SIEMENS

Operating Manual

SITRANS F M MAGFLO® & SITRANS F C MASSFLO®

Modbus RTU RS-485 add-on module for USM II transmitters

Order no.: FDK:521H1183

SFIDK.PS.023.D2.02 - A5E00253376

Contents

1. Introduction

This manual is intended to provide instructions for the installation and use of the Modbus RTU add-on module, product code number **FDK:085U0234**, that can be used in the Siemens Flow Instruments USM II family of transmitters, which presently includes MAG 6000 and MASS 6000.

The Modbus RTU module is effectively a gateway through which a Modbus RTU master device can have controlled access to a number of Siemens Flow Instruments USM II signal converter parameters.

This manual is not intended to be a complete tutorial on the Modbus RTU protocol, and it is assumed the end user already has a general working knowledge of Modbus RTU communications, especially in respect of master station configuration and operation. However an overview is included in the following section to explain some of the fundamental aspects of the protocol.

1.1 Definitions and Abbreviations

CRC	**C**yclic **R**edundancy **C**heck Used for error-checking in Modbus RTU. See appendix
Modbus master	A Modbus device, which is able to access data in one or more connected Modbus slaves
Modbus slave	A Modbus device, which is able to respond to requests from a single Modbus master
Modbus address	Throughout this document the following notation is used to address Modbus RTU registers and coils: ***1:123*** Coil number 123 (addressed in messages by 122) ***4:1234*** Holding register 1234 (addressed in messages by 1233) ***4:54321*** Holding register 54321 (addressed in messages by 54320) ***34567*** The address of a coil/holding register as specified in a message
RS-485	Refers to the 2-wire communication standard defined by EIA/TIA-485. (Physical layer)
RTU	**R**emote **T**erminal **U**nit = Standard Modbus transmission mode

1.2 References

Reference 1	Modbus over Serial Line Specification & Implementation guide v. 1.0 modbus.org 12/02/02
Reference 2	Modbus Application Protocol Specification v. 1.1 modbus.org 12/06/02

2. Technical data

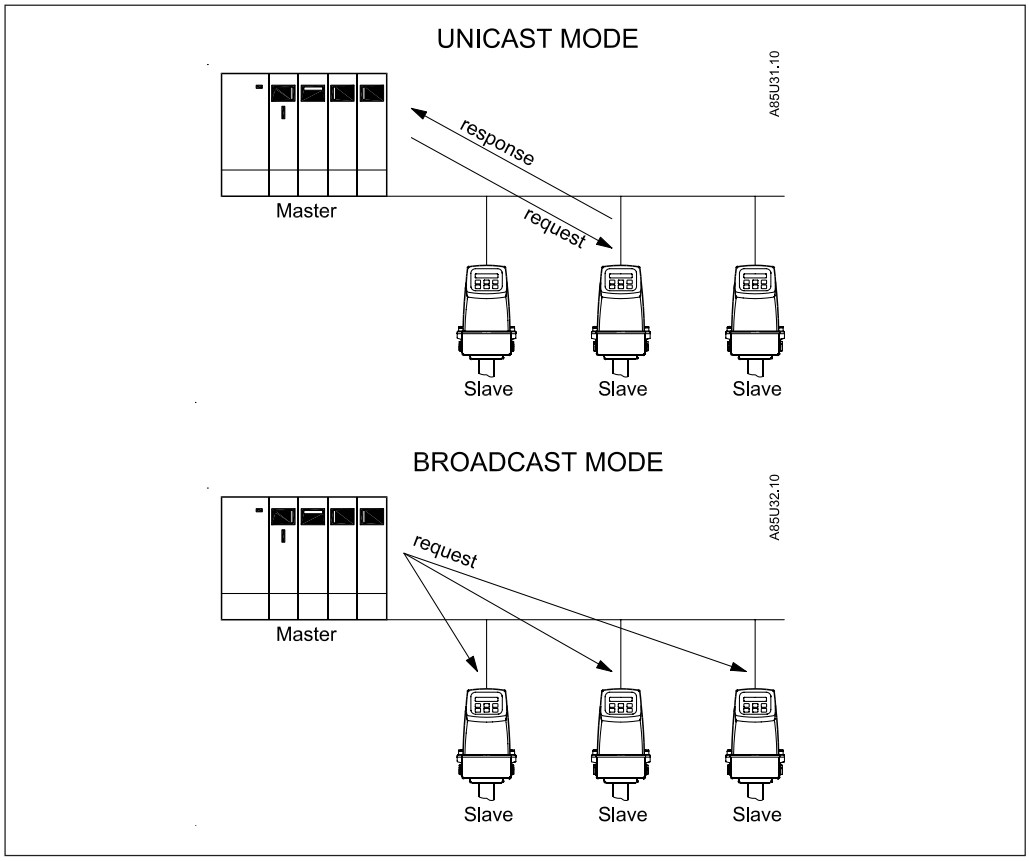
Siemens Flow Instruments	Modbus RTU specification
Device type	Slave
Baud rates	1200, 2400, 4800, 9600, 19200, 38400, 57600,
	76800, 115200 bits/sec.
Number of stations	Recommended: max. 31 per segment without repeaters
Device address range	1-247
Protocol	RTU
	(Other Modbus protocols like ASCII, Plus or TCP/IP are **not** supported)
Electrical interface	RS-485, 2 wire
Connecter type	Screw terminals
Supported function codes	1 read coils
	3 read holding registers
	5 write single coil
	16 write multiple registers
	17 report slave ID
Broadcast	No***)**
Maximum cable length	1200 meters (@115200 bits/sec.)
Standard	Modbus over serial line v1.0*)
Certified	No
Device profile	None

*) **Standard restriction**
The standard requires a LED indicator for visual diagnosis. This module do not support a LED indicator. Instead comprehensive display information is available. This device does not react to any Broadcast commands.

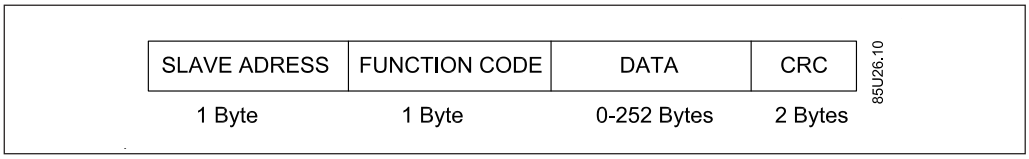
2.1 General Modbus RTU

The module complies with the Modbus serial line protocol [Reference 1].
Among other things this implies a **master-slave** protocol at level 2 of the OSI model. One node (the master) issues explicit commands to one of the „slave"-nodes and processes responses. Slave nodes will not transmit data without a request from the master node, and do not communicate with other slaves.
Modbus is a mono **master system**, which means that only one **master** can be connected at the time.

Two modes of communication are possible, **Unicast** and **Broadcast**. **Unicast** mode is where the **master** sends a request to one **slave device**, and waits a specified time for a response. In **Broadcast** mode the master sends out a request to address „0", which means that the information is for all **slave devices** on the network. In **Broadcast** mode there are no response from the **slave devices**.



The Modbus frame is shown below, and is valid for both requests and responses.

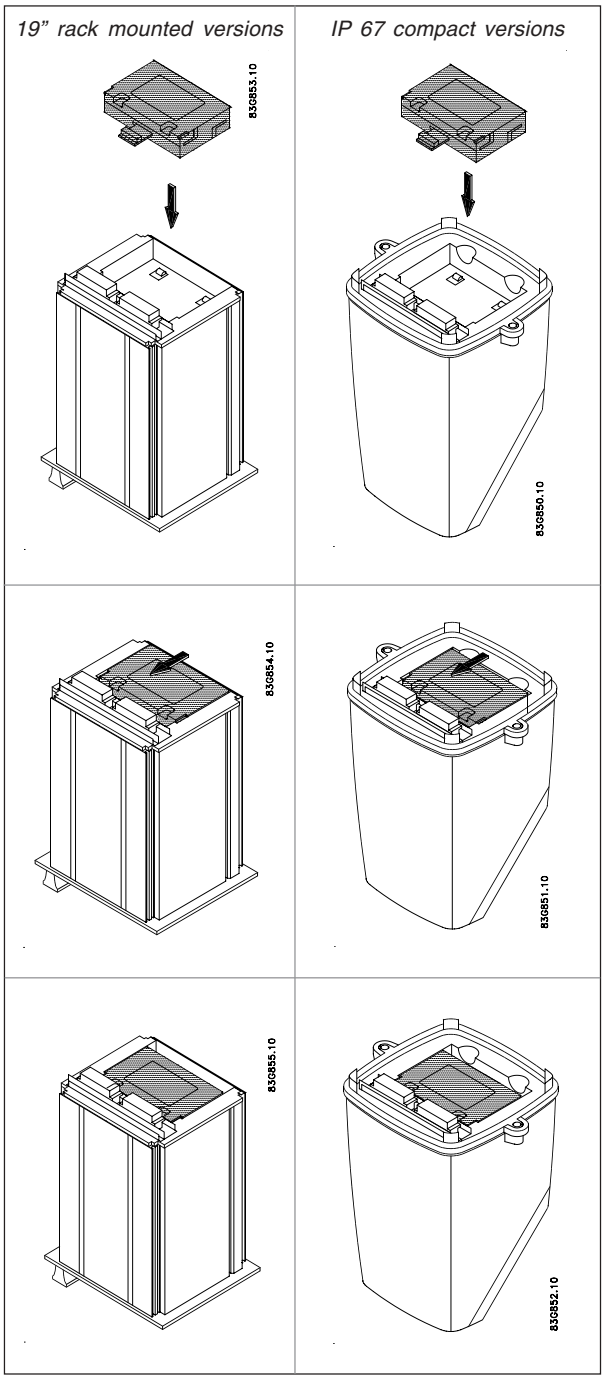


Further details of the Modbus protocol can be found in Reference 1 and 2.

3. Installation

3.1 Add-on module

The installation procedure for an add-on module to a Siemens Flow Instruments USM II transmitter is as follows:



1. Unpack the add-on module and insert it in the bottom of the signal converter as shown.

2. Press the add-on module in the direction shown, until it stops and is firmly seated in position

3. This completes the add-on module installation, and the signal converter may now be connected to the terminal box. Communication with the display/keypad and the electrical input/output terminals is established automatically when the power is applied.

3.2 General electrical information

On the electrical termination boards for USM II transmitters, additional input/output terminals have been reserved for add-on module functions. The numbering range of these terminals is as follows, but how many are actually used depends on the type of add-on module. Please refer to the relevant handbook for other electrical connection information.

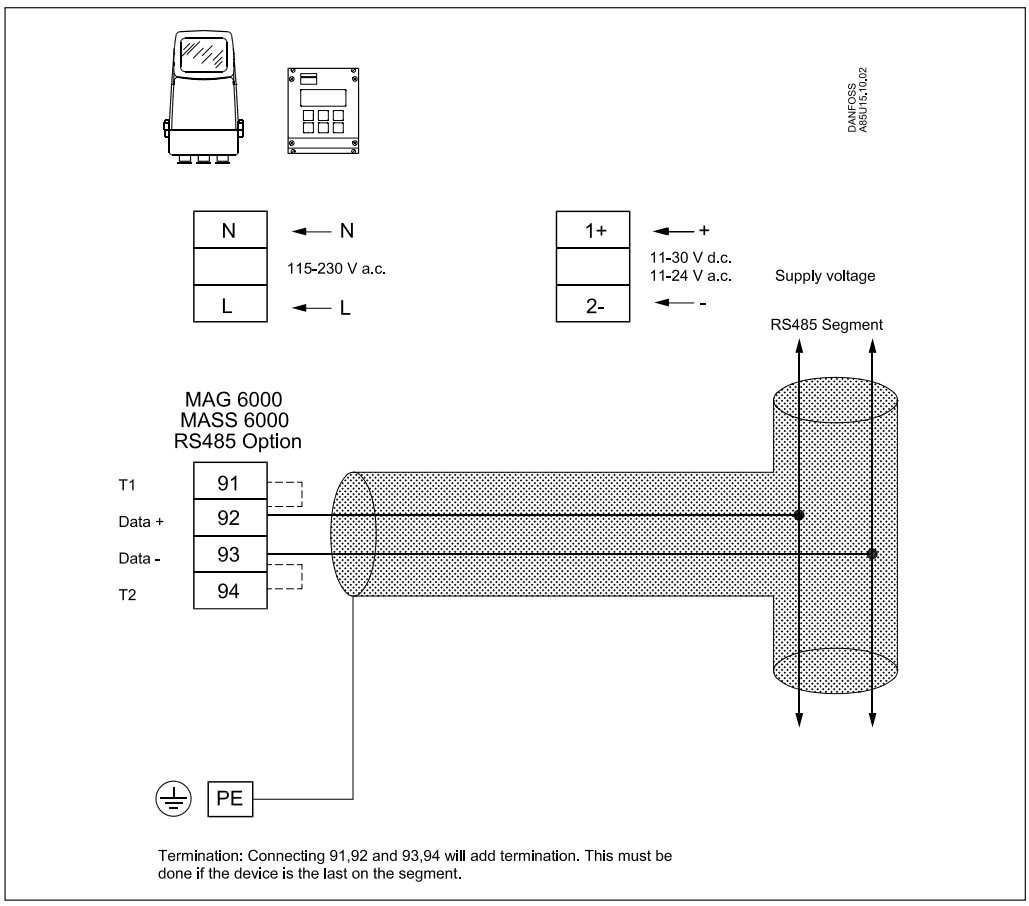
Terminals reserved for add-on modules:
MAG 6000: 91 - 97
MASS 6000: 91 - 100

Note
The standard inputs and outputs continue to function and are not affected by the presence of an add-on module. It is however not possible to install this module in a MASS 6000 with extra outputs. If a **Current Out 2** is present, the MASS 6000 has extra outputs installed.

3.3 USM II connections

The following table shows the connection layout for the USM II Modbus RTU module:

Terminal number	Modbus RTU RS-485 connection
91	T1
92	Data +
93	Data –
94	T2
PE	Shield



3.4 RS-485 termination

All RS-485 based networks must be terminated correct to function properly. A termination must be placed at each end of the segment.
The Modbus RTU module can add a termination by connecting terminals 91 to 92 and 93 to 94. It is important to use very short wires for this connection.

3.4.1 RS-485 cabling

To ensure error free operation, a good quality cable meeting the RS-485 specifications, must be used.

4. Commissioning

Before communicating with the master, baudrate, node ID and update rate must be selected. This can be done from the display. Please look in to the transmitter manual to locate the Modbus RTU menu.

4.1 Effect of changing Modbus communication settings

Changing baudrate or framing has effect on the communication as follows:

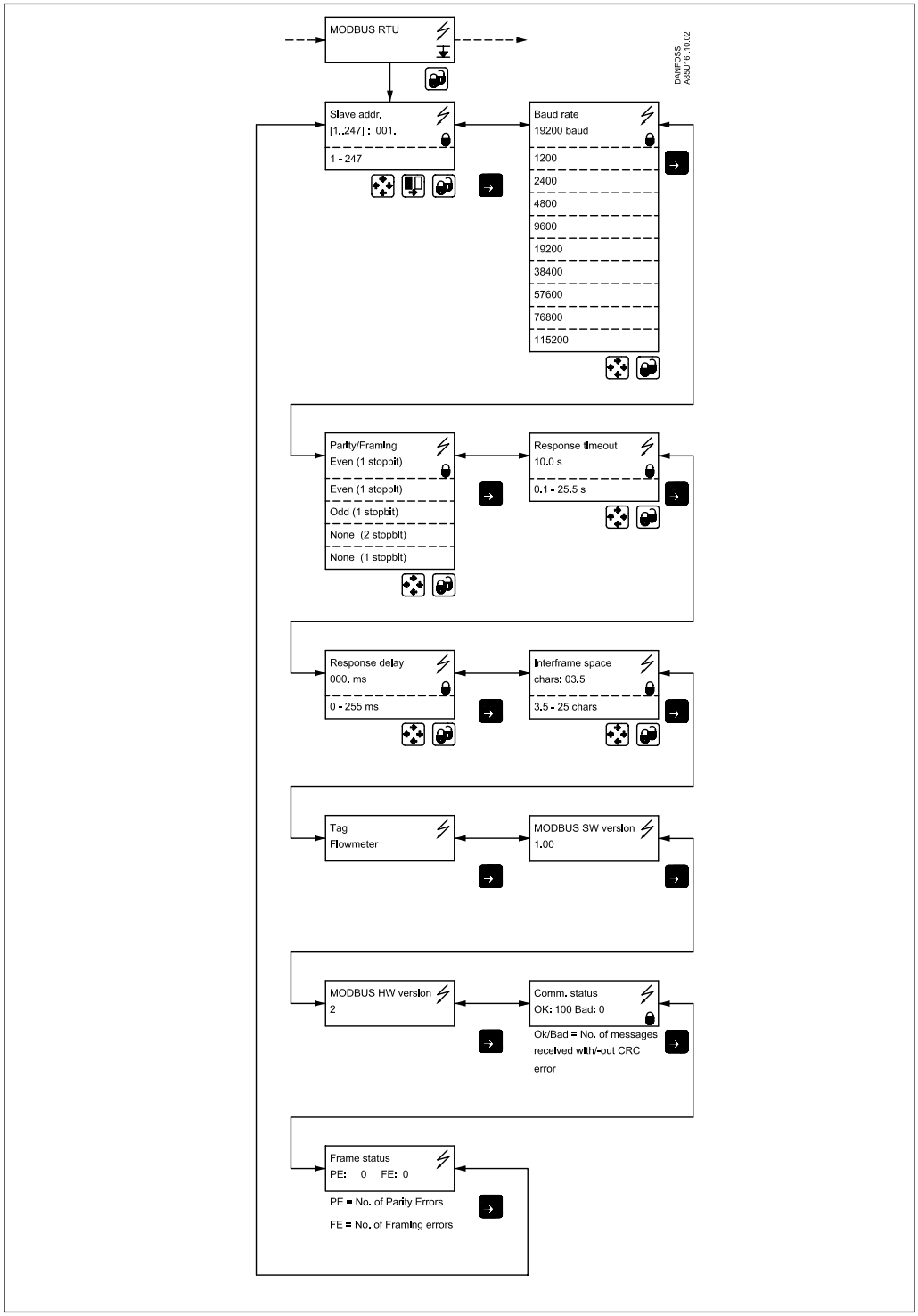
- When changed from the **menusystem**, new settings have effect immediately. (Same effect as writing to the „**ResetCommunication**“ coil).
- When changed from the **Modbus master**, the new settings only have effect after a reset (PowerUp) of the module - or after writing to the „**ResetCommunication**“ coil.

In both cases the new settings will not have effect until the Modbus driver has responded to any ongoing Modbus request.

Note
It is recommended **NOT** to use the default address in a ***multi-slave network***.

It is of great importance to ensure at the time of the procedure of device addressing, that there is not two devices with the same address. In such a case, an abnormal behaviour of the whole serial bus can occur, the master being then in the impossibility to communicate with all present slaves on the bus.

4.2 Modbus RTU display menu



To change (or view) the Modbus RTU settings from the keypad display.

1. Press [Top key] for two seconds. (**Note:** For **"View"** mode only, skip steps 2 & 3).
2. Type in **password (1000)** by pressing [Change key] two times, and then press [Lock key] and hold for two seconds
3. The display now says **"Basic settings"**
4. Press [Forward key] until you reach the **"Modbus RTU module"** menu item
5. Press [Lock key]
6. You can now cycle through all the **Modbus RTU** settings by pressing [Forward key]
7. Press [Top key] for two seconds and you return to 1.

4.3 Menu item explanation

Item	Value	Comments
Slave addr.	1-247	Device address ***[Factory setting: 1]***
Baud rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200	Communication speed ***[Factory setting: 19200]***
Parity/framing	Even, 1 stopbit Odd, 1 stopbit None, 2 stopbit None, 1 stopbit	Communication parameters ***[Factory setting: Even, 1 stopbit]***
Response timeout	0-25,5 sec.	Max. response time. Used in time critical applications, where low cycle times are required. If the response is not ready within the „Response Timeout“ time, an exception code 6 (Busy acknowledge) is returned and the request must be send again. ***[Factory setting: 10,0]***
Response delay	0-255 msec.	The minimum time from when a slave receives a request and until it returns a response. This makes it possible to send data to slow masters without overwhelming its receiver. ***[Factory setting: 0]***
Interframe spacing	3,5-25 chars	The minimum interframe space between two Modbus RTU messages in sequence (specified as 3.5 characters) is configurable. Range: 3.5 - 25 character times. ***[Factory setting: 3,5]***
TAG	„Flowmeter“	The TAG can be changed to any string up to 16 chars. ***[Factory setting: Flowmeter]***
Modbus SW version	1.00	Firmware version of the Modbus module
Modbus HW version	2	Hardware version of the Modbus module
Comm. status	Ok: xx Bad: xx	Ok = Received messages without errors Bad = Received messages with CRC errors Reset after a power down
Frame status	PE: xx FE: xx	PE = Number of parity errors FE = Number of framing errors Reset after a power down

The settings are all stored in the non-volatile memory of the SENSORPROM® unit, and therefore remembered after a power down. Even if the module or transmitter is replaced the settings are kept.

If the SENSORPROM® unit is **NOT** used, then the settings are stored in the transmitters memory. These settings will however be overruled if the SENSORPROM® unit is used again.

5. Modbus addressing model

The module allows R/W access to the following standard Modbus data register blocks:

- Coils (ref. 0x address range)
- Holding registers (ref. 4x address range)

I.e. the module will not support the other standard data register blocks:

- „Discrete input“ (ref. 1x address range)
- „Input registers“ (ref. 3x address range)

5.1 Modbus function codes

This device supports following function codes: 1, 3, 5, 16 and 17.
Function code 1 and 5 are used for accessing coils. 3 and 16 are used for accessing registers. Function code 17 (report slave ID) will return a structure of identification information of the device. Below the different function code exceptions are described.

Function code 1 (Read coils)

General exceptions:

- Requesting less than 1 or more than 2000 coils => Exception 3 (Illegal data value)
- Requesting more than max. message size (440 coils) => Exception 2 (Illegal data address)
- Requesting data above/crossing limitation of max. coil address (0xFFFF) => Exception 2 (Illegal data address)

Application exceptions:

- Application errors => Exception 4 (Slave device error)
- Further information about the error can be read from holding registers 680+681 (Last Coil Addr + ErrorNo)

Holes/register alignment:

- Unmapped coils return zero when read

Function code 3 (Read holding registers)

General exceptions:

- Requesting less than 1 or more than 125 registers => Exception 3 (Illegal data value)
- Requesting more than max. message size (27 registers) => Exception 2 (Illegal data address)
- Requesting data above/crossing limitation of max. register address (0xFFFF) => Exception 2 (Illegal data address)

Application exceptions:

- Application errors => Exception 4 (Slave device error)
- Further information about the error can be read from holding registers 682+683 (Last HoldReg Addr + ErrorNo)

Holes/register alignment:

- The read command always returns data if no exception is given. Bad start/end alignment will result in only parts of the data item being read
- Holes in the holding register map return value zero in all bytes. E.g. reading 2 registers starting at 4:0004 above will result in 2 bytes of **„float B“** followed by 2 zeroes

Function code 5 (Write single coil)

General exceptions:

- Writing anything else but 0x0000 (OFF) or 0xFF00 (ON) to a coil => Exception 3 (Illegal data value)
- Writing to an unmapped coil => Exception 2 (Illegal data address)

Application exceptions:

- Application errors => Exception 4 (Slave device error)
- Further information about the error can be read from holding registers 680+681 (Last Coil Addr + ErrorNo)

Function code 16 (Write multiple registers)

General exceptions:

- Writing less than 1 or more than 120 registers => Exception 3 (Illegal data value)
- If ByteCount is not exactly 2 times NoOfRegisters => Exception 3 (Illegal data value)
- Exceeding max. message size (25 registers) => Exception 2 (Illegal data address)
- Writing data above/crossing limitation of max. register address (0xFFFF) => Exception 2 (Illegal data address)

Application exceptions:

- Application errors => Exception 4 (Slave device error)
- Further information about the error can be read from holding registers 682+683 (Last HoldReg Addr + ErrorNo)
- Application errors include writing to ReadOnly holding registers

Holes / register alignment:

- If start-address is not the start of a mapped holding register => Exception 2 (Illegal data address)
- Writing to holes is allowed (ie ignored - and no exception occurs) - except for the condition described above
- If the end address is only part of a mapped holding register item (e.g. one half of a float value), the action depends on the datatype. It is allowed to update first part of „**VisibleString**“ and „**ByteArray**“ datatypes (although strange results may appear, if the VisibleSting does not include the terminating zero). Writing parts of all other datatypes => Exception 4 (Slave device error)

Function code 17 (Report Slave ID)

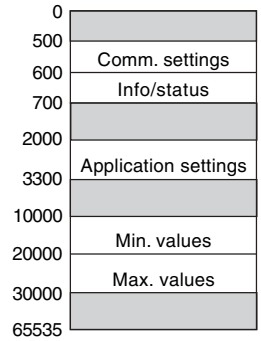
- There are no exceptions for this function

Generally writing stops when the first exception occurs. When writing multiple registers, writing starts with the register with the lowest address - and continues until an exception occurs - or until all registers are updated.

6. Modbus holding registers

In the following the **holding registers** for the USM II Modbus RTU module are described.

Figure:
Holding registers memory map



The minimum value of a writable „**holding register**“ value can be read by adding 10000 to the address of the value.

The maximum value of a writable „**holding register**“ value can be read by adding 20000 to the address of the value.

Where the value is not directly applicable, the min./max. limit shown will be based on the data type - ***e.g. a „WORD-type“ value will show the limits 0-65535*** - even though some of these values are not allowed.

Min./max. values do not apply to all datatypes (e.g. strings). Reading min./max. value for such „**holding registers**“ will return zero-values.

6.1 Process data

MAG

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:03003	3002	4	Float	Absolute Volumeflow (m^3/s)	R
4:03015	3014	8	Double	Totalizer 1 (m^3)	R
4:03019	3018	8	Double	Totalizer 2/Batch (m^3)	R
4:03023	3022	4	Float	Totalizer 1 (m^3)	R
4:03025	3024	4	Float	Totalizer 2/Batch (m^3)	R

MASS

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:03001	3000	4	Float	Absolute Massflow (kg/s)	R
4:03003	3002	4	Float	Absolute Volumeflow (m^3/s)	R
4:03005	3004	4	Float	Absolute Density (kg/m^3)	R
4:03007	3006	4	Float	Sensor temperature (°C)	R
4:03009	3008	4	Float	Fraction A (kg/s)	R
4:03011	3010	4	Float	Fraction B (kg/s)	R
4:03013	3012	4	Float	% fraction A (%)	R
4:03015	3014	8	Double	Totalizer 1 (kg or m^3)	R
4:03019	3018	8	Double	Totalizer 2/Batch (kg or m^3)	R
4:03023	3022	4	Float	Totalizer 1 (kg or m^3)	R
4:03025	3024	4	Float	Totalizer 2/Batch (kg or m^3)	R
4:03100	3099	2	Byte	***Update rate set:***	R/W
				0 = Reserved	
				1 = All process data updated with 2 Hz	
				2 = Like set 1, but with Massflow 10 Hz	
				3 = Like set 2, but with Totalizers 5 Hz	

6.2 Modbus driver settings

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:00501	500	2	Word	No. of ParityErrors	R
4:00502	501	2	Word	No. of FramingErrors	R
4:00504	503	2	Word	No. of CRC Errors	R
4:00505	504	2	Word	No. of Ok Messages (received)	R
4:00508	507	4	Dword	InterFrameSpace (us)	R
4:00512	511	2	Word	Response Timeout (ms)	R/W
4:00513	512	2	Word	Response Delay (ms)	R/W
4:00514	513	2	Byte	10xInterFrameSpace (10 x chars)	R/W
4:00515	514	4	Dword	Baudrate as double word	R
4:00528	528	2	Byte	Device address (1 - 247)	R/W
4:00529	529	2	Byte	***Baudrate:***	R/W
				0 = 1200	
				1 = 2400	
				2 = 4800	
				3 = 9600	
				4 = 19200	
				5 = 38400	
				6 = 57600	
				7 = 76800	
				8 = 115200	
4:00530	530	2	Byte	***Parity/framing:***	R/W
				0 = 8, E, 1	
				1 = 8, O, 1	
				2 = 8, N, 2	
				3 = 8, N, 1	

6.3 Modbus application settings

Slave ID

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:00601	600	2	Byte	***Slave ID:*** 0x2A = Siemens	R
4:00602	601	2	Byte	***Run indicator:*** 0x00 = not running 0xFF = running	R
4:00603	602	2	Byte	***Product code:*** 24 = MAG 6000 25 = MASS 6000	R
4:00604	603	3	Byte array	Capability bits	R
4:00606	605	2	Word	***Flowmeter revision:*** e.g. 0x0201 = v2.01	R
4:00607	606	2	Word	***Modbus revision:*** e.g. 0x0201 = v2.01	R
4:00608	607	12	String	Manufacturer name	R
4:00614	613	18	String	Product name	R
4:00623	622	12	String	Modbus module name	R

TAG

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:00641	640	18	String	TAG	R/W

Modbus module version

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:00650	649	20	String	***Modbus module SW version:*** e.g. „1.00“	R
4:00660	659	2	Byte	***Modbus module HW version:*** e.g. „2“	R

Modbus error reporting

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:00681	680	2	word	Last Coil Error (CoilAddr) (Modbus cmd: 1 or 5)	R
4:00682	681	2	word	Last Coil Error (ErrorNo) (See appendix E)	R
4:00683	682	2	word	Last HoldReg Error (HoldReg Addr) (Modbus cmd: 3 or 16)	R
4:00684	683	2	word	Last HoldReg Error (ErrorNo) (See appendix E)	R

6.4 Basic settings

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02001	2000	2	Byte	***Flow direction:*** 0 = Negative 1 = Positive	R/W
4:02006	2005	4	Float	Q max. (m^3/s)	R/W
4:02008	2007	4	Float	Q max. 2 (Night) (m^3/s)	R/W
4:02026	2025	4	Float	***Low flow cut off:*** e.g. value 0,02 = 2 %	R/W
4:02030	2029	2	Byte	***Empty pipe on/off:*** 0 = Off 1 = On	R/W
4:02032	2031	2	Byte	***Error level:*** 1 = Warning 2 = Permanent 3 = Fatal	R/W
4:02033	2032	2	Byte	***Zero adjust mode[1]:*** 0 = Auto 1 = Manual	R/W
4:02034	2033	4	Float	Manual zero adjust[1] (ms/s)	R/W
4:02041	2040	2	Byte	***Mains Frequency*** 0 = 50 Hz 1 = 60 Hz	R/W

[1] Only available in MAG 6000 SV

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02001	2000	2	Byte	***Flow direction:*** 0 = Negative 1 = Positive	R/W
4:02002	2001	4	Float	Massflow max. (kg/s)	R/W
4:02004	2003	4	Float	Volumeflow max. (m^3/s)	R/W
4:02010	2009	4	Float	Density min. (kg/m^3)	R/W
4:02012	2011	4	Float	Density max. (kg/m^3)	R/W
4:02014	2013	4	Float	Sensor temperature min. (°C)	R/W
4:02016	2015	4	Float	Sensor temperature max. (°C)	R/W
4:02018	2017	4	Float	Fraction A max. (kg/s)	R/W
4:02020	2019	4	Float	Fraction B max. (kg/s)	R/W
4:02022	2021	4	Float	% fraction A min. (1/100 %) e.g. value 0.05 = 5 %	R/W
4:02024	2023	4	Float	% fraction A max. (1/100 %) e.g. value 0.8 = 80 %	R/W
4:02026	2025	4	Float	***Low flow cut off:*** (1/100 %) e.g. value = 0,02 = 2 %	R/W
4:02028	2027	4	Float	Empty pipe limit (kg/m^3)	R/W
4:02030	2029	2	Byte	***Empty pipe on/off:*** 0 = Off 1 = On	R/W
4:02031	2030	2	Byte	***Noise filter:*** 1 = min. 2 3 4 5 = max.	R/W
4:02032	2031	2	Byte	***Error level:*** 1 = Warning 2 = Permanent 3 = Fatal	R/W
4:02033	2032	2	Byte	***Zero adjust mode:*** 0 = Auto 1 = Manual	R/W
4:02034	2033	4	Float	Manual zero adjust (kg/s)	R/W
4:02036	2035	2	Word	Zero adjust time (s)	R/W
4:02037	2036	4	Float	Zero sigma (kg/s)	R
4:02039	2038	4	Float	Zero sigma limit (kg/s)	R/W

6.5 Totalizer

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02102	2101	2	Byte	***Totalizer 1 direction:*** 0 = Reverse 1 = Forward 2 = Net	R/W
4:02104	2103	2	Byte	***Totalizer 2 direction:*** 0 = Reverse 1 = Forward 2 = Net	R/W

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02101	2100	2	Byte	***Totalizer 1 selection:*** 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow	R/W
4:02102	2101	2	Byte	***Totalizer 1 direction:*** 0 = Reverse 1 = Forward 2 = Net	R/W
4:02103	2102	2	Byte	***Totalizer 2 selection:*** 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow	R/W
4:02104	2103	2	Byte	***Totalizer 2 direction:*** 0 = Reverse 1 = Forward 2 = Net	R/W

6.6 Output

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02201	2200	2	Byte	***Current Output 1 selection:*** 0 = Off 1 = On	R/W
4:02202	2201	2	Byte	***Current Output 1 direction:*** 1 = Unidirectional 2 = Bidirectional	R/W
4:02203	2202	2	Byte	***Current Output 1 range:*** 0 = 0 - 20 mA 1 = 4 - 20 mA 2 = 4 - 20 mA + Alarm	R/W
4:02204	2203	4	Float	Current Output 1 time constants	R/W
4:02206	2205	2	Byte	***Digital Output 1 function:*** 0 = Off 1 = Pulse 2 = Frequency 3 = Error Level 4 = Error Number 5 = Direction/Limit 6 = Batch	R/W
4:02208	2207	2	Byte	***Pulse 1 direction:*** 1 = Unidirectional 2 = Bidirectional	R/W

6.6 Output *(continued)*

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02209	2208	2	Byte	***Pulse 1 width:*** 0 = 64 us 1 = 130 us 2 = 260 us 3 = 510 us 4 = 1.0 ms 5 = 2.0 ms 6 = 4.1 ms 7 = 8.2 ms 8 = 16 m 9 = 33 ms 10 = 66 ms 11 = 130 ms 12 = 260 ms 13 = 520 ms 14 = 1.0 s 15 = 2.1 s 16 = 4.2 s	R/W
4:02212	2211	2	Byte	Frequency 1 Direction 1 = Unidirectional 2 = Bidirectional	R/W
4:02213	2212	2	Byte	Frequency 1 Fmax. 0 = 10 kHz 1 = 5 kHz 2 = 1 kHz 3 = 500 Hz	R/W
4:02214	2213	4	Float	Frequency 1 Timeconstants	R/W
4:02217	2216	2	Byte	***Limit Digital mode:*** 0 = 1 setpoint 1 = 2 setpoints	R/W
4:02218	2217	4	Float	Limit Digital Setpoint min. (1/100%)	R/W
4:02220	2219	4	Float	Limit Digital Setpoint max. (1/100%)	R/W
4:02222	2221	4	Float	Limit Digital Hysteresis (1/100%)	R/W
4:02224	2223	2	Byte	***Relay Output 1 function:*** 0 = Off 3 = Error Level 4 = Error Number 5 = Direction/Limit 6 = Batch 7 = Cleaning	R/W
4:02226	2225	2	Byte	***Limit Relay mode:*** 0 = 1 setpoint 1 = 2 setpoints	R/W
4:02227	2226	4	Float	Limit Relay Setpoint min. (1/100%)	R/W
4:02229	2228	4	Float	Limit Relay Setpoint max. (1/100%)	R/W
4:02231	2230	4	Float	Limit Relay Hysteresis (1/100%)	R/W
4:02233	2232	2	Byte	Error number (0-255)	R/W
4:02235	2234	4	Float	Batch Quantity (m^3)	R/W
4:02237	2236	4	Float	Batch Compensation (m^3)	R/W
4:02241	2240	2	Byte	***Batch Time error on/off:*** 0 = Off 1 = On	R/W
4:02242	2241	4	Dword	Max. Batch time (s)	R/W
4:02244	2243	2	Byte	***Batch overrun on/off:*** 0 = Off 1 = On	R/W
4:02245	2244	4	Float	Batch overrun error (m^3)	R/W
4:02247	2246	2	Byte	Batch counter up/down 0 = Down 1 = Up	R/W
4:02248	2247	4	Float	Batch Time constants	R/W
4:02250	2249	4	Dword	Batch cycle counter	R
4:02291	2290	4	Float	Volume per pulse (m^3)	R/W
4:02293	2292	2	Byte	Pulse Polarity 0 = Negative 1 = Positive	R/W
4:02294	2293	4	Float	Pulse Timeout(s)	R/W

6.6 Output *(continued)*

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02201	2200	2	Byte	***Current Output 1 selection:*** 0 = Off 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow 5 = Sensor temp. 6 = Density 7 = % fraction A	R/W
4:02202	2201	2	Byte	***Current Output 1 direction:*** 1 = Unidirectional 2 = Bidirectional	R/W
4:02203	2202	2	Byte	***Current Output 1 range:*** 0 = 0 - 20 mA 1 = 4 - 20 mA 2 = 4 - 20 mA + Alarm	R/W
4:02204	2203	4	Float	Current Output 1 Time constants	R/W
4:02206	2205	2	Byte	***Digital Output 1 function:*** 0 = Off 1 = Pulse 2 = Frequency 3 = Error Level 4 = Error Number 5 = Direction/Limit 6 = Batch	R/W
4:02207	2206	2	Byte	***Pulse 1 selection:*** 0 = Uninitialized 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow	R/W
4:02208	2207	2	Byte	***Pulse 1 direction:*** 1 = Unidirectional 2 = Bidirectional	R/W
4:02209	2208	2	Byte	***Pulse 1 width:*** 0 = 64 us 1 = 130 us 2 = 260 us 3 = 510 us 4 = 1.0 ms 5 = 2.0 ms 6 = 4.1 ms 7 = 8.2 ms 8 = 16 ms 9 = 33 ms 10 = 66 ms 11 = 130 ms 12 = 260 ms 13 = 520 ms 14 = 1.0 s 15 = 2.1 s 16 = 4.2 s	R/W
4:02211	2210	2	Byte	***Frequency 1 selection:*** 0 = Off (read only) 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow 5 = Sensor temp. 6 = Density 7 = % fraction A	R/W
4:02212	2211	2	Byte	Frequency 1 Direction 1 = Unidirectional 2 = Bidirectional	R/W
4:02213	2212	2	Byte	Frequency 1 Fmax. 0 = 10 kHz 1 = 5 kHz 2 = 1 kHz 3 = 500 Hz	R/W

6.6 Output *(continued)*

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02214	2213	4	Float	Frequency 1 Timeconstants	R/W
4:02216	2215	2	Byte	***Limit Digital selection:*** 0 = Off (read only) 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow 5 = Sensor temp. 6 = Density 7 = % fraction A	R/W
4:02217	2216	2	Byte	***Limit Digital mode:*** 0 = 1 setpoint 1 = 2 setpoints	R/W
4:02218	2217	4	Float	Limit Digital Setpoint min. (1/100%)	R/W
4:02220	2219	4	Float	Limit Digital Setpoint max. (1/100%)	R/W
4:02222	2221	4	Float	Limit Digital Hysteresis (1/100%)	R/W
4:02224	2223	2	Byte	***Relay Output 1 function:*** 0 = Off 3 = Error Level 4 = Error Number 5 = Direction/Limit	R/W
4:02225	2224	2	Byte	***Limit Relay selection:*** 0 = Off 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow 5 = Sensor temp. 6 = Density 7 = % fraction A	R/W
4:02226	2225	2	Byte	***Limit Relay mode:*** 0 = 1 setpoint 1 = 2 setpoints	R/W
4:02227	2226	4	Float	Limit Relay Setpoint min. (1/100%)	R/W
4:02229	2228	4	Float	Limit Relay Setpoint max. (1/100%)	R/W
4:02231	2230	4	Float	Limit Relay Hysteresis (1/100%)	R/W
4:02233	2232	2	Byte	Error number (0-255)	R/W
4:02234	2233	2	Byte	***Batch selection:*** 0 = Off (read only) 1 = Massflow 2 = Fraction A 3 = Fraction B 4 = Volumeflow	R/W
4:02235	2234	4	Float	Batch Quantity (kg or m^3)	R/W
4:02237	2236	4	Float	Batch Compensation	R/W
4:02239	2238	4	Float	Batch Lead constant	R/W
4:02241	2240	2	Byte	***Batch Time error on/off:*** 0 = Off 1 = On	R/W
4:02242	2241	4	Float	Max. Batch time (s)	R/W
4:02244	2243	2	Byte	***Batch overrun on/off:*** 0 = Off 1 = On	R/W
4:02245	2244	4	Float	Batch overrun error (kg or m^3)	R/W
4:02247	2246	2	Byte	Batch counter up/down 0 = Down 1 = Up	R/W
4:02250	2249	4	Dword	Batch cycle counter	R
4:02291	2290	4	Float	Mass or Volume per pulse (kg or m^3)	R/W
4:02296	2295	2	Byte	***Quadratur:*** 0 = Off 1 = On	R/W

6.7 External input

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02301	2300	2	Byte	***Input Function:*** 0 = Off 1 = Start Batch 2 = Hold/Continue 3 = Stop Batch 4 = Zero Adjust 5 = Totalizer reset 6 = Force output 7 = Freeze output 8 = Qmax 2 (night) 9 = Manual cleaning	R/W
4:02302	2301	2	Byte	***Totalizer reset:*** 0 = Totalizer 1 1 = Totalizer 2 2 = Totalizer 1 + 2	R/W
4: 02303	2302	4	Float	Force output (1/100%)	R/W

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02301	2300	2	Byte	***Input selection:*** 0 = Off 1 = Start Batch 2 = Hold/Continue 3 = Stop Batch 4 = Zero Adjust 5 = Totalizer reset 6 = Force output 7 = Freeze output	R/W
4:02302	2301	2	Byte	***Totalizer reset:*** 0 = Totalizer 1 1 = Totalizer 2 2 = Totalizer 1 + 2	R/W
4: 02303	2302	4	Float	Force output (1/100%)	R/W

6.8 Sensor characteristics

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02401	2400	4	Float	Sensor size (m)	
4:02403	2402	4	Float	Calibration factor	
4:02405	2404	4	Float	Correction factor	
4:02421	2420	2	Byte	***Excitation frequency:*** 0 = 3.125 Hz (50 Hz) 1 = 6.25 Hz (50 Hz) 2 = 12.5 Hz (50 Hz) 3 = 25 Hz (50 Hz) 4 = 1.5625 Hz (50 Hz) 5 = 44 Hz (only SV) 6 = 2.0833 Hz 7 = 1.875 Hz (60 Hz) 8 = 3.75 Hz (60 Hz) 9 = 7.5 Hz (60 Hz) 10 = 15 Hz (60 Hz) 11 = 30 Hz (60 Hz)	

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02401	2400	4	Float	Sensor size (m)	R/W
4:02403	2402	4	Float	Calibration factor (us2/kg)	R/W
4:02405	2404	4	Float	Correction factor	R/W
4:02407	2406	4	Float	Sensor TC (1/100% / °C)	R/W
4:02409	2408	4	Float	Density parm. A (kg/m^3)	R/W
4:02411	2410	4	Float	Density parm. B (*10E6)	R/W
4:02413	2412	4	Float	Density TC (1/100% / °C)	R/W
4:02415	2414	4	Float	Density offset (kg/m^3)	R/W
4:02417	2416	4	Float	Density factor	R/W
4:02419	2418	4	Float	Table slope (kg/s)	R/W
4:02422	2421	4	Float	Fraction offset (kg/s)	R/W

6.9 Product identity

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02501	2500	20	String	Converter type	R
4:02511	2510	20	String	Converter code no.	R
4:02521	2520	20	String	Converter serial no.	R
4:02531	2530	20	String	Converter SW version	R
4:02541	2540	20	String	Sensor type	R
4:02551	2550	20	String	Sensor code no.	R
4:02561	2560	20	String	Sensor serial no.	R
4:02571	2570	20	String	Sensor size	R

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02501	2500	20	String	Converter type	R
4:02511	2510	20	String	Converter code no.	R
4:02521	2520	20	String	Converter serial no.	R
4:02531	2530	20	String	Converter SW version	R
4:02541	2540	20	String	Sensor type	R
4:02551	2550	20	String	Sensor code no.	R
4:02561	2560	20	String	Sensor serial no.	R
4:02571	2570	20	String	Sensor size	R
4:02581	2580	20	String	Customer code no.	R

6.10 Service info

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02701	2700	4	Double word	Operating time (s)	R
4:02703	2702	54	Byte array	Error pending list See appendix B	R
4:02730	2729	54	Byte array	Error log list See appendix B	R

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02701	2700	4	Double word	Operating time (s)	R
4:02703	2702	54	Byte array	USM II Error pending list See appendix B	R
4:02730	2729	54	Byte array	USM II Error log list See appendix B	R
4:02757	2756	4	Float	Driver signal (A)	R
4:02759	2758	4	Float	Pickup 1 amplitude (V)	R
4:02761	2760	4	Float	Pickup 2 amplitude (V)	R
4:02763	2762	4	Float	Sensor frequency (Hz)	R

6.11 Display settings

MAG 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02901	2900	2	Byte	***Language:*** 0 = English 1 = Deutsch 2 = Français 3 = Dansk 4 = Svenska 5 = Suomeksi 6 = Russian 7 = Español 8 = Italiano 9 = Português 10 = Polski	R/W
4:02902	2901	2	Byte	***Display line 1:*** 0 = Volumeflow 1 = Totalizer 1 2 = Totalizer 2	R/W
4:02903	2902	2	Byte	***Display line 2:*** 0 = Text for line 3 1 = Volumeflow 2 = Volumeflow % 3 = Q max. 4 = Totalizer 1 5 = Totalizer 2 6 = Batch cycle counter 7 = Sensor size 8 = Sensor type 9 = TAG number 10 = Operating time 11 = Q max. text	R/W
4:02904	2903	2	Byte	***Display line 3:*** 0 = Volumeflow 1 = Volumeflow % 2 = Q max. 3 = Totalizer 1 4 = Totalizer 2 5 = Batch cycle counter 6 = Sensor size 7 = Sensor type 8 = TAG number 9 = Operating time 10 = Q max. text	R/W
4:02907	2906	2	Byte	Volumeflow unit	R/W
4:02908	2907	2	Byte	Volumeflow point	R/W
4:02913	2912	2	Byte	Totalizer 1 unit	R/W
4:02914	2913	2	Byte	Totalizer 1 point	R/W
4:02915	2914	2	Byte	Totalizer 2 unit	R/W
4:02916	2915	2	Byte	Totalizer 2 point	R/W

6.11 Display settings *(continued)*

MASS 6000

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:02901	2900	2	Byte	***Language:*** 0 = English 1 = Deutsch 2 = Français 3 = Dansk 4 = Svenska 5 = Suomeksi 6 = Russian 7 = Español 8 = Italiano 9 = Português	R/W
4:02902	2901	2	Byte	***Display line 1:*** 0 = Massflow 1 = Volumeflow 2 = Fraction A 3 = Fraction B 4 = % Fraction A 5 = Totalizer 1 6 = Totalizer 2 7 = Sensor temperature 8 = Density	R/W
4:02903	2902	2	Byte	***Display line 2:*** 0 = Text for line 3 1 = Totalizer 2 2 = Massflow 3 = Massflow % 4 = Volumeflow 5 = Volumeflow % 6 = Fraction A text 7 = Fraction A 8 = Fraction A % 9 = Fraction B text 10 = Fraction B 11 = Fraction B % 12 = % Fraction A 13 = Density 14 = Sensor temperature 15 = Totalizer 1	R/W
4:02904	2903	2	Byte	***Display line 3:*** 1 = Massflow 2 = Massflow % 3 = Volumeflow 4 = Volumeflow % 5 = Fraction A text 6 = Fraction A 7 = Fraction A % 8 = Fraction B text 9 = Fraction B 10 = Fraction B % 11 = % Fraction A 12 = Density 13 = Sensor temperature 14 = Totalizer 1 15 = Totalizer 2	R/W
4:02905	2904	2	Byte	Massflow unit	R/W
4:02906	2905	2	Byte	Massflow point	R/W
4:02907	2906	2	Byte	Volumeflow unit	R/W
4:02908	2907	2	Byte	Volumeflow point	R/W
4:02909	2908	2	Byte	Fraction A + B unit	R/W
4:02910	2909	2	Byte	Fraction A point	R/W
4:02912	2911	2	Byte	Fraction B point	R/W
4:02913	2912	2	Byte	Totalizer 1 unit	R/W
4:02914	2913	2	Byte	Totalizer 1 point	R/W
4:02915	2914	2	Byte	Totalizer 2 unit	R/W
4:02916	2915	2	Byte	Totalizer 2 point	R/W
4:02917	2916	2	Byte	Density unit	R/W
4:02918	2917	2	Byte	Density point	R/W

6.12 Flowmeter status

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:03201	3200	2	Word	***System status:*** bit0=RunIndicator bit1=ErrorPendingOn bit2=ErrPendChanged bit3=Batching bit4=BatchPaused bit5=Zeroadjusting bit6=Totalizer1Hold bit7=Totalizer2Hold	R
4:03202	3201	2	Word	Error pending 1* (oldest/first error) 0xFFFF = no error	R
4:03203	3202	2	Word	Error pending 2*	R
4:03204	3203	2	Word	Error pending 3*	R
4:03205	3204	2	Word	Error pending 4*	R
4:03206	3205	2	Word	Error pending 5*	R
4:03207	3206	2	Word	Error pending 6*	R
4:03208	3207	2	Word	Error pending 7*	R
4:03209	3208	2	Word	Error pending 8*	R
4:03210	3209	2	Word	Error pending 9*	R
4:03211	3210	2	Byte	***Batch status*** 0 = Idle 1 = Ready 2 = Running 3 = Paused	R

***** Further information about the **Error pending numbers** can be found in the MAG/MASS 6000 manuals.

Zero adjust progress MAG

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:03212	3211	2	Byte	***Zero adjust progress*** 0 = Idle 1 = Ready 2 = Running	R

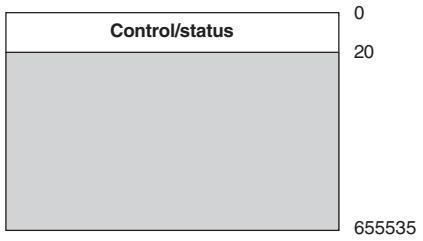
Zero adjust progress MASS

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:03212	3211	4	Float	Zero adjust progress (0-100 %)	R

7. Modbus coils

In the following the coils for the USM II Modbus RTU module are described.

Figure:
Memory map for coils



7.1 Communication settings

Modbus register	Modbus address	Data type	Description	Read/ write
0:00001	0	Coil	***Restart Modbus communication:*** *Write:* 0 = No effect 1 = Restart *Read:* always 0	R/W

7.2 Auto zero adjust

Modbus register	Modbus address	Data type	Description	Read/ write
0:00009	8	Coil	***Start auto zero adjust:*** *Write:* 0 = No effect *1 = StartRead:* 0 = Idle1 = Busy	R/W

7.3 Totalizer

Modbus register	Modbus address	Data type	Description	Read/ write
0:00010	9	Coil	***Reset totalizer 1:*** *Write:* 0 = No effect *1 = ResetRead:* always 0	R/W
0:00011	10	Coil	***Hold totalizer 1:*** *Write:* 0 = Run *1 = HoldRead:* 0 = Not held1 = Held	R/W
0:00012	11	Coil	***Reset totalizer 2:*** *Write:* 0 = No effect *1 = ResetRead:* always 0	R/W
0:00013	12	Coil	***Hold totalizer 2:*** *Write:* 0 = Run *1 = HoldRead:* 0 = Not held1 = Held	R/W

7.4 Batch

Modbus register	Modbus address	Data type	Description	Read/ write
0:00014	13	Coil	***Start Batch:*** *Write:* 0 = Stop Batch *1 = Start BatchRead:* 0 = Stopped1 = Not stopped	R/W
0:00015	14	Coil	***Pause Batch:*** *Write:* 0 = Resume Batch *1 = Pause BatchRead:* 0 = Not paused1 = Paused	R/W

APPENDIX A

SI-units used in USM II products

SITRANS F M MAGFLO®

Volume flow:	m^3/sec.
Totalisers:	m^3

SITRANS F C MASSFLO®

Mass flow:	kg/sec.
Volume flow:	m^3/sec.
Density:	kg/m^3
Temperature:	°C
Fraction (A, B):	kg/sec.
Fraction A pct:	% (percent)
Totalizer 1 & 2:	kg or m^3 depending on totalizer mode (i.e. mass flow or volume flow)
Batch:	same as totalizers

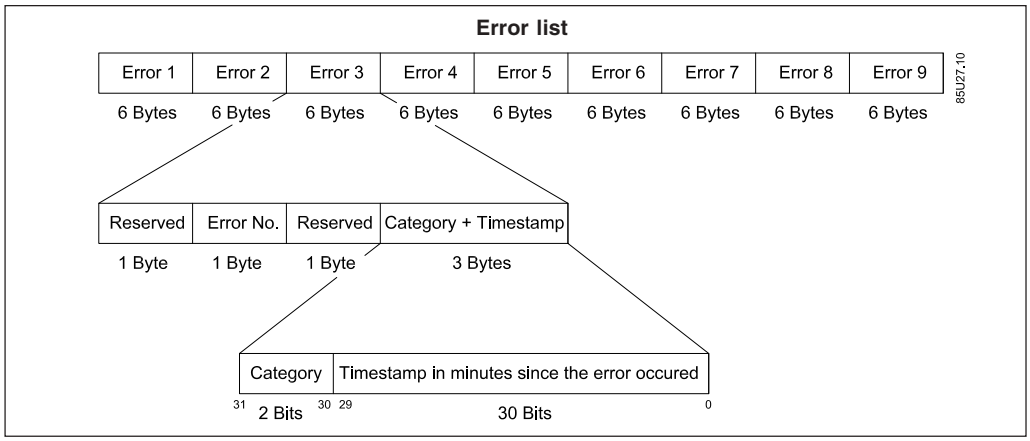
Note
°C for temperature is not strictly speaking an SI unit. This should be K (Kelvin), but K is of little practical significance to most users, hence the use of C (Celsius).

APPENDIX B

USM II Error Pending and Error Log

Reading Modbus address 2702 (USM II **Error Pending list**) and Modbus address 2729 (USM II **Error Log list**) provides detailed error information of the flowmeter.
The **Error Pending list** contains all actual errors and the **Error Log list** provides information of all previous errors. Both lists are structured as 9 error records, each consisting of 6 bytes.

New errors will be placed first on the list (Error 1) and the rest will be shifted down the list.



Error No.: A list of all error numbers can be found in the MAG/MASS manuals. No error is represented by 0x7F.

Category:
0: Information
1: Warning
2: Permanent
3: Fatal

Timestamp: Timestamp represents the time in minutes since the error occurred.

The following example is a reply containing the **Error Pending list**.

17,21,17,40,0,8,17,46,17,c0,0,8,7f,7f,ff,0,0,0,7f,7f,ff,0,0,0,7f,7f,ff,0,0,0,7f,7f,ff,0,0,0,7f,7f,ff,0,0,0,7f,7f,ff,0,0,0,7f,7f,ff,0,0,0,7f,7f,ff,0,0,0

As can be seen, there are two active errors:

17,21,17,40,0,8
Error No.: 33 (dec) = Temp. too low
Category: Warning
Timestamp: 8 minutes

17,46,17,c0,0,8
Error No.: 70 (dec) = Pickup phase
Category: Fatal
Timestamp: 8 minutes

Note
7f,7f,ff,0,0,0 means no error.

APPENDIX C

Modbus communication examples

01 (0x01) Read coil status

Query

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
No. of Points Hi	1 byte
No. of Points Lo	1 byte
CRC	2 bytes

Response

Slave address	1 byte
Function	1 byte
Byte Count	1 byte
Data Coil	1 byte
:	:
Data Coil	1 byte
CRC	2 bytes

Example:

Read Hold Totalizer 1 (0:00011)

Query: 1,1,0,10,0,1,221,200

Response: 1,1,1,0,81,136

03 (0x03) Read holding registers

Query

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
No. of Points Hi	1 byte
No. of Points Lo	1 byte
CRC	2 bytes

Response

Slave address	1 byte
Function	1 byte
Byte Count	1 byte
Data Hi	1 byte
Data Lo	1 byte
:	:
Data Hi	1 byte
Data Lo	1 byte
CRC	2 bytes

Examples

Read absolute mass flow (4:03001)

Query: 1,3,11,184,0,2,70,10

Response: 1,3,4,64,195,82,139,98,200

Absolute mass flow = 6.10383 kg/sec.

Read absolute density (4:03005)

Query: 1,3,11,188,0,2,7,203

Response: 1,3,4,68,54,162,145,182,1

Absolute density = 730.54010 kg/m^3

Read sensor temperature (4:03007)

Query: 1,3,11,190,0,2,166,11

Response: 1,3,4,189,216,115,34,251,77

Sensor temperature = –0.10569 °C

05 (0x05) Force single coil

Query

Slave address	1 byte
Function	1 byte
Coil Address Hi	1 byte
Coil Address Lo	1 byte
Force Data Hi	1 byte
Force Data Lo	1 byte
CRC	2 bytes

Response

Slave address	1 byte
Function	1 byte
Coil Address Hi	1 byte
Coil Address Lo	1 byte
Force Data Hi	1 byte
Force Data Lo	1 byte
CRC	2 bytes

Examples

Coil 0 (Restart Modbus communication)

To activate a new baudrate and parity/framing the coil 0 (restart Modbus communication) must be send. Otherwise a power down/up initiate a new baudrate and parity/framing:

Query: 1,5,0,0,255,0,140,58 (Set coil 0 to 0xFF00)

Receive: 1,5,0,0,255,0,140,58 (Restart Modbus communication)

---

16 (0x10) Write multiple registers

Query

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
No. of Registers Hi	1 byte
No. of Registers Lo	1 byte
Byte Count	1 byte
Data Hi	1 byte
Data Lo	1 byte
:	
Data Hi	1 byte
Data Lo	1 byte
CRC	2 bytes

Response

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
No. of Registers Hi	1 byte
No. of Registers Lo	1 byte
CRC	2 bytes

Examples

Set baud rate to 115200 baud

Query: 1,16,2,17,0,1,2,0,8,135,23 (115200 = value 8)

Receive: 1,16,2,17,0,1,80,116

To activate a new baudrate and parity/framing the coil 0 (Restart Modbus communication) must be send.
Otherwise a power down/up initiate a new baudrate and parity/framing:

Query: 1,5,0,0,255,0,140,58 (Set coil 0 to 0xFF00)

Receive: 1,5,0,0,255,0,140,58 (Restart Modbus communication)

17 (0x11) Report slave ID

Query

Slave address	1 byte
Function	1 byte
CRC	2 bytes

Response

Slave address	1 byte	
Function	1 byte	17 (0x11)
Byte count	1 byte	52 (0x34)
Slave ID	1 byte	0x2a = Siemens
Run indicator	1 byte	0 = Off, 0xFF = Running
Product code	1 byte	24 = MAG 6000, 25 = MASS 6000
Transmitter Code No.	9 bytes	e.g. „083H0222“
Capability bits	3 bytes	0x01, 0xFF, 0x00
Manufacturer name	12 bytes	„Siemens“
Product name	18 bytes	„MAG 6000“ or „MASS 6000“
Flowmeter major rev.	1 byte	e.g. 2
Flowmeter minor rev.	1 byte	e.g. 1
Modbus module name	11 bytes	„Modbus RTU“
Modbus major rev.	1 byte	e.g. 1
Modbus minor rev.	1 byte	e.g. 0
CRC	2 bytes	

Examples

Read report slave ID

Query: 1,11,c0,2c

Receive: 1,11,2a,ff,19,30,38,33,48,30,32,32,32,0,1,ff,0,53,69,65,6d,65,6e,73,0,0,0,0,0,
4d,41,53,53,36,30,30,30,0,54,0,0,2,1,4d,4f,44,42,55,53,20,52,54,55,
0,ff,1,2,3f,98

Address	=	1
Function code	=	17
Byte Count	=	55
Slave ID	=	0x2A
Run Indicator	=	0xFF
Product Code	=	25 (0x19)
Transmitter Code No.	=	083H0222
Capability bits	=	0x01, 0xFF, 0x00
Manufacturer name	=	Siemens
Product name	=	MASS 6000
Product major rev.	=	2
Product minor rev.	=	1
Modbus module name	=	Modbus RTU
Modbus module No.	=	0xFF
Modbus module major rev.	=	1
Modbus module minor rev.	=	2
CRC LO	=	0x3f
CRC HI	=	0x98

APPENDIX D

CRC calculation

The **C**yclical **R**edundancy **C**hecking (CRC) field is two bytes, containing a 16-bit binary value. The CRC value is first generated by the transmitting device, which appends the CRC to the message. The device that receives recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.

There are many ways of calculating a CRC checksum. To ensure correct calculation, please refer to [Reference 1] Modbus over serial line, where detailed descriptions and programming examples are available. Even more information and programming examples in different programming languages can be found on: www.modbus.org searching for CRC.

Below is a short text description of how the CRC is calculated. This description is then followed by a C programming example.

CRC calculation:

1. Load a 16-bit register with FFFF hex (all 1's). Call this the CRC register.
2. Exclusive **OR** the first 8-bit byte of the message with the low-order byte of the 16-bit CRC register, putting the result in the CRC register.
3. Shift the CRC register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.
4. (If the LSB was 0): Repeat step 3 (another shift).
   (If the LSB was 1): Exclusive OR the CRC register with the polynomial value 0xA001 (1010 0000 0000 0001).
5. Repeat steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
6. Repeat steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.
7. The final content of the CRC register is the CRC value.
8. When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.

Placing the CRC into the Message
When the 16-bit CRC (two 8-bit bytes) is transmitted in the message, the low-order byte will be transmitted first, followed by the high-order byte.
For example, if the CRC value is 1241 hex (0001 0010 0100 0001):

Addr	Func	Data Count	Data n	Data n + 1	Data n + 2	Data n + x	CRC LO	CRC HI
							0x41	0x12

C programming example

```
/* Table of CRC values for high-order byte */
static __flash unsigned char auchCRCHi[] = {
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40
} ;

/* Table of CRC values for low-order byte */
static __flash char auchCRCLo[] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE,
0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80,
0x40
} ;

unsigned short int CRC16(unsigned char *puchMsg, unsigned short int usDataLen)
{
   unsigned char uchCRCHi = 0xFF; /* high byte of CRC initialized */
   unsigned char uchCRCLo = 0xFF; /* low byte of CRC initialized */
   unsigned uIndex ;              /* will index into CRC lookup table */
   while(usDataLen—)              /* pass through message buffer */
   {
      uIndex = uchCRCHi ^ *puchMsg++ ; /* calculate the CRC */
      uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex] ;
      uchCRCLo = auchCRCLo[uIndex] ;
   }
   #ifdef INTEL_LIKE_PROCESSOR
     return (unsigned short int)((uchCRCLo << 8) | uchCRCHi);
   #else
     return (unsigned short int)((uchCRCHi << 8) | uchCRCLo);
   #endif
}
```

APPENDIX E

Exception codes

The Modbus module uses the following Modbus exception codes, when responding to a **master** module:

Exception code (Dec)	Exception name
01	Illegal function
02	Illegal data address
03	Illegal data value
04	Slave device failure
06	Device busy

If an exception code 04 is received, further requests have to be done to narrow down the exact problem.

If any doubts about the address that failed, „**Last Coil/HoldReg ErrorAddr**“ can be read. This will return the faulty address.

Modbus register	Modbus address	No. of bytes	Data type	Description	Read/ write
4:00681	680	2	Word	Last Coil ErrorAddr (Modbus cmd: 1 or 5)	R
4:00682	681	2	Word	Last Coil ErrorNo (127 = No error)	R
4:00683	682	2	Word	Last HoldReg ErrorAddr (Modbus cmd: 3 or 16)	R
4:00684	683	2	Word	Last HoldReg ErrorNo (127 = No error)	R

Reading „**Last Coil/HoldReg ErrorNo**“ will return a detailed error reason. A list of error numbers can be seen below.

Error Number (Dec)	Error Number (Hex)	Error name	Reason
3	3	Write access denied	This parameter is in a state where it is not writable
4	4	Max. limit	The value was greater than the allowed maximum value
5	5	Min. limit	The value was less than the allowed minimum value
127	7F	No error	No problem

APPENDIX F

Run Indicator

The **Run Indicator** indicates the state of the device. Two states are possible: ON (0xFF) and OFF (0x00). The device will be in state ON, unless a serious error is present.

The following errors can turn the state to OFF:

- When a ***„Fatal Error“*** is active on the ***„Error Pending List“***
- Boot up problems when powering up the flowmeter.
- If no measurement are delivered or the time between them is too high.

The last condition will be based on the following:
Only the internally broadcasted flow-value is checked. The expected broadcast-rate is read at power up. If a broadcast is not received after 10 times the expected broadcast rate, the broadcast rate is re-read from the USM (it may have been changed since power up). If the broadcast rate was not changed (and the rate was not zero), the **Run Indicator** is set OFF. Reception of ten broadcasted (flow-) values within 10 times the expected window will set the run-indicator TRUE again.

APPENDIX G - Units and Point positions

Volumeflow units

0 m3/s	1 ml/s	2 L/s	3 hl/s	4 kl/s	5 Ml/s	6 m3/s	7 m3/s	8 ft3/s	9 in3/s	10 USGPS	11 USMGPS	12 UKGPS	13 UKMGPS	14 USkGPS	15 UKkGPS
16 m3/min	17 ml/min	18 L/min	19 hl/min	20 kl/min	21 Ml/min	22 m3/min	23 m3/min	24 ft3/min	25 in3/min	26 USGPM	27 USMGPM	28 UKGPM	29 UKMGPM	30 USkGPM	31 UKkGPM
32 m3/h	33 ml/h	34 L/h	35 hl/h	36 kl/h	37 Ml/h	38 m3/h	39 m3/h	40 ft3/h	41 in3/h	42 USGPH	43 USMGPH	44 UKGPH	45 UKMGPH	46 USkGPH	47 UKkGPH
48 m3/d	49 ml/d	50 L/d	51 hl/d	52 kl/d	53 Ml/d	54 m3/d	55 m3/d	56 ft3/d	57 in3/d	58 USGPD	59 USMGPD	60 UKGPD	61 UKMGPD	62 USkGPD	63 UKkGPD

64 - 255: Reserved

Massflow unit

0 kg/s	1 ton/s	2 lb/s	3 mg/s	4 g/s	5 kg/s	6 kg/s	7 kg/s	8 kg/s	9 kg/s	10 kg/s	11 kg/s	12 kg/s	13 kg/s	14 kg/s	15 kg/s
16 kg/min	17 ton/min	18 lb/min	19 mg/min	20 g/min	21 kg/min	22 kg/min	23 kg/min	24 kg/min	25 kg/min	26 kg/min	27 kg/min	28 kg/min	29 kg/min	30 kg/min	31 kg/min
32 kg/h	33 ton/h	34 lb/h	35 mg/h	36 g/h	37 kg/h	38 kg/h	39 kg/h	40 kg/h	41 kg/h	42 kg/h	43 kg/h	44 kg/h	45 kg/h	46 kg/h	47 kg/h
48 kg/d	49 ton/d	50 lb/d	51 mg/d	52 g/d	53 kg/d	54 kg/d	55 kg/d	56 kg/d	57 kg/d	58 kg/d	59 kg/d	60 kg/d	61 kg/d	62 kg/d	63 kg/d

64 - 255: Reserved

Density unit

0 kg/m3	1 ton/m3	2 Lb/m3	3 mg/m3	4 g/m3	5 kg/ m3	6 kg/ m3	7 kg/ m3	8 kg/ m3	9 kg/ m3	10 kg/ m3	11 kg/ m3	12 kg/ m3	13 kg/ m3	14 kg/ m3	15 kg/ m3
16 kg/ft3	17 ton/ft3	18 lb/ft3	19 mg/ft3	20 g/ft3	21 kg/ft3	22 kg/ft3	23 kg/ft3	24 kg/ ft3	25 kg/ ft3	26 kg/ ft3	27 kg/ ft3	28 kg/ ft3	29 kg/ ft3	30 kg/ ft3	31 kg/ ft3
32 kg/in3	33 ton/in3	34 lb/ in3	35 mg/ in3	36 g/ in3	37 kg/ in3	38 kg/ in3	39 kg/ in3	40 kg/ in3	41 kg/ in3	42 kg/ in3	43 kg/ in3	44 kg/ in3	45 kg/ in3	46 kg/ in3	47 kg/ in3
48 kg/cm3	49 ton/cm3	50 lb/cm3	51 mg/cm3	52 g/cm3	53 kg/cm3	54 kg/cm3	55 kg/cm3	56 kg/cm3	57 kg/cm3	58 kg/cm3	59 kg/cm3	60 kg/cm3	61 kg/cm3	62 kg/cm3	63 kg/cm3

64 - 255: Reserved

Totalizer unit volume

0 M3	1 Ml	2 l	3 hl	4 kl	5 Ml	6 m3	7 m3	8 ft3	9 in3	10 USG	11 USMG	12 UKG	13 UKMG	14 USkG	15 UKkG

16 - 254: Reserved

Totalizer unit massflow

0 kg	1 ton	2 lb	3 Mg	4 G

5 - 255: Reserved

Point position

0	=	no digits after the decimal point
1	=	one digit after the decimal point
2	=	two digits after the decimal point
3	=	three digits after the decimal point
4	=	four digits after the decimal point
5	=	five digits after the decimal point
6	=	six digits after the decimal point

7 - 255: Reserved

APPENDIX H

Float Definition

Stuffing of multi-byte numbers into multiple Modbus RTU registers differs among Modbus devises.

„**Big Endian**“ and „**Little Endian**“ describe the order or sequence in which multi-byte data is stored in memory. This device uses (as IEEE and Honeywell) a ‘**Big-Endian**’ representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the **MOST** significant byte is sent first.

Value (decimal)	IEEE FP B MSB LSB	Register N high	Register N low	Register N + 1 high	Register N + 1 low
100.0	42C80000h	42h	C8h	00h	00h
55.32	425D47AEh	42h	5Dh	47h	AEh
2.0	40000000h	40h	00h	00h	00h
1.0	3F800000h	3Fh	80h	00h	00h
-1.0	BF800000h	bFh	80h	00h	00h

Read absolute massflow (4:03001)

Query: 01,03,0B,B8,00,02,46,0A

Response: 01,03,04,**40,C3,52,93**,62,C8

Absolute massflow = 6.10383 kg/s

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are always welcomed.

Technical data subject to change without prior notice.

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Order no.: FDK:521H1183-02
Printed in: Denmark