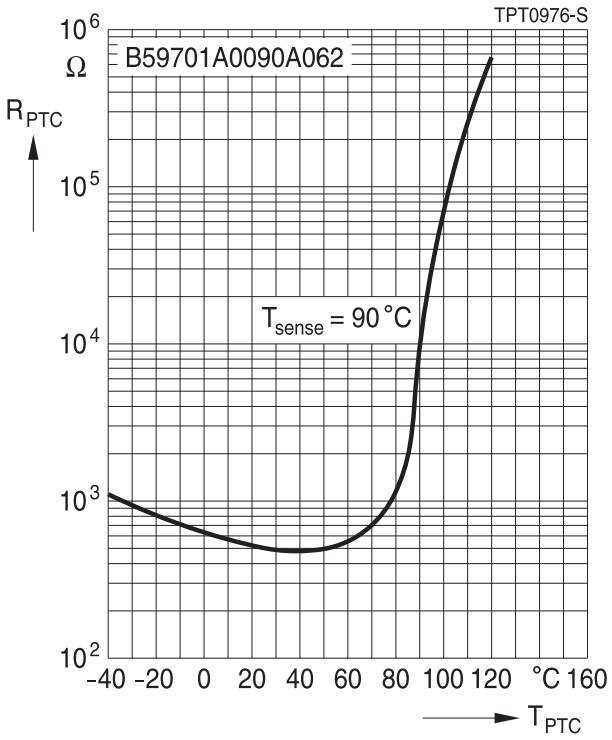


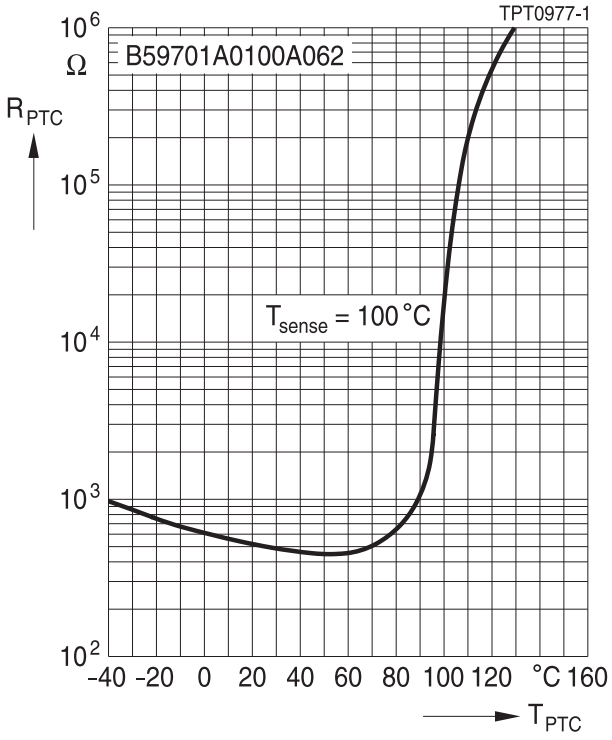
SMD

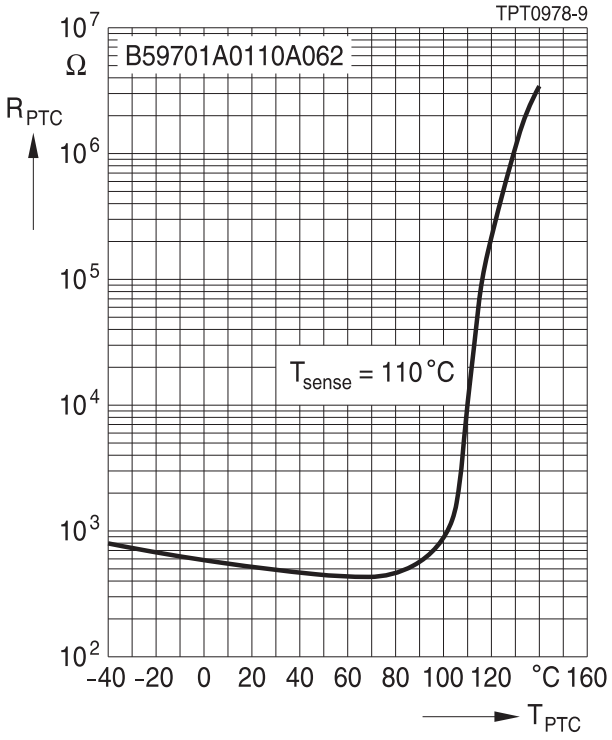
Characteristics (typical) for B59701A*, EIA case size 0805

PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)





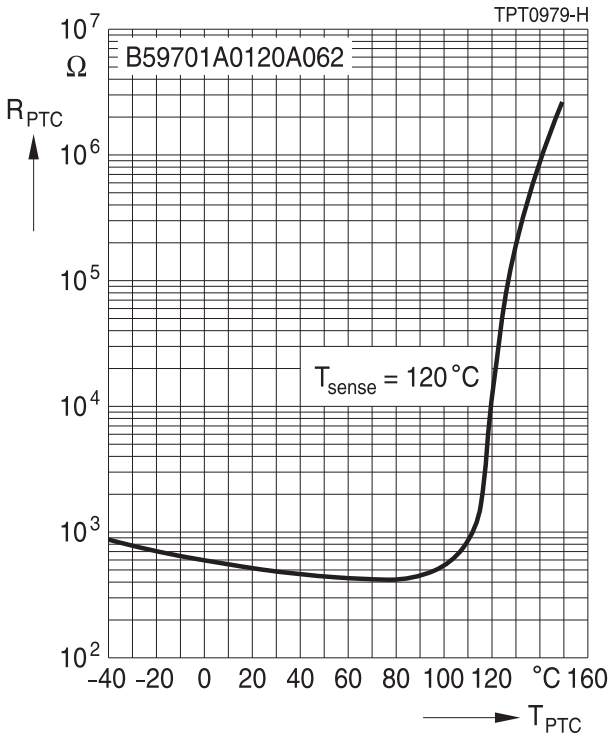


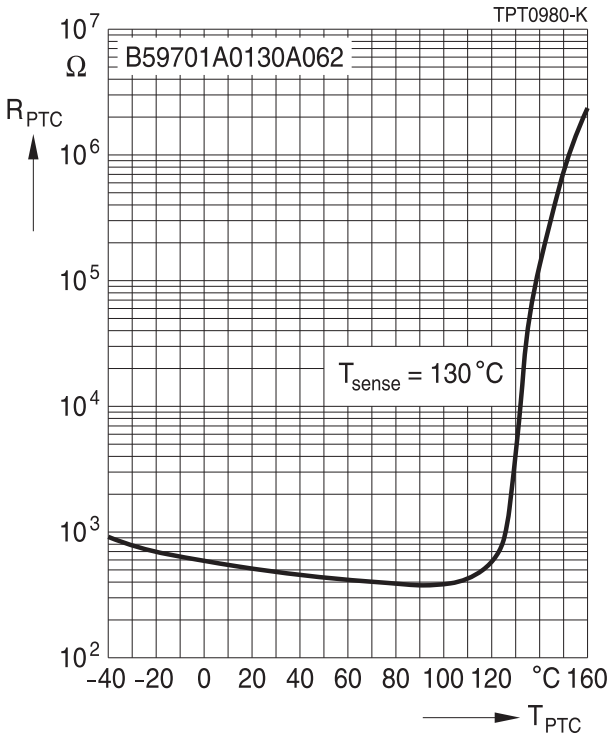


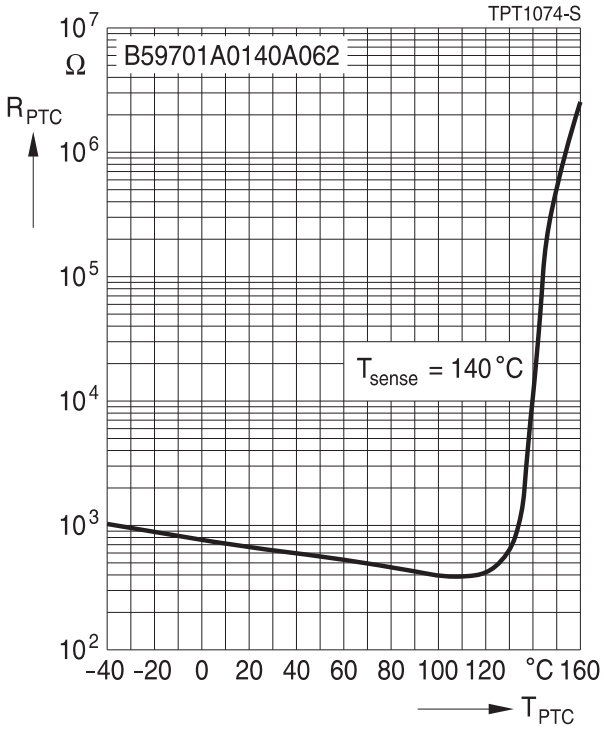
SMD

Characteristics (typical) for B59701A*, EIA case size 0805

PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)







Reliability data

Test	Standard	Test conditions	$\lvert\Delta R_{25}/R_{25}\rvert$
Electrical endurance, cycling	IEC 60738-1	Room temperature: I_{smax} , V_{max}; Number of cycles: 100	< 20%
Electrical endurance, constant	IEC 60738-1	Storage at V_{max} and $T_{op,max}$ (@ V_{max}) Test duration : 1000 h	< 25%
Damp heat	IEC 60738-1	Temperature of air: 40 °C Relative humidity of air: 93% Duration: 56 days Test according to IEC 60068-2-78	< 20%
Rapid change of temperature	IEC 60738-1	$T_{LCT} = T_{op,min}$, $T_{UCT} = T_{op,max}$ Number of cycles: 5 Test duration: 30 min Test according to IEC 60068-2-14, test Na	< 20%
Vibration	IEC 60738-1	Frequency: 10 - 55 - 10 Hz Displacement amplitude: 0.75 mm Test duration: 3 × 2 h Test according to IEC 60028-2-6, test Fc	< 20%
Shock	IEC 60738-1	Pulse shape: half-sine Acceleration: 400 m/s² Pulse duration: 6 ms; 6 x 5000 pulses Test according to IEC 60068-2-27, test Ea	< 20%
Climatic sequence	IEC 60738-1	Dry heat: T_{UCT} = 125 °C Test duration: 16 h Damp heat first cycle Cold: T_{LCT} = −40 °C Test duration: 2 h Damp heat 5 cycles Tests performed according to IEC 60068-2-30	< 20%
Bending test	IEC 60738-1	Components reflow-soldered to test board Maximum bendig: 2 mm Test according to IEC 60068-2-21, test Ue	< 20%
Shear test		Shearing of the component soldered on PCB by a force of 5 N normal to components longitudinal axis	No visible damage
Resistance to soldering heat	IEC 60738-1	Reflow soldering T= 260 −0/+5 °C, t_{Peak}= 30 ... 40 s Pb-free soldering 3 times Test according to IEC 60068-2-58	< 20%

Cautions and warnings

General

- TDK Electronics thermistors are designed for specific applications and should not be used for purposes not identified in our specifications, application notes and data books unless otherwise agreed with TDK Electronics during the design-in-phase.
- Ensure suitability of thermistor through reliability testing during the design-in phase. The thermistors should be evaluated taking into consideration worst-case conditions.

Storage

- Store thermistors only in original packaging. Do not open the package prior to processing.
- Storage conditions in original packaging: storage temperature −25 °C ... +45 °C, relative humidity ≤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 environment with effect on function on long-term operation (examples given under operation precautions).
- Use thermistor within the following period after delivery:
  - Through-hole devices (housed and leaded PTCs): 24 months
  - Motor protection sensors, glass-encapsulated sensors and probe assemblies: 24 months
  - Telecom pair and quattro protectors (TPP, TQP): 24 months
  - Leadless PTC thermistors for pressure contacting: 12 months
  - Leadless PTC thermistors for soldering: 6 months
  - SMDs in EIA sizes 3225 and 4032, and for PTCs with metal tags: 24 months
  - SMDs in EIA sizes 1210 and smaller: 12 months

Handling

- PTCs must not be dropped. Chip-offs must not be caused during handling of PTCs.
- The ceramic and metallization of the components must not be touched with bare hands. Gloves are recommended.
- Avoid contamination of thermistor surface during handling.

Soldering (where applicable)

- Use rosin-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.
- Standard PTC heaters are not suitable for soldering.

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Mounting

- Electrode must not be scratched before/during/after the mounting process.
- Contacts and housing used for assembly with thermistor have to be clean before mounting. Especially grease or oil must be removed.
- When PTC thermistors are encapsulated with sealing material, the precautions given in chapter "Mounting instructions", "Sealing and potting" must be observed.
- When the thermistor is mounted, there must not be any foreign body between the electrode of the thermistor and the clamping contact.
- The minimum force and pressure of the clamping contacts pressing against the PTC must be 10 N and 50 kPa, respectively. In case the assembly is exposed to mechanical shock and/ or vibration this force should be higher in order to avoid movement of the PTC during operation.
- During operation, the thermistor's surface temperature can be very high. Ensure that adjacent components are placed at a sufficient distance from the thermistor to allow for proper cooling at the thermistors.
- Ensure that adjacent materials are designed for operation at temperatures comparable to the surface temperature of thermistor. Be sure that surrounding parts and materials can withstand this temperature.
- Avoid contamination of thermistor surface during processing.

Operation

- Use thermistors only within the specified temperature operating range.
- Use thermistors only within the specified voltage and current ranges.
- Environmental conditions must not harm the thermistors. Use thermistors only in normal atmospheric conditions. Avoid use in deoxidizing gases (chlorine gas, hydrogen sulfide gas, ammonia gas, sulfuric acid gas etc), corrosive agents, humid or salty conditions. Contact with any liquids and solvents should be prevented.
- Be sure to provide an appropriate fail-safe function to prevent secondary product damage caused by abnormal function (e.g. use VDR for limitation of overvoltage condition).

This listing does not claim to be complete, but merely reflects the experience of TDK Electronics.

Display of ordering codes for TDK Electronics products

The ordering code for one and the same product can be represented differently in data sheets, data books, other publications, on the company website, or in order-related documents such as shipping notes, order confirmations and product labels. **The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products**. Detailed information can be found on the Internet under www.tdk-electronics.tdk.com/orderingcodes.

Symbols and terms

Symbol	Term
A	Area
C	Capacitance
C_{th}	Heat capacity
f	Frequency
I	Current
I_{max}	Maximum current
I_R	Rated current
I_{res}	Residual current
I_{PTC}	PTC current
I_r	Residual currrent
$I_{r,oil}$	Residual currrent in oil (for level sensors)
$I_{r,air}$	Residual currrent in air (for level sensors)
I_{RMS}	Root-mean-square value of current
I_S	Switching current
I_{Smax}	Maximum switching current
LCT	Lower category temperature
N	Number (integer)
N_c	Operating cycles at V_{max}, charging of capacitor
N_f	Switching cycles at V_{max}, failure mode
P	Power
P_{25}	Maximum power at 25 °C
P_{el}	Electrical power
P_{diss}	Dissipation power
R_G	Generator internal resistance
R_{min}	Minimum resistance
R_R	Rated resistance @ rated temperature T_R
ΔR_R	Tolerance of R_R
R_P	Parallel resistance
R_{PTC}	PTC resistance
R_{ref}	Reference resistance
R_S	Series resistance
R_{25}	Resistance at 25 °C
$R_{25,match}$	Resistance matching per reel/ packing unit at 25 °C
ΔR_{25}	Tolerance of R_{25}

T	Temperature
t	Time
T_A	Ambient temperature
t_a	Thermal threshold time
T_C	Ferroelectric Curie temperature
t_E	Settling time (for level sensors)
T_R	Rated temperature @ 25 °C or otherwise specified in the data sheet
T_{sense}	Sensing temperature
T_{op}	Operating temperature
T_{PTC}	PTC temperature
t_R	Response time
T_{ref}	Reference temperature
T_{Rmin}	Temperature at minimum resistance
t_S	Switching time
T_{surf}	Surface temperature
UCT	Upper category temperature
V or V_{el}	Voltage (with subscript only for distinction from volume)
$V_{c(max)}$	Maximum DC charge voltage of the surge generator
$V_{F,max}$	Maximum voltage applied at fault conditions in protection mode
V_{RMS}	Root-mean-square value of voltage
V_{BD}	Breakdown voltage
V_{ins}	Insulation test voltage
$V_{link,max}$	Maximum link voltage
V_{max}	Maximum operating voltage
$V_{max,dyn}$	Maximum dynamic (short-time) operating voltage
V_{meas}	Measuring voltage
$V_{meas,max}$	Maximum measuring voltage
V_R	Rated voltage
V_{PTC}	Voltage drop across a PTC thermistor
α	Temperature coefficient
Δ	Tolerance, change
δ_{th}	Dissipation factor
τ_{th}	Thermal cooling time constant
λ	Failure rate
e	Lead spacing (in mm)

Important notes

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, we are 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 a product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or lifesaving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet (www.tdk-electronics.tdk.com/material). Should you have any more detailed questions, please contact our sales offices.
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