Technical
Information
TI 029D/06/en
No. 50068991

Coriolis Mass Flow Measurement System
promass 60 (HART)

Cost-effective mass flow measurement for liquids and gases

Flexible System
- The system can be customised to each application
- Wide choice of materials for process connections and measuring tubes, compatible to the fluid
- Simple and cost-effective installation
- Transmitter housing can be rotated to fit the orientation

Easy to Operate
- All important instrument functions easily configurable:
  – with DIP switches / local display
  – with HART protocol
- Local display: all important variables easily read off

Accurate Measurement
- Measurement accuracy for liquids:
  – Mass flow ± 0.15 %
  – Volume flow ± 0.2 %
- Measurement accuracy for gases:
  – Mass flow ± 0.5 %
- 1000:1 operable flow range
- Excellent repeatability

Safe Operation
- Self-emptying measuring tubes
- Secondary containment vessel as standard
- High electromagnetic compatibility (EMC)
- Self-monitoring with alarm function
- EEPROM stores data on power failure (no batteries required)
- ISO 9001 manufacturer, quality assured

Install Anywhere
- Compact design
- Insensitive to plant vibration
- Rugged and shock-proof surfaces resistant to acids and alkalis
- IP 67 protection for compact and remote versions
- Measurement independent of fluid characteristics

Endress + Hauser
The Power of Know How

Measuring System

Fields of Application

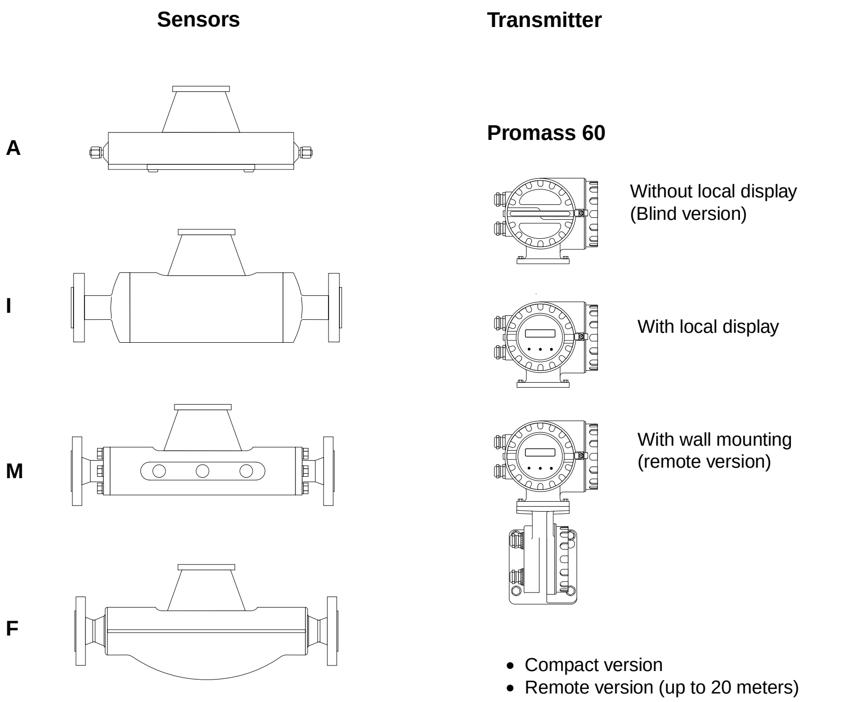
The Promass 60 system measures the mass and volume flow of fluids having widely differing characteristics:

- Chocolate, condensed milk, syrup
- Oils, fats
- Acids, alkalis
- Varnishes, paints
- Suspensions
- Pharmaceuticals
- Catalytic converters, inhibitors
- Gases and gas mixtures

The Promass 60 is used in applications wherever mass flow measurement is of critical importance:

- Mixing and batching of various raw materials
- Controlling processes
- Measuring of quickly changing densities
- Control and monitoring of product quality.

The advantages of this measurement process are demonstrated by its successful use in food processing, the pharmaceutical industry, the chemical and petrochemical industries, waste disposal, energy production, gas applications, etc.



A	DN 1... 4:	For very small flow quantities, single tube system in SS or Alloy C-22
I	DN 8... 50:	Single straight tube system (titanium), completely welded version
M	DN 8... 80:	Two straight measuring tubes (titanium), containment vessel up to 100 bar
	DN 8... 25:	High pressure version, system pressure up to 350 bar
F	DN 8...100:	Two slightely curved measuring tubes in SS or Alloy C-22 (only for DN 8...80), completely welded version

Technical data: see pages 29 – 35

ti029y02

The modular Promass 60 measuring system

Information on all Ex versions is available on request from your E+H Sales Centre.

Measuring System

The measuring system consists of:

- Promass 60 transmitter
- Promass A, I, M or F sensor

The Promass 60 measuring system is mechanically and electronically designed for maximum flexibility with the transmitters and sensors being combined in any variation.

The wide range of materials and process connections (fittings; flanges DIN, ANSI, JIS; Tri-Clamp) ensure that the measuring point can adjust to both plant and process conditions.
The transmitter housing can be rotated for ease of reading and operation in any orientation.

Sensor Function

Measuring Principle

The measuring principle is based on the controlled generation of Coriolis forces. These forces are always present when both translational (straight line) and rotational (revolving) movement occur simultaneously.

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

$\vec{F}_C$ = Coriolis force
Δm = mass of moving body
$\vec{\omega}$ = angular velocity
$\vec{v}$ = radial velocity in a rotating or oscillating system

The amplitude of the Coriolis force depends on the moving mass Δm, its velocity $\vec{v}$ in the system and therefore its mass flow.

The Promass uses an oscillation instead of a constant angular velocity $\vec{\omega}$ and two parallel measuring tubes (Promass M and F), with fluid flowing through them, are made to oscillate in antiphase so that they act like a tuning fork.

The Coriolis forces produced at the measuring tubes cause a phase shift in the tube oscillation (see Figure on left):

- When there is zero flow, i.e. with the fluid standing still, both tubes oscillate in phase (**1**).
- When there is mass flow, the tube oscillation is decelerated at the inlet (**2**) and accelerated at the outlet (**3**).

As the mass flow rate increases, the phase difference also increases (**A-B**). The oscillations of the measuring tubes are determined using electrodynamic sensors at the inlet and outlet. The measurement principle operates independently of temperature, pressure, viscosity, conductivity or flow profile.

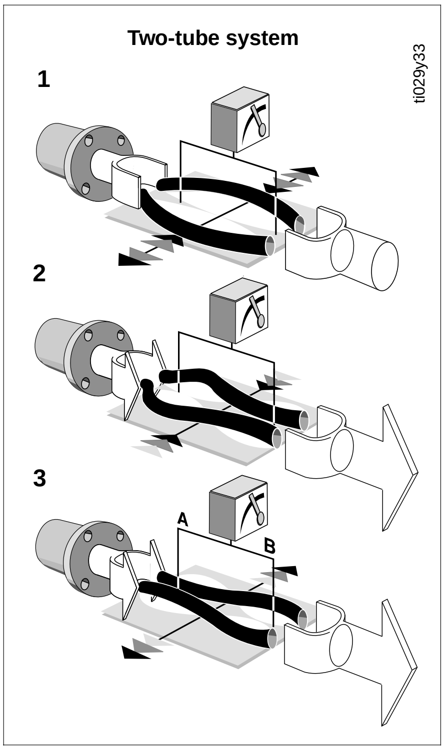
Density Measurement

The measuring tubes are continously excited at their resonant frequency.
As the mass, and therefore the density, of the oscillating system changes (measuring tubes and fluid), the vibrating frequency is readjusted. The resonant frequency is thus a function of the density of the fluid and enables the microprocessor to produce a density signal.

Temperature Measurement

The temperature of the measuring tubes is determined and used to compensate for temperature effects. The signal produced is a function of the process temperature.

Balanced Measuring System



Two-tube systems (Promass M, F)
The system balance is ensured by the two measuring tubes vibrating in antiphase.

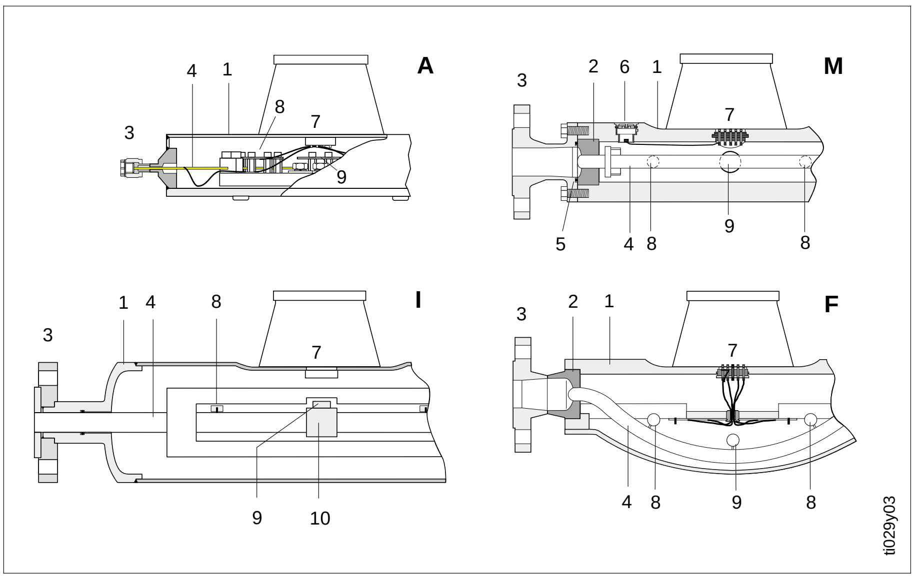
Single tube systems (Promass A, I)
For single tube systems, other design solutions are necessary for system balance than for two-tube systems.

Promass A:
For Promass A, an internal reference mass is used for this purpose.

Promass I:
For Promass I, the system balance necessary for flawless measurement is generated by exciting an eccentrically located, counter-oscillating pendulum mass.
This TMB^{TM} (Torsion Mode Balanced) system is patented and guarantees accurate measurement, also with changing process and ambient conditions. The installation of Promass I is for this reason just as easy as with two-tube systems! Special fastening measures before and after the meter are therefore not necessary.

Sectional view of Promass A, I, M and F sensors

1. Housing/containment vessel
2. Manifold
3. Process connection
4. Measuring tube(s)
   A: 1 curved tube
   I: 1 straight tube
   M: 2 straight tubes
   F: 2 curved tubes
5. Gasket
6. Plug
7. Cable gland
8. Electrodynamic sensors
9. Excitation system
10. Pendulum mass TMB^{TM} System (Promass I)



Transmitter Function

Function of the Promass 60

The Promass transmitter converts the measured values coming from the sensor into standardised output signals. The following outputs are available for these signals:

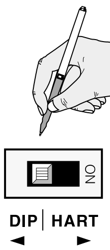
- Current output (with superimposed HART protocol)
- Pulse output
- Status output
- Auxiliary input

Promass 60 can be configured as a mass or volume flowmeter.

Operating Mode / Functionality

Promass can be operated and configured in two, basically different ways:

- with DIP switches and local display
- with HART protocol



The configuration mode is set using a special DIP switch (“DIP” or “HART”), and thereby also the instrument functionality. An overview of all Promass 60 instrument functions, depending on the type of configuration, can be found on page 5 ff.

Configuration with DIP Switches

All important instrument parameters are set using DIP switches in the transmitter (see page 7):

- Current range 0/4...20 mA
- End value scaling of current output
- Pulse weight
- Technical units (SI/US)
- Functions of the status output
- Creep suppression (on/off)
- Functions of the auxiliary input
- Short-cycle batching (on/off)

Configuration with Local Display

A local display is also available for the Promass 60 measuring system.
This ensures that all important variables can be read off and controlled directly at the measuring point:

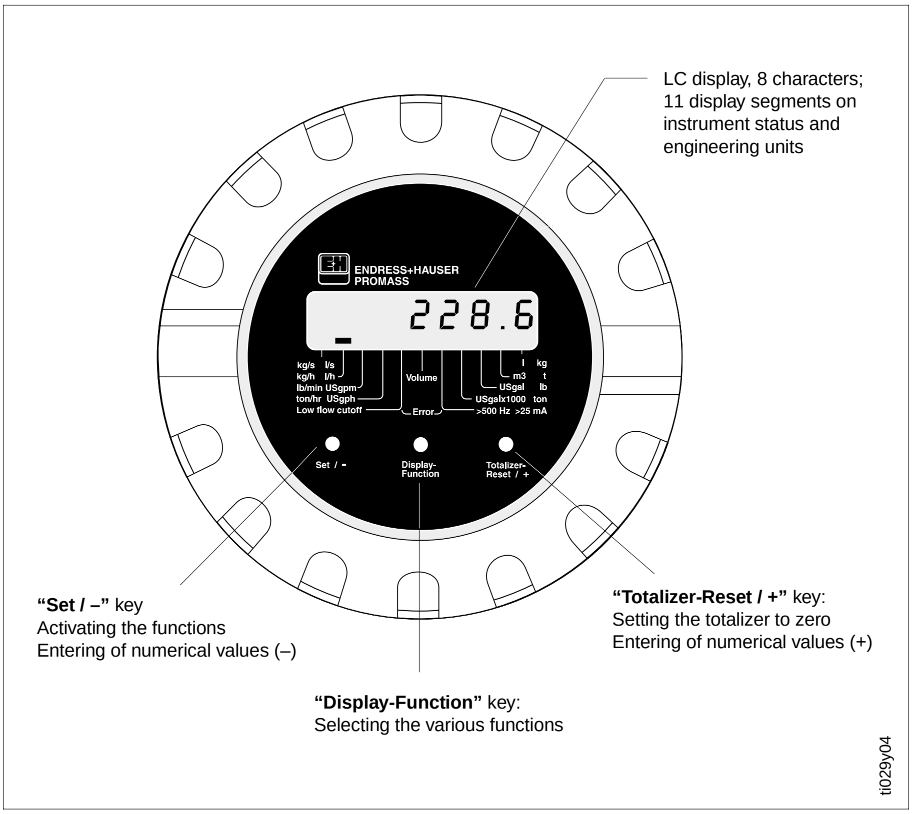
- Flow rate and/or totalised flow
- Technical units
- Process conditions (e.g. falling below creep limit)
- Mass or volume flow measurement
- Signal outputs exceeded
- Error messages

Various functions can be selected and activated using the operating keys, e.g. zero point calibration, density calibration, pressure pulse suppression, etc.

Configuration with HART Protocol

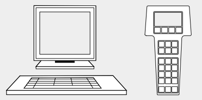
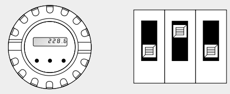
With HART protocol, Promass 60 can be operated, configured and read in different ways:

- via the DXR 275 HART handheld
- via the Commuwin II operating program (in connection with Commubox FXA 191)
- via the HART Universal Commands and Common Practice Commands.

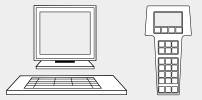
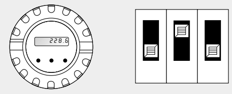


Local display
Promass 60 (optional)

Operating Mode / Functionality

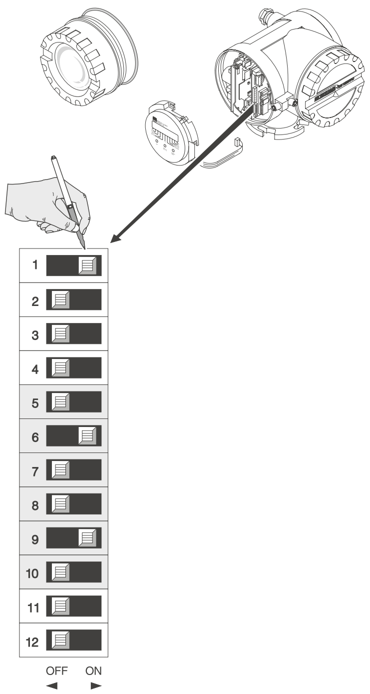
	HART protocol via 	DIP switches / Local display 
Process variables		
Mass flow	display	display
Volume flow	display	display
Density	display	display not possible (only for density adjustment)
Temperature	display	display not possible
Totalizer		
Totalizer 1	display	display
Totalizer 1 overflow	display	display
Reset totalizer	possible	possible
System info		
Code entry	possible	not possible
Diagnostic code	display of error and status messages	display not possible
Multidrop Address (Commuwin II)	entry	entry not possible
Software version Com	display	display not possible
Display test function	not possible	possible
System units		
Volume flow measurement	possible	possible
Mass flow unit	freely selectable: kg/s, kg/h, lb/min, ton/hr	SI or US units selectable
Mass unit	freely selectable: kg, t, lb, ton	SI or US units selectable
Volume flow unit	freely selectable: l/s, l/h, Ugpm, Ugph	SI or US units selectable
Volume unit	freely selectable: l, m^3, USgal, USgal * 1000	SI or US units selectable
Density unit	freely selectable: kg/dm^3, g/cc	–
Temperature unit	freely selectable: °C, K, °F, °R	–
Current outputs		
Assign output	mass or volume flow	mass or volume flow
Full scale value	freely selectable	8 values selectable
Time constant	freely selectable 0.01...99 s	1 s (fixed value)
Current span	4–20 mA 4–20 mA (NAMUR)	0–20 mA or 4–20 mA
Simulation current	possible	not possible
Nominal current	display	display not possible

Operating Mode / Functionality

	HART protocol via  Commuwin II DXR 275	**DIP switches / Local display** 
Pulse / Freq. output		
Assign output	mass or volume flow	mass or volume flow
Operation mode	pulse or frequency	pulse or frequency
Pulse value	freely selectable	8 values selectable
Pulse width	freely selectable	max. 10 s
Full scale value (400 Hz)	freely selectable	fixed value
Simulation frequency	possible	not possible
Processing parameters		
Low flow cutoff	freely selectable	on/off switching
Noise suppression	freely selectable between 0.00...2.00 s	not possible
Empty pipe detection (EPD threshold)	freely selectable	not possible (no empty pipe detection)
Self checking (batching time <60 s)	selectable	selectable
Pressure pulse suppression	time period of activation freely selectable	on/off switching
Zero point adjustment	possible	possible
Density adjustment	possible	possible
Density adjust value	selectable	selectable
Assign auxiliary input	selectable: – positive zero return – zero point adjustment – totalizer reset	selectable: – positive zero return – zero point adjustment – totalizer reset
Assign status output	selectable: – error message – flow direction recognition	selectable: – error message – flow direction recognition
System reset	possible (only with Commuwin II)	not possible
Sensor data		
Calibration factor	read-write possible	not possible
Zero point	selectable	selectable
Nominal diameter	display	display not possible
Sensor coefficients/ values	display (e.g. of density coefficients C0...C5)	display not possible
Serial number	display	display not possible
Software version	display	display not possible

Scaling the Outputs with DIP Switches

MASS



The various pulse value and full scale values are set using the DIP switches inside the housing (electronics area) → see page 7.

If a different pulse- or full scale value, than the selection given with the DIP switches is required, the meter can be configured via HART → see page 4.

On request, Promass 60 measuring instruments are also available with customised parameterisation.

MASS – Pulse value

SI units [g, kg, t]

DN	ON/OFF 5 6 7	5 6 7	5 6 7	5 6 7	5 6 7	5 6 7	5 6 7	5 6 7
1	0.0001 g	0.001 g	0.01 g	0.1 g	1 g	10 g	100 g	0.000020 kg
2	0.01 g	0.1 g	1 g	10 g	100 g	1 kg	10 kg	0.000079 kg
4	0.1 g	1 g	10 g	100 g	1 kg	10 kg	100 kg	0.000314 kg
8	1 g	10 g	100 g	1 kg	10 kg	100 kg	1 t	0.001257 kg
15	1 g	10 g	100 g	1 kg	10 kg	100 kg	1 t	0.004418 kg
15*/25	10 g	100 g	1 kg	10 kg	100 kg	1 t	10 t	0.012272 kg
25*/40	10 g	100 g	1 kg	10 kg	100 kg	1 t	10 t	0.031416 kg
40*/50	10 g	100 g	1 kg	10 kg	100 kg	1 t	10 t	0.049087 kg
80	100 g	1 kg	10 kg	100 kg	1 t	10 t	100 t	0.125664 kg
100	1 kg	10 kg	100 kg	1 t	10 t	100 t	1000 t	0.196350 kg

US units [lb]

DN								
1	0.0000001	0.000001	0.00001	0.0001	0.001	0.01	0.1	0.000043
2	0.00001	0.0001	0.001	0.01	0.1	1	10	0.000174
4	0.0001	0.001	0.01	0.1	1	10	100	0.000697
8	0.001	0.01	0.1	1	10	100	1000	0.002787
15	0.001	0.01	0.1	1	10	100	1000	0.009797
15*/25	0.01	0.1	1	10	100	1000	10000	0.027213
25*/40	0.01	0.1	1	10	100	1000	10000	0.069665
40*/50	0.01	0.1	1	10	100	1000	10000	0.108851
80	0.1	1	10	100	1000	10000	100000	0.278659
100	1	10	100	1000	10000	100000	1000000	0.435397

* DN 15, 25, 40 “FB” = Full bore versions Promass I

MASS – Full scale value (current output)

SI units [kg/h]

DN	ON/OFF 8 9 10	8 9 10	8 9 10	8 9 10	8 9 10	8 9 10	8 9 10	8 9 10
1	1	2	3	4	5	10	16	20
2	5	10	15	20	25	50	80	100
4	20	40	60	80	100	200	320	400
8	100	200	300	400	500	1000	1600	2000
15	300	600	900	1200	1500	3000	4800	6000
15*/25	1000	2000	3000	4000	5000	10000	16000	20000
25*/40	2000	4000	6000	8000	10000	20000	32000	40000
40*/50	4000	8000	12000	16000	20000	40000	64000	80000
80	9000	18000	27000	36000	45000	90000	144000	180000
100	14000	28000	42000	56000	70000	140000	224000	280000

US units [lb/min]

DN								
1	0.05	0.10	0.15	0.20	0.25	0.50	0.80	1.00
2	0.20	0.40	0.60	0.80	1.00	2.00	3.20	4.00
4	0.75	1.50	2.25	3.00	3.75	7.50	12.00	15.00
8	4.00	8.00	12.00	16.00	20.00	40.00	64.00	80.00
15	10.00	20.00	30.00	40.00	50.00	100.00	160.00	200.00
15*/25	30.00	60.00	90.00	120.00	150.00	300.00	480.00	600.00
25*/40	75.00	150.00	225.00	300.00	375.00	750.00	1200.00	1500.00
40*/50	125.00	250.00	375.00	500.00	625.00	1250.00	2000.00	2500.00
80	325.00	650.00	975.00	1300.00	1625.00	3250.00	5200.00	6500.00
100	425.00	850.00	1275.00	1700.00	2125.00	4250.00	6800.00	8500.00

* DN 15, 25, 40 “FB” = Full bore versions Promass I

Factory settings
(grey shaded area)

Scaling the Outputs with DIP Switches

VOLUME

The various pulse values and full scale values are set using the DIP switches inside the housing (electronics area)
→ see page 7.

If a different pulse- or full scale value, than the selection given with the DIP switches is required, the meter can be configured via HART
→ see page 4.

On request, Promass 60 measuring instruments are also available with customised parameterisation.

VOLUME – Pulse value

SI units [ml, l, m^3]

DN	ON / OFF 							
1	0.0001 ml	0.001 ml	0.01 ml	0.1 ml	1 ml	10 ml	100 ml	0.000020 l
2	0.01 ml	0.1 ml	1 ml	10 ml	100 ml	1 l	10 l	0.000079 l
4	0.1 ml	1 ml	10 ml	100 ml	1 l	10 l	100 l	0.000314 l
8	1 ml	10 ml	100 ml	1 l	10 l	100 l	1 m3	0.001257 l
15	1 ml	10 ml	100 ml	1 l	10 l	100 l	1 m^3	0.004418 l
15*/25	10 ml	100 ml	1 l	10 l	100 l	1 m3	10 m^3	0.012272 l
25*/40	10 ml	100 ml	1 l	10 l	100 l	1 m^3	10 m^3	0.031416 l
40*/50	10 ml	100 ml	1 l	10 l	100 l	1 m^3	10 m^3	0.049087 l
80	100 ml	1 l	10 l	100 l	1 m3	10 m^3	100 m^3	0.125664 l
100	1 l	10 l	100 l	1 m^3	10 m^3	100 m^3	1000 m^3	0.196350 l

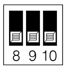
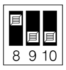
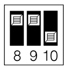
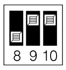
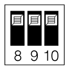
US units [USgal]

DN								
1	0.0000001	0.000001	0.00001	0.0001	0.001	0.01	0.1	0.000005
2	0.00001	0.0001	0.001	0.01	0.1	1	10	0.000021
4	0.0001	0.001	0.01	0.1	1	10	100	0.000083
8	0.001	0.01	0.1	1	10	100	1000	0.000334
15	0.001	0.01	0.1	1	10	100	1000	0.001174
15*/25	0.01	0.1	1	10	100	1000	10000	0.003261
25*/40	0.01	0.1	1	10	100	1000	10000	0.008348
40*/50	0.01	0.1	1	10	100	1000	10000	0.013043
80	0.1	1	10	100	1000	10000	100000	0.033391
100	1	10	100	1000	10000	100000	1000000	0.052173

* DN 15, 25, 40 “FB” = Full bore versions Promass I

VOLUME – Full scale value (current output)

SI units [l/h]

DN	ON / OFF 							
1	1	2	3	4	5	10	16	20
2	5	10	15	20	25	50	80	100
4	20	40	60	80	100	200	320	400
8	100	200	300	400	500	1000	1600	2000
15	300	600	900	1200	1500	3000	4800	6000
15*/25	1000	2000	3000	4000	5000	10000	16000	20000
25*/40	2000	4000	6000	8000	10000	20000	32000	40000
40*/50	4000	8000	12000	16000	20000	40000	64000	80000
80	9000	18000	27000	36000	45000	90000	144000	180000
100	14000	28000	42000	56000	70000	140000	224000	280000

US units [USgal/min]

DN								
1	0.005	0.010	0.015	0.020	0.025	0.050	0.080	0.100
2	0.025	0.050	0.075	0.100	0.125	0.250	0.400	0.500
4	0.100	0.200	0.300	0.400	0.500	1.000	1.600	2.000
8	0.500	1.000	1.500	2.000	2.500	5.000	8.000	10.000
15	1.500	3.000	4.500	6.000	7.500	15.000	24.000	30.000
15*/25	4.000	8.000	12.000	16.000	20.000	40.000	64.000	80.000
25*/40	10.000	20.000	30.000	40.000	50.000	100.000	160.000	200.000
40*/50	15.000	30.000	45.000	60.000	75.000	150.000	240.000	300.000
80	40.000	80.000	120.000	160.000	200.000	400.000	640.000	800.000
100	50.000	100.000	150.000	200.000	250.000	500.000	800.000	1000.000

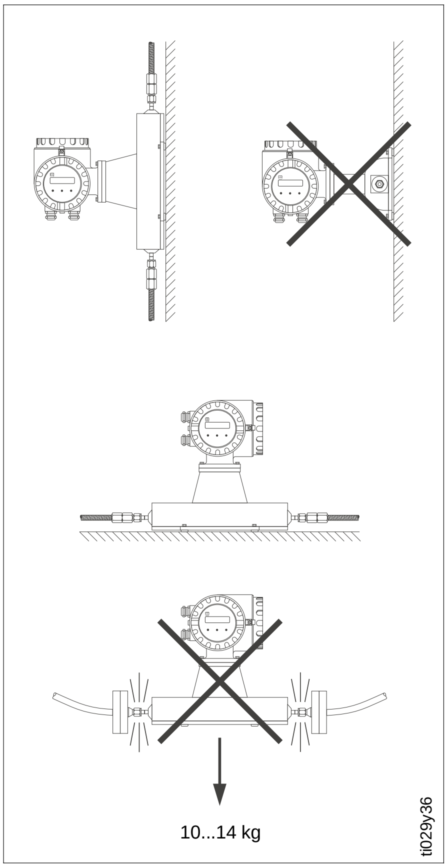
* DN 15, 25, 40 “FB” = Full bore versions Promass I

Factory settings
(grey shaded area)

Mounting

No special fittings such as brackets are needed. External forces are absorbed by the construction of the device, e.g. the secondary containment vessel. The high frequency oscillation of the measuring tubes ensures that correct operation of the measuring system is unaffected by plant vibration.

When mounting, no special precautions need to be taken for turbulence-generating devices (valves, bends T-pieces, etc.) as long as no cavitation occurs.



Orientation
Promass A

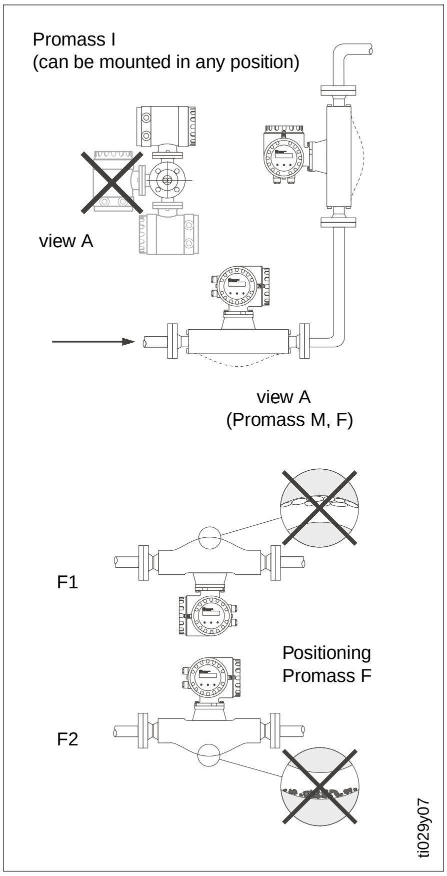
Orientation (Promass A)

Vertical
This is best with the flow direction upwards. Entrained solids sink downward and gases rise away from the measuring tube. This also allows the measuring tube to be completely drained and protects it from solids build-up.

Horizontal
When correctly installed, the transmitter housing is either above or below the piping. This assures that no gas bubbles may collect or solids be deposited in the curved measuring tube.

Wall and post mounting
The sensor may not be suspended in the piping, that is, without support or fixation to avoid excessive stress on the material around the process connection.

The sensor housing base plate allows table, wall, or post mounting. The post mounting requires a special mounting set.



Orientation
Promass I, M, F

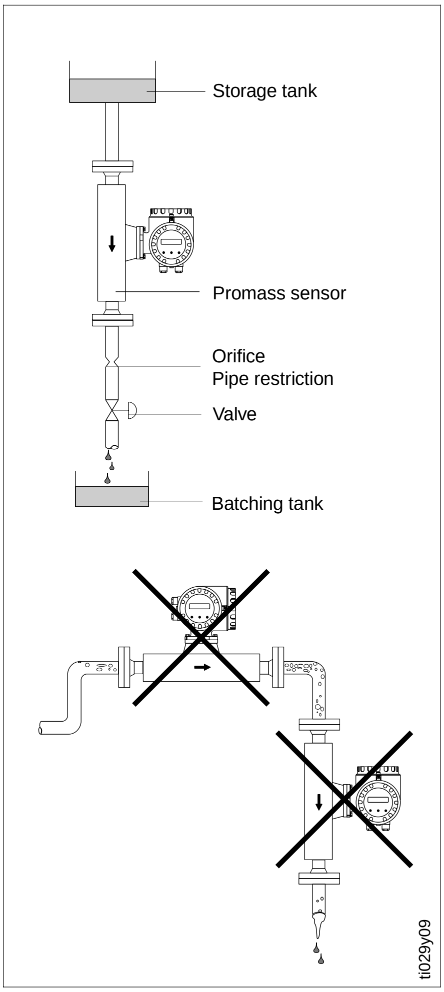
Orientation (Promass I, M, F)

Vertical
This is best with the flow direction upwards. Entrained solids sink downward and gases rise away from the measuring tubes when the product is not flowing. This also allows the measuring tubes to be completely drained and protects them from solids build-up.

Horizontal
- Promass I (single tube) can be freely installed in a horizontal piping.
- For Promass M and F the measuring tubes must lie side by side.
  When correctly installed, the transmitter housing is either above or below the piping (see view A).
- Promass F measuring tubes are slightly curved. Therefore, the sensor position is to be adapted to the fluid properties for horizontal installation:

  F1: not suitable for outgassing fluids
  F2: not suitable for fluids with solids content

Mounting



Mounting location
(vertical piping)

Mounting Location

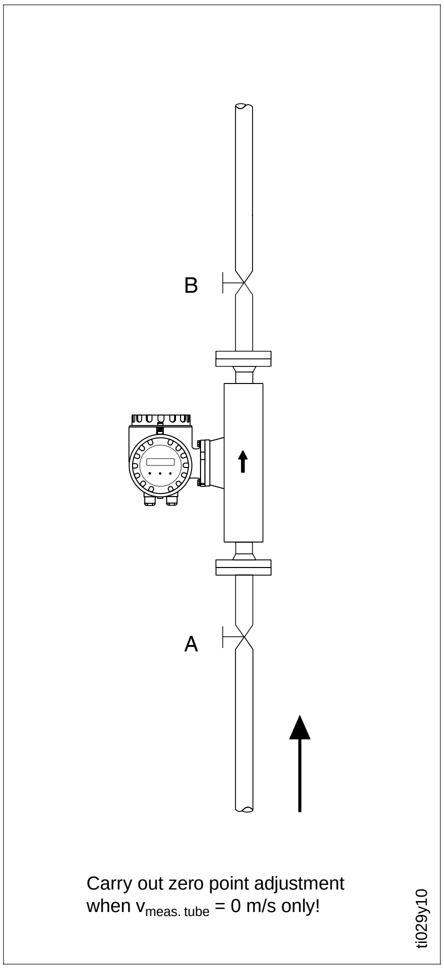
Air or entrained gases in the measuring tube may cause errors in measurement and therefore the following mounting installations are to be avoided:

- Do not install at the highest point of the piping.
- Do not install in a vertical pipeline directly upstream of a free pipe outlet.

Correct installation is still possible using the recommendation in the adjacent figure. Restrictions in the piping or an orifice with a smaller cross section than the measuring instrument can prevent the sensor from running empty during measurement.

Diameter	Ø Orifice / restriction
DN 1	0.8 mm
DN 2	1.5 mm
DN 4	3.0 mm
DN 8	6.0 mm
DN 15	10.0 mm
DN 15 *	15.0 mm
DN 25	14.0 mm
DN 25 *	24.0 mm
DN 40	22.0 mm
DN 40 *	35.0 mm
DN 50	28.0 mm
DN 80	50.0 mm
DN 100	65.0 mm

* DN 15, 25, 40 "FB"
Full bore versions of Promass I



Zero point adjustment
and shut-off valves

Zero Point adjustment

To ensure accurate measurement also with very low flow rates, we recommend to carry out a zero point adjustment under process conditions.
The zero point adjustment should be carried out only with the measuring tubes full and with no flow. This can be achieved with shut-off valves both upstream and downstream of the sensor (or use existing valves if present).

Normal operation
- Open valves A and B

*Zero point adjustment **with** pumping pressure*
- Open valve A
- Close valve B

*Zero point adjustment **without** pumping pressure*
- Close valve A
- Open valve B

Planning and Installation

System Pressure
It is important to avoid cavitation as this can affect tube oscillation.

No special measures need be taken for fluids which have properties similar to those of water under normal conditions.

With volatile liquids (hydrocarbons, solvents, liquefied gases) or liquids in suction lines, the vapour pressure of the liquid must not drop below a point where the liquid begins to boil.
It is also important not to release gases which are found naturally in many liquids. This can be prevented by ensuring that there is sufficient system pressure.
Ideally the sensor should be mounted
- on the descharge side of pumps (avoiding low pressure),
- at the lowest point of a vertical pipeline.

Corrosion Resistance
With corrosive liquids, the chemical resistance of all wetted parts such as measuring tubes, gaskets and process connections must be thoroughly checked. This also applies to the liquids used for cleaning the Promass sensor.

Tracing, Thermal Insulation
With certain products heat transfer at the sensor must be avoided. A wide range of materials can be used for the necessary insulation.
Heating can be provided either electrically, e.g. by heating jackets, or supplied by copper pipes with heated water or steam. Heating elements for heat tracing are available for all sensors.

Caution!
Ensure that the meter electronics are not overheated. The connector between the sensor and the transmitter housings as well as the connection housing of the remote version must therefore always be kept free.

Full Scale Value / Nominal Diameter
The most suitable nominal diameter is selected by taking into account the measuring range required and the permitted pressure drop. The full scales values for each nominal diameter are defined on page 29.

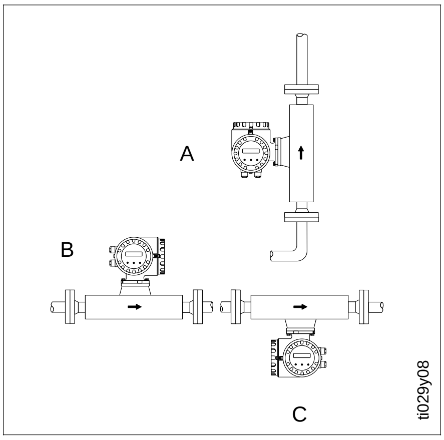
- The minimum recommended full scale value is about $^1/_{20}$ of the indicated max. values above.
- With most applications, the optimum is considered to be between 20...50% of the maximum full scale value.
- With abrasive fluids, e.g. liquids containing solids, a lower full scale value should be used (flow velocity <1 m/s).
- For gas applications the following rules applies:
  – The flow velocity in the tubes should not exceed half of the sonic speed (mach 0.5).
  – The maximum massflow depends on the density of the gas and can be calculated from the formula on page 29.

"Applicator" Design Software
All important instrument data are contained in the E+H software in order to optimise the design of the measuring system.
The Applicator software is used for the following calculations:
- Nominal diameter of the sensor with regard to the characteristics of the fluid such as viscosity, density, etc.
- Pressure loss downstream of the measuring point
- Converting mass flow to volumetric flow, etc.
- Simultaneous display of various nominal diameters.

Fluid Temperature / Orientation
To ensure that the permitted ambient temperature range for the transmitter is not exceeded (–25...+60 °C) positioning is recommended as follows:

High fluid temperature
- Vertical piping: Position A
- Horizontal piping: Position C

Low fluid temperature
- Vertical piping: Position A
- Horizontal piping: Position B



Pressure Loss

The pressure drop is dependent on the characteristics of the fluid and its flow rate. The following formulae can be used for liquids to approximately calculate the pressure loss:

Note!
Calculations on pressure loss can be carried out using the Endress+Hauser “Applicator” software (see page 11).

	Promass A / I	**Promass M / F**
Reynolds No.	$Re = \dfrac{4 \cdot \dot{m}}{\pi \cdot d \cdot \upsilon \cdot \rho}$	$Re = \dfrac{2 \cdot \dot{m}}{\pi \cdot d \cdot \upsilon \cdot \rho}$
Re ≥ 2300 *	$\Delta p = K \cdot \upsilon^{0.25} \cdot \dot{m}^{1.75} \cdot \rho^{-0.75} + \dfrac{K3 \cdot \dot{m}^2}{\rho}$	$\Delta p = K \cdot \upsilon^{0.25} \cdot \dot{m}^{1.85} \cdot \rho^{-0.86}$
Re < 2300	$\Delta p = K1 \cdot \upsilon \cdot \dot{m} + \dfrac{K3 \cdot \dot{m}^2}{\rho}$	$\Delta p = K1 \cdot \upsilon \cdot \dot{m} + \dfrac{K2 \cdot \upsilon^{0.25} \cdot \dot{m}^2}{\rho}$

Δp = pressure loss [mbar]
υ = kinematic viscosity [m^2/s]
$\dot{m}$ = mass flow rate [kg/s]
ρ = fluid density [kg/m^3]
d = internal diameter of measuring tubes [m]
K...K3 = constants dependent on the nominal diameter

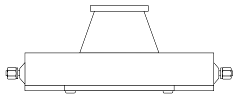
* For gases the pressure loss has always to be calculated by use of the formula for Re ≥ 2300.

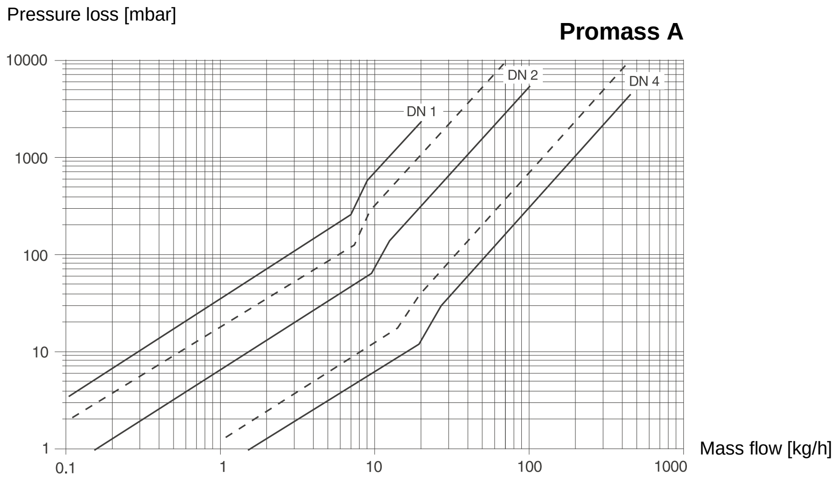
	Diameter	d [m]	K	K1	K2	K3
Promass A	DN 1	$1.10 \cdot 10^{-3}$	$1.2 \cdot 10^{11}$	$1.3 \cdot 10^{11}$	–	0
	DN 2	$1.80 \cdot 10^{-3}$	$1.6 \cdot 10^{10}$	$2.4 \cdot 10^{10}$	–	0
	DN 4	$3.50 \cdot 10^{-3}$	$9.4 \cdot 10^{8}$	$2.3 \cdot 10^{9}$	–	0
Promass A High press.	DN 2	$1.40 \cdot 10^{-3}$	$5.4 \cdot 10^{10}$	$6.6 \cdot 10^{10}$	–	0
	DN 4	$3.00 \cdot 10^{-3}$	$2.0 \cdot 10^{9}$	$4.3 \cdot 10^{9}$	–	0
Promass I	DN 8	$8.55 \cdot 10^{-3}$	$8.1 \cdot 10^{6}$	$3.9 \cdot 10^{7}$	–	$129.95 \cdot 10^{4}$
	DN 15	$11.38 \cdot 10^{-3}$	$2.3 \cdot 10^{6}$	$1.3 \cdot 10^{7}$	–	$23.33 \cdot 10^{4}$
	DN 15 *	$17.07 \cdot 10^{-3}$	$4.1 \cdot 10^{5}$	$3.3 \cdot 10^{6}$	–	$0.01 \cdot 10^{4}$
	DN 25	$17.07 \cdot 10^{-3}$	$4.1 \cdot 10^{5}$	$3.3 \cdot 10^{6}$	–	$5.89 \cdot 10^{4}$
	DN 25 *	$25.60 \cdot 10^{-3}$	$7.8 \cdot 10^{4}$	$8.5 \cdot 10^{5}$	–	$0.11 \cdot 10^{4}$
	DN 40	$25.60 \cdot 10^{-3}$	$7.8 \cdot 10^{4}$	$8.5 \cdot 10^{5}$	–	$1.19 \cdot 10^{4}$
	DN 40 *	$35.62 \cdot 10^{-3}$	$1.3 \cdot 10^{4}$	$2.0 \cdot 10^{5}$	–	$0.08 \cdot 10^{4}$
	DN 50	$35.62 \cdot 10^{-3}$	$1.3 \cdot 10^{4}$	$2.0 \cdot 10^{5}$	–	$0.25 \cdot 10^{4}$
Promass M	DN 8	$5.53 \cdot 10^{-3}$	$5.2 \cdot 10^{7}$	$8.6 \cdot 10^{7}$	$1.7 \cdot 10^{7}$	–
	DN 15	$8.55 \cdot 10^{-3}$	$5.3 \cdot 10^{6}$	$1.7 \cdot 10^{7}$	$9.7 \cdot 10^{5}$	–
	DN 25	$11.38 \cdot 10^{-3}$	$1.7 \cdot 10^{6}$	$5.8 \cdot 10^{6}$	$4.1 \cdot 10^{5}$	–
	DN 40	$17.07 \cdot 10^{-3}$	$3.2 \cdot 10^{5}$	$1.2 \cdot 10^{6}$	$1.2 \cdot 10^{5}$	–
	DN 50	$25.60 \cdot 10^{-3}$	$6.4 \cdot 10^{4}$	$4.5 \cdot 10^{5}$	$1.3 \cdot 10^{4}$	–
	DN 80	$38.46 \cdot 10^{-3}$	$1.4 \cdot 10^{4}$	$8.2 \cdot 10^{4}$	$3.7 \cdot 10^{3}$	–
Promass M High press.	DN 8	$4.93 \cdot 10^{-3}$	$6.0 \cdot 10^{7}$	$1.4 \cdot 10^{8}$	$2.8 \cdot 10^{7}$	–
	DN 15	$7.75 \cdot 10^{-3}$	$8.0 \cdot 10^{6}$	$2.5 \cdot 10^{7}$	$1.4 \cdot 10^{6}$	–
	DN 25	$10.20 \cdot 10^{-3}$	$2.7 \cdot 10^{6}$	$8.9 \cdot 10^{6}$	$6.3 \cdot 10^{5}$	–
Promass F	DN 8	$5.35 \cdot 10^{-3}$	$5.70 \cdot 10^{7}$	$9.60 \cdot 10^{7}$	$1.90 \cdot 10^{7}$	–
	DN 15	$8.30 \cdot 10^{-3}$	$5.80 \cdot 10^{6}$	$1.90 \cdot 10^{7}$	$10.60 \cdot 10^{5}$	–
	DN 25	$12.00 \cdot 10^{-3}$	$1.90 \cdot 10^{6}$	$6.40 \cdot 10^{6}$	$4.50 \cdot 10^{5}$	–
	DN 40	$17.60 \cdot 10^{-3}$	$3.50 \cdot 10^{5}$	$1.30 \cdot 10^{6}$	$1.30 \cdot 10^{5}$	–
	DN 50	$26.00 \cdot 10^{-3}$	$7.00 \cdot 10^{4}$	$5.00 \cdot 10^{5}$	$1.40 \cdot 10^{4}$	–
	DN 80	$40.50 \cdot 10^{-3}$	$1.10 \cdot 10^{4}$	$7.71 \cdot 10^{4}$	$1.42 \cdot 10^{4}$	–
	DN 100	$51.20 \cdot 10^{-3}$	$3.54 \cdot 10^{3}$	$3.54 \cdot 10^{4}$	$5.40 \cdot 10^{3}$	–

Pressure loss data **inclusive** interface measuring tube(s) / piping
Pressure loss diagrams for water can be found on the following page.

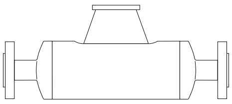
* DN 15, 25, 40 “FB” = Full bore versions of Promass I

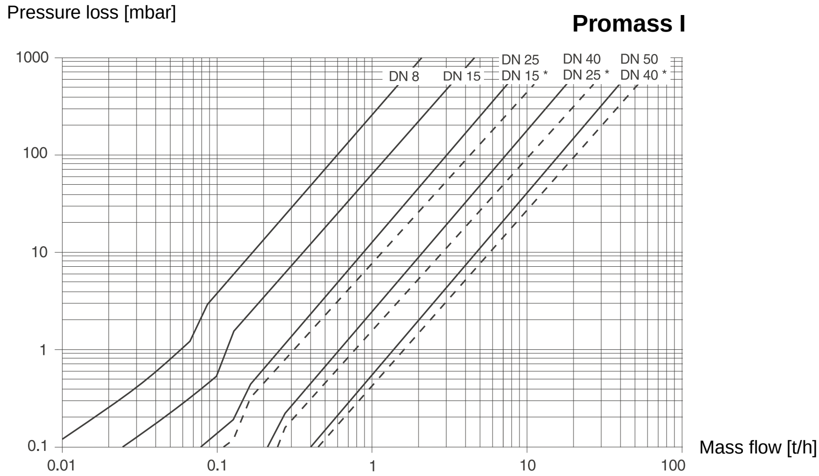
Pressure Loss with Water



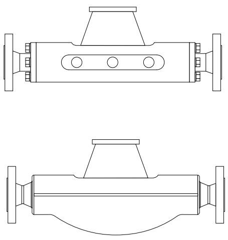


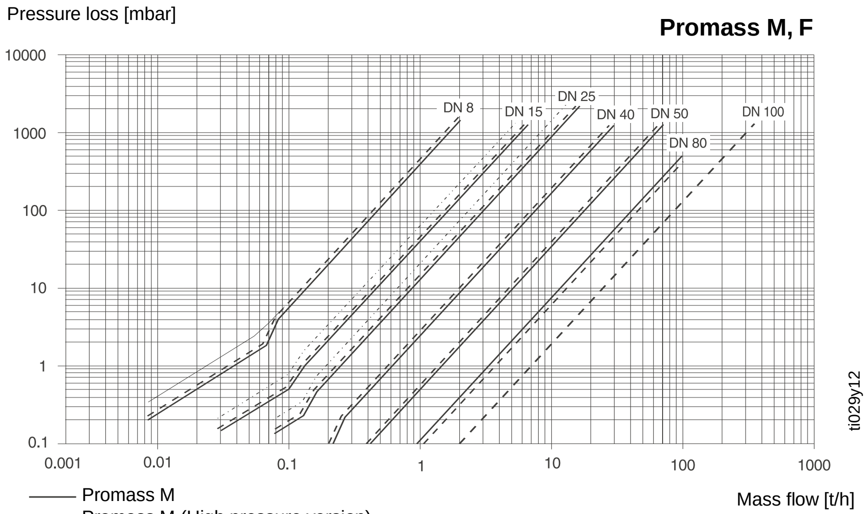
—— Standard version
- - - - High pressure version





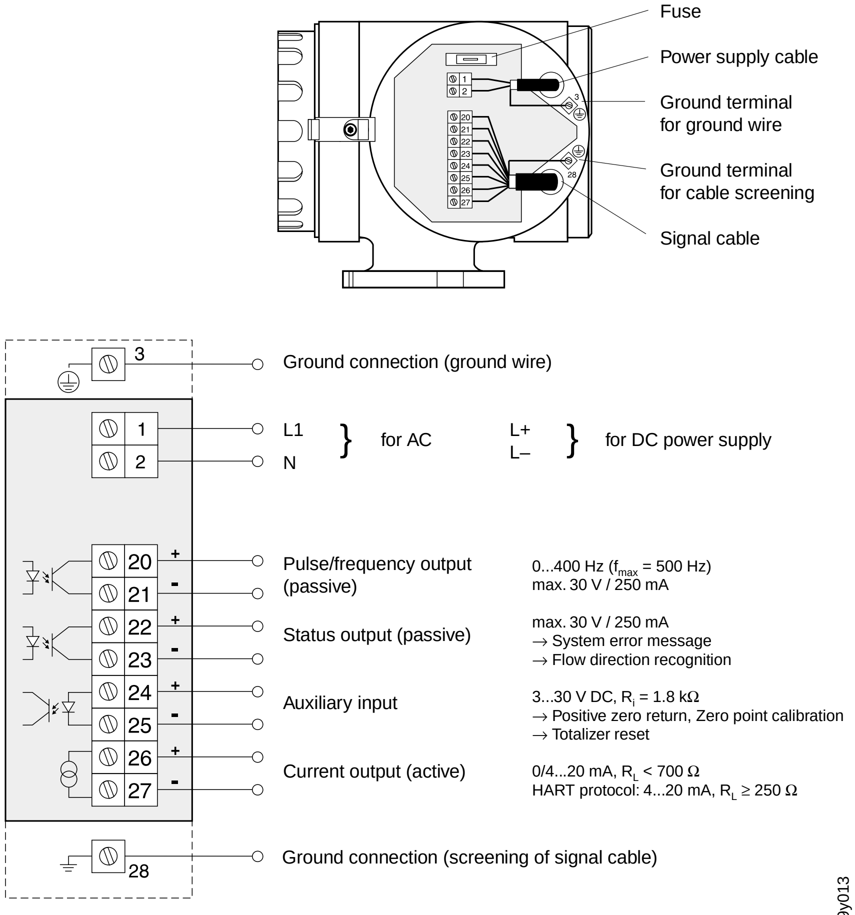
—— Standard versions:
inclusive interface measuring tube(s) / piping
- - - - Full bore versions *





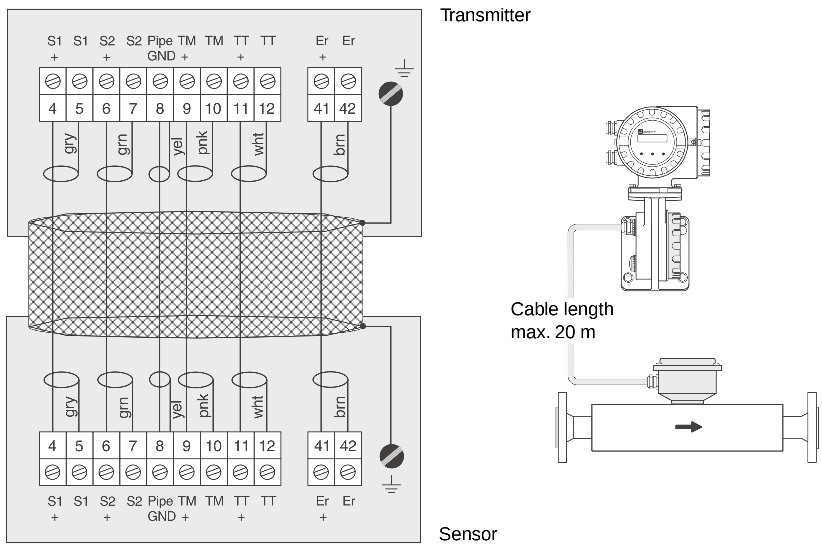
—— Promass M
-·-·- Promass M (High pressure version)
- - - - Promass F

Electrical Connections



Electrical connections: power supply, input and outputs

Remote version



gry = grey; grn = green; yel = yellow; pnk = pink; wht = white; brn = brown

Cable specifications for the remote version
6 x 0.38 mm^2 PVC cable with common screening and individually screened cores.
Conductor resistance: ≤ 50 Ω/km; Capacitance: core/screen ≤ 420 pF/m

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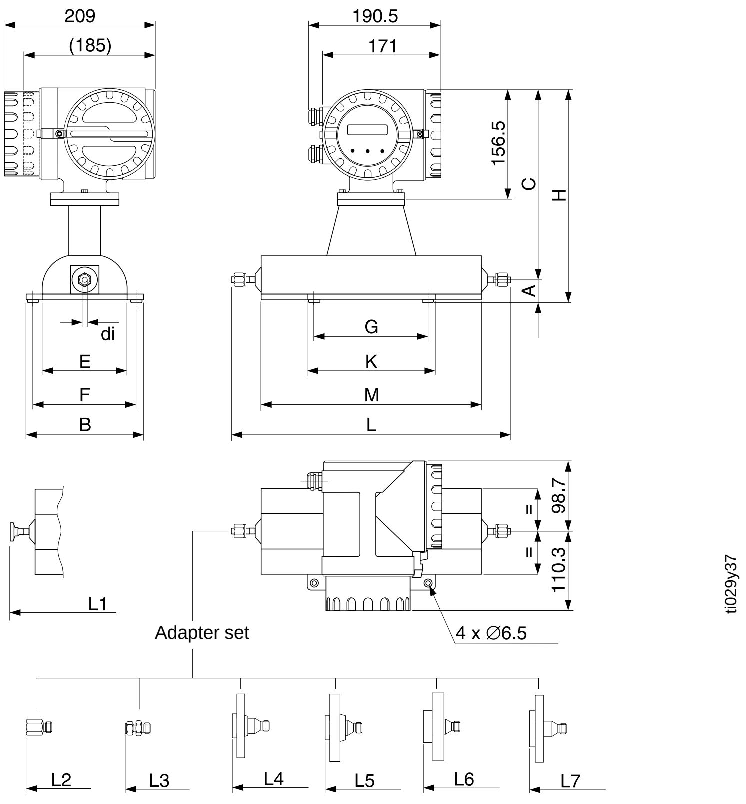
Note!
Technical data on Ex versions are given in separate documentation available from E+H on request.

Dimensions Promass 60 A

Compact version



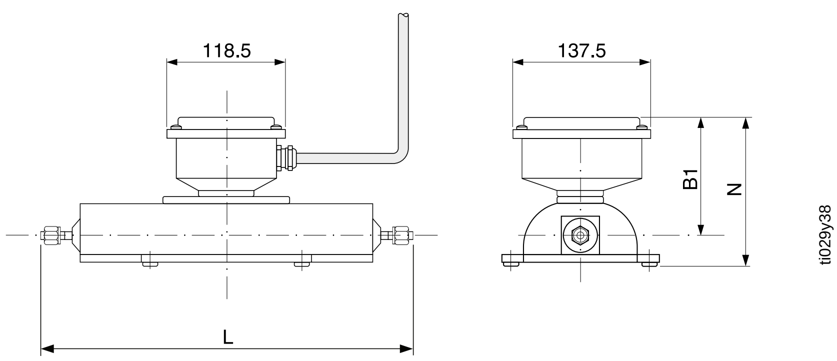
Flange connection with “lap joint flanges”

Process connection	L 4-VCO-4 fittings	L1 ½" Tri-Clamp	L2 ¼" NPT-F	L3 SWAGELOK DN 1, 2: ⅛" or ¼" DN 4: ¼"	L4 ½" flange (ANSI) Cl 150	L5 Cl 300	L6 DN 15 flange (DIN, JIS) PN 40	L7 10K
DN 1	290	296	361	359.6	393	393	393	393
DN 2	372	378	443	441.6	475	475	475	475
DN 4	497	503	568	571.6	600	600	600	600

Diameter DIN	ANSI	di	A	B	C	E	F	G	H	K	M	Weight [kg]
DN 1	1/24"	1.1	32	165	269.5	120	145	160	301.5	180	228	10
DN 2	1/12"	1.8	32	165	269.5	120	145	160	301.5	180	310	11
DN 2*	1/12"	1.4	32	165	269.5	120	145	160	301.5	180	310	11
DN 4	⅛"	3.5	32	195	279.5	150	175	220	311.5	240	435	15
DN 4*	⅛"	3.0	32	195	279.5	150	175	220	311.5	240	435	15

All dimensions in mm; * High pressure version

Remote version (dimensions of the transmitter: see page 17)

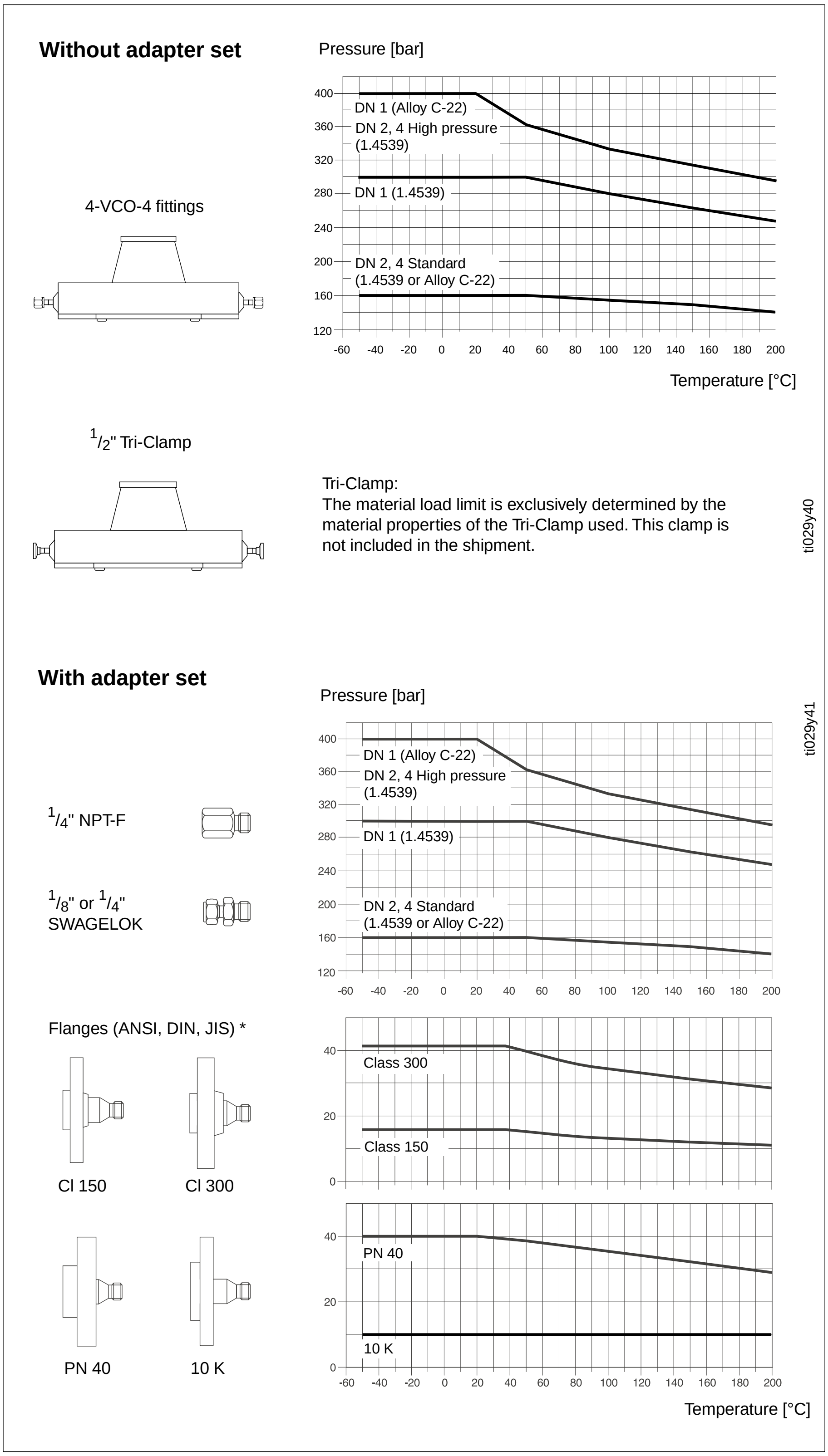


Diameter DIN	ANSI	B1 [mm]	N [mm]	L
DN 1	1/24"	122	154	Dimensions dependent on the process connections (see above)
DN 2	1/12"	122	154	
DN 4	⅛"	132	164	

Note!
Dimensions of Ex instruments are given in separate documentation available from E+H on request.

Wetted Parts Materials

Measuring tube:	SS 1.4539 (904L), Alloy C-22 2.4602 (N 06022)
4-VCO-4 fittings	SS 1.4539 (904L), Alloy C-22 2.4602 (N 06022)
$^1/_2$" Tri-Clamp	SS 1.4539 (904L)
Adapter sets:	
$^1/_8$" or $^1/_4$" SWAGELOK	SS 1.4401 (316)
$^1/_4$" NPT-F	SS 1.4539 (904L), Alloy C-22 2.4602 (N 06022)
Flange:	
DIN, ANSI, JIS	SS 1.4539 (904L), Alloy C-22 2.4602 (N 06022), lap joint flanges (not wetted) SS 1.4404 (316L)
Gaskets (O-ring)	Viton (–15...+200 °C), EPDM (–40...+160 °C), Silicone (–60...+200 °C), Kalrez (–30...+210 °C)

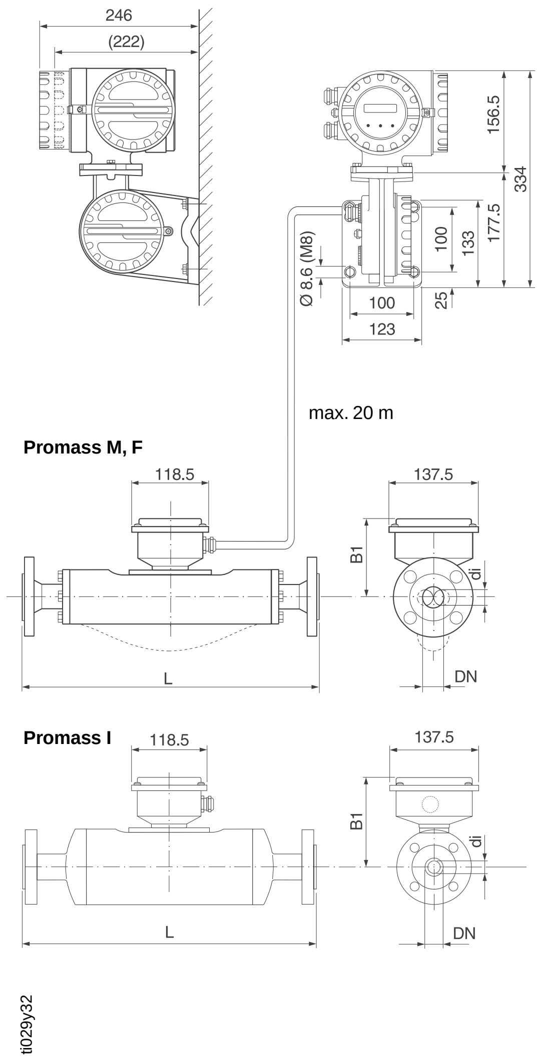


Material load curves Promass A

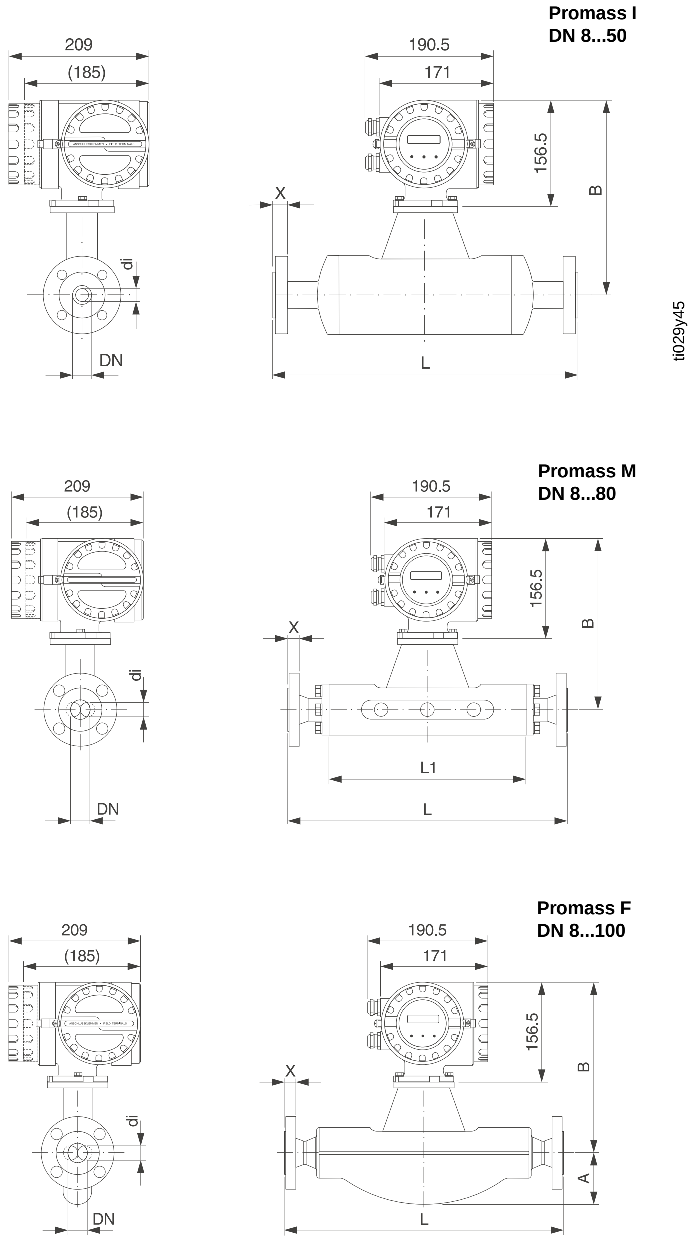
* with $^1/_2$" or DN 15 flanges as standard

Dimensions
Promass 60 I, M, F

Remote version



Compact version



Diameter		L	x	L1 **** [mm]	A [mm]	B [mm]			B1 [mm]			di [mm]			Weight [kg]		
DIN	ANSI					I	M	F	I	M	F	I	M	F	I	M	F
DN 8	3/8"			256	75	288.0	262.5	262.5	138.5	113.0	113.0	8.55	5.53	5.35	12	11	11
DN 15	1/2"			286	75	288.0	264.5	262.5	138.5	114.5	113.0	11.38	8.55	8.30	15	12	12
DN 15*	1/2"	Dimensions		–	–	288.0	–	–	138.5	–	–	17.07	–	–	20	–	–
DN 25	1"	dependent on		310	75	288.0	268.5	262.5	138.5	119.0	113.0	17.07	11.38	12.00	20	15	14
DN 25*	1"	the process		–	–	301.5	–	–	152.0	–	–	25.60	–	–	41	–	–
DN 40	1 1/2"	connections		410	105	301.5	279.5	267.5	152.0	130.0	118.0	25.60	17.07	17.60	41	24	19
DN 40*	1 1/2"	(see following		–	–	316.5	–	–	167.0	–	–	35.62	–	–	67	–	–
DN 50	2"	pages)		544	141	316.5	289.5	279.5	167.0	140.0	130.0	35.62	25.60	26.00	67	41	30
DN 80	3"			644	200	–	305.5	301.0	–	156.0	151.5	–	38.46	40.50	–	67	55
DN 100**	4"			–	200	–	305.5	301.0	–	156.0	151.5	–	38.46	40.50	–	71	61
DN 100	4"			–	247	–	–	320.0	–	–	163.0	–	–	51.20	–	–	96
DN 150***	6"			–	247	–	–	320.0	–	–	163.0	–	–	51.20	–	–	108

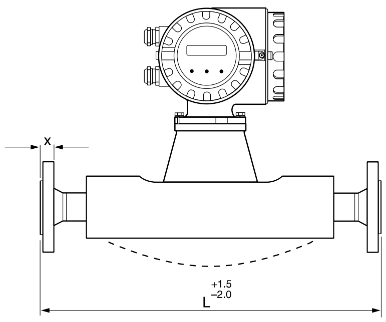
All weights stated are those for the compact version;
DN 8: with DN 15 flanges as standard;
* DN 15, 25, 40 "FB" = Full bore versions of Promass I;
** DN 100 / 4" : Nominal diameter DN 80 / 3" with DN 100 / 4" flanges;
*** DN 150 / 6" : Nominal diameter DN 100 / 4" with DN 150 / 6" flanges;
**** Promass M, high pressure version (DN 8, 15, 25), same dimensions as the standard version

Process Connections Promass 60 I, M, F DIN 2501

Promass I
Wetted parts: titanium Grade 9
Gasket material: no internal gaskets with welded process connections

Promass M
Flange material: SS 1.4404 (316L), titanium Grade 2
Gasket material: O-ring in Viton (–15...+200 °C), EPDM (–40...+160 °C), Silicone (–60...+200 °C), Kalrez (–30...+210 °C), FEP coated (–60...+200 °C)

Promass F
Flange material: (DN 8...100) SS 1.4404 (316L), (DN 8...80) Alloy C-22 2.4602 (N 06022)
Gasket material: no internal gaskets with welded process connections

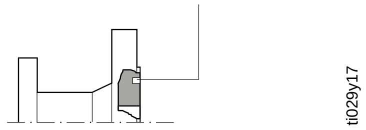


Promass I

	PN 40		PN 64		PN 100	
Diameter	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]
DN 8	402	20	–	–	402	25
DN 15	438	20	–	–	438	25
DN 15 *	572	19	–	–	578	26
DN 25	578	23	–	–	578	29
DN 25 *	700	22	–	–	706	31
DN 40	708	26	–	–	708	32
DN 40 *	819	24	–	–	825	33
DN 50	827	28	832	34	832	36

DN 8: with DN 15 flanges as standard;
* DN 15, 25, 40 “FB” = Full bore versions of Promass I

Flanges also available with grooves to DIN 2512 N (not for Promass I)



Promass M, F

	PN 16		PN 40		PN 64		PN 100	
Diameter	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]
DN 8 **	–	–	370	16	400	20	400	20
DN 15 **	–	–	404	16	420	20	420	20
DN 25	–	–	440	18	470	24	470	24
DN 40	–	–	550	18	590	26	590	26
DN 50	–	–	715	20	724	26	740	28
DN 80	–	–	840	24	875	28	885	32
DN 100 ***	874	20	874	24	–	–	–	–
DN 100	1128	20	1128	24	1128	30	1128	36
DN 150 ****	1168	22	1168	28	–	–	–	–

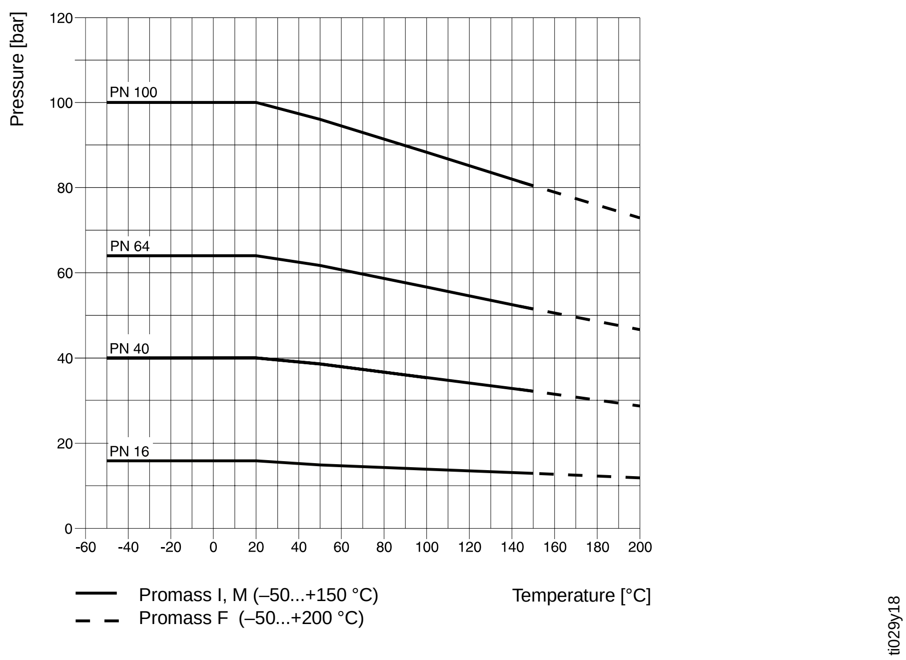
DN 8: with DN 15 flanges as standard; DN 100 only for Promass F available;
** DN 8, DN 15: also available with DN 25, PN 40 flanges (L = 440 mm, x = 18 mm);
*** DN 100: Diameter DN 80 with DN 100 flanges;
**** DN 150: Diameter DN 100 with DN 150 flanges

Surface finish of the flanges

For PN 16, PN 40:
DIN 2526 Form C, R_a 6.3...12.5 µm

For PN 64, PN 100:
DIN 2526 Form E, R_a 1.6...3.2 µm

Pressure limitations due to fluid temperature

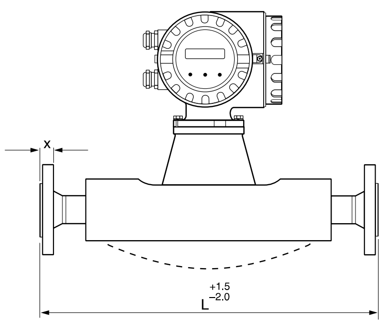


Process Connections Promass 60 I, M, F ANSI B16.5

Promass I
Wetted parts: titanium Grade 9
Gasket material: no internal gaskets with welded process connections

Promass M
Flange material: SS 1.4404 (316L), titanium Grade 2
Gasket material: O-ring in Viton (–15...+200 °C), EPDM (–40...+160 °C), Silicone (–60...+200 °C), Kalrez (–30...+210 °C), FEP coated (–60...+200 °C)

Promass F
Flange material: (DN 8...100) SS 1.4404 (316L), (DN 8...80) Alloy C-22 2.4602 (N 06022)
Gasket material: no internal gaskets with welded process connections



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Promass I

Diameter		Cl 150		Cl 300		Cl 600	
ANSI	DIN	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]
3/8"	DN 8	402	20	402	20	402	20
1/2"	DN 15	438	20	438	20	438	20
1/2" *	DN 15 *	572	19	572	19	578	22
1"	DN 25	578	23	578	23	578	23
1" *	DN 25 *	700	22	700	22	706	25
1 1/2"	DN 40	708	26	708	26	708	28
1 1/2" *	DN 40 *	819	24	819	24	825	29
2"	DN 50	827	28	827	28	832	33

3/8": with 1/2" flanges as standard;
* DN 15, 25, 40 "FB" = Full bore versions of Promass I

Promass M, F

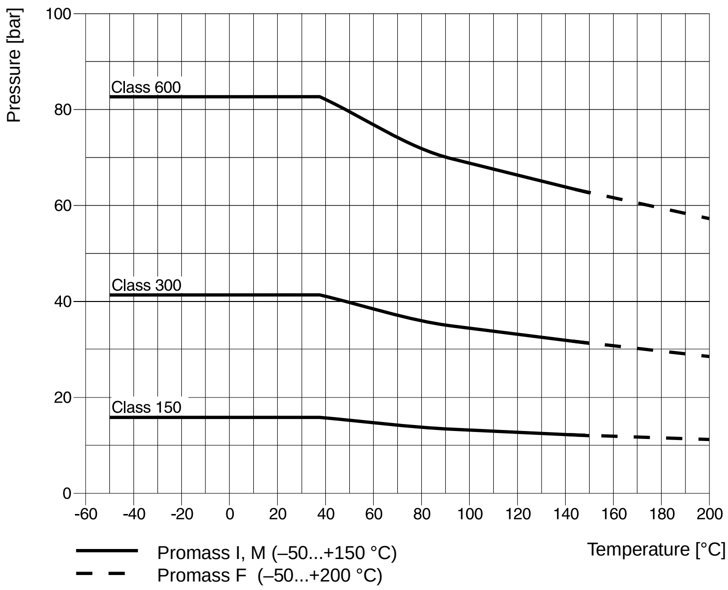
Nennweite		Cl 150		Cl 300		Cl 600	
ANSI	DIN	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]
3/8"	DN 8	370	11.2	370	14.2	400	20.6
1/2"	DN 15	404	11.2	404	14.2	420	20.6
1"	DN 25	440	14.2	440	17.5	490	23.9
1 1/2"	DN 40	550	17.5	550	20.6	600	28.7
2"	DN 50	715	19.1	715	22.3	742	31.8
3"	DN 80	840	23.9	840	28.4	900	38.2
4" **	DN 100 **	874	23.9	894	31.7	–	–
4"	DN 100	1128	23.9	1128	31.7	1158	48.4
6" ***	DN 150 ***	1168	25.4	–	–	–	–

3/8": with 1/2" flanges as standard;
4" / DN 100: only for Promass F available;
** 4" / DN 100: Diameter 3"/DN 80 with 4"/DN 100 flanges;
*** 6" / DN 150: Diameter 4" / DN 100 with 6" / DN 150 flanges

Surface finish of the flanges

For Class 150, Class 300, Class 600:
R_a 3.2...6.3 µm

Pressure limitations due to fluid temperature



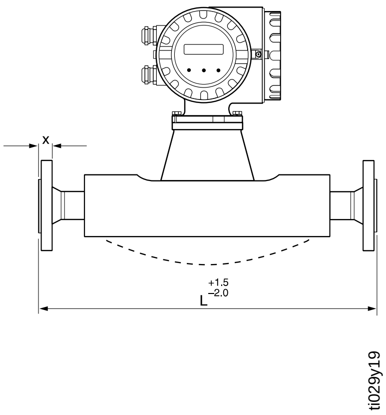
ti029y20

Process Connections Promass 60 I, M, F JIS B2238

Promass I
Wetted parts: titanium Grade 9
Gasket material: no internal gaskets with welded process connections

Promass M
Flange material: SS 1.4404 (316L), titanium Grade 2
Gasket material: O-ring in Viton (–15...+200 °C), EPDM (–40...+160 °C), Silicone (–60...+200 °C), Kalrez (–30...+210 °C), FEP coated (–60...+200 °C)

Promass F
Wetted parts: (DN 8...100) SS 1.4404 (316L), (DN 8...80) Alloy C-22 2.4602 (N 06022)
Gasket material: no internal gaskets with welded process connections



Promass I

	10K		20K		40K		63K	
Diameter	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]
DN 8	–	–	402	20	402	25	402	28
DN 15	–	–	438	20	438	25	438	28
DN 15 *	–	–	572	19	578	26	578	29
DN 25	–	–	578	23	578	27	578	30
DN 25 *	–	–	700	22	706	29	706	32
DN 40	–	–	708	26	708	30	708	36
DN 40 *	–	–	819	24	825	31	825	37
DN 50	827	28	827	28	827	32	832	40

DN 8: with DN 15 flanges as standard
* DN 15, 25, 40 "FB" = Full bore versions of Promass I

Promass M, F

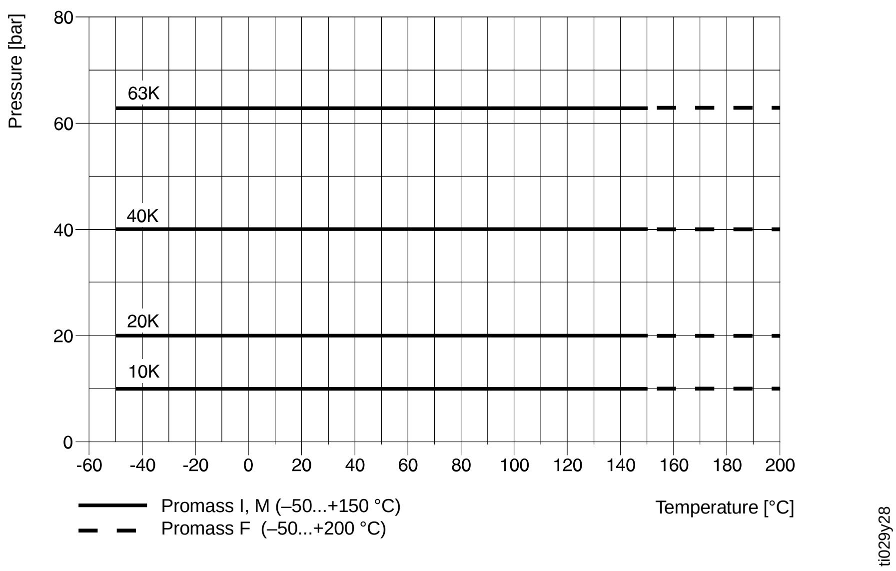
	10K		20K		40K		63K	
Diameter	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]	L [mm]	x [mm]
DN 8	–	–	370	14	400	20	420	23
DN 15	–	–	404	14	425	20	440	23
DN 25	–	–	440	16	485	22	494	27
DN 40	–	–	550	18	600	24	620	32
DN 50	715	16	715	18	760	26	775	34
DN 80	832	18	832	22	890	32	915	40
DN 100 **	864	18	–	–	–	–	–	–
DN 100	1128	18	1128	24	1168	36	1168	44
DN 150 ***	1168	22	–	–	–	–	–	–

DN 8: with DN 15 flanges as standard;
DN 100: only for Promass F available;
** DN 100: Diameter DN 80 with DN 100 flanges;
DN 150: Diameter DN 100 with DN 150 flanges

Surface finish of the flanges

For 10K, 20K, 40K, 63K:
R_a 3.2...6.3 µm

Pressure limitations due to fluid temperature

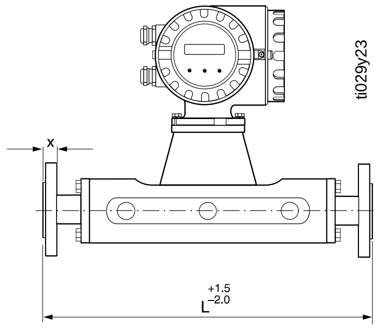


PVDF Process Connections Promass 60 M

Wetted Parts Materials (DIN 2501 / ANSI B16.5 / JIS B2238)

Flange material: PVDF

Gasket material: O-ring in Viton (–15...+200 °C), EPDM (–40...+160 °C), Silicone (–60...+200 °C), Kalrez (–30...+210 °C),

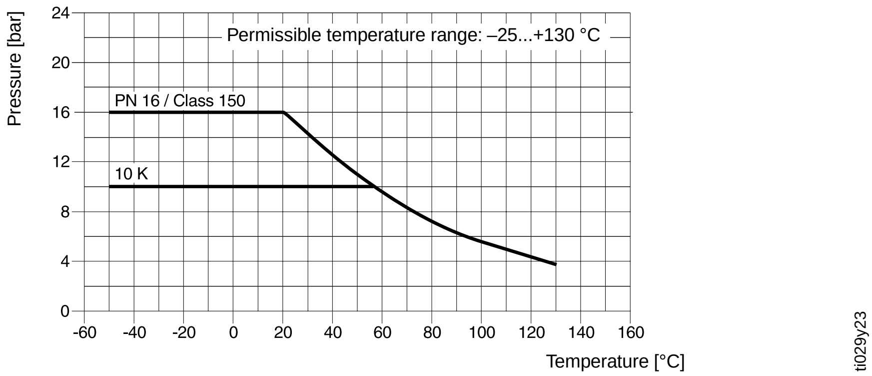


Diameter		PN 16 / Cl 150 / 10K	
DIN	ANSI	L [mm]	x [mm]
DN 8	3/8"	370	16
DN 15	1/2"	404	16
DN 25	1"	440	18
DN 40	1 1/2"	550	21
DN 50	2"	715	22

DN 8 resp. 3/8": instrument fitted with DN 15 resp. 1/2" flanges

Caution!
- When using PVDF process connections
  - Use only gaskets with a hardness Shore A ≤ 75
  - Use only the specified screw tightening torques (see Operating Manual)
- For large diameters and heavy dead weights: sensor must be supported

Pressure limitations due to fluid temperature



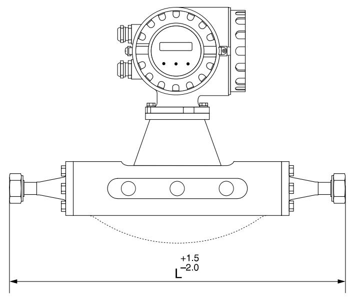
VCO Process Connections Promass 60 I, M, F

Wetted Parts Materials

Promass I
Process connection materials: titanium Grade 2
Gasket material: no internal gaskets with welded process connections

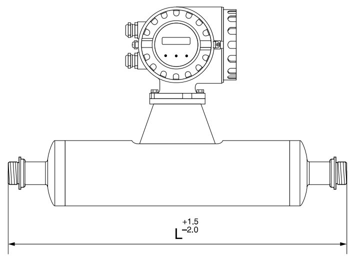
Promass M
Process connection materials: SS 1.4404 (316L)
Gasket materials (O-ring): Viton (–15...+200 °C), Kalrez (–30...+210 °C), Silicone (–60...+200 °C), EPDM (–40...+160 °C

Promass F
Process connection materials: SS 1.4404 (316L)
Gasket material: no internal gaskets with welded process connections



ti029y42

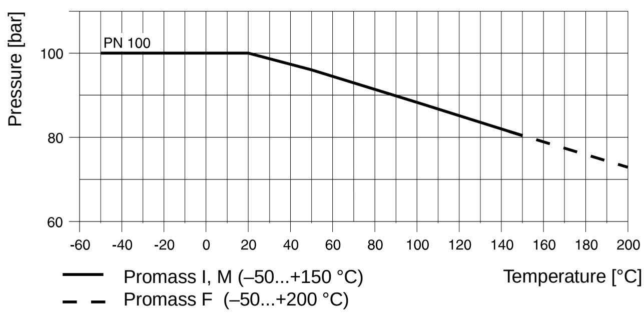
Diameter / Connection	**Promass M** L [mm]	**Promass F** L [mm]
DN 8 8-VCO-4 (½")	390	390
DN 15 12-VCO-4 (¾")	430	430



ti029y44

Diameter / Connection (without nut)	**Promass I** L [mm]
DN 8 12-VCO-4 (¾")	429
DN 15 12-VCO-4 (¾")	465

Pressure limitations due to fluid temperature



ti029y43

Sanitary Process Connections Promass 60 I, M, F

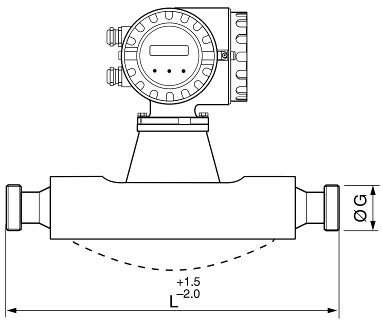
Wetted Parts Materials

Promass I (completely welded version)
Coupling: titanium Grade 2

Promass M (connections with internal gaskets)
Coupling: SS 1.4404 (316L)
Gasket: Silicone flat gasket (–60...+200 °C) or
EPDM (–40...+160 °C), FDA licensed materials

Promass F (completely welded version)
Coupling: SS 1.4404 (316L)

Hygienic coupling
DIN 11581 / SMS 1145



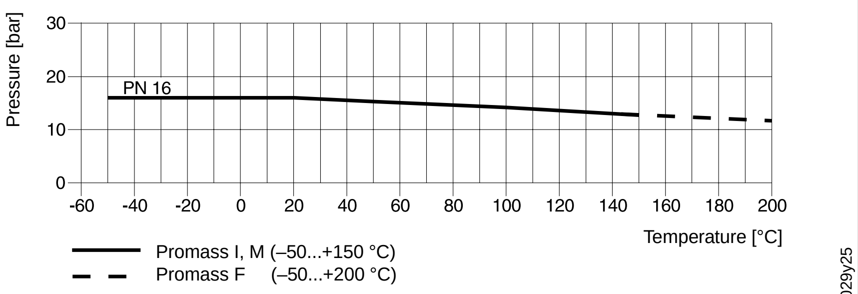
Promass M, F			
Dia-meter	L [mm]	Ø G DIN 11851	Ø G SMS 1145
DN 8	367	Rd 34 x 1/8"	Rd 40 x 1/6"
DN 15	398	Rd 34 x 1/8"	Rd 40 x 1/6"
DN 25	434	Rd 52 x 1/6"	Rd 40 x 1/6"
DN 40	560	Rd 65 x 1/6"	Rd 60 x 1/6"
DN 50	720	Rd 78 x 1/6"	Rd 70 x 1/6"
DN 80 M	815	Rd 110 x 1/4"	–
DN 80 M	792	–	Rd 98 x 1/6"
DN 80 F	900	Rd 110 x 1/4"	Rd 98 x 1/6"
DN 100 *	1128	Rd 130 x 1/4"	Rd 132 x 1/6"

DN 8: with DN 15 connections as standard;
3A version with $R_a \leq 0.8$ µm available;
* DN 100 only for Promass F available

Promass I				
Diameter	L [mm] DIN 11851	L [mm] SMS 1145	Ø G DIN 11851	Ø G SMS 1145
DN 8	426	–	Rd 28 x 1/8"	–
DN 8	427	427	Rd 34 x 1/8"	Rd 40 x 1/6"
DN 15	462	–	Rd 28 x 1/8"	–
DN 15	463	463	Rd 34 x 1/8"	Rd 40 x 1/6"
DN 15 **	602	–	Rd 34 x 1/8"	–
DN 25	603	603	Rd 52 x 1/6"	Rd 40 x 1/6"
DN 25 **	736	736	Rd 52 x 1/6"	Rd 40 x 1/6"
DN 40	731	738	Rd 65 x 1/6"	Rd 60 x 1/6"
DN 40 **	855	857	Rd 65 x 1/6"	Rd 60 x 1/6"
DN 50	856	858	Rd 78 x 1/6"	Rd 70 x 1/6"

** DN 15, 25, 40 "FB" = Full bore versions of Promass I
3A version with $R_a \leq 0.8$ µm as standard

Pressure limitations due to fluid temperature



Sanitary Process Connections Promass 60 I, M, F

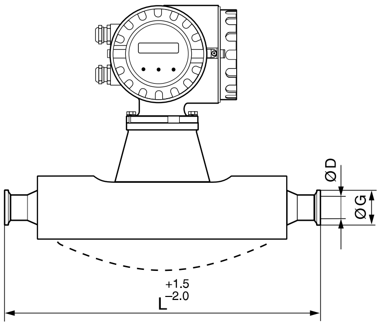
Wetted Parts Materials

Promass I (completely welded version)
Tri-Clamp: titanium Grade 2

Promass M (connections with internal gaskets)
Tri-Clamp: SS 1.4404 (316L)
Gasket: Silicone flat gasket (–60...+200 °C) or
EPDM (–40...+160 °C), FDA licensed materials

Promass F (completely welded version)
Tri-Clamp: SS 1.4404 (316L)

Tri-Clamp



Promass M, F					
Diameter		Clamp	L	Ø G	Ø D
DIN	ANSI		[mm]	[mm]	[mm]
DN 8	3/8"	1/2"	367	25.0	9.5
DN 8	3/8"	1"	367	50.4	22.1
DN 15	1/2"	1/2"	398	25.0	9.5
DN 15	1/2"	1"	398	50.4	22.1
DN 25	1"	1"	434	50.4	22.1
DN 40	1 1/2"	1 1/2"	560	50.4	34.8
DN 50	2"	2"	720	63.9	47.5
DN 80 M	3"	2"	801	90.9	72.9
DN 80 F	3"	3"	900	90.9	72.9
DN 100 *	4"	4"	1128	118.9	97.4

3/8" and 1/2": with 1" connections as standard;
3A version with R_a ≤ 0.8 µm available;
* DN 100 / 4" only for Promass F available

Promass I					
Diameter		Clamp	L	Ø G	Ø D
DIN	ANSI		[mm]	[mm]	[mm]
DN 8	3/8"	1/2"	426	25.0	9.5
DN 8	3/8"	3/4"	426	25.0	16.0
DN 8	3/8"	1"	427	50.4	22.1
DN 15	1/2"	1/2"	462	25.0	9.5
DN 15	1/2"	3/4"	462	25.0	16.0
DN 15	1/2"	1"	463	50.4	22.1
DN 15 **	1/2"	3/4"	602	25.0	16.0
DN 25	1"	1"	603	50.4	22.1
DN 25 **	1"	1"	730	50.4	22.1
DN 40	1 1/2"	1 1/2"	731	50.4	34.8
DN 40 **	1 1/2"	1 1/2"	849	50.4	34.8
DN 50	2"	2"	850	63.9	47.5

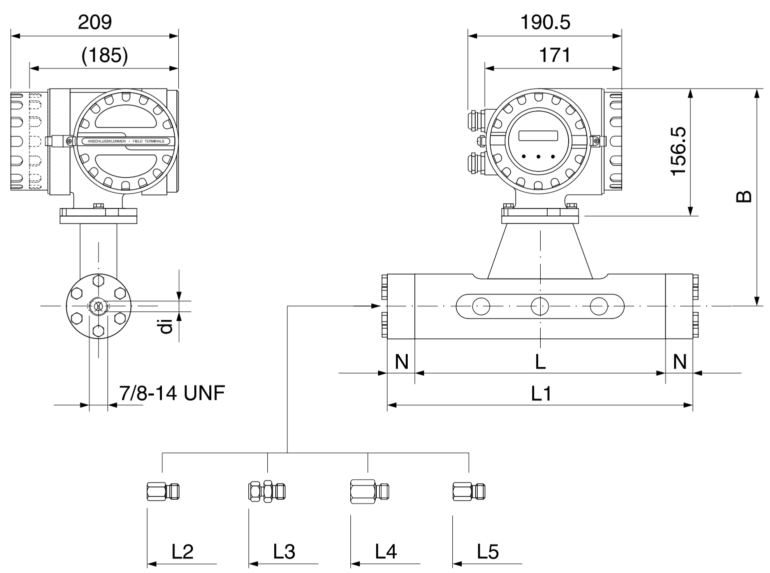
** DN 15, 25, 40 “FB” = Full bore versions of Promass I
3A version with R_a ≤ 0.8 µm or R_a ≤ 0.4 µm as standard

Pressure limitations due to fluid temperature
The material load limit is exclusively determined by the material properties of the Tri-Clamp used. This clamp is not included in the shipment.

Dimensions Process Connections

Promass 60 M (high pressure)

Compact version

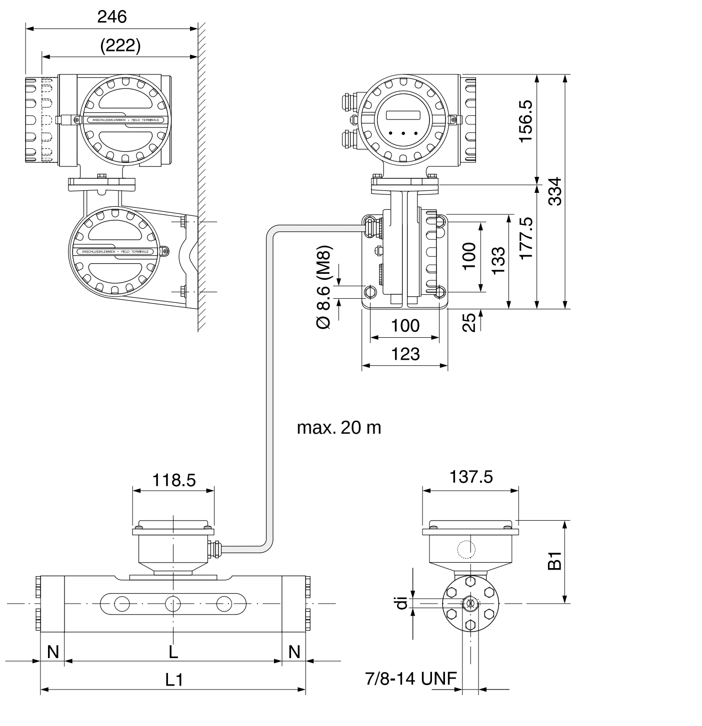


Process connection	N	L without connectors	L1 with connectors	L2 G 3/8"	L3 VCO with 1/2"-SWAGELOK	L4 1/2"- NPT	L5 3/8"- NPT
DN 8	24	256	304	355.8	366.4	370	355.8
DN 15	24	286	334	385.8	396.4	400	385.8
DN 25	34	310	378	429.8	440.4	444	429.8

all dimensions in [mm]

Diameter	B [mm]	B1 [mm]	di [mm]	Weight [kg]
DN 8	262.5	113.0	4.93	11
DN 15	264.5	114.5	7.75	12
DN 25	268.5	119.0	10.20	15

Remote version



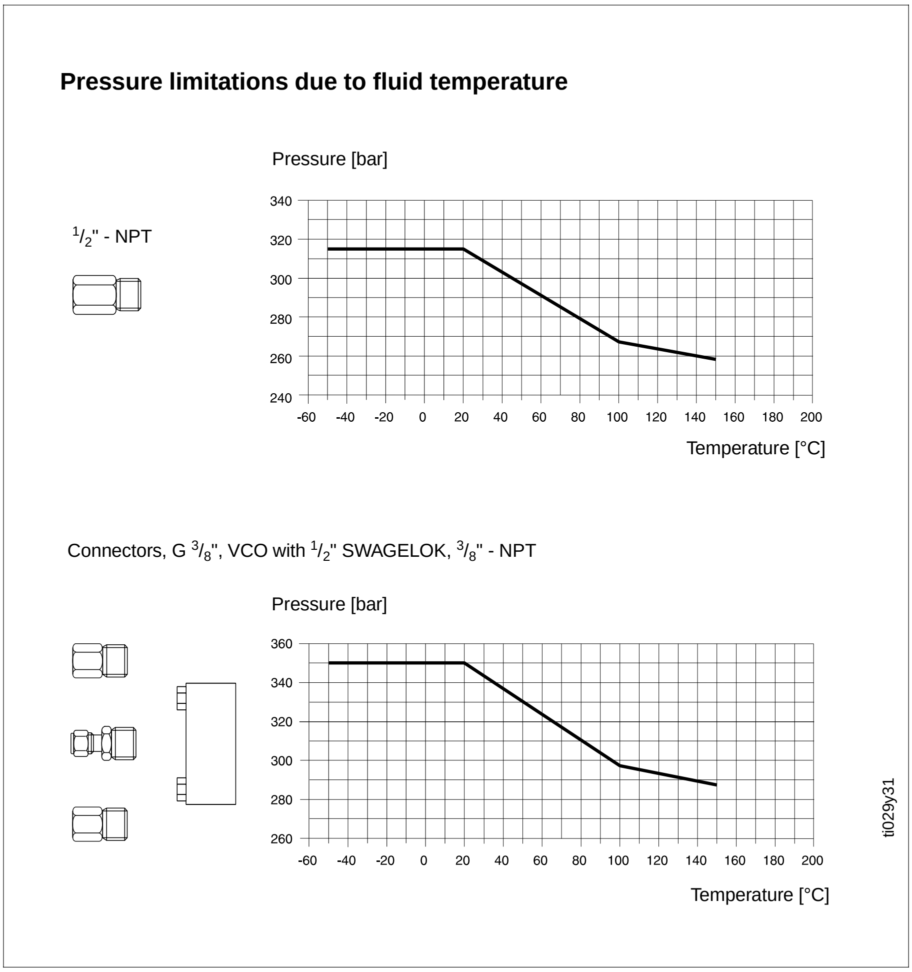
Pressure Limitations

Promass 60 M (high pressure)

Wetted Parts Materials

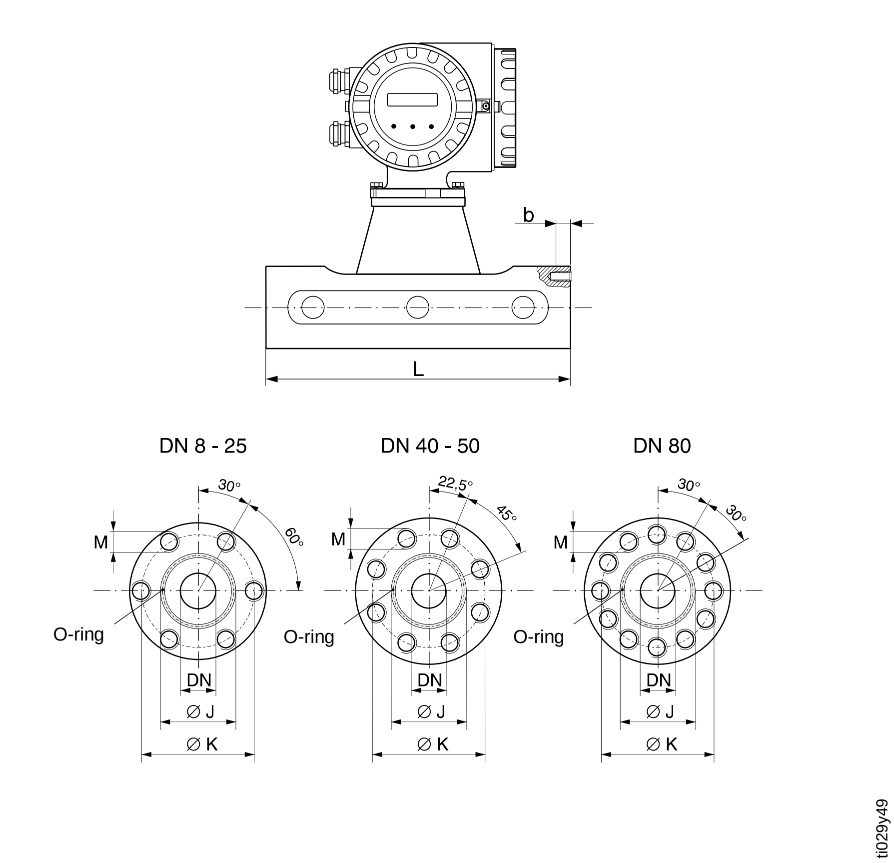
Measuring tube:	titanium Grade 9
Connectors:	SS 1.4404 (316L)
Fittings:	SS 1.4401 (316)
Gaskets:	O-rings in Viton (–15...+200 °C), Silicone (–60...+200 °C)

Couplings and connectors optimized for CNG (Compressed Natural Gas) applications.



Dimensions

Promass 60 M (without Process Connections)

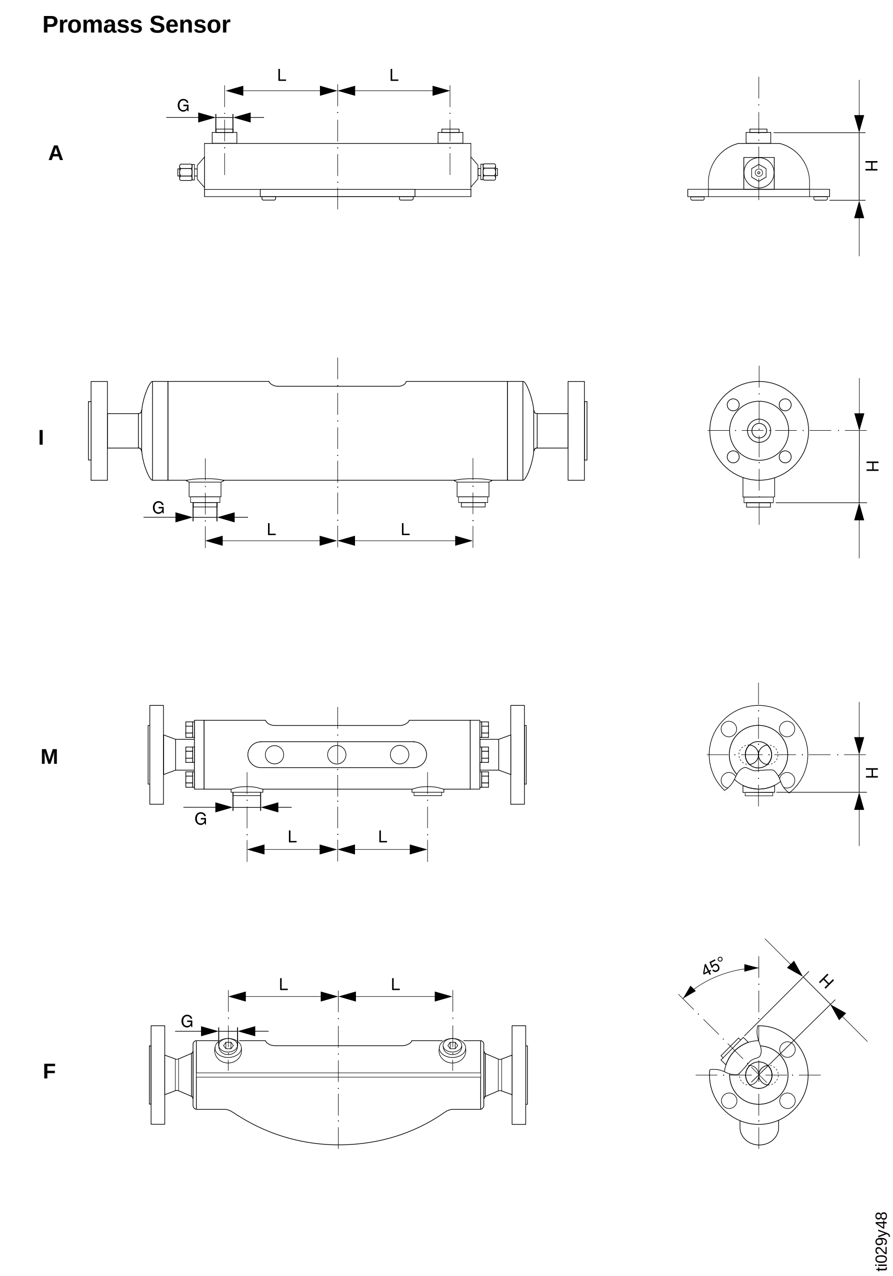


Diameter DN		Dimensions			Coupling		Minimum screw depth	Torque	Lubricated thread	O-ring	
DIN	ANSI	Ø L [mm]	Ø J [mm]	Ø K [mm]	Screws M	Depth b [mm]	[mm]	[Nm]	yes/no	Diam. [mm]	Inside Ø [mm]
DN 8	⅜"	256	27	54	6 x M 8	12	10	30.0	no	2.62	21.89
DN 8*	⅜"	256	27	54	6 x M 8	12	10	19.3	yes	2.62	21.89
DN 15	½"	286	35	56	6 x M 8	12	10	30.0	no	2.62	29.82
DN 15*	½"	286	35	56	6 x M 8	12	10	19.3	yes	2.62	29.82
DN 25	1"	310	40	62	6 x M 8	12	10	30.0	no	2.62	34.60
DN 25*	1"	310	40	62	6 x M 8	12	10	19.3	yes	2.62	34.60
DN 40	1½"	410	53	80	8 x M 10	15	13	60.0	no	2.62	47.30
DN 50	2 "	544	73	94	8 x M 10	15	13	60.0	yes	2.62	67.95
DN 80	3 "	644	102	128	12 x M 12	18	15	100.0	yes	3.53	94.84

* High pressure version; Permissible thread: A4 - 80; Lubricant: Molykote P37

Dimensions

Purge Connection
Pressure vessel control



Diameter		Promass A		Promass I		Promass M		Promass F		Connection
DIN	ANSI	L [mm]	H [mm]	L [mm]	H [mm]	L [mm]	H [mm]	L [mm]	H [mm]	G
DN 1	1⁄24"	92.0	87.0	–	–	–	–	–	–	½" NPT
DN 2	1⁄12"	130.0	87.0	–	–	–	–	–	–	½" NPT
DN 4	⅛"	192.5	97.1	–	–	–	–	–	–	½" NPT
DN 8	⅜"	–	–	61	78.15	85	44.0	108	47	½" NPT
DN 15	⅜"	–	–	79	78.15	100	46.5	110	47	½" NPT
DN 15 *	½"	–	–	79	78.15	–	–	–	–	½" NPT
DN 25	1"	–	–	148	78.15	110	50.0	130	47	½" NPT
DN 25 *	1"	–	–	148	78.15	–	–	–	–	½" NPT
DN 40	1½"	–	–	196	90.85	155	59.0	155	52	½" NPT
DN 40 *	1½"	–	–	196	90.85	–	–	–	–	½" NPT
DN 50	2"	–	–	254	105.25	210	67.5	226	64	½" NPT
DN 80	3"	–	–	–	–	210	81.5	280	86	½" NPT
DN 100	4"	–	–	–	–	–	–	342	100	½" NPT

* DN 15, 25, 40 “FB” = Full bore versions of Promass I;

Technical Data

Application	
Instrument name	Flow measuring system “Promass 60 (HART)”
Instrument function	Mass and volumetric flow measurement of liquids and gases in closed piping.
Function and system design	
Measuring principle	Mass flow measurement according to the Coriolis measuring principle (see page 3)
Measuring system	Instrument family “Promass 60” consisting of: Transmitter: Promass 60 Sensors: Promass A, I, M and F • Promass A — DN 1, 2, 4 and DN 2, 4 high pressure version. Single tube system in SS or Alloy C-22 • Promass I — DN 8, 15, 25, 40, 50 (completely welded version) Straight single tube system in titanium DN 15 “FB”, DN 25 “FB”, DN 40 “FB”: Full bore versions of Promass I with a higher full scale value (see table below) • Promass F — DN 8, 15, 25, 40, 50, 80, 100 (completely welded version) Two slightly curved measuring tubes in SS (DN 8...100) or Alloy C-22 (DN 8...80) • Promass M — DN 8, 15, 25, 40, 50, 80 (two straight measuring tubes in titanium) Containment vessel up to 100 bar. DN 8,15, 25 high pressure version for operating pressures up to 350 bar Two versions are available: • Compact version • Remote version (max. 20 m)
Input variables	
Measured variables	• Mass flow rate (is proportional to the phase difference of two sensors on the measuring tubes which detect differences in its oscillation) • Fluid density (is proportional to the resonance frequency of the measuring tubes) • Fluid temperature (is measured with temperature sensors)
Measuring range	see table below

DN [mm]	Range of full scale values — Liquid $\dot{m}_{min\,(L)} \ldots \dot{m}_{max\,(L)}$
1	0... 20.0 kg/h
2	0...100.0 kg/h
4	0...450.0 kg/h
8	0... 2.0 t/h
15	0... 6.5 t/h
15*	0... 18.0 t/h
25	0... 18.0 t/h
25*	0... 45.0 t/h
40	0... 45.0 t/h
40*	0... 70.0 t/h
50	0... 70.0 t/h
80	0...180.0 t/h
100	0...350.0 t/h

Gas $\dot{m}_{min\,(G)} \ldots \dot{m}_{max\,(G)}$: The full scale depends on the density of the gas. The full scale value can be determined with the following formula:

$$\dot{m}_{max(G)} = \frac{\dot{m}_{max(L)} \cdot \rho_{(G)}}{x \cdot 16}$$

$\dot{m}_{max(G)}$ = Full scale value gas [t/h]

$\dot{m}_{max(L)}$ = Full scale value liquid [t/h] (value from table)

$\rho_{(G)}$ = gas density [kg/m^3] (at operating conditions)

x = constant [kg/m^3]
Promass A: x = 20
Promass I, M, F: x = 100

* DN 15, 25, 40 “FB” = Full bore version of Promass I

(continued on next page)

Technical Data

Input variables (continued)	
Measuring range (continued)	Example for calculating a gas full scale value: Sensor: Promass F → x = 100 Nominal Diameter DN 50 → 70.0 t/h (full scale value from table on page 29) Gas: Air with a density of 60.3 kg/m³ (at 20°C and 50 bar) $\dot{m}_{max(G)} = \frac{\dot{m}_{max(L)} \cdot \rho_{(G)}}{x \cdot 16} = \frac{70.0 \cdot 60.3}{100 \cdot 16} = 26.4$ t/h
Operable flow range	up to 1000 : 1. This enables totalizer values to be accurately determined.
Auxiliary input	U = 3...30 V DC, R_i = 1.8 kΩ Configurable for: zero point adjustment, positive zero return, totalizer reset.
Output variables	
Output signal	• *Current output (with HART protocol)* 0/4...20 mA; R_L < 700 Ω (DIP switches) or 4...20 mA, $R_L \geq$ 250 Ω (HART) Time constant: approx. 1 s (DIP switches) or freely selectable (HART) Full scale value: 8 values selectable (DIP switches) or freely selectable (HART) Temperature coefficient: typ. 0.01% o.f.s./°C o.f.s. = of full scale • *Pulse output* Open Collector: 0...400 Hz (f_{max} = 500 Hz) U_{max} = 30 V, I_{max} = 250 mA Pulse value: 8 values selectable (DIP switch) or freely selectable (HART) Pulse width: max. 10 s (DIP switch) or freely selectable (HART) • *Status output* Open Collector: U_{max} = 30 V, I_{max} = 250 mA configurable for error messages or flow direction recognition
Signal on alarm	The following applies until the fault has been cleared: • *Current output:* is set to a defined value (0...20 mA → 0 mA; 4...20 mA → 2 mA) • *Pulse output:* no pulses • *Status output:* Output is open, if configured for “error”, (i.e. the Open Collector is not conducting).
Load	See specifications “Output signal”
Creep suppression	• *DIP switch configuration:* – Switch on point at v ≤ 0.02 m/s (for water) – Switch off point at v ≥ 0.04 m/s (for water) • *HART configuration:* – Freely selectable switching points (hysteresis: –50%)
Accuracy	
Reference conditions	Error limits based on ISO / DIS 11631: • 20...30 °C; 2...4 bar • Calibration facilities based on national standards • Zero point calibrated under operating conditions • Field density calibration carried out

Accuracy (continued)

Measured error

- *Mass flow rate (liquids):*
  Promass
  A, M, F ± 0.15% ± [(zero stability / flow rate) x 100]% of rate
  I ± 0.20% ± [(zero stability / flow rate) x 100]% of rate

- *Mass flow rate (gas):*
  Promass
  A, I, M, F ± 0.50% ± [(zero stability / flow rate) x 100]% of rate

- *Volume flow rate (liquids):*
  Promass
  A, M ± 0.25% ± [(zero stability / flow rate) x 100]% of rate
  I ± 0.50% ± [(zero stability / flow rate) x 100]% of rate
  F ± 0.20% ± [(zero stability / flow rate) x 100]% of rate

  Zero stability see table below

Note!
The values below refer to the pulse/frequency output.
Additional measuring error of the current output: typ. ± 10 µA.

Diameter	Max. full scale [kg/h] or [l/h]	Zero stability Promass A, M, F [kg/h] or [l/h]	Zero stability Promass I [kg/h] or [l/h]
DN 1	20	0.0010	—
DN 2	100	0.0050	—
DN 4	450	0.0225	—
DN 8	2000	0.1000	0.200
DN 15	6500	0.3250	0.650
DN 15*	18000	—	1.800
DN 25	18000	0.90	1.800
DN 25*	45000	—	4.500
DN 40	45000	2.25	4.500
DN 40*	70000	—	7.000
DN 50	70000	3.50	7.000
DN 80	180000	9.00	—
DN 100	350000	14.00	—

* DN 15, 25, 40 “FB” = Full bore versions of Promass I

Example for calculating the measuring error:
Promass F → ± 0.15% ± [(zero stability/flow rate) x 100]% of rate
DN 25; Flow rate: 3.6 t/h = 3600 kg/h

$$\text{Measuring error} \rightarrow \pm 0.15\% \pm \frac{0.9\ \text{kg/h}}{3600\ \text{kg/h}} \cdot 100\% = \pm 0.175\%$$

Repeatability

- *Mass flow rate (liquids):*
  Promass
  A, I, M, F ± 0.05% ± [$^1/_2$ x (zero stability / flow rate) x 100]% of rate

- *Mass flow rate (gas):*
  Promass
  A, I, M, F ± 0.25% ± [$^1/_2$ x (zero stability / flow rate) x 100]% of rate

- *Volume flow rate (liquids):*
  Promass
  A, M ± 0.10% ± [$^1/_2$ x (zero stability / flow rate) x 100]% of rate
  I ± 0.20% ± [$^1/_2$ x (zero stability / flow rate) x 100]% of rate
  F ± 0.05% ± [$^1/_2$ x (zero stability / flow rate) x 100]% of rate

  Zero stability → see table above

Example for calculating the repeatability:
Promass F
F → ± 0.05% ± [(zero stability / flow rate) x 100]% of rate
DN 25; Flow rate: 3.6 t/h = 3600 kg/h

$$\text{Repeatability} \rightarrow \pm 0.05\% \pm {}^1/_2 \cdot \frac{0.9\ \text{kg/h}}{3600\ \text{kg/h}} \cdot 100\% = \pm 0.0625\%$$

Accuracy (continued)

Process effects

- *Process temperature effect:*
  The below value represents the zero point error due to changing process temperature away from temperature at which a zero point adjustment was carried out:
  Promass A, I, M, F typical = ± 0,0002% of full scale / °C

- *Process pressure effect:*
  The below defined values represent the effect on accuracy of mass flow due to changing process pressure away from calibration pressure (values in % of rate / bar).

DN [mm]	Promass A flow rate % o.r.** / bar	Promass I flow rate % o.r.** / bar	Promass M flow rate % o.r.** / bar	Promass MP flow rate % o.r.** / bar	Promass F flow rate % o.r.** / bar
1	none	—	—	—	—
2	none	—	—	—	—
4	none	—	—	—	—
8	—	0.006	0.009	0.006	none
15	—	0.004	0.008	0.005	none
15 *	—	0.006	—	–	—
25	—	0.006	0.009	0.003	none
25 *	—	none	—	—	—
40	—	none	0.005	—	–0.003
40 *	—	0.006	—	—	—
50	—	0.006	none	—	–0.008
80	—	—	none	—	–0.009
100	—	—	—	—	–0.012

* DN 15, 25, 40 “FB” = Promass I mit vollem Nennweitenquerschnitt
** o.r. = of rate

Operating conditions

Installation conditions

Installation instructions	Orientation: vertical or horizontal. Restrictions on installation and other recommendations: see page 9 – 11
Inlet and outlet sections	Installation site is independent of inlet and outlet sections.
Connection cable length	Remote version: max. 20 meters

Ambient conditions

Ambient temperature

Transmitter and Sensor: –25...+60 °C
(Version with enhanced climate resistance: –40...+60 °C)

- Depending on the fluid temperature, certain installation positions are to be observed to ensure that the permitted ambient temperature range for the transmitter is not exceeded (see page 11).
- An all-weather cover should be used to protect the housing from direct sunlight when mounting in the open. This is especially important in warmer climates and with high ambient temperatures.
- If the ambient temperature is below –25 °C, it is not recommended to use a version with display.

Storage temperature	–40...+80 °C
Degree of protection (EN 60529)	Transmitter: IP 67; NEMA 4X Sensor: IP 67; NEMA 4X
Shock resistance	according to IEC 68-2-31
Vibration resistance	up to 1 g, 10...150 Hz according to IEC 68-2-6
Electromagnetic compatibility (EMC)	Acc. to EN 50081 Part 1 and 2 / EN 50082 Part 1 and 2 as well as to NAMUR recommendations

Operating conditions (continued)	
Process conditions	
Fluid temperature	• *Sensor* Promass A –50...+200 °C Promass I –50...+150 °C Promass M –50...+150 °C Promass F –50...+200 °C • *Gaskets* Viton (–15…+200 °C) EPDM (–40…+160 °C) Silicone (–60…+200 °C) Kalrez (–30…+210 °C) FEP coated (–60…+200 °C)
Nominal pressure *Material load curves (p-T- diagrams): s. page 16, 18 ff.*	• *Promass A* Fittings: max. 160 bar (standard version) max. 400 bar (high pressure version) Flanges: DIN PN 40 ANSI Cl 150, Cl 300 JIS 10K Containment vessel: 25 bar resp. 375 psi • *Promass I* Flanges: DIN PN 40...100 ANSI Cl 150, Cl 300, Cl 600 JIS 10K, 20K, 40K, 63K Containment vessel: 25 bar (optional 40 bar) resp. 375 psi (optional 600 psi) • *Promass M* Flanges: DIN PN 40...100 ANSI Cl 150, Cl 300, Cl 600 JIS 10K, 20K, 40K, 63K Containment vessel: 40 bar (optional 100 bar) resp. 600 psi (optional 1500 psi) • *Promass M (High pressure version)* Measuring tubes, connector, fittings: max. 350 bar Containment vessel: 100 bar resp. 1500 psi • *Promass F* Flanges: DIN PN 16...100 ANSI Cl 150, Cl 300, Cl 600 JIS 10K, 20K, 40K, 63K Containment vessel: DN 8...80: 25 bar resp. 375 psi DN 100: 16 bar resp. 250 psi DN 8...50: optional 40 bar resp.600 psi
Pressure loss	dependent on nominal diameter and sensor type (see page 12, 13)

Technical Data

Mechanical construction	
Design, dimensions	see page 15 ff.
Weights	see page 15, 17, 25
Materials	• *Transmitter housing* Powder-coated die-cast aluminium • *Sensor housing / containment vessel* Promass A, I, F — Surfaces resistant to acids and alkalis, SS 1.4301 (304) Promass M — Surfaces resistant to acids and alkalis, DN 8...50: chemically nickel-plated steel, DN 80: SS 1.4313 • *Sensor connection housing (remote version)* SS 1.4301 (304) • *Process connections* Promass A — see page 16 Promass M — high pressure version see page 26 Promass I, M, F — see page 18 – 24 • *Measuring tubes* Promass A — SS 1.4539 (904L), Alloy C-22 2.4602 (N 06022) Promass I — titanium Grade 9 Promass M — DN 80: titanium Grade 2, DN 8...50: titanium Grade 9 Promass F — DN 8...100: SS 1.4539 (904L), DN 8...80: Alloy C-22 2.4602 (N 06022) • *Gaskets* Promass A, F, I — no internal gaskets Promass M — see page 18 – 24 Promass M — silicone, viton (for high pressure version)
Process connections	• Promass A — Welded process connections: 4-VCO-4 fittings, ½" Tri-Clamp Screw-on process connections: Flanges (DIN 2501, ANSI B16.5, JIS B2238), NPT-F and SWAGELOK fittings • Promass I, F — Welded process connections: 8-VCO-4 fittings (only for Promass F), 12-VCO-4 fittings, Flanges (DIN 2501, ANSI B16.5, JIS B2238), Sanitary connections: Tri-Clamp, Hygienic coupling DIN 11851 / SMS 1145 • Promass M — Screw-on process connections: Flanges (DIN 2501, ANSI B16.5, JIS B2238), Sanitary connections: Tri-Clamp, Hygienic coupling DIN 11851 / SMS 1145 • *Promass M (High press.)* — Screw-on process connections: G ⅜", ½" NPT, ⅜" NPT fittings and VCO with ½" SWAGELOK coupling, connector with 7/8 14UNF internal thread
Electrical connection	• *Wiring diagram:* see page 14 • *Cable glands (In-/outputs; remote version):* PG 13.5 cable glands (5…15 mm) or ½" NPT, M 20 x 1.5 (8…15 mm), G ½" threads for cable glands • *Galvanic isolation:* All circuits for inputs, outputs, power supply, and sensor are galvanically isolated from each other. • *Cable specifications (remote version):* see page 14

Technical Data

User interface	
Operation	The instrument can basically be configured in two different ways: *Configuration with DIP switches and/or the local display:* • DIP switches for setting basic instrument functions • Local display and push-buttons for additional functions • Jumper for configuring the auxiliary input *Configuration using HART protocol:* • HART "Communicator DXR 275" handheld • Commuwin II software for remote configuration and process visualization
Display	LC-display, 8 digits 11 segments for displayed engineering units and operating status
Communication	Current output with superimposed HART protocol
Power supply	
Supply voltage, Frequency	Transmitter 85...260 V AC (50...60 Hz) 20... 55 V AC, 16...62 V DC Sensor is supplied by the transmitter
Power consumption	AC: <15 VA (incl. sensor) DC: <15 W (incl. sensor)
Power supply (continued)	
Power supply failure	Bridges min. 1 power cycle (22 ms). • EEPROM saves measuring system data on power failure (no batteries required). • DAT = exchangeable data storage module which stores all sensor data such as calibration data, nominal diameter, sensor version, etc.
Certificates and approvals	
Ex approvals	Information on presently available Ex versions (e.g. CENELEC, SEV, FM, CSA) can be supplied by your E+H Sales Centre on request. All explosion protection data are given in separate documentation available on request.
CE mark	By attaching the CE-mark, Endress+Hauser confirms that the Promass 60 measurement system has been successfully tested and fulfils all legal requirements of the relevant EC directives.
Order information	
Accessories	• *Post mounting set for Promass A:* DN 1, 2: Order No. 50077972 DN 4: Order No. 50079218 • *Post mounting set for remote transmitter housing:* Order No. 50076905
Supplementary documentation	System Information Promass — SI 014D/06/en Operating Manual Promass 60 — BA 013D/06/en Technical Information Promass 63 — TI 030D/06/en Operating Manual Promass 63 — BA 014D/06/en

Other standards and guidelines	
EN 60529	Degree of protection (IP-Code)
EN 61010	Protection Measures for Electronic Equipment for Measurement, Control, Regulation and Laboratory Procedures
EN 50081	Part 1 and 2 (interference emission)
EN 50082	Part 1 and 2 (interference immunity)
NAMUR	Association of Standards for Control and Regulation in the Chemical Industry

Subject to modification

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