



AF-E 400 Technical Datasheet

Electromagnetic flowmeter for utilities and industrial automation

- Compact, robust design for parallel installation and tight spaces
- Best in class: temperature range, accuracy, pressure drop and flow range
- Outputs: 4...20mA, pulse, frequency, switch, IO-link or Modbus

1	Product features	3
<hr/>		
1.1	AF-E 400 – Simply best in class	3
1.2	Features	5
1.2.1	Loaded with functionality, purpose in every detail	5
1.2.2	Installation in tight spaces without crosstalk	6
1.3	Measuring principle	7
2	Technical data	8
<hr/>		
2.1	Technical data	8
2.2	Accuracy	11
2.3	Flow settings	12
2.4	Temperature settings	13
2.5	Dimensions and weights	14
2.6	Adaptors	15
2.7	Pressure loss	16
3	Installation	17
<hr/>		
3.1	Intended use	17
3.2	General notes on installation	17
3.2.1	Installation specifications	18
3.2.2	Vibrations	18
3.2.3	Magnetic field	18
3.3	Installation conditions	19
3.3.1	Inlet and outlet	19
3.3.2	Open feed or discharge	19
3.3.3	Pump	20
3.3.4	Control valve	20
3.3.5	Mounting position	21
3.3.6	Torques	22
4	Electrical connections	23
<hr/>		
4.1	Safety instructions	23
4.2	Grounding	23
4.3	Cable connection M12 - 4 pin	24
4.4	Cable connection M12 - 5 pin (Modbus)	25
5	Notes	26
<hr/>		

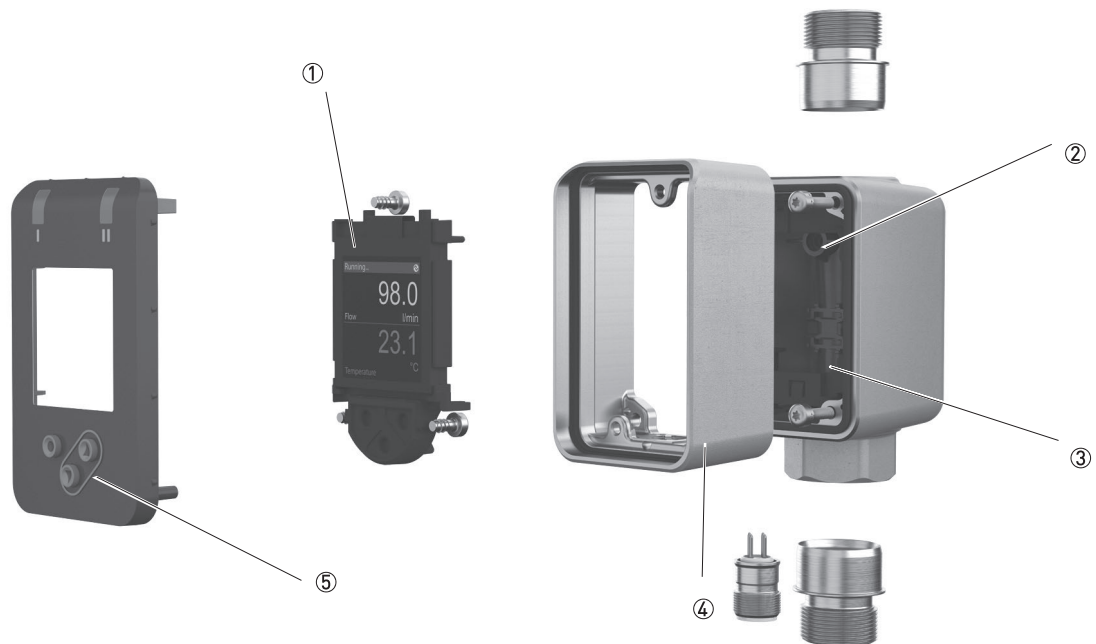
1.1 AF-E 400 – Simply best in class

Compact, robust, reliable and cost-effective; these are important characteristics of instrumentation in industrial automation. The AF-E 400 is the culmination of KROHNE expertise in a **best-in-class electromagnetic flowmeter** specially designed for this industry.

Its **unique compact sensor** design makes it perfect for use in tight spaces and for parallel installations in a variety of conductive liquid applications.

The reliable **round bore reduction** limits pressure drops and ensures strength and accuracy under pressure, while cost-effective **integrated temperature measurement** eliminates the need for an additional temperature measurement device.

The AF-E 400 is best-in-class in terms of temperature range, accuracy, pressure drop and flow range.



- ① Full colour rotatable display
- ② Integrated temperature sensor
- ③ High performance PEEK flow tube with round bore reduction
- ④ Unique compact 2 mm thick cast stainless steel housing
- ⑤ Buttons for easy menu access

Highlights

- Narrow installation width
- High-temperature capability
- Integrated temperature sensor
- Multi-IO-link, Modbus or double analog output option
- Highest flow and low absolute uncertainty per diameter
- Various threaded connections directly on the device (no adapters needed)

Industries

- Machine building (automation) industry
- HVAC industry
- All process industries

Applications

- Rinsing / washing
- Cooling / temperature control
- Heating / heat transfer
- Dosing (chemical)

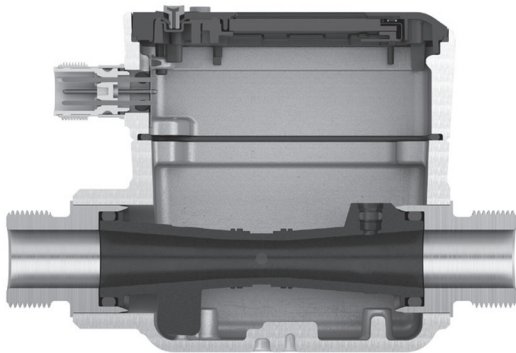
1.2 Features

1.2.1 Loaded with functionality, purpose in every detail

The design of the AF-E 400 is specifically adjusted for **ultra-compact installation**. Three small PCB (Printed Circuit Board) are stacked in the device to enable the sleekest housing construction. This allows installation in distribution manifolds or cabinets where tubes are usually very closely spaced.

Its 2 mm /0.08"-thick, cast stainless steel housing also makes the AF-E 400 **much more robust** than the plastic or sheet metal housings used in similar products on the market.

Thanks to the **rotatable, bright full-colour display** excellent readability is guaranteed from every angle. Harmonisation of the housing design across connection types allows **easy integration** no matter what threaded connection or diameter is chosen.



PEEK lining

Traditionally flowmeters consist of a metal flow tube with a liner. This results in high manufacturing costs and a more expensive end product. The AF-E 400 flow tube is made of high-quality, glass-reinforced injection-moulded PEEK.

This eliminates the need for a metal flow tube. Furthermore, the magnetic circuit production is fully automated. This allows for **highly repeatable production processes and reliability**. The high-performance plastic flow tube is **resistant against a wide range of chemicals, temperature and pressure**.

Round bore sensor design

Where other producers sometimes choose a rectangular bore **in combination with a plastic flow tube**, the AF-E 400 flow tube has been designed with a round bore.

A round bore sensor design is the best when having plastic flow tube to achieve a maintained accuracy over a wide pressure and temperature range.

The small reduction in the round bore straightens inconsistencies in the flow profile and **removes the need for inlet and outlet runs**.

In this way, the meter is suitable for compact installation close to bends or valves. Thanks to the round reduced tube, the pressure drop is kept to a minimum, which means a **high turn-down ratio without the risk of cavitation**.

1.2.2 Installation in tight spaces without crosstalk

The AF-E 400 was designed with tight spaces in mind. An electromagnetic flowmeter typically carries the risk of crosstalk. It can influence the measurement of another device installed close to it because of the magnetic field overlap.

The special design of the magnetic circuit, field strength and electronics of the AF-E 400 allows units to be positioned in extreme proximity to each other: as close as 2 mm/0.08”.

That is less than the width of a matchstick. In the field that means **maximum flexibility when installing the device**.



Quick commissioning

The factory settings of the device make **plug-and-play** installation possible. Thanks to the flow range later adjustments are unnecessary. For easy connection, the common M12 connector is used. The menu item descriptions on the full-colour display enable a quick understanding of each menu item and easy setting without a manual.

For more advanced functions like batching settings, totaliser functions, or hysteresis settings, an easy to use quick-start is available and supplied in the packaging of the AF-E 400.



The meter that monitors itself

Thanks to extensive self-diagnostics a reliable operation can be assured. The meter continuously monitors several critical aspects including:

- Low supply voltage
- Incorrect parametrisation
- Flow range exceeding or short circuit on any of its outputs

Warning messages are categorised according to NE107 alert the user via the display and the IO-Link output.

A step ahead of the rest

We examined some of the common issues with products in this segment and translated them into improvements across the board. The AF-E 400 features, for example, the **highest temperature capability**.

The continuous use at +90°C/+194°F liquid temperature allows its operation in very demanding cooling and hot water applications. The latest insights at KROHNE in magnetic field design and signal conversion enable the **highest accuracy** without adding costs.

Furthermore the combination of tight seals and laser welding guarantees a high IP65 and IP67 ingress protection. The **integrated temperature measurement** eliminates the need for an additional sensor. This minimises the intrusion points in the pipe and provides more data from the process.

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 converter is used to amplify the signal voltage, filter it and convert it into signals for totalizing, recording and output processing.

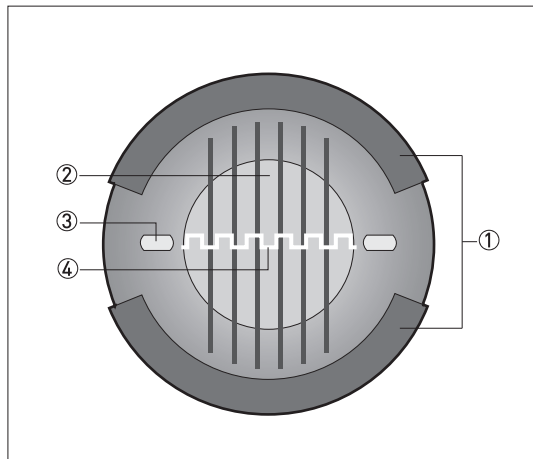


Figure 1-1: Measuring principle

- 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 of induction
Application range	Electrically conductive fluids
Measured value	
Primary measured value	Flow velocity and temperature
Secondary measured value	Volume flow

Design

Features	Standard wet calibration
Modular construction	The measurement system consists of a flow sensor and a signal converter. It is only available as compact version.
Nominal diameter	DN6...25 / ¼...1" (adapter available for DN40 and DN50 / ½ and 2")
Weight	< 0.75 kg / 1.65 lb (without adaptors/accessories)
Measurement range	For flow range settings refer to <i>Flow settings</i> on page 12.
User interface	
Operating data	Factory set
Human Machine Interface (HMI)	Full colour display with buttons and / or IO link USB interface
Cable connections	1 x M12, 4-pin connector for Multi IO or double analog; 1 x M12, 5-pin for Modbus
Measuring accuracy	
Application conditions	Medium: water
	Inlet / outlet section: OD / OD
	Minimum conductivity: 20 µS/cm
	Viscosity: < 70 mm ² /s at 40°C
	Operating pressure: up to 16 bar
Maximum measuring error	Flow: ± 0.8% of reading + 0.2% of full scale
	For accuracy under reference conditions; refer to <i>Accuracy</i> on page 11
	Temperature: ± 2.5 K (Q > 5% of full scale)
Repeatability	≤ 0.2% of full scale

Operating conditions

Temperature	
Process temperature	Dependent on ambient temperature. (for temperature settings refer to <i>Temperature settings</i> on page 13).
Ambient temperature	-20...+60°C / -4...+140°F
Storage temperature	-25...+80°C / -13...+176°F
Pressure	
Ambient	Atmospheric
Process pressure	up to 16 bar / 232 psi
Chemical properties	
Physical conditions	Liquids
	Examples: Water, Chemicals
Electrical conductivity	≥ 20 µS/cm

Installation conditions

Installation	Make sure that the flow sensor is always fully filled.
	Refer to the manual of the flow sensor for detailed installation, operating and connection instructions.
Inlet run	≥ 0 DN
Outlet run	≥ 0 DN
Dimensions and weights	for detailed information refer to <i>Dimensions and weights</i> on page 14
	Weight for all versions: < 0.75 kg

Materials

Housing	Stainless steel 1.4404 / 316L ; PC; P+PC-GF30
Wetted materials	1.4404 / 316L ; Glass fibre-Peek; carbon-fibre; FKM (or EPDM); Centellen (G thread only)
Measuring electrodes	Carbon fibre (temperature sensor 1.4404 (316L))
	Internal (wetted) gaskets FKM or EPDM
Process connections	
Connection	Threaded design G ; NPT or Rc
	Optional: adapter for DN25 / 1" G device to DN40...50 / 1½...2" tube

Electrical connections

Cable connections	
Power supply	M12; 18...30 V DC; (acc. EN50178, SELV, PELV)
Current	≤ 80 mA at 18 V; protection class III
Switch on current	Max. ≤ 400 mA for 50 ms, start-up time 5 s
Line recorder	For parameter setting and diagnostic purposes for the Multi IO version, communication via PC with a single device via IO-link.
Input	Counter reset (only on Multi IO version)
Outputs	
Device variants	Multi IO: 2 digital or 1 digital / 1 analog (current) or IO-link (version. 1.1) Double analog : 2 analog Modbus : Modbus only (see Modbus addendum)
Device multi IO	Switch; analog (current); pulse; IO-link; frequency (configurable)
Number of digital outputs	2
Digital output	2 V max. voltage drop 100 mA max. continuous current
Analog output	Current: 4...20 mA (active) Load: $R_{\max} = 500 \text{ Ohm}$
Device double analog	Analog (current)
Number of analog outputs	2
Output function	Flow, temperature
Analog output	Current: 4...20 mA (active) Load: $R_{\max} = 500 \text{ Ohm}$
Device Modbus	Modbus
Output configuration	Refer to the Modbus documentation.

Approvals and certificates

CE	
This device fulfils the statutory requirements of the EU directives. The manufacturer certifies successful testing of the product by applying the CE mark.	
	For full information of the EU directive & standards and the approved certifications; please refer to the EU Declaration of Conformity or the website of the manufacturer
Other approvals and standards	
Protection category acc. to IEC 60529	IP65/67
Shock resistance	IEC 60068-2-27; 20 g (11 ms)
Vibration resistance	IEC 60068-2-6; 5 g (10...2000 Hz)
Other	KTW (Ger) ; ACS (FR) ; REG 31 (GB) units with EPDM sealing only WRAS (units with EPDM sealing only)

2.2 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: +20°C / +68°F
- Operating pressure: 1 barg / 14.5 psig
- Inlet section: ≥ 0 DN
- Outlet section: ≥ 0 DN

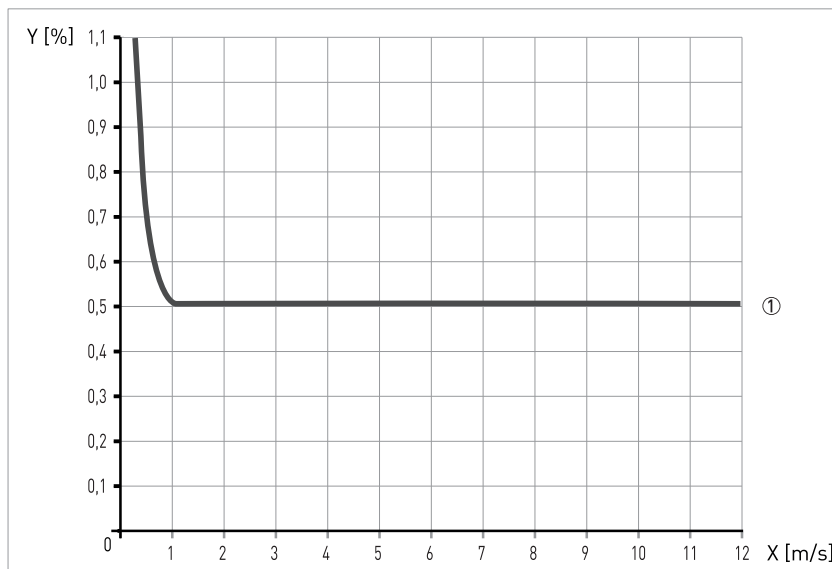


Figure 2-1: Flow velocity vs. accuracy

X [m/s] : flow velocity

Y [%]: deviation from the actual measured value (mv)

Accuracy

Flow sensor diameter	Velocity	Accuracy	Curve
DN6...DN25 / ¼...1"	$v \leq 1$ m/s	0.5% of measured value + 1.5 mm/s	①
	$v > 1$ m/s	0.5% of measured value	

For accuracy under application conditions; refer to Technical data on page 8 section "Design"

2.3 Flow settings

Standard versions (EU settings)

Setting	Unit	¼"/DN 6	½"/DN 15	¾"/DN 20	1"/DN 25
Measuring Range	L/h	0.3...300	2...2100	6...4500	12...9000
	ml/min	5...5000	--	--	--
	L/min	0.005...5	0.05...35	0.1...75	0.2...150
	m/s	0.003...2.95	0.005...3.30	0.005...3.98	0.006...5.09
Resolution	L/h	0.1	2	5	10
	ml/min	1.0	--	--	--
	L/min	0.001	0.02	0.1	0.1
	m/s	0.002	0.002	0.005	0.005
Response time T09	ms	250	250	250	250
Measurement dynamics	--	1:1000	1:700	1:750	1:750
Units	--	ml/min, L/h, mm/s, gal/h, fl oz/min, ft/s, m³/s	L/min, m³/h, m/s, gal/min, gal/h, fl oz/min, ft/s, L/h, m³/s	L/min, m³/h, m/s, gal/min, gal/h, fl oz/min, ft/s, L/h, m³/s	L/min, m³/h, m/s, gal/min, gal/h, fl oz/min, ft/s, L/h, m³/s

Standard versions (US settings)

Setting	Unit	¼ inch	½ inch	¾ inch	1 inch
Measuring Range	fl oz/min	0.2...169.0	2...1183	4...2536	5...5070
	gal/h	0.1...79.3	1.0...555.0	2...1189	4...2378
	ft/s	0.01...9.68	0.02...10.83	0.02...13.06	0.02...16.70
	gal/min	--	0.01...9.25	0.02...19.82	0.06...39.62
Resolution	fl oz/min	0.2	1	2	5
	gal/h	0.1	0.5	1	2
	ft/s	0.01	0.01	0.02	0.02
	gal/min	--	0.01	0.02	0.02
Response time T09	ms	250	250	250	250
Measurement dynamics	--	845	592	634	1014
Units	--	ml/min, L/h, mm/s, gal/h, fl oz/min, ft/s, m³/s	L/min, m³/h, m/s, gal/min, gal/h, fl oz/min, ft/s, L/h, m³/s	L/min, m³/h, m/s, gal/min, gal/h, fl oz/min, ft/s, L/h, m³/s	L/min, m³/h, m/s, gal/min, gal/h, fl oz/min, ft/s, L/h, m³/s

SI versions only

Setting	Unit	¼"/DN 6	½"/DN 15	¾"/DN 20	1"/DN 25
Measuring Range	ml/min	5...5000	--	--	--
	L/min	0.005...5	0.05...35	0.1...75	0.2...150
	m/s	0.003...2.95	0.005...3.30	0.005...3.98	0.006...5.09
Resolution	ml/min	1.0	--	--	--
	L/min	0.001	0.02	0.1	0.1
	m/s	0.002	0.002	0.005	0.005
Response time T09	ms	250	250	250	250
Measurement dynamics	--	1:1000	1:700	1:750	1:750
Units	--	ml/min, L/h, mm/s	L/min, m³/h, m/s	L/min, m³/h, m/s	L/min, m³/h, m/s

2.4 Temperature settings

Setting	Unit	Standard versions	SI versions only
Measuring Range	°C	-20...90	-20...90
	°F	-4..194	-4..194
Resolution	°C	0.2	0.2
	°F	0.5	--
Units	--	°C, °F	°C
Response time T09	s	15	15 Minimum flow: 5 % of VMR

2.4 Dimensions and weights

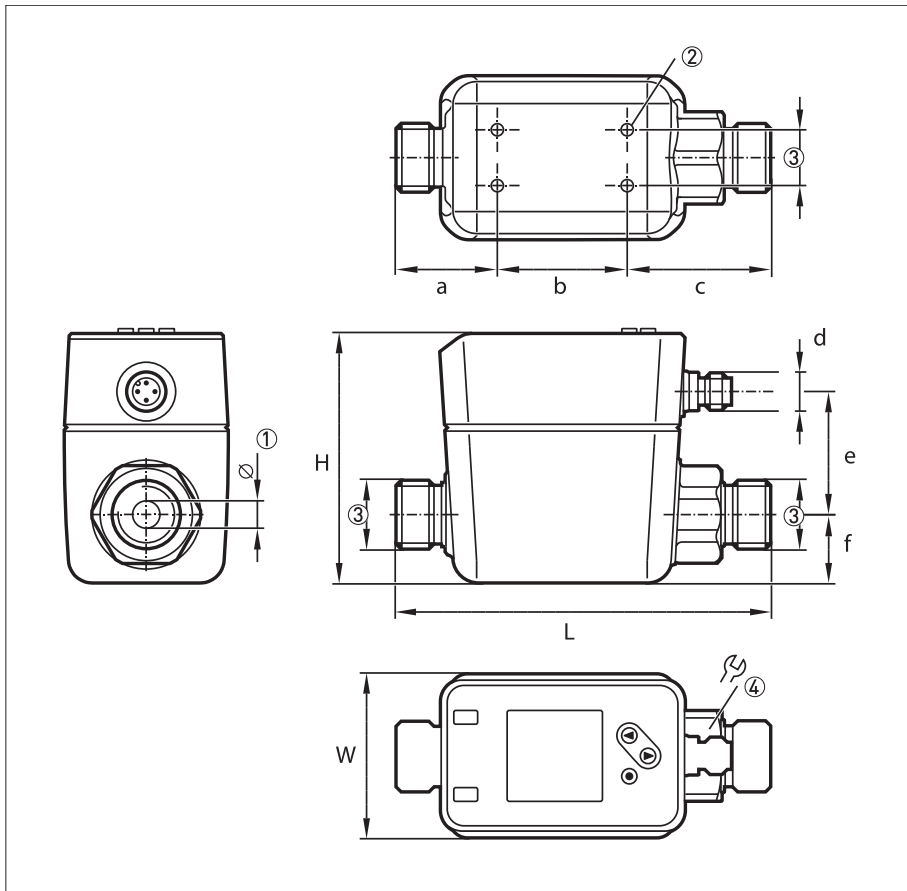


Figure 2-2: Dimensions [mm]

- ① Diameter size depend on version chosen
- ② Inner thread for screw M4 x 0.7
- ③ Sizes depend on the type of connection chosen
- ④ Wrench size 41 (27 mm) or 55 (36 mm)

NPT and Rc connection

	L	H	W	a	b	c	d	e	f
mm	110	73	48	36	38	36	M12 x 1	36	20
inch	4.33	2.87	1.89	1.42	1.5	1.42		1.42	0.79

G-thread connection

	L	H	W	a	b	c	d	e	f
mm	110	73	48	29.9	38	42.2	M12 x 1	36	20
inch	4.33	2.87	1.89	1.18	1.5	1.66		1.42	0.79

2.6 Adaptors

Various adaptors for the G thread variant can be ordered. These can be used to convert the G outer thread to inner thread or to NPT or Rc thread types. Contact KROHNE to discuss your need.

Threaded connection dimensions / options

Type		Inlet pipe [mm]	narrowest part pipe (at electrodes)	
G ¼"	outer thread	6	3.6	
G ½"	outer thread	12.5	8	
G ¾"	outer thread	15	12	
G 1"	outer thread	21	16	
G 1½"	outer thread	35	16	①
G 2"	outer thread	45	16	①
NPT ¼"	inner thread	6	3.6	
NPT ½"	inner thread	12.5	8	
NPT ¾"	inner thread	15	12	
NPT 1"	inner thread	21	16	
Rc ¼"	inner thread	6	3.6	
Rc ½"	inner thread	12.5	8	
Rc ¾"	inner thread	15	12	
Rc 1"	inner thread	21	16	

① adapter to DN25 G device

2.7 Pressure loss

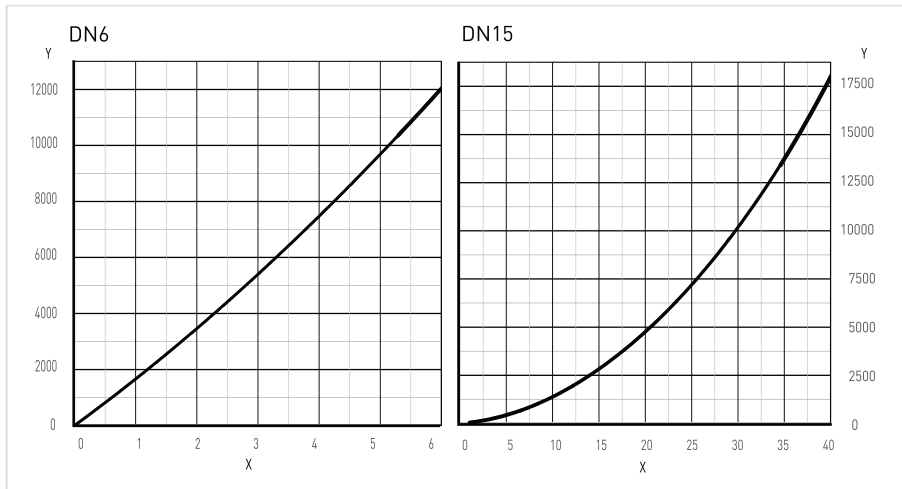


Figure 2-3: X = Flow Q [l/min] - Y = Pressure loss [Pa]

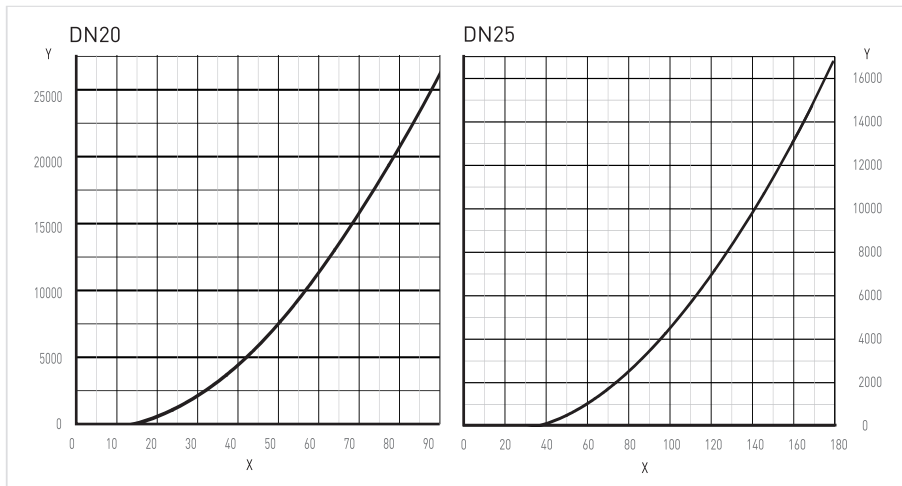


Figure 2-4: X = Flow Q [l/min] - Y = Pressure loss [Pa]

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 AF-E 400 electromagnetic flowmeter is designed exclusively for measuring the volumetric flow rate and temperature of electrically conductive, liquid media.

Minimum electrical conductivity:

- $\geq 20 \mu\text{S}/\text{cm}$

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 Installation specifications

The following precautions must be taken to ensure reliable installation.

- Make sure that there is adequate space to the sides.
- The device must not be heated by radiated heat (e.g. exposure to the sun) to an electronics housing surface temperature above the maximum permissible ambient temperature. If it is necessary to prevent damage from heat sources, a heat protection (e.g. sun shade) has to be installed.
- Signal converters installed in control cabinets require adequate cooling, e.g. by fan or heat exchanger.
- Do not expose the signal converter to intense vibrations. The measuring devices are tested for a vibration level as described in the chapter "Technical data".

3.2.2 Vibrations

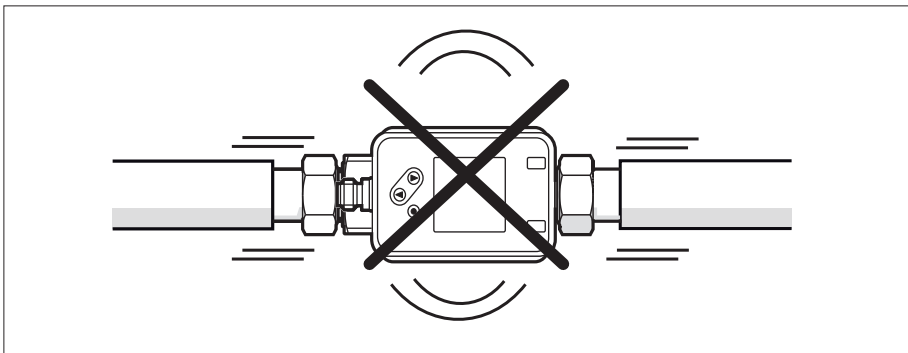


Figure 3-1: Avoid vibration

3.2.3 Magnetic field

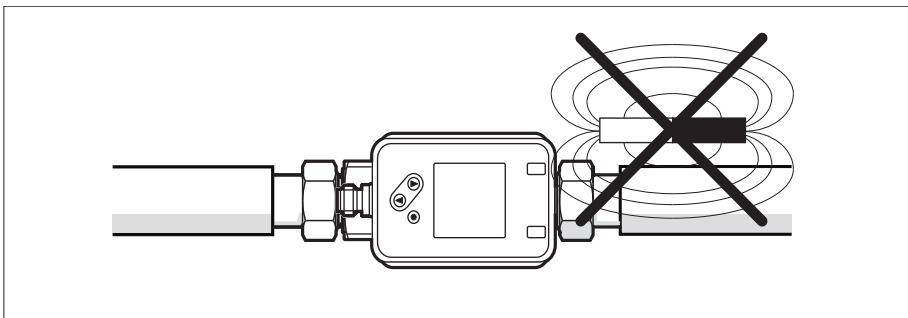


Figure 3-2: Avoid magnetic fields

3.3 Installation conditions

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

3.3.1 Inlet and outlet

It is not necessary to use straight inlet- or outlet length in front of or behind the flowmeter.

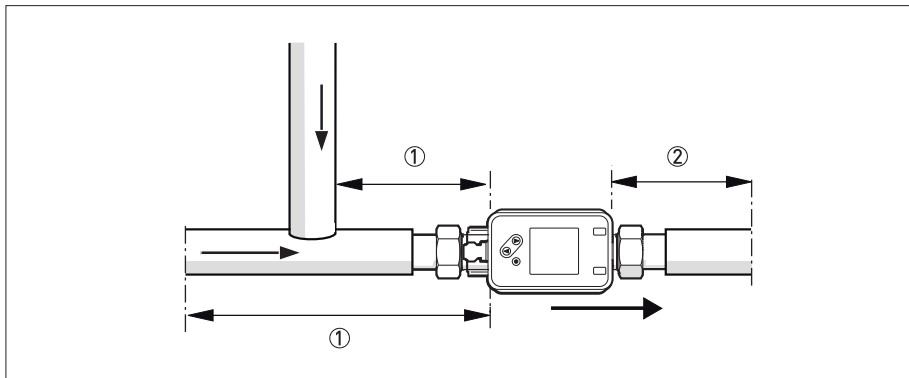


Figure 3-3: Inlet and outlet length

- ① Straight inlet in front of the flowmeter = 0 DN
- ② Straight outlet behind the flowmeter = 0 DN

3.3.2 Open feed or discharge

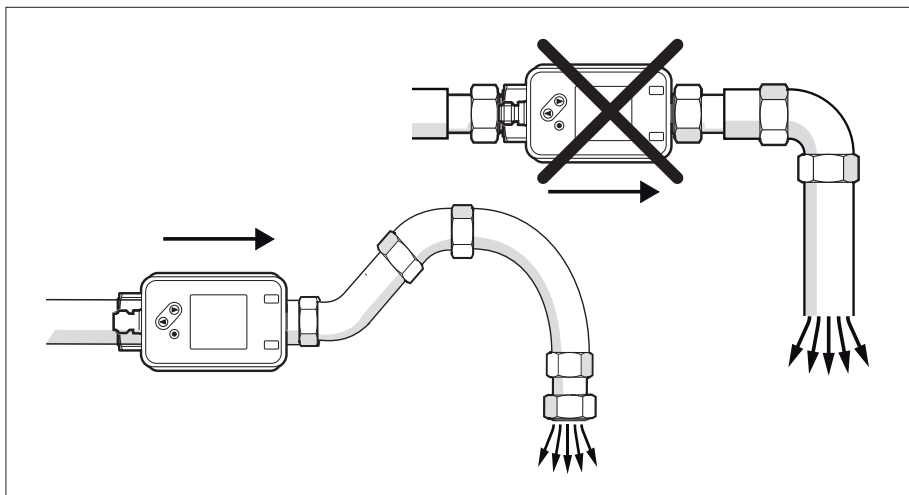


Figure 3-4: Open feed or discharge

3.3.3 Pump

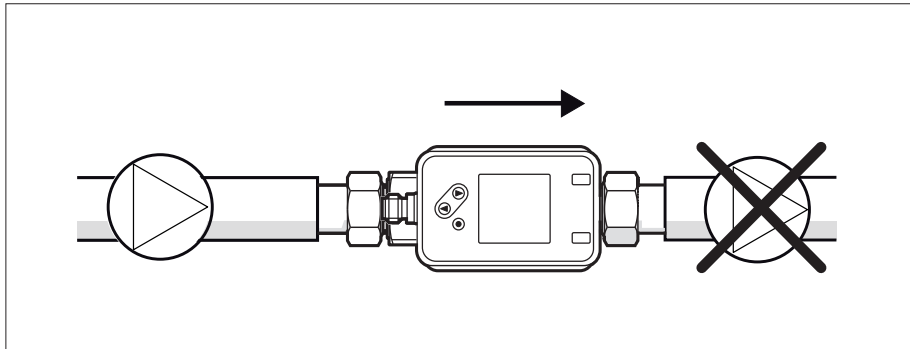


Figure 3-5: Installation behind a pump

3.3.4 Control valve

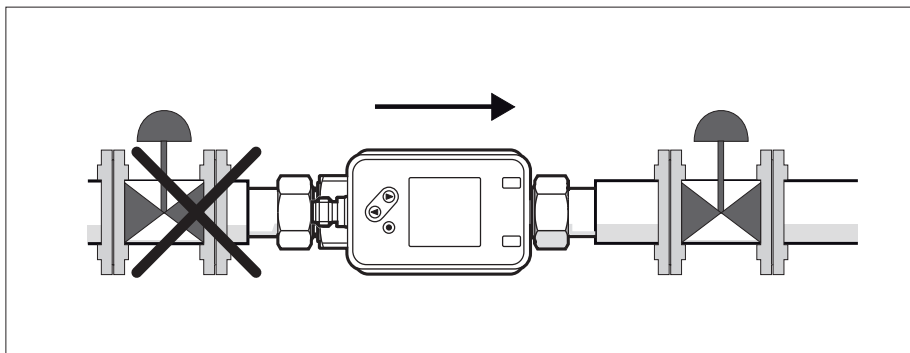


Figure 3-6: Installation in front of a control valve

3.3.5 Mounting position

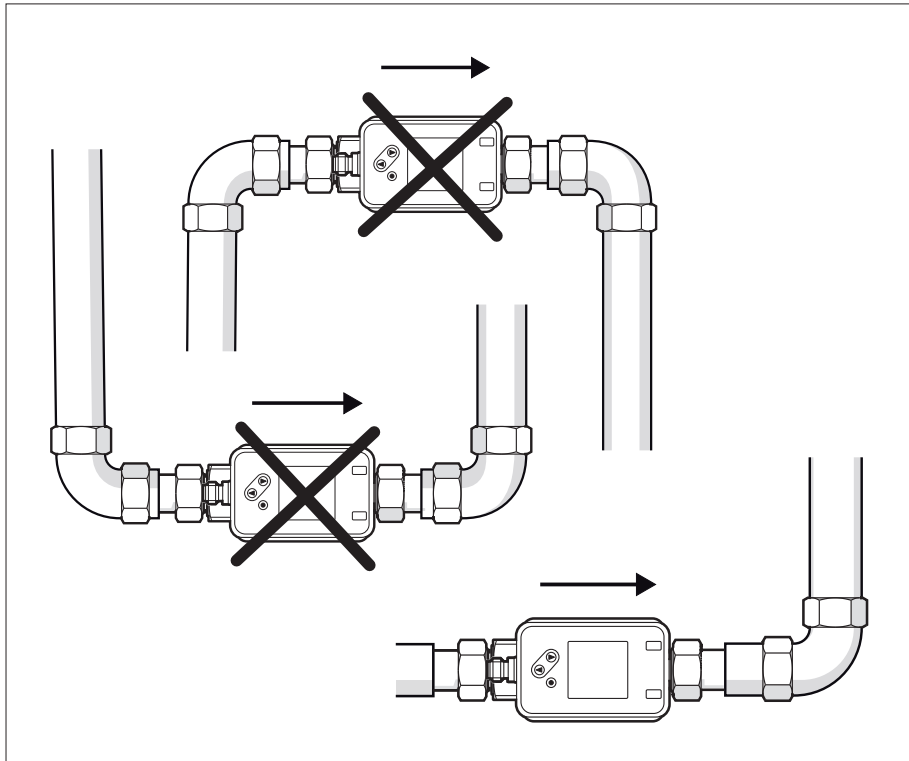


Figure 3-7: Installation in bending pipes

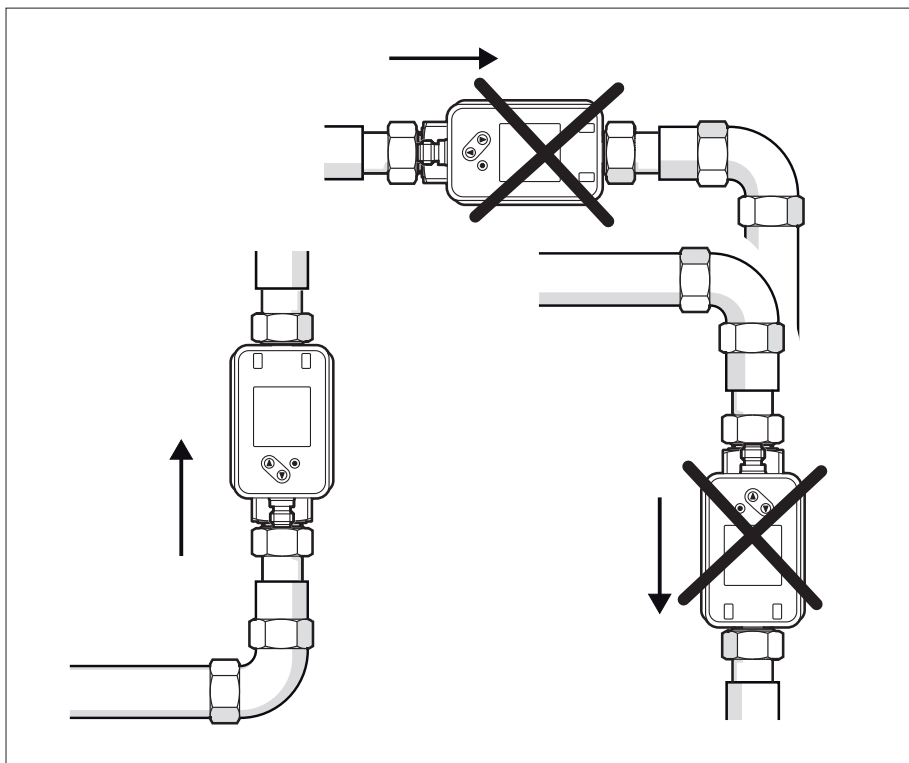


Figure 3-8: Installation in bending pipes

3.3.6 Torques

Thread	Size inch	DN size	Torque [Nm]	Wrench size [mm]	Comment
G ¼	¼ "	DN 6	15	24	external thread, flat seal
NPT	¼ "	DN 6	15	19	internal thread
RC	¼ "	DN 6	15	19	internal thread
G ½	½ "	DN 15	30	27	external thread, flat seal
NPT	½ "	DN 15	30	27	internal thread
RC	½ "	DN 15	30	27	internal thread
G ¾	¾ "	DN 20	30	36	external thread, flat seal
NPT	¾ "	DN 20	30	38	internal thread
RC	¾ "	DN 20	30	38	internal thread
G 1	1 "	DN 25	30	36	external thread, flat seal
NPT	1 "	DN 25	30	38	internal thread
RC	1 "	DN 25	30	38	internal thread

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 Grounding

*The device must be grounded in accordance with regulations in order to protect personnel
against electric shocks.*

*The grounding wire should not transmit any interference voltage. Therefore do not ground any
other electrical device at the same conductor.*

*When connecting to functional extra-low voltages (24 V DC), ensure that you use protective
separation (PELV) according to IEC 364/IEC 536 or VDE 0100/VDE 0106.*

*Make sure that the housing is connected to ground when installing the device in plastic piping
circuits. A grounding clamp accessory is available to connect grounding to the location of the
M12 connector.*

4.3 Cable connection M12 - 4 pin

All the operating data are preset at the factory. For changing the parameters and diagnostic purposes any IO link to USB service tool for the Multi IO version can be used. In all cases the buttons and the full colour display can be used for parametrization.

The USB service tool can be obtained via KROHNE.

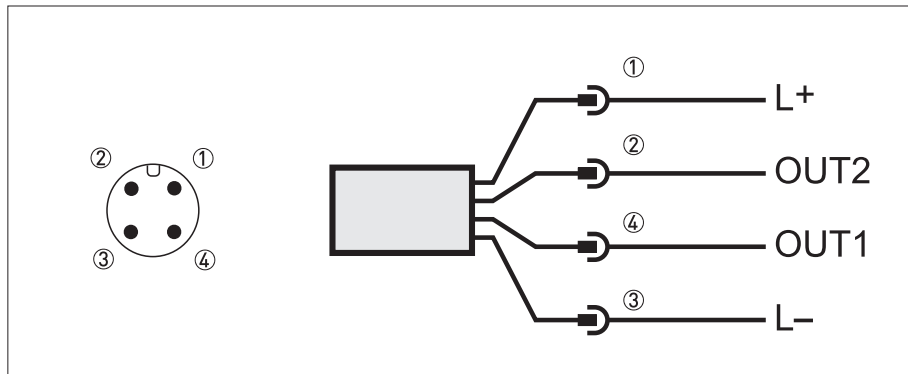


Figure 4-1: M12 - 4 pin connector

- ① L+
- ② OUT 2
- ③ OUT 1
- ④ L -

Output functions:

Multi I/O version	OUT 1	switch / frequency / pulse / IO-link
	OUT 2	switch / 4...20 mA / control input
Double analog version	OUT 1	4...20 mA
	OUT 2	4...20 mA

4.4 Cable connection M12 - 5 pin (Modbus)

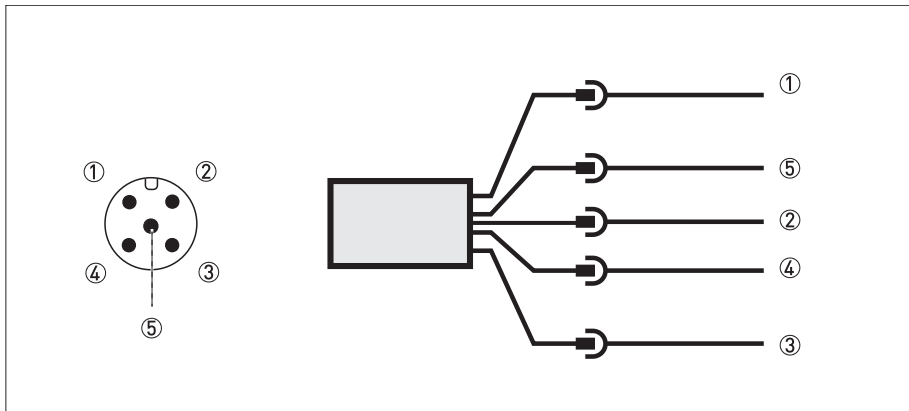


Figure 4-2: M12 - 5 pin connector

- ① Shield
- ② VIN
- ③ GND
- ④ D1 (B+)
- ⑤ D0 (B-)





KROHNE – Products, Solutions and Services

- Process instrumentation for flow, level, temperature, pressure measurement and process analytics
- Flow metering, monitoring, wireless and remote metering solutions
- Engineering, commissioning, calibration, maintenance and training services

Head Office KROHNE Messtechnik GmbH
Ludwig-Krohne-Str. 5
47058 Duisburg (Germany)
Tel.: +49 203 301 0
Fax: +49 203 301 10389
info@krohne.com

The current list of all KROHNE contacts and addresses can be found at:
www.krohne.com

