Instruction manual

Modbus slave interface for digital Mass Flow / Pressure instruments

Doc. no.: 9.17.035S Date: 27-03-2013

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

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Disclaimer

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Bronkhorst High-Tech B.V.
July 2011

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.

Warranty

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

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

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

It excludes failures and damage caused by the customer, such as contamination, improper electrical 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 party 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 for by the customer.

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1 GENERAL PRODUCT INFORMATION

1.1 Introduction

This manual covers the Modbus interface, which offers a direct connection to Modbus for Bronkhorst[1)] digital mass-flow / pressure meters / controllers. The Modbus instrument will behave as a slave. This means all communication (instructions / readout) will be performed by a master device on the same Modbus system. Mostly this will be a PC controlling a process. This manual explains how to install a Bronkhorst instrument to your Modbus system.

[1)] ***Bronkhorst:*** ***This includes Bronkhorst High-Tech B.V. , Bronkhorst Cori-Tech B.V. and M+W Instruments GmbH.***

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

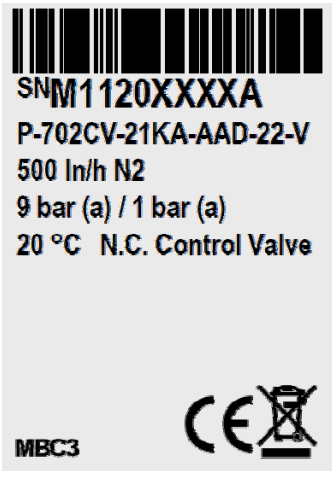
The implementation of the Modbus interface is based on the following standards:

[1]	*Modbus_Application_Protocol_V1_1b.pdf*	*December 28, 2006*
[2]	*Modbus_over_serial_line_V1_02.pdf*	*December 20, 2006*

1.2 Multibus types

In 2000 Bronkhorst developed their first digital instruments according to the "multibus" principle. The basic pc-board on the instrument contained all of the general functions needed for measurement and control, including alarm, totalizing and diagnostic functions. It had **analog** I/O-signals and also an **RS232** connection as a standard feature. In addition to this there is the possibility of integrating an interface board with **DeviceNet™**, **Profibus-DP®**, **Modbus** , **FLOW-BUS** or **EtherCAT** protocol. The first generation (**MBC-I**) was based on a 16 bit Fujitsu controller. It was superseded in 2003 by the Multibus type 2 (**MBC-II)**. This version was also based on the 16 bit Fujitsu controller but it had several improvements to the MBC-I. One of them is the current steering of the valve. It reduced heat production and improved control characteristics. The latest version Multibus controller type 3 (**MBC3**) is introduced in 2011. It is build around a 72MHz 32 bit NXP ARM controller. It has AD and DA controllers on board which makes it possible to measure noise free and control valves without delays. The internal control loop runs 6 times faster compared to the MBC-II therefore control stability has improved significantly. It also has several improved functions like reverse voltage protection, inrush current limitation and overvoltage protection.

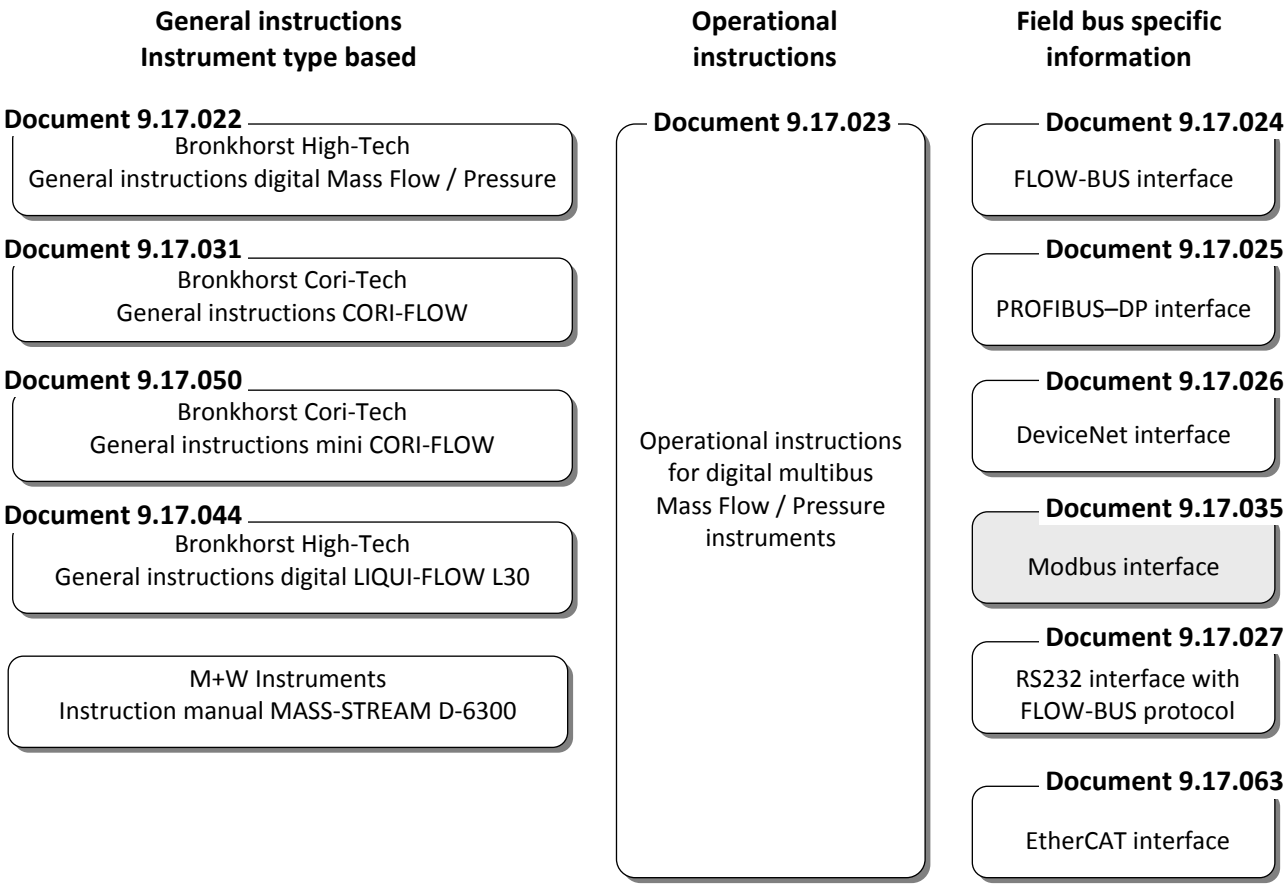
MBC3 instruments can be recognised by the "MBC3" placed on lower left side of the instrument label (see example).



1.3 References to other applicable documents

Manuals and guides for digital instruments are modular. General instructions give information about the functioning and installation of instruments. Operational instructions explain the use of the digital instruments features and parameters. Field bus specific information explains the installation and use of the field bus installed on the instrument.

1.3.1 Manuals and user guides:



1.3.2 Technical Drawings:

Hook-up diagram laboratory-style Modbus	(document nr. 9.16.064)
Hook-up diagram industrial style Modbus	(document nr. 9.16.065)
Hook-up diagram CORI-FLOW Modbus	(document nr. 9.16.066)
Hook-up diagram LIQUI-FLOW L30 digital Modbus	(document nr. 9.16.075)

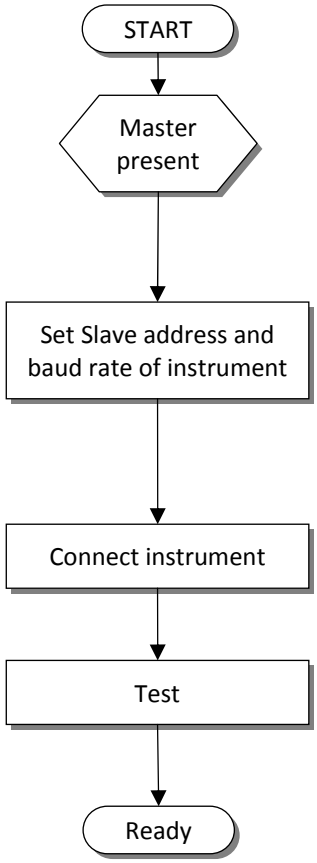
1.3.3 Software tooling:

FlowPlot
FlowView
FlowFix
FlowDDE

All these documents can be found at:
http://www.bronkhorst.com/en/downloads

1.4 Short form start-up

All necessary settings for this module are already performed at Bronkhorst.
To follow next steps carefully is the quickest way to get this module operational in your own Modbus environment.



Make sure your Modbus master has been installed to the system

Instruments will be delivered to customers on address 1 and with a baud rate of 19200 baud. The easiest way to change the slave address is by use of the rotary switches on the instrument. Also you can use the FLOWFIX program to change Slave address and baud rate via the RS232 connection (it may be needed to restart the instrument to apply the changes). Slave address and baud rate can also be changed using the button (if present) on the instrument.

Physically connect the instrument to the Modbus network.

Test communication between your master and the instrument(s)

Instruments with combined RS232 / RS485 signal lines and no user interface automatically detect the bus type at start-up.

Warning: this device uses a vendor specific pin layout on the RJ45 connector that differs from the Modbus recommended pin layout.

2 FIELD BUS INSTALLATION

2.1 General

Modbus is a 3-wire, RS485-based field bus communication system for parameter value exchange. In this system each instrument / device is equipped with a micro-controller for its own dedicated task but also for exchanging parameter value information with other instruments / devices connected to the same Modbus system.

The implementation of the Modbus interface is based on the following standards:
[1] Modbus_Application_Protocol_V1_1b.pdf December 28, 2006
[2] Modbus_over_serial_line_V1_02.pdf December 20, 2006

Physical layer and communication protocol are detected automatically upon reception of messages. These messages must be sent using the correct combination of physical layer and communication protocol. After every power-up the communication detection mode is active.

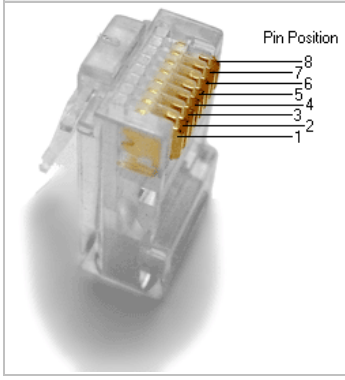
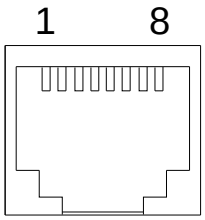
Bronkhorst advices not to use more as 127 instruments in one bus system.

2.2 Modbus connector

2.2.1 Shielded RJ45 modular jack

Warning: this device uses a vendor specific pin layout on the RJ45 connector that differs from the Modbus recommended pin layout.

The shielded RJ45 modular jack connector (for non IP65 applications) has the following pin configuration:

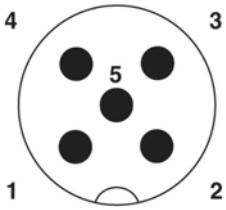
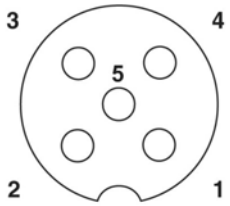
RJ45 Connector	Receptable	Pin number	Description
		1	+15…24Vdc supply
		2	0V
		3	Shield
		4	0V
		5	+15…24Vdc supply
		6	0V (Modbus common)
		7	D0 Modbus (A/A')
		8	D1 Modbus (B/ B')

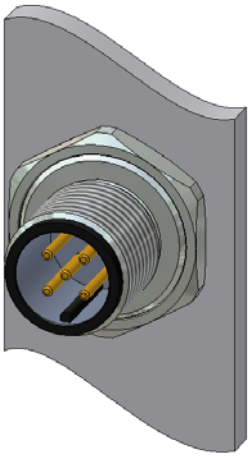
The maximum contact rating for RJ45 connectors is 1.5A.

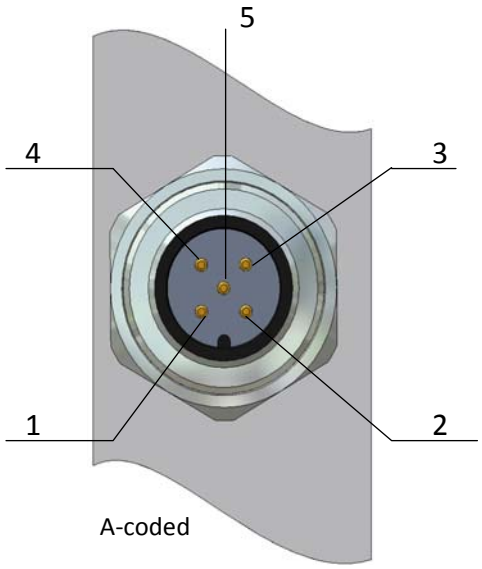
For MASS-VIEW instrument see manual 9.17.051 for pin layout.
http://www.bronkhorst.com/en/downloads/instruction_manuals/

2.2.2 Shielded a coded M12 connector

The chassis M12 circular connector (for IP65 applications) has the following pin configuration:

M12 Connector	Male	Female	nr	Description
			1	Shield
			2	+15…24Vdc supply
			3	0V
			4	D1 Modbus (B/ B')
			5	D0 Modbus (A/A')





A-coded

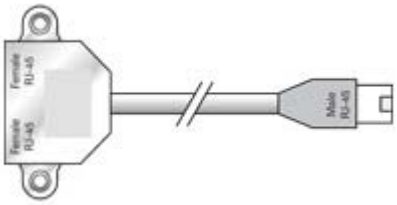
The maximum contact rating for M12 connectors is 4A.

2.3 Modbus Cables and T-parts

2.3.1 RJ45 FTP cables

For connecting instruments to Modbus you need shielded cables with at least 3 wires (for data only). Recommended are twisted wire cables for RS485-communications with 100 or 120 Ohm impedance. All Bronkhorst Modbus cables have also integrated power-supply wires. For the use in the EL-FLOW range (non IP-65) it is best to use Shielded (+Foiled) Twisted Pair patch-cables with RJ45 modular jack connectors (8-pins for data and power-supply connections).

RJ45 shielded FTP CAT.5e cable	RJ45 shielded connectors
	

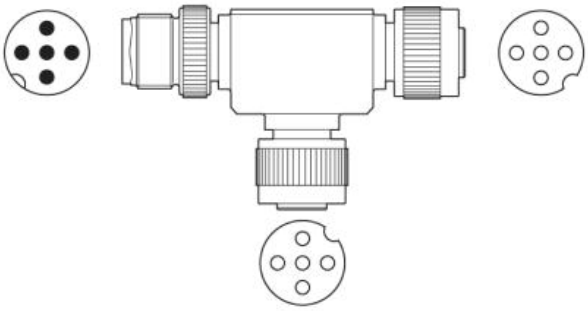
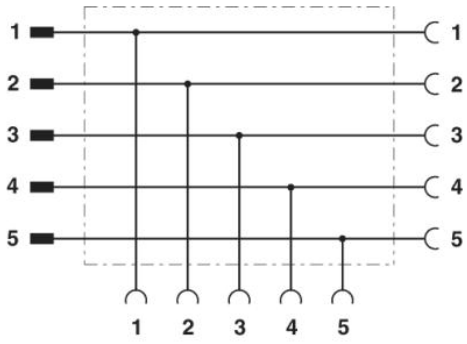
Shielded FTP cable	Power isolator	7.03.241 Modular Y adapter cable
		

CAT.5e cables are available with a wire of:
26AWG (wire diameter 0.140mm^2, with a resistance of 137 Ohm/km).
24AWG (wire diameter 0.205mm^2, with a resistance of 86 Ohm/km).

More information about cat.5e cables can be found at::
http://en.wikipedia.org/wiki/Category_5_cable

2.3.2 M12 DeviceNet drop cables

For the use in for example the IN-FLOW range or CORI-FLOW range (IP-65 applications) it is best to use *DeviceNet Drop* cables assembled on both sides with male connector M12 – female connector M12 (5-pins for data and power-supply connections).

M12 cable	M12 termination resistor
	
T-part	**T-part wiring**
	

In case of powering instruments or transporting data over longer distances Bronkhorst offers also special RS485 Modbus data cable, with lower voltage-drop. Bronkhorst can advise you when to use this special cable, but for most cases the standard patch-cables will do well.

If more cables are used in one system, they have to be connected as a daisy-chain. This means that the total Modbus system has only one begin and one end. For connecting instruments to the bus, Bronkhorst offers special drop-cables which enable you to build a daisy chained network of Modbus modules.

2.4 Termination

For best quality of data transfer Modbus should be terminated correctly.

2.4.1 Termination resistors

A resistor is added in parallel with the receiver's "A" and "B" lines in order to match the data line characteristic impedance specified by the cable manufacturer (120 Ω is a common value). This value describes the intrinsic impedance of the transmission line and is not a function of the line length. A terminating resistor of less than 90 Ω should not be used. Termination resistors should be placed only at the extreme ends of the data line (see Termination schematics resistors RT1 and RT2), and no more than two terminations should be placed in any system that does not use repeaters.

2.4.2 Biasing resistors

When an RS-485 network is in an idle state, all nodes are in listen (receive) mode. Under this condition there are no active drivers on the network. All drivers are tri-stated. Without anything driving the network, the state of the line is unknown. If the voltage level at the receiver's A and B inputs is less than ±200 mV the logic level at the output of the receivers will be the value of the last bit received. In order to maintain the proper idle voltage state, bias resistors must be applied to force the data lines to the idle condition. Bias resistors are nothing more than a pull-up resistor (RB1) on the data D1 Modbus (B/B') line and a pull-down (to ground) on the data D0 Modbus (A/A') line. The "Termination schematic" illustrates the placement of bias resistors on a transceiver. The value of the bias resistors is dependent on termination and number of nodes in the system. The goal is to generate enough DC bias current in the network to maintain a minimum of 200 mV between the B and A data line. Consider the following example of bias resistor calculation.

Ideal situation:
Termination resistors: 120 Ohm
Receiver resistance: omitted
Bias supply voltage: 5Vdc
Wanted situation is a minimum of 200mV between A and B lines and a common mode voltage of 2.5V.

Minimum current therefore: 200mV / 60 Ohm = 3.33mA
Total maximum bias resistor value is (5V – 0.2V)/3.33mA = 1440 Ohm.
The maximum value of each biasing resistor: 720 Ohm.

Situation with 127 nodes:
Termination resistors: 120 Ohm
Receiver resistance: 12 KOhm
Number of instruments: 127
Bias supply voltage: 5Vdc
Wanted situation is a minimum of 200mV between A and B lines and a common mode voltage of 2.5V.

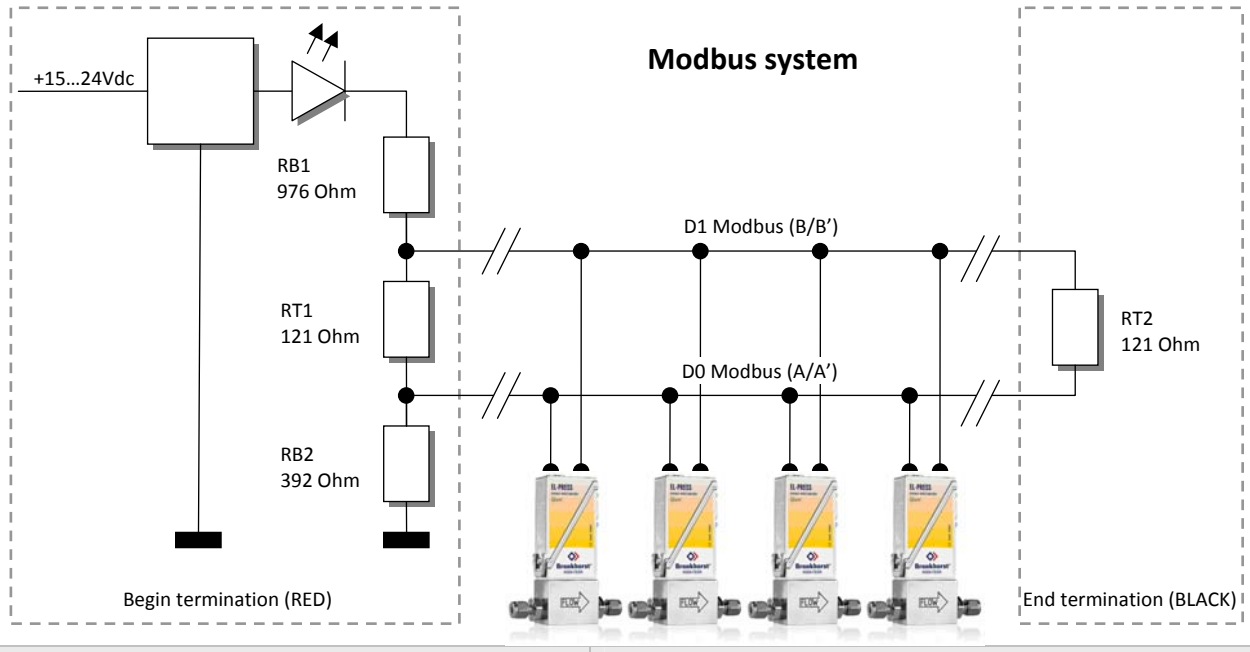
Total termination resistance: 120 // 120 // 12000* 127 = 120 // 120 // 94.5 = 36.7 Ohm
Minimum current therefore: 200mV / 36.7 Ohm = 5.45mA
Total maximum bias resistor value is (5V – 0.2V)/5.45mA = 880 Ohm.
The maximum value of each biasing resistors: 440 Ohm.
Lower values may be used. (Depending on maximum power consumption of the resistors)

Bronkhorst advices the following resistor values for the following voltages.			
Supply voltage termination	**Termination resistors**	**Bias Pull-up resistor**	**Bias Pull-down resistor**
+5V	121 Ohm	392 Ohm	392 Ohm
+10V	121 Ohm	1210 Ohm	392 Ohm
+15V	121 Ohm	2210 Ohm	392 Ohm
+24V	121 Ohm	3480 Ohm	392 Ohm

Bronkhorst offers special begin-termination connectors with the resistor network. This handles correct termination but also gives a defined voltage on the Modbus D1 and D0 line for even more reliability of the bus system.
An end-terminator is also offered by Bronkhorst and handles correct termination ad the end of the bus.

Termination can be performed with special termination-connectors, offered by Bronkhorst.

Termination schematic



RJ45		M12	
703297 **Begin terminator**	**703298** **End terminator**	**703515** **Begin terminator**	**703321** **End terminator**
			

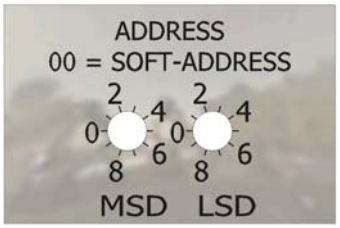
3 CHANGING SLAVE ADDRESS AND BAUD RATE

Default instruments will be delivered to customers on address 1 and with a baud rate of 19200 baud.

The slave address and baud rate of the Bronkhorst meter/controller Modbus slave can be changed to fit the instrument in your existing Modbus network. Standard baud rates for Modbus are 9600, 19200 (default) and 38400.

3.1 Via rotary switches on the side of the instrument (if present)

On the side of the instrument are rotary switches placed and a label with the explanation of the switches. Make sure to use a screwdriver which is suited for the switches.



The switches have the following function: ADDRESS (00 – 99)

With the ADDRESS switch, the instruments address can be set. The MSD is the high part of the decimal number and the LSD the low part. For instance address 25 means MSD on 2 and LSD on 5. The default switch position is 00. In this position the address is software programmable. The default software programmable address is 1.

During instrument initialisation, the address switches are read. If the switches specify a valid Modbus address, i.e. a value from 1 to 99, this value is used. If the specified address differs from the value stored in the instrument, the new address is saved in memory.

Adjusting the rotary switches during operation will not affect the actual address unless the instrument is re-powered and/or re-initialized.

When addressing by rotary switches is used, it's not possible to change the adress by RS-232 or by the microswitch.

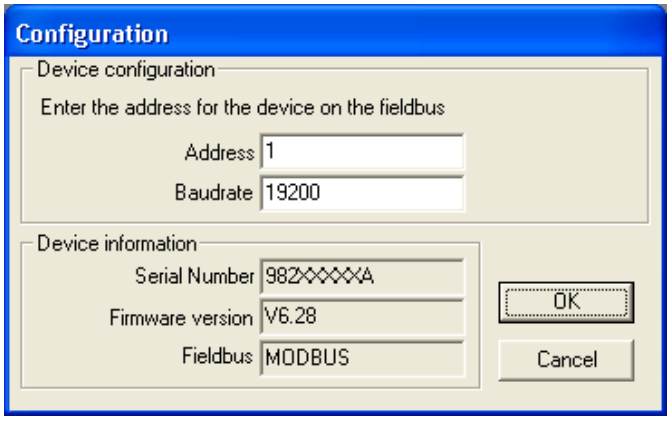
3.2 Via RS232: FlowFix

'Off-line' via the RS232 communication port by means of a special tooling program, called FlowFix.
FlowFix is a tool for multi-bus instruments that can be used for all field busses enabling the user to:

- Change slave address
- Read and optionally change the baud rate
- Make a service log file to be send to Bronkhorst in case of trouble

Connect your Bronkhorst meter / controller Modbus slave instrument to a free COM-port using the special cable with on one side a T-part (with male and female sub-D 9 connector) and on the other side a female sub-D 9 connector (part number 7.03.366). The single sub-D 9 connector should be connected to your COM-port and the female sub-D 9 of the T-part to the male sub-D 9 of the instrument. Standard cables are approx. 3 meters. Maximum length between PC and instrument allowed is approximately 10 meters.

Start-up FlowFix.exe and select the COM-port.
The configuration screen will appear.



Enter the Slave address and Baud rate and press [OK]. Valid values for the slave address are between 1 and 247, valid values for the baud rate are 9600, 19200, 38400, 57600 and 115200. The changed values will be effective immediately after changing.

3.3 Via RS232: other programs

It is also possible to read and or change the slave address or baud rate by means of any program via RS232 using the COM-port of your PC on 38400 baud.

More information about the RS232 protocol can be found in document 917027 Manual RS232 interface
This document can be found at:
http://www.bronkhorst.com/en/downloads/instruction_manuals/

3.4 Via micro-switch and LED's on the instrument (if present)

With the micro-switch on the instrument it is possible to change and readout the settings for slave address and baud rate. The LED's will indicate the tens of the address with green flashes and the units with red flashes. For baud rate-indication both LED's will flash.

3.4.1 Readout bus-address/MAC-ID and baud rate:

Pressing the switch 3x briefly with intervals of max. 1 second in normal running / operation mode will trigger the instrument to "show" its bus-address/MAC-ID and baud rate.

For indication the bus-address/MAC-ID the green LED will flash the amount of tens and the red LED the amount of units in the number. For indication of baud rate setting, both LED's will flash.
The flashes are called "count-flashes" and have a pattern of 0.5 sec. on, 0.5 sec. off.

LED indications for bus-address and baud rate			
Green LED	**Red LED**	**Time**	**Indication**
Green	**Red**		
amount of count flashes (0...12)	Off	0 ... 12 sec. Maximum	tens in bus-address for instrument
Off	Amount of count flashes (0...9)	0 ... 9 sec. Maximum	units in bus-address for instrument
amount of count flashes (1...5)	amount of count flashes (1...5)	1 ... 5 sec. Maximum	baudrate setting for instrument 1 = 9600 Baud 2 = 19200 Baud 3 = 38400 Baud 4 = 57600 Baud (MBC3 type only) 5 = 115200 Baud (MBC3 type only)

Note: Value zero will be indicated by a period of 1 sec. off (0.5 sec. off + 0.5 sec. off).

Examples:

- For bus-address 35 and 9600 baud the green LED will flash 3 times, the red LED will flash 5 times and both LED's will flash 1 time.
- For bus-address 20 and 19200 baud the green LED will flash 2 times, the red LED will flash 0 times and both LED's will flash 2 times.
- For bus-address 3 and 38400 baud the green LED will flash 0 times, the red LED will flash 3 times and both LED's will flash 3 times.

3.4.2 Change bus-address and baud rate:

Pressing the switch 5x briefly with intervals of max. 1 second in normal running/operation mode. Within the time-out period of 60 seconds it is possible to start changing the bus-address/MAC-ID of the instrument. For certain field bus systems it is necessary to select the baud rate also. Other field bus systems only have one baud rate or the baud rate setting will adapt to the setting of the master automatically. In these cases baud rate selection is not needed and will be skipped.

Procedure for changing bus-address and baud rate				
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	time-out: 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	time-out: 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 = 57600 Baud 5 = 115200 Baud	both red and 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	time-out: 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 LED's 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 LED's) will be off and the counting sequence will start.

3.5 By user interface (if present)

See the manual of the instrument for a description of the user interface.

4 FUNCTIONAL DESCRIPTION

4.1 General

The information found here is the basic information needed for the installation of a Modbus system.

The implementation of the Modbus interface is based on the following standards:
[1] Modbus_Application_Protocol_V1_1b.pdf December 28, 2006
[2] Modbus_over_serial_line_V1_02.pdf December 20, 2006

4.2 Implementation class

The physical and data link layer are implemented conforming to the "basic slave" implementation class as described in document [2] “MODBUS over Serial Line specification and implementation guide V1.02”.
The following options have been implemented:

General settings		
parameter	**options**	**remarks**
addressing	address configurable from 1 to 247 (default 1)	
broadcast support	yes	
baud rate	9600 19200 (default) 38400 57600 Baud (MBC3 type only) 115200 Baud (MBC3 type only)	
electrical interface	RS485 2W-cabling	
data bits	RTU = 8, ASCII = 7	
stop bits	1	The use of no parity requires 2 stop bits

MBCII / CORI-FLOW		
parameter	**options**	**remarks**
parity	even	Not configurable
transmission mode	RTU	Not configurable

MBC3 / EL-FLOW Base		
parameter	**options**	**remarks**
parity	even / odd / none	Configurable
transmission mode	RTU / ASCII	Configurable (MBC3) Auto detection (EL-FLOW Base)

MASS-VIEW		
parameter	**options**	**remarks**
parity	even	Not configurable
transmission mode	RTU / ASCII	Configurable

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

4.3 Response time

This slave device will respond on each valid request from the master within 100ms. This means that the response timeout setting of the master should be set to a value larger than or equal to 100ms.

4.4 Supported Modbus functions

This section describes the supported Modbus function codes. Refer to [1] for details.

4.4.1 Read Holding Registers (03)

Possible exception responses		
Code	**Name**	**Meaning**
02	ILLEGAL DATA ADDRESS	in case of reading of non-existing address, or reading a part of a multi register parameter (float, long, etc)
03	ILLEGAL DATA VALUE	in case of reading less than 1 or more than 125 registers
04	SLAVE DEVICE FAILURE	in case of reading a write-only register

Warning: the maximum message size for the Read Holding Registers function is 100 bytes at 9600 baud (200 bytes at 19200 baud and 400 bytes at 38400 baud). When this size is exceeded, corrupted responses may be received.

4.4.2 Write Single Register (06)

Possible exception responses		
Code	**Name**	**Meaning**
02	ILLEGAL DATA ADDRESS	in case of writing to non-existing address, or writing to a part of a multi register parameter (float, long, etc)
04	SLAVE DEVICE FAILURE	in case of writing to read-only register
04	SLAVE DEVICE FAILURE	in case of writing illegal value to register

4.4.3 Write Multiple Registers (16)

Possible exception responses		
Code	**Name**	**Meaning**
02	ILLEGAL DATA ADDRESS	in case of writing to non-existing address, or writing to a part of a multi register parameter (float, long, etc)
03	ILLEGAL DATA VALUE	in case of reading less than 1 or more than 123 registers
04	SLAVE DEVICE FAILURE	in case of writing to read-only register
04	SLAVE DEVICE FAILURE	in case of writing illegal value to register

When one of the written registers raises an exception, the value written to all subsequent registers are discarded (ignored).

4.4.4 Diagnostics (08)

The following sub-functions are supported	
Sub-function code (dec)	**Name**
00	Return Query Data
10	Clear Counters and Diagnostics Register
11	Return Bus Message Count
12	Return Bus Communication Error Count
13	Return Bus Exception Error Count
14	Return Slave Message Count
15	Return Slave No Response Count
16	Return Slave NAK Count (always 0)
17	Return Slave Busy Count (always 0)
18	Return Bus Character Overrun Count

Warning: the maximum message size for the Return Query Data sub function is 100 bytes at 9600 baud (200 bytes at 19200 baud and 400 bytes at 38400 baud). When this size is exceeded, corrupted responses may be received.

Possible exception responses		
Code	**Name**	**Meaning**
01	ILLEGAL FUNCTION	of not-supported sub-function
03	ILLEGAL DATA VALUE	in case of an incorrect value for the data field
04	SLAVE DEVICE FAILURE	in case of writing illegal value to register

4.4.5 Report Slave ID (17)

The Slave ID field in the response is a string with the same contents as FlowDDE parameter 1 (ident number + version nr/serial nr). The Run Indicator Status field in this message will indicate ON when the device is in normal operating mode (FB_NORMAL).

Possible exception responses		
Code	**Name**	**Meaning**
04	SLAVE DEVICE FAILURE	in case of an internal error

4.4.6 Available parameters

Modbus registers (in the data model) are numbered from 1 to 65536. In a Modbus PDU (Protocol Data Unit) these registers are addressed from 0 to 65535. This addressing model has been described in section 4.4 of [1].

The following table lists the most commonly used parameters.

MODBUS REGISTERS						
PARAMETER NAME	PARAMETER TYPE	ACCESS	PDU ADDRESS hex	REGISTER NUMBER		REMARK
				Hex	Dec	
Wink	Unsigned char	W	0x0000	0x0001	1	Value 14592
Initreset	Unsigned char	RW	0x000A	0x000B	11	
Valve output	Unsigned int	RW	0x001F	0x0020	32	Range 0..32767
Measure	Unsigned int	R	0x0020	0x0021	33	
Setpoint	Unsigned int	RW	0x0021	0x0022	34	
Setpoint slope	Unsigned int	RW	0x0022	0x0023	35	
Analog input	Unsigned int	R	0x0023	0x0024	36	
Control mode	Unsigned char	RW	0x0024	0x0025	37	
Sensor type	Unsigned char	RW 🔑	0x002E	0x002F	47	
Capacity unit index	Unsigned char	RW 🔑	0x002F	0x0030	48	
Fluid number	Unsigned char	RW	0x0030	0x0031	49	
Alarm info	Unsigned char	R	0x0034	0x0035	53	
Temperature	Unsigned int	R	0x0427	0x0428	1064	See addr 0xA138
Alarm limit maximum	Unsigned int	RW	0x0C21	0x0C22	3106	
Alarm limit minimum	Unsigned int	RW	0x0C22	0x0C23	3107	
Alarm mode	Unsigned char	RW	0x0C23	0x0C24	3108	
Alarm setpoint mode	Unsigned char	RW	0x0C25	0x0C26	3110	
Alarm new setpoint	Unsigned int	RW	0x0C26	0x0C27	3111	
Alarm delay	Unsigned char	RW	0x0C27	0x0C28	3112	
Reset alarm enable	Unsigned char	RW	0x0C29	0x0C2A	3114	
Counter value	Unsigned int	RW	0x0D01	0x0D02	3330	See addr 0xE808
Counter unit index	Unsigned char	RW	0x0D02	0x0D03	3331	
Counter limit	Unsigned int	RW	0x0D03	0x0D04	3332	See addr 0xE818
Counter setpoint mode	Unsigned char	RW	0x0D05	0x0D06	3334	
Counter new setpoint	Unsigned int	RW	0x0D06	0x0D07	3335	
Counter mode	Unsigned char	RW	0x0D08	0x0D09	3337	
Identification number	Unsigned char	RW 🔑	0x0E2C	0x0E2D	3629	
Normal step c. resp.	Unsigned char	RW 🔑	0x0E45	0x0E46	3654	
Stable situation c. resp.	Unsigned char	RW 🔑	0x0E51	0x0E52	3666	
Open from zero c. resp.	Unsigned char	RW 🔑	0x0E52	0x0E53	3667	
Calibration mode	Unsigned char	RW 🔑	0x0E61	0x0E62	3682	
Monitor mode	Unsigned char	RW 🔑	0x0E62	0x0E63	3683	
Reset	Unsigned char	W	0x0E68	0x0E69	3689	
Bridge potmeter	Unsigned char	RW 🔑	0x0E85	0x0E86	3718	
Modbus slave address	Unsigned char	RW 🔑	0x0FAA	0x0FAB	4011	
Polynomial constant A	Float	RW 🔑	0x8128..0x8129	0x8129..0x812A	33065..33066	
Polynomial constant B	Float	RW 🔑	0x8130..0x8131	0x8131..0x8132	33073..33074	
Polynomial constant C	Float	RW 🔑	0x8138..0x8139	0x8139..0x81A	33081..33082	
Polynomial constant D	Float	RW 🔑	0x8140..0x8141	0x8141..0x8142	33089..33090	
Sensor differentiator dn	Float	RW 🔑	0x8158..0x8159	0x8159..0x815A	33113..33114	
Sensor differentiator up	Float	RW 🔑	0x8160..0x8161	0x8161..0x8162	33121..33122	
Capacity	Float	RW 🔑	0x8168..0x8169	0x8169..0x816A	33129..33130	
Fluid name	String (10 bytes)	RW 🔑	0x8188..0x818C	0x8189..0x818D	33161..33165	
Capacity unit	String (7 bytes)	RW 🔑	0x81F8..0x81FB	0x81F9..0x81FC	33273..33276	

PARAMETER NAME	PARAMETER TYPE	ACCESS	PDU ADDRESS hex	REGISTER NUMBER		REMARK
				Hex	Dec	
Fmeasure	Float	R	0xA100..0xA101	0xA101..0xA102	41217..41218	
FSetpoint	Float	RW	0xA118..0xA119	0xA119..0xA11A	41241..41242	
Temperature	Float	R	0xA138..0xA139	0xA139..0xA13A	41273..41274	See addr 0x0427
Capacity 0%	Float	RW	0xA1B0..0xA1B1	0xA1B1..0xA1B2	41393..41394	
Counter value	Float	RW	0xE808..0xE809	0xE809..0xE80A	59401..59402	See addr 0x0D01
Counter limit	Float	RW	0xE818..0xE819	0xE819..0xE81A	59417..59418	See addr 0x0D03
Counter unit	String (4 bytes)	R	0xE838..0xE839	0xE839..0xE83A	59449..59450	
Device type	String (6 bytes)	R	0xF108..0xF10A	0xF109..0xF10B	61705..61707	
BHTModel number	String (14 bytes)	RW	0xF110..0xF116	0xF111..0xF117	61713..61719	
Serial number	String (16 bytes)	RW	0xF118..0xF11F	0xF119..0xF120	61721..61728	
Customer model	String (16 bytes)	RW	0xF120..0xF127	0xF121..0xF128	61729..61736	
Firmware version	String (5 bytes)	R	0xF128..0xF12A	0xF129..0xF12B	61737..61739	
Usertag	String (13 bytes)	RW	0xF130..0xF136	0xF131..0xF137	61745..61751	
PID-Kp	Float	RW	0xF2A8..0xF2A9	0xF2A9..0xF2AA	62121..62122	
PID-Ti	Float	RW	0xF2B0..0xF2B1	0xF2B1..0xF2B2	62129..62130	
PID-Td	Float	RW	0xF2B8..0xF2B9	0xF2B9..0xF2BA	62137..62138	
Density actual	Float	R	0xF478..0xF479	0xF479..0xF47A	62585..62586	
Dynamic display factor	Float	RW	0xF508..0xF509	0xF509..0xF50A	62729..62730	
Static display factor	Float	RW	0xF510..0xF511	0xF511..0xF512	62737..62738	
Exponential smoothing	Float	RW	0xF520..0xF521	0xF521..0xF522	62753..62754	
Modbus baudrate	Long integer	RW	0xFD48..0xFD49	0xFD49..0xFD4A	64841..64842	

Details and meaning can be found in document 9.17.023 Operation instructions digital instruments. This document can be found at:
http://www.bronkhorst.com/en/downloads/instruction_manuals/

- *Access indicates whether parameter can be Read and/or Written.*
- *When a byte parameter is read, the upper 8-bits of the Modbus register will be 0. When a byte parameter is written, the upper 8-bits must be set to 0.*
- *Long integer parameters have a length of 4 bytes and are mapped on two consecutive Modbus registers. The first register contains bit 32-16, the second register contains bit 15-0.*
- *Floating point parameters have a length of 4 bytes and are mapped on two consecutive Modbus registers. Floats are in single precision IEEE format (1 sign bit, 8 bits exponent and 23 bits fraction). The first register contains bit 32-16, the second register contains bit 15-0.*
- *String parameters can have a length of maximal 16 bytes and can take up to 8 Modbus registers where each register contains two characters (bytes). The upper byte of the first register contains the first character of the string. When writing strings, the write action should always start from the first register as a complete block (it is not possible to write a part of a string). If the string is shorter than the specified maximum length the string should be terminated with an 0.*
- *Parameters Temperature, Counter value and Counter limit can be found in the parameter table as an unsigned integer variant and as a floating point variant. Only the floating point variant supports the full parameter range and resolution.*

5 TROUBLESHOOTING

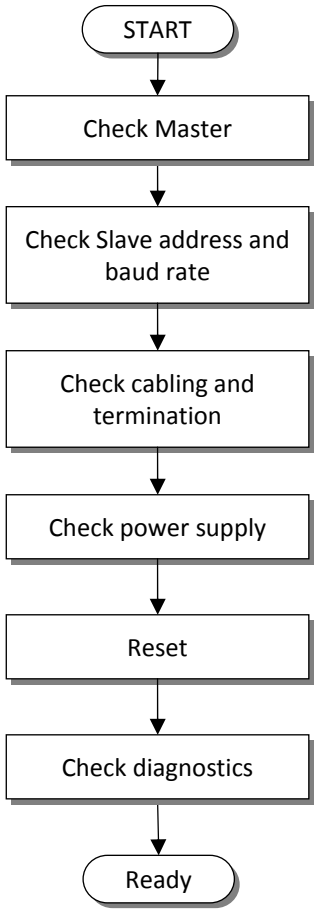
5.1 Visual diagnostics

LED indications (if present) can be very useful in case of problems with the instrument.

The green LED is normally used for instrument status indication, like normal operation or special function mode. The red LED will burn continuously in case of a hardware failure. During normal operation, the red LED is switched on during frame reception or sending on the Modbus interface.

More information can be found in document 9.17.023 Operation instructions digital instruments.
This document can be found at:
http://www.bronkhorst.com/en/downloads/instruction_manuals/

5.2 Step-by-step



Check all Modbus settings at your master. Master and device settings must be the same, check baud rate and parity setting.

Check slave address and baud rate of device (slave).

Check cabling and bus termination of your Modbus system.

Check power supply. Instruments need +15Vdc or +24Vdc.

Try to reset the instrument and/or restart your master.

Check the bus diagnostics string. See below.

5.3 Bus diagnostics string

The bus diagnostics string can be found in the service report that can be created using FlowFix. The string is also available as parameter 202 in the Bronkhorst FlowDDE application.

The format of the string is "mAAAA eBBBB sCCCC cDDDD", where AAAA, BBBB, CCCC and DDDD are hexadecimal representations of 16-bit counters:

- AAAA = bus messages count (CPT1)
- BBBB = bus communication error count (CPT2)
- CCCC = slave message count (CPT4)
- DDDD = bus character overrun count (CPT8)

The following table may be helpful to find the source of communication problems on Modbus. In general, read out this string after trying to communicate between master and slave, without switching off the power in the meantime.

mAAAA	eBBBB	sCCCC	cDDDD	Diagnostics
=0000	=0000	=0000	=0000	No communication detected by slave, check RS485 network, especially D0 and D1 signals.
>0000	=0000	=0000	=0000	Slave detected valid Modbus messages for other addresses, make sure master uses correct slave address
=0000	>0000	=0000	=0000	Slave detected invalid messages on the bus, make sure master uses correct baud rate and parity settings
>0000	>0000	>0000	=0000	Slave detected both valid and invalid messages, make sure RS485 bus termination and polarization are used correctly and the maximum number of devices is not exceeded. See chapter **Error! Reference source not found.** for details.
=0000	>0000	=0000	>0000	Slave has received bytes faster than it could process, make sure master uses correct baud rate. You may want to try a lower baud rate.
>0000	=0000	>0000	=0000	No problem detected by slave, make sure application timeout of master is set to a value larger than 100 ms

6 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:

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