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Technical Information

Proline Promass 80A, 83A

Coriolis Mass Flow Measuring System
The single-tube system for highly accurate measurement of very small flows

Application
The Coriolis measuring principle operates independently of the physical fluid properties, such as viscosity and density.

- Suitable for continuous measurement, filling and dosing of very small flows.
- Extremely accurate measurement of liquids and gases such as emulsions, additives, flavouring, insulin, gases for high pressure and low pressure
- Fluid temperatures up to +200 °C
- Process pressures up to 400 bar

Approvals for hazardous area:
- ATEX, FM, CSA, TIIS

Approvals in the food industry/hygiene sector:
- 3A, FDA, EHEDG

Connection to all common process control systems:
- HART, PROFIBUS PA/DP, FOUNDATION Fieldbus, MODBUS

Relevant safety aspects:
- Pressure Equipment Directive, SIL-2

Features and benefits
The Promass measuring devices make it possible to simultaneously record several process variables (mass/density/temperature) for various process conditions during measuring operation.

The **Proline transmitter concept** comprises:
- Modular device and operating concept resulting in a higher degree of efficiency
- Software options for batching and concentration measurement for extended range of application
- Diagnostic ability and data back-up for increased process quality

The **Promass sensors**, tried and tested in over 100000 applications, offer:
- Multivariable flow measurement in compact design
- Insensitivity to vibrations thanks to balanced single-tube measuring system
- Efficient protection against forces from piping thanks to robust construction
- Easy installation without taking inlet and outlet runs into account

TI054D/06/en/03.05
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Endress+Hauser
People for Process Automation

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Function and system design

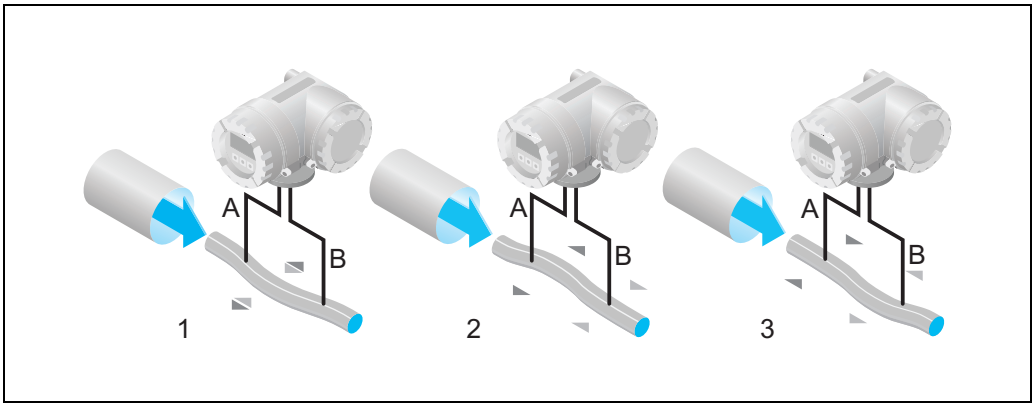
Measuring principle

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, the Promass sensor uses oscillation.

The measuring tube, through which the medium flows, oscillates. The Coriolis forces produced at the measuring tube cause a phase shift in the tube oscillations (see illustration):
- At zero flow, i.e. when the fluid is at a standstill, the oscillation registered at points A and B is in phase, i.e. there is no phase difference (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.
Compared to two-tube systems, other constructive solutions are required for the system balance for single-tube systems. For this purpose, Promass A has an internal reference mass.
The measuring principle operates independently of temperature, pressure, viscosity, conductivity and flow profile.

Density measurement

The measuring tube is continuously excited at its resonance frequency. A change in the mass and thus the density of the oscillating system (comprising measuring tube 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.

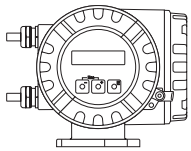
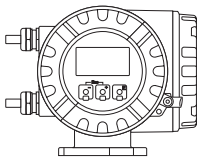
Temperature measurement

The temperature of the measuring tube 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.

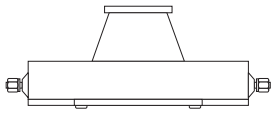
Measuring system

The measuring system consists of a transmitter and a sensor. Two versions are available:
- Compact version: transmitter and sensor form a mechanical unit.
- Remote version: transmitter and sensor are mounted physically separate from one another.

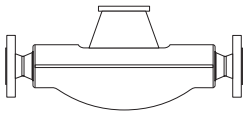
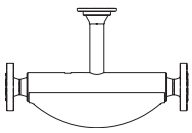
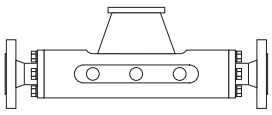
Transmitter

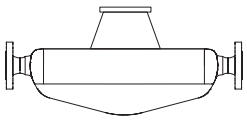
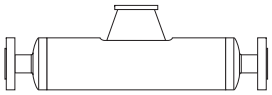
Promass 80  a0003671	■ Two-line liquid-crystal display ■ Configuration also using key operation
Promass 83  a0003672	■ Four-line liquid-crystal display ■ Operation with “Touch control” ■ Application-specific Quick Setup ■ Mass flow, volume flow, density and temperature measurement as well as calculated variables (e.g. fluid concentrations)

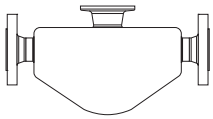
Sensor

A  a0003679	■ Single-tube system for highly accurate measurement of very small flows ■ Nominal diameters DN 1...4 ■ Measuring tube made of stainless steel or Alloy C-22	Documentation No. TI 054D/06/en

Further sensors in separate documentations

F  a0003673	■ Universal sensor for fluid temperatures up to 200 C ■ Nominal diameters DN 8...250 ■ Measuring tubes made of stainless steel or Alloy C-22	Documentation No. TI 053D/06/en
F (High-temperature)  a0003675	■ Universal high-temperature sensor for fluid temperatures up to 350 C ■ Nominal diameters DN 25, 50, 80 ■ Tube material: Alloy C22	Documentation No. TI 053D/06/en
M  a0003676	■ Robust sensor for extreme process pressures, high secondary containment requirements and fluid temperatures up to 150 C ■ Nominal diameters DN 8...80 ■ Tube material: titanium	Documentation No. TI 053D/06/en

H  a0003677	■ Single bent tube. Low pressure loss and chemically resistant material ■ Fit-and-forget ■ Nominal diameters DN 8...40 ■ Tube material: zirconium	Documentation No. TI 052D/06/en
I  a0003678	■ Straight single-tube instrument. Minimal shear stress on fluid, hygienic design, low pressure loss. ■ Fit-and-forget: No special supports required for installation. ■ Nominal diameters DN 8...80 ■ Tube material: titanium	Documentation No. TI 052D/06/en

E  a0002271	■ General purpose sensor, ideal replacement for volumetric flowmeters. ■ Nominal diameters DN 8...50 ■ Tube material: stainless steel	Documentation No. TI 061D/06/en

Input

Measured variable

- Mass flow (proportional to the phase difference between two sensors mounted on the measuring tube to register a phase shift in the oscillation)
- Fluid density (proportional to resonance frequency of the measuring tube)
- Fluid temperature (measured with temperature sensors)

Measuring range

Measuring ranges for liquids

DN	Range for full scale values (liquids) $\dot{m}_{min(F)}...\dot{m}_{max(F)}$
1	0...20 kg/h
2	0...100 kg/h
4	0...450 kg/h

Measuring ranges for gases

The full scale values depend on the density of the gas. Use the formula below to calculate the full scale values:

$\dot{m}_{max(G)} = \dot{m}_{max(F)} \cdot \rho_{(G)} / 32\ [kg/m^3]$

$\dot{m}_{max(G)}$ = max. full scale value for gas [kg/h]
$\dot{m}_{max(F)}$ = max. full scale value for liquid [kg/h]
$\rho_{(G)}$ = gas density in [kg/m³] at process conditions

Here, $\dot{m}_{max(G)}$ can never be greater than $\dot{m}_{max(F)}$

Calculation example for gas:

- Measuring device: Promass A, DN 2
- Gas: air with a density of 11.9 kg/m³ (at 20 °C and 10 bar)
- Measuring range: 100 kg/h

Max. possible full scale value:
$\dot{m}_{max(G)} = \dot{m}_{max(F)} \cdot \rho_{(G)} / 32\ [kg/m^3]$ = 100 kg/h ·11.9 kg/h / 32 kg/m³ = 37.2 kg/h

Recommended measuring ranges:

See information in the “Limiting flow” Section → Page 19 ff.

Operable flow range

Greater than 1000 :1. Flow rates above the preset full scale value do not overload the amplifier, i.e. the totalizer values are registered correctly.

Input signal

Status input (auxiliary input):

U = 3...30 V DC, R_i = 5 kΩ, galvanically isolated.
Configurable for: totalizer reset, positive zero return, error message reset, zero point adjustment start, batching start/stop (optional)

Current input (only Promass 83)

Active/passive selectable, galvanically isolated, resolution: 2 µA
- Active: 4...20 mA, $R_i \leq 150\ \Omega$, U_{out} = 24 V DC, short-circuit proof
- Passive: 0/4...20 mA, $R_i \leq 150\ \Omega$, U_{max} = 30 V DC

Output

Output signal

Promass 80

Current output:

Active/passive selectable, galvanically isolated, time constant selectable (0.05...100 s), full scale value adjustable, Temperature coefficient: typ. 0.005% o.r./°C, resolution: 0.5 µA
- Active: 0/4...20 mA, $R_L < 700\ \Omega$ (at HART: $R_L \geq 250\ \Omega$)
- Passive: 4...20 mA; supply voltage V_S 18...30 V DC; $R_i \geq 150\ \Omega$

Pulse/frequency output:

Passive, open collector, 30 V DC, 250 mA, galvanically isolated.
- Frequency output: full scale frequency 2...1000 Hz (f_{max} = 1250 Hz), on/off ratio 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity can be selected, pulse width adjustable (0.5...2000 ms).

PROFIBUS PA interface:

- PROFIBUS PA in accordance with EN 50170 Volume 2, IEC 61158-2 (MBP), galvanically isolated
- Profile Version 3.0
- Current consumption: 11 mA
- Permissible supply voltage: 9...32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic) = 0 mA
- Data transmission rate: 31.25 kBit/s
- Signal encoding: Manchester II
- Function blocks: 4 x Analog Input, 1 x Totalizer
- Output data: Mass flow, Volume flow, Density, Temperature, Totalizer
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Totalizer control
- Bus address can be set at the measuring device via miniature switches or the on-site display (optional)

Promass 83

Current output:

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

Pulse/frequency output:

active/passive selectable, galvanically isolated
- Active: 24 V DC, 25 mA (max. 250 mA during 20 ms), R_L > 100 Ω
- Passive: open collector, 30 V DC, 250 mA
- Frequency output: full scale frequency 2...10000 Hz (f_{max} = 12500 Hz), on/off ration 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity selectable, pulse width adjustable (0.05...2000 ms); the on/off ratio is 1:1 as of a frequency of 1 / (2 x pulse width)

PROFIBUS DP interface:

- PROFIBUS DP in accordance with EN 50170 Volume 2, IEC 61158-2, galvanically isolated
- Profile Version 3.0
- Data transmission rate: 9.6 kBaud...12 MBaud
- Automatic data transmission rate recognition
- Signal encoding: NRZ-Code
- Function blocks: 6 x Analog Input, 3 x Totalizer
- Output data: Mass flow, Volume flow, Corrected volume flow, Density, Reference density, Temperature, Totalizer 1...3
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Totalizer control
- Bus address can be set at the measuring device via miniature switches or the on-site display (optional)
- Available output combination→ Page 10

PROFIBUS PA interface:

- PROFIBUS PA in accordance with EN 50170 Volume 2, IEC 61158-2 (MBP), galvanically isolated
- Data transmission rate: 31.25 kBit/s
- Current consumption: 11 mA
- Permissible supply voltage: 9...32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Signal encoding: Manchester II
- Function blocks: 6 x Analog Input, 3 x Totalizer
- Output data: Mass flow, Volume flow, Corrected volume flow, Density, Reference density, Temperature, Totalizer 1...3
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Totalizer control
- Bus address can be set at the measuring device via miniature switches or the on-site display (optional)
- Available output combination→ Page 10

MODBUS interface:

- MODBUS device type: slave
- Address range: 1...247
- Supported function codes: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Physical interface: RS485 in accordance with EIA/TIA-485 standard
- Supported baudrate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Automatic data transmission rate recognition
- Transmission mode: RTU or ASCII
- Response times:
  Direct data access = typically 25...50 ms
  Auto-scan buffer (data range) = typically 3...5 ms
- Available output combination→ Page 10

FOUNDATION Fieldbus interface:

- FOUNDATION Fieldbus H1, IEC 61158-2, galvanically isolated
- Data transmission rate: 31.25 kBit/s
- Current consumption: 12 mA
- Permissible supply voltage: 9...32 V
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Bus connection with integrated reverse polarity protection
- Signal encoding: Manchester II
- ITK Version 4.01
- Function blocks: 7 x Analog Input, 1 x Digital Output, 1 x PID
- Output data: Mass flow, Volume flow, Corrected volume flow, Density, Reference density, Temperature, Totalizer 1...3
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Totalizer reset
- Link Master function (LM) is supported

Signal on alarm

Current output:
Failsafe mode selectable (e.g. in accordance with NAMUR Recommendation NE 43)

Pulse/frequency output:
Failsafe mode selectable

Status output:

"Non-conductive" in the event of a fault or if the power supply fails

Relay output (Promass 83):

"Dead" in the event of a fault or if the power supply fails

Load

see "Output signal"

Low flow cut off

Switch points for low-flow cutoff freely selectable.

Galvanic isolation

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

Switching output

Status output:

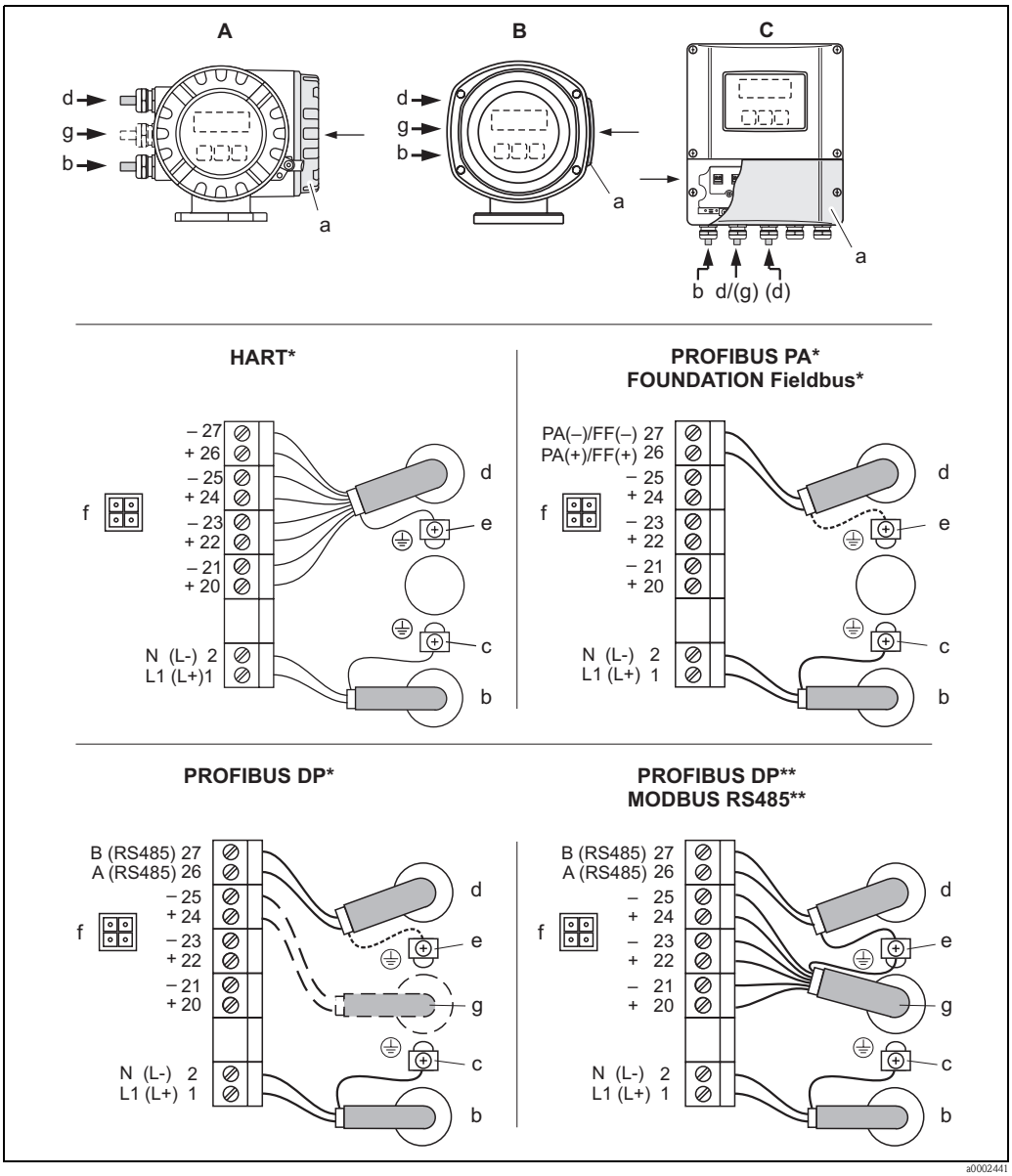
Open collector, max. 30 V DC / 250 mA, galvanically isolated
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values

Relay output (only Promass 83):

Normally closed (NC or break) or normally open (NO or make) contacts available (factory setting: relay 1 = NO, relay 2 = NC),
max. 30 V / 0.5 A AC; 60 V / 0.1 A DC, galvanically isolated.
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values, filler valve 1 and 2 (optional).

Power supply

Electrical connection
Measuring unit



Connecting the transmitter, cable cross-section: max. 2.5 mm²

A View A (field housing)
B View B (stainless steel field housing)
C View C (wall-mount housing)

**) Fixed communication board*
***) Flexible communication board*
a Cover of the connection compartment
b Cable for power supply: 85...260 V AC, 20...55 V AC,16...62 V DC
Terminal No. 1: L1 for AC, L+ for DC
Terminal No. 2: N for AC, L- for DC
c Ground terminal for protective conductor
d Signal cable: see terminal assignment → Page 10
Fieldbus cable:
Terminal No. 26: DP (A) / PA (+) / FF (+) / MODBUS RS485 (A) / (PA, FF: with reverse polarity protection)
Terminal No. 27: DP (B) / PA (-) / FF (-) / MODBUS RS485 (B) / (PA, FF: with reverse polarity protection)
e Earth terminal, signal cable screen / fieldbus cable / RS485 line
f Service connector for connecting service interface FXA 193 (Fieldcheck, ToF Tool - Fieldtool Package)
g Signal cable: see terminal assignment → Page 10
Cable for external termination (only for PROFIBUS DP with fixed communication board):
Terminal No. 24: +5 V
Terminal No. 25: DGND

Electrical connection, terminal assignment

Promass 80

Order variant	Terminal No. (inputs/outputs) 20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
80***-**********A	–	–	Frequency output	Current output, HART
80***-**********D	Status input	Status output	Frequency output	Current output, HART
80***-**********H	–	–	–	PROFIBUS PA
80***-**********S	–	–	Frequency output Ex i, passive	Current output Ex i Active, HART
80***-**********T	–	–	Frequency output Ex i, passive	Current output Ex i Passive, HART
80***-**********8	Status input	Frequency output	Current output 2	Current output 1, HART

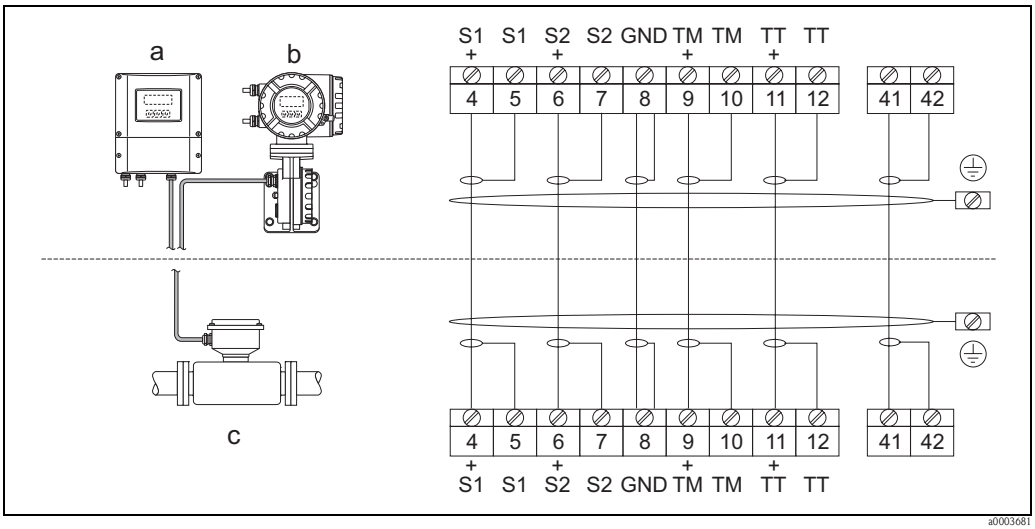
Promass 83

The inputs and outputs on the communication board can be either permanently assigned (fixed) or variable (flexible), depending on the version ordered (see table). Replacements for modules which are defective or which have to be replaced can be ordered as accessories.

Order variant	Terminal No. (inputs/outputs) 20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
Fixed communication boards (permanent assignment)				
83***-**********A	–	–	Frequency output	Current output HART
83***-**********B	Relay output	Relay output	Frequency output	Current output HART
83***-**********F	–	–	–	PROFIBUS PA, Ex i
83***-**********G	–	–	–	FOUNDATION Fieldbus Ex i
83***-**********H	–	–	–	PROFIBUS PA
83***-**********J	–	–	+5V (ext. termination)	PROFIBUS DP
83***-**********K	–	–	–	FOUNDATION Fieldbus
83***-**********Q	–	–	Status input	MODBUS RS485
83***-**********R	–	–	Current output 2 Ex i, active	Current output 1 Ex i active, HART
83***-**********S	–	–	Frequency output Ex i, passive	Current output Ex i Active, HART
83***-**********T	–	–	Frequency output Ex i, passive	Current output Ex i Passive, HART
83***-**********U	–	–	Current output 2 Ex i, passive	Current output 1 Ex i passive, HART
Flexible communication boards				
83***-**********C	Relay output 2	Relay output 1	Frequency output	Current output HART
83***-**********D	Status input	Relay output	Frequency output	Current output HART
83***-**********E	Status input	Relay output	Current output 2	Current output 1 HART
83***-**********L	Status input	Relay output 2	Relay output 1	Current output HART

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	**22 (+) / 23 (–)**	**24 (+) / 25 (–)**	**26 (+) / 27 (–)**
83***-**********M	Status input	Frequency output 2	Frequency output 1	Current output HART
83***-**********N	Current output	Frequency output	Status input	MODBUS RS485
83***-**********P	Current output	Frequency output	Status input	PROFIBUS DP
83***-**********V	Relay output 2	Relay output 1	Status input	PROFIBUS DP
83***-**********W	Relay output	Current output 3	Current output 2	Current output 1 HART
83***-**********0	Status input	Current output 3	Current output 2	Current output 1 HART
83***-**********2	Relay output	Current output 2	Frequency output	Current output 1 HART
83***-**********3	Current input	Relay output	Current output 2	Current output 1 HART
83***-**********4	Current input	Relay output	Frequency output	Current output HART
83***-**********5	Status input	Current input	Frequency output	Current output HART
83***-**********6	Status input	Current input	Current output 2	Current output HART
83***-**********7	Relay output 2	Relay output 1	Status input	MODBUS RS485

Electrical connection Remote version



a Wall-mount housing: Non-hazardous area and ATEX II3G (zone 2)

b Wall-mount housing: ATEX II2G (zone 1)

c Remote sensor flanged version

Wire color:
Terminal no.: 4/5 = grey; 6/7 = green; 8 = yellow; 9/10 = pink; 11/12 = white; 41/42 = brown

Supply voltage

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

Cable entries

Power-supply and signal cables (inputs/outputs):
- Cable entry M20 x 1.5 (8...12 mm)
- Thread for cable entries, 1/2" NPT, G 1/2"

Connecting cable for remote version:
- Cable entry M20 x 1.5 (8...12 mm)
- Thread for cable entries, 1/2" NPT, G 1/2"

Remote version cable specifications

- 6 x 0.38 mm² PVC cable with common shield and individually shielded cores
- Conductor resistance: ≤ 50 Ω/km
- Capacitance: core/shield: ≤ 420 pF/m
- Cable length: max. 20 m
- Operating temperature: max. +105 °C

Operation in zones of severe electrical interference:
The measuring device complies with the general safety requirements in accordance with EN 61010, the EMC requirements of EN 61326/A1, and NAMUR recommendation NE 21/43.

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

Promass 80

Lasting min. 1 power cycle
- EEPROM saves measuring system data if the power supply fails
- S-DAT: exchangeable data storage chip with sensor specific data (nominal diameter, serial number, calibration factor, zero point, etc.)

Promass 83

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

Potential equalisation

No measures necessary.

Performance characteristics

Reference operating conditions

Error limits following ISO/DIS 11631:
- 20...30 °C; 2...4 bar
- Calibration systems as per national norms
- Zero point calibrated under operating conditions
- Field density calibrated (or special density calibration)

Maximum measured error

The following values refer to the pulse/frequency output. The additional measured error at the current output is typically ±5 µA.

Mass flow (liquid):

Promass 80A:

±0.15% ± [(zero point stability / measured value) x 100]% o.r.

Promass 83A:

±0.10% ± [(zero point stability / measured value) x 100]% o.r.

Mass flow (gas):

Promass 80A, 83A:

±0.50% ± [(zero point stability / measured value) x 100]% o.r.

Volume flow (liquid)

Promass 80A, 83A:

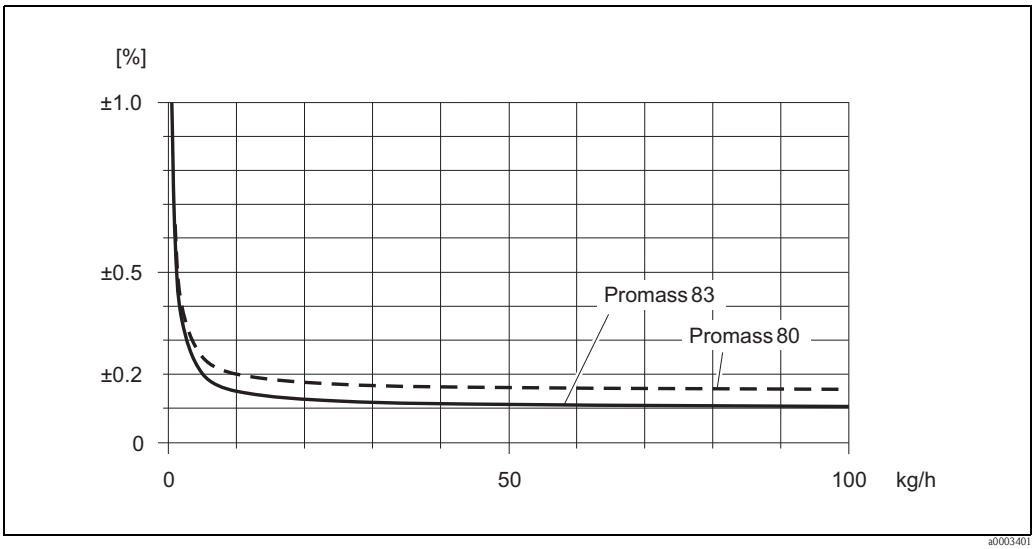
±0.25% ± [(zero point stability / measured value) x 100]% o.r.

o.r. = of reading

Zero point stability (Promass A):

DN	Max. full scale value [kg/h] or [l/h]	Zero point stability [kg/h] or [l/h]
1	20	0.0010
2	100	0.0050
4	450	0.0225

Sample calculation



Max. measured error in % of measured value (example: Promass 80A, 83A / DN 2)

Calculation example (mass flow, liquid):
Given: Promass 83A / DN 2, measured value flow = 40 kg/h
Max. measured error: ±0.10% ± [(zero point stability / measured value) x 100]% o.r.
Max. measured error → ±0.10% ±0.005 kg/h ÷ 40 kg/h · 100% = ±0.11%

Density (liquid)

Standard calibration (1g/cc = 1 kg/l):

±0.02 g/cc

Special density calibration (optional)

±0.002 g/cc

After field density calibration or under reference conditions:

±0.0010 g/cc

Temperature

±0.5 °C ±0.005 x T (T = medium temperature in °C)

Repeatability

Mass flow (liquid):

±0.05% ± [1/2 x (zero point stability / measured value) x 100]% o.r.

Mass flow (gas):

±0.25% ± [1/2 x (zero point stability / measured value) x 100]% o.r.

Volume flow (liquid):

±0.10% ± [1/2 x (zero point stability / measured value) x 100]% o.r.

o.r. = of reading
Zero point stability: see "Max. measured error"

Calculation example (mass flow, liquid):
Given: Promass 83A / DN 2, measured value flow = 40 kg/h
Repeatability: ±0.05% ± [1/2 x (zero point stability / measured value) x 100]% o.r.
Repeatability → ±0.05% ±1/2 · 0.005 kg/h ÷ 40 kg/h · 100% = ±0.056%

Density measurement (liquid)

±0.0005 g/cc

Temperature measurement

±0.25 °C ±0.0025 x T (T = medium temperature in °C)

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 ±0.0002% of the full scale value / °C.

Influence of medium pressure

A difference in pressure between the calibration pressure and the process pressure does not have any effect on the accuracy.

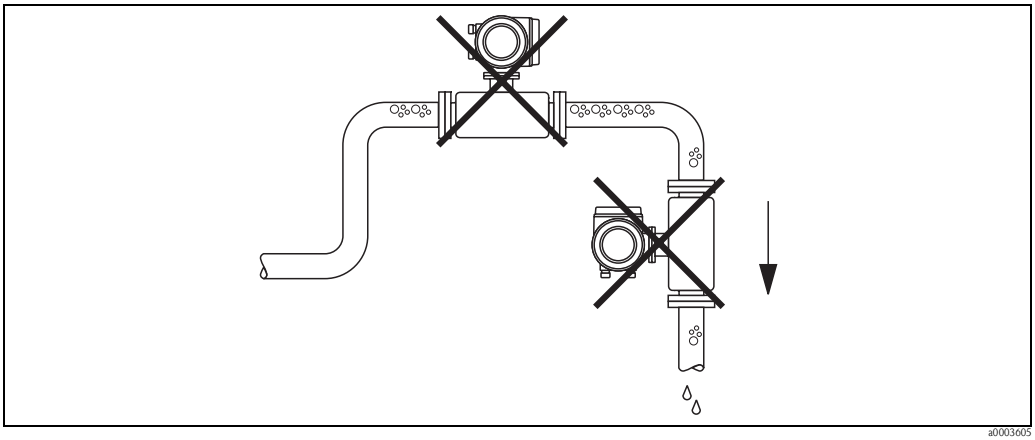
Operating conditions: Installation

Installation instructions

Note the following points:
- No special measures such as supports are necessary. External forces are absorbed by the construction of the instrument, for example the secondary containment.
- 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, Tpieces, etc.), as long as no cavitation occurs.
- For mechanical reasons and to protect the pipe, support is recommended for heavy sensors.

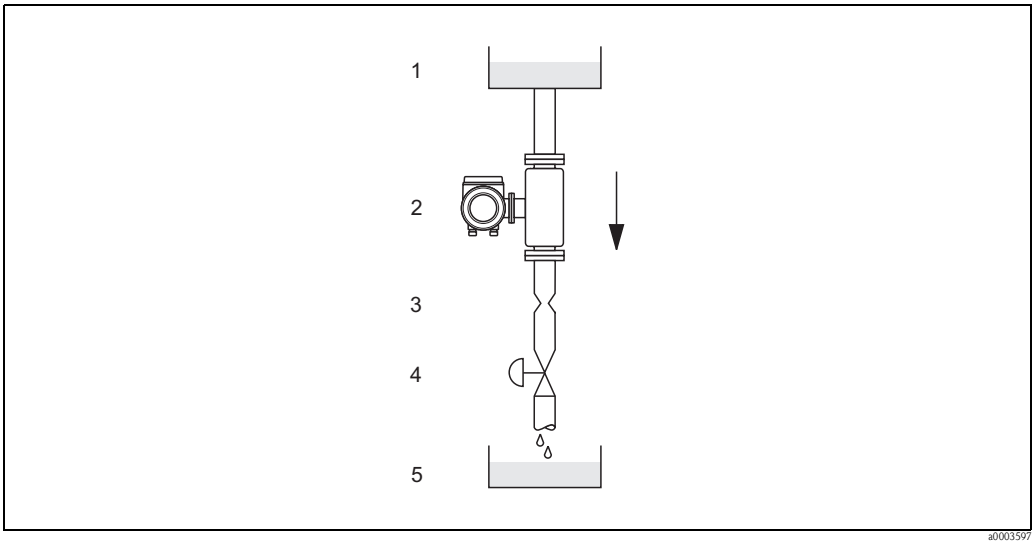
Mounting location

Entrained air or gas bubbles in the measuring tube can result in an increase in measuring errors.
For this reason, avoid the following mounting locations in the pipe:
- Highest point of a pipeline. Risk of air accumulating.
- Directly upstream from a free pipe outlet in a vertical pipeline.



Mounting location

Notwithstanding the above, the installation proposal below permits installation in an open vertical pipeline. Pipe restrictions or the use of an orifice with a smaller cross-section than the nominal diameter prevent the sensor running empty while measurement is in progress.



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

1 Supply tank
2 Sensor
3 Orifice plate, pipe restriction (see Table)
4 Valve
5 Batching tank

DN	1	2	4
∅ **Orifice plate, pipe restriction**	0.8 mm	1.5 mm	3.0 mm

Orientation

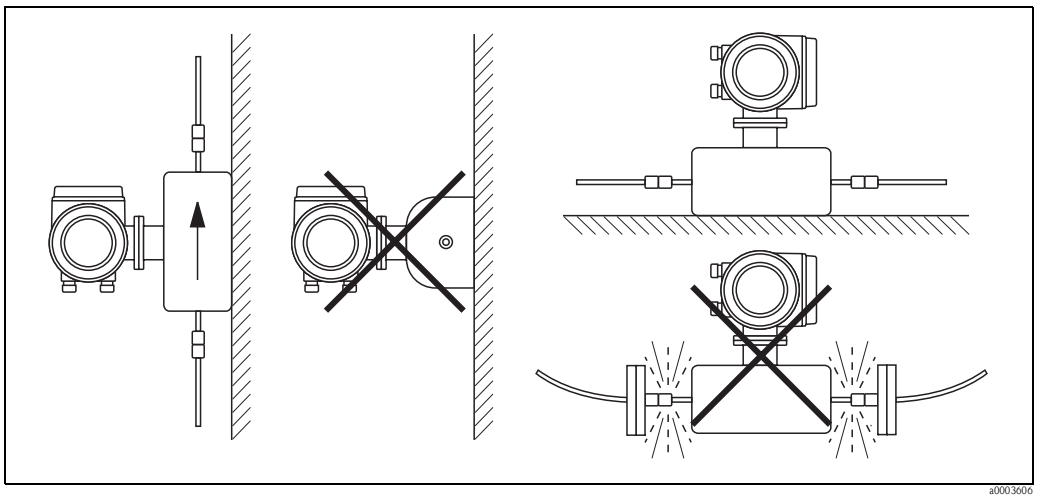
Make sure that the direction of the arrow on the nameplate of the sensor matches the direction of flow (direction of fluid flow through the pipe).

Vertical

Recommended orientation with direction of flow upwards. 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.

Horizontal

When installation is correct the transmitter housing is above or below the pipe. This means that no gas bubbles or solids deposits can form in the bent measuring tube (single-tube system).
The sensor cannot be installed suspended (i.e. without support or holder) in the pipe. This prevents excessive material load in the area of the process connection. The base plate of the sensor housing allows bench, wall or post mounting.



Vertical and horizontal orientation (Promass A)

Heating

Some fluids require suitable measures to avoid heat transfer at the sensor. Heating can be electric, e.g. with heated elements, or by means of hot water or steam pipes made of copper.

Caution!
- Risk of electronics overheating! Consequently, make sure that the adapter between the sensor and transmitter and the connection housing of the remote version always remain free of insulating material. Note that a certain orientation might be required, depending on the fluid temperature .
- If using an electric trace heating system whose heating is regulated via phase angle control or pulse packages, influence on the measured values cannot be ruled out due to magnetic fields (i.e. for values that are greater than the values approved by the EN standard (sine 30 A/m)). In such instances, it is necessary to magnetically screen the sensor.
  The secondary containment can be screened with tin plate or electric sheets without privileged direction (e.g. V330-35A) with the following properties:
  – Relative magnetic permeability $\mu_r \geq 300$
  – Plate thickness $d \geq 0.35$ mm
- Information on permitted temperature ranges → Page 19

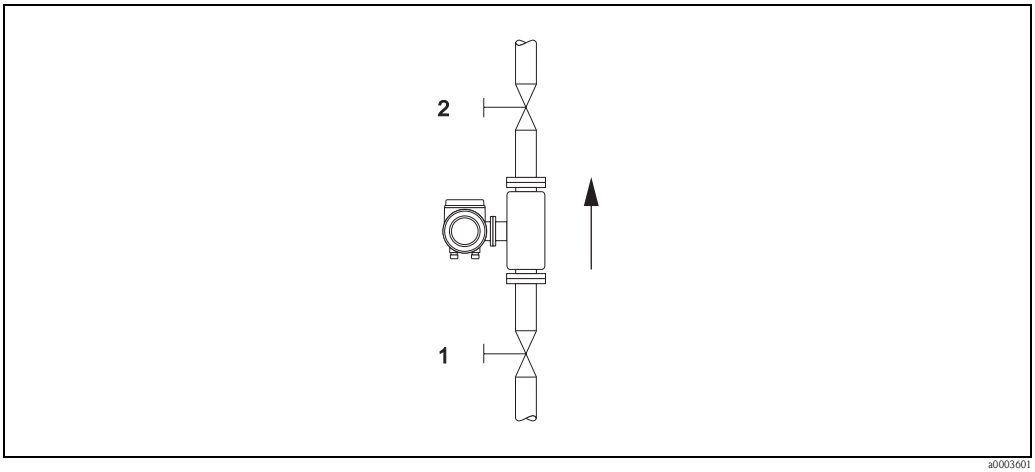
Special heating jackets, which can be ordered separately from Endress+Hauser as an accessory, are available for the sensors.

Zero point adjustment

All Promass devices are calibrated to state-of-the-art technology. The zero point determined in this way is imprinted on the nameplate. Calibration takes place under reference conditions. → Page 12 ff.
For this reason, Promass generally does **not** require 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).

Please note the following before carrying out the adjustment:
- The adjustment can only be performed with fluids that have no gas or solid contents.
- 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



Zero point adjustment and shut-off valves

Inlet and outlet run

There are no installation requirements regarding inlet and outlet runs.

Length of connecting cable

Max. 20 meters (remote version)

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 risk of partial vacuum)
- At the lowest point in a vertical pipe

Operating conditions: Environment

Ambient temperature range	Standard: –20...+60 °C (sensor, transmitter) Optional: –40...+60 °C (sensor, transmitter) Note! ■ Install the device at a shady location. Avoid direct sunlight, particularly in warm climatic regions. ■ At ambient temperatures below –20 °C the readability of the display may be impaired.
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	Acceleration up to 1 g, 10...150 Hz, following IEC 68-2-6
Electromagnetic compatibility (EMC)	To EN 61326 / A1 and NAMUR recommendation NE 21

Operating conditions: Process

Medium temperature range

Sensor

–50...+200 °C

Seals:

(Only for mounting kits with screw-on connections)
Viton –15...200 °C; EPDM –40...+160 °C; silicone –60...+200 °C; Kalrez –20...+275 °C

Medium pressure range (nominal pressure)

Threaded joints:

Max. 160 bar (standard versions), max. 400 bar (high pressure versions)

Flanges:

DIN PN 40...100 / ANSI Cl 150, Cl 300 / JIS 10K

Pressure ranges of secondary containment:

25 bar or 375 psi

Warning!
In case a danger of measuring tube failure exists due to process characteristics, e.g. with corrosive process fluids, we recommend the use of sensors whose secondary containment is equipped with special pressure monitoring connections (ordering option). With the help of these connections, fluid collected in the secondary containment in the event of tube failure can be bled off. This is especially important in high pressure gas applications. These connections can also be used for gas circulation and/or detection. Dimensions

Limiting flow

See information in the “Measuring range” Section → Page 5

Select nominal diameter by optimising between required flow range and permissible pressure loss. An overview of max. possible full scale values can be found in the “Measuring range” Section.

- The minimum recommended full scale value is approx. 1/20 of the max. 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).
- For gas measurement the following rules apply:
  - Flow velocity in the measuring tubes should not be more than half the sonic velocity (0.5 Mach).
  - The maximum mass flow depends on the density of the gas: formula → Page 5

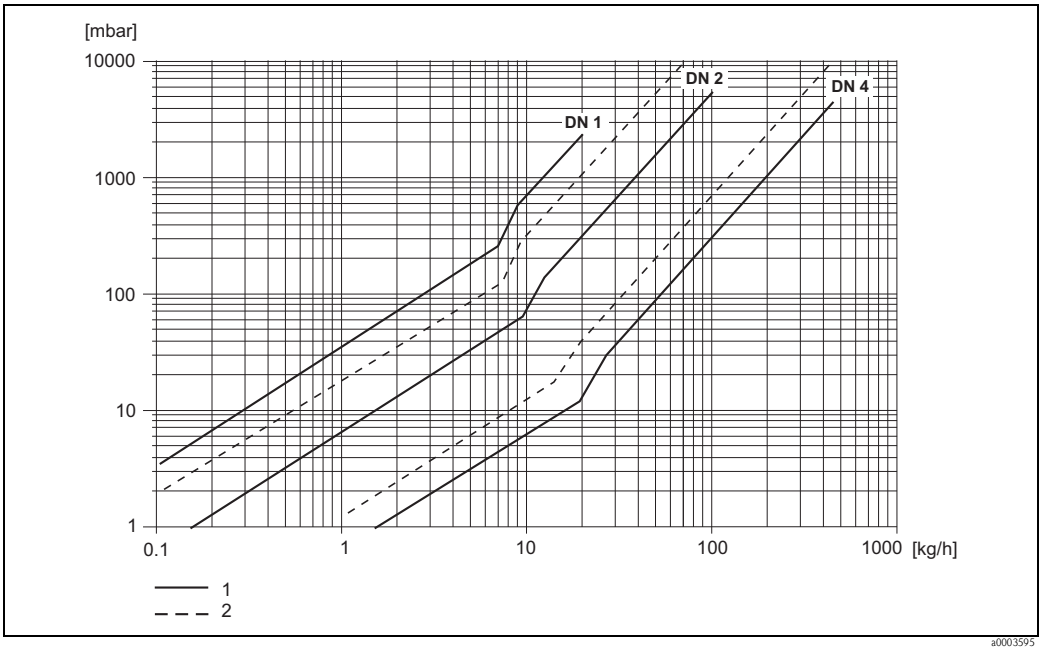
Pressure loss

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

Reynolds number	$Re = \frac{4 \cdot \dot{m}}{\pi \cdot d \cdot \nu \cdot \rho}$ a0003381
$Re \geq 2300$ [1)]	$\Delta p = K \cdot \nu^{0.25} \cdot \dot{m}^{1.75} \cdot \rho^{-0.75}$ a0003380
$Re < 2300$	$\Delta p = K1 \cdot \nu \cdot \dot{m}$ a0003379
Δp = pressure loss [mbar] ν = kinematic viscosity [m2/s] $\dot{m}$ = mass flow [kg/s]	ρ = density [kg/m^3] d = inside diameter of measuring tubes [m] K...K1 = constant (depends on nominal diameter)
1) To compute the pressure loss for gases, always use the formula for $Re \geq 2300$.	

Pressure loss coefficients for Promass A

DN	d [m]	K	K1
1	$1.1 \cdot 10^{-3}$	$1.2 \cdot 10^{11}$	$1.3 \cdot 10^{11}$
2	$1.8 \cdot 10^{-3}$	$1.6 \cdot 10^{10}$	$2.4 \cdot 10^{10}$
4	$3.5 \cdot 10^{-3}$	$9.4 \cdot 10^{8}$	$2.3 \cdot 10^{9}$
High pressure version			
2	$1.4 \cdot 10^{-3}$	$5.4 \cdot 10^{10}$	$6.6 \cdot 10^{10}$
4	$3.0 \cdot 10^{-3}$	$2.0 \cdot 10^{9}$	$4.3 \cdot 10^{9}$



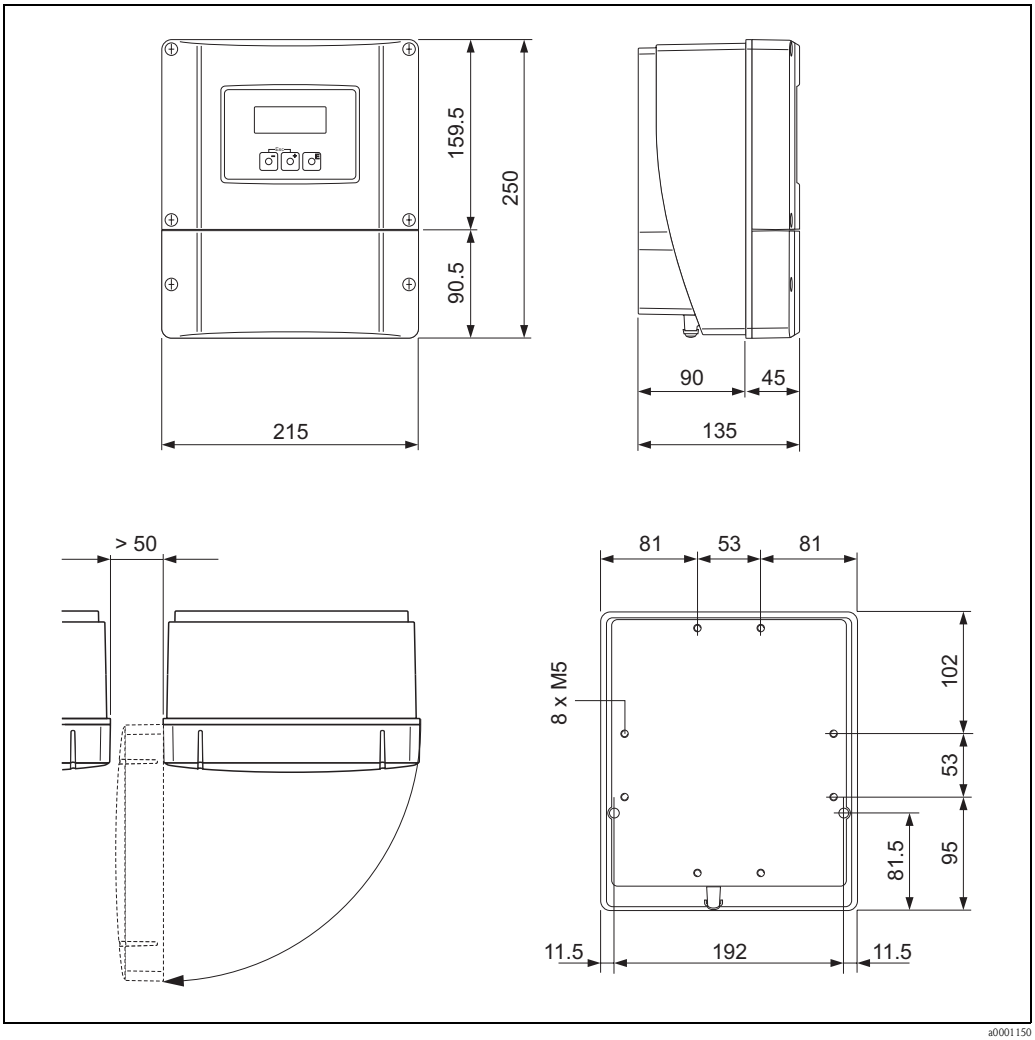
Pressure loss diagram for water

1 Standard version
2 High pressure version

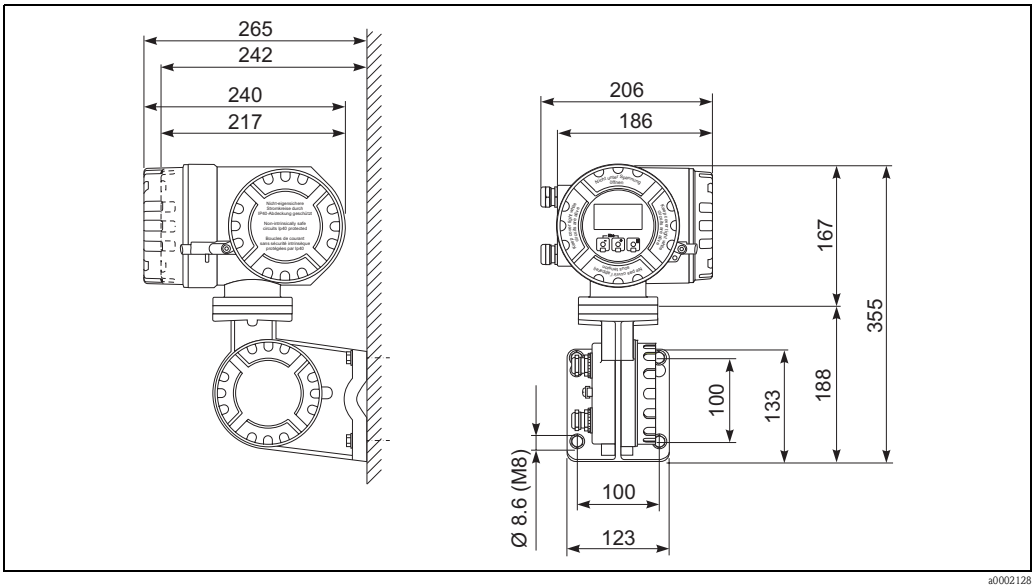
Mechanical construction

Design / dimensions

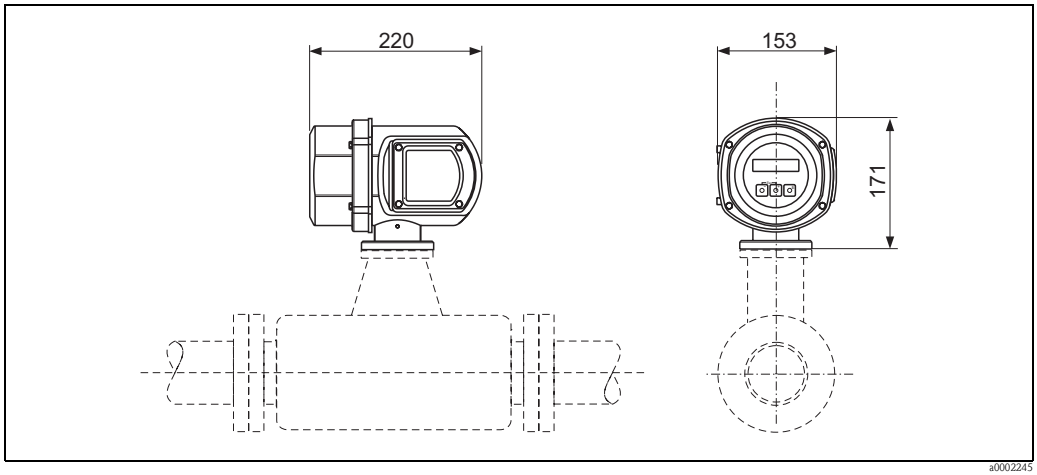
Dimensions: Wall-mount housing (non hazardous area and II3G / zone 2)



Dimensions: Remote field housing (II2G / zone 1)

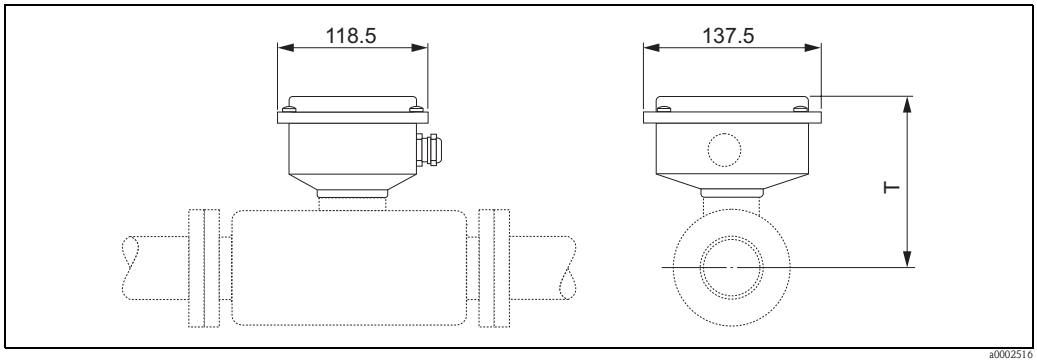


Dimensions: stainless steel field housing



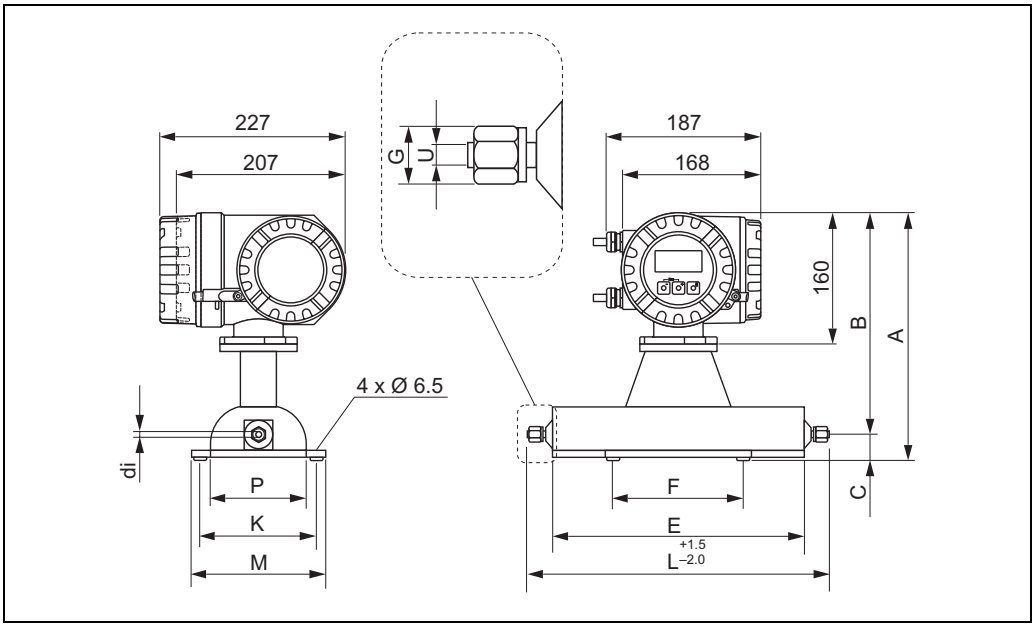
Dimensions: stainless steel field housing

Dimensions: Remote version



T = dimension B in the compact version (with corresponding nominal diameter) minus 153 mm

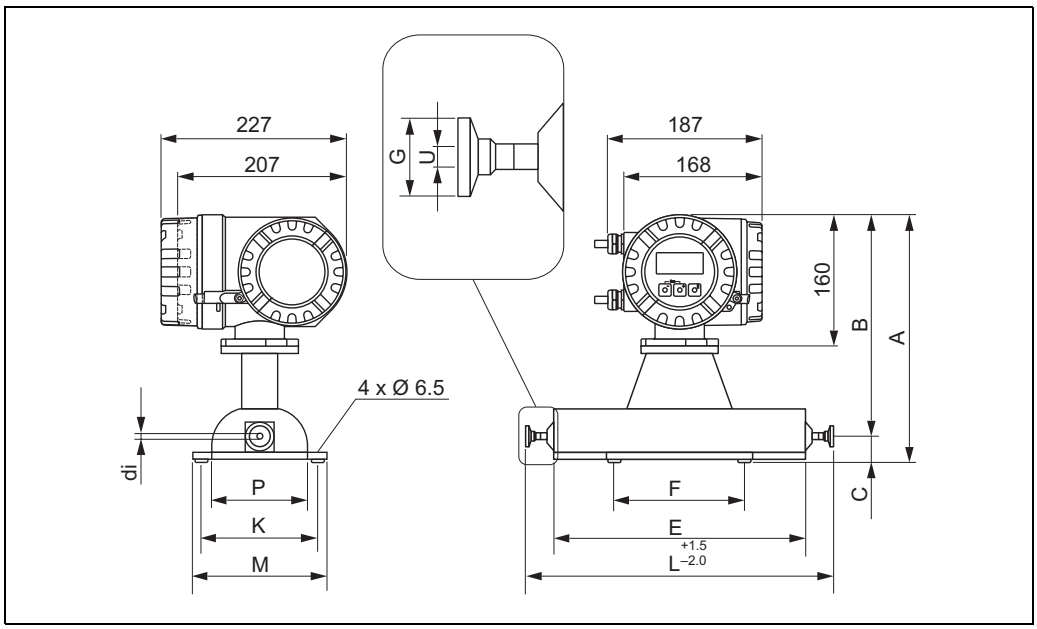
Dimensions: 4-VCO-4-connection (welded)



4-VCO-4-connection: 1.4539/904L, Alloy C-22											
DN	A	B	C	E	F	G	K	L	M	P	U / di
1 [1]	305	273	32	228	160	SW 11/16"	145	290	165	120	1.1
2 [1]	305	273	32	310	160	SW 11/16"	145	372	165	120	1.8
2 [2]	305	273	32	310	160	SW 11/16"	145	372	165	120	1.4
4 [1]	315	283	32	435	220	SW 11/16"	175	497	195	150	3.5
4 [2]	315	283	32	435	220	SW 11/16"	175	497	195	150	3.0

[1] 3A version can be supplied (Ra ≤ 0.4 µm/240 grit). Only for 1.4539/904L
[2] High pressure version

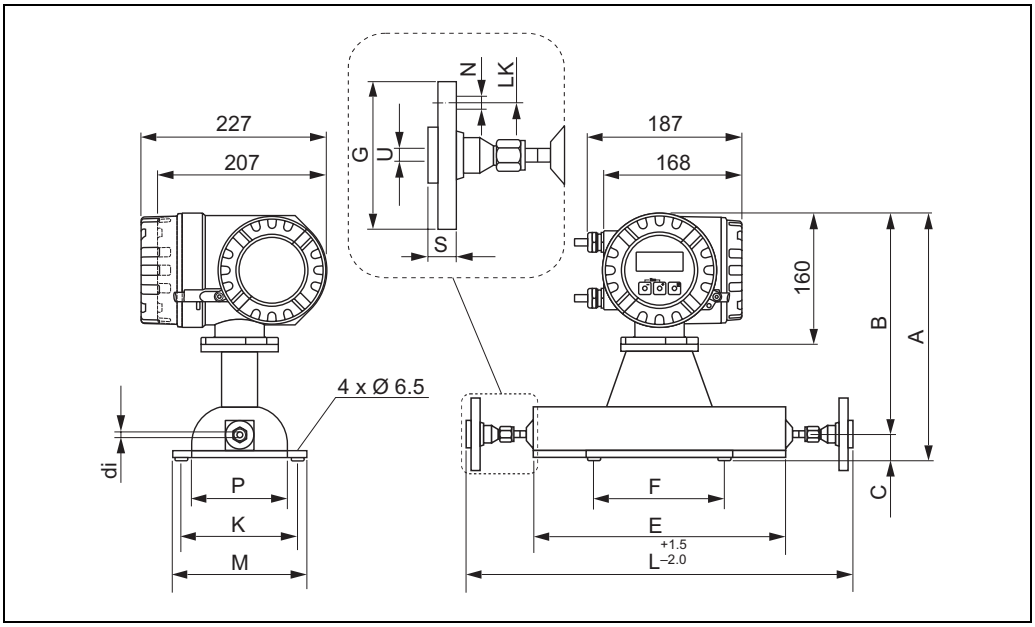
Dimensions: 1/2" Tri-Clamp connection (welded)



1/2" Tri-Clamp connection / 3A version [1]**:** 1.4539/904L												
DN	A	B	C	E	F	G	K	L	M	P	U	di
1	305	273	32	228	160	25	145	296	165	120	9.5	1.1
2	305	273	32	310	160	25	145	378	165	120	9.5	1.8
4	315	283	32	435	220	25	175	503	195	150	9.5	3.5

[1] 3A version (Ra ≤ 0.8 µm/150 grit. option: Ra ≤ 0.4 µm/240 grit).

Dimensions 4-VCO-4-connection with mounting kit:
DN 15 flange EN 1092-1 (DIN 2501), JIS or 1/2" flange ANSI



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Mounting kit DN 15 flange EN 1092-1 (DIN 2501) PN 40: 1.4539/904L, Alloy C-22															
DN	A	B	C	E	F	G	K	L	M	N	P	S	LK	U	di
1	305	273	32	228	160	95	145	393	165	4 x Ø14	120	28	65	17.3	1.1
2	305	273	32	310	160	95	145	475	165	4 x Ø14	120	28	65	17.3	1.8
4	315	283	32	435	220	95	175	600	195	4 x Ø14	150	28	65	17.3	3.5
Loose flanges (not wetted) made of stainless steel 1.4404/316L															

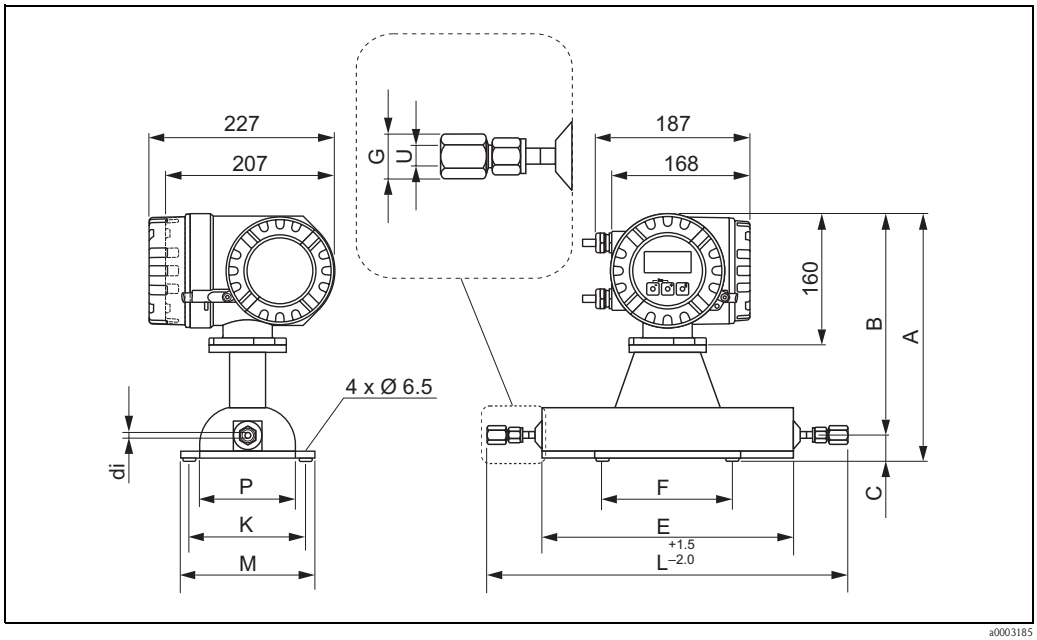
Mounting kit DN 15 flange (JIS) 10K: 1.4539/904L, Alloy C-22															
DN	A	B	C	E	F	G	K	L	M	N	P	S	LK	U	di
1	305	273	32	228	160	95	145	393	165	4 x Ø15	120	28	70	15.0	1.1
2	305	273	32	310	160	95	145	475	165	4 x Ø15	120	28	70	15.0	1.8
4	315	283	32	435	220	95	175	600	195	4 x Ø15	150	28	70	15.0	3.5
Loose flanges (not wetted) made of stainless steel 1.4404/316L															

Mounting kit DN 15 flange (JIS) 20K: 1.4539/904L, Alloy C-22															
DN	A	B	C	E	F	G	K	L	M	N	P	S	LK	U	di
1	305	273	32	228	160	95	145	393	165	4 x Ø15	120	14	70	15.0	1.1
2	305	273	32	310	160	95	145	475	165	4 x Ø15	120	14	70	15.0	1.8
4	315	283	32	435	220	95	175	600	195	4 x Ø15	150	14	70	15.0	3.5

Mounting kit 1/2" flange (ANSI) Cl 150: 1.4539/904L, Alloy C-22																
DN		A	B	C	E	F	G	K	L	M	N	P	S	LK	U	di
1	1/24"	305	273	32	228	160	88.9	145	393	165	4 x Ø15.7	120	17.7	60.5	15.7	1.1
2	1/12"	305	273	32	310	160	88.9	145	475	165	4 x Ø15.7	120	17.7	60.5	15.7	1.8
4	1/8"	315	283	32	435	220	88.9	175	600	195	4 x Ø15.7	150	17.7	60.5	15.7	3.5
Loose flanges (not wetted) made of stainless steel 1.4404/316L																

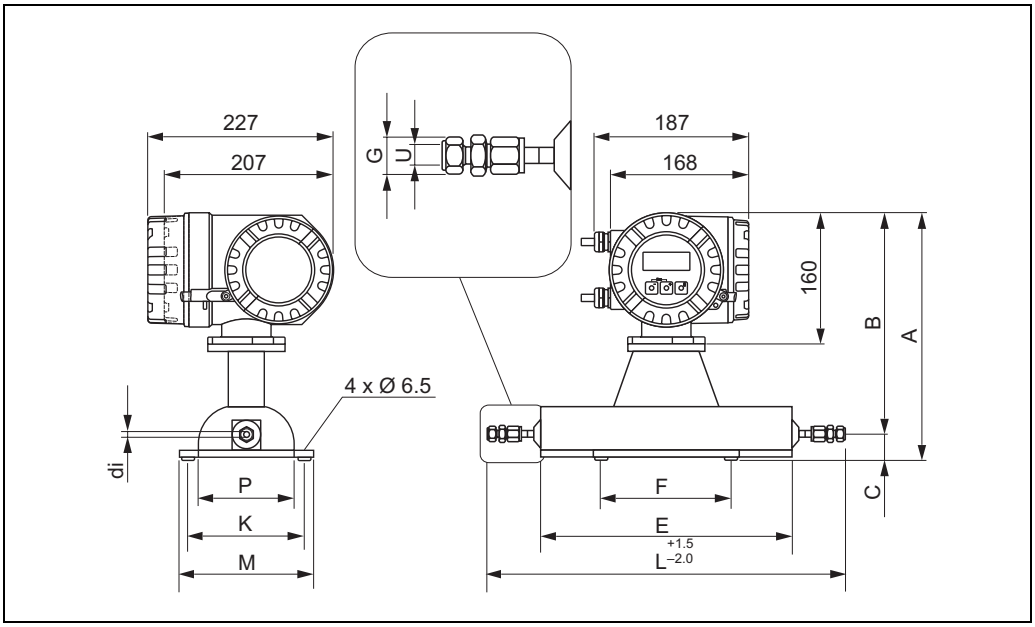
Mounting kit 1/2" flange (ANSI) Cl 300: 1.4539/904L, Alloy C-22																
DN		A	B	C	E	F	G	K	L	M	N	P	S	LK	U	di
1	1/24"	305	273	32	228	160	95.2	145	393	165	4 x Ø15.7	120	20.7	66.5	15.7	1.1
2	1/12"	305	273	32	310	160	95.2	145	475	165	4 x Ø15.7	120	20.7	66.5	15.7	1.8
4	1/8"	315	283	32	435	220	95.2	175	600	195	4 x Ø15.7	150	20.7	66.5	15.7	3.5
Loose flanges (not wetted) made of stainless steel 1.4404/316L																

Dimensions 4-VCO-4-connection with mounting kit: 1/4" NPT-F



Mounting kit 1/4" NPT-F connection: 1.4539/904L, Alloy C-22												
DN	A	B	C	E	F	G	K	L	M	P	U	di
1	305	273	32	228	160	SW 3/4"	145	296	165	120	1/4" NPT	1.1
2	305	273	32	310	160	SW 3/4"	145	378	165	120	1/4" NPT	1.8
2[1)]	305	273	32	310	160	SW 3/4"	145	378	165	120	1/4" NPT	1.4
4	315	283	32	435	220	SW 3/4"	175	503	195	150	1/4" NPT	3.5
4[1)]	315	283	32	435	220	SW 3/4"	175	568	195	150	1/4" NPT	3.0
[1)] High pressure version only available as 1.4539/904L												

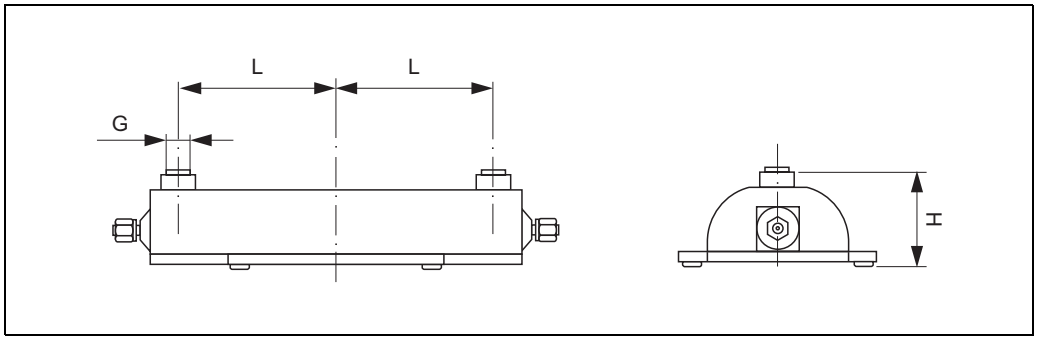
Dimensions 4-VCO-4-connection with mounting kit: 1/8" or 1/4" SWAGELOK



Mounting kit SWAGELOK connection: 1.4539/904L												
DN	A	B	C	E	F	G	K	L	M	P	U	di
1	305	273	32	228	160	SW 7/16"	145	359.6	165	120	1/8"	1.1
1	305	273	32	228	160	SW 9/16"	145	359.6	165	120	1/4"	1.1
2	305	273	32	310	160	SW 7/16"	145	441.6	165	120	1/8"	1.8
2	305	273	32	310	160	SW 9/16"	145	441.6	165	120	1/4"	1.8
2[1)]	305	273	32	310	160	SW 7/16"	145	441.6	165	120	1/8"	1.4
2[1)]	305	273	32	310	160	SW 9/16"	145	441.6	165	120	1/4"	1.4
4	315	283	32	435	220	SW 9/16"	175	571.6	195	150	1/4"	3.5
4[1)]	315	283	32	435	220	SW 9/16"	175	571.6	195	150	1/4"	3.0
[1)] High pressure version												

Purge connections / pressure vessel monitoring

Caution!
The pressure vessel is filled with dry nitrogen (N_2). Do not open the purge connections unless the containment can be filled immediately with a dry inert gas. Use only low gauge pressure to purge. Maximum pressure: 5 bar.



DN	L	H	G
1	92.0	102.0	1/2" NPT
2	130.0	102.0	1/2" NPT
4	192.5	192.5	1/2" NPT

Weight

- Compact version: see table below
- Remote version
  - Sensor: see table below
  - Wall-mount housing: 5 kg

Promass A / DN	**1**	**2**	**4**
Compact version	10	11	15
Remote version	8	9	13

Weight information in [kg].
All values (weight) refer to devices with EN/DIN PN 40 flanges.

Material

Transmitter housing:

- Compact housing: stainless steel 1.4301/304
- Compact housing: powder coated die-cast aluminium
- Wall-mount housing: powder coated die-cast aluminium
- Remote field housing: powder-coated die-cast aluminium

Sensor housing / containment:

Acid and alkali-resistant outer surface
Stainless steel 1.4301/304

Connection housing, sensor (remote version):

- Stainless steel 1.4301/304

Process connections

- Mounting kit for flanges EN 1092-1 (DIN 2501) / ANSI B16.5 / JIS B2238 → stainless steel 1.4539/904L, Alloy C-22 2.4602/N 06022.
  Loose flanges → stainless steel 1.4404/316L
- VCO coupling → stainless steel 1.4539/904L, Alloy C-22 2.4602/N 06022
- Tri-Clamp (OD tubes) (1/2") → stainless steel 1.4539/904L
- Mounting kit for SWAGELOK (1/4", 1/8") → stainless steel 1.4401/316
- Mounting kit for NPT-F (1/4") → stainless steel 1.4539/904L1.4539/904L, Alloy C-22 2.4602/N 06022

Measuring tube(s):

- Stainless steel 1.4539/904L, Alloy C-22 2.4602/N 06022

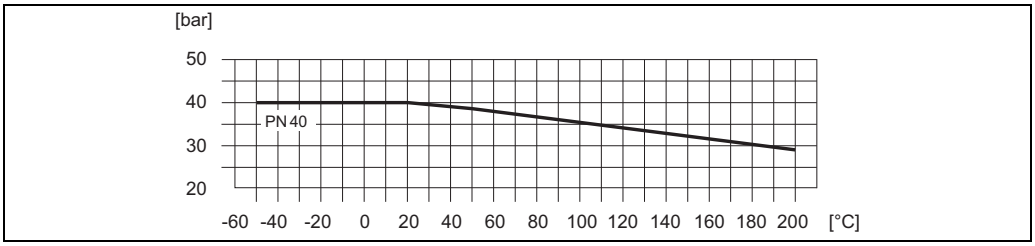
Seals:

Welded process connections without internal seals

Material load curves

Flange connections to EN 1092-1 (DIN 2501) (mounting kit)

Wetted parts (flange, measuring tube): 1.4539/904L, Alloy C-22
Loose flanges (not wetted): 1.4404/316L



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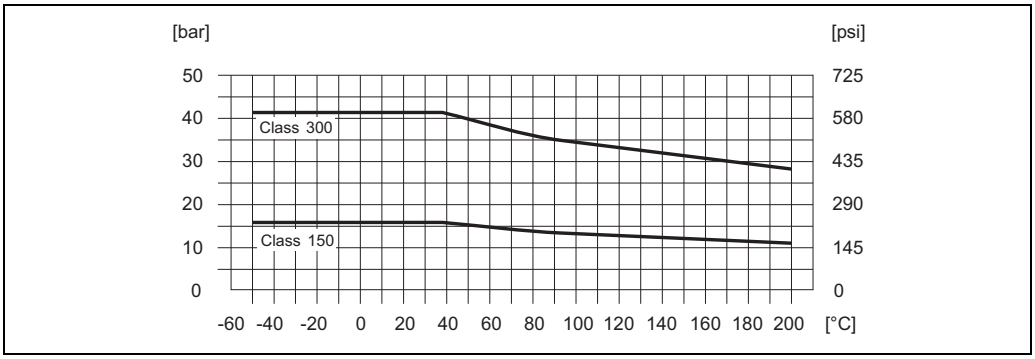
Flange connections to ANSI B16.5 (mounting kit)

Wetted parts (flange, measuring tube): 1.4539/904L, Alloy C-22
Loose flanges (not wetted): 1.4404/316L



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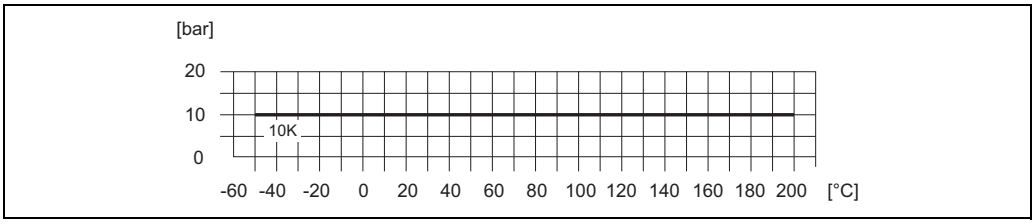
Flange connections to JIS B2238 (mounting kit)

Wetted parts (flange, measuring tube): 1.4539/904L, Alloy C-22
Loose flanges (not wetted): 1.4404/316L



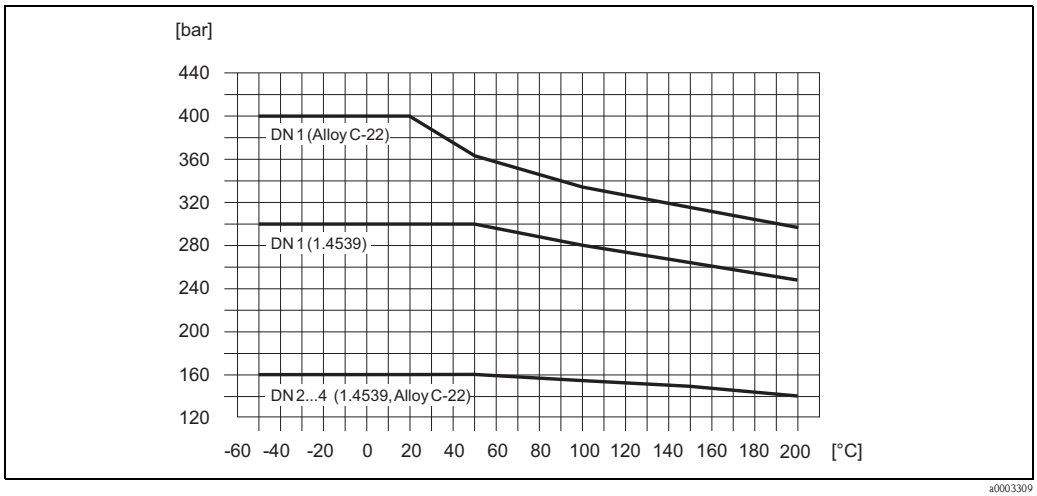
a0003312

Promass A: 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.

Process connection: 4-VCO-4, 1/4" NPT-F, SWAGELOK

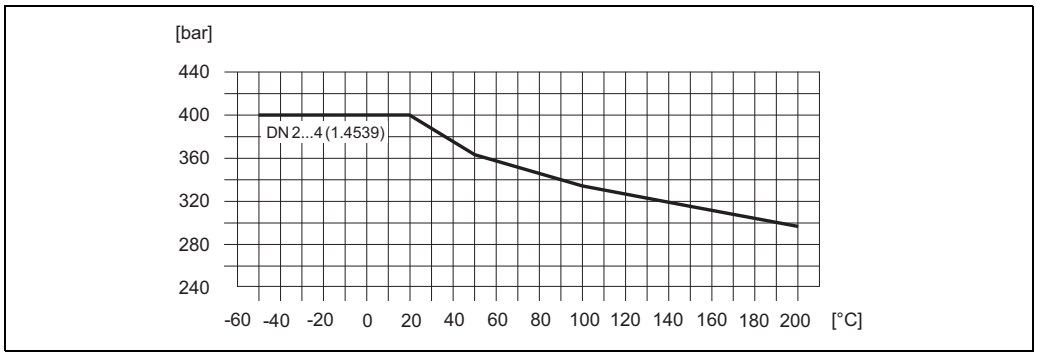
- 4-VCO-4-coupling (welded): 1.4539/904L, Alloy C-22
- 1/4" NPT threaded adapter (screwed, mounting kit): 1.4539/904L, Alloy C-22
- 1/4" or 1/8" SWAGELOK threaded joint (screwed, mounting kit): 1.4401/316



a0003309

Process connections for high pressure version (DN 2...4)

- 4-VCO-4-coupling (welded): 1.4539/904L, Alloy C-22
- 1/4" NPT threaded adapter (screwed, mounting kit): 1.4539/904L
- 1/4" or 1/8" SWAGELOK threaded joint (screwed, mounting kit): 1.4401/316



a0003310

Process connections

- Welded process connections: 4-VCO-4 coupling, 1/2" Tri-Clamp
- Screwed on process connections: flanges EN 1092-1 (DIN 2501), ANSI, JIS; 1/4" NPT threaded adapter; 1/8" or 1/4" SWAGELOK threaded joints

Human interface

Display elements

- Liquid-crystal display: backlit, two lines (Promass 80) or four lines (Promass 83) with 16 characters per line
- Selectable display of different measured values and status variables
- At ambient temperatures below –20 °C the readability of the display may be impaired.

Unified control concept for both types of transmitter:

Promass 80:

- Local operation with three keys (–, +, E)
- Quick Setup menus for straightforward commissioning

Promass 83:

- Local operation with three optical keys (–, +, E)
- 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 and Czech
- South and Eastern Asia (SEA):
  English, Japanese, Indonesian

Only Promass 83:

- China (CN):
  English, Chinese

The language group is changed using the “ToF Tool – Fieldtool Package” operating program.

Remote operation

Promass 80:

Operation via HART, PROFIBUS PA

Promass 83:

Operation via HART, PROFIBUS PA/DP, FOUNDATION Fieldbus

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 is in conformity with the EMC requirements of the Australian Communications Authority (ACA).

Ex approval

Information about currently available Ex versions (ATEX, FM, CSA) can be supplied by your Endress+Hauser Sales Centre on request. All explosion protection data are given in a separate documentation which is available upon request.

Sanitary compatibility

- 3A approval
- EHEDG-tested

FOUNDATION Fieldbus certification

The flow device has successfully passed all the test procedures carried out and is certified and registered by the Fieldbus FOUNDATION. The device thus meets all the requirements of the following specifications:

- Certified to FOUNDATION Fieldbus Specification
- The device meets all the specifications of the FOUNDATION Fieldbus H1.
- Interoperability Test Kit (ITK), revision status 4.0 (device certification number: on request)
- The device can also be operated with certified devices of other manufacturers
- Physical Layer Conformance Test of the Fieldbus FOUNDATION

PROFIBUS DP/PA certification

The flow device has successfully passed all the test procedures carried out and is certified and registered by the PNO (PROFIBUS User Organisation). The device thus meets all the requirements of the following specifications:

- Certified to PROFIBUS Profile Version 3.0 (device certification number: available on request)
- The 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.

Other standards and guidelines

- EN 60529
  Degrees of protection by housing (IP code).
- EN 61010
  Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures.
- EN 61326/A1 (IEC 1326)
  "Emission in accordance with Class A requirements".
  Electromagnetic compatibility (EMC requirements).
- NAMUR NE 21
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment.
- NAMUR NE 43
  Standardisation of the signal level for the breakdown information of digital transmitters with analogue output signal.
- NAMUR NE 53
  Software of field devices and signal-processing devices with digital electronics

Pressure measuring device approval

Flow meters with a nominal diameter smaller or equal to DN 25 are covered by Art. 3(3) of the European directive 97/23/EC (Pressure Equipment Directive) and are designed according to sound engineering practice. For larger nominal diameters, optional approvals according to Cat. II/III are available when required (depends on fluid and process pressure).

Functional safety

SIL-2:
In accordance with IEC 61508/IEC 61511-1 (FDIS)

4...20 mA output according to the following order code:
Promass 80***-**********A
Promass 80***-**********D
Promass 83***-**********A
Promass 83***-**********B

Ordering information

The Endress+Hauser service organisation can provide detailed ordering information and information on the order codes on request.

Accessories

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

Documentation

- ❑ Technical Information Promass 80F, 80M, 83F, 83M (TI053D/06/en)
- ❑ Technical Information Promass 80H, 80I, 83H, 83I (TI052D/06/en)
- ❑ Technical Information Promass 80E, 83E (TI061D/06/en)
- ❑ Operating Instructions Promass 80 (BA 057D/06/en)
- ❑ Operating Instructions Promass 80 PROFIBUS PA (BA072D/06/en)
- ❑ Operating Instructions Promass 83 (BA 059D/06/en)
- ❑ Operating Instructions Promass 83 FOUNDATION Fieldbus (BA065D/06/en)
- ❑ Operating Instructions Promass 83 PROFIBUS DP/PA (BA063D/06/en)
- ❑ Operating Instructions Promass 83 MODBUS (BA107D/06/en)
- ❑ Description of Device Functions Promass 80 (BA 058D/06/en)
- ❑ Description of Device Functions Promass 80 PROFIBUS PA (BA073D/06/en)
- ❑ Description of Device Functions Promass 83 (BA 060D/06/en)
- ❑ Description of Device Functions Promass 83 FOUNDATION Fieldbus (BA066D/06/en)
- ❑ Description of Device Functions Promass 83 PROFIBUS DP/PA (BA064D/06/en)
- ❑ Description of Device Functions Promass 83 MODBUS (BA108D/06/en)
- ❑ Supplementary documentation on Ex-ratings: ATEX, FM, CSA
- ❑ Functional safety manual Promass 80, 83 (SD077D/06/en)

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HART®
Registered trademark of HART Communication Foundation, Austin, USA

PROFIBUS®
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FOUNDATION™ Fieldbus
Registered trademark of the Fieldbus FOUNDATION, Austin, USA

MODBUS®
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