

### DESCRIPTION

The innovative design of the Badger Meter<sup>®</sup> ModMAG<sup>®</sup> M3000 meter represents the next generation of electromagnetic flow meter technology. Incorporating the latest developments in micro processing signal conditioning the advanced design of the M3000 meter allows an accuracy  $\pm 0.20\%$  with a flow range of 300:1. Targeted to a variety of oil and gas, industrial and municipal applications, the M3000 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.

M3000 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 the no moving parts, open flow tube design there is no pressure lost and practically no maintenance required.



### APPLICATION

The M3000 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 2, NEMA 4X/6P (IP66/IP67) enclosure, the M3000 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...24 in. (6...600 mm)
- Accuracy of  $\pm 0.20\%$
- Better than 0.1% repeatability
- Large 4-line by 16-character, back-lit, LCD display
- Digital Signal Processor (DSP) based
- Bi-directional flow sensing and totalization
- Automatic zero point stability
- Measures fluids with as low as 5.0 micromhos/cm conductivity
- Empty pipe detection
- No pressure loss for low operational costs
- Long life, corrosion-resistant liners
- Precise calibration
- NEMA 4X/6P (IP66/IP67) enclosure
- FM approved for Class I, Div 2 hazardous locations
- CE and FCC compliant
- CSA Certified

## SPECIFICATIONS

<b>Sizes</b>	1/4...24 in. (6...600 mm)	
<b>Flow Range</b>	0.10...39.4 ft/s (0.03...12 m/s)	
<b>Accuracy</b>	± 0.20% of rate ± 1 mm/s	
<b>Repeatability</b>	0.1% of rate	
<b>Power Supply</b>	AC or optional 24V DC <b>AC Power Supply:</b> 85...240V AC, 45...65 Hz Voltage Fluctuation = ± 10% of nominal Over Voltage = Category II Power Consumption = 20 W <b>DC Power Supply (optional):</b> 24V DC ± 10% 8 W	
<b>Analog Outputs</b>	0...10 mA, 0...20 mA, 4...20 mA (programmable and scalable) Voltage sourced (18V DC) isolated Max. loop resistance = 750 Ω	
<b>Digital Outputs</b>	(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 D C @ 0.5 A	
<b>Frequency Output</b>	Open Collector; Max. full scale flow = 10 kHz	
<b>Communication</b>	Modbus RTU communications and display for 110/220V AC (P.N. 65778-007) or 24V DC (P.N. 65778-008). Options must be selected at time of order.	
<b>Pulse Width</b>	Open Collector, 5 ms to 1 second (programmable) or automatic 50% duty cycle	
<b>Min-Max Flow Alarm</b>	Open collector or solid-state relay (programmable, 0 to 100% of flow)	
<b>Empty Pipe Detection</b>	Field tunable for optimum performance based on specific application	
<b>Excitation Frequency</b>	Programmable, 3.75 Hz, 7.5 Hz or 15 Hz	
<b>Auxiliary Input</b>	Max. 24V DC (programmable – positive zero return, external totalizer reset or preset batch start)	
<b>Noise Dampening</b>	1 to 30 seconds (programmable)	
<b>Low Flow Cutoff</b>	0...100% of full scale (programmable)	
<b>Zero-Point Stability</b>	Automatic correction	
<b>Galvanic Separation</b>	500V	
<b>Fluid Conductivity</b>	Min. 5 µS/cm (Min. 20 µS/cm for demineralized water)	
<b>Fluid Temperature</b>	<b>With Meter-Mounted Amplifier:</b> PFA, PTFE & Halar®: -4...212° F (-20...100° C) @ max. ambient temperature of 122° F (50° C). Hard rubber: 32...178° F (0...81° C) @ max. ambient temperature of 122° F (50° C).	<b>With Remote Amplifier:</b> PFA, PTFE & Halar: -4...248° F (-20...120° C) @ max. ambient temperature of 122° F (50° C). Hard rubber: 32...178° F (0...81° C) @ max. ambient temperature of 122° F (50° C).
<b>Ambient Temperature</b>	-4...122° F (-20...50° C)	
<b>Relative Humidity</b>	Up to 90% non-condensing	
<b>Altitude</b>	Maximum 6500 ft (2000 m)	
<b>Flow Direction</b>	Uni-directional or bi-directional	
<b>Totalization</b>	3 separate displayable totalizers; 10 digits (programmable – forward, reverse and net)	
<b>Units of Measure</b>	U.S. gallons, imperial gallons, million gallons per day, cubic feet, cubic meters, liters, oil barrels, pounds, ounces, acre feet (programmable). <b>NOTE:</b> Oil Barrels unit is only available for standard output with modbus 485 RTU.	
<b>LC Display</b>	4-line by 16-character, alphanumeric, back light Displays: 3 totalizer values, flow rate, alarm status, output status, error/diagnostic messages	
<b>Programming</b>	Internal 3-button or external magnetic wand	
<b>Field Wiring Entry Ports</b>	(3) 1/2 in. NPT, internal thread	
<b>Amplifier Housing</b>	Amplifier enclosure and remote junction enclosure: cast aluminum (powder coated paint)	
<b>Amplifier Housing Rating</b>	Amplifier enclosure and remote junction enclosure: NEMA 4X/6P (IP66/IP67)	
<b>Detector Pipe Spool Material</b>	304 stainless steel	
<b>Detector Spool Housing Material</b>	Carbon steel, welded, NEMA 4X/6P (IP66/IP67)	
<b>Electrode Materials</b>	Alloy C (standard), 316 stainless steel, gold/platinum plated, tantalum, platinum/rhodium	
<b>Liner Material</b>	PFA from 1/4...3/8 in. (6...10 mm), PTFE from 1/2...24 in. (15...600 mm), hard rubber from 1...24 in. (25...600 mm), Halar from 12...24 in. (300...600 mm)	
<b>Flanges</b>	Carbon steel or 316 stainless steel; In Accordance with ANSI/ASME, B16.5 Class 150 Flange Rating	
<b>Coil Power</b>	Pulsed DC	
<b>Pressure Limits</b>	In Accordance with ANSI/ASME, B16.5 Class 150 Flange Rating	
<b>Mounting</b>	Direct detector mount or remote wall mount, bracket included. For remote mount, max. cable distance = 100 ft (30 m)	
<b>Junction Enclosure Material</b>	For remote mounted amplifier option: Cast aluminum, powder-coated paint, NEMA 4X/6P (IP66/IP67)	
<b>Grounding Ring Material (optional, 2 required)</b>	316 stainless steel (standard) or alloy C	
	<b>Meter Size</b>	<b>Thickness (one ring)</b>
	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)
<b>Optional Grounding Electrodes</b>	Alloy C, 316 stainless steel, gold/platinum plated, tantalum, or platinum/rhodium	
<b>Electrical Classification</b>	FM approved for Class I, Div 2, Groups A-D; Class II, Div 2, Groups F and G, – CSA Certified	

**DIMENSIONS**

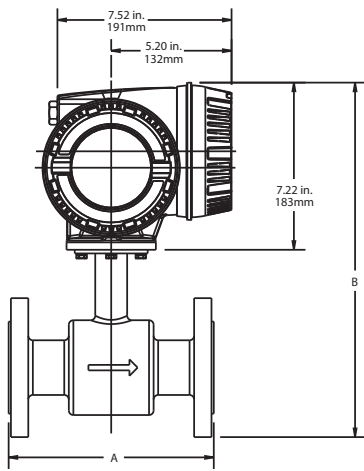


Figure 1: M3000 Meter Mount

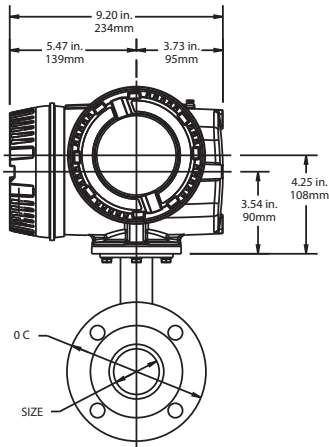
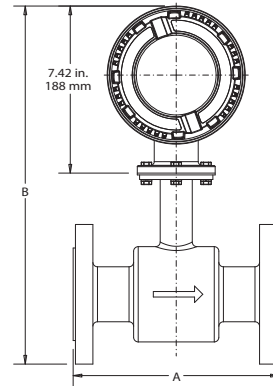


Figure 2: M3000 Remote Mount Junction Box on Detector



Size		A		B		C		D		Est. Weight with 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	264	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	96	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
14	350	19.7	500	30.2	768	21.0	533	30.7	779	287	130.2	45.75	18300	173	69272
16	400	23.6	590	33.1	842	23.5	597	33.5	851	354	160.9	59.75	23902	226	90477
18	450	23.6	590	34.4	876	25.0	635	34.9	885	409	185.3	75.63	30250	286	114511
20	500	23.6	590	37.6	955	27.5	699	38	964	502	228.3	93.37	37346	353	141371
22	550	23.6	590	39	991	29.5	749	39.4	1000	532	241.3	112.97	45189	428	171059
24	600	23.6	590	41.6	1057	32.0	813	42	1066	561	255.3	134.45	53779	509	203574

**PART NUMBER CONSTRUCTION**

**ModMAG®  
Model M3000**

Model Code

		3M	-	-	FAA	H	B	-	-	W	-	-	D	B	A	XX	-	-	
Hazardous Area	ATEX/IECEx Zone 2	V																	
Hazardous Area	Class 1, Division 2	B																	
<b>Size and process connection ANSI</b>																			
Size	Class 150																		
1 IN.																			
1-1/4 IN.																			
1-1/2 IN.																			
2 IN.																			
2-1/2 IN.																			
3 IN.																			
4 IN.																			
5 IN.																			
6 IN.																			
8 IN.																			
10 IN.																			
12 IN.																			
14 IN.																			
16 IN.																			
18 IN.																			
20 IN.																			
22 IN.																			
24 IN.																			
	Class 150																		
	FAA																		
<b>Pressure Rating</b>																			
	ASME Class 150																		
<b>Flange and Housing material</b>																			
Carbon Steel (Standard)																			
Carbon Steel w/ C5M Paint																			
304 Stainless Steel Connection / Housing																			
316 Stainless Steel Connection / Housing																			
Carbon Steel Process Connections (Std. Paint) / 316 Stainless Steel Housing																			
<b>Liner Material</b>																			
Hard Rubber																			
<b>Electrodes / Measuring, Empty pipe, Grounding</b>																			
Hastelloy C-22 (Standard / Measuring & Empty pipe)																			
AISI 316/1.4571																			
Tantalum																			
Platinum/Rhodium																			
<b>Meter LayLength</b>																			
Standard																			
ISO 20456																			
<b>Transmitter, Power Supply, Hardware</b>																			
110/220V AC; Meter-Mounted																			
110/220V AC; Remote-Mounted																			
24V DC; Meter-Mounted																			
24V DC; Remote-Mounted																			
<b>Junction Box (for remote mounted version)</b>																			
Aluminum Enclosure; IP67 (Type 6/4X) Rating																			
None   Used for "Sensor-Mounted" Transmitter Configurations																			
<b>Remote Cable Length (for remote mounted version)</b>																			
15 ft. 5 m																			
30 ft. 10 m																			
50 ft. 15 m																			
65 ft. 20 m																			
80 ft. 25 m																			
100 ft. 30 m																			
None   Used for "Sensor-Mounted" Transmitters Configurations																			
<b>Input/Output Channel</b>																			
Standard Input/Output																			
<b>Communications</b>																			
Standard Communication (None)																			
Modbus RS-485																			
<b>Wiring Method</b>																			
None   not applicable																			
<b>Programming</b>																			
Gallons/gallons per minute (North America Standard)																			
Gallons/cubic feet per minute																			
Gallons/cubic meters per second																			
Cubic Meters/gallons per minute																			
Cubic Meters/cubic meters per second																			
Cubic Meters/cubic meters per minute																			
Cubic Meters/cubic meters per hour																			
Cubic Feet/gallons per minute																			
Cubic Feet/cubic feet per minute																			
Cubic Feet/cubic meters per hour																			
Liters/gallons per minute																			
Liters/liters per second																			
Liters/liters per minute																			
Liters/liters per hour																			
Million Gallons/gallons per minute																			
Gallons/millions gallons per day																			
Acre Feet/gallons per minute																			
Second-Foot Day/cubic feet per second																			
<b>Testing &amp; Tagging</b>																			
0.2% 3-Point Calibration; Factory (Standard)																			
0.2% 3-Point Calibration, Factory / Stainless steel Tag																			
3rd Party Calibrated																			
3rd Party Calibrated w/ Stainless Steel Tag																			
State of Kansas Certified																			

**ModMAG®**  
**Model M3000**

		Model Code													
		3M	V	B	FAA	B	-	W	D	B	A	XX	-	-	-
Hazardous Area		ATEX/IECEx Zone 2													
Hazardous Area		Class 1, Division 2													
<b>Size and process connection ANSI</b>															
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													
14 IN.		140													
16 IN.		160													
18 IN.		180													
20 IN.		200													
22 IN.		220													
24 IN.		240													
Class 150															
FAA		ASME Class 150													
FAA		FAA													
<b>Flange and Housing material</b>															
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													
<b>Liner Material</b>															
PTFE for sizes > DN10 (3/8 IN.)		P													
PFA DN 6...DN 10 (1/4... 3/8 IN.) with PFA liner		A													
<b>Electrodes / Measuring, Empty pipe, Grounding</b>															
Hastelloy C-22 (Standard / Measuring & Empty pipe)		J B													
AlSi 316/1.4571		B B													
Tantalum		C B													
Platinum/Rhodium		D B													
<b>Meter Lead Length</b>															
Standard		S													
ISO 20456		O													
<b>Transmitter, Power Supply, Hardware</b>															
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													
<b>Junction Box</b> (for remote mounted version)															
Aluminum Enclosure; IP67 (Type 6/4X) Rating		A													
None   Used for "Sensor-Mounted" Transmitter Configurations		X													
<b>Remote Cable Length</b> (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													
<b>Input/Output Channel</b>															
Standard Input/Output		D B A													
<b>Communications</b>															
Standard Communication (None)		B													
Modbus RS-485		L													
<b>Wiring Method</b>															
None   not applicable		XX													
<b>Programming</b>															
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													
<b>Testing &amp; Tagging</b>															
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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