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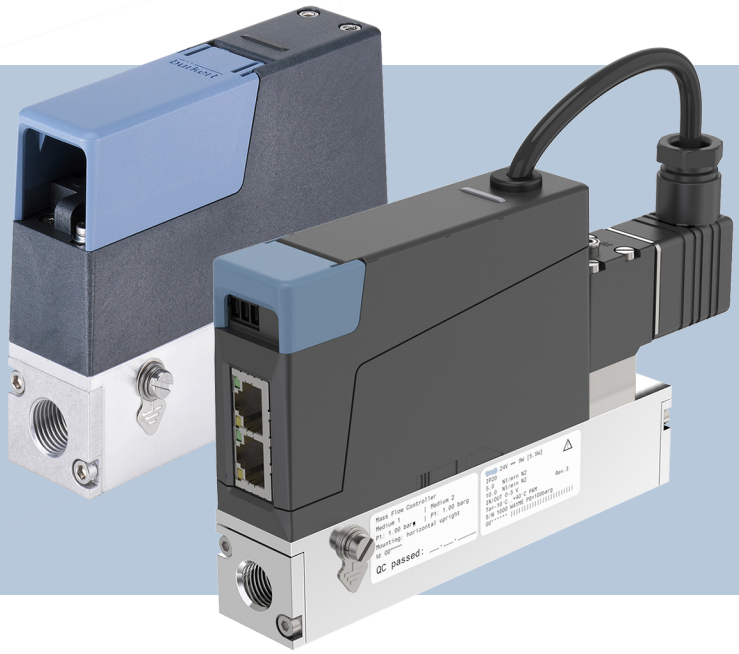
Type 8741-8743-8745-8733

Modbus RTU communication



Supplement to Operating Instructions

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

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Technical documentation 2603/02_GBen_00815471_819540363_9007200621522315 / Original EN

Table of contents

1 About this document 4
1.1 History 4
1.2 Terms and abbreviations 4
2 Product description 5
2.1 Pin assignment 5
2.2 Starting up the Modbus 6
2.3 Modbus in general 6
2.4 Modbus exceptions 7
3 Modbus register and communication objects 9
3.1 Modbus register list 1 9
3.1.1 Supported commands 9
3.1.2 Holding register 9
3.2 Modbus register list 0 13
3.2.1 Supported commands (holding register) 13
3.2.2 Supported commands (Input register) 13
3.2.3 Holding register 13
3.2.4 Input register 15
4 Appendix 17
4.1 ASCII_2 17
4.2 Versions of the hardware and the software 17
4.3 Description of Bit fields 18
4.3.1 Bit field errors 18
4.3.2 Bit field limits 19
4.4 Samples for Modbus commands 19
4.4.1 0x03 Read holding register 19
4.4.2 0x04 Read input register 20
4.4.3 0x06 Write single register 20
4.4.4 0x10 Write multiple register 21

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

1 About this document

This document is a supplement to the operating instructions. It gives a complete overview of the communication interface.

The operating instructions for the device must be followed to ensure safe use of the device for its intended purpose. All related information to the device is available at Products.

- ▸ Enter the article number from the type label in the search bar.

1.1 History

Document version	Device version	Changes
02		Added Type 8733
01	A.28.02	• Added chapter "Samples for Modbus commands" • Modbus register list 1, holding register extended by: – Resister address 40-41 Device ident number – Register address 42-43 Device temperature [°C] • Modbus register list 0, input register extended by: – Register address 31-32 Device temperature [°C]
00	A.25.00	Modbus register list 0 is supported

1.2 Terms and abbreviations

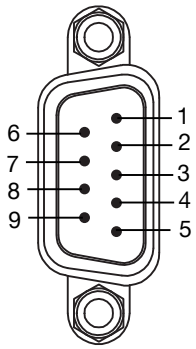
The terms and abbreviations are used in this document to refer to following definitions.

Access type	General access rights RO = Read only RW = Read and write RWR = Cyclic read RWW = Cyclic write WO = Write only

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

2 Product description

2.1 Pin assignment

D-sub DE-9 male connector	Pin	Assignment
	1	Not used
	2	GND
	3	+24 V ⎓
	4	Not used
	5	Not used
	6	TX+ (RS485-Y) * bridge with Pin 9 for Half-Duplex
	7	TX– (RS485-Z) *bridge with Pin 8 for Half-Duplex
	8	RX- (RS485-B)
	9	RX+ (RS485-A)
Housing		FE

Tab. 1: Pin assignment of the D-sub DE-9 male of the device

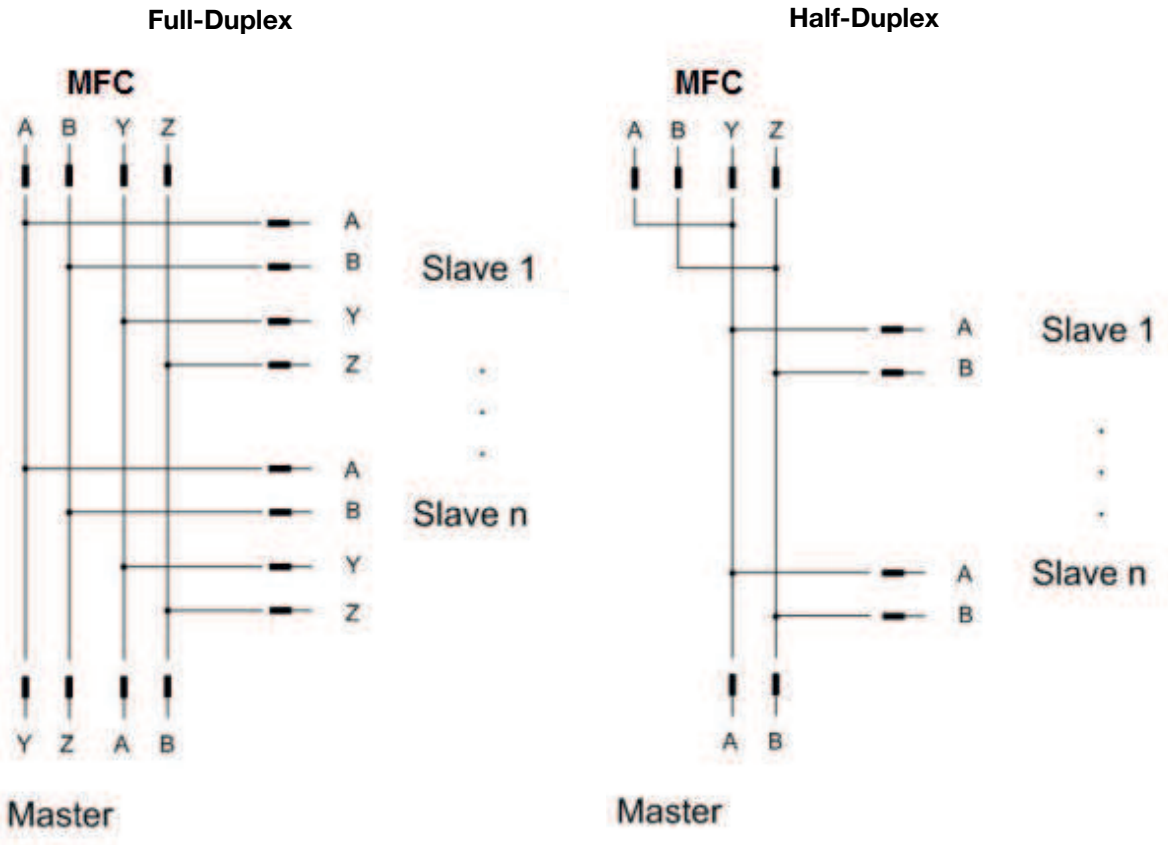
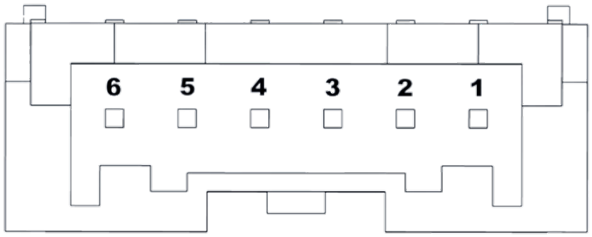


Fig. 1: Difference in wiring between Full-Duplex and Half-Duplex

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

JST PA male connector	Pin	Assignment
	1	RS485- B(-)
	2	RS485- A(+)
	3	Digital input
	4	Digital Input GND
	5	GND
	6	+24 V ⎓

Tab. 2: Pin assignment of the JST PA male connector of the device

2.2 Starting up the Modbus

The Modbus operates according to a master-slave method. In this case the MFC is designed as the slave.

Adjustable addresses are 1 to 247.

The BUS address of the devices can be set either with the “Bürkert Communicator Type 8920” or directly via the Modbus master. If an address change is set via the Modbus master, the new address is not valid until the next commands are issued.

The communication is monitored by a timeout detection. If a timeout occurs, the device is set to a safe state (set-point value is set to 0, causing the valve to close).

The timeout can be specified via the holding register Timeout Detection Time, the default value is 60 (seconds). The timeout detection can be deactivated by a value of 0.

Communication is via Modbus RTU. The preset communication parameters are:

- Transfer rate: 57600 baud
- Start bit: 1
- Data bits: 8
- Stop bits: 2
- Parity: Even
- Address: 1

2.3 Modbus in general

The Modbus protocol was developed by Modicon for programmable controllers and has evolved into a widely used communication protocol in the industry.

A Modbus master can address individual slaves. The slaves send back a telegram (reply) on request which was individually addressed to them. The Modbus protocol defines the format for the request from the master by entering in the protocol the device address, a function code for specifying the requested action, all data to be transmitted and a checksum. The reply telegram of the slaves is also specified with the aid of the Modbus protocol. It includes fields for acknowledgement of the implemented action, for all data to be sent back and for a checksum. If an error occurs on receipt of the telegram or if the slave cannot execute the requested action, the slave sends back an error telegram.

The following diagram shows the structure of a command:

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

Request from master	Reply telegram from slave
Device address	Device address
Function code	Function code
Data	Data
Checksum	Checksum

The request:

The function code in the request informs the addressed slave which action is to be executed. The data bytes include all additional information that the slave requires to execute the action e.g. if the function code 03 requests the slave to read out the holding register and to send back its contents. The data field must include the following information: Start register and the number of registers to be read.

In this case one register corresponds to one WORD (2 bytes). The slave can use the checksum to determine the validity of the telegram contents.

The reply:

The structure of the reply corresponds to the request telegram one. If an error occurs, an error code is sent instead of the function code. In this case the data includes a code which describes the error. The master can use the checksum to determine the validity of the telegram contents.

More technical information can be found at www.modbus.org.

2.4 Modbus exceptions

- If the slave device receives the request without a data transfer error and the request can be processed normally, a normal reply is sent back.
- If the slave device does not receive the request due to a data transfer error, no reply is sent back.
- If the slave device determines a data transfer error, no reply is sent back. The master device program determines a timeout for the request.
- If the slave device receives the request without a data transfer error, but the request cannot be processed (e.g. to read out a non-existent register), an exceptional reply is sent back which informs the master device about the type of error. The exceptional reply has two fields that distinguishes it from a normal reply.

Function code field

If the answer is normal, the slave sends back a copy of the function code included in the original request in the appropriate field of the reply. If the reply is an exception, the value of the function code is exactly 0x80 hexadecimal numbers higher than it would be in a normal reply.

Data field

If the reply is an exception, the slave sends an exception code in the data field that defines the operating status of the slave, which caused the exception.

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

Example of Error Code

Field name	Value	
Slave address	0x01	
Function	0x83 Function code + 0x80	Exception code
Data field	0x02	Illegal data address
Error check	CRC	(high byte)
Error check	CRC	(low byte)

In this example the master addresses a request (“Read Holding Register” 0x03) to slave device 01. The register address in the device is outside the address validity range and this is why the slave sends an exceptional reply with the indicated exception code 02 (Illegal Data Address).

Implemented exceptional replies

Code	Name	Description
01	ILLEGAL FUNCTION	Function code is not supported
02	ILLEGAL DATA ADDRESS	The data address is not permitted in the device
03	ILLEGAL DATA VALUE	A value included in the request field is incorrect for the device
04	SLAVE DEVICE FAILURE	Internal device error

Number formats

Data type	Description	Length (bytes)
UI16	Unsigned integer, 16 bit	2
UI32	Unsigned integer, 32 bit	4
FL32	Floating-point number in accordance with IEEE-754. The Float32 value is saved in two successive addresses, the first address includes the most significant word (sign, exponent, and upper part of the mantissa), and the second address the least significant word (lower part of the mantissa).	4

High byte is send at first.

More technical information can be found at www.modbus.org.

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

3 Modbus register and communication objects

3.1 Modbus register list 1

3.1.1 Supported commands

Code	Name	Broadcast
0x03	Read Holding Register	No
0x06	Write Single Register	No
0x10	Write Multiple Register	No

Valid addresses, refer to Holding register [▶ 9].

3.1.2 Holding register

Register Address	Number of Register	Name / Description	Access type	Data type
0000...0001	2	Actual Flow Value is based on the calibrated device unit. Refer to Holding Register → “Unit Flow Value” (0022...0025)	RO	FL32
0002...0003	2	Medium temperature [°C]	RO	FL32
0004...0005	2	Totalizer [Nl] (0 °C / 1013 mbar)	RO	FL32
0006...0007	2	Set-Point Value is based on the calibrated device unit. Refer to Holding Register → “Unit Flow Value” (0022...0025) Since Mb_Slave version A.01.00.01 the value of set-point is used for the actuators dutycycle in range of 0...100% if the device is in open-loop-control	RW	FL32
0008...0009	2	Not supported	RO	FL32
0010...0011	2	Control Output to Valve (y2) For MFC only. Control output y2 of controller in % (0 – 100.0 %)	RO	FL32

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

Register Address	Number of Register	Name / Description	Access type	Data type
0012	1	Status Limits Status limits/Bit field for the status of device-internal threshold value. Refer to Bit field limits [▶ 19] min. value 0, max. value 65535	RO	UI16
0013	1	Status Errors Refer to Bit field errors [▶ 18] min. value 0, max. value 65535	RO	UI16
0014	1	Controller Function Defines the behavior of the set-point setting 0 – Normal operation of the controller 3 – Hold function active for control output to the valve 22 – off/closed 23 – on/open –flow is restricted by the pressure and orifice of the valve 64 – Open loop control active (RO) 66 – Calibration mode active (RO) 67 – Autotune mode active (RO)	RW	UI16
0015	1	Baudrate Defines the baudrate for Modbus Communication. Value / Baudrate / supported 3 / 2400 / Yes 4 / 4800 / Yes 5 / 9600 / Yes 6 / 19200 / Yes 7 / 38400 / Yes 8 / 57600 / Yes 9 / 115200 / Yes **CAUTION! A changed value will be active after a device reset.**	RW	UI16

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

Register Address	Number of Register	Name / Description	Access type	Data type
0016	1	Parity Defines the parity bit of the Modbus communication. Value: Parity 0: NONE 1: ODD 2: EVEN **CAUTION! A changed value will be active after a device reset.**	RW	UI16
0017	1	Stopbit Defines the number of stop bits of the Modbus communication. Value: Number of Stop bit 1: 1 Stop bit 2: 2 Stop bits **CAUTION! A changed value will be active after a device reset.**	RW	UI16
0018	1	Timeout Detection Time [s] Timeout detection is implemented in the MFC device. The detection time can be specified by this register. The default value is 60 (seconds) If the time between two pollings is longer than the specified time, a timeout will be detected. After timeout detection the device will be set into a safety mode. In this case the set point will be set to 0 and the valve will be closed. The timeout detection can be disabled by a value of 0. Range: 0 – 60	RW	UI16
0019	1	Modbus Device Address Address by which the Modbus master communicates with the device 1 – 247	RW	UI16 UINT16
0020… 0021	2	Flow Full Scale Refer to Holding Register → “Unit Flow Value” (0022…0025)	RO	FL32
0022… 0025	4	Unit Flow Value Unit of the flow value	RO	UI16 ASCII_2
0026… 0029	4	Operating medium	RO	UI16 ASCII_2

Register Address	Number of Register	Name / Description	Access type	Data type
0030… 0031	2	Device Serial Number Bürkert serial number of the device min. value 0, max. value 4294967295	RO	UI32
0032	1	Version number hardware Refer to Versions of the hardware and the software [▶ 17]	RO	UI16
0033	1	Version number software Refer to Versions of the hardware and the software [▶ 17]	RO	UI16
0034	1	Active Gas Active Gas / calibration of this gas is used for control. Value: Gas 0: Gas 1 1: Gas 2 2: Gas 3 3: Gas 4	RW	UI16
0035… 0036	2	Device Type Bürkert type number of the device	RO	UI16 ASCII_2
0037	1	ModusMFC MFC Mode / Activation of the Autotune function. The controller must be in normal mode. (ModusMFC = 0) Autotune can be activated by writing a value of 2	W	UI16
0038	1	Reset Totalizer A value of 1 will reset the Totalizer value of the actual gas. Clearing the value is needless.	W	UI16
0039	1	Reset Device A value of 1 restarts the device. Clearing the value is needless.	W	UI16
0040… 0041	2	Device ident number supported since Modbus version A.03.00.00	RO	UI32
0042… 0043	2	Device temperature [°C] supported since Modbus version A.03.00.00	RO	FL32

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

3.2 Modbus register list 0

3.2.1 Supported commands (holding register)

Code	Name	Broadcast
0x03	Read Holding Register	No
0x06	Write Single Register	No
0x10	Write Multiple Register	No

3.2.2 Supported commands (Input register)

Code	Name	Broadcast
0x04	Read Input register	No

3.2.3 Holding register

Register Address	Number of Re-gister	Name / Description	Access type	Data type
0001	1	Reset Device A value of 1 restarts the device	W	UI16
0002	1	Reset totalizer A value of 1 resets the totalizer from active gas	W	UI16
0003	1	Set-point (in units per mille) A set-point of 2000 activates the flash-mode (valve will be opened completely) The value of set-point is used for the actuators dutycycle in range of 0...100% if the device is in open-loop-control	RW	UI16
0004	1	Active gas	RW	UI16
		0 Gas 1		
		1 Gas 2		
		2 Gas 3		
		3 Gas 4		
0005	1	Controller function (details see Appendix)	RW	UI16
0006	1	ModbusMFC Autotune can be activated by a value of 2	RW	UI16
0007	1	Modbus device address	RW	UI16

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

Register Address	Number of Register	Name / Description	Access type	Data type
0008... 0009	2	Set-point Unit depends on calibrated unit (see also input register: Data Unit(register address 1) A double value of “Flow Full Scale” activates the flash-mode (valve will be opened completely) The value of set-point is used for the actuators dutycycle in range of 0...100% if the device is in open-loop-control	RW	FL32
0010	1	Timeout detection time [s] A value of 0 deactivates the timeout detection	RW	UI16
0011	1	Baudrate Defines the baudrate for Modbus Communication. Value / Baudrate / supported: 3 / 2400 / Yes 4 / 4800 / Yes 5 / 9600 / Yes 6 / 19200 / Yes 7 / 38400 / Yes 8 / 57600 / Yes 9 / 115200 / Yes **CAUTION! A changed value will be active after a device reset.**	RW	UI16
0012	1	Parity Defines the parity bit of the Modbus communication. Value / Parity: 0 / NONE 1 / ODD 2 / EVEN **CAUTION! A changed value will be active after a device reset.**	RW	UI16
0013	1	Stopbit Defines the number of stop bits of the Modbus communication. Value / Number of Stop bit: 1 / 1 Stop bit 2 / 2 Stop bits **CAUTION! A changed value will be active after a device reset.**	RW	UI16

3.2.4 Input register

Register Address	Number of Register	Name / Description	Access type	Data type
0001	1	Data unit: Calibrated device unit 0x801 Nl/sec 0x802 Nl/min 0x803 Nl/h 0x804 Sl/sec 0x805 Sl/min 0x806 Sl/h 0x807 Nm³/sec 0x808 Nm³/min 0x809 Nm³/h 0x80A Sm³/sec 0x80B Sm³/min 0x80C Sm³/h 0x80D Ncm³/sec 0x80E Ncm³/min 0x80F Ncm³/h 0x810 Scm³/sec 0x811 Scm³/min 0x812 Scm³/h 0x813 kg/sec 0x814 kg/min 0x815 kg/h 0x816 SCF/sec 0x817 SCF/min 0x818 SCF/h 0x81F Nml/sec 0x820 Nml/min	RO	UI16
0002	1	Actual Flow (as per mille) -2000...2000	RO	SINT16
0003... 0004	2	Actual Flow Unit depends on calibrated unit Refer to Input register: Data unit (register address 1)	RO	FL32
0005	1	Status errors Refer to Appendix [▶ 17]	RO	UI16
0006	1	Status Limits Refer to Appendix [▶ 17]	RO	UI16
0007	1	Control output to valve y2 (as per mille)	RO	UI16

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

Register Address	Number of Register	Name / Description	Access type	Data type
0008... 0009	2	Flow full scale Refer to Input register: Data unit (register address 1)	RO	FL32
0010... 0011	2	Totalizer [Nl] 0°C/1013mbar	RO	FL32
0012... 0019	8	Operation medium Only low bytes are used as ASCII	RO	UI16
0020	1	Device type	RO	UI16
0021... 0022	2	Device ident number	RO	UI32
0023... 0024	2	Device serial number	R	UI32
0025... 0028	4	Version number software low byte as ASCII	RO	UI16
		0025 version number software (X)		
		0026 version number software (y)		
		0027 version number software (z)		
		0028 version number software (cc)		
0029	1	MODBUS baudrate Refer to Appendix [▶ 17]	RO	UI16
0030	1	Medium temperature Temperature in 1/10°C (231=23,1°C)	RO	SINT16
0031... 0032	2	Device temperature [°C] supported since Modbus version A.03.00.00	RO	FL32

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

4 Appendix

4.1 ASCII_2

An UI16 value is interpreted as two characters. The high byte shows the first character.

e.g.	0x4142 → „AB“
e.g.	Operating Medium “Luft” as 4 x UI16
	0x4C75
	0x6674
	0x0000
	0x0000
e.g.	Device Type“8713” as 2 x UI16
	0x3837
	0x3133

4.2 Versions of the hardware and the software

Returns 2 bytes, which are constructed as follows

X.YY	Range:
X	‚A‘ – ‚Z‘
YY	0 – 99
e.g.	0x4101 → A.01

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

4.3 Description of Bit fields

4.3.1 Bit field errors

Bit field ERRORS	
Bit 0	Not used
Bit 1	Not used
Bit 2	Not used
Bit 3	Not used
Bit 4	Not used
Bit 5	Not used
Bit 6	Not used
Bit 7	Error internal supply voltage Object 0xXX020587
Bit 8	Not used
Bit 9	Error data storage Object 0xXX230508 / 0xXX230507
Bit 10	Not used
Bit 11	Not used
Bit 12	Error sensor fault Object 0xXX1F0583
Bit 13	Error after autotune Object 0xXX3F0586
Bit 14	Not used
Bit 15	Not used

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

4.3.2 Bit field limits

Bit field LIMITS	
Bit 0	Not used
Bit 1	Not used
Bit 2	Not used
Bit 3	Not used
Bit 4	Not used
Bit 5	Not used
Bit 6	Not used
Bit 7	Not used
Bit 8	y2 > 95% Hysterese 2%
Bit 9	Not used
Bit 10	Not used
Bit 11	Not used
Bit 12	Not used
Bit 13	Not used
Bit 14	Not used
Bit 15	Not used

4.4 Samples for Modbus commands

4.4.1 0x03 Read holding register

Command structure							
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Address	Command	Register address		No of register to read		CRC	
Sample for reading the medium temperature [°C] from list 1 located at register address 2-3							
0x01	0x03	0x00 0x02		0x00 0x02		0x65 0xCB	

Receive structure					
Byte 0	Byte 1	Byte 2	Data bytes	Byte	Byte
Address	Command	Amount of data byte		CRC	
Sample for reading the medium temperature [°C] from list 1 located at register address 2-3					
0x01	0x03	0x04	0x41 0xCA 0x40 0xDD (25.281672)	0x37 0xA8	

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

4.4.2 0x04 Read input register

Command structure							
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Address	Command	Register address		No of register to read		CRC	
Sample for reading the flow full scale from list 0 located at register address 8-9							
0x01	0x04	0x00 0x08		0x00 0x02		0xF0 0x09	

Receive structure					
Byte 0	Byte 1	Byte 2	Data bytes	Byte	Byte
Address	Command	Amount of data byte		CRC	
Sample for reading the flow full scale from list 0 located at register address 8-9					
0x01	0x04	0x04	0x41 0x20 0x00 0x00 (10.0)	0xEE 0x72	

4.4.3 0x06 Write single register

Command structure							
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Address	Command	Register address		Value to write		CRC	
Sample for writing the active gas to gas 2 (written value 1) by using list 1 located at register address 34							
0x01	0x06	0x00 0x22		0x00 0x01		0xE8 0x00	

Receive structure							
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte	Byte
Address	Command	Register address		Written value		CRC	
Sample for writing the active gas to gas 2 (written value 1) by using list 1 located at register address 34							
0x01	0x06	0x00 0x22		0x00 0x01		0xE8 0x00	

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026

4.4.4 0x10 Write multiple register

Command structure								
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Data bytes	
Address	Com-mand	Register address		No of register to write		Amount of data bytes		CRC
Sample for writing the active gas to gas 2 (written value 1) by using list 1 located at register address 34								
0x01	0x10	0x00 0x022		0x00 0x01		0x02	0x00 0x01	0x61 0x12

Receive structure							
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Address	Command	Register address		No of registers		CRC	
Sample for writing the active gas to gas 2 (written value 1) by using list 1 located at register address 34							
0x01	0x10	0x00 0x22		0x00 0x01		0xA1 0xC3	

MAN 1000730486 EN Version: B Status: RL (released | freigegeben) printed: 09.04.2026