Vortex and Swirlmeters
V4000 (TRIO-WIRL)

For flow rate and volume measurement of liquids, gases and steam

- Fluid temperatures up to 400 °C (752 °F)
- High accuracy
- Short inlet sections
- Precise digital signal processing (DSP) technology
- Suitable for hazardous area applications
- High communication standard

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ABB
With its new TRIO-WIRL range, ABB introduces Vortex and Swirlmeters that incorporate innovative DSP (Digital Signal Processing) technology. This technology results in greatly improved signal processing ability and increased process reliability. An integral temperature measurement sensor expands the TRIO-WIRL’s application range to include saturated steam metering, mass flowrate metering of liquids and temperature monitoring.

Why use TRIO-WIRL flowmeters? Simply, because they are suitable for liquids, gases and steam.

2-Wire design

**TRIO-WIRL VT/ST**

in a compact design

The compact 2-wire TRIO-WIRL VT/ST measurement system incorporates, as standard, a DSP controlled converter with a two line Liquid Crystal Display (LCD) indicating flowrate and flow total values. The converter is operated and programmed by 3 magnetic sensors. All user displays are in clear text so that, as a rule, an instruction bulletin is not required. An optional integrated temperature sensor provides - without additional cabling costs - a means to monitor the fluid temperature or to provide data for saturated steam calculations. In addition to the 4-20 mA output the contact output can be utilized for pulse outputs or temperature/flow alarm output. Remote communication is possible using either the 4-20 mA current output in conjunction with the HART-Protocol or PROFIBUS PA (pending approval).

**TRIO-WIRL VR/SR**

with remote converter

The TRIO-WIRL VR and TRIO-WIRL SR expand the metering system by adding a remote-mounted converter variant. These remote converters can be installed at distances up to 10 m from the flowmeter primary. The remote design is based on the VT/ST integral converter design and has identical functionality.

Remote converters have two main advantages:

- when accessibility to a converter mounted on the primary would otherwise be difficult.
- where extreme ambient conditions exist at the metering location. Since there are no electronic components mounted in the flowmeter primary it is suitable for ambient temperatures up to 70 °C (158 °F).
**Persuasive arguments**

All calibration data and parameter values are stored in a removable EEPROM, allowing the converter to be exchanged quickly and easily. The sensors are vibration compensated, (pipeline vibrations up to 1g are suppressed in the converter). Identical sensors and converters are utilized for both measuring methods (vortex and swirl). This reduces stocking costs. Installations in Ex-Zones with intrinsically safe and flame proof designs are available.

**Swirlmeter**

The standard 5 mark calibration of each TRIO-WIRL flowmeter with water and/or air assures the highest accuracy within the linearized sector:

- **Vortex flowmeter TRIO-WIRL V:**
  - 0.75 % of rate for liquids
  - 1 % of rate for gases and steam

- **Swirlmeter TRIO-WIRL S:**
  - 0.5 % of rate for liquids, gases and steam

(According to reference conditions; details see Spec. D184S035U02)

**Process reliability through superior DSP technology**

The heart of the 2-wire converter is its DSP processor (Digital Signal Processor). This new processor generation offers optimum signal processing, even when the sensor signals are weak and noisy. In instruments with conventional signal processing the frequency of the sensor signal cannot always be positively detected.

This results in lost pulses, producing noisy indications and erroneous flowrate values. In comparison, the flowrate frequency signal in DSP converters is correctly filtered out of the sensor signal, achieving error free flowrate values.
**Special features overview**

- Wide flowmeter size range
  - Flanged: 1/2”-12” / DN 15-300
  - Wafer design: 1/2”-6” / DN 15-150
- Wafer design with orifice plate installation lengths of 65 mm
- Accuracy
  - ± 0.75% of rate for liquids
  - ± 1% of rate for gases and steam
- Suitable for liquids with viscosities up to 7.5 mPas
- High temperature design to 400 °C (752 °F) fluid temperature (higher upon request)

**Measurement principle TRIO-WIRL V**

The TRIO-WIRL V measurement principle is based on the Karman Vortex Street. If a fluid flows past a body, vortices are alternately formed on each side of the body. The flow causes these vortices to shed, creating a vortex street. The frequency of the vortex shedding is proportional to the flow velocity and inversely proportional to the width of the body. If the dimensions of the body and the shedder are optimized a linear relationship between the vortex shedding frequency and the flowrate (that is independent of fluid density and viscosity) can be achieved over a wide Reynolds Number range. Pressure variations resulting from the vortex shedding are detected by a piezo sensor and converted into electrical pulses corresponding to the vortex shedding frequency. These pulses are processed in the DSP converter into scaled analog and digital signals.

**Contaminated Liquids:**
Contamination or coatings have no effect on signalling. No holes or gaps are required for vortex formation.

**Installation requirements**

In order to guarantee optimum functionality, a straight inlet section with a length of 15D (pipe diameters) and an outlet section 5D long is required. The inlet length requirement may increase depending on location as shown in the adjacent figure.

**Flow ranges TRIO-WIRL V**

<table>
<thead>
<tr>
<th>Meter Size</th>
<th>Liquid(^a) Flow Range [m³/h]</th>
<th>Gas(^b) Flow Range [m³/h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>inch</td>
<td>Q(_{\text{min}})</td>
<td>Q(_{\text{max}}) DN</td>
</tr>
<tr>
<td>1/2</td>
<td>0.5</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>1.6</td>
<td>18</td>
</tr>
<tr>
<td>1-1/2</td>
<td>2.4</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>170</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>270</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>630</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
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<td>10</td>
<td>250</td>
<td>1700</td>
</tr>
<tr>
<td>12</td>
<td>300</td>
<td>2400</td>
</tr>
</tbody>
</table>

\(^a\) water at 20 °C (68 °F)  
\(^b\) air at 20 °C (68 °F), 1013 mbar
**Special features overview**

- Wide flowmeter size range
  - Flanged: 1/2”-16” / DN 15-400
  - (Other connection types upon request, e.g. Tri-Clamp)
- Shortest in-/ outlet sections
  - Typ. 3 x D / 1 x D
- Accuracy
  - ±0.5 % of rate for liquids gases and steam
- Suitable for liquids with viscosities up to 30 mPas
- Wide flowrate range typ. 1:25
- Certified for hot water metering

**Installation requirements**

The TRIO-WIRL S requires virtually no straight pipe sections on the inlet or outlet. Generally lengths of 3D at the inlet and 1D at the outlet are sufficient. If the radius of curvature of single or double elbows upstream or downstream of the flowmeter are greater than 1.8 x D, then inlet and outlet sections are not required. Inlet and outlet straight sections are also not required after reducers per DIN 28545 (a/2=8°).

**Measurement principle TRIO-WIRL S**

A turbine-shaped inlet section forces the axial flow entering the flowmeter into a rotational movement. A vortex core forms in the centre of the primary rotation. A secondary rotation forms in the vortex core producing thread-like spirals.

The frequency of this secondary rotation is linearly proportional to the flowrate over a wide Reynolds Number range.

Pressure variations resulting from the secondary rotation are detected by a Piezo sensor and converted into electrical pulses. These pulses are processed in the DSP converter into scaled analog and digital signals.

### Flow ranges TRIO-WIRL S

<table>
<thead>
<tr>
<th>Meter Size</th>
<th>Liquid$^{(1)}$</th>
<th>Gas$^{(1)}$</th>
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<tr>
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<td>$Q_{\text{max}}$ DN</td>
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<tr>
<td>1/2</td>
<td>0.1</td>
<td>1.6</td>
</tr>
<tr>
<td>3/4</td>
<td>0.2</td>
<td>2</td>
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<tr>
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<td>6</td>
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<td>1 1/4</td>
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<td>12</td>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>16</td>
<td>180</td>
<td>1800</td>
</tr>
</tbody>
</table>

$^{(1)}$ water at 20 °C (68 °F)

$^{(1)}$ air at 20 °C (68 °F), 1013 mbar
TRIO-WIRL - flexibility in explosion protection and communication

During the development of the Ex-Design special emphasis was placed on universal applicability, therefore all the functionality of the standard design instrument is maintained in the explosion-proof variant.

**Type Fieldbus:**
The TRIO-WIRL Ex-version complies with the FISCO (Fieldbus Intrinsically Safe Concept) of the PTB (German Federal Establishment of Physics and Engineering). Marking: II 2 G EEx ia IIC T4

**Type 4...20 mA HART:**
The intrinsically safe design
This instrument is applicable in hazardous area zone 1 as well as in zone 2.
Marking: II 2 G EEx ib IIC T4
II 3 G EEx n(L) IIC T4

Flame proof/intrinsically safe design
In this design the Ignition Protection Type (EEx ib or EEx d) classification is determined by the power supply:
- Non-intrinsically safe power supply:
  - II 2 G EEx d [ib] IIC T6
- Intrinsically safe power supply:
  - II 2 G EEx ib IIC T4

An advantage of this design approach is a reduced stock requirement because the same instrument can be installed in either “EEx d” or “EEx ib” areas FM approval is present. This model is certified for hazardous area zone 2 as well.

**Data links to the process**

2-Wire design
Type 4...20 mA
- Contact output (pulse or alarm contact)
- HART-Protocol

**Type Fieldbus**
- Contact output (pulse or alarm contact)
- PROFIBUS PA (Profile 3.0) or FOUNDATION Fieldbus
- EEx protection acc. to the FISCO Model

**Example for PROFIBUS PA interconnection at TRIO-WIRL**

**Example for FOUNDATION Fieldbus interconnection at TRIO-WIRL**
Compensation of process condition

Integrated temperature measurement

The measurement of the temperature and flowrate at the same location offers considerable advantages:
- High accuracy through advantageous positioning of the temperature sensor
- No additional cabling required
- Fast response time

Pressure and temperature compensation

If the process conditions are changing, e.g. due to pressure variations, or overheated steam is to be measured, the integrated temperature measurement equipment is not sufficient for exact measurement and display of the gas flow (in mass or standard units) or steam mass flow. TRIO-WIRL S and V together with Sensycal G (gases) or S (steam) are the optimal tools for these applications. The instrument supply is realized via the SensyCal evaluation unit, thus reducing the wiring efforts considerably.

Used components

- Flowmeter (vortex and swirl) TRIO-WIRL V or S
- Pressure transmitter for absolute pressure, e.g. Multi Vision 2020 TA
- Resistance thermometer e.g. SensyTemp WT R, optionally with integrated TH 02 head-mounted transmitter
- Evaluation unit SensyCal S, SensyCal G

The TRIO-WIRL S swirlmeter can be connected directly via the NPT 1/4" pressure tap.

Measurement in the hazardous area

The signals must be supplied intrinsically safe, e.g. through a Contrans I isolating power supply.
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