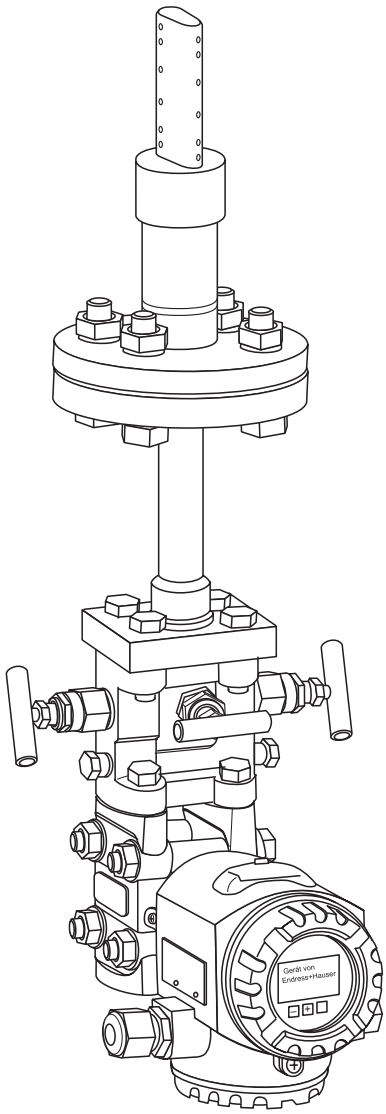
Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Operating Instructions

Deltatop DP71B, DP72B, DP73B

Pitot tubes for differential pressure flow measurement



BA386P/00/EN/07.09
71098177

Endress+Hauser

People for Process Automation

Table of Contents

1 Safety instructions

1.1 Designated use

The measuring system is used to measure the volume or mass flow of saturated steam, superheated steam, gases and liquids.
In the event of incorrect use or use other than that designated, the operational safety of the measuring devices can be suspended. The manufacturer accepts no liability for damage arising as a result.

1.2 Installation, commissioning and operation

The Deltatop is a fail-safe, state-of-the-art measuring system, and meets the applicable standards and EC directives. If used incorrectly or for applications for which it is not intended, however, it can be a source of application-related danger, e.g. product overflow due to incorrect installation or configuration. Installation, electrical connection, startup, operation and maintenance of the measuring device must therefore be carried out exclusively by trained specialists authorized to perform such work by the system operator. Technical personnel must have read and understood these Operating Instructions and must adhere to them. You may only undertake modifications or repair work to the device if this is expressly permitted in the Operating Instructions.

1.3 Hazardous locations

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of these Operating Instructions. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.

- Ensure that all personnel are suitably qualified.
- Observe the specifications in the certificate as well as national and local standards and regulations.

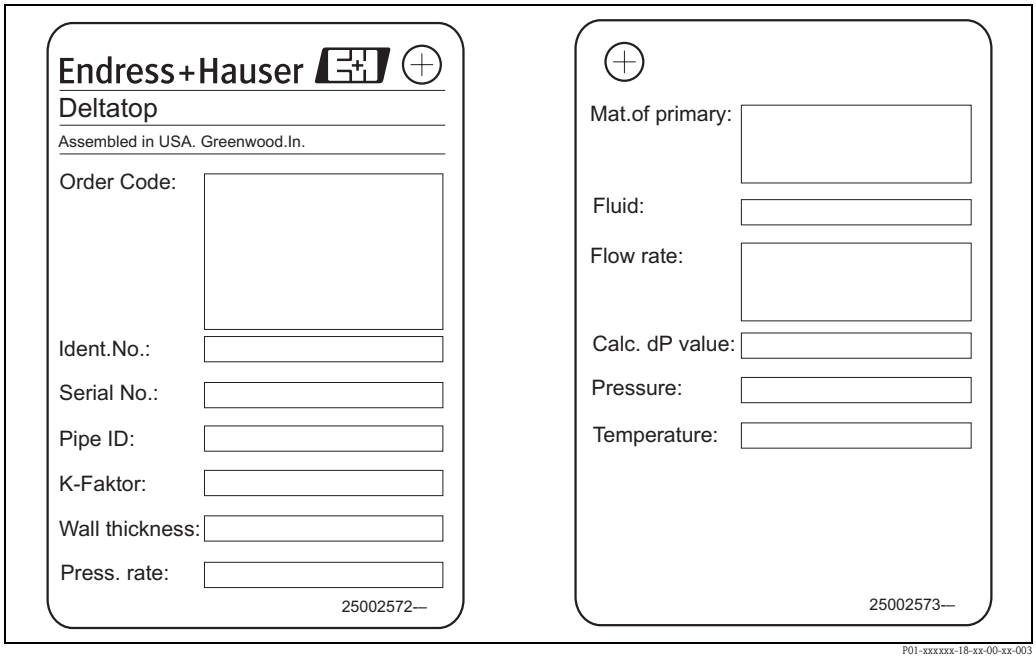
1.4 Notes on safety conventions and icons

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding symbol in the margin.

Safety conventions	
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or the destruction of the device.
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or the incorrect operation of the device.
	**Note!** A note highlights actions or procedures which, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.
Explosion protection	
	**Device certified for use in hazardous locations** If the device has this symbol embossed on its nameplate it can be installed in a hazardous location
	**Hazardous location** Symbol used in drawings to indicate hazardous locations. Devices located in and wiring entering areas designated as “hazardous locations” must comply with the stated type of protection.
	**Safe area (non-hazardous location)** Symbol used in drawings to indicate, if necessary, non-hazardous locations. Devices located in safe areas still require a certificate if their outputs run into hazardous locations.
Electrical symbols	
	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied.
	Alternating voltage A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied.
	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of a grounding system.
	**Protective grounding (earth) terminal** A terminal which must be connected to ground prior to making any other connection to the equipment.
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system. This may be an equipotential line or neutral star bonding depending on national or company codes of practice.
	**Temperature resistance of the connection cables** States that the connection cables must be able to withstand a temperature of at least 185°F (85 °C).

2 Identification

2.1 Nameplate



Order code: *Order code of the device according to the product structure (see Technical Information TI441P)*
Ident. No.: *Identification number; characterizes the device unambiguously*
Serial No.: *Serial number*
Pipe ID: *Inner diameter of the measuring pipe*
K-factor: *Flow coefficient of the Pitot tube*
Wall thickness: *Wall thickness of the measuring pipe*
Press. rate: *Pressure rating*
Mat. of primary: *Material of the Pitot tube*
Medium: *Medium for which the device has been sized*
Flow rate: *Flow rate for which the device has been sized (operating point)*
Calc dP value: *Calculated differential pressure at the operating point*
Pressure: *Operating pressure*
Temperature: *Operating temperature*

2.2 Product structure

See Technical Information TI441P.

2.3 Documentation

2.3.1 Deltatop

Document	Device	Designation
Technical Information		
TI441P	DP71B, DP72B, DP73B	Differential pressure flow measurement with Pitot tubes and Deltabar differential pressure transmitter
Operating Instructions		
BA386P	DP71B, DP72B, DP73B	Differential pressure flow measurement with Pitot tubes and Deltabar differential pressure transmitter

2.3.2 Deltabar S

Document	Device	Designation
Technical Information		
TI382P	Deltabar S	Differential pressure transmitter
Operating Instructions		
BA270P	Deltabar S	Differential pressure transmitter - HART
BA294P	Deltabar S	Differential pressure transmitter - PROFIBUS PA
BA301P	Deltabar S	Differential pressure transmitter - FOUNDATION FIELDBUS
Description of Device Functions		
BA274P	Cerabar S/Deltabar S/Deltapilot S	Pressure and differential pressure transmitter HART
BA296P	Cerabar S/Deltabar S/Deltapilot S	Pressure and differential pressure transmitter PROFIBUS PA
BA303P	Cerabar S/Deltabar S/Deltapilot S	Pressure and differential pressure transmitter FOUNDATION FIELDBUS
Safety Instructions		
XA235P	Deltabar S	ATEX II 1/2 G EEx ia
XA237P	Deltabar S	ATEX II 1/2 D
XA239P	Deltabar S	ATEX II 1/3 D
XA240P	Deltabar S	ATEX II 2G EEx d
XA241P	Deltabar S	ATEX II 3 G EEx nA
XA242P	Deltabar S	ATEX II 1/2 G EEx id; ATEX II 2 G EEx d
XA243P	Deltabar S	ATEX II 1/2 GD EEx ia
XA275P	Deltabar S	ATEX II 1 GD EEx ia

2.3.3 Deltabar M

Document	Device	Designation
Technical Information		
TI434P	Deltabar M	Differential pressure transmitter
Operating Instructions		
BA382P	Deltabar M	Differential pressure transmitter - HART
Safety Instructions		
XA457P	Deltabar M	ATEX II 1/2 G, II 2 G, Ex ia IIC T6 to T4
XA463P	Deltabar M	ATEX II 3 G Ex nA IIC T6 to T4
XA459P	Deltabar M	IECEx Ex ia IIC T6 to T4 Ga/Gb
XA462P	Deltabar M	IECEx Ex d IIC T6 Gb, Ex d IIC T4 Gb
XA461P	Deltabar M	KEMA II 2 G Ex d IIC T6, Ex d IIC T4

2.3.4 Flow and Energy Manager RMS621/RMC621

Document	Device
Technical Information	
TI092R	Flow and Energy Manager RMS621
TI098R	Universal Flow and Energy Manager RMC621
Operating Instructions	
BA127R	Flow and Energy Manager RMS621
BA144R	Universal Flow and Energy Manager RMC621

2.4 Registered trademarks

HART®
Registered trademark of the HART Communication Foundation, Austin, USA

PROFIBUS®
Registered trademark of the PROFIBUS Trade Organization, Karlsruhe, Germany

FOUNDATION Fieldbus®
Registered trademark of the Fieldbus Foundation Austin, Texas, USA

VITON®
Registered trademark of E.I. Du Pont de Nemours & Co., Wilmington, USA

Ermeto®
Registered trademark of Parker Hannifin GmbH, Bielefeld, Germany

3 Installation

3.1 Incoming acceptance, transport, storage

3.1.1 Incoming acceptance

Check the packing and contents for any sign of damage.
Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.1.2 Transport

Caution!
Follow the safety instructions and transport conditions for devices of more than 39.68 lbs (18 kg).
Do not lift the measuring device by the housing of the transmitter in order to transport it.

3.1.3 Storage

For storage and transport, pack the measuring device so that is protected against impact. The original packaging material provides optimum protection.
The permissible storage temperature for the Deltabar transmitter is -40 to +185 °F (-40 to +85 °C).

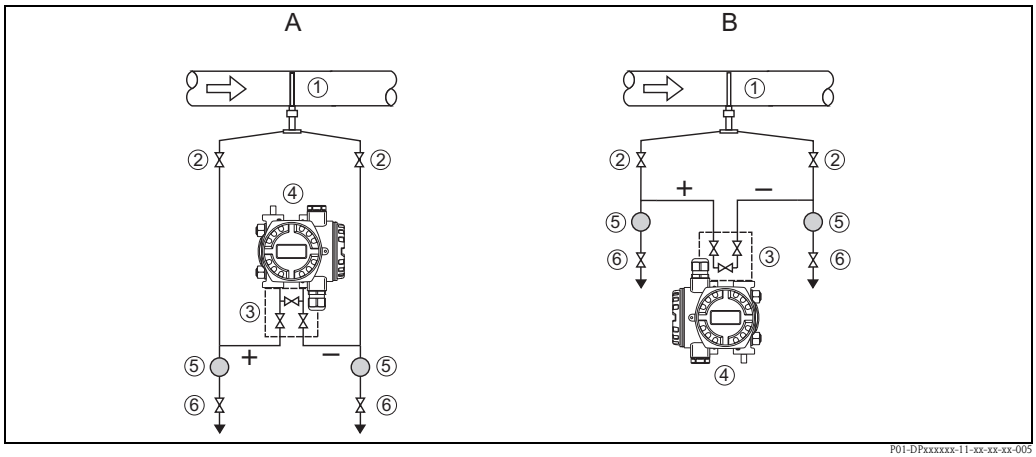
3.2 Dimensions

See Technical Information TI441P.

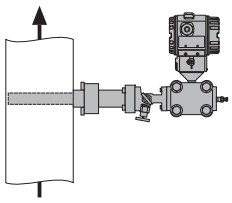
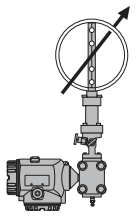
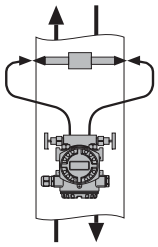
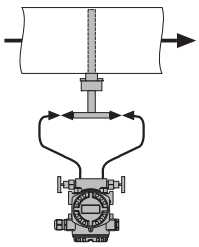
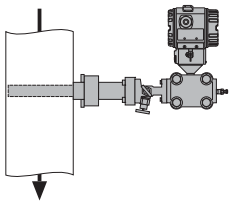
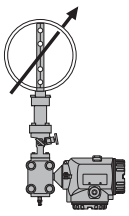
3.3 Mounting position for liquid or steam applications

With liquid or steam applications, the transmitter must be mounted below the pipe. All impulse pipes must be installed with a slope of at least 1:15 to the transmitter – coming from the process connection. This ensures that trapped air travels back to the process pipe and thus does not influence the measurement.

Note!
When measuring in media with solid contents, such as dirty liquids, installing separators (5) and drain valves (6) is useful for capturing and removing sediment.



A: *Preferred configuration* ***B:*** *Alternative configuration (requires less space; only possible for clean media)*
1: *Pitot tube* ***2:*** *Shut-off valves* ***3:*** *Three-valve manifold* ***4:*** *Deltabar differential pressure transmitter* ***5:*** *Separator* ***6:*** *Drain valves*

Compact; vertical[1)]	**Compact; horizontal**[2)]	**Remote; vertical**	**Remote; horizontal**
flow upwards DP7xB-EV... (liquid) DP7xB-GV... (steam)  P01-DP61Dxxx-11-00-00-xx-001	mounting left DP7xB-EB... (liquid); DP7xB-GB... (steam)  P01-DP61Dxxx-11-00-00-xx-009	upwards/downwards DP7xB-DW... (liquid) DP7xB-FW... (steam)  P01-DP61Dxxx-11-00-00-xx-014	top/bottom DP7xB-DD... (liquid) DP7xB-FD... (steam)  P01-DP61Dxxx-11-00-00-xx-017
flow downwards DP7xB-EU... (liquid) DP7xB-GU... (steam)  P01-DP61Dxxx-11-00-00-xx-002	mounting right DP7xB-EC... (liquid) DP7xB-GC... (steam)  P01-DP61Dxxx-11-00-00-xx-010		

1) Recommended housing version for the Deltabar S: T14 (for use of the Deltabar display)

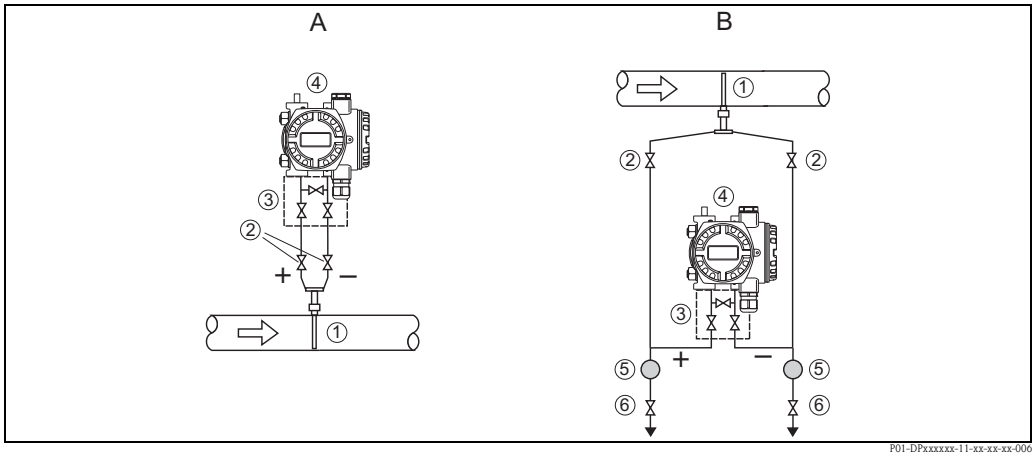
2) Recommended housing version for the Deltabar S: T15 (for use of the Deltabar display)

Caution!
For flow measurements in vertical pipes, the primary device should be mounted at a position with upward flow. This prevents partial emptying of the pipe during measurement.

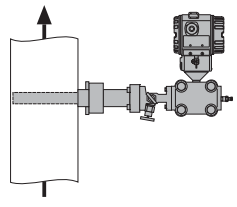
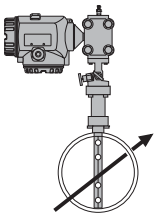
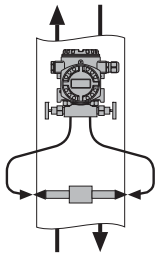
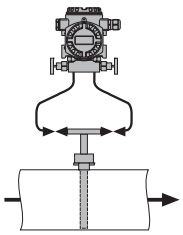
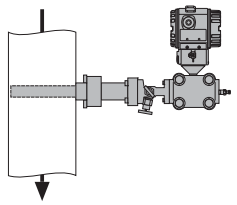
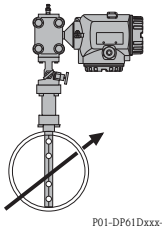
3.4 Mounting position for gas applications

With gas applications, the transmitter must be mounted above the pipe. All impulse pipes must be installed with a slope of at least 1:15 to the process connection – coming from the transmitter. This ensures that any condensate flows back into the process pipe and thus does not influence the measurement.

Note!
When measuring in humid gases, installation of condensate separators (5) and drain valves (6) is useful for capturing and removing condensate.



A: *Preferred configuration* ***B:*** *Alternative configuration (if the transmitter cannot be mounted above the pipe)*
1: *Pitot tube* ***2:*** *Shut-off valves* ***3:*** *Three-valve manifold* ***4:*** *Deltabar differential pressure transmitter* ***5:*** *Separator* ***6:*** *Drain valve*

Compact; vertical[1]	**Compact; horizontal**[2]	**Remote; vertical**	**Remote; horizontal**
flow upwards DP7xB–CV...  P01-DP61Dxxx-11-00-00-xx-001	mounting left DP7xB–CB...  P01-DP61Dxxx-11-00-00-xx-007	upwards/downwards DP7xB–BW...  P01-DP61Dxxx-11-00-00-xx-013	top/bottom DP7xB–BD...  P01-DP61Dxxx-11-00-00-xx-016
flow downwards DP7xB–CU...  P01-DP61Dxxx-11-00-00-xx-002	mounting right DP7xB–CC...  P01-DP61Dxxx-11-00-00-xx-008		

1) Recommended housing version for the Deltabar S: T14 (for use of the Deltabar display)

2) Recommended housing version for the Deltabar S: T15 (for use of the Deltabar display)

3.5 General mounting conditions

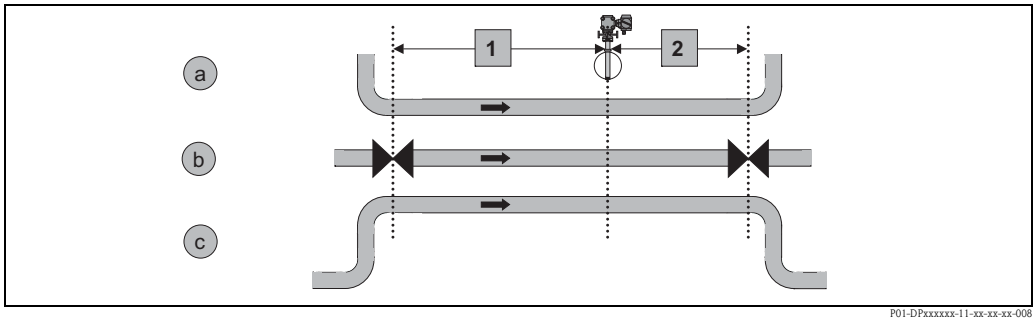
3.5.1 Upstream and downstream lengths

In order to ensure a homogeneous flow profile, it is necessary to mount the Pitot tube at a sufficient distance to narrowings or bends in the pipe. The required upstream and downstream lengths for different types of obstacles are summarized in the following table:

Type of obstacle	Min. upstream length	Min. downstream length
90° bend	7 x D	3 x D
2x90° bend in the same plane	9 x D	3 x D
2x90° bend in perpendicular planes	18 x D	3 x D
Concentric reducer	8 x D	3 x D
Concentric expander	8 x D	3 x D
Ball/gate valve, fully open	24 x D	4 x D

D: Inner pipe diameter

Examples (schematic)



***1:** Upstream length **2:** Downstream length*
***a:** 90° bend **b:** Valve, open **c:** 2x90° bend*

3.5.2 Homogeneity

The medium must be homogeneous. **Changes of the state of aggregation** (liquid, gas, steam) are not permissible.
The measuring pipe must be **completely filled**.

3.5.3 Mounting position

- The mounting position must be chosen such that access to the transmitter is always possible.
- If the following process temperatures are exceeded, a remote version has to be used. The transmitter must be mounted at a sufficient distance from the primary device.

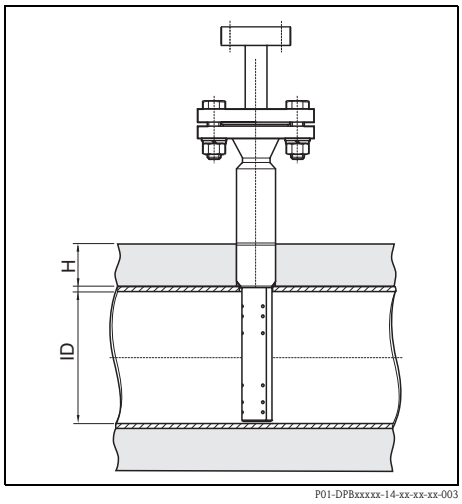
	Compact version	**Remote version**
Max. temperature	▪ For gases, liquids and steam: 390 °F (200°C)	▪ With standard material: approx. 800 °F (427 °C)
Max. pressure	6000 psi (420 bar)	

3.5.4 Heat insulation

Some applications require suitable measures to avoid heat loss to the environment. A wide range of materials can be used to provide the required insulation.
With the compact version, the thickness of the insulating layer is taken into account in the sizing. The actual thickness must not be larger than the thickness specified in the "Sizing sheet – data sheet".
In the case of insulated pipes, make sure that the impulse pipes are not covered in order to ensure sufficient heat dissipation. Otherwise the transmitter may become overheated (or undercooled). This applies equally to both the compact and the remote version.

Caution!
Danger of electronics overheating!
Make sure that the impulse pipes between the primary element and the transmitter are always kept free of insulation.

Caution!
With insulated pipes, the length of the mounting nozzle must be increased by the thickness H of the insulating layer. Therefore, this thickness must be specified on the "Sizing sheet – data sheet" (see Technical Information TI441P). The material of the mounting nozzle extension must be specified in the product structure (feature 80).
The following lengths are available for the extension of the mounting nozzle:
- 2" (50 mm)
- 4" (100 mm)
- 5" (127 mm)
- 6" (152.4 mm)

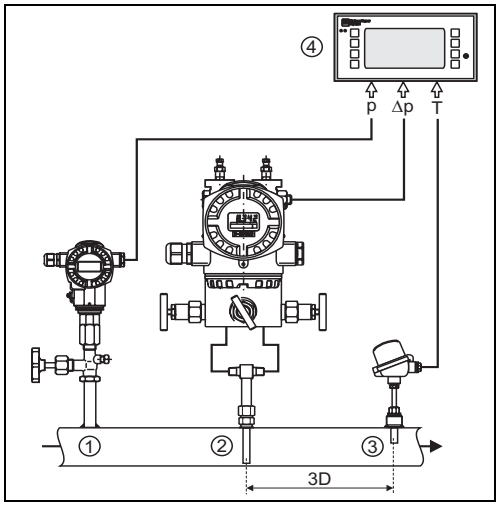


ID: *Inner pipe diameter*
H: *Thickness of the insulating layer*

3.5.5 Mounting position for temperature and pressure compensation

Separate process connections
Two additional probes are required for temperature and pressure compensation:

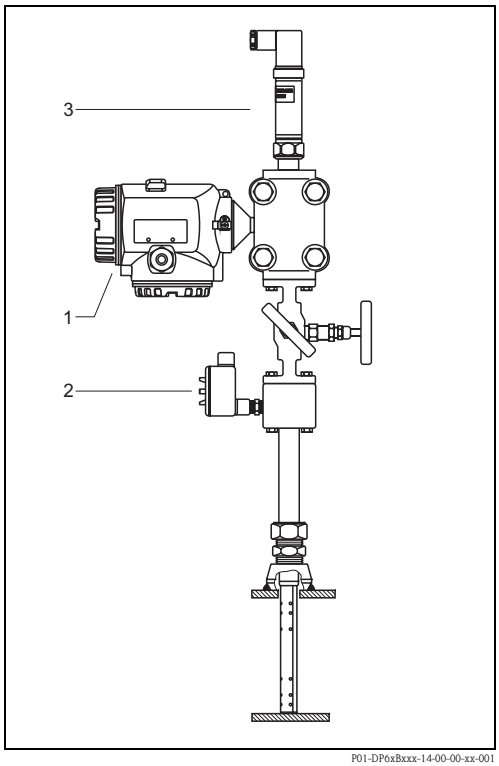
- **An absolute pressure sensor**
  This sensor must be mounted on the upstream side of the Pitot tube.
- **A temperature probe**
  In order to avoid disturbances of the flow profile, this probe is to be mounted on the downstream side of the Pitot tube. The minimum distance between the Pitot tube and the temperature probe is 3D.
  (D: diameter of the pipe)



1: Absolute pressure probe
2: Pitot tube and differential pressure transmitter
3: Temperature probe
4: Flow computer

Combined process connection for absolute pressure, differential pressure and temperature

- Versions of the Deltatop DP72B and DP73B units are available with an integrated Pt100 temperature probe.
- In the case of Deltabar S, an adapter (e.g. oval flange PZO, see TI441P) can be used to screw a pressure transmitter or a pressure sensor into the Deltabar S flange. The absolute pressure sensor must be mounted at the "+" side of the Deltabar S.



1: Deltabar S differential pressure transmitter
2: Integrated Pt100 temperature probe
3: Absolute pressure transmitter (has to be ordered separately)

For the calculation of the compensated flow, refer to Page → 37.

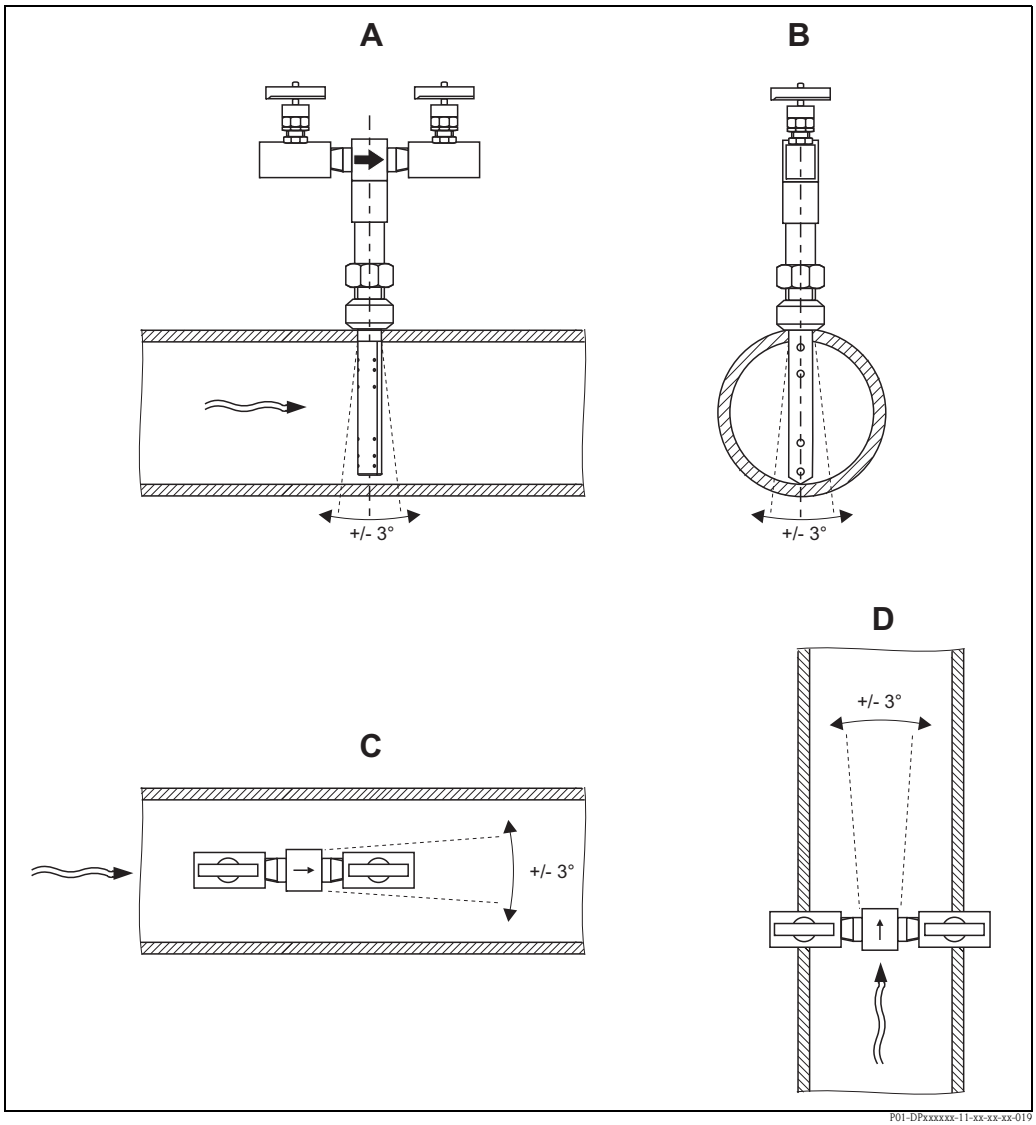
3.5.6 Practical limits

For a reliable measurement with Pitot tubes, the practical limits are shown in the table below. Equivalent dp with the respective medium velocity.

Medium	Minimum DP	Equivalent velocity
Gas	0.1" (2.5 mm) H_2O	15 ft/sec. (4.5 m/sec.)
Liquid	1.0" (25 mm) H_2O	2 ft/sec. (0.6 m/sec.)
Steam	1.5" (38 mm) H_2O	32 ft/sec. (9.7 m/sec.)

3.5.7 Alignment of the Pitot tube

Align the head of the sensor so that the arrow labeled "flow" on the head is in the direction of the flow in the pipe to within the following limits:

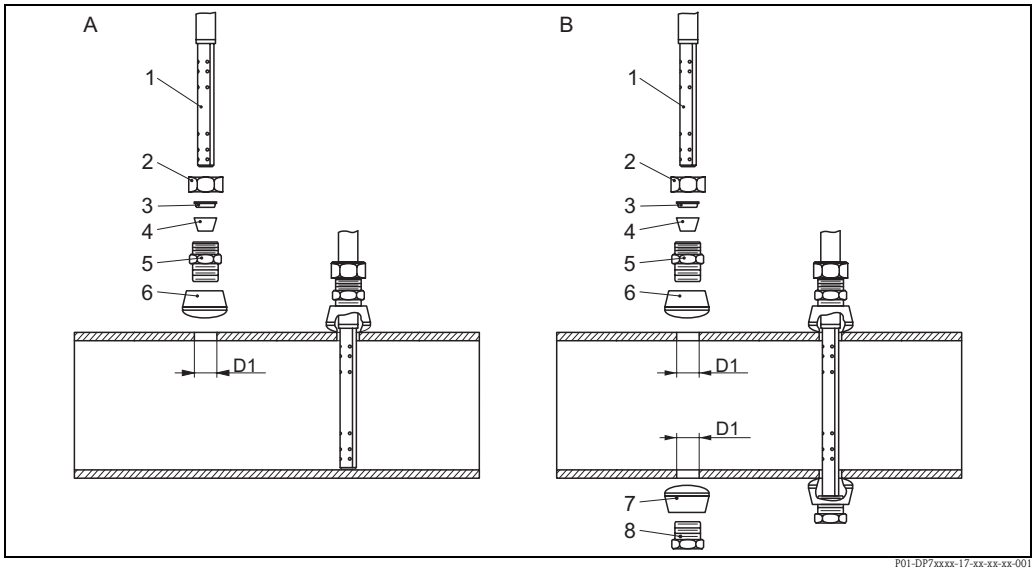


A: *Axial alignment;*
B: *Radial alignment;*
C: *Alignment in the flow direction (for horizontal pipes)*
D: *Alignment in the flow direction (for vertical pipes)*

3.6 General mounting information

- The primary element is calculated for specific pipe and operating data. Therefore it is essential to check if the data on the nameplate (→ 📄 6) match the actual operating data.
- Before installing the device, check if the required upstream and downstream lengths are provided (→ 📄 12).
- Observe the required mounting position:
  – For liquids or steam: → 📄 10
  – For gases: → 📄 11
- For remote versions:
  The shut-off valves are mounted to the pressure taps of the primary element.
- For remote versions:
  The impulse pipes have to be installed with a slope of at least 1:15.
  – For steam and liquids, a venting possibility has to be provided at the highest point.
  – For gases, a drainage has to be provided at the lowest point.
  The impulse lines (+) and (-) have to be mounted to the respective inlets (process connection) of the manifold. The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.7 Installation steps for the welding socket version



A: *Without end support* ***B:*** *With end support*
1: *Sensor* ***2:*** *Compression nut* ***3:*** *Back ferrule* ***4:*** *Front ferrule* ***5:*** *Compression body* ***6:*** *Welding socket*
7: *Opposite end welding socket* ***8:*** *Support plug*

Probe	Diameter of the hole (D1)
DP71B	1/2" (13 mm)
DP72B	1" (25 mm)

Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?

1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. Loosely assemble the sensor to the welding socket (hand-tight) and insert the sensor assembly into the pipe.
4. Tack the welding socket into position by using the appropriate weld gap (typically 1/16" (1.5 mm)).
5. Remove the sensor.
6. Protect the threads on the welding socket and finish welding the welding socket to the pipe as per the applicable piping codes.
7. If an end support is to be mounted:
   a. Take a cord and tie one of its ends around the welding socket. Wrap the other end of the cord around the pipe so that it forms a loop around the pipe. Mark the half-way point of the circumference on the pipe.
   b. Drill a second hole with the diameter D1 into the pipe.
   c. Tack-weld the end support onto the pipe by using the appropriate weld gap (typically 1/16" (1.5 mm)).
   d. Insert the probe into the pipe and check the alignment of the support. If necessary, adjust the alignment.

e. Remove the probe and perform the finish welding.

8. Using appropriate pipe thread sealant, install the compression body into the welding socket.
9. The tapered end of the front ferrule must point towards the compression body.
10. The back ferrule must be next to the front ferrule with the tapered end pointing toward the front ferrule.
11. Insert the probe, with the union compression nut and ferrules attached, into the compression body (do not tighten) until the sensor tip touches the opposite pipe wall or the end support.
12. Align the head of the sensor so that the cover labeled "flow" on the head is in the direction of the flow in the pipe to within 3°.
13. While pushing the sensor against the opposite wall with a force of at least 50 lbs (22 kg) tighten the union compression nut.
14. Check the sensor alignment again. If the sensor is not aligned correctly, loosen the union compression nut and repeat the last installation step.

3.7.1 Installation of the shut-off valves (for the remote version):

The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

3.7.2 Installation of the manifold and the transmitter (for the remote version):

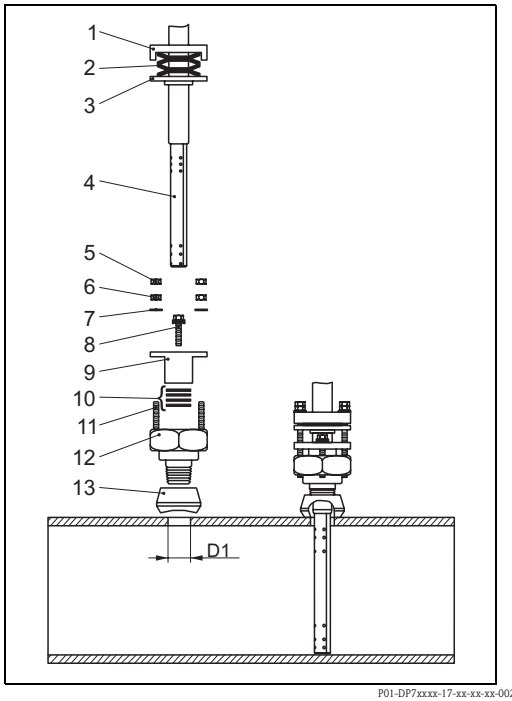
The impulse pipes have to be installed with the required slope.
(For liquids and steam: → 10, for gases: → 11).

- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.8 Installation steps for the welding socket version with a spring lock

Diameter of the hole D1
- DP71B: 1/2" (13 mm)
- DP72B: 1" (25 mm)

✎ Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?



1: Load plate 2: Load springs 3: Indicator ring
4: Sensor 5: Jam nuts 6: Load nuts 7: Lock washers
8: Packing bolts 9: Follower 10: Packing rings 11: Studs
12: Spring lock body 13: Welding socket

1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. With the follower and packing rings already in place, loosely insert the sensor into the spring lock body.
4. Thread the spring lock body into the welding socket (hand-tight) and then insert the complete assembly into the pipe.
   This ensures the welding socket is properly aligned to the hole already drilled in the pipe.
5. Tack-weld the welding socket into position by using the appropriate weld gap (typically 1/16" (1.5 mm)).
6. Remove the sensor and spring lock body.
7. Protect the threads on the welding socket and finish welding the welding socket to the pipe as per the applicable piping codes.
8. Using appropriate pipe thread sealant, thread the spring lock body into the welding socket.
9. With the follower and packing rings already in place, insert the sensor into the spring lock body until the tip of the sensor hits the opposite side of the pipe.

   ✎ Note!
   The three studs must pass through the indicator ring and the load plate.
10. Align the head of the sensor so that the arrow labeled "flow" on the head is in the direction of the flow in the pipe to within 3°.
11. Maintain the head in this position for the remainder of the installation procedure.
12. Place the three lock washers and the three load nuts on the studs and tighten.

✎ Note!
For the DP71B and DP72B sensors, tighten the load nuts until the load plate is 0.050" (1.3 mm) from the indicator ring.
For the DP73B sensors, the load plate should be 0.063" (1.6 mm) from the indicator ring.

13. Thread on the three jam nuts and tighten until they are resting hand-tight against the lock nuts.
14. Place a backup wrench on the load nut to prevent it from rotating. While not allowing the load nut to rotate.
15. Tighten the jam nuts 1/8 turn beyond hand-tight.
16. Tighten the three packing bolts to the appropriate torque value listed in the table below:

Sensor size	Packing bolt Torque (in-lbs)	Packing bolt Torque (ft-lbs)
DP71B	50	4.2
DP72B	100	8.3
DP73B	170	14.1

✎ Note!
The weld on the weld ring should not contact the top surface of the follower. If the weld on the weld ring comes into contact with the follower, the sensor will not be properly bottomed in the pipe. If this occurs, consult the factory before proceeding.

3.8.1 Installation of the shut-off valves (for the remote version):

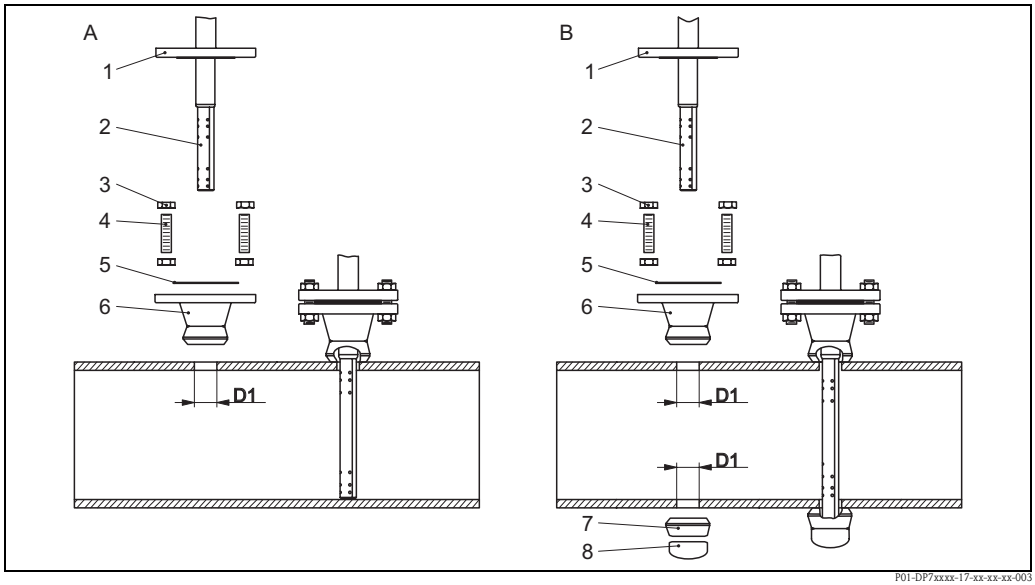
The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

3.8.2 Installation of the manifold and the transmitter for the remote version:

The impulse pipes have to be installed with the required slope.
(For liquids or steam: → 🗎 10, for gases: → 🗎 11).

- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.9 Installation steps for the welding flange version



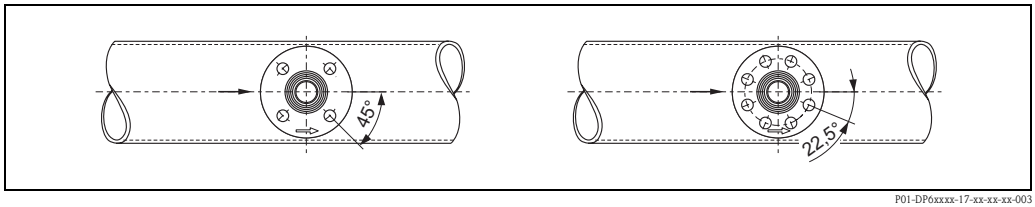
A: *Without end support* ***B:*** *With end support*
1: *Sensor flange* ***2:*** *Sensor* ***3:*** *Nut* ***4:*** *Stud* ***5:*** *Gasket* ***6:*** *Mounting flange and weld coupling*
7: *Weld coupling* ***8:*** *Weld cap*

Probe	Diameter of the hole (D1)
DP71B	1/2" (13 mm)
DP72B	1" (25 mm)
DP73B	1-1/2" (38 mm)

Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?

1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. Loosely bolt the sensor, gasket and mounting flange together (hand-tight).
4. Insert the assembly into the pipe. Align the head of the sensor so that the arrow labeled "flow" on the head is in the direction of the flow to within 3°.
5. Tack-weld the mounting flange into position by using the appropriate weld gap (typically 1/16" (1.5 mm)).

   Note!
   The bolt holes of the flange must be at 45° angles (for four holes) or 22.5° angles (for eight holes) to the pipe axis.



6. If an end support is to be mounted:
   a. Take a cord and tie one of its ends around the welding socket. Wrap the other end of the cord around the pipe so that it forms a loop around the pipe. Mark the half-way point of the circumference on the pipe.
   b. Drill a second hole with the diameter D1 into the pipe.
   c. Tack-weld the end support onto the pipe by using the appropriate weld gap (typically 1/16" (1.5 mm)).
   d. Insert the sensor into the pipe and check the alignment of the support. If necessary, adjust the alignment.
7. Remove the sensor and finish welding the weld couplings as per the applicable piping codes.
8. For the model with an end support, weld the weld coupling and weld the cap into position.
9. Place the supplied gasket surface on the flange, insert the probe into the welding socket and make sure that the arrow on the probe head points in the flow direction.
10. Tighten the bolts and nuts.

3.9.1 Installation of the shut-off valves (for the remote version):

The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

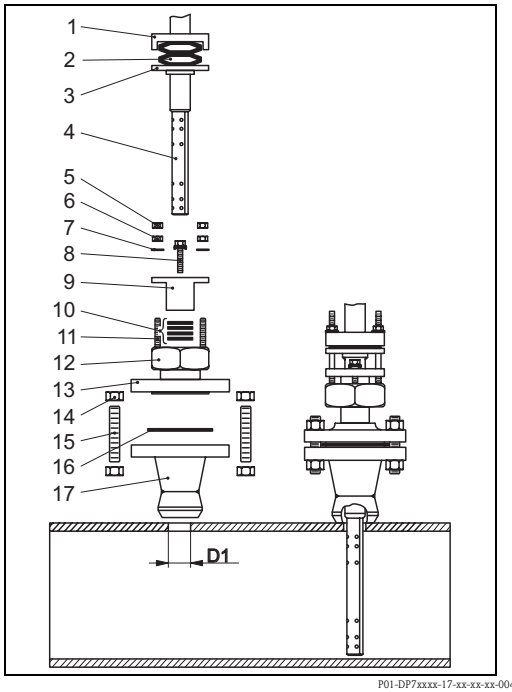
3.9.2 Installation of the manifold and the transmitter (for the remote version):

The impulse pipes have to be installed with the required slope
(for liquids and steam: → 📄 10, for gases: → 📄 11).
- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.10 Installation steps for the welding flange version with a spring lock

Diameter of the hole D1
- DP71B: 1/2" (13 mm)
- DP72B: 1" (25 mm)

Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?

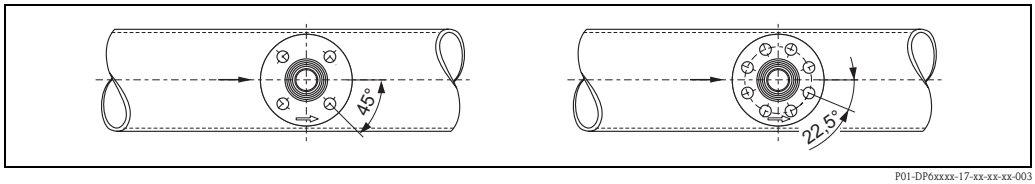


P01-DP7xxxx-17-xx-xx-xx-004

1: Load plate 2: Load springs 3: Indicator ring
4: Sensor 5: Jam nuts 6: Load nuts 7: Lock washers
8: Packing bolts 9: Follower 10: Packing rings 11: Studs
12: Spring lock body 13: Sensor flange 14: Nut 15: Stud
16: Gasket 17: Mounting flange and weld coupling

1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. With the follower and packing rings already in place, loosely insert the sensor into the spring lock body.
4. Loosely bolt the sensor, gasket and mounting flange together (hand-tight).
5. Insert the assembly until the tip of the sensor hits the opposite side of the pipe.
6. Align the head of the sensor so that the arrow labeled "flow" on the head is in the direction of the flow to within 3°.
7. Tack-weld the mounting flange into position by using the appropriate weld gap (typically 1/16" (1.5 mm)).

   Note!
   The bolt holes of the flange must be at 45° angles (for four holes) or 22.5° angles (for eight holes) to the pipe axis.



P01-DP6xxxx-17-xx-xx-xx-003

8. Remove the sensor and the sensor flange and finish welding the weld coupling to the pipe as per the applicable piping codes.
9. For the model with an end support, weld the weld coupling and weld the cap into position.

10. With the follower and packing rings already in place, insert the sensor into the spring lock body.

    ✎ Note!
    The three studs must pass through the indicator ring and the load plate.

11. Bolt the sensor flange to the mounting flange with the gasket between the flanges. The nuts should be tightened until the gasket is completely compressed.
12. Insert the assembly until the tip of the sensor hits the opposite side of the pipe wall or the end support. Align the head of the sensor so that the arrow labeled "flow" on the head is in the direction of the flow in the pipe to within 3°.
13. Maintain the head in this position for the remainder of the installation procedure.
14. Place the three lock washers and the three load nuts on the studs and tighten.

    ✎ Note!
    For the DP71B and DP72B sensors, tighten the load nuts until the load plate is 0.050" (1.3 mm) from the indicator ring.
    For the DP73B sensors, the load plate should be 0.063" (1.6 mm) from the indicator ring.

15. Thread on the three jam nuts and tighten until they are resting hand-tight against the lock nuts.
16. Place a backup wrench on the load nuts to prevent them from rotating. While not allowing the load nuts to rotate.
17. Tighten the jam nuts 1/8 turn beyond hand-tight.
18. Using a torque wrench, tighten the three packing bolts to the appropriate torque value listed in the table below:

Sensor size	Packing bolt Torque (in-lbs)	Packing bolt Torque (ft-lbs)
DP71B	50	4.2
DP72B	100	8.3
DP73B	170	14.1

✎ Note!
The weld on the weld ring should not contact the top surface of the follower. If the weld on the weld ring comes into contact with the follower, the sensor will not be properly bottomed in the pipe. If this occurs, consult the factory before proceeding.

3.10.1 Installation of the shut-off valves (for the remote version):

The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

3.10.2 Installation of the manifold and the transmitter (for the remote version):

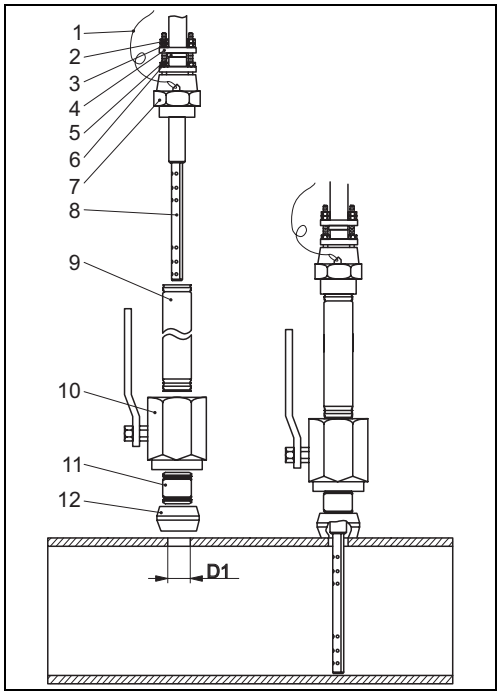
The impulse pipes have to be installed with the required slope
(for liquids or steam: → 🗎 10, for gases: → 🗎 11).

- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.11 Installation steps for the flowtap welding socket version with a safety chain

Diameter of the hole D1
- DP71B: 1/2" (13 mm)
- DP72B: 1" (25 mm)

Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?



1: Safety cable 2: Jam nuts 3: Retaining nuts
4: Retaining ring 5: Weld ring 6: Packing bolts
7: Packing gland 8: Sensor 9: Access nipple
10: Access valve 11: Close nipple 12: Welding socket

1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. Tack the welding socket onto the pipe by using the appropriate weld gap (typically 1/16" (1.5 mm)).
4. Protect the threads on the welding socket and finish welding the welding socket to the pipe as per the applicable piping codes.
5. Using appropriate pipe thread sealant:
   a. Screw the close nipple into the welding socket.
   b. Screw the ball valve into the close nipple. [1)]
   c. Thread the access nipple into the packing gland.
6. Retract the sensor such that the tip of the sensor is flush with the end of the access nipple.
7. Tighten the three packing bolts on the packing gland.
8. Apply appropriate thread sealant to the access nipple and thread the access nipple into the access valve.
9. Orient the sensor such that the arrow labeled "flow" on the device head is in the direction of the flow in the pipe to within 3°.

3.11.1 Installation of the shut-off valves (for the remote version):

The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

1) Be sure that the valve handle does not hit the pipe when opening and closing the valve.

3.11.2 Installation of the manifold and the transmitter (for the remote version):

The impulse pipes have to be installed with the required slope
(for liquids or steam: → 10, for gases: → 11).

- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.11.3 Sensor insertion of the probe without process interruption

1. The Deltatop should be oriented such that the arrow on the head is pointing in the direction of flow.
2. Attach a come-along or similar type of device to the come-along ring on the device head.
3. Wrap the other end of the come-along around the circumference of the pipe and firmly secure it.
4. Completely open the access valve.
5. Insert the Deltatop until the tip of the sensor completely bottoms on the opposite end of the pipe.
6. Once the sensor is completely bottomed, slide the retaining ring over the three retaining studs and tighten the retaining nuts until the ring presses firmly against the weld ring.
7. Jam nuts should now be threaded on and pressed tightly against the retaining nuts.

   ⚠ Warning!
   The retaining ring must be secured before the come-along is removed.
8. At this point, the come-along can be safely removed.
9. Re-verify that the orientation of the sensor is such that the arrow labeled "flow" on the device head is in the direction of the flow in the pipe to within 3°.

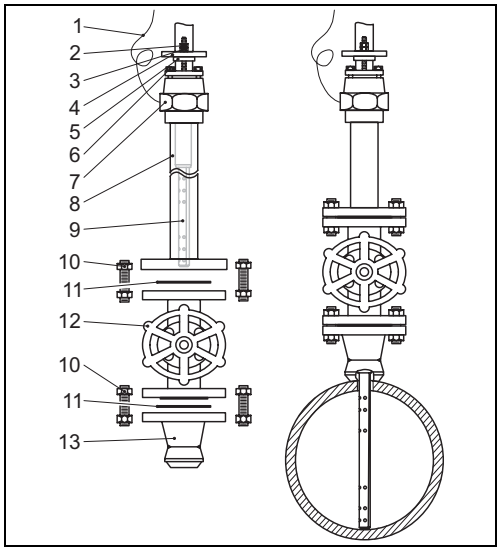
3.11.4 Sensor removal of the probe without process interruption

1. Shut off device valves (disconnect the impulse pipe if necessary).
2. Properly install a come-along and eliminate all slack from the come-along.
3. Remove jam nuts and retaining nuts.
4. Pull retaining ring off retaining studs.
5. Slowly retract the come-along and do not allow more than 1/2" (13 mm) of slack to develop in the come-along during the entire retraction process.
6. Retract the sensor until the safety cable is tight.
7. Completely shut off the access valve.
8. Slowly open one of the Deltatop device valves and bleed off any remaining pressure contained in the access nipple.
9. The sensor assembly can now be removed.

3.12 Installation steps for the flowtap flange socket version with a safety chain

Diameter of the hole D1
- DP71B: 1/2" (13 mm)
- DP72B: 1" (25 mm)

Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?

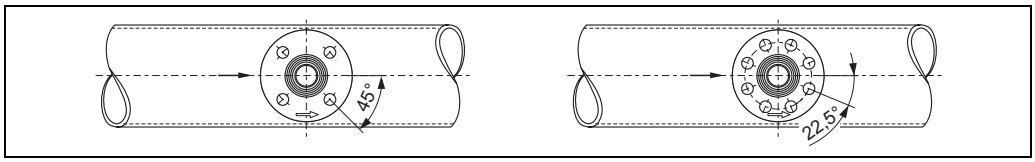


P01-DP7xxxx-17-xx-xx-xx-006

1: *Safety cable* ***2:*** *Jam nut* ***3:*** *Retaining nut*
4: *Retaining ring* ***5:*** *Weld ring* ***6:*** *Packing bolts*
7: *Packing gland* ***8:*** *Access nipple* ***9:*** *Sensor*
10: *Studs and nuts valve* ***11:*** *Gasket* ***12:*** *Access valve*
13: *Mounting flange*

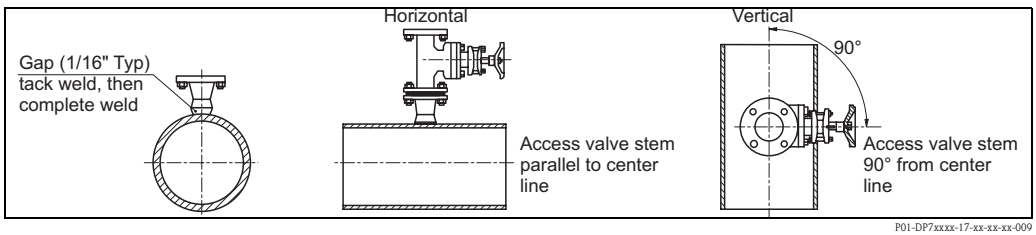
1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. Tack-weld the mounting flange into position by using the appropriate weld gap (typically 1/16" (1.5 mm)).

   Note!
   The bolt holes of the flange must be at 45° angles (for four holes) or 22.5° angles (for eight holes) to the pipe axis.



P01-DP6xxxx-17-xx-xx-xx-003

4. Bolt the access valve to the mounting flange using the gasket, studs and nuts provided.
5. Orient the valve such that the valve stem is parallel to the centerline of the pipe.
   a. For horizontal pipes, orient the valve such that the valve stem is parallel to the centerline of the pipe.
   b. For vertical pipes, orient the valve such that the valve stem is perpendicular to the centerline of the pipe.



P01-DP7xxxx-17-xx-xx-xx-009

6. Orient the sensor such that the arrow labeled "flow" on the device head is in the direction of the flow in the pipe to within 3°.
7. Bolt the access nipple to the access valve using the gasket studs and nuts provided.

3.12.1 Installation of the shut-off valves (for the remote version):

The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

3.12.2 Installation of the manifold and the transmitter (for the remote version):

The impulse pipes have to be installed with the required slope
(for liquids or steam: → 10; for gases: → 11).
- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.12.3 Sensor insertion of the probe without process interruption

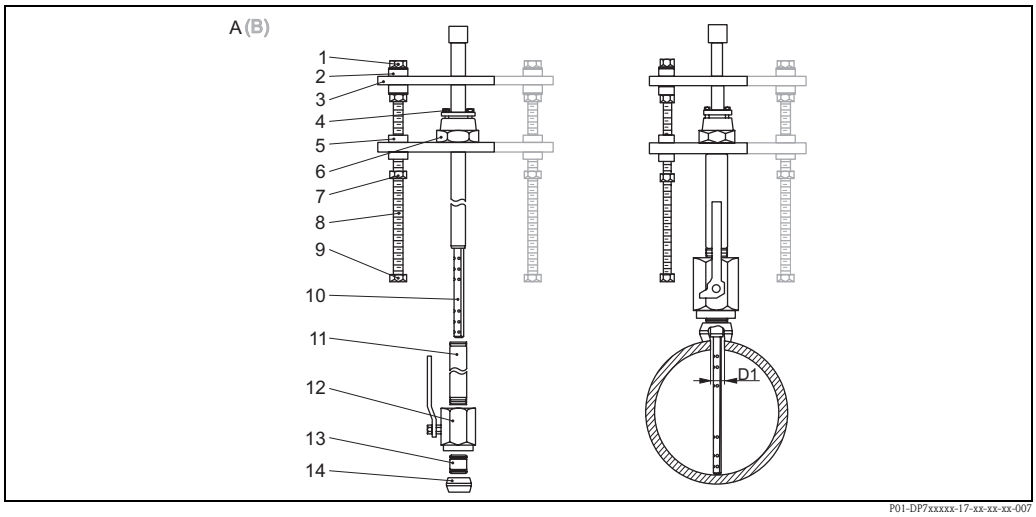
1. The Deltatop should be oriented such that the arrow on the head is pointing in the direction of flow.
2. Attach a come-along or similar type of device to the come-along ring on the device head.
3. Wrap the other end of the come-along around the circumference of the pipe and firmly secure it.
4. Completely open the access valve.
5. Insert the Deltatop until the tip of the sensor completely bottoms on the opposite end of the pipe.
6. Once the sensor is completely bottomed, slide the retaining ring over the three retaining studs and tighten the retaining nuts until the ring presses firmly against the weld ring.
7. Jam nuts should now be threaded on and pressed tightly against the retaining nuts.

   ⚠ Warning!
   The retaining ring must be secured before the come-along is removed.
8. At this point, the come-along can be safely removed.
9. Re-verify that the orientation of the sensor is such that the arrow labeled "flow" on the device head is in the direction of the flow in the pipe to within 3°.

3.12.4 Sensor removal of the probe without process interruption

1. Shut off device valves (disconnect the impulse pipe if necessary).
2. Properly install a come-along and eliminate all slack from the come-along.
3. Remove jam nuts and retaining nuts.
4. Pull retaining ring off retaining studs.
5. Slowly retract the come-along and do not allow more than 1/2" (13 mm) of slack to develop in the come-along during the entire retraction process.
6. Retract the sensor until the safety cable is tight.
7. Completely shut off the access valve.
8. Slowly open one of the Deltatop device valves and bleed off any remaining pressure contained in the access nipple.
9. The sensor assembly can now be removed.

3.13 Installation steps for the flowtap welding socket version with a spindle



A: *Single rod* ***B:*** *Double rod*
1: *Drive nut* ***2:*** *Sensor bushing* ***3:*** *Sensor plate* ***4:*** *Packing bolts* ***5:*** *Threaded bushing* ***6:*** *Packing gland* ***7:*** *Jam nut*
8: *Threaded drive rod* ***9:*** *Stop nut* ***10:*** *Sensor* ***11:*** *Access nipple* ***12:*** *Access valve* ***13:*** *Close nipple* ***14:*** *Welding socket*

Probe	Diameter of the hole (D1)
DP71B	1/2" (13 mm)
DP72B	1" (25 mm)
DP73B	1-1/2" (38 mm)

Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?

1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. Tack the welding socket onto the pipe by using the appropriate weld gap typically 1/16" (1.5 mm)).
4. Protect the threads on the welding socket and finish welding the welding socket to the pipe as per the applicable piping codes.
5. Using appropriate pipe thread sealant:
   a. Screw the close nipple into the welding socket.
   b. Screw the ball valve into the close nipple.[2)]
   c. Thread the access nipple into the packing gland.
6. Retract the sensor such that the tip of the sensor is flush with the end of the access nipple.
7. Tighten the three packing bolts on the packing gland.
8. Apply appropriate thread sealant to the access nipple and thread the access nipple into the access valve.
9. Orient the sensor such that the arrow labeled "flow" on the device head is in the direction of the flow in the pipe to within 3°.

2) Be sure that the valve handle does not hit the pipe when opening and closing the valve.

3.13.1 Installation of the shut-off valves (for the remote version):

The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

3.13.2 Installation of the manifold and the transmitter (for the remote version):

The impulse pipes have to be installed with the required slope
(for liquids or steam: → 10; for gases: → 11).

- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.13.3 Sensor insertion of the probe without process interruption

⚠ Warning!
The flow rate must be decreased to the amount stated on the Deltatop tag: the maximum insertion/ withdrawn dp / flow limit.

1. Verify that the threaded rod is adequately greased prior to inserting the sensor.

   ✎ Note!
   A high-temperature grease should be used for all steam applications and for temperatures above 200°F (100°C).

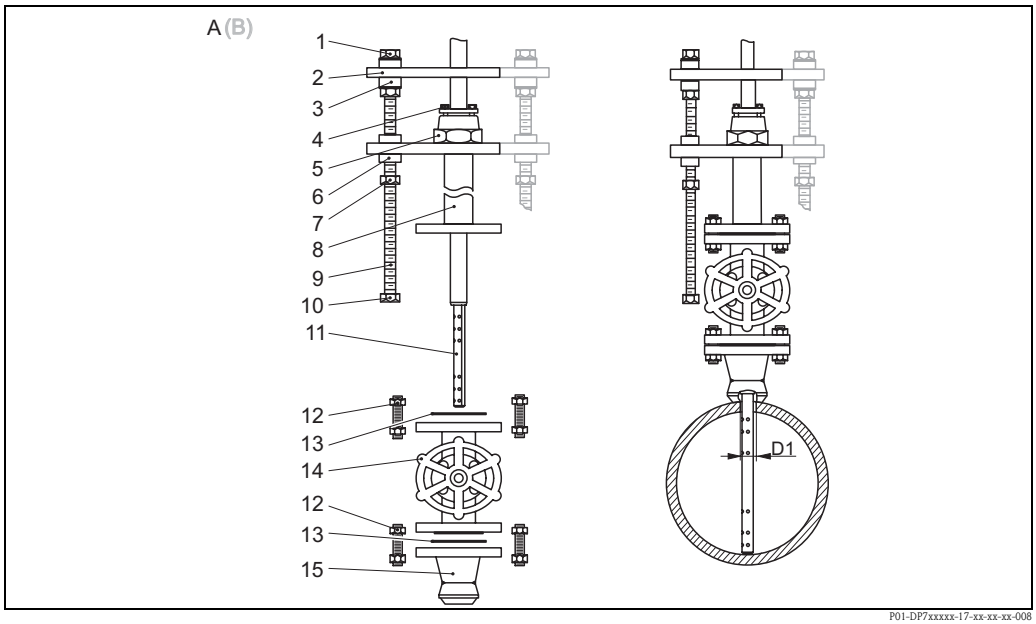
2. Completely open the access valve.
3. Then, using the drive nut, insert the sensor.
4. The tip of the sensor should completely bottom on the sensor until firm resistance is met. This will occur when the sensor plate is approximately 2" (51 mm) from the top of the packing gland.
5. Thread the jam nut towards the threaded bushing. The jam nut should press tightly against the threaded bushing. This will lock the drive rod in place and maintain the sensor position in the pipe.

3.13.4 Sensor removal of the probe without process interruption

⚠ Warning!
The flow rate must be decreased to the amount stated on the Deltatop tag: the maximum insertion/ withdrawn dp / flow limit.

1. Shut off device valves (disconnect the impulse pipe if necessary).
2. Loosen the jam nut. Using the drive nut, retract the sensor until the stop nut and jam nut are pressing against the threaded bushing.
3. Completely shut off the access valve.
4. Slowly open one of the Deltatop device valves and bleed off any remaining pressure contained in the access nipple.
5. The sensor assembly can now be removed.

3.14 Installation steps for the flowtap welding flange version with a spindle



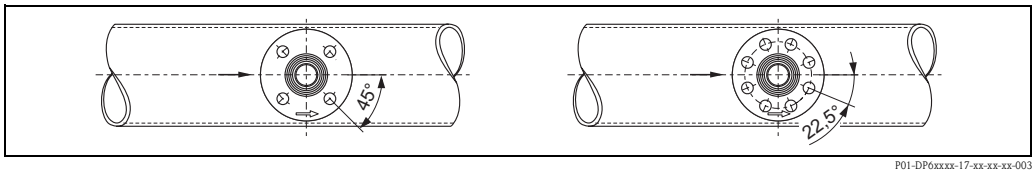
A: *Single rod* ***B:*** *Double rod*
1: *Drive nut* ***2:*** *Sensor plate* ***3:*** *Sensor bushing* ***4:*** *Packing bolts* ***5:*** *Packing gland* ***6:*** *Threaded bush* ***7:*** *Jam nut*
8: *Access nipple* ***9:*** *Threaded drive rod* ***10:*** *Stop nut* ***11:*** *Sensor* ***12:*** *Studs and nuts* ***13:*** *Gasket* ***14:*** *Access valve*
15: *Mounting flange*

Probe	Diameter of the hole (D1)
DP71B	1/2" (13 mm)
DP72B	1" (25 mm)
DP73B	1-1/2" (38 mm)

Note!
- Do the pipe dimensions (inner diameter, wall thickness, thickness of insulation) match the data of the order and the specifications of the device?
- Do the medium properties and process data match the specifications on the supplied calculation sheet?

1. Completely depressurize and drain the pipe prior to installing the Deltatop.
2. Drill a hole with the diameter D1 into the pipe.
3. Tack-weld the welding socket into position by using the appropriate weld gap.typically 1/16" (1.5 mm)).

   Note!
   The bolt holes of the flange must be at 45° angles (for four holes) or 22.5° angles (for eight holes) to the pipe axis.



4. Bolt the access valve to the mounting flange using the gasket, studs and nuts provided.

5. Orient the valve such that the valve stem is parallel to the centerline of the pipe.
   a. For horizontal pipes, orient the valve such that the valve stem is parallel to the centerline of the pipe.
   b. For vertical pipes, orient the valve such that the valve stem is perpendicular to the centerline of the pipe.
6. Orient the sensor such that the arrow labeled "flow" on the device head is in the direction of the flow in the pipe to within 3°.
7. Bolt the access nipple to the access valve using the gasket studs and nuts provided.

3.14.1 Installation of the shut-off valves (for the remote version):

The shut-off valves have to be mounted to the nozzles of the primary element before mounting the sensor into the pipe.

3.14.2 Installation of the manifold and the transmitter (for the remote version):

The impulse pipes have to be installed with the required slope
(for liquids or steam: → 10; for gases: → 11).
- For steam and liquids, a venting possibility has to be provided at the highest point.
- For gases, a drainage has to be mounted at the lowest point. The impulse lines (+) and (-) have to be mounted to the respective inlets (process connections) of the manifold.
  The transmitter is directly screwed to the manifold with the supplied screws and gaskets.

3.14.3 Sensor insertion of the probe without process interruption

Warning!
The flow rate must be decreased to the amount stated on the Deltatop tag: the maximum insertion/ withdrawn dp / flow limit.

1. Completely open the access valve. Then, using the drive nut, insert the sensor. The drive nuts should be alternately tightened approximately 1/8" (3 mm) at a time.
2. The tip of the sensor should completely bottom on the opposite end of the pipe. Continue to insert the sensor until firm resistance is met. This will occur when the sensor plate is approximately 2" (51 mm) from the top of the packing gland.
3. Thread the jam nuts toward the threaded bushings. The jam nuts should press tightly against the threaded bushings. This will lock the drive rods in place and maintain the sensor position in the pipe.

3.14.4 Sensor removal of the probe without process interruption

Warning!
The flow rate must be decreased to the amount stated on the Deltatop tag: the maximum insertion / withdrawn dp / flow limit.

1. Shut off device valves (disconnect the impulse pipe if necessary).
2. Loosen the jam nuts.
3. Using the drive nuts, retract the sensor until the stop nuts and jam nuts are pressing against the threaded bushings.
4. The drive nuts should be alternately loosened approximately 1/8" (3 mm) at a time.
5. Completely shut off the access valve.
6. Slowly open one of the device valves and bleed off any remaining pressure contained in the access nipple.
7. The sensor assembly can now be removed.

3.15 Basic instructions regarding drilling a hole in the pipe without stopping the process (hot tapping)

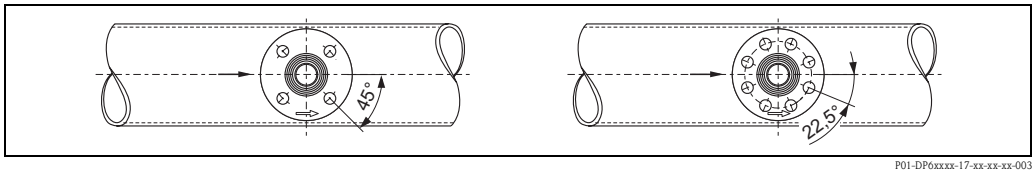
3.15.1 Initial notice

- While drilling a hole in a pipe without stopping the process offers advantages to users, some risks are associated with this procedure. Therefore take all the necessary safety measures before operating.
- The following information only constitutes a general description. The steps to be followed can vary between flowtap Deltatop versions.
- The following description does not explain how to use a hot tap drilling machine. Therefore, refer to the manual of the hot tap drilling machine itself.

3.15.2 Procedure

1. The first step is to determine the wall thickness of the pipe (an ultrasonic thickness tester may be used).
2. Mark the location where the Deltatop is to be mounted.
3. Position the welding socket over the center of the mark.
4. Tack-weld the welding socket into position by using the appropriate weld gap.

   ✎ Note!
   In the case of a flange, note the orientation of the flange. The bolt holes on the flange must be at 45° angles (for four holes) or 22.5° angles (for eight holes) to the pipe axis.



5. Finish welding the welding socket to the pipe as per the applicable codes.
6. Install the access valve correctly.
7. Verify that the access valve is properly tightened because it will not be serviceable beyond this point without depressurizing the line.
8. Attach an appropriate hot tap drilling machine to the access valve.
9. Follow the instructions given by the hot tap drilling machine.
10. Place the access valve in the full open position and drill a hole in the pipe.
11. Once the hole has been made, close the access valve and properly remove the hot tap drilling machine. Follow the instructions given in the manual for the specific flowtap Deltatop model that you have.

3.16 Post-installation check

3.16.1 Checks following initial installation

Perform the following checks after installing the measuring device:

- Do the process temperature/pressure, ambient temperature, measuring range etc. correspond to the specifications of the device?
- Does the arrow on the head of the pipe or the flange plate match the actual flow direction?
- Are the measuring point number and labeling correct (visual inspection)?
- Is the orientation chosen for the sensor correct, in other words suitable for the sensor type, application and medium properties, in particular medium temperature?
- Is the measuring device protected against moisture and direct sunlight?
- Are the screws of the packing or the flange firmly tightened?
- Are the threaded connections and/or flange connections tight?

3.16.2 Additional checks when demounting/mounting the probe during plant operation

Perform the following additional checks when demounting/mounting the probe during plant operation:

- Is the device damaged (visual inspection)?
- Is the probe free of deposit and damage?

4 Wiring

4.1 Wiring of the Deltabar S differential pressure transmitter

The wiring of the Deltabar S differential pressure transmitter is described in the following Operating Instructions:

Communication	Operating Instructions
4 to 20 mA HART	BA270P
PROFIBUS PA	BA294P
Foundation Fieldbus	BA301P

The appropriate Operating Instructions are supplied together with the Deltabar S.

4.2 Wiring of the Deltabar M differential pressure transmitter

The wiring of the Deltabar M differential pressure transmitter is described in the following Operating Instructions:

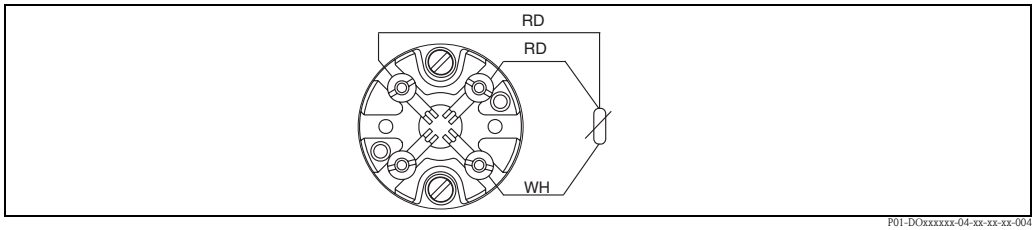
Communication	Operating Instructions
4 to 20 mA HART	BA382P

4.3 Wiring of the integrated Pt100 temperature sensor

Caution!
Before connecting, please note the following:
- The power supply must be identical to the data on the nameplate.
- Switch off the power supply before connecting up the device.
- Connect the equipotential bonding to the transmitter ground terminal before connecting up the device.

Warning!
When you use the measuring system in hazardous locations, make sure to comply with national standards and the specifications in the Safety Instructions (XAs). Make sure you use the specified cable gland.

4.3.1 3-wire terminal block



RD: red; WH: white

5 Operation and commissioning

5.1 Configuration of the differential pressure transmitter Deltabar S and Deltabar M

The operation of the Deltabar S differential pressure transmitter and the process for commissioning measurement are described in the following Operating Instructions:

Communication	Operating Instructions (Deltabar S)	Operating Instruction (Deltabar M)
4 to 20 mA HART	BA270P	BA382P
PROFIBUS PA	BA294P	-
Foundation Fieldbus	BA301P	-

The appropriate Operating Instructions are supplied together with the Deltabar S or Deltabar M.

Note!
If the differential pressure transmitter is ordered with the primary device, then it is completely pre-configured on delivery. The parameters do not have to be configured in this case.
If an unconfigured differential pressure transmitter is used, the configuration data can be obtained from the supplied calculation sheet or can be calculated by the "Applicator" selection and sizing tool.

Note!
The formulae according to which the flow is calculated are summarized in the Appendix (→ 46).

5.2 Configuration of temperature and pressure compensation

5.2.1 Calculation of the compensated volume flow or mass flow

- **For steam**
  Flow and Energy Manager RMS621 for water and steam from Endress+Hauser;
  for details see Technical Information TI092R
- **For all media**
  Universal Flow and Energy Manager RMC621 for gases, liquids and steams from Endress+Hauser; for details see Technical Information TI098R
- **For all media**
  by a PLC;
  In this case the compensation calculation has to be programmed by the user.

5.2.2 Calculation formula for temperature and pressure compensation

The starting point for compensation first has to be defined. The starting point is the calculation sheet which accompanies every primary element. Layout data for specific operating conditions (pressure and temperature) can be found on the calculation sheet.

The relationship between flow and differential pressure is described by a square root function:

$Q_m = \sqrt{2\ \Delta p\ \rho}$ for the mass flow (or volume flow at normal or standard conditions)

and

$Q_v = \sqrt{\frac{2\ \Delta p}{\rho}}$ for volume flow

where
ρ = the density of the medium.

If the current output of the Deltabar transmitter is set to flow values, the square root function is already implemented. Otherwise the square root function must be computed externally, e.g. in a PLC. Please make sure that the square root function is not applied twice.

If the real operating conditions differ from the conditions used in the calculation sheet, the density of the gas will change and thus also the calculated flow rate will change according to the above-mentioned formula.

$$\rho_2 = \rho_1 \frac{P_2}{P_1} \frac{T_1}{T_2} \frac{Z_1}{Z_2}$$

where
P = absolute pressure
T = absolute temperature (K)
Z = compressibility factor
1 = operating condition according to the calculation sheet
2 = operating condition currently measured

The compensation can now be computed as follows:

$Q_2 = Q_1 \sqrt{\frac{P_2}{P_1} \frac{T_1}{T_2} \frac{Z_1}{Z_2}}$ for mass flow (or volume flow at standard conditions)

$Q_2 = Q_1 \sqrt{\frac{P_1}{P_2} \frac{T_2}{T_1} \frac{Z_2}{Z_1}}$ for volume flow

The compressibility factor Z can be neglected if tis value is close to 1. If the compressibility factor is to be included in the compensation, the value must be determined according to the pressure and temperature currently measured. Compressibility factors are available in the corresponding literature in tables or graphs or can be calculated using the Soave-Redlich-Kwong procedure for example.

5.3 Use of accessories

5.3.1 Shut-off valves

Usage

Shut-off valves are used with remote versions for high-pressure and high-temperature applications. They are used as a primary shut-off for the measuring point.
Depending on national regulations, primary shut-off with two shut-off valves per impulse pipe may be recommended or required.

Operating principle

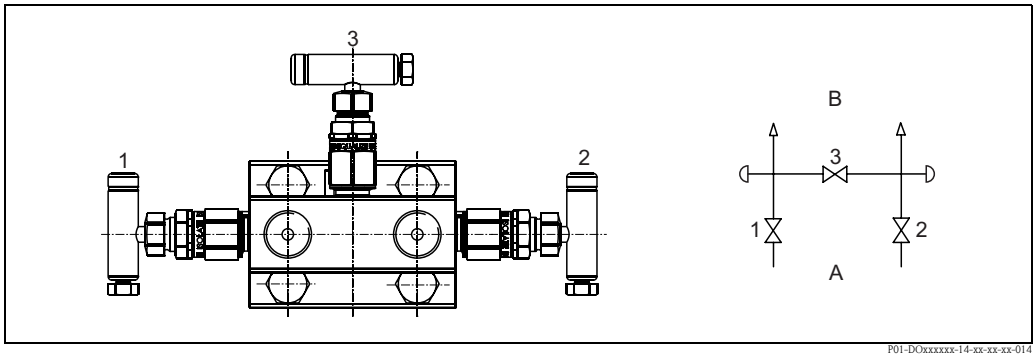
The primary shut-off provides separation close to the process between the measuring system and the measuring pipe in the event of leakage or if maintenance measures are carried out at the impulse pipes.

Installation and commissioning

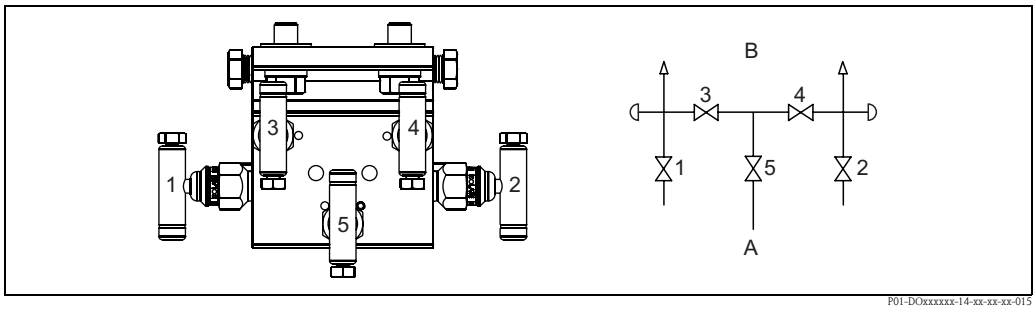
Once installation has been completed, the shut-off valves must be closed. When starting commissioning, the shut-off valves should be opened cautiously and the complete measuring system should be checked for leakage.

5.3.2 Manifold

Versions



3-valve manifold



5-valve manifold; milled

Valve	Application
1, 2	Separates the Deltabar differential pressure transmitter from the process
3, 4	Equalization valve (zero point adjustment of the Deltabar differential pressure transmitter)
5	▪ Venting (for liquids and steam) ▪ Draining (for gases) ▪ Complete emptying of the impulse pipes (e.g. for maintenance purposes)

Usage

The manifold is used to separate the Deltabar differential pressure transmitter from the process and to perform zero point adjustment.

Operating principle

If the Deltabar differential pressure transmitter has to be removed from the measuring point (e.g. for exchange or repair), it is possible to completely separate the transmitter from the process by closing all the valves.

Commissioning

During commissioning, zero point adjustment should be performed on the Deltabar differential pressure transmitter in any case. During initial commissioning, all the valves should be closed when starting the process. Then the valves of the "-" and "+" side should be opened cautiously. The equalization valve remains closed.
After this, make sure that the impulse pipes, the manifold and the transmitter are completely vented (for liquids and steam) or drained (for gases).

Zero point adjustment

To perform zero point adjustment, first close the valve at the "-" side and then open the equalization valves (3, 4), such that the "+" and the "-" side of the transmitter are exposed to the same static process pressure (+). In this state, zero point adjustment of the Deltabar differential pressure can be performed (refer to the Operating Instructions of the Deltabar). On completion of zero point adjustment, the measuring system is put back into operation by performing the same steps in reverse order.
Zero point adjustment should be checked and – if necessary – adjusted regularly. The measuring system should also be checked regularly for complete venting or draining.

Venting/draining

The additional valves of 5-valve manifolds are used for venting or draining or to empty the impulse pipes completely (e.g. for maintenance purposes). In steam applications these valves are used to blow out the impulse pipes.

Note!
The complete venting or draining of the Deltabar differential pressure transmitter is always performed by appropriate devices at the side opposite the transmitter flanges.

Caution!
If all three or four valves at the manifold are opened at the same time, the pressure difference may cause the medium to flow through the manifold. With hot media, this may result in the manifold and the Deltabar differential pressure transmitter overheating. Therefore, it is essential to avoid opening all three valves simultaneously under operating conditions.

6 Troubleshooting

6.1 Error messages of the Deltabar S or Deltabar M

Error messages of the Deltabar S differential pressure transmitter are described in the following Operating Instructions:

Communication	Operating Instructions (Deltabar S)	Operating Instructions (Deltabar M)
4 to 20 mA HART	BA270P	BA382P
PROFIBUS PA	BA294P	-
Foundation Fieldbus	BA301P	-

The appropriate Operating Instructions are supplied together with the Deltabar S or Deltabar M.

6.2 Application errors

Error	Possible cause; measure
No flow indicated	**Installation errors** ■ No contact between process and transmitter -> Check whether the valves to the differential pressure transmitter are open. **Configuration errors** ■ Configuration of the transmitter or flow calculator incorrect or missing -> Check and adjust configuration
Zero point drift; measured value fluctuations	**Planning errors** ■ High turndown -> If necessary use different measuring cell or multiple transmitters ("split range", see Technical Information TI441P) **Installation errors** ■ Gas or liquid in the impulse pipe/transmitter -> Vent or drain impulse pipes and transmitter (→ 🖹 40) **Calibration errors** ■ Low flow cut-off not activated -> Activate low flow cut-off (see Operating Instructions of Deltabar) ■ No zero point adjustment -> Perform zero point adjustment (→ 🖹 40) ■ No compensation for gas measurements -> Complete temperature and pressure compensation (→ 🖹 36)
Wrong measuring value	**Planning errors** ■ Wrong pipe data; wrong flow data; wrong medium data -> Compare values of the "Sizing sheet - data sheet" to the actual values ■ Inappropriate pipe (disturbed flow caused by fixtures, weld seams, protruding sealings, inlets and outlets, fittings etc.) -> Remove obstacles disturbing the flow profile ■ Relative humidity does not match the planning data -> Make sure that the relative humidity matches the specifications on the calculation sheet ■ Wrong measuring range of the differential pressure transmitter -> If necessary, use different measuring cell ■ Pitot tube too long or too short -> Check whether the length of the Pitot tube is equal to "inner pipe diameter + wall thickness" **Installation errors** ■ Wrong mounting position -> Check mounting position (→ 🖹 10, → 🖹 11) ■ Wrong or imprecise alignment of the Pitot tube -> Check alignment of the Pitot tube (→ 🖹 15) ■ Upstream or downstream length too short -> Check upstream and downstream lengths (→ 🖹 12) ■ Leakage -> Check complete measuring system for leakage ■ Welding socket projects into the interior of the pipe -> Mount the welding socket on the outside of the pipe **Calibration error** ■ Compensation for gas measurements wrong or missing -> Correct temperature and pressure compensation (→ 🖹 36) ■ Wrong transmitter settings -> Check configuration of the Deltabar differential pressure transmitter (see Operating Instructions of Deltabar) -> Check configuration of the Flow Manager (see Operating Instructions of RMC621/RMS621) **Maintenance errors** ■ Pressure tap holes of the Pitot tube blocked by dirt —> Clean Pitot tube

7 Maintenance and repairs

7.1 Maintenance

The following maintenance tasks should be performed at regular intervals:

- Checking the zero point adjustment
- For wet gases: drain the condensate
- For soiled media: remove the sediment
- For abrasive media: check the primary device for abrasions
- For buildup formation: check and clean the primary device; exchange gaskets
- After the cutting ring connection has been opened several times (approx. 10 times), replace the cutting ring

Note!
Primary elements do not require further maintenance if used appropriately. During standard revisions of the measuring point it is recommended to examine the primary element carefully to ensure its functionality (material/edge sharpness, traces of wear)

Caution!
Required maintenance work must be carried out with the assistance of the responsible department and/or trained staff. Safety instructions of these departments and staff have to be taken into account (checking pressure/temperature; valves have to be closed)

Caution!
If maintenance measures (e.g. exchanging the transmitter or manifold) have to be carried out under process conditions, it must be ensured that all valves are closed and that there is no danger of medium leaking. If necessary, the temperature and pressure have to be checked before unmounting the device.

7.2 Exterior cleaning

When cleaning the exterior, always use cleaning agents that do not attack the surface of the housing and the seals.

7.3 Replacing seals

Under normal circumstances, wetted seals need not be replaced. Replacement is necessary only in special circumstances, for example if aggressive or corrosive media are incompatible with the seal material.

7.4 Return

The following procedures must be carried out before a transmitter is sent to Endress+Hauser for repair or calibration for example:

- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where medium may be present. This is especially important if the medium is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- Always enclose a duly completed "Declaration of Contamination" form (a copy of the “Declaration of Contamination” is included at the end of this operating manual). Only then can Endress +Hauser transport, examine and repair a returned device.

Additionally specify the following:

- An exact description of the application.
- The chemical and physical properties of the product.
- A short description of the error that occurred (specify error code if possible)
- The operating time of the device.

7.5 Disposal

If disposing of the device, please separate the different components according to their materials.

7.6 Contact addresses of Endress+Hauser

Contact addresses can be found on our homepage: www.endress.com/worldwide. If you have any questions, please do not hesitate to contact your Endress+Hauser representative.

8 Accessories

8.1 Overview

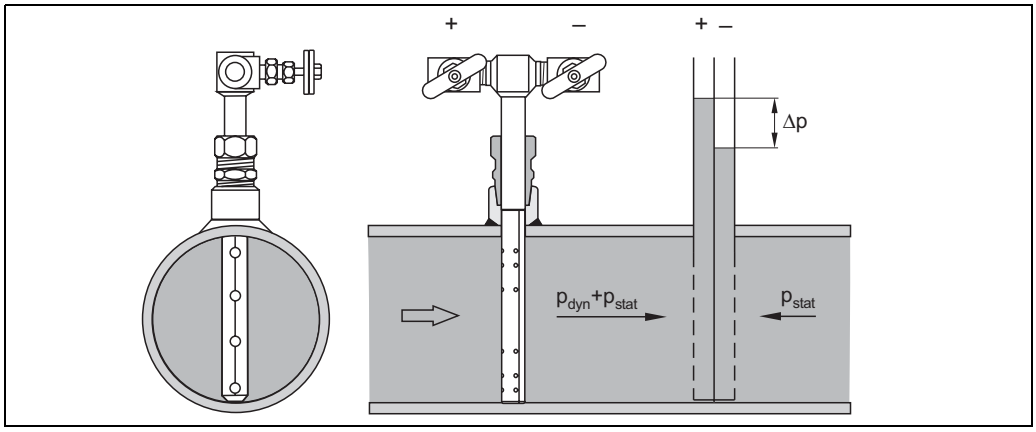
The following accessories are available for differential-pressure flow measurement with Pitot tubes:

- DA73M: Shut-off valves (see Technical Information TI441P)
- DA74M: Manifold (see Technical Information TI441P)

Shut-off valves and the manifold can be ordered together with the Pitot tube Deltatop. They are included in the product structures DP71B, DP72B and DP73B.
Alternatively, they can be ordered via their own product structures. For details refer to Technical Information TI441P.

9 Appendix

9.1 Measuring principle



P01-DPxxx-15-00-00-xx-002

The front of the Pitot tube is exposed to the static pressure p_{stat} plus the dynamic pressure p_{dyn}. The side and the back of the tube is exposed only to the static pressure p_{stat}. The resulting **differential pressure Δp** can be used to calculate the **flow rate Q**.

The relationship between flow rate (Q) and differential pressure (Δp) is given by a square root function:

$$Q \sim \sqrt{\Delta p}$$

P01-DOxxxxx-15-xx-xx-xx-008

Downstream of the Pitot tube the static pressure p_{stat} is reduced by the permanent pressure loss **Δω**. With Pitot tubes this pressure loss Δω is much less significant than with other primary elements.

9.2 Flow calculation

According to the continuity law derived by Bernoulli and the energy equation, the static pressure in the flow plus the dynamic pressure is equal to a constant throughout the flow:

$p_{stat} + p_{dyn} = \text{const.}$

From this law, the following flow equations can be derived:

9.2.1 Volumetric flow for gases under standard conditions

$$Q_{vn} = k\, A\, \varepsilon \sqrt{\frac{2\, \Delta p\, P_b\, Z_n\, T_n}{\rho_n\, P_n\, Z_b\, T_b}}$$

9.2.2 Volumetric flow for gases under operating conditions

$$Q_v = k\, A\, \varepsilon \sqrt{\frac{2\, \Delta p}{\rho_b}}$$

9.2.3 Mass flow for gases and steam

$$Q_m = k\, A\, \varepsilon \sqrt{2\, \Delta p\, \rho_b}$$

9.2.4 Mass flow for liquids

$$Q_m = k\, A \sqrt{2\, \Delta p\, \rho_b}$$

9.2.5 Volumetric flow for liquids

$$Q_v = k\, A \sqrt{\frac{2\, \Delta p}{\rho_b}}$$

9.2.6 Definition of the symbols

Symbol	Quantity	Unit
Δp	Differential pressure at the probe profile	Pa
ρ_n	Medium density at standard conditions	kg/m^3
$_b$	Medium density at operating conditions	kg/m^3
A	Cross-sectional area of the pipe	m^2
b	Width of the probe profile perpendicular to the flow direction	m
k	k-factor of the Pitot tube	1
κ	Isentropic exponent of the gas[1)]	1
P_b	Operating pressure	Pa
P_n	Absolute pressure of the gas at standard conditions	Pa
Q_m	Mass flow	kg/s
Q_v	Volumetric flow	m^3/s
Q_{vn}	Volumetric flow at standard conditions	m^3/s
T_b	Temperature of the gas at operating conditions	K
T_n	Temperature of the gas at standard conditions	K
Z_b	Real gas factor at operating conditions	1
Z_n	Real gas factor at standard conditions	1
ε	Expansion factor	1

1) The isentropic exponent is: 1.66 for monoatomic gases; 1.4 for diatomic gases; 1.3 for triatomic gases

Index

Endress+Hauser

People for Process Automation

Declaration of Hazardous Material and De-Contamination

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.

Type of instrument / sensor _____ **Serial number** _____

☐ **Used as SIL device in a Safety Instrumented System**

Process data

Temperature _____ [°C] Pressure _____ [Pa]

Conductivity _____ [S] Viscosity _____ [mm^2/s]

Medium and warnings

	Medium /concentration	Identification CAS No.	 flammable	 toxic	 corrosive	 harmful/ irritant	 other *	 harmless
Process medium								
Medium for process cleaning								
Returned part cleaned with								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.

Description of failure _____

_____

_____

Company data

Company _____ Phone number of contact person: _____

_____

Address Fax / E-Mail _____

_____

_____ Your order No. _____ _____

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."

_____ _____ _____

(place, date) Name, dept. (please print) Signature

P/SF/Konta XII

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

BA386P/00/EN/07.09
71098177
CCS/FM+SGML 6.0/ProMoDo

71098177