fill level | water level | pressure | temperature | flow | visualization | signal converter | sensoric

PTX

Resistance Thermometer

Measurement of temperatures
in gases, vapors, liquids and dust

Technical manual
05.21

Main features

Process temperature from -200°C to 600 °C

Wide variety of process connections, optionally with coating

Long term stable temperature sensor platinum Pt100 – IEC 60751

- 2-, 3,- or 4-wire-connection
- Double type in 2-wire-connection for redundancy function
- Accuracy classes A or B

Exchangeable measuring insert

Certification for the use in explosion hazardous areas

- ATEX II 1 G Ex ia IIC T6…T1 Ga
- ATEX II 1 D Ex ia IIIC Tx°C Da

Short response time

Integrated temperature head transmitter

- 2-wire with current signal 4…20 mA – fix adjusted
- 2-wire with current signal 4…20 mA – programmable

You have purchased a high-grade and modern measuring device of ACS-CONTROL-SYSTEM GmbH.

We want to give thanks for your purchase and for your confidence to us.

The actual technical manual includes instructions for installation, electrical connection and inauguration, as well as the technical data of the device.

Modifications, that answer the purpose of the technical progress, are reserved by ACS-CONTROL-SYSTEM GmbH without prior notice.

If a question occurs, that can‘t be answered by the listed informations, please call on our technicians team in Eggenfelden Tel: +49 8721/ 9668-0 or info@acs-controlsystem.de

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Application

The device is a Pt100 resistance thermometer, optionally with integrated temperature head transmitter, for continuous measuring of temperatures in gases, steams, liquids and dusts.

The device is approved for the use in explosive hazardous areas.

The use of a long-term stable platinum temperature sensor – Pt100 – allows a precise measurement of temperatures in nearly all fields of industry, especially at hygienic applications.

Function

The device is used for temperature measurement by recording the ohmic resistance of a resistance temperature sensor Pt100.

Construction

The device consists of a changeable measuring insert in a protection tube, the process connection, optionally a neck tube and a terminal enclosure.
The protection tube is fixed at the process connection. Process connection and terminal enclosure can be separated from each other by a neck tube. A temperature head transmitter or a terminal socket can be mounted on the measuring insert.

By using a neck tube of a corresponding length between the respective process connection and the connection housing at high medium temperatures it can be achieved that the temperature in the area of the connection housing does not exceed the permitted environmental temperatures.

The protection tube of the resistance thermometer is the junction point with the applied medium and is in direct contact with it.

The terminal enclosure is used for the connection of the temperature sensor resp. sensors Pt100 with an evaluation electronic and is suitable for the installation of head transmitters.

Inside the resistance thermometer the changeable measuring insert is installed. This measuring insert is the real temperature sensor. In the installed state the tip of the measuring insert is pushed against the lower end of the protection tube and by this an optimal heat transfer is guaranteed.
In the tip of the measuring insert the temperature sensor resp. the two temperature sensors Pt100 are installed.
The resistance temperature sensor Pt100, dependent on the requirements for accuracy up to class AA, ensures a precise and long-term stable temperature measurement.

At the side of the terminal enclosure optionally a temperature head transmitter or a terminal socket is mounted.

Basics Pt100

The temperature measuring sensor of resistance thermometers Pt100 consists of an electrical resistor of the material platinum (element symbol Pt), whose resistance value is ideally 100Ω at a temperature of 0°C.
This results according to the norm EN/IEC 60751 in the expression „Pt100".
The resistance value increases at higher temperatures corresponding to a resistor material characteristic coefficient and decreases correspondingly at lower temperatures.

For industrial thermometers acc. to the standard EN/IEC 60751, the ideal resistance values of a resistor Pt100 can be calculated according to the following equation:

Temperature range from T = -200°C...0°C $R_T = 1000 \times [1 + (3{,}90802 \times 10^{-3} \times T) - (0{,}5802 \times 10^{-6} \times T^2) - (4{,}27350 \times 10^{-12} \times (T - 100) \times T^3)]$
Temperature range from T = 0°C...+600°C $R_T = 1000 \times [1 + (3{,}90802 \times 10^{-3} \times T) - (0{,}5802 \times 10^{-6} \times T^2)]$

In the equation the term R_T describes the resistance in Ω of an ideal Pt100 at the temperature T in °C

Measuring accuracy – tolerances

Different specification accuracy sorting's are available for temperature resistors Pt100.
The accuracy classes define at first the maximum permitted temperature deviation against 0°C, when the temperature resistor Pt100 has a resistance of 100Ω.
Secondary the maximum permitted temperature deviation from the calculated value at an arbitrary resistance value different from 100Ω is determined.

	0°C	**[t]°C**
Deviation Pt100 class A	+/- 0,15 K	+/- (0,15 K + 0,002 K * [t])
Deviation Pt100 class B	+/- 0,30 K	+/- (0,30 K + 0,005 K * [t])
Deviation PTX	depends on accuracy class Pt100 and installation situation	

[t] without sign, in K

Measurement methods – measurement error

For capturing the resistor value of the Pt100 commonly a constant current in the range from 0,1mA to 6mA is used. This current produces at the resistor a processible voltage drop.

The used constant current however causes due to the self-heating through the current flow in the resistor Pt100 an increasing of the temperature that distort the measuring result. By this the constant current should be logically kept as low as possible. Contrary a too low current also can cause problems because on the one hand the susceptibility against electromagnetic interferences increases and on the other hand the measured voltage signal decreases and this leads to higher requirements to the evaluation electronic.

Because the measured voltage signal is very small, the resistance of the Pt100 leads can cause an error source that may not be neglected. The constant current produces in the resistance of the leads a voltage drop and according to the requirements of the measurement it must be tried to neutralize this measurement error.
Using a Pt100 in 3-wire or 4-wire connection-technique it is possible to completely eliminate the influence of the lead resistance, if a suitable evaluation electronic is connected.

Response time

It the temperature sensor is applied to a temperature variation, a defined time goes by until the sensor has taken over this new temperature. This time depends on the style of the thermometer and the environmental conditions like e.g. flow speed, medium, etc.

The values for the response times can be found in the chapter "technical data".
The values refers to measurement in water with 0,4 m/s, temperature step 23 to 33°C acc. to EN/IEC 60751.
The response times for other medias can be determined by using the thermal exchange constant acc. to VDI/VDE 3522.

Safety notes

Operational safety

The device is safely built and tested according to state-of-the-art technology and has left the factory in perfect condition as regards technical safety.

The device meets the legal requirements of all relevant EU directives. This is confirmed by attaching the CE mark.

This measuring device meets article 4 (3) of the EU directive 2014/68/EU (pressure equipment device directive) and is designed and produced in good engineer practice.

Installation, connection, commissioning, operation

Installation, electrical connection, commissioning and operation of the device must be made by a qualified and authorized expert according to the information's in this technical manual and the relevant standards and rules. This expert must have read and understood this technical manual and especially the safety notes.

The device may only be used within the permitted operation limits that are listed in this technical manual. Every use besides these limits as agreed can lead to serious dangers.

The materials of the device must be checked for compatibility with the respective application requirements (contacting materials, process temperature) before use. An unsuitable material can lead to damage, abnormal behavior or destruction of the device and to the resulting dangers.

The sensors may not be used as sole device for prevention of dangerous conditions in machines and plants.

Using the device in a manner that does not fall within the scope of its intended use, disregarding this instruction, using under-qualified personnel, or making unauthorized alterations releases the manufacturer from liability for any resulting damage. This renders the manufacturer‘s warranty null and void.

Special safety notes

Electrical operating supplies for explosive hazardous areas

If a device is installed and operated in explosive hazardous areas, the general Ex construction standards (EN/IEC 60079-14, VDE 0165), these safety notes and the enclosed EU type examination certificate incl. supplements must be observed.
For installed head transmitters also those technical instructions, safety notes and the EU type examination certificate incl. supplements must be observed.
The installation of explosive hazardous systems must be carried out principally by specialist staff.

The device meets the classification:

II 1 G Ex ia IIC T6..T1 Ga	II 1 D Ex ia IIIC Tx°C Da
II 1/2 G Ex ib IIC T6..T1 Ga/Gb	II 1/2 D Ex ib IIIC Tx°C Da/Db
II 2 G Ex ib IIC T6..T1 Gb	II 2 D Ex ib IIIC Tx°C Db

The temperatures Tx°C can be found in the tables of the EU type examination certificate.

The devices are conceived for measurement of temperatures in explosive hazardous areas.
The measured medium may also be combustible gases, vapors, liquids and dusts.
The permitted operating temperatures and pressures are type and variant dependent and can be found in this technical manual.

For applications, which require devices of category 1/2 or category 1, the process pressure and temperature range of the media has to be between 0,8 bar to 1,1 bar and -20 °C to 60 °C.
If the thermometer is operated beyond these atmospheric conditions, the EU type examination certificate can be used as a guide. Additional tests for the special application conditions are recommended.

For specifying the permitted environmental temperature in the area of the terminal enclosure when using a temperature head transmitter that is built into the terminal enclosure the permitted environmental temperature of the transmitter must also be observed.

In explosion hazardous areas with dust-air-atmosphere only the terminal enclosure in steel or aluminum type 4 are permitted.
In explosion hazardous areas with dust-air-atmosphere the coating of the process connection resp. the protection tube is not permitted.

A built-in temperature head transmitter must be certified for II G Ex ia IIC T6…T1 Ga resp. II D Ex ia IIIC Tx°C Da. For the use in zone 1 resp. 21 the certification II G Ex ib IIC T6…T1 resp. II D Ex ib IIIC Tx°C Da is also sufficient. The installation of a temperature head transmitter with lower temperature class resp. maximum surface temperature reduces the temperature class resp. maximum surface temperature of the whole device.

The maximum permitted supply voltage of the device PTX is 30V. The installation of a temperature head transmitter with a lower maximum permitted supply voltage than 30V reduces the maximum permitted supply voltage to those values.

For the use in explosion hazardous areas with dust-air-atmosphere only the temperature head transmitter ExKTM-_A0 or another therefore specially proofed device is permitted.
The maximum surface temperature of the built-in temperature head transmitter Ex-KTM-_A0 is 15K higher than the environmental temperature of the temperature head transmitter. This results e.g. in T55 at T_a = 40°C, T75 at T_a = 60°C and T95 at T_a = 80°C in the area of the temperature head transmitter ExKTM-_A0.

If the thermometer is mounted in the separation wall to the hazardous area that requires devices of category 1, the process connections have to be designed in such a way, that they are sufficiently tight according to EN/IEC 60079-26 section 4.6.

Using a terminal enclosure in aluminum there is a danger of ignition by sparks caused by impact or friction.
Operational conditioned friction or pushes with device parts in iron/steel are not permissible.
The operator has to ascertain the suitability of this device for his application.

At variants of the devices with chargeable plastic parts, a warning marking points out to the safety measures, that must be applied because of the electrostatic charging in operation and especially in the case of maintenance activities:

- avoid friction
- no dry cleaning
- no assembling in pneumatic conveying stream

Installation

The correct function of the device within the specific technical data can only be guaranteed, if the permitted process and environmental temperatures (see chapter „Technical data“) will not be exceeded.

Material terminal enclosure	**Environmental temperature Explosive-free area**		**Environmental temperature gas-explosive-area**		**Environmental temperature dust-explosive-area**	
	Without transmitter	With transmitter KTM	Without transmitter	With transmitter ExKTM-_A0	Without transmitter	With transmitter ExKTM-_A0
Steel / Aluminium	-40°C..+130°C	-40°C..+85°C	-20°C..+100°C cat. 1 -20...+60°C	-20°C..+85°C cat. 1 ...+60°C cat. 1 / T6 ...+49°C	-20°C..+80°C cat. 1 -20...+60°C	-20°C..+80°C cat. 1 ...+60°C
POM	-25°C..+100°C	-25°C..+85°C	-20°C..+100°C cat. 1 -20...+60°C	-20°C..+85°C cat. 1 ...+60°C cat. 1 / T6 ...+49°C	inadmissible	inadmissible
PP	-15°C..+100°C	-15°C..+85°C	-15°C..+100°C cat. 1 -15...+60°C	-15°C..+85°C Kat 1 ...+60°C cat 1 / T6 ...+49°C	inadmissible	inadmissible

Installation place

The choice of the place of installation of the sensor and the length of the sensor tube are of considerable importance for the quality and the reliability of the measuring results.

If the sensor isn't installed deeply enough, an error in the measured temperature can occur because of the different process flow temperature at the pipeline wall and the heat transfer along the sensor tube.

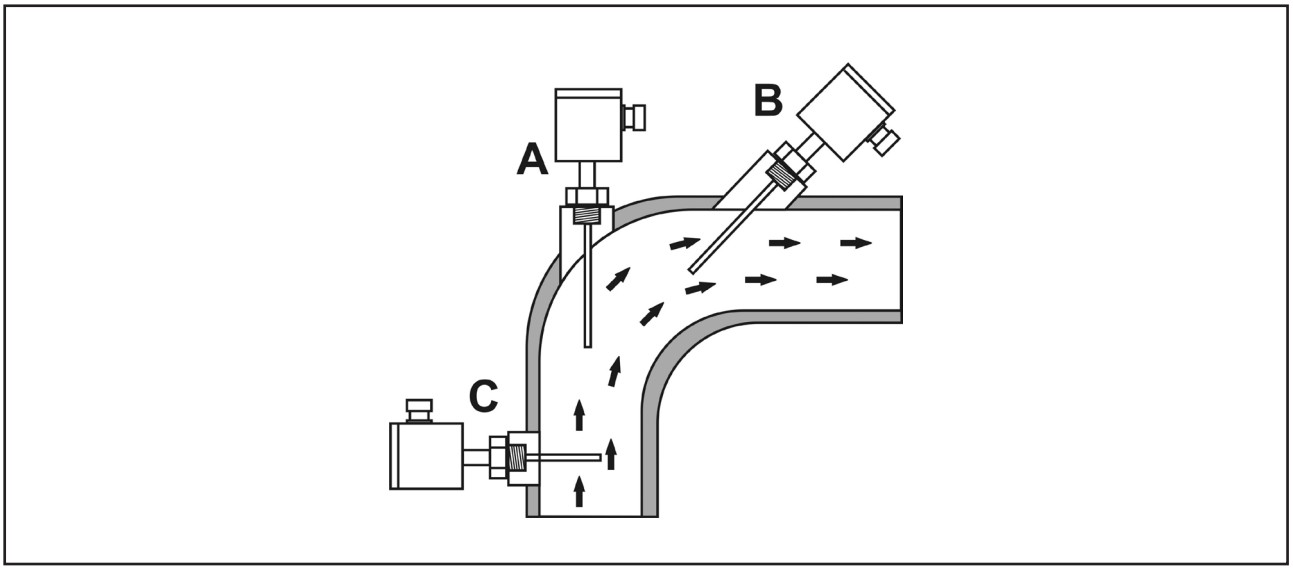
The appearance of the error should not be ignored if a considerable difference between process temperature and environmental temperature exists.
Thus it is suggested to use an installation length of at least 80...100 mm.
The shorter the installation length, the greater is the deviation against the real medium temperature caused by the heat transfer.

The following general recommendations can be applied as approximately guideline:

- In liquids, the sensor tube length should be 5...6 times greater than the diameter of the sensor tube plus the sensitive length of 50 mm.
- In steam, air and gases, the sensor tube length should be 10...15 times greater than the diameter of the sensor tube plus the sensitive length of 50 mm.

In pipelines with small diameter the tip of the sensor tube should reach the axis line, that means the middle of the pipeline, and if possible additionally a little more.

By isolating the external parts of the sensor, the effect caused by too low installation depth, can be reduced.
An additional solution for optimizing the measurement quality of small formatted pipelines could be the installation of the sensor tube diagonal to the pipeline longitudinal axis or the installation of the sensor tube in the pipeline arc.



A) In the pipe arc against the flow direction
B) In small pipes diagonal against the flow direction
C) Vertical to the flow direction

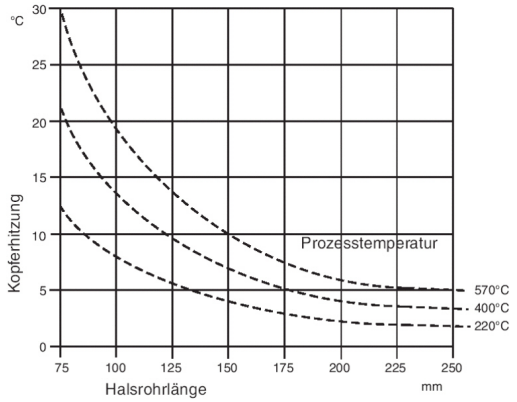
At a horizontal installation, especially in hygienic applications, the probe should be installed with a decline against the horizontal of minimum 3°, to ensure a self-emptying.

Process and environmental temperature

At high process temperatures a heat transfer to the terminal enclosure can be reduced by isolation of the medium carrying part of the plant or by the use of a neck tube.

Neck tube

The neck tube is used to decouple the temperatures between medium and the terminal enclosure in order to reduce the temperature at the terminal enclosure.
By using a neck tube at extreme process temperatures it can be achieved, that the permitted environmental temperature range in the area of the terminal enclosure will not be exceeded.
The length of the needed neck tube depends on the height of the process temperature and the respective installation situation.



Installation notes

Drive the system pressure free prior installation resp. deinstallation of the sensor.
Be also sure that no medium is flowing in the system. At extreme system or medium temperatures there could exist serious dangers.
The screw-in of the thread process connection by using the terminal enclosure is not permitted.
The tightening of the thread process connection may only be done at the hexagon by a suitable spanner and with the maximum permitted torque strength.
The maximum permitted torque strength is 100 Nm.

Electrical connection

The electrical connection of the device must be carried out according to the respective country specific standards.
Incorrect installation or adjustment could cause applicationally conditioned risks.

Potential equalization - earthing

The device must be grounded.
The earthing can be carried out by the metallic process connection.

Connection cable

Use only shielded signal and measurement wires and install these wires separated from power leading wires.
The cable shield of a connected cable must be grounded.

Supply voltage

The voltage applied to the terminal contacts may not exceed the maximum permitted supply voltage to ensure the compliance with the intrinsically safety.
The maximum permitted supply voltage is:

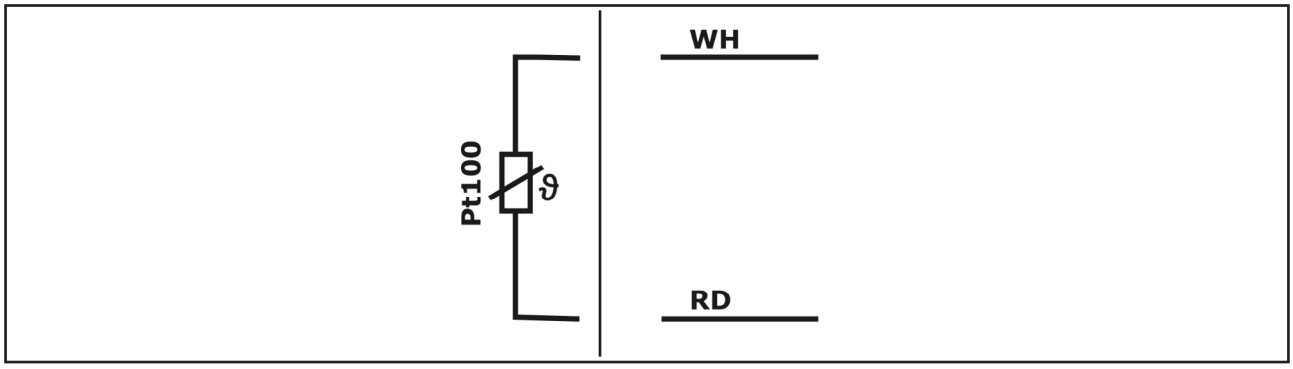
Without head transmitter	$30V_{DC}$
Head transmitter ExKTM-_A0 – type M	$27,3V_{DC}$
Head transmitter UTN500-B – type X	$30V_{DC}$

Further detailed informations to the temperature head transmitters can be found in the technical instructions, safety notes and EC conformity certificate.

Connection scheme

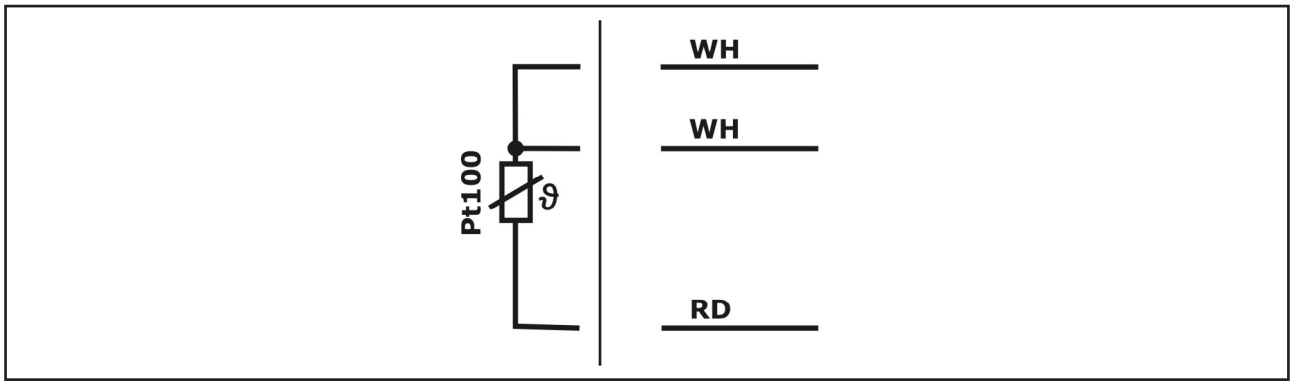
Connection type loose wires – type D

1x Pt100 / 2-wire / sensor type 1



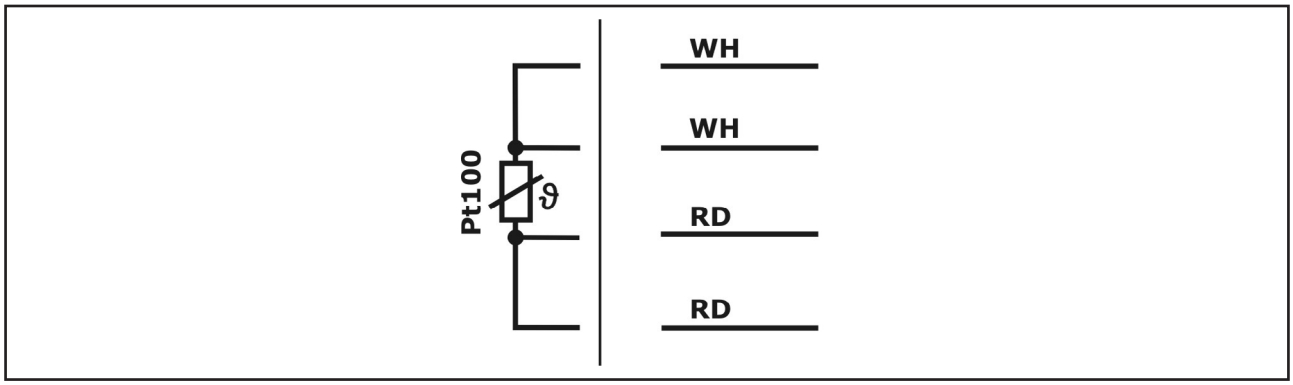
Conductor color:
WH = white, RD = red

1x Pt100 / 3-wire / sensor type 2



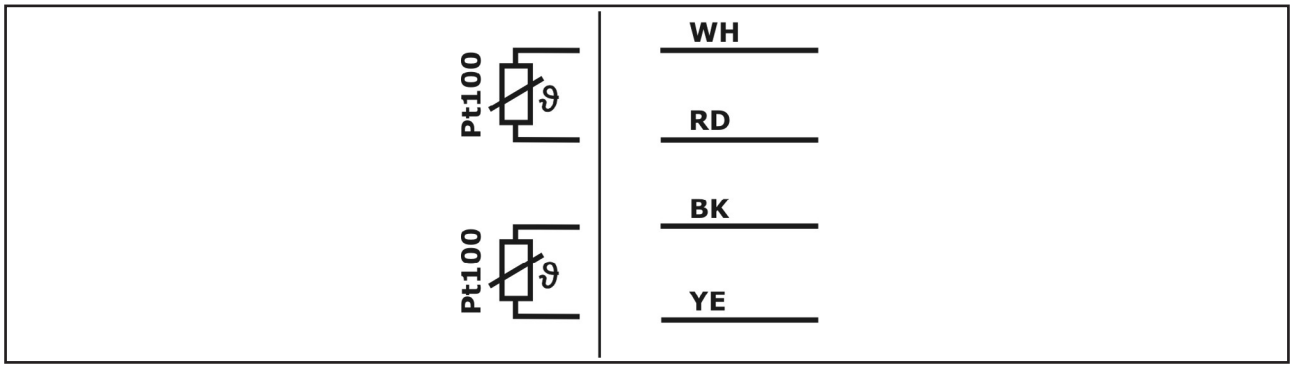
Conductor color:
WH = white, RD = red

1x Pt100 / 4-wire / sensor type 3



Conductor color:
WH = white, RD = red

2x Pt100 / 2-wire / sensor type 4



Conductor color:
WH = white, RD = red, BK = black, YE = yellow

Connection type terminal socket – type K / L

See color assignment connection type loose wires – type D

Connection type head transmitter – type M / X / T

Head transmitter ExKTM-_A0 – type M

- Pt100 / 2- resp. 3-wire
- Output 4…20mA / 2-wire
- Fix adjusted

Head transmitter UTN-500-B – type X

- Pt100 / 2- resp. 3- resp. 4-wire
- Output 4…20mA / 2-wire
- Adjustable per software

See technical manual head transmitter

Operation

An operation provided by user is not designated.

Maintenance

The device is free of maintenance.

Repair

A repair may only be carried out by the manufacturer.

If the device must be sent back for repair, the following informations must be enclosed:

- An exact description of the application.
- The chemical and physical characteristics of the product.
- A short description of the occurred error.

Before returning the device for repair, the following measures must be proceeded:

- All adhesive product residues must be removed. This is especially important, if the product is unhealthily, e.g. caustic, toxic, carcinogenic, radioactive etc.
- A returning must be refrained, if it is not possible by 100% to remove the unhealthily product completely, because e.g. it is penetrate into cracks or is diffused through plastic.

Technical Data

Output Signal Pt100

Function	Pt100
Supply current	≤ 0,1…6 mA
Step response time $T_{50/90}$	*Diameter sensor tip Ø8mm* T_{50} ≤ 18 s / T_{90} ≤ 55 s *Diameter sensor tip Ø10mm* T_{50} ≤ 28 s / T_{90} ≤ 90 s *Diameter sensor tip Ø12mm* T_{50} ≤ 38 s / T_{90} ≤ 125 s
Isolation voltage	≥ 500 V_{ac} Pt100 to Pt100 / Pt100 to metallic parts

Measuring accuracy

Reference conditions	EN/IEC 60770-1
	T = 25 °C, relative humidity 45...75 %, environmental air pressure 860..1060 kPa
Installation position	Vertical, process connection bottom side
Warm-up time	≤ 600 s

Measurand error	*Accuracy class B – type B*	
	T= -50…400°C	≤ ±(0,3K +0,005 * |T|)
	Accuracy class A – type A	
	T= -50…250°C	≤ ±(0,15K +0,002 * |T|)
	T= 250…400°C	≤ ±(0,3K +0,005 * |T|)
	Type S – Accuracy class B	
	T= -200…600°C	≤ ±(0,3K +0,005 * |T|)
	Type S – Accuracy class A	
	T= -200…600°C	≤ ±(0,15K +0,002 * |T|)
	|T| = Numerical value of temperature in °C, no leading sign	

Process conditions

Process temperature	Limitation by category / temperature class/ electrical power, see EU type examination certificate *Accuracy class type B / A* -50°C...+400°C *Accuracy class type S* -200°C...+600°C	
	Permitted process temperature without neck tube	
	Environmental temperature at the terminal enclosure	Maximum process temperature
	Up to +25°C	+150°C
	Up to +40°C	+135°C
	Up to +60°C	+120°C
	Up to +85°C	+100°C
Process pressure	≤ 60 bar *Limitation* depending on process connection	

Environmental conditions

The permitted environmental temperature range results from the combination of standard range and limitation, whereby the range is defined by the narrowest limitation.

Environmental temperature	-40°C...+130°C	
	Limitation by material	
	Terminal enclosure type B – PP	-15…+100°C
	Terminal enclosure type 2 – POM	-25…+100°C
	Limitation by type certificate	
	Certificate type 1 – ATEX II 1 G	-20…+100°C
	Certificate type 2 – ATEX II 1 D	-20…+80°C
	Limitation by application	
	Category 1	-20…+60°C
	Limitation by head transmitter	
	ExKTM / UTN-500	-40...+85°C
	ExKTM category 1 / temperature class T6	-20...+49°C
	UTN-500 temperature class T4	-40...+85°C
	UTN-500 temperature class T5	-40...+70°C
	UTN-500 temperature class T6	-40...+55°C
Protection	IP65/67 (EN/IEC 60529)	
Shock classification	3 g [10 - 500 Hz] (EN/IEC 60068-2-6)	
Vibration classification	3 g [10 - 500 Hz] (EN/IEC 60068-2-6)	
EM compatibility	Operation device class B / Industrial range (EN/IEC 61326)	
Weight	Depends on variant	

Materials - process wetted

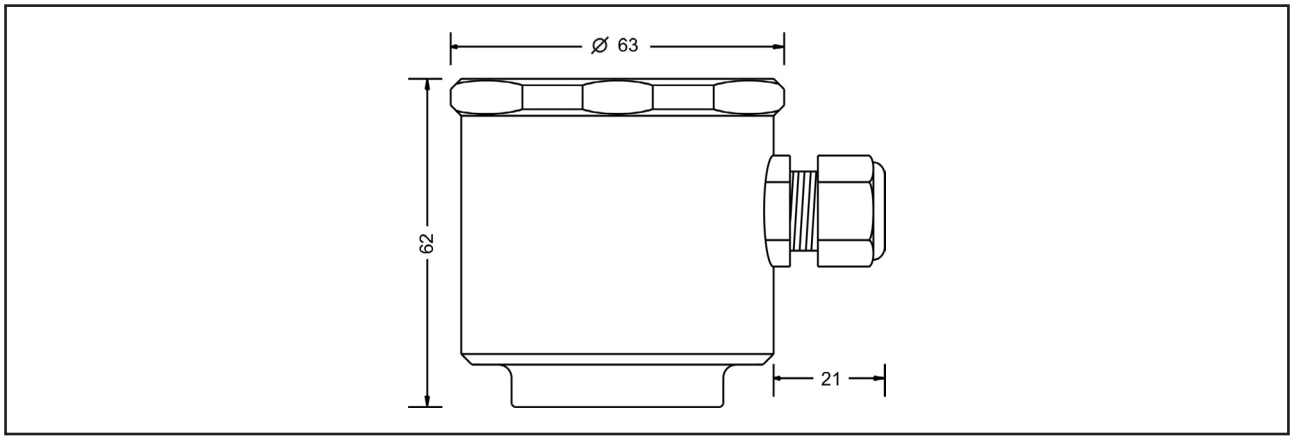
Protection tube	Steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti) Wall thickness ≥ 1mm
Process connection	Steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti)
Surface quality	Ra < 0,8µm
Surface coating	ETFE / others

Materials - not process wetted

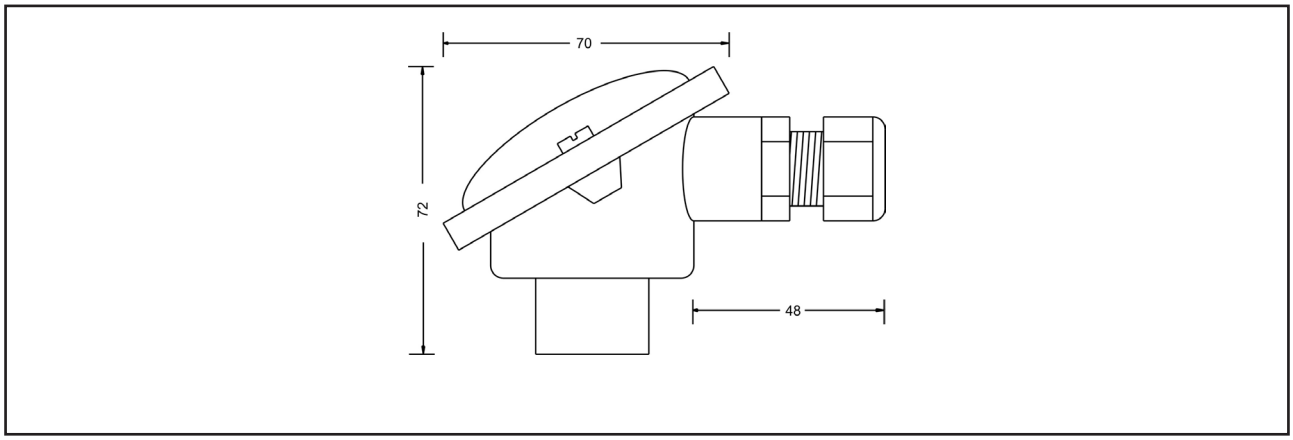
Neck tube	CrNi-steel
Terminal enclosure	CrNi-steel / Aluminium lacquered / PP / POM
Electrical connection part	*Cable gland* CrNi-steel / PA *Gasket* CR / NBR
Gaskets	FPM / Silicone

Dimension drawings

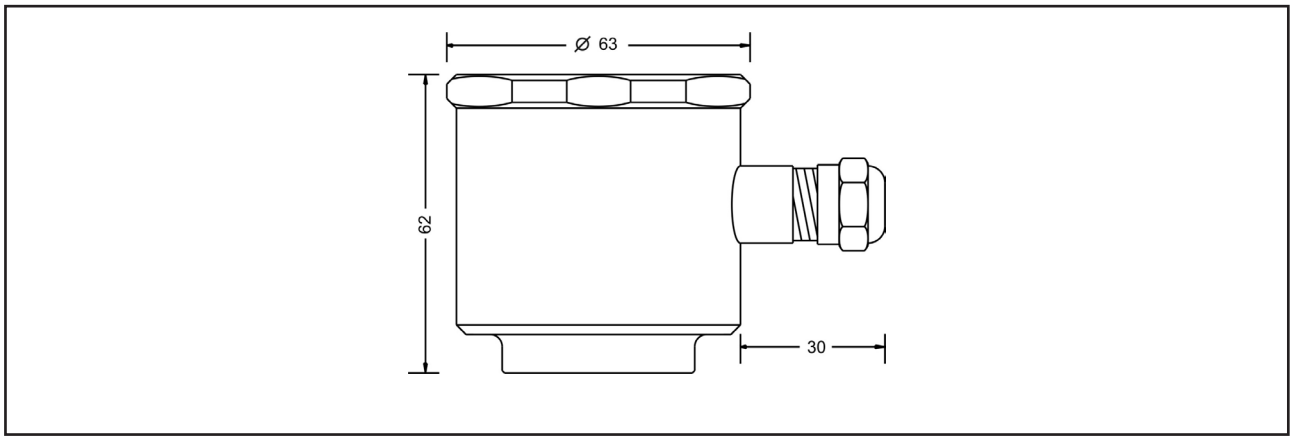
Terminal enclosure



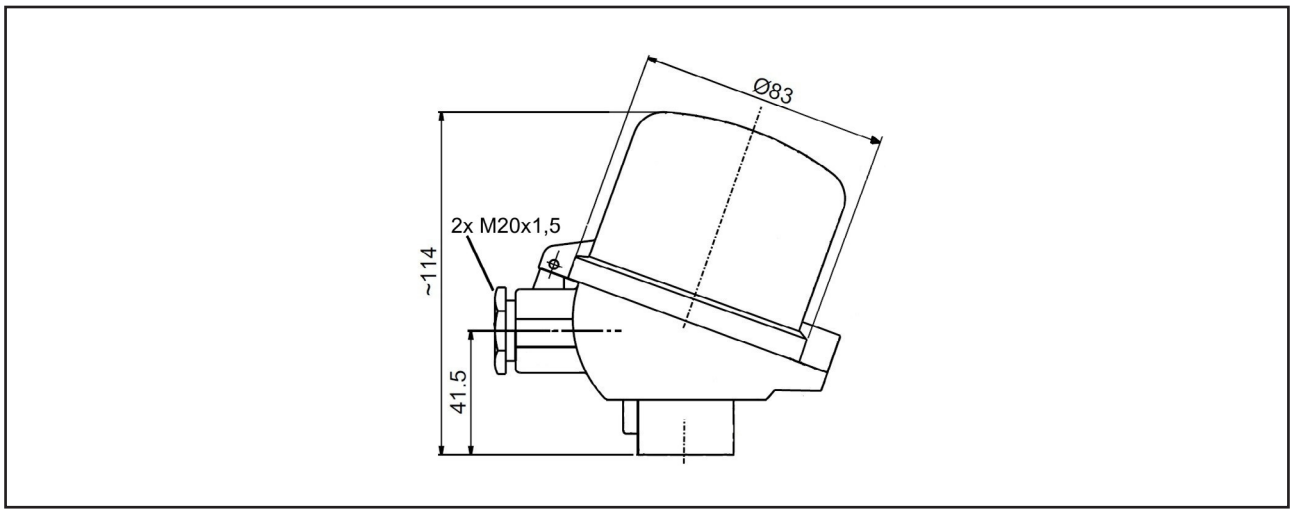
Terminal enclosure type 2 / B



Terminal enclosure type 4

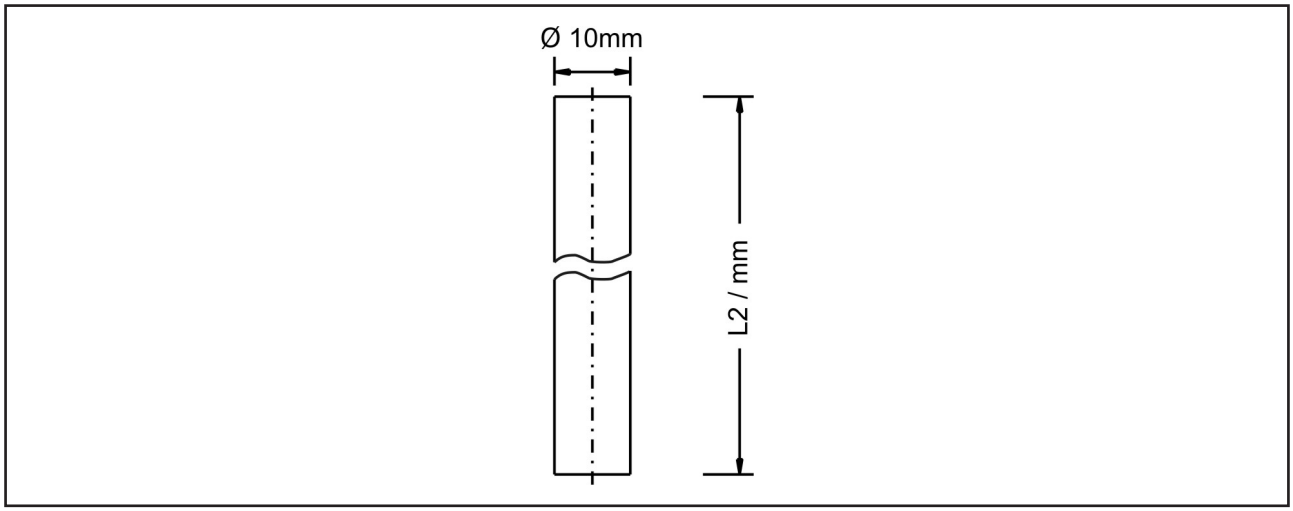


Terminal enclosure type 5

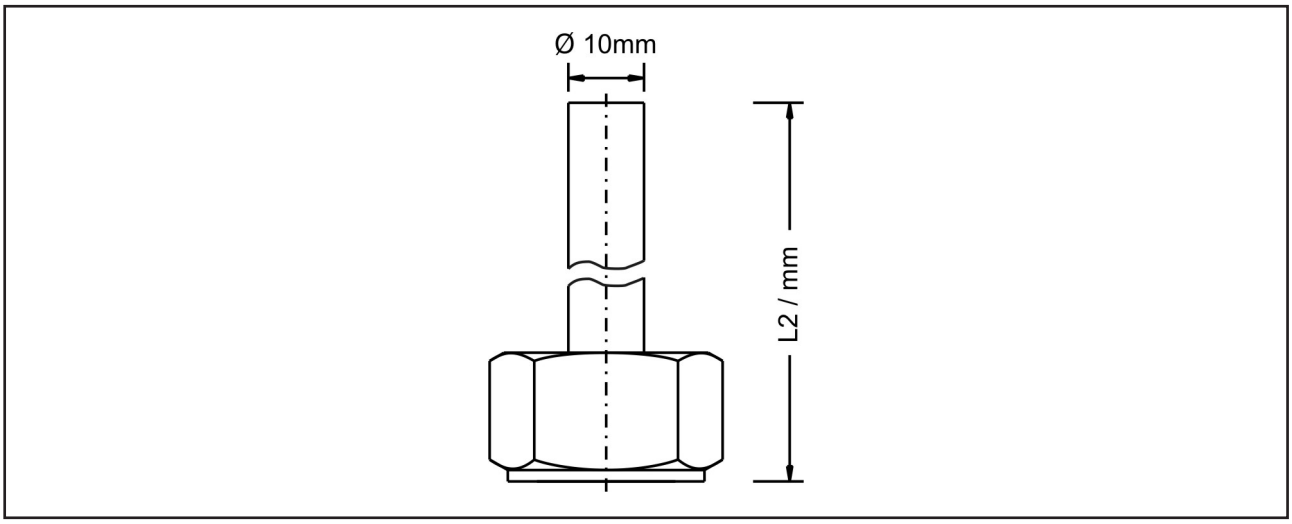


Terminal enclosure type G

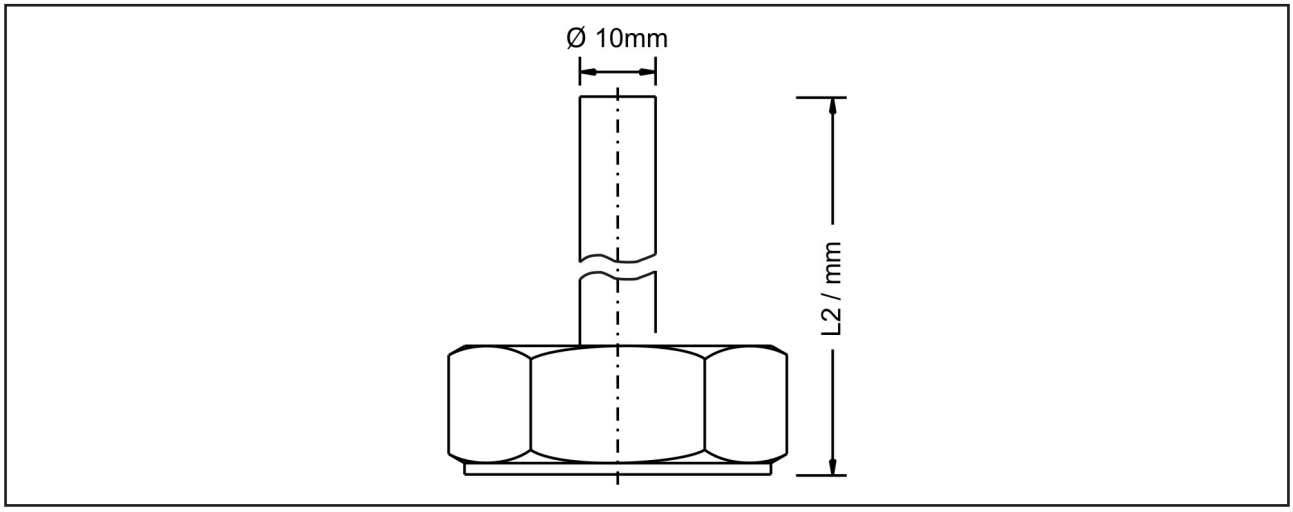
Neck tube



Process connection type E / F

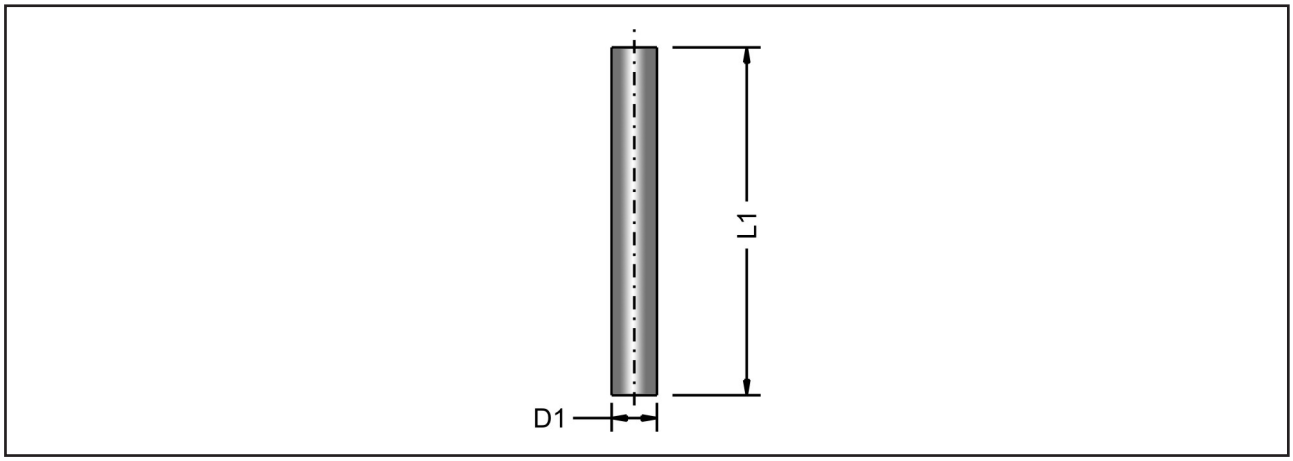


Process connection type 1

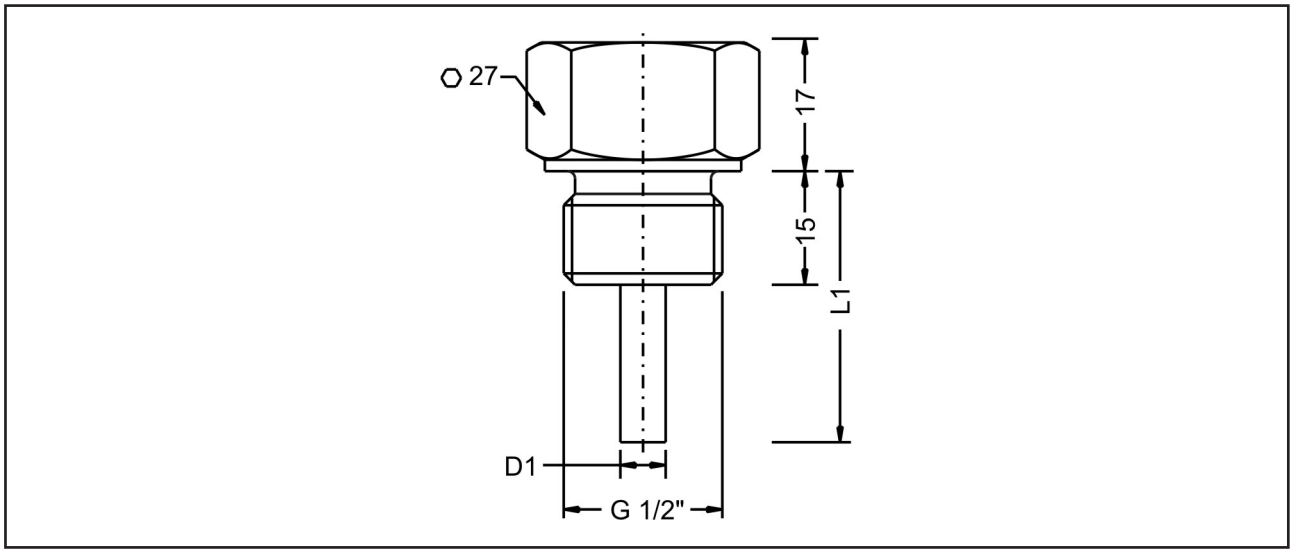


Process connection type 2

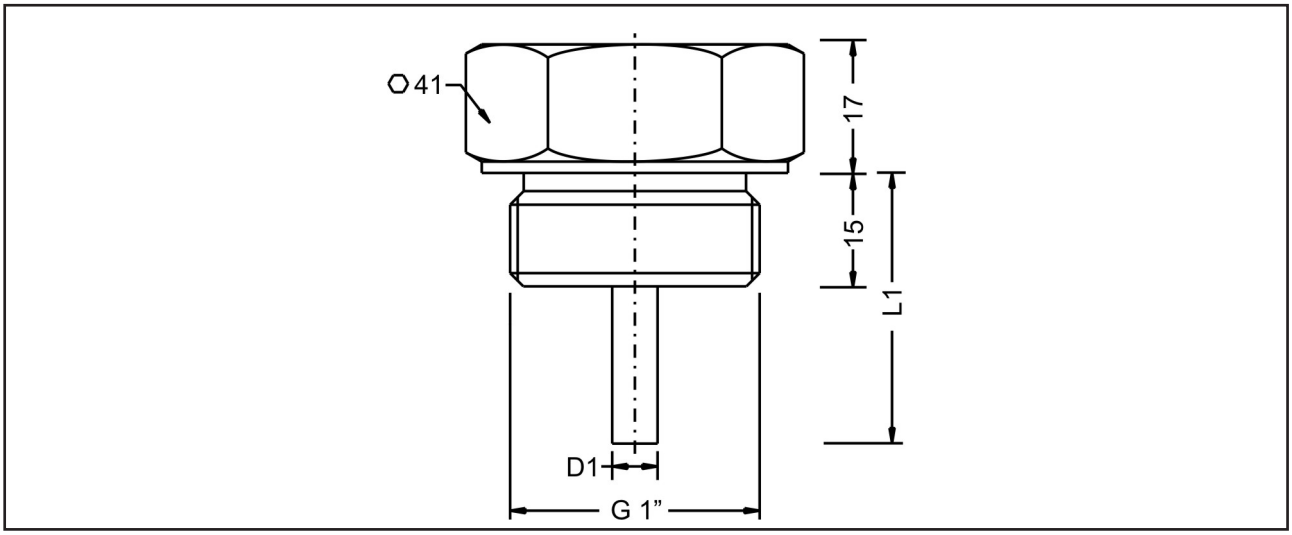
Process connection



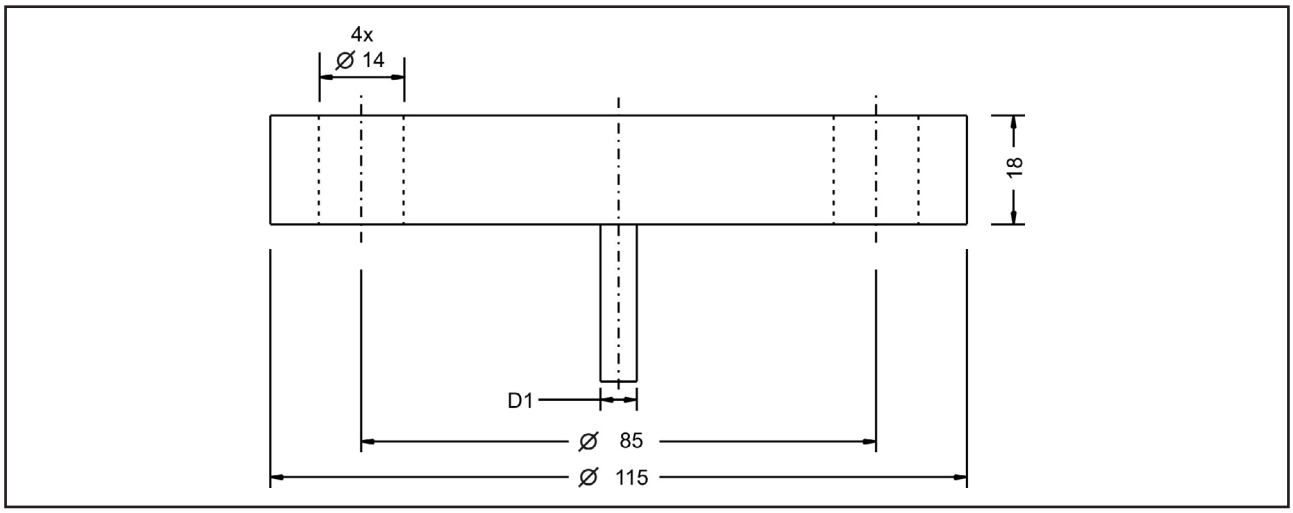
Type 0 - without (for slide sleeve)



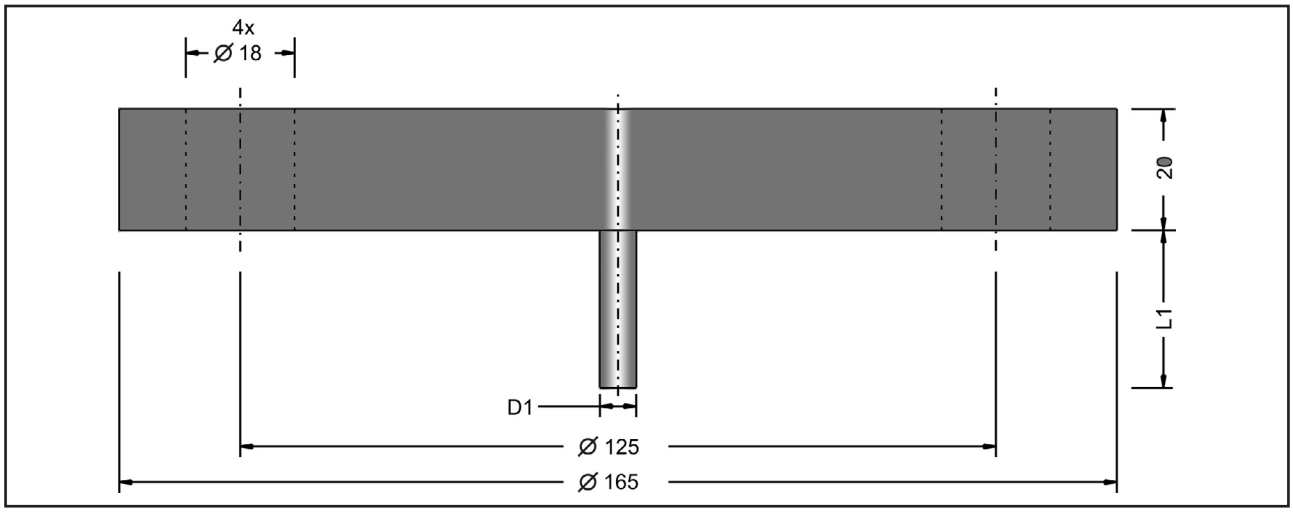
Type 1 - G ½" ISO 228-1



Type 2 - G 1“ ISO 228-1

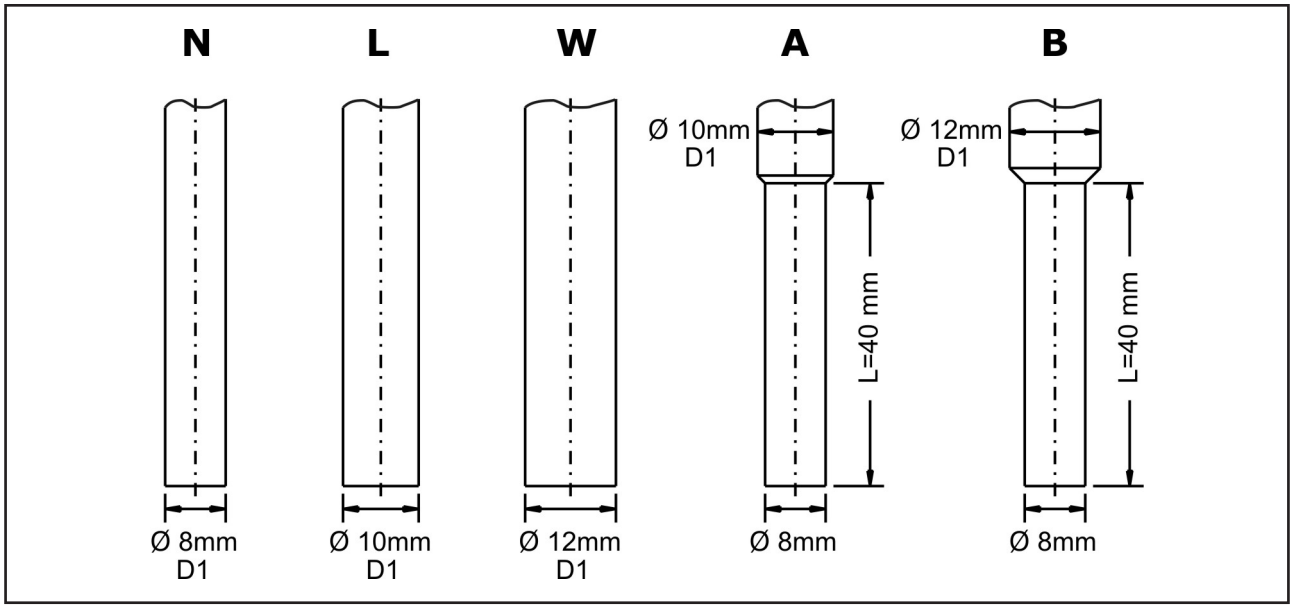


Type E - Flange DIN EN 1092-1, A (B - DIN 2527), DN25



Tyep F - Flange DIN EN 1092-1, A (B - DIN 2527), DN50

Probe


N
L
W
A
B
Ø 8mm
D1
Ø 10mm
D1
Ø 12mm
D1
Ø 10mm
D1
Ø 12mm
D1
L=40 mm
L=40 mm
Ø 8mm
Ø 8mm

Order Code

Type certificate
1 ATEX II 1 G Ex ia IIC T6…T1 Ga
2 ATEX II 1 G Ex ia IIC T6…T1 Ga / ATEX II 1 D Ex ia IIIC Tx°C Da
Only with connection type K / M
Only with material terminal enclosure type 4 / 5
Not with surface coating

Sensor type
1 1x Pt100 / 2-wire
2 1x Pt100 / 3- wire
3 1x Pt100 / 4- wire
4 2x Pt100 / 2- wire

Accuracy class / Process temperature
B Class B - IEC 60751 / -50°C…+400°C
A Class A - IEC 60751 / -50°C…+400°C not for sensor type 4
Y others (e.g. high temperature type -200…+600°C, not for sensor type 4/ surface coating e.g. ETFE)

Process connection
0 without
1 Thread ISO 228-1 – G½"B
2 Thread ISO 228-1 – G1"B
E Flange DIN EN 1092-1, A (B - DIN 2527), DN25, PN10-40
F Flange DIN EN 1092-1, A (B - DIN 2527), DN50, PN10-40
Y others

Material process connection/probe (process wetted) **- probe diameter D1**
N CrNi-steel – Ø8 mm
L CrNi-steel – Ø10 mm
W CrNi-steel – Ø12 mm
A CrNi-steel – Ø10 mm - reduced tip Ø8 mm/L=40 mm
B CrNi-steel – Ø12 mm - reduced tip Ø8 mm/L=40 mm
Y others

Neck tube
A without
B Neck tube L2=100mm
Y Neck tube L2/mm

Material terminal enclosure
B PP
2 POM
4 Aluminum form B – EN 50446
5 CrNi-steel
G Aluminum double size
Y others

Measuring insert
W Exchangeable measuring insert

Connection type
K Terminal socket
M Head transmitter ExKTM-_A0 (4…20mA/fix adjusted) integrated
X Head transmitter UTN500-B (4…20mA/programmable) integrated
D Loose wires
G 1x terminal socket / 1x head transmitter type M/X/T/others terminal enclosure type G
L 2x terminal socket terminal enclosure type G
Y others

Sensor length L1 / mm

Neck tube length L2 / mm

PTX W

Installation material and connection cable are not enclosed in contents of delivery.

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Your partner for measuring technology and automation

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