

# Flow measuring technology For liquids, gases and steam

Products and services at a glance

Flow





Endress+Hauser Customer Center, Greenwood, IN

## Endress+Hauser – Your partner

Local support and manufacturing – close to you, whenever you need us

With dedicated sales centers and a strong network of partners, Endress+Hauser guarantees competent worldwide support. Our production centers in twelve countries meet your needs and requirements quickly and effectively. The Group is managed and coordinated by a holding company in Reinach, Switzerland. As a successful family-owned business, Endress+Hauser is set to remain independent and self-reliant.

Endress+Hauser provides sensors, instruments, systems and services for level, flow, pressure and temperature measurement as well as analytics and data acquisition. The company supports you with automation engineering, logistics and IT services and solutions. Our products set standards in quality and technology.

Every year, Endress+Hauser employees register in excess of 200 patent applications (270 in 2015). The number of proprietary rights active worldwide has meanwhile risen to 6,552. We take pride in developing ground-breaking measurement solutions that bring new levels of safety and reliability to process automation – such as Heartbeat Technology™ providing diagnostics, monitoring and verification of your Proline flowmeters' performance, around the clock.

**Committed to our U.S. operations** Endress+Hauser invests an average of 10% of its annual revenue in its infrastructure with many investments being in the U.S. Endress+Hauser has invested millions of dollars in U.S. operations alone – expanding our flow, level, pressure, temperature, and recorders and components manufacturing capabilities. The new flow expansion – dedicated to Coriolis, Electromagnetic, Thermal, Vortex and Ultrasonic production – allows us to increase our domestic product offerings, including gas calibration for thermal mass flowmeters. More than 90% of all instruments ordered and shipped within the U.S. are manufactured in the U.S. What does this mean for you? When you are experiencing downtime in production, we will be there to get you back up and running – quickly.



Learn more about our U.S. manufacturing:  
[www.us.endress.com/usmanufacturing](http://www.us.endress.com/usmanufacturing)

# Measuring flow reliably

Consistent product quality, safety, process optimization and environmental protection – these are only a few reasons why industrial flow measurement is becoming more important

Endress+Hauser supports you with proven, state-of-the-art flowmeters of high quality. From a single measuring point to the complete solution for higher-level control systems: you can always rely on the fact that we customize our products to your process requirements. Together with automated process control and state-of-the-art communication interfaces (fieldbus systems), flow metering has advanced into more and more fields of application in recent years.

- Totalizing, displaying, recording
- Monitoring, controlling, billing
- Dosing and filling
- Concentration measurement in two-phase fluids
- In-line viscosity measurement
- Condition monitoring and verification

You can find flow measuring technology from Endress+Hauser in almost all industries, applications and utilities:

- Chemical
- Oil and gas
- Life sciences
- Food and beverage
- Water management
- Power generation
- Pulp and paper
- Filling and dosing systems
- Shipbuilding
- Automotive
- Primaries and mining



An electromagnetic flowmeter makes its way into the automatic shrink-wrap machine before it is boxed up and shipped to the customer

Endress+Hauser Flowtec Production Center, Greenwood, IN



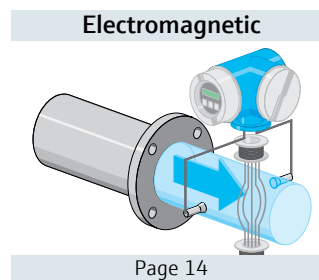
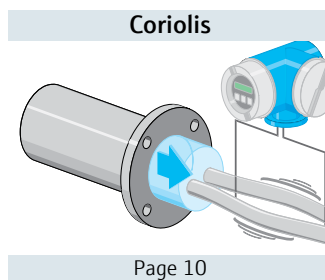
# From oxygen to honey

## The ideal flow metering system for each fluid

Flow is one of the most frequently measured process variables in industry. Water, natural gas, steam, oils, hydrocarbons, chemicals or wastewater are only some examples of fluids that have to be measured day in, day out. There is no single, across-the-board technology suitable for all these applications, so Endress+Hauser will be happy to advise you on the flowmeter best suited to your process needs.



**Applicator** (select and size products)  
For reliable planning and sizing of measuring points – proven in use for 30 years! [www.us.endress.com/applicator](http://www.us.endress.com/applicator)



### Liquid applications

- Liquids in general (e.g. water) ✓✓
- Very low flow rates (< 0.5 gal/h (2 l/h)) ✓✓
- Very high flow rates (> 440,287 gpm (100,000 m<sup>3</sup>/h)) ✗
- Non-conductive liquids ✓✓
- Viscous liquids (> 50 cP) ✓✓
- Cryogenic fluids (e.g. liquid oxygen) ✓✓
- Hygienic applications ✓✓

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### Gas/steam applications

- Gas flow in general (e.g. air flow) ✓✓
- Wet/dirty gases (e.g. biogas) ✗
- Low flow rates (< 5.3 gal/m (20 l/min)) ✓✓
- High flow rates ✓✓
- Steam ✓

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### Special applications

- Slurries, suspended solids ✓
- Liquid/liquid mixtures (oil/water) ✓✓
- Liquid/gas mixtures (water/air) ✓
- Corrosive liquids (acids, alkalis) ✓✓
- Corrosive gas flows (e.g. HCl vapor) ✓✓
- Applications in mining (ore slurry) ✗
- Bidirectional metering (forward/reverse) ✓✓
- Measurement from outside without process interruption ✗

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### Range of applications

- Nominal diameters
- Process pressure
- Process temperature

1/24" to 16"/DN 1 to 400  
max. 5,800 psi/400 bar  
-320.8 to +662°F/  
-196 to +350°C

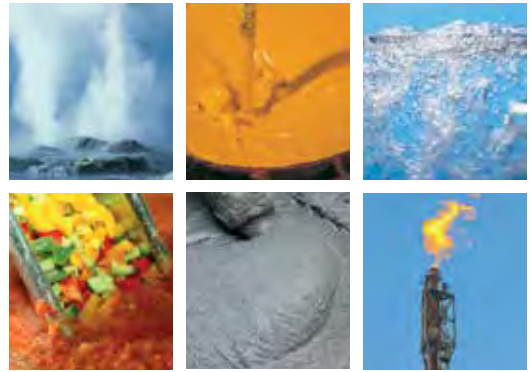
1/2" to 96"/DN 2 to 2400  
max. 580 psi/40 bar  
-40 to +356°F/  
-40 to +180°C



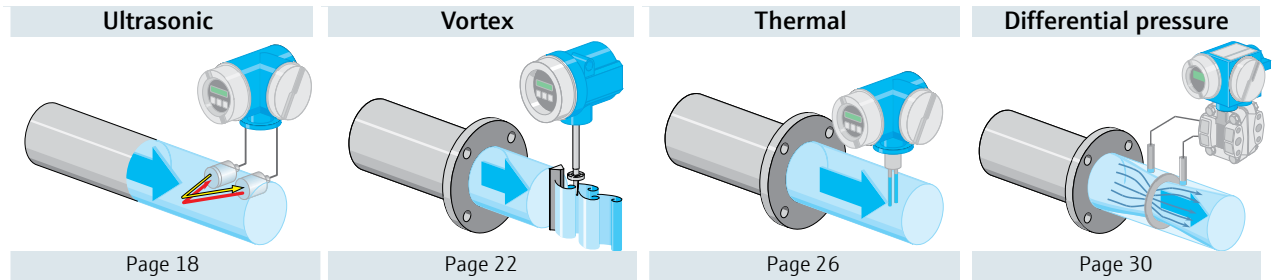
**The perfect flowmeter for any industry**

Depending on the industry the requirements for explosion protection, safety, hygiene, approvals, communication, operation, measuring ranges, or fluid properties are completely different. As a result, Endress+Hauser offers a vast array of tried and tested flowmeters, which are precisely matched to your needs and requirements, whatever your industry sector is.

► Page 10–25



✓✓ suitable    ✗ not suitable    ✓ suitable with limitations (depending on the process conditions, device design and material)



✓✓	✓✓	✓	✓✓
✗	✗	✗	✗
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✓	✓	✓	✓
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1/2" to 160"/DN 15 to 4000	1/2" to 12"/DN 15 to 300	1/2" to 60"/DN 15 to 1500	3/8" to 472"/DN 10 to 12,000
Depending on sensor	max. 3,625 psi/250 bar	max. 580 psi/40 bar	max. 6,090 psi/420 bar
-40 to +392°F/ -40 to +200°C	-328 to +842°F/ -200 to +450°C	-40 to +266°F/ -40 to +130°C	-328 to +1,832°F/ -200 to +1000°C



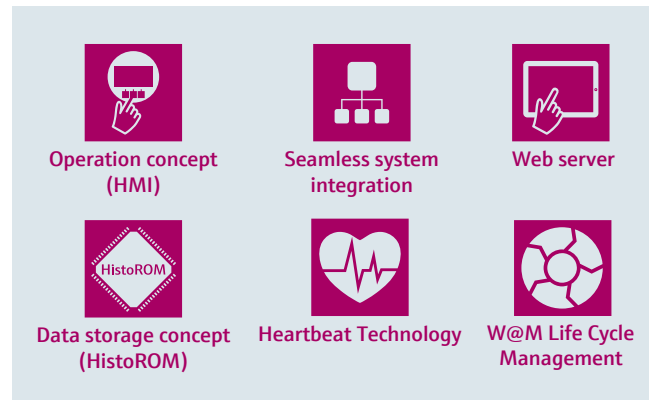
## Proline – simply clever

Proline stands for accurate and reliable flow measuring technology without compromise. For plant operators throughout the world, this means operational safety and top-level product quality.

For nearly 40 years, Endress+Hauser has been providing one of the most comprehensive product portfolios for measuring the flow of liquids, gases, and steam. During this time, over 3 million flowmeters have been installed successfully across the widest possible range of industry sectors.

A significant contribution to this success has been made by the Proline product family (introduced in 1993), whose further development is based on a continuous exchange of experiences with our customers. The latest generation of Proline flowmeters – Proline 100, 200, 300, 400 and 500 – combines the sensors, which have proved themselves hundreds of thousands of times over, with state-of-the-art transmitter technology. Thanks to numerous innovations, such as WLAN, WirelessHART, web server, HistoROM, and Heartbeat Technology, this generation offers added value in every respect. So put your faith in our new Proline, which already surpasses your future process automation requirements:

- **Proline exceeds** all industry-relevant regulations with regard to process safety (SIL), approvals, custody transfer, product quality, and system availability



- **Proline guarantees** significantly lower operating costs over the entire life cycle of your field measuring devices
- **Proline is ready** for digital networking and its opportunities in process automation through “Industry 4.0” and the “Internet of Things”
- **Proline makes it easier** to fully access device and configuration data using all interfaces and therefore increases system availability
- **Proline offers more** than just flow measurement and, with Heartbeat Technology, also gives you an insight into the process



Electromagnetic



Vortex



Coriolis



Thermal



Ultrasonic

# Proline – Added value in every aspect


## No compromises regarding accuracy, performance and conformity

Demands on process systems and measuring devices are constantly increasing: the highest possible process quality with low overall operating costs. The new Proline generation has been developed with precisely this in mind:

- Proline – first-class sensors with state-of-the-art transmitter technology
- Proline – recognized in all process industries all over the world
- Proline – tried and tested sensors
- Proline – available with industry-specific approvals

## Heartbeat Technology – for maximum plant availability

This unique diagnostics, monitoring, and verification concept allows perfect process monitoring. The advantages for you: Avoid unplanned operating failures and boost your competitiveness:

- Built-in testing method – no presence required in the field
- Compliance with legal requirements
- Metrologically traceable verification during operation (TÜV-attested) 
- Verification documents can be printed or archived and retrieved again, e.g. as quality documentation (ISO 9001) for audits

## Seamless integration thanks to the variety of signal outputs

The availability of process, diagnostic, and measurement data is of vital importance, particularly in large industrial plants. Therefore, Proline flowmeters are equipped with the latest fieldbus technologies:

- Seamless integration into existing systems thanks to rigorous stress testing with the most popular control systems and a variety of protocols: HART, WirelessHART, PROFIBUS PA/DP, FOUNDATION Fieldbus, Modbus RS485, EtherNet/IP and PROFINET
- Numerous, freely configurable signal inputs and outputs
- Easy data transfer via web server and WLAN
- HistoROM device memory: complete system integration compatibility through automatic restoration of the original firmware in service cases

## Ready for digital networking – from the sensor to the office

Use of the latest information and communication technologies has become more widespread in industrial production. The new Proline generation is well-prepared for this:

- Optimum connection to existing information networks thanks to numerous communication protocols and signal outputs
- Improved production processes thanks to modern diagnostics, maintenance, and service functions
- Integrated web server technology to allow full data access on site via tablet and WLAN
- Simple and convenient remote data retrieval via Industrial Ethernet using integrated web servers

## Developed for outstanding safety in production facilities

Install and measure safely – Proline puts you on the right track from the word go. Proline is based on years of experience in technical safety applications:

- Developed entirely in accordance with SIL guidelines (IEC 61508)
- Clear display of diagnostic and event messages according to NAMUR NE107 for targeted troubleshooting
- Safe and preventative maintenance thanks to Heartbeat Technology: non-invasive, traceable verification during operation



# Proline 100/200/300/400/500

## The new generation of transmitters

### Proline 100

#### The ultra-compact transmitter

- Full functionality with the smallest footprint
- Space-saving installation (e.g. in skids)
- Integrated web server for time-saving local operation without additional software and hardware (via laptop and standard Ethernet cable)
- Heartbeat Technology for device verification during operation
- With/without display



### Proline 200

#### The transmitter with genuine loop-powered technology

- Convenient device wiring thanks to separate connection compartment
- Safe operation – no need to open the device due to display with touch control and background lighting
- Display module with data backup and data transfer function (e.g. to other measuring points)
- Heartbeat Technology for device verification during operation



### Proline 300

#### The compact, easily accessible transmitter

- Multi-functional transmitter for the process industry
- Easy operation via the display, web server, WLAN, operating tools, or fieldbuses
- HistoROM device memory: complete system integration compatibility through automatic restoration of the original firmware in service cases
- Reduced complexity thanks to freely configurable I/Os
- Heartbeat Technology for device verification during operation



### Proline 400

#### The state-of-the-art transmitter for water and wastewater

- Corrosion-resistant housing made of polycarbonate
- Safe operation – no need to open the device due to display with touch control and background lighting
- Integrated web server for time-saving local operation without additional software and hardware (via laptop and standard Ethernet cable)
- Heartbeat Technology for device verification during operation



### Proline 500

#### The remote version with up to 4 I/Os

- Same functionality, operation, and fieldbus interfaces as on the Proline 300
- With up to 4 inputs and outputs
- With standard cable between sensor and transmitter ("remote digital")
- Remote installation of up to 1,000 ft. (300 meters) between sensor/transmitter





✓	available
Alu	Aluminium
SS	Stainless steel 316L
Poly	Polycarbonate
CF3M	Stainless steel die-cast

**Proline  
100**

Food industry  
Life Sciences

**Proline  
200**

Process  
industry

**Proline  
300**

Process  
industry

**Proline  
400**

Water &  
Wastewater

**Proline  
500**

Process  
industry

Display / Operation					
Local operation	Display	✓	✓	✓	✓
Web server	✓		✓	✓	✓
WLAN (wireless)			✓		✓
Materials / Protection					
Housing material	Alu, SS	Alu, CF3M	Alu, CF3M	Alu, Poly	Alu, CF3M
Degree of protection	IP66/67/69 Type 4X	IP66/67 Type 4X	IP66/67/69 Type 4X	IP66/67 Type 4X	IP66/67 Type 4X
Mounting					
Compact version	✓	✓	✓	✓	
Remote display/operation		✓	✓		
Remote version		Prowirl		✓	✓
System integration					
4–20 mA HART	✓	✓	✓	✓	✓
WirelessHART			✓		✓
PROFIBUS DP	✓		✓	✓	✓
PROFIBUS PA		✓	✓		✓
FOUNDATION Fieldbus		✓	✓		✓
Modbus RS485	✓		✓	✓	✓
EtherNet/IP, PROFINET	✓		✓	(EtherNet/IP)	✓
Pulse/frequency/status output	✓	✓	✓	✓	✓
Relay output			✓		✓
Configurable I/Os			✓		✓
Status input			✓	✓	✓
Current input		Prowirl Prosonic Flow B	✓		✓
Application packages					
Heartbeat Technology	✓	✓	✓	✓	✓
Extended HistoROM		✓	✓	✓	✓
HistoROM device memory			✓		✓
Concentration measurement	Promass		Promass		Promass
Conductivity measurement	Promag		Promag	Promag	Promag
Energy flow measurement		Prowirl F Prosonic Flow B			
Approvals / Certificates					
SIL		✓	✓		✓
Custody transfer			✓	✓	✓
3-A, EHEDG	✓	✓	✓		✓
Ex Zone 2 / Class I Div. 2	✓	✓	✓	✓	✓
Ex Zone 1 / Class I Div. 1		✓	✓		✓



## Global chemicals, competitive and safe

Get the extra project skill and know-how you need to boost your plant's safe performance.

You gain concrete benefits from a partner who has first-hand knowledge of your sector's issues around the globe: on increased safety, on environmental protection, on over-supply leading to cost pressure and on finding engineering support and service when required. You can rely on our help to become more competitive in your line of business.

With a long history of industry firsts we have grown with the sector by listening, acting and innovating to better serve you with:

- Safety, built-in
- The technology to lead
- Best-fit project management

### Advantages at a glance

- Safe operation: simplified access for maintenance work in hazardous areas thanks to the intrinsically safe design (Ex ia) of the loop-powered devices (Proline 200)
- Worldwide recognized Ex approvals for all measuring devices
- Reliable and accurate data: developed entirely in accordance with IEC 61508 (SIL). Clear display of diagnostic and event messages according to NAMUR NE107
- Process safety is guaranteed at all times: built-in Heartbeat Technology testing function for diagnostics, verification, and monitoring

## Product highlights

Two-wire, loop-powered technology



### Promass F 200 (Coriolis)

**With genuine loop-powered technology**  
Proven and robust flowmeter for gases and liquids with highest measurement performance in a wide range of applications. Rated secondary containment, purge connections and rupture disks. Wetted parts made of chemically resistant materials. No inlet/outlet runs.



### Promag P 200 (Electromagnetic)

**Robust flowmeter**  
Genuine loop-powered device (4–20 mA) for corrosive liquids and high medium temperatures. Wetted parts made of chemically resistant materials. Maintenance-free: no moving parts. Free pipe cross-section without pressure loss.



### Prowirl F 200 (Vortex)

**The specialist for steam**  
Highest process safety thanks to the unique wet steam measurement and the dualsensors version enabling redundant measurements. High resistance to vibrations, temperature shocks and water hammer. Maintenance-free. Lifetime calibration factor.



### Prosonic Flow 92F (Ultrasonic)

**Cost-effective flow measurement**  
In-line ultrasonic flowmeter for homogeneous conductive and non-conductive liquids. Minimum inlet/outlet runs thanks to innovative parallel multiple-path design. With Ex approvals. Maintenance-free: no moving parts. Free pipe cross-section without pressure loss.



### Promass F 300 (Coriolis)

**For premium accuracy**  
Highest measurement performance for liquids and gases under varying, demanding process conditions. Rated secondary containment, purge connections and rupture disks. Wetted parts made of chemically resistant materials. No inlet/outlet runs.



### Promag P 300 (Electromagnetic)

**Robust, easily accessible flowmeter**  
For corrosive liquids and high medium temperatures. Wetted parts made of chemically resistant materials. Maintenance-free: no moving parts. Free pipe cross-section without pressure loss.

Four-wire technology

### Unbeatable: SIL and Heartbeat Technology

In the chemical industry, safety devices must be regularly tested to ensure their safety function (SIL). Such proof tests are often time-consuming and costly, particularly for continuously measuring systems. Our new Proline flowmeter generation is equipped with Heartbeat Technology, allowing you to extend proof-test intervals to three years, or more. The embedded self-monitoring functionality enables proof testing in maximal depth without interrupting operation:

- Lower probability of undetected failures thanks to constant self-diagnostics
- Best-in-class diagnostic coverage (minimizes the number of random failure)
- In-line verification can be carried out at any time during operation (minimizes the risk of dangerous systematic faults). No removal necessary.
- Electronically stored verification results in the flowmeter, uploaded to the asset management system
- Safe and seamless documentation in accordance with your local standards
- Generation of secure verification reports according to IEC 61511-1

### Efficient two-wire loop-powered technology

Round-the-clock operational safety and plant availability are particularly important in the chemical industry. In addition, the complexity for plant operators is constantly increasing due to the numerous measuring tasks. Using our uniform two-wire concept (4–20 mA) for all measuring technologies, you are able to increase your operational reliability and reduce costs for planning, purchasing and operation:

- High operational safety and safe device access in Ex areas due to intrinsically safe design (Ex ia)
- Reduced costs for installation and wiring
- Developed for SIL 2/3 applications according to IEC 61508 – suitable for use in safety instrumented systems
- Seamless system integration into existing infrastructures
- Common installation practice
- Uniform operation, components, data management, etc.





## Water is our life

Water quality, discharges, regulations, the environment ... just rely on a trusted partner.

As budgets shrink and legislative demands soar, we bring expertise to challenging needs. Safe potable water, discharges, environmental penalties, water infrastructure for developing countries, energy monitoring, the rising quantities of sludge from wastewater treatment and the opportunities they create for biogas – we make sense of it all for your every need with experienced thinking supported by process technology solutions.

Working with water in over 100 countries, Endress+Hauser offers a refreshing alternative:

- Improve plant safety and availability
- Optimize costs in your internal water processes
- Support your risk and failure management

### Advantages at a glance

- Industry-optimized device portfolio for measuring raw water (stream and seawater), potable water, process water, or wastewater
- Worldwide recognized drinking water approvals
- Fully welded sensors with certified corrosion protection (EN ISO 12944) for permanent installation under water or under ground
- Integrated web server for time-saving local operation without additional software and hardware
- Extended calibration intervals thanks to Heartbeat Technology for device verification during operation



## Product highlights



### Promag L 400 (Electromagnetic)

#### The standard device

Weight-optimized device, e.g. for distribution networks, wastewater treatment plants, etc. Flexible mounting with reduced installation costs due to a unique lap-joint flange concept (DN < 14"/350). Maintenance-free. Drinking water approvals. Up to 90" (DN 2400).



### Promag W 400 (Electromagnetic)

#### The specialist with corrosion protection

For most demanding raw water or wastewater as well as for custody transfer. Robust, completely welded sensor for a secure long-term operation under water or under ground due to IP68 (Type 6P) and a certified corrosion protection (EN ISO 12944). Custody transfer approvals. Drinking water approvals. Maintenance-free. Up to 78" (DN 2000).



### Promag W 500 (Electromagnetic)

#### The specialist for hazardous areas

Flowmeter (remote version) with Ex approvals and with up to three signal outputs (I/Os). Robust, completely welded sensor with certified corrosion protection (EN ISO 12944) for a secure long-term operation. Drinking water approvals. Maintenance-free. Integrated WLAN communication for a time-saving commissioning via remote wireless data transmission. Up to 78" (DN 2000).



### Promag 10D (Electromagnetic)

#### For a cost-effective measurement

Compact, robust wafer flowmeter for a space-saving installation in basic water applications. Also suitable for an installation in plastic pipes. Maintenance-free. Drinking water approvals. Cost-optimized installation due to wafer or threaded-type process connections. Up to 4" (DN 100).



### Prosonic Flow B 200 (Ultrasonic)

#### The specialist for wet biogas


Accurate and reliable measurement of digester gas and biogas also with low process pressure, low flow rates or fluctuating gas composition. Integrated real-time methane fraction analysis. No pressure loss. With diagnostic functions. Energy balancing by calculating corrected volume, calorific value or Wobbe index. With Ex approvals.

### Verification made easy with Heartbeat Technology

The smallest measurement inaccuracies can cause shortfalls in the end-of-year accounting for providers or consumers. In the water industry's 24-hour operation, removing flowmeters for test measurements or recalibration is simply not realistic. The questions asked by a plant operator are therefore always the same:

- How can I prove that my flowmeter measures within the specified accuracy?
- How can flow measuring points be inspected and verified in accordance with the law?
- Is it possible to extend the calibration intervals specified by law?

Answers to all of these questions are provided by the unique "Heartbeat Technology." This function, integrated into the measuring electronics, allows you to monitor your Proline flowmeter constantly and verify its performance at any time – guaranteeing high measurement quality:

- Audited and attested self-monitoring and verification (by TÜV) 
- Verification possible at any time using any device interface – no presence in the field required
- No process interruption required
- Metrologically traceable verification
- Documentation in accordance with ISO 9001
- Guided and time-saving device programming





## Enhancing your productivity

Your global partner for accurate measurements and expert support in food and beverage automation.

From hygienic regulations and food safety to the basic demands of reliability and uptime, high-quality food and beverage producers profit from our experience in more than 100 countries.

Get it right the first time and make your safe choice:

- Constant food quality and compliance
- Resources savings
- An expert partner for reliable solutions

### Advantages at a glance

- Proline 100: industry-optimized flowmeters with an ultra-compact design and full functionality on the smallest footprint (with or without display)
- All measuring devices feature a hygienic design (3-A, EHEDG)
- Fewer measuring points thanks to multivariable measurement of mass flow (Coriolis only), volume flow, density (Coriolis only), temperature, conductivity (electromagnetic only)
- Integrated web server for time-saving local operation without additional software and hardware
- Extended calibration intervals thanks to Heartbeat Technology

## Product highlights



### Promag H 100 (Electromagnetic)

#### The proven specialist for food

Ideally suited for demanding hygienic applications as well as for modular, skid-mounted process facilities. Free pipe cross-section without pressure loss. Numerous hygienic process connections. Highest degree of protection (IP69K). Easy to clean (SIP/CIP) and piggable.



### Promass S 100 (Coriolis)

#### The hygienic single-tube system

With optimal cleanability and self-drainability. Single-tube system with gentle fluid treatment (no shear forces). Immediate availability after SIP/CIP cleaning. Numerous hygienic process connections. Highest degree of protection (IP69K). No inlet/outlet runs.



### Promass F 100 (Coriolis)

#### For premium accuracy and robustness

Highest flow and density measuring accuracy for liquids and gases under varying, demanding process conditions. Immediate availability after SIP/CIP cleaning. Highest degree of protection (IP69K). No inlet/outlet runs.



### Promass E 100 (Coriolis)

#### For cost-efficient liquid measurement

For non-conductive liquids in basic applications. Ideally suited for modular, skid-mounted process facilities. With a clearly lower total cost of ownership than conventional volumetric flowmeters. Immediate availability after SIP/CIP cleaning. Highest degree of protection (IP69K). No inlet/outlet runs.



### Promass Q 100 (Coriolis)

#### Specialist for challenging applications

With unmatched accuracy for mass flow and density measurement even in applications with highest demanding requirements. "Multi-frequency Technology" (MFT) for an outstanding performance for liquids with entrained gas. Immediate availability after SIP/CIP cleaning. Highest degree of protection (IP69K). No inlet/outlet runs.

### Process control made easy – Viscosity and density measurement

The trend toward more efficient processes and higher quality requirements is leading to the need for also monitoring more parameters in the food industry. With Promass, you have what you need for this "all-in-one." This Coriolis flowmeter not only measures the mass flow with peak accuracy, but, in addition fluid density, volume flow and temperature, it also measures industry-specific density values and even the viscosity directly in the piping.

#### Density functions (Promass F, I, Q, S)

The fluid density constantly measured by Promass can be used to calculate further density parameters that are available for optimal process control:

- Temperature-compensated density values
- Concentrations, mass (%) and volume (%) – also of solid contents, e.g. in two-phase fluids
- Industry-specific density units, e.g. standard density, °Brix (sugar content), °Plato (wort, beer) or the alcohol content (%)

#### Viscosity measurement (Promass I)

Promass I is the world's first Coriolis flowmeter that also measures the viscosity of a fluid directly in the piping – without additional devices. As with the density, this characteristic value can be used to constantly monitor and immediately adjust the process.







## The pulse of life sciences

Trust a reliable partner who puts quality, compliance and cost control at the heart of life sciences.

It is a daily requirement to comply with stringent GMP regulations and productivity goals throughout a product's life cycle. You can count on our world-class instruments, designed to ASME-BPE standards and rely on our experienced engineering and support services. We partner with you to help you reach your goals of process optimization, increased plant availability and continuous improvement.

Our experience, gained at the heart of the sector, will help you to:

- Streamline your projects
- Attain operational experience
- Make the right decisions

### Advantages at a glance

- Proline 100: ultra-compact flowmeter with full functionality on the smallest footprint – ideally suited for modular, skid-mounted process facilities
- Fewer measuring points thanks to multivariable measurement of mass flow (Coriolis only), volume flow, density (Coriolis only), temperature, conductivity (electromagnetic only)
- Simple and simultaneous access to extended device and process data thanks to digital signal transmission (Quality by Design)
- Less calibration effort and higher operational safety thanks to Heartbeat Technology



## Product highlights



### Promass P 100 (Coriolis)

#### The specialist for sterile processes

For biotech applications requiring highest compliance. Fully self-drainable even in horizontal installations. Audit safety thanks to industry-compliant design (ASME BPE, etc.), comprehensive documentation and all required approvals. Stainless steel wetted parts with electropolished surface finish. No inlet/outlet runs.



### Promass F 100 (Coriolis)

#### For premium accuracy and robustness

Highest mass flow and density accuracy in regard to chemical API manufacturing under varying demanding process conditions. Measurement is immune to fluctuating processes and harsh environments. Less downtime due to immediate availability after SIP/CIP cleaning. No inlet/outlet runs.



### Promass E 100 (Coriolis)

#### Cost-efficient metering of non-conductive liquids

Especially suited for mass flow measurement with basic requirements. Multi-purpose device as an alternative to conventional volumetric flowmeters. Less downtime due to immediate availability after SIP/CIP cleaning. Easy installation thanks to a light and compact dual-tube sensor design. No inlet/outlet runs.



### Promag H 100 (Electromagnetic)

#### Cost-efficient volumetric measurement of conductive liquids

For a broad range of less demanding applications. Flexible installation thanks to numerous hygienic process connections. Reduction of measuring points due to the multivariable measurement of volume flow, temperature and conductivity. Fulfills internal and external regulatory requirements: FDA compatibility (USP Class VI). No pressure loss.



### Promag H 300 (Electromagnetic)

#### Cost-efficient, easily accessible volumetric flowmeter

For a broad range of less demanding applications. High flexibility in regard to system integration: 3 freely configurable I/Os as well as various fieldbuses. Fulfills internal and external regulatory requirements: FDA compatibility (USP Class VI). Flexible installation due to numerous hygienic process connections. No pressure loss.

### Extended calibration intervals thanks to Heartbeat Technology

Product quality, measuring accuracy and reproducibility are all critical in the highly regulated life sciences industry. Full GMP compliance (Good Manufacturing Practice) is therefore a basic requirement to achieve operational excellence and reduce operational costs. This is especially important when dosing, mixing or filling very expensive active ingredients.

Plant operators are therefore obligated to have process-critical measuring devices periodically checked in a traceable way and to document the results for regulatory audits. Traditional calibration, for example, is not only expensive and time-consuming, but also causes process interruptions and increases the risk of cross contamination due to the opening of sterile process loops.

With Heartbeat Technology, available for all Proline 100 flowmeters, calibration intervals can now be significantly extended:

- Compliant verification without interrupting the process. Can be carried out via all device interfaces at any time.
- Verification results are stored in a data record or in PDF format – available for electronic reporting and quality auditing.
- Complete metrological traceability, thus ensuring that the flowmeter works within specification.
- Minimized residual risk of failure due to total test coverage of 95% – allowing for extended calibration intervals of up to 5 years.





## Fuel for thought

With vast experience in the oil and gas sector, we help you to perform, comply and thrive.

From exploration to refinery, from storage to distribution, from plant upgrades to new projects, we have the application expertise to help you succeed. At a time when the sector faces skills shortages and tightening of regulations, our organization is here across the full life cycle of your project always keeping your deadlines in mind.

While complexity of facilities and processes are ever increasing, and downtime must be reduced, your competitiveness is enhanced with reliable, accurate and traceable asset information. In short, you need to do more with less, benefiting from a stable partner who is here for the long haul and ready across the globe, offering:

- Assured plant safety
- Optimized return on investment
- Best-fit products, solutions and services

### Advantages at a glance

- Globally unique Heartbeat Technology: for the highest level of system safety and measurement integrity. Best-in-class diagnostic coverage, developed in accordance with IEC 61508
- Simple and quick commissioning/maintenance thanks to wireless data transfer via WLAN (web server)
- Worldwide recognized custody transfer approvals
- Certified bunker fuel metering system in accordance with MID (MI-005). Approved for commercial use by the Maritime and Port Authority of Singapore (MPA).
- Comprehensive life-cycle management via the web-based asset management tool "W@M" (► Page 56)



## Product highlights



### Promass X 300 (Coriolis)

#### 4-tube meter for highest capacity

Increased profit thanks to the patented, highly accurate measurement of huge quantities with one single device, especially in onshore/off-shore loading and off-loading.



### Promass O 300 (Coriolis)

#### Robust high-pressure flowmeter

Premium accuracy also at highest process pressures up to PN 250 (Class 1500). Maximum safety (SIL 2/3): highest resistance to stress corrosion cracking and hydrogen sulfide (H<sub>2</sub>S). Measuring tubes made of Super Duplex.



### Promass F 300 (Coriolis)

#### For premium accuracy and robustness

Highest measurement performance for hydrocarbons under varying, demanding process conditions. Highest process safety (SIL 2/3): rated secondary containment, purge connections and rupture disks.



### Promass Q 300 (Coriolis)

#### Specialist for challenging applications

With unmatched accuracy in custody transfer and for mass flow, volume flow and density measurement even in applications with highest demanding requirements. "Multi-frequency Technology" (MFT) for an outstanding performance for liquids with entrained gas.



### Prosonic Flow 92F (Ultrasonic)

#### Cost-efficient flowmeter for hydrocarbons

Loop-powered device (4–20 mA) with high accuracy ( $\pm 0.3\%$ ) for all liquids. Reduced inlet/outlet runs ( $\leq 5$  DN) thanks to the innovative parallel multi-path design (for 3 or 4 beams). No pressure loss.



### Prowirl F/O 200 (Vortex)

#### The all-rounder with integrated natural gas calculation (AGA)

Robust vortex flowmeter for natural gas, liquids and steam. Dualsens version with two sensors and transmitters for redundant measurements and maximum safety (SIL 3, SFF ~ 98%). Lifetime calibration factor. With unique wet steam measurement. Prowirl O 200 for high-pressure applications up to PN 250 (Class 1500).

### Certified bunker fuel metering systems

Day after day, vast quantities of bunker oil are pumped into the fuel tanks of passenger ships, container ships, tankers and bulk carriers.

Even the slightest measurement inaccuracies during this bunkering process cause "cash register" shortages and time-consuming disputes.

As we all know, the traditional quantity measurement via tank gauging can, for example, be associated with a great amount of uncertainty due to error prone volume to mass calculation as well as not considered air content caused by tank stripping and the "cappuccino effect."

Our solution according to MID (MI-005) prevents measurement inaccuracies during the bunkering process, no matter how small:

- Improved profitability – accurate billing thanks to high accuracy ( $\pm 0.5\%$  with areated fuels)
- Maximum transparency – simultaneous monitoring of mass flow, bunker fuel quantity, density, pressure, temperature and air index
- Sustainable efficiency – time savings of up to 3 hours for each bunkering operation
- Guaranteed system integrity – components are sealed by independent agencies
- Simple operation – separate control panel with intuitive user interface





## Power up your plant

Power plants play a vital role. We help minimize downtime while delivering safety and productivity.

Your plant needs a multi-skilled, versatile partner. You need reliable solutions that meet your application requirements and industry quality standards. And you may need to upgrade aging plants with proven and state-of-the-art technologies, to keep output consistently high.

As the industry shifts towards natural gas, renewables and the new market dynamics driven by shale gas, our mission is to provide the all-around support and experience you need. This includes elevated standards of safety for your staff – and the ability to meet even-higher environmental demands in flue gas cleaning processes such as SCR catalysts for nitrogen oxide reduction, electrostatic precipitators (ESPs) for particle separation, and limestone scrubbing processes for desulphurization.

When you choose us, you:

- Boost the efficiency of your plant
- Heighten safety
- Maintain expertise

### Advantages at a glance

- Fewer downtimes thanks to first-class, robust measuring instruments for every application: flow, level, temperature, pressure, analysis, etc.
- Maximum operational safety and energy efficiency: vortex flowmeter with permanent steam quality measurement (dryness fraction)
- Maximum system availability thanks to Heartbeat Technology – traceable device verification during operation
- Decades of experience in engineering and project management



## Product highlights



### Prowirl F 200 (Vortex)

#### Standard device for demineralized water, steam and gas

Multivariable loop-powered two-wire device (4–20 mA). With temperature measurement and a flow computer to calculate mass and energy flow. With worldwide unique inline wet steam measurement. No maintenance. Lifetime calibration factor (K-factor).



### Promass F 500 (Coriolis)

#### Highly accurate mass flow and density measurement for flue gas desulfurization

Reliable measurement of abrasive and chemically aggressive gypsum suspension. Optimum process control thanks to a minimum measured error ( $\pm 0.0005 \text{ g/cm}^3$ ). No inlet/outlet runs.



### Promag L/W 400 (Electromagnetic)

#### For the accurate metering of raw and cooling water

The measuring principle is independent of pressure, density and temperature. With an integrated electrode cleaning function (ECC) to prevent conductive magnetite deposits. Maintenance-free, no moving parts.



### Promass I 300 (Coriolis)

#### For cost-optimized combustion processes

Simultaneous measurement of mass, volume, density and temperature. With unique inline viscosity measurement for adjusting the optimum burning of fuels, e.g. with auxiliary burners. No inlet/outlet runs.



### Deltatop (Differential pressure)

#### For extreme process conditions

Up to 1,832°F (1,000°C) and 6,090 psi (420) bar. Standardized measuring principle (ISO 5167) for steam, liquids and gas. Long measurement tradition since 1929. Low pressure loss (Venturi, nozzle). High long-term stability due to robust primary elements that are purely mechanical. No moving parts.

### Multivariable measurement for more transparency

You can use Promass and Prowirl – without additional sensors – to measure multiple variables simultaneously and thereby control your processes optimally while saving money.

### Cost-reduced combustion (Promass I 300)

The Promass I 300 is the world's only flowmeter that also measures fluid viscosity directly in the piping. This makes it possible to adjust the best possible, viscosity-dependent burning temperature during combustion of fuel oil.

### Efficient flue gas desulfurization (Promass F 500)

During flue gas desulfurization, flue gases are sprayed with a limestone suspension and plaster is produced by blowing in air. For this process to run correctly, Promass F 500 not only measures the amount of plaster suspension, but also measures its density simultaneously with the greatest accuracy ( $\pm 0.0005 \text{ g/cm}^3$ ).

### Comprehensive energy management (Prowirl F 200)

For energy management Prowirl F 200 offers "everything" in a single device: a flow computer for calculating important characteristic values, the option of reading in temperature and pressure values, a temperature sensor and the globally unique wet steam measurement for increased safety and energy efficiency.





## Extracting more from less

In a world of lower grades, skills gaps and excavation challenges – we can help you hit your targets.

We've seen how lower grades are driving an acute need for ever-better automation and controls. You are also facing an emerging skills gap, requiring better-informed industry partners.

At the same time, energy costs are only going one way, and the legislative environment is becoming increasingly stringent. Tough challenges call for experienced heads who can:

- Reduce your metal and mineral production costs
- Keep your plant safe
- Boost compliance and responsibility

### Advantages at a glance

- Maximum system availability even in extreme process conditions – Promag 55S with chemical-resistant and abrasion-resistant linings and electrode materials
- Maximum productivity – Prowirl 200 with integrated wet steam measurement for the highest possible energy efficiency in steam utilities
- Environmentally friendly – reliable and accurate measurement of industrial wastewater with industry-optimized flowmeters (e.g. Promag W 400 for permanent measurement under water or under ground)
- Heartbeat Technology for maximum safety – integrated testing method for traceable device verification during operation

## Product highlights



### Promag 55S (Electromagnetic)

#### For inhomogeneous or abrasive fluids

For slurries with high solids content, fine or rocky size. High resistance to abrasion thanks to industry-optimized linings. Excellent accuracy and repeatability. Calculation of mass flow and solids content. No maintenance.



### Promag P 300/500 (Electromagnetic)

#### Dosing with highest accuracy

Robust and compact device for precise dosing of chemically aggressive fluids, also at high process temperatures – for example during the leaching of metals from stone slurries using sulfuric acid. Acid- and alkali-resistant PTFE or PFA lining (+356°F (180°C)). Hazardous Area (Ex) approvals. No pressure loss. Maintenance-free. Easily accessible transmitter housing. Also available as remote version (Promag 500).



### Promag L/W 400 (Electromagnetic)

#### For industrial wastewater

Corrosion-resistant polycarbonate transmitter housing. Promag W with completely welded sensor in IP68 (Type 6P) and with certified corrosion protection (EN ISO12944) for reliable long-term operation. No maintenance.



### Prowirl F 200 (Vortex)

#### The specialist for gas and steam

Multivariable loop-powered two-wire device (4–20 mA). With temperature measurement and a flow computer for the calculation of mass and energy flow. Unique wet steam measurement for highest safety. No maintenance. Lifetime calibration factor.



### Promass I 100 (Coriolis)

#### For fuel measurement

Simultaneous measurement of mass, volume, density and temperature. With unique inline viscosity measurement to adjust for optimal burning temperatures, e.g. in kilns. No inlet/outlet runs. No pressure loss due to straight single-tube design.

### Measuring flows with solids reliably

Plant operators who pump slurries – for example in mining or in dredging applications – frequently need to register the total density of the fluid or the quantity of solids transported as part of their “quality information”:

- Density measurement of extracted raw materials in water mixtures
- Determination of solid content in concentrators and in settling and clarifying pools
- Density determination of slurries for disposal

With the Promag 55 flowmeter and the Gammapilot M densimeter, Endress+Hauser offers a unique product solution package for computation of solid content flow

### Promag 55S (flow)

- Integrated computation function for solid flow without the need for an external computer (software can be uploaded optionally at any time).
- Density values (from any density meter) can be directly read in via the current input
- Solids readings output in mass, volume or percentage fractions via the frequency or current output

### Gammapilot M (density)

- Radiometric density measurement for extremely abrasive, stone-laden fluids (regardless of grain size)
- Installation/retrofitting without process interruption
- Robust, compact transmitter







## Saving energy and costs – together

Generating and distributing air, steam, gas, cooling or heating water requires a considerable amount of cost and energy. We help you to run these utilities as efficiently as possible.

Are you the maintenance technician, engineer or plant manager whose job it is to maintain competent support for the gas, steam or water utilities of your company? Are you the process or finance manager who has to balance the “trade-off” between increasing plant efficiency and reducing operating overheads and energy costs? Do you find that the dictates of quality audits and environmental protection require ever-stricter process monitoring? Then you can fully count on Endress+Hauser in regard to energy and cost savings:

- Customized solutions for your energy applications
- Planning, commissioning and maintenance
- Engineering, project management of simple solutions, for example, for boiler houses all the way to complete system solutions
- Professional support from specialists

### Advantages at a glance

- All costs kept under control – energy consumption is charged efficiently to internal cost centers
- Maximum supply reliability and transparency – extensive monitoring of all fluid and energy flows around the clock
- Maximum system availability thanks to Heartbeat Technology – integrated and traceable device verification during operation
- Guaranteed compliance with legal requirements and guidelines – many years of experience in the planning and installation of energy (ISO 50001) and environmental management systems (ISO 14001)

## Product highlights



### Prowirl F 200 (Vortex)

**The all-rounder for steam, gas and air**  
Multivariable loop-powered two-wire device (4–20 mA). With temperature measurement and a flow computer for the calculation of mass and energy flow. With worldwide unique inline wet steam measurement. No maintenance. Lifetime calibration factor.



### Promag L/W 400 (Electromagnetic)

**For process, cooling and wastewater**  
Measurement is independent of pressure, density and temperature. No pressure loss. Maintenance-free, no moving parts. Combinable with flow computers and temperature sensors for delta heat applications (energy).



### Prosonic Flow 93T (Ultrasonic)

**For temporary consumption measurement of water**  
Portable ultrasound measuring system for flexible monitoring, testing and verifying metering points. With integrated data logger. Data transmission via USB memory stick.



### t-mass A/B 150 (Thermal)

**Cost-effective metering of utility gases**  
For leakage detection in gas networks and/or in-house consumption accounting of compressed air, CO<sub>2</sub>, nitrogen or argon. Simultaneous measurement of mass flow, corrected volume flow, FAD volume flow and temperature. Inline version (A) as well as insertion version (B) for pipes and rectangular ducts.



### t-mass 65F/I (Thermal)

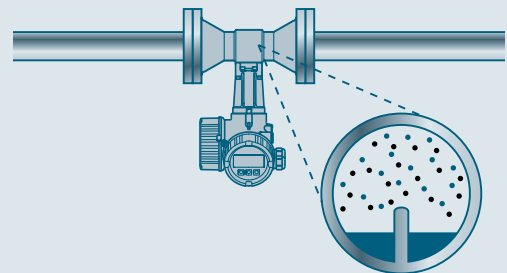
**High-performance gas measurement**  
Suitable for a broad range of utility gases and gas mixtures (freely definable using integrated “Gas Engine”). High turndown and low pressure drop. Inline version (F) as well as insertion version (I) for pipes and rectangular ducts.

### Don't give wet steam a chance

Time and time again, insufficient insulation, defective condensate drains, as well as pressure and temperature fluctuations lead to dangerous wet steam. Moreover, the transfer of heat energy via wet steam is not energy-efficient. This is now a thing of the past! As the world's first vortex flowmeter Prowirl F 200 is capable of permanently measuring the steam quality in the piping.

Wet steam occurs through the condensation of steam. First, the condensate flows at the bottom of the pipe and then smears up the wall, which affects the measuring signal of the Prowirl F 200. This effect can be used to determine the steam quality, which can be outputted as measured variables:

- Measurement of the dryness fraction between 80 and 100% – and thus the determination of the steam type (wet, saturated or superheated steam)
- Exact mass measurement of the steam and/or condensate quantity (e.g. in lb/h)



100% dryness fraction (saturated steam,  $x = 1$ )



90% dryness fraction ( $x = 0.9$ )  
10% condensate (with wavy flow)



80% dryness fraction ( $x = 0.8$ )  
20% condensate (with annular flow)  
Alarm !



# Flow measurement for filling

**Dosimass and Dosimag** – Filling and dosing in a cycle of mere seconds with the highest possible accuracy: these requirements are fulfilled by the two flow specialists from Endress+Hauser without any compromise.

For years now, state-of-the-art flowmeters have been used increasingly for filling applications, since previously used technologies – e.g. piston-type fillers – are no longer adequate for remaining competitive. Endress+Hauser's Dosimass and Dosimag are two measuring devices that not only measure flow reliably, but also exceed all common requirements for hygiene, cleaning and process control.

## Designed for industrial requirements

Dosimass and Dosimag are high-precision, maintenance-free filling meters. Reliability in operation and a high level of performance, even under demanding requirements, are characteristic of both flowmeters. They are an ideal replacement for conventional filling technology:

- Compact, space-saving design of the device
- Optimal integration into existing systems with numerous process connections

- 3-A approval and EHEDG certified
- Measuring system for shorter and faster cleaning cycles
- For non-continuous filling processes
- High repeatability
- Smallest volumes can be metered within the shortest filling cycles thanks to the "batching function" which can directly control up to two closing valves.

## Cost efficiency in metering

In real-world terms, cost-efficient means no unnecessary downtime caused by maintenance or repair. This is exactly where the Dosimass and Dosimag support you with an ideal device concept:

- Functions for self-monitoring and diagnosis
- Maintenance-free, no moving parts in the measuring tube
- SIP and CIP cleanable (up to + (302°F (150°C)) for 60 minutes)
- Self-emptying measuring tubes (open cross-section)
- Practical replacement concept for process seals







### Dosimag

Cost-effective filling of conductive liquids

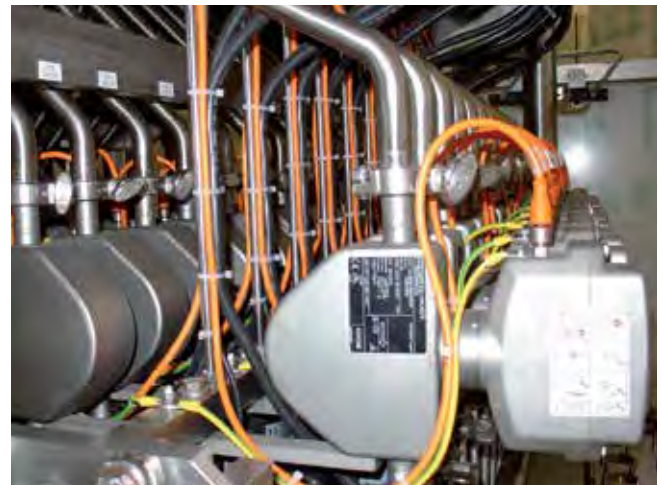
- Electromagnetic flowmeter
- Measured variable: Volume flow of liquids ( $\geq 5 \mu\text{S}/\text{cm}$ )
- Flow rate up to 79.2 gpm (300 l/min)
- Applicable up to +266°F (130°C) and 232 psi (16 bar)
- 5/32" to 1" (DN 4 to 25)



### Dosimass

Direct and highly accurate mass measurement

- Coriolis flowmeter
- Measured variable: Mass/volume flow
- Independent of the physical fluid properties
- Applicable up to +257°F/1,450 psi (125°C/100 bar)
- Especially for handling different fluids
- 3/8" to 1" (DN 8 to 25)



# Gas filling and refueling

**CNGmass, LPGmass and LNGmass** – The number of refueling stations and dispensers for compressed natural gas (CNG), liquefied gas (LPG) and liquefied natural gas (LNG) is increasing around the world. Our unparalleled selection of flowmeters guarantees maximum accuracy for billing and on-site fueling.

Outstanding performance is the norm for these three Coriolis flowmeters, as safety and reliability in operation is always of foremost importance for gas fueling.

- Assured measuring accuracy – since every device is certified on accredited calibration rigs (ISO/IEC 17025)
- Measuring principle independent of physical fluid properties
- Worldwide recognized Hazardous Area (Ex) approvals (e.g. FM, CSA, ATEX)

- Numerous custody transfer approvals (e.g. NTEP, MC, PTB, NMI, and MID)
- Time-saving operation and commissioning using FieldCare software
- Optimal process control with Modbus RS485
- High customer acceptance due to longtime industry experience

## For compressed natural gas (CNG)

### CNGmass (Flameproof/Intrinsically Safe) [Ex d/Ex i]

- For dispensers
- 3/8", 1/2", 1" (DN 8, DN 15, DN 25)
- Direct mass flow measurement
- Max. 330 lbs/min (150 kg/min)
- Max. 5,080 psi (350 bar)
- -58 to +257 °F (-50 to +125°C)
- Process connection:  
Internal thread
- Modbus RS485, pulse/  
frequency/switch output
- High vibration resistance
- With UL approval  
(Underwriters Laboratories)
- Intrinsically Safe (Ex i) version:  
CNGmass (D8CB) in a compact design,  
only with Modbus RS485, no custody  
transfer approval



Flameproof/Ex d



Intrinsically Safe/Ex i

### CNGmass DCI (Ex d)

- Same basic technical data as for CNGmass (Flameproof/Ex d)
- Four-line, backlit display with push buttons or Touch Control (operation from outside)
- -58 to +302°F (-50 to +150°C)
- HART, relay output



Flameproof/Ex d

### Your benefits

- Compact, space-saving design – fits into every dispenser
- Broad range of different instrument versions
- Wide measuring range fulfills the operating requirements of all common refueling station types





## For liquefied petroleum gas (LPG)

### LPGmass (Flameproof/Intrinsically Safe/Ex d/Ex i)

- For dispensers or tank trucks
- $\frac{3}{8}$ ",  $\frac{1}{2}$ ", 1", 1½", 2" (DN 8, DN 15, DN 25, DN 40, DN 50)
- Direct mass or volume flow metering
- Max. 1,654 lbs/min (750 kg/min)
- Max. 580 psi (40 bar)
- -40 to +257°F (-40 to +125°C)
- Process connections:  
Flanges ANSI, EN (DIN), JIS;  
VCO threaded connections, etc.
- Modbus RS485, pulse/  
frequency/switch output
- High vibration resistance



### Your benefits

Direct calculation of temperature-compensated volumes on site without additional measuring instruments:

- Integrated temperature measurement in accordance with MI-005 – can be used for corrected volume flow
- API table integrated as standard



## For liquefied natural gas (LNG)

### LNGmass

- For dispensers
- $\frac{3}{8}$ ",  $\frac{1}{2}$ ", 1" (DN 8, DN 15, DN 25)
- Direct mass flow measurement
- Max. 661 lbs/min (300 kg/min)
- Max. 580 psi (40 bar)
- (-320.8 to +257°F (-196 to +125°C)
- Process connections: Flanges EN (DIN), ASME
- Modbus RS485
- High vibration resistance



### Your benefits

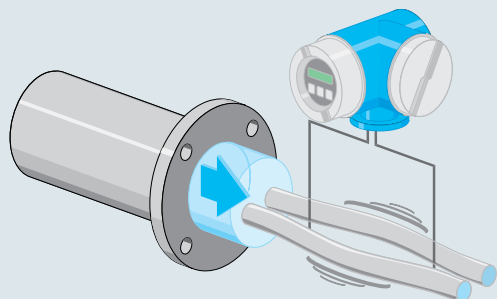
- Smallest flowmeter for LNG dispensers worldwide – fits into every dispenser
- Highest accuracy and security when refueling even at temperatures down to -320.8°F (-196°C)





# Coriolis mass flowmeters

**Proline Promass** – Multivariable sensors and highest accuracy – just two of the many reasons why the Coriolis measuring principle is being used more frequently to measure gases and liquids



## Measuring principle

If a moving mass is subjected to an oscillation perpendicular to its direction of movement, Coriolis forces occur depending on the mass flow. A Coriolis mass flowmeter has oscillating measuring tubes to precisely achieve this effect. Coriolis forces are generated when a fluid (= mass) flows through these oscillating tubes. Sensors at the inlet and outlet ends register the resultant phase shift in the tube's oscillation geometry. The processor analyzes this information and uses it to compute the rate of mass flow. The oscillation frequency of the measuring tubes themselves, moreover, is a direct measure of the fluids' density. The temperature of the measuring tube is also registered for compensating thermal influences. This signal corresponds to the process temperature and is also available as an output signal.

## Advantages at a glance

- Universal measuring principle for liquids and gases
- Simultaneous and direct measurement of mass flow, density, temperature and viscosity
- Very high measuring accuracy
  - typically:  $\pm 0.1\%$  o.r.
  - optionally:  $\pm 0.05\%$  o.r. (PremiumCal)
- Measuring principle independent of the physical fluid properties and the flow profile
- No inlet/outlet runs necessary

Simultaneous measurement of mass flow, density, temperature, even viscosity opens up entirely new perspectives for process control, quality assurance and plant safety. Additional important characteristic values can also be calculated from the primary variables measured:

- Volume flow
- Solids contents in a fluid
- Concentrations in multiple-phase fluids
- Special density values such as reference density, °Brix, °Baumé, °API, °Balling or °Plato
- Viscosity

The Coriolis measuring principle is used in a wide range of industries, such as the life sciences, chemicals, petrochemicals, oil and gas, food and in custody transfer applications. Virtually all fluids can be measured: cleaning agents, solvents, fuels, crude oil, vegetable oils, animal fats, latex, silicon oils, alcohol, fruit solutions, toothpaste, vinegar, ketchup, mayonnaise, gases or liquefied gases.

Over 650,000 Coriolis flowmeters have been successfully installed by Endress+Hauser since 1986.



 Measuring principle movie:  
<http://youtu.be/XIIViaNITlw>





# Promass sensors

## Promass F

For universal use

- Tube material: stainless steel, Alloy C22
- Optional up to 662°F/350 °C
- For custody transfer
- 3/8" to 10"/DN 8 to 250



## Promass E

For basic applications

- Cost-effective sensor
- Tube material: stainless steel
- 3/8" to 3" / DN 8 to 80



## Promass A

For low flows

- Tube material: stainless steel, Alloy C22
- For custody transfer
- 1/2" to 1/8" / DN 1 to 4 (up to 5,800 psi)



## Cubemass C

For low flows

- Space-saving, multivariable measuring system
- Tube material: stainless steel
- 1/2" to 1/4" / DN 1 to 6



## Promass I

Straight single-tube

- Easy-to-clean single-tube system
- Tube material: titanium
- Optionally with viscosity measurement
- 3/8" to 3" / DN 8 to 80



## Promass Q

The top specialist

- "Multi-Frequency Technology" for unmatched accuracy in most demanding applications (e.g. for liquids with entrained gas)
- 1" to 4" / DN 25 to 100



## Promass G

For highest pressures

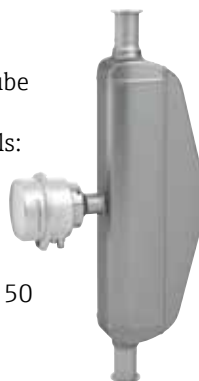
- Ultra-compact design with threaded connections
- Up to 5,075 psi / 350 bar
- Tube material: stainless steel
- 3/8" to 1" / DN 8 to 25



## Promass S

Food industry

- Hygienic single-tube system
- Standard approvals: 3-A, EHEDG and FDA
- Tube material: stainless steel
- 3/8" to 2" / DN 8 to 50



## Promass P

Life sciences industry

- Hygienic single-tube system
- Complies with ASME BPE, ISPE, FDA, EHEDG and 3-A
- Tube material: stainless steel
- 3/8" to 2" / DN 8 to 50



## Promass H

For aggressive fluids

- Bent single-tube system
- Tube material: zirconium, tantalum
- Highest corrosion resistance
- 3/8" to 2" / DN 8 to 50



## Promass O

For highest pressures

- For oil and gas
- Corrosion resistant measuring tubes made of Super Duplex; stainless steel housing
- For custody transfer
- 3" to 6" / DN 80 to 150 (PN 250)



## Promass X

Maximum flow rates

- Highly accurate four-tube measurement technology
- Tubes and housing: stainless steel
- Custody transfer
- 12" to 16" / DN 300 to 400 (up to 4,100 t/h)






# Proline transmitters

## Proline – the perfect transmitter for every application

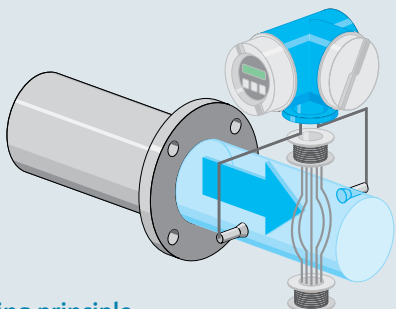
Whether applied in the life sciences, water, or food industry, the new generation of Proline transmitters can be freely combined with any of our sensors, all tried and tested for decades – while maintaining full backwards compatibility. This means a high level of added value and maximum safety when upgrading your previous Proline measuring points – from a mechanical, electronic, and functional point of view.

→ A detailed description of all Proline transmitters can be found on ► page 8/9

Promass sensors ▼	Proline transmitters				
	40	100	200	300	500
					
Promass F		✓	✓	✓	✓
Promass E	✓	✓	✓	✓	✓
Promass A		✓		✓	✓
Cubemass C		✓		✓	✓
Promass I		✓		✓	✓
Promass Q		✓		✓	✓
Promass G		✓			
Promass S		✓		✓	✓
Promass P		✓		✓	✓
Promass H		✓		✓	✓
Promass O		✓		✓	✓
Promass X				✓	✓

# Electromagnetic flowmeters

**Proline Promag** – Universally applicable in all industries and in pipes from 1/12" to 90" (2 mm to 2.4 m). Since 1977, Endress+Hauser has successfully installed over 2 million devices.



## Measuring principle

Faraday's law of induction states that a conductor moving in a magnetic field induces electrical voltage. This principle also governs the way electromagnetic flowmeters work.

With a magmeter, the flowing fluid is the moving conductor. The constant-strength magnetic field is generated by two field coils, one on either side of the measuring tube. Two measuring electrodes on the inside wall of the tube are at right angles to the coils and detect the voltage induced by the fluid flowing through the magnetic field. The induced voltage is proportional to flow velocity and thus to volume flow.

The magnetic field is generated by a pulsed direct current with alternating polarity. This ensures a stable zero point and makes the flow measurement insensitive to multiphase or inhomogeneous liquids, as well as low conductivity.

## Advantages at a glance

- The principle is virtually independent of pressure, density, temperature and viscosity
- Even fluids with entrained solids can be metered, e.g. ore slurry or cellulose pulp
- Large nominal diameter ranges available (1/12" to 90"/DN 2 to 2400)
- Free pipe cross-section: CIP/SIP cleanable, piggable
- No moving parts
- Minimum outlay for maintenance and upkeep
- No pressure losses
- Very high turndown up to 1000:1
- High degree of measuring dependability, reproducibility and long-term stability



The popularity of magmeters across all sectors of industry continues to be unabated, further proof of the worldwide success that this measuring principle has had for more than 50 years. Magmeters can be used to measure all electrically conductive liquids above 5  $\mu\text{S}/\text{cm}$  with or without solids, e.g. water, wastewater, sludge, slurries, pastes, acids, alkalis, juices or fruit pulp. Since 1977, Endress+Hauser has successfully installed over 2 million devices.

The rule of thumb for magmeters is: anything that can be pumped can also be measured – a highly valued trait in measurement technology. Typical tasks include measuring and monitoring continuous flow rates, filling and dosing as well as applications in custody transfer.

In the industrial environment, magmeters are primarily used in water management and in the processing, life sciences and food industries. In primaries and mining, robust magmeters are often the only option for measuring highly abrasive ore slurries with entrained solids, sand-water mixtures, filler materials or bulk solids with the required accuracy.



 Measuring principle movie  
<http://youtu.be/f949gpKdCl4>





# Promag sensors

## Promag H

Food industry

- For the chemicals, life sciences, processing and food industries
- Robust stainless steel housing (3-A, EHEDG)
- CIP/SIP cleanable
- PFA liner (-4 to +302°F / -20 to +150°C)
- Flexible connection concept
- 1/2" to 6" / DN 2 to 150



## Promag S

For demanding fluids

- For inhomogeneous or abrasive fluids (ore slurry, cement, fruit pulp, paper pulp, etc.)
- Industry-optimized measuring electrodes
- Linings: PTFE, PFA, polyurethane or natural rubber
- High-temperature version up to 356°F / +180°C
- 1/2" to 24" / DN 15 to 600



## Promag P

Chemical and process industry

- For high fluid temperatures
- With all common Hazardous Area approvals
- For custody transfer
- PTFE (-40 to +266°F / -40 to +130°C)
- PFA (-4 to +356°F / -20 to +180°C)
- 1/2" to 24" / DN 15 to 600



## Promag D

Water/wastewater

- Wafer device with shorter installation length and less weight
- Drinking water approvals
- Lining: Polyamide (32 to 140°F / 0 to +60°C)
- 1" to 4" / DN 25 to 100



## Promag W

Water/wastewater

- For hazardous areas
- Drinking water approvals
- IP68 (Type 6P) for underground or underwater applications
- For custody transfer
- Linings: hard rubber (32 to 176°F / 0 to +80°C), polyurethane (-4 to +122°F / -20 to +50°C)
- 1" to 78" / DN 25 to 2000



## Promag L

Water/wastewater

- Drinking water approvals
- Up to 30% less weight
- Lap-joint flanges up to 12" / DN 300
- Linings: polyurethane (-4 to +122°F / -20 to +50°C), PTFE (-4 to +194° / -20 to +90°C), hard rubber (32 to 176°F / 0 to +80°C)
- 1" to 90" / DN 25 to 2400



## Magphant

Limit switch

- For cost-effective flow monitoring
- For steel or plastic pipes
- 1/2" to 78" / DN 15 to 2000



# Promag transmitters

## Proline – the perfect transmitter for every application

Whether applied in the life sciences, water, or food industry, the new generation of Proline transmitters can be freely combined with any of our sensors, all tried and tested for decades – while maintaining full backwards compatibility. This means a high level of added value and maximum safety when upgrading your previous Proline measuring points – from a mechanical, electronic, and functional point of view.

→ A detailed description of all Proline transmitters can be found on ► page 8/9

Promag sensors	Proline transmitters							
	10	100	200	300	400	500		800*
▼								
Promag H	✓	✓	✓	✓		✓		
Promag P	✓	✓	✓	✓		✓		
Promag W	✓				✓		✓	
Promag W (IP68, OIML)					✓		✓	✓
Promag L	✓				✓			
Promag D	✓				✓			

\* battery-powered



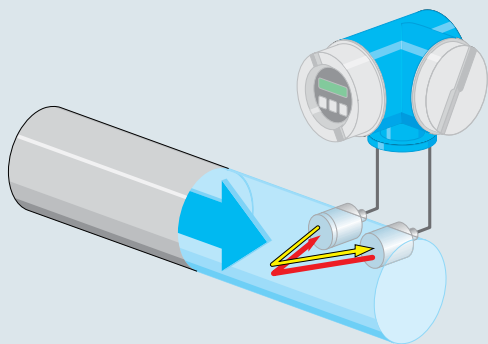
### Promag 55S The specialist for challenging fluids

- Excellent signal stability and measuring accuracy, even with highly fluctuating flow
- Permanent abrasion resistance thanks to industry-optimized linings and measuring electrodes
- Proven PFA lining with metal-mesh reinforcement for high chemical resistance up to 356°F (180°C)
- Integrated function for calculating solids content in the fluid



# Ultrasonic flowmeters

**Proline Prosonic Flow** – whether mounted on the outer wall of the pipe or directly in the pipe – ultrasonic sensors guarantee versatile and economical measurement of liquids up to a nominal diameter of 160" (DN 4000).



## Measuring principle

Swimming against the flow requires more power and more time than swimming with the flow. This simple fact is the basis for ultrasonic flow measurement according to the "differential transit time" method: This method uses two sensors, set opposite each other in the measuring tube. Each sensor can alternately transmit and receive ultrasonic signals while simultaneously measuring the signal transit time. As soon as the fluid in the tube starts to flow, the signals are accelerated in the direction of flow but delayed in the opposite direction. The differential transit time, measured by the two sensors, is directly proportional to the flow rate.

## Advantages at a glance

- Measurement independent of pressure, density, temperature, conductivity and viscosity (for homogeneous fluids)
- Free pipe cross-section, no pressure loss
- No moving parts, minimum maintenance and upkeep
- Long service life, no abrasion or corrosion from the fluid
- Inline or clamp-on design for stationary or temporary flow measurements

Using ultrasonic waves, the flow volume of a wide variety of gases and liquids can be measured reliably – independent of electrical conductivity, pressure, temperature or viscosity. In applications that require traceable and guaranteed accuracy, inline sensors are preferred for use – in petrochemicals and other chemicals as well as in the water industry.

Clamp-on ultrasonic sensors, on the other hand, are installed on the outer wall of the pipe and thus also enable temporary measurements. Their range of applications extends from applications in the water industry to industrial process engineering.

## Clamp-on sensors

- For retrofitted installation without interrupting the process
- Aggressive fluids can be measured without any problems, even under high pressure
- Suitable for pipes made of plastic, steel, cast iron or composite materials (lined/unlined)
- For pipe diameters up to 160" /DN 4000

## Inline sensors

- Guaranteed accuracy thanks to traceable factory calibration
- Robust industrial design in accordance with ASME and EN
- Short inlet runs
- For pipelines up to 160" / DN 4000



Measuring principle movie  
<http://youtu.be/Bx2RnrfLkQg>





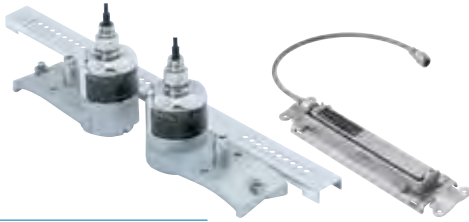
# Prosonic Flow sensors

## For measuring from outside (clamp-on sensors)

### Prosonic Flow W

Water applications

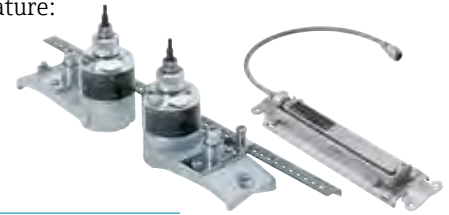
- For water, wastewater, hot/cold water in utilities
- Process temperature:  $-4$  to  $+176^{\circ}\text{F}$  ( $-20$  to  $+80^{\circ}\text{C}$ )
- $\frac{1}{2}$ " to 160" (DN 15 to 4000)



### Prosonic Flow P

Process industry

- For chemicals, petrochemicals, life sciences, oil/gas, energy
- With Hazardous Area approvals
- Process temperature:  $-40$  to  $+338^{\circ}\text{F}$  ( $-40$  to  $+170^{\circ}\text{C}$ )
- $\frac{1}{2}$ " to 160" (DN 15 to 4000)



## For guaranteed accuracy (inline sensors)

### Prosonic Flow B

For biogas, landfill and digester gas

- Ideally suited for wet or dirty gases under low pressure
- Traceable factory calibration ( $\pm 1.5\%$  o.r.)
- Direct monitoring of the methane content
- Calculating corrected volume, calorific value, Wobbe index
- 2" to 8" (DN 50 to 200)



## For attenuating pipe materials

### Prosonic Flow W (insertion sensor)

Water/wastewater

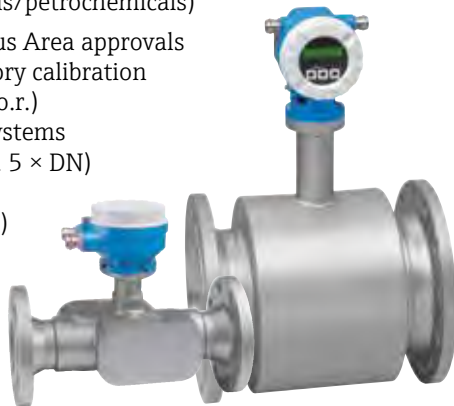
- Installation using sensor holders welded into the piping
- Option of a dual path version (for short inlet runs)
- 8" to 160" (DN 200 to 4000)



### Prosonic Flow F

Liquids (chemicals/petrochemicals)

- With Hazardous Area approvals
- Traceable factory calibration ( $\pm 0.3$  to  $0.5\%$  o.r.)
- For compact systems (inlet run max.  $5 \times \text{DN}$ )
- $-40$  to  $+392^{\circ}\text{F}$  ( $-40$  to  $+200^{\circ}\text{C}$ )
- 1" to 12" (DN 25 to 300)



### Prosonic Flow C

Water/wastewater

- Drinking water approvals
- Traceable factory calibration ( $\pm 0.5\%$  o.r.)
- 12" to 78" (DN 300 to 2000)



## Clamp-on technology Flexible measurement

This design features advantages offered by no other measurement technology:

- Ideally suited for flow monitoring and network balancing
- Low capital investment – cost-effectiveness increases with pipe diameter (up to 160"/DN 4000)
- For temporary flow measurement without interrupting the process
- Verifying already installed measuring devices



# Prosonic Flow transmitters

## For clamp-on sensors (W, P)

### Prosonic Flow 91

Basic applications

- Cost-effective transmitter in a compact design
- Two-line display with push buttons



### Prosonic Flow 93T

Portable transmitter

- For temporary monitoring and test measurements with clamp-on sensors
- Integral data logger
- Data transmission via USB memory stick
- Four-line, backlit display with Touch Control



## For sensors W, P or C

### Prosonic Flow 93

Standard applications

- With extended functionality in process applications
- With Hazardous Area (Ex) approvals and Fieldbus connection
- Four-line, backlit display with Touch Control



## For sensor F (inline)

### Prosonic Flow 92

Two-wire loop-powered technology (4–20 mA)

- With Hazardous Area (Ex) approvals (Intrinsically Safe/Ex i, Flameproof/Ex d)
- With current (HART), pulse, switch outputs; PROFIBUS PA and FOUNDATION Fieldbus
- Two-line display with push buttons



## For sensor B (inline)

### Proline 200

Two-wire loop-powered technology (4–20 mA)

- Four-line display with push buttons or Touch Control
- Display module with backup and transfer function for configuration data
- Event logbook and data logging functionality
- Heartbeat Diagnostics, Monitoring and Verification



Advantages of the Proline 200 transmitter  
 ▶ Page 6 to 9

## Biogas and methane measurement

### Reliable process control

Previously, reliable measurement of slow-flowing, wet or dirty gases in pipes was nearly impossible. With the new Prosonic Flow B 200, gas quantity and methane content can now be measured simultaneously – this is unique worldwide:

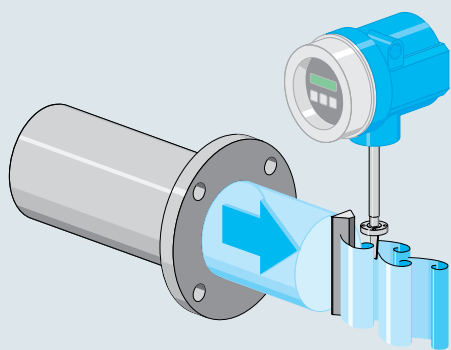
- Continuous monitoring of gas quantity and quality
- Fast reaction in case of interference during the fermentation process
- Efficient process control and energy balancing





# Vortex flowmeters

**Proline Prowirl** – robust and universal. For measuring the volume flow of liquids, gases and steam up to 3,625 psi (250 bar) and 842°F (450°C) reliably.



## Measuring principle

This measuring principle is based on the fact that turbulence forms downstream of obstacles in the flow, such as a bridge pier.

Inside each vortex flowmeter, a bluff body is located in the middle of the pipe. As soon as the flow velocity reaches a certain value, vortices form behind this bluff body, are detached from the flow and transported downstream. The frequency of vortex shedding is directly proportional to mean flow velocity and thus to volume flow.

The detached vortices on both sides of the bluff body generate alternately a local positive or negative pressure that is detected by the capacitive sensor and fed to the electronics as a primary digital, linear signal.

## Advantages at a glance

- Universally suitable for measuring liquids, gases and steam
- Largely unaffected by changes in pressure, density, temperature and viscosity
- High long-term stability: no zero-point drift and lifetime calibration
- No moving parts
- Little pressure loss
- Easy installation and commissioning
- Large turndown of typically 10:1 to 30:1 for gas/steam, or up to 40:1 for liquids
- Wide temperature range: 328 to +752°F (–200 to +400°C) (842°F (450°C) on demand)



Measuring principle movie

<http://youtu.be/GmTmDM7jHzA>

In chemicals, petrochemicals, power engineering and heat supply, a wide variety of fluids can be measured using vortex flowmeters, e.g. saturated steam, superheated steam, compressed air, nitrogen, liquefied gases, flue gases, carbon dioxide, fully demineralized water, solvents, heat-transfer oils, boiler feed water or condensate. Vortex flowmeters are also in widespread use for measuring mass flow. Therefore, modern vortex meters such as the multivariable Prowirl 200 are built for more than merely measuring volume flow, and come complete with temperature sensor and flow computer.

Whenever gas mass flow has to be measured, external pressure values can be read in digitally and with high accuracy via HART, PROFIBUS or FOUNDATION Fieldbus. Prowirl 200 is also available with reduced line sizes, which permits measurements even at very low flow velocities – with the same installation length and accuracy.

Prowirl 200 is the world's first vortex flowmeter with the option of monitoring the steam quality and immediately generating an alarm message in case of wet steam. Prowirl can also be used for flow monitoring systems up to SIL 2 and SIL 3 and is independently evaluated and certified by the TÜV in accordance with IEC 61508.







# Prowirl sensors

## Prowirl D

Compact wafer device

- With centering rings for high fitting accuracy
- Worldwide standardized installation length (2.6"/65 mm) enables one-to-one replacement of orifice plates
- Sensor made of stainless steel (CF3M)
- Cl 150 to 300 (PN 10 to 40)
- -328 to +752°F (-200 to +400°C)
- ½" to 6" (DN 15 to 150)



## Prowirl F

Versatile standard device

- Suitable for detecting wet steam
- Correction function for short inlet runs
- Worldwide standardized installation lengths
- Sensor made of stainless steel (CF3M/316/316L) or Alloy C22
- Cl 150 to 300 (PN 10 to 40)
- -328 to +752°F (-200 to +400°C) (842°F/450°C optional)
- ½" to 12" (DN 15 to 300)



## Prowirl R

For low flows

- With a single and even double line size reduction for:
  - Increasing the flow velocity
  - Extending the lower measuring range
- PN 10 to 40 (Cl 150 to 300)
- 1" to 8" (DN 25 to 200) (single reduct.)
- 1½" to 10" (DN 40 to 250) (double reduct.)



## Prowirl O

The high-pressure specialist

- Flange or butt-weld version
- Worldwide standardized installation lengths
- Sensor made of stainless steel
- Cl 600 to 1500 (PN 63 to 250)
- -328 to +752°F/-200 to +400°C (842°F/450°C optional)
- ½" to 6" (DN 15 to 150)



## Dualsens version

To ensure safety, critical applications often require redundant measurements. Therefore all Prowirl sensors are also available in a Dualsens version; in other words, with two separate DSC sensors and two measuring electronics. Through development in accordance with IEC 61508, the redundant measuring system can even be used in SIL 3 applications.

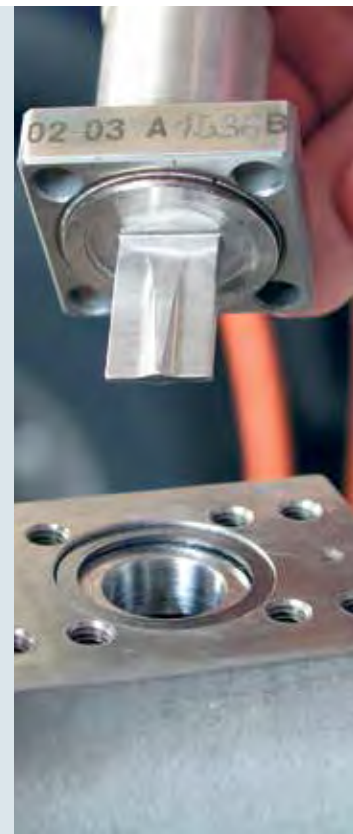


## Robust DSC sensor

Endress+Hauser's unique, patented DSC (Differential Switched Capacitor) sensor ensures high-precision measured values even under the toughest conditions and features a lifetime calibration factor. With an installed base of over 300,000 devices, this sensor concept has been proving its value for decades. The sensor is highly resistant to:

- Vibration
- Dirty fluids
- Water hammer
- Temperature shocks (>150 K/s)

Optionally, the DSC sensor is also available with a built-in temperature sensor, for example for direct mass measurement of saturated steam.





# Proline transmitters

## Proline 200

Two-wire loop-powered technology (4–20 mA)

- Four-line display with push buttons or Touch Control
- Display module with backup and transfer function for configuration data
- HART, PROFIBUS PA, FOUNDATION Fieldbus with pulse/frequency/switch output
- Heartbeat Diagnostics, Monitoring and Verification

- Versatile system integration:
  - Current input for reading in external measured variables such as pressure or temperature (optional)
  - Current output for multiple measurement parameters (optional)



Advantages of the Proline 200 transmitter ▶ Page 6 to 9

Prowirl is the world's first vortex flowmeter developed entirely in accordance with IEC 61508, allowing it to be used in SIL 2/3 applications at any time.

## Multivariable measurement

### Energy management made easy

All industries have utilities with steam, cooling water or hot water. Generating, transporting and distributing these fluids consumes a lot of energy. Therefore Proline Prowirl 200 offers everything in one device for a comprehensive energy management:

- Integrated flow computer for calculating:
  - Mass, heat and energy flow of steam and liquids
  - Corrected volume flow and energy flows of gases
- Reading in external temperature and pressure values via HART, PROFIBUS PA and FOUNDATION Fieldbus as well as via an optional current input
- Integrated temperature measurement for direct mass measurement of saturated steam and liquids (temperature compensation)



For energy management we offer everything from a single source: flow computers, pressure and temperature sensors as well as software solutions for energy monitoring (e.g. eSight).



EngyCal RS33



RSG40



Cerabar M



Omnigrad TR



## One-of-a-kind wet steam measurement

### Process reliability and efficiency

Many industries use large quantities of steam, the generating costs of which are extremely high. Moreover, the transfer of heat energy is energetically efficient only for "saturated steam." Often, however, "wet steam" is what predominates, since fluctuations in pressure and temperature cause water to condense out, or water gets into the steam lines due to disruptions in the boiler system. The consequences are usually serious:

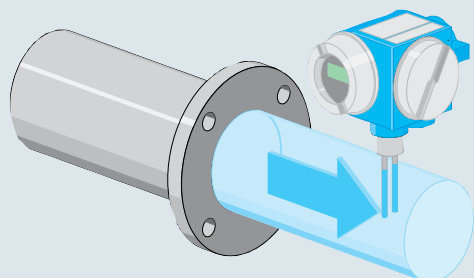
- Low efficiency for the transmission of energy
- Hazardous water hammer
- Heavy corrosion from the salts dissolved in the water carried over



Proline Prowirl 200 is the world's first vortex flowmeter with the option of monitoring the steam quality and immediately generating an alarm message in case of wet steam.

# Thermal mass flowmeters

**Proline t-mass** – for direct mass measurement of industrial gases and compressed air, even at the lowest flow velocities and low pressure, and liquids.



## Measuring principle

Many people are made uncomfortably cold by just a small draft. The thermal flow-measuring principle is based on the fact that heat is drawn from a heated body when a gas flows past.

A thermal flowmeter contains two PT100 temperature sensors for this purpose. One sensor measures the current fluid temperature as a reference. The second sensor is heated and has a constant temperature differential relative to the first sensor at "zero flow". As soon as the fluid begins to flow in the measuring tube, the heated temperature sensor cools off due to the fluid flowing past – the higher the flow velocity, the greater the cooling effect.

The electric current required to maintain the temperature differential is thus a direct measure of mass flow.

## Advantages at a glance

- Multivariable – direct measurement and display of mass flow and fluid temperature
- No pressure or temperature compensation required
- High turndown (100:1)
- Excellent low-end sensitivity
- Quick reaction to fluctuations in flow
- Negligible pressure loss
- Maintenance-free, no moving parts



The thermal measuring principle is widespread in industry and is being used successfully in many applications with gas flow, for example:

- Compressed air (consumption, distribution)
- Carbon dioxide (for fermentation and chilling)
- Argon (in steel production)
- Nitrogen and oxygen (production)
- Natural gas (for burner and boiler feed control)
- Air and biogas measurement (e.g. in wastewater plants)

Whenever high turndown or low pressure losses are important in gas metering applications, thermal mass flowmeters offer a real alternative to traditional measuring techniques – whether for process control, billing or monitoring, detecting leaks or tracking distribution networks.

Using insertion versions, it is also possible to detect gas flows in very large pipelines or in rectangular ducts.



Measuring principle movie:  
<http://youtu.be/YfQSf2NBGqc>







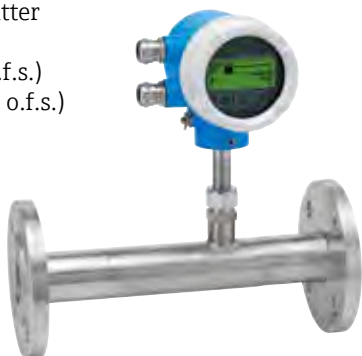
# t-mass sensors

## For basic gas applications (cost-effective measurement)

### t-mass A

Inline version

- For t-mass 150 transmitter
- Max. measured error:  
±3% o.r. (15 to 100% o.f.s.)  
±0.45% o.f.s. (1 to 15% o.f.s.)
- Process pressure:  
PN 10 to 40
- -40 to +212°F  
(-40 to +100°C)
- ½" to 2" (DN 15 to 50)



### t-mass B

Insertion version

- For t-mass 150 transmitter
- Suitable for large pipelines and rectangular ducts
- Max. measured error:  
±3% o.r. (15 to 100% o.f.s.)  
±0.45% o.f.s. (1 to 15% o.f.s.)
- Process pressure: -7.25 to 290 psig  
(-0.5 to 20 bar g)
- -40 to +212°F (-40 to +100°C)
- 3" to 60" (DN 80 to 1500)

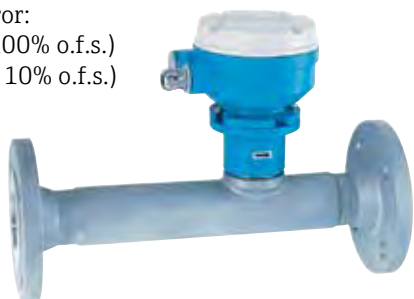


## For demanding gas applications

### t-mass F

Inline version

- For t-mass 65 transmitter
- Max. measured error:  
±1.5% o.r. (10 to 100% o.f.s.)  
±0.15% o.f.s. (1 to 10% o.f.s.)
- Process pressure:  
PN 16 to 40
- -40 to +212°F  
(-40 to +100°C)
- ½" to 4"  
(DN 15 to 100)



### t-mass I

Insertion version

- For t-mass 65 transmitter
- Suitable for large pipelines and rectangular ducts
- Max. measured error:  
±1.5% o.r. (10 to 100% o.f.s.)  
±0.15% o.f.s. (1 to 10% o.f.s.)
- Process pressure: -7.25 to 290 psig  
(-0.5 to 20 bar g)
- -40 to +266°F (-40 to +130°C)
- 3" to 60" (DN 80 to 1500)



### Flexible installation

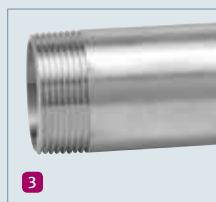
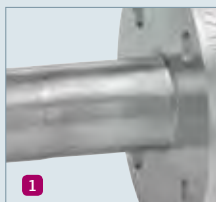
Whether in rectangular ventilation ducts or in pipes – t-mass sensors are always the perfect fit. For installation, both inline and insertion versions in various nominal diameters are available:

#### Inline version

- 1 With flange (t-mass A and F)
- 2 With lap-joint flange (t-mass A)
- 3 With external thread (t-mass A)

#### Insertion version

- 4 Suitable for pipelines or rectangular ventilation ducts up to 60" (DN 1500)
- 5 Optionally with "hot tap" mounting tool for inserting or removing the sensor under operating conditions:
  - For recalibration
  - For certification
  - For service purposes
  - For mobile use



# t-mass – transmitters

## t-mass 65

For demanding applications

- For t-mass F and I sensors
- Two-line, backlit display with three push buttons
- Free selection of up to 20 gases, including gas mixtures with up to 8 components (e.g. digester gas)
- Display/outputs for flow and temperature
- Worldwide recognized Ex approvals
- System integration via PROFIBUS DP, PROFIBUS PA, Modbus RS485, FOUNDATION Fieldbus
- Switch and/or relay output for alarm messages
- Totalizer functions
- Current input for reading external measured variables (e.g. pressure, gas concentration)



### Intelligence in operation

Gas programming made easy

Depending on pressure and temperature, gases change their volume and their specific properties such as operating density, heat capacity or viscosity. Converting operating volume to standard volume is highly labor-intensive and inconvenient. With the t-mass transmitter's integrated "Gas Engine" function, and an automatic temperature and pressure compensation, gases and gas mixtures can now be measured highly reliably:

- 20 freely selectable gases (4 gases for t-mass 150)
- 2 gas mixtures with up to 8 user-definable components (t-mass 65)
- Toggling between 2 gas mixtures (t-mass 65)
- Programmed gases can be changed at any time (without recalibration)



## t-mass 150

For basic applications (cost-effective measurement)

- For t-mass A, B and T sensors
- Easy-to-understand, four-line display with three push buttons
- Display/outputs for flow and temperature
- Free selection of up to 4 gases
- Switch and/or relay output for alarm messages
- Totalizer functions

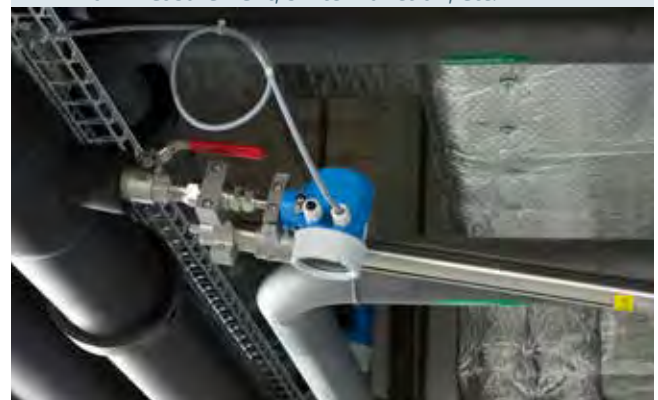


## t-mass T 150

For simple liquid flow monitoring

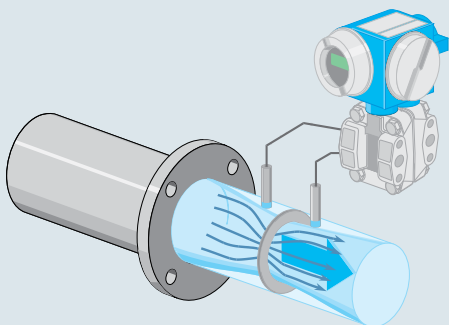
Many industrial processes and utilities require reliable measurement, monitoring and control of liquid flows. Proline t-mass T 150 works according to the thermal measuring principle and measures all aqueous fluids, for example cooling water, heating water, demineralized water (condensate), industrial water, WFI water, irrigation water or fluids in the wastewater area:

- Independent of the electrical conductivity
- Fast commissioning via the local display
- Compact insertion version (1½" to 40"/DN 40 to 1000)
- Standard or hygienic version (3-A, EHEDG)
- Maintenance-free, no moving parts
- Wide variety of applications: monitoring, flow measurement, switch function, etc.



# Differential-pressure flowmeters

**Deltatop** – universally applicable measurement technology for liquids, gases and steam even under extreme process conditions up to 6,090 psi (420 bar) and 1,832°F (1000°C).



## Measuring principle

In pipelines there is a direct relationship between the cross-sectional area, the pressure and the speed of a flowing fluid.

## Orifice plate, nozzle, Venturi tube

The measuring tubes of these differential-pressure flowmeters have an artificial constriction. As soon as the fluid starts moving, the natural laws governing the mechanics of flow dictate that pressure upstream of the constriction increases, to drop again immediately downstream of the constriction. This difference in pressure provides a measure of the flow rate.

## Pitot tube

This method uses a rod-shaped sensor. This sensor has a series of leading and trailing pressure-tapping ports. The upstream, leading array registers dynamic pressure and static pressure, the trailing array registers only static pressure. The pressure differential is a measure of the velocity and flow rate.

## Advantages at a glance

- Universally applicable for liquids, gases and steam
- Worldwide recognized standards (since 1929)
- Long measurement tradition and high acceptance
- For extreme conditions up to 6,090 psi (420 bar) and 1832°F (1000°C)
- Robust primary elements that are purely mechanical and without moving parts
- Wide nominal diameter range:
  - Restriction type devices: 3/8" to 40" (DN 10 to 1,000)
  - Pitot tube: up to DN 12,000 (optionally)
- Transmitter exchange without process interruption

Differential-pressure flowmeters can be used on a broad basis to measure the flow of liquids, gases and steam. The pool of empirical data is large and has been incorporated into numerous standards. Consequently, this method of measurement is accepted around the world and its use is very common. Metering in hot-water and cooling systems and metering steam and condensate at very high temperatures in secondary systems remain the primary application.

Pitot tubes are a viable alternative to orifice plates where low pressure losses are required and when flow has to be measured in large-diameter pipes (up to several inches). The transmitters in differential-pressure systems can be removed and replaced without the process having to be interrupted.



Measuring principle movie

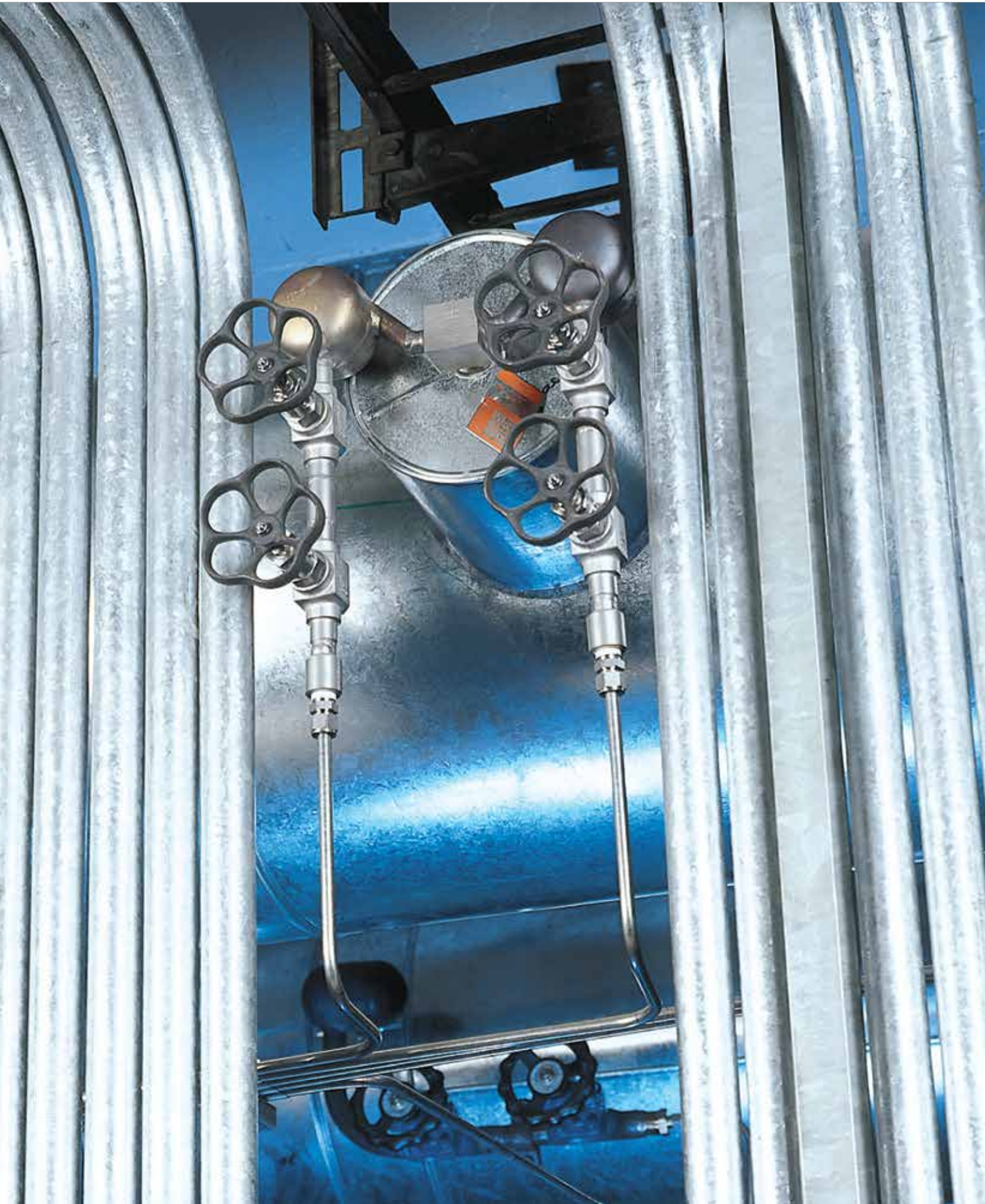
[http://youtu.be/D6sbzKq3\\_c](http://youtu.be/D6sbzKq3_c)



Measuring principle movie

<http://youtu.be/oUd4WxjoHKY>





# Deltatop – sensors

The sensors are orifice plates (DO) or Pitot tubes (DP), available in different designs and with a choice of process connections. Accuracy: typically  $\pm 1$  to 3% of rate.

## Compact version

Primary element and transmitter form a single mechanical unit. Every Deltatop flowmeter is completely assembled with a primary element, manifold, condensate chamber (for steam) and a Deltabar transmitter – ready for commissioning.

- Standard orifice: 1" to 40" (DN 25 to 1000)
- Flanged orifice: 1" to 24" (DN 25 to 600)
- Meter run (calibrated):  $\frac{3}{8}$ " to 2" (DN 10 to 50)



DO71W

- Orifice with flange tapping (to DIN 19214 Part 1 or ANSI 1636)
- Up to 40"



DO75F

- Meter run
- $\frac{1}{2}$ " to 2"



DP7XB

- Pitot tube
- 2" to 21"

## Remote version

Impulse lines (installed by customer) connect the primary element and the remotely installed transmitter. Deltatop is a modular flow measuring point consisting of a primary element, shut-off valves, optional condensate chambers (for steam) and a Deltabar transmitter with a manifold. Deltatop is factory- configured and supplied fully pre-assembled.

- For temperatures up to 930°F/500°C (with standard materials) or 1832°F/1000°C (with special materials)
- For process pressures up to 6000 psi (420 bar)



DO71W

- Orifice with flange tapping (to DIN 19214 Part 1 or ANSI 1636)
- Up to 40"



DP7XB

- Pitot tube
- 2" to 21"

## Deltatop DN

Nozzles

- Standardized as per ISO 5167
- Little pressure loss
- Also for higher flow velocities
- 2" to 20" (DN 50 to 500)



## Deltatop DV

Venturi tubes

- Standardized as per ISO 5167
- Available as welded-in or flanged version
- Little pressure loss
- Unaffected by dirt
- Unaffected by abrasion
- 2" to 80" (DN 50 to 2000)



## Accessories

Various accessories and fittings are available for the remote version, with a wide choice of materials and designs.



Block and bleed valves



ASME Manifolds



Condensate chambers



# Deltatop – transmitters

## Deltabar M (PMD55)

For all standard applications

- Compact transmitter
- Four-line display, operation via push buttons
- Transmitter in two-wire technology
- Fast commissioning via DIP switches
- Easy, secure and menu-guided operation
- Digital communication: HART, PROFIBUS PA, FOUNDATION Fieldbus



## Deltabar S (PMD70/PMD75)

For demanding measuring tasks

- Function-monitored from measuring cell to electronics
- Retrofitted HistoROM/M-DAT memory module for data duplication or cyclic data recording
- Extensive diagnostic functions
- Quick commissioning with Quick Setup menu
- Digital communication: HART, PROFIBUS PA, FOUNDATION Fieldbus
- Functional Safety to IEC 61508 up to SIL 3



### Robust and customized

Orifice plates are widely used and easy to install. The other primary elements available from Endress+Hauser are also used in nearly all applications and industries.

In addition to orifice plates, our product line includes Pitot tubes, nozzles and Venturi tubes with little pressure loss, as well as special designs for difficult fluids or bidirectional measurement.

Because primary elements are extremely robust, work entirely mechanically and do not have any moving parts, they can be made of almost any material and be used even in highly demanding applications. The broad spectrum includes primary elements made of plastic for chemically aggressive fluids, versions for steam or hydraulic oil up to 6090 psi (420 bar), and models for gas measurement at extremely high temperatures up to 1832°F (1000°C) and higher.

Different constriction diameters make it possible for all of these designs to match both the pressure loss and the differential pressure optimally to the process conditions.



A great advantage is that differential-pressure transmitters can be exchanged at any time without interrupting the process. They can be easily isolated from the process by means of shut-off valves or a manifold installed in the impulse lines.





# Seamless system integration

Greater transparency through added information – only digital signal transmission enables device and process data to be transmitted and used simultaneously. Therefore, Endress+Hauser flowmeters are available with all state-of-the-art fieldbus technologies.

In many process facilities, data transmission between measuring devices/actuators and higher-level automation systems still uses analog signals. This fact significantly limits the amount of information that can be transferred. However, most modern field devices are equipped with fieldbus technology and offer the user a vast assortment of information. State-of-the-art and multifunctional flowmeters like those from Endress+Hauser do not just monitor their

own functional capability but also what is going on in the process. The associated benefits associated with this are obvious:

- Simplified maintenance through advanced diagnostics
- More efficient process control and high product quality
- Optimized plant availability due to fewer idle times
- Maximum process reliability



Endress+Hauser's fieldbus laboratory in Reinach (CH)

## Additional advantages

Fieldbuses have many other properties, offering users more cost efficiency and enhanced dependability:

- Greater flexibility in production due to improved plant productivity
- Access to all important process data at any time
- Devices can easily be replaced even in hazardous areas
- Intrinsically safe fieldbus technology for hazardous areas
- Lower cabling costs due to savings on materials and installation
- Heavily reduced costs for commissioning due to simplified loop check

## Fieldbus technology at Endress+Hauser

Endress+Hauser only uses internationally recognized, open standards for digital communication for its field devices. This ensures seamless integration into a plant and guaranteed investment protection. Various communication systems that Endress+Hauser also supports have become established in the area of process automation:

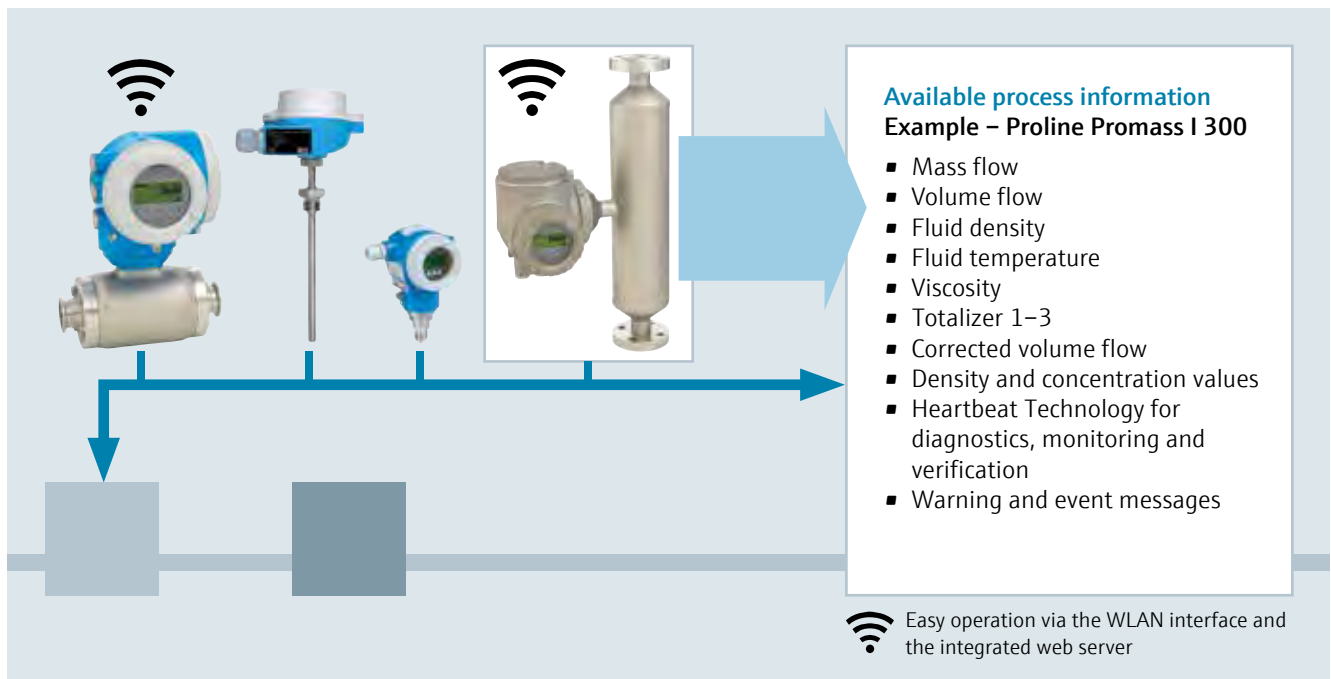
- HART 7 ■ Modbus RS485 ■ EtherNet/IP
- PROFIBUS DP/PA ■ FOUNDATION Fieldbus ■ PROFINET

Endress+Hauser is one of the pioneers of fieldbus technology. The company plays a leading role in the implementation of HART, PROFIBUS DP/PA and FOUNDATION fieldbus technology. Endress+Hauser operates its own fieldbus laboratory in Reinach (CH):

- Accredited PROFIBUS and PROFINET Competence Center
- Engineering of fieldbus networks ■ System integration testing
- Training courses, seminars ■ Customer service



Endress+Hauser ensures full access to all device and diagnostic information via process control and asset management systems.



**HART**  
COMMUNICATION PROTOCOL

**PROFIBUS**

**FOUNDATION**

**Modbus**

EtherNet/IP

**PROFINET**

# W@M – Life Cycle Management

Complete and instantly available device information is a key to any successful production plant operation. Endress+Hauser's W@M Life Cycle Management, is an intelligent information platform designed to support you end-to-end throughout your facility's life cycle.

Data for actuators and sensors is continuously generated when designing and procuring components, during installation and commissioning, and finally during operation and maintenance. This information can be retrieved worldwide with W@M Life Cycle Management – wherever and whenever you want. Your benefits: Increased process reliability and product quality around the clock. With W@M Life Cycle Management, service technicians receive quick and targeted assistance in the event of disruptions or during maintenance:

W@M Life Cycle Management ...

- is an open information system based on intranet and internet technology
- brings together software, products and services from Endress+Hauser
- ensures the worldwide availability of equipment and plant data
- puts an end to time-consuming searches for device information in archive



## Plant Asset Management (W@M Portal)

- Worldwide requesting/ordering of spare parts, software versions, device data, documentation, etc.
- Managing the installed base

## Configuring/parameterizing devices

- With FieldCare (software for Plant Asset Management)
- With Field Xpert (handheld terminal)
- Quick local operation thanks to the integrated **web server (WLAN)** and uniform **operating concept**
- Quick restoration of device data and firmware in case of service (**HistoROM**)

## Calibration management

- CompuCal: Software for the administration of maintenance and calibration tasks
- Device on-site verification with FieldCheck (test instrument) or **Heartbeat Verification** (device function). Remote Heartbeat verification services with verification reports available online.

➔ **Proline** ▶ Page 6 to 9

[www.us.endress.com/wam](http://www.us.endress.com/wam)

## Defining products

- Selecting, sizing and documenting measuring instruments using "Applicator"
- Project documentation

## Configuring products

- Generating product codes with the "Product Configurator"
- Customer-specific pre-configuration
- Download function for CAD drawings

## Finding spare parts

- With the Spare Part Finder (SPF)



## Finding documentation quickly

Downloadable online in multiple languages via "Device Viewer" or the "Operations App":

- Technical information brochures
- Operating manuals
- Approvals
- Calibration certificates, etc.

## Ordering online

- Ordering standard products, services and spare parts
- Pricing information
- Delivery times
- Order status and shipping status





### Selecting the right device

Applicator is a proven selection and sizing program from Endress+Hauser. Applicator has been built around 30 years of industry experience and expert knowledge:

- Targeted product search by measuring task, measured variable, approvals, process data, communication, etc.
- Dependable sizing without specialized knowledge
- Display and depiction of important parameters such as optimal nominal diameter, pressure loss, etc.
- Direct link to Product Configurator and online shop
- Cost-saving administration and documentation of plant projects (project module)
- Language versions: English, German, French, Spanish, Russian, Chinese and Japanese



### Operations App

The Operations App from Endress+Hauser offers fast access to the latest product information bulletins and device details, including order codes, availability, spare parts, successor products and general product information – wherever you are, whenever you need the data. Just key in the serial number or scan the 2D code or RFID TAG on the device to download the information.



Applicator online version / Newsletter:  
<http://www.us.endress.com/applicator>



### Calibration management

In certain industries, measuring devices have to be serviced regularly due to regulations or internal directives. This also includes recalibrating quality-critical measuring points within the installed base. CompuCal is a program that provides optimal assistance in this process:

- Planning, monitoring and documenting calibration, inspection and maintenance cycles
- Complete traceability in conjunction with the test equipment used by Endress+Hauser
- Comprehensive, global data access thanks to web-based software
- Conforms completely to FDA 21 CFR Part 11 – Electronic Records; Electronic Signatures Validation

### Easy commissioning and maintenance

The modular FieldCare software from Endress+Hauser provides users with an extensive toolset for field support of their measuring points (Plant Asset Management).

#### Basic functions

- Configuring and commissioning via fieldbuses or service interface
- Detecting and rectifying errors
- Documenting measuring points (data printout/export)
- Comparing measuring point parameters (set/actual value)
- Backing up/archiving data (upload/download)

#### Expansion functions

- Presenting the measured values graphically
- Calling up service functions
- Monitoring diagnostic data
- Evaluating verification results



## Global calibration concept

“Consistently high measurement quality for customers around the world” – According to this motto, all flowmeters from Endress+Hauser are subjected to strict quality checks, and are tested, calibrated and adjusted on the world’s most state-of-the-art calibration rigs.

Long-term stability and guaranteed, traceable accuracy are essential aspects of flow metering for users. They are pre-requisites for precise, dependable, cost-effective controlling and batching, and for substance cost allocation in custody transfer applications, for example.

For over 35 years, we have developed and built high-tech calibration rigs to document the accuracy of our devices in a reliable and traceable manner. There is one motto that stands above the others: “Consistently high measurement quality for our customers around the world.” Based on this philosophy, we have developed a global calibration concept that offers our customers maximum confidence and security:

- Calibration service in more than 40 countries
- Worldwide accreditation of all flow calibration rigs
- Periodic inspection by national accreditation agencies (e.g. A2LA)
- Complete traceability to national standards in accordance with ISO/IEC 17025 (e.g. NIST, CN, PTB, METAS, NPL, LNE)
- Continuous transfer of knowledge through internal and external training
- Identically designed high-tech calibration rigs



Accreditation A2LA certificate





#### Accredited calibration services

In many production facilities, flowmeters are in permanent operation under the harshest of conditions. Depending on the application and required accuracy, these devices have to be calibrated or verified on a regular basis. Consequently, Endress+Hauser offers its customers a comprehensive calibration service. This service is also available for other manufacturers' flowmeters.

#### On-site verification

- Via Heartbeat Technology  
(integrated device functionality ► page 7)
- Via ultrasonic clamp-on flow sensors
- Via FieldCheck (flowmeter testing/simulation device)

#### Mobile on-site calibration

- Calibration of the device under test directly on site at the customer
- A mobile and accredited calibration rig with traceable calibrated Coriolis measuring devices is used as the reference standard

#### Factory calibration

- "As found" calibration:
  - The flowmeter is calibrated but not adjusted
  - With calibration protocol
- "As left" calibration:
  - The flowmeter is calibrated and adjusted
  - With calibration protocol
- Calibration with certificate:
  - Fully traceable calibration according to ISO/IEC 17025 on an accredited calibration rig (three/five measuring points)









### World's most accurate production calibration facilities

Measurement accuracy is crucial when dealing with expensive fluids. Endress+Hauser has developed the world's most accurate production calibration facility. Through the "PremiumCal" calibration, Coriolis mass flowmeters can be calibrated to an accuracy of +0.05% on fully traceable production calibration rigs (ISO 17025). This is equivalent to the contents of a single champagne glass per one thousand liters of water. In addition, our Gulf Coast Calibration and Service Center, located near Houston, Texas, is also one of the most accurate flow calibration laboratories in the U.S., performing calibrations in compliance with ISO 17025 and A2LA accreditation. On-site calibration is also offered via our mobile trailers equipped with portable flow rigs.



### Maximum precision under constant measuring conditions

Only stable measuring conditions ensure dependable calibration accuracy. This is particularly true when large flowmeters with nominal diameters up to 94" (2.4 meters) are calibrated. Therefore, the largest calibration rig operated by Endress+Hauser for this purpose in Cernay, France, works with a 92 ft. (28-meter) tall water tower that offers the following advantages:

- Uniform and constant water flow
- Constant pressure conditions for the device under test
- No flow pulsation caused by pumps
- No additional measuring uncertainty caused by level measurement
- Any measuring duration possible, e.g. for verifying the long-term behavior of flowmeters at certain calibration points

Flow rates from a few gallons up to more than 1.5 million gallons per hour can be measured for the calibration – with consistently high accuracy.



### Calibration with air

Our air calibration facilities set completely new conceptual and technological standards. Several adapter revolvers enable a rapid and precise positioning of the devices under test into the measurement section (½" to 4"/DN 15 to 100). The measurement sections themselves are equipped with a battery of instruments and each section incorporates a fully automated leak tester. Flow rates from 0.11 lbs/hr to 22,046 lbs/hr (0.05 kg/h to 10 000 kg/h) can be measured with a measuring uncertainty of better than ±0.3%. Reference master meters such as critical-nozzle, rotary-piston and gas turbine meters ensure maximum repeatability. A special air-conditioning system keeps the air in the calibration room at exactly 75.2°F (24°C) and 40% relative humidity – day and night.

It comes as no surprise, therefore, that this commercial calibration facility measures air flows with one of the highest measuring accuracies in the world!



Calibration movie

<http://youtu.be/IPh4afkWM84>



## Service and support the smart way

Only production plants that run properly, guarantee financial success. Endress+Hauser's Sales and Service Centers ensure you are always up and running. We are always close at hand, no matter where you are



### Consulting and planning

Highly skilled technicians, engineers and application consultants support you on site to find the best solution for your application in terms of technology and budget. For sizing measuring points, you can also benefit from our Applicator software, which has proven its value for decades. It includes an engineering tool for managing measurement and control projects.

### Service

Do you need some fast advice on the phone, or support for a maintenance schedule? The Sales and Service Centers not only provide support in emergencies, they also maintain a help desk and provide spare parts and consumables whenever and wherever you need them. The individual services at your disposal include:

- Commissioning and configuration
- Inspection and maintenance (service contracts)
- Factory or on-site calibration according to ISO 17025
- Repair service, spare parts, conversion kits
- Technical Support: 888-ENDRESS (888-363-7377)

### Factory witness testing

Customer satisfaction is a keynote issue for Endress+Hauser. So we offer a tailored inspection service on request. You can come to our factory and see for yourself that the meters ordered are produced to your specification and are complete, and that they leave our plant in perfect condition. You also have the option to be represented by the plant engineering company or an inspection agency such as TÜV, Lloyds, SVTI, Bureau Veritas or SGS. Examples of the tests carried out in your presence include:

 For more information on calibration, visit:  
[www.us.endress.com/calibration](http://www.us.endress.com/calibration)





PTU® (Process Training Unit)

- Hydrostatic pressure testing
- Insulation testing for Hazardous Area devices
- Visual inspection: specifications, documentation, process connections, materials and acceptance-test certificates, etc.
- Check of measuring accuracy
- Metrological audits
- Performance tests
- Verification of analog/digital communication

### Documentation

Our device documentation contains all the important information you need for commissioning and operation, such as installation and safety instructions, wiring diagrams, function descriptions and many other resources. Endress+Hauser also publishes technical books and basic information on a very wide range of topics associated with industrial instrumentation.

### Training and information

Being informed means being confident. We organize training courses and seminars to pass on our expertise to you:

- Industry seminars
- Service seminars
- Specialist seminars
- Workshops
- Technology forums
- Introductory seminars
- Special-interest subjects

Endress+Hauser's unique PTU® (Process Training Unit) network provides our customers hands-on experience with the types of operation, diagnostics and troubleshooting found in process plants.

 For more information on our PTUs, visit:  
[www.us.endress.com/ptu](http://www.us.endress.com/ptu)





Find more information on our flow measurement instruments:

[www.us.endress.com/flow](http://www.us.endress.com/flow)



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