Special Documentation
Proline Prosonic Flow W 400

FlowDC application package
HART

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COMMUNICATION PROTOCOL

Endress+Hauser

People for Process Automation

Table of contents

1 Document information

1.1 Document function

This manual is Special Documentation; it does not replace the Operating Instructions pertaining to the device. It serves as a reference for using the FlowDC function integrated in the measuring device.

1.2 Content and scope

This documentation contains a description of the sensor installation, additional parameters and technical data that are provided with the FlowDC application package.

It provides detailed information on:
• Application-specific parameters
• Advanced technical specifications

1.3 Symbols

1.3.1 Safety symbols

⚠ DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

⚠ WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

1.3.2 Symbols for certain types of Information

Symbol	Meaning
✔	**Permitted** Procedures, processes or actions that are permitted.
✔✔	**Preferred** Procedures, processes or actions that are preferred.
✘	**Forbidden** Procedures, processes or actions that are forbidden.
🛈	**Tip** Indicates additional information.
📖	Reference to documentation
📄	Reference to page
🖼	Reference to graphic
▶	Notice or individual step to be observed

Symbol	Meaning
1. , 2. , 3....	Series of steps
⌐→	Result of a step
A0028662	Operation via local display
A0028663	Operation via operating tool
A0028665	Write-protected parameter

1.3.3   Symbols in graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections

1.4   Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

This Special Documentation is available:
In the Download Area of the Endress+Hauser Internet site: www.endress.com → Downloads

This documentation is an integral part of the following Operating Instructions:

Measuring device	Documentation code
Prosonic Flow W 400	BA02086D

1.5   Registered trademarks

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2 Product features and availability

2.1 Product features

The FlowDC application package provides specific algorithms and device variables for calculating a dynamic correction factor to compensate for flow disturbances due to insufficiently long inlet runs downstream from flow obstructions. This compensates for the measured error generated in the measuring pipe by a disturbance in the velocity profile. In this context, the orientation (circumferential angle) in which the two sensor sets are mounted in relation to the flow disturbance is irrelevant. Other disturbances, such as acoustic disturbances, are not taken into consideration.
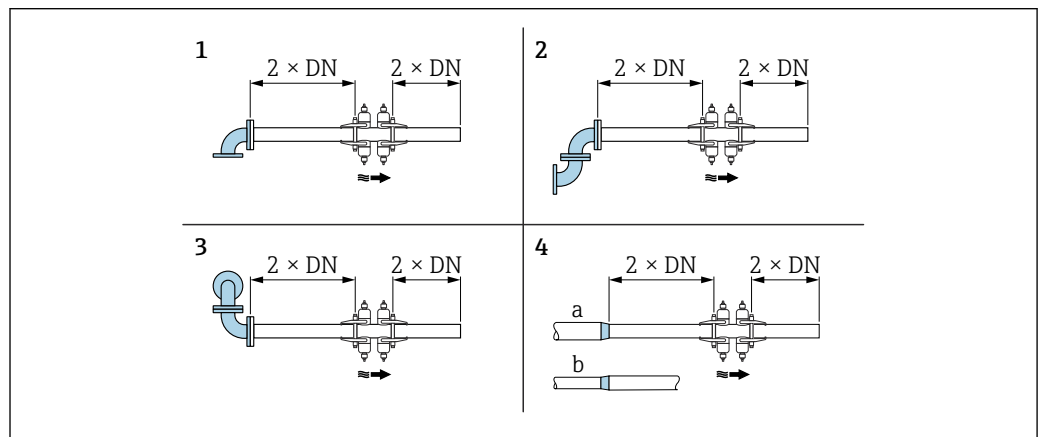
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☑ *1   Minimum inlet and outlet runs with FlowDC with various flow obstructions*

1   Single elbow
2   Double elbow (2× 90° on same plane)
3   Double elbow 3D (2× 90° on different plane)
4a   Concentric diameter change (contraction)
4b   Concentric diameter change (expansion)

ℹ️ Disturbances that are not explicitly listed cannot be compensated.

2.2 Availability

FlowDC is optionally available if a measuring system with two sensor sets is ordered (order code for "Mounting type", option A2 "2 sets"). This also applies if the second sensor set (measuring path) is installed later on and is always available if the **1 measuring point - 2 signal paths** option is set in the **Measuring point configuration** parameter.

ℹ️ Bidirectional measurement: FlowDC is active in the positive flow direction only.

2.2.1 Order code

FlowDC can be ordered via the "Application package" order code, option EN "FlowDC".

2.2.2 Access

The FlowDC correction factor, which is calculated internally, changes dynamically in relation to the Reynolds number and cannot be read out.

3   Configuration of FlowDC

3.1   Overview

The following is a schematic overview of the procedure for configuring the FlowDC application package. The software calculates the appropriate compensation values on the basis of the input measured variables/process variables and the inlet configuration selected.

Input measured variables		
System values		**Process variables**
Reynolds number [1]		Flow velocity

↓

Relative sensor position		
180° 1 traverse [2]: Mount 2 sensor pairs, offset at 180° in relation to one another		90° 2 traverses: Mount 2 sensor pairs, offset at 90° in relation to one another

↓

Inlet configuration				
Off (FlowDC disabled)	Single elbow (1× 90°)	Double elbow (2× 90° on same plane)	Double elbow 3D (2× 90° on different plane)	Concentric diameter change (contraction/expansion)
				↓
				Inlet diameter
				Transition length

↓

Inlet run
Distance between the flange outlet area of the disturbance point and the mounting point (screw of the sensor holder) closest to the disturbance in [mm (in)]

↓

Output measured variables		
Process variables		
Volume flow	Mass flow	Flow velocity

↑

User-specific entries Measurement mode

1)   Depends on the kinematic viscosity, the average flow velocity calculated and the internal diameter of the measuring pipe
2)   2 traverses also possible in the case of the 5 MHz sensor

3.2 Parameter overview

FlowDC based on the compensation of an additional measured error that occurs as a result of a defined flow disturbance and the distance between the measuring point and this disturbance. The following selection parameters are available for this purpose.

3.2.1 Measuring point settings: standard parameters

Navigation
"Setup" menu → Measuring point

► Measuring point 1	
Measuring point configuration (5675–1)	→ 🖹 8
Pipe outer diameter (2910–1)	→ 🖹 8
Pipe wall thickness (2916–1)	→ 🖹 8
Sensor type (2924–1)	→ 🖹 8
Mounting type (2938–1)	→ 🖹 9
Relative sensor position (2985–1)	→ 🖹 9

Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
Measuring point configuration	–	Select configuration for the measuring point.	• 1 measuring point - signal path 1 • 1 measuring point - signal path 2 * • 1 measuring point - 2 signal paths *	Depending on the sensor version
Pipe outer diameter	The **Diameter** option is selected in the **Pipe dimensions** parameter.	Define the outer diameter of the pipe.	10 to 5 000 mm	100 mm
Pipe wall thickness	–	Enter the pipe wall thickness.	Positive floating point number	3 mm
Sensor type	–	Select sensor type.	• C-030-A • C-050-A • C-100-A • C-100-B • C-100-C • C-200-A • C-200-B • C-200-C • C-500-A	As per order

Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
Mounting type	–	Select how the sensors are arranged to each other. • **(1) direct** option: sensor arrangement with 1 traverse • **(2) V-mounting** option: sensor arrangement with 2 traverses • **(3) Z-Mounting** option: sensor arrangement with 3 traverses • **(4) W-mounting** option: sensor arrangement with 4 traverses	• (1) direct • (2) V-mounting • (3) Z-Mounting • (4) W-mounting • Automatic	Automatic
Relative sensor position	The **1 measuring point - 2 signal paths** option is selected in the **Measuring point configuration** parameter.	Shows the correct position for the sensor. Describes the relative position of sensor set 1 to sensor set 2. The relative sensor position is automatically derived from the number of traverses. From the position permitted for FlowDC, the result is 180° for 1 traverse-type mounting and 90° for 2 traverse-type mounting.	• 90° • 180°	–

*   Visibility depends on order options or device settings

3.2.2   Measuring point settings: FlowDC parameters

Navigation
"Setup" menu → Measuring point

▶ **Measuring point 1**

       FlowDC inlet configuration (3049–1)   → 🗎 10

       Inlet diameter (3054–1)   → 🗎 10

   Transition length (3065–1)   → 🗎 10

       Inlet run (3050–1)   → 🗎 10

Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry
FlowDC inlet configuration	• The **1 measuring point - 2 signal paths** option is selected in the **Measuring point configuration** parameter. • Order code for "Application package", option EN "FlowDC" has been purchased.	Select FlowDC inlet configuration. Type of inlet run, which may cause a flow disturbance.	• Off • Single elbow • Double elbow • Double elbow 3D • Concentric diameter change
Inlet diameter	• The **1 measuring point - 2 signal paths** option is selected in the **Measuring point configuration** parameter. • The **Concentric diameter change** option is selected in the **Inlet configuration** parameter.	Enter the outer diameter of the pipe before the cross-section change. For convenience, the same measuring pipe wall thickness as for the clamp-on system is applied.	1 to 10 000 mm
Transition length	• In the **Measuring point configuration** parameter, the **1 measuring point - 2 signal paths** option is selected. • In the **Inlet configuration** parameter, the **Concentric diameter change** option is selected.	Enter length of the concentric diameter change.	0 to 20 000 mm
Inlet run	The **1 measuring point - 2 signal paths** option is selected in the **Measuring point configuration** parameter.	Enter length of the available straight inlet run. Distance of the sensor to the flow disturbance point (e.g. **Single elbow** option). Distance between the flange outlet area of the disturbance point and the mounting point (screw of the sensor holder) closest to the disturbance in [mm (in)].	0 to 50 000 mm

3.2.3   Process variables

Navigation

"Expert" menu → Sensor → Measured values → Process variables

► Process variables	
Volume flow (1838)	→ 🖹 11
Mass flow (1847)	→ 🖹 11
Flow velocity (1852)	→ 🖹 11
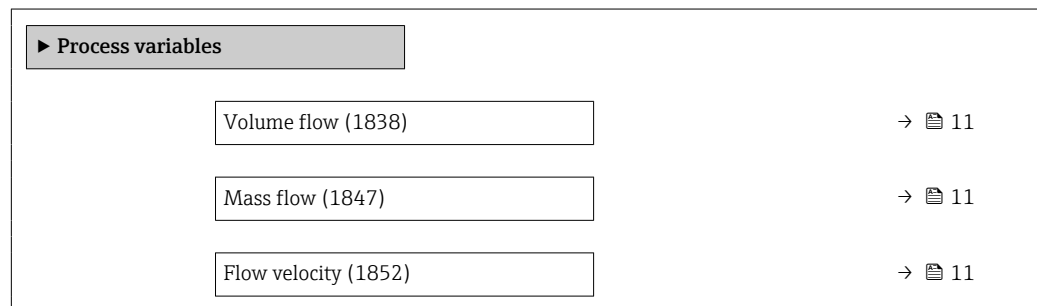
Parameter overview with brief description

Parameter	Description	User interface
Volume flow	Displays the volume flow that is currently measured. *Dependency* The unit is taken from: **Volume flow unit** parameter	Signed floating-point number
Mass flow	Displays the mass flow that is currently calculated. *Dependency* The unit is taken from the **Mass flow unit** parameter.	Signed floating-point number
Flow velocity	Displays the average flow velocity that is currently calculated. *Dependency* The unit is taken from: **Velocity unit** parameter	Signed floating-point number

3.2.4   System variables

Navigation
"Expert" menu → Sensor → Measured values → System values

▶ System values	
Reynolds number (2908)	→ 🗎 11
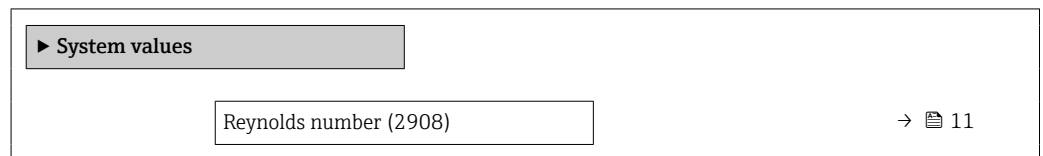
Parameter overview with brief description

Parameter	Description	User interface
Reynolds number	Displays the Reynolds number.	Positive floating point number

3.2.5   Output measured variables

FlowDC affects existing output measured variables:
- Volume flow
- Mass flow
- Flow velocity

FlowDC is active if the option selected in the **Inlet configuration** parameter is not equal to **Off** option.

3.2.6   User-specific entries

User-specific entries can be made for the following parameters:
- Inlet configuration
  and for the **Concentric diameter change** option
- Inlet diameter
- Transition length
- Inlet run

3.3   Types of disturbance

To attain the specified level of accuracy, ultrasonic transit time flowmeters require an inlet run that is sufficiently long. If this is not available, unfavorable flow profiles can form in the measuring pipe and falsify the measured value. The causes of these flow disturbances are referred to as "types of disturbance" in the following section and can be configured using the software parameters during the device configuration.

3.3.1   Single elbow (1× 90°)

The **Single elbow** option causes the measuring pipe containing medium to deflect by 90°
in a certain direction. The measuring pipe is straight before and after the elbow.
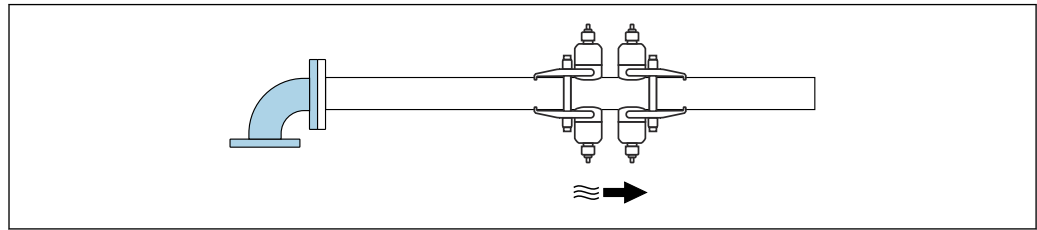
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### 3.3.2   Double elbow (2× 90° on same plane)

The **Double elbow** option (2× 90° on same plane) causes the measuring pipe containing
medium to deflect twice by 90° in opposite directions on the same plane. An S-shaped
deflection is formed. The measuring pipe is straight before and after the elbow.
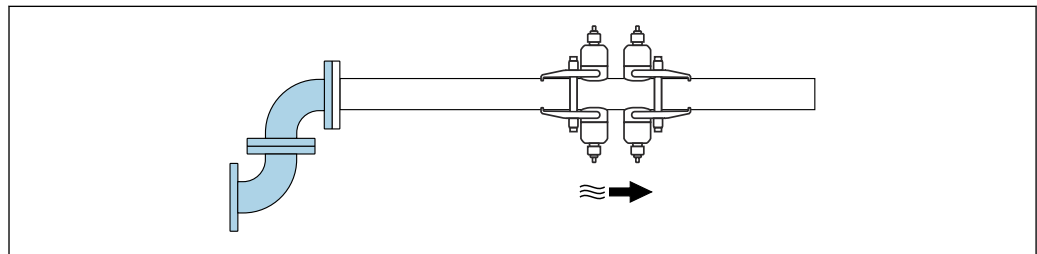
A0044674

3.3.3   Double elbow 3D (2× 90° on different plane)

The **Double elbow 3D** option (2× 90° on different plane) diverts the measuring pipe
through which there is flow twice by 90° on different planes in each case (X, Y, Z). This
results in a measuring pipe arrangement along all three axes of the spatial dimension. The
measuring pipe is straight before and after the elbow.
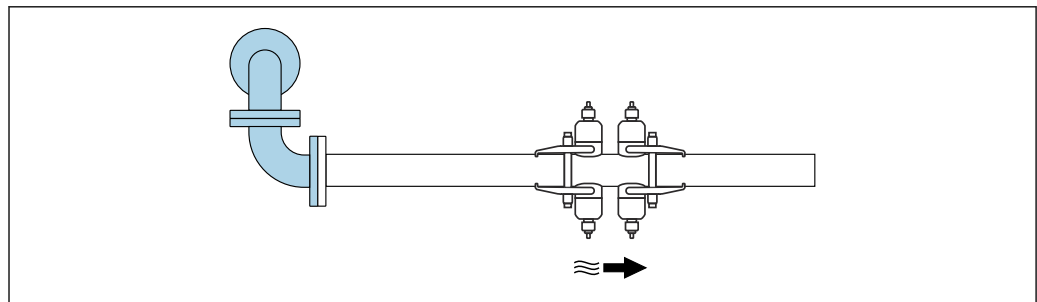
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3.3.4   Concentric diameter change (contraction/expansion)

The **Concentric diameter change** option refers either to a continuous contraction
(narrowing of the diameter) or expansion (widening of the diameter). FlowDC can
compensate for both variants with a rise angle α of 1 to 40° and a diameter ratio (Pipe
inner diameter/Inlet diameter) of 0.01 to 2.70. A stepped change in the diameter cannot
be corrected using FlowDC.

The following information is also required to sufficiently describe this type of disturbance:
- External diameter of measuring pipe upstream from change (**Pipe outer diameter** parameter)
- Section over which the diameter of the measuring pipe changes (**Transition length** parameter)
- Diameter ratio = Diameter downstream from disturbance (sensor)/diameter upstream from disturbance (inlet)
  - Min = 0.01
  - Max = 2.70
- Rise angle α = atan [(Pipe outer diameter - Inlet diameter)/(2 * Transition length)]
  - Min = 1°
  - Max = 40°

For convenience, the measuring pipe wall thickness is taken to be the same as that after the concentric disturbance.
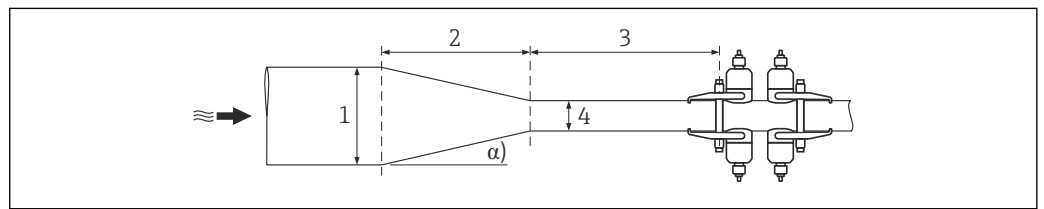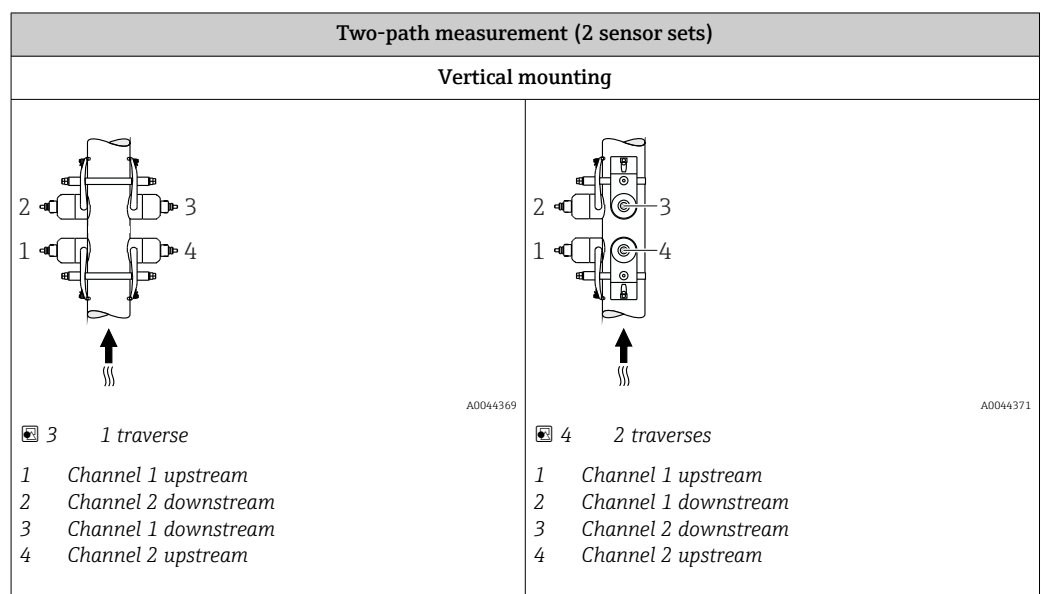

🖼 *2   Concentric diameter change*

1   Inlet diameter
2   Transition length
3   Inlet run
*4   Pipe inner diameter (Pipe outer diameter - 2*Pipe wall thickness)*
α   Rise angle
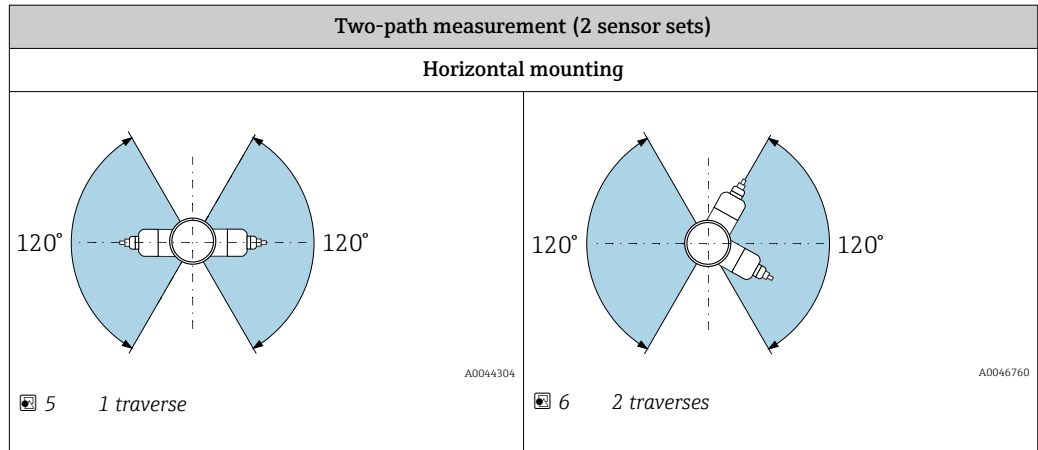
3.4   Commissioning

The FlowDC function option is only possible for two-path measurement (operation of 2 sensor sets). In addition, these sets must be arranged in a defined sensor position (90° or 180°) in relation to one another. The orientation of the two sensor sets, i.e. the circumferential angle in relation to the flow disturbance, is irrelevant.

3.4.1   Sensor positioning

Two-path measurement (2 sensor sets)
Vertical mounting

🖼 *3   1 traverse*

1   Channel 1 upstream
2   Channel 2 downstream
3   Channel 1 downstream
4   Channel 2 upstream

🖼 *4   2 traverses*

1   Channel 1 upstream
2   Channel 1 downstream
3   Channel 2 downstream
4   Channel 2 upstream

| Two-path measurement (2 sensor sets) |
|---|
| Horizontal mounting |

▣ 5	1 traverse	▣ 6	2 traverses

3.4.2 Distance from sensor to disturbance point (Inlet run)

The distance from the sensor to the disturbance point (e.g. Single elbow) is defined as the distance between the flange outlet area of the disturbance point closest to the sensor and the mounting point (screw of the sensor holder) closest to the disturbance.
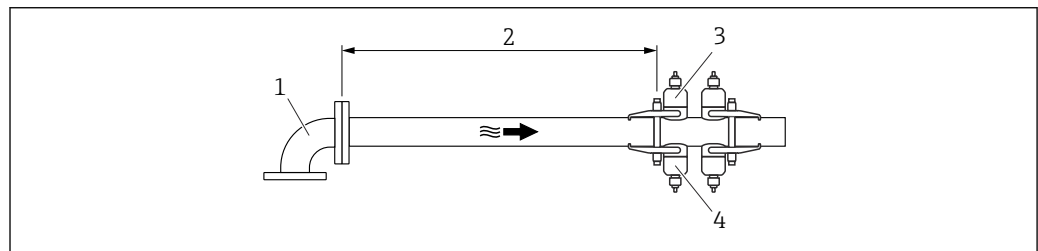
▣ 7   Inlet run

1   Disturbance point
2   Inlet run
3   Sensor channel 1 upstream
4   Sensor channel 2 upstream

3.4.3 Configuring the measuring device

Configuration of the measuring device with the existing flow disturbance selected.

1. Configuration of the standard parameters: select the option in the **Pipe outer diameter** parameter, **Pipe wall thickness** parameter, **Sensor type** parameter, **Mounting type** parameter and **Relative sensor position** parameter→ 🖺 8.

2. Configuration of the FlowDC parameters: select the option in the **Inlet configuration** parameter, **Concentric diameter change** option, **Inlet diameter** parameter, **Transition length** parameter and **Inlet run** parameter→ 🖺 9.

3.5   Application examples

The application examples, with a step-by-step description, help users to perform the FlowDC configuration of the measuring device.

3.5.1   Single elbow (1× 90°), 1 traverse

1. Mount the two sensor sets for a single-traverse measurement at an angle of 180° to one another .

2. Configure/check the standard parameters → 🕮 8.

3. In the **Inlet configuration** parameter, select the **Single elbow** option.

4. In the **Inlet run** parameter, enter the distance to the disturbance point.
   ↳ FlowDC is now active and the measuring device is within the specified accuracy level despite the short inlet run.

3.5.2   Concentric diameter change (contraction/expansion), 2 traverses

1. Mount the two sensor sets for a double-traverse measurement at an angle of 90° to one another (180° for sensor set C-500-A) .

2. Configure/check the standard parameters → 🕮 8.

3. In the **Inlet configuration** parameter, select the **Concentric diameter change** option.

4. In the **Inlet diameter** parameter, enter the external diameter of the measuring pipe upstream from the change in cross-section.

5. In the **Transition length** parameter, enter the length of the concentric diameter change.

6. In the **Inlet run** parameter, enter the distance to the disturbance point.
   ↳ FlowDC is now active and the measuring device is within the specified accuracy level despite the short inlet run.

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