Installation Manual
MMI-20021039, Rev AA
January 2015

Micro Motion® Heavy Fuel Viscosity Meter (HFVM) Viscomaster™

Installation Manual

Micro Motion®

EMERSON™
Process Management

Safety and approval information

This Micro Motion product complies with all applicable European directives when properly installed in accordance with the instructions in this manual. Refer to the EC declaration of conformity for directives that apply to this product. The EC declaration of conformity, with all applicable European directives, and the complete ATEX Installation Drawings and Instructions are available on the internet at *www.micromotion.com* or through your local Micro Motion support center.

Information affixed to equipment that complies with the Pressure Equipment Directive can be found on the internet at *www.micromotion.com/documentation*.

For hazardous installations in Europe, refer to standard EN 60079-14 if national standards do not apply.

Other information

Full product specifications can be found in the product data sheet. Troubleshooting information can be found in the transmitter configuration manual. Product data sheets and manuals are available from the Micro Motion web site at *www.micromotion.com/documentation*.

Return policy

Micro Motion procedures must be followed when returning equipment. These procedures ensure legal compliance with government transportation agencies and help provide a safe working environment for Micro Motion employees. Failure to follow Micro Motion procedures will result in your equipment being refused delivery.

Information on return procedures and forms is available on our web support system at *www.micromotion.com*, or by phoning the Micro Motion Customer Service department.

Emerson Flow customer service

Email:

- Worldwide: *flow.support@emerson.com*
- Asia-Pacific: *APflow.support@emerson.com*

Telephone:

North and South America		**Europe and Middle East**		**Asia Pacific**	
United States	800-522-6277	U.K.	0870 240 1978	Australia	800 158 727
Canada	+1 303-527-5200	The Netherlands	+31 (0) 704 136 666	New Zealand	099 128 804
Mexico	+41 (0) 41 7686 111	France	0800 917 901	India	800 440 1468
Argentina	+54 11 4837 7000	Germany	0800 182 5347	Pakistan	888 550 2682
Brazil	+55 15 3413 8000	Italy	8008 77334	China	+86 21 2892 9000
Venezuela	+58 26 1731 3446	Central & Eastern	+41 (0) 41 7686 111	Japan	+81 3 5769 6803
		Russia/CIS	+7 495 981 9811	South Korea	+82 2 3438 4600
		Egypt	0800 000 0015	Singapore	+65 6 777 8211
		Oman	800 70101	Thailand	001 800 441 6426
		Qatar	431 0044	Malaysia	800 814 008
		Kuwait	663 299 01		
		South Africa	800 991 390		
		Saudi Arabia	800 844 9564		
		UAE	800 0444 0684		

Contents

1 Planning

Topics covered in this chapter:

1.1 Installation checklist

- ☐ Verify the contents of the product shipment to confirm that you have all parts and information necessary for the installation.
- ☐ Verify that the meter calibration-type code corresponds to the pipe size. If it does not, measurement accuracy may be reduced due to the boundary effect.
- ☐ Make sure that all electrical safety requirements are met for the environment in which the meter will be installed.
- ☐ Make sure that the local ambient and process temperatures and process pressure are within the limits of the meter.
- ☐ Make sure that the hazardous area specified on the approval tag is suitable for the environment in which the meter will be installed.
- ☐ Make sure that you will have adequate access to the meter for verification and maintenance.
- ☐ Verify that you have all equipment necessary for your installation. Depending on your application, you may be required to install additional parts for optimal performance of the meter.

1.2 Best practices

The following information can help you get the most from your meter.

- Handle the meter with care. Follow local practices for lifting or moving the meter.
- If you have an HFVM with calibration code B (viscosity and density calibration), perform a Known Density Verification (KDV) check of the meter prior to installing the meter.
- For the DLC-coated tines, always fit the protective cover over the tines when the meter is not in use. The tine coating is not resistant to impact damage.
- Always store and transport the meter in its original packaging.
- Do not use liquids that are incompatible with the materials of construction.

- Do not expose the meter to excessive vibration (greater than 0.5 g continuously). Vibration levels in excess of 0.5 g can affect the meter accuracy.
- For optimal performance of the meter, ensure that operating conditions correspond to the meter calibration-type code and boundary.
- Ensure that all piping connections conform to the local and national regulations and codes of practice.
- Follow fluid velocity guidelines and install the tines vertically for side insertion.
- Properly tighten the transmitter housing cover after wiring to maintain ingress protection and hazardous area approvals.
- After installation, pressure test the meter and the associated pipework to 1½ times the maximum operating pressure.
- Install thermal insulation in the meter, the inlet, and the bypass-loop pipeline to maintain stable temperatures. The thermal insulation should cover the process connection.

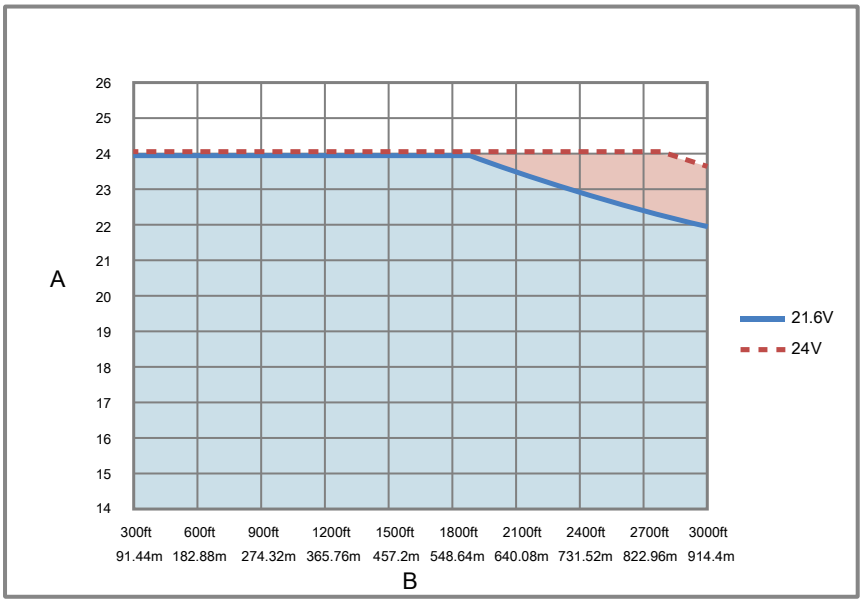
1.3 Power requirements

Following are the DC power requirements to operate the meter:

- 24 VDC, 0.65 W typical, 1.1 W maximum
- Minimum recommended voltage: 21.6 VDC with 1000 ft of 24 AWG (300 m of 0.20 mm^2) power-supply cable
- At startup, power source must provide a minimum of 0.5 A of short-term current at a minimum of 19.6 V at the power-input terminals.

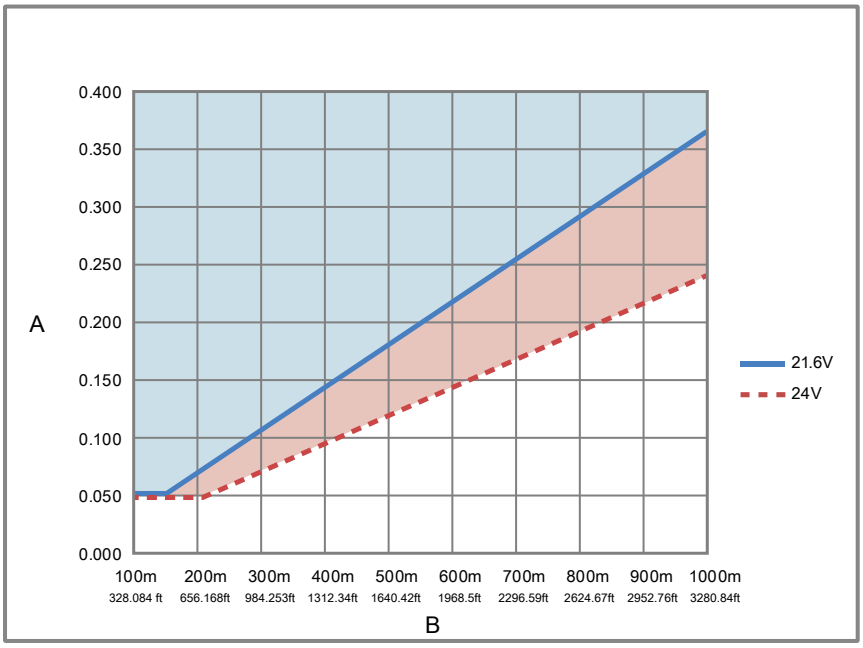
Power cable recommendations for explosion-proof/flameproof meters

Figure 1-1: Minimum wire gauge (AWG per foot or meter)



A. AWG maximum
B. Distance of installation

Figure 1-2: Minimum wire area (mm^2 per meter or foot)



A. Minimum wire area (mm^2)
B. Distance of installation

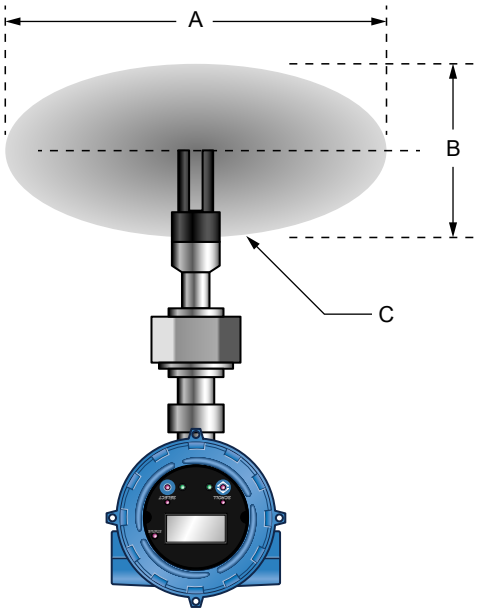
1.4 Other installation considerations

Numerous external factors can affect the meter's successful operation. To ensure that your system works correctly, consider the factors covered in this section when designing your installation.

1.4.1 Boundary effect

Boundary effect refers to the distortion in the wave forms in the process fluid that are caused by reflections from the pipe wall. If the pipe wall is within the meter's effective measurement region, the boundary effect produces measurement inaccuracy.

Figure 1-3: Region of measurement boundary or sensitivity (plan view)



A. Long axis
B. Short axis
C. Sensitive, or effective, region

The factory calibration compensates for the boundary effect. The meter can be calibrated for 2-inch, 2.5-inch, or 3-inch pipe. If the meter is installed in a pipe that does not match the calibration size, the compensation will be inaccurate, and process measurement will be inaccurate.

Verify that the meter was calibrated for the pipe size you plan to use.

1.4.2 Flow rates

Maintain constant flow rates and velocities that are within the limits specified for the meter. The fluid flow provides a steady heat flow into the meter installation, and the flow rate influences the self-cleaning of the meter tines, the dissipation of bubbles, and the solid contaminants around the meter.

If you install the meter in a bypass configuration (such as in a flow-through chamber), use a pressure drop, pitot scoop, or a sample pump to maintain flow. When using a sample pump, place the pump upstream from the meter.

1.4.3 Entrained gas

Entrained gas, or gas pockets, can disrupt the measurement of a fluid. A brief disruption in the signal caused by transient gas pockets can be corrected in the meter configuration, but you must avoid more frequent disruptions or serious gas entrainment to ensure accurate and reliable fluid measurement.

To minimize the possibility of entrained gas:

- Keep pipelines full of fluid at all times.
- Vent any gas prior to the meter installation location.
- Avoid sudden pressure drops or temperature changes that may cause dissolved gases to break out of the fluid.
- Maintain a back pressure on the system that is sufficient to prevent gas breakout.
- Maintain flow velocity at the sensor within the specified limits.

1.4.4 Solid contamination

To avoid issues related to solids contamination:

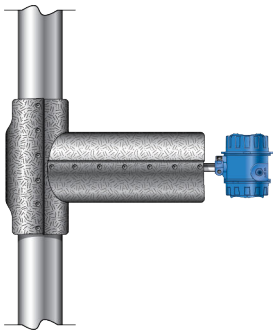
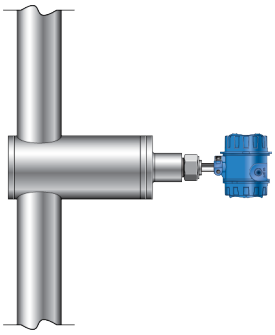
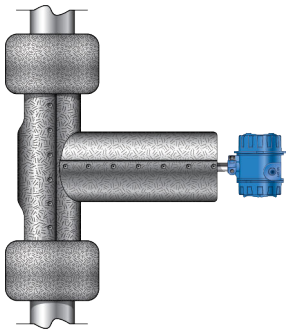
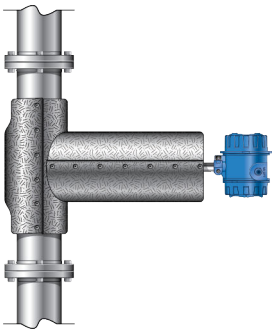
- Avoid sudden changes of the fluid velocity that may cause sedimentation.
- Install the meter far enough downstream from any pipework configuration that may cause centrifuging of solids (such as at a pipe bend).
- Maintain flow velocity at the meter installation that is within the specified limits.
- Use filtration in your process, if necessary.

1.4.5 Temperature gradients and insulation

For high-viscosity fluids, minimize any temperature gradients in the fluid, and in the piping and fittings immediately upstream and downstream of the meter. Minimizing temperature gradients reduces the effect of viscosity changes. Micro Motion recommends using the following guidelines to reduce the thermal effects to your meter installation:

- Always insulate the meter and surrounding pipework thoroughly.
  - Avoid insulating the transmitter housing.
  - Use rock wool or any equivalent heat jacket material that is at least 1 inch (25 mm) thick, but preferably 2 inches (50 mm) thick.
  - Enclose insulation in a sealed protective casing to prevent moisture ingress, air circulation, and crushing of the insulation.
  - For flow-through chamber installations, use the special insulation jacket provided by Micro Motion.
- Avoid direct heat or cold on the meter or on the associated upstream or downstream pipe work that is likely to create temperature gradients.
- If it is necessary to protect against cooling because of flow loss, you can apply electrical-trace heating. If you use electrical-trace heating, use a thermostat that operates below the minimum operating temperature of the system.

Table 1-1: Insulation best practices

Recommended	Not recommended
	
	

1.5 Recommended installations for the HFVM

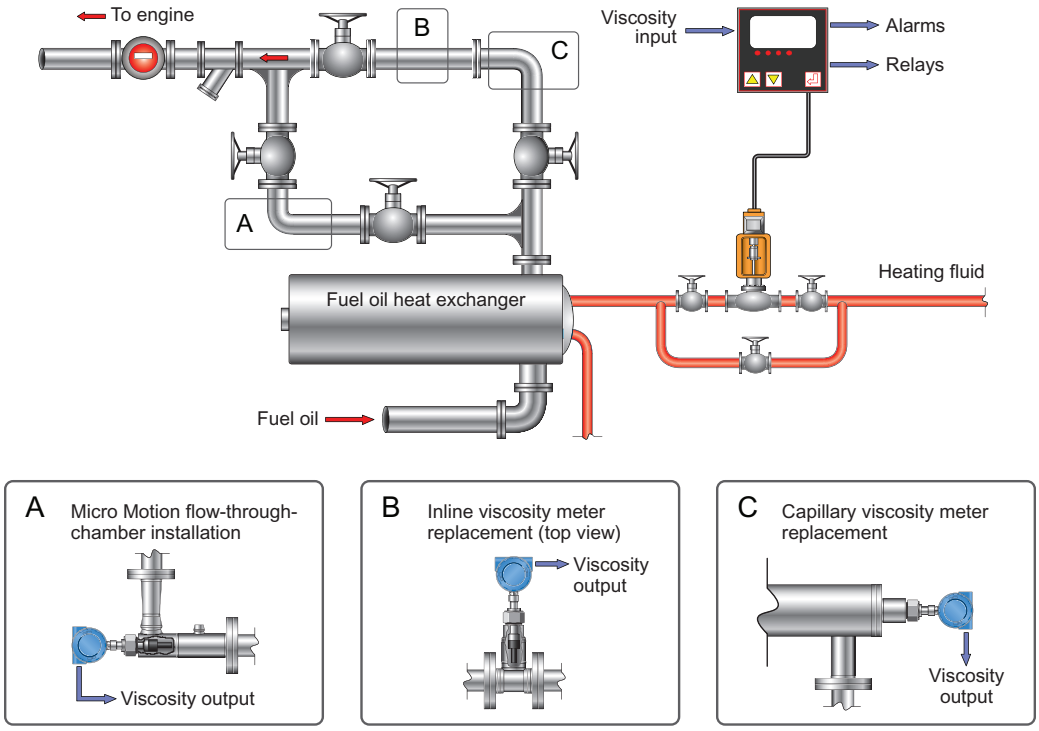
Micro Motion recommends three standard HFVM installations. All meters are factory-calibrated for these installations and take potential boundary effects into consideration.

Table 1-2: Standard HFVM installation types

Type	Characteristics		Advantages
Inline viscosity	Placement	Tines are contained in a side pocket off the main flow, recessed by 25.4 mm (1 in)	• Simple replacement of torsional meter • Fast response • Good flow and temperature conditioning
	Flow rate(1)	10 to 330 l/min (0.6 to 20 m3/hr) (2.6 to 87 US gal./min)	
	Viscosity	Up to 100 cSt	
	Temperature	–50 °C to 200 °C (–58 °F to 392 °F)	
	Main flow pipe size	50 mm (2 in)	
Flow-through chamber	Placement	Tines are contained in a flow-through chamber where fluid is circulated from the main flow	• Adaptable installation to any diameter main pipe and for tank applications • Ideal for flow and temperature conditioning • Fast response
	Flow rate(1)	10 to 330 l/min (0.6 to 20 m3/hr) (2.6 to 87 US gal./min)	
	Viscosity	Up to 100 cSt	
	Temperature	–50 °C to 200 °C (–58 °F to 392 °F)	
	Main flow pipe size	50 mm (2 in)	
Capillary viscosity	Placement	Tines project into adapter kit with 63.5 mm (2.5 in) Schedule 40 boundary	• Simple replacement of capillary meter • Fast response • Good flow and temperature conditioning
	Flow rate(1)	10 to 330 l/min (0.6 to 20 m3/hr) (2.6 to 87 US gal./min)	
	Viscosity	Up to 100 cSt	
	Temperature	–50 °C to 200 °C (–58 °F to 392 °F)	
	Main flow pipe size	Defined by capillary meter chamber	

(1) Meter tines project into adapter kit with 63.5 mm (2.5 in) Schedule 40 boundary, and retracted by 25 mm (1 in)

Figure 1-4: HFVM installation options



1.6 Perform a pre-installation meter check

1. Remove the meter from the box.

   ⚠ CAUTION!

   Handle the meter with care. Follow all corporate, local, and national safety regulations for lifting and moving the meter.

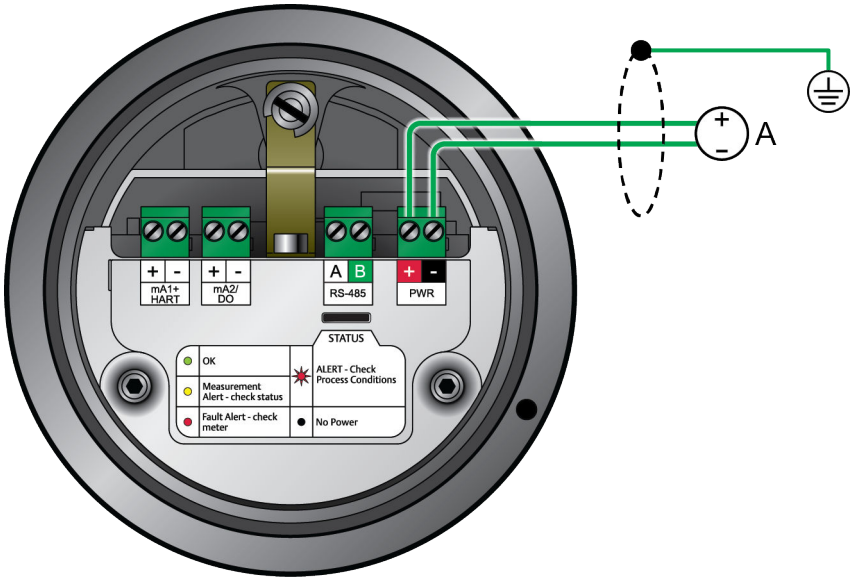
2. Visually inspect the meter for any physical damage.

   If you notice any physical damage to the meter, immediately contact Micro Motion Customer Support at *flow.support@emerson.com*.

3. Connect the power wiring, and power up the meter.

   Remove the back transmitter housing cover to access the PWR terminals.

Figure 1-5: Power supply wiring terminals



A. 24 VDC

4. If you have an HFVM with calibration code B (viscosity and density calibration), perform a Known Density Verification (KDV) check.

   Use the Known Density Verification procedure to match the current meter calibration with the factory calibration. If the meter passes the test, then it has not drifted or changed during shipment.

   For more information on performing a KDV check, see the configuration and use manual that shipped with the product.

2 Mounting

Topics covered in this chapter:

2.1 Prepare the installation

Before you can install the meter and fit the thermal insulation, verify that the system is stable and leak free.

1. Fit a blanking compression nut to the meter mounting, pressurize, and flush the system.
2. Isolate the system, depressurize, and remove the blanking compression nut.

2.2 Mount the meter

There are three ways to mount the meter.

Related information

Mount with a flow-through chamber
Mount with an inline viscosity retrofit kit
Mount with a capillary viscosity retrofit kit

2.2.1 Mount with a flow-through chamber

Flow-through chambers are manufactured by Micro Motion, and are available with either of the following:

- Welded ends or compression fittings that connect into the process pipelines
- 1- inch, 2-inch, or 3-inch inlet and outlet pipes

Important

Do not alter the length of the inlet and outlet pipes. Pipe alterations can adversely affect the fitting temperature response and stability.

Prerequisites

Verify the following conditions:

Flow	• 5–40 l/min for 2-inch Schedule 40 calibration bore section (1.5 - 10.5 gal/min) • 5–300 l/min for 3-inch Schedule 80 calibration bore section (1.5 - 80 gal/min)
Viscosity	0.5 to 100 cSt
Temperature	–50 °C to 200 °C (–58 °F to 392 °F)
	–40 °C to 200 °C (–40 °F to 392 °F) in hazardous areas
Pressure	70 bar @ 204 °C, subject to process connections

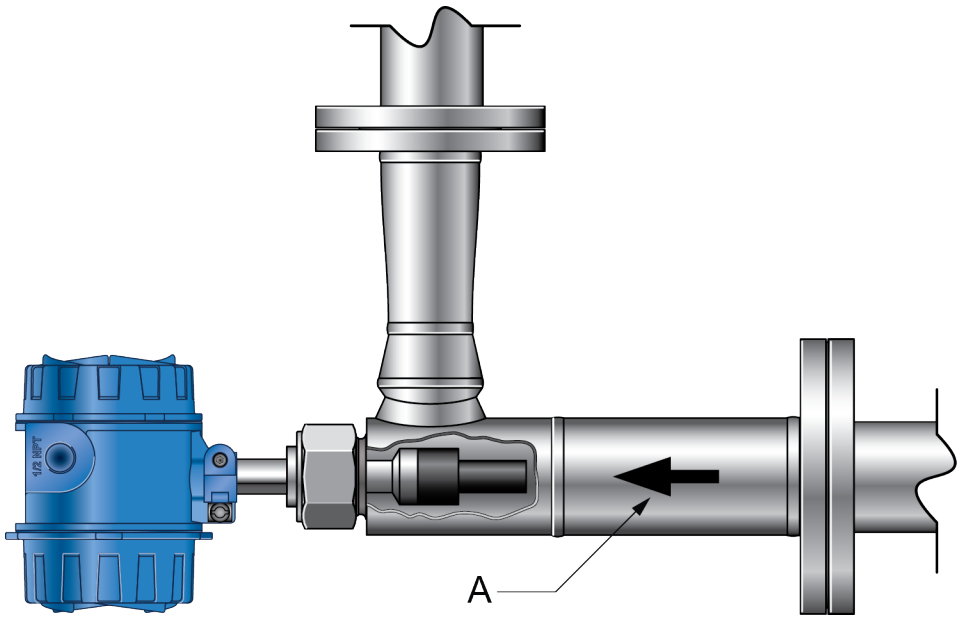
Important

- To ensure that the fluid within the pocket is refreshed in a timely manner, verify that flow velocity at the pipe wall and fluid viscosity are within the limits described in this table.
- The thermal mass of the flanges may affect the response time of the meter to temperature changes.

Procedure

See *Figure 2-1* for an example installation of a meter in a flow-through chamber.

Figure 2-1: Flow-through chamber meter installation



A. Flow direction

Note

- *This flow-through chamber is a direct-insertion type chamber that does not have a thermowell, and uses a 1-½-inch threaded cone-seat connection.*
- *The three compression fittings on the flow pockets (½-inch drain, ¾-inch temperature probe, and 1-½-inch mounting nut for the meter) are rated to above the working pressure of the flow pocket. The fittings may be Swagelok or Parker.*

2.2.2 Mount with an inline viscosity retrofit kit

The inline viscosity retrofit kit provides a simple, direct replacement for existing meters.

Typically, the flange-to-flange distance is 150 mm (5.9 in), although Micro Motion can accommodate larger versions. Usually, no pipework changes are necessary.

⚠ CAUTION!

Observe all corporate and government safety regulations. Wear protective clothing, safety glasses, and gloves to prevent burns and the absorption of hot oil.

Prerequisites

Verify the following conditions:

Temperature	–50 °C to 200 °C (–58 °F to 392 °F)
Flow	40 to 330 l/min 2.5 to 20 m3/hr 11 to 87 US gal/min
Viscosity	Up to 100 cSt
Pressure	As defined by process flanges
Calibration boundary	2.5 in Schedule 40

Procedure

1. Check that the isolation valves are fully closed.
2. Remove insulation and allow the equipment to cool to a safe level.

   Cooling reduces retained pressure.
3. If you have a drain or a pressure-relieving valve, depressurize the system.
4. Slacken the lock nut 1 ½ to 2 turns so that you can rock the sensor.

   If necessary, use your hand to jolt the meter loose from the amplifier housing. This breaks the seal between the sensor and the chamber retrofit kit. Do not slacken the lock nut further unless the seal is broken and the sensor is obviously loose in the fitting.

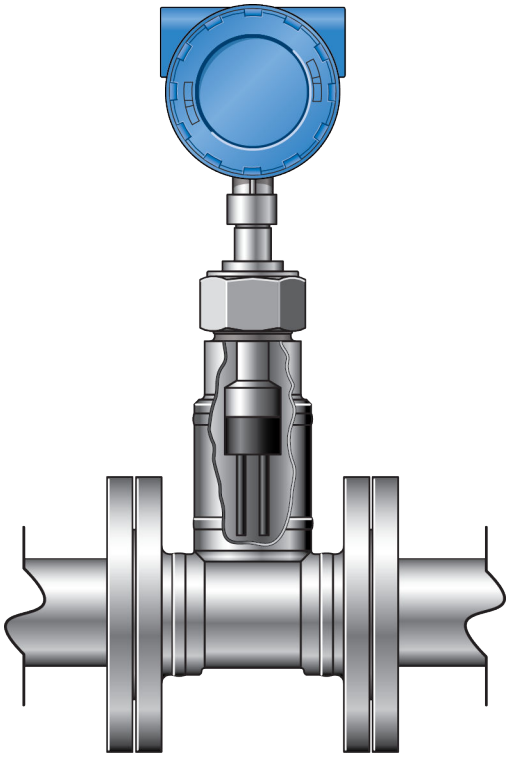
   Note

   If the system is still pressurized, you'll be able to lift and hold the meter against the retaining nut. Rocking and alternately pushing the sensor in and out of the pocket within the limits allowed by the slackened nut breaks the seal and allows oil under pressure to seep past the lock nut. If this leakage is excessive, re-tighten the lock nut and take further action to depressurize the system.
5. **⚠ CAUTION!**

   Keep all parts of your body away from the direction in which you'll remove the sensor. Pressure caused by a valve failure or a poorly placed lock nut can eject the instrument from the flow chamber and cause serious injury.

   Remove the lock nut if you can rock the meter in the flow chamber, and there is no serious or continuous escape of oil.
6. Retrofit the meter per the following diagram.

Figure 2-2: Inline viscosity retrofit (plan view)



Note

The HFVM inline viscosity meter is mounted 25 mm (0.98 in) away from the main flow line, allowing good product mixing, sensor protection, and stable measurement conditions.

2.2.3 Mount with a capillary viscosity retrofit kit

The capillary viscosity retrofit kit provides a simple, direct replacement for existing capillary meters.

Typically, capillary meters operate with their own measurement chamber that attaches to the HFVM. No pipework changes are necessary.

⚠ CAUTION!

Observe all corporate and government safety regulations. Wear protective clothing, safety glasses, and gloves to prevent burns and the absorption of hot oil.

Prerequisites

Verify the following conditions:

Temperature	–50 °C to 200 °C (–58 °F to 392 °F)
Flow	40 to 330 l/min 2.5 to 20 m3/hr 11 to 87 US gal/min
Viscosity	Up to 100 cSt
Pressure	As defined by process flanges
Calibration boundary	2.5 in Schedule 40

Procedure

1. Check that the isolation valves are fully closed.
2. Remove insulation and allow the equipment to cool to a safe level.

   Cooling reduces retained pressure.
3. If you have a drain or a pressure-relieving valve, depressurize the system.
4. Slacken the lock nut 1 ½ to 2 turns so that you can rock the sensor.

   If necessary, use your hand to jolt the meter loose from the amplifier housing. This breaks the seal between the sensor and the chamber retrofit kit. Do not slacken the lock nut further unless the seal is broken and the sensor is obviously loose in the fitting.

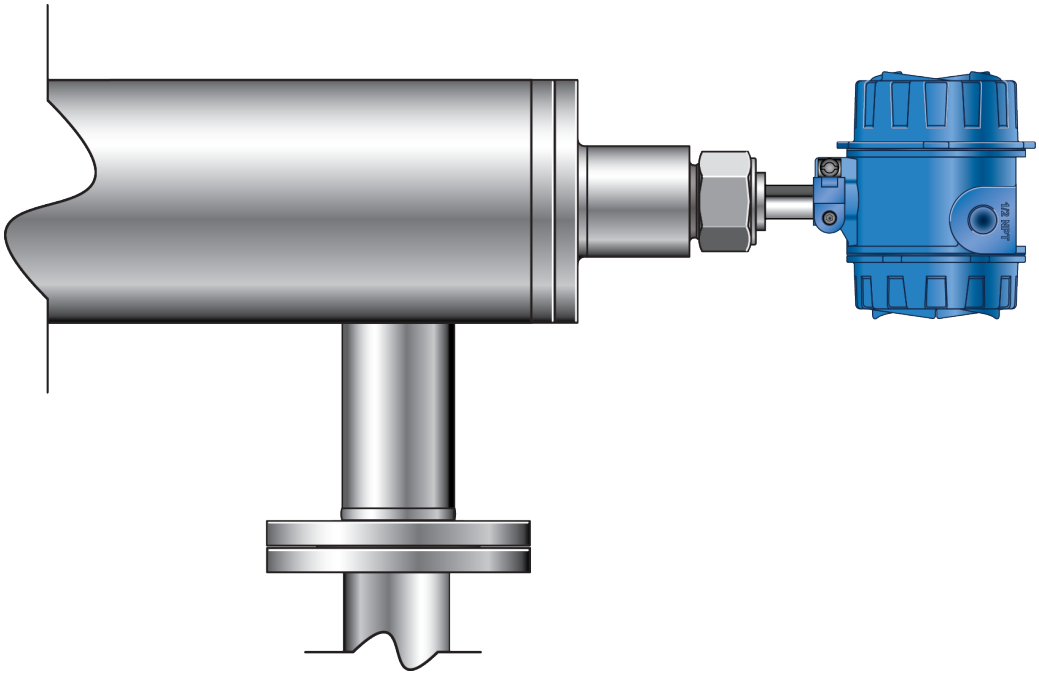
   Note

   If the system is still pressurized, you'll be able to lift and hold the meter against the retaining nut. Rocking and alternately pushing the sensor in and out of the pocket within the limits allowed by the slackened nut breaks the seal and allows oil under pressure to seep past the lock nut. If this leakage is excessive, re-tighten the lock nut and take further action to depressurize the system.
5. **⚠ CAUTION!**

   Keep all parts of your body away from the direction in which you'll remove the sensor. Pressure caused by a valve failure or a poorly placed lock nut can eject the instrument from the flow chamber and cause serious injury.

   Remove the lock nut if you can rock the meter in the flow chamber, and there is no serious or continuous escape of oil.
6. Retrofit the meter per the following diagram.

Figure 2-3: Capillary viscosity retrofit



2.3 Install thermal insulation

Prerequisites

Make sure you have tightened the fitting nut.

Procedure

1. Slowly pressurize the system and check for leaks, particularly if the normal operating temperature is high, or the meter has been fitted cold. Tighten as necessary.
2. Tighten the nut again, if necessary.
3. Verify that the system has stabilized and is leak free.
4. Fit the insulation material.

Related information

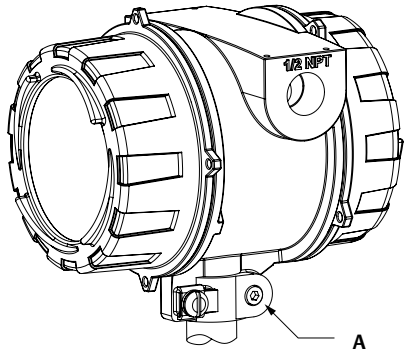
Temperature gradients and insulation

2.4 Rotate the electronics on the meter (optional)

You can rotate the transmitter on the meter up to 90°.

1. Using a 4 mm hex key, loosen the cap screw that holds the transmitter in place.

Figure 2-4: Component to secure transmitter in place



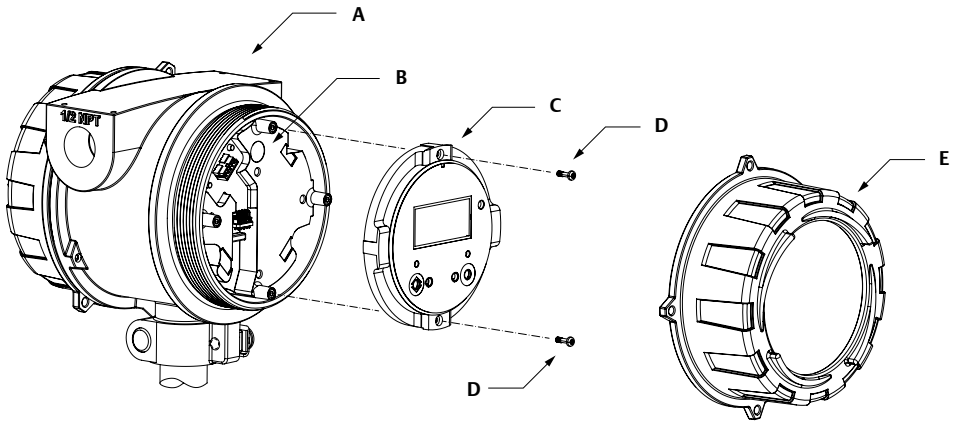
A. M5 socket-head cap screw

2. Rotate the transmitter clockwise to the desired orientation up to 90°.
3. Secure the cap screw in place and tighten to 60 lb·in (6.8 N·m).

2.5 Rotate the display on the transmitter (optional)

The display on the transmitter electronics module can be rotated 90° or 180° from the original position.

Figure 2-5: Display components



A. Transmitter housing
B. Sub-bezel
C. Display module
D. Display screws
E. Display cover

Procedure

1. If the meter is powered up, power it down.
2. Turn the display cover counterclockwise to remove it from the main enclosure.
3. Carefully loosen (and remove if necessary) the semi-captive display screws while holding the display module in place.
4. Carefully pull the display module out of the main enclosure until the sub-bezel pin terminals are disengaged from the display module.

Note
If the display pins come out of the board stack with the display module, remove the pins and reinstall them.

5. Rotate the display module to the desired position.
6. Insert the sub-bezel pin terminals into the display module pin holes to secure the display in its new position.
7. If you have removed the display screws, line them up with the matching holes on the sub-bezel, then reinsert and tighten them.
8. Place the display cover onto the main enclosure.
9. Turn the display cover clockwise until it is snug.
10. If appropriate, power up the meter.

3 Wiring

Topics covered in this chapter:

3.1 Terminals and wiring requirements

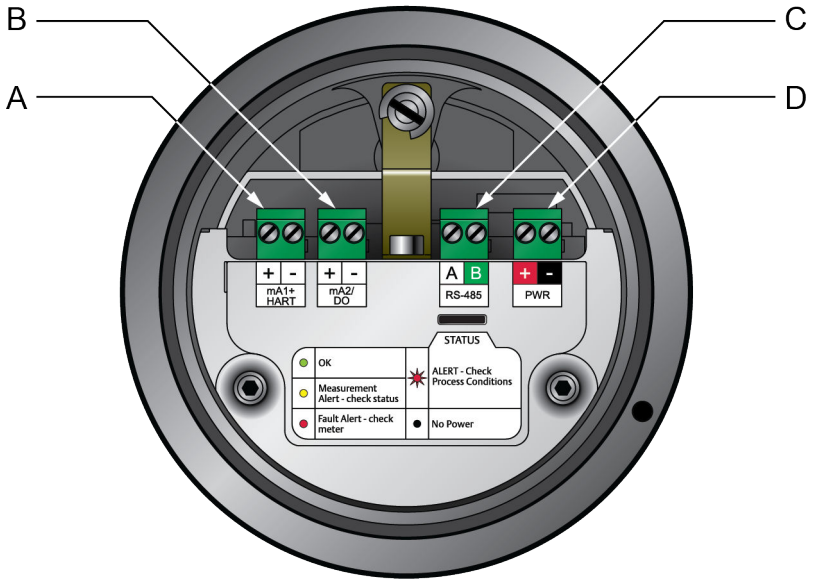
Three pairs of wiring terminals are available for transmitter outputs. A fourth pair is used for power wiring. These outputs vary depending on your transmitter output option ordered. The mA outputs require external power, and must be connected to an independent 24 VDC power supply.

The screw connectors for each output terminal accept a maximum wire size of 14 AWG (2.5 mm^2).

Important

- Output wiring requirements depend on whether the meter will be installed in a safe area or a hazardous area. It is your responsibility to verify that this installation meets all corporate, local, and national safety requirements and electrical codes.
- If you will configure the meter to poll an external temperature or pressure device, you must wire the mA output to support HART communications. You may use either HART/mA single-loop wiring or HART multi-drop wiring.

Figure 3-1: Transmitter outputs



A. Channel A (4-20 mA + HART)
B. Channel B (4-20 mA)
C. Channel C (RS-485)
D. Power terminals

3.2 Wire power and outputs in a HART single-loop environment

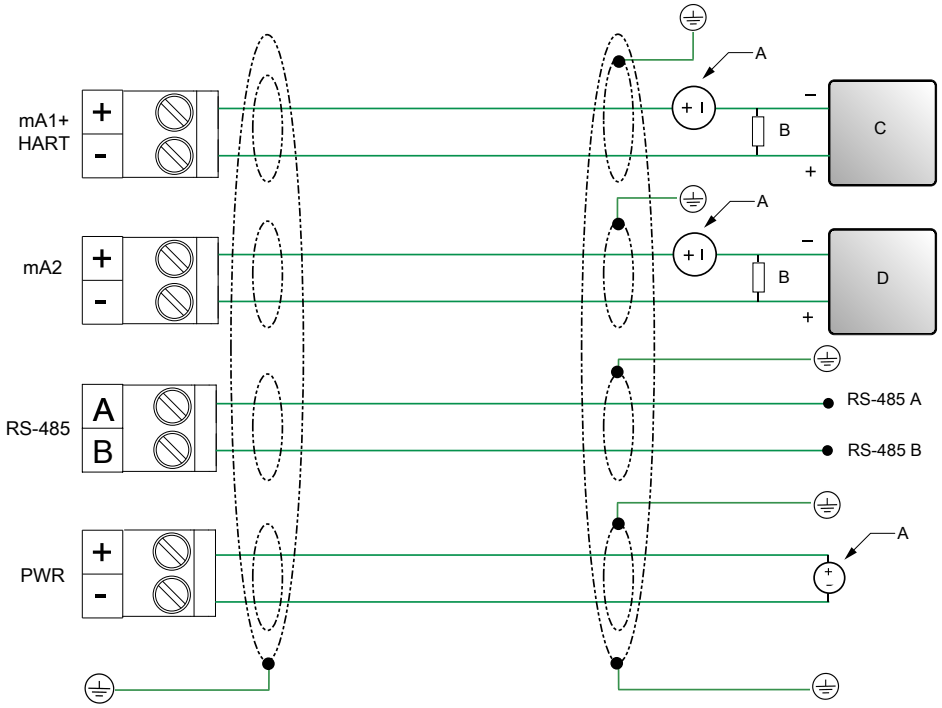
⚠ CAUTION!

Meter installation and wiring should be performed by suitably trained personnel only in accordance with the applicable code of practice.

Procedure

Wire to the appropriate power and output terminals and pins (see *Figure 3-2*).

Figure 3-2: Wire power and outputs in a HART single-loop environment



A. 24 VDC
B. R_{load} (250 Ω resistance)
C. HART-compatible host or controller; and/or signal device
D. Signal device

Note

For operating the milliamp outputs with a 24V supply, a maximum total loop resistance of 657 Ω is allowed.

⚠ CAUTION!

- ***To meet the EC Directive for Electromagnetic Compatibility (EMC), use a suitable instrumentation cable to connect the meter. The instrumentation cable should have individual screens, foil or braid over each twisted pair, and an overall screen to cover all cores. Where permissible, connect the overall screen to earth at both ends (360° bonded at both ends). Connect the inner individual screens at only the controller end.***
- ***Use metal cable glands where the cables enter the meter amplifier box. Fit unused cable ports with metal blanking plugs.***

3.3 Wiring to external devices (HART multidrop)

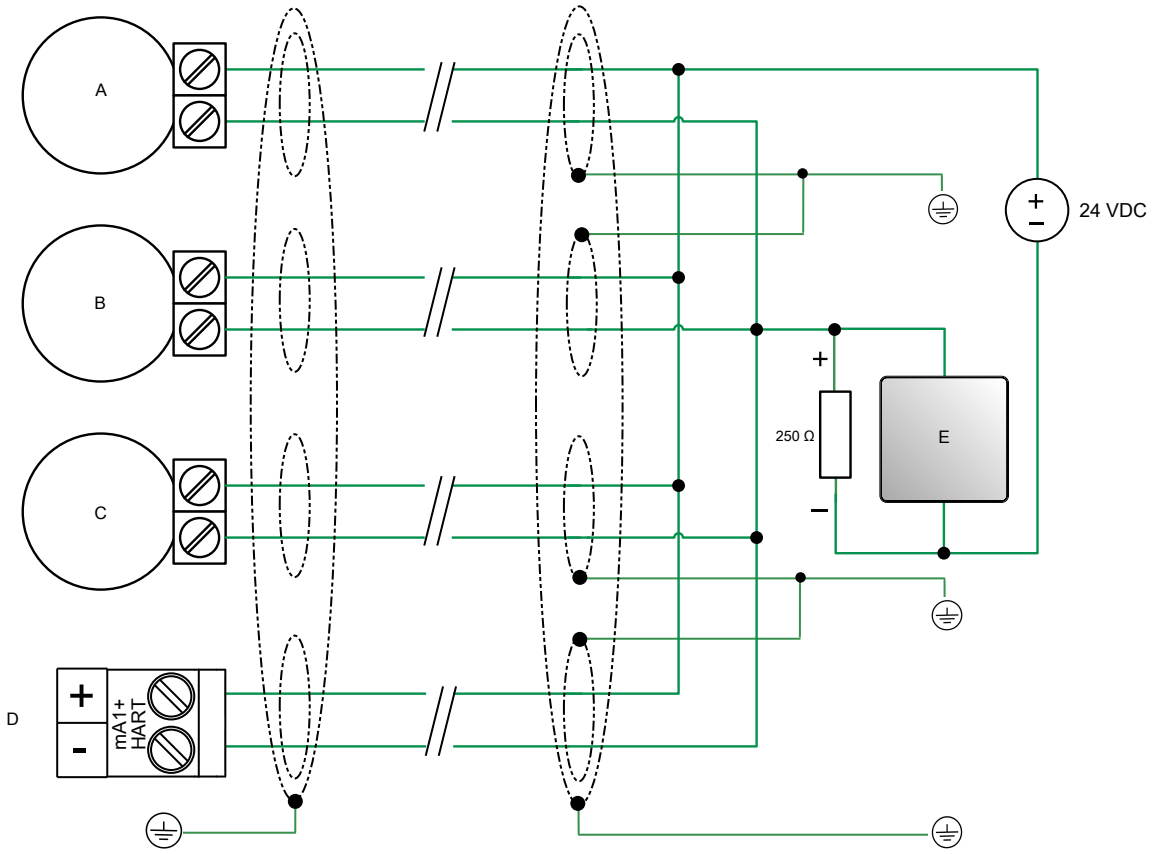
You can wire up to three external HART devices with the meter. The following information provides wiring diagrams for making those connections in safe and hazardous environments.

3.3.1 Wire mA1 in a HART multi-drop environment

Important

To wire power and outputs, see *Section 3.2*.

Figure 3-3: Wire mA1 in a HART multi-drop environment



A. HART Device 1
B. HART Device 2
C. HART Device 3
D. Meter (mA+/HART output)
E. HART/Field Communicator

⚠ *CAUTION!*

- ***To meet the EC Directive for Electromagnetic Compatibility (EMC), use a suitable instrumentation cable to connect the meter. The instrumentation cable should have individual screens, foil or braid over each twisted pair, and an overall screen to cover all cores. Where permissible, connect the overall screen to earth at both ends (360° bonded at both ends). Connect the inner individual screens at only the controller end.***
- ***Use metal cable glands where the cables enter the meter amplifier box. Fit unused cable ports with metal blanking plugs.***

4 Grounding

The meter must be grounded according to the standards that are applicable at the site. The customer is responsible for knowing and complying with all applicable standards.

Prerequisites

Micro Motion suggests the following guides for grounding practices:

- In Europe, EN 60079-14 is applicable to most installations, in particular Sections 12.2.2.3 and 12.2.2.4.
- In the U.S.A. and Canada, ISA 12.06.01 Part 1 provides examples with associated applications and requirements.
- For IECEx installations, IEC 60079-14 is applicable.

If no external standards are applicable, follow these guidelines to ground the meter:

- Use copper wire, 18 AWG (0.75 mm^2) or larger wire size.
- Keep all ground leads as short as possible, less than 1 Ω impedance.
- Connect ground leads directly to earth, or follow plant standards.

⚠ CAUTION!

Ground the meter to earth, or follow ground network requirements for the facility. Improper grounding can cause measurement error.

Procedure

Check the joints in the pipeline or tank installation.

- If the joints in the pipeline or tank are ground-bonded, the meter is automatically grounded and no further action is necessary (unless required by local code).
- If the joints in the pipeline or tank are not grounded, connect a ground wire to the grounding screw located on the meter electronics.

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