MASS-STREAM™
Instruction Manual

D-6400
Digital Mass Flow Meters / Controllers

Doc. No.: 9.17.119I Date: 2025-01

ATTENTION

Please read this document carefully before installing and operating the product.
Not following the guidelines could result in personal injury and/or damage to the equipment.

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Disclaimer

The illustrations in this document serve to provide general notices regarding correct operation. Illustrations are simplified representations of the actual situation and may differ from the actual product.

Bronkhorst Instruments GmbH reserves the right to modify or improve its products and documentation without notice. Prior to work, check whether a newer version of this document is available on the Bronkhorst website.

Symbols in this document

Important information. Disregarding this information could increase the risk of damage to the equipment, or the risk of personal injuries.

Helpful information. This information will facilitate the use of the instrument and/or contribute to its optimal performance.

Additional information available on the internet or from your Bronkhorst representative.

Receipt of equipment

Check the outside packaging box for damage incurred during shipment. If the box is damaged, the local carrier must be notified at once regarding his liability. At the same time a report should be submitted to your Bronkhorst representative. Carefully remove the equipment from the box. Verify that the contents of the package were not damaged during shipment. Should the equipment be damaged, the local carrier must be notified at once regarding his liability. At the same time a report should be submitted to your Bronkhorst representative.

- *Check the packing list to ensure that you received all of the items included in the scope of delivery*
- *Do not discard spare or replacement parts with the packaging material*

Refer to Removal and return instructions about return shipment procedures.

Equipment storage

- The equipment should be stored in its original package in a climate-controlled storage location.
- Care should be taken not to subject the equipment to excessive temperatures or humidity.
- See technical specifications for information about required storage conditions.

Warranty

For information about the warranty and the conditions of sales, please visit the Bronkhorst website:
https://www.bronkhorst.com/de-de/bronkhorst-instruments/

General safety precautions

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

Before operating, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables for cracks or breaks before each use.

The equipment and accessories must be used in accordance with their specifications and operating instructions, otherwise the safety of the equipment may be impaired.

Opening the equipment is not allowed. There are no user serviceable parts inside. In case of a defect please return the equipment to Bronkhorst Instruments GmbH.

To maintain protection from electric shock and fire, replacement components must be obtained from Bronkhorst. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be obtained from other suppliers, as long as they are equivalent to the original component. Selected parts should be obtained only through Bronkhorst, to maintain accuracy and functionality of the product. If you are unsure about the relevance of a replacement component, contact your Bronkhorst representative for information.

Contents

1. Introduction

1.1. Scope of this manual

This manual covers the Bronkhorst® instrument model series **MASS-STREAM D-6400** mass flow meters/controllers for gases. It contains general product information, installation and operating instructions and troubleshooting tips.

1.2. Intended use

The **MASS-STREAM D-6400** is designed to accurately measure and/or control gas flow rates in a fluid system using the media and operating conditions (e.g. temperature, pressure) that were specified at ordering time.

The gas(es) in the pressurized system in which the instrument is mounted should preferably be clean and dry. The equipment is suited for general purpose indoor (dry) applications, like laboratories and machine enclosures, as well as for sheltered outdoor applications, like installations in plant constructions. The compact and robust design of the MASS-STREAM D-6400 series is less sensitive to contamination or moisture in the gas flow and allows installations in rough ambient conditions.

MASS-STREAM D-6400 instruments are suitable for use at ambient temperatures conditions between 0 and +50 °C and a relative humidity of 10 to 90% RH, unless specified otherwise. The instruments have an ingress protection of IP65, implying that the electronics housing and electrical connection offer a certain level of protection against moist and dusty environments.

*The wetted materials incorporated in the **MASS-STREAM D-6400** are compatible with media and conditions (e.g. pressure, temperature) as specified at ordering time. If you are planning to use the product (including any third-party components supplied by Bronkhorst, such as pumps or valves) with other media and/or other conditions, always check the wetted materials (including seals) for compatibility. See the technical specifications of the product and consult third party documentation (if applicable) to check the incorporated materials.*

Responsibility for the use of the equipment with regard to suitability, intended use, cleaning and corrosion resistance of the applied materials against the processed media lies solely with the end user.

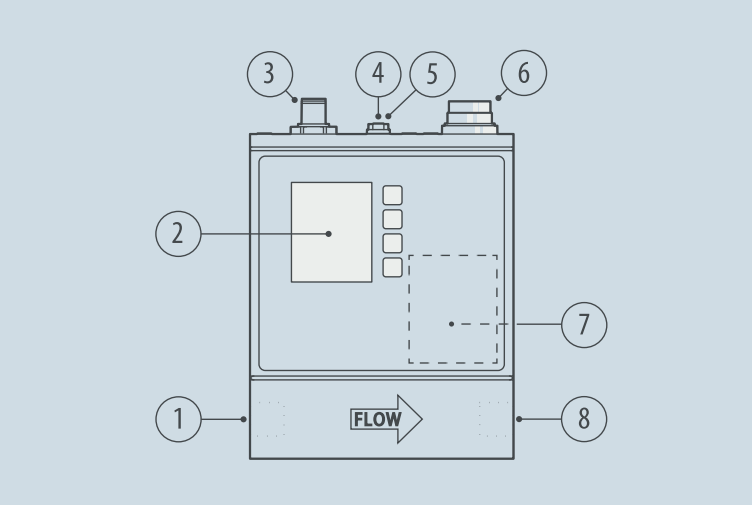
Where appropriate, this document recommends or prescribes safety measures to be taken with respect to media usage or working with the described equipment under the specified conditions. The end user is responsible for taking the necessary safety precautions and proper use of appropriate (personal) protective equipment, even if such is not explicitly recommended or required in this document.

The end user is considered to be familiar with the necessary safety precautions, and to comply with the appropriate protective measures as described in the Material Safety Data Sheets of the media to be used in the system (if applicable).

Bronkhorst Instruments GmbH cannot be held liable for any damage resulting from improper or unsafe use, use for other than the intended purpose or use with other media and/or under other conditions than specified on the purchase order.

See also section Sealing material compatibility.

1.3. Product description



1. Fluid inlet
2. Display/buttons (optional)
3. Connector (optional)
4. Switch/Push button
5. Status LEDs
6. Connector
7. Serial number label
8. Fluid outlet

The **MASS-STREAM D-6400** instruments are measurement devices for thermal mass flow and control of gases. They are equipped with a digital electronic multi-bus pc-board and consist of a micro-controller with peripheral circuitry for measuring, controlling and communication. The flow signal is measured directly in the gas flow, digitized and processed by means of the internal software (firmware). The measured and processed values can be output through the analog interface or through the digital communication line.
For controllers the setting for the actuator is calculated by the firmware. The setpoint can be given through the analog interface or through the digital communication line.

These digital instruments offer great flexibility thanks to the "multibus" concept, whereby the instruments can be equipped with an on-board interface with DeviceNet™, PROFIBUS DP, PROFINET, Modbus, EtherCAT®, FLOW-BUS or EtherNet-based protocols.
Numerous input/output options can be installed through the programmable 8DIN connector (see Customized I/O). In addition to the various analog signal options and the standard RS232 communication, there are such options as RS485 communication, digital frequency/pulse output, alarm output/reset, valve purge/close and analog valve output.

The **MASS-STREAM D-6400** instruments offer high flexibility due to the multi-gas/multi-range functionality. This function is easily accessible via the Bronkhorst customer software or PLC; there is no need to disconnect the instrument from your system. For additional gas types the user can calculate accurate fluid properties for conversion by means of our free, online software tool FLUIDAT® on the Net. Users of **MASS-STREAM D-6400** instruments can rescale their instruments on site, saving time and money for dismounting and recalibration.

The micro switches and LED's on top of the instrument can also be used for manual operation of some options.

1.4. Calibration

The **MASS-STREAM D-6400** is factory calibrated. Periodical inspection, recalibration or verification of the accuracy may be subject to individual requirements of the end user.

Bronkhorst certifies that the instrument meets the rated accuracy. Calibration has been performed using measurement standards traceable to the Dutch Metrology Institute (VSL).

1.5. Conversion with FLUIDAT on board gas database

The **MASS-STREAM D-6400** mass flow meters and controllers are factory calibrated with Air as standard. In case other gases or gas mixtures are used, a flow rate conversion will be applied. The conversion depends on the physical properties of the gas and the process parameters, for instance the media temperature and operating pressure. The on-board FLUIDAT gas database ensures best in class conversion from Air to the customer gas.

Although gas properties and conversion model are very accurate, the result can deviate slightly from the theoretical calculated values. This is called the conversion uncertainty and exists in addition to the calibration accuracy. With a conversion factor (CF) >1 this conversion uncertainty is ≤ 2 x CF (in % FS), and in case the conversion factor (CF) is <1 this conversion uncertainty is ≤ 2 / CF (in % FS).
For the conversion factor, please refer to www.fluidat.com.

1.6. Maintenance

The **MASS-STREAM D-6400** needs no regular maintenance if operated properly, with clean media, compatible with the wetted materials, avoiding pressure and thermal shocks and vibrations. Units may be purged with a clean, dry and inert gas.

In case of severe contamination, cleaning the inside of the device may be required. After cleaning, recalibration of the instrument is recommended.

Inexpertly servicing instruments can lead to serious personal injury and/or damage to the instrument or the system it is used in. Servicing must therefore be performed by trained and qualified personnel. Contact your Bronkhorst representative for information about cleaning and calibration. Bronkhorst has a trained staff available.

1.7. Documentation

The **MASS-STREAM D-6400** comes with all necessary documentation for basic operation and maintenance. Some parts of this manual refer to other documents, most of which can be downloaded from the Bronkhorst website. Calibration certificates, test certificates and material certificates are included in the scope of delivery or can be provided on request.

*The documentation listed in the following table is available on the **MASS-STREAM D-6400** product pages under www.bronkhorst.com/products*

Type	Document name	Document no.
Brochure	MASS-STREAM D-6400 Brochure	9.60.079
Manuals	Instruction manual MASS-STREAM D-6400 (this document)	9.17.119
	Quick Start Guide MASS-STREAM D-6400	9.17.183
	Instruction manual MASS-STREAM D-6400 display	9.17.164
Technical documentation	Hook-up diagram Analog/RS232	9.16.267
	Hook-up diagram CANopen	9.16.272
	Hook-up diagram DeviceNet™	9.16.271
	Hook-up diagram EtherCAT®	9.16.273
	Hook-up diagram EtherNet/IP	9.16.273
	Hook-up diagram FLOW-BUS	9.16.268
	Hook-up diagram Modbus ASCII / RTU	9.16.269
	Hook-up diagram Modbus TCP	9.16.273
	Hook-up diagram POWERLINK	9.16.273
	Hook-up diagram PROFIBUS DP	9.16.270
	Hook-up diagram PROFINET	9.16.273
	Hook-up diagram Optional bus & I/O configurations	9.16.266
	Dimensional drawings model specific	model specific

Type	Document name	Document no.
General documentation	EU Declaration of Conformity	9.06.044
Communication interfaces manuals	Manual CANopen interface	9.17.131
	Manual DeviceNet™ interface	9.17.026
	Manual EtherCAT® interface	9.17.063
	Manual EtherNet/IP interface	9.17.132
	Manual FLOW-BUS interface	9.17.024
	Manual Modbus interface ASCII / RTU / TCP	9.17.035
	Manual POWERLINK interface	9.17.142
	Manual PROFIBUS DP interface	9.17.025
	Manual PROFINET interface	9.17.095
	Manual RS232 interface	9.17.027

1.8. Model key

The model key on the serial number label contains information about the technical properties of the instrument as ordered. The specific properties can be retrieved with the diagrams below.

D-64N N - R A D - NN - V - A - D - D A - 000

Base model

D-641	up to 2 ln/min
D-642	up to 7 ln/min
D-644	up to 50 ln/min
D-646	up to 200 ln/min
D-646.A	up to 500 ln/min
D-647	up to 1.000 ln/min
D-647.A	up to 2.000 ln/min*
D-647./DR3	up to 3.000 ln/min
D-648	up to 5.000 ln/min
D-649	up to 10.000 ln/min

** up to 2.500 ln/min on request*

Function

0	Meter
1	Controller with integrated valve
3	Controller with port connector and external valve

Communication and valve type

Code	Fieldbus	Valve type
A	None	Normally closed
B	None	Normally opened
C	Powerlink	Normally closed
D	DeviceNet	Normally closed
E	DeviceNet	Normally opened
I	EtherNet/IP	Normally closed
J	EtherNet/IP	Normally opened
K	CANopen	Normally closed
L	CANopen	Normally opened
M	Modbus	Normally closed
N	Modbus	Normally opened
O	Powerlink	Normally opened
P	PROFIBUS DP	Normally closed
Q	PROFIBUS DP	Normally opened
R	FLOW-BUS	Normally closed
S	FLOW-BUS	Normally opened
T	EtherCAT	Normally closed
U	EtherCAT	Normally opened
V	PROFINET	Normally closed
W	PROFINET	Normally opened
X	Modbus-TCP	Normally closed
Y	Modbus-TCP	Normally opened

Input/output signal

A	0 - 5 Vdc
B	0 - 10 Vdc
F	0 - 20 mA
G	4 - 20 mA
N	None

Power supply

B	+24Vdc
D	+15..24Vdc

Process fittings inlet/outlet

00	None
11	1/8" OD compression type
22	1/4" OD compression type
33	6 mm OD compression type
44	12 mm OD compression type
55	1/2" OD compression type
88	1/4" Face seal male
DD	3/8" OD compression type
FF	1" OD compression type
GG	8 mm OD compression type
HH	10 mm OD compression type
LL	1/2" Face seal male
99	Other

Sealing material

V	FKM / Viton
E	EPDM
K	FFKM / Kalrez
B	EPDM USP/FDA
Z	Other

Body material

A	Aluminium EN AW-6082-T6
S	Stainless steel SS316

Display

0	None
D	With display

Controller mode

0	Controller disabled (meter only)
A	Analog control
D	Digital control

Integrated communication mode (pin 1/6) 8DIN

A	RS232 - (ProPar)
B	RS485 - FLOW-BUS
C	RS485 - Modbus RTU
D	RS485 - Modbus ASCII

Customized I/O options (pin 5) 8DIN

000	Disabled, pin 5 is pulled down to 0 Vdc (default)
A1V	0..10 Vdc sourcing output, controller
B1V	4..20 mA sourcing output, controller
C3A	Digital output, min/max alarm
C4A	Digital output, counter alarm
C5S	Digital output, enabled by setpoint (for shut-off control)
C0I	Digital output, high/low switch via remote parameter
D9E	Digital frequency output, measure
F9B	Digital pulse output, batch counter
H1P	4..20 mA input, external pressure sensor
I3C	Digital input, controller mode valve close
I8C	Digital input, controller mode valve purge
I1R	Digital input, reset counter
I2R	Digital input, reset alarm

See section Customized I/O options (pin 5) for more information about the configurable input/output (pin-5) options.

1.9. Sealing material compatibility

MASS-STREAM D-6400 instruments are fitted from factory with internal seals compatible with the gas type(s) as specified at ordering time. Before using other media, always check their compatibility with the applied sealing materials. Check the model key on the serial number label to see which sealing materials have been incorporated in your specific instrument. When in doubt, do not hesitate to contact your Bronkhorst representative for more information.

The table below lists compatibility with some commonly used gases:

Name	Formula	Sealing material		
		FKM	EPDM	FFKM
Acetylene	C_2H_2	v[1]	v	v
Air		v	v	v
Ammonia	NH_3	x	v	v
Argon	Ar	v	v	v
n-Butane	C_4H_{10} #1	v	x	v
α-Butylene	C_4H_8 #2	v	x	v
Carbon dioxide	CO_2	max. 10 bar(g), 50 °C	v	max. 10 bar(g), 50 °C
Carbon monoxide	CO	v	v	v
Chlorine	Cl_2	v	x	v
Cyclopropane	C_3H_6 #1	v	x	v
Dimethylether	C_2H_6O #1	x	x	v
Ethane	C_2H_6	v	x	v
Ethylene	C_2H_4	max. 10 bar(g)	max. 10 bar(g)	max. 10 bar(g)
Helium	He	v	v	v
n-Hexane	C_6H_{14} #2	x	x	v
Hydrogen	H_2	v	v	v
Hydrogen chloride	HCl	v	v	v
Hydrogen sulfide	H_2S	x	v	v
Isopentane	C_5H_{12} #1	v	x	v
Methane	CH_4	v	x	v
Methanethiol	CH_4S	x	x	v
3-Methylpentane	C_6H_{14} #1	x	x	v
2-Methylpropane	C_4H_{10} #2	v	x	v
Neopentane	C_5H_{12} #2	x	x	v
Nitric oxide	NO	x	x	v
Nitrogen	N_2	v	v	v
Nitrous oxide	N_2O	v	v	v
Oxygen	O_2	v	v	v
Ozone	O_3	v	x	v
Pentane	C_5H_{12} #3	v	x	v
Pentanethiol	$C_5H_{12}S$ #4	x	x	v
Propane	C_3H_8	v	x	v
Propylene	C_3H_6 #2	max. 10 bar(g)	x	v

Name	Formula	Sealing material		
		FKM	EPDM	FFKM
Silane	SiH_4	v[1]	x	v
Sulfur dioxide	SO_2	x	v	v
Vinylethylene	C_4H_6 #3	v	x	v

1) Only for Mass Flow Meter

- *Always make sure that the used process gases or mixtures thereof are compatible with the sealing materials the instrument is equipped with.*
- *Do not exceed the specified maximum operating pressure and temperature. Using the instrument outside the specified operating limits might lead to serious damage and dangerous situations.*

2. Installation

2.1. General

To avoid personal injury and/or damage to the equipment only trained and qualified personnel shall perform the installation of the instruments.
The instruments contain electronic components which are sensitive to Electro Static Discharges (ESD). Contact with electronically charged persons or objects could possibly endanger these components or even result in their failure.

2.2. Functional properties

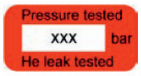
Before installing the **MASS-STREAM D-6400**, check the serial number label to see if the functional properties match your requirements:

- Flow rate
- Media to be used in the instrument
- Upstream and downstream pressure(s)
- Valve type (N.C. - Normally Closed / N.O. - Normally Open)
- Sealing material

2.3. Operating conditions

Test pressure

*Bronkhorst® instruments are pressure tested to at least 1.5 times the specified operating pressure and outboard leak tested to at least 2 * 10^{-8} mbar l/s Helium.*



- *The test pressure is specified on the device with a red label; if this label is missing or if the test pressure is insufficient, the device must not be used and should be returned to the factory.*
- *Before installation, make sure that the pressure rating is within the limits of the normal process conditions and that the tested pressure is in accordance with the safety factor of your application.*
- *Disassembling the device and/or replacing parts will invalidate the test pressure and leak test specification.*

Ambient conditions

Make sure that process gases do not condensate in the instrument due to (changing) ambient conditions, as this may harm the instrument's functionality.

2.4. Mounting

For optimal performance, observe the following guidelines:

- *Preferably, mount the **MASS-STREAM D-6400** in an upright position, especially if the operating pressure is higher than 10 bar.*
- *If the instrument is mounted in a position where the flow is directed upwards or downwards, adjusting the zero point is recommended.*
- *Avoid installation in close proximity of mechanical vibration and/or heat sources.*
- *Use the equipment in an environment with a stable ambient pressure and temperature.*

The instruments' preferred mounting position is horizontally (upright). Especially when installing bigger mass flow controllers (D-6471 and bigger) in different ways you should get in contact with your distributor or Bronkhorst Instruments GmbH beforehand.

For stable fixation, the bottom of the instrument base is fitted with threaded mounting holes. Consult the dimensional drawing for the exact size and locations.

2.5. Piping requirements

- *For reliable performance, make sure the fluid stream is uncontaminated. If necessary, use an inlet filter to ensure a moisture, oil and particle-free gas stream. Select a filter with a surface area and pore size that minimize the pressure drop.*
- *If back flow could occur, the use of a check valve is recommended.*
- *Select a check valve with a low pressure drop.*

- *Use piping or tubing that is suitable for the operating conditions of the application (media, maximum temperature, maximum operating pressure).*
- *Do not install pressure regulators within a distance of 25 times the (inside) pipe diameter from a controlling instrument.*

For reliable measurements, it is important to:

- Prevent turbulence in the flow.
- Make sure that the upstream pressure remains stable and matches the value specified on the serial number label.
- Avoid using reducers, abrupt angles or any objects directly on inlet and outlet of the product.
- The straight pipe inlet and outlet length should be according to the table below.
- The internal pipe diameter must at least correspond to the thread on the inlet and outlet of the instrument.

Straight length relative to inside pipe diameter	Model D-6471/DR3		Other models
	With flow straightener	Without flow straightener	
Upstream	10 x	20 x	10 x
Downstream	4 x	6.x	5 x

The specified inlet pressure should be fully available directly at the inlet of the instrument.

2.6. Fluid connection

The use of incorrect process connection types may lead to fluid leakage due to damage to the inlet threads of the process ports. This may cause severe injury depending on the type of medium and applied system pressure.

- *Use only process connections compatible with the ISO 1179 process ports with G-threads according to BSPP (ISO 228-1).*

Loose connectors and fittings may lead to fluid leakage which may cause severe injury depending on the type of medium and applied system pressure.

- *Check all connections for leaks, before and after pressurizing the system.*

- Remove any protective caps from inlet and outlet of the product.
- Verify that the process connetions are compatible with ISO 1179 BSPP process ports.
- Install the process connections according to the manufacturer's instructions.
- When installing the product, observe the direction of flow indicated by the arrow on the product.

2.7. Electrical connection

Electrical connections must be made with standard cables or according to the applicable hook-up diagram. The factory installed 8DIN settings are indicated in the hook-up diagram. Make sure that the power supply is suitable for the power ratings as indicated in the hook-up diagram and that double or reinforced insulation is used for the power supply.

MASS-STREAM D-6400 instruments are powered with +15…+24 Vdc or +24 Vdc, depending on configuration or the fieldbus system (if applicable).

To prevent damage as a result of reversed polarity, the use of a 2A fuse in the direct +Us line is recommended.

Always turn off electrical power before connecting or disconnecting equipment electrically.

*The device described in this document contains electronic components that are susceptible to **electrostatic discharge**. In order to prevent damage, proper handling procedures must be followed during installation, (dis)connecting and removing the electronics.*

*The device carries the CE-mark and is **compliant with the concerning EMC requirements**. However, EMC requirements can only be met using appropriate cables and connector/gland assemblies. Bronkhorst recommends the use of their standard cables. These cables have the right connectors and loose ends (if any) are marked to help prevent wrong connection. When using other cables, cable wire diameters must be sufficient to carry the supply current, and voltage loss must be kept as low as possible. When in doubt, contact your Bronkhorst representative.*

*When connecting the product to other devices, be sure that the integrity of the shielding is not affected; **always use shielded cabling for signals and communication and do not use unshielded wire terminals**.*

2.8. Fieldbus connection

If the instrument is provided with a dedicated fieldbus interface, it can be operated digitally in a fieldbus system, using RS485 communication. In FLOW-BUS, Modbus, CANopen and DeviceNet™ systems, the fieldbus connector can also be used to power the instrument. In other fieldbus systems, the instrument is always powered through the 8DIN power connector on top of the instrument.

***Never** power the instrument simultaneously from **two different power sources** (e.g. fieldbus and Plug-in Power Supply). Doing so will damage the printed circuit board irreparably.*

Always check the total power consumption of your instruments before connecting them to a fieldbus system. Make sure that the maximum power of the power supply is sufficient to power the product.

If you need assistance with setting up a bus configuration, contact your Bronkhorst representative for information.

The operation via analog interface, RS232 interface and an optional fieldbus can be performed at the same time. A special parameter called “control mode” indicates which connection is controlling the instrument: analog or digital (via fieldbus or RS232). Even when using more interfaces at the same time, the reading can be done simultaneously. When changing a parameter value, the last accepted value will be processed.

2.8.1. FLOW-BUS

FLOW-BUS is a Bronkhorst® designed fieldbus, based on RS485 technology, for digital communication between devices, offering the possibility of host-control by a Windows computer.

Characteristics:
- Baud rate 187500 (default) or 400000 Baud
- +15…24 Vdc supply voltage
- Easy installation and communication with other Bronkhorst® devices
- Automatic node search and bus optimization (gap fixing)
- RS232 communication (ProPar) with Windows computer (local host)
- Connection of up to 120 instruments on a single bus
- Maximum bus length: 600 m

Consult Instruction manual FLOW-BUS interface (document no. 9.17.024) for more information about setting up a FLOW-BUS network.

2.8.2. Modbus

Modbus is a 3-wire, RS485-based fieldbus communication system for parameter value exchange. In this system each instrument/device is equipped with a micro-controller for its own dedicated task. The instrument behaves as a slave, which means all communication (instructions and readout) is initiated by a master device on the Modbus system.

Characteristics:
- Baud rate selectable between 9600 and 256000 Baud (default: 19200 Baud)
- +15…24 Vdc supply voltage
- Connection of up to 247 instruments on a single bus
- Supports RTU and ASCII protocols

Consult Instruction manual Modbus interface (document no. 9.17.035) for more information about setting up a Modbus network.

2.8.3. Other fieldbuses

For other fieldbuses consult the concerning fieldbus manual.

2.9. Communication interface

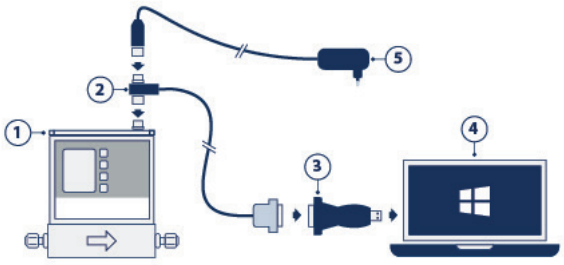
The standard 8DIN connector provides the following communication interfaces:
- Analog (0…5 Vdc; 0…10 Vdc; 0…20 mA or 4…20 mA)
- Digital RS232 (ProPar) or RS485 (FLOW-BUS or Modbus)

Additionally, the instrument can be provided with one of the following optional digital fieldbus interfaces:
- CANopen
- DeviceNet™
- EtherCAT®
- EtherNet/IP
- FLOW-BUS
- Modbus (ASCII / RTU / TCP)
- POWERLINK
- PROFIBUS DP
- PROFINET

The default communication protocol of the instrument (analog, digital RS232 or fieldbus) is specified at ordering time.

2.9.1. RS232 communication

Using a Windows computer, the instrument can be monitored and operated via RS232. For operation, the free Bronkhorst Software tools can be used, providing a comprehensive user interface to the digital instrument functions.



This example uses the following components:
1. MASS-STREAM D-6400
2. RS232 T-part cable (art no. 7.03.444)
3. RS232-USB converter (art no. 9.09.122)
4. Windows computer (for readout and control)
5. Plug-in Power Supply (PiPS, art no. 7.03.423)

Connect the T-part cable with the 8DIN connector on top of the instrument and use the RS232/USB converter to connect the other end of the cable with a free USB port of the computer.

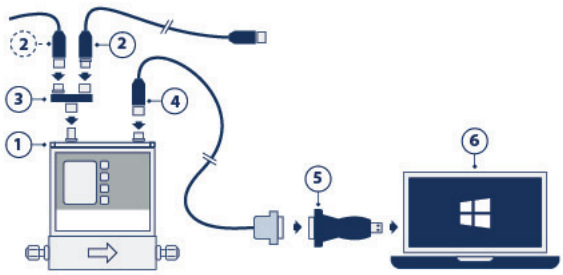
For communication with a PLC or other controlling device, an 8DIN cable with a loose end (part no. 7.03.191, 7.03.540 or 7.03.541) can be used. Consult the RS232 hook-up diagram to connect the required signals.

For RS232 communication at baud rates up to 38400 Baud the maximum allowable cable length is 10m. For higher baud rates, use a maximum cable length of 3m.

- *For more information about communication through the RS232 interface, consult the RS232 manual (document no. 9.17.027).*
- *The Bronkhorst customer software and accompanying documentation can be downloaded from the **Accessories and software** section on the Bronkhorst® product pages (www.bronkhorst.com/products).*

2.9.2. Fieldbus communication

The instrument can be connected to a fieldbus system with the optional fieldbus connector on top. At the same time, RS232 communication with a Windows computer is possible through the 8DIN connector on the top of the instrument.



This example uses the following components:
1. MASS-STREAM D-6400 with DeviceNet™ interface
2. DeviceNet™ M12 cable (art no. 7.03.323)
3. DeviceNet™ M12 Y adapter (art no. 7.03.319)
4. RS232 cable (art no. 7.03.340)
5. RS232-USB converter (art no. 9.09.122)
6. Windows computer (for readout and control)

Note that the used fieldbus components in this example are specific to DeviceNet™. For connecting with other fieldbus systems, other cables and adapters are needed.

3. Operation

After correct installation of the **MASS-STREAM D-6400** and when all safety precautions have been taken into account, the instrument can be used for measuring and/or controlling mass flow in the system.

The Bronkhorst FlowSuite software tool provides a graphical interface to the instrument for monitoring and changing instrument parameters

3.1. Powering up and powering down

- *It is recommended to turn on power before applying fluid pressure and to switch off power only after relieving fluid pressure.*
- *For best performance, allow the device to warm up and stabilize for at least 30 minutes before starting measurement and/or control. This may be done with or without media flow.*

When applying pressure, avoid pressure shocks and bring the fluid system gradually up to the level of the specified operating conditions; open the fluid supply gently.

3.2. First use

In systems for use with corrosive or reactive media, purging for at least 30 minutes with a dry, inert gas (like Nitrogen or Argon) is absolutely necessary before use. After use with corrosive, reactive or hazardous media (e.g. toxic or flammable), purging is also necessary before the fluid system is exposed to air.

If the instrument is mounted in a position with upward or downward flow, adjusting the zero point is advised before using the instrument for the first time. See Adjusting zero point for background information and instructions.

After changing to another fluid set, the instrument must be zeroed at the process conditions. See Adjusting zero point for background information and instructions.

3.3. Mass flow measurement and control

When powering up, the instrument needs a couple of seconds to start up the electronics. As soon as the start-up sequence has finished (green LED glows continuously), the instrument is ready to measure mass flows, however, optimal accuracy is only reached after warming up (see Powering up and powering down).

After powering up, the control valve will act according the last known setpoint. When setpoint is 0, this means the valve closes (normally open) or stays closed (normally closed). The valve stays closed until the instrument receives a new valid setpoint from the active setpoint source. The internal PID controller then immediately opens the control valve, until the measured flow rate matches the setpoint. It maintains the resulting flow rate until another setpoint is given.

***MASS-STREAM D-6400** instruments are most accurate at the specified inlet/outlet pressure, temperature and process gas conditions. However, the instrument will function properly in a wide range of varying conditions. It is strongly advised to use the Bronkhorst customer software available with the instrument to set the correct process conditions if the actual process conditions differ from the conditions for which the instrument is set (see Changing fluid set).*

*Although **MASS-STREAM D-6400** instruments have good temperature stability, the best accuracy is achieved when the gas temperature matches the ambient temperature and the instrument is mounted on a rigid (heat conducting) surface.*

***MASS-STREAM D-6400** instruments handle pressure shocks within the operating limits of the system well but are not insensitive to pressure fluctuations. For optimum control stability, provide a stable (pressure controlled) inlet pressure with sufficient buffer volume between the pressure regulator and the instrument and avoid installing multiple instruments or control valves in close proximity to another with small volume piping in between.*

3.3.1. Changing fluid set

MASS-STREAM D-6400 instruments are equipped with an on-board gas database. This provides the gas properties needed to convert to other gases for the Multi Fluid/Multi Range functionality (MFMR). MFMR enabled instruments are calibrated ex factory for a number of standard measuring ranges, which can be configured for use with different fluids.

Defining fluids and ranges and selecting the active fluid can be done via RS232 with the free available customer software tool Bronkhorst FlowSuite.

Bronkhorst FlowSuite provides the following key functionality:

- Definition and storage of up to eight different fluids in the instrument
- Storing fluid properties for any gas
- Changing inlet- and/or outlet pressure based on actual process conditions
- Re-ranging the full scale (FS) flow rate within the instrument's supported flow range
- Changing control speed per fluid set for faster or slower (smoother) flow control

The entered properties are stored in the instrument, including the required controller settings. When switching to another fluid set, controller settings are automatically adjusted to the new process conditions, so there is no need to change PID controller settings manually.

The Bronkhorst FlowSuite software and the associated documentation can be downloaded from the product pages on the Bronkhorst website: (www.bronkhorst.com/products).

To connect with the Bronkhorst FlowSuite, use RS232 communication via the 8DIN connector. In case a connection cannot be established, use the power-up functionality of the multifunctional switch to switch to configuration mode and enable RS232 communication. After configuring the required parameters, remember to return the instrument to the original communication mode.

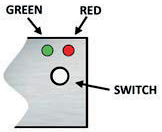
It is advised to use Bronkhorst FlowSuite only in a non-operational environment. Bronkhorst FlowSuite will force the instrument to Valve Safe State as soon as the connection is made.
Be sure to close communication between Bronkhorst FlowSuite and the instrument properly, to restore the normal operating mode.

After changing to another fluid set, the instrument must be zeroed at the process conditions. See Adjusting zero point for background information and instructions.

3.4. Valve Safe State

When a controlling instrument is not powered or cannot communicate with the fieldbus network (if applicable), the control valve automatically returns to its default state (also called Safe State), which is closed for a 'normally closed' valve (n/c) and fully open for a 'normally open' valve (n/o). Taking into account the typical process conditions under which the instrument is used (such as the processed media and ambient conditions; see also LED indications), the default state is generally considered safe.
Check the serial number label or the technical specifications to see which valve type is used on your instrument (if applicable).

3.5. Manual controls



On top of the housing, the instrument is equipped with two LED indicators and a multifunctional switch, which can be used to monitor the instrument visually and start several functions manually.

3.5.1. LED indications

The LEDs on top of the instrument indicate the operational state. The meaning of some indications depends on the specific fieldbus interface of the instrument (if installed).

- (green) Mode: operation mode indication
- (red) Error: error/warning messages

The tables below list the different LED indications:

● **Green**		
Pattern	Time	Indication
off	continuous	Power off or program not running
on	continuous	Normal operation mode
short flash	0.1 sec on, 2 sec off	No communication, valves are in safe/default state
blink	0.2 sec on, 0.2 sec off	Special function mode: the instrument is busy performing a special function
long flash	2 sec on, 0.1 sec off	Configuration mode: the 8DIN connector is set for RS232 communication (ProPar) at 38400 Baud

● **Red**			
Pattern	Time	Indication	
off	continuous	No error	
on	continuous	Critical error: the instrument needs servicing before it can be used	
short flash	0.1 sec on, 2 sec off	**FLOW-BUS** **PROFIBUS DP** **Modbus** **DeviceNet™** **EtherCAT®** **PROFINET**	Node occupied: re-install instrument No data exchange between master and slave (automatic recovery) Data is being received or transmitted Minor communication error Instrument is not in OP mode No application relation established
blink	0.2 sec on, 0.2 sec off	**FLOW-BUS** **PROFIBUS DP** **Modbus** **DeviceNet™** **EtherCAT®** **PROFINET**	Waiting for communication Not used Not used No bus power Not used Not used
long flash	2 sec on, 0.1 sec off	**FLOW-BUS** **PROFIBUS DP** **Modbus** **DeviceNet™** **EtherCAT®** **PROFINET**	Not used Requested parameter not available Not used Serious communication error; manual intervention needed Configuration error Configuration error (e.g. a requested parameter is not available)
● **Green and** ● **red (alternating)**			
Pattern	Time	Indication	
slow wink	1 sec on, 1 sec off	Alarm indication: minimum/maximum alarm, power-up alarm, limit reached or batch size reached	
normal wink	0.2 sec on, 0.2 sec off	Wink mode: by sending a command to the Wink parameter, the instrument flashes its LEDs to indicate its physical location	
fast wink	0.1 sec on, 0.1 sec off	Selected action started (after releasing the multifunctional switch)	

DeviceNet™ instruments have different LED indications, that replace the standard indications described in this section (see below).

3.5.1.1. Interface status

Instruments with an EtherCAT® or PROFINET interface are equipped with a third LED (bi-color: green and red), to indicate the status of the communication interface. This status LED can give the following indications:

Pattern	Time	EtherCAT®	PROFINET
○ off	continuous	Power off or initializing	Interface not (yet) started
● on, green	continuous	Normal operation	Normal operation, application relation established with I/O controller
● blinking, green	0.2 sec on, 0.2 sec off	Pre-operational	Initializing
● blinking, red	0.2 sec on, 0.2 sec off	Invalid state change	Link status OK, no application relation with I/O controller
● single flash, red	0.2 sec on, 1 sec off	Invalid configuration	n/a
● double flash, red	0.2 sec on, 0.2 sec off, 0.2 sec on, 1 sec off	Communication timeout (e.g. communication cable disconnected)	n/a
● on, red	continuous	n/a	No link

Ethernet indicators
RJ-45 connection sockets on instruments with a EtherCAT® or PROFINET interface have two integrated LED indicators, with standard Ethernet functionality:

■ Amber: Ethernet speed

■ Green: Ethernet link/activity

3.5.1.2. DeviceNet™ indications

DeviceNet™ instruments have two bi-color LEDs (green/red) to indicate network and module status. The indications below replace the standard LED indications:

●/● (green/red) Network status (NET; left)

●/● (green/red) Module status (MOD; right)

The tables list the different LED indications.

Network status		
Pattern	Time	Indication
○ off	continuous	Power off or offline
● on, green	continuous	Online, connected, link OK
● blinking, green	0.5 sec on, 0.5 sec off	Online, not connected; the instrument is online but has no connections to other nodes or is not allocated to a master
● blinking, red	0.5 sec on, 0.5 sec off	Connenction timed out
● on, red	continuous	Critical link failure: the device cannot connect to the network

Module status		
Pattern	Time	Indication
● off	continuous	No power
● on, green	continuous	Normal operation mode
● blinking, green	0.5 sec on, 0.5 sec off	Device is in standby mode or configuration is missing, incomplete or incorrect
●/● alternating	0.5 sec on, 0.5 sec off	Self-test mode
● on, red	continuous	Critical error: the instrument needs servicing before it can be used

3.5.2. Multifunctional switch

Some special functions of the instrument can be started manually using the multifunctional switch near the indication LEDs. These functions are available in analog as well as in digital operation mode.

3.5.2.1. Normal operating functions

- In order to access these functions, press and hold the switch while the instrument is in normal operation mode (green LED glowing).
- As long as the switch is held, the LEDs show a repeating sequence of patterns, where each pattern indicates a function.
- All indications in this sequence are continuous.
- Each pattern is shown for a number of seconds; in the table below the column 'Hold time' indicates the time frame within the sequence where the LEDs show the associated pattern.
- To start a function, release the switch when the LEDs show the pattern of the required function.

●Green	●Red	Hold time	Function
off	off	0…1 sec	No action
off	off	1…4 sec	1. In case of a min/max alarm: reset alarm 2. FLOW-BUS: Auto-install to bus - lets instrument obtain free node address if configured node address is occupied Note: min/max alarm (if any) has to be reset before auto install can be performed.
off	on	4…8 sec	Reset instrument: clear all warnings and error messages and restart the instrument
on	off	8…12 sec	Reset instrument: clear all warnings and error messages and restart the instrument
on	on	12…16 sec	Enable FLASH mode for firmware update: • the instrument shuts down and both LEDs are switched off • at the next power-up, the instrument will be active again

See Adjusting zero point for background information and instructions on how to adjust the zero point of an instrument.

Never perform a zeroing procedure before having taken notice of the instructions.

3.5.2.2. Power-up functions

- In order to access these functions, press and hold the switch while powering up the instrument.
- As long as the switch is held, the LEDs show a repeating sequence of patterns, where each pattern indicates a function.
- All indications in this sequence are flashing (0.2 sec on, 0.2 sec off).
- Each pattern is shown for a number of seconds; in the table below the column Hold time indicates the time frame within the sequence where the LEDs show the associated pattern.
- To start a function, release the switch when the LEDs show the pattern of the required function.

Green	Red	Hold time	Function
off	off	0…1 sec	No action
off	on	4…8 sec	Restore factory settings (except communication settings)
on	off	8…12 sec	**FLOW-BUS:** Auto install to bus; let the instrument obtain a free node address from the FLOW-BUS system **Other protocols:** No action
on	on	12…16 sec	Activate configuration mode • The 8DIN connector is set to RS232 communication (ProPar) at baud rate 38400 • In configuration mode, the green LED blinks (2 sec on, 0.1 sec off) • Configuration mode remains active after powering-down and can be deactivated by selecting this function again at the next start-up

3.5.2.3. Control mode - readout/change

Reading control mode

- By briefly pressing the switch 2 times with intervals of up to 1 second in normal operation mode, the instrument shows its current control mode with a series of consecutive LED indication patterns.
- The number of flashes corresponds to the current value of parameter Control Mode (see Special parameters).

Step	Pattern		Indication
1.	Green	● ○	number of flashes indicates the tens of the parameter value
2.	Red	○ ●	number of flashes indicates the units of the parameter value

Examples:

- for value 1 (control mode 'Analog input'), the green LED will flash 0 times and the red LED 1 time
- for value 22 (control mode 'Valve Safe State'), the green and red LED will each flash 2 times

Changing control mode

- By briefly pressing the switch 4 times with intervals of up to 1 second in normal operation mode, the instrument enters a state in which the control mode can be changed.
- This is done in 2 steps, each represented by a LED indication pattern (green or red; see table below).
- The number of flashes corresponds to the available values of parameter Control Mode (see Special parameters).
- At the start of each step, the according LEDs starts flashing fast (0.1 second on, 0.1 second off). By pressing and holding the switch, the associated action is started and the flashing slows (0.5 seconds on, 0.5 seconds off).

Step	Pattern		Maximum flash count	Action
1.	Green	● ○	2	set tens of parameter value
2.	Red	○ ●	9	set units of parameter value

To execute a step, follow these instructions:

- Press and hold the switch (flashing slows)
- To select value 0 (zero), release the switch within 1 second, otherwise:
- Count the number of LED flashes
- Release the switch when the required value is reached
- In case you lose count, keep the switch pressed and wait until the flash count reaches its maximum and restarts

On completion of step 1, the instrument automatically advances to step 2. When both steps have been completed, the instrument returns to its normal operation mode.
If the switch is not pressed within 60 seconds after starting a step, all changes are canceled and the instrument returns to its normal operation mode.

Note that this procedure also sets the default control mode of the instrument (contrary to changing the control mode digitally).

3.5.2.4. Network settings - readout/change

Reading network settings

- By briefly pressing the switch 3 times with intervals of up to 1 second in normal operation mode, the instrument shows its current node address and baud rate with a series of consecutive LED indication patterns:

Step	Pattern		Indication
1.	Green	● ○	number of flashes indicates the tens of the parameter value
2.	Red	○ ●	number of flashes indicates the units of the parameter value
3.	Green and red (simultaneous)	● ●	number of flashes indicates the baud rate

Examples:

- for node address 35, the green LED will flash 3 times and the red LED 5 times
- for node address 116, the green LED will flash 11 times and the red LED 6 times

On DeviceNet™ the node address is called MAC ID.

The number of flashes for the baud rate indication is associated with the following baud rates:

Number of flashes (index)	Baud rate				
	FLOW-BUS	Modbus	PROFIBUS DP	DeviceNet™	Ethernet based
0			Automatically detected		
1	187500	9600	9600	125000	100000000
2	400000	19200	19200	250000	
3		38400	45450	500000	
4		56000	93750		
5		57600	187500		
6		115200	500000		
7		128000	1500000		
8		256000	3000000		
9			6000000		
10			12000000		

Changing network settings

- By briefly pressing the switch 5 times with intervals of up to 1 second in normal operation mode, the instrument enters a state in which the node address and baud rate can be changed (non-Ethernet based protocols only; for Ethernet based protocols (EtherCAT®, PROFINET), network parameters are configured by the fieldbus master and cannot be set on the instrument).
- Changing network parameters with the multifunctional switch is done in 3 steps, each represented by a LED indication pattern (see table below).
- At the start of each step, the according LED(s) start(s) flashing fast (0.1 second on, 0.1 second off). By pressing and holding the switch, the associated action is started and the flashing slows (0.5 seconds on, 0.5 seconds off).

Step	Pattern		Maximum flash count	Action
1.	Green	● ○	2	set tens of parameter value
2.	Red	○ ●	9	set units of parameter value
3.	Green and red (simultaneous)	● ●	10*	set baud rate index (number of flashes)

*) maximum count depends on the supported baud rates of the fieldbus. See the baud rate table above for supported baud rates and associated indexes.

To execute a step, follow these instructions:
- Press and hold the switch (flashing slows)
- To select value 0 (zero), release the switch within 1 second, otherwise:
- Count the number of LED flashes
- Release the switch as soon as the required value is reached
- In case you lose count, keep the switch pressed and wait until the flash count reaches its maximum and restarts

On completion of a step, the instrument automatically advances to the next step. When all required steps have been completed, the instrument returns to its normal operation mode.
If the switch is not pressed within 60 seconds after starting a step, all changes in the previous steps are cancelled and the instrument returns to its normal operation mode.

3.5.2.5. Fieldbus 1 selection

By briefly pressing the switch 6 times with intervals of up to 1 second in normal operation mode, the instrument shows its Fieldbus1 selection with a series of consecutive LED indication patterns:

Step	Pattern		Indication
1.	Green	● ○	number of flashes indicates the tens of the parameter value
2.	Red	○ ●	number of flashes indicates the units of the parameter value

Examples:
- for Fieldbus1 selection Modbus-RTU, the green LED will flash 0 times and the red LED 1 time
- for Fieldbus1 selection Profibus-DP, the green LED will flash 1 times and the red LED 3 times

In case Fieldbus1 is not available on the instrument, the reading / changing bus selection applies to Fieldbus2

Number of flashes (index)	Fieldbus selection	(optional) Fieldbus 1	Fieldbus 2
0	FLOW-BUS	Configurable	Configurable
1	Modbus-RTU	Configurable	Configurable
2	Propar	Not available	Configurable
3	Modbus-ASCII	Configurable	Configurable
9	CANopen	Read only	Not available
10	DeviceNet	Read only	Not available
11	EtherCAT	Read only	Not available
13	Profibus-DP	Read only	Not available
14	Profinet	Read only	Not available

18	POWERLINK	Read only	Not available
19	EtherNet/IP	Read only	Not available
20	Modbus TCP	Read only	Not available

Changing Fieldbus1 selection

In case Fieldbus1 is not available on the instrument, the reading / changing bus selection applies to Fieldbus2

- By briefly pressing the switch 7 times with intervals of up to 1 second in normal operation mode, the instrument enters a state in which the fieldbus1 selection can be changed.
- This is done in 2 steps, each represented by a LED indication pattern (green or red; see table below).
- The number of flashes corresponds to the available values of parameter Fieldbus1 selection (see table above).
- At the start of each step, the according LEDs starts flashing fast (0.1 second on, 0.1 second off). By pressing and holding the switch, the associated action is started and the flashing slows (0.5 seconds on, 0.5 seconds off).

Step	Pattern		Maximum flash count	Action
1.	Green	● ○	2	set tens of parameter value
2.	Red	○ ●	9	set units of parameter value

To execute a step, follow these instructions:
- Press and hold the switch (flashing slows)
- To select value 0 (zero), release the switch within 1 second, otherwise:
- Count the number of LED flashes
- Release the switch when the required value is reached
- In case you lose count, keep the switch pressed and wait until the flash count reaches its maximum and restarts

On completion of step 1 (tens), the instrument automatically advances to step 2 (units). When both steps have been completed, the instrument returns to its normal operation mode. If the switch is not pressed within 60 seconds after starting a step, all changes are cancelled and the instrument returns to its normal operation mode.

3.6. Communication

The following table lists the supported communication modes of the ***MASS-STREAM D-6400***:

Connection	Type	Communication standard	Fieldbus/protocol
8DIN connector	Analog	0…5 Vdc 0…10Vdc 0…20mA 4…20mA	n/a
	Digital	RS232	ProPar
		RS485	FLOW-BUS Modbus ASCII/RTU
Fieldbus specific (M12)	Digital	RS485	FLOW-BUS Modbus ASCII/RTU PROFIBUS DP
		CAN	CANopen DeviceNet™
		Ethernet	EtherCAT® Ethernet/IP Modbus TCP/IP POWERLINK PROFINET

The communication standards (analog and digital) and fieldbus interface (if applicable) are specified at ordering time, i.e.:

- *In analog mode, the instrument is set to the specified voltage/current range*
- *The dedicated fieldbus connection only provides the specified fieldbus interface*

Using analog and digital interfaces simultaneously
The instrument can be monitored and operated via the analog and a digital interface simultaneously, but it only accepts a setpoint from one of both (this is called the control mode; see Special parameters for more information). In analog mode, the analog input and output signals are translated to the digital setpoint and measure parameter respectively. The default control mode (analog or digital) is determined at ordering time.

3.6.1. Analog operation

With analog operation the following signals are available:
- output signal: measured value
- input signal: setpoint (controller only)

Setpoints below 2% of the full scale will be interpreted as 0%.
The analog interface type that is installed on the 8DIN connector can be found in the model key of the instrument.

3.6.2. Digital operation (RS232)

Digital operation via RS232 or fieldbus (RS485) adds extra features to the instrument, such as:
- Direct reading with a readout/control module or host computer
- Diagnostics
- Multi-fluid functionality (up to 8 fluids, if ordered; see Fluid set)
- Device identification
- Adjustable minimum and maximum alarm limits (see Alarms)
- (Batch) counter

Make sure that the instrument's baud rate matches the baud rate of the master/application, otherwise no communication can be established. See section Network configuration for changing baud rate, node address and parity setup.

For RS232 communication, the maximum cable length is 10 m for baud rates up to 38400 Baud. For higher baud rates, use cable lengths of maximum 3 m.

- *If the 8DIN connector is set for RS485 communication, the instrument will not respond when connected to an RS232 configuration. In that case, use the power-up functionality of the multifunctional switch to enter configuration mode and enable RS232 communication.*
- *After configuring the required parameters, use the same procedure to leave configuration mode and restore the original communication settings (otherwise, configuration mode remains enabled after power down).*

For more information about communication through the RS232 interface, consult the RS232 manual (document no. 9.17.027).

3.6.3. Digital fieldbus operation (RS485)
The following optional fieldbuses are available for ***MASS-STREAM D-6400*** instruments. For all mentioned fieldbus systems, except FLOW-BUS, instruments act as slaves on the master/slave bus system. There is no mutual communication between slaves, only between master and slave.

FLOW-BUS
Bronkhorst instruments can be monitored and operated via RS232, using the free Bronkhorst FlowSuite tool. The tool provides a graphical interface to the ProPar protocol (used by FLOW-BUS), for monitoring and changing instrument parameters like the selection of the active fluid and configuration of the fieldbus connection (if applicable).

For instruments that support the definition and use of multiple fluids Bronkhorst FlowSuite can be used to define and store fluids in the instrument and select the active fluid.

- *Bronkhorst FlowSuite can only be used if the 8DIN (power) connector is configured for RS232 communication. If necessary, use the power-up functionality of the multifunctional switch to switch to configuration mode and enable RS232 communication.*
- *After configuring the required parameters, remember to leave configuration mode and restore the original communication settings (otherwise, configuration mode remains enabled after power down).*

Modbus
Instruments in a Modbus system can be monitored and operated using third party software as a master device, such as LabVIEW, ModScan, or a Modbus PLC.

PROFIBUS-DP
Instruments in a PROFIBUS DP system can be monitored and operated using third party software as a master device, such as TIA Portal (by Siemens).

To configure a device, a so-called GSD file (General Station Description) has to be loaded into the software. The GSD file contains all necessary configuration information to operate the device in a PROFIBUS DP system, including all available operating parameters with their data types.

A GSD file for Bronkhorst® instruments or can be downloaded from the product pages on the Bronkhorst website: www.bronkhorst.com/products

DeviceNet™
Instruments in a DeviceNet™ system can be monitored and operated using third party software as a master device, such as TIA Portal (by Siemens).

To configure a device, a so-called EDS file (Electronics Data Sheet) can be loaded into the software. The EDS file contains all necessary configuration information to operate the device in a DeviceNet™ system, including communication and network configuration, and all available operating parameters with their data types.

An EDS file for Bronkhorst® instruments or can be downloaded from the product pages on the Bronkhorst website: www.bronkhorst.com/products

EtherCAT®
Instruments in an EtherCAT® system can be monitored and operated using third party software as a master device, such as <%BRANDNAME_SYCON%> (by Hilscher GmbH).

To configure a device, a so-called ESI file (EtherCAT® Slave Information) can be loaded into the software. The ESI file contains all necessary configuration information to operate the device in a EtherCAT® system, including communication and network configuration, and all available operating parameters with their data types.

An ESI file for Bronkhorst® instruments or can be downloaded from the product pages on the Bronkhorst website: www.bronkhorst.com/products

PROFINET
Instruments in a PROFINET system can be monitored and operated using third party software as a master device, such as TIA Portal (by Siemens).

To configure a device, a so-called GSDML file (General Station Description Markup Language) can be loaded into the software. The GSDML file contains all necessary information, in XML format, to operate the device in a PROFINET system, including communication and network configuration, and all available operating parameters with their data types.

An GSDML file for Bronkhorst® instruments or can be downloaded from the product pages on the Bronkhorst website: www.bronkhorst.com/products

3.7. Adjusting zero point

Zero-stability
The zero point of a Bronkhorst® flow meter/controller (the measurement signal that indicates the absence of a flow) is factory adjusted at approximately 20°C and atmospheric pressure (ambient conditions), with the instrument positioned upright. Under normal circumstances (i.e. at stable process conditions), the zero point will remain stable. However, over time several factors can induce a slight deviation of the measured value from the zero point, causing the instrument to require an auto-zero. Readjusting the zero point eliminates this deviation.

In case of conversion to another fluid, for optimum performance of the instrument it is recommended to re-adjust the zero point for each individual fluid (1...8 when applicable).
Please make sure the instrument is zeroed on the desired gas at the desired operating temperature and pressure conditions.

- *After installation or relocation, always check the zero point*
- *If the instrument still detects a (steady) flow while all valves are closed and fluid system is leak tight, adjusting the zero point is recommended.*

Prerequisites
Zeroing an instrument requires that:

- The ambient conditions (temperature, pressure) match those of the operating environment of the instrument.
- The instrument is filled homogeneously and pressurized with the operational media, according to the typical process conditions.
- The instrument has been warmed up sufficiently.
- There is absolutely no flow through the instrument; preferably, this is achieved by closing a valve immediately after the outlet of the instrument (control valve, shut-off valve).

Blocking the flow through the instrument is essential; zeroing an instrument while there is still a flow will lead to measurement errors.

Procedure

Bronkhorst FlowSuite provides a quick and easy way to adjust the zero point of an instrument; the Autozero function automatically performs the procedure described here.

3.7.1. Using multifunctional switch

To start the built-in autozero function with the multifunctional switch, follow these instructions:

- Change the setpoint of the instrument to 0 (zero)
- Press and hold the multifunctional switch. After 4 seconds, the red LED ● starts glowing for 4 seconds, after which the green LED ● starts glowing
- At that moment (which is after 8 to 12 seconds), release the switch
- The green LED starts to blink fast, indicating that the autozero function is being performed.
- On (successful) completion, the green LED starts to glow continuously, while the output signal is 0% (parameter Measure = 0).

3.7.2. Via digital communication

Bronkhorst FlowSuite provides an easy way to adjust the zero point of an instrument via RS232; the Auto zero function automatically performs the procedure described here.

To adjust the zero-point using digital communication, set parameter values in the following sequence (see section Digital parameters for more information about instrument parameters):

Sequence #	Parameter	Value	Action
1	Setpoint	0	stop flow (close control valve)
2	Init Reset	64	unlock secured parameters
3	Control Mode	9	enable calibration mode
4	Calibration Mode	0	reset calibration mode
5	Calibration Mode	9	start zeroing

The green LED starts to blink fast, indicating that the zeroing procedure is being performed. On completion, the green LED starts to glow continuously, while the output signal is 0% (parameter Measure = 0). At the same time, parameter Control Mode returns to its initial value. If the procedure is successful, parameter Calibration Mode changes to 0 (idle). If the procedure fails, Calibration Mode changes to 255.

After performing the procedure, remember to set parameter Init Reset to value 0 to lock secured parameters.

4. Digital parameters

Each instrument is controlled internally by a number of digital parameters, most of which can only be accessed using digital communication. Each communication protocol uses its own methods for communicating with instruments and accessing parameters.

4.1. General

This section describes the most commonly used parameters for digital operation of the **MASS-STREAM D-6400**. Descriptions are grouped by category in tables as shown below:

Type	Access	Range	FlowDDE	ProPar	Modbus
[type]	RW 🔑	[x]…[y]	[DDE par]	[Process]/[Parameter]	[address]/[register]

In this manual, parameter names are printed in italics (reverted to normal were embedded in italics, like in this tip).

Type
Unsigned char 1 byte unsigned integer (0…255)
Unsigned int 2 byte unsigned integer, MSB first (0…65535)
Unsigned long 4 byte unsigned integer, MSB first (0…4294967295)
Float 4 byte floating point, IEEE 32-bit single precision, MSB first
Unsigned char [x] x byte array (text string)

Access
R Parameter value can be read
W Parameter value can be written
🔑 Parameter is secured and only accepts values if parameter Init Reset is set to 'unlocked' first

Range
Some parameters only accept values within a certain range:
[x] Minimum value of the range
[y] Maximum value of the range

FlowDDE
Parameter number within FlowDDE

FLOW-BUS
Within the FLOW-BUS protocol (ProPar when using RS232 communication), parameters are identified by a unique combination of a process number and a parameter number:
[Pro] Process number
[Par] Parameter number

Consult the RS232 manual (document no. 9.17.027) for detailed information.

Modbus
In the Modbus protocol, parameters are accessed by specifying their unique decimal register number or corresponding PDU address (Protocol Data Unit). The PDU address is the hexadecimal translation of the register number minus 1, e.g. register number 1 corresponds to PDU address 0x0000, register number 11 corresponds to PDU address 0x000A:
[address] Hexadecimal PDU address
[register] Decimal register number

Modbus address blocks are two bytes big. Larger data types use up to 8 subsequent address blocks, resulting in a maximum variable length of 16 bytes. Values longer than the maximum length are truncated.

Other interface protocols
Consult the specific fieldbus manual for accessing parameters using fieldbus communication (see Documentation).

4.2. Special parameters

Init Reset

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	82/64	7	0/10	0x000A/11

Init Reset is used to unlock secured parameters (marked with a 🔑 symbol) for writing. It supports the following values:

Value	Description
64	unlocked, secured parameters can be read and written to
82	locked, secured parameters are read-only

At power-up, Init Reset is always set to 'Locked' (value 82).

Reset

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	R	0…7	114	115/8	0x0E68/3689

This parameter is used to reset the program, counter or alarms.

Value	Description
0	No reset
1	Reset counter
2	Reset alarm
3	Reset counter
4	Reset and disable counter
5	Reset firmware program (soft reset)
6	Reset *Alarm info* error bit
7	Reset *Alarm info* warning bit

The Reset parameter may be disabled by Reset Alarm Enable or Reset Counter Enable. Make sure the value is accepted by sending value 0 first.

Wink

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [27]	W	0…9*	1	0/0	0x0000/1

*) Modbus only supports value 14592

Sending any text string value between 1 and 9 to this parameter makes the indication LEDs (if present) blink for a couple of seconds. This can be useful in order to identify a specific device in a large fieldbus network.

Control Mode

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	12	1/4	0x0024/37

Control Mode is used to select different control modes of the instrument and determines from which source(s) it accepts a setpoint. The following control modes are available:

Value	Mode	Instrument action	Setpoint source
0	BUS/RS232	Controlling	Fieldbus/RS232
1	Analog input	Controlling	Analog input
2	FLOW-BUS slave	Acting as slave instrument on FLOW-BUS	RS485 only: FLOW-BUS master output x *Slave Factor/100%*
3	Valve Close	Controller disabled, valve closed	
4	**Controller Idle**	**Controller disabled, valve frozen in current position**	
7	Setpoint 100%	Controlling, setpoint fixed to 100%	
8	Valve Fully Open	Controller disabled, valve fully opened	
9	Calibration Mode	Calibration mode enabled (factory only)	
10	Analog Slave	Acting as slave of other instrument in analog mode	*Analog Input x Slave Factor/100%*
12	Setpoint 0%	Controlling, setpoint fixed to 0%	
13	FLOW-BUS analog slave	Acting as slave of other instrument on FLOW-BUS, slave factor is set by analog input signal	RS485 only: FLOW-BUS master output x *Analog Input*
18	RS232	Controlling, safe state deactivated	Fieldbus/RS232
20	Valve Steering	Controller disabled, setpoint redirected to *Valve output*	
21	Analog Valve steering	Controller disabled, analog input redirected to *Valve output*	
22	Valve safe State	Force instrument in safe state	

Immediately after power-up, *Control Mode* is set to 'Analog input' or 'BUS/RS232' automatically, depending on the (requested) default setting for analog or digital operation. If *Control mode* is set to value 0, 1, 9 or 18, the instrument returns to its default control mode at the next power-up or reset. Other values are retained after power-up or reset.

4.2.1. Default control mode

IO status

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	86	114/11	0x0E4B/3660

The instrument is set to accept a setpoint from either an analog or a digital source. Although this setting can be changed with parameter Control Mode, the instrument usually returns to its default control mode at every power-up or reset. The default control mode can be set with parameter IO Status; to change it, use the procedures as described below.

Changing from digital operation to analog operation:
1. Set parameter *Init Reset* to 64 (unlocked)
2. Read parameter *IO Status*
3. Add 64 to the read value
4. Write the new value to parameter *IO Status*
5. Set parameter *Init Reset* to 82 (locked)

Changing from analog operation to digital operation:
1. Set parameter *Init Reset* to 64 (unlocked)
2. Read parameter *IO Status*
3. Subtract 64 from the read value
4. Write the new value to parameter *IO Status*
5. Set parameter *Init Reset* to 82 (locked)

The procedures described above do not change the value of parameter Control Mode directly. To apply the new default control mode immediately, change the value of parameter Control Mode manually or reset or restart the instrument.

4.3. Measurement and control

Measure

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned int	R	0…41942	8	1/0	0x0020/33

This parameter indicates the flow metered by the instrument. The value of 32000 corresponds to 100%, the maximum measured value output is 131.07%, which translates to 41942.

Setpoint

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned int	RW	0…32767	9	1/1	0x0021/34

This parameter is used to set the required flow rate for the controller. Within the setpoint range, value 32000 corresponds to 100%.

To convert Measure and Setpoint to actual volume flows, use parameters Capacity and Capacity Unit (see Fluid set)

Temperature

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	R	-250…500	142	33/7	0xA138…0xA139/41273…41274

This parameter returns the internal temperature in the instrument housing in °C, which approximates the actual media temperature.

Pressure

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	143	33/8	0xA140…0xA141/41281…41282

In case an external pressure sensor is connected, this parameter returns the actual system pressure in bar(a).
If there is no external pressure sensor, the default value of this parameter is equal to parameter *Inlet pressure*.

4.3.1. Advanced measurement and control

Fmeasure

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	R	-3.4E+38 …3.4E+38	205	33/0	0xA100…0xA101/41217…41218

Floating point variant of *Measure*. *Fmeasure* shows the measured value in the capacity unit for which the instrument is set. The instrument uses parameters *Capacity*, *Capacity 0%, Capacity Unit* and *Sensor Type* to calculate *Fmeasure*.

Fsetpoint

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	206	33/3	0xA119…0xA11A/41241…41242

Floating point variant of *Setpoint*. *Fsetpoint* shows the setpoint in the capacity unit for which the instrument is set. Like *Fmeasure, Fsetpoint* is dependent of *Capacity, Capacity 0%, Capacity Unit* and *Sensor Type*.

Setpoint Slope

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned int	RW	0…30000	10	1/2	0x0022/35

The value of this parameter represents the time it would take to adjust the setpoint if it were changed from 0 to 100%. This feature can be used to smooth 'nervous' controller behavior, e.g. to reduce setpoint overshoot or undershoot. The supported range corresponds to 0…3000 seconds. Default value = 0.

Example:
If *Setpoint Slope* = 100 it will take 10 seconds to adjust the setpoint if it is changed from 0 to 100%. A setpoint change of 20% will take (20%/100%)*10 seconds = 2 seconds.

Analog Input

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned int	R	0…65535	11	1/3	0x0023/36

This parameter contains a digital translation of the analog input signal (if applicable).

Valve Output

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned long	RW	0…16777215	55	114/1	0xF208…0xF209/61961…61962

This parameter represents the controller output signal for control valve operation.

4.4. Device Identification

User Tag

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [16]	RW	-	115	113/6	0xF130…0xF137/61745…61752

With this parameter, the instrument can be given a custom tag name, with a maximum of 16 characters.

Customer Model

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [16]	RW	-	93	113/4	0xF120…0xF127/61729…61736

This parameter is used to add extra information to the model number information, such as a customer-specific model number.

Serial Number

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [20]	R	-	92	113/3	0xF118…0xF11F/61721…61728

Instrument serial number for identification.

BHT Model Number

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [35]	RW	-	91	113/2	0xF110…0xF117/61713…61720

This parameter shows the Bronkhorst® instrument model type information.

Firmware Version

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [6]	R	-	105	113/5	0xF128…0xF12A/61737…61739

Revision number of the firmware

Identification Number

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	175	113/12	0x0E2C/3629

Bronkhorst® (digital) device type identification number.

Device Type

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [6]	R	-	90	113/1	0xF108…0xF10A/61705…61707

Device type information string: this parameter contains an abbreviation referring to the identification number.

4.5. Alarms

Alarm settings are most easily accessible using Bronkhorst FlowSuite or a Bronkhorst readout and control unit.

The built-in alarm functionality can be used to handle different alarm types:

- system errors and warnings
- min/max alarms
- response alarms
- batch alarms
- master/slave alarms

The used alarm type can be set with parameter *Alarm Mode*. When an alarm is activated, the type can be read out using parameter *Alarm Info*. An automatic setpoint change can be set using the parameters *Alarm Setpoint Mode* and *Alarm New Setpoint*. It is also possible to set an alarm delay, to prevent overreaction to small disturbances, using parameter *Alarm Delay Time*. The methods by which an alarm can be reset are controlled by *Reset Alarm Enable*.

Alarm Mode

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…3	118	97/3	0x0C23/3108

Available modes:

Value	Description
0	Alarm off
1	Alarm on absolute limits
2	Alarm on limits related to setpoint (response alarm)
3	Alarm on power-up (e.g. after power-down)

(On DeviceNet™ instruments, only modes 0 and 1 are available).

Alarm Info

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	R	0…255	28	1/20	0x0034/53

This parameter provides information about the event type(s) that triggered an alarm situation. The value is a bitwise summation of the issued alarm types; convert the value to binary to see which types are issued. The following alarm types can be issued:

Bit	Value	Type	Description
0	1	Error	Error flag raised
1	2	Warning	Warning flag raised
2	4	Minimum alarm	*Measure* < *Alarm minimum limit*
3	8	Maximum alarm	*Measure* > *Alarm minimum limit*
4	16	Batch counter alarm	Batch counter reached its limit
5	32	• This bit only: Power-up alarm • If combined with bit 2 or 3: Response alarm	Alarm possibly caused by a power dip Difference between *Measure* and *Setpoint* too big
6	64	Master/slave alarm	Setpoint out of limits (caused by *Slave factor*)
7	128	Hardware alarm	Hardware error

Alarm Delay Time

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	182	97/7	0x0C27/3112

This value represents the time in seconds the alarm action will be delayed when an alarm limit has been exceeded. This value also delays the alarm off action if an alarm limit is no longer exceeded.
Default value = '0'.

Alarm Maximum Limit

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned int	RW	0…32000	116	97/1	0x0C21/3106

Maximum limit for *Measure* to activate the maximum alarm situation (after *Alarm Delay Time*). Range 0…32000 represents 0…100% signal. *Alarm Maximum Limit* must be greater than *Alarm Minimum Limit*.
Default value: 0.

Alarm Minimum Limit

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned int	RW	0…32000	117	97/2	0x0C22/3107

Minimum limit for *Measure* to activate the minimum alarm situation (after *Alarm Delay Time*). Range 0…32000 represents 0…100% signal. *Alarm Minimum Limit* must be smaller than *Alarm Maximum Limit*.
Default value: 0.

Alarm Setpoint Mode

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…1	120	97/5	0x0C25/3110

Specifies whether or not to change the setpoint after an alarm situation is activated.

Value	Description
0	No setpoint change (default)
1	Change setpoint to *Alarm new setpoint*

Alarm New Setpoint

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…32000	121	97/6	0x0C26/3111

New (safe) setpoint during an alarm until reset. Range 0…32000 represents 0…100% setpoint.
Default value: 0

Reset Alarm Enable

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…15	156	97/9	0x0C29/3114

Available reset methods for alarms. Up to 4 different methods can be specified; convert the value to binary to see which methods are enabled.
Default value: 15 (all bits/methods enabled)

The following methods are supported:

Bit	Value	Description
0	1	Multifunctional switch
1	2	Externally (deprecated)
2	4	By parameter *Reset*
3	8	Automatically (when alarm conditions no longer apply)

4.6. Counter

Counter settings are most easily accessible using Bronkhorst FlowSuite or a Bronkhorst readout and control unit.

Counter Mode

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…2	130	104/8	0x0D08/3337

Available modes:

Value	Description
0	Counter off (default)
1	Counter up continuously
2	Counting up until limit reached (set by *Counter Limit*)

Counter Unit

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [4]	RW	see table below	128	104/7	0xE838…0xE839/59449…59450

This parameter contains the name of the counter readout unit.
Counter Unit supports the following values:

Mass	Normal volume (1.01325 bar(a), 0 °C)	Standard volume (1.01325 bar(a), 20 °C)	Custom volume (*Capacity Unit Pressure, Capacity Unit Type Temperature*)
ug, mg, g, kg	uln, mln, ln, mm3n, cm3n, dm3n, m3n	uls, mls, ls, mm3s, cm3s, dm3s, m3s	ul, ml, l, mm3, cm3, dm3, m3

Parameter 170 (density) is used to calculate the Custom volume flow.

Counter Value

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…10000000	122	104/1	0xE808…0xE809/59401…59402

Current counter value in units selected with parameter *Counter Unit*.

Counter Limit

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…9999999	124	104/3	0xE818…0xE819/59417…59418

Counter limit/batch size in units selected with parameter Counter Unit.
Default value: 0.

Counter Setpoint Mode

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…1	126	104/5	0x0D05/3334

Specifies whether or not to change the setpoint after reaching the counter limit.

Value	Description
0	No setpoint change (default)
1	Change setpoint to *Counter new setpoint*

Counter New Setpoint

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned int	RW	0…32000	127	104/6	0x0D06/3335

New (safe) setpoint when a counter limit is reached until reset. Range 0…32000 represents 0…100% setpoint.
Default value: 0

Reset Counter Enable

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…15	157	104/9	0x0D09/3338

Available reset methods for counters. Up to 3 different methods can be specified. The value is a bitwise summation of the enabled reset methods; convert the value to binary to see which methods are enabled.
Default value: 7 (bits/methods 0, 1 and 2 enabled)

The following methods are supported:

Bit	Value	Description
0	1	Multifunctional switch
1	2	Externally
2	4	By parameter *Reset*
3	8	Automatically (e.g. when *Counter value* is reset)

4.7. Network configuration

*Changes made to the network settings will **not** be restored by a factory reset.*

Default settings
Network configuration is done ex factory as indicated on the serial number label or in the technical specifications. The table below shows the supported configurations for the available interface protocols (default settings are printed in boldface):

Protocol	ProPar (RS232)	FLOW-BUS (RS485)	Modbus (RTU/ASCII)	PROFIBUS DP	DeviceNet™
Address	**3**	**3**…125	**1**…247	0…**126**	0…**63**
Baud Rate	9600 19200 **38400** 57600 115200 230400 460800	**187500** 400000	9600 **19200** 38400 56000 115200 128000 256000	**(autodetect)** 9600 19200 45450 93750 187500 500000 1500000 3000000 6000000 12000000	**125000** 250000 500000
Parity	**0**	**0**	0, 1, **2**	**2**	**0**

Network configuration for EtherCAT® and PROFINET is done automatically via the Ethernet protocol.

Communication via fieldbus connection (RS485)
Use the following parameters to configure the instrument for communication via the fieldbus connection:

Fieldbus 1 Address

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	199	125/10	0x0FAA/4011

Fieldbus 1 Baud Rate

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned long	RW	0…1.0E10	201	125/9	0xFD48…0xFD49/64841…64842

Fieldbus 1 Parity

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…2	335	125/12	0x0FAC/4013

The following values are supported:

Value	Description
0	No parity
1	Odd parity
2	Even parity

Fieldbus 1 Selection

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	305	125/8	0x0FA8/4009

Communication via the power supply connection (RS232/RS485)
Use the following parameters to configure the instrument for communication via the 8DIN (power) connection:

- *If the 8DIN connector is set for RS485 communication, the instrument will not respond when connected to an RS232 configuration. In that case, use the power-up functionality of the multifunctional switch to enter configuration mode and enable RS232 communication.*
- *After configuring the required parameters, use the same procedure to leave configuration mode and restore the original communication settings (otherwise, configuration mode remains enabled after power down).*

Field Bus 2 Address

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	309	124/10	0x0F8A/3979

Field Bus 2 Baud Rate

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned long	RW	0…1.0E10	310	124/9	0xFC48…0xFC49/64585…64586

Field Bus 2 Parity

Type	Access	Range	FlowDDE	ProPar	Modbus

Unsigned char	RW	0…2	336	124/12	0x0F8C/3981

The following values are supported:

Value	Description
0	No parity
1	Odd parity
2	Even parity

Fieldbus 2 Selection

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…255	308	124/8	0x0F88/3977

4.8. Fluid set

For changing fluid, flow range or operating conditions, using the Bronkhorst FlowSuite software is strongly advised. When the parameters described in this section are changed manually, no such checks are performed, and the instrument output may become disordered, or the instrument may even get damaged if used in conditions the instrument is not suited for. When in doubt, consult your Bronkhorst representative.

Fluid Set Index

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…7	24	1/16	0x0030/49

With this parameter, any of the pre-configured fluids (up to 8) can be selected. Each fluid has its specific (configurable) properties, such as *Fluid Name, Capacity*, etc. Default value: 0 (fluid 1).

Note that the selected value is equal to the fluid number minus 1 (value 0 corresponds to fluid 1, value 1 to fluid 2, etc.).

Fluid Name

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [10]	RW	-	25	1/17	0x8188…0x818C/33161…33165

This parameter contains the name of the current fluid.

Capacity

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	1E-10… 1E+10	21	1/13	0x8168…0x8169/33129…33130

This parameter sets the maximum readout/control value (100%) for the current fluid in readout units corresponding to *Capacity Unit*.

Capacity Unit

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char [7]	RW	see below	129	1/31	0x81F8…0x81FB/33273…33276

Available units:

Mass	Normal volume (1.01325 bar(a), 0 °C)	Standard volume (1.01325 bar(a), 20 °C)	Custom volume (*Capacity Unit Pressure, Capacity Unit Type Temperature*)
ug/h, ug/min, ug/s, mg/h, mg/min, mg/s, g/h, g/min, g/s, kg/h, kg/min, kg/s	uln/h, uln/min, uln/s, mln/h, ln/min, mln/s, ln/h, ln/min, ln/s, ccn/h, ccn/min, ccn/s, mm3n/h, mm3n/m, mm3n/s, cm3n/h, cm3n/m, cm3n/s, m3n/h, m3n/min, m3n/s, scfh, scfm, scfs, sccm, slm	uls/h, uls/min, uls/s, mls/h, mls/min, mls/s, ls/h, ls/min, ls/s, ccs/h, ccs/min, ccs/s, mm3s/h, mm3s/m, mm3s/s, cm3s/h, cm3s/m, cm3s/s, m3s/h, m3s/min, m3s/s	ul/h, ul/min, ul/s, ml/h, ml/min, ml/s, l/h, l/min, l/s, cc/h, cc/min, cc/s, mm3/h, mm3/m, mm3/s, cm3/h, cm3/m, cm3/s, m3/h, m3/min, m3/s, cfh, cfm, cfs

Because of the maximum string length (7 characters), some unit names are abbreviated. For instance, mm3n/m means mm3n/min.

Parameter 170 (density) is used to calculate the Custom volume flow.

Capacity Unit Type Temperature

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	-273.15… 3.4E+38	245	33/10	0xA150…0xA151/41297…41298

This parameter defines a reference temperature for conversion of the measured mass flow to a volume flow. See also parameters *Capacity Unit* and *Counter Unit*.

Capacity Unit Type Pressure

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	246	33/11	0xA158…0xA159/41305…41306

This parameter defines a reference pressure for conversion of the measured mass flow to a volume flow. See also parameters Capacity Unit and Counter Unit.

4.8.1. Advanced fluid set parameters

Note that the parameters described in this section do not contain any actual measurement values, but only fixed reference values, which can be used for capacity calculations, etc.

Inlet Pressure

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	178	113/13	0xF168…0xF169/61801…61802

Inlet pressure of the current fluid in bar(a).

Outlet Pressure

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	179	113/14	0xF170…0xF171/61809…61810

Outlet pressure of the current fluid in bar(a).

Fluid Temperature

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	-250…500	181	113/16	0xF180…0xF181/61825…61826

Temperature of the current fluid in °C.

Density

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	170	33/21	0xA1A8…0xA1A9/41385…41386

Density of the current fluid in kg/m^3.

Heat Capacity

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	250	113/18	0xF190…0xF191/61841…61842

Heat capacity of the current fluid in J/kg·K.

Thermal Conductivity

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	251	113/20	0xF1A0…0xF1A1/61857…61858

Thermal conductivity of the current fluid in W/m·K.

Viscosity

Type	Access	Range	FlowDDE	ProPar	Modbus
Float	RW	0…3.4E+38	252	113/21	0xF1A8…0xF1A9/61865…61866

Dynamic viscosity of the current fluid in Pa·s.

4.9. Master/slave configuration (FLOW-BUS)

Normally, there is no communication between slave instruments in a fieldbus system. The FLOW-BUS protocol, however, provides a feature to set up a master/slave relationship between two instruments. The typical behavior of a slave instrument is to automatically set its own setpoint relative to the output (measurement value) of its master.

The output value of any instrument connected to a FLOW-BUS network is automatically available to all other instruments without extra wiring. A slave instrument can in turn be a master to other instruments.

To setup a master/slave relationship between instruments, first determine which instrument should be the master and which should be the slave, then set Control Mode of the slave instrument to ‘FLOW-BUS Slave’ (value 2) or ‘FLOW-BUS Analog Slave’ (value 13), depending on how the setpoint should be calculated (see parameter Control Mode).

The slave instrument polls the output value of its master periodically and uses the slave factor to set its own flow relative to the master's.

Setpoints from master instruments can be received via FLOW-BUS only.

To prevent damage to the instruments and/or the system(s) they are connected to, be sure to avoid circular references between devices on the same fieldbus. The FLOW-BUS system does not have a protection mechanism.

Master Node

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…128	158	33/14	n/a

Set the master node for the instrument
Note that this parameter only is effective in a FLOW-BUS system via RS485.

Slave Factor

Type	Access	Range	FlowDDE	ProPar	Modbus
Unsigned char	RW	0…500	139	33/1	0xA108…0xA109/41225…41226

The controller output from the master instrument is multiplied by *Slave Factor*/100% to get the slave instrument setpoint. In systems other than FLOW-BUS via RS485, *Slave Factor* is effective only if *Control Mode* is set to 'Analog slave', and the analog output signal of the master instrument is redirected to the input of the slave instrument.

Example:
- master output = 80%
- *Slave Factor* = 50

→ slave instrument setpoint = 80% x 50%/100% = 40%

4.10. Customized I/O options (pin 5)

MASS-STREAM D-6400 instruments offer several customized input/output functions through the 8DIN connector as an option. I/O options are factory installed as specified at ordering time and cannot be changed manually.

The last three characters of the model key on the serial number label indicate the installed I/O configuration (see section Model key). The possible configurations are described in the table below. See the hook-up diagram for optional bus and I/O configurations (document 9.16.266) for an explanation of the codes.

Cllode	Description
000	Disabled, pin 5 is pulled down to 0 Vdc (default selection)
A1V	0…10 Vdc sourcing output, controller Analog signal for pump or external valve steering (control signal only). When the controller output is used for pump or external valve steering (only applicable to mass flow meters with the controller function enabled), make sure to set parameter *Valve maximum* to 0.3 [A]. For mass flow controllers, the controller output signal represents the valve actuator current. This output is limited to a value below 10 Vdc, due to the maximum valve current restriction.
B1V	4…20 mA sourcing output, controller Analog signal for pump or external valve steering (control signal only). When the controller output is used for pump or external valve steering (only applicable to mass flow meters with the controller function enabled), make sure to set parameter *Valve maximum* to 0.3 [A]. For mass flow controllers, the controller output signal represents the valve actuator current. This output is limited to a value below 20 mA, due to the maximum valve current restriction.
B2V	3.8…20.8 mA sourcing output, controller Analog signal for Badger Meter valve with TEIP11 signal converter (control signal only)
C3A	Digital output, min/max alarm During a min/max alarm, pin 5 is pulled down to 0 Vdc.
C4A	Digital output, counter alarm During a counter alarm, pin 5 is pulled down to 0 Vdc.
C5S	Digital output, enabled by setpoint (for shut-off control) Pin 5 is pulled down to 0 Vdc at a controller setpoint, e.g. for shut-off valve activation. For factory selected analog control (…-A#-C5S): If parameter *Control mode* is set for analog control by factory, the minimum setpoint at which the device (shut-off valve) connected to pin 5 is activated is 1.9%. This prevents possible noise on the analog input activating the device accidentally. For factory selected digital control (…-D#-C5S): If parameter *Control mode* is set for digital control by factory, the setpoint threshold for activating the device connected to pin 5 is any value > 0. Note: If the instrument is forced into Valve Safe State, the digital output is not affected, so a (n/c) shut-off valve connected to pin 5 will not close when the (n/c) controller is in Valve Safe State'
C0I	Digital output, high/low switch via remote parameter (e.g. for shut-off valve control) Pin 5 is pulled down to 0 Vdc when writing value 1 to parameter *IO switch status*, this is undone by writing value 0. A device connected to pin 5 (e.g. a shut-off valve) can be activated/deactivated by writing parameter IO switch status.

Cllode	Description
	Note: If the instrument is forced into Valve Safe State, the digital output is also affected, so a (n/c) shut-off valve connected to pin 5 will be closed when the (n/c) controller is in 'Valve Safe State'.
D9E	Digital frequency output, measure Measurement value is translated to a frequency within given frequency range. The default frequency range to represent 0…100% flow is 0…10000 Hz. Any other frequency range must be specified on order.
F9B	Digital pulse output, batch counter Pin 5 is pulled down to 0 Vdc when a given batch size is reached (during a given pulse length). By default, a pulse is given at each 1x the *Counter unit* batch value, with a pulse length of 1 second. For instance, when *Counter uni*t is set to 'ln', a pulse is given each time 1 ln has passed through the instrument. An alternative pulse length must be specified on order. Provide a pull-up resistor of 5…10 kOhm to create 15…24 Vdc at pin 5 (according to the applicable hook-up diagram).
H1P	4…20 mA input, external pressure sensor for active pressure correction. Signal is translated to parameter *Pressure*.
I3C	Digital input, controller mode valve close Valve closes when pin 5 is connected to 0 Vdc. This option switches between the default *Control mode* and mode 'Valve Close' (value 3). When the default *Control mode* is digital, the default value is 0 (bus/RS232), when the default *Control mode* is analog, the default value is 1 (Analog input).
I8C	Digital input, controller mode valve purge Valve is fully opened when pin 5 is connected to 0 Vdc. This option switches between the default *Control mode* and mode 'Valve Fully Open' (value 8). When the default *Control mode* is digital, the default value is 0 (bus/RS232), when the default *Control mode* is analog, the default value is 1 (Analog input).
I1R	Digital input, reset counter The counter resets when pin 5 is connected to 0 Vdc.
I2R	Digital input, reset alarm The alarm resets when pin 5 is connected to 0 Vdc.

5. Troubleshooting

To track down problems in the fluid system, it is recommended to disconnect the unit from the process line and check it without applying fluid pressure. Dirt or clogging might be detected quickly by loosening fluid connections and performing a visual inspection.

Energizing and de-energizing the equipment can indicate whether there is an electronic failure. After energizing, control behavior can be checked by applying fluid pressure.

If you suspect leakage, do not disassemble the device for inspection, but contact your Bronkhorst representative for service or repairs.

5.1. Errors and warnings

- *During operation, the LEDs can indicate errors and/or warnings. See LED indications for an explanation of the LED indications the instrument can give.*
- *Error and warning information can be found by connecting the instrument to Bronkhorst FlowSuite.*

5.2. Restoring factory settings

In case changes to the instrument configuration leads to non-recoverable erroneous behavior, the instrument can be reset to the pre-configured factory settings. The easiest way to do this is with the multifunctional switch on top of the instrument.

To restore the factory settings using the multifunctional switch, follow these instructions:

1. Make sure electrical power to the instrument is switched off
2. Press and hold the multifunctional switch, while powering up the instrument. After 4 seconds the red LED ● starts flashing (0.2 seconds on, 0.2 seconds off)
3. At that moment (which is after 4 to 8 seconds), release the switch

*Changes made to the network settings (bus address, baud rate, parity) will **not** be restored by a factory reset.*

Alternatively, factory settings can be restored in Bronkhorst FlowSuite (via RS232 communication), or with a Bronkhorst readout and control unit

If RS232 communication with the instrument cannot be established, use the power-up functionality of the multifunctional switch to switch to configuration mode and enable RS232 communication.

After restoring the factory settings, remember to leave configuration mode and restore the original communication settings (otherwise, configuration mode remains enabled after power down).

5.3. Common issues

Symptom	Possible cause	Action
No (fieldbus) communication	No power supply	• check power supply • check cable connection • check cable hook-up
	Invalid node address	Change node address (see Network configuration)
	Other	Reset instrument and/or restart master. If problem persists, contact Bronkhorst
No output signal	No power supply	• check power supply • check cable connection • check cable hook-up
	Invalid control mode (instrument accepts no setpoint)	Check control mode (see Special parameters)
	No setpoint given or setpoint too low	Give setpoint ≥ 2%
	Control valve in Safe State (normally closed)	Check if control valve is in safe state; solve cause if necessary (see Valve Safe State)
	Inlet pressure or differential pressure too low	Increase inlet pressure
	Piping, filters and/or control valve clogged or blocked	• Flush fluid system with clean, dry air. If problem persists, contact Bronkhorst. • For external proportional control valves: supply 0…15 Vdc and operational inlet pressure to valve and slowly increase voltage. If valve does not open, clean parts and re-adjust valve
	Sensor failure	Return equipment to factory
	Flow too high, valve fully open	Close valve
Maximum output signal (131%)	PCB/sensor failure	Return equipment to factory
	Valve in 'Safe State' (normally open valves)	Remove cause of 'Valve Safe State' (see Valve Safe State)
	Measurement disturbed by vibrations	If possible, avoid installation in close proximity of mechanical vibration
Control behavior unstable	Inlet pressure unstable	Install pressure regulator or increase buffer volume between controlling instruments (see section Piping requirements)
	Inlet and/or outlet pressure too high or too low	Adjust pressure and/or set instrument pressure in accordance with actual process pressure
	Wrong process gas selected	Select correct process gas
	Wrong controller settings	Adjust settings
	Control valve damaged	Return equipment to factory
	No fluid supply	Check upstream components for obstruction, e.g.: • fluid lines • valves filters
No flow (sending a setpoint has no effect)	Setpoint too low	• Give setpoint ≥ 2%
	Inlet pressure or differential pressure out of bounds	Set inlet pressure to a value within specifications

Symptom	Possible cause	Action
Measured value rises, but never reaches setpoint	Piping, filters and/or control valve clogged or blocked	• Flush fluid system with clean, dry air. If problem persists, contact Bronkhorst. • For external proportional control valves: supply 0…15 Vdc and operational inlet pressure to valve and slowly increase voltage. If valve does not open, clean parts and re-adjust valve
	Inlet pressure too low	Increase inlet pressure
	Outlet pressure too high	Check/decrease outlet pressure
	Process outlet blocked	Check process outlet and downstream piping
Measured value or output signal (much) lower than setpoint	Inlet pressure or differential pressure too low	• Increase inlet pressure • Use instrument in conditions it was designed for
	Process gas condensation	Decrease inlet pressure or increase gas temperature
	• Piping, filters and/or control valve clogged or blocked • Sensor blocked or contaminated	Flush fluid system with clean, dry air. If problem persists, contact Bronkhorst.
	Supplied fluid type does not match configured fluid type	Supply equipment with other fluid or change fluid type in instrument configuration
Measured value or output signal indicates a flow, while there is none	Mounting orientation and/or ambient conditions changed significantly	• Use instrument in conditions it was designed for • Adjust zero point (see Adjusting zero point)
	System leakage	Check the system for leakage. Follow vendor instructions when installing third party components (e.g. adapters, tubing, valves)
Continuous maximum measured value or output signal	Inlet pressure too high	Check inlet pressure
	Valve fully open	• Close valve • Check if control valve is in Safe State (normally open valves); remove cause if necessary (see Valve Safe State)
	Sensor failure	Return equipment to factory

6. Contact and service information

For current information about Bronkhorst® and service addresses, please visit our website:

www.bronkhorst.com

Do you have any questions about our products? Our Sales Department will gladly assist you selecting the right product for your application. Contact sales by e-mail:

sales.bhi@bronkhorst.com

For after-sales questions, our Customer Service Department is available with help and guidance. To contact CSD by e-mail:

aftersales@bronkhorst.com

No matter the time zone, our experts within the Support Group are available to answer your request immediately or ensure appropriate further action. Our experts can be reached at:

+31 859 02 18 66

Bronkhorst Instruments GmbH
Am Ziegelwerk 1
85391 Leonardsbuch
Germany

6.1. Returns

In case the product needs to be returned (e.g. for calibration, repair), please refer to our website for information on the online product return process (RMA):
https://www.bronkhorst.com/service-support

6.2. Disposal (end of lifetime)

Within the European Union, manufacturers of electrical and electronic equipment (EEE) are obliged to comply with the WEEE directive (waste electrical and electronic equipment). Bronkhorst® offers its customers the possibility to return electrical and electronic equipment for disposal at the end of its life, so that it can be properly dismantled, and the components recycled or, if possible, reused.

All Bronkhorst® products covered by the WEEE directive carry an image of a crossed-out waste bin (usually on the serial number label). If you wish to dispose of Bronkhorst® equipment bearing this symbol, simply return it in accordance with the removal and return instructions, and Bronkhorst® will take care of proper dismantling, recycling and/or reuse (wherever possible). In the covering letter, just mention that you are returning the product for disposal. Within the EU, returning products for disposal is of course free of charge (except for shipping and handling costs).

In countries outside the EU, electrical and electronic equipment disposal may be subject to local or national directives and/or legislation. If applicable, consult local or national authorities to learn how to handle electrical and electronic equipment properly in your area.

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