MODBUS module

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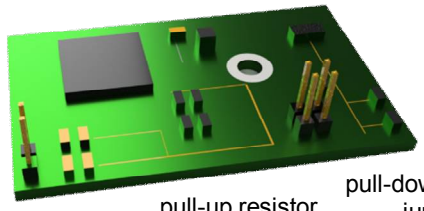
1. Introduction

MODBUS module is a RS485 standard communication module for MQU (ultrasonic) and MQI (electromagnetic) flowmeters, series MQU99 and MQI99. It can work in two modes, which are selected by module jumper:

- **Factory protocol mode** *(with jumper)*: About factory protocol please see MQU/MQI User Guide and factory protocol (ELA-1/ELA2) documentation.
- **MODBUS mode** *(without jumper)*: see this User Guide.

Communication parameters in both modes can be adjusted by means of MQU/MQI local keyboard and display only.



2. MODBUS mode

2.1 Protocol overview

MODBUS module parameter	Value / description
Protocol standard	MODBUS Application Protocol Specification, version 1.1, modbus.org 12/06/02
Physical layer	**RS 485**
Protocol mode	**MODBUS RTU** – unicast mode only
Baud rate	**4800**, **9600**, **19200** and **38400 Bd**
Parity	**None**, **Odd** or **Even**
Stopbits	**1** or **2** (two stopbits with none parity only)
Setting the communication parameters	By means of local MQU/MQI keyboard and display only
Reading the communication parameters	MODBUS function code **3** (registers)
Reading the relays	MODBUS function code **1** (coils)
Reading the measured values	MODBUS function code **3** (registers)
Measured values	MQU: **H**, **Q**, **S**, **T** and failure flags for channel **„a“** and **„b“** MQI: **Q**, **S**, **S+**, **S-** and failure flag
Register organization	Any communication parameter or measured value is stored in **two or four 16-bit registers** – all these registers must be read together
Register format	Inverse longint, inverse float or double, see *Appendix A*

2.2 Electrical parameters

Parameter	Value / description
Physical layer	RS 485
Pull Up / Pull Down resistors	820 Ω, typically
Termination resistor	None
Mounting	Inside the MQU/MQI

2.3 Timing requirements

Minimal space between frames must be according to MODBUS RTU standard, i.e.:

- For Baud rate to 19200 Bd (including): 3.5 times the character time
- For Baud rate above 19200 Bd: 1750 µs

2.4 Exception list

Exception	Exception name	Explanation
1	Illegal Function	Function is not implemented.
2	Illegal Data Address	Some or all requested register(s) or coil(s) are not implemented or parameters of requested registers (address, count) are not even. Caution: According to MODBUS standard physical value of register address inside MODBUS frame is equal to: **Register address - 1**
3	Illegal Data Value	Too many requested registers or coils.
4	Slave Device Failure	Momentary (or permanent) failure of communication between main MQU/MQI processor and the MODBUS module.

3. Adjusting the communication parameters

Caution:

- All communication parameters of the MODBUS module are adjusted by means of MQU/MQI keyboard and display only (see menu ***MAIN***, section ***RS 485***).
- After any change of these parameters please wait at least **1 minute** before first communication at MODBUS line.

Parameter	**Allowed values**	**Meaning for MODBUS line**
Device address	**1** .. **32**	***Slave address*** (i.e. MQU/MQI address)
Baud rate	**9600 Bd** (only)	**-** *(see explanation below)*
R/T timeout	**9.6** .. **11.1**	This parameter represents the ***MODBUS code*** which includes ***Baud rate***, ***Parity*** and ***Stopbits***. See table below for details.

Explanation about *Baud rate* parameter **in table above**:

This parameter controls *internal communication inside the flowmeter* (between main MQU/MQI processor and the MODBUS module processor). It can be set to *9600 Bd only*.

MODBUS code (see table above)	**MODBUS line communication parameters**		
	Baud rate	***Parity***	***Stopbits***
9.6	4800	No	1
9.7	4800	Odd	1
9.8	4800	Even	1
9.9	4800	No	2
10.0	9600	No	1
10.1	9600	Odd	1
10.2	9600	Even	1
10.3	9600	No	2
10.4	19200	No	1
10.5	19200	Odd	1
10.6	19200	Even	1
10.7	19200	No	2
10.8	38400	No	1
10.9	38400	Odd	1
11.0	38400	Even	1
11.1	38400	No	2

4. Reading values

4.1 Reading the relays (coils, function code **1**)

- Address: **1** – but physically (in PDU) must be 00 00 (hex.,16 bits)
- Number of bytes: **1** – physically 00 01 (hex., 16 bits)

Received data byte has following internal format:

Bit	7	6	5	4	3	2	1	0
Meaning	-	-	-	-	Relay 4	Relay 3	Relay 2	Relay 1

4.2 Reading the communication parameters (registers, function code **3**)

Communication parameters for MODBUS line can be adjusted by means of local MQU/MQI keyboard and display only.

First register address	**Value**	**Unit**	**Numeric format** (see *Appendix A*)	**Description**
100	Baud rate	Bd	inverse longint	Baud rate for MODBUS line: **4800**, **9600**, **19200** or **38400 Bd**.
102	Parity	-	inverse longint	Parity and stopbits for MODBUS line: **0** … no parity, 1 stopbit **1** … odd parity, 1 stopbit **2** … even parity, 1 stopbit **3** … no parity, 2 stopbits
104	Slave Address	-	inverse longint	Slave address for MODBUS line. Equal to *MAIN \ RS 485 \ Device address*.
106	Version code	-	inverse longint	This value depends on flowmeter type: for MQU: *Firmware version* x 1000 + 1 for MQI: *Firmware version* x 1000 + 2

4.3 Reading the MQU values (registers, function code **3**)

First register address	Value	Unit	Numeric format (see *Appendix A*)	Description	Ver.
1000	**Ha**	m	inverse float	Level height - „a“	
1002	**Hb**	m	inverse float	Level height - „b“	
1004	**Qa**	m^3/s	inverse float	Current flow - „a“	
1006	**Qb**	m^3/s	inverse float	Current flow - „b“	
1008	Fail	-	inverse longint	**0** .. no failure **1** .. failure at channel „a“ and/or „b“ *See caution below.*	
1010	Sa ***)**	m^3	inverse float	Total volume - „a“	
1012	Sb ***)**	m^3	inverse float	Total volume - „b“	
1014	Ta ***)**	h	inverse float	Operating time - „a“	
1016	Tb ***)**	h	inverse float	Operating time - „b“	
1018	**FailAB**	-	inverse longint	**0** … no failure **1** … failure at channel „a“ only **2** … failure at channel „b“ only **3** … failure at both channels	2.0
1020	**Sa**	m^3	double	Total volume - „a“	3.2
1024	**Sb**	m^3	double	Total volume - „b“	3.2
1028	**Ta**	h	double	Operating time - „a“	3.2
1032	**Tb**	h	double	Operating time - „b“	3.2
1036	**RunFlag**	-	inverse longint	**0** … service mode **1** … measurement mode	3.2

***)** For new MODBUS module firmware versions (ver. 3.2 and above) it is strongly recommended to use registers **1020**, **1024**, **1028** and **1032**, which have double format (high precision).

Caution about the **Fail** value:

- Using the **Fail** value is convenient for dual channel MQU as indication the logical OR of failure flags at both channels.
- On the contrary **Fail** value cannot be used at standard single channel MQU, because such device has failure flag on channel „b“ always active.
- For firmware version 2.0 and above it is better to use the **FailAB** value (with individual channel failure indications).

4.4 Reading the MQI values (registers, function code **3**)

First register address	Value	Unit	Numeric format (see *Appendix A*)	Description	Ver.
2000	q	l/s	inverse float	Caution: See explanation below about calculation of current flow value.	
2002	**Fail**	-	inverse longint	**0** … no error **1** … air-fail (air in pipe failure)	
2004	S *)	m^3	inverse float	S = (S+) – (S-)	
2006	S+ *)	m^3	inverse float	Total volume at forward direction	
2008	S- *)	m^3	inverse float	Total volume at backward direction	
2010	**Q**	l/s	inverse float	Current flow	2.0
2012	**S**	m^3	double	S = (S+) – (S-)	3.2
2016	**S+**	m^3	double	Total volume at forward direction	3.2
2020	**S-**	m^3	double	Total volume at backward direction	3.2
2024	**RunFlag**	-	inverse longint	**0** … service mode **1** … measurement mode	3.2
2028	**Range**	l/s	inverse float	Flow range	3.4

*) For new MODBUS module firmware versions (ver. 3.2 and above) it is strongly recommended to use registers **2012**, **2016** and **2020**, which have double format (high precision).

Explanations about Registers 2000 and 2010:

1. For version 2.0 and later current flow is accessible directly by means of Register **2010**.
2. For older versions current flow must be calculated by means of formula:

Q = q x RangeCoef [l/s; l/s, -]

where **q** is content of the Register 2000 and **RangeCoef** is dependent on value of the **Actual range** parameter:

MAIN \ Range \ Actual range [l/s]	RangeCoef
0.015, 0.15, 1.5, 15, 150 or 1500	0.15
0.02, 0.2, 2, 20, 200 or 2000	0.2
0.03, 0.3, 3, 30, 300 or 3000	0.3
0.04, 0.4, 4, 40, 400 or 4000	0.4
0.05, 0.5, 5, 50, 500 or 5000	0.5
0.06, 0.6, 6, 60, 600 or 6000	0.6
0.08, 0.8, 8, 80, 800 or 8000	0.8
0.1, 1, 10, 100, 1000 or 10000	1

APPENDIX A: Numeric formats for MODBUS module

Description of *inverse longint* format

Inverse longint is integer type format at 32 bits (two MODBUS 16-bit registers).

Register	**Bits of longint format**
Low (even)	15 .. 0
High (odd)	31 .. 16

Note:

Every register is transmitted at MSB-first mode.

Description of *inverse float* format

Inverse float is floating point type format at 32 bits (two MODBUS 16-bit registers). It is equal to *single float* standard.

Register	**Bits of *single float* format**		
Low (even)	mantissa bits: 15 .. 0		
High (odd)	sign	exponent: 7 .. 0	mantissa bits: 22..16

Explanations:

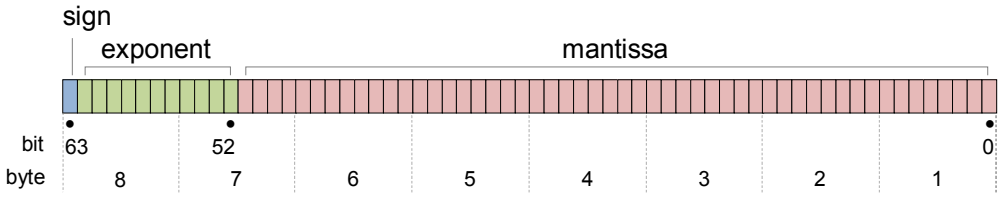
- Sign bit: **0** … plus, **1** … minus
- Exponent: Binary exponent increased by 127
- Mantissa: Mantissa value is **1.X**, where **X** is decimal part of mantissa (bits 22..0)

Note:

Every register is transmitted at MSB-first mode.

Description of *double* format

Double is floating point type format at 64 bits (four MODBUS 16-bit registers) according to IEEE 754 standard.



Explanations:

- Sign bit: **0** … plus, **1** … minus
- Exponent: Binary exponent increased by 1023
- Mantissa: Mantissa value is **1.X**, where **X** is decimal part of mantissa (bits 51..0)

Bytes of *double* format are transmitted at following order: 2, 1, 4, 3, 6, 5, 8 and 7.