

Differential pressure flow meters



Examples of differential pressure flow meters

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Prior to starting any work, read the operating instructions.
Keep for later use.

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1. General Safety Information

1.1 Warning

The Pressure Equipment described in this manual are supplied, where appropriate, in accordance with the Russian Regulation TR CU 032/2013 and are designed to work in pressurized systems. Take care when installing all equipment and follow the instructions given. Failure to do this could result in damage to equipment and create possible hazards to operators and other equipment.

Only use the equipment on the process for which it is designed. Install the equipment into a system that has been designed to allow for venting or draining of the process. For the necessary safety requirements refer to the appropriate instructions in this manual.

Do not exceed the pipe vibration levels stated in this manual. Excessive vibration could result in damage to the equipment and create possible hazards to other equipment and operators.

1.2 User Guidelines

This User Guide should be used in conjunction with the specific transmitter manufacturer's Operating Instructions.

Correct use includes the following:

- Operation within the technical limit values.
- Observing and following the information provided on permissible media (fluids).
- Observing and following the instructions provided in the operating manuals.

The following uses are not permitted:

- Operation as a flexible adaptor in piping; for example, to compensate for pipe offsets, pipe vibrations and/or pipe expansions.
- Use as a climbing aid; for example, for assembly purposes.
- Use as a support for external loads; for example, as a support for piping.
- Material gain; for example, by painting over the type plate or welding or soldering on parts.

Repairs, modifications, supplements or the installation of spare parts are permitted only if performed as described in the operating manual.

More extensive work must be approved by WIKA – the Company accepts no liability for unauthorized work. The operating, maintenance and repair conditions that are stated in this manual must be observed. The Company accepts no liability for damage caused by incorrect or unprofessional usage.

1.3 Permissible Process Media (fluids)

Process media may be used only if:

- It can be assured that the physical and chemical properties of the pressure-bearing materials that come into contact with the process medium are not reduced

from that required for operational safety, during the expected lifetime of the equipment.

- Process media with unknown properties for erosion and/or corrosion may be used only if the operator can perform regular and suitable tests to assure the safe condition of the equipment.

1.4 Technical Limit Values

The equipment is intended for use only within the technical limit values specified on the data plate and in the Specification (refer to Product Data Sheets for detailed information), including those for:

- The maximum working pressure.
- The maximum and minimum operating temperatures.
- The maximum vibration level stated in this manual.

In addition, all connected pipework must be installed as it was designed, to ensure that there is no possibility of leakage or any undue stresses or strain acting upon it.

1.5 Safety Precautions

It is the customer's responsibility to ensure the products detailed in this manual are not used for purposes other than those for which they are designed.

Any modification to or adaptation of the flow meters may invalidate their certification.

It is the user's responsibility to ensure that adequate protection exists to prevent pressurization in excess of the maximum specified pressure for the flow meters, even in the event of a fire. If there are any queries regarding the instructions in this publication, contact either WIKA or their accredited agent before installing the flow meter.

Instructions and procedures in this manual may require special precautions to ensure the safety of personnel performing the operations.

Explosions could result in death or serious injury; therefore refer to the **Warnings** in the transmitter Operating Instructions before performing any operation in this manual.

1.6 Potential Safety Hazards

The following potential safety hazards are associated with operating the system:

- Electrical (line voltage)
- Product weight

Although Warning hazards are related to personal injury, and Caution hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death.

Therefore, comply fully with all **Warning** and **Caution** notices. Information in this manual are intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of WIKA.

2. Instruction Manual for Primary Flow Meters

2.1 Conventions

The following symbol and indication conventions are used throughout this manual.



WARNING! / CAUTION!

... indicates:

- ▶ Danger! Serious personal injury risk
- ▶ Warning! Equipment damage risk.

2.2 General Description of Measuring Instruments

The working base for all differential pressure flow meters is Bernoulli's principle.

When a fluid is forced, either gradually or abruptly, through a narrow passage, its kinetic energy increases with a loss of potential energy (static pressure).

The existing pressure difference between the localised pressure point before the constriction and the localised pressure point beyond the constriction is directly proportional to the square of the velocity of the fluid.

Since the velocity for the cross section is the same as the volumetric flow rate, the basic equation will be the following:

$$Q = F_m \times \sqrt{\frac{Dp}{G_f}}$$

where **Q** is the volumetric flow rate, **F_m** is a correction factor for dimensional units which includes a discharge coefficient to correct for the characteristics of the constriction, positioning of the pressure taps and profile of the velocity (Reynolds Number), **Dp** is the pressure difference between upstream and downstream the measuring device, **G_f** is the density of the fluid.

The necessary condition to obtain an accurate flow rate measurement is to have stable flow rate, pressure and temperature.

For gas applications, temperature and pressure compensation is also possible by coupling the flow element with a multivariable transmitter type. Two additional probes and with dedicated process connections are required for temperature and pressure compensation:

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

The probes can be either embedded with the multivariable transmitter or stand-alone probes.

In the second case, please refer to the specifications in the Transmitter Operating Instructions for electrical connections and wiring. The relationship between flow and differential pressure is described by a square root function (see above) involving density at a specific operating condition (**G_f**).

If the current output of the 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.

Note. Make sure that the square root function is not applied twice in your measuring loop system.

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

The compensation can be computed as follows:

$$Q_2 = Q_1 \times \sqrt{\frac{P_2 T_1 Z_1}{P_1 T_2 Z_2}}$$

for the mass flow (or volume flow at normal or standard conditions).

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.

2.3 Definition of Terms

Term	Meaning
Accuracy	A statement which defines the measurement error limit when a device is used under specific operating condition. Flow meters can be specified with percent of rate or full scale accuracy. Accuracy expressed as a percent of rate implies accuracy anywhere within the flow range of the device. Accuracy expressed as a percent of span applies only at the maximum flow rate of the device. The absolute error obtained at full span is used to calculate accuracy at lower flow rate.
Beta Ratio	Represents the ratio of the meter bore diameter (d) to the pipe bore diameter (D). Low Beta Ratios relax tolerances on the primary elements configuration and installation, but raise the pressure loss through the restriction and reduce meter capacity.
Discharge Coefficient	No primary element follows Bernoulli's equation precisely. Friction and physical phenomena effects must be considered and the factor that accounts for them is the Discharge Coefficient. It is a ration between the actual rate of flow to the theoretical rate of flow and is determined either through laboratory calibration or by Primary Elements Reference Standards.

2. Instruction Manual for Primary Flow Meters

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Term	Meaning
Range	The region between the limits within which a quantity is measured, received or transmitted, expressed by stating the Lower and the Upper Range values. Lower Range Limits = the range of input values over which a device can be zeroed; Lower range Value = the actual value of input within the Lower Range Limits to which a device has been zeroed; Upper Range Limits = the range of input values over which a device can be adjusted to obtain its maximum output; Upper Range Value = the actual value of input within the Upper Range Limits to which a device has been adjusted to obtain its maximum output.
Rangeability	The ratio of maximum flow to minimum flow over which the specified accuracy of a primary element will be maintained.
Repeatability	The ability of a meter to indicate the same reading each time the same condition exists.
Resolution	A measure of the smallest increment of total flow that can be measured.
Secondary element	A transducer which amplifies and convert the signal from a primary element. This unit is usually the Differential Pressure Transmitter.
Span	The algebraic difference between the Upper and Lower Range Values Span Limits = a range of input spans over which a device can be adjusted.

2.4 Receipt and handling of materials

2.4.1 Instructions for the crate lifting and handling



WARNING!

The goods are shipped packed in cases or in wooden and/or sea-worthy crates. Handle the crates with care and follow the handling instructions stencils. Do not turn upside down the crates.

The lifting ropes must be positioned at the reinforced points for slings indicated on the crate with the international graphic symbols. When using a forklift to lift the crate, care must be taken so as not to damage its planking.

For all packages, especially those exceeding 4 tons, locate the centre of gravity point, if indicated, prior to start handling activities.

2.4.2 Instructions for unpacking the materials



WARNING!

Equipment damage risk.

At the receipt of the crates, check the packing list accompanying the goods. All the components are identified with the respective mark and number.

Any damage found shall be reported to carrier and to the supplier.

Remove the cover of the crate carefully to avoid damaging of the planking or the protective lining sheets of the lid (polyethylene or bituminized paper).

The cover of the crate is fixed on with flatheaded nails.

Remove the cross braces and containing material before unpacking the goods.

2.4.3 Storage instructions

The goods shall be stored in a clean unheated warehouse, with ventilation systems for moisture and frost prevention.

Ensure that the materials are protected from bad weather and flooding at floor level.

The packing can be used to hold the goods in storage.

The packing is guaranteed for one year: for longer storage periods an appropriate packing maintenance shall be provided.

2.4.4 Instruction for lifting the flow meter



CAUTION!

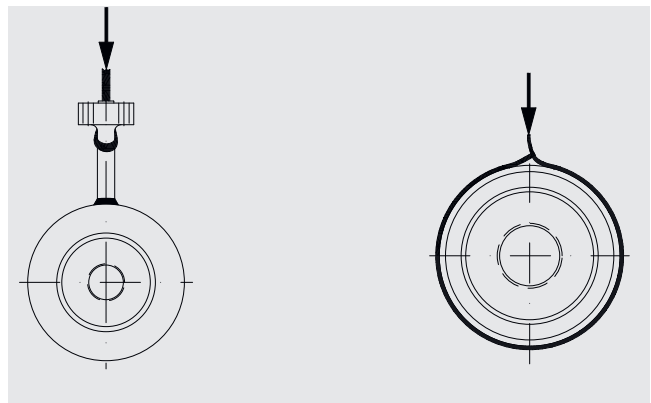
Neither the transmitter nor the bore of the primary element is designed to withstand the weight of the meter.

Do not lift the meter by either the bore or the transmitter.

Lift the meter only by the neck or by lifting lugs where fitted.

The meter must be lifted by means of adequate ropes, chains or belts to make secure slings.

Wait until the meter has stabilized, it must be horizontal and must not slide on the lifting tools in the slinging points.



3. FLC-CO Compact Orifice Flow Meter

EN

3. FLC-CO Compact Orifice Flow Meter

3.1 Direct Mounting Main Specification

3.1.1 Pipe size

- 2 ... 14" per ANSI/ASME
- DN 50 ... 350 per EN

3.1.2 Pressure ratings

- Class 150, 300, 600 raised face (RF) per ANSI/ASME B16.5
- PN 16, 40, 100 raised face (RF) per EN 1092

3.1.3 Material

- SS 316/L

3.1.4 Orifice plate body

- Manufactured from bar stock
- Main body thickness: 30 mm for all sizes
- Orifice plate thickness: 3 or 6 mm

3.1.5 Pressure tap

- Same shape and dimensions for all sizes and connection options

3.1.6 Maximum operating pressure

- 600# per ANSI B16.5
- PN 100 per EN 1092

3.1.7 Maximum operating temperature

Limited by the maximum permissible temperature of the differential pressure transmitter, refer to the specifications in the Transmitter Operating Instructions.

3.2 Carrier Ring Main Specification

3.2.1 Pipe size

- 2 ... 24" per ANSI/ASME
- DN 50 ... 600 per EN
- Other sizes on request

3.2.2 Pressure rating

- Class 150 ... 2500 with raised face (RF) and ring-type joint (RTJ) per ANSI/ASME B16.5
- PN 10 ... 400 with raised face (RF) per EN 1092

3.2.3 Materials

- SS 316/316L
- Special alloys on request

3.2.4 Orifice plate body

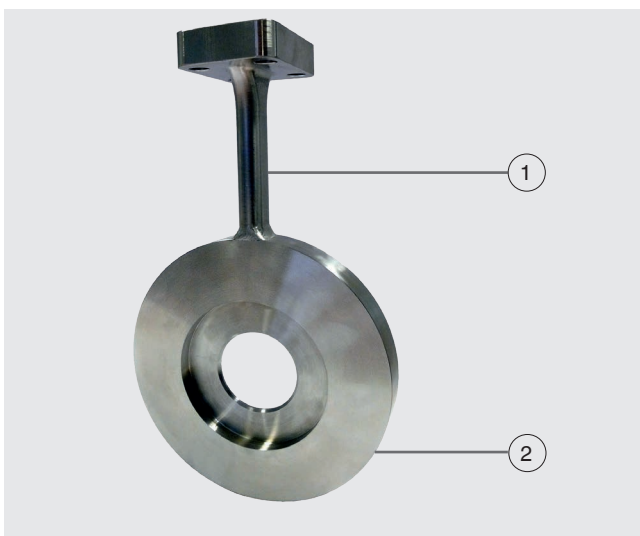
- Welded or turned from one piece
- Main body thickness: 25 ... 65 mm

3.2.5 Pressure taps

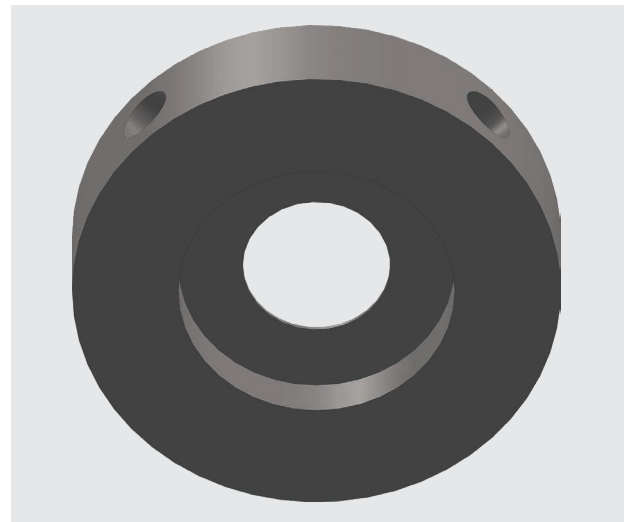
- NPT thread
- Weld stub
- Nipple

3.2.6 Max. operating pressure and temperature

Depending on material, pressure rating and applicable flange Standard.



- 1 Pressure tap
- 2 Carrier ring



3. FLC-CO Compact Orifice Flow Meter

3.3 Mechanical installation

Check the Tag Number of the meter to ensure it is the correct unit for the location.

Ensure all weld outlines in the pipeline where the FLC-CO is to be installed are even. Grind off any protrusions inside the pipe and ensure that the inside of the pipe is smooth and clean.

EN

Ensure that any specialized cleaning requirements are performed (for example, those specifically for oxygen/pharmaceutical applications).

Examine the meter and the flange faces and ensure that:

- the faces of the orifice plate are free from scratches and are not buckled;
- the square edge of the orifice plate is not worn (no light is reflected from the square edge);
- the orifice plate bore is not marked or distorted;
- the gasket surfaces are clean.

Replace defective components as necessary.

Fit sufficient bolts in the lower part of the pipeline flanges to retain the meter in place.

Place the correct gaskets on both sides of the meter body and align them correctly to the orifice plate, ensuring they do not protrude into the pipe bore.

An incorrect alignment of the gaskets may cause measuring errors and/or fluid leakages. The gaskets shall never be bent.

Insert the meter between the pipeline flanges ensuring that:

- the meter is oriented correctly depending on the type of installation;
- if applicable, the manifold's equalizing valve is pointing upstream of the fluid flow.

Fit bolts diametrically opposite those fitted (refer to paragraph 5.2.1 on page 25) and evenly tighten all bolts hand-tight.

Push the bolts against the outer edge of the bolt holes.

Fit the remaining bolts and hand-tighten evenly.

Determine the maximum tightening torque according to the relevant flange specifications.

Tighten each bolt to the correct torque in a diagonally opposing pattern, firstly to 30% of the maximum torque, then 60% and finally to the maximum torque.

3.3.1 FLC-CO alignment

The metered fluid flow rate is subject to considerable error if the in-line installation of the equipment is such that vortices and/or distortion of the velocity profile are generated by an incorrect alignment of the parts.

Accurate centralization in the pipeline is critical to performance. For information on the effects of incorrect centralization, refer to standard ISO 5167:2003.

3.3.2 FLC-CO direction

Install the flow meter in line according to the flow direction marked on the meter body or on the nameplate.

The upstream side of the Compact Orifice is the one with the sharp edge. This side is identified by "INLET" or "UPSTREAM" word stamped on the inlet face or by an arrow on the marker plate (the orifice bevel must always be on downstream side).

Compact orifices intended for reverse flow may be not stamped.

See reference drawing for additional information.

3. FLC-CO Compact Orifice Flow Meter

3.4 Meter Orientation



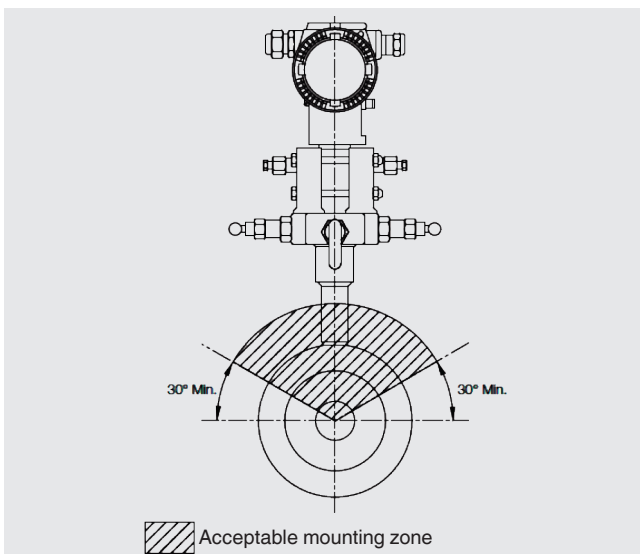
CAUTION!

When installing FLC-CO, ensure that the drain/vent valves are positioned to direct the process medium away from personnel and equipment when it is removed during drain and vent operations.

For all meter orientations, ensure the arrow on the meter body is aligned correctly with the direction of flow in the pipeline.

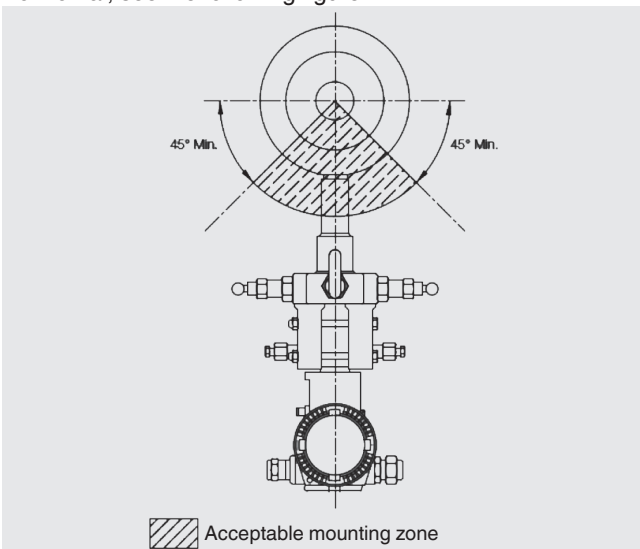
3.4.1 Horizontal Pipe Mounting – Gas

To ensure that condensate drains back into the pipe, mount the meter **above** the pipe, at least 30 degrees above the horizontal, see the following figure:



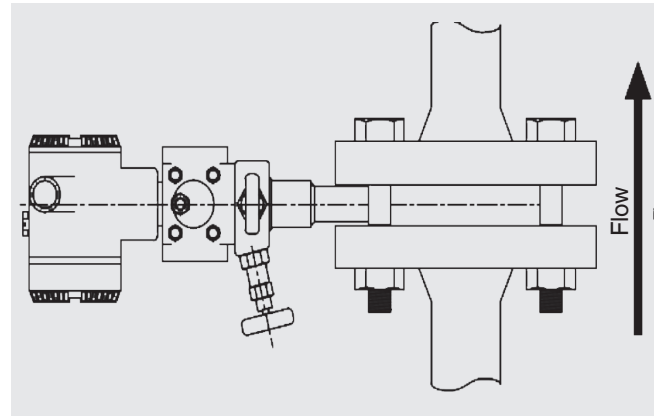
3.4.2 Horizontal Pipe Mounting – Liquids & Steam

To ensure that gases vent back into the pipe, mount the meter **below** the pipe, at least 45 degrees below the horizontal, see the following figure:



3.4.3 Vertical Pipe Mounting – Liquid & Gas (Upward)

Install the meter as shown below:



EN

3. FLC-CO Compact Orifice Flow Meter

3.5 Straight piping requirements

To ensure accurate measurement follow upstream and downstream straight piping requirements.

Table 1 gives indications for a correct installation acc. to ISO 5167.

Valves, joints and other fittings must preferably be positioned after the flow meter. The use of straighteners (Flow conditioners) can be considered in those cases where available straight-line piping is shorter than required.

Table 1 - Required straight lengths between compact orifice and fitting without flow conditioners

Diameter Ratio β	Upstream (inlet) side of orifice plate																								Downstream (outlet) side of the orifice plate	
	Single 90° bend		Two 90° bends in the same plane: S-configuration		Two 90° bends in the same plane: S-configuration		Two 90° bends in perpendicular planes		Two 90° bends in perpendicular planes		Single 90° tee with or without an extension		Single 45° bend. Two 45° bends in the same plane: S-configuration		Concentric reducer $2D$ to D over a length of $1,5D$ to $3D$		Concentric expander $0,5D$ to D over a length of D to $2D$		Full bore ball valve or gate valve fully open		Abrupt symmetrical reduction		Thermometer pocket or well ^c of diameter		Fittings (columns 2 to 11) and the densitometer pocket	
	$(S > 30D)^a$		$(30D \geq S > 10D)^a$		$(10D \geq S)^a$		$(30D \geq S \geq 5D)^a$		$(5D > S)^{a,b}$		Mitre 90° bend		$(S \geq 2D)^a$								$\leq 0,03D^d$					
1	2		3		4		5		6		7		8		9		10		11		12		13		14	
-	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f	A ^e	B ^f
$\leq 0,20$	6	3	10	g	10	g	19	18	34	17	3	g	7	g	5	g	6	g	12	6	30	15	5	3	4	2
0,40	16	3	10	g	10	g	44	18	50	25	9	3	30	g	5	g	12	8	12	6	30	15	5	3	6	3
0,50	22	9	18	10	22	10	44	18	75	34	19	9	30	18	8	5	20	9	12	6	30	15	5	3	6	3
0,60	42	13	30	18	42	18	44	18	65 ^h	25	29	18	30	18	9	5	26	11	14	7	30	15	5	3	7	3,5
0,67	44	20	44	18	44	20	44	20	60	18	36	18	44	18	12	6	28	14	18	9	30	15	5	3	7	3,5
0,75	44	20	44	18	44	22	44	20	75	18	44	18	44	18	13	8	36	18	24	12	30	15	5	3	8	4

Note 1: The minimum straight lengths required are the lengths between various fittings located upstream or downstream of the orifice plate and the orifice plate itself. Straight lengths shall be measured from the downstream end of the curved portion of the nearest (or only) bend or of the tee or the downstream end of the curved or conical portion of the reducer or the expander.

Note 2: Most of the bends on which the lengths in this table are based had a radius of curvature equal to $1,5D$.

a - S is the separation between the two bends measured from the downstream end of the curved portion of the upstream bend to the upstream end of the curved portion of the downstream bend.

b - This is not a good upstream installation; a flow conditioner should be used where possible.

c - This installation of thermometer pockets or wells will not alter the required minimum upstream straight lengths for the other fittings.

d - A thermometer pocket or well of diameter between $0,03D$ and $0,13D$ may be installed provided that the values in Columns A and B are increased to 20 and 10 respectively. This kind of installation is not, however, recommended.

e - Column A for each fitting gives lengths corresponding to "zero additional uncertainty" values.

f - Column B for each fitting gives lengths corresponding to "0,5% additional uncertainty" values.

g - The straight length in Column A gives zero additional uncertainty; data are not available for shorter straight lengths which could be used to give the required straight lengths for Column B.

h - $95D$ is required for $Re_D > 2 \times 10^6$ if $S < 2D$.

EN

3. FLC-CO Compact Orifice Flow Meter

3.6 Maximum pipe vibration level

Vibration limits to IEC60068-2-6: <0.5 g over frequency range 10 to 500 Hz.

3.7 Commissioning

Note. If the meter has been supplied with pre-configured transmitter, do not change parameter settings as this will cause erroneous meter readings.

To configure the transmitter, refer to the specific Transmitter manufacturer's Operating Instructions.

3.7.1 Gas and Liquid Service



CAUTION!

During the following procedure, wear Personal Protection Equipment appropriate for the process.

Install the meter as described in Mechanical Installation Section on page 10.

- Ensure the pipeline is full.
- Gradually bring the pipeline up to normal operating pressure, checking for any leaks in the system. If leaks are detected, de-pressurize the pipeline and repair as necessary observing all local health and safety and environmental requirements.
- When the system is at normal operating pressure and flow established, bleed the FLC-CO manifold/impulse lines using the drain/vent valves.
- Collect and dispose of any bleed liquids in accordance with the local environmental regulations.



CAUTION!

Ensure the drain/vent valves are positioned so that process fluid is directed down and away from personnel when it is removed during the drain/vent operation.

The differential pressure transmitter is normally supplied zeroed at atmospheric conditions (unless otherwise specified).

To ensure the correct operation, it must be zeroed at the normal operating pressure of the process.

To zero the transmitter:

- Ensure the pipeline is at the normal operating pressure and that the transmitter power supply is on.
- Close the high pressure (HP) and low pressure (LP) isolation valves.
- Open the equalization valve, the transmitter should now indicate a value close to zero.
- Zero the differential pressure transmitter – refer to the specific Transmitter manufacturer's Operating Instructions.
- Open the HP and LP isolation valves.
- Close the equalization valve. The transmitter should now indicate flow.

For information on fault diagnosis, refer to Troubleshooting section or to specific Transmitter manufacturer's Operating Instructions.

3.7.2 Steam Service



CAUTION!

During the following procedure, wear Personal Protection Equipment appropriate for the process.

- Install the meter as described in Section Mechanical Installation on page 10.
- Ensure the pipeline is empty and de-pressurized.
- Connect a suitable water supply to the pipeline.
- Open the drain/vent valve.



CAUTION!

Ensure the drain/vent valves are positioned to direct process fluid down and away from personnel when they are opened during the drain/vent operation.

- Open the HP and LP isolation valves to allow water to flow slowly into the manifold/impulse lines until an air-free flow is obtained from the drain/vent valves, indicating they are full.
- Close the HP and LP isolation valves.
- Close the drain/vent valves and disconnect the water supply.
- Gradually bring the pipeline up to normal operating pressure, checking for any leaks in the system. If leaks are detected, de-pressurize the pipeline and repair as necessary observing all local health and safety and environmental requirements.

The differential pressure transmitter is normally supplied zeroed at atmospheric conditions (unless otherwise specified). To ensure the correct operation, it must be zeroed at the normal operating pressure of the process.

To zero the transmitter:

- Ensure the pipeline is at the normal operating pressure and that the transmitter power supply is on.
- Close the high pressure (HP) and low pressure (LP) isolation valves.
- Open the equalization valve, the transmitter should now indicate a value close to zero.
- Zero the differential pressure transmitter – refer to the specific Transmitter manufacturer's Operating Instructions.
- Open the HP and LP isolation valves.
- Close the equalization valve. The transmitter should now indicate flow.

For information on fault diagnosis, refer to Troubleshooting section or to specific Transmitter manufacturer's Operating Instructions.

3. FLC-CO Compact Orifice Flow Meter

3.8 Operating instructions

During normal service the manifold or impulse lines to the transmitter must periodically be vented or drained.



WARNING!

During the service check that pressure and temperature do not exceed the design values.

EN

Monitor that quality and flow regime (velocity) of the fluid do not change from original design ones; this may lead to damage risk for the primary element. Check periodically the transmitter zero set-up and adjust if necessary.

3.9 Troubleshooting

Complete the following checks to ensure correct installation:

- **Direction of flow** - Ensure the flow direction is in accordance with the arrow on the meter. If not, remove and reinstall the meter correctly.
- **Mounting orientation** - Ensure the meter is correctly oriented to the pipework with regard to flow direction, pipeline and nature of the fluid. Incorrect orientation can lead to metering errors and in some cases may damage the meter.
- **Zeroing of the transmitter** - Zero the differential pressure transmitter during installation and commissioning – refer to the specific Transmitter manufacturer's Operating Instructions.
- **Manifold valves** - The meter manifold is fitted with three/five valves. During measurement, ensure the equalization valve is fully closed and the HP and LP isolation valves are fully open.
- **Setup/configuration of the meter** - Ensure the 4 to 20 mA output of the meter is correctly set and that any receiving equipment is configured for the same flowrate range. Refer to the specific Differential Pressure Transmitter's Operating Instructions for information on how to check the loaded configuration.

Refer to the specific differential pressure transmitter's Operating Instructions for procedures to be followed when error messages are shown on the transmitter display.

3.10 Maintenance



WARNING!

Always observe the plant safety regulations. Before beginning work, ensure pipework is de-pressurized and empty.

If properly operated, the primary element requires practically no maintenance.

Note. The frequency of examination depends upon the abrasive or corrosive nature of the process fluid, for example:

- Steam – annually
- Clean fluid – every 2 or 3 years.

In case of a new process or plant, examine the meter during each routine maintenance period until the wear of each installation, relative to others, can be assessed.

Should the measuring unit require cleaning:

- Ensure the transmitter is powered off.
- If the flanges are fitted with a jacking screw, tighten the screw to remove any free play.
- Loosen the flange securing bolts and/or nuts and (using the jacking screw if fitted) separate the flanges.
- Remove sufficient bolts to enable the meter, together with the gaskets, to be lifted clear, ensuring that no part of the meter is damaged.



CAUTION!

Neither the transmitter nor the bore of the orifice plate is designed to withstand the weight of the meter. Do not lift the meter by either the orifice plate bore or the transmitter. Lift the meter only by the neck.

- Use compressed air to blow the parts then clean with solvents using soft cloths.
- If necessary, clean the passages of the pressure taps with wooden dowels or soft rods.
- For installations with impulse lines, blow them with compressed air.
- Replace the gaskets.
- Check whether any part is affected by corrosion and renew the surface protections.
- Check weld and screw connections.
- Check the tightening surface.
- Reinstall the FLC-CO into the pipeline as per Mechanical Installation Section on page 10.

No special equipment or tools are required or provided for maintenance operations.

4. FLC-APT FloTec / Averaging Pitot Tube Flow Meter

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4. FLC-APT FloTec / Averaging Pitot Tube Flow Meter

4.1 Main Specification

4.1.1 Nominal size and pipe schedule

- 50 ... 1,800 mm (2" ... 72")
- The pipe schedule must be specified by the customer.

4.1.2 Nominal pressure rating

Depending on the selected mounting type, the flange complies with nominal pressure rating of the pipeline.

4.1.3 Materials

- SS 316

4.1.4 Mounting type

- **S**: Coupling with gland, packing and threaded ferrule.
- **F**: Flanged mounting nozzle.
- **EM**: Flanged mounting nozzle extractable type under process condition.

4.1.5 Series

- **73**: suitable for small pipe diameter, low-stress conditions.
- **75**: suitable for medium pipe diameter, medium-stress conditions.
- **78**: suitable for large pipe diameter, high-stress conditions.

4.1.6 Application of opposite support (if required)

- **Suffix 0 (Model type xx0)**: without opposite support.
- **Suffix 5 (Model type xx5)**: with opposite support (not applicable for Series 73).

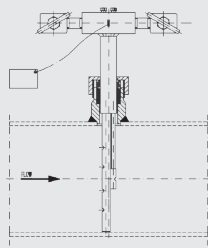
4.1.7 Operating limitations

Refer to Graph 1 on page 16 for structural limitations based on differential pressure, for temperatures up to 93 °C.

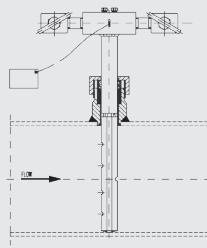
For higher operating temperatures, reduce the maximum allowable differential pressure (Dp) by 3% each 38 °C from 93 °C to 400 °C.

Note. These values are applicable for SS 316 / SS 316L (Stainless Steel) FloTec sensor material only.

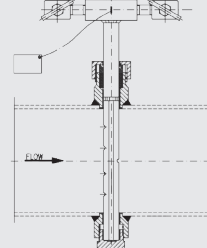
FloTec models.



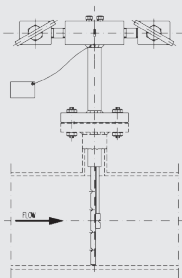
Mod. S-730



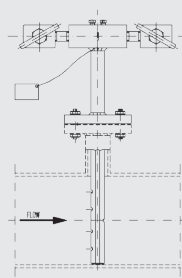
Mod. S-750



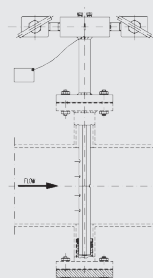
Mod. S-755



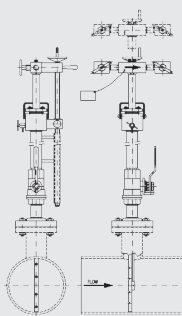
Mod. F-730



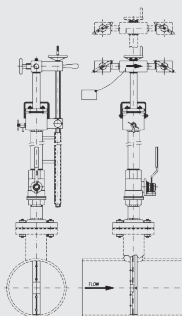
Mod. F-750 / F-780



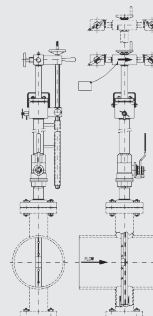
Mod. F-755 / F-785



Mod. EM-730



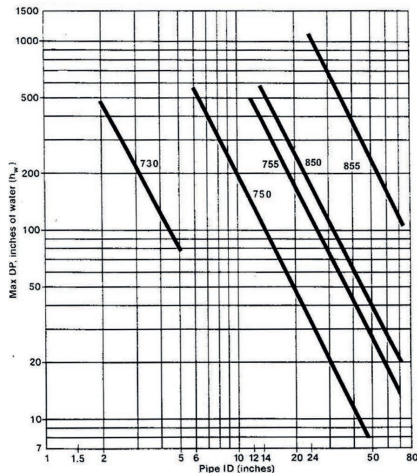
Mod. EM-750 / EM-780



Mod. EM-755 / EM-785

4. FLC-APT FloTec / Averaging Pitot Tube Flow Meter

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Graph 1 • Maximum DP by pipe and sensor type

4.2 Selecting mounting location



CAUTION!

Before drilling into a process pipe, or before carrying out any maintenance activity or component replacement, reduce the pipe pressure to a safe level and remove all potentially injurious process material.



CAUTION!

Ensure the process material does not exceed the pressure and temperature limits of the FloTec as specified. The part of the FloTec external to the

process pipe may present a burn hazard, especially if the maximum temperature of the process material exceeds 100 °C. Either lag or shield the exposed parts of the FloTec to protect personnel or display clear warning signs to alert personnel to the possible hazard. Refer to Standard EN563:1904 'Safety of Machinery – Temperatures of Touchable Surfaces'.

Correct location of the FloTec is important because disturbances in flow by pipe layout may affect the measurement accuracy. The following standard practices should be reviewed before selecting a mounting location.

4.3 Upstream straight pipe requirements

To meet specified accuracy figures, install FloTec at distances of no less than those shown in the Table 2 from flow disturbances in the pipe. If FloTec is installed within distances less than those shown, absolute accuracy will decrease BUT repeatability of measurement will continue to be excellent due to the inherent averaging characteristics.

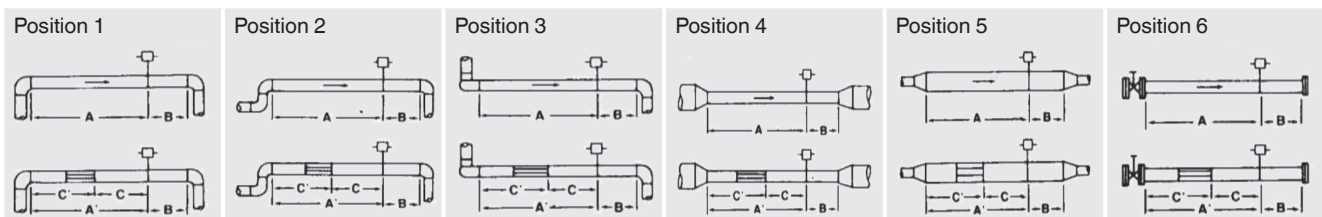
Straightening vanes may be used to reduce the length of straight pipe required in many cases.

If it is not possible to comply with this instruction and maximum accuracy is required, or for other piping configurations, consult WIKA.

Note. Pos. 6 includes gate, globe, plug and other throttling valves that are only partially opened. If valve operates fully opened, refer to Pos. 4 or 5. Control valves shall be located downstream the FloTec element.

Table 2 - Upstream and Downstream straight run pipe requirement (multiple of internal pipe diameter D)

Position	Upstream dimension					Downstream dimension
	Without vanes		With vanes			
	In plane A	Out of plane A	A'	C	C'	
Position 1	7	9	6	3	3	3
Position 2	9	14	8	4	4	3
Position 3	19	24	9	4	5	4
Position 4	8	8	8	4	4	3
Position 5	8	8	8	4	4	3
Position 6	24	24	9	4	5	4



4. FLC-APT FloTec / Averaging Pitot Tube Flow Meter

4.4 Meter Orientation

Avoid the location of the FloTec in pulsating flow.

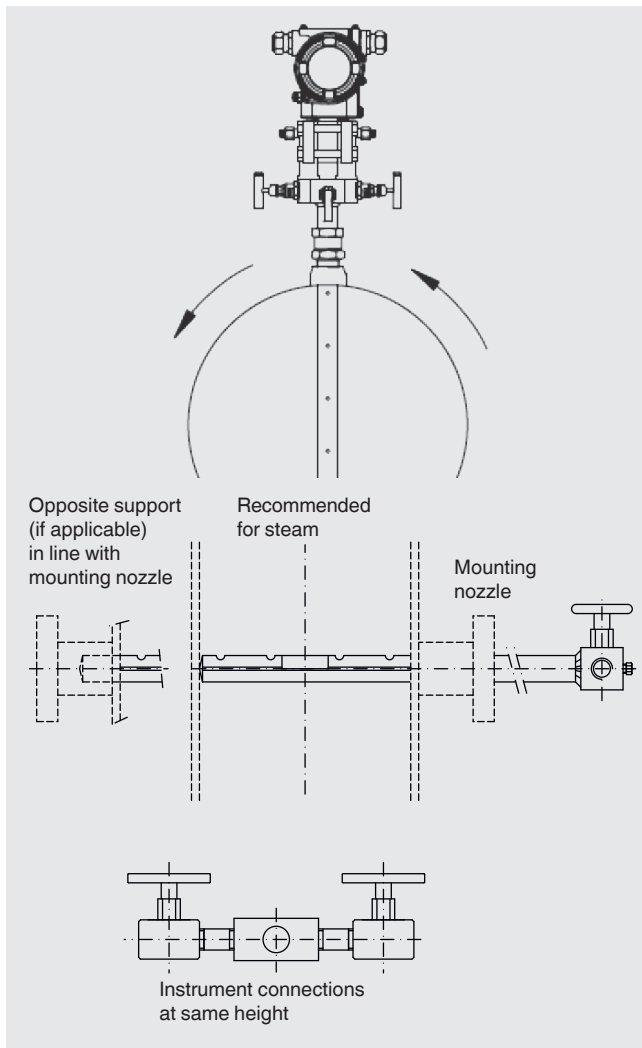
This may result in "noisy" signal problems. Vibration can also distort the output signal and compromise structural limits of the FloTec. Install the FloTec in a secure, stable run of pipe to obtain optimum signal output:

- Vibration resistance
 - Accelerations up to 2 g at frequency up to 1000 Hz (according to IEC 60068-2-6).
- Shock resistance
 - Acceleration: 50 g
 - Duration: 11 ms (according to IEC 60068-2-27).

FloTec may be installed in any plane of the pipe (horizontal, vertical, 45°, or any angle in-between). However, for trouble free operation, consideration must be given to the type of fluid and the transmitter.

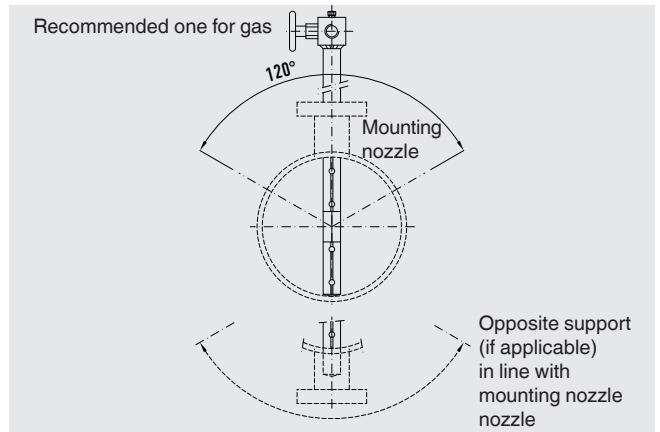
4.4.1 Vertical Pipe Mounting – All Applications

To ensure an equal head of gas, liquid or steam in both instrument lines, FloTec is designed so that the instrument lines are in the horizontal plane when the meter is installed. Any lateral-mounting angle is suitable.



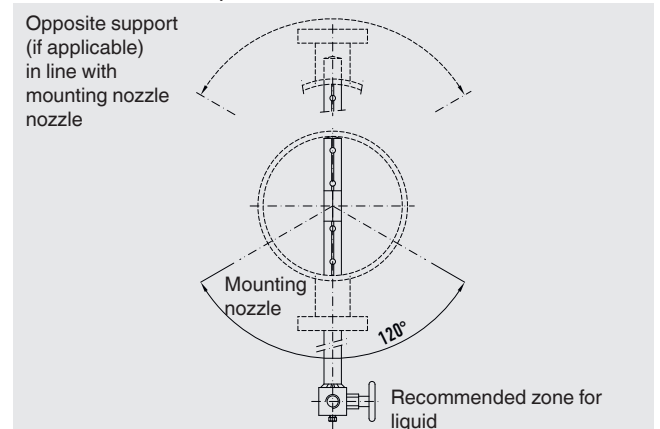
4.4.2 Horizontal Pipe Mounting – Gas

To ensure the instrument lines contain only gas, install the FloTec with the instrument connections **above** the centre line of the pipe, to prevent moisture or condensation from entering the connecting lines.



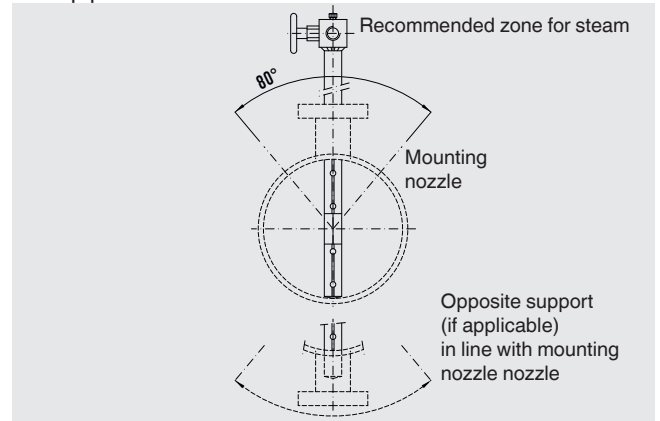
4.4.3 Horizontal Pipe Mounting – Liquids

To ensure the instrument lines contain only the process liquid, install the FloTec with the instrument connections **below** the centre line of the pipe, to keep the instrument lines full of liquid and encourage gas bubbles (if any) to find their way to the sensor and thus into the flowing fluid. Vent the flow meter prior to start flow measurement.



4.4.4 Horizontal Pipe Mounting – Steam

To ensure the instrument lines contain only steam, install the FloTec with the instrument connections **above** the centre line of the pipe.



4. FLC-APT FloTec / Averaging Pitot Tube Flow Meter

4.5 Maximum pipe vibration level

- Accelerations up to 2 g at frequency up to 1000 Hz (according to IEC 60068-2-6).
- Shock resistance
Acceleration: 50 g
Duration: 11 ms (according to IEC 60068-2-27).

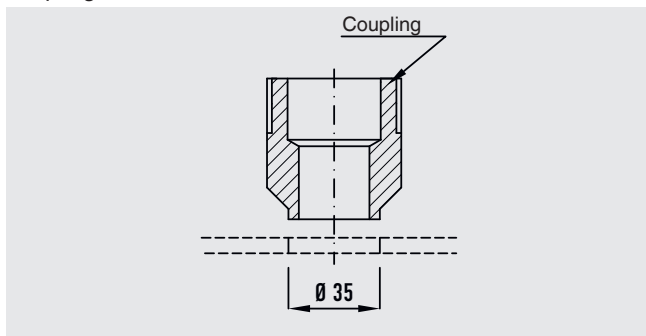
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4.6 Mechanical Installation

4.6.1 Model "S" With Coupling, Gland, Packing And Threaded Ferrule

4.6.1.1 FloTec Model S-730 and S-750 (without opposite support)

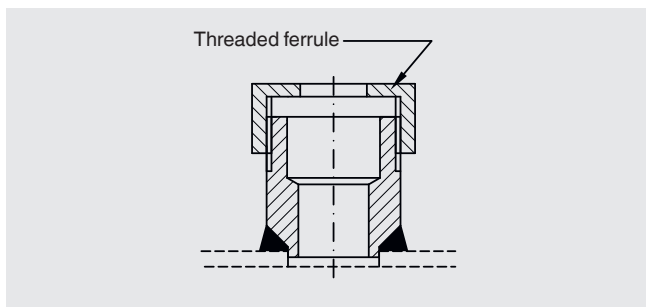
Step 1: Select the required insertion position and mark the pipe. Drill or burn a 35 mm hole in pipe for supplied mounting coupling.



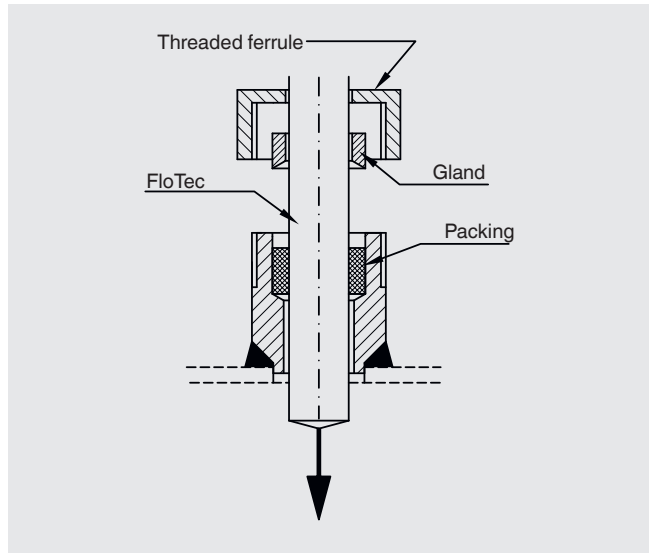
Step 2: Align the threaded fitting concentrically over the hole and tack-weld in place. Using a suitably sized and threaded length of pipe, check the threaded fitting is concentric and aligned correctly.

Step 3: Complete welding.

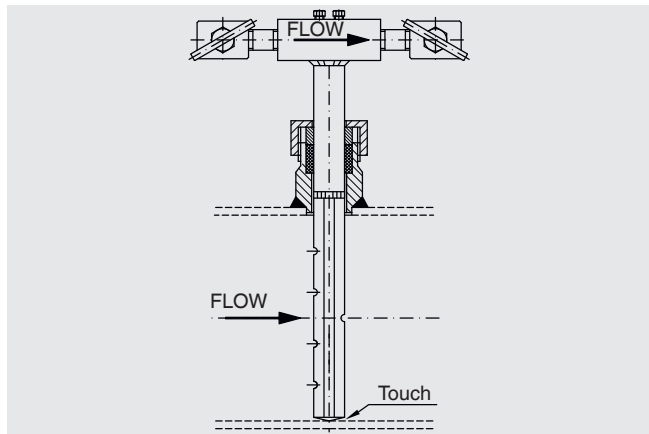
Step 4: Remove threaded ferrule from coupling and slide it onto FloTec along with the gland. The short-tapered end of the gland shall be pointing towards the probe tip.



Step 5: Insert the FloTec with the threaded ferrule and the gland through the threaded fitting into the pipe. Apply appropriate sealant to the threads of the compression fitting. Turn the FloTec until the flow arrow is positioned correctly and the sensor bar tip reaches the back side of the pipe.



Step 6: Screw the compression fitting into the threaded fitting by tightening to 340 Nm torque. Holding the head of the FloTec with a wrench to maintain correct orientation, use a long wrench to tighten the compression fitting until approximately one thread is left exposed under the nut, ensuring the flowmeter does not turn.



Step 7: Check the FloTec is installed correctly and aligned.

4. FLC-APT FloTec / Averaging Pitot Tube Flow Meter

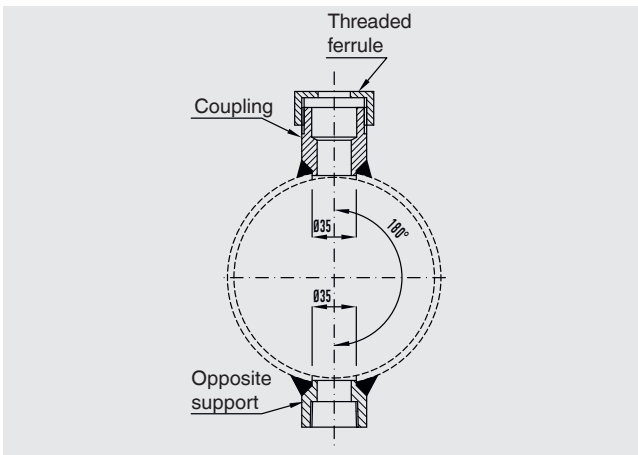
4.6.1.2 FloTec Model S-755 (with opposite support)

Step 1: Select the required insertion position and mark the pipe. Drill or burn a 35 mm hole in pipe for supplied mounting coupling.

Step 2: Align the threaded fitting concentrically over the hole and tack-weld in place. Using a suitably sized and threaded length of pipe, check the threaded fitting is concentric and aligned correctly.

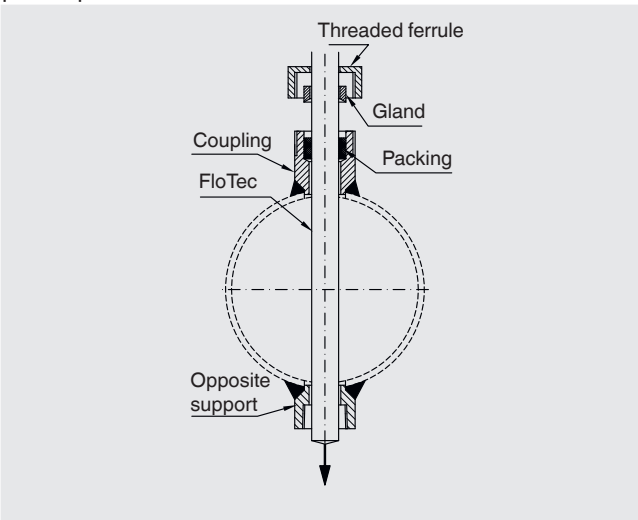
Step 3: Complete welding.

Step 4: Measure exactly 180° around the pipe circumference and mark the pipe.

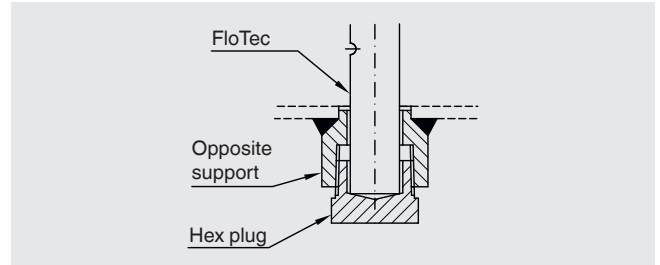


Step 5: Repeat steps from 1 to 3 to install the opposite support fitting.

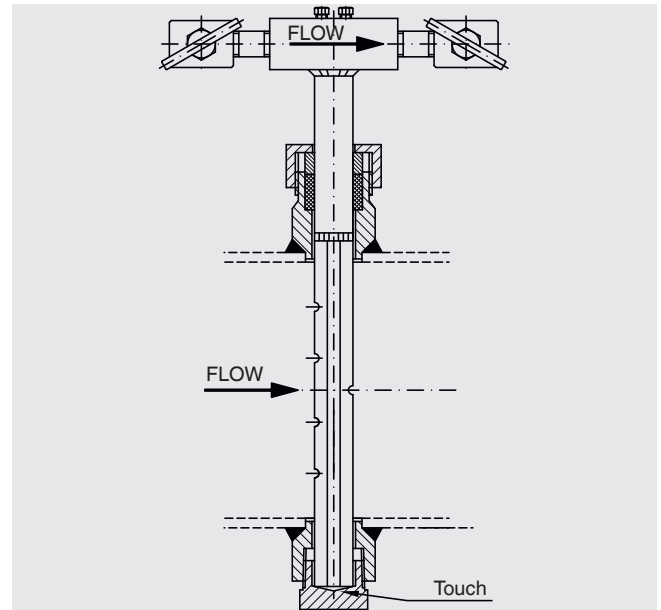
Step 6: Remove threaded ferrule from coupling and slide it onto FloTec along with the gland. The short-tapered end of the gland shall be pointing towards the probe tip.



Step 7: Insert the FloTec with the threaded ferrule and the gland through the threaded fitting into the pipe and through the opposite support. Apply appropriate sealant and tighten opposite support hex plug. Turn the FloTec until the flow arrow is positioned correctly and the sensor bar tip reaches the bottom of the hex plug.



Step 8: Screw the compression fitting into the threaded fitting by tightening to 340 Nm torque. Holding the head of the FloTec with a wrench to maintain correct orientation, use a long wrench to tighten the compression fitting until approximately one thread is left exposed under the nut, ensuring the flowmeter does not turn.



Step 9: Check the FloTec is installed correctly and aligned.

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4.6.2 Model "F" With Flanged mounting nozzle

Note. The flanged nozzle can be either supplied by WIKA or at customer's care. The inner diameter of the nozzle shall be minimum 35 mm for FloTec mod. F-730, F-750 and F-755, and 60 mm for mod. F-780 and F-785.

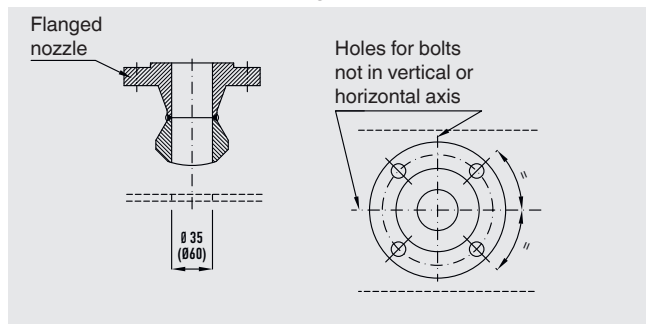
Note. Every flanged pipe fitting (stand-off) is shaped to fit the pipe and is self-aligning on two bolt holes as standard.

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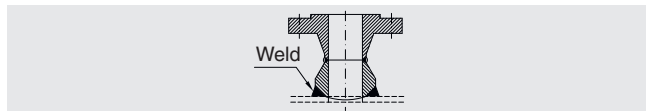
4.6.2.1 FloTec Model F-730, F-750 and F-780 (without opposite support)

Step 1: Select the required insertion position and mark the pipe. Drill or burn a 35 or 60 mm hole in pipe depending on the FloTec model. Place the flanged pipe fitting (stand-off) centrally over the drilled hole and align it correctly to the axis of the pipe according to the number of bolt holes in the flange. Ensure it is perpendicular to the pipe axis and square to the pipe plane.

Step 2: Tack-weld the mounting nozzle in place.

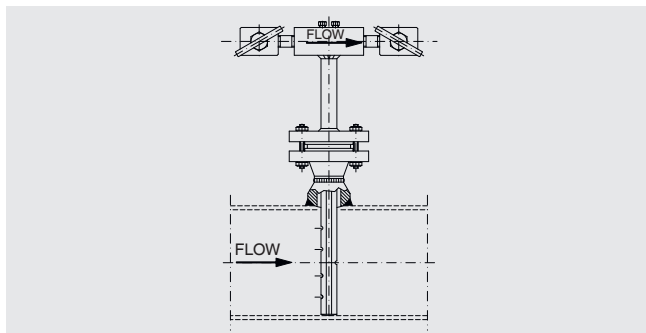


Step 3: Complete welding. Apply a full penetration root run completely around the base of the flanged pipe fitting (stand-off) at the clearly defined weld preparation line.



Step 4 Position the gasket onto the FloTec flange and carefully insert it through the flanged pipe fitting (stand-off) until the two flanges mate squarely. Turn the upper flange until the flow arrow is positioned correctly.

Fit the flange securing bolts and tighten equally and evenly, observing correct procedures appropriate to the flange.



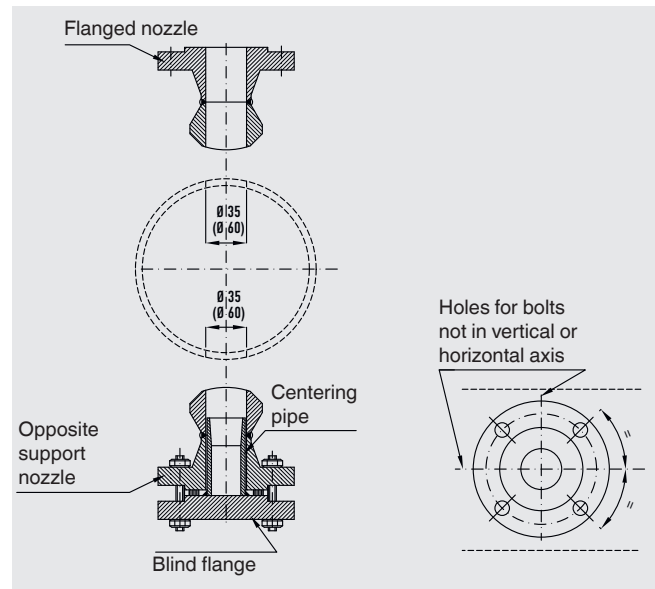
Step 5: Check the FloTec is installed correctly and aligned.

4.6.2.2 FloTec Model F-755 and F-785 (with opposite support)

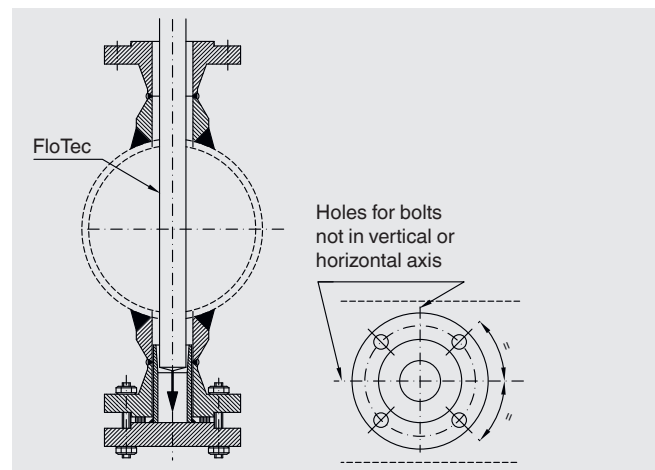
Step 1: Repeat steps 1 to 3 to install the flanged pipe fitting.

Step 2: Measure exactly 180° around the pipe circumference and mark the pipe.

Step 3: Drill or burn a 35 or 60 mm hole in pipe for the opposite support.

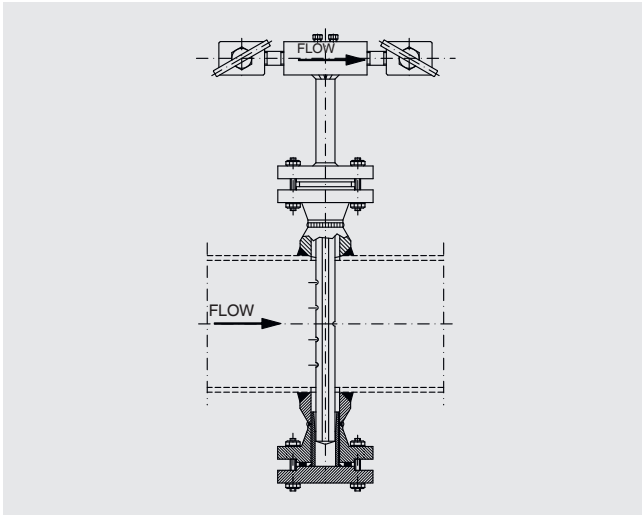


Step 4: Insert the FloTec through the nozzle into the pipe and check that the tip protrudes through the hole in the opposite pipe wall when the two flanges mate squarely. Position the end-support cup over the tip of the flowmeter, ensuring the tip is concentric with the hole, and tack-weld the end-support cup in place. Remove the FloTec and complete the support cup weld.



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Step 5: Position the gasket onto the FloTec flange and carefully insert it through the flanged fitting (stand-off) until the two flanges mate squarely, ensuring the tip of FloTec enters the opposite support cup. Turn the upper flange until the flow arrow is positioned correctly. Fit the flange securing bolts and tighten equally and evenly, observing correct procedures appropriate to the flange. Connect the blind flange (with centering pipe, gaskets and bolts) to the opposite support.



Step 6: Check the FloTec is installed correctly and aligned.

4.6.3 Insertion/extraction tool for removable type FloTec

The removable FloTec model has a flanged mounted nozzle with the extraction system to insert/extract the flowmeter under process condition.

For safety reason, the extractable FloTec model is NOT applicable if one or more of the following process conditions:

- Lethal fluid
- Toxic fluid
- Easily flammable fluid
- Acids or other fluids that could be dangerous in general for the operator
- Operating pressure higher than 200 Bar
- Operating temperature higher than 300 °C

The extraction system is applicable to:

- EM-750 and EM-780: flanged model without opposite support;
- EM-755 and EM-785: flanged model with opposite support.

4.6.4 Model "S" With Coupling, Gland, Packing And Threaded Ferrule

4.6.4.1 FloTec Model S-730 and S-750 (without opposite support)

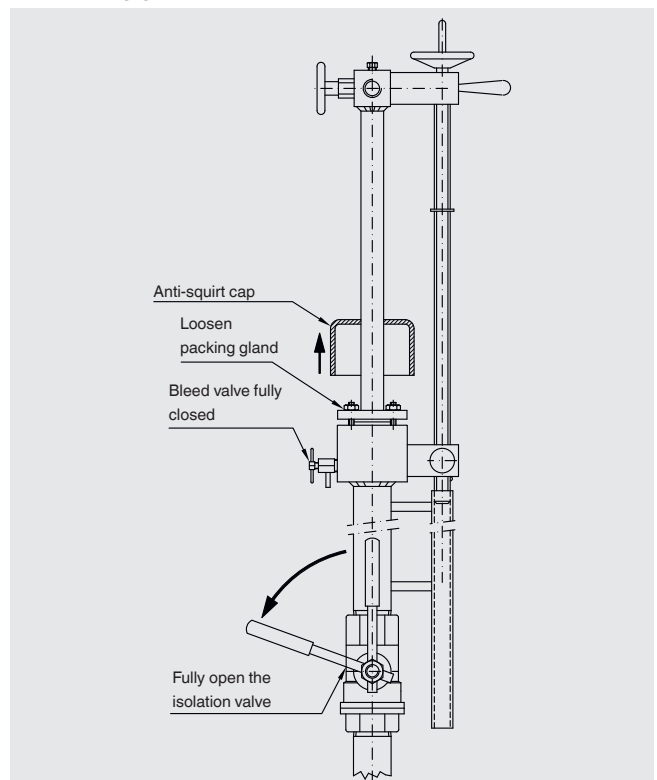
To install:

Step 1: Repeat steps 1 to 3 to install the flanged pipe fitting.

Step 2: Check that the blow-out bleed valve on the packing seat is fully closed.

Step 3: Loosen the packing gland without removing it.

Step 4: Fully open the isolation valve (usually 1.1/2" ball valve type). Should some fluid leak from the packing gland, tighten it till the leakage ends. For operator safety, during tightening close temporarily the isolation valve and test again the packing gland seal.

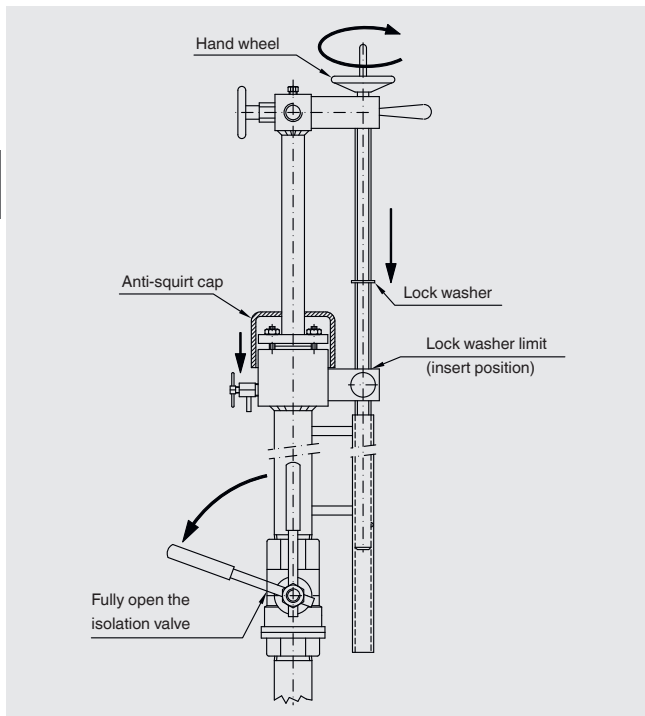


Step 5: Screw the anti-squirt cap on its original position and check that the isolation valve is fully open.

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4. FLC-APT FloTec / Averaging Pitot Tube Flow Meter

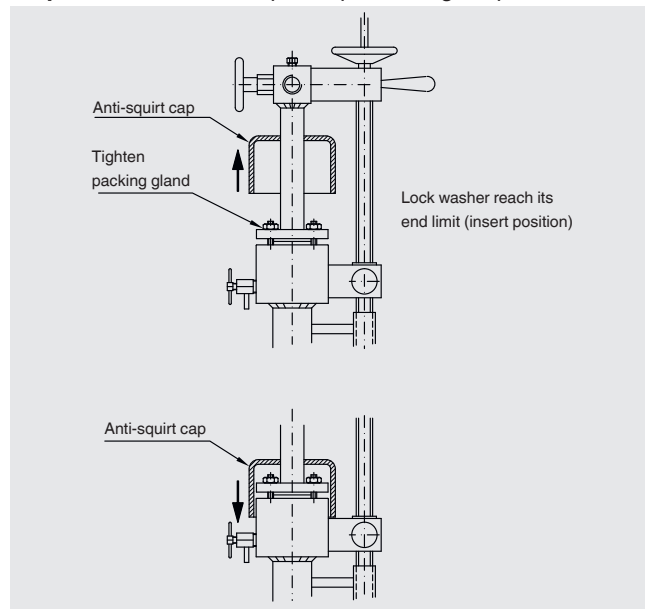
Step 6: Turn the handwheel till the lock-washer welded on the threaded rod reaches its stop limit (inserted position).



Step 7: Unscrew and lift up the anti-squirt cap.

Step 8: Tighten the packing gland.

Step 9: Screw the anti-squirt cap in its original position.

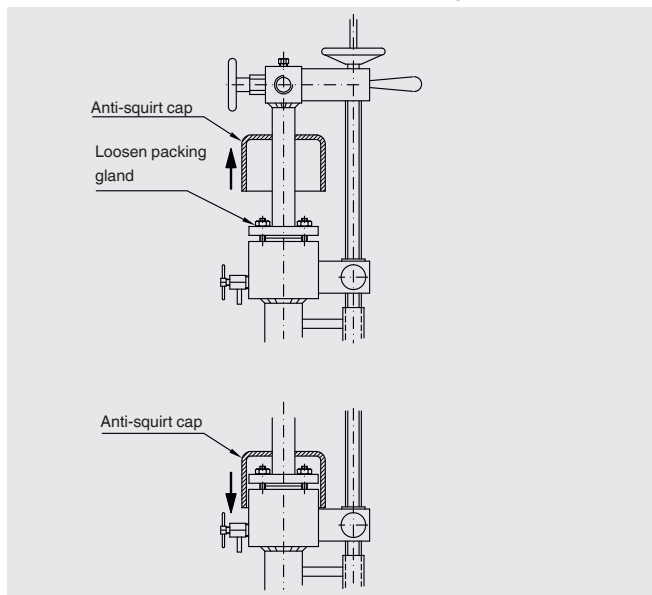


To extract:

Step 1: Unscrew and lift up the anti-squirt cap.

Step 2: Loosen the packing gland without removing it. Should some fluid leak from the packing gland, tighten it till the leak ends.

Step 3: Screw the anti-squirt cap on its original position.

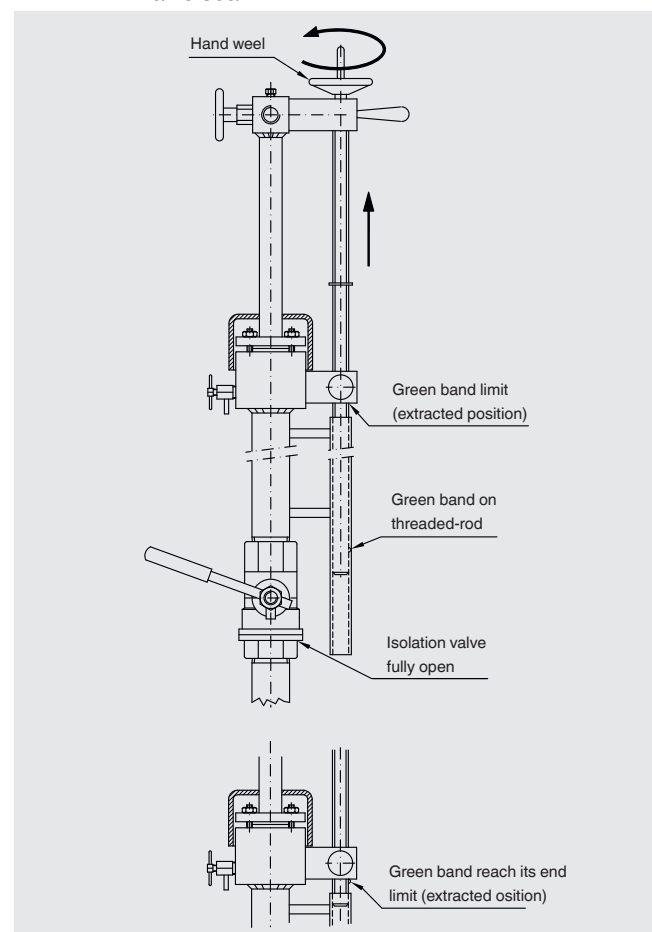


Step 4: Turn the handwheel till the green band painted on the threaded rod reaches its end limit (extracted position).



CAUTION!

Closing the isolation valve before the green band reaches its end limit will seriously damage the valve seal.



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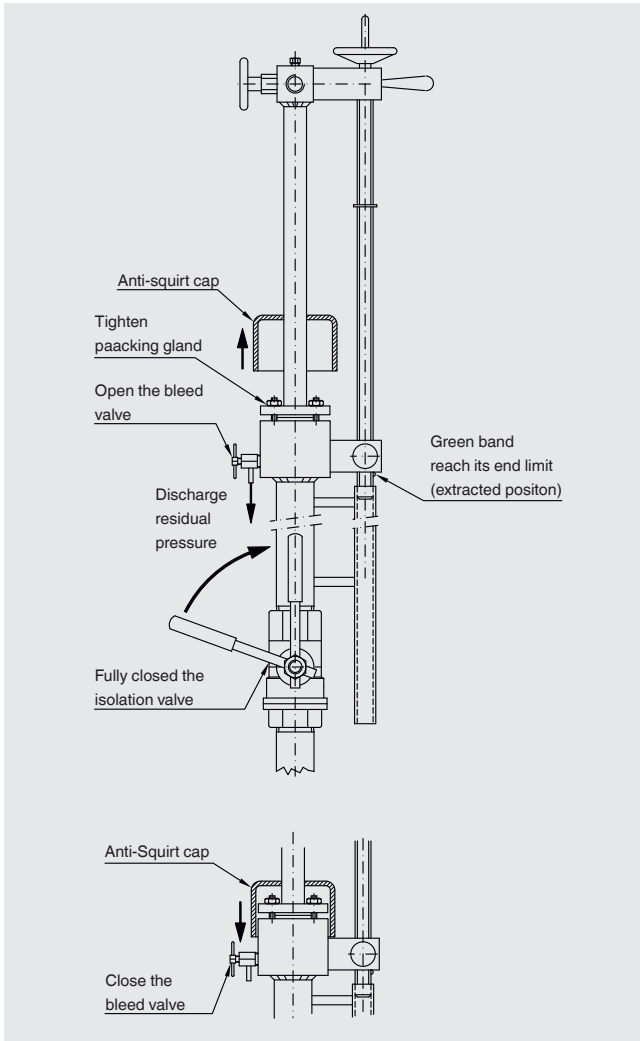
Step 5: Once Step 4 is completed, fully close the isolation valve (usually 1.1/2" ball valve type).

Step 6: Open the bleed valve to blowdown residual pressure and fluid from the extension nipple of the FloTec. If possible, connect the bleed valve to a discharge tank at site.

Step 7: Unscrew and lift up the anti-squirt cap.

Step 8: Tighten the packing gland.

Step 9: Screw the anti-squirt cap on its original position.



Step 10: Close the bleed valve.

4.7 Commissioning

Note. If the meter has been supplied with pre-configured transmitter, do not change parameter settings as this will cause erroneous meter readings.

To configure the transmitter, refer to the specific Transmitter manufacturer's Operating Instructions.

For remote version of the FloTec, get assured the following general instrument practices are observed or refer to the specific Transmitter manufacturer's Installation Instructions.

- Impulse lines shall have a slope of at least 25 mm each 300 mm and shall be supported over the full length to prevent sagging.
- Impulse lines shall run closely to maintain the same temperature.
- Nylon or rubber impulse lines shall be kept away from hot or heating sources.
- Run impulse lines against walls or ceilings; if not possible, use of conduits or cable trays is highly recommended.
- Impulse lines shall be accessible for maintenance; tag every 1000 m on long runs to help identification.
- Impulse lines shall be airtight; if vibration is expected, set up a periodic inspection procedure to prevent joints leakages.

4.7.1 Gas and Liquid Service



CAUTION!

During the following procedure, wear Personal Protection Equipment appropriate for the process.

- Install the meter as described in Section Mechanical Installation on page 18.
- Ensure the pipeline is full.
- Gradually bring the pipeline up to normal operating pressure, checking for any leaks in the system. If leaks are detected, de-pressurize the pipeline and repair as necessary observing all local health and safety and environmental requirements.
- When the system is at normal operating pressure and flow established, bleed the FloTec manifold/impulse lines using the drain/vent valves.
- Collect and dispose of any bleed liquids in accordance with the local environmental regulations.



CAUTION!

Ensure the drain/vent valves are positioned so that process fluid is directed down and away from personnel when it is removed during the drain/vent operation.

The differential pressure transmitter is normally supplied zeroed at atmospheric conditions (unless otherwise specified). To ensure correct operation, it must be zeroed at the normal operating pressure of the process. To zero the transmitter:

- Ensure the pipeline is at the normal operating pressure and that the transmitter power supply is on.
- Close the high pressure (HP) and low pressure (LP) isolation valves.
- Open the equalization valve; the transmitter should now indicate a value close to zero.

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- Zero the differential pressure transmitter – refer to the specific Transmitter manufacturer's Operating Instructions.
- Open the HP and LP isolation valves.
- Close the equalization valve. The transmitter should now indicate flow.

For information on fault diagnosis, refer to Troubleshooting section or to specific Transmitter manufacturer's Operating Instructions.

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4.7.2 Steam Service



CAUTION!

During the following procedure, wear Personal Protection Equipment appropriate for the process.

- Install the meter as described in Section Mechanical Installation on page 18.
- Ensure the pipeline is empty and de-pressurized.
- Connect a suitable water supply to the pipeline.
- Open the drain/vent valve.



CAUTION!

Ensure the drain/vent valves are positioned to direct process fluid down and away from personnel when they are opened during the drain/vent operation.

- Open the HP and LP isolation valves to allow water to flow slowly into the manifold/impulse lines until an air-free flow is obtained from the drain/vent valves, indicating they are full.
- Close the HP and LP isolation valves.
- Close the drain/vent valves and disconnect the water supply.
- Gradually bring the pipeline up to normal operating pressure, checking for any leaks in the system. If leaks are detected, de-pressurize the pipeline and repair as necessary observing all local health and safety and environmental requirements.

The differential pressure transmitter is normally supplied zeroed at atmospheric conditions (unless otherwise specified). To ensure correct operation, it must be zeroed at the normal operating pressure of the process. To zero the transmitter:

- Ensure the pipeline is at the normal operating pressure and that the transmitter power supply is on.
- Close the high pressure (HP) and low pressure (LP) isolation valves.
- Open the equalization valve, the transmitter should now indicate a value close to zero.
- Zero the differential pressure transmitter – refer to the specific Transmitter manufacturer's Operating Instructions.
- Open the HP and LP isolation valves.
- Close the equalization valve. The transmitter should now indicate flow.

For information on fault diagnosis, refer to Troubleshooting section or to specific Transmitter manufacturer's Operating Instructions.

4.8 Operating instructions

During normal service the manifold or impulse lines to the transmitter must periodically be vented or drained.



WARNING!

During the service check that pressure and temperature do not exceed the design values.

Monitor that quality and flow regime (velocity) of the fluid do not change from original design ones; this may lead to damage risk for the primary element. Check periodically the transmitter zero set-up and adjust if necessary.

4.9 Troubleshooting

Complete the following checks to ensure correct installation:

- **Direction of flow** - Ensure the flow direction is in accordance with the arrow on the meter. If not, remove and reinstall the meter correctly.
- **Mounting orientation** - Ensure the meter is correctly oriented to the pipework with regard to flow direction, pipeline and nature of the fluid. Incorrect orientation can lead to metering errors and in some cases may damage the meter.
- **Zeroing of the transmitter** - Zero the differential pressure transmitter during installation and commissioning – refer to the specific Transmitter manufacturer's Operating Instructions.
- **Manifold valves** - The meter manifold is fitted with three/five valves. During measurement, ensure the equalization valve is fully closed and the HP and LP isolation valves are fully open.
- **Setup/configuration of the meter** - Ensure the 4 to 20 mA output of the meter is correctly set and that any receiving equipment is configured for the same flowrate range. Refer to the specific Differential Pressure Transmitter's Operating Instructions for information on how to check the loaded configuration.
- **Pipe Size** - Use of the FloTec on a different pipe size than the one for which it has been designed leads to metering errors.
- **Questionable accuracy** - Ensure the FloTec has recommended straight run pipe available as per table on page 16. For air, gas or steam service, check that actual operating pressure and temperature match with values used for calculation; for liquid service, ensure there is no trapped air in the piping system.
- **Low signal** - Check for leaks, repair and seal if necessary; check for contamination/plugging, back flush through impulse lines, clean out ports or manifold valves.
- **Spiking signal** - Ensure flow regime is not pulsating; if so, relocate the FloTec. If relocation is not possible, install mechanical pressure snubbers in the impulse lines or activate electronic damping function in the transmitter.
- **Two-Phase fluid** - Do not operate FloTec with two-phase or changing phase flow.

Refer to the specific Differential Pressure Transmitter's Operating Instructions for procedures to be followed when error messages are shown on the transmitter display.

4.10 Maintenance

**WARNING!**

Always observe the plant safety regulations. Before beginning work, ensure pipework is de-pressurized and empty.

If properly operated, the primary element requires practically no maintenance.

Note: The frequency of examination depends upon the abrasive or corrosive nature of the process fluid, for example:

- Steam – annually
- Clean fluid – every 2 or 3 years.

In the case of a new process or plant, examine the meter during each routine maintenance period until the wear of each installation, relative to others, can be assessed. Should the measuring unit require cleaning, refer to the following instructions.

4.10.1 Removing Threaded Process Connection

- Ensure the transmitter is powered off.
- Reduce pipe pressure to a safe level and remove all hazardous material.

**CAUTION!**

Failure to reduce the pipe pressure to a safe level and remove all hazardous material prior to removing the FloTec could result in serious injury to personnel.

- Remove the compression fitting and then remove the FloTec.

4.10.2 Removing Flanged Process Connection.

- Ensure the transmitter is powered off.
- Reduce pipe pressure to a safe level and remove all hazardous material.

**CAUTION!**

Failure to reduce the pipe pressure to a safe level and remove all hazardous material prior to removing the FloTec could result in serious injury to personnel.

- Remove the flange security bolts and then remove the FloTec

4.10.3 To clean

- Use compressed air to blow the parts then clean with solvents using soft cloths.
- If necessary, clean the passages of the pressure ports with wooden dowels or soft rods.
- For installations with impulse lines, blow them with compressed air.
- Replace the gaskets.
- Check whether any part is affected by corrosion and renew the surface protections.
- Check weld and screw connections.
- Check the tightening surface.
- Reinstall the FloTec into the pipeline as per Section Mechanical Installation on page 18.

No special equipment or tools are required or provided for maintenance operations.

5. Other Differential Pressure Flow Meters

This section describes the general principles and the essential safety requirements for the handling, installation, use and maintenance of the following differential pressure flowmeters:

- FLC-MR/FLC-IO meter run/integral orifice assembly
- FLC-VT Venturi tube
- FLC-FN Flow nozzle
- FLC-FC Cone flow meter
- FLC-FW Wedge flow meter
- FLC-HHR-FP FlowPak meter
- FLC-HHR-PP ProPak flow meter

5.1 Main Specification

5.1.1 Pipe size

- Starting from 1/2" ... per ANSI/ASME.
- Starting from DN 25 per EN.

Refer to individual primary element data sheet for detailed specification.

5.1.2 Pressure rating

- Class 150 ... 2500 with raised face (RF) and ring-type joint (RTJ) per ANSI/ASME B16.5.
- PN 10 ... 400 with raised face (RF) per EN 1092.

Refer to individual primary element data sheet for detailed specification.

5.1.3 Materials

- Carbon Steel
- Stainless Steel
- Special alloys on request

5.1.4 Flow Element body

- Welded or turned from one piece.

5.1.5 Pressure taps

- NPT thread
- Weld stub
- Nipple
- With adaptor for compact transmitter mounting
- Flanged

5.1.6 Max. operating pressure and temperature

Depending on material, pressure rating and applicable flange Standard. Refer to individual primary element data sheet for detailed specification.

5.2 Mechanical installation

The up- and downstream pipe inner surface shall be free from burrs, deposits and holes for at least 10D and 4D respectively from the measuring element.

At least 2D upstream pipe shall be cylindrical so that no measured diameter differs from the average value by more than 0.3% for orifice assemblies and nozzles or by 1% for Venturi tubes.

No downstream pipe diameter, for a length of 2D from the upstream side of the measuring element shall differ by 3% from the average value of upstream pipe diameter.

To guarantee concentricity requirements it may be necessary to ream out the pipe. The reamed-out part shall be coupled to the non-reamed part by an angle not exceeding 30°. The reaming out depth shall be the minimum to match requirements. Reaming shall be carried out after welding of flanges or other components.

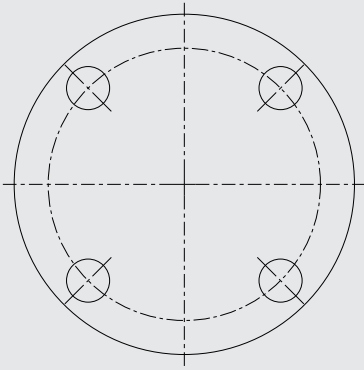
To install:

- Check the Tag Number of the meter to ensure it is the correct unit for the location.
- Ensure all weld outlines in the pipeline where the meter is to be installed are even.
- Grind off any protrusions inside the pipe and ensure that the inside of the pipe is smooth and clean.
- Ensure that any specialized cleaning requirements are performed (for example, those specifically for oxygen/ pharmaceutical applications).
- Examine the meter and the flange faces and ensure that:
 - a) the faces are free from scratches and are not buckled;
 - b) the gasket surfaces are clean.
- Replace defective components as necessary.

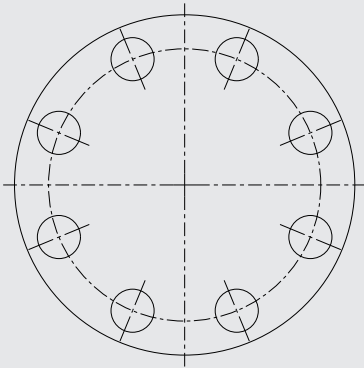
5.2.1 Installation with studs (where applicable)

- Fit sufficient bolts in the lower part of the pipeline flanges to retain the meter in place.
- Place the correct gaskets on both sides of the meter body and align them correctly, ensuring they do not protrude into the pipe bore. An incorrect alignment of the gaskets may cause measuring errors and/or fluid leakages. The gaskets shall never be bent.
- Insert the meter between the pipeline flanges ensuring that:
 - a) the meter is oriented correctly depending on the type of installation;
 - b) if applicable, the manifold's equalizing valve is pointing upstream of the fluid flow.
- Fit bolts diametrically opposite and evenly tighten all bolts hand-tight.
- Push the bolts against the outer edge of the bolt holes. Fit the remaining bolts and hand-tighten evenly.
- Determine the maximum tightening torque according to the relevant flange specifications.
- Tighten each bolt to the correct torque in a diagonally opposing pattern, firstly to 30% of the maximum torque, then 60% and finally to the maximum torque.

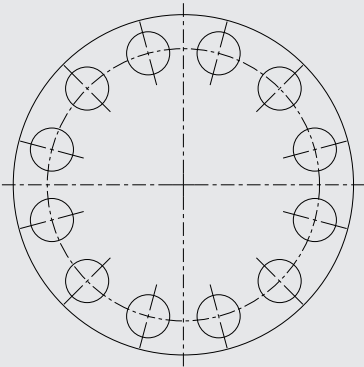
5. Other Differential Pressure Flow Meters



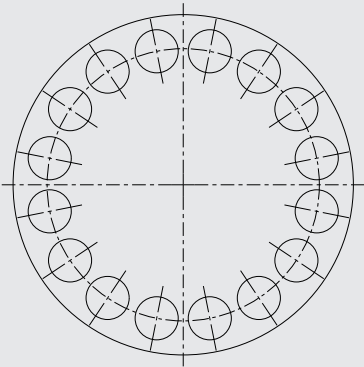
4-bolts Flange



8-bolts Flange



12-bolts Flange



16-bolts Flange

5.2.2 Installation with butt weld ends (where applicable)

All welding activities shall be carried out by qualified personnel only, strictly following qualified welding specification. Ensure that prescribed parameters including pre-heat, interpass and post weld heat treatment are fulfilled for each welded joint.

The metered fluid flow rate is subject to considerable error if the in-line installation of the equipment is such that vortexes and/or distortion of the velocity profile are generated by an incorrect alignment of the parts.

Accurate centralization in the pipeline is critical to performance. For information on the effects of incorrect centralization, refer to standard ISO 5167:2003.

5.3 Meter Orientation

The recommended mounting location for the element is on a horizontal plane. This location allows the integrally mounted differential pressure transmitter (where applicable) to be mounted in its recommended vertical position. The element can be installed also on a vertical plane. However, care must be taken to ensure that the transmitter measuring element is properly vented. With the transmitter on its side, the lower pressure tap is difficult to vent. Gas bubbles in this chamber can cause excessive zero shifts. Routine zero checks can minimize, if not eliminate, this problem.

5.3.1 Vertical Pipe Mounting – Liquid & Gas

In a vertical installation, the flow direction can be either up or down. If the transmitter is mounted remotely (impulse lines), should the temperature of the fluid differ by more than 10 °C from ambient, use a 1/2" "S" nipple on the HP port with ascending flow, on the LP port with descending flow. The nipple length shall be such as impulse line height from ground level is equalized.

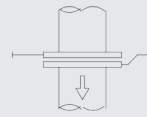


Fig.: 1

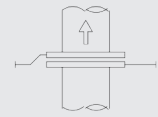


Fig.: 2



CAUTION!

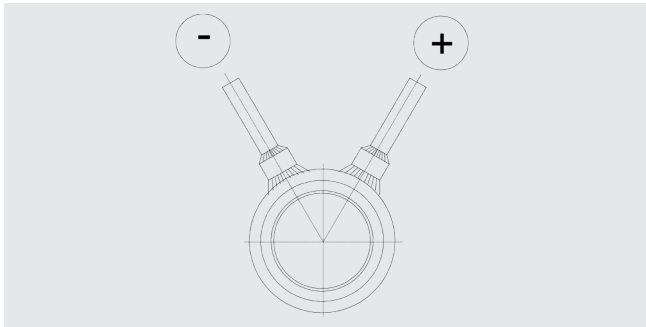
When installing the meter, ensure that drain/vent valves are positioned to direct the process medium away from personnel and equipment when it is removed during drain and vent operations.

For all meter orientations, ensure the arrow on the meter body is aligned correctly with the direction of flow in the pipeline.

5. Other Differential Pressure Flow Meters

5.3.2 Horizontal Pipe Mounting – Gas

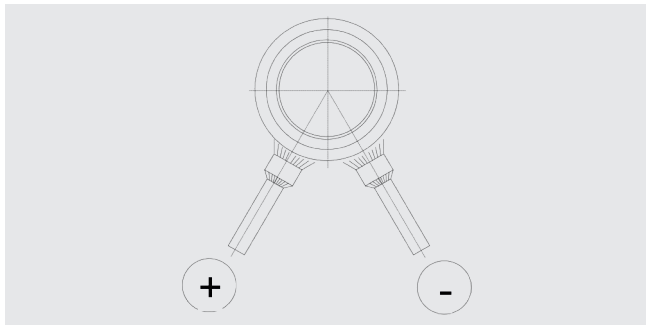
To ensure that condensate drains back into the pipe, mount the meter **above** the pipe, at least 30 degrees above the horizontal, see the following figure:



EN

5.3.3 Horizontal Pipe Mounting – Liquids & Steam

To ensure that gases vent back into the pipe, mount the meter **below** the pipe, at least 45 degrees below the horizontal, see following figure:



5.4 Straight piping requirements

To ensure accurate measurement follow upstream and downstream straight piping requirements. Refer to ISO 5167 or individual flow meters data sheets for detailed straight run requirements. Valves, joints and other fittings must preferably be positioned after the flow meter. The use of straighteners (Flow conditioners) can be considered in those cases where available straight-line piping is shorter than required.

5.5 Maximum pipe vibration level

Vibration limits to IEC60068-2-6: <0.5 g over frequency range 10 to 500 Hz.

5.6 Differential Pressure Connections and Commissioning

Note. If the meter has been supplied with pre-configured transmitter, do not change parameter settings as this will cause erroneous meter readings. To configure the transmitter, refer to the specific Transmitter manufacturer's Operating Instructions.

5.6.1 Compact flow meter

When mounting the element, be sure to orient it so that the flow enters from the side stamped INLET. The HP port is on the inlet side of the element and must be connected to the HP side of the differential pressure transmitter.



WARNING!

Maximum working pressure rating of the flow element may be different from rating of the transmitter. Exceeding the pressure rating can cause personal injury and damage equipment. Make sure that process pressure does not exceed lowest pressure rating of either the element or transmitter.

Mounting dimensions of flow element are in accordance with ISO 61518 type B (54 mm interaxis).

- Remove all plastic shipping plugs from the element ports. Remove any foreign matter from the mating surfaces of the element and transmitter.
- Position the ring gaskets in the grooves on the mating surfaces of the element.
- Connect the element to the transmitter using the four mounting bolts supplied.
- Be sure the high pressure side of the transmitter is connected to the INLET side of the element.
- Tighten the four mounting bolts to a torque of 28.2 to 33.9 Nm.
- Mount the assembled transmitter and flow element in the pipe line.

Refer to the transmitter instructions for additional mounting information. A union connection is required in the process line to permit installation of the element.

Note. If it's more convenient, the flow element can be mounted in the pipe line before connecting the transmitter to the element.

5.6.2 Connection by impulse lines

When mounting the element, be sure to orient it so that the flow enters from the side indicated by the arrow. The HP port is on the inlet side of the element and must be connected to the HP side of the differential pressure transmitter.



WARNING!

Maximum working pressure rating of the flow element may be different from rating of the transmitter. Exceeding the pressure rating can cause personal injury and damage equipment. Make sure that process pressure does not exceed lowest pressure rating of either the element or transmitter.

5. Other Differential Pressure Flow Meters

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WARNING!

For applications with high temperature fluids the nipple and / or impulse line shall be wide enough for the working conditions and long enough to ensure that the temperature at the transmitter never exceeds the transmitter's manufacturer recommended value. Refer to the Transmitter Instructions for additional mounting information.



WARNING!

Outdoor installation may require heating to prevent freezing.



WARNING!

Impulse lines shall be tilted and supported to prevent sagging. Avoid abrupt bending, ensure that impulse lines curvature radius is at least 3D.

Impulse lines shall run closely to maintain the same temperature. Nylon or rubber impulse lines shall be kept away from hot or heating sources.

Run impulse lines against walls or ceilings; if not possible, use of conduits or cable trays is highly recommended.

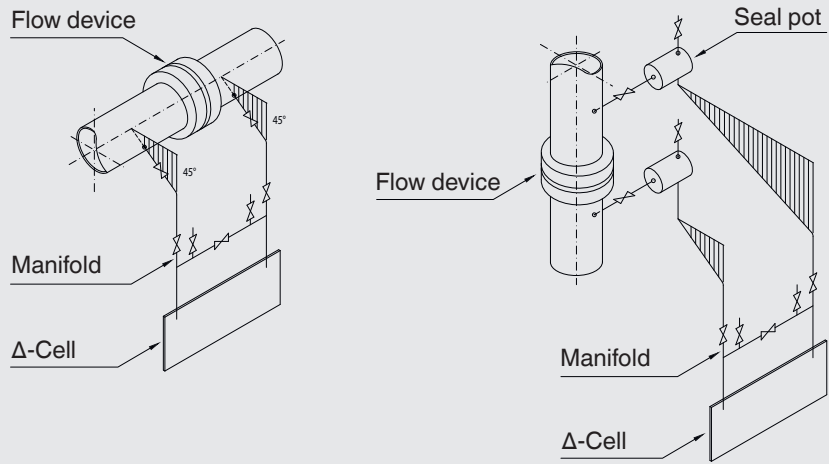
Impulse lines shall be accessible for maintenance; tag every 1,000 m on long runs to help identification.

Impulse lines shall be airtight; if vibration is expected, set up a periodic inspection procedure to prevent joints leakages.

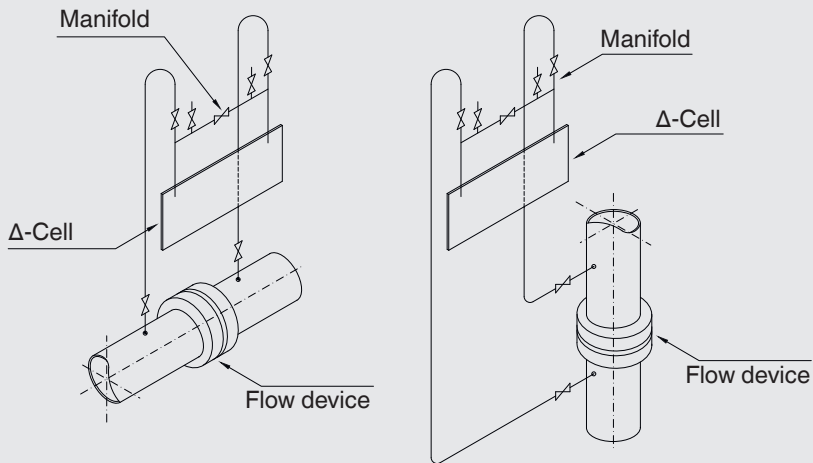
5. Other Differential Pressure Flow Meters

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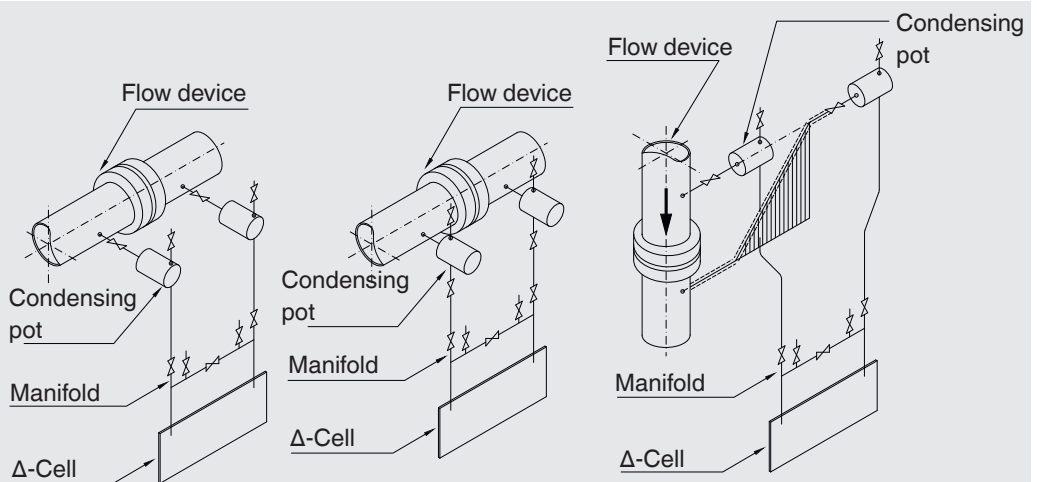
Liquid Service



Gas Service

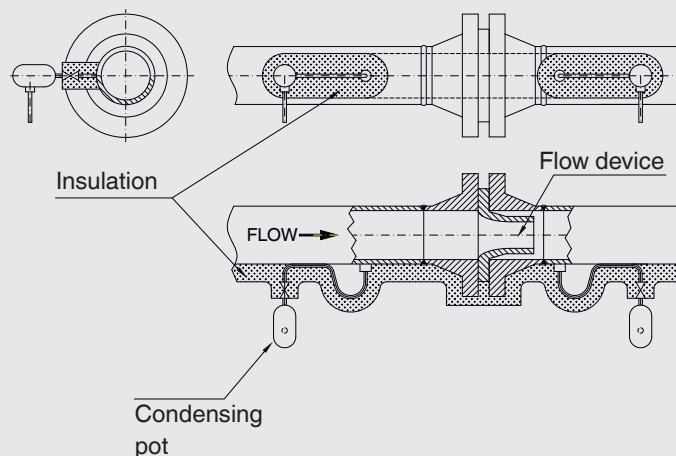


Steam Service



5. Other Differential Pressure Flow Meters

Steam Service with temperatures above 455 °C [851 °F]



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5.6.3 Gas and Liquid Service



CAUTION!

During the following procedure, wear Personal Protection Equipment appropriate for the process.

- Install the meter as described in Section Mechanical Installation on page 25.
- Ensure the pipeline is full.
- Gradually bring the pipeline up to normal operating pressure, checking for any leaks in the system. If leaks are detected, de-pressurize the pipeline and repair as necessary observing all local health and safety and environmental requirements.
- When the system is at normal operating pressure and flow established, bleed the manifold/impulse lines using the drain/vent valves.
- Collect and dispose of any bleed liquids in accordance with the local environmental regulations.



CAUTION!

Ensure the drain/vent valves are positioned so that process fluid is directed down and away from personnel when it is removed during the drain/vent operation.

The differential pressure transmitter is normally supplied zeroed at atmospheric conditions (unless otherwise specified). To ensure correct operation, it must be zeroed at the normal operating pressure of the process. To zero the transmitter:

- Ensure the pipeline is at the normal operating pressure and that the transmitter power supply is on.
- Close the high pressure (HP) and low pressure (LP) isolation valves.
- Open the equalization valve, the transmitter should now indicate a value close to zero.

- Zero the differential pressure transmitter – refer to the specific Transmitter manufacturer's Operating Instructions.
- Open the HP and LP isolation valves.

- Close the equalization valve. The transmitter should now indicate flow.

For information on fault diagnosis, refer to Troubleshooting section or to specific Transmitter manufacturer's Operating Instructions.

5.6.4 Steam Service



CAUTION!

During the following procedure, wear Personal Protection Equipment appropriate for the process.

- Install the meter as described in Section Mechanical Installation on page 25.
- Ensure the pipeline is empty and de-pressurized.
- Connect a suitable water supply to the pipeline.
- Open the drain/vent valve.



CAUTION!

Ensure the drain/vent valves are positioned to direct process fluid down and away from personnel when they are opened during the drain/vent operation.

- Open the HP and LP isolation valves to allow water to flow slowly into the manifold/impulse lines until an air-free flow is obtained from the drain/vent valves, indicating they are full.
- Close the HP and LP isolation valves.
- Close the drain/vent valves and disconnect the water supply.
- Gradually bring the pipeline up to normal operating pressure, checking for any leaks in the system. If leaks are detected, de-pressurize the pipeline and repair as necessary observing all local health and safety and environmental requirements.

5. Other Differential Pressure Flow Meters

The differential pressure transmitter is normally supplied zeroed at atmospheric conditions (unless otherwise specified).

To ensure correct operation, it must be zeroed at the normal operating pressure of the process.

To zero the transmitter:

- Ensure the pipeline is at the normal operating pressure and that the transmitter power supply is on.
- Close the high pressure (HP) and low pressure (LP) isolation valves.
- Open the equalization valve, the transmitter should now indicate a value close to zero.
- Zero the differential pressure transmitter – refer to the specific Transmitter manufacturer's Operating Instructions.
- Open the HP and LP isolation valves.
- Close the equalization valve. The transmitter should now indicate flow.

For information on fault diagnosis, refer to Troubleshooting section or to specific Transmitter manufacturer's Operating Instructions.



WARNING!

In line hydrostatic test (when applicable) is possible under the following conditions:

- ▶ Ensure that water temperature is not lower than the minimum design temperature engraved on the name plate and not less than -5 °C anyway.
- ▶ Do not carry out the hydrotest when pipe wall temperature is lower than the minimum design one.
- ▶ Never exceed piping design pressure engraved on the name plate.

5.7 Operating instructions



WARNING!

No counter-flow is allowed in case of flow nozzle tube.

During normal service the manifold or impulse lines to the transmitter must periodically be vented or drained.



WARNING!

During the service check that pressure and temperature do not exceed the design values.

Monitor that quality and flow regime (velocity) of the fluid do not change from original design ones; this may lead to damage risk for the primary element.

Check periodically the transmitter zero set-up and adjust if necessary.

5.8 Troubleshooting

Complete the following checks to ensure correct installation:

- **Direction of flow** - Ensure the flow direction is in accordance with the arrow on the meter. If not, remove and reinstall the meter correctly.

- **Mounting orientation** - Ensure the meter is correctly oriented to the pipework with regard to flow direction, pipeline and nature of the fluid. Incorrect orientation can lead to metering errors and in some cases may damage the meter.
- **Zeroing of the transmitter** - Zero the differential pressure transmitter during installation and commissioning – refer to the specific Transmitter manufacturer's Operating Instructions.
- **Manifold valves** - The meter manifold is fitted with three/five valves. During measurement, ensure the equalization valve is fully closed and the HP and LP isolation valves are fully open.
- **Setup/configuration of the meter** - Ensure the 4 to 20 mA output of the meter is correctly set and that any receiving equipment is configured for the same flowrate range. Refer to the specific Differential Pressure Transmitter's Operating Instructions for information on how to check the loaded configuration.

Refer to the specific Differential Pressure Transmitter's Operating Instructions for procedures to be followed when error messages are shown on the transmitter display.

5.9 Maintenance



WARNING!

Always observe the plant safety regulations. Before beginning work, ensure pipework is de-pressurized and empty.

If properly operated, the primary element requires practically no maintenance.

Note. The frequency of examination depends upon the abrasive or corrosive nature of the process fluid, for example:

- Steam – annually
- Clean fluid – every 2 or 3 years.

In the case of a new process or plant, examine the meter during each routine maintenance period until the wear of each installation, relative to others, can be assessed.

Should the measuring unit require cleaning:

- Ensure the transmitter is powered off.
- If the flanges are fitted with a jacking screw, tighten the screw to remove any free play.
- Loosen the flange securing bolts and/or nuts and (using the jacking screw if fitted) separate the flanges.
- Remove sufficient bolts to enable the meter, together with the gaskets, to be lifted clear, ensuring that no part of the meter is damaged.



CAUTION!

Neither the transmitter nor the bore of the measuring element is designed to withstand the weight of the meter. Do not lift the meter by either the bore or the transmitter. Lift the meter only by the lifting lugs.

5. Other Differential Pressure Flow Meters

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- Use compressed air to blow the parts then clean with solvents using soft cloths.
- If necessary, clean the passages of the pressure taps with wooden dowels or soft rods.
- For installations with impulse lines, blow them with compressed air.
- Replace the gaskets.
- Check whether any part is affected by corrosion and renew the surface protections.
- Check weld and screw connections.
- Check the tightening surface.
- Reinstall the primary element into the pipeline as per Section Mechanical Installation on page 25.

No special equipment or tools are required or provided for maintenance operations.

5.10 Assistance

In cases where the components need to be replaced or repaired, the manufacturer must be contacted.

Appendix 1 – Quick Troubleshooting guide for DP Transmitters

Always refer to Transmitter's Manufacturer manual to locate the malfunctioning parts of the transmitter and proffer a remedy. This Appendix purpose is only to help verifying that the transmitter hardware and process connections are in good working conditions.

Ensure to follow the precautions below before and during troubleshooting of your malfunctioning DP transmitter:

- Isolate the failed DP transmitter from its pressure source as soon as possible. Pressure that may be present could cause death or serious injury to technicians or personnel if the transmitter is disassembled or ruptures under pressure;
- Do not use higher than the specified voltage to check the transmitter loop. This may damage the transmitter electronics.
- If there is need to open the DP transmitter while troubleshooting, please follow Manufacturer's specific uidelines for disassembly of the transmitter. If you don't, serious injury or death to personnel may occur or the transmitter may be damaged.

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Problem	Potential cause	Corrective action
Low Output or No Output	Primary Element	<ul style="list-style-type: none"> ■ Check the insulation and condition of the primary element.
	Loop Wiring	<ul style="list-style-type: none"> ■ Check for adequate voltage to the transmitter. ■ Check the mA rating of the power supply against the total current being drawn for all transmitters being powered. ■ Check for shorts and multiple grounds. ■ Check for proper polarity at the signal terminal. ■ Check loop impedance (shall not exceed the plant specification). ■ Check wire insulation to detect possible shorts to ground.
	Impulse lines	<ul style="list-style-type: none"> ■ Ensure that the pressure connection is correct. ■ Check for leaks or blockage. ■ Check for entrapped gas in liquid service. ■ Check for sediment or debris in the DP transmitter process flange. ■ Ensure that blocking valves are fully open and that bypass valves are tightly closed. ■ Ensure that the density of fluid in impulse lines is unchanged.
	Sensing Element	<ul style="list-style-type: none"> ■ The sensing element is not field repairable and must be replaced if found defective. ■ Disassemble the transmitter and probe further (check Manufacturer's manual for instruction on how to disassemble the transmitter). ■ Check for any obvious defect of the sensing element.
DP Transmitter does not calibrate properly	Pressure source/correction	<ul style="list-style-type: none"> ■ Check for restrictions or leaks. ■ Check for proper leveling or zeroing of the pressure source. ■ Check weights/gauge to ensure proper pressure setting. ■ Determine if pressure source has sufficient accuracy.
	Meter	<ul style="list-style-type: none"> ■ Determine if the meter is functioning properly.
	Power supply	<ul style="list-style-type: none"> ■ Check the power supply output voltage at transmitter.
	DP transmitter electronics	<ul style="list-style-type: none"> ■ Make sure the transmitter connectors are clean. ■ If the electronics are still suspect, replace with new electronics.
	Sensing Element	<ul style="list-style-type: none"> ■ The sensing element is not field repairable and must be replaced if found defective. ■ Disassemble the transmitter and probe further (check Manufacturer's manual for instruction on how to disassemble the transmitter). ■ Check for any obvious defect of the sensing element.
High Output	Primary Element	<ul style="list-style-type: none"> ■ Check for restrictions at primary element.
	Impulse lines	<ul style="list-style-type: none"> ■ Check for leaks or blockage. ■ Check for entrapped gas in liquid service. ■ Check for sediment or debris in the DP transmitter process flange. ■ Ensure that blocking valves are fully open and that bypass valves are tightly closed. ■ Ensure that the density of fluid in impulse lines is unchanged.
	Power supply	<ul style="list-style-type: none"> ■ Check the power supply output voltage at transmitter.
	DP transmitter electronics	<ul style="list-style-type: none"> ■ Make sure the transmitter connectors are clean. ■ If the electronics are still suspect, replace with new electronics.
	Sensing Element	<ul style="list-style-type: none"> ■ The sensing element is not field repairable and must be replaced if found defective. ■ Disassemble the transmitter and probe further (check Manufacturer's manual for instruction on how to disassemble the transmitter). ■ Check for any obvious defect of the sensing element.
Erratic Output	Loop Wiring	<ul style="list-style-type: none"> ■ Check for adequate voltage to the transmitter. ■ Check for intermittent shorts, open circuits and multiple grounds.
	Process pulsation	<ul style="list-style-type: none"> ■ Adjust damping.
	DP transmitter electronics	<ul style="list-style-type: none"> ■ Make sure the transmitter connectors are clean. ■ If the electronics are still suspect, replace with new electronics.
	Impulse lines	<ul style="list-style-type: none"> ■ Check for entrapped gas in liquid lines and for liquid in gas lines.



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