PTC thermistors as inrush current limiters

PTC thermistors in phenolic resin plastic case

Series/Type: **B5910***

Date: November 2009

Applications

- Inrush current limiter (charging resistor) for smoothing and DC link capacitors
- To replace high-power fixed resistors for capacitor charging

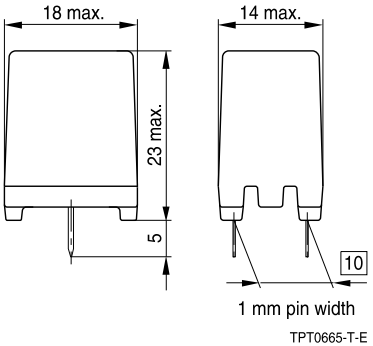
Features

- Self-protecting in case of malfunction of short-circuit relay or internal short circuit of capacitor
- Encased thermistor disk with clamp contacts for high reliability
- For high pulse currents and a high number of operating cycles
- Inrush current limiters are not damaged when directly connected to V_{max} even without additional current limitation
- Flame-retardant plastic case
- Case material UL-listed
- Sn-plated lead-free solder pins
- Manufacturer's logo and type designation stamped on in white
- RoHS-compatible

Delivery mode

- Packed in carton box

Dimensional drawing



Dimensions in mm

General technical data

Operating cycles at V_{max}	(charging of capacitor)	N_c	> 100000	cycles
Switching cycles at V_{max}	(failure mode)	N_f	> 10	cycles
Thermal cooling time constant	(typical)	τ_{th}	150	s
Heat capacity	(typical)	C_{th}	2.3	J/K
Operating temperature range	(V = 0)	T_{op}	−40/+125	°C
Operating temperature range	(V = V_{max})	T_{op}	−20/+85	°C

Electrical specifications and ordering codes

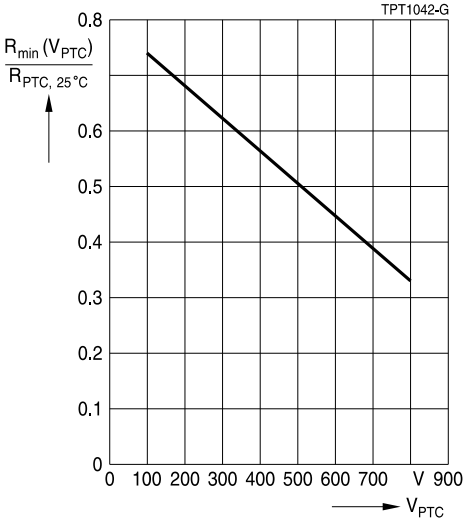
Type	V_{max}	$V_{link,max}$	R_R	ΔR_R	T_{ref} (typ.)	Ordering code
	V AC	V DC	Ω	%	°C	
J105	260	360	22	25	130	B59105J0130A020
J107	440	620	56	25	130	B59107J0130A020
J109	560	800	100	25	130	B59109J0130A020

Reliability data

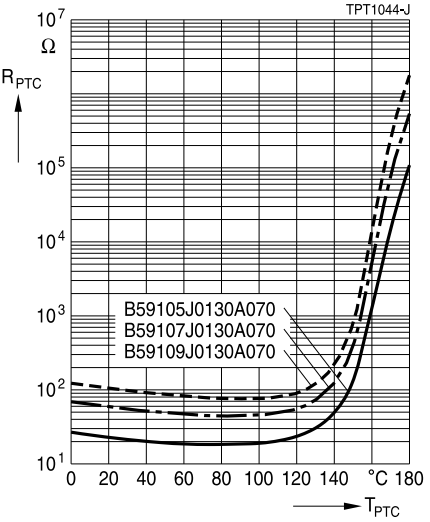
Test	Standard	Test conditions	$\lvert\Delta R_{25}/R_{25}\rvert$
Electrical endurance, cycling		Room temperature, $V_{link,max}$ applied energy < $C_{th} \cdot (T_{ref} - T_A)$ Number of cycles: 100 000	< 25%
Electrical endurance, constant	IEC 60738-1	Storage at V_{max} /$T_{op,max}$ (V_{max}) Test duration: 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	< 10%
Rapid change of temperature	IEC 60738-1	$T_1 = T_{op,min}$ (0 V), $T_2 = T_{op,max}$ (0 V) Number of cycles: 5 Test duration: 30 min Test according to IEC 60068-2-14, Test Na	< 10%
Vibration	IEC 60738-1	Frequency range: 10 to 55 Hz Displacement amplitude: 0.75 mm Test duration: 3 × 2 h Test according to IEC 60068-2-6, Test Fc	< 5%
Climatic sequence	IEC 60738-1	Dry heat: T = $T_{op,max}$ (0 V) Test duration: 16 h Damp heat first cycle Cold: T = $T_{op,min}$ (0 V) Test duration: 2 h Damp heat 5 cycles Tests performed according to IEC 60068-2-30	< 10%

Characteristics

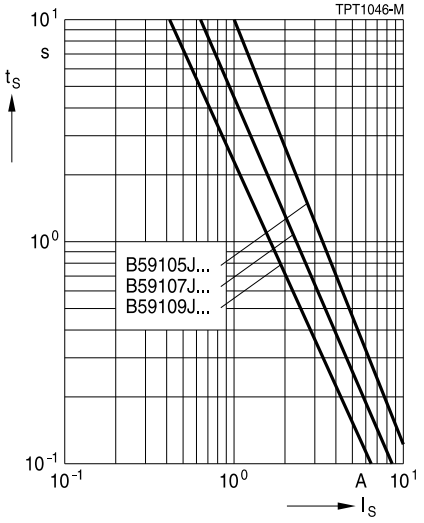
Minimum resistance of PTC thermistors versus applied voltage (pulsed)



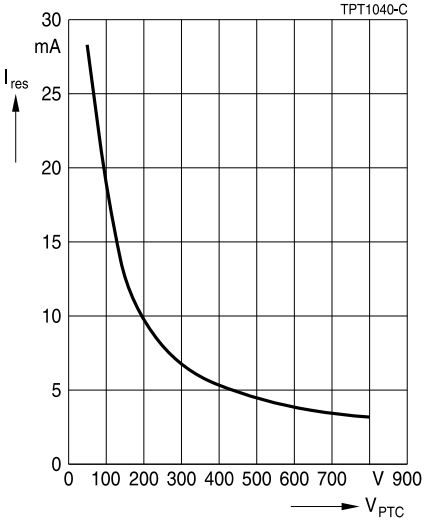
PTC resistance R_{PTC} versus PTC temperature T_{PTC} (measured at low signal voltage)



Switching time t_S versus switching current I_S (measured at 25 °C in still air)



Residual current in high-ohmic state I_{res} as function of applied voltage V_{PTC}, typical (measured at 25 °C in still air)



Calculation of the number of required PTC elements

Number of required PTC elements (connected in parallel) as function of capacitance and charging voltage of smoothing or DC link capacitor:

$$N \geq \frac{C \cdot V^2}{2 \cdot C_{th} \cdot (T_{ref} - T_{A,max})}$$

N	Number of required PTC thermistors connected in parallel
C	Capacitance of smoothing or DC link capacitor in F
V	Charging voltage of capacitor in V
C_{th}	Heat capacity in J/K
T_{ref}	Reference temperature of PTC in °C
$T_{A,max}$	Expected maximum ambient temperature in °C

In case of large N values the resulting resistance of the parallel PTC network might be too low for effective limitation of the charging current. In this case a combination of series and parallel connected PTC thermistors can be used.

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 °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 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.

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).

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 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_{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

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

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