



Inrush Current Limiters

Self-Protecting PTC Resistors

Self-protecting charging resistors based on PTC ceramic are suitable for smoothing capacitors in power supplies. In the event of a short circuit, they limit the currents to safe levels.

Ohmic resistors are generally employed to limit the current when charging capacitors. This, however, is accompanied by technical risks. If, for example, the capacitor short circuits or the relay malfunctions while short-circuiting the capacitor, the resistors will be subjected to continuous high power levels. This can damage or destroy the resistor or the system. The EPCOS charging resistors based on PTC ceramic represent a professional solution that is self-protecting despite its relatively compact size.

Applications

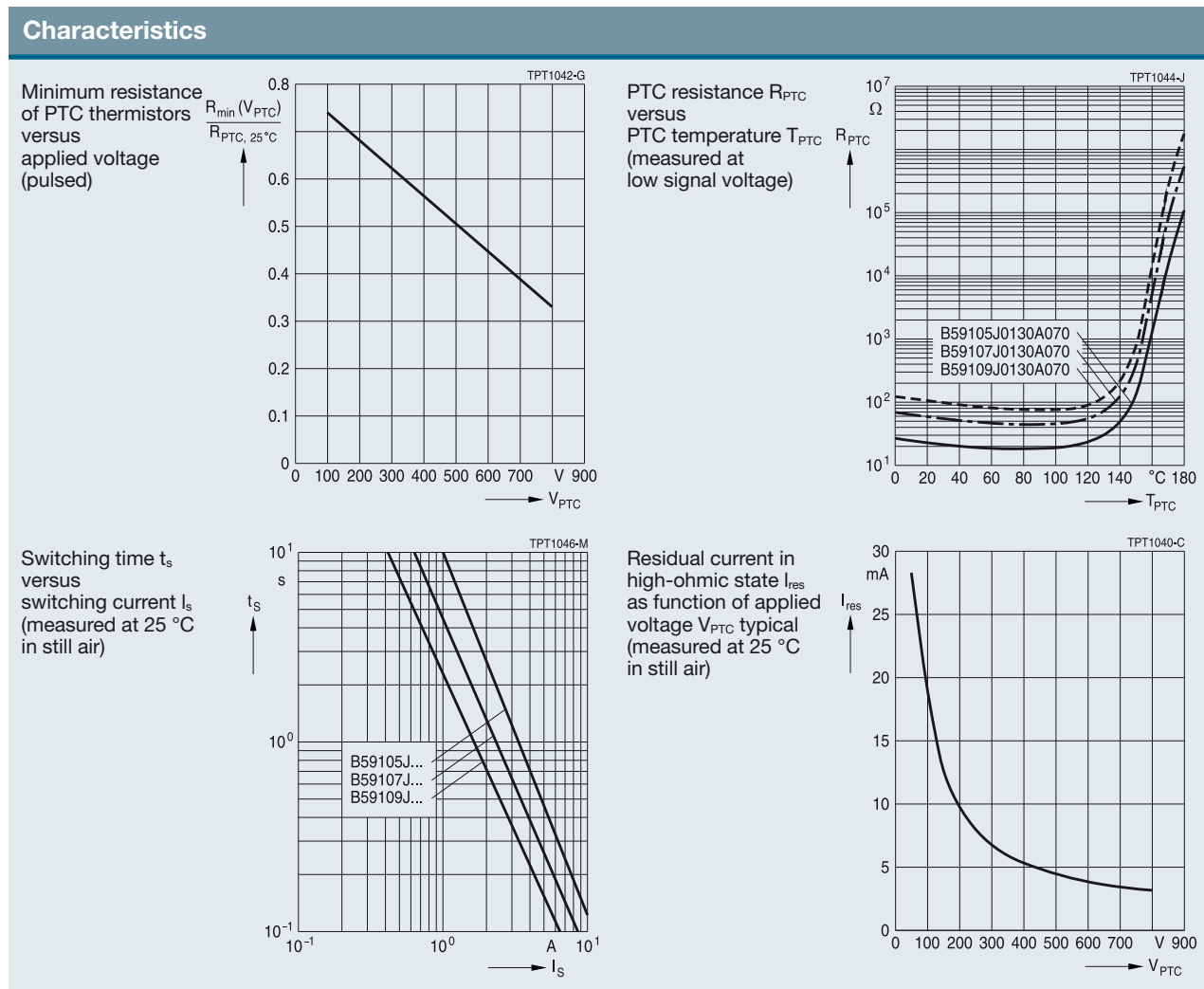
- Inrush current limiter (charging resistor) for smoothing and DC link capacitors
- Replacement of high-power fixed resistors for capacitor charging

Features

- Self-protecting in case of malfunction of short-circuit relay or internal short circuit of capacitor
- 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
- RoHS-compatible

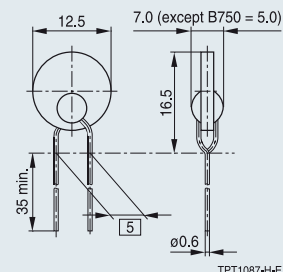
Inrush Current Limiters – PTC Thermistors in Phenolic Resin Plastic Case

General technical data				Dimensional drawing		
Operating cycles at $V_{\max}$ (charging of capacitor)	N_c	> 100000	cycles	TPT0665-T-E 1 mm pin width		
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 AC	$V_{link, max}$ V DC	R_R Ω	ΔR_R %	T_{ref} (typ.) °C	Ordering code
J105	260	360	22	25	130	B59105J0130A020
J107	440	620	56	25	130	B59107J0130A020
J109	560	800	100	25	130	B59109J0130A020

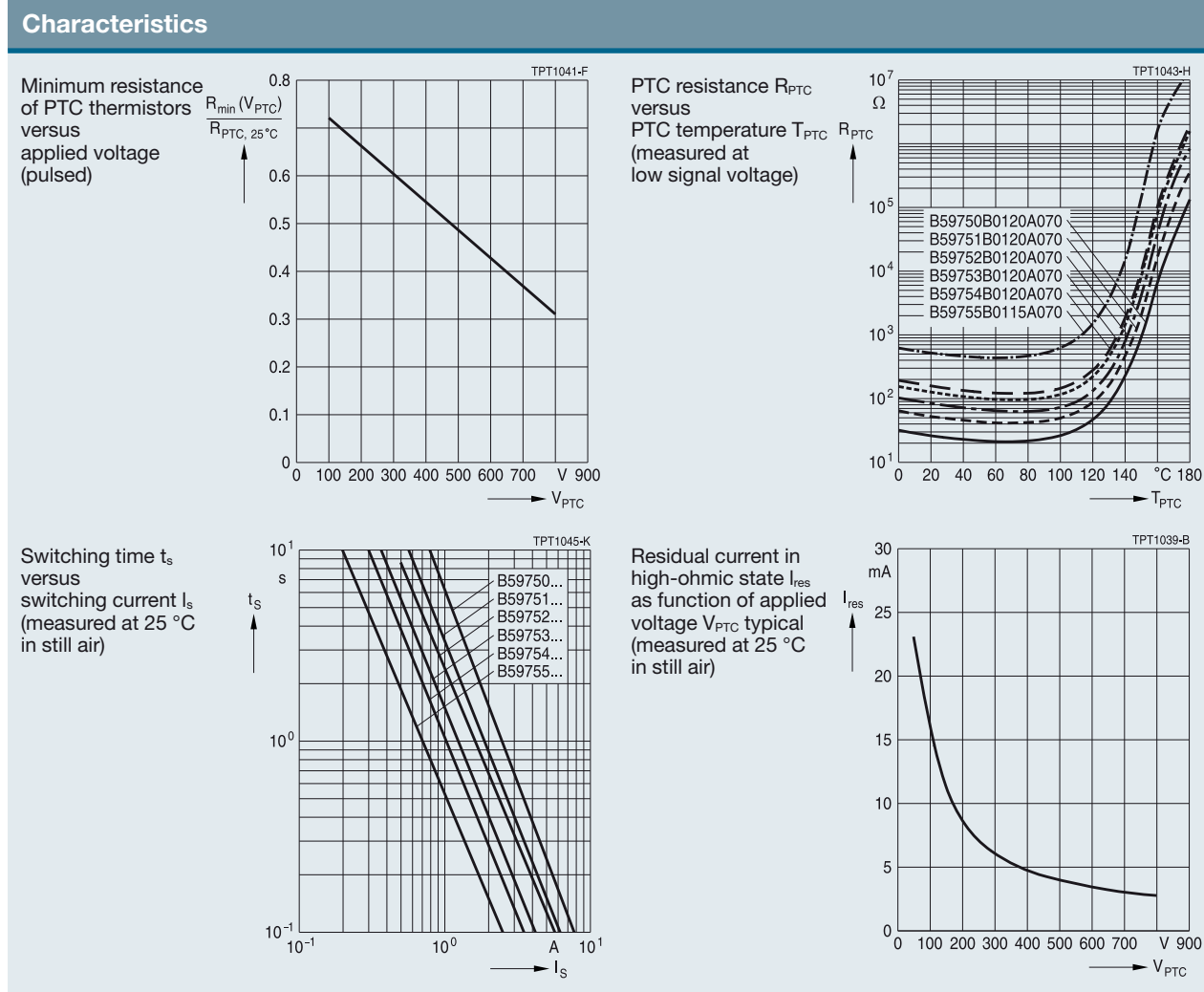


Inrush Current Limiters – PTC Thermistors Leaded Disks

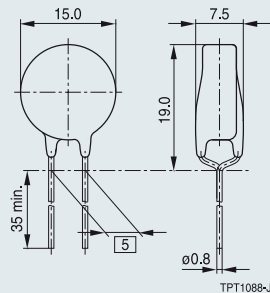
General technical data			Dimensional drawing
Operating cycles at $V_{\max}$ (charging of capacitor)	N_c	> 50000	cycles
Switching cycles at $V_{\max}$ (failure mode)	N_f	> 10	cycles
Operating temperature range ($V = 0$)	T_{op}	$-40/+125$	$^{\circ}\text{C}$
Operating temperature range ($V = V_{\max}$)	T_{op}	$-20/85$	$^{\circ}\text{C}$



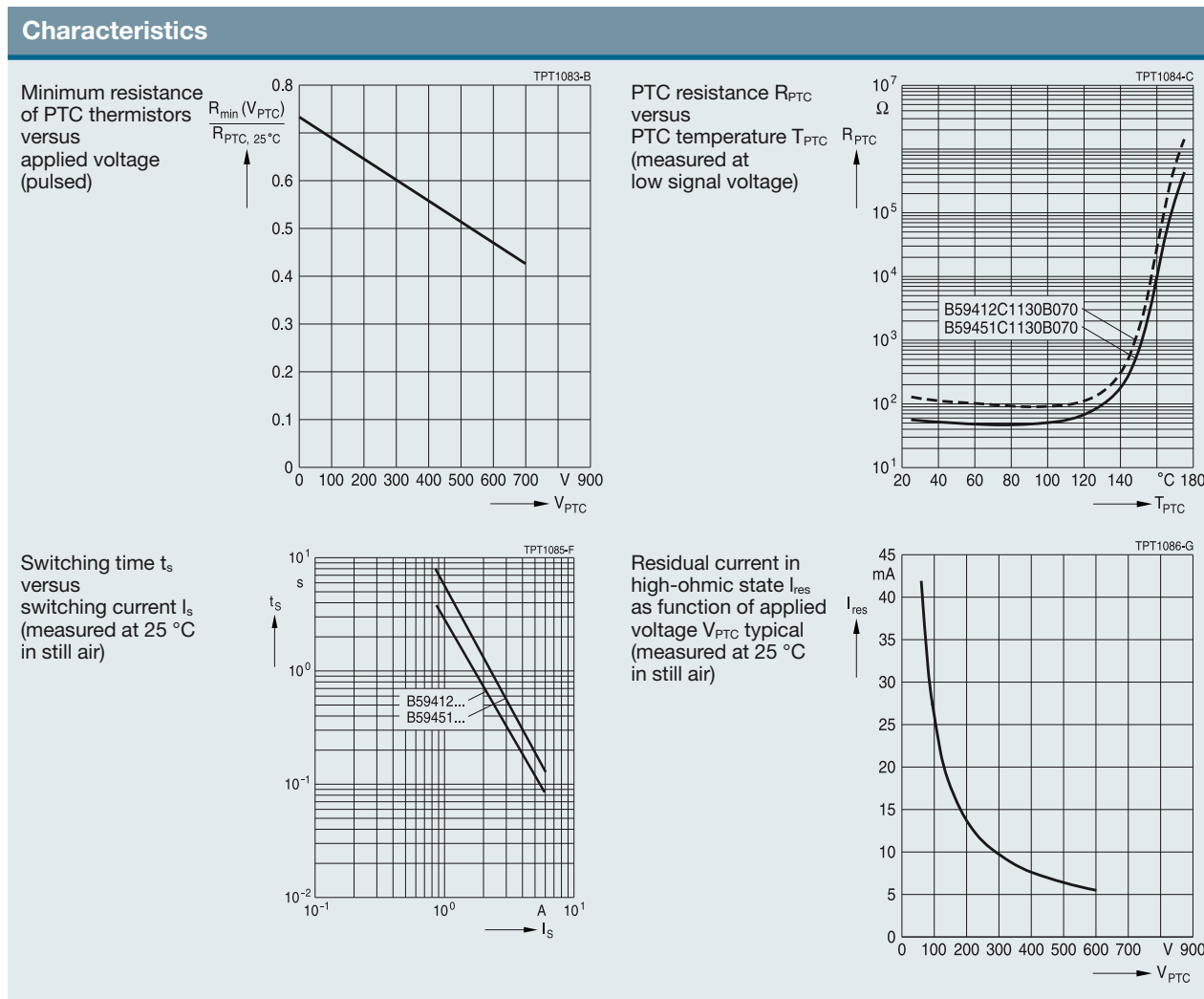
Electrical specifications and ordering codes								
Type	$V_{\max}$ V AC	$V_{\text{link, max}}$ V DC	R_R Ω	ΔR_R %	T_{ref} (typ.) $^{\circ}\text{C}$	C_{th} J/K	τ_{th} s	Ordering code
B750	260	360	25	± 25	115	1.0	100	B59750B0120A070
B751	260	360	50	± 25	115	1.4	120	B59751B0120A070
B752	260	360	80	± 25	115	1.4	120	B59752B0120A070
B753	440	620	120	± 25	115	1.4	120	B59753B0120A070
B754	440	620	150	± 25	115	1.4	120	B59754B0120A070
B755	560	800	500	± 25	110	1.4	120	B59755B0115A070



Inrush Current Limiters – PTC Thermistors Leaded Disks, Coated

General technical data				Dimensional drawing				
Operating cycles at $V_{\max}$ (charging of capacitor)	N_c	> 50000	cycles					
Switching cycles at $V_{\max}$ (failure mode)	N_f	> 10	cycles					
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 AC	$V_{link, \max}$ V DC	R_R Ω	ΔR_R %	T_{ref} (typ.) °C	C_{th} J/K	τ_{th} s	Ordering code
C1412	440	620	120	±25	130	2.1	100	B59412C1130B070
C1451	440	620	56	±25	130	2.1	100	B59451C1130B070

Leaded Disks, Coated



Inrush Current Limiters – General Technical Information

Reliability data

Test	Standard	Test conditions	$ \Delta R_{25}/R_{25} $
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 x 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	$< 10\%$

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.

Symbols and terms

C_{th}	Heat capacity
N_c	Operating cycles at V_{max} , charging of capacitor
N_f	Switching cycles at V_{max} , failure mode
R_R	Rated resistance
ΔR_R	Tolerance of R_R
T_{op}	Operating temperature
T_{ref}	Reference temperature
$V_{link,max}$	Maximum link voltage
V_{max}	Maximum operating voltage
τ_{th}	Thermal cooling time constant



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