



# FLEXI-FLOW™ Compact

Mass Flow & Pressure Meters and Controllers for Gases



## › 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).



### Status indication

NAMUR



### Fast response

Due to TCS technology



### Connectivity

USB-C and Bluetooth



### 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<sub>r</sub>/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.



### Compact design

35% footprint reduction



### On-board gas database

Real-time conversion



### Multi parameter

Flow, Pressure, Temperature



## › 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

## › 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<sub>r</sub>/min up to 0...500 l<sub>r</sub>/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<sub>r</sub>/min and 0,5/2/5/20/50/200/500 l<sub>r</sub>/min (based on N<sub>2</sub>), turndown 1:500, flow + temperature + pressure
- ◆ **'Preconfigured Standard (PS)'**, MFCs in 4 ranges (FS): 0,5/2/5/20 l<sub>r</sub>/min (based on N<sub>2</sub>), 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 and Pressure Meter

Version	Model	Full scale
Standard	FF-M0x	5/20/50/200 ml <sub>r</sub> /min
Standard	FF-M1x	0,5/2/5/20 l <sub>r</sub> /min
High-flow	FF-M2x	50/200/500 l <sub>r</sub> /min
Downported	FF-M1xD	0,5/2/5/20 l <sub>r</sub> /min

### Mass Flow and Pressure Controller

Version	Model	Full scale
Standard	FF-C0x	5/20/50/200 ml <sub>r</sub> /min
Standard	FF-C1x	0,5/2/5/20 l <sub>r</sub> /min
High-flow	FF-C2x	50/200/500 l <sub>r</sub> /min
Downported	FF-C1xD	0,5/2/5/20 l <sub>r</sub> /min
With shut-off valve	FF-C1xS	0,5/2/5/20 l <sub>r</sub> /min



Mass Flow Controller (standard)



Mass Flow Meter (downported)



Mass Flow Controller with shut-off valve



Mass Flow Controller (high-flow)



Mass Flow Controller, with EtherNet interface

## » Technical specifications

### Measurement / control system

#### Flow

Accuracy (N <sub>2</sub> , Air, O <sub>2</sub> ) <i>For other gases see multi gas table</i>	up to ±0,5% Rd plus ±0,1% FS
Repeatability	< ± 0,2% Rd
Settling time (T <sub>90</sub> ) in control	<150 ms typical; <1 sec for 50/200/500 l <sub>v</sub> /min models
Response time (T <sub>63</sub> )	<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 <sub>v</sub> /min N <sub>2</sub> )
Control range / measurement range	up to 1:1000; models ≤ 20 ml <sub>v</sub> /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 <sub>2</sub> ; with pressure correction: typical factor 5 improved

#### Temperature

Accuracy temperature sensor ±2 °C (instrument body temperature)

#### Pressure

Accuracy pressure sensors <i>(incl. linearity and hysteresis)</i>	±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

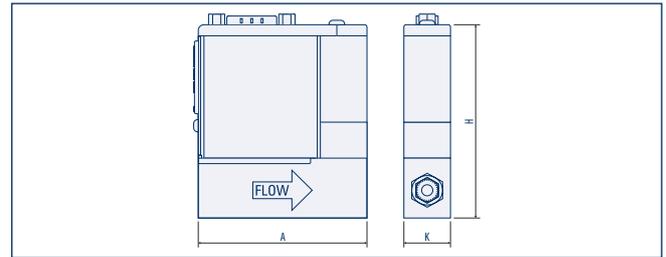
Material ( <i>wetted parts</i> )	aluminium, stainless steel, silicon nitride, epoxy, aluminiumoxide, glass
Process connections	models ≤20 l <sub>v</sub> /min: 1/8" BSPP (ISO 1179-1 cavities); models ≥50 l <sub>v</sub> /min: 1/2" BSPP (ISO 1179-1 cavities); optional compression type, push-in or face seal couplings
Seals	default: FKM 51415 For other materials contact factory
Pressure rating	16 bar(g) / 250 psi(g)
Leaktightness, outboard <i>(prior to permeation through seals)</i>	tested < 2·10 <sup>-9</sup> mbar.l/s He
Leak-by through closed valve	typical: <1.10 <sup>-4</sup> mbar.l/s He; <50 ml <sub>v</sub> /min: <5.10 <sup>-5</sup> mbar.l/s He; >50 l <sub>v</sub> /min: <0,1% FS @ 1 bar; shut-off valve: 2.10 <sup>-8</sup> mbar.l/s He  <i>Note: 50/200/500 l<sub>v</sub>/min models require a minimum ΔP of 1 bard to ensure max. 0,1% FS leak-by rate.</i>
Surface roughness body <i>(wetted parts)</i>	<1,6 μm Ra (<0,8 μm Ra for stainless steel body)
Ingress protection ( <i>housing</i> )	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

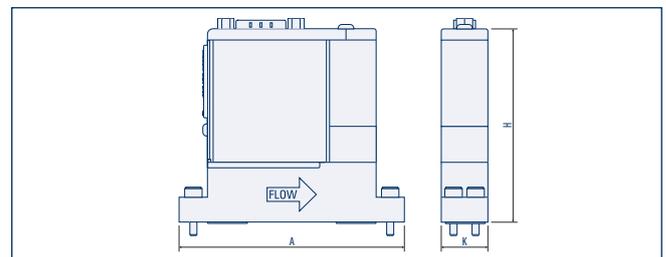
*Technical specifications and dimensions subject to change without notice.*

## » Dimensions (in mm) and weights (in kg)



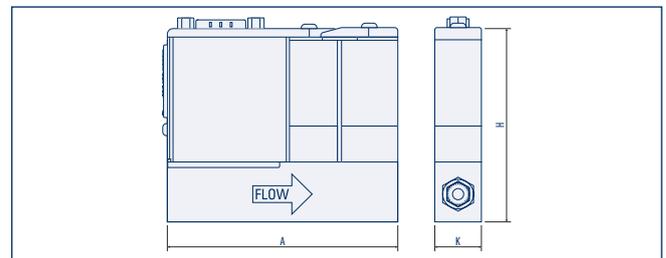
### Standard MFM / MFC

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



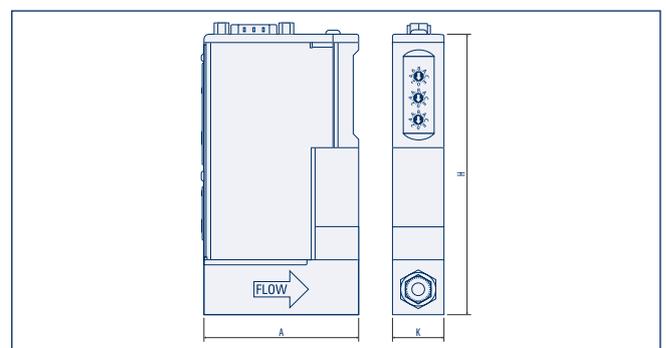
### Downported MFM / MFC

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

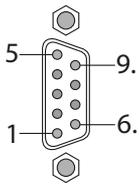


### Standard MFM / MFC with EtherNet interface

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

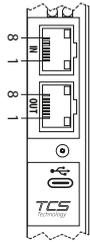
## Electrical connection

### 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 connected

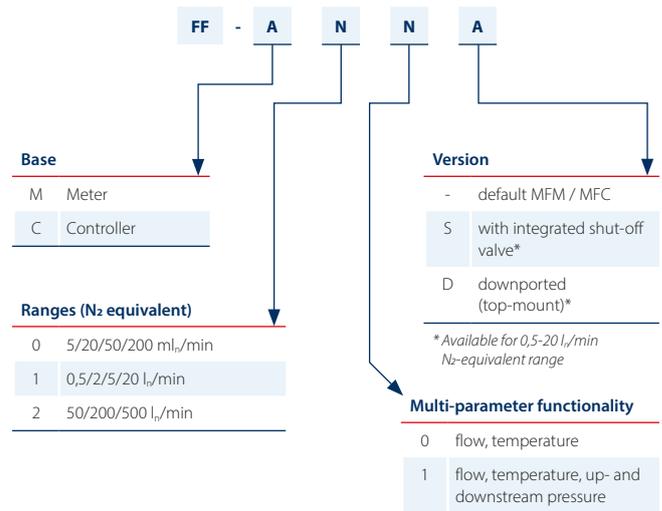
## Multi gas table

To determine which model is suitable for process gases other than N<sub>2</sub>, 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<sub>2</sub> 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 <sub>2</sub> H <sub>2</sub>	0,6	0,6	pure gas only
Air	Air	1	1	
Allene	C <sub>3</sub> H <sub>4</sub> #1	0,4	0,4	
Argon	Ar	1,3	0,8	
Carbon dioxide	CO <sub>2</sub>	0,7	0,7	Max. 10 bar
Carbon monoxide	CO	1	1	
Cyclopropane	C <sub>3</sub> H <sub>6</sub> #1	0,4	0,4	
Deuterium	D <sub>2</sub> #1	1	1	
Ethane	C <sub>2</sub> H <sub>6</sub>	0,5	0,5	
Ethylene	C <sub>2</sub> H <sub>4</sub>	0,6	0,6	Max. 10 bar
Helium	He	1,4	1,4	
Propyne	C <sub>3</sub> H <sub>4</sub> #2	0,4	0,4	
Hydrogen	H <sub>2</sub>	1	1	
Krypton	Kr	1	0,6	
Methane	CH <sub>4</sub>	0,8	0,8	
Neon	Ne	1,4	1,2	
Nitrogen	N <sub>2</sub>	1	1	
Oxygen	O <sub>2</sub>	1	0,9	
Propylene	C <sub>3</sub> H <sub>6</sub> #2	0,4	0,4	Max. 10 bar
Propane	C <sub>3</sub> H <sub>8</sub>	0,3	0,3	
Perfluoropropane	C <sub>3</sub> F <sub>8</sub>	0,15	0,15	Max. 10 bar
Nitrous oxide	N <sub>2</sub> O	0,7	0,7	

## Model number identification



## 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<sub>2</sub>, O<sub>2</sub>, CO<sub>2</sub> - 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<sub>2</sub>, Air, O<sub>2</sub> and CO<sub>2</sub> 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.

