
OPERATION
MANUAL

**Head sensors with unconvertible
measuring insert**



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Head sensors with unconvertible measuring insert

In this Operation Manual, the following series of sensors with non-exchangeable measuring inserts are described:

T...GB-1, T...G-1, T...U-1..., T...U-1, T...U-2, T...GWN-2, T...-755, T...GN-1055,
TT...UO-11, TT...K-1, T...GNN-1, T...I-3,6,8, TOP-764, TOPGN-4.

The sensors presented are equipped with a terminal block or a 4-20 mA transmitter instead of a terminal block (designated as AP).

All the sensors specified comply with the two followings standards:

PN-EN 60751

PN-EN 60584

1. Construction and principle of operation

This sensor consists of a measuring insert placed in an outer, steel sheath having a head of aluminium alloy at its one end. The measuring insert of this sensor is either a thermometric resistor extended by insulated silver wires or a thermocouple sited in insulators, and connected with a terminal block or with a 4-20 mA transmitter. The sheaths in this group of sensors are shaped either as a smooth pipe or as a pipe with a threaded connector that is welded to it. As for sensors with no threaded connector, there are various types of slidable threaded or clamping holders used to mount the sensor.

The measuring element of the insert responses to a change in temperature of a medium by changing its resistance /thermometric resistor/ or electromotive force EMF /thermocouple/. The changes correspond to their thermometric characteristics as defined in the following standards:

PN-EN 60751 – as for the thermometric resistors Pt100

PN-EN 60 584 – as for the thermocouples

Specification:

Resistor.....1 or 2x Pt 100, 500, 1000; class A, B according to PN-EN 60751

Connection Line2, 3, 4-wire line as for Pt100

Thermocouple...1 or 2x Fe-CuNi /J/; NiCr-Ni/K/; class 1, 2 according to PN-EN
60584

Max temperature measurement range.....-200 to +550 °C as for Pt

- 40 to +700 °C as for J

- 40 to +900 °C as for K

Measurement junction.....isolated or earthed

Allowable working temperature of the head with a rubber seal100 °C

with a silicone seal..150 °C

Protection degree provided by the housingIP 65 as for heads: NA, DAN, DANW, DNAG
IP 54 as for MA head

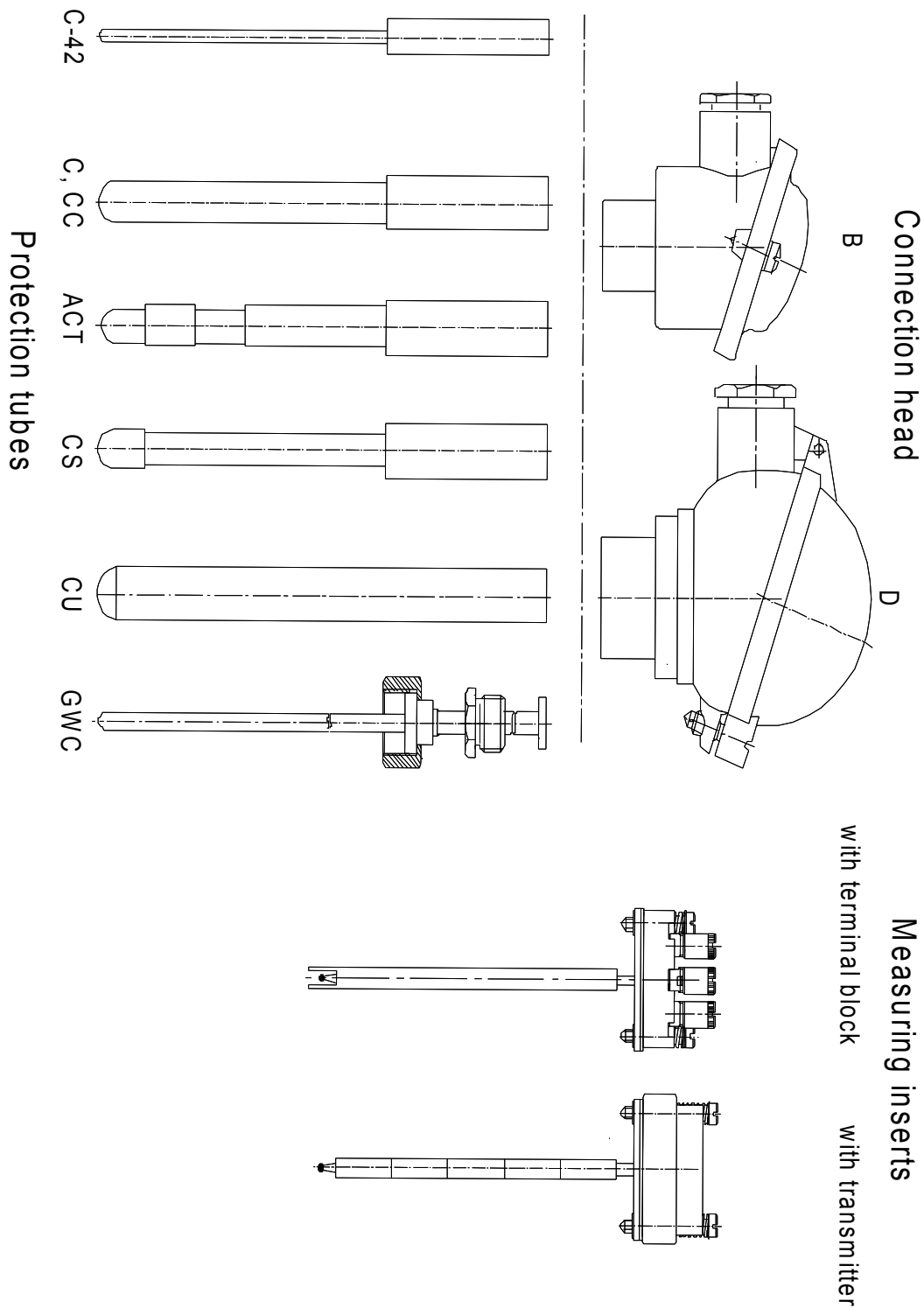
Cable glandPG-9 as for MA head

PG16 or M20x 1.5 as for heads: NA, DAN, DANW heads

Transmitters.....APAQHRF; APAQHCF; LTT-03B; LTT-03J; LTT-01;

FLEX TOP 2201, FLEX TOP 2211.

**2. Assembly diagram of sensor's units
measuring inserts; connection heads MA/DAN/; outer sheaths of the sensors**



<i>Sensor Type</i>	<i>Sheath Material</i>	<i>Measurement Range</i>	<i>Connection Type</i>	<i>Sheath Diameter</i>	<i>IP Protection Degree provided by the Housing</i>
<i>TOPG-1</i>		<i>-200÷600°C</i>			
<i>TTJG-1</i>		<i>-40÷600°C</i>		<i>Ø12</i>	<i>IP 54</i>
<i>TTKG-1</i>		<i>-40÷600°C</i>	<i>Welded</i>		
<i>TOPGB-1</i>		<i>-200÷150°C</i>	<i>Threaded Connector</i>		
<i>TTJGB-1</i>		<i>-40÷150°C</i>		<i>Ø6, Ø8</i>	<i>IP 65</i>
<i>TTKGB-1</i>		<i>-40÷150°C</i>			
<i>TOPU-1</i>		<i>-200÷600°C</i>			
<i>TTJU-2</i>	<i>1.4541</i>	<i>-40÷600°C</i>	<i>UG-1-12</i>	<i>Ø12</i>	<i>IP 54</i>
<i>TTKU-2</i>		<i>-40÷600°C</i>			
<i>TOPGWN-2</i>		<i>-200÷500°C</i>	<i>Clamp Nut</i>	<i>Ø6</i>	
<i>TTJGWN-2</i>		<i>-40÷500°C</i>	<i>To mount on the welded-in sheath</i>	<i>Cone-shaped sheath</i>	
<i>TTKGWN-2</i>		<i>-40÷500°C</i>	<i>welded-in sheath</i>	<i>12/8</i>	<i>IP 65</i>
<i>TOP-755</i>		<i>-40÷400°C</i>	<i>Welded</i>		
<i>TTJ-755</i>		<i>-40÷400°C</i>	<i>Threaded connector</i>	<i>Ø6, Ø8</i>	
<i>TTK-755</i>		<i>-40÷400°C</i>			
<i>TTJK-1</i>		<i>-40÷700°C</i>			
<i>TTKK-1</i>		<i>-40÷1150°C</i>	<i>UG-1-20</i>	<i>Ø20</i>	<i>IP 54</i>
<i>TTJU-1</i>	<i>1.4841</i>	<i>-40÷700°C</i>	<i>UZ-11-20, UZ-21-20</i>		
<i>TTKU-1</i>		<i>-40÷1150°C</i>			
<i>TTJU-1..</i>		<i>-40÷700°C</i>			
<i>TTJUO-1..</i>		<i>-40÷700°C</i>			
<i>TTJU-1..</i>	<i>1.4762</i>	<i>-40÷700°C</i>			

3. Minimum immersion depth of the sensor /thermometer/ - l_{min} .

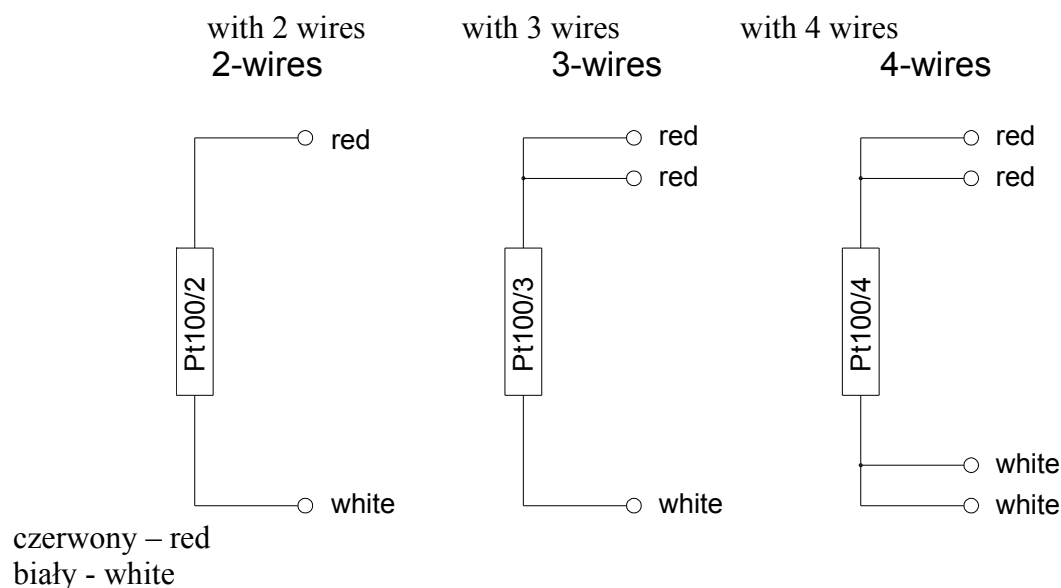
The temperature sensing part of the thermometer $C > 30$ mm

Outer diameter of the sheath: D

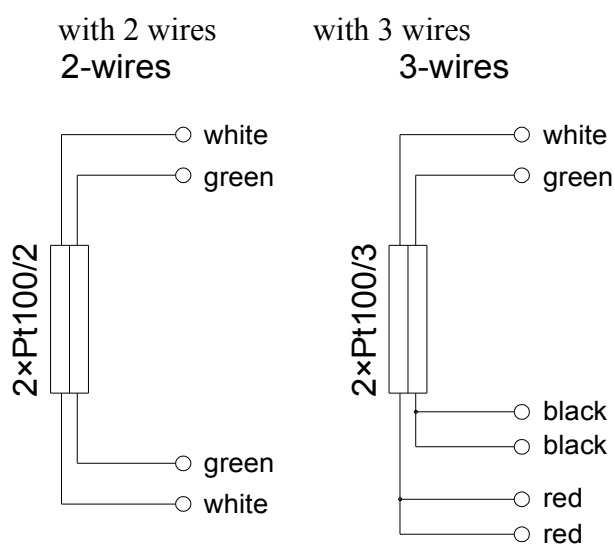
- in flowing water: $l_{min} = C + 5 D$
- in flowing air: $l_{min} = C + 15 D$

4. RTD sensors – designation of connection clamps

Terminal block – one measuring circuit

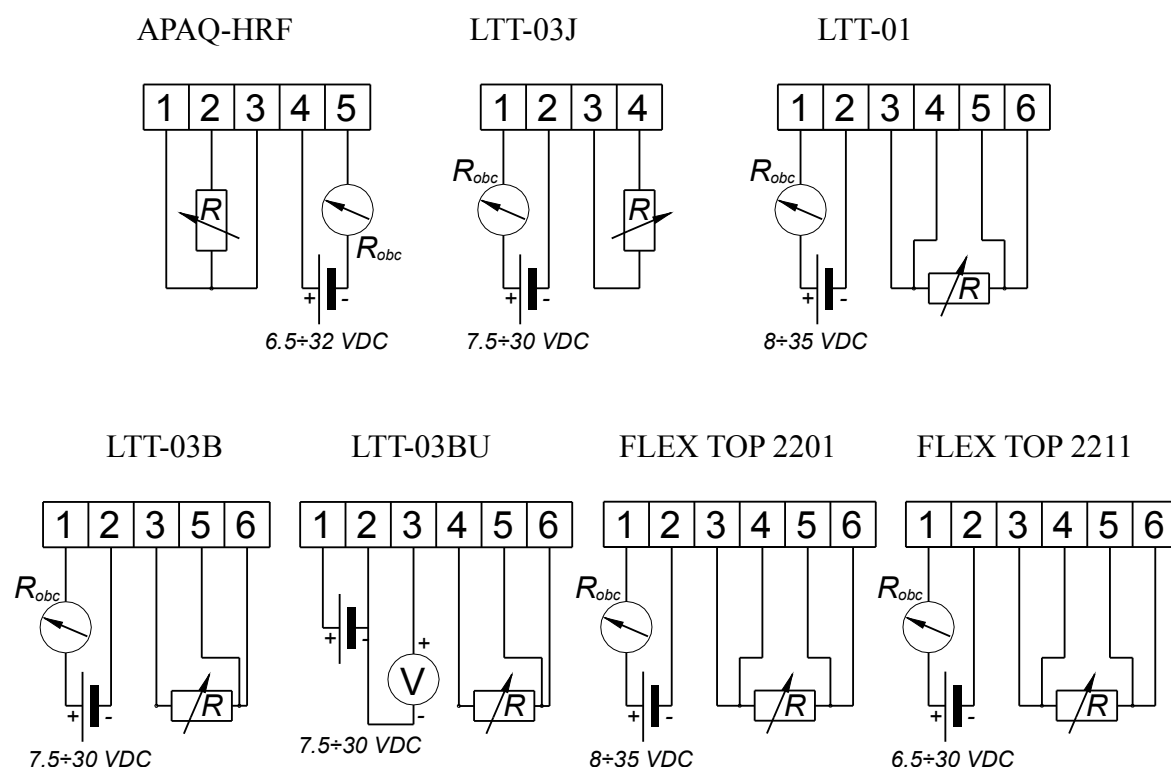


Terminal block – two measuring circuits



green – green czarny – black

RTD/4-20 mA Transmitters



Resistance Sensors – 2-wire connection line

Diameter of the wire / Resistance of the wire

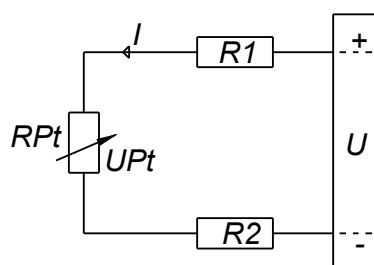
2x0.22 mm² / 0.175 Ω /m

2x0.25 mm² / 0.165 Ω /m

2x0.35 mm² / 0.105 Ω /m

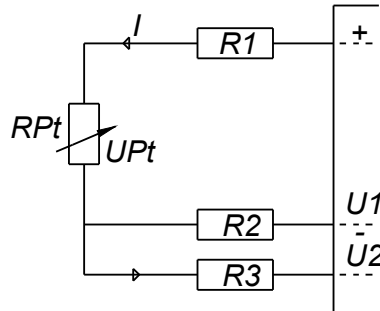
2x0.50 mm² / 0.036 Ω /m

A sensor's 2-wire connection line is applied when it is sufficient to obtain temperature measurements with an average (not high) accuracy. The resistance of $R_1 + R_2$ connection line causes the following error in the temperature measurement: as for Pt 100, the error is about 2.6 °C per one Ω of the wire resistance, and as for Pt 1000: 0.26°C per one Ω of the wire resistance.



Resistance Sensors – 3-wire connection line

A 3-wire connection line between the resistor and devices is the most commonly used connection line in industrial applications since temperature-depending changes in the resistance are automatically compensated, and the resistance of the connection line is also compensated.



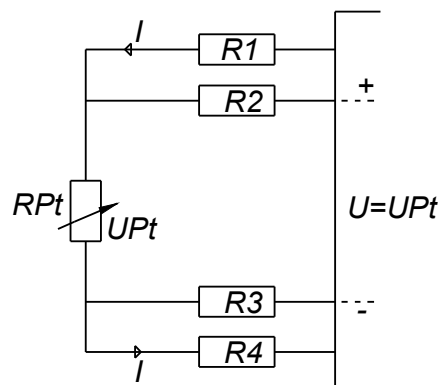
The resistance of all the connection wires must be identical, i.e. $R_1=R_2=R_3$. In the Table below, there are shown examples of errors caused by the resistance difference of 0.1Ω and of 1.0Ω between the wires of a 3-wire connection line for Pt 100 and Pt 1000.

	<i>Difference in the resistance of wires</i>	
	<i>0.1Ω</i>	<i>1Ω</i>
Pt100	0.26°C	2.6°C
Pt1000	0.03°C	0.26°C

For practical reasons, the resistance of a single wire input circuit of RTD should not be higher than 11Ω .

Resistance Sensors – 4-wire connection line

$$R_1=R_2=R_3=R_4$$



This connection line is used when a very high accuracy of temperature measurements is required. In the case of a 4-wire connection line, the impact of resistor's wires resistance is totally eliminated.

For practical reasons, the resistance of a single wire input circuit of RTD should not be higher than 11Ω .

5. Thermocouple Sensors - – designation of connection clamps

Terminal Block

In the case of thermoelectric sensors, polarity must carefully be observed; thus, on a terminal block, the positive pole of thermocouple is marked as $+$ in order to allow the end user to properly connect the thermoelectric sensor.

When the thermoelectric sensor is connected with external devices, then, the corresponding pole on the terminal block must be connected with the corresponding pole of the wire (which has a polarity-specific colour). In the Table below, there are shown: thermoelectric sensor types, the respective rule to connect a specific sensor type, and corresponding colour codes.

Type of thermoelectric sensor	Type of wire		Metal Composition		Colour Code		Tolerances		Temperature range.
	Compensation	Thermoelectric	Wire +	Wire -	IEC 584	PN-89/M	Class 1	Class 2	
J	-	JX	Fe	CuNi	black	blue	± 1.5	± 2.5	$-25 \div 200^{\circ}\text{C}$
K	-	KX	NiCr	NiAl	green	yellow	± 1.5	± 2.5	$-25 \div 200^{\circ}\text{C}$
K	KCA	-	Fe	410 Alloy	green	-	-	± 2.5	$0 \div 150^{\circ}\text{C}$
K	KCB	-	Cu	CuNi	green	-	-	± 2.5	$0 \div 100^{\circ}\text{C}$
T	-	TX	Cu	CuNi	khaki	brown	± 0.5	± 1.0	$-25 \div 200^{\circ}\text{C}$
E	-	EX	NiCr	CuNi	violet	-	± 1.5	± 2.5	$-25 \div 200^{\circ}\text{C}$
N	-	NX	Nicrosil	Nisil	pink	-	± 1.5	± 2.5	$-25 \div 200^{\circ}\text{C}$
N	NC	-	Cu	278 Alloy	pink	-	-	± 2.5	$0 \div 150^{\circ}\text{C}$

Cross-section areas of compensation and extension wires:

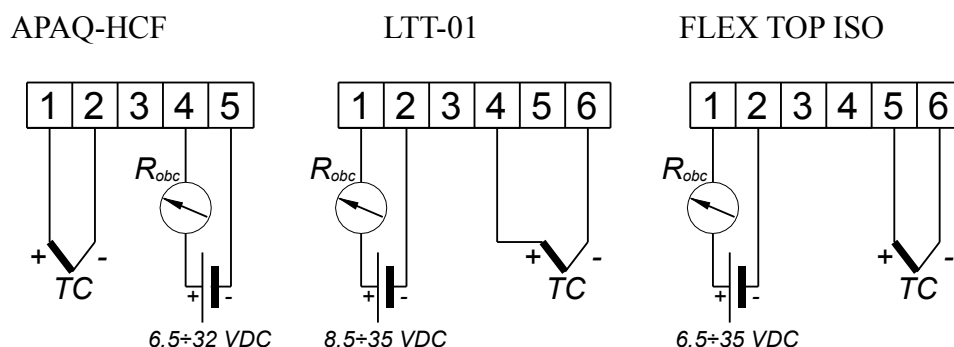
0.22 mm²; 0.5 mm²; 0.75 mm²; 1.0 mm²; 1.5 mm²;

whereas, according to the Polish Standard PN-89/M-53859, the recommended cross-section areas of compensation and extension wires connecting sensors with external devices are: 1.0 mm² or 1.5 mm².

General rules on applying respective colours for compensation wires:

- according to the German Standard DIN IEC 584, the colour of an outer insulating sheath, an outer insulation, and a positive wire assigned to the positive thermoelectrode in the sensor is the same, and the colour of negative thermoelectrode is white.
- according to the Polish Standard PN-89/M-53859, the colours of an outer insulating sheath, and an outer insulation are different, the colour of insulation of the wire assigned to the positive thermoelectrode is red, whereas the insulation of the wire assigned to the negative thermoelectrode may be of any other colour except for red, purple, and pink.

6.



6. Recommended outer diameters of cables for cable glands in the temperature sensors' connection heads manufactured by the company "Limatherm Sensor" in Limanowa, Poland

For Seals without Cuts

Cable Gland: Pg 16 cable diameter /Ø 5.5 - 7.5 mm/

Cable gland: M20x1.5 cable diameter /Ø 5.5 - 7.5 mm/

For Seals with Cuts

Cable Gland: Pg 16 cable diameter /Ø 4 - 12.5 mm/

Cable Gland: M20x1.5 cable diameter /Ø 4 - 12.5 mm/

7. Packing and storing instructions, transportation

The sensors to be transported must always be properly packed in order to avoid any damage during the transportation. It is recommended to place the sensors to be transported either in one general, shared package or in individual unit packages. The sensors should be stored in their packages in indoor storage spaces: the indoor air must contain **no traces of vapours and/or aggressive substances**, the indoor air temperatures 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 packagings. The sensors manufactured by 'Limatherm Sensor' can be transported using maritime, rail, road, or air modes of transport, in all cases provided that the direct impact of atmospheric factors on the sensors during the transportation is totally eliminated. The detailed transportation conditions are specified in the Polish Standard PN-81/M-42009.

8. 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 sensors with a post-warranty service;

- The warranty voids in the case of any changes in and repairs of the instrument performed by the user;
- This warranty does not cover damages resulting from improper transportation, nor defects and errors caused by bad handling or misuse which does not comply with the provisions as set forth in this Operation Manual.

9. Recommended examples of assembling the sensors

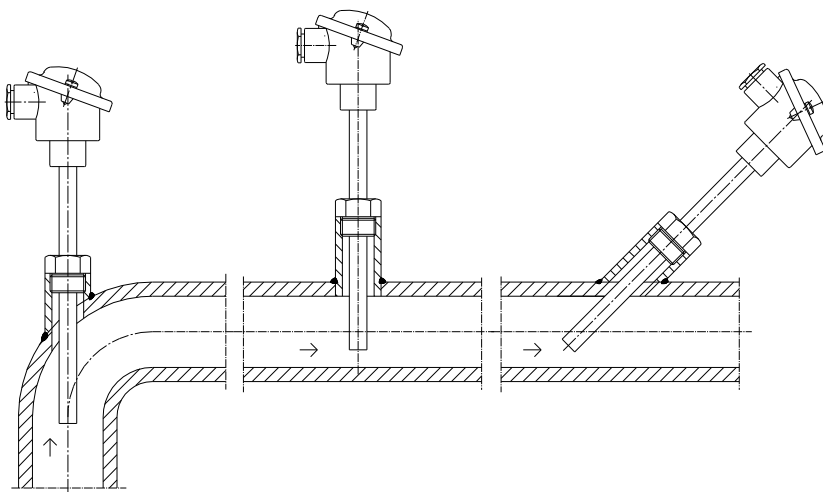


Fig. 1 Examples of assembling sensors with a threaded connector

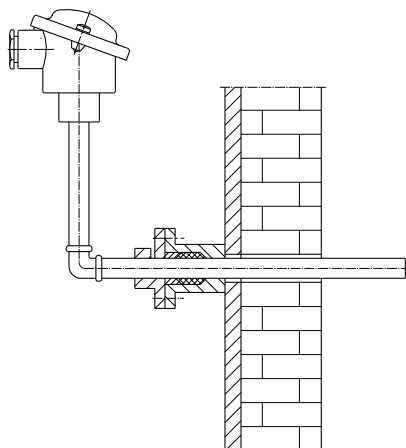


Fig. 2 Examples of assembling sensors with sheaths using UZ mounting bracket