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Section 1: Product Introduction

1.1 Principle of Operation

Turbo-Bar™ flowmeters measure volumetric flow rate of liquid, gas or steam by detecting the local velocity of a fluid stream within a pipe. This local velocity is converted to the average pipe velocity from the following equation:

$$V = V_l \cdot F_p$$

where:

V = average pipe velocity
V_l = local velocity
F_p = profile factor

The profile factor accounts for the parabolic shape of a typical velocity profile in a pipe. It is derived from the Reynolds number of the flow.

The local velocity is determined by the frequency input generated by the turbine probe. The kinetic energy in the fluid stream causes the turbine to rotate at a frequency proportional to the local velocity. A magnetic pickup sensor is positioned near the spinning rotor so that as each blade tip passes underneath the pickup, the blade tip breaks the magnetic field and thus, generates a pulse. The frequency of this pulse is directly proportional to the local velocity.

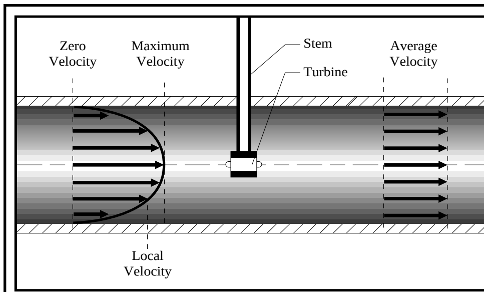
Once the average velocity is calculated from the local velocity, the volumetric flow rate can then be determined from the following equation:

$$Q = V \cdot A$$

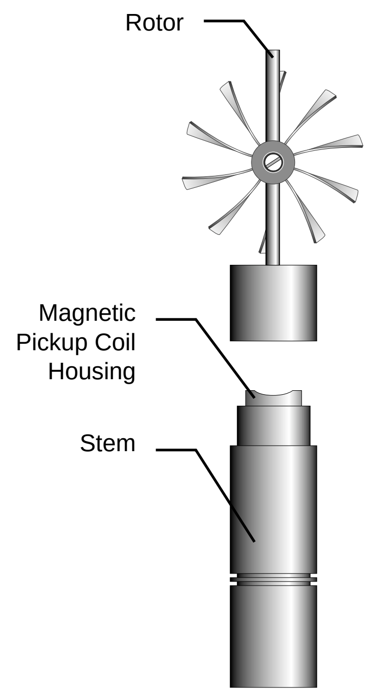
where:

Q = volumetric flow rate
V = average velocity
A = unobstructed cross sectional area of the pipe

Microprocessor electronics provide a frequency or 4-20 mA output proportional to the flow rate. Locally displayed flow rate and total, in user selectable engineering units, are available options.



Profile Factor Principle

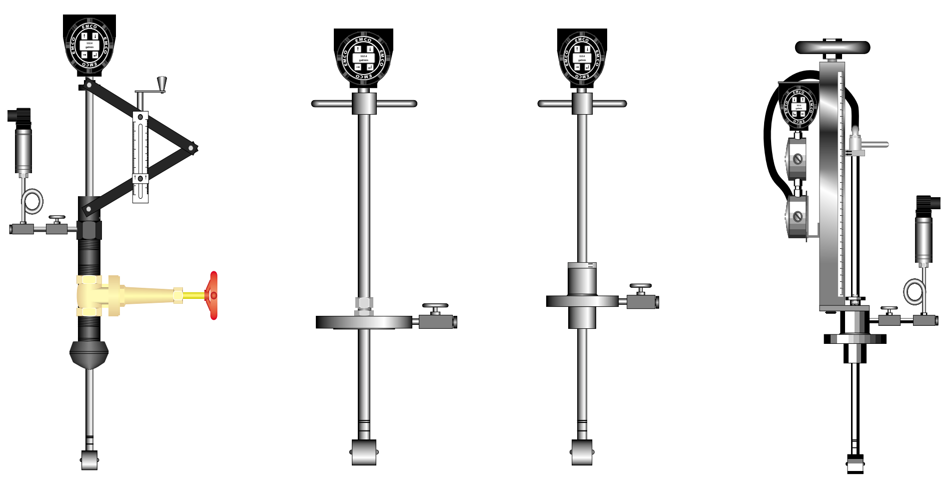


Rotor Generates a Frequency

1.2 General Turbo-Bar™ Flowmeter Features

EMCO's Turbo-Bar™ flowmeters offer:

- Smart transmitter/ HART® Protocol compatibility
- Simultaneous 4–20 mA and frequency outputs
- Negligible pressure loss
- Interchangeable rotors for a wide variety of applications
- Optional, integral pressure and/or temperature transmitters



1.3 TMP-600 Series Features

- Line sizes from 3 to 20" (80 to 500 mm)
- Line pressures up to 125 psig (8.62 barg)
- Temperature range from -40 to 400 °F (-40 to 204 °C)
- Hot tappable
- Bronze isolation valve included
- Retractable using screw thread rising stem design
- Mounting: 2" NPT with thread-o-let
- Integral scale for accurate sensor positioning

1.4 TMP-700 Series Features

- Line sizes from 3 to 78" (80 to 1980 mm)
- Line pressures up to 5000 psig (345 barg)
- Temperature range from -200 to 600 °F (-129 to 316 °C)
- Not hot tappable
- Mounting: 2" NPT or 2" raised face 150#, 300#, 600# or 900# ANSI flanges

1.5 TMP-800 Series Features

- Line sizes from 3 to 84" (80 to 2130 mm)
- Line pressures up to 50 psig (3.45 barg)
- Temperature range from -40 to 400 °F (-40 to 204 °C)
- Manually retractable
- Mounting: 2" NPT or 2" raised face 150# ANSI flange

1.6 TMP-900 Series Features

- Line sizes from 3 to 80" (80 to 2000 mm)
- Line pressures up to 900# flange rating
- Temperature range from -200 to 752 °F (-129 to 400 °C)
- Hot tappable with 2" isolation valve
- Retractable using ACME, non-rising stem
- All stainless steel construction
- Integral scale for accurate sensor positioning
- Mounting: 2" raised face 150#, 300#, 600# or 900# ANSI flanges

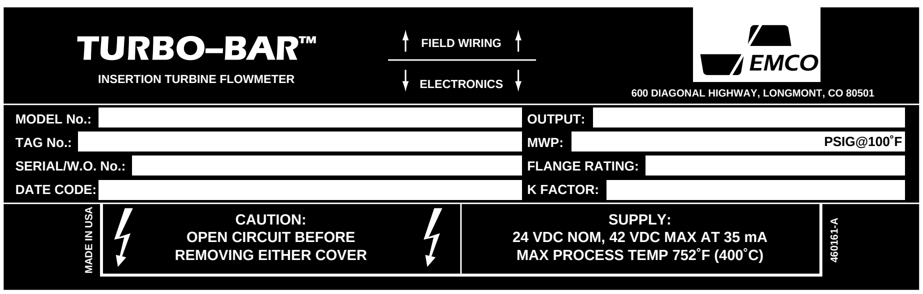
Section 2: Unpacking Your Flowmeter

2.1 Initial Inspection

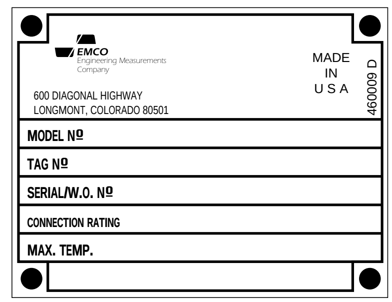
Upon receiving your EMCO equipment, verify that all materials on the packing list are present. Check for possible shipping damage, and notify the freight carrier or your EMCO representative if any has occurred.

2.2 Flowmeter Identification Plate

A permanent identification plate is attached to your Turbo-Bar™ flowmeter. This plate contains information on model, serial/W.O., date, pressure, temperature, and TAG# (if supplied by customer). Verify that this information is consistent with your metering requirements. Model and suffix codes are listed in Section 10, p. 56.



Identification Plate for Turbo-Bar™ Flowmeters with EZ-Logic™ Electronics



Identification Plate for Turbo-Bar™ Flowmeters with All Other Electronics

2.3 Calibration Data

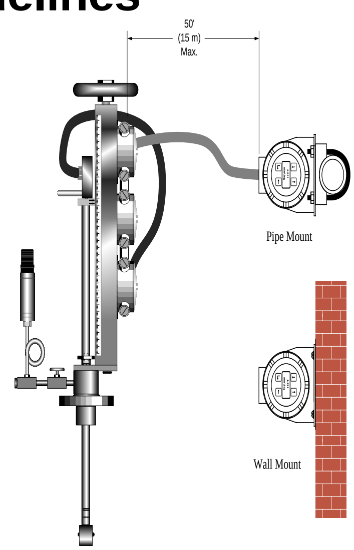
Save the rotor calibration and application information data sheets when unpacking your new Turbo-Bar™ flowmeter. These data sheets are important in setting up and monitoring the performance of your new flowmeter.

2.4 EZ-Logic™ Interface Map

If your Turbo-Bar™ flowmeter is equipped with the optional EZ-Logic™ Electronics, an EZ-Logic™ Interface Map is included with your flowmeter. This map shows how the flowmeter has been programmed at the factory. If your application changes, contact your EMCO representative for an updated map.

Section 3: Installation Guidelines

Choosing the proper installation location for your Turbo-Bar™ flowmeter involves several important considerations:



3.1 Ambient Temperature Limit

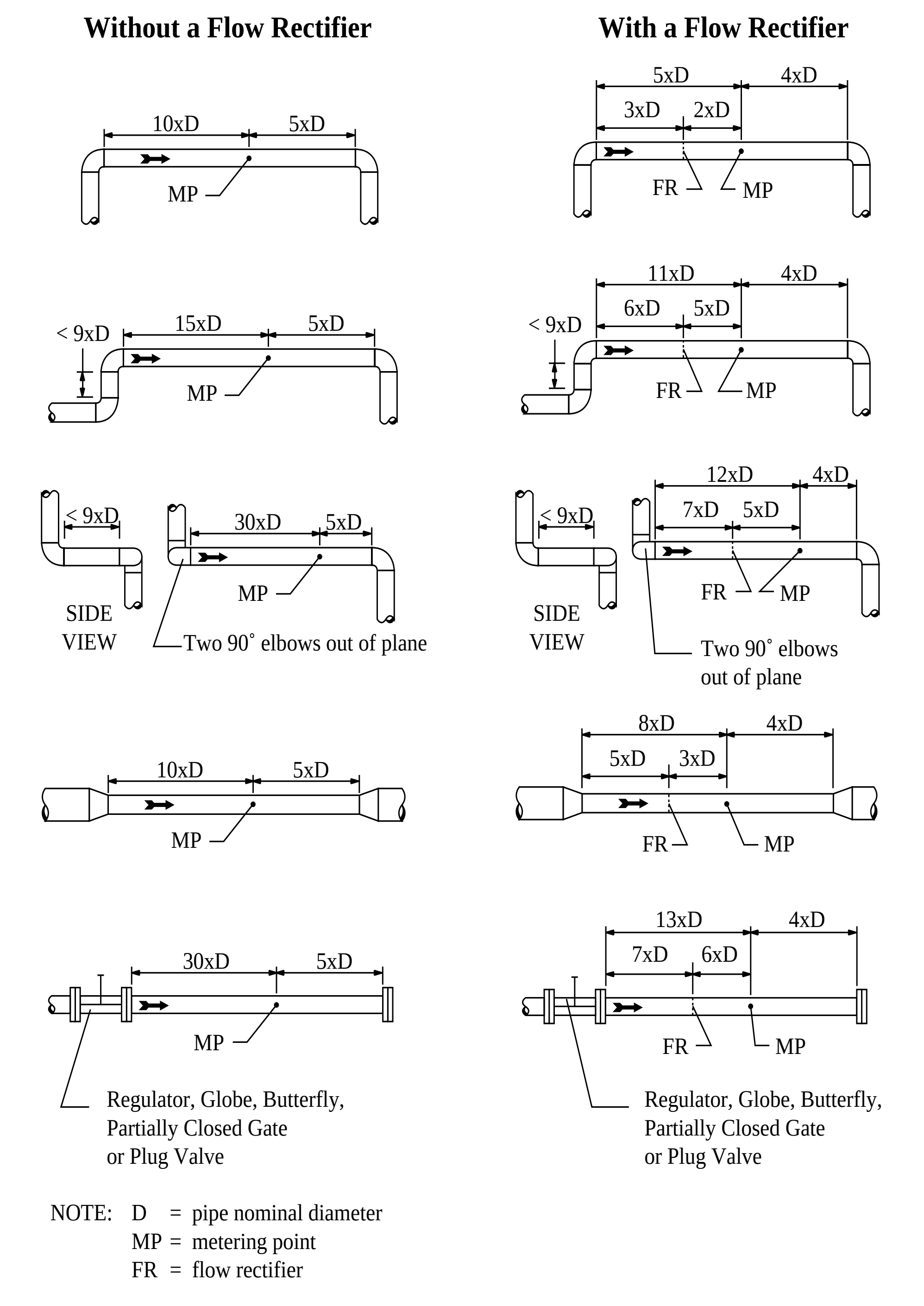
The Turbo-Bar™ electronics are designed to function in a maximum continuous ambient temperature of 140 ˚F (60 ˚C). Flowmeters exposed to ambient temperatures above this level for extended periods of time are subject to a shortened operating life and may not be covered under the EMCO warranty.

If ambient temperatures exceed 140 ˚F (60 ˚C), electronics can be remote mounted with the EZ-Logic™ Electronics option. There are two remote mount options: Pipe Mount and Wall Mount. The maximum cable length between flowmeter and remote mount electronics is fifty (50) feet or fifteen (15) meters.

NOTE: The straight run of pipe must have the same nominal diameter as the flowmeter body.

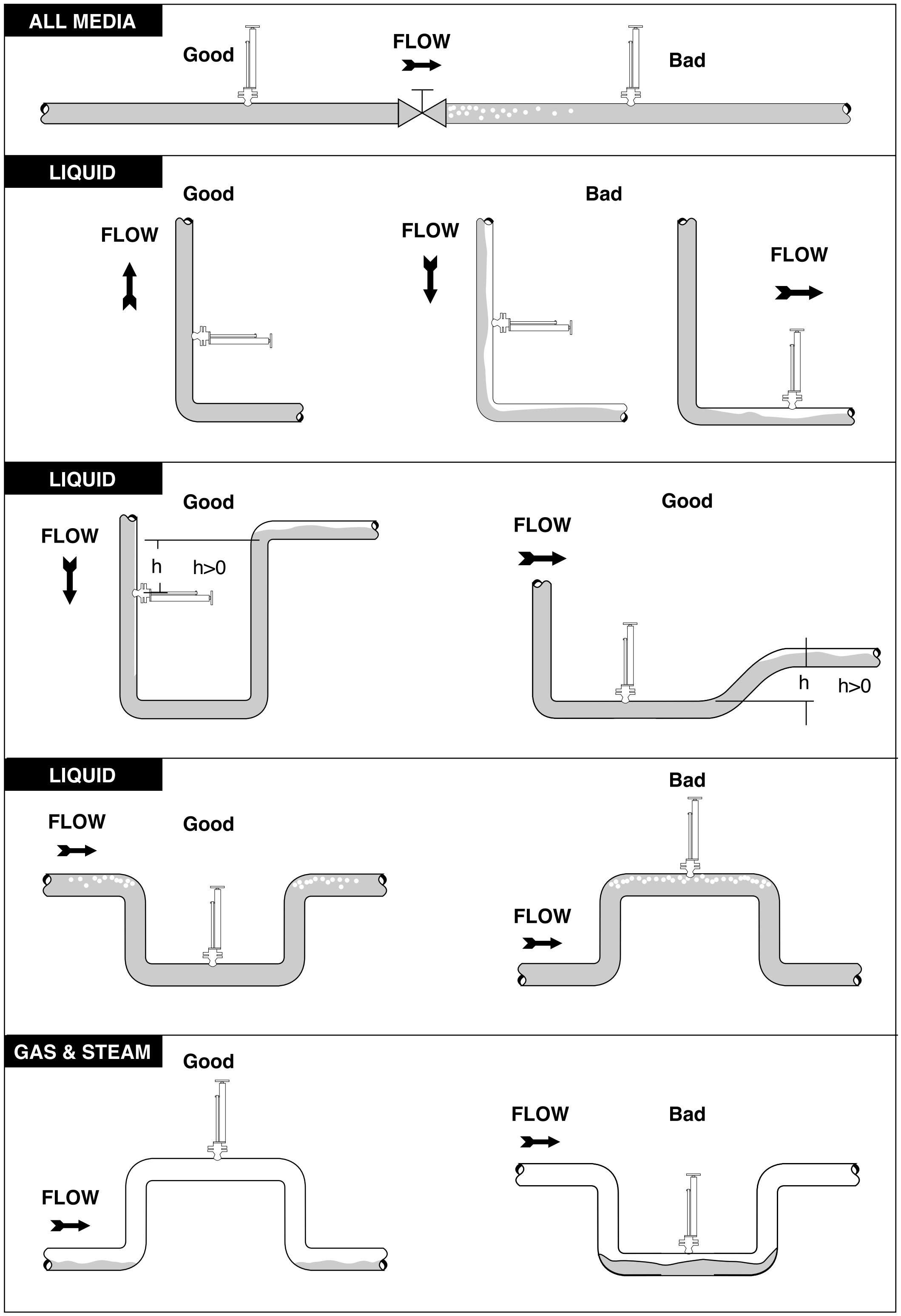
3.2 Straight Run Requirements

The installation location should be selected to minimize possible turbulence and swirl. In general, the minimum unobstructed run of straight pipe is ten (10) pipe diameters upstream and five (5) pipe diameters downstream. The extent of flow disturbances depends upon piping configuration. Valves, elbows, control valves and other piping components may add disturbances to the flow. If such conditions exist and/or sufficient straight pipe is unavailable, a flow conditioner may be used to improve measurement conditions. The minimum straight run requirements for different piping configurations are shown below.



3.3 Flowmeter Location

The flowmeter can be mounted in either horizontal or vertical piping runs. It is important for the pipe to be full for accurate measurements. Follow the guidelines below for recommended flowmeter locations.

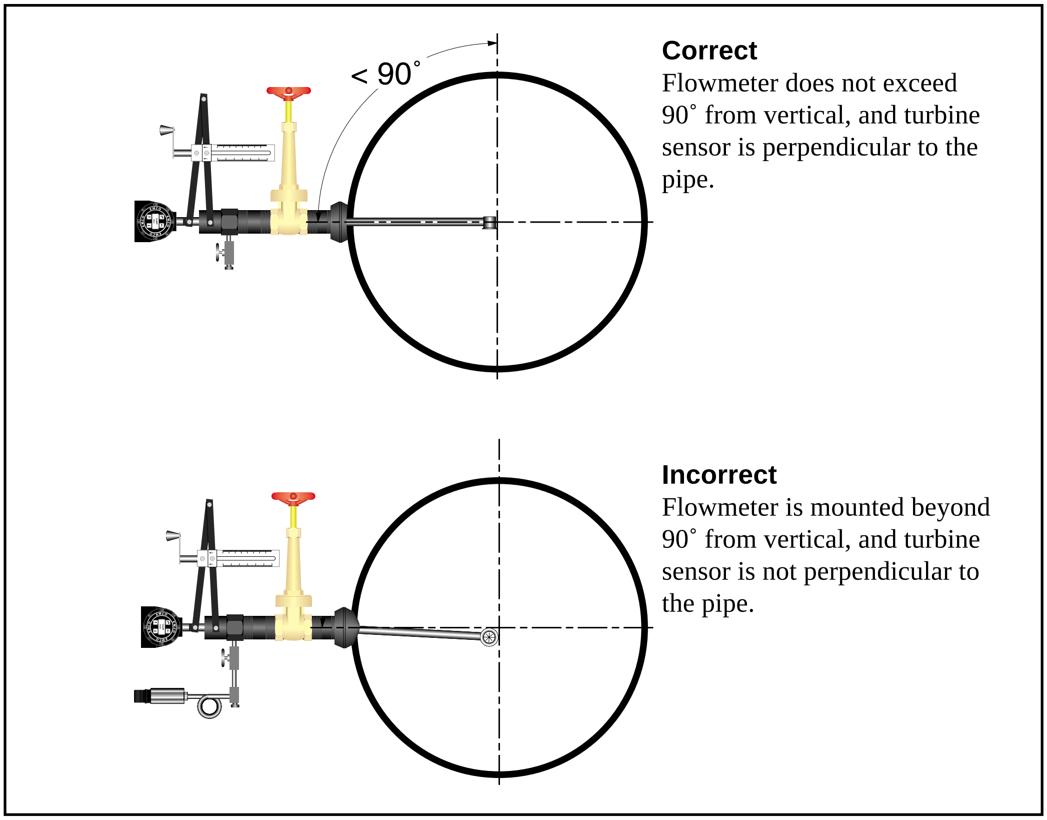


3.4 Nonvertical

If nonvertical mounting is required, the deviation from vertical should not exceed 90˚. When the flowmeter is mounted beyond 90˚, condensate may drip into the condulets (electronics enclosures), causing a short in the flowmeter's electronics. Also, the isolation valve may trap steam or hazardous chemicals, presenting a danger to persons servicing the flowmeter. The flowmeter should always be self-draining.

3.5 Flowmeter Alignment

The flowmeter's turbine sensor must be correctly aligned to the perpendicular axis to avoid measurement errors.



3.6 Overhead Clearance

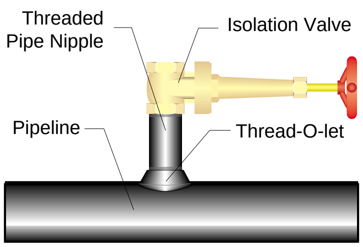
A minimum of 12" of overhead clearance is recommended for ease of installation.

3.7 Easy Accessibility

The installation location should be where the flowmeter will be easy for workers to safely and conveniently access all parts of the flowmeter.

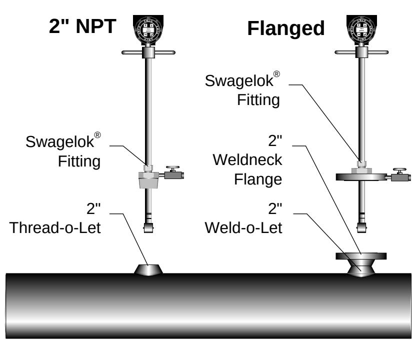
3.8 Pipe Tapping

The pipeline should be prepared for either cold tap or hot tap installations. A cold tap installation involves drilling a hole into a pipeline that has been depressurized and for which service has been shutdown. A hot tap installation involves drilling a hole into a pressurized line without line shutdown and disruption of the process.



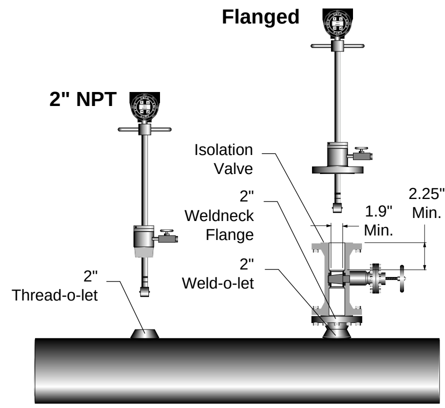
3.8.1 TMP-600 Series

The TMP-600 series can be hot tapped. A mounting kit, which includes a 2" bronze isolation valve, a pipe nipple and a thread-o-let, are standard with each flowmeter.



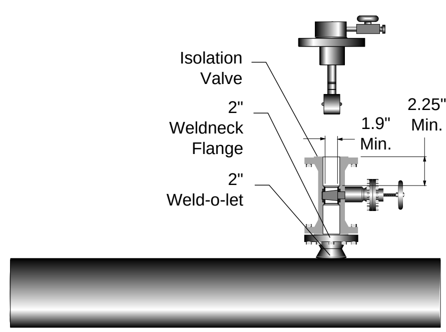
3.8.2 TMP-700 series

The TMP-700 series can not be hot tapped; it can only be installed and removed with process shutdown because it uses a Swagelok® fitting and is nonretractable. There are two mounting connections: 2" NPT and flanged. The 2" NPT connection requires a 2" thread-o-let for installation. The flanged connection requires a 2" weld-o-let and a 2" raised face, weldneck flange with the same pressure rating as the flowmeter flange. These mounting connections are not included with the flowmeter, but may be ordered separately.



3.8.3 TMP-800 series

There are two possible mounting connections for the TMP-800 series: 2" NPT and flanged. The 2" NPT connection requires a 2" thread-o-let for installation, and it can only be installed and removed with process shutdown. The flanged connection requires a 2" weld-o-let and a 2" 150# raised face, weldneck flange. A 2", double flanged, fully ported ball or gate valve that adheres to the dimensions shown may be used as the isolation valve. When used with an isolation valve, the flanged connection TMP-800 series can be hot tapped. These mounting connections are not included with the flowmeter, but may be ordered separately.



3.8.4 TMP-900 series

The TMP-900 series can be hot tapped. Installation requires a 2" weld-o-let and a 2" raised face, weldneck flange with the same pressure rating as the flowmeter flange. A 2", double flanged, fully ported ball or gate valve that adheres to the dimensions shown may be used as the isolation valve. These mounting connections are not included with the flowmeter, but may be ordered separately.

> ⚠ ***CAUTION:** Hot tapping must be performed by a trained professional. Local state regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such permit.*

Section 4: Mechanical Installation

4.1 Hot Tap Installation: TMP-600

The TMP-600 can be installed without process shutdown or line depressurization. The TMP-600 is shipped with an isolation valve and a pipe nipple attached to the flowmeter. For a hot tap installation, the isolation valve and pipe nipple need to be separated from the flowmeter.

Step 1. Weld thread-o-let to pipe.

Step 2. Thread 2" pipe nipple into thread-o-let. Hand tighten.

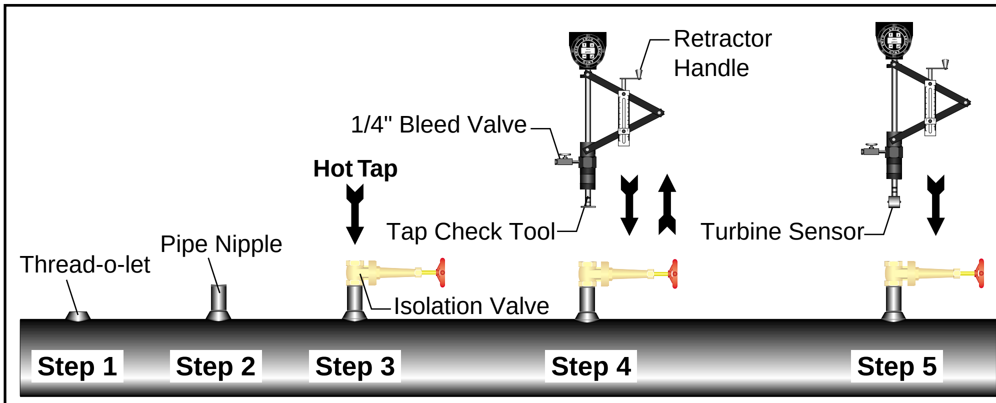
Step 3. Thread 2" bronze, isolation valve to pipe nipple. Attach hot tap tool. Fully open isolation valve. Hot tap pipe. Hole should be 1.875" in diameter. Retract hot tap tool. Close isolation valve. Remove hot tap tool.

Step 4. Attach tap check tool to the end of the flowmeter stem before proceeding.

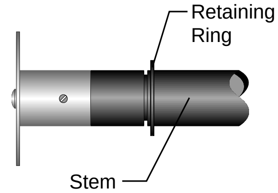
Thread flowmeter into isolation valve. Verify that $^1/_4$" bleed valve is closed. Open isolation valve. Turn the retractor handle to insert tap check tool into pipe and then, retract tap check tool completely. Close isolation valve. Slowly open bleed valve to bleed off the trapped fluid inside the isolation valve and flowmeter assembly. Remove flowmeter from isolation valve. Inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 5. Remove tap check tool and attach turbine sensor (rotor assembly) to end of stem. Verify that screw and safety wire on rotor assembly are properly installed.

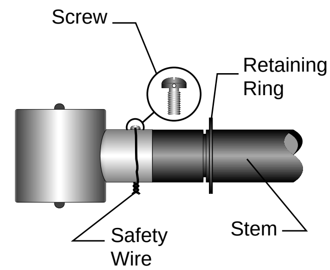
Thread flowmeter into isolation valve. Use Teflon tape or PST on threads to improve seal and to prevent seizing. Verify that bleed valve is closed. Fully open isolation valve. If the flowmeter is supplied with a pressure transmitter, open bleed valve. Do not insert turbine sensor into pipe until calculating the insertion depth, p. 13.



TMP-600 Hot Tap Installation



Tap Check Tool



Rotor Assembly

4.2 Cold Tap Installation: TMP-600

Process shutdown and line depressurization are required for cold tap installation.

Step 1. Tap pipe. Hole should be 1.875" in diameter.

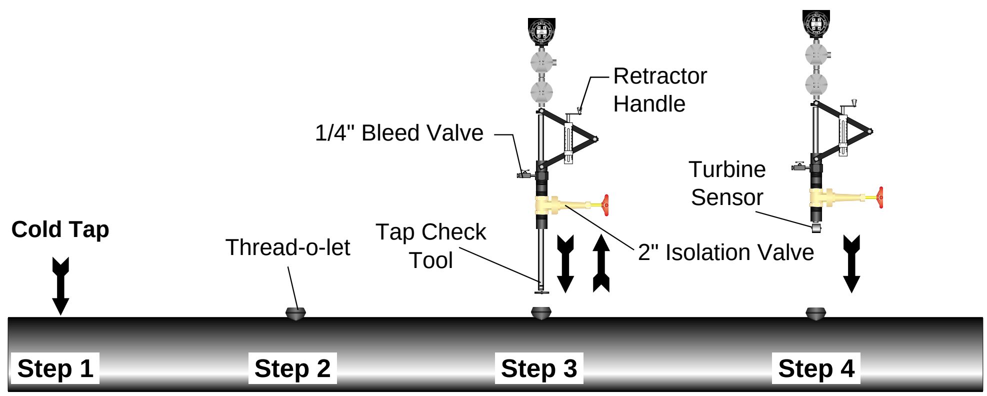
Step 2. Weld thread-o-let to pipe.

Step 3. Attach tap check tool to the end of the flowmeter stem before proceeding.

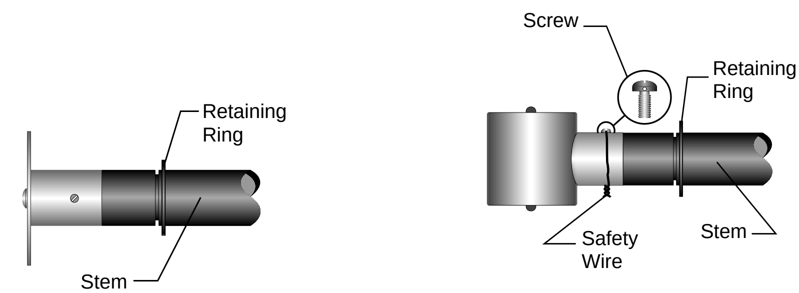
Thread flowmeter to thread-o-let. Verify that 1/4" bleed valve is closed. Open 2" bronze isolation valve. Turn the retractor handle to insert tap check tool into pipe and then, retract tap tool completely. Remove flowmeter from thread-o-let and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 4. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flowmeter stem. Verify that screw and safety wire on rotor assembly are properly installed.

Thread flowmeter to thread-o-let. Use Teflon tape or PST on threads to improve seal and to prevent seizing. Verify that bleed valve is closed. Fully open isolation valve. If the flowmeter is supplied with a pressure transmitter, open bleed valve. Do not insert turbine sensor into pipe until calculating the insertion depth, p. 13.



TMP-600 Cold Tap Installation



Tap Check Tool **Rotor Assembly**

NOTE: The distance the fully retracted rotor travels before becoming visible has been figured into the factory adjustment of the depth scale.

4.3 Insertion Depth Scale Reading Calculation: TMP-600

After tapping the pipe and installing the TMP-600, the turbine sensor needs to be properly positioned within the pipe. To determine the proper insertion depth, the scale reading must be calculated. The scale reading is the figure that the top of the cursor should be set to on the depth scale. Use the proper side of the scale depending on the rotor style. The 150 series (1.5") uses the left side of the scale; the 100 series (1") uses the right side.

Refer to the figure below and use the following equation to calculate the insertion depth:

Scale Reading = *I* + *E* + *Wt*

Where:

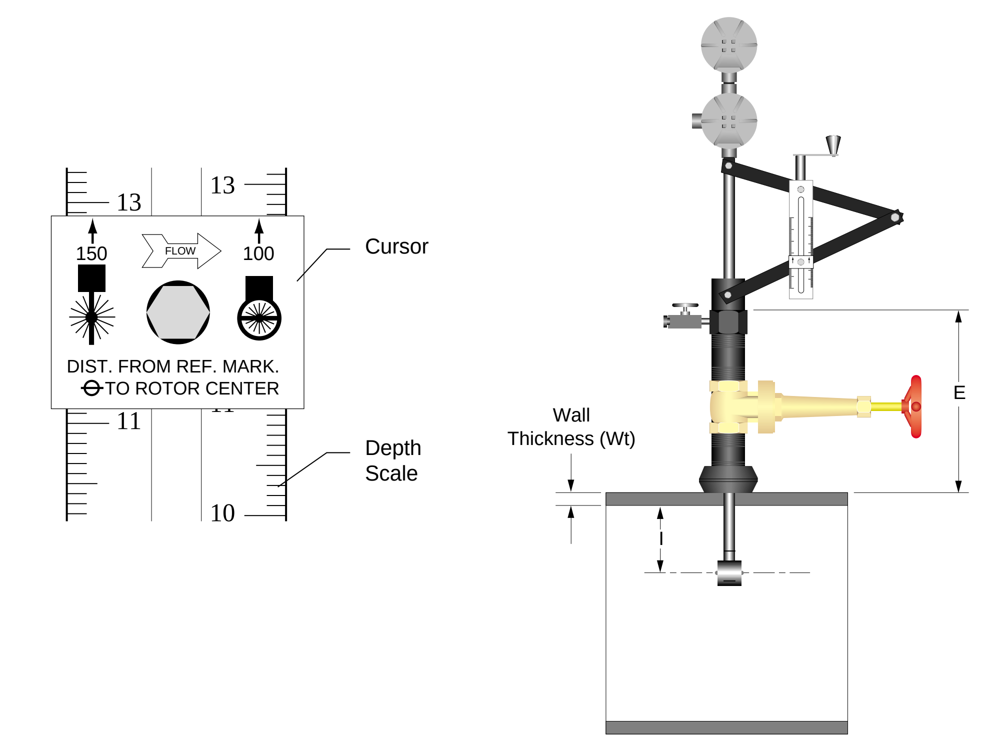
I = For pipe sizes less than 12", inside pipe diameter ÷ 2
I = For pipe sizes 12" and larger, inside pipe diameter ÷ 4
E = Distance from the top of the stem housing to the outside pipe wall. This distance varies depending on how tightly the pipe nipples are screwed into the isolation valve and thread-o-let.
Wt = Thickness of the pipe wall. The disk cut-out or “coupon" from the tapping procedure can be measured, or this number can also be obtained from a piping handbook.

Example:

A TMP-600 is to be installed on a 12" schedule 40 pipe. The following measurements have been obtained:

I = (11.938 ÷ 4) = 2.98"
E = 12.5"
Wt = 0.375"

Scale Reading = *I* + *E* + *Wt*
Scale Reading = 2.98"+12.5"+ 0.375" = **15.855"**



TMP-600 Scale

TMP-600 Dimensions for Determining Insertion Depth

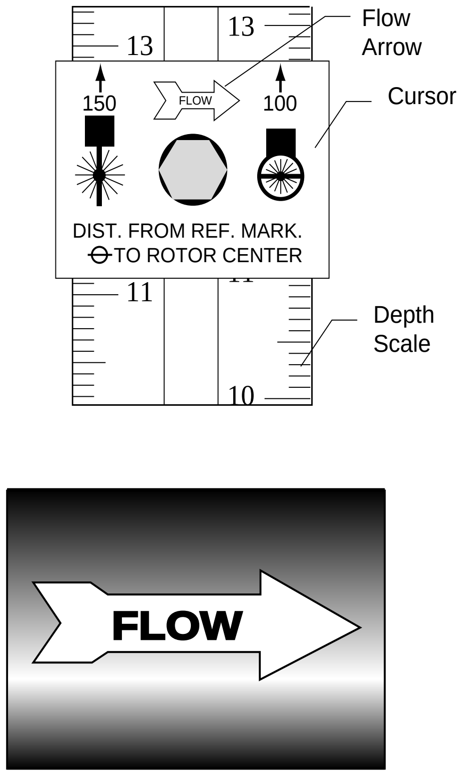
CAUTION: *Do not allow the orientation of the flowmeter or the insertion depth to change after insertion is complete. A change in insertion depth or alignment will cause inaccurate readings and shortened rotor life.*

4.4 Rotor Orientation and Final Positioning: TMP-600

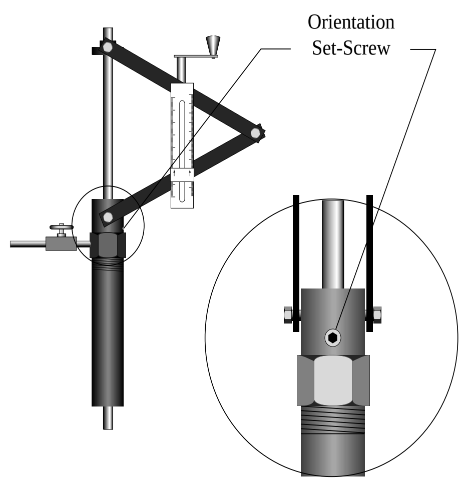
Use the retractor handle to carefully insert the rotor down into the pipe until the calculated insertion depth figure on the depth scale lines up with the top of the cursor.

Use a pipe wrench to align the retractor bar assembly so the flow direction arrow on the cursor is in line with the pipe and pointed downstream.

Lock the stem in position by tightening the orientation set screw.

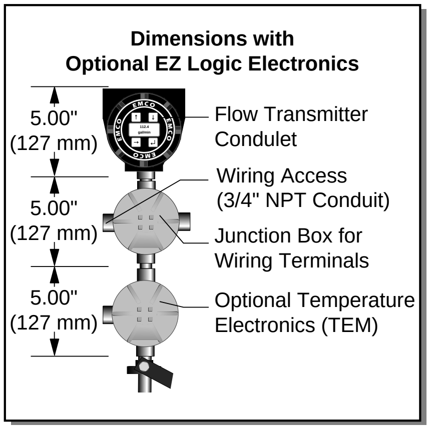


TMP-600 Guides for Determining Rotor Orientation

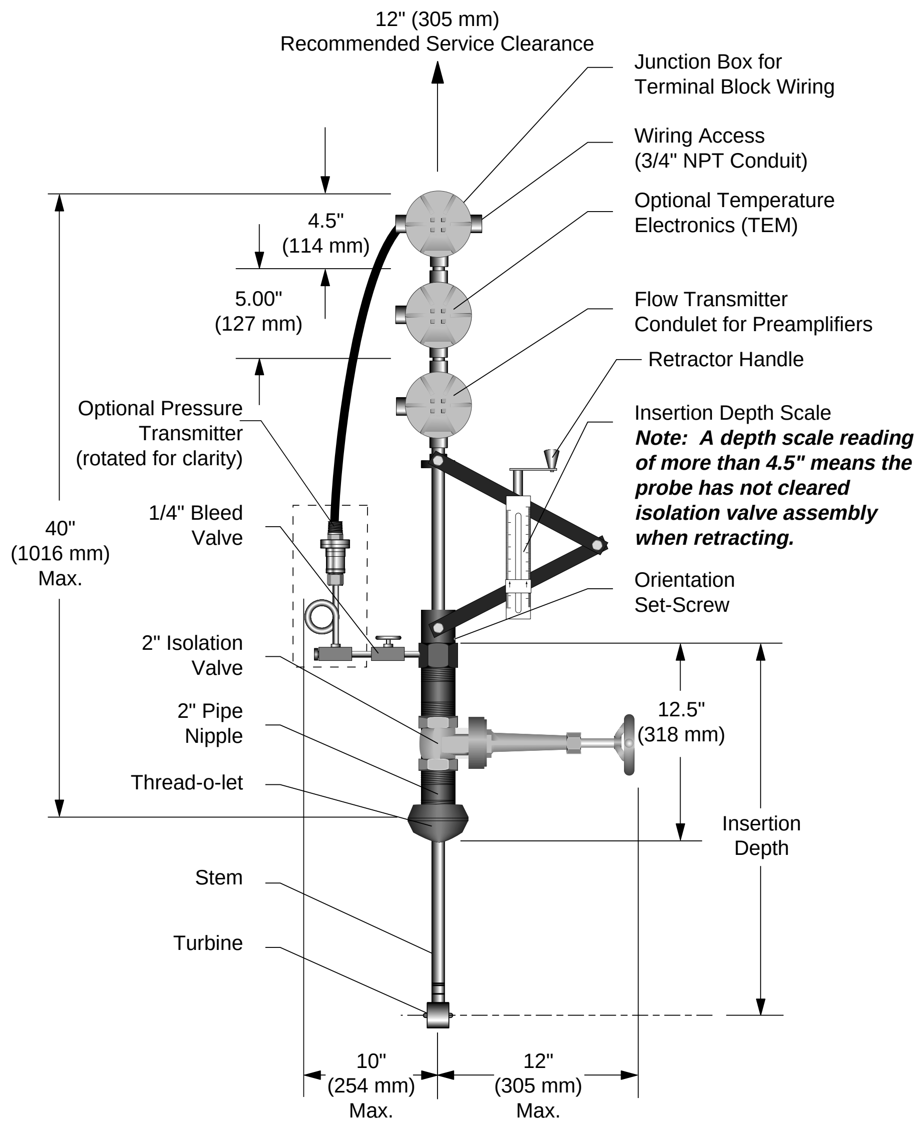


Locking TMP-600 Stem in Position

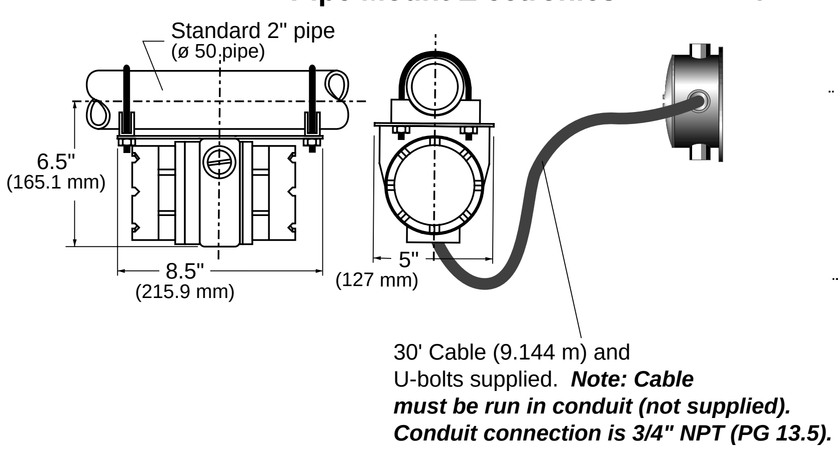
4.5 Dimensional Drawing: TMP-600

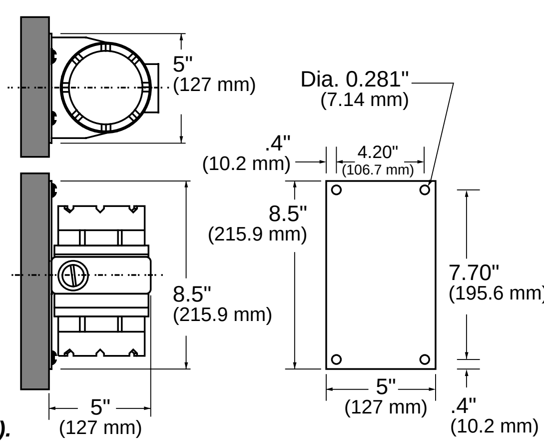


Insertion Depth		Weight
Minimum	Maximum	Maximum
4.5" (114 mm)	18" (457 mm)	28 lbs. (12.7 kg)



Pipe Mount Electronics **OR** **Wall Mount Electronics**





4.6 Cold Tap Installation: TMP-700

The TMP-700 is nonretractable and must be cold tapped. Process shutdown and line depressurization are required for cold tapping. There are two mounting connections available: Flanged or 2" NPT.

4.6.1 Installation for Flanged Connection

Step 1. Tap pipe. Hole should be 1.875" in diameter.

Step 2. Weld weld-o-let to pipe.

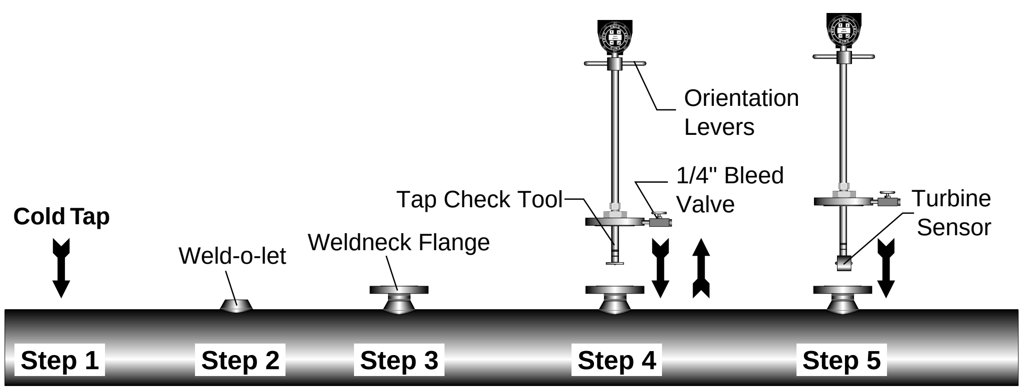
Step 3. Weld weldneck flange to weld-o-let.

Step 4. Attach tap check tool to the end of the flowmeter stem before proceeding.

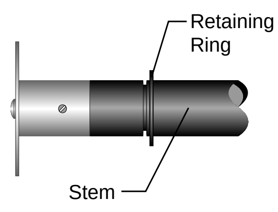
Attach flowmeter to flange. Verify that 1/4" bleed valve is closed. Use orientation levers to manually lower tap check tool into pipe and then, retract tap check tool completely. Remove flowmeter from flange and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 5. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flowmeter stem. Verify that screw and safety wire on rotor assembly are properly installed.

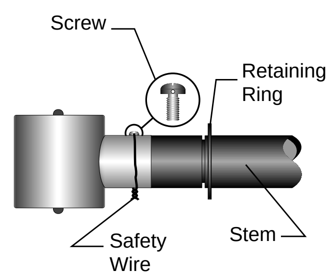
Reconnect flowmeter to flange. Verify that 1/4" bleed valve is closed. If the flowmeter is supplied with a pressure transmitter, open 1/4" bleed valve. Do not lower turbine sensor into pipe until calculating insertion depth, p. 18.



TMP-700 Cold Tap Installation for Flanged Connection



Tap Check Tool



Rotor Assembly

4.6.2 Installation for 2" NPT Connection: TMP-700

Step 1. Tap pipe. Hole should be 1.875" in diameter.

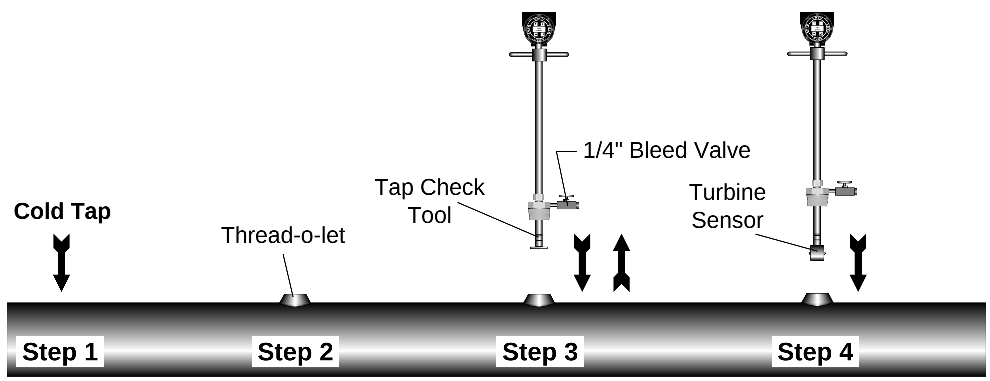
Step 2. Weld thread-o-let to pipe.

Step 3. Attach tap check tool to the end of the flowmeter stem before proceeding.

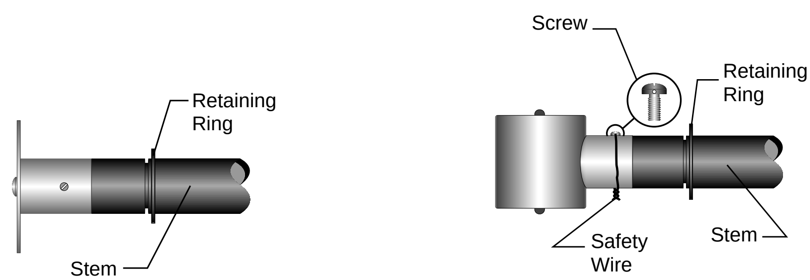
Thread flowmeter to thread-o-let. Verify that 1/4" bleed valve is closed. Use orientation levers to manually lower tap check tool into pipe and then, retract tap tool completely. Remove flowmeter from thread-o-let and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 4. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flowmeter stem. Verify that screw and safety wire are properly installed.

Reconnect flowmeter to thread-o-let. Verify that 1/4" bleed valve is closed. Use Teflon tape or PST on threads to improve seal and prevent seizing. If the flowmeter is supplied with a pressure transmitter, open 1/4" bleed valve. Do not lower turbine sensor into pipe until calculating insertion depth, p. 18.



TMP-700 Cold Tap Installation for 2" NPT Connection



Tap Check Tool **Rotor Assembly**

4.7 Insertion Depth Measurement Calculation: TMP-700

After tapping the pipe and installing the TMP-700, the turbine sensor needs to be properly positioned within the pipe. To determine the proper insertion depth, the insertion depth must be calculated. Refer to the figures below and use to following equation to calculate the insertion depth:

B = C – I – E – Wt

Where:

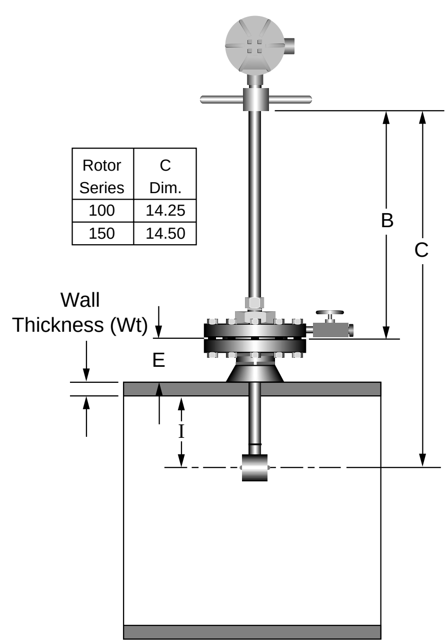
B	=	Installed dimension to be set on the flowmeter
C	=	For 100 series (1") rotors, 14.25"
C	=	For 150 series (1.5") rotors, 14.50"
I	=	For pipe sizes less than 12", inside pipe diameter ÷ 2
I	=	For pipe sizes 12" and larger, inside pipe diameter ÷ 4
E	=	Distance from the raised face of the flange or top of NPT fitting to the outside pipewall
Wt	=	Thickness of the pipe wall. The disk cut-out or "coupon" from the tapping procedure can be measured, or this number can also be obtained from a piping handbook.

Example:
A TMP-700 with a 100 series rotor is to be installed on a 12" schedule 40 pipe. The following measurements have been obtained:

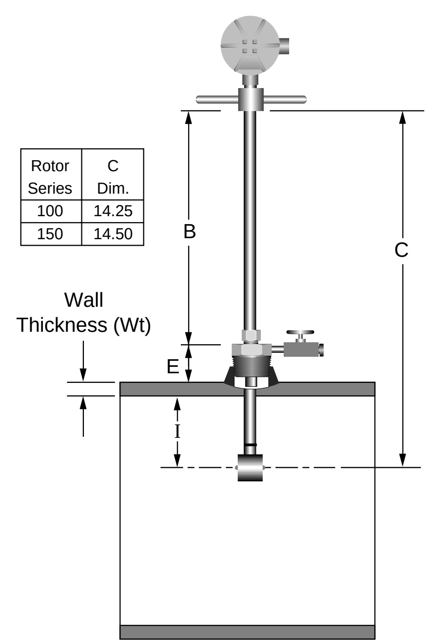
C	=	14.25"
I	=	(11.938" ÷ 4) = 2.98"
E	=	4.5"
Wt	=	0.406"

B = *C* – *I* – *E* – *Wt*

B = 14.25" – 2.98" – 4.5" – 0.406" = **6.364"**



TMP-700 Dimensions for Calculating Insertion Depth with Flanged Connection



TMP-700 Dimensions for Calculating Insertion Depth with 2" NPT Connection

CAUTION: *Do not force stem into pipe. If the stem insertion is blocked, retract and remove the flowmeter from the pipe line, checking to make sure the opening conforms with the guidelines listed in the mounting guidelines.*

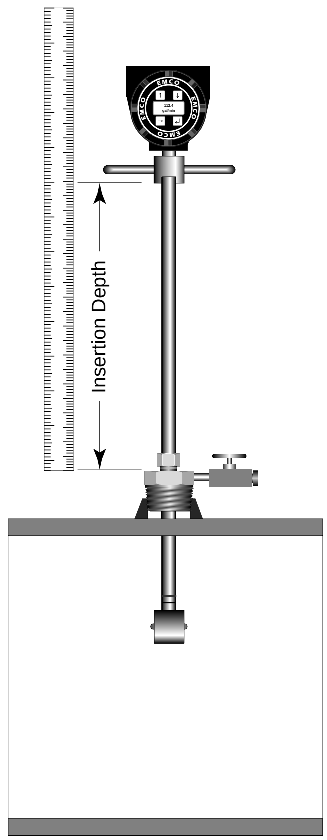
NOTE: *Once the fitting has been tightened, the stem position becomes permanent and cannot be changed. Verify insertion depth prior to final tightening of the fitting.*

4.8 Rotor Orientation and Final Positioning: TMP-700

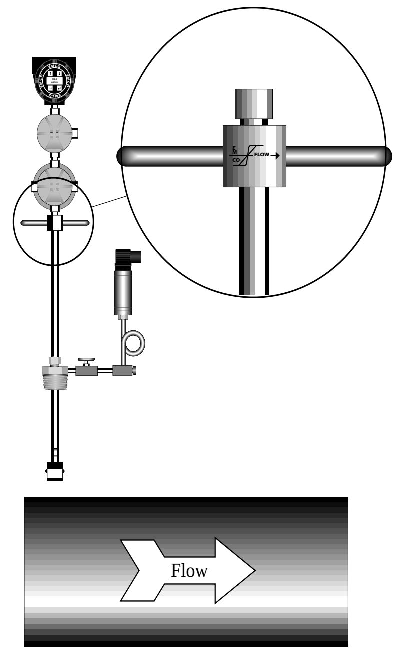
Manually insert the stem into the pipe until the calculated insertion depth is obtained.

Align the rotor by using the orientation levers so that the flow direction arrow is parallel to the pipe and pointed downstream..

Lock the stem in position by tightening the Swagelok® fitting. Verify insertion depth prior to final tightening of the fitting. Once the fitting has been tightened, the stem position becomes permanent and cannot be changed.



TMP-700 Guide for Insertion Depth

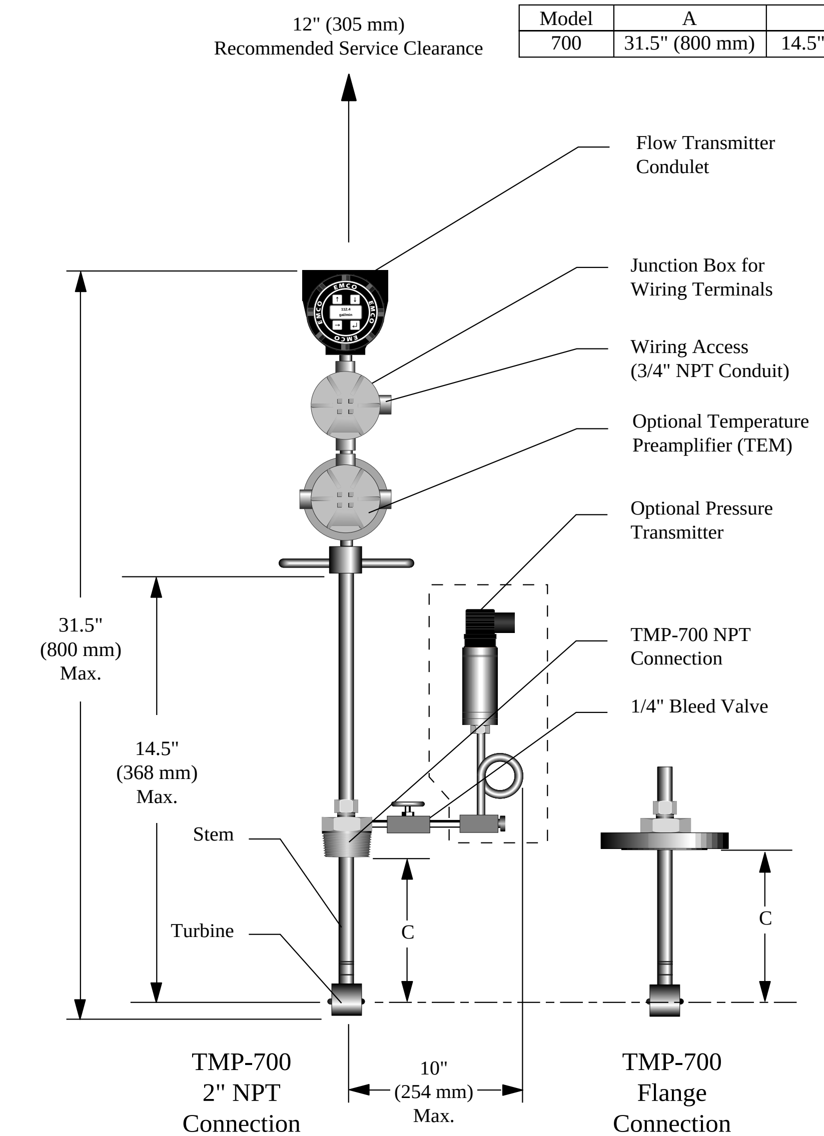


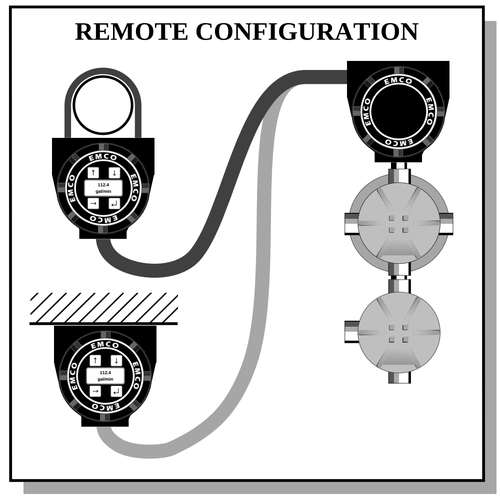
TMP-700 Guide for Rotor Orientation

4.9 Dimensional Outline: TMP-700

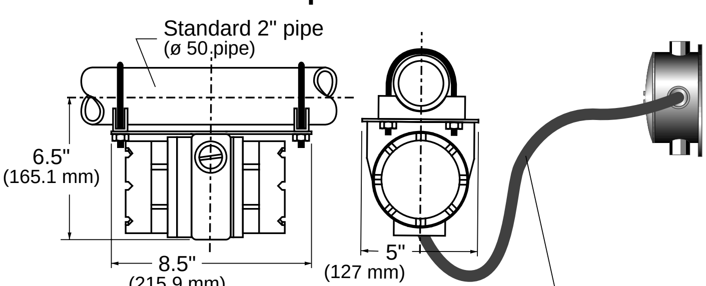
Model	A	B
700	31.5" (800 mm)	14.5" (368 mm)

Model	Connection	Weight
700	2" NPT	9 lbs (4.1 kg)
	2" 150#	12 lbs (5.4 kg)
	2" 300#	14 lbs (6.3 kg)
	2" 600#	16 lbs (7.2 kg)
	2" 900#	20 lbs (9.1 kg)

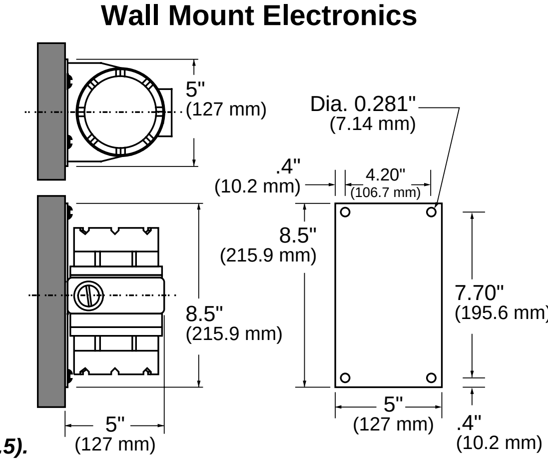




Pipe Mount Electronics **OR** **Wall Mount Electronics**



30' Cable (9.144 m) and U-bolts supplied. ***Note: Cable must be run in conduit (not supplied). Conduit connection is 3/4" NPT (PG 13.5).***



***CAUTION:** Hot tapping must be performed by a trained professional. Local state regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such permit.*

4.10 Hot Tap Installation: TMP-800/80S

The TMP-800/80S with a flanged connection can be installed without process shutdown or line depressurization. The TMP-800/80S with 2" NPT connection cannot be hot tapped.

Stem will rise with line pressure. Do not exceed 50 psig.

Step 1. Weld weld-o-let to pipe.

Step 2. Weld weldneck flange to weld-o-let.

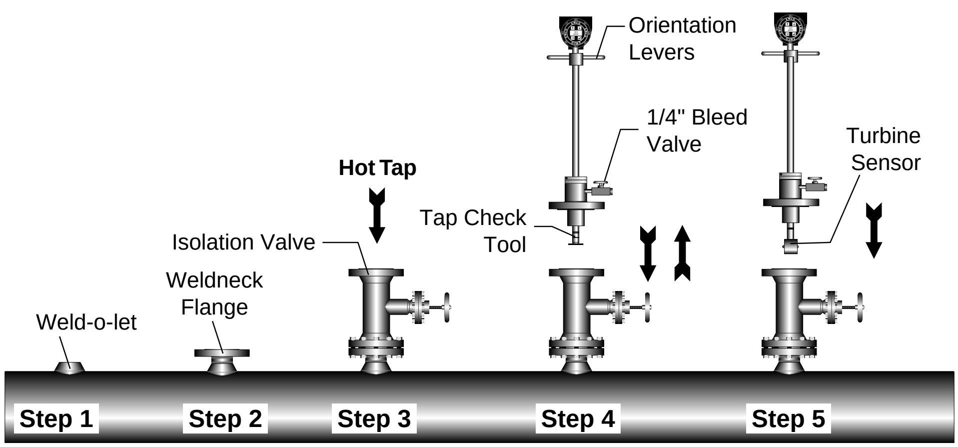
Step 3. Attach 2" isolation valve to weld-o-let. Attach hot tap tool. Fully open isolation valve. Hot tap pipe. Hole should be 1.875" in diameter. Retract hot tap tool. Close isolation valve. Remove hot tap tool.

Step 4. Attach tap check tool to the end of the flowmeter stem before proceeding.

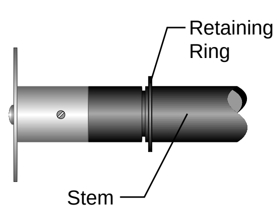
Attach flowmeter to isolation valve. Verify that 1/4" bleed valve is closed. Open isolation valve. Use orientation levers to manually lower tap check tool into pipe and then, retract tap tool completely. Close isolation valve. Slowly open 1/4" bleed valve to bleed off the trapped fluid inside the isolation valve and flowmeter assembly. Remove flowmeter from isolation valve and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 5. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flow-meter stem. Verify that screw and safety wire on rotor assembly are properly installed.

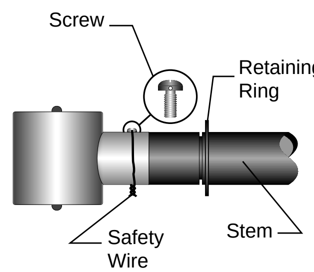
Reconnect flowmeter to isolation valve. Verify that bleed valve is completely closed. Fully open isolation valve. If the flowmeter is supplied with a pressure transmitter, open the 1/4" bleed valve. Do not lower turbine sensor into pipe until calculation the proper insertion depth, p. 23.



TMP-800/80S Hot Tap Installation for Flanged Connection



Tap Check Tool



Rotor Assembly

4.11 Cold Tap Installation: TMP-800/80S

Process shutdown and line depressurization are required for cold tap installations. There are two mounting connections available: Flanged or 2" NPT.

4.11.1 Installation for Flanged Connection: TMP-800/80S

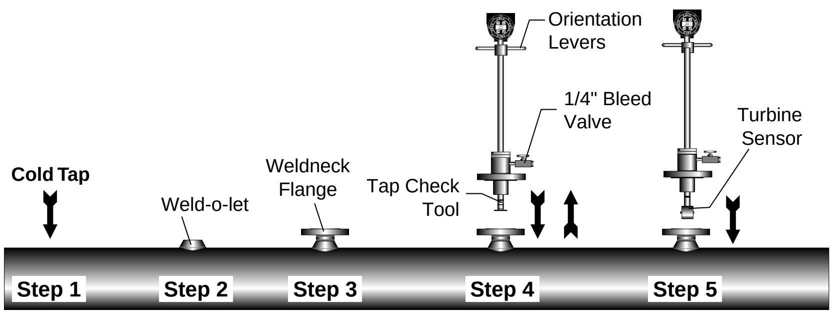
Step 1. Tap pipe. Hole should be 1.875" in diameter.

Step 2. Weld weld-o-let to pipe.

Step 3. Weld weldneck flange to weld-o-let.

Step 4. Attach tap check tool to the end of the flowmeter stem before proceeding. Attach flowmeter to flange. Verify that 1/4" bleed valve is closed. Use orientation levers to manually lower tap check tool into pipe and then, retract tap tool completely. Remove flowmeter from flange and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 5. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flowmeter stem. Verify that screw and safety wire on rotor assembly are properly installed. Reconnect flowmeter to flange. Verify that 1/4" bleed valve is closed. If the flowmeter is supplied with a pressure transmitter, open bleed valve. Do not lower turbine sensor into pipe until calculating the proper insertion depth, p. 23.



TMP-800/80S Cold Tap Installation for Flanged Connection

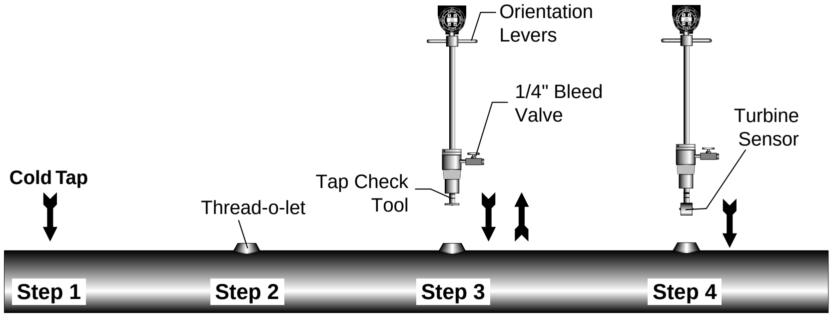
4.11.2 Installation for 2" NPT Connection

Step 1. Tap pipe. Hole should be 1.875" in diameter.

Step 2. Weld thread-o-let to pipe.

Step 3. Attach tap check tool to the end of the flowmeter stem before proceeding. Thread flowmeter into thread-o-let. Verify that 1/4" bleed valve is closed. Use orientation levers to manually lower tap check tool into pipe and then, retract tap tool completely. Remove flowmeter from thread-o-let and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 4. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flowmeter stem. Verify that screw and safety wire on rotor assembly are properly installed. Verify that 1/4" bleed valve is closed. Reconnect flowmeter to thread-o-let. Use Teflon tape or PST on threaded mounting connections to improve seal and prevent seizing. If the flowmeter is supplied with a pressure transmitter, open bleed valve. Do not lower turbine sensor into pipe until calculating the proper insertion depth, p. 23.



TMP-800/80S Cold Tap Installation for 2" NPT Connection

4.12 Insertion Depth Measurement Calculation: TMP-800/80S

After tapping the pipe and installing the TMP 800/80S, the turbine sensor needs to be properly positioned within the pipe. To determine the proper insertion depth, the insertion depth must be calculated.

Refer to the figures below and use the following equation to calculate the proper insertion depth:

B = C – I – E – Wt

Where:

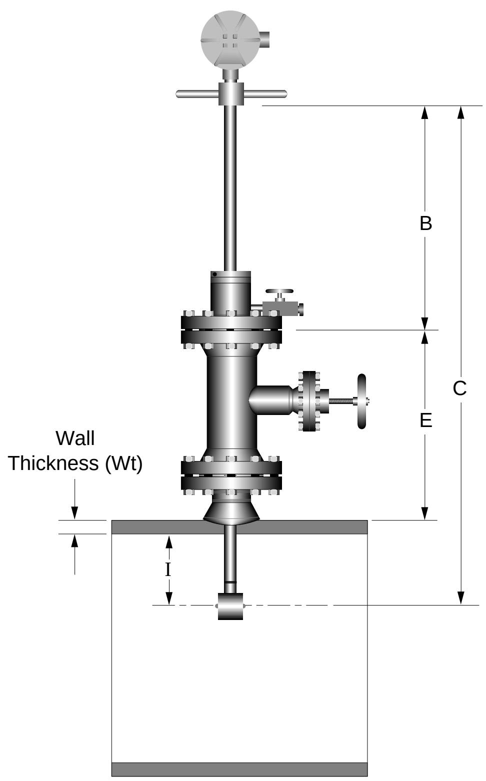
B	=	Installed dimension to be set on the flowmeter
C	=	For 100 series (1") rotors, 25.75"
C	=	For 150 series (1.5") rotors, 26.00"
I	=	For pipe sizes less than 12", inside pipe diameter ÷ 2
I	=	For pipe sizes 12" and larger, inside pipe diameter ÷ 4
E	=	Distance from the raised face of the flange or top of NPT fitting to the outside pipewall
Wt	=	Thickness of the pipe wall. The disk cut-out or "coupon" from the tapping procedure can be measured, or this number can also be obtained from a piping handbook.

Example:
A TMP-800/80S with 100 series rotor is to be installed on a 12" schedule 40 pipe. The following measurements have been obtained:

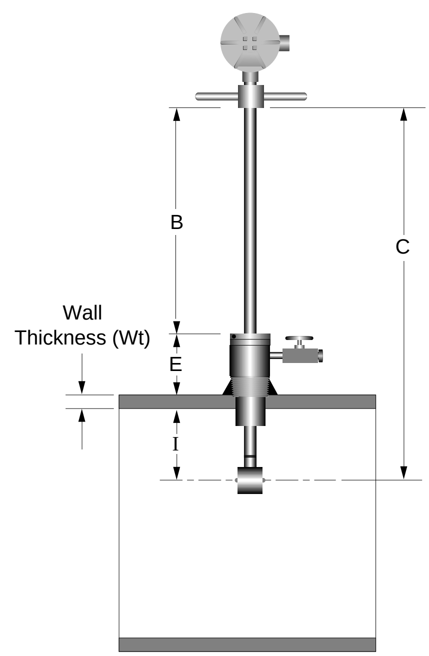
C	=	25.75"
I	=	(11.9538" ÷ 4) = 2.98"
E	=	4.5"
Wt	=	0.406"

B = C – I – E – Wt

B = 25.75" – 2.98" – 4.5" – 0.406" = **6.1"**



TMP-800/80S Dimensions for Calculating Insertion Depth with Flanged Connection

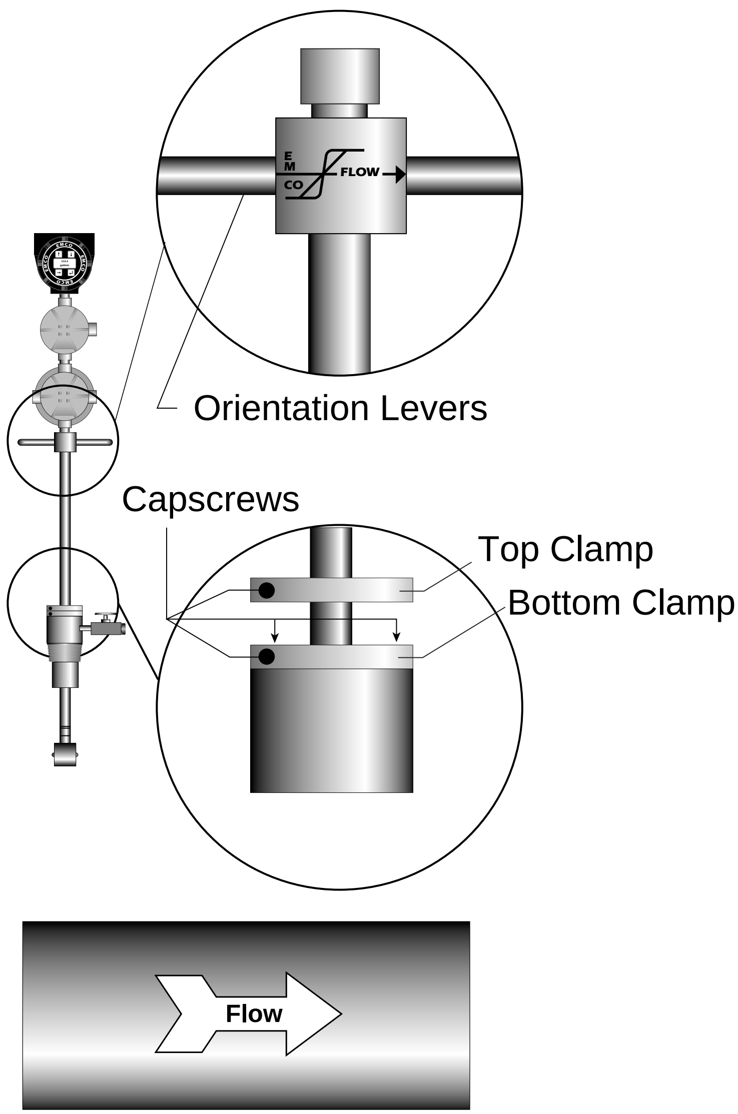


TMP-800/80S Dimensions for Calculating Insertion Depth with 2" NPT Connection

CAUTION: *Do not allow the orientation of the flowmeter or the insertion depth to change after insertion is complete. A change in insertion depth or alignment will cause inaccurate readings and shortened rotor life.*

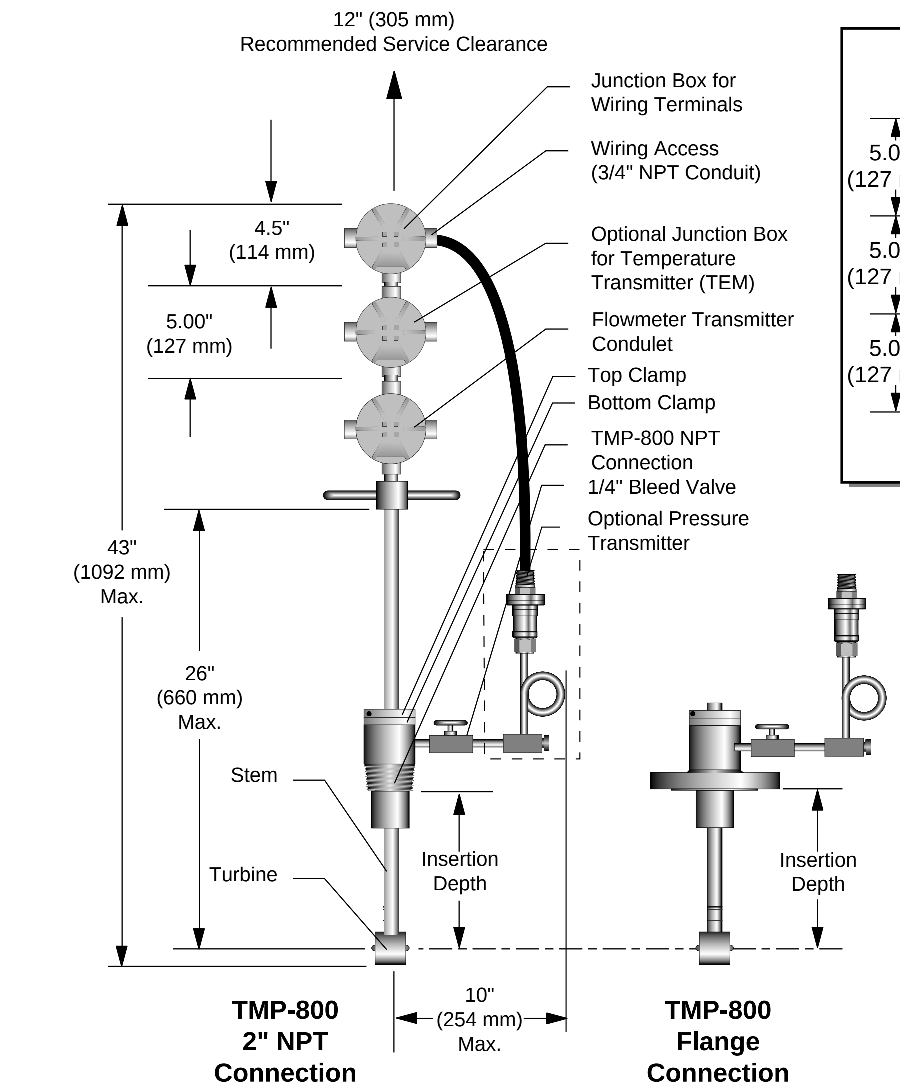
4.13 Rotor Orientation and Final Positioning: TMP-800/80S

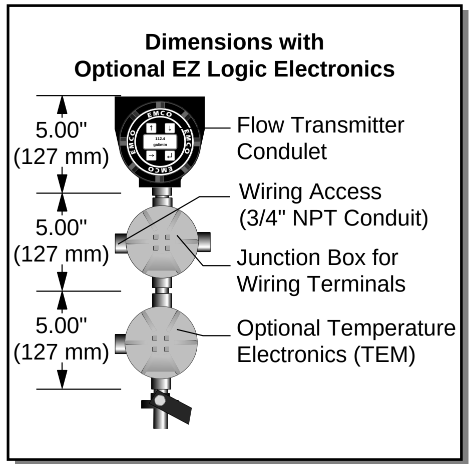
1. Carefully, manually insert the rotor down into the pipe until the calculated installed dimension "B" is reached.
2. Align the rotor by using the orientation levers so the flow direction arrow is parallel to the pipe and pointed downstream.
3. Lock the stem in position by tightening the three (3) capscrews on the bottom clamp.
4. Set the top clamp over the bottom clamp and tighten the capscrew of the top clamp. The top clamp is used as a marker so the insertion depth does not have to be recalculated every time the flowmeter is removed or reinstalled.



TMP-800/80S Guide for Rotor Orientation and Capscrew Location

4.14 Dimension Drawing: TMP-800/80S

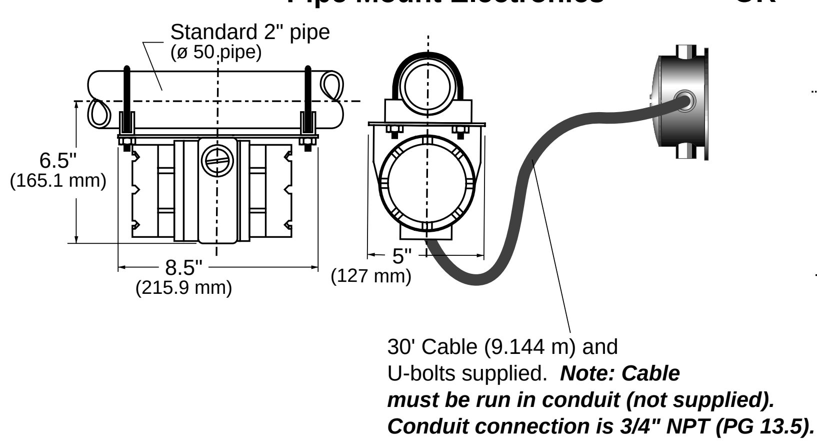


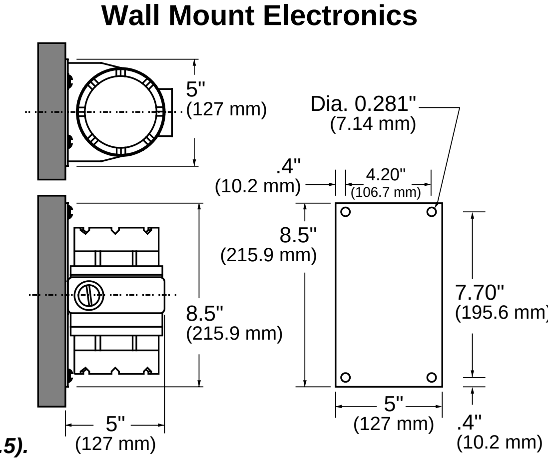


Connection	Weight
2" NPT	11 lbs (5.0 kg)
2" 150#	17 lbs (7.7 kg)

Insertion Depth	
Minimum	Maximum
2" (51 mm)	21" (533 mm)

Pipe Mount Electronics OR Wall Mount Electronics





> **!** ***CAUTION:*** *Hot tapping must be performed by a trained professional. Local state regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such permit.*

4.15 Hot Tap Installation: TMP-910/960

The TMP 910/960 can be installed without process shutdown or line depressurization.

Step 1. Weld weld-o-let to pipe.

Step 2. Weld pipe nipple into weld-o-let.

Step 3. Weld flange to pipe nipple.

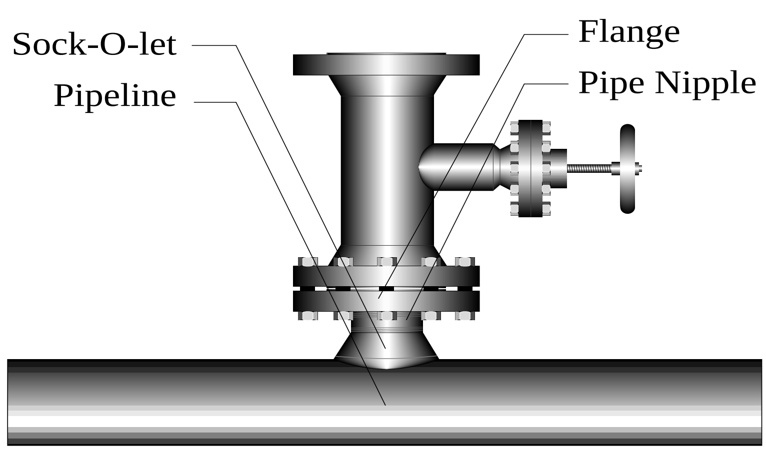
Step 4. Attach isolation valve to flange. Attach hot tap tool. Open isolation valve. Hot tap pipe. Hole should be 1.875" in diameter. Retract hot tap tool. Close isolation valve. Remove hot tap tool.

Step 5. Attach tap check tool to the end of the flowmeter stem before proceeding.

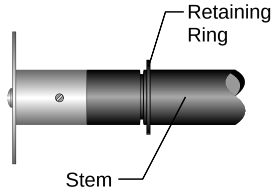
Attach flowmeter to isolation valve. Verify that $^{1}/_{4}$" bleed valve is closed. Open isolation valve. Turn wheel to insert tap check tool into pipe and then, retract tap tool completely. Close isolation valve. Slowly open bleed valve to bleed off the trapped fluid inside the isolation valve and flowmeter assembly. Remove flowmeter from isolation valve and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 6. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flowmeter stem. Verify that screw and safety wire on rotor assembly are properly installed.

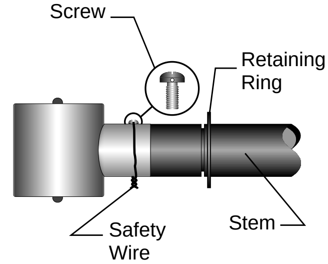
Reconnect flowmeter to isolation valve. Verify that $^{1}/_{4}$" bleed valve is closed. Fully open isolation valve. If the flowmeter is supplied with a pressure transmitter, open $^{1}/_{4}$" isolation valve. Do not lower turbine sensor into pipe before calculating the proper insertion depth, p. 28.



TMP-910/960 Hot Tap Installation



Tap Check Tool



Rotor Assembly

4.16 Cold Tap Installation: TMP-910/960

Process shutdown and line depressurization are required for cold tapping.

Step 1. Tap pipe. Hole should be 1.875" in diameter.

Step 2. Weld weld-o-let to pipe.

Step 3. Attach pipe nipple to weld-o-let.

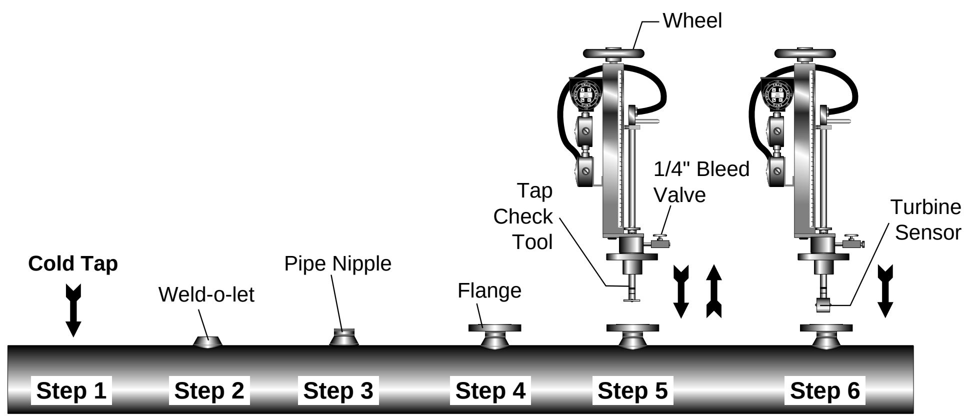
Step 4. Attach flange to pipe nipple.

Step 5. Attach tap check tool to the end of the flowmeter stem before proceeding.

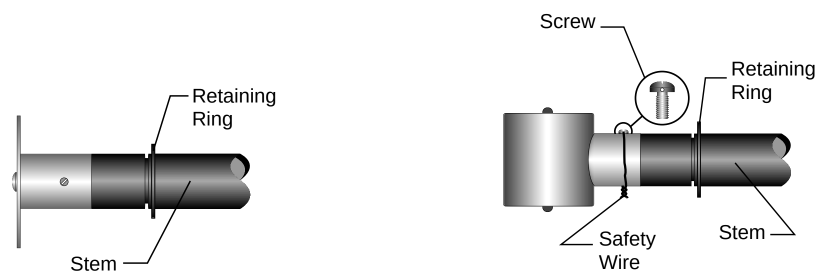
Attach flowmeter to flange. Verify that 1/4" bleed valve is closed. Turn wheel to insert tap check tool into pipe and then, retract tap tool completely. Remove flowmeter from flange and inspect tap check tool for damage. If any has occurred, check installation for clearance problems.

Step 6. Remove tap check tool and attach turbine sensor (rotor assembly) to end of flowmeter stem. Verify that screw and safety wire on rotor assembly are properly installed.

Verify that 1/4" bleed valve is closed. Reconnect flowmeter to flange. If the flowmeter is supplied with a pressure transmitter, open bleed valve. Do not lower turbine sensor into pipe before calculating the proper insertion depth, p. 28.



TMP-910/960 Cold Tap Installation



Tap Check Tool **Rotor Assembly**

NOTE: The distance the fully retracted rotor travels before becoming visible has been figured into the factory adjustment of the depth scale.

4.17 Insertion Depth Scale Reading Calculation: TMP-910/960

After tapping the pipe and installing the TMP 910/960, the turbine sensor needs to be properly positioned within the pipe. To determine the proper insertion depth, the scale reading must be calculated.

The scale reading is the figure that the cursor should be set to on the depth scale. Use the proper arrow depending on the rotor style. The 150 series (1.5") uses the bottom arrow; the 100 series (1") uses the top arrow.

Refer to the figure below and use the following equation to calculation the proper insertion depth:

Scale Reading = *I + E + Wt*

Where:

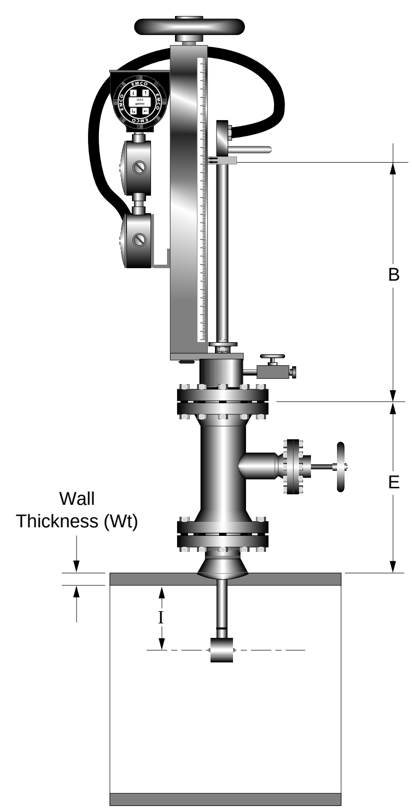
I = For pipe sizes less than 12", inside pipe diameter ÷ 2
I = For pipe sizes 12" and larger, inside pipe diameter ÷ 4
E = Distance from the top of the isolation valve to the outside pipe wall.
Wt = Thickness of the pipe wall. The disk cut-out or “coupon" from the tapping procedure can be measured, or this number can also be obtained from a piping handbook.

Example:

A TMP-910/960 is to be installed on a 12" schedule 40 pipe. The following measurements have been obtained:

I = (11.938 ÷ 4) = 2.98"
E = 12.5"
Wt = 0.375"

Scale Reading = *I* + *E* + *Wt*
Scale Reading = 2.98"+12.5"+0.375" = **15.855"**



TMP-910/960 Insertion Depth

NOTE: *Torquing the nuts above the packing gland over 25 ft-lbs could damage the stem or stem housing.*

CAUTION: *Do not allow the orientation of the flowmeter or the insertion depth to change after insertion is complete. A change in insertion depth or alignment will cause inaccurate readings and shortened rotor life.*

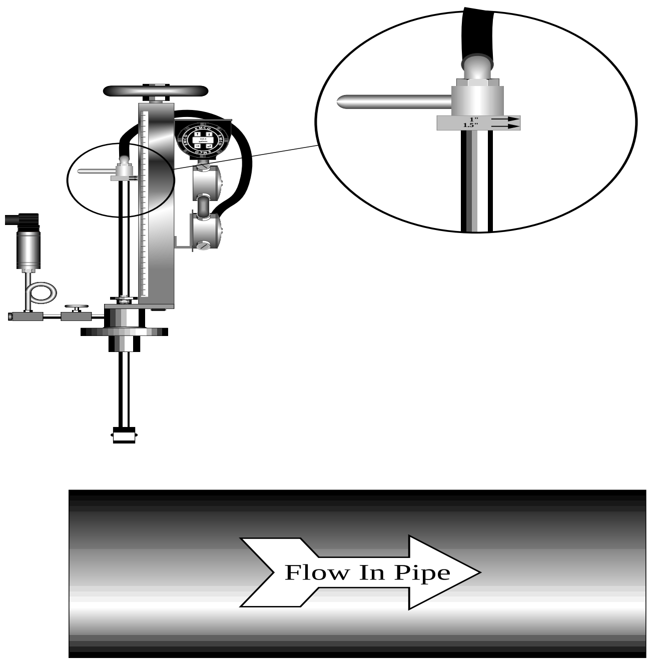
4.18 Rotor Orientation and Final Positioning: TMP-910/960

1. Carefully insert the rotor into the pipe until the calculated scale reading on the depth scale lines up with the arrow on the retractor bar assembly.

   If the rotor is a 1.5" size (series 150), line up the bottom arrow on the retractor bar assembly marked 1.5 with the depth scale as shown above.

   If the rotor is a 1.0" size (series 100), line up the top arrow on the retractor bar assembly marked 1.0 with the depth scale as shown above.

2. Align the rotor by using the orientation lever so the flow direction arrow is in line with the pipe and pointed downstream.
3. Tighten the nuts above the packing gland to stop leakage around stem. Do not torque the nuts over 25 ft-lbs.
4. Lock the stem in position by tightening the orientation lock screw.



TMP-910/960 Guide for Rotor Orientation and Packing Gland Location

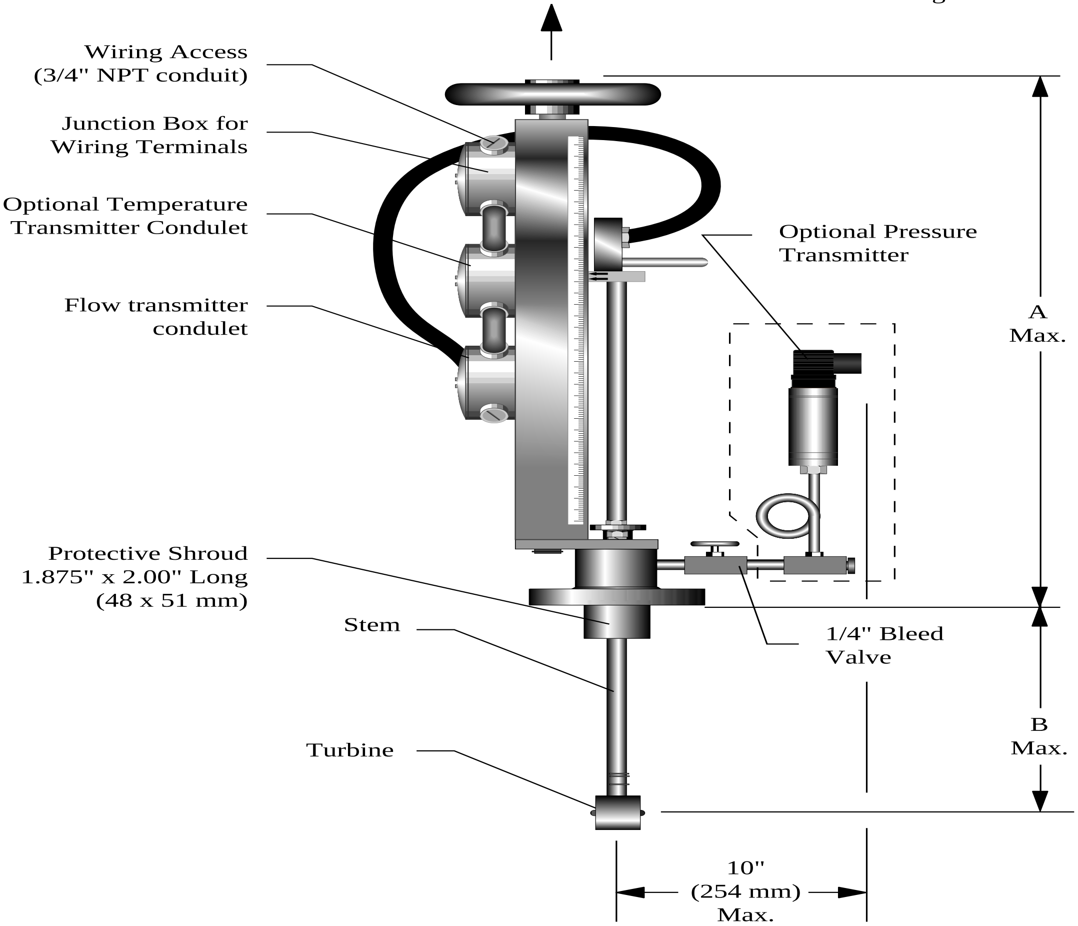
4.19 Dimensional Drawing: TMP-910/960

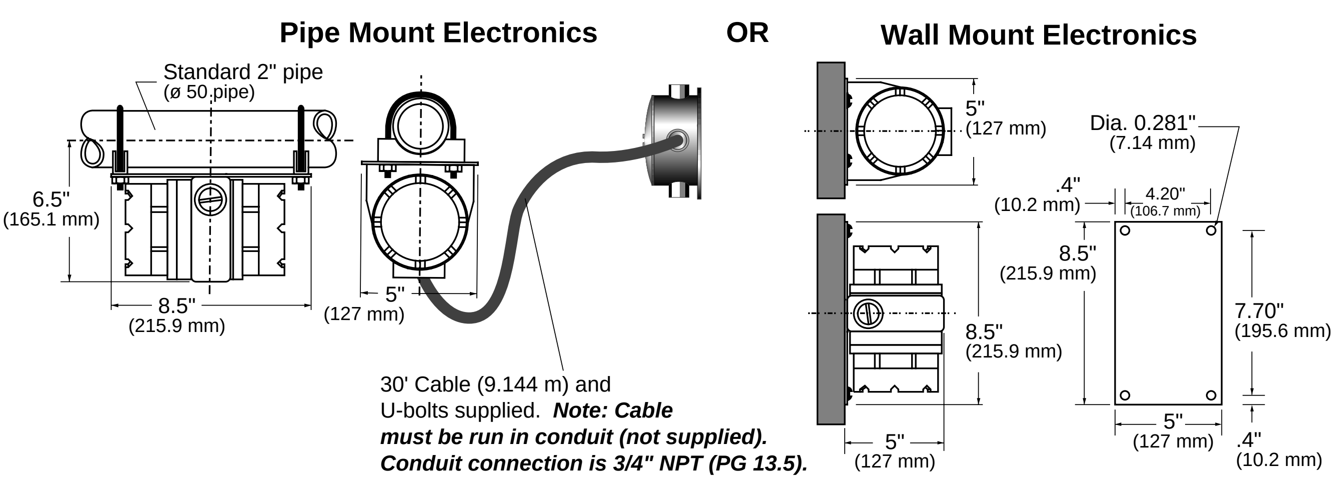
Stem Length	Retractor Length (Dim. A)	Insertion Depth* (Dim. B)
Standard	30" (762 mm)	20" (508 mm)
1' Extended	42" (1067 mm)	32" (813 mm)
2' Extended	54" (1372 mm)	44" (1120 mm)

* Minimum insertion depth is 1.5" (38 mm)

Connection	Weight**
2" 150#	30 lbs (13.6 kg)
2" 300#	35 lbs (15.8 kg)
2" 600#	40 lbs (18.1 kg)
2" 900#	47 lbs (21.3 kg)

** Add 5 lbs (2.3 kg) for each additional foot of retractor length





Section 5: Turbo-Bar™ Flowmeter Electrical Installation

5.1 General Information

The Turbo-Bar™ electronics are preamplifiers, designed to amplify and convert the raw coil output to a square wave pulse or 4-20 mA signal. The available Turbo-Bar™ preamplifiers are:

5.1.1 PA1 Preamplifier

- Unidirectional flow sensing
- 10 V p-p square wave pulse output

5.1.2 PA2 Preamplifier

- Bidirectional flow sensing
- 10 V p-p square wave pulse output
- Includes a contact closure for sensing flow direction changes

5.1.3 PAQ Preamplifier

- Unidirectional flow sensing
- 4-20 mA analog output

5.1.4 P2Q2 Preamplifier

- Bidirectional flow sensing
- Two 4-20 mA analog outputs (one for each flow direction)

5.2 Electronics Enclosures

All Turbo-Bar™ preamplifiers are encased in an elastomer cast housing. The preamplifiers are mounted inside explosion proof condulets using two screws and a stand off. All preamplifiers are factory wired to the electrical junction box of the Turbo-Bar™ flowmeter models.

5.3 Wiring Recommendations

Proper wiring is essential to achieving satisfactory electronic performance. The following is recommended:

1. Always use shielded cable.
2. Select the proper wire gauge. The recommended wire gauge is 18 to 22 AWG.
3. Do not exceed a distance of 6000 feet between the preamplifier and receiving electronics.

5.3.1 Hum and Noise

The maximum run length may be limited due to hum and noise pickup along the cable. In most cases, a properly shielded and grounded cable limits this noise interference and allows accurate data transmission.

In cases where heavy electrical machinery is present, however, strong noise fields are generated, which may interfere with signal transmission. In such conditions, the shielded cable should be run through grounded electrical conduit to provide extra shielding.

5.3.2 Ground Loops

Ground loops may interfere with signal transmission by superimposing unwanted signals on the desired signal. This may be prevented by correctly connecting the cable shields. How the shield should be connected depends on whether a metal or plastic pipeline is being used.

Metal Pipelines: Metal pipelines are usually earth grounded. Thus, the cable shield should not be connected at the flowmeter. The shields should be connected to the AC ground terminal at the power supply.

Plastic Pipelines: Plastic pipelines require the transmitter condulet to be connected to an earth ground. To do so, connect the signal cable shield to the condulet via one of the Turbo-Bar's™ junction box screws. Also, the shield from each transducer cable should be connected to the AC ground terminal at the power supply.

5.4 PA1 Preamplifier

The PA1 preamplifier senses the signal from the pickup coil of a unidirectional Turbo-Bar™ flowmeter, amplifies the signal and produces a frequency output to receiving electronics for flow computation and/or display.

5.4.1 Specifications: PA1

Input:

Level:	2 mV to 10 V p-p
Frequency:	1 Hz to 10 KHz
Impedence:	Coil inputs from 1 Ω to 10 KΩ
Power Requirements:	15 to 40 VDC

Output:

Level:	10 V p-p
Impedence:	1,000 Ω

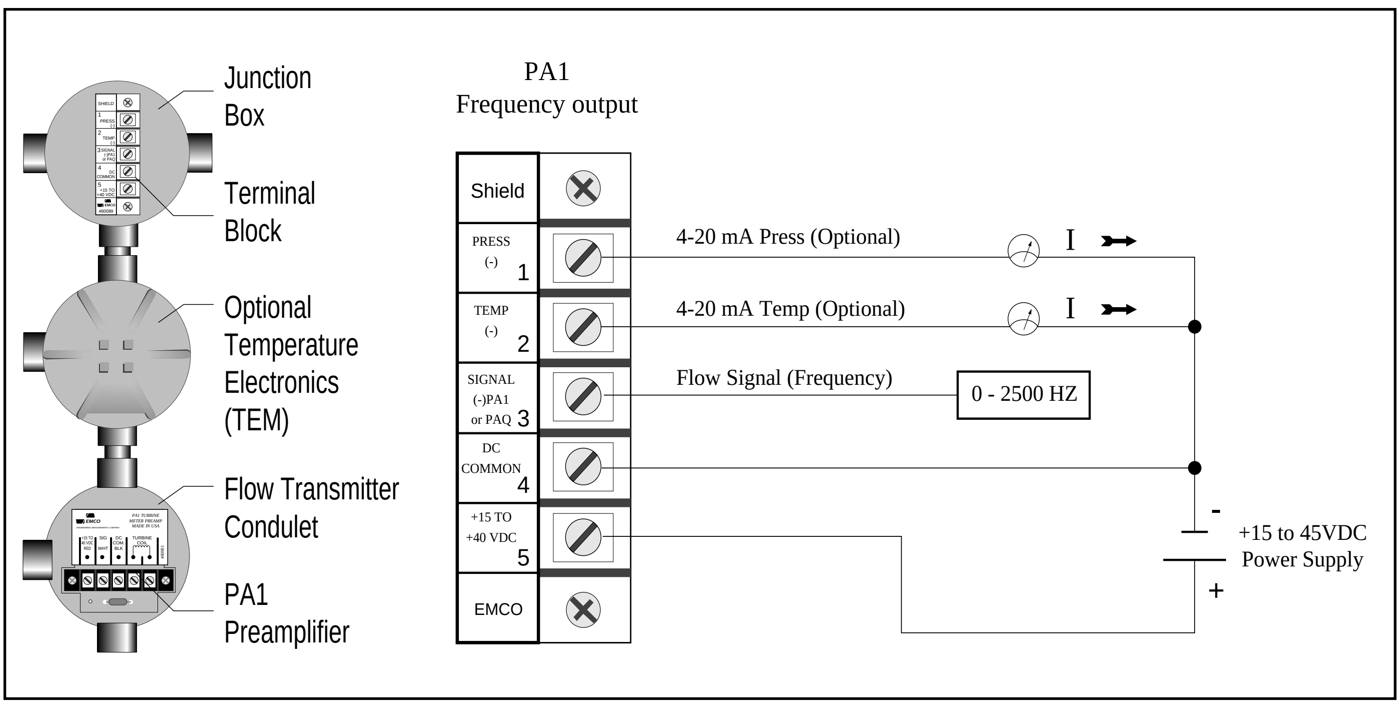
5.5.2 Wiring: PA1

A Turbo-Bar™ flowmeter with a PA1 preamplifier will have at least two condulets. Inside the top condulet, the junction box, is a terminal block. Inside the bottom condulet is the PA1 preamplifier. There are five (5) terminals on the PA1 terminal strip. The PA1 is factory prewired to the junction box terminal block of the Turbo-Bar™ flowmeter. No wiring to the PA1 is required. The factory wiring is:

- Terminal 1 is the voltage supply terminal. It is connected to terminal 5 of the junction box terminal block.
- Terminal 2 is the frequency output. It is connected to terminal 3 of the junction box terminal block.
- Terminal 3 is DC common. It is connected to terminal 4 of the junction box terminal block.
- Terminals 4 and 5 are the pickup coil terminals. The leads from the turbine coil are connected to these terminals.

5.4.3 Junction Box Terminal Block Wiring: PA1

Use a screw driver or similar tool to open the junction box to access the terminal block. Place the screw driver between the four raised tabs and turn counter clockwise. Follow the wiring diagram below to connect the Turbo-Bar™ flowmeter to receiving electronics.



5.5 PA2 Preamplifier

The PA2 preamplifier senses the signal from the pickup coil of a bidirectional Turbo-Bar™ flowmeter, amplifies the signal, compares the signal and produces a frequency output and relay switch closure, which indicates flow direction. The output is then supplied to receiving electronics for flow computation and/or display.

5.5.1 Specifications: PA2

Input:

Level:	2 mV to 10 V p-p
Frequency:	1 Hz to 10 KHz
Impedence:	Coil inputs from 1 Ω to 10 KΩ
Power Requirements:	15 to 40 VDC

Frequency Output:

Level:	10 V p-p
Impedence:	1,000 Ω

Relay Output:

Type:	1 form-C (SPDT)
Rating:	100 mA maximum, 100 V maximum, 10 VA maximum

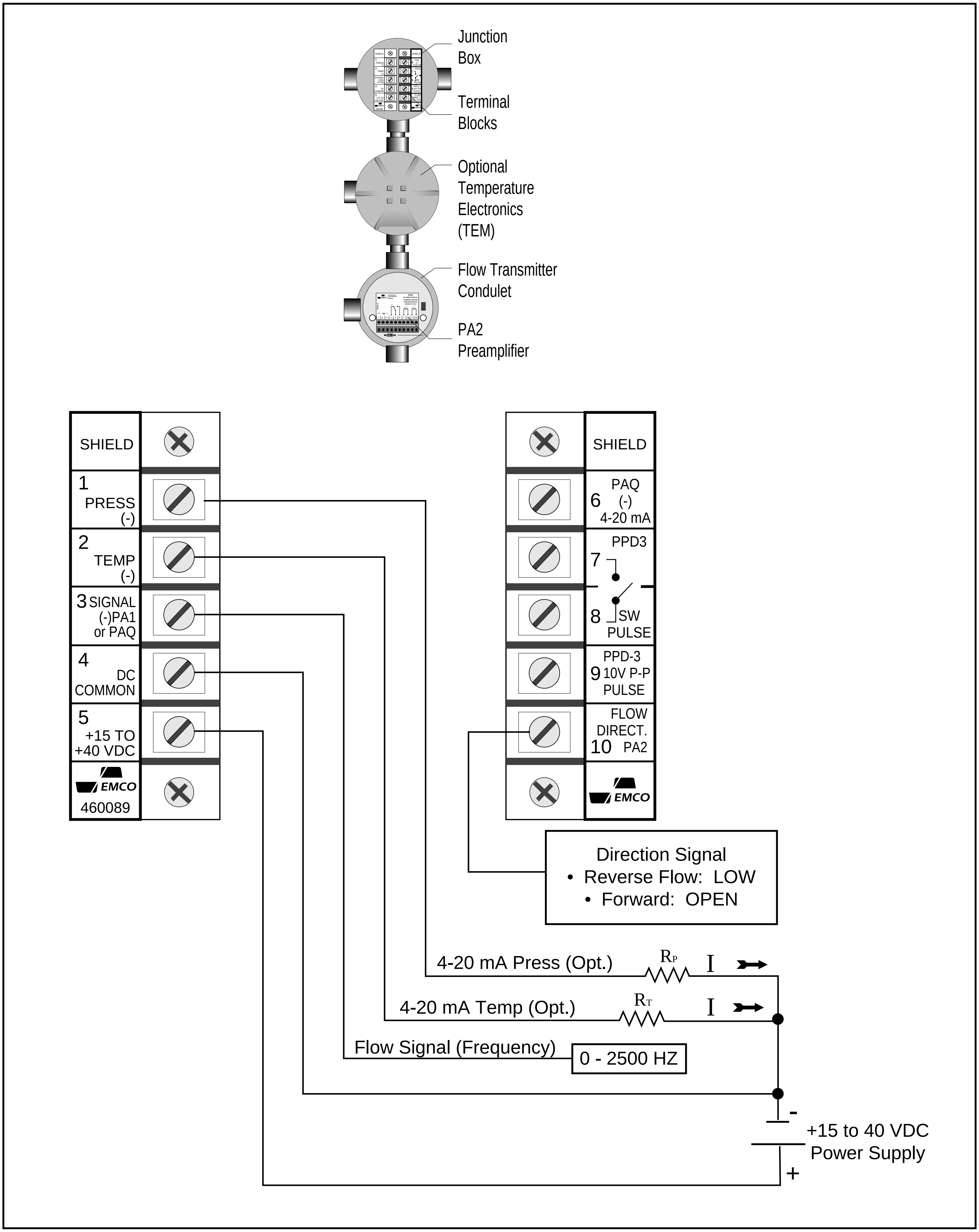
5.5.2 Wiring: PA2

A Turbo-Bar™ flowmeter with a PA2 preamplifier will have at least two condulets. Inside the top condulet, the junction box, is a terminal block. Inside the bottom condulet is the PA2 preamplifier. There are ten (10) terminals on the PA2 terminal strip. The PA2 is factory prewired to the junction box terminal block of the Turbo-Bar™ flowmeter. No wiring to the PA2 is required. The factory wiring is:

- Terminal 1 is the voltage supply terminal. It is connected to terminal 5 of the junction box terminal block.
- Terminal 2 is for frequency output. It is connected to terminal 3 of the junction box terminal block.
- Terminal 3 is DC common. It is connected to terminal 4 of the junction box terminal block.
- Terminals 4 thru 6 are the relay terminals. Terminal 5 is internally jumped to terminal 3 on the PA2 strip. Terminal 6 is connected to terminal 10 of the junction box terminal block.
- Terminals 7 thru 10 are the pickup coil terminals. The leads from the turbine coil are connected to these terminals.

5.5.3 Junction Box Terminal Block Wiring: PA2

Use a screw driver or similar tool to open the junction box to access the terminal block. Place the screw driver between the four raised tabs and turn counter clockwise. Follow the wiring diagram on p. 34 to connect the Turbo-Bar™ flowmeter to receiving electronics.


Junction Box
Terminal Blocks
Optional Temperature Electronics (TEM)
Flow Transmitter Condulet
PA2 Preamplifier
SHIELD
1 PRESS (-)
2 TEMP (-)
3 SIGNAL (-)PA1 or PAQ
4 DC COMMON
5 +15 TO +40 VDC
EMCO
460089
SHIELD
6 PAQ (-) 4-20 mA
PPD3
7
8 SW PULSE
PPD-3
9 10V P-P PULSE
FLOW DIRECT.
10 PA2
EMCO
Direction Signal
• Reverse Flow: LOW
• Forward: OPEN
4-20 mA Press (Opt.)
RP
I
4-20 mA Temp (Opt.)
RT
I
Flow Signal (Frequency)
0 - 2500 HZ
-
+15 to 40 VDC
Power Supply
+

5.6 PAQ Preamplifier

The PAQ preamplifier senses and amplifies the signal from the pickup coil of a unidirectional Turbo-Bar™ flowmeter, producing a 4-20 mA analog output proportional to flow. The output is then supplied to receiving electronics for flow computation and/or display.

5.6.1 Specifications: PAQ

Input:

Level:	2 mV to 10 V p-p
Frequency:	1 Hz to 9,999 Hz
Impedence:	Coil inputs from 1 Ω to 10 KΩ
Power Requirements:	15 to 60 VDC

Frequency Output:

Type:	2 wire analog
Level:	4-20 mA
Time Constant:	1 second

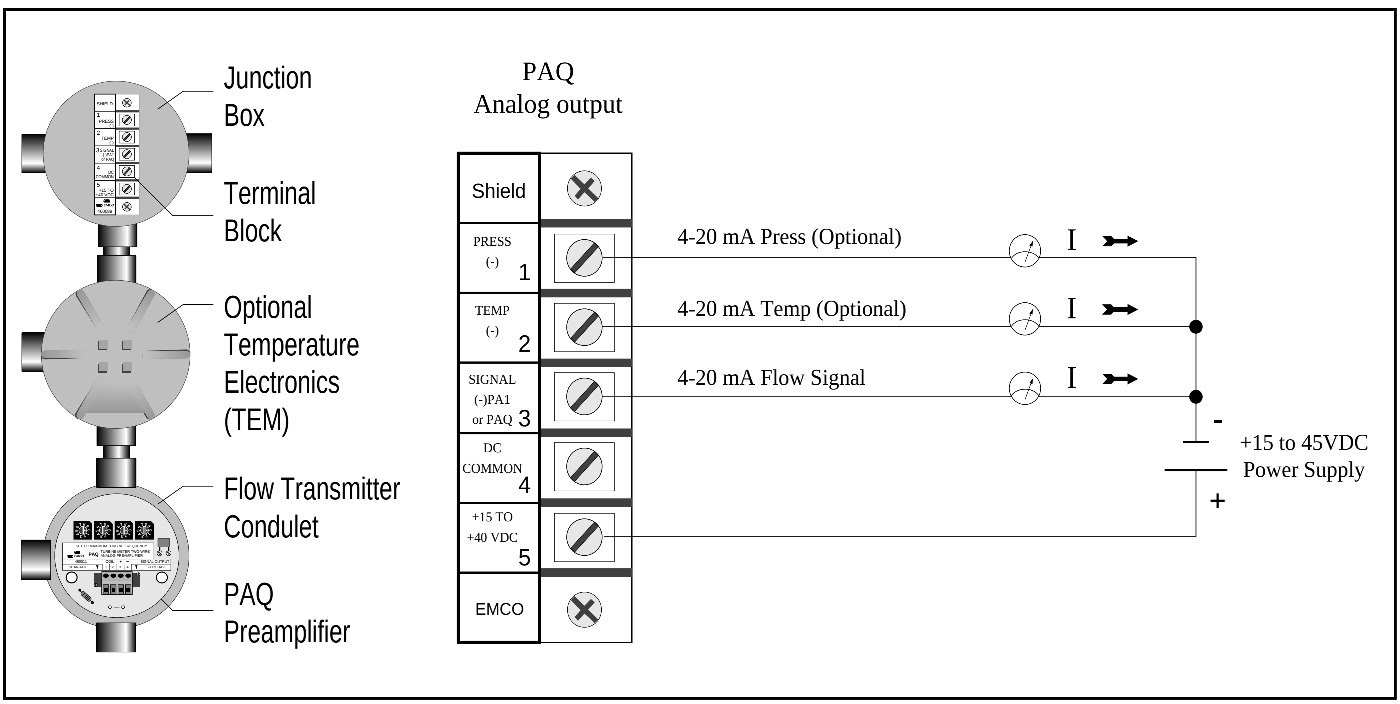
5.6.2 Wiring: PAQ

A Turbo-Bar™ flowmeter with a PA1 preamplifier will have at least two condulets. Inside the top condulet, the junction box, is a terminal block. Inside the bottom condulet is the PAQ preamplifier. There are four (4) terminals on the PAQ terminal strip. The PAQ is factory prewired to the junction box terminal block of the Turbo-Bar™ flowmeter. No wiring to the PAQ is required. The factory wiring is:

- Terminals 1 and 2 are the pickup coil terminals. The leads from the turbine coil are connected to these terminals.
- Terminal 3 is the voltage supply terminal. It is connected to terminal 5 of the junction box terminal block.
- Terminal 4 is the return 4-20 mA signal. It is connected to terminal 3 of the junction box terminal block.

5.6.3 Junction Box Terminal Block Wiring: PAQ

Use a screw driver or similar tool to open the junction box to access the terminal block. Place the screw driver between the four raised tabs and turn counter clockwise. Follow the wiring diagram below to connect the Turbo-Bar™ flowmeter to receiving electronics.



5.6.4 Rescaling the PAQ

It may be necessary to rescale the PAQ preamplifier in the field. Each PAQ has been matched to a particular EMCO Turbo-Bar™ flowmeter and rotor assembly. The PAQ may need to be rescaled if equipment changes have been made. For example, the PAQ must be rescaled if a replacement rotor is to be used, or if the Turbo-Bar™ flowmeter is to be moved to a different location.

To rescale the PAQ preamplifier, use the following equation:

$Ft_{MAX} = Ks \bullet SF$

Where:

Ft_{MAX} = Maximum turbine frequency at which the output is 20 mA. The four numbers to which the BCD switch settings are pointing is Ft_{MAX}.

Ks = System K-Factor. This number is available from EMCO and is supplied with the application information sheet.

SF = Maximum flow rate is engineering units per second.

Example:

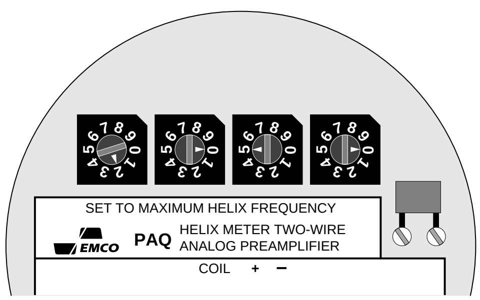
The required output from the PAQ is such that 20 mA must represent 20,000 SCFM. From the EMCO application sheet, Ks is given as 6.15 pulses/SCCF.

Convert 20,000 SCFM to SCCF: 20,000 ÷ 60 = 333.33 SCFC

$Ft_{MAX} = Ks \bullet SF$

$Ft_{MAX} = 6.15 \bullet 33.33 = 2049.97\ Hz = 2050\ Hz$

Set the four digit BCD switch setting on the PAQ to 2050.



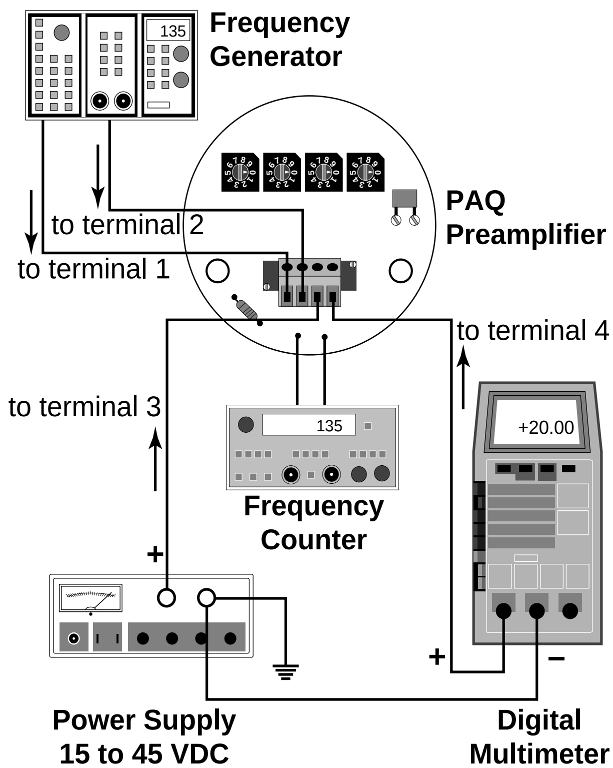
The rescaling of the PAQ is now complete.

5.6.5 Zero and Span Adjustment: PAQ

The PAQ preamplifier is factor calibrated and adjusted for optimum performance. Normally, the PAQ does not require readjustments. The zero and span potentiometers may only be used to fine tune or recalibrate the PAQ.

To adjust the zero and span:

1. Disconnect the factory wiring at the PAQ terminals that connect the PAQ preamplifier and the junction box terminal block.
2. Obtain a 24 VDC power supply, frequency generator, digital multimeter and frequency counter. Make the connection to the PAQ as shown below:



3. The frequency generator should be set to provide a frequency with an amplitude of 2 mV to 10 V.
4. Set the digital multimeter to record the mA output from the PAQ.
5. Without the frequency supplied to the PAQ, turn the zero adjustment potentiometer to receive 4 mA.
6. Apply the full-scale frequency (same as the switch setting value) and turn the span adjustment potentiometer to obtain 20 mA. Verify that the frequency recorded by the frequency counter is the expected full-scale frequency.
7. Repeat steps 3 thru 4 until no further calibration is necessary.
8. Reconnect the cables from the junction box terminal block to the PAQ preamplifier. Refer to the factory wiring listed under 5.6.2 Wiring: PAQ, p. 35.

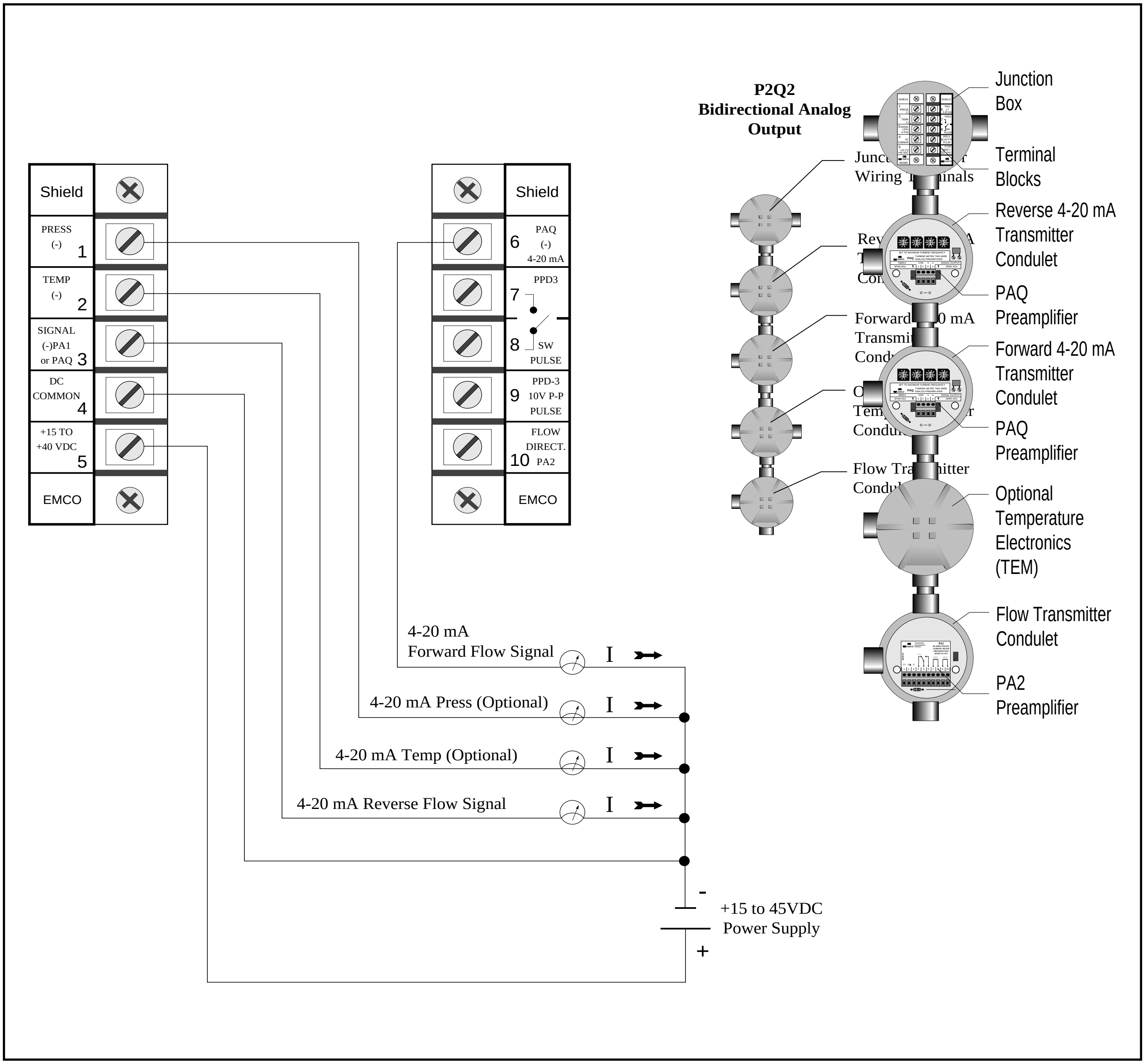
5.7 P2Q2 Preamplifier

The P2Q2 preamplifier is comprised of one (1) PA2 preamplifier and two (2) PAQ preamplifiers. A Turbo-Bar™ flowmeter with a P2Q2 preamplifier will have at least four condulets. Inside the top condulet, the junction box, is a terminal block. Inside the next lower condulet is the PA2 preamplifier; the next two lower condulets each contain a PAQ preamplifier. Refer to the PA2 and PAQ preamplifier descriptions for preamplifier information.

The three (3) preamplifiers are factory prewired to the junction box terminal block. No wiring to the preamplifiers is required.

5.7.1 Junction Box Terminal Block Wiring: P2Q2

Use a screw driver or similar tool to open the junction box to access the terminal block. Place the screw driver between the four raised tabs and turn counter clockwise. Follow the wiring diagram below to connect the Turbo-Bar™ flowmeter to receiving electronics.



Section 6: Optional TEM Temperature Transmitter

6.1 General Information

The TEM is a platinum resistance temperature sensor (RTD). This unit is used to measure the temperature of process fluids. The TEM is highly repeatable and has exceptional resistance stability with respect to temperature. The TEM may be selected with a direct RTD, or resistance, output or with a 4-20 mA analog output.

The 4-20 mA analog output includes a preamplifier, which is factory scaled and calibrated to one of several standard temperature ranges (Fahrenheit or Celsuis).

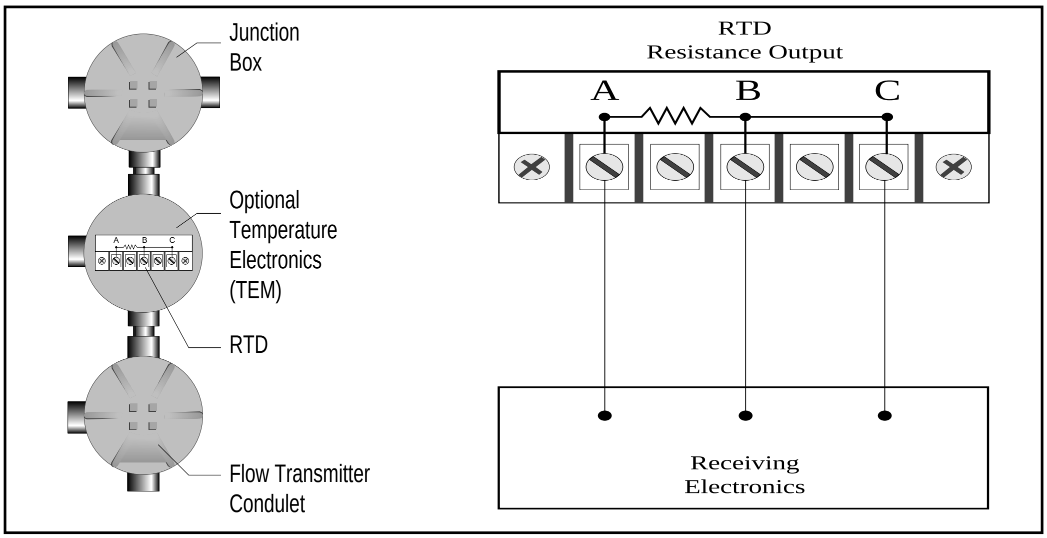
The TEM can be integrally mounted to a Turbo-Bar™ flowmeter at the factory. Like the Turbo-Bar™ flowmeter electronics, it is housed in an explosion proof condulet using two screws and a standoff. Alternatively, the TEM can be mounted separately from the Turbo-Bar™ flowmeter in a thermowell to allow installation and removal without process shutdown.

6.2 RTD

The RTD is factory prewired to the TEM sensor. No wiring to the TEM itself is required. The RTD has three (3) working terminals. They are:

- Terminal A ia the single RTD lead.
- Terminals B and C are the two common RTD leads.

Use a screw driver or similar tool to open the TEM condulet to access the RTD terminal block. Connect the RTD to receiving electronics as shown below.



6.3 PTM1 Preamplifier

The TEM sensor is factory prewired to the PTM1 preamplifier. No wiring to the TEM itself is required. The preamplifier is factory prewired to the junction box terminal strip. No wiring to the PTM1 preamplifier is required. There are four (4) terminals on the PTM1 preamplifier. The factory wiring is:

- Terminals 1 and 5 are the RTD terminals. The leads from the TEM are connected to these terminals.
- Terminal 3 is the supply voltage terminal. It is connected to terminal 5 of the junction box terminal block.
- Terminal 4 is the return 4-20 mA signal. It is connected to terminal 2 of the junction box terminal block.

Refer to the specific electronic preamplifier (PA1, PA2, PAQ, P2Q2) wiring diagram to connect the 4-20 mA temperature output to receiving electronics.

6.3.1 Zero and Span Adjustment: PTM1

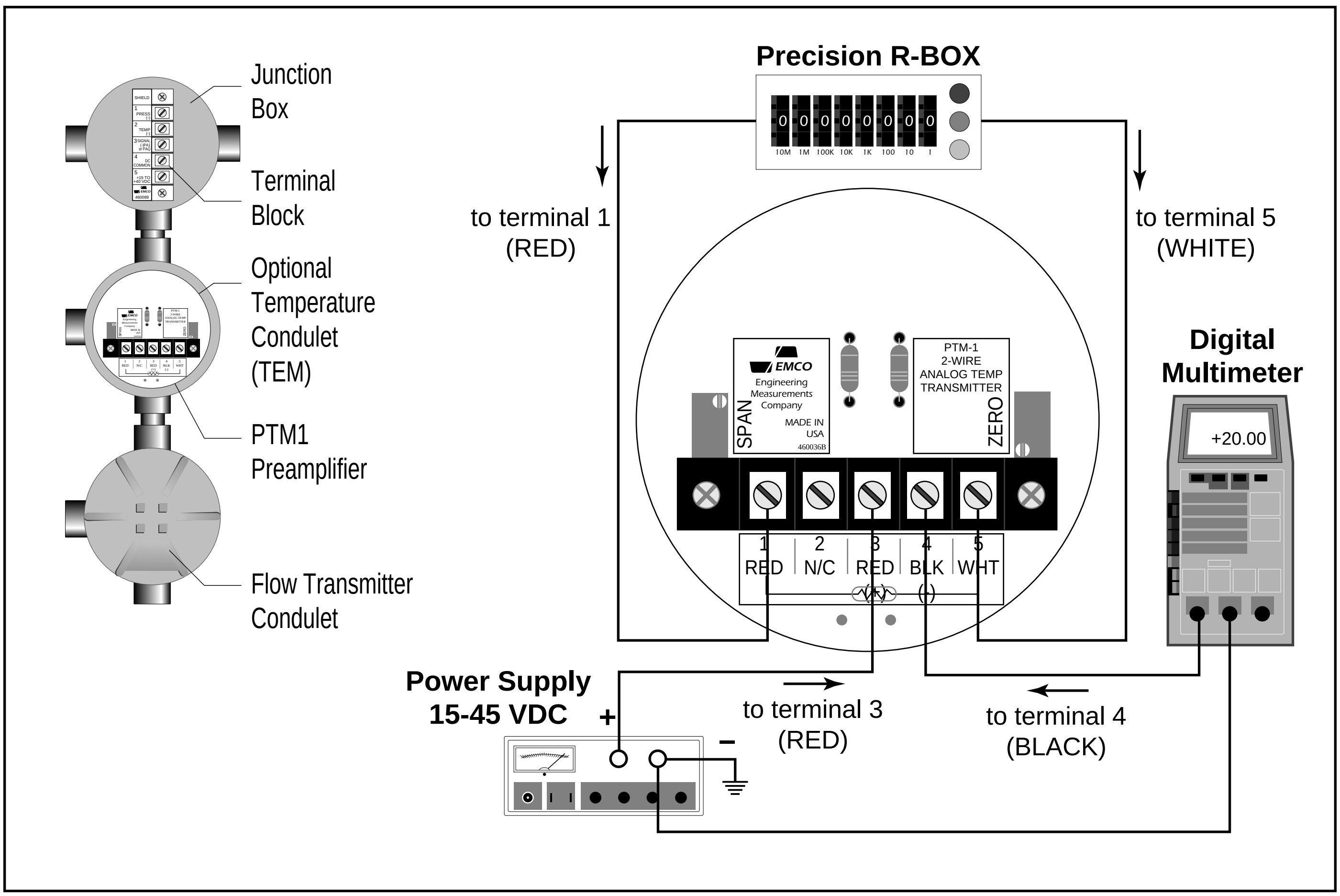
The PTM1 preamplifier is factory calibrated for optimum performance. The zero and span potentiometers may only be adjusted to fine tune or to recalibrate the PTM1. To adjust the zero and span:

1. Disconnect the factory wiring at the PTM1 terminals that connect the PTM1 preamplifier and the junction box terminal block.
2. Use a 24 VDC power supply, presision R-box and digital multimeter. Make the connections shown below.
3. Refer to the TEM calibration data supplied with the Turbo-Bar™ flowmeter. A copy of the calibration data is also inside the PTM1 condulet. For example:

Calibration Data:

4.00 mA:	32 ˚F	=	1000.00 Ω
8.00 mA:	41 ˚F	=	1019.03 Ω
12.00 mA:	50 ˚F	=	1038.04 Ω
16.00 mA:	59 ˚F	=	1057.02 Ω
20.00 mA:	68 ˚F	=	1075.96 Ω

4. Set the R-box to zero scale (4 mA), according to the resistance value in the calibration data. Turn the zero adjustment potentiometer until the output reads 4 ± 0.016 mA.
5. Set the R-box to full-scale (20 mA), according to the resistance value on the calibration data. Turn the span adjustment pentiometer until the output reads 20 ± 0.016 mA.
6. Because the span adjustment affect zero point, steps 3 and 4 must be repeated until the readings are within ± 0.016 of zero scale and full scale.
7. Reconnect the cables from the junction box terminal block to the PTM1 preamplifier. Refer to the factory wiring listed under 6.2 PTM1 Preamplifier, p. 39.



Section 7: Optional PT Pressure Transmitter

7.1 General Information

The PT is a two (2) wire pressure transmitter. This unit is used to measure the pressure of process fluids. Process pressure is applied to an isolating diaphragm, which displaces the sensing capacitor. The PT takes advantage of the large capcitance signal generated by an extremely small amount of motion. This high signal level simplifies the electronics. Because the amplifier circuit has few components and operates at low gain, overall transmitter reliability is maximized.

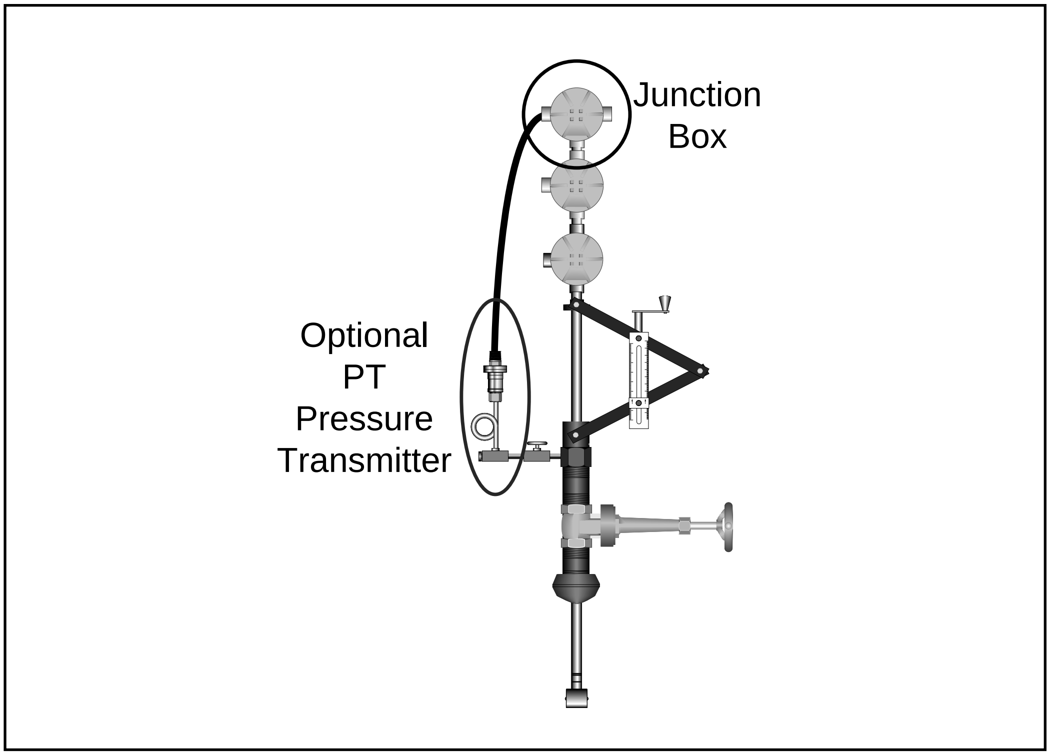
The PT can be integrally mounted to a Turbo-Bar™ flowmeter at the factory.

7.2 PT Wiring

The PT is factory prewired to the junction box terminal block. No wiring to the PT itself is required. The PT has two (2) terminals: positive (+) and negative (–).

- The positive (+) terminal is connected to terminal 5 on the junction box terminal block (blue wire).
- The negative (–) terminal is connected to terminal 1 on the junction box terminal block (red wire).

Refer to the specific electronic preamplifier (PA1, PA2, PAQ, P2Q2) wiring diagram to connect the 4-20 mA pressure output to receiving electronics.



Section 8: Equations and Definitions

8.1 General Information

This section describes definitions and equations necessary for understanding the setup of the Turbo-Bar™ flowmeter and electronics. Referring to the application information sheet supplied with your Turbo-Bar™ flowmeter, note the terms and definitions described below. A sample application information sheet is shown on page 45.

8.2 Definitions

1. Centerline vs. 1/4 Diameter Position:

Depending on pipeline diameter, the rotor is positioned at either centerline (1/2 of the pipe internal diameter) or 1/4 of the pipe internal diameter. For pipe sizes less than 12", the centerline position should be used. For pipe sizes 12" and larger, the 1/4 diameter position should be used.

2. Cal. Constant- Kf (pulses/ ft):

All EMCO rotors are individually calibrated to determine the rotor calibration constant (Kf). Each rotor is supplied with its own calibration sheet. This sheet will include the frequency/velocity pairs used to determine the Kf of each calibration point, the mean Kf and the percent deviation from the best linear fit. A sample rotor calibration sheet is shown on page 50.

3. Obscuration Factor (Fo):

The obscuration factor (Fo) is found on the EMCO application information sheet. The obscuration factor (Fo) is a mathematical correction for the area inside the pipe which is obstructed by the Turbo-Bar™ stem and rotor.

4. Profile Factor (Fp):

The profile factor (Fp) is also found on the EMCO application information sheet. The profile factor (Fp) is a mathematical correction for relating the rotor velocity (point velocity) to an average pipeline velocity.

5. System K-Factor (Ks):

The system K-factor (Ks) is used to convert the rotor input frequency (Ft) to flow rate in appropriate engineering units. The units may be in pulses/gallons, pulses/SCF, pulses/ pounds, etc. Ks is found on the EMCO application information sheet. The mathematical equations used to arrive at the Ks value follow.

8.3 Mathematical Equations Used to Find the Ks Value

8.3.1 Liquid

$$\mathrm{Ks}\left(\mathrm{pulses/ft^3}\right)=\frac{\mathrm{Kf}}{\mathrm{A\bullet Fo\bullet Fp}}$$

or

$$\mathrm{Ks}\left(\mathrm{pulses/gallons}\right)=\frac{\mathrm{Kf}}{\mathrm{A\bullet Fo\bullet Fp\bullet 7.48}}$$

or

$$\mathrm{Ks}\left(\mathrm{pulses/pounds}\right)=\frac{\mathrm{Kf}}{\mathrm{A\bullet Fo\bullet Fp}\bullet\rho}$$

or

$$\mathrm{Ks}\left(\mathrm{pulses/Btus}\right)=\frac{\mathrm{Kf}}{\mathrm{A\bullet Fo\bullet Fp}\bullet\rho\bullet(\mathrm{h1-h2})}$$

Where:

Ks = System K-factor
Kf = Rotor cal. constant in pulse/ft (available from the EMCO application or rotor calibration sheet)
A = Pipeline cross-sectional area in ft^2
Fo = Obscuration factor - available from the EMCO application information sheet
Fp = Profile factor - available from EMCO application information sheet
r = Density of liquid in lbs/ft^3
h1 = Enthalpy of supply line in chilled or hot water systems (Btus/pounds)
h2 = Enthalpy of return line in chilled or hot water systems (Btus/pounds)

8.3.2 Steam

$$\mathrm{Ks}\left(\mathrm{pulses/pounds}\right)=\frac{\mathrm{Kf}}{\mathrm{A\bullet Fo\bullet Fp}\bullet\rho}$$

or

$$\mathrm{Ks}\left(\mathrm{pulses/Btus}\right)=\frac{\mathrm{Kf}}{\mathrm{A\bullet Fo\bullet Fp}\bullet\rho\bullet\mathrm{hg}}$$

Where:

Ks = System K-factor
Kf = Rotor cal. constant in pulses/ft (available from the EMCO application or rotor calibration sheet)
A = Pipeline cross-sectional area in ft^2
Fo = Obscuration factor - available from the EMCO application information sheet
Fp = Profile factor - available from the EMCO application information sheet
r = Density of steam in lbs/ft^3
hg = Enthalpy of steam in BTUs/pounds

8.3.3 Natural Gas and Other Ideal Gases

$$Ks\left(\text{pulses / actual ft}^3\right) = \frac{Kf}{A \bullet Fo \bullet Fp}$$

or

$$Ks\left(\text{pulses / std. ft}^3\right) =$$

$$\frac{Kf}{A \bullet Fo \bullet Fp \bullet Fpv^2} \bullet \left[\frac{14.73}{Pa} \bullet \frac{Ta}{520}\right]$$

or

$$Ks\left(\text{pulses / pounds}\right) = \frac{Kf}{A \bullet Fo \bullet Fp \bullet \rho}$$

Where:

Ks = System K-factor

Kf = Rotor cal. constant in pulses/ft (available from the EMCO application or rotor calibration sheet)

A = Pipeline cross-sectional area in ft^2

Fo = Obscuration factor - available from the EMCO application information sheet

Fp = Profile factor - available from the EMCO application information sheet

Ta = Absolute line temperature in °Rankine °R = (°F + 460)

Pa = Absolute line pressure in psia

psia = (psig + local barometric pressure)

r = Density of natural gas in lbs/ft^3

Fpv = Super compressibility factor

$$\text{Density}\left(\text{lbs / ft}^3\right) = \frac{2.7 \bullet SG \bullet Pa}{Ta}$$

Where:

SG = Specific gravity of natural gas

Pa = Same as above

Ta = Same as above

8.4 Determining Flow Rate

Once the Ks has been determined, the following equation can be used to determine flow rate:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

Where:

Q = Flow rate in appropriate engineering units

Ft = Turbine flowmeter frequency in Hz (pulses/sec)

Ks = System K-Factor (equations 1 thru 10)

Tb = Time base
(sec; Tb=1)
(min; Tb=60)
(hour; Tb=3,600)
(day; Tb=86,400)

Note:

The values of Fo and Fp in the application information sheets are based on actual operating conditions. If conditions such as pipe size, flow rate, pressure, temperature, density (major elements) change, new values should be obtained from EMCO. In such applications, an EMCO flow processor, such as an FP-93 or FP-100, may be used to automatically compute the values for Fo or Fp.

8.5 Liquid Application Examples

8.5.1 Example 1

The Turbo-Bar™ referenced in the sample application sheet on page 45 shows an output of 135 Hz. Determine flow rate in ft^3/min.

Answer:

Step 1. Find Ks in pulses/ft^3. Ks for liquid in pulses/ft^3 is calculated as:

$$Ks\left(pulses / ft^3\right) = \frac{Kf}{A \bullet Fo \bullet Fp}$$

$$Ks\left(pulses / ft^3\right) = \frac{23.1254}{2.7917 \bullet 0.9901 \bullet 0.8267}$$

Ks = 10.12 pulses/ft^3

Step 2. Find the flow rate. Flow rate for liquid in ft^3/min is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{135}{10.12} \bullet 60$$

Q = 800.39 ft^3/min

8.5.2 Example 2

The Turbo-Bar™ referenced in the sample application sheet on page 45 shows an output of 135 Hz. Determine flow rate in gal/min.

Answer:

Step 1. Find Ks in pulses/gallons. Ks for liquid in pulses/gallon is already calculated on the sample application sheet as:
Ks= 1.3528 pulses/gallons.

Step 2. Find the flow rate. Flow rate for liquid in gal/min is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{135}{1.3528} \bullet 60$$

Q = 5,987.58 gal/min

8.5.3 Example 3

The Turbo-Bar™ referenced in the sample application sheet on page 45 shows an output of 135 Hz. Determine flow rate in pounds/hr.

Answer:

Step 1. Find Ks in pulses/pounds. Ks for liquid in pulses/pounds is calculated as:

$$Ks\left(pulses / pounds\right) = \frac{Kf}{A \bullet Fo \bullet Fp \bullet \rho}$$

$$Ks\left(pulses / pounds\right) = \frac{23.1254}{2.7917 \bullet 0.9901 \bullet 0.8267 \bullet 62.42}$$

Ks = 0.1621 pulses/pounds

Step 2. Find flow rate. Flow rate for liquid in pounds/hr is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{135}{0.1621} \bullet 3,600$$

Q = 2,998,149.29 pounds/hr

8.5.4 Sample Application Information Sheet for Water

Engineering Measurements Company
Flow Products Division
600 Diagonal Highway
Longmont, CO 80501
PH: 303-651-0550

Work Order #: C111111-001
Date: 2/15/92
Purchase Order: 2235
Data Entry: By B.G.
Tag #:

Application Information

Customer: Sample
Address:
Person:
Comments:

Fluid: Water
Pipe Inside Diameter: 22.624 in   Area: 2.7917E+00 sq. ft.

	min	nom	max	units
Pressure	110	110	110	psig
Temperature	42	42	52	deg F
Density	62.4229	62.4229	62.4229	lb/cu ft
Flow Rate	0	4000	8000	US gallons/min
Velocity	0	3.192339	6.384677	ft/sec
Viscosity		1.5057		c-poise
REYNOLDS NUMBER	0	371059	742118	

Barometric Pressure: 14.7 psia

*** Rotor Data ***

Rotor Model: 150-040-U-CSJ (L1)
Serial #:C111111-001   Cal. Number: 0
Cal. Constant. Kf (Mean lin-Inp): 22.51 pulses per foot (Nom-Adj): 23.1254
System K Factor (Ks) : 1.3528E+00 pulses per US gallons
Obscuration Factor (Fo): .9901067
Profile Factor (Fp): .8267239
Probe Insertion Depth: 5.656 in   1/4 ID- position
Max. Rotor Velocity: 7.800033 ft/sec

*** Electrical Scaling ***

Electronics Model : PA1/2   Serial #

Maximum Scaling Frequency (hz): 180.0

Full-Scale Setting: 8,000 US gallons per min (gpm)

page 1 of 1

8.6 Steam Application Examples

8.6.1 Example 1

The Turbo-Bar™ referenced in the sample application sheet on page 47 shows an output of 1,000 Hz at 165 psig. Determine flow rate in pounds/hr.

Answer:

Step 1. Find Ks in pulses/pounds. Ks for steam in pulses/pounds is calculated as:

$$Ks\left(pulses / pounds\right) = \frac{Kf}{A \bullet Fo \bullet Fp \bullet \rho}$$

ρ (at 165 psig) = .3944 pounds/ft^3

$$Ks\left(pulses / pounds\right) = \frac{12.6601}{0.5476 \bullet 0.9557 \bullet 0.76208 \bullet 0.3944}$$

Ks = 80.48 pulses/pounds

Step 2. Find flow rate. Flow rate for steam in pounds/hr is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{1,000}{80.48} \bullet 3,600$$

Q = 44,731 pounds/hr

8.6.2 Example 2

The Turbo-Bar™ referenced in the sample application sheet on page 47 shows an output of 1,000 Hz at 165 psig. Determine the heat content flow rate in Btus/hr.

Answer:

Step 1. Find Ks in pulses/BTUs. Ks for steam in pulses/BTUs is calculated as:

$$Ks\left(pulses / Btus\right) = \frac{Kf}{A \bullet Fo \bullet Fp \bullet \rho \bullet hg}$$

ρ (at 165 psig)=.3944 pounds/ft^3

hg (165 psig: from steam tables) =1196.9 Btus/lbs

$$Ks\left(pulses / Btus\right) = \frac{12.6601}{0.5476 \bullet 0.9557 \bullet 0.7628 \bullet 0.3944 \bullet 1196.9}$$

Ks = 0.06718 pulses/Btus

Step 2. Find flow rate. Flow rate for steam in BTUs/hr is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{1,000}{0.06718} \bullet 3,600$$

Q = 53,587,377.2 BTUs/hr

8.6.3 Sample Application Information Sheet for Steam

Engineering Measurements Company
Flow Products Division
600 Diagonal Highway
Longmont, CO 80501
PH: 303-651-0550

Work Order #: C111111-002
Date: 2/15/92
Purchase Order: 2235
Data Entry:By B.G.
Tag #:

Application Information

Customer: Sample
Address:
Person:
Comments:

Fluid: Saturated Steam
Pipe Inside Diameter: 10.02 in Area: 5.4760 E-01 sq ft

	min	nom	max	units
Pressure	165	165	165	psig
Temperature	372.7683	372.7683	372.7683	deg F
Density	0.3944	0.3944	0.3944	lb/cu ft
Flow Rate	0	25000	50000	pounds/hr
Velocity	0	32.15131	64.30262	ft/sec
Viscosity		0.0162		c-poise
REYNOLDS NUMBER	0	972009.6	1944019	

Barometric Pressure: 14.7 psia

*** Rotor Data ***

Rotor Model: 150-030-U-DEV (G3)
Serial #:C111111-002 Cal. Number: 121
Cal. Constant. Kf (Mean lin-Inp): 12.563 pulses per foot (Nom-Adj): 12.6601
System K Factor (Ks) : 8.0476E+01 pulses per pound
Obscuration Factor (Fo): .9557077
Profile Factor (Fp): .762088
Probe Insertion Depth: 5.01 in centerline position
Max. Rotor Velocity: 88.28734 ft/sec

*** Electrical Scaling ***

Electronics Model : PA1/2 Serial #

Maximum Scaling Frequency (hz): 1118.0

Full-scale Setting: 8,000 US gallons per min (gpm)
Scaling based on 179.7 psia 372.7683 deg F .3944355 lb/cu ft

page 1 of 1

8.7 Natural Gas Application Examples

8.7.1 Example 1

The Turbo-Bar™ referenced in the sample application sheet on page 49 shows an output of 800 Hz. Determine flow rate in actual ft³/min.

Answer:

Step 1. Find Ks in pulses/ft³. Ks for natural gas in pulses/ft³ is calculated as:

$$Ks\left(\text{pulses / actual ft}^3\right) = \frac{Kf}{A \bullet Fo \bullet Fp}$$

$$Ks\left(\text{pulses / actual ft}^3\right) = \frac{8.10411}{0.7854 \bullet 0.9824 \bullet 0.7923}$$

Ks =13.257 pulses/ft³

Step 2. Find flow rate. Flow rate for natural gas in pulses/ft³ is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{800}{13.257} \bullet 60$$

Q = 3,620.7 actual ft³/min

8.7.2 Example 2

The Turbo-Bar™ referenced in the sample application sheet on page 49 shows an output of 800 Hz. Determine flow rate in std ft³/min.

Answer:

Step 1. Find Ks in pulses/gallons. Ks is already calculated on the application sample sheet as, Ks= 0.71157.

Step 2. Find flow rate. Flow rate for natural gas in std ft³/min is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{800}{0.71157} \bullet 60$$

Q = 67,456.47 std ft³/min

8.7.3 Example 3

The Turbo-Bar™ referenced in the sample application sheet on page 49 shows an output of 800 Hz. Determine flow rate in pounds/min.

Answer:

Step 1. Find Ks in pulses/pounds. Ks for natural gas in pulses/pounds is calculated as:

$$Ks\left(\text{pulses / pounds}\right) = \frac{Kf}{A \bullet Fo \bullet Fp \bullet \rho}$$

$$\rho\left(\text{pounds / ft}^3\right) = \frac{2.7 \bullet SG \bullet Pa}{Ta} = \frac{2.7 \bullet 0.667 \bullet 279.73}{530}$$

$$\rho = 0.8555 \text{ pounds/ft}^3$$

$$Ks\left(\text{pulses / pounds}\right) = \frac{8.10411}{0.7854 \bullet 0.9824 \bullet 0.7923 \bullet 0.8555}$$

Ks = 15.495 pulses/pounds

Step 2. Find flow rate. Flow rate for natual gas in pounds/min is calculated as:

$$Q = \frac{Ft}{Ks} \bullet Tb$$

$$Q = \frac{800}{15.495} \bullet 60$$

Q = 3,097.77 pounds/min

8.7.4 Sample Application Information Sheet for Natural Gas

Engineering Measurements Company
Flow Products Division
600 Diagonal Highway
Longmont, CO 80501
PH: 303-651-0550

Work Order #: C111111-003
Date: 2/15/92
Purchase Order: 2235
Data Entry:By B.G.
Tag #:

Application Information

Customer: Sample
Address:
Person:
Comments:

Fluid: Natural Gas (AGA 3)
Pipe Inside Diameter: 12 in   Area: 7.8540 E-01

	min	nom	max	units
Pressure	265	265	435	psig
Temperature	70	70	70	deg F
Density	0.8555	0.8555	1.3754	lb/cu ft
Flow Rate	16,666	50,000	100,000	std cu f t/min
Velocity	18.98434	56.95302	70.84617	ft/sec
Viscosity		0.0105		c-poise
REYNOLDS NUMBER	2289253	6867759	8543083	

Barometric Pressure: 14.7 psia
Base pressure: 14.73   Base Temperature: 60 deg F
Supercompressibility (FPV): 1   Specific Gravity: .6

*** Rotor Data ***

Rotor Model: 150-020-U-DEV (G3)
Serial #:C111111-003   Cal. Number: 0
Cal. Constant. Kf (Mean lin-Inp): 8.183 pulses per foot (Nom-Adj): 8.104114
System K Factor (Ks) : 7.1157E-01 pulses per std cu ft
Obscuration Factor (Fo): .9824475
Profile Factor (Fp): .7922764
Probe Insertion Depth: 3 in 1/4 ID- position
Max. Rotor Velocity: 91.01862 ft/sec

*** Electrical Scaling ***

Electronics Model : PA1/2   Serial #

Maximum Scaling Frequency (hz): 1186.0

Full-scale Setting: 6,000,000 std cu ft per hr
Scaling based on: 279.7 psia   70 deg F

page 1 of 1

8.8 Sample Rotor Calibration Sheet

Engineering Measurements Company
Flow Products Division
600 Diagonal Highway
Longmont, CO 80501
PH: 303-651-0550

Work Order #:
Date:
Customer:
Purchase Order:
Data Entry By:
Calibration #:
Serial # : I002
150-040-CSJ

150 Liquid Rotor Calibration

Pipe dia = 2.900 inches
Area = 4.59e-02 sq. feet

LBS.	TIME	PULSES	TEMP °F	density lbs/cu-ft	freq Hz	avg vel. Ft/Sec	Reynolds Number	Profile Factor	Obscur. Factor	Local Vel Ft/sec	Local K pulse/ft	% DEV. MEAN
200	82.49	2014.00	68.00	62.33	24.42	0.85	18960	0.8049	0.7982	1.32	18.50	non-lin
200	52.44	2072.00	68.00	62.33	39.51	1.33	29825	0.8086	0.7982	2.07	19.12	0.72%
200	34.83	2069.00	68.00	62.33	59.40	2.01	44905	0.8118	0.7982	3.10	19.16	0.97%
500	59.00	5055.00	68.00	62.33	85.68	2.96	66273	0.8147	0.7982	4.56	18.80	-0.97%
500	50.93	5060.00	68.00	62.33	99.35	3.43	76774	0.8158	0.7982	5.27	18.84	-0.74%
500	28.49	5047.00	68.00	62.33	177.15	6.14	137244	0.8200	0.7982	9.38	18.89	-0.49%
										Mean =	18.98	

freq Hz	Local Vel ft/sec
24.42	1.32
39.51	2.07
59.40	3.10
85.68	4.56
99.35	5.27
177.15	9.38
K-Factor	18.98 pulses/ft
Serial #	I002

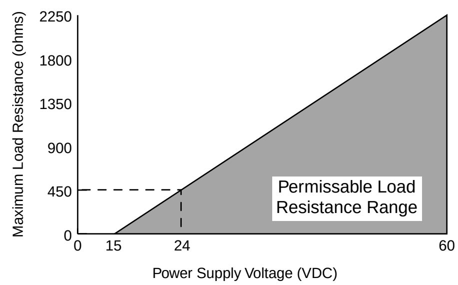
Section 9: Maintenance and Troubleshooting

9.1 General Information

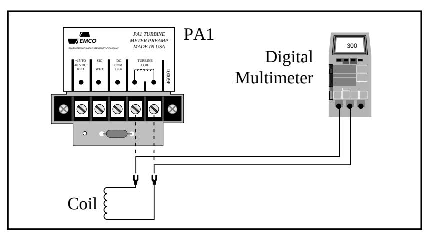
If you are experiencing difficulties with your Turbo-Bar™ flowmeter, use the following information to identify and solve problems.

9.2 No Output

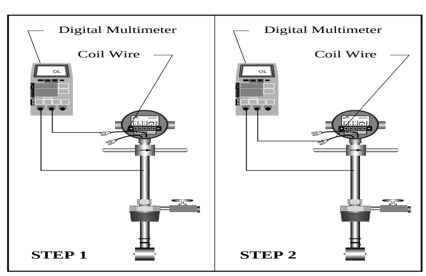
1. Verify wiring is in accordance with all wiring diagrams in Section 5: Electrical Installation.
2. Check supply power to the preamplifier. Supply voltage should be 24 VDC.
3. For Turbo-Bar™ flowmeters using either the PAQ or P2Q2 preamplifiers, check loop resistance. Make sure the total load resistance does not exceed the values shown below:



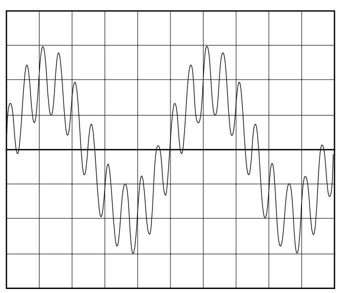
4. Check the pickup coil for shorts— both across the coil and coil to ground. To do so, shut off power to the preamplifier and remove the coil wires from the preamp terminal. First, check for a short across the coil by attaching an ohm flowmeter to the pickup coil wires as shown below. The coil should have a nominal resistance of 300 ohms at ambient temperature. (Resistance will change with temperature). Zero or infinite resistance indicates a defective pickup.



Next, check for a coil to ground short. Using the same two wires from the previous example, hold one of the coil wires and make solid contact with one of the ohm flowmeter leads. Take the other ohm meter lead and touch it to the stem. The ohm meter should read infinite resistance. Zero resistance indicates a coil to ground short and the stem and coil assembly should be replaced. Repeat this step for the other coil wire as shown below.



5. Check the rotor for bearing drag or seizure. To do so, check by holding the rotor assembly between the thumb and forefinger while blowing on the rotor. If the bearings are worn the rotor may seize or spin poorly.
6. Check the rotor for bent blades or a bent yoke. All turbine blades are profiled for different flow conditions. Look for blade(s) which are clearly different from the factory profiled blades. The yoke, which houses the turbine, is usually damaged when the gate valve is inadvertently shut before the turbine is fully retracted. Over-inserting the rotor into the bottom of the pipe yields the same result. Be very careful when lowering and retracting the sensor.
7. Check the rotor for contamination. Look for debris sticking to the rotor blades. If the rotor stops spinning, the blades may be unbalanced by debris. A contaminated blade will always stop or unbalance the rotor. To remove heavy contaminants from the rotor or bearings, use an ultrasonic cleaner.
8. Check the rotor for magnetization. If a rotor has been left on a flowmeter, which is out of service, or in flows without enough kinetic energy to spin the rotor, the blade nearest the magnetic pickup will become over-magnetized. As a result, the rotor spins unevenly or does not spin at all. To demagnetize a rotor, a small magnet and oscilloscope is needed. Follow the steps outlined below:
   a. Disconnect the coil wires from the preamplifier terminal block.
   b. Connect the ground lead of the oscilloscope to DC common, terminal 3.
   c. Connect the scope probe to the test point in the lower left hand corner of the terminal block. This will yield a sine wave. If a square wave is desired, connect the scope probe to terminal 2.
   d. Blow hard on the rotor until it spins. The oscilloscope should display sine waves. If the rotor is magnetized, the scope tracing should resemble:



   e. Apply air flow sufficient to spin the rotor steadily at about 3,000 - 4,000 RPM. Using the south (negative) pole of a strong (approximately 30 million gauss) permanent magnet, slowly move the magnet close to the rotor, about 1/4" away, then back to 2" away. Repeat several times, but do not touch the blades of the rotor with the magnet. This yields uniform polarity.

10. Check the preamplifier for proper operation and scaling, according to Section 5: Electrical Installation.
11. Contact EMCO or your EMCO sales representative.

9.3 Analog Output Equals 0 mA

1. Verify wiring is in accordance with the power and wiring diagrams in Section 5: Electrical Installation.
2. Check the power supply voltage.
3. For Turbo-Bar™ flowmeters using the PAQ or P2Q2 preamplifiers, check loop resistance. Make sure the total loop resistance does not exceed 9 volts.
4. Check the voltage at the flowmeter.
5. Contact EMCO or your EMCO sales representative.

9.4 Analog Output less than 4 mA

1. Verify wiring is in accordance with the power and wiring diagrams in Section 4: Electrical Installation..
2. Check the power supply voltage.
3. For Turbo-Bar™ flowmeters using the PAQ or P2Q2 preamplifiers, check loop resistance. Make sure the total loop resistance does not exceed 9 volts.
4. Check the voltage at the flowmeter.
5. Verify the analog zero and span calibration.
6. Contact EMCO or your EMCO sales representative.

9.5 Inaccurate Output

1. Verify the piping installation has allowed for the required straight pipe run. See 3.2 Straight Run Pipe, p. 7.
2. Verify flow is within the range of the rotor. See Table below.

English Units			**Liquid**		**Gas or Steam**				
Pipe Size		Rotor	L1 (40° pitch)	G1 (40° pitch)	G2 (30° pitch)	G3 (20° pitch)	G4 (15° pitch)	G5 (10° pitch)	G6[1] (5° pitch)
All	$V_{max.}$	*(ft/sec)*	30	55	70	85	115	145	175
3 - 5"	V_{lin}	*(ft/sec)*	1.4	$3.19 / \sqrt{\rho}$	$3.98 / \sqrt{\rho}$	$4.52 / \sqrt{\rho}$	$5.84 / \sqrt{\rho}$	$6.91 / \sqrt{\rho}$	$6.10 / \sqrt{\rho}$
	V_{min}	*(ft/sec)*	0.5	$1.94 / \sqrt{\rho}$	$2.26 / \sqrt{\rho}$	$2.42 / \sqrt{\rho}$	$3.85 / \sqrt{\rho}$	$4.57 / \sqrt{\rho}$	N/A
6"	V_{lin}	*(ft/sec)*	1.5	$2.00 / \sqrt{\rho}$	$2.27 / \sqrt{\rho}$	$2.52 / \sqrt{\rho}$	$3.78 / \sqrt{\rho}$	$4.78 / \sqrt{\rho}$	$5.53 / \sqrt{\rho}$
	V_{min}	*(ft/sec)*	0.6	$1.23 / \sqrt{\rho}$	$1.63 / \sqrt{\rho}$	$1.95 / \sqrt{\rho}$	$2.84 / \sqrt{\rho}$	$3.47 / \sqrt{\rho}$	N/A
8" +	V_{lin}	*(ft/sec)*	1.6	$1.50 / \sqrt{\rho}$	$1.90 / \sqrt{\rho}$	$2.18 / \sqrt{\rho}$	$3.00 / \sqrt{\rho}$	$3.54 / \sqrt{\rho}$	$5.00 / \sqrt{\rho}$
	V_{min}	*(ft/sec)*	0.7	$1.00 / \sqrt{\rho}$	$1.31 / \sqrt{\rho}$	$1.40 / \sqrt{\rho}$	$2.19 / \sqrt{\rho}$	$2.81 / \sqrt{\rho}$	N/A
Metric Units			**Liquid**		**Gas or Steam**				
All	V_{max}	*(m/sec)*	9	17	21	26	35	44	53
75-125 mm	V_{lin}	*(m/sec)*	0.4	$3.89 / \sqrt{\rho}$	$4.86 / \sqrt{\rho}$	$5.51 / \sqrt{\rho}$	$7.12 / \sqrt{\rho}$	$8.43 / \sqrt{\rho}$	$7.44 / \sqrt{\rho}$
	V_{min}	*(m/sec)*	0.2	$2.37 / \sqrt{\rho}$	$2.76 / \sqrt{\rho}$	$2.95 / \sqrt{\rho}$	$4.70 / \sqrt{\rho}$	$5.57 / \sqrt{\rho}$	N/A
150 mm	V_{lin}	*(m/sec)*	0.5	$2.44 / \sqrt{\rho}$	$2.77 / \sqrt{\rho}$	$3.07 / \sqrt{\rho}$	$4.61 / \sqrt{\rho}$	$5.83 / \sqrt{\rho}$	$6.75 / \sqrt{\rho}$
	V_{min}	*(m/sec)*	0.2	$1.50 / \sqrt{\rho}$	$2.00 / \sqrt{\rho}$	$2.38 / \sqrt{\rho}$	$3.46 / \sqrt{\rho}$	$4.23 / \sqrt{\rho}$	N/A
200 mm +	V_{lin}	*(m/sec)*	0.5	$1.83 / \sqrt{\rho}$	$2.32 / \sqrt{\rho}$	$2.67 / \sqrt{\rho}$	$3.66 / \sqrt{\rho}$	$4.32 / \sqrt{\rho}$	$6.10 / \sqrt{\rho}$
	V_{min}	*(m/sec)*	0.2	$1.22 / \sqrt{\rho}$	$1.60 / \sqrt{\rho}$	$1.71 / \sqrt{\rho}$	$2.67 / \sqrt{\rho}$	$3.43 / \sqrt{\rho}$	N/A

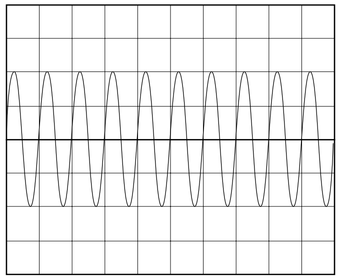
Where:

V_{max} = maximum velocity of fluid [ft/sec (m/sec)]
V_{lin} = minimum velocity of fluid at which rotor response is linear [ft/sec (m/sec)]
V_{min} = minimum measurable velocity of fluid [ft/sec (m/sec)]
ρ = density of fluid [lbs/ft^3 (kg/m)]
N/A = no application

3. Check pickup coil for intermittent resistance. Follow step 4 in 9.2 No Output, p. 51.
4. Verify the correct K-factor has been used.

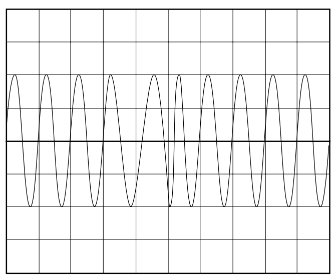
5. Check the quality of the rotor signal. To do so, shut off power to the preamplifier and remove the coil wires from the preamp terminal. Attach an oscilloscope to the pickup coil wires as described in step 4 under 9.2 No Output, p. 51. Set the scope to horizontal and vertical sweep, displaying ten cycles of rotor output. The accompanying illustrations depict oscilloscope tracings characteristic of normal and damaged rotors.

9.5.1 Normal Rotor



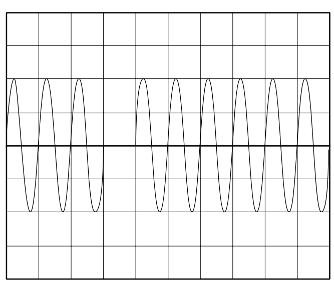
The normal signal from the magnetic pickup coil is a sine wave. For a normal ten-blade rotor, there are ten identical sinewaves per revolution

9.5.2 Bent Blades



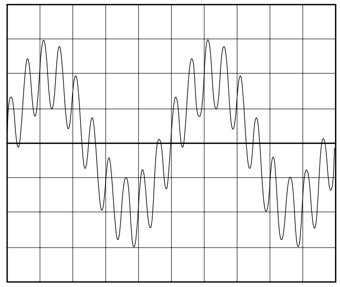
Bent blades display one or more cycles which lean away from perpendicular or drop below the center line.

9.5.3 Missing Rotor



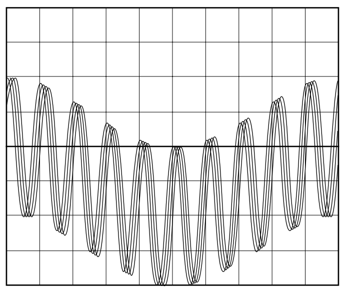
A rotor missing a blade produces an abnormal wave form or cycle. Typically, the wave pattern will have a gap left from the missing blade.

9.5.4 Magnetized Rotor



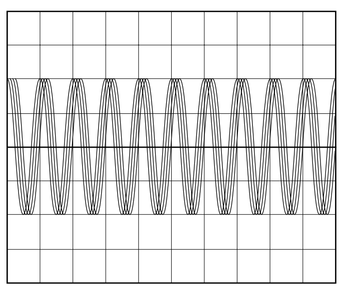
A rotor with residual magnetism produces an erratic signal which will appear as if a high frequency signal has been combined with a longer, lower frequency signal.

9.5.5 Overranged Flowmeter



Excessive flow velocity can cause the rotor to overspeed. The sine wave of an over-ranged rotor looks as if several sine waves were superimposed on each other each wave slightly offset from the other.

9.5.6 Chatter



Worn bearings or a bent yolk can cause chatter. The wave form of chatter will show the horizontal sweep pulled down from the center.

6. Check for electrical noise according to Section 5: Electrical Installation.
7. Check the preamplifier for proper scaling and operation according to Section 5: Electrical Installation.
8. Contact EMCO or your EMCO sales representative.

Section 10: Model and Suffix Codes

Category	Description	Suffix Codes							TMP-700 Only
Model	Liquid or gas service, 400 °F (204 °C)	TMP-600	...	...	...	...	...	...	...
	Steam or hot water service, 400 °F (204 °C)	TMP-60S	...	...	...	...	...	...	...
	Liquid, gas or steam service, 600 °F (315 °C)	TMP-700	...	...	...	...	...	...	...
	Liquid or gas service, 400 °F (204 °C)	TMP-800	...	...	...	...	...	...	...
	Steam or hot water service, 400 °F (204 °C)	TMP-80S	...	...	...	...	...	...	...
	Liquid, gas or steam service, 400 °F (204 °C)	TMP-910	...	...	...	...	...	...	...
	Liquid, gas or steam service, 752 °F (400 °C)	TMP-960	...	...	...	...	...	...	...
Connection	2", male NPT with isolation valve & Thread-o-Let (XX=03-70" pipe)(model 600 only)	...	VXX	...	...	...	...	...	...
	2", male NPT (models 700, 800 only)	...	2NPT	...	...	...	...	...	...
	2", 150# flange (all models except 600)	...	2F150	...	...	...	...	...	...
	2", 300# flange (all models except 600 and 800)	...	2F300	...	...	...	...	...	...
	2", 600# flange (all models except 600 and 800)	...	2F600	...	...	...	...	...	...
	2", 900# flange (all models except 600 and 800)	...	2F900	...	...	...	...	...	...
	2", 1500# flange (models 910 and 960 only)	...	2F1500	...	...	...	...	...	...
Rotor	Liquid, 30 ft/sec maximum(9 m/sec)(40˚ Pitch)	...	...	L1	...	...	...	...	...
	Gas or steam, 55 ft/sec maximum (17 m/sec) (40˚ Pitch)	...	...	G1	...	...	...	...	...
	Gas or steam, 70 ft/sec maximum (21 m/sec) (30˚ Pitch)	...	...	G2	...	...	...	...	...
	Gas or steam, 85 ft/sec maximum (26 m/sec) (20˚ Pitch)	...	...	G3	...	...	...	...	...
	Gas or steam,115 ft/sec maximum (35 m/sec) (15˚ Pitch)	...	...	G4	...	...	...	...	...
	Gas or steam,145 ft/sec maximum (44 m/sec) (10˚ Pitch)	...	...	G5	...	...	...	...	...
	Gas or steam,175 ft/sec maximum (53 m/sec) (05˚ Pitch)[1]	...	...	G6	...	...	...	...	...
	For bidirectional rotor	...	...	XXB	...	...	...	...	...
Electronics	10 V p-p frequency output[2]	...	...	...	PA1	...	...	...	...
	Bidirectional, 10 V p-p frequency output (relay)[2]	...	...	...	PA2	...	...	...	...
	4-20 mA current output[2]	...	...	...	PAQ	...	...	...	...
	Bidirectional, two 4-20 mA current outputs[2]	...	...	...	P2Q2	...	...	...	...
	EZ Logic with local rate and total[3]	...	...	...	LOC-TOT	...	...	...	...
	Remote, only available with LOC-TOT option[4]	...	...	...	RMT	...	...	...	...
	FM Approval[5]	...	...	...	FM	...	...	...	...
Pressure Transmitter	No pressure transmitter	...	...	...	...	XX	...	...	...
	Pressure transmitter with scaled preamplifier:								
	0 - 50 psi gauge (0 - 3.44 barg)	...	...	...	...	50	...	...	...
	0 - 100 psi gauge (0 - 6.89 barg)	...	...	...	...	100	...	...	...
	0 - 150 psi gauge (0 -10.34 barg)	...	...	...	...	150	...	...	...
	0 - 200 psi gauge (0 -13.79 barg)	...	...	...	...	200	...	...	...
	0 - 250 psi gauge (0 -17.24 barg)	...	...	...	...	250	...	...	...
	0 - 500 psi gauge (0 -34.47 barg)	...	...	...	...	500	...	...	...
	0 -1000 psi gauge (0 -68.95 barg)	...	...	...	...	1000	...	...	...
	Transmitters can be scaled to accommodate special requests and bar scaling (see below)[6]	...	...	...	...	PXX	...	...	...
Temperature Sensor or Transmitter	No temperature transmitter	...	...	...	...	...	XXX	...	...
	RTD only	...	...	...	...	...	RTD	...	...
	Temp. transmitter with scaled preamplifier:								
	32 to 68 °F	...	...	...	...	...	T09	...	...
	0 to 250 °F	...	...	...	...	...	T10	...	...
	-40 to 150 °F	...	...	...	...	...	T11	...	...
	212 to 400 °F	...	...	...	...	...	T12	...	...
	212 to 800 °F	...	...	...	...	...	T13	...	...
	-17.7 to 121.1 °C	...	...	...	...	...	T20	...	...
	-40 to 65 °C	...	...	...	...	...	T21	...	...
	100 to 204 °C	...	...	...	...	...	T22	...	...
	100 to 426 °C	...	...	...	...	...	T23	...	...
	Transmitters can be scaled to accommodate special requests and bar scaling (see below)[6]	...	...	...	...	...	TXX	...	...
Extended Stem	None (standard length)	...	...	...	...	...	...	XX	...
	1' extension (not available on 600 or 60S)	...	...	...	...	...	...	E1	...
	2' extension (gas or steam applications only)(not available on 600 or 60S)	...	...	...	...	...	...	E2	...
Pick–up Coil Wires (Internal)	**TMP-700 Only:** Teflon, -200 to 400 ˚F, (-129 to 204 ˚C)	...	...	...	...	...	...	...	T
	TMP-700 Only: Fiberglass, 150 to 600 ˚F, (65 to 316 ˚C)	...	...	...	...	...	...	...	F

EXAMPLE: **TMP-910-2F900-G3-PA1-0200-T12-E1**

(for bidirectional meters): **TMP-910-2F900-G3B-PA2-0200-T12-E1**

Notes:
1. The G6 is the only available 1" shrouded rotor. Not available for use with bidirectional meters.
2. Not available with European CE Mark.
3. Unidirectional only. Unit has 4-20 mA and frequency output.
4. Remote mount electronics are required for high process temperatures. The standard remote mount option comes with 30' feet of cable.
5. Certified by FM for Class I, Division 2, Groups A, B, C, D; Class II,III, Division 2, Groups F,G. FM approval with only LOC-TOT and RMT electronics options. If FM is required, use RTD option only for temperature selection.
6. Special transmitter scaling is available. Please note scaling range below model code with ordering. If no special scaling is indicated, transmitter will be scaled per model code.