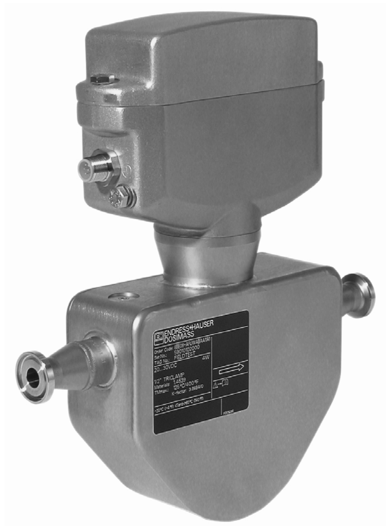
Technical Information
TI 065D/06/en
50106486

Coriolis Mass Flow Measuring System *dosimass*

Mass flow measuring system for filling applications



Application
Suitable for use as a mass or volume flowmeter for filling applications.

Liquids with the most diverse properties from the following branches can be measured:
- Food and beverage industry
- Cosmetics industry
- Pharmaceutical industry
- Chemical industry
- Petrochemicals

Your benefits
- Small size meets the requirements for installation on rotary and linear filling machines
- Highly accurate
- Easy operation via the E+H "FieldTool" operating software:
  - Graphic display allows exact analysis and optimisation of the batching process
  - Complete system documentation can be created with device configuration and batching diagram
- 3A approval
- CIP, SIP cleaning as well as external cleaning with aggressive media
- No moving parts

Endress + Hauser
The Power of Know How

Table of contents

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.

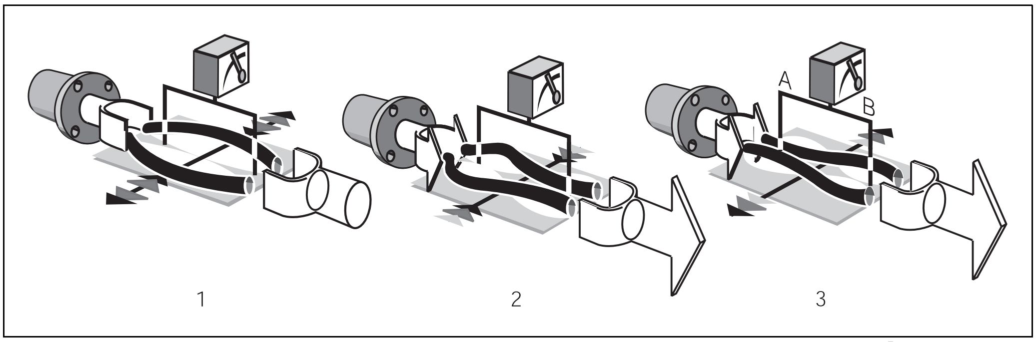
$\vec{F}_C = 2 \cdot \Delta m (\vec{v} \cdot \vec{\omega})$

$\vec{F}$ = Coriolis force
Δm = moved mass
$\vec{\omega}$ = angular velocity
$\vec{v}$ = radial velocity in the rotating or oscillating system

The amplitude of the Coriolis force depends on the moving mass Δm, its velocity in the system, and thus on the mass flow. Instead of a constant rotating velocity, the Dosimass uses oscillation.

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 oscillation at the inlet of the tubes (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 operates independently of temperature, pressure, viscosity, conductivity and flow profile.

Density measurement
The measuring tubes are continuously 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 oscillation frequency. Resonance frequency is thus a function of fluid density. The microprocessor utilises this relationship to obtain a density signal.

Temperature measurement
The temperature of the measuring tubes is determined in order to calculate the compensation factor due to temperature effects. This signal corresponds to the process temperature and is also available as an output.

Measuring system

The measuring system is a compact unit consisting of a sensor and transmitter.

Input

Measured variable

- Mass flow
- Volume flow (calculated from mass flow and density)
- Density
- Fluid temperature (measured with temperature sensors)

Measuring range

DN	Range of full scale values (liquids) $m_{min}...m_{max}$
8	0... 2000 kg/h
15	0... 6500 kg/h
25	0...18000 kg/h

Recommended full scale values:
See information on Page 10, ("Limiting flow")

Operable flow range

Greater than 1000 :1. Flows above the preset full scale value do not overload the amplifier, i.e. totalized flow values are registered correctly.

Output

Output signal

Pulse output:
Passive, max. 30VDC/250mA, pulse value and pulse polarity can be selected, pulse width adjustable (0.05 ms ... 1 s).

Note!
The device may only be connected to SELV, PELV or CLASS 2 circuits.

Signal on alarm

Pulse output → behaviour can be selected
Transistor status output not conducting in the event of a fault/notice (depending on setting) or if the power supply fails

Low flow cutoff

Switch point for low flow cutoff selectable.

Galvanic isolation

The power supply and outputs are galvanically isolated from one another.

Switching output

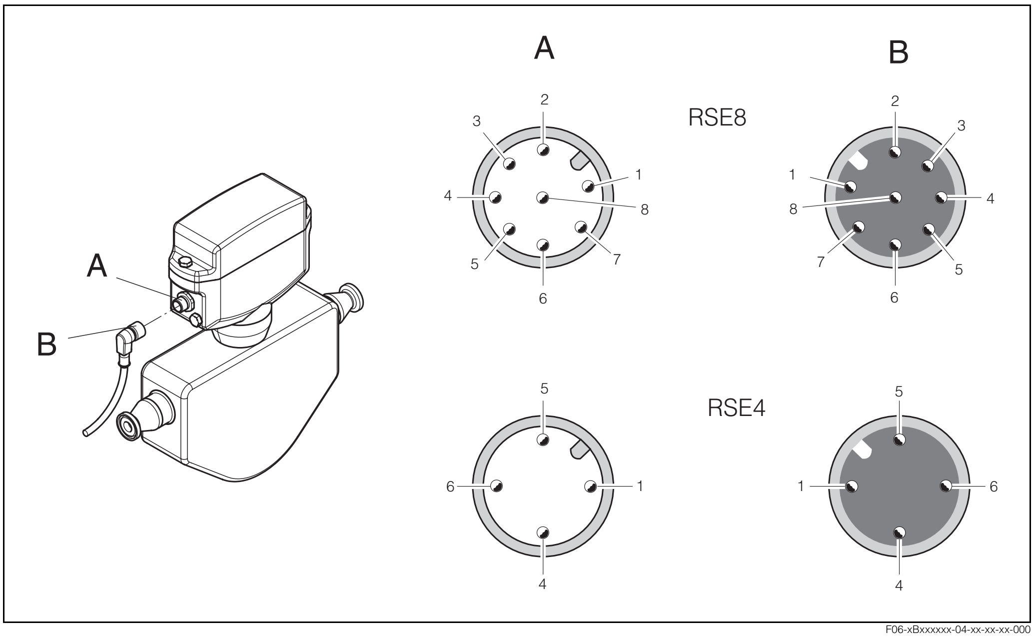
Status output:
Passive, max. 30 VDC / 250 mA

Note!
The device may only be connected to SELV, PELV or CLASS 2 circuits.

Power supply

Electrical connections

The electrical connection of the device is established using a Lumberg connector (type RSE8 or RSE4, M12x1).



Wiring diagram

A Socket at device
B Cable connector
1 (+), power supply (24VDC nominal voltage (20...30 VDC), 4.3 W)
4 (-), power supply (24VDC nominal voltage (20...30 VDC), 4.3 W)
5 (+), pulse, status output (max. 30 V)
6 (-), pulse output (max. 250 mA)
7 (-), status output (max. 250 mA)
2 Service interface (may not be connected during normal operation)
3 Service interface (may not be connected during normal operation)
8 Service interface (may not be connected during normal operation)

Supply voltage

24VDC nominal voltage (20...30 VDC)

Note!
- The power supply may not exceed a maximum short-circuit current of 50 A.
- The device may only be connected to SELV, PELV or CLASS 2 circuits.

Power consumption

Max. 4.3 W
Switch-on current: max. 1A (< 6 ms)

Power supply failure

Lasting min. 20 ms.:
All sensor and measuring point data remain in the DAT

Potential equalisation

No special measures are necessary for potential equalisation. For devices for the Ex area, see the notes in the Ex-specific supplement to these Operating Instructions.

Cable connection

Lumberg plug (RSE8 or RSE4, M12x1) for power supply and signal outputs

Cable specification

Every suitable cable with a temperature specification at least 20 °C higher than the ambient temperature in the application. We recommend you use a cable with a temperature specification of +80 °C.

Performance characteristics

Reference operating conditions

Error limits following ISO/DIS 11631:

- 20...30 °C; 2...4 bar
- Calibration systems traced to national norms.
- Zero point calibrated under operating conditions
- Density calibration performed

Max. measured error

Mass flow:
±0.15% o.r. (1...4 m/s)
or
±0.3% ± [(zero point stability / measured value) x 100]% o.r.
or
±5% ± [(zero point stability / measured value) x 100]% o.r.

o.r. = of reading

Zero point stability:

DN	Maximum full scale value [kg/h]	Zero point stability [kg/h]
8	2000	0.20
15	6500	0.65
25	18000	1.8

Calculation example:
Give that: Dosimass DN 15, flow = 1300 kg/h, measured error: ±0.3% ± [(zero point stability / measured value) x 100]% o.r.

Measured error → $\pm 0{,}3\ \% \pm \frac{0{,}65\ \mathrm{kg/h}}{1300\ \mathrm{kg/h}} \times 100\ \% = \pm 0{,}35$

Repeatability

Dosing time [s]	Standard deviation [%]	Confidence limit of the mean 3s = 99.7% [%]
≥ 0.75	0.2	± 0.6
≥ 1.5	0.1	± 0.3
≥ 3.0	0.05	± 0.15

Influence of medium temperature

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

Influence of medium pressure

The effect of a difference in pressure between the calibration pressure and the process pressure on the measured error for mass flow is negligible.

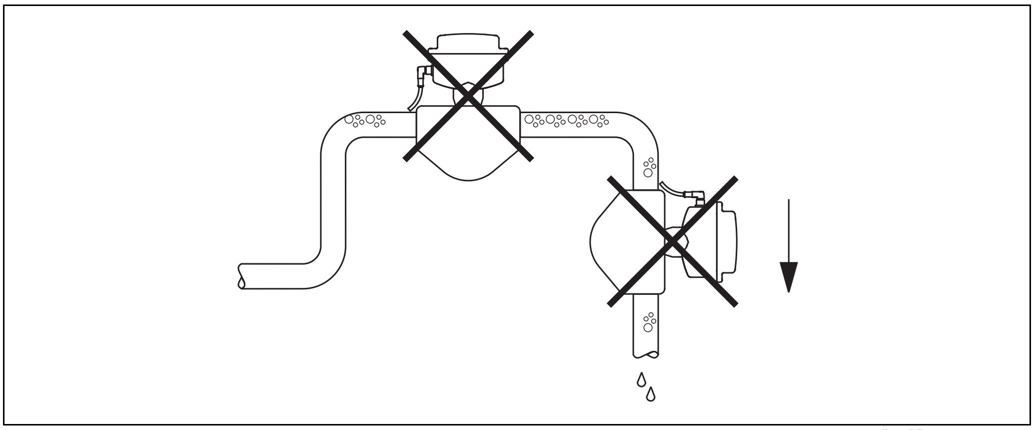
Operating conditions: Installation

Installation instructions

Note the following points:
- No special measures such as supports are necessary. External forces are absorbed by the construction of the instrument.
- The high oscillation frequency of the measuring tubes ensures that the correct operation of the measuring system is not influenced by plant vibrations.
- No special precautions need to be taken for fittings which create turbulence (valves, elbows, Tpieces, etc.), as long as no cavitation occurs.

Mounting location

Correct measurement is only possible if the pipe is filled. **For this reason, avoid** the following mounting locations in the pipe:
- At the highest point of the pipeline. Risk of air accumulating.
- Directly upstream of a free pipe outlet in a down pipe.



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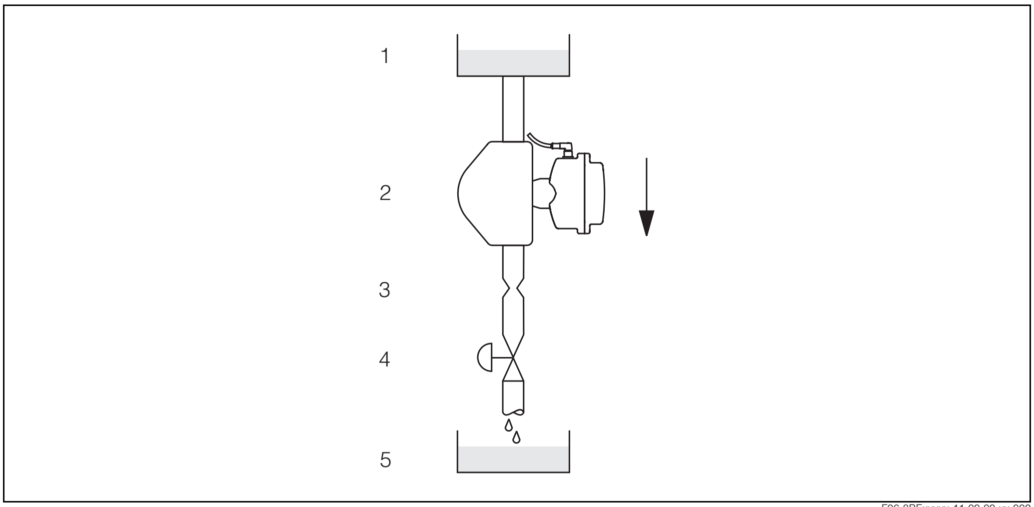
The following proposed installation, however, permits installation in an open down pipe. Pipe restrictors or the use of an orifice with a cross-section smaller than the nominal diameter prevent the pipe from running empty during measurement.



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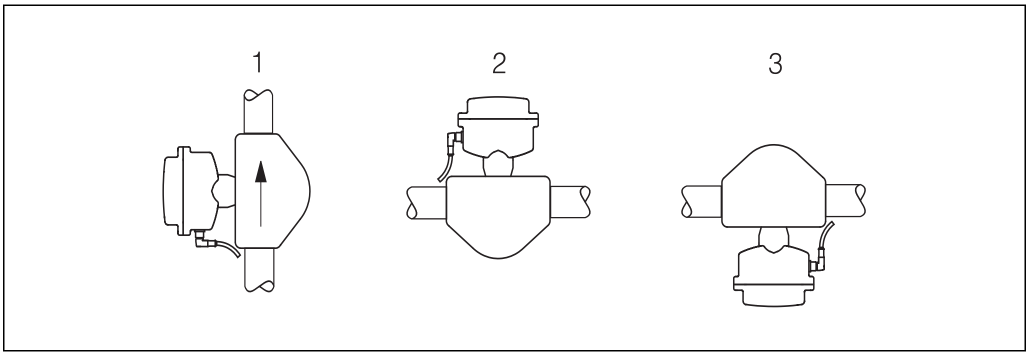
Installation in a down pipe (e.g. for batching applications)

1 = Supply tank, 2 = Sensor, 3 = Orifice plate, pipe restriction, 4 = Valve, 5 = Batching tank

Dosimass / DN	8	15	25
∅ **Orifice plate, pipe restriction**	6 mm	10 mm	14 mm

Orientation

Vertical:
Recommended orientation with upward direction of flow. When fluid is not flowing, entrained solids will sink down and gases will rise away from the measuring tube. The measuring tubes can be completely drained and protected against solids build-up.



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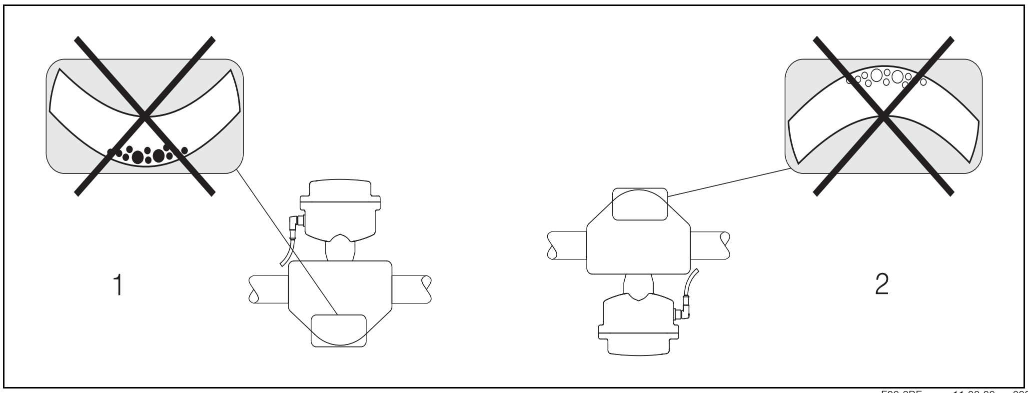
Horizontal:
The measuring tubes of Dosimass must be horizontal and beside each other. When installation is correct, the transmitter housing is above or below the pipe (View 2, 3). Always avoid having the transmitter housing in a lateral position.

Caution!
The measuring tubes of Dosimass are slightly curved. The position of the sensor, therefore, has to be matched to the fluid properties when the sensor is installed horizontally.



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1 Not suitable for fluids with entrained solids. Risk of solids accumulating.
2 Not suitable for outgassing fluids. Risk of air accumulating.

Fluid temperature

Caution!
Hot surface temperatures can arise at the housing of the device if fluid temperatures are >70°C.

In order to ensure that the maximum permissible ambient temperature for the transmitter (-20...+60 °C) is not exceeded, we recommend the following orientations:

High fluid temperature
Vertical piping: installation in accordance with View 1
Horizontal piping: installation in accordance with View 3

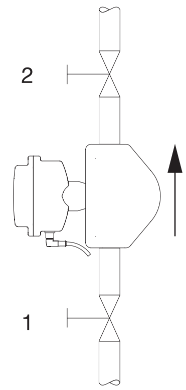
Low fluid temperature
Vertical piping: installation in accordance with View 1
Horizontal piping: installation in accordance with View 2

Zero point adjustment

Experience shows that the zero point adjustment is advisable only in special cases:
- To achieve highest measuring accuracy also with very small flow rates.
- Under extreme process or operating conditions (e.g. very high process temperatures or very high-viscosity fluids).

A zero point adjustment can be performed only with fluids that contain no gas or solid contents. A zero point adjustment is performed with the measuring tubes completely filled and at zero flow (v = 0 m/s). This can be achieved, for example, with shut-off 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* pump pressure → valve 1 open / valve 2 closed
- Zero point adjustment *without* pump pressure → valve 1 closed / valve 2 open



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Heating, heating insulation

Some fluids require suitable measures to avoid loss of heat or heat supply at the sensor.
A wide range of materials can be used to provide the required thermal insulation. Heating can be electric, e.g. with electric band heaters, or by means of hot water or steam pipes made of copper.

Caution!
Risk of electronics overheating!
- Consequently, make sure that the adapter between sensor and transmitter always remains free of insulating material. Note that a certain orientation might be required, depending on the fluid temperature (→ Page 8 “Fluid temperature” Section).
- For information on the permitted temperature ranges, see Page 10, "Ambient temperature range" Section.

Inlet and outlet runs

There are no installation requirements regarding inlet and outlet runs.

System pressure

It is important to ensure that cavitation does not occur because it would influence the oscillation of the measuring tube. No special measures need to be taken for fluids which have properties similar to water under normal conditions.
In the case of liquids with a low boiling point (hydrocarbons, solvents, liquefied gases) or in suction lines, it is important to ensure that pressure does not drop below the vapour pressure and that the liquid does not start to boil. It is also important to ensure that the gases that occur naturally in many liquids do not outgas. Such effects can be prevented when system pressure is sufficiently high.

Consequently, it is generally best to install the sensor:
- downstream from pumps (no danger of vacuum),
- at the lowest point in an ascending pipeline.

Operating conditions: Environment

Ambient temperature range	-20...+60 °C (sensor, transmitter) Install the device at a shady location. Avoid direct sunlight, particularly in warm climatic regions.
Storage temperature	-40...+80 °C (preferably +20 °C)
Degree of protection	Standard: IP 67 (NEMA 4X) for transmitter and sensor
Shock resistance	In accordance with IEC 68-2-31
Vibration resistance	In accordance with IEC 68-2-31
Electromagnetic compatibility	In accordance with EN 61326 (IEC 1326)

Operating conditions: Process

Medium temperature range	Sensor: • -40...+125 °C Seals: • No internal seals
Medium pressure range	Max. 100 bar, depending on process connection
Limiting flow	See information on Page 4, ("Measuring range") Select nominal diameter by optimising between required flow range and permissible pressure loss. See Page 4, "Measuring range" Section for a list of maximum possible full scale values. • The minimum recommended full scale value is approx. 1/20 of the maximum full scale value. • In most applications, 20...50% of the maximum full scale value can be considered ideal. • Select a lower full scale value for abrasive substances such as fluids with entrained solids (flow velocity < 1 m/s).

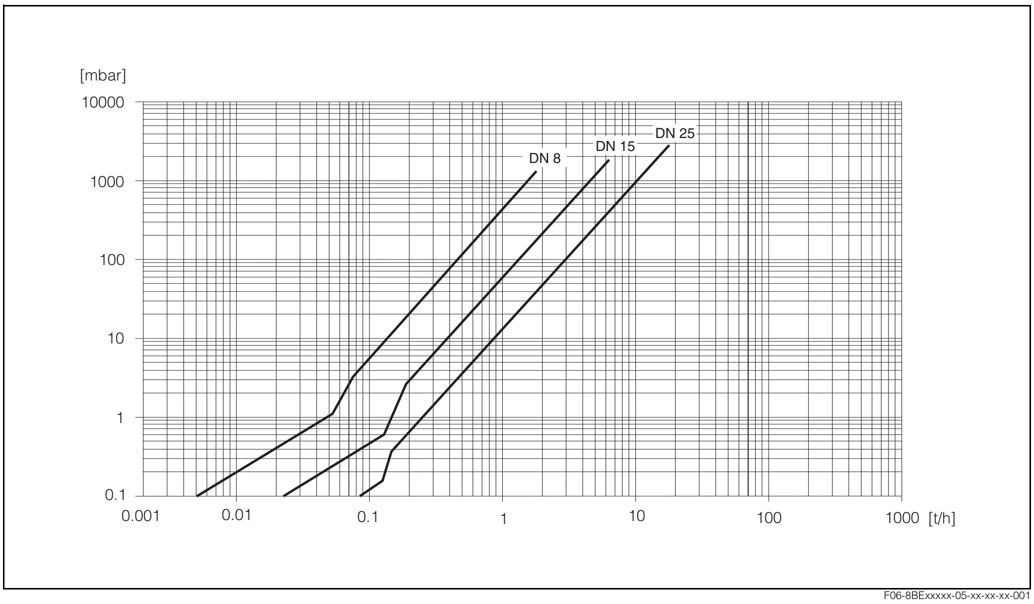
Pressure loss

Pressure loss depends on the fluid properties and on the flow rate. The following formulas can be used to approximately calculate the pressure loss:

Reynolds number	$R_e = \dfrac{2 \cdot \dot{m}}{\pi \cdot d \cdot \upsilon \cdot \rho}$
Re ≥ 2300	$\Delta p = K \cdot \upsilon^{0.25} \cdot \dot{m}^{1.85} \cdot \rho^{-0.86}$
Re < 2300	$\Delta p = K1 \cdot \upsilon \cdot \dot{m} + \dfrac{K2 \cdot \upsilon^{0.25} \cdot \dot{m}^2}{\rho}$
Δp = pressure loss [mbar] υ = kinematic viscosity [m^2/s] $\dot{m}$ = mass flow [kg/s]	ρ = density [kg/m^3] d = inside diameter of measuring tubes [m] K...K2 = constants (depending on nominal diameter)

Pressure loss coefficients:

DN	d [m]	K	K1	K2
8	$5.35 \cdot 10^{-3}$	$5.70 \cdot 10^{7}$	$7.91 \cdot 10^{7}$	$2.10 \cdot 10^{7}$
15	$8.30 \cdot 10^{-3}$	$7.62 \cdot 10^{6}$	$1.73 \cdot 10^{7}$	$2.13 \cdot 10^{6}$
25	$12.00 \cdot 10^{-3}$	$1.89 \cdot 10^{6}$	$4.66 \cdot 10^{6}$	$6.11 \cdot 10^{5}$
Pressure loss data including interface between measuring tubes and piping				

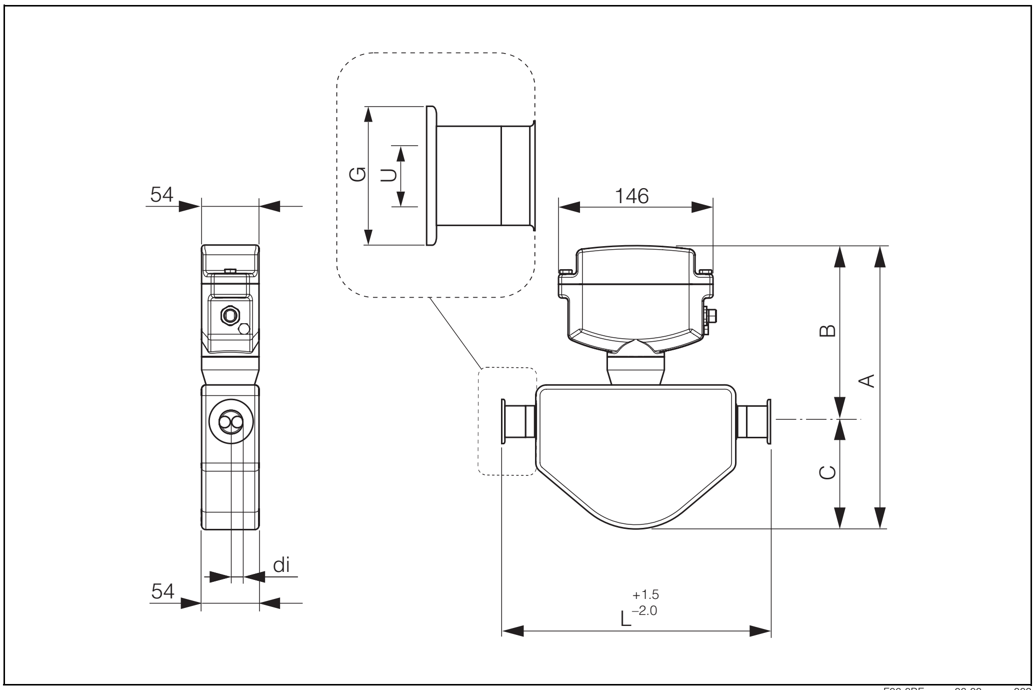


Pressure loss diagram with water

Mechanical construction

Design / dimensions

Dosimass dimensions: Tri-Clamp connections



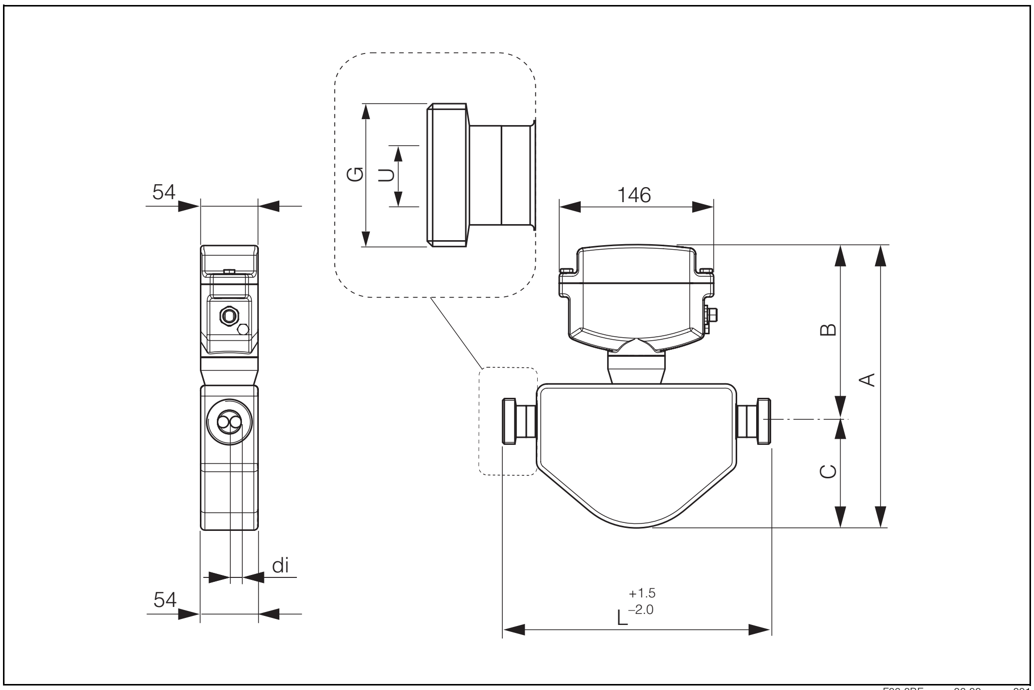
Dosimass dimensions: Tri-Clamp connections

1/2" Tri-Clamp: 1.4404/316L								
DN	Clamp	A	B	C	G	L	U	di
8	1/2"	253	160	93	25.0	229	9.5	5.35
15	1/2"	267	167	105	25.0	273	9.5	8.30
3A version also available (Ra ≤0.8 µm/150 grit)								

3/4" Tri-Clamp: 1.4404/316L								
DN	Clamp	A	B	C	G	L	U	di
8	3/4"	253	160	93	25.0	229	16	5.35
15	3/4"	267	167	105	25.0	273	16	8.30
3A version also available (Ra ≤0.8 µm/150 grit)								

1" Tri-Clamp: 1.4404/316L								
DN	Clamp	A	B	C	G	L	U	di
8	1"	253	160	93	50.4	229	22.1	5.35
15	1"	267	162	105	50.4	273	22.1	8.30
25	1"	273	167	106	50.4	324	22.1	12.00
3A version also available (Ra ≤0.8 µm/150 grit)								

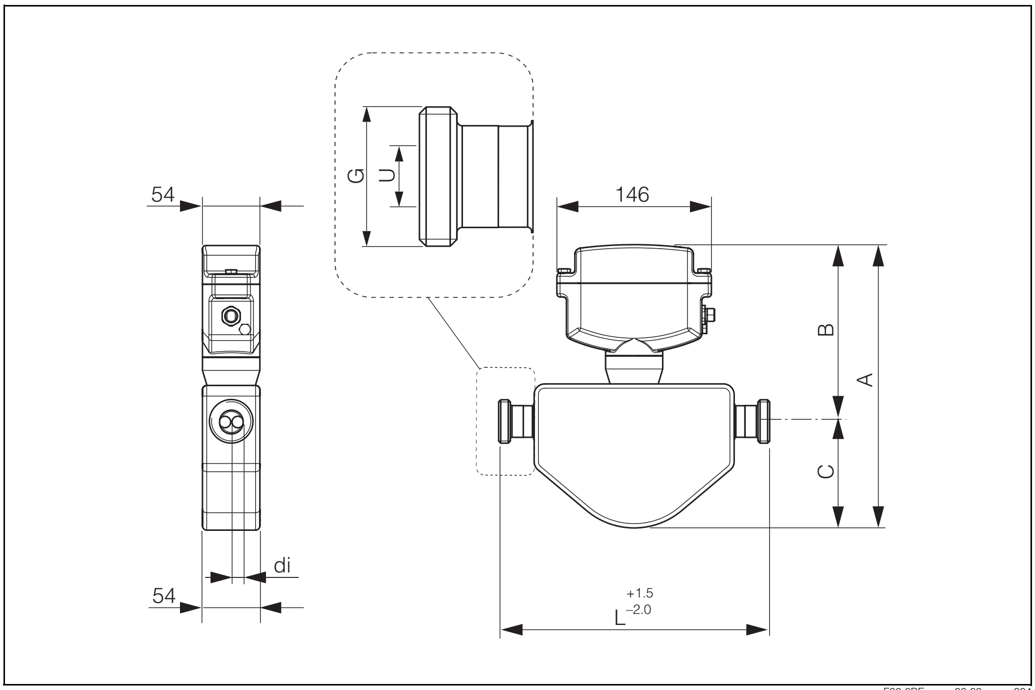
Dosimass dimensions: DIN 11851 connections (sanitary connection)



Dosimass dimensions : DIN 11851 connections (sanitary connection)

Sanitary connection DIN 11851: 1.4404/316L							
DN	A	B	C	G	L	U	di
8	253	160	93	Rd 34 x 1/8"	229	16	5.35
15	267	162	105	Rd 34 x 1/8"	273	16	8.30
25	273	167	106	Rd 52 x 1/6"	324	26	12.00
3A version also available (Ra ≤0.8 µm/150 grit)							

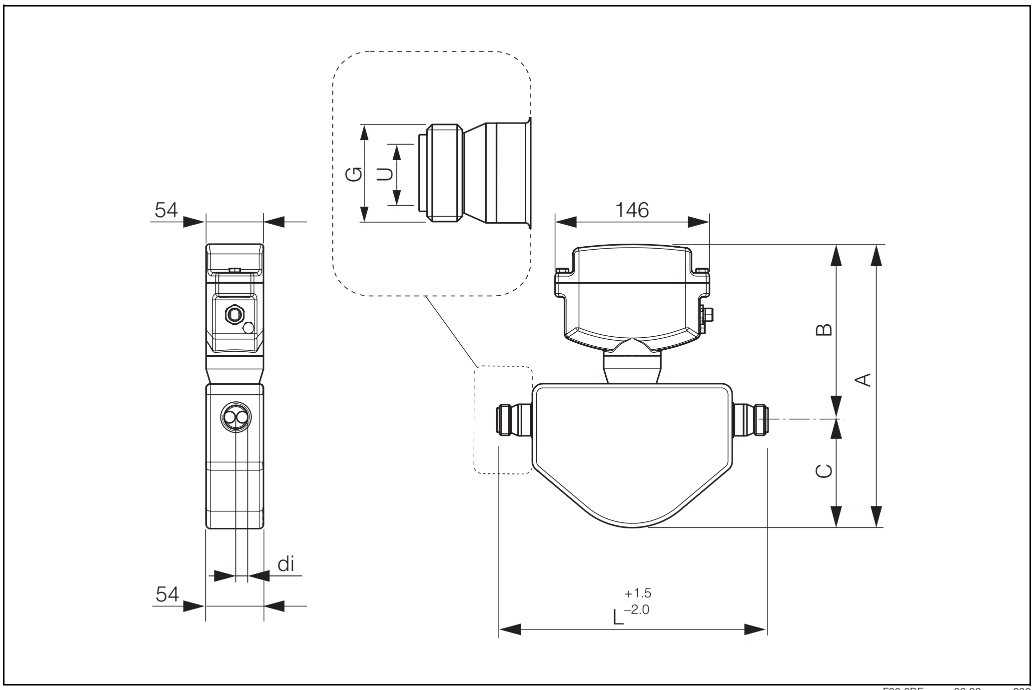
Dosimass dimensions : DIN 11864-1 Form A (threaded joint)



Dosimass dimensions: DIN 11864-1 Form A (threaded joint)

Threaded joint DIN 11864-1 Form A: 1.4404/316L							
DN	A	B	C	G	L	U	di
8	253	160	93	Rd 28 x 1/8"	229	10	5.35
15	267	162	105	Rd 34 x 1/8"	273	16	8.30
25	273	167	106	Rd 52 x 1/6"	324	26	12.00
3A version also available (Ra ≤0.8 µm/150 grit)							

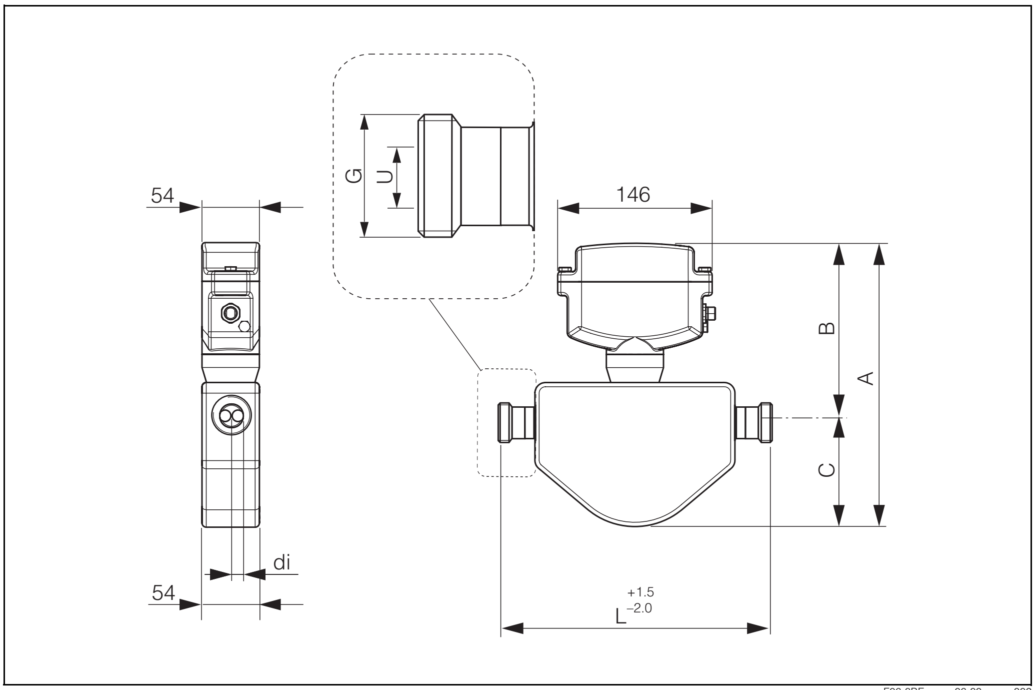
Dosimass dimensions : ISO 2853 connections (threaded connection)



Dosimass dimensions: ISO 2853 connections (threaded joint)

Threaded joint ISO 2853: 1.4404/316L							
DN	A	B	C	G[1)]	L	U	di
8	253	160	93	37.13	229	22.6	5.35
15	267	162	105	37.13	273	22.6	8.30
25	273	167	106	37.13	324	22.6	12.00
[1)] Max. thread diameter to ISO 2853 Annex A, 3A version also available (Ra ≤0.8 µm/150 grit)							

Dosimass dimensions: SMS 1145 connections (sanitary connection)



Dosimass dimensions : SMS 1145 connections (sanitary connection)

Sanitary connection SMS 1145: 1.4404/316L							
DN	A	B	C	G	L	U	di
8	253	160	93	Rd 40 x 1/6"	229	22.5	5.35
15	267	162	105	Rd 40 x 1/6"	273	22.5	8.30
25	273	167	106	Rd 40 x 1/6"	324	22.5	12.00
3A version also available (Ra ≤0.8 µm/150 grit)							

Weight

Dosimass / DN	8	15	25
Weight in [kg]	3.5	4.0	4.5

Material

Transmitter housing:
1.4308/304

Sensor housing:
Acid and alkali-resistant outer surface; stainless steel 1.4301/304

Process connection:
- Threaded joint DIN 11864-1 → stainless steel 1.4404/316L
- Sanitary connection DIN 11851 / SMS 1145 → stainless steel 1.4404/316L
- Threaded joint ISO 2853 / DIN 11864-1 → stainless steel 1.4404/316L
- Tri-Clamp → stainless steel 1.4404/316L

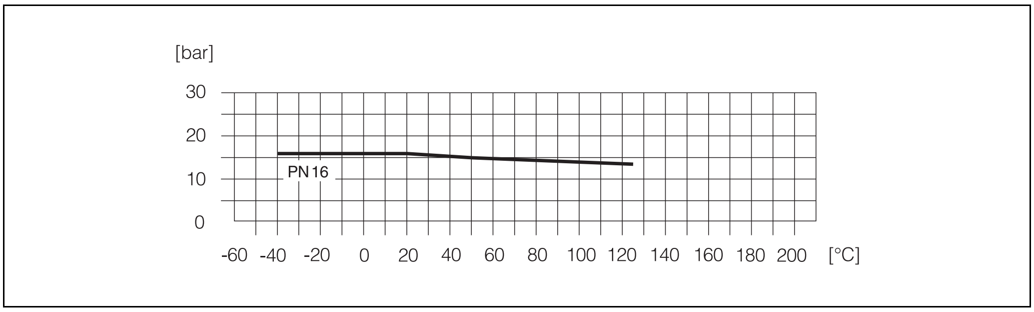
Measuring tubes:
Stainless steel 1.4539/904L

Seals:
Welded process connections without internal seals

Material load diagram

Sanitary connection as per DIN 11851 / SMS 1145

Material connection:



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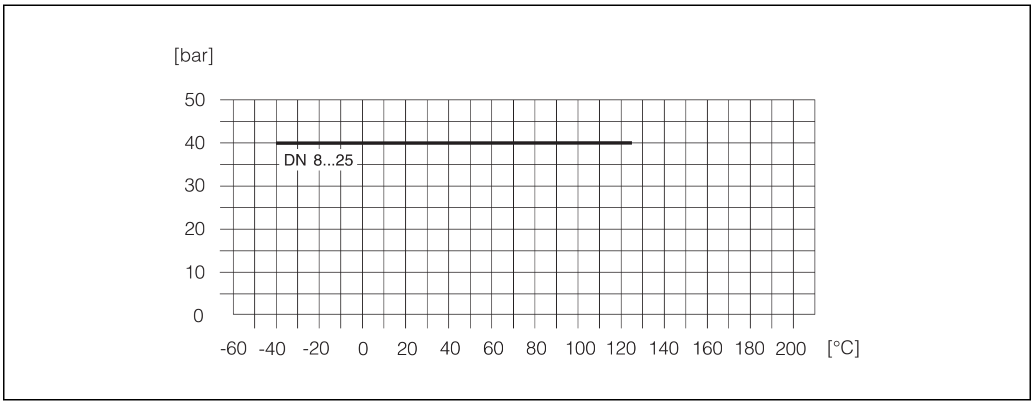
Tri-Clamp process connection

The load limit is defined exclusively by the material properties of the outer clamp used. This clamp is not included in the scope of delivery.

Threaded joint DIN 11864-1



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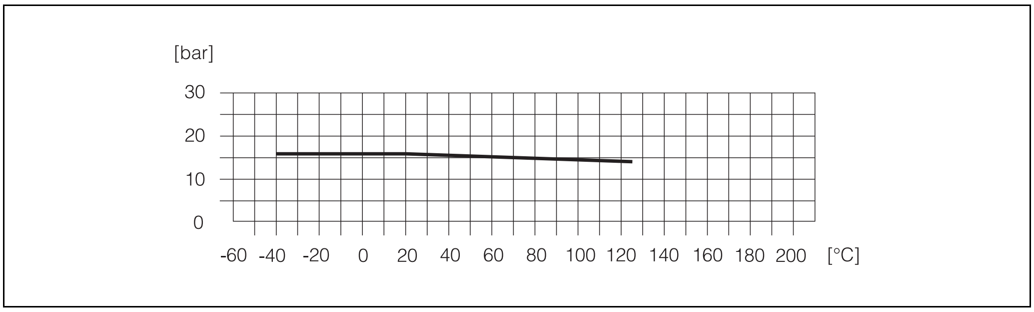
Threaded joint ISO 2853



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Process connection

Sanitary connections: Tri-Clamp, threaded joints (DIN 11851, SMS 1145, ISO 2853, DIN 11864-1)

User interface

Display elements	Dosimass does not have a display or display elements.
Remote operation	Operation takes place via the "FieldTool" configuration and service program from Endress+Hauser. This can be used to configure functions and read off measured values.

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.
Ex approval	Information about currently available Ex versions (ATEX, FM, CSA, etc.) can be supplied by your E+H Sales Centre on request. All explosion protection data are given in a separate documentation which is available upon request.
Sanitary compatibility	3A approval
Other standards and guidelines	EN 60529: Degrees of protection by housing (IP code) EN 61010-1: Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures. EN 61326 (IEC 1326): Electromagnetic compatibility (EMC requirements) EN 61000-4-3 (IEC 1000-4-3) Operating behaviour A with screened connecting cable possible (screening placed as short as possible on both sides), otherwise operating behaviour B. NAMUR NE 21: Association for Standards for Control and Regulation in the Chemical Industry
Pressure measuring device approval	All Dosimass devices correspond to Article 3(3) of the EC Directive 97/23/EC (Pressure Equipment Directive) and have been designed and manufactured according to good engineering practice.

Ordering information

The E+H service organisation can provide detailed ordering information and information on specific order codes on request.

Accessories/spare parts

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter. The E+H service organisation can provide detailed information on request.

Documentation

- Dosimass Operating Instructions (BA097D/06/en)
- Supplementary documentation on Ex-ratings: ATEX

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