Instruction manual

DeviceNet™ slave interface for digital multibus Mass Flow / Pressure instruments

Doc. no.: 9.17.026Z Date: 25-07-2022

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

Bronkhorst®

Disclaimer

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

Copyright

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

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 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.

Table of contents

1 GENERAL PRODUCT INFORMATION

1.1 INTRODUCTION

The DeviceNet interface offers a direct connection to DeviceNet Networks for Bronkhorst® digital mass-flow/pressure meters/controllers according to the Mass Flow Controller Profile specified by the ODVA. This manual is limited to the description of the interface between the DeviceNet Mass Flow Controller with a master device.

This manual will explain how to install a Bronkhorst® instrument to your DeviceNet system. It only consists of that information which is needed most.

There is no mutual communication between DeviceNet slaves, only between master and slave. Each slave should have its own unique MAC ID on the network, otherwise there is no communication possible. Setting MAC ID can be performed by either:

- Master configuration software
- Bronkhorst® tooling software: FlowFix (on Multibus documentation/software tool CD) This programme is able to communicate with the instrument via RS232 using a special cable. If you don't have such a cable, ask your local sales representative.
- Button (+ LED's) on top of the instrument
- Rotary switches on the side of the instrument (if present).

Information about DeviceNet can be found at the website of the ODVA organisation. www.odva.org

1.2 MULTIBUS TYPES

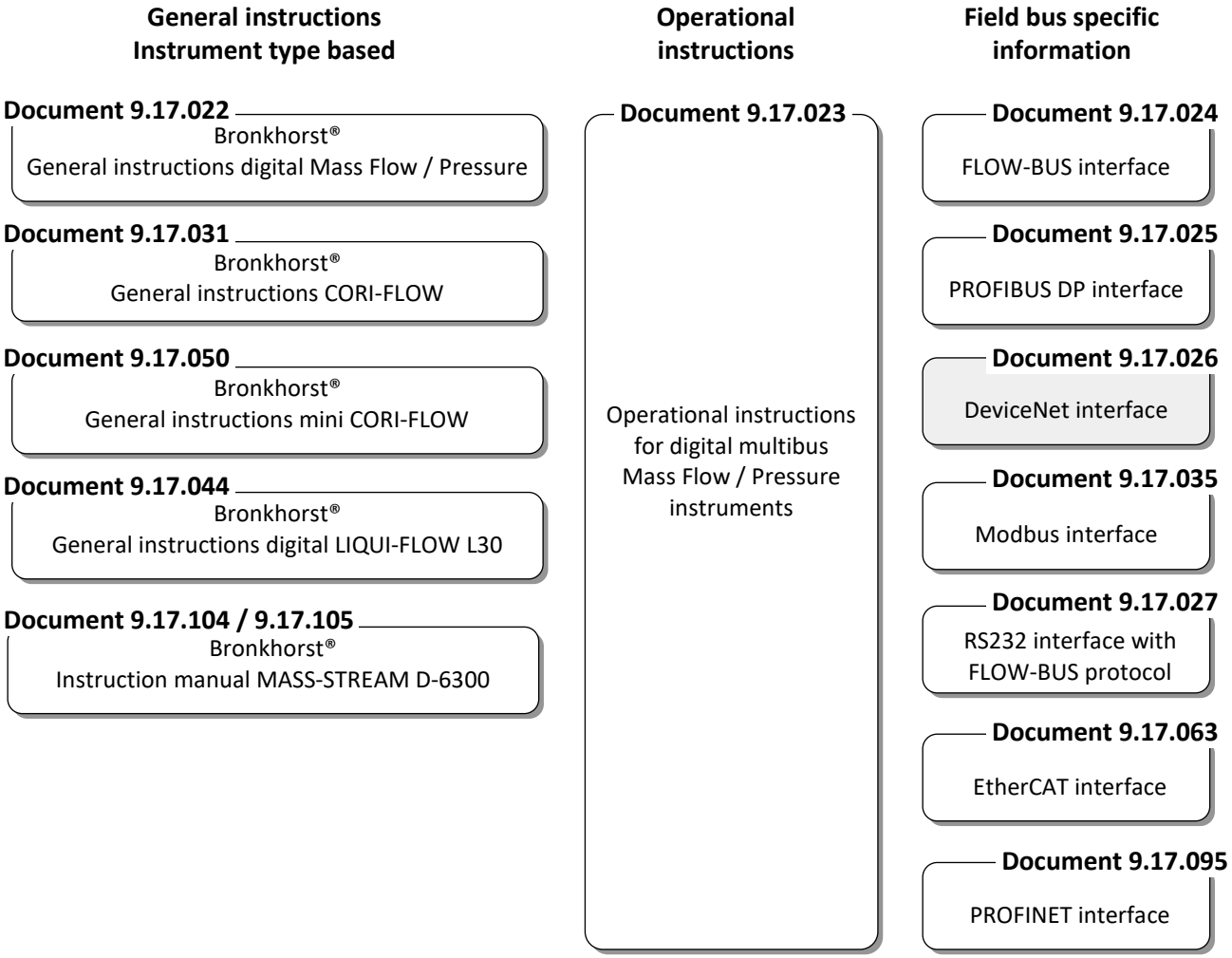
In 2000 Bronkhorst® developed their first digital instruments according to the "multibus" principle. The basic pc-board on the instrument contained all of the general functions needed for measurement and control, including alarm, totalizing and diagnostic functions. It had **analog** I/O-signals and 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 built 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 MBC DeviceNet.pdf	(document 9.16.060)
Hook-up diagram industrial style MBC DeviceNet.pdf	(document 9.16.054)
Hook-up diagram CORI-FLOW DeviceNet.pdf	(document 9.16.050)
Hook-up diagram LIQUI-FLOW L30 digital DeviceNet.pdf	(document 9.16.071)

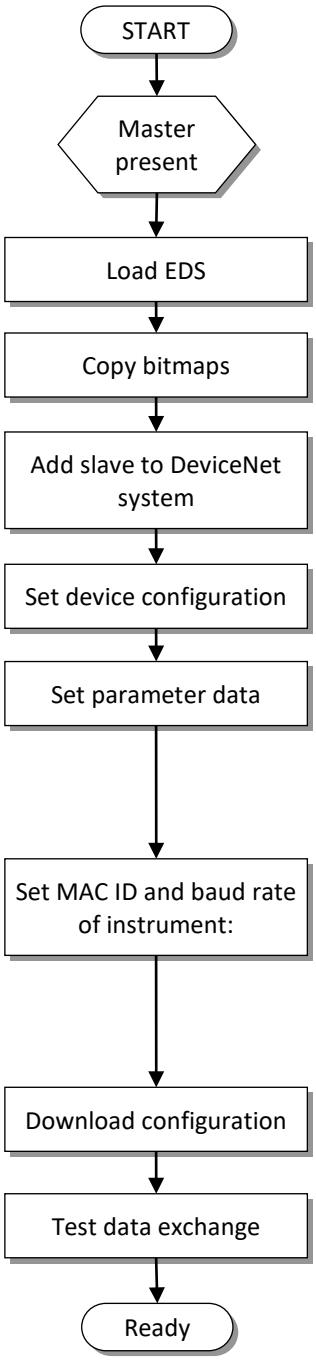
1.3.3 Software tooling:

Flowfix
FlowDDE
EDS file

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 DeviceNet environment.



Make sure your master has been installed to the DeviceNet system

Load EDS-file with configuration tool

Bitmaps (with flow controllers) can be copied in the proper directory (mostly automatic, sometimes by hand; depends on program)

Select "Bronkhorst meter/controller" and add new instrument to the bus

Set parameter data for a-cyclic setting of parameter values

Default instruments will be delivered to customers on address 63 and with a baud rate of 125000 baud. Normally setting an address can be performed by your master configuration software.
However, if you choose to set a station address off-line you can use the programme FLOWFIX to change MAC ID and baud rate via RS232 connection. MAC ID and baud rate can also be changed by using the button on top of the instrument or the rotary switches on the side of the instrument if present. See chapter 8 for more details.

Download all configuration settings into your master

Test data-exchange communication between your master and the instrument(s)

2 FIELD BUS INSTALLATION

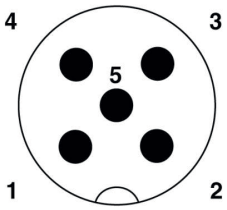
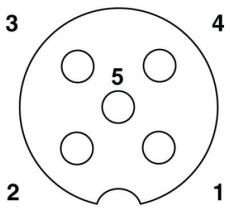
2.1 GENERAL

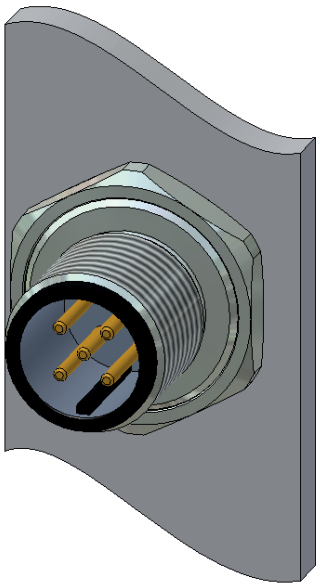
This chapter introduces the DeviceNet cable system and provides a brief overview of how to set up a DeviceNet network efficiently. The steps in this chapter describe the basic tasks involved in setting up a network.

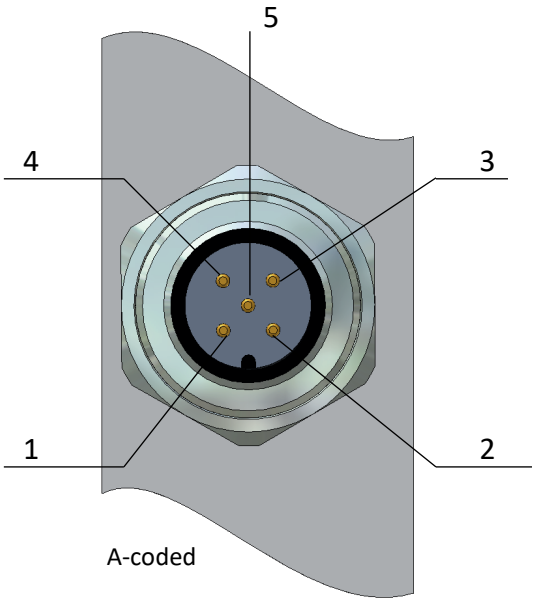
For the installation of DeviceNet, ODVA has created document "DeviceNet Planning and Installation manual" which can be found at the website of de ODVA organisation.
www.odva.org

2.2 DEVICENET CONNECTOR

Bronkhorst® instruments are fitted with a micro-style sealed M12 connector.

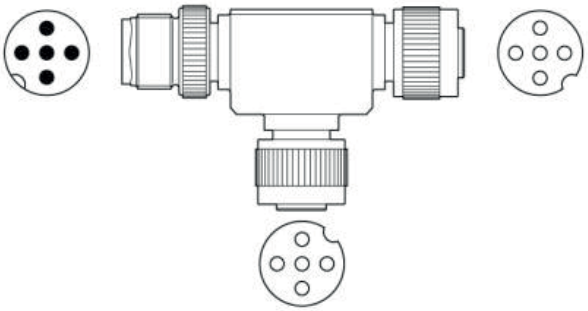
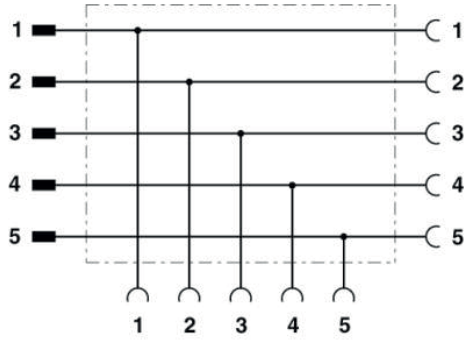
M12 Connector	Male	Female	nr	Color	Wire Identity	Usage Round
			1	Bare	Drain	shield
			2	RED	V+ (+24Vdc)	power
			3	Black	V- (0Vdc)	power
			4	White	CAN_H (CAN+)	signal
			5	Blue	CAN_L (CAN-)	signal





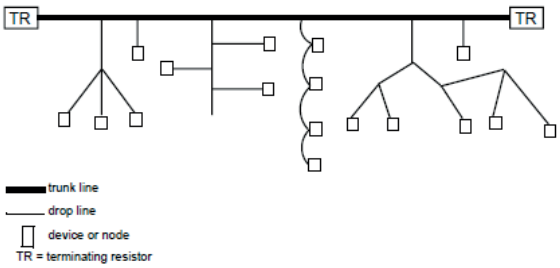
A-coded

2.3 DeviceNet cables and T-parts

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

2.4 Maximal cable lengths with DeviceNet

The DeviceNet cable system uses a trunk/drop line topology



Round shielded cable (thick, mid and thin) contains five wires: One twisted pair (red and black) for 24V dc power; one twisted pair (blue and white) for signal, and a drain wire (bare).
Flat cable contains four wires: One pair (red and black) for 24 dc power; one pair (blue and white) for signal. Unshielded 4-wire drop cable is only designed for use with flat cable systems.

The distance between any two points must not exceed the maximum cable distance allowed for the data rate used.

Data rate	Maximum distance (flat cable)	Maximum distance (thick cable)	Maximum distance (mid cable)	Maximum distance (thin cable)
125k bit/s	420m	500m	300m	100m
250k bit/s	200m	250m	250m	100m
500k bit/s	75m	100m	100m	100m

The maximum cable distance is not necessarily the trunk length only. It is the maximum distance between any two devices.

2.5 DROP LINES WITH DEVICENET

The cumulative drop line length refers to the sum of all drop lines, thick, thin, or mid cable, in the cable system. This sum cannot exceed the maximum cumulative length allowed for the data rate used.

Data rate	Cumulative drop line length
125k bit/s	156m
250k bit/s	78m
500k bit/s	39m

The maximum cable distance from any device on a branching drop line to the trunk line is 6m.

2.6 NETWORK TERMINATION

You must terminate the trunk line at both ends with 121 Ohms, 1%, 1/4W terminating resistors.

2.7 POWER SUPPLY

The cable system requires the power supply to have a rise time of less than 250 milliseconds to within 5% of its rated output voltage. You should verify the following:

- The power supply has its own current limit protection
- Fuse protection is provided for each segment of the cable system
- Any section leading away from a power supply must have protection
- The power supply is sized correctly to provide each device with its required power
- De-rate the supply for temperature using the manufacturer's guidelines

Use the power supply to power the DeviceNet cable system only. If a device requires a separate 24V power source other than the DeviceNet power source, you should use an additional 24V power source.

Use only the BUS connector to power the device.
Powering from the BUS connector and Sub-D9 (or 8 DIN) connector could damage the device.
Please refer the corresponding Bus Hook-up manual for the right connections.

Choosing a Power Supply

The total of all of the following factors must not exceed 3.25% of the nominal 24V needed for a DeviceNet system.	
initial power supply setting	1.00%
line regulation	0.30%
temperature drift (total)	0.60%
time drift	1.05%
load regulation	0.30%

3 FUNCTIONAL DESCRIPTION

3.1 GENERAL

The Bronkhorst® digital instruments will behave as slaves on the DeviceNet bus. This means all communication (instructions / readout) will be performed by a master on the same DeviceNet field bus. Mostly this will be any PLC or PC-card controlling a process.

The Bronkhorst® DeviceNet MFC is a Group 2 Only Server device which messages comply with the CAN 2.0A standard and with the DeviceNet protocol. The DeviceNet MFC supports two types of connection: Explicit and Polled I/O. As defined by the DeviceNet protocol.

3.2 OBJECTS AND SERVICES

Bronkhorst® MFC's consist of several objects with attributes and services for interfacing to DeviceNet. These objects are described below.

The DeviceNet Mass Flow Controller will be in "Idle" state after powered on or reset. In this state, the device will not allow the Master to use the Setpoint Attribute to control gas flow. Instead, gas flow will be controlled by the value previously set in the Analog Actuator Object's Safe-State Attribute and Safe-Value Attribute. For instance, if the Safe-State Attribute had a value 0x03 which is the code for "Use Safe Value" then the device will set the actuator (valve) according to the value previously stored in the Analog Actuator Object's Safe-Value Attribute. To be able to control the flow, the Master device must send a "Start" request to the supervisor object of the Mass Flow Controller. The "Start" request brings the device from "Idle" state to "Executing" state. In this state, the device will be executing new setpoints received from the Master and then control the flow accordingly. Another way to bring the device in the "Executing" state is by sending I/O data (Polled I/O).

3.3 EXPLICIT MESSAGING

Using explicit messaging, following tables are needed with the descriptions of DeviceNet objects for Digital Mass Flow / Pressure Controllers / Meters. These messages have an a-cyclic character. For cyclic messages, see Polled I/O in the next paragraph.

The FLOW-BUS column shows how DeviceNet attributes are mapped on the internal FLOW-BUS variables of the instrument. This information can be useful for who is familiar with FLOW-BUS.

3.3.1 Identity Object

Class Code: 01 HEX
This object provides identification of and general information about the device. The Identity Object is present in all CIP products.

IDENTITY OBJECT'S INSTANCE ATTRIBUTES (Instance = 1)						
IDENTITY OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x01	0x01	Vendor Id	0x0E	UINT		706
0x01	0x02	Device Type	0x0E	UINT		0x001A
0x01	0x03	Product Code	0x0E	UINT	113,12	IdentNr
0x01	0x04	Revision	0x0E	STRUCT		V major. minor
0x01	0x05	Status	0x0E	WORD		always 0x0001
0x01	0x06	Serial Number	0x0E	UDINT		calculate from 113,3
0x01	0x07	Product Name	0x0E	SHORT-STRING		"Bronkhorst meter/controller"

IDENTITY OBJECT SERVICES			
IDENTITY OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x01	0x05	Reset	Reset device, parameters: 0 = reset, 1 = load default values + reset
0x01	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x01	0x10	Set_Attribute_Single	Modifies an attribute value

3.3.2 DeviceNet Object

Class Code: 03 HEX
The DeviceNet Object provides the configuration and status of a DeviceNet port. Each DeviceNet product must support (and only one) DeviceNet object per physical connection to the DeviceNet communication link.

DEVICENET OBJECT'S INSTANCE ATTRIBUTES (Instance = 1)						
DEVICENET OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x03	0x01	MAC ID	0x0E, 0x10	USINT	125,10	0-63
0x03	0x02	BAUD Rate	0x0E, 0x10	USINT	126,9	0-2
0x03	0x03	Bus Off Interrupt	0x0E, 0x10	BOOL		0,1
0x03	0x04	Bus Off Counter	0x0E, 0x10	USINT		0-255
0x03	0x05	Allocation Information	0x0E	STRUCT		Alloc choice, Masters MAC ID

DEVICENET OBJECT SERVICES			
DEVICENET OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x03	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x03	0x10	Set_Attribute_Single	Modifies an attribute value
0x03	0x4B	Allocate M/S connection set	Requests the use of the Predefined Master/Slave connection set
0x03	0x4C	Release M/S connection set	Release Master/Slave connection set

3.3.3 Connection Objects

Class Code: 05 HEX
Use the Connection Object to manage the characteristics of a communication connection.

CONNECTION OBJECT'S INSTANCE ATTRIBUTES (Instance = 1)						
CONNECTION OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x05	0x01	State	0x0E	USINT		
0x05	0x02	Instance Type	0x0E	USINT		
0x05	0x03	Transport Class Trigger	0x0E	BYTE		
0x05	0x04	Produced Connection ID	0x0E	UINT		
0x05	0x05	Consumed Connection ID	0x0E	UINT		
0x05	0x06	Initial Comm. Characteristics	0x0E	BYTE		
0x05	0x07	Production Connection Size	0x0E	UINT		
0x05	0x08	Consumption Connection Size	0x0E	UINT		
0x05	0x09	Expected Packet Rate	0x0E,0x10	UINT		
0x05	0x0C	Watchdog Time out Action	0x0E,0x10	USINT		
0x05	0x0D	Produced Connection Path Length	0x0E	UINT		
0x05	0x0E	Produced Connection Path	0x0E,0x10	EPATH		
0x05	0x0F	Consumed Connection Path Length	0x0E	UINT		
0x05	0x10	Consumed Connection Path	0x0E,0x10	EPATH		
0x05	0x11	Production Inhibit Time	0x0E,0x10	UINT		

CONNECTION OBJECT SERVICES			
CONNECTION OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x05	0x05	Reset	Used to reset all resetable Connection Objects
0x05	0x09	Delete	Used to delete all Connection Objects and to release all associated resources
0x05	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x05	0x10	Set_Attribute_Single	Modifies an attribute value

3.3.4 Supervisor Objects

Class Code 30 HEX
This object models the interface, functions and behaviour associated with the management of application objects for devices within the “Hierarchy of Semiconductor Equipment Devices”

SUPERVISOR OBJECT’S INSTANCE ATTRIBUTES (Instance = 1)						
DEVICE SUPERVISOR OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x30	0x01	Number of Attributes	0x0E	USINT		20
0x30	0x02	Attribute List	0x0E	Array of USINT		
0x30	0x03	Manufacturer’s Device Type	0x0E	SHORT-STRING	113,1; Char[6]	“MFM" or "MFC”
0x30	0x04	SEMI Standard Revision	0x0E	SHORT-STRING		“E54-0997”
0x30	0x05	Manufacturer’s Name	0x0E	SHORT-STRING		“Bronkhorst High-Tech”
0x30	0x06	Manufacturer’s Model #	0x0E	SHORT-STRING	113,2; Char[14]	
0x30	0x07	Digital MFC Software Revision Level	0x0E	SHORT-STRING	113,5; Char[5]	“V6.XX”
0x30	0x08	DeviceNet Hardware Revision Level	0x0E	SHORT-STRING	113,7; Char[1]	“C”
0x30	0x09	Manufacturer’s Serial Number	0x0E	SHORT-STRING	113,3; Char[20]	Unique serial nr. for BHT instruments
0x30	0x0A	Device Configuration	0x0E	SHORT STRING	113,4; Char[16]	Manufacturer configuration
0x30	0x0B	Device Status	0x0E	USINT		
0x30	0x0C	Exception Status	0x0E	BYTE		
0x30	0x0D	Exception Detail Alarm	0x0E	STRUCT		
0x30	0x0E	Exception Detail Warning	0x0E	STRUCT		
0x30	0x0F	Alarm Enable	0x0E, 0x10	BOOL		0-1
0x30	0x10	Warning Enable	0x0E, 0x10	BOOL		0-1
0x30	0x13	Last Maintenance Date	0x0E	DATE	113,11; Char[8]	Service date
0x30	0x17	Running Hours	0x0E	UDINT	118,2	0-65535
0x30	0x64	Init Mode	0x0E, 0x10	USINT	0,10	0,64,73,82
0x30	0x65	Monitor	0x0E, 0x10	USINT	115,2	0: measure=setpoint
0x30	0x66	Default_Inp_IO_Assembly_Inst	0x0E, 0x10	USINT		
0x30	0x67	Default_Outp_IO_Assembly_Inst	0x0E, 0x10	USINT		

Device status	
Attribute value	**State**
0	Undefined
1	Self testing
2	Idle
3	Self test Exception
4	Executing
5	Abort
6	Critical fault
7-50	Reserved by CIP
51-99	Device specific
100-255	Vendor specific

Exception Status		
Bit	**Exception status bit map, Bit 7 set to 0 Function**	**State**
0	Device specific definition	Alarm/device-common
1		Alarm/device-specific
2		Alarm/manufacturer-specific
3		reserved – set to 0
4		Warning/device-common
5		Warning/device-specific
6		Warning/manufacturer-specific
7	0=basic method	1= Expanded Method

SUPERVISOR OBJECT SERVICES			
SUPERVISOR OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x30	0x05	Reset	Resets the device to the **Self-Testing** state
0x30	0x06	Start	Starts the device execution by moving the device to the **Executing** state
0x30	0x07	Stop	Moves the device to the **Idle** state
0x30	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x30	0x10	Set_Attribute_Single	Modifies an attribute value
0x30	0x4B	Abort	Moves the device to the **Abort** state
0x30	0x4C	Recover	Moves the device out of the **Abort** state
0x30	0x4E	Perform_Diagnostics	Causes the device to perform a set of diagnostic routines

3.3.5 S-Analog Sensor Object

Class Code 31 HEX
The S-Analog Sensor Objects models the acquisition of a reading from a physical sensor in a device.

ANALOG SENSOR OBJECT'S INSTANCE ATTRIBUTES (Instance = 1)						
ANALOG SENSOR OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x31	0x01	Number of Attributes	0x0E	USINT		12
0x31	0x02	Attribute List	0x0E	Array of USINT		
0x31	0x03	Data Type	0x0E, 0x10	USINT		0xC3=INT, 0xCA=REAL
0x31	0x04	Data Unit	0x0E, 0x10	UINT		0x1001=counts, 0x1400=sccm, etc
0x31	0x05	Reading Valid	0x0E	BOOL		0 = invalid, 1 = valid
0x31	0x06	Sensor Value	0x0E	INT or REAL[1]	1,0	see attribute 3 and 4 For data unit **counts** the value attribute will be in the range of 0..32767 where: 0 = no flow/pressure 32000 = max flow /pressure (100.0%) 32767 = max flow /pressure (102.4%) Note: 32767 is max. flow for data type INT. Max. flow REAL = 41943.04 (131.07%)
0x31	0x07	Status	0x0E	BYTE		1=High Alarm Exception, 2=Low Alarm Exception
0x31	0x08	Alarm Enable	0x0E, 0x10	BOOL		
0x31	0x0A	Full Scale	0x0E	INT		32000
0x31	0x11	Alarm Trip Point High	0x0E, 0x10	INT	97,1	see attribute 3 and 4
0x31	0x12	Alarm Trip Point Low	0x0E, 0x10	INT	97,2	see attribute 3 and 4
0x31	0x14	Alarm Settling Time	0x0E, 0x10	UINT	97,7	0-65000, alarm delay (msec)
0x31	0x1C	Autozero status	0x0E	UINT		1 = busy, 0 = ready
0x31	0x23	Gas Calibration Object Instance	0x0E, 0x10	UINT		1-8 1 = fluid 1 selected
0x31	0x69	Temperature	0x0E	REAL	33,7	Actual fluid Temperature (mini CORI-FLOW)
0x31	0x6A	Density	0x0E	REAL	116.15	Actual fluid Density (mini CORI-FLOW)
0x31	0x6B	Counter Value	0x0E, 0x10	REAL	104, 1	Actual counter value
0x31	0x6C	Counter Unit Index	0x0E, 0x10	USINT	104, 2	Index of counter unit table
0x31	0x6D	Counter Limit	0x0E, 0x10	REAL	104, 3	Counter lImit
0x31	0x6E	Counter Setpoint mode	0x0E, 0x10	USINT	104, 5	0 = No setpoint change 1 = Setpoint change on limit reached
0x31	0x6F	Counter Setpoint	0x0E, 0x10	UINT	104, 6	Setpoint when counter limit reached 0..32000 where 0 = 0% and 32000 = 100%
0x31	0x70	Counter Unit	0x0E	STRING	104, 7	Counter unit string
0x31	0x71	Counter Mode	0x0E, 0x10	USINT	104, 8	0 = Counter Off 1 = Counter On 2 = Counter On, Up to limit
0x31	0x72	Counter Reset Mode	0x0E, 0x10	USINT	104, 9	Counter reset mode (see manual)

0x31	0x73	Counter Convergence factor	0x0E, 0x10	REAL	104, 10	0.0 …. 1.0 (mini CORI-FLOW only)
0x31	0x74	Counter Controller Gain	0x0E, 0x10	REAL	104, 11	(mini CORI-FLOW only)
0x31	0x75	Reset	0x10	USINT	115, 8	0 = No Action 1 = Reset counter 3 = Reset counter 4 = Reset and stop counter
0x31	0x76	Pressure	0x0E	REAL	33,8	Actual fluid Pressure (bara) (EL-FLOW Prestige PI)

[1] Depends on the value assigned to the Data Type attribute. If the value of this attribute is 0xC3, the selected data type is Integer. If the value of this attribute is 0xCA, the selected data type will be the IEEE-754 single-precision floating-point.

No indication is available if counter limit is reached.
A workaround could be:
read counter limit and counter value all the time by the master application.
If counter value >= counter limit, the batch has been reached.

ANALOG SENSOR OBJECT SERVICES			
ANALOG SENSOR OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x31	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x31	0x10	Set_Attribute_Single	Modifies an attribute value
0x31	0x4B	Zero Adjust	Start Autozero

3.3.6 S-Analog Actuator Object

Class Code 32 HEX
The S-Analog Actuator Object models the interface to a physical actuator in a device.

ANALOG ACTUATOR OBJECT'S INSTANCE ATTRIBUTES (Instance = 1)						
ANALOG ACTUATOR OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x32	0x01	Number of Attributes	0x0E	USINT		7
0x32	0x02	Attribute List	0x0E	Array of USINT		
0x32	0x03	Data Type	0x0E, 0x10	USINT		0xC3=INT, 0xCA=REAL
0x32	0x04	Data Units	0x0E, 0x10	UINT		0x1001 = counts, 0x1007 = %
0x32	0x05	Override	0x0E, 0x10	USINT		
0x32	0x06	Actuator Value (valve)	0x0E, 0x10	INT or REAL[1]	114,1	See attribute 3 and 4 For data unit **counts** the value attribute will be in the range of 0..32767. Where: 0 = valve closed 32767 = valve fully open
0x32	0x07	Status	0x0E	BYTE		always 0
0x32	0x15	Safe State	0x0E, 0x10	USINT		
0x32	0x16	Safe Value	0x0E, 0x10	INT	114,6	

[1] Depends on the value assigned to the Data Type attribute. If the value of this attribute is 0xC3, the selected data type is Integer, and if the value of this attribute is 0xCA, the selected data type will be the IEEE-754 single-precision floating-point.

ANALOG ACTUATOR OBJECT SERVICES			
ANALOG ACTUATOR OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x32	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x32	0x10	Set_Attribute_Single	Modifies an attribute value

3.3.7 S-Single Stage Controller Object

Class Code 33 HEX
The S-Single Stage Controller Object models a closed-loop control system within a device.

CONTROLLER OBJECT'S INSTANCE ATTRIBUTES (Instance = 1)						
SINGLE STAGE CONTROLLER OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x33	0x01	Number of Attributes	0x0E	USINT		6
0x33	0x02	Attribute List	0x0E	Array of USINT		
0x33	0x03	Data Type	0x0E, 0x10	USINT		0xC3=INT, 0xCA=REAL
0x33	0x04	Data Units	0x0E, 0x10	UINT		0x1001=counts, 0x1400=sccm, etc
0x33	0x05	Control Mode	0x0E, 0x10	USINT		
0x33	0x06	Setpoint	0x0E, 0x10	INT or REAL[1]	1,1	See attribute 3 and 4. For data unit **counts** the setpoint attribute must be in the range of 0..32000. Where: 0 = min. setpoint (0%) 32000 = max. setpoint (100%)
0x33	0x0A	Status	0x0E	BYTE		
0x33	0x13	Ramp Rate	0x0E, 0x10	UDINT	1,2	Setpoint slope in msec (max. 3000000 msec)

[1] Depends on the value assigned to the Data Type attribute. If the value of this attribute is 0xC3, the selected data type is Integer, and if the value of this attribute is 0xCA, the selected data type will be the IEEE-754 single-precision floating-point.

CONTROLLER OBJECT SERVICES			
SINGLE STAGE CONTROLLER OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x33	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x33	0x10	Set_Attribute_Single	Modifies an attribute value

3.3.8 S-Gas Calibration Object

Class Code 34 HEX
An S-Gas Calibration Object affects the behaviour of an associated S-Analog Sensor object instance.

GAS CALIBRATION OBJECT'S CLASS ATTRIBUTES (Instance = 0)						
GAS CALIBRATION OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x34	0x02	Max Instance[1]	0x0E	UINT		8

[1] This is the total number of process gases currently calibrated for the device.

GAS CALIBRATION OBJECT'S INSTANCE ATTRIBUTES (Instance = 1...8)						
GAS CALIBRATION OBJECT	**ATTRI-BUTE**	**ATTRIBUTE NAME**	**SERVICE CODE**	**DATA TYPE**	**FLOW-BUS**	**Comment**
0x34	0x01	Number of attributes	0x0E	USINT		6
0x34	0x02	Attribute List	0x0E	Array of USINT		
0x34	0x03	Gas Standard number	0x0E	UINT		see list from SEMI
0x34	0x04	Valid Sensor instance	0x0E	UINT		1
0x34	0x05	Gas Symbol	0x0E	SHORT STRING	1,17; Char[10]	fluidname
0x34	0x06	Full Scale	0x0E	STRUCT		Full scale capacity (REAL), capacity unit (UINT)
0x34	0x08	Calibration Date	0x0E	DATE	113,9; Char[8]	

[1] The gas calibration is formed by a 3rd grade polynomial ($y=a+bx+cx^2+dx^3$). This polynomial will perform linearization to achieve the wanted accuracy. Up to 8 polynomials can be stored for different fluids. Each fluid has its own instance (1...8).

GAS CALIBRATION OBJECT SERVICES			
GAS CALIBRATION OBJECT	**SERVICE CODE**	**SERVICE NAME**	**SERVICE DESCRIPTION**
0x34	0x0E	Get_Attribute_Single	Returns the contents of the specified attribute
0x34	0x10	Set_Attribute_Single	Modifies an attribute value

3.3.9 Elementary data Types

This section describes the data type specification syntaxes, data type value ranges and operations that can be performed on the defined data types.

Table 2-18: SUBSET OF ELEMENTARY DATA TYPES

Keyword	Description	Minimum range	Maximum range
BOOL	Boolean	0	1
SINT	Short Integer	-128	127
INT	Integer	-32768	32767
USINT	Unsigned Short Integer	0	255
UINT	Unsigned Integer	0	65535
UDINT	Unsigned Double Integer	0	2^32-1
REAL	Floating Point	IEEE 754 single floating point	
DATE	Date only	D#1972-01-01	D#2151-06-06 (65536 days)
BYTE	Bit string – 8 bits		
WORD	Bit string – 16 bits		
STRING	Character string (1 byte per character)	See IEC1131-3	
SHORT_STRING	Character string (1 byte per character, 1 byte length indicator)	See IEC1131-3	

3.4 POLLED I/O

3.4.1 Representation

All of the above attributes in the tables from Table 2-1 to Table 2-16 can be accessed using Explicit Messaging. Upon existence of an explicit connection, a Polled I/O connection can also be established and coexist. Once the Polled I/O connection has been established, the device will be able to accept and process the Polled I/O requests. For example, if Instance #7 has been selected as Output IO Assembly Instance, two data bytes representing the new setpoint shall be appended to the Polled I/O request for setting a setpoint. If the Data Unit attribute were 0x1001 as the code for "Counts", the value of the setpoint bytes will be an signed integer where 0x7D00 (*) represents 100% flow and 0x0000 represents 0% flow. Upon reception of the Polled I/O Request, if Instance #2 has been selected as Input IO Assembly Instance the DeviceNet MFC will respond with a Polled I/O Response carrying with it three data bytes as described below:

Polled I/O Response's Data Field using Counts as Data Unit		
Byte0: **Exception Status**	**Byte1:** **Indicated Flow (LSB)**	**Byte2:** **Indicated Flow (MSB)**
BYTE	INT (0x7D00 = 100%)	

Polled I/O Request's Data Field using Counts as Data Unit	
Byte0: **New Setpoint (LSB)**	**Byte1:** **New Setpoint (MSB)**
INT (0x7D00 = 100%)	

Note that if "Counts" has been selected for the Data Unit attribute of the Analog Sensor and Controller object (i.e., the value of these attributes is 0x1001), then the Indicated-Flow bytes in the Polled I/O Response represent the same information as that of the New-Setpoint bytes in the Polled I/O Request (i.e., 0x0000 represents 0% flow and 0x7D00 (*) represents 100% flow). However, if the "Data Unit" attribute of the Sensor and the Setpoint object are 0x1400, the value of the indicated flow and setpoint will be in Standard Cubic Centimeter (SCCM). Note that the setpoint and the indicated flow can be set with different data unit (i.e., Counts for Setpoint and SCCM for Indicated-flow or vice versa). Since the Indicated-flow and Setpoint attribute are integer, if used in SCCM mode the value of these attribute can not exceed 32767 SCCM. Therefore the SCCM mode shall not be used for MFCs having gases with the full-scale exceeding 32767 SCCM or having the Full-scale loaded with SLM data unit.

Polled I/O Response's Data Field using SCCM as Data Unit		
Byte0: **Exception Status**	**Byte1:** **Indicated Flow (LSB)**	**Byte2:** **Indicated Flow (MSB)**
BYTE	INT (0 to Full Scale)	

Polled I/O Request's Data Field using SCCM as Data Unit	
Byte0: **New Setpoint (LSB)**	**Byte1:** **New Setpoint (MSB)**
INT (0 to Full Scale)	

The tables above show some examples of the Polled I/O setting. There are eight (8) IO Assembly Instances that the user can choose from; 4 for input and 4 for output. These instances are specified in the MFC Device Profile document. See next paragraph for more details.

(*) 100% Measured Value indication for Bronkhorst® instruments is 0x7D00 (signed integer). Maximum value for Measured Value is 102.4 %, which is: 0x7FFF. Other suppliers may use different ranges for Measured Value. Via Full Scale: attribute 0x0A of object 0x31, analog sensor, it is possible to readout the signed integer value used for 100%.

Furthermore, with the use of the Data-type attribute(0x03) and Data-unit attribute(0x04) of the Sensor object 0x31 and the Controller object 0x33 the user can select one of the following settings for both Explicit and Polled I/O messages (see paragraph 3.2.2 for a complete list of supported data-units, the settings below are just a few examples):

Example 1 *(ClassId: 0x31, Data-type: 0xC3, Data-unit: 0x01 0x10)*: Signed Integer Count Indicated-flow.
Example 2 *(ClassId: 0x31, Data-type: 0xC3, Data-unit: 0x00 0x14)*: Signed Integer SCCM Indicated-flow.
Example 3 *(ClassId: 0x31, Data-type: 0xCA, Data-unit: 0x01 0x10)*: Single-precision floating-point Count Indicated-flow.
Example 4 *(ClassId: 0x31, Data-type: 0xCA, Data-unit: 0x00 0x14)*: Single-precision floating-point SCCM Indicated-flow.
Example 5 *(ClassId: 0x33, Data-type: 0xC3, Data-unit: 0x01 0x10)*: Signed Integer Count Setpoint.
Example 6 *(ClassId: 0x33, Data-type: 0xC3, Data-unit: 0x00 0x14)*: Signed Integer SCCM Setpoint.
Example 7 *(ClassId: 0x33, Data-type: 0xCA, Data-unit: 0x01 0x10)*: Single-precision floating-point Count Setpoint.
Example 8 *(ClassId: 0x33, Data-type: 0xCA, Data-unit: 0x00 0x14)*: Single-precision floating-point SCCM Setpoint.

For Polled I/O messages only Data-type can be selected. The Data-unit attribute will be automatically set when Polled I/O is started (on receipt of the first Polled I/O Request's Data). The Data-unit setting will be determined by the selected IO Assembly Instance (see paragraph 2.5.1, Available data combinations for Polled I/O).

The Data-type and Data-unit Attribute can only be set when the MFC is in the Idle state. If the MFC is not in this state (i.e., Executing state) the user must use the Stop service (0x07) of Instance (0x01) of the Supervisor object (0x30) to allow the MFC to enter the Idle state for making the change. When the attribute has been set the user can use the Start service (0x06) of the same object and instance to resume the Executing state.

Example 1: How to program instrument with option 1 from above					
Object	**Instance**	**Service code**	**Attribute**	**Value**	**Description**
30	1	0x07			stop: instrument to idle state; green LED long flash: 2 sec on, 0.1 sec off
31	1	0x10	0x03	0xC3	Data type = INT
31	1	0x10	0x04	0x01 0x10	Data unit = COUNT
30	1	0x06			start: instrument to executing state green LED on continuously

Example 2: How to program instrument with option 8 from above					
Object	**Instance**	**Service code**	**Attribute**	**Value**	**Description**
30	1	0x07			stop: instrument to idle state; green LED short flash: 2 sec on, 0.1 sec off
33	1	0x10	0x03	0xCA	Data type = REAL
33	1	0x10	0x04	0x00 0x14	Data unit = SCCM
30	1	0x06			start: instrument to executing state green LED on continuously

3.5 DEVICE CONFIGURATION

3.5.1 Available data combinations for Polled I/O

Using the EDS-file in the DeviceNet configuration program of the master, following I/O combinations are available (IO Assembly Instances**)**:

Inputs:

1.	ExceptionStatus + Flow	data-type: integer	(0xC3)
2.	ExceptionStatus + Flow + Setp + Override + Valve signal	data-type: integer	(0xC3)
3.	ExceptionStatus + Flow	data-type: float	(0xCA)
4.	ExceptionStatus + Flow + Setpoint + Override + Valve	data-type: float	(0xCA)

Outputs:

1.	Setpoint	data-type: integer	(0xC3)
2.	Override + Setpoint	data-type: integer	(0xC3)
3.	Setpoint	data-type: float	(0xCA)
4.	Override + Setpoint	data-type: float	(0xCA)

3.5.2 Available parameter data

Using the EDS-file in the configuration program of the master, following parameters are available for customising:

1.	Polled I/O (input)	: select IO Assembly Instance for input (data combination polled I/O)
2.	Polled I/O (output)	: select IO Assembly Instance for output (data comb. polled I/O)
3.	Control mode	: sets controller to idle, valve off, purge or normal setpoint
4.	Setpoint ramp rate (msec)	: sets ramp rate of setpoint from 0…3000000 msec
5.	Fluid number	: selects wanted calibration/fluid nr.: 1…8
6.	Alarm	: switches alarms on or off
7.	Alarm delay (msec)	: sets alarm delay time in range 0…65000 msec

Parameter "Polled I/O (input)" and "Polled I/O (output)" must always be set to the correct value. This will select the data combination for Polled I/O (IO Assembly Instance). If it is not possible to start communication with the device always check these two settings!

4 OBJECT DESCRIPTION

4.1 SUPERVISOR OBJECT

4.1.1 FLOW-BUS interfacing (via RS232)

To enable controlling the device by RS232, a new control mode has been added: CTRL_RS232 (18). This control mode is equal to CTRL_FB (0), but in this case the device will always make the transition to the EXECUTING state (no start request or receipt of I/O data needed). So CTRL_RS232 makes it possible to give setpoints without the need of a DeviceNet connection.

The device will only be compliant with the ODVA profile when control mode is CTRL_FB (0).

In case of taking over control via RS232, it is possible to send value 18 to parameter "Control Mode" (FLOW-BUS: proc1, par4 or FLOWDDE: parameter 12). From this moment on, it will be possible to give setpoints without being overruled by the safe state. This control mode will be valid until the next power-up situation. Control mode = 18 will not be stored into non-volatile memory. At each power-up, the instrument will be normally set to control mode = 0.

*The **safe state** is active when the device is not in the EXECUTING state.*
The functionality of the RS232 FLOW-BUS "Control Mode" parameter is not the same as the Control Mode attribute in the Single State Controller Object (attribute 0x05, object 0x33).

4.1.2 I/O assembly instances selection

Attribute 0x66 and 0x67 can be used to select the I/O assembly instances used for the Polled I/O connection (see also Polled I/O input/output parameters in EDS file).

Devicenet	Input I/O assembly
obj 0x30, attr 102	instance
0	2
1	6
2	14
3	18

Devicenet	Output I/O assembly
obj 0x30, attr 103	instance
0	7
1	8
2	19
3	20

4.1.3 Exception Status

Exception status is a single byte which indicates the status of alarms and warnings. When 128 is read everything is o.k. This means that the expanded method is used for the exception status.

Bit	Meaning
0	alarm device common
1	alarm device specific
2	alarm manufacturer specific
3	reserved
4	warning device common
5	warning device specific
6	warning manufacturer specific
7	1 = expanded method

For more details, see the DeviceNet specification.

4.2 SINGLE STAGE CONTROLLER

4.2.1 Control mode

The Control Mode is implemented as follows:

Control Mode	Setpoint Value
0 (Normal)	set by attribute 6 (setpoint)
1 (Close)	0
2 (Open)	max. value
3 (Hold)	last used value
4 (Safe state)	(not supported)

When Override attribute of Analog actuator (object 0x32, attribute 0x05) is set to a value other than 0, this attribute will override the Control Mode attribute.

4.2.2 Setpoint

For the objects Analog Sensor and Single Stage Controller, the following data types and data units are supported for Value and alarm levels. Note that data type and data unit can only be changed when not in executing mode. The followings data units are supported (dependent on sensor type, actual sensor type can be found in calibration sheet):

Sensortype	Supported units
0 (pressure)	0x1001 (counts) 0x1007 (percentage) [not for Sensor value] 0x1300 (psi) 0x1301 (Torr) 0x1303 (mm Hg) 0x1305 (cm H_2O) 0x1307 (bar) 0x1308 (mbar) 0x1309 (Pa) 0x130A (kPa) 0x130B (atm) 0x130C (gf/cm^2) 0x0800 (cm Hg) 0x0801(kgf/cm^2)
1 (liq. Volume)	0x1001 (counts) 0x1007 (percentage) [not for Sensor value] 0x0900 (l/min) 0x0901 (ml/h) 0x0902 (ml/min) 0x0903 (l/h) 0x0904 (mm^3/s) 0x0905 (cm^3/min)
2 (mass flow)	0x1001 (counts) 0x1007 (percentage) [not for Sensor value] 0x1404 (kg/s) 0x140E (mg/min) 0x140F (g/min) 0x1410 (kg/h) 0x0A00 (kg/min) 0x0A01 (g/h) 0x0A02 (g/s) 0x0A03 (mg/h) 0x0A04 (mg/s)
3 (gas volume)	0x1001 (counts) 0x1007 (percentage) [not for Sensor value] 0x1400 (sccm) 0x1401 (slm) 0x0B00 (ln/min) 0x0B01 (mln/h) 0x0B02 (mln/min) 0x0B03 (ln/h) 0x0B04 (m^3n/h) 0x0B05 (mls/min) 0x0B06 (mls/h) 0x0B07 (ls/h) 0x0B08 (m^3s/h) 0x0B09 (ls/min)
4 (other)	0x1001 (counts) 0x1007 (percentage) [not for Sensor value]
5 (temperature)	0x1001 (counts) 0x1007 (percentage) [not for Sensor value] 0x1200 (deg. C) 0x1201 (deg. F) 0x1202 (K)

The following data types are supported: 0xC3 (int) 0xCA (real)

4.3 ANALOG SENSOR OBJECT

4.3.1 Sensor value

See Setpoint attribute of Single stage controller above.

4.3.2 Alarm enable

Attribute Alarm enable of Analog Sensor object is linked to propar 97;3 (Alarmmode).

FLOW-BUS	Devicenet
Alarmmode	**Alarm enable**
proc 97; par 3	**obj 0x31, attr 8**
ALRM_OFF (ALRM_RESPONSE) (ALRM_POWERFAILURE)	0 (off)
ALRM_MINMAX	1 (on)

When 0 is written to Alarm enable attribute, the internal alarm mode is always set to ALRM_OFF. The modes ALRM_RESPONSE and ALRM_POWERFAILURE can be set by RS232, not by DeviceNet.

More information can be found in the manual "917023 Operational instructions digital instruments"
This document can be found at:
http://www.bronkhorst.com/en/downloads/instruction_manuals/

4.3.3 Alarm Trip Points

Alarm_Trip_Point_Low attribute is linked to propar 97/2 (Min. limit). Valid range is [0, 32000].
Alarm_Trip_Point_High attribute is linked to propar 97/1 (Max. limit). Valid range is [0, 32000].
A value outside the valid range is rounded to the nearest value within the range. Note that the Trip Point values are dependent on the selected data types/units.

For the maximum value the following mapping is used:

FLOW-BUS	DeviceNet
Max limit	**Alarm Trip Point High**
proc 97; par 1	**obj 0x31, attr 17**
0 (off)	32000
1	0
32000	31999

4.3.4 Gas calibration object instance

Indicates which Gas Calibration object instance is active for this object. The value of this attribute is equal to (fluidnumer+1). Value 0 (disabled) is not supported.

4.4 ANALOG ACTUATOR OBJECT INSTANCE

4.4.1 Actuator value

The followings data units are supported:
0x1001 (counts): 0 = valve closed, 32767 = valve fully open
0x1007 (percent): 0 = valve closed, 100 = valve fully open

The following data types are supported: 0xC3 (int) 0xCA (real)

4.4.2 Override

The Override attribute is implemented as follows:

Override	Value to Valve
0 (Normal)	set by attribute 6 (Actuator Value)
1 (Zero)	0
2 (Maximum value)	max. value
3 (Hold)	last used value
4 (Safe state)	See section 4.4.3.

4.4.3 Safe state

In the following table the implemented values of the Valve output are shown. Mapping Safe state:

Safe state	Value to Valve
0 (zero/off)	0
1 (full scale / on)	max. value
2 (hold last value)	last used value
3 (use safe value)	Safe value (obj 0x32, attr 0x16)

4.5 GAS CALIBRATION OBJECT INSTANCE

4.5.1 Gas standard number

The retrieval of the gas standard number is implemented as follows: the first 2 characters of the fluid name are interpreted as a decimal number. This number is returned as the gas standard number.

4.5.2 Gas Symbol

The fluid name is returned as the Gas Symbol.

4.6 NETWORK ERROR DETECTION

When a network error is detected while the device is in Executing state, it is set back to the Idle or Critical Fault state. In those states the valve is set to the Safe state (see attribute Safe State in Analog Actuator object). When the device detects that no bus power is available, the network is closed and no communication is started until the bus power is detected again.

Such errors are shown by the LED's on the instrument. See the chapter "Troubleshooting"

4.7 BUS DIAGNOSTICS

A propar (FLOW-BUS) variable (process 125, parameter 20) can be used to retrieve a string with bus diagnostics. This zero terminated string contains 13 bytes of data and is described below.
Layout bus diagnostics string for DeviceNet:

Byte field	Description	Diagnostic values		Explanation	Length
0	ces_state	0	error active	CAN error state	1
		1	error passive		
		2	bus off		
1	ces_event	0	no events (always 0)	CAN error state event	1
2	nas_state	0	on line	Network access state	1
		1	waiting for dup MAC ID check message		
		2	sending dup MAC ID check message		
		3	non existent		
		4	communication fault		
3	nas_event	0	duplicate MAC ID check req/resp not received (num_reties = 1)	Network access state	1
		1	duplicate MAC ID check req/resp not received (num_reties = 0)		
		2	duplicate MAC ID check request received		
		3	duplicate MAC ID check response received		
		4	powerup/reset		
		5	bus off detected		
4	sos_state	0	executing	duplicate MAC ID check req/resp not received (num_reties = 1)	1
		1	idle		
		2	abort		
		3	self-testing		
		4	self-test exception		
		5	critical fault		
5	sos_event	0	receipt of first valid IO data	Supervisor object state event	1
		1	IO connection timeout		
		2	IO connection deleted		
		3	start request		
		4	abort request		
		5	stop request		
		6	reset request		
		7	recover request		
		8	self test passed		
		9	self test failed		
		10	perform diagnostics request		
		11	power applied		
		12	critical fault from any state		
6	diag_bits	bit 0	ces state, error passive	Diagnostic bits (will be reset automatically)	2
		bit 1	ces state, bus off		
		bit 2	nas state, communication fault		
		bit 3	nas event occurred, duplicate MAC ID check request received		
		bit 4	nas event occurred, duplicate MAC ID check response received		
		bit 5	sos state, critical fault		
		bit 6	sos event occurred, IO connection timeout		
		bit 7	sos event occurred, IO connection deleted		
		bit 8	sos event occurred, self test failed		
		bit 9	sos event occurred, critical fault from any state		
		bit 10	rx queue overrun		
		bit 11	tx queue overrun		
		bit 12	can overrun		
		bit 13	explicit connection timeout		
		bit 14	devicenet reset		
		bit 15	bus sense error (24V detection)		
8	AnSens Data Type (attr:0x31/1/3)			Analog sensor data type	1
9	AnAct Data Type (attr:0x32/1/3)			Actuator data type	1
10	Contrl Data Type (attr: 0x33/1/3)			Controller data type	1
11	Default Inp IO (attr: 0x30/1/102)			Current Assembly Instance (Input)	1
12	Default Outp IO (attr: 0x30/1/103)			Current Assembly Instance (Output)	1

4.8 SERIAL NUMBER

The DeviceNet serial number (attribute 6 of Identity object) must be unique in combination with the Vendor id. In our implementation this number is calculated from the Bronkhorst® serial number string (propar process 113, parameter 3).

Layout serial number string: "AB2#####NNP"

Meaning:

AB = *year*
A = 'M' : year 2000-2099
B = '0' - '99' : year modulo 100
2 = always '2' (indicates that an order has been received)

= order number of 4 or 5 digits (0000 to 9999 or 00000 to 99999)

NN = optional code of 1 or 2 letters (for example 'A', 'B' or 'AA' etc)
'A' = 0,
'B' = 1,
'Z' = 25,
'AA' = 26,
'AZ' = 51,
'IV' = 255

P = optional sequence number ('0' to '9')

NN and P are optional and may be omitted; in that case they are assumed to be 0.

Computation of DeviceNet serial number (0x01/1/6, UDINT)

The DeviceNet serial number is computed as follows:

	value	range	bits
(a)	(year-2000)	0 - 19	5
(b)	order number	0 - 52427	
(c)	sequence number	0 - 9	
(bc)	(order number * 10) + sequence number	0 - 524279	19
(d)	code	0 - 255	8

The DeviceNet serial number is computed by bitwise concatenating of (a), (bc) and (d). This will result in a 32 bits value.

Note: when the serial number string is not filled in according to the above template, the resulting DeviceNet serial number will not be unique anymore.

5 EDS-FILE

To assist users in configuring the Polled I/O communication, an Electronics Data Sheet (EDS) file will be provided. Each type DeviceNet instrument should have its own EDS-file with instrument specifications to tell the master configuration software which facilities/features the instruments/slaves offer to the master. For Bronkhorst® meter/controller the file is called: BHT_DMFC.EDS. This file is available on the Multibus documentation/software tool CD.

This EDS-file is a text-file containing:

Identification info:

- Model name: "Bronkhorst meter/controller"
- Vendor name: "Bronkhorst High-Tech B.V."
- Vendor ID: 706

Setting info:

- IO Characteristics section, contains available polled I/O combinations (IO Assembly Instances)
- Parameter section, the configuration software uses this section to generate a dialog box where the user can enter instrument parameters for customising (see paragraph 2.5.2).

After starting-up your master configuration software, this EDS-file should be load/import/copied. This is needed only once (until a eventual next revision from the file).

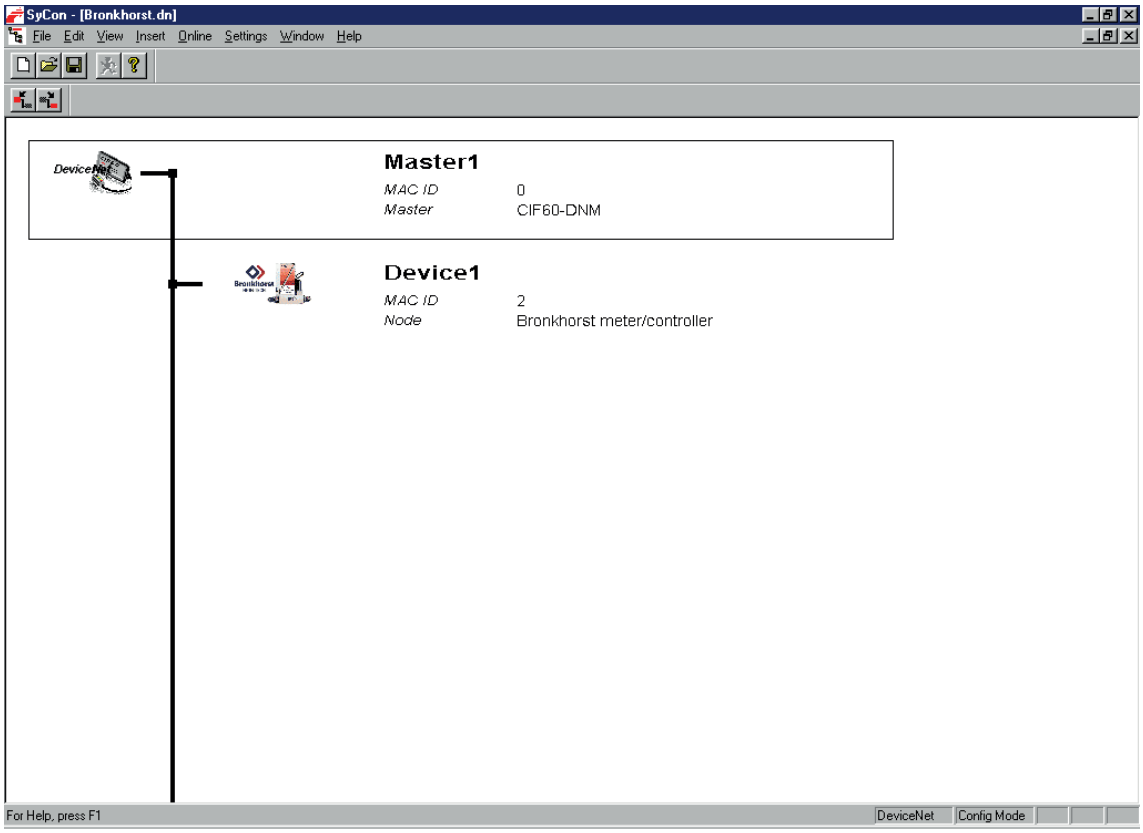
Note: Some DeviceNET configuration software may report a Device mismatch in relation to the "ProdCode". A solution can be provided, please contact support@bronkhorst.com.

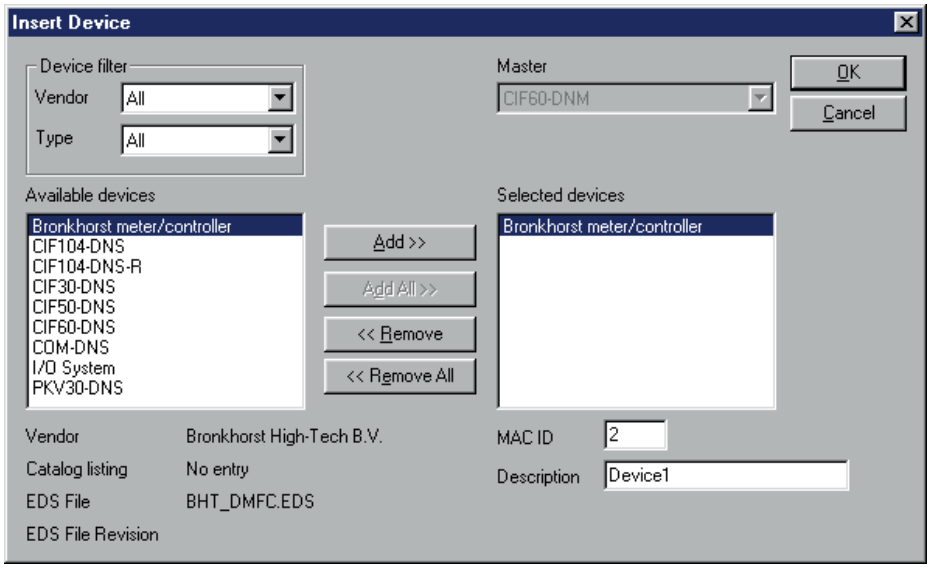
6 ADD SLAVE TO DEVICENET

In next paragraphs some example screens will be showed of a master configuration tool to explain how to install a Bronkhorst® meter/controller DeviceNet slave. The tool used for this purposes is Sycon V2.6.2. from Hilscher G.m.b.H. For other master configuration software tools the working will be almost the same, because DeviceNet is a standardised field bus system. Read the user manual carefully for correct operation of other programs than Sycon.

In your master configuration software select: [Insert][Device].
Select [Bronkhorst meter/controller] and evt. press [Add].

AN EXAMPLE OF THIS PROCEDURE CAN BE FOUND BELOW:



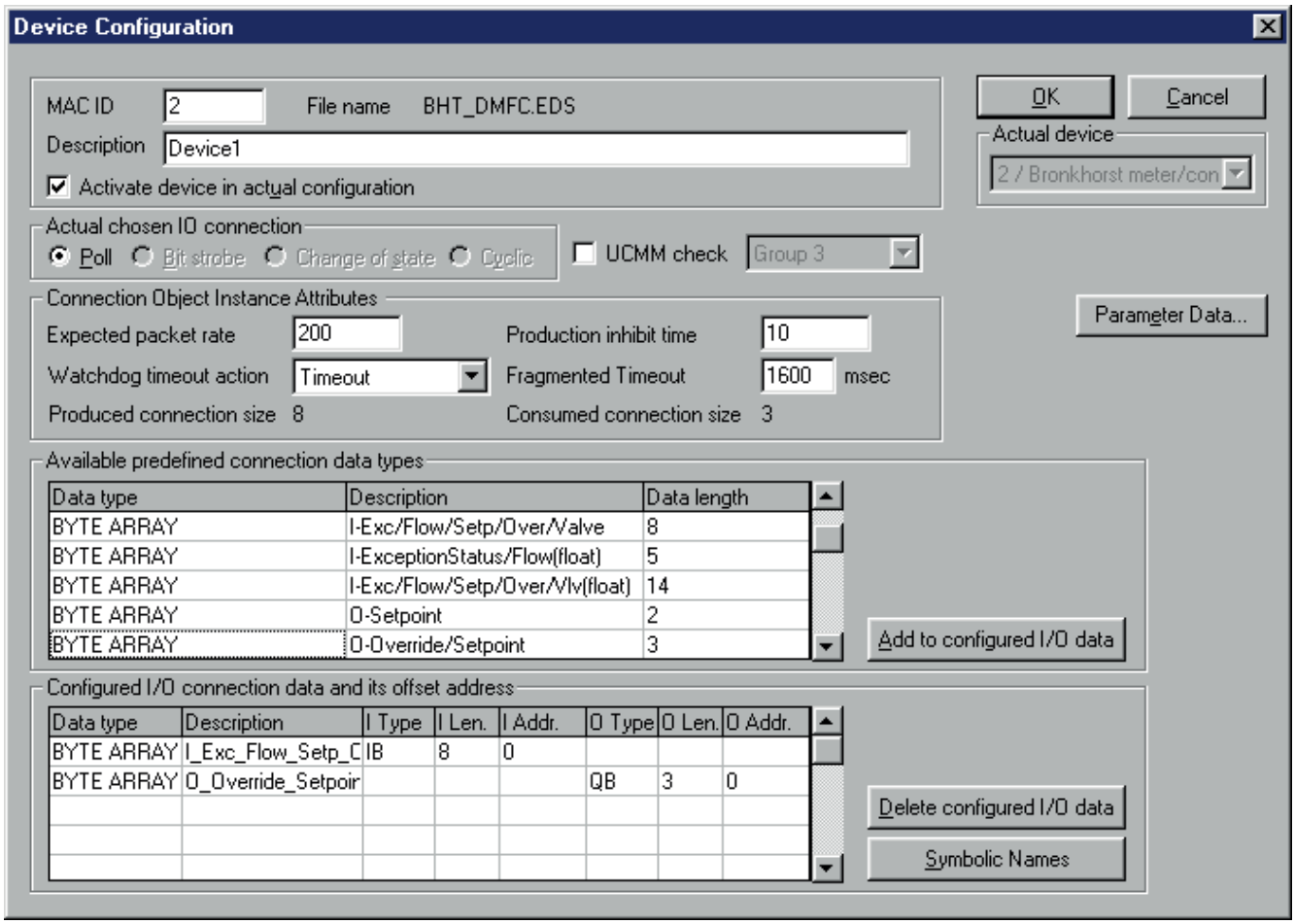


7 SLAVE CONFIGURATION SETTINGS

Bronkhorst® DeviceNet instruments offer many available attributes/parameters for operation of the instruments. These attributes/parameters can be selected by means of the master configuration tooling software (after loading the EDS-file: BHT_DMFC.EDS).

After installing the slave to the DeviceNet system, point to actual slave and select: [Device Configuration]. In the first table all available data types for polled I/O are listed. Select those instrument variables you want to use. The selected connections will be displayed in the second table.

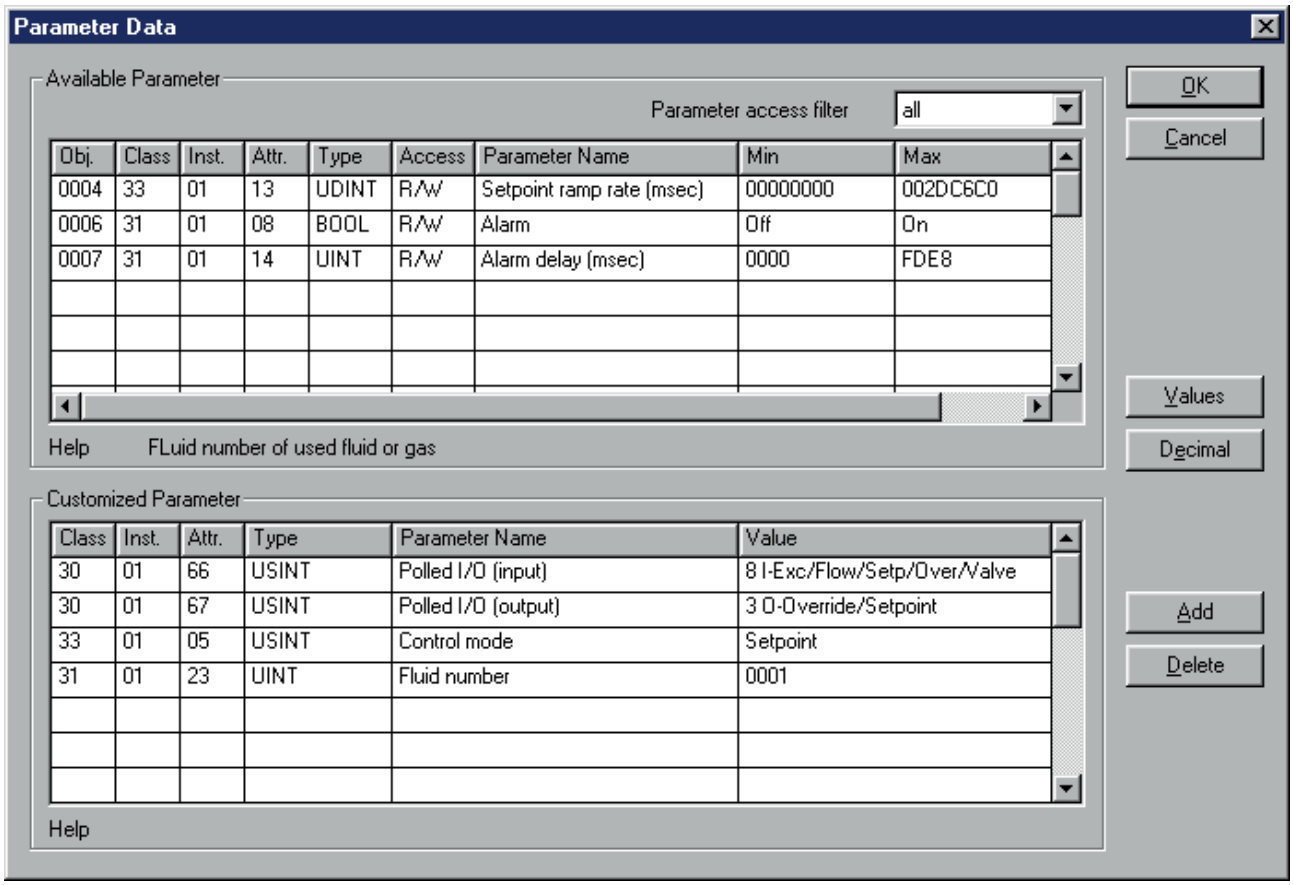
An example:



8 SLAVE PARAMETER SETTINGS

If you want to give your instrument specific values for certain parameters at start-up you can do this by means of parameter settings. In your master configuration tool, in the Device Configuration menu select [Parameter data]. All available parameters will become visible. Selecting/double clicking on the value enables you to add Available Parameters to Customise Parameters. E.g. Parameter fluid number will be default = 1, but when added to Customised Parameter it can be changed into another value.

Example:



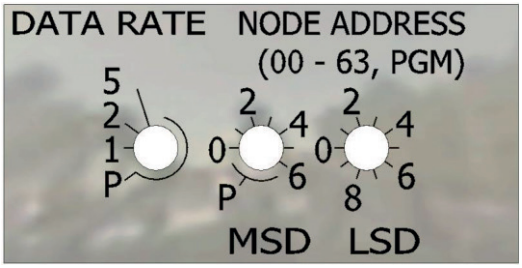
Parameter "Polled I/O (input)" and "Polled I/O (output)" must always be set to the correct value. This will select the data combination for Polled I/O (IO Assembly Instance). This data combination must be the same as the selected data combination in the "Device Configuration" dialog box.

9 CHANGING MAC ID AND BAUD RATE

When you have installed your Bronkhorst® meter/controller DeviceNet slave and made right settings for device configuration and parameter data, you can give your instrument the MAC ID you want. Default instruments will be delivered with MAC ID 63. This MAC ID has been agreed by the DeviceNet organisation to be free for installing new devices to the bus. Changing the MAC ID can be performed in different ways:

9.1 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:

9.1.1 DATA RATE

With the DATA RATE switch the baud rate of the instrument can be set.

Data rate	BAUD Rate
1	125kbps (default)
2	250kbps
5	500kbps
P	Programmable mode

If the switch is set to P the baud rate is software programmable.

During instrument initialisation, the DATA RATE switch is read. If the switch specifies one of the valid data rates, i.e. 125, 250, 500Kbaud, this value is used. If the specified data rate differs from the value stored in the instrument, the new data rate is saved in memory. If the switch specifies the programmable mode, the value stored in the instrument's memory will be used as the data rate.

9.1.2 NODE ADDRESS (00 – 63 PGM)

With the NODE ADDRESS switch the MAC ID 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 address is 63.

During instrument initialisation, the node address switches are read. If the switches specify a valid DeviceNet MAC ID, i.e. a value from 0 to 63 this value is used. If the specified MAC ID differs from the value stored in the instrument, the new MAC ID is saved in memory. If the switches specify an invalid DeviceNet MAC ID, i.e. a value greater than 63, the value stored in the instrument's memory will be used as the MAC ID.

If the address is set by the switch and it is not on the P position the instrument will respond with error status code 0E (Attribute not settable) if by software is tried to change the address.

9.2 VIA DEVICENET:

9.2.1 MAC ID

MAC ID can be changed by writing to attribute 1 of the DeviceNet Object (Object 0x03). The MAC ID must be in the range of 0-63 and will be stored in non-volatile memory.

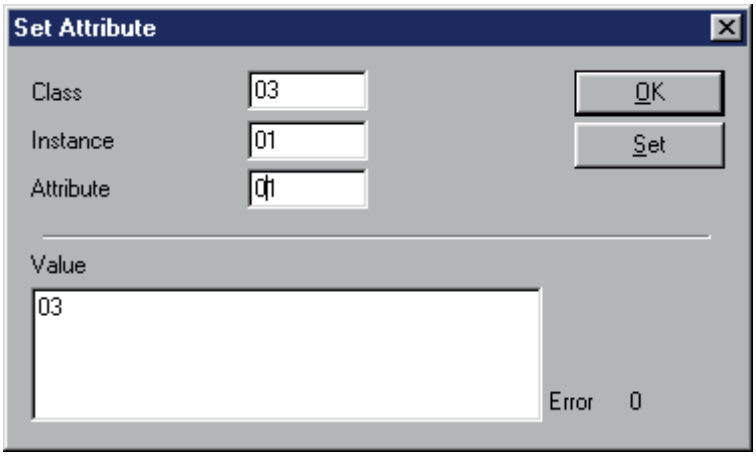
9.2.2 BAUD Rate

BAUD Rate can be changed by writing to attribute 2 of the DeviceNet Object (Object 0x03). The BAUD Rate code must be in the range of 0-2 and will be stored in non-volatile memory. The following table describes the actual BAUD Rate that corresponds to the BAUD Rate code stored in attribute 2.

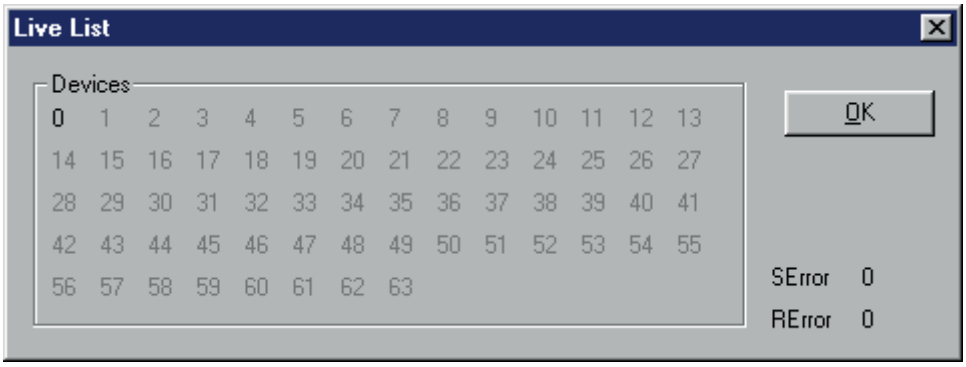
Value attribute 2	BAUD Rate
0	125K
1	250K
2	500K

The normal way to change MAC ID. Point to the actual slave in your master configuration tool and select [online] [Set Device Attribute]. Give correct new address at Value and press [Set]. This is the common way to Set or Get Attribute values of a device. Look for correct Class, Instance and Attribute in the tables at chapter 2.

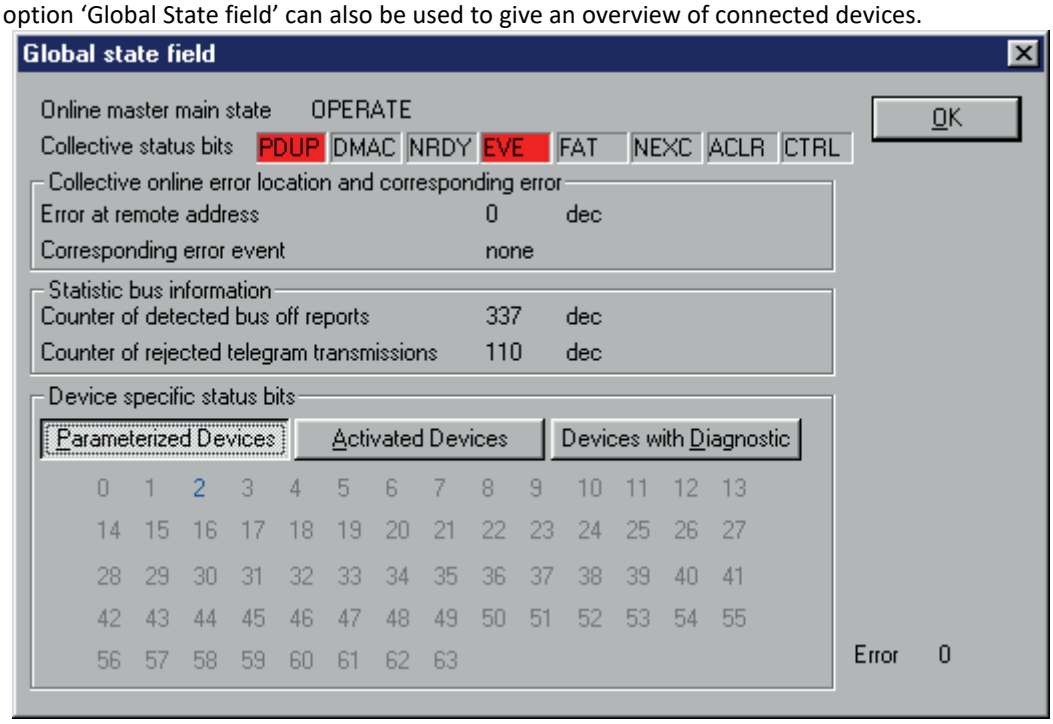
Example:



Re-address action can be checked using the option 'Live list'. This gives an overview of all devices connected to a DeviceNet segment.



The menu option ‘Global State field’ can also be used to give an overview of connected devices.

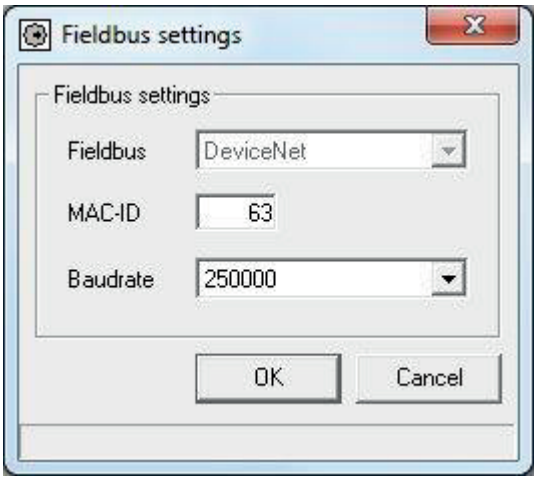


9.3 VIA RS232: FLOWFIX

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

- Change station address/MAC-ID
- Read and evt. change baud rate (depends on field bus system)
- Make a service log file to be send to Bronkhorst® in case of trouble

Connect your Bronkhorst® meter/controller DeviceNet 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 connectors and on the other side a female sub-D 9 connector. 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 approx. 10 meters.



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

Enter MAC-ID and Baud rate and press [OK].

Re-address action can be checked using the option ‘Live list’ or ‘Global State Field’. This gives an overview of all masters and slaves connected to a DeviceNet segment (see example in previous paragraph).

9.4 VIA RS232: OTHER PROGRAMS

It is also possible to read and or change station address or baud rate by means of any program via RS232 using the COM-port of your PC on 38.4 KBaud. This can be achieved using the FLOW-BUS protocol.

The following table gives the parameters in proc 125 which may be used:

Parameter	Type	R/W	Init mode	Description
9	LONG	R/W	Soft init	Baud rate for field bus interface
10	CHR	R/W	Soft init	Field bus station address/MAC ID

More detailed information about the RS232 protocol (document 9.17.027) can be found at:
http://www.bronkhorst.com/en/downloads/instruction_manuals/

9.5 VIA MICRO-SWITCH AND LEDS ON TOP OF INSTRUMENT

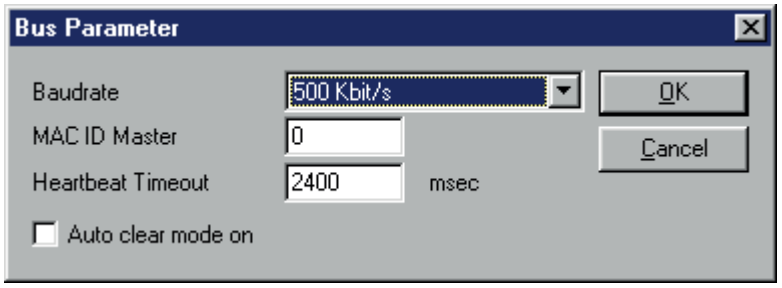
With the micro-switch on top of the instrument it is possible to change and readout the settings for MAC-ID and baud rate. The LED's will indicate the tens of the address with green flashes and the units with red flashes. For baud rate indication both LED's will flash.

See document 9.17.023 for a detailed description
This document can be found at:
http://www.bronkhorst.com/en/downloads/instruction_manuals/

10 DOWNLOAD TO MASTER

When needed baud rate for the master can be changed at [Settings][Bus parameter].

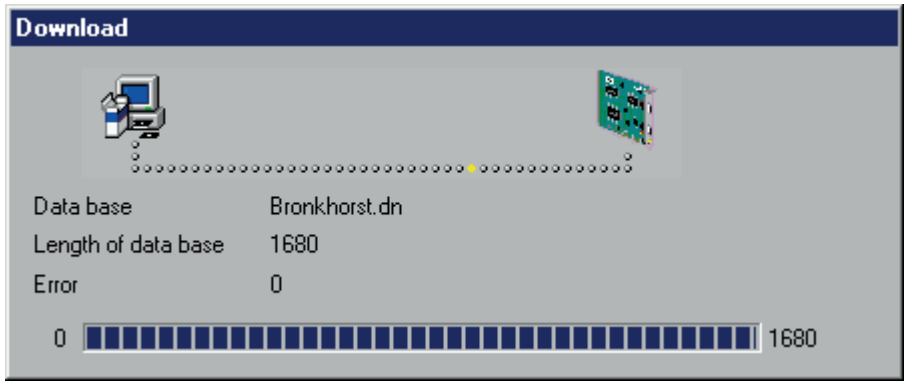
See example:



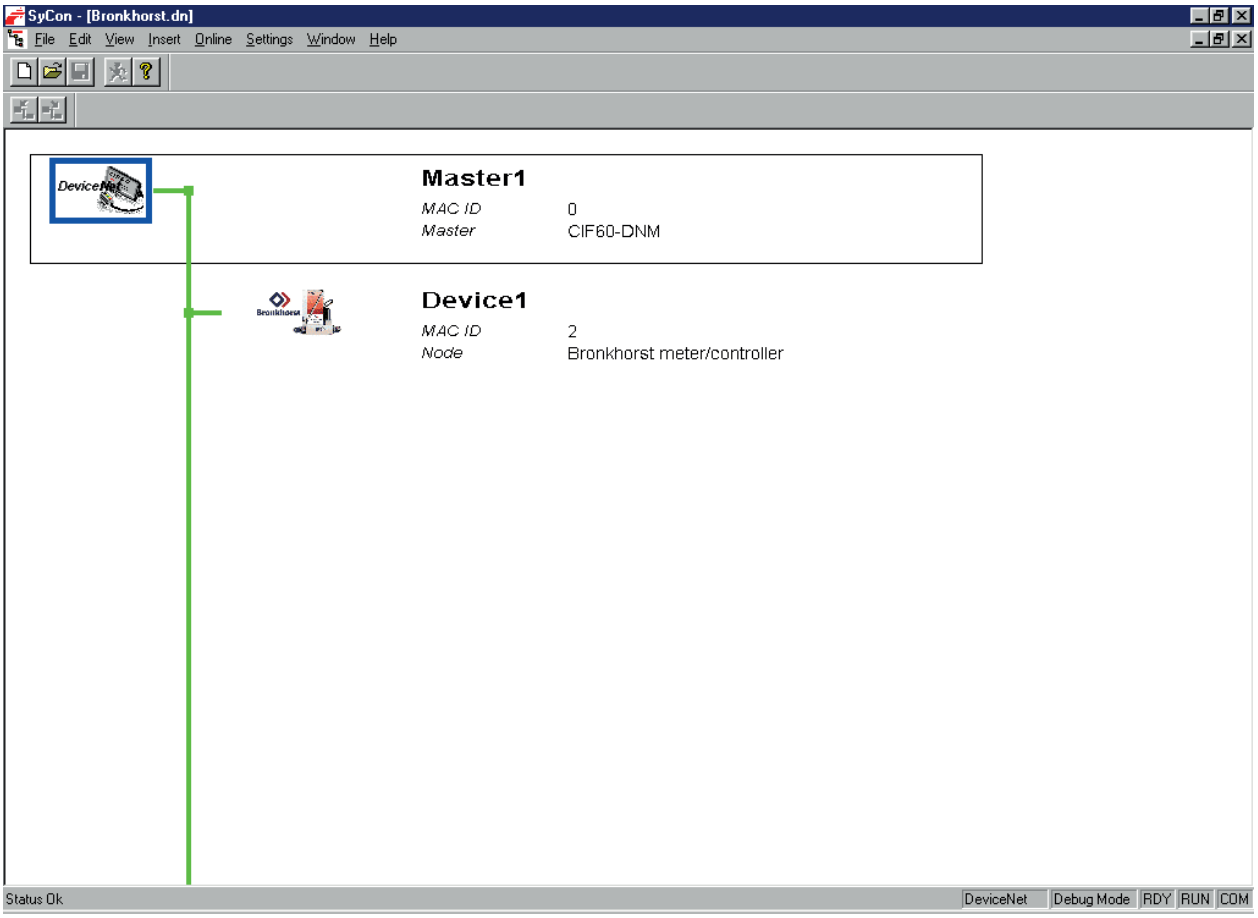
When slave has been installed and all settings are done the configuration has to be downloaded to the master.

Point to actual master and select [online][download]. When this is ready, from that moment on there will be data-exchange between master and slave. The green LED on the instrument will stop blinking and will go on continuously when data-exchange is O.K.

Example:



Data-exchange between master and slaves can be checked with Sycon by selecting [online][start debug mode].
When everything is O.K. the screen looks like this:

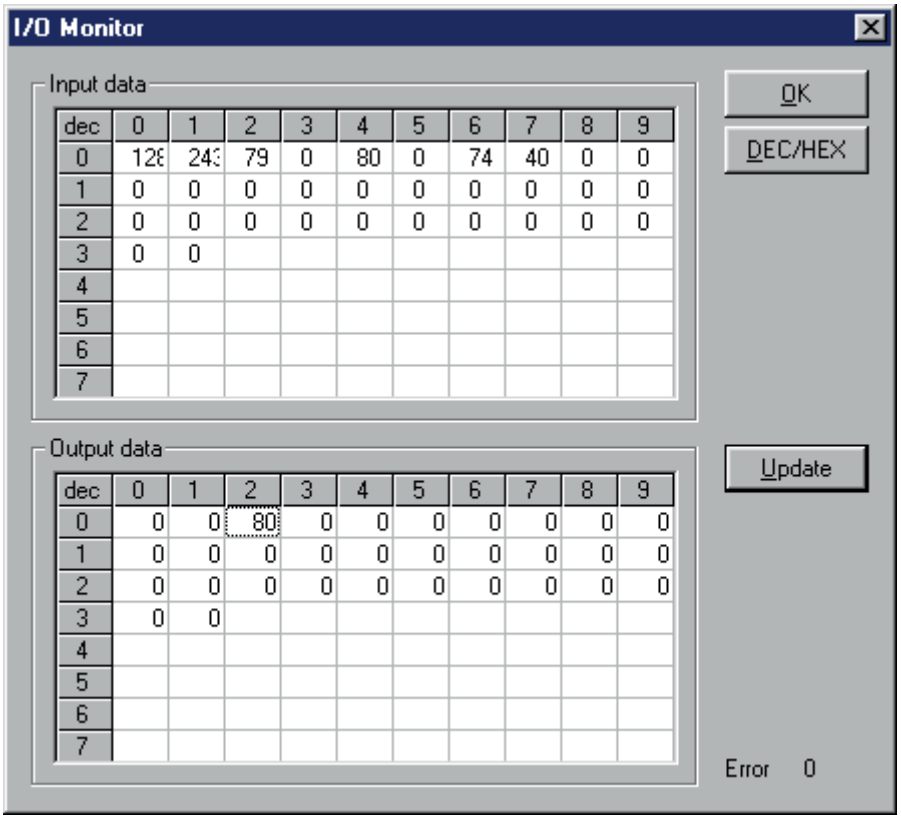


Note: It is possible that your master configuration software does not support this option.

When there is something wrong, see ‘device diagnostic’ for details.

11 TEST COMMUNICATION

Some master configuration tool programs offer facilities to read input I/O and write output I/O data.
An example of this:



Only the first 32 bytes from your input and output data area will be displayed in this monitor

If your program does not support such option, you have to use your master software or other available programs to check communication between master and slave(s).

12 TROUBLESHOOTING

12.1 LED INDICATIONS

LED indications 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. For DeviceNet it is also possible to show that the instrument is in abort state and idle state. The red LED is normally used to for error/warning indication (how longer the flash, how greater the trouble).

12.1.1 LED indications mode (MBC-II and MBC3)

Led	Time	Indication
Green		
off	Continuous	Power-off or program not running
on	Continuous	Normal running/operation mode
Short flash	0.1 sec on 2.0 sec off	Initialization mode Abort state Secured params can be changed
normal flash	0.2 sec on 0.2 sec off	Special function mode Instrument is busy performing any special function. E.g. auto-zero or self-test
long flash	2.0 sec on 0.1 sec off	idle state
Red		
off	Continuous	No error
Short flash	0.1 sec on 2.0 sec off	Minor communication error
normal flash	0.2 sec on 0.2 sec off	No bus power
long flash	2.0 sec on 0.1 sec off	Serious communication error manual intervention needed
long flash	1.0 sec on 0.1 sec off	For special service purpose only
on	Continuous	Critical error message. A serious error occurred in the instrument. Instrument needs service before further using.
Wink Mode	**Green Red Green Red**	**turn by turn**
slow wink	0.2 sec on 0.2 sec off	Wink mode By a command send via FLOW-BUS the instrument can “wink” with Led’s to indicate its position in a (large) system
normal wink	1.0 sec on 1.0 sec off	Alarm indication: minimum alarm, limit/maximum alarm; power-up alarm or limit exceeded or batch reached.
fast wink	0.1 sec on 0.1 sec off	Switch-released, selected action started

12.1.2 LED indications mode (MBC3 only)

for this state	Led	Indication
Network status LED (NET)		
Not powered/ Not online	Off	Device is not online • The device has not been completed the Dup_MAC_ID test yet. • The device may not be powered, look at module status LED • No network power present
Link OK, Online, Connected	On green	Device is online and has connections in the established state • For a group 2 device it means that the device is allocated to a master.
Online, Not connected	Flashing green 0.5 sec on 0.5 sec off	The device is online but has no connections in the established state. • The device has passed the Dup_MAC_ID test, is online but has no established connections to other nodes • For a group 2 device it means that the device is not allocated to a master.
Connection Time-out	Flashing red 0.5 sec on 0.5 sec off	One or more I/O connections are in timed-out state.
Critical link Failure	On red	Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network. (Duplicate MAC ID or bus off)
Module status LED (MOD)		
No power	Off	There is no power applied to the device
Device operational	On green	The device is operating in normal condition.
Device in Standby (The device needs commissioning)	Flashing green 0.5 sec on 0.5 sec off	The device needs commissioning due to configuration missing, incomplete or incorrect. The device may be in the standby state.
Unrecoverable fault	On red	The device has an unrecoverable fault, may need replacing.
Device self testing	Flashing red / green 0.5 sec on 0.5 sec off	The device is in self test.
Module and status LED's sequence at power-up		
Network LED (NET)	off	
Module LED (MOD)	green	0.25 sec
Module LED (MOD)	red	0.25 sec
Module LED (MOD)	green	
Network LED (NET)	green	0.25 sec
Network LED (NET)	red	0.25 sec
Network LED (NET)	off	

More information can be found in the manual "917023 Operational instructions digital instruments"
This document can be found at:
http://www.bronkhorst.com/en/downloads/instruction_manuals/

12.1.3 DeviceNet error description

SITUATION	Description
Minor communication error (red LED: 0.1 sec on, 2 sec off)	Each communication error will be seen as a minor communication error except for when the instrument is in the communication fault state. Instrument will stay in the on-line state. These errors will be recovered automatically. Examples of minor errors: When instrument is only member on DeviceNet network When an I/O connection time-out has occurred
No bus power (red LED: 0.2 sec on, 0.2 sec off)	Instrument hardware detects that +24 Vdc in DeviceNet cable is not present.
Serious communication error (red LED: 2 sec on, 0.1 sec off)	Instrument will get in communication fault state. This will happen at duplicate MAC ID or at bus-off event (This node is faulty and is not allowed to have any influence on the bus). This state can only be left by manual intervention. Instrument needs a reset either by using the micro-switch on top of the instrument or a new power-up. At duplicate MAC ID situation, sending a new MAC ID via RS232 (e.g using FlowFix) could also solve the problem.

12.2 TROUBLESHOOTING HINTS AND TIPS

SITUATION	Description
DeviceNet problems	Check all DeviceNet settings at your master. Master and device settings for use of memory modules must be the same. Make sure selected configuration at device configuration for polled I/O is the same as the settings at parameter data. See chapter 7 for more details. Check MAC ID and Baud rate of device (slave). Check cabling and bus termination of your DeviceNet system. Check power supply. Instruments need +24Vdc. Try to reset the instrument and/or restart your master. Make sure all settings for your slave are downloaded to your master (otherwise it won't work). Contact DeviceNet sales representative or service department.
Other (FLOW-BUS) problems	Contact Bronkhorst® local sales representative or send e-mail describing your problem to: see service chapter.

13 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