

Mineral Insulated Temperature Sensors



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Mineral Insulated Temperature Sensors

The following Operation Manual provides information of temperature sensors suitable for particularly difficult conditions due to their constructional and operational properties. Mineral insulated sensors are vibration and shock resistant and can be easily bent with no risk of short-circuit. Owing to their properties they are widely used in hard to reach places. Suitable for mounting in small spaces, mineral insulated sensors are used where there is a need for flexible sensing elements with small diameters and low thermal inertia.

These sensors are suitable both for industrial and laboratory applications. Their range of applications is really wide. The sensors are used in nuclear engineering, chemical and petrochemical industry, industrial building, mechanical engineering, power engineering, metallurgy, etc.

Thermocouple sensors with insulated junctions are recommended for temperature measurements in corrosive atmospheres, where there is a necessity for the thermocouple to be electrically insulated and sheathed. Temperature sensors with grounded junctions are suitable for measurements of static temperature and temperature of flowing gases and non-aggressive liquids, when a quick response to temperature change is required. Resistance sensors are used for very accurate measurements.

These sensors are made with voltage output (thermocouple sensors), ohm output (resistance sensors) or standard 4÷20 mA current signal (both types).

Mineral insulated temperature sensors comply with the following standards: PN-EN 60584 (thermocouple), PN-EN 60751 (resistance).

1. Construction and principle of operation.

Mineral insulated metal sheathed cable is a thin pipe with two or four nickel or thermocouple conductors inside, surrounded by very compact insulation (e.g. magnesium oxide). At one end of cable, either thermocouple wires are joined to create a measuring junction or a resistor is used with nickel conductors.

Measuring junction can be insulated from the sheath (**SO**) or connected with it—grounded junction (**SP**); for double thermocouples the measuring junctions of both thermocouples insulated from the sheath, can be connected (**SOA**) or insulated from each other (**SOB**).

Thermocouple and resistance sensors can have following termination types:

- exposed wire ends 20 mm long (**BT**)
- sleeve that protects the connection of exposed wires with insulated stranded wires 50 mm long (**T**)
- miniature (**BTW**) or standard (**BTWS**) flat plug
- LEMO plug (**BTL**)
- sleeve that protects the connection of exposed wires with cable in double silicone insulation 50 mm long (**TKb**)
- as above, with miniature flat plug (**TkbW**)
- as above, with LEMO plug
- BT type sensor terminated with a terminal block (mineral insulated insert type **.W2../..**)
- insert as described above mounted in connection head type BA (mineral insulated sensor PT...-BA)
- all above-mentioned versions can be made with standard mineral insulated cable or with special OMEGACLAND XL –XL-.....is used before the code then.

Other types of temperature sensors specified in the product catalogue are also made with mineral insulated metal sheathed cable, e.g.:

- head: PTT.-453, PTT.-533,
- with handgrip: PTR-1, PTR-2, PTR-3, PTT.-147
- cable: PTT.-183, PT...-186, TTP.-187

2. Specification.

Mineral insulated cable diameter d* 1,0; 1,5; 2,0; 3,0; 4,5; 6 mm
 Sensing element type 1 or 2xFe-CuNi(J) or NiCr-NiAl(K) or NiCrSi-NiSi(N) or Cu-CuNi(T)
 1 or 2xPt100 or Pt1000
 Recommended max. temperature ** acc. to Table 1

Type	Diameter					
	1	1,5	2	3	4,5	6
J	315°C	315°C	400°C	450°C	550°C	700°C
K	760°C	760°C	800°C	900°C	1000°C	1200°C
N	–	–	–	900°C	–	1200°C
T	–	–	–	350°C	–	350°C
Pt100	–	–	–	600°C	–	600°C

Thermocouple class 2 or 1 acc. to PN-EN 60584
 Resistor class B or A acc. to PN-EN 60751
 Measuring junction type insulated or grounded
 Sheath material acid-resistant steel (for J, T and Pt100), Inconel 600 (for K,N)***
 Acceptable vibrations 5 to 80 Hz, up to 5g
 Acceptable working pressure 4 MPa
 Temperature of air surrounding the exposed wire ends...-40...150°C
 Time constant T_{05} (air – 0,4 m/s).....

Diameter d [mm]	Insulated junction [s]	Grounded junction [s]	Pt100 [s]
1	0,15	0,06	–
1,5	0,25	0,13	–
3	1,2	0,22	1,5
6	4	0,6	4,5

Minimum bend radius 5xd
 (in case of resistance sensors bending of 50 mm long sensor termination is forbidden)
 Sensor length L any, sensor with L>500 mm distributed coiled.
 Compensation cable length L_k any

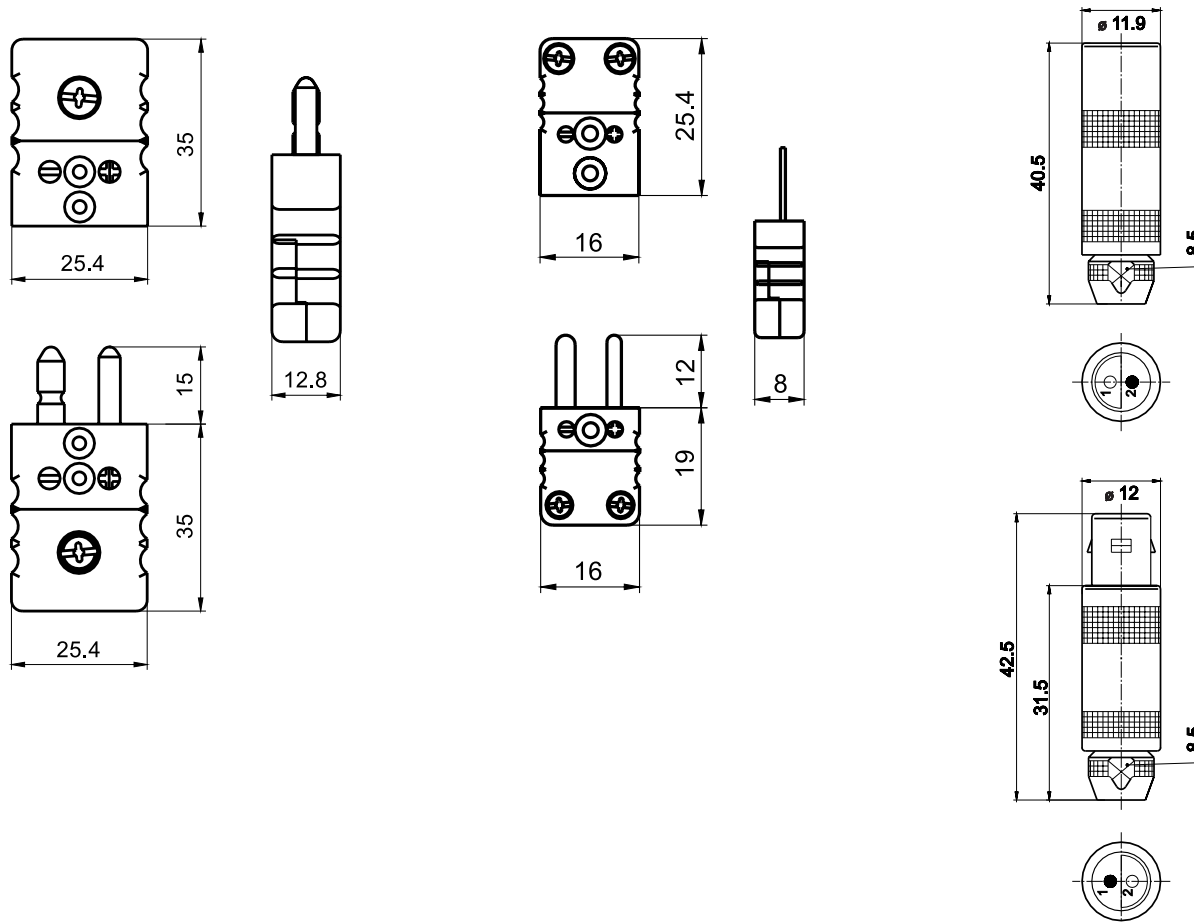
* - minimum sheath diameter for double thermocouple is 2 mm;

- Pt sensor diameter 3 and 6 mm, XL version of sensor diameter 6 mm

** - given temperature is the temperature of clean air and refers to class 2 thermocouple and class B resistance sensors

*** - thermocouple K and N, class 1, with diameter 6 mm -only up to 1000°C, resistance sensors, class A up to 400°C, special 6 mm mineral insulated cable OMEGACLAND XL for thermocouple K and N, class 2, allows its use in air up to 1335°C

Connection head type BA.....	IP55, ambient temperature $-40\div 100^{\circ}\text{C}$
NAA.....	IP65, ambient temperature $-40\div 100^{\circ}\text{C}$
MAA.....	IP54, ambient temperature $-40\div 100^{\circ}\text{C}$
Head transmitters type	LTT, FLEX TOP, TxBlock, 248HA ambient temperature $-40\div 85^{\circ}\text{C}$
Flat plugs and sockets (mini up to $\varnothing 4,5$).....	dimensions as below, sheath material: (standard to $\varnothing 6$) Nylon filled with fiberglass, operating temperature up to 200°C
LEMO plugs and sockets (up to $\varnothing 4,5$).....	dimensions as below, material: plated brass, operating temperature up to 250°C



3. Properties of sheath materials.

acid-resistant steel

max. operating temperature..... in air 850°C
 resistance to carbon dioxide..... 650°C
 resistance to intercrystalline corrosion
 good resistance to oxidizing atmosphere
 good resistance to alkaline compounds, organic and most
 inorganic acids, except HCl i H_2SO_4

Inconel 600

max. operating temperature in air..... 1200°C
 resistance to carbon dioxide..... 500°C
 resistance to atmosphere containing sulphur or water vapour..
 up to 500°C good resistance to oxidizing atmosphere
 resistance to corrosion and low electrochemical corrosion
 in high temperatures it lets through hydrogen

OMEGA CLAND

max. operating temperature in air: 1355 °C

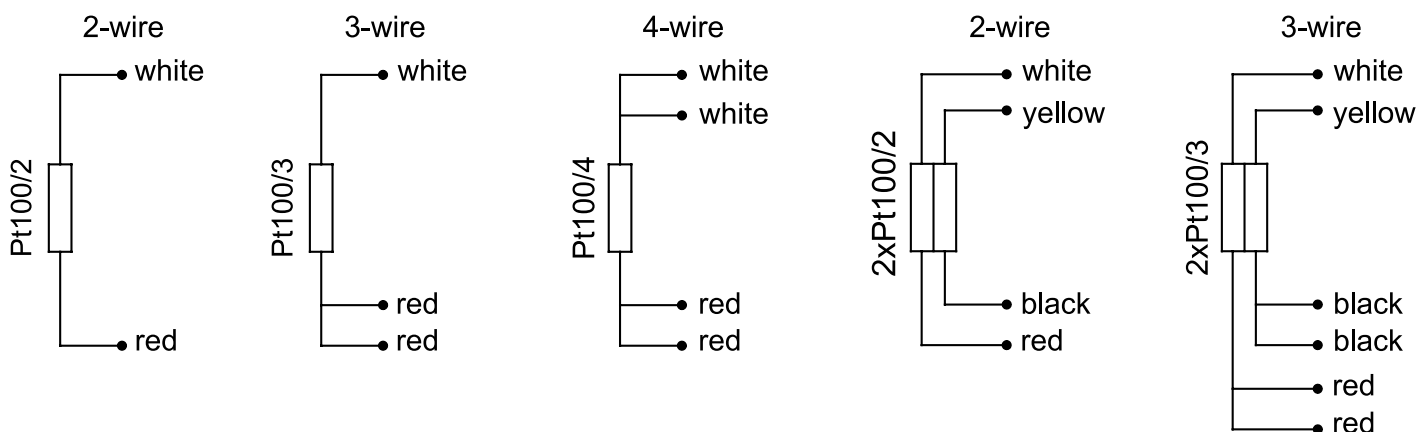
very good resistance to oxidizing atmosphere and carburising as well as chlorination processes low resistance to sulphur containing atmosphere

4. Sensor connection.**Terminal block**

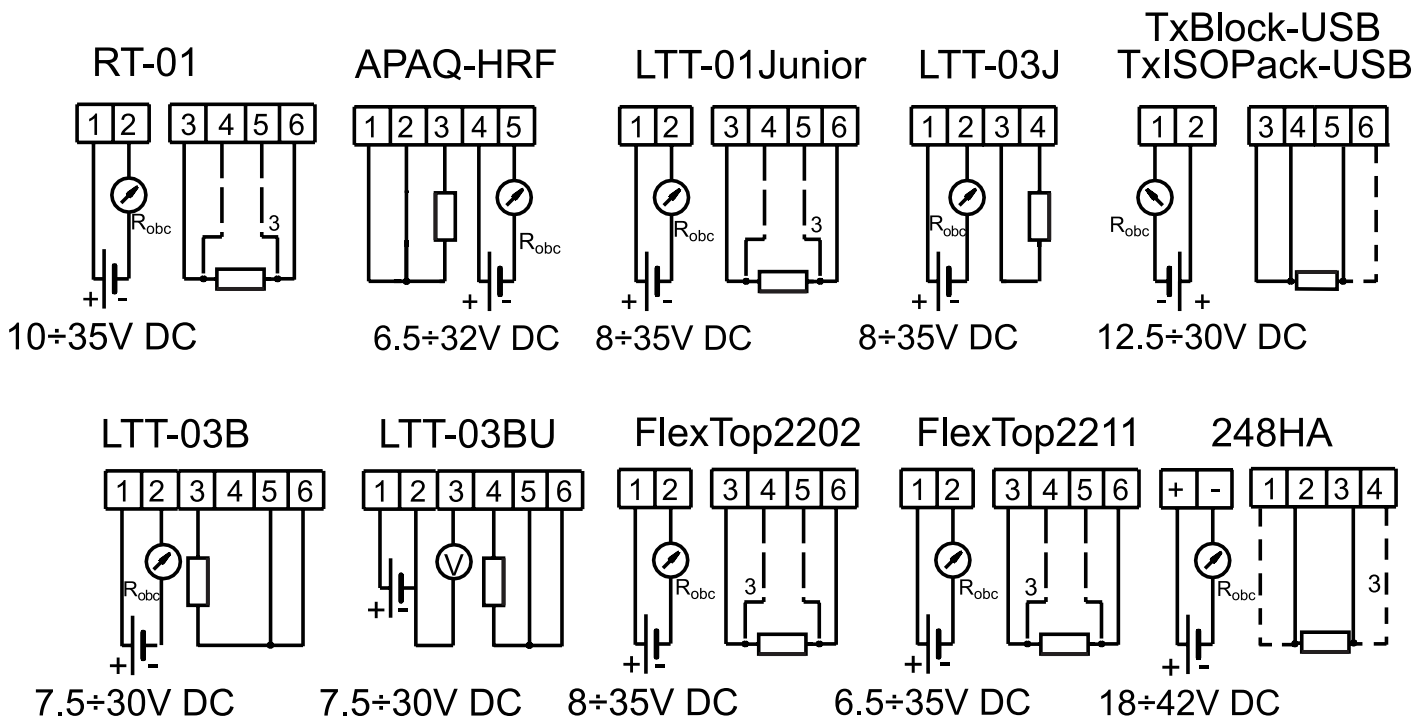
Since thermocouple sensors must be connected with an adequate polarity, a sign “+” thermocouple positive wire is marked on a terminal block for the purpose of proper connection. In case of connecting the thermocouple sensor with outer devices an adequate pole of terminal block must be joined with an adequate pole of wire (proper colour). Terms of connection and colour codes are provided in table:

Type of thermoelectric sensor	Type of wire		Metal Composition		Colour Code „+”		Tolerances		Temperature range
	Compensation	Thermoelectric	Wire +	Wire -	IEC 584 „-”white	ANSI „-”red.	Class 1	Class 2	
J	-	JX	Fe	CuNi	black	white	±1.5	±2.5	-25÷200°C
K	-	KX	NiCr	NiAl	green	yellow	±1.5	±2.5	-25÷200°C
K	KCA	-	Fe	410 Alloy	green	-	-	±2.5	0÷150°C
K	KCB	-	Cu	CuNi	green	-	-	±2.5	0÷100°C
T	-	TX	Cu	CuNi	khaki	blue	±0.5	±1.0	-25÷200°C
N	-	NX	Nicrosil	Nisil	pink	orange	±1.5	±2.5	-25÷200°C
N	NC	-	Cu	278 Alloy	pink	-	-	±2.5	0÷150°C

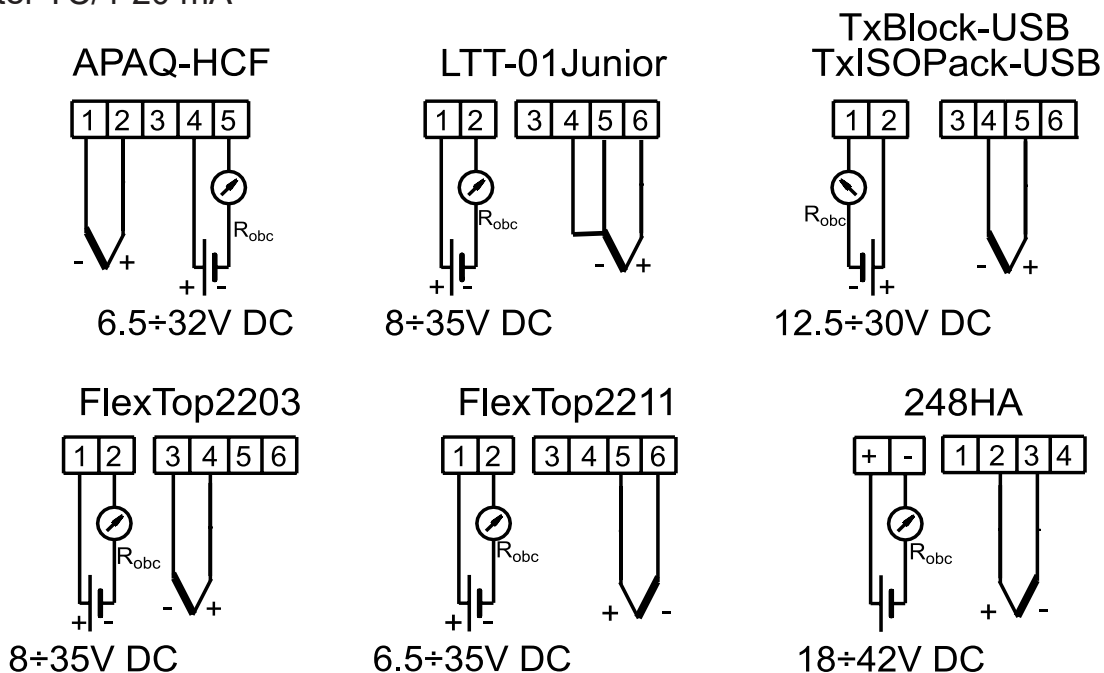
For distinction of resistance sensor connection types, terminal blocks are colour marked acc. to the following scheme:



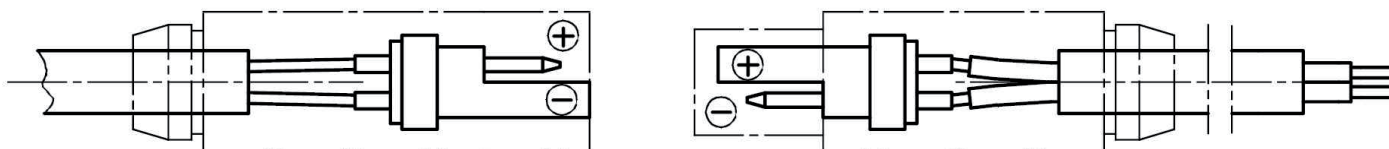
• transmitters RTD/4-20 mA or 0-10 V



• transmitter TC/4-20 mA



• LEMO plug



Recommended compensation and extension cable cross-sections, for connecting sensors with outer devices, acc. to PN-89/M-53859 are 1,0 mm² or 1,5 mm².

General rules for marking (colour coding) of thermocouple sensor cable:

- acc. to PN-EN 60584-3 – colour of the outer insulation and positive conductor that is assigned to positive thermocouple element is the same ; negative conductor colour always white.

5. Cable outer diameters for cable glands.

- Cable gland: Pg9, M16x1,5 cable diameter / \varnothing 3÷9 mm/
- Cable gland: Pg16, M20x1,5 cable diameter / \varnothing 4÷12,5 mm/

6. Packing and storing instructions, transportation.

For the purpose of transportation temperature sensors should be properly packed (as multipacks and/or individual packages) in order to avoid any damage. They should be stored indoor in their original packages; the indoor air must be free of vapours and/or aggressive substances, the indoor air must range from +5°C to 50°C, and the relative humidity must not exceed 85%. Whilst being transported, the sensors must be protected against shifting inside the packaging. Temperature sensors can be transported by air, by sea and road providing that the direct influence of atmospheric agents is eliminated.

7. Warranty.

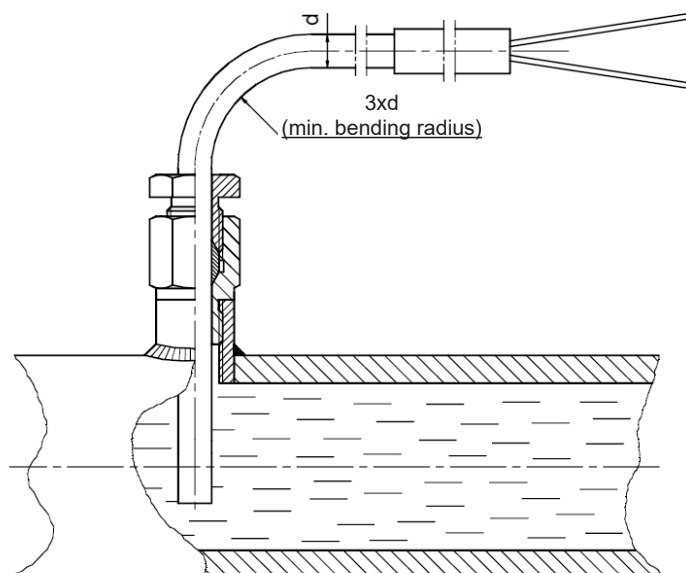
- the Manufacturer provides the original purchaser of the sensor (sensors) with a twelve (12) month warranty and necessary service; for this period, the Manufacturer guarantees the uninterrupted and error free functioning of sensors;
- the twelve (12) month warranty begins on the day of purchase;
- also, the Manufacturer provides the original purchaser of the performed of the sensor with a post-warranty service;
- the warranty voids in the case of any changes in and repairs of the instrument;
- this warranty does not cover damages resulting from improper transportation, nor defect and errors caused by bad handling or misuse which does not comply with the provisions as set forth in this Operation Manual.
- this warranty does not cover damage of the sheath working in environment different than air and water if this has not been specified in the request for quotation or purchase order.

8. Recommended examples of sensor installation.

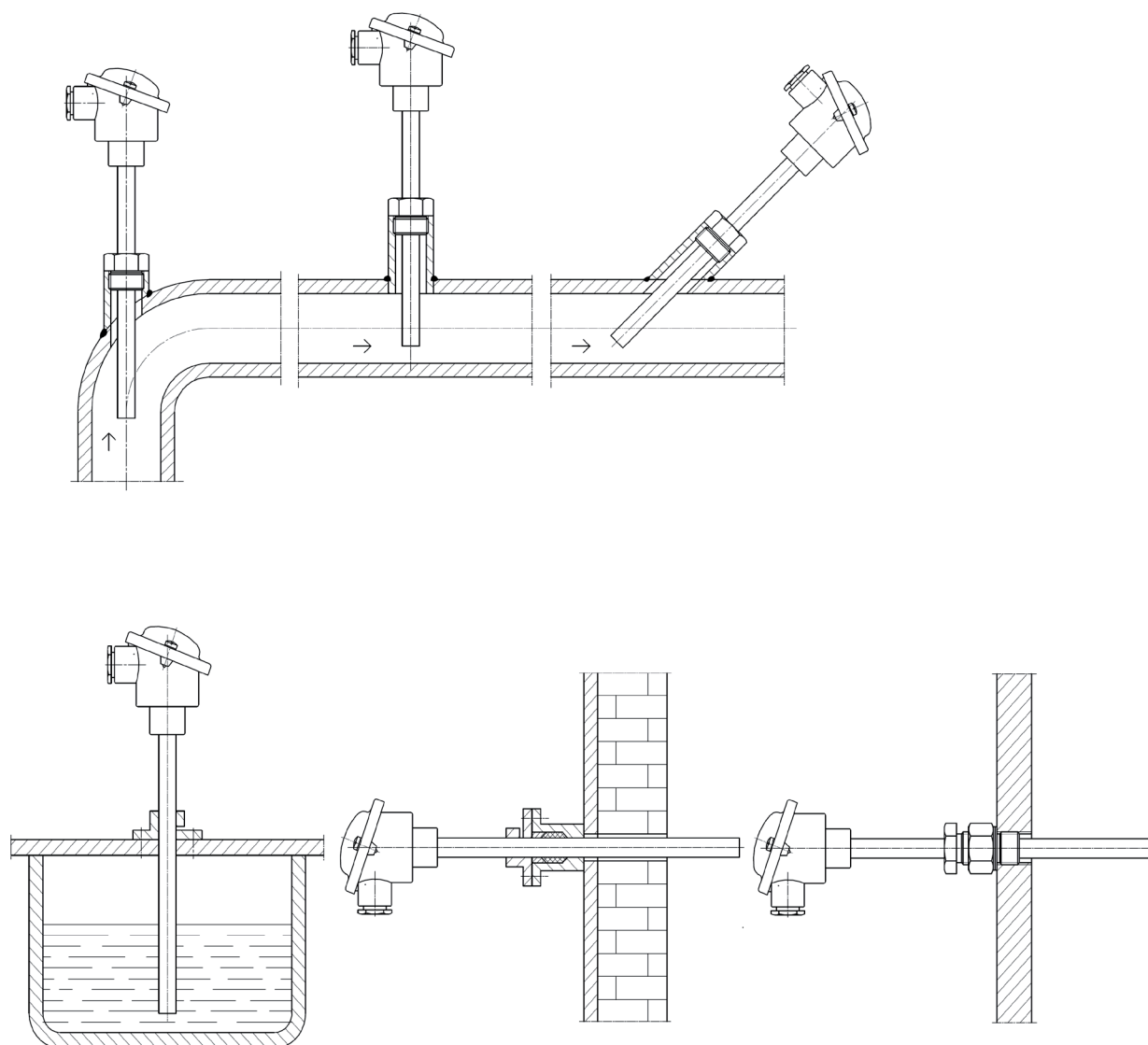
NOTE: Temperature sensor without additional outer sheath can be freely bend providing, however, the following limitations:

- 1. Bending of 50 mm long tip of resistance sensor is forbidden since it brings the risk of damaging the resistor.**
- 2. Acceptable minimum inner bend radius of mineral insulated metal sheathed cable equals five times its diameter.**

- cable sensors



- head sensors



Examples of sensors assembly in the pipeline:

- in pipe elbow (e.g. for pipelines with small diameters)
- parallel to the axis of the pipeline
- at angle to the axis of the pipeline

