



Instruction Manual



LIQUI-FLOW™ mini Series **Digital Liquid Mass Flow Meters**

Doc. no.: 9.17.065H Date: 09-03-2017



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.



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.

Copyright

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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. When the packing 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 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 local sales representative.



*Check the packing list to ensure that you received all of the items.
Do not discard spare or replacement parts with the packing 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 packing 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 subjected 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 undeterminable 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® 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.

Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation.

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, test leads, cracks, or breaks before each use.

The module and accessories must be used in accordance with its specifications and operating instructions or 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.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

Surfaces near the  symbol may be hot.

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. (Note that selected parts should be obtained only through Bronkhorst® to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Bronkhorst® office for information.

Table of contents

1	Scope of this manual	6
1.1	Introduction	6
1.2	Product description	6
1.3	References to other applicable documents	6
2	Starting up	7
2.1	Check properties	7
2.2	Rated pressure test inspection	7
2.3	Check piping	7
2.4	Install system	7
2.5	Leak check	8
2.6	Electrical connection	8
2.7	Hook-up diagram	8
2.8	Analog / digital operation	9
2.9	Multi-functional switch operation	9
2.10	Purging	9
2.11	Zeroing	10
2.12	Calibration	10
2.13	Supply pressure	10
2.14	Measuring principle	10
2.15	Model key	11
3	Basic operation	12
3.1	General	12
3.2	Analog operation	12
3.3	Manual interface: micro-switch and LEDs	13
3.3.1	Micro-switch operation	13
3.3.2	LED functions	14
3.4	Basic RS232 operation	14
3.4.1	Hook-up	14
3.4.2	Dynamic Data Exchange (DDE)	15
3.4.3	FlowDDE	15
3.4.4	Software	15
3.4.5	FlowDDE parameter numbers	16
3.4.6	Baud rate setup	16
3.5	Basic RS485 operation	16
3.5.1	Hook-up	16
3.5.1.1	FLOW-BUS setup	16
3.5.1.2	Modbus setup	17
3.5.1.3	RS232 stand alone setup	17
3.5.2	Software	17
3.5.3	Slave address, baud rate and parity setup	17
3.6	Basic parameters and properties	18
3.6.1	Introduction	18
3.6.2	Basic measurement parameters	19
3.6.3	Basic identification parameters	19
4	Advanced operation	20
4.1	Reading and changing instrument parameters	20

4.1.1	Special parameters	20
4.1.2	Fluid information	21
4.1.3	Advanced measurement parameters	22
4.1.4	Display filter	23
4.1.5	Alarm / Status parameters	23
4.1.6	Counter parameters	23
4.2	Special instrument features	24
4.2.1	Auto zeroing	24
4.2.2	Changing default control mode	24
4.2.3	Disabling micro switch	24
4.2.4	Changing slave address, baud rate and parity	26
5	Troubleshooting and service	28
5.1	General	28
5.2	LED indication	28
5.3	Troubleshooting summary general	28
5.4	Service	29
6	Removal and return instructions	29

1 Scope of this manual

1.1 Introduction

This manual covers the LIQUI-FLOW™ mini series mass flow meters for micro fluidic flow. An example of the instrument is shown in the picture below. This manual includes product information, installation instructions, operation, maintenance and troubleshooting.

LIQUI-FLOW™ mini instruments are one of the smallest micro fluidic Mass Flow Meters (MFM) of its kind. The very compact instruments with dimensions 20 x 40 x 60 mm are capable of measuring ultra low flow rates in ranges starting from 1.5...75 mg/h up to 12...600 mg/h, based on water. The straight, duplex steel sensor tube (W1.4462) has an internal volume of less than 1 mm³ and operates on the thermal measuring principle. Due to its high pressure rating of max. 1200 bar (17400 psi) the MFM is suited for HPLC systems. The instruments are equipped with a microprocessor-based printed circuit board, offering high accuracy and excellent temperature stability. The RJ45 connection is used for power supply and for both analog and digital (RS232/RS485) communication.



1.2 Product description

A LIQUI-FLOW™ mini flow meter consists of a thermal mass flow sensor with a digital electronic PC-board for sensor enhancement and communication. The sensor consists of a straight capillary with two heat resistant wires wound around it. The measuring principle is explained briefly in **section 2.14**. The sensor signal is measured and digitized directly at the sensor by the PC-board. The internal software (firmware) processes the signal (linearisation and amplification) to the desired signal level, which is then translated to the desired output. Each instrument is equipped with an analog and a digital interface, which can be used simultaneously. Digital operation adds a lot of extra features (compared to analog operation) to the instruments, such as direct reading at readout/control module or host computer, identification (serial number, model number, device type, usertag) and adjustable instrument settings.

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, see **section 3**.

1.3 References to other applicable documents

Instructions:

- LIQUI-FLOW™ mini Quick Installation Guide (document nr. 9.17.066)
- 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 LIQUI-FLOW™ mini RS232/RS485 + Analog I/O (document nr. 9.16.097)
- Dimensional drawing LIQUI-FLOW™ mini (document nr. 7.05.823)



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

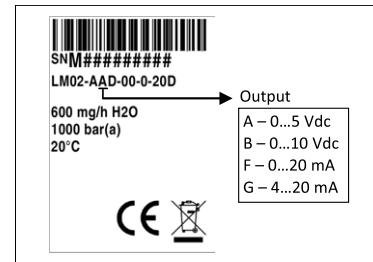
2.1 Check properties



1. Check LIQUI-FLOW™ mini properties

Before installing it is important to read the attached label and check:

- Flow rate
- Pressure
- Fluid to be measured
- Input and output signals
- Temperature

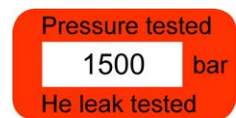


2.2 Rated pressure test inspection



Each LIQUI-FLOW™ mini instrument is pressure tested to at least 1.5 times the working pressure of the process conditions stipulated by the customer.

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 particle-free liquid stream. Recommended pore-size: 2 µm. If back flow can occur, a downstream filter is recommended too. Be aware of the pressure drop caused by using filters.

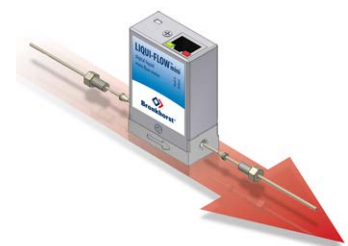


2.4 Install system



For LIQUI-FLOW™ mini the upright position is preferred. When using a LIQUI-FLOW™ mini 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.

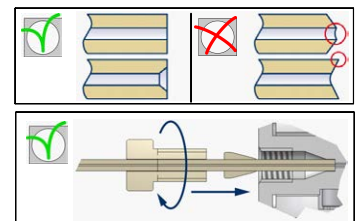
Install the LIQUI-FLOW™ mini instrument in the line, in accordance with the direction of the FLOW arrow. The arrow for flow direction is indicated on the body of the instrument. If applicable follow the guidelines of the supplier of the fittings. Special types of fittings are available on request.



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.



2.5 Leak check



Check the system for leaks before applying (fluid) pressure. Especially if toxic or other dangerous fluids are used!

2.6 Electrical connection



Electrical connections must be made with a standard cable or according to the LIQUI-FLOW™ mini hook-up diagram. Several hook-up examples and standard cables are found in **section 3**. LIQUI-FLOW™ mini 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.

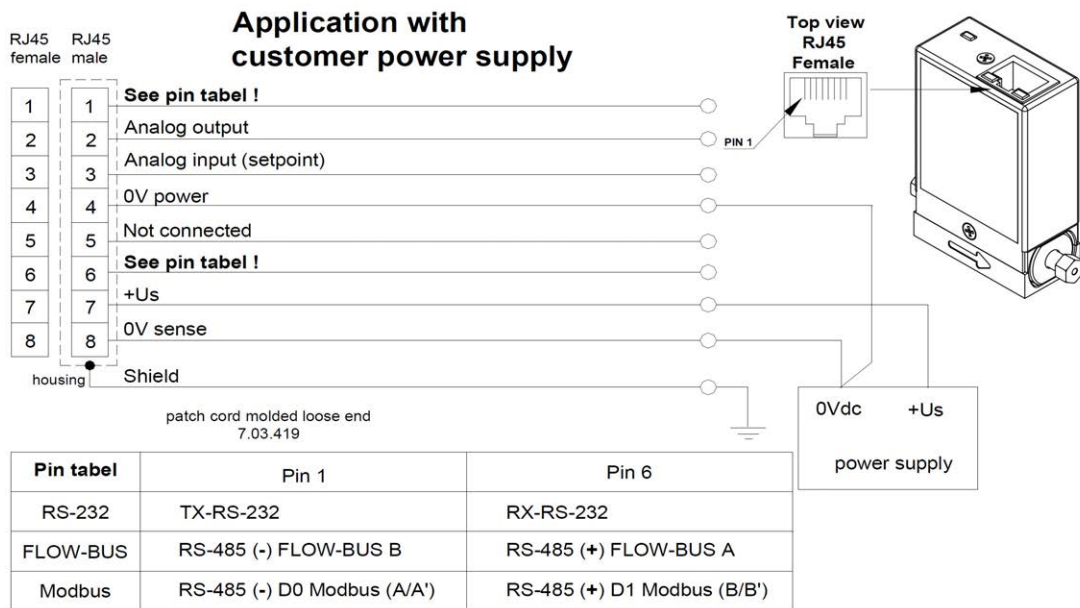


The instruments described in this manual carry the CE-mark and are **compliant with the EMC requirements**. However compliance with the EMC requirements is not possible without the use of proper cables and connector/gland assemblies. Bronkhorst® recommends the use of their standard cables. These cables have the right connectors and if loose ends are used, these 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 Hook-up diagram

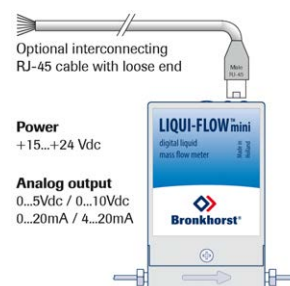


2.8 Analog / digital operation



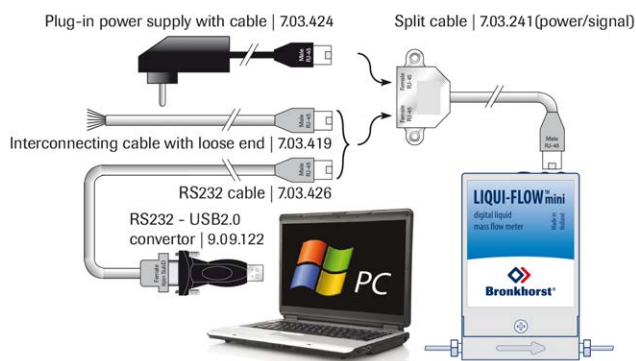
Analog operation

For analog operation refer to the "Hook-up diagram LIQUI-FLOW™ mini" 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

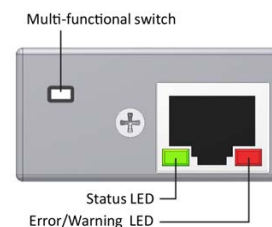
With digital operation over RS485 a bus-system with multiple instruments can be set up. See **section 3.5** for possible systems.

2.9 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.



2.10 Purging



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 an inert fluid is absolutely necessary before use. After use with toxic or other dangerous fluids, complete purging is also required before exposing the system to air.



Waste fluid

Make sure not to spill fluid on the instrument while purging. Always keep the sensor exterior dry.



Warm-up time

Let the LIQUI-FLOW™ mini warm-up for at least 30 minutes for best accuracy. During warm-up period, fluid pressure may either be on or off.

2.11 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:

- 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.
- 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.

2.12 Calibration



Each LIQUI-FLOW™ mini instrument is factory calibrated. Bronkhorst® 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 fluid, 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.

2.13 Supply pressure



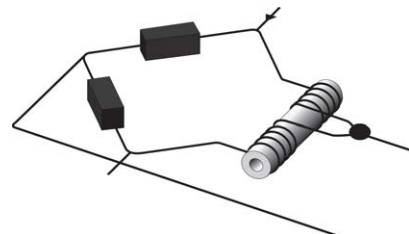
It is recommended to turn on power before applying pressure on the instrument and to switch off power after removing pressure.



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.

2.14 Measuring principle

The liquid flow sensor operates on a principle of heat transfer by sensing the temperature difference along a heated section of a capillary tube. The temperature difference sensed by the upstream and downstream temperature sensors on the capillary depends on the amount of heat absorbed by the fluid flow. The temperature sensors are part of a bridge circuit, as seen in the figure. The measured imbalance of the bridge, caused by the flow in the capillary is linearised to the mass flow rate and amplified to the desired signal level.



Thermal sensor in a bridge configuration

The transfer function between mass flow and sensor signal can be described by the equation:

$$V_{\text{signal}} = K \cdot c_p \cdot \dot{O}_m$$

with:

V_{signal} = sensor signal

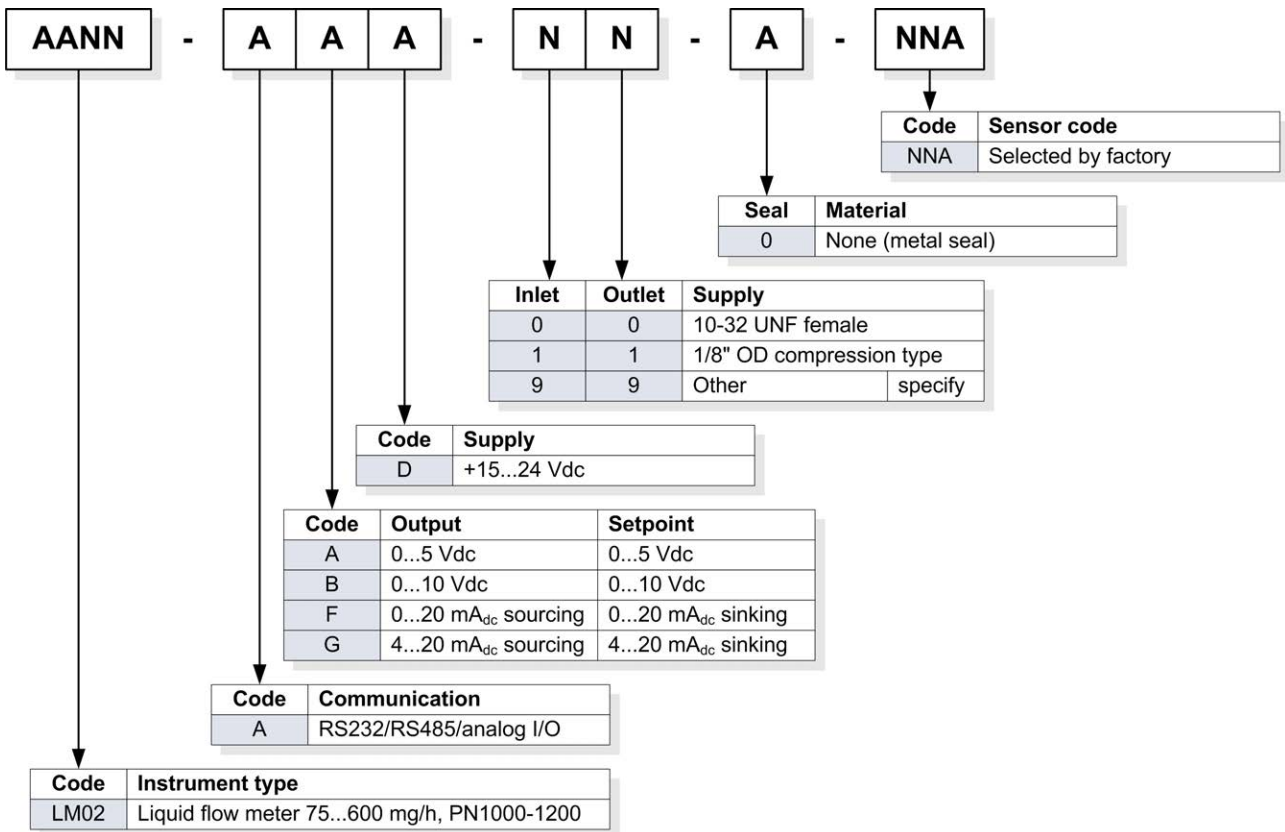
K = constant factor

c_p = specific heat of the fluid

$\dot{O}_m$ = mass flow

From this formula it can be concluded that for each different fluid (with heat capacity c_p) a certain sensor signal represents a different mass flow. Using accurate fluid data and a conversion factor it is possible to predict the mass flows for liquids other than water.

2.15 Model key



3 Basic operation

3.1 General

A LIQUI-FLOW™ mini 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
- 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.

	Analog interface (section 3.2)	Digital RS232 interface (section 3.4)	Digital RS485 interface (section 3.5)
LM02	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, 56000, 57600 or 115200 Baud; FLOW-BUS protocol on 187500 or 400000 Baud (software selectable)

3.2 Analog operation

At analog operation the measured value (analog output) is available at pin 2.

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.

See **section 2.15**.



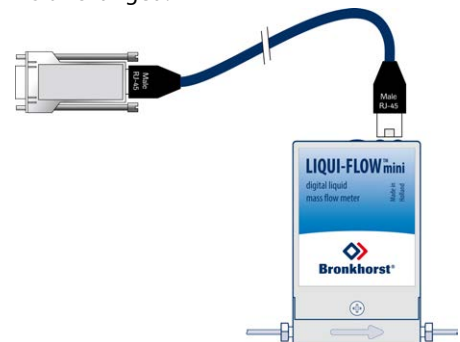
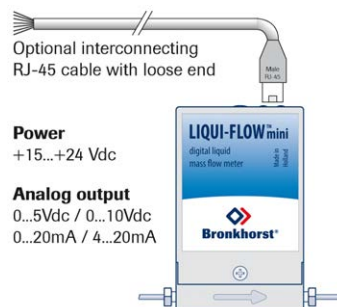
When operating the instrument through the analog interface it is possible to connect the instrument simultaneously to RS232 for reading/changing parameters (e.g. settings or fluid selection).

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 **section 2.7** 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 and LEDs

In this section the manual instrument interfaces are described. In **section 3.3.1** the micro-switch operation is explained, **section 3.3.2** specifies the LED functionality.

3.3.1 Micro-switch operation

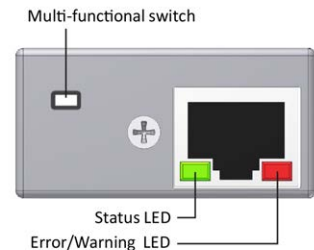
By means of manual operation of the micro push-button switch some important actions for the instrument can be selected or started. These options are available in both analog and digital operation mode.

These functions are:

- Reset alarm
- Reset instrument (firmware program reset)
- Auto-zeroing
- Restore factory settings (in case of accidentally 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 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 section 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 2.11 .
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	On	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 recognized by the green LED blinking 2 sec on, 0,1 sec off. 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:
http://www.bronkhorst.com/files/downloads/manuals_english/917023_operation_instructions_digital_instruments.pdf (document nr. 9.17.023, Chapter 11)

3.4 Basic RS232 operation

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

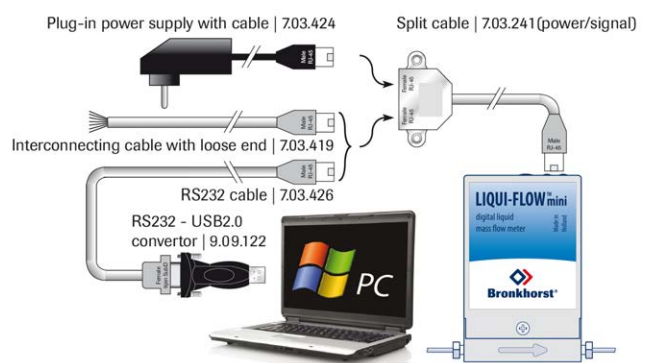
- Up to eight selectable fluids (if installed)
- Direct reading at readout/control module or host computer
- Testing and self diagnosis
- Identification (serial number, model number, device type, user tag)
- Adjustable minimal and maximal alarm limits
- (Batch) counter

3.4.1 Hook-up

Connecting a LIQUI-FLOW™ mini 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 micro controller devices.

See **section 2.7** for the Hook-up diagram.

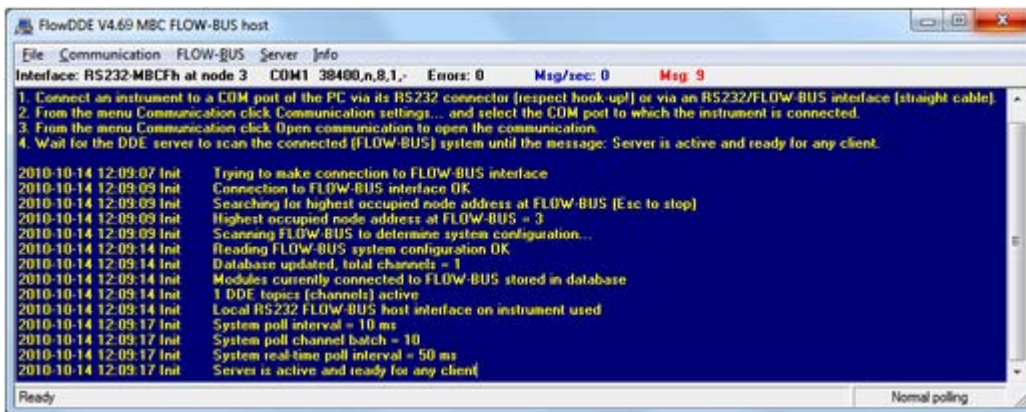


3.4.2 Dynamic Data Exchange (DDE)

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 LIQUI-FLOW™ mini and when the measured value changes, it will be updated automatically in the Excel spreadsheet.

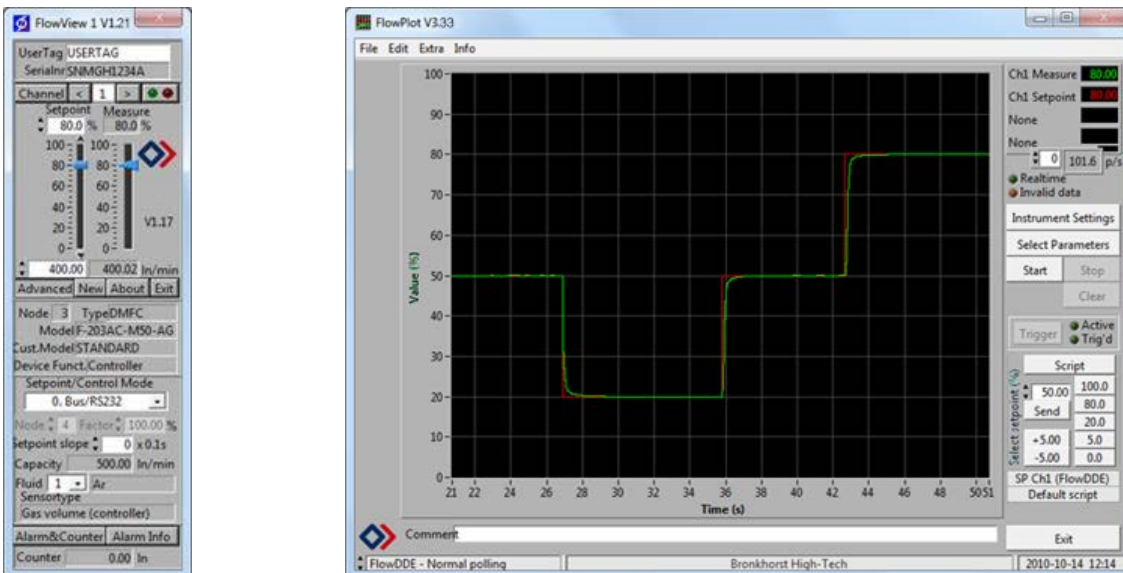
3.4.3 FlowDDE

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.



3.4.4 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® website: http://www.bronkhorst.com/en/products/accessories_and_software/bronkhorst_flowware/

3.4.5 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)'

3.4.6 Baud rate setup

Make sure that the instrument's baud rate corresponds with the baud rate of the application the instrument is communicating with. The selectable baud rates are 9K6, 19K2, 38K4, 57K6 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.

http://www.bronkhorst.com/files/downloads/manuals_english/917027manual_rs232_interface.pdf

3.5 Basic RS485 operation

This section is limited to the description of the interface between the LIQUI-FLOW™ mini instrument with a master device. LIQUI-FLOW™ mini 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.

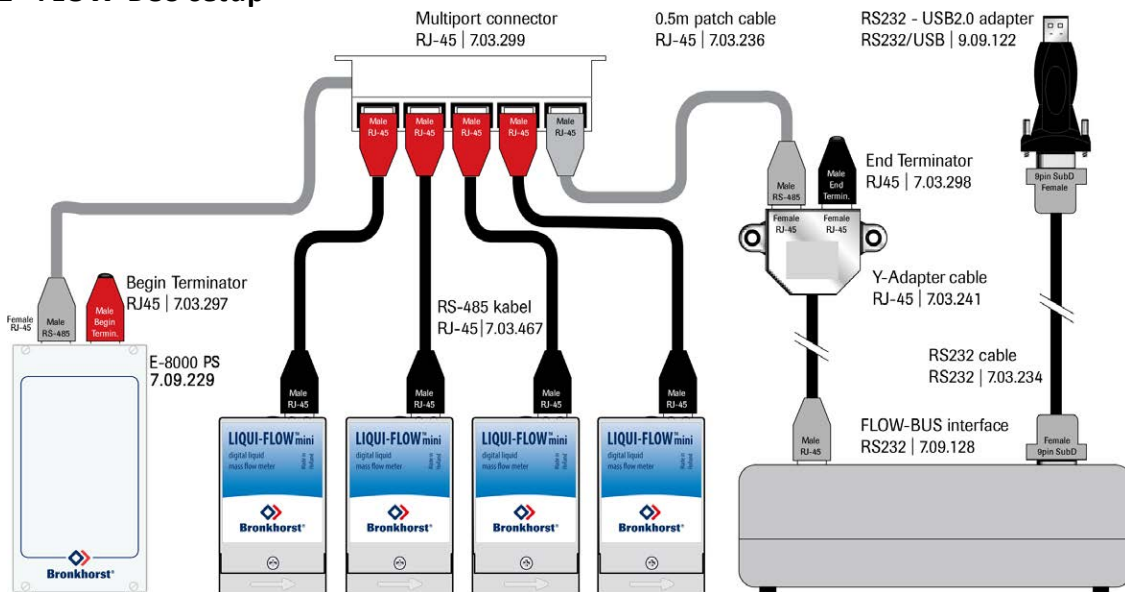


More detailed information about Modbus can be found at <http://www.modbus.org> or any website of the (local) Modbus organisation of your country (when available).

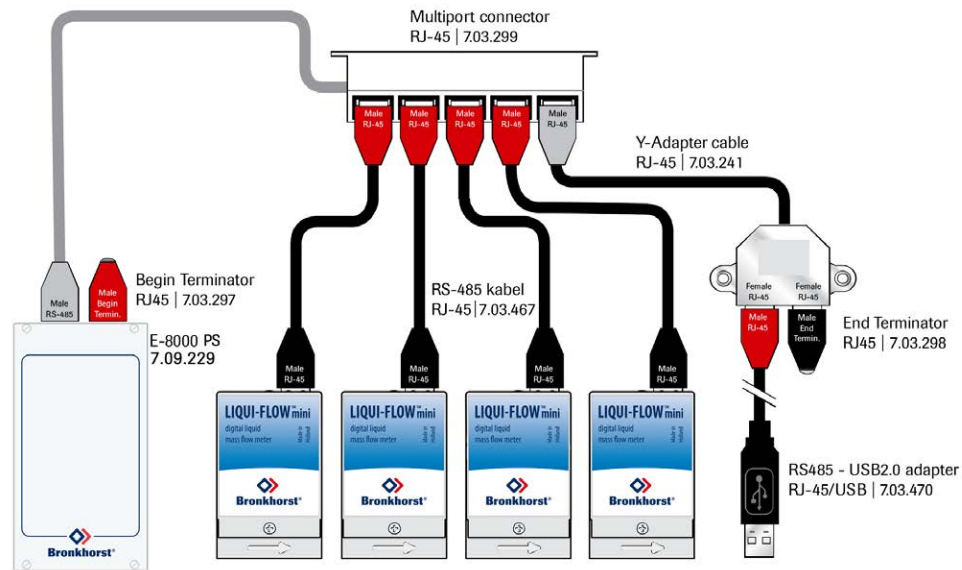
3.5.1 Hook-up

The illustrations below show examples of LIQUI-FLOW™ mini instruments in an RS485 bus-system.

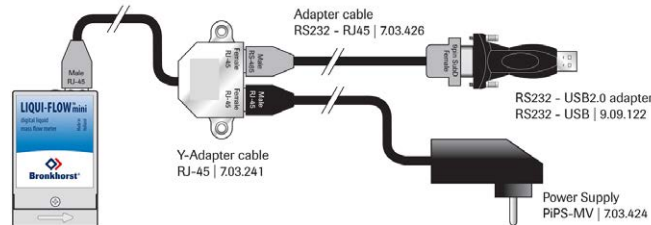
3.5.1.1 FLOW-BUS setup



3.5.1.2 Modbus setup



3.5.1.3 RS232 stand alone setup



3.5.2 Software

When using a pc to communicate with LIQUI-FLOW™ mini 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: a LIQUI-FLOW™ mini instrument set for RS485 FLOW-BUS or Modbus communication will not respond 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).

3.5.3 Slave address, baud rate and parity setup

The LIQUI-FLOW™ mini 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.

Mode:	Analog	Digital			
Interface/medium:	-	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

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 shown 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.

http://www.bronkhorst.com/files/downloads/manuals_english/917027manual_rs232_interface.pdf

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 (identifiable by the '0x' prefix), which corresponds to the decimal register number minus one, e.g. PDU Address 0x0000 equals register number 1, PDU Address 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 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.
http://www.bronkhorst.com/files/downloads/manuals_english/917023_operation_instructions_digital_instruments.pdf

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**.

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.

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 LIQUI-FLOW™ mini. Please be aware that wrong settings can disorder the output. To avoid unintentional 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 *	FLOW-BUS *	Analog input

Value	Mode	Instrument action	Setpoint source	Master source	Slave factor
			slave factor / 100%	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. http://www.bronkhorst.com/files/downloads/manuals_english/917023_operation_instructions_digital_instruments.pdf

4.1.2 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 calibration 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.

http://www.bronkhorst.com/files/downloads/manuals_english/917023_operation_instructions_digital_instruments.pdf

4.1.3 Advanced measurement 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%'.

4.1.4 Display filter

The output signal of a LIQUI-FLOW™ mini 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	FLOW-BUS	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	FLOW-BUS	Modbus
Float	RW 	0...1.0	57	117/2	0xF510...0xF511/62737...62738

This value should not be changed.

CycleTime

Type	Access	Range	FlowDDE	FLOW-BUS	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

4.1.5 Alarm / Status parameters



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

http://www.bronkhorst.com/files/downloads/manuals_english/917023_operation_instructions_digital_instruments.pdf

4.1.6 Counter parameters



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

http://www.bronkhorst.com/files/downloads/manuals_english/917023_operation_instructions_digital_instruments.pdf

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
- Write 'IOStatus'

Procedure for changing default analog operation to default digital operation:

- Read 'IOStatus'
- Subtract 64 from the read value
- Write 'IOStatus'

4.2.3 Disabling micro switch

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.

0 = micro switch disabled

1 = micro switch enabled

Procedure to enable the micro switch:

- Read 'IOStatus'
- Add 8 to the read value $(OR[0x08])$
- Write 'IOStatus'

Procedure to disable the micro switch:

- Read 'IOStatus'
- Subtract 8 from the read value $(AND[\overline{0x08}])$
- Write 'IOStatus'

4.2.4 Changing slave address, baud rate and parity

Changing node address or baud rate by micro-switch operation

Press the micro-switch 5x briefly with intervals of max. 1 second in normal running/operation mode. Within the timeout period of 60 seconds it is possible to start changing the node address and baud rate of the instrument.

Step	Action	Indication	Time	Handling
1	Start			Press the switch 5x briefly with intervals of max. 1 second in normal running/operation mode.
2	Set tens of bus address	 Green LED flashes 0.1 sec on, 0.1 sec off count flashes start when switch is pressed: 0.5 sec on, 0.5 sec off	timeout: 60 sec	Press switch and count green flashes for tens of bus address. Release when wanted amount has been count. Counts up to max. 12 and than starts at 0 again. When counting fails, keep switch pressed and restart counting for next attempt.
3	Set units of bus address	 red LED flashes 0.1 sec on, 0.1 sec off count flashes start when switch is pressed: 0.5 sec on, 0.5 sec off	timeout: 60 sec	Press switch and count red flashes for units of bus address. Release when wanted amount has been count. Counts up to max. 9 and than starts at 0 again. When counting failed, keep switch pressed and restart counting for next attempt.
4	Set baud rate of field bus communication. 1 = 9600 Baud 2 = 19200 Baud 3 = 38400 Baud 4 = 56000 Baud 5 = 57600 Baud 6 = 115200 Baud	both  red and  green LEDs flashes 0.1 sec on, 0.1 sec off count flashes start when switch is pressed: 0.5 sec on, 0.5 sec off	timeout: 60 sec	Press switch and count red and green flashes for baud rate setting. Release when wanted amount has been count. Counts up to max. 5 and than starts at 0 again. When counting failed, keep switch pressed and restart counting for next attempt. Note: selection of 0 means: No change

Instrument returns to normal running / operation mode. Changes are valid when they are made within the time-out times.



Value zero will be indicated by a period of 1 sec off (0.5 sec off + 0.5 sec off).
When value zero is wanted, press switch shortly and release it again within 1 sec.



Before each action of flash-counting, the LEDs to be used for counting will flash in a high frequency.
(Pattern: 0.1 sec on, 0.1 sec off). As soon as the switch is pressed-down, this LED (or both LEDs) will be off and the counting sequence will start.

Changing node address, baud rate or parity in 'Configuration Mode' or in normal mode

The procedure for changing the baud rate, node address or parity for a FLOW-BUS or Modbus configuration over RS485 is described in **Section 3.5.3**. In the list below the selectable bus parameters with corresponding values are presented.



When changing any of the parameters below in normal running/operation mode the communication with the instrument may be lost. After a restart the instrument is available for communication on the newly selected parameters. When in doubt activate the 'Configuration Mode' (38k4 and RS232 FLOW-BUS (Propar)) using the micro-switch.

Fieldbus 2 selection

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char	RW 	0...3	308	124/8	0xFC40/64577

This parameter sets the fieldbus type. Parameter value 0 = FLOW-BUS, 1 = Modbus RTU, 2 = Propar, 3 = Modbus ASCII

Fieldbus 2 address

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char	RW 	0...255	309	124/10	0xFC50/64593

Set the node address at any of the allowed values listed in the table in **Section 3.5.3**, e.g. '3'.

Fieldbus 2 baud rate

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char	RW 	0...1E+10	310	124/9	0xFC48...0xFC49/64585...64586

Set the baud rate at any of the allowed values listed in table in section **Section 3.5.3**, e.g. '19200'.

Fieldbus 2 medium

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char	RW 	0...1	311	124/11	0xFC58/64601

Select the communication medium. Parameter value 0 = RS232, 1 = RS485

Fieldbus 2 parity

Type	Access	Range	FlowDDE	FLOW-BUS	Modbus
Unsigned char	RW 	0...2	336	124/12	0xFC60/64609

Set the parity for Modbus communication. Parameter value 0 = None, 1 = Odd, 2 = Even.

5 Troubleshooting and service

5.1 General

For a correct analysis of the proper operation of an instrument 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/files/downloads/manuals_english/917023_operation_instructions_digital_instruments.pdf

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 definitely 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® 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

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Nijverheidsstraat 1A
NL-7261 AK Ruurlo
The Netherlands

6 Removal and return instructions

Instrument handlings:

- Purge gas lines
- When toxic or dangerous fluids have been used, the customer should pre-clean the instrument
- Remove instrument from line
- The instrument must be at ambient temperature before packaging
- Insert the instrument into a plastic bag and seal the bag
- Place the bag in a 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.

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

Important:

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

NL801989978B01

If applicable, otherwise contact your distributor for local arrangements.



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