



PTC thermistors as limit temperature sensors

SMD, EIA case sizes 0402, 0603 and 0805
with $\pm 3\text{ }^{\circ}\text{C}$ and $\pm 5\text{ }^{\circ}\text{C}$ tolerance

Series/Type:

Date:

November 2009

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Applications

- DC/DC converters
- Home appliances
- Dimmers
- Electronic ballasts
- Temperature management in automotive electronics
- Over-temperature protection of power transistors and power ICs
(e.g. in battery pack, notebook)
- SMPS

Features

- Thermistor chip with lead-free tinned terminations
- Small size
- Fast and reliable response
- Suitable for reflow soldering only
- RoHS-compatible
- Lead-free (total Pb content <0.1%), for $T_{\text{sense}} \leq 125\text{ °C}$, except B59602A... and B59603A...
- UL approval to UL 1434 for B59601A... and B59604A... (file number E69802)

Options

- Other T_{sense} 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

General technical data

Max. operating voltage	$(T_A = -40\text{ °C} \dots T_{\text{sense}} + 15\text{ K})$	V_{max}	32	V_{DC}
Operating temperature range	$(V \leq V_{\text{max}})$	T_{op}	$-40 / T_{\text{sense}} + 15$	°C

Sensors

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Electrical specifications and ordering codes

T_{sense} °C	R_R Ω	ΔR_R %	R ($T_{\text{sense}} - \Delta T$) kΩ	R ($T_{\text{sense}} + \Delta T$) kΩ	R ($T_{\text{sense}} + 10 \text{ K}$) kΩ	R ($T_{\text{sense}} + 15 \text{ K}$) kΩ	Ordering code
Case size 0402, standard series, $\Delta T = \pm 5 \text{ °C}$							
105	470	± 50	≤ 4.7	≥ 4.7			B59401A0105A062
115	470	± 50	≤ 4.7	≥ 4.7			B59401A0115A062
Case size 0603, high-ohmic series, $\Delta T = \pm 5 \text{ °C}$							
120	10000	± 50	≤ 4700	≥ 4700			B59604A0085A062
130	10000	± 50	≤ 4700	≥ 4700			B59604A0090A062
Case size 0603, standard series, $\Delta T = \pm 5 \text{ °C}$							
75	470	± 50	≤ 4.7	≥ 4.7			B59601A0075A062
85	470	± 50	≤ 4.7	≥ 4.7			B59601A0085A062
95	470	± 50	≤ 4.7	≥ 4.7			B59601A0095A062
105	470	± 50	≤ 4.7	≥ 4.7			B59601A0105A062
115	470	± 50	≤ 4.7	≥ 4.7			B59601A0115A062
125	470	± 50	≤ 4.7	≥ 4.7			B59601A0125A062
135	470	± 50	≤ 4.7	≥ 4.7			B59601A0135A062
Case size 0603, tight resistance tolerance series, $\Delta T = \pm 5 \text{ °C}$							
70	110	± 15	≤ 1.1	≥ 1.1			B59602A0055B062
55	470	± 15	≤ 4.7	≥ 4.7			B59603A0055A062
85	470	± 15	≤ 4.7	≥ 4.7			B59603A0085A062
105	470	± 15	≤ 4.7	≥ 4.7			B59603A0105A062
Case size 0603, tight temperature tolerance series, $\Delta T = \pm 3 \text{ °C}$							
75	470	± 50	≤ 4.7	≥ 4.7			B59601A0075B062
85	470	± 50	≤ 4.7	≥ 4.7	≥ 15		B59601A0085B062
95	470	± 50	≤ 4.7	≥ 4.7	≥ 40		B59601A0095B062
105	470	± 50	≤ 4.7	≥ 4.7	≥ 40		B59601A0105B062
115	470	± 50	≤ 4.7	≥ 4.7	≥ 40		B59601A0115B062
125	470	± 50	≤ 4.7	≥ 4.7	≥ 40		B59601A0125B062
135	470	± 50	≤ 4.7	≥ 4.7	≥ 40		B59601A0135B062
Case size 0805, standard series, $\Delta T = \pm 5 \text{ °C}$							
70	< 1000		≤ 5.7	≥ 5.7		$\geq 40^{1)}$	B59701A0070A062
90	< 1000		≤ 5.5	≥ 13.3		≥ 40	B59701A0090A062
100	< 1000		≤ 5.5	≥ 13.3		≥ 40	B59701A0100A062
110	< 1000		≤ 5.5	≥ 13.3		≥ 40	B59701A0110A062
120	< 1000		≤ 5.5	≥ 13.3		≥ 40	B59701A0120A062
130	< 1000		≤ 5.5	≥ 13.3		≥ 40	B59701A0130A062
140	< 1000		≤ 5.5	≥ 13.3		≥ 40	B59701A0140A062

Note:

In order to limit self heating effects the electrical power during measurement should be below 2 mW for case size 0402, below 4 mW for case size 0603 and below 6 mW for case size 0805.

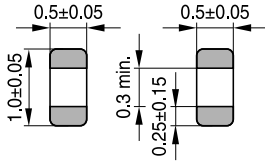
1) R ($T_{\text{sense}} + 25 \text{ °C}$)

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Dimensional drawings in mm

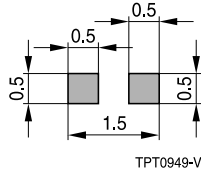
EIA case size 0402



Termination

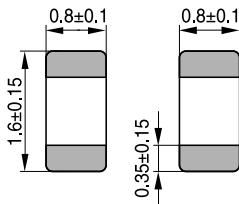
TPT0948-M-E

Solder pad



TPT0949-V

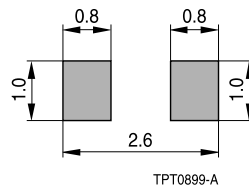
EIA case size 0603



Termination

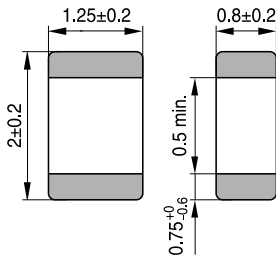
TPT0698-5-E

Solder pad



TPT0899-A

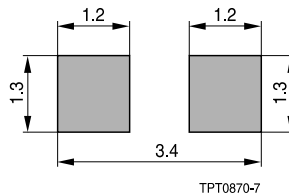
EIA case size 0805



Termination

TPT0650-F-E

Solder pad



TPT0870-7

Recommended maximum dimensions (mm)

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Reliability data

Test	Standard	Test conditions	$ \Delta R_{25}/R_{25} $
Electrical endurance, constant at 85 °C	IEC 60738-1	Storage at $V_{\max}/T_{\text{op,max}} (V_{\max})$ T = 85 °C 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	< 10%
Rapid change of temperature	IEC 60738-1	$T_1 = T_{\text{op,min}} (0 \text{ V})$, $T_2 = T_{\text{op,max}} (0 \text{ V})$ Number of cycles: 5 Test duration: 30 min Test according to IEC 60068-2-14, Test Na	< 10%
Vibration	IEC 60738-1	Frequency: 10 to 55 Hz Displacement amplitude: 0.75 mm Test duration: $3 \times 2 \text{ h}$ Test according to IEC 60068-2-6, Test Fc	< 5%
Shock	IEC 60738-1	Acceleration: 390 m/s ² Pulse duration: 6 ms; 6×4000 pulses	< 5%
Climatic sequence	IEC 60738-1	Dry heat: T = $T_{\text{op,max}} (0 \text{ V})$ Test duration: 16 h Damp heat first cycle Cold: T = $T_{\text{op,min}} (0 \text{ V})$ Test duration: 2 h Damp heat 5 cycles Tests performed according to IEC 60068-2-30	< 10%
Bending test	EN 130000/4.35	Components reflow-soldered to test board Maximum bending: 2 mm	< 10%
Adhesive strength on PCB		A shear force of 5 N is applied perpendicular to the longitudinal axis of the component which is soldered on PCB.	No visible damage

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

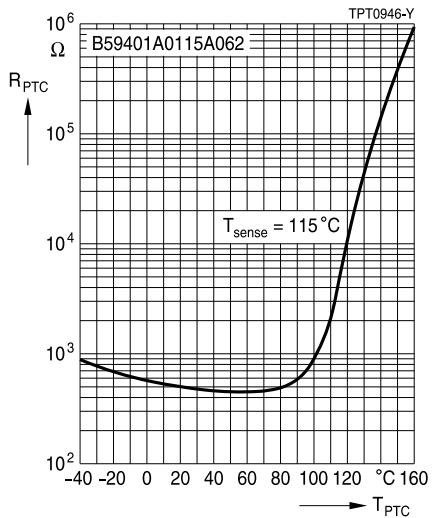
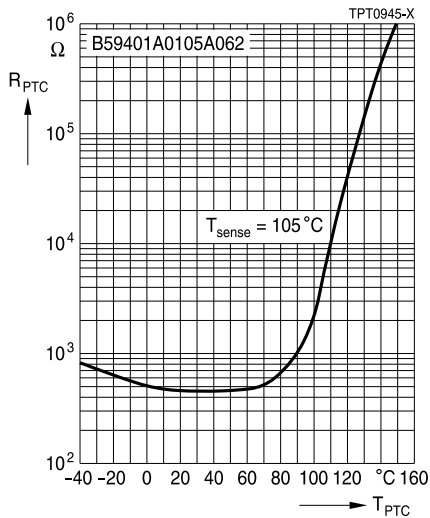
SMD

Characteristics (typical) for type A401

PTC resistance R_{PTC} versus

PTC temperature T_{PTC}

(measured at low signal voltage)



Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

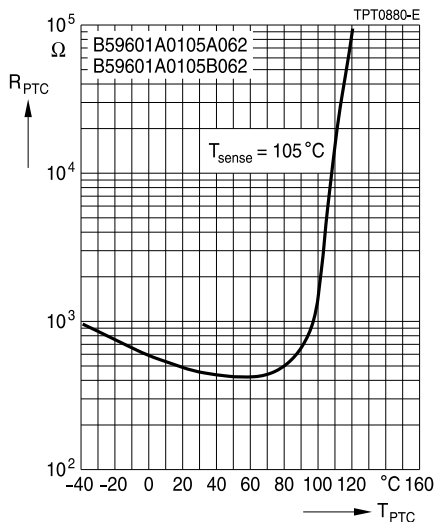
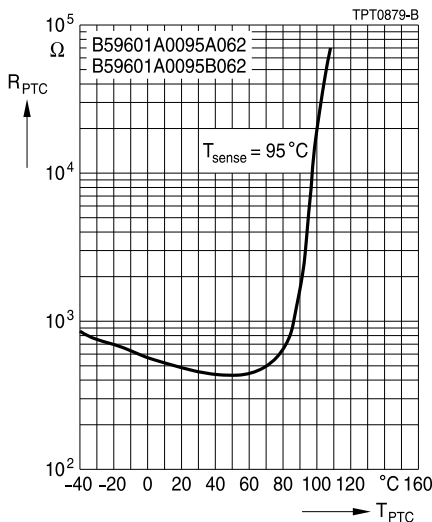
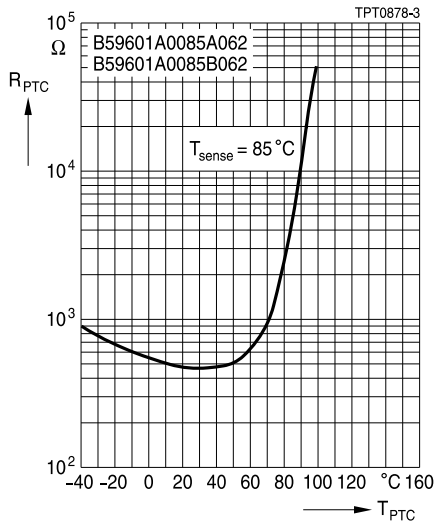
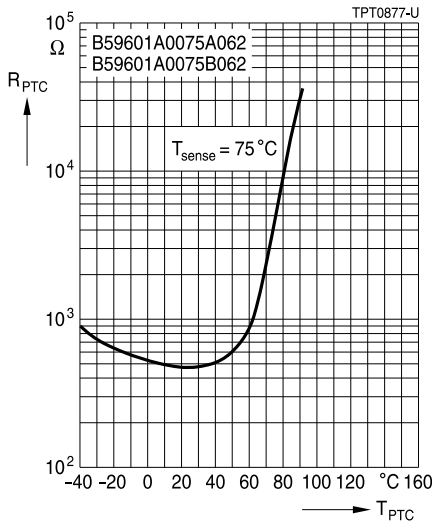
SMD

Characteristics (typical) for type A601

PTC resistance R_{PTC} versus

PTC temperature T_{PTC}

(measured at low signal voltage)



Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

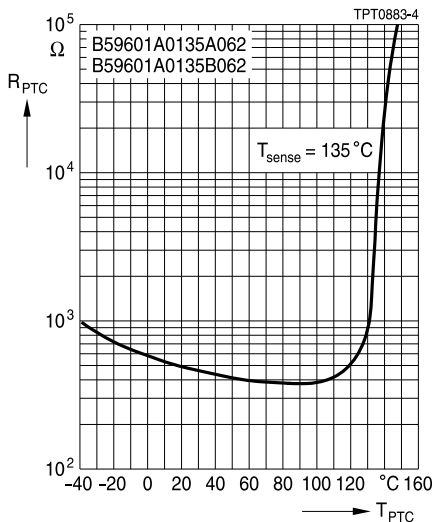
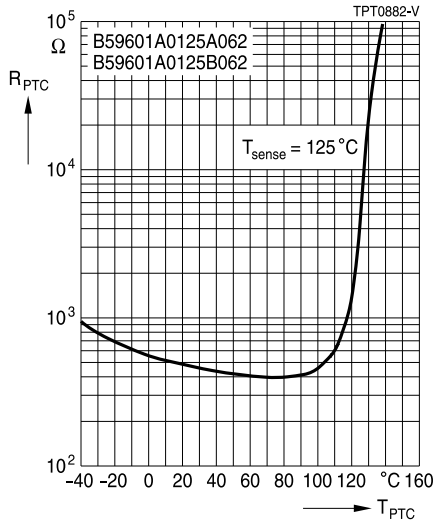
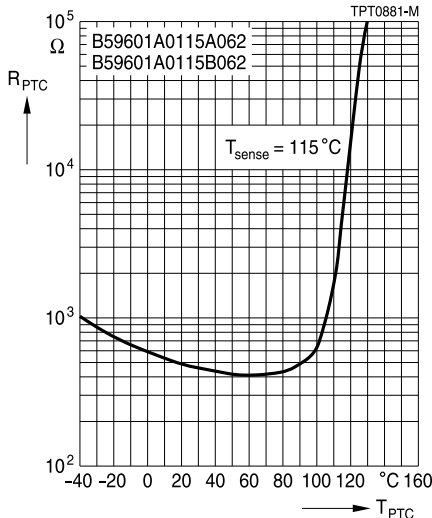
SMD

Characteristics (typical) for type A601

PTC resistance R_{PTC} versus

PTC temperature T_{PTC}

(measured at low signal voltage)

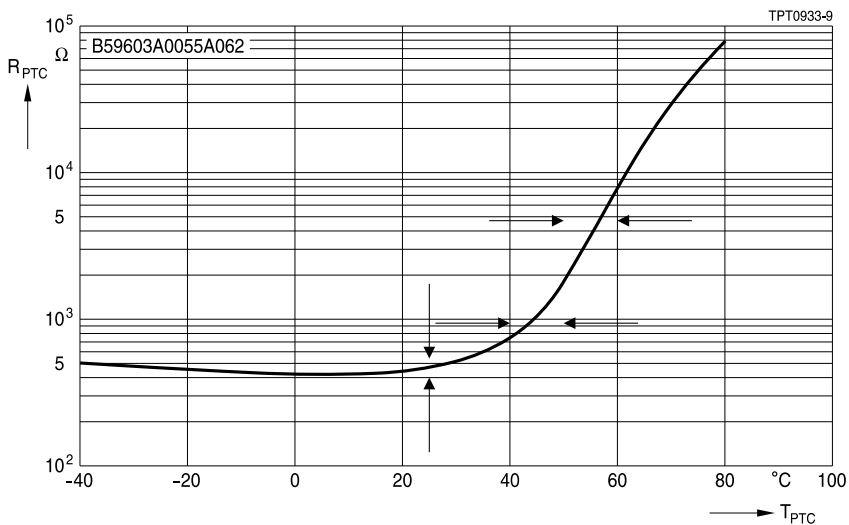
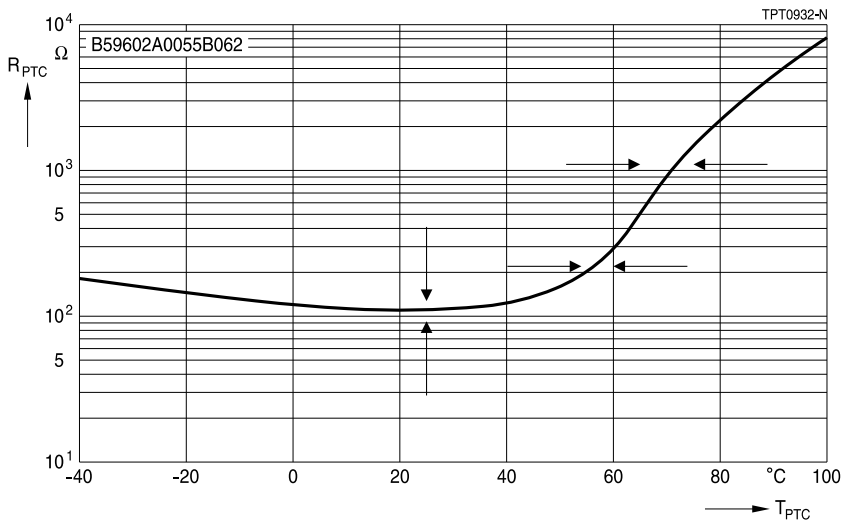


Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Characteristics (typical) for type A602 and A603

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

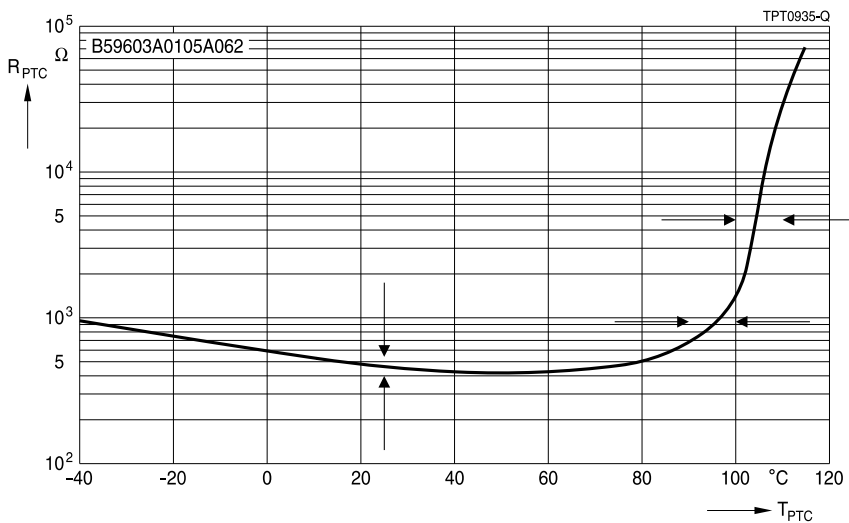
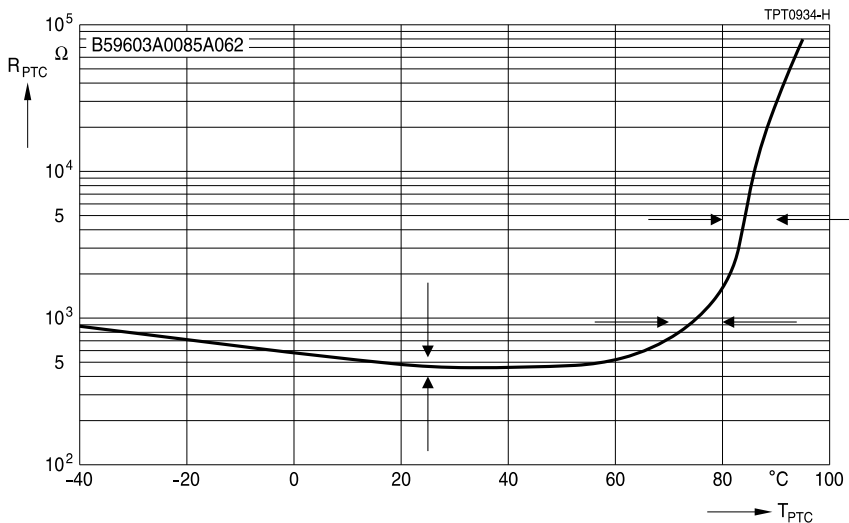


Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Characteristics (typical) for type A603

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

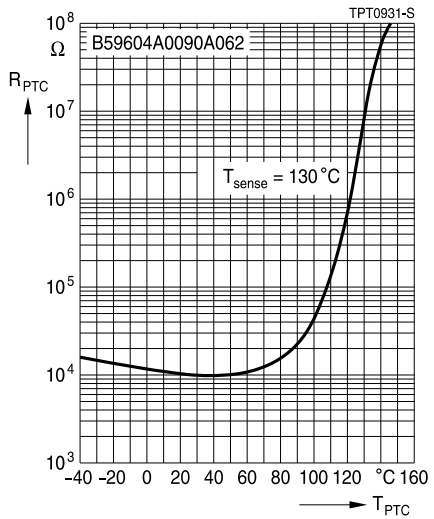
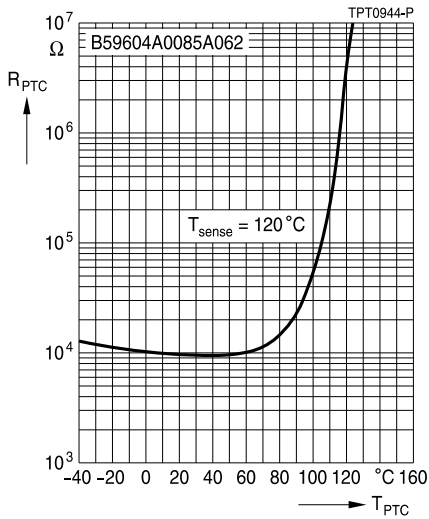


Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Characteristics (typical) for type A604

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

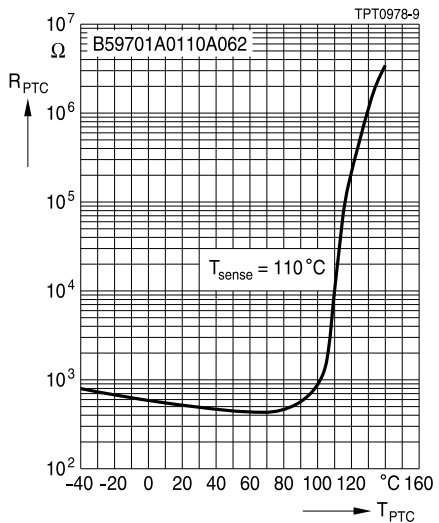
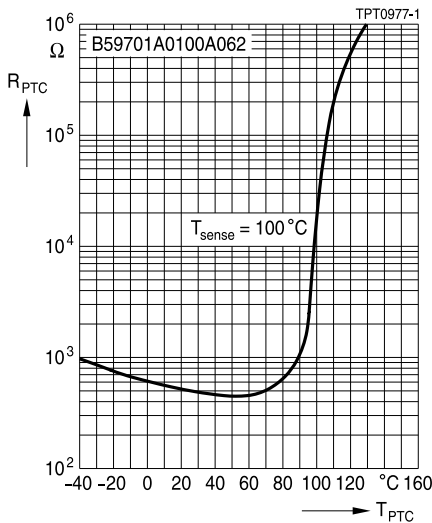
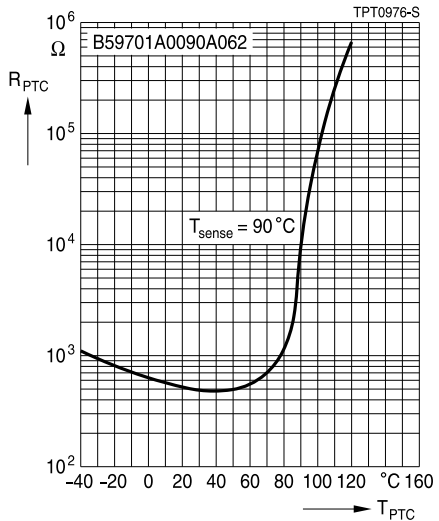
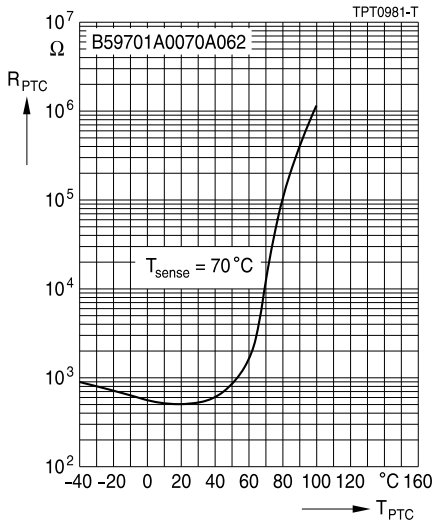


Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Characteristics (typical) for type A701

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

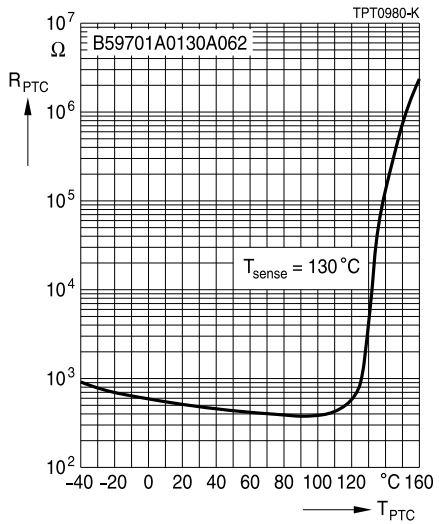
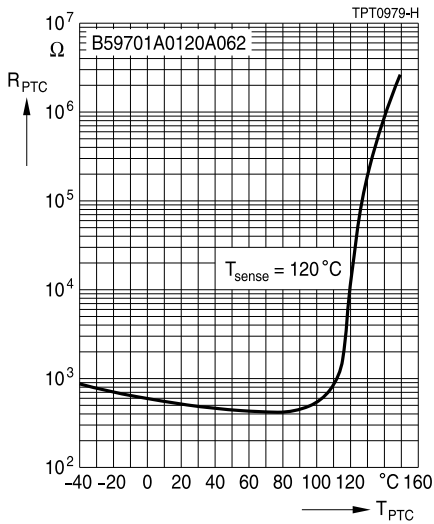


Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Characteristics (typical) for type A701

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



Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

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.

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

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).

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

Symbols and terms

A	Area
C_{th}	Heat capacity
f	Frequency
I	Current
I_{max}	Maximum current
I_R	Rated 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_{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
t_a	Thermal threshold time
T_C	Ferroelectric Curie temperature

Sensors

Limit temperature sensors, EIA sizes 0402, 0603 and 0805

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_{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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