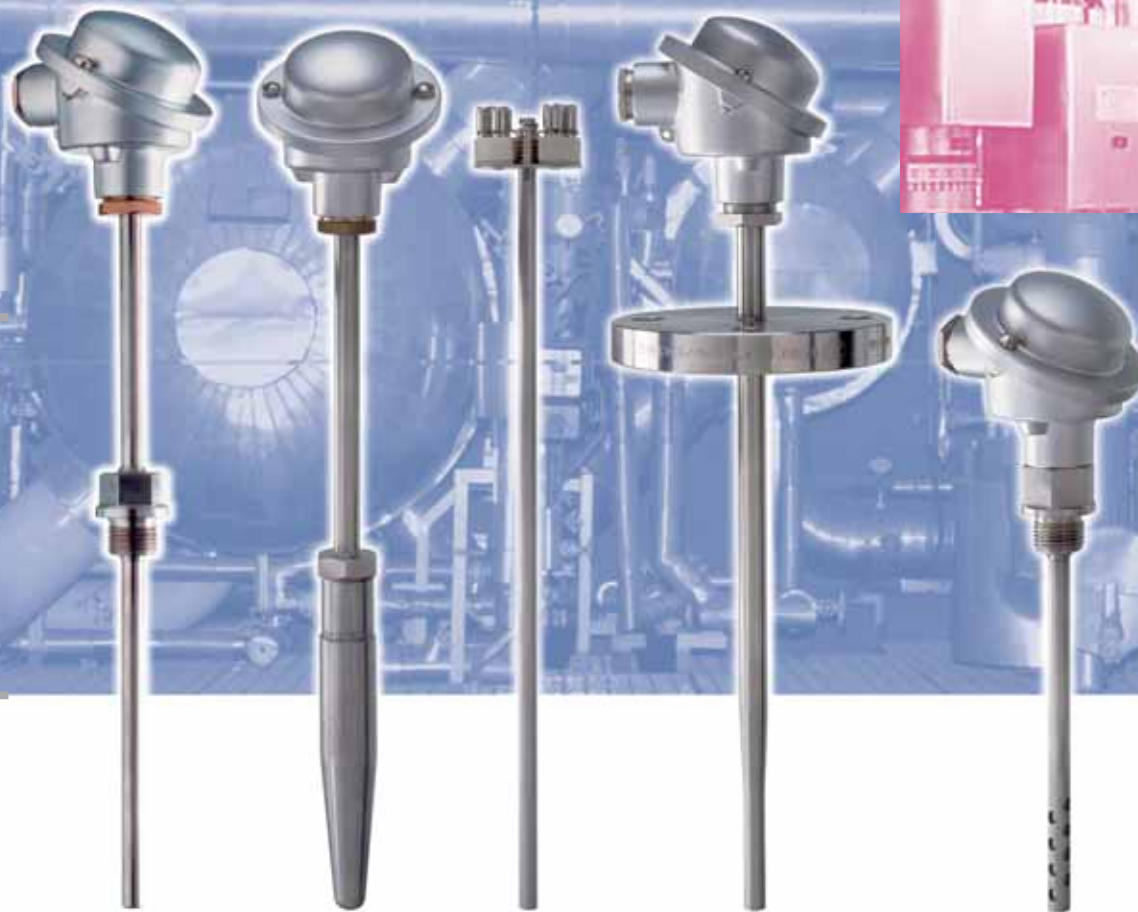


# *Resistance Thermometers and Thermocouples*

**According to DIN 43772  
for machine tool, plant and engine construction**

Measuring inserts, connection heads, head transmitters

Catalogue **12**



**Ludwig Schneider** 

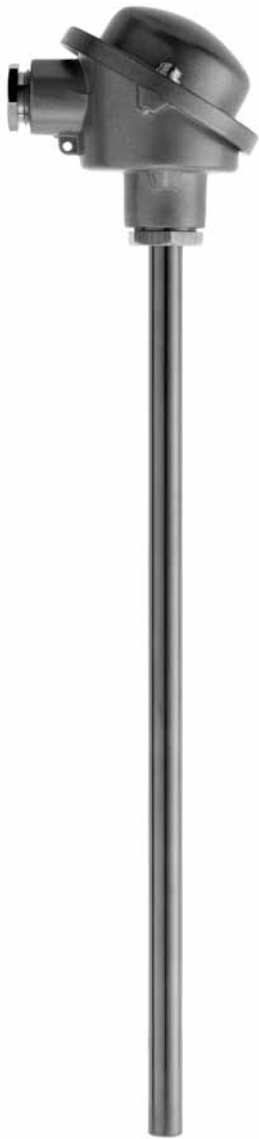
*High-precision measuring instruments for  
temperature and density*



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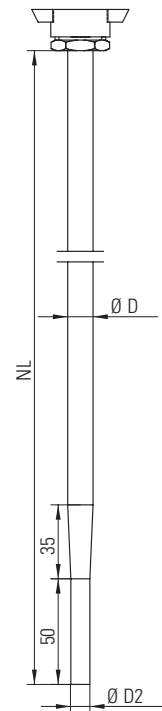
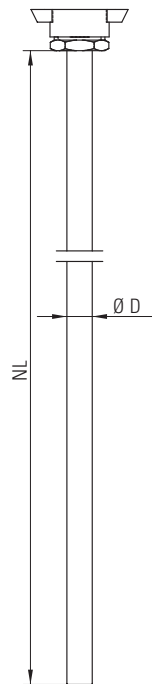
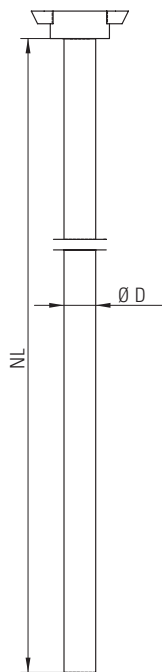
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# Insertable resistance thermometers with additional thermowell



## Insertable resistance thermometers acc. to DIN 43772

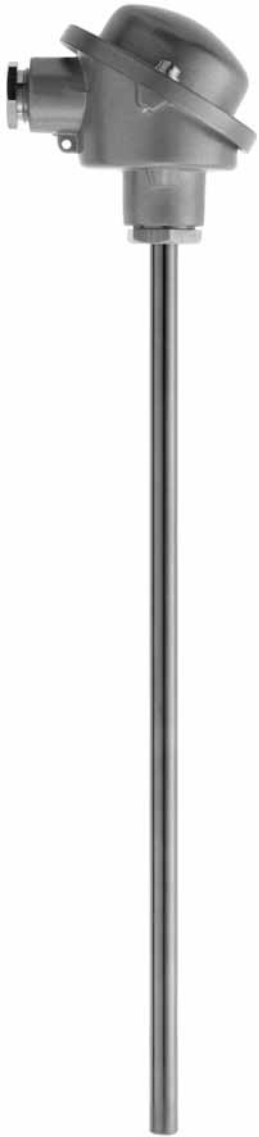
- for insertion in solid, liquid or gaseous media
- for variable installation environments (adjustable immersion depth)
- suitable for overpressure applications (with corresponding fasteners)
- for moderate mechanical loads
- protective stainless steel sheath 1.4571
- cable entry of connecting head alignable



Type	WT-BA	WT-BE	WT-BE (R)
			<b>Fast reaction</b>
Design acc. to DIN 43772	Form 1	Form 2	Form 3
Diameter of thermowell D [D2] (mm)	15	9/11/12/14	12[9]/14[11]
Insertion length NL (mm)	500...2.000	100...550	300...450
Operating temperature (°C)		-100 to +500	
Connection head (acc.to DIN)		Form B	
Connection		Ceramic block with bush terminals	
Sensor type and wire connection		Pt 100 for 2-, 3- or 4-wire connection; single or twin	
Accuracy class (acc. to DIN EN 60751)		B	
Measuring insert		Changeable	
Accessories		Flanges, couplings, clamping rings	

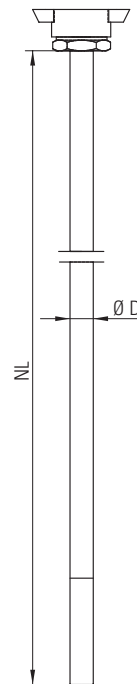
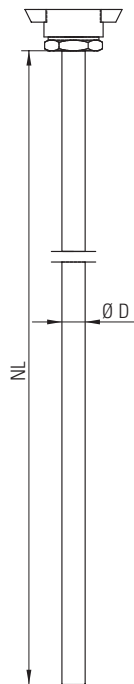
Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Insertable resistance thermometers without additional thermowell



## Insertable resistance thermometers

- for insertion in solid, liquid or gaseous media
- for variable installation environments (adjustable immersion depth)
- rapid response
- suitable for overpressure applications (with corresponding fasteners)
- for low mechanical loads
- without additional sheath
- for direct installation in the medium
- cable entry of connecting head alignable



Type	<b>WT-BL-ME</b> <b>Rigid measuring insert</b>	<b>WT-BL-MI</b> <b>Flexible measuring insert</b>
Diameter of measuring insert (mm)	6/8	
Insertion length NL (mm)	250...1.000	
Operating temperature (°C)	-100 to +500	
Connection head (acc.to DIN)	Form B	
Connection	Ceramic block with bush terminals	
Sensor type and wire connection	Pt 100 for 2-, 3- or 4-wire connection; single or twin	
Accuracy class (acc. to DIN EN 60751)	B	
Measuring insert (not changeable)	Rigid protection tube made of stainless steel	Flexible mineral-insulated cable, rigid probe
Accessories	Couplings, clamping rings	

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Screw-in resistance thermometers with lagging tube

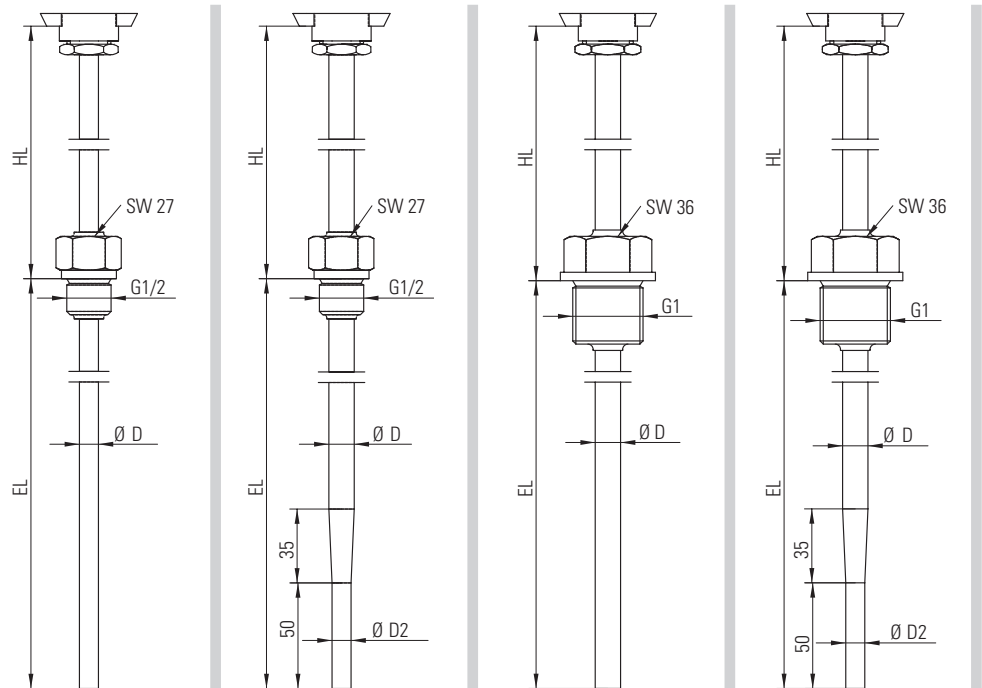


## Screw-in resistance thermometers

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- for applications requiring measuring head distance for temperature or installation reasons

- fixed installation length
- suitable for overpressure applications
- for moderate mechanical loads
- protective stainless steel sheath 1.4571
- for direct installation in the medium
- cable entry of connecting head alignable



Type	WT-BB	WT-BB (R) Fast reaction	WT-BC	WT-BC (R) Fast reaction
Design acc. to DIN 43772	Form 2G	Form 3G	Form 2G	Form 3G
Fixation	Mounting bush G1/2		Mounting bush G1	
Diameter of thermowell D [D2] (mm)	9/11/12/14	12[9]/14[11]	11/12/14	12[9]/14[11]
Insertion length EL (mm)	160...400	160...280	160...400	160...280
Lagging tube length HL (mm)	145	147	145	147
Operating temperature (°C)	-100 to +500			
Connection head (acc.to DIN)	Form B			
Connection	Ceramic block with bush terminals			
Sensor type and wire connection	Pt 100 for 2-, 3- or 4-wire connection; single or twin			
Accuracy class (acc. to DIN EN 60751)	B			
Measuring insert	Changeable			

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

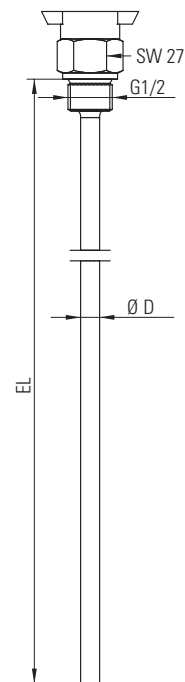
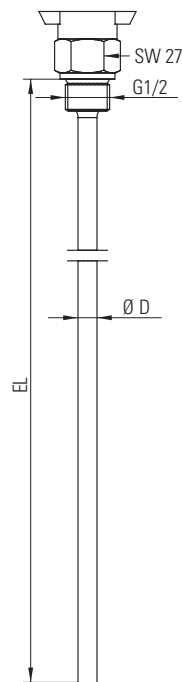
# Screw-in resistance thermometers without lagging tube



## Screw-in resistance thermometers

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- for compact installation conditions (no need for temperature- or geometry-related measuring head distance)
- fixed installation length
- suitable for overpressure applications
- for moderate mechanical loads
- protective stainless steel sheath 1.4571
- for direct installation in the medium
- cable entry of connecting head not alignable



Type	WT-BB-k	WT-BB-ko
Design acc. to DIN 43772	Form 2G	
Fixation	Mounting bush G1/2	
Diameter of thermowell D (mm)	9/11/12/14	6/8/9/11
Insertion length EL (mm)	160...400	100...400
Operating temperature (°C)	-100 to +500	
Connection head (acc.to DIN)	Form B	
Connection	Ceramic block with bush terminals	
Sensor type and wire connection	Pt 100 for 2-, 3- or 4-wire connection; single or twin	
Accuracy class (acc. to DIN EN 60751)	B	
Measuring insert	<b>Changeable</b>	<b>Not changeable</b>

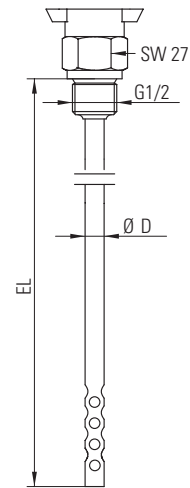
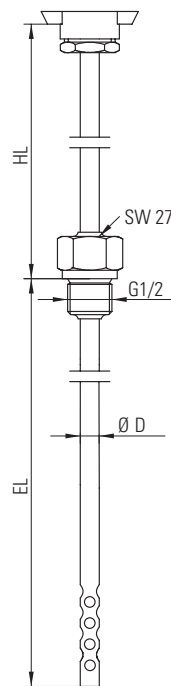
Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Screw-in resistance thermometers with perforated thermowell



## Screw-in resistance thermometers

- for insertion in gaseous media
- unsuitable for overpressure applications
- for low mechanical and thermal loads
- rapid response
- fixed installation length
- protective stainless steel sheath 1.4571
- for direct installation in the medium
- cable entry of connecting head not alignable



Type	<b>WT-BB (perf.) With lagging tube</b>	<b>WT-BB-k (perf.) Without lagging tube</b>
Fixation	Mounting bush G1/2	
Diameter of thermowell D (mm)	9/11	
Insertion length EL (mm)	160...400	100...400
Lagging tube length HL (mm)	145	—
Operating temperature (°C)	-30 to +300	
Connection head (acc. to DIN)	Form B	
Connection	Ceramic block with bush terminals	
Sensor type and wire connection	Pt 100 for 2-, 3- or 4-wire connection; single or twin	
Accuracy class (acc. to DIN EN 60751)	B	
Measuring insert	Changeable	

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Flanged resistance thermometers

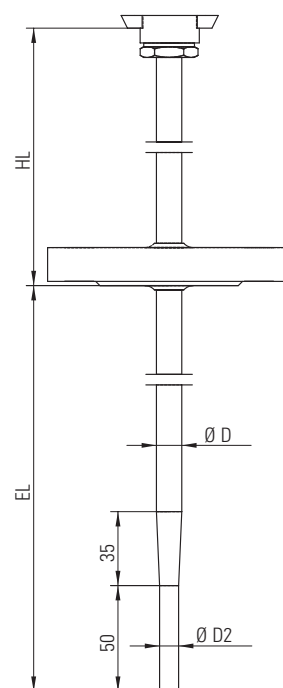
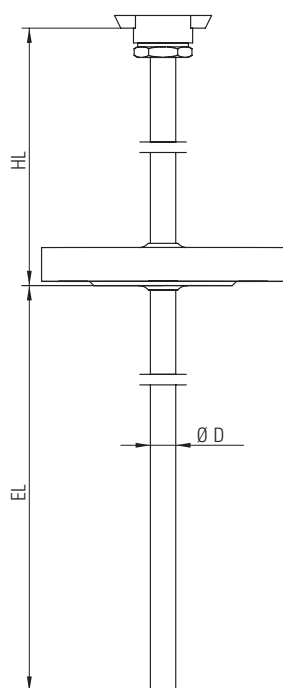


## Flanged resistance thermometers

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- especially suitable for overpressure applications

- fixed installation length
- for high mechanical and thermal loads
- protective stainless steel sheath 1.4571
- cable entry of connecting head alignable



Type	WT-BF	WT-BF (R) Fast reaction
Design acc. to DIN 43772	Form 2F	Form 3F
Fixation	Flange NW25 ND40	
Diameter of thermowell D (mm)	11/12/14	12[9]/14[11]
Insertion length EL (mm)	225...465	225...345
Lagging tube length HL (mm)	82	
Operating temperature (°C)	-100 to +500	
Connection head (acc.to DIN)	Form B	
Connection	Ceramic block with bush terminals	
Sensor type and wire connection	Pt 100 for 2-, 3- or 4-wire connection; single or twin	
Accuracy class (acc. to DIN EN 60751)	B	
Measuring insert	Changeable	

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

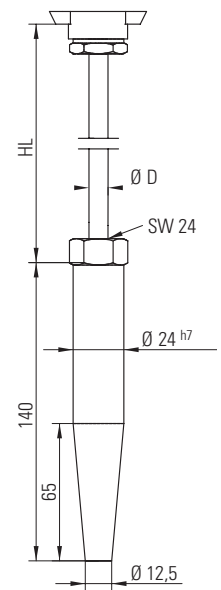
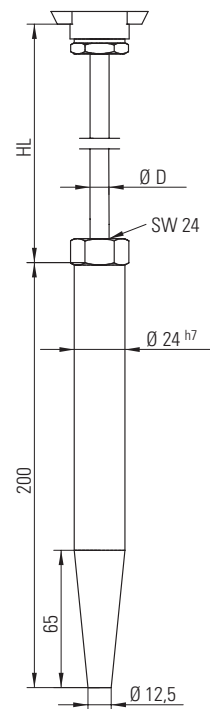
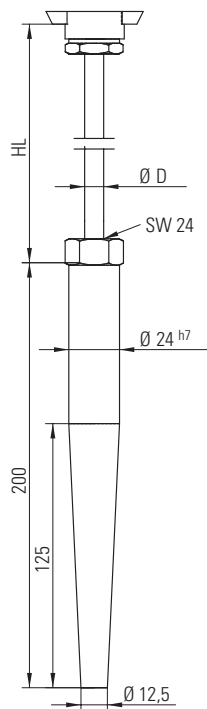
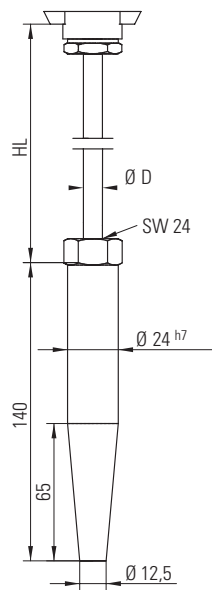
# Weld-in resistance thermometers with thermowell 24 mm dia.



## Weld-in resistance thermometers acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- especially suitable for overpressure applications

- moderate variable installation length
- for high mechanical and thermal loads
- with weld-in protective stainless steel sheath 1.4571
- cable entry of connecting head alignable



Type	WT-BD-D1	WT-BD-D2	WT-BD-D4	WT-BD-D5
Design acc. to DIN 43772			Form 4	
Fixation			Welding	
Diameter of thermowell D (mm)			24 <sup>h7</sup>	
Insertion length (mm)	140	200	200	260
Lagging tube length HL (mm)			165	
Operating temperature (°C)			-60 to +500	
Connection head (acc. to DIN)			Form B	
Connection			Ceramic block with bush terminals	
Sensor type and wire connection			Pt 100 for 2-, 3- or 4-wire connection; single or twin	
Accuracy class (acc. to DIN EN 60751)			B	
Measuring insert			Changeable	
Accessories			Weld-in thermowells	

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

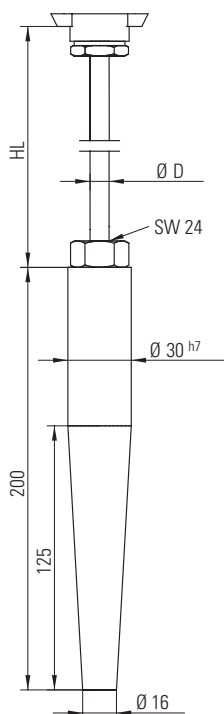
# Weld-in resistance thermometers with thermowell 30 mm dia.



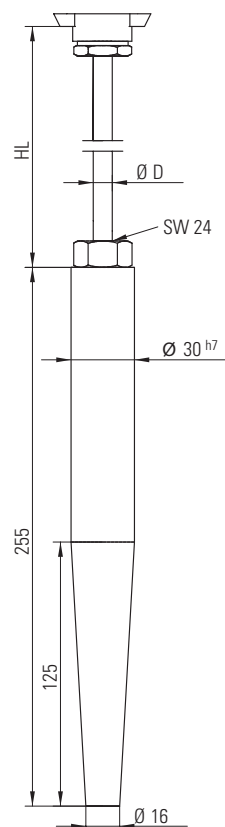
## Weld-in resistance thermometers acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- especially suitable for overpressure applications

- moderate variable installation length
- for high mechanical and thermal loads
- with weld-in protective stainless steel sheath 1.457
- cable entry of connecting head alignable



**WT-BD-D3**



**WT-BD-D6**

Type		
Design acc. to DIN 43772		Similar to Form 4
Fixation		Welding
Diameter of thermowell D (mm)		30 <sup>h7</sup>
Insertion length (mm)	200	255
Lagging tube length HL (mm)		165
Operating temperature (°C)		-60 to +500
Connection head (acc. to DIN)		Form B
Connection		Ceramic block with bush terminals
Sensor type and wire connection		Pt 100 for 2-, 3- or 4-wire connection; single or twin
Accuracy class (acc. to DIN EN 60751)		B
Measuring insert		Changeable
Accessories		Weld-in thermowells

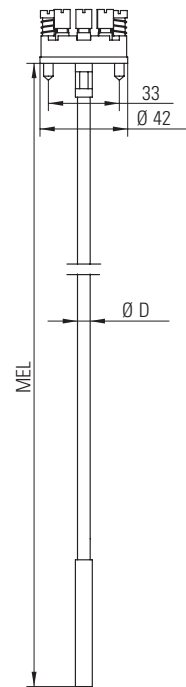
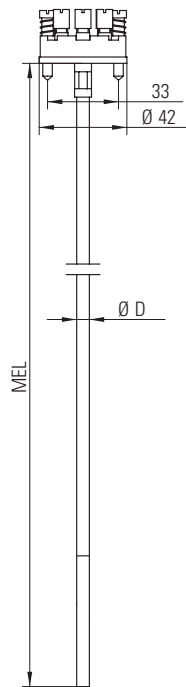
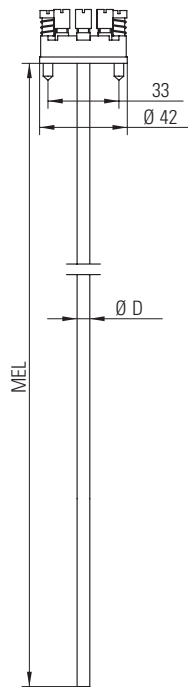
Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, sensors, accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Measuring inserts for resistance thermometers



## Measuring inserts as spare part or independent assembly group for installation in protection tubes

- Measuring tube and mineral-insulated cable at stainless steel
- With direct insertion in the media only for low mechanical loads
- Mounting screws with spring
- Connection by ceramic block with bush terminals



Type	WT-ME Rigid protection tube	WT-ME-MI-D Flexible mineral-insulated cable, rigid probe	WT-ME-MI-S Flexible mineral-insulated cable, rigid probe
Diameter (mm)		6/8	
Length MEL (mm)		100...2.000	
Measuring range (°C)		-100 to +500	
Connection	Ceramic block with bush terminals		
Sensor type and wire connection	Pt 100 for 2-, 3- or 4-wire connection; single or twin		
Accuracy class (acc. to DIN EN 60751)	B		

# Head transmitters for resistance thermometers

Head transmitters transform the measured unit of a sensor, eg. temperature, into a normed analog, most electrical signal. Ludwig Schneider offers special head transmitters for resistance thermometers. Ludwig Schneider offers two special head transmitters for resistance thermometers: an economic version with fixed settings (type 1) and the free programmable type 2. Furthermore the product program covers head transmitters with Hart® protocol, Foundation™-Fieldbus communication and Profibus®-PA-Technology.

## Technical data of head transmitters for resistance thermometers



Head transmitter	Type 1	Type 2
	economical	free programmable
<b>General specifications</b>		
Supply voltage	6.5 V to 32 V (DC)	7.2 V to 35 V (DC)
Electrical insulation	—	1500 V (AC)
Linearity error	± 0.1%	≤ 0.05%
Response time	≤ 0.2 s	1 s to 60 s (programmable)
EEProm error check	—	< 3.5 s (≤ 3.5 mA)
Conductor cross section (max.)	1.5 mm <sup>2</sup>	
Weight	40 g	50 g
Dimensions	Ø 44 x H 17 mm	Ø 44 x H 20.2 mm
Operating temperature	-40 °C to 85 °C	
Relative air humidity	0 to 95 %	
Suitable connection heads	Form B or larger size	
<b>Input specifications</b>		
Temperature span for Pt 100	-50 °C to 600 °C	-200 °C to 850 °C
Temperature span for Ni 100	—	-60 °C to 250 °C
Measuring span (min.)	50 °C	25 °C
Temperature range	Pt 100 (fixed setting)	Free programmable
Suitable sensors	Pt 100	Pt 100/500/1000 or Ni 100
Wire connection	2- and 3-wire connection	2-, 3- and 4-wire connection
Resistor current	1.1 mA	0.2 mA
Lead resistance (max.)	10 Ω	5 Ω
Accuracy	± 0.3 °C	± 0.2 °C
<b>Output specification</b>		
Current signal	4 to 20 mA	4 to 20 mA/20 to 4 mA

# General technical informations for resistance thermometers (RTs)

## Platinum resistance thermometers

In the preceding chapter we have introduced our wide range of resistance thermometers with integrated measuring resistor. These measuring elements are frequently used in electrical temperature measurement. The measuring method is based on the electrical resistance of metals in relation to the temperature: the positive temperature coefficient (PTC). In order to use this property the metal material must be selected in a way that the change in resistance can be reproduced reliably. This means that the specific characteristic may not be changed by internal and external influences causing measuring errors. For this reason platinum has become the norm in industrial temperature measurement, since it can be mined in a highly pure form meaning that the electrical properties can be reproduced very well. It is easy to work a property which is essential for forming wires. In addition it has a high melting point and very high chemical stability.

Only a small part of resistance thermometer designs is defined by standard DIN 43772, in which components and dimensions are specified. These standardised resistance thermometers always consist of a connection head, a thermowell and an exchangeable measuring insert, and can be assembled as modules.

## Measuring inserts

The measuring insert is an independent and pre-wired assembly. It mainly consists of a tube insert, an actual measuring resistor and a ceramic terminal block.

Fitting an exchangeable measuring insert has the advantage that the system does not have to be emptied or depressurized.

Construction and dimensions are defined according to standard DIN 43762. The thin-walled tube of the measuring insert, made of stainless steel forms the outer sleeve for the measuring resistor which is always directly at the tip of the measuring insert. Ceramically isolated extension wires on the measuring resistor are used to transfer measured values to the ceramic terminal block.

To improve response performance and mechanical load capacity, all interspaces in the measuring insert tube are filled with aluminium oxide powder.

Two pressure springs on the fixing screws are used to press the assembled measuring insert into the inside of the thermowell base in order to ensure efficient heat transfer. The two pressure springs also compensate any differences in length between the thermowell and the measuring insert.

The diameter and length of the measuring insert are harmonized with the respective thermowell with connection head.

Ludwig Schneider also produces measuring inserts in mineral insulated design, based on standard DIN 43762. A mineral insulated cable consists of a cable with an outer sheath of stainless steel, in which the inner conductors are embedded in highly compacted magnesium oxide.

The measuring resistor is thereby connected with the inner conductors and is also protected by a short insert tube welded to the mineral insulated cable. This variant allows very long measuring inserts to be produced which are flexible at the mineral insulated cable.

This design is also used with mechanical loads and vibration.

# Technical informations for RTs

## Measuring resistors

### Method of functioning

The measuring resistor is connected to a constant measuring current and the voltage drop caused by the resistance is measured. This voltage drop can be derived directly from Ohm's law:

$$U = R \cdot I$$

( $U$  = voltage in V,  $R$  = resistance in  $\Omega$ ,

$I$  = current intensity in A)

The measuring voltage must be transferred genuine to the point of evaluation or display as far as possible. Particularly the 2-wire connection, which will be discussed later, causes the additional wire resistance and an increase in the overall resistance and thus measuring inaccuracies. The measuring current should be selected as low as possible so that the measuring resistor is not heated up by the current. It can be assumed that a measuring current of  $\leq 1$  mA causes a negligible warm up heat in the measuring resistor.

### Standards for measuring resistors

IEC 751 respectively EN 60751 describe the requirements placed on industrial platinum measuring resistors whose electrical resistance is a function of the temperature. These standards apply for the temperature range of -200 to 850 °C and ensure international comparability as well as the exchange of resistance thermometers. They specify the nominal value, the basic and the deviation limits of measuring resistors.

The data specified in the standards only apply for the Pt100 platinum measuring resistor. On the other hand other measuring resistors, such as Pt500 or the Pt1000 are also used in practical applications. Their advantage lies in their greater sensitivity, meaning that a greater change in their resistance value is caused in relation to the temperature. The values which are specified in the standards have to be multiplied correspondingly by 5 or 10 for these measuring resistors.

### Nominal values

The nominal value in a measuring resistor is the value in Ohm at 0 °C. The term Pt is used for platinum measuring resistors. This means:

*Pt100 (100  $\Omega$  at 0 °C)*

*Pt500 (500  $\Omega$  at 0 °C)*

*Pt100 (1,000  $\Omega$  at 0 °C)*

# Technical informations for RTs

## Basic values

### Basic values

Basic values were calculated with specific equations of the electrical resistance values depending on temperature. The International Temperature Scale (ITS 90) of 1990 was used for the specifications of the temperature. The equation for the temperature range -200 to 0 °C is:

$$R_t = R_0 \cdot [1 + A \cdot t + B \cdot t^2 + C \cdot (t - 100 \text{ °C}) \cdot t^3]$$

The equation for the temperature range 0 to 850 °C is:

$$R_t = R_0 \cdot [1 + A \cdot t + B \cdot t^2]$$

The following constants apply in these equations for the quality of platinum which is commonly used for industrial measuring resistors:

$$A = 3.9083 \cdot 10^{-3} \text{ °C}^{-1}$$

$$B = -5.7750 \cdot 10^{-7} \text{ °C}^{-2}$$

$$C = -4.1830 \cdot 10^{-12} \text{ °C}^{-3}$$

In the case of platinum measuring resistors which fulfil the above requirements the temperature coefficient  $\alpha$  is defined as:

$$\alpha = \frac{R_{100} - R_0}{100 \cdot R_0} = 0.00385 \text{ °C}^{-1}$$

( $R_{100}/R_0$  = resistance at 100/0 °C)

Note: For calculations the exact value of  $\alpha$  is used as 0.00385055°C<sup>-1</sup>.

### Basic values acc. to IEC 751 resp. EN 60751 for the temperature range -200 to 0 °C

°C	-1	-2	-3	-4	-5	-6	-7	-8	-9
-200	18.52	—	—	—	—	—	—	—	—
-190	22.83	22.40	21.97	21.54	21.11	20.68	20.25	19.82	19.38
-180	27.10	26.67	26.24	25.82	25.39	24.97	24.54	24.11	23.68
-170	31.34	30.91	30.49	30.07	29.64	29.22	28.80	28.37	27.95
-160	35.54	35.12	34.70	34.28	33.86	33.44	33.02	32.60	32.18
-150	39.72	39.31	38.89	38.47	38.05	37.64	37.22	36.80	36.38
-140	43.88	43.46	43.05	42.63	42.22	41.80	41.39	40.97	40.56
-130	48.00	47.59	47.18	46.77	46.36	45.94	45.53	45.12	44.70
-120	52.11	51.70	51.29	50.88	50.47	50.06	49.65	49.24	48.83
-110	56.19	55.79	55.38	54.97	54.56	54.15	53.75	53.34	52.93
-100	60.26	59.85	59.44	59.04	58.63	58.23	57.82	57.41	57.01
-90	64.30	63.90	63.49	63.09	62.68	62.28	61.88	61.47	61.07
-80	68.33	67.92	67.52	67.12	66.72	66.31	65.91	65.51	65.11
-70	72.33	71.93	71.53	71.13	70.73	70.33	69.93	69.53	69.13
-60	76.33	75.93	75.53	75.13	74.73	74.33	73.93	73.53	73.13
-50	80.31	79.91	79.51	79.11	78.72	78.32	77.92	77.52	77.12
-40	84.27	83.87	83.48	83.08	82.69	82.29	81.89	81.50	81.10
-30	88.22	87.83	87.43	87.04	86.64	86.25	85.85	85.46	85.06
-20	92.16	91.77	91.37	90.98	90.59	90.19	89.80	89.40	89.01
-10	96.09	95.69	95.30	94.91	94.52	94.12	93.73	93.34	92.95
0	100.00	99.61	99.22	98.83	98.44	98.04	97.65	97.26	96.87

### Basic values acc. to IEC 751 resp. EN 60751 for the temperature range 0 to 319 °C

°C	1	2	3	4	5	6	7	8	9
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12
10	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90
30	111.67	112.06	112.45	112.83	113.22	113.61	114.00	114.38	114.77
40	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63
50	119.40	119.78	120.17	120.55	120.94	121.32	121.71	122.09	122.47
60	123.24	123.63	124.01	124.39	124.78	125.16	125.54	125.93	126.31
70	127.08	127.46	127.84	128.22	128.61	128.99	129.37	129.75	130.13
80	130.90	131.28	131.66	132.04	132.42	132.80	133.18	133.57	133.95
90	134.71	135.09	135.47	135.85	136.23	136.61	136.99	137.37	137.75
100	138.51	138.88	139.26	139.64	140.02	140.40	140.78	141.16	141.54
110	142.29	142.67	143.05	143.43	143.80	144.18	144.56	144.94	145.31
120	146.07	146.44	146.82	147.20	147.57	147.95	148.33	148.70	149.08
130	149.83	150.21	150.58	150.96	151.33	151.71	152.08	152.46	152.83
140	153.58	153.96	154.33	154.71	155.08	155.46	155.83	156.20	156.58
150	157.33	157.70	158.07	158.45	158.82	159.19	159.56	159.94	160.31
160	161.05	161.43	161.80	162.17	162.54	162.91	163.29	163.66	164.03
170	164.77	165.14	165.51	165.89	166.26	166.63	167.00	167.37	167.74
180	168.48	168.85	169.22	169.59	169.96	170.33	170.70	171.07	171.43
190	172.17	172.54	172.91	173.28	173.65	174.02	174.38	174.75	175.12
200	175.86	176.22	176.59	176.96	177.33	177.69	178.06	178.43	178.79
210	179.53	179.89	180.26	180.63	180.99	181.36	181.72	182.09	182.46
220	183.19	183.55	183.92	184.28	184.65	185.01	185.38	185.74	186.11
230	186.84	187.20	187.56	187.93	188.29	188.66	189.02	189.38	189.75
240	190.47	190.84	191.20	191.56	191.92	192.29	192.65	193.01	193.37
250	194.10	194.46	194.82	195.18	195.55	195.91	196.27	196.63	196.99
260	197.71	198.07	198.43	198.79	199.15	199.51	199.87	200.23	200.59
270	201.31	201.67	202.03	202.39	202.75	203.11	203.47	203.83	204.19
280	204.90	205.26	205.62	205.98	206.34	206.70	207.05	207.41	207.77
290	208.48	208.84	209.20	209.56	209.91	210.27	210.63	210.98	211.34
300	212.05	212.41	212.76	213.12	213.48	213.83	214.19	214.54	214.90
310	215.61	215.96	216.32	216.67	217.03	217.38	217.74	218.09	218.44

# Technical informations for RTs

## Basic values

Basic values acc. to IEC 751 resp. EN 60751 for the temperature range 320 to 850 °C

°C	1	2	3	4	5	6	7	8	9	
320	219.15	219.51	219.86	220.21	220.57	220.92	221.27	221.63	221.98	222.33
330	222.68	223.04	223.39	223.74	224.09	224.45	224.80	225.15	225.50	225.85
340	226.21	226.56	226.91	227.26	227.61	227.96	228.31	228.66	229.02	229.37
350	229.72	230.07	230.42	230.77	231.12	231.47	231.82	232.17	232.52	232.87
360	233.21	233.56	233.91	234.26	234.61	234.96	235.31	235.66	236.00	236.35
370	236.70	237.05	237.40	237.74	238.09	238.44	238.79	239.13	239.48	239.83
380	240.18	240.52	240.87	241.22	241.56	241.91	242.26	242.60	242.95	243.29
390	243.64	243.99	244.33	244.68	245.02	245.37	245.71	246.06	246.40	246.75
400	247.09	247.44	247.78	248.13	248.47	248.81	249.16	249.50	249.85	250.19
410	250.53	250.88	251.22	251.56	251.91	252.25	252.59	252.93	253.28	253.62
420	253.96	254.30	254.65	254.99	255.33	255.67	256.01	256.35	256.70	257.04
430	257.38	257.72	258.06	258.40	258.74	259.08	259.42	259.76	260.10	260.44
440	260.78	261.12	261.46	261.80	262.14	262.48	262.82	263.16	263.50	263.84
450	264.18	264.52	264.86	265.20	265.53	265.87	266.21	266.55	266.89	267.22
460	267.56	267.90	268.24	268.57	268.91	269.25	269.59	269.92	270.26	270.60
470	270.93	271.27	271.61	271.94	272.28	272.61	272.95	273.29	273.62	273.96
480	274.29	274.63	274.96	275.30	275.63	275.97	276.30	276.64	276.97	277.31
490	277.64	277.98	278.31	278.64	278.98	279.31	279.64	279.98	280.31	280.64
500	280.98	281.31	281.64	281.98	282.31	282.64	282.97	283.31	283.64	283.97
510	284.30	284.63	284.97	285.30	285.63	285.96	286.29	286.62	286.95	287.29
520	287.62	287.95	288.28	288.61	288.94	289.27	289.60	289.93	290.26	290.59
530	290.92	291.25	291.58	291.91	292.24	292.56	292.89	293.22	293.55	293.88
540	294.21	294.54	294.86	295.19	295.52	295.85	296.18	296.50	296.83	182.82
550	297.49	297.81	298.14	298.47	298.80	299.12	299.45	299.78	300.10	186.47
560	300.75	301.08	301.41	301.73	302.06	302.38	302.71	303.03	303.36	190.11
570	304.01	304.34	304.66	304.98	305.31	305.63	305.96	306.28	306.61	193.74
580	307.25	307.58	307.90	308.23	308.55	308.87	309.20	309.52	309.84	197.35
590	310.49	310.81	311.13	311.45	311.78	312.10	312.42	312.74	313.06	200.95
600	313.71	314.03	314.35	314.67	314.99	315.31	315.64	315.96	316.28	204.55
610	316.92	317.24	317.56	317.88	318.20	318.52	318.84	319.16	319.48	208.13
620	320.12	320.43	320.75	321.07	321.39	321.71	322.03	322.35	322.67	211.70
630	323.30	323.62	323.94	324.26	324.57	324.89	325.21	325.53	325.84	215.25
640	326.48	326.79	327.11	327.43	327.74	328.06	328.38	328.69	329.01	218.80
650	329.64	329.96	330.27	330.59	330.90	331.22	331.53	331.85	332.16	222.33
660	332.79	333.11	333.42	333.74	334.05	334.36	334.68	334.99	335.31	225.85
670	335.93	336.25	336.56	336.87	337.18	337.50	337.81	338.12	338.44	229.37
680	339.06	339.37	339.69	340.00	340.31	340.62	340.93	341.24	341.56	232.87
690	342.18	342.49	342.80	343.11	343.42	343.73	344.04	344.35	344.66	236.35
700	345.28	345.59	345.90	346.21	346.52	346.83	347.14	347.45	347.76	239.83
710	348.38	348.69	348.99	349.30	349.61	349.92	350.23	350.54	350.84	243.29
720	351.46	351.77	352.08	352.38	352.69	353.00	353.30	353.61	353.92	246.75
730	354.53	354.84	355.14	355.45	355.76	356.06	356.37	356.67	356.98	250.19
740	357.59	357.90	358.20	358.51	358.81	359.12	359.42	359.72	360.03	253.62
750	360.64	360.94	361.25	361.55	361.85	362.16	362.46	362.76	363.07	257.04
760	363.67	363.98	364.28	364.58	364.89	365.19	365.49	365.79	366.10	260.44
770	366.70	367.00	367.30	367.60	367.91	368.21	368.51	368.81	369.11	263.84
780	369.71	370.01	370.31	370.61	370.91	371.21	371.51	371.81	372.11	267.22
790	372.71	373.01	373.31	373.61	373.91	374.21	374.51	374.81	375.11	270.60
800	375.70	376.00	376.30	376.60	376.90	377.19	377.49	377.79	378.09	273.96
810	378.68	378.98	379.28	379.57	379.87	380.17	380.46	380.76	381.06	277.31
820	381.65	381.95	382.24	382.54	382.83	383.13	383.42	383.72	384.01	280.64
830	384.60	384.90	385.19	385.49	385.78	386.08	386.37	386.67	386.96	283.97
840	387.55	387.84	388.14	388.43	388.72	389.02	389.31	389.60	389.90	287.29
850	390.48	-	-	-	-	-	-	-	-	-

# Technical informations for RTs

## Deviation limits

### Deviation limits

The deviation limit is the maximum permissible deviation in °C of a platinum measuring resistor from the standardized basic values.

Acc. to IEC 751 resp. EN 60751 the deviation limits are based on the measuring resistor Pt100 with a nominal value of 100 Ω at 0 °C. The deviation limits are divided in two tolerance classes.

The tables shown on this page specify the values of the deviation limits in Ohm and °C.

### Tolerance classes acc. to standards

Acc. to IEC 751 resp. EN 60751 two tolerance classes called class B and class A are standardized.

Tolerance class B is the basic tolerance class and applies across the entire temperature range of -200 to 850 °C.

Tolerance class A only applies to a limited temperature range of -200 to 600 °C.

### Restricted tolerance classes

For special applications pretentious requirements are applying which are not covered by any standard.

By continued development in the field of measuring resistors Ludwig Schneider offers also the restricted tolerance classes 1/3 B, 1/5 B und 1/10 B which however are not standardized.

Tolerance class	Standard	Deviation limit (°C)	for temperature range
B	IEC 751 resp. EN 60751	$\pm 0.30 + 0.00500 \cdot t$	-200 to 850 °C
A	IEC 751 resp. EN 60751	$\pm 0.15 + 0.00200 \cdot t$	-200 to 600 °C
1/3 B	no (acc. to LSW)	$\pm 0.10 + 0.00167 \cdot t$	-50 to 400 °C
1/5 B	no (acc. to LSW)	$\pm 0.06 + 0.00100 \cdot t$	-50 to 400 °C
1/10 B	no (acc. to LSW)	$\pm 0.03 + 0.00050 \cdot t$	-50 to 400 °C

### Deviation limits acc. to IEC 751 resp. EN 60751 for resistance thermometers

Temp. °C	Basic value Ω	Tolerance class acc. to IEC 751/EN 60751				Restricted tolerance class acc. to Ludwig Schneider					
		B		A		1/3 B		1/5 B		1/10 B	
		±Ω	±°C	±Ω	±°C	±Ω	±°C	±Ω	±°C	±°C	±°C
-200	18.520	0.562	1.30	0.238	0.55	–	–	–	–	–	–
-150	39.723	0.438	1.05	0.188	0.45	–	–	–	–	–	–
-100	60.256	0.324	0.80	0.142	0.35	–	–	–	–	–	–
-50	80.306	0.218	0.55	0.099	0.25	0.073	0.18	0.044	0.11	0.022	0.055
-40	84.271	0.198	0.50	0.091	0.23	0.066	0.17	0.040	0.10	0.020	0.050
-30	88.222	0.178	0.45	0.083	0.21	0.059	0.15	0.036	0.09	0.018	0.045
-20	92.160	0.157	0.40	0.075	0.19	0.052	0.13	0.031	0.08	0.016	0.040
-10	96.086	0.137	0.35	0.067	0.17	0.046	0.12	0.027	0.07	0.014	0.035
0	100.000	0.117	0.30	0.059	0.15	0.039	0.10	0.023	0.06	0.012	0.030
10	103.903	0.136	0.35	0.066	0.17	0.045	0.12	0.027	0.07	0.014	0.035
20	107.794	0.155	0.40	0.074	0.19	0.052	0.13	0.031	0.08	0.016	0.040
30	111.673	0.174	0.45	0.081	0.21	0.058	0.15	0.035	0.09	0.017	0.045
40	115.541	0.193	0.50	0.089	0.23	0.064	0.17	0.039	0.10	0.019	0.050
50	119.397	0.212	0.55	0.096	0.25	0.071	0.18	0.042	0.11	0.021	0.055
60	123.242	0.230	0.60	0.104	0.27	0.077	0.20	0.046	0.12	0.023	0.060
70	217.075	0.249	0.65	0.111	0.29	0.083	0.22	0.050	0.13	0.025	0.065
80	130.897	0.267	0.70	0.118	0.31	0.089	0.23	0.053	0.14	0.027	0.070
90	134.707	0.285	0.75	0.125	0.33	0.095	0.25	0.057	0.15	0.029	0.075
100	138.506	0.303	0.80	0.133	0.35	0.101	0.27	0.061	0.16	0.030	0.080

# Technical informations for RTs

## Deviation limits

Deviation limits acc. to IEC 751 resp. EN 60751 for resistance thermometers

Temp. °C	Basic value Ω	Tolerance class acc. to IEC 751/EN 60751				Restricted tolerance class acc. to Ludwig Schneider					
		B		A		1/3 B		1/5 B		1/10 B	
		±Ω	±°C	±Ω	±°C	±Ω	±°C	±Ω	±°C	±Ω	±°C
110	142.293	0.321	0.85	0.140	0.37	0.107	0.28	0.064	0.17	0.032	0.085
120	146.068	0.339	0.90	0.147	0.39	0.113	0.30	0.068	0.18	0.034	0.090
130	149.832	0.357	0.95	0.154	0.41	0.119	0.32	0.071	0.19	0.036	0.095
140	153.584	0.374	1.00	0.161	0.43	0.125	0.33	0.075	0.20	0.037	0.100
150	157.325	0.392	1.05	0.168	0.45	0.131	0.35	0.078	0.21	0.039	0.105
160	161.054	0.409	1.10	0.175	0.47	0.136	0.37	0.082	0.22	0.041	0.110
170	164.772	0.427	1.15	0.182	0.49	0.142	0.38	0.085	0.23	0.043	0.115
180	168.478	0.444	1.20	0.189	0.51	0.148	0.40	0.089	0.24	0.044	0.120
190	172.173	0.461	1.25	0.195	0.53	0.154	0.42	0.092	0.25	0.046	0.125
200	175.856	0.478	1.30	0.202	0.55	0.159	0.43	0.096	0.26	0.048	0.130
210	179.528	0.495	1.35	0.209	0.57	0.165	0.45	0.099	0.27	0.049	0.135
220	183.188	0.511	1.40	0.215	0.59	0.170	0.47	0.102	0.28	0.051	0.140
230	186.836	0.528	1.45	0.222	0.61	0.176	0.48	0.106	0.29	0.053	0.145
240	190.473	0.544	1.50	0.229	0.63	0.181	0.50	0.109	0.30	0.054	0.150
250	194.098	0.561	1.55	0.235	0.65	0.187	0.52	0.112	0.31	0.056	0.155
260	197.712	0.577	1.60	0.242	0.67	0.192	0.53	0.115	0.32	0.058	0.160
270	201.314	0.593	1.65	0.248	0.69	0.198	0.55	0.119	0.33	0.059	0.165
280	204.905	0.609	1.70	0.254	0.71	0.203	0.57	0.122	0.34	0.061	0.170
290	208.484	0.625	1.75	0.261	0.73	0.208	0.58	0.125	0.35	0.062	0.175
300	212.052	0.641	1.80	0.267	0.75	0.214	0.60	0.128	0.36	0.064	0.180
310	215.608	0.656	1.85	0.273	0.77	0.219	0.62	0.131	0.37	0.066	0.185
320	219.152	0.672	1.90	0.279	0.79	0.224	0.63	0.134	0.38	0.067	0.190
330	222.685	0.687	1.95	0.285	0.81	0.229	0.65	0.137	0.39	0.069	0.195
340	226.206	0.703	2.00	0.292	0.83	0.234	0.67	0.141	0.40	0.070	0.200
350	229.716	0.718	2.05	0.298	0.85	0.239	0.68	0.144	0.41	0.072	0.205
360	233.214	0.733	2.10	0.304	0.87	0.244	0.70	0.147	0.42	0.073	0.210
370	236.701	0.748	2.15	0.310	0.89	0.249	0.72	0.150	0.43	0.075	0.215
380	240.176	0.763	2.20	0.315	0.91	0.254	0.73	0.153	0.44	0.076	0.220
390	243.640	0.777	2.25	0.321	0.93	0.259	0.75	0.155	0.45	0.078	0.225
400	247.092	0.792	2.30	0.327	0.95	0.264	0.77	0.158	0.46	0.079	0.230
410	250.533	0.806	2.35	0.333	0.97	–	–	–	–	–	–
420	253.962	0.821	2.40	0.339	0.99	–	–	–	–	–	–
430	257.379	0.835	2.45	0.344	1.01	–	–	–	–	–	–
440	260.785	0.849	2.50	0.350	1.03	–	–	–	–	–	–
450	264.179	0.863	2.55	0.355	1.05	–	–	–	–	–	–
460	267.562	0.877	2.60	0.360	1.07	–	–	–	–	–	–
470	270.933	0.891	2.65	0.366	1.09	–	–	–	–	–	–
480	274.293	0.905	2.70	0.371	1.11	–	–	–	–	–	–
490	277.641	0.918	2.75	0.377	1.13	–	–	–	–	–	–
500	280.978	0.932	2.80	0.383	1.15	–	–	–	–	–	–
550	297.487	0.997	3.05	0.409	1.25	–	–	–	–	–	–
600	313.708	1.060	3.30	0.434	1.35	–	–	–	–	–	–
650	329.640	1.119	3.55	–	–	–	–	–	–	–	–
700	345.284	1.176	3.80	–	–	–	–	–	–	–	–
750	360.638	1.230	4.05	–	–	–	–	–	–	–	–
800	375.704	1.281	4.30	–	–	–	–	–	–	–	–
850	390.481	1.329	4.55	–	–	–	–	–	–	–	–

# Technical informations for RTs

## Connecting techniques

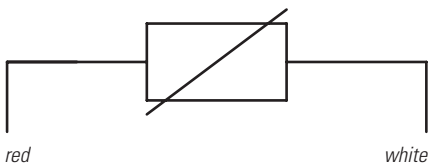
### 2-wire connection

The resistance thermometer is connected by a 2-core connecting lead. This version is the simplest but also most inaccurate connecting technique, because the additional resistance of the connecting lead which is added to the measuring resistor value increases the total resistance. This increase inevitably causes a higher temperature to be displayed and leads to considerable distortions in the case of a long connection.

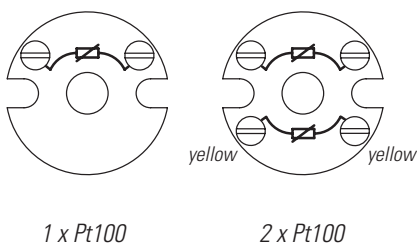
$$R_{display} = R_{sensor} + R_{connecting\ lead}$$

The error can be avoided by compensation of the lead resistance. The resistance thermometer is initially replaced by a resistor with 100,00 Ohm and a compensating resistance is switched into one core of the connecting lead. The compensating resistance has to be adjusted until 0 °C is indicated at the display or measured value logger. This procedure causes high efforts and does not take any changes in the lead resistance into account which are caused by temperature influences.

Circuit diagram 2-wire connection



2-wire connection  
Coding of ceramic terminal block



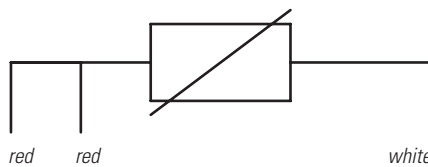
### 3-wire connection

The resistance thermometer is connected by a 3-core connecting lead to the display or to the measured value logger. The use of two measuring circuits, one of which is used as a bridge circuit or proportionate circuit, allows the almost complete compensation of the lead resistance. The lead resistance error is minimized to such an extent that the temperature specific changes in the lead resistance are also eliminated by the additional loop. However, all 3 cores must change in the same way.

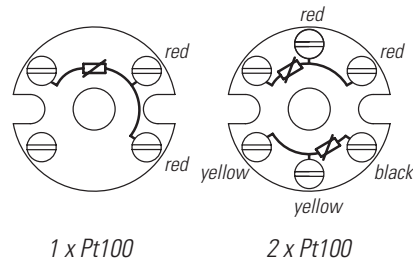
$$R_{display} = (R_{sensor} + R_{connecting\ lead}) - R_{connect.\ lead}$$

In this connecting technology the lead resistance no longer has to be compensated. For this reason it is used most often in industrial temperature measurement.

Circuit diagram 3-wire connection



3-wire connection  
Coding of ceramic terminal block



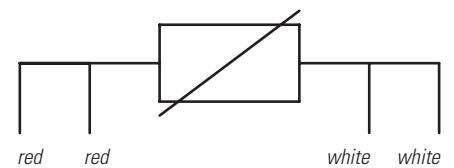
### 4-wire connection

The resistance thermometer is connected by a 4-core connecting lead. The measuring current is fed in through two cores and the voltage drop is picked off at the other two cores. This means that the influence of the lead resistance is eliminated completely.

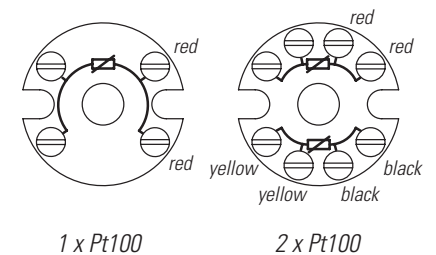
$$R_{display} = R_{sensor}$$

This connecting technique is used wherever extremely precise temperature measurements are required.

Circuit diagram 4-wire connection



4-wire connection  
Coding of ceramic terminal block





# Insertable thermocouples with additional thermowell

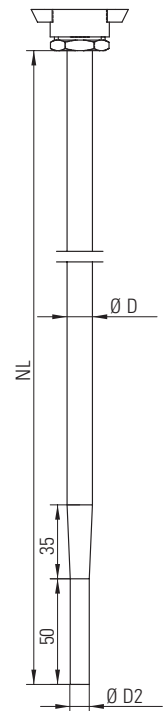
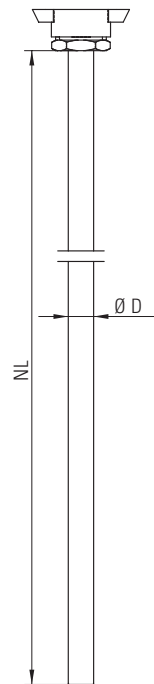
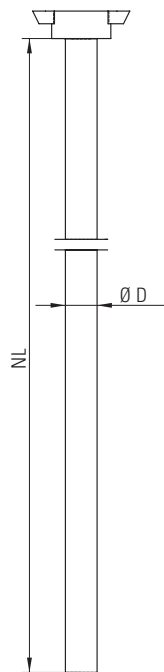


## Insertable thermocouples

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- for variable installation environments (adjustable immersion depth)

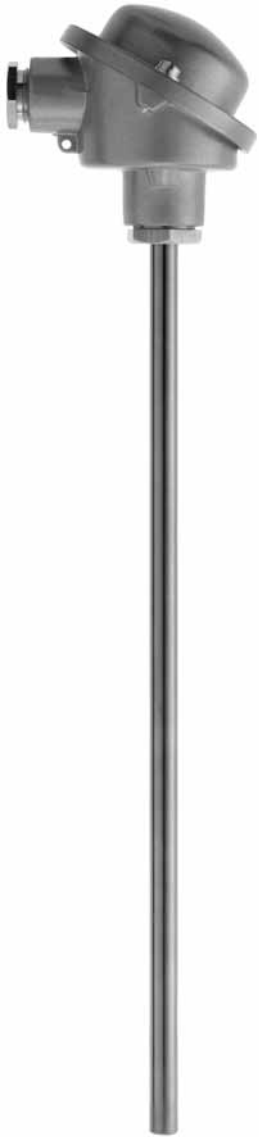
- suitable for overpressure applications (with corresponding fasteners)
- for moderate mechanical loads
- protective stainless steel sheath 1.4571
- cable entry of connecting head alignable



Type	TE-BA	TE-BE	TE-BE (R)
			<b>Fast reaction</b>
Design acc. to DIN 43772	Form 1	Form 2	Form 3
Diameter of thermowell D [D2] (mm)	15	9/11/12/14	12[9]/14[11]
Insertion length NL (mm)	500...2.000	100...550	300...450
Operating temperature (°C)		-100 to +600	
Connection head (acc.to DIN)		Form B	
Connection		Ceramic block with bush terminals	
Thermocouple		NiCr-Ni Type K or Fe-CuNi Type J; single or twin	
Thermocouple accuracy acc. to DIN EN 60584		Class 2	
Measuring insert		Changeable	
Accessories		Flanges, couplings, clamping rings	

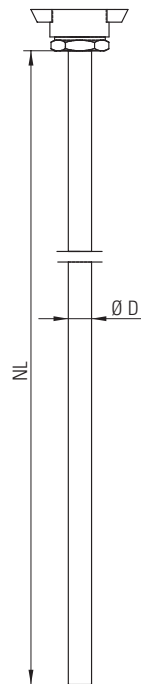
Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, thermocouples and accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Insertable Thermocouples without additional thermowell



## Insertable thermocouples

- for insertion in solid, liquid or gaseous media
- for variable installation environments (adjustable immersion depth)
- rapid response
- suitable for overpressure applications (with corresponding fasteners)
- for low mechanical loads
- without additional thermowell
- for direct installation in the medium
- cable entry of connecting head alignable



Type	<b>TE-BL-MI</b>
	<b>Flexible measuring insert</b>
Fixation	Couplings with clamping rings
Insertion length NL (mm)	250...1.000
Operating temperature (°C)	-100 to +600
Connection head (acc.to DIN)	Form B
Connection	Ceramic block with bush terminals
Thermocouple	NiCr-Ni Type K or Fe-CuNi Type J; single or twin
Thermocouple accuracy acc. to DIN EN 60584	Class 2
Measuring insert (not changeable)	Flexible mineral-insulated cable
Accessories	Couplings, clamping rings

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, thermocouples and accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Screw-in thermocouples with lagging tube

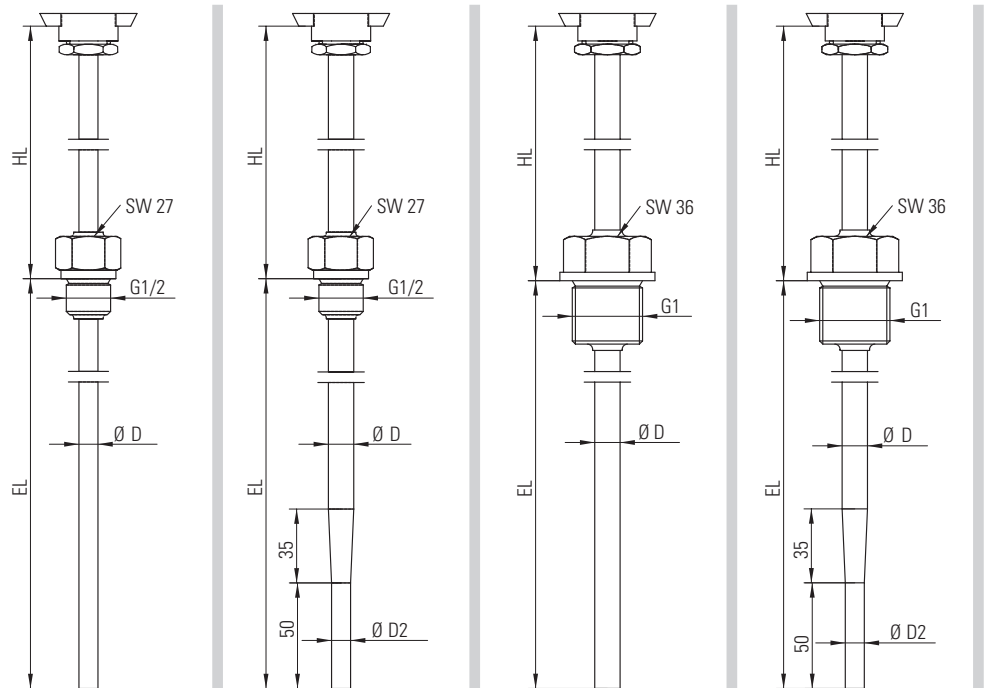


## Screw-in thermocouples

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- for applications requiring measuring head distance for temperature or installation reasons

- fixed installation length
- suitable for overpressure applications
- for moderate mechanical loads
- protective stainless steel sheath 1.4571
- for direct installation in the medium
- cable entry of connecting head alignable



Type	TE-BB	TE-BB (R) Fast reaction	TE-BC	TE-BC (R) Fast reaction
Design acc. to DIN 43772	Form 2G	Form 3G	Form 2G	Form 3G
Fixation	Mounting bush G1/2		Mounting bush G1	
Diameter of thermowell D [D2] (mm)	9/11/12/14	12[9]/14[11]	11/12/14	12[9]/14[11]
Insertion length EL (mm)	160...400	160...280	160...400	160...280
Lagging tube length HL (mm)	145	147	145	147
Operating temperature (°C)	-100 to +600			
Connection head (acc.to DIN)	Form B			
Connection	Ceramic block with bush terminals			
Thermocouple	NiCr-Ni Type K or Fe-CuNi Type J; single or twin			
Thermocouple accuracy	acc. to DIN EN 60584; class 2			
Measuring insert	Changeable			

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, thermocouples and accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Screw-in thermocouples without lagging tube

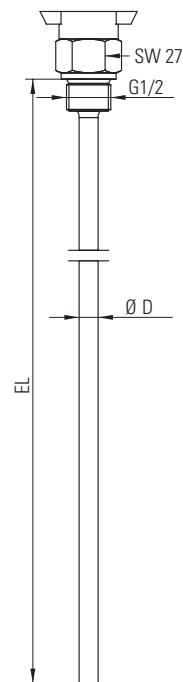
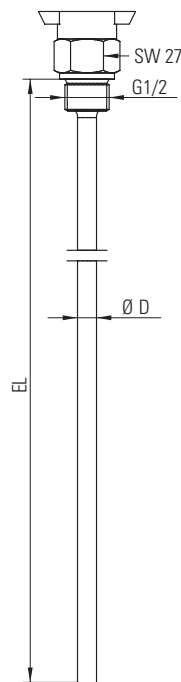


## Screw-in thermocouples

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- for compact installation conditions (no need for temperature- or geometry-related measuring head distance)

- fixed installation length
- suitable for overpressure applications
- for moderate mechanical loads
- protective stainless steel sheath 1.4571
- for direct installation in the medium
- cable entry of connecting head not alignable



Type	TE-BB-k	TE-BB-ko
Design acc. to DIN 43772	Similar to Form 2G	
Fixation	Mounting bush G1/2	
Diameter of thermowell D (mm)	9/11/12/14	6/8/9/11
Insertion length EL (mm)	160...400	100...400
Operating temperature (°C)	-100 to +600	
Connection head (acc.to DIN)	Form B	
Connection	Ceramic block with bush terminals	
Thermocouple	NiCr-Ni Type K or Fe-CuNi Type J; single or twin	
Thermocouple accuracy acc. to DIN EN 60584	Class 2	
Measuring insert	<b>Changeable</b>	<b>Not changeable</b>

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, thermocouples and accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Flanged thermocouples

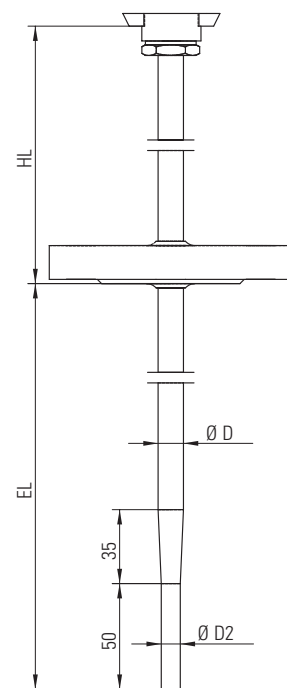
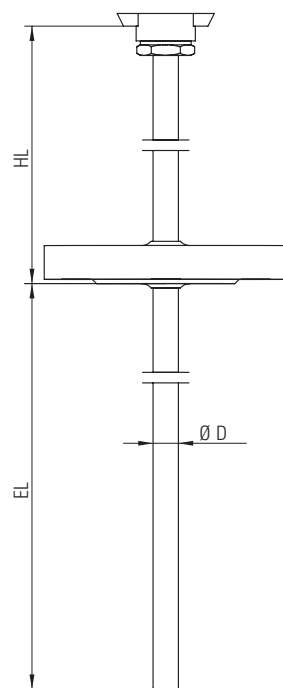


## Flanged thermocouples

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- especially suitable for overpressure applications

- fixed installation length
- for high mechanical and thermal loads
- protective stainless steel sheath 1.4571
- cable entry of connecting head alignable



Type	TE-BF	TE-BF (R) Fast reaction
Design acc. to DIN 43772	Form 2F	Form 3F
Fixation	Flange NW25 ND40	
Diameter of thermowell D [D2] (mm)	11/12/14	12[9]/14[11]
Insertion length EL (mm)	225...465	225...345
Lagging tube length HL (mm)	82	
Operating temperature (°C)	-100 to +600	
Connection head (acc.to DIN)	Form B	
Connection	Ceramic block with bush terminals	
Thermocouple	NiCr-Ni Type K or Fe-CuNi Type J; single or twin	
Thermocouple accuracy acc. to DIN EN 60584	Class 2	
Measuring insert	Changeable	

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, thermocouples and accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Weld-in thermocouples with thermowell 24 mm dia.

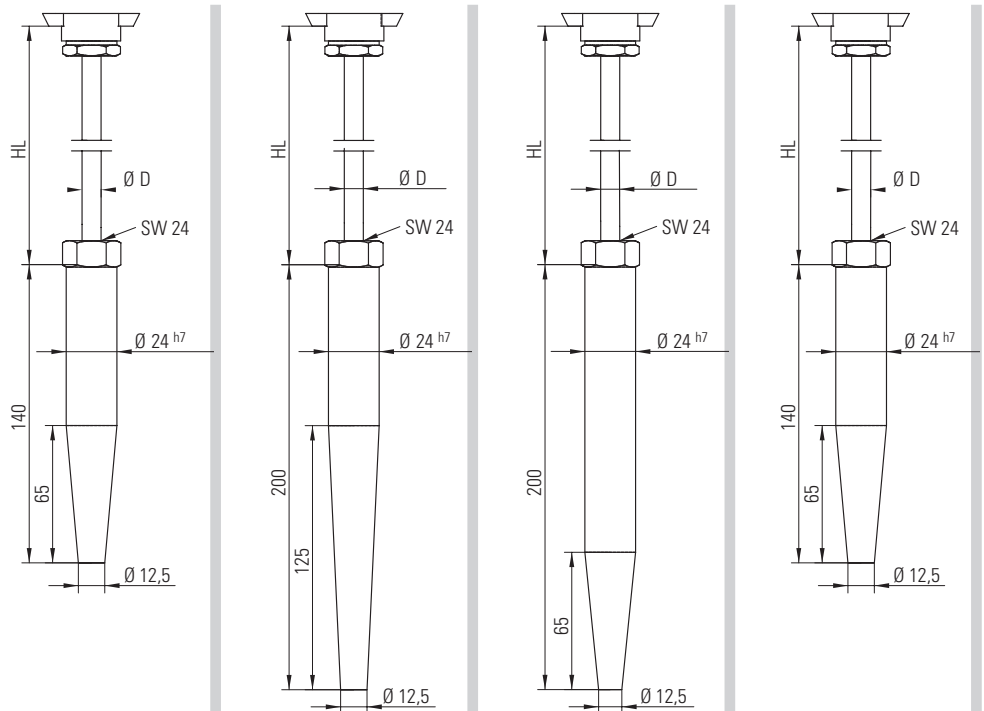


## Weld-in thermocouples

### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- especially suitable for overpressure applications

- moderate variable installation length
- for high mechanical and thermal loads
- with weld-in protective stainless steel sheath 1.457
- cable entry of connecting head alignable



Type	TE-BD-D1	TE-BD-D2	TE-BD-D4	TE-BD-D5
Design acc. to DIN 43772	Form 4			
Fixation	Welding			
Diameter of thermowell D (mm)	24 <sup>h7</sup>			
Insertion length EL (mm)	140	200	200	260
Lagging tube length HL (mm)	165			
Operating temperature (°C)	-60 to +500			
Connection head (acc.to DIN)	Form B			
Connection	Ceramic block with bush terminals			
Thermocouple	NiCr-Ni Type K or Fe-CuNi Type J; single or twin			
Thermocouple accuracy	acc. to DIN EN 60584; class 2			
Measuring insert	Changeable			
Accessories	Weld-in thermowells			

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, thermocouples and accuracy classes, vibration resistance, materials, DKD certificates, etc.)

# Weld-in thermocouples with thermowell 30 mm dia.

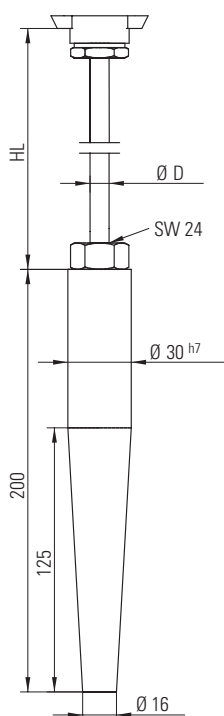


## Weld-in thermocouples

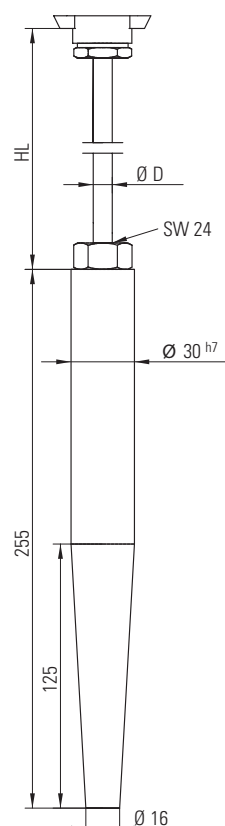
### acc. to DIN 43772

- for insertion in solid, liquid or gaseous media
- especially suitable for overpressure applications

- moderate variable installation length
- for high mechanical thermal loads
- with weld-in protective stainless steel sheath 1.4571
- cable entry of connecting head alignable



**WT-BD-D3**



**WT-BD-D6**

Type		
Design acc. to DIN 43772		Similar to Form 4
Fixation		Welding
Diameter of thermowell D (mm)		30 <sup>h7</sup>
Insertion length EL (mm)	200	255
Lagging tube length HL (mm)		165
Operating temperature (°C)		-60 to +500
Connection head (acc.to DIN)		Form B
Connection		Ceramic block with bush terminals
Thermocouple		NiCr-Ni Type K or Fe-CuNi Type J; single or twin
Thermocouple accuracy acc. to DIN EN 60584		Class 2
Measuring insert		Changeable
Accessories		Weld-in thermowells

Besides the standard versions shown on this page we can also supply specials (dimensions, connection heads, head transmitters, thermocouples and accuracy classes, vibration resistance, materials, DKD certificates, etc.)

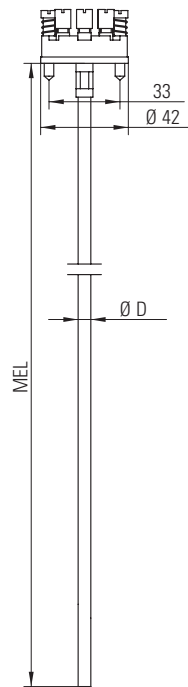
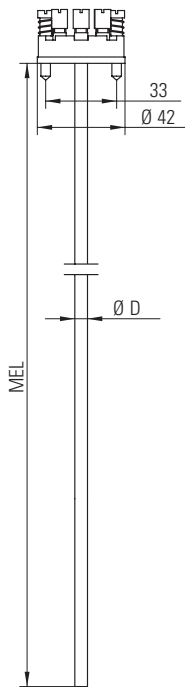
# Measuring inserts for thermocouples



## Measuring inserts as spare part or independent assembly group for installation in protection tubes

- Measuring tube made of stainless steel

- With direct insertion in the media only for low mechanical loads
- Mounting screws with spring
- Connection by ceramic block with bush terminals



Type	TE-ME	TE-ME-MI
	<b>Rigid protection tube at stainless steel</b>	<b>Flexible mineral-insulated cable</b>
Diameter (mm)	6/8	
Length MEL (mm)	100...2.000	
Measuring range (°C)	-100 to +600	
Connection	Ceramic block with bush terminals	
Thermocouple	NiCr-Ni Type K or Fe-CuNi Type J; single or twin	
Thermocouple accuracy acc. to DIN EN 60584	Class 2	

# Head transmitters for thermocouples

Head transmitters transform the measured unit of a sensor (eg. temperature) into a normed analog, mostly electrical signal.

Ludwig Schneider offers two special head transmitters for thermocouples: an economic version with fixed settings (type 3) and the free programmable type 2.

Furthermore the product program covers head transmitters with Hart® protocol, Foundation™-Fieldbus communication and Profibus®-PA-Technology.

## Technical data of head transmitters for thermocouples



Head transmitter		Type 3	Type 2
Characteristics		economical	free programmable
<b>General specifications</b>			
Supply voltage		6.5 V to 32 V (DC)	7.2 V to 35 V (DC)
Electrical insulation		—	1500 V (AC)
Linearity error		± 0.1%	≤ 0.05%
Response time		≤ 0.2 s	1 s to 60 s (programmable)
EEPROM error check		—	< 3.5 s (≤ 3.5 mA)
Conductor cross section (max.)		1.5 mm <sup>2</sup>	
Weight		40 g	50 g
Dimensions		Ø 44 x H 17 mm	Ø 44 x H 20.2 mm
Operating temperature		-40 °C to 85 °C	
Relative air humidity		0 to 95%	
Suitable connection heads		Form B or larger size	
<b>Input specifications</b>			
Temperature range	Type B	—	400 °C to 1820 °C
	Type E	—	-100 °C to 1000 °C
	Type J	186 °C to 870 °C	-100 °C to 1200 °C
	Type K	246 °C to 1232 °C	-180 °C to 1372 °C
	Type L	183 °C to 855 °C	-100 °C to 900 °C
	Type N	319 °C to 1300 °C	-180 °C to 1300 °C
	Type R	—	-50 °C to 1760 °C
	Type S	—	-50 °C to 1760 °C
	Type T	213 °C to 400 °C	-200 °C to 400 °C
	Type U	—	-200 °C to 600 °C
	Type W3	—	0 °C to 2300 °C
	Type W5	—	0 °C to 2300 °C
	Measuring range (min.)	Type E, J, K, L, T	100 °C
Type U		—	75 °C
Type N		—	100 °C
Type B, R, S, W3, W5		—	200 °C
Lead resistance (max.)		5 Ω	
Accuracy	Type E, J, K, L, N, T, U	—	≤ 1 °C
	Type B, R, S, W3, W5	—	≤ 2 °C
Cold junction		internal	internal, external
Cold junction compensation (CJC)		1.25 °C	< 1 °C
<b>Output specification</b>			
Current signal		4 to 20 mA	4 to 20 mA/20 to 4 mA



# General technical informations for thermocouples (TCs)

## Thermocouples

In the preceding chapter we have introduced our wide range of thermocouples with integrated measuring resistor. These measuring elements are frequently used in electrical temperature measurement.

The measuring procedure of thermocouples utilises the effect that a temperature dependent tension develops at the junction between two different metals. This tension is known as thermo-electromotive voltage and increases as the temperature increases in the case of all thermocouples.

The entire temperature sensor is generally described as a thermocouple. The actual measuring element, the so called thermocouple pair, is formed from the two different conductors (+ and - poles), the thermocouple wires.

Thermocouples have various advantages against resistance thermometers. Comparatively small designs are possible, some of them have a greater temperature range and are less sensitive to mechanical loads. Disadvantages include less precision and more effort in installation.

The combination of thermocouple wires and their material composition is specified and standardized, thus ensuring international interchangeability.

## Method of functioning

As already mentioned, a thermocouple consists of two conductors (thermocouple wires) with different material composition. If these two conductors are connected, a voltage is generated as a result of the different binding forces of the electrons, which is called thermo-electromotive voltage.

This thermo-electromotive voltage is very slight and is created as a result of the thermoelectric effect. In order to be able to measure the thermo-electromotive voltage at all, the circuit must be closed at the other end. At this point of connection, also known as reference junction, a voltage is also generated.

When measuring temperature with a thermocouple, always make sure that only one temperature difference between measuring point and reference junction is measured. If the temperature at the two points is the same, no voltage is created, as the individual reduced voltages cancel each other out. With different temperatures, the reduced voltages do not cancel each other out, a voltage is generated and a current flows.

$$E_{TC} = (E_{\text{measuring point}} - E_{\text{ref. junction}}) + E_{\text{ref. junction}}$$

( $E$  = thermo-electromotive voltage in  $\mu V$ ,  
 $TC$  = thermocouple)

For correct temperature measurement with a thermocouple, it is important to know the temperature at the reference junction and that this remain constant if possible. If the temperature of the reference junction is not constant, this must be recorded separately and taken into account continuously. You must also ensure that no additional thermo-electromotive voltages are generated in the transmission line between measuring point and reference junction, as these may cause measurement errors.

The most accurate and safest means of connection is to lead and connect the thermocouple wires directly to the reference junction.

In practise however for reasons of cost, a compensation cable is often used for the transmission line. The conductors of the compensation cable consist of a substitute material which matches the thermoelectric properties of the thermocouple and thus does not cause any additional thermo-electromotive voltage.

# General technical informations for TCs

## Standards for thermocouples

The standards IEC 584 resp. EN 60584, define the requirements for thermocouples. In particular, the temperature dependent thermo-electromotive voltages are defined, as well as deviation limits and to some extent the material composition of thermocouple wires.

The following thermocouples are standardized and defined:

<i>Cu-CuNi (T)</i>	<i>Copper-Constantan</i>
<i>Fe-CuNi (J)</i>	<i>Iron-Constantan</i>
<i>NiCr-CuNi (E)</i>	<i>Chromel-Constantan</i>
<i>NiCr-Ni (K)</i>	<i>Chromel-Alumel</i>
<i>NiCrSi-NiSi (N)</i>	<i>Nicrosil-Nisil</i>
<i>Pt10Rh-Pt (S)</i>	<i>PlatinumRhodium-Platinum</i>
<i>Pt13Rh-Pt (R)</i>	<i>PlatinumRhodium-Platinum</i>
<i>Pt30Rh-Pt6Rh(B)</i>	<i>PlatinumRhodium-Platinum</i>

In standard DIN 43770 two further thermocouples, Cu-CuNi (U) and Fe-CuNi (J) were standardized. The standard has meanwhile been withdrawn and these thermocouples should no longer be used for new installations. For this reason, they are not considered here.

## Measuring inserts

The measuring insert is an independent and pre-wired assembly. It consists mainly of a mineral-insulated thermocouple cable with the actual thermocouple and a ceramic terminal block.

The mineral-insulated thermocouple cable consists of a cable with an outer sheath of stainless steel, in which the inner conductors of the thermocouple are embedded in highly compacted magnesium oxide.

The sheath of the mineral-insulated thermocouple cable forms the outer sleeve and the measuring point is always directly at the tip of the measuring insert.

The thermocouple wires transfer the thermo-electromotive voltage to the ceramic terminal block. Measuring inserts in this design are flexible and are also used in the case of high mechanical loads and vibration. The construction and dimensions of the measuring inserts are defined in standard DIN 43735.

Two pressure springs on the fixing screws are used to press the assembled measuring insert into the inside of the thermowell base in order to ensure efficient heat transfer. The two pressure springs also compensate any differences in length between the thermowell and the measuring insert. The diameter and length of the measuring insert are coordinated to the respective thermowell with connection head.

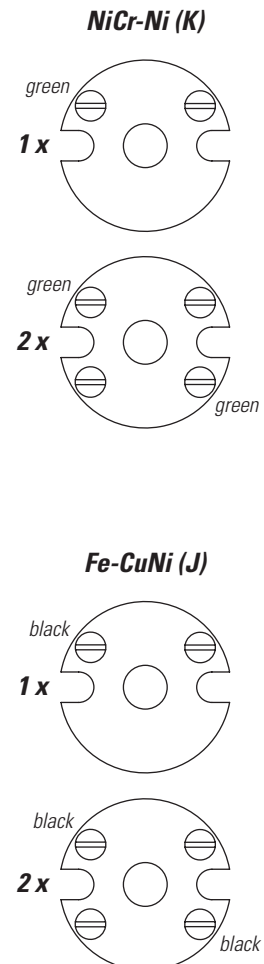
Fitting an exchangeable measuring insert has the great advantage that the system does not have to be emptied or depressurized.

## Colour coding

The coding is defined by standards IEC 584 resp. EN 60584 and may be applied either in symbols or colour. In order to fulfil the demand for coding, the connection pins are marked by LSW at the ceramic terminal block either in symbols or colours.

### Thermocouples

Colour coding of ceramic terminal block



# Technical informations for TCs

## Basic values

### Basic values acc. to standards

For thermocouples thermo-electromotive voltages are calculated as basic values depending on temperature and defined in the standards IEC 584 resp. EN 60584.

This is based on the reference junction temperature of 0 °C and the International Temperature Scale (ITS 90) of 1990.

Depending on thermocouple, thermo-electromotive voltages are determined and listed in the temperature range from -270 to 1820 °C.

### **Thermocouple** **Temperature range**

<i>Cu-CuNi (T)</i>	<i>-270 to 400 °C</i>
<i>Fe-CuNi (J)</i>	<i>-210 to 1200 °C</i>
<i>NiCr-CuNi (E)</i>	<i>-270 to 1000 °C</i>
<i>NiCr-Ni (K)</i>	<i>-270 to 1372 °C</i>
<i>NiCrSi-NiSi (N)</i>	<i>-270 to 1300 °C</i>
<i>Pt10Rh-Pt (S)</i>	<i>-50 to 1768 °C</i>
<i>Pt13Rh-Pt (R)</i>	<i>-50 to 1768 °C</i>
<i>Pt30Rh-Pt6Rh (B)</i>	<i>0 to 1820 °C</i>

The table on the following page shows the basic values for thermocouples which are specified in  $\mu\text{V}$  and refer to a reference junction temperature of 0 °C. The basic values are calculated according to the International Temperature Scale (ITS-90) and listed for the temperature range of -200 to 1800 °C.

The step line (bold line) is understood as the temperature limit at constant use for thermocouples in pure air. Care has to be taken at higher temperatures. Precise details of temperature limits under constant use are unfortunately not possible, since changes in the thermal stress can be caused by many factors.

# Technical informations for TCs

## Basic values

Basic values acc. to IEC 751 resp. EN 60751 in  $\mu\text{V}$

	<b>Cu-CuNi (T)</b>	<b>Fe-CuNi (J)</b>	<b>NiCr-CuNi (E)</b>	<b>NiCr-Ni (K)</b>	<b>NiCrSi-NiSi (N)</b>	<b>PtRh-Pt (S)</b>	<b>PtRh-Pt (R)</b>	<b>PtRh-Pt (B)</b>
Plus pole (+)	Cu	Fe	NiCr	NiCr	NiCrSi	PtRh90/10%	PtRh87/13%	PtRh70/30%
Minus pole (-)	CuNi	CuNi	CuNi	Ni	NiSi	Pt	Pt	PtRh94/6%
$^{\circ}\text{C}$	$\mu\text{V}$	$\mu\text{V}$	$\mu\text{V}$	$\mu\text{V}$	$\mu\text{V}$	$\mu\text{V}$	$\mu\text{V}$	$\mu\text{V}$
-200	-5603	-7890	-8825	-5891	-3990	–	–	–
-175	-5167	-7265	-8121	-5454	-3702	–	–	–
-150	-4648	-6500	-7279	-4913	-3336	–	–	–
-125	-4052	-5616	-6314	-4276	-2902	–	–	–
-100	-3379	-4633	-5237	-3554	-2407	–	–	–
-75	-2633	-3566	-4058	-2755	-1859	–	–	–
-50	-1819	-2431	-2787	-1889	-1269	–	–	–
-25	-940	-1239	-1432	-968	-646	–	–	–
0	0	0	0	0	0	0	0	–
25	992	1277	1495	1000	659	143	141	–
50	2036	2585	3048	2023	1340	299	296	–
75	3132	3918	4656	3059	2045	467	466	–
100	4279	5269	6319	4096	2774	646	647	–
125	5470	6634	8031	5124	3527	834	839	–
150	6704	8010	9789	6138	4302	1029	1041	–
175	7977	9392	11587	7140	5098	1232	1251	–
200	9288	10779	13421	8138	5913	1441	1469	178
225	10634	12167	15287	9141	6747	1655	1693	231
250	12013	13555	17181	10153	7597	1874	1923	291
275	13423	14942	19098	11176	8462	2096	2159	358
300	14862	16327	21036	12209	9341	2323	2401	431
325	16327	17710	22993	13248	10233	2553	2646	510
350	17819	19090	24964	14293	11136	2786	2896	596
375	19335	20469	26950	15343	12050	3021	3150	688
400	20872	21848	28946	16397	12974	3259	3408	787
425	–	23228	30952	17455	13906	3500	3669	891
450	–	24610	32965	18516	14846	3742	3933	1002
475	–	25998	34983	19579	15794	3987	4201	1119
500	–	27393	37005	20644	16748	4233	4471	1242
525	–	28798	39029	21710	17707	4482	4745	1371
550	–	30216	41053	22776	18672	4732	5021	1505
575	–	31650	43075	23842	19641	4984	5301	1646
600	–	33102	45093	24905	20613	5239	5583	1792
625	–	34575	47107	25967	21588	5495	5869	1944
650	–	36071	49116	27025	22566	5753	6157	2101
675	–	37590	51118	28079	23546	6013	6448	2263
700	–	39132	53112	29129	24527	6275	6743	2431
725	–	40696	55100	30174	25508	6539	7040	2604
750	–	42281	57080	31213	26491	6806	7340	2782
775	–	43881	59053	32247	27473	7074	7644	2965
800	–	45494	61017	33275	28455	7345	7950	3154
825	–	47109	62974	34297	29436	7618	8259	3347
850	–	48715	64922	35313	30416	7893	8571	3546
875	–	50306	66860	36323	31394	8170	8887	3749
900	–	51877	68787	37326	32371	8449	9205	3957
925	–	53427	70701	38323	33346	8731	9526	4170
950	–	54956	72603	39314	34319	9014	9850	4387
975	–	56464	74492	40298	35289	9300	10177	4608
1000	–	57953	76373	41276	36256	9587	10506	4834
1100	–	–	–	45119	40087	10757	11850	5780
1200	–	–	–	48838	43846	11951	13228	6786
1300	–	–	–	52410	47513	13159	14629	7848
1400	–	–	–	–	–	14373	16040	8956
1500	–	–	–	–	–	15582	17451	10099
1600	–	–	–	–	–	16777	18849	11263
1700	–	–	–	–	–	–	–	12433
1800	–	–	–	–	–	–	–	13591

# Technical informations for TCs

## Deviation limits

The deviation limit is the maximum permissible deviation in °C of a thermocouple from the standardized basic values. Three tolerance classes called class 1, 2 and 3 are standardized and in class 1 the smallest deviations are allowed.

The values can be taken directly from the table or have to be calculated according to the formula for higher temperatures. The deviation limits are specified in °C.

**Deviation limits for thermocouples acc. to IEC 584 resp. EN 60584**

Thermocouple	Tolerance class			
	1	2	3*	
<b>Type T</b>	Temperature range	-40...125 °C	-40...133 °C	-200...-67 °C
	Deviation limit	±0.5 °C	±1 °C	±0.015 ·  t
	Temperature range	125...350 °C	133...350 °C	-67...40 °C
	Deviation limit	±0.004 ·  t	± 0.0075 ·  t	±1 °C
<b>Type J</b>	Temperature range	-40...375 °C	-40...333 °C	–
	Deviation limit	±1.5 °C	±2.5 °C	–
	Temperature range	375...750 °C	333...750 °C	–
	Deviation limit	±0.004 ·  t	±0.0075 ·  t	–
<b>Type E</b>	Temperature range	-40...375 °C	-40...333 °C	-200...-167 °C
	Deviation limit	±1.5 °C	±2.5 °C	±0.015 ·  t
	Temperature range	375...800 °C	333...900 °C	-167...40 °C
	Deviation limit	±0.004 ·  t	±0.0075 ·  t	±2.5 °C
<b>Type K + N</b>	Temperature range	-40...375 °C	-40...333 °C	-200...-167 °C
	Deviation limit	±1.5 °C	±2.5 °C	±0.015 ·  t
	Temperature range	375...1000 °C	333...1200 °C	-167...40 °C
	Deviation limit	±0.004 ·  t	±0.0075 ·  t	±2.5 °C
<b>Type S + R</b>	Temperature range	0...1100 °C	0...600 °C	–
	Deviation limit	±1 °C	±1.5 °C	–
	Temperature range	1000...1600 °C	600...1600 °C	–
	Deviation limit	±[1 + 0.003 · ( t  - 1100)]	±0.0025 ·  t	–
<b>Type B</b>	Temperature range	–	–	600...800 °C
	Deviation limit	–	–	±4 °C
	Temperature range	–	600...1700 °C	800...1700 °C
	Deviation limit	–	±0.0025 ·  t	±0.005 ·  t

\* Thermocouples and thermocouple wires usually meet the deviation limits for the temperature range above -40 °C in accordance with the table shown above. At temperatures below -40 °C the deviations for thermocouples made out of the same material could be higher than the deviations defined in class 3. The customer placing the order has to give notification if thermocouples are required whose deviation limits have to be observed for classes 1, 2 and/or 3. A special selection of material is normally required for these items.

# General technical informations

## Temperature, thermowells

### Temperature

Temperature is one of seven physical basic quantities. The character T is the general symbol for the temperature. Kelvin (K) is used as the physical unit for temperature.

In normal use degrees Centigrade (°C) is established as the unit for the absolute value (exception: North America = Fahrenheit). However, the unit Kelvin is used for the temperature difference or the measurement uncertainty. The following correlation exists between the two units:

$$0 \text{ K} = -273.15 \text{ }^{\circ}\text{C} \quad 0 \text{ }^{\circ}\text{C} = 273.15 \text{ K}$$

### Temperature scale

Physical basis for temperature measurement is the thermodynamic temperature scale. It is based on the valid equation for ideal gases:

$$p \cdot V = R \cdot T$$

( $p$  = pressure,  $V$  = specific volume,

$R$  = specific gas constant,  $T$  = temperature)

The thermodynamic temperature can be realized with a gas thermometer. Since this process is complicated, an international temperature scale has been created which has been specified by defined fixpoints of pure materials.

The term fixpoint is used for states of equilibrium at phase transitions (e.g. freezing point, boiling point etc.).

The International Temperature Scale (ITS 90) has been valid since 1990.

### The International Temperature Scale

1084.62 °C	1357.77 K
	Copper freezing point
1064.18 °C	1337.33 K
	Gold freezing point
961.78 °C	1234.93 K
	Silver freezing point
419.527 °C	92.73 K
	Zinc freezing point
100.00 °C	373.15 K
	Water boiling point
0.01 °C	273.16 K
	Water triple point
-38.8344 °C	234.3156 K
	Mercury triple point
-218.7916 °C	54.361 K
	Oxygen triple point
-259.3467 °C	13.81 K
	Hydrogen triple point
-273.15 °C	0 K
	Absolute zero

*Exemplary fixpoints of chemical element's equilibrium at phase transitions.*

### Thermowells

Thermowells are subdivided into types 1 to 9 according to standard DIN 43772, which defines the design and the dimensions.

Depending on construction type, thermowells are produced either in welded design or made of solid material and can be fitted by clamping, screwing in, flange-mounting or welding in.

Thermowells are preferably made of stainless steel 1.4571 (AISI 316Ti).

As the thermowell comes into direct contact with the measured medium, it is essential to take account of pressure loads, flow velocities and temperature loads when selecting the type. The load diagrams of standard DIN 43772 can be used for this. When selecting the material, chemical stability and mechanical load capacity must also be taken into account.

Besides the standard types there are also various non standardized designs which are also manufactured by Ludwig Schneider for customer-specific applications.

According to standard DIN 43772 the design of the thermowells is classified in reference numbers. This standard has replaced the standard DIN 43763 in which the design has been classified in letters.

*Form 1: Insertible thermowell*

*Form 2: Insertible or weld-in thermowell*

*Form 2G: Screw-in thermowell with G ½ or G1 connection*

*Form 2F: Flanged thermowell; Flange DN25/PN40 acc. to DIN 2527, sealing form C acc. to DIN 2526*

*Form 3: Insertible or weld-in thermowell with tapered tip*

*Form 3G: Screw-in thermowell with G ½ or G1 connection*

*Form 3F: Flanged thermowell with tapered tip; Flange DN25/PN40 acc. to DIN 2527,*

*sealing form C acc. to DIN 2526*

*Form 4: Weld-in thermowell for thermometers and lagging tubes with external thread*

*Form 4F: Flanged thermowell for thermometers and lagging tubes with external thread*

# General technical informations

## Connection heads

The connection heads of resistance thermometers and thermocouples are divided into form A and form B by standard DIN 43729.


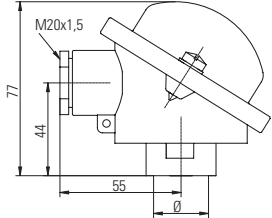

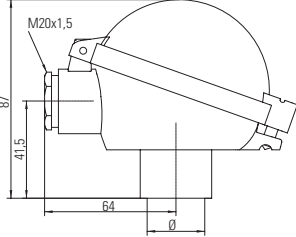


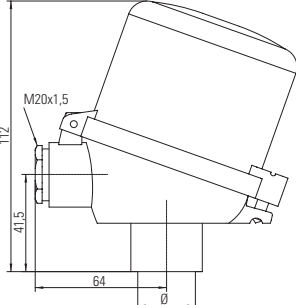
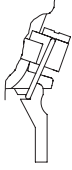

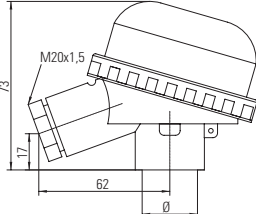
They are made of cast iron, aluminium or plastic material and have enough space for the mounting of a terminal block or a head transmitter.

Connection heads will be mounted on the protection tube by screw or push-on fixing.

The products in this catalogue are fitted with connection heads form B, made of light metal cast. Beside these standard versions special designs are available for specific requirements on request.

The connection heads are suitable for mounting of a terminal block or a head transmitter (diameter max. 44 mm).

- cord grip and cap with rubber sealing
- max. temperature load 80 °C
- protection class IP54

		Form	Cap closing	Material
 		<b>B</b>	Screw fixing	Light metal cast
  		<b>DAN</b>	Screw fixing	Light metal cast
		<b>DAN-S</b>	Quick-snap fixing	
  		<b>DANH</b>	Screw fixing	Light metal cast
		<b>DANH-S</b>	Quick-snap fixing	
 		<b>BBK</b>	Screw fixing	Plastic material



# Product summary

- Catalogue 1 **Engine Thermometers**
- Catalogue 2 **General Purpose Thermometers**
- Catalogue 3 **Precision Laboratory Thermometers**
- Catalogue 4 **Precision Laboratory Thermometer Sets**
- Catalogue 5 **Precision Thermometers for Meteorology**
- Catalogue 6 **Ground Joint and Precision Thermometers for Mineral Oil Testing**
- Catalogue 7 **Precision Contact Thermometers**
- Catalogue 8 **Thermometers for Special Applications**
- Catalogue 9 **Precision Hydrometers**
- Catalogue 10 **Dial Thermometers**
- Catalogue 11 **Systems for Measuring and Calibration**
- Catalogue 12 **Resistance Thermometers and Thermocouples**

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