Measurement made easy

Orifice-based flow metering made simple

Integrated DP flow measurement system, pressure tested as an assembly
— combines primary element with DP transmitter in a single flowmeter assembly

Mass flow version with optional, integral temperature element
— integral multivariable transmitter and RTD for direct reading of mass (liquids and steam) and corrected volume (gas) flowrates in a single unit

Plugged impulse line detection
— detects partial or complete blockage of DP connections
— provides warnings visually and via outputs

Integrated impulse connections
— no impulse piping installation required
— provides repeatable DP connection across installation locations

Reduced installation costs
— only one piece to install
— eliminates need to supply and connect separate manifold, transmitter and impulse piping

Easy to specify and maintain
— single ordering code covers complete flowmeter
— only two orifice ratios for simple specification process
— optional replaceable orifice plates offer easy, economic maintenance and flexibility for changing process conditions

New ‘through-the-glass’ (TTG) keypad technology
— enables quick and easy local configuration without the need to open the cover – even in hazardous areas

Factory acceptance report
— supplied with report detailing results of critical inspection checks, plus certification data
OriMaster FPD500
Compact orifice flowmeter

OriMaster – the one-piece DP flowmeter

OriMaster is a stand-alone orifice-based flowmeter with a difference – its advanced design greatly simplifies installation and commissioning.

OriMaster incorporates the following features:
— A wafer-bodied orifice carrier assembly with integral square-edged, concentric plate and corner tapping points
— Integral 3-valve manifold (optional 5-valve manifold available)
— Integral direct connections between the carrier tappings and manifold
— DP transmitter, factory-mounted onto the manifold and pre-configured for the application
— Fully leak-tested and configured

Benefits

OriMaster avoids many of the difficulties involved in the sizing, selection, procurement, installation and commissioning of conventional orifice plate installations.
— With all the major components in one assembly, OriMaster eliminates the problems of sourcing multiple components. Provides large savings in cost and time due to the simplicity of design and installation.
— Integral transmitter and manifold with compact tapping connections eliminates the need to run and connect impulse piping and offers:
— guaranteed accuracy of positioning and installation of the tapping points
— reduced possibility of impulse line blockage
— The assembly is pressure-tested in the factory, giving the user confidence that the connections between the tapping points and the transmitter are completely free of leaks
— Factory configuration of the meter saves the user time during commissioning and ensures that the flowmeter output span truly matches that of the application flowrate
— Choice of two discrete Beta ratio values, together with the free sizing, selection and coding software, simplifies the sizing and selection process
— Optional design with replaceable orifice plates enables low-cost repair or, when process conditions change, re-ranging of the meter
— Element centralizing system ensures every meter is concentric with its pipe, thus avoiding significant additional metering errors
— New ‘through-the-glass’ (TTG) keypad technology enables meter configuration without terminals and with no need to remove the transmitter covers
Basic principle of operation

DP devices work on a principle based upon the Law of Conservation of Energy, where a restriction in the fluid path causes an acceleration in the fluid velocity with a corresponding increase in kinetic energy. The gain in kinetic energy is at the expense of pressure energy, resulting in a drop in fluid pressure across the narrowest part of the restriction. The drop in pressure and the flow rate are linked by the following (simplified) relationship:

\[ Q = k \sqrt{DP} \]

where
- \( Q \) = fluid flow rate
- \( k \) = a constant for that DP device
- \( DP \) = the pressure difference across the restriction

The DP generated for a given class of device depends on the bore of the restriction. Many calculation standards exist but in all cases the differential pressure produced by the restriction is larger than would normally be expected. This effect occurs because a stream is unable to follow the contours of a restriction perfectly, resulting in a flow stream whose narrowest diameter (known as the Vena Contracta) is less than the diameter of the restriction.

The Vena Contracta increases the velocity (and therefore the kinetic energy) and this produces a larger drop in pressure than would normally be expected. Some of the differential pressure generated is recovered downstream of the meter but all DP devices incur some loss, known as the 'irrecoverable pressure loss'; this is usually expressed as a percentage of the differential pressure.

To correct for the Vena Contracta effect, each device has a Discharge Coefficient; a multiplying factor of less than 1 that is part of the calculation. Typically, the smaller the Vena Contracta compared with the bore of the device, the larger the deviation from expectations and hence the smaller the coefficient.

Fig. 1: DP and Vena Contracta
Versions

OriMaster is available in two versions:

**OriMaster V** – a compact flowmeter for general purpose measurement in volumetric units (actual volume). OriMaster V uses the ABB 364 or 266 DP transmitter to provide a flow rate and total display and a 4 to 20 mA output proportional to the actual volume flowrate. The transmitter case and meter body are all in stainless steel as standard when the 364 transmitter is fitted. 316 stainless steel transmitter cases are also available.

There are 5 DP sensor ranges available. For optimum accuracy select the sensor so that the full scale DP is in the shaded area and as close as possible to the maximum range of the sensor – see Table 1.

### Table 1: OriMaster V full scale DP application range

<table>
<thead>
<tr>
<th>Sensor code</th>
<th>2 (0.8)</th>
<th>40 (16)</th>
<th>160 (64)</th>
<th>400 (160)</th>
<th>650 (260)</th>
<th>1600 (642)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 2: OriMaster V – volumetric flowmeter with 364 transmitter

Fig. 3: OriMaster V – volumetric flowmeter with removable orifice plate and 266 transmitter
OriMaster M – a compact flowmeter, providing measurement directly in mass units for liquids and steam. Gas flow is measured directly in reduced volume units. OriMaster M uses the ABB 267 multivariable transmitter to measure DP, temperature and pressure, providing a flowrate display and a 4 to 20 mA output proportional to the mass or corrected volume flowrate. The body is stainless steel and the case is alloy (stainless steel optional). An optional internal temperature element is available.

There are 3 DP sensor ranges available. For optimum accuracy select the sensor so that the full scale DP is in the shaded area and as close as possible to the maximum range of the sensor – see Table 2.

<table>
<thead>
<tr>
<th>Sensor code</th>
<th>10 (4)</th>
<th>60 (24)</th>
<th>400 (160)</th>
<th>2500 (1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: OriMaster M full scale DP application range
Specifying – general

Fluids
Liquids, gases and saturated steam

Line sizes
25, 40, 50, 80, 100, 150, 200, 250 and 300 mm
(1, 1 1/2, 2, 3, 4, 6, 8, 10 and 12 in.)

Output signal
— Two-wire, 4 to 20 mA, selected for square-root output
— Low flow cut-off facility
— HART® communication provides digital process variable
  (% , mA or engineering units) superimposed on 4 to 20 mA signal, with protocol based on Bell202 FSK standard
— Optional Profibus PA, Foundation Fieldbus or Modbus communications (OriMaster M only)

Output current limits (to NAMUR standard)

Overload condition
Lower limit:
— 3.8 mA (configurable from 3.7 to 4 mA)

Upper limit:
— 20.5 mA (configurable from 20 to 22.5 mA)

Alarm current
Minimum alarm current:
— 3.8 mA (configurable from 3.7 to 4 mA)

Maximum alarm current:
— 22 mA (configurable from 20 to 22.5 mA)

Standard setting:
— maximum alarm current

Power supply
— The meter operates from 10.5 to 45 V DC with no load and
  is protected against reverse polarity connection (additional
  load allows operations over 45 V DC)
— For EEx ia and other intrinsically safe approvals, the power
  supply must not exceed 30 V DC. Minimum operating
  voltage is 14 V DC with backlit display

Load limitations
— \( R(k) = \frac{\text{Supply voltage} - \text{min. operating voltage (V DC)}}{22.5} \)
— A minimum of 250 is required for HART communication

Optional indicators

OriMaster V integral display
— Wide-screen LCD, 128 x 64 pixel, 52.5 x 27.2 mm
  (2.06 x 1.07 in.) dot matrix
— 4 keys for device configuration and management.
— Easy setup for quick commissioning
— Totalized and instantaneous flow indication
— Display also indicates in/out transfer function, static
  pressure, sensor temperature and diagnostic messages and
  provides configuration facilities

OriMaster M integral display
2-line, 6-character, 19-segment alphanumeric display with
additional bar-chart display. Back illumination optional.
User-specific display, percentage of the output current, output
current in mA or process variable. Diagnostic messages, alarms, measuring range infringements and changes in the
configuration are also displayed.
**Wetted materials**

**Orifice assembly, stem and manifold**
316L stainless steel

**Transmitter sensor housing**
OriMaster V:
- Aluminum alloy (266DSH transmitter)
  (316L stainless steel optional)
- 304L stainless steel (364DS transmitter)
  (316L stainless steel optional)

OriMaster M:
- Aluminum alloy
  (316L stainless steel optional)

**Process isolating diaphragms**
Hastelloy C276 (NACE)

**Seals**
Transmitter to manifold:
- PTFE

Manifold:
- Graphite, PTFE

**Process connections**

**Wafer body to fit between the following flange drillings**
- ASME B16.5 (ANSI) Class 150, 300 or 600
- DIN PN16, PN25, PN40 or PN100

Pipeline centralization assured by centralizing tool(s) supplied with every unit as standard

**Pressure limitations**
100 bar (1450 psi) or as flange rating, whichever is the lower

**Temperature limitations**

**Process**
- –20 to 121 °C (–4 to 250 °F)
- –20 to 230 °C (–4 to 446 °F) for steam applications

**Ambient**
–20 to 70 °C (–4 to 158 °F)

**Note.** LCD display may not be clearly readable below
–20 °C (–4 °F) or above 70 °C (158 °F)

M1, M3: –40 and 85 °C (–40 and 185 °F)

V1, V3: Sensors A, B: –25 and 85 °C (–13 and 185 °F)
  Other sensors: –40 and 85 °C (–40 and 185 °F)

V2, V4: Sensors A to E incl: –25 and 85 °C (–13 and 185 °F)
  Other sensors: –40 and 85 °C (–40 and 185 °F)
Orifice plate bore at 20 °C (68 °F):

For Beta = 0.4

- 25 mm (1 in.) 10.66 mm (0.42 in.)
- 40 mm (1 1/2 in.) 16.36 mm (0.644 in.)
- 50 mm (2 in.) 20.99 mm (0.826 in.)
- 80 mm (3 in.) 31.17 mm (1.227 in.)
- 100 mm (4 in.) 40.90 mm (1.610 in.)
- 150 mm (6 in.) 61.63 mm (2.426 in.)
- 200 mm (8 in.) 81.10 mm (3.193 in.)
- 250 mm (10 in.) 101.8 mm (4.008 in.)
- 300 mm (12 in.) 121.29 mm (4.775 in.)

For Beta = 0.65

- 25 mm (1 in.) 17.32 mm (0.682 in.)
- 40 mm (1 1/2 in.) 26.58 mm (1.047 in.)
- 50 mm (2 in.) 34.11 mm (1.343 in.)
- 80 mm (3 in.) 50.65 mm (1.994 in.)
- 100 mm (4 in.) 66.47 mm (2.617 in.)
- 150 mm (6 in.) 100.15 mm (3.942 in.)
- 200 mm (8 in.) 131.78 mm (5.188 in.)
- 250 mm (10 in.) 165.43 mm (6.501 in.)
- 300 mm (12 in.) 197.1 mm (7.76 in.)

Weight in kg (lb) (approximately)

<table>
<thead>
<tr>
<th>Size</th>
<th>Typical Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>9.5 (21)</td>
</tr>
<tr>
<td>40 mm (1 1/2 in.)</td>
<td>10 (22)</td>
</tr>
<tr>
<td>50 mm (2 in.)</td>
<td>10.5 (23)</td>
</tr>
<tr>
<td>80 mm (3 in.)</td>
<td>11.5 (25.3)</td>
</tr>
<tr>
<td>100 mm (4 in.)</td>
<td>12 (26.5)</td>
</tr>
<tr>
<td>150 mm (6 in.)</td>
<td>14 (31)</td>
</tr>
<tr>
<td>200 mm (8 in.)</td>
<td>16 (35.3)</td>
</tr>
<tr>
<td>250 mm (10 in.)</td>
<td>19 (42)</td>
</tr>
<tr>
<td>300 mm (12 in.)</td>
<td>21.5 (47.4)</td>
</tr>
</tbody>
</table>

Upstream straight pipe requirements to ISO 5167:2003

<table>
<thead>
<tr>
<th>Fitting</th>
<th>β = 0.4</th>
<th>β = 0.65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conical reducer (2D – D)</td>
<td>5D</td>
<td>12D</td>
</tr>
<tr>
<td>Conical expander (0.5D – D)</td>
<td>12D</td>
<td>28D</td>
</tr>
<tr>
<td>Single 90° bend</td>
<td>16D</td>
<td>44D</td>
</tr>
<tr>
<td>2 off 90° bends in same plane</td>
<td>10D</td>
<td>44D</td>
</tr>
<tr>
<td>2 off 90° bends in different plane</td>
<td>50D</td>
<td>60D</td>
</tr>
</tbody>
</table>

Where D = pipe diameter

Vibration limits to IEC60068-2-6

Maximum pipe vibration level

<0.5g over frequency range 10 to 500 Hz
Performance
System accuracy at reference conditions (for Re > $10^5$)

Uncalibrated

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>% Vol. flow rate</th>
<th>Size in mm (in.)</th>
<th>% Mass flow rate</th>
<th>25 to 40 (1 to 1½)</th>
<th>50 to 200 (2 to 8)</th>
<th>25 to 40 (1 to 1½)</th>
<th>50 to 200 (2 to 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OriMaster V</td>
<td>0.4</td>
<td>2</td>
<td>1.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.65</td>
<td>1.5</td>
<td>1.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OriMaster M</td>
<td>0.4</td>
<td>2</td>
<td>1.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.65</td>
<td>2</td>
<td>1.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For a combination of Re < $10^5$ and Beta = 0.65, add 0.5 %

Calibrated
ABB standard water calibration (3 points over a 5:1 flow range)
System accuracy:
— ± 1 % of flowrate

Repeatability
OriMaster V:
— 0.1 %

OriMaster M:
— 0.1 %

Turndown
OriMaster V:
— up to 8:1

OriMaster M:
— up to 8:1
Specification – OriMaster V

**DP span**

<table>
<thead>
<tr>
<th>Sensor code</th>
<th>Upper range limit (URL)</th>
<th>Minimum span</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>4 kPa</td>
<td>0.2 kPa</td>
</tr>
<tr>
<td></td>
<td>40 mbar</td>
<td>1.4 mbar</td>
</tr>
<tr>
<td></td>
<td>16 in. H₂O</td>
<td>0.56 in. H₂O</td>
</tr>
<tr>
<td>E</td>
<td>16 kPa</td>
<td>0.54 kPa</td>
</tr>
<tr>
<td></td>
<td>160 mbar</td>
<td>1.6 mbar</td>
</tr>
<tr>
<td></td>
<td>64 in. H₂O</td>
<td>0.65 in. H₂O</td>
</tr>
<tr>
<td>F (266DSH only)</td>
<td>40 kPa</td>
<td>0.4 kPa</td>
</tr>
<tr>
<td></td>
<td>400 mbar</td>
<td>4 mbar</td>
</tr>
<tr>
<td></td>
<td>160 in. H₂O</td>
<td>1.6 in. H₂O</td>
</tr>
<tr>
<td>G</td>
<td>65 kPa</td>
<td>0.65 kPa</td>
</tr>
<tr>
<td></td>
<td>650 mbar</td>
<td>6.5 mbar</td>
</tr>
<tr>
<td></td>
<td>260 in. H₂O</td>
<td>2.6 in. H₂O</td>
</tr>
<tr>
<td>H</td>
<td>160 kPa</td>
<td>1.6 kPa</td>
</tr>
<tr>
<td></td>
<td>1600 mbar</td>
<td>16 mbar</td>
</tr>
<tr>
<td></td>
<td>642 in. H₂O</td>
<td>6.4 in. H₂O</td>
</tr>
<tr>
<td>L (364DS only)</td>
<td>250 kPa</td>
<td>2.5 kPa</td>
</tr>
<tr>
<td></td>
<td>2500 mbar</td>
<td>25 mbar</td>
</tr>
<tr>
<td></td>
<td>1000 in. H₂O</td>
<td>10 in. H₂O</td>
</tr>
</tbody>
</table>

**Temperature limits**

**Ambient**

- Lower limit:
  - –40 ºC (–40 ºF)
  - –20 ºC (–4 ºF) for LCD indicator

- Upper limit:
  - 85 ºC (185 ºF)

**Note.** For Hazardous Atmosphere applications refer to the temperature range specified on the certificate / approval relevant to the required type of protection.

**Process**

- Lower limit:
  - –40 ºC (–40 ºF)

- Upper limit:
  - 121 ºC (250 ºF) at the transmitter
  - 230 ºC (446 ºF) at the process

**Storage**

- Lower limit:
  - –50 ºC (–58 ºF)
  - –40 ºC (–40 ºF) for LCD indicator

- Upper limit:
  - 85 ºC (185 ºF)

**Hazardous atmospheres**

With or without integral display – combined ATEX, FM and CSA

**ATEX approval**

**Intrinsic safety (Category 1)**

- II 1 GD T50 ºC, EEx ia IIC T6
  
  \(-50 ^\circ C \leq T_a \leq 40 ^\circ C\) respectively

- II 1 GD T95 ºC, EEx ia IIC T4
  
  \(-50 ^\circ C \leq T_a \leq 85 ^\circ C\) or

- II 1/2 GD T50 ºC, EEx ia IIC T6
  
  \(-50 ^\circ C \leq T_a \leq 40 ^\circ C\) respectively

- II 1/2 GD T95 ºC, EEx ia IIC T4
  
  \(-50 ^\circ C \leq T_a \leq 85 ^\circ C\)

**Explosion proof (Category2)**

- II 1/2 GD T50 ºC, EEx d IIC T6 IP67 T85 ºC
  
  \(-50 ^\circ C \leq T_a \leq 75 ^\circ C\)
Canadian Standards Association (CSA) and Factory Mutual (FM)

Explosion proof:
— Class I, Div. 1, Groups A, B, C, D

Dust ignition proof:
— Class II, Div. 1, Groups E, F, G

Suitable for:
— Class II, Div. 2, Groups F, G; Class III, Div. 1, 2

Non-incendive:
— Class I, Div. 2, Groups A, B, C, D

Intrinsically safe:
— Class I, II, III, Div. 1, Groups A, B, C, D, E, F, G AEx ia IIC T6/T4, Zone 0 (FM)
Specification – OriMaster M

Range and span limits

<table>
<thead>
<tr>
<th>Sensor code</th>
<th>Upper range limit (URL)</th>
<th>Minimum span</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 kPa</td>
<td>0.2 kPa</td>
</tr>
<tr>
<td>C</td>
<td>60 mbar</td>
<td>2 mbar</td>
</tr>
<tr>
<td></td>
<td>24 in. H₂O</td>
<td>0.8 in. H₂O</td>
</tr>
<tr>
<td>F</td>
<td>40 kPa</td>
<td>0.4 kPa</td>
</tr>
<tr>
<td></td>
<td>400 mbar</td>
<td>4 mbar</td>
</tr>
<tr>
<td></td>
<td>160 in. H₂O</td>
<td>1.6 in. H₂O</td>
</tr>
<tr>
<td>L</td>
<td>250 kPa</td>
<td>2.5 kPa</td>
</tr>
<tr>
<td></td>
<td>2500 mbar</td>
<td>25 mbar</td>
</tr>
<tr>
<td></td>
<td>1000 in. H₂O</td>
<td>10 in. H₂O</td>
</tr>
</tbody>
</table>

Temperature limits

**Ambient**
- Silicone oil filling: –40 to 85 ºC (–40 to 185 ºF)
- LCD display: –20 to 70 ºC (–4 to 158 ºF)
- Lower ambient limit for Viton and PTFE gaskets: –20 ºC (–4 ºF)

**Note.** For Hazardous Atmosphere applications refer to the temperature range specified on the certificate / approval relevant to the required type of protection.

**Process**
- Lower limit:
  - refer to lower ambient limits
- Upper limit (silicone oil):
  - 121 ºC (250 ºF) for working pressure above 10 kPa abs., 100 mbar abs., 1.45 psia

**Storage**
- Lower limit:
  - 85ºC (185 ºF)
- Upper limit:
  - –50 ºC (–58 ºF)
  - –40 ºC (–40 ºF) for LCD indicator

Temperature element

**Integral**
- 100 Ω Platinum RTD, cabled directly to the transmitter

**Remote** (where supplied by ABB):
- Element:
  - 100 Ω Platinum RTD
- Cable:
  - 4-core screened, PTFE
- Thermowell:
  - 3/4 in. NPT screwed pocket in 316L stainless steel

Hazardous Atmospheres – ATEX according to Directive 94/9/EC – ordering code EW (see page 22)
- Transmitter of protection type 'Intrinsically safe EEx ia', 'Flameproof enclosure EEx d', Limited energy equipment EEx nL'
- Transmitter with 4 to 20 mA output signal and HART communication
- Identification:
  - II 1/2 GD T50 ºC EEx ia IIC T6
  - OR
  - II 1/2 GD T85 °C EEx d IIC T6
- Ambient temperature range:
  - –40 to 75 ºC (–40 to 167 ºF)
  - OR
  - II 3 GD T50 ºC EEx nL IIC T6
  - OR
  - II 3 GD T95 ºC EEx nL IIC T4
  - (refer to ‘EEx ia’ for additional data)
Hazardous Atmospheres – Factory Mutual (FM) Intrinsically Safe – ordering code EA (see page 22)  
Transmitter with 4 to 20 mA output signal and HART communication  
Intrinsically safe:  
— Class I; Division 1; Groups A, B, C, D  
— Class I; Zone 0; Group IIC; AEx ia IIC  
Degree of protection:  
— NEMA Type 4X (indoor or outdoor)  

Maximum permissible ambient temperatures depending on the temperature class:

<table>
<thead>
<tr>
<th>Ambient temperature</th>
<th>Temperature class</th>
<th>Imax</th>
<th>Pi</th>
</tr>
</thead>
<tbody>
<tr>
<td>–40 to 85 °C (–40 to 185 °F)</td>
<td>T4</td>
<td>200 mA</td>
<td>0.8 W</td>
</tr>
<tr>
<td>–40 to 70 °C (–40 to 158 °F)</td>
<td>T5</td>
<td>25 mA</td>
<td>0.75 W</td>
</tr>
<tr>
<td>–40 to 40 °C (–40 to 104 °F)</td>
<td>T6</td>
<td></td>
<td>0.5 W</td>
</tr>
</tbody>
</table>

Fieldbus transmitters  
(PROFIBUS PA/FOUNDATION Fieldbus)  
Intrinsically safe:  
— Class I, II and III; Division 1; Groups A, B, C, D, E, F, G  
— Class I; Zone 0; AEx ia Group IIC T6, T4;  
Non-incendive Class I, II and III; Division 2;  
Groups A, B, C, D, E, F, G  

Hazardous Atmospheres – Factory Mutual (FM) Explosion Proof – ordering code EB (see page 22)  
Transmitters with 4 to 20 mA output signal and HART communication and Fieldbus transmitter  
(PROFIBUS PA/FOUNDATION Fieldbus)  
Explosion proof:  
— Class I; Division 1; Groups A, B, C, D  
— Class II/III; Division 1; Groups E, F, G  
Degree of protection:  
— NEMA Type 4X (indoor or outdoor)
OriMaster FPD500
Compact orifice flowmeter

Operating influences – OriMaster V

**Ambient temperature**
Per 20 K (36 °F) change between the limits of –20 to 65 °C (–4 to 150 °F):

<table>
<thead>
<tr>
<th>Sensor code</th>
<th>for TD</th>
</tr>
</thead>
<tbody>
<tr>
<td>E, G, H</td>
<td>15:1</td>
</tr>
</tbody>
</table>

but not greater than total ± 0.10 % of URL from –40 to 85 °C (–40 to 185 °F)

**Static pressure**
(Zero errors can be calibrated out at line pressure)
Per 7 MPa, 70 bar or 1015 psi
Zero error:
— ±0.06 % of URL

Span error:
— ±0.06 % of reading

**Supply voltage**
Within voltage/load specified limits the total effect is less than 0.005 % of URL per volt

**Load**
Within voltage/load specified limits the total effect is negligible

**Electromagnetic field**
Total effect is less than 0.06 % of span from 20 to 1000 MHz and for field strengths up to 10 V/m when tested with shielded conduit and grounding, with or without meter.

**Common mode interference**
No effect from 100 V rms @ 50 Hz or 50 V DC

**Mounting position**
Rotations in plane of diaphragm have negligible effect. A tilt to 90 ° from vertical causes a zero shift up to 0.6 kPa, 6 mbar or 2.4 in. H₂O; this can be corrected with the zero adjustment. No span effect.

**Stability**
±0.15 % of URL over a ten year period

Operating influences – OriMaster M

**Ambient temperature** (for turndown up to 15:1)
Per 20 K (36 °F) change between the limits of –20 to 65 °C (–4 to 150 °F)

For differential pressure sensor
±(0.04 % URL + 0.065 % span)

Per 20 K (36 °F) change between the limits of –40 to 80 °C (–40 to 176 °F)

For absolute pressure sensor
±(0.08 % URL + 0.008 % span)
Limited to ±(0.1 % URL + 0.1 % span) per the complete temperature range of 120 K (216 °F)

**Static pressure**
(Zero errors can be calibrated out at line pressure)

**Measuring range**

<table>
<thead>
<tr>
<th>Measuring range</th>
<th>Sensors C, F, L</th>
</tr>
</thead>
<tbody>
<tr>
<td>on zero</td>
<td>up to 100 bar:</td>
</tr>
<tr>
<td></td>
<td>0.05 % URL</td>
</tr>
<tr>
<td></td>
<td>&gt; 100 bar:</td>
</tr>
<tr>
<td></td>
<td>0.05 % URL/100 bar</td>
</tr>
<tr>
<td>on span</td>
<td>up to 100 bar:</td>
</tr>
<tr>
<td></td>
<td>0.05 % span</td>
</tr>
<tr>
<td></td>
<td>&gt; 100 bar:</td>
</tr>
<tr>
<td></td>
<td>0.05 % span/100 bar</td>
</tr>
</tbody>
</table>

**Supply voltage**
Within voltage/load specified limits the total effect is less than 0.001 % of URL per volt.

**Load**
Within load/voltage specified limits the total effect is negligible.

**Electromagnetic field**
Total effect: less than 0.05 % of span from 80 to 1000 MHz and for field strengths up to 10 V/m when tested with unshielded conduit, with or without meter.

**Common mode interference**
No effect from 250 V rms @ 50 Hz or 50 V DC
Mounting position
Rotations in plane of diaphragm have negligible effect. A tilt from vertical causes a zero shift of \( \sin \alpha \times 0.35 \text{ kPa} \) (3.5 mbar, 1.4 in. H\(_2\)O) of URL; this can be corrected with the zero adjustment. No span effect.

Stability
\( \pm 0.15 \% \) of URL over a sixty-month period
Overall dimensions – OriMaster V

Dimensions in mm (in.)

<table>
<thead>
<tr>
<th>Size</th>
<th>H</th>
<th>J</th>
<th>E (J/2)</th>
<th>D (H – E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 (1)</td>
<td>180 (7.10)</td>
<td>50.8 ±1 (2.00 ±0.04)</td>
<td>25.4 ±0.5 (1.00 ±0.02)</td>
<td>154.6 ±5 (6.10 ±0.20)</td>
</tr>
<tr>
<td>40 (1½)</td>
<td>203 (8.00)</td>
<td>73.2 ±1 (2.88 ±0.04)</td>
<td>36.6 ±0.5 (1.44 ±0.02)</td>
<td>166.4 ±5 (6.56 ±0.20)</td>
</tr>
<tr>
<td>50 (2)</td>
<td>221 (8.70)</td>
<td>92.1 ±1 (3.63 ±0.04)</td>
<td>46.05 ±0.5 (1.81 ±0.02)</td>
<td>174.95 ±5 (6.89 ±0.20)</td>
</tr>
<tr>
<td>80 (3)</td>
<td>257 (10.12)</td>
<td>127 ±1 (4.99 ±0.04)</td>
<td>63.5 ±0.5 (2.50 ±0.02)</td>
<td>193.5 ±5 (7.62 ±0.20)</td>
</tr>
<tr>
<td>100 (4)</td>
<td>314 (12.36)</td>
<td>157.2 ±1 (6.19 ±0.04)</td>
<td>78.6 ±0.5 (3.09 ±0.02)</td>
<td>235.4 ±5 (9.27 ±0.20)</td>
</tr>
<tr>
<td>150 (6)</td>
<td>372 (14.65)</td>
<td>215.9 ±1 (8.50 ±0.04)</td>
<td>107.95 ±0.5 (4.25 ±0.02)</td>
<td>264.05 ±5 (10.40 ±0.20)</td>
</tr>
<tr>
<td>200 (8)</td>
<td>426 (16.77)</td>
<td>269.9 ±1 (10.63 ±0.04)</td>
<td>134.95 ±0.5 (5.31 ±0.02)</td>
<td>291.05 ±5 (11.46 ±0.20)</td>
</tr>
<tr>
<td>250 (10)</td>
<td>502 (19.76)</td>
<td>323.8 ±1 (12.75 ±0.04)</td>
<td>161.9 ±0.5 (6.37 ± 0.20)</td>
<td>340.1 ±5 (13.39 ±0.20)</td>
</tr>
<tr>
<td>300 (12)</td>
<td>560 (22.04)</td>
<td>381 ±1 (15.00 ± 0.04)</td>
<td>190.5 ±0.5 (7.50 ± 0.20)</td>
<td>369.5 ±5 (14.56 ±0.20)</td>
</tr>
</tbody>
</table>

OriMaster V1 and V3 – 3-valve and 5-valve sizing table (dimensions in mm (in.))
Fig. 6: OriMaster V2 and V4 – 3-valve and 5-valve sizing table (dimensions in mm (in.))
Overall dimensions – OriMaster M

Dimensions in mm (in.)

Fig. 7: OriMaster M1 and M3 – 3-valve

<table>
<thead>
<tr>
<th>Size</th>
<th>H</th>
<th>J</th>
<th>E (J/2)</th>
<th>D (H – E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 (1)</td>
<td>180 (7.1)</td>
<td>50.8 ±1 (2.00 ±0.04)</td>
<td>25.4 ±0.5 (1.00 ±0.02)</td>
<td>154.6 ±5 (6.10 ±0.20)</td>
</tr>
<tr>
<td>40 (1½)</td>
<td>203 (8)</td>
<td>73.2 ±1 (2.88 ±0.04)</td>
<td>36.6 ±0.5 (1.44 ±0.02)</td>
<td>166.4 ±5 (6.56 ±0.20)</td>
</tr>
<tr>
<td>50 (2)</td>
<td>221 (8.7)</td>
<td>92.1 ±1 (3.63 ±0.04)</td>
<td>46.05 ±0.5 (1.81 ±0.02)</td>
<td>174.95 ±5 (6.89 ±0.20)</td>
</tr>
<tr>
<td>80 (3)</td>
<td>257 (10.12)</td>
<td>127 ±1 (4.99 ±0.04)</td>
<td>63.5 ±0.5 (2.50 ±0.02)</td>
<td>193.5 ±5 (7.62 ±0.20)</td>
</tr>
<tr>
<td>100 (4)</td>
<td>314 (12.36)</td>
<td>157.2 ±1 (6.19 ±0.04)</td>
<td>78.6 ±0.5 (3.09 ±0.02)</td>
<td>235.4 ±5 (9.27 ±0.20)</td>
</tr>
<tr>
<td>150 (6)</td>
<td>372 (14.65)</td>
<td>215.9 ±1 (8.50 ±0.04)</td>
<td>107.95 ±0.5 (4.25 ±0.02)</td>
<td>264.05 ±5 (10.40 ±0.20)</td>
</tr>
<tr>
<td>200 (8)</td>
<td>426 (16.77)</td>
<td>269.9 ±1 (10.63 ±0.04)</td>
<td>134.95 ±0.5 (5.31 ±0.02)</td>
<td>291.05 ±5 (11.46 ±0.20)</td>
</tr>
<tr>
<td>250 (10)</td>
<td>502 (19.76)</td>
<td>323.8 ±1 (12.75 ±0.04)</td>
<td>161.9 ±0.5 (6.37 ±0.02)</td>
<td>340.1 ±5 (13.39 ±0.20)</td>
</tr>
<tr>
<td>300 (12)</td>
<td>560 (22.04)</td>
<td>381 ±1 (15.00 ±0.04)</td>
<td>190.5 ±0.5 (7.5 ±0.02)</td>
<td>369.5 ±5 (14.55 ±0.20)</td>
</tr>
</tbody>
</table>

OriMaster M1 and M3 – 3-valve sizing table (dimensions in mm (in.))
Dimensions in mm (in.)

**Fig. 8: OriMaster M1 and M3 – 5-valve**

<table>
<thead>
<tr>
<th>Size</th>
<th>H</th>
<th>J</th>
<th>E (J/2)</th>
<th>D (H – E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 (1)</td>
<td>180 (7.1)</td>
<td>50.8 ±1 (2.00 ±0.04)</td>
<td>25.4 ±0.5 (1.00 ±0.02)</td>
<td>154.6 ±5 (6.10 ±0.20)</td>
</tr>
<tr>
<td>40 (1½)</td>
<td>203 (8)</td>
<td>73.2 ±1 (2.88 ±0.04)</td>
<td>36.6 ±0.5 (1.44 ±0.02)</td>
<td>166.4 ±5 (6.56 ±0.20)</td>
</tr>
<tr>
<td>50 (2)</td>
<td>221 (8.7)</td>
<td>92.1 ±1 (3.63 ±0.04)</td>
<td>46.05 ±0.5 (1.81 ±0.02)</td>
<td>174.95 ±5 (6.89 ±0.20)</td>
</tr>
<tr>
<td>80 (3)</td>
<td>257 (10.12)</td>
<td>127 ±1 (4.99 ±0.04)</td>
<td>63.5 ±0.5 (2.50 ±0.02)</td>
<td>193.5 ±5 (7.62 ±0.20)</td>
</tr>
<tr>
<td>100 (4)</td>
<td>314 (12.36)</td>
<td>157.2 ±1 (6.19 ±0.04)</td>
<td>78.6 ±0.5 (3.09 ±0.02)</td>
<td>235.4 ±5 (9.27 ±0.20)</td>
</tr>
<tr>
<td>150 (6)</td>
<td>372 (14.65)</td>
<td>215.9 ±1 (8.50 ±0.04)</td>
<td>107.95 ±0.5 (4.25 ±0.02)</td>
<td>264.05 ±5 (10.40 ±0.20)</td>
</tr>
<tr>
<td>200 (8)</td>
<td>426 (16.77)</td>
<td>269.9 ±1 (10.63 ±0.04)</td>
<td>134.95 ±0.5 (5.31 ±0.02)</td>
<td>291.05 ±5 (11.46 ±0.20)</td>
</tr>
<tr>
<td>250 (10)</td>
<td>502 (19.76)</td>
<td>323.8 ±1 (12.75 ±0.04)</td>
<td>161.9 ±0.5 (6.37 ±0.02)</td>
<td>340.1 ±5 (13.39 ±0.20)</td>
</tr>
<tr>
<td>300 (12)</td>
<td>560 (22.04)</td>
<td>381 ±1 (15.00 ±0.04)</td>
<td>190.5 ±0.5 (7.5 ±0.02)</td>
<td>369.5 ±5 (14.55 ±0.20)</td>
</tr>
</tbody>
</table>

OriMaster M1 and M3 – 5-valve sizing table (dimensions in mm (in.))
### OriMaster FPD500
### Compact orifice flowmeter

#### Ordering Information

<table>
<thead>
<tr>
<th>OriMaster compact orifice flowmeter</th>
<th>FPD500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model and design level</td>
<td></td>
</tr>
<tr>
<td>Volume flow fixed plate (364DS)</td>
<td>V1</td>
</tr>
<tr>
<td>Volume flow fixed plate (266DSH)</td>
<td>V2</td>
</tr>
<tr>
<td>Volume flow removable plate (364DS)</td>
<td>V3*</td>
</tr>
<tr>
<td>Volume flow removable plate (266DSH)</td>
<td>V4*</td>
</tr>
<tr>
<td>Mass flow fixed plate (267CS)</td>
<td>M1</td>
</tr>
<tr>
<td>Mass flow removable plate (267CS)</td>
<td>M3*</td>
</tr>
<tr>
<td>Meter size</td>
<td></td>
</tr>
<tr>
<td>25 mm. (1 in.)</td>
<td>10</td>
</tr>
<tr>
<td>40 mm (1½ in.)</td>
<td>15</td>
</tr>
<tr>
<td>50 mm (2 in.)</td>
<td>20</td>
</tr>
<tr>
<td>80 mm (3 in.)</td>
<td>30</td>
</tr>
<tr>
<td>100 mm (4 in.)</td>
<td>40</td>
</tr>
<tr>
<td>150 mm (6 in.)</td>
<td>60</td>
</tr>
<tr>
<td>200 mm (8 in.)</td>
<td>80</td>
</tr>
<tr>
<td>250 mm (10 in.)</td>
<td>90</td>
</tr>
<tr>
<td>300 mm (12 in.)</td>
<td>92</td>
</tr>
<tr>
<td>Fluid</td>
<td></td>
</tr>
<tr>
<td>Liquid</td>
<td>L</td>
</tr>
<tr>
<td>Gas</td>
<td>G</td>
</tr>
<tr>
<td>Saturated steam</td>
<td>S</td>
</tr>
<tr>
<td>Beta ratio</td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td>1</td>
</tr>
<tr>
<td>0.65</td>
<td>2</td>
</tr>
<tr>
<td>Pressure rating</td>
<td></td>
</tr>
<tr>
<td>ASME CL 150</td>
<td>A1</td>
</tr>
<tr>
<td>ASME CL 300</td>
<td>A3</td>
</tr>
<tr>
<td>ASME CL 600</td>
<td>A6</td>
</tr>
<tr>
<td>PN 10</td>
<td>D1</td>
</tr>
<tr>
<td>PN 16</td>
<td>D2</td>
</tr>
<tr>
<td>PN 25</td>
<td>D3</td>
</tr>
<tr>
<td>PN 40</td>
<td>D4</td>
</tr>
<tr>
<td>PN 63</td>
<td>D5</td>
</tr>
<tr>
<td>PN 100</td>
<td>D6</td>
</tr>
<tr>
<td>Pipeline orientation</td>
<td></td>
</tr>
<tr>
<td>Horizontal pipe</td>
<td>H</td>
</tr>
<tr>
<td>Vertical pipe **</td>
<td>V</td>
</tr>
</tbody>
</table>

*Not available for meter sizes below 100 mm. (4 in.)*

** Not available for steam applications
**OriMaster compact orifice flowmeter**

<table>
<thead>
<tr>
<th>Main code</th>
<th>Optional code</th>
</tr>
</thead>
</table>
| FPD500 | XX XX XX XI X XX XX XX XX XX | See page 20 | See next page ...

### Manifold

- Integral 3-valve manifold: 3
- Integral 5-valve manifold: 5

### DP span limits

- 0.05 ... 1 kPa / 0.5 ... 10 mbar / 0.2 ... 4 in. H₂O: A
- 0.2 ... 4 kPa / 1.4 ... 40 mbar / 0.56 ... 16 in. H₂O: B
- 0.2 ... 6 kPa / 2 ... 60 mbar / 0.8 ... 24 in. H₂O: C
- 0.27 ... 16 kPa / 2.7 ... 160 mbar / 1.08 ... 64 in. H₂O: E
- 0.4 ... 40 kPa / 4 ... 400 mbar / 1.6 ... 160 in. H₂O: F
- 0.65 ... 65 kPa / 6.5 ... 650 mbar / 2.6 ... 260 in. H₂O: G
- 1.6 ... 160 kPa / 16 ... 1600 mbar / 6.4 ... 642 in. H₂O: H
- 2.5 ... 250 kPa / 25 ... 2500 mbar / 10 ... 1000 in. H₂O: L

### Transmitter seal material

- Without seal: 0
- Viton: 3
- PTFE: 4
- EPDM: 5
- Perbunan: 6

### Electronic housing material / electrical connection

- Aluminium Alloy ½ –14 NPT: A
- Aluminium Alloy M20 x 1.5: B
- AISI 304L SST ½ –14 NPT: H
- AISI 304L SST M20 x 1.5: L
- AISI 316L SST ½ –14 NPT: S
- AISI 316L SST M20 x 1.5: T

### Integrated digital display (LCD)

- None (blind): 0
- Integrated LCD display: 1
- Integrated LCD display (backlit): 2
- TTG (through-the-glass) controlled LCD display: 5

### Output signal

- HART digital communications and 4 ... 20 mA: H1
- HART digital communications and 4 ... 20 mA, SIL2 and SIL3 certified to IEC 61508: H2
- PROFINET PA: P1
- FOUNDATION Fieldbus: F1
- Modbus RS485: M1
- Wireless HART: W1

---

1. Model and design level V1 and V3 only
2. Model and design level V2, V4, M1 and M3 only
3. Model and design level V2 and V4 only
4. Model and design level M1 and M3 only
### Temperature element

| Integral ² | AT |
| Remote ²  | AR |
| None ³     | AY |

### Calibration

- Standard water calibration at reference conditions
- Other

### Certificates

- Material monitoring with inspection certificate 3.1 in accordance with EN 10204
- Material monitoring NACE MR 01-75 with inspection certificate 3.1 in accordance with EN 10204

### Explosion protection certification

- ATEX + FM + CSA ¹
- Factory Mutual (FM) – Intrinsically Safe ²
- Factory Mutual (FM) – Explosion Proof ²
- Canadian Standard Association – Explosion Proof ²
- ATEX II 1/2 GD, EEx ia + ATEX II 1/2 GD EEx d + ATEX EEEx nL ²

### Documentation language

| German | M1 |
| Italian | M2 |
| Spanish | M3 |
| French | M4 |
| English | M5 |
| Chinese | M6 |

### Special applications

- Degreased (oil and grease free) with inert capsule filling for oxygen applications
- Gold plated diaphragm (silicone oil filled) for hydrogen applications

---

¹ Model and design level V1, V2, V3 and V4 only
² Model and design level V2, V4 only
Acknowledgements

MODBUS is a registered trademark of the Modbus-IDA organization
PROFIBUS is a registered trademark of Profibus International FOUNDATION is a trademark of the Fieldbus Foundation
HART is a registered trademark of the HART Communication Foundation