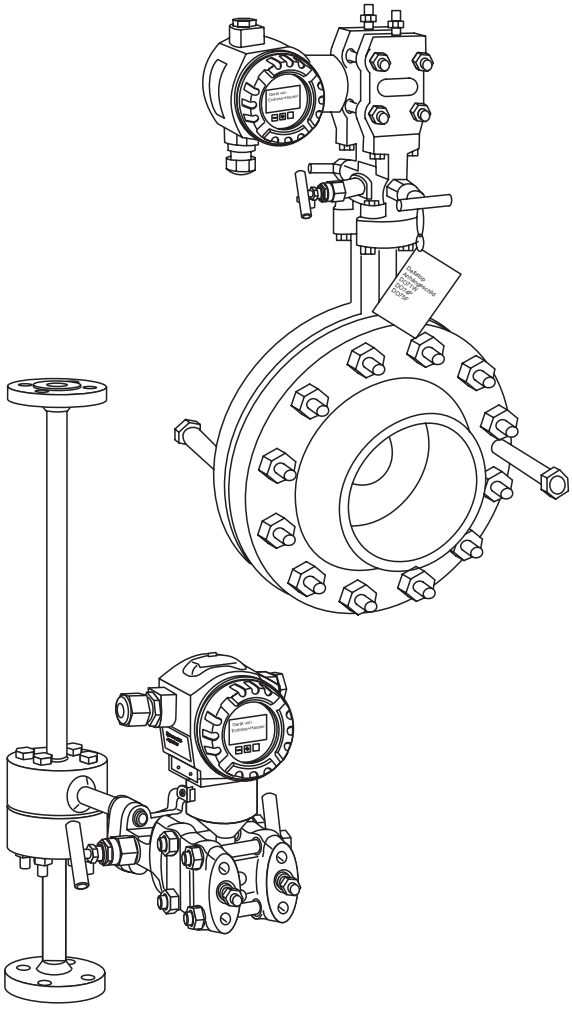
Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Operating Instructions

Deltatop
DO71W, DO74P, DO75F

Orifices for differential pressure flow measurement



BA389P/00/EN/08.10
71119555

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, over-heated steam, gases and liquids. Resulting from incorrect or from use other than that desiganted the operational safety of the measuring devices can be suspended. The manufacturer accepts no liability for damages being produced from this.

1.2 Installation, commissioning, operation

The Deltatop measuring system is fail-safe and is constructed to the state-of-the-art. It meets the appropriate standards and EC directives. However, if you use it improperly or other than for its designated use, it may pose application-specific hazards, e.g. product overflow due to incorrect installation or configuration. Installation, electrical connection, start-up, operation and maintenance of the measuring device must therefore be carried out exclusively by trained specialists authorised 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 when it is expressly permitted by the operating instructions.

1.3 Hazardous area

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of this Operating Manual. 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.

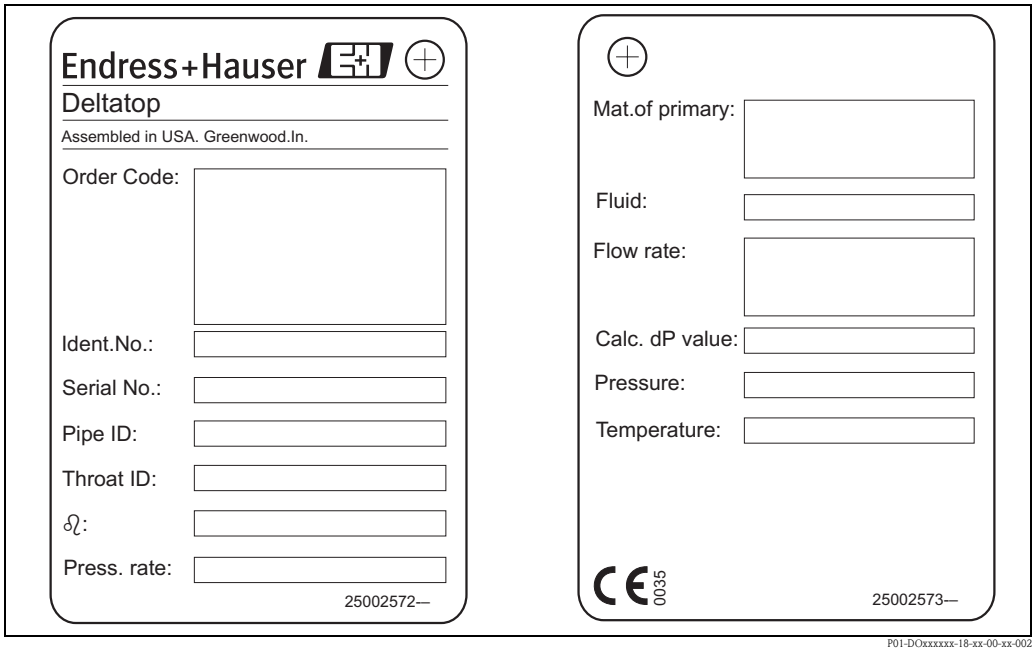
1.4 Notes on safety conventions and symbols

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 destruction of the instrument.
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument.
	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.
Explosion protection	
	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its name plate it can be installed in an explosion hazardous area.
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. Devices located in and wiring entering areas with the designation "explosion hazardous areas" must conform with the stated type of protection.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas.
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 an earth grounding system.
	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment.
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice.
	**Temperature resistance of the connection cables** States, that the connection cables must be resistant to a temperature of at least 85 °C.

2 Identification

2.1 Nameplate



Order Code: *Order code of the instrument according to the product structure (see Technical Information TI444P)*
Ident. No.: *Identification number; characterizes the instrument unambiguously*
Serial No.: *Serial number*
Pipe ID: *Inner diameter of the measuring pipe*
Throat ID: *Diamter of the orifice bore*
β: *diameter ratio (= throat ID / pipe ID)*
Press. rate: *pressure rating*
Mat. of primary: *Material of the orifice*
Fluid: *Fluid for which the instrument has been sized*
Flow rate: *Flow rate for which the instrument has been sized (operating point)*
Calc dP value: *calculated differential pressure at the operating point*
Pressure: *operating pressure*
Temperature: *operating temperature*
CE 0035: *CE mark for pressure equipment directive*

2.2 Product structure

See Technical Information TI444P/00/EN.

2.3 Documentation

2.3.1 Deltatop

Document	Device	Designation
Technical Information		
TI444P/00/EN	DO71W, DO74P, DO75F	Differential pressure flow measurement with orifices and Deltabar differential pressure transmitter
TI441P/00/EN	DP71B, DP72B, DP73B	Differential pressure flow measurement with Pitot tubes and Deltabar differential pressure transmitter
Operating Instructions		
BA389P/00/EN	DO71W, DO74P, DO75F	Differential pressure flow measurement with orifices and Deltabar differential pressure transmitter
BA386P/00/EN	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/00/EN	Deltabar S	Differential pressure transmitter
Operating Instructions		
BA270P/00/EN	Deltabar S	Differential pressure transmitter – HART
BA294P/00/EN	Deltabar S	Differential pressure transmitter – PROFIBUS PA
BA301P/00/EN	Deltabar S	Differential pressure transmitter – FOUNDATION FIELDBUS
Description of Instrument Functions		
BA274P/00/EN	Cerabar S/Deltabar S/Deltapilot S	Pressure and differential pressure transmitter HART
BA296P/00/EN	Cerabar S/Deltabar S/Deltapilot S	Pressure and differential pressure transmitter PROFIBUS PA
BA303P/00/EN	Cerabar S/Deltabar S/Deltapilot S	Pressure and differential pressure transmitter FOUNDATION FIELDBUS
Safety Instructions (ATEX)		
XA235P/00/A3	Deltabar S	ATEX II 1/2 G EEx ia
XA237P/00/A3	Deltabar S	ATEX II 1/2 D
XA239P/00/A3	Deltabar S	ATEX II 1/3 D
XA240P/00/A3	Deltabar S	ATEX II 2G EEx d
XA241P/00/A3	Deltabar S	ATEX II 3 G EEx nA
XA242P/00/A3	Deltabar S	ATEX II 1/2 G EEx id; ATEX II 2 G EEx d
XA243P/00/A3	Deltabar S	ATEX II 1/2 GD EEx ia
XA275P/00/A3	Deltabar S	ATEX II 1 GD EEx ia

2.3.3 Deltabar M

Document	Device	Designation
Technical Information		
TI434P/00/EN	Deltabar M	Differential pressure transmitter
Operating Instructions		
BA382P/00/EN	Deltabar M	Differential pressure transmitter - HART
Safety Instructions (ATEX)		
XA457P/00/A3	Deltabar M	ATEX II 1/2 G, II 2 G, Ex ia IIC T6 to T4
XA463P/00/EN	Deltabar M	ATEX II 3 G Ex nA IIC T6 to T4
XA459P/00/A3	Deltabar M	IECEx Ex ia IIC T6 to T4 Ga/Gb
XA462P/00/EN	Deltabar M	IECEx Ex d IIC T6 Gb, Ex d IIC T4 Gb
XA461P/00/A3	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/09/EN	Energy Manager RMS621
TI098R/09/EN	Universal Flow and Energy Manager RMC621
Operating Instructions	
BA127R/09/EN	Energy Manager RMS621
BA144R/09/EN	Universal Flow and Energy Manager RMC621

2.4 Registered trademarks

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

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

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

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

Ermeto®
Registered trademark of the 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 instruments of more than 39.69 lbs (18 kg).
Do not lift the measuring instrument by the housing of the transmitter in order to transport it.

3.1.3 Storage

For storing and transport, shock proof packaging of the measuring instrument is required. The original packaging material provides optimum protection. The permissible storage temperature for the Deltabar transmitter is -40 °F to 176 °F (-40 °C to +80 °C).

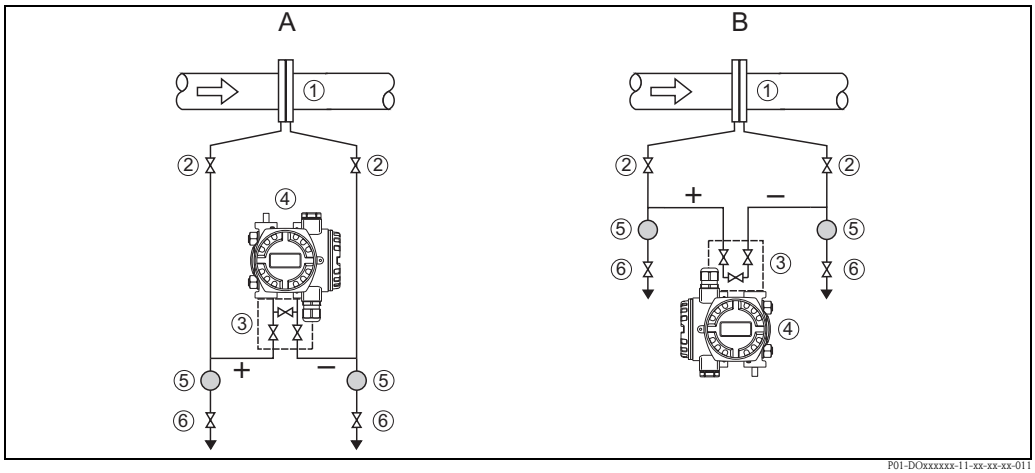
3.2 Dimensions

See Technical Information TI444P/00/EN.

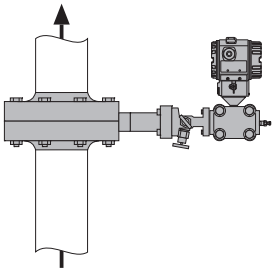
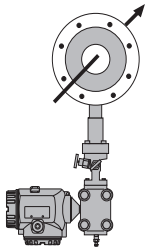
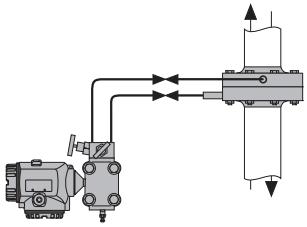
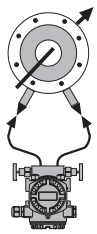
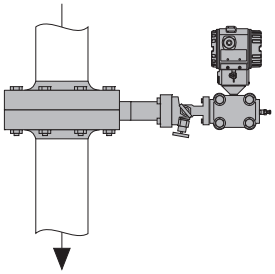
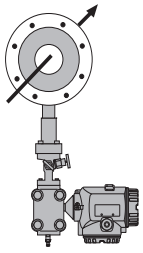
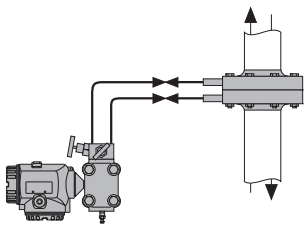
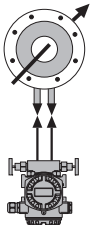
3.3 Mounting position for liquid applications

With liquid 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 and bubbles travel back to the process pipe and thus do not influence the measurement.

Note!
When measuring in fluids with solid content, 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: *Orifice plate* ***2:*** *Shut-off valves* ***3:*** *Three valve manifold* ***4:*** *Differential pressure transmitter Deltabar* ***5:*** *Separator*
6: *Drain valve*

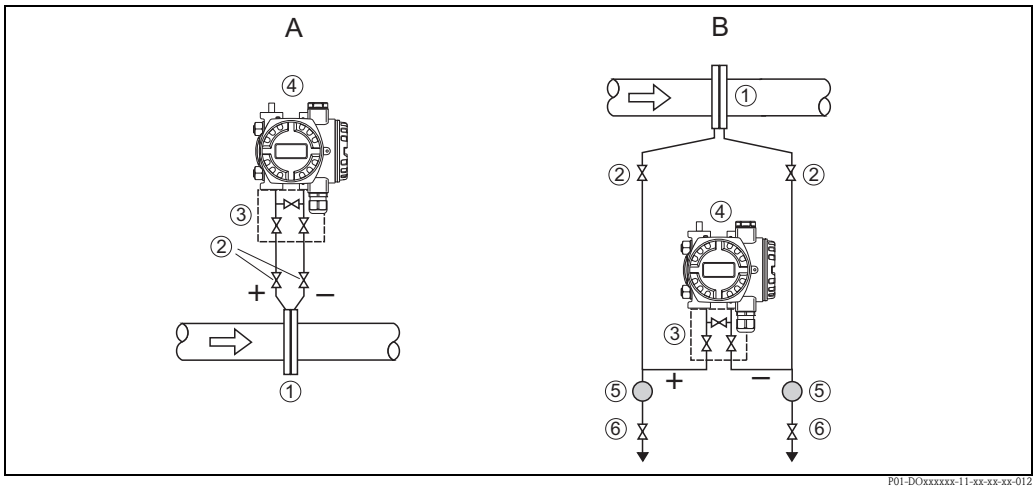
compact; vertical	**compact; horizontal**	**remote; vertical**	**remote; horizontal**
flow upwards DO7xxxx-EM...	mounting left DO7xxxx-EB...	taps 90° DO7xxxx-DT...	tap angle according to DIN DO7xxxx-DF...
 P01-DO71Wxxx-11-00-00-xx-001	 P01-DO61Wxxx-11-00-00-xx-009	 P01-DO71Wxxx-11-00-00-xx-005	 P01-DO61Wxxx-11-00-00-xx-021
flow downwards DO7xxxx-EP...	mounting right DO7xxxx-EC...	taps 0° DO7xxxx-DS...	taps 0° DO7xxxx-DE...
 P01-DO71Wxxx-11-00-00-xx-002	 P01-DO61Wxxx-11-00-00-xx-010	 P01-DO71Wxxx-11-00-00-xx-006	 P01-DO61Wxxx-11-00-00-xx-022

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

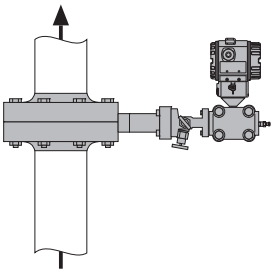
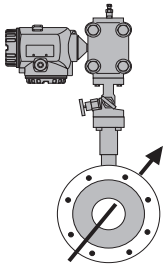
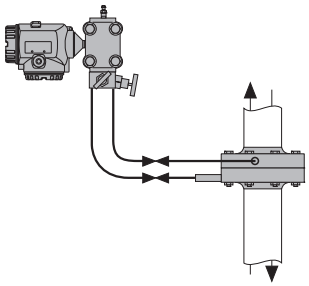
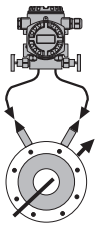
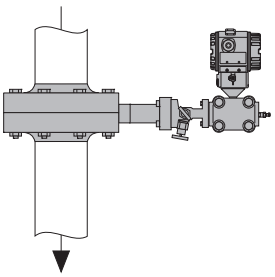
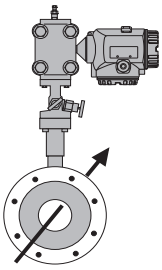
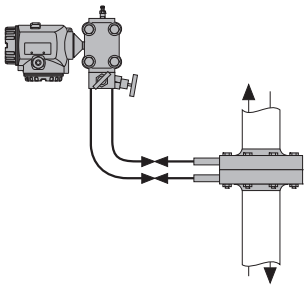
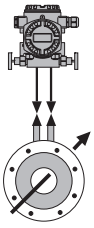
3.4 Mounting position for gas applications

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.



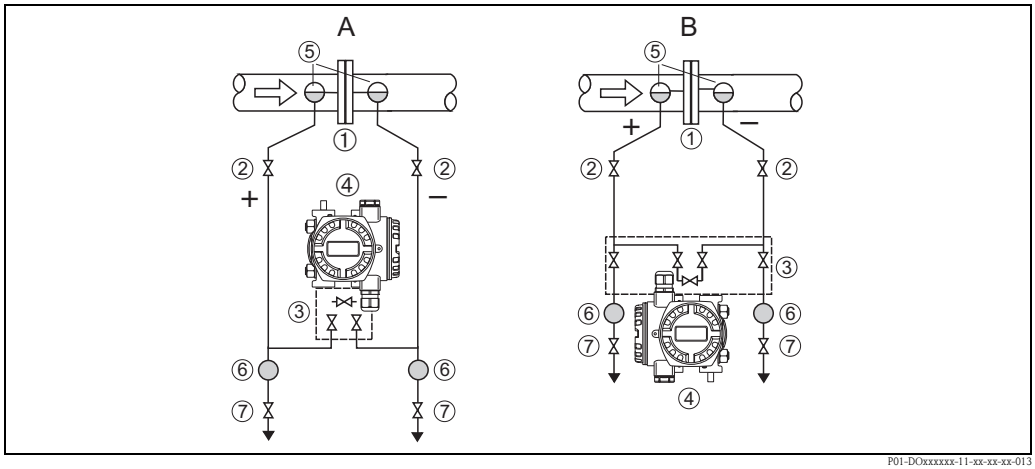
A: *Preferred configuration* ***B:*** *Alternative configuration (if the transmitter can not be mounted above the pipe)*
1: *Orifice plate* ***2:*** *Shut-off valves* ***3:*** *Three-valve manifold* ***4:*** *Differential pressure transmitter Deltabar* ***5:*** *Separator*
6: *Drain valves*

compact; vertical	**compact; horizontal**	**remote; vertical**	**remote, horizontal**
flow upwards DO7xxxx-CM...	mounting left DO7xxxx-CB...	taps 90° DO7xxxx-BT...	tap angle according to DIN DO7xxxx-BF...
 P01-DO71Wxxx-11-00-00-xx-001	 P01-DO61Wxxx-11-00-00-xx-007	 P01-DO71Wxxx-11-00-00-xx-003	 P01-DO61Wxxx-11-00-00-xx-019
flow downwards DO7xxxx-CP...	mounting right DO7xxxx-CC...	taps 0° DO7xxxx-BS...	taps 0° DO7xxxx-BE...
 P01-DO71Wxxx-11-00-00-xx-002	 P01-DO61Wxxx-11-00-00-xx-008	 P01-DO71Wxxx-11-00-00-xx-004	 P01-DO61Wxxx-11-00-00-xx-020

3.5 Mounting position for steam applications

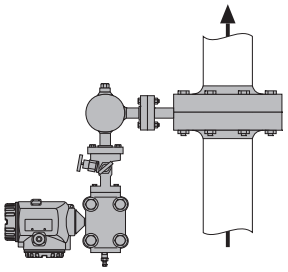
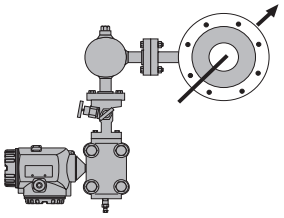
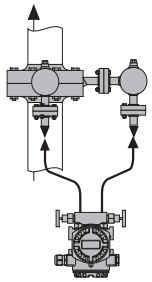
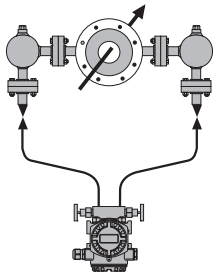
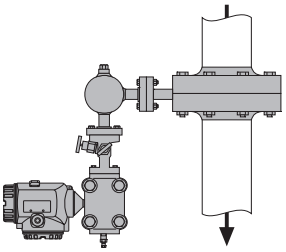
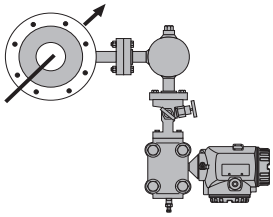
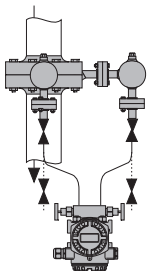
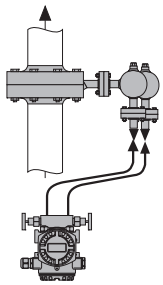
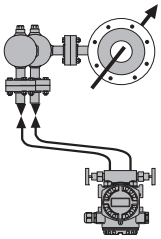
With steam applications, there is the possibility to do the mounting with or without condensate pots. If the choice is made to do without condensate pots see flow measurement in liquids.
When the choice is made to do with condensate pots then the two condensate pots must be mounted on the same level. The transmitter must be located below the pipe. The pipes between the transmitter and the condensate pots must be completely filled with water on both sides.
A 5-valve manifold allows simple piping and can be used instead of T-sections and additional blow-out-valves. The impulse pipes must be installed with a slope of at least 1:15 to reliably ensure rising of trapped air in the water of the impulse line to the transmitter.
It is recommended to use welded connections for steam applications, behind the condensate pots continue with ½"NPT thread.

Note!
When measuring in steam, installing separators (5) and drain valves (7) is useful for capturing and removing dirt.



P01-DOxxxxxx-11-xx-xx-xx-013

A: *with 3-valve manifold; for easy venting of the transmitter; especially for small differential pressures*
B: *with 5-valve manifold for blowing out the impulse pipes*
1: *Orifice plate* ***2:*** *Shut-off valves* ***3:*** *Valve manifold* ***4:*** *Differential pressure tranmsitter Deltabar* ***5:*** *Condensate chambers*
6: *Separator (optional)* ***7:*** *Drain valves (optional)*

<table>
<tr><th>co7rtical</th><th>compact; horizontal</th><th>remote; vertical</th><th>remote; horizontal</th></tr>
<tr><td>flow upwards
DO7xxxx-GM...
 
P01-DO61Wxxx-11-00-00-xx-005</td><td>mounting left
DO7xxxx-GB...
 
P01-DO61Wxxx-11-00-00-xx-011</td><td>taps 90°; flow upwards
DO7xxxx-FN...
 
P01-DO71Wxxx-11-00-00-xx-007</td><td rowspan="2">taps 180°
DO7xxxx-FG...
 
P01-DO61Wxxx-11-00-00-xx-023</td></tr>
<tr><td>flow downwards
DO7xxxx-GP...
 
P01-DO61Wxxx-11-00-00-xx-006</td><td>mounting right
DO7xxxx-GC...
 
P01-DO61Wxxx-11-00-00-xx-012</td><td>taps 90°; flow downwards
DO7xxxx-FR...
 
P01-DO71Wxxx-11-00-00-xx-008</td></tr>
<tr><td colspan="2" rowspan="3"></td><td>taps 0°, flow upwards
DO7xxxx-FM...
 
P01-DO71Wxxx-11-00-00-xx-009</td><td>taps 0°; mounting left
DO7xxxx-FB...
 
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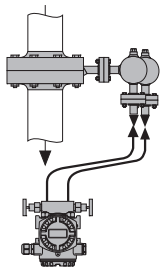
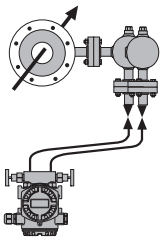
<tr><td>taps 0°; flow downwards
DO7xxxx-FP...
 
P01-DO71Wxxx-11-00-00-xx-010</td><td>taps 0°; mounting right
DO7xxxx-FC...
 
P01-DO61Wxxx-11-00-00-xx-025</td></tr>
</table>

3.6 General mounting conditions

3.6.1 Up- and downstream lengths

In order to ensure a homogeneous flow profile it is necessary to mount the orifice in a sufficient distance to narrowings or bends of the pipe. The required upstream lengths for different types of obstacles are summarized in the following table. Detailed specifications can be obtained from ASME MFC-3M-2004 and ISO 5167.

Type of obstacle	β ≤ 0,2		β = 0,5		β = 0,75	
	A[1)]	B[2)]	A[1]	B[2]	A[1]	B[2]
Upstream length						
90° bend	6 x D	3 x D	22 x D	9 x D	44 x D	20 x D
2x90° bend[3)] in the same plane	10 x D	-	22 x D	10 x D	44 x D	22 x D
2x90° bend in perpendicular planes	19 x D	18 x D	44 x D	18 x D	44 x D	20 x D
concentric reducer	5 x D	-	8 x D	5 x D	13 x D	8 x D
concentric expander	6 x D	-	20 x D	9 x D	36 x D	18 x D
ball/gate valve, fully open	12 x D	6 x D	12 x D	6 x D	24 x D	12 x D
Downstream length						
any obstacle	4 x D	2 x D	6 x D	3 x D	8 x D	4 x D

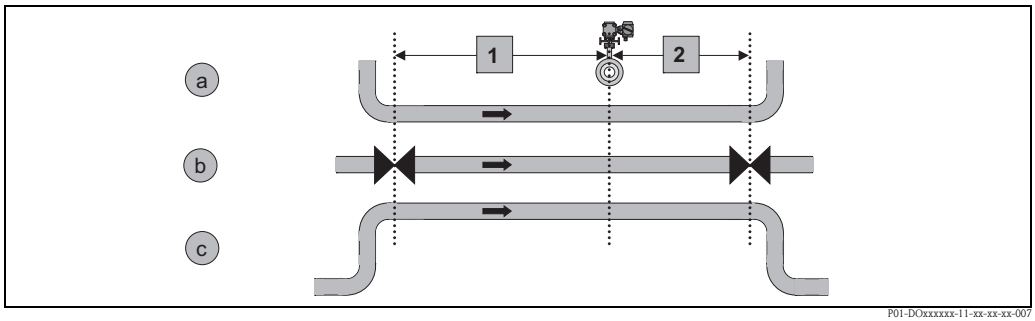
D: inner pipe diameter; β = *d/D: opening ratio (d: inner orifice diameter)*

1) For 0 % of additional uncertainty

2) For 0.5 % of additional uncertainty

3) The required lengths depend on the distance of the two elbows; typical values are given in this table. For detailed specifications refer to ASME MFC-3M part 2 and ISO 5167-2. The upstream length is also calculated by the selection and sizing tool "Applicator".

Examples (schematic)



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

Note!
- The requirements conerning the pipe as stated in ASME MFC-3M and ISO 5167 must be met (weld seams, roughness etc).
- The required upstream length can be reduced by a rectifier (→ 30). Details are specified in ASME MFC-3M appendix 1C and ISO 5167-2.

3.6.2 Homogeneity

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

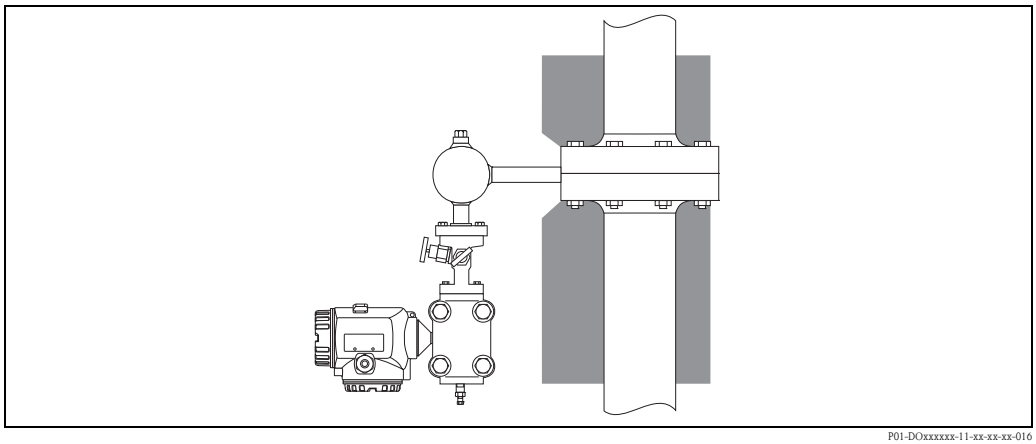
3.6.3 Mounting position

- 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 in a sufficient distance from the primary device.

Application	Maximum temperature for the compact version
Gas / Liquids	390 °F (200 °C)
Steam	570 °F (300 °C)

3.6.4 Heat insulation

Some applications require suitable measures to avoid heat loss to the ambiance. A wide range of materials can be used to provide the required insulation. With 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. The maximum insulation thickness for the compact version is 5" (120 mm).



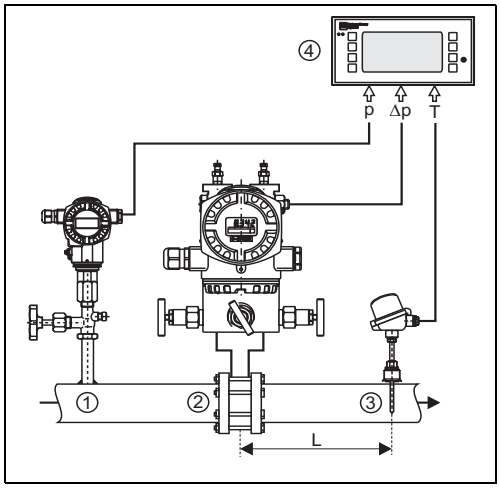
P01-DOxxxxxx-11-xx-xx-xx-016

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

3.6.5 Mounting position for temperature and pressure compensation

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

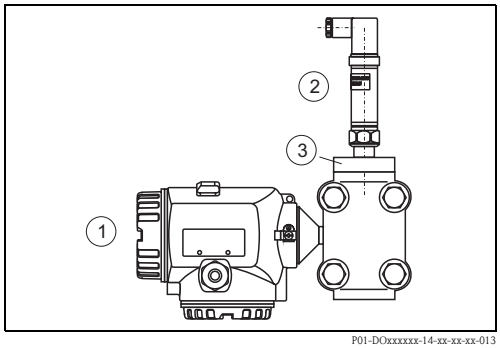
- **An absolute pressure sensor**
  This sensor must always be mounted on the upstream side of the orifice.
- **A temperature probe**
  In order to avoid disturbances of the flow profile, this probe is to be mounted on the downstream side of the orifice. In doing so, the minimum downstream length L has to be observed (→ 🖹 13).



P01-DOxxxxx-15-xx-xx-xx-010

1: *Absolute pressure sensor*
2: *orifice and differential pressure transmitter*
3: *temperature probe*
4: *evaluation unit*
A: *downstream length*

Combined process connection for absolute and differential pressure
An adapter (e.g. oval flange adapter PZO, → 🖹 33) can be used to screw a pressure transmitter or a pressure transducer onto the Deltabar flange.
The absolute pressure transmitter is to be mounted at the "+" side of the Deltabar.



P01-DOxxxxxx-14-xx-xx-xx-013

1: *Deltabar*
2: *Transmitter for abslute pressure*
3: *Oval flange adapter PZO*

For the calculation of the compensated flow refer to, → 🖹 20.

3.6.6 Measuring range

The lower limit of the measuring range is determined by the minimum Reynolds number required for the measurement. For details see Technical Information TI444P/00/EN.
The limit can be calculated by the "Applicator" selection and sizing tool.

3.7 Installation hints

3.7.1 General hints

- The primary element is calculated for specific pipe and operating data. Therefore it is essential to check if the data on the nameplate (see page 5) match the actual operating data.
- Before installing the device, check if the required upstream and downstream lengths are provided (→ 13).
- Observe the required mounting position:
  – for liquids, → 9
  – for gases, → 10
  – for steam, → 11
- For remote versions:
  The shut-off valves are mounted to the pressure taps of the primary element or (in the case of steam applications) to the condensate chambers.
- 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.

3.7.2 Installation of DO71W (Flange tap)

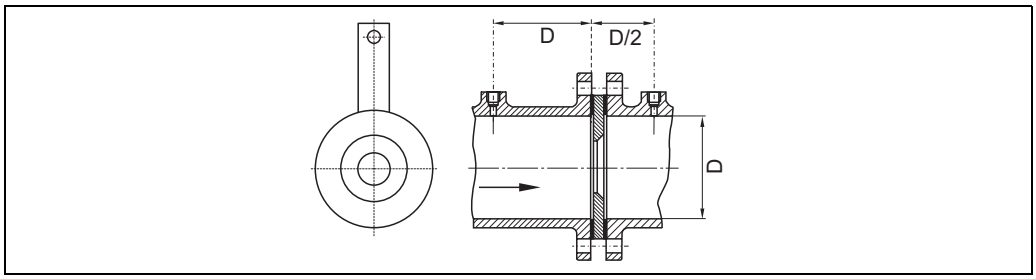
- Observe the orientation of the orifice: The upstream side is marked by the labelling on the orifice plate handle.
- The instrument is supplied with welding neck flanges (orifice flange union). If necessary, the instrument must be disassembled before the welding. The welding and the checking of the welding seams must be performed according to the state of the art taking into account all relevant welding regulations.
- Orifice plates wit a flat face are centered by the flange screws. In the case of horizontal mounting the lower flange screws have to be mounted first. The orifice plate and the gaskets are inserted from above. The remaining screws are mounted and slightly fastened. The orifice plate must be centered (this can be checked from the outer flange diameter). Then the flange screws can be tightened.

3.7.3 Installation of DO74P (Orifice plate)

For flange tapping

The tapping flanges must comply with ANSI 16.36 or DIN 19214, respectively.

For D-D/2 tapping



P01-DOxxxxxx-14-xx-xx-xx-017

The following conditions have to be met for D-D/2 tapping:

- Distance between orifice plate and "+" tap: 0,9 D to 1,1 D
- Distance between orifice plate and "-" tap:
  – 0,48 D to 0,52 D for $\beta \leq 0{,}6$
  – 0,49 D to 0,51 D for $\beta > 0{,}6$

Both distances are measured from the upstream face of the orifice plate.

- The centreline of the tapping shall meet the pipe centreline at an angle as near to 90° as possible, but in every case within 3° of the perpendicular.
- The diameter of pressure tappings shall be less than 0,13 D and less than 0.51 in (13 mm).

General mounting hints

- Observe the orientation of the orifice: The upstream side is marked by the labelling on the handle of the orifice plate.
- When installing the primary element between flanges with flat face, two gaskets suitable for the pressure, temperature and type of medium have to be applied (not contained in scope of supply).
- Orifice plates with flat face are centered by the flange screws. In the case of horizontal mounting the lower flange screws have to be mounted first. The orifice plate and the gaskets are inserted from above. The remaining screws are mounted and slightly fastened. The orifice plate must be centered (this can be checked from the outer flange diameter). Then the flange screws can be tightened.
- To replace the orifice plate, the flanges can be forced apart by the jack screws.

3.7.4 Installation of DO75F (Meter run)

- Observe the orientation of the orifice: The longer pipe of the meter run must point upstream.
- The meter run is mounted to the measuring pipe by the end flanges.

3.8 Installation check

Perform the following checks after installing the measuring device:

- Is the device damaged (visual inspection)?
- Do the process temperature/pressure, ambient temperature, measuring range etc. correspond to the specifications of the device?
- Does the marking of the flow direction on the device match the direction of flow through the pipe?
- Are the measuring point number and labeling correct (visual inspection)?
- Is the orientation chosen for the sensor correct, in other words suitable for sensor type, application and fluid properties, in particular fluid temperature?
- Is the measuring device protected against moisture and direct sunlight?
- Are all screws firmly tightened?

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 documents:

Communication	Operating Instructions
4 to 20 mA HART	BA270P/00/EN
PROFIBUS PA	BA294P/00/EN
FOUNDATION Fieldbus	BA301P/00/EN

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 documents:

Communication	Operating Instructions
4 to 20 mA HART	BA382P/00/EN

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

5 Operation and commissioning

5.1 Configuration of the Deltabar M/S differential pressure transmitter

The operation of the Deltabar S differential pressure transmitter and the commissioning of the measurement are described in the following documents:

Communication	Operating Instructions; Deltabar S	Operating Instructions; Deltabar M
4 to 20 mA HART	BA270P/00/EN	BA382P/00/EN
PROFIBUS PA	BA294P/00/EN	in preparation
FOUNDATION Fieldbus	BA301P/00/EN	in preparation

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.

5.2 Configuration of a temperature and pressure compensation

5.2.1 Calculation of the compensated volume or mass flow

- **For steam**
  Flow and Energy Manager RMS621 for water and steam from Endress+Hauser;
  for details see Technical Information TI092R/09/EN.
- **For all media**
  Universal Flow and Energy Manager RMC621 for gases, liquids and steam from Endress+Hauser;
  for details see Technical Information TI098R/09/EN.
- **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 the temperature and pressure compensation

At first the starting point for the compensation has to be defined. The starting point is the calculation sheet, which accompanies every primary element. On the calculation sheet, layout data can be found for a specific operating condition (pressure and temperature).

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 the 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.

Whenever 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 = actually measured operating condition

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 the 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 the volume flow

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

5.3 Usage of the accessories

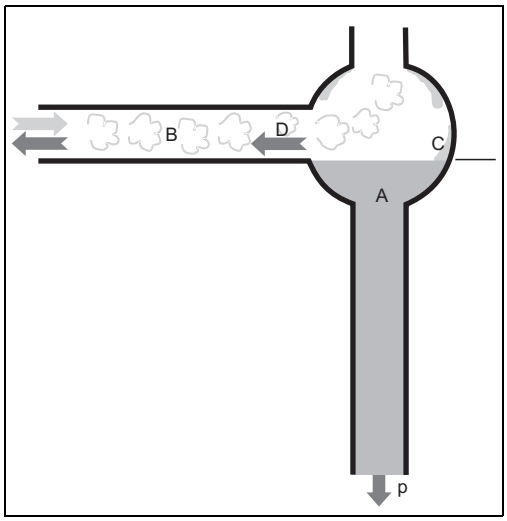
5.3.1 Condensate pots (for steam applications)

Usage

Usage of condensate pots is recommended for gaseous media, which condense when cooling down in the impulse pipes. This is mainly the case in steam; depending on temperature and pressure it may also occur in other media (e.g. in alcohols).

Operating principle

Condensate pots ensure that the impulse lines are alwas completely filled with liquid and that the membrane of the transmitter is not exposed to hot steam. The liquid level is maintained by condensing steam. Excess condensate flows back and is re-evaporated.
The usage of condensate pots considerably reduces fluctuations of the water column. The stabilized measuring signal and the increased zero point stability ensure a consistent measurement quality.
The water column transfers the pressure to the transmitter membrane.



***A:** water **B:** steam **C:** condensing steam*
***D:** excess condensate flows back*

Installation and commissioning

- When installing the condensate pots, make sure that they are located at the same height. Otherwise the zero point adjustment is hardly achievable.
- Before commissioning, the condensate chambers as well as the impulse pipes to the Deltabar differential pressure transmitter must be completely filled with water. There are different possible methods for the filling of the condensate chambers:
  – Through the filling nozzle at the condensate chambers (if present)
  – Through the condensate drain valve or the venting valve of the Deltabar differential pressure transmitter. To do so, the impulse linesmust be connected to the water supply, e.g. by a hose connector.
  – After the commissioning of the steam pipe wait until the impulse pipes and the condensate chambers have been filled by themselves with condensate. To do so, the valves at the manifold have to be closed.

Caution!
It is essential to avoid any overheating of the Deltabar differential pressure transmitter. Depending on the steam temperature the temperature at the manifold has to be monitored. If there is any risk of overheating, the shut-off valves in the impulse pipes must be closed.

Note!
In any case after filling and after commissioning of the steam supply, wait for stable conditions before performing the zero point adjustment.

5.3.2 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

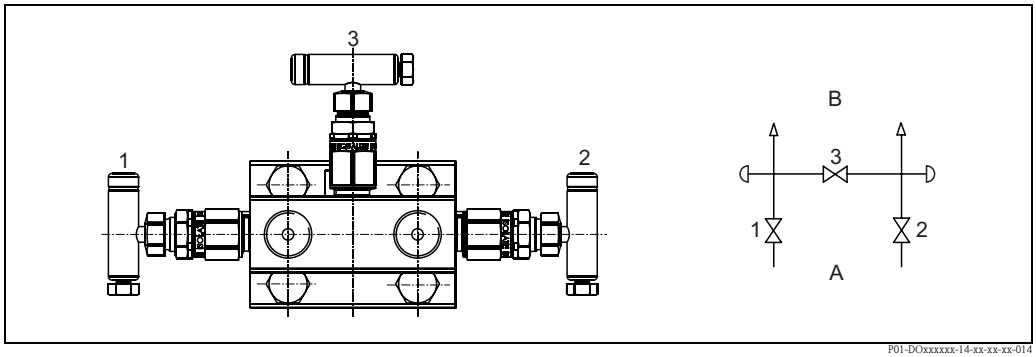
The primary shut-off provides separation close to the process between the measuring system and the measuring pipe in the case of leakages or if maintenance measures are carried out at the impulse pipes.

Installation and commissioning

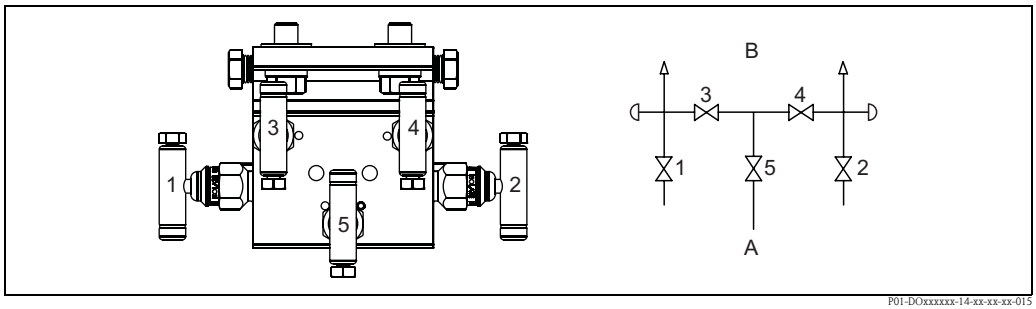
After completion of the installation, the shut-off valves must be closed. When starting the commissioning, the shut-off valves should be opened cautiously and the complete measuring system should be checked for leakages.

5.3.3 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 the 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 valves.

Commissioning

During commissioning a zero point adjustment of the Deltabar differential pressure transmitter should be performed in any case. During the first commissioning, when starting the process, all valves should be closed. Then, the valves of the "-" and "+" side should be opened cautiously. The equalization valve(s) 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 the zero point adjustment, first close the valve at the "-" side and then open the equalization valve (3)(4), such that the "+" and the "-" side of the transmitter are exposed to the same static process pressure (+). In this state the zero point adjustment of the Deltabar differential pressure can be performed (refer to the Operating Instructions of the Deltabar). After completion of the zero point adjustment the measuring system is put back into operation by performing the same steps in reverse order.
The zero point adjustment should be checked and – if necessary – adjusted regularly. Also the measuring system should regularly be checked for complete venting or draining, respectively.

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 to the transmitter flanges.

Caution!
If all the valves of the 3-valve manifold or all from the valves of the 5-valve manifold are opened at the same time, the pressure difference may cause a flow of the medium through the manifold. With hot media this may result in an overheating of the manifold and of the Deltabar differential pressure transmitter. Therefore, it is essential to avoid simultaneous opening of all three valves under operating conditions.

6 Troubleshooting

6.1 Error messages of the Deltabar M/S

Error messages of the Deltabar M/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/00/EN	BA382P/00/EN
PROFIBUS PA	BA294P/00/EN	in preparation
FOUNDATION Fieldbus	BA301P/00/EN	in preparation

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 if the valves to the differential pressure transmitter are open. **Configuration errors** ■ Configuration of the transmitter or flow calculator false or missing → Check and adjust configuration
Zero point drift; measured value fluctuations	**Planning error**s ■ High turndown → if necessary use different measuring cell or select arrangement with multiple transmitters ("split range", see Technical Information TI444P) **Installation errors** ■ Gas or liquid in the impulse pipe/in the transmitter → vent or drain impulse pipes and transmitter (→ 25) **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 (→ 25) ■ No compensation for gas measurements → complete temperature and pressure compensation (→ 20)
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 profile caused by fixtures, weld seams, protruding sealings, in- 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 **Installation errors** ■ Wrong mounting position → check mounting position (→ 9, 10, 11) ■ Wrong orifice orientation → DO71W, DO74P: The labelling of the orifice plate must point into the upstream direction. → DO75F: The longer pipe of the meter run must point into the upstream direction. ■ Upstream or downstream length too short → check up and downstream lengths (→ 13) ■ Leakages → check complete measuring system for leakages **Calibration error** ■ Compensation for gas measurements wrong or missing → complement temperature and pressure compensation (→ 20) ■ 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 error** ■ Wear of the orifice (especially with abrasive media) → if necessary, exchange orifice plate

7 Maintenance and repairs

7.1 Maintenance

The following maintenance tasks should be performed in regular intervals:

- Checking of 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 build-up formation: check and clean the primary device; exchange gaskets

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 funcitonality (material/edge sharpness, traces of wear)

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

Caution!
If maintenance measures (e.g. exchange of the transmitter or the 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 leaking medium. If necessary, temperature and pressure have to be checked before unmounting the instrument.

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 to be replaced. Replacement is necessary only in special circumstances, for example if aggressive or corrosive fluids are incompatible with the seal material.

7.4 Return

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

- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid 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.
- Enclose special handling instructions if necessary, for example a madium safety data sheet.

Additionally specify:

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

7.5 Disposal

In case of disposal please seperate the different components according to their material consistence.

7.6 Contact addresses of Endress+Hauser

Contact addresses can be found on our homepage: www.endress.com/worldwide.
Please contact Endress+Hauser if you have any questions.

8 Accessories

8.1 Overview

The following accessories are available for the differential-pressure flow measurement with orifices:

- DA71V: Shut-Off Valve (see Technical Information TI444P)
- DA71C: Condensate pot (see Technical Information TI444P)
- DA73M: Manifold (see Technical Information TI444P)
- DA63R: Rectifier (→ 30)
- PZO: Oval flange adapter (→ 33)

The condensate pots, shut-off valves and manifold can be ordered together with the orifice. They are included in the product structures DO71W and DO75F.
Alternatively, they can be ordered by their own product structures. For details refer to Technical Information TI444P. The rectifier can only be ordered by its own product structure.

8.2 Rectifier DA63R

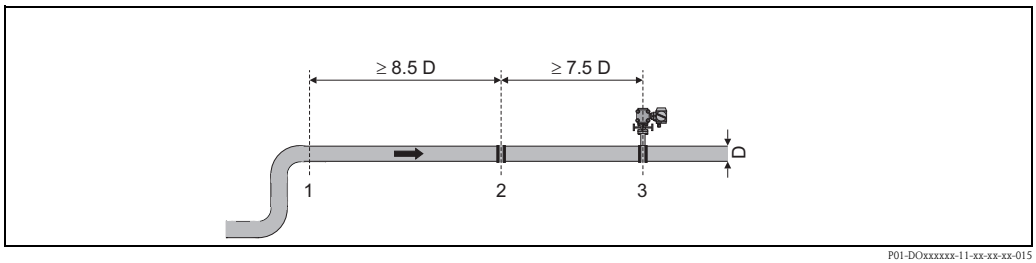
8.2.1 Usage

The rectifier can be used to reduce the required upstream length between an obstacle in the pipe and the orifice.

Installation conditions

- Distance between rectifier and obstacle: min. 8,5 D
- Distance between rectifier and orifice: min. 7,5 D

D: inner pipe diameter



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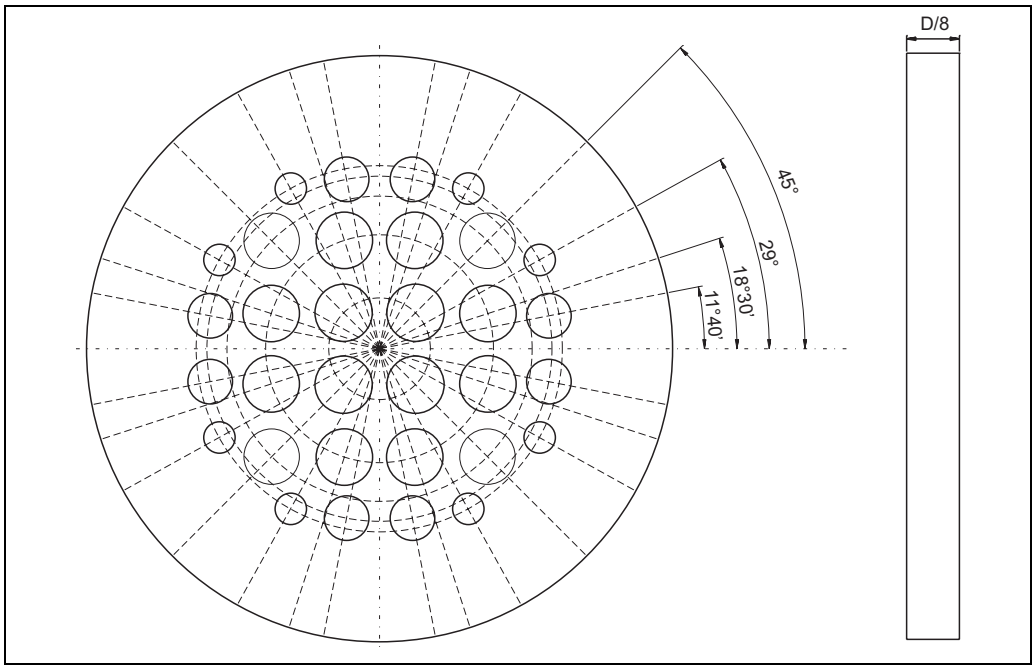
Pressure loss

Pressure loss across the rectifier:

$\Delta p = 1{,}5\ \rho\ v^2$

– Δp: Pressure loss across the rectifier [Pa]
– ρ: Density of the fluid [kg/m^3]
– v: Flow velocity [m/s]

8.2.2 Dimensions



The Zanker perforated plate conditioner according to ASME MFC-3M and ISO 5167-2 consists of 32 bores in a circular symmetrical arrangement. The dimensions of the bores depend on the inner diameter *D* of the pipe:

- 4 bores, bore diameter 0,141 *D*, reference diameter 0,25 *D*
- 8 bores, bore diameter 0,139 *D*, reference diameter 0,56 *D*
- 4 bores, bore diameter 0,1365 *D*, reference diameter 0,75 *D*
- 8 bores, bore diameter 0,11 *D*, reference diameter 0,85 *D*
- 8 bores, bore diameter 0,077 *D*, reference diameter 0,90 *D*

The plate thickness is 1/8 *D*.
The plate diameter is adjusted to the outer diameter of the flange (according to feature 30 "orifice").

8.2.3 Versions

Version	Mean Diameter
DA63R25	DN25 / 1"
DA63R40	DN40 / 1-1/2"
DA63R50	DN50 / 2"
DA63R65	DN65 / 2-1/2"
DA63R80	DN80 / 3"
DA63R1H	DN100 / 4"
DA63R1Z	DN125 / 5"
DA63R1F	DN150 / 6"
DA63R2H	DN200 / 8"
DA63R2F	DN250 / 10"
DA63R3H	DN300 / 12"
DA63R3F	DN350 / 14"
DA63R4H	DN400 / 16"
DA63R4F	DN450 / 18"
DA63R5H	DN500 / 20"
DA63R6H	DN600 / 24"
DA63R7H	DN700 / 28"
DA63R8H	DN800 / 32"
DA63R9H	DN900 / 36"
DA63R1T	DN1000 / 40"

8.2.4 Product structure

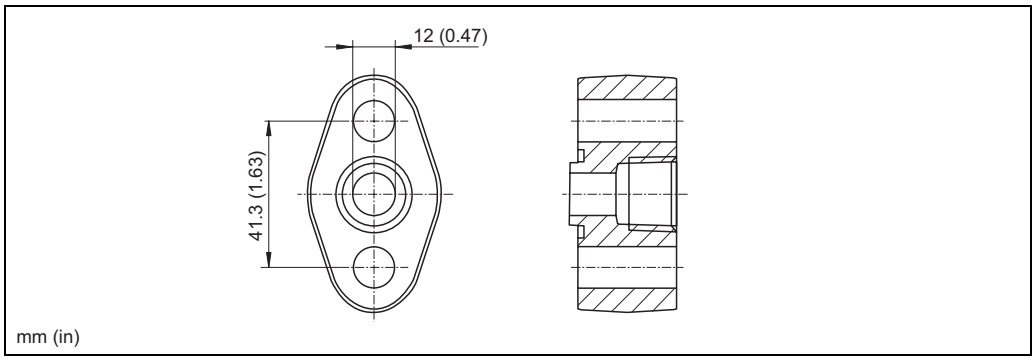
10	Version
S	Standard
Y	Special version, to be specified

30	Pressure Rating; Material
	EN flanges
BAC	PN6 B1, 316L
BBC	PN10 B1, 316L
BCC	PN16 B1, 316L
BDC	PN25 B1, 316L
BEC	PN40 B1, 316L
BFC	PN63 B2, 316L
BGC	PN100 B2, 316L
BHC	PN160 B2, 316L
	ANSI flanges
FAC	Cl.150 RF, 316L
FBC	Cl.300 RF, 316L
FCC	Cl.600 RF, 316L
FDC	Cl.900 RF, 316L
FEC	Cl.1500 RF, 316L
FFC	Cl.2500 RF, 316L
FKC	Cl.900 RTJ, 316L
FLC	Cl.1500 RTJ, 316L
FMC	Cl.2500 RTJ, 316L
Y99	Special version, to be specified

550	Additional Option (optional, multiple options can be selected)
F1	EN10204-3.1 material (wetted parts) inspection certificate
F2	EN10204-3.1 material, NACE MR0175 (wetted parts) inspection certificate

8.3 Oval flange adapter PZO

8.3.1 Dimensions



P01-DOxxxxx-15-xx-xx-xx-022

8.3.2 Product structure PZO

010	Approval
B	EN10204-3.1 material, oval flange inspection certificate
R	Basic version
S	Cleaned from oil+grease, oxygen service
Y	Special version, to be specified

020	Process Connection
A	FNPT1/2-14
E	JIS RC1/4"
Y	Special version, to be specified

030	Material
1	316L
2	Steel C22.8
9	Special version, to be specified

040	Seal
1	PTFE
2	FKM Viton
9	Special version, to be specified

050	Mounting Screw
1	2x Mounting screw M10
2	2x Mounting screw UNF7/16-20
3	Not selected
4	2x Mounting screw M12
9	Special version, to be specified

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

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