

# IN-FLOW

## Industrial Style Digital 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 experience in designing and manufacturing precise and reliable measurement and control devices. With a wide range of instruments, Bronkhorst High-Tech 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 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.

### > Multi-Bus technology

Bronkhorst High-Tech developed their latest digital instruments according to the "multi-bus" principle. 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. As an option, an integrated interface board provides DeviceNet™, PROFIBUS DP, Modbus-RTU or FLOW-BUS protocols. The latter is a fieldbus based on RS485, specifically designed by Bronkhorst High-Tech for their mass flow metering and control solutions.

### > 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 approval Cat.3, Zone 2
- ◆ Fast response, excellent repeatability
- ◆ Flow ranges from 0,014...0,7 ml<sub>n</sub>/min up to 220...11000 m<sup>3</sup><sub>n</sub>/h
- ◆ Pressure ratings up to 700 bar
- ◆ Compliant with RoHS directives

### > Digital features

- ◆ RS232 communication and standard analog 0...5 (10) V / 0(4)...20 mA
- ◆ Fieldbus interface options: DeviceNet™, PROFIBUS DP, Modbus-RTU, FLOW-BUS
- ◆ control characteristics user-configurable
- ◆ optional Multi Gas / Multi Range functionality up to 10 bar
- ◆ alarm and counter functions

## > Technical specifications

### Measurement / control system

Accuracy (incl. linearity) (based on actual calibration)	: standard: $\pm 0,5\%$ Rd plus $\pm 0,1\%$ FS $\pm 1\%$ FS for ranges 3...5 ml <sub>n</sub> /min; $\pm 2\%$ FS for ranges < 3 ml <sub>n</sub> /min; $\pm 1\%$ FS for ranges > 1670 l <sub>n</sub> /min; for ranges > 1100 m <sup>3</sup> <sub>n</sub> /h contact factory)
Turndown	: 1:50 (in digital mode up to 1:187,5)
Repeatability	: < 0,2% Rd
Settling time (controller)	: standard: 1...2 seconds
Operating temperature	: -10...+70°C for ATEX cat. 3 max. 50°C
Temperature sensitivity	: zero: < 0,05% FS/°C; 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, typical N <sub>2</sub>
Warm-up time	: 30 min. for optimum accuracy 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 type on series F-106; DIN or ANSI flanges on series F-107
Seals	: standard: Viton®; options: EPDM, Kalrez® (FFKM)
Ingress protection (housing)	: IP65

### Electrical properties

Power supply	: +15...24 Vdc
Power consumption	: meter: 70 mA; controller: max. 320 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: RS232 options: PROFIBUS DP, DeviceNet™, Modbus-RTU, FLOW-BUS

### Electrical connection

Analog/RS232	: 8 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)

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)

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

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

For ranges of 200, 400 or 700 bar rated MFMs please contact factory

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

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

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

Model	min. flow	max. flow
F-200CI/F-210CI <sup>1)</sup>	0,014...0,7 ml <sub>n</sub> /min	0,18...9 ml <sub>n</sub> /min
F-201CI/F-211CI <sup>1)</sup> *	0,16...8 ml <sub>n</sub> /min	0,16...25 l <sub>n</sub> /min
F-201AI/F-211AI <sup>1)</sup> *	0,4...20 l <sub>n</sub> /min	0,6...100 l <sub>n</sub> /min
F-202AI/F-212AI <sup>2)</sup>	0,8...40 l <sub>n</sub> /min	1,4...250 l <sub>n</sub> /min
F-203AI/F-213AI <sup>3)</sup>	4...200 l <sub>n</sub> /min	8...1670 l <sub>n</sub> /min
F-206AI/F-216AI <sup>3)</sup>	0,4...20 m <sup>3</sup> <sub>n</sub> /h	4...200 m <sup>3</sup> <sub>n</sub> /h
F-206BI/F-216BI <sup>4)</sup>	1...50 m <sup>3</sup> <sub>n</sub> /h	10...500 m <sup>3</sup> <sub>n</sub> /h

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

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

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

For ranges of 700 bar rated MFCs please contact factory.

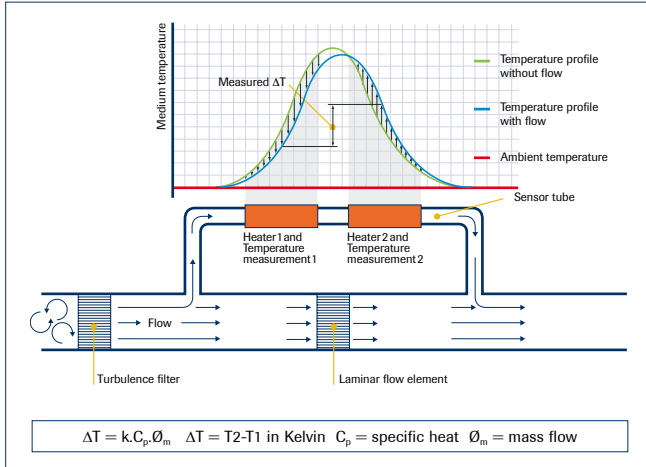
\* For these models the Multi Gas / Multi Range option is available on request.



F-107BI Mass Flow Meter for high flow ranges

## > 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 High-Tech 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:

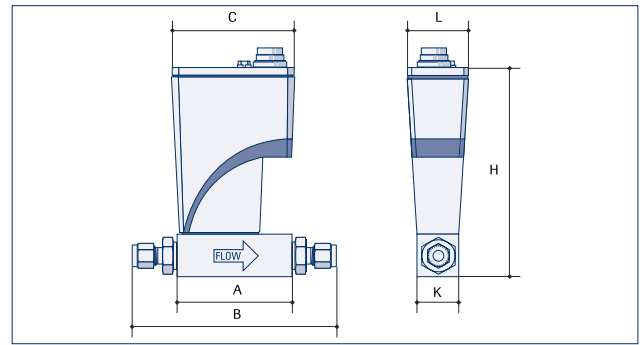
- ◆ Process gas measurement or control in food, pharmaceutical and (petro) chemical industries, in fermentation installations and in fuel cell technology
- ◆ Sample gas measurement
- ◆ Burner control
- ◆ Gas consumption measurement for internal accounting
- ◆ Making of defined gas mixtures

## > For low pressure drop and corrosive gases

For applications with only little differential pressure, Bronkhorst High-Tech 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>n</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 High-Tech 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.

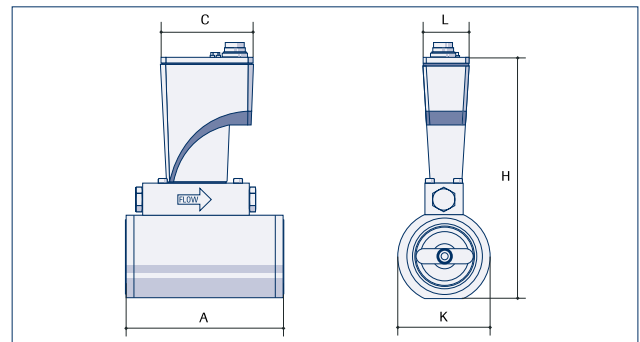
*Dimensions subject to change without notice. For certified drawings, dimensions of high pressure instruments (PN200/PN400/PN700) and of the F-107 series (flanged type MFM) please contact factory.*

## > Dimensions (mm)



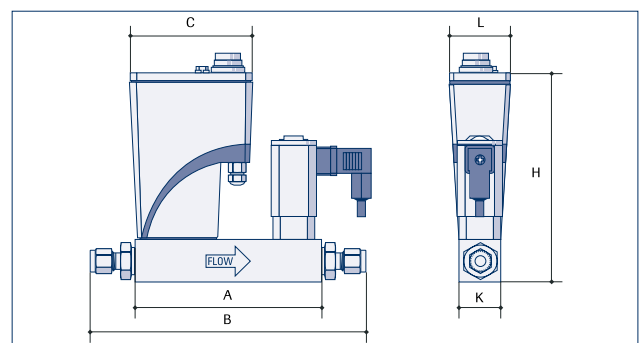
### Mass Flow Meters

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	125	74	192	75	36	4,0
F-106BI	125	74	205	85	36	4,6
F-106CI	125	74	234	115	36	6,8
F-106DI	125	74	264	145	36	9,5
F-106EI	125	74	319	198	36	13,3
F-106FI	125	74	371	249	36	18,1
F-106GI	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

## > Model number identification

F - N N NAA - NNN - A A A - NN - A

### Base

0	Valve only
1	Meter
2	Controller

### Pressure rating

0	64 bar
1	100 bar
2	200 bar
3	400 bar
4	700 bar

### Ranges

#### for PN64/PN100 Flow Meters/Controllers

0CI	0...0,7 / 0...9 ml <sub>v</sub> /min
1BI/1CI	0...8 / 0...25000 ml <sub>v</sub> /min
1AI	0...20 / 0...100 l <sub>v</sub> /min
2AI	0...40 / 0...250 l <sub>v</sub> /min
3AI	0...200 / 0...1670 l <sub>v</sub> /min
6AI/7AI	0...20 / 0...200 m <sup>3</sup> <sub>v</sub> /h
6BI/7BI	0...50 / 0...500 m <sup>3</sup> <sub>v</sub> /h
6CI/7CI	0...100 / 0...1000 m <sup>3</sup> <sub>v</sub> /h
6DI/7DI	0...180 / 0...1800 m <sup>3</sup> <sub>v</sub> /h
6EI	0...400 / 0...4000 m <sup>3</sup> <sub>v</sub> /h
6FI	0...700 / 0...7000 m <sup>3</sup> <sub>v</sub> /h
6GI	0...1100 / 0...11000 m <sup>3</sup> <sub>v</sub> /h

#### for PN200/PN400 Flow Meters

0MI	0...10 / 0...15 ml <sub>v</sub> /min
1MI	0...15 / 0...15000 ml <sub>v</sub> /min
2MI	0...10 / 0...250 l <sub>v</sub> /min
3MI	0...200 / 0...1250 l <sub>v</sub> /min

#### for PN400 Flow Controllers

0MI	0...10 / 0...500 ml <sub>v</sub> /min
1MI	0...0,5 / 0...10 l <sub>v</sub> /min
2MI	0...10 / 0...100 l <sub>v</sub> /min

### Nominal range

Factory selected

### Communication (I/O)

A	RS232 + analog (n/c control)
B	RS232 + analog (n/o control)
D	RS232 + DeviceNet™ (n/c control)
E	RS232 + DeviceNet™ (n/o control)
M	RS232 + Modbus-RTU (n/c control)
N	RS232 + Modbus-RTU (n/o control)
P	RS232 + PROFIBUS DP (n/c control)
Q	RS232 + PROFIBUS DP (n/o control)
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
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### Connections (in/out)

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

### Mounting between flanges

01	mounting betw. flange	DIN PN10
02	mounting betw. flange	DIN PN16
03	mounting betw. flange	DIN PN40
06	mounting betw. flange	ANSI 150 lbs
07	mounting betw. flange	ANSI 300 lbs
13	Flanged connections	DIN PN40
15	Flanged connections	DIN PN100
26	Flanged connections	ANSI 150 lbs
27	Flanged connections	ANSI 300 lbs
28	Flanged connections	ANSI 600 lbs
99	other	

### Internal seals

V	Viton®
E	EPDM
K	Kalrez® (FFKM)



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



F-112AI Mass Flow Meter



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

  
**Bronkhorst®**  
 HIGH-TECH

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