ModMAG®
M-Series® | Electromagnetic Flow Meters

Electromagnetic Flow Meters

M1000 Modbus Map

Badger Meter
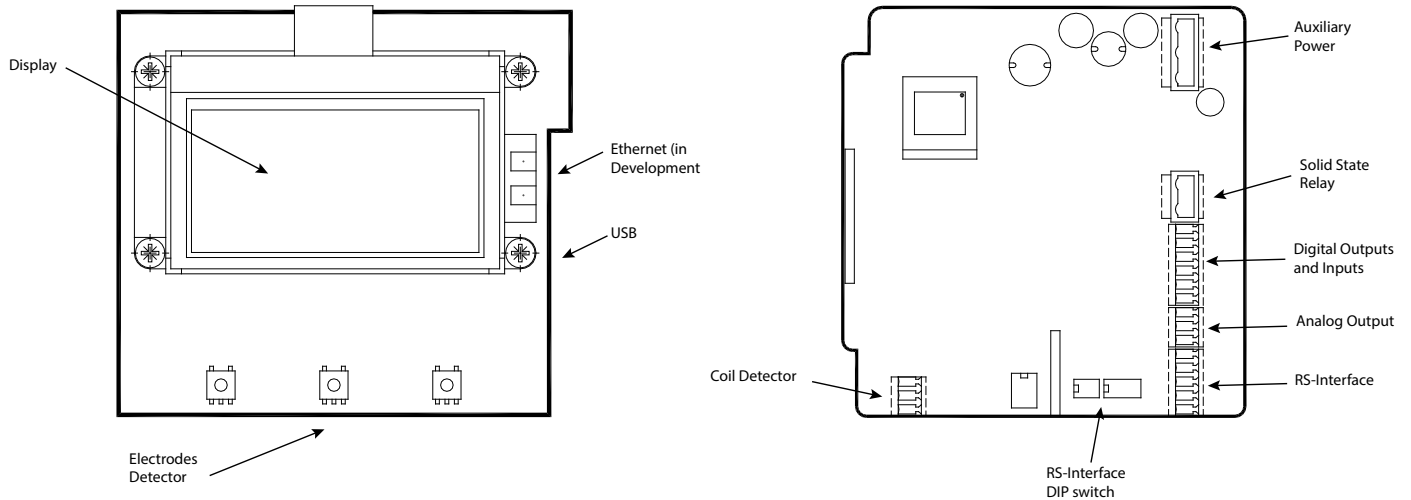
Installation Manual

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SCOPE OF THIS MANUAL

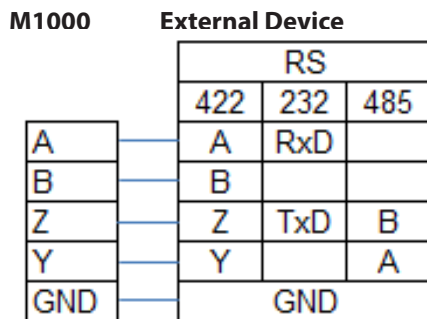This manual is designed to instruct on how to set up the M1000 Flow Meter for Modbus communications.

OVERVIEW

The M1000 supports Modbus RTU communications. Physical layers are: RS-232, RS-422, RS-485, USB CDC, and Ethernet (if assembled).

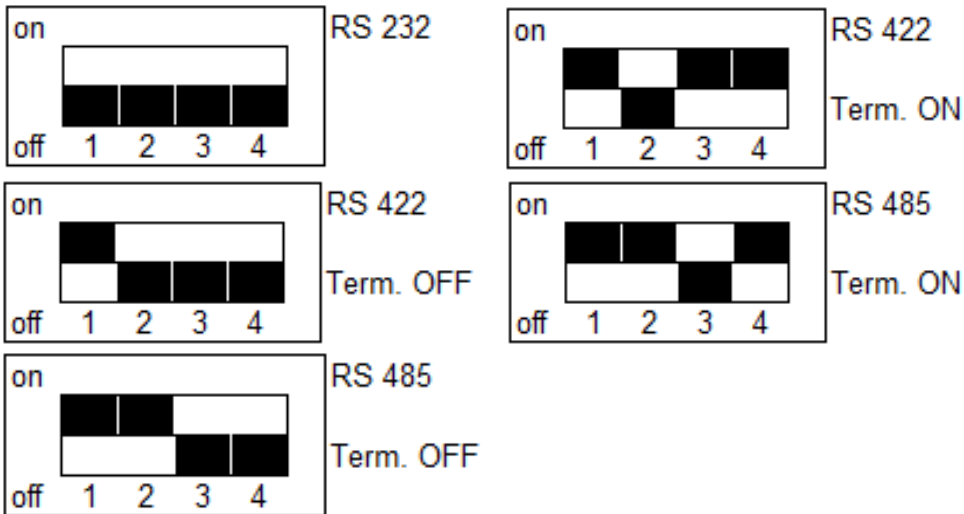## Wiring

Wiring diagram for RS232, RS422, and RS485

M1000   **External Device**

	RS		
	422	232	485
A	A	RxD	
B	B		
Z	Z	TxD	B
Y	Y		A
GND		GND	

Interface Mode Selection and Termination of the Bus

RS232, RS485 and RS422 with Modbus® RTU.

Mode can be configured by DIP switches. Each terminal can be switched ON or OFF.

REGISTERS

Register Name

Register Name, when applicable, describes the parameter so it can be associated within the display menu items. Please note, not all registers can be modified directly by the menu manager. Some registers are not accessible via the menu manager.

Register Security

Register Security identifies the security level required for the register to be reprogrammed. This feature does not prevent reading of the register. Registers listed with ADMIN, SERVICE or USER security levels are unprotected if no PIN is set for the meter. There are several different levels of security:

- **READ-ONLY** – Only the flow meter firmware can update the register
- **FACTORY** – Registers can only be written by the factory
- **ADMIN** – Register requires administrator level access
- **SERVICE** – Register requires service level access
- **USER** – Register requires user level access

All registers can be protected by enabling security on the flow meter. Once the flow meter is secured, all registers are write-protected unless remote privilege is granted. All read accesses to registers are still accepted when the flow meter is secured. Obtaining remote privilege for write operations requires a sequence of Modbus actions to take place. The remote login process is encrypted to protect the login PINs.

1. Read the random value register (Address 0x012B).
2. Perform necessary calculations (contact Badger Meter for details).
3. Write the remote login register (Address 0x012F).

A support application has been written to perform this process and is embedded within the main application software used to access the flow meter.

Register Address

Register Address defines the physical address that is required to be transmitted over the Modbus RTU serial link. Some third-party applications require the use of logical addressing when communicating over Modbus. The logical address determines the Modbus function code that is transmitted over the serial link.

Logical address range 4xxxx is supported. Logical address range 4xxxx issues the Read Holding Register function code 0x03. All logical addresses start at index 1 (example, 40001).

For example, suppose the application requires logical addressing and is targeting to access the "Flow Rate [User Units]" register. The physical address for this register is 0xF1 or 241d. This register can be read from logical address 40242. The logical address is calculated by adding the physical address to the logical start address (40001).

> 40001 + 241 = 40242 (Issues function code 0x03 – Read Holding Register)

Register Type

Register Type identifies the number of registers the parameter requires. Each register is 16 bits. Supported Register Types include:

Register type	Description	Number of Modbus registers
HEXADECIMAL[x]	Unsigned Character (16 bits)	x
UCHAR8[x]	Unsigned Character Array	x/2
UINT16	Unsigned Integer (16 bits)	1
UINT64	Unsigned Integer (64 bits)	4
UINT32	Unsigned Integer (32 bits)	2
FLOAT32	Floating Point (32 bits)	2

For FLOAT32 register types, these registers make use of IEEE-754 floating point standard. For example, 1.0 is transmitted as 0x3F800000. Modbus serial link transmits the most significant byte first, 0x3F, followed by 0x80, 0x00, 0x00.

Support Function Codes

Following table identifies the Modbus function codes (commands) available to access the register. Supported Modbus function codes include:

Modbus function code	Description
0x03	Read holding register
0x10	Write multiple registers

IMPORTANT

Write function codes update only the working register located in volatile memory. Any sequence of writes must be followed by a write of value 0x01 to the "Command Action Request Register", address 0x0125. Otherwise changes will be lost if the flow meter is power cycled or reset.

It is not possible with read function code 0x03 to read blocks of registers. Read multiple registers in one transmission is not allowed.

M1000 MEMORY MAP BY REGISTER ADDRESS

Register Address	Register Name		Register Type	Security	Stored in Non-volatile Memory
0x0000	Product code	4 : M1000R	UINT16	Read-Only	
0x0001	HW name		UCHAR8[16]	Read-Only	
0x0009	FW name		UCHAR8[32]	Read-Only	
0x0019	Application version		UCHAR8[20]	Read-Only	
0x0023	Compile date		UCHAR8[32]	Read-Only	
0x0033	Compile time		UCHAR8[32]	Read-Only	
0x0043	Identification number		UCHAR8[10]	Factory	Yes
0x0048	OTP boot checksum		UCHAR8[6]	Read-Only	
0x004B	Flash OS checksum		UCHAR8[6]	Read-Only	
0x006F	Detector Diameter	1: 6mm -1/8inch 2: 8mm -1/4inch 3: 10mm -3/8inch 4: 15mm -1/2inch 5: 20mm -3/4inch 6: 25mm -1inch 7: 32mm -1 1/4inch 8: 40mm -1 1/2inch 9 : 50mm -2inch 10 : 65mm -2 1/2inch 11 : 80mm -3inch 12 : 100mm -4inch 13 : 125mm -5inch 14 : 150mm -6inch 15 : 200mm -8inch 16 : 250mm -10inch 17 : 300mm -12inch 18 : 350mm -14inch 19 : 400mm -16inch 20 : 450mm -18inch 21 : 500mm -20inch 22 : 550mm -22inch 23 : 600mm -24inch 24 : 700mm -28inch 25 : 750mm -30inch 26 : 800mm -32inch 27 : 900mm -36inch 28 : 1000mm -40inch 29 : 1050mm -42inch 30 : 1200mm -48inch 31 : 1400mm -54inch 32 : 1600mm -64inch 33 : 1800mm -72inch 34 : 2000 mm -80 inch	UINT16	Factory	Yes
0x0071	Detector factor		FLOAT32	Factory	Yes
0x0075	Detector offset [m/s]		FLOAT32	Factory	Yes
0x0079	Amplifier factor		FLOAT32	Factory	Yes
0x007D	Detector current [mA]		FLOAT32	Factory	Yes
0x0081	Power line frequency [Hz]	0 : 50Hz 1 : 60Hz	UINT16	User	Yes

Register Address	Register Name		Register Type	Security	Stored in Non-volatile Memory
0x0082	Excitation frequency	1 : 3.125/3.75 Hz 2 : 6.25/7.5 Hz 3 : 12.5/15 Hz 4 : 2.083/2.5 Hz 5 : 1.042/1.25 Hz 6 : 0.833/0.833 Hz	UINT16	Service	Yes
0x0083	Flow unit	0 : LPS-liter/sec 1 : LPM-liter/min 2 : LPH-liter/hour 3 : M3S-cu.meter/sec 4 : M3M-cu.meter/min 5 : M3H-cu.meter/hour 6 : F3S-cu.ft./sec 7 : F3M-cu.ft./min 8 : F3H-cu.ft./hour 9 : GPS-gal./sec 10 : GPM-gal./min 11 : GPH-gal./hour 12 : MGD-mega gal/day 13 : IGS-UKG/sec 14 : IGM-UKG/min 15 : IGH-UKG/hour 17 : OPM-oz./min 18 : BPM-barrel/min	UINT16	User	Yes
0x0084	Totalizer unit	0 : L-liters 1 : HL-hectoliters 2 : M^3-cubic meters 3 : Ft^3-cu. feet 4 : USG-US gallons 5 : MG-mega gallons 6 : MG-mega gallons 8 : Oz.-fl. ounces 9 : Aft-acre feet 10 : bbl-barrel	UINT16	User	Yes
0x0086	Full scale velocity [m/s]		FLOAT32	Factory	Yes
0x008E	Low flow cutoff [%]		FLOAT32	Admin	Yes
0x0090	Full scale flow [User Units]		FLOAT32	Factory	Yes
0x0092	Flow direction	0 : UniDirectional 1 : BiDirectional	UINT16	Factory	Yes
0x0094	Digital Input: function	0 : None 1 : Remote reset 2 : Positive zero return 3 : Batch reset 4 : ADE	UINT16	Service	Yes
0x0095	Analog output range	1 : 4 -20 mA 2 : 0 -20 mA 3 : 0 -10 mA 4 : 2 -10 mA	UINT16	Service	Yes
0x00A3	Output #1: Mode	0 : Normally open 1 : Normally closed	UINT16	Service	Yes

Register Address	Register Name		Register Type	Security	Stored in Non-volatile Memory
0x00A4	Output #1: Function	0 : Off 1 : Flow Alarm 2 : Empty Pipe Alarm 3 : Error Alarm 4 : Pulse Forward 6 : Pulse Reverse 8 : Preset Batch Output 9 : Direction 10 : Verification Test 11 : Ade 12 : Loopback	UINT16	Service	Yes
0x00B0	Output #2: Mode	0 : Normally Open 1 : Normally Closed	UINT16	Service	Yes
0x00B1	Output #2: Function	0 : Off 1 : Flow Alarm 2 : Empty Pipe Alarm 3 : Error Alarm 4 : Pulse Forward 6 : Pulse Reverse 9 : Direction 10 : Verification Test 12 : Loopback	UINT16	Service	Yes
0x00E9	Flow velocity [M/S]		FLOAT32	Read-Only	
0x00ED	Flow rate [M3/S]		FLOAT32	Read-Only	
0x00F1	Flow rate [User Units]		FLOAT32	Read-Only	
0x010B	Scale factor [%]		FLOAT32	Service	Yes
0x0114	Menu Language Setting	0 : English 1 : German 2 : Czech 3 : Spanish 4 : French 5 : Russian 6 : Italian	UINT16	User	Yes
0x0115	Analog input measure value		FLOAT32	Read-Only	
0x0119	Analog input measure counter		UINT16	Read-Only	
0x011A	Empty pipe actual resistance [Ohms]		FLOAT32	Read-Only	
0x0124	Empty pipe mode	0 : Off 1 : On	UINT16	Admin	Yes
0x0125	Command action request		UINT16	Admin	
0x0126	Analog output calibration point A [mA]		FLOAT32	Factory	Yes
0x0128	Analog output calibration point B [mA]		FLOAT32	Factory	Yes

Register Address	Register Name		Register Type	Security	Stored in Non-volatile Memory
0x012A	Flow simulation	0 : 0.0% 10 : + 10.0% 20 : + 20.0% 30 : + 30.0% 40 : + 40.0% 50 : + 50.0% 60 : + 60.0% 70 : + 70.0% 80 : + 80.0% 90 : + 90.0% 100 : +100.0% 65408 : Off 65436 : -100.0% 65446 : -90.0% 65456 : -80.0% 65466 : -70.0% 65476 : -60.0% 65486 : -50.0% 65496 : -40.0% 65506 : -30.0% 65516 : -20.0% 65526 : -10.0%	UINT16	Service	
0x012B	Random value		UINT32	Read-Only	
0x012E	Alarm mode	0 : Meter error has no influence on analog output 1 : Meter error drives output 2 mA below min 2 : Meter error drives output 2 mA beyond max	UINT16	Service	Yes
0x0155	Digital input: Status		UINT16	Read-Only	
0x0201	Empty pipe counter		UINT16	Read-Only	
0x0202	Pulse: PulsesPerM3		FLOAT32	Service	Yes
0x0204	Pulse: width		UINT16	Service	Yes
0x0205	Out low		UINT16	Service	Yes
0x0206	Out high		UINT16	Service	Yes
0x0207	Totalizer T1Plus		FLOAT32	Read-Only	
0x0209	Totalizer T1Minus		FLOAT32	Read-Only	
0x020B	Totalizer T1BiDir		FLOAT32	Read-Only	
0x020D	Totalizer T2Plus		FLOAT32	Read-Only	
0x020F	Totalizer T2Minus		FLOAT32	Read-Only	
0x0211	Totalizer T2BiDir		FLOAT32	Read-Only	
0x0216	Totalizer ActualUnit T1Plus		FLOAT32	Read-Only	
0x0218	Totalizer ActualUnit T1Minus		FLOAT32	Read-Only	
0x021A	Totalizer ActualUnit T1BiDir		FLOAT32	Read-Only	
0x021C	Totalizer ActualUnit T2Plus		FLOAT32	Read-Only	
0x021E	Totalizer ActualUnit T2Minus		FLOAT32	Read-Only	
0x0220	Totalizer ActualUnit T2BiDir		FLOAT32	Read-Only	

Register Address	Register Name		Register Type	Security	Stored in Non-volatile Memory
0x0222	Pulse: Pulses Per ActualUnit		FLOAT32	Service	Yes
0x0224	Empty Pipe Treshold Resistance		FLOAT32	Admin	Yes
0x0226	Date Time		DATETIME	Service	Yes
0x0232	Fault		HEXADECIMAL	Read-Only	
0x0233	Port		HEXADECIMAL	Read-Only	
0x024A	Serial Interface	0 : None 1 : Irda 2 : Serial 3 : M-Bus 4 : Hart 5 : RS 485	UINT16	Service	Yes
0x025B	Internal Disk Size [byte]		UINT64	Read-Only	
0x025F	Internal Disk Free Space [byte]		UINT64	Read-Only	
0x0263	Dataloger period	1 : 1 Minute 15 : 15 Minutes 61 : 1 Hour 66 : 6 Hours 72 : 12 Hours 84 : 24 Hours	UINT16	Service	Yes
0x0265	MBUS Manufacturer		UINT16	Factory	Yes
0x0266	MBUS product code		UINT16	Factory	Yes
0x0267	Filter median		UINT16	Service	Yes
0x0268	Filter moving average		UINT16	Service	Yes
0x0269	Filter display		UINT16	Service	Yes
0x0270	MBUS primary address		UINT16	Service	Yes
0x0271	ADE control	0 : Off 1 : On	UINT16	Service	Yes
0x0272	ADE protocol	1 : Protocol v.1 2 : Protocol v.2 3 : Protocol v.3	UINT16	Service	Yes
0x0273	ADE Dial	0 : 4 Dial 1 : 5 Dial 2 : 6 Dial 3 : 7 Dial 4 : 8 Dial 5 : 9 Dial	UINT16	Service	Yes
0x0274	ADE Resolution	1 : 10000 2 : 1000 3 : 100 4 : 10 5 : 1 6 : 0.1 7 : 0.01 8 : 0.001 9 : 0.0001	UINT16	Service	Yes
0x0275	Polarization voltage [v]		FLOAT32	Read-Only	
0x0279	Analog output K		FLOAT32	Read-Only	
0x0281	Analog output Q		FLOAT32	Read-Only	
		0 : M1000 mode 1 : M7600 mode	UINT16	Service	Yes

TROUBLESHOOTING

Modbus transmissions can be rejected for various reasons:

• Write request received with an invalid value (out-of range value).
• Write request received to a secured meter.
• Invalid register address supplied in Modbus serial request.
• Invalid number of registers supplied in Modbus serial request (too many or too few).
• Invalid function code supplied in Modbus serial request.

The following error response codes are returned.

Error response code	Reason
0x01 – Illegal function code	Request received with invalid function code.
0x02 – Illegal data address	Read/Write request received with invalid number of registers.
	Read/Write request received with address not supported.
	Write request received to a read-only register.
0x04 – Device failure	Write request received with invalid value.
0x21	Write request received to a protected parameter (secured device).

Modbus transmissions may not be responded to for various reasons:

• **Bad CRC** – Verify serial link is properly shielded.
• **Framing / Parity Errors** – Verify serial communication settings match for both the flow meter and application software.
• **Wrong port address** – Verify the flow meter is properly programmed with the correct node address.
• **Duplicate port addresses on serial link** – May cause collisions when multiple meters respond at the same time.
• **Wrong serial wiring** – verify wiring is appropriate.
• For RS485, lack of termination on end devices or lack of biasing by Modbus Master. Flow meter does not provide RS485 biasing. This is assumed to be accomplished by the Modbus Master.

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