

SIEMENS

SITRANS F

Communication Modules Modbus RTU RS 485

Operating Instructions


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FDK-085U0234 (MODBUS RTU module)


Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

 DANGER
indicates that death or severe personal injury will result if proper precautions are not taken.

 WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.

 CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.


If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

 WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Introduction

1.1 Purpose of the Operating Instructions

Purpose

The Operating Instructions provide all information necessary for the installation and use of the Modbus RTU add-on module (FDK-085U0234), intended for use with the Siemens Flow Instruments USM-II family of transmitters presently including SITRANS FM MAG 6000 and SITRANS FC MASS 6000.

Basic knowledge required

The instructions are 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 communication, especially in respect of master station configuration and operation. However an overview is included in the following section to explain some fundamental aspects of the protocol.

See also

For more information about SITRANS FC and SITRANS FM transmitters and sensors, please refer to the appropriate Operating Instructions available on the flowdocumentation homepage (<http://www.siemens.com/flowdocumentation>) or on the SITRANS F literature CD-ROM.

1.2 Document history

The contents of these instructions are regularly reviewed and corrections are included in subsequent editions. We welcome all suggestions for improvement.

The following table shows the most important changes in the documentation compared to each previous edition.

Edition	Remarks
03/2021	Changes to the available customer units for MAG 6000
06/2010	Revision 04: Contents restructured

1.3 Modbus RTU technology

Modbus RTU is an open, serial (RS-232 or RS-485) protocol based on master/slave or client/server architecture. The protocol interconnects field equipment such as sensors, actuators, and controllers and is widely used in both process and manufacturing automation. The fieldbus environment is the base level group of digital networks in the hierarchy of plant networks.

Features

The SITRANS F Modbus RTU Communication modules comply with the MODBUS Serial Line Protocol. Among other things this implies a Master-Slave protocol at level 2 of the OSI model. A 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.

Communication modes

Two modes of communication are possible, Unicast and Broadcast.

- In unicast mode the Master sends a request to a specific Slave device, and waits a specified time for a response.

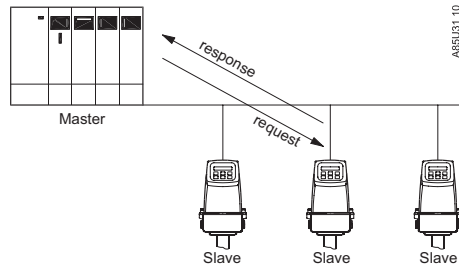


Figure 1-1 Unicast Communication Mode

- 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 is no response from the Slave devices.

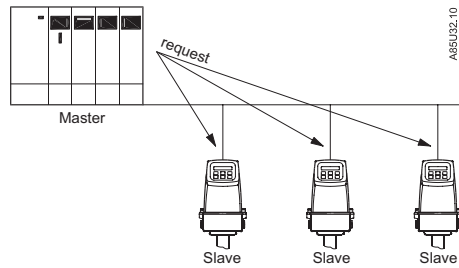


Figure 1-2 Broadcast Communication Mode

Modbus Frame

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

Table 1-1 Modbus Frame

SLAVE ADDRESS	FUNCTION MODE	DATA	CRC
1 Byte	1 Byte	0 ... 252 Bytes	2 Bytes

References

For further information, please refer to the following specification and guidelines available at the Modbus Organisation (<http://www.modbus.org/>) Website

1. Serial Line Specification & Implementation guide v. 1.0
2. Application Protocol Specification v. 1.1

1.4 Further Information

The contents of these Operating Instructions shall not become part of or modify any prior or existing agreement, commitment or legal relationship. All obligations on the part of Siemens AG are contained in the respective sales contract which also contains the complete and solely applicable warranty conditions. Any statements contained herein do not create new warranties or modify the existing warranty.

Product information on the Internet

The Operating Instructions are available on the CD-ROM shipped with the device, and on the Internet on the Siemens homepage, where further information on the range of SITRANS F flowmeters may also be found:

Product information on the internet (<http://www.siemens.com/flow>)

Worldwide contact person

If you need more information or have particular problems not covered sufficiently by the operating instructions, please get in touch with your contact person. You can find contact information for your local contact person on the Internet:

Local contact person (<http://www.automation.siemens.com/partner>)

Safety notes

**CAUTION**

Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance. Only qualified personnel should install or operate this instrument.

Note

Alterations to the product, including opening or improper repairs of the product, are not permitted.

If this requirement is not observed, the CE mark and the manufacturer's warranty will expire.

2.1 Installation in hazardous area

**WARNING**

NOT allowed for use in hazardous areas!

Equipment used in hazardous areas must be Ex-approved and marked accordingly!

This device is NOT approved for use in hazardous areas!

2.1 Installation in hazardous area

Installing/mounting

This chapter describes the HW installation procedure for the add-on module on Siemens Flow Instruments USM-II transmitters.

The Module can be installed into SITRANS FC MASS 6000 and SITRANS FM MAG 6000 transmitters.

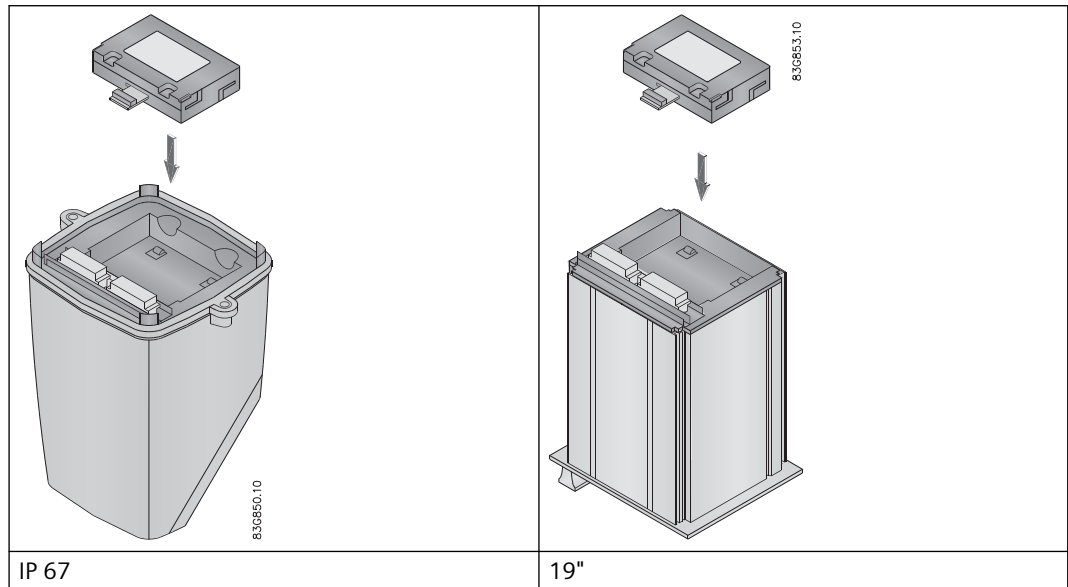
Note**Not allowed for use in hazardous areas**

The Communication module is NOT allowed for use in hazardous areas.

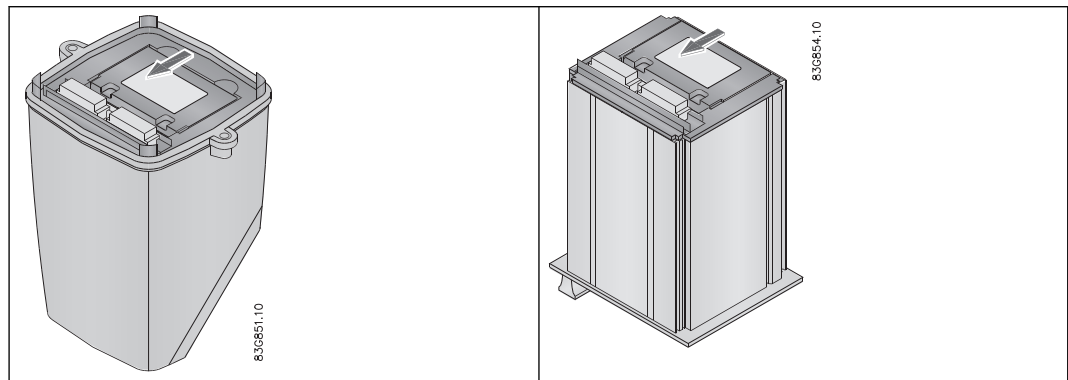
3.1 MAG/MASS 6000 IP67 or 19"

The installation of the add-on module on transmitter types SITRANS FM MAG 6000 IP67, SITRANS FM MAG 6000 19", SITRANS FC MASS 6000 IP67 and SITRANS FC MASS 6000 19" is carried out as follows:

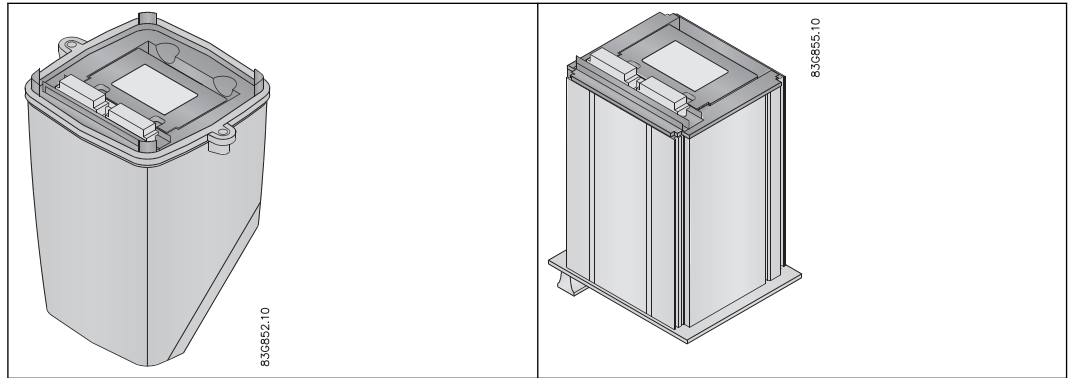
1. Insert the add-on module in the rear end of the transmitter



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



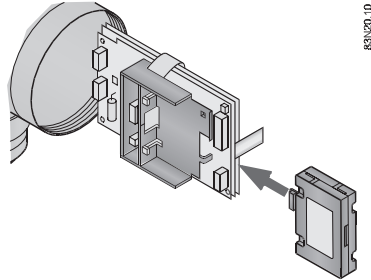
3. The installation is completed



3.2 MAG 6000 I

The installation of the add-on module on a SITRANS FM MAG 6000 I is completed as follows:

1. Open the transmitter

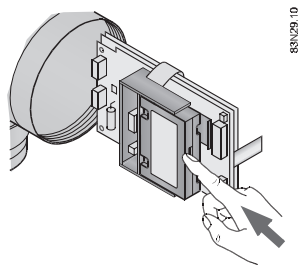


⚠ WARNING

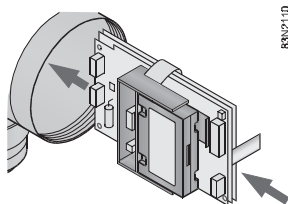
Electric shock

Do not open the transmitter while power is on.

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



3. Reinsert the complete transmitter module



⚠ WARNING

Installation in hazardous area

The communication module is NOT approved for use in hazardous area.

3.3 MASS 6000 Ex d

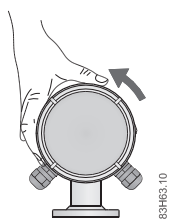
⚠ WARNING

Installation in hazardous area

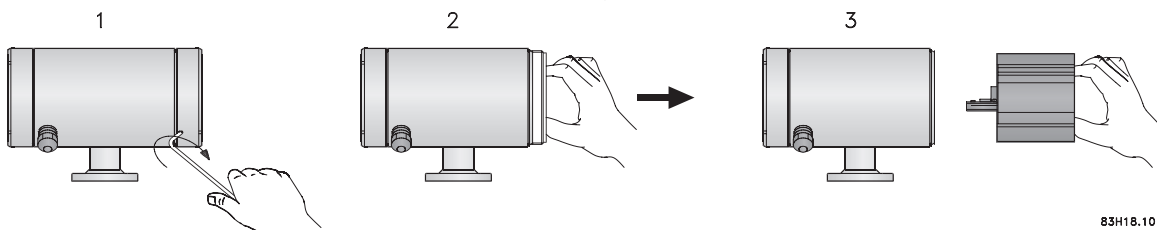
The communication module is NOT approved for use in hazardous area.

The installation of the add-on module on a SITRANS F C MASS 6000 Ex d is completed as follows:

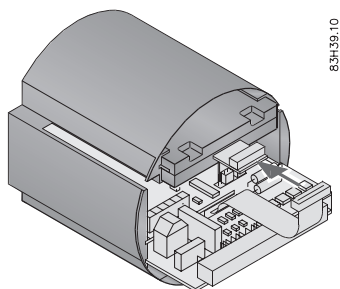
1. Disconnect the equipment from the supply circuits
2. Remove the rear cover by loosening the safety tap allen screw and turn the rear cover counter-clockwise



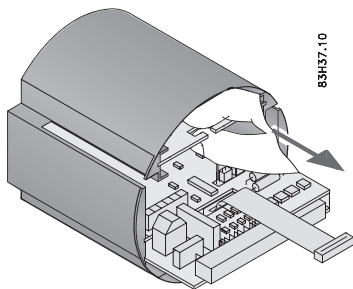
3. Remove the electronics using the holes provided



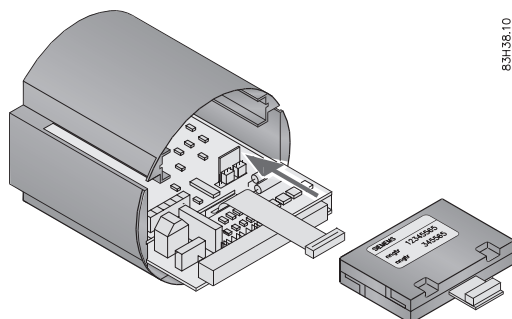
4. Remove the flat cable from the plate



5. Remove the plate from the module bay



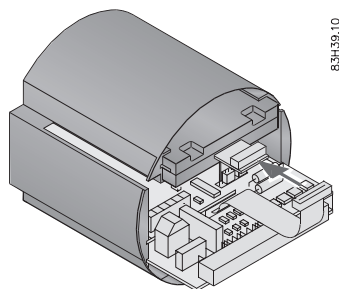
6. Insert the add-on module as shown.



Note

The label on the add-on module must face upwards and the connector outwards

7. Press the add-on module into position and connect the flat cable connector.



Connecting

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.

Additional 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. Any existing transmitter electrical connections remain undisturbed. The MASS 6000 with extra outputs, i.e. 3 current outputs, cannot be extended with an add-on module



Only authorized personnel are allowed to carry out work on electrical connections.

Please refer to the relevant product operating instruction for other electrical connection information.

Note

Shielding

Always shield a Modbus over Serial Line Cable. At one end of each cable its shield must be connected to protective ground. If a connector is used at this end, the shell of the connector is connected to the shield of the cable.

Note

Cable specifications

A RS 485-Modbus must use a balanced pair (for D0-D1) and a third wire (for the ground reference). For the balanced pairs used in an RS 485-system, a Characteristic Impedance with a value between 100 and 120 Ohms must be used.

4.1 Wiring

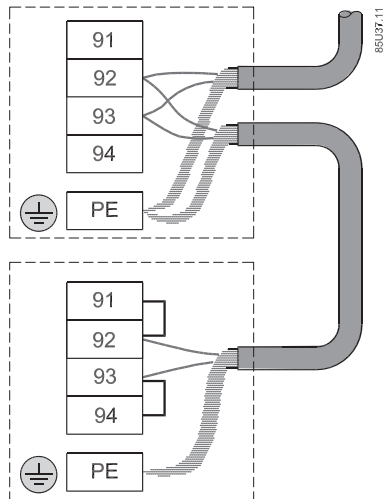


Figure 4-1 Modbus USMII connection

Table 4-1 Connection layout

Terminal number	MODBUS RTU RS485
91	T1
92	Data +
93	Data -
94	T2
PE	Shield

Note

Termination

Connecting 91,92 and 93,94 will add termination. This must be carried out if the device is the last on the segment.

System integration

This chapter provides information on how to integrate the flowmeter in a Modbus RTU automation and control system.

The chapter shows the necessary steps in order to put the system into operation. After finishing the steps, the system is ready to go into normal operation in the Modbus RTU automation control system.

Transmitter settings

All Modbus settings of the transmitter are stored in the add-on module in a non-volatile memory. All other transmitter settings are stored in the memory unit of the transmitter.

Note

If the communication module is replaced, all communication settings must be downloaded from the master to the device.

Device Tag and address

The transmitter is shipped with a default device tag containing device name and serial number. Each Modbus device has a unique physical device tag. A device tag is assigned to the device when it is commissioned and it retains the tag in its memory when it is disconnected.

All devices are shipped with a temporary address that allows the host to automatically commission the transmitter. The network address is the current device address used by the fieldbus.

Note

It is recommended NOT to use the default address in a multi-slave network. It is of great importance to ensure that no devices have the same address. Otherwise an abnormal behaviour of the whole serial bus can occur, the master being unable to communicate with all present slaves on the bus.





5.1 Function check

Before proceeding further, make sure that installation and connection have been performed successfully.

- See chapter "Hardware installation (Page 11)" for installation verification.
- See chapter "Connecting (Page 17)" for connection verification.

When the function check has been successfully carried out, the device can be switched on.

5.2 Navigating the Modbus display menu

1. Power up the device. If the device has been installed correctly a new menu entry has appeared in the local user interface of the device (between the "Reset mode" and the "Service mode" menu entries.)
2. Navigate the new menu:
 - Press  for two seconds. The display now says "Basic settings"
 - Press  until you reach the "MODBUS RTU module" menu entry
 - Press 
 - Cycle through the MODBUS RTU settings by pressing .

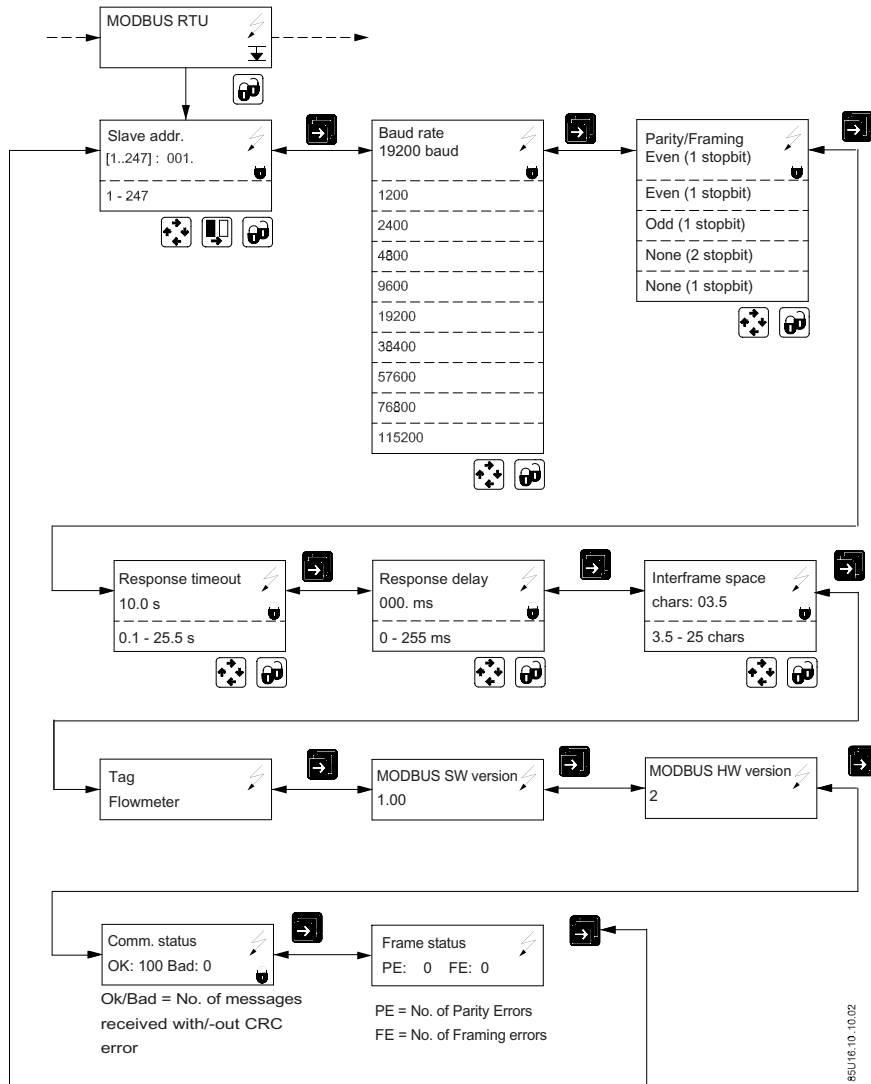


Figure 5-1 MODBUS USMII Display menu

Table 5-1 Menu items

Item	Value	Description
Device Communication Address	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	<ul style="list-style-type: none"> • Even, 1 stopbit • Odd, 1 stopbit • None, 2 stopbit • None, 1 stopbit 	Communication parameters [Factory setting: Even, 1 stopbit]
Interframe Space	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]
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, 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 a slave receives a request until it returns a response. This makes it possible to send data to slow masters without overwhelming its receiver. [Factory setting: 0]
TAG	Flowmeter	The TAG can be changed to any string up to 16 characters [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	<ul style="list-style-type: none"> • Ok: xx • Bad: xx 	<ul style="list-style-type: none"> • Ok = Received messages without errors • Bad = Received messages with CRC errors Reset after power down.
Frame status	<ul style="list-style-type: none"> • PE: xx • FE: xx 	<ul style="list-style-type: none"> • PE = Number of parity errors • FE = Number of framing errors Reset after power down.

Functions codes

6.1 Modbus Commands

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)

Commands

Broadcast communication from master to slave(s) through device address 0 is supported. No response from the slave is generated in that case. Broadcast communication is not secured by the normal check mechanisms and shall be limited to very few uses.

A SITRANS F Modbus slave only recognizes (and accepts) few Modbus RTU commands/function codes.

Supported function codes are listed in the table below.

Table 6-1 Function codes

Function code	Command text	Description
01 hex	Read coils	Reads the status of single bit(s) in a slave
03 hex	Read multiple registers	Reads the binary content of multiple 16-bit registers in the slave. The maximum number of registers is 26
05 hex	Write single coil	Writes a single on/off bit
10 hex	Write multiple registers	Preset values into a sequence of 16-bit registers. The maximum number of registers is 25
11 hex	Report Slave ID	The SITRANS F slave will respond to a Report Slave ID command (Command 17) request from the master by giving in formation about device type, vendor, revision level etc. in a format as shown

6.2 Read coils

Command messages

The read coils functions (01 hex x) allow the master to request information from the slave. The command message of a coil read is structured as shown below. Each row in the table compares to a byte in the message – top byte (Slave address) is transmitted first.

The initial slave address is 1. Address 0 (broadcast) and other values between 1 and 255 can be used.

The function code of this message is 01 hex (read coil) .

The starting coil is the first binary data to be read.

The quantity indicates how many consecutive bits are to be read. The quantity may range from 1 to 432 bits.

A CRC value is generated from a calculation using the values of the slave address, function code, and data sections of the message. When the slave receives the command message it calculates a CRC-16 value and compares it to the one in the CRC-16 field of the command message. If these two CRC-16 values are the same the slave has received the proper command message. If the two CRC-16 values are not the same the slave will not respond.

Table 6-2 Read coil command messages

Message byte		Example
Slave address		xxhex
Function code		01hex
Starting coil	Upper	00hex
	Lower	00hex
Quantity	Upper	00hex
	Lower	xxhex
CRC-16	Lower	xxhex
	Upper	xxhex

Normal response

If the command message has a valid slave address, function code, starting coil and quantity value the slave will respond with a normal response message. If the command message has an invalid slave address, function code, starting coil and/or quantity the slave will respond with an exception response message.

The normal response message contains the same slave address and function code as the command message.

The Bit count is the number of status bits returned in the response message. The number equals the quantity in the command message.

The data section of the response message contains a number of bits representing the status of the coils(s) that has been read from the device. The LSB of the coil status byte indicates the status of the coil.

Table 6-3 Read coil normal response messages

Message byte		Example
Slave address		xxhex
Function code		01hex
Bit count		xxhex
Coil status byte(s)		xxhex
		xxhex
Next coil status byte(s)		xxhex
		xxhex
Last coil status byte(s)		xxhex
		xxhex
CRC-16	Lower	xxhex
	Upper	xxhex

Exception response

The exception response message contains the same slave address as the command message.

The function code of the exception message is actually a value of 80 hex plus the original function code of 01 hex .

The exception code indicates where the error occurred in the command message. A complete listing of exception codes is shown in a later chapter.

Table 6-4 Read coil exception response messages

Message byte		Example
Slave address		xxhex
Function code		81hex
Exception code		02hex
CRC-16	Lower	xxhex
	Upper	xxhex

Example

Read Coil Totalizer 1 (0:00011):

- Query: 1,1,0,10,0,1,221,200 (Hex 01,01,00,10,00,01,DD,C8)
- Response: 1,1,1,0,81,136 (Hex 01,01,01,00,51,88)

6.3 Read multiple registers

Command messages

The multiple register read functions (03hex) allows the master to request information from the slave. The command message of a multiple register read is structured as shown below. Each row in the table compares to byte in the message – top byte (Slave address) is transmitted first.

The initial slave address is 1. Address 0 (broadcast) and other values between 1 and 255 can be used.

The function code of this message is 03hex (read multiple registers)

The starting register is the first register to be read.

The quantity indicates how many consecutive 16-bit registers are to be read. The quantity may range from 1 to 26 registers. If the quantity is greater than 26 an error code of 03 hex is returned in the exception response message.

A CRC value is generated from a calculation using the values of the slave address, function code, and data sections of the message. When the slave receives the command message it calculates a CRC-16 value and compares it to the one in the CRC-16 field of the command message. If these two CRC-16 values are the same the slave has received the proper command message. If the two CRC-16 values are not the same the slave will not respond.

If the command message has a valid slave address, function code, starting register and quantity value the slave will respond with a normal response message. If the command message has an invalid function code, starting register and/or quantity the slave will respond with an exception response message.

Table 6-5 Read multiple registers command messages

Message byte		Example
Slave address		xxhex
Function code		03hex
Starting register	Upper	00hex
	Lower	20hex
Quantity	Upper	00hex
	Lower	04hex
CRC-16	Lower	xxhex
	Upper	xxhex

Normal response

The normal response message contains the same slave address and function code as the command message.

The Byte count is the number of data bytes returned in the response message. The number is actually the quantity (in the command message) times 2, since there are two bytes of data in each register.

The data section of the response message contains 8 upper and 8 lower bits of data for each register that has been read from the device.

Table 6-6 Read multiple registers normal response messages

Message byte		Example
Slave address		xxhex
Function code		03hex
Byte count		xxhex
Starting register	Upper	xxhex
	Lower	xxhex
Next register	Upper	xxhex
	Lower	xxhex
Last register	Upper	xxhex
	Lower	xxhex
CRC-16	Lower	xxhex
	Upper	xxhex

Exception response

The exception response message contains the same slave address as the command message.

The function code of the exception message is actually a value of 80 hex plus the original function code of 03hex. The exception code indicates where the error occurred in the command message. A complete listing of exception codes is shown in a later chapter.

Table 6-7 Read multiple registers exception response messages

Message byte		Example
Slave address		xxhex
Function code		83hex
Exception code		01hex to 06hex
CRC-16	Lower	xxhex
	Upper	xxhex

Examples

Read absolute mass flow (4:03001)

- Query: 1,3,11,184,0,2,70,10 (Hex 01,03,0B,B8,00,02,46,0A)
- Response: 1,3,4,64,195,82,139,98,200 (Hex 01,03,04,40,C3,52,8B,62,C8)
- Absolute mass flow = 6.10383 kg/sec.

Read absolute density (4:03005)

- Query: 1,3,11,188,0,2,7,203 (Hex 01,03,0B,BC,00,02,07,CB)
- Response: 1,3,4,68,54,162,145,182,1 (Hex 01,03,04,44,36,A2,91,B6,01)
- Absolute density = 730.54010 kg/m³

6.4 Write single coil

Read sensor temperature (4:03007)

- Query: 1,3,11,190,0,2,166,11 (Hex 01,03,0B,BE,00,02,A6,0B)
- Response: 1,3,4,189,216,115,34,251,77 (Hex 01,03,04,BD,D8,73,22,FB,4D)
- Sensor temperature = -0.10569 °C

6.4 Write single coil

Command messages

The write coil functions (05hex) allow the master to control single bits in the slave. The command message of a coil write is structured as shown below.

The initial slave address is 1. Address 0 (broadcast) and other values between 1 and 255 can be used.

The function code of this message is 05hex (write coil).

The coil address is the coil to be written to.

The requested coil status is specified by a constant in the query data field. A value of FFhex , 00hex (upper, lower) requests the coil/bit to be set. A value of 00hex , 00hex requests it to be reset. All other values are illegal and will not affect the coil.

CRC check and exception handling is performed as described for command 'Read multiple registers'.

Table 6-8 Write coil command messages

Message byte		Example
Slave address		xxhex
Function code		05hex
Coil address	Upper	xxhex
	Lower	xxhex
New coil value	Upper	FFhex or 00hex
	Lower	00hex
CRC-16	Lower	xxhex
	Upper	xxhex

Normal response

The normal response message contains the same slave address and function code as the command message.

The coil address is the coil that was written to.

The new coil value is the value written to the coil.

Table 6-9 Write coil normal response messages

Message byte		Example
Slave address		xxhex
Function code		05hex
Coil address	Upper	xxhex
	Lower	xxhex
New coil value	Upper	FFhex or 00hex
	Lower	00hex
CRC-16	Lower	xxhex
	Upper	xxhex

Exception response

The exception response message contains the same slave address as the command message. The function code of the exception message is actually a value of 80 hex plus the original function code of 05hex. The exception code indicates where the error occurred in the command message. A complete listing of exception codes is shown in a later chapter

Table 6-10 Write coil exception response messages

Message byte		Example
Slave address		xxhex
Function code		85hex
Exception code		01hex to 06hex
CRC-16	Lower	xxhex
	Upper	xxhex

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 (Hex 01,05,00,00,FF,00,8C,3A) (Set coil 0 to 0xFF00)
- Receive: 1,5,0,0,255,0,140,58 (Hex 01,05,00,00,FF,00,8C,3A) (Restart Modbus communication)

6.5 Write multiple registers

Command messages

The multiple register write functions (10hex) allows the master to write data to the slaves registers. The command message of a multiple register write is structured as shown below.

The initial slave address is 1. Address 0 (broadcast) and other values between 1 and 255 can be used.

The function code of this message is 10hex (write multiple registers).

The starting register is the first register to be written to.

The quantity indicates how many consecutive 16-bit registers are to be written to. The quantity may range from 1 to 25 registers. If the quantity is greater than 25 an error code of 03 hex is returned in the exception response message.

The Byte count is the number of bytes of data to be written to the device. The number of bytes is actually the quantity times 2, since there are two bytes of data in each register.

The data section of the command message contains 8 upper and 8 lower bits of data for each register that is being written to.

CRC check and exception handling is performed as described for command 'Read multiple registers'.

Table 6-11 Write multiple coil command messages

Message byte		Example
Slave address		xxhex
Function code		10hex
Starting register	Upper	00hex
	Lower	20hex
Quantity	Upper	00hex
	Lower	04hex
Byte count		xxhex
Starting register value	Upper	xxhex
	Lower	xxhex
Next register value	Upper	xxhex
	Lower	xxhex
Last register value	Upper	xxhex
	Lower	xxhex
CRC-16	Lower	xxhex
	Upper	xxhex

Normal response

The normal response message contains the same slave address and function code as the command message.

The starting register is the first register that was written to.

The quantity value indicates how many consecutive registers were written to.

Table 6-12 Write multiple coil normal response messages

Message byte		Example
Slave address		xxhex
Function code		10hex
Starting register	Upper	xxhex
	Lower	xxhex
Quantity	Upper	xxhex
	Lower	xxhex
CRC-16	Lower	xxhex
	Upper	xxhex

Exception responses

The exception response message contains the same slave address as the command message.

The function code of the exception message is actually a value of 80 hex plus the original function code of 10 hex.

The exception code indicates where the error occurred in the command message. A complete listing of exception codes is shown in a later chapter.

Table 6-13 Write multiple coil exception response messages

Message byte		Example
Slave address		xxhex
Function code		90hex
Exception code		01hex to 06hex
CRC-16	Lower	xxhex
	Upper	xxhex

Example

Set baud rate to 115200 baud

- Query: 1,16,2,17,0,1,2,0,8,135,23 (115200 = value 8) (Hex 01,10,02,11,00,01,02,00,08,87,17)
- Receive: 1,16,2,17,0,1,80,116 (Hex 01,10,02,11,00,01,50,74)

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 (Hex 01,05,00,00,FF,00,8C,3A) (Set coil 0 to 0xFF00)
- Receive: 1,5,0,0,255,0,140,58 (Hex 01,05,00,00,FF,00,8C,3A) (Restart Modbus communication)

6.6 Report slave ID command

All SITRANS F slaves will respond to a Report Slave ID command (Command 17) request from the master by giving in formation about device type, vendor, revision level etc. in a format as shown:

Table 6-14 Report slave ID command messages

Message byte		Example
Slave address		xxhex
Function code		11hex
CRC-16	Lower	xxhex
	Upper	xxhex

Table 6-15 Report slave ID messages

Message byte	Description	Length
Slave address		1 byte
Function code	17 (0x11)	1 byte
Byte count	52 (0x34)	1 byte
Slave ID	0x2a = Siemens	1 byte
Run Indicator	0=Off; FF=Running	1 byte
Product code	24 = MAG 6000, 25 = MASS 6000	1 byte
Software code no	e.g. "083H0222"	9 bytes
Capability bits	Bits describing the capabilities of this module. 0x01, 0xFF, 0x00	3 bytes
Manufacturer name	"Siemens"	12 bytes
Product name	"MAG 6000" or "MASS 6000"	18 bytes
Flowmeter major revision	e.g. 2	1 byte
Flowmeter minor revision	e.g. 1	1 byte
MODBUS module name	"MODBUS RTU"	11 bytes
MODBUS major rev.	e.g. 1	1 byte
MODBUS minor rev.	e.g. 0	1 byte
CRC		2 bytes

Examples

Read report slave ID:

- Query: Hex 1,11,c0,2c
- Receive: Hex
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

6.7 Exception handling

There is a defined set of exception codes to be returned by slaves in the event of problems. All exceptions are signalled in the response from the slave by adding 80hex to the function code of the request and following this byte by an exception code.

Table 6-16 Exception codes

Exception code (dec)	Exception text	Description
01	Illegal function	The function code received in the query is not an allowable action for the slave
02	Illegal data address	The data address received in the query is not an allowable address for the slave.
03	Illegal data value	A value contained in the query data field is not an allowable value for the addressed location. This may indicate a fault in the structure of the remainder of a complex request, such that the implied length is incorrect.
04	Slave device failure	The request is by some other reason not acceptable. It may e.g. indicate that the data value to write is evaluated to be beyond limits.
06	BUSY-acknowledge	The slave is processing a long-duration command. The master should retransmit the message later when the slave is free.

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

6.7 Exception handling

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

Technical specifications

Table 7-1 Technical data

Device type	Slave
Baud rates	1200, 2400, 4800, 9600, 19200, 38400, 57800 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	<ul style="list-style-type: none"> • RS485, 2 wire
Connector type	Screw terminals
Supported function codes	<ul style="list-style-type: none"> • 1 Read coils • 3 Read holding registers • 5 Write single coil • 16 Write multiple registers • 17 Report slave Id
Broadcast	No ¹⁾
Maximum cable length	1200 meters (@ 115200 bits/sec)
Standard	Modbus over serial line v1.0 ²⁾
Certified	No
Device Profile	None

1) 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)According to the Specification & Implementation guide v. 1.0 available at the Modbus Organisation website

Modbus holding registers

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

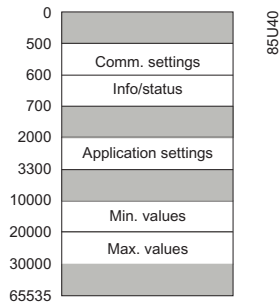


Figure A-1 Modbus Holding Registers Memory Map

- 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.

If 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.

Note

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

A.1 Process data

Table A-1 Process data, MAG 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:03003	3002	4	Float	Absolute Volumeflow (customer unit ¹⁾)	R
4:03015	3014	8	Double	Totalizer 1 (customer unit ²⁾)	R
4:03019	3018	8	Double	Totalizer 2/Batch (customer unit ³⁾)	R

A.2 MODBUS driver settings

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:03023	3022	4	Float	Totalizer 1 (customer unit ²⁾)	R
4:03025	3024	4	Float	Totalizer 2/Batch (customer unit ³⁾)	R

- 1) As defined in MODBUS register 4:02907
- 2) As defined in MODBUS register 4:02913
- 3) As defined in MODBUS register 4:02915

Table A-2 Process data, MASS 6000

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: 1. Reserved 2. All process data updated with 2 Hz 3. Like set 1, but with Massflow 10 Hz 4. Like set 2, but with Totalizers 5 Hz 5. Like set 1, but with Massflow 30 Hz	R/W

See also

Display settings (Page 53)

A.2 MODBUS driver settings

Table A-3 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

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
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	Word	10xInterFrameSpace (10 x chars)	R/W
4:00515	514	4	Dword	Baudrate as double word	R
4:00529	528	2	Byte	Device address (1 - 247)	R/W
4:00530	529	2	Byte	Baudrate <ul style="list-style-type: none"> • 0 = 1200 • 1 = 2400 • 2 = 4800 • 3 = 9600 R/W • 4 = 19200 • 5 = 38400 • 6 = 57600 • 7 = 76800 • 8 = 115200 	R/W
4:00531	530	2	Byte	Parity/framing <ul style="list-style-type: none"> • 0 = 8, E, 1 • 1 = 8, O, 1 • 2 = 8, N, 2 • 3 = 8, N, 1 	R/W

A.3 MODBUS application settings

Table A-4 Slave ID

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:00601	600	2	Byte	Slave ID: <ul style="list-style-type: none"> • 0x2A = Siemens 	R
4:00602	601	2	Byte	Run indicator: <ul style="list-style-type: none"> • 0x00 = not running • 0xFF = running 	R
4:00603	602	2	Byte	Product code <ul style="list-style-type: none"> • 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

A.4 Basic settings

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
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

Table A-5 TAG

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

Table A-6 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

Table A-7 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 Exception handling (Page 33)	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 Exception handling (Page 33)	R

A.4 Basic settings

Table A-8 Basic settings, MAG 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02001	2000	2	Byte	Flow direction <ul style="list-style-type: none"> • 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

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
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: <ul style="list-style-type: none"> • 0 = Off • 1 = On 	R/W
4:02032	2031	2	Byte	Error level: <ul style="list-style-type: none"> • 1 = Warning • 2 = Permanent • 3 = Fatal 	R/W
4:02033	2032	2	Byte	Zero adjust mode ¹⁾ : <ul style="list-style-type: none"> • 0 = Auto • 1 = Manual 	R/W
4:02034	2033	4	Float	Manual zero adjust ¹⁾ (m ³ /s)	R/W
4:02041	2040	2	Byte	Mains Frequency: <ul style="list-style-type: none"> • 0 = 50 Hz • 1 = 60 Hz 	R/W

¹⁾ Only available in MAG 6000 SV

Table A-9 Basic settings, MASS 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02001	2000	2	Byte	Flow direction <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 0 = Off • 1 = On 	R/W

A.5 Totalizer

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02031	2030	2	Byte	Noise filter: <ul style="list-style-type: none"> • 1 = min. • 2 • 3 • 4 • 5 = max. 	R/W
4:02032	2031	2	Byte	Error level: <ul style="list-style-type: none"> • 1 = Warning • 2 = Permanent • 3 = Fatal 	R/W
4:02033	2032	2	Byte	Zero adjust mode: <ul style="list-style-type: none"> • 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

A.5 Totalizer

Table A-10 Totalizer, MAG 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02102	2101	2	Byte	Totalizer 1 direction: <ul style="list-style-type: none"> • 0 = Reverse • 1 = Forward • 2 = Net 	R/W
4:02104	2103	2	Byte	Totalizer 2 direction: <ul style="list-style-type: none"> • 0 = Reverse • 1 = Forward R/W • 2 = Net 	R/W

Table A-11 Totalizer, MASS 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02101	2100	2	Byte	Totalizer 1 selection: <ul style="list-style-type: none"> • 1 = Massflow • 2 = Fraction A • 3 = Fraction B • 4 = Volumeflow 	R/W
4:02102	2101	2	Byte	Totalizer 1 direction: <ul style="list-style-type: none"> • 0 = Reverse • 1 = Forward • 2 = Net 	R/W
4:02103	2102	2	Byte	Totalizer 2 selection: <ul style="list-style-type: none"> • 1 = Massflow • 2 = Fraction A • 3 = Fraction B • 4 = Volumeflow 	R/W
4:02104	2103	2	Byte	Totalizer 2 direction: <ul style="list-style-type: none"> • 0 = Reverse • 1 = Forward • 2 = Net 	R/W

A.6 Output

Table A-12 Output, MAG 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02201	2200	2	Byte	Current Output 1 selection: <ul style="list-style-type: none"> • 0 = Off • 1 = On 	R/W
4:02202	2201	2	Byte	Current Output 1 direction: <ul style="list-style-type: none"> • 1 = Unidirectional • 2 = Bidirectional 	R/W
4:02203	2202	2	Byte	Current Output 1 range: <ul style="list-style-type: none"> • 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

Modbus holding registers

A.6 Output

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02206	2205	2	Byte	Digital Output 1 function: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 1 = Unidirectional • 2 = Bidirectional 	R/W
4:02209	2208	2	Byte	Pulse 1 width: <ul style="list-style-type: none"> • 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
4:02212	2211	2	Byte	Frequency 1 Direction <ul style="list-style-type: none"> • 1 = Unidirectional • 2 = Bidirectional 	R/W
4:02213	2212	2	Byte	Frequency 1 Fmax. <ul style="list-style-type: none"> • 0 = 10 kHz • 1 = 5 kHz • 2 = 1 kHz • 3 = 500 Hz 	R/W
4:02214	2213	4	Float	Frequency 1 Timeconstants	R/W

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02217	2216	2	Byte	Limit Digital mode: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 0 = Off • 1 = On 	R/W
4:02242	2241	4	Dword	Batch time (s)	R/W
4:02244	2243	2	Byte	Batch overrun on/off: <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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
4:02252	2251	4	Dword	Cleaning cycle time (s)	R/W
4:02291	2290	4	Float	Volume per pulse (m ³)	R/W
4:02293	2292	2	Byte	Pulse Polarity <ul style="list-style-type: none"> • 0 = Negative • 1 = Positive 	R/W
4:02294	2293	4	Float	Pulse Timeout(s)	R/W

A.6 Output

Table A-13 Output, MASS 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02201	2200	2	Byte	Current Output 1 selection: <ul style="list-style-type: none"> • 0 = Off • 1 = Massflow • 2 = Fraction A • 3 = Fraction B R/W • 4 = Volumeflow • 5 = Sensor temp. • 6 = Density • 7 = % fraction A 	R/W
4:02202	2201	2	Byte	Current Output 1 direction: <ul style="list-style-type: none"> • 1 = Unidirectional • 2 = Bidirectional 	R/W
4:02203	2202	2	Byte	Current Output 1 range: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 0 = Uninitialized • 1 = Massflow • 2 = Fraction A • 3 = Fraction B • 4 = Volumeflow 	R/W
4:02208	2207	2	Byte	Pulse 1 direction: <ul style="list-style-type: none"> • 1 = Unidirectional • 2 = Bidirectional 	R/W

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02209	2208	2	Byte	Pulse 1 width: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 1 = Unidirectional • 2 = Bidirectional 	R/W
4:02213	2212	2	Byte	Frequency 1 Fmax. <ul style="list-style-type: none"> • 0 = 10 kHz • 1 = 5 kHz • 2 = 1 kHz • 3 = 500 Hz 	R/W
4:02214	2213	4	Float	Frequency 1 Timeconstants	R/W

Modbus holding registers

A.6 Output

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02216	2215	2	Byte	Limit Digital selection: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 0 = Off 3 = Error Level 4 = Error Number 5 = Direction/Limit 	R/W
4:02225	2224	2	Byte	Limit Relay selection: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02234	2233	2	Byte	Batch selection: <ul style="list-style-type: none"> • 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 (m ³)	R/W
4:02239	2238	4	Float	Batch Lead constant	R/W
4:02241	2240	2	Byte	Batch Time error on/off: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 (m ³)	R/W
4:02293	2292	2	Byte	Pulse Polarity <ul style="list-style-type: none"> • 0 = Negative • 1 = Positive 	R/W
4:02296	2295	2	Byte	Quadratur: <ul style="list-style-type: none"> • 0 = Off • 1 = On 	R/W

A.7 External input

Table A-14 External input, MAG 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02301	2300	2	Byte	Input Function: <ul style="list-style-type: none"> • 0 = Off • 1 = Start Batch • 2 = Hold/Continue • 3 = Stop Batch • 4 = Zero Adjust (only SV) • 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: <ul style="list-style-type: none"> • 0 = Totalizer 1 • 1 = Totalizer 2 • 2 = Totalizer 1 + 2 	R/W
4: 02303	2302	4	Float	Force output (1/100%)	R/W

Table A-15 External input, MASS 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02301	2300	2	Byte	Input Function: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 0 = Totalizer 1 • 1 = Totalizer 2 • 2 = Totalizer 1 + 2 	R/W
4: 02303	2302	4	Float	Force output (1/100%)	R/W

A.8 Sensor characteristics

Table A-16 Sensor characteristics, MAG 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	R/W
4:02405	2404	4	Float	Correction factor	R/W
4:02421	2420	2	Byte	Excitation frequency: <ul style="list-style-type: none"> • 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) 	R/W

Table A-17 Sensor characteristics, 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 (us ² /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

A.9 Product identity

Table A-18 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

Table A-19 Product identity, 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

A.10 Service info

Table A-20 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 Error information (Page 66)	R
4:02730	2729	54	Byte array	Error log list See Error information (Page 66)	R

Table A-21 Service info, 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 Error information (Page 66)	R
4:02730	2729	54	Byte array	USM II Error log list See Error information (Page 66)	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

A.11 Display settings

Table A-22 Display settings, MAG 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02901	2900	2	Byte	Language: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 0 = Volumeflow • 1 = Totalizer 1 • 2 = Totalizer 2 	R/W

A.11 Display settings

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02903	2902	2	Byte	Display line 2: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 ¹⁾ (Page 60)	R/W
4:02908	2907	2	Byte	Volumeflow point	R/W
4:02913	2912	2	Byte	Totalizer 1 unit ¹⁾ (Page 63)	R/W
4:02914	2913	2	Byte	Totalizer 1 point	R/W
4:02915	2914	2	Byte	Totalizer 2 unit ¹⁾ (Page 63)	R/W
4:02916	2915	2	Byte	Totalizer 2 point	R/W

¹⁾ Unit settings on MODBUS and the display are linked. Changing the MODBUS units influence the units displayed on the device and vice versa.

Table A-23 Display settings, MASS 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02901	2900	2	Byte	Language: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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

A.11 Display settings

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:02904	2903	2	Byte	Display line 3: <ul style="list-style-type: none"> • 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

See also

Units and point positioners (Page 60)

A.12 Flowmeter status

Table A-24 Flowmeter status

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:03201	3200	2	Word	System status: <ul style="list-style-type: none"> • 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) <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 0 = Idle • 1 = Ready • 2 = Running • 3 = Paused 	R

Table A-25 Zero adjust progress, MAG 6000

MODBUS register	MODBUS address	No. of bytes	Data type	Description	Read / write
4:03212	3211	2	Byte	Zero adjust progress <ul style="list-style-type: none"> • 0 = Idle • 1 = Ready • 2 = Running 	R

A.12 Flowmeter status

Table A-26 Zero adjust progress, MASS 6000

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

Appendix

B.1 Units

The following units are used in USMII transmitters:

SITRANS FM

- Volume flow: Table B-2 Volume flow units (Page 60) (default: m³/s)
- Totalizers: Table B-5 Totalizer units for volume flow (Page 63) (default: m³)

Note

Unit settings on MODBUS and the display are linked

Changing the MODBUS units influence the units displayed on the device and vice versa.

SITRANS FC

- Mass flow: Table B-1 Massflow units (Page 60) (default: kg/sec)
- Volume flow: Table B-2 Volume flow units (Page 60) (default: m³/sec)
- Density: Table B-3 Density Units (Page 62) (default: kg/m³)
- Temperature: °C
- Fraction (A, B): kg/sec.
- Fraction A pct: % (percent)
- Totalizer 1 & 2: Table B-4 Totalizer units for massflow (Page 63) or Table B-5 Totalizer units for volume flow (Page 63) (default: kg or m³) depending on totalizer mode
- 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).

See also

Units and point positioners (Page 60)

B.2 Units and point positioners

Table B-1 Massflow units

ID	Unit	Description
00	kg / s	kilogram per second
01	ton / s	ton per second
02	lb / s	pound per second
03	mg / s	milligram per second
04	g / s	gram per second
05 ... 15	kg / s	kilogram per second
16	kg / min	kilogram per minute
17	t / min	metric ton per minute
18	lb / min	pound per minute
19	mg / min	milligram per minute
20	g / min	gram per minute
21 ... 31	kg / min	kilogram per minute
32	kg/h	kilogram per hour
33	ton/h	metric ton per hour
34	lb / h	pound per hour
35	mg / h	milligram per hour
36	g / h	gram per hour
37 ... 47	kg / h	kilogram per hour
48	kg / d	kilogram per day
49	ton / day	metric ton per day
50	lb / d	pound per day
51	mg / d	milligram per day
52	g / d	gram per day
53 ... 63	kg / d	kilogram per day
64 ... 255	Reserved	

Table B-2 Volume flow units

ID	Unit	Description
00	m ³ / s	cubic meter per second
01	ml / s	milliliter per second
02	L / s	liter per second
03	hl / s	hectoliter per second
04	BBL42 / s	barrel per second
05	ML / s	megaliter per second
06	US bbl / s	US barrel per second
07	m ³ / s	cubic meter per second
08	ft ³ / s	cubic feet per second
09	in ³ / s	cubic inch per second

ID	Unit	Description
10	USGPS	US gallon per second
11	USMGPS	mega US gallon per second
12	UKGPS	Imperial gallon per second
13	UKMGPS	mega imperial gallon per second
14	USkGPS	kilo US gallon per second
15	UKkGPS	kilo imperial gallon per second
16	m ³ / min	cubic meter per minute
17	ml / min	milliliter per minute
18	L / min	liter per minute
19	hl / min	hectoliter per minute
20	BBL42 / min	barrels per minute
21	ML / min	megaliter per minute
22	bbl / min	barrel per minute
23	m ³ / min	cubic meter per minute
24	ft ³ / min	cubic feet per minute
25	in ³ / min	cubic inch per minute
26	USGPM	US gallon per minute
27	USMGPM	mega US gallon per minute
28	UKGPM	Imperial gallon per minute
29	UKMGPM	mega imperial gallon per minute
30	USkGPM	kilo US gallon per minute
31	UKkGPM	kilo imperial gallon per minute
32	m ³ /h	cubic meter per hour
33	ml / h	milliliter per hour
34	L / h	liter per hour
35	hl / h	hectoliter per hour
36	BBL42 / h	barrels per hour
37	ML / h	megaliter per hour
38	bbl / h	barrel per hour
39	m ³ /h	cubic meter per hour
40	ft ³ / h	cubic feet per hour
41	in ³ / h	cubic inch per hour
42	USGPH	US gallon per hour
43	USMGPH	mega US gallon per hour
44	UKGPH	Imperial gallon per hour
45	UKMGPH	mega imperial gallon per hour
46	USkGPH	kilo US gallon per hour
47	UKkGPH	kilo imperial gallon per hour
48	m ³ / d	cubic meter per day
49	ml / d	milliliter per day
50	L / d	liter per day
51	hl / d	hectoliter per day
52	BBL42 / d	barrels per day

ID	Unit	Description
53	ML / d	megaliter per day
54	bbl / d	barrel per day
55	m ³ / d	cubic meter per day
56	ft ³ / d	cubic feet per day
57	in ³ / d	cubic inch per day
58	USGPD	US gallon per day
59	USMGPD	Mega US gallon per day
60	UKGPD	Imperial gallon per day
61	UKMGPD	mega imperial gallon per day
62	USkGPD	kilo US gallon per day
63	UKkGPD	kilo imperial gallon per day
64 ... 255	Reserved	

Table B-3 Density Units

ID	Unit	Description
00	kg/m ³	kilogram per cubic meter
01	t / m ³	metric ton per cubic meter
02	lb / m ³	pound per cubic meter
03	mg / m ³	milligram per cubic meter
04	g / m ³	gram per cubic meter
05 ... 15	kg/m ³	kilogram per cubic meter
16	kg / ft ³	kilogram per cubic foot
17	t / ft ³	metric ton per cubic foot
18	lb / ft ³	pound per cubic foot
19	mg / ft ³	milligram per cubic foot
20	g / ft ³	gram per cubic foot
21 ... 31	kg / ft ³	kilogram per cubic foot
32	kg / in ³	kilogram per cubic inch
33	t / in ³	ton per cubic inch
34	lb / in ³	pound per cubic inch
35	mg / in ³	milligram per cubic inch
36	g / in ³	gram per cubic inch
37 ... 47	kg / in ³	kilogram per cubic inch
48	kg / cm ³	kilogram per cubic centimeter
49	t / cm ³	metric ton per cubic centimeter
50	lb / cm ³	pound per cubic centimeter
51	mg / cm ³	milligram per cubic centimeter
52	g / cm ³	gram per cubic centimeter
53 ... 63	kg / cm ³	kilogram per cubic centimeter

Table B-4 Totalizer units for massflow

ID	Unit	Description
00	kg	kilogram
01	t	metric ton
02	lb	pound
03	Mg	megagram
04	G	gram
05-255	Reserved	

Table B-5 Totalizer units for volume flow

ID	Unit	Description
00	m ³	cubic meter
01	ml	milliliter
02	L	liter
03	hl	hectoliter
04	BBL42	barrels
05	MI	megaliter
06	USBBL	US barrels
07	m ³	cubic meter
08	ft ³	cubic feet
09	in ³	cubic inch
10	USG	US gallon
11	USMG	mega US gallon
12	UKG	Imperial gallon
13	UKMG	mega Imperial gallon
14	USkG	kilo US gallon
15	UKkG	kilo imperial gallon
16-254	Reserved	

Table B-6 Point position

ID	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

B.3 Modbus Coils

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

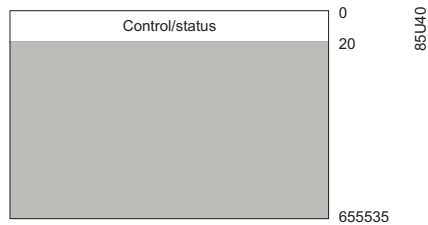


Figure B-1 Modbus Coils Memory Map

Communication settings

Table B-7 Communication settings

MODBUS register	MODBUS address	Data type	Description	Read/write
0:00001	0	Coil	Restart MODBUS communication: <ul style="list-style-type: none"> • Write: <ul style="list-style-type: none"> – 0 = No effect – 1 = Restart • Read: always 0 	R/W

Auto zero adjust

Table B-8 Auto zero adjust

MODBUS register	MODBUS address	Data type	Description	Read/write
0:00009	8	Coil	Start auto zero adjust: <ul style="list-style-type: none"> Write: <ul style="list-style-type: none"> • 0 = No effect • 1 = StartRead: <ul style="list-style-type: none"> – 0 = Idle – 1 = Busy 	R/W

Totalizer

Table B-9 Totalizer

MODBUS register	MODBUS address	Data type	Description	Read/write
0:00010	9	Coil	Reset totalizer 1: Write: <ul style="list-style-type: none"> • 0 = No effect • 1 = ResetRead: <ul style="list-style-type: none"> – always 0 	R/W
0:00011	10	Coil	Hold totalizer 1: Write: <ul style="list-style-type: none"> • 0 = Run • 1 = HoldRead: <ul style="list-style-type: none"> – 0 = Not held – 1 = Held 	R/W
0:00012	11	Coil	Reset totalizer 2: Write: <ul style="list-style-type: none"> • 0 = No effect • 1 = ResetRead: <ul style="list-style-type: none"> – always 0 	R/W
0:00013	12	Coil	Hold totalizer 2: Write: <ul style="list-style-type: none"> • 0 = Run • 1 = HoldRead: <ul style="list-style-type: none"> – 0 = Not held – 1 = Held 	R/W

Batch

Table B-10 Batch

MODBUS register	MODBUS address	Data type	Description	Read/write
0:00014	13	Coil	Start Batch: Write: <ul style="list-style-type: none"> • 0 = Stop Batch • 1 = Start Batch Read: <ul style="list-style-type: none"> – 0 = Stopped – 1 = Not stopped 	R/W
0:00015	14	Coil	Pause Batch: Write: <ul style="list-style-type: none"> • 0 = Resume Batch • 1 = Pause Batch Read: <ul style="list-style-type: none"> – 0 = Not paused – 1 = Paused 	R/W

B.4 Error information

Error pending list and error log list

Reading MODBUS address 2702 (USM II Error Pending list) and MODBUS address 2729 (USM II Error Log list) provides detailed error information about the flowmeter.

The Error Pending list contains all actual errors and the Error Log list provides information about all previous errors. Both lists are structured as 9 error records, each consisting of 6 bytes.

New errors will be placed on the top of list (Error 1).

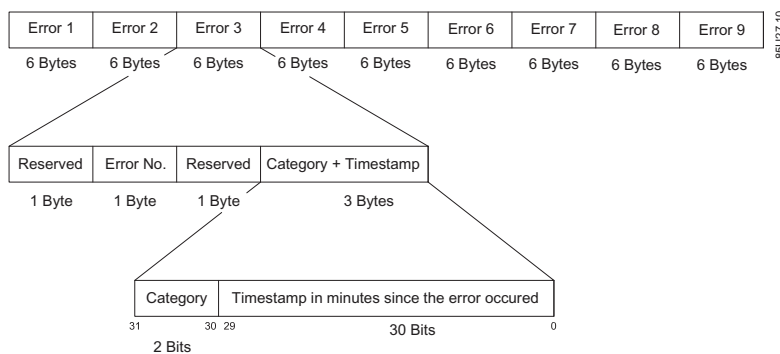


Figure B-2 MODBUS Error List

Error Number	A list of all error numbers can be found in the relevant SITRANS FM / SITRANS FC Operating Instructions. No error is represented by 0x7F.
Category	<ul style="list-style-type: none">• 0: Information• 1: Warning• 2: Permanent• 3: Fatal
Timestamp	Timestamp represents the time in minutes since the error occurred.

Example

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,0,0,0,7f,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.

B.5 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.

B.6 CRC calculation

The Cyclical Redundancy Checking (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 receiving device 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.

In the following a short text description of how the CRC is calculated is provided. 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
6. processed.
7. Repeat Steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.
8. The final content of the CRC register is the CRC value.
9. 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, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,
0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 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,
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 ^ auctCRCHi[uIndex] ;
        uchCRCLo = auctCRCLo[uIndex] ;
    }
#ifdef INTEL_LIKE_PROCESSOR
    return (unsigned short int)((uchCRCLo << 8) | uchCRCHi);
#else
    return (unsigned short int)((uchCRCHi << 8) | uchCRCLo);
#endif
}

```

See also

There are many ways of calculating a CRC checksum. For further information, please refer to the Modbus Organisation Website (<http://www.modbus.org/>), where detailed descriptions and programming examples are available.

B.7 Data type mapping

Some standard datatypes are defined in the SITRANS F protocol. Most of these datatypes are not present in the MODBUS® RTU protocol as it defines 'Registers' and 'Coils' for all variables. A register in this context is always 16 bit long. This will prove restrictive for the parameters found in Siemens Flow products and therefore a number of approaches have been adopted to overcome this restriction.

Table B-11 Data type mapping

Datatype	Modbus RTU implementation
Byte	Data organized as 8-bit unsigned integers. The parameters are read using function code 03hex 'Read multiple registers'. Parameters are written using function code 10hex 'Write multiple registers'. 'uint8' type of data is accessed through a single register, where the data is found in the lower byte of the register. Datavalue can be 0 – 255 with no sign bit.
Word	Data organized as 16-bit unsigned integers. The parameters are read using function code 03 hex 'Read multiple registers'. Parameters are written using function code 10 hex 'Write multiple registers'. 'uint16' type of data is accessed through a single register. Datavalue can be 0 – 65536 with no sign bit.
float32	Data organized as 32-bit signed floats (IEEE format). The parameters are read using function code 03 hex 'Read multiple registers'. Parameters are written using function code 10 hex 'Write multiple registers'. 'float32' type of data is accessed through two registers. Datavalues are coded in IEEE floating point format.
float64	Data organized as 64-bit signed floats (IEEE format). The parameters are read using function code 03 hex 'Read multiple registers'. Parameters are written using function code 10 hex 'Write multiple registers'. 'float64' type of data is accessed through four registers. Datavalues are coded in IEEE floating point format.
String	Consecutive pairs of 8-bit ASCII characters stored one pair per 16-bit register. Strings are read using function code 03 hex "Read multiple registers". Strings are written using function code 10 hex 'Write multiple registers'. 'string' type of data must be read or written as a series of 1 to 25 consecutive registers, depending on the number of characters specified for the string. The max. string length is therefore 50 chars (incl. delimiter). Strings are terminated by a zero-delimiter.

B.8 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 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.

Table B-12 Float definition

Value (decimal)	IEEE FP B MSB LSB	Register N		Register N + 1	
		high	low	high	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

Example

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

Glossary

CRC

Cyclic Redundancy Check. Used for error-checking in Modbus RTU

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.

RS232

Refers to communication standard defined by EIA/TIA-232 (Physical layer).

RS485

Refers to communication standard defined by EIA/TIA-485 (Physical layer).

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