Instruction Manual

# mini CORI-FLOW™ MI-series MKII

## Industrial Coriolis Mass Flow Meters/Controllers for Liquids and Gases

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**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.**
**Keep this document for future reference.**

Bronkhorst®

## Copyright



## Disclaimer

The illustrations in this document serve to provide general notices regarding correct operation and may differ from the actual product.

Bronkhorst High-Tech B.V. 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 Prior to work, check whether a newer version of this document is available on the Bronkhorst website.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.*

*Tips, useful information, attention points. This will facilitate the use of the product and/or contribute to its optimal performance.*


*Additional information available in the referenced documentation, on the indicated website(s) or from your Bronkhorst representative.*

## Receipt of equipment

- Check that the outer packaging and its contents have not been damaged during transport. If the outer packaging or its contents are damaged, the local carrier must be informed immediately regarding his liability, if so required. At the same time a report should be submitted to your Bronkhorst representative.
- If the product is damaged, it should not be put into service. In that case, contact your Bronkhorst representative for service.
- Check the packing list to ensure that you received all items included in the scope of delivery.
- Do not discard spare or replacement parts.
- See Removal and return instructions for information 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 general terms of delivery, please visit **www.bronkhorst.com/terms-and-conditions/**

## 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.

If required, replace fuses with the same type and rating for continued protection against fire hazard.

Opening the equipment beyond the wiring terminal box cover is not allowed. There are no user serviceable parts inside. In case of a defect please return the equipment to Bronkhorst High-Tech B.V.

One or more warning signs may be attached to the product. These signs have the following meaning:

*General warning; consult the instruction manual for handling instructions*

*Surface may get hot during operation*

*Shock hazard; electrical parts inside*

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. Non-safety related components 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 suitability of a replacement component, contact your Bronkhorst representative for information.

# Table of contents

# 1 Introduction

## 1.1 Scope of this manual

This manual contains general product information, installation and operating instructions and troubleshooting tips for the **mini CORI-FLOW™ MI-series MKII** industrial mass flow meters and - if combined with an external valve - controllers for liquids and gases.

## 1.2 Intended use

The **mini CORI-FLOW™ MI-series MKII** is designed to measure and/or control mass flow rates of non-aggressive gases and liquids in a fluid system at conditions as specified at ordering time and as stated on the serial number label. The instrument is less suitable for use with corrosive, erosive, reactive or otherwise aggressive media, as these can cause wear and damage to the measuring tube.

The instrument is built into a robust, weatherproof housing, making it especially suitable for operation in a wide range of industrial environments, like pilot plants.

Any other use than mentioned here is considered unintended.

*The wetted materials incorporated in the mini CORI-FLOW™ MI-series MKII 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 its intended use, suitability for the intended application, cleaning and compatibility of process media with the applied materials lies solely with the user.*

*The user is responsible for taking the necessary safety measures to prevent damage and/or injury while working with the equipment and process media (as described in the associated Material Safety Data Sheets).*

*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. However, this does not relieve the user of aforementioned responsibility, not even if such is not explicitly recommended or prescribed in this document.*

*Bronkhorst High-Tech B.V. cannot be held liable for any damage and/or injury resulting from unintended, improper or unsafe use, or use with other media and/or under other process conditions than specified at ordering time.*

### 1.2.1 Use in an Ex-area

*The product may only be used in an Ex-area if both conditions below are met:*

- *It is indicated on the product serial number plate that it concerns an Ex-certified product.*
- *The requirements as described in the supplied Ex Manual have been met.*

## 1.3 Declaration of conformity

*The CE mark on the product indicates that it complies with requirements imposed by the European Union.*

*The UKCA mark on the product indicates that it complies with requirements imposed by the United Kingdom.*

*Declarations of Conformity applicable to standard Bronkhorst® products can be downloaded from* ***www.bronkhorst.com/downloads***

## 1.4 Product description

The Bronkhorst® **mini CORI-FLOW™ MI-series MKII** is an accurate mass flow meter and controller for measuring gas and liquid flows, virtually independent of pressure and temperature changes. It can be operated analog, via RS-232 or HART, or via an optional fieldbus interface (CANopen, DeviceNet®, EtherCAT®, Ethernet/IP, FLOW-BUS, Modbus (RTU/ASCII/TCP), POWERLINK, PROFIBUS DP, and PROFINET). For RS-232 and FLOW-BUS communication, Bronkhorst offers free tooling software (e.g. FlowPlot).

**Measuring principle**

**mini CORI-FLOW™ MI-series MKII** instruments contain a uniquely shaped, single loop sensor tube, forming part of an oscillating system. When a fluid flows through the tube, Coriolis forces cause a variable phase shift, which is detected by sensors and fed into the integrally mounted printed circuit board. The resulting output signal is strictly proportional to the real mass flow rate, independent of fluid density, temperature, viscosity, pressure, heat capacity or conductivity. Coriolis mass flow measurement is fast, accurate and inherently bi-directional. The **MI-series MKII** features density and temperature of the fluid as secondary outputs.

**Multi-range**

The **mini CORI-FLOW™ MI-series MKII** offers multi-range functionality: factory calibrated ranges can be re-ranged to a different full scale range. The analog output and the digital measured value are scaled accordingly. Switching between ranges can be done via the RS-232 interface or the fieldbus interface (if applicable), or with a Bronkhorst® readout and control unit E-8000.

The instrument comes with a calibration certificate for all supported full scale flow ranges. The actual full scale of the instrument is set to a value as ordered and can be found on the serial number label.

**Custom I/O options**

The Main terminal and the Actuator terminal (see Product overview) each can provide additional input/output functionality, selectable from a wide range of options (see Customized I/O options). In addition to the various analog signal options and the standard RS-232 communication, there are such options as RS-485 communication, digital frequency/pulse output, alarm output/reset, valve purge/close and analog valve output.

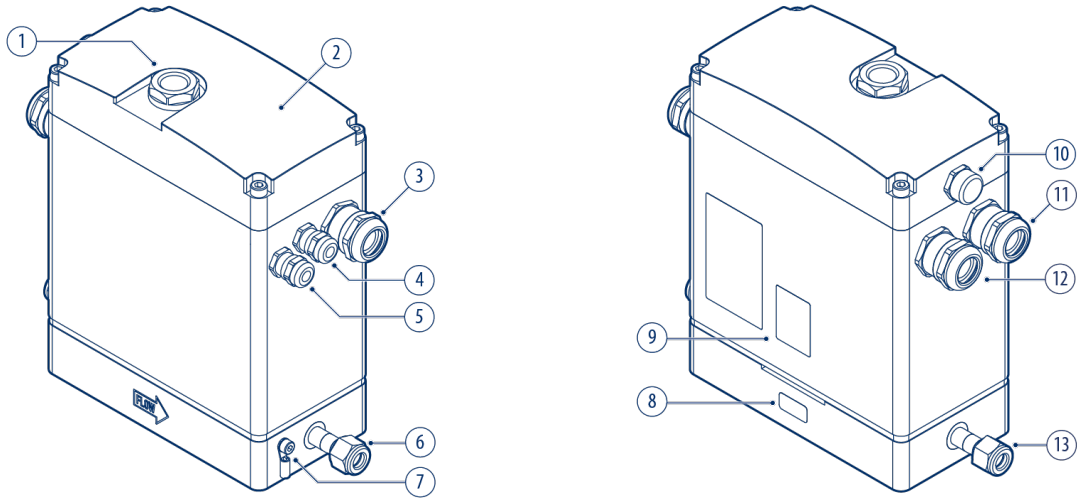
## 1.5 Product overview

**Front**

1. Sight glass
2. Top cover
3. Gland - main terminal
4. Gland - actuator terminal (optional)
5. Gland - valve terminal (optional)
6. Fluid outlet
7. Ground terminal

**Back**

8. Pressure tested label
9. Product labels
10. Breather plug
11. Gland - fieldbus terminal 2 (optional)
12. Gland - fieldbus terminal 1 (optional)
13. Fluid inlet




*Depending on the ordering details, fittings and/or glands on your instrument might differ from the images above.*

## 1.6 Calibration

The MI-series MKII has been factory calibrated. Periodical inspection, recalibration or verification of the accuracy may be subject to individual requirements of the user. Whenever necessary, contact your Bronkhorst representative for information and/or making arrangements for recalibration.

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

## 1.7 Maintenance

*Inexpertly servicing instruments can lead to serious personal injury and/or damage to the product 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 trained staff available.*

- The product needs no regular maintenance if operated properly, with clean media, compatible with the wetted materials, avoiding pressure and thermal shocks and vibrations.
- The product's fluid path (the wetted parts) may be purged with a clean, dry and inert gas or flushed with a non-aggressive, non-corrosive cleaning liquid.
- In case of severe contamination, cleaning the the wetted parts may be necessary.

## 1.8 Documentation

The MI-series MKII comes with all necessary documentation for basic operation and maintenance. At some points this document refers to other documents, most of which can be downloaded from the Bronkhorst website. Insofar as agreed upon within the framework of the sales agreement, calibration certificates, test certificates and material certificates are included in the scope of delivery.

*The documentation listed in the following table is available on the **MI-series MKII** product pages under **www.bronkhorst.com/products** :*

| Type | Document name | Document no. |
|---|---|---|
| Manuals | Instruction Manual mini CORI-FLOW™ MI-series MKII (this document) | 9.17.206 |
| | Ex Manual mini CORI-FLOW™ MI-series MKII | 9.27.098 |
| Technical documentation | Hook-up diagram Analog, RS-232, HART | 9.16.199 |
| | Hook-up diagram DeviceNet®, CANopen | 9.16.262 |
| | Hook-up diagram EtherCAT®, Ethernet/IP, Modbus TCP, POWERLINK, PROFINET | 9.16.200 |
| | Hook-up diagram FLOW-BUS | 9.16.201 |
| | Hook-up diagram Modbus (ASCII/RTU) | 9.16.202 |
| | Hook-up diagram PROFIBUS DP | 9.16.203 |
| | Hook-up diagram custom bus & I/O configurations | 9.16.205 |
| | Dimensional drawing | 7.14.158 |

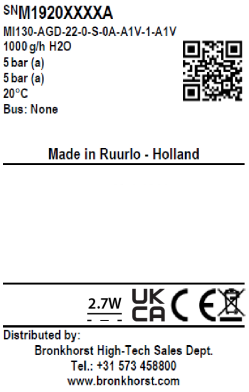
*The documentation listed in the following table can be downloaded from* ***www.bronkhorst.com/downloads*** *:*

| Type | Document | Document no. |
|---|---|---|
| General documentation | EU Declaration of Conformity | 9.06.059 |
| Instruction manuals | Manual CANopen | 9.17.131 |
| | Manual DeviceNet® | 9.17.026 |
| | Manual EtherCAT® interface | 9.17.063 |
| | Manual Ethernet/IP | 9.17.132 |
| | Manual FLOW-BUS interface | 9.17.024 |
| | Manual HART interface | 9.17.121 |
| | Manual Modbus interface | 9.17.035 |
| | Manual POWERLINK | 9.17.142 |
| | Manual PROFIBUS DP interface | 9.17.025 |
| | Manual PROFINET interface | 9.17.095 |
| | Manual RS-232 interface | 9.17.027 |

# 2 Product specifications

Before installing the MI-series MKII, check that the functional and technical properties of the product match your requirements. If you have a question about the product or if you find the product does not meet the specifications as ordered, do not hesitate to contact your Bronkhorst representative. See section Service for contact information.

The serial number label shows some essential technical specifications of the product as ordered (note that the image on the right does not necessarily reflect the actual specifications of your MI-series MKII instrument):



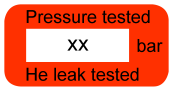

- Flow/pressure rate(s)
- Process media
- Inlet and outlet pressure(s)
- Operating temperature

The model key on the second line of the label contains more detailed information about the technical properties of the product as ordered.

Where applicable, follow the directions on any additional labels in order to ensure a safe working environment and to comply with the regulations applicable to the product and its operating environment.

## 2.1 Pressure rating

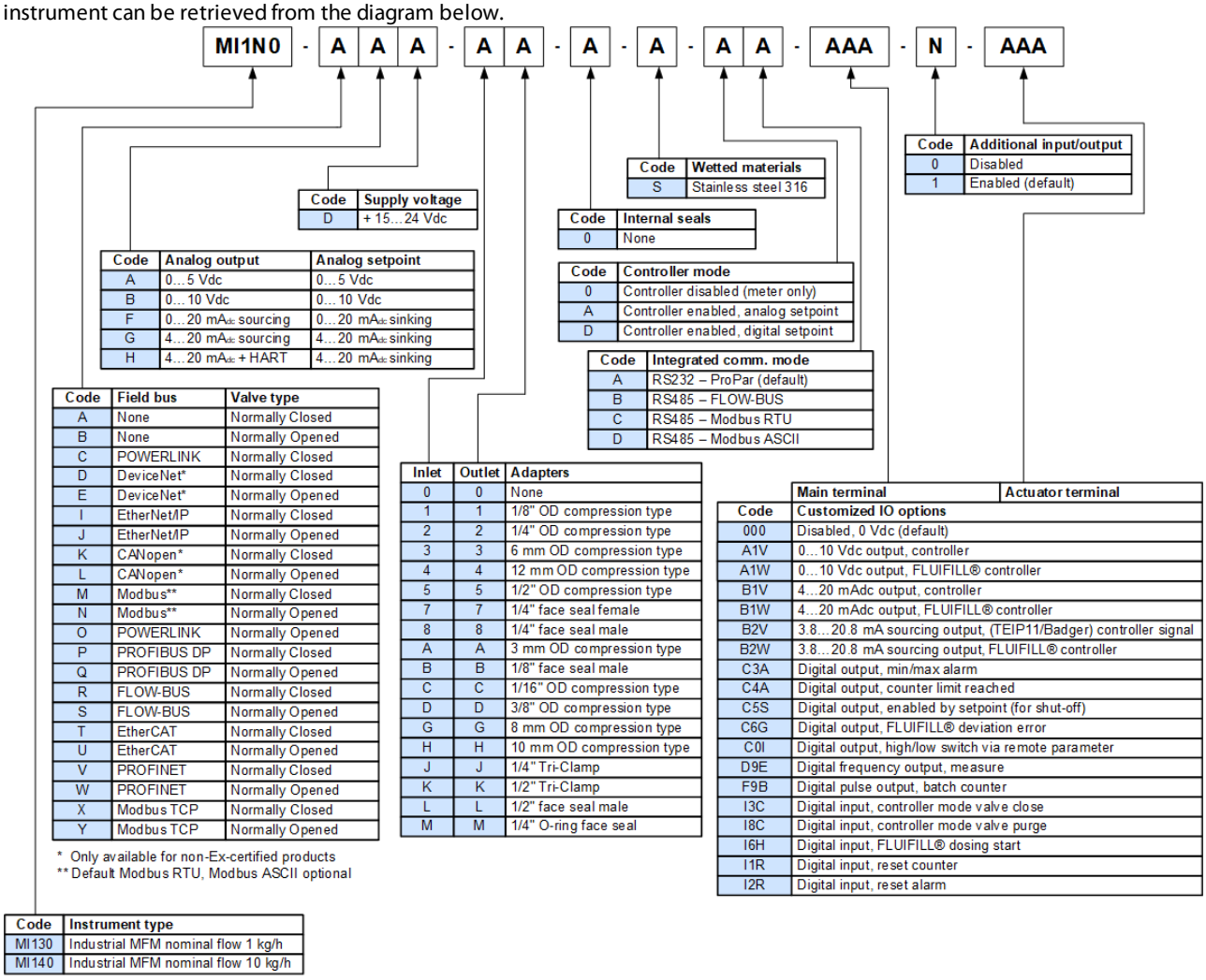
*At the factory the product has been pressure tested and tested for outboard leakage. The operating pressure must never exceed the specified test pressure.*




- *The test pressure is specified 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 test pressure is in accordance with the safety factor of your application.*

## 2.2 Model key

The model key contains information about the technical properties of the instrument as ordered. The actual properties of your instrument can be retrieved from the diagram below.




| Code | Instrument type |
|---|---|
| MI130 | Industrial MFM nominal flow 1 kg/h |
| MI140 | Industrial MFM nominal flow 10 kg/h |

| Code | Field bus | 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 |

* Only available for non-Ex-certified products
** Default Modbus RTU, Modbus ASCII optional

| Code | Analog output | Analog setpoint |
|---|---|---|
| A | 0…5 Vdc | 0…5 Vdc |
| B | 0…10 Vdc | 0…10 Vdc |
| F | 0…20 $mA_{dc}$ sourcing | 0…20 $mA_{dc}$ sinking |
| G | 4…20 $mA_{dc}$ sourcing | 4…20 $mA_{dc}$ sinking |
| H | 4…20 $mA_{dc}$ + HART | 4…20 $mA_{dc}$ sinking |

| Code | Supply voltage |
|---|---|
| D | + 15…24 Vdc |

| Inlet | Outlet | Adapters |
|---|---|---|
| 0 | 0 | None |
| 1 | 1 | 1/8" OD compression type |
| 2 | 2 | 1/4" OD compression type |
| 3 | 3 | 6 mm OD compression type |
| 4 | 4 | 12 mm OD compression type |
| 5 | 5 | 1/2" OD compression type |
| 7 | 7 | 1/4" face seal female |
| 8 | 8 | 1/4" face seal male |
| A | A | 3 mm OD compression type |
| B | B | 1/8" face seal male |
| C | C | 1/16" OD compression type |
| D | D | 3/8" OD compression type |
| G | G | 8 mm OD compression type |
| H | H | 10 mm OD compression type |
| J | J | 1/4" Tri-Clamp |
| K | K | 1/2" Tri-Clamp |
| L | L | 1/2" face seal male |
| M | M | 1/4" O-ring face seal |

| Code | Internal seals |
|---|---|
| 0 | None |

| Code | Wetted materials |
|---|---|
| S | Stainless steel 316 |

| Code | Controller mode |
|---|---|
| 0 | Controller disabled (meter only) |
| A | Controller enabled, analog setpoint |
| D | Controller enabled, digital setpoint |

| Code | Integrated comm. mode |
|---|---|
| A | RS232 – ProPar (default) |
| B | RS485 – FLOW-BUS |
| C | RS485 – Modbus RTU |
| D | RS485 – Modbus ASCII |

| Code | Additional input/output |
|---|---|
| 0 | Disabled |
| 1 | Enabled (default) |

| | Main terminal | Actuator terminal |
|---|---|---|
| Code | Customized IO options | |
| 000 | Disabled, 0 Vdc (default) | |
| A1V | 0…10 Vdc output, controller | |
| A1W | 0…10 Vdc output, FLUIFILL® controller | |
| B1V | 4…20 mAdc output, controller | |
| B1W | 4…20 mAdc output, FLUIFILL® controller | |
| B2V | 3.8…20.8 mA sourcing output, (TEIP11/Badger) controller signal | |
| B2W | 3.8…20.8 mA sourcing output, FLUIFILL® controller | |
| C3A | Digital output, min/max alarm | |
| C4A | Digital output, counter limit reached | |
| C5S | Digital output, enabled by setpoint (for shut-off) | |
| C6G | Digital output, FLUIFILL® deviation error | |
| C0I | Digital output, high/low switch via remote parameter | |
| D9E | Digital frequency output, measure | |
| F9B | Digital pulse output, batch counter | |
| I3C | Digital input, controller mode valve close | |
| I8C | Digital input, controller mode valve purge | |
| I6H | Digital input, FLUIFILL® dosing start | |
| I1R | Digital input, reset counter | |
| I2R | Digital input, reset alarm | |

## 2.3 Customized I/O options

At ordering time, the firmware allows the configuration of two additional input/output functions, customized I/O options. The model key contains information about the customized I/O configuration and is described in the table below.

- See the serial number label for the model key.
- Consult the hook-up diagram for custom bus and I/O configurations for an explanation of the codes.

| Code | Description |
|---|---|
| 000 | Disabled, M8/A2 is pulled down to 0Vdc (default selection) |
| A1V | 0…10Vdc sourcing output, controller<br>Analog signal for pump or external valve steering (control signal only)<br><br>When the controller output is used for pump or external valve steering (mass flow meters only), make sure to set parameter *Valve maximum* to 0.3 [A]. For mass flow controllers, the controller output is limited to a value below 10Vdc, due to the maximum valve current restriction. |

| Code | Description |
|---|---|
| B1V | 4…20mA sourcing output, controller<br>Analog signal for pump or external valve steering (control signal only).<br><br>When the controller output is used for pump or external valve steering (mass flow meters only), make sure to set parameter *Valve maximum* to 0.3 [A]. For mass flow controllers, the controller output is limited to a value below 20mA, due to the maximum valve current restriction. |
| B2V | 3.8…20.8mA sourcing output, controller<br>Analog signal for Badger Meter valve with TEIP11 signal converter (control signal only) |
| C3A | Digital output, min/max alarm<br>During a min/max alarm, M8/A2 is pulled down to 0Vdc. |
| C4A | Digital output, counter alarm<br>During a counter alarm, M8/A2 is pulled down to 0Vdc. |
| C5S | Digital output, enabled by setpoint (for shut-off control)<br>M8/A2 is pulled down to 0Vdc at a controller setpoint, e.g. for shut-off valve activation.<br><br>For factory selected analog control:<br>If parameter *Control mode* is set for analog control by factory, the minimum setpoint at which the device (shut-off valve) connected to M8/A2 is activated is 1.9%. This prevents possible noise on the analog input activating the device accidentally.<br><br>For factory selected digital control:<br>If parameter *Control mode* is set for digital control by factory, the setpoint threshold for activating the device connected to M8/A2 is any value > 0.<br><br>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 M8/A2 will not close when the (n/c) controller is in Valve Safe State'<br><br>Make sure to use 24Vdc power supply corresponding to the shut-off valve specifications. |
| C0I | Digital output, high/low switch via remote parameter (e.g. for shut-off valve control)<br>M8/A2 is pulled down to 0Vdc when writing value 1 to parameter *IO switch status*, this is undone by writing value 0.<br><br>A device connected to M8/A2 (e.g. a shut-off valve) can be activated/de-activated by writing parameter *IO switch status*.<br><br>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 M8/A2 will be closed when the (n/c) controller is in 'Valve Safe State'.<br><br>Make sure to use 24Vdc power supply corresponding to the shut-off valve specifications. |
| D9E | Digital frequency output, measure<br>Measurement value is translated to a frequency within given frequency range.<br><br>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<br>M8/A2 is pulled down to 0Vdc when a given batch size is reached (during a given pulse length).<br><br>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 unit* 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.<br><br>Provide a pull-up resistor of 5…10kOhm to create 15…24Vdc at M8/A2 (according to the applicable hook-up diagram). |

| Code | Description |
|---|---|
| I3C | Digital input, controller mode valve close<br>Valve closes when M8/A2 is connected to 0Vdc.<br><br>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/RS-232), when the default *Control mode* is analog, the default value is 1 (Analog input). |
| I8C | Digital input, controller mode valve purge<br>Valve is fully opened when M8/A2 is connected to 0Vdc.<br><br>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/RS-232), when the default *Control mode* is analog, the default value is 1 (Analog input). |
| I1R | Digital input, reset counter<br>The counter resets when M8/A2 is connected to 0Vdc. |
| I2R | Digital input, reset alarm<br>The alarm resets when M8/A2 is connected to 0Vdc. |

# 3 Installation

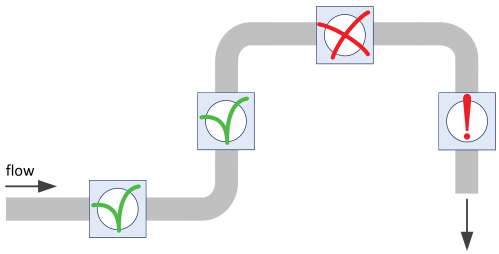
## 3.1 Location in fluid system

*To minimize the risk of gas entrapment due to cavitation, the position of the following system components is important:*

- *Install a control valve downstream from the instrument.*
- *Install a pump upstream from the instrument.*

For **gas applications**: if there is a chance of condensation or if the gas stream can contain solid particles, it is advisable not to mount the instrument at the lowest point of a pipe segment. In more general terms, mount the instrument in a location where condensate or particles (if any) cannot accumulate inside the instrument's media conduits.

In **liquid applications**, the presence of gas bubbles in the liquid can cause measurement errors. If there is a risk of expansion of dissolved gas in the metered liquid, the instrument should be mounted in a pipe segment where gas bubbles cannot accumulate. The image to the right shows the preferable mounting locations.




- The best location is a horizontal pipe segment or a segment where the fluid direction is upward.

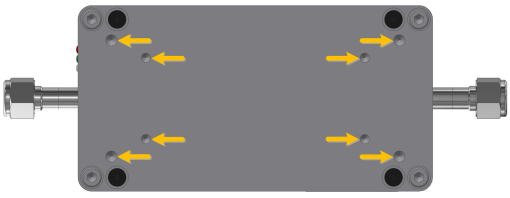
- Gas might accumulate in a horizontal segment if it is followed by a downward segment. Do NOT mount the instrument in a location like this.

- Mounting in a downward pipe segment with an open end is strongly dissuaded.
- Gravity might cause the segment to drain; depending on the system dimensions and the viscosity of the metered fluid, this effect might be stronger or weaker.
- If the instrument is part of a closed fluid system, mounting the instrument in a downward pipe segment is not preferable, but may be considered if other mounting locations are more problematic.

## 3.2 Mounting

- *Limit the mounting of system components to the product to avoid unwanted influences/vibrations.*
- *If a product is mounted on a spring mass, make sure that cables and tubes do not transmit mechanical stress.*

To increase the reliability and accuracy of the measurement, it is essential to reduce vibrational influence on the product to a minimum.



- Fixate the instrument to a firm, rigid base, such as a wall, a heavy rig or stable construction.
- Mount the product using the wall mounting holes or the mounting holes at the bottom of the base.

**-or-**

- Mount the product using the threaded holes in the dampeners.
- See online available dimensional drawings for further details.

**Multiple products in a system**

If multiple products will be used in the same fluid system or close to each other, vibrations from one instrument might interfere with the resonance frequency of another, e.g. through piping or a mounting frame.

- Isolate instruments mechanically by mounting them on individual, rigid, stiff bases.
- Preferably, mount multiple instruments parallel to each other.

## 3.3 Fluid connections

*Check the fluid system for leak tightness after any modification and before applying full operating pressure, especially when using hazardous media (e.g. toxic or flammable).*

*After using the product for the first time with low temperature media, re-tighten the fluid connectors in order to prevent leakage.*

- *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 also recommended.*
- *Make sure that the instrument is not suspended by the piping and isolate the product from vibrations in the piping. The use of flexible piping is recommended.*

- Install the product in the process line, in accordance with the direction of the FLOW arrow on the base of the instrument.
- Connect the piping without stress to the product fluid inlet and fluid outlet.
- Tighten fluid connections according to the manufacturer's instructions.


## 3.4 Electrical connection

- When using self-assembled cables, follow the guidelines provided by the cable manufacturer.
- If a surge protection device is used, make sure its specifications match the power consumption of the application.
- Before powering up, make sure all required cabling is properly connected.
- Before each use, inspect cabling for damage.

*The equipment 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 equipment 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.Cable wire diameters must be sufficient to carry the supply current, and voltage loss must be kept as low as possible.*

*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.***

*When in doubt about the suitability of your cabling, contact your Bronkhorst representative.*

***Never** power the instrument simultaneously from **two different power sources** (e.g. fieldbus and Plug-in Power Supply). Doing so will blow the power line fuse on the wiring terminal box.*

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

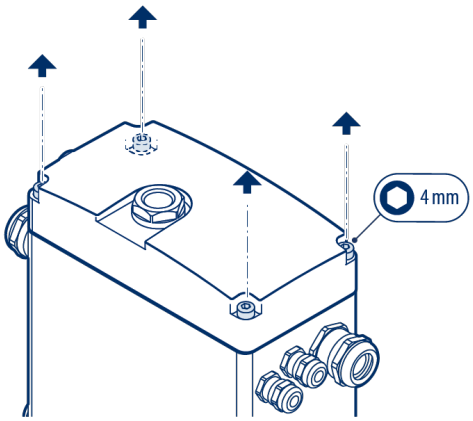
### 3.4.1 Accessing wiring terminals

- *The instrument cover may only be opened in a clean, dry and non-hazardous environment.*
- *Before opening the cover, make sure that the operating environment is perfectly safe and that the electrical components cannot be affected by moisture or aggressive atmospheric components.*
- *Ensure that no particles, objects, etc. can fall into the instrument when the cover is open.*
- *The top cover has a notch on the left side that allows it to be mounted in only one way.*
- *Make sure the top cover is placed with the sight glass facing forward.*

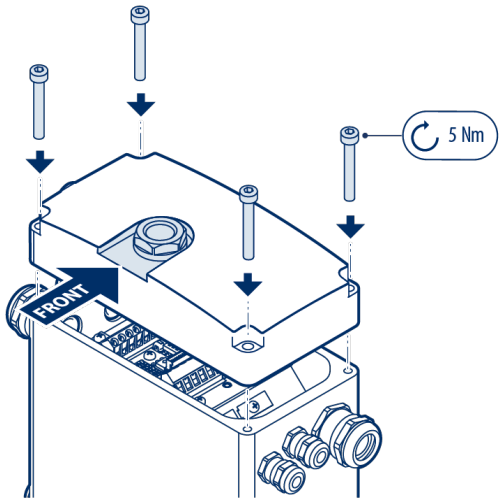
To connect an instrument, the cover has to be removed in order to access the wiring terminal box.
To remove the top cover:
1. Unscrew the 4 screws of the top cover.
2. Remove the top cover.
3. Make the connections according the applicable hook-up diagram . A hook-up legend is also printed on the inside of the cover.

To place the top cover:
1. Check the seal inside the top cover on wear and damage.
2. Replace the seal if needed.
3. Place the top cover on the instrument with the sight glass facing forward.
4. Tighten the 4 screws crosswise with a torque of 5 Nm.

**Opening top cover**




**Closing top cover**




*All wiring terminals are suitable for cables with a core diameter from 0.25 to 1.5 mm$^2$.*

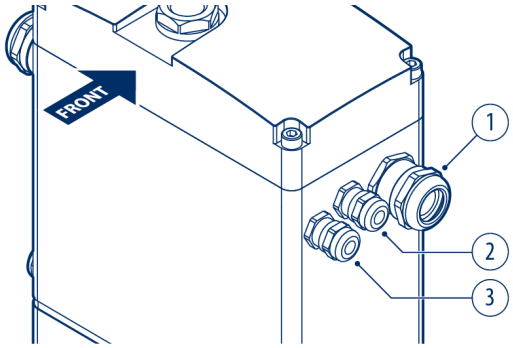
## 3.4.2 Installing glands

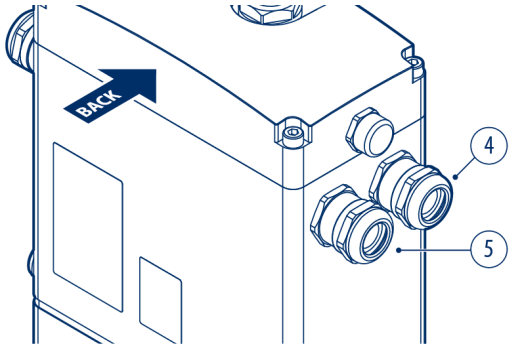
- *To ensure proper shielding, connect the cable shielding with the glands before re-installing them to the instrument housing.*
- *For instruments with plastic cable glands, use the supplied clamps to connect the shielding to the metal base plate of the wiring terminal box.*

All glands in the instrument must be used to ensure the IP rating (ingress protection) of the product.
1. Replace unused glands with blind plugs.
2. Close remaining openings in the housing with blind plugs.

**If the product is supplied without glands:**
1. Take the designated use into account when choosing the relevant parts.
2. Mount the glands and blind plugs according to the manufacturer's instructions.

The following glands are specified:




1. Main: M20 - cable diameter Ø 7…12 mm
2. Actuator: M12 - cable diameter Ø 3…6.5 mm
3. Valve: M12 - cable diameter Ø 3…6.5 mm
4. Fieldbus: M20 - cable diameter Ø 7…12 mm
5. Fieldbus: M20 - cable diameter Ø 7…12 mm

After the cable has been routed through the gland:
- Make the electrical connections according to the applicable hook-up diagrams
- Use suitable cables with respect to required supply current, voltage loss, cable and gland diameters and operating conditions.
- Refer to the supplied instructions manual of the gland manufacturer for tightening instructions.

# 4 Operation

After correct installation and taking all necessary safety precautions, the MI-series MKII can be used to measure and/or control flow.

## 4.1 Powering up

*After cleaning at high temperature, allow the instrument to return to ambient temperature before turning it on.*

*To maintain control of the fluid system and ensure a safe situation, it is recommended to turn on power before applying fluid pressure and to switch off power only after the fluid system is depressurized.*

*When pressurizing, prevent pressure shocks by gradually bringing the fluid system to the required operating pressure.*

*For best performance, allow the product 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 powering up, the instrument needs a couple of seconds to start up the electronics and perform a self-test. After successful initialization, the green LED will glow continuously to indicate that the instrument is ready to use.
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.

## 4.2 First use

- *Despite the fact that everything necessary has been done to ensure the cleanliness of the product upon delivery, the presence of some remaining contamination cannot be ruled out completely.*
- *In order to prevent undesired reactions, purging the MI-series MKII for a minimum of 30 minutes with a dry, inert gas (like Nitrogen or Argon) is recommended before first use. In systems for use with corrosive or reactive media, this is even imperative.*
- *During the manufacturing process, the instrument has been tested with water. Purging prior to first use is also recommended to remove any remaining water droplets.*

*The very first time the instrument is used, adjusting the zero point is recommended. See Adjusting zero point for background information and instructions.*

## 4.3 Preventing slug flow

*Reliable measurement results can only be obtained if the fluid flows through the instrument in a single state (either gas or liquid). The following measures can help prevent so called 'slug flow' (two-phase flow):*

*Before starting measurement and control:*
- *for liquid applications, remove (dissolved) gas from the system, by flushing the instrument and all fluid lines with the process fluid at a high flow rate.*
- *for gas applications, remove condensation from the system, by purging the instrument and all fluid lines with a dry gas at a high flow rate.*

*During measurement and control:*
- *prevent external heating or cooling (can cause gas bubbles in liquid or condensation of gas).*
- *prevent extreme pressure fluctuations (can cause cavitation in liquid or condensation of gas).*

## 4.4 After use

- *Depending on the properties of the process medium and the (expected) time until the next use, it is advisable to flush the fluid system with a suitable (cleaning) fluid after use.*
- *If the equipment has been used to process corrosive, reactive or hazardous media (e.g. toxic or flammable), cleaning the fluid system is imperative before it is exposed to air.*
- *If the equipment is not used for an extended period, the fluid system should be dry after use and after cleaning. If it is not dry, it should be purged with a dry, inert gas for a minimum period of 30 minutes.*

## 4.5 Powering down

- *Prior to powering down the MI-series MKII, the fluid system should be depressurized.*
- *When depressurizing, prevent sudden pressure changes, by shutting off the fluid supply gradually.*

## 4.6 Valve Safe State

The mini CORI-FLOW™ MI-series MKII can operate an external control valve, using the analog actuator output signal.

When a controlling instrument is not powered or cannot communicate with the fieldbus network (if applicable), all electrical valves operated by the instrument (whether integrated or external) automatically assume their default state. The default state is closed for 'normally closed' valves (n/c) and fully open for 'normally open' valves (n/o).

Check the serial number label or the technical specifications to see which valve function is used on your instrument (if applicable).

## 4.7 Temperature considerations

Although the mini CORI-FLOW™ MI-series MKII has excellent temperature stability, the best accuracy is achieved when temperature gradients within and across the instrument are prevented. Observe the following attention points:

- Keep the media temperature as close as possible to the ambient temperature, and above the dew point of the ambient air.
- To prevent simultaneous heating and cooling of different parts of the instrument, make sure the ambient temperature is as stable and evenly distributed across the environment as possible.
- Prevent temperature shocks; heating or cooling should amount to no more than 1 °C per second.
- The MI-series MKII will show an amount of self heating, due to power dissipation of the electronics. Depending on media and ambient temperature, this effect can be as large as 10 °C. In practice, there will be a balance between media temperature, self heating and ambient temperature.
- Operation in a cool environment can compensate somewhat for the effect of high media temperature.
- Heating and cooling effects also depend on the cooling/heat conductivity of the construction on which the instrument is mounted.

- *In normal operation mode, the fluid temperature should stay between -20 °C and 70 °C.*
- *The media temperature can be monitored with digital parameter Temperature.*

### 4.7.1 Preventing condensation

In a moist environment, water condensate may precipitate on the measuring tube if the media temperature is significantly lower than the ambient temperature. Condensed water increases the tube's mass, causing a density measurement error, and can have a negative impact on the mass flow measurement accuracy.

*Continuous purging of the housing interior with a dry, inert gas like Nitrogen can help prevent condensation. Contact your Bronkhorst representative for setting up an optimal purging configuration.*

### 4.7.2 Cleaning temperature

- *With cleaning fluid temperatures above 70 °C, the instrument must be powered off during the cleaning cycle.*
- *After cleaning at high temperature, allow the instrument to return to ambient temperature before turning it on.*

The product may be cleaned with high temperature fluids. Observe the following temperature range and maximum cleaning duration:

- -20 °C ... 120 °C, for a maximum of 30 minutes.

## 4.8 Communication interface

The following table lists the communication interfaces the MI-series MKII can be equipped with (ex factory):

| Connector/terminal | Type | Communication standard | Fieldbus/protocol |
|---|---|---|---|
| Main | Analog | 0…5Vdc<br>0…10Vdc<br>0…20mA<br>4…20mA | n/a |
| | Digital | RS-232 | ProPar |
| | | RS-485 | FLOW-BUS<br>Modbus (RTU/ASCII) |
| | | HART | HART |
| Fieldbus | Digital | RS-485 | FLOW-BUS<br>Modbus (RTU/ASCII)<br>PROFIBUS DP |
| | | CAN | CANopen<br>DeviceNet® |
| | | Ethernet | PROFINET<br>EtherCAT®<br>EtherNet/IP<br>Modbus TCP<br>POWERLINK<br>PROFINET |

*Which communication interface(s) the instrument is equipped with, is specified at ordering time:*
- *In analog mode, the instrument is set to the specified voltage/current range.*
- *The fieldbus connection only provides the specified fieldbus interface (if ordered).*
- *A digital interface on the main terminal is optional.*

**Simultaneous analog and digital operation**

- *The instrument can be monitored and operated through the analog and a digital interface simultaneously, but it only accepts a setpoint from either one. The active setpoint source is selected with digital parameter Control Mode.*
- *Digital parameters Measure and Setpoint are equivalent with the analog output and input signals.*

### 4.8.1 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%.

### 4.8.2 Digital operation

Digital operation (RS-232 or fieldbus) adds extra features to the instrument, such as:

- Direct reading with a readout/control module or host computer
- Diagnostics
- Multi-range functionality
- Device identification
- Secondary measurement outputs: density and temperature readout
- Adjustable minimum and maximum alarm limits (Alarms)
- (Batch) counter (Counter)
- No limitations on setpoint values below 2%

#### 4.8.2.1 RS-232 operation

*RS-232 operation with the instrument is always possible through the micro USB service port near the wiring terminals (see Hardware interface), even if the instrument is configured for RS-485 operation. Connecting the service port with a standard micro USB to USB2.0 adapter cable to a Windows computer enables operation with the FlowWare software tools.*

Digital Bronkhorst® instruments can be monitored and operated using the free **FlowWare** software tools for Windows. These tools provide a graphical interface to the ProPar protocol (used by FLOW-BUS), for monitoring and editing parameter values.

The FlowWare toolkit provides functionality for monitoring and operating digital instruments (Bronkhorst FlowSuite, FlowPlot) and selection of the active fluid and configuration of the fieldbus connection (if applicable). For instruments that support the definition and use of multiple fluids, FlowTune™ can be used to define and store fluids in the instrument and select the active fluid.

Digital instrument parameters are made accessible by **FlowDDE**, a Dynamic Data Exchange server (DDE) that handles communication between the instrument and (dedicated) client software in Windows (e.g. FlowPlot). FlowDDE can also be used by other client applications, such as Microsoft Office or custom made software, built with third party development software like LabVIEW or a SCADA platform.

*The FlowWare tools and associated documentation can be downloaded from the product pages on the Bronkhorst website: **www.bronkhorst.com/products***

*For more information about communication through the RS-232 interface, consult the **RS-232 manual** (document no. 9.17.027).*

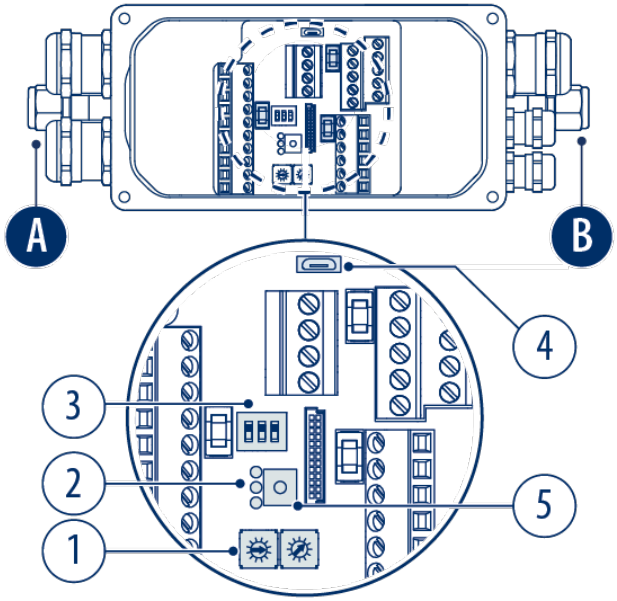
#### 4.8.2.2 Fieldbus operation

*Not all parameters described in this document are necessarily available for all digital communication protocols. For information about parameter access and availability for Bronkhorst® instruments in a network with a specific communication protocol, consult the manual for the according protocol.*

## 4.9 Hardware interface

- *The instrument cover may only be opened in a clean, dry and non-hazardous environment.*
- *Before opening the cover, make sure that the operating environment is perfectly safe and that the electrical components cannot be affected by moisture or aggressive atmospheric components.*
- *Ensure that no particles, objects, etc. can fall into the instrument when the cover is open.*

The wiring terminal PCB under the instrument cover provides several hardware controls. Depending on the installed digital interface type, the following controls are available:




| No. | Control | Function | No fieldbus | CANopen DeviceNet® FLOW-BUS Modbus (ASCII/RTU) | EtherCAT® Ethernet/IP Modbus TCP POWERLINK PROFINET | PROFIBUS DP |
|---|---|---|---|---|---|---|
| 1. | Rotary switches | Node address selection | | ✓ | | ✓ |
| 2. | Indication LEDs | Visual indications | ✓ | ✓ | ✓ | ✓ |
| 3. | Bus termination switch | Bus termination | | ✓ | | ✓ |
| 4. | Service port (micro USB) | RS-232 communication | ✓ | ✓ | ✓ | ✓ |
| 5. | Multifunctional switch | Starting functions | ✓ | ✓ | ✓ | ✓ |
| A. | Fluid inlet | | | | | |
| B. | Fluid outlet | | | | | |

### 4.9.1 LED indications

The 3 LED indications on the wiring terminal box are visible through the sight glass in the top cover:

| Position | Color | Function |
|---|---|---|
| Top | ● / ● (bi-color; green/red) | interface status* |
| Middle | ● (green) | operational mode (Mode/MOD/RUN)** |
| bottom | ● (red) | error/warning messages (Error/Err/NET)** |

*) The *Interface status* LED is only used by (Ethernet based) interface types EtherCAT®, POWERLINK and PROFINET.
**) Different interface types use specific names for the different indicator LEDs (indicated between brackets, also see the specific fieldbus manual).

The tables below list the different LED indications:

| ● Mode | | |
|---|---|---|
| **Pattern** | **Time** | **Indication** |
| off | continuous | Power-off or program not running |
| on | continuous | Normal operation mode |
| short flash | 0.1 sec on,<br>2 sec off | No bus communication, valves are in safe state |
| blink | 0.2 sec on,<br>0.2 sec off | Special function mode; the instrument is busy performing a special function (e.g. autozero or self-test) |
| long flash | 2 sec on,<br>0.1 sec off | Configuration mode; the baud rate and bus type for the Main terminal are set to 38400 and RS-232 FLOW-BUS (ProPar) respectively |

| ● Error | | |
|---|---|---|
| **Pattern** | **Time** | **Indication** |
| on | continuous | Liquid application: measuring error (no liquid in measuring tube); flush instrument to remove gas<br>**OR** Critical error; the instrument needs servicing before it can be used |
| short flash | 0.1 sec on,<br>2 sec off | **FLOW-BUS** Node occupied: re-install instrument<br>**PROFIBUS DP** No data exchange between master and slave (automatic recovery)<br>**Modbus** Data is being received or transmitted<br>**EtherCAT®** Instrument is not in OP mode<br>**PROFINET** No application relation established |
| blink | 0.2 sec on,<br>0.2 sec off | **FLOW-BUS** Waiting for communication, check communication settings of all FLOW-BUS devices in the fieldbus setup. Usually the 'last node address' setting of one of the devices is incorrect. |
| long flash | 2 sec on,<br>0.1 sec off | **PROFIBUS DP** Requested parameter not available<br>**EtherCAT®** Configuration error<br>**PROFINET** Configuration error (e.g. a requested parameter is not available) |

| ● Mode and ● Error (alternating) | | |
|---|---|---|
| **Pattern** | **Time** | **Indication** |
| slow wink | 1 sec on,<br>1 sec off | Alarm indication; minimum/maximum alarm, power-up alarm, limit reached or batch size reached |
| normal wink | 0.2 sec on,<br>0.2 sec off | Wink mode; by sending a command to the *Wink* parameter, the instrument flashes its LEDs to indicate its position in a (large) system. |
| fast wink | 0.1 sec on,<br>0.1 sec off | Selected action started (after releasing the multifunctional switch) |

### 4.9.2 Multifunctional switch

Several instrument functions can be started manually using the multifunctional switch on the wiring terminal PCB. These functions are available in analog as well as in digital operation mode.

#### 4.9.2.1 Normal operating functions

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

| LED pattern | Time | Function |
|---|---|---|
| ● ● | 0…1 sec | No action |
| ● ● | 1…4 sec | 1. In case of a min/max alarm: reset alarm<br>2. FLOW-BUS: Auto-install to bus - lets instrument obtain free node address<br>Note: min/max alarm (if any) has to be reset before auto install can be performed. |
| ● ● | 4…8 sec | Reset instrument; clear all warnings and error messages and restart the instrument |
| ● ● | 8…12 sec | Auto-zero; re-adjust the zero-point of the instrument (flow meter/controller only) |
| ● ● | 12…16 sec | Enable FLASH mode for firmware update:<br>• the instrument shuts down and both LEDs are switched off<br>• 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.*
- *Do not adjust the zero point before having taken notice of the instructions.*

#### 4.9.2.2 Power-up functions

- In order to access these functions, press and hold the switch while powering up the instrument.
- The available functions are presented in a repeating sequence of patterns, where each pattern indicates a function.
- Indications in this sequence are flashing (0.2 sec on, 0.2 sec off).
- To start a function, release the switch when the LEDs show the pattern of the required function.

| ● (green) | ● (red) | Time | Function |
|---|---|---|---|
| off | off | 0…4 sec | No action |
| off | on | 4…8 sec | Restore factory settings (except communication settings) |
| on | off | 8…12 sec | FLOW-BUS only: Auto install to bus; let the instrument obtain a free node address from the FLOW-BUS system |
| on | on | 12…16 sec | Activate configuration mode<br>• The Main terminal is set to RS-232 communication (ProPar) at baud rate 38400<br>• In configuration mode, the green LED blinks 2 seconds on and 0.1 second off<br>• Configuration mode remains active after powering down and can be deactivated by selecting this function again at the next start-up |

#### 4.9.2.3 Control mode - readout/change

**Reading control mode**

- By briefly pressing the switch 2 times within 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 | LED 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 | LED 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.

*This procedure also sets the default control mode of the instrument.*

#### 4.9.2.4 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 | LED pattern | | Indication |
|---|---|---|---|
| 1 | Green | ● ○ | number of flashes indicates the tens of the node address |
| 2 | Red | ○ ● | number of flashes indicates the units of the node address |
| 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 (ASCII/RTU) | PROFIBUS DP | CANopen | DeviceNet® | Ethernet based |
| 0 | | | automatically detected | | | |
| 1 | 187500 | 9600 | 9600 | 1000000 | 125000 | 100000000 |
| 2 | 400000 | 19200 | 19200 | 800000 | 250000 | |
| 3 | | 38400 | 45450 | 500000 | 500000 | |
| 4 | | 56000 | 93750 | 250000 | | |
| 5 | | 57600 | 187500 | 125000 | | |
| 6 | | 115200 | 500000 | 50000 | | |
| 7 | | 128000 | 1500000 | 20000 | | |
| 8 | | 256000 | 3000000 | 10000 | | |
| 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, 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 | LED pattern | | Maximum flash count | Action |
|---|---|---|---|---|
| 1 | Green |  | 12 | set tens of node address |
| 2 | Red |  | 9 | set units of node address |
| 3 | Green and red (simultaneous) |  | 10* | set baud rate index (number of flashes) |

*) maximum count depends on the supported number of 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.

### 4.9.3 Rotary switches

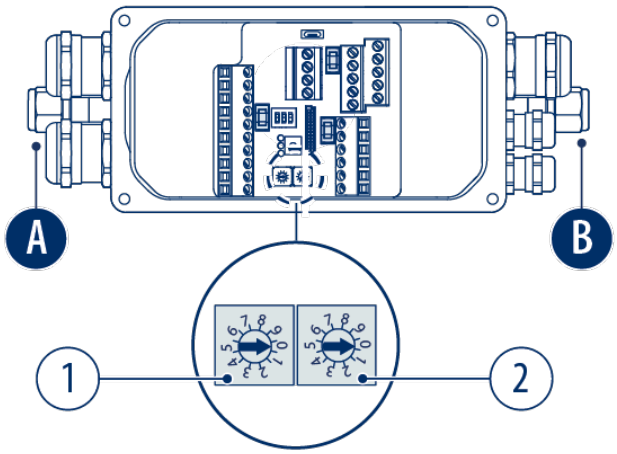
Using the MSD and LSD switches, the main fieldbus address (Fieldbus 1) of the instrument can be selected, in the range from 1 to 99. MSD (Most Significant Digit) sets the tens, LSD (Least Significant Digit) sets the units.

If both switches are set to 0, the node address is selected according to the digital parameter settings (see Network configuration), otherwise the rotary switch setting overrules the digital parameter settings.

The switches can be adjusted using a small flat blade screwdriver.

1. MSD - most significant digit
2. LSD - least significant digit

A. Fluid inlet
B. Fluid outlet

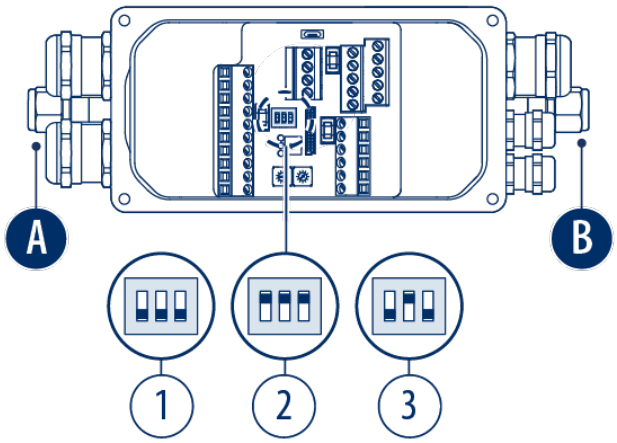



### 4.9.4 Bus termination switches

To minimize signal reflections on the fieldbus network and achieve reliable data transfer over a FLOW-BUS, Modbus or PROFIBUS DP system, the network must be terminated properly. The bus termination DIP switches replace the termination resistors that are used normally for the according fieldbus types. On instruments that are installed at the beginning or at the end of the fieldbus, the DIP switches must be configured accordingly (**up = on, down = off**):

1. Normal (default)
2. Begin terminator
3. End terminator

A. Fluid inlet
B. Fluid outlet




*Consult the applicable fieldbus manual for information about setting up and terminating a FLOW-BUS, Modbus or PROFIBUS DP network.*

### 4.9.5 Service port

The micro USB port provides an alternative way to operate the instrument via RS-232. With a micro USB to USB2.0 adapter cable, the instrument can be connected to a Windows computer. This enables RS-232 operation with the use of the free Bronkhorst® FlowWare software, even if the instrument is already being operated through one of the other interfaces (analog, RS-232 or fieldbus, if applicable).

## 4.10 Adjusting zero point

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 detect a flow when in reality there is none. Readjusting the zero point eliminates this deviation.

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

The following factors can affect the zero-stability error (in order of importance):

- fluid temperature
- ambient temperature
- mounting orientation
- (upstream) pressure
- fluid density
- fluid viscosity
- vibrations from the environment
- pressure fluctuations

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.*

Adjusting the zero point of an instrument can be done by the following methods:

- manually (using the multifunctional switch)
- digitally (via RS-232 or fieldbus)
- with the autozero function of a Bronkhorst® readout and control unit

Once started, the procedure takes approximately 40 seconds to complete (longer if the output signal is unstable), regardless of the preferred method.

### 4.10.1 Digital procedure

*Bronkhorst FlowSuite and FlowPlot provide an easy way to adjust the zero point of an instrument using RS-232 communication; the* Autozero *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 or click on a parameter name to jump directly to its full description):

| Sequence # | Parameter | Value | Action |
|---|---|---|---|
| 1 | *Setpoint* or *fSetpoint* | 0 | stop flow |
| 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 in progress. On completion, the green LED lights up, 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 82 to lock secured parameters.*

*Alternatively, when HART functionality is enabled, the procedure can easily be performed with a single HART command.*

### 4.10.2 Manual procedure

The built-in autozero function of the instrument can be activated with the multifunctional switch (see Hardware interface).
To start the autozero function with the multifunctional switch, follow these instructions:

1. Change the setpoint of the instrument to 0 (zero).
2. Press and hold the multifunctional switch. After 4 seconds, the red LED ● lights up; another 4 seconds later the red LED extinguishes and the green LED ● lights up.
3. At that moment (which is after 8 to 12 seconds), release the switch.

The green LED starts to blink fast, indicating that the autozero procedure is in progress. After (successful) completion, the green LED lights up continuously, while the output signal is 0 % (parameter *Measure* = 0).

# 5 Digital parameters

This section describes the most commonly used parameters for digital operation of the MI-series MKII. Descriptions are grouped by category in tables:

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| [type] | RW 🔑 | [x]…[y] | [DDE par] | [Pro]/[Par] | [address]/[register] |

*In this manual, parameter names are printed in italics (reverted to* normal *where 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 text string |
| String | text string of unspecified length |

**Access**

| | |
|---|---|
| R | Parameter value can be read |
| W | Parameter value can be written |
| 🔑 | Parameter is secured and can only be written if parameter *Init Reset* is set to 'unlocked' first |

**Range**

Some parameters only support values within a certain range:

| | |
|---|---|
| [x] | Minimum value |
| [y] | Maximum value |

**FlowDDE**

Parameter number within FlowDDE

**FLOW-BUS**

FLOW-BUS uses the ProPar protocol, where parameters are identified by a unique combination of a process number and a parameter number.

- *For more information about setting up a FLOW-BUS network with Bronkhorst® instruments, consult the FLOW-BUS manual (see Documentation).*
- *For more information about the ProPar protocol, consult the RS-232 manual (see Documentation).*

**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.

Modbus address blocks are two bytes long. 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.

*For more detailed information about setting up a Modbus network with Bronkhorst® instruments, consult the Modbus manual (see Documentation).*

**Other interface protocols**

Parameter descriptions in this document are based on their availability with FLOW-BUS, Modbus or RS-232 (ProPar) communication. Due to limitations in, for example, memory capacity or communication properties, definition files for other communication protocols usually do not make all parameters available.

*Not all parameters described in this document are necessarily available for all digital communication protocols. For information about parameter access and availability for Bronkhorst® instruments in a network with a specific communication protocol, consult the manual for the according protocol.*

## 5.1 Measurement and control

**Measure**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned int | R | 0…41942 (65535*) | 8 | 1/0 | 0x0020/33 |

This parameter returns a dimensionless representation of the measured flow rate or pressure. The value 32000 corresponds to 100 %, the maximum value corresponds to 131.07 %.

**In case the instrument is prepared for bi-directional measurement, the negative signals with an output range of -73.73…-0.003% are represented by the range of 41943…65535, whereas the positive signals 0…131.07% are still represented by the range of 0…41942. (FlowDDE converts the numbers to negative values automatically).*

**Setpoint**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned int | RW | 0…32000 | 9 | 1/1 | 0x0021/34 |

This parameter is a dimensionless representation of the required flow rate or pressure. Value 32000 corresponds to 100 %.

**Temperature**

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

This parameter returns the temperature in °C on the outside of the sensor tube, which is an approximation of the actual media temperature.

**Density Actual**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | R | 0…3.4E+38 | 270 | 116/15 | 0xF478…0xF479/62584…62585 |

This parameter returns the actual density measured by the instrument in kg/m$^3$. If the selected *Capacity Unit* is a volume flow type, the instrument uses this parameter for conversion of the measured mass flow to the selected unit.

### 5.1.1 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 |

This parameter represents the value of parameter *Measure*, expressed in the selected *Capacity Unit*. Its value is calculated from the dimensionless value of *Measure*, using the fluid set parameters *Capacity 100%* and *Capacity Unit*.

**Fsetpoint**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | RW | 0…3.4E+38 | 206 | 33/3 | 0xA118…0xA119/ 41241…41242 |

This parameter represents the value of parameter *Setpoint*, expressed in the selected *Capacity Unit*. Conversion between *Fsetpoint* and the dimensionless value of *Setpoint* uses fluid set parameters *Capacity 100%* and *Capacity Unit*.

**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.

**Sensor type**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned int | RW | 0…255 | 22 | 1/14 | 0x8170/33127 |

The following sensor types are supported:

| Instrument type | Value | Description |
|---|---|---|
| Controller | 1 | Liquid volume |
| | 2 | Liquid /gas mass |
| | 3 | Gas volume |
| Sensor | 129 | Liquid volume |
| | 130 | Liquid/gas mass |
| | 131 | Gas volume |

## 5.2 Alarms

*Alarm settings are most easily accessible using Bronkhorst FlowSuite, FlowPlot or FlowView 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 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 minor 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 at 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 maximum limit* |
| 4 | 16 | Batch counter alarm | Batch counter reached its limit |
| 5 | 32 | • This bit only: Power-up alarm<br>• If combined with bit 2 or 3: Response alarm | Alarm possibly caused by a power dip<br>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 int | 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. The value is a bitwise summation of the enabled methods; 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 | By hardware switch (if present) |
| 1 | 2 | Externally (obsolete) |
| 2 | 4 | By parameter *Reset* |
| 3 | 8 | Automatically (when alarm conditions no longer apply) |

## 5.3 Counter

- *Counter settings are most easily accessible using Bronkhorst FlowSuite, FlowPlot or FlowView or a Bronkhorst® readout and control unit.*
- *When the instrument is powered down, it remembers the state of the counter. If the counter is active when the instrument is powered down, it continues counting after powering on again.*

**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 | Counting 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 Density (FlowDDE ID 170) is used to calculate Custom volume.*

**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. 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 | By hardware switch (if present) |
| 1 | 2 | Externally (obsolete) |
| 2 | 4 | By parameter *Reset* |
| 3 | 8 | Automatically (e.g. when counter value is reset) |

## 5.4 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 bold):

| Protocol | ProPar (RS-232) | FLOW-BUS | Modbus (RTU/ASCII) | PROFIBUS DP | CANopen | DeviceNet® | HART |
|---|---|---|---|---|---|---|---|
| Bus Address | **3** | **3**…125 | **1**…247 | 0…**126** | 1…**127*** | 0…**63** | 0 |
| Baud Rate | 9600<br>19200<br>**38400**<br>57600<br>115200<br>230400<br>460800 | **187500**<br>400000 | 9600<br>**19200**<br>38400<br>56000<br>57600<br>115200<br>128000<br>256000 | **(autodetect)**<br>9600<br>19200<br>45450<br>93750<br>187500<br>500000<br>1500000<br>3000000<br>6000000<br>12000000 | 10000<br>20000<br>50000<br>125000<br>250000<br>**500000**<br>800000<br>1000000 | **125000**<br>250000<br>500000 | **1200** |
| Bus Parity | **0** | **0** | 0, 1, **2** | **2** | **0** | **0** | **1** |

*) Supported range for digital parameter; when using rotary switches to set the bus address, range is limited to 0…79.

Network configuration for Ethernet based fieldbus protocols is done automatically.

**Fieldbus Interface Index**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned char | RW | 0…4 | 378 | 125/7 | 0x0FA7/4008 |

This parameter indicates the communication interface to which *Fieldbus 1 Address*, *Fieldbus 1 Baud Rate* and *Fieldbus 1 Parity* apply (see further). Each specific interface has its own index and corresponding network parameter values:

| Value | Description |
|---|---|
| 0 | Fieldbus (fieldbus terminal B/C) |
| 1 | Fieldbus (main terminal M) |
| 2 | Display |
| 3 | Service port |
| 4 | HART |

**Fieldbus1 Address**

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

**Fieldbus1 Baud Rate**

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

**Fieldbus1 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 |

## 5.5 Fluid set

**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 selected fluid.

**Capacity 100%**

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

- This parameter represents the 100 % readout/control value (span), expressed in the *Capacity Unit* of the selected fluid.
- *Capacity 100%* is scaled when *Inlet Pressure*, *Fluid Temperature* or *Fluid Name* is changed for the selected fluid.

**Capacity Unit**

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

This parameter represents the unit in which *Capacity 100%* is expressed.
Available units:

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

*Because of the maximum string length (7 characters), some unit names are abbreviated, for instance mm3n/m means $mm^3n/min$.*

**Capacity Unit Type Temperature**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | RW | -273.15…<br>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*.

## 5.5.1 Advanced fluid set parameters

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

**Inlet Pressure**

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

Upstream pressure of the selected 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 |

Downstream pressure of the selected 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 selected fluid in °C.

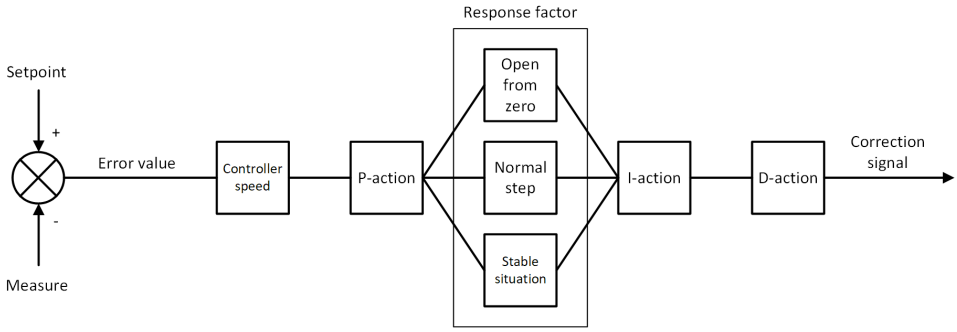
**Density**

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

Density of the selected fluid in $kg/m^3$

## 5.6 Controller

The picture below is a simplified visualization of the PID controller algorithm (proportional, integral, derivative) used by digital Bronkhorst® instruments.




The controller speed controls the overall performance of the controller algorithm. Basically, to adjust the controller response, only the controller speed needs to be changed.

The algorithm is based upon the difference between the setpoint and the measured value (called the error value). The correction signal to eliminate the error is assembled from 3 components (giving the algorithm its name):

- The P-action (proportional) multiplies the error value by a constant factor, to adjust the measure towards the (new) setpoint.
- The I-action (integral) amplifies the correction signal with a factor depending on the integral of the error value over time.
- The D-action (derivative) reduces the strength of the P-action, to prevent overshoot when the (new) setpoint is reached.

The proportional action is enhanced by one of three additional response factors, depending on the control cycle stage:

- Open from zero: the setpoint is larger than zero and the measured value is below 2% of the full scale range.
- Normal step: the measured value differs more than 2% from the setpoint, typically after changing the setpoint (step).
- Stable situation: the measured value differs less than 2% from the setpoint.

*For more information about controlling characteristics, consult the **Instruction manual FlowPlot** (document no. 9.17.030).*

*Control characteristics are optimized during production and should only be changed by or under the supervision of trained service personnel.*

**Controller Speed**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | RW | 0.2…5 | 254 | 114/30 | 0xF2F0…0xF2F1/62193…62194 |

This parameter sets the overall controller speed factor for the selected fluid. *Controller speed* is set ex factory between value '0.5' (slow) and '2' (fast). The default value is '1'.

**PID-Kp**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | RW | 0…1E+10 | 167 | 114/21 | 0xF2A8…0xF2A9/62121…62122 |

PID controller proportional action, multiplication factor.

**PID-Ti**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | RW | 0…1E+10 | 168 | 114/22 | 0xF2B0…0xF2B1/62129…62130 |

PID controller integral action in seconds.

**PID-Td**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | RW | 0…1E+10 | 169 | 114/23 | 0xF2B8…0xF2B9/62137…62138 |

PID controller derivative action in seconds. The default value is 0.0.

**Open From Zero Response**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned char | RW | 0…255 | 165 | 114/18 | 0x0E52/3667 |

Response factor, applied to proportional action when opening the valve from 0%.
- Default value: 128 (no correction)
- Other values adjust the controller gain (correction signal) as follows: Controller gain = *Controller Speed* * *PID-Kp* * $1.05^{(\text{response factor - 128})}$

**Normal Step Response**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned char | RW | 0…255 | 72 | 114/5 | 0x0E45/3654 |

Response factor, applied to proportional action during normal control (at setpoint step).
- Default value: 128 (no correction)
- Other values adjust the controller gain (correction signal) as follows: Controller gain = *Controller Speed* * *PID-Kp* * $1.05^{(\text{response factor - 128})}$

**Stable Situation Response**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned char | RW | 0…255 | 141 | 114/17 | 0x0E51/3666 |

Stable situation response, applied when the controller is stable (within a 2% band around the setpoint).
- Default value: 128 (no correction)
- Other values adjust the controller gain (correction signal) as follows: Controller gain = *Controller Speed* * *PID-Kp* * $1.05^{(\text{response factor - 128})}$

## 5.7 Master/slave configuration (FLOW-BUS)

Normally, there is no communication between the 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 in a FLOW-BUS network is automatically available to all other instruments without extra wiring. A slave instrument can also be a master to other instruments.

To set up a master/slave relationship between instruments, set parameter *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.

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

*To prevent damage to the instruments an/or the system(s) they are connected to, be sure to avoid circular references between devices on the same fieldbus. The FLOW-BUS system has no protection mechanism to prevent circular references.*

**Master Node**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned char | RW | 1…128 | 158 | 33/14 | n/a |

Sets the master node for the instrument.
Note that this parameter is only effective in a FLOW-BUS network (RS-485).

**Slave Factor**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Float | 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, *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 %

## 5.8 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.

## 5.9 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 |

Sending any text 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 device in a large network.

*) Modbus only supports value 14592

**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 modes are available:

| Value | List option | Description | Setpoint source |
|---|---|---|---|
| 0 | Bus/RS232 | Normal digital operation | Fieldbus or RS-232 |
| 1 | Analog input | Normal analog operation | Analog input |
| 2 | FLOW-BUS slave | Acting as slave instrument on FLOW-BUS | FLOW-BUS master |
| 3 | Valve close | Controller disabled, valve closed | |
| 4 | Controller idle | Controller disabled, valve frozen in current position | |
| 7 | Setpoint 100% | Setpoint fixed at 100 % | |
| 8 | Valve fully open | Controller disabled, valve fully open | |
| 9 | Calibration mode | Calibration mode enabled | |
| 10 | Analog slave | Acting as slave of other instrument in analog mode | Analog input |
| 12 | Setpoint 0% | Setpoint fixed at 0% | |
| 13 | FLOW-BUS analog slave | Acting as slave of other instrument on FLOW-BUS, slave factor set by analog input signal | Analog input |
| 18 | RS232 | Controlling, default state disabled | Fieldbus or RS-232 |
| 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 | Instrument in default state | |

- Default value: 0 or 1 (as ordered).
- If *Control Mode* is changed to value 0, 1, 9 or 18, the instrument returns to the default value at the next power-up or reset. Other values are persistent.
- *Control Mode* 18 prevents the instrument from assuming its default state in the event of a digital communication failure.
- The column labeled *List option* shows the control modes as used in Bronkhorst® software. Not all options might be supported by your specific instrument.

**Calibration Mode**

| Type | Access | Range | FlowDDE | ProPar | Modbus |
|---|---|---|---|---|---|
| Unsigned char | RW | 0, 9, 255 | 58 | 1/4 | 0x0E61/3682 |

After enabling calibration mode by means of parameter *Control Mode*, this parameter is used to start the autozero function of the flow sensor. The following modes are supported:

| Value | Description |
|---|---|
| 0 | Idle (no action) |
| 9 | Start zeroing |
| 255 | Error (result of previous calibration mode) |

### 5.9.1 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. *To apply the new default control mode, reset or restart the instrument.*

# 6 Troubleshooting and service

- Electronic problems can be traced by restarting the product and/or the master application.
- If the equipment starts up normally, the measurement and control behavior can be checked by applying fluid pressure.
- To track down problems in the fluid system, depressurize the fluid system and disconnect the suspected unit from the process line. Dirt or clogging might be quickly detected by visual inspection of disassembled fluid connections.

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

## 6.1 Errors and warnings

*See LED indications for an explanation of all possible LED indications.*

*In case of problems during operation, error and warning information can be found in FlowDDE and FlowPlot. FlowDDE puts all errors and warnings on the console screen; FlowPlot provides several alarm and counter indicators. See also section Digital operation.*

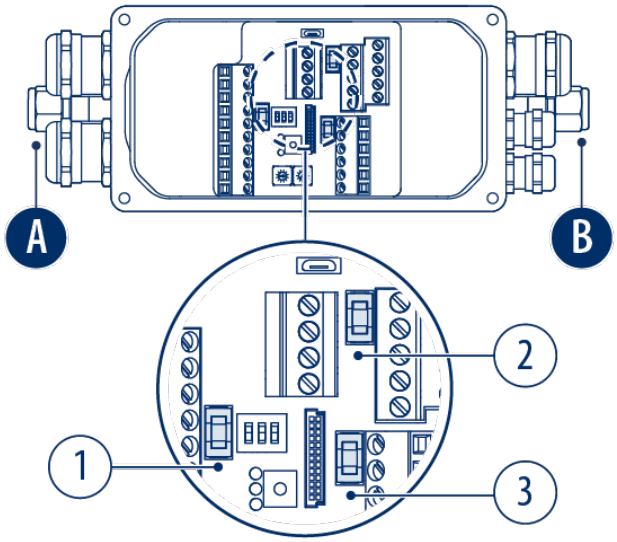
## 6.2 Replacing fuses

*Fuses may only be replaced by qualified service personnel.*

The fuses are located under the top cover and protect the following wiring terminals (see the applicable hook-up diagram for wiring details):

1. Fieldbus (if applicable)
2. Main
3. Actuator

A. Fluid inlet
B. Fluid outlet




When replacing fuses, observe the following:

1. Determine and solve the cause of the blow.
2. Switch off the equipment and disconnect it from the electrical power source.
3. Open the top cover by removing the bolts (see Accessing wiring terminals for details).
4. Locate the defective fuse.
5. Replace the fuse with the same type (Littelfuse NANO2® Slo-Blo 2A; no 0454002).

If you are unsure about the suitability of a replacement fuse or if replacement fuses keep blowing, contact your Bronkhorst representative for support.

## 6.3 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. This can be done with the following methods:

- via RS-232 communication, with the *Restore settings* function in FlowPlot
- with the multifunctional switch (see Multifunctional switch)
- with the *restore* function of a Bronkhorst® readout and control unit E-8000

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

### 6.3.1 Manual procedure

- *The instrument cover may only be opened in a clean, dry and non-hazardous environment.*
- *Before opening the cover, make sure that the operating environment is perfectly safe and that the electrical components cannot be affected by moisture or aggressive atmospheric components.*
- *Ensure that no particles, objects, etc. can fall into the instrument when the cover is open.*

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.

## 6.4 Common issues

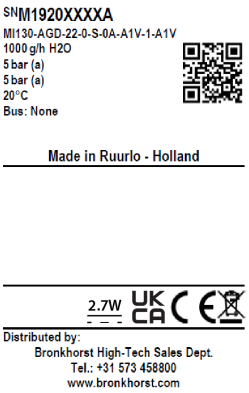
| Symptom | Possible cause | Action |
|---|---|---|
| No communication between instruments and readout/control unit | No power supply | • Check power supply<br>• Check cable connection<br>• Check cable hook-up |
| | Fuse blown | Replace fuse |
| | Sensor failure | Return equipment to factory |
| Red LED glows continuously | Slug flow (combined gas and liquid flow) | Make sure the measuring tube only contains either gas or liquid (see First use) |
| | Hardware error | Return equipment to factory |
| No (fieldbus) communication | No power supply | • Check power supply<br>• Check cable connection<br>• Check cable hook-up |
| | Fuse blown | Replace fuse |
| | 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<br>• Check cable connection<br>• Check cable hook-up |
| | Fuse blown | Replace fuse |
| | Inlet pressure or differential pressure too low | Increase inlet pressure |
| | Piping, filters and/or control valve clogged or blocked | • Clean system (flush with clean, dry air or a non-aggressive cleaning liquid (e.g. ethanol or isopropyl alcohol) |

| Symptom | Possible cause | Action |
|---|---|---|
| | | • 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 |
| • Control behavior unstable<br>• Red LED flashes irregularly | Measurement disturbed by vibrations | • If possible, avoid installation in close proximity of mechanical vibration<br>• Reduce sensitivity to vibrations by using a mass block, shock absorbers, and flexible tubing |
| | Inlet pressure unstable | Eliminate pressure fluctuations, e.g. by installing a pressure regulator |
| | Gas accumulation in tubing | Flush the system to remove gas<br>Tip: use frequency or density signal to detect presence of gas bubbles |
| | Wrong controller settings | Adjust settings (e.g. with FlowPlot) |
| | Control valve damaged | Return equipment to factory |
| No flow (sending a setpoint has no effect) | No fluid supply | Check upstream components for obstruction, e.g.:<br>• fluid lines<br>• valves<br>• filters |
| | Inlet pressure or differential pressure out of bounds | Set inlet pressure to a value within specifications |
| Measured value rises, but never reaches setpoint | Piping, filters and/or control valve clogged or blocked | • Clean system (flush with clean, dry air or a non-aggressive cleaning liquid (e.g. ethanol or isopropyl alcohol)<br>• 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<br>• Pressure signal gradually decreasing without setpoint change | Inlet pressure or differential pressure too low | • Increase inlet pressure<br>• Use instrument in conditions it was designed for |
| | Process gas condensation | Decrease inlet pressure or increase gas temperature |
| | Piping or filters blocked or contaminated | Clean system |
| | Sensor blocked or contaminated | Clean sensor |
| | Valve blocked or contaminated | Clean valve |
| | 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 should be none | Mounting orientation and/or ambient conditions changed significantly | • Use instrument in conditions it was designed for<br>• Adjust zero point (see Adjusting zero point) |

| Symptom | Possible cause | Action |
|---|---|---|
| | 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<br>• Check if valve is in safe state (normally open valves); remove cause if necessary (see Valve Safe State) |
| | Sensor failure | Return equipment to factory |

## 6.5 Service

If you have a question about a product or if you find the product does not meet the specifications as ordered, do not hesitate to contact your Bronkhorst representative. To enable us to help you quickly and effectively, make sure to have the serial number (SN) ready whenever seeking contact with your Bronkhorst representative about a specific item.




For current information about Bronkhorst® and worldwide 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@bronkhorst.com**

For after-sales questions, help and guidance, our Customer Care department is available by e-mail:

**aftersales@bronkhorst.com**

No matter the time zone, our experts within the Customer Care department are available to answer your request immediately or take appropriate further action. Our experts can be reached at:

**+31 859 02 18 66**

Bronkhorst High-Tech B.V.
Nijverheidsstraat 1A
NL-7261 AK Ruurlo
The Netherlands

# 7 Returns

## 7.1 Removal and return instructions

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).

- Visit the Bronkhorst website.
- Go to the *Service & Support* section.
- Follow the on-screen instructions to return the product.

## 7.2 Disposal (end of lifetime) (2)

If you are a customer within the European Union and wish to dispose of Bronkhorst® equipment bearing the symbol of a crossed out waste disposal bin, you can return it in accordance with the removal and return instructions. Bronkhorst will then take care of proper dismantling, recycling and/or reuse (wherever possible). In the covering letter, mention that you are returning the product for disposal.

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

# Parameter index

## Parameters

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Bronkhorst®

Bronkhorst High-Tech B.V.
Nijverheidsstraat 1a
NL-7261 AK Ruurlo, The Netherlands

+31 573 45 88 00
info@bronkhorst.com
www.bronkhorst.com