Instruction Manual

ES-FLOW™
Ultrasonic Volume Flow Meter/Controller

Doc. no.: 9.17.116B Date: 19-12-2017

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®

Disclaimer

The information in this manual has been reviewed and is believed to be wholly reliable. No responsibility, however, is assumed for inaccuracies. The material in this manual is for information purposes only.

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Symbols

Important information. Disregarding this information could cause injuries to people or damage to the instrument or installation.

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

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

Receipt of equipment

Check the outside package box for damage incurred during shipment. If the box is 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 local sales representative.

Carefully remove the equipment from the 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 local sales representative.

Check the packing list to ensure that you received all of the items within the scope of delivery.
Do not discard spare or replacement parts with the packaging material and inspect the contents for damage.

Refer to Removal and return instructions about return shipment procedures.

Equipment storage

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

Warranty

Bronkhorst® products are warranted 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 not subject to abuse or physical damage. Products that do not operate properly during this period may be repaired or replaced at no charge. Repairs are normally warranted for one year or the balance of the original warranty, whichever is the longer.

See 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 indeterminable internal causes.

It excludes failures and damage caused by the customer, such as contamination, improper electrical hook-up, 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. or affiliated company prepays outgoing freight charges when any part of the service is performed under warranty, unless otherwise agreed upon beforehand, however, if the product has been returned collect to our factory or service center, these costs are added to the repair invoice. Import and/or export charges, foreign shipping methods/carriers are paid by the customer.

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 module 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 of the equipment is not allowed. There are no repairable parts inside. In case of a defect please return the equipment to Bronkhorst High-Tech B.V..

One or more warning signs may be present on different parts of the product. These signs have the following meaning:

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. Other components that are not safety related may be obtained from other suppliers, as long as they are equivalent to the original component. Selected parts should be obtained only through Bronkhorst, to maintain accuracy and functionality of the product. If you are unsure about the relevance of a replacement component, contact Bronkhorst for information.

Table of contents

1 Introduction

1.1 Scope of this manual

This manual covers general product information, installation and operating instructions and troubleshooting tips for the **ES-FLOW™** digital volume flow meter/controller for liquids.

1.2 Intended use

The **ES-FLOW™** is designed to accurately measure and control low volume flows with high precision and a limited pressure drop. A wide range of liquids can be measured independent of fluid density, temperature and viscosity.

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

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

Bronkhorst High-Tech B.V. cannot be held liable for any damage resulting from improper use or use for other than the intended purpose.

1.3 Product description

The **ES-FLOW™** is a precise and compact volume flow meter with control function for liquids, based on a novel ultrasonic technology.

Measuring principle
Measuring is done in a straight tube, without obstructions or dead spaces. Multiple transducers measure both the surface acoustic wave and the transit time through the media. All up- and down-stream combinations are recorded and processed in nanoseconds. The sound wave velocity and the surface area are recalculated to the volume flow value. This ultrasonic measuring method is fast, accurate and inherently bi-directional.

Application
The combination of a straight sensor tube with zero dead volume, self-drainability, orbital TIG-welding and hygienic connections, makes the ES-FLOW especially suitable for hygienic applications. For non-hygienic applications, the instrument can be equipped with compression type fittings. Wetted parts are made of stainless steel, the housing has a high ingress protection rating.

Operation

The **ES-FLOW™** can be operated with the integrated readout and control unit, as well as digitally, via RS232 or fieldbus (Modbus, FLOW-BUS, PROFIBUS DP or DeviceNet™), or in analog mode. The readout and control unit has a capacitive touchscreen with a TFT display. The fluid temperature can be read out as a secondary output. An on-board PID controller can be used to drive a control valve or pump, establishing a complete, compact control loop.

Multi-range

The **ES-FLOW™** offers multi-range functionality: factory calibrated ranges can be re-ranged to a different full scale range. Because of the extremely high linearity of the sensor, this does not affect the original accuracy specifications.

The instrument comes with a calibration certificate for all supported full scale ranges. The actual full scale of the instrument is set to a value as ordered.

1.4 Other documents

*The **ES-FLOW™** comes with all necessary information for basic operation and maintenance. This section lists all documentation that is relevant to the **ES-FLOW™**. Some documents are not necessarily part of the scope of delivery, but can be provided on request. Documents with a check mark in the column labeled 'www' can be downloaded from **http://www.bronkhorst.com/en/downloads**.*

Type	Document	Document no.	www
General documentation	EU Declaration of Conformity	9.06.021	✓
	Calibration certificates	n/a	
Technical documentation	ES-FLOW Brochure	9.60.069	✓
	Dimensional drawing ES-FLOW	7.15.194	✓
	Hook-up diagram ES-FLOW, Optional bus and I/O configurations	9.16.196	✓

Some parts of this manual refer to fieldbus specific features of the instrument. This may concern relevant hook-up diagrams, as well as a detailed description of the digital interface and how to access the available parameters. The information referred to can be found in the following documents:

Interface type	Document	Document no.	www
DeviceNet™	Instruction manual DeviceNet™ interface	9.17026	✓
	Hook-up diagram ES-FLOW instruments DeviceNet™	9.16.184	✓
FLOW-BUS	Instruction manual FLOW-BUS interface	9.17.024	✓
	Hook-up diagram ES-FLOW instruments FLOW-BUS	9.16.186	✓
Modbus	Instruction manual Modbus interface	9.17.035	✓
	Hook-up diagram ES-FLOW instruments Modbus	9.16.185	✓
PROFIBUS DP	Instruction manual PROFIBUS DP interface	9.17.025	✓
	Hook-up diagram ES-FLOW instruments PROFIBUS DP	9.16.187	✓
RS232	Instruction manual RS232 interface	9.17.027	✓
	Hook-up diagram ES-FLOW instruments RS232	9.16.156	✓

A full list of instrument parameters can be found in the Instruction manual RS232 interface (document no 9.17.027). However, most Bronkhorst® instruments only support a limited set of parameters.

Be aware that some unsupported parameters may be ignored by the device or may even have harmful (side) effects if used.

1.5 Model key

ES- A A A A - A A A - NN - A - A - A A - AAA - A - AAA

Code	Base
1	Meter

Code	Pressure rating
0	10 bar (g)
1	100 bar (g)

Code	Flow range
3	4…200 ml/min / 30…1500 ml/min

Code	Housing
I	Industrial

Code	Communication (I/O)
A	RS232 + Analog (n/c control)
B	RS232 + Analog (n/o control)
D	RS232 + DeviceNet (n/c control)
E	RS232 + DeviceNet (n/o control)
M	RS232 + Modbus (n/c control)
N	RS232 + Modbus (n/o control)
P	RS232 + PROFIBUS (n/c control)
Q	RS232 + PROFIBUS (n/o control)
R	RS232 + FLOW-BUS (n/c control)
S	RS232 + FLOW-BUS (n/o control)

Code	Analog output
A	0…5 Vdc
B	0…10 Vdc
F	0…20 mA sourcing
G	4…20 mA sourcing

Code	Supply voltage
D	+ 15…24 Vdc

Code	Fluidic connections (in/out)
AA	3 mm OD compression type
11	1/8" OD compression type
22	1/4" OD compression type
33	6 mm OD compression type
88	1/4" Face Seal male
JJ	1/4" Triclamp flanges (max 10 bar (g))
KK	1/2" Triclamp flanges (max 10 bar (g))
99	Other (on request)

Code	Internal seals
0	None

Code	Material
S	Stainless steel SS316

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

Code	Digital communication via M12-connection
A	RS232 - ProPar (default)
B	RS485 - FLOW-BUS
C	RS485 - Modbus RTU
D	RS485 - Modbus ASCII

Code	Additional I/O connector (M8)
1	Enabled, Bronkhorst valve output (default)

	M12 connector, pin 5	Additional I/O (M8, pin 2)
Code	Customized IO options	
000	Disabled, 0 Vdc (default)	
A1V	0…10 Vdc sourcing output, controller	
B1V	4…20 mA sourcing output, controller	
B2V	3.8...20.8mA sourcing output (TEIP11/Badger), controller	
C3A	Digital output, min/max alarm	
C4A	Digital output, counter alarm	
C5S	Digital output, enabled by setpoint (for shut-off control)	
C0I	Digital output, high/low switch via remote parameter	
D9E	Digital frequency output, measure	
F9B	Digital pulse output, batch counter	
I3C	Digital input, controller mode Valve Close	
I8C	Digital input, controller mode Valve Fully Open	
I1R	Digital input, reset counter	
I2R	Digital input, reset alarm	

1.5.1 Customized I/O options

ES-FLOW™ instruments offer various customized input/output functions through pin 5 of the M12 connector and through pin 2 of the M8 connector as an option. I/O options are factory installed as specified at ordering time, and cannot be changed manually.

The last 3 groups of the model key on the instrument label indicate the installed I/O configuration. The possible configurations are described in the table below. See the hook-up diagram for custom bus and I/O configurations (document 9.16.196) for an explanation of the codes.

Code	Description
000	Disabled, pin 5 is pulled down to 0 Vdc (default selection)
A1V*	0…10 Vdc sourcing output, controller Analog signal for pump or external valve steering (control signal only) When the controller output is used for pump or external valve steering (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.
B1V*	4…20 mA sourcing output, controller Analog signal for pump or external valve steering (control signal only). When the controller output is used for pump or external valve steering (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 20 mA, due to the maximum valve current restriction.
B2V*	3.8…20.8 mA sourcing output, controller Analog signal for Badger Meter valve with TEIP11 signal converter (control signal only)
C3A	Digital output, min/max alarm During a min/max alarm, pin 5 is pulled down to 0 Vdc.
C4A	Digital output, counter alarm During a counter alarm, pin 5 is pulled down to 0 Vdc.
C5S	Digital output, enabled by setpoint (for shut-off control) Pin 5 is pulled down to 0 Vdc at a controller setpoint, e.g. for shut-off valve activation. For factory selected analog control (…-A#-C5S): If parameter *Control mode* is set for analog control by factory, the minimum setpoint at which the device (shut-off valve) connected to pin 5 is activated is 1.9%. This prevents possible noise on the analog input activating the device accidentally. For factory selected digital control (…-D#-C5S): If parameter *Control mode* is set for digital control by factory, the setpoint threshold for activating the device connected to pin 5 is any value > 0. Note: If the instrument is forced into Valve Safe State, the digital output is not affected, so a (n.c.) shut-off valve connected to pin 5 will not close when the (n.c.) controller is in Valve Safe State' Make sure to use 24 Vdc 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) Pin 5 is pulled down to 0 Vdc when writing value 1 to parameter *IO switch status*, this is undone by writing value 0. A device connected to pin5 (e.g. a shut-off valve) can be activated/deactivated by writing parameter *IO switch status*. Note: If the instrument is forced into Valve Safe State, the digital output is also affected, so a (n.c.) shut-off valve connected to pin 5 will be closed when the (n.c.) controller is in 'Valve Safe State'. Make sure to use 24 Vdc power supply corresponding to the shut-off valve specifications.

Code	Description
D9E	Digital frequency output, measure Measurement value is translated to a frequency within given frequency range. The default frequency range to represent 0…100% flow is 0…10000 Hz. Any other frequency range must be specified on order.
F9B	Digital pulse output, batch counter Pin 5 is pulled down to 0Vdc when a given batch size is reached (during a given pulse length). By default, a pulse is given at each 1x the *Counter unit* batch value, with a pulse length of 1 second. For instance, when *Counter 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. Provide a pull-up resistor of 5…10 kOhm to create 15…24 Vdc at pin 5 (according to the applicable hook-up diagram).
I3C	Digital input, controller mode valve close Valve closes when pin 5 is connected to 0 Vdc. This option switches between the default *Control mode* and mode 'Valve Close' (value 3). When the default *Control mode* is digital, the default value is 0 (bus/RS232), when the default *Control mode* is analog, the default value is 1 (Analog input).
I8C	Digital input, controller mode valve purge Valve is fully opened when pin 5 is connected to 0 Vdc. This option switches between the default *Control mode* and mode 'Valve Fully Open' (value 8). When the default *Control mode* is digital, the default value is 0 (bus/RS232), when the default *Control mode* is analog, the default value is 1 (Analog input).
I1R	Digital input, reset counter The counter resets when pin 5 is connected to 0 Vdc.
I2R	Digital input, reset alarm The alarm resets when pin 5 is connected to 0 Vdc.

) Notes regarding controller options:

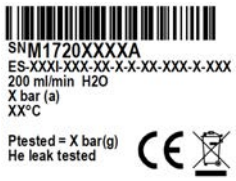
- *A controller output option (A1V, B1V or B2V) can only be installed in combination with controller mode A or D (controller enabled, see model key).*
- *If the controller is enabled, the M8 connector can always be used to control a Bronkhorst® valve (through pin 3).*
- *Although it is theoretically possible to have 3 controller options installed, no more than 1 signal should be used at any time.*

2 Installation

This chapter describes the steps to take in order to prepare the **ES-FLOW™** for first time use.

2.1 Functional properties

Before installing the **ES-FLOW™**, check if the functional properties match your requirements. The ES-FLOW Brochure provides general technical specifications, specific technical data can be found on the product label and in the ordering details.



- Flow/pressure rate(s)
- Media to be used in the instrument
- Upstream and downstream pressure(s)
- Ambient temperature
- Input and output signal

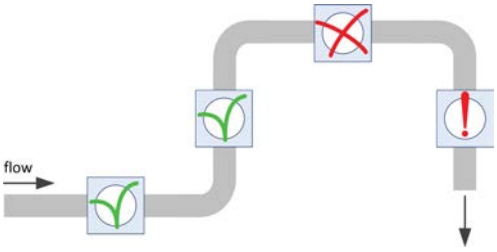
*Bronkhorst® instruments are pressure tested to 1.5 times the requested pressure rating and outboard leak tested to at least 2 * 10^{-9} mbar l/s Helium. The tested pressure is specified on the product label. If the product label is missing or if the specified pressure is insufficient, the instrument must not be used and should be returned to the factory.*

Before installation, make sure that the tested pressure is in accordance with the safety factor of your application. The tested pressure must always be higher than the maximum operating pressure.

2.2 Mounting

Location

The presence of gas bubbles in the liquid can lead to measuring errors. In general, the instrument should be mounted in a pipe segment where gas bubbles cannot accumulate. The image to the right shows the preferable mounting locations.

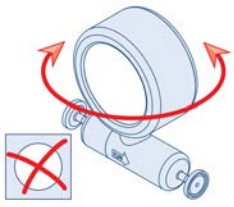


- The best location is a horizontal pipe segment or a segment where the fluid direction is upward.
- Gas might accumulate in the horizontal segment if it is followed by a downward segment. Do NOT mount the instrument in a location like this.
- Mounting in a downward pipe segment with an open end is strongly dissuaded, especially if the pipe diameter is 1/2" or more. Gravity might let the segment run empty; depending on the specific system dimensions and the viscosity of the metered fluid, this effect might be stronger or weaker.
- If the instrument is part of a closed fluidic system, mounting the instrument in a downward pipe segment is not preferable, but may be considered if other mounting locations are more problematic.

To minimize the risk of gas inclusion by cavitation, the preferred location to install a control valve is downstream from the instrument, the preferred location for a pump is upstream.

Orientation

*The **ES-FLOW™** has no preferred mounting orientation. However, take into account that the connection between the measuring tube and the instrument housing is fixed. The display cannot be turned to get a better view, it can only be adjusted by repositioning the entire instrument.*



Environment

To prevent damage to the internal electronics, make sure the temperature inside the instrument housing does not exceed 60 °C. If necessary, take appropriate heat discharging measures, especially if the instrument is operated inside an enclosure (e.g. a control cabinet).

2.3 Fluidic connections

The FLOW arrow on the measuring tube indicates the normal flow direction. For normal use, install the **ES-FLOW™** in the process line, in accordance with the direction of the FLOW arrow. For bi-directional measuring, install the instrument in the direction where the highest flow will be measured (if applicable). When deciding in which direction to install the instrument, take into account that the measuring range in the opposite direction is approximately 73% of the full scale range (whereas the instrument can measure 131% FS in the normal direction).

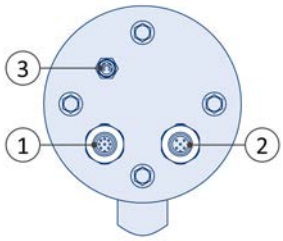
Tighten fittings according to the instructions of their manufacturer.

Do not install small diameter piping on high flow rates and avoid abrupt angles or other disturbances within a distance of 10 pipe diameters from the inlet or outlet of the device.
Do not install pressure regulators within a distance of 25 pipe diameters.

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

2.4 Electrical connections

The **ES-FLOW™** is equipped with one or more electrical connection ports. The image to the right shows the locations of the different ports (the actual presence and appearance of ports might be different, depending on the ordered fieldbus interface and instrument type):



1. Standard connection port, 8-pin M12 male
2. Fieldbus connection port, 5-pin M12 male/female (optional, fieldbus dependent)
3. Connection port for actuator output, 4-pin M8 female

See sections Model key and Functional properties for configurable and installed options respectively.

Upon delivery, all connection ports are covered with plastic caps. To maintain the original ingress protection rating, do not remove the caps of unused connections.

Electrical connections must be made with standard cables or according to the applicable hook-up diagram. Make sure that the power supply is suitable for the power ratings as indicated on the instrument label or in the technical specifications, and that double or reinforced insulation is used for the power supply cabling.

Do not power the instrument simultaneously from two different power sources (e.g. bus connection and Plug-in Power Supply). Doing so will damage the printed circuit board irreparably.

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

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

*When connecting the product to other devices (for instance a PLC), be sure that the integrity of the shielding is not affected. **Do not use unshielded wire terminals**.*

2.5 Communication interface

Check if the default network settings match the configuration of the fieldbus system (if applicable). If necessary, the default settings can be overruled by changing the appropriate parameters (see Network configuration).

3 Operation

3.1 Powering up and powering down

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

Be sure to apply the specified operating pressure(s) . Avoid pressure shocks and bring the fluidic system gradually up to the level of operating conditions; open and close the fluid supply gently.

3.2 First use

Before starting measurement and control, make sure to expel gas from the system by flushing all fluidic lines with the process fluid at a relatively high flow rate.

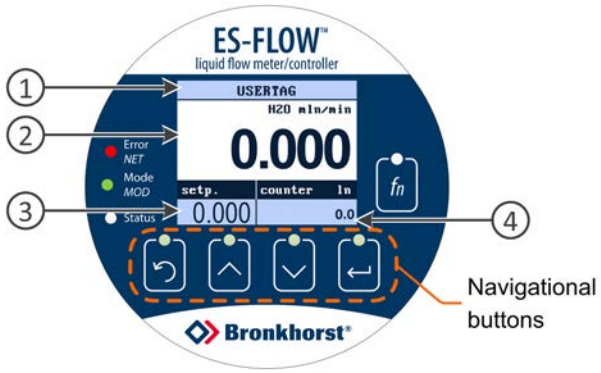
For controllers, give setpoint = 100% or use special Control mode = 8 (valve fully open), to ensure getting the highest possible flow rate. Control mode 8 bypasses the PID controller, which is particularly useful when having the ES-FLOW™ set to a low capacity flow range.

3.3 User interface

The screen representations in this section are for illustration purposes only. They do not necessarily reflect the exact lay-out and/or information displayed on the screen. Some representations might only be applicable to certain instrument types or factory configurations.

The image to the right shows the screen display, immediately after powering up. The following screen areas can be distinguished:

1. Top line
2. Measure readout
3. Custom readout 1 (only for instruments with control function)
4. Custom readout 2



The navigational buttons have the following functionality:

- Enter selected menu
- Enter edit mode
- Confirm selection/changes

- Navigate up in menu
- Change character or list item

- Navigate down in menu
- Change character or list item

- Return to previous menu
- Leave edit mode without making changes
- Select display info

The communication status of the instrument can be monitored with the three LEDs to the left of the screen. See LED indications for a description of the possible indications.

A multifunctional switch (fn) to the right of the screen can be used to start several functions without having to enter the menu (see Multifunctional switch).

3.3.1 Main screen functions

3.3.1.1 Unlocking buttons

The switch lock function prevents accidental activation of the user interface (.e.g. by cleaning the instrument and/or its environment with a hose or high-pressure cleaner). The lock is activated after a period of inactivity (lock time; 60 seconds by default), after which the individual tip buttons are disabled. The buttons can be unlocked by pressing and holding ↵ and ↶ for a couple of seconds (unlock time; default: 4 seconds).

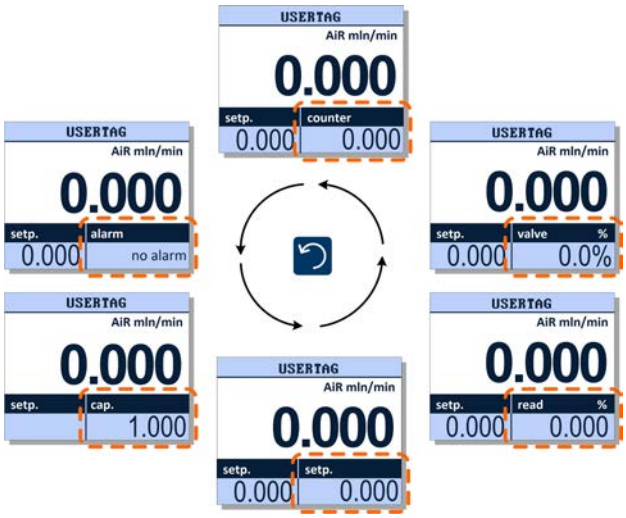
The switch lock properties can be edited in the *Settings* menu.

3.3.1.2 Selecting display information

The *Custom readout 2* area can show different parameters. Depending on the instrument type, the following parameters may be available (editable parameters are marked with an *):

- setpoint*
- percentage reading
- actuator/valve percentage
- counter*
- alarm*
- capacity
- temperature
- density
- instrument*

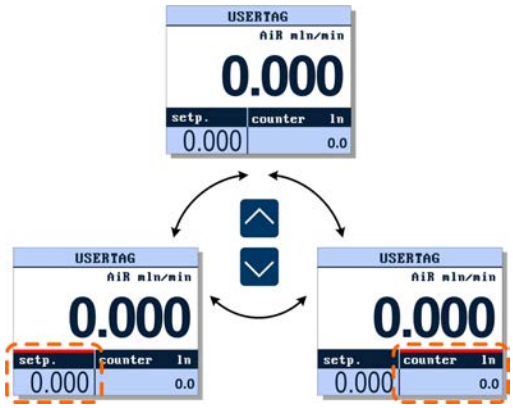
To change the displayed parameter, press ↶ from the main screen. Cycle through the available parameters by pressing the button repeatedly.



3.3.1.3 Selecting screen area

Depending on the instrument type and the settings of the readout and control unit, none, one or both of the custom readout areas can display an editable parameter. If an area contains an editable parameter, it can be selected and edited in place. Selection is made visible by a red line above the concerning area.

- To cycle through the editable screen areas, press ^ or v repeatedly
- To enter edit mode for the selected area, press ↵
- When edit mode is active, press ↶ at any time to leave edit mode without making changes



3.3.1.4 Editing setpoint

- *The setpoint of a controllable instrument can be changed if the parameter is displayed in the custom readout area.*
- *Instruments without a control function have no editable setpoint and can only be monitored (*Custom readout 1 *not available).*

If the setpoint is configured to be entered as a character string, follow these steps to change its value:

1. Select a readout area that displays the setpoint:

2. Press ↵ to enter edit mode (the first character position is highlighted):

3. Press ^ or v to select the required character:

4. Press ↵ to advance to the next character position:

On confirmation of the last digit, the entered value is stored and edit mode is left (whereupon the character highlight is removed).

If the setpoint is configured to be entered step-wise, follow these steps to change its value:

1. Select a custom readout area that displays a setpoint:

2. Press ↵ to enter edit mode (the current value is highlighted):

3. Press ^ or v to change the parameter value (hold the button to scroll fast):

4. Press ↵ to store the current value and leave edit mode:

The setpoint input method (string or step-wise) can be set in the Settings menu (Settings > Setup > Customize > Setpoint)

3.3.1.5 Resetting counter

1. In the main screen, select the *Custom readout 2* area:

2. Press ↵ to enter edit mode:

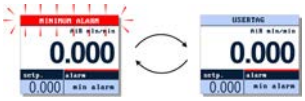
3. Press ^ or v to change the value to 'yes':

4. Press ↵ to confirm the selected option and reset the counter:

3.3.1.6 Resetting alarm

Before resetting the alarm, be sure to eliminate the cause. Resetting the alarm without changing the conditions that caused it will re-activate the alarm immediately.

When an alarm occurs, a message blinks in the top line of the main screen. If the alarm is configured to be reset automatically, the blinking stops as soon as the alarm conditions no longer apply. If the alarm is configured to be reset manually, follow these steps to reset it:



1. *Custom readout 2* area is selected automatically:

2. Press ↵ to enter edit mode:

3. Press ▲ or ▼ to change the value to 'yes':

4. Press ↵ to confirm the selected option and reset the alarm:

3.3.2 Menu navigation

The configurable parameters of the instrument and settings of the readout and control unit are organized in a menu structure.

Items
Menus can contain items of 3 different types:

Sub menu — An arrow pointing to the right indicates a sub menu

Parameter with list selection — An arrow pointing down indicates a parameter that can be changed by selecting a value from a list

Character string parameter

- First line: unit (if applicable)
- Second line: current parameter value

Not all parameters can be edited; some parameter values are protected, or display a value that is directly linked to the value of another parameter:

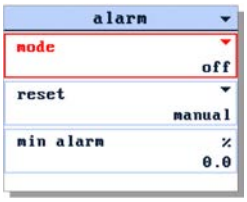
Normal display — Parameter can be edited

Dimmed — Parameter is read-only

Navigation

- Inside menus and sub menus, the selected item is highlighted in red
- Press ↑ or ↓ to navigate to the required menu item
- Arrows pointing up and/or down in the top line indicate the menu contains more items than can be displayed.

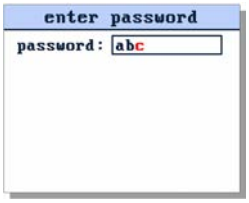
- Press ↵ to enter the selected sub menu or to enter edit mode
- Press ↩ to return to the previous screen or menu or to leave edit mode without making changes



3.3.2.1 Password protection

1. By default, some items are accessible only after entering a password:

2. Enter the password (if the password contains less than 8 characters, fill the remaining positions with spaces):



3. If the password is correct, the selected (sub) menu is displayed on confirmation of the last character position:

4. If the password is incorrect, access is denied:

The default password is 'abc' (without quotes) and is case sensitive.

To avoid unauthorized access, change the default password immediately after installation. See Changing password for instructions.

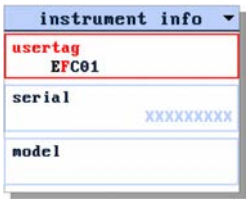
3.3.2.2 Editing string

1. Select the parameter to be edited:

2. Press ↵ to enter edit mode (the first character position is highlighted):

3. Press ↑ or ↓ to select the required character/digit:

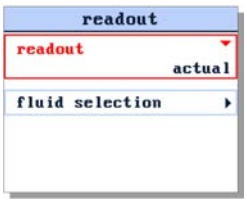
4. Press ↵ to advance to the next character position:



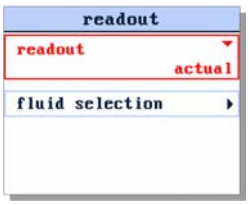
On confirmation of the last character/digit, the entered value is stored and edit mode is left (wherupon the character highlight is removed).

3.3.2.3 Editing list selection

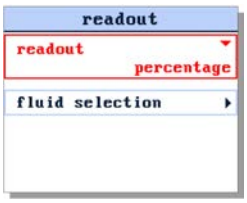
1. Select the parameter to be edited:



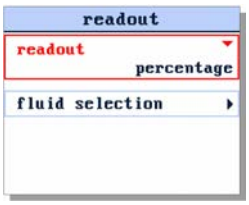
2. Press ↵ to enter edit mode (the selected value is highlighted):



3. Press ^ or v to scroll through the available options:



4. Press ↵ to confirm the selected option and leave edit mode (the highlight is removed):



3.3.3 Settings menu

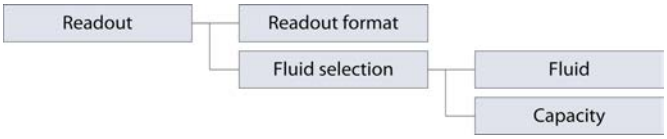
The *Settings* menu provides access to the user configurable instrument parameters, and contains settings for customizing display behavior of the readout and control unit. The menu is divided into the following sections (available as sub menus):

Sub menu	Description
Readout	Readout settings and fluid selection
Controller	Instrument controller characteristics
Counter	Counter settings
Alarm	Alarm settings
Setup	Device identification, display customization and bus configuration
Advanced	Sensor filter settings and special functions

1. Start in the main screen:

2. Press ↵ to enter the *Settings* menu:

3.3.3.1 Readout



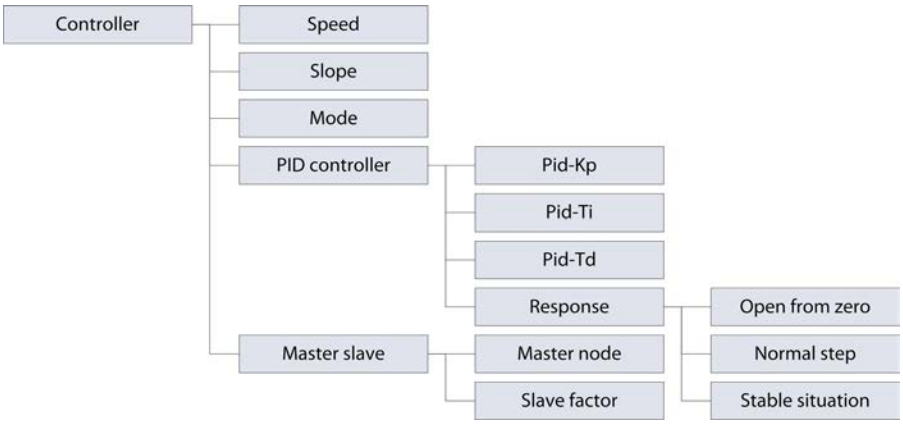
In the *Readout* sub menu, the following parameters can be edited:

Parameter	Description	Supported values
Readout format	Display format of the measured value in the main screen	• actual • percentage
Fluid	Selected (metered) fluid	As ordered
Capacity	Maximum readout/control value (100%) for the selected fluid	As ordered

3.3.3.2 Controller

The Controller *sub menu is only available if the control function of the instrument is enabled. This setting is part of the instrument configuration at the factory.*

Because controlling characteristics are optimized during manufacture, Bronkhorst strongly advises not to change these parameters. If changing controller settings is absolutely necessary, it should be performed by or under supervision of trained service personnel only.



In the *Controller* sub menu, the following parameters can be edited:

Parameter	Description	Supported values
Speed	Controller speed factor	0.001…99.999
Slope	Controller adjustment speed	0.0…3000.0 seconds
Mode	Control mode	see table below
Pid-Kp	PID controller proportional action	
Pid-Ti	PID controller integration action	
Pid-Td	PID controller differentiation action	
Open from zero	Open from zero response	0…255
Normal step	Normal step response	0…255
Stable situation	Stable situation response	0…255
Master node	Node address of the master instrument	0…128
Slave factor	percentage of the measurement value of the master instrument	0…100.0%

The following control modes are available:

Value	Description
rs232	Normal operation via RS232
bus/rs232	Normal operation via fieldbus or RS232
analog input	Normal analog operation
setpoint 0 perc.	Setpoint set to 0%
setpoint 100 perc.	Setpoint set to 100%
control idle	Controller disabled, valve frozen in current position
actuator 0 perc.	Controller disabled, valve closed
actuator 100 perc.	Controller disabled, valve fully open
actuator steering	Controller disabled, valve opening equal to setpoint (percentage)
fb slave	Acting as slave of other instrument on FLOW-BUS
analog slave	Acting as slave of other instrument on analog input
fb ana slave	Acting as slave of other instrument on FLOW-BUS, slave factor set by analog input signal

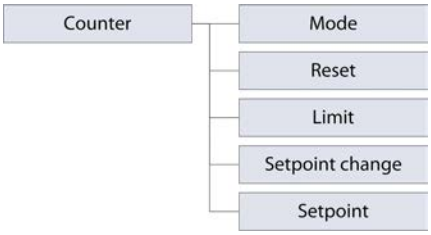
The *Master slave* item is only available if one of the slave control modes is selected. Availability of *Master node* and *Slave factor* depends on the selected mode:

Control mode	Master node	Slave factor
fb slave	✓	✓
analog slave		✓
fb ana slave	✓	

See also Master/slave configuration for more information about setting up a master/slave relationship between instruments.

3.3.3.3 Counter

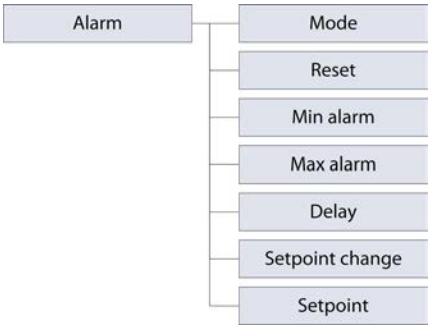
Bronkhorst® flow meters have a built-in counter function, which can be used to monitor and/or control the amount of media flowing through the instrument. The flow can be stopped or changed when a certain limit is reached. Until the counter is reset, the counter setpoint overrules the regular setpoint.



In the *Counter* sub menu, the following parameters can be edited:

Parameter	Description	Supported values
Mode	Selected counter mode	• off • up to limit • up
Reset	Reset method	• automatic • manual
Limit	Counter limit or batch size	Setpoint range
Setpoint change	Specifies whether or not to change the setpoint after reaching the counter limit	• yes • no
Setpoint	New setpoint after reaching counter limit (until counter reset)	Setpoint range

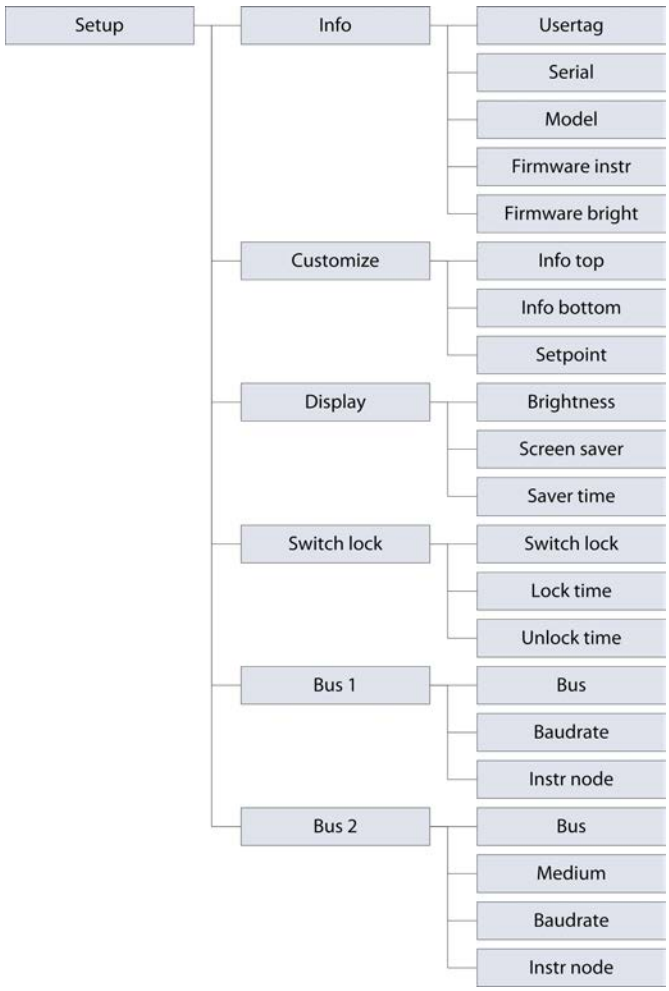
3.3.3.4 Alarm



In the *Alarm* sub menu, the following parameters can be edited:

Parameter	Description	Supported values
Mode	Alarm type	• off • min/max • response • power-up
Reset	Reset method; reset the alarm automatically if the alarm conditions no longer apply, or manually via the user interface	• automatic • manual
Min alarm	Minimum limit	0…100%
Max alarm	Maximum limit	0…100%
Delay	Number of seconds to wait before triggering the alarm action (after the alarm situation was activated)	0…255
Setpoint change	Specifies whether or not to change the setpoint after an alarm situation is activated	• yes • no
Setpoint	New setpoint until alarm reset	Setpoint range

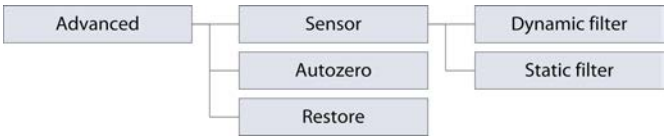
3.3.3.5 Setup



The following parameters are available in the *Setup* sub menu:

Parameter	Description	Supported values
Usertag	Custom instrument name	text (16 positions)
Serial	Instrument serial number	n/a (read only)
Model	Instrument model number	n/a (read only)
Firmware instr	Firmware version instrument	n/a (read only)
Firmware bright	Firmware version readout and control unit	n/a (read only)
Info top	Information to show in the top line of the display	• usertag • serial number
Info bottom	Information to show in the *Custom readout 2* area	• setpoint • valve • disabled
Setpoint	Specifies if the setpoint is edited as digits or step-wise	• cursor • step
Brightness	Screen brightness	0 ... 9
Screen saver	Enable or disable screen saver	• dimmer • off
Saver time	Number of minutes of inactivity before screen saver becomes active	1 ... 99
Switch lock	Enable or disable switch lock	• enabled • disabled
Lock time	Number of seconds of inactivity before switches are locked	0...600
Unlock time	Number of seconds to hold buttons to unlock switches	2...100
Bus (Bus 1 and 2)	Fieldbus type	n/a (read only)
Medium (only Bus 2)	Communication type	• rs232 • rs485
Baudrate (Bus 1 and 2)	Communication speed	fieldbus dependent
Instr node (Bus 1 and 2)	Primary node address on the fieldbus	fieldbus dependent

3.3.3.6 Advanced



In the *Advanced* sub menu, the following parameters can be edited:

Parameter/function	Description	Supported values
Dynamic filter		0…1
Static filter		0…1
Autozero	Function for adjusting zero point (only for flow meters/controllers)	
Restore	Function for restoring instrument settings	

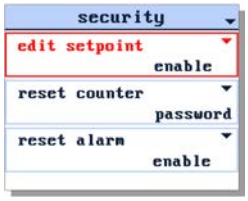
3.3.4 Security menu

To enter the Security menu, follow these instructions:

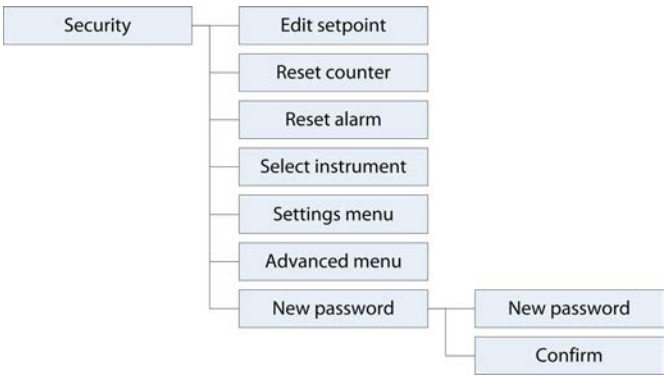
1. Start in the main screen:

2. Press and hold ^ and v simultaneously for 5 seconds:

3. Enter the password to enter the *Security* menu:



In the *Security* menu, access to some delicate items can be restricted. The password that is used for password protected items can also be changed here.



The following items can be restricted:

Item	Description
Edit setpoint	Edit mode of the setpoint
Reset counter	Manually resetting the counter in the *Custom readout 2* area
Reset alarm	Manually resetting alarms in the *Custom readout 2* area
Select instrument	Selecting another instrument in the fieldbus system (*Custom readout 2* area)
Settings menu	Availability of the *Settings* menu
Advanced menu	Availability of the *Advanced* sub menu in the *Settings* menu

For each of these items, one of the following access modes can be set:

- **Enabled**: item is available without restrictions
- **Disabled**: item is not available
- **Password**: item is password protected

The password protection of the Security *menu itself cannot be removed, nor can the menu be disabled.*

3.3.4.1 Changing password

1. Open the *Security* menu and select the *New password* item:

2. Press ↵ to enter the *New password* sub menu:

3. Press ↵ to enter edit mode and enter the new password:

4. After confirming the last character, select the *Confirm* item:

5. Press ↵ to confirm the new password:

The new password is applied only after confirmation; the password is active throughout the entire readout and control program.

3.3.4.2 Resetting password

If the password is lost (after changing it), it can be reset by entering an encrypted key. This reset key can be obtained by sending a so-called 'bht key' to your local Bronkhorst representative. After entering the reset key, the password will be reset to the default value ('abc').

To get a *bht key* from the readout and control unit, follow these instructions:

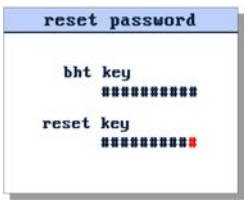
1. Press ^ and v simultaneously for 5 seconds, until the 'enter password' screen appears:

2. Again, press ^ and v simultaneously for 5 seconds, until the *Reset password* screen appears:

3. Write down the *bht key* and send it to your local Bronkhorst representative by e-mail. After validation, you will receive a reset key.

When you have received your reset key, return to the *Reset password* screen and proceed as follows:

4. Enter the reset key:



5. On confirmation of the last character position, the password is reset:

6. Press any key to return to the main readout screen

3.3.5 LED indications

● (green) Mode/MOD: operation mode indication
● (red) Error/NET: error/warning messages

(Until further notice, the Status LED has no functionality. It is present anticipating future development and will be described in due time.)

The tables below list the different LED indications:

● **Green**		
Pattern	**Time**	**Indication**
off	continuous	Power-off or program not running
on	continuous	Normal operation mode
short flash	0.1 sec on, 2 sec off	No bus communication, valves are in safe state
blink	0.2 sec on, 0.2 sec off	Special function mode; the instrument is busy performing a special function (e.g. auto-zero or self-test)
long flash	2 sec on, 0.1 sec off	Configuration mode; on the 5-pin M12 connector, the baud rate is set to 38400 and the bus type to RS232 FLOW-BUS (ProPar)

● Red		
Pattern	**Time**	**Indication**
off	continuous	No error
on	continuous	No liquid in measuring tube **OR** Pulsating flow rate **OR** Critical error; the instrument needs servicing before it can be used
short flash	0.1 sec on, 2 sec off	**FLOW-BUS** Node occupied: re-install instrument **PROFIBUS DP** No data exchange between master and slave (automatic recovery) **Modbus** Data is being received or transmitted
blink	0.2 sec on, 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. **PROFIBUS DP** Not used **Modbus** Not used
long flash	2 sec on, 0.1 sec off	**FLOW-BUS** Not used **PROFIBUS DP** Requested parameter not available **Modbus** Not used

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

3.3.5.1 DeviceNet™

DeviceNet™ instruments have different LED indications altogether, replacing the previously mentioned standard indications.

DeviceNet™ instruments have two bi-color LEDs (green/red), to indicate network and module status:

● /● (green/red) Network status (NET)
● /● (green/red) Module status (MOD)

The tables below list the different LED indications:

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

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

3.3.6 Multifunctional switch

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

The available functions are presented in a repeating sequence of patterns, where each pattern indicates a special function. To select and start a function, press and hold the switch until the LEDs show the pattern of the function to be started. By releasing the switch, the selected function is started.

Available functions in normal operating mode

- LED indications in this sequence are continuous

● (green)	● (red)	Time	Function
○	○	0…1 sec	No action
○	○	1…4 sec	FLOW-BUS: **Auto install to bus**; let the instrument obtain a free node address from the FLOW-BUS system Other fieldbuses: **reset alarm**
○	●	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 (only for flow meters/controllers)
●	●	12…16 sec	**Enable FLASH mode** for firmware update: • the instrument shuts down and both LEDs turn off • at the next power-up, the instrument will be active again

See Adjusting zero point for background information and instructions on how to adjust the zero point of an instrument. Never perform this procedure before having taken notice of the instructions.

Available functions during powering-up

- In order to access this sequence, press and hold the switch while powering-up the instrument.
- LED indications in this sequence are flashing (0.2 sec on, 0.2 sec off).

● (green)	● (red)	Time	Function
●	●	0...4 sec	No action
●	●	4...8 sec	Restore factory settings (except communication settings)
●	●	8...12 sec	**FLOW-BUS**: Auto install to bus; let the instrument obtain a free node address from the FLOW-BUS system
●	●	12...16 sec	Activate configuration mode: • The baud rate and bus type for the 5-pin M12 connector are set to 38k4 and RS232 FLOW-BUS (ProPar) • In configuration mode, the green LED blinks 2 seconds on and 0.1 second off • Configuration mode remains active after powering-down and can be deactivated by selecting this function again at the next start-up

To avoid unwanted use of the multifunctional switch, it can be disabled through the digital interface using the following procedure:

1. Set parameter *Init reset* to 64
2. Read parameter *IO status*
3. Subtract 8 from the read value
4. Write the new value to parameter *IO status*
5. Set parameter *Init reset* to 82

To re-enable te switch, add 8 to the value of *IO status* in step 3.

3.4 Digital parameters

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

FLOW-BUS
In a FLOW-BUS system, instrument configuration and operation can be done using the free Bronkhorst® FlowWare tools. These tools provide a graphical interface to the ProPar protocol (used by FLOW-BUS), for monitoring and changing instrument settings. Digital communication between the instrument and the client software (e.g. FlowPlot, FlowTune™) is handled by FlowDDE, a Dynamic Data Exchange server (DDE), the core component of the FlowWare software.

*The FlowWare tools and associated documentation can be downloaded from **http://www.bronkhorst.com/en/downloads**.*

Modbus
Monitoring and operating instruments in a Modbus system can be done using third party software as a master device, such as LabVIEW, ModScan, or a Modbus PLC.

PROFIBUS-DP
Monitoring and operating instruments in a PROFIBUS DP system can be done using third party software as a master device, such as SyCon® (by Hilscher GmbH) or Step 7 for PLC (by Siemens).

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

*A GSD file for Bronkhorst® instruments can be downloaded from **http://www.bronkhorst.com/en/downloads**.*

DeviceNet™
Monitoring and operating instruments in a DeviceNet™ system can be done using third party software as a master device, such as SyCon® (by Hilscher GmbH) or Step 7 for PLC (by Siemens).

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

*An EDS file for Bronkhorst® instruments can be downloaded from **http://www.bronkhorst.com/en/downloads**.*

3.4.1 General

This section contains information on the most commonly used parameters for operating the ES-FLOW. Descriptions are grouped by category in tables as shown below:

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

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 array (text string)

Access

R	The parameter is read-only
RW	The parameter can be read and written to
RW 🔑	The parameter is protected and can only be written to when *Init Reset* is set to value 'unlocked' first

Range

Some parameters only accept values within a certain range:

[x]	Minimum value of the range
[y]	Maximum value of the range

FlowDDE

Parameter number within FlowDDE

FLOW-BUS

Within the FLOW-BUS protocol (ProPar when using RS232), parameters are identified by a unique combination of a process number and a parameter number:

[Pro]	Process number
[Par]	Parameter number

*Consult **Instruction manual RS232 interface** (document no. 9.17.027) for detailed information.*
*This document can be downloaded from **http://www.bronkhorst.com/en/downloads***

Modbus

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

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

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

Other interface protocols

Consult the specific fieldbus manual for accessing parameters via fieldbus communication (see Other documents).

3.4.2 Special parameters

Init Reset

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

Init Reset is used to unlock secured parameters (designated by a 🔑 symbol) for writing. This parameter can be set to 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	FLOW-BUS	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	Restart batch 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 0 first.*

Wink

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char [27]	W	0…9	1	0/0	0x0000/1

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

Control Mode

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

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

Value	Mode	Instrument action	Setpoint source
0	BUS/RS232	Normal operation via fieldbus or RS232	Fieldbus or RS232
1	Analog Input	Normal analog operation	Analog input
2	FLOW-BUS Slave	Acting as slave instrument on FLOW-BUS	RS485 only: FLOW-BUS master output x *Slave Factor*/100%
3	Valve Close	Controller disabled, valve closed	
4	Controller Idle	Controller disabled, valve frozen in current position	
7	Setpoint 100%	Setpoint fixed to 100%	
8	Valve Fully Open	Controller disabled, valve fully open	
9	Calibration Mode	Calibration mode enabled (factory only)	
10	Analog Slave	Acting as slave of other instrument in analog mode	*Analog Input* x *Slave Factor*/00%
12	Setpoint 0%	Setpoint fixed to 0%	
13	FLOW-BUS Analog Slave	Acting as slave of other instrument on FLOW-BUS, slave factor is set by analog input signal	RS485 only: FLOW-BUS master output x *Analog Input*
18	RS232	Normal operation via RS232	RS232
20	Valve Steering	Controller disabled, setpoint redirected to *Valve output*	
21	Analog Valve Steering	Controller disabled, analog input redirected to *Valve output*	
22	Valve Safe State	Valve is in safe state (closed for N.C. valves, fully open for N.O. valves)	

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

3.4.2.1 Default control mode

IO Status

Type	Access	Range	FlowDDE	FLOW-BUS	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 will always return to its default control mode at every power-up or reset. Parameter *IO Status* sets this default control mode; to change it, use the procedures as described below.

Changing from digital operation to analog operation:
1. Set parameter *Init Reset* to 64
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

Changing from analog operation to digital operation:
1. Set parameter *Init Reset* to 64
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

3.4.3 Measurement and control

Measure

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

This parameter indicates the flow metered by the instrument. The signal of 0…100% is presented in a range of 0…32000. The maximum measured value output is 131.07%, which translates to 41942.

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

This parameter is used to set the required flow rate for the controller. The signals have the same range as *Measure*, only the setpoint is limited between 0 and 100% (0…32000).

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 variant of *Measure*. *Fmeasure* shows the measured value in the capacity and capacity unit for which the instrument has been set. *Fmeasure* is dependent of *Capacity Unit* and *Sensor Type*.

Fsetpoint

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

Floating point variant of *Setpoint*. *Fsetpoint* shows the setpoint in the capacity and capacity unit for which the instrument has been set. *Fsetpoint* is dependent of *Capacity Unit* and *Sensor Type*.

Setpoint Slope

Type	Access	Range	FlowDDE	FLOW-BUS	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 with 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	FLOW-BUS	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	FLOW-BUS	Modbus
Unsigned long	RW	0… 16777215	55	114/1	0xF208…0xF209/61961…61962

Digital steering signal for driving the control valve, where 0…16777215 corresponds with 0…100%.

3.4.4 Device identification

User Tag

Type	Access	Range	FlowDDE	FLOW-BUS	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	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

Instrument serial number for identification.

BHT Model Number

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char[27]	RW	-	91	113/2	0xF110…0xF117/ 61713…61720

This parameter shows the Bronkhorst® instrument model type information.

Firmware Version

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

Revision number of the firmware

Identification Number

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

Bronkhorst® (digital) device type identification number.

Device Type

Type	Access	Range	FlowDDE	FLOW-BUS	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.

3.4.5 Alarms

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

Alarm Mode

Type	Access	Range	FlowDDE	FLOW-BUS	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)

(For DeviceNet™, only modes 0 and 1 are available)

Alarm Info

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

This parameter provides information about the event type(s) that activated an alarm situation. Up to 8 different event types can be specified. The value is a bit-wise summation of the specified alarm types; convert the value to binary to see which types are specified. The following alarm types are supported:

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	Alarm possibly caused by a power dip
		• If combined with bit 2 or 3: Response alarm	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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	Modbus
Unsigned char	RW	0…15	156	97/9	0x0C29/3114

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

The following methods are supported:

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

3.4.6 Counter

Counter settings are most easily accessible via FlowPlot or FlowView or a Bronkhorst® readout and control unit.

Counter Mode

Type	Access	Range	FlowDDE	FLOW-BUS	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	FLOW-BUS	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

Counter Value

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

Available reset methods for counters. Up to 3 different methods can be specified. The value is a bit-wise 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	Micro-switch
1	2	External
2	4	By parameter *Reset*
3	8	Automatic (e.g. when counter value is reset)

3.4.7 Network configuration

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

Communication via fieldbus connection (RS485)
Use the following parameters to configure the instrument for communication via the fieldbus connection (5-pin M12):

Bus Address

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

Baud Rate

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

Bus 1 Parity

Type	Access	Range	FlowDDE	FLOW-BUS	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

Communication via standard connection (RS232/RS485)
Use the following parameters to configure the instrument for communication via the 8-pin M12 connection:

If the 9-pin D-sub (side) connector of the instrument is configured for RS485 communication (FLOW-BUS/Modbus), it will not respond when connected to an RS232 configuration. In that case, use the power-up functionality of the multifunctional switch to switch to configuration mode and enable RS232 communication.
After configuring the required parameters, remember to return the instrument to the original communication mode.

Bus 2 Address

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

Bus 2 Baud Rate

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

Bus 2 Parity

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char	RW	0…2	336	124/12	0x0F8C/3981

The following values are supported:

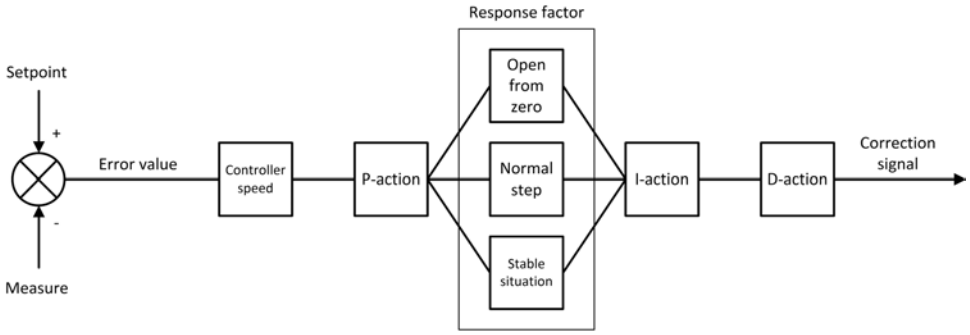
Value	Description
0	No parity
1	Odd parity
2	Even parity

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

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

3.4.8 Controller

The picture below shows a basic diagram of the PID controller algorithm (proportional, integral, derivative) used in a digital instrument.



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 basic components:
- 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.

Because controlling characteristics are optimized during manufacture, Bronkhorst strongly advises not to change these parameters. If changing controller settings is absolutely necessary, it should be performed by or under supervision of trained service personnel only.

Controller Speed

Type	Access	Range	FlowDDE	FLOW-BUS	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 set. *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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	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	FLOW-BUS	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* * $1.05^{(\text{response factor - 128})}$

3.4.9 Master/slave configuration

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

The output value of any instrument connected to FLOW-BUS is automatically available to all other instruments (without extra wiring). A FLOW-BUS system can have multiple masters and slaves. A slave instrument can also be a master to other instruments.

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

The slave instrument periodically polls the output value of its master and multiplies it by the slave factor, thus setting its own flow to a percentage of the master's.

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

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

Master Node

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

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

Slave Factor

Type	Access	Range	FlowDDE	FLOW-BUS	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 via RS485, *Slave Factor* is effective only if *Control Mode* is set to 'Analog slave', and the analog output signal of the master instrument is redirected to the input of the slave instrument.

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

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

3.5 Adjusting zero point

The zero point of the instrument (the point at which it detects no flow) is factory adjusted at approximately 20 °C and atmospheric pressure. If the ambient conditions or mounting position are significantly different, the instrument may detect a flow when actually there is none. In that case, the instrument needs to be adapted to the new conditions by re-adjusting the zero point.

Zeroing an instrument requires that:

- the ambient conditions (temperature, pressure) match those of the operating environment of the instrument
- the instrument is filled homogeneously with the operational media
- there is absolutely no fluid flow through the instrument; preferably, this is done by closing valves directly after the outlet of the instrument (control valve, shut-off valve)

The zeroing procedure can be performed in the following ways:
- with the autozero function of the integrated user interface module
- manually (using the multifunctional switch)
- digitally (via RS232 or fieldbus)

Once started, the zeroing procedure takes approximately 25 seconds to complete (longer if the output signal is unstable), regardless of the preferred method.

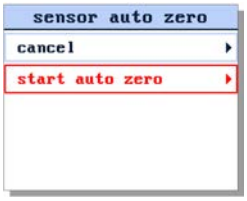
3.5.1 Autozero function

The readout and control unit provides an automatic function for re-adjusting the zero-point of a flow meter, which automatically steps through the required parameter settings. This autozero function can be found in the *Advanced* section of the *Settings* menu:

1. In the *Settings* menu, select the *Advanced* item:

2. Enter the *Advanced* sub menu and select the *Autozero* item:

3. Enter the *Autozero* sub menu and select *Start auto zero*:



4. Press ↵ to start the procedure and wait until it is finished:

3.5.2 Manual procedure

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 ● starts glowing for 4 seconds, after which the green LED ● starts glowing
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 function is being performed. On (successful) completion, the green LED starts to glow continuously, while the output signal is 0% (parameter *Measure* = 0).

3.5.3 Digital procedure

FlowPlot provides an easy way to adjust the zero point of an instrument via RS232; the Auto zero *function automatically performs the procedure described below.*

To re-adjust the zero point using digital communication (RS232 or fieldbus), set parameter values in the following sequence:

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

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

After performing the procedure, remember to set parameter Init reset *to value 0 to lock secured parameters*

4 Maintenance

4.1 General

No regular maintenance is required if the ES-FLOW is operated properly, with clean media, compatible with the wetted materials, avoiding pressure and thermal shocks and vibrations. Units may be purged with a clean, dry and inert gas.

In case of severe contamination, cleaning the inside of the device may be required. After cleaning, the instrument has to be re-calibrated.

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

4.2 Calibration

The ES-FLOW is factory calibrated. Bronkhorst certifies that the instrument meets the rated accuracy. Calibration is performed using measurement standards traceable to the Dutch Metrology Institute (VSL). Calibration certificates are included in the scope of delivery.

Periodical inspection, recalibration or verification of the accuracy may be subject to individual requirements of the end user.

5 Troubleshooting and service

For a correct analysis of the proper operation of an instrument, it is recommended to disconnect 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 performing a visual inspection.

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

If you suspect leakage, do not disassemble the instrument for inspection, but contact your local distributor for service or repairs.

5.1 Common issues

Symptom	Possible cause	Action
Red LED glows continuously, while display shows irregular measure readout	No liquid in measuring tube	Fill fluidic lines with process liquid before starting measurement and control (see First use)
	Inlet pressure unstable (flow rate pulsating)	Eliminate pressure fluctuations, e.g. by installing a pressure regulator
Red LED glows continuously, display shows no flow	Hardware error	Return equipment to factory
No (fieldbus) communication	No power supply	• Check power supply • Check cable connection • Check cable hook-up
	Invalid node address	Change node address (see Network configuration)
	Other	Reset instrument and/or restart master. If problem persists, contact Bronkhorst.
No output signal	No power supply	• Check power supply • Check cable connection • Check cable hook-up
	Sensor failure	Return equipment to factory
• Control behavior unstable • Red LED flickers or flashes irregularly	Inlet pressure unstable (flow rate pulsating)	Eliminate pressure fluctuations, e.g. by installing a pressure regulator
	Gas accumulation in tubing	Flush the system to remove gas
	Wrong controller settings	Adjust settings (e.g. with FlowPlot)
No flow (sending a setpoint has no effect)	No fluid supply	Check upstream components for obstruction, e.g.: • fluidic lines • valves • filters
	Inlet pressure or differential pressure out of bounds	Set inlet pressure to a value within specifications
Flow rate or pressure 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) • 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

Symptom	Possible cause	Action
	Outlet pressure too high	Check/decrease outlet pressure
	Process outlet blocked	Check process outlet and downstream piping
Measured value or output signal (much) lower than setpoint	Inlet pressure or differential pressure too low	• Increase inlet pressure • Use instrument in conditions it was designed for
	Piping or filters blocked or contaminated	Clean system
	Supplied fluid type does not match configured fluid type	Supply equipment with other fluid or change fluid type in instrument configuration
Measured value or output signal indicates a flow, while there is none	Instrument not mounted horizontally or ambient conditions differ significantly from conditions stated on instrument label	• Follow mounting instructions • Use instrument in conditions it was designed for • Adjust zero point (see Adjusting zero point)
	System leakage	Check the system for leakage. Follow vendor instructions when installing third party components (e.g. adapters, tubing, valves)
Continuous maximum measured value or output signal	Inlet pressure too high	Check inlet pressure
	Sensor failure	Return equipment to factory

5.2 Service

For current information on Bronkhorst® 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:

+31 859 02 18 66

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

6 Removal and return instructions

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

Instrument handling:

1. Purge all gas and/or liquid lines
2. If toxic or dangerous fluids have been used, the instrument must be cleaned before shipping
3. Disconnect all external cabling and tubing and remove the instrument from the process line
4. If applicable, secure movable parts with appropriate transport safety materials, to prevent damage during transportation
5. The instrument must be at ambient temperature before packaging
6. Insert the instrument into a plastic bag and seal the bag
7. Place the bag in an appropriate shipping container; if possible, use the original packaging box

Add documentation:

- Reason of return
- Failure symptoms
- Contaminated condition
- Declaration on decontamination

It is absolutely required to notify the factory if toxic or dangerous fluids have been in contact with the device!
This is to enable the factory to take sufficient precautionary measures to safeguard the staff in their repair department.

All instruments must be dispatched with a completely filled in 'Declaration on decontamination'. Instruments without this declaration will not be accepted.

A 'Declaration on decontamination' form (document no 9.17.032) can be downloaded from ***http://www.bronkhorst.com/en/downloads****.*

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

NL801989978B01

(only if applicable, otherwise contact your distributor for local arrangements.)