

IN-FLOW^{CTA}

Industrial Mass Flow Meters and Controllers for Gases

> Introduction

Bronkhorst High-Tech B.V., the European market leader in thermal Mass Flow Meters/Controllers and Electronic Pressure Controllers, has many years of experience in designing and manufacturing precise and reliable measurement and control devices. With a wide range of instruments and offering innovative solutions for many different applications in a variety of different markets, Bronkhorst High-Tech is dedicated to customer satisfaction, quality and sustainability.

> IN-FLOW^{CTA} series for industrial applications

The Mass Flow Meters and Controllers of the IN-FLOW^{CTA} series are of rugged design (IP65) for use in pilot and production plants in industrial environments. The instruments operate on the principle of direct thermal mass flow measurement (no by-pass) and have no moving parts and no obstructions to the flow path. These features make IN-FLOW^{CTA} Mass Flow Meters ideal for low pressure drop applications and for the use on wet or dirty gases. Another advantage of using this type of sensor is that the instruments measure direct mass flow, without the need of temperature and pressure correction. Mass Flow Meters can be supplied in ranges starting from 10...200 ml_n/min up to 50...5000 l_n/min Air-equivalent. Mass Flow Control loops can be offered, up to 4...200 l_n/min Air-equivalent as flow meter with integrated control valve and up to 5000 l_n/min with separate control valve.

> State of the art digital design

The IN-FLOW^{CTA} Mass Flow Meters and Controllers are equipped with a digital pc-board, offering excellent performance and many features, at an affordable price. The main digital pc-board on the instrument contains all of the general functions needed for measurement and control. It has analog I/O-signals and also an RS232 connection as a standard feature. In addition to this there is the possibility of integrating an interface board with DeviceNet™, Profibus-DP®, Modbus-RTU or FLOW-BUS protocol.



> General IN-FLOW^{CTA} features

- ◆ Virtually pressure and temperature independent
- ◆ Low pressure drop
- ◆ Weatherproof IP65 housing
- ◆ Optional: ATEX approval Cat.3, Zone 2
- ◆ Virtually insensitive to moisture or particulates
- ◆ Outstanding price/performance ratio
- ◆ Compliant with RoHS directives

> Digital features

- ◆ PROFIBUS-DP®, DeviceNet™, Modbus-RTU or FLOW-BUS slave
- ◆ RS232 interface
- ◆ Alarm and counter functions
- ◆ Control characteristics user configurable

> Technical specifications

| Performance | |
|--|---|
| Accuracy (incl. linearity) (based on actual calibration) | : ± 1% FS plus ± 1% RD |
| Repeatability | : < 0,2% FS typical |
| Turndown | : 1 : 50 or 1 : 100 (see flow range table) |
| Operating pressure | : 0...10 bar(g) |
| Pressure sensitivity | : 0,3% RD/bar typical at Air |
| Operating temperature | : 0...50°C; |
| Temperature sensitivity | : zero: < 0,1% FS/°C; span: < 0,2% RD/°C |
| Leak integrity (outboard) | : tested < 2 x 10 ⁻⁹ mbar l/s He |
| Attitude sensitivity | : max. error at 90° off horizontal 0,2% at 1 bar, typical N ₂ |
| Sensitivity to upstream piping configuration | : virtually insensitive |
| Response time (sensor, t63%) | : T10/T11: 0,3 seconds; other models: 0,9 seconds |
| Settling time (controller) | : approx. 2 seconds |
| Warm-up time | : 30 min. for optimum accuracy 2 min for accuracy ± 2% FS |
| Mechanical parts | |
| Material (wetted parts) | : SS316; other on request |
| Process connections | : BSPP female thread: T10/T20/T11/T21: 1/8" T12/T22: 1/4" T13/T23/T14: 1/2" T15: 1" |
| Seals | : standard: Viton®; options: EPDM, FFKM (Kalrez)® |
| Ingress protection (housing) | : IP65 |
| Electrical properties | |
| Power supply | : + 15...24 Vdc |
| Power consumption | : meter: max. 125 mA; controller: max. 375 mA; add 50 mA for PROFIBUS, if applicable |
| Analog output/command | : 0...5 (10) Vdc or 0 (4)...20 mA (sourcing output) |
| Digital communication | : standard: RS-232 options: PROFIBUS-DP®, DeviceNet™, Modbus-RTU, FLOW-BUS |
| Electrical connection | |
| Analog/RS232 | : 8-pin DIN male |
| PROFIBUS-DP® | : bus: 5-pin M12 female; power: 8-DIN male |
| DeviceNet™ | : 5-pin M12 male |
| Modbus-RTU/FLOW-BUS | : 5-pin M12 male |
| <i>Technical specifications subject to change without notice</i> | |

> Warranty

All instruments and accessories are warranted for a period of 3 years from order date.

> Models and flow ranges (based on Air)

| Mass Flow Meters (MFM) | | |
|---|--------------------------------|-------------------------------|
| Model | Minimum | Maximum |
| T10 | 0,01...0,2 l _v /min | 0,02...2 l _v /min |
| T11 | 0,02...1 l _v /min | 0,05...5 l _v /min |
| T12 | 0,1...5 l _v /min | 0,5...50 l _v /min |
| T13 | 0,4...20 l _v /min | 2...200 l _v /min |
| T14 | 2...100 l _v /min | 10...1000 l _v /min |
| T15 | 10...500 l _v /min | 50...5000 l _v /min |
| Mass Flow Controllers (MFC) | | |
| Model | Minimum | Maximum |
| T20 ¹⁾ | 0,01...0,2 l _v /min | 0,04...2 l _v /min |
| T21 ¹⁾ | 0,02...1 l _v /min | 0,1...5 l _v /min |
| T22 ¹⁾ | 0,1...5 l _v /min | 1...50 l _v /min |
| T23 ²⁾ | 0,4...20 l _v /min | 4...200 l _v /min |
| ¹⁾ K _v -max = 6,6 x 10 ⁻² ²⁾ K _v -max = 0,35 | | |

The MFCs listed above are equipped with integrated control valves. For higher flowrates Bronkhorst High-Tech offers combinations of Mass Flow Meters with separate control valves. Typical combinations:

T13 + F-002AI, K_v-max = 0,4
 T13 + F-004AI, K_v-max = 0,3
 T14 + F-003AI, K_v-max = 1,5
 T14 + F-004BI, K_v-max = 1
 T15 + F-003BI, K_v-max = 6

> Conversion factor table

For conversion to Air at 1013 mbar and 0°C you may use the following table for model selection:

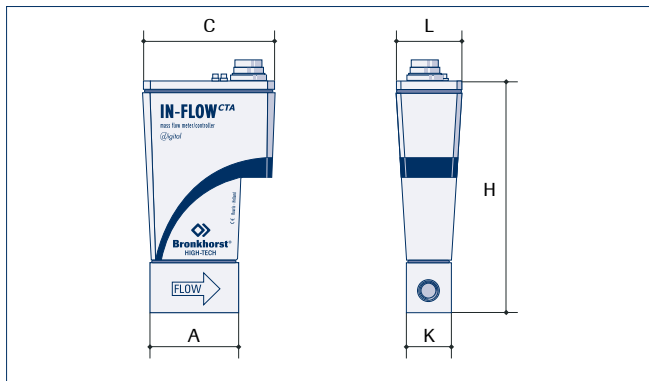
| Gas | Cf (T10, T11, T20, T21) | Cf (other models) | Gas | Cf (T10, T11, T20, T21) | Cf (other models) |
|--------------------------------|-------------------------------|-------------------------|------------------------|-------------------------------|-------------------------|
| Air | 1,00 | 1,00 | CO ₂ | 0,86 | 1,13 |
| Ar | 1,50 | 2,02 | HCl | 1,12 | 1,53 |
| CH ₄ | 0,77 | 0,61 | N ₂ | 1,00 | 1,00 |
| C ₂ H ₂ | 0,66 | 0,68 | NH ₃ | 0,82 | 0,74 |
| C ₂ H ₄ | 0,70 | 0,75 | NO | 1,00 | 1,01 |
| C ₂ H ₆ | 0,58 | 0,62 | N ₂ O | 0,83 | 1,08 |
| C ₃ H ₈ | 0,43 | 0,51 | O ₂ | 0,99 | 0,97 |
| C ₄ H ₁₀ | 0,32 | 0,41 | Xe | 1,96 | 6,09 |
| CO | 1,01 | 1,04 | Other gases on request | | |

Best accuracy is achieved by calibrating IN-FLOW^{CTA} instruments under actual process conditions. The conversion factor introduces an additional error in absolute accuracy in the order of:

$$Cf \geq 1 : 2xCf \text{ in } \% \text{ FS}$$

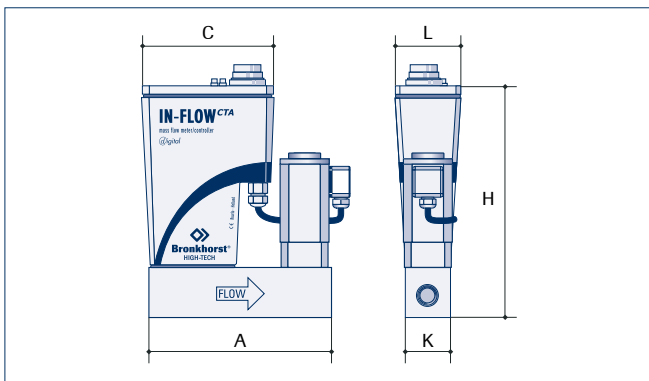
$$Cf \leq 1 : 2/Cf \text{ in } \% \text{ FS}$$

> Dimensions (mm)



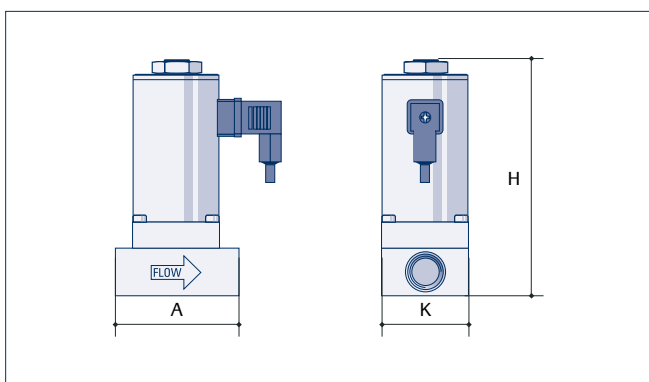
Mass Flow Meter

| Model | A | C | H | K | L |
|---------|-----|----|-----|----|----|
| T10/T11 | 47 | 74 | 129 | 25 | 36 |
| T12 | 90 | 74 | 125 | 30 | 36 |
| T13 | 90 | 74 | 135 | 30 | 36 |
| T14 | 115 | 74 | 150 | 40 | 36 |
| T15 | 155 | 74 | 180 | 75 | 36 |



Mass Flow Controller

| Model | A | C | H | K | L |
|---------|-----|----|-----|----|----|
| T20/T21 | 100 | 74 | 129 | 25 | 36 |
| T22 | 120 | 74 | 125 | 30 | 36 |
| T23 | 135 | 74 | 135 | 34 | 36 |



Control Valves

| Model | A | H | K |
|---------|-----|-----|----|
| F-002AI | 78 | 116 | 59 |
| F-004AI | 64 | 122 | 45 |
| F-003AI | 97 | 130 | 74 |
| F-004BI | 85 | 174 | 65 |
| F-003BI | 114 | 147 | 89 |

> Accessories

For the IN-FLOW^{CTA} Mass Flow Meters and Controllers we offer the following accessories:

Adapter sets (in- and outlet, OD compression type)

| For models | Inch sizes | Metric sizes |
|------------|-------------|---------------|
| T10/T20 | 1/8" / 1/4" | 6 mm |
| T11/T21 | 1/4" | 6 mm |
| T12/T22 | 1/4" / 1/2" | 6 mm / 12 mm |
| T13/T23 | 1/2" | 12 mm |
| T14 | 1/2" / 3/4" | 12 mm / 20 mm |
| T15 | 1" | 25 mm |

Power supply and electrical connection

- ◆ Plug-in Power
Supply 110-240 Vac,
c/w cable 2 m
- ◆ Split cable
Power/Signal, 30 cm
- ◆ Interconnecting
cable, RJ-45 –
Loose end, 3 m
- ◆ RS-232 cable,
RJ-45 – 9-pin
Sub-D, 3 m

BRIGHT Series, IP65 Local Readout/Control Module

Mounted directly on
MFM/MFC or on wall,
panel or pipework



BRIGHT module



IN-FLOW^{CTA} model T15 Mass Flow Meter for high flow rates

> Fields of application

The IN-FLOW^{CTA} series find application in a wide variety of applications in the following markets (typically):

- ◆ Gas consumption monitoring for internal accounting
- ◆ Process gas measurement or control in food, pharmaceutical and (petro-) chemical industries, in fermentation installations and in fuel cell technology
- ◆ Environmental technology (air sampling)
- ◆ Methane production in anaerobic digestors
- ◆ Surface treatment (coating, hardening)
- ◆ Test benches

Some typical examples of applications are:

> Burner Control

Burner control using Mass Flow Controllers brings many advantages compared to conventional systems, where flow is adjusted through needle valves. When burner orifices get clogged or when gas supply pressure varies, an MFC will automatically adapt to the changed conditions. For the control of relatively large flows with low differential pressure, which is typical for natural gas or CH₄, Bronkhorst High-Tech offers mass flow meters with separate pressure compensated bellows valves.

> Measurement of leak or throughput

Mass Flow Meters are often installed in quality control test benches to determine, for example, the leak through valves or engine blocks. In similar systems the gas throughput is measured of filter, membranes, catalists, etc. The results of the measurement can be indicated on a display as a readout value or as a minimum or maximum alarm.

> Gas consumption measurement

When mass flow meters are installed at locations with different cost centres (laboratories, hospitals, etc.) it will be clear which users are responsible for the gas consumption. This enables a fair internal accounting and will often lead to a reduced expenditure for the organisation.

> Air supply in food processing

In many systems in the food industry you will find Bronkhorst's mass flow meters and controllers being used for air supply in ratio to a bulk mass stream of half-finished product. Some typical examples are: icecream and other dairy products, dough for bakery products and candy or chocolate foam.

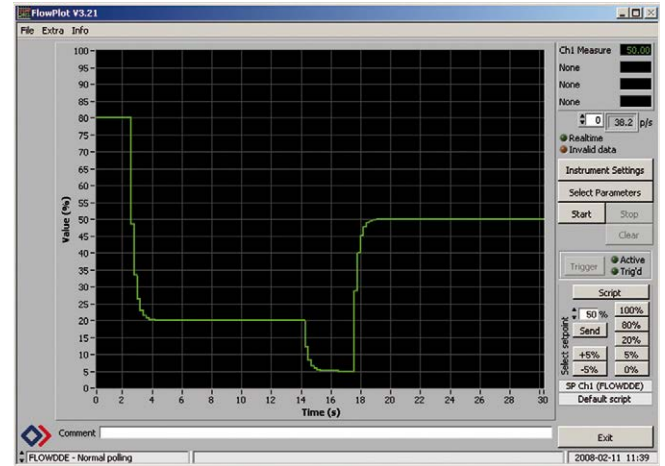
> Compressed air flow measurement

IN-FLOW^{CTA} Mass Flow Meters are ideally suited for the monitoring of compressed air systems. Due to their construction, the instruments are insensitive to any moisture, oil or particulates that may be carried through the compressed air network. Furthermore, the mass flow meters are virtually independent from variations in both pressure and temperature. Typical applications would include performance testing, leak detection, maintenance management and the measurement of compressed air consumption. For point of use measurement we recommend our BRIGHT display module, which can indicate both actual and totalized air flow.

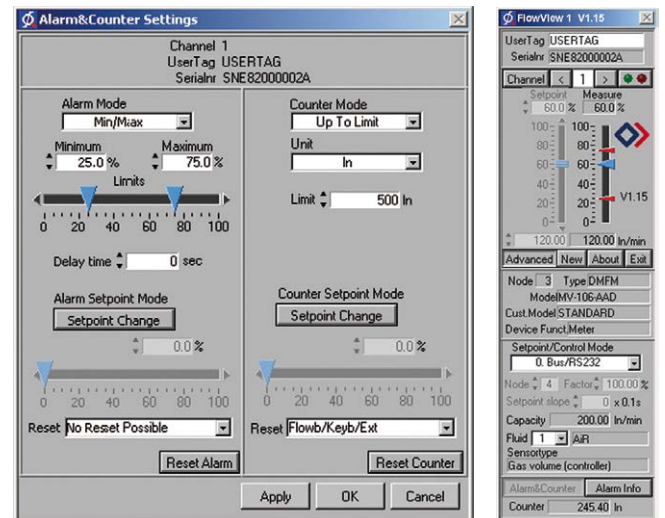
> Bronkhorst FlowWare, free software tools

Bronkhorst High-Tech offers the following software support for installation and operation by personal computer:

- *FlowDDE*: Software tool to interface between digital instruments and windows software.
- *FlowPlot*: Software tool for monitoring and optimizing digital instruments parameters.



- *FlowView*: Software tool to operate Bronkhorst digital instruments.



These software tools are freeware for users of our IN-FLOW^{CTA} series and other digital Bronkhorst instruments.

> Model number identification

T N N - N N N - NN - A

Base

| | |
|---|------------|
| 1 | Meter |
| 2 | Controller |

Capacity (based on air)

| | | |
|---|---------------------|--------------------------------|
| 0 | ultra low flow (UF) | up to 2 l _v /min |
| 1 | small flow (SF) | up to 5 l _v /min |
| 2 | low flow (LF) | up to 50 l _v /min |
| 3 | medium flow (MF) | up to 200 l _v /min |
| 4 | high flow (HF) | up to 1000 l _v /min |
| 5 | very high flow (VF) | up to 5000 l _v /min |

Communication (I/O)

| | |
|---|--------------------------------|
| A | RS232 + analog (n/c) |
| B | RS232 + analog (n/o) |
| D | RS232 + DeviceNet™ (n/c) |
| E | RS232 + DeviceNet™ (n/o) |
| M | RS232 + Modbus-RTU (n/c) |
| N | RS232 + Modbus-RTU (n/o) |
| P | RS232 + PROFIBUS-DP® (n/c) |
| Q | RS232 + PROFIBUS-DP® (n/o) |
| R | RS232 + FLOW-BUS (n/c control) |
| S | RS232 + FLOW-BUS (n/o control) |

Analog output

| | |
|---|--------------------|
| A | 0...5 Vdc |
| B | 0...10 Vdc |
| F | 0...20 mA sourcing |
| G | 4...20 mA sourcing |

Supply voltage

| | |
|---|--------------|
| D | +15...24 Vdc |
|---|--------------|

Internal seals

| | |
|---|--------------------------|
| V | Viton (factory standard) |
| E | EPDM |
| K | Kalrez (FFKM) |

Connections (in/out)

| | | UF | SF | LF | MF | HF | VF |
|---|----------------------------|----|----|----|----|----|----|
| 0 | None (factory standard) | • | • | • | • | • | • |
| 1 | 1/8" OD compression type | • | | | | | |
| 2 | 1/4" OD compression type | • | • | • | | | |
| 3 | 6 mm OD compression type | • | • | • | | | |
| 4 | 12 mm OD compression type | | | • | • | • | |
| 5 | 1/2" OD compression type | | | • | • | • | |
| 6 | 20 mm OD compression type | | | | • | • | |
| 8 | 1/4" Face seal male | • | • | • | | | |
| 9 | Other: 3/4" OD compr. type | | | | • | • | |
| | 1" OD compr. type | | | | | • | • |
| | 25 mm OD compr. type | | | | | • | • |



IN-FLOW^{CTA} model T13 Mass Flow Meter with close coupled Control Valve F-002B1



IN-FLOW^{CTA} model T21 Mass Flow Controller for small flow rates



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