IN-FLOW

Industrial Mass Flow Meters and Controllers for Gases

Koning Willem I Award

ISO 9001
ISO 14001

Capacities (Air): min. 0,2...10 ml_n/min;
max. 0-11000 m^3_n/h

Pressure ratings up to 700 bar

Industrial style

No moving parts

Short response time

IP65 protection

BRONKHORST
HI-TEC

Introduction and Contents

Introduction

This brochure describes the IN-FLOW series; Mass Flow Meters and Controllers of rugged design (IP65) for use in pilot and production plants in industrial environments.

Contents

THE ADVANTAGES AT A GLANCE:

The superiority of the IN-FLOW Mass Flow Meters and Controllers becomes clear as soon as you realize what you do not need: delta “p” measurement and piping, valves, pressure and temperature sensors. The compact instruments can easily be mounted in the pipeline, electrically connected and.....ready. New in this brochure are the instruments with digital “multibus” PC-boards with RS-232 or fieldbus interfaces.

Bronkhorst High-Tech BV

Product range

Bronkhorst High-Tech B.V. was established in 1981 and now offers a very wide range of thermal and coriolis mass flow meters and controllers. Numerous styles of both standard and customized instruments can be offered for applications in laboratory, industrial and hazardous areas. The full scale measuring range (with 50:1 turn-down) for these instruments can be selected between 0…1 ml_n/min and 0…10000 $m3_n$/h for gases and 0…30 mg/h up to 0…600 kg/h for liquids. Furthermore Bronkhorst High-Tech offers pressure transducers and controllers with a minimum range of 0…100 mbar and a maximum range of 0…400 bar.

Round-the-clock support

Bronkhorst High-Tech is a truly worldwide organisation with its Head Office being located in the town of Ruurlo in The Netherlands. With a total head-count now exceeding 220 employees, it is impressive that 45 of these are involved with R&D, 100 in manufacture and 40 involved with after-sales service and customer care. In actual fact, the Customer Service Department offers “round-the-clock” support, seven days a week, to customers in every corner of the world.

Sales representation and service

In addition to the sales office in Veenendaal of The Netherlands there are branch offices in Great Britain, France, Switzerland and northern Germany whereby local expertise and service is offered. Bronkhorst High-Tech has also built up an extensive complimentary network of distributors and service stations across the rest of Europe and, indeed, yet further representation in such countries as the USA, Japan, Australia, New Zealand, Canada, Israel, India, South Africa, Brazil and Korea.

Quality

Customer satisfaction, innovation and quality of product and service have been the cornerstones of Bronkhorst High-Tech's success. In 1987 the company obtained the Koning Willem I Award for a young successful enterprise and in 1992 the company was accredited to ISO 9001 with ISO 14001 (an International Standard for environmental management) following three years later. In January 2004 this ongoing commitment was rewarded by accreditation to the most recent Quality Management System, ISO 9001:2000.

The principle of operation of Thermal Mass Flow Measurement and Control for Gases

To measure mass flow, various methods can be applied, but below we outline the thermal measuring principle, as it is used by Bronkhorst High-Tech B.V.

The user need not necessarily know these details to successfully apply Hi-Tec instruments, but it helps to understand things better with regard to time- and control characteristics of the instruments.

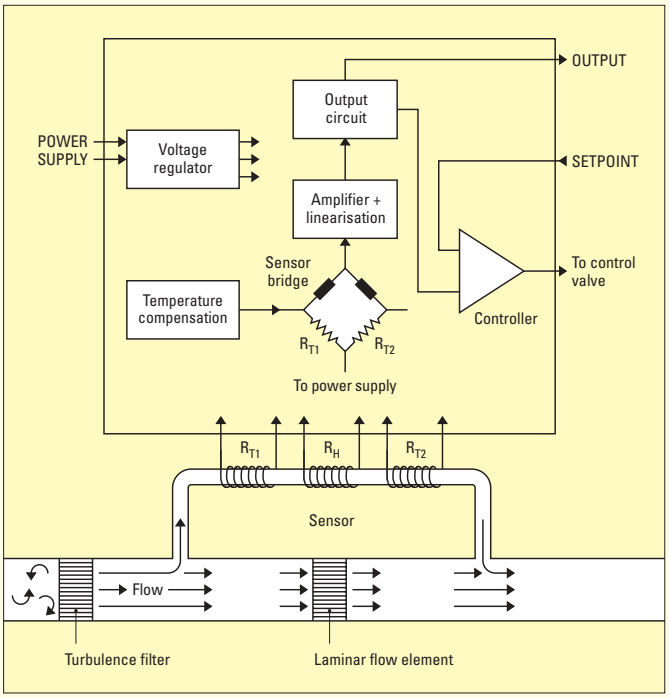


FIGURE A

Principle of operation

As shown in figure A a part of the gas flows through the Sensor, and is warmed up by heater R_H. Consequently the measured temperatures T_1 and T_2 move apart, as shown in figure B. The formulas for ΔT demonstrate that the temperature difference is directly proportional to mass flow.

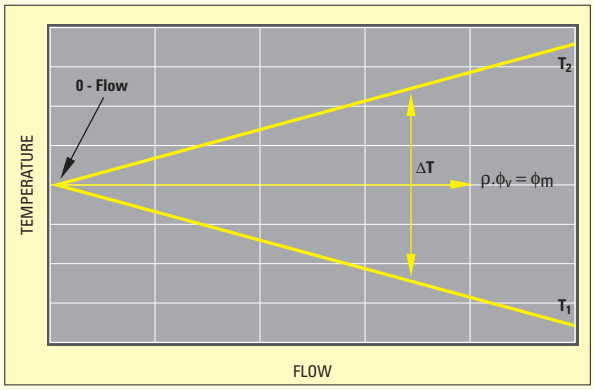


FIGURE B

$\Delta T = k.C_p.\rho.\phi_v$
or
$\Delta T = k.C_p.\phi_m$

ΔT = T_2-T_1 in Kelvin
C_p = Specific heat
ρ = Density
ϕ_v = Volume flow
ϕ_m = Mass flow

Electrically, temperatures T_1 and T_2 are in fact temperature dependent resistors R_{T1} and R_{T2}. In figure A it is shown how the signals measured in the sensor are amplified to electric signals. All common output signals are available and one can be selected.

In the case of mass flow control, the output signal is continuously compared with a setpoint signal from a voltage source. Any deviations between setpoint signal and measured signal are translated into a control valve adjustment until the two signals are identical.

Calibration and accuracy

Each instrument is calibrated under actual operating conditions whenever possible. Otherwise the FLUIDAT database is used to calculate accurate conversion factors. For applications that require a better accuracy than the standard 1% of full scale, Bronkhorst High-Tech can offer the “Polynomial Calibration”: accuracy +/- 0,5% of measured value plus +/- 0,1% of full scale value.

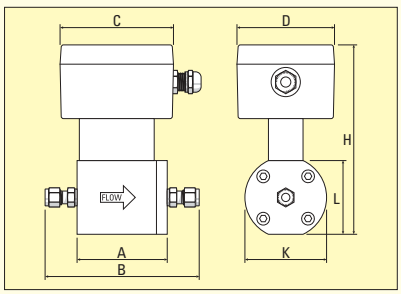
IN-FLOW Mass Flow Meters for Gases up to PN700

General

Instruments of the IN-FLOW series are thermal mass flow meters in rugged construction for use under industrial operating conditions. The electronics compartment is IP65 protected.

Fields of application

- Process gas measurement in food industry, chemical and petrochemical industries, in fermentation installations and in biotechnology.
- Sample gas measurement in environmental analysis.
- Gas consumption measurement for internal accounting.



	Dimensions (mm)							Weight
Model	A	B	C	D	H	K	L	(kg)
F-112AI	65	115	80	75	145	59	53	1,6
F-113AI	112	181	80	75	159	74	67	3,3
F-116AI	174	241	80	75	184	74	67	5,2
F-126AI/F-136AI	211	336	80	75	220	110	100	16,8
F-116BI	192	280	80	75	201	89	84	8,0
F-110MI/F-120MI/F-130MI	60	106	80	75	124	30	30	1,2
F-111MI/F-121MI/F-131MI	60	114	80	75	124	30	30	1,2
F-122MI/F-132MI	77	131	80	75	150	69	55	2,3
F-123MI/F-133MI	124	194	80	75	187	99	93	6,8
F-141MI	124	-	80	75	147	69	57	4,7
F-142MI	125	-	80	75	170	99	76	7,7
F-143MI	178	-	80	75	224	142	132	20,8

All data are subject to change without notice. Certified drawings are available on request.

Features

The characteristic features of thermal mass flow meters of Bronkhorst High-Tech are also offered in the IN-FLOW series:

- no moving parts.
- short response time.
- no need for flow computer, temperature- and pressure measurement; therefore easy to install and economic.
- low pressure drop.
- pressure ratings up to 700 bar.
- available with control valve to constitute a complete, compact control loop.
- optional pulse output for totalization.

There are the F-106 series for mounting between flanges, instruments with flanges, F-107 and F-117, see page 6, and those with compression type couplings. The latter series are described in this page.

Capacities (based on N_2)

			Pressure rating / Model		
lowest range	**highest range**	**intermediate values**	**100 bar**	**200 bar**	**400 bar**
0,2.....10 ml_n/min	0,3.....15 ml_n/min	available	F-110MI	F-120MI	F-130MI
0,3.....15 ml_n/min	0,3.....15 l_n/min	available	F-111MI	F-121MI	F-131MI
0,3.....15 l_n/min	5.....250 l_n/min	available	F-112AI	F-122MI	F-132MI
2.....100 l_n/min	25.....1250 l_n/min	available	F-113AI	F-123MI	F-133MI
0,3.....15 m^3_n/h	4.....200 m^3_n/h	available	F-116AI	F-126AI	F-136AI
1.....50 m^3_n/h	10.....500 m^3_n/h	available	F-116BI	F-126BI	F-136BI

lowest range	**highest range**	**intermediate values**	**700 bar**	
0,3.....15 ml_n/min	2.....100 l_n/min	available	F-141MI	All instruments with pressure rating higher than 100 bar have metal-sealed sensors for optimal safety.
1.....50 l_n/min	5.....250 l_n/min	available	F-142MI	
2.....100 l_n/min	25.....1250 l_n/min	available	F-143MI	

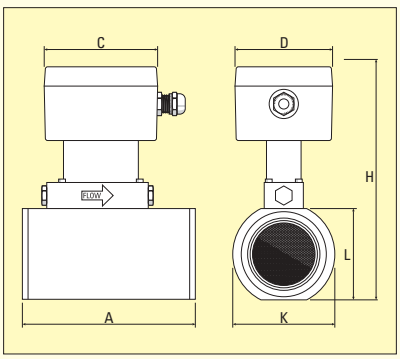
IN-FLOW Mass Flow Meters for Gases

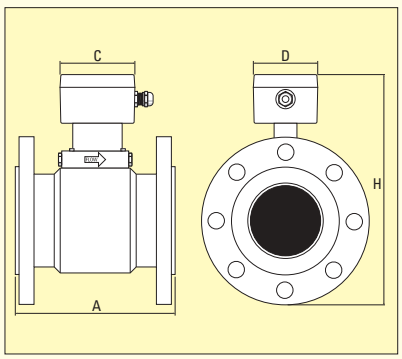
Series F-106I:

Instruments for mounting between flanges according to DIN up to PN 40, or ANSI 150 lbs/300 lbs.
Smallest range (N_2) 0,4...20 m^3_n/h
Biggest range (N_2) 220...11000 m^3_n/h

Series F-107I/117I:

Instruments with flanged connections according to DIN or ANSI.
F-107I: DIN PN 40, ANSI 150 lbs, ANSI 300 lbs.
F- 117I: DIN PN 100.
Smallest range (N_2) 0,4...20 m^3_n/h
Biggest range (N_2) 36...1800 m^3_n/h





			Dimensions (mm)						Weight
DIN	ANSI	Model	A	C	D	H	K	L	(kg)
DN40	1½"	**F-106AI**	125	80	75	183	74	66	4,0
DN50	2"	**F-106BI**	125	80	75	195	84	78	4,6
DN80	3"	**F-106CI**	125	80	75	225	114	108	6,8
DN100	4"	**F-106DI**	125	80	75	255	144	138	9,5
DN150	6"	**F-106EI**	125	80	75	310	197	193	13,3
DN200	8"	**F-106FI**	125	80	75	362	248	245	18,1
DN250	10"	**F-106GI**	125	80	75	426	312	309	27,0

Dimensions and weights of other models on request.
All date are subject to change without notice. Certified drawings are available on request.

	Dimensions (mm)			H (DIN,	H (DIN,	H (ANSI,	Weight
Model	A	C	D	PN40)	PN100)	150 Lbs)	(kg)
F-107AI	200	80	75	229	-	218	8,3
F-107BI	200	80	75	243	-	237	9,8
F-107CI	200	80	75	274	-	270	15,3
F-107DI	200	80	75	305	-	302	19,8
F-117AI	225	80	75	-	247	-	12,2
F-117BI	225	80	75	-	271	-	17,1
F-117CI	225	80	75	-	302	-	24,4
F-117DI	225	80	75	-	333	-	35,2

Capacities (based on N_2)

			Pressure rating / Model	
lowest range	**highest range**	**intermediate values**	**40 bar**	**100 bar**
0,4.....20 m^3_n/h	4.....200 m^3_n/h	available	F-106AI/F-107AI	F-117AI
1.....50 m^3_n/h	10.....500 m^3_n/h	available	F-106BI/F-107BI	F-117BI
2.....100 m^3_n/h	20.....1000 m^3_n/h	available	F-106CI/F-107CI	F-117CI
3,6.....180 m^3_n/h	36.....1800 m^3_n/h	available	F-106DI/F-107DI	F-117DI
8.....400 m^3_n/h	80.....4000 m^3_n/h	available	F-106EI	
14.....700 m^3_n/h	140.....7000 m^3_n/h	available	F-106FI	
22.....1100 m^3_n/h	220.....11000 m^3_n/h	available	F-106GI	

IN-FLOW Mass Flow Controllers for Gases

General

To convert a mass flow meter to a mass flow controller a control valve is added. The instruments of a F-112AI and F-113AI series can be furnished with a piped-on control valve. The electronics housing of the mass flow meter then contains a p.c. board with control function to complete the control loop.

The instruments that start with the figure 2 in their model code (e.g. F-203AI and F-216AI) are furnished with integrated control valve.

Control Valves

are available in various constructions such as

Directly actuated valve F-001AC

The valve consists of a valve module which is mounted in a base block. This can be a separate valve F-001AC or an MFC (F-203AI, F-206AI/BI, F-213AI or F-216AI/BI). In the bigger valves/controllers the valve module is used as pilot-valve. See below.

Vary-P-Valve F-033C and F-042C

This is a 2-stage valve. The pilot-valve acts as the valve module described above. The second stage is a patented pressure compensation valve to maintain a constant ΔP of 4 bar across the first stage.
By doing this both inlet and outlet pressures may change without affecting the operation of the Vary-P-Valve.

Pilot-Operated Valves F-002AC, F-003AC and F-003BC

Are indirect operated valves; they use a complete Vary-P-Valve as described above as pilot valve, and are thus pressure compensated. The pilot controls the pressure on the rear side of a spring-loaded cylinder of which the front side is pressurized by the inlet pressure of the main valve. This cylinder provides the positioning force for the main valve. When the pressure difference is bigger than the spring force, the main valve opens.

Bellows Valves F-004AC and F-004BC

These directly actuated valves were developed for applications with high flow rates at low differential pressures as often seen in burner applications. A bellows compensates the spring force and makes it possible to easily control flow at differential pressures between 1 mbar and 5 bar. F-004AC has an IP40 or IP64 housing and F-004BC is IP65.

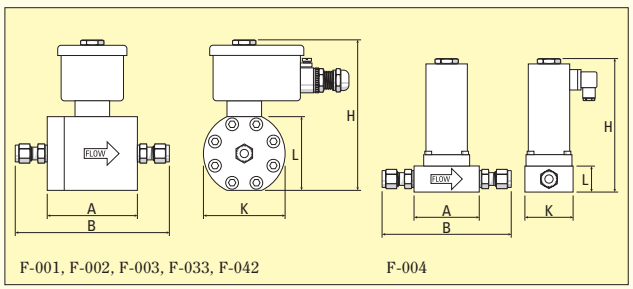
Block diagrams of the various valves are found in the EL-FLOW® brochure.

Applications

Some examples of applications have already been dealt with on page 5. Herewith some more applications for F-004 control valves:

- systems for environmental air sampling.
- control systems for natural gas or acetylene.
- the making of defined gas mixtures.
- pilot installations in research.
- fermentation and biotechnology.
- burner control.
- hydrogen techniques.

Dimensional drawing Control Valve



F-001, F-002, F-003, F-033, F-042 F-004

	Dimensions (mm)					Weight
Model	A	B	H	K	L	(kg)
F-001AC - IB	47	97	83	25	25	0,5
F-002AC - IB	78	128	109	59	53	1,5
F-003AC - IB	97	166	126	74	67	3,2
F-003BC - IB	114	203	140	89	84	5,1
F-033C - IB	77	127	111	69	55	2,3
F-042C - IB	129	-	140	99	76	6,0
F-004AC - LU/IU	64	114	123	45	25	1,3
F-004BC - IV	85	154	174	65	35	3,2

IB/IV corresponds with protection class IP65; LU corresponds with IP40.

IN-FLOW Mass Flow Controllers for Gases

Flow capacities (based on N_2)

MFM + Valve	smallest	biggest
F-111MI/F-001AC	0,3 ....15 ml_n/min	0,3 .....15 l_n/min
F-112AI/F-001AC	0,3 .....15 l_n/min	2,0 .....100 l_n/min
F-112AI/F-002AC	0,1 .....5 l_n/min	5 .....250 l_n/min
MFC with integrated valve		
F-203AI/F-213AI	1 .....50 l_n/min	25 ....1250 l_n/min
F-206AI/F-216AI	0,4.....20 m^3_n/h	4.....200 m^3_n/h
F-206BI/F-216BI	1.....50 m^3_n/h	10.....500 m^3_n/h
MFC for high-pressure applications (PN400/PN700)		
F-230MI/F-240MI	0,2....10 ml_n/min	10...500 ml_n/min
F-231MI/F-241MI	10...500 ml_n/min	0,2 .....10 l_n/min
F-232MI/F-242MI	0,2 .....10 l_n/min	2 .....100 l_n/min

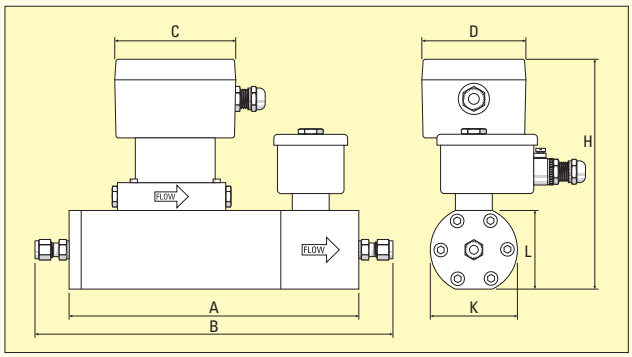
New series for high pressure applications

Bronkhorst High-Tech introduced a new product line of mass flow meters and controllers for high pressure ratings up to 700 bar. The metal sealed sensor construction offers increased safety, which is very important, e.g. when being used with hydrogen for high pressure applications.

Selecting the correct instrument

and defining the corresponding model number requires a certain degree of system knowledge. We try to give you this herein, however, should you not have the time to familiarise yourself with the information, then Bronkhorst High-Tech and its distributors have the experts to do this for you. Of course they need some data to select the optimum solution. Please refer also to page 10, model number code, for more information.

Dimensional drawing Mass Flow Controller



	Dimensions (mm)							Weight
Model	A	B	C	D	H	K	L	(kg)
F-230MI/F-231MI/F-232MI	115	169	80	125	180	69	55	4,4
F-240MI/F-241MI/F-242MI	157	-	80	125	200	99	76	12,6
F-203AI/F-213AI	171	240	80	125	159	74	67	5,3
F-206AI/F-216AI	233	300	80	125	188	74	67	7,3
F-206BI/F-216BI	251	340	80	125	201	89	84	10,5

The complete solution to a control problem

cannot be found without including the associated components. How it is built up depends on the requirements of the user. One of the specialities of Bronkhorst High-Tech is the large selection of readout systems for most requirements.

We describe the instruments on pages 13...14 in detail, however much more is possible than setpoint selection and control of one or more controllers, as for example required for making defined gas mixtures. The control parameter to be influenced by the flow may also be different, for example temperature, process pressure, pH-value. These can be directly used as the setpoint.

In combination with computers or PLCs special control profiles can be programmed, and as such be completely integrated in the process control system. It is difficult to discuss all possibilities in this brochure and our local representative will gladly discuss your particular application.

A very good summary of the most important instruments and necessary information concerning the special services that Bronkhorst High-Tech can perform is found in the EL-FLOW catalogue.
Apply for it if you do not have it yet.

Technical specifications IN-FLOW

Measurement System

Accuracy	Standard calibration
	± 1% of full scale (up to 1200 m^3_n/h)
(at calibration under operating conditions)	Polynomial calibration
	± 0,5% of reading plus ± 0,1% of full scale
Reproducibility	< 0,1% full scale
Repeatability	< 0,2% of reading
Time constant	approx. 3 sec.
Control stability	< ± 0,1% full scale (typical for 1 l_n/min N_2)
Pressure sensitivity	0,1%/bar typ. N_2
	0,01%/bar typ. H_2
Attitude sensitivity	max. error 0,015% at 1 bar N_2 and 90° change
Vibration sensitivity	negligible
Temperature sensitivity	zero point approx. 0,05% of full scale/°C
	span approx. 0,05% of reading/°C
Leak integrity	tested < 2 x 10^{-9} mbar l/s He. Additional pressure
	test at 1,5 times the max. stated operating pressure
RFI	CE approved design

Mechanical parts

Process connections	see model number code; other on application
Material wetted parts	stainless steel AISI 316L or comparable
Material electronic housing	Aluminium, painted
Seals	Viton, EPDM, elast. PTFE, other on application
Surface quality	Ra 0,2...0,6 µm

Operating limits

Range	2%...100%
Types of gases	all gases compatible with AISI 316L
Temperature	-10°C up to +70°C
Pressure	Vacuum up to 700 bar, see tables on pages 6 and 8
Warming-up time	20 min. for optimum accuracy,
	2 min. for accuracy ± 2% of full scale

Electrical properties

Supply voltage Mass Flow Meter	+15...24 Vdc, 50 mA
Mass Flow Meter + Valve	+15...24 Vdc, 60 mA
	add approx. 250 mA for control valve
Mass Flow Meter + Valve	+15...24 Vdc, 70 mA
+ Pulse Output	add approx. 250 mA for control valve
Output signal	0...5 V, 0...10 V, min. load impedance > 2 kOhm
(short circuit protected)	0(4)...20 mA, max. load impedance < 375 Ohm
Setpoint signal	0(1)...5 V, 0...10 Vdc, input resistance min. 1 Mohm
	0(4)...20 mA, input resistance 250 Ohm
Electrical connection	terminal strip end, protection IP65
Cable gland for MFM	PG 9
Cable gland for MFC	PG 11

Calibration

References

The calibration is done with equipment certified by the Netherlands Measurement Institute (NMi) and is in accordance with European and most important other countries' regulations.

System

Precision glass bore cylinders with mercury seal, or for higher capacities volumetric flow meters with temperature and pressure compensation.

Gases

If possible, every instrument is calibrated under its operating conditions. A number of standard gases are available.

Gas data

A substantial data base is available for determining the physical properties such as density, viscosity and specific heat under operating conditions (usually not available in standard gas books). All this data is extremely important for the calculation of the conversion factor. The calculation is automatically performed in the calibration programme.

Model number code IN-FLOW

Instruments with compression couplings

F – N N NAI – A A D – N N – A

Base block

0	Valve only
1	Sensor
2	Sensor + integral Valve

Pressure rating

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

Sensor range

2AI	0 .....15 l_n/min up to 0 .....250 l_n/min
3AI	0 .....100 l_n/min up to 0 .....1250 l_n/min
6AI	0 .....20 m^3_n/h up to 0 .....200 m^3_n/h
6BI	0 .....50 m^3_n/h up to 0 .....500 m^3_n/h

For sensor ranges of models with "MI" in model code please see tables at pages 5 and 8.

P.C. Board

H	Sensor only
F	Controller, N/C

Output signal

A	0 .....5 Vdc	F	0 .....20 mA sourcing
B	0 .....10 Vdc	G	4 .....20 mA sourcing
C	0 .....20 mA	K	0 .....5 Vdc
D	4 .....20 mA	L	0 .....10 Vdc
Z	Other		

Inlet Connection Outlet

Inlet	Connection	Outlet
1	1/8" Compression coupling	1
2	1/4" Compression coupling	2
3	6 mm Compression coupling	3
4	12 mm Compression coupling	4
5	1/2" Compression coupling	5
6	20 mm Compression coupling	6
8	1/4" Face Seal coupling	8
9	Other	9

Seals

E	EPDM
P	Elast. PTFE
V	Viton
Z	Other

Instruments for mounting between flanges

F-1 N NAI – A A D – NN – A

Pressure rating

0	40 bar
1	100 bar

Sensor range

6AI	Mounting betw. flanges	0..20 up to 0..200 m^3_n/h
6BI	Mounting betw. flanges	0..50 up to 0..500 m^3_n/h
6CI	Mounting betw. flanges	0..100 up to 0..1000 m^3_n/h
6DI	Mounting betw. flanges	0..180 up to 0..1800 m^3_n/h
6EI	Mounting betw. flanges	0..400 up to 0..4000 m^3_n/h
6FI	Mounting betw. flanges	0..700 up to 0..7000 m^3_n/h
6GI	Mounting betw. flanges	0..1100 up to 0..11000 m^3_n/h
7AI	Flanged connection	0..20 up to 0..200 m^3_n/h
7BI	Flanged connection	0..50 up to 0..500 m^3_n/h
7CI	Flanged connection	0..100 up to 0..1000 m^3_n/h
7DI	Flanged connection	0..180 up to 0..1800 m^3_n/h

P.C. Board

H	Sensor only
F	Controller, N/C

Output signal

A	0 .....5 Vdc	F	0 .....20 mA sourcing
B	0 .....10 Vdc	G	4 .....20 mA sourcing
C	0 .....20 mA	K	0 .....5 Vdc
D	4 .....20 mA	L	0 .....10 Vdc

Connection

01	Mounting between flanges	DIN PN10
02	Mounting between flanges	DIN PN16
03	Mounting between flanges	DIN PN40
06	Mounting between flanges	ANSI 150 lbs
07	Mounting between flanges	ANSI 300 lbs
13	Flanged connection	DIN PN40
15	Flanged connection	DIN PN100
26	Flanged connection	ANSI 150 lbs
27	Flanged connection	ANSI 300 lbs
28	Flanged connection	ANSI 600 lbs
99	Other	

Seals

E	EPDM
P	Elast. PTFE or equivalent
V	Viton
Z	Other

The model number code serves primarily to identify instruments. When making enquiries or placing orders we determine the correct model number in accordance with the process details.

Enquiry and ordering information

In order to furnish the optimum instrument for your application we request you to state: type of gas, flow range, operating temperature and pressure (for controllers supply pressure and back pressure), electrical connection, desired output signal, type of process connection and seals. Based on this information we perform the following actions/calculations:

- Convert the desired flow to N_2-equivalent flow, i.e., divide the desired flow by the conversion factor as calculated by FLUIDAT.
- Only for controllers, check if the differential pressure across the valve (ΔP) is within the limits.
- Only for controllers, check if the FLUIDAT calculated K_v-value is within the specifications allowed.

LOW-ΔP-FLOW Mass Flow Meters and Controllers

For low pressure drop applications

LOW-ΔP-FLOW Mass Flow Meters and Controllers were developed based on the IN-FLOW series. A special type of sensor and valve make these instruments especially suited for applications where only a very small pressure loss is allowable. The sensor needs only 0,2 mbar.

This is achieved by using a cylindrical flow element of which the annular area forms laminar flow. The enlarged and obstructionless flow channel not only has a very low ΔP but also lowers the risk of coating or clogging and facilitates purging and cleaning of the instrument. The LOW-ΔP-FLOW series are also recommended for use on very aggressive fluids also when ΔP does not play such an important role.

The F-106Z does not have the cylindrical laminar flow element as described above, but the standard Meriam laminar flow element. By using a special capillary the pressure drop is decreased.

Flow capacities (bases on N_2)

Mass Flow Meters	
Series F-101DI	min. 0,15.....7,5 ml_n/min
	max. 0,03.....1,5 l_n/min
Series F-101EI	min. 0,03.....1,5 l_n/min
	max. 0,2.....10 l_n/min
Series F-102DI	min. 0,1.....5 l_n/min
	max. 0,6.....30 l_n/min
Series F-102EI	min. 0,6.....30 l_n/min
	max. 1,0.....50 l_n/min
Series F-103DI	min. 0,4.....20 l_n/min
	max. 2,0.....100 l_n/min
Series F-103EI	min. 2,0.....100 l_n/min
	max. 4,0.....200 l_n/min
Series F-106Z/F-107Z	min. 0,2.....10 m^3_n/h
	max. 4,0.....200 m^3_n/h*

*) higher on application

Mass flow controllers with integrated control valve are not available in the industrial execution of the LOW-ΔP-FLOW series. So far they are only available with piped-on control valves.

For the control of high flows at low differential pressure Bronkhorst High-Tech has the direct acting valves with pressure compensation bellows models F-004BC as described on page 7.

Field experience has learned that these control valves are an attractive alternative to the common servo-driven valves, which are bigger, slower and more complex to constitute a complete control loop.

IN-FLOW® Digital Mass Flow Meters/Controllers

Mass flow meters and controllers of the IN-FLOW series are also available in a digital version. As is often the case, mass flow meters in their standard analog construction are then furnished with AD/DA converters and so made digital. Not so in our case.

IN-FLOW digital is based on a new digital PC-board on which the sensor signal is sent direct to a micro processor. By doing so an optimum signal stability and accuracy is achieved. An integral alarm function continuously checks the difference between the set-point- and the measured value. If, for example, the supply pressure of a mass flow controller drops and therefore the flow can no longer be controlled, the instrument gives a warning. In addition the instrument checks itself through an integral, self diagnosis routine.

Multi-Bus technology

Bronkhorst High-Tech B.V. developed their latest digital instruments according to the 'multi-bus' principle. The basic 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 RS-232 connection as a standard feature. In addition to this there is the possibility of integrating an interface board with DeviceNet™, Profibus-DP®, Modbus or FLOW-BUS protocol. The latter is a fieldbus based RS485, specifically designed by Bronkhorst High-Tech B.V. for their mass flow metering and control solutions, and through which the company already has fifteen years of experience with digital communication.

IN-FLOW digital MFC model F-201CI

IN-FLOW digital MFC model F-202AI

To support PC/PLC controlled process control Bronkhorst High-Tech has devised various software programmes, for instance a DDE-server for parameter exchange with MS WINDOWS application programmes. Furthermore Bronkhorst High-Tech offers free software tools for fieldbus connection and for monitoring, optimizing and opertion of digital instruments.

Specifications

Digital Mass Flow Meter/Controller

- Digital input/output (DeviceNet™, Profibus-DP®, Modbus or FLOW-BUS operation) or analog (0...5 (10) V, 0 (4)...20 mA).
- Interchangeable with analog instruments.
- Accuracy: ±0,5% of reading plus ±0,1% of full scale.
- Storage of up to 8 calibration curves.
- In-situ self-diagnosis.
- Alarm and counter functions.
- Fast (adjustable) response controller.
- Single rail power supply +15...+24 Vdc.

Software support

Bronkhorst Hi-Tec offers free software support for personal computer or PLC.

- 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.
- FlowFix: Software tool for fieldbus connection of digital instruments.

Readout Systems with Integrated Power Supply

Flow-bus Single Channel Module

Series E-7000

The digital single channel control module was developed by Bronkhorst HighTech B.V. for mass flow measurement and control systems. Its application is not limited to operation in combination with Bronkhorst Hi-Tec mass flow controllers and pressure controllers, but it can also be used with other transmitters or transducers, or in master/slave control systems.
The Bronkhorst Hi-Tec FLOW-BUS Series E-7000 offers the user a menu driven device with the possibility to define and control mass flow meters/controllers, pressure transducers/controllers or other instruments.

E-7100 3-channel execution

The µ-processor based single channel module offers the possibility to show tag numbers, measurement identifications, fluid names and totalizing units on top of the measurement and command signals in percent of max. flow or direct reading units.

In addition there is the feature to programme the polynomial function of the calibration curve to obtain an accuracy of ±0,5% of the measured value plus ±0,1% of full scale.

Features

A user-friendly indication/control/alarm/totalization module, menu driven with 5 push buttons for:

- Use with digital or analog instruments.
- Indication of measured value on 2-line, 16-figure display in percent or direct indication, combined with totalized quantity or preset quantity.
- Internal/external command.
- Master/slave control.
- Totalization or batch functions.
- Programmable alarm functions.
- NO/NC relays for status outputs.
- Programming of polynomial function.

FLOW-BUS Multi-Channel configurations

Based on the single-channel module it is easy to form multi-channel units. Three channels fit in a ½19" housing and 6 channels can be housed in a 19" table top or rack mounting unit.

Specifications

Housing:

- Cassette for panel mounting (1 channel) 96 x 144 mm.
- Table top housing (1 channel) 76 x 134 x 260 mm.
- Table top or rack housing (max. 3 channels) 3 HE ½19".
- Table top or rack housing (max. 6 channels) 3 HE 19".

Electrical Data

- Power supply 100...240 Vac, 50...60 Hz or 24 Vac/Vdc.
- Output signals/command signals 0...5 (10) Vdc, 0 (4)...20 mA.
- Sub-D Connector for instrument connection.
- Sub-D Connector for analog I/O functions.
- Sub-D Connector for connection to FLOW-BUS (RS-485 interface).
- Max. power consumption + 15 Vdc 1,5 A, - 15 Vdc 150 mA.

E-7000 Single Channel Module

Readout Systems with Integrated Power Supply

Analog Standard Readout Systems

Series E-5700

This series comprises standard types for use with analog mass flow meters and controllers. The most commonly used function are offered. Those who do not yet work digitally, find here the successors of the E-5512, E-5513 and E-5514, which were sold by the thousands.

- **E-5752:** 2-channel system, table top model.
- **E-5762:** 2-channel system, for panel mount (96 x 144 mm).

- **E-5712:** 2-channel system, ½ 19" table top model.
- **E-5732:** 2-channel system, ½ 19" for rack mounting.

- **E-5714:** 4-channel system, ½ 19" table top model.
- **E-5734:** 4-channel system, ½ 19" for rack mounting.

- **E-5716:** 6-channel system, ½ 19" table top model.
- **E-5736:** 6-channel system, ½ 19" for rack mounting.

E-5736 6-channel PS/Readout

Functions:

- 1 indicator per 2 channels, with selector switch.
- 1 setpoint potentiometer per channel.
- 1 internal/external command signal switch.
- 100…240 Vac power supply.

E-5752 2-channel PS/Readout

Electrical data:

- Power supply 100…240 Vac.
- Suitable for connection of instruments with output signal 0…5 (10) Vdc.
- Ext. output and/or setpoint signals: 0…5 (10) Vdc; 0 (4) …20 mA (to be advised).
- Sub-D socket for instrument connection.
- Sub-D socket for analog I/0 function.
- Max. power +15 Vdc, 2 A / -15 Vdc, 300 mA.

Other BRONKHORST HI-TEC Products

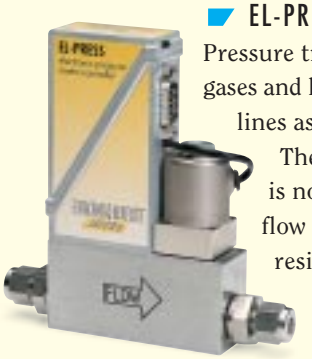
In addition to the instruments of the IN-FLOW series described in this catalogue we would like to identify some other product groups within our range of instruments and their corresponding brochures.

EL-FLOW®

Mass flow meters and controllers for gases with an electronic housing suitable for laboratory conditions. Instruments of the EL-FLOW® series are the only ones on the market that can control flow ranges between 0...1 ml_n/min and 0...1250 l_n/min between vacuum and 400 bar in one range of instruments. This versatility in flow ranges and in operating conditions have made EL-FLOW® our best selling and field proven instrument series.

EX-FLOW

Mass flow meters and controllers for gases in rugged construction with approval for use in hazardous areas. The measuring ranges are from 0,15...7,5 ml_n/min up to 220...11.000 m^3_n/h. The mass flow meter has ATEX approval according to II 2 G EEx ib II C T4. The electronic housing is IP65. The control valves have K_v-values between 5,7 x 10^{-5} and 6,0 and approvals to ATEX II 2 G/D IP6X T 130°C EEx me II T4 and II 1 G/D EEx ia IIC T6



EL-PRESS

Pressure transducers and controllers for gases and liquids are built along the same lines as the EL-FLOW® instruments. The only difference is that there is no laminar flow device, and the flow sensor is replaced by a piezo-resistive pressure transducer. The measuring ranges are between 2...100 mbar abs. or relative, and 8...400 bar. Upstream or downstream pressures up to 100 bar are controlled with integrally mounted control valves. For higher pressures separate control valves are used.

LIQUI-FLOW®

Mass flow meters and controllers for liquids in ranges between 0,1...5 g/h and 0,4...20 kg/h (water equivalent). LIQUI-FLOW® flow meters only require a small differential pressure. In spite of measurement without a by-pass the rise in temperature of the fluid is minimal; only approx. 1...5 °C. This greatly limits the danger of evaporation or degradation of the fluid. For even smaller ranges Bronkhorst High-Tech offers the µ-Flow series; smallest range: 1,5...30 mg/h (water equivalent).

If one or more instruments described here are of interest to you, then please do not hesitate to contact your distributor.