INTRA-AUTOMATION

MESS- UND REGELINSTRUMENTE / MEASUREMENT AND CONTROL

TÜV CERT EN ISO 9001

FLOW MEASUREMENT WITH ORIFICES

Types: BLS500 / BLS550

Technical Information

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Differential pressure flow measurement with orifices and differential pressure transmitters

Types: BLS500 / BLS550

The universal measuring system for steam, gases and liquids

Application:

- Flow measurement of gases, steam and liquids
- Nominal diameters from DN 10 (3/8”) to DN 1000 (40”)
- Medium temperatures -200 °C (-328 °F) to 1000 °C (1830 °F)
- Pressure up to 420 bar (6300 psi)
- Compliant to DGRL (PED) 97/23/EC
- NACE compliant materials

Advantages:

- Selectable according to the application:
  - operational compact version: minimizes installation costs
  - modular remote version: for demanding process conditions (high temperature, high pressure) and difficult installation conditions
- Optimized for minimum pressure loss, highest accuracy and maximum measuring dynamics
- Measuring range of the differential pressure transmitter adjusted on delivery
- Measuring method globally standardized according to ISO 5167
- Optional symmetric orifice for bidirectional measurements
- Rugged design, no moving parts

Differential pressure flow measurement with orifices and differential pressure transmitters

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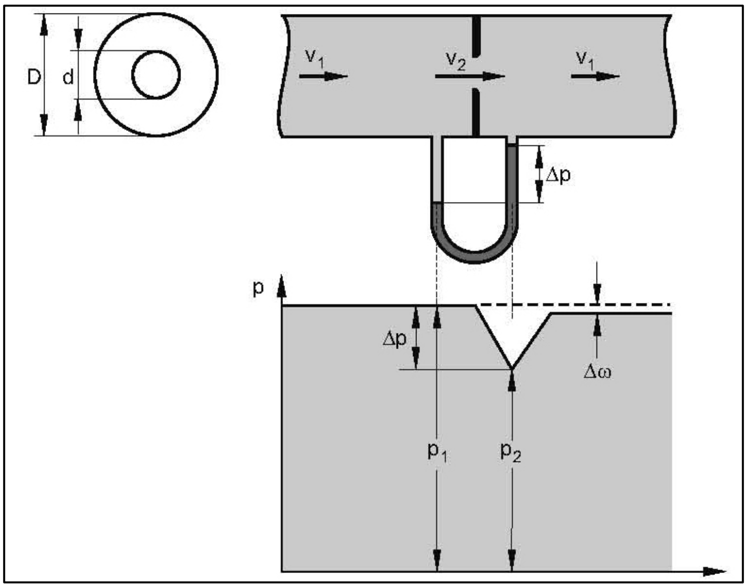
A. Function and system design

A.1. Measuring principle

Within the orifice the flow velocity is larger than in the rest of the tube. According to the Bernoulli equation this results in a reduction of the static pressure. The pressure difference between the static pressures upstream and downstream of the orifice plate is measured by a differential pressure transmitter.
The value of the differential pressure is very much depending on the diameter ratio (β) of the internal diameter of the orifice bore (d) to the internal diameter of the pipe (D):

B = d/D



Orifice and other similar devices are also designated as primary elements.

The relationship between flow rate (Q) and differential pressure (dp) is a square root function.

Q ~ $\sqrt{dp}$

Behind the orifice the pressure recovers partly to its original value. There is a remaining **pressure loss Δω**.

Differential pressure flow measurement with orifice plates (and other types of restrictions) is standardized by ISO 5167. This refers to the geometries, system configurations and to the rules of measured value calculation.

A.2. Sizing and optimization

The relationship between differential pressure, permanent pressure loss, flow rate and the diameter ratio β as well as the dependencies on further parameters are described in detail by the international standard ISO 5167. Intra Automation executes all orifice calculations acc. to ISO 5167-2 based on the application specific process conditions given by the user. Therefore, a questionnaire (sizing sheet-data sheet) should be completed for each measuring point. All primary elements (orifices) will be supplied by Intra-Automation with an enclosed calculation sheet. This provides the benefit to the user not to be involved in the complicated sizing calculations anymore.

An orifice measurement can be sized with different diameter ratios β. By changing β the measuring point can be optimized to a vide variety of different applications. Intra-Automation optimizes each measuring point according to one of the following optimization criteria which can be chosen by the user:

- **Optimized by Intra-Automation**
  Intra-Automation completely calculates and optimizes the measuring point in consideration of the given process parameters. The optimum solution provides the best achievable compromise between differential pressure, measuring cell selection, measurement dynamics, measurement uncertainty and permanent pressure loss.
- **Maximum measurement dynamics (small β)**
  Intra-Automation calculates and optimizes the measuring point to the smallest reasonably achievable diameter ratio β in order to provide maximum measurement dynamics and minimum measurement uncertainty.
- **Low permanent pressure loss (large β)**
  Intra-Automation calculates and optimizes the measuring point to the largest achievable diameter ratio β in order to keep the permanent pressure loss as low as possible.
- **Maximum allowable permanent pressure loss**
  Intra-Automation calculates the measuring point in consideration of the maximum allowable pressure loss at the layout point (max. flow rate).
- **Fixed diameter ratio β**
  The sizing has to be executed with a user-defined diameter ratio β. Intra-Automation calculates the measuring point accordingly.
- **Fixed differential pressure**
  The sizing has to be executed with a user-defined differential pressure. Intra-Automation calculates the primary element in order to meet the requested differential pressure at the layout point.
- **Fixed sizing calculation**
  A complete sizing calculation already exists. Intra-Automation verifies the calculation and manufactures the flow element according to the given sizing calculation.

A.3. Sizing sheet – Data sheet

To ensure that the orifice measuring point exactly matches the requirements of the process, the completed “Sizing sheet – Data sheet” (part of this technical information) has to be attached to the order. Intra-Automation uses the data of this form to determine the optimum configuration of the measuring point.

A.4. Selection of the differential pressure transmitter and the measuring cell

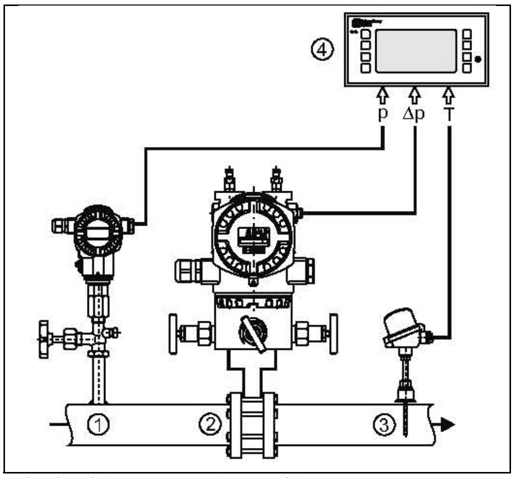
If requested, Intra-Automation will select the best suitable differential pressure transmitter and measuring cell according to the results of the sizing calculation. The differential pressure transmitter will be supplied completely configured and pre-adjusted to the calculated values. This allows easy and convenient ordering and commissioning of the measuring point even for the less experienced user.

A.5. Temperature and pressure compensation

Separate Process Connections

Two additional proves are required for temperature and pressure compensation:

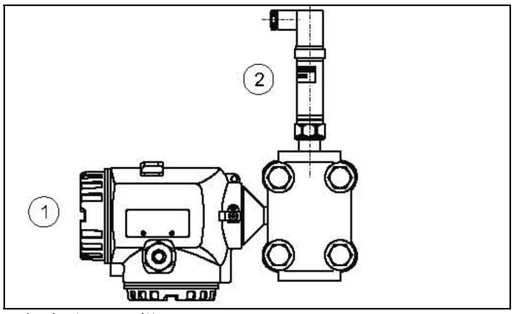
- **An absolute pressure sensor**
  According to ISO 5167, this probe always must be mounted on the upstream side of the orifice.
- **A temperature probe**
  In order to avoid disturbances of the flow profile, this probe must be mounted on the downstream side of the orifice.



1: absolute pressure transmitter
2: orifice and differential pressure transmitter
3: temperature probe
4: evaluation unit

Combined process connection for absolute and differential pressure

An adapter (e.g. oval flange adapter) can be used to screw a pressure transmitter or a pressure into the transmitter flange. The absolute pressure transmitter must be mounted at the "+"-side of the transmitter.



1: dp-transmitter
2: Transmitter for absolute pressure

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 is supplied with each 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 in a square root function:

Qm = $\sqrt{2dp\rho}$ for the massflow (or volume flow at normal or standard conditions)

Qv = $\sqrt{\frac{2dp}{\rho}}$ for the volume flow

where
ρ = the density of the medium.

If the current output of the dp 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 has not been 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 range will change and thus also the calculated flow range will change according to the above-mentioned equation.

$$\rho 2 = \rho 1 \frac{P2}{P1}\frac{T1}{T2}\frac{Z1}{Z2}$$

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:

Q2 = Q1 $\sqrt{\frac{P2}{P1}\frac{T1}{T2}\frac{Z1}{Z2}}$ for the mass flow (or volume flow at normal or standard conditions)

Q2 = Q1 $\sqrt{\frac{P1}{P2}\frac{T2}{T1}\frac{Z2}{Z1}}$ for the volume flow

The compressibility factor Z can be neglected if this 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.

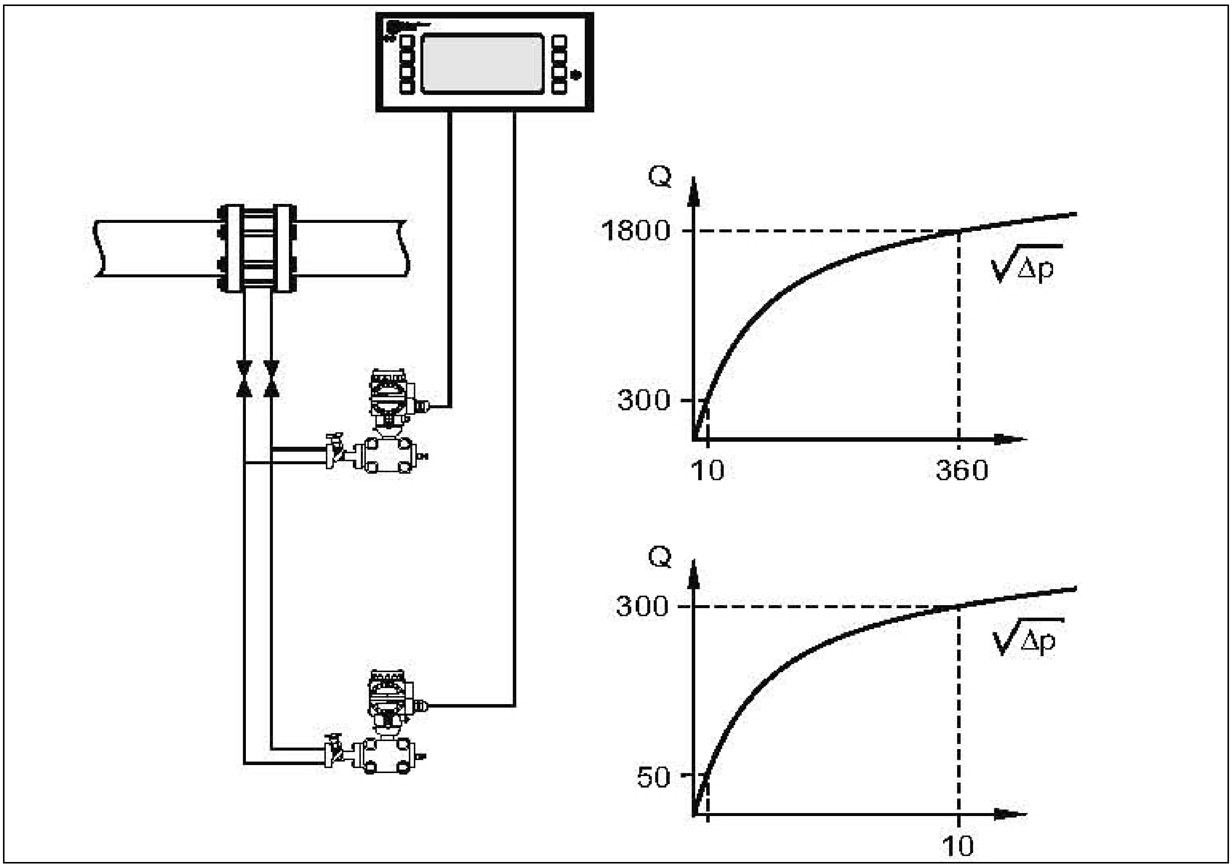
A.6. Split range (expansion of the measuring range)

The square root function has a very steep slope in the vicinity of the zero point. Therefore, the measuring range is limited from below, which results in a measuring dynamics of typically 6:1 (max. 12:1).
If the differential pressure is high enough, it is possible to increase the dynamics by connecting multiple dp transmitters with different measuring ranges.

NOTE
The maximum available measuring range depends on the differential pressure available.

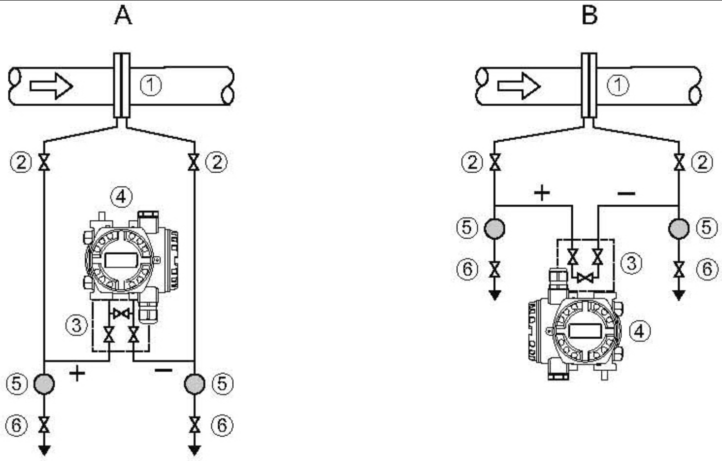
NOTE
The same method can be used to implement redundant measurements.

Example:



A.7. Flow measurement in liquids

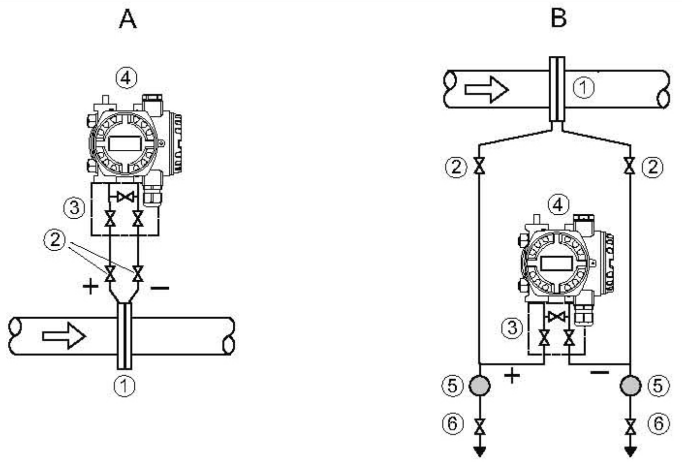
With liquid applications, the transmitter must be mounted below the pipe. All impulse pipes must be installed with a slope of at least 1:15 to the process connection – coming from the transmitter. This ensures that trapped air and bubbles rise back to the process pipe and thus do not influence the measurement.



A: Preferred configuration; B: alternative configuration (requires less space; only possible for clean media)
1: Orifice plate; 2: shut-off-valves; 3: Three-way-manifold; 4: dp transmitter; 5: Separator; 6: Drain valve

A.8. Flow measurement in gases

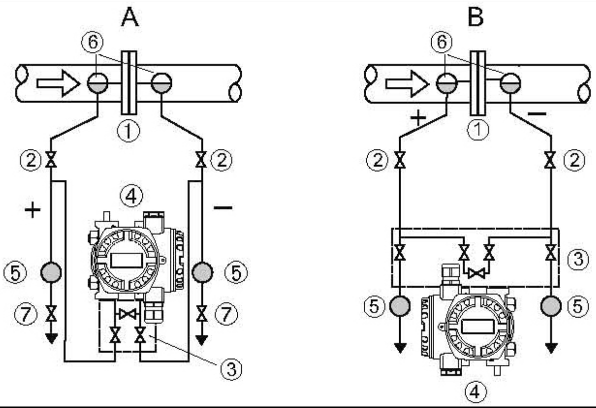
With gas application, the transmitter must be mounted above the pipe. All impulse pipes must be installed with a slope of at least 1:15 to the process connection – coming from the transmitter. This ensures that any condensate flows back into the process pipe and thus does not influence the measurement.



A: Preferred configuration; B: alternative configuration (if the transmitter cannot be mounted above the pipe, only possible for clean media)
1: Orifice plate; 2: shut-off-valves; 3: Three-way-manifold; 4: dp transmitter; 5: Separator; 6: Drain valve

A.9. Flow measurement in steam

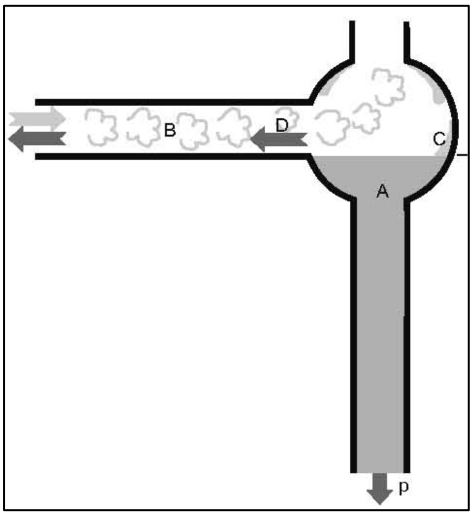
With steam applications, two condensate chambers have to be applied. They must be mounted on the same level. The transmitter must be located below the pipe. The pipes between the transmitter and the condensate chambers must be completely filled with water on both sides.
A 5-way-manifold allows simple piping and can be used instead of T-sections and additional blow-out-valves. The impulse pipes must be installed a gradient of 1:15 to reliably ensure rising of trapped water of the impulse line to the transmitter.
It is recommended to use flange pairs – or preferably welded connections – for steam applications. Behind the condensate chambers, continue piping with Ermeto 12S.



A: with 3-way-manifold, for easy venting of the transmitter; especially for small differential pressures;
B: with 5-way-manifold, for cleaning of the transmitter
1: Orifice plate; 2: shut-off-valves; 3: Manifold; 4: dp transmitter; 5: Separator; 6: Condensate chambers; 7: Drain valve

Function of the condensate chambers

The condensate chambers make sure that the impulse lines are always completely filled with water and that the membrane of the transmitter is not exposed to hot steam. The water level is maintained by condensing steam. Excess condensate flows back and is re-evaporated.
Using the condensate chambers considerably reduces fluctuations of the water column. The stabilized measuring signal and the increased zero point stability ensures a consistent measuring quality.
The water column transfers the pressure to the transmitter membrane.



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

Operating conditions

- both condensate chambers must be mounted at the same level
- both condensate chambers must be filled completely before commissioning.

B. Mounting positions

B.1. Versions

B.1.1. Compact version

With the compact version of the measuring system, the orifice, the manifold and the transmitter are supplied readily mounted. Additional piping and additional valves are not required. Thus, leakage problems are eliminated.

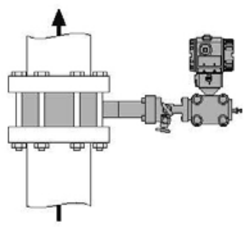
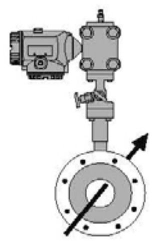
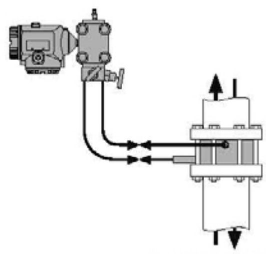
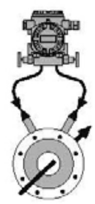
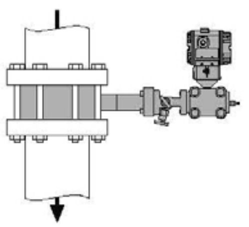
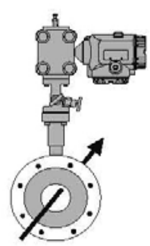
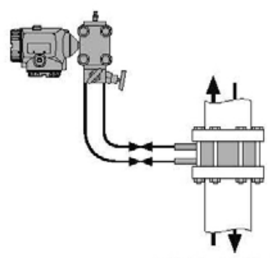
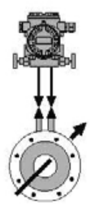
B.1.2. Remote version

With the remote version of the measuring system, the orifice, the manifolds, the shut-off-valves and the transmitter are delivered separately and must be mounted on-site. This version is recommended:
- for high process temperatures which impede a direct mounting of the transmitter.
- if due to shortage of space the transmitter cannot be mounted directly at the orifice.

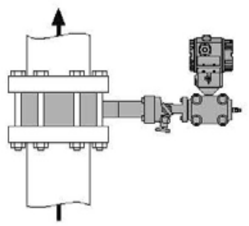
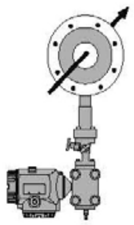
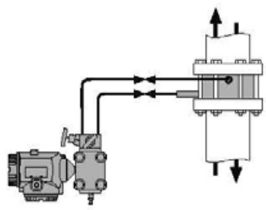
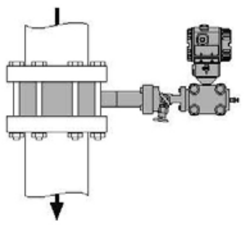
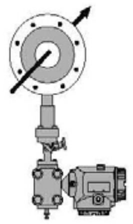
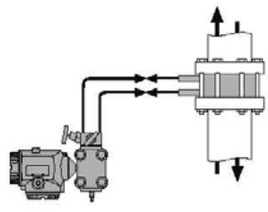
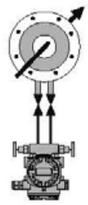
B.2. Flow direction

- ♦ The flow direction is marked by an arrow on the holding ring or by a labelling of the handle for orifice plates and measuring flanges. The labelling is always located on the upstream side of the orifice (+).
- ♦ “Mounting left” and “Mounting right” refer to the flow direction.
  For compact instruments, which are mounted from above or from below, the instrument is shipped in a way that the transmitter is mounted at the left or right side, respectively (with respect to the flow direction.
  For steam versions, which are mounted laterally, the condensate chambers and the transmitters are mounted on the left or right side, respectively (with respect to the flow direction).
- ♦ For compact versions the transmitter is always mounted in a way such that the display can be read in the specified mounting position and does not need to be rotated.

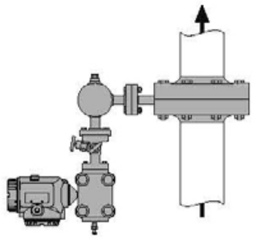
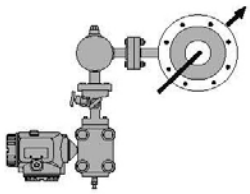
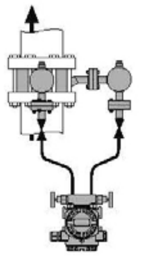
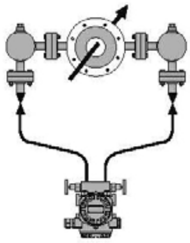
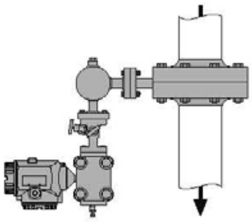
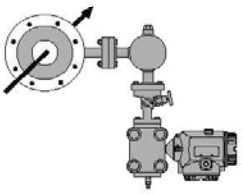
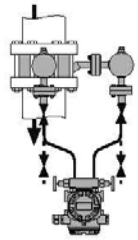
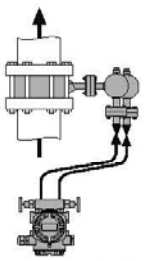
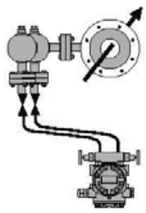
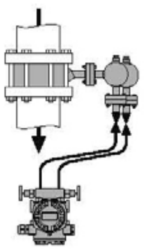
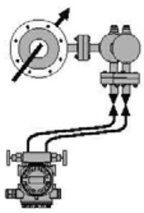
B.3. Mounting position for gas measurements

compact; vertical[1]	compact; horizontal[2]	remote; vertical	remote, horizontal
flow upwards 	mounting left 	taps 90° 	tap angle according to DIN 
flow downwards 	mounting right 	taps 0° 	taps 0° 

B.4. Mounting position for liquid measurements

compact; vertical[1]	compact; horizontal[2]	remote; vertical	remote; horizontal
flow upwards  P01-DO61Wxxx-11-00-00-xx-001	mounting left  P01-DO61Wxxx-11-00-00-xx-009	taps 90°  P01-DO61Wxxx-11-00-00-xx-015	tap angle according to DIN  P01-DO61Wxxx-11-00-00-xx-021
flow downwards  P01-DO61Wxxx-11-00-00-xx-002	mounting right  P01-DO61Wxxx-11-00-00-xx-010	taps 0°  P01-DO61Wxxx-11-00-00-xx-016	taps 0°  P01-DO61Wxxx-11-00-00-xx-022

B.5. Mounting position for steam measurements

compact; vertical[1)]	**compact; horizontal**[1]	**remote; vertical**	**remote; horizontal**
flow upwards  P01-DO61Wxxx-11-00-00-xx-005	mounting left  P01-DO61Wxxx-11-00-00-xx-011	taps 90°; flow upwards  P01-DO61Wxxx-11-00-00-xx-017	taps 180°  P01-DO61Wxxx-11-00-00-xx-023
flow downwards  P01-DO61Wxxx-11-00-00-xx-006	mounting right  P01-DO61Wxxx-11-00-00-xx-012	taps 90°; flow downwards  P01-DO61Wxxx-11-00-00-xx-026	
		taps 0°, flow upwards  P01-DO61Wxxx-11-00-00-xx-018	taps 0°; mounting left  P01-DO61Wxxx-11-00-00-xx-024
		taps 0°; flow downwards  P01-DO61Wxxx-11-00-00-xx-027	taps 0°; mounting right  P01-DO61Wxxx-11-00-00-xx-025

C. Installation and process conditions

C.1. Up- and Downstream lengths

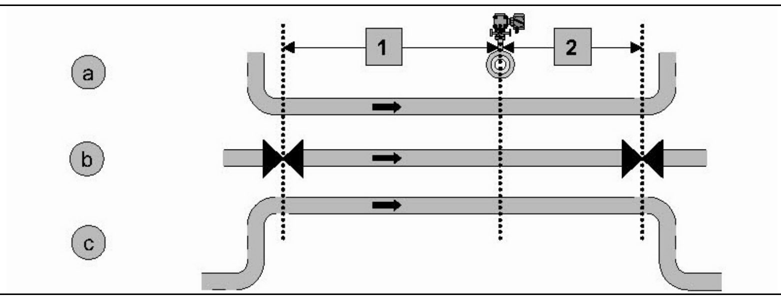
In order to ensure a homogeneous flow profile, it is necessary to mount the orifice in a sufficient distance to narrowings or bends of the pipe. The required upstream lengths for different types of obstacles are summarized in the following table. Detailed specifications can be obtained from ISO 5767-2.

Type of obstacle	$\beta \leq 0{,}2$		$\beta = 0{,}5$		$\beta = 0{,}75$	
	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 ISO 5167-2.

Examples (schematic):



1: upstream length; 2: downstream length
A: 90° bend; b: valve, open, c: 2x90° bend

NOTE
The requirements concerning the pipe as stated in ISO 5167 must be met (weld seams, roughness etc.).

NOTE
The required upstream length can be reduced by a rectifier. Details are specified in ISO 5197-2

C.2. Homogeneity

The fluid must be homogeneous. **No changes of the state of aggregation** (liquid, gas, steam) may occur. The pipe must always be **completely filled**.

C.3. Temperature, Pressure

	Compact version	Remote version
Max. temperature	♦ For gases and liquids: 200°C (390 °F) ♦ For steam: 300°C (570°F)	♦ with standard material: approx. 500°C (930°F) ♦ with special material: approx. 1000°C (1830°F)
Max. pressure	420 bar (6000 psi)	

Temperature and pressure may not be subject to large fluctuations.
If required, a temperature and pressure compensation must be applied for gases and steam (see chapter A.5.).

C.4. Reynolds number

A turbulent flow is required for differential pressure flow measurement. The Reynolds number Re determines whether the flow is laminar or turbulent. Re is a non-dimensional parameter which describes the dependency of the flow on the velocity, the internal diameter of the tube as well as the medium density and viscosity.
For a reliable measurement the Reynolds number should not fall below the values given in the following table:

Type of orifice	Approx. min. Reynolds number[1]
sharp	5000
quarter circle nozzle	500
double cone	80
segmental orifice	5000
bidirectional	5000

1) The exact conditions depend on the type of pressure tapping and of the aperture ratio β.

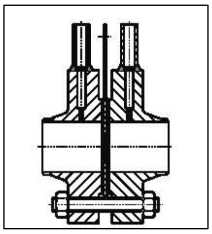
D. Mechanical construction

D.1. Product overview / Types of pressure tapping

The type of the pressure tapping has a crucial influence on the mechanical construction of the orifice and on the mounting into the pipe. The product family BLS comprises all types of pressure tapping described in ISO 5167.

Flange tapping

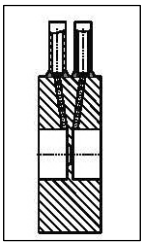
The pressure is tapped at a distance of 1" (25,4 mm) before (+) and behind (-) the orifice. Usually the tapping is realised by a bore through the flange. Standardized measuring flanges are available for flange tapping (DIN19214 or ASME B16.36). The orifice plate is exchangeable. Flange tapping is preferred wherever ASME applies.



Example

Corner tapping with single bore

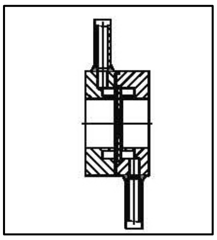
The pressure is tapped immediately before (+) and behind (-) the orifice. The tapping is often realized by a bore through the carrier rings. The orifice with the carrier rings is mounted between two flanges. Corner tapping is preferred wherever DIN is valid.

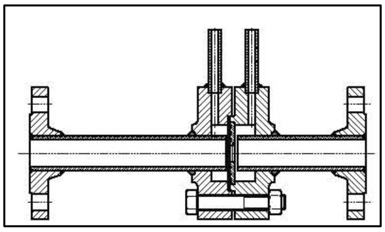


Example

Corner tapping with annular chamber

The pressure is tapped directly before (+) and behind (-) the orifice. An annular chamber in the carrier rings enables averaging of the pressure along the complete circumference of the pipe. The averaging reduces the influence of obstacles in the pipe. The orifice with the carrier rings is mounted between two flanges. Annular chamber tapping is preferred if a high measuring accuracy is required (e.g. accounting measurements, calibrated meter runs).





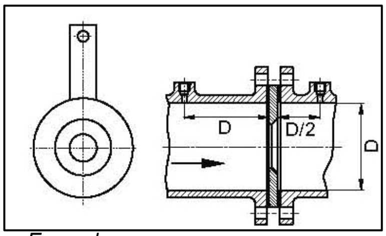
Examples

D-D/2 tapping

The pressure is tapped in a distance of 1D before (+) and 0,5 D behind (-) the orifice. D is the inner pipe diameter. Usually the tapping is realized by a single bore in the pipe. The orifice an exchangeable orifice plate. D-D/2 tapping is especially useful for later mounting of a measurement in an existing pipe.

Pipe tapping

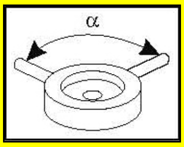
The pressure is tapped in a distance of 2,5D before (+) and 8D behind (-) the orifice. D is the inner pipe diameter. Usually tapping is realized by a single bore in the pipe. The orifice is exchangeable orifice plate. With pipe tapping the differential pressure is equal to the remaining pressure loss.



Example

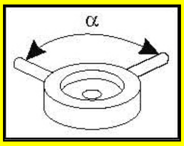
D.2. Position of the pressure taps

D.2.1. Pressure taps according to DIN19205-1, tables 1 to 4

DN [mm]								
	PN6	**PN10**	**PN16**	**PN25**	**PN40**	**PN63**	**PN100**	**PN160**[1)]
32	135°	135°	135°	135°	135°	135°	135°	135°
40	135°	135°	135°	135°	135°	135°	135°	135°
50	135°	135°	135°	135°	135°	135°	135°	135°
65	135°	135°	135°	90°	90°	90°	90°	90°
80	135°	90°	90°	90°	90°	90°	90°	90°
100	135°	90°	90°	90°	90°	90°	90°	90°
125	90°	90°	90°	90°	90°	90°	90°	90°
150	90°	90°	90°	90°	90°	90°	60°	60°
200	90°	90°	60°	60°	60°	60°	60°	60°
250	60°	60°	60°	60°	60°	60°	60°	60°
300	60°	60°	60°	45°	45°	45°	45°	45°
350	60°	45°	45°	45°	45°	45°	45°	
400	45°	45°	45°	45°	45°	45°	45°	
450	45°	36°	36°	36°				
500	36°	36°	36°	36°	36°	36°	36°	
600	36°	36°	36°	36°	36°	36°		
700	30°	30°	30°	30°	30°			
800	30°	30°	30°	30°				
900	30°	26°	26°	26°				
1000	26°	26°	26°	26°				

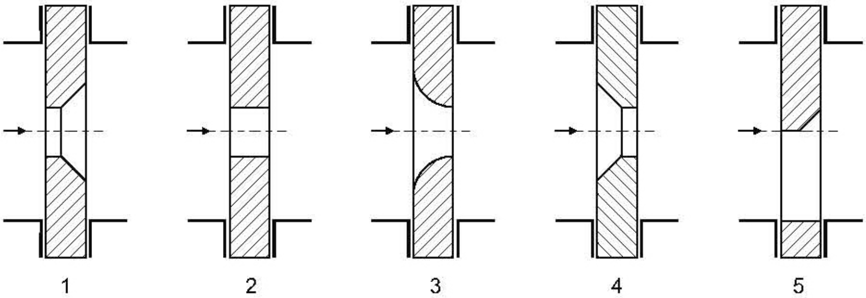
1) Similar to DIN19205-1

D.2.2. Pressure taps for flanges according to ASME 16.5 and ASME B16.474, similar to DIN19205-1



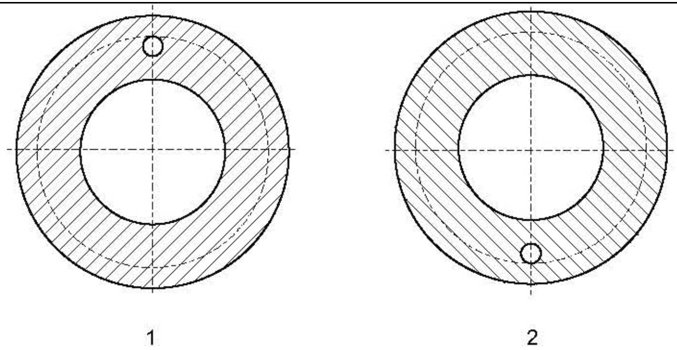
DN [inch]	150#	300#	600#	900#	1500#	2500#
1 ½	135°	135°	135°	135°	135°	135°
2	135°	90°	90°	90°	90°	90°
2 ½	135°	90°	90°	90°	90°	90°
3	135°	90°	90°	90°	90°	90°
4	90°	90°	90°	90°	90°	90°
5	90°	90°	90°	90°	90°	90°
6	90°	60°	60°	60°	60°	90°
8	90°	60°	60°	60°	60°	60°
10	60°	45°	45°	45°	60°	60°
12	60°	45°	36°	36°	45°	60°
14	60°	36°	36°	36°	45°	
16	45°	36°	36°	36°	45°	
18	45°	30°	36°	36°	45°	
20	36°	30°	30°	36°	45°	
24	36°	30°	30°	36°	45°	
28	26°	26°	26°	36°		
32	26°	26°	26°	36°		
36	22,5°	22,5°	26°	36°		
40	20°	22,5°	22,5°	30°		

D.3. Inlet Edge Orifice



No.	Inlet edge	Min. Reynolds no.	Application
1	sharp	Re ≥ 5000	Standard; Should always be used if the Reynolds no. is large enough.
2	bidirectional	Re ≥ 5000	Apply if flows in both directions are to be measured.
3	quarter circle nozzle	Re ≥ 500	only for Re ≤ 5000
4	conical inlet	Re ≥ 80	only for Re ≤ 500
5	Segmental orifice	Re ≥ 5000	♦ for liquids with gas content (aperture at the top) ♦ for liquids with solid content (aperture at the bottom)

D.4. Vent/Drain hole



1: orifice plate with vent hole; 2: orifice plate with drain hole

- Orifice plates with vent hole are applied for liquids with gas formation.
  Gas can pass the orifice plate through the vent hole.
- Orifice plates with drain hole are applied for gases with condensate formation.
  Condensate can pass the orifice plate through the drain hole.

NOTE

- Orifice plates with vent or drain holes can only be applied in horizontal pipes
- Vent and drain holes are not available for the annular chamber and meter run.

Dimensions

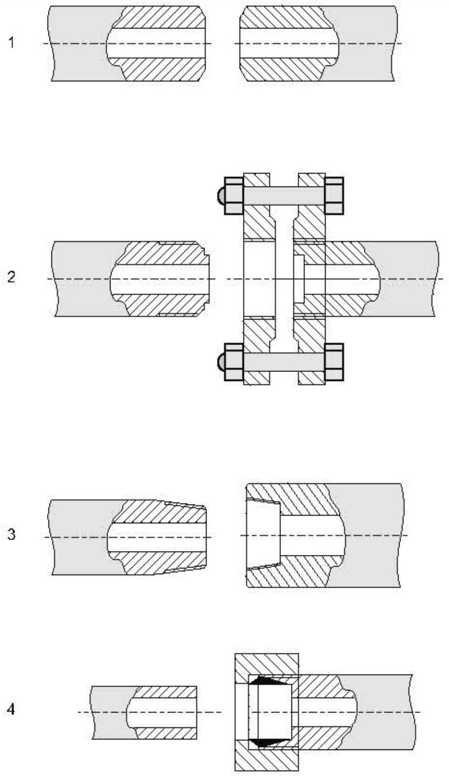
The diameter of the vent or drain hole depends on the diameter of the orifice.

Diameter of the orifice [mm (inch)]	Diameter of the vent or drain hole [mm (inch)]
25,4 - 88,9 (1.000 – 3.500)	2,4 (3/32)
89,0 - 104,8 (3.501 – 4.125)	3,2 (1/8)
104,9 - 127,0 (4.126 – 5.000)	4,0 (5/32)
127,1 – 152,4 (5.001 – 6.000)	4,8 (3/16)
152,4 – 171,5 (6.001 – 6.750)	5,6 (7/32)
171,5 – 190,5 (6.751 – 7.500)	6,4 (1/4)
190,6 – 212,7 (7.501 – 8.375)	7,1 (9/32)
212,8 – 235,0 (8.376 – 9.250)	8,0 (5/16)
235,1 – 254,0 (9.251 – 10.000)	8,7 (11/32)
254,0 – 276,2 (10.001 – 10.875)	9,5 (3/8)
276,3 – 295,3 (10.876 – 11.625)	10,3 (13/32)
295,3 – 317,5 (11.626 – 12.500)	11,1 (7/16)
317,5 – 336,6 (12.501 – 13.250)	11,9 (15/32)
> 336,6 (> 13.251)	12,7 (1/2)

D.5. Differential pressure connection

D.5.1. Differential pressure connection for the remote version

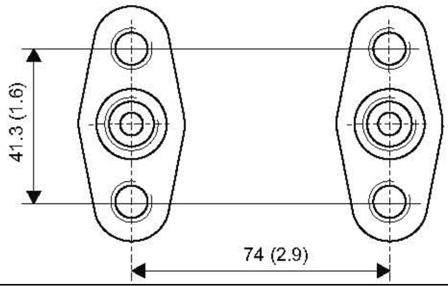
For the remote version, the following connections are available for the impulse lines between the individual components:



No.	Outlet (from the primary element)	Inlet (to the accessory)	Application/Remarks
1	welding connection 14/21,3/24 mm	welding connection 14/21,3/24 mm	For highly demanding applications; permanent joint
2	G ½ DIN 19207	G ½ DIN 19207 + 2 flanges[1)]	Disconnectable; especially suitable for steam
3	MNPT ½	FNPT ½	Simple mounting; not suited for steam
4	Pipe 12 mm	Cutting ring (Ermeto 12S)	Simple mounting; easy disconnectable; not suited for steam

1) The flanges are included in the scope of supply of the accessory.
2)

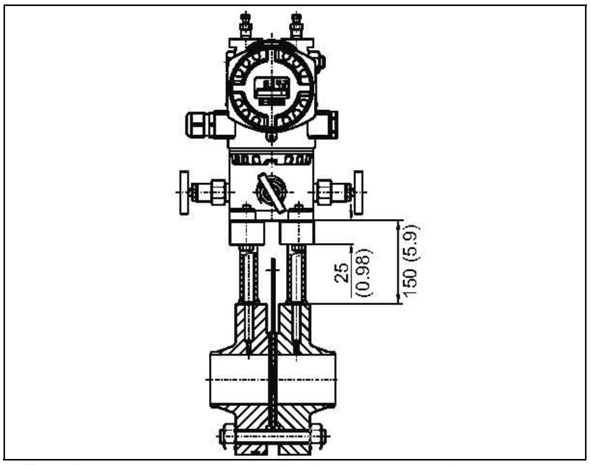
D.5.2. Differential pressure connection for the compact version (IEC61518)



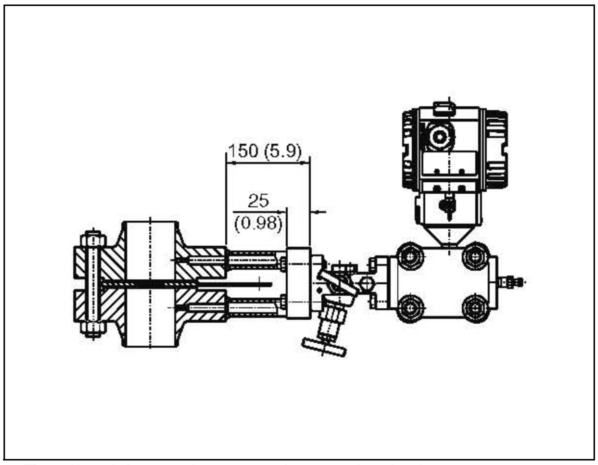
Dimensions in mm (inch)

E.1. BLS550: Flange Tap

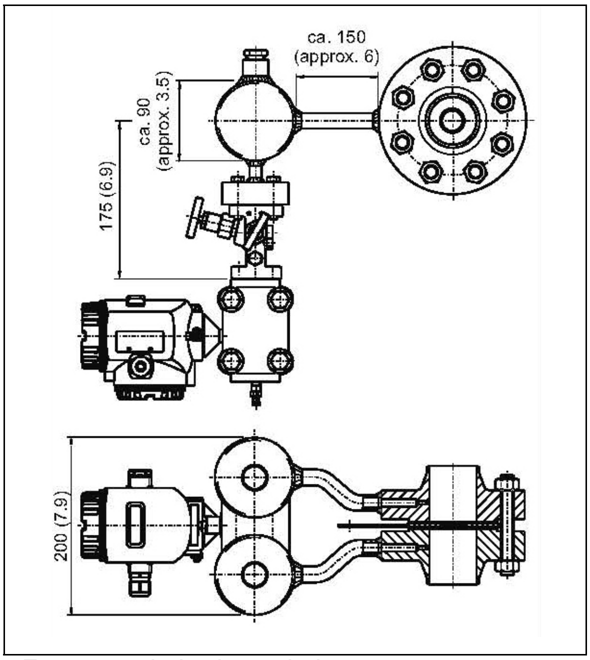
Typical configurations:



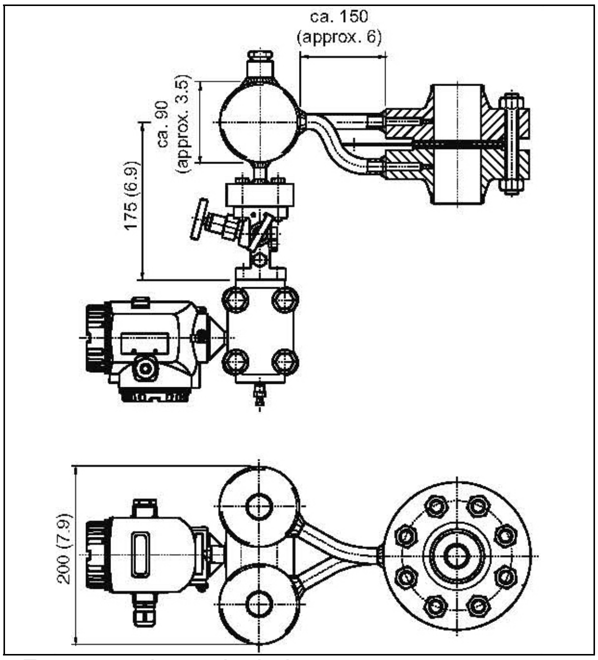
For liquids and gases in horizontal pipes;
Dimensions in mm (inch)



For liquids and gases in vertical pipes;
Dimensions in mm (inch)



For steam in horizontal pipes;
Dimensions in mm (inch)



For steam in vertical pipes;
Dimensions in mm (inch)

Design

Measuring flange with exchangeable orifice plate in compact or remote design; accessories included.

Type of pressure tapping

Flange tapping.

Materials

	Version High-carbon steel (C22.8; A105)	Stainless steel (316L)
Flanges DIN	C22.8	316L (1.4404)
Flanges ASME	A105	316L
Orifice plate	316L (1.4404)	316L (1.4404)
Seal between orifice plate and flange	♦ Standard (Klingersil or Graphite, dep. on the application) ♦ Spiral seal: 316L/Graphite	

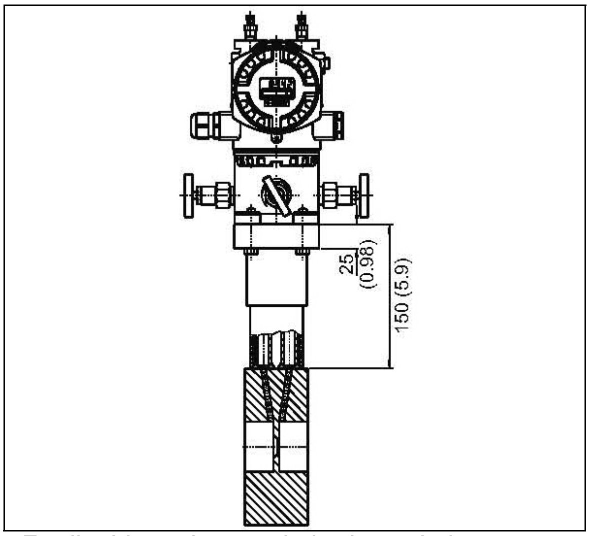
Dimensions / Weight

BLS550 Flanges acc. to DIN 19214									
D (mm)	L [mm (inch)]							E[1)] [mm (inch)]	Weight[2)] [kg (lbs)]
	PN10	PN16	PN25	PN40	PN64	PN100	PN160		
50	133 (5.24)	133 (5.24)	135 (5.31)	135 (5.31)	150 (5.91)	159 (6.26)	3)	3 (0.118)	16 (35)
65	133 (5.24)	133 (5.24)	139 (5.47)	139 (5.47)	162 (6.38)	170 (6.69)	3)	3 (0.118)	18 (40)
80	140 (5.51)	140 (5.51)	148 (5.83)	148 (5.83)	167 (6.57)	170 (6.69)	3)	4 (0.157)	21 (46)
100	144 (5.67)	144 (5.67)	162 (6.38)	162 (6.38)	175 (6.89)	191 (7.52)	3)	4 (0.157)	27 (60)
125	146 (5.75)	146 (5.75)	164 (6.46)	164 (6.46)	187 (7.36)	222 (8.74)	3)	4 (0.157)	37 (82)
150	146 (5.75)	146 (5.75)	174 (6.85)	174 (6.85)	201 (7.91)	242 (9.53)	3)	4 (0.157)	49 (108)
200	156 (6.14)	156 (6.14)	180 (7.09)	188 (7.40)	232 (9.13)	272 (10.7)	3)	4 (0.157)	77 (170)
250	164 (6.46)	168 (661)	192 (7.56)	217 (8.54)	262 (10.3)	326 (11.8)	3)	4 (0.157)	107 (236)
300	164 (6.46)	180 (7.09)	196 (7.72)	237 (9.33)	292 (11.5)	352 (13.9)	3)	4 (0.157)	131 (289)
350	164 (6.46)	186 (7.24)	257 (10.1)	257 (10.1)	312 (12.3)	390 (15.4)	3)	4 (0.157)	177 (390)
400	172 (6.77)	186 (7.32)	277 (10.9)	277 (10.9)	332 (13.1)			4 (0.157)	215 (474)
450	3)	3)	3)	3)				3)	3)
500	176 (6.93)	194 (7.64)	289 (11.4)	289 (11.4)				6 (0.236)	245 (540)
600	3)	3)	3)	3)				3)	3)

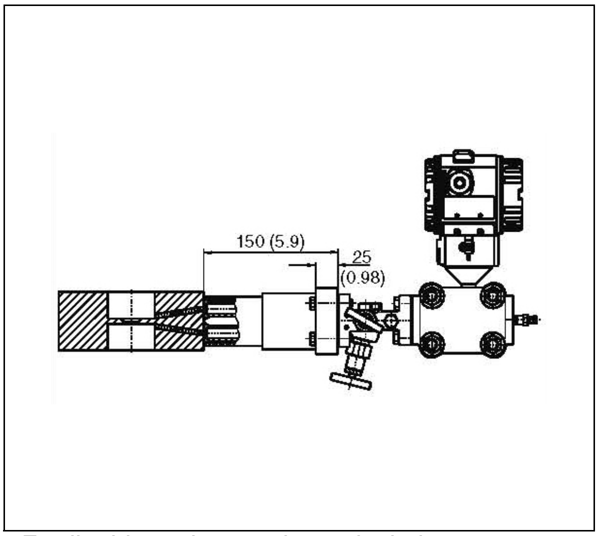
1) Minimum values; the precise value is determined during the sizing
2) The weight depends on the inner diameter of the pipe. The table only gives appr. values.
3) In preparation; following DIN19214

E.2. BLS550: Corner Tap

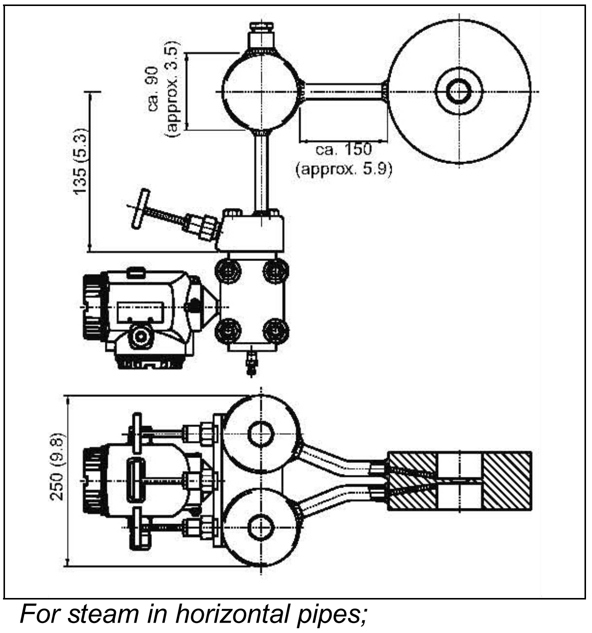
Typical configurations



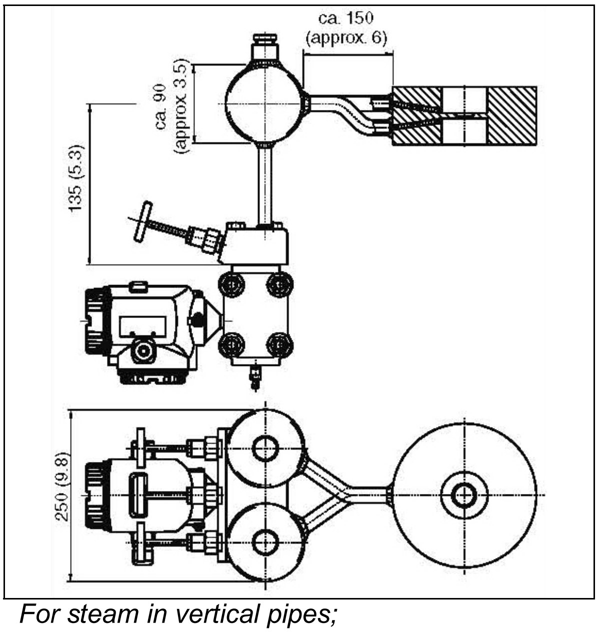
For liquids and gases in horizontal pipes;
Dimensions in mm (inch)



For liquids and gases in vertical pipes;
Dimensions in mm (inch)



For steam in horizontal pipes;
Dimensions in mm (inch)



For steam in vertical pipes;
Dimensions in mm (inch)

Design

Undivided standard orifices with carrier ring in compact or remote design, accessories included.

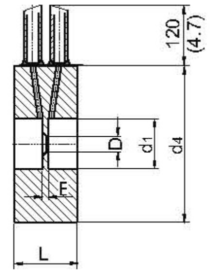
Type of pressure tapping

Corner tapping with single bore.

Materials

	High Carbon Steel	Stainless Steel	High temperature version
Carrier Ring DIN	C22.8 (1.0460)	316L (1.4404)	16Mo3 (1.5415)
Carrier Ring ASME	C22.8	316L	A182 Gr. F1
Orifice plate	316L (1.4404)	316L (1.4404)	316L (1.4404)

Dimensions



Dimensions in mm (inch)

BLS550 Flanges according to DIN EN										
D mm	**D_4 [mm (inch)]**								**E [mm (inch)]**	**d_1**
	PN6[1)]	**PN10[1)]**	**PN16[1)]**	**PN25[1)]**	**PN40[1)]**	**PN63[1)]**	**PN100[1)]**	**PN160[2)]**		
25	64 (2.52)	71 (2.80)	71 (2.80)	71 (2.80)	71 (2.80)	82 (3.23)	82 (3.23)	82 (3.23)	3 (0.118)	D+1 mm (1 mm = 0.0394")
40	86 (3.39)	92 (3.62)	92 (3.62)	92 (3.62)	92 (3.62)	103 (4.29)	103 (4.29)	103 (4.29)	3 (0.118)	
50	96 (3.78)	107 (4.21)	107 (4.21)	107 (4.21)	107 (4.21)	112 (4.41)	112 (4.41)	112 (4.41)	3 (0.118)	
65	116 (4.57)	127 (5.00)	127 (5.00)	127 (5.00)	127 (5.00)	137 (5.39)	143 (5.63)	143 (5.63)	3 (0.118)	
80	132 (5.20)	142 (5.59)	142 (5.59)	142 (5.59)	142 (5.59)	147 (5.79)	153 (6.02)	153 (6.02)	3 (0.118)	
100	152 (5.98)	162 (6.38)	162 (6.38)	167 (6.57)	167 (6.57)	173 (6.81)	180 (7.09)	180 (7.09)	3 (0.118)	
125	182 (7.17)	192 (7.56)	192 (7.56)	193 (7.60)	193 (7.60)	210 (8.27)	217 (8.54)	217 (8.54)	3 (0.118)	
150	207 (8.15)	217 (8.54)	217 (8.54)	223 (8.78)	223 (8.78)	247 (9.72)	257 (10.1)	257 (10.1)	3 (0.118)	D+2 mm
200	262 (10.3)	272 (10.7)	272 (10.7)	283 (11.1)	290 (11.4)	309 (12.2)	324 (12.8)	324 (12.8)	4 (0.157)	
250	317 (12.5)	327 (12.9)	328 (12.9)	340 (13.4)	352 (13.9)	364 (14.3)	391 (15.4)	388 (15.3)	4 (0.157)	
300	372 (14.6)	377 (14.8)	383 (15.1)	400 (15.7)	417 (16.4)	424 (16.7)	458 (18.0)	458 (18.0)	4 (0.157)	
350	422 (16.6)	437 (17.2)	443 (17.4)	457 (18.0)	474 (18.7)	486 (19.1)	512 (20.2)		4 (0.157)	
400	472 (18.6)	488 (19.2)	495 (19.5)	514 (20.2)	546 (21.5)	543 (21.4)	572 (22.5)		4 (0.157)	D+4 mm
450	527 (20.7)	538 (21.1)	557 (21.9)	565 (22.2)					4 (0.157)	
500	577 (22.7)	593 (23.3)	617 (24.3)	625 (24.6)	628 (24.7)	657 (25.9)	704 (27.7)		6 (0.236)	
600	678 (26.7)	695 (27.4)	734 (28.9)	731 (28.8)	747 (29.4)	764 (30.1)			6 (0.236)	
700	783 (30.8)	810 (31.9)	804 (31.7)	833 (32.8)					8 (0,315)	
800	890 (35.0)	917 (36.1)	911 (35.9)	942 (37.1)					8 (0,315)	
900	990 (39.0)	1017 (40.0)	1011 (39.8)	1042 (41.0)					8 (0,315)	
1000	1090 (42.9)	1124 (44.3)	1128 (44.4)	1154 (45.4)					10 (0.394)	

1) according to EN 1092-1
2) according to DIN 2638

BLS550 Flanges according to ASME B16.5 and ASME B16.47 series A								
D [inch]	**D_4 [mm (inch)]**						**E [mm (inch)]**	**d_1**
	150#	**300#**	**600#**	**900#**	**1500#**	**2500#**		
1	67 (2.6)	73 (2.9)	73 (2.9)	79 (3.1)	79 (3.1)	86 (3.4)	3 (0.118)	D+1 mm (1 mm = 0.0394")
1 ½	86 (3.4)	95 (3.7)	95 (3.7)	98 (3.9)	98 (3.9)	117 (4.6)	3 (0.118)	
2	105 (4.1)	111 (4.4)	111 (4.4)	143 (5.6)	143 (5.6)	146 (5.7)	3 (0.118)	
2 ½	124 (4.9)	130 (5.1)	130 (5.1)	165 (6.5)	165 (6.5)	168 (6.6)	3 (0.118)	
3	137 (5.4)	149 (5.9)	149 (5.9)	168 (6.6)	175 (6.9)	197 (7.8)	3 (0.118)	
4	175 (6.9)	181 (7.1)	194 (7.6)	206 (8.1)	210 (8.3)	235 (8.3)	3 (0.118)	
5	197 (7.8)	216 (8.5)	241 (9.5)	248 (9.8)	254 (10.0)	279 (11.0)	3 (0.118)	D+2 mm
6	222 (8.8)	251 (9.9)	267 (10.5)	289 (11.4)	283 (11.1)	318 (12.5)	3 (0.118)	
8	279 (11.0)	308 (12.1)	321 (12.6)	359 (14.1)	352 (13.8)	387 (15.2)	4 (0.157)	
10	340 (13.3)	362 (14.3)	400 (15.7)	435 (17.1)	435 (17.1)	476 (18.7)	4 (0.157)	
12	410 (16.1)	422 (16.6)	457 (18.0)	499 (19.6)	521 (20.5)	549 (21.6)	4 (0.157)	
14	451 (17.8)	486 (19.1)	492 (19.4)	521 (20.5)	578 (22.8)		4 (0.157)	
16	514 (20.3)	540 (21.3)	565 (22.2)	575 (22.6)	641 (25.2)		4 (0.157)	D+4 mm
18	549 (21.6)	597 (25.5)	613 (24.1)	638 (25.1)	705 (27.8)		4 (0.157)	
20	606 (23.9)	654 (25.7)	683 (26.9)	699 (27.5)	756 (29.8)		6 (0.236)	
24	718 (27.9)	775 (30.5)	791 (31.1)	838 (32.0)	902 (35.5)		6 (0.236)	
28	832 (32.8)	898 (35.4)	915 (36.0)	946 (37.3)			6 (0.236)	
32	940 (37.0)	1006 (39.6)	1022 (40.2)	1073 (42.3)			8 (0,315)	
36	1048 (41.3)	1118 (44.0)	1130 (44.5)	1200 (47.2)			8 (0,315)	
40	1162 (45,7)	1114 (43.9)	1156 (45.5)	1251 (49.3)			10 (0.394)	

E.3. BLS550 Annular Chamber

Design

Three-piece orifice with carrier rings in compact or remote design; accessories included.

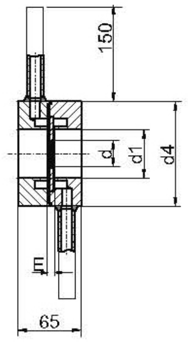
Type of pressure tapping

Corner tapping with annular chamber

Materials

	High-Carbon Steel	Stainless Steel
Carrier ring DIN	C22.8 (1.0460)	316L (1.4404)
Carrier ring ASME	C22.8	316L
Orifice plate	316L (1.4404)	316L (1.4404)
Seal between orifice plate and carrier ring	♦ Standard (Klingersil or Graphite, dep. on the application ♦ Spiral seal 316L/Graphite	

Dimensions



For the dimensions please refer to the tables of Corner taps.

E.4. BLS200 Orifice plate

Design

Orifice plate for mounting between two flanges.

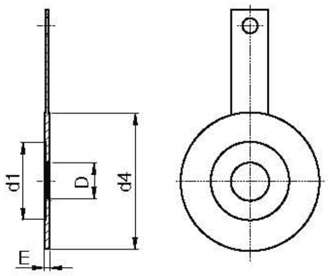
Type of pressure tapping

- Flange tapping
- D-D/2 tapping

Material

316L (1.4404)

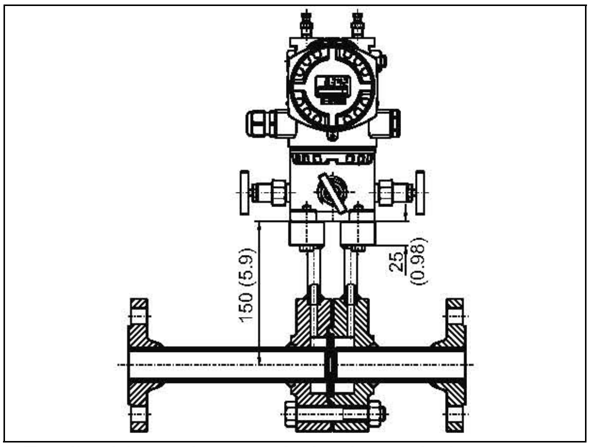
Dimensions



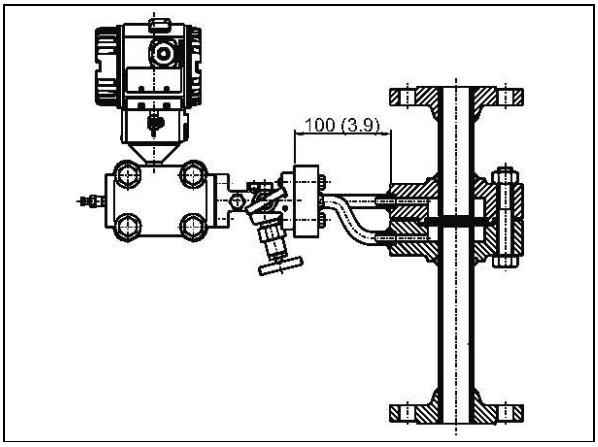
BLS550 Flanges acc. to DIN 19214									
D (mm)	d_4 [mm (inch)]							E [mm (inch)]	d_1
	PN6	PN10	PN16	PN25	PN40	PN64	PN100		
25	64 (2.52)	71 (2.80)	71 (2.80)	71 (2.80)	71 (2.80)	82 (3.23)	82 (3.23)	3 (0.118)	D+1 mm (1 mm = 0.0394")
40	86 (3.39)	92 (3.62)	92 (3.62)	92 (3.62)	92 (3.62)	103 (4.29)	103 (4.29)	3 (0.118)	
50	96 (3.78)	107 (4.21)	107 (4.21)	107 (4.21)	107 (4.21)	112 (4.41)	112 (4.41)	3 (0.118)	
65	116 (4.57)	127 (5.00)	127 (5.00)	127 (5.00)	127 (5.00)	137 (5.39)	143 (5.63)	3 (0.118)	
80	132 (5.20)	142 (5.59)	142 (5.59)	142 (5.59)	142 (5.59)	147 (5.79)	153 (6.02)	3 (0.118)	
100	152 (5.98)	162 (6.38)	162 (6.38)	167 (6.57)	167 (6.57)	173 (6.81)	180 (7.09)	3 (0.118)	
125	182 (7.17)	192 (7.56)	192 (7.56)	193 (7.60)	193 (7.60)	210 (8.27)	217 (8.54)	3 (0.118)	
150	207 (8.15)	217 (8.54)	217 (8.54)	223 (8.78)	223 (8.78)	247 (9.72)	257 (10.1)	3 (0.118)	D+2 mm
200	262 (10.3)	272 (10.7)	272 (10.7)	283 (11.1)	290 (11.4)	309 (12.2)	324 (12.8)	4 (0.157)	
250	317 (12.5)	327 (12.9)	328 (12.9)	340 (13.4)	352 (13.9)	364 (14.3)	391 (15.4)	4 (0.157)	
300	372 (14.6)	377 (14.8)	383 (15.1)	400 (15.7)	417 (16.4)	424 (16.7)	458 (18.0)	4 (0.157)	
350	422 (16.6)	437 (17.2)	443 (17.4)	457 (18.0)	474 (18.7)	486 (19.1)	512 (20.2)	4 (0.157)	
400	472 (18.6)	488 (19.2)	495 (19.5)	514 (20.2)	546 (21.5)	543 (21.4)	572 (22.5)	4 (0.157)	D+4 mm
450	527 (20.7)	538 (21.1)	557 (21.9)	565 (22.2)				4 (0.157)	
500	577 (22.7)	593 (23.3)	617 (24.3)	625 (24.6)	628 (24.7)	657 (25.9)	704 (27.7)	6 (0.236)	
600	678 (26.7)	695 (27.4)	734 (28.9)	731 (28.8)	747 (29.4)	764 (30.1)		6 (0.236)	
700	783 (30.8)	810 (31.9)	804 (31.7)	833 (32.8)				8 (0,315)	
800	890 (35.0)	917 (36.1)	911 (35.9)	942 (37.1)				8 (0,315)	
900	990 (39.0)	1017 (40.0)	1011 (39.8)	1042 (41.0)				8 (0,315)	
1000	1090 (42.9)	1124 (44.3)	1128 (44.4)	1154 (45.4)				10 (0.394)	

E.4. BLS500 Meter Run

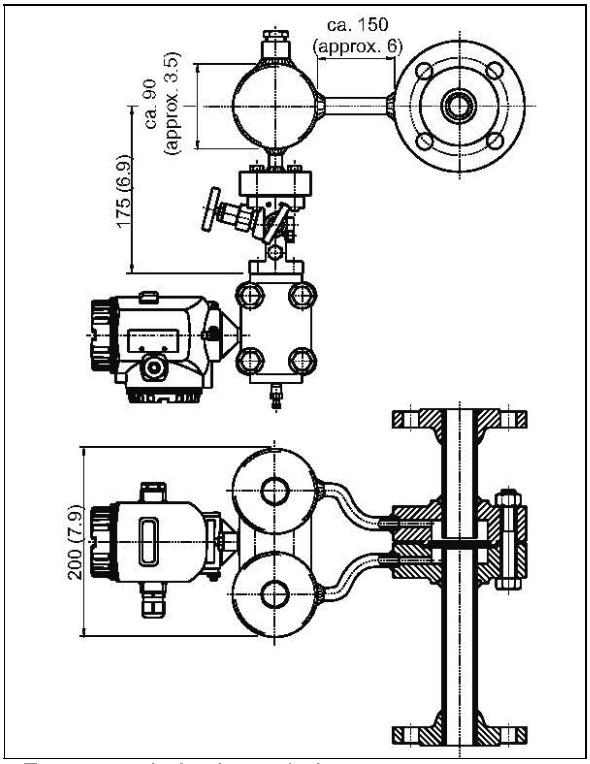
Typical configurations



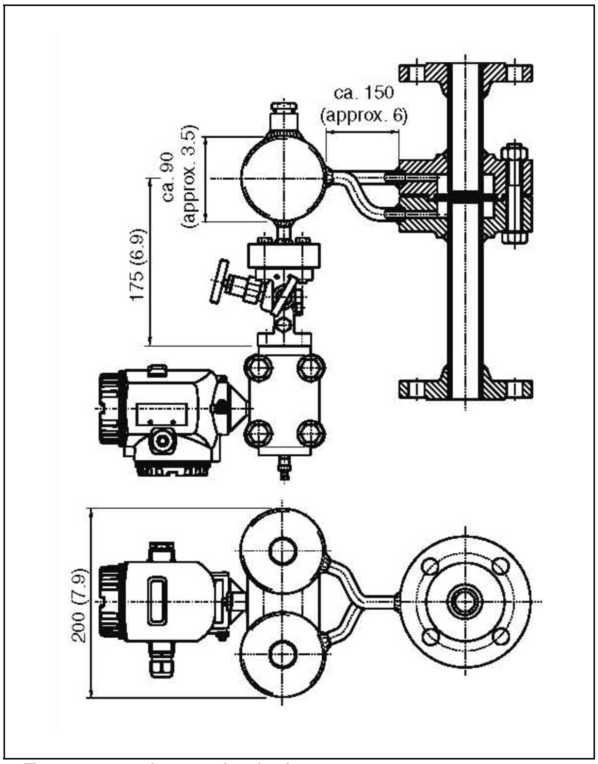
For liquids and gases in horizontal pipes; Dimensions in mm (inch)



For liquids and gases in vertical pipes; Dimensions in mm (inch)



For steam in horizontal pipes; Dimensions in mm (inch)



For steam in vertical pipes; Dimensions in mm (inch)

Design

Meter run with standard orifice in compact or remote version, accessories included.

- Up to PN100 / Cl 900: three-piece standard orifice
- From PN160 / Cl 1500: completely welded version

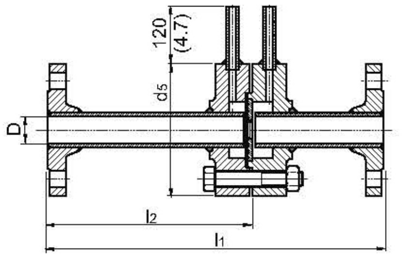
Type of pressure tapping

Corner tapping with annular chamber

Materials

	High-Carbon Steel	Stainless Steel	High temperature version
Meter run DIN (pipe)	St35.8 (1.0305)	316L (1.4404)	16Mo3 (1.5415)
Annular chamber and flanges DIN	C22.8 (1.0460)	316L (1.4404)	16Mo3 (1.5415)
Meter run ASME (pipe)	A106	316L	
Annular chamber ASME	C22.8	316L	
Flanges ASME	A105	316L	
Orifice plate	316L (1.4404)	316L (1.4404)	316L (1.4404)
Seal between orifice plate and carrier ring	♦ Standard (Klingersil or Graphite)		♦ Standard (Graphite)
	♦ Welded		♦ Welded

Dimensions, weight



D	l1 [mm (inch)]	l2 [mm (inch)]	weight [kg (lbs)]
DN10; 3/8”	400 (15.7)	230 (9.06)	appr. 11 (24)
DN15; ½”	550 (21.7)	380 (14.9)	appr. 12 (26)
DN20; ¾”	700 (27.6)	500 (19.7)	appr. 16 (35)
DN25; 1”	900 (35.4)	650 (25.6)	appr. 19 (42)
DN32; 1 ¼”	1100 (43.3)	800 (31.5)	appr. 22 (49)
DN40; 1 ½”	1300 (51.2)	1000 (39.4)	appr. 25 (55)
DN50; 2”	1)	1)	1)

1) in preparation

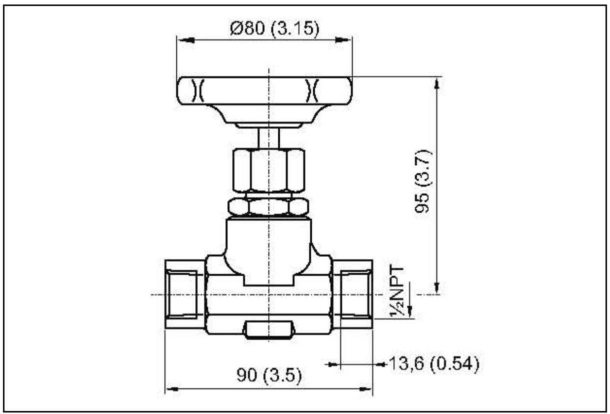
d^5 [mm (inch)]							
150#	300# 600#	1500#	2500#	PN6	PN16 PN40	PN63 PN100	PN160
1)	1)	1)	1)	75 (2.9)	90 (3.5)	100 (3.9)	1)
88.9 (3.5)	95,2 (3.75)	1)	1)	80 (3.1)	95 (3.5)	105 (4.1)	1)
98,6 (3.9)	117,3 (4.6)	1)	1)	90 (3.5)	105 (4.1)	1)	1)
108,0 (4.25)	124,0 (4.9)	1)	1)	100 (3.9)	115 (4.5)	140 (5.5)	1)
1)	1)	1)	1)	120 (4.7)	140 (5.5)	155 (6.1)	1)
127,0 (5.0)	155,4 (6.1)	1)	1)	130 (5.1)	150 (5.9)	170 (6.7)	1)
1)	1)	1)	1)	1)	1)	1)	1)

1) in preparation

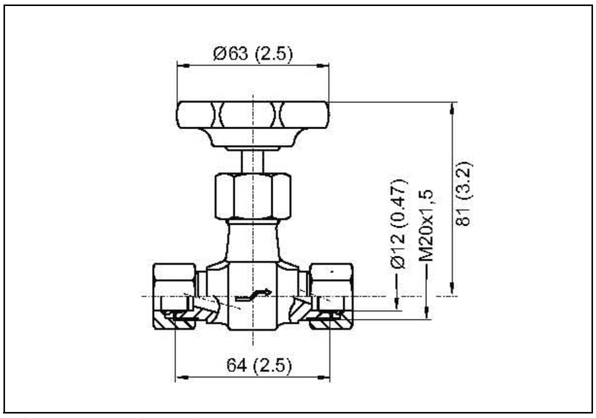
F. Accessories

F.1. Shut-Off Valve

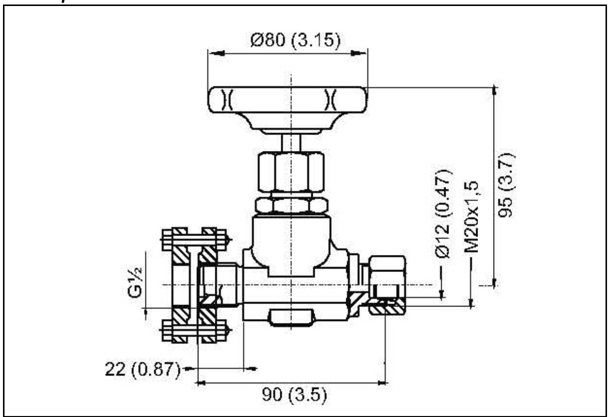
Dimensions



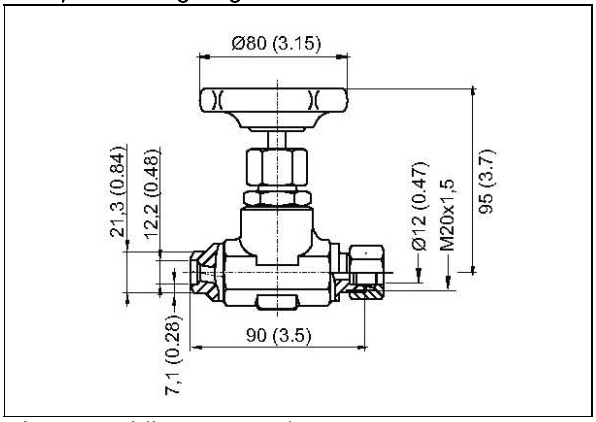
Input: FNPT1/2
Output: FNPT1/2



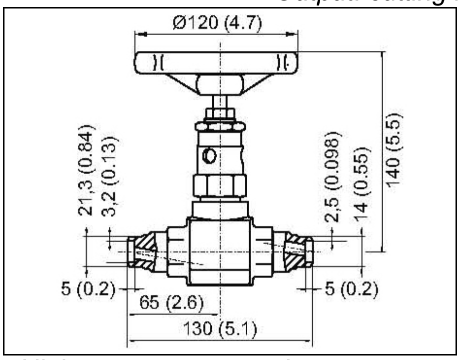
Input: cutting ring
Output: cutting ring



Input: typ DIN19207 and 2 flanges
Output: cutting ring



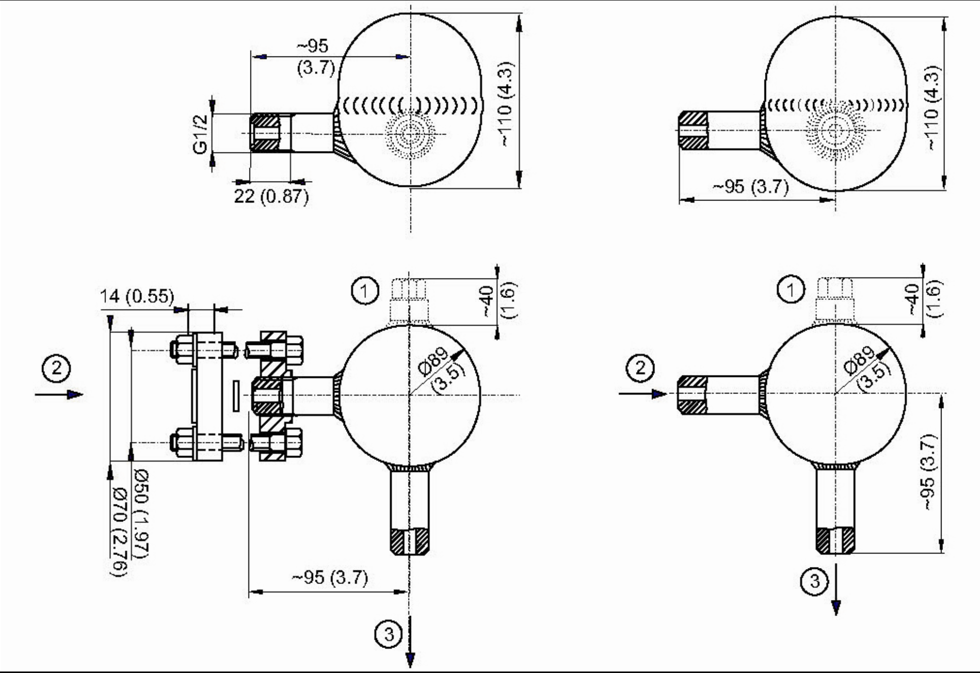
Input: welding connection
Output: cutting ring



High temperature version
Input: welding connection
Output: welding connection

F.2. Condensate pots

Dimensions



1: filling cap NPT1/2 (option)
2: to process
3: to transmitter

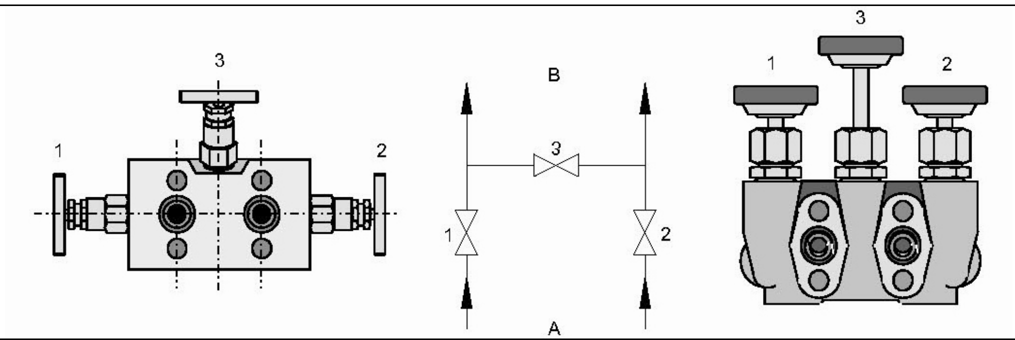
Weight

Material	Weight
HII (265 GH)	appr. 1,7 kg (3.8 lbs)
316L	appr. 1,7 kg (3.8 lbs)
16Mo3	appr. 2,2 kg (4.9 lbs)

F.3. Manifold

3-Way-Manifold

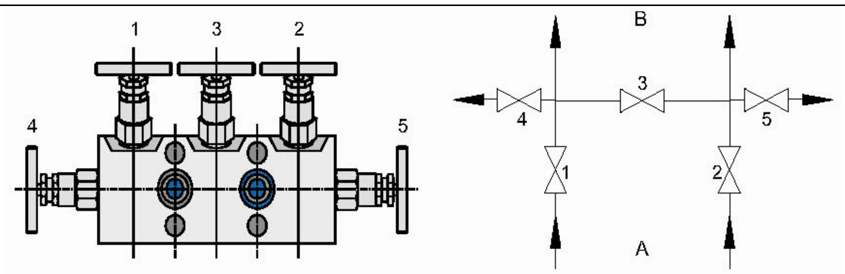
The manifold is used to connect the impulse pipes to the dp transmitter. Valves 1 und 2 can be used to separate the transmitter from the impulse pipes.
Valve 3 is used for a zero point adjustment between the impulse pipes.



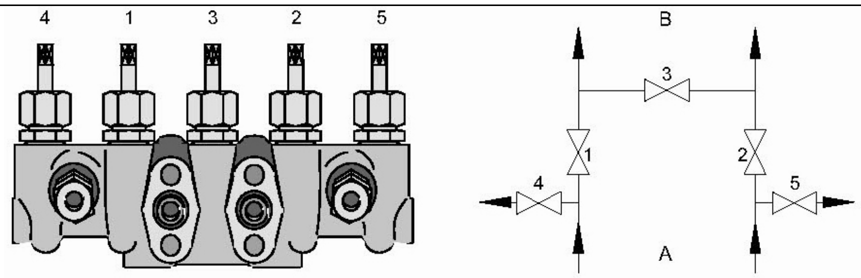
Left: milled version (for gases and liquids); right: forged version (for steam)
A: process side; B: transmitter side

5-Way-Manifold

The manifold is used to connect the impulse pipes to the dp transmitter. Valves 1 und 2 can be used to separate the transmitter from the impulse pipes.
Valve 3 is used for a zero point adjustment between the impulse pipes.
Valves 4 and 5 offer the possibility of venting or purging the impulse pipes.



5-Way-Manifold with venting valve, milled version (for gases and liquids);
A: process side; B: transmitter side



5-Way-Manifold with purging valve, forged version (for steam);
A: process side; B: transmitter side

F.4. Rectifier

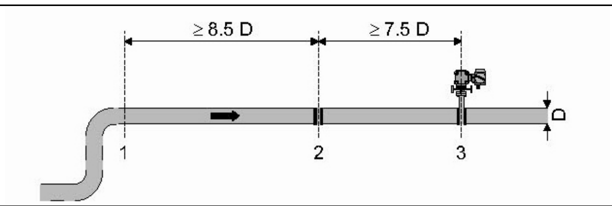
Usage

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



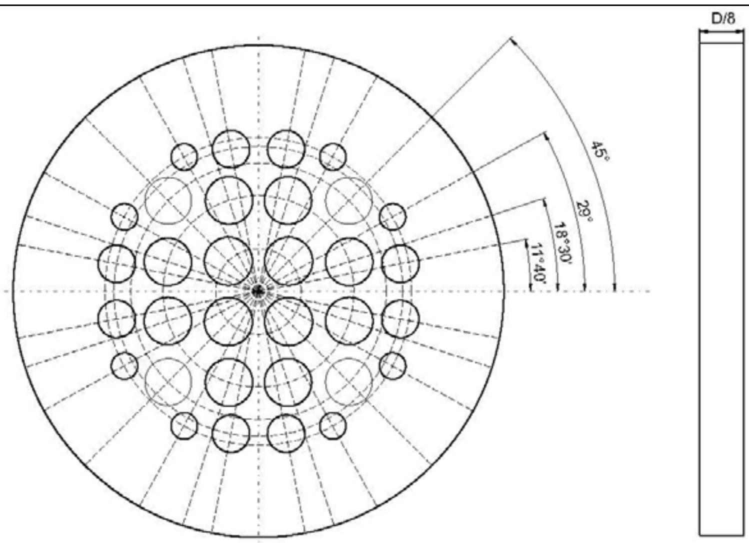
Pressure loss

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/m³]
- V: Flow velocity [m/s]

Dimensions



The Zanker perforated plate conditioner according to ISO 5167-2 consits 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.

H. Sizing Sheet – Data Sheet

Fields marked with * are mandantory to be filled-in

Sizing Sheet – Data Sheet / Orifice					
Project:					
Customer:		**Project no.**		**Contact:**	
TAG-no.					

Main Parameters		
Medium*:		**State*:** ☐ **Gas** ☐ **Liquid** ☐ **Steam**

Operating Conditions						
Pressure*:	*For gauge pressure the ambient pressure is additionally required if different from sea level.*					
						unit
☐ **absolute** ☐ **gauge**				**ambient pressure**		
Only for gases:	*The values for requested flow rep. density of medium are based on the following conditions:*					
	Operating	**Normal**	**Standard (acc. to reference conditions)**			**unit**
Flow rate*:	☐	☐	☐	**Reference Temp.:**		
Density*:	☐	☐	☐	**Reference pressure:**		

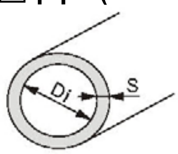
	minimum	nominal	maximum	Unit*
Requested flow:			*	
Pressure:		*		
Temperature:		*		
Density: 1)				
Viscosity: 1)				
Z-factor: 1,2)				
Isentropic index 1,2)				

The sizing will be based on the maximum requested flow and nominal pressure and temperature.
The maximum requested flow will be set as upper range value.
1.) For clearly specified fluids (e.g. water or air) those entries are not mandantory.
2.) For gases only. If there are no values available the sizing will be based on standard values or the ideal gas law.

Flowmeter			
Nominal width*:		**Pressure rating*:**	

Pipe dimensions*

☐ **pipe (round)***



		unit
Inner diameter (Di)		
Wall thickness (S):		
Isolation thickness:		
Pipematerial:		

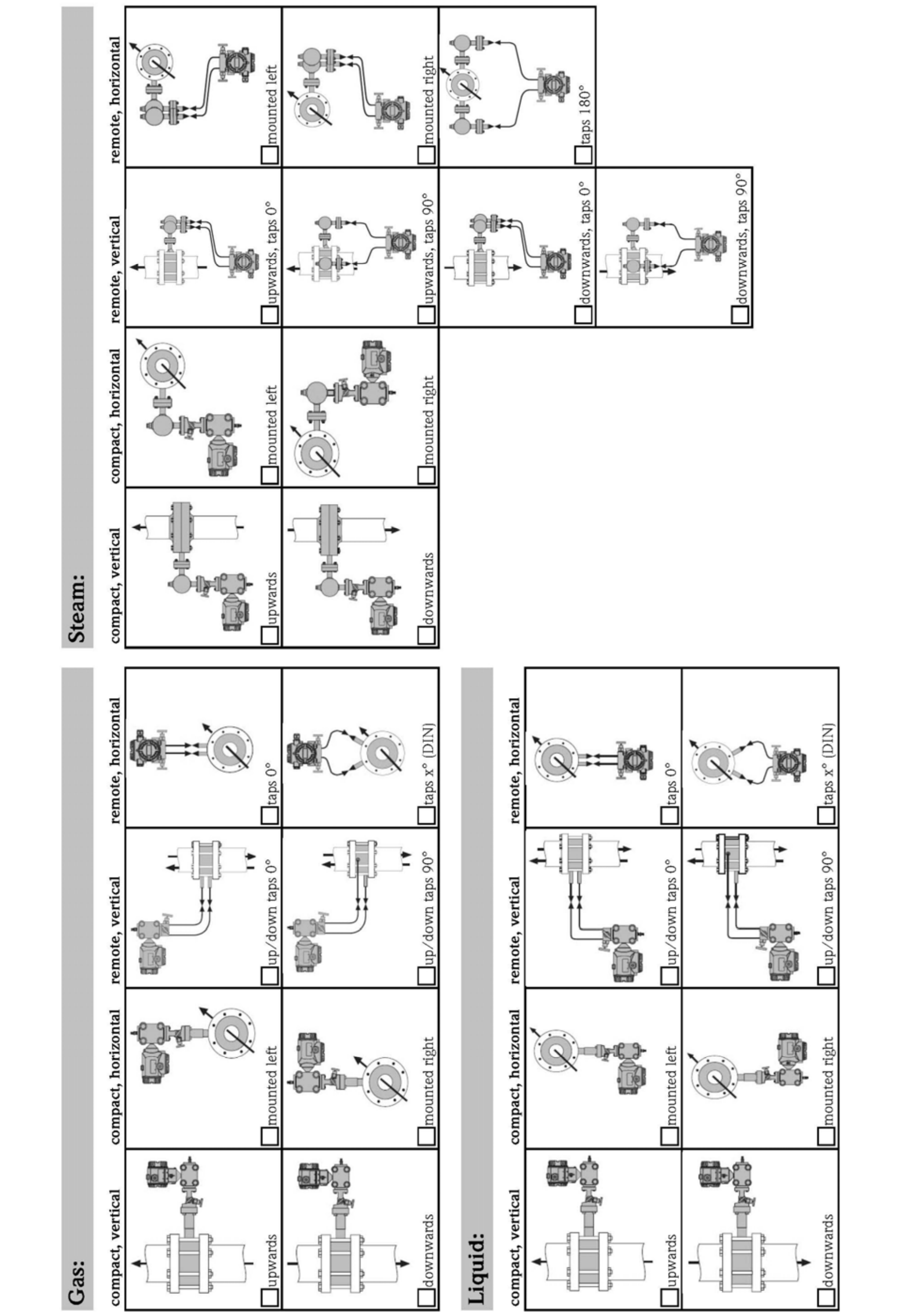
The exact specification of the internal dimensions is absolutely necessary.
Nominal width of DIN pipes DNxxx are not sufficient. Nominal width of ANSI pipes including schedules acc. to ASME are sufficient.

Additional Data

Optimization Criteria

			unit
☐ optimized by Intra	☐ Max. allowable pressure loss		
☐ max. turn down (small β)	☐ Fixed diameter ratio β		
☐ low pressure loss (large β)	☐ Fixed differential pressure:		
	☐ Fixed calculation (attachment)		

Sizing sheet – Mounting Position / Orifice



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Flow Measurement

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IntraSonic IS210 Ultrasonic Flow Meters

Level Measurement

ITA-mag. level gauges

MAGLINK level indicators

Other measurement tasks:

DigiFlow Flow and Level Computers

IntraCont digital Controllers

IntraDigit digital indicators

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