bürkert
FLUID CONTROL SYSTEMS

Type 8741 - 8743 - 8745

Modbus RTU Communication

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

Supplement to Operating Instructions

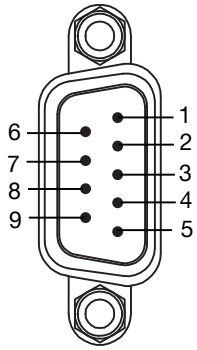
MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

Operating Instructions 2402/00 00815471 / Original EN

TABLE OF CONTENTS

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

1 PIN ASSIGNMENT (SUB-D 9)

D-sub DE-9 male connector	Pin	Assignment
	1	Not used
	2	GND
	3	+24 V DC
	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

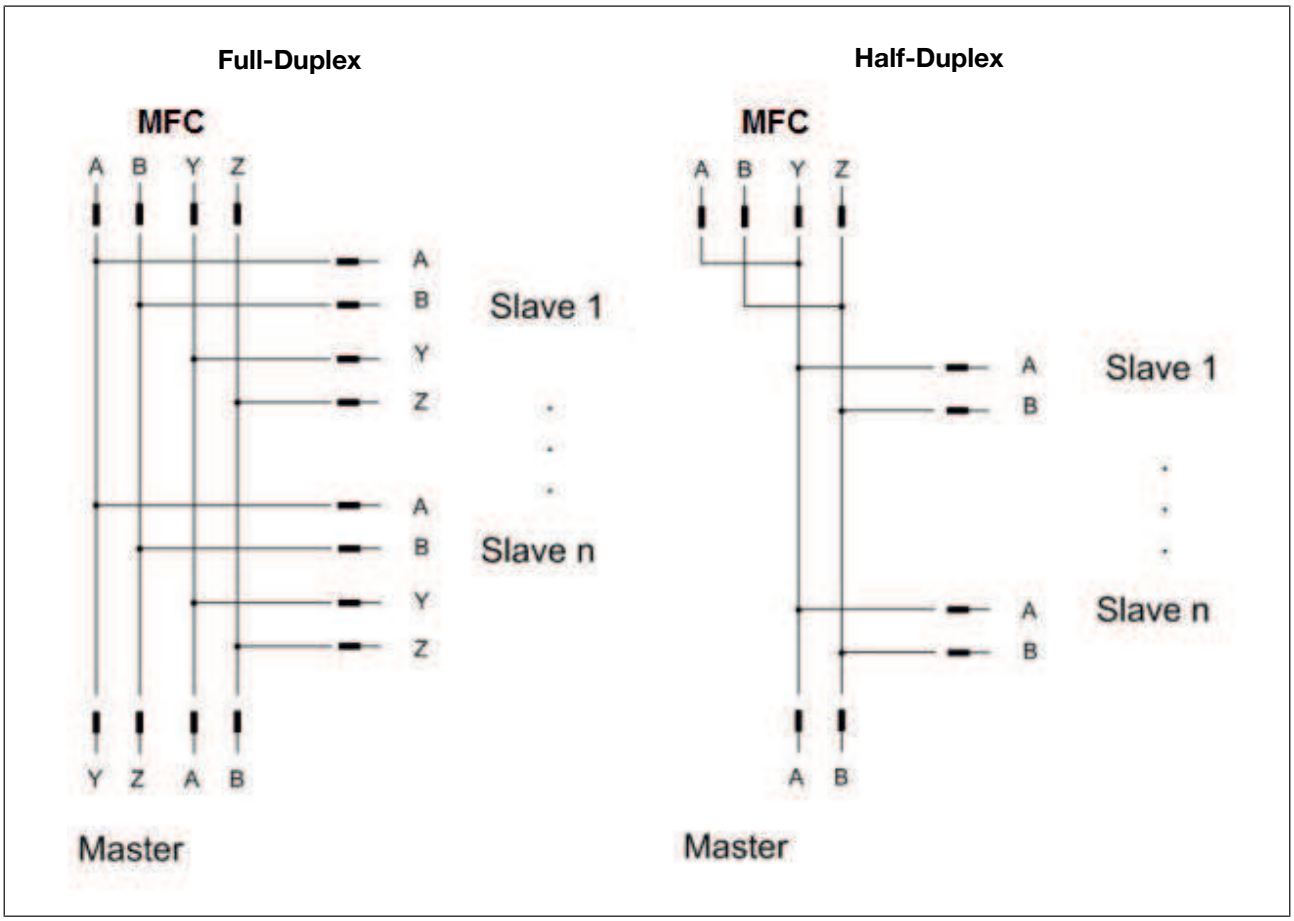


Fig. 1: Difference in wiring between Full-Duplex and Half-Duplex

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

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

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

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:

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.

Exceptional reply

- 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.

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

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.

Example of Error Code

Field name	Value	
Slave address	0x01	
Function	0x83	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)
UINT16	Unsigned integer, 16 bit	2
UINT32	Unsigned integer, 32 bit	4
FLOAT32	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 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

4 MODBUS REGISTER AND COMMUNICATION OBJECTS

4.1 Modbus register list 1

4.1.1 Supported commands

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

Valid addresses see below

4.1.2 Holding register

Register Address in MFC	Number of Register	Name / Description	R/W	Type
0000…0001	2	Actual Flow Value is based on the calibrated device unit. Refer to Holding Register → “Unit Flow Value” (0022…0025)	R	FLOAT32
0002…0003	2	Medium temperature Temperatur in °C	R	FLOAT32
0004…0005	2	Totalizer Totalizer in unit Nl. (0 °C / 1013 mbar)	R	FLOAT32
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	R/W	FLOAT32
0008…0009	2	Not supported	R	FLOAT32
0010…0011	2	Control Output to Valve (y2) For MFC only. Control output y2 of controller in % (0 – 100.0 %)	R	FLOAT32

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

Register Address in MFC	Number of Register	Name / Description			R/W	Type
0012	1	Status Limits Status limits/Bit field for the status of device-internal threshold value. Refer to Bit field Errors [▶ 17] min. value 0, max. value 65535			R	UINT16
0013	1	Status Errors Refer to Bit field Errors [▶ 16] min. value 0, max. value 65535			R	UINT16
0014	1	Controller Function Defines the behavior of the set-point setting			R/W	UINT16
		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 (Read only)			
		66	Calibration mode active (Read only)			
		67	Autotune mode active (Read only)			
0015	1	Baudrate Defines the baudrate for Modbus Communication.			R/W	UINT16
		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.				

Register Address in MFC	Number of Register	Name / Description	R/W	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.**	R/W	UINT16
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.**	R/W	UINT16
0018	1	Timeout Detection Time (In Second) 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	R/W	UINT16
0019	1	Modbus Device Address Address by which the Modbus master communicates with the device 1 – 247	R/W	UINT16
0020…0021	2	Flow Full Scale Refer to Holding Register → “Unit Flow Value” (0022…0025)	R	FLOAT32
0022…0025	4	Unit Flow Value Unit of the flow value	R	UINT16 ASCII_2
0026…0029	4	Operating medium	R	UINT16 ASCII_2

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

Register Address in MFC	Number of Register	Name / Description	R/W	Type
0030…0031	2	Device Serial Number Bürkert serial number of the device min. value 0, max. value 4294967295	R	UINT32
0032	1	Version number hardware Refer to Versions of the hardware and the software [▶ 16]	R	UINT16
0033	1	Version number software Refer to Versions of the hardware and the software [▶ 16]	R	UINT16
0034	1	Active Gas Active Gas / calibration of this gas is used for control. Value: Gas 0: Gas 1 1: Gas 2	R/W	UINT16
0035…0036	2	Device Type Bürkert type number of the device	R	UINT16 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	R/W	UINT16
0038	1	Reset Totalizer A value of 1 will reset the Totalizer value of the actual gas. Clearing the value is needless.	W	UINT16
0039	1	Reset Device A value of 1 restarts the device. Clearing the value is needless.	W	UINT16

4.2 Modbus register list 0

4.2.1 Supported commands (holding register)

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

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

4.2.2 Supported commands (Input register)

Code	Name	Broadcast
0x04	Read Input register	No

4.2.3 Holding register

Register Address in MFC	Number of Register	Name / Description		R/W	Type
0001	1	Reset Device A value of 1 restarts the device		W	UINT16
0002	1	Reset totalizer A value of 1 resets the totalizer from active gas		W	UINT16
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 duty-cycle in range of 0…100% if the device is in open-loop-control		R/W	UINT16
0004	1	Active gas		R/W	UINT16
		0	Gas 1		
0005	1	Controller function (details see Appendix)		R/W	UINT16
0006	1	Modbus MFC Autotune can be activated by a value of 2		R/W	UINT16
0007	1	Modbus device address		R/W	UINT16
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 duty-cycle in range of 0…100% if the device is in open-loop-control		R/W	FLOAT32
0010	1	Timeout detection time [s] A value of 0 deactivates the timeout detection		R/W	UINT16

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

<table>
<tr><th>Register Address in MFC</th><th>Number of Register</th><th>Name / Description</th><th>R/W</th><th>Type</th></tr>
<tr><td>0011</td><td>1</td><td>Baudrate
Defines the baudrate for Modbus Communication.
<table>
<tr><td>Value</td><td>Baudrate</td><td>supported</td></tr>
<tr><td>3</td><td>2400</td><td>Yes</td></tr>
<tr><td>4</td><td>4800</td><td>Yes</td></tr>
<tr><td>5</td><td>9600</td><td>Yes</td></tr>
<tr><td>6</td><td>19200</td><td>Yes</td></tr>
<tr><td>7</td><td>38400</td><td>Yes</td></tr>
<tr><td>8</td><td>57600</td><td>Yes</td></tr>
<tr><td>9</td><td>115200</td><td>Yes</td></tr>
</table>
CAUTION! A changed value will be active after a device reset.</td><td>R/W</td><td>UINT16</td></tr>
<tr><td>0012</td><td>1</td><td>Parity
Defines the parity bit of the Modbus communication.
<table>
<tr><td>Value</td><td>Parity</td></tr>
<tr><td>0</td><td>NONE</td></tr>
<tr><td>1</td><td>ODD</td></tr>
<tr><td>2</td><td>EVEN</td></tr>
</table>
CAUTION! A changed value will be active after a device reset.</td><td>R/W</td><td>UINT16</td></tr>
<tr><td>0013</td><td>1</td><td>Stopbit
Defines the number of stop bits of the Modbus communication.
<table>
<tr><td>Value</td><td>Number of Stop bit</td></tr>
<tr><td>1</td><td>1 Stop bit</td></tr>
<tr><td>2</td><td>2 Stop bits</td></tr>
</table>
CAUTION! A changed value will be active after a device reset.</td><td>R/W</td><td>UINT16</td></tr>
</table>

4.2.4 Input register

Register Address in MFC	Number of Register	Name / Description		R/W	Type
0001	1	Data unit Calibrated device unit supported units:		R	UINT16
		Value	Unit		
		0x801	Nl/sec		
		0x802	Nl/min		
		0x803	Nl/h		
		0x804	Sl/sec		
		0x805	Sl/min		
		0x806	Sl/h		
		0x807	Nm^3/sec		
		0x808	Nm^3/min		
		0x809	Nm^3/h		
		0x80A	Sm^3/sec		
		0x80B	Sm^3/min		
		0x80C	Sm^3/h		
		0x80D	Ncm^3/sec		
		0x80E	Ncm^3/min		
		0x80F	Ncm^3/h		
		0x810	Scm^3/sec		
		0x811	Scm^3/min		
		0x812	Scm^3/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		
0002	1	Actual Flow (as per mille) -2000…2000		R	SINT16

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

Register Address in MFC	Number of Register	Name / Description		R/W	Type
0003…0004	2	Actual Flow Unit depends on calibrated unit Refer to Input register: Data unit (register address 1)		R	FLOAT32
0005	1	Status errors Refer to Appendix [▶ 16]		R	UINT16
0006	1	Status Limits Refer to Appendix [▶ 16]		R	UINT16
0007	1	Control output to valve y2 (as per mille)		R	UINT16
0008…0009	2	Flow full scale Refer to Input register: Data unit (register address 1)		R	FLOAT32
0010…0011	2	Totalizer [Nl] 0°C/1013mbar		R	FLOAT32
0012…0019	8	Operation medium Only low bytes are used as ASCII		R	UINT16
0020	1	Device type		R	UINT16
0021…0022	2	Device ident number		R	UINT32
0023…0024	2	Device serial number		R	UINT32
0025…0028	4	Version number software low byte as ASCII		R	UINT16
		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 [▶ 16]		R	UINT16
0030	1	Medium temperature Temperature in 1/10°C (231=23,1°C)		R	SINT16

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

5 APPENDIX

5.1 ASCII_2

An UINT16 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 UINT16
0x4C75
0x6674
0x0000
0x0000

e.g. Device Type“8713” as 2 x UINT16
0x3837
0x3133

5.2 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

5.3 Description of Bit fields

5.3.1 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

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024

Bit field ERRORS	
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

5.3.2 Bit field Errors

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

MAN 1000608261 EN Version: B Status: RL (released | freigegeben) printed: 19.02.2024