Technical Information
CNGmass DCI
Coriolis flowmeter

The refueling application flowmeter with seamless system integration

Application

- Measuring principle operates independently of physical fluid properties such as viscosity or density
- Accurate measurement of compressed natural gas (CNG) in high-pressure refueling applications

Device properties

- Flow rates up to 150 kg/min (330 lb/min)
- Process pressure up to 350 bar (5080 psi)
- Rupture disc available
- Device in compact or remote version
- Flexible outputs and Modbus RS485
- Transmitter for custody transfer

Your benefits

- Excellent operational safety - reliable under extreme process conditions
- Fewer process measuring points – multivariable measurement (flow, density, temperature)
- Space-saving installation – no in/outlet run needs
- High flexibility in system integration - wide range of communication interfaces
- Fast commissioning – pre-configured devices
- Automatic recovery of data for servicing

Endress+Hauser
People for Process Automation

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Function and system design

Measuring principle

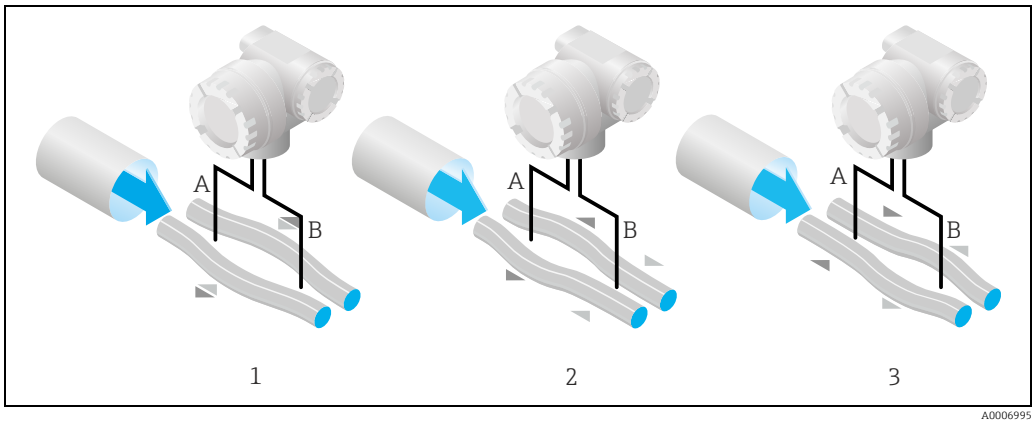
The measuring principle is based on the controlled generation of Coriolis forces. These forces are always present when both translational and rotational movements are superimposed.

$F_C = 2 \cdot \Delta m\ (v \cdot \omega)$
F_C = Coriolis force
Δm = moving mass
ω = rotational velocity
v = radial velocity in rotating or oscillating system

The amplitude of the Coriolis force depends on the moving mass Δm, its velocity v in the system, and thus on the mass flow. Instead of a constant angular velocity ω, oscillation occurs.

In the sensor, two parallel measuring tubes containing flowing fluid oscillate in antiphase, acting like a tuning fork. The Coriolis forces produced at the measuring tubes cause a phase shift in the tube oscillations (see illustration):

- At zero flow, in other words when the fluid is at a standstill, the two tubes oscillate in phase (1).
- Mass flow causes deceleration of the tube oscillation at the inlet (2) and acceleration at the outlet (3).



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The phase difference (A-B) increases with increasing mass flow. Electrodynamic sensors register the tube oscillations at the inlet and outlet. System balance is ensured by the antiphase oscillation of the two measuring tubes. The measuring principle works independently of temperature, pressure, viscosity, conductivity and flow profile.

Density measurement

The measuring tubes are always excited at their resonance frequency. A change in the mass and thus the density of the oscillating system (comprising measuring tubes and fluid) results in a corresponding, automatic adjustment in the exciter frequency. Resonance frequency is thus a function of fluid density. The microprocessor utilizes this relationship to obtain a density signal.

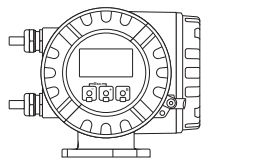
Temperature measurement

To make calculations to compensate for temperature effects, the temperature of the measuring tubes is measured. This signal corresponds to the process temperature and is also available as an output signal.

Measuring system

The measuring system consists of a transmitter and a sensor. Two versions are available:
- Compact version: transmitter and sensor form a single mechanical unit.
- Remote version: transmitter and sensor are installed separately.

Transmitter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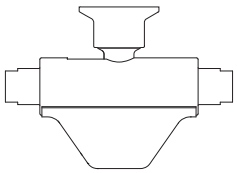
- Four-line liquid-crystal display
- Configuration via Touch Control, HART, Modbus RS485, FieldCare
- Application-specific Quick Setup
- Mass, density, volume and temperature measurement as well as variables calculated from these data (e.g. fluid concentrations)

Sensor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- Sensor for fluid temperatures up to 150 °C (302 °F)
- Nominal diameter range DN 8 to 25 (⅜ to 1")
- Stainless steel measuring tubes

Input

Measured variable

- Mass flow (proportional to the phase difference between two sensors mounted on the measuring tube which record differences in the pipe oscillation geometry during flow)
- Volume flow (measured from the mass flow and density)
- Fluid density (proportional to the resonance frequency of the measuring tube)
- Fluid temperature (measured with temperature sensors)

Measuring range

Measuring ranges for Compressed Natural Gas (CNG), non-custody transfer operation.

DN		$\dot{m}_{min(F)}$ to $\dot{m}_{max(F)}$	
[mm]	[in]	[kg/min]	[lb/min]
8	⅜"	0 to 30	0 to 66
15	½"	0 to 80	0 to 175
25	1"	0 to 150	0 to 330

Note!
The values of the corresponding custody transfer certificate apply for custody transfer operation.

Operable flow range

1:100

Input signal

Status input (auxiliary input)

U = 3 to 30 V DC, R_i = 3 kΩ, galvanically isolated.
Switching level: 3 to 30 V DC, polarity-independent.
Configurable for: totalizer reset, positive zero return, error message reset, start zero point adjustment.

Output

Output signal

Current output

Active/passive selectable, galvanically isolated, time constant selectable (0.05 to 100 s), full scale value selectable, temperature coefficient: typically 0.005% o.r. / °C, resolution: 0.5 µA
- Active: 0/4 to 20 mA, R_L < 700 Ω, R_L ≥ 250 Ω (HART)
- Passive: 4 to 20 mA; supply voltage V_S 18 to 30 V DC; R_i ≥ 150 Ω

o.r. = of reading

Pulse/frequency output

Passive can be selected, galvanically isolated
- Open collector, 30 V DC, 250 mA
- Frequency output: end frequency 2 to 10000 Hz (f_{max} = 12500 Hz), on/off ratio 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity selectable, pulse width configurable (0.05 to 2000 ms)

Modbus RS485

- Modbus device type: slave
- Address range: 1 to 247
- Functions codes supported: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Physical interface: RS485 in accordance with standard EIA/TIA-485
- Baud rates supported: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Transmission mode: RTU or ASCII
- Response times:
  Direct data access = typically 25 to 50 ms
  Auto-scan buffer (data range) = typically 3 to 5 ms
- Possible output combinations → Operating Instructions (BA00138D, BA00140D)

Signal on alarm

Current output
Failsafe mode selectable (for example, according to NAMUR Recommendation NE 43)

Pulse/frequency output
Failsafe mode selectable

Relay output
De-energized in the event of fault or power supply failure

Modbus RS485
If an error occurs, the value NaN (not a number) is output for the process variables.

Switching output

Relay output
Normally closed (NC or break) or normally open (NO or make) contacts available (factory setting: relay 1 = normally open), max. 30 V / 0.5 A AC; 60 V / 0.1 A DC, galvanically isolated.

Load

→ "Output signal"

Galvanic isolation

All circuits for inputs, outputs, and power supply are galvanically isolated from each other.

Power supply

Terminal assignment

Electrical values of the inputs/ outputs → Operating Instructions (BA00138D, BA00140D).

Order characteristic for "inputs/outputs"	Terminal No. (inputs/outputs)			
	20 (+) / 21 (-)	22 (+) / 23 (-)	24 (+) / 25 (-)	26 (+) / 27 (–)
Fixed communication boards (permanent assignment)				
S	–	–	Frequency output, Ex i, passive	Current output, Ex i, active, HART
T	–	–	Frequency output, Ex i, passive	Current output, Ex i, passive, HART
Q	–	–	Status input	Modbus RS485
Flexible communication boards				
D	Status input	Relay output	Frequency output	Current output, HART
M	Status input	Frequency output 2	Frequency output 1	Current output, HART
N	Current output	Frequency output	Status input	Modbus RS485
1	Relay output	Frequency output 2	Frequency output 1	Current output, HART
2	Relay output	Current output 2	Frequency output	Current output 1, HART
7	Relay output 2	Relay output 1	Status input	Modbus RS485

Supply voltage

85 to 260 V AC, 45 to 65 Hz
20 to 55 V AC, 45 to 65 Hz
16 to 62 V DC

Power consumption

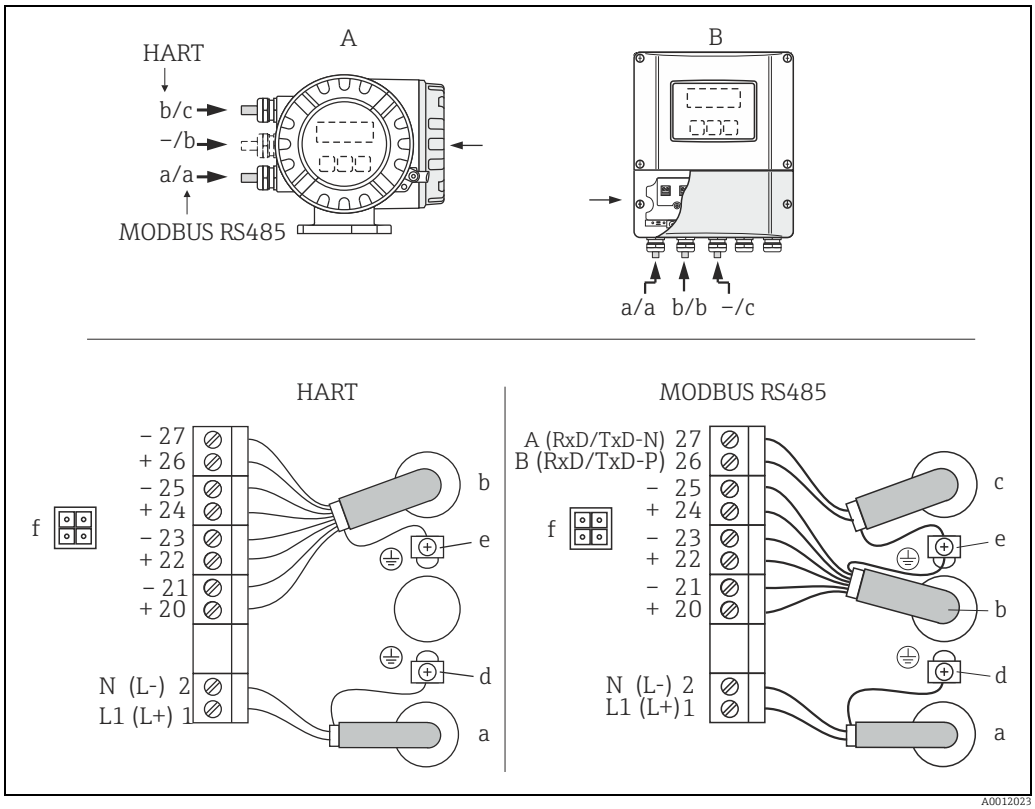
AC: < 15 VA (including sensor)
DC: < 15 W (including sensor)

Switch-on current
- max. 13.5 A (< 50 ms) at 24 V DC
- max. 3 A (< 5 ms) at 260 V AC

Power supply failure

Lasting min. 1 power cycle:
- EEPROM or HistoROM T-DAT saves measuring system data if power supply fails.
- HistoROM/S-DAT: exchangeable data storage chip which stores the data of the sensor (nominal diameter, serial number, calibration factor, zero point etc.)

Electrical connection



Connecting the transmitter, cable cross-section: max. 2.5 mm² (14 AWG)

A View A (field housing)
B View B (wall-mount housing)

a Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
- *Terminal No. 1: L1 for AC, L+ for DC*
- *Terminal No. 2: NN for AC, L- for DC*

b Signal cable: terminal assignment → 🖹 6

c Fieldbus cable
- *Terminal No. 26: B (RxD/TxD-P)*
- *Terminal No. 27: A (RxD/TxD-N)*

d Ground terminal for protective ground

e Ground terminal, signal cable shield / fieldbus cable shield
Observe the following:
- *the shielding and grounding of the fieldbus cable →Operating Instructions (BA00138D, BA00140D)*
- *that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible*

f Service adapter for connecting service interface FXA193 (Fieldcheck, FieldCare)

Potential equalization

No measures necessary. For explosion-protected equipment → separate Ex-documentation supplied.

Cable entries

Power supply and signal cables (inputs/outputs):
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Threads for cable entries, ½" NPT, G ½"

Connecting cable for remote version:
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Threads for cable entries, ½" NPT, G ½"

Cable specifications

Each compatible cable, with a temperature specification at least 20 °C (68 °F) higher than the ambient temperature prevailing in the application. We recommend using a cable with a temperature specification of +80 °C (+176 °F).

Modbus RS485
- Characteristic impedance: 120 Ω
- Cable capacity: < 30 pF/m (< 9.2 pF/ft)
- Core cross-section: > 0.34 mm² (AWG 22)
- Cable type: twisted pairs
- Loop-resistance: ≤110 Ω/km (≤0.034 Ω/ft)
- Shield: Copper braided shielding or braided shielding and foil shielding

Performance characteristics

Reference operating conditions

Error limits following ISO/DIS 11631:

- Fluid: water
- 15 to 45 °C (59 to 113 °F); 2 to 6 bar (29 to 87 psi)
- Calibration rigs returned to national calibration standards
- Zero point calibrated under operating conditions
- Density adjustment carried out

To obtain measured errors, use the Applicator sizing tool *Applicator*: → 🖹 17.

Maximum measured error

Mass flow

±0.5% of the quantity filled in typical CNG fueling.

Repeatability

Mass flow (gases)

±0.25% of the quantity filled in typical CNG fueling.

Influence of medium temperature

When there is a difference between the temperature for zero point adjustment and the process temperature, the typical measured error is ±0.0003% of the full scale value / °C.

Influence of medium pressure

The following section shows the effect on accuracy of mass flow due to a difference between calibration pressure and process pressure is negligible.

Installation

Installation instructions

Note the following points:

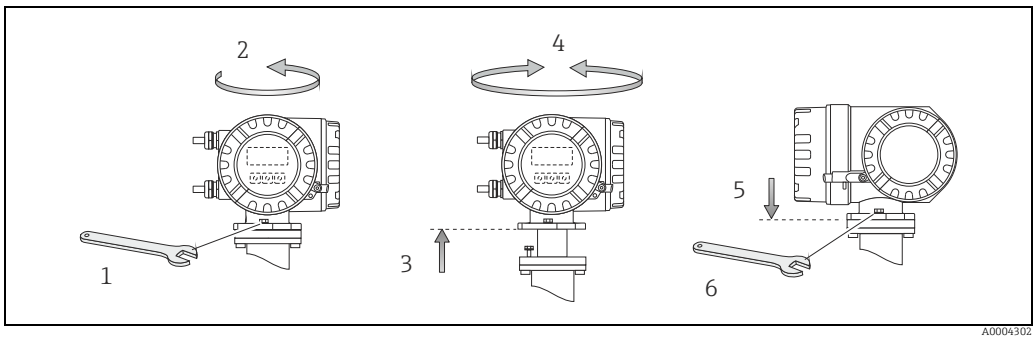
- No special measures such as supports are necessary. The housing absorbs external forces.
- The high oscillation frequency of the measuring tubes ensures that the correct operation of the measuring system is not influenced by pipe vibrations.
- No special precautions need to be taken for fittings which create turbulence (valves, elbows, T-pieces etc.).

Connection length

Max. 20 m (max. 66 ft)

Special installation instructions

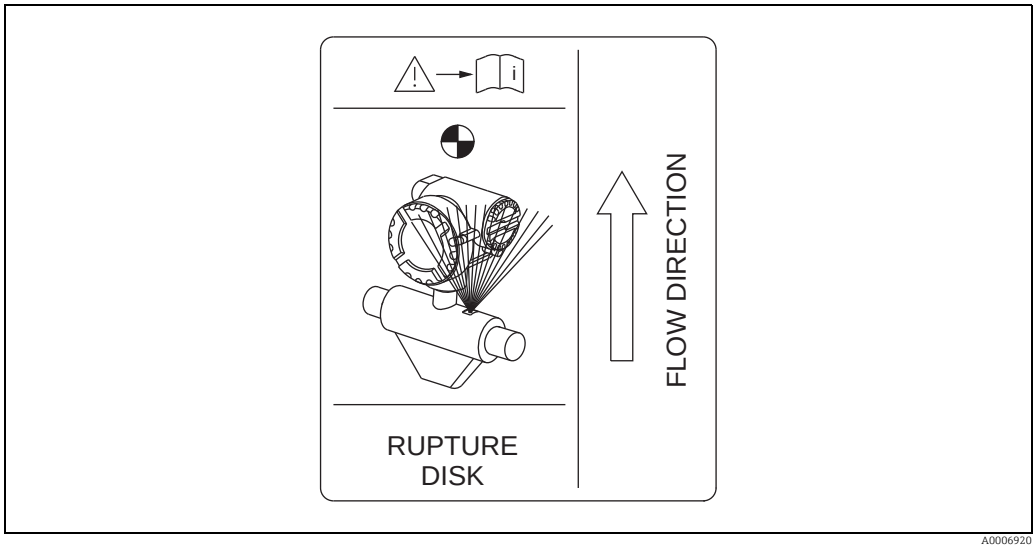
Turning the transmitter housing



Turning the transmitter housing

Rupture disk

Make sure that the function and operation of the rupture disk is not impeded through the installation of the device. The position of the rupture disk is indicated on a sticker applied over it. If the rupture disk is triggered, the sticker is destroyed. The disk can therefore be visually monitored. For additional information that is relevant to the process (→ 🖹 10).

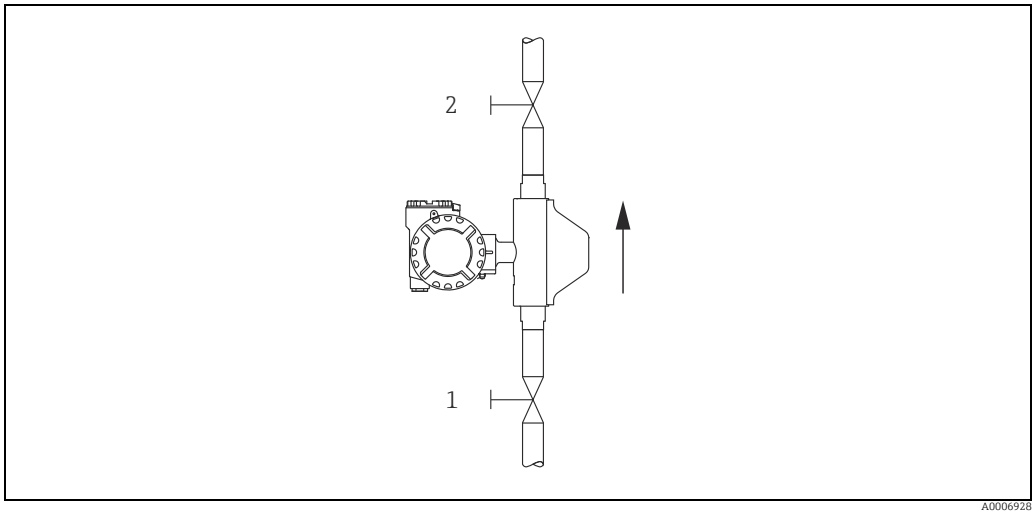


Indication label for the rupture disk

Zero point adjustment

All measuring devices are calibrated with state-of-the-art technology. Calibration takes place under reference operating conditions. Therefore, a zero point adjustment is generally **not** required.

If you want to carry out a zero point adjustment, note the following points before doing so:
- The calibration can be carried out under stable pressure conditions only.
- The zero point adjustment is carried out a zero flow. This can be achieved, for example, with shutoff valves upstream and/or downstream of the sensor or by using existing valves and gates.
  - Normal operation → valves 1 and 2 open
  - Zero point adjustment *with* process pressure → valve 1 open / valve 2 closed
  - Zero point adjustment *without* process pressure → Valve 1 closed / valve 2 open
- A zero point adjustment is **not** possible if the SECURITY function is enabled or if an error message is pending.



Zero point adjustment and shutoff valves

Environment

Ambient temperature range

Sensor and transmitter:
- Standard: −20 to +60 °C (−4 to +140 °F)
- Optional: −40 to +60 °C (−40 to +140 °F)

Note!
- Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions.
- At ambient temperatures below −20 °C (−4 °F), the readability of the display may be impaired.

Storage temperature

−40 to +80 °C (−40 to +176 °F), preferably +20 °C (+68 °F)

Degree of protection

Standard: IP 67 (NEMA 4X) for transmitter and sensor

Shock resistance

In accordance with IEC/EN 60068-2-31

Vibration resistance

In accordance with IEC/EN 60068-2-31

Electromagnetic compatibility (EMC)

As per IEC/EN 61326

Process

Medium temperature range

−50 to +150 °C (−58 to +302 °F)

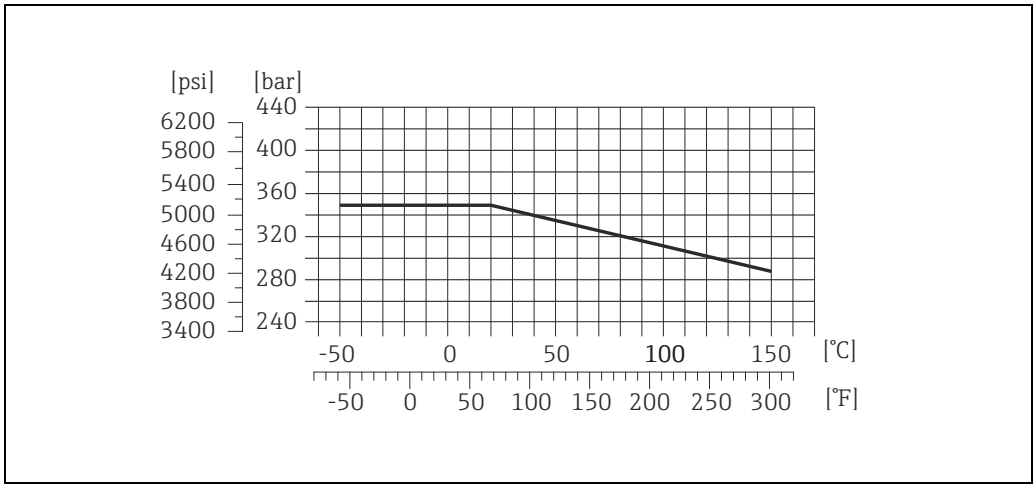
Medium pressure range (nominal pressure)

Max. 350 bar (max. 5080 psi)

Pressure-temperature ratings

Process connection: Cylindrical internal thread BSP (G) in accordance with ISO 228-1

Connection material: 1.4404 (316)



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Rupture disk

Triggering pressure in the housing 10 to 15 bar (145 to 218 psi), → 🖹 9 "Special mounting instructions".

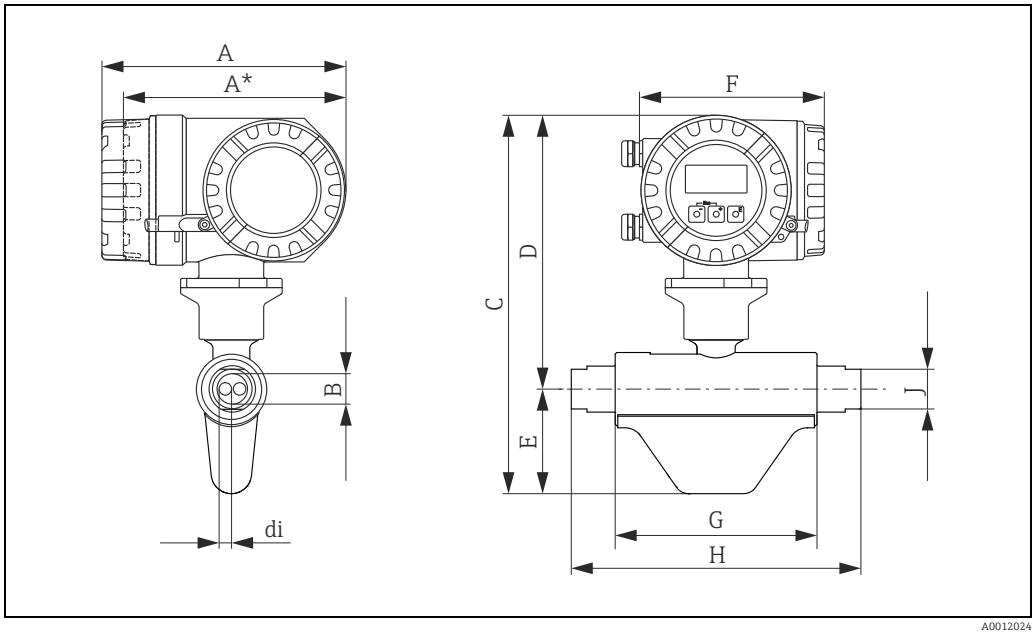
Limiting flow

→ 🖹 4, "Measuring range"

Mechanical construction

Design, dimensions

Compact version field housing (non-hazardous area and II2G / Zone 1)



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Dimensions in SI units

DN	A	A*	B	C	D	E	F	G	H	J	di
8	227	207	G½"	350	252	98	168	150	214	32	3.87
15	227	207	G¾"	352	252	100	168	193	267	41	6.23
25	227	207	G1"	357	252	105	168	244	316	46	8.80

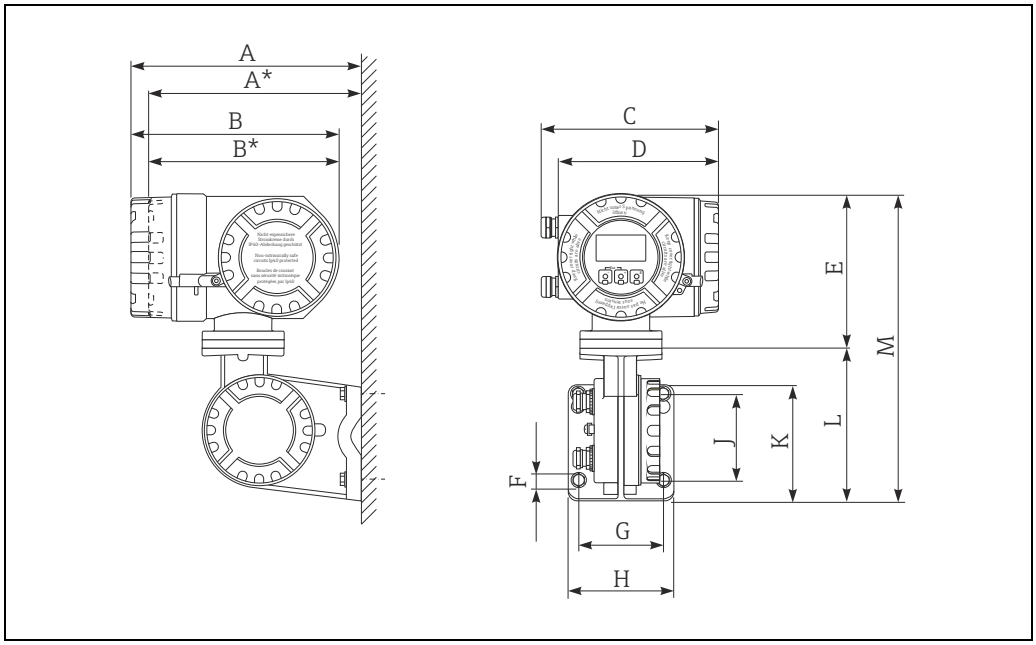
* Blind version (without local display)
All dimensions in [mm]

Dimensions in US units

DN	A	A*	B	C	D	E	F	G	H	J	di
⅜"	8.94	8.15	G½"	13.78	9.92	3.86	6.61	5.91	8.43	1.26	0.15
½"	8.94	8.15	G¾"	13.86	9.92	3.94	6.61	7.60	10.51	1.61	0.25
1"	8.94	8.15	G1"	14.06	9.92	4.13	6.61	9.61	12.44	1.81	0.35

* Blind version (without local display)
All dimensions in [in]

Remote version of transmitter, connection housing (II2G / Zone 1)



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Dimensions in SI units

A	A*	B	B*	C	D	E	F	G	H	J	K	L	M
265	242	240	217	206	186	178	Ø 8.6 (M8)	100	130	100	144	170	355

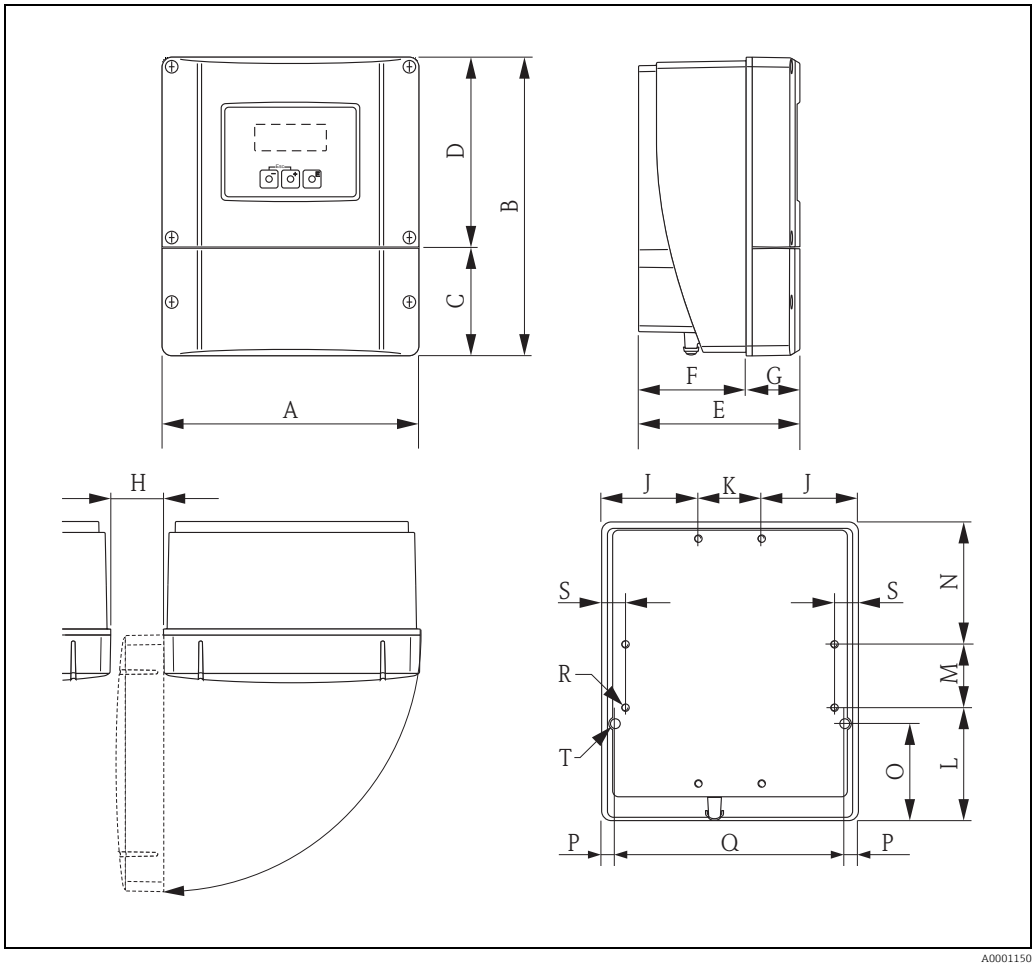
* Blind version (without local display)
All dimensions in [mm]

Dimensions in US units

A	A*	B	B*	C	D	E	F	G	H	J	K	L	M
10.4	9.53	9.45	8.54	8.11	7.32	7.01	Ø 8.6 (M8)	3.94	5.12	3.94	5.67	6.69	13.9

* Blind version (without local display)
All dimensions in [in]

Remote version of transmitter, wall-mount housing (non-hazardous area)



Dimensions in SI units

A	B	C	D	E	F	G	H	J	K
215	250	90.5	159.5	135	90	45	> 50	81	53
L	M	N	O	P	Q	R	S	T [1]	
95	53	102	81.5	11.5	192	8 × M5	20	2 × Ø 6.5	

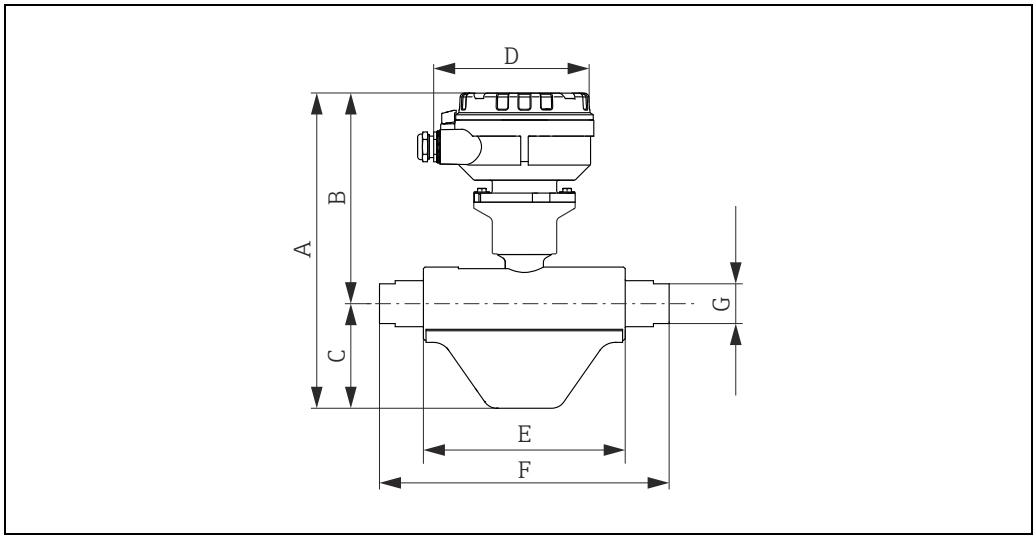
[1] Securing screw for wall mounting: M6 (screw head max. 10.5 mm)
All dimensions in [mm]

Dimensions in US units

A	B	C	D	E	F	G	H	J	K
8.46	9.84	3.56	6.27	5.31	3.54	1.77	> 1.97	3.18	2.08
L	M	N	O	P	Q	R	S	T [1]	
3.74	2.08	4.01	3.20	0.45	7.55	8 × M5	0.79	2 × Ø 0.26	

[1] Securing screw for wall mounting: M6 (screw head max. 0.41")
All dimensions in [in]

Remote version of sensor, connection housing (non-hazardous area and II2G / Zone 1)



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Dimensions in SI units

DN	A	B	C	D	E	F	G
8	350	196	98	144	150	214	32
15	352	196	100	144	193	267	41
25	357	196	105	144	244	316	46

All dimensions in [mm]

Dimensions in US units

DN	A	B	C	D	E	F	G
⅜"	13.78	7.72	3.86	5.67	5.91	8.43	1.26
½"	13.86	7.72	3.94	5.67	7.60	10.51	1.61
1"	14.06	7.72	4.13	5.67	9.61	12.44	1.81

All dimensions in [in]

Weight

DN in mm (inch)	8 (⅜")	15 (½")	25 (1")
Weight in kg	8.9	10.8	11.8
Weight in lb	19.6	23.8	26.0

Material

Transmitter housing:

Powder coated die-cast aluminium

Housing of sensor/secondary containment

Acid-resistant and alkali-resistant external surface, stainless steel 1.4301 (304)

Process connections

Stainless steel 1.4404 (316)

Measuring tubes

Stainless steel 1.4435 (316L)

Process connections

Cylindrical internal thread BSP (G) in accordance with ISO 228-1 with sealing surfaces in accordance with DIN 3852-2/ISO 1179-1:

- G ½" for DN 08 (⅜")
- G ¾" for DN 15 (½")
- G 1" for DN 25 (1")

Note!
Sealed with profile seal in accordance with DIN 3869 or copper disk or steel seal disk with plastic lip.

Operability

Local display

Display elements

- Liquid crystal display: illuminated, four lines with 16 characters per line
- Selectable display of different measured values and status variables
- At ambient temperatures below −20 °C (−4 °F), the readability of the display may be impaired.

Control elements

- Local operation with three optical sensors (⊟⊞Ⓔ)
- Application specific Quick Setup menus for straightforward commissioning

Language groups

Language groups available for operation in different countries:
- Western Europe and America (WEA): English, German, Spanish, Italian, French, Dutch and Portuguese
- Eastern Europe/Scandinavia (EES): English, Russian, Polish, Norwegian, Finnish, Swedish, Czech
- South and East Asia (SEA): English, Japanese, Indonesian
- China (CN): English, Chinese

Note!
You can change the language group via the operating program FieldCare.

Remote operation

Operation via HART or Modbus protocol.

Certificates and approvals

CE mark

The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

C-tick mark

The measuring system meets the EMC requirements of the Australian Communications and Media Authority (ACMA).

Ex approval

Information about currently available Ex versions (ATEX, NEC/CEC etc.) can be supplied by your Endress+Hauser sales center on request. All explosion protection data are given in a separate Ex documentation, which is available upon request.

Approval for custody transfer

Information about currently available approvals for custody transfer can be supplied by your E+H Sales Center on request.

HART certification

The flowmeter has successfully passed all the test procedures carried out and is certified and registered by the HCF (Hart Communication Foundation). The device thus meets all the requirements of the following specifications:
- Certified in accordance with HART Revisions 5 (device certification number: available on request)
- The measuring device can also be operated with certified devices of other manufacturers (interoperability).

Modbus certification

The measuring device meets all the requirements of the Modbus/TCP conformity test and has the "Modbus/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "Modbus/TCP Conformance Test Laboratory" of the University of Michigan.

Pressure Equipment Directive

The measuring devices can be ordered with or without PED (Pressure Equipment Directive). If a device with PED is required, this must be ordered explicitly. For devices with nominal diameters less than or equal to DN 25 (1"), this is neither possible nor necessary.

- With the identification PED/G1/III on the sensor nameplate, Endress+Hauser confirms conformity with the "Basic safety requirements" of Appendix I of the Pressure Equipment Directive 97/23/EC.
- Devices with this identification (with PED) are suitable for the following types of fluid:
  - Fluids of Group 1 and 2 with a steam pressure greater than, or smaller and equal to 0.5 bar (7.3 psi)
  - Unstable gases
- Devices without this identification (without PED) are designed and manufactured according to good engineering practice. They correspond to the requirements of Art. 3, Section 3 of the Pressure Equipment Directive 97/23/EC. Their application is illustrated in Diagrams 6 to 9 in Appendix II of the Pressure Equipment Directive 97/23/EC.

Other standards and guidelines

- EN 60529
  Degrees of protection by housing (IP code)
- EN 61010-1
  Safety requirements for electrical equipment for measurement, control and laboratory use
- IEC/EN 61326
  Electromagnetic compatibility (EMC requirements)
- OIML R139
  Suitability for custody transfer measurement

Ordering Information

Detailed ordering information is available from the following sources:
- In the Product Configurator on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser Sales Center: www.endress.com/worldwide

Note!
Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Device-specific accessories

For the Transmitter

Accessories	Description
Mounting set for transmitter	Mounting set for wall-mount housing (remote version). Suitable for: ▪ Wall mounting ▪ Pipe mounting ▪ Installation in control panel Mounting set for aluminium field housing: Suitable for pipe mounting (¾" to 3")

Communication-specific accessories

Accessories	Description
HART Communicator Field Xpert handheld terminal	Handheld terminal for remote parameterization and for obtaining measured values via the current output HART (4 to 20 mA). Contact your Endress +Hauser representative for more information.
Commubox FXA195 HART	The Commubox FXA195 connects intrinsically safe smart transmitters with the HART protocol with the USB port of a personal computer. This enables remote operation of the transmitter with operating software (e.g. FieldCare). Power is supplied to the Commubox via the USB port.

Service-specific accessories

Accessories	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, accuracy or process connections ▪ Graphic illustration of the calculation results Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://wapps.endress.com/applicator ▪ On CD-ROM for local PC installation
W@M	Life cycle management for your plant. W@M supports you with a wide range of software applications over the entire process: from planning and procurement, to the installation, commissioning and operation of the measuring devices. All the relevant device information, such as the device status, spare parts and device-specific documentation, is available for every device over the entire life cycle. The application already contains the data of your Endress+Hauser device. Endress+Hauser also takes care of maintaining and updating the data records. W@M is available: ▪ Via the Internet: www.endress.com/lifecyclemanagement ▪ On CD-ROM for local PC installation
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.
FieldCare	FieldCare is Endress+Hauser's FDT-based plant asset management tool and allows the configuration and diagnosis of intelligent field devices. By using status information, you also have a simple but effective tool for monitoring devices. The flowmeters are accessed via a service interface or via the service interface FXA193.
FXA291	Service interface from the measuring device to the PC for operation via FieldCare.

System components

Accessories	Description
Memograph M graphic display recorder	The Memograph M graphic display recorder provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analysed. The data are stored in the 256 MB internal memory and also on a DSD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available enable continuous monitoring of specific power consumption, boiler efficiency and other parameters which are important for efficient energy management.

Documentation

- Flow measurement (FA00005D)
- Operating Instructions (BA00138D)
- Operating Instructions Modbus RS485 (BA00140D)
- Description of Device Parameters (GP00001D)
- Description of Device Parameters Modbus RS485 (GP00003D)
- Ex-Supplementary documentation: ATEX (II2G) (XA00135D)
- Ex-Supplementary documentation: NEC/CEC (XA00137D)
- Ex-Supplementary documentation: NEPSI (XA00138D)

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