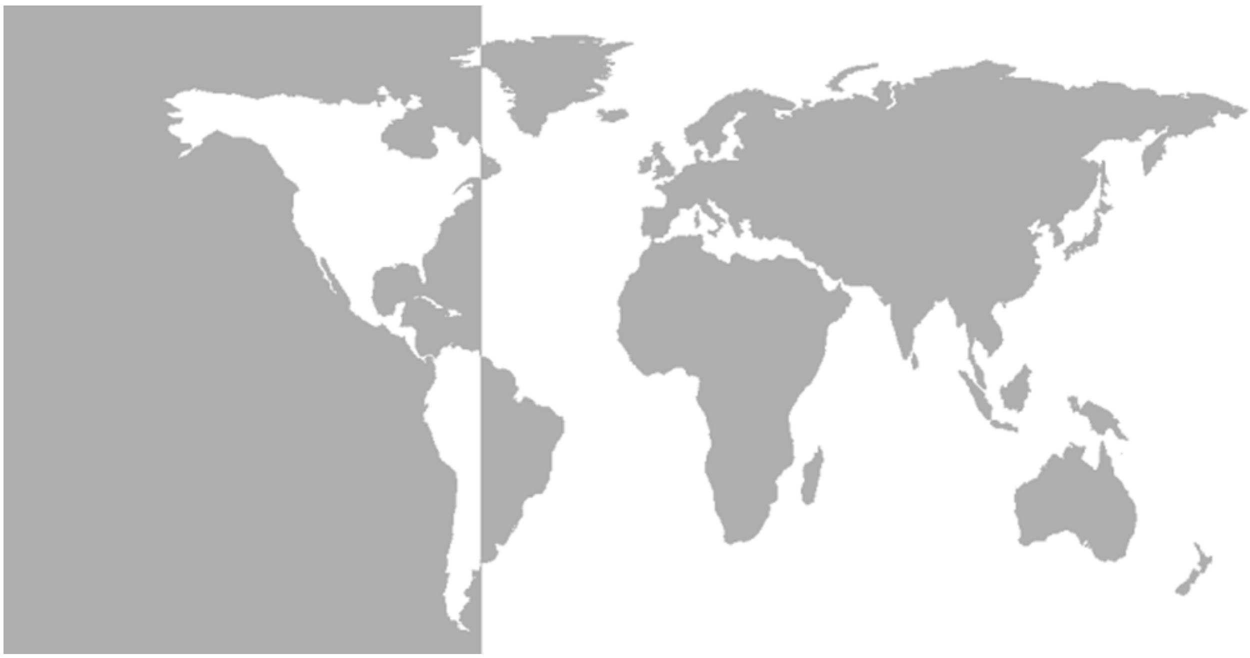
GE
Sensing



PanaFlow™ MV80 & MV82

Vortex Volumetric Flowmeter

User's Manual

GE
Sensing

Panaflow™ MV80 & MV82

Vortex Volumetric Flowmeter

User's Manual
910-279B
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Warranty

Each instrument manufactured by GE Sensing, Inc. is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Sensing. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Sensing determines that the equipment was defective, the warranty period is:

- one year for general electronic failures of the instrument
- one year for mechanical failures of the sensor

If GE Sensing determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Sensing, the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties of merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Sensing instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Sensing, giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Sensing will issue a RETURN AUTHORIZATION number (RA), and shipping instructions for the return of the instrument to a service center will be provided.
2. If GE Sensing instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.
3. Upon receipt, GE Sensing will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If GE Sensing determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner’s approval to proceed, the instrument will be repaired and returned.

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Chapter 1

Introduction

Overview

The GE Sensing Series MV80 In-Line and the Series MV82 Insertion PanaFlow MV Vortex Flowmeters provide a reliable solution for process flow measurement. From a single entry point in the pipeline, PanaFlow MV meters offer precise measurements of mass or volumetric flow. The velocity sensor reduces the effects of pipeline vibration by incorporating a unique piezoelectric element that senses the vortex frequency. To extend range-ability at the low end of flow, the meter's smart electronics calculates the Reynolds number (Re) based on constant values of fluid density and viscosity stored in memory, and automatically corrects for any non-linearity down to Re = 5,000.

PanaFlow MV digital electronics allows reconfiguration for most gases, liquids and steam. The instrument is loop powered (12 to 36 VDC) with two output signals. The pulse output signal is proportional to volumetric flow rate; the analog linear 4-20 mA signal offers your choice of volumetric flow rate or mass flow rate. The mass flow rate is based on a constant value for fluid density stored in the instrument's memory. The local keypad/display provides instantaneous flow rate in engineering units or totalized flow.

Operating the PanaFlow MV

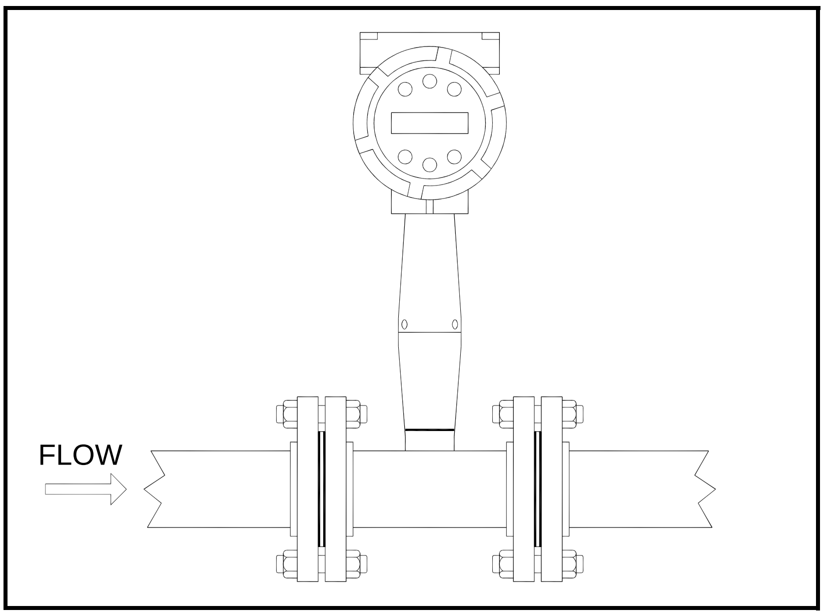


Figure 1-1: In-Line Vortex Multi-Parameter Mass Flowmeter

The Series MV80 and MV82 PanaFlow MV Vortex Flowmeters use a unique velocity sensor head to monitor volumetric flow rate. The built-in flow computer calculates mass flow rate based on a constant value of fluid density stored in the instrument's memory. To measure fluid velocity, the flow meter incorporates a bluff body (shedder bar) in the flow stream, and the velocity sensor measures the frequency of vortices created by the shedder bar. The velocity sensor head is located downstream of the shedder bar within the flow body.

Velocity Measurement

The PanaFlow MV vortex velocity sensor is a patented mechanical design that minimizes the effects of pipeline vibration and pump noise, both of which are common error sources in flow measurement with vortex flowmeters. The velocity measurement is based on the well-known Von Karman vortex shedding phenomenon. Vortices are shed from a shedder bar, and the vortex velocity sensor located downstream of the shedder bar senses the passage of these vortices. This method of velocity measurement has many advantages including inherent linearity, high turndown, reliability and simplicity.

Vortex Shedding Frequency

Von Karman vortices form downstream of a shedder bar into two distinct wakes. The vortices of one wake rotate clockwise while those of the other wake rotate counterclockwise. Vortices generate one at a time, alternating from the left side to the right side of the shedder bar. Vortices interact with their surrounding space by over-powering every other nearby swirl on the verge of development. Close to the shedder bar, the distance (or wave length) between vortices is always constant and measurable. Therefore, the volume encompassed by each vortex remains constant, as shown below. By sensing the number of vortices passing by the velocity sensor, the PanaFlow MV Vortex Flowmeter computes the total fluid volume.

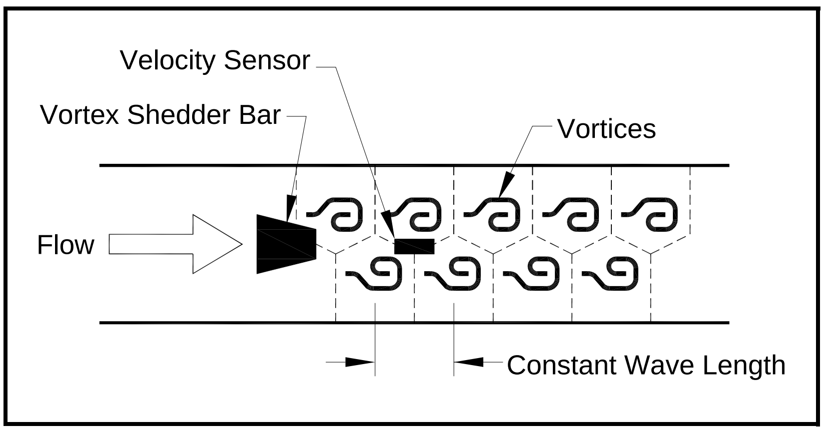


Figure 1-2: Measurement Principle of Vortex Flowmeters

Vortex Frequency Sensing

The velocity sensor incorporates a piezoelectric element that senses the vortex frequency. This element detects the alternating lift forces produced by the Von Karman vortices flowing downstream of the vortex shedder bar. The alternating electric charge generated by the piezoelectric element is processed by the transmitter's electronic circuit to obtain the vortex shedding frequency. The piezoelectric element is highly sensitive and operates over a wide range of flows, pressures and temperatures.

Flow Velocity Range

To ensure trouble-free operation, vortex flowmeters must be correctly sized so that the flow velocity range through the meter lies within the measurable velocity range (with acceptable pressure drop) and the linear range.

The measurable range is defined by the minimum and maximum velocity using the following table.

Table 1-1: Measurable Ranges

	Gas	Liquid	
Vmin	$\sqrt{\frac{25\,ft/s}{\rho}}$	1 ft/s	English ρ (lb/ft^3)
Vmax	300 ft/s	30 ft/s	
Vmin	$\sqrt{\frac{37\,m/s}{\rho}}$	0.3 m/s	Metric ρ (kg/m^3)
Vmax	91 m/s	9.1 m/s	

The pressure drop for series MV82 insertion meters is negligible. The pressure drop for series MV80 in-line meters is defined as:

$\Delta P = .00024\ \rho\ V^2$ English units (ΔP in psi, ρ in lb/ft^3, V in ft/sec)

$\Delta P = .000011\ \rho\ V^2$ Metric units (ΔP in bar, ρ in kg/m^3, V in m/sec)

The linear range is defined by the Reynolds number. The Reynolds number is the ratio of the inertial forces to the viscous forces in a flowing fluid and is defined as:

$$Re = \frac{\rho V D}{\mu}$$

Where:
Re = Reynolds Number
ρ = mass density of the fluid being measured
V = velocity of the fluid being measured
D = internal diameter of the flow channel
μ = viscosity of the fluid being measured

Flow Velocity Range (cont.)

The Strouhal number is the other dimensionless number that quantifies the vortex phenomenon. The Strouhal number is defined as:

$$St = \frac{fd}{V}$$

Where:
St = Strouhal Number
f = frequency of vortex shedding
d = shedder bar width
V = fluid velocity

As shown in Figure 1-3 below, PanaFlow MV meters exhibit a constant Strouhal number across a large range of Reynolds numbers, indicating a consistent linear output over a wide range of flows and fluid types. Below this linear range, the intelligent electronics in PanaFlow MV automatically corrects for the variation in the Strouhal number. PanaFlow MV's smart electronics correct for this non-linearity by calculating the Reynolds number based on constant values of the fluid's density and viscosity stored in the instrument's memory. PanaFlow MV Vortex Flowmeters automatically correct down to a Reynolds number of 5,000.

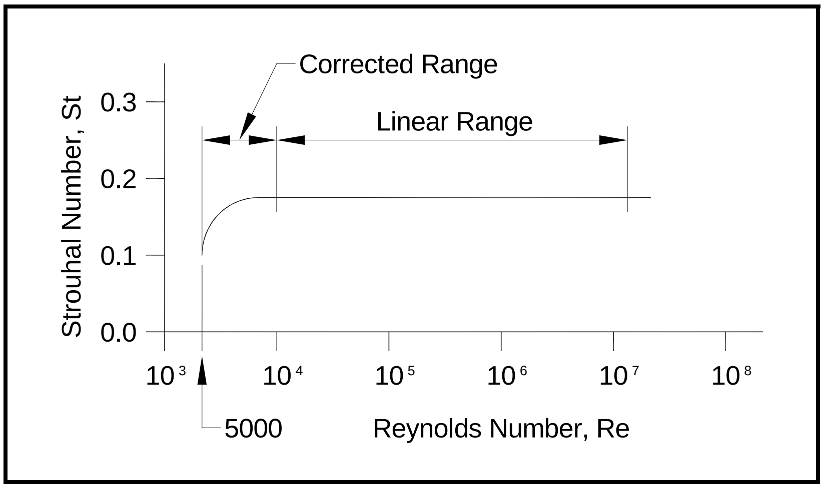


Figure 1-3: Reynolds Number Range for the PanaFlow MV

Flowmeter Configurations

PanaFlow MV Vortex Flowmeters are available in two configurations:

- Model MV80 in-line flowmeter (replaces a section of the pipeline)
- Model MV82 insertion flowmeter (requires a “cold” tap or a “hot” tap into an existing pipeline)

The in-line and insertion configurations are similar in that they use identical electronics and have similar sensor heads. Besides installation differences, the main difference between an in-line flowmeter and an insertion flowmeter is their method of measurement.

For an in-line vortex flowmeter, the shedder bar is located across the entire diameter of the flow body. Thus, the entire pipeline flow is included in the vortex formation and measurement. The sensing head, which directly measures velocity, temperature and pressure is located just downstream of the shedder bar.

An insertion vortex flow meter has its sensing head at the end of a 0.750 inch diameter tubular stem. The stem is inserted into the pipe until the sensing head is properly located in the pipe's cross section. The sensing head fits through any entry port with an 1.875 inch minimum internal diameter.

The sensing head of an insertion vortex flow meter directly monitors the velocity at a point in the cross-sectional area of a pipe, duct, or stack (referred to as "channels"). The velocity at a point in the pipe varies as a function of the Reynolds number. The insertion vortex flow meter computes the Reynolds number based on constant values of the fluid's density and viscosity stored in its memory and then computes the total flow rate in the channel. The output signal of insertion meters is the total flow rate in the channel. The accuracy of the total flow rate computation depends on adherence to the piping installation requirements given in Chapter 2. If adherence to those guidelines cannot be met, contact the factory for specific installation advice.

Flowmeter Electronics

PanaFlow MV Flowmeter electronics are available mounted directly to the flow body, or remotely mounted. The electronics housing may be used indoors or outdoors, including wet environments. The instrument requires 4-20 mA loop power (12 to 36 VDC). One analog output signal is available for your choice of volumetric flow rate or mass flow rate. A pulse output is available for totalization.

The meter includes a local 2 x 16 character LCD display housed within the enclosure. Local operation and reconfiguration is accomplished using six push buttons. For hazardous locations, the six push buttons can be operated through the sealed enclosure using a hand-held magnet, thereby not compromising the integrity of the hazardous location certification.

The electronics include nonvolatile memory that stores all configuration information. The memory allows the flowmeter to function immediately upon power up, or after an interruption in power.

Chapter 2

Installation

Overview

The PanaFlow MV Flowmeter installations are simple and straightforward. Both the Series MV80 In-Line and Series MV82 Insertion type flowmeter installations are covered in this chapter. After reviewing the installation requirements given below, see page 2-3 for Series MV80 Installation instructions. See page 2-8 for Series MV82 Installation instructions. Wiring instructions begin on page 2-24.

Flowmeter Installation Requirements

Caution!
Consult the flowmeter nameplate for specific flowmeter approvals before any hazardous location installation.

Before installing the flowmeter, verify that the installation site allows for these considerations:

1. Line pressure and temperature will not exceed the flowmeter rating.
2. The location meets the required minimum number of pipe diameters upstream and downstream of the sensor head as illustrated in Figure 2-1 on page 2-2.
3. There is safe and convenient access with adequate overhead clearance for maintenance purposes.
4. The cable entry into the instrument meets the specific standard required for hazardous area installations.
5. For remote installations, the supplied cable length is sufficient to connect the flowmeter sensor to the remote electronics.

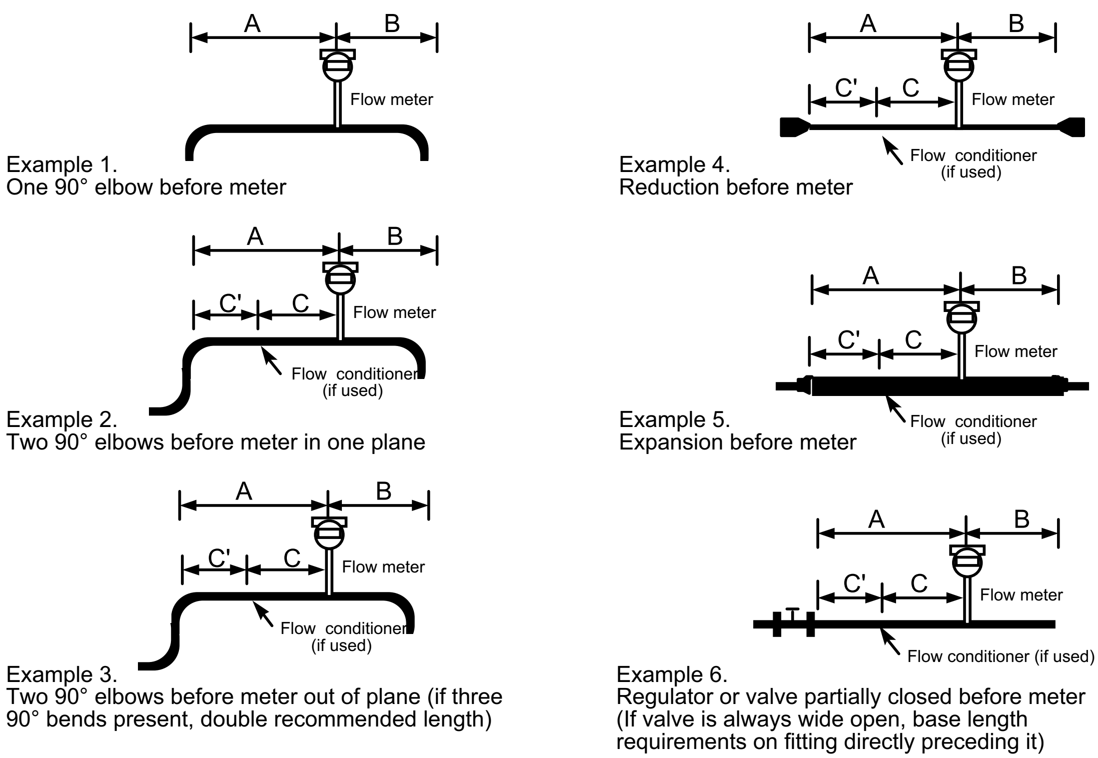
Also, before installation, check the flow system for anomalies such as:

- leaks
- valves or restrictions in the flow path that could create disturbances in the flow profile that might cause unexpected flow rate indications

Unobstructed Flow Requirements

Select an installation site that will minimize possible distortion in the flow profile. Valves, elbows, control valves and other piping components may cause flow disturbances. Check your specific piping condition against the examples shown below. In order to achieve accurate and repeatable performance, install the flowmeter using the recommended number of straight run pipe diameters upstream and downstream of the sensor.

Note: *For liquid applications in vertical pipes, avoid installing with flow in the downward direction because the pipe may not be full at all points. Choose to install the meter with flow in the upward direction if possible.*



	Minimum Required Upstream Diameters				Minimum Required Downstream Diameters	
	No Flow Conditioner	With Flow Conditioner			No Flow Conditioner	With Flow Conditioner
Example	A	A	C	C´	B	B
1	10 D	N/A	N/A	N/A	5 D	5 D
2	15 D	10 D	5 D	5 D	5 D	5 D
3	25 D	10 D	5 D	5 D	10 D	5 D
4	10 D	10 D	5 D	5 D	5 D	5 D
5	20 D	10 D	5 D	5 D	5 D	5 D
6	25 D	10 D	5 D	5 D	10 D	5 D
D = Internal diameter of channel. N/A = Not applicable						

Figure 2-1: Recommended Pipe Length Requirements for Installation - Series MV80 & MV82

Series MV80 In-Line Flowmeter Installation

Install the Series MV80 In-Line Flowmeter between two conventional pipe flanges as shown in Figure 2-3 on page 2-4 and Figure 2-4 on page 2-6. Table 2-1 below provides the recommended minimum stud bolt lengths for wafer-style meter body size and different flange ratings.

The meter inside diameter is equal to the same size nominal pipe ID in schedule 80. For example, a 2” meter has an ID of 1.939” (2” schedule 80). **Do not install the meter in a pipe with an inside diameter smaller than the inside diameter of the meter**. For schedule 160 and higher pipe, a special meter is required. Consult the factory before purchasing the meter.

Series MV80 Meters require customer-supplied gaskets. When selecting gasket material make sure that it is compatible with the process fluid and pressure ratings of the specific installation. Verify that the inside diameter of the gasket is larger than the inside diameter of the flowmeter and adjacent piping. If the gasket material extends into the flow stream, it will disturb the flow and cause inaccurate measurements.

Table 2-1: Minimum Stud Bolt Lengths for Wafer Meters

Stud Bolt Lengths for Each Flange Rating (inches)			
Line Size	**Class 150**	**Class 300**	**Class 600**
1 inch	6.00	7.00	7.50
1.5 inch	6.25	8.50	9.00
2 inch	8.50	8.75	9.50
3 inch	9.00	10.00	10.50
4 inch	9.50	10.75	12.25

The required bolt load for sealing the gasket joint is affected by several application-dependent factors, therefore the required torque for each application may be different. Refer to the ASME Pressure Vessel Code guidelines for bolt tightening standards.

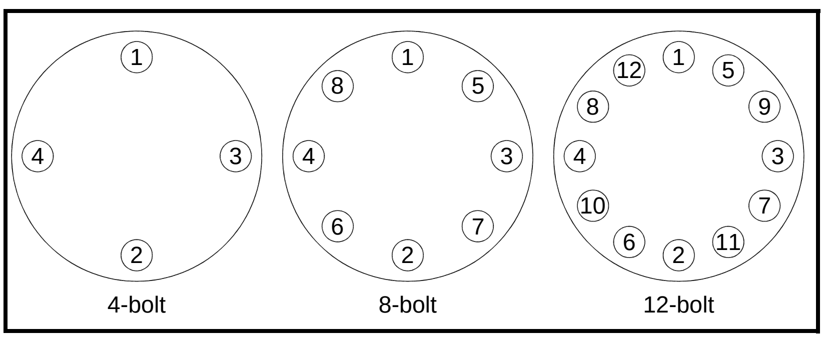


Figure 2-2: Flange Bolt Torquing Sequence

Wafer-Style Flowmeter

Install the wafer-style meter between two conventional pipe flanges of the same nominal size as the flowmeter. If the process fluid is a liquid, make sure the meter is located where the pipe is always full. This may require locating the meter at a low point in the piping system.

Note: *Vortex flowmeters are not suitable for two-phase flows (i.e., liquid and gas mixtures).*

For horizontal pipelines having a process temperature above 300° F, mount the meter at a 45° or 90° angle to avoid overheating the electronics enclosure. To adjust the viewing angle of the enclosure or display/keypad, see *Display/Keypad Adjustment* on page 2-22.

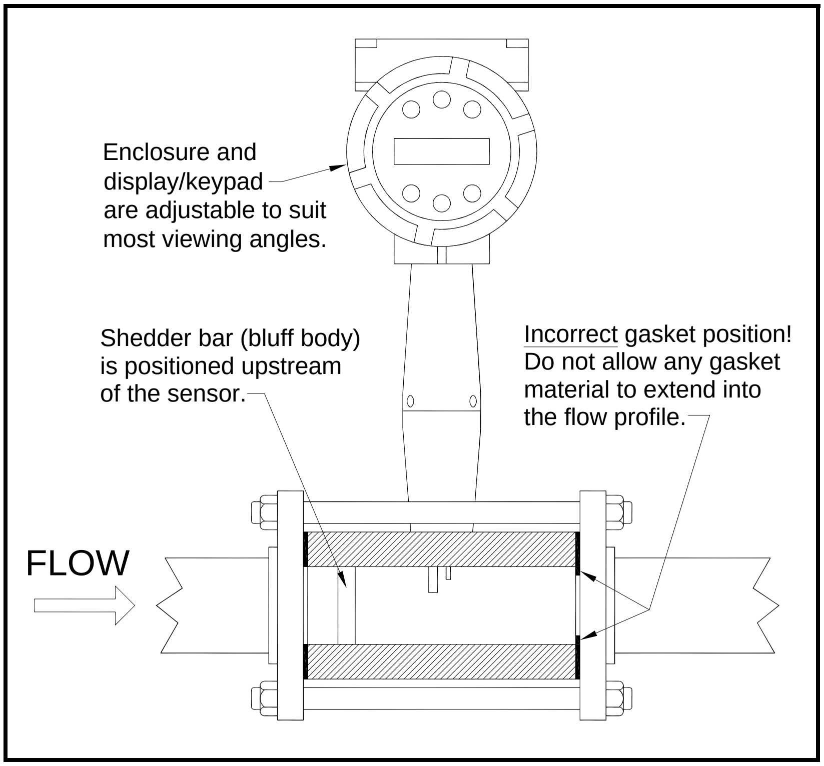


Figure 2-3: Wafer-Style Flowmeter Installation

Caution!
When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the flowmeter.

When installing the meter make sure the section marked “inlet” is positioned upstream of the outlet, facing the flow. This ensures that the sensor head is positioned downstream of the vortex shedder bar and is correctly aligned to the flow. Installing the meter opposite this direction will result in completely inaccurate flow measurement.

Wafer-Style Flowmeter (cont.)

To install the meter:

1. Turn off the flow of process gas, liquid or steam. Verify that the line is not pressurized. Confirm that the installation site meets the required minimum upstream and downstream pipe diameters.
2. Insert the studs for the bottom side of the meter body between the pipe flanges. Place the wafer-style meter body between the flanges with the end stamped “inlet” facing flow. Center the meter body inside the diameter with respect to the inside diameter of the adjoining piping.
3. Position the gasket material between the mating surfaces. Make sure both gaskets are smooth and even with no gasket material extending into the flow profile. Obstructions in the pipeline will disturb the flow and cause inaccurate measurements
4. Place the remaining studs between the pipe flanges. Tighten the nuts in the sequence shown in Figure 2-2 on page 2-3. Check for leaks after tightening the flange bolts.

Flange-Style Flowmeter

Install the flange-style meter between two conventional pipe flanges of the same nominal size as the flowmeter. If the process fluid is a liquid, make sure the meter is located where the pipe is always full. This may require locating the meter at a low point in the piping system.

Note: *Vortex flowmeters are not suitable for two-phase flows (i.e., liquid and gas mixtures).*

For horizontal pipelines having a process temperature above 300° F, mount the meter at a 45° or 90° angle to avoid overheating the electronics enclosure. To adjust the viewing angle of the enclosure or display/keypad, see *Display/Keypad Adjustment* on page 2-22.

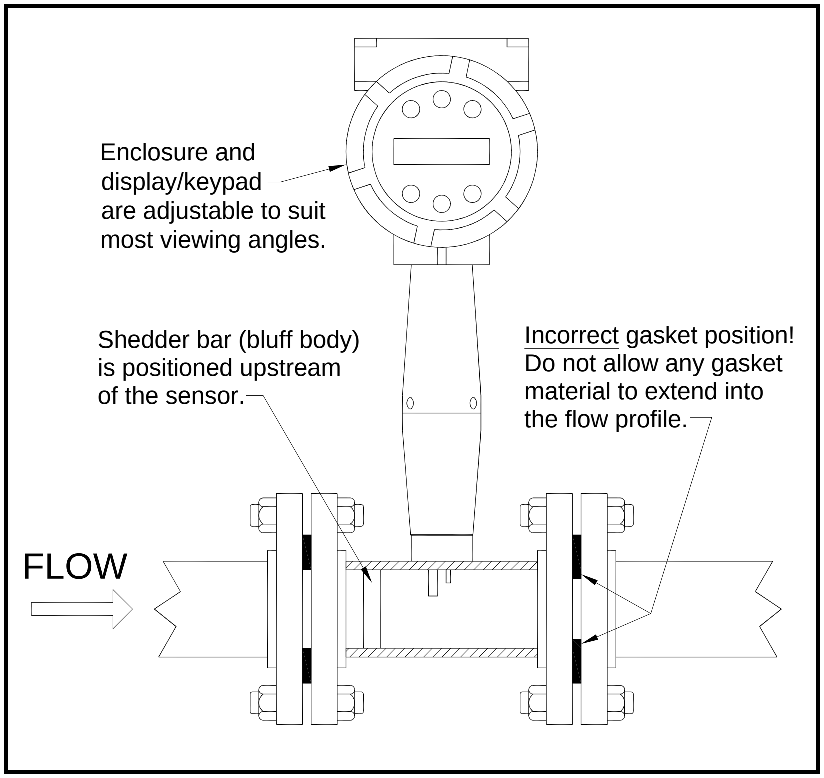


Figure 2-4: Flange-Style Flowmeter Installation

Caution!
When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the flowmeter.

When installing the meter make sure the flange marked “inlet” is positioned upstream of the outlet flange, facing the flow. This ensures that the sensor head is positioned downstream of the vortex shedder bar and is correctly aligned to the flow. Installing the meter opposite this direction will result in completely inaccurate flow measurement.

Flange-Style Flowmeter (cont.)

To install the meter:

1. Turn off the flow of process gas, liquid or steam. Verify that the line is not pressurized. Confirm that the installation site meets the required minimum upstream and downstream pipe diameters.
2. Seat the meter level and square on the mating connections with the flange marked “inlet” facing the flow. Position a gasket in place for each side. Make sure both gaskets are smooth and even with no gasket material extending into the flow profile. Obstructions in the pipeline will disturb the flow and cause inaccurate measurements.
3. Install bolts in both process connections. Tighten the nuts in the sequence shown in Figure 2-2 on page 2-3. Check for leaks after tightening the flange bolts.

Series MV82 Insertion Flowmeter Installation

Prepare the pipeline for installation using either a cold tap or hot tap method described on the following pages. Refer to a standard code for all pipe tapping operations. The following tapping instructions are general in nature and intended for guideline purposes only. Before installing the meter, review the mounting position and isolation value requirements given below.

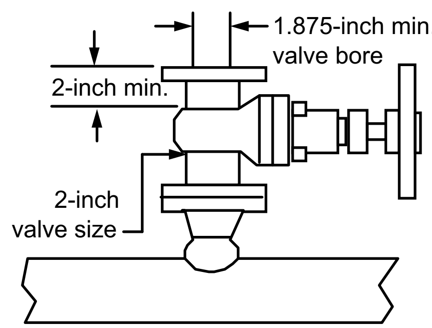
Mounting Position

Allow clearance between the electronics enclosure top and any other obstruction when the meter is fully retracted.

Isolation Valve Selection

An isolation valve is available as an option with Series MV82 meters. If you supply the isolation valve, it must meet the following requirements:

1. A minimum valve bore diameter of 1.875 inches is required, and the valve's body size should be two inches. Normally, gate valves are used.



Isolation Valve Requirements

2. Verify that the valve's body and flange rating are within the flowmeter's maximum operating pressure and temperature.
3. Choose an isolation valve with at least two inches existing between the flange face and the gate portion of the valve. This ensures that the flowmeter's sensor head will not interfere with the operation of the isolation valve.

Cold Tap Guidelines

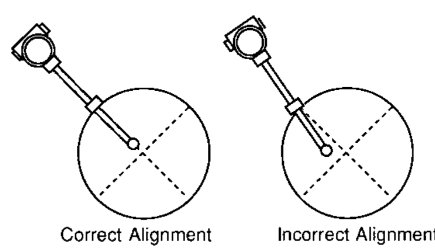
Refer to a standard code for all pipe tapping operations.

Caution!
When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the flowmeter.

!WARNING!
All flowmeter connections, isolation valves and fittings for cold tapping must have the same as or higher pressure rating than the main pipeline.

The following tapping instructions are general in nature and intended for guideline purposes only.

1. Turn off the flow of process gas, liquid or steam. Verify that the line is not pressurized.
2. Confirm that the installation site meets the minimum upstream and downstream pipe diameter requirements (see Figure 2-1 on page 2-2).
3. Use a cutting torch or sharp cutting tool to tap into the pipe. The pipe opening must be at least 1.875 inches in diameter. (Do not attempt to insert the sensor probe through a smaller hole.)
4. Remove all burrs from the tap. Rough edges may cause flow profile distortions that could affect flowmeter accuracy. Also, obstructions could damage the sensor assembly when inserting into the pipe.
5. After cutting, measure the thickness of the cut-out and record this number for calculating the insertion depth.
6. Weld the flowmeter pipe connection on the pipe. Make sure this connection is perpendicular to the pipe centerline within ± 5°.



7. Install the isolation valve (if used).
8. When welding is complete and all fittings are installed, close the isolation valve or cap the line. Run a static pressure check on the welds. If pressure loss or leaks are detected, repair the joint and retest.
9. Connect the meter to the pipe process connection.
10. Calculate the sensor probe insertion depth as described on the following pages. Insert the sensor probe into the pipe.

Hot Tap Guidelines

Refer to a standard code for all pipe tapping operations.

!WARNING!
Hot tapping must be performed by a trained professional. U.S. regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such a permit.

!WARNING!
All flowmeter connections, isolation valves and fittings for hot tapping must have the same as or higher pressure rating than the main pipeline.

The following tapping instructions are general in nature and intended for guideline purposes only.

1. Confirm that the installation site meets the minimum upstream and downstream pipe diameter requirements.
2. Weld a two inch mounting adapter on the pipe. Make sure the mounting adapter is within ± 5° perpendicular to the pipe centerline (see page 2-9). The pipe opening must be at least 1.875 inches in diameter.
3. Connect a two inch process connection on the mounting adapter.
4. Connect an isolation valve on the process connection. The valve's full open bore must be at least 1.875 inches in diameter.
5. Hot tap the pipe.
6. Close the isolation valve. Run a static pressure check on the welds. If pressure loss or leaks are detected, repair the joint and re-test.
7. Connect the flowmeter to the isolation valve.
8. Calculate the sensor probe insertion depth as described on the following pages. Insert the sensor probe assembly into the pipe.

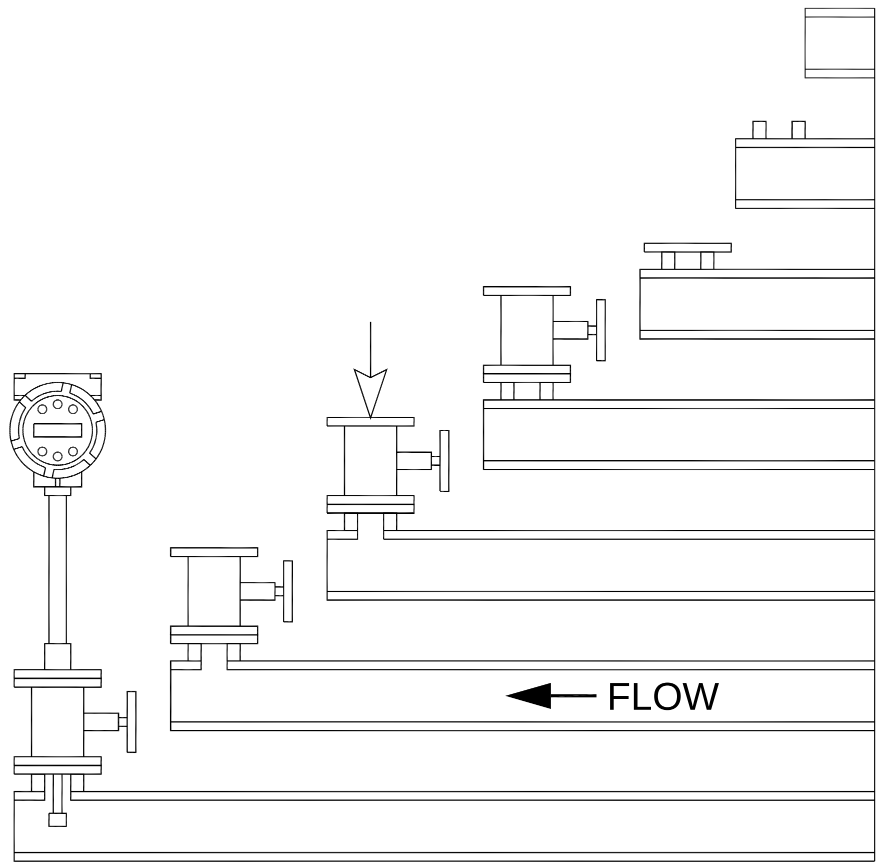


Figure 2-5: Hot Tap Sequence

Flowmeter Insertion

The sensor head must be properly positioned in the pipe. For this reason, it is important that insertion length calculations are carefully followed. A sensor probe inserted at the wrong depth in the pipe will result in inaccurate readings.

Insertion flowmeters are applicable to pipes 2 inch and larger. For pipe sizes ten inches and smaller, the centerline of the meter's sensing head is located at the pipe's centerline. For pipe sizes larger than ten inches, the centerline of the sensing head is located in the pipe's cross section five inches from the inner wall of the pipe; i.e., its "wetted" depth from the wall to the centerline of the sensing head is five inches.

Insertion flowmeters are available in three probe lengths:

- *Standard Probe* configuration is used with most flowmeter process connections. The length, S, of the stem is 29.47 inches.
- *Compact Probe* configuration is used with compression fitting process connections. The length, S, of the stem is 13.1 inches.
- *12-Inch Extended Probe* configuration is used with exceptionally lengthy flowmeter process connections. The length, S, of the stem is 41.47 inches.

Use the Correct Insertion Formula

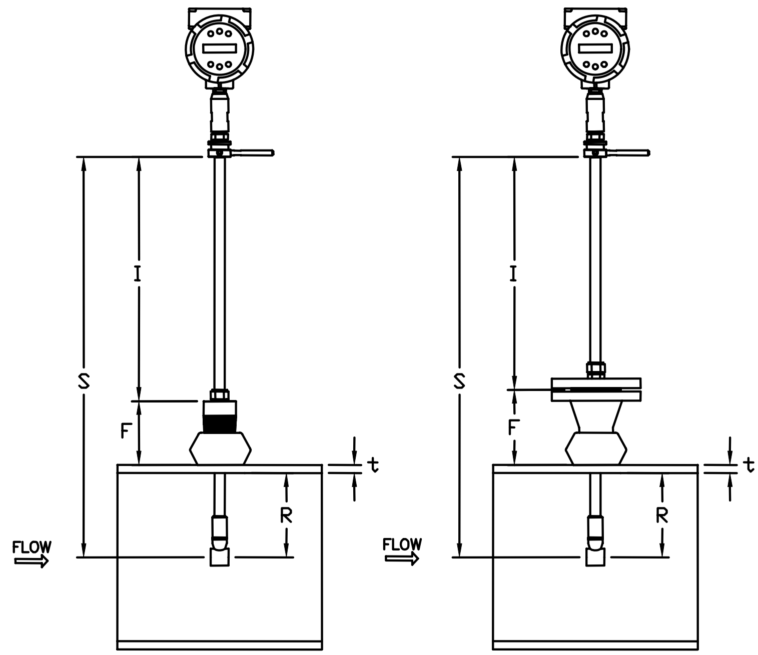
Depending on the flowmeter's process connection, use the applicable insertion length formula and installation procedure as follows:

- For flowmeters with a compression type connection (NPT or flanged), follow the instructions beginning on page 2-13.
- For flowmeters with a packing gland type connection (NPT or flanged) configured *with* an insertion tool, follow the instructions beginning on page 2-16.
- For flowmeters with a packing gland type connection (NPT or flanged) *without* an insertion tool, follow the instructions beginning on page 2-20.

!WARNING!
An insertion tool must be used for any installation where a flowmeter is inserted under pressure greater than 50 psig.

Installation with a Compression Connection*

Use the following formula to determine insertion length for flowmeters (NPT and flanged) with a compression process connection. The installation procedure is given on page 2-15.



Insertion Length Formula

$$I = S - F - R - t$$

Where:

I = Insertion length.
S = Stem length – the distance from the center of the sensor head to the base of the enclosure adapter (S = 29.47 inches for standard probes; S = 13.1 inches for compact; S = 41.47 inches for 12-inch extended).
F = Distance from the raised face of the flange or top of NPT stem housing to the outside of the pipe wall.
R = Pipe inside diameter ÷ 2 for pipes ten inches and smaller.
R = Five inches for pipe diameters larger than ten inches.
t = Thickness of the pipe wall. (Measure the disk cut-out from the tapping procedure or check a piping handbook for thickness.)

Figure 2-6: Insertion Calculation (Compression Type)

Example:
To install a Series MV82 meter with a standard probe (S = 29.47 in.) into a 14 inch schedule 40 pipe, the following measurements are taken: F = 3 inches; R = 5 inches; t = 0.438 inches

The insertion length for this example is 21.03 inches. Insert the stem through the fitting until an insertion length of 21.03 inches is measured with a ruler.

*All dimensions are in inches.

Installation with a Compression Connection (cont.)

Caution!
The sensor alignment pointer must point downstream, in the direction of the flow.

!WARNING!
To avoid serious injury, DO NOT loosen the compression fitting under pressure.

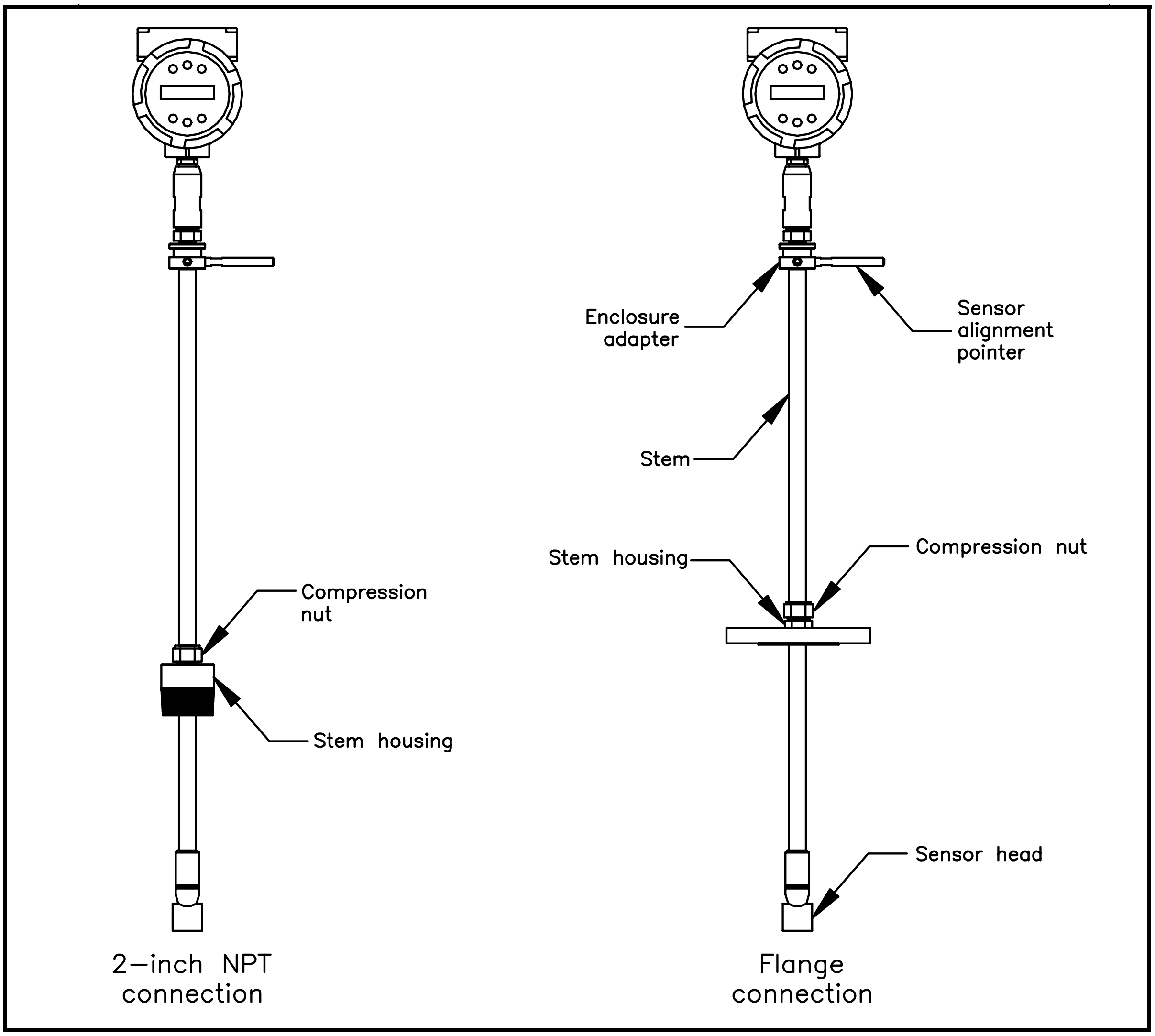


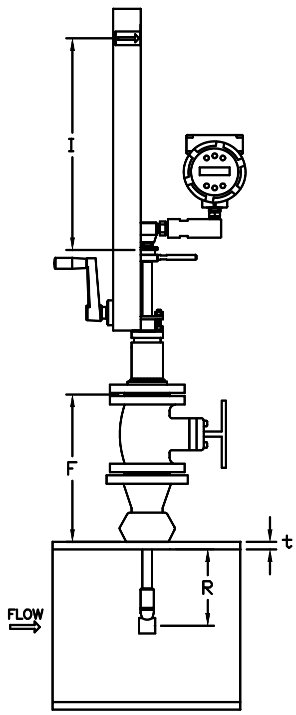
Figure 2-7: Flowmeter with a Compression Type Fitting

Installation with a Compression Connection (cont.)

1. Calculate the required sensor probe insertion length.
2. Fully retract the stem until the sensor head is touching the bottom of the stem housing. Slightly tighten the compression nut to prevent slippage.
3. Bolt or screw the flowmeter assembly into the process connection.
4. Use PTFE tape or pipe sealant to improve the seal and prevent seizing on NPT styles.
5. Hold the meter securely while loosening the compression fitting. Insert the sensor into the pipe until the calculated insertion length, I, is measured between the base of the enclosure adapter and the top of the stem housing, or to the raised face of the flanged version. Do not force the stem into the pipe.
6. Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream.
7. Tighten the compression fitting to lock the stem in position. **When the compression fitting is tightened, the position is permanent**.

Installation with a Packing Gland Connection*

Use the formula below to determine the insertion depth for flowmeters (NPT and flanged) equipped with an insertion tool. To install, see page 2-17 for instructions for meters with a permanent insertion tool. For meters with a removable insertion tool, see page 2-18.



Insertion Length Formula

$$I = F + R + t - 1.35$$

Where:

I = Insertion length.

F = Distance from the raised face of the flange or top of the process connection for NPT style meters to the top outside of the process pipe.

R = Pipe inside diameter ÷ 2 for pipes ten inches & smaller.

R = Five inches for pipe diameters larger than ten inches.

t = Thickness of the pipe wall. (Measure the disk cut-out from the tapping procedure or check a piping handbook for thickness.)

Figure 2-8: Insertion Calculation (Meters with Insertion Tool)

Example 1: Flange Style Meters:
To install a Series MV82 Flowmeter into a 14 inch schedule 40 pipe, the following measurements are taken:

F = 12 inches; R = 5 inches; t = 0.438 inches
The example insertion length is 16.09 inches.

Example 2: NPT Style Meters:
The length of thread engagement on the NPT style meters is also subtracted in the equation. The length of the threaded portion of the NPT meter is 1.18 inches. Measure the thread portion still showing after the installation and subtract that amount from 1.18 inches. This gives you the thread engagement length. If this cannot be measured use .55 inch for this amount.

F = 12 inches; R = 5 inches; t = 0.438 inches
The example insertion length is 15.54 inches.

*All dimensions are in inches.

Insertion Procedure for Flowmeters with Permanent Insertion Tool

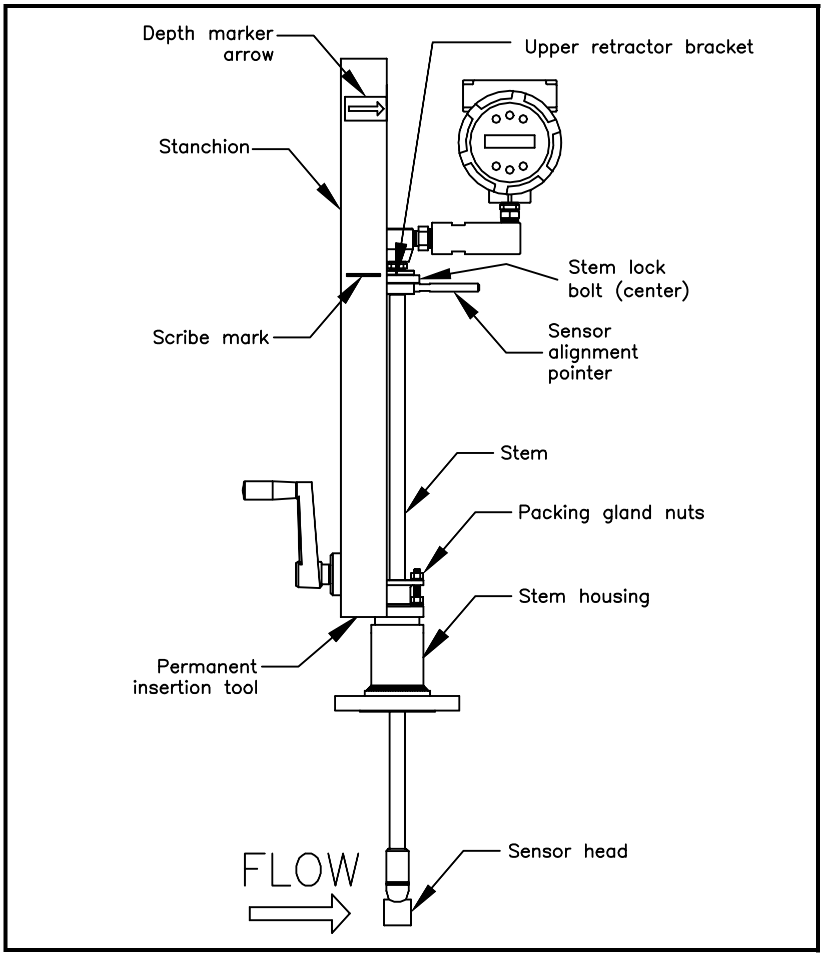


Figure 2-9: Flowmeter with Permanent Insertion Tool

Caution!
The sensor alignment pointer must point downstream, in the direction of the flow.

---

1. Calculate the required sensor probe insertion length (refer to page 2-16). Measure from the depth marker arrow down the stanchion and scribe a mark at the calculated insertion depth.
2. Fully retract the flowmeter until the sensor head is touching the bottom of the stem housing. Attach the meter assembly to the two inch full-port isolation valve, if used. Use PTFE tape or pipe sealant to improve seal and prevent seizing on NPT style.
3. Loosen the two packing gland nuts on the stem housing of the meter. Loosen the stem lock bolt adjacent to the sensor alignment pointer. Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream. Tighten the stem lock bolt to secure the sensor position.

Insertion Procedure for Flowmeters with Permanent Insertion Tool (cont.)

4. Slowly open the isolation valve to the full open position. If necessary, slightly tighten the two packing gland nuts to reduce the leakage around the stem.

5. Turn the insertion tool handle clockwise to insert the sensor head into the pipe. Continue until the top of the upper retractor bracket aligns with the insertion length position scribed on the stanchion. Do not force the stem into the pipe.

6. Tighten the packing gland nuts to stop leakage around the stem. Do not torque over 20 ft-lb.

Note: *If line pressure is above 500 psig, it could require up to 25 ft-lb of torque to insert the flowmeter. Do not confuse this with possible interference in the pipe.*

Insertion Procedure for Flowmeters with Removable Insertion Tool

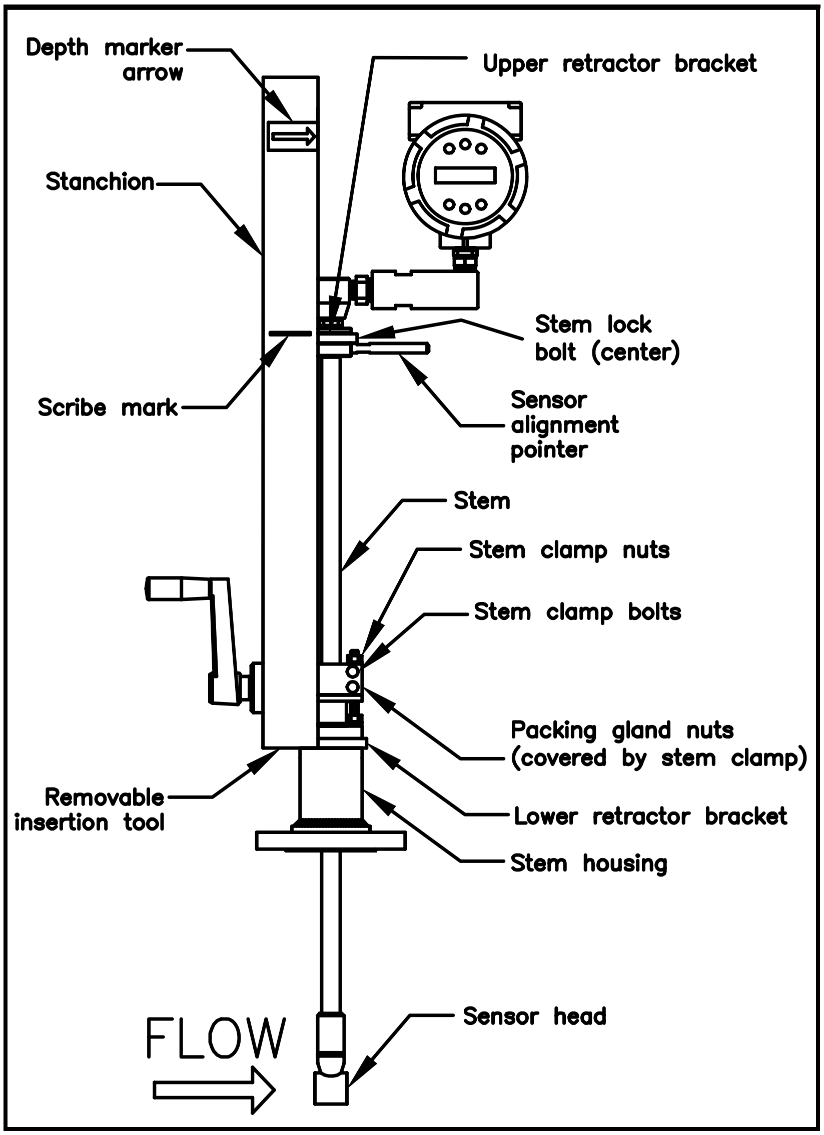


Figure 2-10: Flowmeter with Removable Insertion Tool

Insertion Procedure for Flowmeters with Removable Insertion Tool (cont.)

Caution!
The sensor alignment pointer must point downstream, in the direction of the flow.

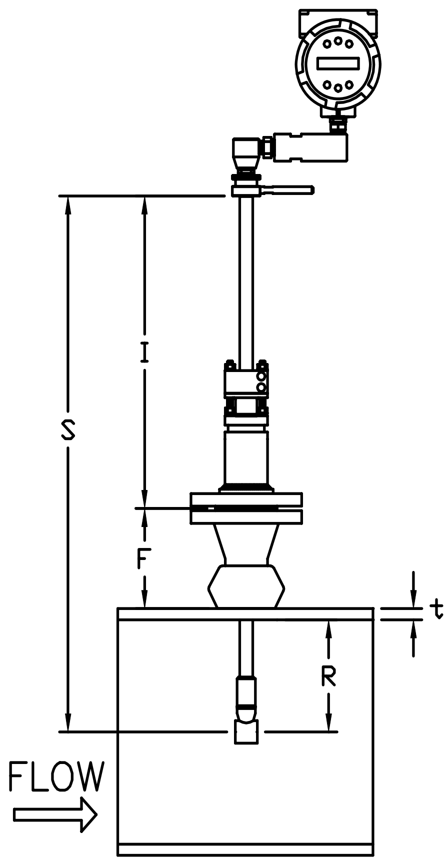
1. Calculate the required sensor probe insertion length. Measure from the depth marker arrow down the stanchion and scribe a mark at the calculated insertion depth.
2. Fully retract the flowmeter until the sensor head is touching the bottom of the stem housing. Attach the meter assembly to the two inch full-port isolation valve, if used. Use PTFE tape or pipe sealant to improve seal and prevent seizing on NPT style.
3. Remove the two top stem clamp nuts and loosen two stem clamp bolts. Slide the stem clamp away to expose the packing gland nuts.
4. Loosen the two packing gland nuts. Loosen the stem lock bolt adjacent to the sensor alignment pointer. Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream. Tighten the stem lock bolt to secure the sensor position.
5. Slowly open the isolation valve to the full open position. If necessary, slightly tighten the two packing gland nuts to reduce the leakage around the stem.
6. Turn the insertion tool handle clockwise to insert the stem into the pipe. Continue until the top of the upper retractor bracket lines up with the insertion length mark scribed on the stanchion. Do not force the stem into the pipe.

Note: *If line pressure is above 500 psig, it could require up to 25 ft-lb of torque to insert the flowmeter. Do not confuse this with possible interference in the pipe.*

7. Tighten the packing gland nuts to stop leakage around the stem. Do not torque over 20 ft-lbs.
8. Slide the stem clamp back into position. Torque stem clamp bolts to 15 ft-lbs. Replace the stem clamp nuts and torque to 10-15 ft-lbs.
9. Attach the safety chain from the stem clamp to the hook on the enclosure adapter at the nearest link. To separate the insertion tool from the flowmeter, remove four socket head cap bolts securing the upper and lower retractor brackets. Remove the insertion tool.

Installation with a Packing Gland Connection and No Insertion Tool*

Use the following formula to determine insertion depth for meters with a packing gland connection (NPT and flanged) without an insertion tool.



Insertion Length Formula

$$I = S - F - R - t$$

Where:

I = Insertion length.

S = Stem length – the distance from the center of the sensor head to the base of the enclosure adapter (S = 29.47 inches for standard probes; S = 41.47 inches for 12 inch extended probes).

F = Distance from the raised face of the flange or top of NPT stem housing to the outside of the pipe wall.

R = Pipe inside diameter ÷ 2 for pipes ten inches & smaller.

R = Five inches for pipe diameters larger than ten inches.

t = Thickness of the pipe wall. (Measure the disk cut-out from the tapping procedure or check a piping handbook for thickness.)

Figure 2-11: Insertion Calculation (Meters without Insertion Tool)

Example:

To install a Series MV82 Flowmeter with a standard probe (S = 29.47) into a 14 inch schedule 40 pipe, the following measurements are taken:

F = 3 inches; R = 5 inches; t = 0.438 inches

The example insertion length is 21.03 inches.

*All dimensions are in inches.

Insertion Procedure with No Insertion Tool (Packing Gland Connection)

!WARNING!
The line pressure must be less than 50 psig for installation.

Caution!
The sensor alignment pointer must point downstream, in the direction of the flow.

1. Calculate the required sensor probe insertion length.
2. Fully retract the stem until the sensor head is touching the bottom of the stem housing. Remove the two top stem clamp nuts and loosen two stem clamp bolts. Slide the stem clamp away to expose the packing gland nuts. Loosen the two packing gland nuts.
3. Align the sensor head using the sensor alignment pointer. Adjust the alignment pointer parallel to the pipe and pointing downstream.
4. Insert the sensor head into the pipe until insertion length, I, is achieved. Do not force the stem into the pipe.
5. Tighten the packing gland nuts to stop leakage around the stem. Do not torque over 20 ft-lbs.
6. Slide the stem clamp back into position. Torque stem clamp bolts to 15 ft-lbs. Replace the stem clamp nuts and torque to 10-15 ft-lbs.

Adjusting Meter Orientation

Depending on installation requirements, you may need to adjust the meter orientation. There are two adjustments available. The first rotates the position of the LCD display/keypad and is available on both in-line and insertion meters. The second is to rotate the enclosure position. This adjustment is allowed only on Series MV80 In-Line meters.

Display/Keypad Adjustment (All Meters)

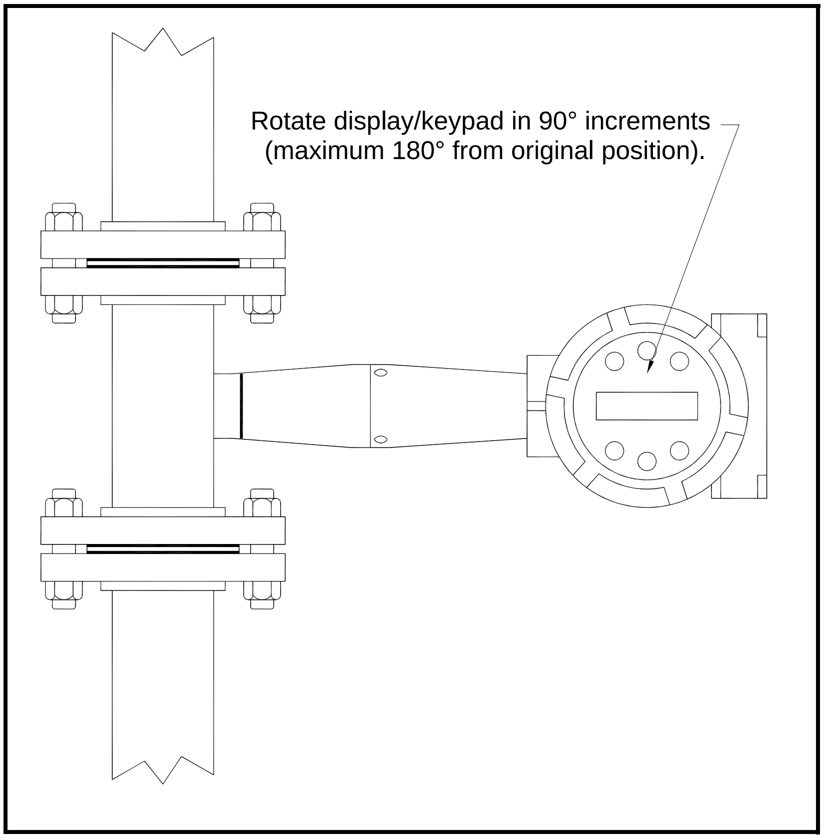


Figure 2-12: Display/Keypad Viewing Adjustment

The electronics boards are electrostatically sensitive. Wear a grounding wrist strap and make sure to observe proper handling precautions required for static-sensitive components. To adjust the display:

1. Disconnect power to the flowmeter.
2. Loosen the small set screw which secures the electronics enclosure. Unscrew and remove the cover.
3. Loosen the 4 captive screws.
4. Carefully pull the display/microprocessor board away from the meter standoffs. Make sure not to damage the connected ribbon cable.
5. Rotate the display/microprocessor board to the desired position. Maximum turn, two positions left or two positions right (180°).
6. Align the board with the captive screws. Check that the ribbon cable is folded neatly behind the board with no twists or crimps.
7. Tighten the screws. Replace the cover and set screw. Restore power to the meter.

Enclosure Adjustment (Series MV80 Only)

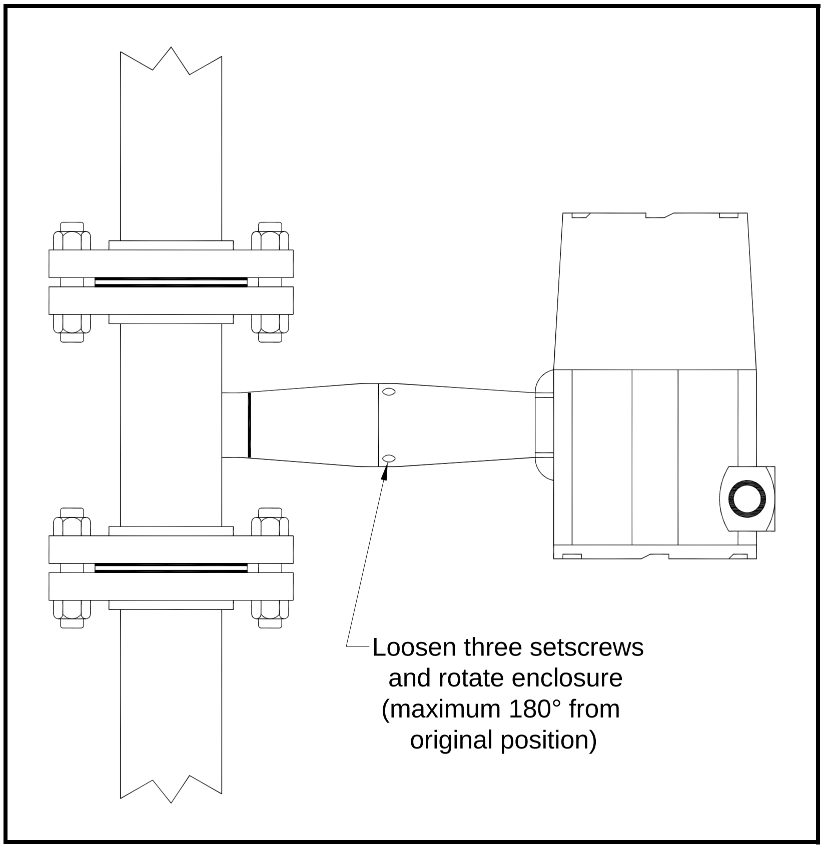


Figure 2-13: Enclosure Viewing Adjustment

To avoid damage to the sensor wires, do not rotate the enclosure beyond 180° from the original position. To adjust the enclosure:

1. Remove power to the flowmeter.
2. Loosen the three set screws shown above. Rotate the display to the desired position (maximum 180°).
3. Tighten the three set screws. Restore power to the meter.

Wiring Connections

!WARNING!
To avoid potential electric shock, follow National Electric Code safety practices or your local code when wiring this unit to a power source and to peripheral devices. Failure to do so could result in injury or death. If AC power is being used, all connections must be in accordance with published CE directives. All wiring procedures must be performed with power off.

Caution!
If AC power is being used, the wire insulation temperature rating must meet or exceed 85°C (185°F).

The Type 4X enclosure contains an integral wiring compartment with one dual strip terminal block (located in the smaller end of the enclosure). Two 3/4-inch female NPT conduit entries are available for separate power and signal wiring. For all hazardous area installations, make sure to use an agency-approved fitting at each conduit entry. If conduit seals are used, they must be installed within 18 inches (457 mm) of the enclosure.

Input Power Connections

To access the wiring terminal blocks, locate and loosen the small set screw which locks the small enclosure cover in place. Unscrew the cover to expose the terminal blocks.

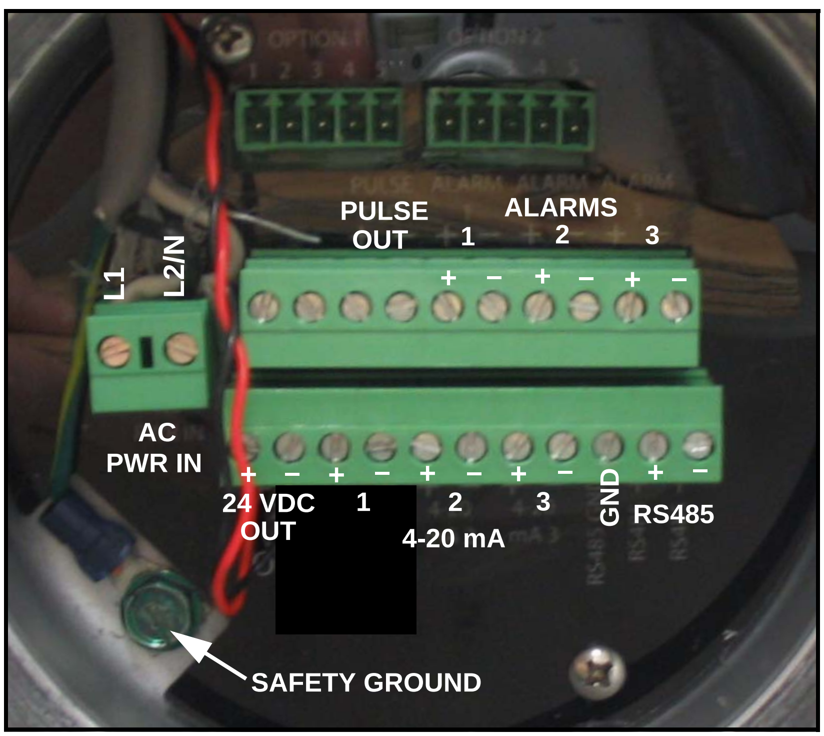
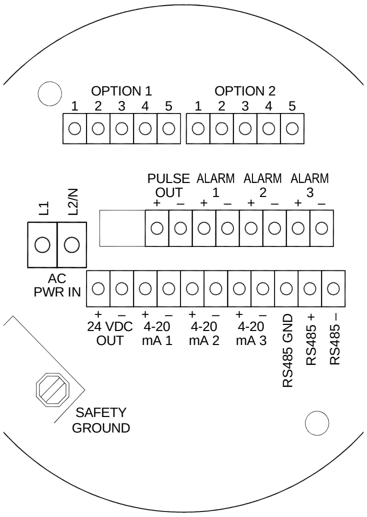


Figure 2-14: AC Terminal Blocks and Safety Ground Connection

AC Power Wiring



If AC input was ordered, the power wire size must be 20 to 10 AWG with the wire stripped 1/2 inch (14 mm). The wire insulation temperature must meet or exceed 85°C (185°F). Connect 100-240 VAC (25 watts maximum) to the L1 and L2/N terminals on the small terminal block to the left. Connect the ground wire to the safety ground lug. Torque all connections to 4.43 to 5.31 in-lbs (0.5 to 0.6 Nm). Use a separate conduit entry for signal lines to reduce the possibility of AC noise interference.

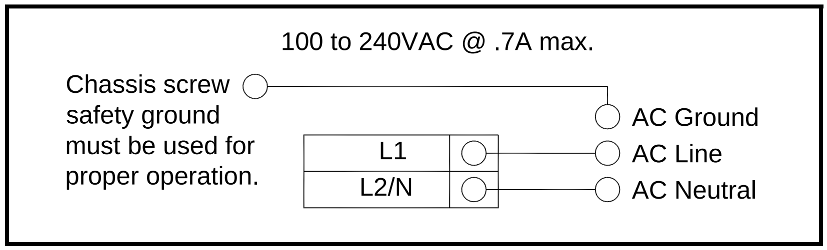
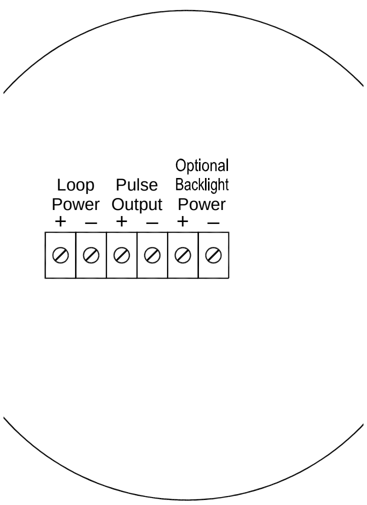


Figure 2-15: AC Power Connections

DC Power Wiring



If DC input was ordered, connect 4-20 mA loop power (12-36 VDC) to the LOOP PWR +/– terminals on the terminal block. Torque all connections to 4.43-5.31 in-lbs (0.5-0.6 Nm). The DC power wire size must be 20-10 AWG with the wire stripped 1/2 inch (14 mm). The nominal voltage required to operate the 4-20 mA loop is 12 volts at the meter. The 4-20 mA loop is optically isolated from the flow meter electronics.

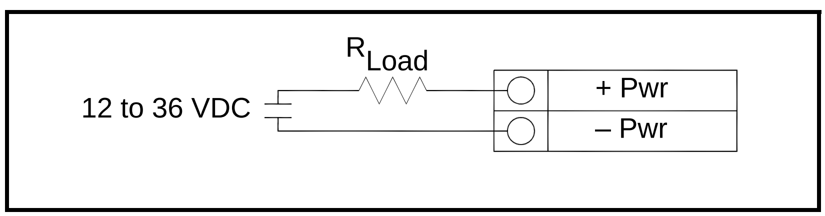


Figure 2-16: DC Power Connections

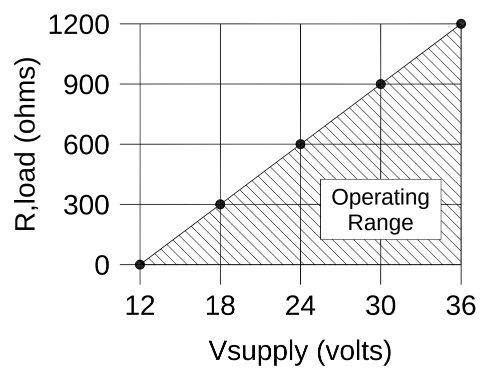
4-20mA Output Connections

The standard PanaFlow MV Flowmeter has a single 4-20 mA loop. The 4-20 mA loop current is controlled by the meter electronics. The electronics must be wired in series with the sense resistor or current meter. The current control electronics require 12 volts at the input terminals to operate correctly.

The maximum loop resistance (load) for the current loop output is dependent upon the supply voltage and is given in Figure 2-17. The 4-20 mA loop is optically isolated from the flowmeter electronics.

R_{load} is the total resistance in the loop, including the wiring resistance ($R_{load} = R_{wire} + R_{sense}$). To calculate R_{max}, the maximum R_{load} for the loop, use the maximum loop current, 20 mA. The voltage drop in the loop due to resistance is 20 mA times R_{load} and this drop is subtracted from the input voltage. Thus:

The maximum resistance $R_{load} = R_{max} = 50 \times (V_{supply} - 12V)$.



Vsupply (volts)	Rmax (ohms)
12	0
18	300
24	600
30	900
36	1200

Figure 2-17: Load Resistance Versus Input Voltage

Pulse Output Connections

The pulse output is used for a remote counter. When the preset volume or mass (defined in the totalizer settings, see page 3-6) has passed the meter, the output provides a 50 millisecond square pulse.

The pulse output requires a separate 5 to 36 VDC power supply. The pulse output optical relay is a normally-open single-pole relay. The relay has a nominal 200 volt/160 ohm rating. This means that it has a nominal on-resistance of 160 ohms, and the largest voltage that it can withstand across the output terminals is 200 volts. However, there are current and power specifications that must be observed. The relay can conduct a current up to 40 mA and can dissipate up to 320 mW. The relay output is isolated from the meter electronics and power supply.

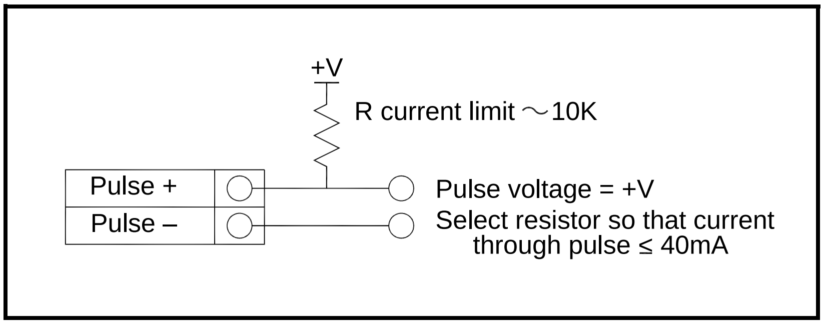


Figure 2-18: Isolated Pulse Output with External Power Supply

Optional Backlight Connection

The Sierra Model MV80 has an optional backlight connection provided. It is intended to be powered by a separate 12 to 36 VDC power supply or by the pulse power input. Both are shown below.

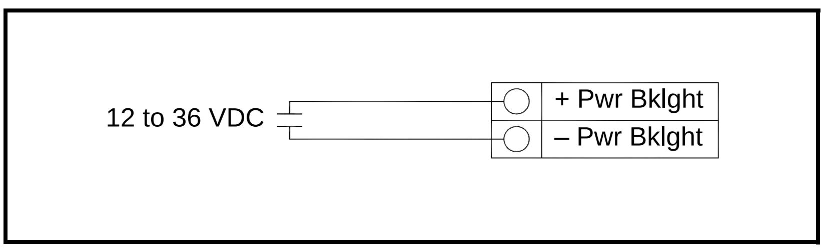


Figure 2-19: Backlight Conn. Powered by 12-36VDC Pwr Supply

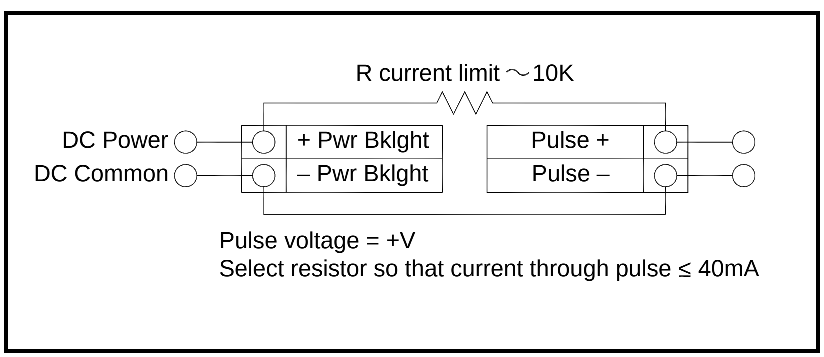


Figure 2-20: Backlight Conn. Powered by Pulse Power Input

Remote Electronics Wiring

The remote electronics enclosure should be mounted in a convenient, easy to reach location. For hazardous location installations, make sure to observe agency requirements for installation. Allow some slack in the interface cable between the junction box and the remote electronics enclosure. To prevent damage to the wiring connections, do not put stress on the terminations at any time.

The meter is shipped with temporary strain relief glands at each end of the cable. Disconnect the cable from the meter's terminal block inside the junction box–not at the remote electronics enclosure. Remove both glands and install appropriate conduit entry glands and conduit. When installation is complete, re-connect each labeled wire to the corresponding terminal position on the junction box terminal block. Make sure to connect each wire pair's shield.

Note: *Incorrect connection will cause the meter to malfunction.*

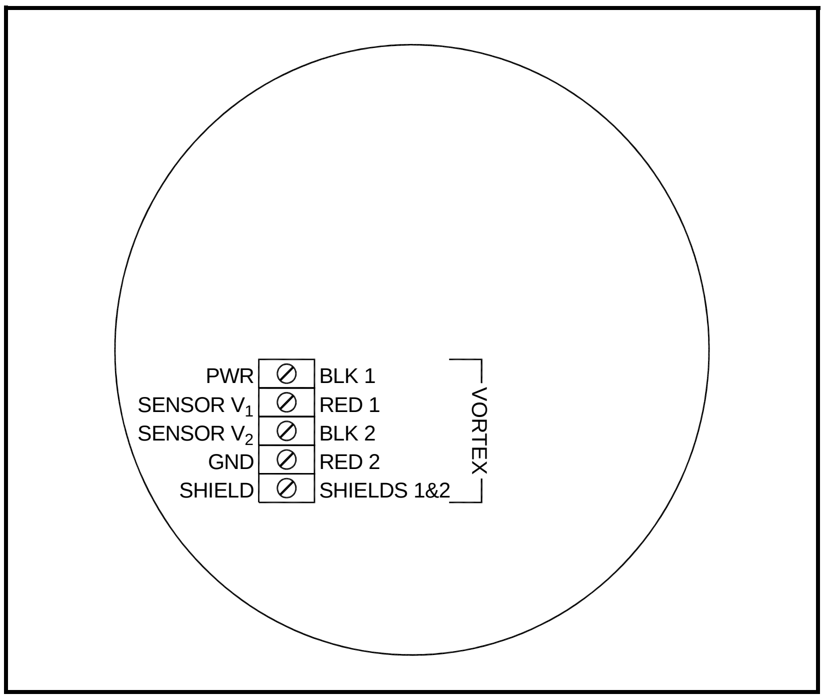


Figure 2-21: Junction Box Sensor Connections

Note: *The numeric code in the junction box label matches the wire labels.*

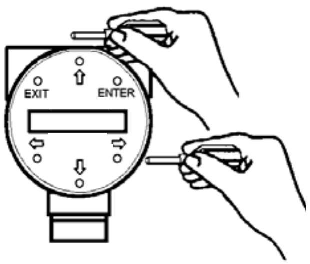
Chapter 3

Operation

Introduction

After installing the PanaFlow MV Vortex Flowmeter, you are ready to begin operation. The sections in this chapter explain the display/keypad commands, meter start-up and programming. The meter is ready to operate at start up without any special programming. To enter parameters and system settings unique to your operation, see the following pages for instructions on using the setup menus.

Display/Keypad



The flowmeter's digital electronics enable you to set, adjust and monitor system parameters and performance. A full range of commands is available through the display/keypad. The LCD display gives 2 x 16 characters for flow monitoring and programming. The six push buttons can be operated with the enclosure cover removed. Or, the explosion-proof cover can remain in place and the keypad operated with a hand-held magnet positioned at the side of the enclosure as shown in the illustration at the left.

From the Run Mode, the ENTER key enables access to the Setup Menus (through a password screen). Within the Setup Menus, pressing ENTER activates the current field. To set new parameters, press the ENTER key until an underline cursor appears. Use the ↑ ↓ ← → keys to select new parameters. Press ENTER to continue. (If change is not allowed, ENTER has no effect.) All outputs are disabled when using the Setup Menus.

The EXIT key is active within the Setup Menus. When using a Setup Menu, EXIT returns you to the Run Mode. If you are changing a parameter and make a mistake, EXIT enables you to start over.

The ↑ ↓ ← → keys advance through each screen of the current menu. When changing a system parameter, all ↑ ↓ ← → keys are available to enter new parameters.

Figure 3-1: Flowmeter Display/Keypad

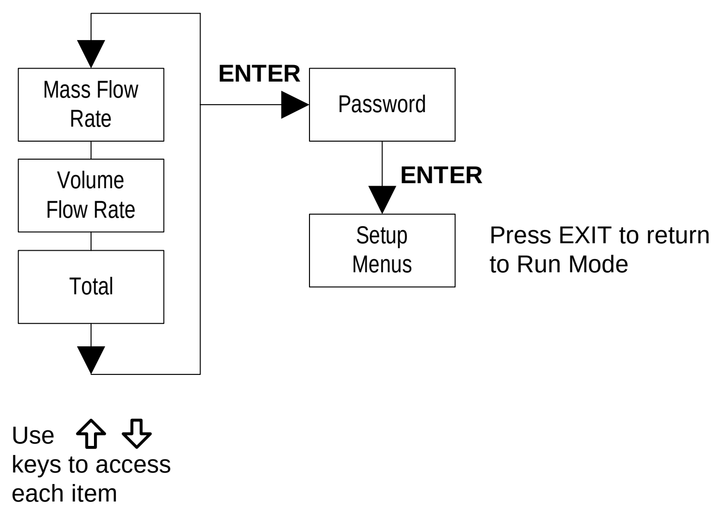
Startup

To begin flowmeter operation:

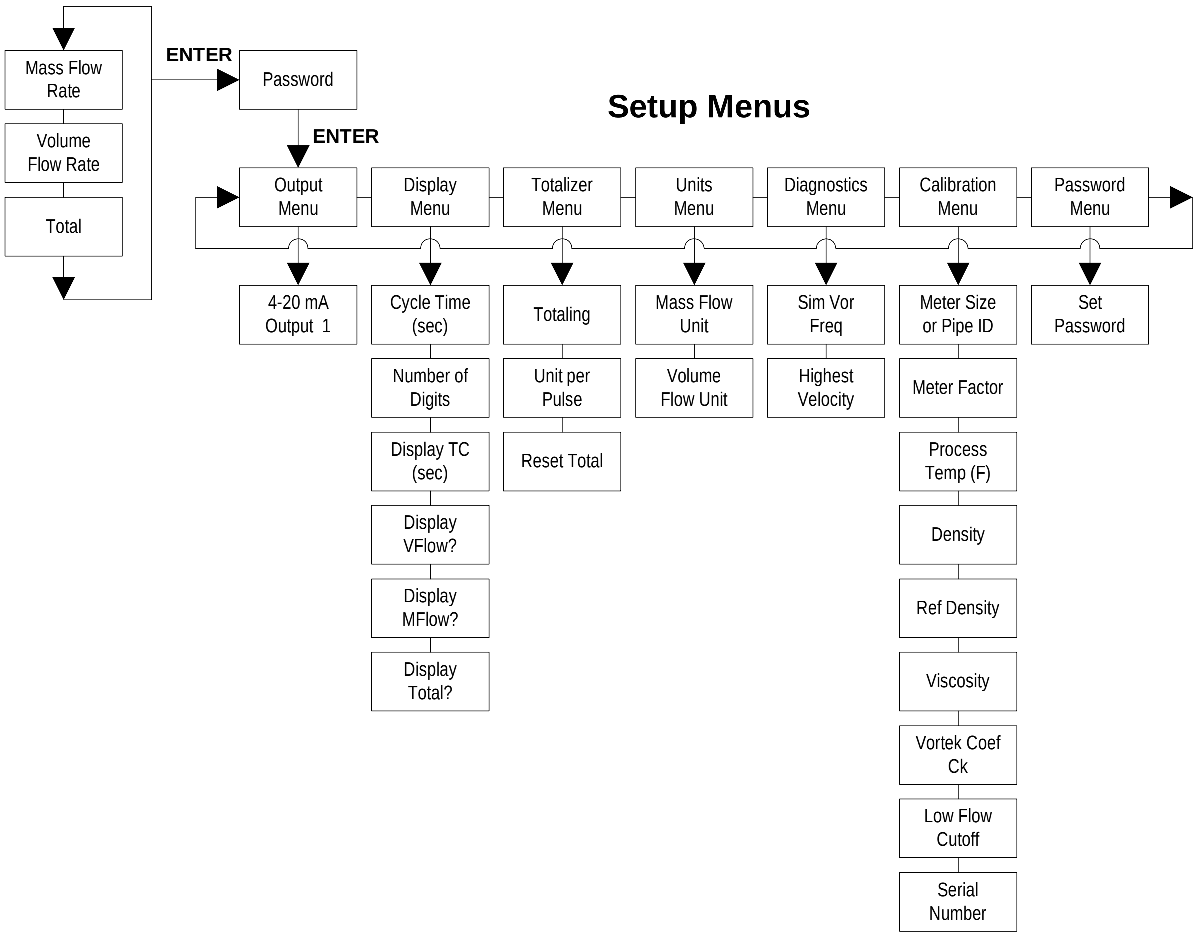
1. Verify the flowmeter is installed and wired as described in Chapter 2.
2. Apply power to the meter. At start up, the unit runs a series of self tests that check the RAM, ROM, EPROM and all flow sensing components. After completing the self-test sequence, the Run Mode screens appear (see figure below).

Note: *Starting the flowmeter or pressing EXIT will always display the Run Mode screens.*

3. The Run Mode displays flow information as determined by system settings. Press the ↑ ↓ arrow keys to view the Run Mode screens.
4. Press the ENTER key from any Run Mode screen to access the Setup Menus. Use the Setup Menus to configure the meter's multi parameter features to fit your application.



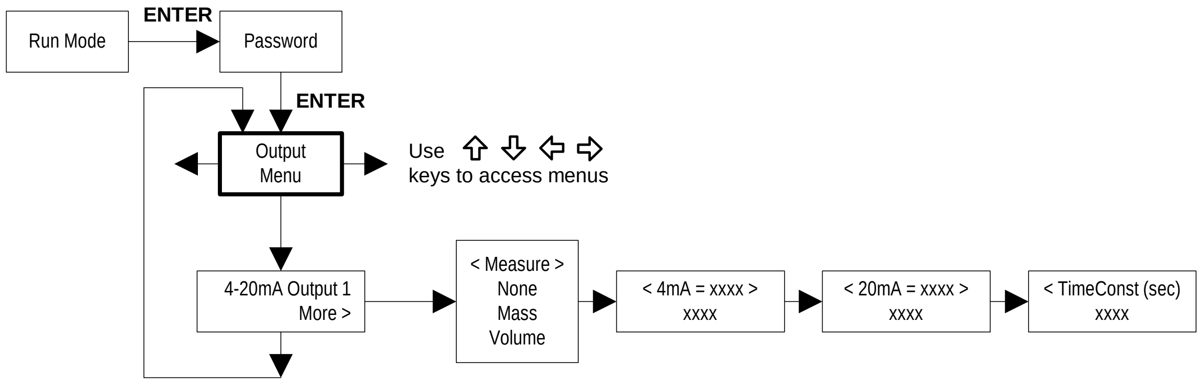
Using the Setup Menus



Programming the Flowmeter

1. Enter the Setup Menu by pressing the ENTER key until prompted for a password. (All outputs are disabled while using the Setup Menus.)
2. Use the ↑ ↓ ← → keys to select the password characters (1234 is the factory-set password). When the password is correctly displayed, press ENTER to continue.
3. Use the Setup Menus described on the following pages to customize the multi parameter features of your PanaFlow MV Flowmeter. (The entire lower display line is available for entering parameters.)
4. To activate a parameter, press ENTER. Use the ↑ ↓ ← → keys to make selections. Press ENTER to continue. Press EXIT to save or discard changes and return to Run Mode.

Output Menu



Example for Setting an Output

The following shows how to set Output 1 to measure volumetric flow with 4 mA = 0 gal/min and 20 mA = 100 gal/min with a time constant of 5 seconds. (All outputs are disabled while using the Setup Menus.)

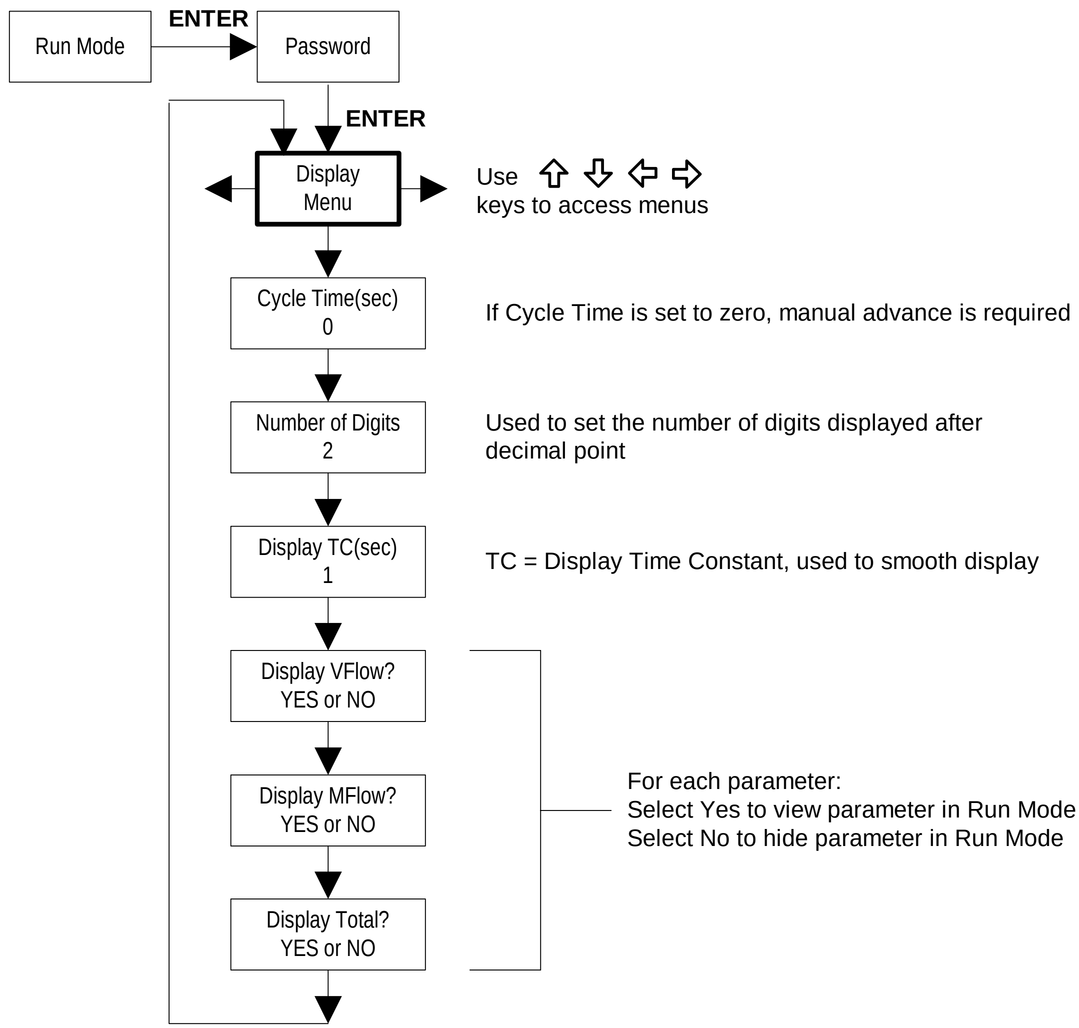
First, set the desired units of measurement:

1. Use the ←→ keys to move to the Units Menu (see page 3-7).
2. Press the ↓ key until the Volume Flow Unit appears. Press ENTER.
3. Press the ↓ key until **gal** appears in the numerator. Press the → key to move the underline cursor to the denominator. Press the ↓ key until **min** appears in the denominator. Press ENTER to select.
4. Press the ↑ key until the Units Menu appears.

Second, set the analog output:

1. Use the ←→ keys to move to the Output Menu.
2. Press the ↓ key until 4-20 mA Output 1 appears.
3. Press the → key to access Measure selections. Press ENTER and press the ↓ key to select Volume. Press ENTER.
4. Press the → key to set the 4 mA point in the units you have selected for volume of gal/min. Press ENTER and use the ↑ ↓ ←→ keys to set 0 or 0.0. Press ENTER.
5. Press the → key to set the 20 mA point. Press ENTER and use the ↑ ↓ ←→ keys to set 100 or 100.0. Press ENTER.
6. Press the → key to select the Time Constant. Press ENTER and use the ↑ ↓ ←→ keys to select 5. Press ENTER.
7. Press the EXIT key and answer YES to permanently save your changes.

Display Menu



Use the Display Menu to set the cycle time for automatic screen sequencing used in the Run Mode, change the precision of displayed values, smooth the values or enable or disable each item displayed in the Run Mode screens.

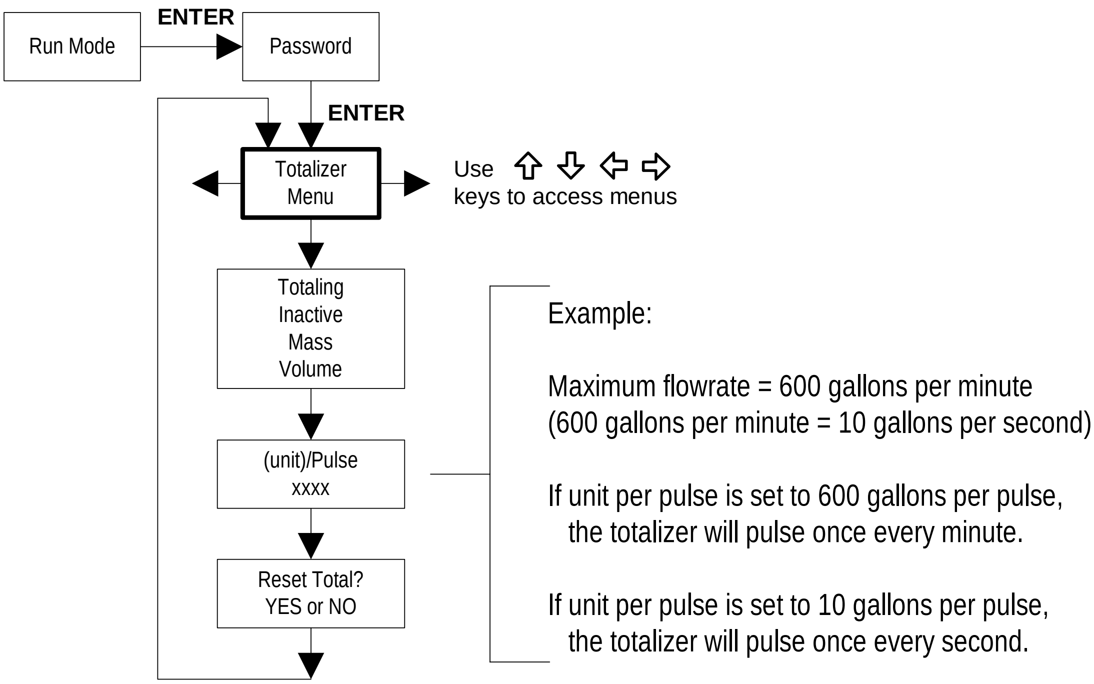
Example for Changing a Run Mode Display Item

The following shows how to remove the mass flow screen from the Run Mode screens.

Note: *All outputs are disabled while using the Setup Menus.*

1. Use the ←→ keys to move to the Display Menu.
2. Press the ↓ key until Display MFlow? appears.
3. Press ENTER to select.
4. Press the ↓ key until N appears. Press ENTER to select.
5. Press EXIT and then ENTER to save changes and return to the Run Mode.

Totalizer Menu



Use the Totalizer Menu to configure and monitor the totalizer. The totalizer output is a 50 millisecond (.05 second) positive pulse (relay closed for 50 milliseconds). The totalizer cannot operate faster than one pulse every 100 millisecond (.1 second). A good rule to follow is to set the unit per pulse value equal to the maximum flow in the same units per second. This will limit the pulse to no faster than one pulse every second.

Example for Setting the Totalizer

The following sets the totalizer to track volumetric total gallons.

Note: *All outputs are disabled while using the Setup Menus.*

First, set the desired units of measurement:

1. Use the ← → keys to move to the Units Menu (see page 3-7).
2. Press the ↓ key until Volume Flow Unit appears. Press ENTER.
3. Press the ↓ key until **gal** appears in the numerator. Press the → key to move the underline cursor to the denominator. Press the ↓ key until **min** appears in the denominator. Press ENTER to select.
4. Press the ↑ key until the Units Menu appears.

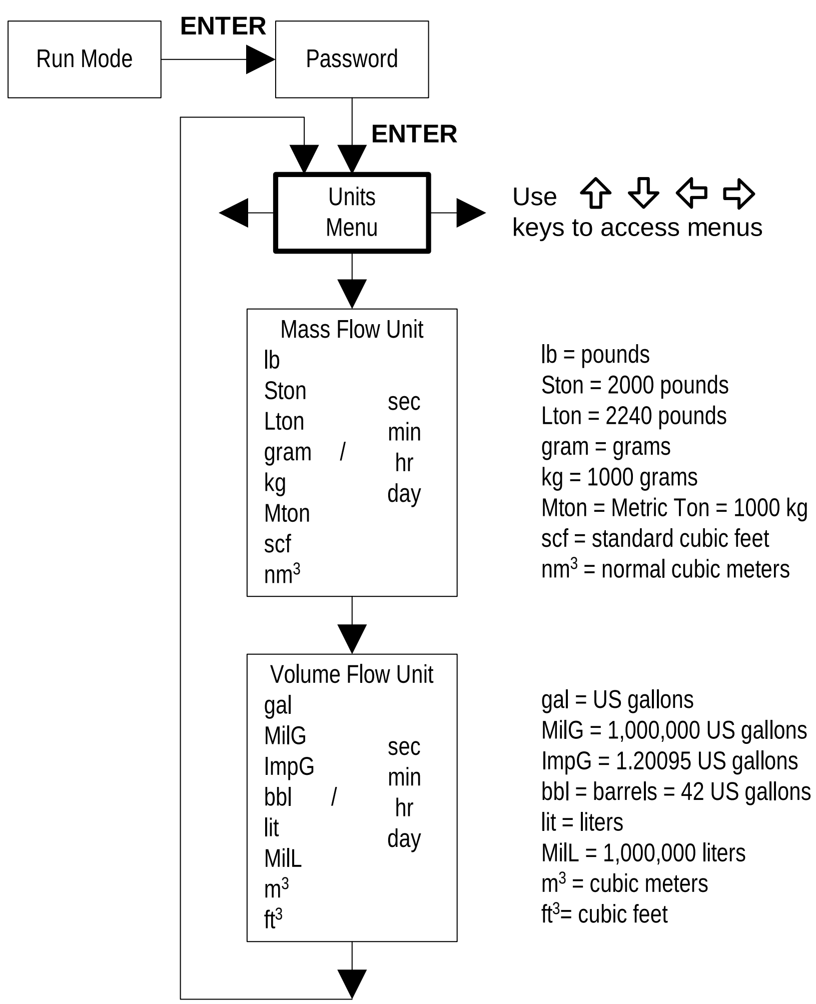
Example for Setting the Totalizer (cont.)

Second, set the pulse output:

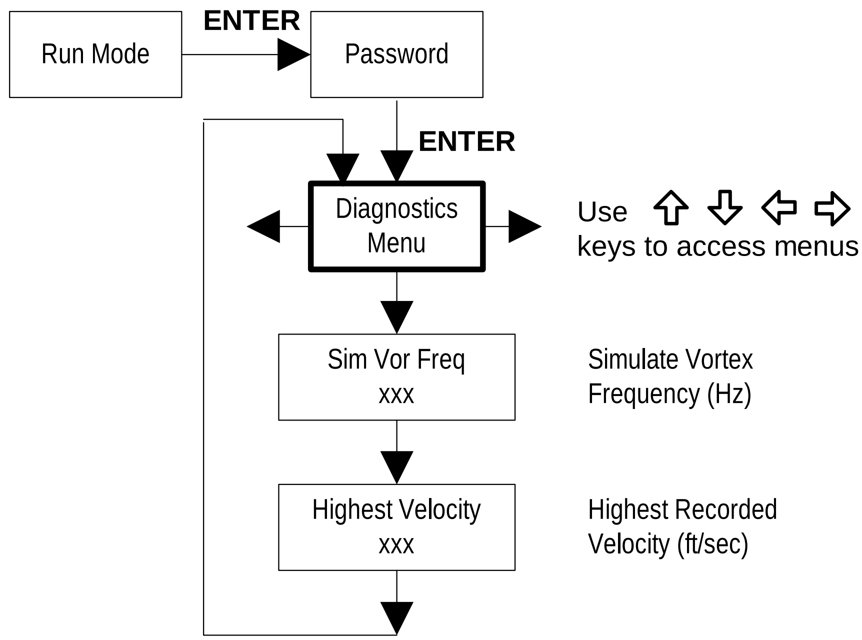
1. Use the ← → keys to move to the Totalizer Menu.
2. Press the ↓ key until **Totaling** appears.
3. Press ENTER and press the ↓ key to select Volume. Press ENTER.
4. Press the ↓ key to set the gallons per pulse. Press ENTER and use the ↑ ↓ ← → keys to set the pulse value equal to the maximum flow in the same units per second. This will limit the frequency to 1 Hz. Press ENTER.
5. To reset the totalizer, press the ↓ key until **Reset Total?** appears. Press ENTER and the ↓ key to reset the totalizer if desired. Press ENTER.
6. Press the EXIT key and answer YES to permanently save your changes.

Units Menu

Use the Units Menu to configure the flowmeter with the desired units of measurement. (These are global settings and determine what appears on all screens.)



Diagnostics Menu



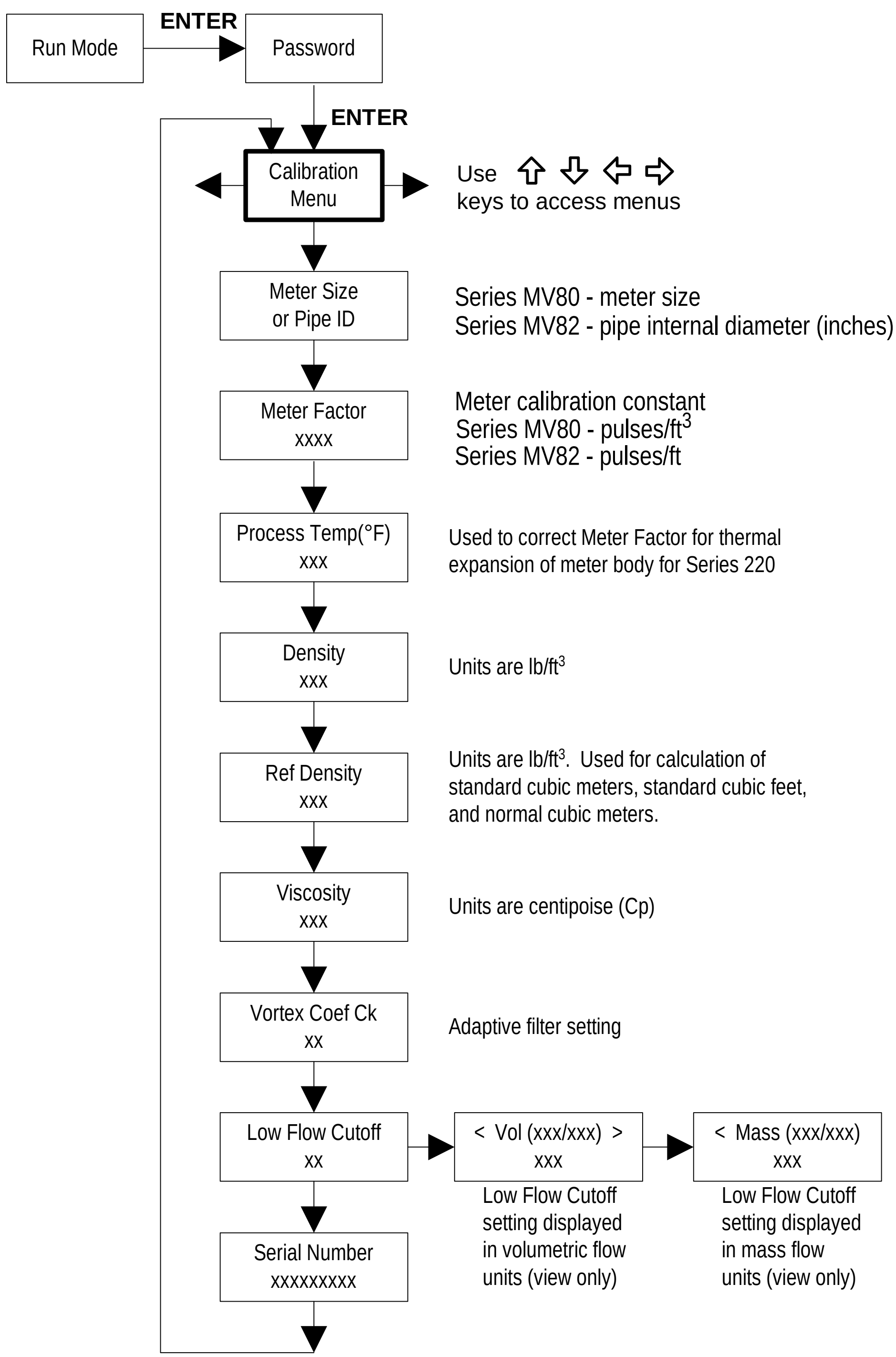
Use the Diagnostics Menu to simulate flow and review the highest recorded velocity in ft/sec.

The simulated vortex frequency is used for testing the meter to verify that the programming is correct. Enter any value for the sensor input in Hz. The meter will calculate a flow rate based on the corresponding value and update the analog output and totalizer pulse output.

Note: *When your diagnostic work is complete, make sure to return the simulated frequency to zero to allow the electronics to use the actual value.*

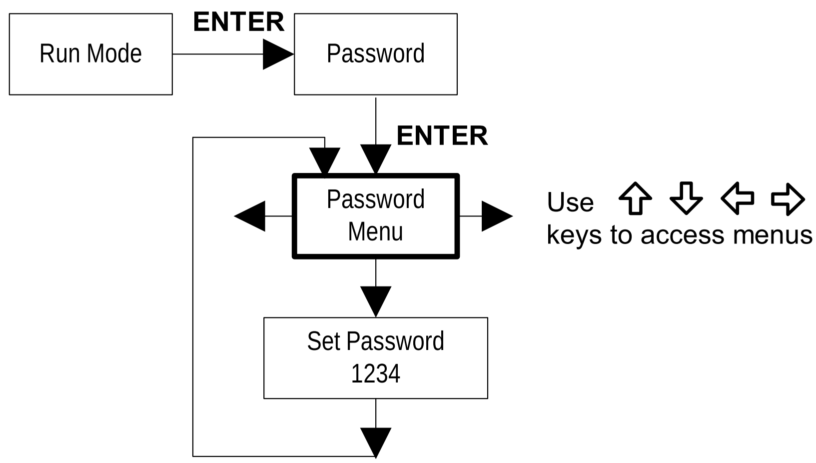
Calibration Menu

The Calibration Menu contains the calibration coefficients for the flowmeter. These values should by changed only by properly trained personnel. The Vortex Coef Ck and Low Flow Cutoff are set at the factory. Consult the factory for help with these settings if the meter is showing erratic flow rate. The units of measurement used in the Calibration Menu are preset and are as follows: Density = lbm/ft^3, Reference Density = lbm/ft^3, Viscosity = centipoise.



Password Menu

Use the Password Menu to set or change the system password. The factory-set password is 1234.



Chapter 4

HART Communications

Wiring

Figure 4-1 below details the proper connections required for HART Communications:

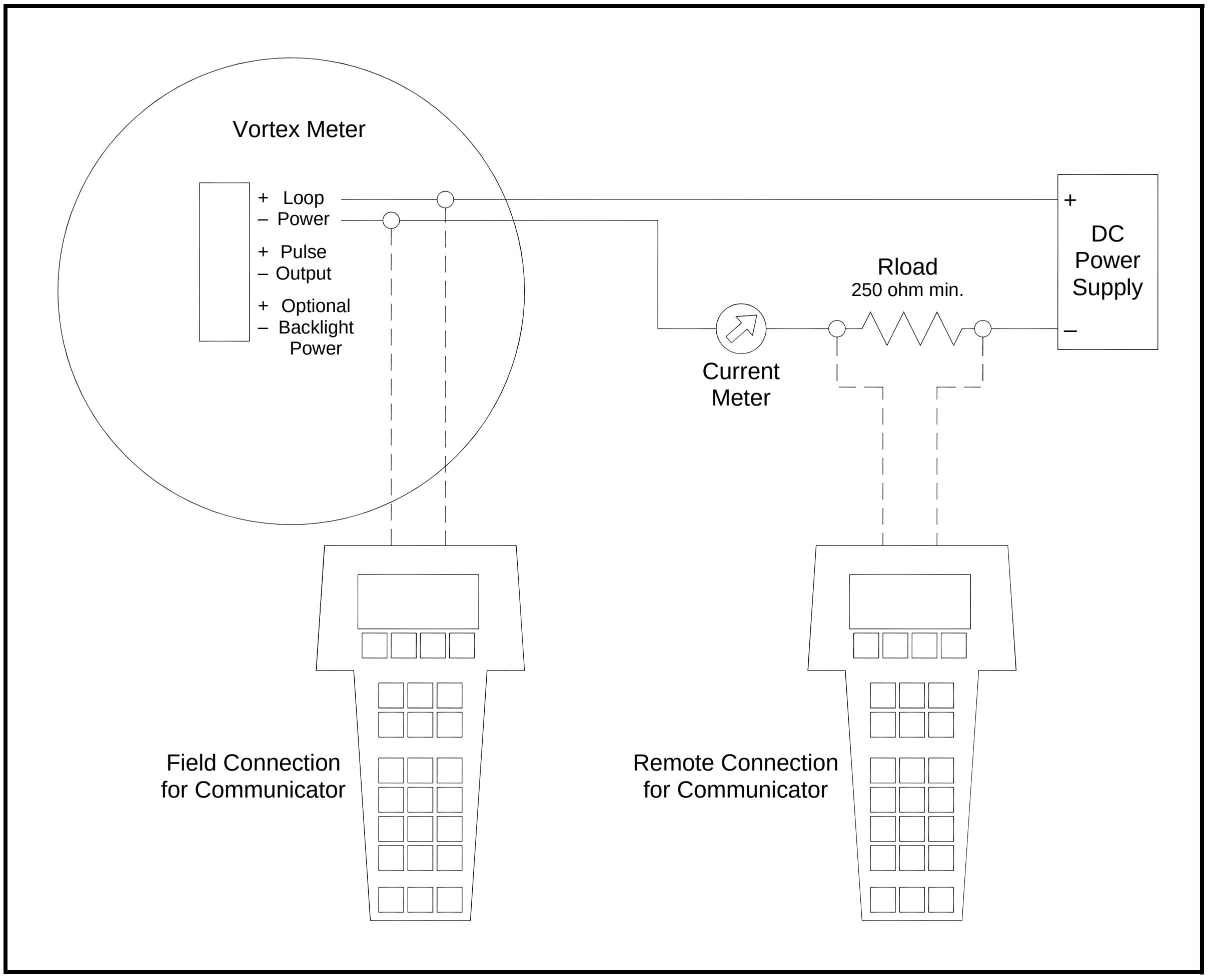
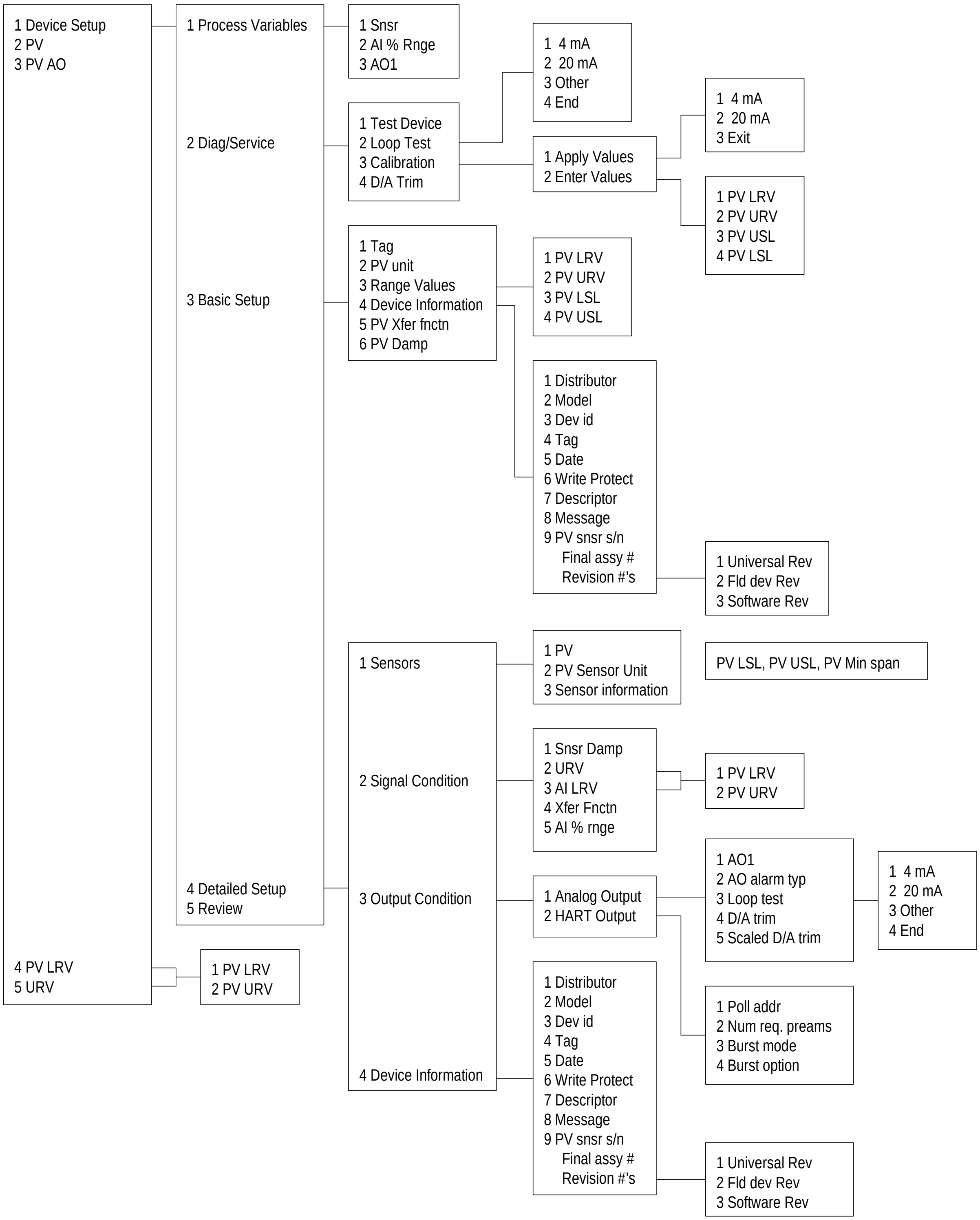


Figure 4-1: HART Communications Wiring Diagram

HART Menus

Online Menu



Fast Key Sequence

Use password 16363.

Sequence	Description	Access	Notes
1,1,1	Snsr	View	Primary variable value
1,1,2	AI % Rnge	View	Analog output % range
1,1,3	AO1	View	Analog output, mA
1,2,1	Test Device	N/A	Not used
1,2,2,1	4 mA	View	Loop test, fix analog output at 4 mA
1,2,2,2	20 mA	View	Loop test, fix analog output at 20 mA
1,2,2,3	Other	Edit	Loop test, fix analog output at mA value entered
1,2,2,4	End		Exit loop test
1,2,3,1,1	4 mA	N/A	Not used, apply values
1,2,3,1,2	20 mA	N/A	Not used, apply values
1,2,3,1,3	Exit		Exit apply values
1,2,3,2,1	PV LRV	Edit	Primary variable lower range value
1,2,3,2,2	PV URV	Edit	Primary variable upper range value
1,2,3,2,3	PV USL	View	Primary variable upper sensor limit
1,2,3,2,4	PV LSL	View	Primary variable lower sensor limit
1,2,4	D/A Trim	Edit	Calibrate electronics 4mA and 20mAvalues
1,3,1	Tag	Edit	Tag
1,3,2	PV unit	Edit	Primary variable units
1,3,3,1	PV LRV	Edit	Primary variable lower range value
1,3,3,2	PV URV	Edit	Primary variable upper range value
1,3,3,3	PV LSL	View	Primary variable upper sensor limit
1,3,3,4	PV USL	View	Primary variable lower sensor limit
1,3,4,1	Distributor	N/A	Not used
1,3,4,2	Model	N/A	Not used
1,3,4,3	Dev id	View	Device identification
1,3,4,4	Tag	Edit	Tag
1,3,4,5	Date	Edit	Date
1,3,4,6	Write Protect	View	Write protect
1,3,4,7	Descriptor	Edit	Vortex flowmeter
1,3,4,8	Message	Edit	32 character alphanumeric message
1,3,4,9	PV snsr s/n	View	Primary variable sensor serial number
1,3,4,menu	Final assy #	Edit	Final assembly number
1,3,4,menu,1	Universal Rev	View	Universal revision
1,3,4,menu,2	Fld dev Rev	View	Field device revision
1,3,4,menu,3	Software Rev	View	Software revision
1,3,5	PV Xfer fnctn	View	Linear
1,3,6	PV Damp	Edit	Primary variable damping (time constant) in seconds
1,4,1,1	PV	View	Primary variable value
1,4,1,2	PV Sensor Unit	Edit	Primary variable units
1,4,1,3	Sensor Information	View	PV LSL, PV USL, PV Min span
1,4,2,1	Snsr Damp	Edit	Primary variable damping (time constant) in seconds
1,4,2,2,1	PV LRV	Edit	Primary variable low range value
1,4,2,2,2	PV URV	Edit	Primary variable upper range value
1,4,2,3,1	PV LRV	Edit	Primary variable low range value
1,4,2,3,2	PV URV	Edit	Primary variable upper range value
1,4,2,4	Xfer Fnctn	View	Linear
1,4,2,5	AI % rnge	View	Analog output % range
1,4,3,1,1	AO1	View	Analog output, mA
1,4,3,1,2	AO alarm typ	N/A	Not used

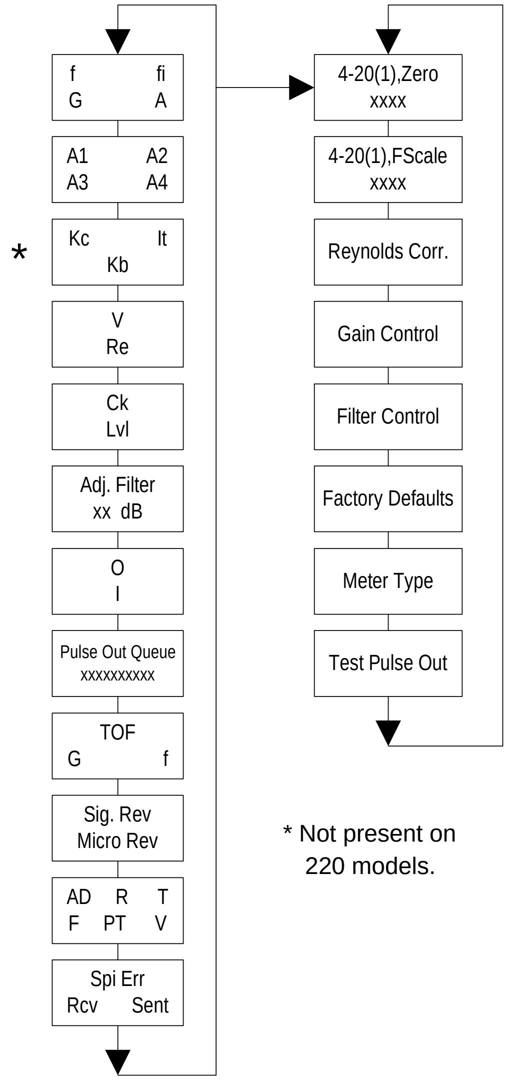
Fast Key Sequence (cont.)

Sequence	Description	Access	Notes
1,4,3,1,3,1	4 mA	View	Loop test, fix analog output at 4 mA
1,4,3,1,3,2	20 mA	View	Loop test, fix analog output at 20 mA
1,4,3,1,3,3	Other	Edit	Loop test, fix analog output at mA value entered
1,4,3,1,3,4	End		Exit loop test
1,4,3,1,4	D/A trim	Edit	Calibrate electronics 4mA and 20mAvalues
1,4,3,1,5	Scaled D/A trim	N/A	Not used
1,4,3,2,1	Poll addr	Edit	Poll address
1,4,3,2,2	Num req. preams	View	Number of required preambles
1,4,3,2,3	Burst mode	N/A	Not used
1,4,3,2,4	Burst option	N/A	Not used
1,4,4,1	Distributor	N/A	Not used
1,4,4,2	Model	N/A	Not used
1,4,4,3	Dev id	View	Device identification
1,4,4,4	Tag	Edit	Tag
1,4,4,5	Date	Edit	Date
1,4,4,6	Write Protect	View	Write protect
1,4,4,7	Descriptor	Edit	Vortex flowmeter
1,4,4,8	Message	Edit	32 character alphanumeric message
1,4,4,9	PV snsr s/n	View	Primary variable sensor serial number
1,4,4,menu	Final assy #	Edit	Final assembly number
1,4,4,menu,1	Universal Rev	View	Universal revision
1,4,4,menu,2	Fld dev Rev	View	Field device revision
1,4,4,menu,3	Software Rev	View	Software revision
1,5	Review	N/A	Not used
2	PV	View	Primary variable value
3	PV AO	View	Analog output, mA
4,1	PV LRV	Edit	Primary variable lower range value
4,2	PV URV	Edit	Primary variable upper range value
5,1	PV LRV	Edit	Primary variable lower range value
5,2	PV URV	Edit	Primary variable upper range value

Chapter 5

Troubleshooting and Repair

Hidden Diagnostics Menus



The menus shown above can be accessed using the password 16363, then moving to the display that reads “Diagnostics Menu” and pressing ENTER (rather than one of the arrow keys).

Caution!
Password 16363 will allow full access to the configuration and should be used carefully to avoid changes that can adversely alter the function of the meter.

Use the right arrow key to move to the second column. Press EXIT to move from the second column back to the first, press EXIT while in the first column to return to the setup menus.

Each of the menus above will first be defined, followed by specific troubleshooting steps.

Column One Hidden Diagnostics Values

Table 5-1: Column One Hidden Diagnostic Values

	Description
f	Vortex shedding frequency (Hz). If an asterisk (*) is displayed after the **f** value, a valid vortex signal is being registered for the flow.
fi	Adaptive filter – Should be approximately 25% higher than the vortex shedding frequency. This is a low-pass filter. **Note:** If the meter is using the Filter Control (see below) in the manual mode, **fi** will be displayed as **fm**.
G	Gain (applied to vortex signal amplitude). Gain defaults to 1.0 and can be changed using the Gain Control (see below).
A	Amplitude of vortex signal in Volts rms.
A1, A2, A3, A4	A/D counts representing the vortex signal amplitude. Each stage (A1-A4) cannot exceed 512. Beginning with stage A1, the A/D counts increase as the flow increases. When stage A1 reaches 512, it will shift to stage A2. This will continue as the flow rate increases until all 4 stages read 512 at high flow rates. Higher flow rates (stronger signal strength) will result in more stages at 512.
Kc, It, Kb	Profile equation (factory use only). Series 221 only.
V	Calculated average pipe velocity (ft/sec).
Re	Calculated Reynolds number.
Ck	Calculated Ck at current operating conditions. Ck is a variable in the equation that relates signal strength, density, and velocity for a given application. It is used for noise rejection purposes. Ck directly controls the **fi** value (see above). If the Ck is set too low (in the calibration menu), then the **fi** value will be too low and the vortex signal will be rejected resulting in zero flow rate being displayed. The calculated Ck value in this menu can be compared to the actual Ck setting in the calibration menu to help determine if the Ck setting is correct.
Lvl	Threshold level. If the Low Flow Cutoff in the calibration menu is set above this value, the meter will read zero flow. The Lvl level can be checked at no flow. At no flow, the Lvl must be below the Low Flow Cutoff setting or the meter will have an output at no flow
Adj. Filter	Adjustable filter. Displays filtering in decibels. Normally reads zero. If value is consistently –5 or –10, for example, the Ck or density setting may be wrong.
O,I	Factory use only.
Pulse Out Queue	Pulse output queue. This value will accumulate if the totalizer is accumulating faster than the pulse output hardware can function. The queue will allow the pulses to "catch up" later if the flow rate decreases. A better practice is to slow down the totalizer pulse by increasing the value in the (unit)/pulse setting in the totalizer menu.
TOF, G, f	Factory use only.
Sig. Rev	Signal board hardware and firmware revision.
Miro Rev	Microprocessor board hardware and firmware revision.
AD, R, T, F, PT, V	Factory use only.
SPR Err, Rcv, Sent	Factory use only.

Column Two Hidden Diagnostic Values

Table 5-2: Column Two Hidden Diagnostic Values

	Description
4-20(1) Zero	Analog counts to calibrate zero on analog output.
4-20(1) FScale	Analog counts to calibrate full scale on analog output.
Vor Freq Direct?	Frequency output setting, used by factory calibration. Set to NO if totalizer is used.
Reynolds Corr.	Reynolds number correction for the flow profile. Set to Enable for Series MV82 insertion and set to Disable for Series MV80 in-line.
Gain Control	Manual gain control (factory use only). Leave set at 1.0.
Filter Control	Manual filter control. This value can be changed to any number to force the **fi** value to a constant. A value of zero activates the automatic filter control which sets **fi** at a level that floats above the **f** value.
Factory Defaults	Reset to factory defaults. If you change this to YES and press ENTER, all factory configuration is lost and you must reconfigure the entire program. Consult the factory before performing this process. It is required only in very rare cases.
Meter Type	Insertion (Model MV82) or In-line (Model MV80) meter.
Test Pulse Out	Force totalizer pulse. Set to YES and press ENTER to send one pulse. Very useful to test totalizer counting equipment.

Analog Output Calibration

To check the 4–20 mA circuit, connect a DVM in series with the output loop. Select zero or full scale (from the second column of the hidden diagnostics) and then actuate the ENTER key twice. This action will cause the meter to output its 4 mA or 20 mA condition. If the DVM indicates a current greater than ± 0.006 mA from 4 or 20, adjust the setting up or down until the output is calibrated.

Note: *These settings are not for adjusting the output zero and span to match a flow range. That function is located in the Output Menu.*

Troubleshooting the Flowmeter

Symptom: Output at no Flow

The low flow cutoff is set too low. At no flow, go to the first column of the hidden diagnostics menu and record the Lvl value. The low flow cutoff must be set above this value.

Example: At no flow, Lvl = 25. Set the low flow cutoff in the Calibration Menu to approximately 28 and the meter will no longer read a flow rate at no flow.

Symptom: Erratic Output

1. The flow rate may be too low, just at the cutoff of the meter range, and the flow cycles above and below the cutoff making an erratic output. The meter range is stamped on the label on the outside of the electronics enclosure cover (based on application conditions when the meter was ordered). Consult the factory if necessary to confirm the meter range based on current operating conditions. It may be possible to lower the low flow cutoff to increase the meter range. See the example above for output at no flow, only this time the low flow cutoff is set too high. You can lower this value to increase the meter range as long as you do not create the output at no flow condition previously described.

2. Mechanical installation may be incorrect. Verify the straight run is adequate as described in Chapter 2. For in-line meters, make sure the meter is not installed backwards and there are no gaskets protruding into the flow stream. For insertion meters, verify the insertion depth and flow direction.

3. The meter may be reacting to actual changes in the flow stream. The output can be smoothed using a time constant. The displayed values can be smoothed using the time constant in the Display Menu. The analog outputs can be smoothed using the time constant in the Output Menu. A time constant of 1 will result in the change in value reaching 63% of its final value in one second. A time constant of 4 is 22%, 10 is 9.5% and 50 is 1.9% of the final value in one second. The time constant equation is shown below (TC = Time Constant).

$$\%\ \text{change to final value in one second} = 100\,(1 - e^{(-1/TC)})$$

4. The vortex coefficient Ck may be incorrectly set. The Ck is a value in the equation used to determine if a frequency represents a valid vortex signal given the fluid density and signal amplitude. In practice, the Ck value controls the adaptive filter, **fi**, setting. During flow, view the **f** and **fi** values in the first column of the hidden diagnostics. The **fi** value should be approximately 10-20% higher than the **f** value. If you raise the Ck setting in the Calibration Menu, then the **fi** value will increase. The **fi** is a low pass filter, so by increasing it or lowering it, you can alter the range of frequencies that the meter will accept. If the vortex signal is strong, the **fi** value will increase to a large number – this is correct.

Symptom: No Output

1. For remote mounted electronics, carefully check all the wiring connections in the remote mount junction box. There are six connections that must be correct. Verify each color (black and red), shield, and wire number.
2. Check the density value in the Calibration Menu to see if it is correct for the current operating conditions.
3. Using ESD precautions and hazardous area precautions, remove the electronics enclosure window cover. Disconnect the vortex sensor from the Signal board. Measure the resistance from each Sensor pin to the meter ground - each should be open (see Figure 5-2 below). Measure the resistance from the Ground pin to the meter ground – this should be grounded to the meter. With the sensor still disconnected, go to the first column of the hidden diagnostics and display the vortex shedding frequency, **f**. Hold a finger on the four exposed pins on the Signal board. The meter should read electrical noise, 60 Hz for example. If all readings are correct, re-install the vortex sensor wires.
4. Verify all meter configuration and troubleshooting steps previously described. There are many possible causes of this problem, consult factory if necessary.

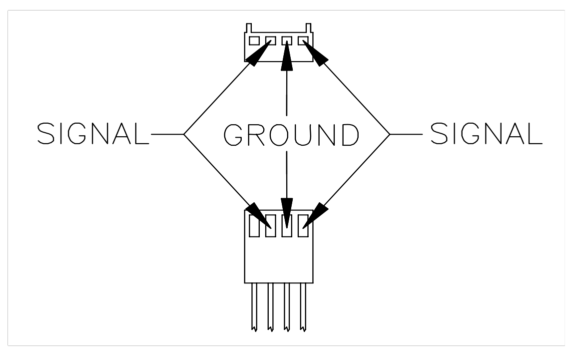


Figure 5-2: Measuring Resistance - Sensor Pin to Meter Ground

Electronics Assembly Replacement (All Meters)

!WARNING!
Before attempting any flowmeter repair, verify that the line is not pressurized. Always remove main power before disassembling any part of the flowmeter.

Caution!
Electronics boards are electrostatically sensitive. Wear a grounding wrist strap and be sure to observe proper handling precautions for static-sensitive components.

1. Turn off power to the unit.
2. Locate and loosen the small set screw which locks the larger enclosure cover in place. Unscrew the cover to expose the electronics stack.
3. Locate the sensor harnesses which come up from the neck of the flowmeter and attaches to the circuit board. Use small pliers to pull the connector off the circuit board.
4. Locate and loosen the small set screw which locks the smaller enclosure cover in place. Unscrew the cover to expose the field wiring strip. Tag and remove the field wires.
5. Remove the screws that hold the black wiring label in place. Remove the label.
6. Locate the four Phillips head screws which are spaced at 90° around the terminal board. These screws hold the electronics stack in the enclosure. Loosen these screws.

Note: *These are captive screws. They will stay inside the enclosure.*

7. Carefully remove the electronics stack from the opposite side of the enclosure. If the electronics stack will not come out, gently tap the terminal strip with a screwdriver handle. This will loosen the rubber sealing gasket on the other side of the enclosure wall. Be careful that the stack does not hang up on loose sensor harnesses.
8. Repeat steps 1 through 6 in reverse order to install the new electronics stack.

Returning Equipment to the Factory

Before returning any PanaFlow MV flowmeter to the factory, contact Customer Service. When contacting Customer Service, be sure to have the meter serial number and model code.

When requesting further troubleshooting guidance, record the following values first:

f, **fi**, **G**, and **A** at no flow and during flow if possible.
Pressure, temperature, and flow rate

Appendix A

Specifications

Performance

Accuracy:

Table A-1: Accuracy Specifications

Process Variables	MV80 Series In-Line Meters		MV82 Series Insertion Meters[1]	
	Liquids	Gas & Steam	Liquids	Gas & Steam
Volumetric Flow Rate	±0.7% of rate over a 30:1 range[2]	±1% of rate over a 30:1 range[2]	±1.2% of rate over a 30:1 range[2]	±1.5% of rate over a 30:1 range[2]

Notes: 1. Accuracies stated are for the total volumetric flow through the pipe.
2. Nominal rangeability is stated. Precise rangeability depends on fluid and pipe size

Repeatability: 0.1% of rate.

Response Time: Adjustable from 1 to 100 seconds.

Material Capability: Series MV80 In-Line Flowmeter:
Any gas, liquid or steam compatible with 316L stainless steel, C276 hastelloy or A105 carbon steel.
Not recommended for multi-phase fluids.

Series MV82 Insertion Flowmeter:
Any gas, liquid or steam compatible with 316L stainless steel.
Not recommended for multi-phase fluids.

Flow Rates: Typical volumetric flow ranges are given in the following tables. Precise flow range depends on the fluid and pipe size. MV82 insertion meters are applicable to pipe sizes from 2 inch and above. Consult factory for sizing program.

Table A-2: Air Minimum and Maximum Flow Rates (scfm)[1]

Pressure	Nominal Pipe Size (inches)								
	0.5	0.75	1	1.5	2	3	4	6	8
0 psig	1.8 17.5	3.3 41.4	5 90	13 221	22 369	50 826	88 1438	198 3258	347 5708
100 psig	5 137	9.2 324	15 701	37 1728	62 2879	138 6447	240 11222	543 25421	952 44536
200 psig	6.8 257	12.6 608	20 1313	50 3234	83 5389	185 12067	322 21006	730 47585	1279 67122
300 psig	8.3 378	15.3 893	24 1924	59 4740	98 7900	219 17687	382 30789	866 48821	1518 64552
400 psig	9.5 500	17.5 1178	27 2535	66 6246	110 10410	247 23308	430 31141	975 46884	1708 61990
500 psig	10.6 620	19.5 1464	29 3147	72 7752	120 12920	270 22592	469 29834	1063 44915	1862 59387

[1]Standard conditions are 70° F and 1 atmosphere

Flow Rates (cont.):

Table A-3: Steam Minimum and Maximum Flow Rates (lb/hr)

	Nominal Pipe Size (in)								
Pressure	**0.5**	**0.75**	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**
5 psig	6.5 51.7	12 122	20 265	49 652	82 1087	183 2434	319 4237	722 9598	1265 16815
100 psig	14.8 270	27.4 639	46 1385	112 3413	187 5688	419 12735	729 22157	1651 50219	2893 87980
200 psig	20 493	37 1164	61 2524	151 6217	252 10362	565 23200	984 40385	2229 91485	3905 160275
300 psig	24 716	44.5 1689	74 3662	182 9021	304 15035	681 33664	1185 58601	2685 132750	4707 232570
400 psig	27.7 940	51 1731	85 4814	209 11859	349 19764	781 44253	1359 77033	3078 174505	5393 305721
500 psig	30.8 1170	57 2761	95 5986	233 14745	389 24575	870 55025	1515 95784	3433 216983	6014 331080

Table A-4: Water Minimum and Maximum Flow Rates

Units	Nominal Pipe Size (inches)								
	0.5	**0.75**	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**
gpm	1 22	1.3 40	2.2 67	5.5 166	9.2 276	21 618	36 1076	81 2437	142 4270
m^3/hr	0.23 5	0.3 9.1	0.5 15	1.3 38	2.1 63	4.7 140	8.1 244	18 554	32 970

Linear Range: Smart electronics corrects for lower flow down to a Reynolds number of 5,000. The Reynolds number is calculated using the fluid density and viscosity entered into the memory. Rangeability depends on the fluid, process connections and pipe size. Consult the factory for your application. Velocity rangeability under ideal conditions is as follows:

Liquids 30:1 - 1 foot per second velocity minimum
30 feet per second velocity maximum

Gases 30:1 - 10 feet per second velocity minimum
300 feet per second velocity maximum

Process Fluid Pressure:

Table A-5: MV80 Pressure Ratings

Process Connection	Material	Rating
Flanged	316L SS, A105 Carbon Steel, C276 Hastelloy	150, 300, 600 lb
Wafer	316L SS, A105 Carbon Steel, C276 Hastelloy	600 lb

Process Fluid Pressure:

Table A-6: MV82 Pressure Ratings

Probe Seal	Process Connection	Material	Rating	Ordering Code
Compression Fitting	2-inch MNPT	316L SS	ANSI 600 lb	CM
	2-inch 150 lb flange	316L SS	ANSI 150 lb	CF
	2-inch 300 lb flange	316L SS	ANSI 300 lb	CG
	2-inch 600 lb flange	316L SS	ANSI 600 lb	CH
Packing Gland	2-inch MNPT	316L SS	50 psig	PM
	2-inch 150 lb flange	316L SS	50 psig	PF
	2-inch 300 lb flange	316L SS	50 psig	PG
Packing Gland with Removable Retractor	2-inch MNPT	316L SS	ANSI 300 lb	PM, RR
	2-inch 150 lb flange	316L SS	ANSI 150 lb	PF, RR
	2-inch 300 lb flange	316L SS	ANSI 300 lb	PG, RR
Packing Gland with Permanent Retractor	2-inch MNPT	316L SS	ANSI 600 lb	PMR
	2-inch 150 lb flange	316L SS	ANSI 150 lb	PFR
	2-inch 300 lb flange	316L SS	ANSI 300 lb	PGR
	2-inch 600 lb flange	316L SS	ANSI 600 lb	PHR

Operation

Process Fluid Temperature: Standard temperature sensor: –40° to 500°F (–40° to 260°C).
Medium temperature sensor: 250° to 500°F (120° to 260°C)
High temperature sensor: Up to 750°F (400°C).

Ambient Temperature: Operating: –40° to 185°F (–40° to 85°C).
Storage: –40° to 185°F (–40° to 85°C).
0-98% relative humidity, non-condensing conditions.

Power Requirements: Loop powered, 12 to 36 VDC

Output Signals Analog: field rangeable linear, 4-20mA output signal, 1000 ohms maximum loop resistance, selected by user for volumetric flow rate or mass flow rate.

Pulse: field rangeable volume/pulse output for totalization is a 50-millisecond duration pulse operating a solid-state relay capable of switching 40 VDC, 40mA maximum.

Display: Alphanumeric 2 x 16 LCD digital display.
Six push-button switches (up, down, right, left, ENTER, EXIT) operable either directly on the display panel or with a hand-held magnet through the display glass of the explosion-proof enclosure.
Viewing at 90° mounting intervals.

Totalizer: Based on user-determined flow units, six significant figures in scientific notation. Total stored in non-volatile memory.

Physical

Wetted Materials: Series MV80 In-Line Flowmeter:
316L stainless steel standard.
C276 hastelloy or A105 carbon steel optional.

Series MV82 Insertion Flowmeter:
316L stainless steel standard.
PTFE packing gland below 500°F (260°C).
Graphite packing gland above 500°F (260°C).

Enclosure: Type 4X cast enclosure.

Electrical Ports: Two 3/4-inch female NPT ports.

Mounting Connections: Series MV80:
Wafer or 150, 300, 600 lb ANSI flange, PN16, PN40, PN64 flange.

Series MV82 Permanent installation:
2-inch MNPT; 150, 300, 600 lb ANSI flange with compression fitting probe seal.

Series MV82 Hot Tap[1] installation:
2-inch MNPT; 150, 300, 600 lb ANSI flange and optional retractor with packing gland probe seal.

[1]Removable under line pressure.

Mounting Position[2] Series MV80 In-Line Flowmeter: No effect.
Series MV82 Insertion Flowmeter: Meter must be perpendicular within ±5° of the pipe centerline.

[2]For liquid applications, the pipeline must remain full at all times.

Certifications

FM approved USA/CAN.
CE and ATEX approval pending.

FM approvals: Class I, Division 1, Groups B, C, & D, T6 at Tamb = 60°C
Class II/III, Division 1, Groups E, F, & G
IP66, Type 4X

Appendix B

Glossary

A Cross sectional area.

acfm Actual Cubic Feet Per Minute (volumetric flow rate).

ASME American Society of Mechanical Engineers.

Bluff Body A non-streamlined body placed into a flow stream to create vortices. Also called a Shedder Bar.

BTU British Thermal Unit, an energy measurement.

Cenelec European Electrical Code.

Compressibility Factor A factor used to correct for the non-ideal changes in a fluid's density due to changes in temperature and/or pressure.

CSA Canadian Standards Association.

d Width of a bluff body or shedder bar.

D Diameter of a flow channel.

f Frequency of vortices generated in a vortex flowmeter, usually in Hz.

Flow Channel A pipe, duct, stack, or channel containing flowing fluid.

Flow Profile A map of the fluid velocity vector (usually nonuniform) in a cross-sectional plane of a flow channel (usually along a diameter).

FM Factory Mutual.

Ft Foot, 12 inches, a measure of length.

Ft^2 Square feet, measure of area.

Ft^3 Cubic feet, measure of volume.

gpm Gallons Per Minute.

Hz Hertz, cycles per second.

In-Line Flowmeter A flowmeter which includes a short section of piping which is put in-line with the user's piping.

Insertion Flowmeter A flowmeter which is inserted into a hole in the user's pipeline.

Joule A unit of energy equal to one watt for one second. Also equal to a Newton-meter.

LCD Liquid crystal display.

$\dot{m}$ Mass flow rate.

mA Milliamp, one thousandth of an ampere of current.

μ Viscosity, a measure of a fluid's resistance to shear stress. Honey has high viscosity, alcohol has low viscosity.

ΔP Permanent pressure loss.

P Line pressure (psia or bar absolute).

ρ act The density of a fluid at the actual temperature and pressure operating conditions.

ρ std The density of a fluid at standard conditions (usually 14.7 psia and 20° C).

Permanent Pressure Loss Unrecoverable drop in pressure.

Piezoelectric Crystal A material which generates an electrical charge when the material is put under stress.

PRTD An resistance temperature detector (RTD) with platinum as its element. Used because of high stability.

psia Pounds per square inch absolute (equals psig + atmospheric pressure). Atmospheric pressure is typically 14.696 psi at sea level.

psig Pounds per square inch gauge.

P_V Liquid vapor pressure at flowing conditions (psia or bar absolute).

Q Flow rate, usually volumetric.

Rangeability Highest measurable flow rate divided by lowest measurable flow rate.

Reynolds Number or Re A dimensionless number equal to the density of a fluid, times the velocity of the fluid, times the diameter of the fluid channel, divided by the fluid viscosity (i.e., $Re = \rho VD/\mu$). The Reynolds number is an important number for vortex flowmeters because it is used to determine the minimum measurable flow rate. It is the ratio of the inertial forces to the viscous forces in a flowing fluid.

RTD Resistance temperature detector, a sensor whose resistance increases as the temperature rises.

scfm Standard cubic feet per minute (flow rate converted to standard conditions, usually 14.7 psia and 20° C).

Shedder Bar A non-streamlined body placed into a flow stream to create vortices. Also called a Bluff Body.

Strouhal Number or St A dimensionless number equal to the frequency of vortices created by a bluff body, times the width of the bluff body, divided by the velocity of the flowing fluid (i.e., $St = fd/V$). This is an important number for vortex flowmeters because it relates the vortex frequency to the fluid velocity.

Totalizer An electronic counter which records the total accumulated flow over a certain range of time.

Traverse The act of moving a measuring point across the width of a flow channel.

Uncertainty The closeness of agreement between the result of a measurement and the true value of the measurement.

V Velocity or voltage.

VAC Volts, alternating current.

VDC Volts, direct current.

VORTEX An eddy of fluid.

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USA

1100 Technology Park Drive
Billerica, MA 01821-4111
Web: www.gesensing.com

Ireland

Sensing House
Shannon Free Zone East,
Shannon, Co. Clare,
Ireland