The most important variable area flow metering practices and their principles are described.

A large number of practical details provide the user with comprehensive and valuable information about the topic variable area flowmetering in an industrial environment.
Handbook for
Variable Area Flowmeters

ABB Automation Products GmbH
Introduction

For decades Variable Area flowmeters have become established in industrial measurement technology with an economical, mature measurement principle. The large variety of instrument designs, their repeatability and independence from supply power requirements for local indication provide a suitable solution in almost every flow metering application for liquids, gases and steam.

The ABB-Program includes, a line of metal meter tube flowmeters particularly suited for high pressure and temperature applications, for aggressive and opaque fluids and for steam metering. Also offered is a line of glass meter tube flowmeters (the solution for extremely low pressure conditions) including float designs for viscous fluids or high flowrates in the smaller sizes. The purge flowmeters in both lines are available with a differential pressure regulator to maintain a constant flowrate even when there are pressure variations. The smallest flow ranges required in laboratory applications and high flowrates in industrial applications can be satisfied with ABB instruments.

This new “Handbook for Variable Area Flowmeters“ is a practical guide for the user with selection criteria for real applications (see Check List/Parameter Questionnaire), correction factors, Accuracy Classes, corrosion resistance tables and much more. A separate flyer with actual pictures demonstrate the application versatility.

Answers are provided to frequently asked questions about this measurement principle (see Page 20) and we have incorporated a preferential quick ship program for the most popular instrument versions.

We hope that this Handbook provides you with a practical selection guide; naturally our sales team is always ready to provide you with any personal assistance you may require.
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1 General Fundamentals and Details

1.1 Measurement Principle

In VDI/VDE-Directive 3513 the Variable Area flowmeter principle is described as follows:

The Variable Area flowmeter is an instrument for metering the flowrate of liquids and gases in a pipeline. It includes a vertically oriented conical tube, whose diameter is larger at the top than at the bottom, through which the fluid flows upward and in which a vertically moving float is positioned.

The height of the float in the tube increases as the flowrate increases in such a manner that the resistance to the flow is always balanced by the weight of the float and remains constant regardless of the flowrate.

The height of the float in the tube is a measure of the flowrate. The value of the flowrate can be read from a scale.

1.2 Basic Design

In its simplest form the design of the Variable Area flowmeter consists of metering elements (see Fig. 1-1). Float (1), meter tube (2) and flowrate scale (3), including fittings (5), flanges or couplings for installation in the pipeline and sealed with gaskets and O-Rings (7).

![Fig. 1-1: Basic Design, Glass Tube Flowmeter](image-url)
The float travel is limited by float stops (4) and the meter tube is surrounded by a protective housing (6).

The flowrate scale for glass tube flowmeters is located directly on the meter tube. Variable Area flowmeters generally have a flow range of 1:12.5, which corresponds to a percent range from 8 to 100%.

If the mechanical, thermal or corrosion properties of glass tubes are not adequate in certain applications, metal meter tubes can be used. The height of the float, which is a measure of the flowrate, is then transmitted externally to the meter tube using a float position detector system (see Fig. 1-2).

The application of converters having electrical analog output signals (0/4...20 mA) can also be used for flow control or for remote indication and recording. In addition, alarm conditions can be signalled.

The data sheets corresponding to the individual Variable Area models include construction details, technical specifications, materials used and dimensions together with flowrate tables. The flowrate tables always indicated the maximum flowrate for the specific meter size and the various meter tube / float combinations.

![Diagram of Metal Cone Variable Area Flowmeter](image-url)

**Fig. 1-2:** Basic Design, Metal Cone Variable Area Flowmeter
The listed flowrates are generally based on a stainless steel float material No. 1.4301 [304] (density $\rho_f = 8.02 \text{ g/cm}^3$) and are for liquids or water (density $\rho = 1 \text{ g/cm}^3$, viscosity $\eta = 1 \text{ mPa s}$) or for gases or air at normal conditions ($t_n = 0 \degree \text{C}; p_n = 1.013 \text{ bar (a)}$).

### 1.3 Determination of the Meter Tube/Float Combination

The precision manufacture of the meter tubes and floats allows, based on Directive VDI/VDE 3513, simplified calculations for volume or mass flowrates.

The software package **Flow Tools** is available from ABB for flowmeter selection as a function of the existing conditions for the metering application. With this program it is possible to select the optimal flowmeter by considering the actual operating conditions. This program is available upon request.

### 1.4 Viscosity Effects (1/2” to 2”)

The float shapes are designed to be essentially independent of the viscosity over a wide range. This means that within this range the viscosity of the fluid can change without any change in the flowrate indications. The flowrate tables for the Variable Area flowmeters include a column entitled VIN in which the Viscosity Influence Number is listed.

If the calculated VIN-Number is lower or exactly the same as the value in the flowrate table in the instrument specifications, the measured values are not affected by viscosity.

$$VIN = \eta \cdot \sqrt{\frac{(\rho_f - 1) \cdot 1}{(\rho_{f1} - \rho_1) \cdot \rho_1}}$$

- $\eta$ = Dynamic viscosity of the fluid [mPa s]
- $\rho_f$ = Density of the float in the flowrate table ($\rho = 8.02 \text{ g/cm}^3$)
- $\rho_{f1}$ = Density of the float actually used
- $\rho_1$ = Density of the fluid
1.5 Density Effects

Table 1-1 is used to correct the indicated flowrate value for Variable Area flowmeters used to meter gases when the normal density of the actual gas is different from the normal density used for the calibration (same operating conditions).

Example

The existing flowmeter was calibrated for air, normal density 1.293 kg/m³ and is to be used to meter Nitrogen, normal density 1.25 kg/m³.

In the column for Air where it meets the row for Nitrogen, the factor 1.02 (enclosed in a box) is found. The values indicated by the Variable Area flowmeter must be multiplied by this factor when metering Nitrogen.

Information:
Actual normal density higher: Factor < 1
Actual normal density lower: Factor > 1

When the operating temperature or the operating pressure changes, the multiplication factors to correct the readings can be calculated using the following equations:

Normal or Weight Units | Actual Volume Units at Operating Conditions

\[ K_p = \sqrt{\frac{p_2}{p_1}} \]
\[ K_p = \sqrt{\frac{p_1}{p_2}} \]

\[ K_t = \sqrt{\frac{t_1}{t_2}} \]
\[ K_t = \sqrt{\frac{t_2}{t_1}} \]

\( K_p \) = Correction factor for pressure
\( K_t \) = Correction factor for temperature
\( p_1 \) = 1.013 bar (a) + calibration pressure in bar
\( p_2 \) = 1.013 bar (a) + actual operating pressure in bar
\( t_1 \) = 273 K + calibration temperature in °C
\( t_2 \) = 273 K + actual operating temperature in °C
Calculation of the Correction Factors for Liquid Density Changes

**Volume Flowrate**

\[ K_F = \frac{[\rho_{f1} - \rho_2] \cdot \rho_1}{[\rho_{f1} - \rho_1] \cdot \rho_2} \]

\[ K_F \left( \frac{\rho_{f1} - \rho_2}{\rho_{f1} - \rho_1} \right) \cdot \rho_2 \]

\[ - \left( \frac{\rho_{f1} - \rho_1}{\rho_{f1} - \rho_1} \right) \cdot \rho_2 \]

**Mass Flowrate**

\[ K_F = \frac{[\rho_{f1} - \rho_2] \cdot \rho_2}{[\rho_{f1} - \rho_1] \cdot \rho_1} \]

\[ K_F \left( \frac{\rho_{f1} - \rho_2}{\rho_{f1} - \rho_1} \right) \cdot \rho_1 \]

\[ - \left( \frac{\rho_{f1} - \rho_1}{\rho_{f1} - \rho_1} \right) \cdot \rho_1 \]

\[ K_F = \frac{[\rho_{f1} - \rho_2] \cdot \rho_2}{[\rho_{f1} - \rho_1] \cdot \rho_1} \]

- \[ K_F \left( \frac{\rho_{f1} - \rho_2}{\rho_{f1} - \rho_1} \right) \cdot \rho_1 \]

\[ - \left( \frac{\rho_{f1} - \rho_1}{\rho_{f1} - \rho_1} \right) \cdot \rho_1 \]

**Symbols**

- \( K_F \) = Correction factor
- \( \rho_{f1} \) = Density of the float which is actually used
- \( \rho_1 \) = Density of the calibration fluid
- \( \rho_2 \) = Density of the actual fluid
### 1.5.1 Normal Density Correction Table for Volume Units
(Meter Tube Sizes 1/2” to 2”)

**Gas**

<table>
<thead>
<tr>
<th>Gas</th>
<th>Acetylene</th>
<th>Ammonia existing</th>
<th>Ammonia actual</th>
<th>Argon existing</th>
<th>Butane</th>
<th>Chlorine</th>
<th>Natural Gas</th>
<th>Helium</th>
<th>Carbon Dioxide</th>
<th>Carbon Monoxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene</td>
<td>1.17</td>
<td>1</td>
<td>0.81</td>
<td>0.566</td>
<td>1.23</td>
<td>1.51</td>
<td>1.66</td>
<td>0.84</td>
<td>0.39</td>
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<td>Ammonia</td>
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<td>1.232</td>
<td>1</td>
<td>0.697</td>
<td>1.52</td>
<td>1.86</td>
<td>2.04</td>
<td>1.04</td>
<td>0.48</td>
<td>1.6</td>
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<td>Ammonia diss.</td>
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<td>1.77</td>
<td>1.43</td>
<td>1</td>
<td>2.18</td>
<td>2.67</td>
<td>2.93</td>
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<td>2.3</td>
</tr>
<tr>
<td>Argon</td>
<td>1.78</td>
<td>0.81</td>
<td>0.66</td>
<td>0.458</td>
<td>1</td>
<td>1.22</td>
<td>1.34</td>
<td>0.68</td>
<td>0.32</td>
<td>1.05</td>
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<td>Butane</td>
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<td>0.374</td>
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<td>0.51</td>
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<td>0.78</td>
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<td>Natural Gas</td>
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<td>0.963</td>
<td>0.67</td>
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<td>1.79</td>
<td>1.97</td>
<td>0.46</td>
<td>1.54</td>
<td>1.23</td>
</tr>
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<td>1.54</td>
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<td>1.58</td>
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<td>0.634</td>
<td>0.44</td>
<td>0.96</td>
<td>1.18</td>
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<td>0.66</td>
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<td>1.5</td>
<td>0.76</td>
<td>0.35</td>
<td>1.18</td>
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<td>1.6</td>
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</tr>
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<td>3.05</td>
<td>1.41</td>
<td>4.72</td>
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**Tbl. 1-1:** Normal Density Correction Table
<table>
<thead>
<tr>
<th>Gas</th>
<th>existing</th>
<th>actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krypton</td>
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<tr>
<td>Air</td>
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<td>Methane</td>
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<td>Propane</td>
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<td>Propane</td>
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<td>0.63</td>
</tr>
<tr>
<td>Oxygen</td>
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<td>1.25</td>
</tr>
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<td>Nitrous Oxide</td>
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<td>Ammonia</td>
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<td>Argon</td>
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<td>1.02</td>
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<td>Butane</td>
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<td>1.2</td>
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<td>Chlorine</td>
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<td>Helium</td>
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</tr>
<tr>
<td>Hydrogen</td>
<td>6.5</td>
<td>3.81</td>
</tr>
</tbody>
</table>
1.6 Defining the Operating Pressure in a Variable Area Flowmeter

The term “Operating Pressure” means that pressure which exists in the meter tube of the flowmeter. This pressure is usually identical to the pressure immediately downstream of the flowmeter. The pressure drop in the flowmeter is negligible.

1.6.1 Needle Valve Location

For liquids it is immaterial whether the needle valve is installed at the inlet or outlet of the flowmeter. For gas measurements it is recommended that the needle valve be installed at the outlet of the flowmeter because of compressibility effects. In this arrangement the pressure in the flowmeter will always be constant and independent of downstream pressure variations. For constant downstream pressure conditions, the needle valve can be installed at the inlet. If the gas measurements are made at atmospheric conditions, then the needle valve must be installed at the inlet of the flowmeter.

In addition for gas measurements, the location of the valve (at inlet or outlet) must always be considered in conjunction with the calibration pressure. As a result of the density changes due to compression changes in the gas, the upward forces on the float vary and therefore the float height. In order for the operating pressure in the meter tube to remain constant, the flow control valve should be installed as shown in the following (see Fig. 1-3).

![Diagram of Needle Valve Locations]

**Examples:**

- **A** Flowmeter without needle valve; \( P_2 = \text{Operating pressure} \)
- **B** Flowmeter with needle valve in inlet; \( P_2 = \text{Operating pressure} \)
- **C** Flowmeter with needle valve in outlet; \( P_1 = \text{Operating pressure} \)
- **D** Flowmeter with needle valves in in- and outlet; \( P_2 = \text{Operating pressure} \)

---

**Fig. 1-3:** Needle Valve Locations
1.7 Installation Recommendations

See also VDI/VDE-Directive 3513 Sheet 3, Selection and Installation Recommendations for Variable Area Flowmeters.

Fig. 1-4: Flowmeter Installation

Variable Area flowmeters are installed in the pipeline vertically. Pipeline vibrations and strong magnetic fields must be kept distant from the flowmeter. The size of the pipeline should correspond the flowmeter connection sizes. Straight in- and outlet sections are no required.

Accuracy and Operating Conditions

The float design is selected for defined fluid operating conditions. For liquids and gases they are the pressure and temperature dependent density and viscosity values at the operating conditions. Especially for gases, this means a defined operating pressure and a defined operating temperature. The specified accuracy of the instrument is always based on the actual fluid operating conditions.

Pressure Drop

The pressure available at the meter location must always be greater than the pressure drop through the flowmeter listed in the Specifications. The pressure drops in the pipeline, fittings and other devices installed downstream from the flowmeter must be taken into account.
Damping and Compression Oscillations in Gas Measurements

When a critical volume between the throttling points up- and downstream of the flow-meter is exceeded, it may be possible, at low operating pressures with gases, that float bounce (compression oscillations) may occur.

To prevent the occurrence of the self-generated float bounce the following information should be noted:

• Select a flowmeter with as low a pressure drop as possible.
• Keep the pipeline lengths between the closest up- and downstream throttling points as short as possible.
• Increase the operating pressure taking into account the changes in the flowrate indication due to the density changes in the gas at the new operating conditions.

Pressure Shocks

Especially when metering gases or liquids with gas bubbles, pressure shocks or excessive float travel may occur if fast opening solenoid valves together with unrestricted pipeline cross sections are employed. As a result of the sudden expansion of the gas that the float may be driven against the upper float stop with considerable force. Under certain conditions the instrument may be damaged or even destroyed.

Solids in the Fluid

Variable Area flowmeters are only suitable for metering fluids containing solids to a limited degree. As a function of the concentration, particle size and type of solids, accelerated wear due to mechanical friction may result. It may also cause weight and shape changes if solids deposit on the float. These effects can result in erroneous flowrate measurements. Generally the installation of an appropriate filter is recommended.
1.8 Accuracy Classes

For Variable Area flowmeters the accuracy is defined in VDE/VDI-Directive 3513, Sheet 2 by various classifications, where each Accuracy Class corresponds to a specific range of errors. The maximum allowable error is the sum of the following partial errors:

1. Partial error: \(\frac{3}{4}\) of the value of the specified Accuracy Class value is the error in percent of rate
2. Partial error: \(\frac{1}{4}\) of the value of the specified Accuracy Class value is the error in percent of full scale

For each measurement value the total error in % of rate is calculated as follows:

\[
F = \left(\frac{3}{4}M + \frac{1}{4}E\right) \cdot \frac{C}{M}
\]

\(M\) = Measured value in flowrate units
\(E\) = Scale end (full scale) value in flowrate units
\(C\) = Accuracy Class values per VDI/VDE 3513/2
\(F\) = Total error in % of rate

<table>
<thead>
<tr>
<th>Flowrate in %</th>
<th>Accuracy Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>100</td>
<td>1.000</td>
</tr>
<tr>
<td>90</td>
<td>1.028</td>
</tr>
<tr>
<td>80</td>
<td>1.063</td>
</tr>
<tr>
<td>70</td>
<td>1.107</td>
</tr>
<tr>
<td>60</td>
<td>1.167</td>
</tr>
<tr>
<td>50</td>
<td>1.250</td>
</tr>
<tr>
<td>40</td>
<td>1.375</td>
</tr>
<tr>
<td>30</td>
<td>1.583</td>
</tr>
<tr>
<td>20</td>
<td>2.000</td>
</tr>
<tr>
<td>10</td>
<td>3.250</td>
</tr>
</tbody>
</table>

Tbl. 1-2: Flowrate Accuracy for the Accuracy Classes
1.9 Frequently Asked Questions (FAQ)

• Why should a solenoid valve not be installed?
  The VDI/VDE-3513 does not recommend the installation of solenoid valves because of the moving parts in the Variable Area flowmeter, however good operating experiences have been reported using a so called Starting Valve.

• Where on the float is the flowrate read?
  For a ball float, at its center. For all other float shapes see the description in the instrument Specifications.

• Why is information about so many parameters required?
  For an optimal instrument selection it is essential to consider the actual operating conditions. Because the Variable Area principle depends considerably on the density, the pressure and temperature for gases are the critical values.

• Why is my flow range different than the air flow range listed in the Specifications?
  The values in the instrument Specifications are based 1.013 bar (a) and 0 °C. If your operating conditions differ from these base values (e.g. 2.5 bar (g) and 20 °C), then the density of your gas is different and your flow range will also be different.

• Can one calculate a conversion factor from Air to Helium?
  Yes, see the values in Table 1-1 in Chapter 1.5.1. The values in the table only apply for identical pressure and temperature conditions.

• Can one calculate a conversion factor for an instrument sized for Air at 1 bar (a) 0 °C to 2.5 bar (g) and 20 °C (T)?
  Yes, the conversion formulas in Chapter 1.5 can be used, or we can provide a software program which can be used to calculate the conversion factors and also print direct reading scales for any operating condition. For %-scales it is necessary to calculate the individual scale values starting at 100 %.

• What are the advantages of using a conversion calculation?
  You can use an existing instrument with a % or direct reading scale for a new application under different operating conditions. If you take into account the minimal cost for making the corrections, you avoid additional costs. Also the Variable Area principle itself is extremely economical.
# 1.10 Questionnaire Variable Area Flowmeter

## Customer Address:
- **Company:**
- **Contact:**
- **Street:**
- **Administrator:**
- **City/State:**
- **Date:**
- **Country**
- **Phone:**
- **Postal Code:**
- **Fax:**
- **Customer No.:**
- **Email:**

## Operating Data:

<table>
<thead>
<tr>
<th>Fluid (for gas applications)</th>
<th>Fluid (for fluid applications)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
<td>Name:</td>
</tr>
<tr>
<td>Normal density (kg/m³)</td>
<td>Operating density (kg/l)</td>
</tr>
<tr>
<td>Inlet pressure (bar (g))</td>
<td>Viscosity (mPAs)</td>
</tr>
<tr>
<td>Outlet pressure (bar (g))</td>
<td>Pressure rating (bar (g))</td>
</tr>
<tr>
<td>Operating temp. (°C)</td>
<td>Operating temp. (°C)</td>
</tr>
</tbody>
</table>

## Flowrate max.:

<table>
<thead>
<tr>
<th>Flow Units:</th>
<th>Normal&lt;sup&gt;1)&lt;/sup&gt;</th>
<th>Actual Volume</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>cm³/min (Qn)</td>
<td>cm³/min</td>
<td>g/min</td>
<td></td>
</tr>
<tr>
<td>l/h (Qn)</td>
<td>l/h</td>
<td>kg/h</td>
<td></td>
</tr>
<tr>
<td>l/min (Qn)</td>
<td>l/min</td>
<td>kg/min</td>
<td></td>
</tr>
<tr>
<td>m³/h (Qn)</td>
<td>m³/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>Others</td>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

## Required Instrument Design:
- Glass tube meter
- Metal tube meter

## Flowrate Indication:
- Direct reading scale
- Scale in %
- 4...20 mA with display

## Required Options:
- 4...20 mA Alarm contacts
- Ex design Needle valve
- 3.1B certificate Others

## Comments:

---

Thompson Equipment (TECO) | 800-528-8997 | www.teco-inc.com
1.11 Overview Metal Cone Instrument Designs

Fig. 1-5: Selection help for Metal Cone Variable Area Flowmeter

- Flowrate 0.1...120,000 l/h (Qv) Water or 0.008...3,600 m³/h (Qn) Air at 1.013 bar (a) and 0 °C
- Stainless steel primary
- Alarm transmitter
- 4...20 mA output signal

2.5...120,000 l/h (Qv) Water or 0.1...1,600 m³/h (Qn) Air at 1.013 bar (a) and 0 °C

VA Master FAM540

0.1...3,000 l/h (Qv) Water or 0.008...90 m³/h (Qn) Air at 1.013 bar (a) and 0 °C

FAM3200
1.12 Overview Glass Tube Instrument Designs

**Meter Location**
- Flowrate 0.002...17,600 l/h (Qv) Water or 4 cm³/min...520 m³/h (Qn) Air at 1.013 bar (a) and 0 °C
- Visual fluid monitoring
- Alarm transmitter

**Glass Tube**

0.002...17,600 l/h (Qv) Water or 4 cm³/min...520 m³/h (Qn) Air at 1.013 bar (a) and 0 °C

FAG1190

0.002...140 l/h (Qv) Water or 4...71,280 cm³/min (Qn) Air at 1.013 bar (a) and 0 °C

FAG6100

**Fig. 1-6:** Selection help for Glass Tube Variable Area Flowmeter
2 Variable Area Flowmeters

2.1 Metal Cone Flowmeter

Application Range
The proven, rugged metal cone flowmeter is well suited to numerous applications. It can be used to meter the flowrate of gases, liquids and steam, in process technology, the chemical, pharmaceutical and food industries. It is especially well suited for aggressive or opaque fluids or wherever for safety reasons a glass tube flowmeter cannot be utilized. For higher pressures and temperatures it is essential. The instrument operates according to the Variable Area principle. The primary section consists of a metal cone and a float. A magnet embedded in the float transmits the instantaneous height of the float, the measure for the flowrate, over a decouple proof magnet follower system. The flowrate value is indicated by a rotating pointer on a scale in the secondary section (indicator section).

![Metal Cone Flowmeter Images]

<table>
<thead>
<tr>
<th>Standard Designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAM540-A</td>
</tr>
<tr>
<td>FAM540-B/C/D</td>
</tr>
<tr>
<td>FAM540-E</td>
</tr>
<tr>
<td>FAM540-F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specifications – Standard Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow range</td>
</tr>
<tr>
<td>Scale format</td>
</tr>
<tr>
<td>Accuracy Class</td>
</tr>
<tr>
<td>Connections</td>
</tr>
<tr>
<td>Standard pressure rating</td>
</tr>
<tr>
<td>Temperature range</td>
</tr>
<tr>
<td>Meter length</td>
</tr>
<tr>
<td>Materials</td>
</tr>
<tr>
<td>Housing</td>
</tr>
<tr>
<td>Gaskets</td>
</tr>
<tr>
<td>Sight glass</td>
</tr>
<tr>
<td>Safety glass</td>
</tr>
<tr>
<td>Gas damping</td>
</tr>
</tbody>
</table>
### 2.1.1 Indicator with/without Alarm Transmitter VA Master

**FAM540-A/B/C/D**

#### Design Features
- Two housing designs:
  - Non-Ex and Ex designs
  - Ex housing design flameproof enclosure.
- Explosion protection according to ATEX / IECEx Ex d, Ex ia, Ex nA, dust-ignition proof
- Alarm signals can be added using a Compact-Module.
- Alarm settings visible externally.
- Alarm points can be set on the scale.
- Ball bearing, decouple proof and hysteresis free magnet follower system.
- Instrument corresponds to NAMUR-Recommendations NE21 for Electromagnetic Compatibility of Equipment in Processes and Laboratories 5/93 and EMC-Directive 89/EWG.
- Minimum difference between min. and max. alarm points 5 %.
- Secondary can be removed or mounted on the primary section without opening the indicator housing.
- Reproducibility ± 0.25 % of range end value.
- Round indicator housing.

#### Alarm Transmitter for FAM540

An alarm is released when the control vane enters the slot initiator (active surface becomes covered). The contact opens. The alarm setting can be monitored, – visible externally – set and changed.

<table>
<thead>
<tr>
<th>Operating mode</th>
<th>Bi-stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproducibility</td>
<td>± 0.5 % of range end value</td>
</tr>
<tr>
<td>Nominal voltage</td>
<td>8 V DC (Ri approx. 1 kΩ)</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>5...25 V</td>
</tr>
<tr>
<td>Switch frequency, max</td>
<td>3 kHz</td>
</tr>
</tbody>
</table>

---

Special Designs

- Heating jacket design, Food Industry design
- PTFE liner
- Higher pressure ratings
- DN 100 [4"] for higher flowrates
- Pressure tight design per ATEX / IECEx
- Intrinsic Safety design per ATEX / IECEx
- Ex-Design per FM
- NACE per MR0175
- Design with GOST-R-Certificate
Isolated Switch Amplifiers are required for the alarm transmitter.

Recommended Amplifiers

<table>
<thead>
<tr>
<th>Amplifier</th>
<th>Supply power</th>
<th>Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>KFD2-SR2-Ex1.W</td>
<td>24 V DC</td>
<td>1</td>
</tr>
<tr>
<td>KFA5-SR2-Ex1.W</td>
<td>115 V AC</td>
<td>1</td>
</tr>
<tr>
<td>KFA6-SR2-Ex1.W</td>
<td>230 V AC</td>
<td>1</td>
</tr>
<tr>
<td>KFD5-SR2-Ex2.W</td>
<td>24 V DC</td>
<td>2</td>
</tr>
<tr>
<td>KFA5-SR2-Ex2.W</td>
<td>115 V AC</td>
<td>2</td>
</tr>
<tr>
<td>KFA6-SR2-Ex2.W</td>
<td>230 V AC</td>
<td>2</td>
</tr>
</tbody>
</table>

These Isolated Switch Amplifiers from Pepperl & Fuchs are examples. Others could also be used.

2.1.2 Indicator with Electrical Converter with/without Display

VA Master FAM540-E/F

Design Features

- Flowrate indication or flow totalization (FAM540-F).
- Display can be added later.
- Electronic Min./Max. instrument alarms.
- Menu controlled configuration (FAM540-F).
- Configuration using HART-Communication from Handheld Terminal or DSV401 (SMART-VISION).
- Electronic linearization of the flow curve.
- Menu controlled configuration of the instrument without opening the housing using a Magnet Stick (FAM540-F).
- User configurable display (FAM540-F).
- For connection to all designs of primaries.
- Two housing designs:
  - Non-Ex and Ex designs
  - Ex housing design flameproof enclosure
- The same instrument for intrinsically safe or non-intrinsically safe installations.
- Explosion protection according to ATEX/IECEx Ex d, Ex ia, Ex nA, dust-ignition proof
- Changing the pressure and temperature values of the fluid possible at any time.
- Supply power
  - 10...46 V DC (Standard)
  - 10...28 V DC (Ex-Design)
Output Signals
Current output for flowrate signal: 4...20 mA

Binary Output
The function assigned to the binary output can be selected in the software as:

- Flowrate alarm: Min., Max. or Min.-Max.
- System alarm
- Pulse output: fmax 50 Hz;
  pulse width: 5...256 ms
- Standard: Optocoupler $U_H = 16...30$ V,
  $I_L = 2...15$ mA
- Ex ia: Configured as a NAMUR-Contact

Display (Design FAM540-F)
High contrast LC-Display. For indication of the instantaneous flowrate or totalized flow values.

Data can be entered in the plain text dialog using the 4 keys of the display (if the cover is closed use the magnet stick) or using digital communication via the HART protocol (FDT DTM interface, handheld).
## 2.1.3 Ordering Information FAM541

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>2.5...28 l/h</td>
<td>DN15; 1/2 inch</td>
<td>90</td>
<td>FAM541 A Y0 D L01</td>
</tr>
<tr>
<td>Water</td>
<td>5.0...50 l/h</td>
<td>DN15; 1/2 inch</td>
<td>90</td>
<td>FAM541 A Y0 D L02</td>
</tr>
<tr>
<td>Water</td>
<td>10...100 l/h</td>
<td>DN15; 1/2 inch</td>
<td>30</td>
<td>FAM541 A Y0 D L03</td>
</tr>
<tr>
<td>Water</td>
<td>25...250 l/h</td>
<td>DN15; 1/2 inch</td>
<td>60</td>
<td>FAM541 A Y0 D L04</td>
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<tr>
<td>Water</td>
<td>50...500 l/h</td>
<td>DN15; 1/2 inch</td>
<td>70</td>
<td>FAM541 A Y0 D L05</td>
</tr>
<tr>
<td>Liquid</td>
<td>Special scale*</td>
<td>DN15; 1/2 inch</td>
<td></td>
<td>FAM541 A Y0 D L06</td>
</tr>
<tr>
<td>Water</td>
<td>0.1...1 m³/h</td>
<td>DN25; 1 inch</td>
<td>50</td>
<td>FAM541 A Y0 D L07</td>
</tr>
<tr>
<td>Water</td>
<td>0.25...2.5 m³/h</td>
<td>DN25; 1 inch</td>
<td>50</td>
<td>FAM541 A Y0 D L08</td>
</tr>
<tr>
<td>Water</td>
<td>0.4...4.0 m³/h</td>
<td>DN25; 1 inch</td>
<td>80</td>
<td>FAM541 A Y0 D L09</td>
</tr>
<tr>
<td>Liquid</td>
<td>Special scale*</td>
<td>DN25; 1 inch</td>
<td></td>
<td>FAM541 A Y0 D L10</td>
</tr>
<tr>
<td>Water</td>
<td>0.5...5.0 m³/h</td>
<td>DN50; 2 inch</td>
<td>30</td>
<td>FAM541 A Y0 D L11</td>
</tr>
<tr>
<td>Water</td>
<td>1.0...10.0 m³/h</td>
<td>DN50; 2 inch</td>
<td>50</td>
<td>FAM541 A Y0 D L12</td>
</tr>
<tr>
<td>Water</td>
<td>1.5...16.0 m³/h</td>
<td>DN50; 2 inch</td>
<td>70</td>
<td>FAM541 A Y0 D L13</td>
</tr>
<tr>
<td>Water</td>
<td>2.0...24.5 m³/h</td>
<td>DN50; 2 inch</td>
<td>80</td>
<td>FAM541 A Y0 D L14</td>
</tr>
<tr>
<td>Liquid</td>
<td>Special scale*</td>
<td>DN50; 2 inch</td>
<td></td>
<td>FAM541 A Y0 D L15</td>
</tr>
<tr>
<td>Water</td>
<td>5.0...50.0 m³/h</td>
<td>DN80; 3 inch</td>
<td>70</td>
<td>FAM541 A Y0 D L16</td>
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<tr>
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<td>Special scale*</td>
<td>DN80; 3 inch</td>
<td></td>
<td>FAM541 A Y0 D L17</td>
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<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>0.1...1.0 m³/h (Qn)</td>
<td>DN15; 1/2 inch</td>
<td>90</td>
<td>FAM541 A Y0 D G01</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>0.25...2.75 m³/h (Qn)</td>
<td>DN15; 1/2 inch</td>
<td>30</td>
<td>FAM541 A Y0 D G02</td>
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<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>0.5...5.4 m³/h (Qn)</td>
<td>DN15; 1/2 inch</td>
<td>60</td>
<td>FAM541 A Y0 D G03</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>1.5...15.0 m³/h (Qn)</td>
<td>DN15; 1/2 inch</td>
<td>70</td>
<td>FAM541 A Y0 D G04</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>DN15; 1/2 inch</td>
<td></td>
<td>FAM541 A Y0 D G05</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>2.0...20.0 m³/h (Qn)</td>
<td>DN25; 1 inch</td>
<td>30</td>
<td>FAM541 A Y0 D G06</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>5.0...50.0 m³/h (Qn)</td>
<td>DN25; 1 inch</td>
<td>30</td>
<td>FAM541 A Y0 D G07</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>8.0...80.0 m³/h (Qn)</td>
<td>DN25; 1 inch</td>
<td>40</td>
<td>FAM541 A Y0 D G08</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>DN25; 1 inch</td>
<td></td>
<td>FAM541 A Y0 D G09</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>10.0...120.0 m³/h (Qn)</td>
<td>DN50; 2 inch</td>
<td>20</td>
<td>FAM541 A Y0 D G10</td>
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<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>20.0...200.0 m³/h (Qn)</td>
<td>DN50; 2 inch</td>
<td>40</td>
<td>FAM541 A Y0 D G11</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>DN50; 2 inch</td>
<td></td>
<td>FAM541 A Y0 D G12</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20°C</td>
<td>50.0...500.0 m³/h (Qn)</td>
<td>DN80; 3 inch</td>
<td>40</td>
<td>FAM541 A Y0 D G13</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>DN80; 3 inch</td>
<td></td>
<td>FAM541 A Y0 D G14</td>
</tr>
</tbody>
</table>

**Indicator**

- Min. alarm contact = A
- Max. alarm contact = B
- Min/Max. alarm contact = C
- Signal output 4...20 mA = D
- Signal output 4...20 mA with display = E
- Without explosion protection = Y0
- Approval ATEX / IECEx zone 2 = B1
- Approval ATEX / IECEx zone 1 = A4

**DIN-Flanges**

- ASME CL 150 = D

* To design "special scales" we require the information in the questionnaire. Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc.

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Bild 2-1: 1 Threaded socket 1/2" NPT
2 Cable entry M20 x 1.5
3 Threaded plug M25 x 1.5 (FAM541-A only)
4 N number of holes
5 Protective conductor
6 FAM541-F only

<table>
<thead>
<tr>
<th>Meter size</th>
<th>Press. rating</th>
<th>Standard design</th>
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<tbody>
<tr>
<td>1/2&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PN 40</td>
<td>Ø D 95,0</td>
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<tr>
<td></td>
<td>15</td>
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<td></td>
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<td>A 250,0</td>
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<td></td>
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<td>C 87,0</td>
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<td></td>
<td>PN 63</td>
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<td></td>
<td>Ø L 14,0</td>
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<td></td>
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<td>G 130,0</td>
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</table>

Dimensions tolerances ± 2,0
Bild 2-2: 1 Threaded socket 1/2" NPT
2 Cable entry M20 x 1.5
3 Threaded plug M25 x 1.5 (FAM541-A only)
4 N number of holes
5 Protective conductor
6 FAM541-F only

Alle dimensions in mm

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<tr>
<th>Meter size</th>
<th>Press. rating</th>
<th>Standard design</th>
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</table>

Comments:
Installation lengths for PTFE lined flowmeters DN 25 [1"] PN 40 = 260 mm;
DN 50/80 [2"/3"]PN 40 = 375 mm. Others upon request
2.2 Armored Purgemeter

Application Range
With small Variable Area flowmeters in an all metal design it is possible, without difficulty, to meter under extreme conditions. Opaque liquids, often found in the chemical, petrochemical and pharmaceutical industries present no problems. But also in the laboratory, gas analysis systems and everywhere that glass tube flowmeters cannot be installed, the advantages of the small armored purgemeter come to the fore.

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<tr>
<td>FAM3200-25</td>
<td>Local indication</td>
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<tr>
<td>FAM3200-25A</td>
<td>Indicator with alarm transmitter, Min. alarm</td>
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<tr>
<td>FAM3200-25B</td>
<td>Indicator with alarm transmitter, Max. alarm</td>
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<tr>
<td>FAM3200-25C</td>
<td>Indicator with alarm transmitter, Min. + Max. alarm</td>
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<tr>
<td>FAM3200-55</td>
<td>Indicator with electrical converter, Output 4...20 mA</td>
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</table>

Specifications – Standard Design

Flow range: See Table, others upon request
Scale format: Direct reading
Accuracy Classes: 6
Connections: NPTi vertical
Max. allowable pressure: 100 bar
Max. allowable temperature: 100 °C
Meter length: See Dimensions

Materials
- Fluid wetted parts: 1.4571 [316Ti] /Viton-A
- Housing: Polycarbonate

Gas damping: For standard designs > 1/4” integrated

Special Designs
- With integrated needle valve in 1/4”
- With needle valve and differential pressure regulator
- With horizontal connections in 1/4”
- Higher flowrates in 1”
- Higher temperature limit to 150 °C
2.2.1 Specifications for Accessories

Alarm Signal Contacts for FAM3200-25A-C

Alarm signal contacts can be installed in the housing that respond for min.- and/or max. flowrates. They can be used to switch pumps, magnet valves, etc. (Fig. 2-3).

The alarm transmitter consists of a slot initiator and a switch amplifier. The switch amplifier is mounted external from the indicator housing. A control vane activates the switch when it enters the slot initiator. The slot initiator setting can be adjusted using a screwdriver.

![Fig. 2-3: Armored Purgemeter FAM3200-25; Indicator with Single alarm](image)

| Alarm point setting | Single alarm min. 0...60 %, max. 40...100 %; Minimum double alarm settings approx. 5 % |
| Setting accuracy    | ± 2 % of rate |

Electrical Converter FAM3200-55

Attention!

Model FAM3200-55 is a flowmeter with a built-in angular transducer. The transducer is mounted on the axle of the pointer and transforms the pointer position into a flowrate proportional 4...20 mA output current. The Models with angular transducers may not be installed in Ex-Areas.

| Output signal 4...20 mA, 2-Wire | $U_{\text{max}} = 30 \text{ V}; I_{\text{max}} = 30 \text{ mA}$ |
| Ambient temperature           | -20 °C...+40 °C |
### 2.2.2 Ordering Information FAM3200-25/-55

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<td>Gas</td>
<td>Special scale</td>
<td>1/2&quot; NPTi</td>
<td>125</td>
<td>D10A32</td>
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</table>

## Options:

- **Local indication with/without alarm = 25**
- **4...20 mA output signal Local ind. w/ 4...20 mA output signal = 55**

<table>
<thead>
<tr>
<th>Local indication</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. alarm contact</td>
<td>Indicator with Min. alarm = A</td>
</tr>
<tr>
<td>Max. alarm contact</td>
<td>Indicator with Max. alarm = B</td>
</tr>
<tr>
<td>Min./Max. alarm contact</td>
<td>Indicator with Min./Max. alarm = C</td>
</tr>
</tbody>
</table>

* To design "special scales" we require the information in the questionnaire (page 21)

Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc.
### 2.2.3 Dimensions FAM3200-20/-25

**FAM3200-20 ≤ 100 l/h Water**  
(Horizontal pipeline connections)

![Diagram of FAM3200-20](image)

**FAM3200-25 ≤ 800 l/h Water**  
(Vertical pipeline connections)

![Diagram of FAM3200-25](image)

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>Øb</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>SW</th>
<th>Model</th>
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<tr>
<td>Flow range ≤ 100 l/h Water</td>
<td>SW19</td>
<td>18</td>
<td>125</td>
<td>29</td>
<td>1/4&quot; NPT</td>
<td>34</td>
<td>29</td>
<td>FAM3200-20/-25</td>
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<td>Flow range 100 l/h to 300 l/h Water</td>
<td>SW24</td>
<td>25</td>
<td>164</td>
<td>48.5</td>
<td>3/8&quot; NPT</td>
<td>30.5</td>
<td>32.5</td>
<td>FAM3200-20/-25</td>
<td></td>
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<tr>
<td>Flow range ≤ 400 l/h to 800 l/h Water</td>
<td>SW27</td>
<td>25</td>
<td>164</td>
<td>48.5</td>
<td>1/2 NPT</td>
<td>30.5</td>
<td>32.5</td>
<td>FAM3200-20/-25</td>
<td></td>
</tr>
<tr>
<td>Flow range 800 l/h to 3000 l/h Water</td>
<td>SW50</td>
<td>50</td>
<td>230</td>
<td>81</td>
<td>1&quot; G 1&quot; NPT</td>
<td>18</td>
<td>45/50</td>
<td>FAM3200-20/-25</td>
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</tr>
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</table>

SW = Size of Wrench

**Fig. 2-4:** FAM3200-20/-25 to 800 l/h Water
2.2.4 Dimensions FAM3200-50/-55

FAM3200-50 ≤ 100 l/h Water
Armored Purgemeter
with Electronic Converter

FAM3200-55 ≤ 800 l/h Water
Armored Purgemeter
with Electronic Converter

<table>
<thead>
<tr>
<th>Flow range ≤ 100 l/h Water</th>
<th>Flow range 100 l/h to 300 l/h Water</th>
<th>Flow range ≤ 400 l/h to 800 l/h Water</th>
<th>Flow range 800 l/h to 3000 l/h Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Øb</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>SW19</td>
<td>18</td>
<td>125</td>
<td>29</td>
</tr>
<tr>
<td>SW24</td>
<td>25</td>
<td>164</td>
<td>48.5</td>
</tr>
<tr>
<td>SW27</td>
<td>25</td>
<td>164</td>
<td>48.5</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

SW = Size of Wrench

Fig. 2-5: FAM3225 (10A3225) 800 to 3000 l/h Water
2.3 Glass Tube Flowmeter

Application Range
This universal, rugged measurement instrument for liquids and gases is used in many sectors of industry, e.g., system apparatus manufacture, water treatment facilities, food and beverage industries and the chemical sector. The availability of a wide range of available fluid wetted material combinations make the flowmeter suitable for metering aggressive fluids.

<table>
<thead>
<tr>
<th>Standard Design</th>
<th>Local indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAG1190-97</td>
<td>With Options:</td>
</tr>
<tr>
<td></td>
<td>Add-on alarm transmitter Model 55AX1000 for</td>
</tr>
<tr>
<td></td>
<td>Min. alarm</td>
</tr>
<tr>
<td></td>
<td>Max. alarm or</td>
</tr>
<tr>
<td></td>
<td>Min. + Max. alarm</td>
</tr>
</tbody>
</table>

**Specifications – Standard Design**

- **Flow range**: See Table, others upon request
- **Scale format**: Direct reading
- **Accuracy Classes**: 1.6
- **Connections**: R-internal threads, vertical, see Table
- **Max. allowable pressure**: See Table
- **Max. allowable temperature**: Liquids 150 °C; Gases 100 °C
- **Meter length**: See Dimensions
- **Materials**: Borosilicate glass
  - Meter tube: 1.4571 [316Ti]
  - Fittings: Viton-A
  - O-rings: 1.4571 [316Ti]
  - Floats: 1.4571 [316Ti]
- **Mounting design**: Pipeline mount
- **Burst protection**: Integrated for gas measurements

**Special Designs**
- Additional flow ranges
- Designs with threaded stubs per DIN 11851
- Designs with flanged connections
- Diverse materials available for other fluids
- Special float designs for minimal pressure drop and larger flowrates
- Designs for panel mounting to R 1“
- Separate needle valve
## 2.3.1 Ordering Information FAG1190

<table>
<thead>
<tr>
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<th></th>
<th></th>
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<tbody>
<tr>
<td>Water</td>
<td>0.4...6.6 l/h</td>
<td>R1/4&quot;</td>
<td>30</td>
<td></td>
<td>D10A1197 0 L01³</td>
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<tr>
<td>Water</td>
<td>2...25 l/h</td>
<td>R1/4&quot;</td>
<td>30</td>
<td></td>
<td>D10A1197 0 L02³</td>
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<tr>
<td>Water</td>
<td>3...49 l/h</td>
<td>R1/4&quot;</td>
<td>30</td>
<td></td>
<td>D10A1197 0 L03³</td>
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<tr>
<td>Water</td>
<td>10...90 l/h</td>
<td>R1/4&quot;</td>
<td>30</td>
<td></td>
<td>D10A1197 0 L04³</td>
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<tr>
<td>Liquid</td>
<td>Special scale*</td>
<td>R1/4&quot;</td>
<td>30</td>
<td></td>
<td>D10A1197 0 L05³</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>20...350 cm³/min (Qn)</td>
<td>R1/4&quot;</td>
<td>30</td>
<td></td>
<td>D10A1197 0 G01³²</td>
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<td>40...660 cm³/min (Qn)</td>
<td>R1/4&quot;</td>
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<td>80...1000 cm³/min (Qn)</td>
<td>R1/4&quot;</td>
<td>30</td>
<td></td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>0.2...2.7 l/min (Qn)</td>
<td>R1/4&quot;</td>
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<td></td>
<td>D10A1197 0 G04³²</td>
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<tr>
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<td>0.4...5 l/min (Qn)</td>
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<td></td>
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<td>1...13 l/min (Qn)</td>
<td>R1/4&quot;</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>1.5...22 l/min (Qn)</td>
<td>R1/4&quot;</td>
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<td></td>
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<td>6...46 l/min (Qn)</td>
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<td>10...65 l/min (Qn)</td>
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<td>Special scale*</td>
<td>R1/4&quot;</td>
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<td></td>
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<tr>
<td>Water</td>
<td>4...53 l/h</td>
<td>R1/2&quot;</td>
<td>5</td>
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<td>D10A1197 0 L05³</td>
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<td>Water</td>
<td>12...110 l/h</td>
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<td>10</td>
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<td>12...158 l/h</td>
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<td>Water</td>
<td>20...255 l/h</td>
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<td>R1/2&quot;</td>
<td>21</td>
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<tr>
<td>Water</td>
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<td>Water</td>
<td>50...610 l/h</td>
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<td>20</td>
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<td>Water</td>
<td>60...810 l/h</td>
<td>R3/4&quot;</td>
<td>30</td>
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<td>Special scale*</td>
<td>R3/4&quot;</td>
<td>17</td>
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<td>D10A1197 0 L13</td>
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<td>Water</td>
<td>80...1060 l/h</td>
<td>R1&quot;</td>
<td>30</td>
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<td>D10A1197 0 L14</td>
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<td>Water</td>
<td>140...1700 l/h</td>
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<td>250...3050 l/h</td>
<td>R1-1/2&quot;</td>
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<tr>
<td>Water</td>
<td>300...4000 l/h</td>
<td>R1-1/2&quot;</td>
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<tr>
<td>Water</td>
<td>400...4800 l/h</td>
<td>R1-1/2&quot;</td>
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<td>Special scale*</td>
<td>R1-1/2&quot;</td>
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<td>Water</td>
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<tr>
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<td>600...7000 l/h</td>
<td>R2&quot;</td>
<td>60</td>
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<tr>
<td>Water</td>
<td>1800...9600 l/h</td>
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<td>80</td>
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<td>Special scale*</td>
<td>R2&quot;</td>
<td>7</td>
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<td>0.18...1.7 m³/h (Qn)</td>
<td>R1/2&quot;</td>
<td>5</td>
<td></td>
<td>D10A1197 0 G10³²</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>0.2...2.75 m³/h (Qn)</td>
<td>R1/2&quot;</td>
<td>5</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>0.3...3.9 m³/h (Qn)</td>
<td>R1/2&quot;</td>
<td>10</td>
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<td>0.4...5.3 m³/h (Qn)</td>
<td>R1/2&quot;</td>
<td>15</td>
<td></td>
<td>D10A1197 0 G13³²</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>R1/2&quot;</td>
<td>17</td>
<td></td>
<td>D10A1197 0 G14³²</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>0.6...7.5 m³/h (Qn)</td>
<td>R3/4&quot;</td>
<td>5</td>
<td></td>
<td>D10A1197 0 G15³²</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>1...12.8 m³/h (Qn)</td>
<td>R3/4&quot;</td>
<td>20</td>
<td></td>
<td>D10A1197 0 G16³</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>1.4...17.6 m³/h (Qn)</td>
<td>R3/4&quot;</td>
<td>20</td>
<td></td>
<td>D10A1197 0 G17³</td>
</tr>
</tbody>
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Continued on next page
### Continuation Ordering Information FAG1190

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</thead>
<tbody>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>R3/4&quot;</td>
<td>-</td>
<td>-</td>
<td>G18^2(\text{\textsuperscript{3}})</td>
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<td>1.6...20.8 m³/h (Qn)</td>
<td>R1&quot;</td>
<td>15</td>
<td>10</td>
<td>D10A1197</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>2.5...30.5 m³/h (Qn)</td>
<td>R1&quot;</td>
<td>30</td>
<td>10</td>
<td>D10A1197</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>3.5...43 m³/h (Qn)</td>
<td>R1&quot;</td>
<td>40</td>
<td>10</td>
<td>D10A1197</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>5...57 m³/h (Qn)</td>
<td>R1&quot;</td>
<td>50</td>
<td>10</td>
<td>D10A1197</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>R1&quot;</td>
<td>-</td>
<td>-</td>
<td>G19^2(\text{\textsuperscript{3}})</td>
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<td>Air 1.013 bar (a) 20 °C</td>
<td>2.5...28.5 m³/h (Qn)</td>
<td>R1-1/2&quot;</td>
<td>10</td>
<td>4</td>
<td>D10A1197</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>6...56 m³/h (Qn)</td>
<td>R1-1/2&quot;</td>
<td>20</td>
<td>4</td>
<td>D10A1197</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>R1-1/2&quot;</td>
<td>-</td>
<td>-</td>
<td>G20^2(\text{\textsuperscript{3}})</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>8...102 m³/h (Qn)</td>
<td>R2&quot;</td>
<td>30</td>
<td>2</td>
<td>D10A1197</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td>R2&quot;</td>
<td>-</td>
<td>-</td>
<td>G21^2(\text{\textsuperscript{3}})</td>
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</tbody>
</table>

### Options:
- **no alarm contact = 0**
- **Min. alarm contact with Min. alarm contact = 1**
- **Max. alarm contact with Max. alarm contact = 2**
- **Min./ Max. alarm contact with Min./ Max. alarm contact = 3**

### Accessories: Switch Amplifier
**Model**
- Single alarm 230V AC, 50/60 Hz
- Single alarm 115V AC, 50/60 Hz
- Single alarm 24V DC
- Double alarm 230V AC, 50/60 Hz
- Double alarm 115V AC, 50/60 Hz
- Double alarm 24V DC

* To design special scales we require the parameters listed in the Questionnaire.
* Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc..
2) with Polycarbonate protection tube for gas applications
3) not available with alarms, we will be glad to suggest alternative solutions

### Reductions to the max. allow. pressure
For meter pipe sizes 1"...2" the max. allow. pressure is reduced by 1 % for every 2 °C at operating temperatures above 95 °C.

The reduced pressures for gas applications result from safety considerations.
The strength of the Polycarbonate protection tube is reduced as the temperature increases. Therefore further restrictions must be observed when metering gases:
- Listed max. allow. operating pressure is for 30 °C fluid temperature and 30 °C ambient temperature
- Max. ambient temperature 40 °C
- Max. fluid temperature 100 °C
- For fluid or ambient temperatures over 30 °C the max. allow. operating pressure is reduced by 1.05 % / 1 °C.
### 2.3.2 Dimensions FAG1190

**FAG1190-97 (P)**

<table>
<thead>
<tr>
<th>Meter Tube Size</th>
<th>Threaded Connections</th>
<th>Size of Wrench SW</th>
<th>Weight ca. kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16&quot;/1/8&quot;/1/4&quot;</td>
<td>G 1/4</td>
<td>260</td>
<td>0.5</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>G 1/2</td>
<td>405</td>
<td>1.7</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>G 3/4</td>
<td>405</td>
<td>2.3</td>
</tr>
<tr>
<td>1&quot;</td>
<td>G1</td>
<td>405</td>
<td>2.7</td>
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<td>1 1/2&quot;</td>
<td>G1 1/2</td>
<td>78</td>
<td>4.4</td>
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<td>2&quot;</td>
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<td>97</td>
<td>6.5</td>
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</table>

**FAG1190-97 (V)**

<table>
<thead>
<tr>
<th>Meter Tube Size</th>
<th>Threaded Stubs per DIN 11851</th>
<th>Weight ca. kg</th>
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<tbody>
<tr>
<td>1/2&quot;</td>
<td>Rd 34 x 1/8&quot; Rd 44 x 1/6&quot; Rd 52 x 1/6&quot;</td>
<td>1.7</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>SC 15 SC 20 SC 25</td>
<td>2.3</td>
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<tr>
<td>1&quot;</td>
<td>SC 40 SC 50</td>
<td>2.7</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>Rd 65 x 1/6&quot; Rd 78 x 1/6&quot;</td>
<td>4.4</td>
</tr>
<tr>
<td>2&quot;</td>
<td>SC 40 SC 50</td>
<td>6.5</td>
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</table>

**FAG1190-98 (P)**

<table>
<thead>
<tr>
<th>Meter Tube Size</th>
<th>Flanged Connections per DIN 2501</th>
<th>ANSI - Drilled for CL 300</th>
<th>Wgt., ca. kg</th>
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</thead>
<tbody>
<tr>
<td>1/16&quot;/1/8&quot;/1/4&quot;</td>
<td>10 15 20 40 40 95 60 4 4 14 14 14 1/2&quot;</td>
<td>95.2 95.2 117.5 66.7 66.7 82.6 4 4 15.9 15.9 19.0 270 29</td>
<td>1.4 2.4 3.5</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>20 40 40 105 65 4 4 4 14</td>
<td>115.6 114.3 127.0 4 4 19.0 22.5 19.0 415 415</td>
<td>29 40 53</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>16 40 16 165 75 4 4 4 14</td>
<td>165.1 165.1 165.1 4 8 22.5 22.5 19.0 425 425</td>
<td>58.5 78 97</td>
</tr>
<tr>
<td>1&quot;</td>
<td>50 40 16 16 150 110 4 4 4 14</td>
<td>165.1 165.1 165.1 4 8 22.5 22.5 19.0 425 425</td>
<td>1.4 2.4 3.5</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>16 40 16 16 150 110 4 4 4 14</td>
<td>165.1 165.1 165.1 4 8 22.5 22.5 19.0 425 425</td>
<td>58.5 78 97</td>
</tr>
<tr>
<td>2&quot;</td>
<td>50 40 16 16 165 125 4 4 4 14</td>
<td>165.1 165.1 165.1 4 8 22.5 22.5 19.0 425 425</td>
<td>1.4 2.4 3.5</td>
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</tbody>
</table>

*Fig. 2-6: Dimensions*
## 2.4 Glass Tube PurgeMeter

### Application Range
This universally applicable Variable Area flowmeter is especially suitable for metering and injecting small flowrates of liquids and gases. The application range includes, among others, the gas analysis sector, biotechnology, medical technology, system apparatus manufacture and the laboratory.

![FAG6100](image)

### Standard Design

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAG6100-41</td>
<td>Local indication, 70 mm scale length</td>
</tr>
<tr>
<td>FAG6100-42</td>
<td>Local indication, 130 mm scale length</td>
</tr>
</tbody>
</table>

Each with options:
- Add-on alarm transmitter Model 55AN3000 for Min. alarm
- Max. alarm or Min. + Max. alarm

### Specifications – Standard Design

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>Flow range</td>
<td>See Table, others upon request</td>
</tr>
<tr>
<td>Scale format</td>
<td>Direct reading</td>
</tr>
<tr>
<td>Accuracy Classes</td>
<td>6 (70 mm-scale); 2.5 (130 mm-scale)</td>
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<tr>
<td>Connections</td>
<td>R1/4&quot;-internal threads, horizontal</td>
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<tr>
<td>Max. allowable pressure</td>
<td>18 bar</td>
</tr>
<tr>
<td>Max. allowable temperature</td>
<td>0...150 °C</td>
</tr>
<tr>
<td>Meter length</td>
<td>See Dimensions</td>
</tr>
<tr>
<td>Materials</td>
<td></td>
</tr>
<tr>
<td>Meter tube</td>
<td>Borosilicate glass</td>
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<tr>
<td>Fittings</td>
<td>1.4401 [316]</td>
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<tr>
<td>O-rings</td>
<td>Viton-A</td>
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<tr>
<td>Floats</td>
<td>1.4401[316] (SS); Carboloy (CA); Glass (BG, CD)</td>
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<tr>
<td>Mounting design</td>
<td>Pipeline mount/panel mount M5 x 20</td>
</tr>
<tr>
<td>Burst protection</td>
<td>Polycarbonate</td>
</tr>
<tr>
<td>Needle valve</td>
<td>Integrated in inlet</td>
</tr>
</tbody>
</table>

### Special Designs
- Diverse materials available for other fluids
- Without needle valve or with valve in outlet
- Panel or laboratory stand mounting
- Design with add-on differential pressure regulator for constant flowrate
## 2.4.1 Ordering Information FAG6100-41

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Flow Range</th>
<th>Float</th>
<th>Catalog No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>0.8...5.4 l/h</td>
<td>SS-18</td>
<td>10A6141 0 L01</td>
</tr>
<tr>
<td>Water</td>
<td>2...23 l/h</td>
<td>SS-14</td>
<td>10A6141 0 L02</td>
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<tr>
<td>Water</td>
<td>10...75 l/h</td>
<td>SS-14</td>
<td>10A6141 0 L03</td>
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<tr>
<td>Water</td>
<td>15...105 l/h</td>
<td>CA-14</td>
<td>10A6141 0 L04</td>
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<tr>
<td>Liquid</td>
<td>Special scale*</td>
<td></td>
<td>10A6141 0 L05</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>40...340 cm³/min (Qn)</td>
<td>BG-18</td>
<td>10A6141 0 G01</td>
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<tr>
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<td>100...850 cm³/min (Qn)</td>
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<td>10A6141 0 G02</td>
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<td>Air 1.013 bar (a) 20 °C</td>
<td>150...1500 cm³/min (Qn)</td>
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<td>10A6141 0 G03</td>
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<td>Air 1.013 bar (a) 20 °C</td>
<td>0.2...3 l/min (Qn)</td>
<td>SS-18</td>
<td>10A6141 0 G04</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>0.8...6 l/min (Qn)</td>
<td>CD-14</td>
<td>10A6141 0 G05</td>
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<td>Air 1.013 bar (a) 20 °C</td>
<td>1.5...12 l/min (Qn)</td>
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<td>10A6141 0 G06</td>
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<td>2...24 l/min (Qn)</td>
<td>CA-14</td>
<td>10A6141 0 G07</td>
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<td>Air 1.013 bar (a) 20 °C</td>
<td>4...38 l/min (Qn)</td>
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<td>10A6141 0 G08</td>
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<tr>
<td>Gas</td>
<td>Special scale*</td>
<td></td>
<td>10A6141 0 G09</td>
</tr>
</tbody>
</table>

**Options:**

- Without alarm contact = 0
- Min. alarm contact = 1
- Max. alarm contact = 2
- Min./Max. alarm contact = 3

**Accessories: Switch amplifier**

**Model**

- Single alarm 230 V AC, 50/60 Hz
- Single alarm 115 V AC, 50/60 Hz
- Single alarm 24 V DC

- Double alarm 230 V AC, 50/60 Hz
- Double alarm 115 V AC, 50/60 Hz
- Double alarm 24 V DC

* To design "special scales" we require the information in the questionnaire (page 21)

Our Expert Team will gladly answer any questions you may have regarding your

2) not available with alarms, we will be glad to suggest alternative solutions
### Ordering Information FAG6100-42

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Flow Range</th>
<th>Float</th>
<th>Catalog No.</th>
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<tbody>
<tr>
<td>Water</td>
<td>0.4...6.6 l/h</td>
<td>SS-18</td>
<td>10A6142 0</td>
</tr>
<tr>
<td>Water</td>
<td>2...25 l/h</td>
<td>SS-14</td>
<td>10A6142 0</td>
</tr>
<tr>
<td>Water</td>
<td>3...49 l/h</td>
<td>CA-14</td>
<td>10A6142 0</td>
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<tr>
<td>Water</td>
<td>10...90 l/h</td>
<td>SS-14</td>
<td>10A6142 0</td>
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<tr>
<td>Liquid</td>
<td>Special scale*</td>
<td></td>
<td>10A6142 0</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>8...125 cm³/min (Qn)</td>
<td>SS-16</td>
<td>10A6142 0</td>
</tr>
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<td>Air 1.013 bar (a) 20 °C2)</td>
<td>20...350 cm³/min (Qn)</td>
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<tr>
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<td>40...660 cm³/min (Qn)</td>
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<td>80...1000 cm³/min (Qn)</td>
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<td>0.2...2.7 l/min (Qn)</td>
<td>SS-18</td>
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<tr>
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<td>0.4...5 l/min (Qn)</td>
<td>CA-18</td>
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<tr>
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<td>1...13 l/min (Qn)</td>
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<td>10A6142 0</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>1.5...22 l/min (Qn)</td>
<td>SS-14</td>
<td>10A6142 0</td>
</tr>
<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>6...46 l/min (Qn)</td>
<td>SS-14</td>
<td>10A6142 0</td>
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<tr>
<td>Air 1.013 bar (a) 20 °C</td>
<td>10...65 l/min (Qn)</td>
<td>CA-14</td>
<td>10A6142 0</td>
</tr>
<tr>
<td>Gas</td>
<td>Special scale*</td>
<td></td>
<td>10A6142 0</td>
</tr>
</tbody>
</table>

**Options:**
- Without alarm contact = 0
- Min. alarm contact = 1
- Max. alarm contact = 2
- Min./Max. alarm contact = 3

**Accessories: Switch amplifier**

**Model**
- Single alarm 230 V AC, 50/60 Hz
- Single alarm 115 V AC, 50/60 Hz
- Single alarm 24 V DC
- Double alarm 230 V AC, 50/60 Hz
- Double alarm 115 V AC, 50/60 Hz
- Double alarm 24 V DC

* To design "special scales" we require the information in the questionnaire (page 21)
  Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc.
2) not available with alarms, we will be glad to suggest alternative solutions.
2.4.2 Dimensions FAG6100

**Fig. 2-7:** Pipeline and Panel Mounting

### Dimensions:

<table>
<thead>
<tr>
<th>D</th>
<th>F</th>
<th>E</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>Scale Length</th>
<th>Model No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>G 1/4</td>
<td>1/4” NPT</td>
<td>36.5</td>
<td>165</td>
<td>181</td>
<td>238</td>
<td>264</td>
<td>5”</td>
</tr>
<tr>
<td>G 1/4</td>
<td>1/4” NPT</td>
<td>27.2</td>
<td>71</td>
<td>68</td>
<td>125</td>
<td>151</td>
<td>3”</td>
</tr>
</tbody>
</table>

* These holes are only for “panel mount” designs, adapter plate required.
3 Material Selections for Variable Area Flowmeters

This selection does not claim to be complete, however it does offer ease when selecting materials. At the present time these recommendations are based on laboratory tests by the material manufacturers or upon repetitive applications in practice. When in doubt the material recommendations should be obtained from the manufacturer since he has the most experience. Not included are the ball floats sizes 1/16” to 1/4”. If a glass meter tube is suitable for the application, then the assumption that a ball float made of glass or sapphire should also be suitable can be made.

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Concentration in %</th>
<th>Temperature in °C</th>
<th>Fittings</th>
<th>Floats</th>
<th>O-Rings</th>
<th>Meter Tube for All Metal Flowmeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x x x</td>
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<td>Acetic Acid</td>
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<td>x</td>
<td>x</td>
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<td>x</td>
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<td>x x x</td>
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<td>x x x</td>
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<td>Alaun, see Kalialaun</td>
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</table>

44
Thompson Equipment (TECO) | 800-528-8997 | www.teco-inc.com
<table>
<thead>
<tr>
<th>Fluid</th>
<th>Concentration in %</th>
<th>Temperature in °C</th>
<th>Fittings</th>
<th>Floats</th>
<th>O-Rings</th>
<th>Meter Tube for All Metal Flowmeters</th>
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☐ Materials are to be specified by the user, because in some cases 316Ti/316 [1.4571/1.4401] are unsatisfactory, alternate 1.4439
Additional information about our flow measurement technology may be found on our website

www.abb.com/flow
The most important variable area flow metering practices and their principles are described.

A large number of practical details provide the user with comprehensive and valuable information about the topic variable area flowmetering in an industrial environment.