FLEXMAG 4050 C

Technical Datasheet

Single use electromagnetic flowmeter

- Factory calibrated, high accuracy
- Available in 5 sizes from ¼ inch to 1 inch
- Wetted material gamma sterilizable up to 50 kGy, FDA and Class VI compliant

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1.1 Single use electromagnetic flow meter for high measuring accuracy

The **FLEXMAG 4050 C** is the first electromagnetic transmitter that features a disposable flow tube and consists of two parts, a transmitter and a flow tube.
It is designed specifically for single-use Bio-Pharmaceutical applications such as filtration processes, chromatography, or buffer and media preparation.

The transmitter is integrated in a system and connected to the control system, or connected to a display. It is provided with pre-set maximum flow values. The disposable flow tube is produced and packed in a cleanroom and is provided with a pre-determined calibration factor, which is determined by batching calibration.

The flow tube is meant to be installed in flow kit assembly that can be Gamma sterilized. When the assembly is installed into the machine, the flow-tube is inserted into the transmitter. The transmitter is ready to use after setting the k factor of the tube into the control system.

As an electromagnetic meter, the FLEXMAG 4050 C will not drift over time. It provides a completely stable, direct and accurate volumetric flow measurement, unaffected by fluid properties such as density, viscosity or conductivity (> 20 µS/cm).

① Transmitter construction
② Sealed electronics with M12 connector
③ Clamp-in design
④ Separate flow tubes

Highlights

- Disposable/single-use flow tube (packed in double sealed individual pouches)
- One transmitter fits 2 diameters of tubes (3/8-½ inch and ¾-1 inch)
- Accuracy: 1% of measured value
- Full bore (no obstructions) flow path/low pressure drop
- Pulse and current output
- Factory calibrated. No recalibration needed
- No maintenance required
- Flow path minimizes hold up volume
- Wetted parts materials made from biocompatible material (FDA, USP VI, BSE/TSE free)
- The flow tube is gamma sterilizable up to 50 kGy and autoclavable

Industries

- Bio-Pharmaceutical Industry

Applications

- Normal filtration
- Tangential flow filtration (Cross flow filtration)
- Chromatography
- Buffer and media preparation
- General monitoring and control of fluid transfer

1.2 Product features

Highest accuracy without recalibration

Thanks to the electromagnetic principle and the manufacturing precision of the flow tube, the FLEXMAG 4050 C transmitter provides a highly accurate measurement with outstanding repeatability.

The transmitter is factory calibrated and each flow tube is provided with a specific pre-determined calibration factor to implement in the control system. The precision manufacturing of the flow tubes eliminates the need of individual calibration.
The transmitter and the flow tube do not require on-site calibration.

A flexible transmitter

The tubes sizes 3/8 and ½ inch are mounted with the medium transmitter and the tubes sizes 3/4 and 1 inch are mounted with the large transmitter, providing the flexibility of two different flow ranges by a simple exchange of the tube without the need of recalibration.

Flow tube sizes available:

- ID ¼" : 0.015...3 l/min
- ID $^3/_8$" : 0.07...14 l/min
- ID ½" : 0.1... 20 l/min
- ID ¾" : 0.3...62 l/min
- ID 1" : 0.5...75 l/min

Aseptic design

The FLEXMAG 4050 C has been developed for biopharmaceutical applications. The wetted part of the transmitter is manufactured in a ISO 13485 certified site. The production takes place in a cleanroom ISO 7 environment.

The single use flow path tubes are gamma sterilizable at a 25 - 40 kGy irradiation, and are tested up to 50 kGy. All wetted materials meet the USP class VI / ISO 10993 requirements and are BSE/TSE free compliant. Each tube is individually packed in a double layered PA/PE pouch.

The full-bore construction of the flow tube is designed for minimal hold-up volume without obstruction and the single barb fitting is suitable for braided as well as non-braided hoses.

1.3 Measuring principle

An electrically conductive fluid flows inside an electrically insulated pipe through a magnetic field. This magnetic field is generated by a current, flowing through a pair of field coils.
Inside of the fluid, a voltage U is generated:
U = v * k * B * D

in which:
v = mean flow velocity
k = factor correcting for geometry
B = magnetic field strength
D = inner diameter of flowmeter

The signal voltage U is picked off by electrodes and is proportional to the mean flow velocity v and thus the flow rate Q. A signal transmitter is used to amplify the signal voltage, filter it and convert it into signals for totalizing, recording and output processing.

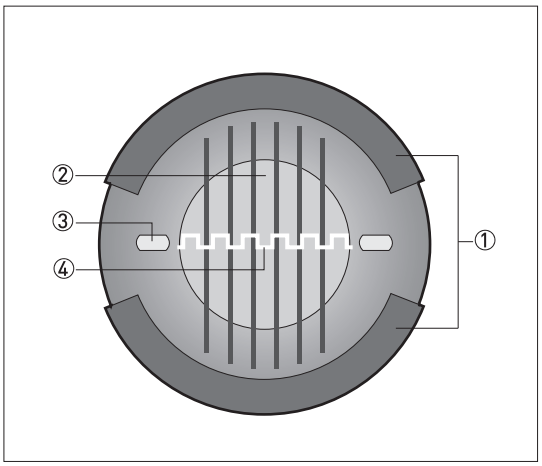

Figure 1-1: Measuring principle

① Field coils
② Magnetic field
③ Electrodes
④ Induced voltage (proportional to flow velocity)

2.1 Technical data

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Downloadcenter).*

Measuring system

Measuring principle	Faraday's law
Application range	Electrically conductive fluids
Measured value	
Primary measured value	Flow velocity

Design

Modular construction	The measurement system consists of a transmitter and a single use flow tube
Features	One transmitter for 2 diameters of flow tubes
Version	FLEXMAG 4050 C
Nominal diameter	Transmitter (Small) 1/4", (Medium) 3/8" and 1/2", (Large) 3/4" and 1".

Measuring accuracy

Measuring error	Depends on flow velocity, size and installation. For detailed information refer to *Measurement accuracy* on page 11
Measuring range (factory set up)	ID 1/4" = 0.015...3 litre per minute
	ID 3/8" = 0.07...14 litre per minute
	ID 1/2" = 0.1...20 litre per minute
	ID 3/4" = 0.3...62 litre per minute
	ID 1" = 0.5...75 litre per minute
Maximum measuring error	The max. measuring error depends on the installation conditions
Repeatability	0.5% (v > 0.5 m/s)
Calibration / Verification	**Standard:**
	Calibration in factory for transmitter and separate flow tubes. Batching calibration of flow tubes in factory.
	No on-site calibration required
Optional:	
Special calibration	On request

Operating conditions

Temperature	
Process temperature	+2...+45°C / 35...+113°F
Ambient temperature	+2...+60°C / 35...+140°F
Storage temperature	-40...+60°C / -40...+140°F
Shelf life (flow tube)	3 years
Pressure	
Ambient pressure	Atmospheric
Process pressure	Up to 4 bar/58 psi
Burst pressure	20 bar/290 psi
Chemical properties	
Physical condition	Electrically conductive liquids
Electrical conductivity	Water: ≥ 20 µS/cm

Installation conditions

Installation	Assure that the flow sensor is always fully filled
	For detailed information refer to *Installation conditions* on page 15.
Flow direction	Forward
	The arrow on the transmitter indicates the positive flow direction
Inlet / Outlet	ID ¼", $^{3}/_{8}$", and ½": no straight lengths required.
	ID ¾" and 1": 1 DN
Dimensions and weights	For detailed information refer to *Dimensions and weights* on page 12.

Materials

Transmitter housing	Polycarbonate/Acrylonitrile butadiene styrene (PC/ABS)
Flow tube	Manufactured in cleanroom at ISO 13485 certified site. Packed in individual double sealed packing material (pouches).
Wetted materials flow tube	Thermoplastic: Polysulfone (UDEL 1700)
Material of flow tube pouches	Polyamide/Polyethylene (PA/PE)
Measuring electrodes	Hastelloy C22
Earthing electrodes	Hastelloy C22
Sterilization of flow tube outside of the original pouch	Gamma sterilizable up to 50 kGy and autoclavable up to 121°C for 30 min

Process connections

Single barb	1/4", 3/8", 1/2", 3/4" or 1" ID.

Electrical connections

Mains	
Power supply	For pulse output: 24 VDC ± 25% (18...30 VDC)
	For current output: 24 VDC ± 1%
Power consumption	≤ 3 W
Cable connections	Standard; 1 x M12, 8-pin connector
Outputs	
General	All operating data are preset at the factory
Pulse output	Pulse/frequency output active
	¼": 0...10000 Hz; 10000 Hz at Qmax (up to 120%) 3/8"...1": 0...1000 Hz; 1000 Hz at Qmax (up to 120%)
Pulse width value (at full scale)	Pulse width = symmetrical, 1:1
Active operation	U_0 nom = 24 V
Current output	Current (active)
	4...20 mA; 4 mA at 0 litre per minute; 20 mA at Q_{max}

Approvals and certificates

CE	
This device fulfils the statutory requirements of the relevant directives. The manufacturer certifies successful testing of the product by applying the conformity mark on the device.	
	For more information on the directives, standards and the approved certifications, please refer to the declaration of conformity supplied with the device or downloadable from the manufacturer's website.
Compliance	
Raw material (wetted part)	FDA 21 CFR 177
	ISO 10 993
	Material certificate 3.1
	Hemolysis
Manufactured tubes	USP VI
	USP 87, USP 88.
	USP 661
	BSE/TSE free
	Extractable on demand
Clean room	ISO 13485
	Particulate matters USP 788, EP 2.9.19.
	Endotoxin EP 2.6.14
	Bioburden EN NF ISO 11737-1
Other approvals and standards	
Protection category acc. to IEC 60529	IP54
Vibration resistance	IEC 60721-3-3 Stationary operation at weather protected locations Class 3M5
Shock resistance	

2.2 Measurement accuracy

Every electromagnetic flowmeter is calibrated by direct volume comparison. The wet calibration validates the performance of the flowmeter under reference conditions against accuracy limits.

The accuracy limits of electromagnetic flowmeters are typically the result of the combined effect of linearity, zero point stability and calibration uncertainty.

Reference conditions

- Medium: water
- Temperature:
- Operating pressure:
- Inlet section: ≥ 5 DN
- Outlet section: ≥ 2 DN

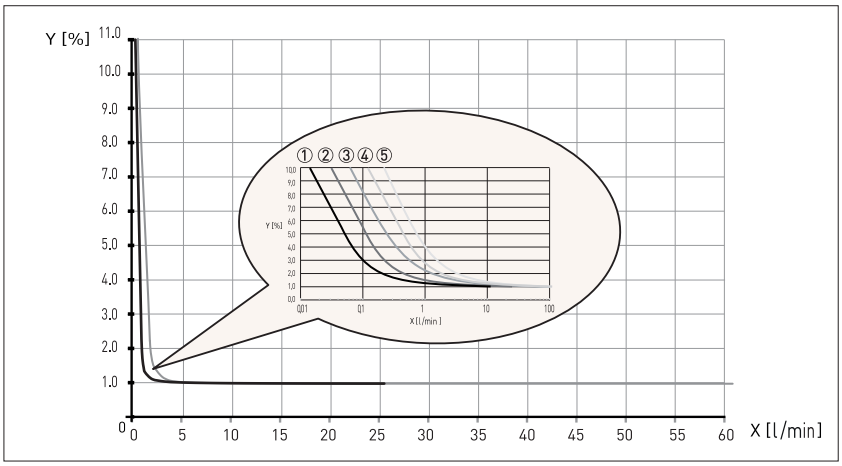

Figure 2-1: Flow rate versus accuracy
X [litre/minute]: flow rate
Y [%]: deviation from the actual measured value (MV)

Accuracy

Nominal size	Minimal flow rate [l/min]	Flow rate error [l/min] Pulse output: 3…1% Analog output: 5.5…1.2%	Flow rate error l/min] Pulse output: 1% Analog output: 1.2…1%	Curve
ID 1/4"	0.015	0.1...1	1...3	①
ID 3/8"	0.07	0.2...2	2...14	②
ID 1/2"	0.1	0.4...4	4...20	③
ID 3/4"	0.3	0.9...8.5	8.5...62	④
ID 1"	0.5	1.5...15	15...75	⑤

Check for the exact values the stickers on the flow tube and transmitter

2.3 Dimensions and weights

The measured values are according standard DIN 16901-130

Transmitter dimensions

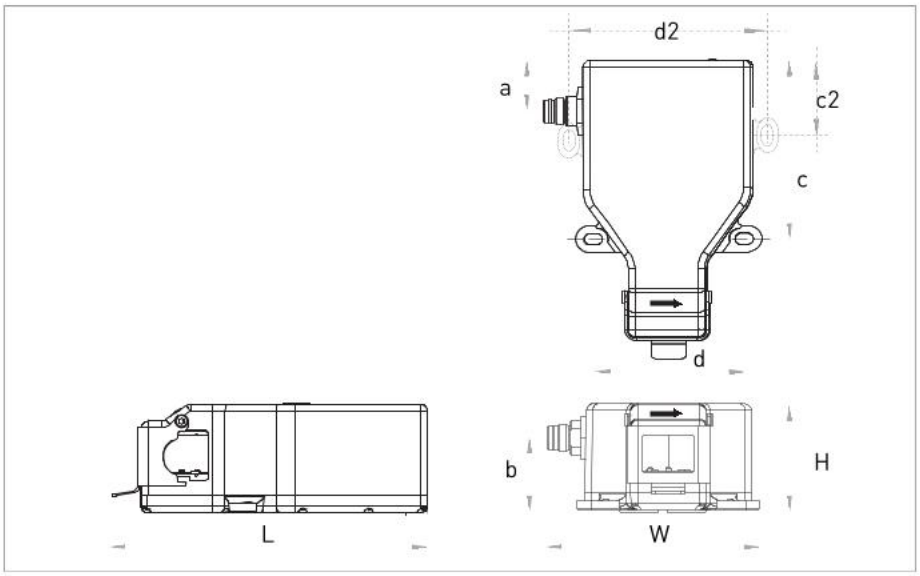

Figure 2-2: Dimensions of transmitter

Nominal size	Dimensions transmitter [mm]							Weight [g]
	L	W	H	a	b	c	d	
Large	160	100	60	23	42	100	59	460
Medium	139	90	48	23	33	82	66	390
Small	144	90	48	28	33	94	66	400
Mounting holes diameter 5.2 x 8.2 mm Note: only for Large version: c2 = 41 mm / d2 = 84 mm								

Nominal size	Dimensions Transmitter [inches]							Weight [ounce]
	L	W	H	a	b	c	d	
Large	6.3"	4.0"	2.4"	0.9"	1.7"	4.0"	2.3"	16.2
Medium	5.5"	3.6"	1.9"	0.9"	1.3"	3.2"	2.6"	13.8
Small	5.7"	3.6"	1.9"	1.1"	1.3"	3.7"	2.6"	14.1
Mounting holes diameter 0.2 x 0.3 inch Note: only for Large version: c2 = 1.6" / d2 = 3.3"								

Dimension L: the total space minimal needed to open the clamp and remove the flow tube is size L + 25 mm / 1" + size W of the flow tube (see next page for W dimensions.)

Flow tube dimensions

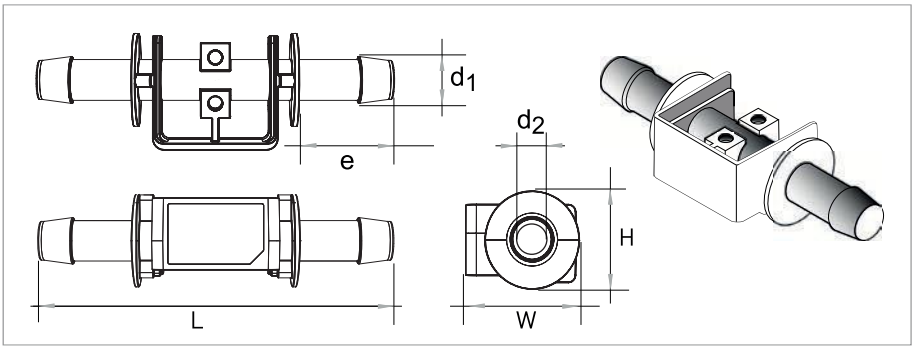

Figure 2-3: Dimensions of the flow tubes

Nominal size	Dimensions flow tube [mm]						Wetted surface [mm²]	Wetted volume [mm³]	Weight [g]
	L	W	H	e	d1	d2			
ID ¼"	70	22	17	16.6	8.5	6.0	1270	1802	6.4
ID ⅜"	95	30	25	25.6	12.6	9.5	2652	5847	13
ID ½ "					16.9	12.7	3650	10987	14
ID ¾ "	125	45	41	36.0	23.4	19.0	7199	33148	36
ID 1"	140			44.0	30.0	25.4	10026	57470	44

Nominal size	Dimensions flow tube [inches]						Wetted surface [inch²]	Wetted volume [inch³]	Weight [ounce]
	L	W	H	e	d1	d2			
ID ¼ "	2.8"	0.9"	0.7"	0.7"	0.3"	0.2"	2.0	0.11	0.22
ID ⅜"	3.7"	1.2	1"	1"	0.5"	0.4"	4.1	0.36	0.46
ID ½ "					0.7"	0.5"	5.7	0.67	0.49
ID ¾ "	4.9"	1.8"	1.6"	1.4"	0.9"	0.7"	11.2	2.0	1.3
ID 1"	5.5"			1.7"	1.2"	1.0"	15.5	3.5	1.6

3.1 Intended use

Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The FLEXMAG 4050 C electromagnetic flowmeter is designed exclusively to measure the flow of electrically conductive, liquid media for the pharmaceutical/bio-technology industry and is not a medical device.

The electromagnetic flowmeter is designed exclusively to measure the flow of electrically conductive, liquid media.

3.2 General notes on installation

Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

Do a check of the packing list to make sure that you have all the elements given in the order.

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

3.2.1 Vibration

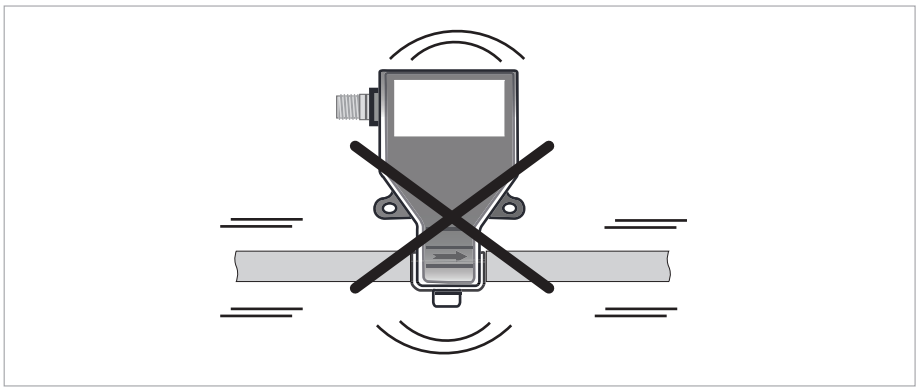

Figure 3-1: Avoid vibration

3.2.2 Magnetic field

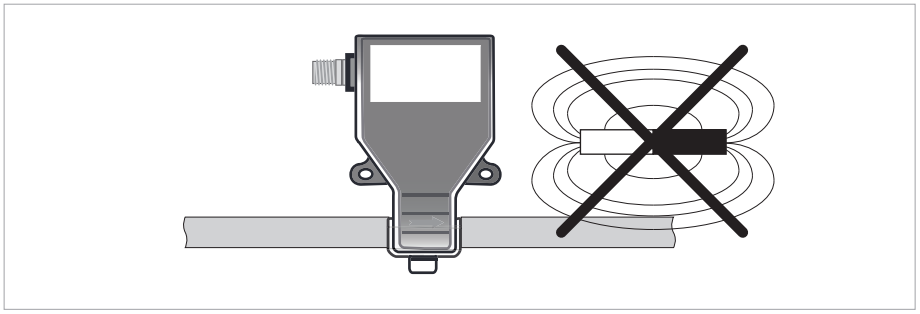

Figure 3-2: Avoid magnetic fields

3.3 Installation conditions

To avoid meter malfuction make sure that minimal mechanical stress and no lateral force is applied to the flow tube (e.g. during installation and/or attaching the hoses).

When attaching the hoses, make sure that the hoses are attached in axis to the flow tube and that they are properly supported to avoid any lateral forces to the meter.

Support the pipeline on both side of the flowmeter. Make sure the M12 connector is on the flow inlet side.

Please comply with the following recommendations:

3.3.1 Control valve

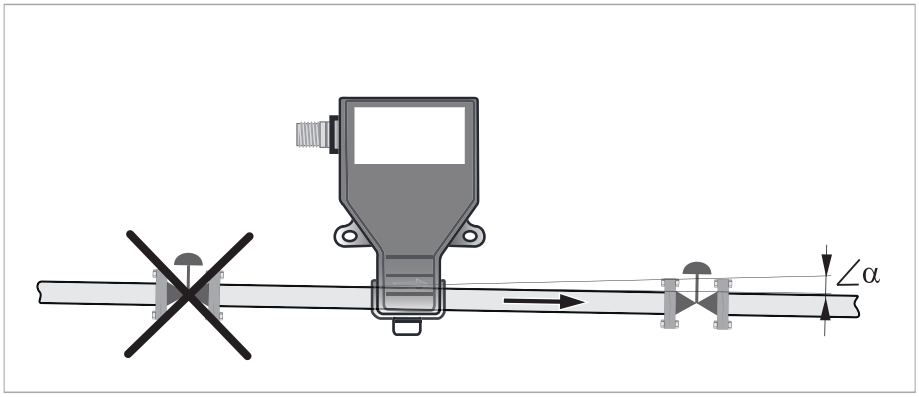

Figure 3-3: Installation in front of a control valve

$\angle\alpha > 2°$

3.3.2 Pump

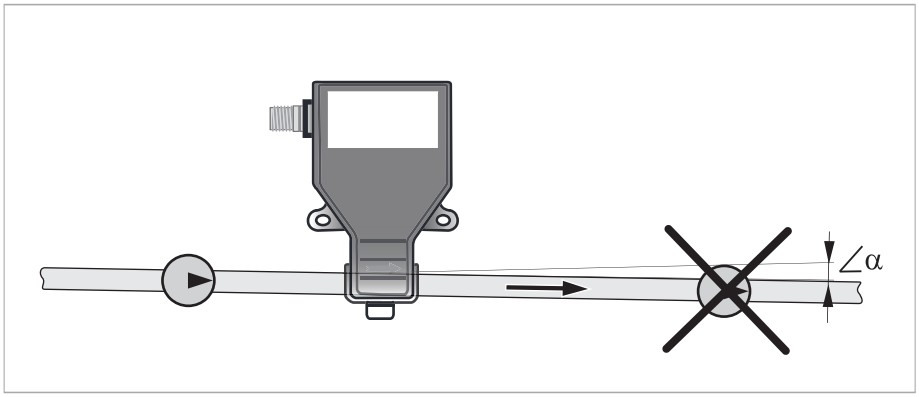

Figure 3-4: Installation behind a pump

$\angle\alpha > 2°$

3.3.3 Open feed or discharge

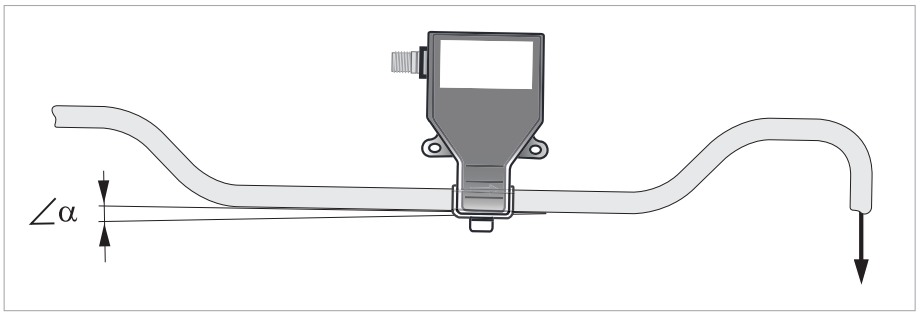

Figure 3-5: Installation in front of an open discharge

$\angle\alpha > 2°$

3.3.4 Mounting position

The FLEXMAG 4050 C transmitter can be installed in every position.

Do not use (or apply) forces above 1.5 Nm when mounting the transmitter on a surface.

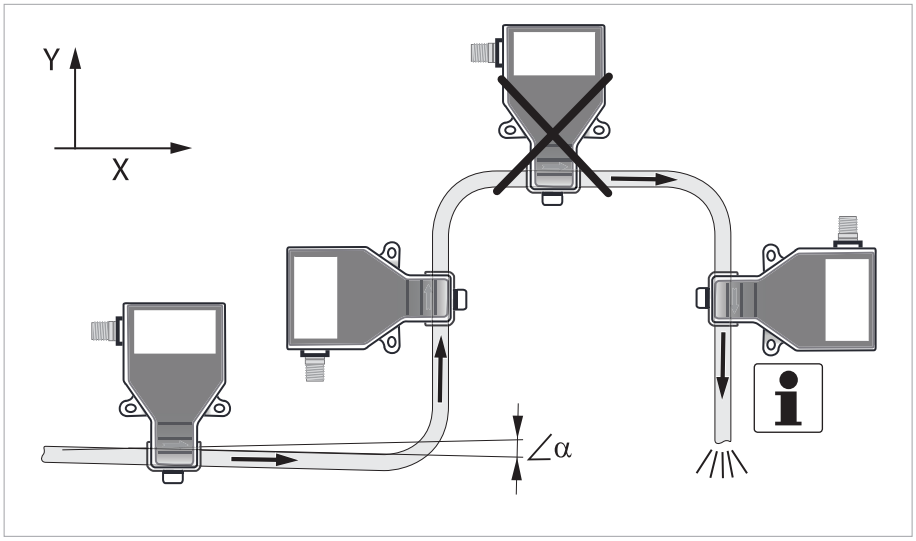

Figure 3-6: Installation in bending pipes

$\angle\alpha > 2°$

Install in a slightly descending pipe section, to prevent air from collecting and to avoid faulty measurements (meter can drain).

For correct measurements, avoid draining or partial filling of the flow sensor during operation.

Vertical down position only in conjunction with a control valve.

3.4 Mounting

3.4.1 Design of the single use assembly

When designing the single-use assembly related to the machine, make sure that minimal mechanical force is applied to the flow tube to avoid meter malfunction. When attaching the hoses, make sure that the hoses are attached in axis to the flow tube and that they are correctly supported to avoid any lateral forces to the meter.

The flow tube holder of the transmitter is designed specifically to fit the flow tube in only one way. During the assembling, make sure that the positioning of the tube is correct.

The flow tubes are compatible with bio-pharmaceutical (braided or non-braided) flexible hoses and are attached with clamps. Be sure to use the correct nominal inner diameter related to the inner diameter of the flow tube.

Examples of applicable hoses and clamps:

Hoses

- Advantapure APSH silicone hose
- C-Flex (CFB)
- SaniTech STHT-R silicone hose

Clamps

- Optiker StepLess ear clamp

3.4.2 Positioning of the flow tube in the single-use kit assembly

The flow tubes are designed for single-use and are manufactured in a cleanroom ISO 7 environment. Each tube is individually packed in a double layer PA/PE pouch. Special handling is required to keep the flow tube free of contamination. Please refer to your local procedures for the handling of single-use parts.

Carefully inspect the flow tube pouches for signs of damage or holes. Report damage to the carrier and the local office of the manufacturer and do not use flow tubes from damaged pouches.

To avoid contamination of the tubes it is recommended to wear gloves during the complete procedure.
The storage, packing, sterilization or another handling of the FLEXMAG flow tube have to be done according to the applicable specifications.

3.4.3 Installation and removal of the flow tube

To install or exchange the flow tubes from the transmitter, please follow up the necessary steps:

- Move the tube ① in a horizontal direction into the transmitter ③ until the tube is flush with the front side of the transmitter.
- Push the clamp ② downward until the tube is locked (until the "click"). By moving the clamp downwards, the tube is guided to its correct position.
- Enter the diameter and the k factor (of the new tube in place) into the control system (For more information see the manual of the transmitter).

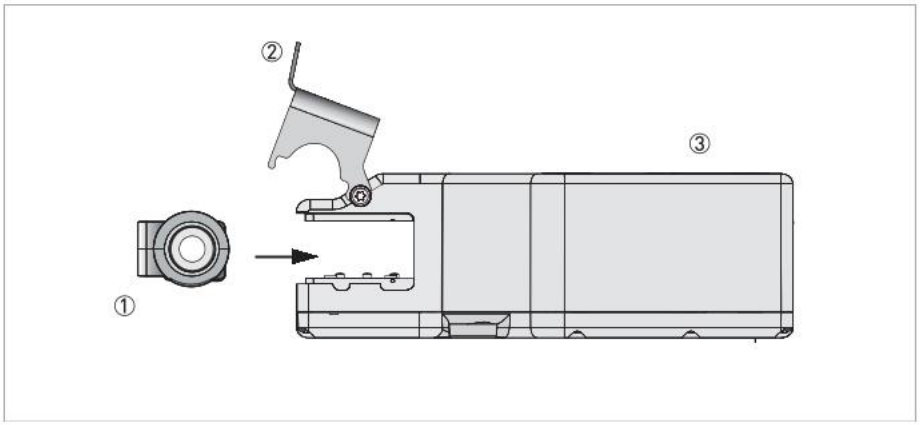

Figure 3-7: Inserting the flow tube

When the flow tube is removed from the transmitter, the electrical contacts do not carry any harmful electrical load. However, in order to avoid corrosion or static discharge of those contacts avoid touching them.

Make sure that the information (Q max., k factor and diameter) are the correct ones that are related to the installed tube.

4.1 Safety instructions

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

Observe the national regulations for electrical installations!

Observe without fail the local occupational health and safety regulations.
Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

4.2 M12-8 pin connector

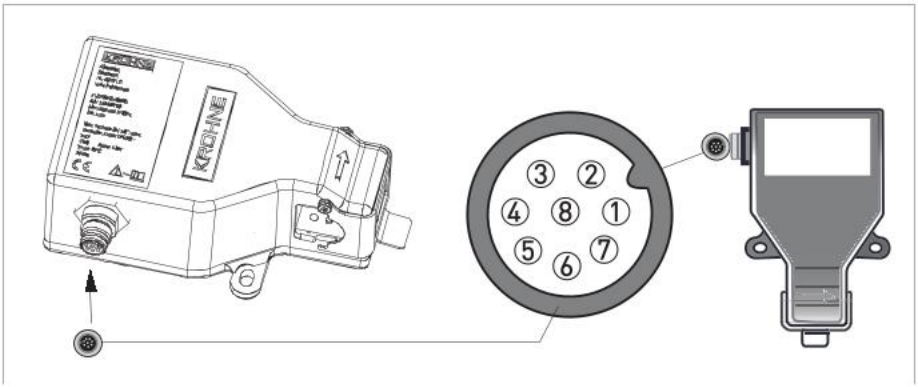

Figure 4-1: Pin location and layout

Use one of the following plug types to connect the flowmeter:

- moulded plug, straight
- integrally extruded plug with cable (2 meter)

For the connection diagrams refer to the manual of the transmitter.

4.3 Grounding and electrical connection

Make sure to use a galvanically isolated power source.

For detailed information about the output connection diagrams, see the manual of the transmitter.

The transmitter is working with the pulse or mA output. Do not connect both outputs at the same time. The cable of the output which is not used, should be cut short or placed in a connector with open ends.

Avoid any electrostatic discharge, to minimize the risk of non-reversible damages.

The manufacturer provides an optional connection cable for the connection to the transmitter. The cable length is 2 m / 6.56 ft., but can be cut to shorter length.

Cable connection

Pin	Function	Wire colour
1	Not used	White
2	+24 VDC	Red
3	Ground (GND)	Blue
4	Frequency output (+)	Yellow
5	Frequency output (GND)	Grey
6	Current output (+)	Brown
7	Current output (-)	Green
8	To be connected for service only	Pink

To comply with the EMC standard EN 61326-1: 2013, follow the cable guidelines. Disregarding this warning could lead to electromagnetic interferences which could harm the meter as well as other electrical equipment in the proximity of the device.

Cable guidelines

- Use shielded cables if the cable length > 2 m/ 6.6 ft (with a maximum length of 10 m/ 32.8 ft)

- The outer shielding is open at the M12 connector on the flowmeter side

- Connect the outer shielding at the safety ground at the counter side for a proper signal performance

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- Process instrumentation for flow, level, temperature, pressure measurement and process analytics
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