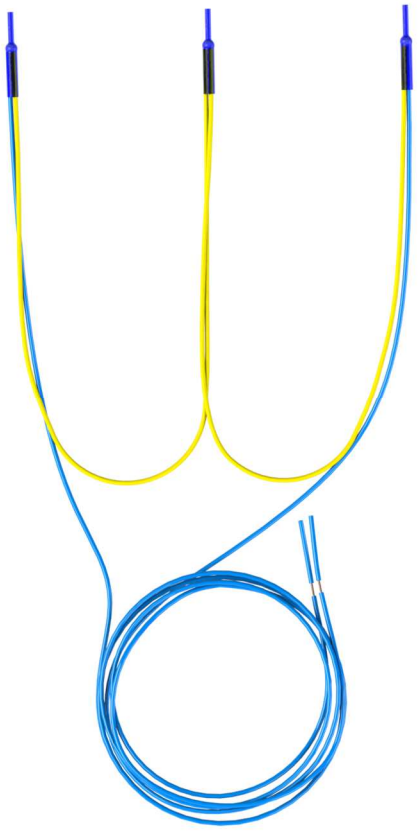
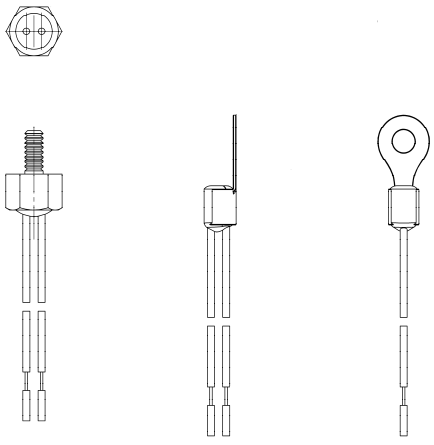
Motor and machine protection

Temperature monitoring with PTC-thermistors according Norm DIN VDE V 0898-1-401 (previously DIN 44081 and DIN 44082)

PTC-thermistor
for windings control



PTC-screw-in-sensor and surface sensor



- Basic information

PTC thermistors are ceramic semi-conductors which because of the very high Positive Temperature Coefficient lend themselves to a variety of applications.

- Applications

Specially constructed versions of these products are available and this facility enables most applications to be catered for. Most typical application for PTC thermistors is to protect the windings of heavy duty motors and transformers.

- General function

The PTC thermistor, for the thermal protection of electrical machines, is a temperature dependent component. The rated operating temperature (ROT) corresponds to the curie point temperature of the ceramic. The resistance, of the PTC thermistor, rises very steeply with relatively small increases in temperature, thus triggering the switching function.

- Advantages

- Precise repeatability of the response point.
- Long hysteresis free switch cycle life.
- Extremely cost effective.
- Steep temperature-resistance curve characteristic allows for simple evaluation electronics.
- Current self-limiting.
- Light weight.
- Low thermal time constant.
- Extremely small designs are available.

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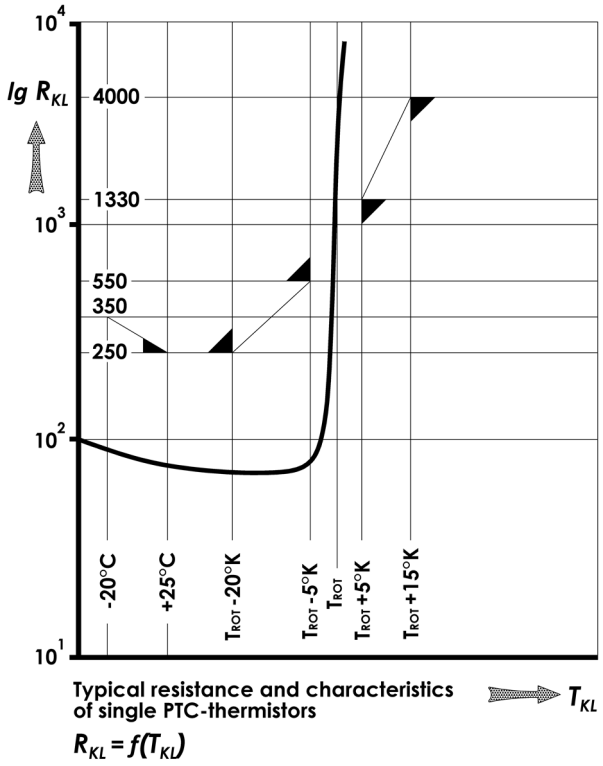


Typical resistance and characteristics of single PTC-thermistors

$R_{KL} = f(T_{KL})$

- Technical base data

Typical resistance-temperature characteristic

The PTC thermistor has the particular advantage of a steep rise in the resistance-temperature characteristic at the nominal response temperature T_{ROT}. For this reason, it can be used with little effort preferably as temperature protection and for measurement and control tasks with fixed limit values.

The diagram opposite shows an example of the resistance RKL of such a thermistor as a function of temperature. It clearly shows that when the nominal response temperature T_{NAT} is reached, the resistance of the PTC thermistor becomes higher by several powers of ten within a few degrees. The characteristic curves of the sensors with nominal response temperatures of T_{ROT} = 90°C to 170°C correspond to the new standard for PTC thermistors DIN VDE V 0898-1-401. PTC sensors with nominal response temperatures between 60°C and 80°C, as well as above 170°C, exhibit a somewhat flatter characteristic curve in the range of the nominal response temperature.

Resistance values (DIN VDE V 0898-1-401)

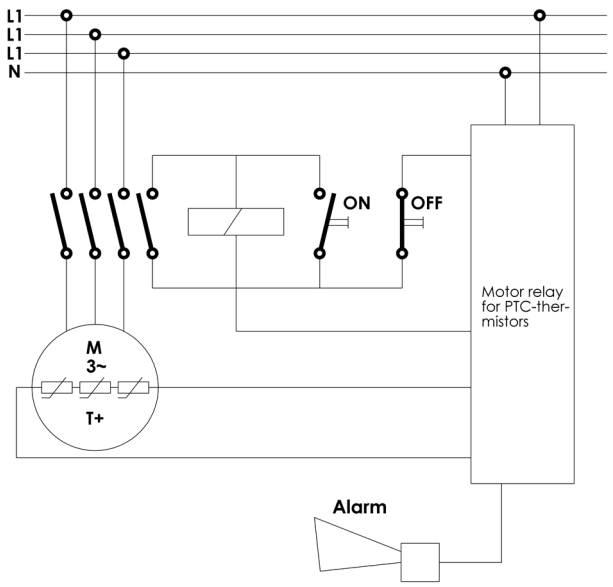
The resistance temperature characteristic of PTC-thermistors for the thermic protection of machines is defined by the following formula:

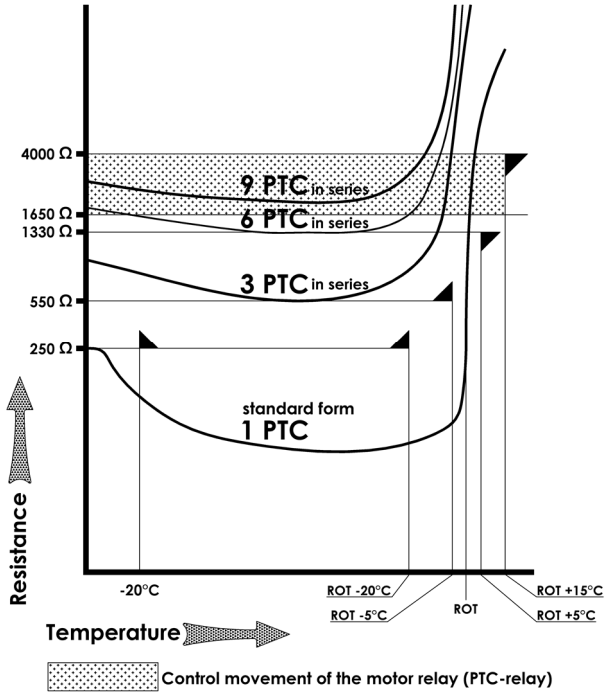
Temperature Range (T_{KL})	PTC-Resistance (R_{KL})	Measuring DC voltage U (test voltage)
-20°C to T_{ROT} -20K	$R_{KL} \leq 250\ \Omega$	$U \leq 2{,}5$ V
at T_{ROT} -5K	$R_{KL} \leq 550\ \Omega$	$U \leq 2{,}5$ V
at T_{ROT} +5K	$R_{KL} \geq 1330\ \Omega$	$U \leq 2{,}5$ V
at T_{ROT} +15K	$R_{KL} \geq 4000\ \Omega$	$U \leq 7{,}5$ V

Load must not be applied to the thermistors as this creates a self-heating effect.

At ambient temperature the resistance value of thermistors is normally between 50 Ω and 100 Ω. It can also be between 30 and 250 Ω. At ambient temperature the resistance values have no relevance to the serviceability (functionality) at the ROT (rated operating temperature).

Temperature monitoring with PTC-thermistors according Norm DIN VDE V 0898-1-401 (previously DIN 44081 and DIN 44082)





Application-example for electric motor- and machine protection

The accurate sensitivity and small dimensions of PTC's makes them ideal for all electrical machine protection applications. For electric motor or transformer protection the PTC must be placed within the windings. The ROT (rated operating temperature) is chosen in relation to the insulation class of the windings. Three-phase motors will require 3 PTC-Thermistors, wired in series. The terminal leads of the PTC must be connected through a terminal block to a relay and cut-off device (Schütz). When the temperature of the motor exceeds ROT the relay is activated and triggers the power cut-off. When the temperature of the windings cools to below ROT the low resistance of the PTC-thermistor will allow the motor (transformer) to be re-started.

Control-relays suitable for use in conjunction with PTC's are produced by several manufacturers Useful are REISSMANN TMS-Basic or TMS-PTC-LB But also all other standard control-relays can be used.

PTC-operational range for use with control relays for temperature protection

Type A control relays switch off according to the standard DIN EN 60947 8 (VDE 0660-302) at PTC resistance values above 1650 Ω. Exemplary characteristic curves of series connections of 1, 3, 6 and 9 PTC sensors are shown in the adjacent figure.

- 1 PTC switches at T_{ROT} +15 K at the latest, at T_{ROT} +5 K at the earliest.
- 3 PTCs switch at the latest at T_{ROT} +5 K, at the earliest at T_{ROT} -5 K
- 6 PTCs switch at T_{ROT} at the latest, at T_{ROT} -20 K at the earliest
- 9 PTCs are in the switch-off range. According to the standard, they cannot be connected to a tripping device at the same time. Their resistance addition can simulate constant overtemperature even in the cold state. PTC thermistor trip units with adapted switching thresholds (available on request) can, however, also properly evaluate series connections of 9 PTCs.

Temperature monitoring with PTC-thermistors according Norm DIN VDE V 0898-1-401 (previously DIN 44081 and DIN 44082)

Mechanical and electrical qualities

characteristics	miniature form K135, KZ 235, KD 335,G 135, GO 135	
pellet diameter	approx. 2-2,5 mm	
shrink tube	Kynar, ca. 12mm	
leads	stranded silvered copper wire insulated with Teflon (PTFE), AWG 24, or AWG 26 according to the manufactures choice.	
length single-sensor: twin-sensor: triple-sensor:	 500/500 ± 10 mm 500/180/500 ± 10 mm 500/180-180/500 ± 10 mm	
colour code	Standard coding according to DIN VDE V 0898-1-401 corresponding to T_{NAT} according to table on page 6.	
endconnections	Stripped & plucked to protect against fanning out	
insulation strength	U ≤ 400 VAC (other operating voltages on request)	
lead resistance	at +20°C: AWG26= 0,133 Ω/m; AWG24= 0,827 Ω/m	
admissable working temperature	up to +180°C, (up to 250°C possible on customer request).	
maximum working voltage	U_{max} = 25V DC	
DC measuring voltage	U = 2,5V DC	
testing of insulation: wire against insulation (insulation strength)	U_{eff} = 2500V AC	
rated operating temperature T_{ROT} in 10K steps: in 5K steps:	 +60°C to +180°C +145°C, +155°C	
Tolerance Δ T_{ROT} ROT=+60°C to +160°C: ROT=+170°C to +180°C:	 ± 5 K ± 6 K	 ± 5 K ± 7 K
operational cut-off time	< 5 s	< 3 s
storage temperature	minimum: -25°C maximum: +65°C	

Temperature monitoring with PTC-thermistors according Norm DIN VDE V 0898-1-401 (previously DIN 44081 and DIN 44082)

Mechanical and electrical qualities

Insulation class

For machines in which the PTC sensors are known to be placed at the hottest point and which are fully utilized in their permissible heating according to the insulating material classes (DIN EN 60034-11), the values according to the following table are recommended (extract from DIN EN 60085):

Insulating material class	Y	A	E	B	F	H	N	R
Classified temperature limit	90°C	105°C	120°C	130°C	155°C	180°C	200°C	220°C

Insulation test

Before testing the leads of the sensors have to be connected electroconductively. The testing voltage is connected to the leads and the motor winding according to DIN VDE V 0898-1-401 and DIN EN 60034-1.

resistance test of the installed thermistors

Because of the self-heating effect a method to measure PTC-thermistors must be used in which the voltage drop per sensor is not greater than 2,5V DC. The measurement is to be done with a measuring bridge, e.g. Wheatstone The resistance must not exceed approx. 100 Ω per individual sensor (measured at room temperature) when the sensor is fully functional. If the PTC sensors are connected in series, the resistances add up.

installation instructions for electric motors

It is important that the sensors are inserted in the stator coils, nearest to the rotor before impregnating the windings. The sensors should be tested prior to the impregnation of the rotor, winding temperatures must not exceed 175°C for sensors with T_{ROT} 160°C or 185°C for sensors with T_{ROT} 170°C. If impregnating agents or impregnating varnishes are used, that are not chemically neutral, the resistivity of the sensors has to be tested by the user. The sensor must be inserted in the middle of the end coils, ensuring that they are completely surrounded by the windings. Hollow space and trapped air influence the heat transmission. One sensor must be inserted into each leg of the windings with the leads parallel to the coil conductors. The mounting of several sensors has to be done in series. The leads must be connected to a terminal block on the terminal board, to ensure that they are separate from the winding terminals. Tension and other mechanical stresses must be avoided when installing sensors. Please avoid loops in the leads to avoid possibly occurring interfering voltage.

Quality control

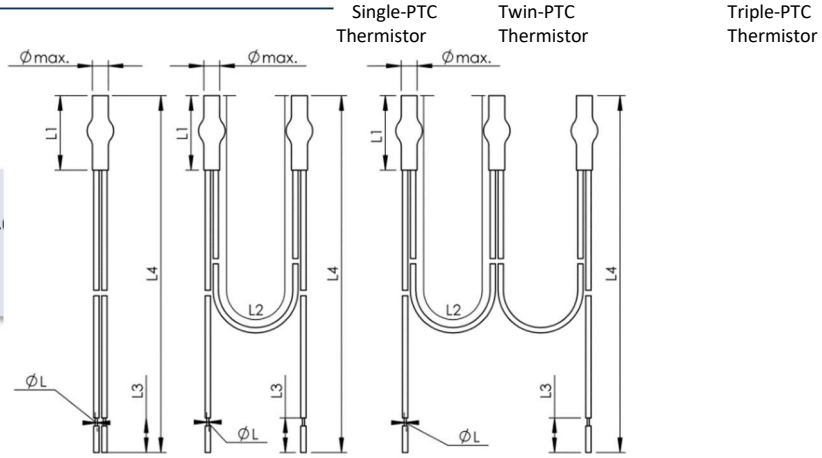
Unless requested otherwise, quality control is to DIN 40080, AQL (acceptable quality level) in accordance with MIL-standard 105D and IEC 410 at the discretion of the manufacturer. Precise manufacturing and testing techniques guarantee the accuracy of REISSMANN-PTC-thermistors. All manufacturing operations are designed to conform to DIN VDE V 0898-1-401 Special versions (e.g. longer leads) are quickly available on request.

Caution:
The lead ends of the PTC-thermistors must not be connected to a voltage larger than 2,5 V DC!
We recommend that a warning label be fixed to any apparatus where there is a possibility of more than 2,5 V DC being connected to the sensor. These warning labels may be purchased from REISSMANN when required.

Product Information

Motor and machine protection

Temperature monitoring with PTC-thermistors according Norm DIN VDE V 0898-1-4
(previously DIN 44081 and DIN 44082)



Technical information, color coding of leads and ordering codes for PTC thermistors:

Rated operating Temperature ± Tolerance $T_{ROT} \pm \Delta T_{ROT}$ [°C]	Resistance R [Ω] [1] from -20°C to T_{ROT} -20K	Resistence R [Ω] [1] at PTC-thermistor temperature:			color coding leads-in		order reference [2]				
		$T_{ROT} - \Delta T_{ROT}$ ($U_{KL} \leq 2,5$ V)	$T_{ROT} + \Delta T_{ROT}$ ($U_{KL} \leq 2,5$ V)	$T_{ROT} + 15K$ ($U_{KL} \leq 7,5$ V)			single sensor	twin sensor	triple sensor	screw-in-sensor	surface sensor
60 ± 5	≤ 100	≤ 570	≥ 570	-	white	grey	31-K135	31-KZ235	31-KD335	31-G135	31-GO135
70 ± 5		≤ 570	≥ 570	-	white	brown	41-K135	41-KZ235	41-KD335	41-G135	41-GO135
80 ± 5		≤ 570	≥ 570	-	white	white	51-K135	51-KZ235	51-KD335	51-G135	51-GO135
90 ± 5		≤ 550	≥ 1330	≥ 4000	green	green	61-K135	61-KZ235	61-KD335	61-G135	61-GO135
100 ± 5		≤ 550	≥ 1330	≥ 4000	red	red	71-K135	71-KZ235	71-KD335	71-G135	71-GO135
110 ± 5		≤ 550	≥ 1330	≥ 4000	brown	brown	81-K135	81-KZ235	81-KD335	81-G135	81-GO135
120 ± 5		≤ 550	≥ 1330	≥ 4000	grey	grey	91-K135	91-KZ235	91-KD335	91-G135	91-GO135
130 ± 5		≤ 550	≥ 1330	≥ 4000	blue	blue	101-K135	101-KZ235	101-KD335	101-G135	101-GO135
140 ± 5		≤ 550	≥ 1330	≥ 4000	white	blue	111-K135	111-KZ235	111-KD335	111-G135	111-GO135
145 ± 5		≤ 550	≥ 1330	≥ 4000	white	black	116-K135	116-KZ235	116-KD335	116-G135	116-GO135
150 ± 5		≤ 550	≥ 1330	≥ 4000	black	black	121-K135	121-KZ235	121-KD335	121-G135	121-GO135
155 ± 5		≤ 550	≥ 1330	≥ 4000	blue	black	126-K135	126-KZ235	126-KD335	126-G135	126-GO135
160 ± 5		≤ 550	≥ 1330	≥ 4000	blue	red	131-K135	131-KZ235	131-KD335	131-G135	131-GO135
170 ± 7		≤ 570	≥ 570	-	white	green	141-K135	141-KZ235	141-KD335	141-G135	141-GO135
180 ± 7		≤ 570	≥ 570	-	white	red	151-K135	151-KZ235	151-KD335	151-G135	151-GO135
190 ± 7 [3]		≤ 570	≥ 570	-	blue	green	-	-	-	-	-
200 ± 7 [3]		≤ 570	≥ 570	-	green	red	-	-	-	-	-
210 ± 7 [3]		≤ 570	≥ 570		brown	green					
220 ± 7 [3]		≤ 570	≥ 570	-	black	red	-	-	-	-	-

Legend:

1. *Resistance value is given for single PTC-thermistors, the value is to be multiplied for twin, triple and multiple sets.*
2. *The sensor types ROT 190°C, 200°C and 210°C did not meet the standard DIN VDE V 0898-1-401 and thus are not subordinated to the standardized characteristic curves and the color coding.*

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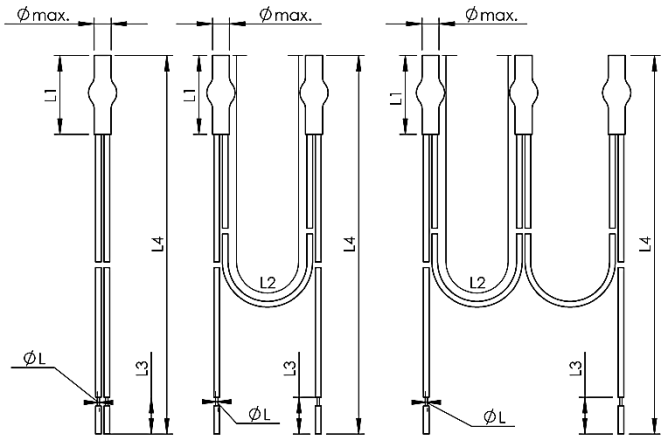
Example models:

PTC-model	dimensions: other design and change of length of leads (L4) according to customer‘s requirements					
	L1 [mm]	L2 [mm] / colour	L3 [mm]	L4 [mm]	Ømax. [mm]	ØL [mm] (according to choice of producer)
mini	12	180 / yellow	10	520	2,5	0,42 / 0,54

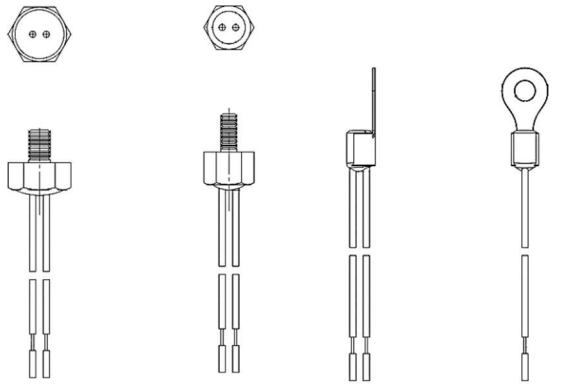
Electric motor- and machine protection

Single-PTC Thermistor | Twin-PTC Thermistor | Triple-PTC Thermistor



PTC-thermistors for measurements and control 30V

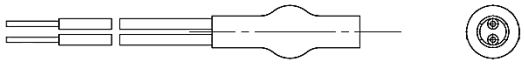
PTC-screw-in sensor | PTC-surface sensor

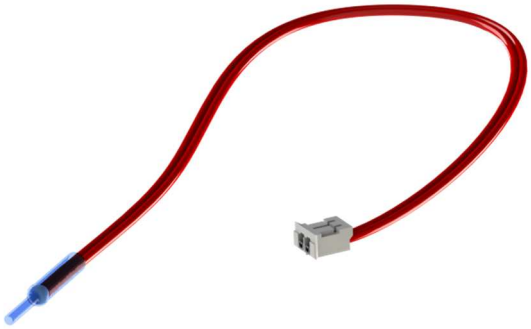


Temperature monitoring with PTC-thermistors according Norm DIN VDE V 0898-1-401
(previously DIN 44081 and DIN 44082)

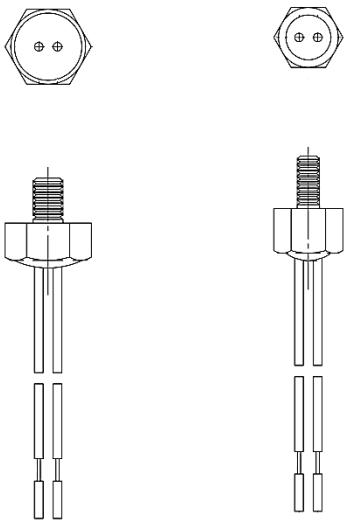
- PTC-sensors

examples of PTC-thermistor-housings





shrink tube housing,
e.g. for monitoring windings



screw-in-sensors in alu housing:
AL-M3/SW8 and AL-M4/SW10

Motor and machine protection

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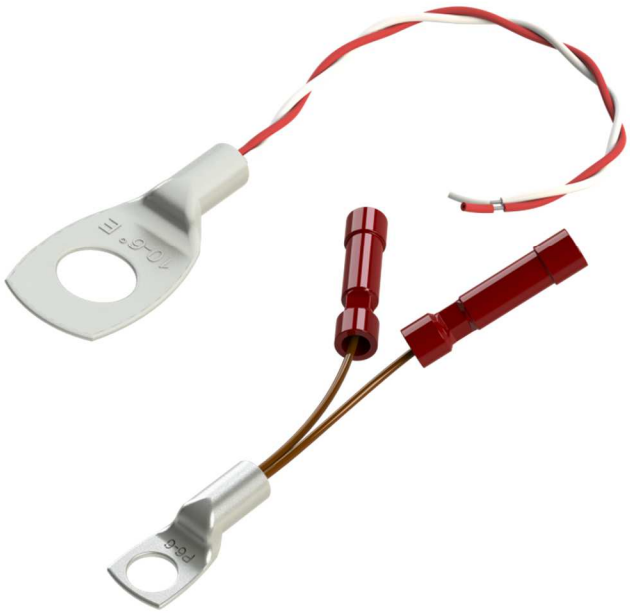
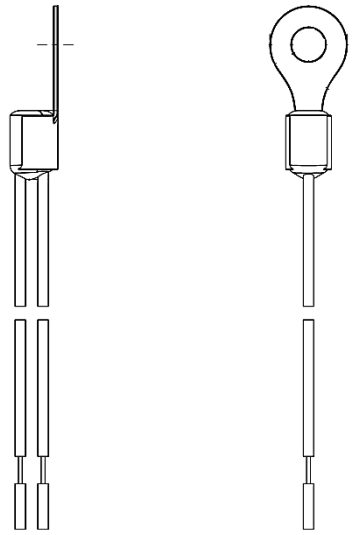
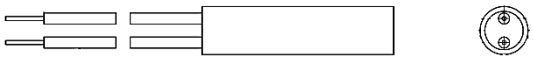
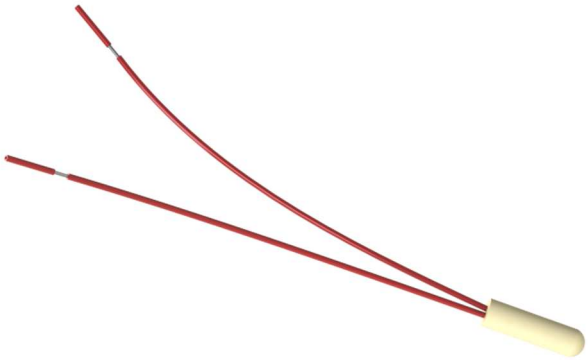


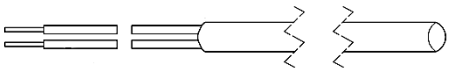


PTC-thermistor in cable shoe
surface sensor



PTC-thermistor in stainless steel housing





PTC-thermistor in ceramics
or brass housing

Responsibility:
No responsibility will be accepted for thermistors which have not been installed and tested according to the relevant standards as previously listed in our data sheet.
Due to the ongoing research and development program, product specification may be subject to change, at the manufacturers discretion.

For further advice and information contact:

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