Instruction manual

IQ+FLOW® series
Digital Mass Flow / Pressure Controllers for gases

Doc. no.: 9.17.045L Date: 07-01-2013

ATTENTION:
Please read this instruction manual carefully before installing and operating the instrument.
Not following the guidelines could result in personal injury and/or damage to the equipment.

Bronkhorst®
HIGH-TECH

Disclaimer

Even though care has been taken in the preparation and publication of the contents of this manual, we do not assume legal or other liability for any inaccuracy, mistake, mis-statement or any other error of whatsoever nature contained herein. The material in this manual is for information purposes only, and is subject to change without notice.

Bronkhorst High-Tech B.V.
January 2013

Symbols

Important information. Discarding this information could cause injuries to people or damage to the Instrument or installation.

Helpful information. This information will facilitate the use of this instrument.

Additional info available on the internet or from your local sales representative.

Receipt of equipment

Check the outside packing box for damage incurred during shipment. Should the packing box be damaged, then the local carrier must be notified at once regarding his liability, if so required. At the same time a report should be submitted to your distributor.

Carefully remove the equipment from the packing box. Verify that the equipment was not damaged during shipment. Should the equipment be damaged, then the local carrier must be notified at once regarding his liability, if so required. At the same time a report should be submitted to your distributor.

Before installing an IQ+FLOW® instrument it is important to read the attached labels and check:
- Instrument type
- Flow rate
- Fluid to be measured/controlled
- Up- and downstream pressure
- Input and output signal
- Temperature

Do not discard spare or replacement parts with the packing material and inspect the contents for damaged or missing parts.

Refer to chapter 6 about return shipment procedures.

Equipment storage

The equipment should be stored in its original packing in a cupboard warehouse or similar. Care should be taken not to subject the equipment to excessive temperatures or humidity.

Warranty

The products of Bronkhorst High-Tech B.V. are warranteed against defects in material and workmanship for a period of three years from the date of shipment, provided they are used in accordance with the ordering specifications and the instructions in this manual and that they are not subjected to abuse, physical damage or contamination. Products that do not operate properly during this period may be repaired or replaced at no charge. Repairs are normally warranteed for one year or the balance of the original warranty, whichever is the longer.

See also paragraph 9 of the Conditions of sales:
http://www.bronkhorst.com/files/corporate_headquarters/sales_conditions/en_general_terms_of_sales.pdf

The warranty includes all initial and latent defects, random failures, and undeterminable internal causes.

It excludes failures and damage caused by the customer, such as contamination, improper electrical hookup, physical shock etc.

Re-conditioning of products primarily returned for warranty service that is partly or wholly judged non-warranty may be charged for.

Bronkhorst High-Tech B.V. prepays outgoing freight charges when any party of the service is performed under warranty, unless otherwise agreed upon beforehand. However, if the product has been returned collect to Bronkhorst High-Tech B.V., these costs are added to the repair invoice. Import and/or export charges, foreign shipping methods/carriers are paid for by the customer.

Table of Contents

1. Scope of this manual

1.1 Introduction

This manual covers the IQ+FLOW® series mass flow/pressure meters/controllers for gases. Examples of the instrument series are shown in the pictures below. This manual includes product information, installation instructions, operation, maintainance and troubleshouting.

IQ+FLOW® digital mass flow/pressure meters and controllers for gases are one of the smallest chip based instruments of its kind. IQ+FLOW® mass flow meters/controllers can be applied for measuring and fast control of gas flows up to 5000 ml_n/min, for applications with pressure conditions up to 10 bar (145 psi) and temperatures between 5 to 50 °C (41 to 122 °F). IQ+FLOW® pressure meters/controllers can be applied for pressure ranges from 0,01…0,5 bar up to 0,2…10 bar. The instruments can either be operated in analog or digital mode (RS232 or RS485).

1.2 References to other applicable documents

Instructions:

- IQ+FLOW® Quick Installation Guide (document nr. 9.17.074)
- Operation instructions digital instruments (document nr. 9.17.023)
- RS232 interface with FLOW-BUS for digital instruments (document nr. 9.17.027)
- Modbus slave interface for digital Mass Flow / Pressure instruments (document nr. 9.17.035)

Technical drawings :

- Hook-up diagram IQ+FLOW® RS232/RS485 + Analog I/O (document nr. 9.16.101)
- Hook-up diagram IQ+FLOW® Manifold (multi-channel) (document nr. 9.16.090)
- Dimensional drawing IQF/IQP (document nr. 7.05.545)
- Dimensional drawing IQFD/IQPD (document nr. 7.05.656)
- Dimensional drawing IQM (document nr. 7.05.760)

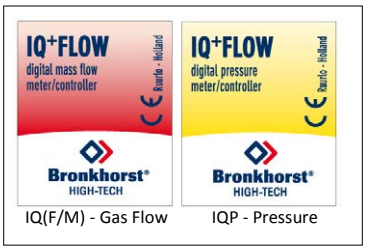
These documents are available on: *http://www.bronkhorst.com/en/downloads*
or can be applied for at our local sales & service representatives

2. Starting up

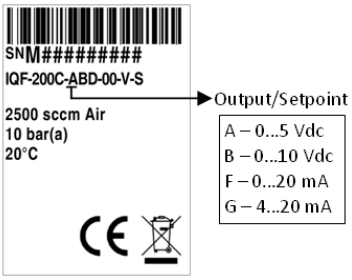
2.1 Check properties

Before installing it is important to read the attached label and check:
- Instrument type:
- *gas (IQF) red label or*
- *pressure (IQP) yellow label*

- Flow rate
- Fluid to be measured / controlled
- Up- and downstream pressure
- Input and output signals
- Temperature



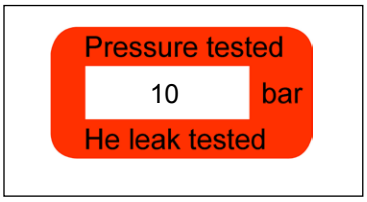
IQ(F/M) - Gas Flow IQP - Pressure



IQ+FLOW® instruments are designed for dry, clean, inert and non-explosive gases. Do not use the instruments for gases that do not belong to this category.

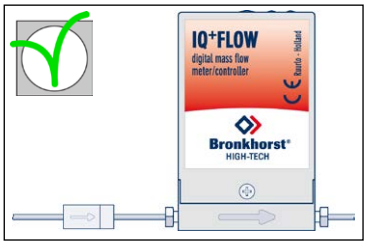
2.2 Rated pressure test inspection

The tested pressure is stated on the instrument with a red-coloured sticker. Before installation, make sure that the test pressure is in accordance with normal safety factors for your application.
If there is no Pressure Testing Sticker on the device or if the test pressure is incorrect, the instrument should ***not*** *be mounted in the process line and be returned to the factory.*



2.3 Check piping

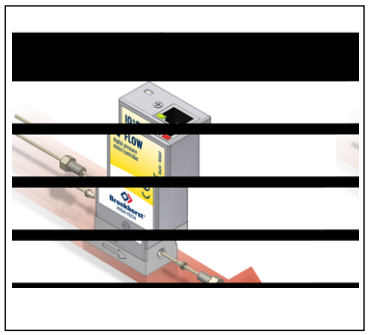
For reliable measurement always make sure that the fluid stream is clean. Use filters to ensure a clean, moisture- and oil- free gas stream. Recommended pore-size: 7 µm. If back flow can occur, a downstream filter is recommended too. Be aware of the pressure drop caused by using filters.



2.4 Install system

For IQ+FLOW® the upright position is preferred. When using an IQ+FLOW® instrument in up- or downward position make sure to "zero" the instrument prior to use (see section 2.10). Avoid installation in close proximity of mechanic vibration and/or heat sources. The housing of the instrument is according to class IP40, which means that the instrument is suitable for indoor (dry) applications, like laboratories or well protected (OEM) housings.

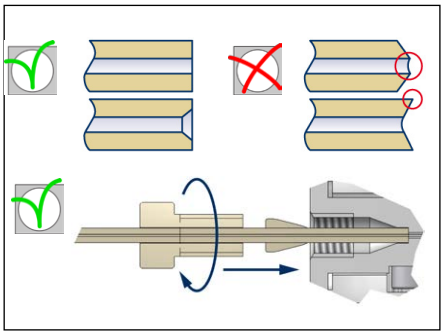
Install the IQ+FLOW® instrument in the line, in accordance with the direction of the FLOW arrow. The arrow for flow direction is indicated on the body of the instrument. If applicable follow the guidelines of the supplier of the fittings. Special types of fittings are available on request.



Compression type fittings
For leak tight installation of compression type fittings make sure that the tube is inserted up to the shoulder in the fitting body and that no dirt or dust is present on tube, ferrules or fittings. Tighten the nut finger tight; while holding the instrument, then tighten the nut one turn.

10-32 UNF fittings
Tighten the 10-32 UNF fittings according to the instructions of the supplier of the fittings.

Only use 1/16" tubing with a straight and clean cut without burrs to ensure leak tightness. Preferably deburr the tubing prior to installation. A new ferrule connection must be made for each new adapter to ensure leak-tightness and minimum dead volume, due to variances in the adapter dimensions.



Mounting downported instruments
For downported instruments make sure that the seals are present at the bottom, that the surfaces are undamaged and that they are dry and free from dirt or dust.

2.5 Leak check

Check the system for leaks before applying pressure. Especially if toxic, explosive or other dangerous fluids are used!

2.6 Electrical connection

Electrical connections must be made with a standard cable or according to the IQ+FLOW® hook-up diagram. Several hook-up examples and standard cables are found in chapter 3.
IQ+FLOW® instruments are powered with +15…+24 Vdc.

*Electrical connections must be made with standard cables or according to the applicable **hook-up diagrams**. These documents can be found at: http://www.bronkhorst.com/en/downloads*

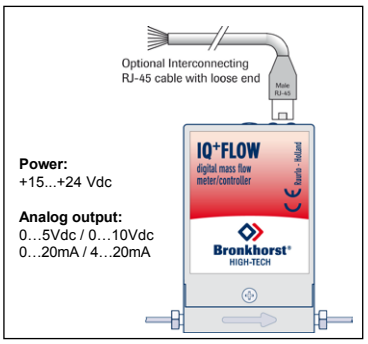
*The instruments contain electronic components that are susceptible to damage by **electrostatic discharge**. Proper handling procedures must be taken during installation, removing and connecting the electronics.*

*The instruments described in this manual carry the CE-mark and are **complient with the EMC requirements**. However compliance with the EMC requirements is not possible without the use of proper cables and connector/gland assemblies. Bronkhorst High-Tech B.V. recommends the use of their standard cables. These cables have the right connectors and if loose ends are used, these will be marked to prevent wrong connection. When using other cables, cable wire diameters should be sufficient to carry the supply current and voltage losses must be kept as low as possible. When in doubt: contact your distributor.*

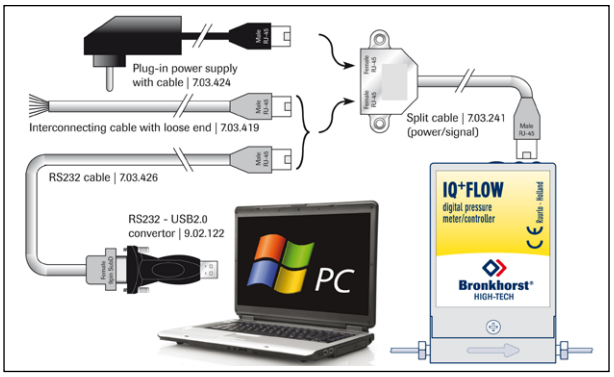
*When connecting the system to other devices (e.g. to PLC), be sure that the integrity of the **shielding** is not affected. Do not use unshielded wire terminals.*

2.7 Analog / digital operation

Analog operation (single channel versions only)
For analog operation refer to the "Hook-up diagram IQ⁺FLOW®" or use an RJ45 loose-end cable (7.03.419) to connect the required signals.



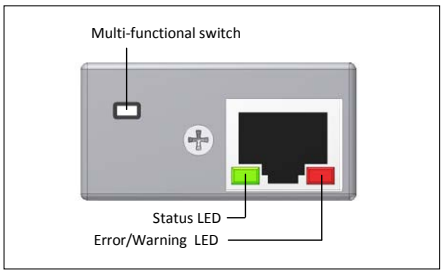
Digital RS232 operation
Digital operation over RS232 can be established when using the following setup. Using a RS232 cable or a USB-RS232 converter with a PC will allow you to use (free) Bronkhorst® software for Windows, such as FlowDDE and FlowPlot. See also section 3.4.



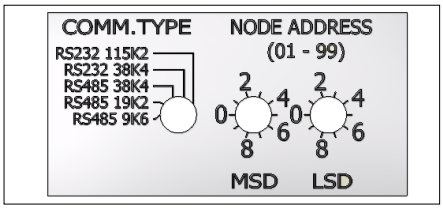
Digital RS485 operation
With digital operation over RS485 a bus-system with multiple instruments can be set up. See section 3.5 for possible systems.

2.8 Multi-functional switch operation

Micro-switch operation (single channel versions only)
Using the micro-switch on the instruments, several actions can be monitored and started. The green LED is used for status indication. The red LED is used for errors/warnings/messages. The micro-switch can be used to start several actions, such as auto-zero, restore factory settings and bus-initialisation actions, if applicable. See specific zero-procedure below and section 3.3 for more details.



Rotary switch operation (multi-channel versions only)
Select the communication type and Baud rate with the "COMM. TYPE" switch. Select the node address with the "MSD" and "LSD" switch (e.g. MSD = 1 and LSD = 9 selects node 19 for channel 1, but also node 20 and 21 for channels 2 and 3). See section 3.3 for more details.



2.9 Purging

Do not apply pressure until electrical connections are made. When applying pressure to the system, avoid pressure shocks in the system and increase pressure gradually. Also decrease pressure gradually when required.

In systems for use with toxic or other dangerous fluids, purging for at least 30 minutes with a dry, inert gas (like Nitrogen or Argon) is absolutely necessary before use. After use with toxic or other dangerous fluids, complete purging is also required before exposing the system to air.

Warm-up time
Let the IQ+FLOW® warm-up for at least 30 minutes for best accuracy.

2.10 Zeroing

The zero point of each instrument is factory adjusted. If required the zero point can be re-adjusted over RS232 or by means of using the micro-switch. Procedure for zeroing by-micro switch (not for pressure meter/controller):

- *Warm-up, pressure up the system and fill the instrument according to the process conditions.*
- *Make sure no flow is going through the instrument by closing valves near the instrument.*
- *The setpoint must be zero.*
- *Press micro-switch and hold it. After a short time the red LED will go ON and OFF, then the green LED will go ON. At that moment release the micro-switch.*
- *The zeroing procedure will start at that moment and the green LED will blink fast. The zeroing procedure waits for a stable signal and saves the zero. If the signal is not stable, zeroing will take long and the nearest point to zero is accepted. The procedure will take approximately 10 seconds.*
- *When the indication is showing 0% signal and the green indication LED is burning continuously again, the zeroing action was successful.*

2.11 Calibration

Each IQ+FLOW® instrument is factory calibrated. Bronkhorst High-Tech B.V. certifies that all instruments meet the rated accuracy. Calibration is performed using measurement standards traceable to the standards of the Dutch Metrology Institute (VSL). Calibration certificates are included in the shipment. When operated properly (clean gas, no pressure shocks, no vibrations, no thermal shocks, etc.), regular maintenance is not required. However, periodical inspection, recalibration or verification of the accuracy may be subject to individual requirements of the end-user.

2.12 Supply pressure

It is recommended to turn on power before applying pressure on the instrument and to switch off power after removing pressure.

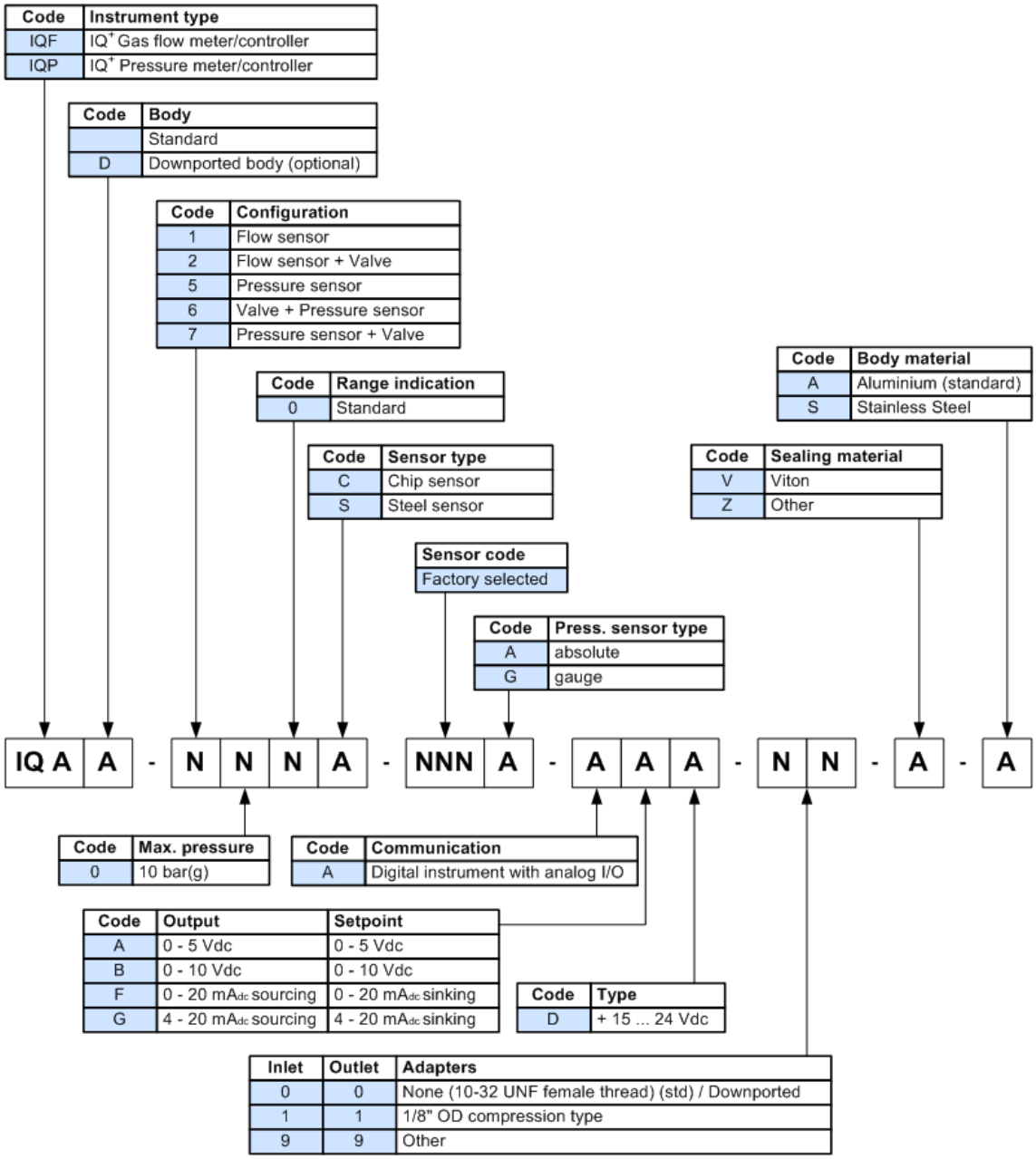
Turn on fluid supply gently. Avoid pressure shocks and bring the instrument gradually up to the level of the actual operating conditions. Also switch off fluid supply gently.

2.13 Product description

The IQ+FLOW® series is one of the smallest mass flow sensors of its kind. Due to the use of micro system technology, ultra compact flow controllers are realised with dimensions of only 20 x 40 x 60 mm. The (IQF) flow controllers are able to measure and control flow rates of 10 ml_n/min full scale (FS) up to 5000 ml_n/min FS. The (IQP) pressure controllers are available in ranges from 0.5 to 10 bar FS. The IQ+FLOW® series has a modular concept with combinations of 20 mm footprint modules, available as single instruments, but also as multiple channel arrangements. A very compact manifold (IQM) system can be constructed, with one multi-channel digital pc-board (per 3 channels) in a single housing, optionally available with filters and/or shut-off valves.

Communication with the devices can be either in analog mode or digital over RS232 or RS485. Communication over RS232 is established with the Propar (FLOW-BUS) protocol. With digital operation over RS485 a bus-system with multiple instruments can be set up. Modbus RTU/ASCII and FLOW-BUS protocols are supported (some exceptions for multi-channel versions, see section 3).

2.14 Model key



3. Basic operation

3.1 General

An IQ+FLOW® instrument must be powered with +15…+24 Vdc according to the applicable hook-up diagram, supplied with the instrument. The instrument can be operated by means of:

- Analog interface: 0…5 Vdc; 0…10 Vdc; 0…20 mA or 4…20 mA (single-channel versions only)
- Digital RS232 interface (FLOW-BUS (Propar) protocol)
- Digital RS485 interface (Modbus RTU, Modbus ASCII or FLOW-BUS protocols)

By default the instrument is set as specified. The table below lists the supported interfaces for single-channel and multi-channel versions.

	Analog interface (section 3.2)	**Digital RS232 interface (section 3.4)**	**Digital RS485 interface (section 3.5)**
IQF/IQP (single-channel)	0…5 Vdc; 0…10 Vdc; 0…20 mA; 4…20 mA (software selectable)	FLOW-BUS (Propar) protocol on 9600, 19200, 38400, 57600 or 115200 Baud (software selectable)	Modbus RTU and Modbus ASCII protocols on 9600, 19200, 38400, 57600 or 115200 Baud; FLOW-BUS protocol on 187500 or 400000 Baud (software selectable)
IQM (multi-channel)	Not supported	FLOW-BUS (Propar) protocol on 38400 or 115200 Baud (select with rotary switch)	Modbus RTU protocol on 9600, 19200 or 38400 Baud (select with rotary switch)

3.2 Analog operation

Analog operation is only possible with single-channel IQ+FLOW® instruments. Multi-channel instruments can only be operated digitally. At analog operation the following signals are available:

- Measured value (analog output) at pin 2
- Setpoint (analog input/setpoint) at pin 3

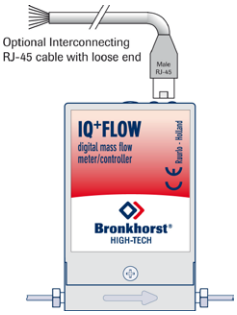
The valve output is no longer available as analog signal with IQ+FLOW®. The selected analog interface (0…5 Vdc; 0…10 Vdc; 0…20 mA or 4…20 mA) can be found in the model key of the instrument. Refer to paragraph 2.14.

When operating the instrument through the analog interface it is possible to connect the instrument simultaneously to RS232 for reading/changing parameters (e.g. settings or fluid selection).

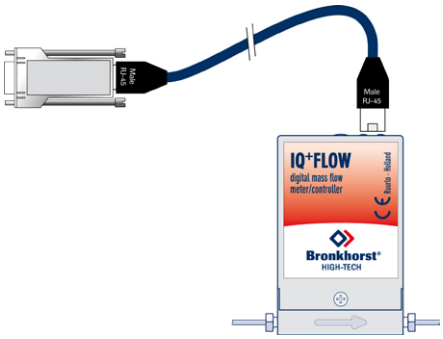
Hook-up

For analog operation either an RJ-45 loose-end cable or an RJ-45 to 9-pin sub-D converter may be used to connect the required signals.

Refer to the “Hook-up diagram IQ+FLOW®” or use an RJ-45 loose-end cable (7.03.419) to connect the required signals.



When using a Bronkhorst readout unit use only an RJ-45 cable (7.03.236) in combination with the RJ-45 to 9-pin sub-D converter (7.03.376). With these items the pin configuration is unchanged.

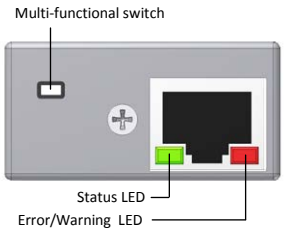


3.3 Manual interface: micro-switch, LEDs and rotary switches

In this section the manual instrument interfaces are described. In section 3.3.1 the micro-switch operation is discussed (if present), section 3.3.2 specifies the LED functionality and in section 3.3.3 the rotary switch operation is described.

3.3.1 Micro-switch operation (single-channel versions only)

By means of manual operation of the micro push-button switch some important actions for the instrument can be selected or started. These options are available in both analog and digital operation mode.



These functions are:

- Reset alarm
- Reset instrument (firmware program reset)
- Auto-zeroing
- Restore factory settings (in case of accidently changing of the settings)

Using digital RS232 or RS485 operation it is also possible to set:

- Bus-address (only required for RS485)
- Baudrate

The tables below describe the micro-switch functions that can be started in respectively normal operation mode and during power-up:

LEDs		Time Pushed	Indication
Green	Red		
Off	Off	0 – 1 sec	**No action**. Pressing a switch shortly by accident will not start any unwanted reaction of instrument. Pressing the switch 3x briefly with intervals of max. 1 sec. forces the instrument to indicate its bus-address/MAC-ID and baud rate. Check chapter 3.5 for more details.
Off	Off	1 – 4 sec	In case of min/max alarm or counter batch reached: **Reset alarm** (only if reset by keyboard has been enabled) For FLOW-BUS only: if the node address is occupied, this function will **install a free node-address** on FLOW-BUS.
Off	On	4 – 8 sec	**Reset instrument** Instrument program will be restarted and all warning and error messages will be cleared. During start-up the instrument will perform a (new) self-test.
On	Off	8 – 12 sec	**Auto-zero** Instrument will be re-adjusted for measurement of zero-flow (not for pressure meter/controller). See section 2.10.
On	On	12 – 16 sec	Prepare instrument for **FLASH mode** for firmware update. Instrument shuts down and both LEDs turn off. At next power-up instrument will be active again.

LED indications using micro-switch at normal operation mode of an instrument

LEDs		Time Pushed	Indication
Green	Red		
Off	Off	0 – 4 sec	**No action**. Pressing a switch shortly by accident will not start any unwanted reaction of the instrument.
Off	Normal flash 0,2 sec on, 0,2 sec off	4 – 8 sec	**Restore factory settings** All parameter settings (except field bus settings) will be restored to situation of final test at BHT production
Normal flash 0,2 sec on, 0,2 sec off	Off	8 – 12 sec	For FLOW-BUS only: **install a free node-address** on FLOW-BUS.
Normal flash 0,2 sec on, 0,2 sec off	Normal flash 0,2 sec on, 0,2 sec off	12 – 16 sec	**Activate "Configuration Mode"**. The baud rate and bus type are set to 38K4 and RS232 FLOW-BUS (Propar). The "Configuration Mode" is deactivated only after applying this micro-switch action again.

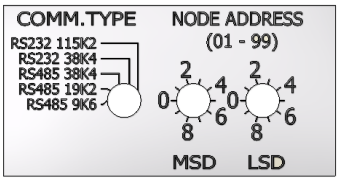
LED indications using micro-switch at power-up situation of an instrument

3.3.2 LED functions

The LEDs on top of the instrument can also be used for manual operation of some options. The green LED will indicate in what mode the instrument is active. The red LED will indicate error/warning situations.

*For details see **"Manual interface: micro-switch and LEDs "** in Operation Instructions Digital Instruments (document nr. 9.17.023, Chapter 11)*

3.3.3 Rotary switch operation (multi-channel versions only)



The IQ+FLOW® multi-channel instruments are equipped with rotary switches for selection of communication type, Baud rate and node address.

Communication type switch
With the 'COMM. TYPE' switch the following communication types can be selected:

0. RS485 9k6: Modbus RTU protocol with Baud rate 9600, EVEN parity
1. RS485 19k2: Modbus RTU protocol with Baud rate 19200, EVEN parity
2. RS485 38k4: Modbus RTU protocol with Baud rate 38400, EVEN partiy
3. RS232 38k4: FLOW-BUS protocol with Baud rate 38400
4. RS232 115k2: FLOW-BUS protocol with Baud rate 115200

Node address switches
With the two 'NODE ADDRESS' switches the node address of the instrument channels can be selected. The 'MSD' (Most Significant Digit) sets the first digit (tens), the 'LSD' (Least Significant Digit) sets the second digit (units). The node address of channel 1 is set with the switches, the channels 2 and 3 receive 'node address' + 1 and 'node address' + 2 respectively (e.g. MSD = 1 and LSD = 9 selects node 19 for channel 1, but also node 20 and 21 for channels 2 and 3).

3.4 Basic RS232 operation

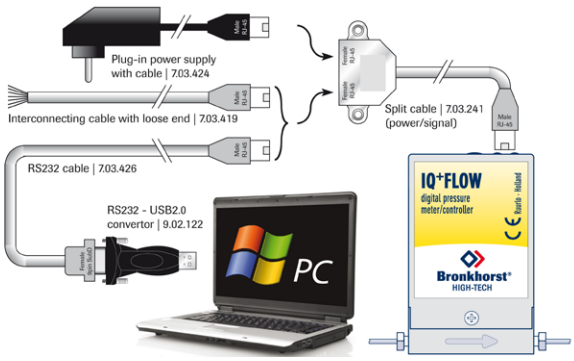
Digital operation adds a lot of extra features (compared to analog operation) to the instruments, such as:

- Up to eight selectable fluids (if installed)
- Direct reading at readout/control module or host computer
- Testing and self diagnosis
- Identification (serial number, model number, device type, user tag)
- Adjustable minimal and maximal alarm limits
- (Batch) counter

Hook-up

Connecting an IQ+FLOW® instrument to a COM port of a pc requires a special cable (7.03.426) which changes the appropriate pin configuration. Optionally use an RS232 to USB2.0 converter (9.02.122) to connect to a USB port. Use the split cable (Y-adapter 7.03.241) in combination with the Plug-in Power Supply (7.03.424) for powering the instrument.

Instead of using a COM or USB port, it is also possible to connect the RS232 pinning manually using the loose-end cable (7.03.419), typically for connection to PLC or microcontroller devices.

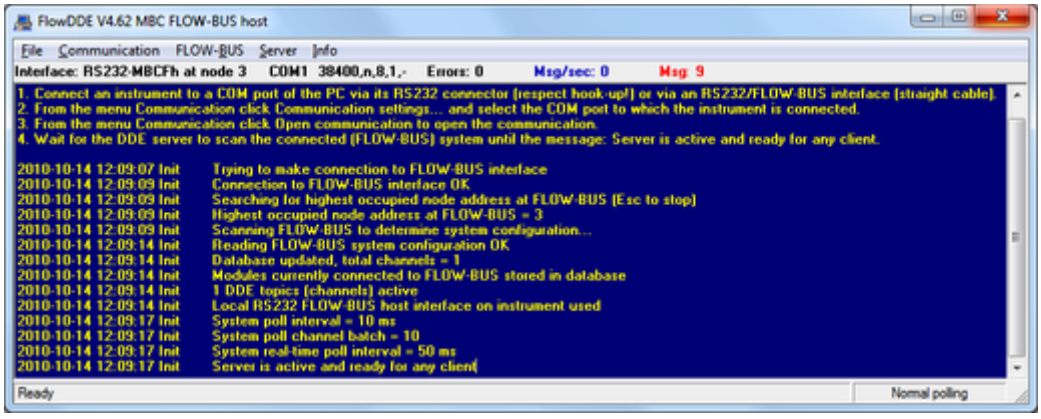


Dynamic Data Exchange (DDE)

RS232 communication can be used for operating the instrument using the Bronkhorst FlowDDE server application. Dynamic Data Exchange (DDE) provides the user a basic level of interprocess communication between Windows applications. FlowDDE is a DDE server application. Together with a client-application, either self-made or with a SCADA-program from third parties, it is possible to create an easy way of data exchange between the flow controller and a Windows application. For example, a cell in Microsoft Excel could be linked to the measured value of the flow controller and when the measured value changes, it will be updated automatically in the Excel spreadsheet.

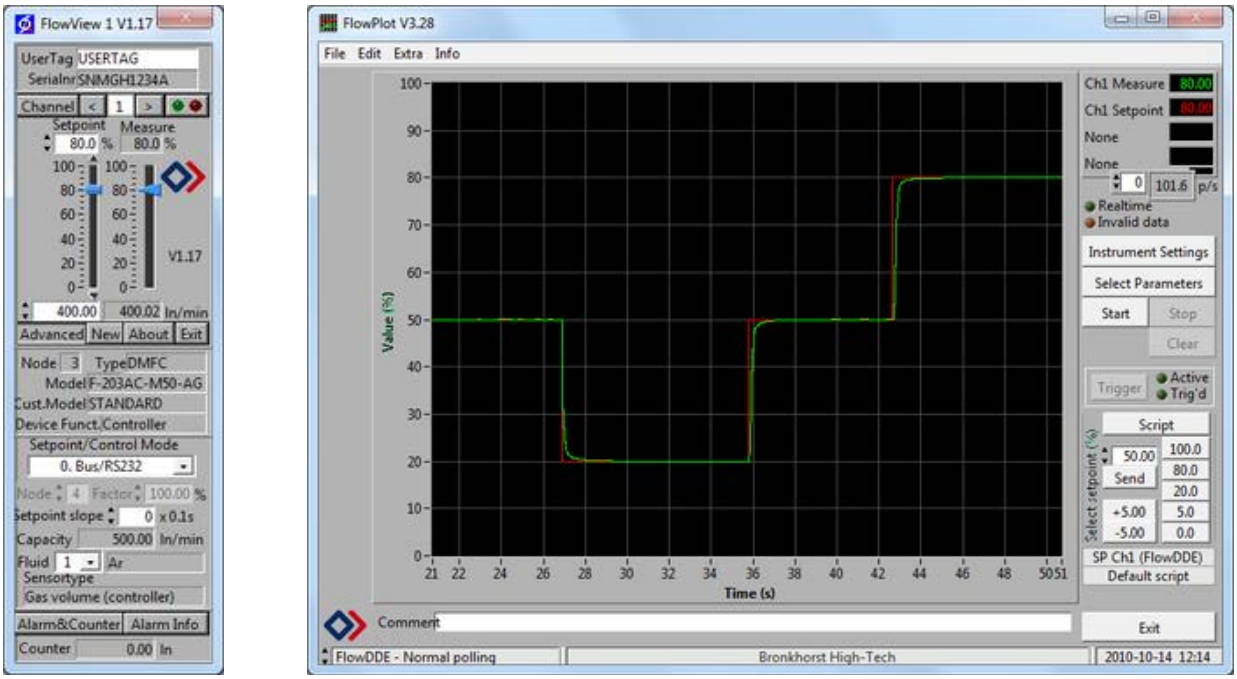
FlowDDE

The FlowDDE server also offers a lot of test facilities and user-adjustable settings for efficient communication with the connected flow/pressure meter or controller. How to setup a DDE link with FlowDDE is described in the help-file of the FlowDDE application. Programming examples are available for making applications in: Visual Basic, LabView and Microsoft Excel.



Software

Examples of free Bronkhorst® DDE client applications: FlowDDE, FlowPlot and FlowView. Other software programs supporting DDE are for example MS-Office, LabView, Intouch and Wizcon.



Bronkhorst® software programs "FlowView" (left) and "FlowPlot" (right)

FlowDDE and other Bronkhorst applications are available on the support CD or can be downloaded from the Bronkhorst internet site: http://www.bronkhorst.com/en/downloads

FlowDDE parameter numbers

Reading/changing parameter values via FlowDDE offers the user a different and user-friendly interface to the instrument. A DDE-parameter number is a unique number in a special FlowDDE instruments/parameter database and not the same as the parameter number from the process on an instrument. Node-address and process number will be translated by FlowDDE to a channel number.

An instrument parameter can be changed by using the application name: 'FlowDDE' with only:

- topic, used for channel number: 'C(X)'
- item, used for parameter number: 'P(Y)'

Baud rate setup

Make sure that the instrument's baud rate corresponds with the baud rate of the application the instrument is communicating with. For single-channel instruments the selectable baud rates are 9K6, 19k2, 38k4, 57k6 and 115k2 Baud; for multi-channel instruments the selectable baud rates are 38k4 and 115k2 Baud.

For more information regarding communication through an RS232 interface, see document nr. 9.17.027: RS232 interface with FLOW-BUS for digital instruments.

3.5 Basic RS485 operation

This section is limited to the description of the interface between the IQ+FLOW® instrument with a master device. IQ+FLOW® instruments always serve as slaves in a Modbus system. There is no mutual communication between Modbus slaves; only between master and slave. The master device is for example a pc.

More detailed information about Modbus can be found at http://www.modbus.org or any website of the (local) Modbus organisation of your country (when available).

Hook-up

The figures below show examples of a number of IQ+FLOW® instruments in an RS485 bus-system. When the power consumption is more than 15W, two seperated power networks are required due to the maximum power supply of 15 W for one PiPS.

Software
When using a pc to communicate with IQ+FLOW® instruments only the FLOW-BUS protocol is supported by Bronkhorst software. When using Modbus operation, software from third parties, such as LabView, ModScan or a Modbus PLC must be used to serve as Modbus master.

Note: an IQ+FLOW® instrument set for RS485 FLOW-BUS or Modbus communication will not react when connecting to an RS232 configuration. When required press the micro-switch according to the procedure in section 3.3.1 at start-up to activate the "Configuration Mode". The baud rate and bus type are set to 38K4 and RS232 FLOW-BUS (Propar). For multi-channel instruments the communication type can be set with the rotary switches.

Slave address, baud rate and parity setup
The IQ+FLOW® instrument is configured as specified on order. If there is a need of changing any of the specified settings, see the tables below for the supported configurations.

Single-channel versions

Mode:	**Analog**	**Digital**			
Interface:	-	**RS232**	**RS485**		
Bus protocol:	-	**Propar**	**FLOW-BUS**	**Modbus RTU**	**Modbus ASCII**
Baud rate:	-	9600 19200 38400 57600 115200	187500 400000	9600 19200 38400 56000 57600 115200	9600 19200 38400 56000 57600 115200
Node address:	-	3…125	3…125	1…247	1…247
Parity:	-	None*	None*	None; Even; Odd	None; Even; Odd

Multi-channel versions (select with rotary switches)

Mode:	**Digital**	
Medium:	**RS232**	**RS485**
Bus protocol:	**Propar**	**Modbus RTU**
Baud rate:	38400 115200	9600 19200 38400
Node address:	3…99	1…99
Parity:	None*	Even

* Not selectable

3.6 Basic parameters and properties

3.6.1 Introduction

Most instrument parameters can only be accessed with digital communication. For each communication protocol the instrument parameters are accessed differently. When using Bronkhorst® software programs FlowView or FlowPlot, easy access is provided to the mostly used parameters by menu interfaces. When using other communication methods the addressing method for the supported communication protocol is presented for a number of basic parameters in a table as seen below:

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
[type]	RW 🔑	[x]…[y]	[FB]	[Pro]/[Par]	[address]/[index]

Type

Unsigned char	1 byte character
Unsigned char[x]	x byte array (string)
Unsigned int	2 byte unsigned integer
Unsigned long	4 byte unsigned long
Float	4 byte floating point

Access

R	The parameter is read-only
RW	The parameter can be read and written
RW🔑	The parameter is protected and can only be written when the 'Init Reset' parameter is set to 64. See section 4.1.1 for more details.

Range

Some parameters only accept values within a certain range:

[x]	Minimal value of the range.
[y]	Maximal value of the range.

FlowDDE

Parameter number within FlowDDE. Refer to section 3.4 for more information about FlowDDE.

FLOW-BUS

Within the FLOW-BUS protocol (Propar when using RS232) parameters are divided into a 'Process' and a 'Parameter' number. To address parameters using the FLOW-BUS/Propar protocol write both numbers:

[Pro]	Process number
[Par]	Parameter number

Check document 9.17.027, "RS232 interface with FLOW-BUS protocol" for detailed information.

Modbus

Parameters can be read or written via the Modbus protocol by specifying either the PDU Address or the register number. The PDU Address is a hexadecimal number (identifyable by the '0x' prefix), which corresponds to the decimal register number minus one, e.g. PDU Adress 0x0000 equals register number 1, PDU Adress 0x000A equals register number 11 etc.):

[address]	Hexadecimal PDU address
[index]	Decimal register number

For the Modbus protocol every two bytes are addressed separately.

3.6.2 Basic measurement and control parameters

The list below provides the most basic parameters for digital communication with the instrument.

For more detailed information regarding operation parameters, see document nr. 9.17.023: Operational instructions for digital instruments.

Measured Value (Measure)

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned int	R	0…41942	8	1/0	0x0020/33

The 'Measured Value' indicates the amount of mass flow or pressure metered by the instrument. The signal of 0...100% will be presented in a range of 0...32000. The maximum measured value output is 131.07 %, which is: 41942. A floating point variable of the measured value, 'Fmeasure', is also available in the capacity and capacity unit for which the instrument has been set, see section 4.

Setpoint

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned int	RW	0…32000	9	1/1	0x0021/34

The 'Setpoint' is used to set the required mass flow rate or pressure for the controller. The signals have the same range as the measured value, only the setpoint is limited between 0 and 100% (0…32000). A floating point variable of the setpoint, 'Fsetpoint', is also available in the capacity and capacity unit for which the instrument has been set, see section 4.

3.6.3 Basic identification parameters

User Tag

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char[16]	RW	-	115	113/6	0xF130…0xF136/61745…61751

The 'User Tag' parameter allows the user to give the instrument a custom tag name, with a maximum of 16 characters. It is advised however to limit the user tag name up to 7 characters when using the Bronkhorst® E-7000 readout and control modules. These modules can display the tag name of an instrument only up to 7 characters.

Customer Model

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

This parameter consists of a maximum 20-byte string with instrument serial number for identification, for example: 'M1111111A'.

BHT Model Number

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char[23]	R	-	91	113/2	0xF111…0xF117/61713…61719

This parameter shows the Bronkhorst® instrument model type information.

4. Advanced operation

4.1 Reading and changing instrument parameters

4.1.1 Special parameters

All parameters described in this chapter have influence on the behaviour of the mass flow meter. Please be aware that wrong settings can disorder the output. To avoid unintential changes, some parameters are locked (shown by the 🔑 symbol). To unlock parameters set parameter 'Init Reset' to 'Unlocked'.

Init Reset

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char	RW	82/64	7	0/10	0x000A/11

The 'Init Reset' parameter is used to unlock advanced parameters for writing. This parameter can be set to the following values:

Value	Mode	Instrument action
82	Locked	Advanced parameters are read-only
64	Unlocked	Advanced parameters are writeable and readable

This parameter is always set to 'Locked' at power-up.

Control Mode

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned int	RW	0…255	12	1/4	0x0024/37

The 'Control mode' is used to select different functions of the instrument. The following modes are available:

Value	Mode	Instrument action	Setpoint source	Master source	Slave factor
0	BUS/RS232	Controlling	RS232/RS485		
1	Analog input	Controlling	Analog input		
2	FLOW-BUS slave	Controlling as slave of other instrument on bus	FLOW-BUS * slave factor / 100%	FLOW-BUS	Slave factor
3	Valve close	Close valve			
4	Controller idle	Stand-by on BUS/RS232 Controlling is stopped; Valve Out freezes in current position			
5	Testing mode	Test mode enabled (factory only)			
6	Tuning mode	Tuning mode enabled (factory only)			
7	Setpoint 100%	Controlling at setpoint 100%	Fixed 100%		
8	Valve fully open	Valve fully opened			
9	Calibration mode	Calibration mode enabled (factory only)			
10	Analog slave	Controlling as slave of other instrument on analog input	Analog input * slave factor / 100%	Analog input	Slave factor
12	Setpoint 0%	Controlling at setpoint 0%	Fixed 0%		
13	FLOW-BUS analog slave	Controlling as slave of other instrument on bus, slave factor is set with signal on analog input	FLOW-BUS * analog input * slave factor / 100%	FLOW-BUS * analog input	Analog input
18	RS232	Controlling	RS232		
20	Valve steering	Setpoint is redirected to Valve Out with controller idle			
21	Analog valve steering	Analog input is redirected to Valve Out with the controller idle			
22	Valve safe state				

After power-up the control mode will be set to 'Analog input' or 'BUS/RS232', depending on the customer's default setting for analog or digital operation. Except when the actual control mode setting is other than 0, 1, 9 or 18 the actual control mode setting is maintained. For more information see parameter 'IOStatus', section 4.2.2.

For dual interface operation or slave factors, see document nr. 9.17.023: Operational instructions for digital instruments.

4.1.2 Identification

See also section 3.6.3.

Firmware Version

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

Revision number of firmware, e.g 'V1.11a'.

4.1.3 Fluid information

The following parameters give information about the selected fluid range.

Fluid Number

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char	RW	0…7	24	1/16	0x0030/49

The 'Fluid number' is a pointer to the set of calbration parameters. Each selectable fluid has its own set of calibration parameter values. Parameter value 0 = fluid 1 and parameter value 7 = fluid 8. Up to eight fluids can be stored in an instrument. Default value = 0 (fluid 1).

Fluid Name

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

This parameter consists of the name of the selected fluid number, e.g. 'Air'.

Fluid Unit

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char[7]	RW 🔑	-	129	1/31	0x81F8…0x81FB/33273…33276

The 'Fluid Unit' can be read by parameter 'Capacity Unit'. This parameter contains the unit in maximal 7 characters.

Fluid Capacity (@100%)

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Float	RW 🔑	±1E-10… ±1E+10	21	1/13	0x8168…0x8169/33129…33130

Capacity is the maximum value at 100% for direct reading in sensor readout units.

Fluid Capacity (@0%)

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Float	RW 🔑	±1E-10… ±1E+10	183	33/22	0xA1B0…0xA1B1/41393…41394

This is the capacity zero point for direct reading in sensor readout units.

For using the 'Capacity Unit Index' or 'Capacity Unit' parameters, see document nr. 9.17.023: Operational instructions for digital instruments.

4.1.4 Advanced measurement and control parameters

Measured Value (Fmeasure)

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

Floating point variable of the 'Measured Value'. The 'Fmeasure' variable shows the measured value in the capacity and capacity unit for which the instrument has been set. The 'Fmeasure' parameter is dependent of 'Capacity', 'Capacity Unit', 'Sensor Type' and 'Capacity 0%'.

Setpoint (Fsetpoint)

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Float	RW	0…3.4E+38	206	33/1	0xA119…0xA11A/41241…41242

Floating point variable of the 'Setpoint'. The 'Fsetpoint' variable shows the setpoint value in the capacity and capacity unit for which the instrument has been set. The 'Fsetpoint' parameter is dependent of 'Capacity', 'Capacity Unit', 'Sensor Type' and 'Capacity 0%'.

Valve Output

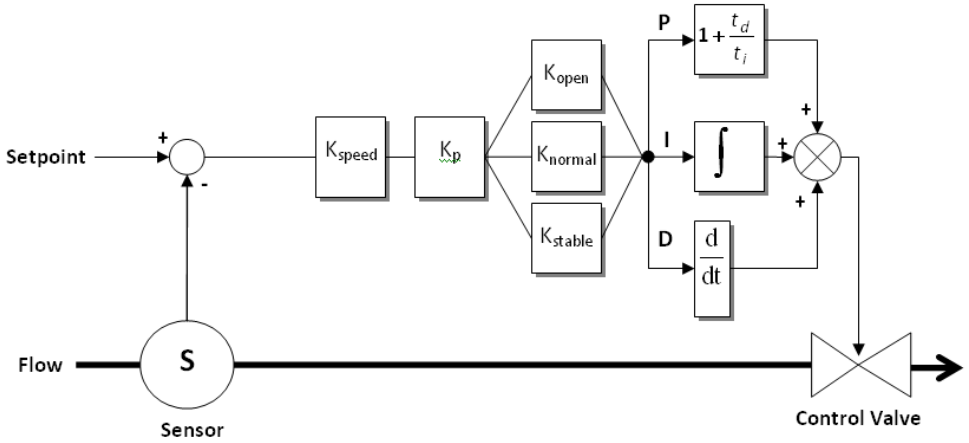
Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned long	RW	0…16777215	55	114/1	0x001F/32

This parameter is the signal coming out of the controller, used for driving the valve. 0…16777215 corresponds with approximately 0…60 mAdc.

4.1.5 Controller parameters

The controlling algorithm for the valve handled by the micro-controller consists of several parameters which can be set. Although many parameters could be accessed, Bronkhorst® advises not to change these parameters because during manufacturing the controller is optimized. Changing of controller settings should be performed by or under supervision from trained service personnel only.

The picture below shows the basic controller diagram of the digital instrument. It consists of a standard PID controller with a number of add-ons. Basically, when a faster or slower controller response is needed, only the controller speed (Kspeed) or PID-Kp should be changed.



Kp (PID-Kp)

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Float	RW 🔑	0…1E+10	167	114/21	0xF2A8…0xF2A9/62121…62122

PID controller proportional action, multiplication factor.

Controller Speed (Kspeed)

Type	*Access*	*Range*	*FlowDDE*	*FlowBus*	*Modbus*
Float	RW	0…3.4E+38	254	114/30	0xF2F0…0xF2F1/62193…62194

This parameter is the controller speed factor. PID-Kp is multiplied by this factor.

Ti (PID-Ti)

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

PID controller integration action in seconds. This value should not be changed.

Td (PID-Td)

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

PID controller differentiation action in seconds. The default value is 0.0. This value should not be changed.

Open from Zero control response (Kopen)

Type	*Access*	*Range*	*FlowDDE*	*FlowBus*	*Modbus*
Unsigned char	RW	0…255	165	114/18	0x0E52/3667

Controller response when starting-up from 0% (when valve opens). Value 128 is default and means: no correction. Otherwise controller speed will be adjusted as follows:

$$\text{New response} = \text{Old response} \cdot 1.05^{(128 - Kspeed)}$$

Normal Step response (Knormal)

Type	*Access*	*Range*	*FlowDDE*	*FlowBus*	*Modbus*
Unsigned char	RW	0…255	72	114/5	0x0E45/3654

Controller response during normal control (at setpoint step). Value 128 is default and means: no correction. Otherwise controller speed will be adjusted as follows:

$$\text{New response} = \text{Old response} \cdot 1.05^{(128 - Knormal)}$$

Stable Situation control response (Kstable)

Type	*Access*	*Range*	*FlowDDE*	*FlowBus*	*Modbus*
Unsigned char	RW	0…255	141	114/17	0x0E51/3666

Controller response when controller is stable (within band of 2% of setpoint). Value 128 is default and means: no correction. Otherwise controller speed will be adjusted as follows:

$$\text{New response} = \text{Old response} \cdot 1.05^{(128 - Kstable)}$$

4.1.6 Display filter

The output signal of an IQ⁺FLOW® instrument (measured value) is filtered. The filter has dynamic behaviour: when a change in sensor signal is detected, the measured value will be less filtered than when the sensor signal is constant and stable. There are two filter constants: Static Display Factor and Dynamic Display Factor. These two factors can be transformed into time constants using the following formula:

$$\tau = \text{cycletime} \cdot \frac{1 - \text{factor}}{\text{factor}}$$

The measured value is filtered with a first order low pass filter with a filter time constant between the two τ values.

Dynamic Display Factor

Type	*Access*	*Range*	*FlowDDE*	*FlowBus*	*Modbus*
Float	RW	0…1.0	56	117/1	0xF508…0xF509/62729…62730

This value should not be changed.

Static Display Factor

Type	*Access*	*Range*	*FlowDDE*	*FlowBus*	*Modbus*
Float	RW	0…1.0	57	117/2	0xF510…0xF511/62737…62738

This value should not be changed.

CycleTime

Type	*Access*	*Range*	*FlowDDE*	*FlowBus*	*Modbus*
Unsigned char	R	0…255	52	114/12	0x0E4C/3661

Note: The unit of parameter CycleTime is 10 ms. Example: value 0.2 means 2 ms

4.1.7 Alarm / Status parameters

See document nr. 9.17.023: Operational instructions for digital instruments, chapter 6.

4.1.8 Counter parameters

See document nr. 9.17.023: Operational instructions for digital instruments, chapter 7.

4.2 Special instrument features

4.2.1 Auto zeroing

To start the auto zero-procedure by digital operation two parameters should be written:

Control Mode

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char	RW	0…255	12	1/4	0x0024/37

Calibration Mode

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char	RW🔑	0…255	58	115/1	0x0E61/3682

Value	Mode	Instrument action
0	Idle	Idle
9	Auto zero	Auto-zeroing
255	Error	Idle

Auto-zero procedure:

Step 1: Set 'Control Mode' to 'Calibration Mode' (value 9)
Step 2: Set 'Calibration Mode' to 'Auto zero' (value 9)
Step 3: Check 'Calibration Mode',

Idle (value 0)	Auto-zeroing succeeded
Auto zero (value 9)	Auto-zeroing active
Error (value 255)	Auto-zeroing failed

4.2.2 Changing default control mode

Instruments are delivered with either analog or digital signal as default, depending on customer's requirement. After every (power-up) reset the instrument will return to its default control mode. The default control mode can be changed with the following parameter:

IOStatus

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char	RW🔑	0…255	86	114/11	0xF258…0xF259/62041…62042

Bit 6 [7…0] represents the former analog jumper.
1 = default control mode is analog
0 = default control mode is digital

Procedure for changing default digital operation to default analog operation:

- Read 'IOStatus'
- Add 64 to the read value $(OR[0x40])$
- Write 'IOStatus'

Procedure for changing default analog operation to default digital operation:

- Read 'IOStatus'
- Subtract 64 from the read value $(AND[\overline{0x40}])$
- Write 'IOStatus'

4.2.3 Disabling micro switch (single-channel versions only)

It is possible to disable the micro-switch on top of the instrument. This can prevent undesired use of this button. Disabling the micro-switch can be performed with the following parameter:

IOStatus

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned char	RW	0…255	86	114/11	0xF258…0xF259/62041…62042

Bit 3 [7…0] is used to disable the micro switch.
1 = micro switch disabled
0 = micro switch enabled

Procedure to disable the micro switch:

- Read 'IOStatus'
- Add 8 to the read value
- Write 'IOStatus'

Procedure to enable the micro switch:

- Read 'IOStatus'
- Subtract 8 from the read value
- Write 'IOStatus'

4.2.4 Setting digital output (multi-channel versions only)

The IQ⁺FLOW® multi-channel pc-board is equipped with three digital outputs. The digital outputs can be used for driving shut-off valves (for instance). The digital outputs can be read or written via the parameter 'IO Switch Status'. The parameters can be set as indicated in the value table below. Note that this parameter is channel-independent. Each output can be accessed via all channels. E.g. by writing this parameter via channel 2, it is possible to open/close a shut-off valve located at channel 1.

IO Switch Status

Type	*Access*	*Range*	*FlowDDE*	*FLOW-BUS*	*Modbus*
Unsigned long	RW	0…7	288	114/31	0xF2F8/62201

Value	Status output 1	Status output 2	Status output 3
0	Off	Off	Off
1	**On**	Off	Off
2	Off	**On**	Off
3	**On**	**On**	Off
4	Off	Off	**On**
5	**On**	Off	**On**
6	Off	**On**	**On**
7	**On**	**On**	**On**

5. Troubleshooting and service

5.1 General

For a correct analysis of the proper operation of a flow meter it is recommended to remove the unit from the process line and check it without applying fluid supply pressure. In case the unit is dirty or clogged, this can be ascertained immediately by loosening the fittings and inspecting visually.

Energizing or de-energizing of the instrument indicates whether there is an electronic failure. After energizing, fluid pressure is to be applied in order to check behaviour. If there should be suspicion of leakage, do not disassemble the sensor for inspection but contact your local distributor for service or repairs.

5.2 LED indication

The red LED on the instrument gives error or warning information.

Red LED	Time	Indication
Off	Continuously	No error
On	Continuously	Critical error message A serious error occurred in the instrument Instrument needs service before further use

For more information check the instruction manual for digital communication 9.17.023 at http://www.bronkhorst.com/en/downloads/instruction_manuals/

5.3 Troubleshooting summary general

Symptom	**Possible cause**	**Action**
No output signal	No power supply	Check power supply and hook-up
		Check cable connection and hook-up.
		Check status of LED's (see manual 9.17.023)
	Cable damaged or hooked-up incorrectly	Check and compare signals at both ends of cable.
	PC-board damaged due to long lasting shortage and/or high-voltage peaks	Return to factory
	No or too low inlet pressure	Increase inlet pressure
		Open shut-off at inlet and outlet
	Supply pressure too high, or differential pressure across meter too high	Reduce supply pressure
	Sensor failure	Return to factory
Maximum output signal	Sensor failure	Return to factory
Output signal much lower than setpoint signal or desired flow	Incorrect type of fluid or too low inlet pressure	Test instrument on conditions for which it was designed
Oscillation / Signal noise	Pressure regulator of supply pressure is oscillating or wrong sized	Replace pressure regulator
Small flow indication when flow is definetly zero	Increased zero reading without flow caused by raised zero-point	Perform an auto-zero action
No digital communication	Occupied or wrong bus address	Change address with software

5.4 Service

For current information on Bronkhorst High-Tech B.V. and service addresses please visit our website:

http://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, our Customer Service Department is available with help and guidance.
To contact CSD by e-mail:

support@bronkhorst.com

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

+31 573 45 88 39

6. Removal and return instructions

Instrument handlings:

- Purge fluid lines
- Remove instrument from line
- Insert the instrument into a plastic bag and seal the bag
- Place the bag in an appropriate shipping container

Add documentation:

- Reason of return
- Failure symptoms
- Contaminated condition
- Declaration on Contamination form: 9.17.032

When returning material, always describe the problem and if possible the work to be done, in a covering letter.

It is absolutely required to notify the factory if toxic or dangerous fluids have been metered with the instrument!
This to enable the factory to take sufficient precautionary measures to safeguard the staff in their repair department.
Take proper care of packing, if possible use the original packing box; seal instrument in plastic, etc.

Contaminated instruments must be dispatched with a completely filled in 'declaration on contamination form'.
Contaminated instruments without this declaration will not be accepted.

Note:
If the instruments have been used with toxic or dangerous fluids the customer should pre-clean the instrument.

Important:
Clearly note, on top of the package, the customer clearance number of Bronkhorst High-Tech B.V., namely:
NL801989978B01

If applicable, contact your distributor for local arrangements.

The declaration on contamination form is available at the Bronkhorst download site:
http://www.bronkhorst.com/en/downloads/safety_information_for_returns.pdf