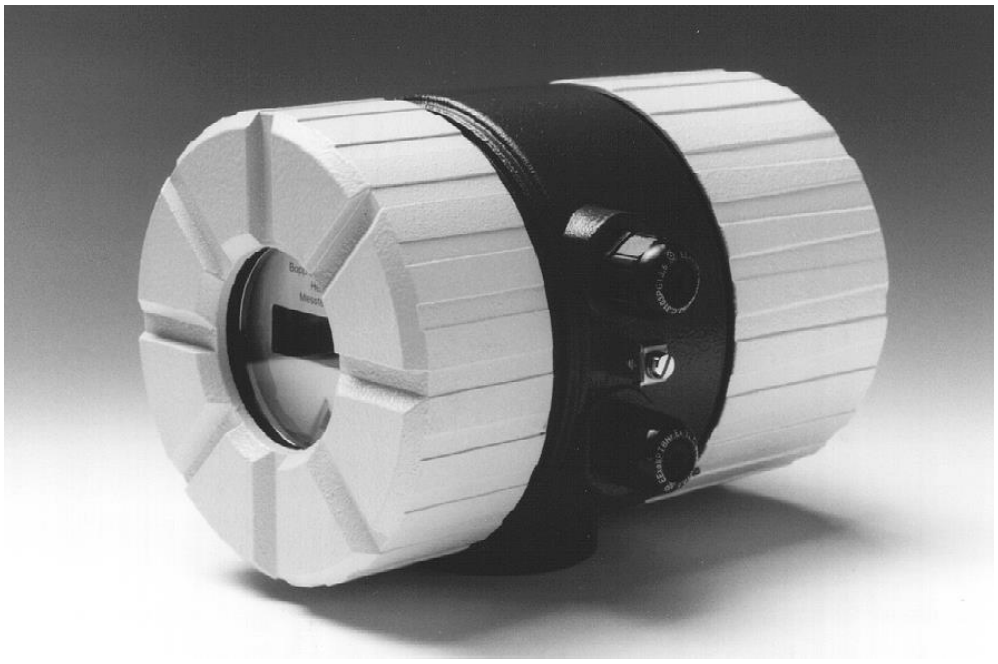
Heinrichs
KOBOLD Group

Transmitter for Coriolis Mass Flowmeter
Supplementary Operating Instructions
Transmitter UMC3 with Modbus- Interface

UMC3



Read these Operating Instructions thoroughly and keep them available for future reference

Dimensions, weight, and other technical data are subject to modifications
Printed in Germany

These operating instructions are a supplement to the operating manuals TM-UMC3, TME-UMC3, TMU-UMC3, TMR-UMC3.

Table of contents

1 Identification

1.1 Manufacturer

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1.2 Product type

Transmitter UMC3-Modbus, for Coriolis mass flow meters with Modbus - interface.

1.3 Issue date

09.03.2017

1.4 Version No. / file

3.1
file: UMC3_Modbus_BA_03-1_Eng.Docx

2 Introduction

The Modbus interface of the UMC3 offers the capability to read measured values as well as the reading and changing of parameters if required. The interface fulfils the requirements of the RS485-IS. It may be operated intrinsically safe or non-intrinsically safe.
The Modbus-RTU-Protocol is supported.

Digital fieldbus instrument communication via Modbus complements the analogue outputs (current output and binary outputs) of the standard design. With the exception of current output 2, all outputs described in the operation manual of the standard version remain available for use.

The Modbus interface is designed as a pluggable module. After entering the customer password, Modbus parameters may be changed. If the transmitter is used in custody transfer applications, all parameters can be read but not changed.

3 Electrical installation of Modbus

3.1 Shielding

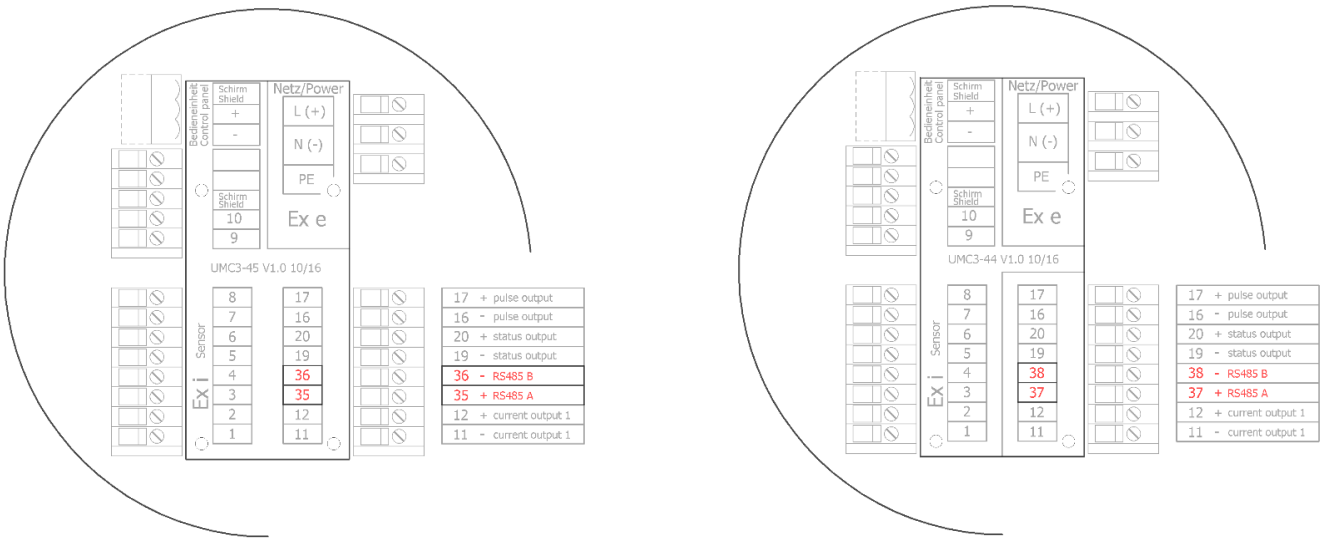
Generally, Modbus requires no screen. However, if a shielding is used, it must be connected at both ends. In this case, equipotential bonding in accordance with the explosion protection guidelines must be ensured. The shield is connected in the special EMC cable gland.

	**Warning:** Additional cable glands: Not included in the scope of delivery. It is the responsibility of the operator to ensure that the used cable glands and plugs are certified according to the applicable ignition- and IP-protection of the enclosure. The type of thread used is stated on the rating plate.

3.2 Installation procedure

1. De-energize the device.
2. Unscrew the front cover and remove the control unit BE2.
3. If available, connect the outer shield to the metalized cable gland.
4. **The signal lines have to be connected to the terminals 35 and 36 (intrinsically safe and standard version) or 37 and 38 (non-intrinsically safe Ex e version).**
   Polarity must be observed!
5. Reinstall control unit BE2 and close cover.
6. Switch on device.

3.3 Modbus terminals



Intrinsically safe version **Non-intrinsically safe version**

Fig 1:UMC3 Modbus terminals

3.4 Termination resistor

Shipped from factory a termination resistor of 200 Ohms is connected. If necessary, it can be disconnected by removing 2 jumpers (JP1 and JP2). For this purpose, the electronic compartment has to be opened. This may only be carried out under a dry environment and by qualified personnel!

- Unscrew locking grub screw.
- Unscrew rear cover plate (without window),
- Pull out the plug in module on the upper visible board,
- Replace jumpers on plug in module,
  To switch off the termination resistor the 2 jumpers (→) must be removed. To store them for future use, they can be placed onto position (- - ->).
- Re-assemble. Finally insert and fix the locking grub screw.

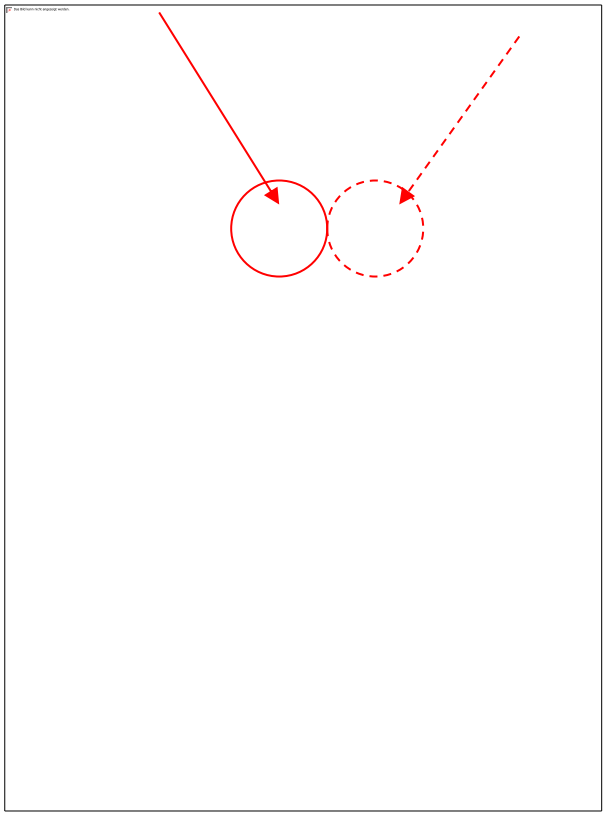


Fig. 2: RS-485-Modul

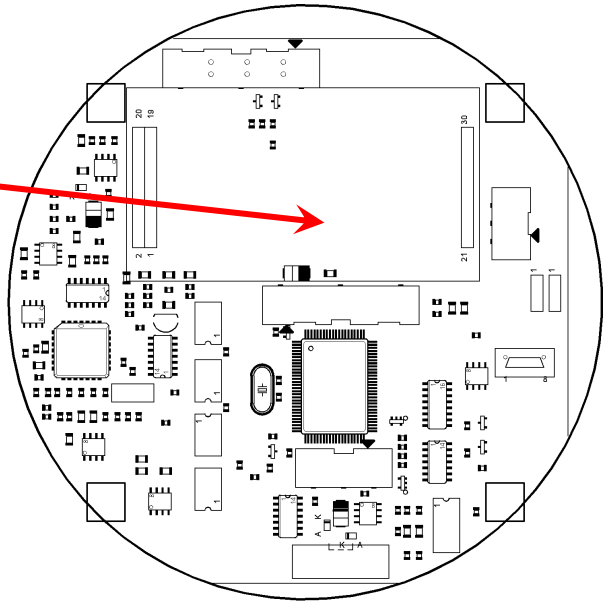


Fig 3: CPU-board with plugged-in Modbus interface

4 Protocol

The transmitter UMC3 supports the Modbus-RTU-protocol with the following parameters:

4.1 Baud rate

Selectable transmission rates are:

- 1200 Bd
- 2400 Bd
- 4800 Bd
- 9600 Bd
- 19200 Bd
- 38400 Bd.

The baud rate can only be set manually by means of the control unit BE2 and not over the Modbus communication.

4.2 Transmission data format

Available for selection:

- 1 start bit, 8 data bit, no parity, 2 stop bits or
- 1 start bit, 8 data bits, 1 parity bit, 1 stop bit

Parity can be set to odd or even.

4.3 Response time

The response time is less than 20 ms.

4.4 Factory settings

Standard factory settings are:

- Device address: 1
- Transmission rate: 9600 Bd
- Transmission data format: 1 start bit, 8 data bits, no parity, 2 stop bits.

5 Local operation with control unit BE2

The user interface is identical to that of the standard design of the UMC3, with the exemption of the functional class “Transmitter settings”, which is extended by three additional functions.

Fehler! Kein Thema angegeben.

5.1 Device address

A device address is required to select the device within the system. Each address may only be assigned once. Note that devices with identical addresses will collide during bus accesses! The device address can be set via the bus or the control unit BE2 (see UMC3 settings, device address).

When the device is shipped from the factory, the **preset address is 1**.

Before commissioning the system, every new device must be designated a new, unassigned address (< 248).

	**Warning:** The change of address takes place immediately. The device will not respond when addressed under the old address (communication abort). However, the device is immediately addressable under its new address.

5.2 Baud rate

Refer to chapter 4.1 baud rate on page 7.

5.3 Parity

Parity can only be set by using the control unit BE2. Selectable is:

- No parity
- Even parity
- Odd parity.

The selection affects the transmission's data format. Details can be found in chapter 4.2 transmission data format on page 7.

5.4 Swap

It is possible to exchange the sequence of high and low integer for the representation of the data types float and double. This parameter can also be set via Modbus.

Example:
Swap switched on:

- Representation in the standard IEEE754 format („big endian", most significant byte first)
  123.456 = hexadecimal *42 F6* **E9 79** transmitted

Swap switched off:

- 123.456 = hexadecimal **E9 79** *42 F6* transmitted
  (e. g. used by Modbus master „Modscan32")

6 Data formats

Modbus uses a 16-bit integer as the smallest entity called “**register**“. The following data types are supported:

Integer: often also referred to as “int16“
Example: 1000 = hexadecimal 03 E8 in the telegram, (most significant byte first)

Float: floating point number

swapped float: floating point number hi- and lo-integer swapped

long: often also referred as “int32“
Example: 123456 = hexadecimal 00 01 E2 40 in the telegram, most significant byte first.

Double: floating point number with double precision (8 bytes)

swapped double floating point number hi- and lo-integer swapped.
Example:
swap switched on:
0.056252 = hexadecimal 3F AC *CD 1B* 14 EF 18 00 (standard)
swap switched off:
0.056252 = hexadecimal 18 00 14 EF *CD 1B* 3F AC

string24: conforms to 24 integer
(for texts, only if Baud rate > = 4800Bd readable in one transferred block)

The following characteristics apply to this data type:

1 … 24 registers can be read or written in a block. The beginning can be placed at any random position. Thereby it is possible to read or write only parts of strings.

Contents of these registers can take on any values (texts are intended, however these registers can be used for other purposes).
Variables of this type may only be read or written individually (not in combination with neighboring variables other data types).

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7 Commands

Command	Name	Example or description
1	read coil status	Reading bit-coded status messages
3	read multiple registers	Reading measured values and parameters
15	force multiple coils	e. g. counter reset
16	write multiple registers	Parameter settings

Note for command 3 and 16:
Reading or writing of several measured values or parameters in one telegram is possible. However the number of the bytes and/or registers (1 register corresponds to 2 bytes) is limited and dependent on the Baud rate:

Baud rate	1200	2400	4800	9600	19200	38400
read (bytes / registers)	8/4	22/11	52/26	58/29	58/29	58/29
write (bytes / registers)	54/27	54/27	54/27	54/27	54/27	54/27

Should an unknown command be requested, the error message “illegal function” is returned.

8 Counter

To represent the forward and backward counter three different data formats are provided:

- **Floating point with simple accuracy**
  (float, 4 bytes, IEEE754)
  Note: This data type can only represent 6 digits. With larger numbers > 1000000 the representation becomes increasingly inaccurate.
- **Floating point with double accuracy**
  (double, 8 bytes),
- **Allocation in whole number and fraction.**
  The whole number component is represented as long integer. The range is up to 2^{31}-1. The fraction component is represented as float.

9 Password

In order to change any settings, a valid password must first be written into the associated register. The factory-setting password is 0002.

		**Note:** If no writing activity is registered over a period of 5 minutes, the password is reset and the authorization to change settings automatically cancelled.

	**Warning:** An activated simulation mode is **not** terminated automatically!

10 Register allocation

In the appendix, starting on page 16, can be found the tables of register assignment.

The first column of each table indicates the address of the register or value (index). The second column describes the function. The following columns describe the length and type of the parameter, its range of values and the rights of access.

Note: **The indicated address of a register corresponds to the Modbus data telegram.**

11 Examples

Note: Depending on the used Modbus master, e.g. “modscan32” it might be necessary to increase the addresses by 1 in the following examples.

11.1 Measured values read as a block

Reading of mass flow, density and temperature:

- Command 3, (read)
- Address 40010,
- Length = 6 registers

11.2 Zero point calibration

- Command 16, (write)
- Address 40003
- Length 1
- Value 0002 (write password)

- Command 15 (write)
- Address 8
- Length 1
- Value 1 = „on“ (start zero point calibration)

The zero point calibration is started and terminated automatically. The calibration procedure runs in the background and takes approx. 30 seconds.

11.3 Reset counters

- Command 16, (write)
- Address 40003
- Length 1
- Value 0002 (write password)

- Command 15 (write)
- Address 3
- Length 1
- Value 1 = „on“ (reset counters)

11.4 Plausibility check

The parameters set via bus accesses are not verified for inconsistencies to other settings. In contrast to manual settings, using the control panel BE2, these settings are adopted without any criticism.
A written parameter is always compared to the permitted range. In the event of a range violation, the return value of the command is “illegal value“.

A plausibility check of the entire parameters set is initiated by command 15 (“force coils”). The checked result can be read from register (command 3) or can be picked out bit-coded using command 1.

- Command 16,
- Address 40003,
- Length 1,
- Value 0002 (write password)

- Command 15,
- Address 10,
- Length 1,
- Value 1 „on“ (start plausibility check)

- Command 1,
- Address 12,
- Length 16 (read result)

11.5 Read transmitter status

- Command 1,
- Address 14,
- Length 32 (device status)

12 Explosion protection

The EIA-485 interface (RS 485) of the UMC3 can be operated intrinsically safe as RS 485-IS. In this case, all other signal outputs (current output, binary outputs) of the UMC3 must also be operated in the protection class intrinsically safe!

If the Modbus interface is not operated intrinsically safe, then all other outputs must also be operated non-intrinsically safe.

	**Warning:** The Modbus interface must always be operated in the same protection class as the signal outputs.

12.1 Safety-relevant maximum values

RS 485-IS (terminals 35 and 36) type of protection Ex ia IIC Ga

Linear characteristic line

Voltage	Uo	DC	4,1	V
Current	Io		59	mA
Power	Po		61	mW

Linear characteristic line

Voltage	Ui	DC	4,5	V

Effective inner inductance	Li	<= negligible
Effective inner capacitance	Ci	<= negligible

13 Appendix

13.1 Register assignment

13.1.1 Commands 1 and 15

command 15 "force coils" write only

index	function	length	content	access
2	Self-test calibration	1		write
3	Reset all counters	1		write
4	Reset forward counter	1		write
5	not used			
6	Reset reverse counter	1		write
7	Reset system error	1		write
8	Zero point calibration	1		write
9	Simulation on/off	1		write
10	Check plausibility	1		write

command 1 "read coil status" read only

index	function	length	content	access
12	Result of checking plausibility	16	assignment see below	read
13	System status	32	assignment see below	read
14	Self-test status	32	assignment see below	read

13.1.2 Commands 3 and 16

command 3 "read holding registers" read
command 16 "write multiple registers" write

address	function	length (registers)	assignment	access
40000	Device address	1	Attention: change causes termination of communication	r/w
40001	Result of checking plausibility	2	assignment see below	read
40002	Integer swap off/on	1	0 = off 1 = on	r/w
40003	Customer password	1	password=2	r/w

13.1.3 Units

	command 3	**"read holding registers"**		**read**	
	command 16	**"write multiple registers"**		**write**	
address	function	length (registers)	content	unit	access
	Units				
40005	Massflow unit	1	0	kg/s	r/w
			1	kg/min	
			2	kg/h	
			3	t/h	
			4	g/min	
			5	lbs/s	
			6	lbs/min	
			7	lbs/h	
			8	ston/h	
			9	lton/h	
40006	Density unit	1	0	kg/l	r/w
			1	g/l	
			2	g/cm³	
			3	lbs/ft³	
40007	Temperature unit	1	0	°C	r/w
			1	K	
			2	°F	
40008	Volumeflow unit	1	0	m³/h	r/w
			1	l/h	
			2	l/min	
			3	l/s	
			4	USG/h	
			5	USG/min	
			6	USG/s	
			7	UKG/h	
			8	UKG/min	
			9	UKG/s	
			10	USB/d	
			11	MG/d	
			12	m³/s	
			13	ft³/min	
			14	acft/s	
			15	cm³/s	
40009	Counter unit	1	0	g	r/w
			1	kg	
			2	t	
			3	m³	
			4	l	
			5	USG	
			6	UKG	
			7	USB	
			8	lbs	
			9	shton	
			10	lton	
			11	ft³	
			12	acft	
			13	cm³	

13.1.4 Measured values

address	Kommando 3 Kommando 16 function	length (register)	"read holding registers" "write multiple registers" data type		read write access
	measured values				
40010, 40011	mass flow	2	float		read
40012, 40013	density	2	float		read
40014, 40015	temperature	2	float		read
40016, 40017	volume flow				read
40018, 40019	counter forward (single precision)	2	float		read
40020, 40021	counter reverse (single precision)				read
40024, 40025	system status	2	long		read
40026, 40027	self-test status	2	long		read
40028, 40029 40030, 40031	counter forward (double precison)	4	double		read
40032, 40033 40034, 40035	counter reverse (double precision)	4	double		read
40042, 40043	counter forward decimals	2	long		read
40044, 40045	counter forward fraction	2	float		read
40046, 40047	counter reverse decimals	2	long		read
40048, 40049	counter reverse fraction	2	float		read
40040, 40041	elapsed time	2	long	minutes	read

13.1.5 Measurement processing

address	command 3 command 16 function	length (registers)	"read holding registers" "write multiple registers" data type	read write 	access
	Measurement processing				
40054, 40055	Damping	2	float		r/w
40056, 40057	Low flow cut-off	2	float		r/w
40058, 40059	Low flow cut-off hysteresis	2	float		r/w

13.1.6 Flow

address	command 3 command 16 function	length (registers)	"read holding registers" "write multiple registers" data type	read write	access
	Massflow (QM)				
40060, 40061	Massflow measured value	2	float		read
40066	Massflow unit	1		units see register 40005	r/w
40067, 40068	Massflow range	2	float		r/w
40069, 4007	Massflow limit MIN (%)	2	float		r/w
40071, 40072	Massflow limit MAX (%)	2	float		r/w
40073, 40074	Massflow limit hysteresis (%)	2	float		r/w
	Volumeflow				
40075, 40076	Volumeflow measured value	2	float		read
40077	Volumeflow unit	1		units see register 40008	r/w
40078, 40079	Volumeflow range	2	float		r/w

13.1.7 Density and temperature

address	command 3 "read holding registers" command 16 "write multiple registers" function	length (registers)	data type	read write	access
	Density				
40080, 40081	Density measured value	2	float		read
40086	Density measurement off/on	1		off = 0 on = 1 fixed = 2	r/w
40087	Density unit	1		units see register 40006	r/w
40088, 40089	Density lower range value (in density unit)	2	float		r/w
40090, 40091	Density upper range value (in density unit)	2	float		r/w
40092, 40093	Density limit MIN (in density unit)	2	float		r/w
40094, 40095	Density limit MAX (in density unit)	2	float		r/w
40096, 40097	Density limit hysteresis (in density unit)	2	float		r/w
40098, 40099	Density limit for empty pipe (in density unit)	2	float		r/w
40100, 40101	Fixed Density (in density unit)	2	float		r/w
40102	Reference/process density display	1		process density=0 reference density=1	r/w
40103, 40104	Temperature coeffizient *10E-5/K	2	float		r/w
40105, 40106	Reference temperature (°C)	2	float		r/w
40107, 40108	Reference pressure (bar)	2	float		r/w
	Temperature				
40134, 40135	Temperature measured value	2	float		read
40140, 40141	max. measured temperature (°C)	2	float		read
40142	Temperature unit	1		units see register 40007	r/w
40143, 40144	Temperature lower range value (in temperature unit)	2	float		r/w
40145, 40146	Temperature upper range value (in temperature unit)	2	float		r/w
40147, 40148	Temperature limit MIN (in temperature unit)	2	float		r/w

13.1.8 Outputs

	Pulse output				
40181	Pulse or frequency output	1		pulse output=0 frequency output=1	r/w
40182	Pulse output unit	1		units see register 40009	r/w
40183	Pulse value: 1 pulse per xxx unit	1		"0.001"= 0 "0.01" = 1 "0.1" = 2 "1.0" = 3	r/w
40184, 40185	Pulse width (ms)	2	float		r/w r/w
	Status output				r/w
40177	Status output active state	1		"closed"=0 "opened"=1	r/w
40178	Status output 1 assignment	1		"forward flow"=0 "reverse flow"=1 "MIN QM"=2 "MAX QM"=3 "MIN density"=4 "MAX density"=5 "Alarm"=6 "IMP2 90°"=7	r/w
40179	Status output 2 assignment	1	not available with MODBUS	"not available"=7	read
40180	Binary input assignment	1	additional feature used in custody transfer	"not available"=0 "counters=0!"=1 "cal zero !"=2 "reset errors"=3	r/w

address	command 3 command 16 function	"read holding registers" "write multiple registers" length (registers)	data type	read write	access
	Current outputs				
40171	Current output I1 0/4-20mA	1		"0-21.6" = 0 "4-21.6" = 1 "4-20.5" = 2	r/w
40172	Current output I1 alarm	1		"<3.8 mA" = 0 ">22 mA" = 1 "not used" = 2	r/w
40173	Current output I1 assignment	1		massflow = 0 volumeflow = 1 density = 2 temperature = 3	r/w
40174	Current output I2 0/4-20mA	1		"0-21.6" = 0 "4-21.6" = 1 "4-20.5" = 2	read

13.1.9 Simulation

address	command 3 / command 16 function	length (registers)	data type	read / write	access
	Simulation				
40151	Simulation of outputs ("direct") or flow, density,temperature ("QM,D,T")	1		direct = 0 QM,D,T = 1	r/w
40152, 40153	Simulated massflow (in massflow unit)	2	float		r/w
40154, 40155	Simulated density (in density unit)	2	float		r/w
40156, 40157	Simulated temperature (in temperature unit)	2	float		r/w
40158	Simulated status output	1		"on" = 1 "off" = 0	r/w
40159, 40160	Simulated pulse output (Hz)	2	float		r/w
40161, 40162	Simulated Current output I1 (in mA)	2	float		r/w
40163, 40164	Simulated Current output I2 (in mA)	2	float	not available with MODBUS	r/w

13.1.10 Self-test

address	command 3 / command 16 function	length (registers)	data type	read / write	access
	Self-test				
40165	Sensor test off/on	1		off = 0 on = 1	r/w
40167	max. deviation of excitation	1	unsigned Integer	unsigned integer 0...999%	r/w
40168	calibrated amplitude of sensor 1	1	Integer	Set by command 15, index 2	read
40169	calibrated amplitude of sensor 2	1	Integer	Set by command 15, index 2	read
40170	calibrated amplitude of excitation	1	Integer	Set by command 15, index 2	read

13.1.11 UMC3 transmitter settings

address	command 3 / command 16 function	length (registers)	data type	read / write	access
	UMC Transmitter settings				
40215, 40216	Serial number	2	long		read
40217, 40218	Software version of UMC	2	float		read
40219	Flash checksum	1	unsigned Integer		read
40220	Binary input available	1	additional feature used in custody transfer	"not available"= 0	read
40221	Status output 2 available	1	not available with MODBUS	"not available"= 7	read
40222 ... 40245	Text 1	1...24	string, 24 Register		r/w
40246 ... 40269	Text 2	1...24	string, 24 Register		r/w

13.1.12 Sensor settings

address	command 3 / command 16 function	length (registers)	data type	read / write	access
	Sensor settings				
40186, 40187	Sensor constant	2	float		r/w
40188	Sensor material	1		"1.4571" = 0 "1.4301" = 1 "HC 4" = 2 "HB 2" = 3 "Tantal" = 4 "Titan" = 5 "Nickel" = 6 "Special" = 7	r/w
40189	Flow direction	1		"forward" = 0 "reverse" = 1 "forward&reverse" = 2	r/w

13.1.13 Raw values

address	command 3 function	length (registers)	data type	read	access
	raw values				
40199, 40200	Phase	2	float		read
40201, 40202	Frequency	2	float		read
40203, 40204	Temperature in °C	2	float		read
40205, 40206	Amplitude Sensor 1	2	float		read
40207, 40208	Amplitude Sensor 2	2	float		read
40209, 40210	Exciter current	2	float		read

13.2 Self-test status bit assignment

Message	bit mask hexadeci-mal
Malfunction sensor 1	0x00010000
Malfunction sensor 2	0x00020000
Exciter current too small	0x00040000
Exciter current too large	0x00080000
Partially filled?	0x08000000
Malfunction temperature	0x00200000
Loops do not vibrate	0x02000000
Current output I1 saturated	0x00000080
Current output I2 saturated	0x00000040
Pulse output saturated	0x00000100
Power fail (custody transfer only)	0x01000000
Missing EEPROM	0x00004000
Wrong EEPROM	0x00000008
Parameters are inconsistent	0x00008000
Density measurement is switched off	0x00100000
Pipe is empty	0x00000400
Simulation is switched on	0x00000020
Calibration of zero point is running	0x04000000
Temperature < MIN-limit	0x00002000
Temperature > MAX-limit	0x00001000
Mass flow > 110%	0x00000800
Mass flow > upper sensor limit	0x00000010

13.3 System status bit assignment

Message	Bit mask hexadecimal
Division by zero	0x00000001
internal EEPROM empty	0x00000002
external or internal EEPROM : wrong checksum	0x00000004
external EEPROM empty	0x00000008
EEPROM writing or reading failed (timeout)	0x00000010
Initializing of time constant failed	0x00000100
Faulty calculation of measured value e.g. negative density	0x00000200
Parameters are inconsistent	0x00000400
Communication with DSP failed	0x00020000
wrong version of DSP-firmware	0x00000080
wrong checksum over program memory	0x00001000
Messages in custody transfer:	
wrong checksum over static parameters	0x00000800
wrong checksum over DSP-firmware	0x00002000
counters and their copies differ at power on	0x00004000
internal watchdog timed out	0x00008000
defective memory location in main memory	0x00010000

13.4 Validation check errors

Message	
unspecified failure	0x8000
Status output 1 or 2 is assigned to MIN/MAX-density although density measurement is switched off; Current output 1 or 2 is assigned to density or volume flow although density measurement is switched off; Counters or pulse output are set to count volume units although density measurement is switched off;	0x4000
Pulse width too large for mass flow upper range	0x2000
Overlap mass flow MIN/MAX	0x1000
Overlap density MIN/MAX	0x0800
Overlap temperature MIN/MAX	0x0400
Temperature lower range value>=upper range value	0x0200
Density lower range value>=upper range value	0x0100
Mass flow range out of sensor limits (>USL or <LSL)	0x0080
Density measurement switched on but not calibrated	0x0040
Current output 2, status output 2 or binary input used but not available	0x0020
custody transfer::	
Status output 2 or binary input used but not available	0x0010
Self-test of sensor not switched on	
Current output I2 not logged out	
Pulse output is configured as frequency output	
Binary input is not assigned to reset errors	
Status output is not configured as "active opened"	
Unit of pulse output is not kg,t,m3,l	
Status output 1 is not configured as "IMP2_90°"	
Status output 2 is not configured as "Alarm"	
Flow direction is not configured as "forward & reverse"	