

Attracting Tomorrow



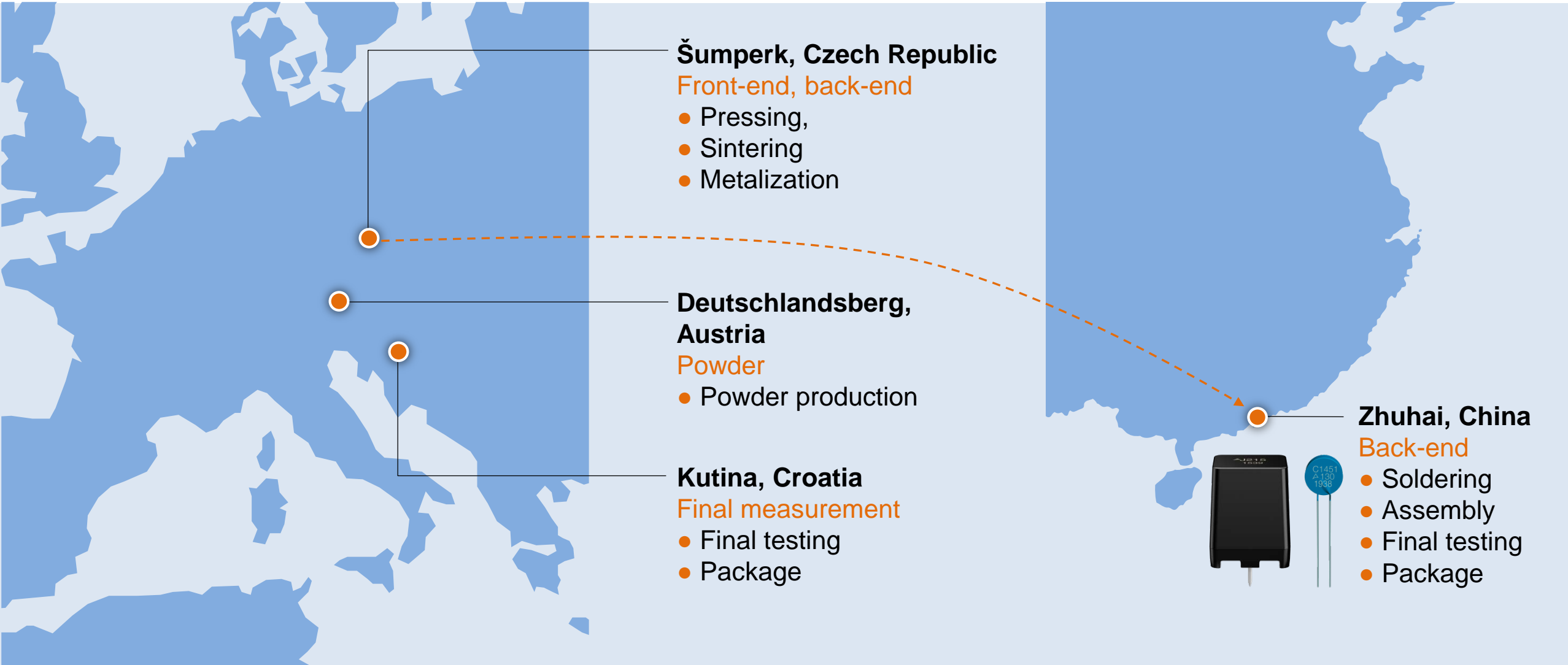
PTC Inrush Current Limiters

Self-Protecting PTC Resistors

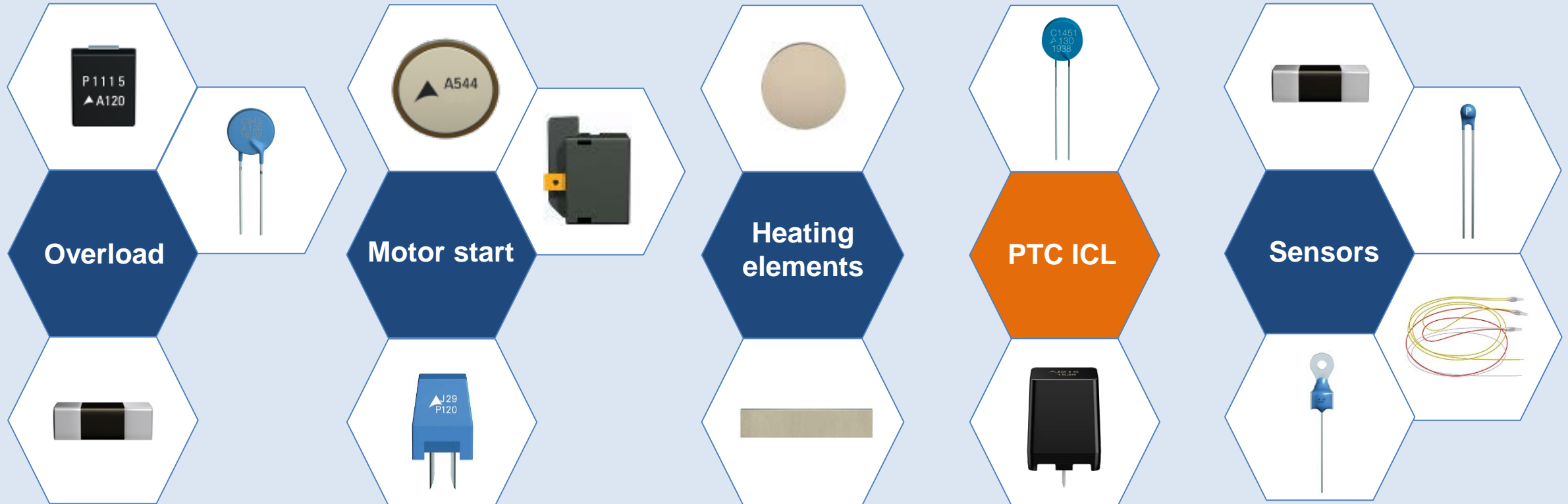
TDK Electronics AG
Piezo and Protection Devices Business Group
Product Marketing PTC
Munich, Germany
September 2019



Production plants



PTC product spectrum



Overload

Parameters

U: 12...500 V
 R: 0.3...1800 Ω
 Ø: 4...22 mm
 SMD: 0603...4032

Motor start

Parameters

U: 180...265 V
 R: 4.7...5000 Ω
 Ø: 16...20 mm

Heating elements

Parameters

U: 12...800 V
 R: 0.75...960 Ω
 th: 1...3.0 mm
 Ts: 40...280 °C

PTC ICL

Parameters

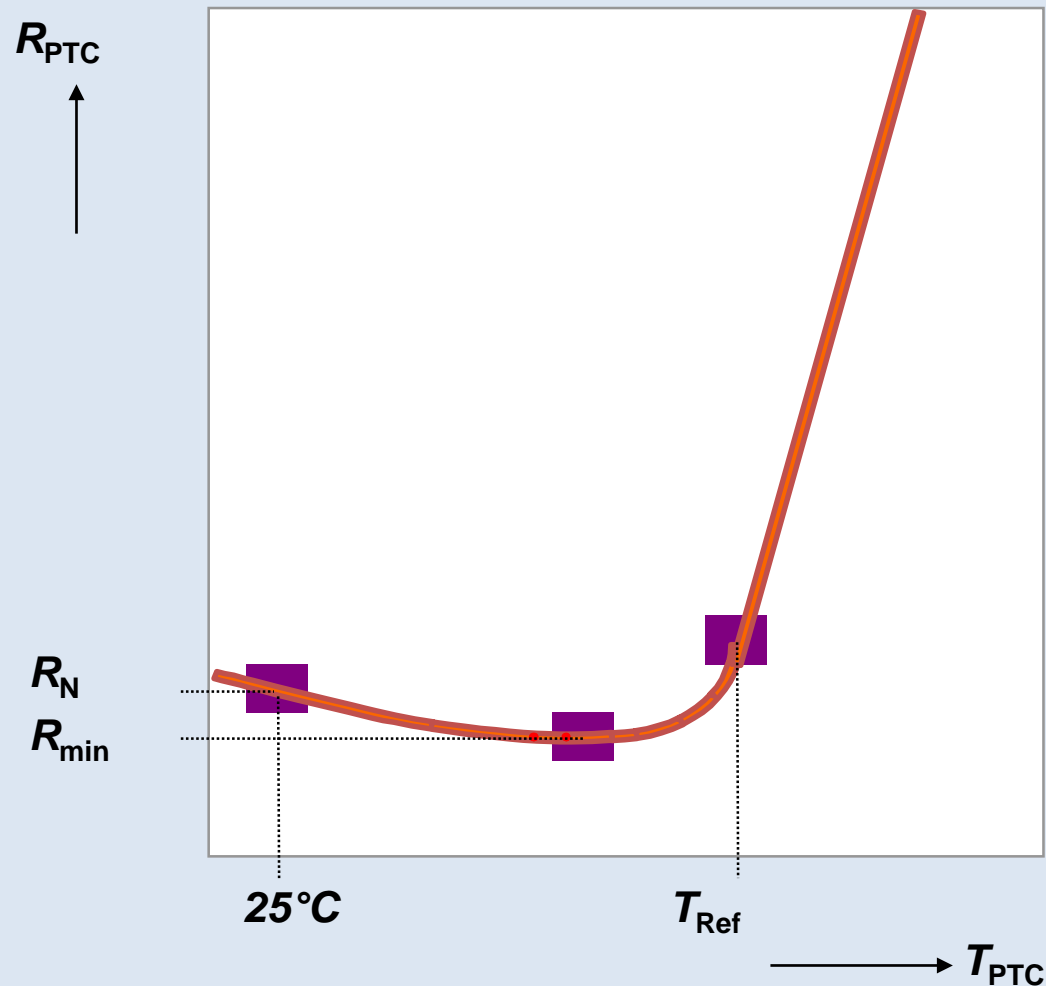
U: 400...1000 V
 R: 22...7500 Ω
 C_{th}: 0.5...2.3 J/K

Sensors

Parameters

T_{sens}: 60...180 °C
 Size: Leaded, SMD,
 single, tripple sensor
 SMD: 0402, 0603, 0805

Description of a PTC and key parameters: Typical R/T curve



What is a PTC?

A PTC (**P**ositive **T**emperature **C**oefficient) is a resistor whose resistance varies with temperature.

With increasing temperature, the resistance of the PTC will increase.

R_N Resistance value at 25°C

R_{min} Minimum resistance of the PTC

T_{ref} Reference temperature or Curie temperature; at this temperature, the resistance value is $2 \times R_{min}$.

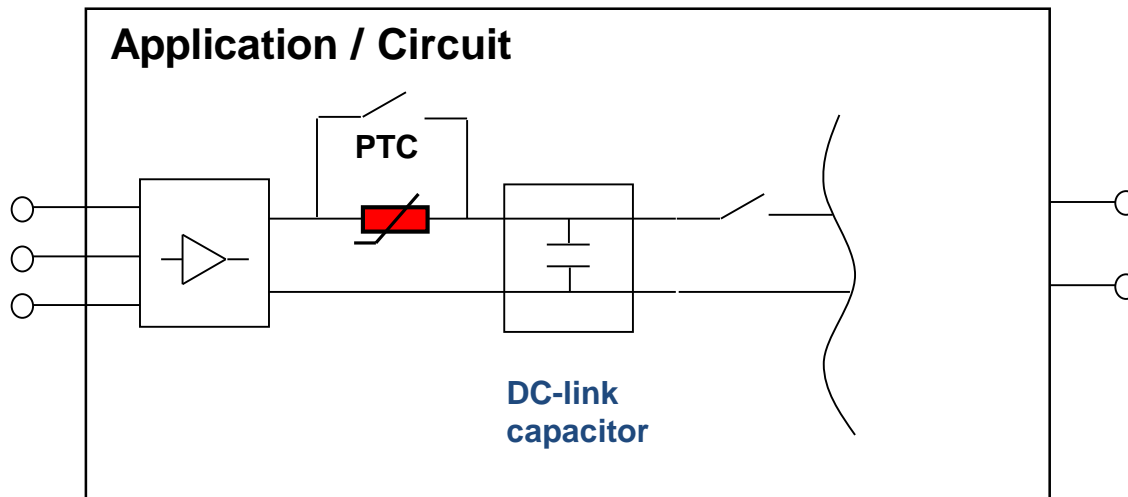
Functions and applications

Functions of the PTC thermistor

- Limit the inrush current during charging of DC-link capacitor.
- In case of malfunction of the circuit (short-circuit switch does not close, short-circuit at the terminals) the PTC increases its resistance and limits the current to an uncritical value.



Replacement of fixed resistors



Product advantages PTC ICLs

PTC ICLs have built in advantages for following failure modes

- Short circuit of capacitor
- Current limiting element not bypassed during normal operation (failure of switching element)

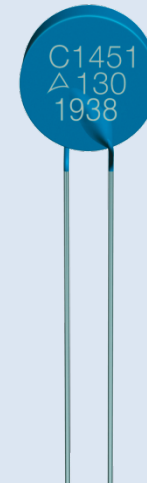
PTC ICLs act as self protecting elements in all of the above failure modes.

PTC ICLs for capacitor charging: Product range overview

- Housing (l x w x h) 18 x 14 x 22.2 mm
- V max AC 280...560 V
- V link max DC 400...800 V
- R25 33...100 Ohm
- C_{th} 1.1...2.3 J/K
- Approvals UL 1434, IECQ, VDE





- Diameter min/max 8.5...16 mm
- V max AC 260...560 V
- V link max DC 370...800 V
- R25 70...1100 Ohm
- C_{th} 0.6...2.1 J/K
- Approvals UL1434, IECQ, VDE, qualification based on AEC Q-200



PTC ICLs capacitor charging: Product range B5921X family housed type

PTC thermistors in housing, $V_{max} = 280 \text{ V AC}$ up to 560 V AC



Electrical specifications and ordering codes

Type	V_{max}	$V_{link,max}$	R_R	ΔR_R	T_{ref} (typ.)	C_{th} (typ.)	τ_{th} (typ.)	Circuit diagram	Approvals			Ordering code
	V AC	V DC	Ω	%	C	J/K	s				AEC-Q200	
PBT plastic case, preferred types for new designs												
J213	280	400	33	25	130	1.1	140	2	●	●	●	B59213J0130A020
J215	280	400	22	25	130	2.3	150	2	●	●	●	B59215J0130A020
J217	440	620	56	25	130	2.3	150	1, 2, 3	●	●	●	B59217J0130A020
J219	560	800	100	25	130	2.3	150	1, 2, 3	●	●	●	B59219J0130A020



PTC ICLs for capacitor charging: Product range leaded disks

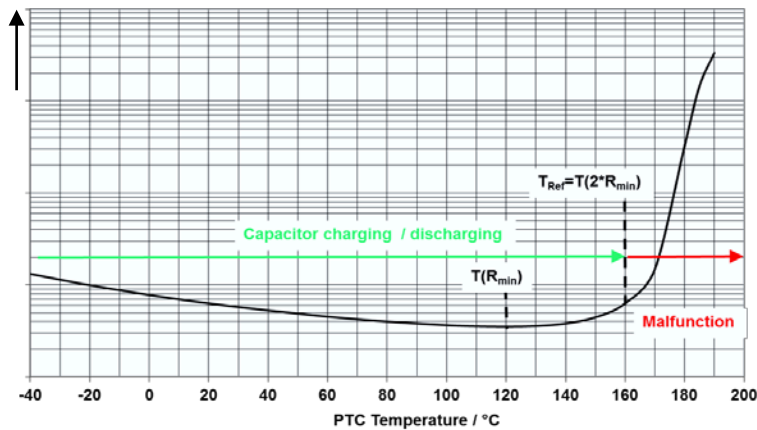
Electrical specification and ordering codes

Type	V _{max}	V _{link,max}	R _R	ΔR _R	T _{ref} (typ.)	C _{th}	τ _{th}	Circuit diagram	Approvals			Ordering code
	V AC	V DC	Ω	%	°C	J/K	s				AEC-Q200	
C770	260	370	70	±25	120	0.4	70	2	–	–	–	B59770C0120A070
C771	260	370	120	±25	120	0.6	80	2	–	–	–	B59771C0120A070
C772	260	370	150	±25	120	0.6	80	2	–	–	–	B59772C0120A070
C750	280	400	25	±25	120	1.0	100	2	●	●	●	B59750C0120A070
C751	280	400	50	±25	120	1.4	120	2	●	●	–	B59751C0120A070
C752	280	400	80	±25	120	1.4	120	2	●	●	–	B59752C0120A070
C1451	440	620	56	±25	130	2.1	100	1, 2, 3	●	●	●	B59451C1130B070
C753	440	620	120	±25	120	1.4	120	1, 2, 3	●	●	–	B59753C0120A070
C754	440	620	150	±25	120	1.4	120	1, 2, 3	●	●	–	B59754C0120A070
C773	440	620	500	±25	120	0.6	80	1, 2, 3	–	–	–	B59773C0120A070
C774	440	620	1100	±25	115	0.6	80	1, 2, 3	–	–	–	B59774C0115A070
C1412	480	680	120	±25	130	2.1	100	1, 2, 3	●	●	●	B59412C1130B070
C755	560	800	500	±25	115	1.4	120	1, 2, 3	–	–	–	B59755C0115A070



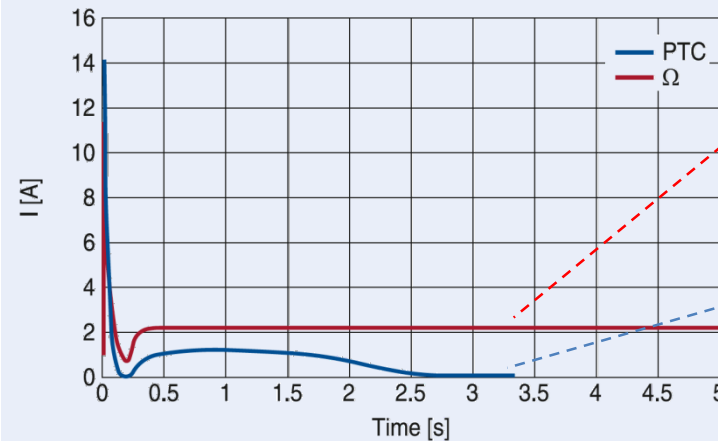
Comparison resistance fixed resistor versus PTC ICLs

Resistance



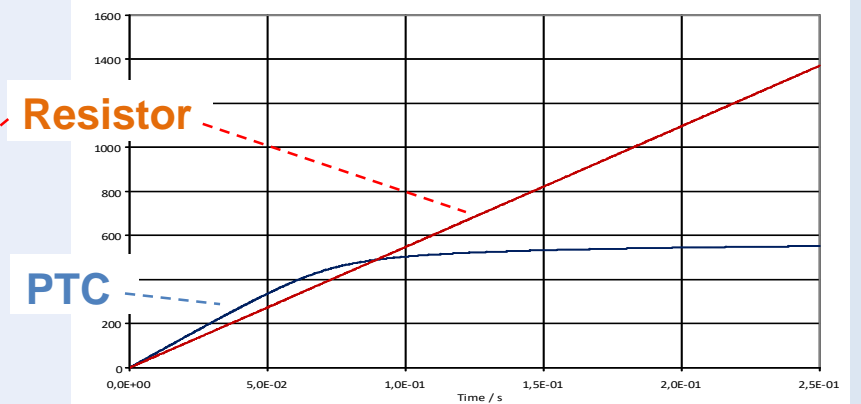
Increase of resistance at failure mode
PTC versus **fixed resistor**

Current



Malfunction current
PTC versus **fixed resistor**

Energy absorption



Comparison energy
Absorption at failure mode
PTC versus **fixed resistor**

Malfunction in smoothing or DC-link capacitor: Self protection – PTC gets high-ohmic

Comparison: Fixed resistor and PTC ICLs

Functionality	Fixed resistor		PTC	
Malfunction of relay	Thermal overload possible	✘	Self-protection and circuit protection	✔
Terminal short circuit	Thermal overload possible	✘	Self-protection and circuit protection	✔
Repetitive inrush operation with too short cool down phase	Thermal overload possible	✘	Self-protection and circuit protection	✔
Power loss during operation	Approx. 0.4 W power loss		Approx. 0.4 W power loss	
Operation at high ambient temperature	No significant change of inrush current	✔	Only moderate increase of inrush current	✔
Operation at low ambient temperature	No significant change of inrush current	✔	No significant increase of charging time at low temperature	✔

Applications (1)

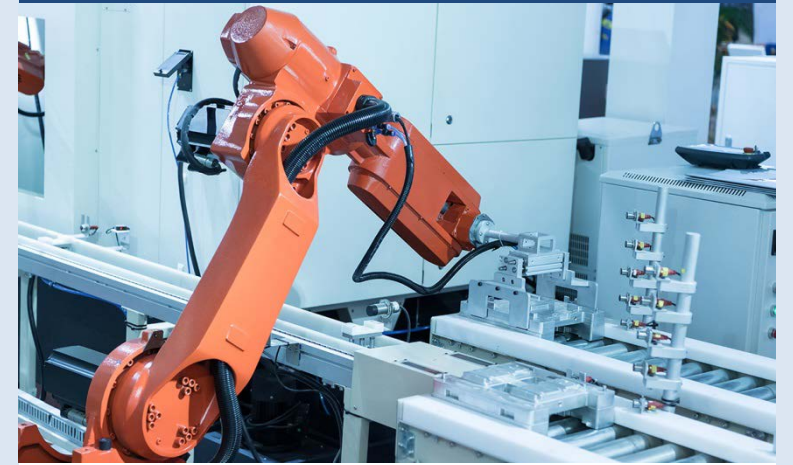
Inverter room air conditioner



Washing machine inverter control



Servo motor control



Applications (2)

Server power surge protection



Frequency inverters for industrial drives

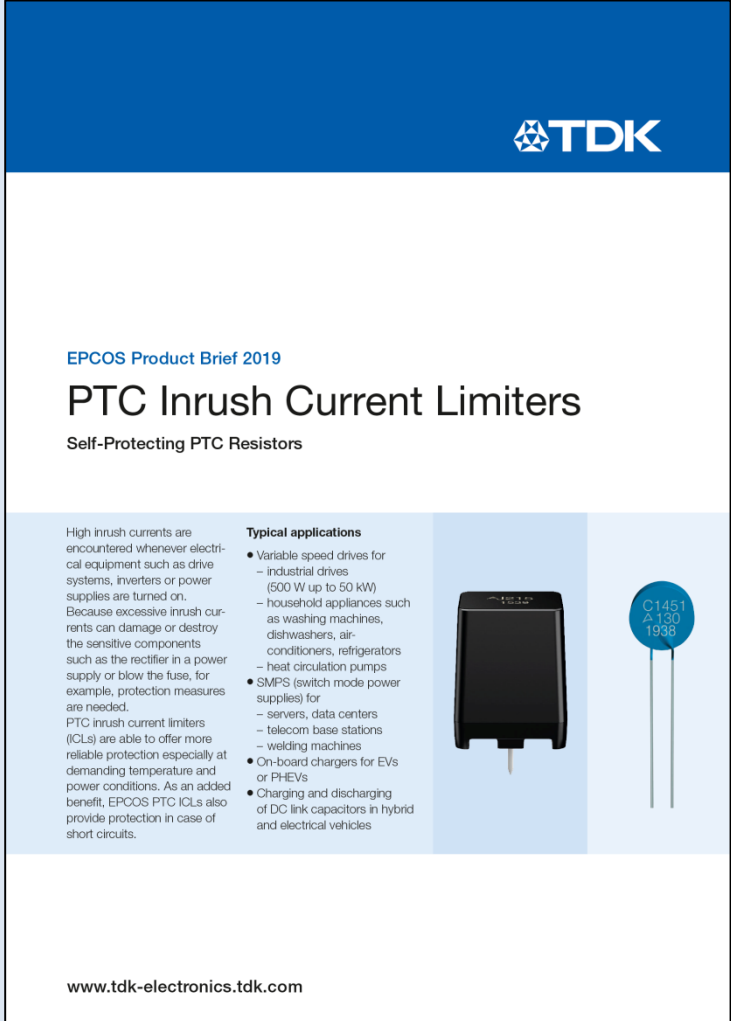


Automotive on-board charging



Information needed for design-in

- Component style
- Capacitance of DC-link capacitors
- DC-link voltage
- Max. allowed charging time
- Max. allowed inrush current peak
- Time interval between charging events
- Supply source (battery, kind of rectifier)
- Expected number of charging events over lifetime
- Operating temperature range (especially max. temperature at charging)



TDK

EPCOS Product Brief 2019


PTC Inrush Current Limiters

Self-Protecting PTC Resistors

High inrush currents are encountered whenever electrical equipment such as drive systems, inverters or power supplies are turned on. Because excessive inrush currents can damage or destroy the sensitive components such as the rectifier in a power supply or blow the fuse, for example, protection measures are needed. PTC inrush current limiters (ICL) are able to offer more reliable protection especially at demanding temperature and power conditions. As an added benefit, EPCOS PTC ICLs also provide protection in case of short circuits.

Typical applications

- Variable speed drives for
 - industrial drives (500 W up to 50 kW)
 - household appliances such as washing machines, dishwashers, air-conditioners, refrigerators
 - heat circulation pumps
- SMPS (switch mode power supplies) for
 - servers, data centers
 - telecom base stations
 - welding machines
- On-board chargers for EVs or PHEVs
- Charging and discharging of DC link capacitors in hybrid and electrical vehicles



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