Thermoelectric temperature sensor to heat sink without converter or with converter type series 340 type 341

PRODUCT MANUAL

FOR DESIGNS WITH CONVERTER A MANUAL IS ENCLOSED TO THE RELEVANT CONVERTER

APPLICATION

- For exact remote measurement of temperature of steady and running liquids (gases and fluids), for which the properties of the heat sink of the sensor selected by the customer are suitable; measurement may be realized up to temperature and pressure determined by heat sink resistance
- For explosive environment in premises Zone 2, Zone 1 and Zone 0 pursuant to ČSN EN 60079-10 when using the converter Ex ia or when connecting to do Ex ia circuit
- In a set with control or diagnostic systems for process monitoring
- In design with converter for transfer of resistance sensor signal to unified output signal 4 to 20 mA or digital signal (converter with HART protocol)

The sensors with converter are rated products pursuant to the Act No. 22/1997 and Declaration of Conformity **EC-231000** is issued for them.

DESCRIPTION

The sensor consists of a replaceable measuring insert with a flange and a ceramic terminal board or installed two-wire converter (insulated or non-insulated, even in design Ex i) and protective armature consisting of a head and an adapter with a screw union for the connection of the sensor into the heat sink selected by the customer. The head is provided with a lid and a cable outlet for the connecting wiring. The terminal board of the sensor (converter) is accessible after tilting of the lid of the head that is connected with one screw. The sensor with converter with Ex ia design is provided with external and internal terminals on the head for the connection of ground wire or wire for mutual interconnection. The converter is installed either directly on the flange of the measuring insert or in the lid of the head.

The sensor with converter is supplied from an external source. The installed converter is pre-set to the required range at the sensor manufacturer.

To measure temperature, a defined change of sensor resistance in dependence on the change of temperature of the measured environment is used.

TECHNICAL DATA

The sensor dimensions are based on the original ČSN 25 8301. The sensor is designed pursuant to ČSN EN 61140 ed.2 as an electrical equipment of protection class III for the application in networks with category of overvoltage in installation II and pollution grade 2 pursuant to ČSN EN 61010-1; the follow-up (evaluation) device shall comply with Article 6.3 of the said standard.

Measuring range:

Sensor with standard adapter Ln = 150 mm

for thermocouple of type "J" -200 to 800 °C
for thermocouple of type "K" -200 to 1150 °C

Sensor with shortened adapter Ln min = 80 mm

for thermocouple of type "J" and "K" -200 to 250 °C

The upper limit of the measuring range is limited by resistance of the material of the used heat sink.

Measuring range of the sensor with converter is established by the range of the selected converter.

Electric strength pursuant to ČSN EN 61010-1 Article 6.8.4: 500 V eff

(only measuring insert without converter or design with insulated converter)

Electric insulation resistance pursuant to ČSN IEC 751, Article 4.2.1:

min. 100 M , at 15 to 35°C, max. 80 % rel. humidity

Power supply of converter:

DC 24 V from source SELV, e.g. INAP 16 and INAP 901

Other data of the converter: refer to the enclosed manual

Ingress protection pursuant to ČSN EN 60529: IP65

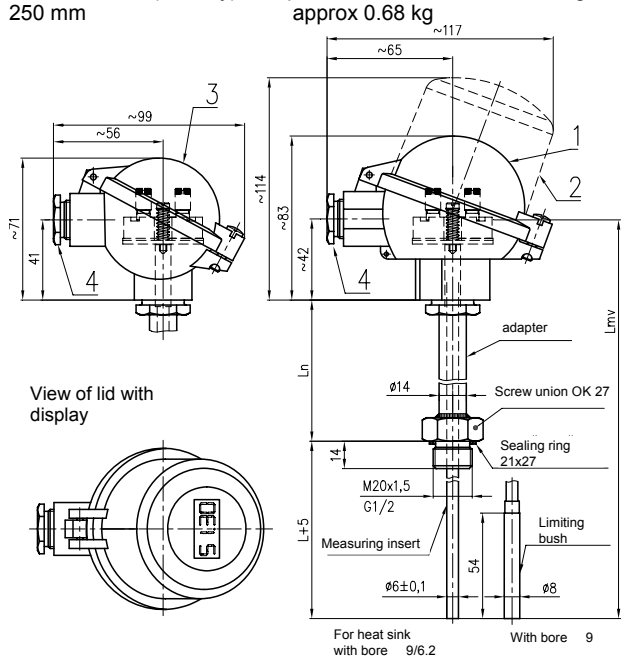
Operation position:

discretionary, the outlet shall not be situated upwards

Type of operation: continuous

Sensor weight:

with ball head (Al alloy), adapter 150 mm and nominal length 250 mm approx 0.68 kg



1 - Ball head (Al alloy)
(for converter Ex i with external and internal terminals)
or plastic ball head
(it may not be used for converter Ex i)

2 - Ball head with increased lid (Al alloy)
without display for converter in the lid or with display
(for converter Ex i with external and internal terminals)

3 - Small ball head (Al alloy)
(only for the terminal board)

4 - Cable outlet M20x1.5

L nominal length
L_n length of adapter
L_{mv} length of measuring insert

Used materials:

Steam tube of measuring insert	
for thermocouple of type "J"	steel 1.4541
for thermocouple of type "K"	INCONEL 600
Adapter	steel 1.4541
Head	aluminium alloy painted with polyester paint or plastic PPO (phenyl polyoxide)
Sealing of lid of the head	oil resistant rubber
Head terminals of the terminal board	brass with Ni surface
Sensor connecting element	stainless steel

OPERATION CONDITIONS

The environment is defined by the group of parameters and their severity grades IE 36 pursuant to ČSN EN 60721-3-3 and the following operation conditions.

Ambient temperature for head and outlet of the sensor:

- for design without converter -50 °C to 120 °C
- for design with converter pursuant to the type of the converter
  (refer to the enclosed manual of the converter)
- for design with converter and display -20 °C to 70 °C

Vibrations:

Sensor	with converter			without converter		
Nominal length L [mm]	100, 160	250, 400	630	100, 160	250, 400	630
Frequency range [Hz]	10 to 500					
Drift amplitude [mm]	0.2	0.15	0.075	0.5	0.2	0.075
Acceleration amplitude [ms^{-2}]	29.4	19.6	9.8	68.7	39.2	9.8

Relative ambient humidity:
10 to 100 % with condensation, with upper limit of water content 29 g H2O/kg of dry air
Atmospheric pressure: 70 to 106 kPa
Maximum speed of flow of liquids:
pursuant to parameters of heat sink used by the customer
Resistance of material of the head PPO (phenyl polyoxide):

Kerosene	partially resistant
Diesel oil	resistant
Benzene	partially resistant
Animal and vegetable oil	resistant
Weak hydrohydes	
Strong hydroxides	
Weak acids	
Strong acids	
Sea water	
Trichloroethylene	partially resistant

Resistance of lid sealing material (oil resistant rubber):

Spirit	resistant
Ether	
Benzole	
Petrol	
Ester	
Animal and vegetable oil	
Mineral oil	
Diesel oil	
Weak alkali hydrohydes	
Strong alkali hydroxides	not resistant
Weak acids	resistant
Strong acids	not resistant
Sea water	resistant
Trichloroethylene	partially resistant
Hot water	

METROLOGICAL DATA

Probe: measuring thermocouple **J** (Fe-CuNi) or **K** (NiCr-NiAl) pursuant to ČSN EN 60584-1, Ø 6 or Ø 3 mm, tolerance class 2 or 1 pursuant to ČSN IEC 584-2 single or double with insulated measuring connection
Output signal
of the analogue converter (linear with thermoelectric voltage):
4 to 20 mA
of the programmable converter (linear with measured temperature):
4 to 20 mA (+ digital for HART protocol)
Calibration depth of immersion of the measuring insert of the sensor
for temperature points within range -70 to 250°C:
200 mm (min. 160 mm)
for temperature points over 250°C:
300 mm (min. 260 mm)
The distance of flange of the measuring insert from the level of medium in the calibration bath shall be at least 40 mm at temperatures to 250°C and min. 70 mm at temperatures above 250°C.
Temperature response time pursuant to ČSN IEC 751 in whirling water (characteristic value):
without heat sink (independent measuring insert) $_{0.5}$ 4.3 s
with heat sinks 991100....991110....991120... and 991130...
(L = 160) $_{0.5}$ 85 s
$_{0.9}$ 250 s
with heat sinks 991100....991110....991120... and 991130...
(L = 250, 400, 630) $_{0.5}$ 53 s
$_{0.9}$ 155 s
with heat sink 991150...(L = 160) $_{0.5}$ 80 s
$_{0.9}$ 235 s
with heat sink 991170...(L = 160) $_{0.5}$ 36 s
$_{0.9}$ 100 s

DESIGNATION:

Data on label of head
- Trademark of the manufacturer
- Made in Czech Republic
- Type of the thermoelectric sensor / tolerance class
- Measuring range or adjustable range of the converter
- Product ordering number
- Ingress protection
- Manufacturing number
- Output signal 4 to 20 mA (design with converter)
- Ambient temperature
- Designation of non-explosiveness and EC Type Examination Certificate number(for design with converter Ex i)
- CE mark with identification number of notified person (for design with converter Ex i)

Data on label of measuring insert
- Trademark
- Type of probe
- Manufacturing number

Data on converter label
- Type of probe
- Adjustable temperature range

DELIVERY

Unless agreed otherwise with the customer, each delivery includes
- Delivery note
- Sensor pursuant to the purchase order
- Sealing ring 21x27 TPD 62-014-91
- Suitable heat sinks and weld-on pieces ordered separately pursuant to the catalogue of accessories, type 991
- Optional accessories to sensor with programmable converter
  - Configuration (parameterization) programme pursuant to the required converter
  - Communication modem (for serial port RS 232C) pursuant to the required converter
- Accompanying technical documentation in Czech
  - Product quality and completeness certificate, which also serves as the warranty certificate
  - EC Declaration of Conformity for design with converter Ex i
  - Calibration sheet (for uncertified calibrated design)
  - Product manual

If it is established in the purchase contract or agreed otherwise, the following documentation can be also delivered with the product
- Copy of the Inspection Certificate 3.1 for material of stem tube and heat sink with the casting number
- Copy of EC Type Examination Certificate pursuant to the Decree of the Government 23/2003 Coll.
  for design with converter Ex i

ORDERING TEMPERATURE SENSORS

The purchase order shall specify
- Name
- Product ordering number
- Measuring range
- If calibration is required and in what temperature points
- If the delivery of heat sink and weld-on piece pursuant to the type 991 is required for the sensor as accessories
- If optional accessories to the senor with programmable converter are required
- Other (special) requirements
- Number of pieces

Behind the ordering number specified pursuant to the table 1, the customer shall identify the required range of measured temperature (i.e. lower and upper temperature limits in °C) and, as the case may be, other non-standard required parameters for converter configuration (e.g. indication of sensor tripping, dampening, required designation - tagging etc.).

PURCHASE ORDER EXAMPLE

Standard design:
Thermoelectric temperature sensor to heat sink ČSN without converter
341 410 231 K2/JI
Range -200 to 1150°C
6 pcs

Special request:
Thermoelectric temperature sensor to heat sink ČSN with converter
341 910 331 J2/HCF
Nominal length L 380 mm
Range 0 to 300°C
6 pcs

TABLE 1 - DESIGN OF TEMPERATURE SENSORS TO HEAT SINK ČSN TYPE 341

SPECIFICATION						ORDERING NUMBER										
						341	x	x	0	x	x	x	x	/xxxxxx	/xxx
Nominal length L [mm]	100	Length of adapter L_n [mm]	150	Length of measuring insert L_{mv} [mm]	280		1	1	0						
	160				340		2								
	250				430		3								
	400				580		4								
	630				810		5								
	Other (min. 75) *)						9								
Nominal length L [mm]	100	Length of adapter L_n [mm]	80	Length of measuring insert L_{mv} [mm]	210		1	2	0						
	160				270		2								
	250				360		3								
	400				510		4								
	630				740		5								
	Other (min. 75) *)						9								
Length of adapter	150 mm							1	0						
	80 mm	max. –200 to 250°C						2							
	Other *)**	(min. 80 mm)						9							
Connecting thread	M20 x 1.5									2					
	G1/2									3					
Sensor head	Ball (Al alloy) (for converter Ex i with external and internal terminals)										3				
	Plastic ball (it may not be used for converter Ex i)										4				
	Ball head with increased lid (Al alloy) without display for converter in the lid or with display (for converter Ex i with external and internal terminals)										5				
	Small ball (Al alloy) (only for the terminal board and converters APAQ-HCF, MINIPAQ-HLP)										6				
	Other *)										9				
Design of measuring end	Ø 6 mm											1			
	Ø 8 mm (with limiting bush)											2			
Thermocouple	K												K		
	J												J		
Accuracy class	1 *)													1	
	2													2	
Design of measuring ends of thermocouple pursuant to figure 5	Single thermocouple, insulated end														/JI
	Double thermocouple, independent end														/DU

Converter type		Galvanic separation	Ex	Range [°C]								
Analogue linear output signal with thermoelectric voltage	APAQ-HCF			Adjustable range							/HCF	
	APAQ-HCFX		•								/HCFX	
Programmable linear output signal with temperature	TH 200	•		Programmable range							/TH200	
	TH 200-ex	•	•								/TH200X	
	IPAQ-H	•									/IPAQH	
	IPAQ-HX	•	•								/IPAQHX	
	MINIPAQ-HLP										/MINIPAQ	
Programmable with HART protocol linear output signal with temperature	TH 300	•									/TH300	
	TH 300-ex	•	•								/TH300X	
	MESO-H	•									/MESOH	
	MESO-HX	•	•								/MESOHX	
	248 HA NA	•									/248HANA	
	248 HA I1	•	•								/248HAI1X	
	644 HA NA	•						5			/644HANA	
	644 HA I1	•	•								/644HAI1X	
Other *)											/99	
Without converter (for installation of the converter by the customer)											/00	
LED display to loop 4-20 mA (only with converter, with the exception of converter 644 HA)												
LED display							5					/LD

standard design

*) Only as a special request after an agreement with the manufacturer

**) In case of adapter length below 150 mm (minimum 80 mm), the temperature range is decreased to -200 to 250 °C

ORDERING HEAT SINKS

The purchase order shall specify:
- Name
- Product ordering number
- Number of pieces

PURCHASE ORDER EXAMPLE

Standard design:

Screwing cylindrical heat sink, non-reduced
991 1000 33 20 pcs

Special request:

Welding cylindrical heat sink, non-reduced
991 1200 24 10 pcs
Nominal length L = 380 mm

ORDERING WELD-ON PIECES

The purchase order shall specify:
- Name
- Ordering number of weld-on piece
- Number of pieces

ORDERING NUMBERS OF WELD-ON PIECES, type 991

Direct weld-on piece - 991 NVP4 M27 13 (material 11 353.0)
- 991 NVP4 M27 72 (material 1.4541)

Angular weld-on piece - 991 NVS4 M27 13 (material 11 353.0)
- 991 NVS4 M27 72 (material 1.4541)

TABLE 2 - HEAT SINKS RECOMMENDED FOR ASSEMBLY OF TEMPERATURE SENSORS TO HEAT SINK, TYPE 991

SPECIFICATION									ORDERING NUMBER			
									991	xxxx	x	x
Cylindrical heat sink	PN 160	Screwing	Non-reduced (ON 02 7210)	L = line / thread M27x2 / sensor thread M20x1.5 / bore Ø 9mm						1000		
			Reduced	L = line / thread M27x2 / sensor thread M20x1.5 / bore Ø 9 / Ø 6.2mm						1100		
		Welding	Non-reduced (ON 02 7212)	L = line / sensor thread M20x1.5 / bore Ø 9mm						1200		
			Reduced	L = line / sensor thread M20x1.5 / bore Ø9 / Ø 6.2mm						1300		
Conical heat sink	PN 250	Bore Ø9	For high speeds of flow (ON 02 7215)	only L = 160 / thread M33x2 / M20x1.5 / bore Ø 9mm						1500		
		Bore Ø6.2	For high parameters of operation liquid (ON 02 7217)	only L = 160 / thread M33x2 / M20x1.5 / bore Ø 9 / Ø 6.2mm						1700		
Material of immersion part of heat sink	15 128.5			Maximum operation temperature		550°C					2	
	1.4541					550°C (650°C)***)					3	
	1.4571 **)					500°C					4	
	Other *)					Pursuant to heat sink material					9	
Nominal length L [mm]	100			L1 [mm]	101	L2 [mm]	79					1
	160				161		139					2
	250				251		229					3
	400				401		379					4
	630				631		610					5
	Other *)											9

*) Only as a special request after an agreement with the manufacturer
**) Only for heat sinks with codes 1000, 1100, 1200 and 1300
***) Maximum operation temperature 650°C only for heat sinks with code 1700

PACKING

Both sensors and accessories are delivered in a packing ensuring resistance to the impact of thermal effects and mechanical effects pursuant to controlled packing regulations.

TRANSPORT

The sensors may be transported on conditions corresponding to the set of combinations of classes IE 21 pursuant to ČSN EN 60721-3-2 (i.e. by airplanes and trucks, in premises that are ventilated and protected against atmospheric effects).

STORAGE

The sensors may be stored on conditions corresponding to the set of combinations of classes IE 12 pursuant to ČSN EN 60721-3-1, but with ambient temperature from -20 to 70 °C (i.e. in places where temperature and humidity are not regulated, with a threat of occurrence of condensation, dripping water and formation of ice, without a special threat of an attack with biological agents, with vibrations of small significance and not situated close to sources of dust and sand).

RELIABILITY

Reliability indicators in operation conditions and ambient conditions specified herein
- Mean time of operation between failures 96 000 hours (inf. value)

Expected service life 10 years

CERTIFICATION

- Non-explosiveness Ex i, EC Type Examination Certificate pursuant to the Decree of the Government 23/2003 Coll., (pursuant to the type of the converter)

CALIBRATION

It is realized pursuant to TPM 3342-94 and in compliance with ČSN IEC 751, usually in three temperature points evenly distributed within the operation range of the sensor or in the points according to the requirement of the customer. Calibration sheets with measured data are issued for calibrated sensors.

INSTALLATION AND CONNECTION

SENSOR INSTALLATION

Install the sensors by screwing into the relevant heat sink screwed into the weld-on piece on the piping (technological equipment) or welded into the piping wall. Before the installation, put on the enclosed sealing ring in advance. During the installation, torque of 70 Nm is recommended.

A proposal of securing the heat sink of the temperature sensors for nominal lengths exceeding 630 m is in figure 1; examples of installation of direct and angular weld-on pieces are in figure 2.

With respect to maintaining metrological properties and the longest possible service life, it is not recommended to install the sensors in places with high turbulence of the medium, which is caused e.g. by a rapid transition from a small diameter of the piping to a larger one (when failing to comply with the required shape and dimensions of diffuser behind the flow meter), etc. Recommended distance of the temperature sensor from the installation flange of the flow meter is min. 1 m.

ELECTRICAL CONNECTION

The electrical connection may be only realized by qualified workers pursuant to § 5 of the Decree 50/1978 Coll.
The terminal board of the sensor (converter) is accessible after tilting the lid of the head, which is connected with one screw.
Connect the evaluation devices to the sensor with a non-armoured cable with double insulation with outer diameter from 5 to 8 mm; internal wires with Cu core (sensor with converter) or compensation wiring (sensor without converter) 0.5 **to** 1.5 mm^2. Seal the cable outlet adequately.

WARNING

Do not use independent wires without jacket for electrical connection. To ensure the ingress protection grade in the outlet, the connecting cable shall have circular cross-section. Temperature resistance of the cable shall comply with the ambient temperature!

The cable insulation shall have chemical and mechanical resistance in compliance with the conditions, in which the cable will be installed. It is recommended supporting the cable along its length between the sensor and the follow-up device.
In the environment with interfering signals, use shielded cable in the power supply circuit. Shielding may be only grounded (earthed) in one point. The cable should not be placed together with power cables.
In case of the sensor with HART protocol converter, the maximum length of wiring is defined by the arrangement of wires of the connecting cable. The total length of wiring may be up to 1500 m. It requires a twisted two-wire with shared shielding with the cross section of the core min. 0.5 mm^2. HART communicator is connected to the supply loop of the converter pursuant to Figure 3. To achieve reliable communication, total load resistor of min. 250 shall be in the circuit of the output loop.

INSTALLATION OF THE SENSOR WITH CONVERTER Ex i IN CONDITIONS WITH EXPLOSIVE GASEOUS ATMOSPHERE

The sensor installation in conditions with explosive gaseous atmosphere shall comply with the requirements of ČSN EN 60079-14 ed. 2.

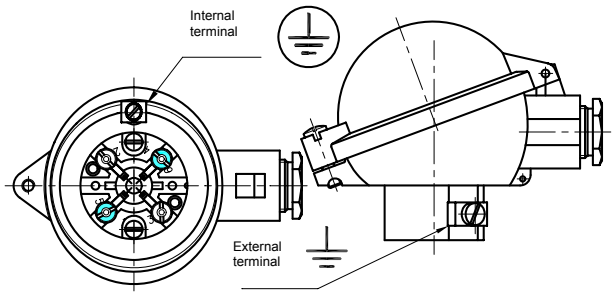
WARNING

Ex i parameters shall be complied with pursuant to the enclosed converter manual.
To ensure safety, an intrinsic safe source shall be always used pursuant to the converter manual, e.g. INAP 901 ordering number 901 000 101.
Surface temperature of the converter may not exceed maximum surface temperature for that particular temperature class.
Programmable converter may not be connected to a computer or a HART communicator if the converter is located in explosive environment.

For installations in dangerous areas, mutual interconnection is required (bringing to the same potential). To achieve it, terminals on the sensor head can be used.
The sensor need not be connected to the system of mutual connection independently if it is installed firmly and has metal interconnection with the structural parts or the piping, which is connected to the system of mutual connection.

SENSOR HEAD WITH CLAMPS

for the sensor with converter Ex i



Maximum cross-section of wire for connection to external and internal terminals:
Internal terminal: stranded wire 1.5 mm^2, full wire 2.5 mm^2
External terminal: stranded wire 4.0 mm^2, full wire 6.0 mm^2
If stranded wires are used for the interconnection, they shall be protected against fraying with pressing hollow.

COMMISSIONING

After the sensor installation, including closing the fixed closure, and connection of the follow-up (evaluation) device to the supply voltage (and the settlement period of the converter), the equipment is prepared for operation.

OPERATION AND MAINTENANCE

The sensor does not require any operation and maintenance.

SENSOR UNINSTALLATION

Disconnect the sensor from the supply source.
The terminal board of the sensor (converter) is accessible after tilting of the lid of the head that is connected with one screw.
Measuring insert of the sensor can be replaced and is uninstalled from the head after disconnecting the cable by releasing two screws.
If the sensor is connected to the system of interconnection, it is necessary to release the wire for mutual interconnection from the terminal on the head of the sensor before the total uninstallation of the sensor.
Screw the sensor from the heat sink; torque is approx. 70 Nm. While releasing the screw union of the sensor, the heat sink may never be released.

SPARE PARTS

Spare parts shall be delivered by the manufacturer.
Relevant measuring inserts can be ordered pursuant to the following table:

SPECIFICATION		ORDERING NUMBER					
		MV340	/x xx /	x	x	x	/xxxx
Length of measuring insert [mm]			acc. to tab. 1				
Design of measuring end	Ø 6mm			1			
	Ø 8mm (with limiting bush)			2			
Probe	thermocouple **K**				K		
	thermocouple **J**				J		
Accuracy class	1					1	
	2					2	
Connection of terminal board and design of measuring ends of thermocouple or converter	Single thermocouple, insulated end						/JI
	Double thermocouple, independent end						/DU
	Converter pursuant to tab. 1						/converter

EXAMPLE OF PURCHASE ORDER OF MEASURING INSERT

Thermoelectric measuring insert without converter
340 /430/ 1K2/JI - 6 pcs

WARRANTY

Pursuant to § 429 of the Commercial Code and the provisions of § 620 (2) of the Civil Code, the manufacturer warrants for technical and operation parameters of the product specified in the manual. The warranty period is 24 months from the receiving of the product by the customer, unless established otherwise in the contract. Rejection of defects shall be

enforced in writing at the manufacturer within the warranty period. The rejecting side shall identify the product name, ordering and manufacturing numbers, date of issue and number of the delivery note, clear description of the occurring defect and the subject of the claim. If the rejecting side is invited to send the device for repair, it shall do so in the original package of the manufacturer and/or in another package ensuring safe transport.
The warranty shall not apply to defects caused by unauthorized intervention into the device, its forced mechanical damage or failure to comply with operation conditions of the product and the product manual.

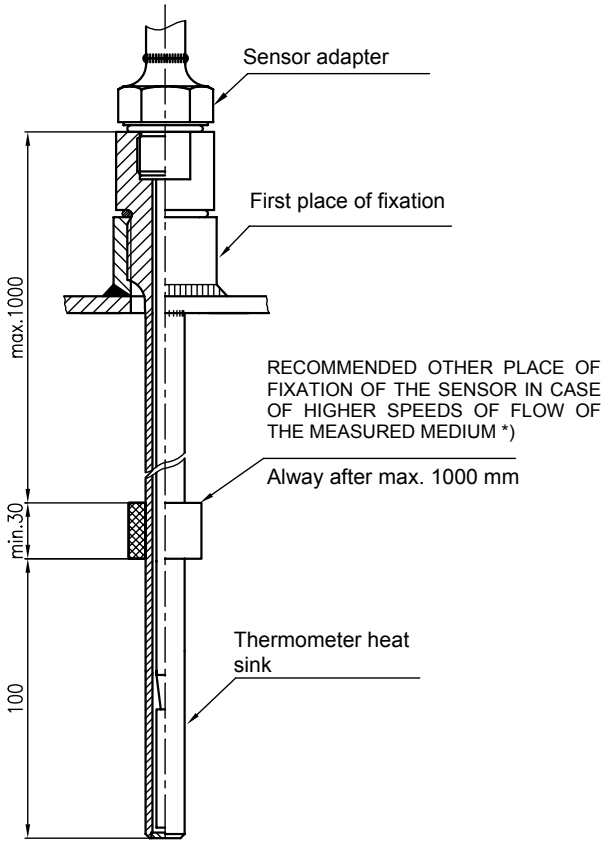
REPAIRS

The sensors shall be repaired by the manufacturer. They shall be sent for repair in the original or equal package without accessories.

DISABLING AND LIQUIDATION

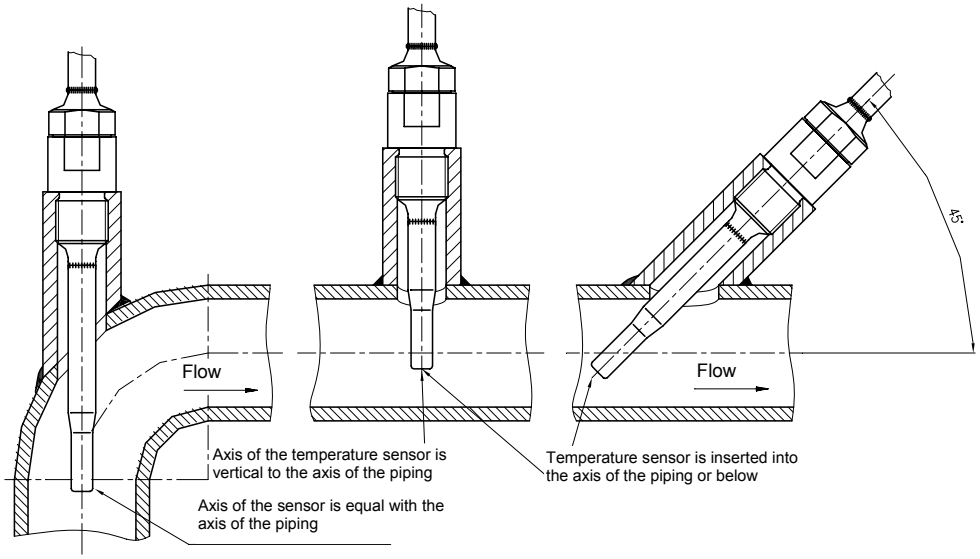
They shall be realized in compliance with the Waste Act 106/2005 Coll.
The product and its package do not include any parts that could impact the environment.
The products that are withdrawn from operation (including their packages, with the exception of products marked as electrical equipment for the purposes of return withdrawal and separate salvage of electrical waste), may be disposed of to sorted or unsorted waste pursuant to the type of waste.
The manufacturer realizes free return withdrawal of marked electrical equipment (from 13.8.2005) from the consumer and points out the danger connected with their illegal disposal.
The package of the sensor can by recycled completely. Metal parts of the products are recycled, non-recyclable plastic materials and electrical waste shall be disposed of in compliance with the aforesaid Act.

FIGURE 1 - PROPOSAL OF SECURING HEAT SINK OF TEMPERATURE SENSORS
(for nominal lengths exceeding 630 mm)
Prescribed heat sinks of type 991 (pursuant to ON 02 7210, ON 02 7212, ON 02 7215 or ON 02 7217) shall be used.



*) In case of flow of the measured medium, the heat sinks are stressed with dynamic effects of the flowing medium and this stress depends on the speed of flow, physical properties of the measured medium and immersion length of the heat sink.
If the occurrence of such dynamic effects can be expected, it is recommended to realize further fixation of the sensor heat sink pursuant to the above mentioned proposal.

FIGURE 2 - EXAMPLES OF INSTALLATION OF DIRECT AND ANGULAR WELD-ON PIECES PURSUANT TO ČSN EN 1434-2



WARNING
- **When using the sensor with an angular weld-on piece, locate the sensor with heat sink at an angle against the direction of flow.**
- **The sensor may not touch the opposite side of the piping.**
- **It is also advantageous to use the temperature sensors in the piping elbow. In such a case, locate the sensor with the heat sink against the direction of flow so that the measured medium flows around evenly**

FIGURE 3 - SCHEME OF CONNECTION OF TEMPERATURE SENSORS

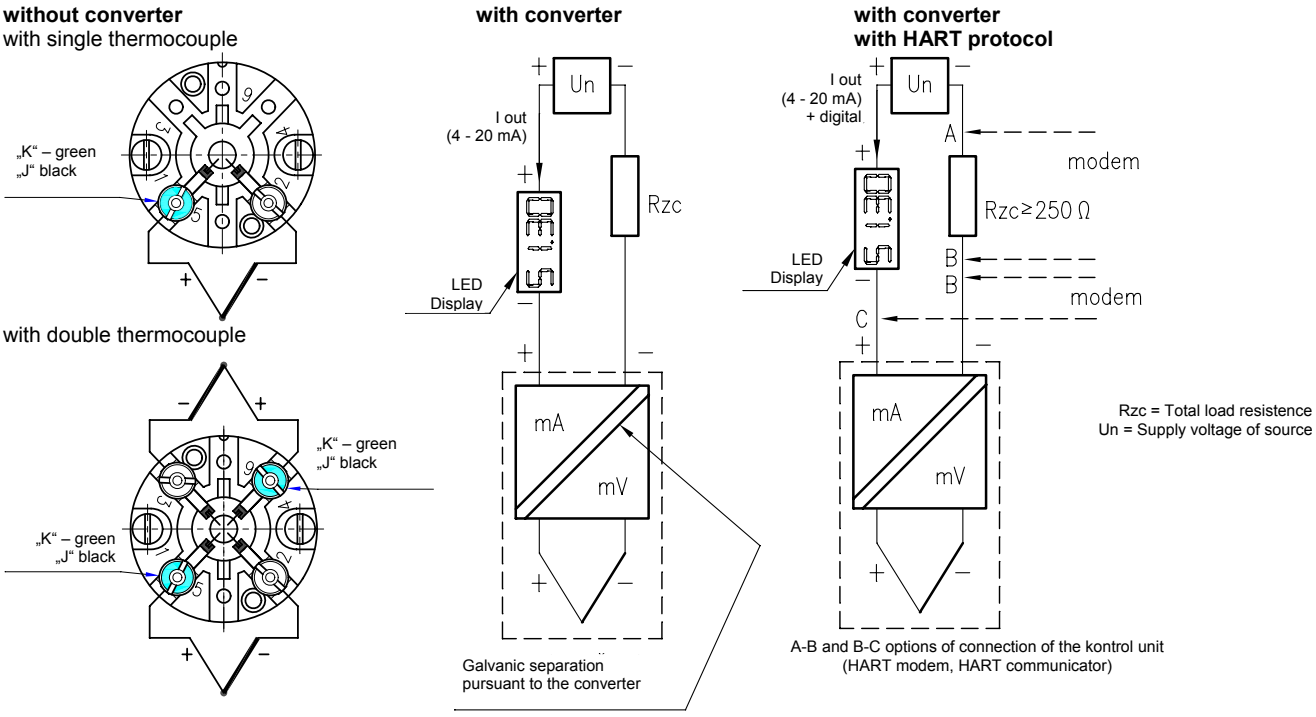


FIGURE 4 - EXAMPLE OF OPERATION CONNECTION OF TEMPERATURE SENSOR WITH CONVERTER IN LOOP 4 - 20 mA

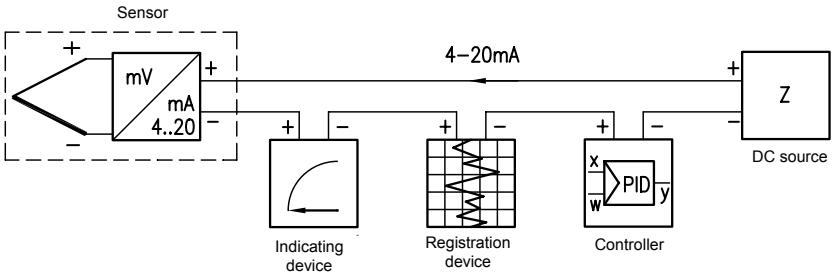


FIGURE 5 - DESIGN OF MEASURING ENDS OF JACKETED THERMOCOUPLES (SCHEMATIC ILLUSTRATION)

January 2008
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