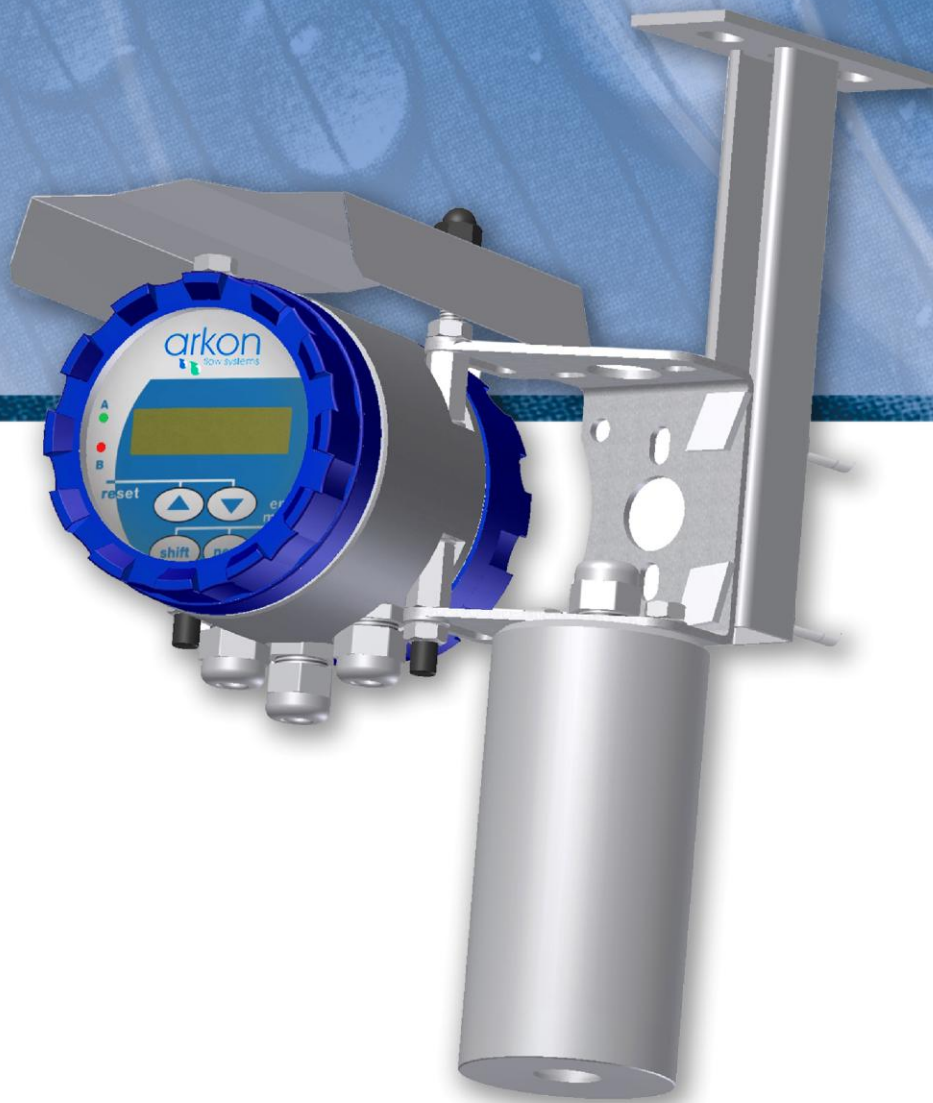


Modbus RTU Protocol

User Guide



for **MQU & MHU**

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1 INTRODUCTION

This manual describes the Modbus-RTU communication protocol.

1.1 Definitions and Abbreviations

CRC	Cyclic Redundancy Check, Used for error-checking in Modbus RTU. See appendix
Modbus master	A Modbus device, which is able to access data in one or more connected Modbus slaves
Modbus slave	A Modbus device, which is able to respond to requests from a single Modbus master
Modbus address	Throughout this document the following notation is used to address Modbus RTU registers: <ul style="list-style-type: none">• 1234 - Holding register• 1234 (addressed in messages by 1233)
RS 232	Refers to the communication standard defined by EIA/TIA-232C. (Physical layer) EIA/TIA232C
USB	Refers to the USB Specification usb.org
RS 485	Refers to the 2-wire communication standard defined by EIA/TIA-485. (Physical layer)
RTU	Remote Terminal Unit – Standard Modbus transmission mode

1.2 References

Reference 1	Modbus over Serial Line Specification & Implementation guide v. 1.0 Modbus.org 12/02/02
Reference 2	Modbus Application Protocol Specification v. 1.1 Modbus.org 12/06/02
Reference 3	MQU manual

2 TECHNICAL DATA

Modbus RTU specification

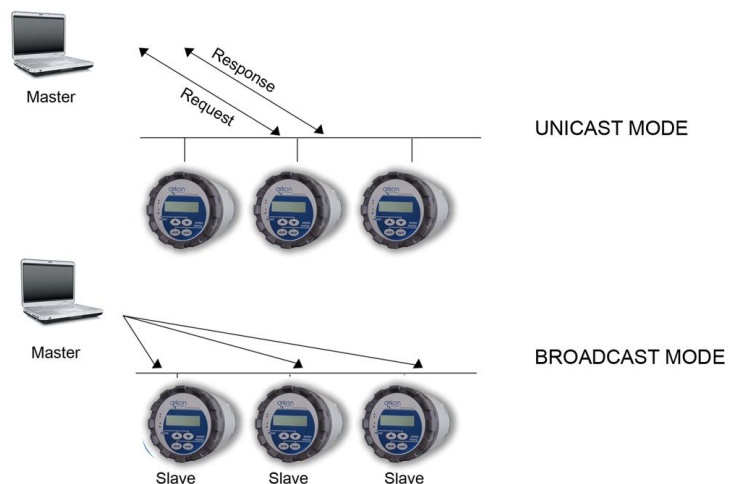
Device type	Slave
Baud rates:	4800, 9600 (default), 19200, 38400 bits/sec.
Device address range	max. 31 per segment without repeaters
Number of stations	1-247
Protocol	Modbus RTU (Other Modbus protocols like ASCII, Plus or TCP/IP are not supported)
Electrical interface	RS232, RS 485 - 2 wire, USB, Ethernet
Supported function code	<ul style="list-style-type: none"> • 3 read holding registers • 16 write multiple registers
Broadcast	No
Maximum cable length	Reference 3
Standard Modbus over serial line v1.0)	

2.1 General Modbus RTU

The module complies with the Modbus serial line protocol [Reference 1].

Among other things, this implies a masterslave protocol at level 2 of the OSI model. One node, (the master), issues explicit commands to one of the „slave“-nodes and processes responses. Slave nodes will not transmit data without a request from the master node, and do not communicate with other slaves.

Modbus is a mono master system, which means that only one master can be connected at any single point in time. Two modes of communication are possible, Unicast and Broadcast. Unicast mode is where the master sends a request to one slave device, and waits a specified time for a response. In Broadcast mode the master sends out a request to address „0“, which means that the information is for all slave devices on the network. In Broadcast mode there is no response from the slave devices.



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

Slave address	Function code	Data	CRC
1 Byte	1 Byte	0-252 Bytes	2 Bytes

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

3 COMMISSIONING

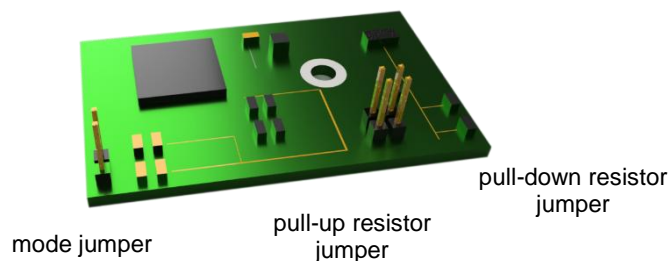
Before communicating with the master, Baud rate, node ID and update rate must be selected. This can be done from the display. Please look in to the MQU transmitter manual to locate the Modbus RTU menu. (see Reference 3).

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 (default), 19200 and 38400 Bd
Parity	None (default), Odd or Even
Stopbits	1 (default) or 2 (two stopbits with none parity only)
Setting the communication parameters	By means of local MQU 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“
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 <i>Appendix A</i>
Physical layer	RS 485
Pull Up / Pull Down resistors	820 Ω, typically
Termination resistor	None

MODBUS module is a RS485 standard communication module for MQU flowmeters, series MQU99. It can work in two modes, which are selected by module jumper:

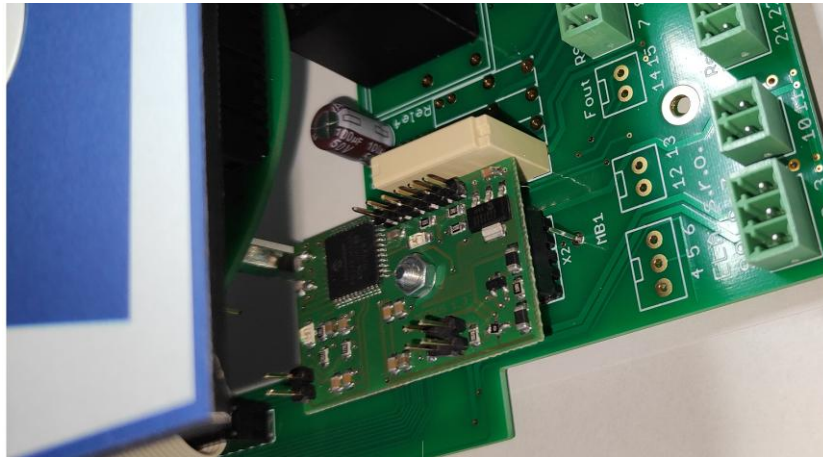
- **Factory protocol mode** (*with jumper*): About factory protocol please see MQU User Guide and factory protocol documentation.
- **MODBUS mode** (*without jumper*): see this User Guide.

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

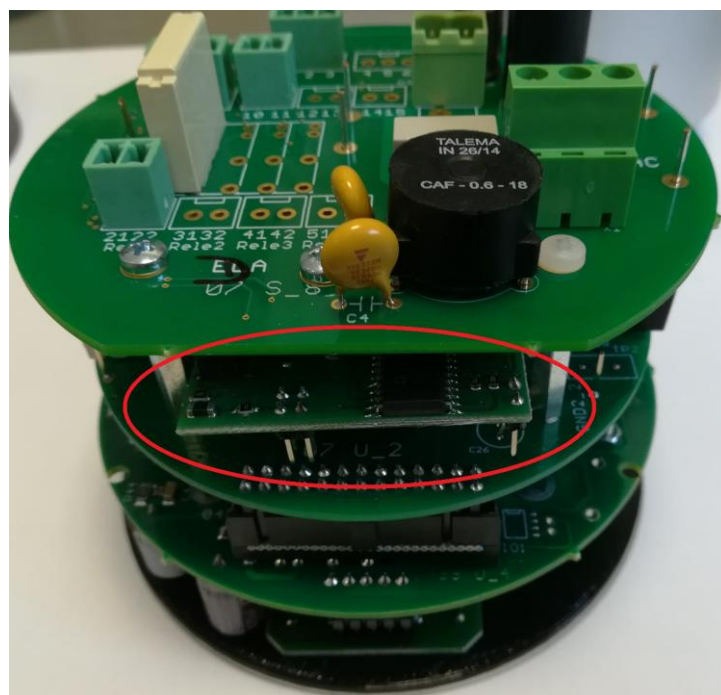


3.1 Module position in the MQU flowmeter

MQU/MHU99

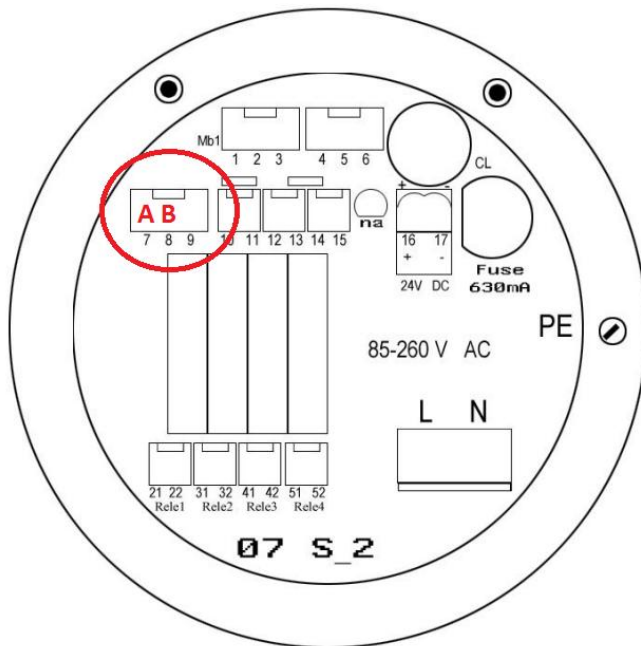


MQU/MHU99-S/C

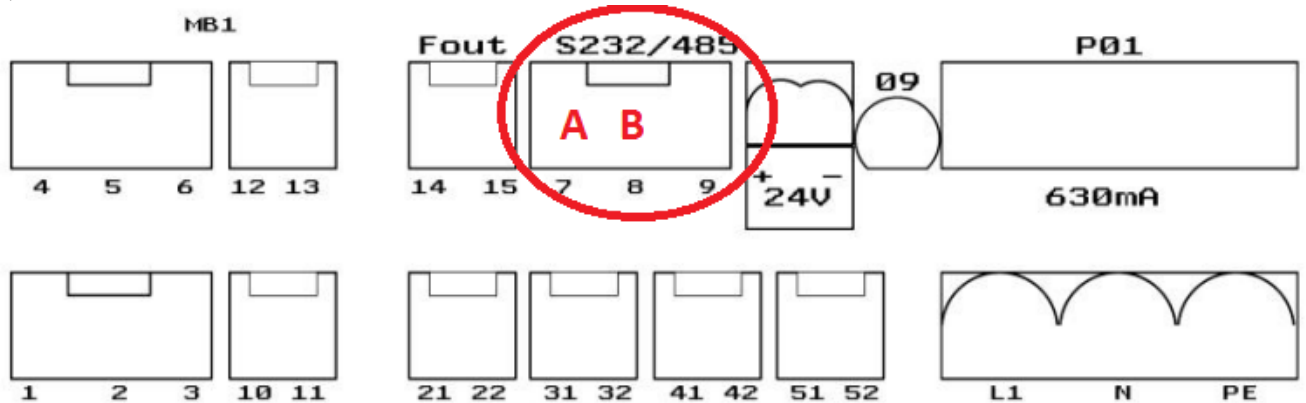


3.2 RS485 MODBUS RTU line connection in the flowmeter

MQU/MHU99-S/C



MQU/MHU99



3.3 Adjusting the communication parameters

Caution:

- All communication parameters of the MODBUS module are adjusted by means of MQU 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 .. 31	Slave address (i.e. MQU 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 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 MODBUS

4.1 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

4.2 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. <u>Caution:</u> 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 processor and the MODBUS module.

4.3 Reading the relays (coils, function code 1)

- Address: 1 – but physically (in PDU) must be 00 00 (hex., 16 bits)
- Number of coils: 4 – physically 00 04 (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

4.4 Reading the communication parameters (registers, function code 3)

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

First register	Value	Unit	Numeric format (see <i>Appendix</i>)	Description
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address			A)	
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 <i>MAIN \ RS 485 \ Device address</i> .
106	Version code	-	inverse longint	This value depends on flowmeter type: for MQU: <i>Firmware version</i> x 1000 + 1

4.5 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“ <i>See caution below.</i>	
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	Failure indicators: bit 0 ... failure at channel „a“ bit 1 ... failure at channel „b“	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	RunFla	-	inverse longint	0 ... service mode	3.2

	g			1 ... measurement mode	
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*) 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).

5 CONTACT



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 8:30 – 18:00 (GMT+1)

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 8:00 – 16:30 (GMT+1))

6 APPENDIX A: Numeric formats for MODBUS module

6.1 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.

6.2 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 <i>single float</i> format		
Low (even)	mantissa bits: 15 .. 0		
High (odd)	sign	exponent: 7 .. 0	mantissa bits: 22..16

Explanations:

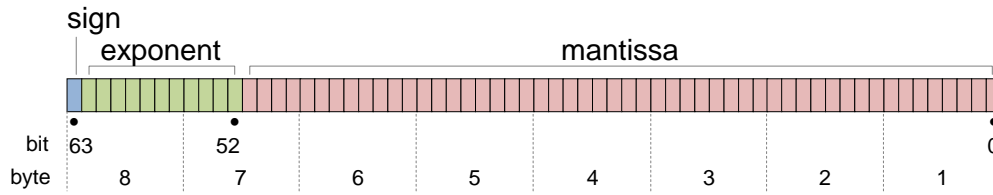
- Sign bit: **0** ... plus, **1** ... minus
- Exponent: Binary exponent increased by 127
- Mantissa: Mantissa value is **1.X**, where **X** is decimal part of mantissa (bits 22..0)

Note:

Every register is transmitted at MSB-first mode.

6.3 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.