Reference Manual
00809-0100-4809, Rev DB
December 2024

Rosemount™ Annubar® Flow Meter Series

Rosemount 3051SFA Annubar Flowmeter

Rosemount 3051CFA Annubar Flowmeter

Rosemount 2051CFA Annubar Flowmeter

Rosemount 485 Annubar Primary Element

Rosemount 585 Severe Service Annubar Primary Element

ROSEMOUNT™

EMERSON™

Safety messages

Read this manual before working with the product. For personal and system safety and for optimum product performance, ensure that you thoroughly understand the contents before installing, using, or maintaining this product.

The United States has two toll-free assistance numbers and one International number.

Customer Central	1-800-999-9307 (7:00 A.M. to 7:00 P.M. CST)
International	1-(952) 906-8888
National Response Center	1-800-654-7768 (24 hours a day) Equipment service needs

⚠ WARNING

Failure to follow these installation guidelines could result in death or serious injury.

Ensure only qualified personnel perform the installation.

If the line is pressurized, serious injury or death could occur by opening valves.

⚠ WARNING

Explosions could result in death or serious injury.

Do not remove the transmitter cover in explosive atmospheres when the circuit is live.

Before connecting a Field Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.

Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠ WARNING

Electrical shock could cause death or serious injury.

Avoid contact with the leads and terminals.

⚠ CAUTION

The products described in this document are NOT designed for nuclear-qualified applications. Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Emerson nuclear-qualified products, contact your local Emerson Sales Representative.

This device is intended for use in temperature monitoring applications and should not be used in control and safety applications.

If pipe/duct wall is less than 0.125 in. (3.2 mm) use extreme caution when installing sensor. Thin walls can deform during welding, installation, or from the weight of a cantilevered flow meter. These installations may require a fabricated outlet, saddle, or external flow meter support. Consult factory for assistance.

Contents

1 Introduction

1.1 Using this manual

This product manual provides installation, configuration, calibration, troubleshooting, and maintenance instructions for the Rosemount™ Annubar® Flow Meter Series.

Installation

- Installation flowchart and checklist
- Orienting, mounting, and installing the flow meter
- Connecting the Wiring

Commissioning

- Calibrating the flow meter

Operation and Maintenance

- Troubleshooting information
- Disassembly
- RTD maintenance

Specifications and Reference Data

- Specifications
- Dimensional drawings

Product Certifications

- Approvals certifications
- Installation drawings

Information in this manual applies to circular pipes only. Consult Rosemount Customer Central for instructions regarding use in square or rectangular ducts.

1.2 Product recycling/disposal

When possible, recycle equipment or packaging when finished. Dispose of equipment and packaging in accordance with local and national legislation/regulations.

2 Installation

2.1 Safety messages

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Refer to the following safety messages before performing any operation in this section.

⚠ WARNING

Explosions could result in death or serious injury.

Do not remove the transmitter cover in explosive atmospheres when the circuit is live.

Before connecting a Field Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.

Both transmitter covers must be fully engaged to meet explosion-proof requirements.

Failure to follow these installation guidelines could result in death or serious injury.

Ensure only qualified personnel perform the installation.

⚠ CAUTION

If pipe/duct wall is less than 0.125 in. (3.2 mm), use extreme caution when installing sensor. Thin walls can deform during welding, installation, or from the weight of a cantilevered flow meter. These installations may require a fabricated outlet, saddle, or external flow meter support. Consult factory for assistance.

2.2 Receiving and inspection

Note
Flow meters are available in different models with different options. Before flow meter installation, inspect and verify the appropriate model was delivered.

When shipment is received, verify the packing list against both the material received and the purchase order. All items are tagged with a:

- sales order number
- serial number
- customer tag number

Report any damage to the carrier.

2.3 Considerations

2.3.1 Limitations

Structural

NOTICE

Potential sensor failure

Exceeding structural limitations may cause sensor failure.

Structural limitations are printed on the sensor tag.

Functional

The most accurate and repeatable flow measurement occurs in the following conditions:

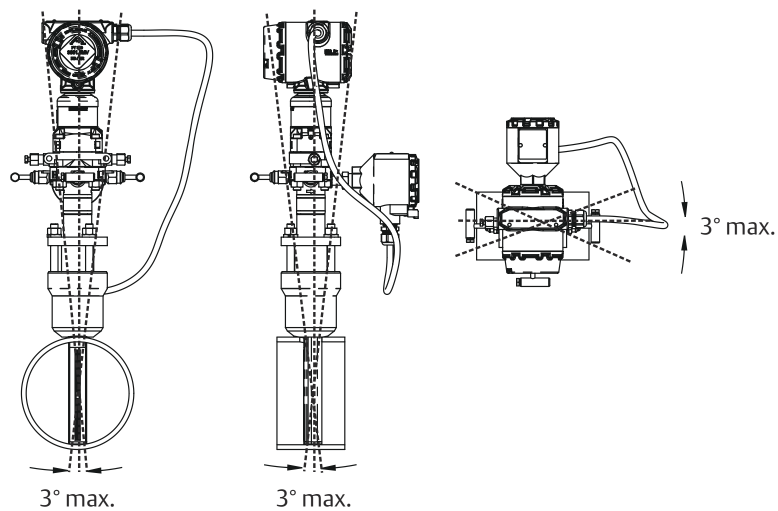
- The structural limit differential pressure, as printed on the sensor tag, is not exceeded.
- The instrument is not used for two-phase flow or for steam service below saturation temperature.
- The flow meter is installed:
  - — in the correct location within the piping branch to prevent measurement inaccuracies caused by flow disturbances
  - — with a maximum misalignment of 3 degrees (see Figure 2-1).

NOTICE

Potential measurement errors

Misalignment exceeding 3 degrees causes flow measurement errors.

Figure 2-1: Permissible Misalignment



2.3.2 Environmental

Mount the flow meter in a location with minimal ambient temperature changes. Specifications and Reference Data lists the temperature operating limits. Mount to avoid vibration, mechanical shock, and external contact with corrosive materials.

Access requirements

Consider the need to access the flow meter when choosing an installation location and orientation.

Process flange orientation

Orient the process flanges on a remote mounted flow meter so that process connections can be made. For safety reasons, orient the drain/vent valves so that process fluid is directed away from technicians when the valves are used. In addition, consider the possible need for a testing or calibration input.

Housing rotation

The electronics housing may be rotated up to 180 degrees (left or right) to improve field access to the two compartments or to better view the optional LCD meter. To rotate the housing, release the housing rotation set screw and turn the housing up to 180 degrees.

Electronics housing

Terminal side

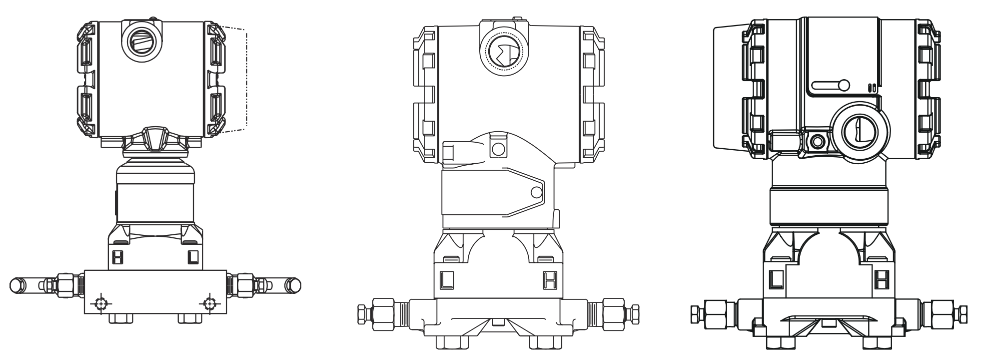
The circuit compartment should not routinely need to be opened when the unit is in service. Wiring connections are made through the conduit openings on the top or side of the housing. The field terminal side is marked on the electronics housing. Mount the flow meter so that the terminal side is accessible. A 0.75 in. (19 mm) clearance is required for cover removal. Use a conduit plug on the unused side of the conduit opening. If a meter is installed, a 3 in. (76 mm) clearance is required for cover removal.

Cover installations

To ensure a proper seal, always install the electronics housing covers metal-to-metal.

Figure 2-2: Transmitter Housing

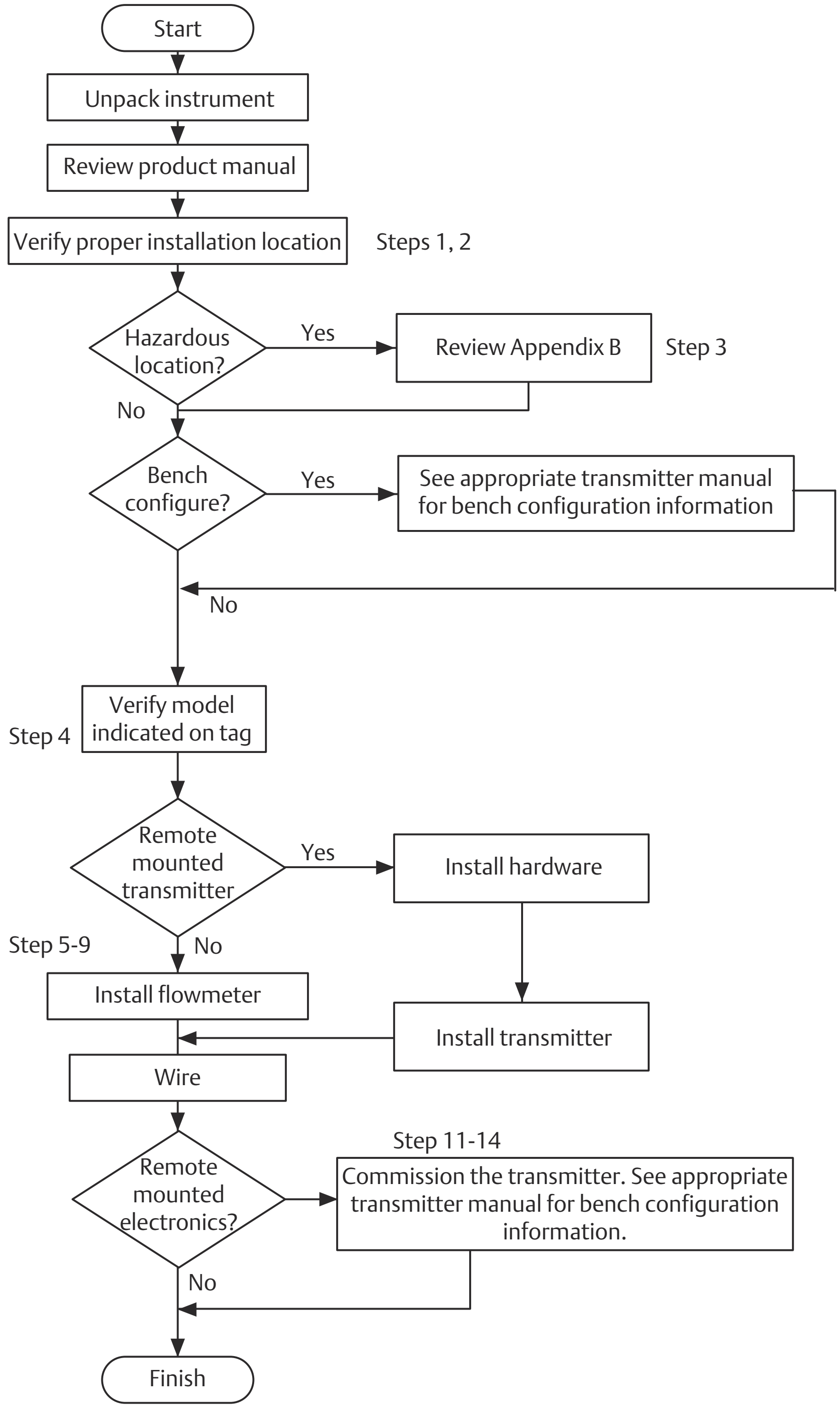
Rosemount™ 3051S MultiVariable™ Transmitter | **Rosemount 3051C Transmitter** | **Rosemount 2051C Transmitter**



2.4 Installation flowchart and checklist

Figure 2-3 is an installation flowchart that provides guidance through the installation process. An installation checklist is provided after Figure 2-3 to verify that all critical steps have been taken in the installation process. The checklist numbers are indicated in the flowchart.

Figure 2-3: Installation Chart



The following is a summary of the steps required to complete a flow meter installation. If:

- this is a new installation, begin with Step 1
- the mounting is already in place, then:

1. Verify the hole size and fittings match the recommended specifications (see Table 2-4).
2. Begin with Step 5.

Procedure

1. Determine where to place the flow meter within the piping system.
2. Establish the proper orientation as determined by the intended application.
3. Review Product Certifications and determine if the flow meter is located in a hazardous location.
4. Confirm the configuration.
5. Drill the correct sized hole into the pipe and deburr. If installing a wafer-style Annubar flow meter, then place the flow meter between raised-face flanges, utilizing the centering ring to install the flow meter, and skip to Step 11.

   NOTICE

   Do not torch cut the hole.

6. For instruments equipped with opposite-side support, drill a second hole 180° from the first hole.
7. Weld the mounting per plant welding procedures.
8. Measure the pipe's internal diameter (ID), preferably at 1 × ID from the hole (upstream or downstream).

   Note
   To maintain published flow meter accuracy, provide the pipe ID when purchasing the flow meter.

9. Check the setup of the instrument assembly to the pipe.
10. Install the flow meter.
11. Wire the instrument.
12. Supply power to the flow meter.
13. Perform a trim for mounting effects.
14. Check for leaks.
15. Commission the instrument.

2.5 Mounting

2.5.1 Tools and supplies

Tools required include the following:

- Open end or combination wrenches (spanners) to fit the pipe fittings and bolts: 9/16 in., ⅝ in., and ⅞ in.
- Adjustable wrench: 15 in. (1½ in. jaw)
- Nut driver: ⅜ in. for vent/drain valves (or ⅜ in. wrench)
- #1 Phillip's screwdriver
- Standard screwdrivers: ¼ in. and ⅛ in. wide
- 14 in. Pipe wrench
- Wire cutters/strippers
- 7/16 in. box wrench (required for the ferry head bolt design)

Supplies required include the following:

- ½ in. tubing or ½ in. pipe (recommended) to hook up the electronics to the sensor probe. The length required depends upon the distance between the electronics and the sensor
- Fittings including (but not limited to)
  - — Two tube or pipe tees (for steam or high temperature liquid)
  - — Six tube/pipe fittings (for tube)
- Pipe compound or PTFE tape (where local piping codes allow)

2.5.2 Mounting brackets

Mounting brackets are provided with any flow meter order with a remote mounted transmitter to facilitate mounting to a panel, wall, or 2 in. (50.8 mm) pipe. The bracket option for use with the Coplanar flange is 316 SST with 316 SST bolts.

When installing the transmitter to one of the mounting brackets, torque the bolts to 125 in-lb. (169 N-m).

2.5.3 Bolt installation guidelines

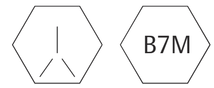
The following guidelines have been established to ensure a tight flange, adapter, or manifold seal. Only use bolts supplied with the instrument or sold by the factory.

The instrument is shipped with the coplanar flange installed with four 1.75 in. (44.5 mm) flange bolts. The following bolts also are supplied to facilitate other mounting configurations:

- Four 2.25 in. (57.2 mm) manifold/flange bolts for mounting the coplanar flange on a three-valve manifold. In this configuration, the 1.75 in. (44.5 mm) bolts may be used to mount the flange adapters to the process connection side of the manifold.
- (Optional) If flange adapters are ordered, four 2.88 in. (73.2 mm) flange/adapter bolts for mounting the flange adapters to the coplanar flange.

Stainless steel bolts supplied by Rosemount Inc. are coated with a lubricant to ease installation. Carbon steel bolts do not require lubrication. Do not apply additional lubricant when installing either type of bolt. Bolts supplied by Rosemount Inc. are identified by the following head markings:

Carbon Steel Head Markings (CS)



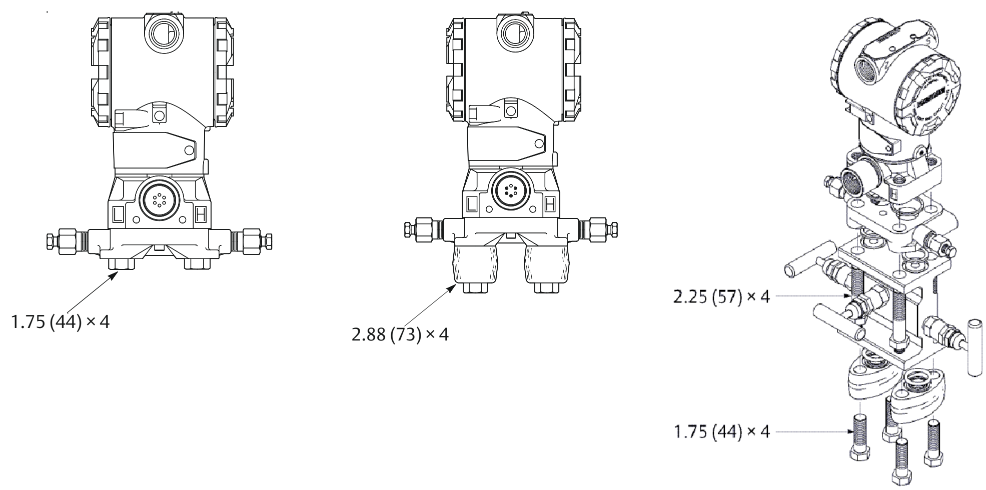
Stainless Steel Head Markings (SST)

Figure 2-4: Coplanar Mounting Bolts and Bolting Configurations for Coplanar Flange

Transmitter with flange bolts

Transmitter with optional flange adapters and flange/adapter bolts

Transmitter with 3-valve manifold, manifold/flange bolts, flange adapters, and flange/adapter bolts



Description	Size in. (mm)
Flange bolts (4)	1.75 in. (44 mm)
Flange/adapter bolts (4)	2.88 in. (73 mm)
Manifold/flange bolts (4)	2.25 in. (57 mm)

2.5.4 Instrument manifolds

Figure 2-5 identifies the valves on a 5-valve and a 3-valve manifold. Table 2-1 and Table 2-2 explain the purpose of these valves.

An instrument manifold is recommended for all installations. A manifold allows an operator to equalize the pressures prior to the zero calibration of the transmitter as well as to isolate the electronics from the rest of the system without disconnecting the impulse piping. Although a 3-valve manifold can be used, a 5-valve manifold is recommended.

5-valve manifolds provide a positive method of indicating a partially closed or faulty equalizer valve. A closed faulty equalizer valve will block the DP signal and create errors that may not be detectable otherwise. The labels for each valve will be used to identify the proper valve in the procedures to follow.

Note

Some recently-designed instrument manifolds have a single valve actuator, but cannot perform all of the functions available on standard 5-valve units. Check with the manufacturer to verify the functions that a particular manifold can perform. In place of a manifold, individual valves may be arranged to provide the necessary isolation and equalization functions.

Figure 2-5: Valve Identification for 5-Valve and 3-Valve Manifolds

5-valve manifold **3-valve manifold**

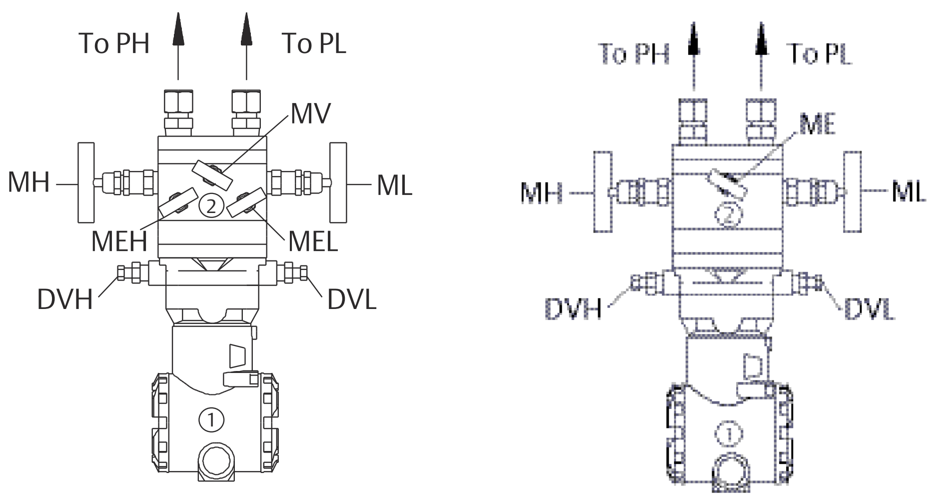


Table 2-1: Manifold and Impulse Valves Descriptions

Name	Description	Purpose
PH	Primary Sensor – High Pressure	Isolates the flow meter sensor from the impulse piping system
PL	Primary Sensor – Low Pressure	
DVH	Drain/Vent Valve – High Pressure	Drains (for gas service) or vents (for liquid or steam service) the DP electronics chambers
DVL	Drain/Vent Valve – Low Pressure	
MH	Manifold – High Pressure	Isolates high side or low side pressure from the process.
ML	Manifold – Low Pressure	
MEH	Manifold Equalizer – High Pressure	Allows high and low pressure side access to the vent valve, or for isolating the process fluid
MEL	Manifold Equalizer – Low Pressure	
ME	Manifold Equalizer	Allows high and low side pressure to equalize
MV	Manifold Vent Valve	Vents process fluid

Table 2-2: Component Descriptions

Name	Description	Purpose
1	Transmitter	Reads Differential Pressure
2	Manifold	Isolates and equalizes transmitter
3	Vent Chambers	Collects gases in liquid applications.
4	Condensate Chamber	Collects condensate in gas applications.

2.5.5 Straight run requirements

Use the following to aid in determining the straight run requirements.

Table 2-3: Straight Run Requirements

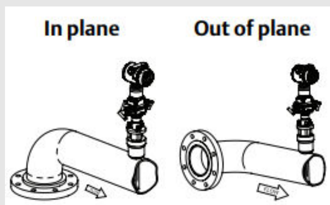
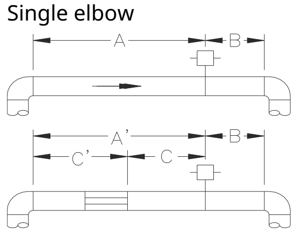
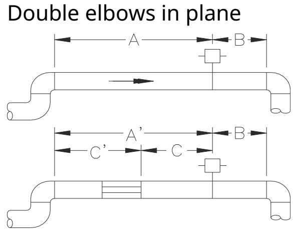
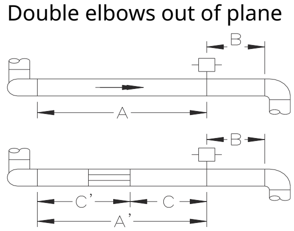
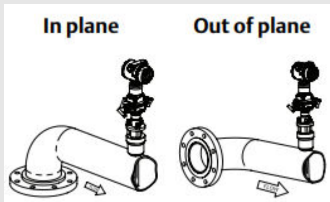
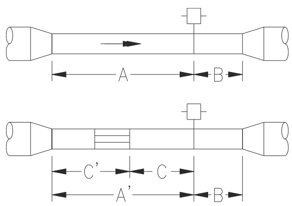
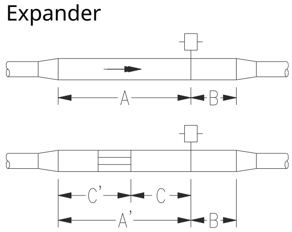
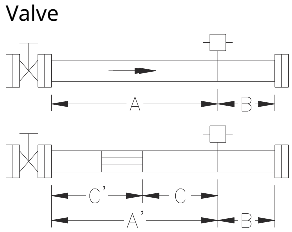
		Upstream dimensions					Downstream dimensions
		Without straightening vanes		With straightening vanes			
		In plane A	Out of plane A	A'	C	C'	B
1	Single elbow  Single elbow with straightening vanes	8 N/A	10 N/A	N/A 8	N/A 4	N/A 4	4 4
2	Double elbows in plane  Double elbow in plane with straightening vanes	11 N/A	16 N/A	N/A 8	N/A 4	N/A 4	4 4
3	Double elbows out of plane  Double elbows out of plane with straightening vanes	23 N/A	28 N/A	N/A 8	N/A 4	N/A 4	4 4

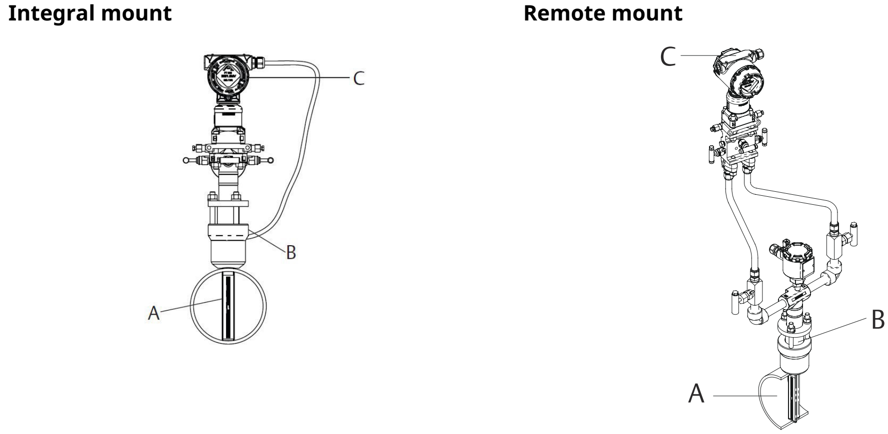
Table 2-3: Straight Run Requirements *(continued)*

		Upstream dimensions					Downstream dimensions
		Without straightening vanes		With straightening vanes			
		In plane A	Out of plane A	A’	C	C’	B
4	Reducer  Reducer with straightening vanes	12 N/A	12 N/A	N/A 8	N/A 4	N/A 4	4 4
5	Expander  Expander with straightening Vanes	18 N/A	18 N/A	N/A 8	N/A 4	N/A 4	4 4
6	Valve  Valve with straightening Vanes	30 N/A	30 N/A	N/A 8	N/A 4	N/A 4	4 4

Note

- If proper lengths of straight run are not available, then position the mounting such that 80% of the run is upstream and 20% is downstream.
- “In Plane A” means the sensor is in the same plane as the elbow. “Out of Plane A” means the sensor is perpendicular to the plane of the elbow.
- The information contained in this manual is applicable to circular pipes only. Consult the factory for instructions regarding use in square or rectangular ducts.
- Straightening vanes may be used to reduce the required straight run length.
- The last row in Table 2-3 applies to gate, globe, plug, and other throttling valves that are partially opened, as well as control valves.

Figure 2-6: Mounting Configuration



A Annubar sensor

B Mounting hardware (Annubar type)

C Transmitter

Note

Unless ordered with a Remote-mount Transmitter Connection Platform, the direct-mounted flow meter is usually shipped with the transmitter assembled to the sensor.

2.5.6 Flow meter orientation

Liquid

Due to the possibility of air getting trapped in the Annubar sensor, it should be located according to Figure 2-7 for liquid applications. It should be mounted between 15° to 45° from vertical down to ensure that air is vented from the Annubar sensor, and that sediment or solid particles are not collected within the Annubar sensor.

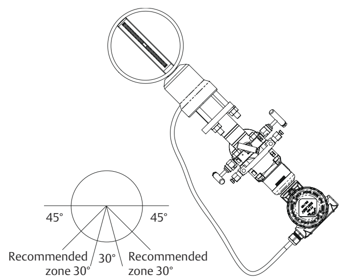
For liquid applications, mount the side drain/vent valve upward to allow the gases to vent. In vertical lines, the Annubar sensor can be installed in any position around the circumference of the pipe, provided the vents are positioned properly for bleeding or venting. Vertical pipe installations require more frequent bleeding or venting, depending on the location.

For a remote mounted transmitter, mount the transmitter below the process piping, adjust 10° to 15° above direct vertical down. Route the impulse piping down to the transmitter and fill the system with cool water through the two cross fittings.

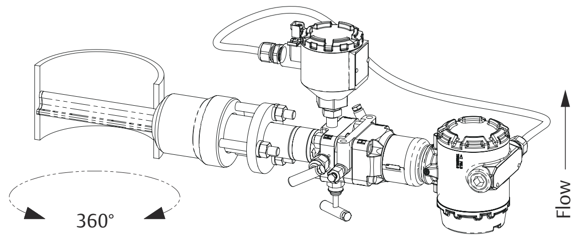
Figure 2-7: Liquid Applications

Direct mount

Horizontal liquid



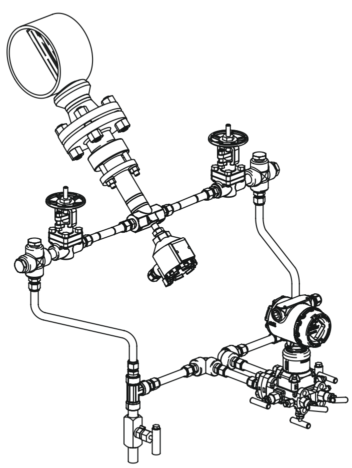
Vertical liquid



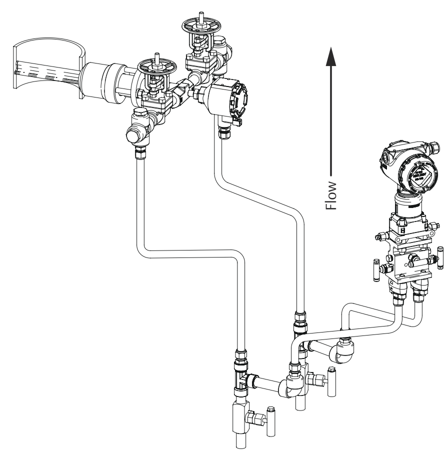
Note
Downward flow is not recommended.

Remote mount

Horizontal liquid



Vertical liquid



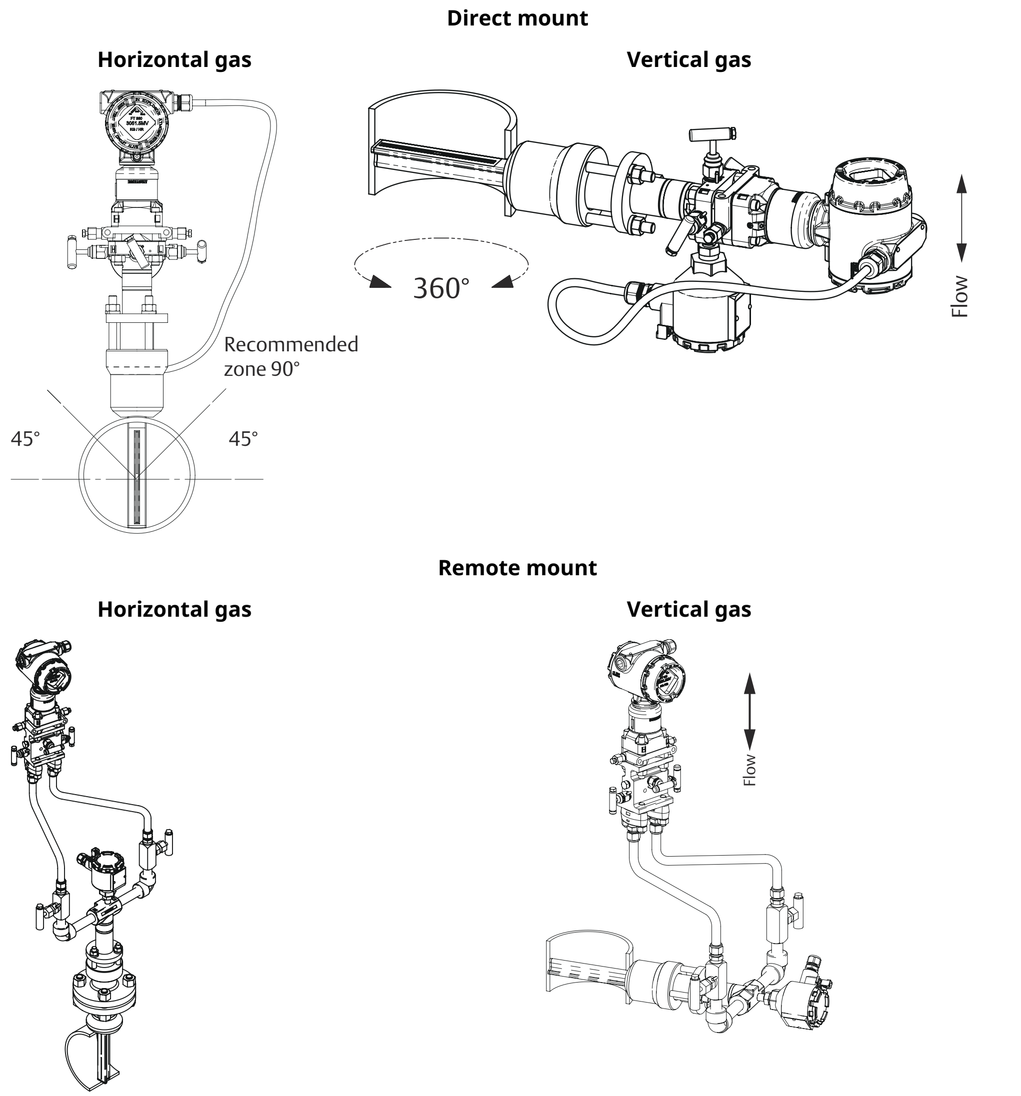
Gas

Figure 2-8 illustrates the recommended location of the flow meter in gas applications. The sensor should be located on the upper half of the pipe, at least 45° above the horizontal line.

For gas applications, mount the drain/vent valve downward to allow liquid to drain. In vertical lines, the Annubar sensor can be installed in any position around the circumference of the pipe, provided the vents are positioned properly for bleeding or venting. Vertical pipe installations require more frequent bleeding or venting, depending on the location.

For a remote mounted transmitter, secure the transmitter above the Annubar sensor to prevent condensible liquids from collecting in the impulse piping and the DP cell.

Figure 2-8: Gas Applications



Steam

In steam applications, fill the lines with water to prevent the steam from contacting the transmitter. Condensate chambers are not required because the volumetric displacement of the transmitter is negligible.

For a remote mounted transmitter,

1. Mount the transmitter below the process piping.
2. Adjust to 10° to 15° above direct vertical down.
3. Route the impulse piping down to the transmitter.
4. Fill the system with cool water through the two cross fittings.

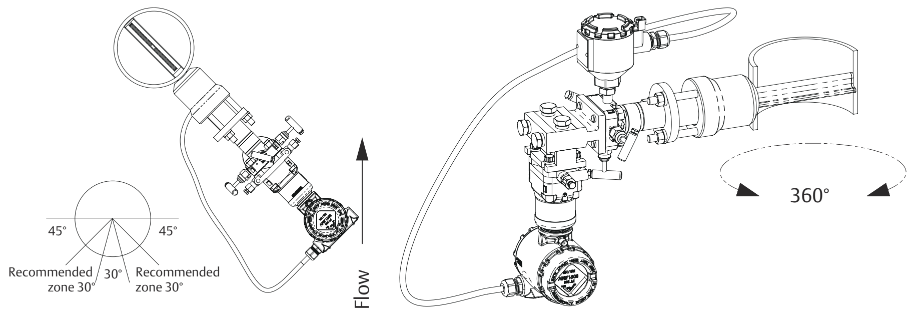
Top mounting for steam applications is an appropriate mounting option in many cases. For instructions regarding steam on top mounting, consult Rosemount Customer Central .

Figure 2-9 illustrates the recommended location of the flow meter in steam applications.

Figure 2-9: Steam Applications

Direct mount

Horizontal steam | **Vertical steam**



Note
Downward flow is not recommended.

Remote mount

Horizontal steam | **Vertical steam**

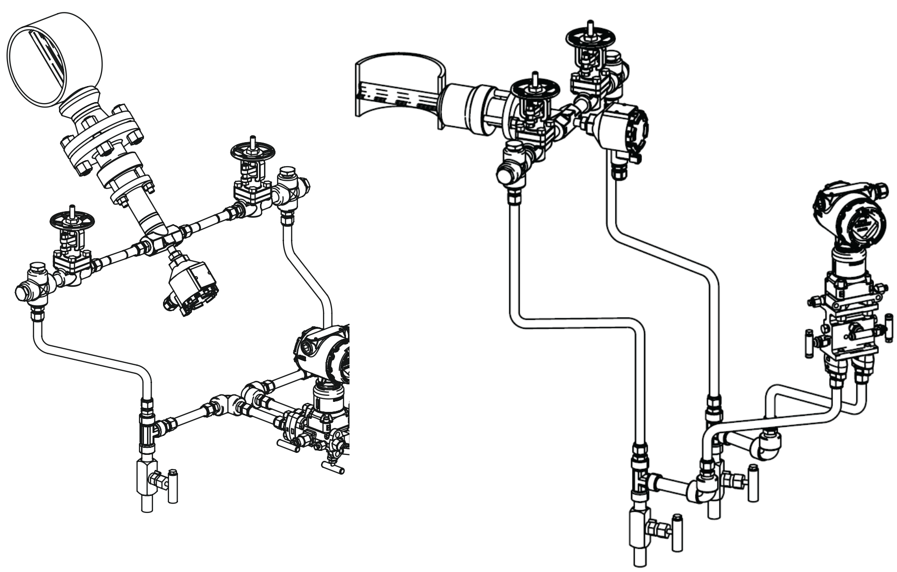
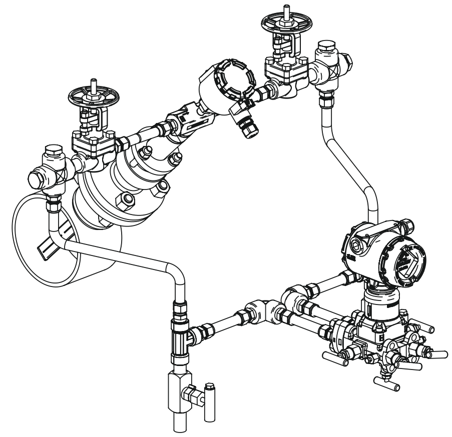


Figure 2-10: Top Mounting for Steam(1)

Remote mount



Note
For wet steam, do not mount the flow meter at the direct vertical position. Mounting at an angle will avoid measurement inaccuracy due to water running along the bottom of the pipe.

2.5.7 Remote mounted transmitter

Instrument head connections differ between horizontal and vertical pipes. For horizontal lines, the instrument connections are parallel to the pipe and for vertical lines, the instrument connection are perpendicular.

Valves and fittings

Throughout the remote mounting process:

- Use only valves, fittings, and pipe thread sealant compounds that are rated for the service pipeline design pressure and temperature as specified in Specifications and Reference Data.
- Verify that all connections are tight and that all instrument valves are fully closed.
- Verify that the Annubar sensor is properly oriented for the intended type of service: liquid, gas, or steam (see Flow meter orientation).

Impulse piping

Impulse piping connects a remote mounted transmitter to the Annubar sensor. Temperatures in excess of 250 °F (121 °C) at the transmitter will damage electronic components; impulse piping allows service flow temperatures to decrease to a point where the transmitter is no longer vulnerable.

The following restrictions and recommendations apply to impulse piping location:

- Piping used to connect the Annubar sensor and transmitter must be rated for continuous operation at the pipeline-designed pressure and temperature.
- Impulse piping that runs horizontally must slope at least 1 in. per foot (83 mm/m).

(1) Consult with RCC to determine if this installation is right for your application.

- With the Annubar mounted below the pipe, impulse piping must slope downwards (toward the transmitter) for liquid and steam applications.
- With the Annubar sensor mounted above the pipe, impulse piping must slope up (toward from the transmitter) for gas applications.
- For applications where the pipeline temperature is below 250 °F (121 °C), the impulse piping should be as short as possible to minimize flow temperature changes. Insulation may be required.
- For applications where pipeline temperature is above 250 °F (121 °C), the impulse piping should have a minimum length of 1-ft. (0.30 m) for every 100 °F (38 °C) over 250 °F (121 °C), which is the maximum operating transmitter temperature. Impulse piping must be uninsulated to reduce fluid temperature. Because connections may be loosened by the expansion and contraction caused by temperature changes, all threaded connections should be checked after the system comes up to temperature.
- It is recommended to use a stainless steel tubing with a minimum of ½ in. (12mm) outer diameter (OD) and a wall thickness of at least 0.035 in.
- Outdoor installations for liquid, saturated gas, or steam service may require insulation and heat tracing to prevent freezing.
- For installations where the transmitter is more than 6-ft. (1.8m) from the Annubar sensor, the high and low impulse piping must be run together to maintain equal temperature. They must be supported to prevent sagging and vibration.
- Threaded pipe fittings are not recommended because they create voids where air can become entrapped and have more possibilities for leakage.
- Run impulse piping in protected areas or against walls or ceilings. If the impulse piping is run across the floor, ensure that it is protected with coverings or kick plates. Do not locate the impulse piping near high temperature piping or equipment.
- Use an appropriate pipe sealing compound rated for the service temperature on all threaded connections. When making threaded connections between stainless steel fittings, Loctite® PST® Sealant is recommended.

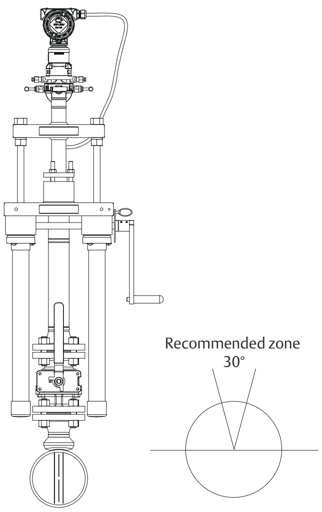
2.5.8 Flo-Tap models

Gas

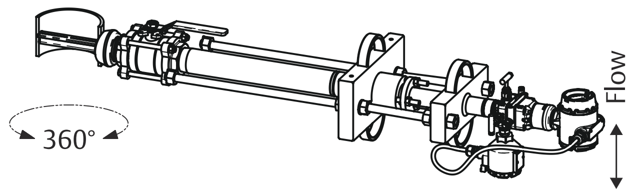
Figure 2-11: Gas Service

Direct mount

Horizontal gas

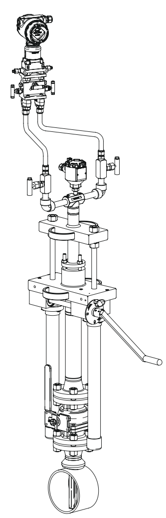


Vertical gas

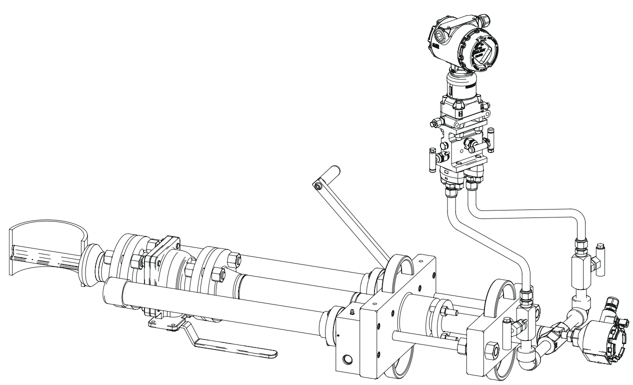


Remote mount

Horizontal gas



Vertical gas

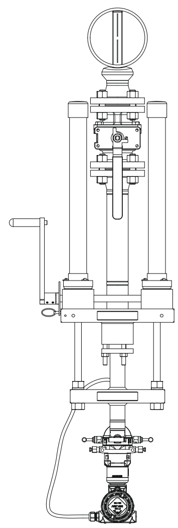


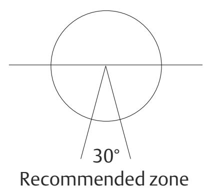
Liquid

Figure 2-12: Liquid Service

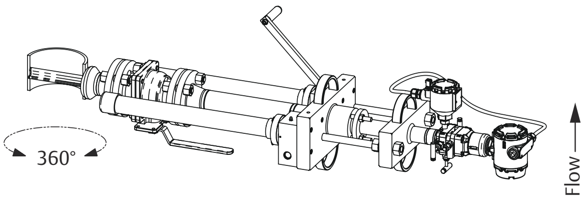
Direct mount

Horizontal liquid





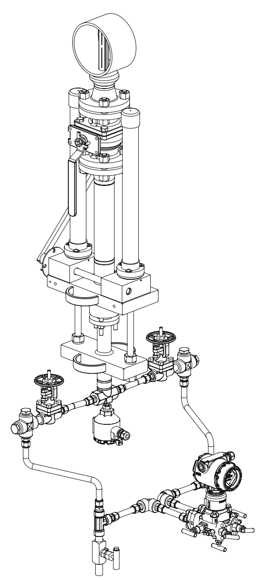
Vertical liquid



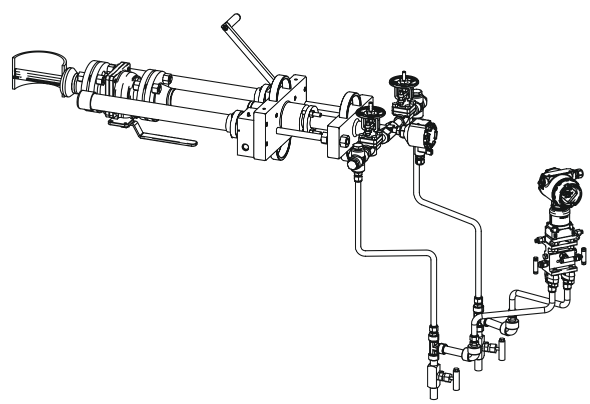
Note: Downward flow is not recommended.

Remote mount

Horizontal liquid



Vertical liquid

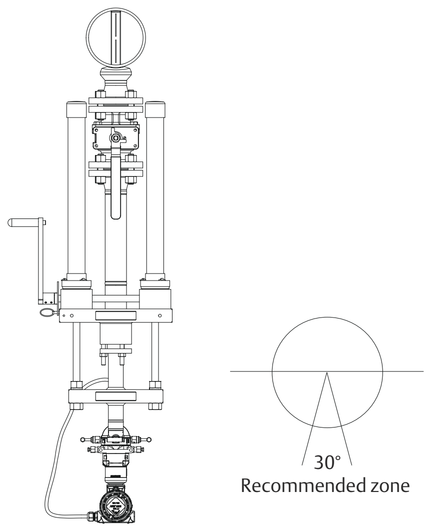


Steam

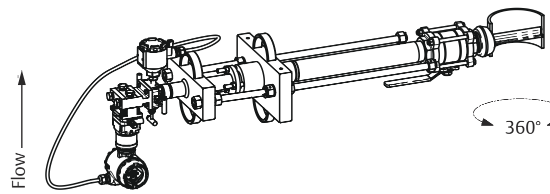
Figure 2-13: Steam

Direct mount

Horizontal steam



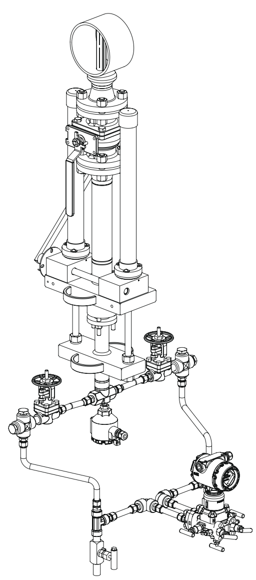
Vertical steam



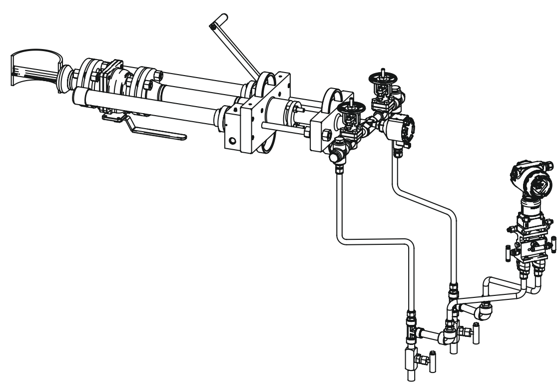
Note
Downward flow is not recommended.

Remote mount

Horizontal steam



Vertical steam



2.6 Installation

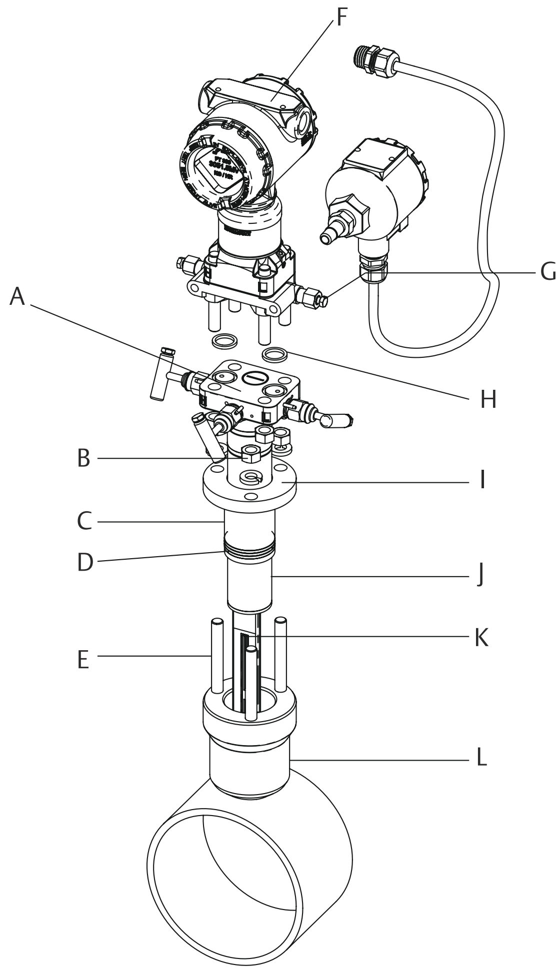
This manual contains the horizontal and vertical installation procedures for the following Annubar sensor models:

- Pak-Lok Annubar sensor type (for 485 Annubar Flow Meters)
- Flanged with opposite side support Annubar sensor type (for 485 and 585 Annubar Flow Meters)
- Flange-Lok model (for 485 Annubar Flow Meters)
- Threaded Flo-tap (for 485 Annubar Flow Meter)
- Flanged Flo-tap (for 485 and 585 Annubar Flow Meters)
- Flanged Flo-tap (for 485 and 585 Annubar Flow Meters)

2.6.1 Pak-Lok Annubar sensor type (for 485 Annubar Flow Meters)

Figure 2-14 identifies the components of the Pak-Lok assembly.

Figure 2-14: Components



Transmitter and housing are shown for clarity purposes – only supplied if ordered.

- **A** Direct mount transmitter connection with valves
- **B** Nuts
- **C** Follower
- **D** Packing rings (3)
- **E** Studs
- **F** Transmitter
- **G** Coplanar flange with drain vents
- **H** O-rings (2)
- **I** Compression plate
- **J** Retaining ring
- **K** 485 Annubar sensor
- **L** Pak-Lok body

Step 1: Determine the proper orientation

Refer to Mounting for straight run requirements and orientation information.

Step 2: Drill a hole into the pipe

Procedure

1. Determine the drill hole size based on the sensor size of sensor width.
2. Determine the sensor size based on the width of the Annubar sensor. See Table 2-4.
3. From the previous steps, select the location to drill the hole.
4. Determine the diameter of the hole to be drilled according to the specifications in Table 2-4 and drill the hole with a hole saw or drill.

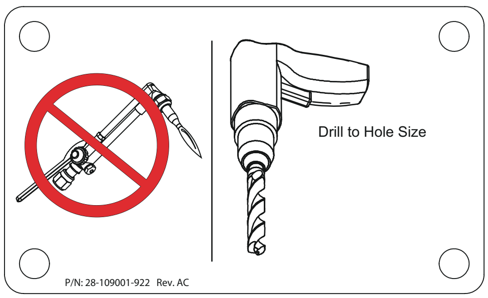
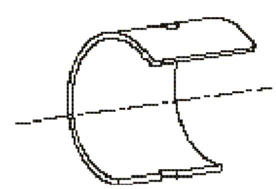


Table 2-4: 485 Sensor Size/Hole Diameter Chart

Sensor size	Sensor width	Hole diameter		
1	0.590 in. (14.99 mm)	¾ in. (19 mm)	+ 1/32 in. (+ 0.8 mm)	**Note** Drill the hole 180° from the first hole for opposite-side support models.
			– 0.00	
2	1.060 in. (26.92 mm)	1 5/16 in. (34 mm)	+ 1/16 in. (+ 1.6 mm)	
			– 0.00	
3	1.935 in. (49.15 mm)	2 ½ in. (64 mm)	+ 1/16 in. (+ 1.6 mm)	
			– 0.00	Drill the appropriate diameter hole through the pipe wall.

NOTICE

Do not torch cut the hole.

5. If opposite-side support coupling is supplied, then a second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. (To determine an opposite-side support model, measure the distance from the tip of the first slot or hole. If the distance is greater than 1 in. (25.4 mm), it is the opposite-side model.) To drill the second hole, follow these steps:
   a) Measure the pipe circumference with a pipe tape, soft wire, or string.

Note

To achieve the most accurate measurement, the pipe tape needs to be perpendicular to the axis of flow.

b) Divide the measured circumference by two to determine the location of the second hole.

c) Re-wrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.

d) Using the diameter determined from Table 2-4, drill the hole into the pipe with a hole saw or drill.

NOTICE

Do not torch cut the hole.

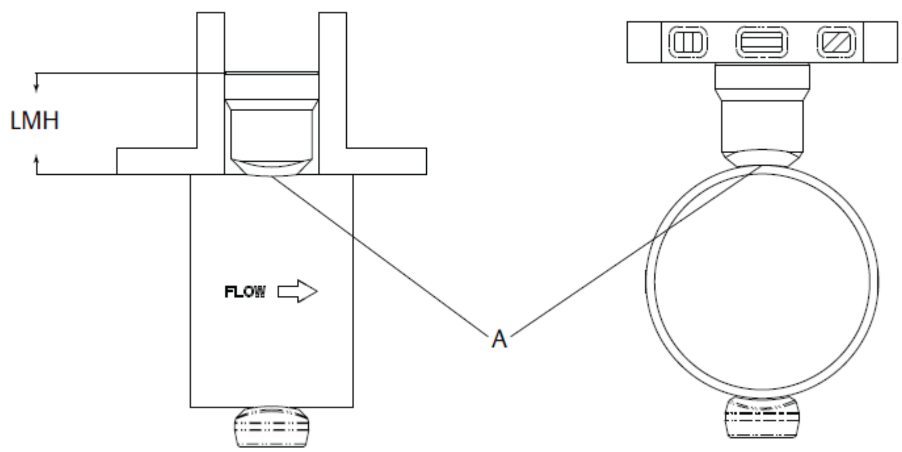
6. Deburr the drilled hole(s) on the inside of the pipe.

Step 3: Weld the mounting hardware

Procedure

1. Center the Pak-Lok body over the mounting hole, gap 1/16 in. (1½ mm) and place four ¼ in. (6 mm) tack welds at 90° increments.
2. Check alignment of the Pak-Lok body both parallel and perpendicular to the axis of flow. If alignment of mounting is within tolerances (see Figure 2-15), finish weld per local codes. If alignment is outside of specified tolerance, make adjustments prior to finish weld.

Figure 2-15: Alignment



A Tack welds

3. If opposite side support is being used, center the fitting for the opposite side support over the opposite side hole, gap 1/16 in. (1½ mm) and place four ¼ in. (6 mm) tack welds at 90° increments. Insert the sensor into the mounting hardware. Verify that the tip of the bar is centered in the opposite side fitting and verify that

the plug will fit around bar. If the bar is centered in the fitting and plug fits around the bar, finish weld per local codes. If the alignment of the bar does not allow enough clearance to insert the opposite side plug, make the necessary adjustments prior to making the finish weld.

4. To avoid serious burns, allow the mounting hardware to cool before continuing.

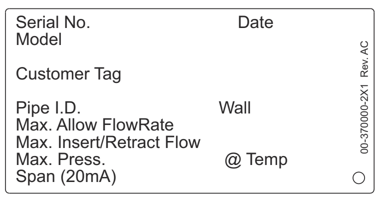
Step 4: Insert Annubar sensor

After the mounting hardware has cooled, use the following steps for installation.

Procedure

1. Thread studs into the Pak-Lok body.
2. **Note**
   If the sensor was ordered with special-cleaned option code P2 or PA, do not mark.

   To ensure the flow meter contacts the opposite side wall, mark the tip of the sensor with a marker.
3. Insert the flow meter into the Pak-lok body until the sensor tip contacts the pipe wall (or support plug).
4. Rotate the flow meter back and forth.
5. Remove the flow meter.



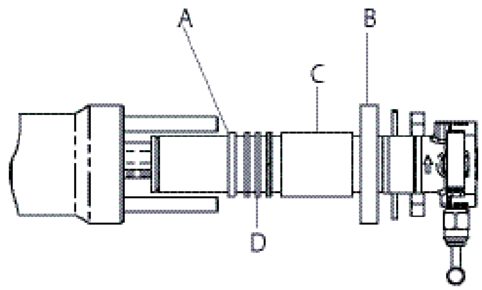
6. **Note**
   If the tip did not touch the wall, verify pipe dimensions and the height of mounting body from the outer diameter of the pipe and re-insert.

   Verify the sensor tip made contact with the pipe wall by removing the sensor from the pipe and ensuring some of the marker has been rubbed off. For special-cleaned Annubar sensors, look for wear marks on the tip.
7. Align the flow arrow with the direction of flow.
8. Re-insert the flow meter into the Pak-Lok body.
9. Install the first packing ring on the sensor between the lock ring and the packing follower.

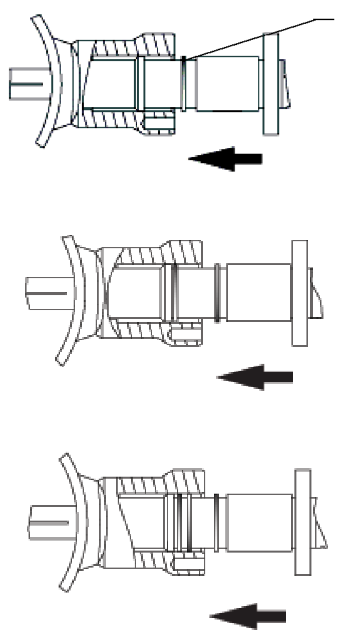
   NOTICE

   When performing this step, do not damage the split packing rings.
10. Push the packing ring into the Pak-Lok body and against the weld lock ring. Repeat this process for the two remaining rings, alternating the location of the packing ring split by 180°.

Figure 2-16: Packing Ring Detail



A	Retaining ring
B	Compression plate
C	Follower
D	Packing rings (3)



a. Install the first Packing Ring underneath the Follower.
b. Use the Follower and the Compression Plate to compress the first Packing Ring against the Retaining Ring.
c. Install the second Packing Ring underneath the Follower. Alternate packing ring splits by 120 degrees to each other.
d. Use the Follower and the Compression Plate to compress the second Packing Ring against the first Packing Ring.
e. Install the third Packing Ring underneath the Follower.
f. Use the Follower and the Compression Plate to compress the third Packing Ring against the second Packing Ring.

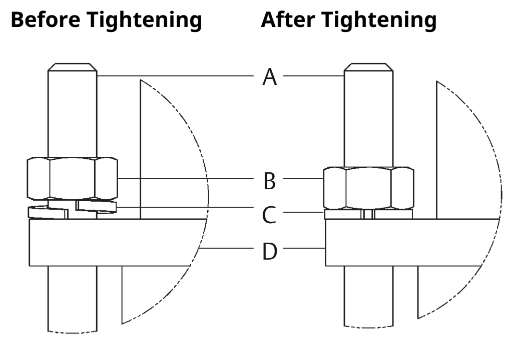
11. Tighten the nuts onto the studs:
    - Place the included split-ring lock washer between each of the nuts and the compression plate. Give each nut 180° turn in succession until the split-ring lock washer is flat between the nut and the compression plate.

Sensor size	Torque
1	40 in./lb (4.52 Nm)
2	100 in./lb (11.30 Nm)
3	250 in./lb (28.25 Nm)

- Inspect the unit for leakage; if any exists, tighten the nuts in one-quarter (1/4) turn increments until there is no leakage.

Note
On sensor size (1), failure to use the split-ring lock washers, improper washer orientation, or over-tightening the nuts may result in damage to the flow meter.

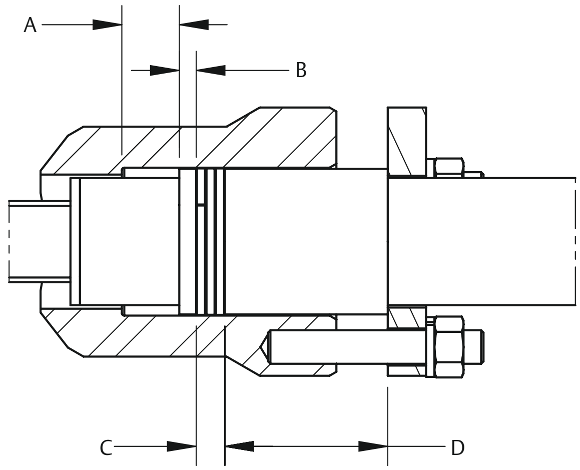
Figure 2-17: Split-Ring Lock Washer Orientation



A	Stud
B	Nut
C	Split ring lock washer
D	Compression plate

Note
Pak-Lok sealing mechanisms generate significant force at the point where the sensor contacts the opposite pipe wall. To avoid damage to the pipe, exercise caution on thin-walled piping (ANSI Schedule 10 and below).

Figure 2-18: Complete Installation of Pak-Lok



A	Gap
B	Weld ring
C	Packing rings (3)
D	Follower

Figure 2-18 shows a view of the Pak-Lok Annubar sensor when installation is completed. Please note that there should be a gap between the Pak-Lok Body and the Weld Ring.

Step 5: Mount the transmitter

Direct mount head

With valves

- Place PTFE O-rings into grooves on the face of head.
- Align the high side of the transmitter to the high side of the probe ("Hi" is stamped on the side of the head) and install.
- Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

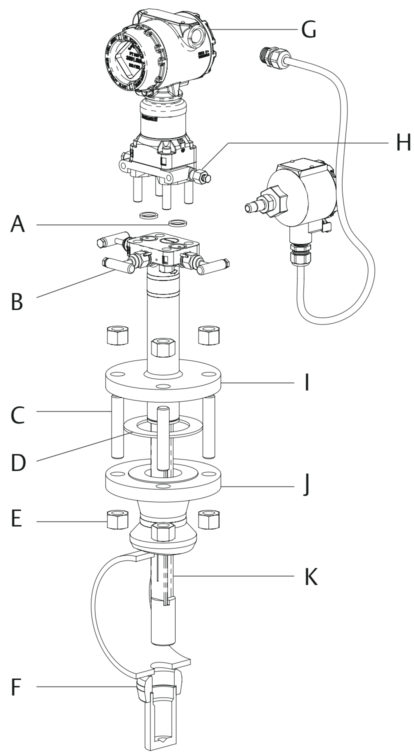
Without valves

- Place PTFE O-rings into grooves on the face of head.
- To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb. (45 N-m).
- Place PTFE O-rings into grooves on the face of the manifold.
- Align the high side of the transmitter to the high side of the probe ("Hi" is stamped on the side of the head) and install.
- Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

2.6.2 Flanged with opposite side support Annubar sensor type (for 485 and 585 Annubar Flow Meters)

Figure 2-19 identifies the components of the Flanged assembly.

Figure 2-19: Components



Transmitter and housing are shown for clarity purposes – only supplied if ordered.

- **A** O-rings (2)
- **B** Direct mount transmitter connection with valves
- **C** Studs
- **D** Gasket
- **E** Nuts
- **F** Opposites side support
- **G** Transmitter
- **H** Coplanar flange with drain vents
- **I** Sensor flange
- **J** Mounting flange assembly
- **K** 485 Annubar sensor

Step 1: Determine the proper orientation

Refer to Mounting for straight run requirements and orientation information.

Step 2: Drill a hole into the pipe

Procedure

1. Determine the drill hole size based on the sensor size of sensor width.
2. Depressurize and drain the pipe.

3. From the previous steps, select the location to drill the hole.
4. Determine the diameter of the hole to be drilled according to the specifications in Table 2-5 and Table 2-6 and drill the hole with a hole saw or a drill.

Table 2-5: 485 Sensor Size/Hole Diameter Chart

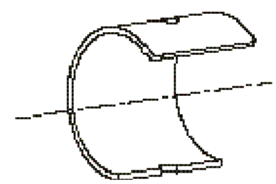
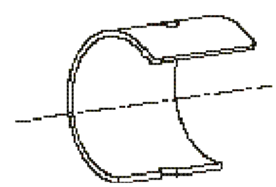
Sensor size	Sensor width	Hole diameter		
1	0.590 in. (14.99 mm)	¾ in. (19 mm)	+ 1/32 in. (+ 0.8 mm) – 0.00	**Note** Drill the hole 180° from the first hole for opposite-side support models.
2	1.060 in. (26.92 mm)	1 5/16 in. (34 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00	
3	1.935 in. (49.15 mm)	2 ½ in. (64 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00	Drill the appropriate diameter hole through the pipe wall.

Table 2-6: 585 Sensor Size/Hole Diameter Chart

Sensor size	Sensor width	Hole diameter		
11	0.80 in. (20.32 mm)	7/8 in. (22 mm)	+ 1/32 in. (+ 0.8 mm) – 0.00	**Note** Drill the hole 180° from the first hole for opposite-side support models.
22	1.20 in. (30.48 mm)	1 5/16 in. (34 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00	
44	2.28 in. (57.9 mm)	2 ½ in. (64 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00	Drill the appropriate diameter hole through the pipe wall.

NOTICE

Do not torch cut the hole.

5. If opposite-side support coupling is supplied, a second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. To drill the second hole, follow these steps:
   a) Measure the pipe circumference with a pipe tape, soft wire, or string (for the most accurate measurement the pipe tape needs to be perpendicular to the axis of flow).
   b) Divide the measured circumference by two to determine the location of the second hole.

c) Re-wrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.

d) Using the diameter determined from Table 2-5 and Table 2-6, drill the hole into the pipe with a hole saw or drill.

NOTICE

Do not torch cut the hole.

6. Deburr the drilled holes on the inside of the pipe.

Step 3: Assemble and check fit-up

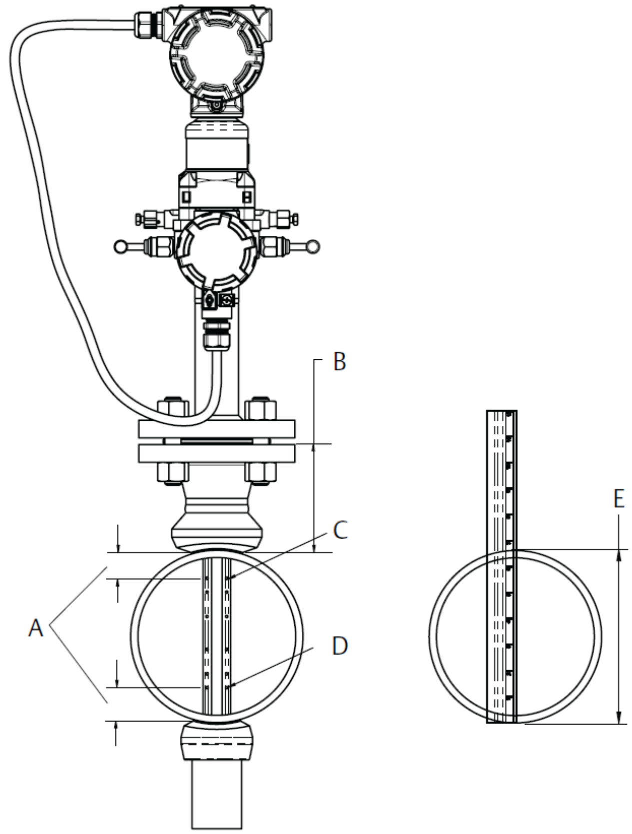
For accurate measurement, use the following steps to ensure that Ports A and B are equal distances from the inside walls of the pipe.

Procedure

1. Assemble the Annubar sensor to the mounting hardware with the gaskets and bolts.
2. Hand-tighten the bolts just enough to hold the position of the sensor centered in the mounting hardware.
3. Measure the distance from the high point of the weldolet to the first sensing hole, port B, then subtract 1/16 in. (1.6 mm).
4. Measure the distance from the end of the transferred length in Step 3 to the last sensing hole, port A.
5. **Note**
   Small discrepancies can be compensated for with the fit-up of the mounting hardware. Large discrepancies may cause installation problems or error.

   Compare the numbers obtained in Step 3 and Step 4.

Figure 2-20: Fit-Up Check for Annubar Sensor with Opposite Side Support



A The same within ⅛ in. (3 mm)

B ODF

C Port B

D Port A

E Pipe outside diameter

Step 4: Weld the mounting hardware

Procedure

1. Center the Flanged body over the mounting hole, gap 1/16 in. (1.5 mm) and measure the distance from the outside diameter of the pipe to the face of the flange. Compare this to the table below and adjust the gap as necessary.

Table 2-7: 485 and 585 Flange Sizes and ODF per Sensor Size

485 Sensor size	585 Sensor size	Flange type	Pressure class	Flange size/ rating/ type	ODF(1) in. (mm)
1	11	A	1	1½ in. 150# RF	3.88 (98.6)
			3	1½ in. 300# RF	4.13 (104.9)
			6	1½ in. 600# RF	4.44 (112.8)

Table 2-7: 485 and 585 Flange Sizes and ODF per Sensor Size *(continued)*

485 Sensor size	585 Sensor size	Flange type	Pressure class	Flange size/ rating/ type	ODF(1) in. (mm)
			N/9	1½ in. 900# RF	4.94 (125.5)
			F	1½ in. 1500# RF	4.94 (125.5)
			T	1½ in. 2500# RF	6.76 (171.7)
		R	1	1½ in. 150# RTJ	4.06 (103.1)
			3	1½ in. 300# RTJ	4.31 (109.5)
			6	1½ in. 600# RTJ	4.44 (112.8)
			N/9	1½ in. 900# RTJ	4.94 (125.5)
			F	1½ in. 1500# RTJ	4.94 (125.5)
			T	1½ in. 2500# RTJ	6.81 (173.0)
		D	1	DN40 PN16 RF	3.21 (81.5)
			3	DN40 PN40 RF	3.21 (81.5)
			6	DN40 PN100 RF	3.88 (98.6)
2	22	A	1	2.0 in. 150# RF	4.13 (104.9)
			3	2.0 in. 300# RF	4.38 (111.3)
			6	2.0 in. 600# RF	4.75 (120.7)
			N/9	2.0 in. 900# RF	5.88 (149.4)
			F	2.0 in. 1500# RF	5.88 (149.4)
			T	3.0 in. 2500# RF	9.88 (251.0)
		R	1	2.0 in. 150# RTJ	4.31 (119.5)
			3	2.0 in. 300# RTJ	4.63 (117.6)
			6	2.0 in. 600# RTJ	4.81 (122.2)
			N	2.0 in. 900# RTJ	5.94 (150.9)
			F	2.0 in. 1500# RTJ	5.94 (150.9)
			T	3.0 in. 2500# RTJ	10.00 (254.0)
		D	1	DN50 PN16 RF	3.40 (86.4)
			3	DN50 PN40 RF	3.52 (89.4)
			6	DN50 PN100 RF	4.30 (109.5)
3	44	A	1	3.0 in. 150# RF	4.63 (117.6)
			3	3.0 in. 300# RF	5.00 (127.0)
			6	3.0 in. 600# RF	5.38 (136.7)
			N/9	4.0 in. 900# RF	8.19 (208.0)
			F	4.0 in. 1500# RF	8.56 (217.4)
			T	4.0 in. 2500# RF	11.19 (284.2)
		R	1	3.0 in. 150# RTJ	4.81 (122.2)
			3	3.0 in. 300# RTJ	5.25 (133.4)

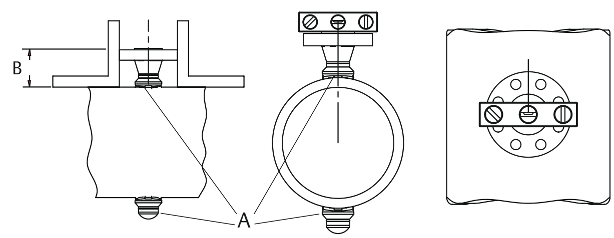
Table 2-7: 485 and 585 Flange Sizes and ODF per Sensor Size *(continued)*

485 Sensor size	585 Sensor size	Flange type	Pressure class	Flange size/ rating/ type	ODF(1) in. (mm)
			6	3.0 in. 600# RTJ	5.44 (138.2)
			N/9	4.0 in. 900# RTJ	8.25 (209.6)
			F	4.0 in. 1500# RTJ	8.63 (219.2)
			T	4.0 in. 2500# RTJ	11.38 (289.1)
		D	1	DN80 PN16 RF	3.85 (97.8)
			3	DN80 PN40 RF	4.16 (105.7)
			6	DN80 PN100 RF	4.95 (125.7)

(1) *Tolerances for the ODF dimension above a 10 in. (254 mm) line size is ±0.060 in. (1.6 mm). Below 10 in. (254 mm) line size is ±0.030 in. (0.8 mm).*

2. Place four ¼ in. (6 mm) tack welds at 90° increments. Check alignment of the mounting both parallel and perpendicular to the axis of flow (see Figure 2-21).
   If alignment of the mounting is within tolerances, finish weld per local codes. If alignment is outside of specified tolerance, make adjustments prior to making the finish weld.

Figure 2-21: Alignment



A Tack welds

3. Center the fitting for the opposite side support over the opposite side hole, gap 1/16 in. (1.5 mm) and place four ¼ in. (0.5 mm) tack welds at 90° increments. Insert the sensor into the mounting hardware. Verify that the tip of the bar is centered in the opposite side fitting and that the plug will fit around bar. If the sensor is centered in the fitting and plug fits around the sensor, finish weld per local codes. If alignment of the sensor does not allow enough clearance to insert the opposite side plug, make the necessary adjustments prior to making the finish weld.
4. To avoid serious burns, allow the mounting hardware to cool before continuing.

Step 5: Insert the Annubar sensor

Procedure

1. If opposite side support is threaded, apply an appropriate thread sealing compound to the support plug threads and tighten until no leakage occurs.
2. Align the flow arrow on the head with the direction of flow. Assemble the Annubar sensor to the mounting flange using a gasket, bolts, and nuts.

3. If opposite side support is a socket weld fitting, insert the plug into the sockolet fitting until the parts contact. Retract the plug 1/16 in. (1.5 mm), remove the Annubar sensor and apply fillet weld per local codes.
4. Tighten the nuts in a cross pattern to allow even compression of the gasket.

Step 6: Mount the transmitter

Direct mount head

With valves

Procedure

1. Place PTFE O-rings into grooves on the face of head.
2. Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

Without valves

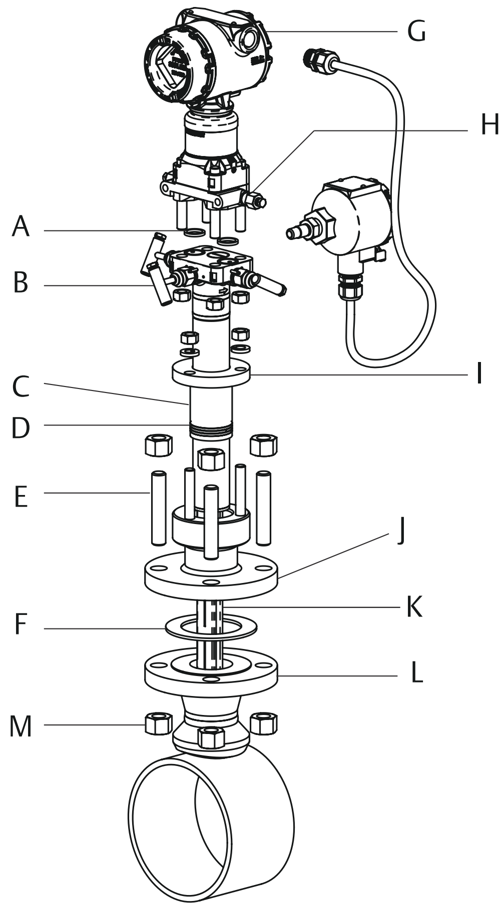
Procedure

1. Place PTFE O-rings into grooves on the face of head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb. (45 N-m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.
5. Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

2.6.3 Flange-Lok model (for 485 Annubar Flow Meters)

Figure 2-22 identifies the components of the Flange-Lok assembly.

Figure 2-22: Components



Transmitter and housing are shown for clarity purposes – only supplied if ordered.

- **A** O-Rings (2)
- **B** Direct mount transmitter connection with valves
- **C** Follower
- **D** Packing rings (3)
- **E** Studs
- **F** Gasket
- **G** Transmitter
- **H** Coplanar flange with drain vents
- **I** Compression plate
- **J** Flange-Lok assembly
- **K** 485 Annubar sensor
- **L** Mounting flange assembly
- **M** Nuts

Step 1: Determine the proper orientation

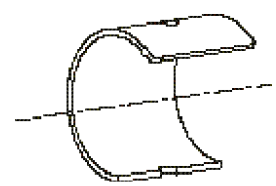
Refer to Mounting for straight run requirements and orientation information.

Step 2: Drill a hole into the pipe

Procedure

1. Determine the drill hole size based on the Sensor Size of Sensor Width.
2. De-pressurize and drain the pipe.
3. Select the location to drill the hole.
4. Determine the diameter of the hole to be drilled according to the specifications in Table 2-8.
5. Drill the hole with a hole saw or a drill.

Table 2-8: 485 Sensor Size/Hole Diameter Chart

<table>
<tr><th>Sensor size</th><th>Sensor width</th><th colspan="3">Hole diameter</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">0.590 in.
(14.99 mm)</td><td rowspan="2">¾ in.
(19 mm)</td><td>+ 1/32 in.
(+ 0.8 mm)</td><td rowspan="6">Note
Drill the hole 180° from the first hole for opposite-side support models.

Drill the appropriate diameter hole through the pipe wall.</td></tr>
<tr><td>– 0.00</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">1.060 in.
(26.92 mm)</td><td rowspan="2">1 5/16 in.
(34 mm)</td><td>+ 1/16 in.
(+ 1.6 mm)</td></tr>
<tr><td>– 0.00</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">1.935 in.
(49.15 mm)</td><td rowspan="2">2 ½ in.
(64 mm)</td><td>+ 1/16 in.
(+ 1.6 mm)</td></tr>
<tr><td>– 0.00</td></tr>
</table>

NOTICE

Do not torch cut the hole.

6. If opposite-side support coupling is supplied, a second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. To drill the second hole, follow these steps:
   a) Measure the pipe circumference with a pipe tape, soft wire, or string.

   Note
   To achieve the most accurate measurement, the pipe tape must be perpendicular to the axis of flow.

   b) Divide the measured circumference by two to determine the location of the second hole.
   c) Re-wrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.
   d) Using the diameter determined from Table 2-8, drill the hole into the pipe with a hole saw or drill.

NOTICE

Do not torch cut the hole.

Note
To determine an opposite-side support model, measure the distance from the tip of the first slot or hole. If the distance is greater than 1 in. (25.4 mm), it is the opposite-side model.

7. Deburr the drilled hole or holes on the inside of the pipe.

Step 3: Weld the mounting hardware

Procedure

1. Center the Flange-Lok body over the mounting hole, gap 1/16 in. (2 mm) and measure the distance from the OD of the pipe to the face of the flange. Compare this to the table below and adjust the gap as necessary.

Table 2-9: 485 and 585 Flange Sizes and ODF Per Sensor Size

485 Sensor size	Flange type	Pressure class	Flange size/ rating/type	ODF[1] in. (mm)
1	A	1	1½ in. 150# RF	3.88 (98.6)
		3	1½ in. 300# RF	4.13 (104.9)
		6	1½ in. 600# RF	4.44 (112.8)
		N	1½ in. 900# RF	4.94 (125.5)
		F	1½ in. 1500# RF	4.94 (125.5)
		T	1½ in. 2500# RF	6.76 (171.7)
	R	1	1½ in. 150# RTJ	4.06 (103.1)
		3	1½ in. 300# RTJ	4.31 (109.5)
		6	1½ in. 600# RTJ	4.44 (112.8)
		N	1½ in. 900# RTJ	4.94 (125.5)
		F	1½ in. 1500# RTJ	4.94 (125.5)
		T	1½ in. 2500# RTJ	6.81 (173.0)
	D	1	DN40 PN16 RF	3.21 (81.5)
		3	DN40 PN40 RF	3.21 (81.5)
		6	DN40 PN100 RF	3.88 (98.6)
2	A	1	2.0 in. 150# RF	4.13 (104.9)
		3	2.0 in. 300# RF	4.38 (111.3)
		6	2.0 in. 600# RF	4.75 (120.7)
		N	2.0 in. 900# RF	5.88 (149.4)
		F	2.0 in. 1500# RF	5.88 (149.4)
		T	3.0 in. 2500# RF	9.88 (251.0)
	R	1	2.0 in. 150# RTJ	4.31 (119.5)

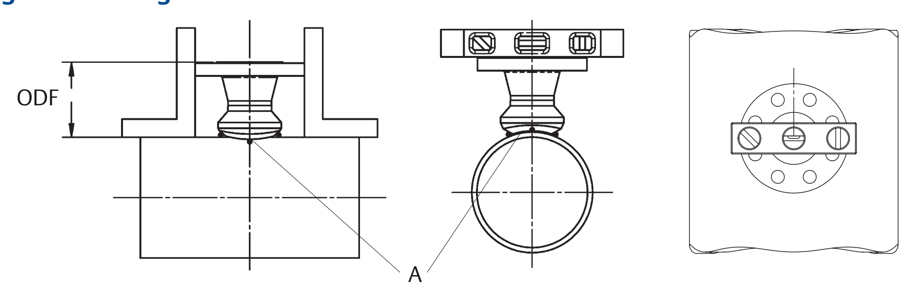
Table 2-9: 485 and 585 Flange Sizes and ODF Per Sensor Size *(continued)*

485 Sensor size	Flange type	Pressure class	Flange size/ rating/type	ODF(1) in. (mm)
		3	2.0 in. 300# RTJ	4.63 (117.6)
		6	2.0 in. 600# RTJ	4.81 (122.2)
		N	2.0 in. 900# RTJ	5.94 (150.9)
		F	2.0 in. 1500# RTJ	5.94 (150.9)
		T	3.0 in. 2500# RTJ	10.00 (254.0)
	D	1	DN50 PN16 RF	4.63 (117.6)
		3	DN50 PN40 RF	5.00 (127.0)
		6	DN50 PN100 RF	5.38 (136.7)
3	A	1	3.0 in. 150# RF	4.63 (117.5)
		3	3.0 in. 300# RF	5.00 (126.9)
		6	3.0 in. 600# RF	5.38 (136.6)
	R	1	3.0 in. 150# RTJ	4.81 (122.2)
		3	3.0 in. 300# RTJ	5.25 (133.4)
		6	3.0 in. 600# RTJ	5.44 (138.2)
	D	1	DN80 PN16 RF	3.85 (97.8)
		3	DN80 PN40 RF	4.16 (105.7)
		6	DN80 PN100 RF	4.95 (125.7)

(1) Tolerances for the ODF dimension above a 10 in. (254 mm) line size is ±0.060 in. (1.6 mm). Below 10 in. (254 mm) line size is ±0.030 in. (0.8 mm).

2. Place four ¼ in. (6-mm) tack welds at 90° increments. Check alignment of the mounting both parallel and perpendicular to the axis of flow (see Figure 2-23). If mounting alignment is: within tolerances, finish weld per local codes. If mounting alignment is outside of specified tolerance, adjust as needed to meet specified tolerance prior to making the finish weld.

Figure 2-23: Alignment



A Tack welds

3. If opposite side support is being used, center the fitting for the opposite side support over the opposite side hole, gap 1/16 in. (1.5 mm) and place four ¼ in. (6-mm) tack welds at 90° increments. Insert the sensor into the mounting hardware.

Verify that the tip of the bar is centered in the opposite side fitting and that the plug will fit around the bar. If the sensor is centered in the fitting and plug fits around the sensor, finish weld per local codes. If alignment of the sensor does not allow enough clearance to insert the opposite side plug, make the necessary adjustments prior to making the finish weld.

Note
The Annubar sensor must be removed before welding or installing the opposite side support plug.

4. To avoid serious burns, allow the mounting hardware to cool before continuing.

Step 4: Insert into pipe

After the mounting hardware has cooled, use the following steps for installation.

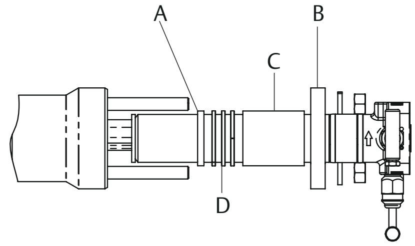
Procedure

1. Assemble the sensor flange to the mounting flange using gasket, studs, and nuts.
2. Tighten the nuts in a cross pattern to allow even compression of the gasket.
3. Thread studs into Flange-Lok body.
4. To ensure the flow meter contacts the opposite side wall, mark the tip of the sensor with a marker.

Note
Do not mark if the sensor was ordered with special-cleaned option code P2 or PA.

5. Insert the flow meter into the Flange-lok body until the sensor tip contacts the pipe wall (or support plug), rotating back and forth.
6. Remove the flow meter.
7. Verify the sensor tip made contact with the pipe wall by ensuring that some of the marker has been rubbed off. For special-cleaned bars, look for wear marks on the tip. If the tip did not touch the wall, verify pipe dimensions and the height of the mounting body from the OD of the pipe and re-insert.
8. Re-insert the flow meter into the Flange-Lok body and install the first packing ring on the sensor between the lock ring and the packing follower. Take care not to damage the split packing rings.
9. Push the packing ring into the Flange-Lok body and against the weld retaining ring. Repeat this process for the two remaining rings, alternating the location of the packing ring split by 180°.

Figure 2-24: Packing Ring Detail



A	Retaining ring
B	Compression plate
C	Follower
D	Packing rings (3)

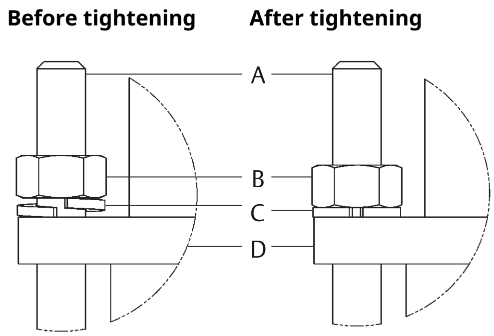
10. Tighten the nuts onto the studs:
    a) Place the included split-ring lock washer between each of the nuts and the compression plate. Give each nut one-half (1/2) turn in succession until the split-ring lock washer is flat between the nut and the compression plate. Torque is as follows:

Sensor size	Torque
1	40 in/lb (4.52 Nm)
2	100 in/lb (11.30 Nm)
3	250 in/lb (28.25 Nm)

    b) Inspect the unit for leakage; if any exists, tighten the nuts in one-quarter (1/4) turn increments until there is no leakage.

Note
On sensor size (1), failure to use the split-ring Lock washers, improper washer orientation, or over-tightening the nuts may result in damage to the flow meter.

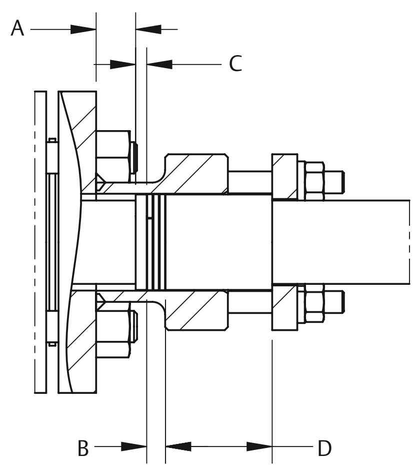
Figure 2-25: Split-Ring Lock Washer Orientation



A	Stud
B	Nut
C	Split ring lock washer
D	Compression plate

Note
Flange-Lok sealing mechanisms generate significant force at the point where the sensor contacts the opposite pipe wall. Caution needs to be exercised on thin-walled piping (ANSI Schedule 10 and below) to avoid damage to the pipe.

Figure 2-26: Complete Installation of Flange-Lok



A	Gap
B	Packing rings (3)
C	Weld ring
D	Follower

Figure 2-26 shows a view of the Flange-Lok Annubar sensor when installation is completed. Please note that there should be a gap between the Flange-Lok Body and the Weld Ring.

Step 5: Mount the transmitter

Direct mount head

With valves

Procedure

1. Place PTFE O-rings into grooves on the face of head.
2. Align the high side of the transmitter to the high side of the Annubar sensor ("Hi" is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

Without valves

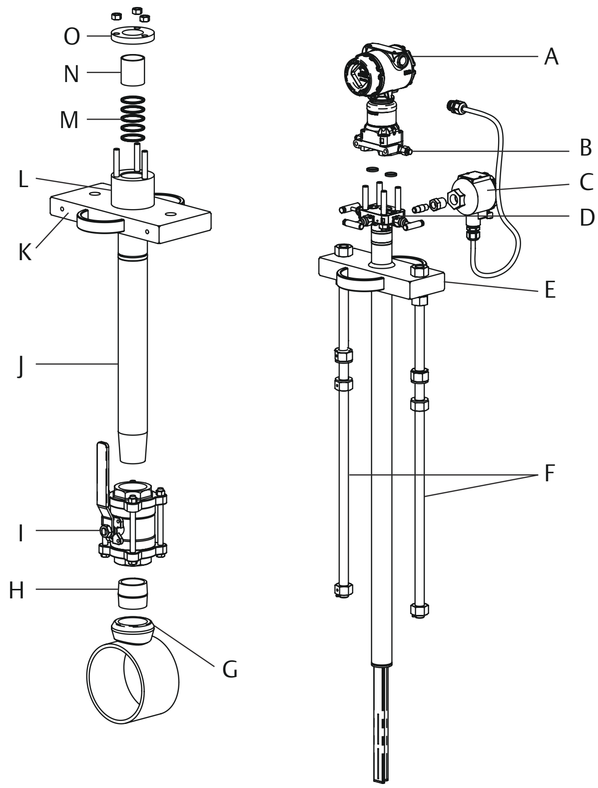
Procedure

1. Place PTFE O-rings into grooves on the face of head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb. (45 N-m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the Annubar sensor ("Hi" is stamped on the side of the head) and install.
5. Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

2.6.4 Threaded Flo-tap (for 485 Annubar Flow Meter)

Figure 2-27 identifies the components of the Threaded Flo-Tap assembly.

Figure 2-27: Components



Transmitter and housing are shown for clarity purposes – only supplied if ordered.

- **A** Transmitter
- **B** Coplanar flange with drain vents
- **C** Temperature sensor connection housing
- **D** Direct mount transmitter connection with valves
- **E** Head plate
- **F** Drive rods
- **G** Threaded pipe fitting
- **H** Guide nipple
- **I** Isolation valve
- **J** Cage nipple
- **K** Support plate
- **L** Packing gland
- **M** Packing
- **N** Follower
- **O** Compression plate
- **P** O-rings (2)

Step 1: Determine the proper orientation

Refer to Mounting for straight run requirements and orientation information.

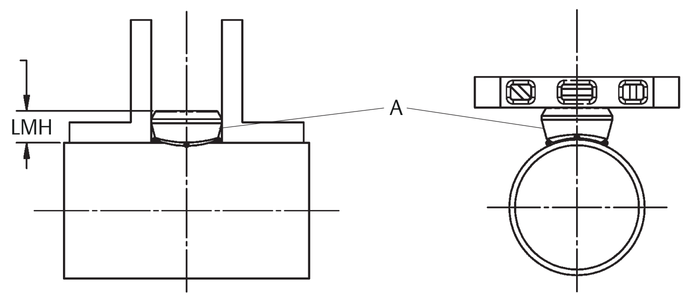
Step 2: Weld the mounting hardware

Note
Rosemount-supplied mounting includes critical alignment hardware that assists in the correct drilling of the mounting hole. This significantly reduces problems encountered during insertion.

Procedure

1. At the pre-determined position, place the threadolet on the pipe, gap 1/16 in. (16 mm) and place four ¼ in. (6 mm) tack welds at 90° increments.
2. Check alignment of the mounting both parallel and perpendicular to the axis of flow. If the mounting alignment is within tolerances, finish weld per local codes. If outside of tolerances, make adjustments prior to making the finish weld.
3. To avoid serious burns, allow mounting hardware to cool before continuing.

Figure 2-28: Alignment



A	Tack weld

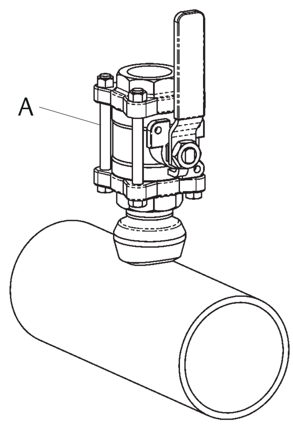
Step 3: Install the isolation valve

Procedure

1. Thread the guide nipple into the mounting.
2. Thread the isolation valve into the guide nipple, ensuring that the valve stem is positioned so that when the Flo-Tap is installed, the insertion rods will straddle the pipe and the valve handle will be centered between the rods (see Figure 2-29).

Note
Interference will occur if the valve is located inline with the insertion rods.

Figure 2-29: Install the Isolation Valve



A	Isolation valve

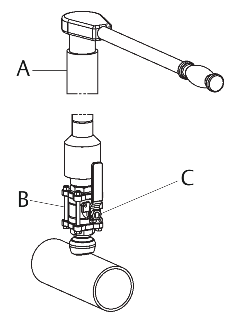
Step 4: Mount the drilling machine and drill hole

Drilling machine is not provided with the assembly.

Procedure

1. Determine the drill hole size based on the sensor size or sensor width.
2. Mount the drilling machine to the isolation valve.
3. Open the valve fully.
4. Drill the hole into the pipe wall in accordance with the instructions provided by the drilling machine manufacturer.
5. Fully retract the drill beyond the valve.

Table 2-10: Sensor Size/Hole Diameter Chart

Sensor size	Sensor width	Hole diameter		
1	0.590 in. (14.99 mm)	¾ in. (19 mm)	+ 1/32 in. (+ 0.8 mm)	
			– 0.00	
2	1.060 in. (26.92 mm)	1 5/16 in. (34 mm)	+ 1/16 in. (+ 1.6 mm)	
			– 0.00	
3	1.935 in. (49.15 mm)	2 ½ in. (64 mm)	+ 1/16 in. (+ 1.6 mm)	
			– 0.00	**A** Pressure drilling machine **B** Isolation valve is fully open when inserting drill **C** Isolation Valve is fully closed after withdrawing drill

Step 5: Remove the drilling machine

Follow these steps to remove the drilling machine:

Procedure

1. Verify the drill has been fully retracted past the valve.
2. Close the isolation valve to isolate the process.
3. Bleed drilling machine pressure and remove.
4. Check isolation valve and mounting for leakage.

Step 6: Mount the Annubar sensor

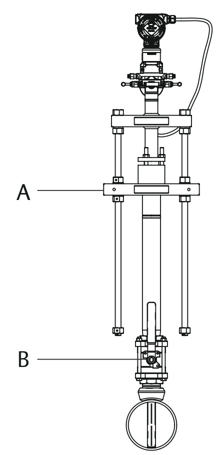
Procedure

1. Install the complete Flo-Tap assembly (fully retracted) onto the isolation valve by threading the close nipple into the valve using the proper thread sealant compound.

2. Rotate the Flo-Tap assembly until the flow arrow on the head aligns with the direction of flow in the pipe.
3. Ensure the vent valves are closed before proceeding to the next step.
4. Quickly open and close the isolation valve to pressurize the Annubar sensor. Use extreme caution if the flowing medium is steam or caustic.
5. Check the entire installation for leakage. Tighten as required to stop any connection from leaking. Repeat steps 4 and 5 until there is no leakage.
    a) If the Flo-tap comes equipped with the gear drive option, place the PVC protector rod assembly over the drive rods and attach to the gear drive with the supplied hardware.

Note
Flo-Tap Annubar sensors have the potential to carry a large amount of weight at a great distance from the piping, necessitating external support. The support plate has threaded holes to assist in supporting the Annubar sensor. Threaded holes (3/8 in.-16 UNC) are provided on the support plate for external support.

Figure 2-30: Flo-Tap Installation



A	Support plate
B	Isolation valve

Step 7: Insert the Annubar sensor

Insert the sensor with one of the two drive options available – manual drive (M) or gear drive (G).

Manual (not recommended for line sizes above 12 in. [300 mm])

Procedure

1. Open the isolation valve fully.
2. Rotate drive nuts clockwise (as viewed from the top) as shown in Figure 2-30. The nuts must be tightened alternately, about two turns at a time to prevent binding caused by unequal loading.
3. Continue this procedure until the tip of the probe firmly contacts the opposite side of the pipe.

a) The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.

b) As the orange stripe approaches the support plate, place a finger above the packing gland while cranking.

c) Turn the drive nuts an additional 1/4 to 1/2 turn to secure the sensor.

Gear drive (G)

Procedure

1. Fully open the isolation valve.
2. Rotate the crank clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.
    a) Continue rotating the crank until the sensor firmly contacts the opposite side of the pipe. The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.

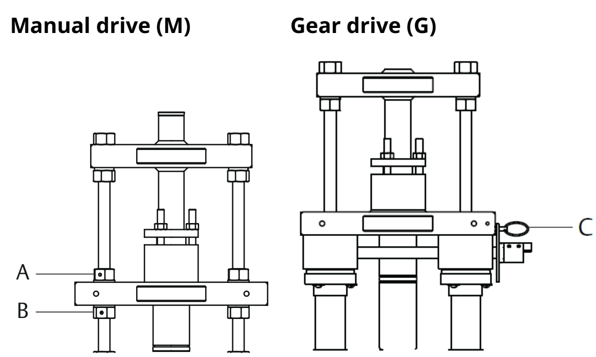
    b) As the orange stripes approach the support plate, remove the power drill and continue cranking manually. Place a finger above the packing gland while cranking. When the movement stops, the sensor is in contact with the opposite side wall.

    c) Turn the handle an additional 1/4 to 1/2 turn to secure the sensor.

3. Secure the drive by inserting the drive lock pin as shown in Figure 2-31.

Note
Do not place a finger above the packing gland for high temperature applications.

Figure 2-31: Insert Annubar Sensor



A	Lock nuts
B	Drive nuts
C	Drive lock pin

Step 8: Mount the transmitter

Direct mount head

With valves

Procedure

1. Place PTFE O-rings into grooves on the Annubar sensor head.
2. Align the high side of the transmitter to the high side of the sensor ("Hi" is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

Without valves

Procedure

1. Place PTFE O-rings into grooves on the Annubar sensor head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb. (45 N-m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the probe ("Hi" is stamped on the side of the head) and install.

   Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

Step 9: Retract the Annubar sensor

Manual drive (M)

Procedure

1. Retract by rotating the drive nuts counter-clockwise. The nuts must be turned alternately, about two turns at a time, to prevent binding caused by unequal loading.
2. Continue this procedure until the rod end nuts are against the packing body mechanism.

Gear drive (G)

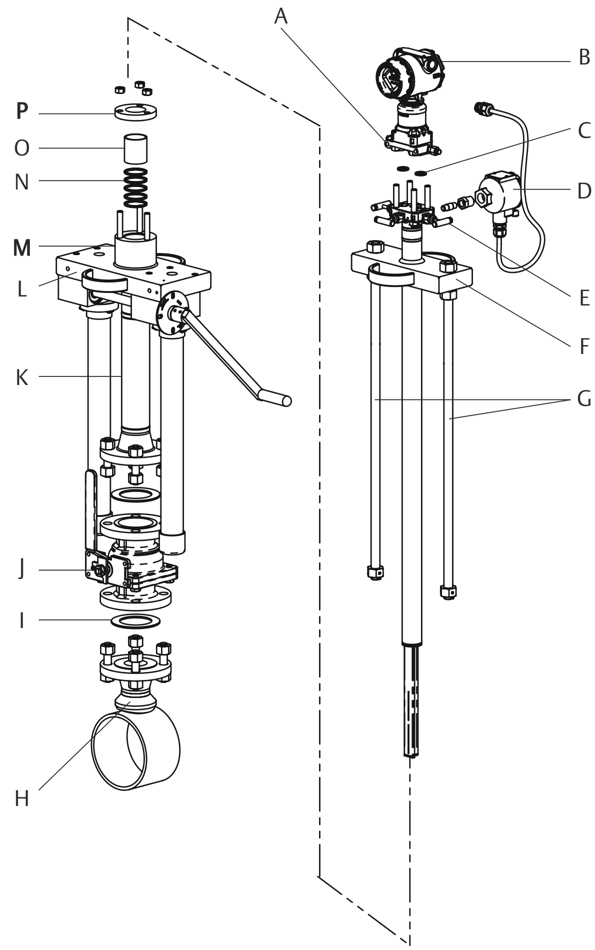
Procedure

1. Remove the drive lock pin.
2. Retract the sensor by rotating the crank counter-clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.
3. Retract until the rod end nuts are against the packing body mechanism.

2.6.5 Flanged Flo-tap (for 485 and 585 Annubar Flow Meters)

Figure 2-32 identifies the components of the Flanged Flo-Tap assembly.

Figure 2-32: Components



Transmitter and housing are shown for clarity purposes – only supplied if ordered.

- **A** Coplanar flange with drain vents
- **B** Transmitter
- **C** O-rings (2)
- **D** Temperature sensor connection housing
- **E** Direct mount transmitter connection with valves
- **F** Head plate
- **G** Drive rods
- **H** Mounting flange assembly
- **I** Gasket
- **J** Isolation valve
- **K** Cage nipple
- **L** Support plate
- **M** Packing gland
- **N** Packing
- **O** Follower
- **P** Compression plate

Step 1: Determine the proper orientation

Refer to Mounting for straight run requirements and orientation information.

Step 2: Weld the mounting hardware

Note
Rosemount-supplied mounting includes critical alignment hardware that assists in the correct drilling of the mounting hole. This significantly reduces problems encountered during insertion.

Procedure

1. At the pre-determined position, place the flanged assembly on the pipe, gap 1/16 in. (1.6 mm) and measure the distance from the outside diameter of the pipe to the face of the flange. Compare this to the chart below and adjust the gap as necessary.

Table 2-11: 485 and 585 Flange Sizes and ODF per Sensor Size

485 Sensor size	585 Sensor size	Flange type	Pressure class	Flange size/ rating/type	ODF(1) in. (mm)
1	11	A	1	1 ½ in. 150# RF	3.88 (98.6)
			3	1 ½ in. 300# RF	4.13 (104.9)
			6	1 ½ in. 600# RF	4.44 (112.8)
			N	1 ½ in. 900# RF	4.94 (125.5)
			F	1 ½ in. 1500# RF	4.94 (125.5)
			T	1 ½ in. 2500# RF	6.76 (171.7)
		R	1	1 ½ in. 150# RTJ	4.06 (103.1)
			3	1 ½ in. 300# RTJ	4.31 (109.5)
			6	1 ½ in. 600# RTJ	4.44 (112.8)
			N	1 ½ in. 900# RTJ	4.94 (125.5)
			F	1 ½ in. 1500# RTJ	4.94 (125.5)
			T	1 ½ in. 2500# RTJ	6.81 (173.0)
		D	1	DN40 PN16 RF	3.21 (81.5)
			3	DN40 PN40 RF	3.21 (81.5)
			6	DN40 PN100 RF	3.88 (98.6)
2	22	A	1	2.0 in. 150# RF	4.13 (104.9)
			3	2.0 in. 300# RF	4.38 (111.3)
			6	2.0 in. 600# RF	4.75 (120.7)
			N	2.0 in. 900# RF	5.88 (149.4)
			F	2.0 in. 1500# RF	5.88 (149.4)
			T	3.0 in. 2500# RF	9.88 (251.0)
		R	1	2.0 in. 150# RTJ	4.31 (119.5)
			3	2.0 in. 300# RTJ	4.63 (117.6)
			6	2.0 in. 600# RTJ	4.81 (122.2)

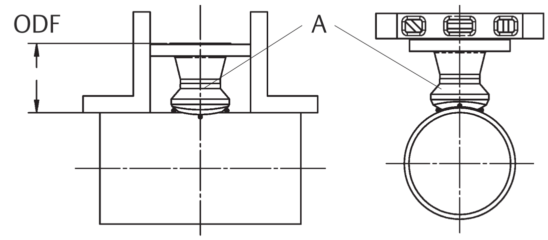
Table 2-11: 485 and 585 Flange Sizes and ODF per Sensor Size *(continued)*

485 Sensor size	585 Sensor size	Flange type	Pressure class	Flange size/ rating/type	ODF[(1)] in. (mm)
			N	2.0 in. 900# RTJ	5.94 (150.9)
			F	2.0 in. 1500# RTJ	5.94 (150.9)
			T	3.0 in. 2500# RTJ	10.00 (254.0)
		D	1	DN50 PN16 RF	3.40 (86.4)
			3	DN50 PN40 RF	3.52 (89.4)
			6	DN50 PN100 RF	4.30 (109.5)
3	44	A	1	3.0 in. 150# RF	4.63 (117.6)
			3	3.0 in. 300# RF	5.00 (127.0)
			6	3.0 in. 600# RF	5.38 (136.7)
			N	4.0 in. 900# RF	8.19 (208.0)
			F	4.0 in. 1500# RF	8.56 (217.4)
			T	4.0 in. 2500# RF	11.19 (284.2)
		R	1	3.0 in. 150# RTJ	4.81 (122.2)
			3	3.0 in. 300# RTJ	5.25 (133.4)
			6	3.0 in. 600# RTJ	5.44 (138.2)
			N	4.0 in. 900# RTJ	8.25 (209.6)
			F	4.0 in. 1500# RTJ	8.63 (219.2)
			T	4.0 in. 2500# RTJ	11.38 (289.1)
		D	1	DN80 PN16 RF	3.85 (97.8)
			3	DN80 PN40 RF	4.16 (105.7)
			6	DN80 PN100 RF	4.95 (125.7)

(1) Tolerances for the ODF dimension above a 10 in. (254 mm) line size is ±0.060 in. (1.6 mm). Below 10 in. (254 mm) line size is ±0.030 in. (0.8 mm).

2. Place four ¼ in. (6 mm) tack welds at 90° increments. Check alignment of the mounting both parallel and perpendicular to the axis of flow.
3. If the mounting alignment is within tolerances, finish weld per local codes. If outside of tolerances, make adjustments prior to making the finish weld.
4. To avoid serious burns, allow the mounting hardware to cool before continuing.

Figure 2-33: Alignment



A	Tack weld

Step 3: Install the isolation valve

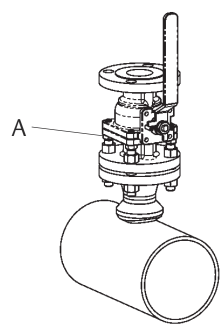
Procedure

1. Position the isolation valve onto the mounting flange. Ensure the valve stem is positioned so that when the Flo-Tap is installed, the insertion rods will straddle the pipe and the valve handle will be centered between the rods (see Figure 2-34).

   Note
   Interference will occur if the valve is located inline with the insertion rods.

2. Fasten the isolation valve to the mounting using gasket, bolts, and nuts.

Figure 2-34: Install Isolation Valve



A	Isolation valve

Step 4: Mount the drilling machine and drill hole

Drilling machine is not provided with the assembly.

Procedure

1. Determine the drill hole size based on the sensor size or sensor width.
2. Mount the drilling machine to the isolation valve.
3. Open the valve fully.
4. Drill the hole into the pipe wall in accordance with the instructions provided by the drilling machine manufacturer.
5. Retract the drill fully beyond the valve.

Table 2-12: Sensor Size/Hole Diameter Chart

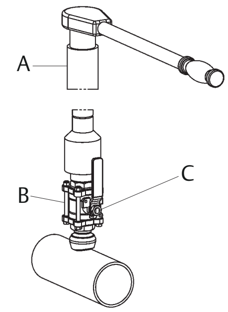
Sensor size	Sensor width	Hole diameter		
1	0.590 in. (14.99 mm)	¾ in. (19 mm)	+ 1/32 in. (+ 0.8 mm) – 0.00	 **A** Pressure drilling machine **B** Isolation valve is fully open when inserting drill **C** Isolation Valve is fully closed after withdrawing drill
2	1.060 in. (26.92 mm)	1 5/16 in. (34 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00	
3	1.935 in. (49.15 mm)	2 ½ in. (64 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00	

Table 2-13: 585 Drill Hole Sizes

Sensor size	Sensor width	Hole diameter	
11	0.80 in. (20.32 mm)	7/8 in. (22 mm)	+ 1/32 in. (+ 0.8 mm) – 0.00
22	1.20 in. (30.48 mm)	1 5/16 in. (34 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00
44	2.28 in. (57.9 mm)	2 ½ in. (64 mm)	+ 1/16 in. (+ 1.6 mm) – 0.00

Step 5: Remove the drilling machine

Procedure

1. Verify that the drill has been fully retracted past the valve.
2. Close the isolation valve to isolate the process.
3. Bleed drilling machine pressure and remove.
4. Check isolation valve and mounting for leakage.

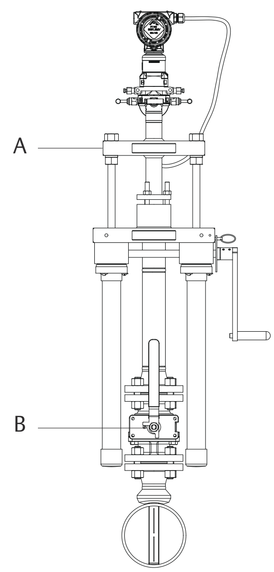
Step 6: Mount the Annubar sensor

Procedure

1. Align the flow arrow on the head with the direction of flow.
2. Use the supplied gaskets and flange bolts to fasten the Flo-Tap assembly to the isolation valve.
3. Tighten the nuts in a cross pattern to compress the gasket evenly.
4. Ensure the vent valves are closed before proceeding.
5. Quickly open and close the isolation valve to pressurize the Annubar sensor. Use extreme caution if the flowing medium is steam or caustic.
6. Check the entire installation for leakage. Tighten as required to stop any connection from leaking. Repeat Step 4 and Step 5 until there is no leakage.
    a) If the Flo-tap comes equipped with the gear drive option, place the PVC protector rod assembly over the drive rods and attach to the gear drive with the supplied hardware.

Note
Flo-Tap Annubar sensors have the potential to carry a large amount of weight at a great distance from the piping, necessitating external support. The support plate has threaded holes to assist in supporting the Annubar sensor. Threaded holes (3/8 in.-16 UNC) are provided on the support plate for external support.

Figure 2-35: Flo-Tap Installation



A	Support plate
B	Isolation valve

Step 7: Insert the Annubar sensor

Insert the sensor with one of the two drive options available – manual (M) or gear drive (G).

Manual (M) (not recommended for line size above 12 in. (300 mm))

Procedure

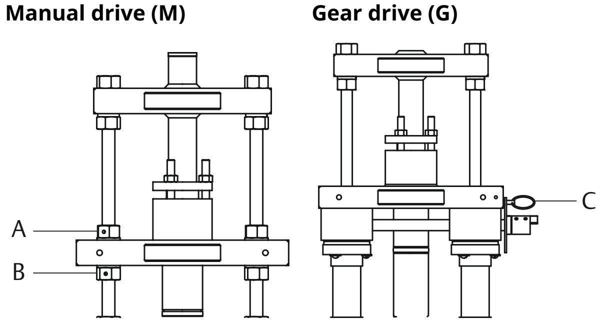
1. Open the isolation valve fully.
2. Rotate drive nuts clockwise (as viewed from the top) as shown in Figure 2-35. The nuts must be tightened alternately, about two turns at a time to prevent binding caused by unequal loading.
3. Continue this procedure until the tip of the probe firmly contacts the opposite side of the pipe.
    a) The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.
    b) As the orange stripe approaches the support plate, place a finger above the packing gland while cranking.
    c) Turn the drive nuts an additional ¼ to ½ turn to secure the sensor.

Gear drive (G)

Procedure

1. Open the isolation valve fully.
2. Rotate the crank clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.
    a) Continue rotating the crank until the sensor firmly contacts the opposite side of the pipe. The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.
    b) As the orange stripes approach the support plate, remove the power drill and continue cranking manually. Place a finger above the packing gland while cranking. When movement stops, the sensor is in contact with the opposite side wall.
    c) Turn the handle an additional ¼ to ½-turn to secure the sensor.
3. Secure the drive by inserting the drive lock pin as shown in Figure 2-36.

Figure 2-36: Insert Annubar Sensor



A	Lock nuts
B	Drive nuts
C	Drive lock pin

Step 8: Retract the Annubar sensor

Manual Drive (M)

Procedure

1. Retract by rotating the drive nuts counter-clockwise. The nuts must be turned alternately, about two turns at a time, to prevent binding caused by unequal loading.
2. Continue this procedure until the rod end nuts are against the packing body mechanism.

Gear Drive (G)

Procedure

1. Remove the drive lock pin.
2. Retract the sensor by rotating the crank counter-clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.
3. Retract until the rod end nuts are against the packing body mechanism.

Step 9: Mount the transmitter

Direct mount head

With valves

Procedure

1. Place PTFE O-rings into grooves on the face of head.
2. Align the high side of the transmitter to the high side of the sensor (“Hi” is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

Without valves

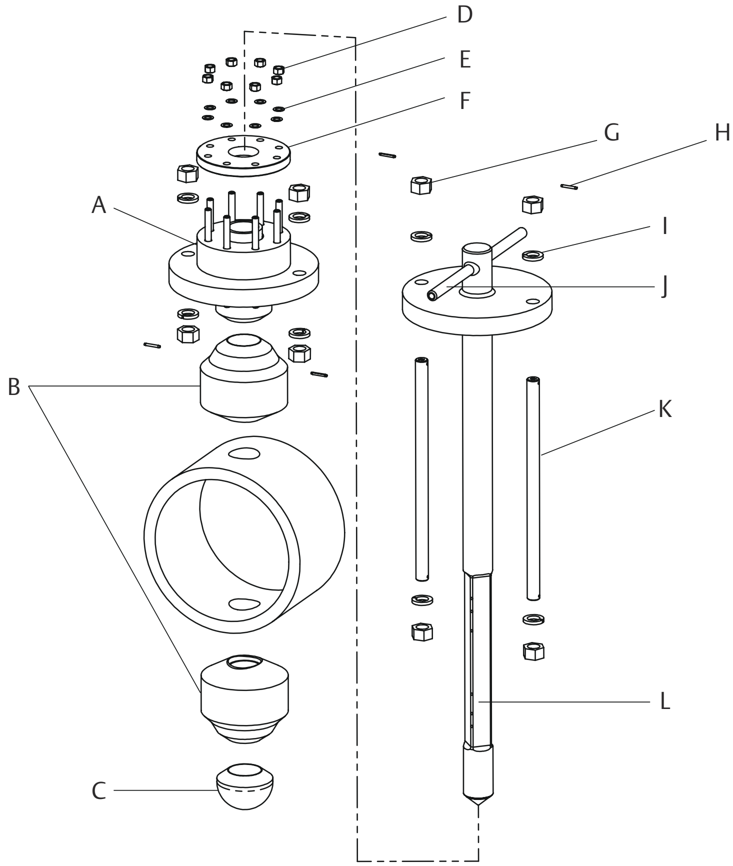
Procedure

1. Place PTFE O-rings into grooves on the face of head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb. (45 N-m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the probe ("Hi" is stamped on the side of the head) and install.
5. Tighten the nuts in a cross pattern to 400 in-lb. (45 N-m).

2.6.6 Main steam line (for 585 Annubar Flow Meters)

Figure 2-37 identifies the components of the Main Steam Annubar sensor assembly.

Figure 2-37: Components



A	Packing gland	**G**	Locking nuts
B	Weldolet	**H**	Roll pins
C	Opposite side support cap	**I**	Locking washers
D	Packing gland nuts	**J**	Remote mount instrument connections
E	Packing gland washers	**K**	Locking rods
F	Packing Gland Cover	**L**	585 sensor

Step 1: Determine the proper orientation

Refer to Mounting for straight run requirements and orientation information.

Step 2: Drill mounting hole into pipe

Procedure

1. De-pressurize and drain the pipe.
2. At the predetermined position, drill the hole into the pipe wall in accordance with the instructions provided by the drilling machine manufacturer. Drill 2½ in. (64 mm) hole. Drill hole has a tolerance of +1/16 in. or -0 in. (1.6 mm or -0 mm).
3. After the hole is drilled, deburr the hole on the inside of the pipe.

4. A second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. To drill the second hole, follow these steps:
    a) Measure the pipe circumference with a pipe tape, soft wire, or string. (For the most accurate measurement the pipe tape needs to be perpendicular to the axis of flow.)
    b) Divide the measured circumference by two to determine the location of the second hole.
    c) Re-wrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.
    d) Using the diameter determined in Step 3, drill the hole into the pipe with a hole saw or drill.

    NOTICE

    Do not torch cut the hole.

5. Deburr the drilled holes on the inside of the pipe.

Step 3: Weld the mounting hardware

An alignment bar is needed during the welding of the heavy wall weldolets to the steam pipeline. The alignment bar can be ordered from Emerson Process Management.

Procedure

1. Weld the heavy wall weldolet to the packing gland assembly with a full penetration-groove weld.
    a) Place the alignment bar through the packing gland and the weldolet. The weldolet will also have a bearing sleeve in it and it should be near the radius end of the weldolet which will be the end welded to the pipe. Ensure the support plate is attached to the packing gland before making the weld.
    b) Tack weld the weldolet to the packing gland. Remove the alignment bar.
    c) Weld the first pass. Recheck alignment with the alignment bar. Adjust alignment as necessary. Do not allow the alignment bar to get too hot, as it will be difficult to remove. Use it only briefly to check alignment between weld passes.
    d) Complete remaining weld passes, using alignment bar to verify alignment several times during the process. Emerson Process Management recommends the weld thickness is equal to the base metal thickness.
2. Weld the weldolet and packing gland assembly to the pipe.
    a) Place alignment bar back into the pipe, slide the weldolet and packing gland assembly down the alignment bar, and let it rest on the pipe.
    b) Ensure the 1⅛ in. (29 mm) holes in the support plate are perpendicular to the pipe centerline within ± 3° for horizontal lines and parallel to the pipe centerline within ± 3° for vertical lines. This will ensure the impact and static holes will be in line with the flow stream. See Figure 2-5.
    c) Tack weld the weldolet to the pipe. Check alignment. Remove the alignment bar and weld the first pass. Emerson Process Management recommends

using TIG welding for the first two passes as a minimum. Experience has shown that welding about 1/2 to 2/3 of the weld using GTAW (TIG) and then using other weld processes (GMAW, SMAW, FCAW) leads to lower chances of movement of the weldment during welding.

Note
It is very helpful to have two welders welding the assemblies to pipe, with one welder starting 180° from the other. This helps prevent movement of the fittings during the temperature changes associated with welding.

d) Check the alignment after the first pass. Remove the alignment bar and weld the next pass. Recheck alignment.

e) Continue applying weld passes and rechecking alignment until welding is complete. The fillet welds will be approximately 1⅛ in. (29 mm).

3. Weld the opposite side weldolet to the pipe.
   a) Slide the alignment bar through mounting and hole in top side of pipe and place the opposite-side support weldolet over the end of the alignment bar.
   b) Visually center the opposite-side weldolet over the hole. Tack weld the weldolet, using tack bars or an equivalent method.
   c) Weld the first pass and check alignment using the alignment bar and continue welding. Check alignment frequently during welding. Adjust weldolet as you are making tacks to keep aligned. Do not leave alignment bar in too long as it will heat up and make it very difficult to remove.
   d) When welding is complete, the alignment bar should slide freely through the packing into the opposite-side weldolet.
   e) Weld opposite end cap to weldolet using a full penetration groove weld.
4. Perform required heat treatment.
5. Reinstall 585 Main Steam Annubar sensor after heat treating and ensure the flow arrow is pointing in the direction of flow.

Step 4: Insert the Annubar sensor

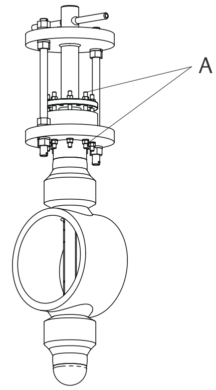
Procedure

1. Place the packing into the packing gland with the two split rings (Garlock style 1303FEP) on the outside and the three Garlock Carbon/Graphite solid die-formed rings on the inside. Make sure the splits in the outer packing are 180° apart.

   Note
   The packing gland and support plate will be shipped fully assembled.

2. Slide the 585 Annubar sensor through the packing and install the locking rods, nuts, and lock washers. The dimension between the plates should be 11.0 in. (279 mm). See Figure 2-38. If there is visual access to the inside of the pipe, ensure that the sensing holes are equally spaced from the inner diameter of the pipe.
3. Make the small adjustment (if necessary), then lock the 585 in place with the locking rods, nuts, and lock washers. When installed, the 585 will have a dimension of 29.6 in. (752 mm) from pipe OD to top of head.
4. The last thing to be done is to tighten the packing gland nuts to 25 to 30 ft-lbs. (34 to 41 N-m). See Figure 2-36.

Figure 2-38: Tighten The Packing Gland Nuts



A	Packing gland nuts

Step 5: Mount the transmitter

- Impulse piping that runs horizontally must slope downward at least one inch per foot (83 mm/m).
- Impulse piping should have a minimum length of 1 ft. (0.3048 m) for every 100 °F (38 °C) temperature increase over 250 °F (121 °C).
  - Impulse piping must be non-insulated to reduce fluid temperature.
  - Any threaded connections should be checked after the system reaches the intended temperature because connections may come loose with contraction and expansion caused by temperature change.
- Outdoor installations may require insulation and heat tracing to prevent freezing.
- When impulse piping is longer than 6 ft. (1.8 m) the high and low impulse lines must be positioned together to maintain equal temperature. They must be supported to prevent sagging and vibration.
- Impulse lines should be positioned in protected areas or against walls or ceilings. Use appropriate pipe sealing compound rated for the service temperature on all threaded connections. Do not place the impulse piping near high temperature piping or equipment.
  - An instrument manifold is recommended for all installations. Manifolds allow an operator to equalize the pressures prior to zeroing and isolates the process fluid from the transmitter.
  - **Note**
    In some cases, the primary instrument valve may be supplied by Emerson Process Management with the Annubar sensor.

    Use only valves and fittings rated for the design pressure and temperature.
  - Use a pipe thread sealant compound that is rated for use at the service temperature and pressure for all valves and fittings.
  - Verify that all connections are tight and that all instrument valves are fully closed.
  - Verify that the sensor probe is properly oriented as per the submitted outline drawings.

- The piping used to connect the sensor probe and transmitter must be rated for continuous operation at the pipeline-designed pressure and temperature. A minimum of ½ in. (12 mm) OD stainless steel tubing with a wall thickness of at least 1/16 in. (1.6 mm) is recommended.

2.7 Wire the transmitter

See appropriate transmitter manual for bench configuration information.

Transmitter	HART® document number	FOUNDATION Fieldbus™ document number	PROFIBUS® document number
Rosemount 3051S MultiVariable Mass and Energy Flow Transmitter	00809-0100-4803	N/A	N/A
Rosemount 3051S Pressure Transmitter	00809-0100-4801	00809-0200-4801	N/A
Rosemount 3095MV MultiVariable Mass Flow Transmitter	00809-0100-4716	00809-0100-4716	N/A
Rosemount 3051 Pressure Transmitter	00809-0100-4001	00809-0100-4774	00809-0100-4797
Rosemount 2051 Pressure Transmitter	00809-0100-4101	00809-0200-4101	N/A

Do not connect the powered signal wiring to the test terminals. Power may damage the test diode in the test connection.

Plug and seal unused conduit connections on the electronics housing to avoid moisture accumulation in the terminal side of the housing. Excess moisture accumulation may damage the electronics. If the connections are not sealed, the electronics should be remote mounted with the electrical housing positioned downward for drainage. Wiring should be installed with a drip loop and the bottom of the drip loop should be lower then the conduit connections and the housing.

Inductive-based transient protectors, including the Rosemount 470 transient protector, can adversely affect the output of the Annubar sensor. If transient protection is desired, install the Transient Protection Terminal Block. Consult the factory for instructions.

2.7.1 Wiring diagrams

Procedure

1. Remove the housing cover on the side marked FIELD TERMINALS. Do not remove the instrument covers in explosive atmospheres when the circuit is live.
2. Connect the lead that originates at the positive side of the power supply to the terminal marked "+" and the lead that originates at the negative side of the power supply to the terminal marked "–." Avoid contact with the leads and terminals.

3 Commissioning

3.1 Safety messages

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Refer to the following safety messages before performing any operation in this section.

⚠ WARNING

Explosions could result in death or serious injury.

Do not remove the transmitter cover in explosive atmospheres when the circuit is live.

Before connecting a Field Communicator in an explosive atmosphere, verify the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.

Both transmitter covers must be fully engaged to meet explosion-proof requirements.

Failure to follow these installation guidelines could result in death or serious injury.

Ensure only qualified personnel perform the installation.

If the line is pressurized, serious injury or death could occur by opening valves.

⚠ CAUTION

Commissioning contains information that are suggested procedures only. The user must follow all plant safety procedures for their process and location.

3.2 Transmitter commissioning

See the appropriate transmitter manual for wiring and configuration instructions.

Table 3-1: Transmitter Manual Document Numbers

Transmitter	HART® document number	FOUNDATION fieldbus™ document number	PROFIBUS® document number
Rosemount™ 3051S MultiVariable™ Mass and Energy Flow Transmitter	00809-0100-4803	N/A	N/A
Rosemount 3051S Pressure Transmitter	00809-0100-4801	00809-0200-4801	N/A
Rosemount 3095 MultiVariable Mass Flow Transmitter	00809-0100-4716	00809-0100-4716	N/A
Rosemount 3051 Pressure Transmitter	00809-0100-4001	00809-0100-4774	00809-0100-4797
Rosemount 2051 Pressure Transmitter	00809-0100-4101	00809-0200-4101	N/A

3.3 Commissioning the Annubar sensor

3.3.1 Direct mount transmitter

Prepare transmitter for service

Prior to commissioning the flow meter, perform a zero trim procedure (or "dry zero") to eliminate any positional effects to the transmitter. Refer to Figure 3-1 and Figure 3-2 for valve designations.

Procedure

1. Open first the equalizer valve(s) MEL and MEH or ME.
2. Close valves MH and ML.
3. Read the transmitter output. It should read within the range 3.98 mA to 4.02 mA. If the output is outside of this range, perform a zero trim procedure as described in transmitter manual (see Table 3-1 for transmitter manual document numbers).

"Calibrate out" line pressure effects

For applications with static pressures of 100 psi (6.9 bar) and higher, the DP sensor should be zeroed for line pressure effects. The "zero" calibration procedure is affected by static pressure and ambient temperature, but these effects can be minimized by zeroing the DP sensor at normal operating conditions.

The effect of static pressure is calibrated out by exposing the transmitter to the line pressure and performing a "zero" or wet calibration, as described below.

Although the line pressure effects are relatively small, they significantly affect the accuracy of the Annubar sensor when used with low flows.

Periodic "zero" calibration and/or commissioning is recommended to maintain the accuracy of Annubar sensor. The frequency of this type of maintenance should be established for each individual application.

Liquid service 3-valve manifold

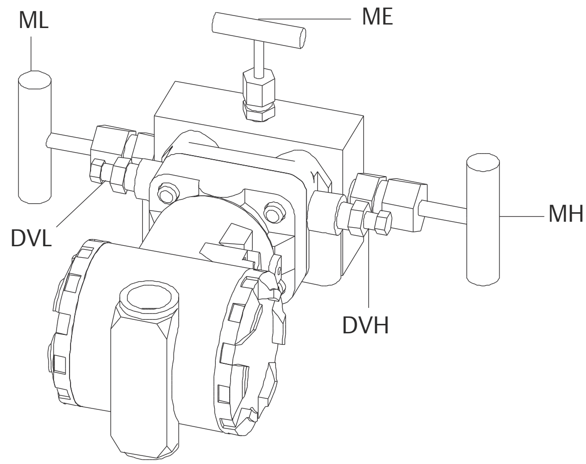
The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or "pipe" pressure.

Procedure

1. Open the high and low manifold valves MH and ML. Refer to Figure 3-1 for valve designations.
2. Open the Equalizer valve ME.
3. Open the drain/vent valves on the transmitter DVH and DVL; bleed until no air is apparent in the liquid.
4. Close both drain/vent valve DVH and DVL.
5. Close the low side manifold valve ML.
6. Check the transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then perform a zero trim procedure as described in the transmitter manual.
7. After the zero trim, if the signal reads outside of the range 3.98 mA to 4.02 mA, repeat Step 1 - Step 6.
8. Close the Equalizer valve ME.

9. Open the low side valve ML and ensure that the high side valve MH is open.
10. The system is now operational.

Figure 3-1: Valve Identification for Direct Mounted Annubar Sensor Models with 3-Valve Manifold



Liquid service 5-valve manifold

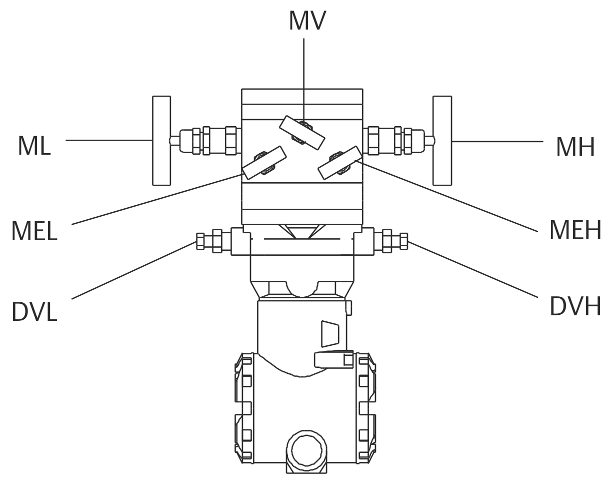
The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or "pipe" pressure.

Procedure

1. Open high and low manifold valves MH and ML. Refer to Figure 3-2 for valve designations.
2. Open high side equalizer valve MEH.
3. Open low side equalizer valve MEL.
4. Open manifold vent MV.
5. Bleed until no air is present in the liquid.
6. Close manifold vent MV.
7. Close low side manifold valve ML.
8. Check transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then perform a zero trim procedure as described in the transmitter manual.
9. After the zero trim, if the signal reads outside the range 3.98 mA to 4.02 mA, repeat Step 1 - Step 7.
10. Close low side equalizer valve MEL.
11. Close high side equalizer valve MEH.
12. Open low side manifold valve ML.

13. Ensure high side manifold valve MEH is open.
    The system is now operational.

Figure 3-2: Valve Identification for Direct Mounted Models with 5-Valve Manifold



Gas service 3-valve manifold

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or “pipe” pressure.

Procedure

1. Open the high and low manifold valves MH and ML. Refer to Figure 3-1 for valve designations.
2. Open the Equalizer valve ME.
3. Open the drain/vent valves on the transmitter DVH and DVL; bleed to ensure that no liquid is present.
4. Close both drain/vent valve DVH and DVL.
5. Close the low side valve ML.
6. Check the transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA, then perform a zero trim.
7. After zero trim, if the signal reads outside of the range 3.98 mA to 4.02 mA, repeat Step 1 - Step 6.
8. Close the Equalizer valve ME.
9. Open the low side valve ML, ensure that the high side valve MH is open. The system is now operational.

Gas service 5-valve manifold

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or “pipe” pressure.

Procedure

1. Open high and low manifold valves MH and ML. Refer to Figure 3-2 for valve designations.
2. Open high side equalizer valve MEH.

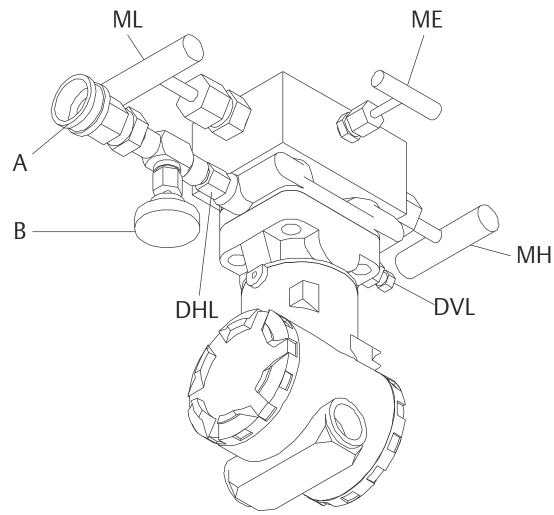
3. Open low side equalizer valve MEL.
4. Open manifold vent MV.
5. Bleed until no liquid is present in the gas.
6. Close manifold vent MV.
7. Close low side manifold valve ML.
8. Check transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then, perform a zero trim procedure as described in the transmitter manual.
9. After the zero trim, if the signal reads outside the range 3.98 mA to 4.02 mA, repeat Step 1 - Step 7.
10. Close low side equalizer valve MEL.
11. Close high side equalizer valve MEH.
12. Open low side manifold valve ML and ensure high side manifold valve MEH is open.
13. The system is now operational.

Steam service (filling the water legs)

Procedure

1. Ensure the steam line is depressurized with no steam.
2. Check the transmitter for a dry zero of 4 mA with no water loss.
3. Attach hose connection valve to high side vent DVH. See Figure 3-3.
4. Attach a water supply to the hose connection. The water supply should have a maximum psi of 100.
5. Open the high and low manifold valves MH and ML and equalizer valve ME (MEH and MEL for 5-Valve Manifolds).
6. Ensure low side vent DVL is closed.
7. Open the hose connect valve for a minimum of 30 seconds.Water will flow through both the high and low chambers and into the pipe.
8. Close the high side manifold valve MH for 30 seconds to force water to the ML side.
9. Re-open the MH valve.
10. Open low side vent DVL until no air is observed.
11. Close the low-side vent DVL.
12. Close the hose connect valve and remove hose.
13. Close both manifold high side valve MH and manifold low side valve ML.
14. Check the transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA, air is probably still in the system; repeat this procedure from step 2, and trim sensor if necessary.
15. Open the manifold high side valve MH.
16. Close equalizer valve ME (for 5-Valve Manifolds first close valve MEL, then close valve MEH).
17. Open the manifold low side valve ML. The system is now operational.

Figure 3-3: Valve Identification for Direct Mounted Annubar Sensor Models in Steam Service



A	Hose connection
B	Hose connect valve

Steam service 3-valve manifold

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or “pipe” pressure.

After flow has been started and allowed to reach operating conditions, a zero trim procedure needs to be performed.

Procedure

1. **Note**
   To burp, carefully crack vents open and closed to ensure that no air is present. This may need to be done more than once.

   Using the drain/vent valves DVH and DVL, burp. Refer to Figure 3-1 for valve designations.

   Note
   Step 1 would cause a loss of some water column in both the high and low sides, due to draining of the water legs. If Step 2 is performed, the Annubar sensor assembly should be given sufficient time to re-stabilize before continuing to Step 3.

2. Close the low side valve ML.
3. Open the Equalizer valve ME.
4. Check the transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then, perform a zero trim.
5. Close the Equalizer valve ME.
6. Open the low side valve ML, ensure that the high side valve MH is open.
   The system is now operational.

Steam service 5-valve manifold

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or "pipe" pressure.

After flow has been started and allowed to reach operating conditions a zero trim procedure needs to be performed.

Procedure

1. **Note**
   To burp, carefully crack vents open and closed to ensure that no air is present. This may need to be done more than once.

   Using the drain/vent valves DVH and DVL; burp. Refer to Figure 3-2 for valve designations.

   Note
   Step 1 would cause a loss of some water column in both the high and low sides, due to draining of the water legs. If Step 2 is performed, the Annubar sensor assembly should be given sufficient time to re-stabilize before continuing to Step 3.

2. Close the low side valve ML.
3. Open manifold vent MV.
4. Bleed until no liquid is present in the gas.
5. Close manifold vent MV.
6. Close low side manifold valve ML.
7. Check transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then, perform a zero trim procedure as described in the transmitter manual.

3.3.2 Remote mount transmitter

Prepare transmitter for service

Prior to commissioning the flow meter, a zero trim procedure (or "dry" zero) should be performed to eliminate any positional effects to the transmitter. Refer to Figure 3-1 and Figure 3-2 for valve designations.

Procedure

1. Open first the equalizer valve(s) MEL and MEH or ME.
2. Close valves MH and ML.
3. Read the transmitter output. It should read within the range 3.98 mA to 4.02 mA. If the output is outside of this range, perform a zero trim procedure as described in transmitter manual (see Table 3-1 for transmitter manual document numbers).

Check for system leaks

Check the system for leaks after installation is complete. A leak in a differential pressure instrument system can produce a difference in pressure that is larger than the signal itself.

Before the system is filled and/or commissioned, it is a simple matter to use compressed air or another inert, compressed gas to check for leaks. The gas pressure must be below the maximum allowed, but at least equal to the normal operating pressure in order to reveal potential leaks. A typical pressure used is 100 psig (690 kPa).

Before pressurizing the system, check for leaks by doing the following:

Procedure

1. Open equalizer valve(s) MEH, MEL, or ME to prevent over-pressuring the DP sensor on one side. Refer to Figure 3-4, Figure 3-5, and Figure 3-6 for valve designations.
2. Close valves PH, PL, MV, DVH, and DVL.
3. Open valves MH and ML.
4. Install all appropriate tapped plugs.
5. Apply pressure at a convenient point on either the high or low side of the system. The DVH, DVL, or MV ports could be used.
6. Use a suitable leak detection solution and apply to all of the impulse piping, valves, manifold, and connections. A leak is indicated by a continuous stream of bubbles.
7. Repair any leaks in the system by first removing pressure from the system. Repeat Step 1 - Step 6 as necessary until no leaks are detected.
8. Remove test pressure and re-install all appropriate plugs.

"Calibrate out" line pressure effects

Note
Do not begin this procedure until the system leak check has been completed on the impulse piping and all leaks have been fixed.

For applications 100 psi and higher, the DP sensor should be zeroed for line pressure effects. The "zero" calibration procedure is affected by static pressure and ambient temperature, but these effects can be minimized by zeroing the DP sensor at normal operating conditions.

The effect of static pressure is calibrated out by exposing the transmitter to the line pressure and performing a "zero" or wet calibration, as described below.

Although the line pressure effects are relatively small, they significantly affect the accuracy of the Annubar sensor when used with low flows.

Periodic "zero" calibration and/or commissioning is recommended to maintain the accuracy of Annubar sensor. The frequency of this type of maintenance should be established for each individual application.

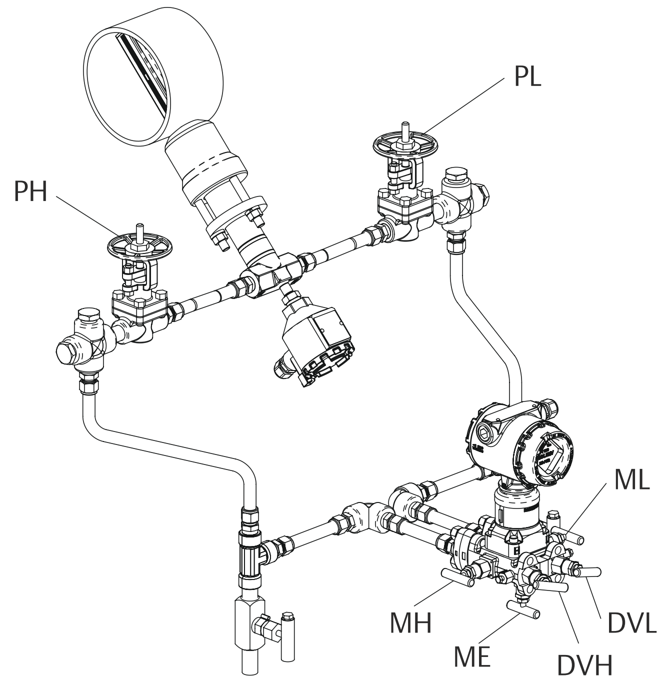
Liquid service below 250 °F (121 °C)

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or "pipe" pressure.

Procedure

1. Ensure that primary instrument valves PH and PL are *closed*. Refer to Figure 3-4 for valve designations.
2. Open valves ME, ML, and MH.
    a) For 5-valve manifolds, first open valve MEH, then open valve MEL.
3. Slowly open the low side primary instrument valve PL and then the high side primary instrument valve PH.
4. For 3-valve manifolds:
    a) Open drain/vent valves DVL and DVH to bleed air out of system. Bleed until no air is apparent in the liquid.
    b) Close valves DVL and DVH.

Figure 3-4: Remote Mount Liquid Application



5. For five-valve manifolds:
    a) Slowly open vent valve MV to bleed out any entrapped air in manifold. Bleed until no air is apparent in the liquid.
    b) Close vent valve MV.
6. Gently tap the transmitter body, valve manifold, and impulse piping to dislodge any remaining entrapped air. If air remains, repeat Step 4 or Step 5.
7. Close the low side primary instrument valve PL.
8. Check the transmitter zero by noting the output. If the signal reads outside the range 3.98 mA to 4.02 mA, air is probably still in the system; repeat the procedure from Step 2. Perform a zero trim procedure, if necessary.
9. Close equalizer valve(s).
    a) For 3-valve manifolds, close valve ME.
    b) For 5-valve manifolds, first close valve MEL, then close valve MEH.
10. Slowly open low side primary instrument valve PL. The system is now operational.
    a) For 5-valve manifolds only: Open vent valve MV. If valve MV is leaking, valves MEH and/or MEL are not fully closed or require repair. This must be done before taking any readings. Close vent valve MV once verified.

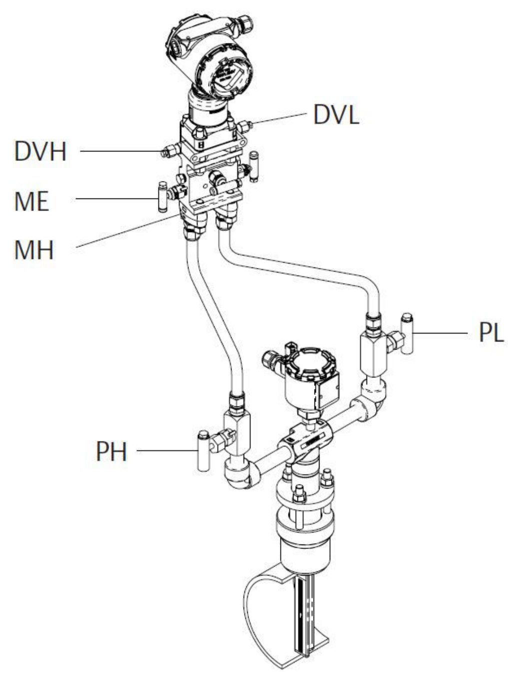
Gas service

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or “pipe” pressure.

Procedure

1. Ensure primary instrument valves PH and PL are open. Refer to Figure 3-5 for valve designations.
2. Slowly open drain valves DVH and DVL to allow the condensate to drain.
3. Close drain valves DVH and DVL.
4. Close the primary instrument valves PH and PL.
5. Open valves ME, ML, and MH.
    a) F or 5-valve manifolds, first open valve MEH, then open valve MEL.
6. Slowly open the high side primary instrument valve PH.
7. Check transmitter zero by noting the reading. If the signal reads outside of the range 3.98 mA to 4.02 mA, condensate may be in the DP transmitter or system; repeat the procedure from step 1 to remove any condensate. A signal outside the range 3.98 mA to 4.02 mA can also be caused by system leaks; check for leaks in system. Perform zero trim procedure, if necessary.
8. Close equalizer valve(s).
    a) For 3-valve manifolds, close valve ME.
    b) For 5-valve manifolds, first close valve MEH, then close valve MEL.
9. Slowly open the low side primary instrument valve PL. The system is now operational.
    a) For 5-valve manifolds only: Open vent valve MV. If valve MV is leaking, valves MEH and/or MEL are not fully closed or require repair. This must be done before taking any readings. Close vent valve MV once verified.

Figure 3-5: Remote Mount Gas Application



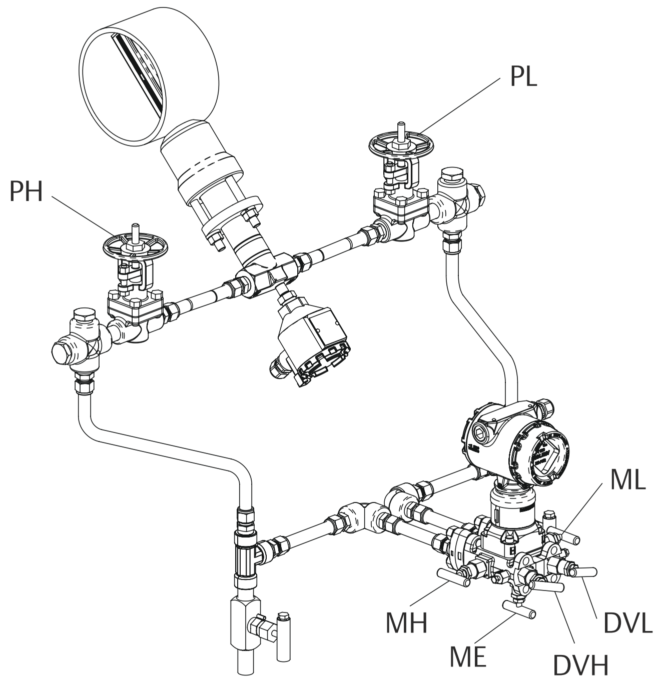
Steam service or liquid service above 250 °F (121 °C)

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or "pipe" pressure.

Procedure

1. Ensure that primary instrument valves PH and PL are *closed*; ME, ML, and MH are *closed*; and DVL and DVH are *closed*. Refer to Figure 3-6 for valve designations.
   a) For 5 -valve manifolds, ensure that valves MEH and MEL are *closed*.
2. Fill tees with water on each side until water overflows.
3. Open valves MH, ML, and equalizer valve ME.
   a) For 5-valve manifolds, open valves MH and ML and equalizer valves by first opening MEH, then opening MEL.
4. Briefly, open drain valves DVL and DVH.
5. Tap manifold until no air bubbles are visible.
6. Close both drain valves DVL and DVH.
7. Refill tees with water to the middle of each tee fitting.
8. Gently tap transmitter body, valve manifold, and impulse piping to dislodge any remaining entrapped air.
9. Check transmitter zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA, air is probably still in the system; repeat this procedure from step 2. Perform zero trim procedure, if necessary.
10. Close equalizer valve ME.
    a) For 5-valve manifolds, first close valve MEH, then close valve MEL.
11. Replace plugs in tees, allowing for air gap at the top of each tee.
12. Slowly open primary instrument valves PH and PL. The system is now operational.
    a) For 5-valve manifolds only: Open vent valve MV. If valve MV is leaking, valves MEH and/or MEL are not fully closed or require repair. This must be done before taking any readings. Close vent valve MV once verified.

Figure 3-6: Remote Mount Steam Installation



Re-check zero post equilibrium

The following procedures assume the process pipe is pressurized to normal operating pressure and should be followed to obtain a true zero at static or "pipe" pressure.

Procedure

1. Close primary instrument valves, PH and PL.
2. Remove plugs on tee fittings.
3. Check transmitter zero by noting output. Perform zero trim procedure, if necessary.
4. Re-install plugs on tee fittings.
5. Open primary instrument valves, PH and PL.

4 Operation and Maintenance

4.1 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

Explosions could result in death or serious injury.

Do not remove the transmitter cover in explosive atmospheres when the circuit is live.

Both transmitter covers must be fully engaged to meet explosion-proof requirements.

Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices.

Electrical shock could cause death or serious injury.

Avoid contact with the leads and terminals.

4.2 RTD maintenance

This section covers RTD maintenance procedures.

4.2.1 Replacing an RTD

Direct mount

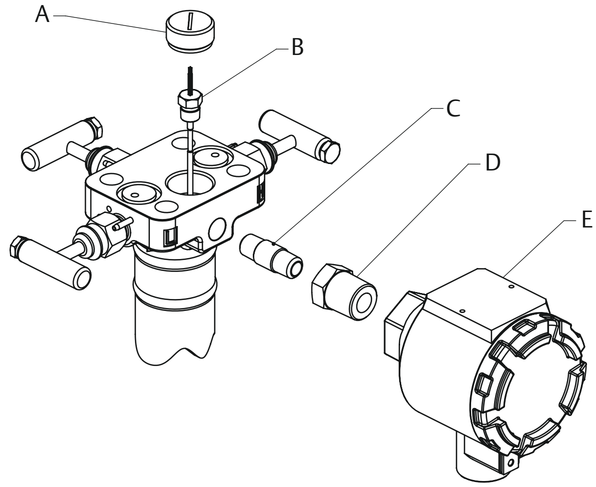
If an RTD needs to be replaced on a direct mounted Annubar Flow Meter, proceed as follows:

Procedure

1. Close instrument valves to ensure that the pressure is isolated from the transmitter.
2. Open the bleed valves on the transmitter to remove all pressure.
3. Remove the cap and the RTD wiring only from the temperature housing and from the transmitter.
4. Remove the transmitter.
5. Remove the RTD plug.
6. Pull the RTD wire out of the nipple and remove the RTD. Remove the RTD by inserting the wires through a 7/16 in. deep socket. Then use pliers or vise grips to rotate the socket. The RTD is in a thermowell. No live line pressure will be present.
7. Install the new RTD and thread finger tight plus 1/8 of a turn. Thread the wires through the nipple. Note it may be easier to remove the terminal block from the temperature housing to reinsert the RTD wires.
8. Using appropriate thread lubricant, reinstall the ½ in. NPT plug.

9. Use the same PTFE gaskets to reinstall the transmitter to the Annubar Flow Meter sensor head.
10. Use a torque wrench to tighten the stainless steel hex nuts in a cross pattern to 300 in-lbs.
11. Reconnect the RTD wires in the temperature housing and replace the cover.
12. Open the instrument valves.

Figure 4-1: Exploded View of Direct Mounted Annubar Sensor, Integral RTD Installation



A	RTD plug
B	¼″ MNPT RTD
C	¼″ MNPT close nipple
D	¼″ FNPT x ½″ MNPT adapter
E	Temperature housing

Remote mount

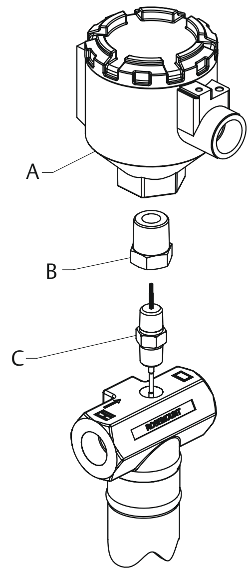
If an RTD needs to be replaced on a remote mounted Annubar Flow Meter, proceed as follows:

Procedure

1. Close instrument valves to ensure that the pressure is isolated from the transmitter.
2. Open the bleed valves on the transmitter to remove all pressure.
3. Remove the cap from the temperature housing.
4. Remove the RTD wiring from the terminal block.
5. Remove the temperature housing from the head.
6. Pull the RTD wire out of the nipple and remove the RTD. The RTD is in a thermowell. No live line pressure will be present.
7. Install the new RTD and thread the wires through the nipple.
8. Using the appropriate thread lubricant or tape, install the terminal housing onto the remote head.

9. Reconnect the RTD wires to the terminal.
10. Open the instrument valves.

Figure 4-2: Exploded View of Remote Mounted Annubar Sensor, Integral RTD Installation



A	Temperature housing
B	¼″ FNPT x ½″ MNPT adapter
C	¼″ MNPT x ¼″ MNPT RTD

4.2.2 Electrical RTD check procedure

If the RTD is not functioning properly, perform the following checks to determine if the RTD is failed. Figure 4-3 shows the schematic of a 4-wire RTD.

Continuity check

Procedure

1. Using an Ohm meter or a Multimeter, check the resistance between each of the red and white wires.
2. If the resistance measured represents the proper temperature, proceed to the Grounding Check.
3. If the resistance measured does not represent the proper temperature or no resistance is measured (i.e. Open circuit), the RTD is damaged and must be replaced.

Grounding check

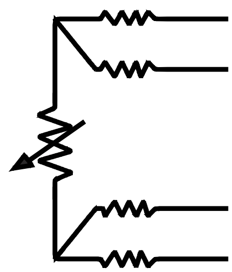
Procedure

1. Using an Ohm meter or a Multimeter, test for each wire of the RTD to the sheath for a resistance value. If the RTD is installed in the Annubar sensor, test to the instrument connections of Annubar sensor instead of the sheath of the RTD. All tests

should measure an infinite resistance (i.e. Open circuit) between the RTD wires and the sheath.

2. If all tests verify an open circuit, the RTD is functioning properly.
3. If any tests confirm a shorted wire to the RTD sheath, the RTD is damaged and must be replaced.

Figure 4-3: Schematic of a Typical 4-Wire RTD



4.3 Pak-Lok, Flange-Lok, and Flo-Tap maintenance

The Pak-Lok, Flange-Lok, and Flo-Tap models utilize a packing gland mechanism to sustain a seal on the process fluid. Periodically the packing rings need to be checked to ensure that they are continuing to seal properly.

- Check the packing gland for leaks. If a leak is present, check that the nuts are tightened down on the packing studs. If the leak persists, then the packing rings should be replaced.
- If the process fluid goes through large degrees of temperature cycling, verify that the packing is tightened down sufficiently and that the tip of the Annubar sensor is still secured against the opposite side pipe wall. A leak would indicate the packing has loosened. Also, excessive vibration of the Pak-Lok, Flange-lok, or Flo-tap model could indicate the tip of the sensor is no longer secured to the pipe wall. For the Pak-lok or Flange-lok models, re-tighten the nuts to ensure that the packing is sufficiently tightened and that the tip of the Annubar sensor is still secured against the opposite side pipe wall. For the Flo-tap models, tighten the drive nuts or rotate the crank clockwise until the sensor is secured against the opposite side pipe wall. Re-tighten the packing gland nuts to ensure that the packing is sufficiently tightened.
- If there is excessive vibration present in the Annubar sensor, immediate attention is required as the sensor may no longer be secured against the opposite side pipe wall. This could result in the sensor bending, cracking, or breaking. For the Pak-lok or Flange-lok models, re-tighten the nuts to ensure that the packing is sufficiently tightened and that the tip of the Annubar sensor is still secured against the opposite side pipe wall. For the Flo-tap models, tighten the drive nuts or rotate the crank clockwise until the sensor is secured against the opposite side pipe wall. Re-tighten the packing gland nuts to ensure that the packing is sufficiently tightened. If excessive vibration is still present, contact an Emerson Process Management representative.
- If the packing rings appear brittle, old, or compressed beyond further use, a new set of rings should be ordered for replacement. Installation instructions can be found in Installation of this manual.

Table 4-1: Replacement Part Numbers for Pak-Lok, Flange-Lok, and Flo-Tap Packing

Model	Packing kits	Part number
Pak-Lok or Flange-Lok	Sensor Size 1 Grafoil (Standard)	28-503002-920
	Sensor Size 2 Grafoil (Standard)	28-503002-921
	Sensor Size 3 Grafoil (Standard)	28-503002-922
	Sensor Size 1 PTFE (Option P2)	28-503002-910
	Sensor Size 2 PTFE (Option P2)	28-503002-911
	Sensor Size 3 PTFE (Option P2)	28-503002-912
Flo-tap	485 Sensor Size 1 Grafoil (Standard)	28-505010-900
	485 Sensor Size 2/585 Sensor Size 22 Grafoil (Standard)	28-505010-901
	485 Sensor Size 3/585 Sensor Size 44 Grafoil (Standard)	28-505010-902
	485 Sensor Size 1 PTFE (Option P2)	28-505010-910
	485 Sensor Size 2/585 Sensor Size 22 PTFE (Option P2)	28-505010-911
	485 Sensor Size 3/585 Sensor Size 44 PTFE (Option P2)	28-505010-912

4.4 Gas entrapment

In certain liquid applications (i.e. – buried water lines) it may be necessary to mount the transmitter and Annubar sensor above the pipe. This can lead to gas entrapment in the impulse piping which causes erratic flow readings.

One way to combat this problem is to install Automatic Vent Packages (AVP) on the impulse lines. The vents will purge the gas periodically and keep the impulse lines clear. The key to the installation is installing the vents and impulse piping so that any gas travels up to the vents and away from the transmitter. Vents can usually be installed at any time. Contact your Emerson Process Management representative for more details.

4.5 Dirt accumulation

One inherent advantage of an Annubar primary element over devices such as orifice plates is the ability to function in flows carrying dirt and grease. However, under extreme cases, some of the sensing ports are completely obstructed or the outside shape is drastically changed by buildup.

There are two methods of cleaning the Annubar primary element to restore performance. Mechanical cleaning is the more certain method, but does require removal of the Annubar primary element. Purging is effective if the accumulation covers the sensing ports or blocks internal passages.

In applications where a large amount of foreign material exists, it may be necessary to perform a routine preventative maintenance by removing the Annubar primary element for cleaning. The outer surfaces should be cleaned with a soft wire brush. The internal passages should be cleaned with compressed air. If necessary, a solvent for dissolving foreign material may be appropriate.

Purging with an external fluid source under a higher pressure is an effective means of retaining clear pressure pathways in the Annubar primary element.

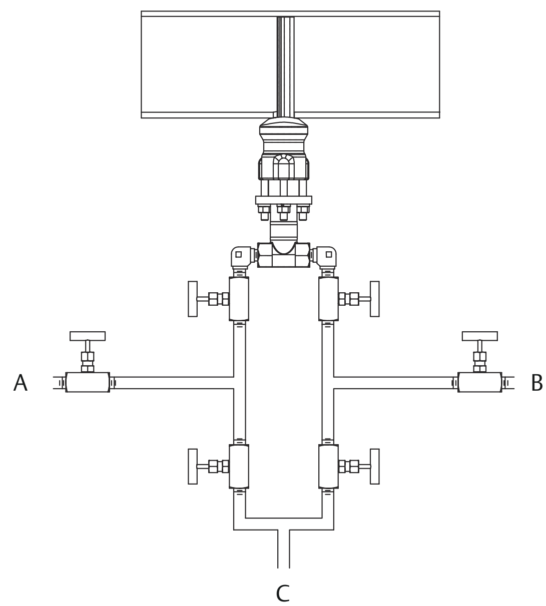
The following precautions should be taken:

1. The purging fluid must be compatible with the process fluid and shouldn't cause other problems such as contamination.
2. The purging fluid should be preheated or pre-cooled if the temperature difference of the fluid and the process exceeds 150 °F (66 °C).
3. The differential pressure transmitter or meter should be isolated from the purge fluid to prevent over-ranging.
4. Continuous purging is not recommended.

The length of time between purges, or the cycle time, as well as the length and volume of the purge cycle must be determined experimentally. Some guidelines established as a starting point for experimentation are as follows:

1. Supply pressure of at least 60 PSIG (415 kPa-g) and not exceeding 115 PSIG (795 kPa).
2. Purge air flow rate of at least 40 SCFM (68 Nm^3/h) when flowing at 60 PSIG (415 kPa).
3. Purge duration of at least 60 seconds.
4. Purge with dry air (less than 5% moisture by weight).
5. Stainless steel purge tubing should have a minimum of ½ in. (12.5 mm) O.D. and at least 0.035 in. (0.89 mm) wall thickness. Care must be taken to protect the secondary instrumentation from high pressures and temperatures when purging an Annubar primary element. Ear protection is also recommended for all personnel in the vicinity of the system being purged. See figure for sample set-up.

Figure 4-4: Impulse Tube Arrangement for Purge



A	To high side of secondary element
B	To low side of secondary element
C	To external source of fluid pressure

4.6 Main steam line Annubar sensor maintenance

Due to the extreme conditions that the Rosemount™ 585 Main Steam Line Annubar Flow Meters come into contact with, it should be removed and inspected annually to check for wear. Emerson Process Management recommends a visual inspection and a Dye Penetrant; examine to identify any cracks or wear on the Annubar sensor. After the Annubar sensor is inspected, it is recommended to replace the packing rings to ensure a proper seal. Pak-Lok, Flange-Lok, and Flo-Tap maintenance shows the replacement part numbers for the packing rings and other spare parts.

Table 4-2: Replacement Part Numbers for the Packing Rings and Other Spare Parts

Packing kits	Part number	Quantity
Packing Rings – Split	19006-67	2
Packing Rings – Solid Carbon/Graphite	19006-04	3
Packing Gland Stud	16147-07	16
Packing Gland/Support Plate Nuts	16068-06	16
Support Plate Lock Washers	00-101005-01	8
Packing Gland Washers	16103-01	8
Locking Rod	30343-02	2
Roll Pins for Locking Rod	00-101007-01	4
Locking Nuts	16068-01	8
Locking Washers	00-101005-03	8

Emerson Process Management also recommends that the Annubar sensor is removed for steam blow down and other maintenance procedures. The sensor must be replaced with the packing gland plug to seal the mounting hardware.

4.6.1 Removal procedures

Procedure

1. Allow the Annubar sensor and the mounting hardware to cool.
2. Loosen the Packing Gland Nuts.
3. Remove the Locking Nuts and Washers from the top of the Locking Rods.
4. Slide the Annubar Sensor out of the mounting hardware.

4.6.2 Installation of the packing gland plug

Procedure

1. Place the packing into the packing gland with the two split rings (Garlock style 1303FEP) on the outside and the three Garlock Carbon/Graphite solid die-formed rings on the inside. Make sure the splits in the outer packing are 180° apart.
2. Slide the Packing Gland Plug through the packing and install the locking rods, nuts, and washers.
3. Tighten the packing gland nuts to 25 to 30 ft.-lbs. (34 to 41 Nm).

   Refer to Installation of this manual for re-installation procedures of the Annubar sensor.

5 Troubleshooting

5.1 Basic troubleshooting

If a malfunction is suspected despite the absence of a diagnostic message on the communicator display, follow the procedures described below to verify that the flow meter hardware and process connections are in good working order. Always approach the most likely and easiest-to-check conditions first.

Table 5-1: Troubleshooting Guide

Symptom	Possible cause	Corrective action
Low Reading	Annubar sensor not fully installed (not spanning the inner diameter of the pipe)	• Verify the actual pipe ID and wall dimensions and compare to the Calculation Data Sheet. • Consult Factory if dimensions do not match. • During re-installation mark tip of Annubar® sensor, install, remove and inspect marking to insure contact with opposite side of the pipe.
	Annubar sensor not aligned properly in flow profile	• Refer to the installation instructions in Installation of this manual for proper alignment straight across pipe I.D., with upstream sensing holes facing straight upstream in flow profile.
	Annubar sensor not installed in proper pipe size	• Verify the actual pipe ID and wall dimensions and compare to the Calculation Data Sheet. • Consult Factory if dimensions do not match.
	Annubar sensor installed too close to an upstream flow disturbance, such as a pipe elbow.	• Compare installation to recommended straight pipe run referenced in the installation instructions in Installation of this manual.
	DP Transmitter not zeroed properly, or not configured correctly	• Verify DP sensor has been zeroed properly. • Verify transmitter range is correct, and if square root output is correct. • Verify Annubar sensor calc sheet represents fluid density properly so that transmitter is configured correctly for the application.
High Reading	Annubar sensor not installed in proper pipe size	• Verify the actual pipe ID and wall dimensions and compare to the Calculation Data Sheet. • Consult Factory if dimensions do not match.
	DP transmitter not zeroed properly or not configured properly	• Verify DP sensor has been zeroed properly. • Verify transmitter range is correct, and if square root output is correct. • Verify Annubar sensor calc sheet represents fluid density properly so that transmitter is configured correctly for the application.

Table 5-1: Troubleshooting Guide *(continued)*

Symptom	Possible cause	Corrective action
Erratic Signal/ Negative Reading/ No reading	Annubar sensor is installed backwards	• Verify that the flow arrow on the instrument connections of the Annubar sensor is pointing in the direction of flow.
	Annubar sensor is broken or missing	• Remove sensor and verify that the Annubar sensing element is in tact and undamaged.
	Instrument valves are closed	• Verify the high and low instrument valves are open.
	Annubar Flow Meter is mounted too close to flow disturbance	• Verify the installation and compare with recommended installation distances from disturbances as shown in Installation section of this manual.
	Air in instrument impulse lines (liquid applications)	• Reinstall impulse lines, eliminating high areas in which air can collect.
	Noisy DP signal from vertical down steam or liquid application	• Relocate Annubar sensor to a location that is not vertical down or use the transmitter dampening to smooth out the DP signal.
Annubar sensor too long or too short	Pipe dimensions were not properly supplied	• Verify the actual pipe ID and wall dimensions and compare to the Calculation Data Sheet. • Consult Factory if dimensions do not match.
	The mounting hardware supplied is not the correct length	• Check mounting height and compare to the dimensions shown in the Dimensional Drawings. • Consult factory if dimensions do not match.
	Annubar sensor looks too long (Pak-lok or Flange-lok Models)	• Verify the actual pipe ID and wall dimensions and compare to the Calculation Data Sheet. • Consult factory if dimensions do not match. • Review the installation instructions found in section 2 and review the images of a proper installation.
	Opposite Side Support is not installed on pipe	• Install Opposite side support (if required by Annubar sensor model) as specified in the installation instructions found in Installation .
Annubar sensor won't fit in the drilled hole	Drill hole is not the proper size	• Verify that the drill hole matches the size specified in the installation instructions found in Installation . • Re-drill the mounting hole with proper drill hole size.
	Drill hole is not aligned properly with Annubar sensor mounting hardware	• Verify that the mounting hardware is centered over pipe hole. • If necessary, re-install mounting hardware.
	Hole was torch-cut (pipe fragments blocking hole)	• Re-Drill the hole in a different location as specified in the installation instructions found in Installation .

Table 5-1: Troubleshooting Guide *(continued)*

Symptom	Possible cause	Corrective action
Severe Vibration of the Sensor	Annubar sensor is not properly sized for the application	• Verify process conditions on the Calculation Data Sheet are accurate. • Consult Factory if process conditions have changed.
	The tip of the Annubar Flow Meter is not properly bottomed for Pak-lok, Flange-lok or Flo-tap Models	• For Flo-tap models, turn crank handle until the sensor is bottomed per the installation instructions found in Installation . • For Pak-lok and Flange-lok models, tighten the nuts per the installation instructions found in Installation .
	Excessive Pipe Vibration	• Check vibration on pipe and install additional supports for Annubar sensor if necessary. Consult factory.
Incorrect Measurement	Failed RTD	• See maintenance section for removal and testing of RTD element.
	Transmitter out of calibration	• See calibration procedures for the appropriate style transmitter.
	Transmitter improperly configured	• Verify flow configuration information for MultiVariable™ Mass Flow Transmitters or scaled variable information for 3051S DP transmitters. • Also verify the 20 mA point set in the transmitter corresponds to the 20 mA point in the control system.

5.2 Return of materials

To expedite the return process, call the Rosemount™ National Response Center toll-free at 800-654-7768. This center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for the following information:

- Product model
- Serial numbers
- The last process material to which the product was exposed

The center will provide:

- A Return Material Authorization (RMA) number
- Instructions and procedures that are necessary to return goods that were exposed to hazardous substances

Note
If a hazardous substance is identified, a Material Safety Data Sheet (MSDS), required by law to be available to people exposed to specific hazardous substances, must be included with the returned materials.

6 Reference data

6.1 Product certifications

To view current product certifications for your product, follow these steps:

Procedure

1. Using the **Search** function at www.Emerson.com, locate and navigate to the catalog page for your product.
2. Scroll as needed to the green menu bar.
3. Select **Documents & Drawings**.
4. Click **Manuals & Guides**.
5. Select the appropriate Quick Start Guide.

6.2 Ordering information, specifications, and drawings

To view current ordering information, specifications, and drawings, follow these steps:

Procedure

1. Using the **Search** function at www.Emerson.com, locate and navigate to the catalog page for your product.
2. Scroll as needed to the green menu bar.
3. Select **Documents & Drawings**.
4. For installation drawings, click **Drawings & Schematics** and select the appropriate document.
5. For ordering information, specifications, and dimensional drawings, click **Data Sheets & Bulletins** and select the appropriate Product Data Sheet.

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For more information: **Emerson.com/global**

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