# Temperature sensors
## and accessories for heat and cooling measurement points

## Applications

Temperature sensors are integral components of every hot and cooling measurement point. They are used for determining temperature changes in fluids due to energy taken from or supplied to the loop. The temperature is thus measured by mounting temperature sensors upstream and downstream from the point where there is a exchange in the heat energy of the system.

## Features

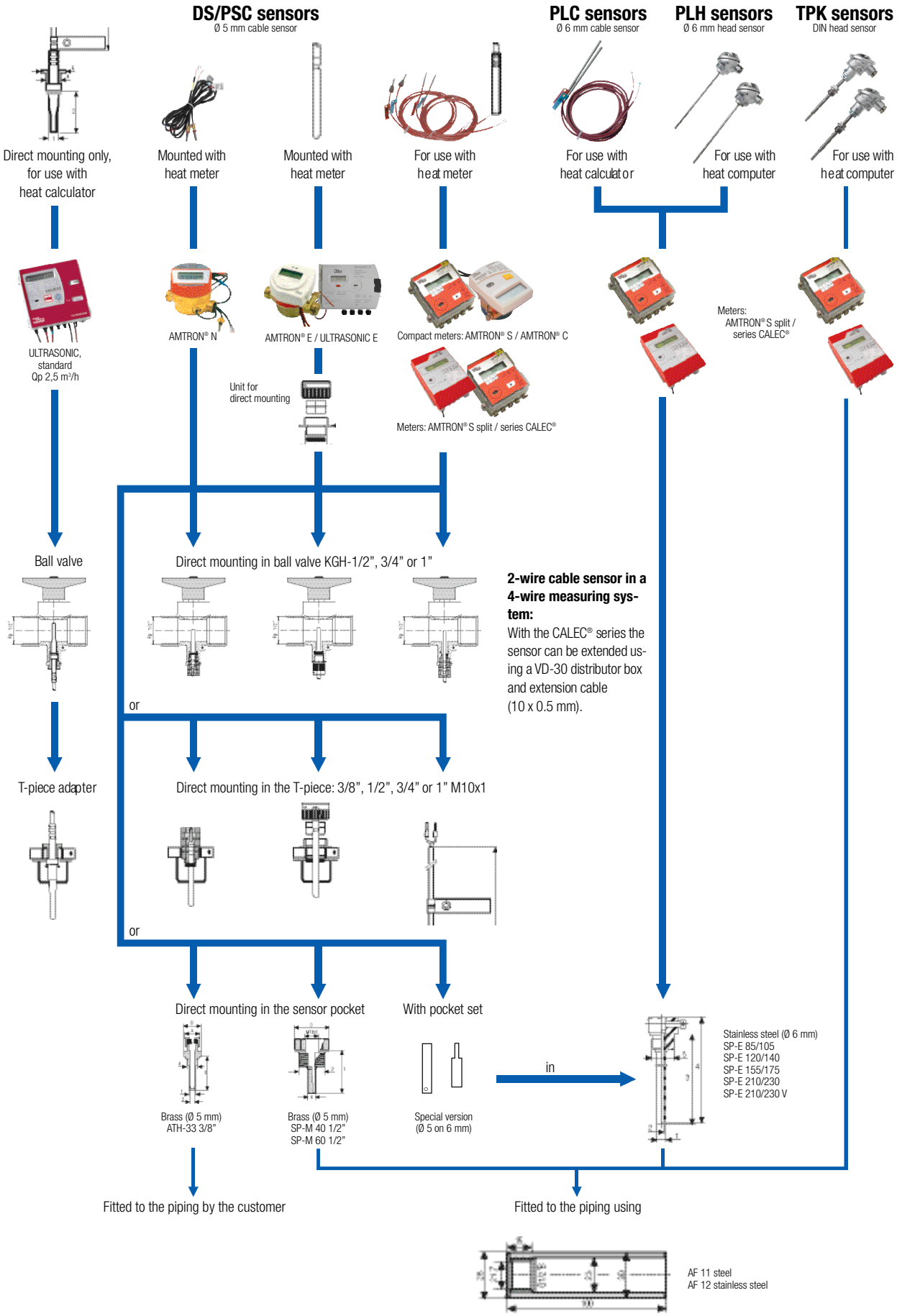
- A wide range of platinum resistance temperature sensors (as cable or head sensors) in different lengths for direct or sensor pocket mounting.
- With Pt 100 or Pt 500 temperature sensors
- Type approvals and verifications according to EN 1434 for Switzerland and Germany
- Matching accessories for direct mounting
- Customised sensor pocket in various sizes
- Special versions for small temperature differences (e.g. for cooling measurement) and high absolute temperatures

## Benefits

- Matching hot and cold measurement components from Aquametro ensuring high accuracy over long periods of time.
- Low inventory management with the same temperature sensors used for direct or sensor pocket measurement (DS/PSC)

VD 3-110 e 03.2005

# Products, applications and installation



# Introduction to temperature measurement

## Applications for heat and cooling meters

When considering heat transport systems, the release of energy (heat loss) is determined by measuring both the supply (hot side) and return (cold side) temperatures as well as the volume of the flowing heat carrier itself.
In heating loops the supply side is known as the hot side and the return the cold side. Cooling systems are opposite to heating systems in the sense that the supply side is now the cold side and the return the hot side.
Of critical importance for determining the thermal energy exchanged is always the effective difference between the supply and return temperatures. The absolute value of the temperature is required but is only of secondary importance for purposes of accuracy. The measuring error in the differential temperature is directly included in the total error when calculating the energy involved.

Example
Temperature difference of plant: 3 K
A measurement deviation of ± 0.1 K results in a measurement range of 2.9 to 3.1 K
=> maximum percentage error in temperature measurement: 3.3 % (0.1:3)

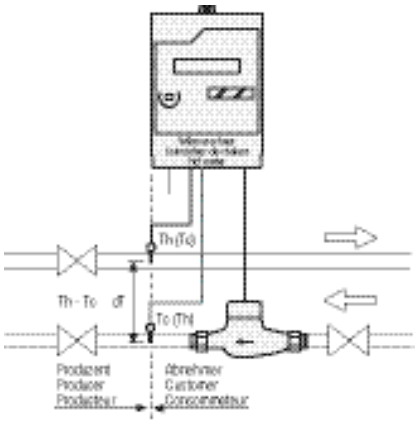



Fig. 1: A typical heating/cooling measurement system

In contrast to other consumption measurements (water, gas) the consumption of energy in heating/cooling closed circuits does not involve depletion of the heat carrier.

A large proportion of the energy supplied to a circuit is usually returned unused. This often requires small amounts having to be measured from the large quantity supplied. This particular measurement task requires exceptional accuracy for determining temperature differences.

Because the temperature sensors cannot be manufactured with the required accuracy for working in matched pairs, the sensor pairs themselves are individual sensors with approximately similar properties determined by careful measurement. Only in this way can the necessary maximum matched pair deviation of 0.05 K be fulfilled.

Stated accuracy limits apply to all heating/cooling measurement applications. Even though significantly higher costs are involved, there is scarcely any difference between domestic and district heating measurement systems as the measurement accuracy in percentage terms remains the same.

Special care is required for measurements in loops with permanently small temperature differences (cooling applications) as are commonly found with e.g. heat pumps and cooling circuits.

## Common sources of error

Unfortunately there are many ways of installing temperature sensors incorrectly.
Here are just a few examples of incorrect mounting:

- Incorrectly matched sensor pairs
- Sensors incorrectly installed
- Sensors installed in the wrong place or in the wrong pipe
- Unsuitable sensor design
- Sensor response time not taken into account
- External heat radiation of sensor not taken into account
- Sensor cables shortened to different lengths (e.g. for "aesthetic" reasons)
- Incorrect sensor lengths and connections
- Sensor pocket length too short or too long into the pipe
- Temperature sensor immerged length too short or too long installed in the sensor pocket
- Asymmetric mounting of sensor pocket or temperature sensor

## Basic principles of platinum resistance temperature sensors

The EN 1434:1997 standard stipulates platinum resistance temperature sensors according to IEC 751 for heat meters with separate temperature sensors. This is because these are the only ones that can provide the required long-term stability and interchangeability. (Note: although imminent, cooling meters are not yet included in the EN 1434 standard.)
Whereas the choice of basic resistance values is open, in practice 100 Ω, 500 Ω and 1000 Ω sensors have generally gained acceptance.
Temperature measurement is based on a change in the resistance of the platinum (Pt) resistor caused by a change in temperature. According to IEC 751, a Pt 100 sensor has a value of 100 Ω at 0 °C and 138.5 Ω at 100 °C.
The average change in resistance between 0 °C and 100 °C is thus: 38.5 Ω : 100 K= 0.385 Ω/K (Pt 500 : 1.925 Ω/K).

**Pt 100/500 resistance values (in Ω) according to IEC 751 (1983)**

| | -20°C | -10°C | 0°C | 10°C | 20°C | 30°C | 40°C | 50°C | 60°C | 70°C | 80°C | 90°C | 100°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pt 100 | 92.16 | 96.09 | 100 | 103.90 | 107.79 | 111.67 | 115.54 | 119.40 | 123.24 | 127.07 | 130.89 | 134.70 | 138.50 |
| Pt 500 | 460.80 | 480.45 | 500 | 519.50 | 538.95 | 558.35 | 577.70 | 597.0 | 616.20 | 635.35 | 654.45 | 673.50 | 692.50 |

| | 110°C | 120°C | 130°C | 140°C | 150°C | 160°C | 170°C | 180°C | 190°C | 200°C | 210°C | 220°C | 230°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pt 100 | 142.29 | 146.06 | 149.82 | 153.58 | 157.31 | 161.04 | 164.76 | 168.46 | 172.16 | 175.84 | 179.51 | 183.17 | 186.82 |
| Pt 500 | 711.45 | 730.30 | 749.10 | 767.90 | 786.55 | 805.20 | 823.80 | 842.30 | 860.80 | 879.20 | 897.55 | 915.85 | 934.10 |

According to IEC 751, the formula for determining the exact resistance values in the range between 0 to 850 °C is

$R_1 = R_0 (1 + A \cdot t + B \cdot t^2)$

$R_1$ = resistance at temperature t in °C
$R_0$ = resistance at 0 °C.
A = $3.90802 \cdot 10^{-3}$ /°C
B = $-5.802 \cdot 10^{-7}$ /°C$^2$

The accuracy required depends on the minimum temperature difference that occurs ($\Delta T_{min}$).
According to EN 1434, the formula for the maximum relative error of the matched temperature sensor pair is :

$E_t = \pm (0.5 + 3\ \Delta T_{min}/\Delta T)$ in %

$E_t$ = relative error in %
$\Delta T$ = temperature difference in K
$\Delta T_{min}$ = minimum temperature difference in K

Three classes are specified:

Class 1 $\Delta T_{min} = 1$ K
Class 2 $\Delta T_{min} = 2$ K
Class 3 $\Delta T_{min} = 3$ K

Common heat meter types with 3 K as the minimum temperature difference (Class 3) have a maximum matched pair error of 3.5 % at the minimum temperature difference. This corresponds to an absolute value of 0.105 K. (This would be 0.070 K for a $\Delta T_{min}$ of 2 K and is a significant challenge for today's temperature measurement technology using platinum resistance sensors.)

**Pt 500 sensors** are used in large quantities for domestic purposes and are therefore the most economical solution. Their use is, however, restricted to local applications with short cable lengths.

**Pt 100 sensors** are preferred when maximum long-term stability and reproducibility are required for district heating supply systems as well as for industrial versions.

There is, however, no reason to select the heat meter based on the type of temperature sensor. The meter is always the master and the sensor type is selected accordingly.

The sensor response time is of importance for quickly changing temperatures with large fluctuations. For this reason the temperature calibration time of the individual sensors must be specified.

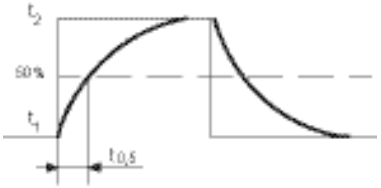



Fig. 2: Definition of the response time (t 0.5)

The response time (t 0.5) is the time required by the sensor to measure a 50 % change in temperature (see Fig. 2)

## Standards and regulations

As already mentioned above, the requirements for heat meters and peripheral equipment (calculators, temperature sensors, flowmeters) were defined in 1997 by the European standard EN 1434. It not only includes all the requirements for measurement but also, in part 6, regulations and recommendations for installation and operation. It states that it is the responsibility of the manufacturer to ensure that the specialist installing the equipment is familiar with all necessary documentation by providing installation instructions and copies of regulations in order for him to assume responsibility for its correct installation.

## Heat meter systems used for custody transfer are subject to legal calibration

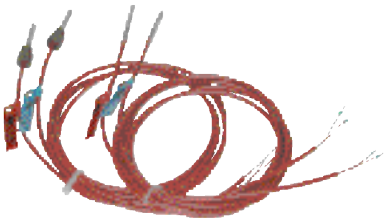
The national regulations in force today for verification purposes in Switzerland and Germany are based on EN 1434. Peripheral equipment used in those measurement points subject to verification must be dismounted after five years and verified again by an authorised verification centre.

The metrological aspect of recalibration includes the use of predefined error limits. In practice, this means that attention must be paid to the installation and assembly of heat measurement points so that assembly and disassembly of all components of the measurement points can be quickly and efficiently carried out at all times.

The EN 1434 standard also requires that, whenever possible, sensors without a pocket can be mounted in DN 50, or 2" (50 mm) pipes, which means directly into the liquid. Shut-off valves are required so that the sensor can be exchanged without emptying the pipe. One method is to use ball valves with an integrated CEN sensor holder. Exceptions to this are those applications with high operating pressures and temperatures where direct mounting is not permitted. All regulations must be strictly observed when updating existing measuring equipment.

In addition, there are recommendations of national industry-specific associations (e.g. German AGFW recommendations "Requirements of the AGFW for heat meters for district heating plants - technical specifications and guarantee conditions" and "Design and installation of temperature sensors for heat meters").

# DS/PSC Temperature sensors



## Description

- Cable temperature sensors for direct (Direct Short) and pocket (Pocket Short Cable) mounting with Pt 100 and Pt 500, sensor diameter 5 mm, sensor length 45 mm
- Brass sensor pockets
- Ball valves for temperature sensors
- T-piece adapter

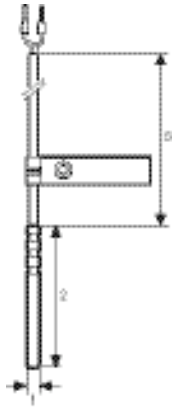
## Applications

- Recommended for piping up to DN 50 for direct and pocket mounting
- According to international heat transfer standard EN 1434-2, direct mounting into piping up to DN 50 is recommended over pocket installation
- Interchangeable, e.g. for Aquametro meters AMTRON® and CALEC® for piping up to DN 50 mm
- The two-wire system can be converted into a four-wire system using a sealed VD-30 distributor box

## Note

- There must be mounting symmetrically of both temperature sensors, i.e. both sensors must be identically mounted, e.g. both in ball valves (and not one sensor in a pocket and the other directly mounted in the ball valve or T-piece).
- For direct installing of temperature sensors, only matching T-pieces are to be used. This ensures that no unnecessary measurement errors occur due to unequal immersion depths.

## Technical data



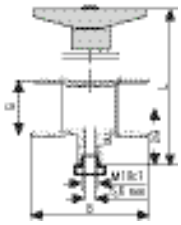
| | |
|---|---|
| Sensor type | Two-wire connection, Pt 100 and Pt 500 |
| Protective tube | Stainless steel |
| Temperature range | 0 to 150 °C |
| Connector | Silicon |
| Matched pairs | at 10 °C, 65 °C, 120 °C |
| Tolerance class to IEC 751 | Class B |
| Diameter of protective tube (1) | 5 mm |
| Material of protective tube | 1.4571 |
| Length of sensor (2) | 45 mm |
| Immersion depth with direct mounting | ≈ 27.5 mm |
| Connection wire terminals | Terminal sleeves to DIN 46 228 Part 4 |
| Connection wire lengths (3) | 1500 mm and 2500 mm |
| Type approval | EN 1434 for Switzerland and Germany |
| Permissible range for ΔT | 3...150 K |
| Verification | As required for Switzerland and Germany |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| DS/PSC 500/45/2.5 m verified | Pair of cable sensors Pt 500, sensor length 45 mm, connecting cable 2.5 m | Paired, bag-packed, with screw adapters for direct mounting and installation instructions | 80206 |
| DS/PSC 100/45/2.5 m verified | Pair of cable sensors Pt 100, sensor length 45 mm, connecting cable 2.5 m | Paired, bag-packed, with screw adapters for direct mounting and installation instructions | 80069 |

# Accessories for DS/PSC temperature sensors

## Direct mounting

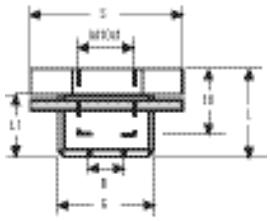
### Ball valve with CEN sensor holder (M10x1) for temperature sensor



| | | | | |
|---|---|---|---|---|
| Thread | | Internal thread G 1/2" or G 3/4" or 1" | | |
| Connection piece | | M10x1 to EN 1434 | | |
| Material | | Nickel-plated brass | | |
| Maximum media temperature | | 150 °C | | |
| Pressure rating | | PN 16 | | |
| Dimensions | (G) | G 1/2" | G 3/4" | G 1" |
| | (L) | 77 mm | 84 mm | 84 mm |
| | (B) | 64 mm | 73 mm | 85.5 mm |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| KGH 1/2" | Ball valve 1/2"<br>for direct mounting of sensor | Single, loose<br>with locking top | 2505 |
| KGH 3/4" | Ball valve 3/4"<br>for direct mounting of sensor | Single, loose<br>with locking top | 2504 |
| KGH 1" | Ball valve 1"<br>for direct mounting of sensor | Single, loose<br>with locking top | 2507 |

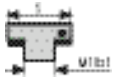
### T-piece adapter with CEN sensor holder (M10x1) for temperature sensor, mounting in the T-piece



| | | | | | |
|---|---|---|---|---|---|
| Thread | | External thread G 3/8", G 1/2" or 1" | | | |
| Connection piece | | M10x1 to EN 1434 | | | |
| Material | | Brass | | | |
| Dimensions | (G) | G 3/8" | G 1/2" | G 3/4" | G 1" |
| Width (AF) | (S) | 20 mm | 30 mm | 32 mm | 41 mm |
| | (L) | 19 mm | 16.5 mm | 20 mm | 20 mm |
| | (L1) | 11 mm | 11.5 mm | 14 mm | 14 mm |
| | (B) | | Ø 5.7 mm (5.4 mm) | | |

| Part | Description | Quantity and packaging | Art. No, |
|---|---|---|---|
| T-piece adapter<br>G 3/8" / M10x1 | Adapter for 3/8" T-piece<br>for sensor mounting, M10x1 | Single, loose<br>without seal ring or locking top | 19406 |
| T-piece adapter<br>G 1/2" / M10x1 | Adapter for 1/2" T-piece<br>for sensor mounting, M10x1 | Single, bag-packed<br>with copper seal ring, without locking top | 80072 |
| T-piece adapter<br>G 3/4" / M10x1 | Adapter for 3/4" T-piece<br>for sensor mounting, M10x1 | Single, bag-packed<br>with copper seal ring, without locking top | 80073 |
| T-piece adapter<br>G 1" / M10x1 | Adapter for 1" T-piece<br>for sensor mounting, M10x1 | Single, bag-packed<br>with copper seal ring, without locking top | 80074 |

### Locking top M10x1

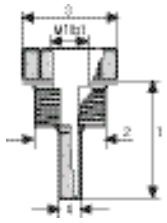


| | | |
|---|---|---|
| Connection piece | | M10x1 to EN 1434 |
| Material | | Brass |
| Width (S) | | 12 mm |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| Locking top set<br>M10x1 | Locking top for T-piece adapter<br>(G3/8"...1") | Bag-packed | 80207 |

## Sensor pockets mounting

### Sensor pockets with CEN holder (M10x1) and straight protective tube



| | |
|---|---|
| Face-to-face length (1) | 40 mm and 60 mm |
| Process connection (2) | External thread G 1/2" |
| Width (AF) (3) | 24 mm |
| Material | Brass |
| Maximum media temperature | 130 °C |
| Pressure rating | PN 16 |
| External diameter (4) | 6.6 mm |
| Internal diameter of protective tube | 5 mm |
| Sensor mounting | with synthetic threads |

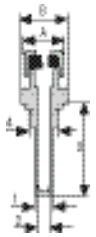
| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| SP-M 40, single | Brass sensor pocket immersion depth 40 mm, G 1/2" | Single, bag-packed, with copper seal ring compling unit and installation instructions | 80209 |
| SP-M 40, set | Brass sensor pocket immersion depth 40 mm, G 1/2" | Paired, bag-packed, with copper seal ring compling unit and installation instructions | 80075 |
| SP-M 60, single | Brass sensor pocket immersion depth 60 mm, G 1/2" | Single, bag-packed, with copper seal ring compling unit and installation instructions | 80210 |
| SP-M 60, set | Brass sensor pocket immersion depth 60 mm, G 1/2" | Paired, bag-packed, with copper seal ring compling unit and installation instructions | 80076 |

### Accessories for sensor pocket / direct mounting of DS/PSC sensors with CEN holders (M10x1)

| | |
|---|---|
| Process connection | M10x1 |
| Mounting set for DS/PSC sensor (1) | Direct sensor mounting or in sensor pocket SP-M 40 |
| Coupling parts for SP-M 60 (2) | Mounting in sensor pocket SP-M 60 only |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| Mounting set for DS/PSC sensors | Mounting components for direct mounting or in sensor pocket SP-M 40 | 1 pair of threaded coupling units (brown), 2 O-rings (4.3 x 2.4), tools and installation instructions | 80205 |
| Coupling for SP-M 60 (grey) | Mounting components for direct mounting or in sensor pocket SP-M 60 | One threaded coupling unit (grey) , folding | 20040 |

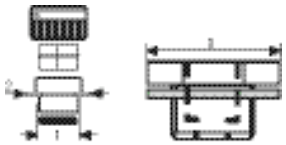
### Special versions: sensor pockets



| | |
|---|---|
| Face-to-face length (3) | 33 mm |
| Process connection (4) | External thread G 3/8" |
| Width (AF) | A = 17 mm, B = 14 mm and C = 22 mm |
| Material | Brass |
| Maximum media temperature | 130 °C |
| Pressure rating | PN 16 |
| External diameter (1) | 6.6 mm |
| Internal diameter of protective tube (2) | 5 mm |
| Sensor mounting | with cap nut |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| ATH-33 | Brass sensor pocket,<br>immersion depth 33 mm, G 3/8” | Single, loose | 81568 |

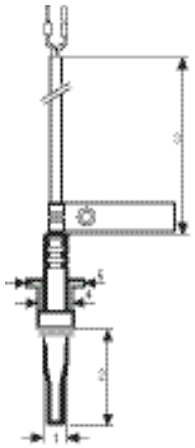
**Direct mounting: for AMTRON® E and ULTRASONIC E only**



| | |
|---|---|
| Process connection (1) | M10x1 |
| Width (AF) | (2) = 12 mm,<br>(3) = 24 mm |
| Material | Brass |
| Maximum media temperature | 130 °C |
| Pressure rating | PN 16 |
| Sensor mounting | with O-ring |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| MG Mounting set for ball valve<br>AMTRON® E / ULTRASONIC E CEN | Mounting set, brass | Single, bag-packed with<br>installation instructions | 81598 |
| MG 1/2” Mounting set for T-piece<br>AMTRON® E / ULTRASONIC E CEN | Mounting set, brass,<br>with T-piece adapter 1/2” | Single, bag-packed with<br>installation instructions | 81599 |

**Direct mounting: for ULTRASONIC only**



| | |
|---|---|
| Sensor type | Two-wire connection Pt 500 |
| Protective tube | Stainless steel |
| Temperature range | 0 to 150 °C |
| Connector/length (3) | Silicon, screened / 1500 mm |
| Matched pairs | at 10 °C, 65 °C, 120 °C |
| Tolerance class to IEC 751 | Class B |
| Diameter of protective tube (1) | 5.4 mm / shouldered |
| Material of protective tube | 1.4571 |
| Length of sensor (2) | 27.5 mm |
| Connection wire terminals | Terminal sleeves to DIN 46 228 Part 4 |
| Type approval | EN 1434 for Switzerland and Germany |
| Permissible range for $\Delta T$ | 3...150 K |
| Verification | On demand for Switzerland and Germany |
| Process connection (4) | M10x1 / with flat packing |
| Width (AF) (5) | 12 mm |
| Material | Brass |
| Maximum media temperature | 130 °C |
| Pressure rating | PN 16 |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| Pair of sensors Pt 500, 1,5 m<br>verified for ULTRASONIC | Pair of temperature sensors<br>for ULTRASONIC as replacement,<br>for direct mounting only, length 27.5 mm,<br>DS, M10x1, connecting cable 1.5 m | Paired loose | 80048 |
| Replacement gasket<br>for ULTRASONIC sensor | Flat packing | Single, loose | 20041 |

# PLC temperature sensors

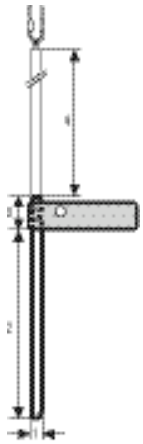
## Description

- Cable temperature sensor for pocket mounting (Pocket Long Cable), types Pt 100 and Pt 500, sensor diameter 6 mm, sensor lengths 105 mm, 140 mm, 175 mm and 230 mm
- Special versions for high absolute temperatures up to 180 °C

## Applications

- For facilities with pipe diameters from approx. DN 50 upwards
- Good thermal properties with low heat radiation
- Two-wire connection but can be converted to four-wire using a sealed VD-30 distributor box
- Used with SP-E sensor pockets (see accessories for PLC and PLH temperature sensors)

## Technical data



| | |
|---|---|
| Sensor type | Two-wire connection, Pt 100 and Pt 500 |
| Protective tube | Stainless steel |
| Temperature range | 0 to 150 °C (180 °C) |
| Connector | Silicon |
| Matched pairs (standard 150 °C)<br>Matched pairs (for 180 °C) | at 10 °C, 65 °C, 120 °C<br>at 10 °C, 80 °C, 150 °C |
| Tolerance class to 751 | Class B |
| Diameter of protective tube (1)<br>Material of protective tube | 6 mm<br>1.4571 |
| Length of sensor (2) | 105, 140, 175 and 230 mm |
| Connection wire terminals<br>Connection wire lengths (4) | Terminal sleeves to DIN 46 228 Part 4<br>1500 mm and 2500 mm |
| Size of tag to sensor end (3) | 15 mm |
| Type approval | EN 1434 for Switzerland and Germany |
| Permissible range for $\Delta T$ | 3...150 K (180 K) |
| Verification | On demand for Switzerland and Germany |

## PLC - Pt 500 sensor

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| PLC 500/105/2.5 m verified | Pair of cable sensors Pt 500, sensor length 105 mm, connecting cable 2.5 m | Paired, bag-packed | 80204 |
| PLC 500/140/2.5 m verified | Pair of cable sensors Pt 500, sensor length 140 mm, connecting cable 2.5 m | Paired, bag-packed | 80208 |
| PLC 500/175/2.5 m verified | Pair of cable sensors Pt 500, sensor length 175 mm, connecting cable 2.5 m | Paired, bag-packed | 80222 |
| PLC 500/230/2.5 m verified | Pair of cable sensors Pt 500, sensor length 230 mm, connecting cable 2.5 m | Paired, bag-packed | 80230 |

## PLC - Pt 100 sensor

| Part | Description | Quantity and Packaging | Art. No. |
|---|---|---|---|
| PLC 100/105/2.5 m verified | Pair of cable sensors Pt 100, Longueur de sonde 105 mm, connecting cable 2.5 m | Paired, bag-packed | 80200 |
| PLC 100/105/3 m verified | Pair of cable sensors Pt 100, sensor length 105 mm, connecting cable 3 m | Paired, bag-packed | 81659 |
| PLC 100/140/2.5 m verified | Pair of cable sensors Pt 100, sensor length 140 mm, connecting cable 2.5 m | Paired, bag-packed | 80201 |
| PLC 100/175/2.5 m verified | Pair of cable sensors Pt 100, sensor length 175 mm, connecting cable 2.5 m | Paired, bag-packed | 80202 |
| PLC 100/230/2.5 m verified | Pair of cable sensors Pt 100, sensor length 230 mm, connecting cable 2.5 m | Paired, bag-packed | 80203 |

## For special applications

| | | |
|---|---|---|
| PLC 180 °C | Order for special applications | 180413 |

# PLH temperature sensors

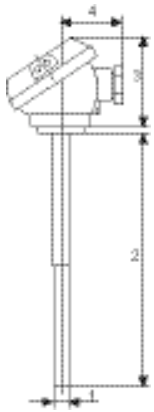
## Description

- Head sensor for pocket mounting (Pocket Long Head), types Pt 100 and Pt 500, sensor diameter 6 mm, sensor lengths 105 mm, 140 mm, 175 mm and 230 mm
- Special versions for low temperature differences (e.g. for cooling measurements) and high absolute temperatures up to 180 °C

## Applications

- For facilities with pipe diameters from approx. DN 50 upwards
- Good thermal properties with low heat loss
- Two-wire connection but can be converted to four-wire by connecting directly to the sensor head
- Used with SP-E sensor pockets (see. accessories for PLC and PLH temperature sensors)

## Technical data




| | |
|---|---|
| Sensor type | Two-wire connection Pt 100 and Pt 500 |
| Protective tube | Stainless steel |
| Temperature range | 0 to 150 °C (180 °C) |
| Connector | Metal, version PL |
| Matched pairs (standard 150 °C) | at 10 °C, 65 °C, 120 °C |
| Matched pairs (for cooling applicat.) | at (0 °C), 10 °C, 30 °C, 50 °C |
| Matched pairs (180 °C) | at 10 °C, 80 °C, 180 °C |
| Tolerance class to IEC 751 | Class B |
| Diameter of protective tube (1) | 6 mm |
| Material of protective tube | 1.4571 |
| Length of sensor (2) | 105, 140, 175 and 230 mm |
| Height of sensor head (3) | 44.5 mm |
| Connection head (4) | 33 mm |
| Type approval | EN 1434 for Switzerland and Germany |
| Permissible range for $\Delta T$ | 3...150 K |
| Verification | On demand for Switzerland and Germany |

## PLH - Pt 500 sensor

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| PLH 500/105 verified | Pair of head sensors Pt 500, sensor length 105 mm | Paired, bag-packed | 80081 |

## PLH - Pt 100 sensor

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| PLH 100/105 verified | Pair of head sensors Pt 100, sensor length 105 mm | Paired, bag-packed | 80070 |
| PLH 100/140 verified | Pair of head sensors Pt 100, sensor length 140 mm | Paired, bag-packed | 80078 |
| PLH 100/175 verified | Pair of head sensors Pt 100, sensor length 175 mm | Paired, bag-packed | 80079 |
| PLH 100/230 verified | Pair of head sensors Pt 100, sensor length 230 mm | Paired, bag-packed | 80080 |

## Cold applications

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| PLH 100/140 verified / cold | Pair of head sensors Pt 100, sensor length 140 mm for cold applications | Paired, bag-packed | 80085 |
| PLH 100/175 verified / cold | Pair of head sensors Pt 100, sensor length 175 mm for cold applications | Paired, bag-packed | 80086 |

## For special applications

| | | | |
|---|---|---|---|
| PLH 180 °C | Order for special application | | 180412 |

# Accessories for PLC and PLH temperature sensors

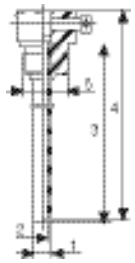
### Description

- Stainless steel sensor pockets, face-to-face lengths 85 mm, 120 mm, 155 mm and 210 mm for PN 40
- Reinforced 210 mm sensor pocket for flows greater than 2 m/s
- Steel or stainless steel welded sleeve
- Distributor box VD-30 converting from two- to four-wire connections
- Extension cable for distributor box

### Note

The face-to-face sensor pocket length for PLC and PLH sensors must be 20 mm shorter than the length of the sensor itself. This is shown in the table below

### SP-E (SP-EV) sensor pocket

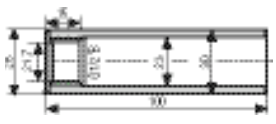


| | |
|---|---|
| External diameter (1) | 8 mm |
| Internal diameter of protective tube (2) | 6 mm |
| Material of protective tube | 1.4571 |
| With sealing screw | |
| Maximum media temperature | 200 °C |
| Pressure rating | PN 40 |
| Thread (5) | G 1/2" |
| Length (4) | 98, 133, 168 and 223 mm |
| Face-to-face length (3) | 85, 120, 155 and 210 mm |

### Product range

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| SP-E 85 / 105 | Stainless steel sensor pocket G1/2", face-to-face length 85 mm, PN 40, for sensor PLxxx/105 | Single, with copper seal ring, bag-packed | 80059 |
| SP-E 120 / 140 | Stainless steel sensor pocket G1/2", face-to-face length 120 mm, PN 40, for sensor PLxxx/140 | Single, with copper seal ring, bag-packed | 80060 |
| SP-E 155 / 175 | Stainless steel sensor pocket G1/2", face-to-face length 155 mm, PN 40, for sensor PLxxx/175 | Single, with copper seal ring, bag-packed | 80062 |
| SP-E 210 / 230 | Stainless steel sensor pocket G1/2", face-to-face length 210 mm, PN 40, for sensor PLxxx/230 | Single, with copper seal ring, bag-packed | 80064 |
| SP-EV 210 / 230 | Stainless steel sensor pocket G1/2", reinforced for v > 2 m/s, face-to-face length 210 mm PN 40, for sensor PLxxx/230 | Single, with copper seal ring, bag-packed | 80077 |

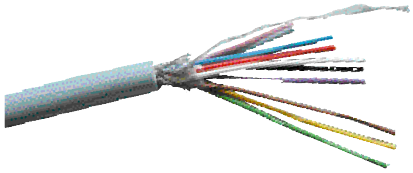
### Welded sleeve



| | |
|---|---|
| External diameter | 30 mm |
| Pressure rating | PN 40 |
| Thread | Internal thread G 1/2" |
| Length | 100 mm |
| Material of protective tube | Steel / stainless steel |

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| SWM-11 | Steel welded sleeve for the face-to-face length of the sensor pocket | Single, with copper seal ring, bag-packed | 81551 |
| SWM-12 | Stainless steel welded sleeve for the face-to-face length of the sensor pocket | Single, with copper seal ring, bag-packed | 81552 |

# Connection box (VD-30), extension cable (10x0.5 mm)



## Description

Incorrect handling of sensor cable extensions leads to measurement errors.

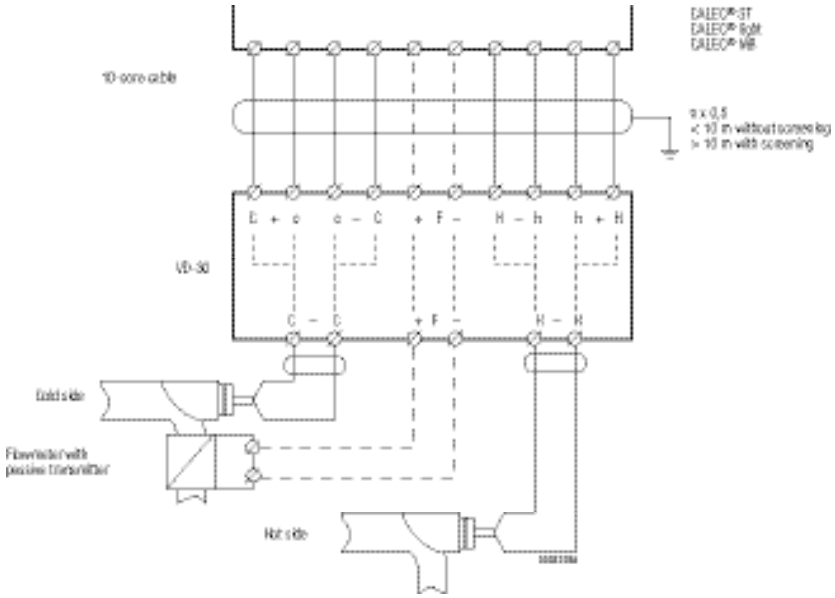
Features of VD-30:

- Converts 2-wire cable sensors systems (measurement of resistance) to 4-wire systems (measurement of voltage loss)
- Negligible cable resistance for smaller cable diameters
- Appropriate extension of cable sensors (PLC and DS/PSC)
- Optional connection for a passive pulse transmitter
- Clear installation
- Optional access protection with lead seal

Extension cable recommanded

- 10-core, flexible, 0.5 mm$^2$
- Screened
- Cable designation LiYCY

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| VD-30 | Distributor box for temperature sensor and pulse transmitter | Single, bag-packed with installation instructions | 93331 |
| Cable 10x0.5 mm screened | Cable for cable sensor and pulse transmitter extension with VD-30 | per meter | 20042 |



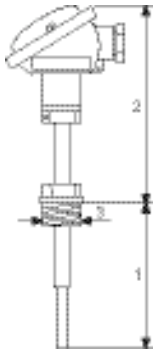
# TPK sensor heads with 4-wire connection

## Description

- Pt 100 head sensor with 4-wire connection for direct mounting, with or without cold bridges
- Sensor lengths 100 mm, 160 mm and 250 mm

## Applications

- For high pressures, large temperature ranges and, due to mechanical stability, long face-to-face lengths
- Four-wire connection right up to the measuring element
- The "cold bridge" version to be used for low temperature applications




| | |
|---|---|
| Resistance values | IEC 751 with the Pt 100 basic values |
| Temperature measuring range | 0...180 °C (250 °C) |
| Absolute deviation from IEC 751 theoretical values | < +/-0.5 K / 40 °C |
| Max. deviation of matched sensor pair | In the temperature range 0...130 °C: 30 mΩ |
| Mean gradient tolerance against the IEC 751 curve | at 40 °C (80 °C and 80 °C/130 °C: max 0,5 % |
| Insulation resistance between measurement resistor and sensor pipe | > 1 MΩ |
| Mounting thread (3) | External thread G 1/2", AF 19 mm |
| Sensor pipe | Ø 7 mm tip, Ø 10 mm shaft, material CrNiMo |
| Face-to-face lengths (1) | 100, 160 and 250 mm |
| Length connect. head/connect. thread | (2) 125 mm (150 mm with cold bridge) |
| Pressure rating | PN 40 |
| Connection thread | DIN-B aluminium head |

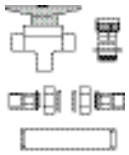
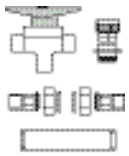
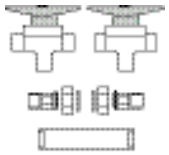
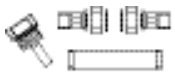
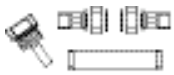
| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| TPK 1121 | Head sensor, 4-wire connection face-to-face length 100 mm, Pt 100 | Paired, bag-packed | 81560 |
| TPK 1131 | Head sensor, 4-wire connection face-to-face length 160 mm, Pt 100 | Paired, bag-packed | 81549 |
| TPK 1141 | Head sensor, 4-wire connection face-to-face length 250 mm, Pt 100 | Paired, bag-packed | 81550 |

## Cold applications

| Part | Description | Quantity and packaging | Art. No. |
|---|---|---|---|
| TPK 1121 / K | Head sensor with cold bridge 4-wire connection face-to-face length 100 mm, Pt 100 | Paired, bag-packed | 81670 |
| TPK 1131 / K | Head sensor with cold bridge 4-wire connection face-to-face length 160 mm, Pt 100 | Paired, bag-packed | 81671 |
| TPK 1141 / K | Head sensor with cold bridge 4-wire connection face-to-face length 250 mm, Pt 100 | Paired, bag-packed | 81672 |

# Mounting sets

### Complete mounting set

| | | |
|---|---|---|
| 1/2” for AMTRON® E / ULTRASONIC E CEN | Complete mounting set for AMTRON® E / ULTRASONIC E CEN | 81632 |
|  | consisting of 1 x KGH 1/2”<br>1 set VSR 3/4” - 1/2”<br>1 x PSG DN 15 x 110 mm<br>1 x sensor mounting AMTRON® P | |
| 3/4” for AMTRON® E / ULTRASONIC E CEN | Complete mounting set for AMTRON® E / ULTRASONIC E CEN | 81597 |
|  | consisting of 1 x KGH 3/4”<br>1 set VSR 1” - 3/4”<br>1 x PSG DN 20 x 130 mm<br>1 x sensor mounting AMTRON® P | |
| For compact heat meters | Complete mounting set for compact heat meters | 81586 |
|  | consisting of 1 x KGH 1/2”<br>1 set VSR 3/4” - 1/2”<br>1 x PSG DN 15 x 110 mm | |
| For compact heat meters | Complete mounting set for compact heat meters | 81655 |
|  | consisting of 1 set VSR 1” - 3/4”<br>1 x PSG DN 20 x 130 mm<br>1 x SP-M 40 | |
| | Complete mounting set for compact heat meters | 81654 |
|  | consisting of 1 set VSR 3/4” - 1/2”<br>1 x PSG DN 15 x 110 mm<br>1 x SP-M 40 | |

# Recommendations for installation

### Mechanical considerations

The location of the installation point of the temperature sensors and the flow sensor in the heating/cooling circuit is determined by the measurement itself. The two temperature measurement points form the limits for which the energy flow is calculated. (The supplier, for example, bears all pipe losses, which occur upstream, and the consumer all those downstream from the temperature measurement points.)

Both sensors for differential temperature measurement must be installed in an identical way. This also applies to the pipe diameter and the thermal insulation of the sensor surroundings. The aim is to ensure the same flow rates and thermal conditions for both measurement points. If, for example, one of the sensors is installed in non-insulated pipe, then the second should/must also be installed in non-insulated pipe (principle of equality).

The sensors should be installed so that the first 20 mm of the one upstream (active measuring length) is in the middle third of the pipe cross-section.

Adjusting the face-to-face length is done with welded sleeves. These also ensure that the sensor locking screw is still accessible after attaching the insulation. Welded sleeves are made to a standard length of 100 mm. They must be adjusted to the pipe in both length and position.

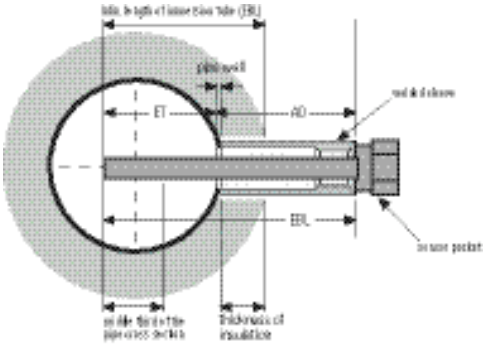
Sensor pockets and head sensors must be installed so that there is sufficient room to replace them. (The sensors or measuring inserts must be in a position to be removed easily without the use of force).

The type of sensors used must be suitable for the temperature, pressure and flow speed of the application. Sensors, especially those with long immersion lengths, may be subject to considerable forces created by the flow.

The standard sensors today ensure maximum heat transfer with the sensor fitting snugly in the sensor pocket. Any dirt in the immersion tube will prevent the sensor from being properly seated in the pocket, and thus falsifying the results. The pockets are therefore mounted either from the side or from below. This is especially important for cooling systems as otherwise condensation or ice can build up in the pocket.

### Immersion lengths for Aquametro for sensor pockets and temperature sensors

**Recommendations for heating systems (Example: Germany)**



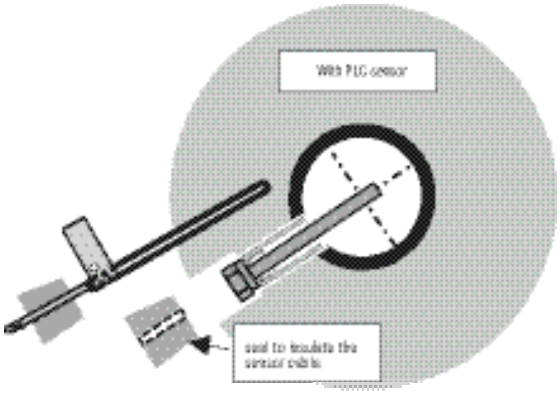

**Insulation in the heating loops, heating plant regulations**

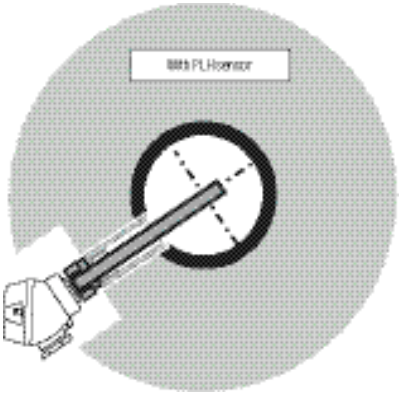
| Pipe cross-section (mm) | Thickness of insulation |
|---|---|
| up to DN 20 | 20 mm |
| DN 20 to DN 35 | 30 mm |
| DN 40 to DN 100 | same DN as width |
| DN 100 upwards | 100 mm |

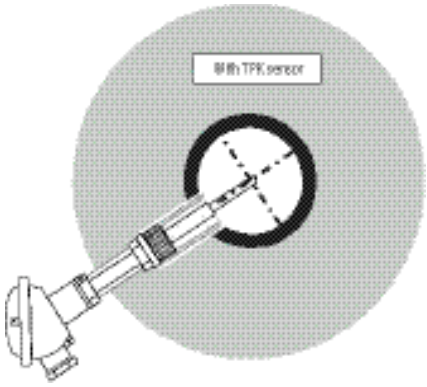
| Nominal width of pipe DN | 15 | 20 | 25 | 32 | 40 | 50 | 65 | 80 | 100 | 125 | 150 | 200 | 250 | 300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thickness of insulation (mm) | 20 | 20 | 30 | 30 | 40 | 50 | 65 | 80 | 100 | 100 | 100 | 100 | 100 | 100 |
| Immersion depth ET (mm) | 10 | 15 | 20 | 25 | 30 | 38 | 45 | 60 | 70 | 83 | 95 | 120 | 145 | 170 |
| Face-to-face length EBL (mm) | 30 | 35 | 50 | 55 | 70 | 88 | 110 | 140 | 170 | 183 | 195 | 220 | 245 | 270 |
| External length for sensor pockets in relation to immersion depth | | | | | | | | | | | | | | |
| 3/8" / ATH-33 | 23 | 18 | 13 | 8 | | | | | | | | | | |
| 1/2" / SP-M 40 | 30 | 25 | 20 | 15 | 10 | | | | | | | | | |
| 1/2" / SP-M 60 | | 45 | 40 | 35 | 30 | 22 | 15 | | | | | | | |
| 1/2" / SP-E 85/105 | | | | 60 | 55 | 47 | 40 | 25 | 15 | | | | | |
| 1/2" / SP-E 120/140 | | | | | 90 | 82 | 75 | 60 | 50 | 37 | 25 | | | |
| 1/2" / SP-E 155/175 | | | | | | 117 | 110 | 95 | 85 | 72 | 60 | 35 | 10 | |
| 1/2" / SP-E 210/230 | | | | | | | 165 | 150 | 140 | 127 | 115 | 90 | 65 | 40 |

**Recommendations for cooling systems**

**Remarks**
- Larger insulation thickness
- Condensate run-out: mounting from below



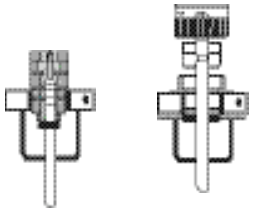



## Hydraulic considerations

The most accurate results are achieved by direct installation of the temperature sensors into the liquid without sensor pockets (see Fig 10). This ensures that the flow of liquid around the temperature sensors is optimal. Flow velocity is also important in achieving accuracy as additional temperature measurement errors must be taken into account at flow velocities of less than 0.3 m/s.

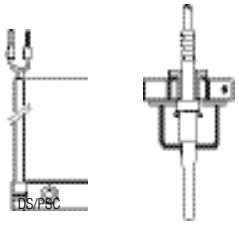
## Selecting the length and type of mounting for Aquametro temperature sensors

Mounting with cast iron fittings with T-piece adapter (within tolerance)

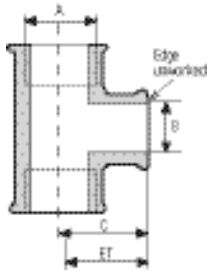


AMTRON® N

AMTRON® E
ULTRASONIC E




ULTRASONIC




| A | B | C | T-piece adapter | | Mounting with immersion depth ET (mm) | | |
|---|---|---|---|---|---|---|---|
| Inches | Inches | mm | Art. No. | AMTRON® N | AMTRON® E / ULTRASONIC E | DS/PSC | ULTRASONIC |
| 3/8” | 3/8” | 25 | 19406 | 23 | 25,5 | 33 | 32 |
| 3/8” | 1/2” | 26 | 80072 | 25,5 | 27 | 29,6 | 31 |
| 3/8” | 1/2” | 26 | 81599 | - | 29,5 | - | - |
| 1/2” | 3/8” | 26 | 19406 | 23 | 25,5 | 33 | 32 |
| 1/2” | 1/2” | 28 | 80072 | 25,5 | 27 | 29,6 | 31 |
| 1/2” | 1/2” | 28 | 81599 | - | 29,5 | - | - |
| 1/2” | 3/4” | 30 | 80073 | 24,5 | 25,5 | 26 | 27 |
| 1/2” | 1” | 32 | 80074 | 23,3 | 23,3 | 26 | 27 |
| 3/4” | 3/8” | 28 | 19406 | 23 | 25,5 | 33 | 32 |
| 3/4” | 1/2” | 32 | 80072 | 25,5 | 27 | 29,6 | 31 |
| 3/4” | 1/2” | 32 | 81599 | - | 29,5 | - | - |
| 3/4” | 3/4” | 33 | 80073 | 24,5 | 25,5 | 26 | 27 |
| 3/4” | 1” | 35 | 80074 | 23,3 | 23,3 | 26 | 27 |
| 1” | 3/8” | 32 | 19406 | 23 | 25,5 | 33 | 32 |
| 1” | 1/2” | 34 | 80072 | 25,5 | 27 | 29,6 | 31 |
| 1” | 1/2” | 34 | 81599 | - | 29,5 | - | - |
| 1” | 3/4” | 36 | 80073 | 24,5 | 25,5 | 26 | 27 |
| 1” | 1” | 38 | 80074 | 23,3 | 23,3 | 26 | 27 |
| 1 1/4” | 3/8” | 36 | 19406 | 23 | 25,5 | 33 | 32 |
| 1 1/4” | 1/2” | 38 | 80072 | 25,5 | 27 | 29,6 | 31 |
| 1 1/4” | 1/2” | 38 | 81599 | - | 29,5 | - | - |
| 1 1/4” | 3/4” | 41 | 80073 | 24,5 | 25,5 | 26 | 27 |
| 1 1/4” | 1” | 42 | 80074 | 23,3 | 23,3 | 26 | 27 |
| 1 1/2” | 3/8” | 38 | 19406 | 23 | 25,5 | 33 | 32 |
| 1 1/2” | 1/2” | 42 | 80072 | 25,5 | 27 | 29,6 | 31 |
| 1 1/2” | 1/2” | 42 | 81599 | - | 29,5 | - | - |
| 1 1/2” | 3/4” | 44 | 80073 | 24,5 | 25,5 | 26 | 27 |
| 1 1/2” | 1” | 46 | 80074 | 23,3 | 23,3 | 26 | 27 |

T-pieces for direct sensor mounting are recommended.

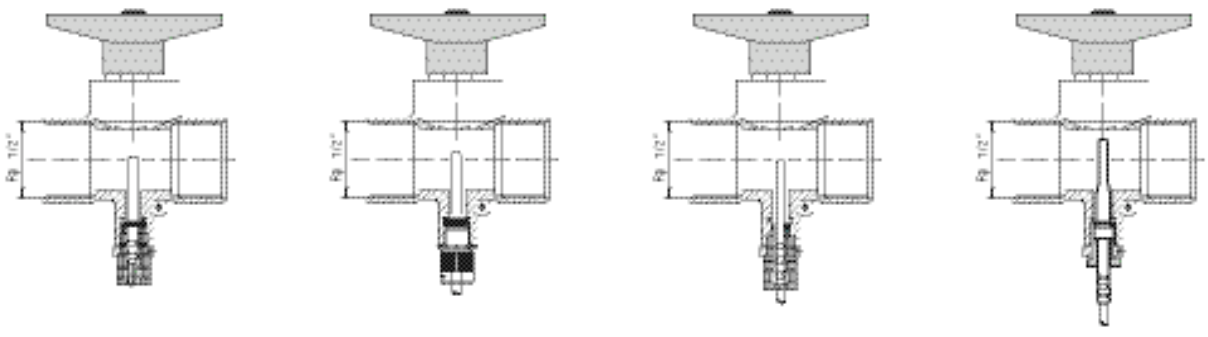
ET correct
ET within tolerance
ET outside tolerance

### In general

Direct sensor mounting up to DN 50 should be possible.

### Mounting in ball valves

This ensures that the immersion depth is always correct.



1
AMTRON® N

2
AMTRON® E / ULTRASONIC E

3
DS/PSC cable sensor

4
ULTRASONIC

Sensors with sensor pockets are usually only used in plants with large pipe diameters or where the operating conditions are extreme (e.g. pressure, temperature, flow velocities).

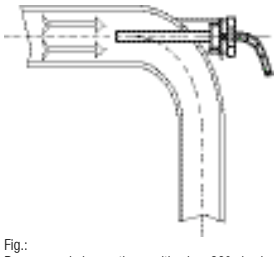


Fig.:
Recommended mounting position in a 90° pipe bend

Installation in a pipe bend is also recommended in which the sensor tip must always be pointing against the direction of flow and the entire active length is in the centre of flow. To avoid vortices and their associated influence on the flowmeter, the centre must be mounted immediately downstream from this.

A welded sleeve is used for adjusting the sensor to the piping. This sleeve is then shortened or lengthened according to the length of the pipe.

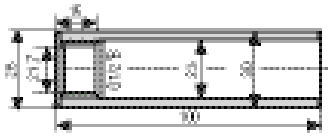


Fig.: Welded sleeve

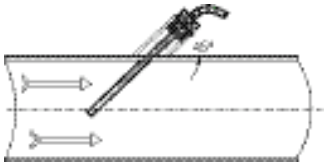


Fig: Mounting at 45° against the direction of flow

## Thermal considerations

Heat flows from a warmer to a colder region. If a sensor head at a measurement point becomes warmer, then the heat has most probably come from the liquid, i.e. heat flows from the measurement point to the sensor head located on the outside of the pipe. This dissipation inevitably produces varying temperatures along the path of flow where the measuring resistor may be situated. For exact measurements, it is therefore important that this heat dissipation is kept as low as possible.

For example, this can be done by:

- optimising heat contact with the liquid (mounting without a sensor pocket)
- using sensors with little thermal mass and a small radiation surface area
- preventing heat flow by using insulating materials (keeping all metallic sensor parts at the same temperature as the pipe work by using insulation). This also prevents the build-up of condensation for cooling measurements.

## Electrical considerations

The connecting cable from the measuring element to the heat calculator has a resistance, which depends both on the cable temperature of the cross section as well as on the cable materials used and the length of the cable. It is necessary either to eliminate these factors or else keep them as small as possible. Two- or four-wire connections can be used for connecting temperature sensors to the heat meter.

For four-wire connections, the sensors is supplied by a two-wire cable and the measurement resistance read via another two-wire cable. If the input resistance of the heat meter is very much higher than the cable resistance (which is usually the case), then cable resistance can be neglected. The voltage drop detected is not dependent on the characteristics of the cable.

## Note

A two-wire extension is not recommended.

## This means that

A four-wire connection is the only way to ensure measurement accuracy with long cables. However, it can only be used for 4-wire heat-calculators.

Two-wire connections are frequently made between the measuring element (sensor) and the connection head by using an extension. This is then only possible using a four-wire connection (see Fig.). Four-wire telephone cables, Ø 0.8 mm, with terminal boxes, for example, are suitable (CH: U72; D:J-YY 2 x 2 x 0.8).

The best connection is done by using a distributor box (VD-30) and an extension cable 10x0.5 mm).

**Extracts from EN 1434:**
"Temperature sensors are to be connected according to the instructions given by the manufacturer. They are to be connected directly to the meter. No interruptions in the cable using separable connections (plugs, terminals, etc.) are permitted for two-wire sensors."
"If such connections are used with 4-wire cabling, then the operator must protect them with a lead seal against accidental or deliberate breakage."
"Signal cables between heat meter components are to be connected and laid so that they are protected from interference or breakage."

**What is the maximum cable length for four-wire censor connections?**
This question is often asked but cannot however be completely answered as the theoretical ohmic resistance as well as the complex impedance values (capacitive and inductive resistance) of the extension cabling must be taken into account along with the unknown effects of local interference emissions.

The metrological (approval) tests are carried out with a maximum cable length of 10 to 15 m. The appropriate information is stated on the approval certificate. Longer lengths are not covered by the certificate and the operator uses these at his own risk. Cable screening is not required for cable lengths up to 15 m. Screening can be used for longer lengths. The screening should then be connected to the piping system on the sensor side or to the ground connection of the building. There is thus no connection on the calculator side. Screening is to be left open and insulated.

The quality of the connection is seen on the differential temperature display of the meter. Persistently changing values which jump around indicate interference on the sensor cabling.

**Cooling facilities and heat pumps**
Pipework at temperatures below room temperature are susceptible to formation of condensation water. If the piping is not properly insulated it will probably become permanently wet. This will especially affect sensors with connection heads, which would then have to be connected with water-tight seals.

Water entering the sensor pocket can result in the formation of ice in its chamber which (despite the locking device) can force the sensor out of the pocket due to the expansion every time the water freezes.

Measuring small temperature differences requires very careful mounting and good insulation of the sensor from its surroundings. The best results are achieved with direct mounting or with non-grounded cables. The TPK head sensors are available with insulation ("cooling bridges").

**Checking the temperature difference**
The deviation of the matched censor pair that is already in use can be determined by placing both sensors in a water-filled vessel.

Both sensors can be attached together in parallel (cord, wire, rubber) and completely submerged in the liquid (do not touch the vessel by hand!). With a resolution 0.01 K, the deviation between the matched sensor pair ($\Delta T_{theoretical} = 0K$) can be read off after about 3 to 5 minutes.

## Several sensors for large pipe diameters

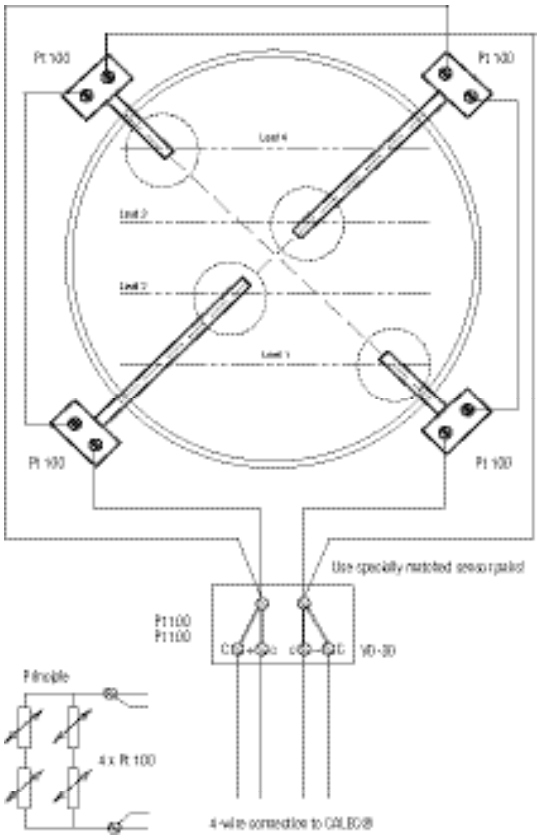



Fig.: Principle of temperature measurement with large pipe diameters

Temperature layering which occurs in the cross section of pipes must be considered with long horizontal or pipework (>300 mm) and low flow velocities and where measurements are taken at a single measurement point.

When water is not flowing, the lower pipe side becomes colder than the upper side (boiler effect). The assumption that the actual mean temperature is in the centre of this range is rarely correct.

It is often the case that four sensors per pipe will provide a certain improvement by taking the average temperature (two Pt 100 each are connected in series and both measuring arms are then connected in parallel which again results in an initial 100 Ω value).

The connection cables must, of course, be absolutely symmetrical up to the four-wire connection. It should be noted that this arrangement cannot offer any greater advantage than that of individual sensors. However, it does allow larger temperature differences to be detected within the pipe.

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