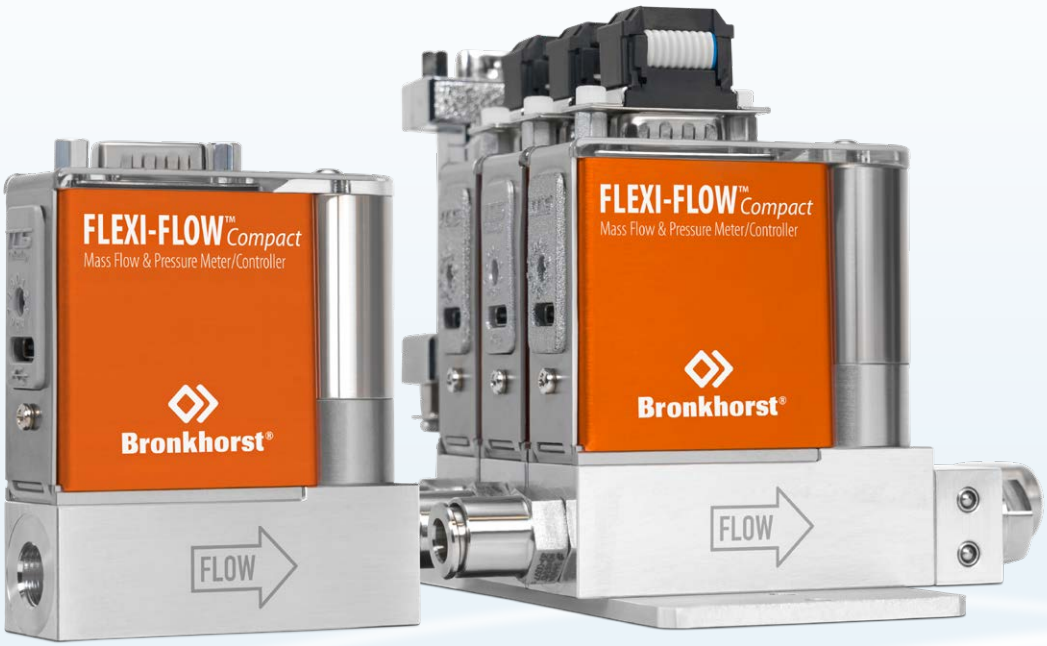


FLEXI-FLOW™ Compact

Mass Flow & Pressure Meters and Controllers for Gases

Bronkhorst®

Bronkhorst, the low-flow specialists

At Bronkhorst, we develop and manufacture smart, sustainable and customer-specific low flow instruments and solutions. Our precise and reliable mass flow and pressure meters and controllers find their way in laboratories, test-benches, machinery and a wide variety of industries. By continuous improvement and applying the latest techniques we succeeded in developing a new, revolutionary product line, the FLEXI-FLOW Compact.

TCS Technology

Bronkhorst has created a completely new concept for measuring mass flow using the thermal measuring principle. The unique **TCS (Through Chip Sensor)** combines the best of two technologies: a fast and stable chip flow sensor applied in Bronkhorst's proven by-pass construction. Due to the TCS Technology, accurate mass flow measurement, virtual independent of variations in temperature and line pressure is established. By measuring the actual process conditions (temperature and line pressure), a real-time correction is made to the measured value. And because all gas properties are available on-board, accurate conversion to other gases is possible.

Unique features of FLEXI-FLOW Compact

Fast response
Due to the ultra-thin sensor tube, the sensor reacts instantaneously to changes of the gas flow, resulting in very fast flow measurement. Combined with a direct acting control valve, settling times smaller than 150 ms are achieved.

Multi parameter
Besides mass flow measurement, the instrument has an integrated temperature sensor and 2 pressure sensors (instrument inlet and outlet pressure). These measurement parameters do not only provide information about the instrument but also about the process conditions.

On-board FLUIDAT® gas database
Select your process gas. With 22 on-board gases, it is very easy to switch to another gas or mixture. Additionally, the on-board gas database is used for real-time corrections on the flow measurement based on the actual process conditions (temperature and line pressure).

Namur NE107 status indication
The instrument shows the status of self-monitoring and diagnosis by means of a coloured LED. This signal can be easily recognized by the operator. For more details the diagnostic parameters can be used.

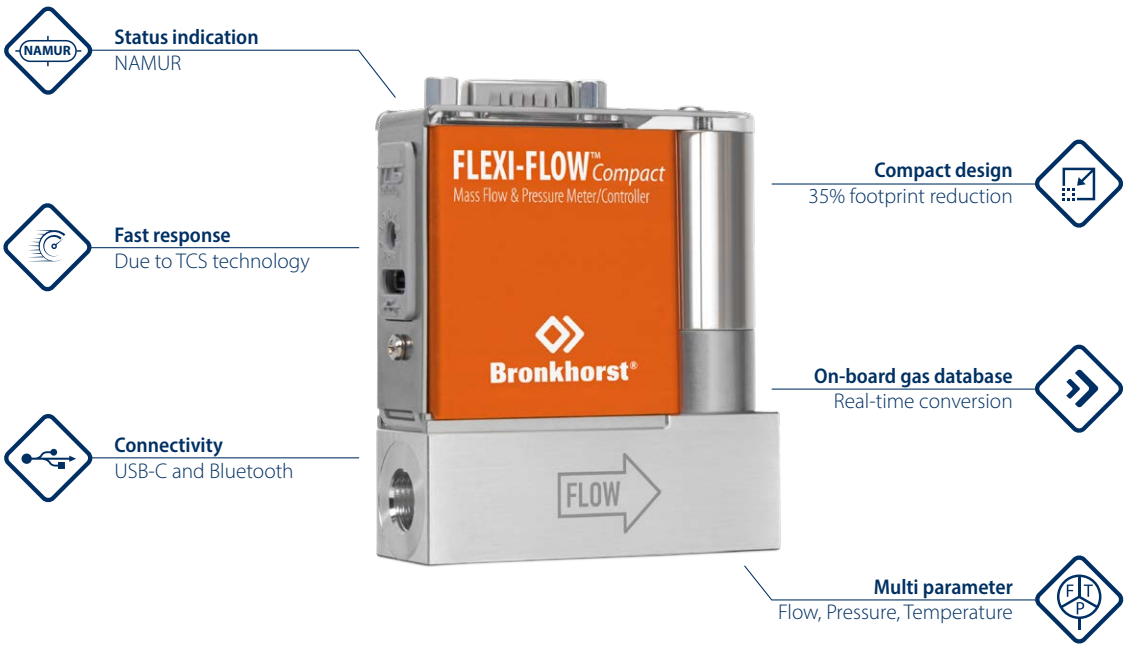
Compact design
We have been able to reduce the footprint by 35% compared to similar instruments up to 20 l_n/min. Due to this compact size, the instrument is very suitable to be used inside desktop equipment or at places where space is limited.

Separate USB-C communication interface
For easy setup outside the installation, the USB-C port can be used. Communication can be established with the Bronkhorst FlowSuite software without the need of an additional power supply.
During operation, this port can also be used to monitor the instrument without disconnecting the power and data connection.

Bluetooth communication
To enhance user flexibility, a wireless connection allows monitoring the instrument without disconnecting the regular power and data connection. In case Bluetooth is not desired, this function can be disabled.

Sustainable and environmentally friendly
Due to the accurate conversion, calibration with valuable or rare gases is no longer necessary. In addition, Bronkhorst's products are known for their low power consumption. The reduced size and weight of the instrument minimizes its environmental impact.

Predictive maintenance
Prepared for predictive maintenance and diagnostic functions by means of datalogging of several parameters, that can be used to predict the health status of the instrument and condition of the process. With multiple configurable alarms the information can be transferred to the user.



The new standard in measurement & control of Mass flow and pressure

- 3 control types in one compact instrument
  - Mass flow
  - Upstream pressure
  - Downstream pressure
- Multi parameter output
  - Actual mass flow
  - Upstream pressure
  - Downstream pressure
  - Temperature (instrument)
- Simple and secure connection through Bluetooth or USB-C
- Advanced diagnostics functionalities
- High accuracy through on-board gas database and real-time conversion
- Easy to configure
- MTBF 145 years

Mass Flow Controller (standard)

Models and ranges

The FLEXI-FLOW™ Compact series comprises 3 variants:

- **'Built-to-Order (BtO)'**, Mass Flow Meters (MFM) and Controllers (MFC) with free selection of ranges from 0…5 ml_n/min up to 0…500 l_n/min, turndown up to 1:1000; including multi-channel versions up to 8 channels.
- **'Preconfigured Advanced (PA)'**, MFCs in 11 ranges (FS): 5/20/50/200 ml_n/min and 0.5/2/5/20/50/200/500 l_n/min (based on N_2), turndown 1:500, flow + temperature + pressure
- **'Preconfigured Standard (PS)'**, MFCs in 4 ranges (FS): 0.5/2/5/20 l_n/min (based on N_2), turndown 1:50, flow + temperature

Note: The technical specifications in this brochure solely apply to Built-to-Order variants. For the specifications of our Preconfigured models we refer to our website.

Mass Flow Meter (downported)

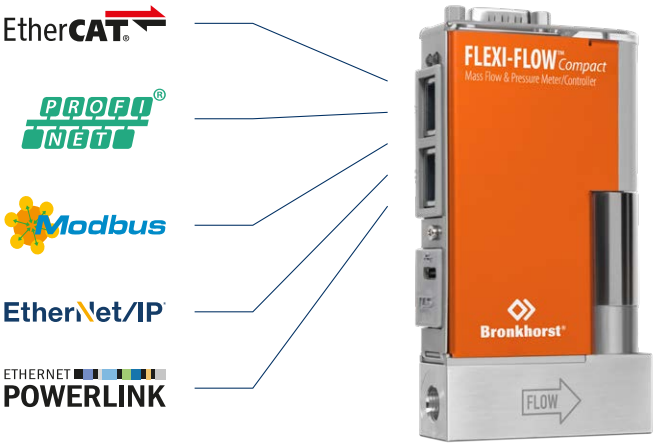
Mass Flow and Pressure Meter

Version	Model	Full scale
Standard	FF-M0x	5/20/50/200 ml_n/min
Standard	FF-M1x	0.5/2/5/20 l_n/min
High-flow	FF-M2x	50/200/500 l_n/min
Downported	FF-M1xD	0.5/2/5/20 l_n/min

Mass Flow and Pressure Controller

Version	Model	Full scale
Standard	FF-C0x	5/20/50/200 ml_n/min
Standard	FF-C1x	0.5/2/5/20 l_n/min
High-flow	FF-C2x	50/200/500 l_n/min
Downported	FF-C1xD	0.5/2/5/20 l_n/min
With shut-of valve	FF-C1xS	0.5/2/5/20 l_n/min

Mass Flow Controller with shut-off valve



Mass Flow Controller, with EtherNet interface

Mass Flow Controller (high-flow)

Technical specifications

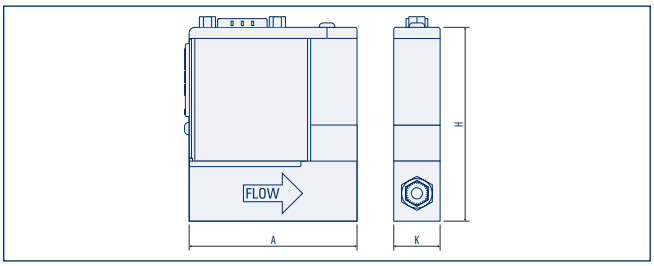
Measurement / control system	
Flow	
Accuracy (N_2, Air, O_2) *For other gases see multi gas table*	up to ±0.5% Rd plus ±0.1% FS
Repeatability	< ± 0.2% Rd
Settling time (T_{98}) in control	<150 ms typical; <1 sec for 50/200/500 l_n/min models
Response time (T_{63})	<30 ms
Long term stability	<0.5% FS over period of 3 years, then <0.2% FS per year
Control stability	< ± 0.1% FS (typical for 1 l_n/min N_2)
Control range / measurement range	up to 1:1000; models ≤ 20 ml_n/min: up to 1:500
Multi Gas / Multi Range	embedded gas data for 22 unique gases plus any mixture of these gases
Temperature sensitivity	zero 0.015 % FS/°C span 0.05 % Rd/°C
Pressure sensitivity	standard: < 0.15% Rd/bar typical N_2; with pressure correction: typical factor 5 improved
Temperature	
Accuracy temperature sensor	±2 °C (instrument body temperature)
Pressure	
Accuracy pressure sensors *(incl. linearity and hysteresis)*	±0.5% FS
Repeatability pressure sensors	<0.2% FS
Temperature sensitivity	zero: 0.16 mbar/°C span: 0.05% Rd/°C
General	
Operating pressure	0.8…17 bar(a)
Operating temperature	0…50 °C (32°F - 122°F)
Storage / transport conditions	-20…50 °C
Mounting	any position, attitude sensitivity negligible

Mechanical parts	
Material *(wetted parts)*	aluminium, stainless steel, silicon nitride, epoxy, aluminiumoxide, glass
Process connections	models ≤20 l_n/min: ⅛" BSPP (ISO 1179-1 cavities); models ≥50 l_n/min: ½" BSPP (ISO 1179-1 cavities); optional compression type, push-in or face seal couplings
Seals	default: FKM 51415 For other materials contact factory
Pressure rating	16 bar(g) / 250 psi(g)
Leaktightness, outboard *(prior to permeation through seals)*	tested < $2 \cdot 10^{-9}$ mbar.l/s He
Leak-by through closed valve	typical: <$1 \cdot 10^{-4}$ mbar.l/s He; <50 ml_n/min: <$5 \cdot 10^{-5}$ mbar.l/s He; >50 l_n/min: <0.1% FS @ 1 bard; shut-off valve: $2 \cdot 10^{-8}$ mbar.l/s He *Note: 50/200/500 l_n/min models require a minimum ΔP of 1 bard to ensure max. 0.1% FS leak-by rate.*
Surface roughness body *(wetted parts)*	<1.6 µm Ra (<0.8 µm Ra for stainless steel body)
Ingress protection *(housing)*	IP40

Electrical properties	
Power supply	24 Vdc ± 10%
Electrical connection	9-pin D-sub male
Power consumption	meter: 0.5 Watt controller: 2.5 Watt EtherNet: add +0.9 Watt Shut-off: add +2.4 Watt
Digital communication	Modbus-RTU, FLOW-BUS, EtherCAT®, EtherNet/IP, Modbus-TCP, POWERLINK, PROFINET
Certification	CE / RoHS

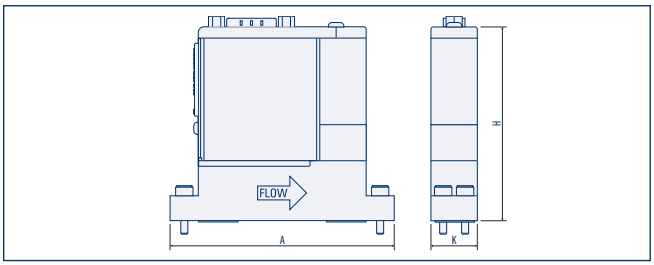
Technical specifications and dimensions subject to change without notice.

Dimensions (in mm) and weights (in kg)



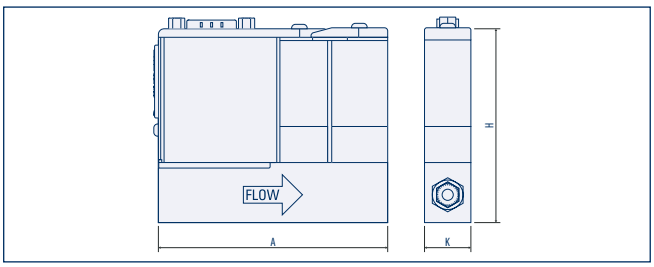
Standard MFM / MFC

Model	A	H	K	Weight (Aluminium)	Weight (SS316)
FF-M0x	60	68	20	0.250	0.350
FF-M1x	60	68	20	0.225	0.325
FF-M2x	89	106	40	0.650	1.175
FF-C0x	60	68	20	0.225	0.325
FF-C1x	60	68	20	0.200	0.300
FF-C2x	89	106	40	0.625	1.150



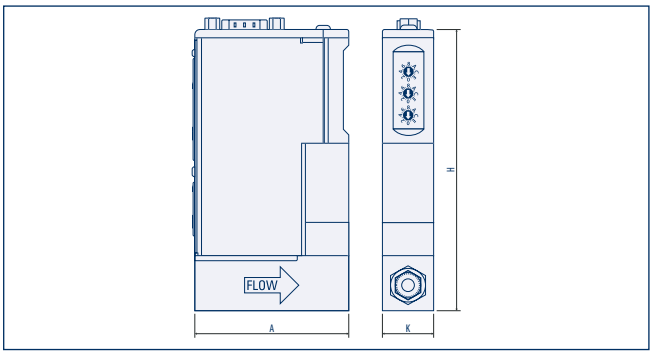
Downported MFM / MFC

Model	A	H	K	Weight (Aluminium)	Weight (SS316)
FF-M1xD	80	71	20	0.275	0.375
FF-C1xD	80	71	20	0.250	0.350



MFC with shut-off valve

Model	A	H	K	Weight (Aluminium)	Weight (SS316)
FF-C1xS	81	69	20	0.350	0.450

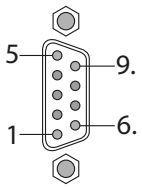


Standard MFM / MFC with EtherNet interface

Model	A	H	K	Weight (Aluminium)	Weight (SS316)
FF-M0x	60	109	20	0.300	0.400
FF-M1x	60	109	20	0.275	0.375
FF-M2x	89	147	40	0.700	1.225
FF-C0x	60	109	20	0.275	0.375
FF-C1x	60	109	20	0.250	0.350
FF-C2x	89	147	40	0.675	1.200

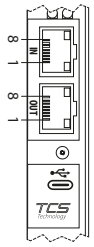
Electrical connection

9-pin D-sub male



1	RS-485 D0 (A/A')
2	Not connected
3	Not connected / +Us shut-off 24Vdc
4	0Vs
5	Not connected / +Us shut-off 24Vdc
6	RS-485 D1 (B/B')
7	+Us
8	0Vs
9	Shield

RJ45 modular jack connectors



2x RJ45 modular jack chassis part female

1	TxD+
2	TxD-
3	RxD+
4	Not connected
5	Not connected
6	RxD-
7	Not connected
8	Not conected

Model number identification

FF - A N N A

Base

M	Meter
C	Controller

Ranges (N_2 equivalent)

0	5/20/50/200 ml_n/min
1	0.5/2/5/20 l_n/min
2	50/200/500 l_n/min

Version

-	default MFM / MFC
S	with integrated shut-off valve*
D	downported (top-mount)*

** Available for 0.5-20 l_n/min N_2-equivalent range*

Multi-parameter functionality

0	flow, temperature
1	flow, temperature, up- and downstream pressure

Multi gas table

To determine which model is suitable for process gases other than N_2, the full-scale flow must be multiplied by the below-mentioned "flow factor". Note: this factor might be different for a flow meter (MFM) or a flow controller (MFC).

The highly accurate on-board Fluidat gas database ensures best in class conversion from N_2 to the customer gas. When converting one gas to another, a small uncertainty is introduced. Although gas properties and conversion model are very accurate, mechanical tolerances can cause slight deviations from the theoretical conversion values. When the best accuracy performance is needed, calibration on actual process gas can be performed.

Name	Gas Formula	Full scale factor (MFM)	Full scale factor (MFC)	Remarks
Acetylene	C_2H_2	0.6	0.6	pure gas only
Air	Air	1	1	
Allene	C_3H_4 #1	0.4	0.4	
Argon	Ar	1.3	1	
Carbon dioxide	CO_2	0.7	0.7	Max. 10 bar
Carbon monoxide	CO	1	1	
Cyclopropane	C_3H_6 #1	0.4	0.4	
Deuterium	D_2 #1	1	1	
Ethane	C_2H_6	0.5	0.5	
Ethylene	C_2H_4	0.6	0.6	Max. 10 bar
Helium	He	1.4	1.4	
Propyne	C_3H_4 #2	0.4	0.4	
Hydrogen	H_2	1	1	
Krypton	Kr	1	0.6	
Methane	CH_4	0.8	0.8	
Neon	Ne	1.4	1.2	
Nitrogen	N_2	1	1	
Oxygen	O_2	1	0.9	
Propylene	C_3H_6 #2	0.4	0.4	Max. 10 bar
Propane	C_3H_8	0.3	0.3	
Perfluoropropane	C_3F_8	0.15	0.15	Max. 10 bar
Nitrous oxide	N_2O	0.7	0.7	

Multi-channel systems

FLEXI-FLOW Compact instruments can be combined to build a compact system – ready to use. Multi-channel systems up to 8 channels can be easily created with the help of configuration software.

The use of distribution chambers at the inlet or mixing chambers at the outlet ensures a compact and small build of the system. Communication from the multi-channel system to the PLC can be established with additional gateways.

Since the system is completely assembled and tested at Bronkhorst, the effort required for commissioning is kept to a minimum.

3-Channel version

Typical markets

Bioreactors

Increased deployment of a flow instrument by Air, N_2, O_2, CO_2 - multi-gas functionality and availability of multiple flow ranges in a single instrument.

Compact for desktop equipment.

Reactive sputtering

Fast follow-up of setpoints for layer thickness and transparency control.

Large dynamic range for flexibility within the application.

Fuel cell

Very accurate and repeatable over short-term and long-term for H_2, Air, O_2 and CO_2 flow measurement and control. Fast response flow measurement and control for accuracy at any time.

Large dynamic range flow measurement and control for accuracy over a wide flow range. Compact for space-restricted mobile applications.

Analytical equipment

Trace Elemental Analysis (TEA)
Gas Chromatography (GC)
Optical Emission Spectroscopy (ICP-OES)
Mass Spectrometry (MS, ICP-MS)
Atomic Absorption Spectrometry (AAS)

Excellent repeatability and long-term stability.

Analytical grade; low outgassing. Fast flow control, also at very low flow rates. Compact for desktop equipment.

And many other applications

High-end burners, plasma spray, leak testing, ALD, etc.

Bronkhorst®

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®!

www.bronkhorst.com

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