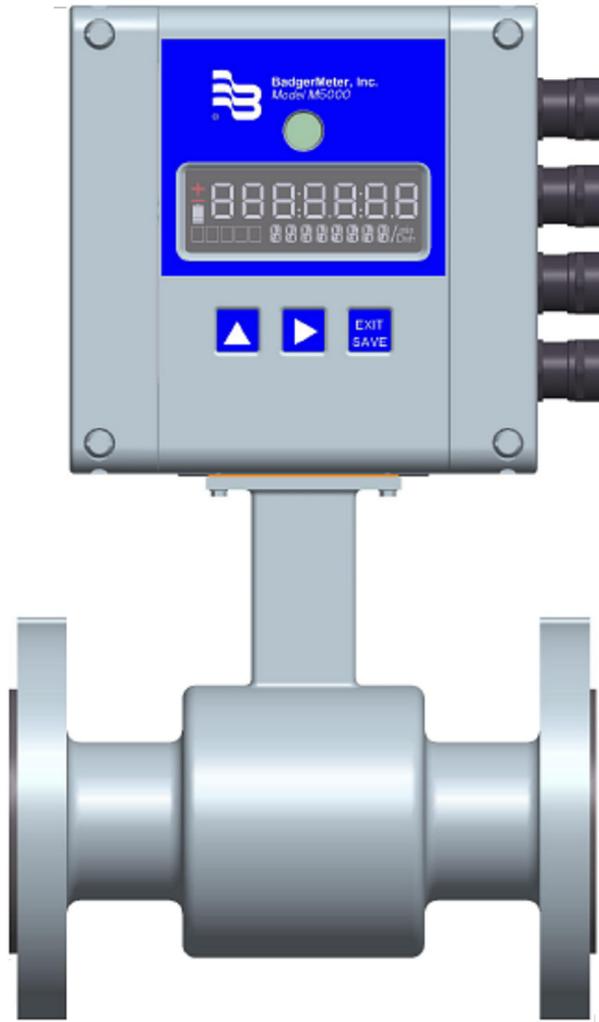




Badger Meter

M-Series® Mag Meter
Model M-5000



IMPORTANT:
This manual contains important information.
READ AND KEEP FOR REFERENCE.

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Safety Precautions and Instructions

Some procedures in this manual require special safety considerations. In such cases, the text is emphasized with the following symbols:

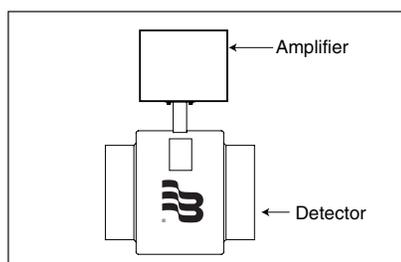
Symbol	Explanation
	When attached to the product, this symbol indicates a potential hazard. Review the documentation to determine the nature of the potential hazard and any required actions or precautions.
	Warning indicates the potential for severe personal injury, death or substantial property damage. Comply with the instructions and proceed with care.
	Caution indicates the potential for minor personal injury or property damage. Comply with the instructions and proceed with care.

System Description

The Badger Meter M-Series® model M-5000 electromagnetic flow meter is intended for fluid metering in most industries including water, wastewater, food and beverage, pharmaceutical and chemical.

The basic components of an electromagnetic flow meter are:

- The **detector**, which includes the flow tube, isolating liner and measuring electrodes.
- The **amplifier**, which is the electronic device responsible for the signal processing, flow calculation, display and output signals.



The construction materials of the wetted parts (liner and electrodes) should be appropriate for the specifications on the intended type of service. Make sure to review all of the compatibilities consistent with the specifications.

Each meter is factory tested and calibrated. A calibration certificate is included with each meter.

Unpacking and Inspection

Follow these guidelines when unpacking the M-Series equipment.

- If a shipping container shows any sign of damage, have the shipper present when unpacking the meter.
- Follow all unpacking, lifting and moving instructions associated with the shipping container.
- Open the container and remove all packing materials. Store the shipping container and packing materials in the event the unit needs to be shipped for service.
- Verify that the shipment matches the packing list and order form.
- Inspect the meter for any signs of shipping damage, scratches, or loose or broken parts.

Note: If the unit was damaged in transit, request an inspection report from the carrier within 48 hours. A claim must be filed with the carrier, and contact Badger Meter for appropriate repairs or replacement.

- All detectors with polytetrafluoroethylene (PTFE) liners are shipped with a liner protector on each end to maintain proper form of the PTFE material during shipping and storage.

Note: Do not remove the liner protectors until installation.

- Storage: If the meter is to be stored, place it in its original container in a dry, sheltered location. Storage temperature ranges are: -40°F to 160°F (-40°C to 70°C).

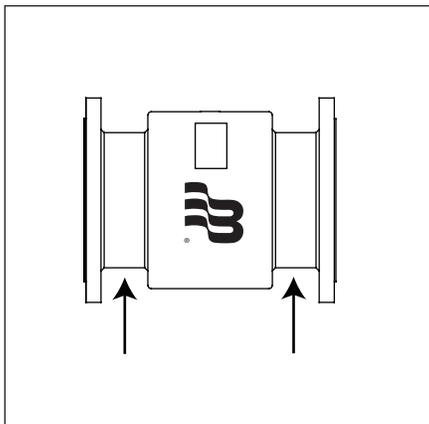
Rigging, Lifting and Moving Large Units

⚠ CAUTION When rigging, lifting or moving large units, follow these guidelines.

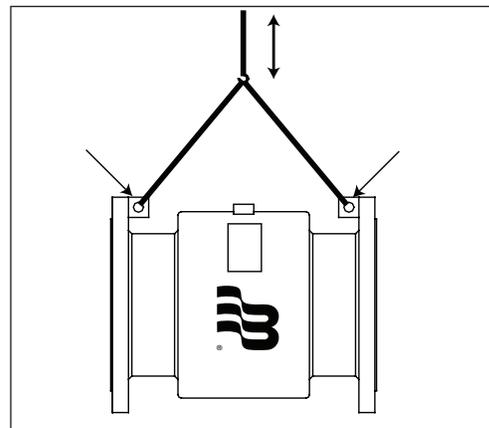
DO NOT lift or move a meter by its amplifier, junction box or cables.

Use a crane rigged with soft straps to lift and move meters with flow tubes that are between two inches and eight inches (50 mm and 200 mm). Place the straps around the detector body, between the flanges, on each side of the detector.

Use the lifting lugs when lifting meter flow tubes that are 10 inches (250 mm) in diameter or larger.

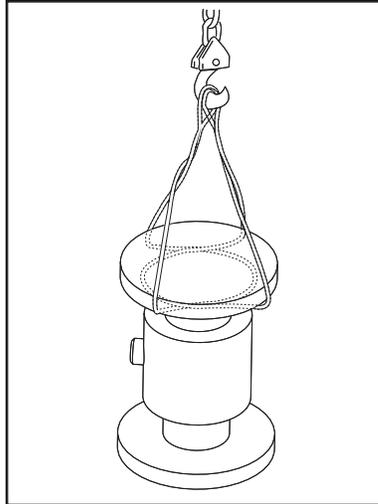


Place straps between flanges.



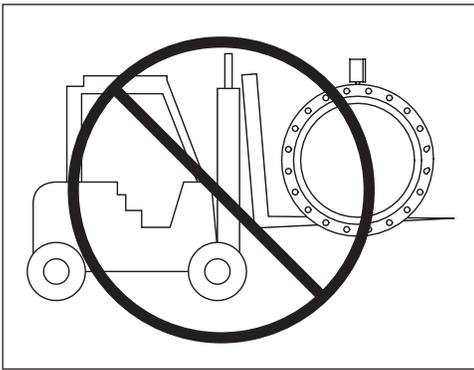
Use lifting lugs with 10-inch or larger meters.

Use the sling-rigged method to lift large detectors into a vertical position while they are still crated. Use this method to position large detectors vertically into pipelines.

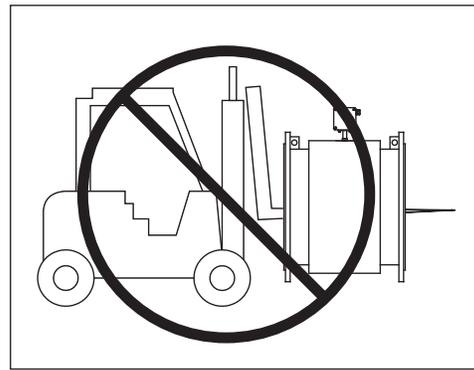


Do not lift a detector with a forklift by positioning the detector body on the forks, with the flanges extending beyond the lift. This could dent the housing or damage the internal coil assemblies.

Never place forklift forks, rigging chains, straps, slings, hooks or other lifting devices inside or through the detector's flow tube to hoist the unit. This could damage the isolating liner.



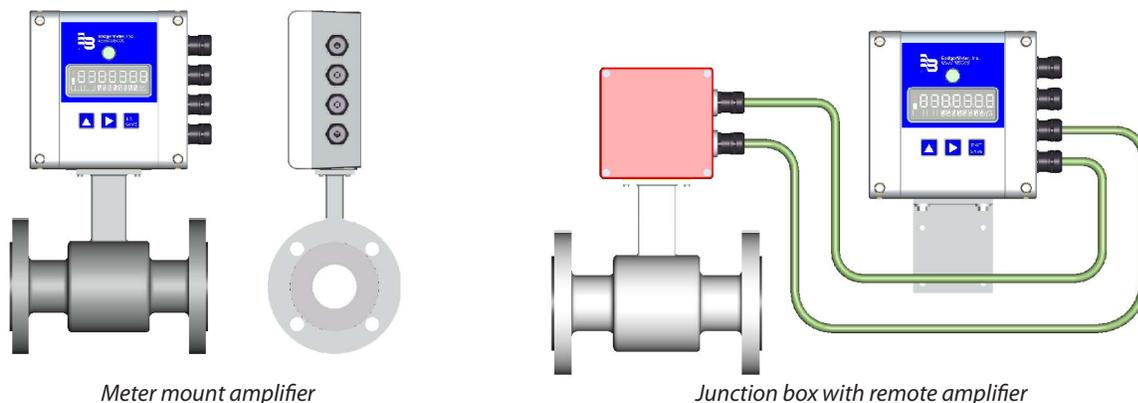
Do not lift detector with forklift.



Do not lift or rig lifting devices through detector.

Meter Location, Orientation and Applications

The M-5000 provides two amplifier mounting options: an integral or meter mount option and a junction box/remote option.



Remote Amplifier Outdoor Location

The amplifier can be installed and operated outdoors. However, it must be protected from the elements, as follows:

- The ambient environment/temperature rating for the unit is -4° F to 140° F (-20° C to 60° C).
- If an indoor location is within 100 feet (30 meters) of the detector, consider increasing the cable length and mounting the amplifier indoors.
- At minimum, fabricate a roof or shield over and/or around the amplifier to protect the LCD display screen from direct sunlight.

Pipelines and Fluid Flow

Take the following precautions during installation:

- Do not install the meter on pipes with extreme pipe vibrations. If pipes are vibrating, secure the piping with appropriate pipe supports in front of and behind the meter. If vibrations can't be restrained, mount the amplifier in a remote location.
- Do not install the detector close to pipeline valves, fittings or impediments that can cause flow disturbances.
- For detectors with PTFE liners, do not install the detector on suction sides of pumps.
- Do not install the detector on outlet sides of piston or diaphragm pumps. Pulsating flow can affect meter performance.
- Avoid installing the detector near equipment that produces electrical interference such as electric motors, transformers, variable frequency, power cables, etc.
- Verify that both ends of the signal cables are securely fastened.
- Place power cables and signal cables in separate conduits.
- Place the meter where there is enough access for installation and maintenance tasks.

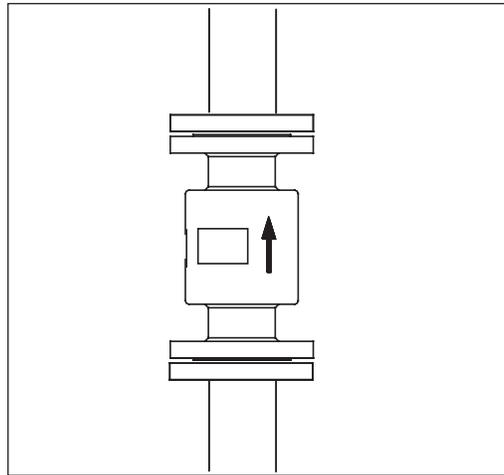
Meter Orientation

Mag meters can operate accurately in any pipeline orientation and can measure volumetric flow in forward and reverse directions.

Note: A "Forward Flow" direction arrow is printed on the detector label.

Vertical Placement

Mag meters perform best when placed vertically, with liquid flowing upward and meter electrodes in a closed, full pipe.



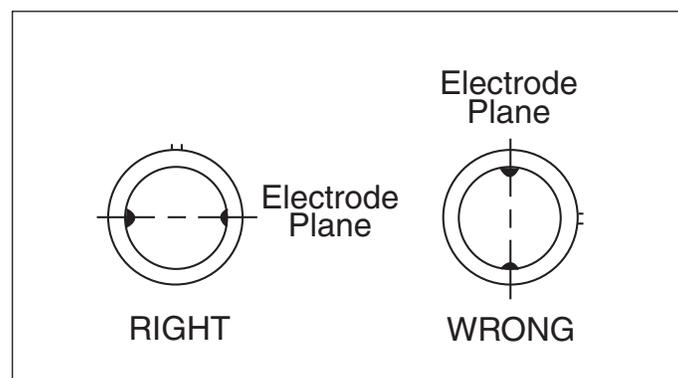
Vertical placement allows the pipe to remain completely full, even in low flow, low pressure applications, and it prevents solids build-up, sediment deposit and accumulation on the liner and electrodes.

Note: Carefully observe the "Forward Flow" label on the meter body and install the meter accordingly.

Horizontal Placement

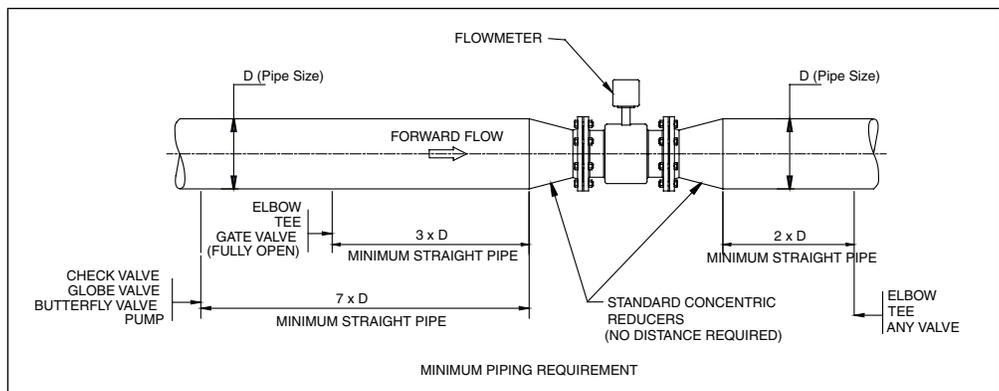
M-5000 meters are equipped with an "Empty Pipe Detection" feature. If an electrode mounted in the pipe is not covered by fluid, the meter will display an "Empty Pipe Detection" condition. The meter will send out an error message and stop measuring flow. When the electrode is again covered with fluid, the error message disappears and the meter will begin measuring.

When installing the meter on a horizontal pipe, mount the detector to the pipe with the flow-measuring electrode axis in a horizontal plane (three and nine o'clock). This placement helps prevent solids build-up, sediment deposit and accumulation on the electrodes.



Straight Pipe Requirements

Sufficient straight-pipe runs are required at the detector inlet and outlet for optimum meter accuracy and performance. An equivalent of three diameters of straight pipe is required on the inlet (upstream) side. Two diameters are required on the outlet (downstream) side.

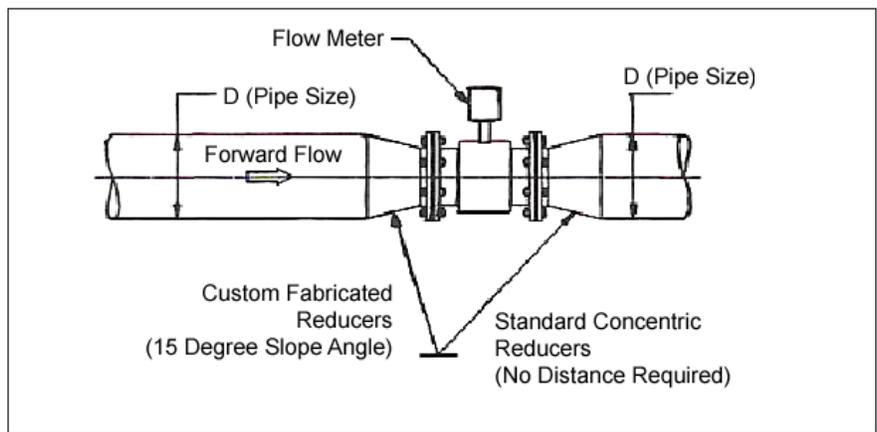


Pipe Reducer Requirements

With pipe reducers, a smaller meter can be mounted in larger pipelines. This arrangement may increase low-flow accuracy.

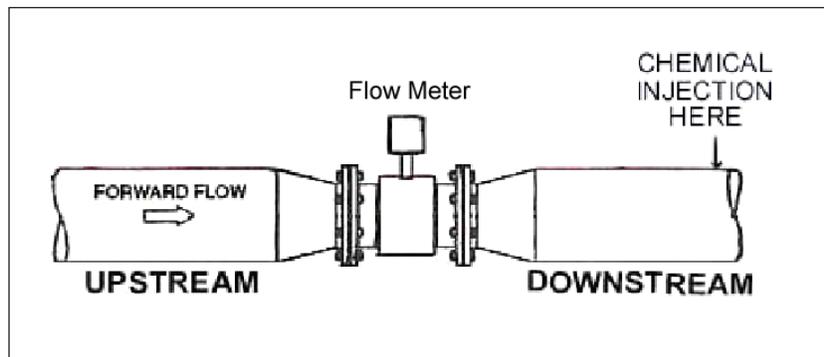
There are no special requirements for standard, concentric, pipe reducers.

Custom fabricated pipe reducers must have an approximate slope angle of 15 degrees to minimize flow disturbances and excessive loss of head. If this is not possible, install the custom pipe reducers as if they were fittings and install the required amount of straight pipe.

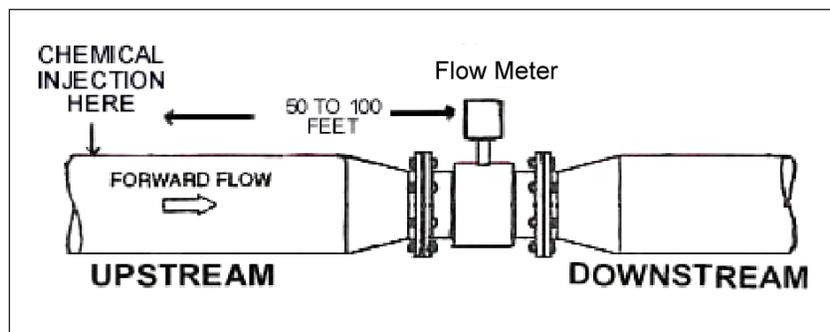


Chemical Injection Applications

For water line applications with a chemical injection point, install the meter upstream of the injection point. This eliminates any meter performance issues.



If a meter must be installed downstream of a chemical injection connection, the distance between the meter and the injection point should be between 50 and 100 feet (15 and 30 meters). The distance must be long enough to allow the water/chemical solution to reach the meter in a complete, homogeneous mixture. If the injection point is too close, the meter senses the two different conductivities for each liquid. This will likely result in inaccurate measurements. The injection method – spaced bursts, continuous stream of drips or liquid or gas – can also affect downstream readings by the meter.

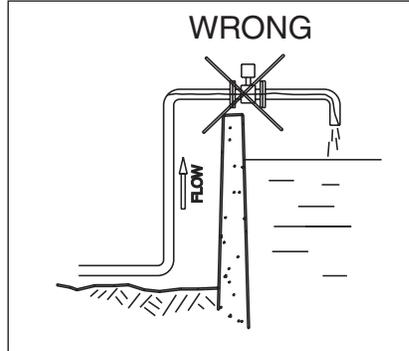


Sometimes, due to circumstances, it's difficult to specify the exact downstream placement distances. Contact Badger Meter Technical Support to review your application, if necessary.

Partially-Filled Pipe Situations

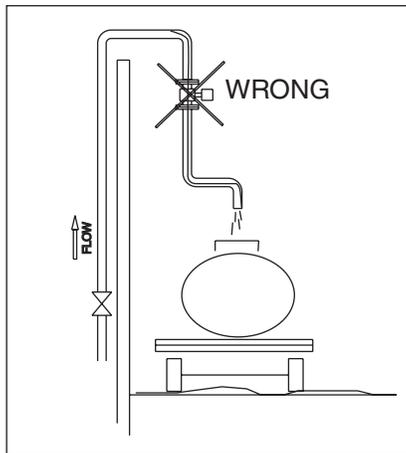
In some locations, the process pipe may be momentarily only partially filled. Examples include: lack of back pressure, insufficient line pressure, gravity flow applications, etc.

To eliminate these situations, do not install the meter at the highest point of the pipeline.

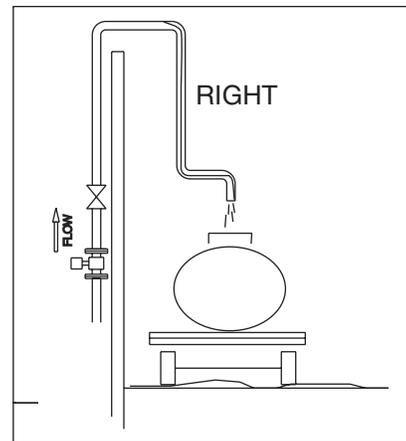


Do not install the meter in a vertical, downward flow section of pipe.

Always position the ON/OFF valves on the downstream side of the meter.

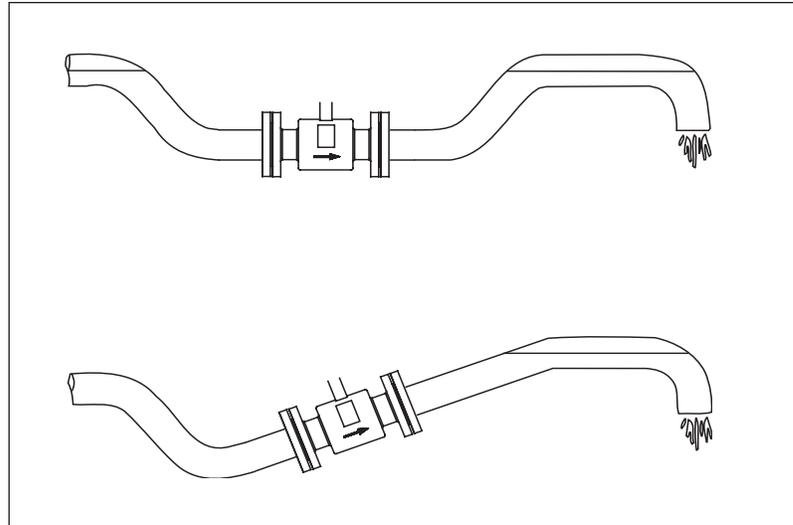


Do not install in a vertical, downward position.



Position "On/Off" valves on downstream side.

To minimize the possibility of partially-full pipe flows in horizontal, gravity or low pressure applications, create a pipe arrangement that ensures the detector remains full of liquid at all times.

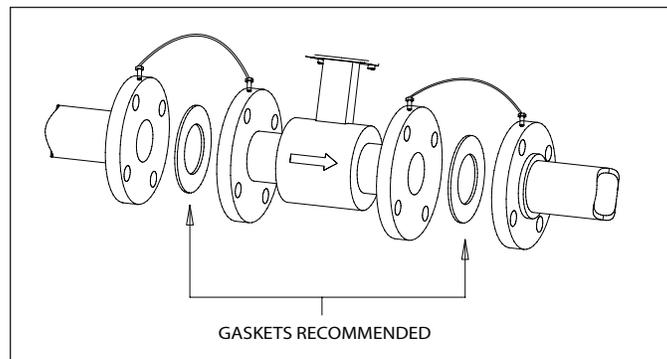


Meter Gaskets and Grounding

Gasket and grounding requirements must be considered when determining the meter location, orientation and application.

Meter/Pipeline Connection Gaskets

Install gaskets (not provided) between the detector's isolating liner and the pipeline flange to ensure a proper and secure hydraulic seal. Use gaskets that are compatible with the fluid. Center each gasket on the flange to avoid flow restrictions or turbulence in the line.



During installation, do not use graphite or any electrically conductive sealing compound to hold the gaskets. This could compromise the accuracy of the measuring signal.

If using a grounding ring in the detector/pipeline connection, place the ring between two gaskets. (See *Non-Conductive Pipe Grounding* on page 14.)

Meter Grounding

Process pipeline material can be either electrically conductive (metal) or not electrically conductive (made of or lined with PVC, fiberglass or concrete).

Important: It is essential that the mag meter amplifier's input ground (zero voltage reference) be electrically connected to the liquid media and to a good, solid earth ground reference.

Conductive Pipe Grounding

To achieve an adequate ground, the meter body **MUST** be electrically connected to the liquid media. The mag meter flanges are provided with grounding bolts for this purpose.

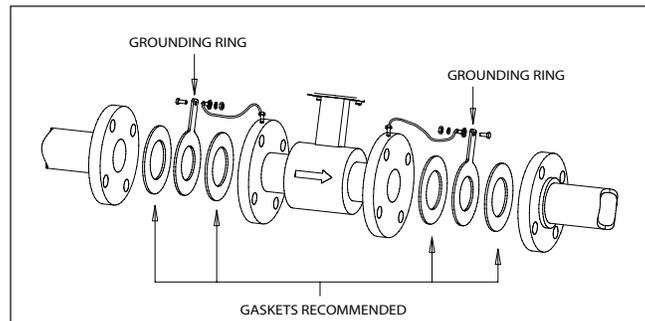
If the pipe material is electrically conductive, simply install grounding straps between these grounding bolts and the mating flanges.

To ensure a good electrical connection at the mating flanges, we recommend that drilling and tapping the flanges and install a grounding screw (not provided).

These grounding straps must be copper wire, at least 12AWG size. They must be connected on both sides (inlet and outlet) of the detector and to a local, earth ground.

Non-Conductive Pipe Grounding

Important: If the process pipe is not electrically conductive (PVC, fiberglass, cement-lined pipes or any other non-conductive material) and the meter was not originally ordered with an optional grounding electrode, install a pair of grounding rings between the mating flanges at both ends of the meter. See the following illustration.



In this case, the grounding straps should be connected to both of the grounding rings and to a good, solid earth ground. Grounding rings are available in stainless steel. If the fluid is too aggressive for stainless steel, order a meter with the optional grounding electrode in a material compatible with the fluid.

Amplifier Mounting Configuration Options

There are two configuration options for mounting the amplifier. There are many options to accommodate a variety of meter-placement and environmental conditions.

Meter Mount Configuration

The meter mount configuration has the amplifier mounted directly on the detector. This compact, self-contained configuration minimizes installation wiring.

Remote Mount Configuration

The remote mount configuration places the amplifier at a location away from the fluid flow and detector. This is necessary in situations where process fluid temperature or the environment exceeds amplifier ratings.

The detector and amplifier are connected by wires, run through conduit, between junction boxes on the detector and the amplifier. The distance between the detector junction box and amplifier junction box can be up to 100 feet (30 meters). A remote mounting bracket is supplied.

Submersible Option

If installing the meter in a vault, order the remote amplifier option. Do not install the amplifier inside a vault. We also recommend ordering the remote meter package with the submersible option (NEMA 6P). This will eliminate any potential problems resulting from humidity or temporary flooding in the vault.

Note: The National Electronics Manufacturer's Association (NEMA) 6P enclosures are constructed for indoor or outdoor use to provide protection against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects and water (hose directed water and the entry of water during prolonged submersion at a limited depth); that provide an additional level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.

Wiring

Wiring Safety

⚠ WARNING At installation, be sure to comply with the following requirements:

- Keep all lines as short as possible.
- Use twisted pair shielded wire for all output wiring.
- Observe all applicable, local electrical codes.

Opening the M-5000 Cover

The M-5000 amplifier's design allows opening the cover without completely removing it.

Follow these steps:

1. Completely remove the top two screws from the amplifier using a blade/slotted screwdriver.



2. Loosen both of the bottom screws so that the round head of each screw clears the top face of the cover.



3. Pull the cover down to the open position.



Power

Battery

(2) D-cells battery pack (1/2" to 6") or Double (2) D-cell battery pack (8" to 24").

Battery Life

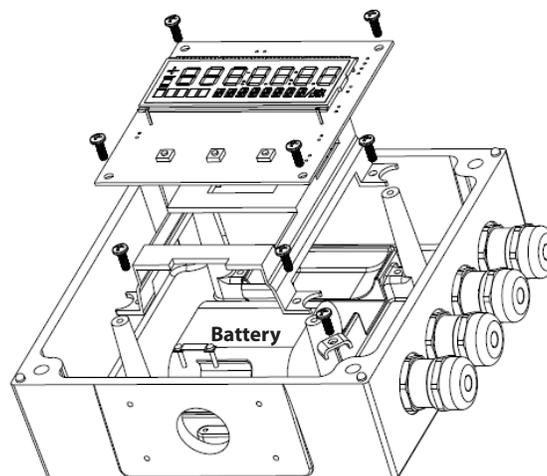
Standard Pack	
Sampling	Expected Life
0.25	3 months
4	4 years
8	8 years
15	10 years

These calculations are for a standard battery pack, with two D-size batteries., with communication and outputs OFF, at a temperature of 25° C (77° F).

Battery Replacement

- 1) Save totalizers in the M-5000 menu (MainMenu>Misc>Battery>Change>).
- 2) Remove the circuit board, battery cover and the old battery pack.
- 3) Put the new battery pack into the enclosure, connect the new battery pack to M-5000 PCB and fasten PCB with four M3,5 screws with serrated lock washer.
- 4) Replace the battery cover, circuit board and enclosure cover.
- 5) Set time and date in the M-5000 menu (MainMenu>Misc>Date DMY> (MainMenu>Misc>Time>).
- 6) Set burned capacity of battery pack through Modbus to 0.0Ah.
- 7) Set initial capacity of battery pack through Modbus to 38.0Ah (38.0Ah for standard battery pack).

Note: Totalizers and configuration remain unaffected battery replacement.



Amplifier Housing Components - Exploded View

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Remote Mount Installation

If installing the M-5000 amplifier in a remote location, review the procedures in this section.

Mount Bracket to Amplifier

1. Align bracket-mounting holes with amplifier mounting holes.
2. Attach bracket to amplifier with supplied screws. Torque screws to 80 in. lb.

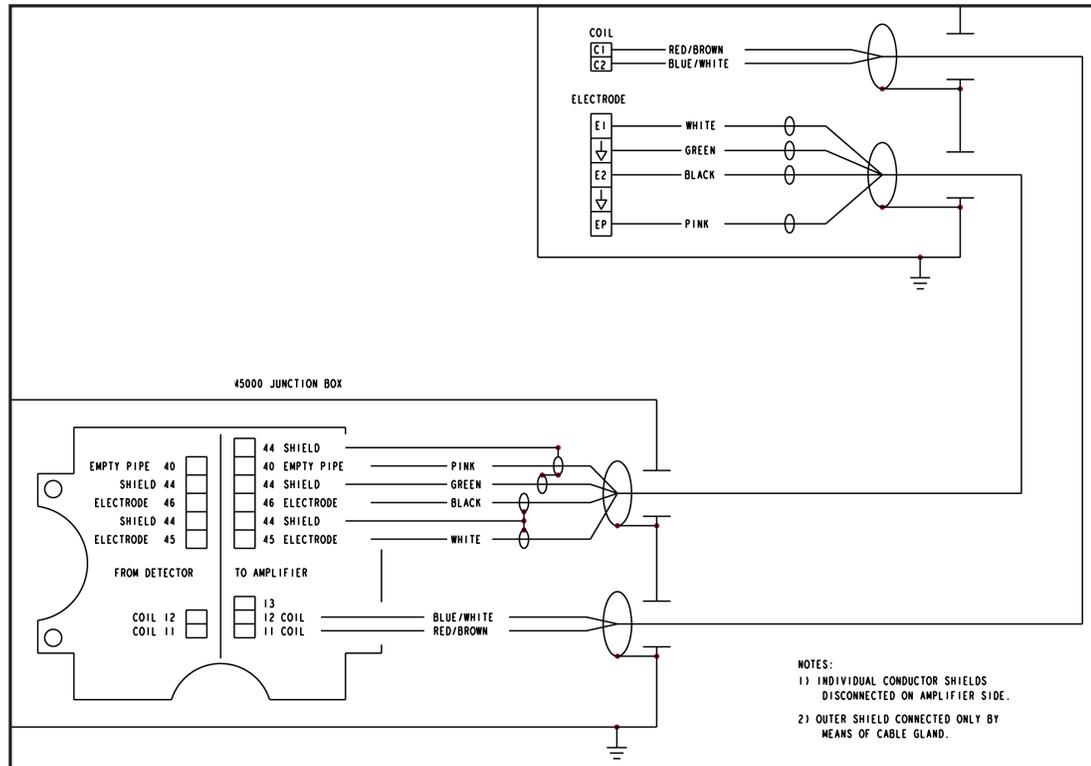
Wiring Configuration

Wiring between the detector and the M-5000 amplifier comes complete from the factory. If installation requires the use of conduit, Badger Meter recommends following these steps when wiring the detector to the amplifier.

1. Remove the junction box lid. Carefully remove the wires connected to the terminal blocks that run to the M-5000 amplifier. See the chart below for a reference of wire color to terminal connection.
2. Run cable through the conduit from the amplifier location while retaining the wiring of the cable to the amplifier, as supplied.
3. Complete conduit assembly on both ends and rewire the cable into the junction box as it was previously wired.

Wiring for Remote Configuration

Remote style M-5000 amplifier models can be ordered with standard cables measuring 15, 30, 50 and 100 feet.



Connection No.	Description	Wire Color
11	Coil	Red/Brown
12	Coil	Blue/White
13	Main Shield	Not Used
40	Empty Pipe	Pink
44*	Shield	Green
44*	Empty Pipe Shield	Shield Wire
45	Electrode	White
46	Electrode	Black

*Connections with the No. 44 are lying on the same potential.

Configuring Output

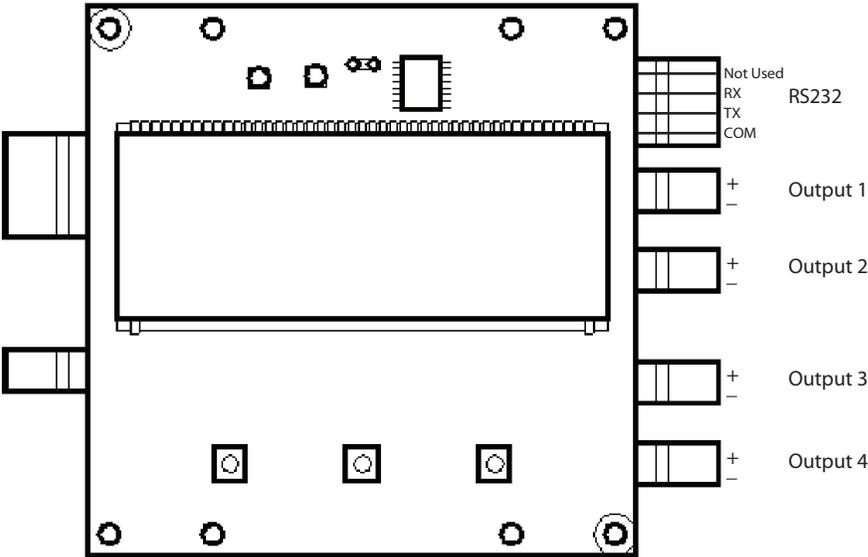
This section describes wiring the following M-5000 outputs:

- Digital outputs
- Communication

When the sensor and the amplifier have been wired, wire any outputs to the M-5000 amplifier.

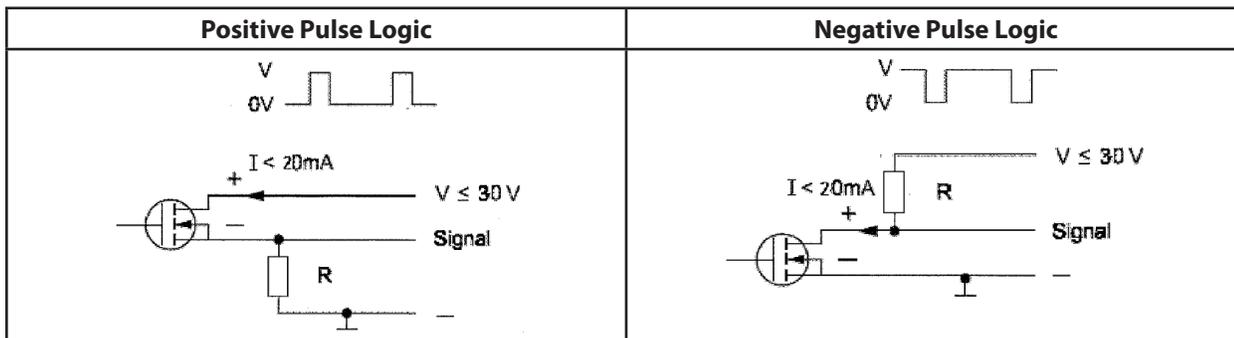
Follow all of the safety precautions and local code to prevent electrical shock and damage to the electronic components.

Circuit Board Diagram



Outputs	Description
Output 1	Passive max. 30 VDC, 20 mA Max. Frequency 100 Hz
Output 2	Passive max. 30 VDC, 20 mA Max. Frequency 100 Hz
Output 3	Passive Max 30 VDC, 20 mA
Output 4	Passive Max 30 VDC, 20 mA
RS232	Modbus RTU

Digital Output Wiring Diagrams



Digital Output Wiring Diagram

Digital Output Selections:

Output 1	Output 2	Output 3	Output 4
Forward Flow Pulse Output	Reverse Flow Pulse Output	Flow direction (Forward vs. Reverse)	High/Low flow alarm (0 – 100% of full scale, resolution 1%)
High/Low flow alarm (0 – 100% of full scale, resolution 1%)	High/Low flow alarm (0 – 100% of full scale, resolution 1%)	High/Low flow alarm (0 – 100% of full scale, resolution 1%)	Empty pipe alarm
Empty pipe alarm	Empty pipe alarm	Empty pipe alarm	Error alarm
Error alarm	Error alarm	Error alarm	
Can be used with AMR when pulse width is set to 50 milliseconds			

Outputs are configurable for Pulses/Unit (PPU) and Pulse Width (PW). The PW is configurable from 5 – 500 milliseconds, with a frequency limit is 100Hz. The PPU is displayed using an automatically selected resolution.

The high/low flow alarm functionality is configurable for maximum and minimum set points as a percentage of full-scale flow. Configurable value are settable from 0 – 100% in 1% increments.

Programming the M-5000

The M-5000 amplifier is pre-programmed from the factory. No additional programming is necessary, however, for special features, the meter can be programmed for specific requirements.

Function Buttons

All M-5000 programming is accomplished using the three function buttons located on the front of the amplifier. Screen navigation and digit and parameter selection is performed by a combination of these three buttons.

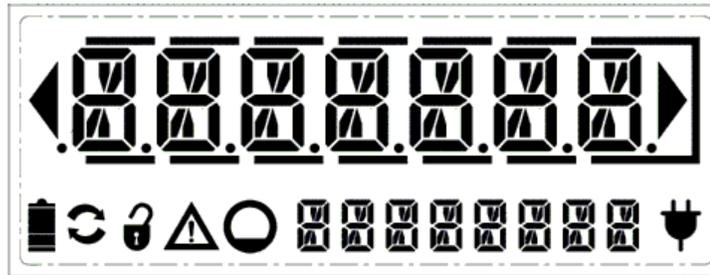


The **up-arrow** button allows scrolling through eight menu screens. This button is also used to advance numerical digits to change values, such as frequency, period, EP level, etcetera, as well as toggle on-off conditions and flow directions.

The **right-arrow** button allows digit selection from left to right and allows selecting either the top row of the display or the bottom row (the bottom row is active when flashing).

The **EXIT SAVE** button allows the saving of changed values and conditions, toggling between the upper and lower display lines and returning to a previous menu.

Display



The top row displays seven digits for specific values on each screen and the bottom row displays meter and register condition icons and current screen descriptions.

The icons, from left to right indicate:

battery status (shown full charge), data communication, password-protected amplifier lock (shown unlocked), warning/caution condition and empty pipe detection

Battery Levels

The battery icon indicates three levels of capacity:

	Greater than 3 volts (maximum = 3.6V)
	Greater than 2 volts, less than 3 volts (recommended battery replacement)
	Less than 2 volts (measuring has stopped)

Display Menu Screen Hierarchy Structure

T 1+

T1-

T1n

T2+

T2-

T2n

Errors

Login

Main Menu → Meter Setup → Diameter
Detector Factor
Detector Zero
Amplifier Factor
Coil Current
Frequency
Period
Empty Pipe Level
Empty Pipe On Off
Empty Pipe Measure
Measure → Flow Unit
Totalizer Unit
Full Scale Flow
Low Flow Cutoff
Direction
T1 Reset
Outputs → Pulse/Unit
Pulse Width
Set Min
Set Max
Simulation
Out1Oper
Out2Oper
Out3Oper
Out4Oper
Out1Mode
Out2Mode
Out3Mode
Out4Mode
Communication → Interface
BaudRate
Parity
Address

Misc → Voltage
Capacity
Language
Date DMY
Time
EEPROM
Battery
Factory CFG
Restart
Info → Serial Number
Version
Compilation Date
PINs → Pins Control
User
Service
Admin

Security

The M-5000 security feature allows the option to restrict access to the meter by way of a five-digit Personal Identification Number (PIN). The system administrator can set up a single PIN for each of the three different levels of access:

- **Administration** - allows access to all M-5000 menu configuration screens.
- **Service** - allows access to service-level and user-level menu configuration screens.
- **User** - allows access only to user-level menu configuration screens.

Note: For a lost PIN, Contact Badger Meter Technical Support at 800-456-5023 for a replacement PIN.

Not all levels of access need to be set. If no PINs are set up, any M-5000 user will have access to all functions.

Note: The security settings will also apply to remote access. All remote via modbus writes to the meter will be blocked unless the user is remotely logged in.

Setting a PIN

1. From the Main Menu, press the **right-arrow** button.
2. From the Meter Setup menu, press the **up-arrow** button until the Pin menu is displayed.
3. Press the **right-arrow** button to display the PINS Control menu.
4. Press the **right-arrow** button to flash ON or OFF.
5. With either ON or OFF flashing, press the **up-arrow** button to display ON.
6. Press the **EXIT SAVE** button to save the ON setting.
7. With the Control menu flashing, press the **up-arrow** button to display the desired security level (user service, admin, etc.).
8. With the desired security level flashing, press the **right-arrow** button to display the upper row of six zeros (digits).
9. Press the **up-arrow** button to change the first digit, followed by pressing the **right-arrow** button to select the next digit.
10. Press the **EXIT SAVE** button to save the PIN number for that security level.

The saved PIN number will be the same PIN number used to Login to the amplifier.

Note: Be sure to log off when you have completed work with the M-5000. Otherwise, a five-minute time delay occurs between the most recent activity and the time when the M-5000 automatically logs off.

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M-5000 Main Menu Programming Options

The following M-5000 programming options are available from the Main Menu:

- Meter Setup
- Measure
- Outputs
- Communication
- Miscellaneous
- Information
- Pin

Note: Options that are listed [Factory Set] should not be changed without specific directions from authorized Badger Meter personnel.

The applicable security level for each menu option is indicated as follows:



Note: Parameters indicated by the battery icon, if changed will affect battery performance

Administrative

Service

User

The factory default values are shown, enclosed in brackets.

Meter Setup	
<p>Empty Pipe ON/OFF [ON]</p> 	<p>When set to ON, an Empty Pipe condition indicates to the outputs and the display that the meter is not completely filled. When set to Off, empty pipe conditions are not detected..</p>
<p>Power Line Frequency [60 Hz]</p> 	<p>This parameter provides measuring immunity to industrial noise from a power supply feed.</p> <p>Factory-set.</p>
<p>Diameter [Factory Set]</p> 	<p>This parameter is set at the factory. In the event the amplifier is replaced, verify that the pipe diameter matches the installed pipe size.</p>

Meter Setup	
<p>Period</p> <p>[15 Seconds]</p> <div style="display: flex; align-items: center; gap: 10px;">   </div> <p>Note: Parameters indicated by the battery icon, if changed will affect battery performance.</p>	<p>This parameter configures the frequency (0 seconds to 63 seconds) of sampled measurements.</p>
<p>Detector Factor</p> <p>[Factory Set]</p> 	<p>This parameter is set at the factory. This factor compensates for accuracy error as a result of the installed detector.</p> <p>In the event the amplifier is replaced, this parameter must be reprogrammed with the original detector zero.</p>
<p>Detector Zero</p> <p>[Factory Set]</p> 	<p>This parameter is set at the factory.</p> <p>This parameter compensates for accuracy error as a result of the installed detector.</p> <p>In the event the amplifier is replaced, this parameter must be reprogrammed with the original detector factor.</p>
<p>Amplifier Factor</p> <p>[Factory Set]</p> <p>Read Only</p>	<p>This parameter is set at the factory. This factor compensates for accuracy error as a result of the installed amplifier.</p>
<p>Coil Current</p> <p>[Factory Set]</p> <p>Read Only</p>	<p>This parameter is set at the factory. This factor compensates for accuracy error as a result of the installed amplifier.</p>

Measure

<p>Flow Unit</p> <p>[GAL/Min]</p> 	<p>This parameter lets you set the unit of measure for the flow rate and full scale flow. Changing this parameter readjusts the full scale flow parameter. For example, changing from GPM to GPS would change the full scale flow from 60 GPM to 1 GPS.</p> <table border="1" data-bbox="570 380 1438 831"> <thead> <tr> <th><i>Display</i></th> <th><i>Flow Unit</i></th> <th><i>Display</i></th> <th><i>Flow Unit</i></th> </tr> </thead> <tbody> <tr> <td>L / S</td> <td>Liter/Second</td> <td>GAL / Min</td> <td>Gallons/Min.</td> </tr> <tr> <td>L / Min</td> <td>Liter/Minute</td> <td>GAL / h</td> <td>Gallons/Hour</td> </tr> <tr> <td>L / h</td> <td>Liter/Hour</td> <td>MG / D</td> <td>MegaGallon/Day</td> </tr> <tr> <td>M3 / S</td> <td>Cubic Meter/Sec.</td> <td>IG / S</td> <td>ImperialGallon/Sec.</td> </tr> <tr> <td>M3 / Min</td> <td>Cubic Meter/Min.</td> <td>IG / Min</td> <td>ImperialGallon/Min.</td> </tr> <tr> <td>M3 / h</td> <td>Cubic Meter/Hour</td> <td>IG / h</td> <td>ImperialGallon/Hour</td> </tr> <tr> <td>Ft3 / S</td> <td>Cubic Feet/Sec.</td> <td>OZ / Min</td> <td>Ounce/Min</td> </tr> <tr> <td>Ft3 / M</td> <td>Cubic Feet/Min.</td> <td>bbI / Min</td> <td>Barrel/Min</td> </tr> <tr> <td>Ft3 / h</td> <td>Cubic Feet/Hour.</td> <td></td> <td></td> </tr> <tr> <td>GAL / S</td> <td>Gallons/Sec.</td> <td></td> <td></td> </tr> </tbody> </table>	<i>Display</i>	<i>Flow Unit</i>	<i>Display</i>	<i>Flow Unit</i>	L / S	Liter/Second	GAL / Min	Gallons/Min.	L / Min	Liter/Minute	GAL / h	Gallons/Hour	L / h	Liter/Hour	MG / D	MegaGallon/Day	M3 / S	Cubic Meter/Sec.	IG / S	ImperialGallon/Sec.	M3 / Min	Cubic Meter/Min.	IG / Min	ImperialGallon/Min.	M3 / h	Cubic Meter/Hour	IG / h	ImperialGallon/Hour	Ft3 / S	Cubic Feet/Sec.	OZ / Min	Ounce/Min	Ft3 / M	Cubic Feet/Min.	bbI / Min	Barrel/Min	Ft3 / h	Cubic Feet/Hour.			GAL / S	Gallons/Sec.		
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Measure	
<p>Full Scale Flow</p> <p>[Factory Set]</p> 	<p>This parameter sets the maximum flow the system is expected to measure. This parameter has influence on other system parameters. These parameters include:</p> <ul style="list-style-type: none"> • Low Flow Cutoff – Changes to full scale flow affect the measuring cut-off threshold of the meter • Alarm Outputs – Changes to full scale flow adjusts the thresholds for generating set point alarms • Pulse Outputs – Changes to full scale flow adjusts the pulse frequency and duty cycle <p>Change the full scale flow based on the meter size and the application's requirements. Verify that the full scale flow falls within the meter's suggested flow range limits"</p> <p>Flow Range: 0.328 to 32.8 FPS (0.1 to 10 m/s)</p> <p>The full scale flow is valid for both flow directions.</p> <p>Note: If the flow rate exceeds the full scale setting of more than 25%, a FLOW_OVERLOAD_WARNING message indicates that the configured full scale range has been exceeded. However, the meter will continue to measure. This will affect the latency of the pulse outputs and possibly cause overflow.</p>
<p>Low Flow Cutoff</p> <p>[2%]</p> 	<p>Low flow cutoff defines the threshold at which flow measurement will be forced to zero. The cutoff value can be set from 0% to 10% of the full scale flow. Increasing this threshold will help prevent false readings during "no flow" conditions possibly caused by pipe vibration or inherent system noise..</p>

Measure	
<p>Direction</p> <p>[Bi-Directional]</p> 	<p>This parameter allows setting the meter to measure forward flow only (uni-directional) or both forward and reverse flow (bi-directional).</p> <p>Uni-Directional</p> <p>Flow is totalized in only one direction. The flow direction is indicated by the arrow printed on the detector label. Uni-directional measurements on the main display screen include:</p> <p>T1: Registers forward flow, resettable by menu or Modbus RTU.</p> <p>T2: Registers forward flow, non-resettable.</p> <p>Bi-Directional</p> <p>Flow is totalized in both directions. Bi-directional measurements on the main display screen include:</p> <p>T1+: Registers forward flow, resettable by menu or Modbus RTU</p> <p>T1-: Registers reverse flow, resettable by menu or Modbus RTU</p> <p>T1N: Registers total flow, T+ - T-, resettable by menu or Modbus RTU</p> <p>T2+: Registers forward flow, non-resettable</p> <p>T2-: Registers reverse flow, non-resettable</p> <p>T2N: Registers total flow, T+ - T-, non-resettable</p>
<p>T1 Reset</p> <p>[N/A]</p> 	<p>This parameter allows the reset of totalizer 1.</p>

Outputs		
Digital Output	<p>Pulse/Unit [1]</p> 	<p>This parameter lets you set how many pulses per unit of measure will be transmitted to remote applications. For example, assuming the unit of measure is gallons:</p> <ul style="list-style-type: none"> • Setting the Pulses/Unit to 1 will transmit 1 pulse every gallon • Setting the Pulses/Unit to 0.01 will transmit 1 pulse every 100 gallons <p>You must configure pulses/unit if the function of the selected output is to be forward or reverse .</p> <p>This parameter must be considered with the Pulse Width and Full Scale Flow parameters. The maximum pulse frequency is 100 Hz. The frequency is correlated with the flow rate. Violation of output frequency limits will generate a PULSE_OVERLOAD_WARNING.</p>
	<p>Width [0 ms]</p> 	<p>This parameter establishes the ON duration of the transmitted pulse. The configurable range is from 0 to 500ms.</p> <ul style="list-style-type: none"> • Non-zero pulse width configuration – the OFF duration of the transmitted pulse is dependent on flow rate. The OFF duration is to be at least the configured ON duration. At full scale flow, the ON duration equals the Off duration. The maximum configurable output frequency is limited to 100 Hz. • The duty cycle of the transmitted pulse is at 50% of the output frequencies greater than 1 Hz. <p>This parameter must be considered with the Pulses/Unit and Full Scale Flow parameters. The maximum pulse frequency is 100 Hz. The frequency is correlated with the flow rate. Violation of output frequency limits will generate a PULSE_OVERLOAD_WARNING.</p>

Outputs		
Digital Output	<p>Set Min. [0%] </p>	<p>This parameter establishes, as a percentage of full scale flow, the threshold at which the output alarm will be activated. Flow rates below the threshold will activate the output alarm.</p>
	<p>Set Max. [100%] </p>	<p>This parameter establishes, as a percentage of full scale flow, the threshold at which the output alarm will be activated. Flow rates above the threshold will activate the output alarm.</p>
	<p>Output Mode [1: Normally Open] [2: Normally Open] [3: Normally Open] [4: Normally Open] </p>	<p>This parameter lets you set the output switch to normally open or normally closed. If normally open is selected, the output switch is open (no current) when the output is inactive, and closed (current flows) when the output is active.</p> <p>If normally closed is selected, the output switch is closed (current flows) when the output is inactive, and open (no current) when the output is active.</p>

Outputs																
<p>Digital Output Operation</p> <p>[1: OFF] [2: OFF] [3: OFF] [4: OFF]</p> <p> </p>	<p>This parameter provides configuration of the functional operation of the associated output. The following operations are supported:</p> <ul style="list-style-type: none"> • Forward Pulse – Generates pulses during forward flow conditions (output 1 - only) • Reverse Pulse – Generates pulses during reverse flow conditions (output 2 - only) • Flow Direction – Provides indication on current flow direction (output 3 - only): <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th colspan="2" style="text-align: center;">OUTPUT TYPE</th> </tr> <tr> <th style="text-align: center;">FLOW DIRECTION</th> <th style="text-align: center;">NORMALLY OPEN</th> <th style="text-align: center;">NORMALLY CLOSED</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">REVERSE</td> <td style="text-align: center;">Closed</td> <td style="text-align: center;">Open</td> </tr> <tr> <td style="text-align: center;">FORWARD</td> <td style="text-align: center;">Open</td> <td style="text-align: center;">Closed</td> </tr> <tr> <td style="text-align: center;">NO FLOW</td> <td style="text-align: center;">No Change</td> <td style="text-align: center;">No Change</td> </tr> </tbody> </table> <ul style="list-style-type: none"> • Flow Set Point – Provides indication when flow rate exceeds thresholds defined by flow set points (outputs 1, 2, 3, 4) • Error Alarm – Provides indication when meter has error condition. Error conditions include, empty pipe error, full scale flow error, and detector error (outputs 1, 2, 3, 4) • Empty Pipe Alarm – Provides indication when pipe is empty (outputs 1, 2, 3, 4) 		OUTPUT TYPE		FLOW DIRECTION	NORMALLY OPEN	NORMALLY CLOSED	REVERSE	Closed	Open	FORWARD	Open	Closed	NO FLOW	No Change	No Change
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FORWARD	Open	Closed														
NO FLOW	No Change	No Change														
<p>Simulation</p> <p>[OFF]</p> <p></p>	<p>Flow Simulation provides output simulation based on a percentage of the full scale flow. Simulation will not accumulate the totalizers. The range of simulation includes -100% to 100% of the full scale flow.</p> <p>The Flow Simulation Parameter lets you set the range of simulation in increments of 50 (OFF, 0, 50, 100, -50, -100).</p>															

Communication: Port Settings	
<p>Interface</p> <p>[OFF]</p> 	<p>This parameter provides communication port configuration.</p> <ul style="list-style-type: none"> • Serial (Modbus RTU) • Irda (Modbus RTU)
<p>Baud Rate</p> <p>[9600]</p> 	<p>This parameter sets the baud rate.</p> <p>The following baud rates are supported:</p> <ul style="list-style-type: none"> • 9600 • 1200 • 2400
<p>Parity</p> <p>[Even]</p> 	<p>This parameter sets the parity.</p> <p>The following parities are supported:</p> <ul style="list-style-type: none"> • Even • Odd • Mark
<p>Address</p> <p>[01]</p> 	<p>This parameter configures the Modbus address in the range from 1 to 247.</p>

Misc	
<p>Voltage [Read Only]</p>	Displays the current battery voltage.
<p>Capacity [Read Only]</p>	<p>Displays the current battery capacity (0/38V to 38/38V).</p> <p>Note: A new battery should be at or near a 0/38 reading.</p>
<p>Language Select [English]</p> <p></p>	<p>This parameter allows changing the current language. The M-5000 supports alternate languages along with English as the default setting.</p> <p>The following languages are supported:</p> <p>German (Deutch), Czech (Cestina), Spanish (Espanol), French (Francai), Russian (Pycck-hIII)</p> <p>.</p>
<p>Date, Month, Year [N/A]</p> <p></p>	A real-time clock. The month, date and year must be reprogrammed after the battery is replaced.
<p>Time [N/A]</p> <p></p>	A real-time clock. The month, date and year must be reprogrammed after the battery is replaced.
<p>EEPROM [N/A]</p> <p></p>	Format the EEPROM to erase all log files. Totalizers and configuration remain unaffected during a format.
<p>Battery [N/A]</p> <p></p>	Saves Totalizers to non-volatile memory in preparation for battery replacement.
<p>Restart [N/A]</p> <p></p>	Provides the ability to reset the meter electronics.

PIN	
Security [OFF] 	Two options are available: <ul style="list-style-type: none">• ON (requires PIN configuration)• OFF
User 	Users logged in with this PIN will have access to all user-level. Users at this level do not have access to Service or Admin functions.
Service 	Users logged in with this PIN will have access to both service and user-level procedures. User at this level will not have access to administrative functions.
Admin 	Users logged in with this PIN will have access to all procedures. User at this level will have full access to the meter.

Maintenance

Mandatory, routine or scheduled maintenance should not be required for the Badger M-5000 Mag Meter electronics or flow tube after proper installation.

However, some occurrences may require personnel to perform the following:

- Flow tube and electrode cleaning
- Circuit board replacement

⚠ WARNING These maintenance procedures are discussed in this section.

Do not clean components inside the amplifier or junction box.

Cleaning the Flow Tube and Electrode

At times flow tube, electrodes, amplifier/junction box housings and the amplifier window may need periodic cleaning, depending on process fluid properties, fluid flow rate and surrounding environment.

Clean the flow tube and electrodes by following the material handling and cleaning procedures documented in Material Safety Data Sheet (MSDS) guidelines for the product(s) that were in contact with the flow tube and electrodes.

Should flow tube and/or electrode cleaning become necessary:

1. Disconnect detector from pipeline.
2. Clean electrodes according to MSDS guidelines.
3. Reconnect detector to pipeline.

Troubleshooting

The M-5000 mag meter is designed for many years of optimal performance. However, should it malfunction, there are certain things that we recommend you check before contacting our Technical Support department or your local Badger Meter Representative.

Note: If the fluid measured has a high concentration of conductive solids, deposits may accumulate on the internal liner walls and electrodes. These deposits will cause a reduction of the measuring output. Thus, Badger Meter recommends that you remove the meter and inspect the liner and electrodes after six months. If deposits are found, remove them with a soft brush. Repeat inspection process every six months or until an appropriate inspection cycle can be established for the specific application. Other general conditions include:

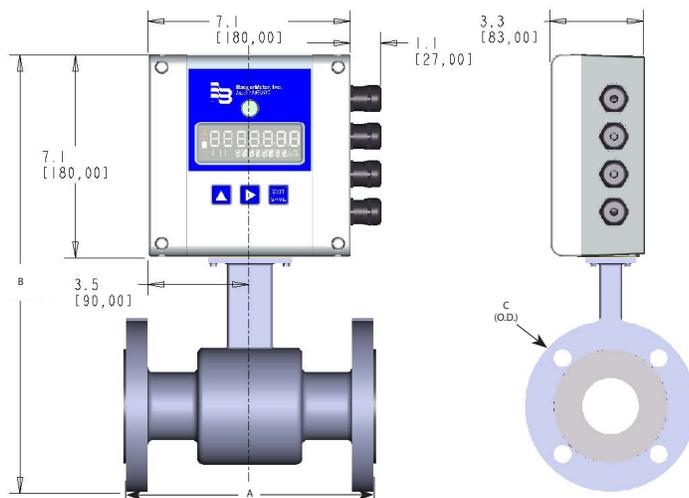
Description	Possible Cause	Recommended Action
Flow is present but display is "0"	Disconnected signal cable. Detector mounted opposite of the main Flow direction (see arrow on the nameplate). Coil or electrode cables exchanged. Improper low flow cutoff or full scale flow.	Check signal cable. Turn detector 180° or switch terminal E1 and E2 or reprogram to bi-directional mode Check cable connections for cross wiring. Replace configuration defaults.
Inaccurate measuring	Improper calibration. Wrong calibration parameter. Pipe not fully filled, or air in pipe. Invalid fluid conductivity. Invalid fluid mixture.	Check the parameters (detector factor and size) according to supplied data sheet. Check if meter is completely filled with fluid. Purge line to eliminate air bubbles.
Blank display	Dead battery	Replace battery.
Flow rate value known to be wrong	Detector factor. Deposits on electrodes and/or liner. Incorrect pipe size programmed.	Check value on label. Check and remove deposits. Check size if necessary.
Flow rate indication unstable	Cable issue. Grounding issue. Partially full pipe. Air in pipe. Invalid fluid conductivity.	Make sure cable is shielded and not vibrating. Make sure meter is properly grounded to a good earth ground. Make sure pipe is full of fluid. Make sure fluid does not contain air bubbles. Make sure amplifier is not too close to sources of electrical interference.

Errors & Warnings

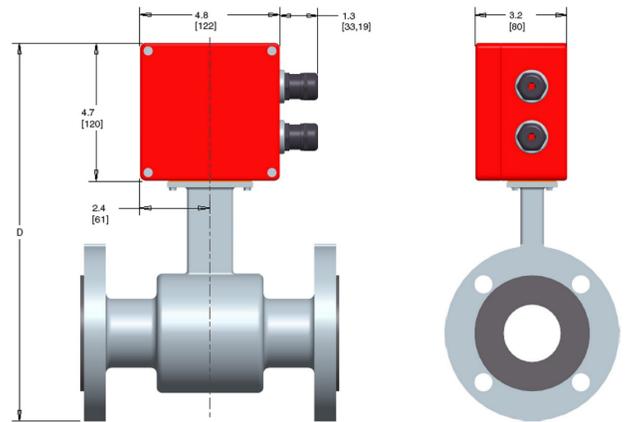
- **MEASURE_TIMEOUT**
Measurement was not completed in 250ms
- **COMMON_MODE_VOLTAGE_OVERLOAD**
Common mode voltage is smaller than -2.0V or larger than +4.1V.
- **EMPTY_PIPE_WARNING**
Measured impedance between the Empty Pipe electrode and the Ground exceeded the set value.
- **PULSE_OVERLOAD_WARNING**
Overflow occurred on the flow output
- **FLOW_OVERLOAD_WARNING**
Flow exceeded the Full Scale of more than 25%.
- **LOW_POWER_WARNING**
Battery voltage is smaller than 3.0V. Consider replacing the battery upon reading this warning.
- **EEPROM_ERROR**
Configuration file is missing.
- **CONFIG_ERROR**
Configuration file is corrupted.
- **PREAMPLIFIER_OVERLOAD**
Input voltage exceeded the limits. Maximum polarization is $\pm 227\text{mV}$; maximum power line noise is 10.6mV; maximum useful signal is 10.7mV.

Detector Specifications

Dimensions in inches (millimeters)



Meter with M-5000 Amplifier



Meter with junction box for remote M-5000 Amplifier

Size		A		B		C		D		Est.Weight with Amplifier		Flow Range			
												GPM		LPM	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	Lbs	Kg	Min	Max	Min	Max
1/2	15	6.7	170	13.4	342	3.5	89	13.9	351	17	7.7	0.11	33	0.416	125
3/4	20	6.7	170	13.6	347	3.9	99	14	356	17	7.7	0.2	59	0.75	225
1	25	8.9	225	13.8	352	4.3	108	14.2	361	18	8.8	0.3	93	1.20	350
1 1/4	32	8.9	225	14.6	372	4.6	117	15	381	20.3	9.2	0.5	152	2.00	575
1 1/2	40	8.9	225	14.8	376	5.0	127	15.2	386	22	10	0.8	239	3.00	900
2	50	8.9	225	15.3	389	6.0	152	15.7	398	26	11.7	1	373	4.70	1400
2 1/2	65	11.0	280	16.5	420	7.0	178	16.9	429	35	15.7	2	631	8	2400
3	80	11.0	280	16.7	426	7.5	191	17.2	435	38	17.1	3	956	12	3600
4	100	11.0	280	17.8	452	9.0	229	18.2	461	49	22.1	5	1493	19	5600
5	125	15.8	400	19	484	10.0	254	19.4	493	60	27.1	8	2334	30	8800
6	150	15.8	400	20	510	11.0	279	20.4	519	71	32.1	11	3361	40	12,700
8	200	15.8	400	21.9	558	13.5	343	22.9	583	95	43.1	20	5975	75	22,600
10	250	19.7	500	26.2	677	16.0	406	26.6	676	130	59.1	30	9336	120	35,300
12	300	19.7	500	28.3	720	19.0	483	28.7	729	219	99.3	45	13,444	170	50,800
14	350	23.6	590	30.2	768	21.0	533	30.7	779	287	130.2	60	18,299	230	69,200
16	400	23.6	590	33.1	842	23.5	597	33.5	851	354	160.9	80	23,901	300	90,400
18	450	23.6	590	34.4	876	25.0	635	34.9	885	409	185.3	100	30,250	380	114,000
20	500	23.6	590	337.6	955	27.5	699	38	964	502	228.3	125	37,346	470	140,000
22	550	23.6	590	39	991	29.5	749	39.4	1000	532	241.3	150	45,188	570	170,000
24	600	23.6	590	41.6	1057	32.0	813	42	1066	561	255.3	180	53,778	680	200,000

SPECIFICATIONS - Detector

Flow Range: 0.328 to 32.8 fps (0.1 to 10 m/s)
Sizes: 1/2-inch to 24 inches (15 mm to 600 mm)
Min. Conductivity: ≥ 20 micro siemens/cm
Accuracy:
 ± 0.50% of rate for velocities greater than 1.64 ft/s (0.50 m/s)
 ± 0.008 ft/s (± 0.0025 m/s) for velocities less than 1.64 ft/s (0.50 m/s)
Electrode Materials: Standard: Alloy C
 Optional: 316 stainless steel
Liner Material: PTFE 1/2 inch to 24 inches, hard rubber 1 inch to 24 inches
NSF Listed: Models with hard rubber liner 4-inch size and larger; PTFE liner (all sizes).

Fluid Temperature:

With Remote Amplifier:
 PTFE 311°F (155°C)
 Hard Rubber 178°F, (80°C)
 With Meter-Mounted Amplifier:
 PTFE 212°F (100°C)
 Hard Rubber 178°F, (80°C)

Pressure Limits:

Maximum allowable non-shock pressure and temperature ratings for steel pipe flanges, according to American National Standard ANSI B16.5. Examples: 150-pound flanges, rated 285 PSI at ambient temperature; 300-pound flange rated 740 PSI at ambient temperature.

Coil Power: Pulsed DC

Ambient Temperature: -4°F to 140°F (-20°C to 60°C)

Pipe Spool Material: 316 stainless steel

Meter Housing Material: Carbon steel welded

Flanges: Carbon steel - Standard (ANSI B16.5 Class 150 RF)
 316 stainless steel (optional)

Meter Enclosure Classification: NEMA 4X (IP66)

Optional: Submersible NEMA 6P (remote amplifier required)

Junction Box Enclosure Protection:

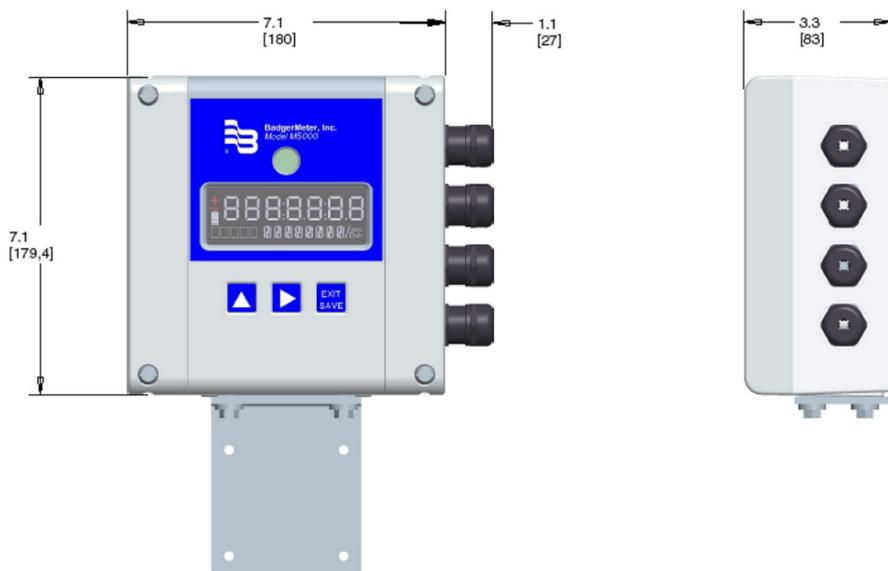
(for remote amplifier option) Powder-coated die-cast aluminum, NEMA 4 (IP65)

Cable Entries: 1/2-inch NPT Cord Grip

Optional Stainless Steel Grounding Rings:

Meter Size	Thickness (of one ring)
Up through 10 inches	.135 inch
12 to 24 inches	.187 inch

Amplifier Specifications



Power Supply	Internal lithium batteries 3.6 volt
Battery Life	10 years
Accuracy	± 0.50% of rate for velocities greater than 1.64 ft/s (0.50 m/s) ± 0.008 ft/s (± 0.0025 m/s) for velocities less than 1.64 ft/s (0.50 m/s)
Sampling Rate	Programmable from 1 to 63 seconds
Repeatability	±0.1%
Flow Range	0.328 to 32.8 ft/s (.03 to 10ms)
Minimum Fluid Conductivity	≥ 20 micro siemens/cm
Processing	Low power microcontroller (16 bit)
Flow Direction	Uni-directional or bi-directional. Two separate programmable totalizers for uni-directional measurement.
Outputs (4 digital)	Galvanically isolated open collector, 30 VDC maximum, 20mA each, maximum output frequency at 100 Hz
Outputs	High/low flow alarm (0-100% of flow), error alarm, empty pipe alarm, flow direction

Empty Pipe Detection	Field-tunable for optimum performance based on specific application
Pulse Width	Programmable 5 to 500ms
Min-Max Flow Alarm	Programmable outputs 0 to 100% of flow
Units of Measure	Gallons, ounces, MGD, liters, cubic meters, cubic feet, imperial gallon, barrel, hectoliter, acre feet
Galvanic Separation	Functional 50 volts
Low Flow Cut-Off	Programmable 0 to 10% of maximum flow
Liquid Crystal Display	Two lines x 15 characters (7-top + 8-bottom)
Programming	Three external buttons
Housing	NEMA 4X (IP66), cast aluminum, powder-coated paint
Mounting	Detector-mount or remote wall mount (bracket supplied)
Cable Connection	Four 1/2-inch NPT Cord Grip
Ambient Temperature	-4° F to 140° F (-20° C to 60° C)
Serial Communication	RS232 Modbus RTU, IRDA

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