MagX1 Modbus Protocol

MAGX1
MODBUS

arkon
flow systems

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1. Introduction

This manual describes the MAGX1 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:
	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	**MagX1 manual**

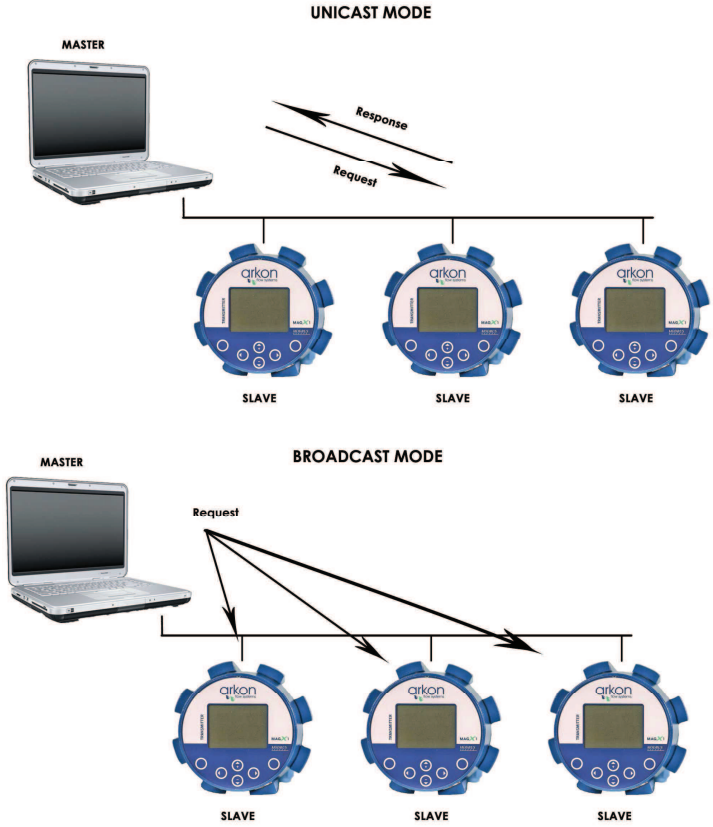
2. Technical data

ARKON Flowmeter MODBUS RTU specification	
Device type	Slave
Baud rates	4800, 9600, 19200, 38400 bits/sec.
Number of stations Recommended:	max. 31 per segment without repeaters
Device address range	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	3 read holding registers
	16 write multiple registers
	17 report slave ID
Broadcast	No
Maximum cable length	Reference 3
Standard MODBUS over serial line v1.0)	
Certified	No

2.1 General MODBUS RTU

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

Among other things, this implies a **master-slave** protocol at level 2 of the OSI model. One node, (the master), issues explicit commands to one of the „slave"-nodes and processes responses. Slave nodes will not transmit data without a request from the master node, and do not communicate with other slaves. MODBUS is a mono **master system**, which means that only one **master** can be connected at 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 ADRESS	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 MagX1 transmitter manual to locate the MODBUS RTU menu. (see Reference 3.)

Item	Value	Comments
Slave address	1-247	Device address [Factory setting: 1]
Baud rate	4800, 9600, 19200, 38400	Communication speed [Factory setting: 9600]
Parity/framing	Even, 1 stopbit	Communication parameters [Factory setting: Even, 1 stopbit]
	Odd, 1 stopbit	
	None, 2 stopbit	
	None, 1 stopbit	
Response delay	0-255 msec.	The minimum time from when a slave receives a request and until it returns a response. This makes it possible to send data to slow masters without overwhelming its receiver. [Factory setting: 0]
Interframe spacing	3.5-25 chars	The minimum interframe space between two MODBUS RTU messages in sequence (specified as 3.5 characters) is configurable. Range: 3.5 - 25 character times. [Factory setting: 3,5]

4. MODBUS addressing module

The module allows R/W access to the following standard MODBUS data register blocks:
• Holding registers

I.e. the module will not support the other standard data register blocks:
• Coils
• „Discrete input“
• „Input registers“

4.1 MODBUS function codes

This device supports following function codes: 3, 16 and 17.

Function code 3 and 16 are used for accessing registers. Function code 17 (report slave ID) will return a structure of identification information of the device. Below the different function code exceptions are described.

Function code 3 (Read holding registers)
General exceptions:
• Requesting less than 1 or more than 125 registers => Exception 3 (Illegal data value)
• Requesting more than max. message size => Exception 2 (Illegal data address)
• Requesting data above/crossing limitation of max. register address (0xFFFF) => Exception 2 (Illegal data address)
• If the end address is only part of a mapped holding register item (e.g. one half of a longint value) => Exception 2 (Illegal data address)

Application exceptions:
• Application errors => Exception 2 (Illegal data address)
Holes/register alignment:
• The read command always returns data if no exception is given. Bad start/end alignment will result in only parts of the data item being read.
• Holes in the holding register map return Exception 2 (Illegal data address)

Function code 16 (Write multiple registers)
General exceptions:
• Exceeding max. message size => Exception 2 (Illegal data address)
• Writing data above/crossing limitation of max. register address (0xFFFF) => Exception 2(Illegal data address)
Application exceptions:
• Application errors => Exception 2 (Illegal data address)
• Application errors include writing to ReadOnly holding registers
Holes / register alignment:
• If start-address is not the start of a mapped holding register => Exception 2 (Illegal data address)
• Writing to holes is not allowed => Exception 2 (Illegal data address)

• If the end address is only part of a mapped holding register item (e.g. one half of a longint value), the action depends on the datatype.
• If the end address is only part of a mapped holding register item (e.g. one half of a longint value) => Exception 2 (Illegal data address)

Function code 17 (Report Slave ID)
• There are no exceptions for this function

5. MODBUS holding registers

In the following the holding registers for the MAGX1 MODBUS RTU module are described.

MODBUS Start Register	Section
2	Password
100	Real-time measurement
1000	Info
1500	Display
2000	User settings
3000	Service settings
4000	Factory settings
5000	Authorize
49998	Data-logger

Holding registers memory map

When writing to the Holding registers, data validity is not checked. Writing incorrect values can result in unexpected behaviour of the device. In any further explanations, the following data types are used:

• Longint – Number consisting of 32 bits, formed by 2 MODBUS registers. It is necessary to write both Low and High Word of this item, the register number always has to be an even number. Not meeting these requirements will cause an Exception 2 error (Illegal data address). In case information about the number of decimals is available, then the final number is given by the following formula: Y = X * 10^(-DEC), where Y is the final number, X the read number, and DEC the number of decimals.

• Bool – this item can be read, but its value has no meaning. Writing value 1 to this item will cause an unspecified operation to be performed (erasing the Memory module, resetting the flow totalisers, etc. Reference 3). It is necessary to write both Low and High Word of this item, the register number always has to be an even number. Not meeting these requirements will cause an Exception 2 error (Illegal data address).

MODBUS register	Data Type	Low/High Word
2	Longint	L
3		H
4	Bool	L
5		H
6	Word	-

Data type memory map

5.1 Password

To enter the "User settings, Service settings, Factory settings, and Authorize" sections, it is necessary to enter a password the same way as for the MAGX1 flowmeter menu, see reference 3.

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
2	1	4	Longint	0	0	9999	Password (user)	R*/W
4	3	4	Longint	0	0	9999	Password (Service)	R*/W
6	5	4	Longint	0	0	9999	Password (Factory)	R*/W
8	7	4	Longint	0	0	9999	Password (Authorize)	R*/W

*) For safety purposes, it is not possible to read this item directly. In case a 0 is read from this register, it means that no valid password was entered, and the given section is not accessible. In case a 1 is read, a valid password was entered and hence the given section can be accessed freely. To close the section, you write any possible invalid password to the password entry.

5.2 Real-time measurement

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
100	99	4	Longint	3	-10^7	10^7	FLOW	R
102	101	4	Longint	0	0	2^32	TOTAL *	R
104	103	4	Longint	6	0	2^32	TOTAL DEC *	R
106	105	4	Longint	0	0	2^32	AUX *	R
108	107	4	Longint	6	0	2^32	AUX DEC *	R
110	109	4	Longint	0	0	2^32	TOTAL+ *	R
112	111	4	Longint	6	0	2^32	TOTAL+ DEC *	R
114	113	4	Longint	0	0	2^32	TOTAL- *	R
116	115	4	Longint	6	0	2^32	TOTAL- DEC *	R
118	117	4	Longint	1	0	2^32	TEMP	R
120	119	4	Longint	-	0	4	FLOW UNIT, 0=UKG/min, 1=USG/min, 2=m3/h, 3=l/min, 4=l/s	R
122	121	4	Longint	-	0	3	VOLUME UNIT, 0=UKG, 1=USG, 2=m3, 3=l	R
124	123	4	Longint	-	0	1	TEMP UNIT, 0=°C, 1=°F	R

*) The final number is given by the sum of the whole and the decimal. Example: Resulting Total measurement = (TOTAL) + (TOTAL DEC*10^-6).

5.3 Info

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
1000	999	4	Longint	0	-	-	Unit No.	R
1002	1001	4	Longint	0	-	-	Sensor Unit No.	R
1004	1003	4	Longint	0	-	-	Error (min)	R
1006	1005	4	Longint	0	-	-	OK (min)	R
1008	1007	4	Longint	0	-	-	Diameter	R
1010	1009	4	Longint	3	-	-	Flow Range	R
1012	1011	4	Longint	2	-	-	FirmWare No.	R
1014	1013	4	Longint	0	-	-	Error Info	R
1016	1015	4	Longint	0	-	-	Power Frequency	R
1018	1017	4	Longint	0	0	1	Module RTC pressent, 0=No, 1=Yes	R
1020	1019	4	Longint	0	0	1	Module Memory pressent, 0=No, 1=Yes	R

5.4 Display

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
1500	1499	4	Longint	-	0	4	Unit Flow (+/-), 0=UKG/min, 1=USG/min, 2=m3/h, 3=l/min, 4=l/s	R/W
1502	1501	4	Longint	-	0	3	Unit Volume, 0=UKG, 1=USG, 2=m3, 3=l	R/W
1504	1503	4	Longint	-	0	1	Unit Temperature 0=°C, 1=°F	R/W
1506	1505	4	Longint	-	0	1	Language, 0=ENG, 1=SPA	R/W
1508	1507	4	Longint	-	0	100	Contrast [%]	R/W

5.5 User settings

To enter this section, please first read chapter 6.1. For an explanation of individual entries, please refer to reference 3.

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
2000	1999	4	Longint	-	0	1	Measurement, 0=Run, 1=Stop	R/W
2002	2001	4	Longint	-	0	1	Air Detector, 0=ON, 1=OFF	R/W
2004	2003	4	Longint	3	0	999	Air Constant	R/W
2006	2005	4	Bool	-	0	1	Datalogger Delete? !!Warning: Move to Service setting, here is not available	NA
2008	2007	4	Bool	-	0	1	Delete Auxiliary Volume ?	R/W
2010	2009	4	Longint	0	0	25	Start Delay	R/W
2012	2011	4	Longint	0	0	60	Samples per Avg.	R/W
2014	2013	4	Longint	-	0	5	Low Flow Cutoff, 0=0.5%, 1=1%, 2=2%, 3=5%, 4=10%, 5=OFF	R/W
2016	2015	4	Longint	3	0	10 000	Flow Qn	R/W
2018	2017	4	Longint	-	0	1	Invert Flow, 0=No-invert, 1=Invert	R/W
2020	2019	4	Longint	-	0	6	Current Loop Setting - Signal, 0=Flow+, 1=Flow-, 2=Error, 3=Air detector, 4=Fixed, 5=Direct driving, 6=OFF	R/W
2022	2021	4	Longint	3	0	10 000	Flow min.	R/W

2024	2023	4	Longint	3	0	10 000	Flow max.	R/W
2026	2025	4	Longint	0	0	20	Current min.	R/W
2028	2027	4	Longint	0	0	20	Current max.	R/W
2030	2029	4	Longint	-	0	6	Voltage Output Setting - Signal, 0=Flow+, 1=Flow-, 2=Error, 3=Air detector, 4=Fixed, 5=Direct driving, 6=OFF	R/W
2032	2031	4	Longint	3	0	10 000	Flow min.	R/W
2034	2033	4	Longint	3	0	10 000	Flow max.	R/W
2036	2035	4	Longint	0	0	10	Voltage min.	R/W
2038	2037	4	Longint	0	0	10	Voltage max.	R/W
2040	2039	4	Longint	-	0	6	Relay 1 Setting - Signal, 0=Flow+, 1=Flow-, 2=Error, 3=Air detector, 4=Fixed, 5=Comparator, 6=OFF	R/W
2042	2041	4	Longint	-	0	4	Relay 1 Comparator Mode, 0=On In, 1=On Out, 2=On>F1, 3=On<F1, 4=OFF	R/W
2044	2043	4	Longint	3	0	10 000	Flow 1	R/W
2046	2045	4	Longint	3	0	10 000	Flow 2	R/W
2048	2047	4	Longint	3	0	10 000	Hysteresis 1	R/W
2050	2049	4	Longint	3	0	10 000	Hysteresis 2	R/W
2052	2051	4	Longint	3	0	99 999	Relay 2 Litres/1 (Q+)	R/W
2054	2053	4	Longint	3	0	99 999	Relay 2 Litres/1 (Q-)	R/W
2056	2055	4	Longint	3	0	99 999	Relay 2 Dosing	R/W

2058	2057	4	Longint	-	0	6	F-out Setting - Signal, 0=Flow+, 1=Flow-, 2=Error, 3=Air detector, 4=Fixed, 5=Direct driving, 6=OFF	R/W
2060	2059	4	Longint	3	0	10 000	Flow min.	R/W
2062	2061	4	Longint	3	0	10 000	Flow max.	R/W
2064	2063	4	Longint	0	0	10 000	F min.	R/W
2066	2065	4	Longint	0	0	10 000	F max.	R/W
2068	2067	4	Longint	-	0	4	Speaker Setting - Signal, 0=Flow+-, 1=Error, 2=Air detector, 3=Fixed, 4=OFF	R/W
2070	2069	4	Bool	-	0	1	Load Default Settings?	R/W
2072	2071	4	Longint	0	0	9 999	Password Setup	R/W
2074	2073	4	Longint	0	0	247	Modbus Slave Address	R/W
2076	2075	4	Longint	-	0	5	Modbus BaudRate, 0=1200, 1=2400, 2=4800, 3=9600, 4=19200, 5=38400	R/W
2078	2077	4	Longint	-	0	3	Modbus Parity, 0=Even 1 stopbit, 1=Odd 1 stopbit, 2=None 2 stopbit, 3=None 1 stopbit	R/W
2080	2079	4	Longint	1	0	250	Modbus Interframe spacing	R/W

2082	2081	4	Longint	0	0	255	Modbus Response delay	R/W
2084	2083	4	Longint	0	0	23	Time - hour	R/W
2086	2085	4	Longint	0	0	59	Time - min	R/W
2088	2087	4	Longint	0	1	31	Date - day	R/W
2090	2089	4	Longint	0	1	12	Date - month	R/W
2092	2091	4	Longint	0	0	99	Date - year, number of years after 2000	R/W
2094	2093	4	Longint	-	0	2	Electrode clean power, 0=Off, 1=On, 2=On Start	R/W
2096	2095	4	Longint	0	1	9999	Electrode clean time [sec.]	R/W
2098	2097	4	Bool	-	0	1	Electrode clean start now!	R/W
2100	2099	4	Longint	0	1	99	F-out Duty cycle [%]	R/W
2102	2101	4	Longint	0	0	1	Totalizer cycling, 0=On, 1=Off	R/W

5.6 Service Settings

To enter this section, please first read chapter 6.1. For an explanation of individual entries, please refer to reference 3.

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
3000	2999	4	Bool	-	0	1	Error Delete?	R/W
3002	3001	4	Bool	-	0	1	OK Delete?	R/W
3004	3003	4	Bool	-	0	1	Delete Volume (-)?	R/W
3006	3005	4	Bool	-	0	1	Delete Volume (+)?	R/W
3008	3007	4	Bool	-	0	1	Delete Volume Total?	R/W
3010	3009	4	Longint	0	0	1	Flow simulation, 0=ON, 1=OFF	R/W
3012	3011	4	Longint	0	0	100	Simulated flow [%]	R/W
3014	3013	4	Bool	-	0	1	Datalogger Delete ?	R/W

5.7 Factory Settings

To enter this section, please first read chapter 6.1. For an explanation of individual entries, please refer to reference 3.

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
4000	3999	4	Longint	0	0	999	L = Diameter	R/W
4002	4001	4	Longint	0	0	< 10^7	Unit No.	R/W
4004	4003	4	Bool	-	0	1	Zero Flow?	R/W
4006	4005	4	Longint	-	0	1	Service Mode, 0=ON, 1=OFF	R/W
4008	4007	4	Bool	-	0	1	Save Settings?	R/W
4010	4009	4	Longint	3	0	10 000	L_Calibration Data1	R/W
4012	4011	4	Longint	3	0	10 000	L_Calibration Data2	R/W
4014	4013	4	Longint	3	0	10 000	L_Calibration Data3	R/W
4016	4015	4	Longint	3	0	10 000	M_Calibration Data1	R/W *
4018	4017	4	Longint	0	0		Measurment Data1	R/W *
4020	4019	4	Longint	3	0	10 000	M_Calibration Data2	R/W *
4022	4021	4	Longint	0	0		Measurment Data2	R/W *
4024	4023	4	Longint	3	0	10 000	M_Calibration Data3	R/W *
4026	4025	4	Longint	0	0		Measurment Data3	R/W *
4028	4027	4	Longint	-	0	1	Excitation frequency, 0=3.125Hz, 1=6.250Hz	R/W
4030	4029	4	Longint	-	0	1	Excitation, 0=ON, 1=OFF	R/W
4032	4031	4	Bool	-	0	1	Zero Flow Erase?	R/W

5.8 Authorize

For access to this section, first read chapter 6.1. For a description of individual items, please note reference 3.

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
5000	4999	4	Longint	0	0	9 999	Password Setup	R/W

5.9 Dataloger

MODBUS register	MODBUS address	No. of bytes	Data type	No. of decimal	Min Value	Max Value	Description	Read/ Write
49 998	49 997	4	Longint	0	0	4095	Page address register	R/W
50 000	49 999	2	Word	-	-	-	1.Word	R
50 001	50 000	2	Word	-	-	-	2.Word	R
..	..	..	..	..	..	..	..	..
50 126	50 125	2	Word	-	-	-	127.Word	R

The MEMORY module provides an address area with a size of 1MB. Addressing is done through pages and offsets. The size of each page is 256 byte, the total number of pages is 4096.

To read data from the module, you should do the following the steps:
• you save the page address to the holding register 49998 (page address register).
• you read any number of data with a maximum size of 127 registers = 256 bytes from the holding registers 50000 to 50126.
• you repeat the above steps until you have read the required data block.

Data are saved to memory in the following way:

Month	January	February	March	April	May	June
Start page address	300	600	900	1200	1500	1800
End page address	599	899	1199	1499	1799	2099
Month	**July**	**August**	**September**	**October**	**November**	**December**
Start page address	2100	2400	2700	3000	3300	3600
End page address	2399	2699	2999	3299	3599	3899

Saving of individual months into the pages

Page address	Description	Page address	Description			Page address	Description
300	5-minute	**600**	5-minute		.	**3600**	5-minute
	248 pages		248 pages		.		248 pages
					.		
					.		
					.		
					.		
					.		
					.		
					.		
					.		
					.		
					.		
					.		
547		**847**			.	**3847**	
548	Hourly	**848**	hourly		.	**3848**	hourly
	31 pages		31 pages		.		31 pages
578		**878**			.	**3878**	
579	daily	**879**	daily		.	**3879**	daily
580	2 pages	**880**	2 pages		.	**3880**	2 pages
581	monthly	**881**	monthly		.	**3881**	monthly
	January		February				December

Saving of individual statistics to pages

5.9.1 Monthly statistics only

Each 5 minutes, the 13B total monthly flow is updated at the beginning of the given page, the rest remains unused. To read the records for total flow for one month it is necessary to read 13byte data from pages 581, 881, 1181....

The following table describes the "monthly" statistics for each month:

Date	Total +	Total-	Measured with error	Records size [B]	Monthly record	Used capacity [B]	Used memory pages
DDMMYY	FFFFFFFF	FFFFFFFF	FFFF	13	1	13	1

5.9.2 Daily statistics only

Each 5 minutes, the total daily flow is updated at the correct location in memory. To read the total flow records, you need to load 2 pages for each month. On each page, there are 15 or 16 data-records as per the following table:

Page address	Number of saved days
579	16
580	15
880	16
881	15
..	..

The "daily" statistics format for each month is as per the following table:

Date	Total +	Total-	Measured with error	Record size[B]	Data-records per month	Used capacity [B]	Used memory pages
DDMMYY	FFFFFFFF	FFFFFFFF	FFFF	13	31	403	2

5.9.3 Hourly statistics only

Each 5 minutes, the total hourly flow is updated at the correct location in memory. To read the total flow records, you need to load 31 pages for each month. On each page, there are 24 data-records = 1 day. Individual records are saved after each other.

The "hourly" statistics format for each month is as per the following table:

Date	Time	Total +	Total-	Measured with error	Record size[B]	Data-records per month	Used capacity [B]	Used memory pages
DDMMYY	HHMM	FFFF	FFFF	FF	10	744	7440	30

5.9.4 Five minutes statistics only

In order to read the 5-minute average flow-records, it is necessary to read 31 pages for each month. On each page are 36 records = 3 hours. Individual records are saved after each other.

The "5-minute" statistics format for each month is as per the following table:

Date	Time	5-minute average flow	Record size[B]	Data-records per month	Used capacity [B]	Used memory pages
DDMMYY	HHMM	FFFF	7	8928	62496	248