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Technical Information

Proline Promass 80/83 F, M

Coriolis Mass Flow Measuring System
The universal and multivariable flowmeter for liquids and gases

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

- Extremely accurate measurement of liquids and gases such as oils, lubricants, fuels, liquefied gases, solvents, foodstuffs and compressed gases (CNG)
- Fluid temperatures up to +350 C
- Process pressures up to 350 bar
- Mass flow measurement up to 2200 t/h

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

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

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

Relevant safety aspects:
- Secondary containment (up to 100 bar), 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 two-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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Endress+Hauser
People for Process Automation

Function and system design

Measuring principle

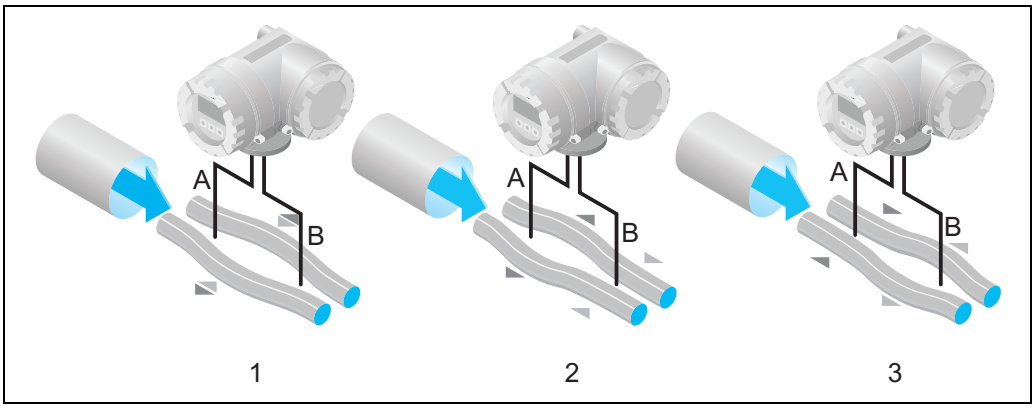
The measuring principle is based on the controlled generation of Coriolis forces. These forces are always present when both translational and rotational movements are superimposed.

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

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

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



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

Density measurement

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

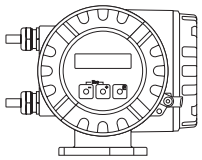
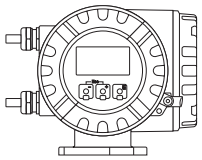
Temperature measurement

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

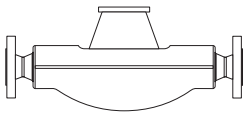
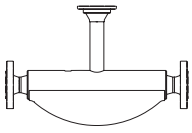
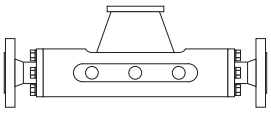
Measuring system

The measuring system 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

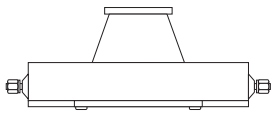
Transmitter

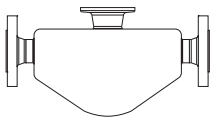
Promass 80  a0003671	■ Two-line liquid-crystal display ■ Operation with push buttons
Promass 83  a0003672	■ Four-line liquid-crystal display ■ Operation with "Touch control" ■ Application-specific Quick Setup ■ Mass flow, volume flow, density and temperature measurement as well as calculated variables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

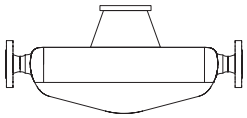
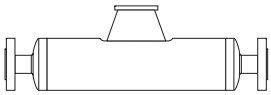
Sensor

F  a0003673	■ Universal sensor for fluid temperatures up to 200 °C. ■ Nominal diameters DN 8 to 250 ■ Tube material: 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 C-22	
M  a0003676	■ Robust sensor for extreme process pressures, high requirements for the secondary containment and fluid temperatures up to 150 °C ■ Nominal diameters DN 8 to 80 ■ Tube material: titanium	

Additional sensors in separate documentation

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

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

H  a0003677	■ Single bent tube. Low pressure loss and chemically resistant material ■ Nominal diameters DN 8 to 50 ■ 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. ■ Nominal diameters DN 8 to 80 ■ Tube material: titanium	

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) $m_{min(F)}$ to $m_{max(F)}$
8	0 to 2000 kg/h
15	0 to 6500 kg/h
25	0 to 18000 kg/h
40	0 to 45000 kg/h
50	0 to 70000 kg/h
80	0 to 180000 kg/h
100 (only Promass F)	0 to 350000 kg/h
150 (only Promass F)	0 to 800000 kg/h
250 (only Promass F)	0 to 2200000 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:

$m_{max(G)} = m_{max(F)} \cdot \rho_{(G)} : x \ [kg/m^3]$

$m_{max(G)}$ = max. full scale value for gas [kg/h]
$m_{max(F)}$ = max. full scale value for liquid [kg/h]
$\rho_{(G)}$ = gas density in [kg/m³] under process conditions
x = 160 (Promass F DN 8 to 100, Promass M); x = 250 (Promass F DN 150 to 250)

Here, $m_{max(G)}$ can never be greater than $m_{max(F)}$

Calculation example for gas:

- Sensor type: Promass F, DN 50
- Gas: air with a density of 60.3 kg/m³ (at 20 °C and 50 bar)
- Measuring range (liquid): 70000 kg/h
- x = 160 (for Promass F DN 50)

Max. possible full scale value:
$m_{max(G)} = m_{max(F)} \cdot \rho_{(G)} : x\ [kg/m^3] = 70000\ kg/h \cdot 60.3\ kg/h : 160\ kg/m^3 = 26400\ kg/h$

Recommended measuring ranges:

See information in the "Limiting flow" Section → Page 21 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 to 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 to 20 mA, R_L < 700 Ω, U_{out} = 24 V DC, short-circuit proof
- Passive: 0/4 to 20 mA, R_i = 150 Ω, U_{max} = 30 V DC

Output

Output signal

Promass 80

Current output:

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

Pulse/frequency output:

Passive, open collector, 30 V DC, 250 mA, galvanically isolated.
- Frequency output: end frequency 2 to 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 to 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 to 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 onsite display (optional)

Promass 83

Current output:

Active/passive selectable, galvanically isolated, time constant selectable (0.05 to 100 s), full scale value selectable, temperature coefficient: typically 0.005% of full scale value/C, resolution: 0.5 μA
- Active: 0/4 to 20 mA, $R_L < 700\ \Omega$ (for HART: $R_L \geq 250\ \Omega$)
- Passive: 4 to 20 mA; supply voltage U_S 18 to 30 V DC; $R_i \geq 150\ \Omega$

Pulse/frequency output:

Active/passive selectable, galvanically isolated
- Active: 24 V DC, 25 mA (max. 250 mA during 20 ms), $R_L > 100\ \Omega$
- Passive: open collector, 30 V DC, 250 mA

- Frequency output: end frequency 2 to 10000 Hz (f_{max} = 12500 Hz), on/off ratio 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity can be selected, pulse width adjustable (0.05 to 2000 ms)

PROFIBUS DP interface:

- PROFIBUS DP in accordance with EN 50170 Volume 2
- Profile Version 3.0
- Data transmission rate: 9.6 kBaud to 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 to 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 onsite 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 to 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 to 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 onsite display (optional)
- Available output combination → Page 10

MODBUS interface:

- MODBUS device type: slave
- Address range: 1 to 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
- Transmission mode: RTU or ASCII
- Response times:
  Direct data access = typically 25 to 50 ms
  Auto-scan buffer (data range) = typically 3 to 5 ms
- 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 to 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 to 3
- Input data: Positive zero return (ON/OFF), Zero point adjustment, Measuring mode, Reset totalizer
- 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 (Promass 80):

"Nonconductive" 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 cut off are selectable

Galvanic isolation

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

Switching output

Status output (Promass 80):

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.

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