

PTC thermistors as limit temperature sensors

SMD, EIA case sizes 0402, 0603 and 0805,
superior series

Series/Type: B59421, B59641, B59721

Date: March 2014

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EPCOS AG is a TDK Group Company.

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Superior series

SMD

Applications

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

Features

- Qualification based on AEC-Q200 rev. D
- Reflow soldering only
- Fast and reliable response
- RoHS-compatible
- UL approval to UL1434
- Certified in accordance with IEC 60738-1 and IEC 60730-1; Annex J15 and J17
- Lead-free terminations (tinned) for case sizes 0603 and 0805
- Lead-free ceramics for case sizes 0402 and 0805

Options

- Other T_{sense} or resistance values on request

Delivery mode

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

General technical data

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

Sensors
Limit temperature sensors, EIA sizes 0402, 0603 and 0805
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Electrical specifications and ordering codes

| R_R ($V \leq V_{max}$) Ω | ΔR_R % | $T_{sense,1}$ (@ 4.7 k Ω) $^{\circ}C$ | $T_{sense,2}$ (@ 47 k Ω) $^{\circ}C$ | Ordering code |
|---|-------------------|---|--|-----------------|
| EIA case size 0402 | | | | |
| 470 | ± 50 | 75 ± 5 | - | B59421A0075A062 |
| 470 | ± 50 | 85 ± 5 | - | B59421A0085A062 |
| 470 | ± 50 | 95 ± 5 | - | B59421A0095A062 |
| 470 | ± 50 | 105 ± 5 | - | B59421A0105A062 |
| 470 | ± 50 | 115 ± 5 | - | B59421A0115A062 |
| 470 | ± 50 | 125 ± 5 | - | B59421A0125A062 |
| 470 | ± 50 | 135 ± 5 | - | B59421A0135A062 |
| EIA case size 0603 | | | | |
| 470 | ± 50 | 75 ± 5 | 90 ± 7 | B59641A0075A062 |
| 470 | ± 50 | 85 ± 5 | 100 ± 7 | B59641A0085A062 |
| 470 | ± 50 | 95 ± 5 | 110 ± 7 | B59641A0095A062 |
| 470 | ± 50 | 105 ± 5 | 120 ± 7 | B59641A0105A062 |
| 470 | ± 50 | 115 ± 5 | 130 ± 7 | B59641A0115A062 |
| 470 | ± 50 | 125 ± 5 | 140 ± 7 | B59641A0125A062 |
| 470 | ± 50 | 135 ± 5 | 150 ± 7 | B59641A0135A062 |
| 470 | ± 50 | 145 ± 5 | - | B59641A0145A062 |

Note:

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

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| R_R ($V \leq V_{max}$) Ω | ΔR_R % | $T_{sense,1}$ $^{\circ}C$ | R ($T_{sense,1} - 5^{\circ}C$) $k\Omega$ | R ($T_{sense,1} + 5^{\circ}C$) $k\Omega$ | R ($T_{sense,1} + 15^{\circ}C$) $k\Omega$ | Ordering code |
|---|-------------------|------------------------------|--|--|---|-----------------|
| EIA case size 0805 | | | | | | |
| 680 | ± 50 | 70 | ≤ 5.7 | ≥ 5.7 | $\geq 40^{1)}$ | B59721A0070A062 |
| 680 | ± 50 | 80 | ≤ 5.7 | ≥ 5.7 | $\geq 40^{1)}$ | B59721A0080A062 |
| 680 | ± 50 | 90 | ≤ 5.5 | ≥ 13.3 | ≥ 40 | B59721A0090A062 |
| 680 | ± 50 | 100 | ≤ 5.5 | ≥ 13.3 | ≥ 40 | B59721A0100A062 |
| 680 | ± 50 | 110 | ≤ 5.5 | ≥ 13.3 | ≥ 40 | B59721A0110A062 |
| 680 | ± 50 | 120 | ≤ 5.5 | ≥ 13.3 | ≥ 40 | B59721A0120A062 |
| 680 | ± 50 | 130 | ≤ 5.5 | ≥ 13.3 | ≥ 40 | B59721A0130A062 |

Note:

In order to limit self heating effects the electrical power during measurement should be below 6 mW for case size 0805.

1) $R(T_{sense,1} + 25^{\circ}C)$

Sensors

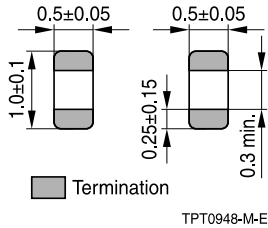
Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Superior series

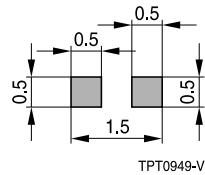
SMD

Dimensional drawings in mm

EIA case size 0402

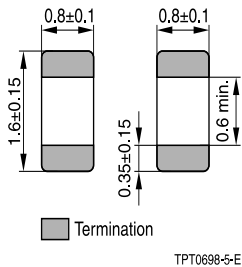


Solder pad

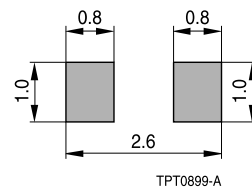


Recommended maximum dimensions (mm)

EIA case size 0603

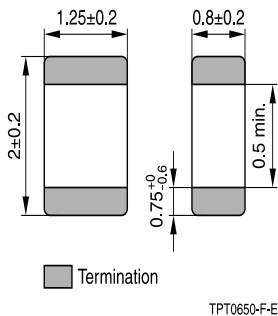


Solder pad

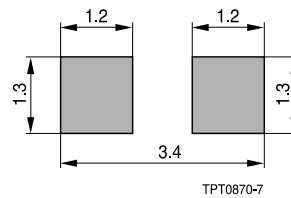


Recommended maximum dimensions (mm)

EIA case size 0805



Solder pad



Recommended maximum dimensions (mm)

Sensors
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Reliability data

| Test | Standard | Test conditions | $ \Delta R_{25}/R_{25} $ |
|--------------------------------|-------------------------|---|--------------------------|
| Electrical endurance, cycling | IEC 60738-1 | Room temperature: I_{smax} , V_{max} ; Number of cycles: 100 | < 10% |
| Electrical endurance, constant | IEC 60738-1 | Storage at V_{max}/T_{op} Test duration: 1000 h | < 20% |
| 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 | < 10% |
| Rapid change of temperature | IEC 60738-1 | $T_{LCT} = -40$ °C, $T_{UCT} = 125$ °C Number of cycles: 5 Test duration: 30 min Test according to IEC 60068-2-14, test Na | < 10% |
| Vibration I | IEC 60738-1 | Frequency: 10 - 55 - 10 Hz Displacement amplitude: 0.75 mm, resp. Acceleration: 50 m/s ² Test duration: 3 × 2 h Test according to IEC 60028-2-6, test Fc | < 5% |
| Vibration II | MIL-STD-202, method 204 | Frequency: 10 ... 2000 Hz Displacement amplitude: 0.75 mm, resp. Acceleration: 50 m/s ² Test duration: 3 × 2 h Test according to IEC 60028-2-6, test Fc | < 5% |
| Shock | IEC 60738-1 | Pulse shape: half-sine Acceleration: 390 m/s ² Pulse duration: 6 ms; 6 × 4000 pulses Test according to IEC 60068-2-27, test Ea | < 5% |
| 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 | < 10% |
| Bending test | IEC 60738-1 | Components reflow-soldered to test board Maximum bendig: 2 mm Test according to IEC 60068-2-21, test Ue | < 5% |
| Adhesive strength on PCB | | Shearing of the component soldered on PCB by a force of 5 N normal to components longitudinal axis | No visible damage |

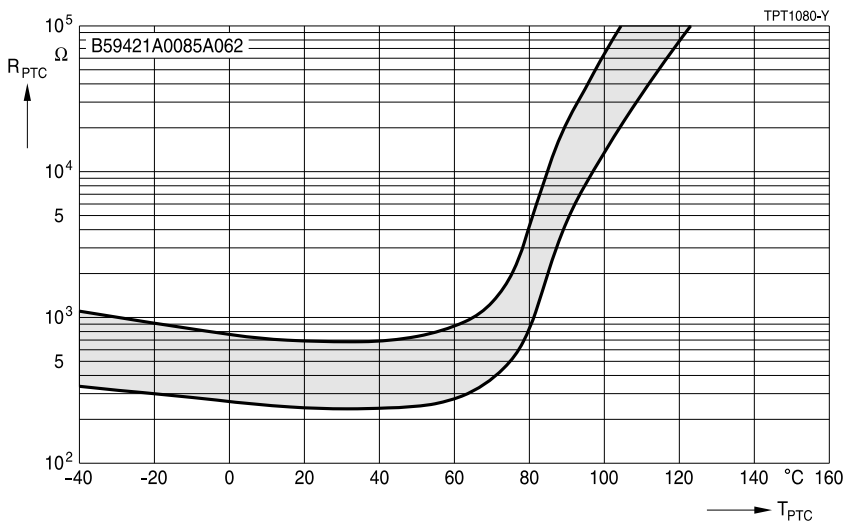
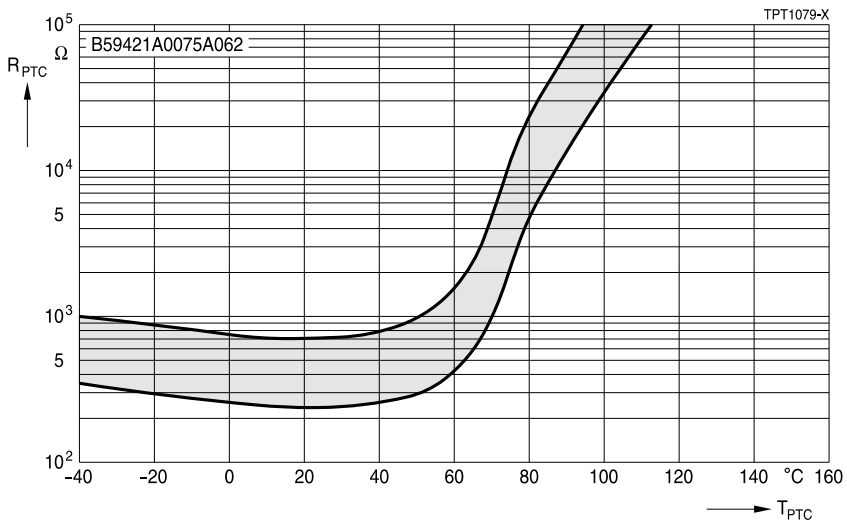
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| Test | Standard | Test conditions | $ \Delta R_{25}/R_{25} $ |
|---------------------------------|--|--|--------------------------|
| Moisture resistance | AEC-Q200 / IEC 60069-2-30 | Test Db2, category 25/125/56 | < 10% |
| Humidity | AEC-Q200 / MIL-STD-202, method 103 | T = 80 °C; H = 85% r.H.; t = 1000 h V = 0.05 · V _{max} | < 20% |
| Thermal shock | AEC-Q200 / IEC 60738-1, item 4.17 | T _{LCT} = -55 °C, T _{UCT} = 125 °C Number of cycles: 1000 | < 25% |
| Resistance to soldering heat | AEC-Q200 / IEC 60068-2-20, test Tb | Soldering bath: 260 °C; t = 20 s | < 20% |
| ESD | AEC-Q200-002 | 150 pF/ 330 Ω; 8 kV contact discharge, 10 pulses in each polarity | < 5% |
| High temperature load | | Soldered PTC to PCB @ 85 °C, load maximum operating voltage for 1.5 h on and 0.5 h off. This cycle is repeated for 1000 ±12 h | < 20% |

SMD

Characteristics (typical) for case size 0402

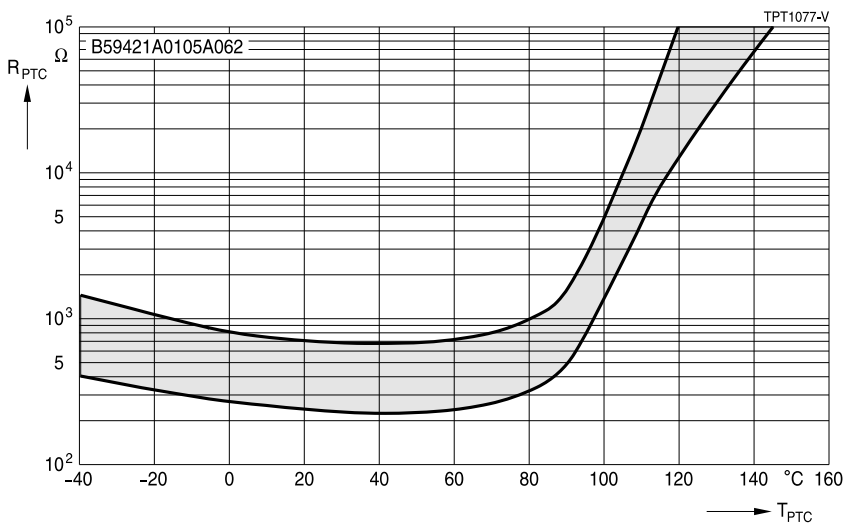
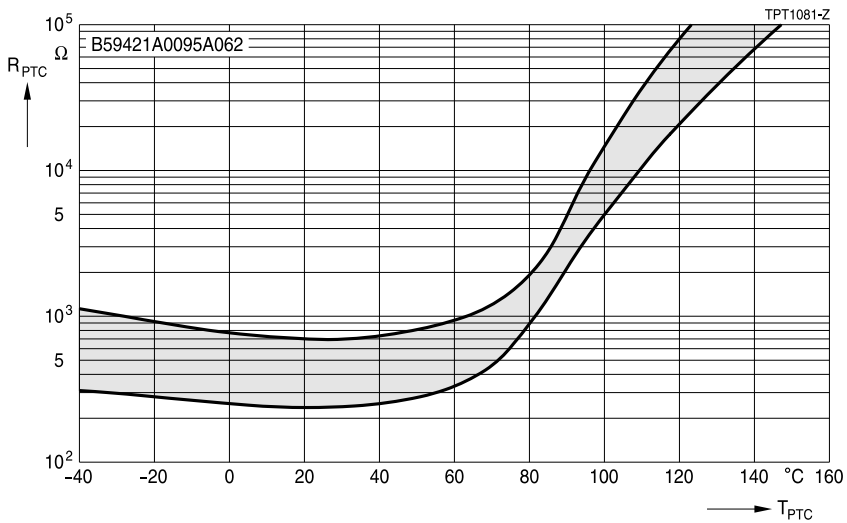
PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)



SMD

Characteristics (typical) for case size 0402

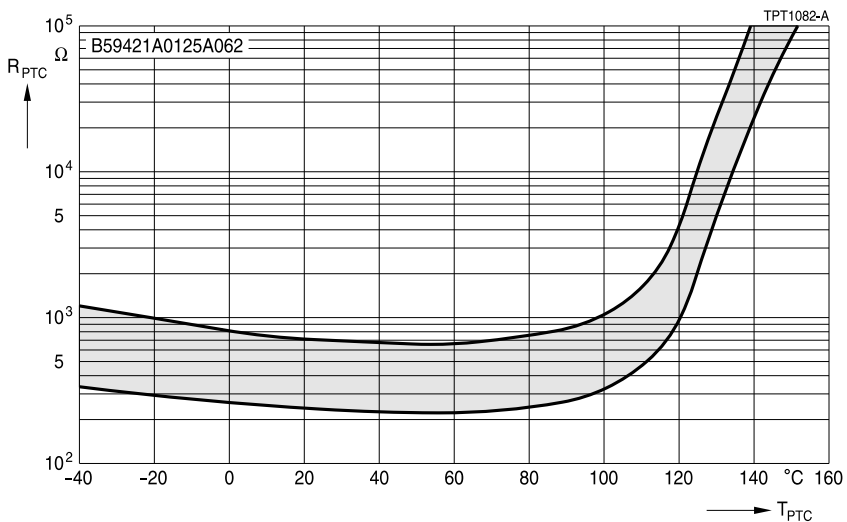
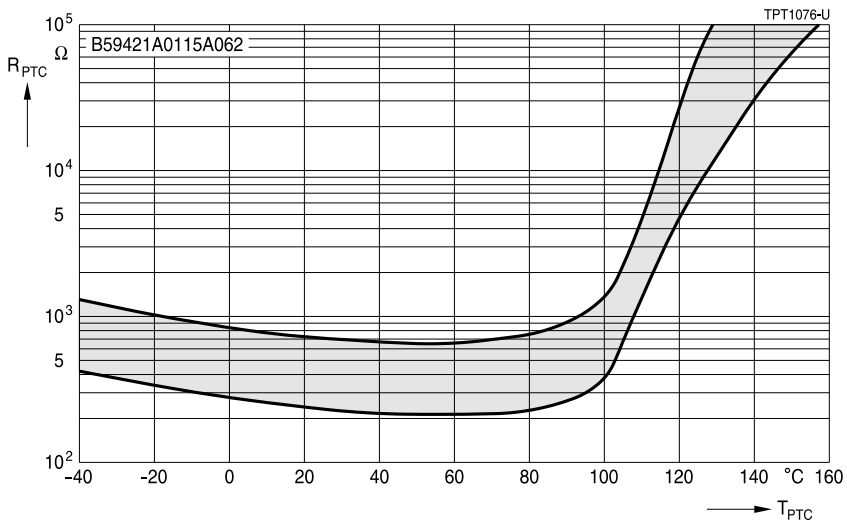
PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)



SMD

Characteristics (typical) for case size 0402

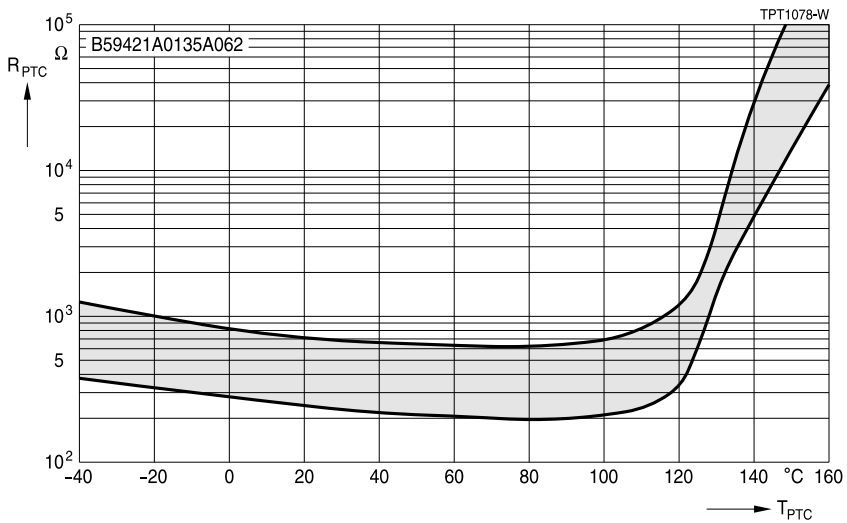
PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)



SMD

Characteristics (typical) for case size 0402

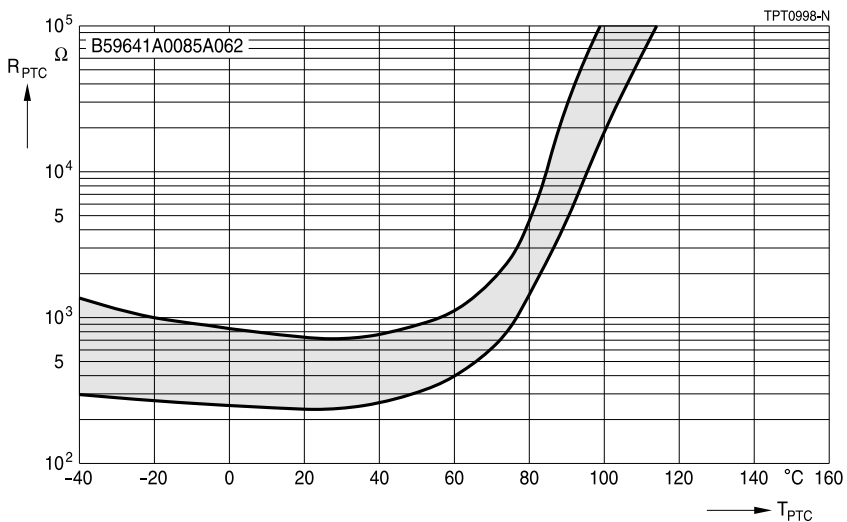
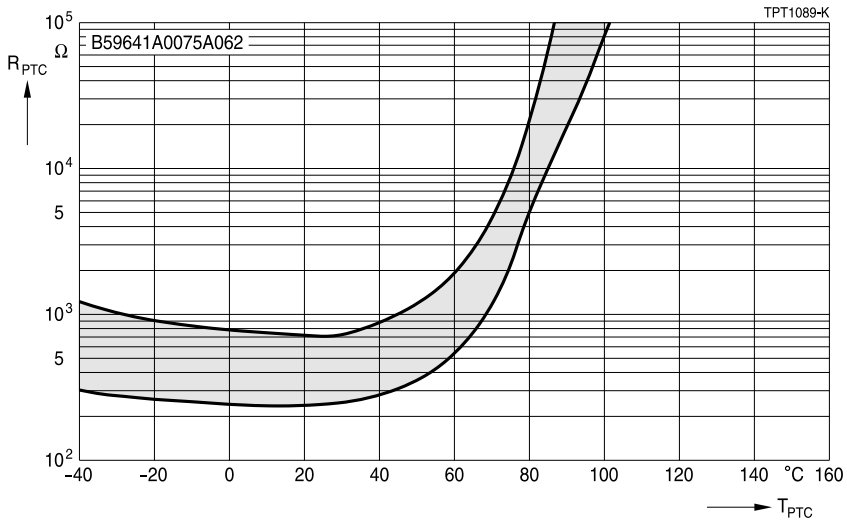
PTC resistance R_{PTC} versus PTC temperature T_{PTC}
 (measured at low signal voltage)



SMD

Characteristics (typical) for case size 0603

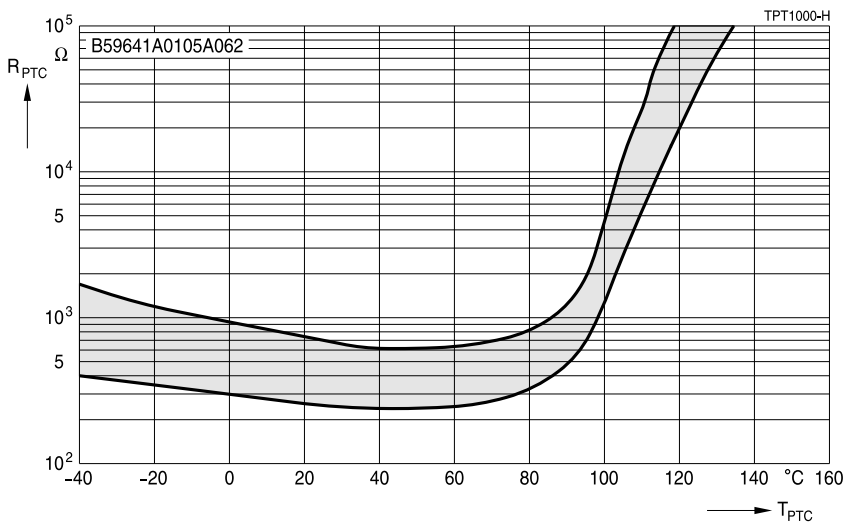
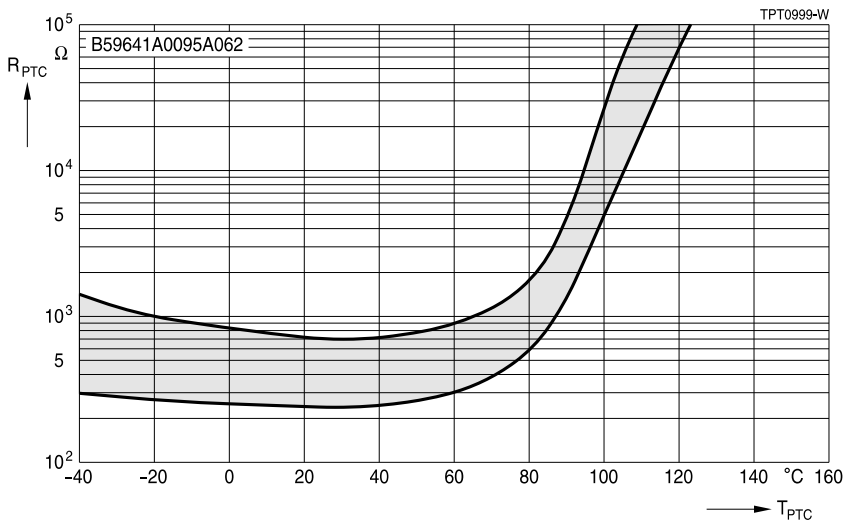
PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)



SMD

Characteristics (typical) for case size 0603

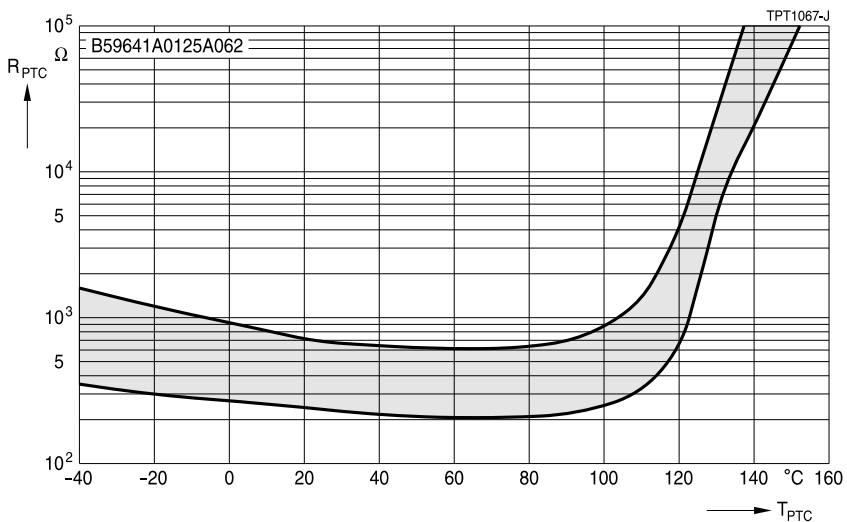
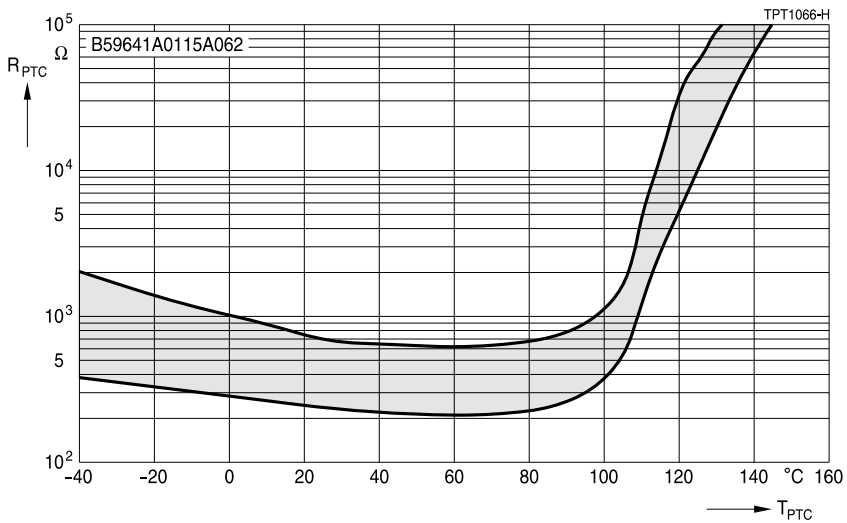
PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)



SMD

Characteristics (typical) for case size 0603

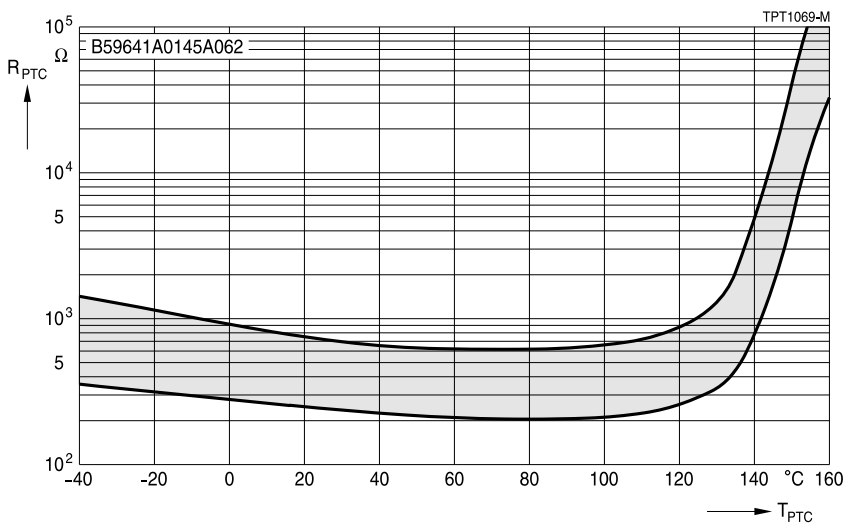
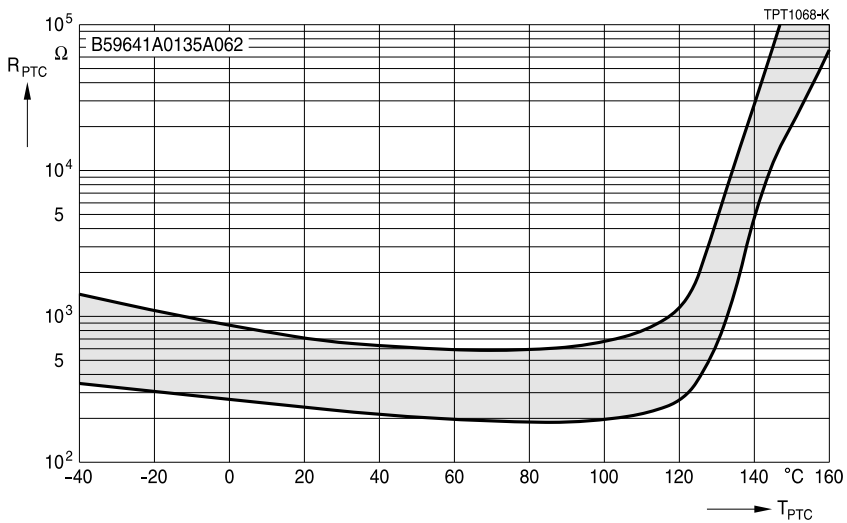
PTC resistance R_{PTC} versus PTC temperature T_{PTC}
(measured at low signal voltage)



SMD

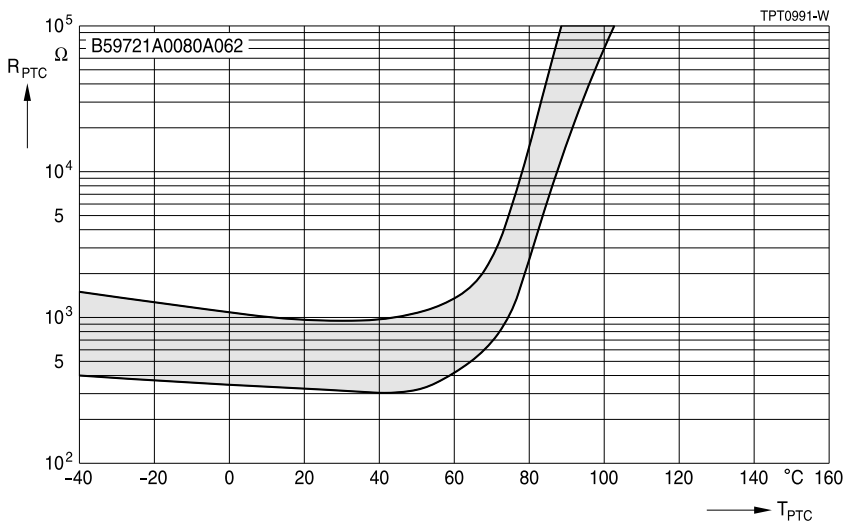
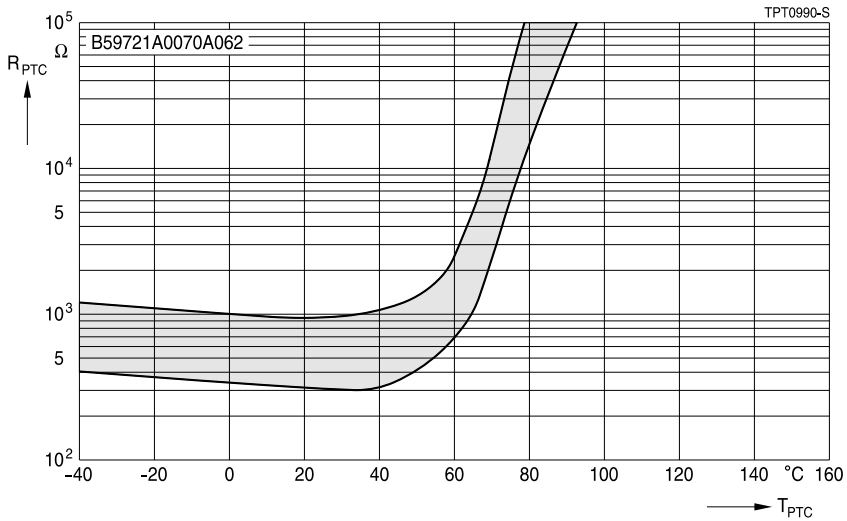
Characteristics (typical) for case size 0603

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



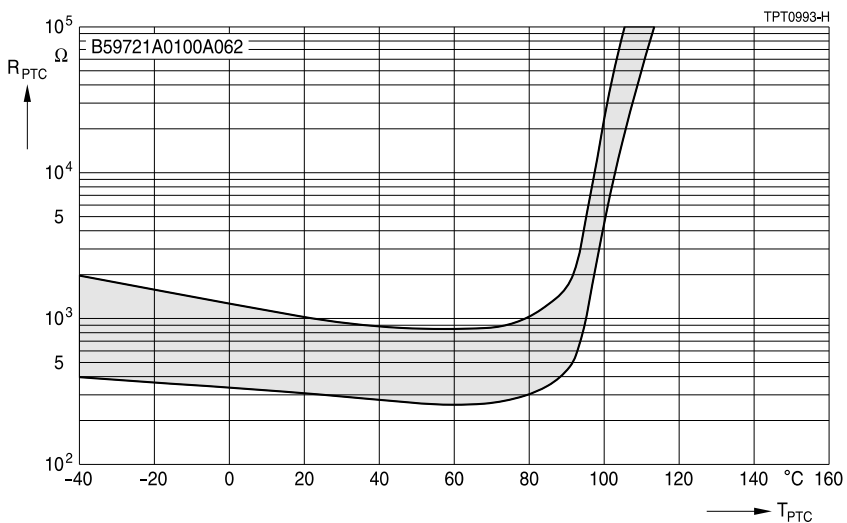
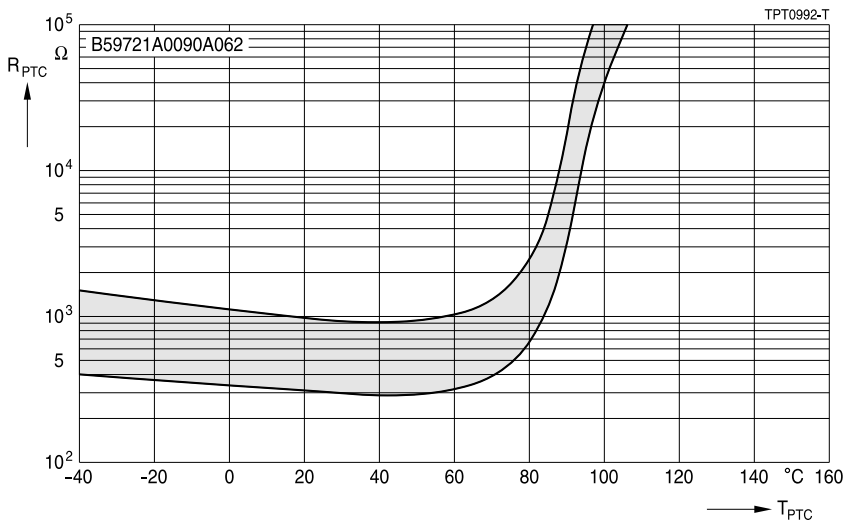
Characteristics (typical) for case size 0805

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



Characteristics (typical) for case size 0805

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



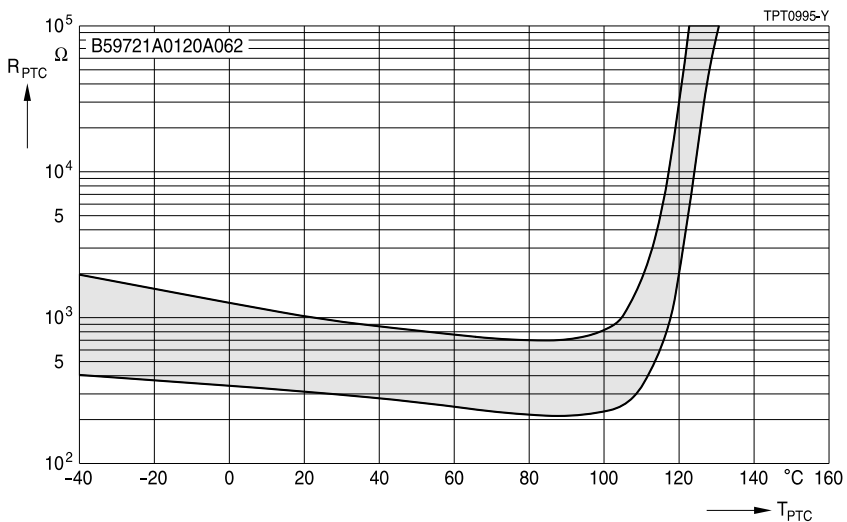
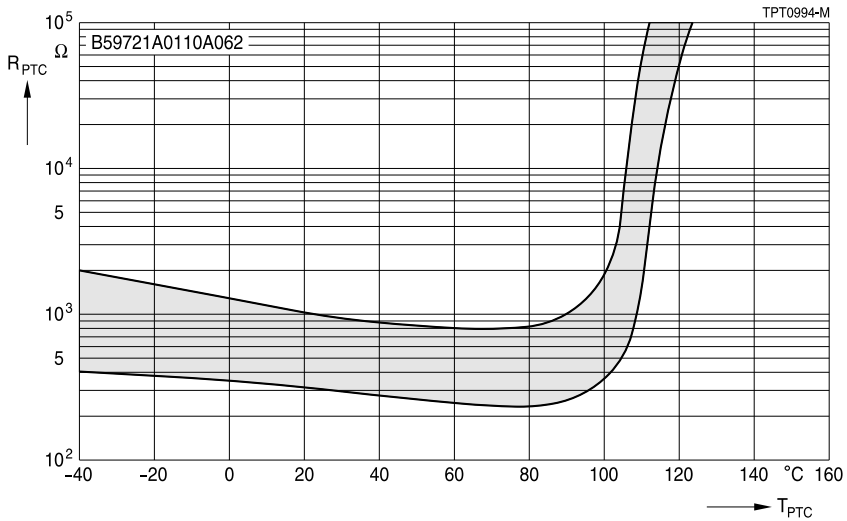
Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Superior series

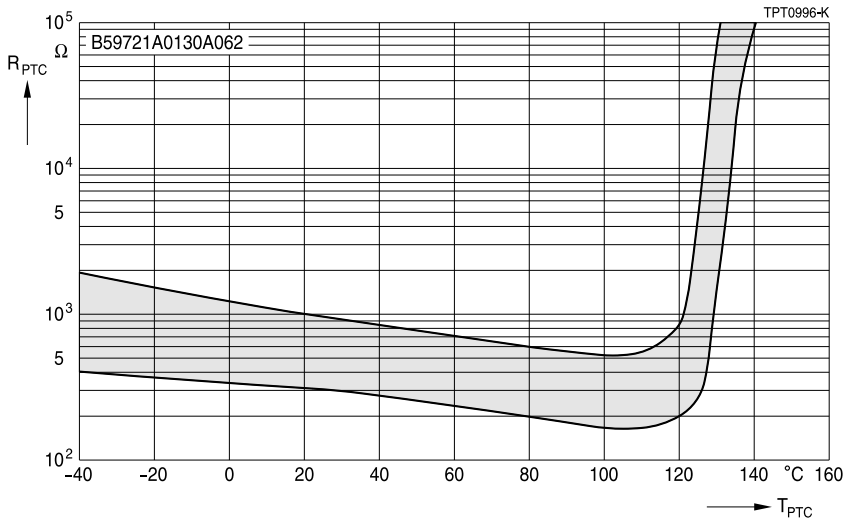
Characteristics (typical) for case size 0805

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



Characteristics (typical) for case size 0805

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



SMD**Cautions and warnings****General**

- EPCOS 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 EPCOS 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 before storage.
- Storage conditions in original packaging: storage temperature $-25\text{ }^{\circ}\text{C} \dots +45\text{ }^{\circ}\text{C}$, 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 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 0402, 0603, 0805 and 1210: 12 months

Handling

- PTCs must not be dropped. Chip-offs must not be caused during handling of PTCs.
- 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.

SMD**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 of the clamping contacts pressing against the PTC must be 10 N.
- 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 EPCOS AG.

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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 current |
| $I_{r,oil}$ | Residual current in oil (for level sensors) |
| $I_{r,air}$ | Residual current 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 |
| 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 |

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| | |
|----------------|--|
| t_a | Thermal threshold time |
| T_C | Ferroelectric Curie temperature |
| t_E | Settling time (for level sensors) |
| T_R | Rated temperature |
| 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) |

Abbreviations / Notes

SMD Surface-mount devices

* To be replaced by a number in ordering codes, type designations etc.

+ To be replaced by a letter

All dimensions are given in mm.

The commas used in numerical values denote decimal points.

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, 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.
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.epcos.com/material). Should you have any more detailed questions, please contact our sales offices.
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