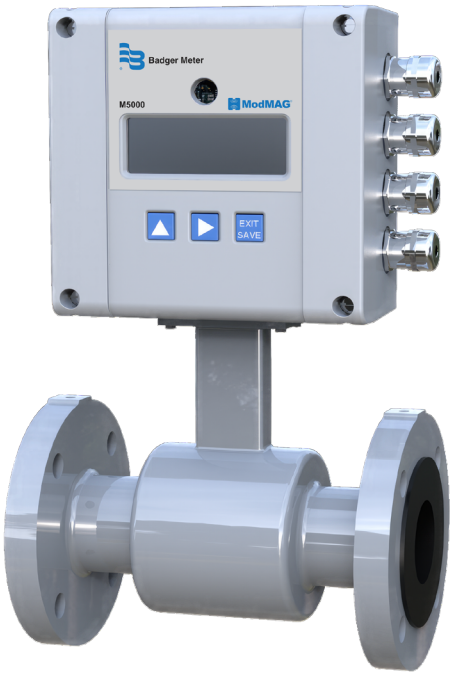
ModMAG®
M-Series® | Electromagnetic Flow Meters

Electromagnetic Flow Meters

M5000 M-Bus Communication Protocol



Badger Meter

MAG-UM-04281-EN-02 (April 2024)

User Manual

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BASIC SAFETY RECOMMENDATION

Please see "*Basic Safety Recommendations*" in the *ModMAG M5000 User Manual*.

INTRODUCTION

The M-Bus interface provides an EN13757-compatible M-Bus interface to the M5000 flow meter with the following features:

- M-Bus primary and secondary address selection
- The primary address is saved in a non-volatile memory
- 300, 2400 and 9600 baud communication speed
- Automatic baud rate detection
- Standard M-Bus serial communication parameters: 8 data bits, 1 parity even bit, 1 stop bit.
- Five different M-Bus response telegrams with different meter values (according to EN13757-3, chapter 4.22, table 2):
  - ◊ All
  - ◊ Instantaneous values
  - ◊ Testing
  - ◊ Calibration
  - ◊ Manufacturing
- M-Bus wrapper command for Modbus® communication

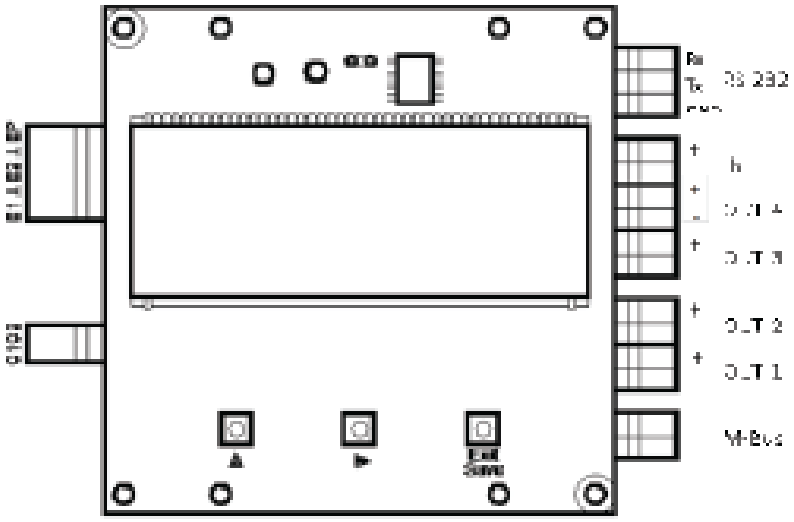
METER SETTINGS

Please check following meter settings:
MainMenu > Communication > Interface > M-Bus

MainMenu > Communication > M-Bus > Address > 0

ELECTRICAL CONNECTION

Terminal	Description
X11/1	M-Bus
X11/2	M-Bus
No Polarity	



M-BUS ADDRESSING

Primary Address

The module may be addressed using its primary address (range: 0…250). The default (factory setting) primary address of the module is 0 (zero). The primary address can be reconfigured using the appropriate M-Bus command (see below).

Secondary Address

The module may be addressed using the secondary address selection scheme of M- Bus. The secondary address consists of:

- PCB serial number (8 digits BCD)
- Manufacturer code (BMI, 0x09A9)
- Generation (0x01)
- Measured medium (0x07, cold water)

Example:

```
19100995,09A9,01,07
```

Any wildcard selection using the joker character ('F') is also possible:

```
19100995,FFFF,FF,FF
1910FFFF,FFFF,FF,FF
19100995,FFFF,FF,07
```

etc.

M-Bus Commands

Since the device has got only two SND_UD commands, it is not possible to send multiple commands within one M-Bus telegram.

Setting Primary Address

The default (factory setting) primary address of the module is 0 (zero). You may program any other primary address in the range of 1 to 249 by using the standard M- Bus SND_UD command for primary address setting:

Request (values in hex):

```
68 06 06 68 73/53 PAddr 51 01 7A NewAddr ChkS 16
```

Answer (values in hex):

```
E5
```

PAddr: Current primary address of the device

NewAddr: New primary address to program

NOTE: The primary address is immediately written in the non-volatile flash memory of the module. The number of write cycles of the flash memory is limited.

Slave Select

This command selects slave and can be used for testing communication.

```
Slave Select Request
68 0B 0B 68 53 FD 52 FF FF FF FF FF FF FF FF 9A 16
```

Where:

```
68                Start of Long Frame
0B 0B       L Field
68                Start
53                C Field     SND_UD
FD                A Field
52                CI Field - selection of slaves
FF FF FF FF S/N - no filter
FF FF       Manufacturer - no filter
FF    Generation - no filter
FF    Medium - no filter
9A    Check Sum
16    Stop
```

Slave Select Answer

```
E5
```

Changing M-Bus Response Telegram

The module may answer an M-Bus REQ_UD2 (request user data 2) telegram with one of five different M-Bus RSP_UD (respond user data) telegrams, according to EN13757-3 chapter 4.22 table 2:

- All
- Instantaneous values
- Testing
- Calibration
- Manufacturing

The telegram is selected by sending the appropriate M-Bus application reset telegram.

Request (values in hex):

68	03		03	68	73/53	PAddr	50	ChkS	16	set "All" telegram
68	04		04	68	73/53	PAddr	50	00 ChkS	16	set "All" telegram
68		04	04	68	73/53	PAddr	50	50 ChkS	16	set "Instantaneous" telegram
68		04	04	68	73/53	PAddr	50	90 ChkS	16	set "Testing" telegram
68		04	04	68	73/53	PAddr	50	A0 ChkS	16	set "Calibration" telegram
68		04	04	68	73/53	PAddr	50	B0 ChkS	16	set "Manufacturing" telegram

Answer to all of the above requests (values in hex):

```
E5
```

The next (and all the following) REQ_UD2 requests are then answered with the selected telegram.

NOTE: The RSP_UD telegram setting is not written immediately in the non-volatile flash memory of the module but only:

- On the cyclic 24 hours reset
- Or if a set primary address command has been received and executed
- Or if the command to write the configuration area to flash has been received and executed.

Write Configuration Area to Flash

The module has got a configuration area which holds settings for e.g. the primary address, the selected answer telegram etc. These settings are kept in volatile RAM memory unless they are written in the non-volatile flash memory. If the user wants to save the configuration in the non-volatile memory, he may execute the command below:

Request (values in hex):

```
68 06 06 68 73/53 PAddr 51 00 FE 00 ChkS 16
```

save configuration to flash

Answer (values in hex):

```
E5
```

Send Modbus Commands

Since not all of the Modbus registers of the M5000 are retrievable using *native* M-Bus commands, it is also possible to encapsulate *native* Modbus commands within an M-Bus command. It is then possible to use all the Modbus commands understood by the M5000 (0x03, 0x04, 0x06 and 0x10, register reading and writing) with an M-Bus interface, too.

Request (values in hex):

```
68 LL LL 68 73/53 PAddr 51 0F [ModBus] ChkS 16
```

send Modbus command

LL: Length byte of M-Bus telegram

[ModBus]: Modbus command without CRC

Example:

```
68 0A 0A 68 73/53 PAddr 51 0F 01 03 00 43 00 05 ChkS 16
```

The underlined part is the Modbus command for reading the address 0x0043 (5 registers) of the M5000.

Answer (values in hex):

```
68 LL LL 68 08 PAddr 72 SecAddr AccessCtr Status Signature
0F [ModBus] ChkS 16
```

Example:

```
68 1D 1D 68 08 00 72 95 09 10
19 A9 09 01 07 08 01 00 00 Header for M-Bus RSP_UD
0F Flag: manufacturer specific
01 03 0A 31 39 31 30 30 39 39 35 00 00 Modbus answer
ChkS 16
```

NOTE: These commands are compatible with M-Bus physical and link layers, but not completely compatible with the application layer. Therefore, all standard M-Bus communication lines will transmit the command, however, the software on the application side must be able to understand and interpret the command.

M-Bus REQ_UD2 Answers

As mentioned before, the module may answer a REQ_UD2 data request by five different RSP_UD answers according to its configuration:

All: Contains the volumes, flow rate, flow speed, flow direction, etc.

Instantaneous: Contains a short form of "All" with only the volumes, flow rate and flow direction (smaller telegram = faster reading)

Testing: Contains the meter diagnostic counters of the M5000

Calibration: Contains the meter calibration registers of the M5000

Manufacturing: Contains the product identification registers of the M5000

Parameters or data are in the following manual identified with a PID (Parameter Ident) in front of the number, where the information is stored.

M-Bus Short Frame Format (REQUEST)

Example Value (hex)	Meaning
10	Start of Short Frame
5B or 7B	C-Field REQ_UD2
A-Field	Address field
Check Sum	Check Sum
16	Stop

M-Bus Long Frame Format (ANSWER)

PID	Example Value	Description
LF-01	68	Start of Long Frame
LF-02	L-Field	Length Field
LF-03	L-Field	Length Field
LF-04	68	Start of Long Frame (2nd)
LF-05	8	Function field RSP_UD
LF-06	A-Field	A-Field Primary Address
LF-07	72	Control information field - variable data respond
LF-08	0	Identification Number LSB
	0	Identification Number
	0	Identification Number
	0	Identification Number MSB
LF-09	A9	Manufacturer code LSB
	9	Manufacturer code MSB
LF-10	1	Generation
LF-11	7	Medium (cold water)
LF-12	Access counter	Access counter
LF-13	0	M-Bus Status byte
LF-14	0	Signature LSB
	0	Signature LSB
LF-15	—	Data records, see following sections
LF-16	Check Sum	Check Sum
LF-17	16	Stop

All

PID	Parameter/Data	Unit/ Format	Data	Function field	Unit	Tariff	Storage	Data Record Header			
								DIB		VIB	
								DIF	DIFE	VIF	VIFE
A-01	Totalizer T1+	0.001 m^3	REAL4	Inst.	0	0	0	05	—	13	—
A-02	Totalizer T1-	0.001 m^3	REAL4	Inst.	1	0	0	85	40	13	—
A-03	Totalizer T1N	0.001 m^3	REAL4	Inst.	2	0	0	85	80 40	13	—
A-04	Totalizer T2+	0.001 m^3	REAL4	Inst.	3	0	0	85	C0 40	13	—
A-05	Totalizer T2-	0.001 m^3	REAL4	Inst.	4	0	0	85	80 80 40	13	—
A-06	Totalizer T2N	0.001 m^3	REAL4	Inst.	5	0	0	85	C0 80 40	13	—
A-07	Flow velocity	mm/s	REAL4	Inst.	0	0	0	05	—	7C	14 5D 73 2F 6D 6D 5B 20 79 74 69 63 6F 6C 65 76 2D 77 6F 6C 66
A-08	Flow rate	0.01 m^3/h	REAL4	Inst.	0	0	0	05	—	3C	—
A-09	Customer Ident No	YYBMMNN NNN	Var.	Inst.	0	0	0	0D	—	FD	11
A-10	Total operating time	h	INT4	Inst.	0	0	0	04	—	26	—
A-11	Error timer	h	INT4	Inst.	0	0	0	04	—	A6	18
A-12	Alarm flags	binary	INT1	Inst.	0	0	0	01	—	FD	17
A-13	Actual date and time	DD.MM.YY mm:hh	INT4	Inst.	0	0	0	04	—	6D	—
A-14	Used battery capacity	Ah	REAL4	Inst.	0	0	0	05	—	7C	02 68 41
A-15	Initial battery capacity	Ah	REAL4	Inst.	0	0	1	45	—	7C	02 68 41
A-16	Actual battery capacity	%	INT2	Inst.	0	0	0	02	—	7C	01 25
A-17	Remaining Battery lifetime	days	REAL4	Inst.	0	0	0	05	—	FD	6D
A-18	Error flags	binary	INT2	Inst.	0	0	0	02	—	FD	17
A-19	Power on	Counter	INT4	Inst.	0	0	0	04	—	FD	61
A-20	Start flow overflow Q4	DD.MM.YY mm:hh	INT4	Inst.	0	0	0	04	—	96	4E
A-21	End flow overflow Q4	DD.MM.YY mm:hh	INT4	Inst.	0	0	0	04	—	96	4F
A-22	Flow overflow timer	h	INT4	Inst.	0	0	0	04	—	96	5E
A-23	Measuring error	Counter	INT4	Inst.	0	0	14	84	07	FD	61
A-24	Not Implemented - Temp. out of range	Counter	INT4	Inst.	0	0	15	C4	07	FD	61
A-25	Empty pipe	Counter	INT4	Inst.	0	0	16	84	08	FD	61
A-26	Flow overflow	Counter	INT4	Inst.	0	0	17	C4	08	FD	61
A-27	Empty pipe timer	h	INT4	Inst.	0	0	16	84	08	A6	18

Instantaneous Values

PID	Parameter/Data	Unit/Format	Data	Function Field	Unit	Tariff	Storage	Data Record Header			
								DIB		VIB	
								DIF	DIFE	VIF	VIFE
I-01	Totalizer T1+	0.001 m^3	REAL4	Inst.	0	0	0	05	—	13	—
I-02	Totalizer T1-	0.001 m^3	REAL4	Inst.	1	0	0	85	40	13	—
I-03	Totalizer T1N	0.001 m^3	REAL4	Inst.	2	0	0	85	80 40	13	—
I-04	Totalizer T2+	0.001 m^3	REAL4	Inst.	3	0	0	85	C0 40	13	—
I-05	Totalizer T2-	0.001 m^3	REAL4	Inst.	4	0	0	85	80 80 40	13	—
I-06	Totalizer T2N	0.001 m^3	REAL4	Inst.	5	0	0	85	C0 80 40	13	—
I-07	Flow rate	0,01 m^3/h	REAL4	Inst.	0	0	0	05	—	3C	—
I-08	Alarm flags	binary	INT1	Inst.	0	0	0	01	—	FD	17

Testing

PID	Parameter/Data	Unit	Data field	Function Field	Unit	Tariff	Storage	Data Record Header			
								DIB		VIB	
								DIF	DIFE	VIF	VIFE
T-01	Valid flow measurement	Counter	INT2	Inst.	0	0	14	82	07	FD	61
T-02	Empty pipe Meas. Counter	Counter	INT2	Inst.	0	0	2	82	01	FD	61
T-03	Used battery capacity	Ah	REAL4	Inst.	0	0	0	05	—	7C	02 68 41
T-04	Initial battery capacity	Ah	REAL4	Inst.	0	0	1	45	—	7C	02 68 41
T-05	Battery voltage	V	REAL4	Inst.	0	0	0	05	—	FD	49
T-06	Error flags	binary	INT2	Inst.	0	0	0	02	—	FD	17
T-07	Actual battery capacity	%	INT2	Inst.	0	0	0	02	—	7C	01 25
T-08	Total operating time	s	INT4	Inst.	0	0	0	04	—	20	—
T-09	Remaining Battery lifetime	years	REAL4	Inst.	0	0	0	05	—	FD	6F
T-10	Power on	Counter	INT4	Inst.	0	0	0	04	—	FD	61
T-11	Start flow overflow Q4	DD.MM.YY mm:hh	INT4	Inst.	0	0	0	04	—	96	4E
T-12	End flow overflow Q4	DD.MM.YY mm:hh	INT4	Inst.	0	0	0	04	—	96	4F
T-13	Flow overflow timer	h	INT4	Inst.	0	0	0	04	—	96	5E
T-14	Measuring error	Counter	INT4	Inst.	0	0	14	84	07	FD	61
T-15	Not Implemented - Temp. out of range	Counter	INT4	Inst.	0	0	15	C4	07	FD	61
T-16	Empty pipe	Counter	INT4	Inst.	0	0	16	84	08	FD	61
T-17	Flow overflow	Counter	INT4	Inst.	0	0	17	C4	08	FD	61
T-18	Alarm flags	binary	INT1	Inst.	0	0	0	01	—	FD	17
T-19	Empty pipe timer	h	INT4	Inst.	0	0	16	84	08	A6	18

Calibration

PID	Parameter/Data	Unit	Data	Function Field	Unit	Tariff	Storage	Data Record Header			
								DIB		VIB	
								DIF	DIF E	VIF	VIF E
C-01	Detector size	mm	INT2	Inst.	0	0	0	02	—	7C	02 6D 6D
C-02	Detector factor	—	REAL4	Inst.	0	0	2	85	01	FD	3A
C-03	Detector offset	m/s	REAL4	Inst.	0	0	2	85	01	7C	03 73 2F 6D
C-04	Amplifier factor	—	REAL4	Inst.	0	0	4	85	02	FD	3A
C-05	Coil current	A	REAL4	Inst.	0	0	0	05	—	FD	5C
C-06	Power line freq.	Hz	INT1	Inst.	0	0	0	01	—	7C	02 7A 48
C-07	Measurement period	s	INT1	Inst.	0	0	0	01	—	70	—
C-08	Scale factor	—	REAL4	Inst.	0	0	6	85	03	FD	3A

Manufacturing

PID	Parameter/Data	Unit	Data	Function Field	Unit	Tariff	Storage	Data Record Header			
								DIB		VIB	
								DIF	DIFE	VIF	VIFE
M-01	Product code	—	INT1	Inst.	0	0	0	01	—	FD	0C
M-02	Product name	—	Var.	Inst.	0	0	0	0D	—	FD	0C
M-03	Firmware name	—	Var.	Inst.	0	0	1	4D	—	FD	0C
M-04	Application version	—	Var.	Inst.	0	0	0	0D	—	FD	0F
M-05	Compile date	MM:DD: YYYY	Var.	Inst.	0	0	0	0D	—	FD	3A
M-06	Compile time	HH:MM:SS	Var.	Inst.	0	0	1	4D	—	FD	3A
M-07	OTP boot checksum	—	Var.	Inst.	0	0	2	8D	01	FD	3A
M-08	Flash OS checksum	—	Var.	Inst.	0	0	3	CD	01	FD	3A

Alarm Flags

PID	Alarm flag	BIT	Description
A-12 I-08 T-18	Reverse flow 35 d	0	The meter detects reverse flow and triggers the reverse flow alarm. The alarm remains active for 35 days. The alarm automatically clears after 35 days if the condition has not recurred.
	Reverse flow	1	The meter detects reverse flow and triggers the reverse flow alarm. The alarm remains active as long as reverse flow is detected and will automatically cleared after the condition no longer exists.
	30 day no usage	2	No measured flow in past 30 days. The alarm automatically clears once flow occurs.
	Meter alarm	3	If any error of the meter occur (except empty pipe) this alarm is triggered. The alarm automatically clears once the error condition no longer exists.
	Suspected leak	4	Meter detects 24 hours without one 15-minute interval of no flow. The alarm clears automatically when a 15-minute no-flow interval occurs.
	Empty pipe	5	Pipe is empty (Air in the pipe)
	Battery alarm	6	Remaining battery life is shorter than 1 year
	Flow overflow alarm	7	Actual flow is higher than Q3 (full scale)

Error Flags

PID	Error flag	BIT	Description
T-06	Low battery	0	When bit is set, the battery voltage is low. Consider replacement of battery
	HW Error	1	When bit is set there is a problem detected with the hardware. Contact Badger Meter Technical support.
	Empty pipe	2	When bit is set the detector pipe is empty.
	CM Voltage	3	When bit is set the common mode voltage measurement is too small or too large, typically signifying empty detector or dirty electrodes.
	ADC overflow	4	When bit is set the ADC measurement is out of range. Contact Badger Meter technical support.
	Coil error	5	When bit is set a coil error is detected. Coils aren't connected or the coils are shorted, or there is an issue with the coil current.
	Flow Overload	6	When bit is set the measured flow exceeds the full scale flow value by 100% or more.
	Disk Error	7	When the bit is set the configuration file is missing due to an internal failure. Replace the circuit board.
	Config Error	8	When the bit is set the configuration file is corrupted due to an internal failure. Replace the circuit board.
	Pulse Overload	9	When the bit is set, an overflow occurred on the pulse output. Reduce the output pulse rate.
	Partial Filled Pipe	10	When the bit is set, empty pipe function is disabled and pipe is detected as partially filled, or electrodes are no longer covered with liquid or missing a signal reference.
	Not used	11	Bit not used.
	Not used	12	Bit not used.
	Flow direction	13	Bit indicates the direction of flow. Bit set = reverse flow. Bit not set = forward flow.

TECHNICAL DATA

The M-Bus interface provides an EN13757-compatible M-Bus interface to the ModMAG M5000 flow meter

M-Bus Interface	2-wire EN13757 compatible M-Bus interface 300, 2400, 9600 baud auto-baud detection 8 data bits 1 stop bit 1 even parity bit 1 M-Bus unit load (1.5 mA) 15 mA active M-Bus current M-Bus input with reversible mains protection 2-pin clamp
Isolation	2500 V RMS isolation between M-Bus interface and B-MAG I M5000

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