



# IN-FLOW™

Industrial Style Digital Mass Flow Meters and Controllers for Gases



## › Introduction

Bronkhorst High-Tech B.V., the European market leader in low flow thermal and Coriolis Mass Flow Meters/Controllers, has many years experience in designing and manufacturing precise and reliable measurement and control devices. With a wide range of instruments, Bronkhorst offers innovative solutions for many different applications in many different markets. The instruments are made to customers' specification, in various styles, suitable for use in laboratory, industrial environment, hazardous areas and production machinery.

## › IN-FLOW series for industrial environments

The Mass Flow Meters of the IN-FLOW series are of rugged design (IP65) for use in pilot and production plants in industrial environments or even Zone 2 hazardous areas, with optional ATEX Category 3, FM Class I Div. 2 or KCs approval. Mass Flow Meters can be supplied in ranges starting from 0,014...0,7 ml<sub>n</sub>/min up to 11000 m<sup>3</sup><sub>n</sub>/h air-equivalent, with pressure rating between vacuum and 700 bar. In combination with control valves, either integrated or separate, Mass Flow Controllers can be offered up to 10...500 m<sup>3</sup><sub>n</sub>/h air-equivalent.

Today's IN-FLOW series are equipped with a digital pc-board, offering high accuracy, excellent temperature stability and fast response. The main digital pc-board contains all of the general functions needed for measurement and control. In addition to the standard RS232 output the instruments also offer analog I/O and a variety of fieldbus interface options.

## › Selectable gases and flow ranges

The IN-FLOW design features optional Multi-Gas / Multi Range functionality, providing (OEM-) customers with extra flexibility and process efficiency. Users of MFC's in pilot plants or laboratories can rescale their instruments on site, saving time and money; substantial costs for stock keeping, (dis)mounting and also for service and recalibration are no longer applicable. Our free and easy-to-use software tool 'FlowTune' enables the user to change the instrument's configuration swiftly via a computer.



F-112AI Mass Flow Meter

## › Mass Flow Controllers for every application

The control valve can be furnished as integral part of an IN-FLOW MFC, or as separate component. It is a proportional, electromagnetic control valve with extremely fast and smooth control characteristics.

With reference to the specific field of application there are different series of control valves. There is a standard direct acting valve for common applications, a pilot operated valve for high flow rates, the so-called Vary-P valve with pressure rating 400 or 700 bar, that can cope with up to 400 bar ΔP and a bellows valve for applications with very low differential pressure.

## › General IN-FLOW features

- ◆ Weatherproof IP65 housing
- ◆ Optional: ATEX Cat.3, Zone 2, FM Class I Div. 2 or KCs approval
- ◆ Fast response, excellent repeatability
- ◆ Pressure ratings up to 700 bar
- ◆ Compliant with RoHS directives

## › Digital features

- ◆ Fieldbus interfaces:
  - ◆ DeviceNet™, CANopen®
  - ◆ PROFIBUS DP, FLOW-BUS, Modbus RTU/ASCII
  - ◆ PROFINET, EtherCAT®, Modbus TCP, EtherNet/IP, POWERLINK
- ◆ Control characteristics user-configurable
- ◆ Optional Multi Gas / Multi Range functionality up to 10 bar
- ◆ Alarm and counter functions



F-106CI Mass Flow Meter for high flow ranges (wafer type)

## › Technical specifications

### Measurement / control system

|   |  |
|---|--|
| Accuracy (incl. linearity)<br>(based on actual calibration) | standard: $\pm 0,5\%$ Rd plus $\pm 0,1\%$ FS;<br>$\pm 0,8\%$ Rd plus $\pm 0,2\%$ FS for F-110CI-005/<br>F-200CI-005;<br>$\pm 2\%$ FS for F-110CI-002/F200CI-002;<br>$\pm 1\%$ FS for ranges > 1670 l <sub>v</sub> /min;<br>for ranges > 1100 m <sup>3</sup> /h contact factory |
| Turndown  | up to 1:187,5 (1:50 in analog mode)  |
| Repeatability   | < 0,2% Rd  |
| Settling time (controller)                                  | standard: 1...2 seconds  |
| Operating temperature                                       | -10...+70°C;<br>for ATEX cat. 3 and FM Class I Div. 2: 0...50°C  |
| Temperature sensitivity                                     | zero: < 0,05% FS/°C;<br>span: < 0,05% Rd/°C  |
| Pressure sensitivity  | 0,1% Rd/bar typical N <sub>2</sub> ; 0,01% Rd/bar typical H <sub>2</sub>   |
| Leak integrity  | tested < 2 x 10 <sup>-9</sup> mbar l/s He  |
| Attitude sensitivity  | max. error at 90° off horizontal 0,2% at 1 bar,<br>typical N <sub>2</sub>  |
| Warm-up time  | 30 min. for optimum accuracy<br>2 min. for accuracy $\pm 2\%$ FS   |

### Mechanical parts

|                              |  |
|------------------------------|--|
| Material (wetted parts)      | stainless steel 316L or comparable   |
| Process connections          | compression type or face seal couplings; wafer<br>type on series F-106; DIN or ANSI flanges on series<br>F-107 |
| Seals                        | standard: Viton®;<br>options: EPDM, Kalrez® (FFKM)   |
| Ingress protection (housing) | IP65   |

### Electrical properties

|                                    |  |                |                |
|------------------------------------|--|----------------|----------------|
| Power supply                       | +15...24 Vdc   |                |                |
| Max. power consumption             | Supply   | at voltage I/O | at current I/O |
| Meter                              | 15 V   | 95 mA          | 125 mA         |
|                                    | 24 V   | 65 mA          | 85 mA          |
| Controller                         | 15 V   | 290 mA         | 320 mA         |
|                                    | 24 V   | 200 mA         | 215 mA         |
| Extra for fieldbus (if applicable) | 15 V < 75 mA<br>24 V < 50 mA   |                |                |
| Analog output/command              | 0...5 (10) Vdc or 0 (4)...20 mA (sourcing output)  |                |                |
| Digital communication              | standard: RS232<br>options: CANopen®, DeviceNet™, EtherCAT®,<br>PROFIBUS DP, PROFINET, Modbus RTU,<br>ASCII or TCP/IP, EtherNet/IP, POWERLINK<br>or FLOW-BUS |                |                |

### Electrical connection

|  |  |
|--|--|
| Analog, RS232  | 8 DIN (male);  |
| PROFIBUS DP  | bus: 5-pin M12 (female);<br>power: 8 DIN (male)              |
| Modbus TCP, EtherNet/IP, POWERLINK,<br>EtherCAT®, PROFINET | bus: 2 x 5-pin M12 (female) (in/out);<br>power: 8 DIN (male) |
| DeviceNet™, CANopen®                                       | 5-pin M12 (male)   |
| Modbus-RTU/ASCII, FLOW-BUS                                 | 5-pin M12 (male)   |

Technical specifications subject to change without notice.



F-201CI Compact IP65 Mass Flow Controller for low flow ranges

## › Models and flow ranges (based on air)

### Mass Flow Meters (MFM); PN100 (pressure rating 100 bar)

| Model     | min. flow                        | max. flow                     |
|-----------|----------------------------------|-------------------------------|
| F-110CI * | 0,014...0,7 ml <sub>v</sub> /min | 0,06...9 ml <sub>v</sub> /min |
| F-111BI * | 0,16...8 ml <sub>v</sub> /min    | 0,16...25 l <sub>v</sub> /min |
| F-111AI * | 0,4...20 l <sub>v</sub> /min     | 0,6...100 l <sub>v</sub> /min |
| F-112AI * | 0,8...40 l <sub>v</sub> /min     | 1,4...250 l <sub>v</sub> /min |
| F-113AI * | 4...200 l <sub>v</sub> /min      | 8...1670 l <sub>v</sub> /min  |

For ranges of 200, 400 or 700 bar rated MFMs please see our website.

### High-Flow MFMs; PN10 / PN16 / PN25 / PN40 / PN100

| Model                   | min. flow                                | max. flow                                  |
|-------------------------|--|--|
| F-116AI                 | 0,4...20 m <sup>3</sup> <sub>v</sub> /h  | 4...200 m <sup>3</sup> <sub>v</sub> /h     |
| F-116BI                 | 1...50 m <sup>3</sup> <sub>v</sub> /h    | 7,5...375 m <sup>3</sup> <sub>v</sub> /h   |
| F-106AI/F-107AI/F-117AI | 0,4...20 m <sup>3</sup> <sub>v</sub> /h  | 4...200 m <sup>3</sup> <sub>v</sub> /h     |
| F-106BI/F-107BI/F-117BI | 1...50 m <sup>3</sup> <sub>v</sub> /h    | 10...500 m <sup>3</sup> <sub>v</sub> /h    |
| F-106CI/F-107CI/F-117CI | 2...100 m <sup>3</sup> <sub>v</sub> /h   | 20...1000 m <sup>3</sup> <sub>v</sub> /h   |
| F-106DI/F-107DI/F-117DI | 3,6...180 m <sup>3</sup> <sub>v</sub> /h | 36...1800 m <sup>3</sup> <sub>v</sub> /h   |
| F-106EI                 | 8...400 m <sup>3</sup> <sub>v</sub> /h   | 80...4000 m <sup>3</sup> <sub>v</sub> /h   |
| F-106FI                 | 14...700 m <sup>3</sup> <sub>v</sub> /h  | 140...7000 m <sup>3</sup> <sub>v</sub> /h  |
| F-106GI                 | 22...1100 m <sup>3</sup> <sub>v</sub> /h | 220...11000 m <sup>3</sup> <sub>v</sub> /h |

### Mass Flow Controllers (MFC); PN64 / PN100

| Model                           | min. flow                               | max. flow                                |
|---------------------------------|---|--|
| F-200CI/F-210CI <sup>1)</sup>   | 0,014...0,7 ml <sub>v</sub> /min        | 0,18...9 ml <sub>v</sub> /min            |
| F-201CI/F-211CI <sup>1)</sup> * | 0,16...8 ml <sub>v</sub> /min           | 0,16...25 l <sub>v</sub> /min            |
| F-201AI/F-211AI <sup>1)</sup> * | 0,4...20 l <sub>v</sub> /min            | 0,6...100 l <sub>v</sub> /min            |
| F-202AI/F-212AI <sup>2)</sup>   | 0,8...40 l <sub>v</sub> /min            | 1,4...250 l <sub>v</sub> /min            |
| F-203AI/F-213AI <sup>2)</sup>   | 4...200 l <sub>v</sub> /min             | 8...1670 l <sub>v</sub> /min             |
| F-206AI/F-216AI <sup>3)</sup>   | 0,4...20 m <sup>3</sup> <sub>v</sub> /h | 4...200 m <sup>3</sup> <sub>v</sub> /h   |
| F-206BI/F-216BI <sup>4)</sup>   | 1...50 m <sup>3</sup> <sub>v</sub> /h   | 7,5...375 m <sup>3</sup> <sub>v</sub> /h |

<sup>1)</sup> K<sub>v</sub>-max = 6,6x10<sup>-2</sup> <sup>2)</sup> K<sub>v</sub>-max = 0,4 <sup>3)</sup> K<sub>v</sub>-max = 1,5 <sup>4)</sup> K<sub>v</sub>-max = 6,0

### Mass Flow Controllers (MFC); PN200

| Model                 | min. flow                     | max. flow                     |
|-----------------------|-------------------------------|-------------------------------|
| F-221MI <sup>5)</sup> | 0,3...15 ml <sub>v</sub> /min | 0,16...25 l <sub>v</sub> /min |

<sup>5)</sup> K<sub>v</sub>-max = 6,65x10<sup>-3</sup>

### MFCs for high-pressure / high-ΔP applications; PN400

| Model   | min. flow                     | max. flow                     |
|---------|-------------------------------|-------------------------------|
| F-230MI | 0,2...10 ml <sub>v</sub> /min | 10...500 ml <sub>v</sub> /min |
| F-231MI | 10...500 ml <sub>v</sub> /min | 0,2...10 l <sub>v</sub> /min  |
| F-232MI | 0,2...10 l <sub>v</sub> /min  | 2...100 l <sub>v</sub> /min   |

For ranges of 700 bar rated MFCs please see our website.

\* For these models the Multi Gas / Multi Range option is available on request.



F-107BI Mass Flow Meter for high flow ranges

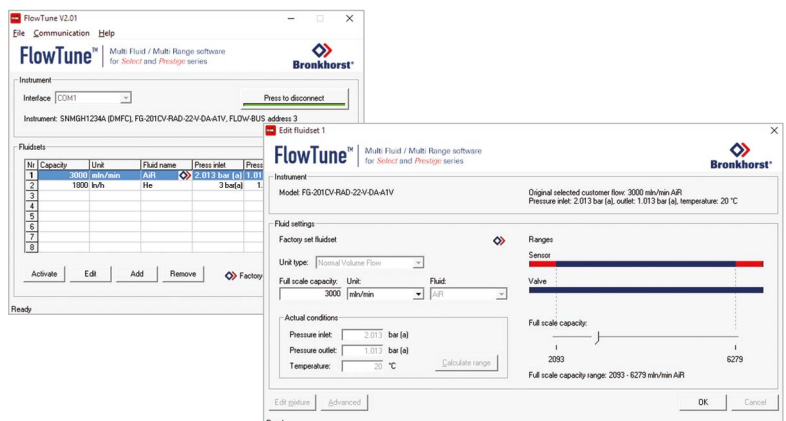
**» Table with minimum and maximum flow ranges for IN-FLOW instruments suitable for Multi Fluid / Multi Range functionality (valid for operating conditions from 0,8 to 10 bar abs and 0 to 70°C)**

| IN-FLOW MFM Model # | IN-FLOW MFC Model #         | Air flow ranges<br>Minimum/Nominal/Maximum  | Min/Max flow ranges for other gases  |                            |                               |                          |
|---------------------|-----------------------------|---|--------------------------------------|----------------------------|-------------------------------|--------------------------|
|                     |                             |   | Ar                                   | CH <sub>4</sub>            | C <sub>2</sub> H <sub>6</sub> | CO                       |
| F-110CI - 002       | F-200CI - 002 <sup>1)</sup> | Min. 0,014 - 0,7 ml <sub>r</sub> /min<br>Nom. 0,014 - 2 ml <sub>r</sub> /min<br>Max. 0,014 - 5 ml <sub>r</sub> /min | Min. 0,02 - 1<br>Max. 0,02 - 6       | 0,012 - 0,6<br>0,012 - 3,5 | 0,008 - 0,4<br>0,008 - 2      | 0,014 - 0,7<br>0,014 - 5 |
| F-110CI - 005       | F-200CI - 005 <sup>1)</sup> | Min. 0,06 - 3 ml <sub>r</sub> /min<br>Nom. 0,06 - 5 ml <sub>r</sub> /min<br>Max. 0,06 - 9 ml <sub>r</sub> /min      | Min. 0,07 - 3,5<br>Max. 0,07 - 9,5   | 0,04 - 2<br>0,04 - 5,5     | 0,028 - 1,4<br>0,028 - 4      | 0,06 - 3<br>0,06 - 9     |
| F-111BI - 020       | F-201CI - 020               | Min. 0,16 - 8 ml <sub>r</sub> /min<br>Nom. 0,16 - 20 ml <sub>r</sub> /min<br>Max. 0,16 - 30 ml <sub>r</sub> /min    | Min. 0,2 - 10<br>Max. 0,2 - 30       | 0,11 - 5,5<br>0,11 - 18    | 0,08 - 4<br>0,08 - 13         | 0,16 - 8<br>0,16 - 30    |
| F-111BI - 050       | F-201CI - 050               | Min. 0,4 - 20 ml <sub>r</sub> /min<br>Nom. 0,4 - 50 ml <sub>r</sub> /min<br>Max. 0,4 - 75 ml <sub>r</sub> /min      | Min. 0,54 - 27<br>Max. 0,54 - 75     | 0,34 - 17<br>0,34 - 47     | 0,22 - 11<br>0,22 - 34        | 0,4 - 20<br>0,4 - 75     |
| F-111BI - 100       | F-201CI - 100               | Min. 0,8 - 40 ml <sub>r</sub> /min<br>Nom. 0,8 - 100 ml <sub>r</sub> /min<br>Max. 0,8 - 150 ml <sub>r</sub> /min    | Min. 1,12 - 56<br>Max. 1,12 - 150    | 0,64 - 32<br>0,64 - 95     | 0,42 - 21<br>0,42 - 70        | 0,8 - 40<br>0,8 - 150    |
| F-111BI - 200       | F-201CI - 200               | Min. 1,6 - 80 ml <sub>r</sub> /min<br>Nom. 1,6 - 200 ml <sub>r</sub> /min<br>Max. 1,6 - 300 ml <sub>r</sub> /min    | Min. 2,4 - 120<br>Max. 2,4 - 300     | 1,3 - 65<br>1,3 - 190      | 0,88 - 44<br>0,88 - 140       | 1,6 - 80<br>1,6 - 300    |
| F-111BI - 500       | F-201CI - 500               | Min. 4 - 200 ml <sub>r</sub> /min<br>Nom. 4 - 500 ml <sub>r</sub> /min<br>Max. 4 - 750 ml <sub>r</sub> /min         | Min. 5,4 - 270<br>Max. 5,4 - 750     | 3,2 - 160<br>3,2 - 470     | 2,2 - 110<br>2,2 - 340        | 4 - 200<br>4 - 750       |
| F-111BI - 1K0       | F-201CI - 1K0               | Min. 8 - 400 ml <sub>r</sub> /min<br>Nom. 8 - 1000 ml <sub>r</sub> /min<br>Max. 8 - 1500 ml <sub>r</sub> /min       | Min. 11,2 - 560<br>Max. 11,2 - 1500  | 6,4 - 320<br>6,4 - 950     | 4,2 - 210<br>4,2 - 680        | 8 - 400<br>8 - 1500      |
| F-111BI - 2K0       | F-201CI - 2K0               | Min. 16 - 800 ml <sub>r</sub> /min<br>Nom. 16 - 2000 ml <sub>r</sub> /min<br>Max. 16 - 3000 ml <sub>r</sub> /min    | Min. 24 - 1200<br>Max. 24 - 3000     | 13 - 650<br>13 - 1900      | 8,8 - 440<br>8,8 - 1300       | 16 - 800<br>16 - 3000    |
| F-111BI - 5K0       | F-201CI - 5K0               | Min. 0,04 - 2 l <sub>r</sub> /min<br>Nom. 0,04 - 5 l <sub>r</sub> /min<br>Max. 0,04 - 7,5 l <sub>r</sub> /min       | Min. 0,054 - 2,7<br>Max. 0,054 - 7,5 | 0,032 - 1,6<br>0,032 - 4,7 | 0,022 - 1,1<br>0,022 - 3,3    | 0,04 - 2<br>0,04 - 7,5   |
| F-111BI - 10K       | F-201CI - 10K               | Min. 0,08 - 4 l <sub>r</sub> /min<br>Nom. 0,08 - 10 l <sub>r</sub> /min<br>Max. 0,08 - 15 l <sub>r</sub> /min       | Min. 0,112 - 5,6<br>Max. 0,112 - 15  | 0,064 - 3,2<br>0,064 - 9,5 | 0,042 - 2,1<br>0,042 - 6,9    | 0,08 - 4<br>0,08 - 15    |
| F-111BI - 20K       | F-201CI - 20K               | Min. 0,16 - 8 l <sub>r</sub> /min<br>Nom. 0,16 - 20 l <sub>r</sub> /min<br>Max. 0,16 - 25 l <sub>r</sub> /min       | Min. 0,2 - 10<br>Max. 0,2 - 25       | 0,13 - 6,5<br>0,13 - 16    | 0,088 - 4,4<br>0,088 - 11     | 0,16 - 8<br>0,16 - 25    |
| F-111AI - 50K       | F-201AI - 50K               | Min. 0,4 - 20 l <sub>r</sub> /min<br>Nom. 0,4 - 50 l <sub>r</sub> /min<br>Max. 0,4 - 75 l <sub>r</sub> /min         | Min. 0,54 - 27<br>Max. 0,54 - 75     | 0,32 - 16<br>0,32 - 47     | 0,22 - 11<br>0,22 - 34        | 0,4 - 20<br>0,4 - 75     |
| F-111AI - 70K       | F-201AI - 70K               | Min. 0,6 - 30 l <sub>r</sub> /min<br>Nom. 0,6 - 70 l <sub>r</sub> /min<br>Max. 0,6 - 100 l <sub>r</sub> /min        | Min. 0,9 - 45<br>Max. 0,9 - 100      | 0,5 - 25<br>0,5 - 60       | 0,4 - 20<br>0,4 - 45          | 0,6 - 30<br>0,6 - 100    |
| F-112AI - M10       | F-202AI - M10 <sup>1)</sup> | Min. 0,8 - 40 l <sub>r</sub> /min<br>Nom. 0,8 - 100 l <sub>r</sub> /min<br>Max. 0,8 - 150 l <sub>r</sub> /min       | Min. 1,12 - 56<br>Max. 1,12 - 150    | 0,64 - 32<br>0,64 - 95     | 0,42 - 21<br>0,42 - 68        | 0,8 - 40<br>0,8 - 150    |
| F-112AI - M20       | F-202AI - M20 <sup>1)</sup> | Min. 1,4 - 70 l <sub>r</sub> /min<br>Nom. 1,4 - 200 l <sub>r</sub> /min<br>Max. 1,4 - 250 l <sub>r</sub> /min       | Min. 2 - 100<br>Max. 2 - 250         | 1,1 - 55<br>1,1 - 170      | 0,7 - 35<br>0,7 - 120         | 1,4 - 70<br>1,4 - 250    |
| F-113AI - M50       | F-203AI - M50 <sup>1)</sup> | Min. 4 - 200 l <sub>r</sub> /min<br>Nom. 4 - 500 l <sub>r</sub> /min<br>Max. 4 - 750 l <sub>r</sub> /min            | Min. 5,4 - 270<br>Max. 5,4 - 750     | 3,2 - 160<br>3,2 - 470     | 2,2 - 110<br>2,2 - 340        | 4 - 200<br>4 - 750       |
| F-113AI - 1M0       | F-203AI - 1M0 <sup>1)</sup> | Min. 8 - 400 l <sub>r</sub> /min<br>Nom. 8 - 1000 l <sub>r</sub> /min<br>Max. 8 - 1670 l <sub>r</sub> /min          | Min. 11,2 - 560<br>Max. 11,2 - 1670  | 6,4 - 320<br>6,4 - 900     | 4,2 - 210<br>4,2 - 750        | 8 - 400<br>8 - 1500      |

<sup>1)</sup> Multi Gas / Multi Range option not available for these models

**» Multi Gas / Multi Range features**

- ◆ Rangeability up to 187,5 : 1
- ◆ Flexible, user-programmable ranges and gas types
- ◆ Easy-to-use configuration software
- ◆ Multi Gas / Multi Range functionality up to 10 bar; pressure rating up to 100 bar
- ◆ High accuracy and repeatability



| CO <sub>2</sub> | H <sub>2</sub> | He          | N <sub>2</sub> | N <sub>2</sub> O | O <sub>2</sub> |  |
|-----------------|----------------|-------------|----------------|------------------|----------------|--|
| 0,012 - 0,6     | 0,014 - 0,7    | 0,02 - 1    | 0,014 - 0,7    | 0,012 - 0,6      | 0,014 - 0,7    |  |
| 0,012 - 3       | 0,014 - 5      | 0,02 - 7    | 0,014 - 5      | 0,012 - 3        | 0,014 - 5      |  |
| 0,04 - 2        | 0,06 - 3       | 0,07 - 3,5  | 0,06 - 3       | 0,04 - 2         | 0,06 - 3       |  |
| 0,04 - 4,5      | 0,06 - 7,2     | 0,07 - 10   | 0,06 - 9       | 0,04 - 4,5       | 0,06 - 9       |  |
| 0,14 - 7        | 0,144 - 7,2    | 0,2 - 10    | 0,16 - 8       | 0,12 - 6         | 0,16 - 8       |  |
| 0,14 - 16       | 0,144 - 25     | 0,2 - 35    | 0,16 - 30      | 0,12 - 16        | 0,16 - 30      |  |
| 0,3 - 15        | 0,42 - 21      | 0,56 - 28   | 0,4 - 20       | 0,3 - 15         | 0,4 - 20       |  |
| 0,3 - 39        | 0,42 - 65      | 0,56 - 90   | 0,4 - 75       | 0,3 - 38         | 0,4 - 73       |  |
| 0,62 - 31       | 0,84 - 42      | 1,12 - 56   | 0,8 - 40       | 0,6 - 30         | 0,8 - 40       |  |
| 0,62 - 79       | 0,84 - 130     | 1,12 - 180  | 0,8 - 150      | 0,6 - 77         | 0,8 - 140      |  |
| 1,22 - 61       | 1,68 - 84      | 2,4 - 120   | 1,6 - 80       | 1,2 - 60         | 1,6 - 80       |  |
| 1,22 - 150      | 1,68 - 260     | 2,4 - 360   | 1,6 - 300      | 1,2 - 150        | 1,6 - 290      |  |
| 3 - 150         | 4,2 - 210      | 5,6 - 280   | 4 - 200        | 3 - 150          | 4 - 200        |  |
| 3 - 390         | 4,2 - 650      | 5,6 - 900   | 4 - 750        | 3 - 380          | 4 - 730        |  |
| 6,2 - 310       | 8,4 - 420      | 11,2 - 560  | 8 - 400        | 6 - 300          | 8 - 400        |  |
| 6,2 - 790       | 8,4 - 1300     | 11,2 - 1800 | 8 - 1500       | 6 - 770          | 8 - 1400       |  |
| 12,2 - 610      | 16,8 - 840     | 24 - 1200   | 16 - 800       | 12 - 600         | 16 - 800       |  |
| 12,2 - 1500     | 16,8 - 2600    | 24 - 3600   | 16 - 3000      | 12 - 1500        | 16 - 2900      |  |
| 0,03 - 1,5      | 0,042 - 2,1    | 0,056 - 2,8 | 0,04 - 2       | 0,03 - 1,5       | 0,04 - 2       |  |
| 0,03 - 3,9      | 0,042 - 6,5    | 0,056 - 9   | 0,04 - 7,5     | 0,03 - 3,8       | 0,04 - 7,3     |  |
| 0,062 - 3,1     | 0,084 - 4,2    | 0,112 - 5,6 | 0,08 - 4       | 0,06 - 3         | 0,08 - 4       |  |
| 0,062 - 7,9     | 0,084 - 13     | 0,112 - 18  | 0,08 - 15      | 0,06 - 7,7       | 0,08 - 14      |  |
| 0,122 - 6,1     | 0,168 - 8,4    | 0,24 - 12   | 0,16 - 8       | 0,12 - 6         | 0,16 - 8       |  |
| 0,122 - 14      | 0,168 - 25     | 0,24 - 30   | 0,16 - 25      | 0,12 - 14        | 0,16 - 25      |  |
| 0,3 - 15        | 0,42 - 21      | 0,56 - 28   | 0,4 - 20       | 0,3 - 15         | 0,4 - 20       |  |
| 0,3 - 39        | 0,42 - 65      | 0,56 - 90   | 0,4 - 75       | 0,3 - 38         | 0,4 - 73       |  |
| 0,5 - 25        | 0,6 - 30       | 0,9 - 45    | 0,6 - 30       | 0,5 - 25         | 0,6 - 30       |  |
| 0,5 - 50        | 0,6 - 90       | 0,9 - 125   | 0,6 - 100      | 0,5 - 50         | 0,6 - 90       |  |
| 0,62 - 31       | 0,84 - 42      | 1,12 - 56   | 0,8 - 40       | 0,6 - 30         | 0,8 - 40       |  |
| 0,62 - 79       | 0,84 - 130     | 1,12 - 180  | 0,8 - 150      | 0,6 - 77         | 0,8 - 140      |  |
| 1 - 50          | 1,4 - 70       | 2 - 100     | 1,4 - 70       | 1 - 50           | 1,4 - 70       |  |
| 1 - 130         | 1,4 - 200      | 2 - 300     | 1,4 - 250      | 1 - 130          | 1,4 - 250      |  |
| 3 - 150         | 4,2 - 210      | 5,6 - 280   | 4 - 200        | 3 - 150          | 4 - 200        |  |
| 3 - 390         | 4,2 - 650      | 5,6 - 900   | 4 - 750        | 3 - 380          | 4 - 730        |  |
| 6,2 - 310       | 8,4 - 420      | 11,2 - 560  | 8 - 400        | 6 - 300          | 8 - 400        |  |
| 6,2 - 850       | 8,4 - 1350     | 11,2 - 1850 | 8 - 1670       | 6 - 840          | 8 - 1500       |  |

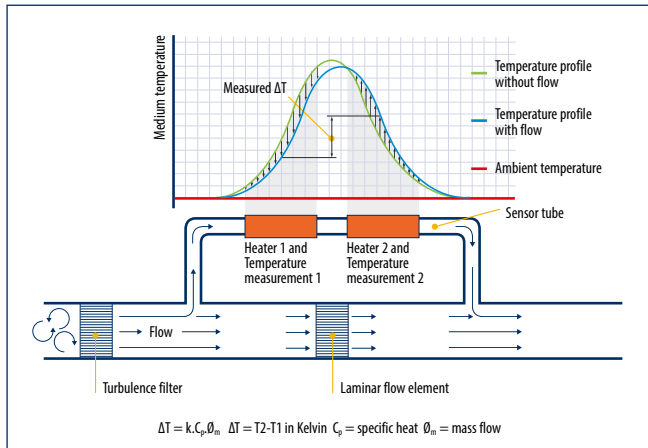
ml<sub>n</sub>/minl<sub>n</sub>/min

## Notes

- ◆ Multi Gas / Multi Range is optional on low-flow IN-FLOW series and must be requested at the point of ordering
- ◆ Extended rangeability for digital communication only; turndown 50:1 when using analog I/O options
- ◆ The selected orifice of the control valve may limit the rangeability
- ◆ Standard accuracy (based on actual calibration):  $\pm(0,5\% \text{ RD} + 0,1\% \text{ FS})$ ;  
 $\pm 0,8\% \text{ Rd plus } \pm 0,2\% \text{ FS for F-110CI-005/F-200CI-005; } \pm 2\% \text{ FS for F-110CI-002/F-200CI-002}$
- ◆ Maximum range for gases not mentioned in this list; rule of thumb: nominal range for Air x Conversion Factor;  
e.g. F-111BI - 1K0: maximum range for SF<sub>6</sub> = 1000 x 0,27 = 270 ml<sub>n</sub>/min
- ◆ Minimum range for gases not mentioned in this list; rule of thumb: minimum range for Air x Conversion Factor;  
e.g. F-111BI - 1K0: minimum range for SF<sub>6</sub> = 400 x 0,27 = 108 ml<sub>n</sub>/min
- ◆ The Conversion Factors for these calculations can be extracted from Fluidat on the Net ([www.fluidat.com](http://www.fluidat.com)): Go to 'Flow calculations' and select 'Gas Conversion factor'. Select 'Fluid from' and make sure 'Fluid to' is Air. Select the applicable instrument model from the pulldown menu. Then press 'Calculate' and look up the conversion factor from the table.

## › Thermal mass flow measuring principle

The heart of the thermal mass flow meter/controller is the sensor, that consists of a stainless steel capillary tube with resistance thermometer elements. A part of the gas flows through this bypass sensor, and is warmed up by heating elements. Consequently the measured temperatures T1 and T2 drift apart. The temperature difference is directly proportional to mass flow through the sensor. In the main channel Bronkhorst applies a patented laminar flow element consisting of a stack of stainless steel discs with precision-etched flow channels. Thanks to the perfect flow-split the sensor output is proportional to the total mass flow rate.



## › Fields of application

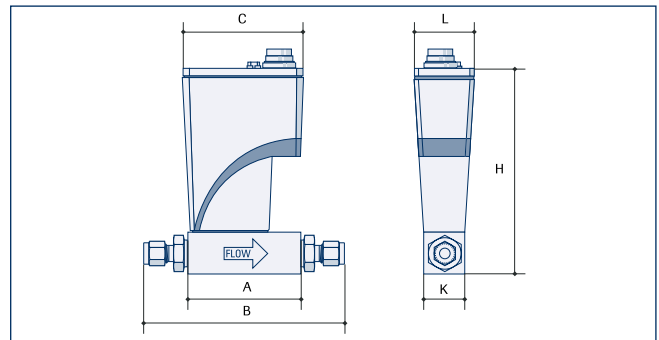
The IN-FLOW series have been successfully applied in a wide variety of industrial applications, such as:

- ◆ Process gas measurement or control in food, pharmaceutical and (petro) chemical industries, in fermentation installations and in fuel cell technology
- ◆ Sample gas measurement
- ◆ Burner control
- ◆ Gas consumption measurement for internal accounting
- ◆ Making of defined gas mixtures

## › For low pressure drop and corrosive gases

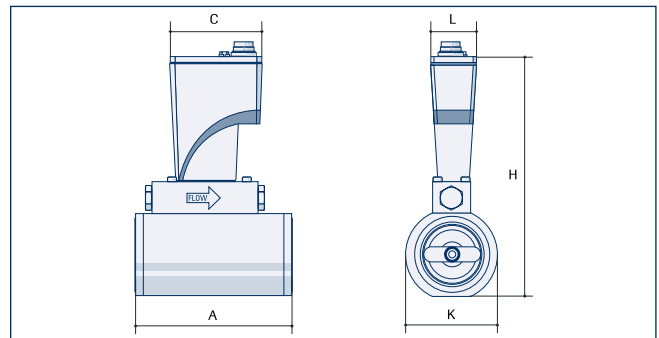
For applications with only little differential pressure, Bronkhorst developed the LOW- $\Delta P$ -FLOW series mass flow meters and controllers, which can also be supplied with an IP65 (IN-FLOW) housing. In these instruments the flow resistance is minimized by using a large bore sensor in combination with a cylindrical flow splitter. Except for the resulting lower pressure drop, this construction also minimises the risks of clogging and facilitates the cleaning and purging of these instruments. Up to 50 l<sub>v</sub>/min air-equivalent, flow control applications with restricted delta-P can be handled with integrated LOW- $\Delta P$ -FLOW Mass Flow Controllers. For the control of higher flow rates at very low differential pressures Bronkhorst has devised special control valves with pressure compensation bellows (series F-004). These control valves are piped on to the flow meter while the electronic PI-control function is an integral part of the flow meter.

## › Dimensions (mm)\*



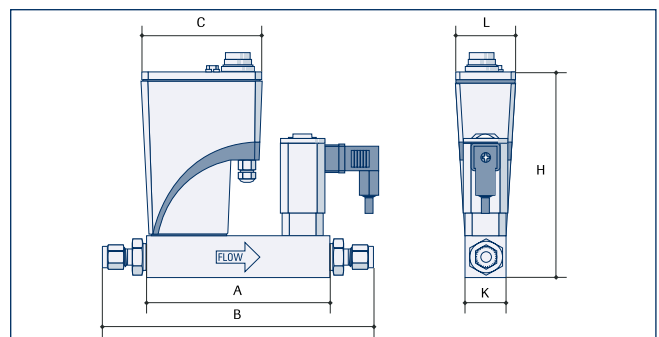
### Mass Flow Meters

| Model             | A   | B   | C  | H   | K  | L  | Weight (kg) |
|-------------------|-----|-----|----|-----|----|----|-------------|
| F-110CI (1/8" OD) | 47  | 98  | 74 | 125 | 25 | 36 | 0,8         |
| F-111BI (1/4" OD) | 69  | 126 | 74 | 125 | 25 | 36 | 0,9         |
| F-111AI (1/4" OD) | 69  | 126 | 74 | 137 | 26 | 36 | 1,0         |
| F-112AI (1/2" OD) | 65  | 130 | 74 | 153 | 59 | 36 | 1,8         |
| F-113AI (1/2" OD) | 112 | 189 | 74 | 167 | 74 | 36 | 3,3         |
| F-116AI (1/2" OD) | 174 | 241 | 74 | 192 | 74 | 36 | 5,0         |
| F-116BI (1" OD)   | 192 | 275 | 74 | 209 | 89 | 36 | 8,0         |



### Mass Flow Meters, high flow, wafer type

| Model               | A   | C  | H   | K   | L  | Weight (kg) |
|---------------------|-----|----|-----|-----|----|-------------|
| F-106AI (DN40/1,5") | 125 | 74 | 192 | 75  | 36 | 4,0         |
| F-106BI (DN50/2")   | 125 | 74 | 205 | 85  | 36 | 4,6         |
| F-106CI (DN80/3")   | 125 | 74 | 234 | 115 | 36 | 6,8         |
| F-106DI (DN100/4")  | 125 | 74 | 264 | 145 | 36 | 9,5         |
| F-106EI (DN150/6")  | 125 | 74 | 319 | 198 | 36 | 13,3        |
| F-106FI (DN200/8")  | 125 | 74 | 371 | 249 | 36 | 18,1        |
| F-106GI (DN250/10") | 125 | 74 | 436 | 313 | 36 | 27,0        |

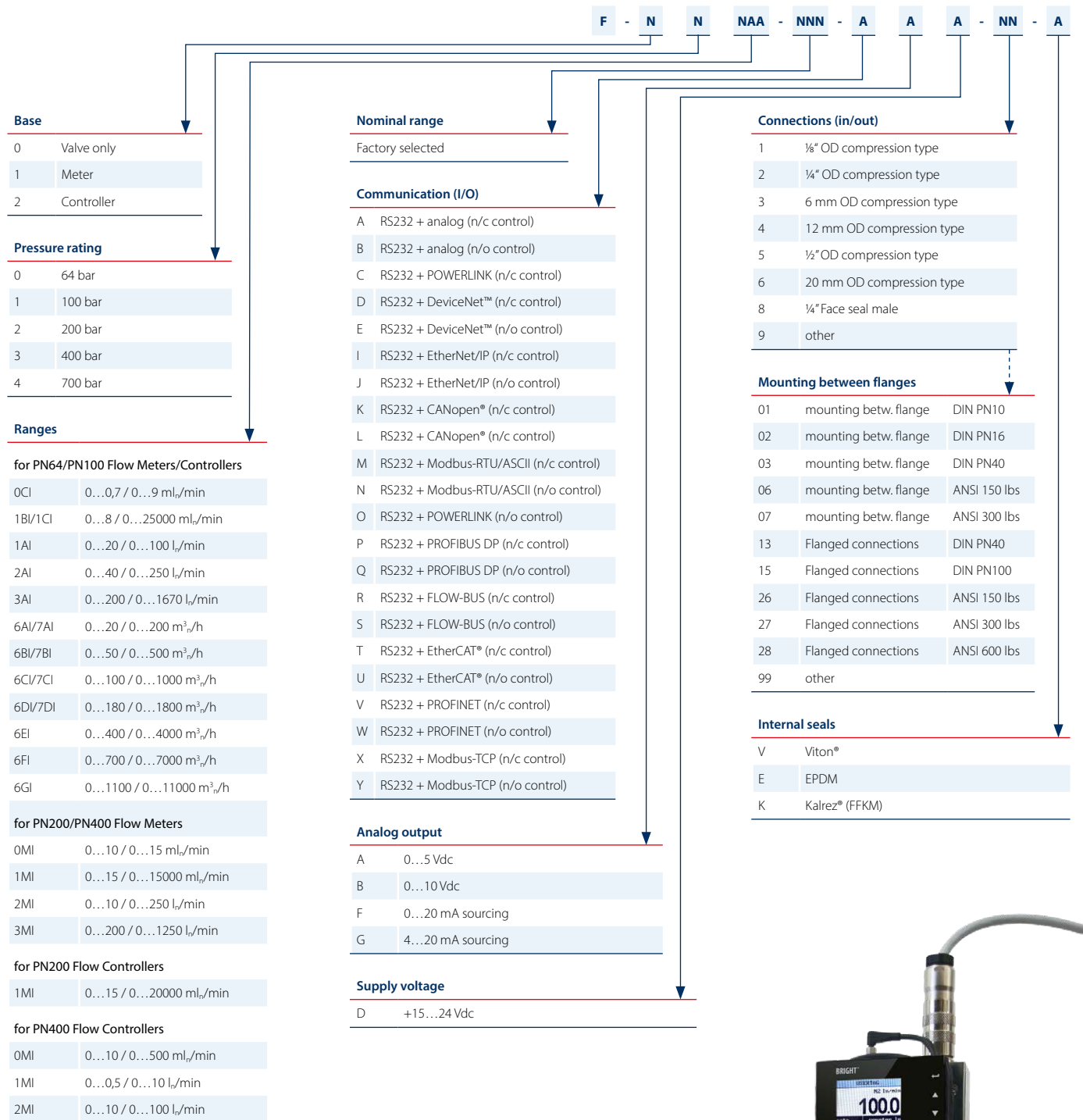


### Mass Flow Controllers

| Model                     | A   | B   | C  | H   | K  | L  | Weight (kg) |
|---------------------------|-----|-----|----|-----|----|----|-------------|
| F-200CI/F-210CI (1/8" OD) | 112 | 164 | 74 | 125 | 25 | 36 | 1,3         |
| F-201CI/F-211CI (1/4" OD) | 112 | 169 | 74 | 125 | 25 | 36 | 1,4         |
| F-201AI/F-211AI (1/4" OD) | 112 | 169 | 74 | 137 | 26 | 36 | 1,5         |
| F-202AI/F-212AI (1/4" OD) | 112 | 169 | 74 | 153 | 59 | 36 | 3,0         |
| F-203AI/F-213AI (1/2" OD) | 171 | 238 | 74 | 160 | 74 | 36 | 5,0         |
| F-206AI/F-216AI (1/2" OD) | 233 | 300 | 74 | 192 | 74 | 36 | 6,7         |
| F-206BI/F-216BI (1" OD)   | 251 | 334 | 74 | 209 | 89 | 36 | 10,0        |

\* Dimensions subject to change without notice. For certified drawings, dimensions of high pressure instruments (PN200/PN400/PN700) and of the F-107 series (flanged type MFM's) please contact factory.

## Model number identification



F-116AI Mass Flow Meter with BRIGHT Local Readout/Control Module



[www.bronkhorst.com](http://www.bronkhorst.com)

Bronkhorst High-Tech designs and manufactures innovative instruments and subsystems for low-flow measurement and control for use in laboratories, machinery and industry. Driven by a strong sense of sustainability and with many years of experience, we offer an extensive range of (mass) flow meters and controllers for gases and liquids, based on thermal, Coriolis and ultrasonic measuring principles. Our global sales and service network provides local support in more than 40 countries. Discover Bronkhorst®!

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