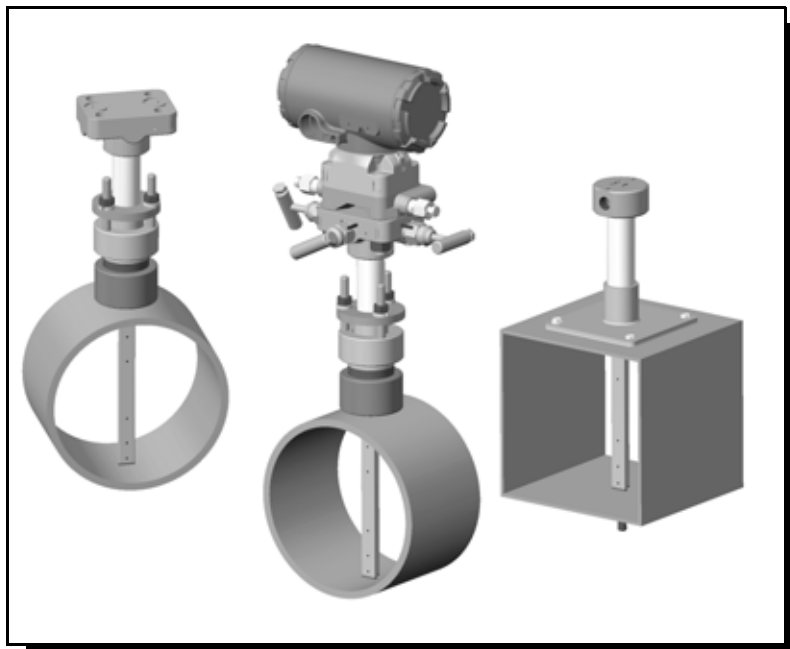


The 285 Annubar[®] Primary Element Series



HART
FIELD COMMUNICATIONS TECHNOLOGY



285 Annubar Primary Element Series

NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure 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

⚠ 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 Rosemount nuclear-qualified products, contact your local Rosemount Sales Representative.

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

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USING THIS MANUAL

This product manual provides installation, configuration, calibration, troubleshooting, and maintenance instructions for the Annubar Flowmeter Series.

Section 2: Installation

- Installation flowchart and checklist
- Orienting, mounting, and installing the flowmeter
- Commissioning the flowmeter according to the application

Section 3: Commissioning

- Commissioning on the Bench
- Commissioning the 285 with the 2024 transmitter

Section 4: Operation and Maintenance

- Troubleshooting information
- Disassembly

Appendix A: Specifications and Reference Data

- Specifications
- Dimensional drawings

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Rosemount 285

RECEIVING AND INSPECTION

Annubar Primary Elements are available in different models and with different options, so it is important to inspect and verify that the appropriate model was delivered before installation.

Upon receipt of the shipment, check the packing list against the material received and the purchase order. All items are tagged with a model number, serial number, and customer tag number. Report any damage to the carrier.

RETURNING THE PRODUCT

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.

CONSIDERATIONS

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

Limitations

Structural

Structural limitations are printed on the sensor tag. Exceeding structural limitations may cause sensor failure.

Functional

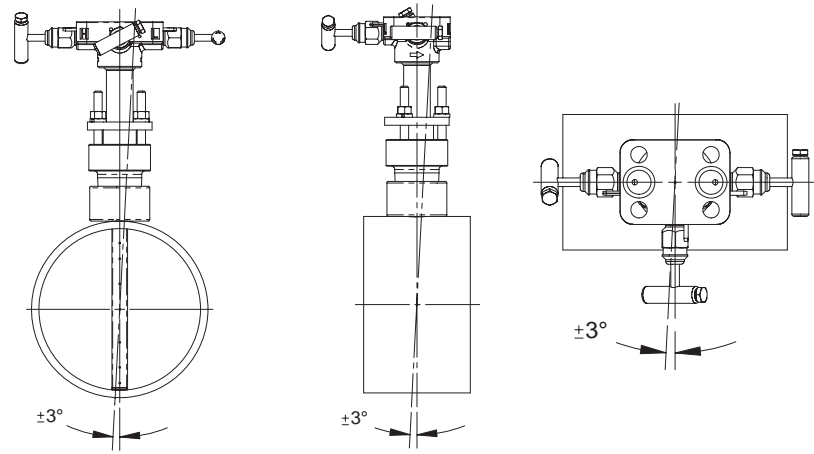
The most accurate and repeatable flow measurement occurs in the following conditions:

- 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.

Install the flowmeter in the correct location within the piping branch to prevent measurement inaccuracies caused by flow disturbances.

The flowmeter can be installation with a maximum misalignment of 3 degrees (see Figure 1-1). Misalignment beyond 3 degrees will cause flow measurement errors.

Figure 1-1. Permissible Misalignment



Environmental

Mount the Annubar Primary Element in a location with minimal ambient temperature changes. Appendix A: 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 flowmeter when choosing an installation location and orientation.

Process Flange Orientation

Orient the process flanges on a remote mounted Annubar Primary Element 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.

Optional Electronics Housing

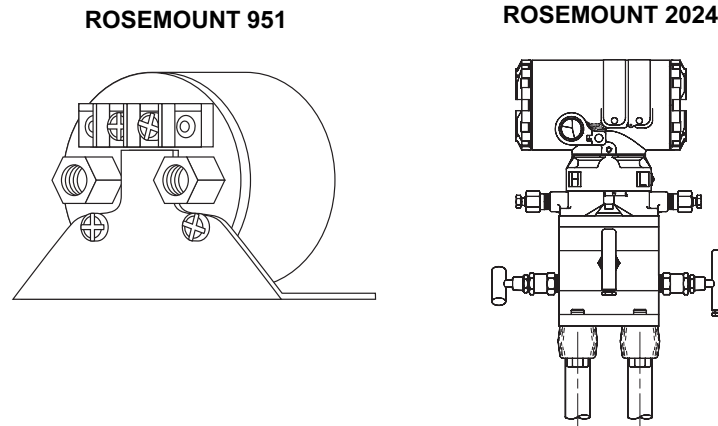
Terminal Side

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 side of the housing. The field terminal side is marked on the electronics housing. Mount the flowmeter 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. A 3-in. (76 mm) clearance is required for cover removal if a meter is installed.

Cover Installations

Always install the electronics housing covers metal-to-metal to ensure a proper seal.

Figure 1-2. Electronics Housing



Process Considerations

The process connections on the 2024 transmitter flange are 1/4–18 NPT. These are Class 2 threads; use the plant-approved lubricant or sealant when making the process connections. The process connections on the transmitter flange are on 2 1/8-in. (54 mm) centers to allow direct mounting to a three- or five-valve manifold. The process connections on the 951 transmitter are 1/8-27 NPT. These are class 3 threads; use the plant-approved lubricant or sealant when making the process connections. The process connections on the transmitter are 1 1/2-in. (39 mm) apart.

Electrical

For the Rosemount 951 electrical installation see 00825-0100-4362.
For the Rosemount 2024 electrical installation see 00809-0100-4592.

Section 2 Installation

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SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Please 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 Rosemount HART 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.

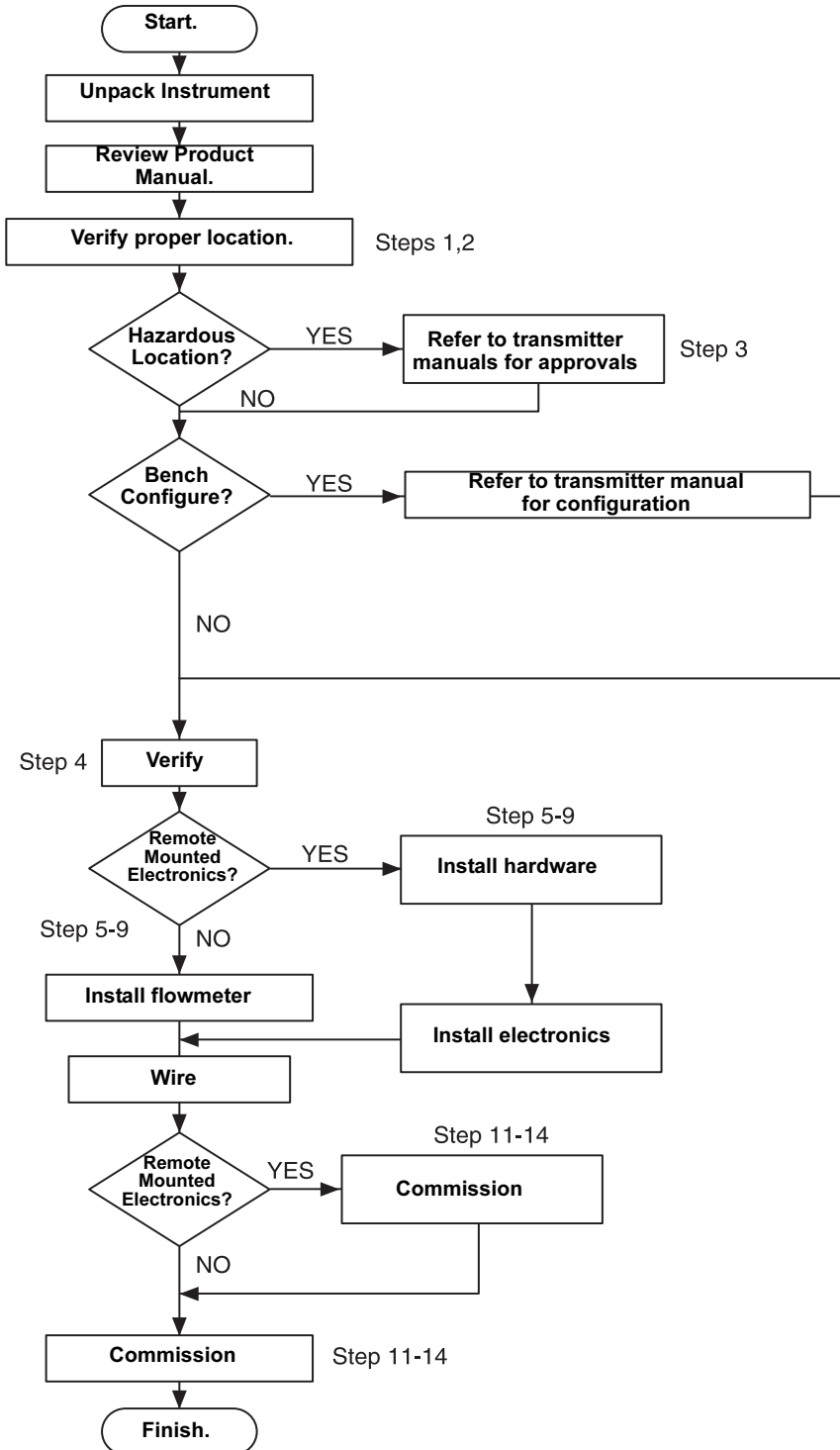
Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

INSTALLATION FLOWCHART AND CHECKLIST

Figure 2-1 is an installation flowchart that provides guidance through the installation process. Following the figure, an installation checklist has been provided to verify that all critical steps have been taken in the installation process. The checklist numbers are indicated in the flowchart.

Figure 2-1. Installation Chart



The following list is a summary of the steps required to complete a flowmeter installation. If this a new installation, begin with step 1. If the mounting is already in place, verify that the hole size and the fittings match the recommended specifications (see Table 2-3 on page 2-13) and begin with step 5.

1. Determine where the flowmeter is to be placed within the piping system.
2. Establish the proper orientation as determined by the intended application.
3. Review the transmitter manual and determine if the flowmeter is located in a hazardous location.
4. Confirm the configuration.
5. Drill the correct sized hole into the pipe.

For instruments equipped with opposite-side support, drill a second hole 180° from the first hole.

6. Weld the mounting and clean the burrs and welds.
7. Measure the pipe's internal diameter (ID), preferably at 1 x ID from the hole (upstream or downstream).

NOTE

To maintain published flowmeter accuracy, provide the pipe ID when purchasing the flowmeter.

8. Check the fit-up of the instrument assembly to the pipe.
9. Install the flowmeter.
10. Wire the instrument.
11. Supply power to the flowmeter.
12. Perform a trim for mounting effects.
13. Check for leaks.
14. Commission the instrument

MOUNTING

Tools and Supplies

Tools required include the following:

- Open end or combination wrenches (spanners) to fit the pipe fittings and bolts: 9/16-in., 5/8-in., 7/8-in.
- Adjustable wrench: 15-in. (1½-in. jaw).
- Nut driver: 3/8-in. for vent/drain valves (or 3/8-in. wrench).
- Phillip's screwdriver: #1.
- Standard screwdrivers: ¼-in., and 1/8-in. wide.
- Pipe wrench: 14-in.
- Wire cutters/strippers

Supplies required include the following:

- ¼-in. tubing (recommended) or ¼-in. pipe 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) and
- Six tube/pipe fittings (for tube)
- Pipe compound or Teflon (PTFE) tape (where local piping codes allow).

Mounting Brackets

Mounting bracket for the 951 transmitter will facilitate mounting to a panel or wall.

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 2024 transmitter 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 Emerson Process Management 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. Rosemount bolts are identified by the following head markings:

Figure 2-2. Bolts

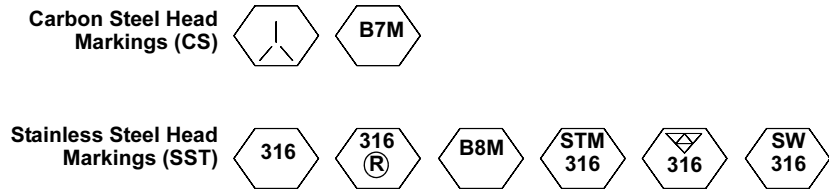
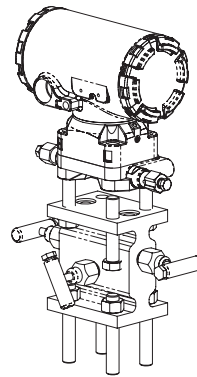


Figure 2-3. Coplanar Mounting Bolts and Bolting Configurations for Coplanar Flange.



Instrument Manifolds

Figure 2-4 identifies the valves on a 3-valve manifold. Table 2-1 explains 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 electronics as well as to isolate the electronics from the rest of the system without disconnecting the impulse piping.

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 2-4. Valve Identification for a 3-Valve Manifold

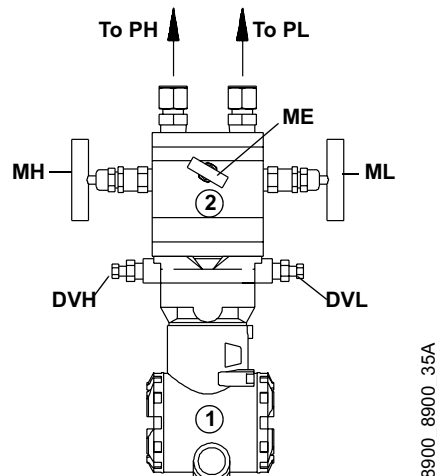


Table 2-1. Description of Impulse Valves and Components

Name	Description	Purpose
Manifold and Impulse Pipe Valves		
PH	Primary Sensor – High Pressure	Isolates the flowmeter 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	
Components		
1	Electronics	Reads Differential Pressure Isolates and equalizes electronics.
2	Manifold	
3	Vent Chambers	Collects gases in liquid applications.
4	Condensate Chamber	Collects condensate in gas applications.

Straight Run Requirements

Use the following to aid in determining the straight run requirements

NOTE

- If longer lengths of straight run are available, position the mounting such that 80% of the run is upstream and 20% is downstream.
- Straightening vanes may be used to reduce the required straight run length.
- Row 5 in Table 2-2 is to be used if a “through type” valve will remain open. Row 6 in Table 2-2 applies to gate, globe, plug, and other throttling valves that are partially opened, as well as control valves.

Table 2-2. Straight Run Requirements

	Upstream Dimensions					Downstream Dimensions
	Without Vanes		With Vanes			
	In Plane A	Out of Plane A	A'	C	C'	
<p>1</p>	8	10	—	—	—	4
—	—	8	4	4	4	
<p>2</p>	11	16	—	—	—	4
—	—	8	4	4	4	
<p>3</p>	23	28	—	—	—	4
—	—	8	4	4	4	
<p>4</p>	12	12	—	—	—	4
—	—	8	4	4	4	

Figure 2-5. Mounting Configuration

Table 1. Minimum straight duct requirements for the 285 Annubar

	Upstream Length	Downstream Length
	7W	2W
	7W	2W
	15W	2W
	7W	2W
	15W	2W

Direct Mount

Horizontal Pipes

Liquid or Steam Applications

Due to the possibility of air getting trapped in the probe, the sensor should be located according to Figure 2-6 for liquid or steam applications. The area between 0° and 30° angle should not be used unless full bleeding of air from the probe is possible.

For liquid applications, mount the side drain/vent valve upward to allow the gases to vent.

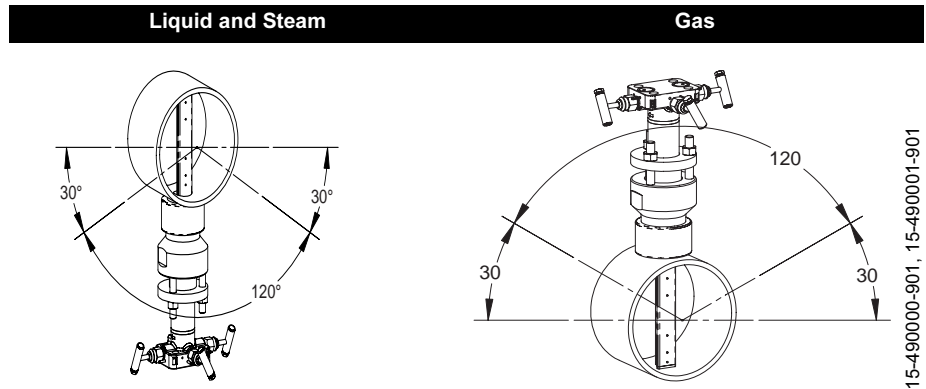
In steam applications, fill the lines with water to prevent the steam from contacting the electronics. Condensate chambers are not required because the volumetric displacement of the electronics is negligible.

Air and Gas Applications

Figure 2-6 illustrates the recommended location of the flowmeter in air or gas applications. The sensor should be located on the upper half of the pipe, at least 30° above the horizontal line.

For air and gas applications, mount the drain/vent valve downward to allow liquid to drain.

Figure 2-6. Horizontal Pipe Applications



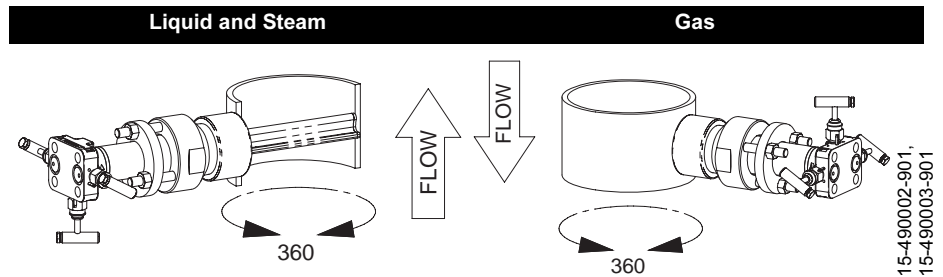
Vertical Pipes

Liquid, Steam, Air, and Gas Applications

Figure 2-7 illustrates the recommended location of the flowmeter in liquid, air, or gas applications.

The 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.

Figure 2-7. Vertical Pipe Applications



Remote Mount

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 Appendix A: Reference Data.
- Verify that all connections are tight and that all instrument valves are fully closed.
- Verify that the sensor probe is properly oriented for the intended type of service: liquid, gas or steam (see “Direct Mount” on page 2-8 and “Remote Mount” on page 2-9).

Impulse Piping

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

The following restrictions and recommendations apply to impulse piping location.

- Piping used to connect the sensor probe and electronics 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 (83mm/m).

It must slope downwards (toward the electronics) for liquid and steam applications.

It must slope up (away from the electronics) 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 electronics temperature. Impulse piping must be uninsulated to reduce fluid temperature. All threaded connections should be checked after the system comes up to temperature, because connections may be loosened by the expansion and contraction caused by temperature changes.
- A minimum of 1/4-in. (6.35 mm) outer diameter (OD) stainless steel tubing with a wall thickness of at least 0.035-in. (0.9 mm) is recommended.
- Outdoor installations for liquid, saturated gas, or steam service may require insulation and heat tracing to prevent freezing.
- For installations where the electronics are more than 6-ft. (1.8m) from the sensor probe, 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.

Horizontal Pipes

Liquid or Steam Applications

Due to the possibility of air getting trapped in the probe, the sensor should be located according to Figures 2-8 and 2-10 for liquid or steam applications. The area between 0° and 30° angle should not be used unless full bleeding of air from the probe is possible.

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

Air and Gas Applications

Figure 2-9 illustrates the recommended location of the flowmeter in air or gas applications. The sensor should be located on the upper half of the pipe, at least 30° above the horizontal line.

Figure 2-8. Liquid Service

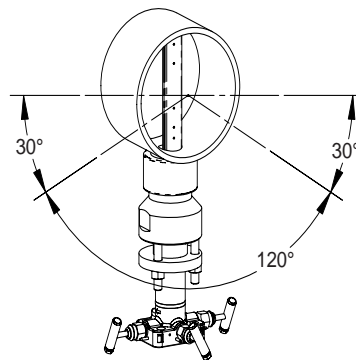


Figure 2-9. Gas Service

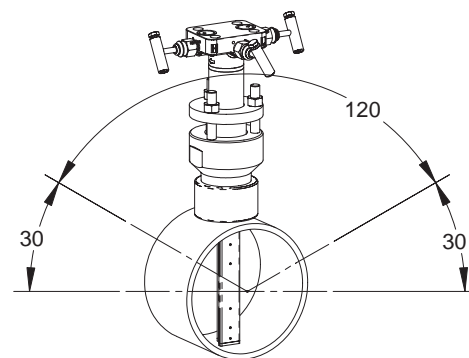
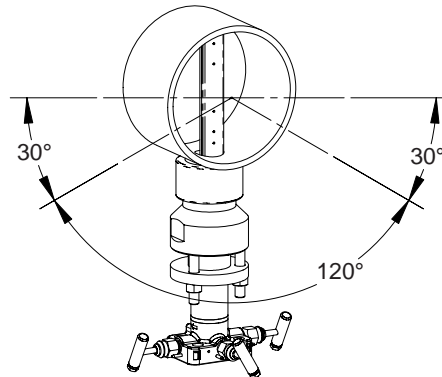


Figure 2-10. Steam Service



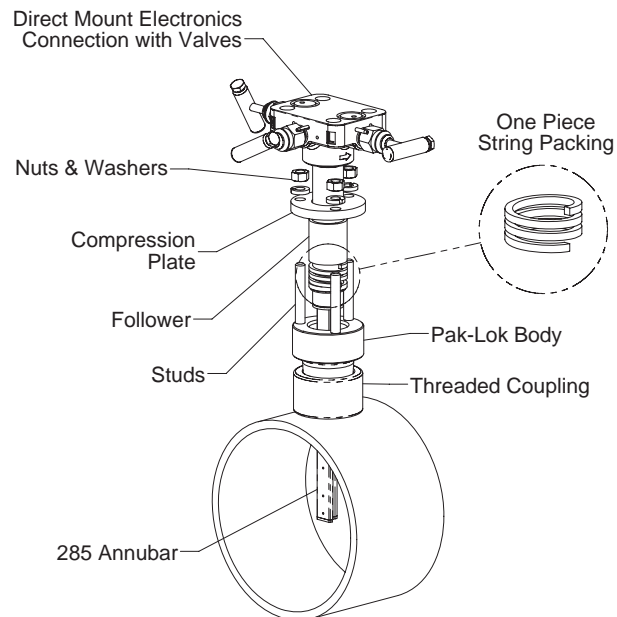
INSTALLATION

This manual contains the horizontal and vertical installation procedures for the Pak-Lok and Duct Mount Annubar models.

Pak-Lok Model

Figure 2-11 identifies the components of the Pak-Lok assembly.

Figure 2-11. Components



15-490023-901a.eps

Step 1: Determine the Proper Orientation

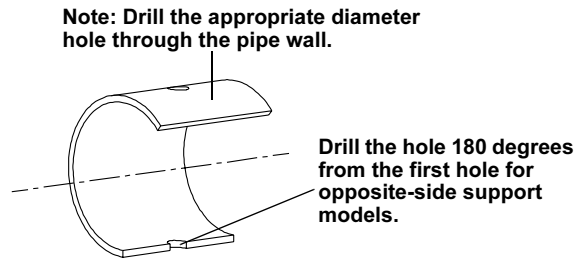
Please refer to "Mounting" on page 2-4 for straight run requirements and orientation information.

Step 2: Drill a Hole into the Pipe

Follow the steps below to drill the hole in the pipe.

1. Depressurize and drain the pipe.
2. From the previous steps, select the location to drill the hole.
3. Determine the diameter of the hole to be drilled according to the specifications in Table 2-3 and drill the hole. **Do not torch cut the hole.**

Figure 2-12. Drill Hole into Pipe



8900-8900_15A.EPS

Table 2-3. Sensor Size / Hole

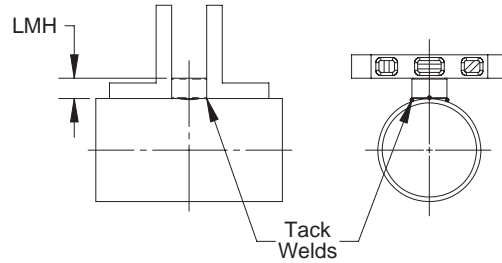
Sensor Width	Sensor Size	Hole Diameter	
0.590-in. (14.99 mm)	1	3/4-in. (19 mm)	+ 1/32-in (1 mm) - 0.00
1.060-in. (26.92 mm)	2	1 ⁵ / ₁₆ -in. (34 mm)	+ 1/16-in. (1 mm) - 0.00

4. 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 determine a 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 (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. Rewrap 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 2-3, drill the hole into the pipe with a hole saw or drill. Do not torch cut the hole.
 - e. Deburr the drilled hole(s) on the inside of the pipe.

Step 3: Weld the Mounting Hardware

1. Center the weld fitting over the mounting hole, gap 1/16-in. (1.5 mm) and place four 1/4-in. (6-mm) tack welds at 90° increments. Check alignment of the weld fitting both parallel and perpendicular to the axis of flow. If alignment of mounting is within tolerances (see Figure 1-1), finish weld per local codes. If alignment is outside of specified tolerance make adjustments prior to finish weld.

Figure 2-13. Alignment



- (1) *LMH values are as follows:*
 Sensor Size 1: 2.89-in. (73 mm)
 Sensor Size 2: 3.92-in. (100 mm)

NOTE

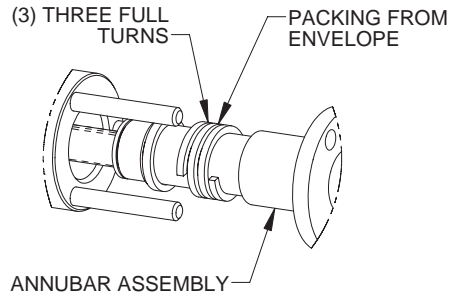
To avoid serious burns, allow the mounting hardware to cool before continuing.

Step 4: Insert into the Pipe

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

1. Apply appropriate thread sealant to Thread Pak-Lok body, insert into weld fitting and tighten.
2. Thread studs into the Pak-Lok body.
3. To ensure that the flowmeter contacts the opposite side wall, mark the tip of the sensor with a marker.
4. Rotating the flowmeter back and forth, insert the flowmeter into the Pak-Lok body until the sensor tip contacts the pipe wall (or support plug).
5. Remove the flowmeter.
6. Verify that the sensor tip made contact with the pipe wall by removing from the pipe and ensuring that some of the marker has been rubbed off. If the tip did not touch the wall, verify pipe dimensions and the height of mounting body from the OD of the pipe and re-insert.
7. Re-insert the flowmeter into the Pak-Lok body and install the string packing ring on the sensor between the lock ring and the packing follower. Do not damage the string packing.
8. Push the packing ring into the Pak-Lok body and against the weld lock ring.

Figure 2-14. Packing Ring Detail



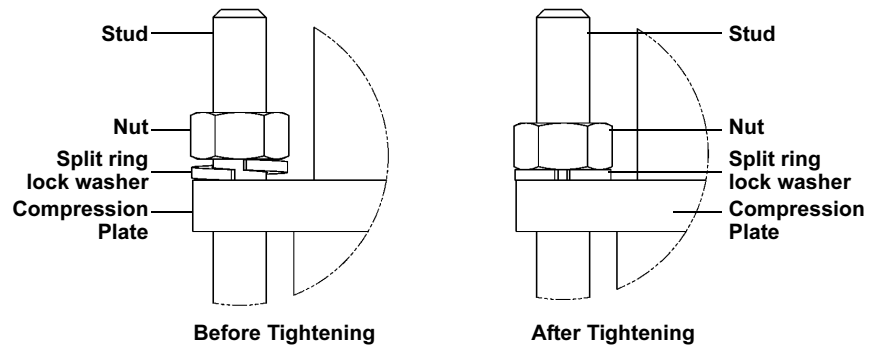
9. Tighten the nuts onto the studs:

Place the included split-ring lock washer between each of the nuts and the compression plate. Give each nut one half (1/2) turn in succession until the split-ring lock washer is flat between the nut and the compression plate. 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 flowmeter.

Figure 2-15. Split-Ring Lock Washer Orientation



28-490000_943A01A

NOTE

Pak-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.

Step 5: Mount the Transmitter

Direct Mount Head

With Valves

- Place Teflon (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).

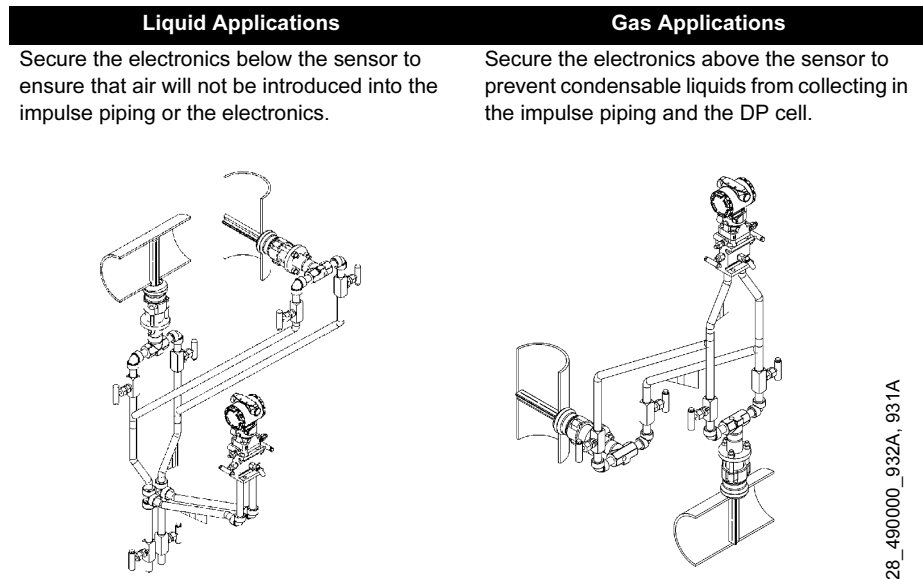
Without Valves

- Place Teflon (PTFE) O-rings into grooves on the face of head.
- 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 Teflon (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).

Remote Mount Head – temperatures below 250 °F (121 °C)

See “Remote Mount” on page 2-9 for more information.

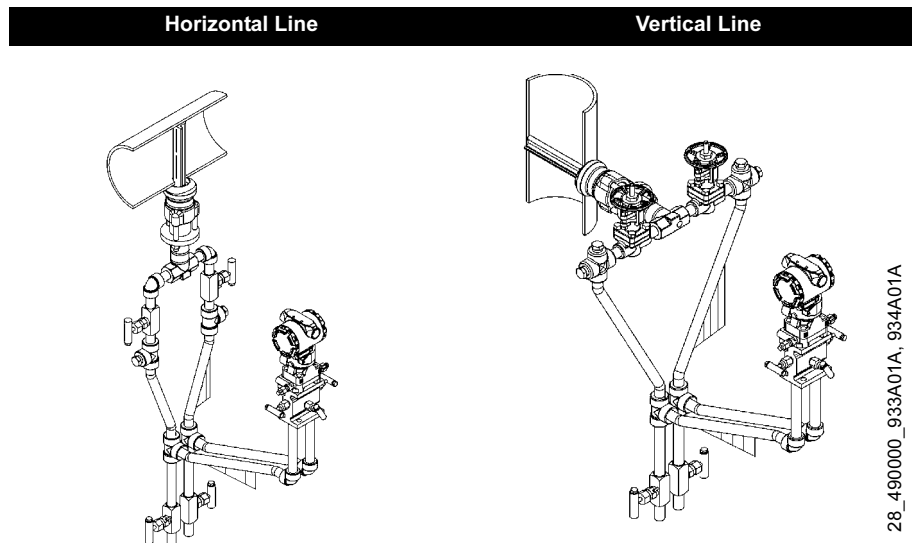
Figure 2-16.



28_490000_932A, 931A

Remote Mount Head – temperature above 250 °F (121 °C)

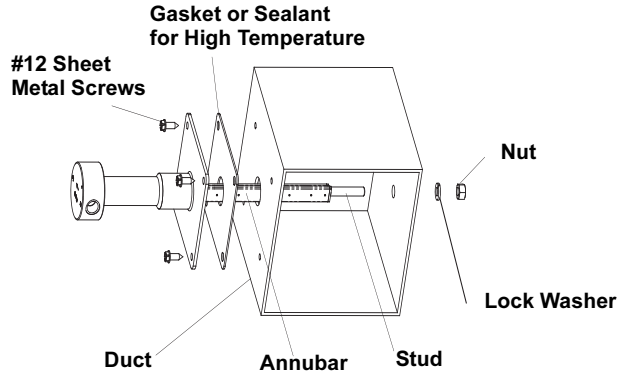
Figure 2-17. Liquid or Steam Applications



Duct Model

Figure 2-18 identifies the components of the Duct Model assembly.

Figure 2-18. Components



Step 1: Determine the Proper Orientation

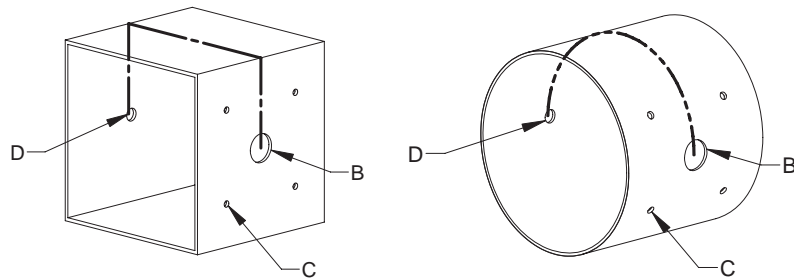
Please refer to “Mounting” on page 2-4 for straight run requirements and orientation information.

Step 2: Drill a Hole into the Duct

Follow the steps below to drill the hole in the duct.

1. Depressurize and drain the duct.
2. From the previous steps, select the location to drill the hole.
3. 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 a drill. **Do not torch cut the hole.**

Figure 2-19. Drill Hole into Duct



285/15-490014-901,
15-490035-901.EPS

Table 2-4. Installation dimensions

Annubar Model Number	B	D
285xxxxxxxD1x1x	0.75 in (19.05 mm)	0.38 in (9.65 mm)
285xxxxxxxD1x2x	1.31 in (33.27 mm)	0.38 in (9.65 mm)
285xxxxxxxD2x1x	0.75 in (19.05 mm)	not applicable
285xxxxxxxD2x2x	1.31 in (33.27 mm)	not applicable

Table 2-5. Hole drill size for #12 self-tapping screws (C-dimension) inches (mm)

Duct Wall Thickness	Hole Required	
	Hole Size	Drill Size
less than 0.036 in (0.91 mm)	0.166 in (4.2 mm)	#19
0.048 in (1.22 mm)	0.169 in (4.3 mm)	#18
0.060 in (1.52 mm)	0.177 in (4.5 mm)	#16
0.075 in (1.91 mm)	0.182 in (4.6 mm)	#14
0.105 in (2.67 mm)	0.185 in (4.7 mm)	#13
0.125 in (3.18 mm)	0.196 in (5.0 mm)	#9
0.135 in (3.43 mm)	0.196 in (5.0 mm)	#9
0.164 in (4.17 mm)	0.201 in (5.1 mm)	#7

4. If opposite-side support is supplied, a second hole must be drilled opposite the first hole so that the sensor support can pass through the pipe. To drill the second hole, follow these steps:
 - a. Mark the mounting location of the Annubar, locating it along the center line of the rectangular duct or anywhere on the circumference of a round duct. Mark horizontal and vertical center lines through the mounting location.
 - b. For duct mount Annubars without compression fitting (threaded stud welded to tip of sensor), extend the center line to the opposite duct wall (or 180° around a circular duct).
 - c. Rewrap 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. Do not torch cut the hole.
5. Deburr the drilled hole or holes on the inside of the pipe.

Step 3: Assemble and check Fit-Up

1. Measure the Annubar Primary Element from the duct plate to the end of the probe shape.
2. Measure the duct from the far inside wall to the close outside wall and add 1/16-in. (1.5 mm).
3. Compare the numbers in steps 1 and 2.

Small discrepancies can be compensated for with the fit-up of the mounting hardware. Large discrepancies may cause installation problems or error.

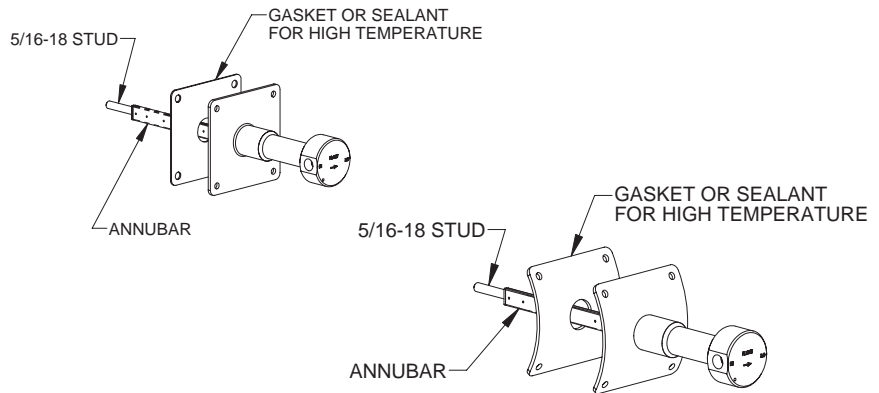
Figure 2-20. Fit-up Check for Annubar with Opposite Side Support

Step 4: Insert into Duct

Duct-Mount without Compression Fitting (Annubar type D1)

1. Place the gasket over the end of the probe and push it up against the mounting flange. Alternatively, a high-temperature gasket sealant may be used.
2. Insert the end of the Annubar through the mounting hole, and push it through the duct until the threaded stud protrudes through the hole on the opposite side of the duct.

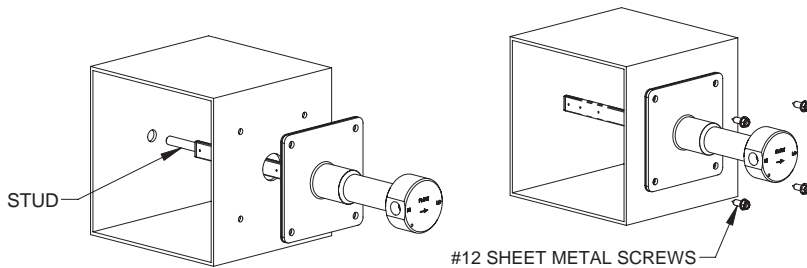
Figure 2-21.



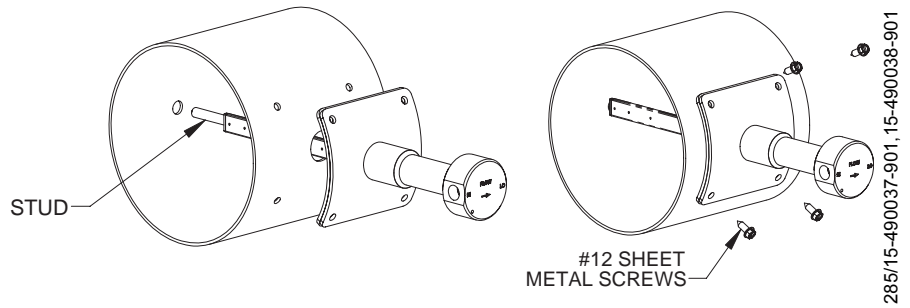
285/15-490015-901, 15-490036-901

3. Push the flange and gasket flush against the duct wall; align the flow arrow in the direction of flow and fasten the flange to the duct using the #12 sheet metal screws provided.

Figure 2-22.

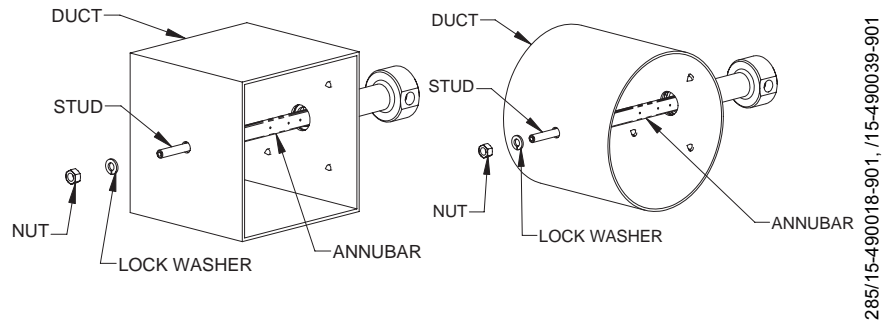


285/15-490016-901, 15-490017-901



4. On the opposite side of the duct, place the $\frac{5}{16}$ -in. lock washer over the stud, screw on the $\frac{5}{16}$ nut, and tighten. Depending on the pressure in the duct, it may be necessary to add some high temperature gasket sealant where the stud protrudes through the duct wall.

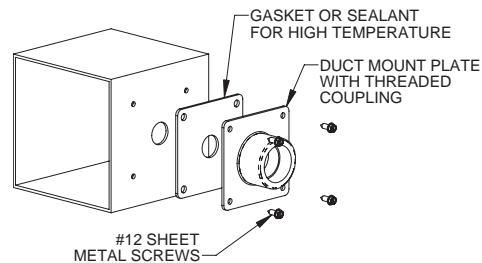
Figure 2-23.



Duct Mount With Compression Fitting (Annubar type D2)

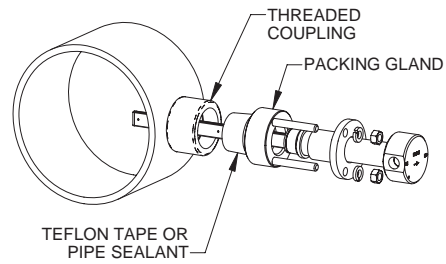
1. Place gasket against the mounting flange. Alternatively, a high-temperature gasket sealant may be used.
2. Push the flange and gasket flush against the duct wall, and fasten the flange to the duct using the #12 sheet metal screws provided.

Figure 2-24.



3. Remove the packing gland from the Annubar, and thread it into the threaded coupling, using teflon tape or pipe sealant.

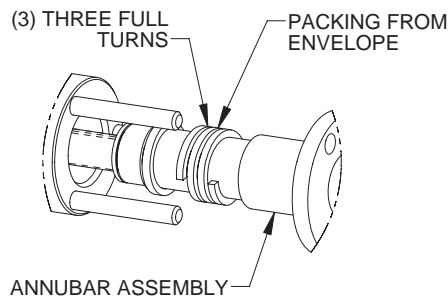
Figure 2-25.



285/ 15-490040-901

4. Remove the packing from the envelope and wrap it around the Annubar three full turns. Insert the Annubar into the mounting until the packing is completely contained within the gland, and the tip of the Annubar is contacting the opposite side of the duct wall. Place the lock washers over the studs on the packing gland and hand tighten the nuts.

Figure 2-26.



285/ 15-490041-901

5. Align the flow arrow on the Annubar with the flow direction in the duct and tighten the nuts on the packing.

NOTE

Do not over tighten the packing, as this can lead to deforming the opposite wall of the duct.

6. Observe the opposite side of the duct and ensure that the ducting has not deformed.

Step 5: Mount the Transmitter

Direct Mount Head

With Valves

1. Place Teflon (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

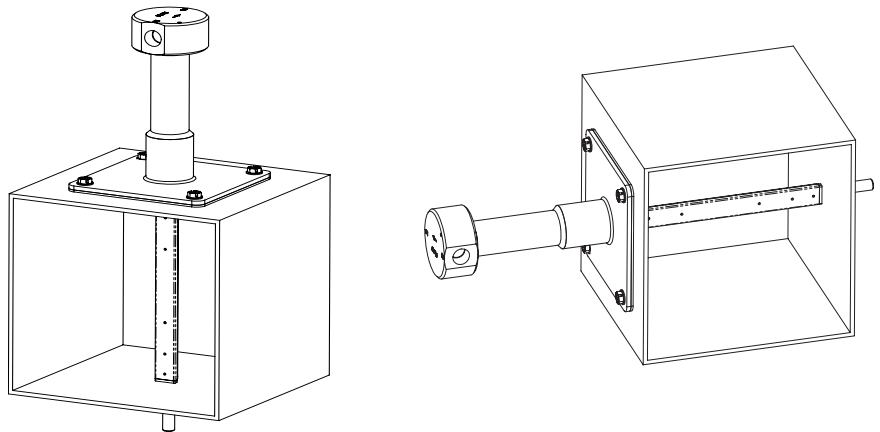
1. Place Teflon (PTFE) O-rings into grooves on the face of head.
2. Orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in•lb (45 N•m).
3. Place Teflon (PTFE) O-rings into 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).

Remote Mount Head

See "Remote Mount" on page 2-9 for more information.

Gas Applications

Secure the electronics above the sensor to prevent condensable liquids from collecting in the impulse piping and the DP cell.



Section 3 Commissioning

Safety Messages page 3-5
 Commissioning on the Bench page 3-5
 Commissioning the 285 with the 2024 transmitter page 3-6

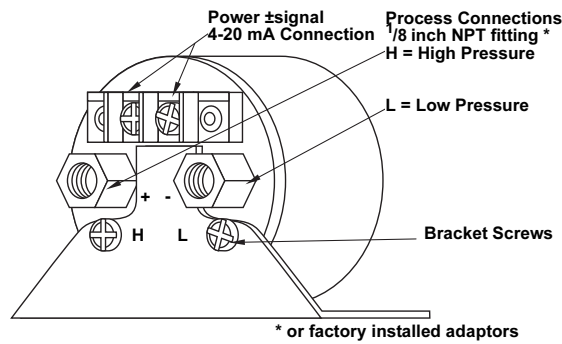
COMMISSIONING THE 951 TRANSMITTER

Step 1: Mount the Transmitter

Gas Flow Applications

- Non-corrosive, non-combustible, and non-condensing gas only.
- Restrain ⁵/₈ Hex when torquing process adaptors or connections.
- Process connections should be mounted horizontally or vertically for best performance.
- Pressure maximum may be limited by connector.

Figure 1. Rosemount 951 Transmitter



951/951_01ae.eps

Figure 2. Rosemount 951 Transmitter Flush Mount

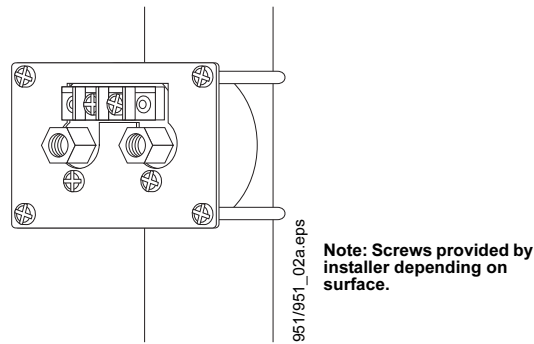
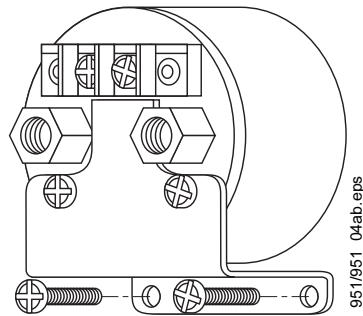
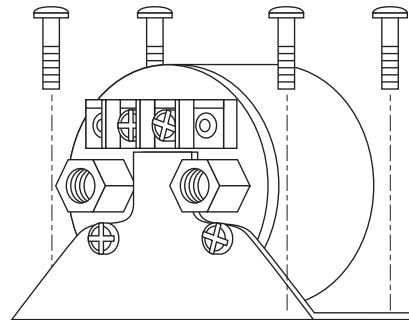


Figure 3. Rosemount 951 Transmitter Panel Mount



Note: Screws provided by installer depending on surface.

Figure 4. Rosemount 951 Transmitter Side Mount



Note: Screws provided by installer depending on surface.

Step 2: Connect Wiring and Power Up

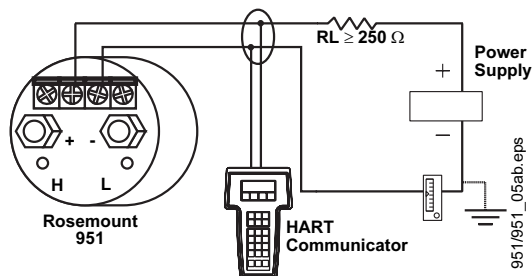
1. Connect the positive lead to the "+" terminal, and the negative lead to the "-" terminal.

NOTE

Twisted pairs yield best results; shielded signal wiring is not necessary. Use 24 AWG or larger wire and do not exceed 5,000 feet (1,500 meters).

Figure 5 shows the wiring connections necessary to power a Rosemount 951 and enable communications with a hand-held HART communicator.

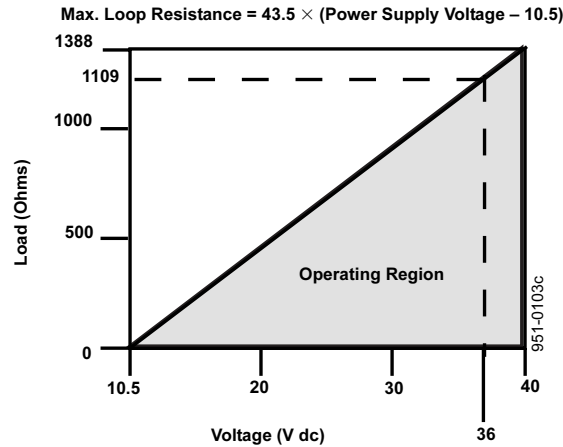
Figure 5. Rosemount 951 Wiring



Power Supply

The dc power supply should provide power with less than two percent ripple. The total resistance load is the sum of the resistance of the signal leads and the load resistance of the controller, indicator, and related pieces.

Figure 6. Power Supply Load Limitations, 4-20 mA Transmitters



Communication requires a minimum loop resistance of 250 ohms.

Step 3: Configure the Transmitter

A check (✓) indicates the basic configuration parameters. At minimum, these parameters should be verified as part of the configuration and startup procedure if a HART Communicator is used.

Function	HART Fast Key Sequence
Alarm Level Config.	1, 4, 2, 7, 6
Alarm and Saturation Levels	1, 4, 2, 7
Analog Output Alarm Direction	1, 4, 2, 7, 1
Analog Output Trim	1, 2, 3, 2
Burst Mode On/Off	1, 4, 3, 3, 3
Burst Options	1, 4, 3, 3, 4
✓ Damping	1, 3, 6
Date	1, 3, 4, 1
Descriptor	1, 3, 4, 2
Digital To Analog Trim (4–20 mA Output)	1, 2, 3, 2, 1
Field Device Information	1, 4, 4, 1
Loop Test	1, 2, 2
Lower Sensor Trim	1, 2, 3, 3, 2
Message	1, 3, 4, 3
Number of Requested Preambles	1, 4, 3, 3, 2
Poll Address	1, 4, 3, 3, 1
Poll a Multidropped Transmitter	Left Arrow, 4, 1, 1
Rerange- Keypad Input	1, 2, 3, 1, 1
Saturation Level Config.	1, 4, 2, 7, 7
Scaled D/A Trim (4–20 mA Output)	1, 2, 3, 2, 2
Self Test (Transmitter)	1, 2, 1, 1
Sensor Information	1, 4, 4, 2
Sensor Temperature	1, 1, 4
Sensor Trim	1, 2, 3, 3
Sensor Trim Points	1, 2, 3, 3, 5
Status	1, 2, 1, 2
✓ Tag	1, 3, 1
✓ Transfer Function (Setting Output Type)	1, 3, 5
✓ Units (Process Variable)	1, 3, 2
Upper Sensor Trim	1, 2, 3, 3, 3
Zero Trim	1, 2, 3, 3, 1

Step 4: Trim the Transmitter

NOTE

Transmitters are shipped from Rosemount Inc. fully calibrated per request or by the factory default of full scale (span = upper range limit.)

Zero Trim

A zero trim is a single-point adjustment used for compensating mounting position. When performing a zero trim, ensure that the equalizing valve is open (if present).


If zero offset is less than 3% of true zero, follow the “Using the 275/375 HART Communicator” instructions below to perform a zero trim. If zero offset is greater than 3% of true zero, follow the “Local Re-ranging and Trim” instructions below to rerange.

Using the 275/375 HART Communicator

HART Fast Keys	Steps
1, 2, 3, 3, 1	<ol style="list-style-type: none"> 1. Equalize or vent the transmitter and connect HART communicator. 2. At the menu, input the HART Fast Key sequence. 3. Follow the commands to perform a zero trim.

Local Re-ranging and Trim

Both 4 and 20 mA points can be adjusted at the transmitter to a desired zero and full scale using the adjustment key or LCD adjustment buttons while powered.

 **Caution:** Make sure no high voltage is present.

NOTE:

More comprehensive adjustment is possible with a HART Communicator.

Zero - 4 mA point

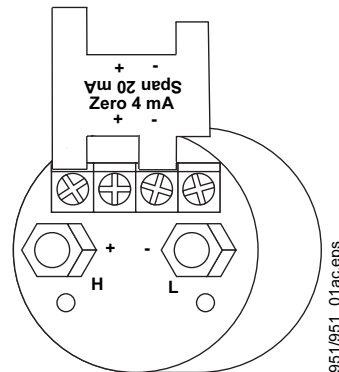
Without an LCD meter

1. Using an appropriate quality pressure source, apply a pressure equivalent to the desired lower range value to the transmitter. If zero, make sure the High (H) and Low (L) pressure ports are at the same pressure.
2. Touch the key to the terminals, as shown in Figure 7, for at least two seconds but no longer than ten seconds.

With an LCD meter

1. Using an appropriate quality pressure source, apply a pressure equivalent to the desired lower range value to the transmitter. If zero, make sure the High (H) and Low (L) pressure ports are at the same pressure.
2. Push and hold the zero LCD adjustment button for at least two seconds but no longer than ten seconds.

Figure 7. Zero 4 mA



Span - 20 mA point

Without an LCD meter

1. Using an appropriate quality pressure source, apply a pressure equivalent to the desired upper range value.
2. Touch the key to the terminals, as shown in Figure 8, for at least two seconds but no longer than ten seconds.

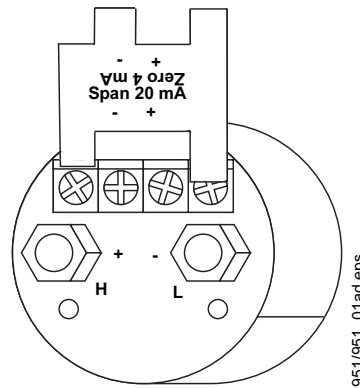
With an LCD meter

1. Using an appropriate quality pressure source, apply a pressure equivalent to the desired upper range value.
2. Push and hold the span LCD adjustment button for at least two seconds but no longer than ten seconds.

NOTE:

The Span is maintained when the 4 mA point is set. The span changes only when the 20 mA point is set. Changing the span should not be required as a result of installation.

Figure 8. Span 20 mA



SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Please 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 Rosemount HART 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:

- Make sure only qualified personnel perform the installation.
- If the line is pressurized, serious injury or death could occur by opening valves.

COMMISSIONING ON THE BENCH

Commissioning consists of testing the flowmeter, testing the loop, and verifying the flowmeter configuration data. The flowmeter can be commissioned either before (on the bench) or after (in the field) installation. Commissioning on the bench ensures that all flowmeter components are in good working order and acquaints the user with the operation of the device.

To avoid exposing the flowmeter electronics to the environment after installation, set the failure mode and flowmeter security switches while commissioning the flowmeter on the bench.

Figure 2-4 on page 2-5 identifies the valves on a 3-valve manifold. Table 2-1 on page 2-6 explains the purpose of these valves.

Complete the following tasks before beginning the commissioning procedure:

1. Connect an appropriate readout instrument so the differential pressure signal can be monitored.
2. Identify the manifold equalizer valves by their ME prefix. 3-valve manifolds have one equalizer valve, ME.
3. Close all valves before commissioning the system.

COMMISSIONING THE 285 WITH THE 2024 TRANSMITTER

For complete 2024 transmitter information, refer to manual 00809-0100-4592.

Direct Mount

Liquid Service

1. Open the high and low manifold valves MH and ML.
2. Open the equalizer valve ME.
3. Open the drain/vent valves on the electronics DVL and DVH; bleed until no air is apparent in the liquid.
4. Close both drain/vent valves DVL and DVH.
5. Close the high and low manifold valves MH and ML.
6. Check the electronics zero by noting the output—this is called a wet zero. If the signal reads outside of the range 3.98 mA to 4.02 mA, air is probably still in the system; repeat step 2, and trim zero if necessary.
7. Open the high and low manifold valves ML and MH.
8. Close equalizer valve ME. The system is now operational.

Liquid Service 3-Valve Manifold

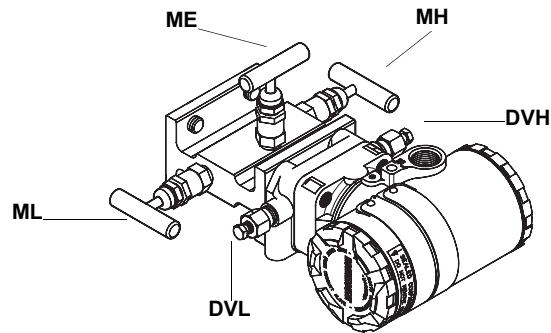
Dry Zero

1. Prior to commissioning the flowmeter a dry zero should be performed to eliminate any positional effects to the transmitter.
2. Keeping both the high and low main valves closed MH and ML open the equalizer valve ME.
3. Perform a zero trim
4. Check the electronics zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then repeat step 3 and 4.

Wet Zero

1. Open the High and Low manifold valves MH and ML.
2. Open the Equalizer valve ME.
3. Open the drain/vent valves on the electronics DVH and DVL; bleed until no air is apparent in the liquid.
4. Close both drain/vent valve DVH and DVL.
5. Close the High side valve MH.
6. Check the electronics 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. Check the electronics zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then repeat steps 1 - 6.
8. Close the Equalizer valve ME.
9. Open the High side valve MH and ensure that the Low side valve ML is open.
10. The system is now operational.

Figure 3-1. Valve Identification for Direct Mounted Annubar model in Liquid Service



2024/2024A24A.EPS

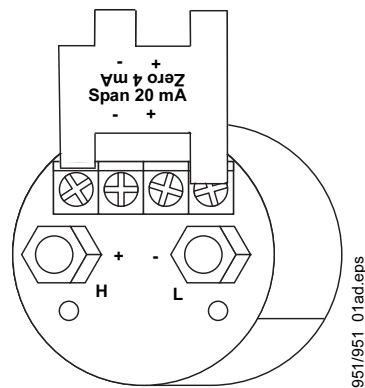
Gas Service

1. Ensure that the pipe is pressurized.
2. Open both high and low side main valves MH and ML.
3. Open equalization valve ME.
4. Open the drain valves DVL and DVH on the electronics to ensure that no liquid is present.
5. Close drain valves DVL and DVH.
6. Check the electronics for the 4 mA signal. Trim zero if necessary.
7. Close the equalizer valve ME. The system is now operational.

Gas Service 3-Valve Manifold

Dry Zero

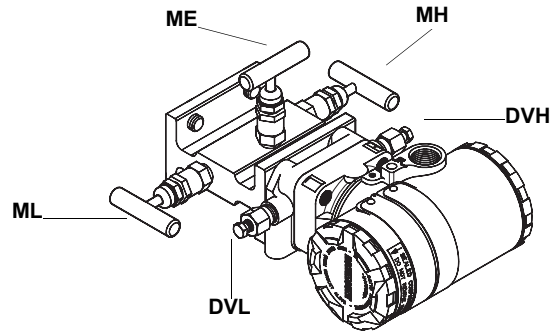
1. Prior to commissioning the flowmeter a dry zero should be performed to eliminate any positional effects to the transmitter.
2. Keeping both the high and low main valves closed MH and ML open the equalizer valve ME.
3. Perform a zero trim.
4. Check the electronics zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then repeat step 3.



Wet Zero

1. Open the High and Low manifold valves MH and ML.
2. Open the Equalizer valve ME.
3. Open the drain/vent valves on the electronics DVH and DVL; bleed to ensure that no liquid is present.
4. Close both drain/vent valve DVH and DVL.
5. Close the High side valve MH.
6. Check the electronics 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. Check the electronics zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then repeat steps 1 - 6.
8. Close the Equalizer valve ME.
9. Open the High side valve MH, ensure that the Low side valve ML is open. The system is now operational.

Figure 3-2. Valve Identification
for Direct Mounted Model in Gas
Service



2024/2024A24A.EPS

Steam Service

1. Ensure that the steam line is depressurized with no steam.
2. Check the electronics for a dry zero of 4 mA with no water loss.
3. Open the high and low main valves MH and ML and equalizer valve ME.
4. Close low side vent DVL on the electronics.
5. Close the high MH for 30 seconds to force water to the ML side.
6. Re-open the MH valve.
7. Open low side vent DVL on the electronics until no air is observed.
8. Close the vent.
9. Close the hose connect valve.
10. Close both MH and ML.
11. Check the instrument zero by noting the electronics 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.
12. Open MH and ML.
13. Close equalizer valve ME. The system is now operational.

3-Valve Steam No Flow

1. Prior to commissioning the flowmeter a dry zero should be performed to eliminate any positional effects to the transmitter.
2. Keeping both the high and low main valves closed MH and ML open the equalizer valve ME.
3. Perform a zero trim (see “Trim the Transmitter” on page 3-26).
4. Check the electronics zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA then repeat step 3.
5. Verify that the line is depressurized with no steam.
6. Open the High and Low main valves as well as the equalizer valve MH, ML and ME.
7. Close low side vent DVL on the electronics.
8. 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.
9. Close the high valve MH for 30 seconds to force water to the Low side.
10. Re-open the main High valve MH.
11. Open the low side vent DVL on the electronics until no air is observed.
12. Close the low side vent DVL.
13. Open both the high and low main valves MH and ML and close the equalizer valve ME.
14. The sensor is ready for flow.
15. After flow has been started and allowed to reach operating conditions a wet zero needs to be performed.
16. Using the drain/vent valves on the electronics DVH and DVL; burp (carefully crack vents open and closed to ensure that no air is present, this may need to be done more than one time.)
17. Close the High side main valve MH.
18. Open the Equalizer valve ME.
19. Check the electronics 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.
20. After zero trim is done check the electronics zero by noting the output. If the signal reads outside of the range 3.98 mA to 4.02 mA. Set sensor back to flow by closing the Equalizer valve ME and opening the High side valve MH. Repeat steps 14 - 17.
21. Close the Equalizer valve ME.
22. Open the High side valve MH, ensure that the Low side valve ML is open. The system is now operational

Remote Mount

Zero the Electronics

Before the electronics are exposed to line pressure, check the “zero” calibration (or, “dry” zero) by using the following procedure.

1. Open first the equalizer valve(s) MEL and MEH or ME.
2. Close valves MH and ML.
3. Read the Annubar output. It should read within the range 3.98 mA to 4.02 mA. If the output is outside of this range, zero trim.

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:

1. Open equalizer valve(s) MEH, MEL or ME to prevent overpressuring the DP.
2. Close valves PH, PL (unless the piping system is also being pressure-checked), MV, DVH, DVL.

If present, also close valves BH and BL or DH and DL.

3. Open valves MH and ML.
4. Install all appropriate tapped plugs.
5. Install a current meter to read the signal, if necessary.

Apply pressure at a convenient point on either the high or low side of the system. 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.

“Calibrate Out” Temperature Effects

NOTE

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

The flowmeter’s proportional output-to-flow ratio makes a true “zero” calibration critical for producing accurate measurements. The “zero” calibration procedure is affected by static pressure and ambient temperature, but these effects can be removed by calibrating them “out.”

The effect of static pressure is calibrated out by exposing the Annubar electronics to the line pressure and performing a “zero” or wet calibration, as described below. In order to calibrate out the effect of ambient temperature, two aspects should be taken into consideration:

- The electronics should be located where the ambient temperature does not change rapidly or vary by more than 10 to 15 °F (26 to 29 °C).
- When commissioning the electronics, the flowing fluid (condensate/water for steam service) could bring the sensor to a temperature significantly different than the temperature during normal operations. In this situation, perform another “zero” calibration at least 60 minutes after the Annubar Primary Element has been commissioned.

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

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

Zero or Wet Calibration

Follow this procedure to obtain a true zero at static or “pipe” pressure:

1. Open ME and high side MH equalizer valves:
2. Close low side valve ML to prevent generating differential pressure.

Liquid Service below 250 °F (121 °C)

1. Ensure that primary instrument valves PH and PL are closed.
2. Open valves ME, ML, and MH.
3. Slowly open valve PL and then PH, which are the primary instrument valves.
4. Open drain/vent valves DVL and DVH to bleed air out of system. Bleed until no air is apparent in the liquid.
5. Close valves DVL and DVH.

NOTE

For the alternate electronics location, open vent valves VH and VL and bleed until no air is apparent in the liquid.

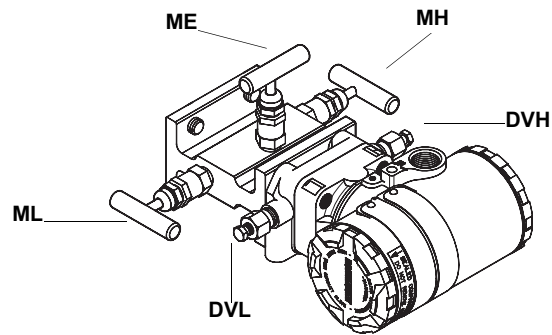
6. Slowly open vent valve MV to bleed out any entrapped air in manifold. Bleed until no air is apparent in the liquid.
7. Close vent valve MV.
8. Gently tap the electronics body, valve manifold, and impulse piping with a small wrench to dislodge any remaining entrapped air.
9. Repeat steps 2, 2A, and 3.
10. Close valve PH.
11. Check the Annubar zero by noting the electronics output — this is called a wet zero. The electronics should indicate a zero DP (Differential Pressure) signal. 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. Trim zero if necessary.
12. Close ME equalizer valve(s).
13. Slowly open valve PH. The system is now operational.

Gas Service

1. For an impulse piping arrangement as shown in Figure (vertical pipe) only, open primary instrument valves PH and PL.
2. Open drain valves DH and DL slowly to allow the condensate to drain.
3. Close valves DH and DL.
4. Ensure that primary instrument valves PH and PL closed.
5. Open valves ME, ML and MH.
6. Slowly open valve PL, the primary high pressure instrument valve.
7. Check electronics zero by noting the electronics reading. The electronics should indicate a “zero” DP signal. If the signal reads outside of the range 3.98 mA to 4.02 mA, condensate may be in the DP electronics 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.
8. Close ME equalizer valve(s).
9. Slowly open valve PH. The system is now operational.

Figure 3-3. Valve Identification for Direct Mounted Annubar model in Steam Service or Liquid Service above 250 °F (121 °C)

Valve Identification for Direct Mounted Annubar



2024/2024A24A.EPS

Steam Service or Liquid Service above 250 °F (121 °C)

1. Ensure that primary instrument valves PH and PL closed; ME, ML and MH are closed; and DVL and DVH are closed.
2. Fill tees with water on each side until water overflows.
3. Open valves MH, ML and equalizer valve ME.
4. Open valves DVL and DVH.
5. Tap manifold until no air bubbles are visible.
6. Close both valves DVL and DVH.
7. Refill tees with water.
8. Gently tap electronics body, valve manifold, and impulse piping with a small wrench to dislodge any remaining entrapped air.
9. Check Annubar zero by noting the electronics output — this is called a wet zero. The electronics should indicate a “zero” DP signal. 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. Trim zero if necessary.
10. Close equalizer valve ME.
11. Replace plugs in tees.
12. Slowly open valves PH and PL. The system is now operational.

Section 4 Operation and Maintenance

Safety Messages	page 4-1
Troubleshooting	page 4-2
Disassembly	page 4-3

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 can result in death or serious injury.

- Do not remove the instrument cover in explosive environments 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 can result in death or serious injury.

- Avoid contact with the leads and the terminals.

Rosemount 285

TROUBLESHOOTING

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

Table 4-1. 285 Troubleshooting

Symptom	Possible Cause	Corrective Action
Questionable accuracy or erroneous flow signal	Improper installation	<ul style="list-style-type: none"> Is the flow arrow pointed in the direction of the flow? Verify that the cross reservoirs are perfectly level with one another Is there sufficient straight run upstream and downstream of the flowmeter?
	System leaks	<ul style="list-style-type: none"> Check for leaks in instrument piping. Repair and seal all leaks.
	Contamination/plugging	<ul style="list-style-type: none"> Remove the flowmeter and check for contamination.
	Closed valve	<ul style="list-style-type: none"> Verify that both manifold (MH & ML) valves are open. Verify that vent, equalizer, and line valves are properly positioned per the "start up procedure."
	Calibration	<ul style="list-style-type: none"> Is the calibration too high or low for the flow rate?
	Connections (remote mount only)	<ul style="list-style-type: none"> Verify that the high side of the electronics is connected to the high side of the flowmeter. Check the same for the low side.
	Entrapped air (liquid applications)	<ul style="list-style-type: none"> Are there uneven water legs caused by air entrapment in the instrument connections? If so, bleed air.
	Annubar Primary Element misalignment	<ul style="list-style-type: none"> Misalignment of the flowmeter beyond 3 degrees will cause an erroneous signal.
	Opposite-side support duct mount	<ul style="list-style-type: none"> If the flowmeter is an opposite-side support model, is it installed through the pipe wall and into the nut?
	Operating conditions	<ul style="list-style-type: none"> Are the operating conditions in compliance with those given at the time the flowmeter was purchased? Check the flow calculation and the fluid parameters for accuracy. Double-check pipe inside diameter for proper sizing. <p>Note: For the multipoint flow calibrated flowmeter, refer to the Handbook for corrections.</p>
Spiking flow signal	Two-phase flow	<ul style="list-style-type: none"> The flowmeter is a head measurement device and will not accurately measure a two-phase flow.
Spiking flow signal (Stream Service)	Improper insulation (Vertical pipes only) Excessive vibration	<ul style="list-style-type: none"> Added insulation may be required to ensure that a phase change occurs at the cross reservoirs. Check the impulse piping for vibration.
Vibration of sensor or leakage at Pak-Lok fitting	Pak-Lok Compression nut(s) loose	<ul style="list-style-type: none"> Tighten compression nut(s) until condition is corrected and then ½ turn more only.
No response to changes in applied flow		<ul style="list-style-type: none"> Check test equipment Check impulse piping for blockage Check for disabled span adjustment Check electronics security switch Verify calibration settings (4 and 20 mA points) Contact factory for replacement
Low reading/high reading		<ul style="list-style-type: none"> Check impulse piping for blockage Check test equipment Contact factory for replacement
Erratic reading for pressure variable		<ul style="list-style-type: none"> Check impulse piping for blockage Check damping Check for EMF interference Contact factory for replacement

DISASSEMBLY

Remove the Flowmeter from Service

NOTE

Once you have determined a that flowmeter is inoperable, remove it from service.

Be aware of the following:

- Isolate and vent the process from the flowmeter before removing the flowmeter from service.
- Remove all electrical leads and conduit.

Appendix A Reference Data

Rosemount 285 Annubar Primary Specifications	page A-1
Optional Rosemount 2024 Transmitter Specifications . .	page A-7
Optional Rosemount 951 Transmitter Specifications . . .	page A-9
Dimensional Drawings	page A-12
Ordering Information	page A-15

ROSEMOUNT 285 ANNUBAR PRIMARY SPECIFICATIONS

Performance Specifications

Performance Statement Assumptions

Measured pipe I.D.

Repeatability

±0.1%

Line Sizes

- Sensor Size 1: 2-in. to 8-in. (50 to 200 mm)
- Sensor Size 2: 8-in. to 36 in (915mm)
 For larger line sizes, consult factory.

Table A-1. Reynolds Number and Probe Width

Sensor Size	Minimum Rod Reynolds Number (R_d)	Probe Width (d) (inches)
1	6500	0.590-in. (14.99 mm)
2	12500	1.060-in. (26.92 mm)

Where

d = Probe width (feet)

v = Velocity of fluid (ft/sec)

ρ = Density of fluid (lbm/ft³)

μ = Viscosity of the fluid (lbm/ft-sec)

$$R_d = \frac{d \times v \times \rho}{\mu}$$

Sizing

Contact an Emerson Process Management representative for assistance. A Configuration Data Sheet is required prior to order for application verification.

Flow Turndown

10:1 or better

Rosemount 285

Functional Specifications

Service

- Liquid
- Gas
- Steam (limited)

Temperature Limits⁽¹⁾

- -40 to 300°F
- -40 to 850°F for Duct Mount Version (D1) only

Pressure Limits⁽¹⁾

- Pak-Lok: 150# ANSI
- Duct Mount (D1 & D2): 10 PSIG

Pressure and Temperature Limits

Direct Mount Electronics

- Up to 150# ANSI (275 psig at 100 °F (19 bar at 38 °C))
- Integral temperature measurement is not available.

Remote Mount Electronics

- Up to 150# ANSI (275 psig at 100 °F (19 bar at 38 °C)).
- Integral temperature measurement is not available.

Physical Specifications

Annubar Sensor Material

- 316 Stainless Steel

Pak-Lock

See “Dimensional Drawings” on page A-12

Pak-Lok Model (option P1)

- Provided with a compression sealing mechanism rated up to 150# ANSI (275 psig at 100 °F (19 bar at 38 °C))
- Teflon Packing (-40 to 300 °F (-40 to 149 °C))

Duct Mount

See “Dimensional Drawings” on page A-13.

Duct Mount without Compression Fitting Model (option D1)

- Provided with duct mounting rated up to 10 psig at 850°F (0.6 bar at 454°C).

Duct Mount with Compression Fitting

See “Dimensional Drawings” on page A-14.

Duct Mount with Compression Fitting Model (option D2)

- Provided with duct mount compression fitting rated up to 10 psig at 300°F (0.6 bar at 38°C).

(1) Annubar option selections may effect pressure and temperature limitations.

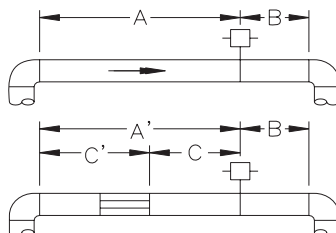
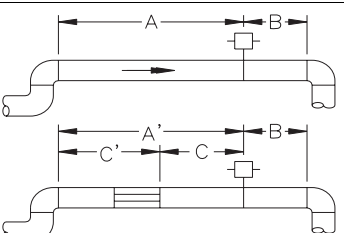
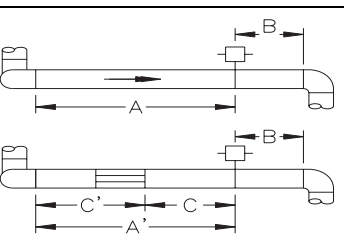
Instrument Connections Temperature Ranges

Table A-2. Minimum / Maximum Temperature Range

Code	Description	Temperature
G1	Needle Valves, Carbon Steel	-40 to 500°F (-40 to 260°C)
G2	Needle Valves, Stainless Steel	-40 to 500°F (-40 to 260°C)
B1	Ball Valve, Carbon Steel	-40 to 300°F (-40 to 149°C)
B2	Ball Valve, Stainless Steel	-40 to 300°F (-40 to 149°C)

Installation Considerations

Straight Run Requirements⁽¹⁾

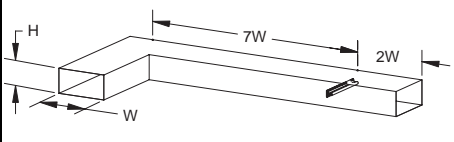
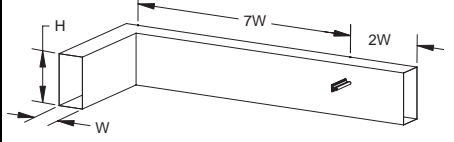
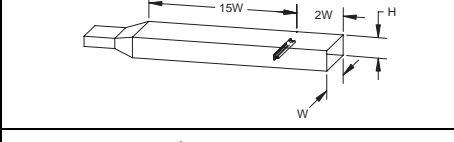
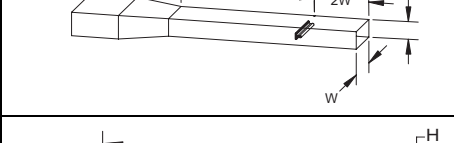
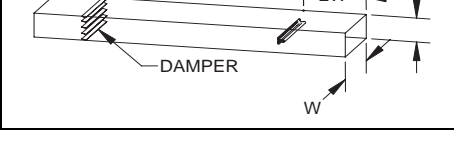
	Upstream Dimensions					Downstream Dimensions
	Without Vanes ⁽²⁾		With Vanes ⁽³⁾			
	In Plane A	Out of Plane A	A'	C	C'	
1 	8	10	—	—	—	4
	—	—	8	4	4	4
2 	11	16	—	—	—	4
	—	—	8	4	4	4
3 	23	28	—	—	—	4
	—	—	8	4	4	4

Straight Run Requirements⁽¹⁾

	Upstream Dimensions					Downstream Dimensions
	Without Vanes ⁽²⁾		With Vanes ⁽³⁾			
	In Plane A	Out of Plane A	A'	C	C'	
<p>4</p>	12	12	—	—	—	4
	—	—	8	4	4	4
<p>5</p>	18	18	—	—	—	4
	—	—	8	4	4	4
<p>6</p>	30	30	—	—	—	4
	—	—	8	4	4	4

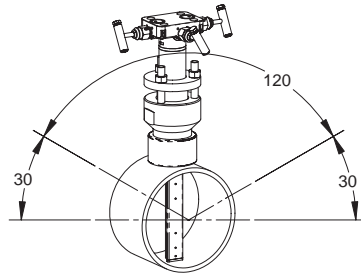
- (1) Consult the factory for instructions regarding use in square or rectangular ducts.
- (2) "In Plane A" means the bar is in the same plane as the elbow. "Out of Plane A" means the bar is perpendicular to the plane of the elbow.
- (3) Use straightening vane to reduce the required straight run length.

Table 1. Minimum straight duct requirements for the 285 Annubar

	Upstream Length	Downstream Length
 <p>285/15-490028-901</p>	7W	2W
 <p>285/15-490029-901</p>	7W	2W
 <p>285/15-490030-901</p>	15W	2W
 <p>285/15-490031-901</p>	7W	2W
 <p>285/15-490032-901</p>	15W	2W

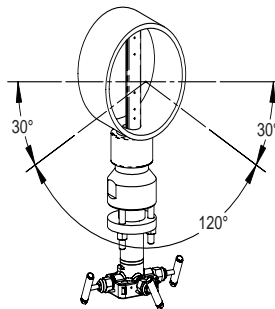
Flowmeter Orientation

Gas (Horizontal)



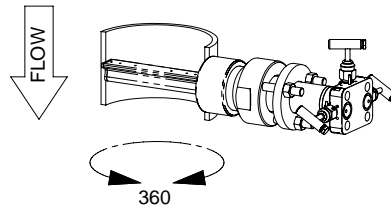
15-490000-901

Liquid and Steam (Horizontal)



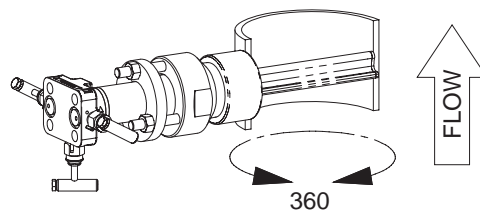
15-490001-901

Gas (Vertical)



15-490002-901

Steam (Vertical)



15-490003-901

Drill Hole Size According to Sensor Size

Sensor Size	Diameter
1	3/4-in. (19 mm)
2	1 ⁵ / ₁₆ -in. (33 mm)

**OPTIONAL ROSEMOUNT
2024 TRANSMITTER
SPECIFICATIONS**

**Performance
Specifications**

(Zero-based spans, reference conditions, and 316L SST isolating diaphragms)

Accuracy

±0.25% of calibrated span. Includes combined effects of linearity, hysteresis, and repeatability.

Dead Band

None

Stability

±0.25% of upper range limit for six months

Temperature Effect (Total)

Less than ±1.5% of upper range limit per 100 °F (55 °C)

Static Pressure Effect

Zero Error

- Less than ±0.5% of upper range limit per 1,000 psi (6.9 MPa). Correctable through rezeroing at line pressure

Span Error

- Less than ±0.5% of reading per 1,000 psi (6.9 MPa)

Vibration Effect

Less than ±0.1% of upper range limit shift per test condition of SAMA PMC 31.1 Section 5.3

Power Supply Effect

Less than ±0.01% of calibrated span per volt

Load Effect

Output Code A

- No load effect other than the change in voltage supplied to the transmitter

Mounting Position Effect

Zero shift of up to 3.0 inH₂O (0.75 kPa), which can be calibrated

**Functional
Specifications**

Service

Liquid, gas, and vapor

Range

Code 2: 0–50 to 0–250 inH₂O (0–12.4 to 0–62.2 kPa)

Output

Code A: 4–20 mA dc, linear to DP

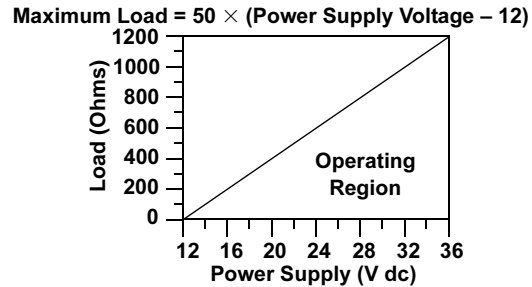
Power Supply

External power supply required

Output Code A: Operates on 12 to 36 V dc, with no load

Load Limitations

Output Code A



Span and Zero

Continuously adjustable

Temperature Limits

Process

- -20 to 220 °F (-29 to 104 °C)

Ambient

- -40 to 185 °F (-40 to 85 °C)⁽¹⁾

Storage

- -50 to 185 °F (-46 to 85 °C)

Static Pressure and Overpressure Limits

0 psia to 2,000 psig (0 to 13.79 MPa) on either side without damage to the transmitter. Operates within specifications between static line pressures of 14.7 psia and 2,000 psig (0.1 to 13.79 MPa). 6,000 psig (41.37 MPa) burst pressure

Humidity Limits

0 to 100% relative humidity

Damping

Fixed at a maximum of 0.2 second at reference conditions

Turn-on Time

Output Code A

- 1.5 seconds maximum at reference operating conditions

(1) Electronics temperature limits decrease three degrees for every one degree increase in process temperature above 185 °F (85 °C).

Optional 2024 Specifications Continued

Physical Specifications

Process Connections

1/4–18 NPT on 2 1/8-inch (54 mm) center

Electrical Connections

1/2–14 NPT conduit connection, screw terminals, and internal grounding stud

Weight

6 lb. (2.7 kg) excluding options

Materials of Construction

Isolating Diaphragms

- 316L SST

Drain/Vent Valves

- 316 SST

Flange

- 316 SST

Wetted O-rings

- Glass filled TFE

Fill Fluid

- Silicone oil

Bolts

- Plated carbon steel

Electronics Housing

- Low-copper aluminum. NEMA 4X

Paint

- Polyurethane

Calibration

Transmitters are factory calibrated to customer's specified range. If calibration is not specified, transmitters are calibrated at maximum range. Calibration is at ambient temperature and pressure.

OPTIONAL ROSEMOUNT 951 TRANSMITTER SPECIFICATIONS

Performance Specifications

Reference Accuracy

±0.25% of span for spans 1:1 to 6:1
±0.04% of URL for spans 6:1 to 40:1

Ambient Temperature Effect

±0.25% URL + 0.05% of Span per 50°F (28°C)

Mounting Effect

Zero shifts up to ± 0.01 inH₂O which can be calibrated out.
No span effect.

Functional Specifications

Time Response

Less than 200 milliseconds

Stability

0.125% of URL for 12 months

Power Supply Effect

Less than ±0.01% of calibrated span per volt

DP/GP Pressure Ranges

Range	Minimum Span	Range and Sensor Limits	
		Upper (URL)	Lower (LRL)
1	1.25 inH ₂ O (3.10 mbar)	25 inH ₂ O (62.3 mbar)	-25 inH ₂ O (-62.3 mbar)

Service

Non-condensing (0-95% relative humidity), non-combustible, non-corrosive, and clean gases.

Output

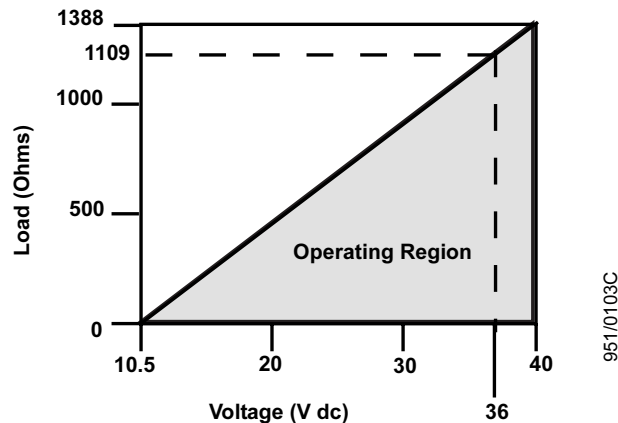
2-wire 4-20 mA; linear or square root
HART® digital communication and configuration

Power Supply & Load Limits

External Power Supply required 10.5 to 36 V
Minimum 250 Ohms loop resistance for digital communications

Figure A-1. Power Supply Load Limitations, 4–20 mA Transmitters

Max. Loop Resistance = $43.5 \times (\text{Power Supply Voltage} - 10.5)$



Communication requires a minimum loop resistance of 250 ohm:

Process and Ambient Temperature Limits

-40 to 185°F (-40 to 85°C)

Static and Overpressure Limit

100 psi (6,89 bar)

Burst Pressure

500 psi (34,47 bar)

Humidity Limits

0-95% relative humidity

Damping

Analog output response to a step input change is user-selectable from 0 to 60 seconds for one time constant. This software damping is in addition to sensor module response time.

Failure Mode Alarm

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven offscale to alert the user.

Table A-3. Alarm Configuration

	High Alarm	Low Alarm
Default - High Alarm	≥ 21.75 mA	≤ 3.75 mA

Turn-On Time

Performance within specifications less than 2.0 seconds after power is applied to the transmitter

Physical Specifications

Process Connections

1/8 inch NPT stainless fittings to accommodate any process connection
 Process Connections include HDPE internal filter

Housing

NEMA 4X Delrin® Acetal
 IP 65
 Anodized aluminum side mount bracket

Materials Exposed to Gases

- HAVAR®
- Nitronic® 32
- Hastelloy C-276®
- Ceramic
- Silicon Dioxide

Sensor Module Fill Fluid

None

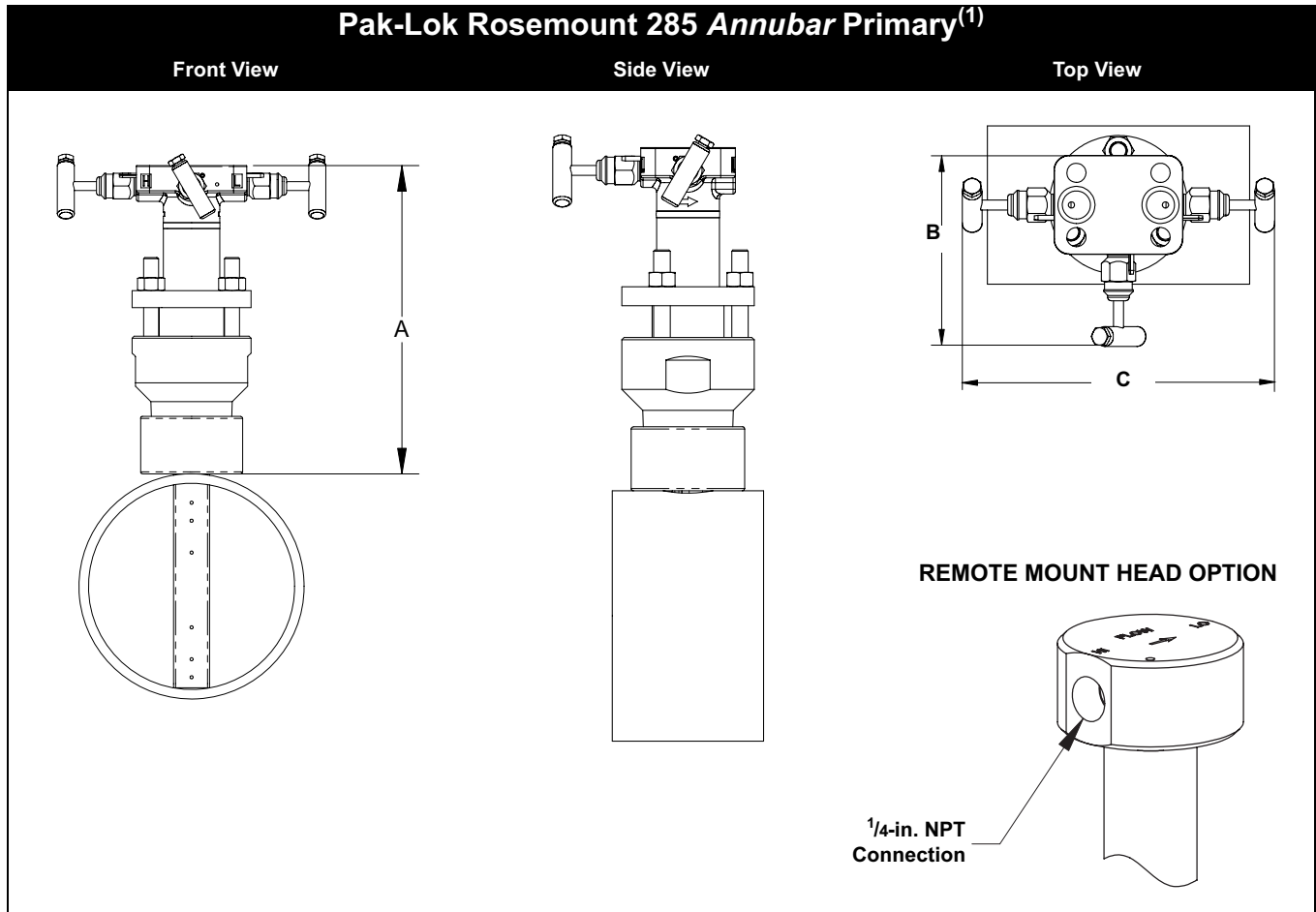
Shipping Weight

Approximately 1 lb. (0,45 kg.)

Electrical Connections

Terminal block with HART interface connections

DIMENSIONAL DRAWINGS



(1) The Pak-Lok Annubar model is available up to 150# ANSI (275 psig at 100 °F (19 bar at 38 °C)).

TABLE 2. Rosemount 285 Annubar Primary - Pak-Lok

Sensor Size	A (Max)	B (Max)	C (Max)
1	8.50 (215.9)	5.00 (127.0)	9.00 (228.6)
2	11.00 (279.4)	5.00 (127.0)	9.00 (228.6)

Dimensions are in inches (millimeters)

Dimensional Drawings (continued)

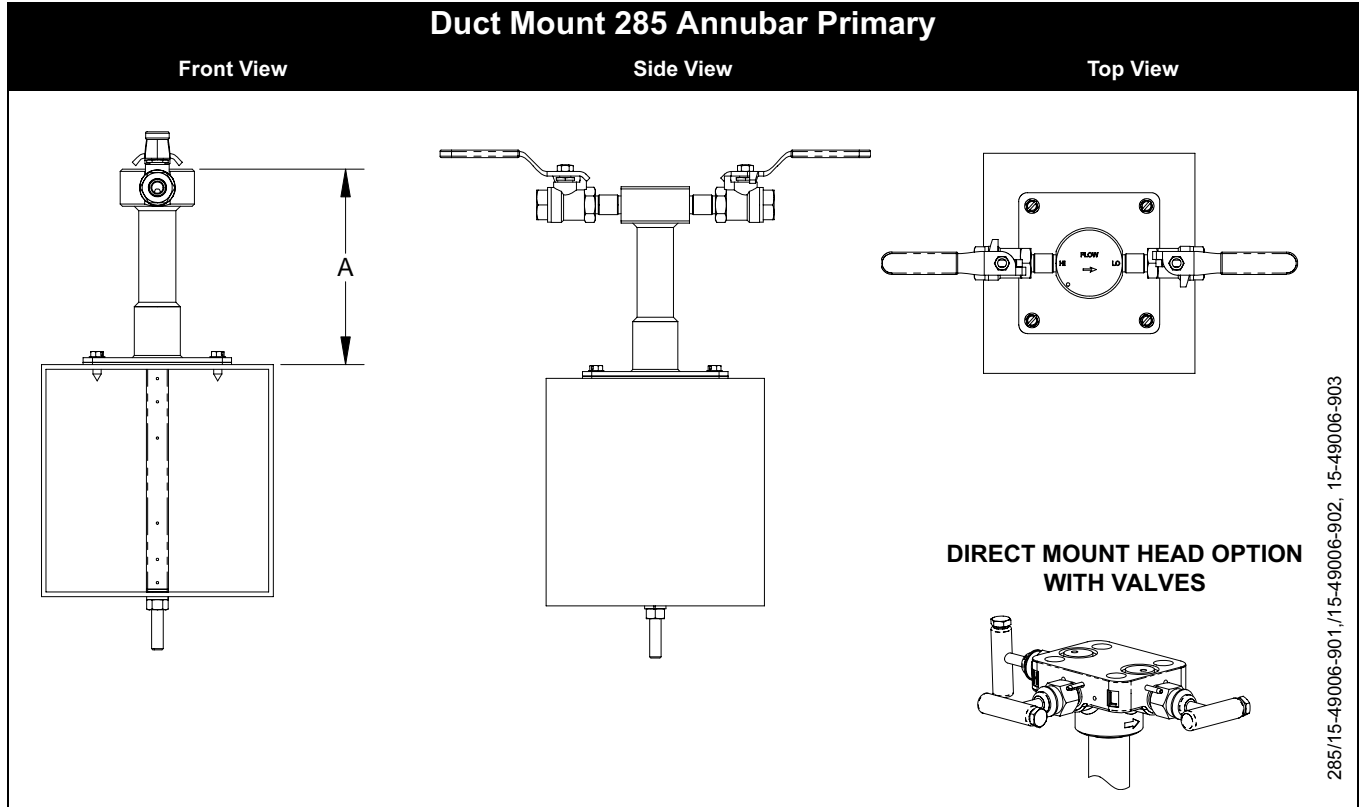


TABLE 3. Rosemount 285 Annubar with Duct Mount

Sensor Size	A (Max)
1	7.00 (177.8)
2	9.00 (228.6)

Dimensions are in inches (millimeters)

Dimensional Drawings (continued)

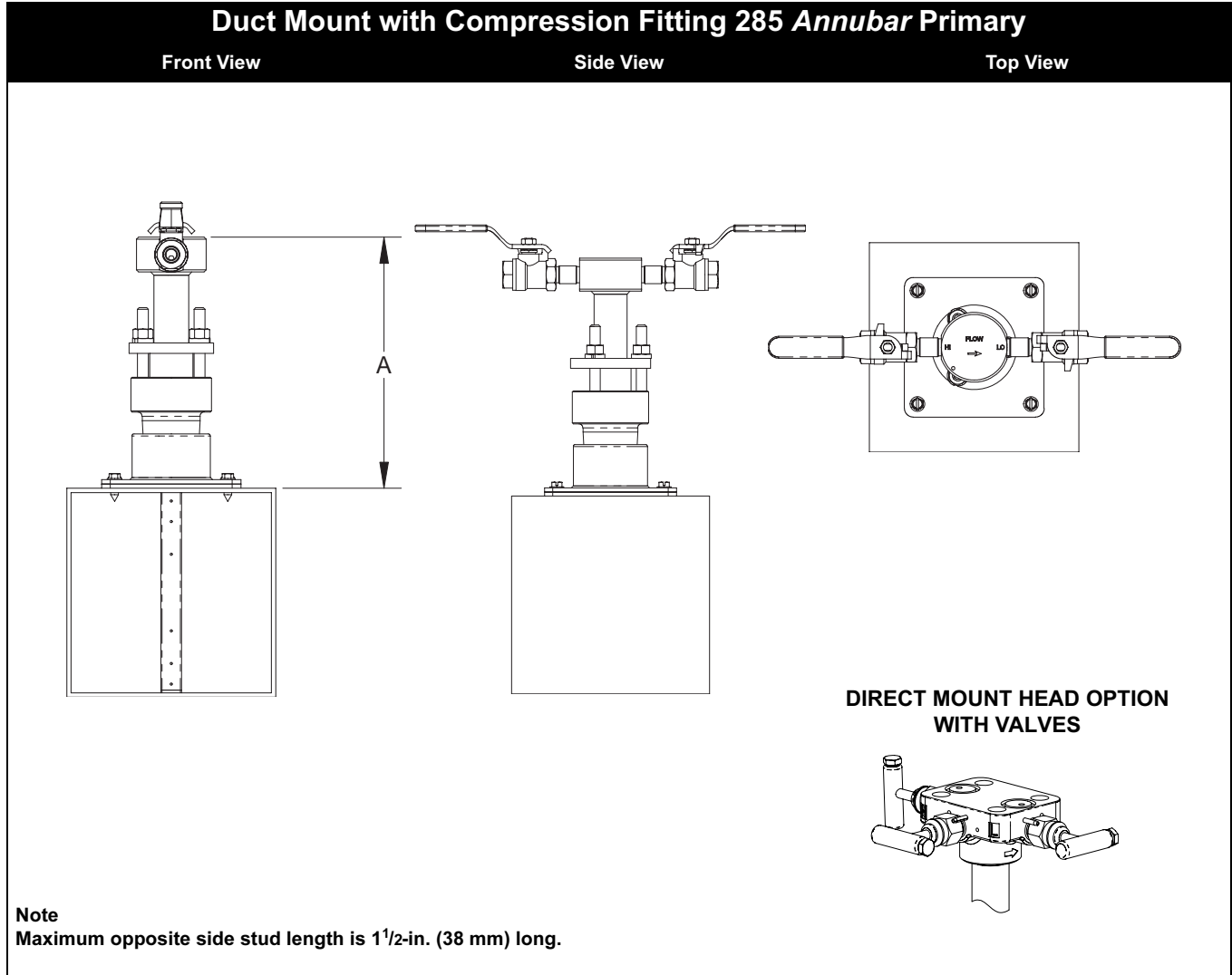


TABLE 4. Duct Mount with Compression Fitting

Sensor Size	A (Max)
1	8.50 (215.9)
2	11.00 (279.4)

Dimensions are in inches (millimeters)

**ORDERING
 INFORMATION**

Rosemount 285 Annubar Primary Ordering Information

Model	DP Flow Primary Type
285	Economy Annubar
Code	Fluid Type
L	Liquid
G	Gas
S	Steam
Code	Line Size
020	2-in. (50 mm)
025	2½-in. (63.5 mm)
030	3-in. (80 mm)
035	3½-in. (89 mm)
040	4-in. (100 mm)
050	5-in. (125 mm)
060	6-in. (150 mm)
080	8-in. (200 mm)
100	10-in. (250 mm)
120	12-in. (300 mm)
140	14-in. (350 mm)
160	16-in. (400 mm)
180	18-in. (450 mm)
200	20-in. (500 mm)
240	24-in. (600 mm)
300	30-in. (750 mm)
360	36-in. (900 mm)
420	42-in. (1066 mm)
480	48-in. (1210 mm)
600	60-in. (1520 mm)
720	72-in. (1820 mm)
Code	Pipe I.D. Range (Refer to Pipe ID Range Table for Code)
A	Range A from the Pipe I.D. table
B	Range B from the Pipe I.D. table
C	Range C from the Pipe I.D. table
D	Range D from the Pipe I.D. table
E	Range E from the Pipe I.D. table
Z	Non-standard Pipe I.D. Range or Line Sizes greater than 12 inches (sensor size 2) or greater than 8 inches (sensor size 1).
Code	Piping Configuration
C	Circular
R	Rectangular or Square
Code	Pipe Material/Mounting Assembly Material
C	Carbon Steel
S	316 Stainless Steel
0	No Mounting (Customer Supplied)
Code	Annubar Type
P1	Pak-Lok
D1	Duct Mount Plate without Compression Fitting
D2	Duct Mount Plate with Compression Fitting
Continued on Next Page	

Rosemount 285

Code	Sensor Material
S	316 Stainless Steel
Code	Sensor Size
1	Sensor Size 1
2	Sensor Size 2
Code	Electronics Connection Platform
3	Direct-mount
7	Remote-mount NPT Connections
Code	Options
Instrument Connections for Remote Mount Option	
G1	Needle Valves, CS
G2	Needle Valves, SS
B1	Ball Valves, CS
B2	Ball Valves, SS
Variable Mount Height	
VM	Variable Mounting Height for Customer Supplied Mounting
Transmitter	
X01 ⁽¹⁾	951 Dry Gas Pressure Transmitter
X12 ⁽²⁾	2024D Range 2 D.P. Transmitter (4-20 mA output)
X22 ⁽²⁾	2024D Range 2 D.P. Transmitter (4-20 mA output) with CSA E.P. / I.S.
X32 ⁽²⁾	2024D Range 2 D.P. Transmitter (4-20 mA output) with FM E.P. / I.S.
Manifold	
F2 ⁽³⁾	3-Valve Manifold, SST Special Inspection ⁽³⁾
QC1	Visual and Dimensional Inspection w/Cert
QC7	Inspection and Performance Certificate
Material Traceability Certification ⁽³⁾	
Q8	Material Cert per ISO 10474 3.1.B and EN 10204 3.1.B
Special Shipment	
Y1	Mounting Hardware Shipped Separately

(1) Available with electronics connection platform code '7' and fluid type 'G' only. Transmitter is supplied with mounting bracket.

(2) Minimum span is 50-in. (1270 mm)

(3) Applies to 285 Primary Element only

(3) If F2 option is ordered with Electronic Connections Platform Code '3' (Direct Mount), manifold is integral to head. If F2 is ordered with Code '7' (Remote Mount), the manifold is supplied loose.

**Pipe I.D. Range Code—
measured in inches
(millimeters)**

See “Rosemount 285 Annubar Primary Ordering Information” on page A-15
For pipes with an Inner Diameter (I.D.) Range / Pipe Wall Thickness not found in this table or with a line size greater than 12-in. (300 mm), choose option code Z and specify the exact pipe dimensions (I.D. and Pipe Wall Thickness) on the Configuration Data Sheet (00813-0100-4028). The Emerson process Management sizing program will determine this code, based on the application piping.

	Line Size			Pipe Wall Thickness		I.D. Range Code	
	Nominal	Max. O.D.	Option Code	Inner Diameter (I.D.) Range	ANSI Pipes		Non-ANSI Pipes
Sensor Size 1	2-in. (50 mm)	2.625-in. (66.68 mm)	020	1.784 to 1.841-in. (45.31 to 46.76 mm)	0.065 to 0.545-in. (1.7 to 13.8 mm)	0.065 to 0.488-in. (1.7 to 12.4 mm)	A
				1.842 to 1.938-in. (46.79 to 49.23 mm)		0.065 to 0.449-in. (1.7 to 11.4 mm)	B
				1.939 to 2.067-in. (49.25 to 52.50 mm)		0.065 to 0.417-in. (1.7 to 10.6 mm)	C
				2.068 to 2.206-in. (52.53 to 56.03 mm)		0.065 to 0.407-in. (1.7 to 10.3 mm)	D
	2 1/2-in. (63.5 mm)	3.188-in. (80.98 mm)	025	2.207 to 2.322-in. (56.06 to 58.98 mm)	0.083 to 0.563-in. (2.1 to 14.3 mm)	0.083 to 0.448-in. (2.1 to 11.4 mm)	B
				2.323 to 2.469-in. (59.00 to 62.71 mm)		0.083 to 0.417-in. (2.1 to 10.6 mm)	C
				2.470 to 2.598-in. (62.74 to 65.99 mm)		0.083 to 0.435-in. (2.1 to 11.0 mm)	D
				2.599 to 2.647-in. (66.01 to 67.23 mm)		0.083 to 0.515-in. (2.1 to 13.1 mm)	E
	3-in. (80 mm)	3.75-in. (95.25 mm)	030	2.648 to 2.751-in. (67.26 to 69.88 mm)	0.083 to 0.563-in. (2.1 to 14.3 mm)	0.083 to 0.460-in. (2.1 to 11.7 mm)	A
				2.752 to 2.899-in. (69.90 to 73.63 mm)		0.083 to 0.416-in. (2.1 to 10.6 mm)	B
				2.900 to 3.068-in. (73.66 to 77.93 mm)		0.083 to 0.395-in. (2.1 to 10.0 mm)	C
				3.069 to 3.228-in. (77.95 to 81.99 mm)		0.083 to 0.404-in. (2.1 to 10.3 mm)	D
3 1/2-in. (89 mm)	4.25-in. (107.95 mm)	035	3.229 to 3.333-in. (82.02 to 84.66 mm)	0.120 to 0.600-in. (3.0 to 15.2 mm)	0.120 to 0.496-in. (3.0 to 12.6 mm)	B	
			3.334 to 3.548-in. (84.68 to 90.12 mm)		0.120 to 0.386-in. (3.0 to 9.8 mm)	C	
			3.549 to 3.734-in. (90.14 to 94.84 mm)		0.120 to 0.415-in. (3.0 to 10.5 mm)	D	
			3.735 to 3.825-in. (94.87 to 97.16 mm)		0.120 to 0.510-in. (3.0 to 13.0 mm)	B	
4-in. (100 mm)	5.032-in. (127.81 mm)	040	3.826 to 4.026-in. (97.18 to 102.26 mm)	0.120 to 0.600-in. (3.0 to 15.2 mm)	0.120 to 0.400-in. (3.0 to 10.2 mm)	C	
			4.027 to 4.237-in. (102.29 to 107.62 mm)		0.120 to 0.390-in. (3.0 to 9.9 mm)	D	
			4.238 to 4.437-in. (107.65 to 112.70 mm)		0.120 to 0.401-in. (3.0 to 10.2 mm)	E	
			4.438 to 4.571-in. (112.73 to 116.10 mm)		0.134 to 0.481-in. (3.4 to 12.2 mm)	A	
5-in. (125 mm)	6.094-in. (154.79 mm)	050	4.572 to 4.812-in. (116.13 to 122.22 mm)	0.134 to 0.614-in. (3.4 to 15.6 mm)	0.134 to 0.374-in. (3.4 to 9.5 mm)	B	
			4.813 to 5.047-in. (122.25 to 128.19 mm)		0.134 to 0.380-in. (3.4 to 9.7 mm)	C	
			5.048 to 5.249-in. (128.22 to 133.32 mm)		0.134 to 0.413-in. (3.4 to 10.5 mm)	D	
			5.250 to 5.472-in. (133.35 to 138.99 mm)		0.134 to 0.392-in. (3.4 to 9.9 mm)	A	
6-in. (150 mm)	6.93-in. (176.02 mm)	060	5.473 to 5.760-in. (139.01 to 146.30 mm)	0.134 to 0.614-in. (3.4 to 15.6 mm)	0.134 to 0.327-in. (3.4 to 8.3 mm)	B	
			5.761 to 6.065-in. (146.33 to 154.05 mm)		0.134 to 0.310-in. (3.4 to 7.9 mm)	C	
			6.066 to 6.383-in. (154.08 to 162.13 mm)		0.134 to 0.297-in. (3.4 to 7.5 mm)	D	
			6.384 to 6.624-in. (162.16 to 168.18 mm)		0.250 to 0.499-in. (6.4 to 12.6 mm)	B	
8-in. (200 mm)	9.688-in. (246.08 mm)	080	7.625 to 7.981-in. (193.68 to 202.72 mm)	0.250 to 0.73-in. (6.4 to 18.5 mm)	0.250 to 0.374-in. (6.4 to 9.5 mm)	C	
			7.982 to 8.400-in. (202.74 to 213.36 mm)		0.250 to 0.312-in. (6.4 to 7.9 mm)	D	
			8.401 to 8.766-in. (213.39 to 222.66 mm)		0.250 to 0.364-in. (6.4 to 9.2 mm)	E	
			8.767 to 9.172-in. (222.68 to 232.97 mm)		0.250 to 1.239-in. (6.4 to 31.4 mm)	B	
8-in. (200 mm)	9.688-in. (246.08 mm)	080	7.393 to 7.624-in. (187.78 to 193.65 mm)	0.250 to 1.47-in. (6.4 to 37.3 mm)	0.250 to 1.114-in. (6.4 to 28.3 mm)	C	
			7.625 to 7.981-in. (193.68 to 202.72 mm)		0.250 to 1.052-in. (6.4 to 26.7 mm)	D	
			7.982 to 8.400-in. (202.74 to 213.36 mm)		0.250 to 1.104-in. (6.4 to 28.0 mm)	E	
			8.401 to 8.766-in. (213.39 to 222.66 mm)		0.250 to 1.065-in. (6.4 to 27.1 mm)	A	
10-in. (250 mm)	11.75-in. (298.45 mm)	100	9.173 to 9.561-in. (232.99 to 242.85 mm)	0.250 to 1.470-in. (6.4 to 37.3 mm)	0.250 to 1.082-in. (6.4 to 27.5 mm)	B	
			9.562 to 10.020-in. (242.87 to 254.51 mm)		0.250 to 1.012-in. (6.4 to 25.7 mm)	C	
			10.021 to 10.546-in. (254.53 to 267.87 mm)		0.250 to 0.945-in. (6.4 to 24.0 mm)	D	
			10.547 to 10.999-in. (267.89 to 279.37 mm)		0.250 to 1.018-in. (6.4 to 25.9 mm)	E	
12-in. (300 mm)	13.0375-in. (331.15 mm)	120	11.000 to 11.373-in. (279.40 to 288.87 mm)	0.250 to 1.470-in. (6.4 to 37.3 mm)	0.250 to 1.097-in. (6.4 to 27.9 mm)	B	
			11.374 to 11.938-in. (288.90 to 303.23 mm)		0.250 to 0.906-in. (6.4 to 23.0 mm)	C	
			11.939 to 12.250-in. (303.25 to 311.15 mm)		0.250 to 1.159-in. (6.4 to 29.4 mm)	D	

Appendix B Approvals

Hazardous Locations Installations	page B-1
Rosemount 2024 Product Certifications	page B-1

HAZARDOUS LOCATIONS INSTALLATIONS

The flowmeter is designed with explosion-proof housings and circuitry suitable for intrinsically safe and non-incendive operation. Each flowmeter is clearly marked with a tag indicating the approvals. To maintain certified ratings for installed transmitters, install in accordance with all applicable installation codes and approval drawings. 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.

ROSEMOUNT 2024 PRODUCT CERTIFICATIONS

Approved Manufacturing Locations

Rosemount Inc. — Chanhassen, Minnesota USA
Fisher-Rosemount GmbH & Co. — Wessling, Germany
Emerson Process Management Asia Pacific Private Limited — Singapore
Beijing Rosemount Far East Instrument Co., LTD — Beijing, China

European Directive Information

The EC declaration of conformity for all applicable European directives for this product can be found on the Rosemount website at www.rosemount.com. A hard copy may be obtained by contacting our local sales office.

ATEX Directive (94/9/EC)

Emerson Process Management complies with the ATEX Directive.

Ordinary Location Certification for Factory Mutual

As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

Hazardous Locations Certifications

North American Certifications

Factory Mutual (FM) Approvals

- E5 Explosion Proof for Class I, Division 1, Groups B, C, and D; Dust-Ignition Proof for Class II, Division 1, Groups E, F, and G. Suitable for Class III, Division 1, indoor and outdoor (NEMA 4X) hazardous locations.
- I5 Intrinsically safe for use in Class I, Division 1, Groups A, B, C, and D; Class II Division 1, Groups E, F, and G; and Class III, Division 1 when connected in accordance with Rosemount drawing 02024-0150. Temp. Code T4. Non-incendive for Class I, Division 2, Groups A, B, C, and D.
- K5 Combined **E5** and **I5**. **Standard Offering**

Canadian Standards Association (CSA) Approvals

- C6 Explosion Proof for Class I, Division 1, Groups C and D; Dust-ignition Proof for Class II, Division 1, Groups E, F, and G; Suitable for Class III, indoor and outdoor hazardous locations, CSA enclosure 4x. Approved for Class I, Division 2, Groups A, B, C, and D.

Intrinsically safe for Class I, Division I, Groups A, B, C, and D when connected in accordance with Rosemount drawing 02024-1064. Temp. Code T3C.

Annubar Flowmeter Series

Reference Manual
00809-0100-4809, Rev AA
May 2002

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