



MASS-STREAM™ D-6400

Mass Flow Meters and Controllers for Gases



MASS-STREAM™

Your best choice for inline flow measurement

➤ Introduction

The thermal Bronkhorst® mass flow meters and controllers for gases based on direct through-flow measurement are produced in Germany since 1997. The MASS-STREAM™ series D-6400 works following the constant temperature anemometer principle.

Our MASS-STREAM™ instruments cover a wide range of measurement and control applications in almost every industry sector - like mechanical engineering and process industry, gas production, food and beverage industry as well as environmental engineering and the chemical industry.

We are committed to a long lasting cooperation with our customers and of course we are also your competent contact for special solutions. You benefit from our well-trained, highly motivated team and our culture of quality.

Please visit our website www.bronkhorst.com to find your local sales partner.

➤ Flow ranges

Smallest standard range

0,01 ... 0,2 l_v/min (Air)

Highest standard range

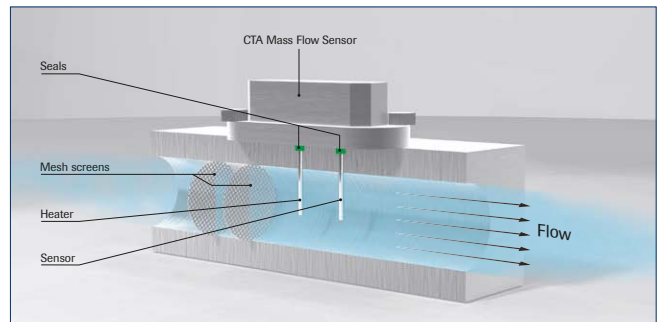
200 ... 10.000 l_v/min (Air)

Within the above mentioned borders intermediate calibrations with a turn-down ratio up to 1:100 are also possible.

The comprehensive Bronkhorst product range includes a variety of instruments with smaller and higher flow ranges as well as extended standards and tailor-made special solutions.

➤ Principle of through-flow measurement

The mass flow meters and controllers consist of a metal body with a straight through-flow path. Two sensors are encased with stainless steel and protrude inside this bore; one is designed as a heater and the other one is designed as a temperature probe. A constant difference in temperature (ΔT) is created between the two sensors. The heater energy required to maintain this ΔT is dependent on the mass flow. The working principle is based on King's law of the ratio between the mass flow and the heater energy. That means the higher the flow, the more energy is required to maintain the specific ΔT .



➤ Features

- ◆ Direct inline measurement principle
- ◆ Usable for many gases and gas-mixes
- ◆ Mass flow measurement and control for a wide scope of applications
- ◆ Many on-board communication options to connect with Ethernet, CAN and other serial fieldbuses
- ◆ Precise control mode and good response times
- ◆ Compact and robust design
- ◆ IP65 for full product range
- ◆ Bodies available in aluminium (EN AW-6082-T6) or stainless steel (SS316) for corrosive gases
- ◆ Sensor made of stainless steel
- ◆ Low sensitivity to dirt and humidity
- ◆ Measurement without moving parts
- ◆ Modern multi-coloured TFT display
 - ◆ IP65 compliant
 - ◆ Operator buttons on the instrument
 - ◆ Customized adjustable multi-functional display: actual flow, fluid sets, totalizer with memory and reset, alarm, setup and much more
- ◆ Compatible with Bronkhorst FlowSuite software
- ◆ On-board gas database (FLUIDAT on board)
- ◆ Customized input/output options
- ◆ Optional connectors (fittings) according to ISO-1179 standard

➤ Applications

- ◆ Aeration
- ◆ Analytical instruments
- ◆ Biogas applications
- ◆ Burner / furnace controls
- ◆ Coating plant and paint-spray lines
- ◆ Exhaust gas and ammonia measurement
- ◆ Gas consumption measurement
- ◆ Gas monitoring systems
- ◆ Gas purging
- ◆ Mechanical engineering
- ◆ N₂/O₂/O₃-generators
- ◆ Heat treatment and casting
- ◆ and much more



Multi-coloured TFT display

Mass flow meter (MFM) D-64X0

Mass flow controller (MFC) D-64X1, D-64X3

► Principle of operation

The digital MASS-STREAM™ mass flow meters (MFM) and controllers (MFC) are operated with a main-board with all functions for the flow measurement and control. The instruments can be supplied with commonly used digital or analog input/output signals and when ordering a digital instrument please forward the required presets. Along with the standard RS232 interface the additional fieldbuses CANopen®, DeviceNet™, EtherCAT®, PROFIBUS DP, PROFINET, Modbus (RTU, ASCII or TCP/IP), EtherNet/IP, POWERLINK and FLOW-BUS are also available. The digital MASS-STREAM™ model series is characterized by a high degree of signal integrity and, as an option, up to 8 calibration curves of different gases and process conditions can be memorized in the instrument. To provide adaptability and flexibility for a wide range of different process conditions our customers are offered the possibility to adjust, to optimize and to evaluate the parameters and control characteristics, even whilst on site.

Bronkhorst supplies compact MASS-STREAM mass flow controllers for flows up to 10.000 l_n/min Air-equivalent with the valve integrated with the instrument body and K_v-values up to 8,2. (Additional mass flow controllers with separate control valves on request.)

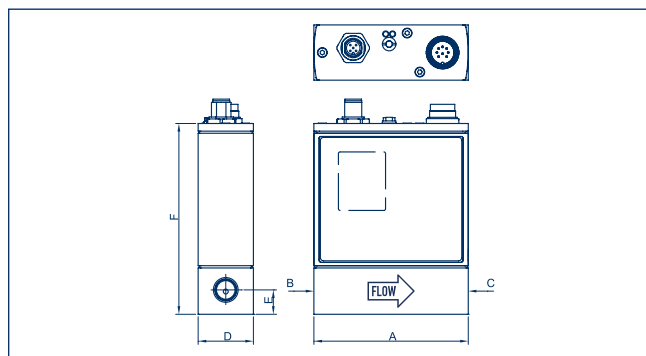
The accompanying software and documentation is a basic part of our scope of supply as well as the calibration certificate.

► D-6400 dimensions (in mm) and weights (in kg)

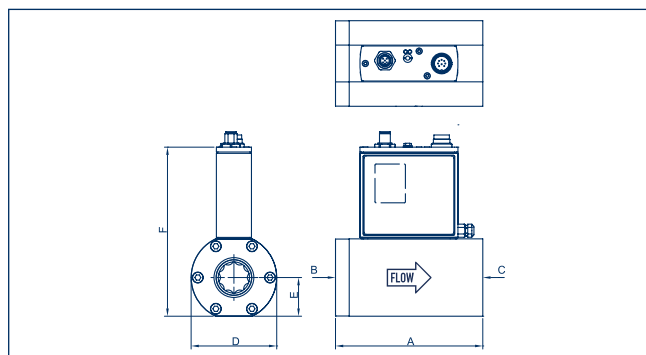
Model	A	B*	C*	D	E	F	I	ALU	SS316
D-6410	95	G1/4"	G1/4"	34	15	117		1,0	1,5
D-6420	95	G1/4"	G1/4"	34	15	117		1,0	1,5
D-6440	95	G1/4"	G1/4"	34	15	114		1,0	1,5
D-6460(A)	95	G1/2"	G1/2"	34	16	122		1,1	1,6
D-6470	117	G1/2"	G1/2"	58	25	136		1,4	2,5
D-6470A	150	G1/2"	G1/2"	74	33,5	155		n.a.	2,5
D-6480	143	G1"	G1"	83	37,5	164		2,3	4,9
D-6490	211	G2"	G2"	120	56,3	201		5,5	12,2
D-6411	95	G1/4"	G1/4"	34	15	117		1,1	1,6
D-6421	95	G1/4"	G1/4"	34	15	117		1,1	1,6
D-6441	95	G1/4"	G1/4"	34	15	114		1,1	1,6
D-6461/FAS	110	G1/2"	G1/2"	34	16	122		1,2	1,7
D-6461(A)/002BI	145	G1/2"	G1/2"	34	16	122	106	1,7	2,2
D-6471/004BI	192	G1/2"	G1/2"	65	25	136	186	4,4	6,9
D-6471A/003AI	208	G1/2"	G1/2"	74	33,5	155	130	n.a.	6,6
D-6481/003AI	212	G1"	G1/2"	83	37,5	164	134	n.a.	7,0
D-6481/003BI	236	G1"	G1"	89	42	168	147	n.a.	9,3
D-6491/003BI	304	G2"	G1"	120	56,3	201	161	n.a.	16,0

Dimensions for other models, please consult our website.

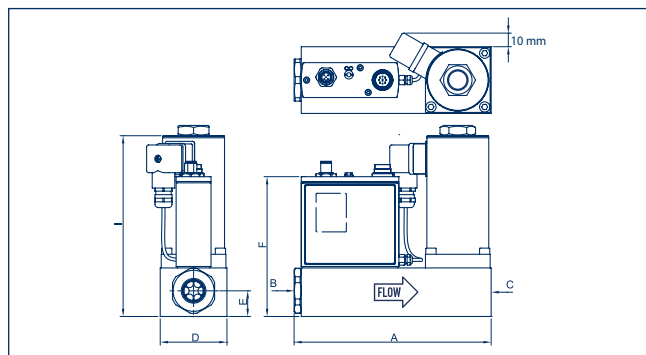
* ISO 1179-1 cavities



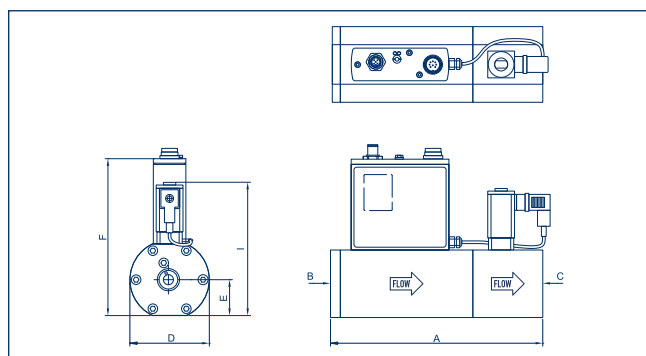
Model D-6410, D-6411, D-6420, D-6421, D-6440, D-6441, D-6460(A), D-6461/FAS



Model D-6470(A), D-6480, D-6490



Model D-6461(A)/002BI, D-6471/004BI



Model D-6471A/003AI, D-6481/003AI, D-6481/003BI, D-6491/003BI

› Standard measurement ranges

Mass flow meter/controller Model		Flow ranges (Air) intermediate ranges are available	
D-6410	Min. 0,01...0,2 l _r /min	Max. 0,1...2,0 l _r /min	
D-6420	Min. 0,05...1,0 l _r /min	Max. 0,35...7,0 l _r /min	
D-6440	Min. 0,14...7,0 l _r /min	Max. 0,5...50,0 l _r /min	
D-6460	Min. 0,4...20,0 l _r /min	Max. 2,0...200 l _r /min	
D-6460A	Min. 1,0...50,0 l _r /min	Max. 5,0...500 l _r /min	
D-6470	Min. 2,0...100 l _r /min	Max. 10,0...1.000 l _r /min	
D-6470A	Min. 4,0...200 l _r /min	Max. 20,0...2.000 l _r /min*	
D-6480	Min. 10,0...500 l _r /min	Max. 50,0...5.000 l _r /min	
D-6490	Min. 40,0...2.000 l _r /min	Max. 100...10.000 l _r /min	
D-6411	Min. 0,01...0,2 l _r /min	Max. 0,1...2,0 l _r /min	
D-6421	Min. 0,05...1,0 l _r /min	Max. 0,35...7,0 l _r /min	
D-6441	Min. 0,14...7,0 l _r /min	Max. 1,0...50,0 l _r /min	
D-6461/ D-6463	Min. 0,4...20,0 l _r /min	Max. 4,0...200 l _r /min	
D-6461A	Min. 1,0...50,0 l _r /min	Max. 10,0...500 l _r /min	
D-6471/ D-6473	Min. 2,0...100 l _r /min	Max. 20,0...1.000 l _r /min	
D-6471A	Min. 4,0...200 l _r /min	Max. 20,0...2.000 l _r /min	
D-6481/ D-6483	Min. 10,0...500 l _r /min	Max. 100...5.000 l _r /min	
D-6491	Min. 40,0...2.000 l _r /min	Max. 200...10.000 l _r /min	

* up to 2.500 l_r/min on request.

Technical changes and alterations in construction are reserved.

› On-board FLUIDAT® gas database

Simply select your process gas. With the on-board gas database, it is very easy to switch to another gas or gas-mixture without the need for recalibration. MASS-STREAM™ mass flow meters and controllers are factory calibrated with Air as standard. In case other gases or gas mixtures are used, a conversion will be applied by means of the on-board gas database (FLUIDAT on board). The conversion depends on the physical properties of the gas and the process parameters, for instance the media temperature and operating pressure.

The highly accurate FLUIDAT gas database ensures best in class conversion from Air to the customer gas. Additionally, the on-board gas database is used for real-time corrections of the flow measurement based on the actual process temperature.

When converting one gas to another, a small uncertainty is introduced. Although gas properties and conversion model are very accurate, the result can deviate slightly from the theoretical calculated values. With a conversion factor >1 this conversion uncertainty is ≤ 2 x CF (in % FS) and in case the conversion factor is <1 this conversion uncertainty is ≤ 2 / CF (in % FS). For an estimation of the conversion factor, please refer to www.fluidat.com.

› Flow profile and sensitivity

In general mass flow measurement is very sensitive to variations of the shape of the flow profile. The MASS-STREAM™ instruments are designed for a consistent, fully developed flow profile in the metering section. Installing a suitable well-sized inlet pipe is recommended for our robust and concurrent precise mass flow measurement. Without an inlet run or insufficient inlet piping conditions severe deviations in the accuracy could possibly occur.

› Pressure loss

The pressure drop over the instrument's D-6400 measurement chamber is almost comparable to a straight run of pipe of the same diameter and is thus almost negligible.

However, to make the instruments less sensitive to upstream piping configurations (e.g. turbulences, welded joints, elbows) special mesh screens are required to condition the flow profile. These meshes create a certain pressure drop.

The frequently used compression fittings can cause a considerable additional pressure loss. We recommend to install fittings with maximized internal diameter. We would be happy to advise you on questions about the suitable inlet pipe in front of the instrument.

› Enquiry and order information

In order to supply the correct instrument for your application, please submit the following data:

- ◆ Type of gas
- ◆ Flow range
- ◆ Operating temperature
- ◆ Operating pressure (for controllers inlet and back pressure)
- ◆ Electrical connection
- ◆ Type of fieldbus (if applicable)
- ◆ Type of fittings (only when needed)
- ◆ Analog or digital presets



» Technical specifications

Measurement system

Accuracy (at calibration conditions)	± 1,0 % RD plus ± 0,5 % FS
Repeatability	< ± 0,2 % FS
Pressure sensitivity	± 0,3 % RD / bar typical (Air)
Temperature sensitivity	± 0,1 % RD / °C (Air)
Attitude sensitivity	at 90° deviation from horizontal max. error 0,2 % at 1 bar typical N ₂
Control stability	< 0,2 % FS typical
External leak integrity	< 2 x 10 ⁻⁸ mbar l/s He
Response time sensor (63 %)	D-641x / D-642x: approx. 0,3 seconds other models: approx. 0,9 seconds
Settling time (controller)	< 2 sec for direct acting valve < 5 sec for indirect acting valve
Certification	CE / RoHS

Mechanical parts

Sensor	Stainless steel SS 316 (AISI 316)
Instrument body	Aluminium EN AW-6082-T6 or stainless steel SS 316
Sieves and rings	Stainless steel SS 316
Protection	IP65 (with and without display)
Process connections	Female gas thread (ISO1179-1)
Seals	standard: FKM/Viton®; options: EPDM, FFKM/Kalrez®, FDA and USP Class VI approved compounds

Operating limits

Measuring range (turn-down-ratio)	up to 1...100 % (1:100) for meters up to 2...100 % (1:50) for controllers
Type of gases	almost all gases and gas-mixes, compatible with chosen materials
Temperature	0...50 °C
Storage / transport conditions	with display: 0...50 °C, max. 95% RH (non-condensing); without display: -20...+80 °C, max. 95% RH (non-condensing)
Pressure rating	0...10 bar (g) for instrument body in aluminium, 0...20 bar (g) for instruments body in stainless steel SS 316, 0...30 bar (g) on request
Warm-up time	30 minutes for optimum accuracy within 30 seconds for accuracy ± 4 % FS

Electrical properties

Supply voltage	+15...24 Vdc ± 10 %
Current peak values	Meter approx. 75 mA at 0 % flow approx. 125 mA at 100 % flow Controller add 250 mA add 30 mA for display, if applicable add 50 mA for additional fieldbus, if applicable
Analog output	0...5 (10) Vdc or 0 (4)...20 mA (sourcing output)
Digital communication	standard: RS232 options: CANopen®, DeviceNet™, EtherCAT®, PROFIBUS DP, PROFINET, Modbus (RTU, ASCII or TCP/IP), EtherNet/IP, POWERLINK or FLOW-BUS

Electrical connection

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

Technical changes and alterations in construction are reserved.

» Customized Input/Output configurations

Besides the I/O-options for measured and setpoint values via analog signals, RS232 or fieldbus communication, MASS-STREAM D-6400 instruments features a programmable pin (pin 5) at the 8DIN connector for customized Inlet/Outlet (I/O) configurations. This functionality can be used for advanced operations such as digital frequency/pulse output, alarm output/reset, processing an external setpoint signal, valve purge/close or analog valve output.

» Bronkhorst FlowSuite

Bronkhorst FlowSuite is a software application for monitoring and service purposes on Bronkhorst instruments and gives a good insight into the dynamic behavior of Bronkhorst devices.

Bronkhorst FlowSuite allows you to:

- ◆ Configure controller, alarms, counters, totalizers
- ◆ Add or change the fluid settings of your device with FLUIDAT on board functionality
- ◆ Get insights, configure and visualize your personal dashboard or graphs

Bronkhorst FlowSuite can be downloaded from our website:

www.bronkhorst.com/FlowSuite



Model number identification

