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01.00.zz (Device firmware)

Special Documentation
Proline Prosonic Flow W 400

FlowDC application package
Modbus RS485

Endress+Hauser
People for Process Automation

Table of contents

1 About this document

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.
	**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

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:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

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

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

Measuring device	Documentation code
Prosonic Flow W 400	BA02302D

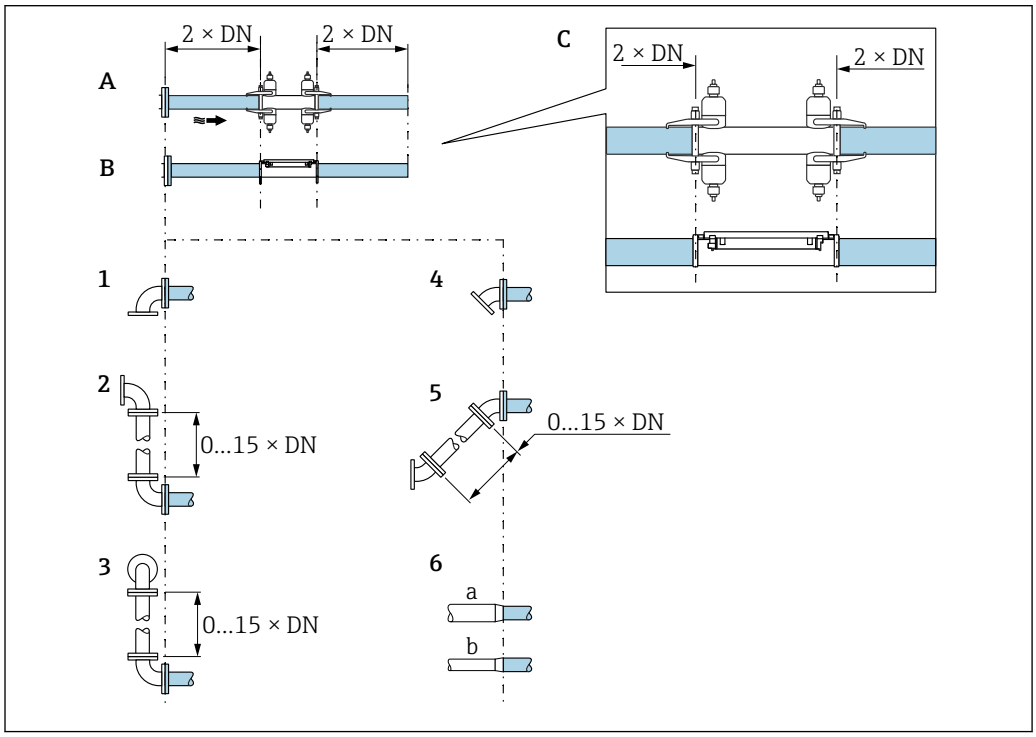
1.5 Registered trademarks

Modbus®
Registered trademark of SCHNEIDER AUTOMATION, INC.

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 measuring 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.



1

A Inlet and outlet runs DN 50 to 4000 (2" to 160")
B Inlet and outlet runs DN 15 to 65 (½" to 2½")
C Position for measuring the inlet and outlet run length on the sensor
1 Single elbow
2 Double elbow (2 × 90° in the same plane, with 0–15 x DN intermediate pipe between the elbows)
3 Double elbow 3D (2 × 90° in different planes, with 0–15 x DN intermediate pipe between the elbows)
4 45° bend
5 "2 x 45° bend" option (2 × 45° in the same plane, with 0–15 x DN intermediate pipe between the elbows)
6a Concentric diameter change (contraction)
6b Concentric diameter change (expansion)

Disturbances that are not explicitly listed cannot be compensated.

2.2 Availability

FlowDC is available as an option if a measuring system with two sensor sets is ordered. 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.

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

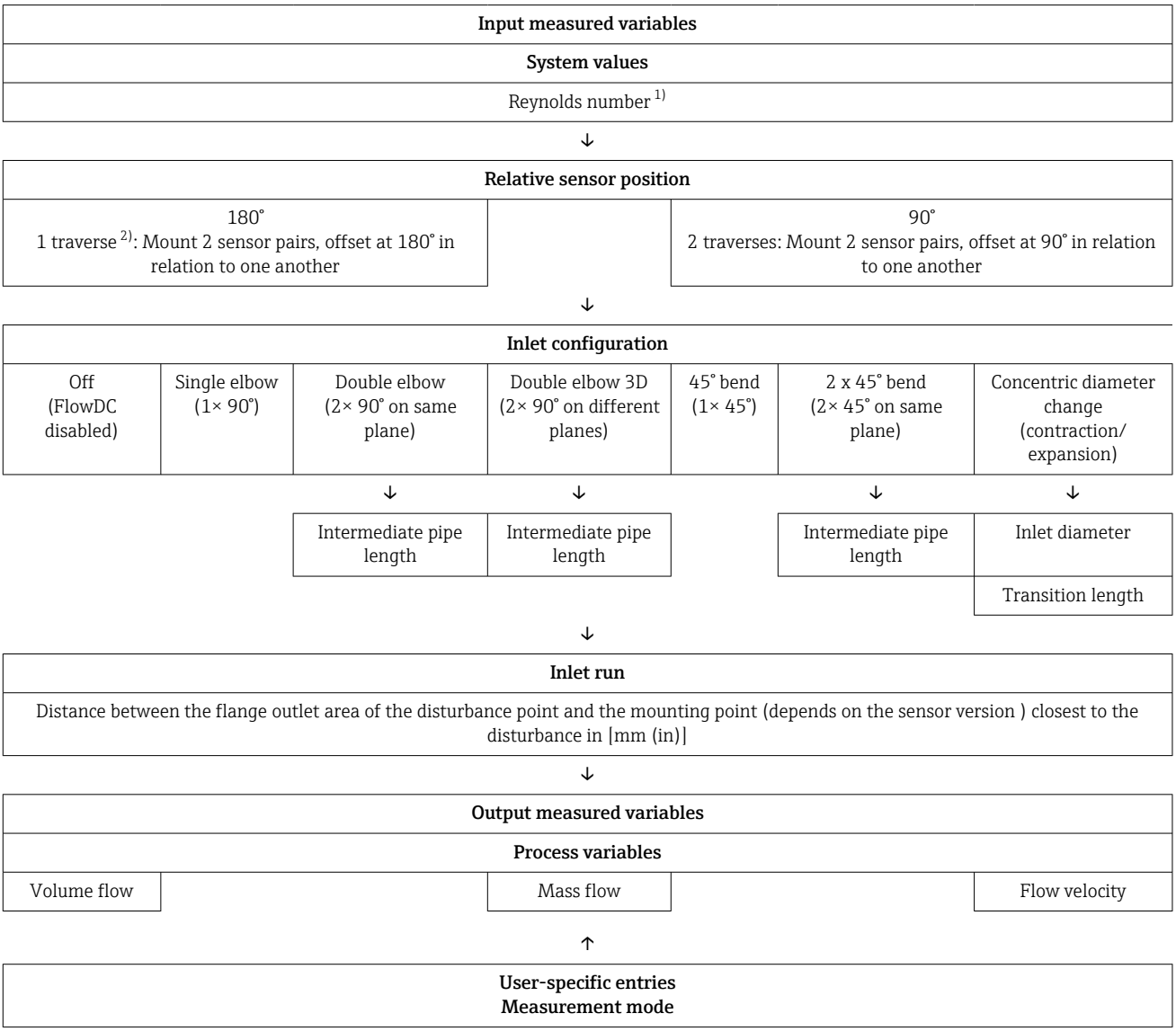
2.2.1 Access

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.



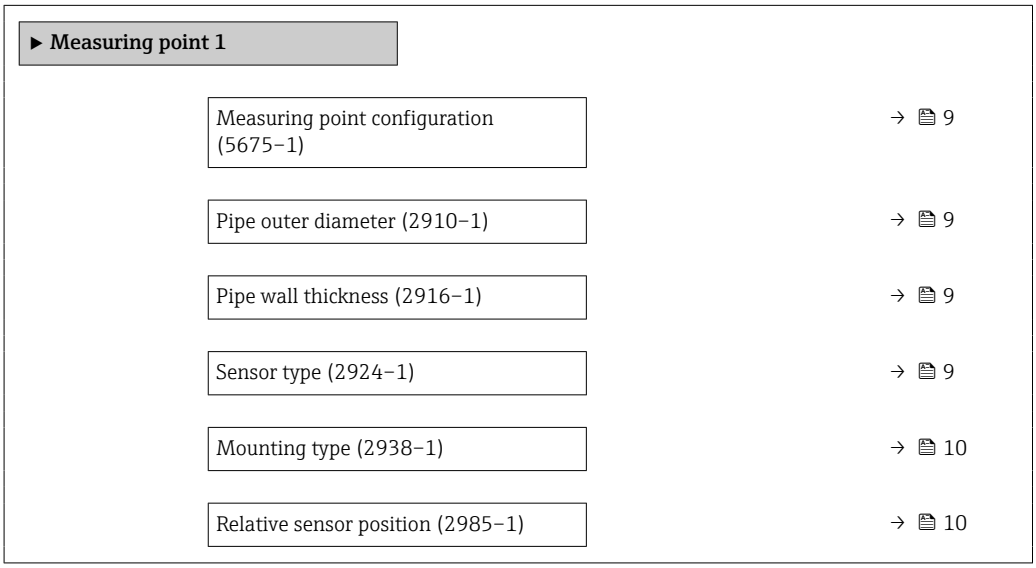
1) Depends on the kinematic viscosity, the average flow velocity calculated and the internal diameter of the measuring pipe
2) 2 traverses are also possible in the case of the 5 MHz sensor

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
"Expert" menu → Sensor → Measuring point 1



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 **Pipe dimensions** parameter.	Define the outer diameter of the pipe.	0 to 20 000 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

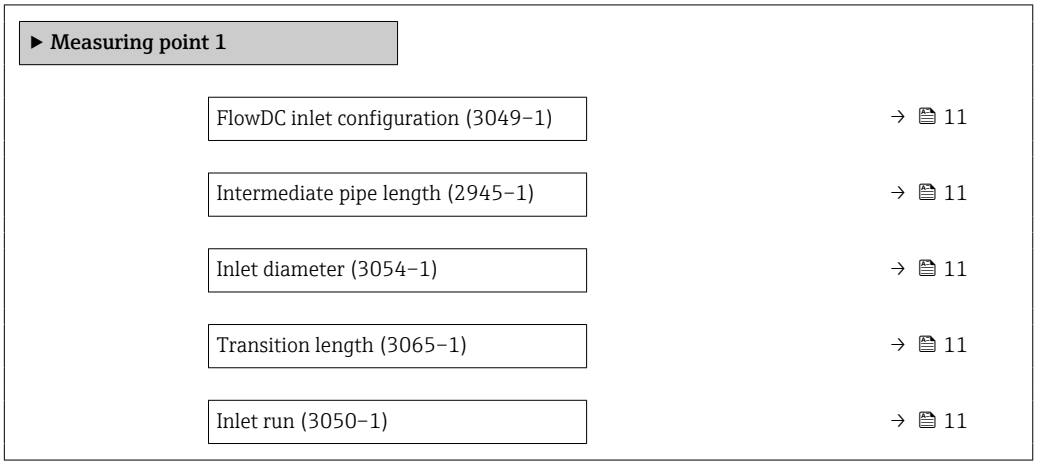
Parameter	Prerequisite	Description	Selection / User entry / User interface	Factory setting
Mounting type	–	Select the number of traverses (number of times the signal passes through the medium). ▪ **(1) direct** option: Sensor arrangement with 1 traverse ▪ **(2) V-mounting** option: Sensor arrangement with 2 traverses ▪ **(3) Z-Mounting** option: Sensor arrangement with 3 traverses ▪ **(4) W-mounting** option: Sensor arrangement with 4 traverses	▪ 1 traverse ▪ 2 traverses ▪ 3 traverses ▪ 4 traverses ▪ Automatic	Automatic
Relative sensor position	The **1 measuring point - 2 signal paths** option is selected in the **Measuring point configuration** parameter and the **Off** option is not selected in **FlowDC inlet 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

"Expert" menu → Sensor → Measuring point 1



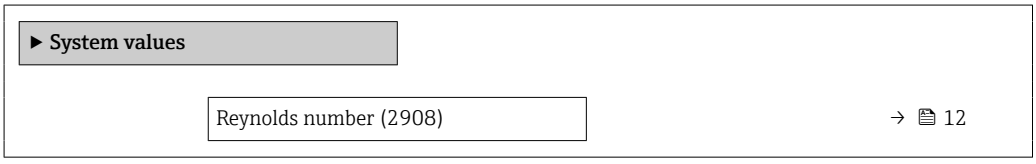
Parameter overview with brief description

Parameter	Prerequisite	Description	Selection / User entry	Factory setting
FlowDC inlet configuration	The **1 measuring point - 2 signal paths** option is selected in **Measuring point configuration** parameter.	Select FlowDC inlet configuration. Type of inlet run, which may cause a flow disturbance.	▪ Off ▪ Single elbow ▪ Double elbow ▪ Double elbow 3D ▪ 45° bend ▪ 2 x 45° bend ▪ Concentric diameter change ▪ Other *	Off
Intermediate pipe length	The **1 measuring point - 2 signal paths** option is selected in **Measuring point configuration** parameter.	Enter the length of the intermediate pipe between the two bends.	Positive floating-point number	0 mm
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	88.9 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	0 mm
Inlet run	The **1 measuring point - 2 signal paths** option is selected in **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 (depends on the sensor version) closest to the disturbance in [mm (in)].	0 to 300 000 mm	0 mm

* Visibility depends on order options or device settings

3.2.3 System variables

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



Parameter overview with brief description

Parameter	Description	User interface
Reynolds number	Displays the Reynolds number.	Positive integer

3.2.4 Output measured variables

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

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

3.2.5 User-specific entries

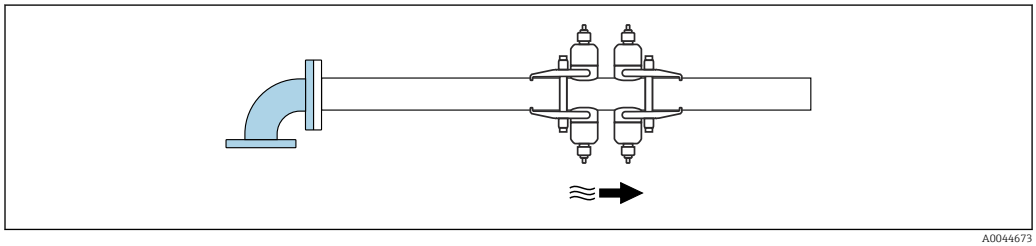
User-specific entries can be made for the following parameters:
- Inlet configuration
- Concentric diameter change
- Inlet diameter
- Transition length
- Inlet run

3.3 Types of disturbance

To attain the specified level of accuracy, ultrasonic 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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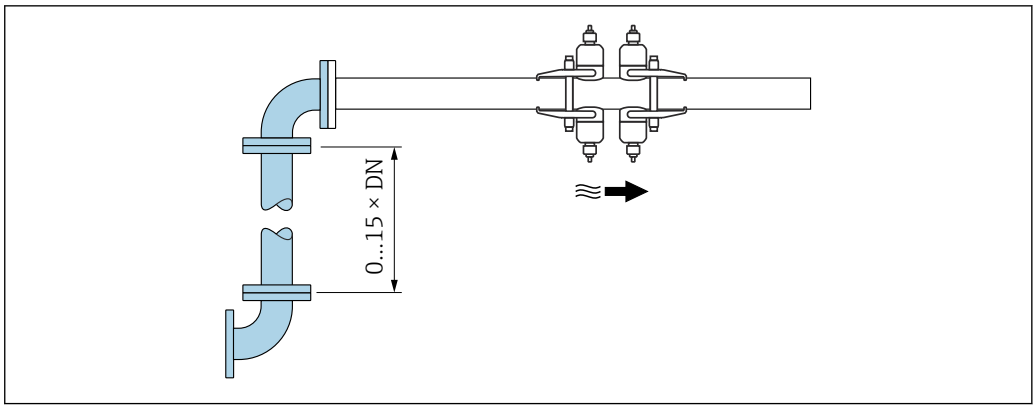
3.3.2 Double elbow (2× 90° on same plane)

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. Intermediate pipe length: 0 to 15 x DN between the elbows.



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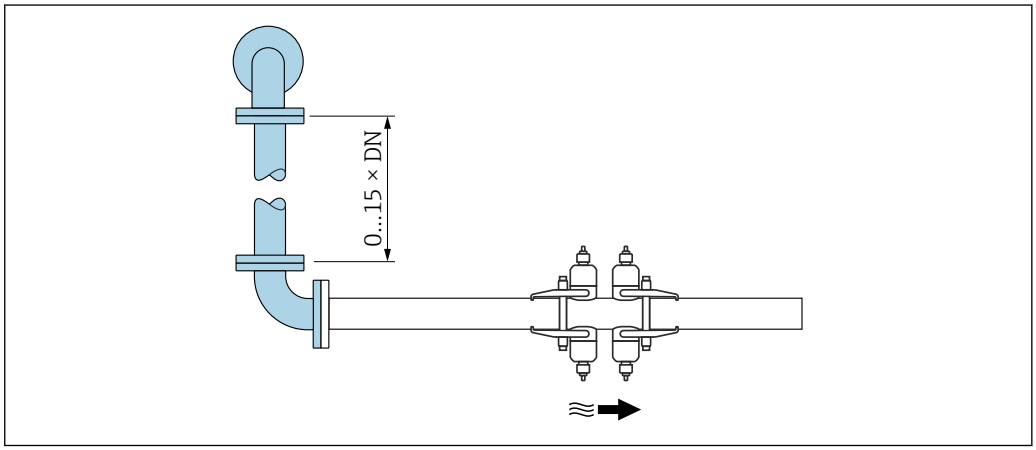
3.3.3 Double elbow 3D (2× 90° on different plane)

The **Double elbow 3D** option (2× 90° on different plane) causes the measuring pipe containing medium to deflect twice by 90° in different planes (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. Intermediate pipe length: 0 to 15 x DN between the elbows.



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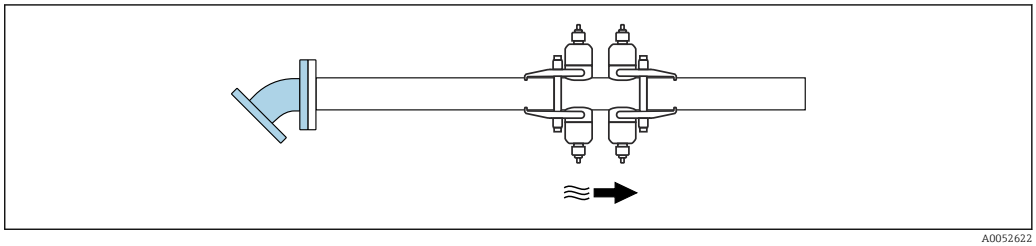
3.3.4 "45° bend" option

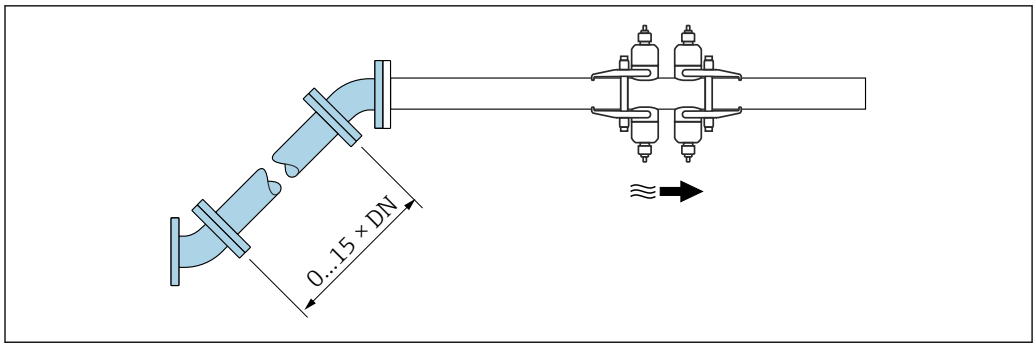
The **45° bend** option causes the measuring pipe containing medium to deflect by 45° in a certain direction. The measuring pipe is straight before and after the elbow.



A0052622

3.3.5 "2 x 45° bend" option (2× 45° on same plane)

The **2 x 45° bend** option (2× 90° on same plane) causes the measuring pipe containing medium to deflect twice by 45° in opposite directions on the same plane. An S-shaped deflection is formed. The measuring pipe is straight before and after the elbow. Intermediate pipe length: 0 to 15 x DN between the elbows.



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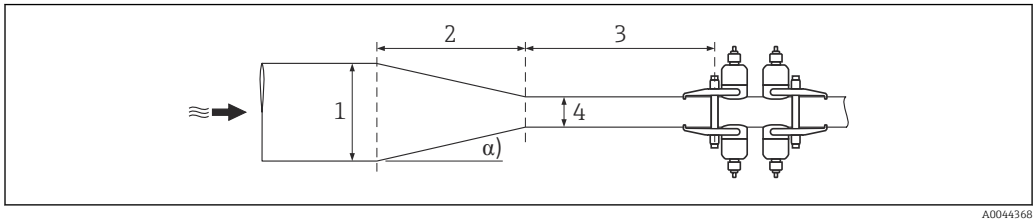
3.3.6 Concentric diameter change (contraction/expansion)

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 versions with an angle of inclination α of 1 to 40 ° and a diameter ratio (Pipe inner diameter/Inlet diameter → 2, 14) 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:
- Measuring pipe outer diameter before the change (**Pipe outer diameter** parameter)
- Length over which the measuring pipe diameter has changed (**Transition length** parameter)
- Diameter ratio = Diameter after disturbance (sensor)/diameter before disturbance (inlet)
  - Min. = 0.01
  - Max. = 2.70
- Angle of inclination α = atan [(Inlet diameter - Pipe outer 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.



A0044368

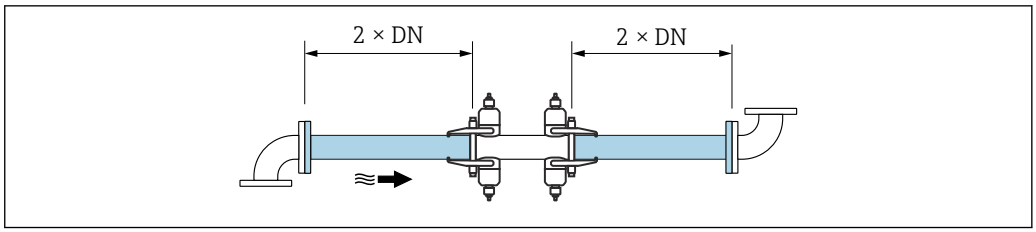
2 *Concentric diameter change*

1 Inlet diameter
2 Transition length
3 Inlet run
*4 Pipe inner diameter (Pipe outer diameter - 2*Pipe wall thickness)*
α Angle of inclination

3.4 Commissioning

The optional FlowDC function is only possible for two-path measurements (operation of two 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.

Mounting on the intermediate pipe is preferred if the intermediate pipes are sufficiently long (→ 3, 15) and there is enough space to mount the clamp-on sensors.



3 *Example for mounting on the intermediate pipe for a Double elbow.*

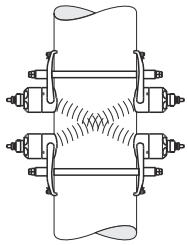
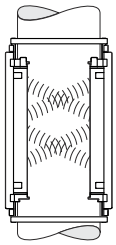
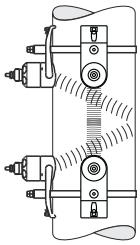
3.4.1 Sensor positioning

If mounting horizontally, always mount the sensor set so that it is offset at an angle of ±30° to the top of the measuring pipe to avoid incorrect measurements caused by gas pockets or bubbles at the top of the pipe.

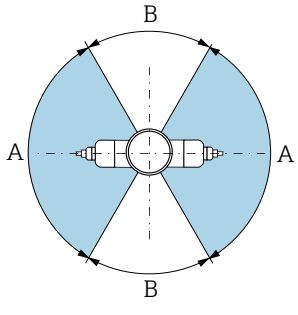
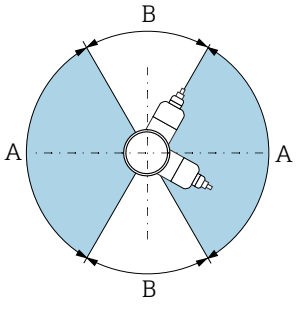
The sensors can be arranged in different ways:
- Mounting arrangement for measurement with one sensor set (one measuring path):
  - The sensors are located on opposite sides of the measuring pipe (offset by 180°): Measurement with one or three traverses
  - The sensors are located on the same side of the measuring pipe: Measurement with two or four traverses
- Mounting for measurement with two sensor sets [1] (two measuring paths):
  - One sensor of each sensor set is located at the opposite side of the measuring pipe (offset by 180°): Measurement with one or three traverses
  - The sensors are located on the same side of the measuring pipe: Measurement with two or four traverses

  The sensor sets are arranged on the measuring pipe, offset by 90°.

Using 5 MHz sensors
Here, the rails of the two sensor sets are always arranged at an angle of 180° to one another for all measurements with one, two, three or four traverses. The sensor functions are assigned in the two rails via the transmitter electronics unit depending on the selected number of traverses. It is not necessary to swap the cables in the transmitter between the channels.

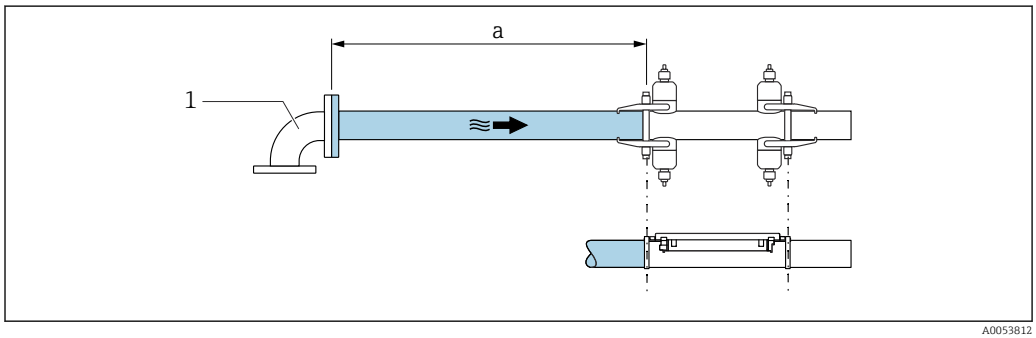
Two-path measurement (two sensor sets)		
Vertical mounting		
 A0042016	 A0053773	 A0042017
4 *180° relative sensor position (1 traverse)*	5 *180° relative sensor position (2 traverses)*	6 *90° relative sensor position (2 traverses)*

1) Do not swap the sensors of the two sensor sets, as this can affect the measurement performance.

Two-path measurement (two sensor sets)	
Horizontal mounting	
 A0053777	 A0053776
7 180° relative sensor position (1 traverse) A 120° recommended installation range B 60° installation range not recommended	8 90° relative sensor position (2 traverses) A 120° recommended installation range B 60° installation range not recommended

3.4.2 Distance from sensor to disturbance point (Inlet run)

The distance from the sensor to the flow 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 (depends on the sensor version) closest to the disturbance.



A0053812

9 Inlet run

1 Disturbance point
a Inlet run

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, and **Mounting type** parameter.→ 9
2. Configuration of the FlowDC parameters: Select the option in the **Inlet configuration** parameter, and **Inlet run** parameter. Enter the value for the **Concentric diameter change** option in the **Inlet diameter** parameter and **Transition length** parameter. Enter the value for the **2 x 45° bend** option, **Double elbow** option, and **Double elbow 3D** option in the **Intermediate pipe length** parameter. → 10.

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 → 9.
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 → 9.
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.

4 Modbus RS485 register information

4.1 Notes

4.1.1 Structure of the register information

The individual parts of a parameter description are described in the following section:

Navigation: navigation path to the parameter					
Parameter	**Register**	**Data type**	**Access type**	**User interface/ Selection/User entry**	**→**
Name of parameter	Indicated in decimal numerical format	▪ Float length = 4 byte ▪ Integer length = 2 byte ▪ String length, depending on parameter	Possible type of access to parameter: ▪ Read access via function codes 03, 04 or 23 ▪ Write access via function codes 06, 16 or 23	**Options** List of the individual options for the parameter ▪ Option 1 ▪ Option 2 ▪ Option 3 (+) (+) = Factory setting depends on country, order options or device settings **User entry** Specific value or input range for the parameter	Page number information and cross-reference to the standard parameter description

NOTICE

If non-volatile device parameters are modified via the MODBUS RS485 function codes 06, 16 or 23, the change is saved in the EEPROM of the measuring device.

The number of writes to the EEPROM is technically restricted to a maximum of 1 million.

- ▶ Make sure to comply with this limit since, if it is exceeded, data loss and measuring device failure will result.
- ▶ Avoid constantly writing non-volatile device parameters via the MODBUS RS485.

4.1.2 Address model

The Modbus RS485 register addresses of the measuring device are implemented in accordance with the "Modbus Applications Protocol Specification V1.1".

In addition, systems are used that work with the register address model "Modicon Modbus Protocol Reference Guide (PI-MBUS-300 Rev. J)".

Depending on the function code used, a number is added at the start of the register address with this specification:

- "3" → "Read" access
- "4" → "Write" access

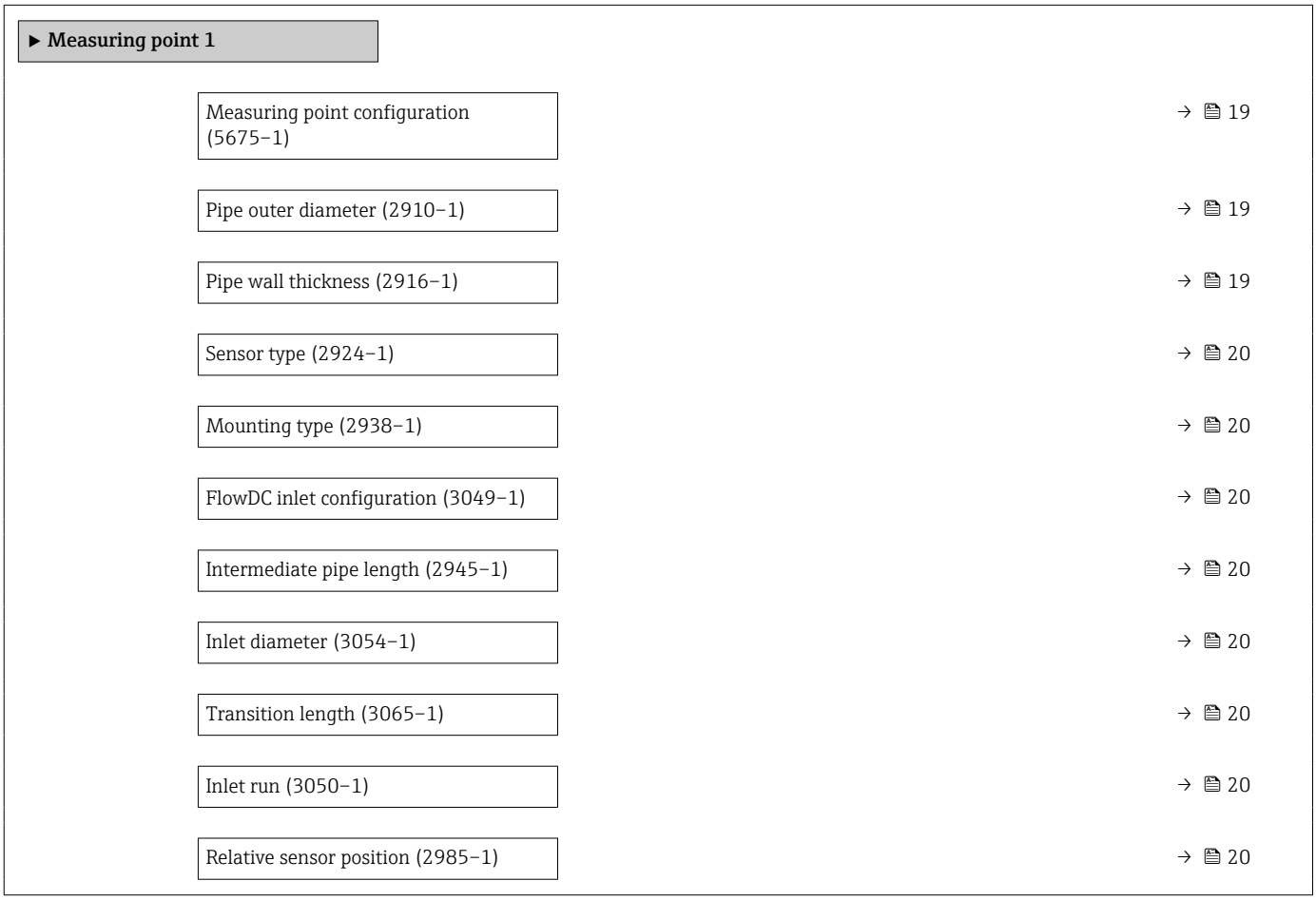
Function code	Access type	Register in accordance with "Modbus Applications Protocol Specification"	Register in accordance with "Modicon Modbus Protocol Reference Guide"
03 04 23	Read	XXXX Example: mass flow = 2007	3XXXX Example: mass flow = 32007
06 16 23	Write	XXXX Example: reset totalizer = 6401	4XXXX Example: reset totalizer = 46401

4.2 Overview of the Expert operating menu

The following table provides an overview of the menu structure of the expert operating menu and its parameters. The page reference indicates where the associated description of the submenu or parameter can be found.

4.2.1 Measuring point settings

Navigation
"Expert" menu → Sensor → Measuring point 1



4.2.2 Register information

Navigation: Measuring point 1					
Parameter	**Register**	**Data type**	**Access**	**Selection / User entry / User interface**	**→**
Measuring point configuration (5675–1)	4285	Integer	Read / Write	0 = 1 measuring point - signal path 1 1 = 1 measuring point - 2 signal paths * 2 = 1 measuring point - signal path 2 *	9
Pipe outer diameter (2910–1)	4971 to 4972	Float	Read / Write	0 to 20 000 mm	9
Pipe wall thickness (2916–1)	4975 to 4976	Float	Read / Write	Positive floating point number	9

Navigation: Measuring point 1					
Parameter	**Register**	**Data type**	**Access**	**Selection / User entry / User interface**	→ 🖹
Sensor type (2924–1)	4928	Integer	Read / Write	0 = C-030-A 0 = C-050-A 0 = C-100-A 0 = C-100-B 0 = C-100-C 0 = C-200-A 0 = C-200-B 0 = C-200-C 0 = C-500-A	9
Mounting type (2938–1)	4998	Integer	Read / Write	1 = 1 traverse 2 = 2 traverses 3 = 3 traverses 4 = 4 traverses 250 = Automatic	10
FlowDC inlet configuration (3049–1)	21570	Integer	Read / Write	**0 = Off** 1 = Single elbow 2 = Double elbow 3 = Double elbow 3D 4 = Concentric diameter change 5 = 45° bend 6 = 2 x 45° bend 22 = Other *	11
Intermediate pipe length (2945–1)	32808 to 32809	Float	Read / Write	Positive floating-point number	11
Inlet diameter (3054–1)	36730 to 36731	Float	Read / Write	1 to 10 000 mm	11
Transition length (3065–1)	27608 to 27609	Float	Read / Write	0 to 20 000 mm	11
Inlet run (3050–1)	36023 to 36024	Float	Read / Write	0 to 300 000 mm	11
Relative sensor position (2985–1)	5122	Integer	Read	90 = 90° 180 = 180°	10

* Visibility depends on order options or device settings
* Visibility depends on order options or device settings

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