ModMAG®
M-Series® | Electromagnetic Flow Meters

Electromagnetic Flow Meters

ModMAG® M4000

DESCRIPTION

The innovative design of the Badger Meter® ModMAG® M4000 meter represents the next generation of electromagnetic flow meter technology. Incorporating the latest developments in micro processing signal conditioning, the advanced design of the M4000 meter allows an accuracy of ± 0.20% with a flow range of 300:1. Targeted to a variety of oil and gas, industrial and municipal applications, the M4000 meter is virtually unaffected by density, temperature, pressure, and viscosity changes and provides an accurate and reliable long term metering solution. This meter complies with ANSI/NSF Standard 61, Annex G.

OPERATION

The operating principle of the electromagnetic flow meter is based on Faraday's law of magnetic induction: The voltage induced across any conductor, as it moves at right angles through a magnetic field, is proportional to the velocity of that conductor. The voltage induced within the fluid is measured by two diametrically opposed internally mounted electrodes. The induced signal voltage is proportional to the product of the magnetic flux density, the distance between the electrodes and the average flow velocity of the fluid.

ELECTRODES

When looking from the end of the meter into the inside bore, the two measuring electrodes are positioned at three o'clock and nine o'clock. As a conductive fluid flows through the magnetic field, a voltage is induced across the electrodes. This voltage is proportional to the average flow velocity of the fluid and is measured by the two electrodes. This induced voltage is then amplified and processed digitally by the converter to produce an accurate analog or digital signal. The signal can then be used to indicate flow rate and totalization or to communicate to remote sensors and controllers.

M4000 meters also have an "empty pipe" detection feature. This is accomplished with a third electrode positioned in the meter between twelve o'clock and one o'clock. If this electrode is not covered by fluid for minimum of five seconds, the meter will display an "empty pipe" condition. When the electrode again becomes covered with fluid, the error message will disappear and the meter will continue measuring.

DETECTOR

The flow meter is a stainless steel tube lined with a non-conductive material. Outside the tube, two DC-powered electromagnetic coils are positioned opposing each other. Perpendicular to these coils, two electrodes are inserted into the flow tube. Energized coils create a magnetic field across the whole diameter of the pipe. With no moving parts and open-flow design, there is no pressure lost and practically no maintenance required.

APPLICATION

The M4000 meter is suited for use in applications where indication of rate and totalization is required. The ability to display flow parameters locally at the flow meter, or remotely by mounting the amplifier up to 100 feet away from the detector, provides a versatile solution for most industrial and municipal flow applications. Whether the fluid is water or something highly corrosive, very viscous, contains a moderate amount of solids, or requires special handling, the meter is able to accurately measure it. Housed in a Class 1, Division 1, NEMA 4X (IP66) enclosure, the M4000 design has been tested and approved by Factory Mutual (FM) in the United States and the Canadian Standards Association (CSA international) in Canada.

FEATURES

- Sizes 1/4…12 in. (6…300 mm)
- Accuracy of ± 0.20%
- Better than 0.1% repeatability
- Digital Signal Processor (DSP) based
- Automatic zero point stability
- No pressure loss for low operational costs
- Long life, corrosion-resistant liners
- Precise calibration
- Digital and analog outputs
- Detector or remote wall mount
- NEMA 4X (IP66) enclosure
- FM approved for Class I, Div 1 hazardous locations
- CE and FCC compliant
- CSA Certified

Badger Meter

MAG-DS-00558-EN-13 (October 2022)

Product Data Sheet

DIMENSIONS

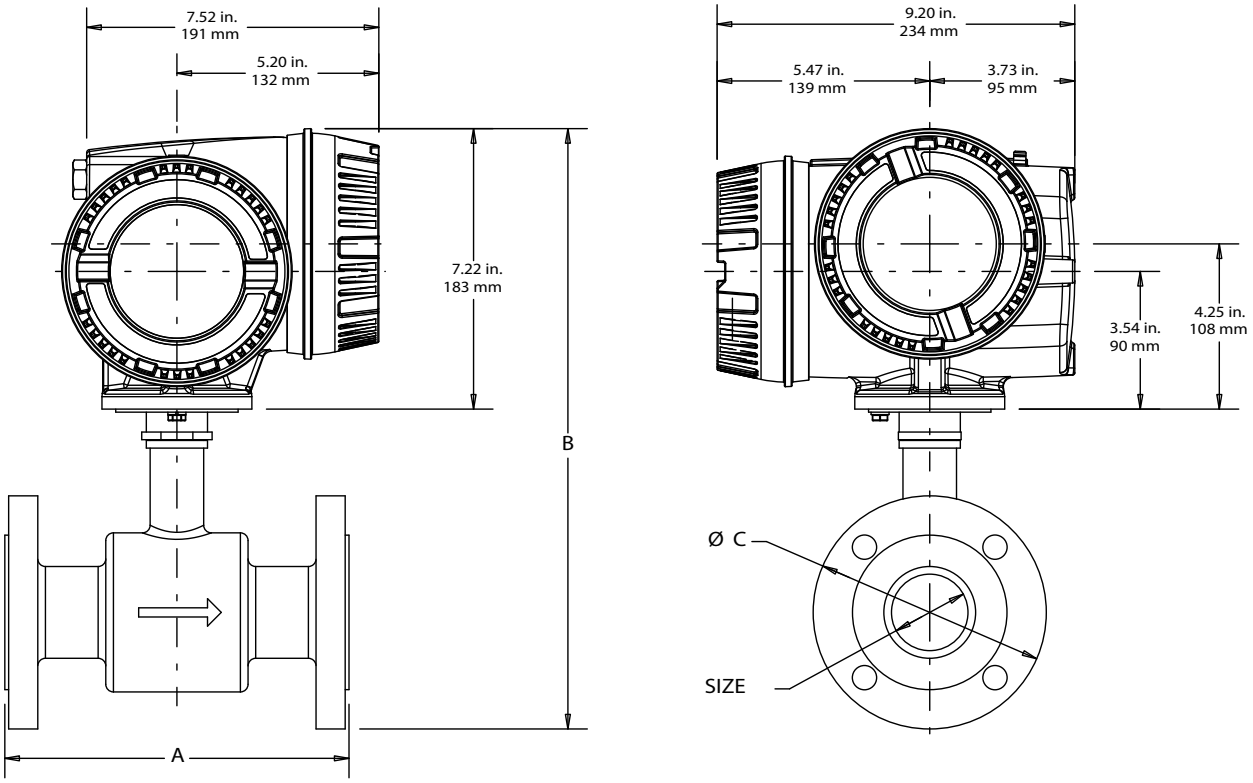

Figure 1: M4000 meter mount amplifier on detector

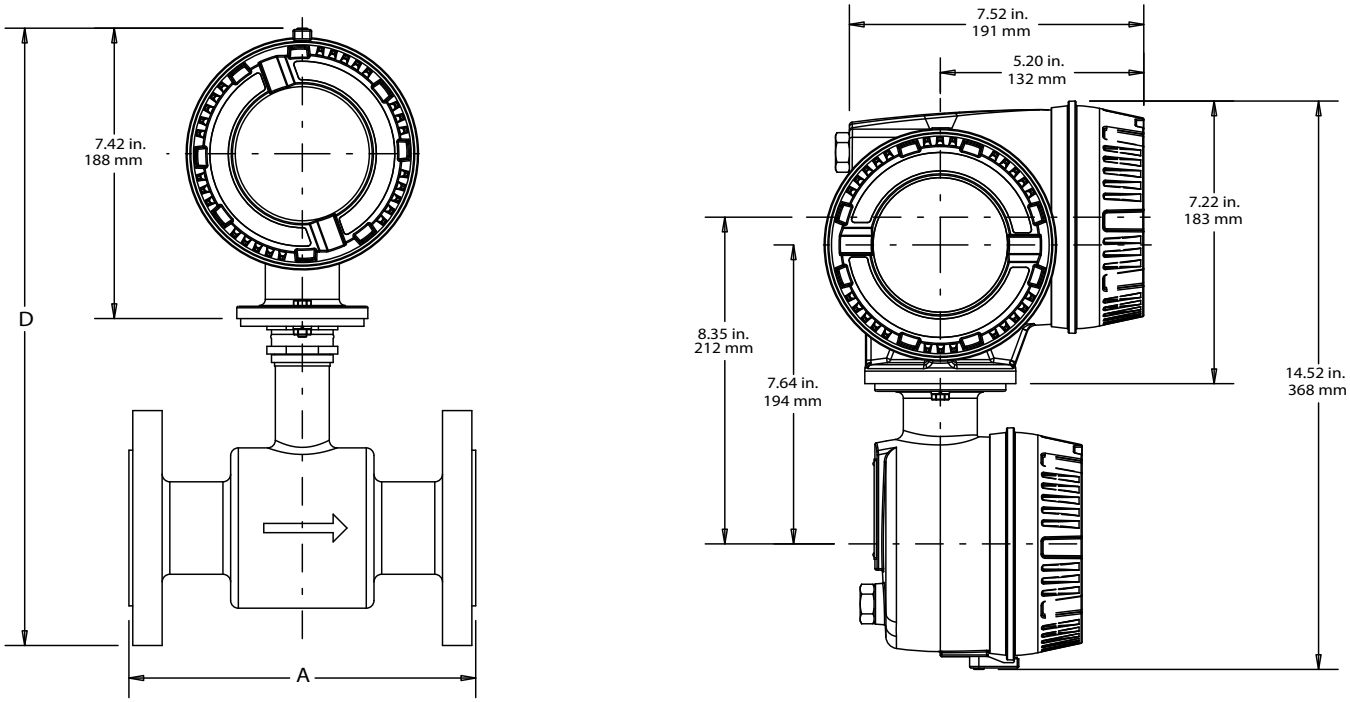

Figure 2: M4000 remote mount junction box on detector

Detector Dimensions and Specifications

Size		A		B		C		D		Est. Weight w/ Amplifier		Flow Range			
												gpm		lpm	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	lb	kg	min	max	min	max
1/4	6	6.7	170	13.4	342	3.5	89	13.9	351	17	7.7	0.01	5	0.05	20
5/16	8	6.7	170	13.4	342	3.5	89	13.9	351	17	7.7	0.02	10	0.09	36
3/8	10	6.7	170	13.4	342	3.5	89	13.9	351	17	7.7	0.04	15	0.14	57
1/2	15	6.7	170	13.4	342	3.5	89	13.9	351	17	7.7	0.08	34	0.32	127
3/4	20	6.7	170	13.6	347	3.9	99	14	356	17	7.7	0.12	48	0.46	183
1	25	8.9	225	13.8	352	4.3	108	14.2	361	18	8.8	0.21	84	0.79	318
1-1/4	32	8.9	225	14.6	372	4.6	117	15	381	20.3	9.2	0.39	157	1.5	594
1-1/2	40	8.9	225	14.8	376	5.0	127	15.2	386	22	10	0.55	220	2.1	834
2	50	8.9	225	15.3	389	6.0	152	15.7	398	26	11.7	0.94	378	3.6	1431
2-1/2	65	11.0	280	16.5	420	7.0	178	16.9	429	35	15.7	1.63	653	6.2	2471
3	80	11.0	280	16.7	426	7.5	191	17.2	435	38	17.1	2.21	883	8.4	3344
4	100	11.0	280	17.8	452	9.0	229	18.2	461	49	22.1	3.30	1320	12	4997
5	125	15.8	400	19	484	10.0	254	19.4	493	60	27.1	5.29	2115	20	8008
6	150	15.8	400	20	510	11.0	279	20.4	519	71	32.1	7.85	3141	30	11890
8	200	15.8	400	21.9	558	13.5	343	22.9	583	95	43.1	15.69	6278	59	23765
10	250	19.7	500	26.2	677	16.0	406	26.6	676	130	59.1	25.05	10021	95	37934
12	300	19.7	500	28.3	720	19.0	483	28.7	729	219	99.3	33.61	13445	127	50894

SPECIFICATIONS

Sizes	1/4…12 in. (6…300 mm)	
Flow Range	0.1…39.4 ft/s (0.03…12 m/s)	
Accuracy	± 0.20% of rate ± 1 mm/s	
Repeatability	0.1% of rate	
Power Supply	85…240V AC, 45…65 Hz; 24V DC	
Analog Outputs	0…10 mA, 0…20 mA, 4…20 mA (programmable and scalable), Voltage sourced (18V DC) – isolated, max. loop resistance = 750 Ω	
Digital Outputs	(2) Open collector, (programmable scaled pulse, flow alarm, status, or frequency output), max. 24V DC, 0.5 W (2) AC solid-state relay (programmable flow alarm or status), max. 24V DC @ 0.5 A	
Frequency Output	Open collector, max. full scale flow = 10 kHz	
Communication	RS232C serial, standard ANSI terminal compatible data stream	
Pulse Width	Open collector, 5 ms to 1 second (programmable) or automatic 50% duty cycle	
Min-Max Flow Alarm	Open collector or solid-state relay (programmable 0…100% of flow)	
Empty Pipe Detection	Field tunable for optimum performance based on specific application	
Excitation Frequency	Programmable 3.75 Hz, 7.5 Hz or 15 Hz	
Auxiliary Input	Max. 24V DC (programmable positive zero return, external totalizer reset or preset batch start)	
Power Consumption	20 W	
Noise Dampening	1…30 seconds (programmable)	
Low Flow Cutoff	0…100% of full scale (programmable)	
Zero-Point Stability	Automatic correction	
Galvanic Separation	500V	
Fluid Conductivity	Min. 5 µS/cm (Min. 20 µS/cm for demineralized water)	
Fluid Temperature	**With remote mounted amplifier**	PFA & PTFE: – 4…248° F (–20…120° C) @ max. ambient temp. of 122° F (50° C) Hard rubber: 32…178° F (0…80°C) @ max. ambient temp. of 122° F (50° C)
	With meter mounted amplifier	PFA & PTFE: – 4…212° F (–20…100° C) @ max. ambient temp. of 122° F (50° C) Hard rubber: 32…178° F (0…80° C) @ max. ambient temp. of 122° F (50° C)
Ambient Temperature	– 4…122° F (–20…50°C)	
Altitude	Maximum 6500 ft (2000 m)	
Flow Direction	Uni-directional or Bi-directional	
Totalization	3 separate displayable totalizers, 10 digits (programmable forward, reverse and net)	
Units of Measure	U.S. gallons, imperial gallons, million gallons per day, cubic feet, cubic meters, liters, oil barrels, pounds, ounces, acre feet	
LCD Display	4 lines x 16 character alphanumeric, backlight; actively displays 3 totalizer values, flow rate, alarm status, output status, error / diagnostic messages	
Programming	Internal 3-button or external magnetic wand	
Field Wiring Entry Ports	(3) 1/2 in. NPT, internal thread	
Housing	Amplifier enclosure and remote junction enclosure: cast aluminum (powder-coated paint)	
Housing Rating	Amplifier enclosure and remote junction enclosure, NEMA 4X (IP66)	
Pipe Spool Material	304 stainless steel	
Spool Housing Material	Carbon steel, welded, NEMA 4 (IP66)	
Electrode Materials	Alloy C (standard), 316 stainless steel, gold/platinum plated, tantalum, platinum/rhodium	
Liner Material	PFA from 1/4…3/8 in. (6…10 mm), PTFE from 1/2…12 in. (15…300 mm), Hard rubber from 1…12 in. (25…300 mm)	
Flange Material	Carbon steel or 316 stainless steel; In Accordance with ANSI/ASME, B16.5 Class 150 Flange Rating	
Coil Power	Pulsed DC	
Pressure Limits	In Accordance with ANSI/ASME, B16.5 Class 150 Flange Rating	
Locations	Indoor and outdoor	
Mounting	Direct detector mount or remote wall mount, bracket included. For remote mount, max. cable distance = 100 ft (30 m)	
Junction Enclosure Material	(For remote mounted amplifier option) cast aluminum (powder coated paint), NEMA 4X (IP66)	
Grounding Electrode Material (optional)	Alloy C, 316 stainless steel, gold/platinum plated, tantalum, or platinum/rhodium	
Grounding Ring Material (optional, 2 required)	316 stainless steel (standard) or alloy C	
	Meter Size	**Thickness (one ring)**
	1/4…10 in. (6 …250 mm)	0.135 in. (3.43 mm)
	10…12 in. (250…600 mm)	0.187 in. (4.75 mm)
Electrical Classification	FM approved for Class I, Div 1 Groups C-D, Class II, Div 1 Groups E, F & G – CSA Certified	
NSF Listed	Models with hard rubber liner, size 4 in. and larger; PTFE liner, all sizes	

PART NUMBER CONSTRUCTION

ModMAG®
Model M4000

Model Code

4M	-		-		FAA		H		B		-			W			D	B	A	B	XX	-		

Hazardous Area	ATEX/IECEx Zone 1	U
Hazardous Area	Class 1, Dvision 1	D

Size and process connection ANSI

Size	Class 150
1 IN.	010
1-1/4 IN.	012
1-1/2 IN.	015
2 IN.	020
2-1/2 IN.	025
3 IN.	030
4 IN.	040
5 IN.	050
6 IN.	060
8 IN.	080
10 IN.	100
12 IN.	120

Class 150	Pressure Rating	
FAA	ASME Class 150	FAA

Flange and Housing material

Carbon Steel (Standard)	C1
Carbon Steel w/ C5M Paint	C2
304 Stainless Steel Connection / Housing	S3
316 Stainless Steel Connection / Housing	S7
Carbon Steel Process Connections (Std. Paint) / 316 Stainless Steel Housing	C4

Liner Material

Hard Rubber	H

Electrodes / Measuring, Empty pipe, Grounding

Hastelloy C-22 (Standard / Measuring & Empty pipe)	J	B
AISI 316/1.4571	B	B
Tantalum	C	B
Platinum/Rhodium	D	B

Meter LayLength

Standard	S
ISO 20456	O

Transmitter, Power Supply, Hardware

110/220V AC; Meter-Mounted	SA	AA	W
110/220V AC; Remote-Mounted	RA	AA	W
24V DC; Meter-Mounted	SA	AC	W
24V DC; Remote-Mounted	RA	AC	W

Junction Box (for remote mounted version)

Aluminum Enclosure; IP67 (Type 6/4X) Rating	A
None | Used for "Sensor-Mounted" Transmitter Configurations	X

Remote Cable Length (for remote mounted version)

15 ft.	5 m	MA
30 ft.	10 m	MB
50 ft.	15 m	MC
65 ft.	20 m	MD
80 ft.	25 m	ME
100 ft.	30 m	MF
None | Used for "Sensor-Mounted" Transmitters Configurations		WW

Input/Output Channel

Standard Input/Output	D	B	A

Communications

Standard Communication (None)	B

Wiring Method

None | Not applicable	XX

Programming

Gallons/gallons per minute (North America Standard)	NA
Gallons/cubic feet per minute	NC
Gallons/cubic meters per second	ND
Cubic Meters/gallons per minute	NE
Cubic Meters/cubic meters per second	NF
Cubic Meters/cubic meters per minute	NG
Cubic Meters/cubic meters per hour	NH
Cubic Feet/gallons per minute	NJ
Cubic Feet/cubic feet per minute	NK
Cubic Feet/cubic meters per hour	NL
Liters/gallons per minute	NM
Liters/liters per second	NN
Liters/liters per minute	NP
Liters/liters per hour	NR
Million Gallons/gallons per minute	NS
Gallons/millions gallons per day	NT
Acre Feet/gallons per minute	NU
Second-Foot Day/cubic feet per second	NV

Testing & Tagging

0.2%	3-Point Calibration; Factory	(Standard)	F
0.2%	3-Point Calibration, Factory / Stainless steel Tag		S
3rd Party Calibrated			3
3rd Party Calibrated w/ Stainless Steel Tag			T
State of Kansas Certified			K

ModMAG®
Model M4000

Model Code

4M	-		-		FAA				B		-			W			D	B	A	B	XX	-		

Hazardous Area	ATEX/IECEx Zone 1	U
Hazardous Area	Class 1, Dvision 1	D

Size and process connection ANSI

	Class 150		
1/4 IN.		liner PFA / flange & housing 316 SST	002
5/16 IN.		liner PFA / flange & housing 316 SST	003
3/8 IN.		liner PFA / flange & housing 316 SST	004
1/2 IN.			005
3/4 IN.			007
1 IN.			010
1-1/4 IN.			012
1-1/2 IN.			015
2 IN.			020
2-1/2 IN.			025
3 IN.			030
4 IN.			040
5 IN.			050
6 IN.			060
8 IN.			080
10 IN.			100
12 IN.			120

Class 150	***Pressure Rating***	
FAA	ASME Class 150	FAA

Flange and Housing material

Carbon Steel (Standard)	C1
Carbon Steel w/ C5M Paint	C2
304 Stainless Steel Connection / Housing	S3
316 Stainless Steel Connection / Housing	S7
Carbon Steel Process Connections (Std. Paint) / 316 Stainless Steel Housing	C4

Liner Material

PTFE	for sizes > DN10 (3/8 IN.)	P
PFA	DN 6...DN 10 (1/4... 3/8 IN.) with PFA liner	A

Electrodes / Measuring, Empty pipe, Grounding

Hastelloy C-22 (Standard / Measuring & Empty pipe)	J	B
AISI 316/1.4571	B	B
Tantalum	C	B
Platinum/Rhodium	D	B

Meter LayLength

Standard	S
ISO 20456	O

Transmitter, Power Supply, Hardware

110/220V AC; Meter-Mounted	SA	AA	W
110/220V AC; Remote-Mounted	RA	AA	W
24V DC; Meter-Mounted	SA	AC	W
24V DC; Remote-Mounted	RA	AC	W

Junction Box (for remote mounted version)

Aluminum Enclosure; IP67 (Type 6/4X) Rating	A
None | Used for "Sensor-Mounted" Transmitter Configurations	X

Remote Cable Length (for remote mounted version)

15 ft.	5 m	MA
30 ft.	10 m	MB
50 ft.	15 m	MC
65 ft.	20 m	MD
80 ft.	25 m	ME
100 ft.	30 m	MF
None | Used for "Sensor-Mounted" Transmitters Configurations		WW

Input/Output Channel

Standard Input/Output	D	B	A

Communications

Standard Communication (None)	B

Wiring Method

None | Not applicable	XX

Programming

Gallons/gallons per minute (North America Standard)	NA
Gallons/cubic feet per minute	NC
Gallons/cubic meters per second	ND
Cubic Meters/gallons per minute	NE
Cubic Meters/cubic meters per second	NF
Cubic Meters/cubic meters per minute	NG
Cubic Meters/cubic meters per hour	NH
Cubic Feet/gallons per minute	NJ
Cubic Feet/cubic feet per minute	NK
Cubic Feet/cubic meters per hour	NL
Liters/gallons per minute	NM
Liters/liters per second	NN
Liters/liters per minute	NP
Liters/liters per hour	NR
Million Gallons/gallons per minute	NS
Gallons/millions gallons per day	NT
Acre Feet/gallons per minute	NU
Second-Foot Day/cubic feet per second	NV

Testing & Tagging

0.2%	3-Point Calibration; Factory (Standard)	F
0.2%	3-Point Calibration, Factory / Stainless steel Tag	S
	3rd Party Calibrated	3
	3rd Party Calibrated w/ Stainless Steel Tag	T
	State of Kansas Certified	K

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