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Архангельск (8182)63-90-72
Астрахань (8512)99-46-04
Барнаул (3852)73-04-60
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Иркутск (395)279-98-46
Казань (843)206-01-48

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Калуга (4842)92-23-67
Кемерово (3842)65-04-62
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Мурманск (8152)59-64-93
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Новокузнецк (3843)20-46-81
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Омск (3812)21-46-40
Орел (4862)44-53-42
Оренбург (3532)37-68-04
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Тольятти (8482)63-91-07
Томск (3822)98-41-53
Тула (4872)33-79-87
Тюмень (3452)66-21-18
Улан-Удэ (3012)59-97-51
Ульяновск (8422)24-23-59
Уфа (347)229-48-12
Хабаровск (4212)92-98-04
Чебоксары (8352)28-53-07
Челябинск (351)202-03-61
Череповец (8202)49-02-64
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ТЕРМОМЕТРЫ

OPTITEMP TR/TC 100

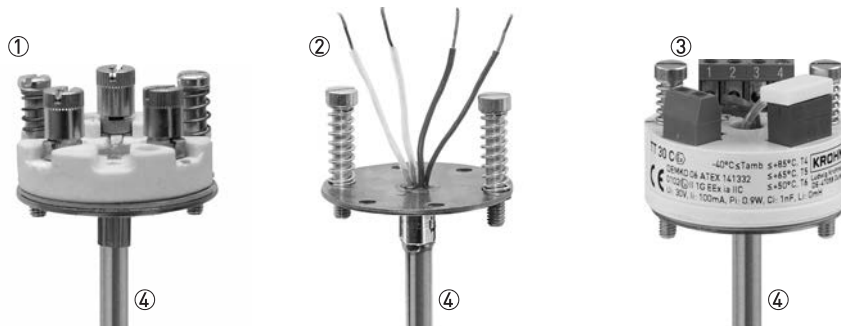


1.1 Heavy-duty mineral insulated measuring inserts

The **OPTITEMP TR/TC 100** measuring inserts are intended for installation in thermometer assemblies and are made using mineral insulated mantle cable. They feature flexibility, superior insulation resistance and a high degree of shock resistance.

The **TR 100** version contains a Pt100 RTD with a characteristic curve according to DIN EN 60751. The **TC 100** version features a thermocouple according to DIN EN 60584.

Thermocouple measuring inserts come in type "K" or "J", other types are available on request.



- ① Measuring insert with flying wires
- ② Measuring insert with terminal block
- ③ Measuring insert with transmitter
- ④ Sheath

Highlights

- Versions: With terminal block, with flying wires or with OPTITEMP head-mounted transmitter
- Intrinsically safe versions for use in hazardous areas
- Quick-response versions with a diameter of 3 mm / 0.12"
- Spring-loaded version ensures secure contact with the bottom of the thermowell and good heat transfer
- Maximum measuring range TR 100: -200...+600°C / -328...1112°F
- Maximum measuring range TC 100: -40...+1000°C / -40...1832°F

Industries:

- Chemical and Petrochemical
- Oil and Gas
- Power Supply
- Machinery
- Pharmaceuticals and Food & Beverage
- Water and Wastewater
- Iron and Steel
- Paper and Pulp

Applications

Different process connections allow thermometer assemblies to be adapted for use in almost all industrial sectors:

- Insertion-type thermometer
- Threaded thermometer
- Flange thermometer
- Weld-in thermometer

1.2 Options and variants

Variant with ceramic terminal block



- Fully sealed solder joints
- Pt100 connection in 2, 3 and 4-wire connection
- Available with 2, 3, 4, 6 or 8 connection terminals
- Sheath diameter: 3 + 0 - 0.1 mm
- Sheath diameter: 6 + 0 - 0.1 mm
- Washer disc with 2 screws, 2 springs and 2 locking rings

Variant with flying wire ends



Excepting the following points, the features correspond to those of the version with ceramic terminals:

- Colour-coded, Teflon-insulated lead wires
- Lead wires measuring 50 mm / 1.97" in length for the first measuring point
- Lead wires measuring 100 mm / 3.94" in length for the second measuring point

Variant with head-mounted transmitter



The features correspond to those of the version with flying wire ends. A mounted temperature transmitter is also included in delivery:

- TT10/20: Analogue, Pt100 RTD without galvanic isolation
- TT30/40: Digital, Pt100/1000, Ni100, thermocouple
- TT50/51: Digital, HART, SIL2
- TT60: Profibus PA

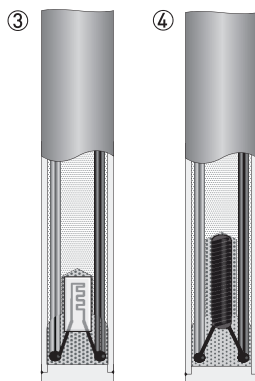
All three variants (with terminal block, with flying wire ends, with head-mounted transmitter) are available with the following sheath diameters and sensor types:

Pt100 measuring insert, Ø 3 mm



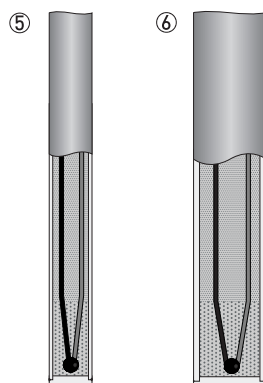
- Sheath diameter 3 mm / 0.12": Available with thin film RTD (①) and wire-wound RTD (②)
- Mineral insulated mantle cable (material 1.4404)
- Magnesium oxide insulation (MgO)
- 1 x Pt100 in 2, 3 or 4-wire connection
- 2 x Pt100 in 2-wire connection

Pt100 measuring insert, Ø 6 mm



- Sheath diameter 6 mm / 0.24": Available with thin film RTD (③) and wire-wound RTD (④)
- Mineral insulated mantle cable (material 1.4404)
- Magnesium oxide insulation (MgO)
- 1 x Pt100 in 2, 3 or 4-wire connection
- 2 x Pt100 in 2, 3 or 4-wire connection

Thermocouple measuring insert



- Available with sheath diameters of 3 mm / 0.12" (⑤) and 6 mm / 0.24" (⑥)
- Mineral insulated mantle cable (Inconel 600®)
- Magnesium oxide insulation (MgO)
- Measuring point insulated against housing
- 1 x thermocouple, type "J" or "K"
- 2 x thermocouples, type "J" or "K"
- Other thermocouples on request

All three variants (with terminal block, with flying wire ends, with head-mounted transmitter) are also available as **intrinsically safe measuring inserts**. The ATEX marking is:

II 1 G Ex ia IIC T6

The intrinsically safe measuring inserts always have a sheath diameter of 6 mm / 0.24". The following options are available:

- Sensor: 1 x Pt100 RTD (wire-wound, ceramic) or 1 x thermocouple ("K" or "J")
- Tolerance class A (Pt100) or 1 (thermocouple)

1.3 Measuring principle

1.3.1 Resistance thermometer

The measuring insert with a resistance thermometer features a temperature-sensitive sensor made from a platinum RTD, whose value at 0°C / +32°F is 100 Ω. That is where the name "Pt100" comes from.

It is generally valid that the electric resistance of metals increases according to a mathematical function as the temperature rises. This effect is taken advantage of by resistance thermometers to measure temperature. The "Pt100" thermometer features a measuring resistance with defined characteristics, standardised in IEC 60751. The same is true for the tolerances. The average temperature coefficient of a Pt100 is $3.85 \times 10^{-3} \text{ K}^{-1}$ in the range from 0...+100°C / +32...+212°F.

During operation, a constant current $I (\leq 1 \text{ mA})$ flows through the Pt100 RTD, which brings about a voltage drop U . The resistance R is calculated using Ohm's Law ($R=U/I$). As the voltage drop U at 0°C / +32°F is 100 mV, the resulting resistance of the Pt100 thermometer is 100 Ω (100 mV / 1 mA = 100 Ω).

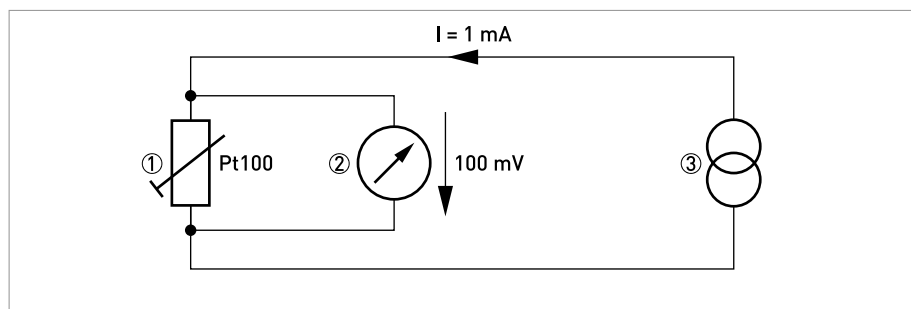


Figure 1-1: Pt100 resistance thermometer in 4 wire connection at 0°C / +32°F, schematic.

- ① Pt100 RTD
- ② Voltage meter
- ③ Current source

1.3.2 Thermocouples

The thermocouple features two electric conductors made from different metals, connected at one end. Each free end is connected to a compensation cable which is then connected to a millivolt meter. This circuitry forms a "thermal circuit". The point at which the two electric conductors connect is called the measuring point (hot junction) and the point at which the compensation cables connect to the conductors of the millivolt meter is called the reference junction (cold junction).

If the measuring point of this thermal circuit is heated up, a small electrical voltage (thermal voltage) can be measured. If, however, the measuring point and the reference junction are at the same temperature, no thermoelectric voltage is generated. The degree of thermoelectric voltage, also known as electromotive force (EMF), depends on the thermocouple material and the extent of the temperature difference between the measuring point and the reference junction. It can be measured using the millivolt meter with no auxiliary power.

Simply put, the thermocouple behaves like a battery, the voltage of which also increases as the temperature rises.

The characteristic curves and tolerances of commercially available thermocouples are standardised in IEC 60584.

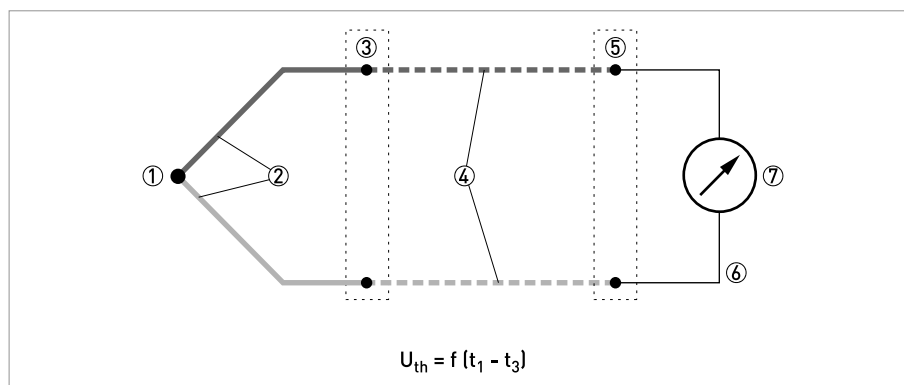


Figure 1-2: Thermocouple measuring circuit, schematic.

- ① Measuring point t_1 (hot junction)
- ② Thermocouple
- ③ Transition junction t_2
- ④ Compensation cable / extension cable
- ⑤ Reference junction t_3 (cold junction)
- ⑥ Copper conductor
- ⑦ Voltage meter U_{th}

2.1 Technical data tables

2.1.1 Technical data TR 100

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local representative.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Download Center).*

	Thin film Pt100 (TF)	Wire-wound Pt100 (WW)
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Measuring system

Measuring principle	Resistance thermometer measuring insert acc. to DIN 43735-1.
Type of sensor	Pt100 acc. to DIN EN 60751.

Measuring accuracy

Measuring accuracy varies with the temperature and is described in terms of a tolerance class. Values for the individual tolerance classes are as follows:		
Tolerance class A	$\pm (0.15 + 0.002 \times t) \text{ } ^\circ\text{C}$	
Tolerance class B	$\pm (0.3 + 0.005 \times t) \text{ } ^\circ\text{C}$	
1/3 tolerance class B	$\pm 1/3 (0.3 + 0.005 \times t) \text{ } ^\circ\text{C}$	
ø 3 mm / 0.12"	Tolerance class A -50...+300°C / -58...+572°F	Tolerance class A -200...+600°C / -328...+1112°F
	Tolerance class B -70...+500°C / -94...+932°F	
	1/3 tolerance class B at 0...150°C / +32...302°F, otherwise tolerance class A	
ø 6 mm / 0.24"	Tolerance class A -50...+300°C / -58...+572°F	Tolerance class A -200...+600°C / -328...+1112°F
	Tolerance class B -70...+500°C / -94...+932°F	
	Tolerance class B -50...+600°C / -50...+1112°F Shock resistant	
	1/3 tolerance class B at 0°C / +32°F, otherwise tolerance class A	
Calibration of the measuring inserts	Under normal operating conditions we recommend annual recalibration.	

Insulation resistance R_{ISO}

The insulation resistance was measured with 250 VDC (measuring insert: 3 mm) or 500 VDC (measuring insert: 6 mm).	
20°C ± 15°C / 68°F ± 27°F	> 1000 MΩ
100°C ± 15°C / 212°F ± 27°F	> 500 MΩ
500°C ± 15°C / 932°F ± 27°F	> 50 MΩ

Operating conditions

Shock and vibration	acc. to DIN EN 60751 (10...500 Hz)	
	≤10 g, ≤20 g for shock resistant version	≤3 g

Materials

Mineral insulated mantle cable	Insulated with magnesium oxide (MgO)
Inner conductor	Copper (Cu) or nickel (Ni)
Tauchrohr	Chromium-nickel steel (CrNi), e.g. 316L

Approvals

ATEX (pending)	II 1/2 GD EEx ia 2C T6...T1 (+85...+450°C / +185...+842°F)
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2.1.2 Technical data TC 100

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local representative.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Download Center).*

	Thermocouple type J	Thermocouple type K
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Measuring system

Measuring principle	Thermocouple measuring insert acc. to DIN 43735-1.
Type of sensor	Thermocouples acc. to DIN EN 60584.

Measuring accuracy

Measuring accuracy varies with the temperature and is described in terms of a tolerance class. They are as follows:		
Tolerance class 1 (acc. to DIN EN 60584-2)	-40...+375°C: ±1.5°C, +375...+750°C: ±0.004 x t	-40...+375°C: ±1.5°C, +375...+1000°C: ±0.004 x t
∅ 3 mm / 0.12"	Tolerance class 1 (-40...+750°C)	Tolerance class 1 (-40...+1000°C)
∅ 6 mm / 0.24"		
Calibration	Under normal operating conditions we recommend annual recalibration of the measuring inserts.	

Insulation resistance R_{iso}

The insulation resistance was measured with 250 VDC (measuring insert: 3 mm) or 500 VDC (measuring insert: 6 mm).	
20°C ± 15°C / 68°F ± 27°F	> 1000 MΩ
500°C ± 15°C / 932°F ± 27°F	> 5 MΩ

Operating conditions

Shock and vibration	acc. to DIN EN 60751 (10...500 Hz)
	60 g

Materials

Mineral insulated mantle cable	Insulated with magnesium oxide (MgO)
Inner conductor	Respective thermocouple material of the sensor e. g. K-material (NiCr-Ni)
Tauchrohr	Inconel 600®

Approvals

ATEX (pending)	II 1/2 GD EEx ia 2C T6...T1 (85...450 °C / 185...842°F)
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2.2 Measuring ranges and tolerances

2.2.1 Measuring insert with Pt100 resistance thermometers

Pt100: basic values and tolerances

Temperature (T ₉₀) in °C / °F	Basic value in Ω	Sensitivity in Ω/K	Tolerances acc. to DIN EN 60751			
			Class A		Class B	
			Ω	°C / F°	Ω	°C / F°
-200 / -328	18.5	0.425	±0.24	±0.55 / 0.99	±0.56	±1.30 / 2.34
-100 / -148	60.3	0.405	±0.14	±0.35 / 0.63	±0.32	±0.80 / 1.44
-50 / -58	80.3	0.396	±0.10	±0.25 / 0.45	±0.22	±0.55 / 0.99
0 / +32	100.0	0.390	±0.06	±0.15 / 0.27	±0.12	±0.30 / 0.54
+50 / +122	119.4	0.384	±0.10	±0.25 / 0.45	±0.21	±0.55 / 0.99
+100 / +212	138.5	0.378	±0.13	±0.35 / 0.63	±0.30	±0.80 / 1.44
+200 / +392	212.1	0.369	±0.20	±0.55 / 0.99	±0.48	±1.30 / 2.34
+300 / +572	212.1	0.355	±0.27	±0.75 / 1.35	±0.64	±1.80 / 3.24
+400 / +752	247.1	0.344	±0.33	±0.95 / 1.71	±0.79	±2.30 / 4.14
+500 / +932	281.0	0.332	±0.38	±1.15 / 2.07	±0.93	±2.80 / 5.04
+600 / +1112	313.7	0.321	±0.43	±1.35 / 2.43	±1.06	±3.30 / 5.94

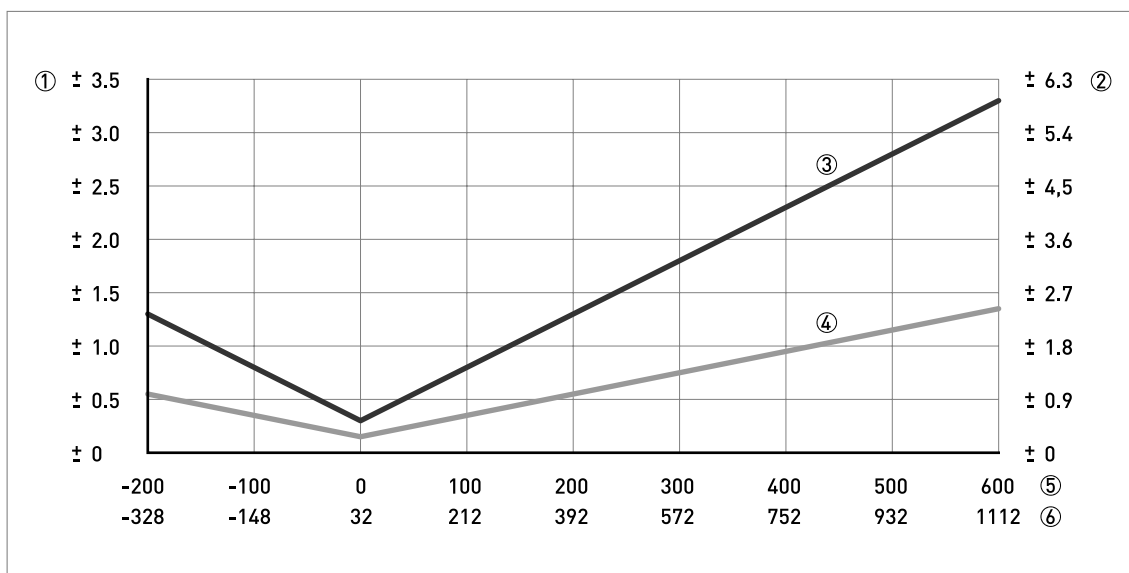


Figure 2-1: Pt100 tolerances

- ① Tolerances in °C
- ② Tolerances in °F
- ③ Tolerance class B
- ④ Tolerance class A
- ⑤ Temperature in °C
- ⑥ Temperature in °F

2.2.2 Measuring insert with type J thermocouples

Type J: basic values and tolerances

Temperature (T ₉₀) in °C / °F	Basic value in mV	Thermal EMF in mV/K	Tolerances acc. to DIN EN 60584-2			
			Class 1		Class 2	
			mV	°C / F°	mV	°C / F°
-40 / -40	-1.961	0.046	±0.07	±1.5 / 2.7	±0.12	±2.5 / 4.5
0 / +32	0	0.053	±0.08	±1.5 / 2.7	±0.13	±2.5 / 4.5
+100 / +212	5.269	0.055	±0.08	±1.5 / 2.7	±0.14	±2.5 / 4.5
+200 / +392	10.779	0.055	±0.08	±1.5 / 2.7	±0.14	±2.5 / 4.5
+300 / +572	16.327	0.055	±0.08	±1.5 / 2.7	±0.14	±2.5 / 4.5
+400 / +752	21.848	0.055	±0.09	±1.6 / 2.9	±0.17	±3.0 / 5.4
+500 / +932	27.393	0.057	±0.11	±2.0 / 3.6	±0.21	±3.8 / 6.8
+600 / +1112	33.102	0.056	±0.13	±2.4 / 4.3	±0.25	±4.5 / 8.1
+700 / +1292	39.132	0.064	±0.18	±2.8 / 5.0	±0.34	±5.3 / 9.5
+750 / +1382	42.281	0.064	±0.19	±3.0 / 5.4	±0.36	±5.6 / 10.1

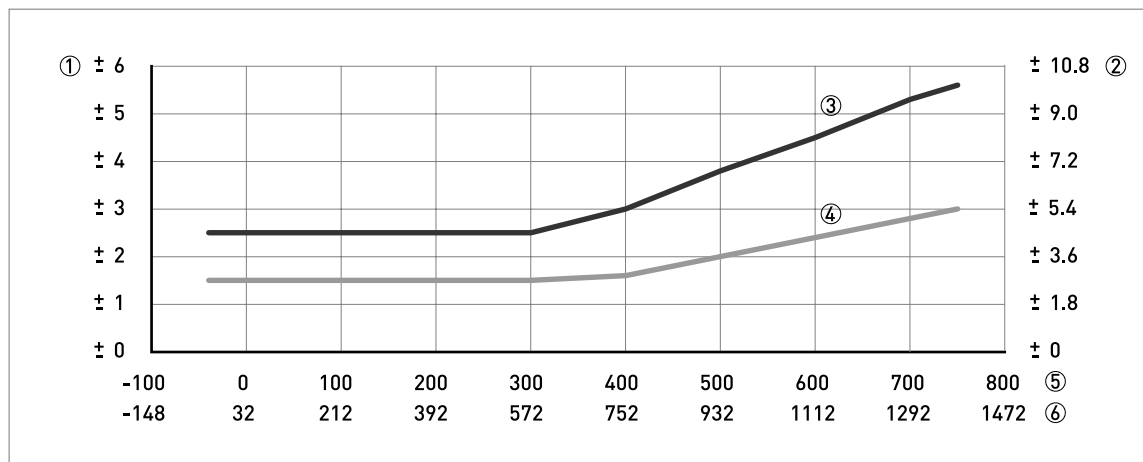


Figure 2-2: Type J tolerances

- ① Tolerances in °C
- ② Tolerances in °F
- ③ Tolerance class 2
- ④ Tolerance class 1
- ⑤ Temperature in °C
- ⑥ Temperature in °F

2.2.3 Measuring insert with type K thermocouples

Type K: basic values and tolerances

Temperature (T ₉₀) in °C / °F	Basic value in mV	Thermal EMF in mV/K	Tolerances acc. to DIN EN 60584-2			
			Class 1		Class 2	
			mV	°C / F°	mV	°C / F°
-40 / -40	-1.527	0.037	±0.06	±1.5 / 2.7	±0.09	±2.5 / 4.5
0 / +32	0	0.039	±0.06	±1.5 / 2.7	±0.10	±2.5 / 4.5
+100 / +212	4.096	0.042	±0.06	±1.5 / 2.7	±0.11	±2.5 / 4.5
+200 / +392	8.138	0.040	±0.06	±1.5 / 2.7	±0.10	±2.5 / 4.5
+300 / +572	12.209	0.042	±0.06	±1.5 / 2.7	±0.11	±2.5 / 4.5
+400 / +752	16.397	0.042	±0.07	±1.6 / 2.9	±0.13	±3.0 / 5.4
+500 / +932	20.644	0.043	±0.09	±2.0 / 3.6	±0.16	±3.8 / 6.8
+600 / +1112	24.905	0.043	±0.10	±2.4 / 4.3	±0.19	±4.5 / 8.1
+800 / +1472	33.275	0.041	±0.13	±3.2 / 5.8	±0.25	±6.0 / 10.8
+1000 / +1832	41.276	0.039	±0.16	±4.0 / 7.2	±0.29	±7.5 / 13.5
+1200 / +2192	48.838	0.036	±0.17	±4.8 / 8.6	±0.32	±9.0 / 16.2

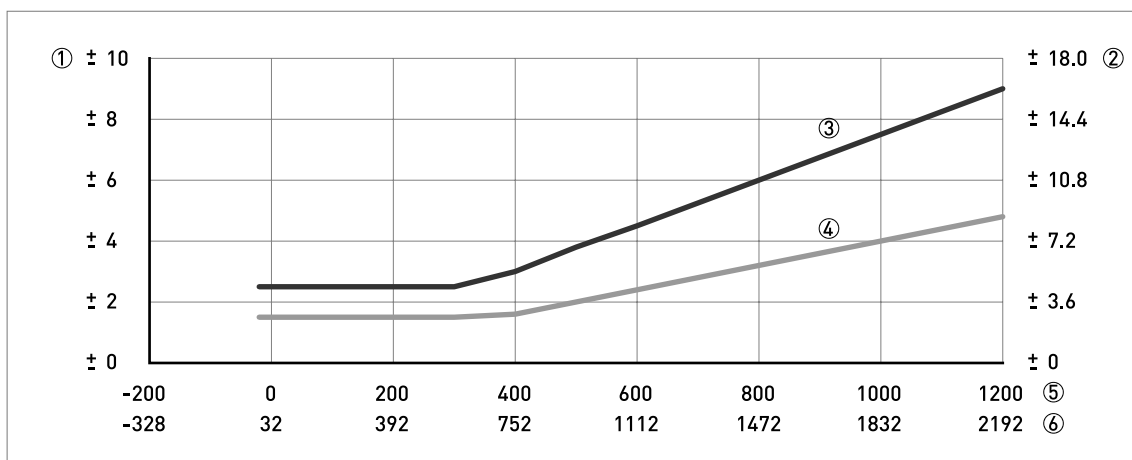


Figure 2-3: Tolerances type K

- ① Tolerances in °C
- ② Tolerances in °F
- ③ Tolerance class 2
- ④ Tolerance class 1
- ⑤ Temperature in °C
- ⑥ Temperature in °F

2.3 Permissible flow speed

The maximum permissible flow speed for the measuring insert depends on its immersion depth and on the density of the product. The greater the immersion depth and the higher the density, the larger the load.

If the measuring insert is used in the thermowell, the flow speed is irrelevant. If, however, the flow goes against an unprotected measuring insert, its load must be calculated individually. If this is the case, the manufacturer will offer further support.

2.4 Permissible operating pressure

The maximum permissible load of the measuring inserts through the static operating pressure may not exceed 0.8...1.1 bar.

2.5 Response times

The response times t_{50} (50% time) and t_{90} (90% time) were calculated in water acc. to VDE/VDI 3522 with 0.4 m/s, corresponding to 78.7 ft/min:

Type of measuring insert	t_{50} [s]	t_{90} [s]
TR 100, \varnothing 6 mm / 0.236"	3.5	8
TR 100, \varnothing 3 mm / 0.118"	2	5
TC 100, \varnothing 6 mm / 0.236"	2.5	7
TC 100, \varnothing 3 mm / 0.118"	1	2.5

2.6 Dimensions

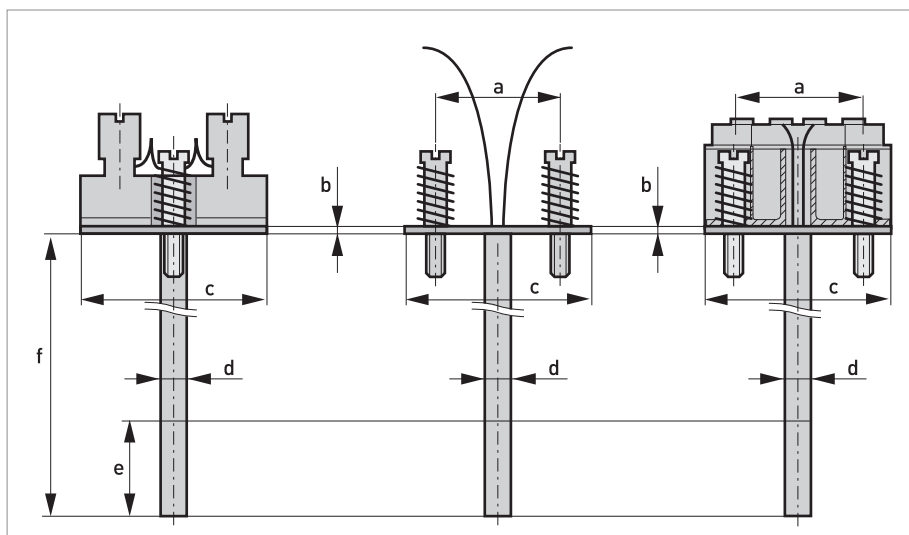


Figure 2-4: Measuring insert with terminal block, without terminal block, with transmitter (from left to right).

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	Designation	TR/TC 100, Ø 3 mm / 0.118"		TR/TC 100, Ø 6 mm / 0.236"	
		[mm]	[inches]	[mm]	[inches]
a	Distance between fixing screws	33	1.3	33	1.3
b	Washer disc thickness	1.5	0.06	1.5	0.06
c	Washer disc diameter	40	1.58	40	1.58
d	Sheath diameter	3	0.12	6	0.24
e	Sensitive sensor length	10...35	0,39...1.38	10...35	0,39...1.38
f	Measuring insert length	120	4.72	120	4.72
		145	5.71	145	5.71
		160	6.3	160	6.3
		205	8.07	205	8.07
		255	10.04	255	255
		275	10.83	275	10.83
		315	12.4	315	12.4
		345	13.58	345	13.58
		375	14.76	375	14.76
		405	15.94	405	15.94
		435	17.13	435	17.13
		525	20.67	525	20.67
		555	21.85	555	21.85
		585	23.03	585	23.03
655	25.97	655	25.97		
735	28.94	735	28.94		

The length of the connection wires is the same (40 mm / 1.58") for both variants (TR and TC 100).

Different installation lengths are available on request.

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