Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Proline Promass 84A

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

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, verified 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 custody transfer:
- PTB, NMi, METAS, BEV

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

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

Connection to process control system:
- HART

Relevant safety aspects:
- Pressure Equipment Directive

Your 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
- 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
- Immune from external piping forces due to robust design
- Easy installation without taking inlet and outlet runs into consideration

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Function and system design

Measuring principle

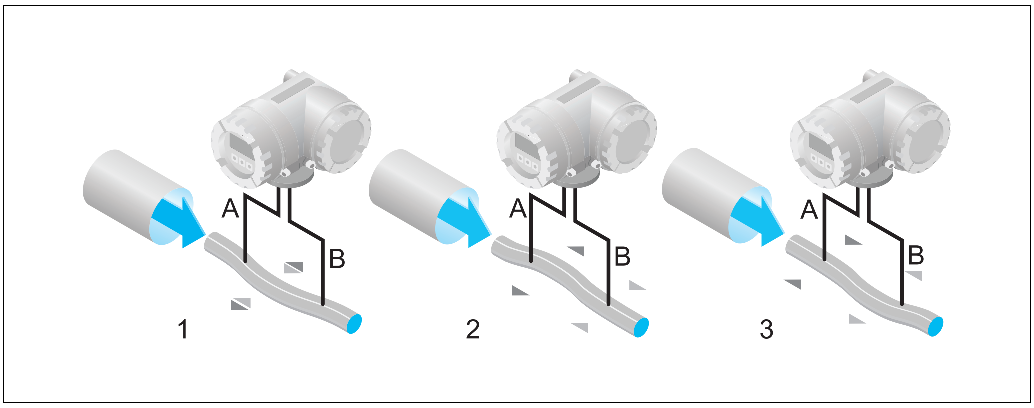
The measuring principle is based on the controlled generation of Coriolis forces.
These forces are always present when both translational and rotational movements are superimposed.

$F_C = 2 \cdot \Delta m \, (v \cdot \omega)$
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.

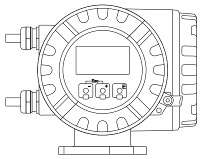
Density measurement
The measuring tube is continuously excited at its resonance frequency. A change in the mass and thus the density of the oscillating system (comprising measuring tube and fluid) results in a corresponding, automatic adjustment in the oscillation frequency. Resonance frequency is thus 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.
The temperature measurement cannot be used to generate data for invoicing in applications subject to legal metrology controls.

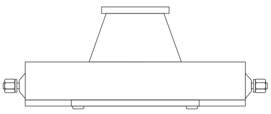
Measuring system

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.

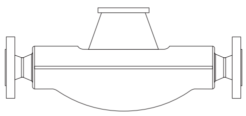
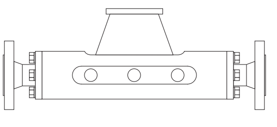
Transmitter

Promass 84  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 2 to 4 ▪ Measuring tube made of stainless steel or Alloy C-22

Further sensors in separate documentations

F  a0003673	▪ Universal sensor for fluid temperatures up to 350 °C ▪ Nominal diameters DN 8 to 250 ▪ Measuring tubes made of stainless steel or Alloy C-22	Documentation No. TI067D/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 to 80 ▪ Tube material: titanium	Documentation No. TI067D/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 in non-custody transfer mode

Measuring ranges for liquids

Nominal Diameter [mm]	Range for full scale values (liquids), $\dot{m}_{min}$ to $\dot{m}_{max}$ [kg/h]
2	0 to 100
4	0 to 450

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:
$\dot{m}_{max(G)} = \dot{m}_{max(F)} \cdot \rho_{(G)} / 32\ [kg/m^3] = 100\ kg/h \cdot 11.9\ kg/h / 32\ kg/m^3 = 37.2\ kg/h$

Recommended full scale values:

See information in the "Limiting flow" Section → Page 16 ff.

Measuring range in custody transfer mode

The following are example data for German PTB approval (liquids other than water).

Measuring ranges for liquids in mass flow:

Nominal Diameter [mm]	Range for mass flow (liquids) Q_{min} to Q_{max} [kg/min]	Smallest measured quantity [kg]
2	0.1 to 2	0.05
4	0.4 to 8	0.20

Measuring ranges for liquids in volume flow (also LPG):

Nominal Diameter [mm]	Range for mass flow (liquids) Q_{min} to Q_{max} [l/min]	Smallest measured quantity [l]
2	0.1 to 2	0.05
4	0.4 to 8	0.20

Note!
For information about the other approvals → see corresponding certificate.

Operable flow range

Over 20 : 1 for verified device

Input signal

Status input (auxiliary input), HART:

U = 3 to 30 V DC, R_i = 5 kΩ, galvanically isolated.
Configurable for: totalizer reset, positive zero return, error message reset, zero point adjustment start.

Status input (auxiliary input), MODBUS RS485:

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

Output

Output signal

Current output:

Active/passive selectable, galvanically isolated, time constant selectable (0.05 to 100 s), full scale value selectable, temperature coefficient: typically 0.005% o.r./°C, resolution: 0.5 µA

- Active: 0/4 to 20 mA, R_L < 700 Ω (for HART: R_L ≥ 250 Ω)
- Passive: 4 to 20 mA; supply voltage V_S 18 to 30 V DC; R_i ≥ 150 Ω

o.r. = of reading

Pulse / frequency output, HART:

For custody transfer measurement, two pulse outputs can be operated.
Passive, galvanically isolated, open collector, 30 V DC, 250 mA

- Frequency output:
  Full scale frequency 2 to 10000 Hz (f_{max} = 12500 Hz), on/off ratio 1:1, pulse width max. 2 s.
  In "Phase-shifted pulse outputs" operating mode, the end frequency is limited to a maximum of 5000 Hz.
- Pulse output:
  Pulse value and pulse polarity selectable, pulse width configurable (0.05 to 2000 ms)

Pulse / frequency output, MODBUS RS485:

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 to 10000 Hz (f_{max} = 12500 Hz), on/off ratio 1:1, pulse width max. 2 s.
- Pulse output:
  Pulse value and pulse polarity selectable, pulse width configurable (0.05 to 2000 ms)

MODBUS RS485

- MODBUS device type: slave
- Address range: 1 to 247
- Functions codes supported: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Physical interface: RS485 in accordance with standard EIA/TIA-485
- Baudrate supported: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Transmission mode: RTU oder ASCII
- Response time:
  Direct data access = typically 25 to 50 ms
  Auto-scan buffer (data area) = typically 3 to 5 ms
- Possible output combinations → Page 8

Relay output:

Normally closed (NC or break) or normally open (NO or make) contacts available
max. 30 V / 0.5 A AC; 60 V / 0.1 A DC,
galvanically isolated.

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