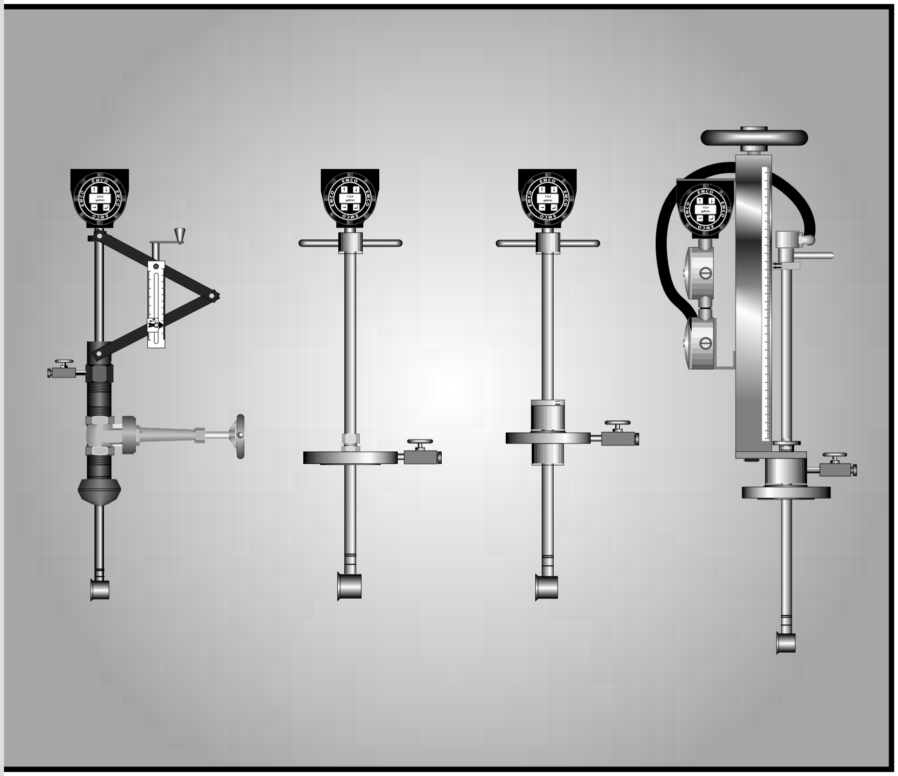
insertion
vortex
flowmeter

Model V-Bar Operation & Maintenance Manual

V-Bar-600
V-Bar-60S
V-Bar-700
V-Bar-800
V-Bar-80S
V-Bar-910
V-Bar-960



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ISO 9001 QUALITY SYSTEM CERTIFIED

Contents

Section 1: Product Introduction

Principle of Operation

The V-Bar is an insertion vortex flowmeter. Unlike a full-bore flowmeter, which replaces a section of pipe, an insertion meter is inserted into the pipe line through a hole cut into the pipe wall. When installed with an isolation valve, a retractable insertion flowmeter can be installed without process shutdown.

The V-Bar measures the volumetric flow rate by measuring the local velocity at the sensor insertion depth. The local velocity is determined by detecting the frequency at which vortices are alternately shed from the sensor's bluff body. The vortices pass the sensor wing, causing a slight deformation in the wing, which is detected by semiconductor strain gauges. The strain gauges generate an electrical frequency signal that is proportional to the local velocity.

The V-Bar's microprocessor-based electronics amplify and filter the sensor input. The local velocity is converted into an average velocity and then into an average flow rate in user-selectable engineering units. The electronics then provide a 4-20 mA and/or frequency output proportional to the flow rate. Standard local display alternately indicates flow rate and totalized flow.

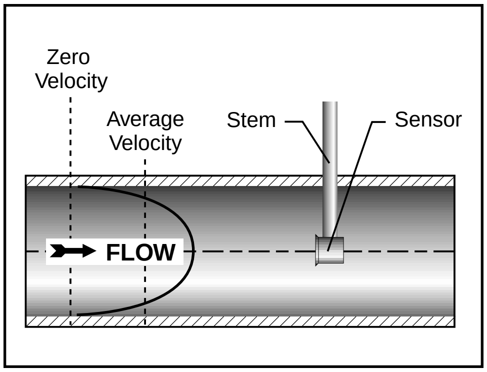


Figure 1-1. Principle of Operation. *The local velocity is measured at the insertion depth, converted into an average velocity, and then converted into an average flow rate.*

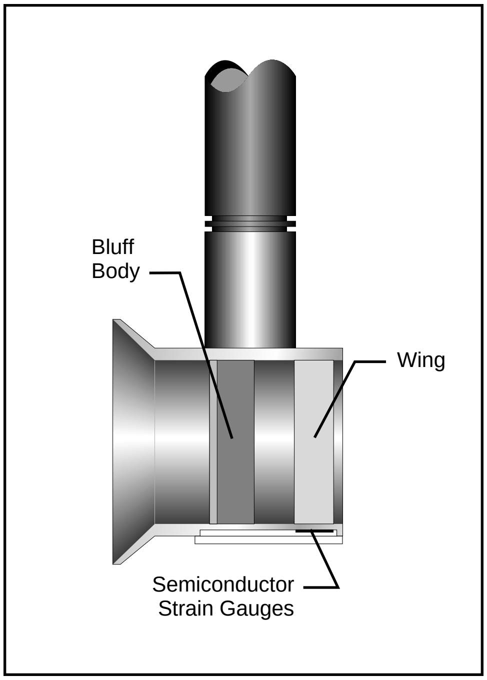


Figure 1-2. Cross Section of the V-Bar Sensor Head.

Product Features

- Menu-driven EZ-Logic™ user interface
- Smart transmitter
- HART® communications protocol
- 4-20 mA and/or frequency/pulse outputs
- Line sizes from 3 to 80 in. (80 to 2000 mm)
- Negligible pressure loss
- Optional, integral pressure transmitter
- Optional, integral temperature transmitter

V-Bar-600 Series Features: (Figure 1-3)

- Line pressures up to 125 psig (8.62 barg)
- Temperature range from –40 to 400 °F (–40 to 204 °C)
- Hot tappable installation
- Bronze isolation valve included with each flowmeter
- Retractable using screw-thread-rising stem design

- Mounting: 2" NPT with thread-o-let
- Integral scale for accurate sensor positioning

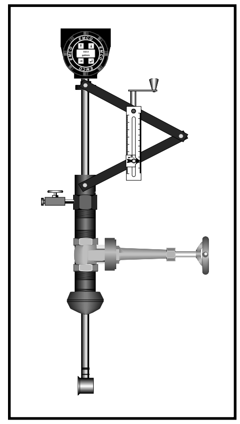


Figure 1-3.
V-Bar-600 Series.

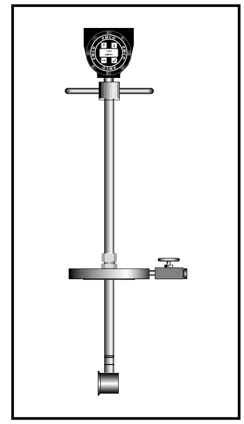


Figure 1-4.
V-Bar-700 Series.

V-Bar-700 Series Features:
(Figure 1-4)

- Line pressures up to 2000 psig (138 barg)
- Temperature range from –40 to 500 °F (–40 to 260 °C)
- Mounting: 2" NPT or 2" raised face 150#, 300#, 600#, or 900# ANSI flanges

V-Bar-800 Series Features:
(Figure 1-5)

- Line pressures up to 50 psig (3.45 barg)
- Temperature range from –40 to 400 °F (–40 to 204 °C)
- Hot tappable (when installed with an isolation valve)
- Manually retractable
- Mounting: 2" NPT or 2" raised face 150# ANSI flange

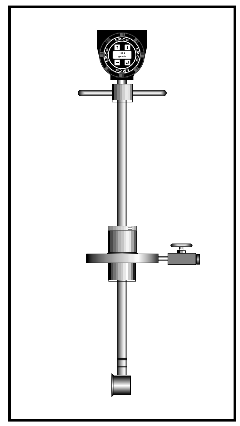


Figure 1-5.
V-Bar-800 Series.

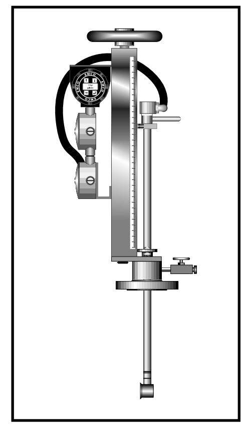


Figure 1-6.
V-Bar-900 Series.

V-Bar-900 Series Features
(Figure 1-6)

- According to flange rating, up to 900 psi
- Temperature range from –40 to 500 °F (–40 to 260 °C)
- Hot tappable (when installed with an 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

Equipment 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.

Identification Plate

A permanent identification plate (I.D.) is attached to your V-Bar flowmeter. This I.D. plate contains the following information: Model, Serial/W.O., date, pressure, temperature, and tag (if supplied by customer). Verify that this information is consistent with your metering requirements. This I.D. plate also shows applicable approvals. For CE approved meter/installations, see notes regarding wiring, DC power and remote electronics. (Figures 1-8 and 1-9)

Calibration Sheet

Save the calibration data sheet when unpacking your new meter. This is important for monitoring the performance of your meter.

EZ-Logic Interface Map

This map shows how the meter has been programmed at the factory. If your application changes, contact your EMCO representative for an updated map.

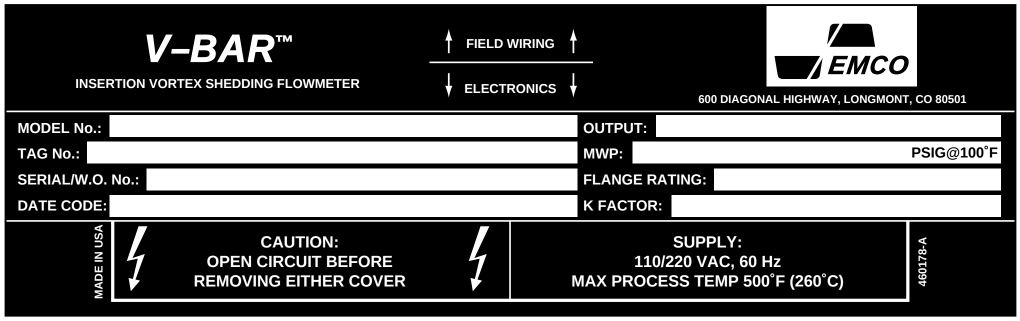


Figure 1-7. Identification Plate for a V-Bar with 110/220 VAC Power Supply

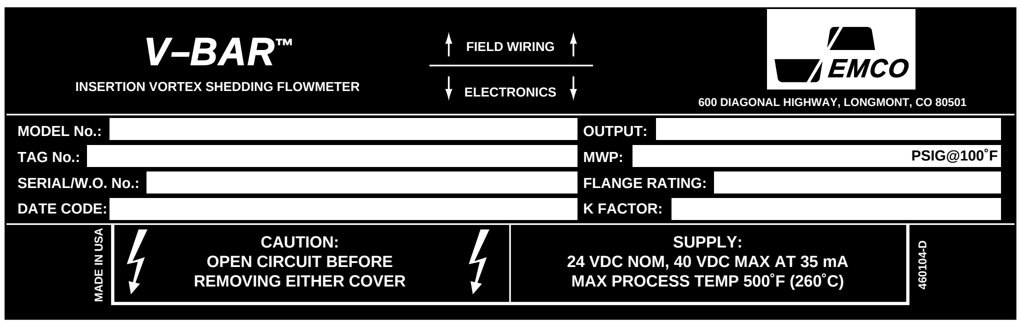


Figure 1-8. Identification Plate for a V-Bar with a 24 VAC Power Supply

Section 2: Installation Guidelines

Not all plumbing is laid out with flowmetering in mind. For optimum performance, you must consider straight run requirements and the installation site relative to flow direction. Figures 2-1 through 2-5 illustrate useful examples of both proper and improper flowmeter installations. If you have special requirements, please consult the factory.

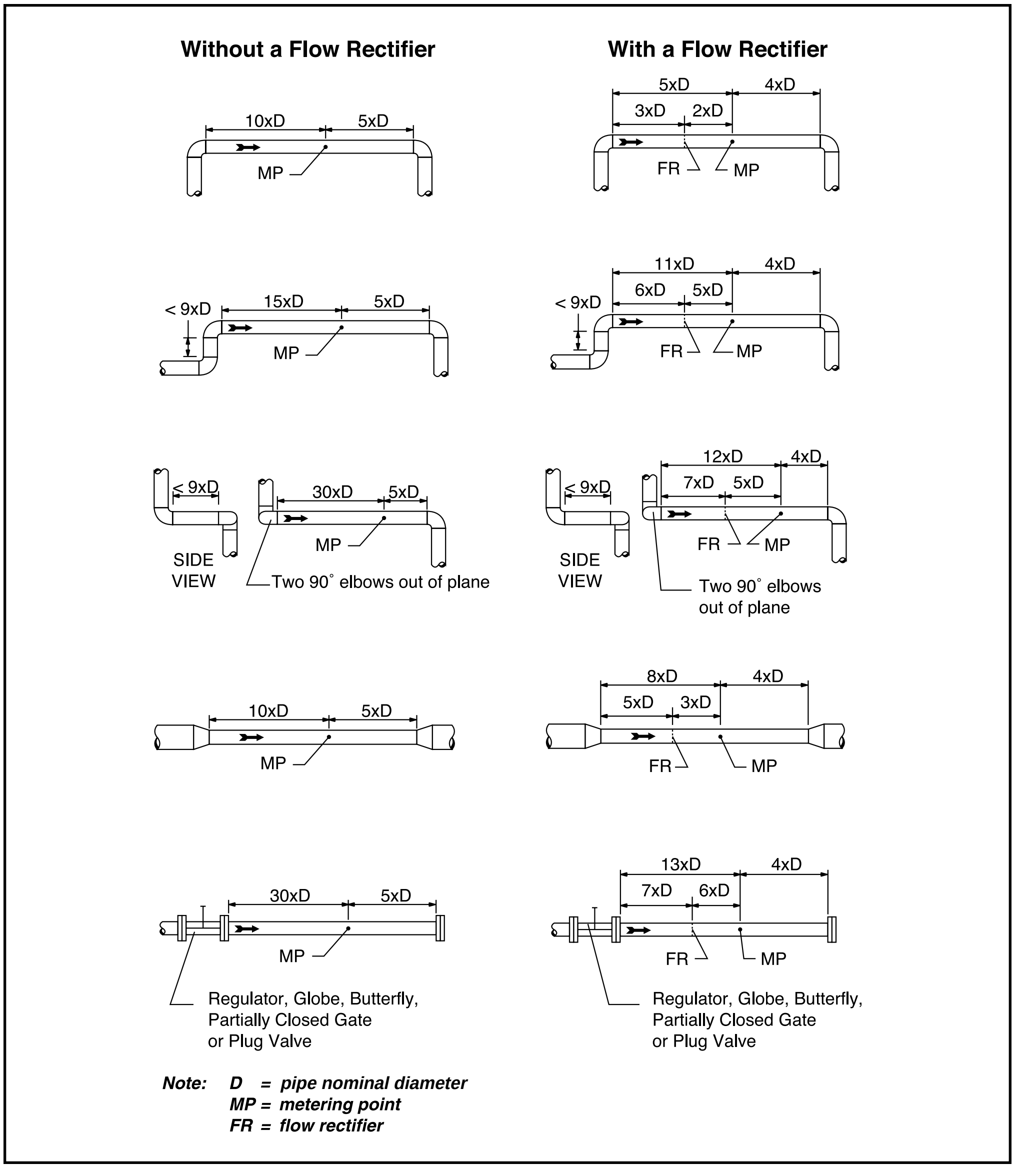


Figure 2-1. Straight Run Requirements. *The straight run of pipe must have the same nominal diameter as the flowmeter body.*

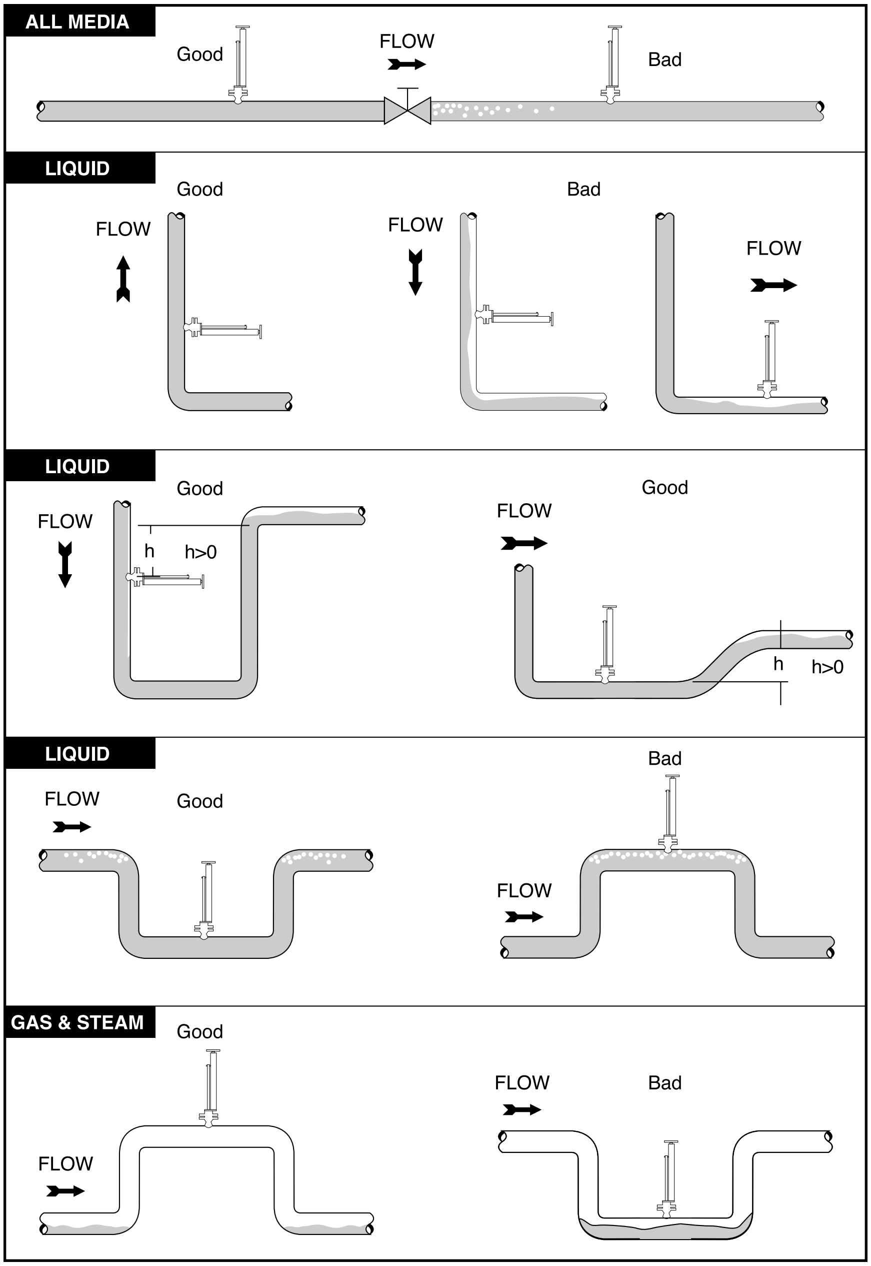


Figure 2-2. Meter Location. *Recommended meter locations ensure that the pipe will always be filled with fluid.*

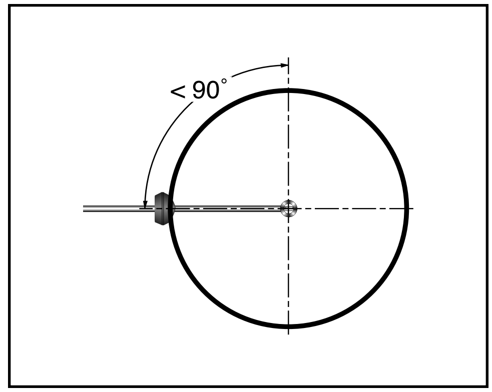


Figure 2-3. Non-vertical Mounting. *If non-vertical mounting is necessary, the deviation from vertical should not exceed 90°.*

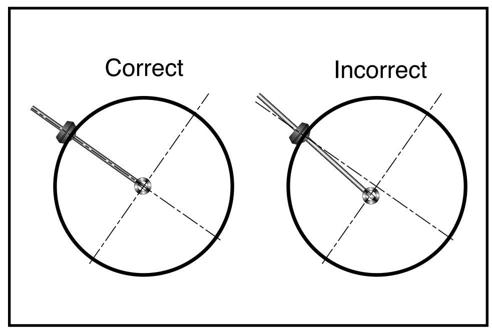


Figure 2-4. Meter Alignment. *The flowmeter should be aligned perpendicular to the pipe to avoid measurement errors.*

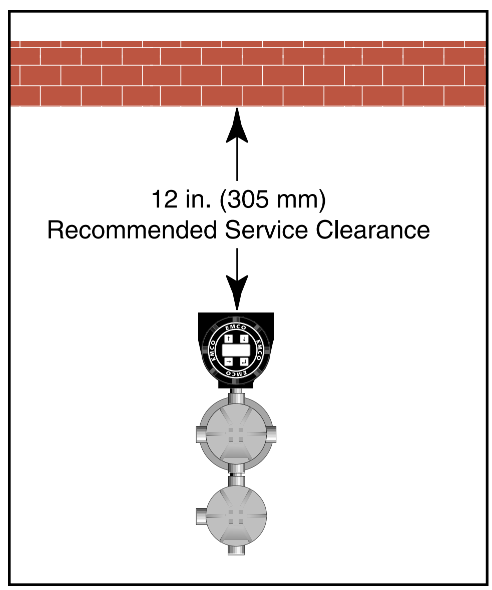


Figure 2-5. Overhead Clearance. *A minimum of 12 in. (305 mm) of overhead clearance is recommended for ease of installation.*

Section 3: Mechanical Installation

V-Bar-600/60S: Hot Tap Installation

A hot tap installation does not require process shutdown or line depressurization. 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 a permit.

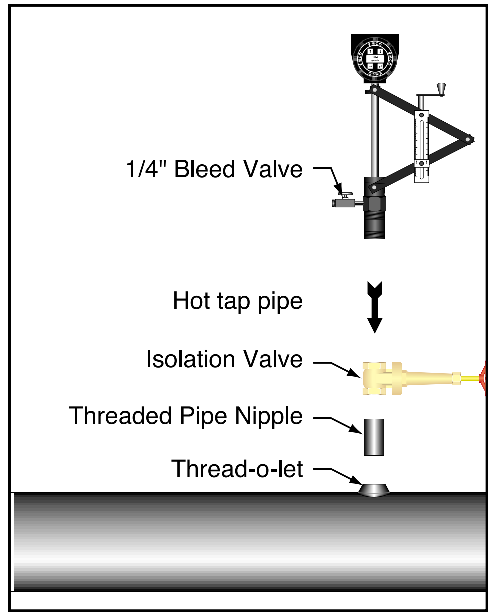


Figure 3-1. Hot Tap Installation for V-Bar-600/60S

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

Step 2. Attach the pipe nipple to the thread-o-let.

Step 3. Attach the 2" bronze, isolation valve to the pipe nipple. Install hot tap tool on to the isolation valve. Fully open the isolation valve. Hot tap pipe. Hole must be 1.875 inches in diameter. Close the isolation valve after hot tap tool has been retracted. Remove hot tap tool.

Step 4. Connect the flowmeter to the 2" isolation valve. Use teflon tape or PST on threads to improve seal and to prevent seizing. Verify that the ¼" bleed valve is completely closed. Fully open the 2" bronze, isolation valve. If the meter is supplied with a pressure transmitter, open the ¼" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

V-Bar-600/60S: Cold Tap Installation

A cold tap installation requires process shut down and line depressurization.

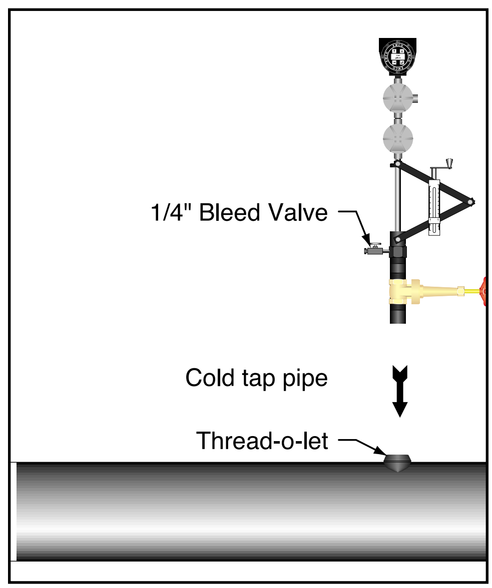


Figure 3-2. Cold Tap Installation for V-Bar-600/60S

Step 1. Tap pipe. Hole must be 1.875 inches in diameter.

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

Step 3. Connect the flowmeter to the thread-o-let. Use teflon tape or PST on threads to improve seal and to prevent seizing. Fully open the 2" bronze, isolation valve. If the meter is supplied with a pressure transmitter, open the ¼" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

V-Bar-600/60S: Insertion Depth Calculation

To properly position the sensor within the pipe, the scale reading must be calculated. The scale reading is the value to which the cursor points. The scale reading is equal to the insertion depth of the sensor. Use the following equation to calculate the scale reading:

$$\text{Scale Reading} = I + E + Wt$$

Where:

I = *For pipe sizes 10" and smaller*, pipe internal diameter ÷ 2
= *For pipe sizes 12" and larger*, 5"

E = The 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 = The thickness of the pipe wall, which can be determined by measuring the disk cut out of the pipe from the tapping procedure or obtained from a piping handbook.

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

I = 5"
E = 12.5"
Wt = 0.406"

Scale reading = I + E + Wt
Scale reading = 5" + 12.5" + 0.406 = 17.906"

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

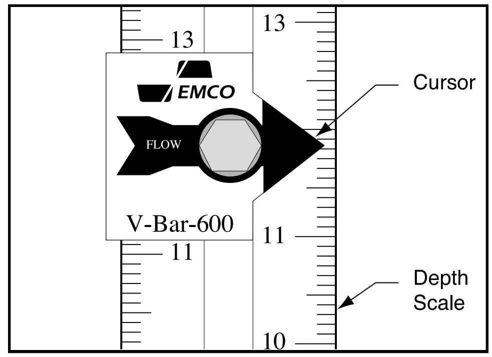


Figure 3-3. V-Bar-600/60S Scale Reading. *The scale reading is the value to which the cursor points. The scale reading is equal to the insertion depth for the sensor.*

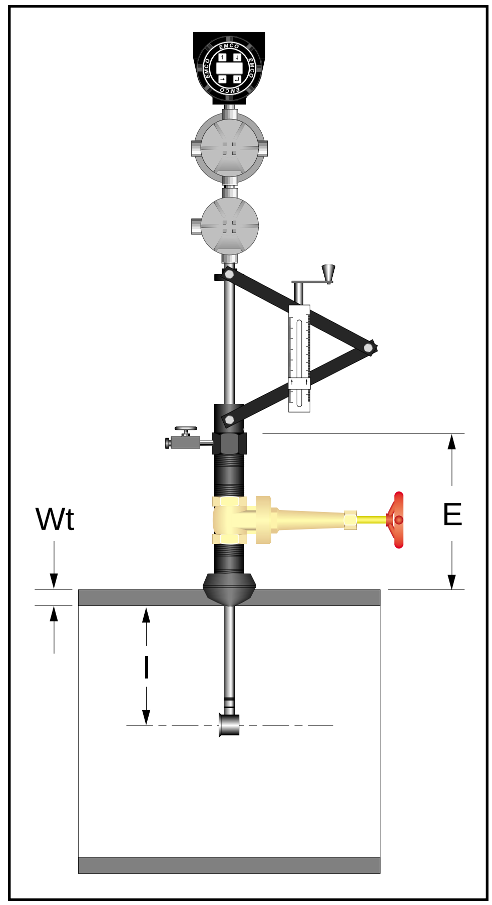


Figure 3-4. Insertion Depth Calculation for V-Bar-600/60S. *The insertion depth is equal to the sum of the measured values for I, E, and Wt.*

V-Bar-600/60S: Final Positioning

Carefully crank the retractor handle clock wise to insert the sensor down into the pipe until the calculated insertion depth Figure on the depth scale lines up with the cursor.

Caution: Do not force the stem into pipe. If the handle stops turning, retract and remove the meter from the pipe line. Verify that the hole is 1.875 inches in diameter and that the thread-o-let is centered on the hole.

Align the retractor bar assembly so that the flow direction arrow on the scale is parallel to the pipe and pointed downstream. (Figure 3-5).

Lock the stem in position by tightening the orientation set-screw. (Figure 3-6)

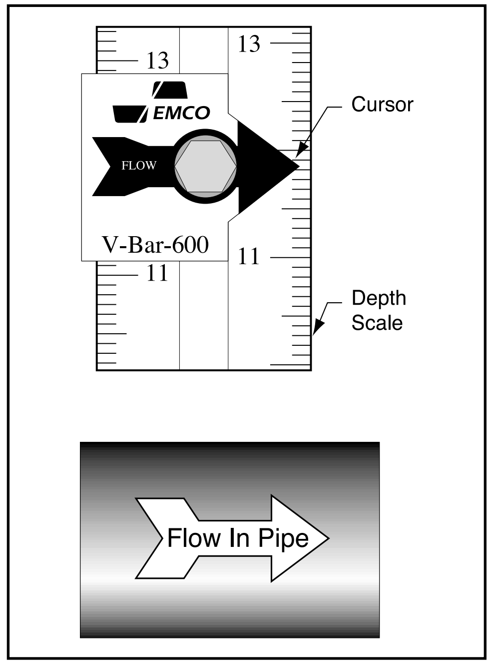


Figure 3-5. Flowmeter Orientation for V-Bar-600/60S. *Align the retractor bar assembly so that the flow direction arrow on the scale is parallel to the pipe and pointed downstream.*

V-Bar-700: Installation for 2" NPT connection

Installation requires process shutdown and line depressurization. (Figure 3-7)

Step 1. Tap pipe. Hole must be 1.875 inches in diameter.

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

Step 3. Retract the stem by manually pulling the orientation levers so that the retaining ring is just below the base of the stem housing. Attach meter to thread-o-let. Use teflon tape or PST on threads to improve seal and prevent seizing. If the meter is supplied with a pressure transmitter, open the ¼" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

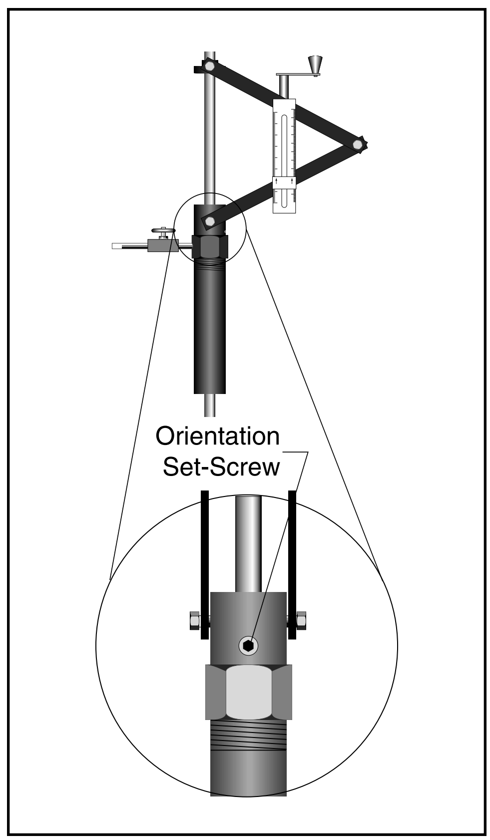


Figure 3-6. Orientation Set-Screw Location. *To lock the stem into position, tighten the orientation set-screw.*

V-Bar-700: Installation for Flanged Connection

Installation requires process shutdown and line depressurization. (Figure 3-8)

Step 1. Tap pipe. Hole must be 1.875 inches in diameter.

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

Step 3. Retract the stem by manually pulling the orientation levers so that the retaining ring is just below the base of the stem housing. Attach meter to weld neck flange. If the meter is supplied with a pressure transmitter, open the ¼" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

V-Bar-700: Insertion Depth Calculation

To properly position the sensor within the pipe, the insertion depth must be calculated. (See Figures 3-9 and 3-10). Use the following equation to calculate the insertion depth:

Insertion Depth = B = C – I – E – Wt

Where:

B = The insertion depth

C = The distance from the center of the sensor to the base of the condulet mount

I = *For pipe sizes 10" and smaller*, pipe internal diameter ÷ 2
= *For pipe sizes 12" and larger*, 5"

E = *For flanged connection*, the distance from the raised face of the flange to the outside pipe wall
= *For 2" NPT connection*, the distance from the top of the stem housing to the outside pipe wall

Wt = The thickness of the pipe wall, which can be determined by measuring the disk cut out of the pipe from the tapping procedure or obtained from a piping handbook

Example
A V-Bar-700 is to be installed on a 12" schedule 40 pipe. The following measurements have been obtained:

C = 13.25"
I = 5"
E = 4.5"
Wt = 0.406"

B = C – I – E – Wt
B = 13.25" – 5" – 4.5" – 0.406" = 3.344"

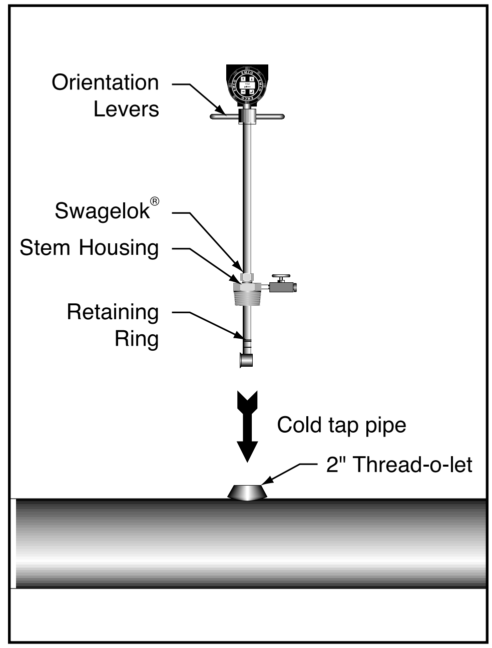


Figure 3-7. Installation for V-Bar-700 with 2" NPT Connection

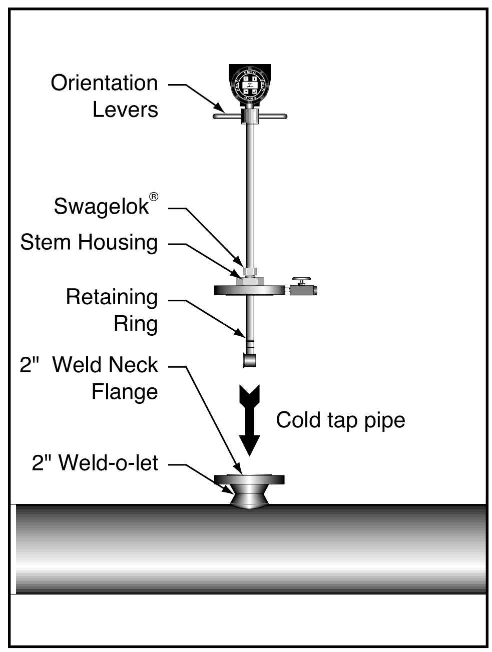


Figure 3-8. Installation for V-Bar-700 with Flanged Connection

V-Bar-700: Final Positioning

Manually insert the stem into the pipe until the calculated insertion depth is obtained. (Figure 3-11)

Caution: Do not force the stem into the pipe. If the stem insertion is blocked, retract and remove the meter from the pipe line. Verify that the hole is 1.875 inches in diameter and that the mounting connection is centered on the hole.

Align orientation levers so that they are parallel to the pipe with the flow direction arrow pointed downstream. (Figure 3-12)

Lock the stem in position by tightening the Swagelok™ fitting.

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.

Warning: Do not loosen the Swagelok fitting under pressure. Doing so may cause serious injury.

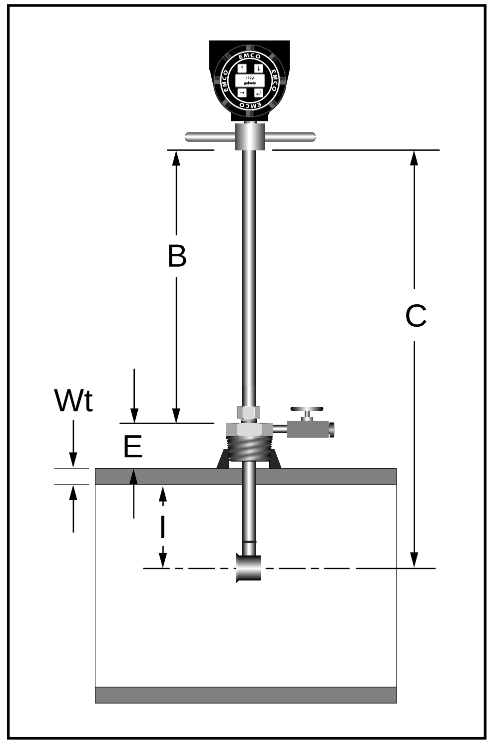


Figure 3-9. Insertion Depth Calculation for V-Bar-700 with 2" NPT Connection. *The insertion depth is equal to the sum of the measured values for C, I, E, and Wt.*

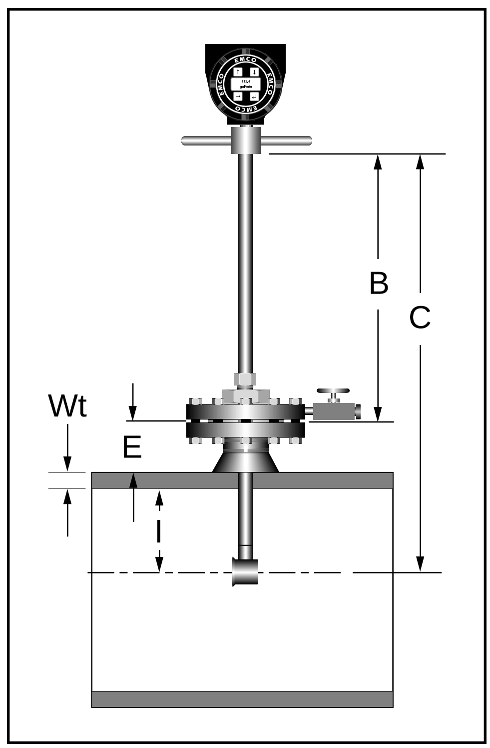


Figure 3-10. Insertion Depth Calculation for V-Bar-700 with Flanged Connection. *The insertion depth is equal to the sum of the measured values for C, I, E, and Wt.*

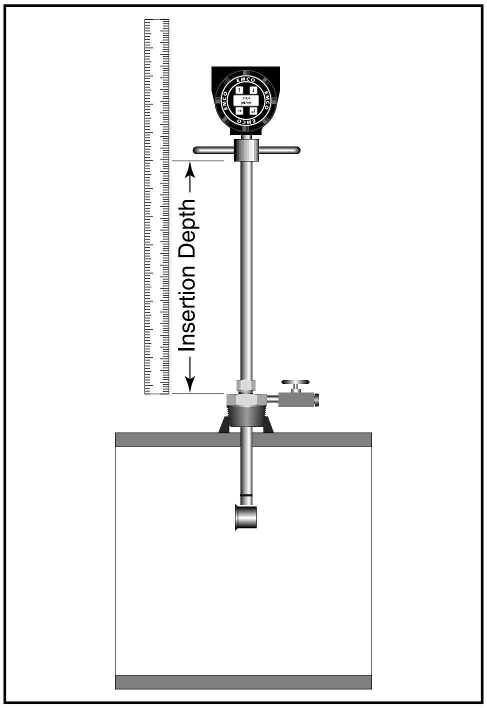


Figure 3-11. Final Positioning for V-Bar-700. *Manually insert the stem into the pipe until the calculated insertion depth is obtained.*

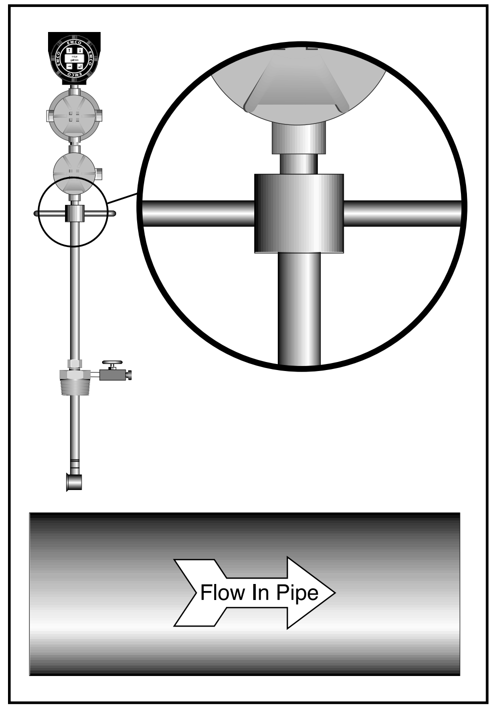


Figure 3-12. Flowmeter Alignment for V-Bar-700. *Align the orientation levers so that they are parallel to the pipe with the flow direction arrow pointed downstream.*

V-Bar-800/80S: Hot Tap Installation for Flanged Connection

A hot tap installation does not require process shutdown or line depressurization. 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. Stem will rise with line pressure; do not exceed 50 psig. (Figure 3-13)

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

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

Step 3. Attach isolation valve to weld neck flange. Install hot tap tool on to the isolation valve. Fully open isolation valve. Hot tap pipe. Hole must be 1.875 inches in diameter. Close isolation valve after hot tap tool has been retracted. Remove hot tap tool.

Step 4. Connect meter to isolation valve. Verify that the ¼" bleed valve is completely closed. Fully open isolation valve. If the meter is supplied with a pressure transmitter, open the ¼" bleed valve.

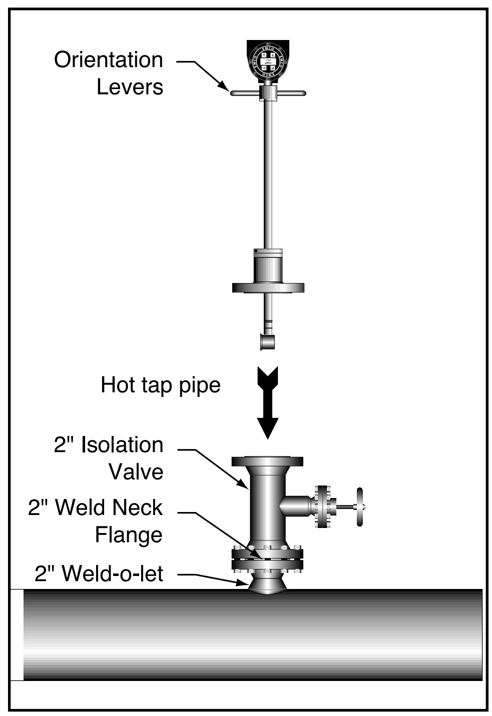


Figure 3-13. Hot Tap Installation for V-Bar-800/80S with Flanged Connection

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

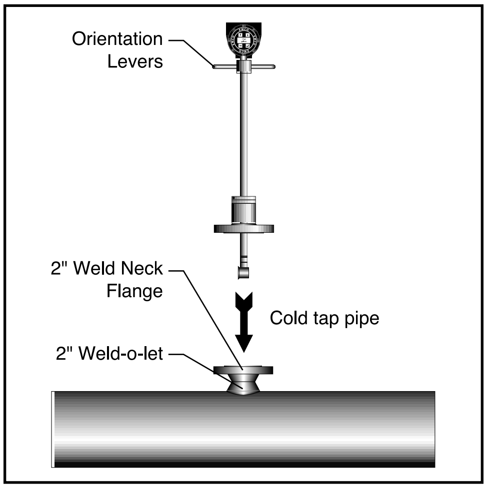


Figure 3-14. Installation for V-Bar-800/80S with Flanged Connection

V-Bar-800/80S: Cold Tap Installation for Flanged Connection

Cold tap installation requires process shutdown and line depressurization. (Figure 3-14)

Step 1. Tap pipe. Hole must be 1.875 inches in diameter.

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

Step 3. Connect meter to weld neck flange. If the meter is supplied with a pressure transmitter, open the ¼" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

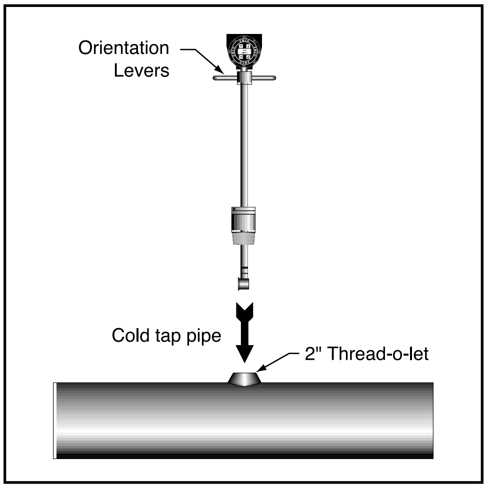


Figure 3-15. Installation for V-Bar-800/80S with 2" NPT Connection

V-Bar-800/80S: Cold Tap Installation for 2" NPT Connection

Cold tap installation requires process shutdown and line depressurization. (Figure 3-15)

Step 1. Tap pipe. Hole must be 1.875 inches in diameter.

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

Step 3. Connect meter to thread-o-let. Use teflon tape or PST on threaded mounting connections to improve seal and prevent seizing. If the meter is supplied with a pressure transmitter, open the ¼" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

V-Bar-800/80S: Insertion Depth Calculation

To properly position the sensor within the pipe, the insertion depth must be calculated. (See Figures 3-16 and 3-17) Use the following equation to calculate the insertion depth:

$$\text{Insertion Depth} = B = C - I - E - Wt$$

Where:

B = The insertion depth

C = Distance from the center of the sensor to the base of the condulet mount

I = *For pipe sizes 10" and smaller*, pipe internal diameter ÷ 2
= *For pipe sizes 12" and larger*, 5"

E = *For flanged connection*, the distance from the raised face of the flange to the outside pipe wall
= *For 2" NPT connection*, the distance from the top of the lock rings to the outside pipe wall

Wt = The thickness of the pipe wall, which can be determined by measuring the disk cut out of the pipe from the tapping procedure or obtained from a piping handbook

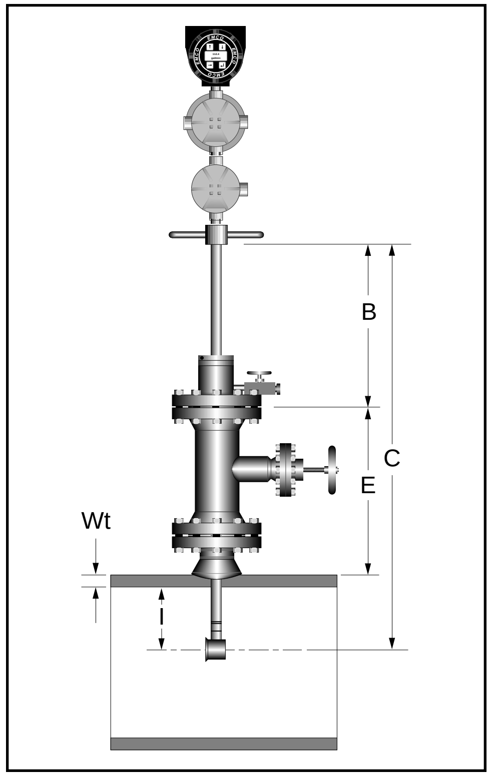


Figure 3-16. Insertion Depth Calculation for V-Bar-800/80S with Flanged Connection. *The insertion depth is equal to the sum of the measured values for C, I, E, and Wt.*

Example
A V-Bar-800/80S is to be installed on a 12" schedule 40 pipe. The following measurements have been obtained:

C = 25"
I = 5"
E = 4.5"
Wt = 0.406"

B = C – I – E – Wt
B = 25" – 5" – 4.5" – 0.406" = 15.094"

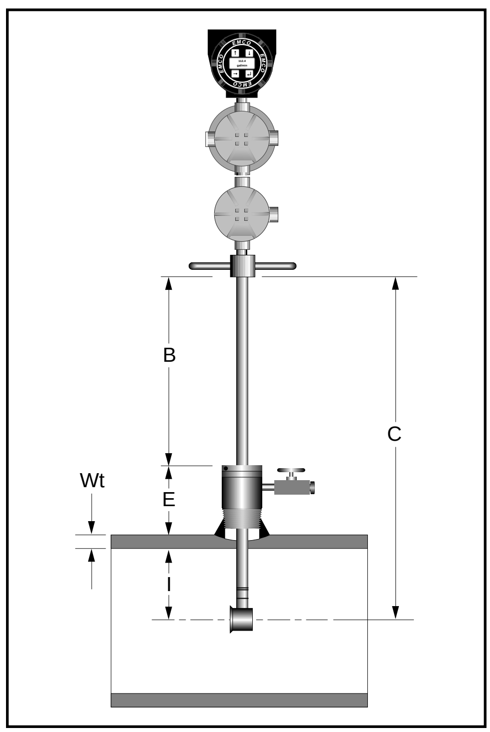


Figure 3-17. Insertion Depth Calculation for V-Bar-800/80S 2" NPT Connection. *The insertion depth is equal to the sum of the measured values for C, I, E, and Wt.*

V-Bar-800/80S: Final Positioning

Slightly loosen the two cap screws located in the two lock rings. (Figure 3-18)

Manually insert the stem into the pipe until the calculated insertion depth is obtained. (Figure 3-19)

⚠ ***Caution: Do not force stem into pipe. If the stem insertion is blocked, retract and remove the meter from the pipe line. Verify that the hole is 1.875 inches in diameter and that the mounting connections are centered on the hole.***

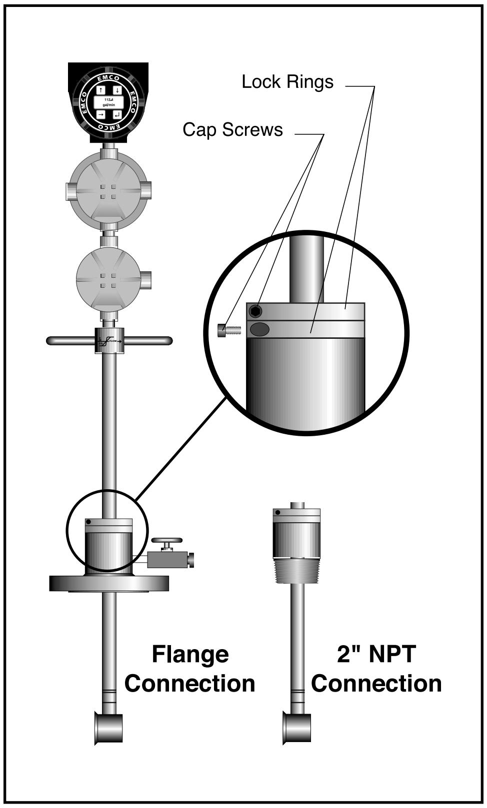


Figure 3-18. Cap Screw Location. *To lock the stem into position, tighten the cap screws located in the two lock rings.*

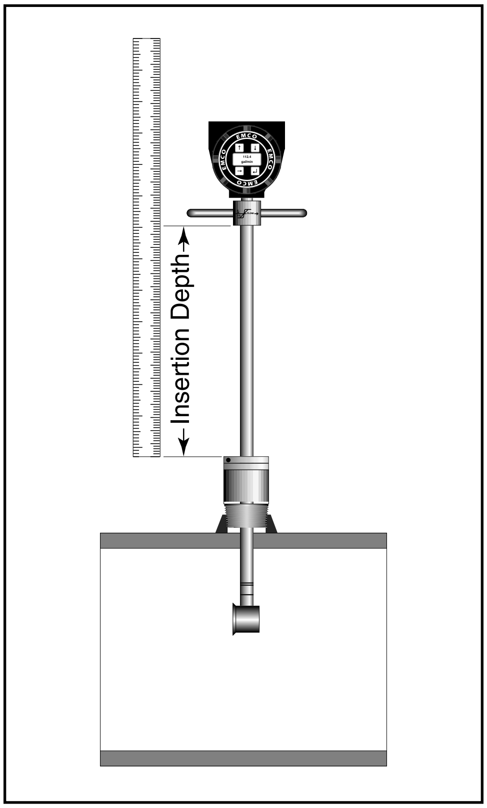


Figure 3-19. Final Positioning for V-Bar-800/80S. *Manually insert the stem into the pipe until the calculated insertion depth is obtained.*

Align orientation levers so that they are parallel to the pipe with the flow direction arrow pointed downstream. (Figure 3-20)

Lock the stem in position by tightening the two cap screws located on the two lock rings.

Note: Do not allow the orientation of the meter or the insertion depth to change after insertion is complete.

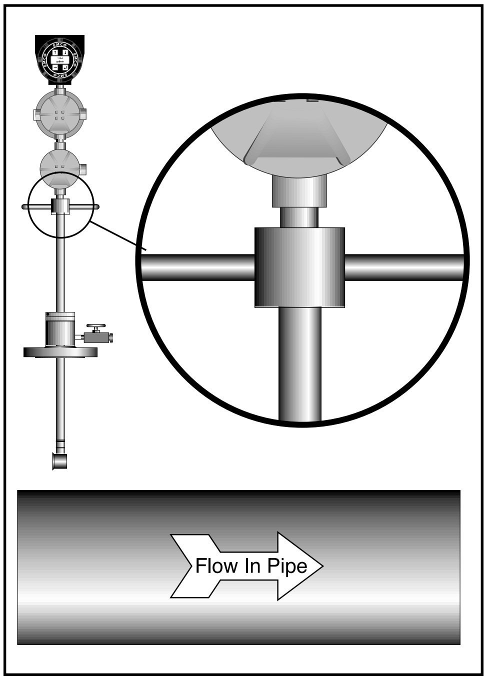


Figure 3-20. Flowmeter Alignment for V-Bar-800/80S. *Align the orientation levers so that they are parallel to the pipe with the flow direction arrow pointed downstream.*

V-Bar-910/960: Hot Tap Installation

A hot tap installation does not require process shutdown or line depressurization. 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. (Figure 3-21)

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

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

Step 3. Attach isolation valve to weld neck flange. Install hot tap tool on to the isolation valve. Fully open valve. Hot tap pipe. Hole must be 1.875 inches in diameter. Close isolation valve after hot tap tool has been retracted. Remove hot tap tool.

Step 4. Connect meter to isolation valve. Verify that the 1/4" bleed valve is completely closed. Fully open isolation valve. If the meter is supplied with a pressure transmitter, open 1/4" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

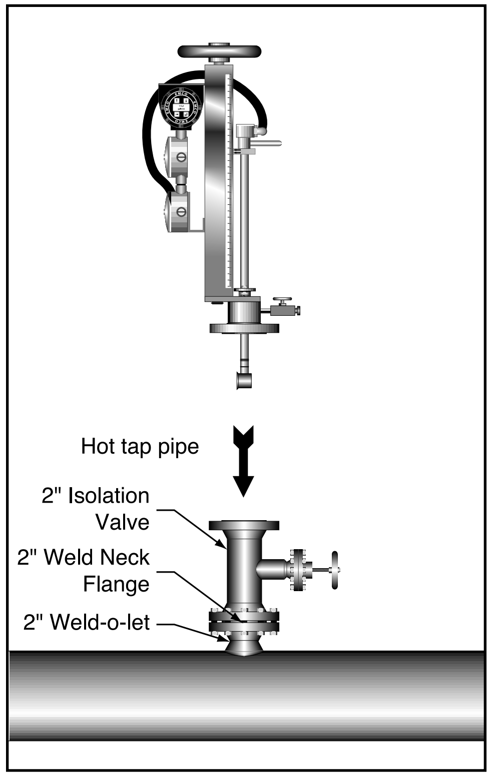


Figure 3-21. Hot Tap Installation for V-Bar-910/960

V-Bar-910/960: Cold Tap Installation

Cold tap installation requires process shutdown and line depressurization. (Figure 3-22)

Step 1. Tap pipe. Hole must be 1.875 inches in diameter.

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

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

Step 4. Connect meter to weld neck flange. If the meter is supplied with a pressure transmitter, open the 1/4" bleed valve.

To complete the mechanical installation, the sensor must be properly positioned in the pipe line. Follow the instructions for Insertion Depth Calculation and Final Positioning to complete the installation.

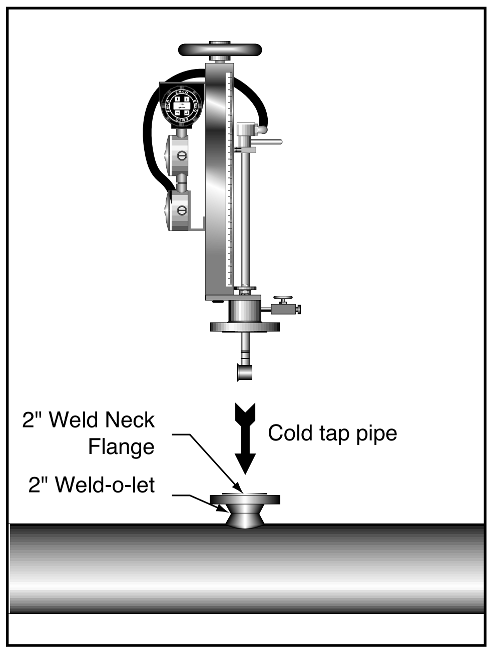


Figure 3-22. Cold Tap Installation for V-Bar-910/960

V-Bar-910/960: Insertion Depth Calculation

To properly position the sensor within the pipe, the scale reading must be calculated (Figures 3-23 and 3-24). The scale reading is the value to which the cursor should be pointing on the depth scale. Use the following equation to calculation the scale reading:

$$\text{Scale Reading} = I + E + Wt$$

Where:

I = *For pipe sizes 10" and smaller*, pipe internal diameter ÷ 2
= *For pipe sizes 12" and larger*, 5"

E = Distance from the raised face of the flange to the outside pipe wall

Wt = The thickness of the pipe wall which can be determined by measuring the disk cut out of the pipe from the tapping procedure. This number can also be obtained from a piping handbook.

Example

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

I = 5"
E = 12.5"
Wt = 0.406"

Scale reading = I + E + Wt
Scale reading = 5" + 12.5" + 0.406" = 17.906"

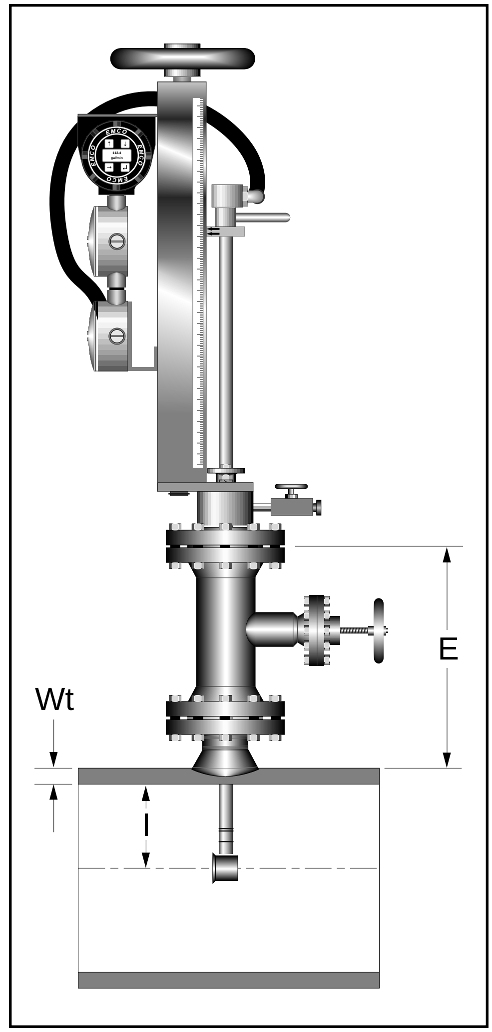


Figure 3-23. Insertion Depth Calculation for V-Bar-910/960. *The insertion depth is equal to the sum of the measured values for I, E, and Wt.*

V-Bar-910/960: Final Positioning

Loosen the two packing gland nuts on the stem housing of the meter. (Figure 3-25)

Turn handwheel clockwise to insert the stem into the pipe. Do so until the calculated scale reading lines up with the 1.0 arrow on the retractor bar assembly.

Caution: Do not force stem into pipe. If the stem insertion is blocked, retract and remove the meter from the pipe line. Verify that the hole is 1.875 inches in diameter and that the mounting connections are centered on the hole.

Align the sensor by using the orientation lever so that the flow direction arrow is parallel to the pipe and pointed downstream. (Figure 3-26)

Tighten the packing gland nuts to stop leakage around the stem. Do not torque over 25 ft/lb.

Lock the stem into position by tightening the orientation lock screw.

Note: Do not allow the orientation of the meter or the insertion depth to change after insertion is complete.

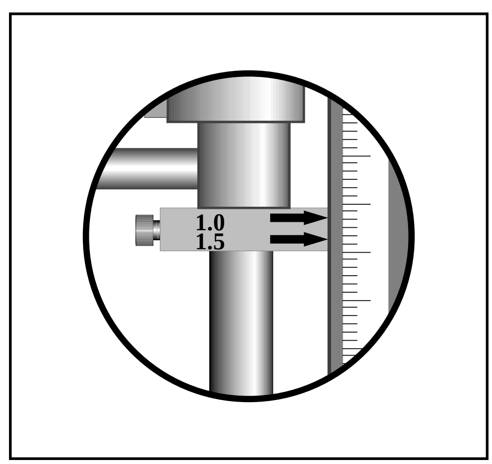


Figure 3-24. V-Bar-910/960 Scale Reading. *The scale reading is the value to which the 1.0 arrow points. The scale reading is equal to the insertion depth for the sensor.*

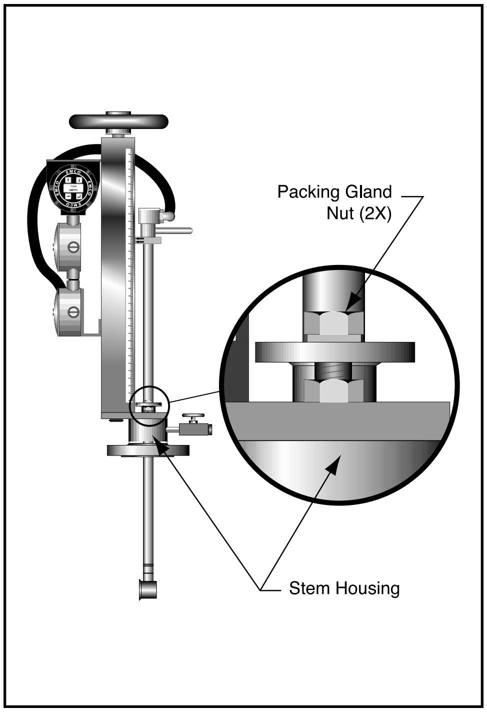


Figure 3-25. Packing Gland Nuts Location. *To lock the stem into position, tighten the packing gland nuts located above the stem housing.*

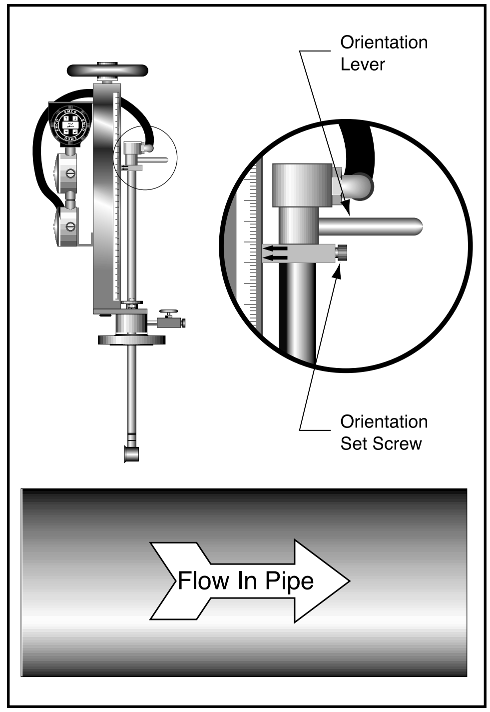


Figure 3-26. Flowmeter Orientation for V-Bar-910/960. *Align the orientation lever so that the lever is parallel to the pipe and pointed downstream.*

Section 4: Electrical Installation

Wiring and conduit must be installed in accordance with national, local laws, standards, codes, and industry practices to avoid personal injury or property damage from electrical shock, contact with live electrical systems, or ignition of combustible material or explosive gases, which can be ignited by electrical arcing.

Hardware Configuration

The flowmeter hardware is factory configured for each specific application. Additional configuration should not be required unless your application changes. Jumper position JP3 selects fluid type. JP3 should be installed for gas applications and removed for liquid applications. The installation of jumpers JP1 and JP2 on the filter board control the output selection. Jumper positions JP1 and JP2 indicate pulse output configuration. JP1 is installed at the factory. These jumpers are located on the filter board (the base board of the electronic stack). See figure 4-1.

To configure jumpers, access the filter board, located in the flow transmitter condulet. To access the filter board, see Electronics Removal in Section 6: Troubleshooting and Maintenance.

Mounting Electronics

Electronics can be ordered for either integral or remote mounting. With integral mounting, the sensor and electronics are manufactured as one unit. The ambient temperature must be less than 140 °F for integral mounting.

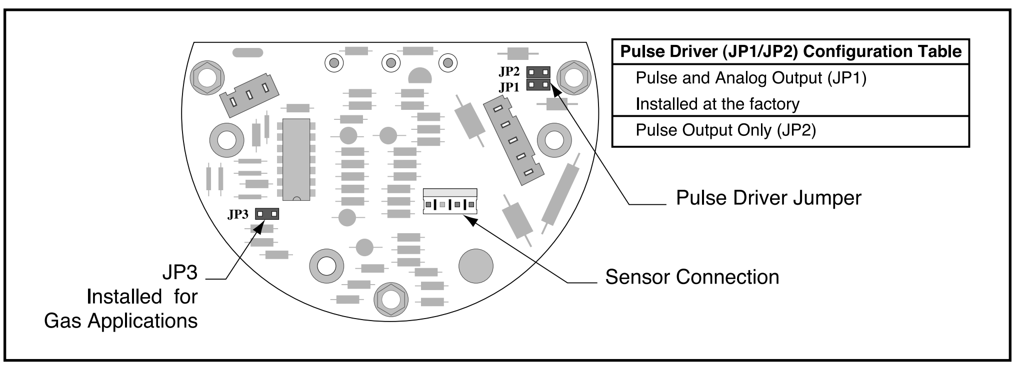


Figure 4-1. Filter Board for V-Bar™

With remote mounting, the electronics are manufactured as a unit separate from the flow sensor. Remote electronics can be mounted on either a pipe or a wall. The distance between the sensor and the electronics must not exceed 50 feet (17 meters). If remote mounting is specified in an order, EMCO supplies 30 feet of cable and pipe mounting clamps.

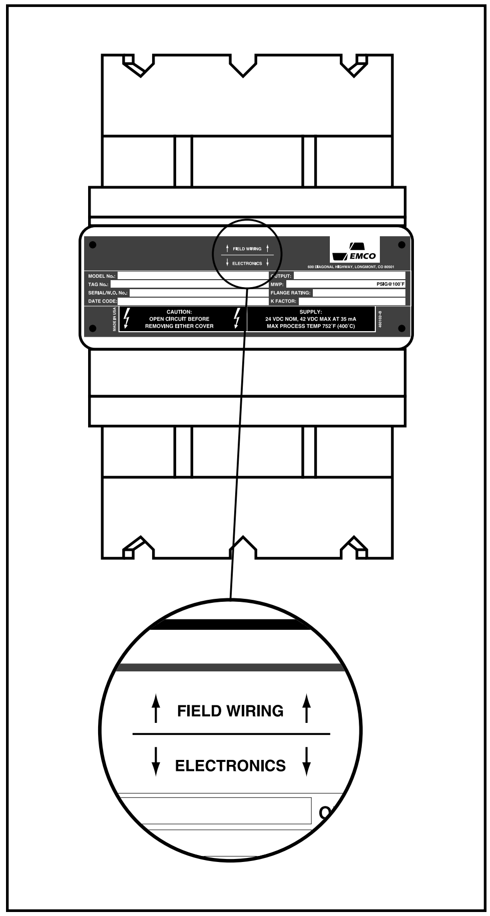


Figure 4-2. Field Wiring Access

Field Wiring Access

Remove the field wiring condulet cap to access the field wiring terminal block for power and signal wiring. (Figure 4-2)

Grounding the Meter

To ensure proper electrical noise rejection, connect ground strap (size 8 AWG or larger wire) from the ground screw attached to the outside of the electronics enclosure to a known earth ground (not the pipe). (Figure 4-3)

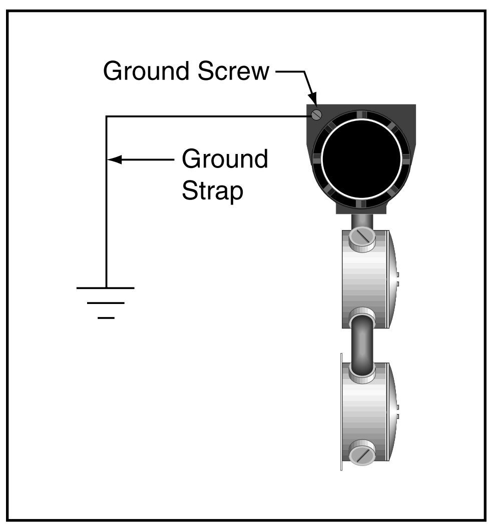


Figure 4-3. Ground Screw Location

VAC Power Supply

The V-Bar may be operated using a 24 volt power supply. For proper power and signal wiring, shielded cable should be at least 18 AWG or larger. Connect shield wire from shielded cable to earth ground at power supply. Insulate other end of shield wire from electrical condulet at the meter. (Figure 4-4)

VAC Power: Analog Output
(JP1 installed or no jumpers)

Scalable 4–20 mA output, 2-wire principle. Load resistor may be installed on supply or return line. V_s = 18 to 40 VAC. (Maximum voltage is 30 VAC with pressure transmitter option.) Permissible load resistance values shown are in the graph below. (Figure 4-5)

VAC Power:
Pulse Output Only
(JP2 installed)

This option is for pulse output only using a low impedance electromechanical counter. V_{pulse} will vary from 0-1 V to $V_s\{R_c/(R_c+6800)\}$. (Figure 4-6)

VAC Power:
Pulse Output Only
(No Jumpers)

This is an open collector pulse output using a high impedance electronic counter. V_{pulse} will vary from 0-1 V to $V_s\{R_c/(R_c+R_{pulse})\}$. (Figure 4-7)

VAC Power:
Pressure and Temperature Transmitter Wiring

Remove the field wiring condulet cap to access the field wiring terminal block for power and signal wiring. Flow, pressure, and temperature output wiring connects to the terminal block. Refer to the previous section on 24 VAC power and signal wiring for appropriate load resistance and power supply values. Pressure and temperature transmitters

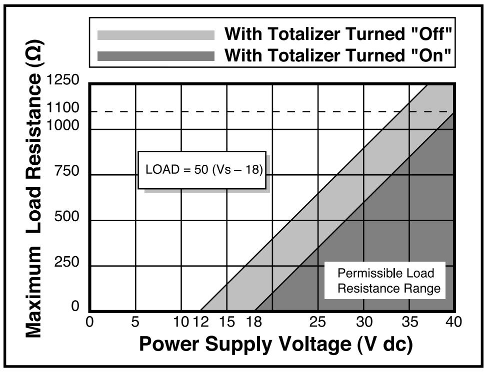


Figure 4-4. Load Resistance Graph for VAC Power with Analog Output

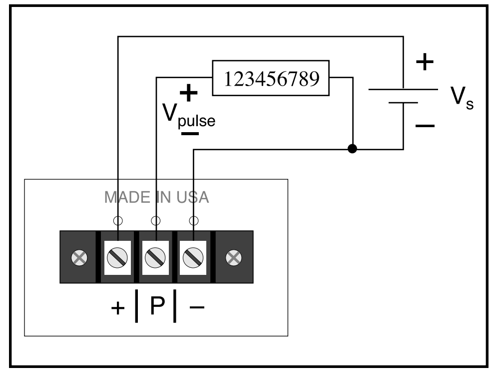


Figure 4-6. Wiring Diagram for Pulse Output with VAC Power (JP2 jumper installed)

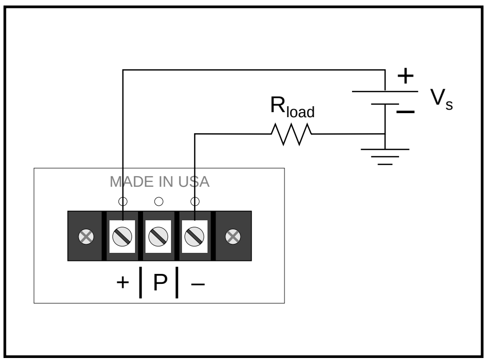


Figure 4-5. Wiring Diagram for Analog Output with VAC Power (JP1 jumper or no jumpers installed)

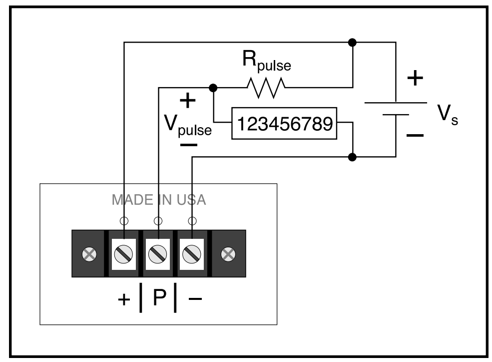


Figure 4-7. Wiring Diagram for Pulse Output with VAC Power (no jumpers installed)

For all equations:

V_{pulse}	=	**output voltage**
V_s	=	**power supply voltage: 18 to 40 VAC (30 VAC maximum with pressure transmitter option)**
V_c	=	**minimum required voltage to trip counter**
I	=	**current (4–20 mA)**
R_{load}	=	**load resistance**
R_c	=	**counter impedance**

$$R_c \geq 6800\left(\frac{V_c}{V_s - V_c}\right)$$

$$R_{pulse} \geq \left(\frac{V_s}{0.16}\right)$$

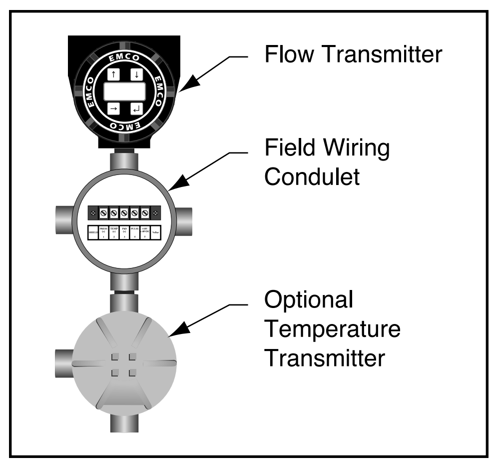


Figure 4-8. Field Wiring Condulet Location

are scaled to the appropriate ranges at the factory. (Figure 4-8)

Note: Maximum voltage with optional pressure transmitter is 30 VAC and 110 VAC power supply is not available with pressure and/or temperature transmitters.

For all equations:

V_{pulse}	=	output voltage
V_s	=	power supply voltage: 110/220 VAC
V_c	=	minimum required voltage to trip counter
I	=	current (4–20 mA)
R_{load}	=	load resistance
R_c	=	counter impedance

$$R_c \geq 6800\left(\frac{V_c}{V_s - V_c}\right)$$

$$R_{pulse} \geq \left(\frac{V_s}{0.16}\right)$$

Wiring with analog output

See Figure 4-9.

Wiring with pulse output

See Figure 4-10.

where:

V_s = Power supply: 18 to 30 VAC
R_p= Pressure measuring resistance
R_T= Temperature measuring resistance
R_F= Flow rate measuring resistance

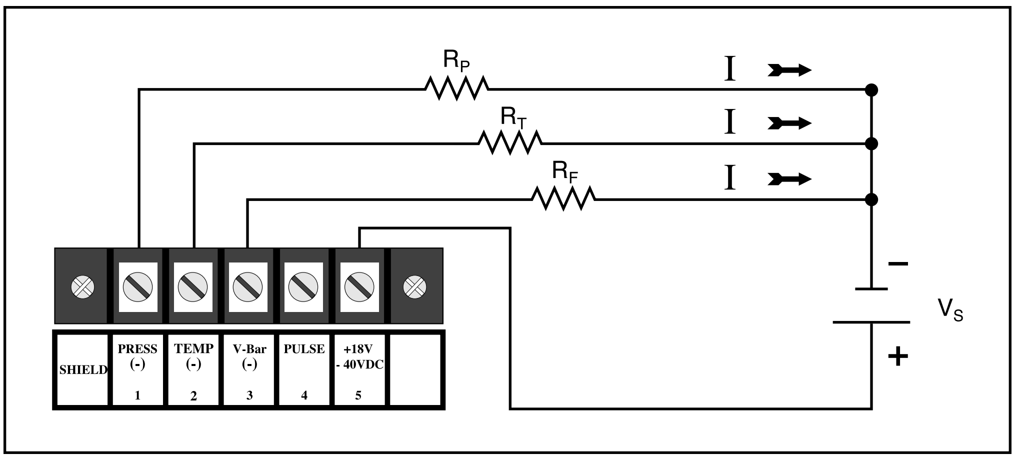


Figure 4-9. Wiring Diagram for Pressure and Temperature Transmitter with Pulse Output and VAC Power

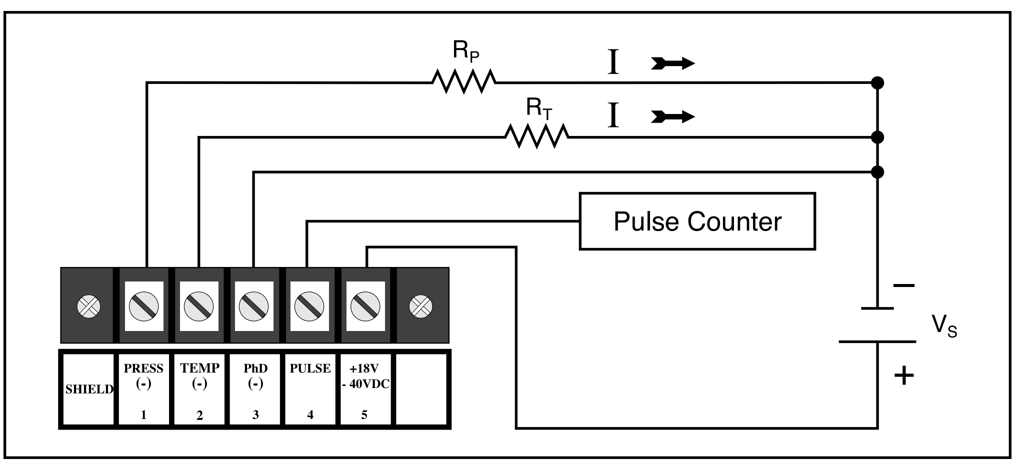


Figure 4-10. Wiring Diagram for Pressure and Temperature Transmitter with Analog Output and VAC Power

VAC Power Supply

The V-Bar may be operated using 110 VAC power supply. The power supply converts the 110 VAC to 24 VAC.

VAC Power: Analog Output (JP1 installed or no jumpers)

Scalable 4–20 mA output, 2-wire principle. Load resistor may be installed on supply or return line. R_{load} must be less than 300 Ω.

VAC Power: Pulse Output Only (JP2 installed)

This option is for pulse output only. V_{pulse} will vary from 0-1 V to $24\{R_c/(R_c+6800)\}$.

Remote Wiring

Output wiring from remote electronics is identical to output wiring from integral electronics. Wiring from the remote electronics condulet to the electrical junction box must be performed in the field. Connect the remote cable to the terminal block in the junc-

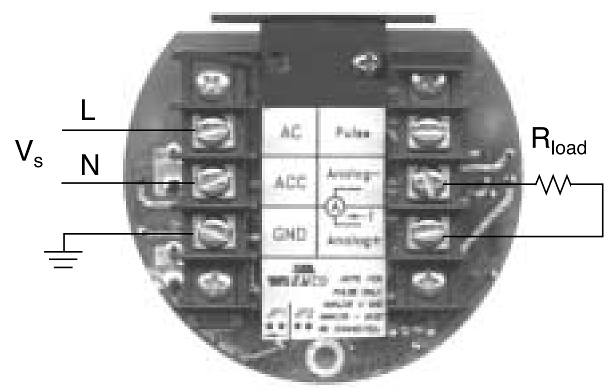


Figure 4-11. Wiring Diagram for Analog Output with VAC Power

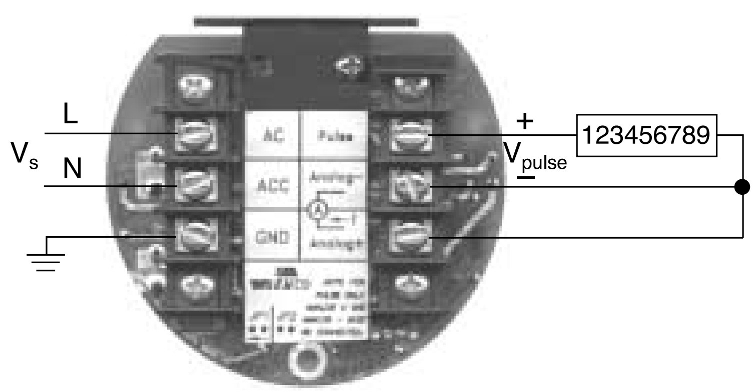


Figure 4-12. Wiring Diagram for Pulse Output with VAC Power (JP2 jumper installed)

tion box as shown. If nonconductive conduit is used, attach a ground strap from the ground screw on the remote electronics condulet. If the remote cable is cut to a shorter length, insulate shield with tape at electrical junction box. (Figure 4-13)

Note: If remote mounting is required with a pressure and/or temperature transmitter, two power supplies are required for operation: one for the remote flow transmitter and one for the pressure and/or temperature transmitter.

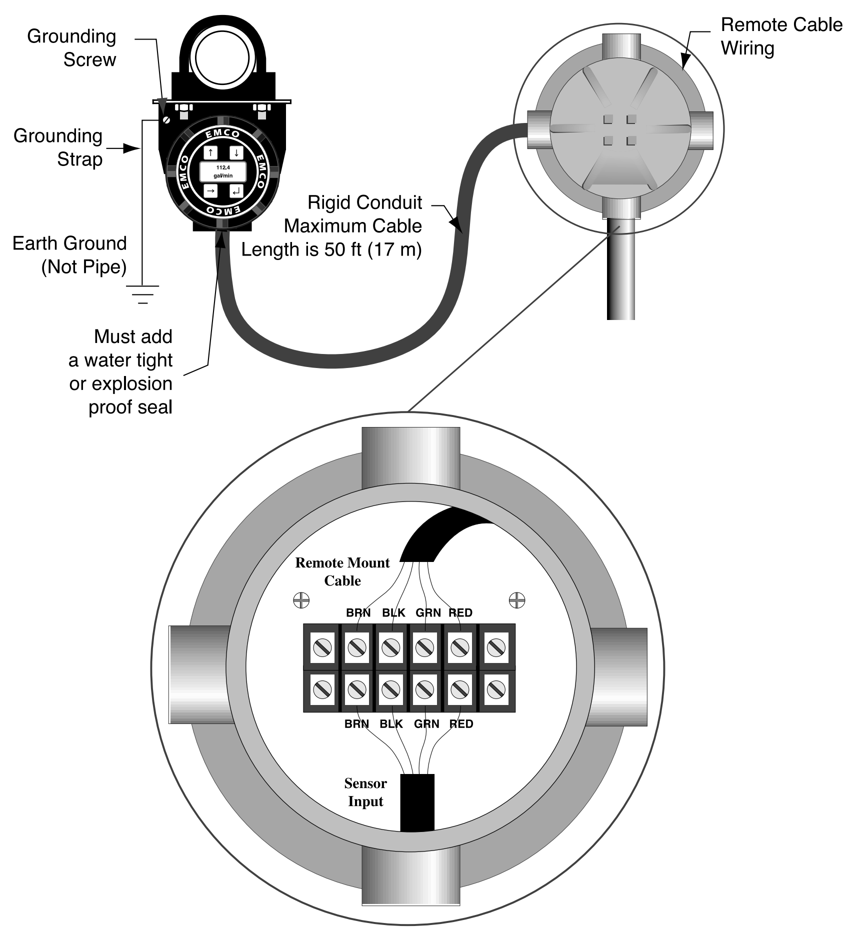


Figure 4-13. Wiring Diagram for Remote Mounted Electronics

Remote Electronics

with 4-20 mA Pressure and 4-20 mA Temperature

See Figure 4-14.

with 4-20 mA Pressure and RTD

See Figure 4-15.

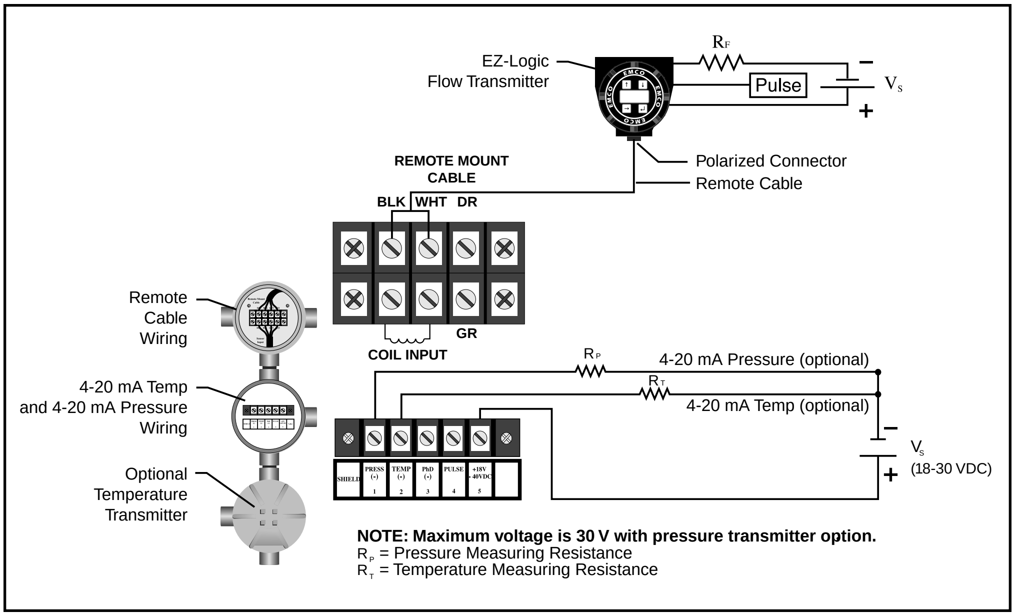


Figure 4-14. Wiring Diagram for Pressure and Temperature Transmitter with Remote Mount Electronics

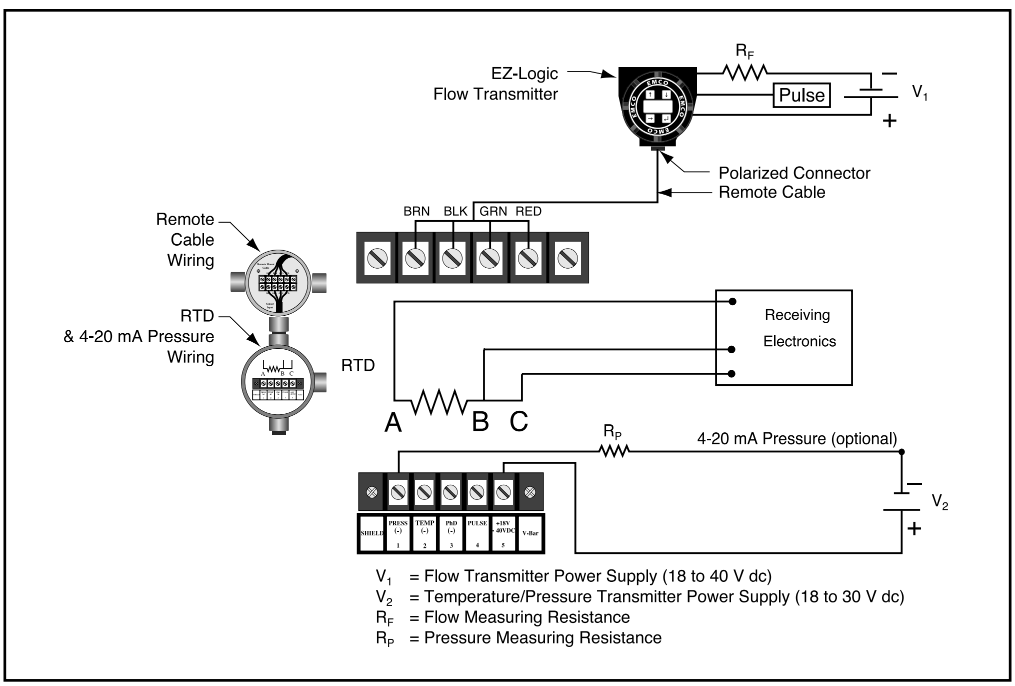


Figure 4-15. Wiring Diagram for Pressure Transmitter and RTD with Remote Mount Electronics

Section 5: EZ-Logic Programming

Introduction to EZ-Logic

EZ-Logic is a menu driven user interface. It consists of the top display menu and nine programming submenus, which are grouped by functionality. The submenu groups are:

The ConFigure group, which configures the flowmeter for operation in a specific application and includes:

- The Basic Menu
- The Output Menu
- The Fluid Menu
- The Sensor Menu

The Diagnose group, which contains information relating to flowmeter maintenance and includes:

- The Reset Menu
- The Service Menu

The Personalize group, which allows the user to customize the flowmeter by choosing display parameters or changing the password and includes:

- The Password Menu
- The HART Menu
- The Display Menu

Each group has it's own icon, ConFigure "**C**", Diagnose "**D**", and Personalize "**P**", which appears in the upper or lower right hand corner of the display. The user can identify the location within the interface map from the displayed icon.

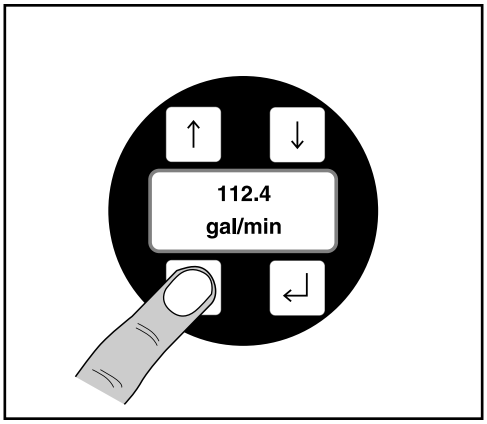


Figure 5-1. Manual Manipulation of the Keypad. *Remove the condulet cap and depress the membrane keys using your fingers.*

Keypad Activation

The keypad can be manipulated by either removing the condulet cap and depressing the membrane keys using your fingers or using the magnet wand to activate the keys through the condulet cap, without sacrificing the explosion proof rating. To activate keys, place magnet wand on the targeted area and remove. (Figures 5-1 and 5-2)

Note: The magnet wand is only supplied as a standard tool with the explosion proof meters.

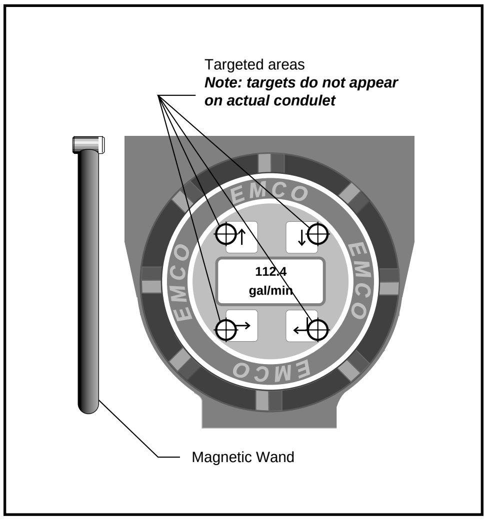


Figure 5-2. Magnetic Manipulation of the Keypad. *Activate the keys without removing the condulet cap by placing the magnetic wand on the target areas shown.*

Caution: Do not place magnet wand near magnetically sensitive items such as: credit cards, card key, etc.

Movement Through the Interface

The interface was designed to be simple. For example, to go right across the submenu headings press the right arrow key [→].

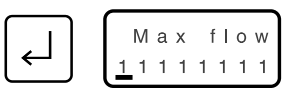
To move up or down through each submenu use the down [↓] or up [↑] arrow keys.

Note: Each submenu is setup as a loop. Once you reach the bottom (using the down arrow key) depressing the same key will move you to the column heading.

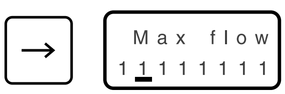
The enter key [↵] is used to exit the programming submenus.

How to Alter Real Number Data

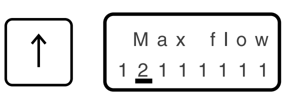
To alter data in a selected block, press the enter key. A cursor will appear under the first digit. The blinking icon will disappear when altering data.

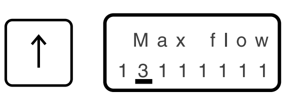


To move the cursor to the desired digit, press the right arrow key .

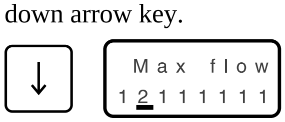


To increase the value of the digit, press the up arrow key. Possible values for each position are: 0–9, blank space, or a decimal point.





To decrease the value of the digit, press the down arrow key.



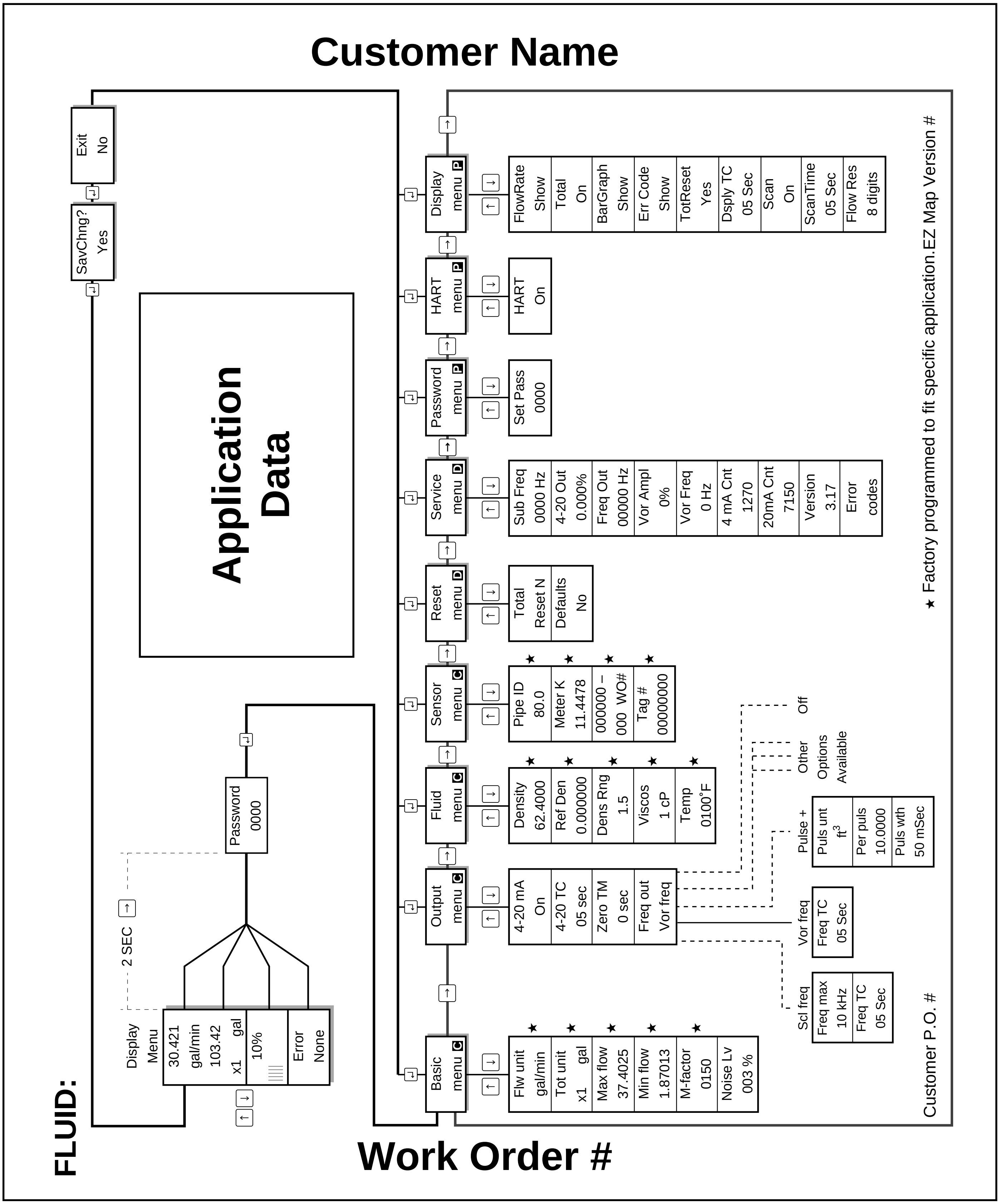


Figure 5-3. EZ-Logic Interface Map

After the desired alterations are made, press the enter key to store the new value. The blinking icon will reappear.

↵

```
Max floC
12111111
```

How to Alter Preset Data

```
Flw uniC
gal/min
```

To alter data in a selected block, press the enter key. A cursor will appear. The blinking icon will disappear when altering data.

↵

```
Flw unit
_ gal/min
```

To change the volume unit, press the up key.

↑

```
Flw unit
_ bbl/min
```

To change the time unit, press the down key.

↓

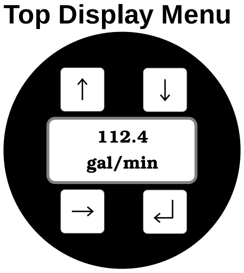
```
Flw unit
_ bbl/hr
```

After desired alterations are made, press the enter key to store the new units. The blinking icon will reappear.

↵

```
Flw uniC
bbl/hr
```

Top Display Menu



The top display menu appears when the meter is powered up. The display menu scans through four screens. The screens are:

Flow Rate

Continuously displays the actual flow rate in the units selected in the Flow Unit screen in the Basic Menu.

```
0.0
gal/min
```

Totalized Flow

Continuously displays totalized flow in the units selected in the Totalizer Unit screen in the Basic Menu.

```
196580
X10  gal
```

Bar Graph

Displays the percentage of full scale flow and a corresponding bar graph.

```
45%
||||||
```

Error Code

The electronics monitor and record several possible errors that may occur during operation. Push right arrow key to scroll through errors. See Section 6: Troubleshooting and Maintenance for error codes.

```
Error
code 1
```

Accessing Programming Submenus

To enter the programming submenus, press the right arrow key for 2 seconds. Enter the correct password. If the correct password is entered, the display will read “Full Access.” If an incorrect password is entered, the display will read “Read Only” and the user will not be able to alter the programming. (Figure 5-4)

Note: The flowmeter ships from the factory without a password; “Full Access” will automatically be permitted until a password is entered. See the Set New Password screen in the Password Menu to enter a password.

Note: While accessing the programming submenus, the meter will be “off line.” The last values of the totalizer and the flow rate will be stored until the meter is returned to the display menu.

The Basic Menu

```
Basic
↓ menu C
```

Flow Unit

Sets the units for the displayed flow rate and for setting the maximum and minimum flow for scaling the 4-20 and frequency/pulse outputs. Press the up arrow key to scroll through the volume units. Possible flow units: gallons, bbl, cm^3, liters, m^3, lb, tons, grams, kilograms, metric tons, standard ft^3, normal m^3, ft^3, and in^3. Press the down arrow key to scroll through time units. Possible time units: minutes, hours, days, and seconds.

```
Flw unit
gal/min
```

Totalizer Unit
Sets the units for the displayed totalized flow. Select a multiplier to slow the counting of the totalizer. Press the up arrow key to scroll through multipliers. Possible multipliers: x1, x10, x100, x10^3. Press the down arrow key to scroll through units. Possible units: gallons, bbl, cm^3, liters, m^3, lb, tons, grams, kilograms, metric tons, standard ft^3, normal m^3, ft^3, and in^3.

```
Tot unit
1X   gal
```

Maximum Flow
Maximum flow is entered in the units programmed in the Flow Unit screen. This value sets the 20 mA point for the analog output and the maximum frequency for the scaled frequency output.

```
Max flow
 37.4025
```

Minimum Flow
Minimum flow is entered in the units programmed in the Flow Unit screen. This value sets the cutoff point, below which the analog output drops to 4 mA and/or the scaled frequency output drops to 0 Hz. This value

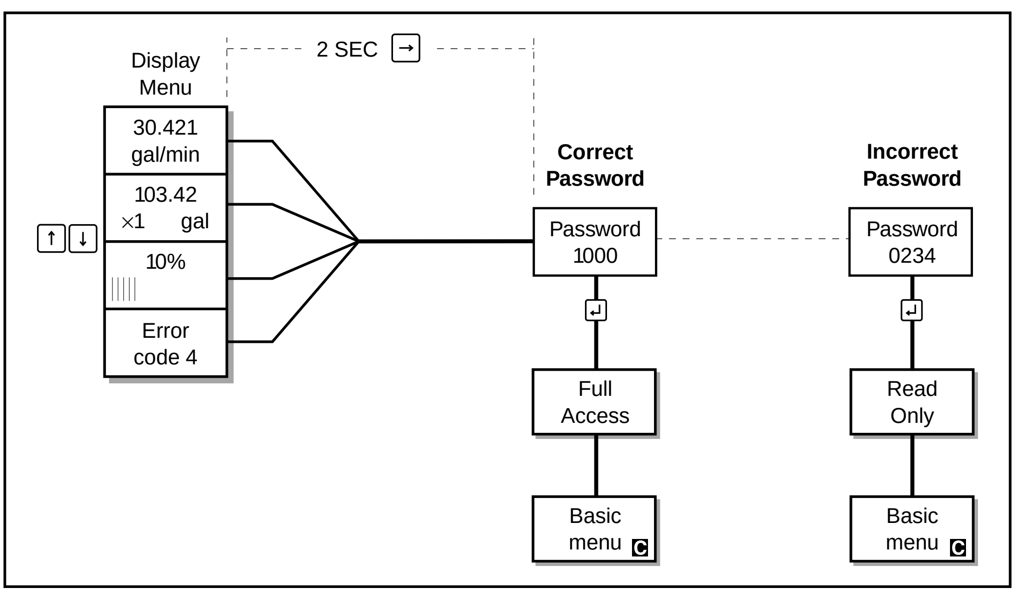


Figure 5-4. Password Access to Submenus

can not be programmed below the published minimum flow rate of the meter.

```
Min flow
 1.87013
```

M-Factor

M–factor is a value that sets the signal input filter. The nominal M–factor for all V-Bar flowmeters is 150.

```
M-factor
  0150
```

Noise Level

Sets the no flow cutoff level. If the input signal level drops below this value, the meter will not output or display a flow rate. The Noise Level can be set from 1-100%. 0% represents no flow, 100% represents 100% of the meter's maximum flow, not the maximum flow for specific application which is programmed in the Basic Menu.

```
Noise Lv
  010 %
```

Caution: An automatic Noise Level setting should be performed only at no flow conditions.

To perform an automatic Noise Level setting, select a value of 000. After 5 seconds, the meter will calculate the new value. For best results, auto set the noise level with any pumps on and any downstream valve closed.

The Output Menu

```
   Output
↓   Menu   C
```

Analog Output

Linear analog output set by minimum and maximum flow. Toggle on/off with the up and down arrow keys. (Figure 5-5)

```
4-20 mA
  On
```

Analog Output Time Constant

Dampens the analog output. Possible time constants: from 0 to 99 seconds.

```
4-20 TC
05 sec
```

Output Zero Time

Sets the number of seconds before analog output drops to 4 mA and the scaled frequency output drops to 0 Hz after the actual flow drops below the programmed minimum flow.

```
Zero TM
 0 sec
```

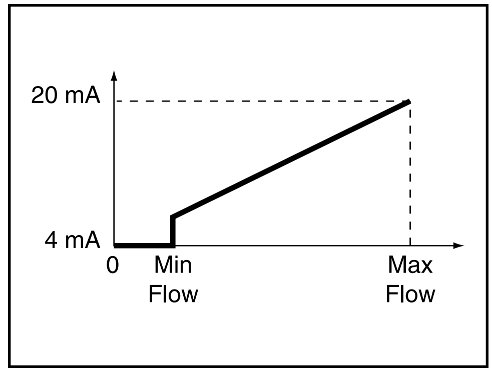


Figure 5-5. Linear Analog Output

Frequency/Pulse Output Setup

Selects the type of Frequency/Pulse output. Possible output options: Scaled Frequency, Vortex Frequency, Direct Frequency, Pulse –, Pulse +, and Transition.

```
Freq out
00000  Hz
```

To disable the frequency/pulse output, select “off.” The remainder of the Output menu will change based on the output option selected. Refer to the EZ-Logic Map.

Note: When connecting the V-Bar to the flow processor, select Vortex Frequency as the output option.

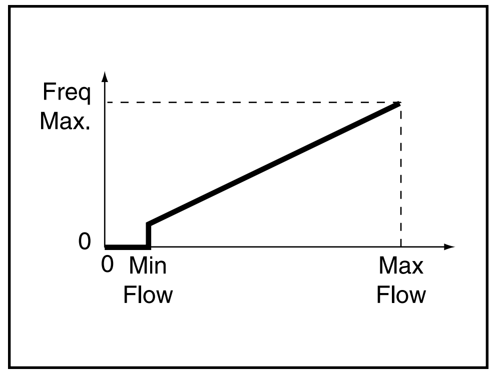


Figure 5-6. Linear Scaled Frequency Output

Scaled Frequency Output

The output frequency is a linear output scaled between minimum and maximum flow. (Figure 5-6)

```
Freq out
00000  Hz
```

Maximum Output Frequency

Sets the maximum output frequency. Possible settings: 500 Hz, 1kHz, 3 kHz, 5 kHz, or 10 kHz.

```
Freq max
 10 kHz
```

Frequency Output Time Constant

Dampens the frequency output. Possible time constants: from 0 to 99 seconds.

```
Freq TC
 05 sec
```

Vortex Frequency Output

The output frequency is equal to average pipe velocity (1 Hz = 1 ft/s). Use this output when connecting to a flow processor. The flow processor's programmed K-factor should be 1/Area (ft^2).

```
Freq out
Vor freq
```

Frequency Output Time Constant

Dampens the frequency output. Possible time constants: from 0 to 99 seconds. Default is 5 seconds.

```
Freq TC
  05 sec
```

Direct Frequency Output

The output frequency is the true shedding frequency at the sensor head. This is an instantaneous representation of the flow. The local velocity may be calculated using the following equation: Velocity(ft/s) = Frequency/K-factor

```
Freq out
Direct
```

Pulse –

The output frequency is one negative pulse for each time the totalizer increments. The totalizer increment is set in the Per Pulse and Pulse Unit screens.

```
Freq out
Pulse –
```

Per pulse

Sets the amount of fluid that passes through the meter per pulse.

```
Per puls
  10,000
```

Pulse Unit

Possible units: gallons, bbl, cm^3, liters, m^3, lb, tons, grams, kilograms, metric tons, standard ft^3, normal m^3, ft^3, and in^3. Possible multipliers: $\times1$, $\times10$, $\times100$, $\times10^3$.

```
Puls unt
  ft³
```

Pulse Width

Possible pulse width settings: 5 msec, 50 msec, 500 msec, 1 sec, 5 sec. Programmed pulse width must be less than actual output signal pulse width at maximum flow rate.

```
Puls wth
50 mSec
```

Pulse +

The output frequency is one positive pulse for each time the totalizer increments. The totalizer increment is set in the Per Pulse and Pulse Unit screens.

```
Freq out
Pulse +
```

Per pulse

Sets the amount of fluid that passes through the meter per pulse.

```
Per puls
 10,000
```

Pulse Unit

Possible units: gallons, bbl, cm^3, liters, m^3, lb, tons, grams, kilograms, metric tons, standard ft^3, normal m^3, ft^3, and in^3. Possible multipliers: ×1, ×10, ×100, $\times 10^3$.

```
Puls unt
   ft³
```

Pulse Width

Possible pulse width settings: 5 msec, 50 msec, 500 msec, 1 sec, 5 sec. Programmed pulse width must be less than actual output signal pulse width at maximum flow rate.

```
Puls wth
50 mSec
```

Transition

The output frequency is one transition from low state to high state for each time totalizer increments. The increment is set in the Per Pulse and Pulse Unit screens.

```
Freq out
Transit
```

Per Pulse

Sets the amount of fluid that passes through the meter per pulse.

```
Puls unt
ft³
```

Pulse Unit

Possible units: gallons, bbl, cm^3, liters, m^3, lb, tons, grams, kilograms, metric tons, standard ft^3, normal m^3, ft^3, and in^3. Possible multipliers: $\times 1$, $\times 10$, $\times 100$, $\times 10^3$.

```
Puls wth
50 mSec
```

The Fluid Menu

```
   Fluid
↓  Menu    C
```

Fluid Density

This value represents the actual fluid density of the application in lbm/ft^3.

```
Density
62.4000
```

Reference Density

This value represents the density of fluid at standard conditions in lbm/ft^3. Reference Density is used for displaying and scaling standard or normal flow rates. If the reference density is set to zero, the reference density will be the fluid density.

```
Ref Den
0.000000
```

Density Range

This value represents the maximum density divided by the minimum density. Density Range is used to set the input filter. (M-factor)

```
Dens Rng
1.5
```

Fluid Viscosity

This value represents the fluid viscosity used to calculate Reynolds number.

```
Viscos
1 cP
```

Fluid Temperature
The fluid temperature is used to compensate for changes in internal diameter of the sensor, by shifting the K-Factor.

```
Temp
0100°F
```

The Sensor Menu

```
Sensor
↓ Menu C
```

Size
Pipe inside diameter, 3 to 80 in. (80 to 2000 mm).

```
Pipe ID
84
```

Calibration Factor
This value represents the calibrated meter K-factor in pulses/ft.

```
Meter K
2400.00
```

Serial
Meter body serial number. (Cannot be changed)

```
000000 –
000 WO#
```

Tag Number
Meter tag number. (Cannot be changed)

```
Tag #
00000000
```

The Reset Menu

```
Reset
↓ Menu D
```

Totalizer Reset
Reset the totalizer by selecting Y (yes).

```
Total
Reset N
```

Set Defaults
Reset the meter to the original programmed defaults shown below by selecting "Yes." Selecting "Yes" will erase existing meter programming. (Figure 5-7)

```
Defaults
No
```

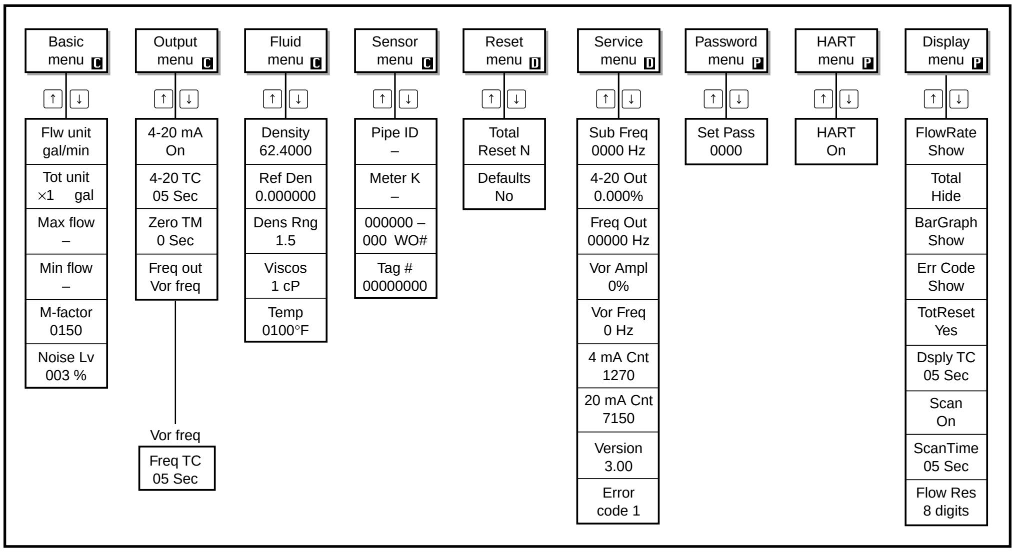


Figure 5-7. Programmed Defaults

The Service Menu

Service
↓ Menu D

Substitute Frequency

Substitute frequency simulates the vortex shedding frequency for the display and the output. The substitute frequency value must be set to zero before meter returns to actual frequency input.

Sub freq
0000 Hz

Simulated Analog Output

Simulation of the analog output 0% = 4 mA and 100% = 20 mA. Can be set at any value between 0 and 100%. Operates only while in this display.

4-20 Out
0.000%

Simulated Frequency Output

Simulation of the frequency output, 0–10,000 Hz. Only possible if frequency/ pulse output setup is either the scaled or the vortex frequency options. Operates only while in this display.

Freq out
00000 Hz

Input Signal Amplitude
Input signal level 0–100% of meter's maximum, not maximum flow of specific application which is programmed in the Basic Menu.

```
Vor Ampl
0%
```

Vortex Frequency
The raw input frequency from the sensor.

```
Vor Freq
0 Hz
```

4 mA Calibration Value
Sets the number of units the microprocessor sends to the current output circuit to generate 4 mA.

```
4 mA Cnt
1270
```

20 mA Calibration Value
Sets the number of units the microprocessor sends to the current output circuit to generate 20 mA.

```
20mA Cnt
7150
```

To set the 4 mA and 20 mA Calibration Values, access the 4 mA Calibration Value screen. Adjust the microprocessor count until the multimeter value deviates from 4 mA by no more than ± 0.012 mA. Press enter. Repeat in the 20 mA Calibration Value screen. (Figure 5-8)

Software Revision
The revision of the software used.

```
Version
2.10
```

Self Diagnostics
Displays current errors. When error condition no longer exists, error code is cleared. Push right arrow key to scroll through arrows. See Section 6: Troubleshooting and Maintenance for error code descriptions.

```
Error
code 1
```

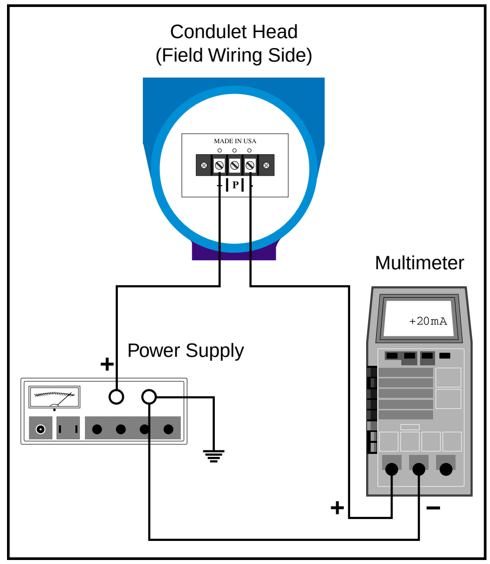


Figure 5-8. Wiring diagram for 4-20 mA output calibration

The Password Menu

Password
↓ Menu P

Set New Password

Programs the password for future protection of the meter. If 0000 is selected, no password is required for "Full Access."

Set Pass
1000

The HART Menu

HART
↓ Menu P

HART Enable/Disable

Turns the meter's HART communication abilities on or off.

HART
On

The Display Menu

Display
↓ Menu P

Show or Hide the flow rate in the top display menu.

FlowRate
Show

Turns on or off the totalizer in the top display menu. Turning off the totalizer allows for 12 VAC operation.

Total
Off

Show or Hide the bar graph in the top display menu.

BarGraph
Show

Show or Hide the error codes in the top display menu.

Err Code
Show

If yes is selected, push the enter key once to reset the totalizer, when the totalizer is displayed in the top display menu.

TotReset
Yes

Dampens the displayed flow rate.

Dsply TC
05 Sec

Turns the automatic scrolling of the display menu off or on.

```
Scan
 On
```

The amount of time that each display is shown is the display mode if scan is turned on.

```
ScanTime
 05 Sec
```

Selects the number of significant digits displayed for the flow rate.

```
Flow Res
8 digits
```

Exiting Programming Submenus

Press the enter key at the top screen of each submenu to exit the programming submenus. The display reads “Exit.” Press the up or down arrow key to toggle to “Yes.” Press enter. The display reads “SavChng?” (Save Changes?). Press enter to save changes or press the up or down arrow keys to toggle to “No” and press enter to exit without saving changes.

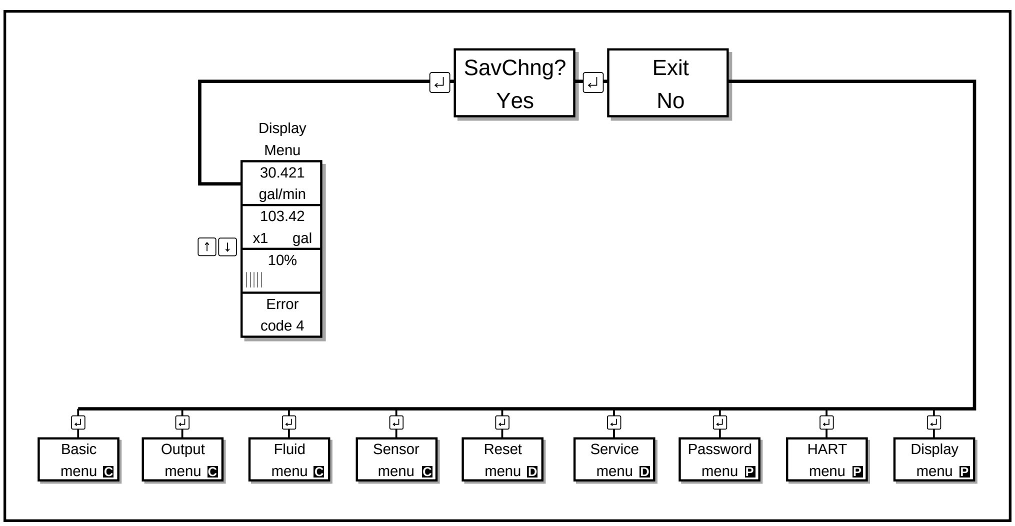


Figure 5-9. Exiting the Programming Submenus

Section 6: Trouble-shooting and Service

Electronics Removal

The electronics used in the V-Bar are CMOS and susceptible to electrostatic discharge. A wrist strap, used to ground the technician during service work, is recommended.

Turn the power supply off. Remove condulet cap. Unscrew the three display board screws. Gently remove the display board from the electronics stack. Unscrew the hex standoff bolts to remove electronics stack from filter board. Carefully pull the electronics board set from the condulet and set electronics aside in an antistatic bag. Remove sensor female connector from the filter board male connector. Loosen the three filter board screws. Remove filter board from condulet taking care not to bend the three feed through pins. Reassemble the electronics by following the described above in reverse order. (Figures 6-1, 6-2, and 6-3)

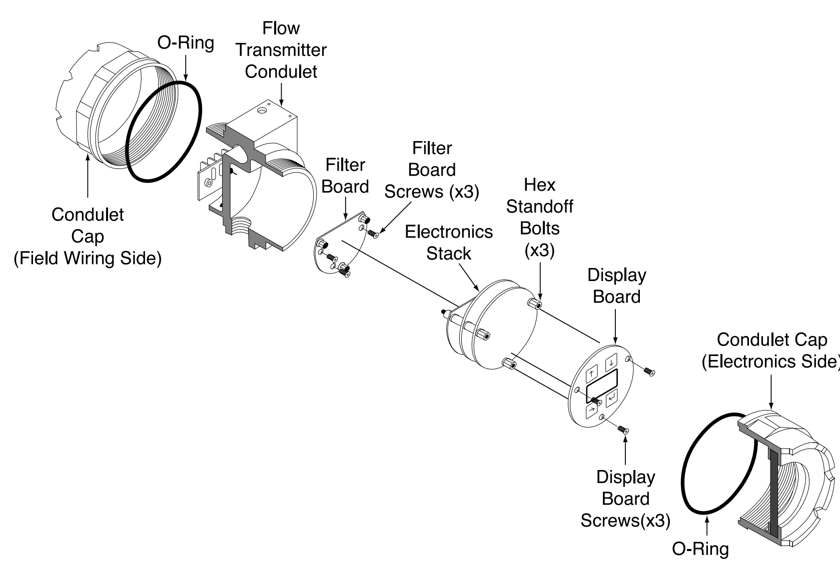


Figure 6-1. Electronics Exploded Assembly

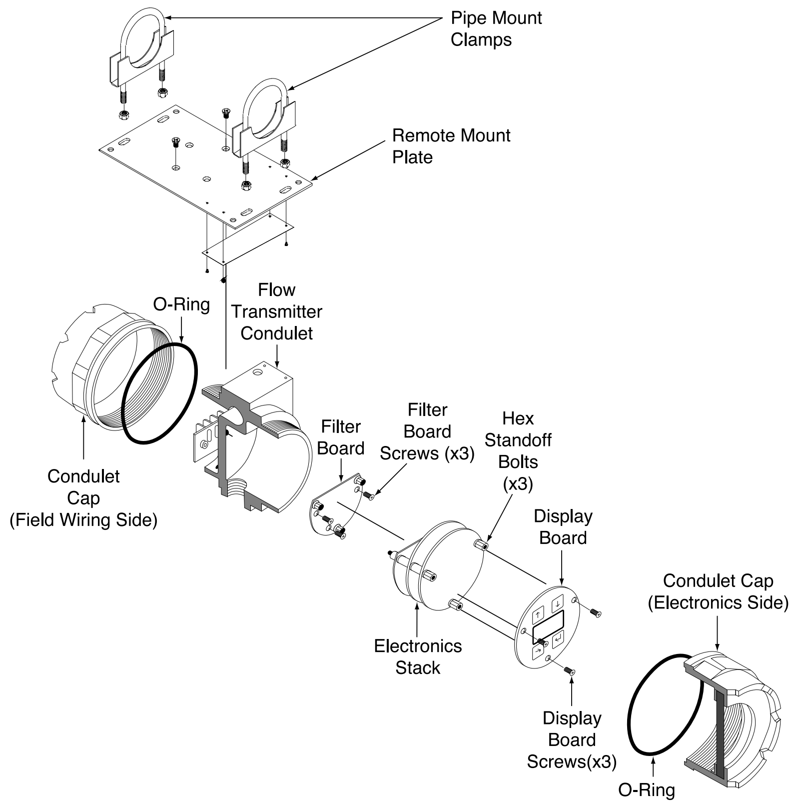


Figure 6-2. Remote Electronics Assembly

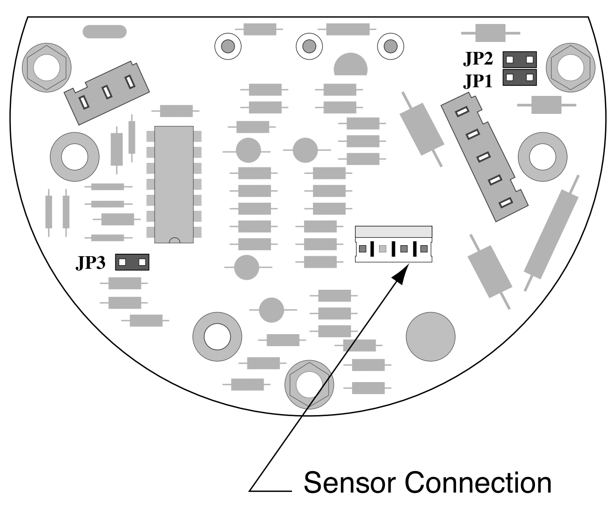


Figure 6-3. Sensor Connection Location on the Filter Board

Symptom	Output Signals	Error Code	Possible Reason	Solution
Blank display	0-4 mA or 0 Hz		Supply voltage	Check suppy voltage on the terminal board of the meter
				Check resistance of the current loop. Refer to the analog output section for permissible values.
			Defective electronics	Replace electronics stack in the meter.
Displays flow without output signal	<4 mA		Current output deselected	Turn 4-20 mA to "On" in Output Menu
	O Hz		Frequency output deselected	Turn frequency/pulse to "On" in Output Menu
No flow displayed or no output at flow	4 mA or 0 Hz	1	Minimum flow setting too high	Reduce minimum flow in Basic Menu.
		2	No signal from sensor	Check resistance across sensor wires. Check remote cable connections.
			Flow too low to measure	Check meter for correct sizing.
Shows flow without flow in pipe.	Undefined		Pipe vibration	Auto set noise level in Basic Menu.
				Increase minimum flow until output goes to 4 mA or 0 Hz.
				Support pipe to reduce vibration
			Electrical noise	Check meter and power supply for proper grounding.
Unstable flow signal	Unstable		Pipe vibration and/or flow pulsations disturbing flow measurement	Support pipe to reduce vibration
				Auto set M-factor in Basic Menu.
			Air bubbles in the media	Follow piping guidelines.
			Pulsating flow	Increase the time constant for outputs and display.
Measuring error	>20 mA	3	Flow exceeds 110% of maximum flow	Verify that the sensor is correctly sized and increase maximum flow in Basic Menu.
	>10 kHz max	4	Flow exceeds 110% of maximum flow	Verify that the sensor is correctly sized and increase maximum flow in Basic Menu.
	o Hz	5	Volume/pulse too low or pulse width too long	Check volume/pulse and pulse width in Output Menu for the flow measured.
			Wrong calibration constant	Check that the K-factor in the Sensor menu corresponds to the value on the nameplate of the meter.
			The sensor is not correctly positioned	Check calculation of insertion depth. Verify the sensor is inserted to correct depth. Verify that sensor is aligned correctly.
	4 mA offset at no flow		4 mA calibration value incorrect	Calibrate 4 mA point in Service Menu.
	20 mA offset at max. flow		20 mA calibration value incorrect	Calibration 20 mA point in Service Menu.

Table 6-1. Troubleshooting Chart

Sensor Functionality Test

A functionality test should be performed at the electronics condulet regardless of mounting configuration (integral or remote). Use proper ESD precautions at all times. Disconnect the power. Remove the electronics stack from the condulet and place into an antistatic bag. Verify the sensor is properly connected to the filter board. Disconnect the sensor from the filter board. Insert solid wire (approximately. 1⁄32" diameter) into the sensor female connector to serve as leads. Check the resistance between the red wire and the green (or white) wire. The resistance should be between 500 and 2500 Ω. Check the resistance between the green (or white) and the black wire. The resistance should be between 500 and 2500 Ω. The two previous resistance measurements should be within 30 Ω of each other. Check the resistance between all four wires and earth ground (the condulet or meter body). The resistance should be 20 mΩ or greater. (Figure 6-4)

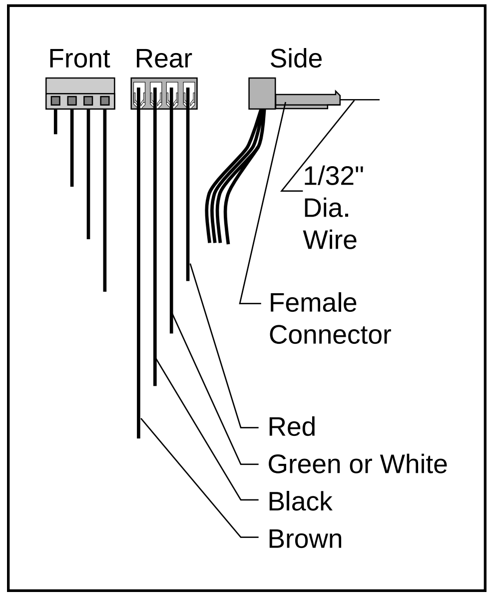


Figure 6-4. Wire Identification for Sensor.

V-Bar-600/60S: Flowmeter Removal

It is not necessary to depressurize the system to remove the V-Bar-600/60S flowmeter, because the V-Bar-600/60S is mounted with an isolation valve.

Step 1. Disconnect the power to the meter.

Step 2. Loosen the orientation set screw. (Figure 6-5)

Step 3. Retract the stem fully into the threaded pipe nipple by turning the retractor handle counterclockwise. Close the 2" isolation valve. Remove the plug in the ¼" bleed valve. Slowly open the ¼" bleed valve to release entrained fluid pressure. (Figure 6-6)

Step 4. Remove the meter from the isolation valve by unscrewing the meter out of the isolation valve. Reinstall the flowmeter as described in Section 3: Mechanical Installation.

V-Bar-600/60S: Sensor Removal

Step 1. Remove the meter from the pipe as described in Flowmeter Removal.

Step 2. Disconnect sensor filter board connection as described in Electronics Removal.

Step 3. Loosen the junction set screw (Figure 6-5). For the temperature or pressure transmitter options remove the two

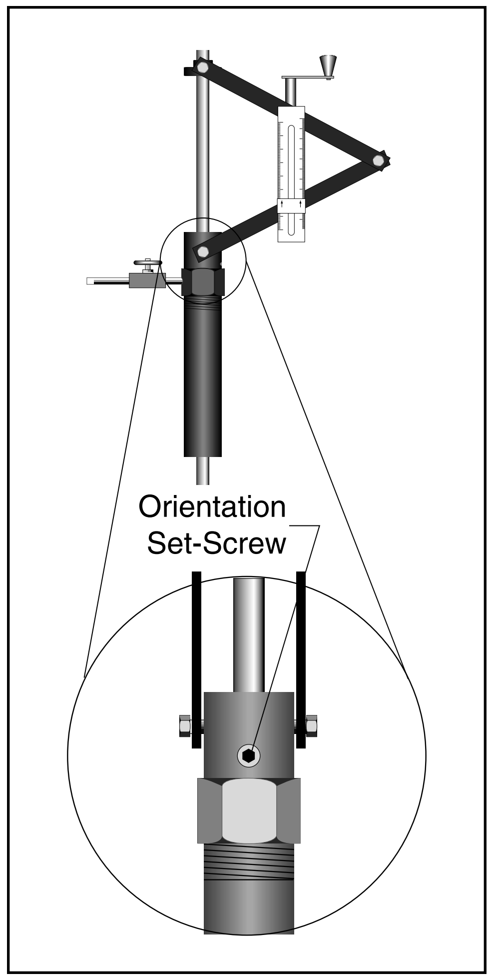


Figure 6-5. Orientation Set-Screw Location. *To unlock the stem into position, loosen the orientation set-screw.*

terminal block set screws from the terminal wiring block in the field wiring condulet (Figures 6-8 and 6-9). Pull the terminal block out far enough to clear a path for the sensor connector.

Step 4. Unscrew the stem (Figure 6-10) from the junction mount and remove the stem by pulling it out from the bottom of the meter. Replace sensor by following the steps above in reverse order.

Note: When reassembling the stem, make sure that the flow direction arrow and Vortex sensor head input (flared side) are in opposite directions.

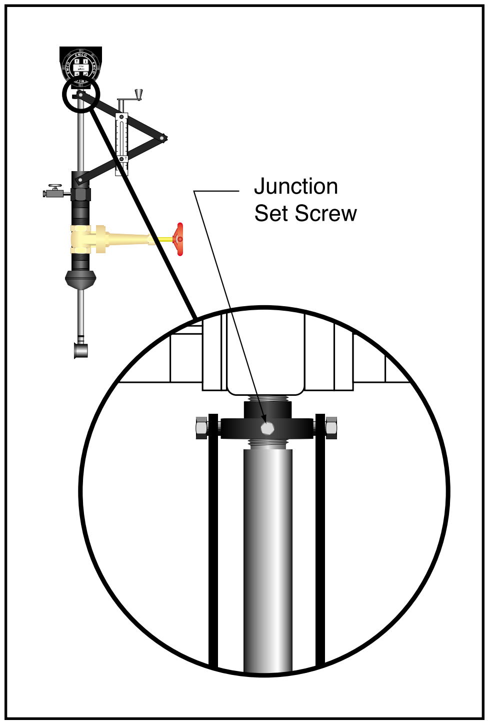


Figure 6-7. Junction Set-Screw Location

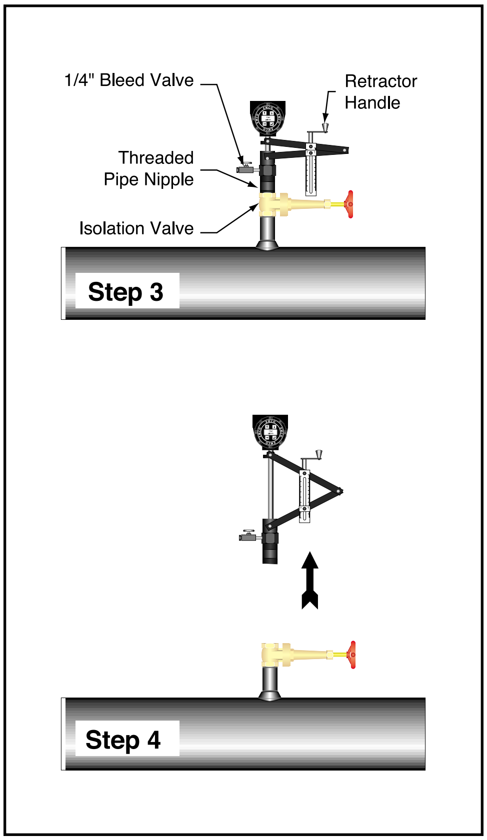


Figure 6-6. Removing the V-Bar-600/60S

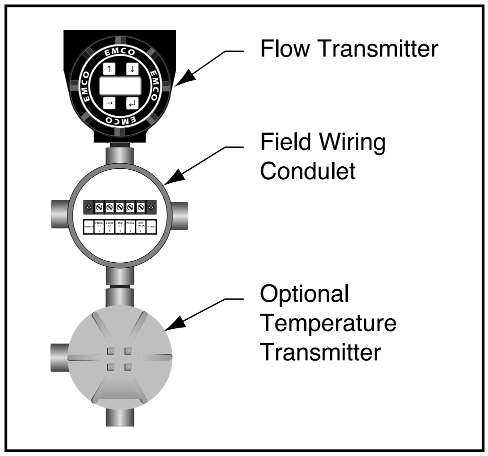


Figure 6-8. Field Wiring Condulet Location

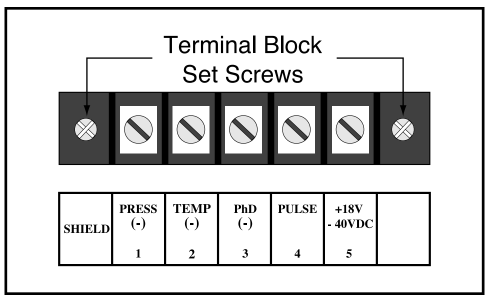


Figure 6-9. Terminal Block Set Screw Location

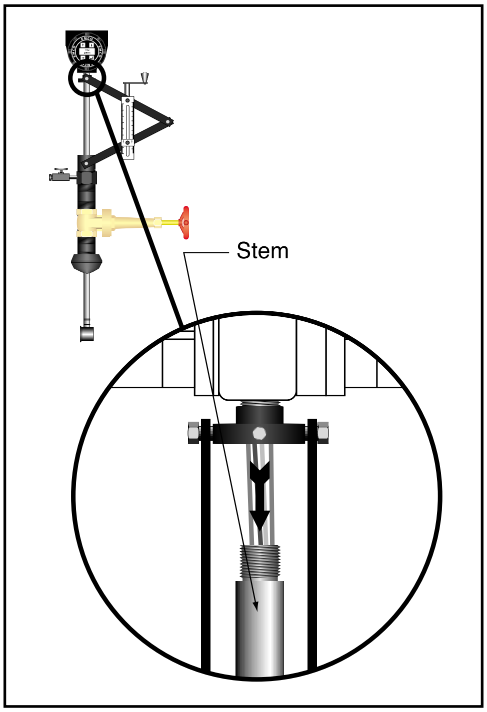


Figure 6-10. Removing the V-Bar-600 Sensor. *Unscrew the stem from the junction mount and remove the stem by pulling it out from the bottom of the meter.*

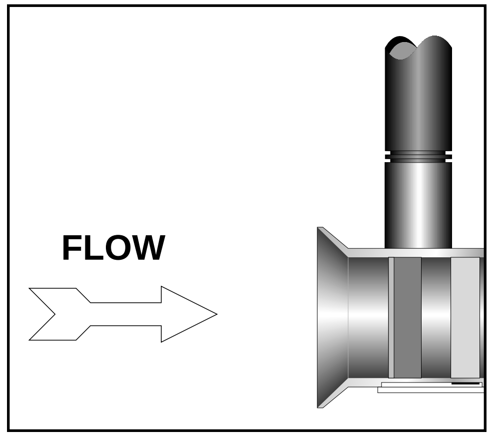


Figure 6-11. Vortex Sensor Head Input. *When reassembling the stem, verify that the flow direction arrow and vortex sensor head input are in opposite directions.*

Insertion Depth		Weight
Minimum	Maximum	Maximum
4.5 (114)	18 (457)	28 lb (12.7 kg)

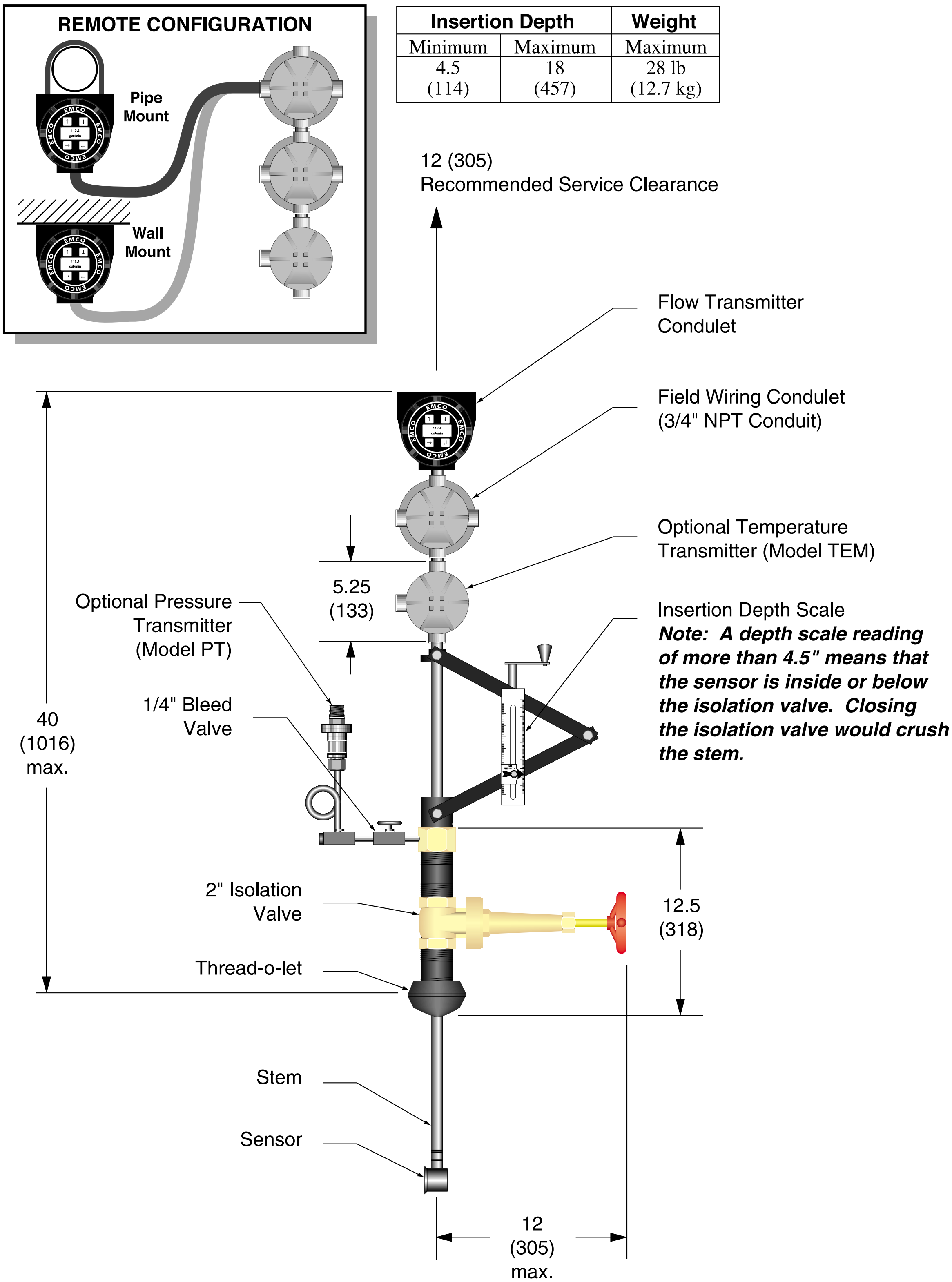


Figure 6-12. V-Bar-600/60S Dimensional Outline. *All dimensions are in inches (millimeters).*

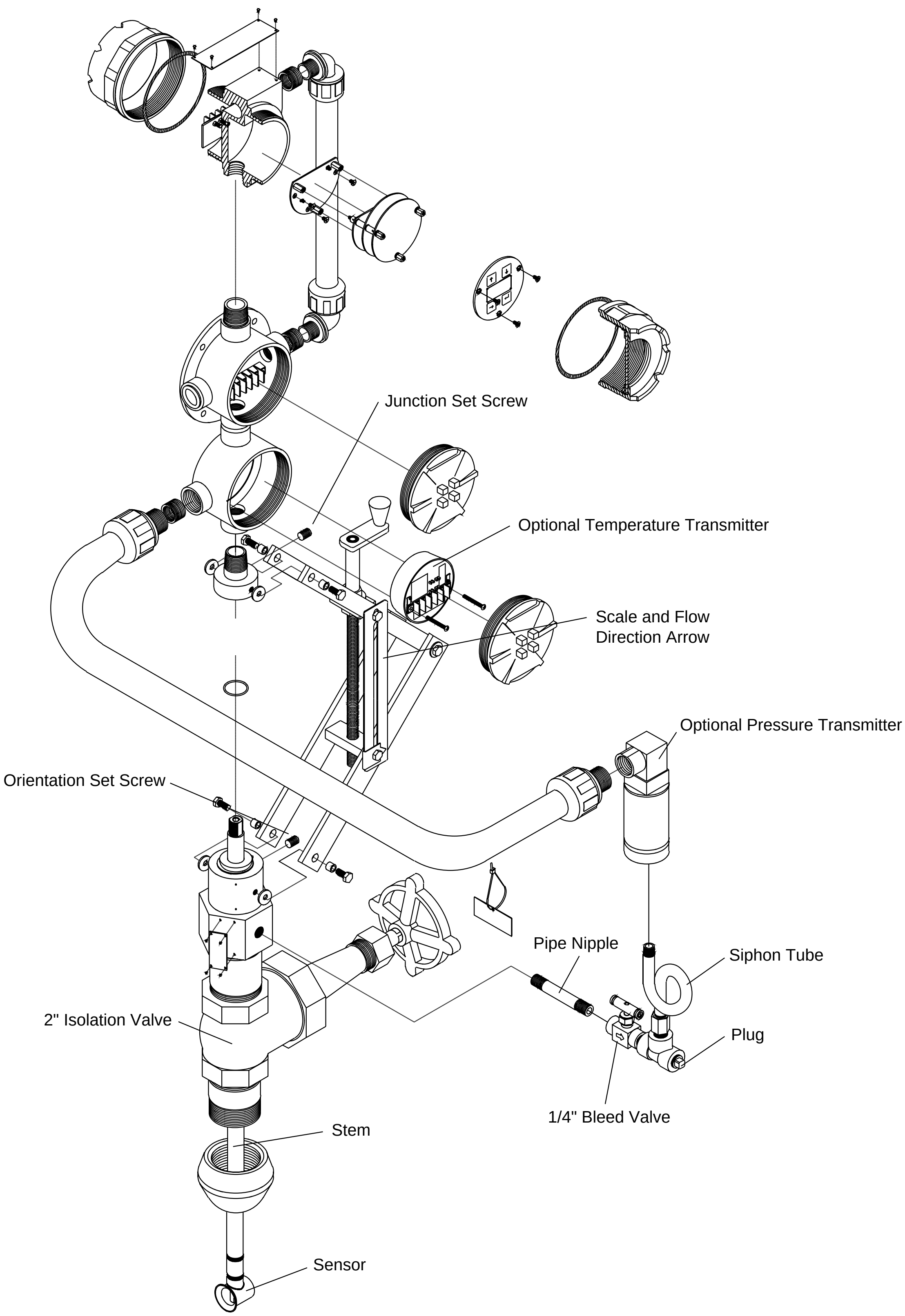


Figure 6-13. V-Bar-600/60S Integral Assembly

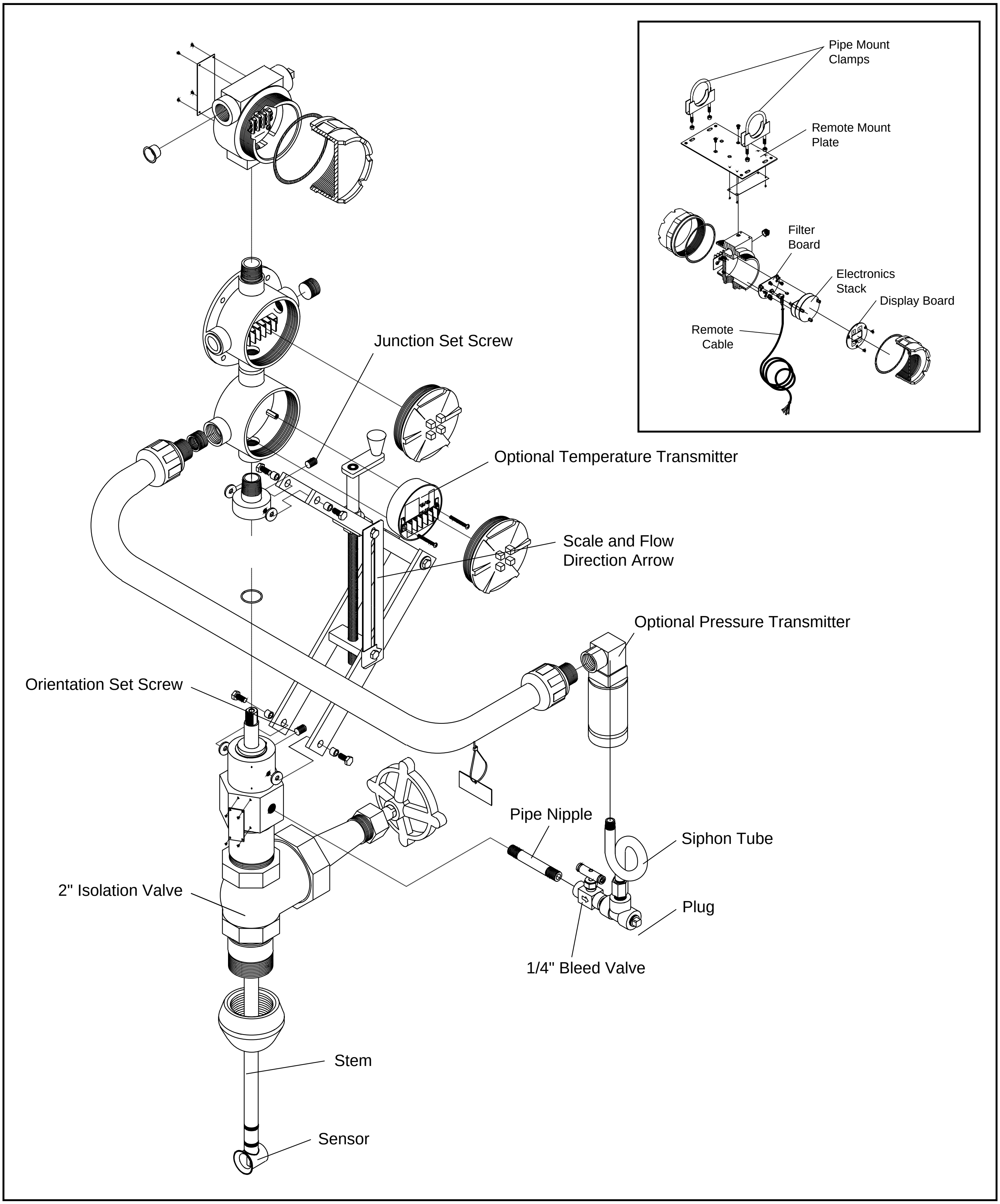


Figure 6-14. V-Bar-600/60S Remote Assembly

V-Bar-700: Flowmeter Removal

(Figure 6-15)

Warning: Do not loosen the Swagelok fitting under pressure. Doing so may result in serious injury.

Step 1. Disconnect the power to the meter. Depressurize the system. Loosen the Swagelok fitting.

Step 2. Manually pull up on the orientation levers to retract the stem so that the retaining ring contacts the base of the stem housing. Lightly tighten the Swagelok fitting to hold stem in place.

Step 3. Carefully detach the meter from the thread-o-let or flanged mounting. Reinstall the flowmeter as described in Section 3: Mechanical Installation.

V-Bar-700: Sensor Removal

To remove the sensor V-Bar-700, contact EMCO or your EMCO sales representative.

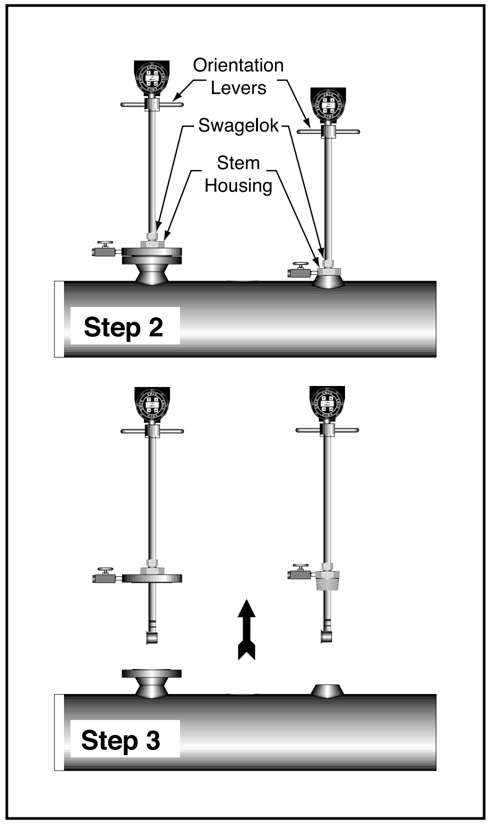
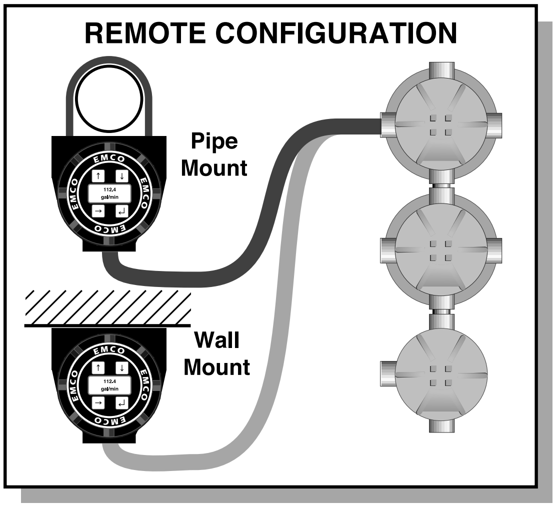


Figure 6-15. Removing the V-Bar-700



Model	Connection	Insertion Depth (Dim. "C")		Weight
		Minimum	Maximum	
700	2" NPT	3 (76)	10.00 (254)	9 lb (4.1 kg)
	2" 150#	3 (76)	11.50 (292)	12 lb (5.4 kg)
	300#	3 (76)	11.25 (285)	14 lb (6.3 kg)
	600#	3 (76)	11.00 (279)	16 lb (7.2 kg)
	900#	3 (76)	10.75 (273)	20 lb (9.1 kg)

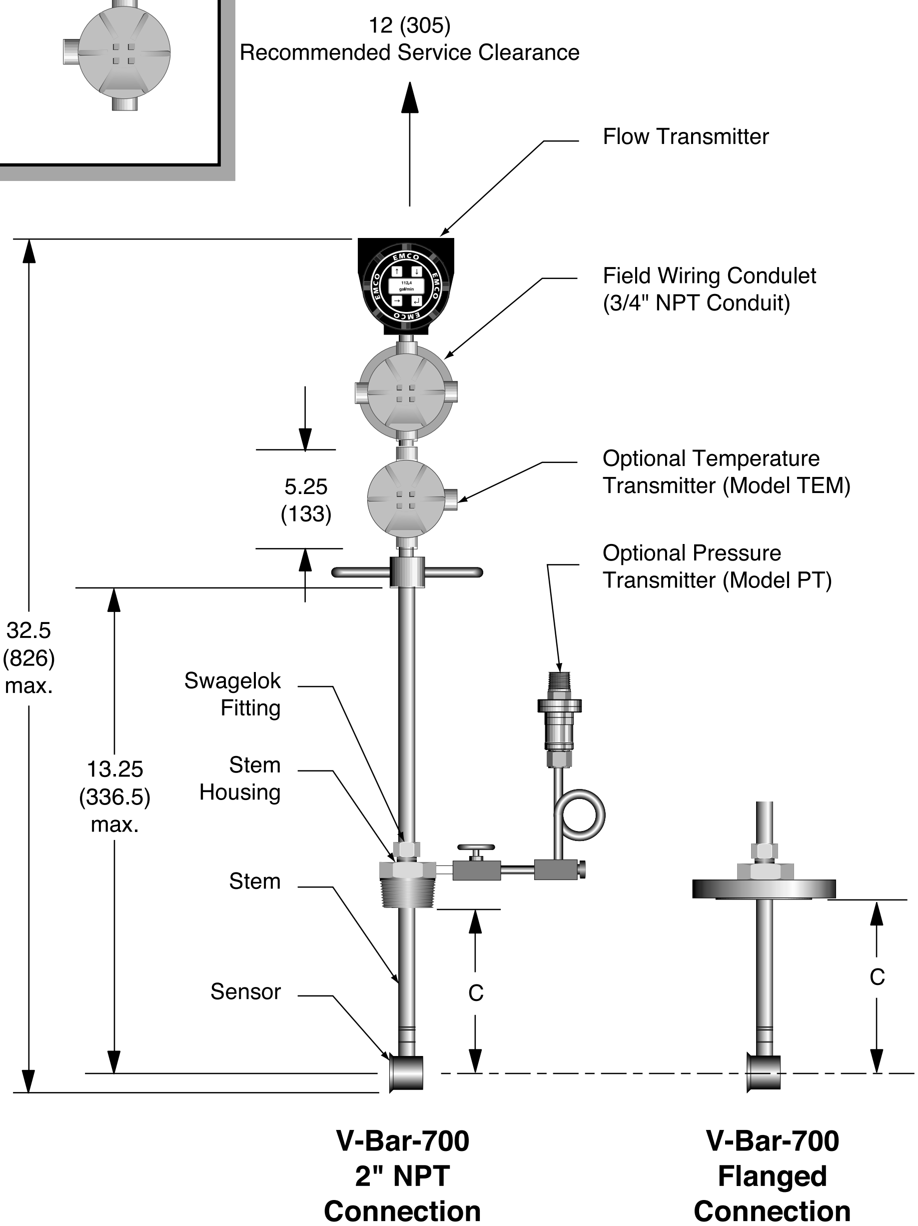


Figure 6-16. V-Bar-700 Dimensional Outline. *All dimensions are in inches (millimeters).*

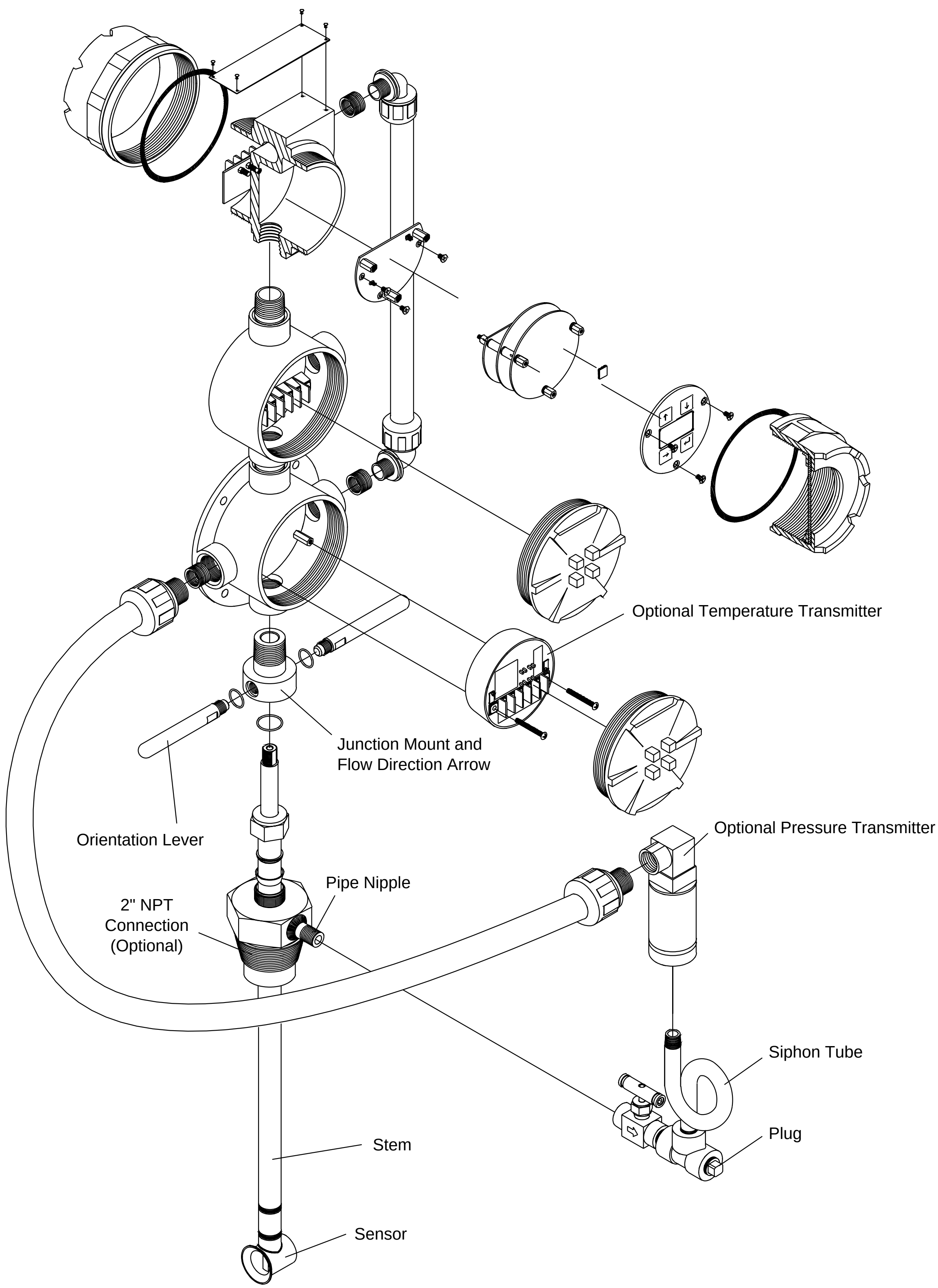


Figure 6-17. V-Bar-700 Integral Assembly

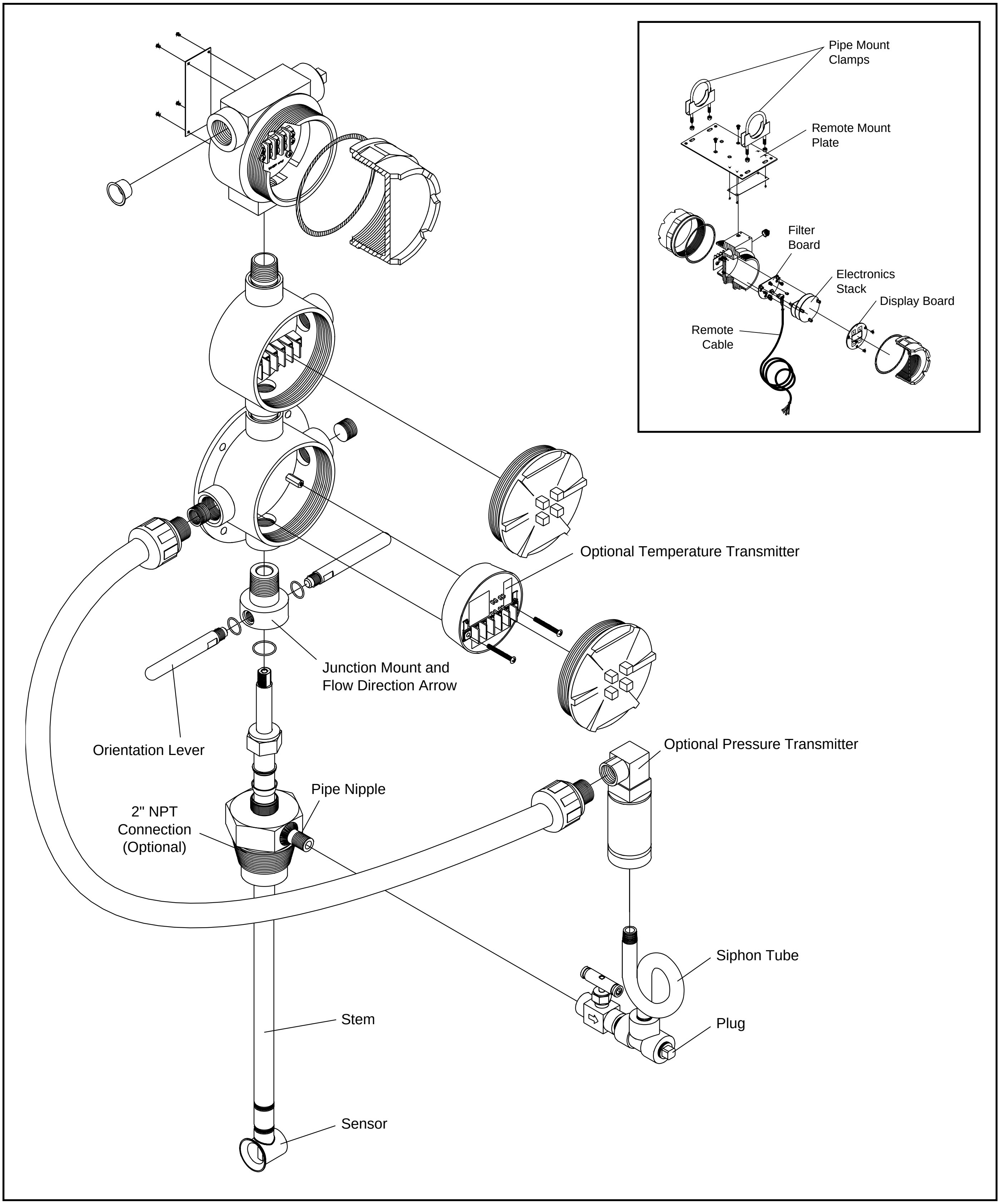


Figure 6-18. V-Bar-700 Remote Assembly

V-Bar-800/80S: Flowmeter Removal

(Figure 6-19)

Warning: For a V-Bar-800/80S with a 2" NPT connection or a flanged connection installed without an isolation valve, the system needs to be depressurized.

Step 1. Disconnect the power to the meter.

Step 2. Loosen the horizontal cap screw on the bottom clamp. Do not loosen the cap screw on the top clamp. The top clamp is used as a marker so the insertion depth does not have to be recalculated every time the meter is removed or reinstalled.

Step 3a. Manually pull up on the orientation levers until the stem retracts completely.

Step 3b. If the meter is installed with an isolation valve, close the isolation valve; remove the plug in the ¼" bleed valve and slowly open the bleed valve to release entrained fluid pressure.

Step 4. Detach the meter from the mounting connection. Reinstall the flowmeter as described in the installation process.

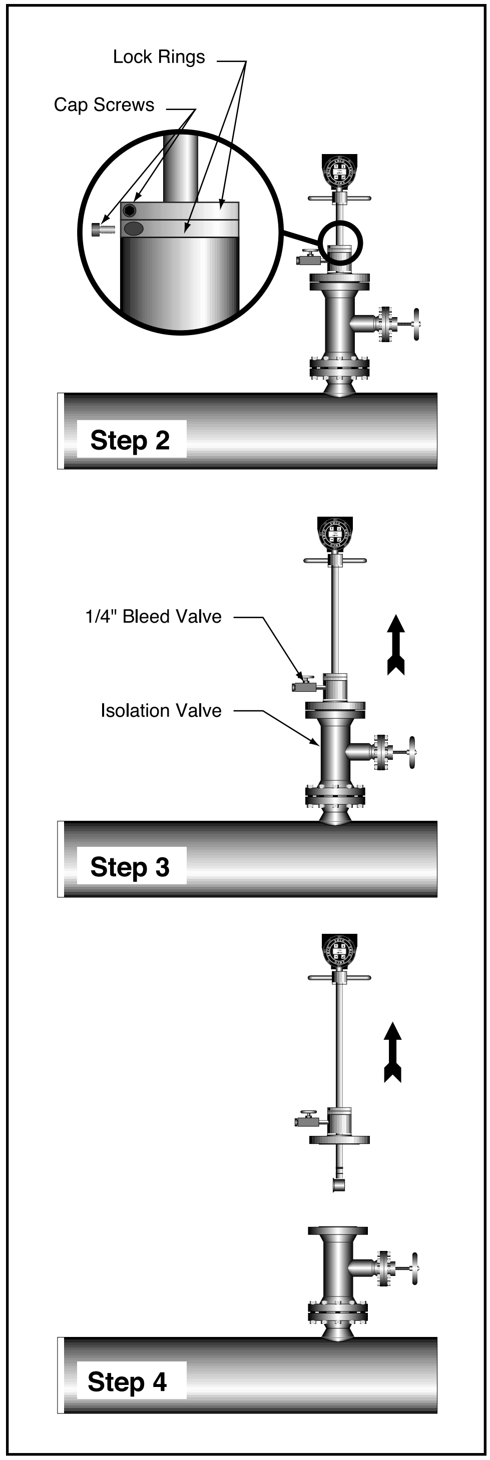


Figure 6-19. Removing the V-Bar-800/80S

V-Bar-800/80S: Sensor Removal

Step 1. Remove the meter from the pipe as described in Flowmeter Removal.

Step 2. Disconnect sensor filter board connection as described in Electronics Removal.

Step 3. Loosen the orientation levers. For the temperature or pressure transmitter options remove the two terminal block set screws from the terminal wiring block in the field wiring condulet. Pull the terminal block out far enough to clear a path for the sensor connector. (Figure 6-20)

Step 4. Unscrew the stem from the junction mount and remove the stem by pulling it out from the bottom of the meter. Replace sensor by following steps above in reverse order.

Note: When reassembling the stem, make sure that the flow direction arrow and Vortex sensor head input (flared side) are in opposite directions.

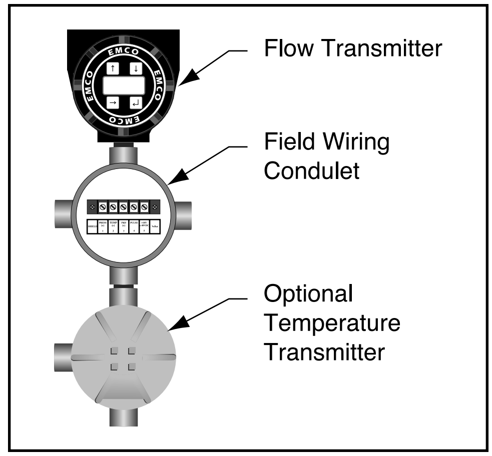


Figure 6-21. Field Wiring Condulet Location

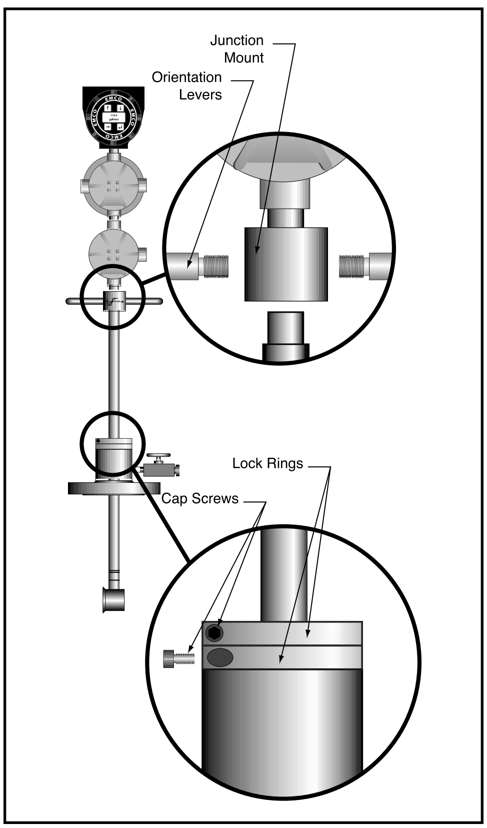


Figure 6-20. Removing the V-Bar-800 Sensor. *Unscrew the stem from the junction mount and remove the stem by pulling it out from the bottom of the meter.*

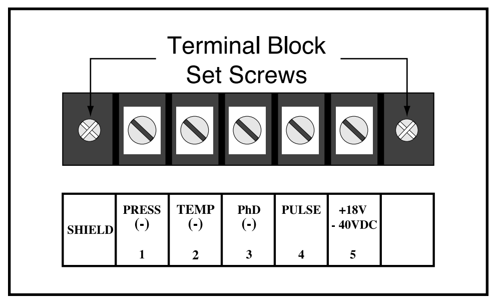


Figure 6-22. Terminal Block Set Screw Location

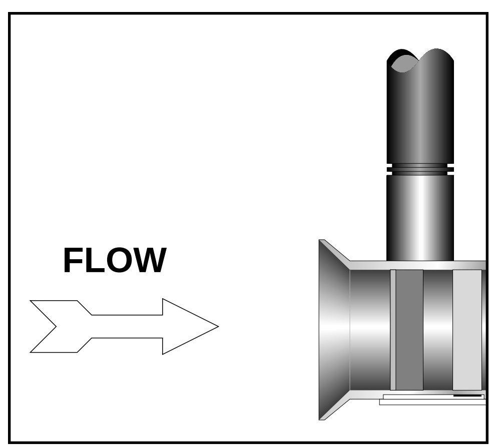
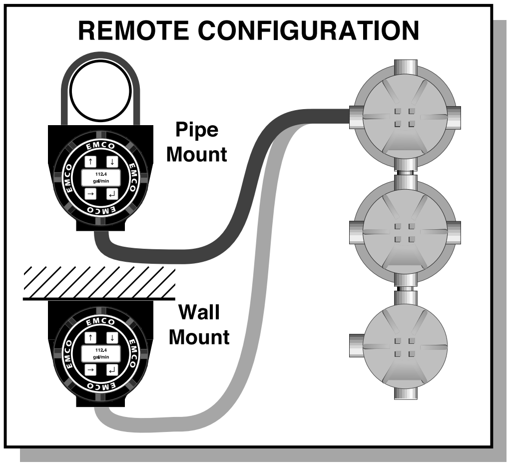


Figure 6-23. Vortex Sensor Head Input. *When reassembling the stem, verify that the flow direction arrow and vortex sensor head input are in opposite directions.*



Model	Connection	Insertion Depth (Dim. "C")		Weight
		Minimum	Maximum	
800/80S	2" NPT 2 F150	2 (51) 2 (51)	20.00 (508) 20.00 (508)	11 lb (5.0 kg) 17 lb (7.7 kg)

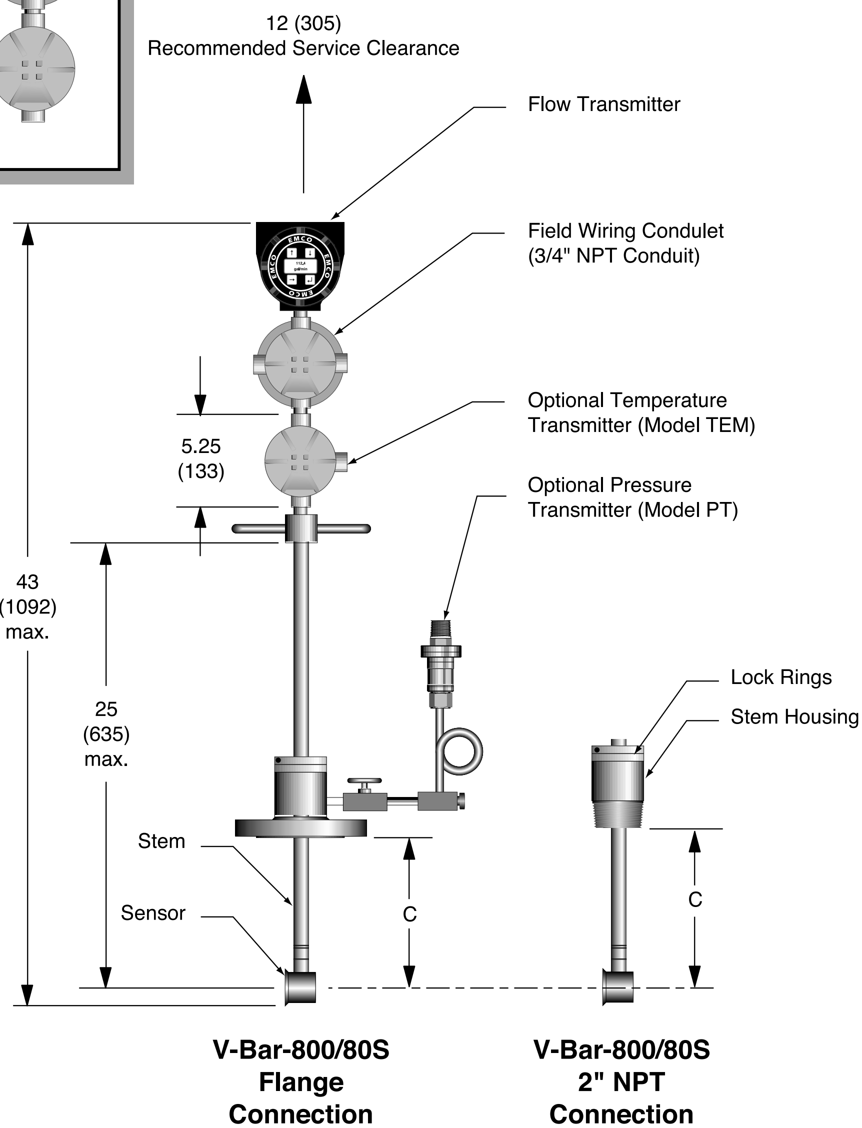


Figure 6-24. V-Bar-800/80S Dimensional Outline. All dimensions are in inches (millimeters).

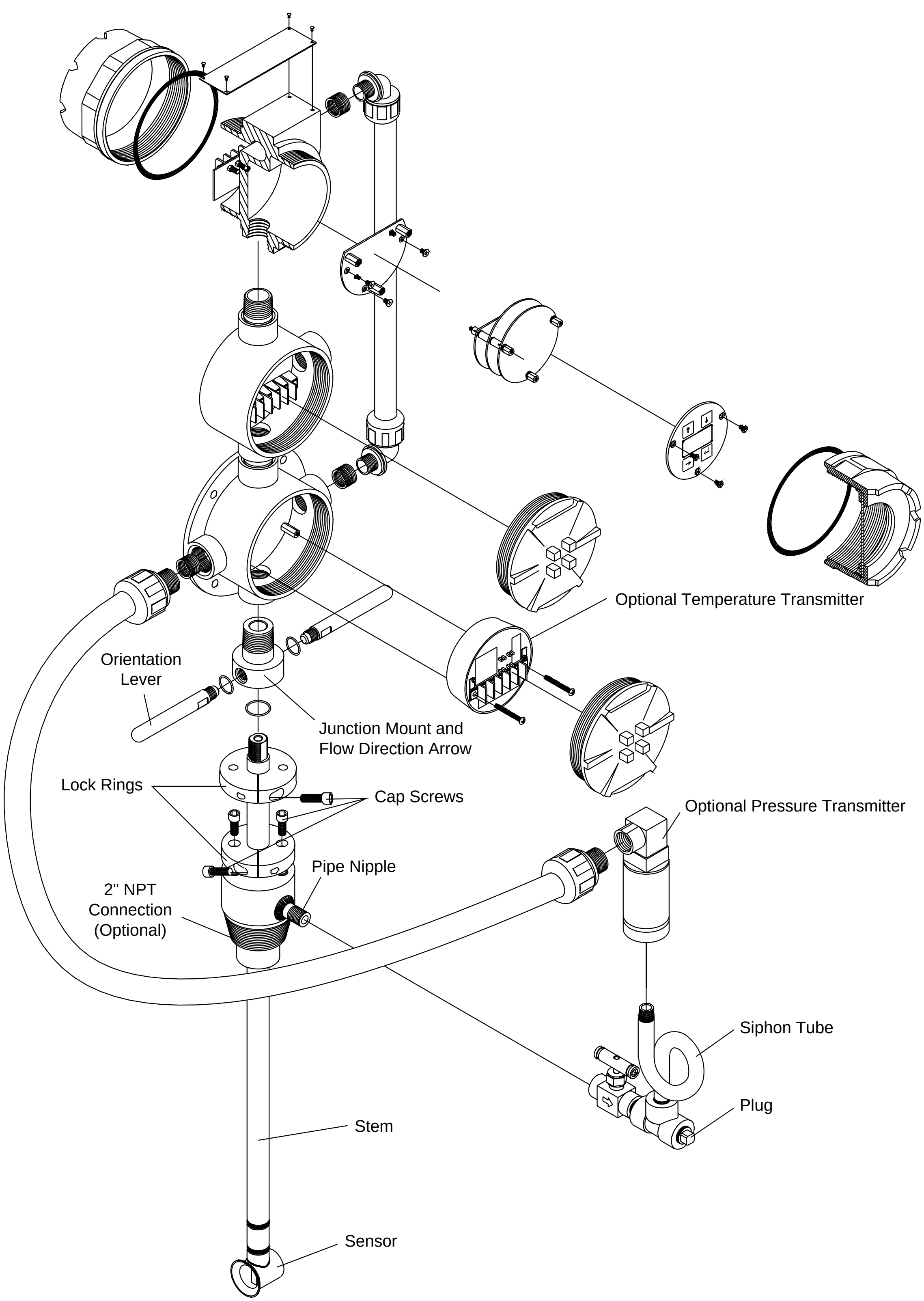


Figure 6-25. V-Bar-800/80S Integral Assembly

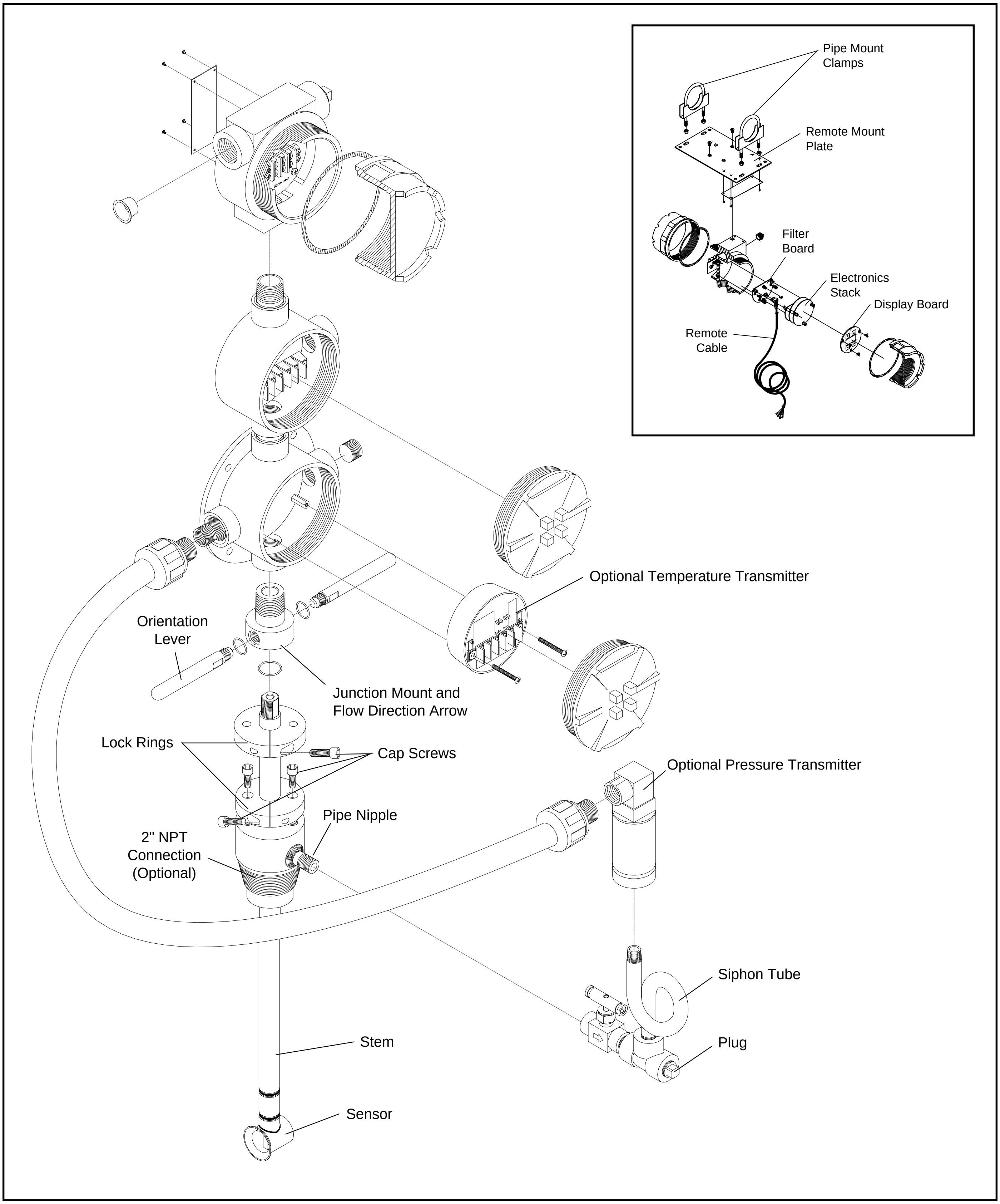


Figure 6-26. V-Bar-800/80S Remote Assembly

V-Bar-910/960: Flowmeter Removal

(Figure 6-27)

Warning: For a meter without an isolation valve, the system needs to be depressurized.

Step 1. Disconnect the power to the meter.

Step 2. Loosen packing gland nuts.

Step 3a. Turn the handwheel counterclockwise to retract the stem out of the pipe (and above the isolation valve assembly, if installed with an isolation valve).

Step 3b. If the meter was installed with an isolation valve, close the isolation valve. Slowly open the ¼" bleed valve to remove entrained fluid pressure.

Step 4. Detach the meter from the mounting connection. Reinstall the flowmeter as described in Section 3: Mechanical Installation.

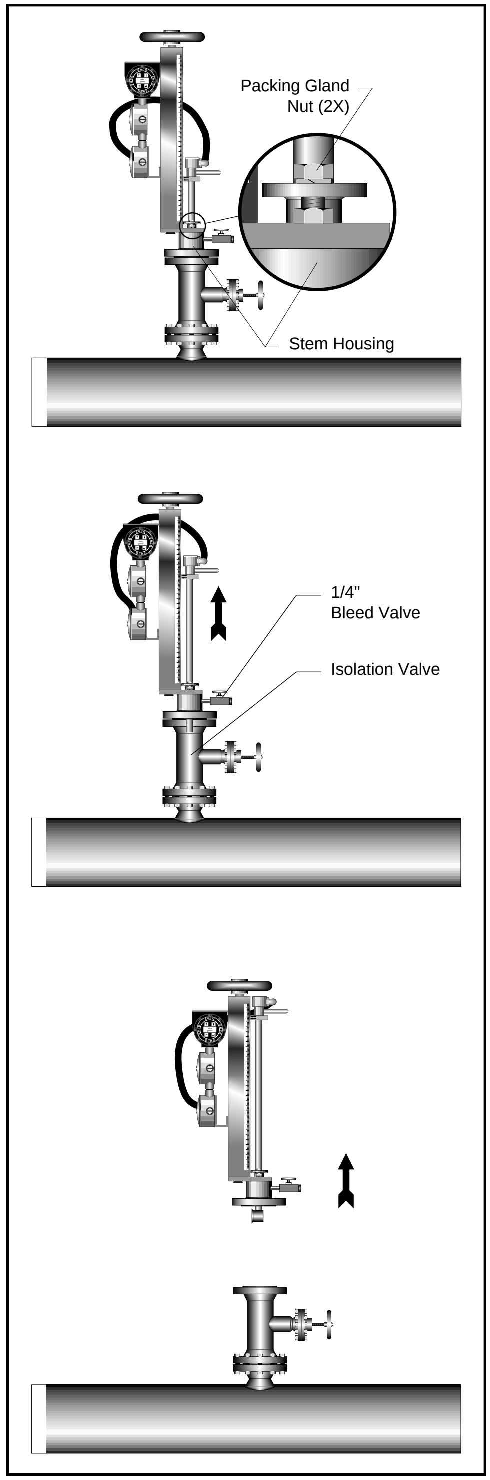


Figure 6-27. Removing the V-Bar-910/960

V-Bar-910/960: Sensor Removal

Step 1. Remove the meter from the pipe as described in Flowmeter Removal.

Step 2. Disconnect sensor filter board connection as described in Electronics Removal.

Step 3. Remove the orientation lever and the orientation set screw. For the temperature or pressure transmitter options remove the two terminal block set screws from the terminal wiring block in the field wiring condulet. Pull the terminal block out far enough to clear a path for the sensor connector. (Figure 6-28)

Step 4. Unscrew the stem from the junction mount and remove it by pulling it out from the bottom of the meter. Replace sensor by following the steps above in reverse order.

Note: When reassembling the stem, make sure that the flow direction arrow and Vortex sensor head input (flared side) are in opposite directions.

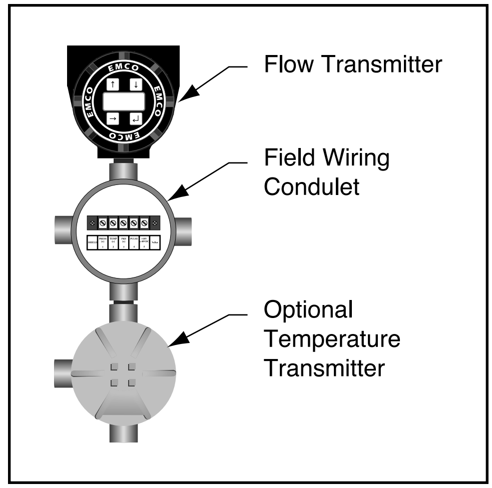


Figure 6-29. Field Wiring Condulet Location

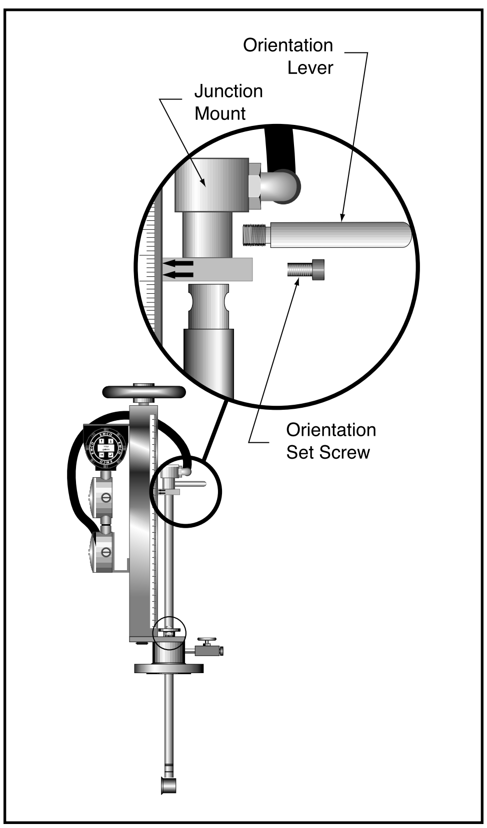


Figure 6-28. Removing the V-Bar-900 Sensor. *Unscrew the stem from the junction mount and remove the stem by pulling it out from the bottom of the meter.*

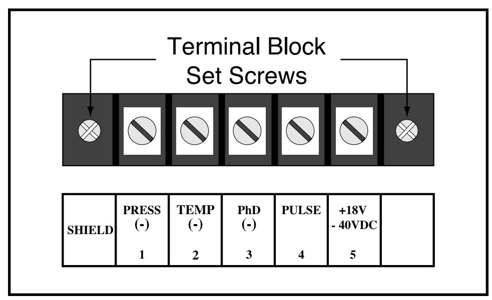


Figure 6-30. Terminal Block Set Screw Location

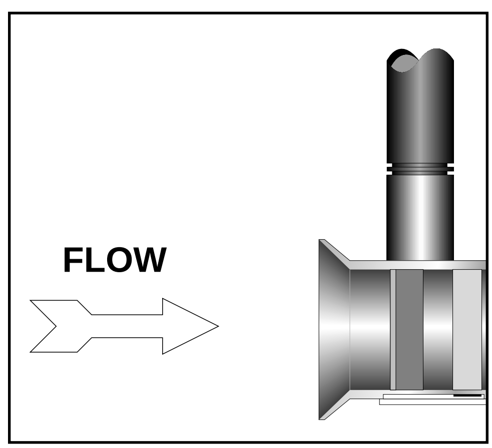
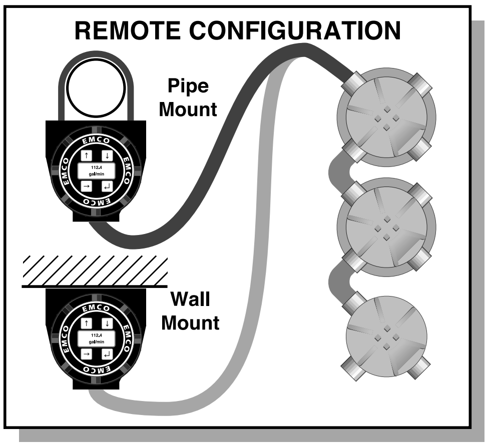


Figure 6-31. Vortex Sensor Head Input. *When reassembling the stem, verify that the flow direction arrow and vortex sensor head input are in opposite directions.*



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

*Minimum insertion depth is 1.5 (38)

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

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

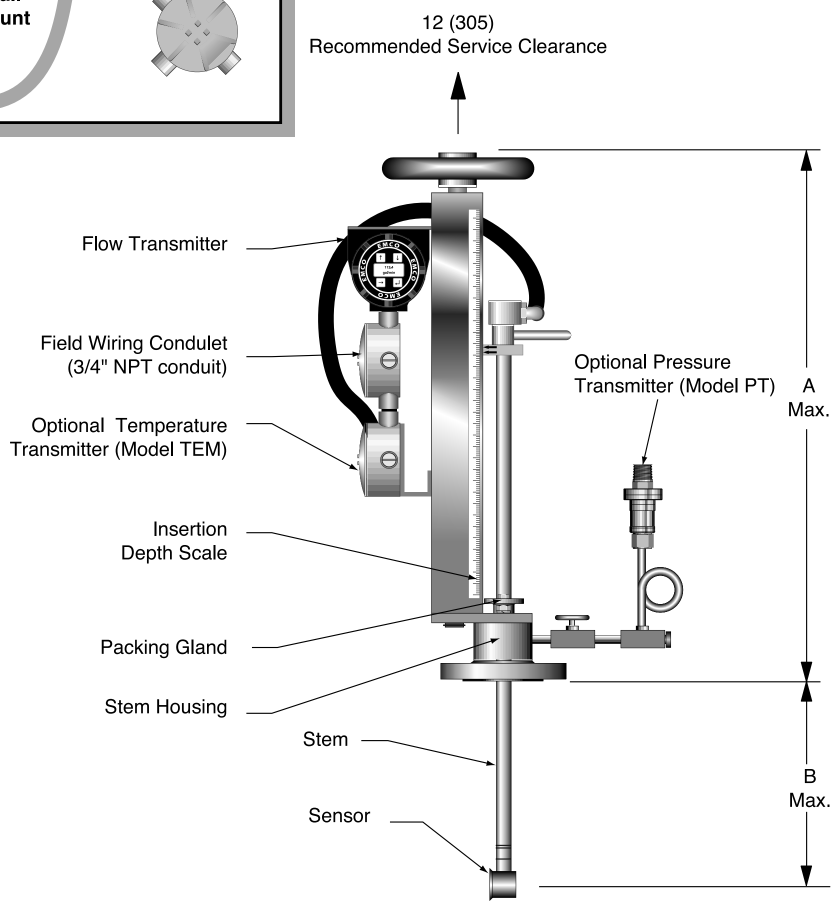


Figure 6-32. V-Bar 900/960 Dimensional Outline. *All dimensions are in inches (millimeters).*

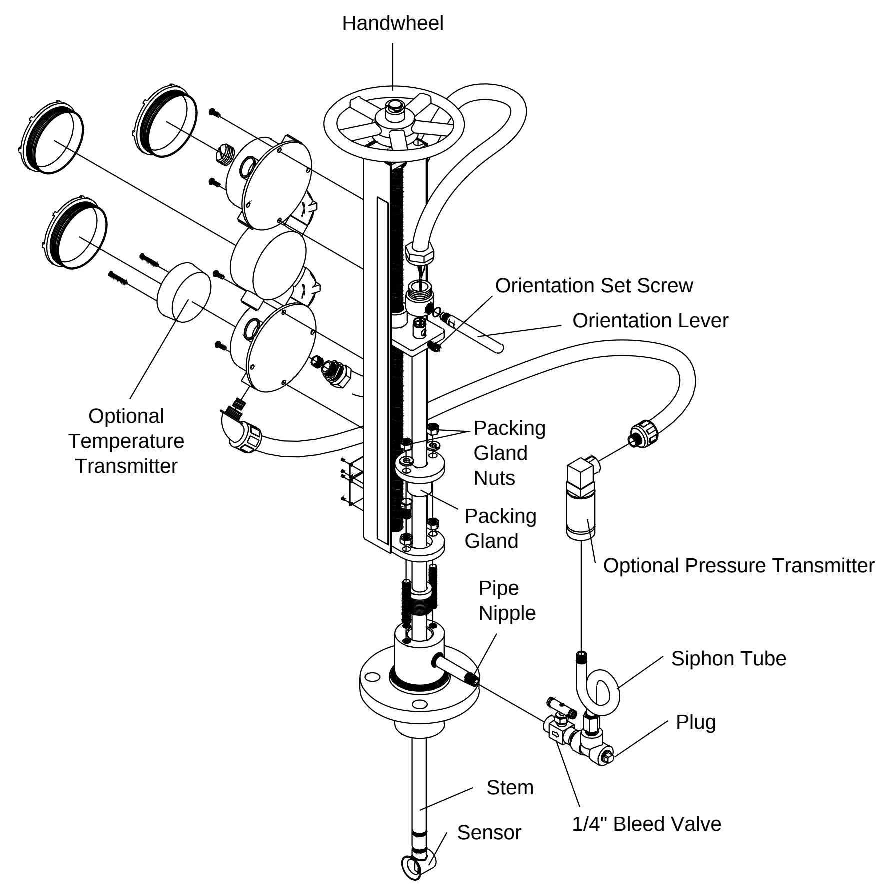


Figure 6-33. V-Bar-910/960 Integral Assembly

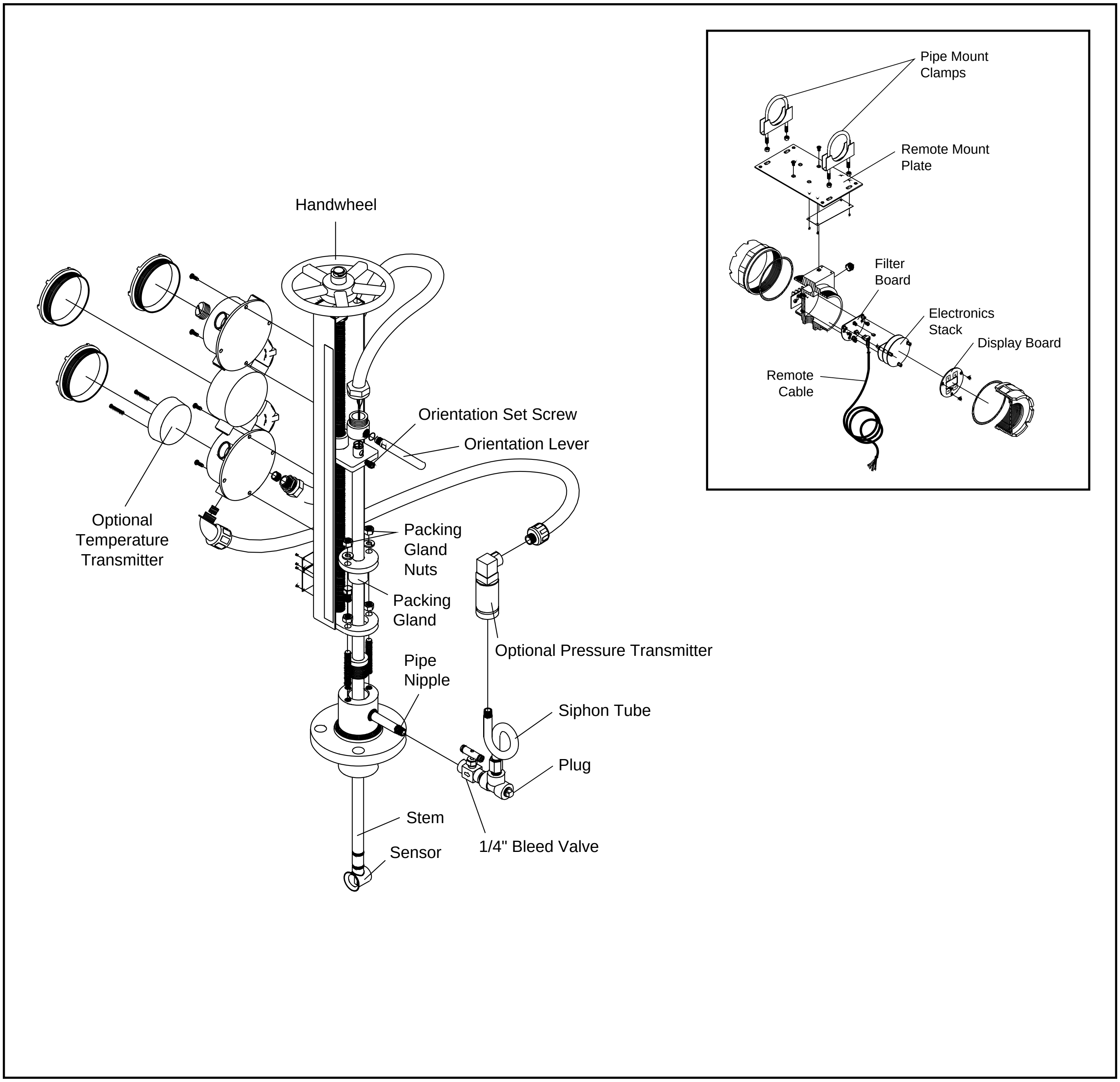


Figure 6-34. V-Bar-910/960 Remote Assembly

TEM Wiring

The temperature transmitter is factory prewired to the field wiring terminal block of the V-Bar. No wiring to the TEM itself is required. There are four terminals on the TEM terminal strip:

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

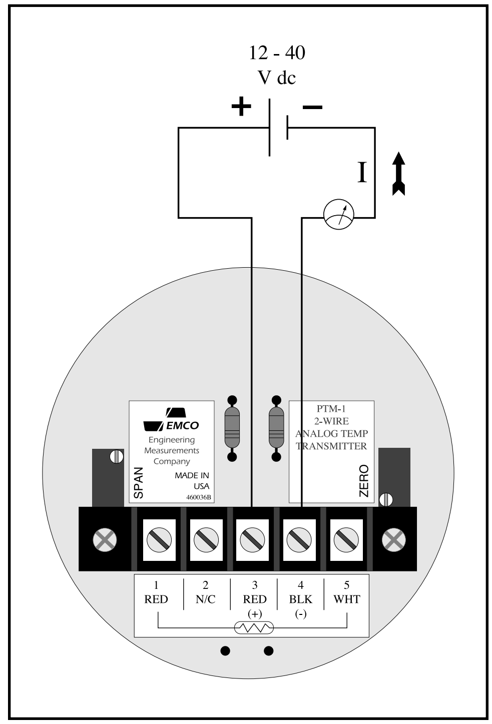


Figure 6-35. TEM Internal Wiring

TEM: Zero and Span Adjustments

Using a 24 VAC power supply, precision R-box, and digital multimeter, make the connections to the TEM as shown in Figure 6-36. Refer to the TEM calibration data supplied with the instrument. (A copy is also inside the condulet). The table below is an example of this data sheet.

Calibration Data

4.00 mA: 32 °F = 1000.00W
8.00 mA: 41 °F = 1019.03W
12.0 mA: 50 °F = 1038.04W
16.0 mA: 59 °F = 1057.02W
20.0 mA: 68 °F = 1075.96W

Step 1. Set the R-box to zero scale (4 mA), according to the resistance value in the calibration data.

Step 2. Turn the zero adjustment potentiometer until the output reads 4 ± 0.016 mA.

Step 3. Set the R-box to full-scale (20 mA), according to the resistance value on the calibration data.

Step 4. Turn the span adjustment potentiometer until the output reads 20 ± .016 mA.

Step 5. Because the span adjustment affects the zero point, repeat the steps above until the zero and span readings are within ± 0.016 of zero and full- scale.

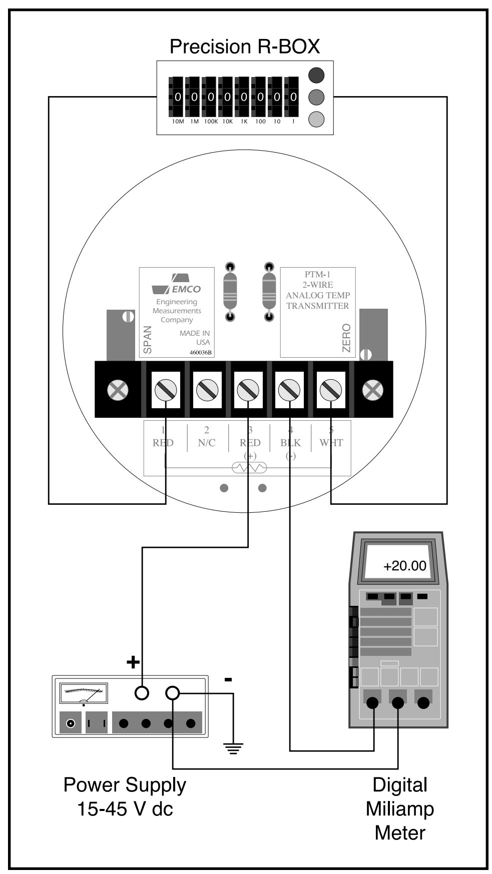


Figure 6-36. Zero and Span Adjustments for TEM

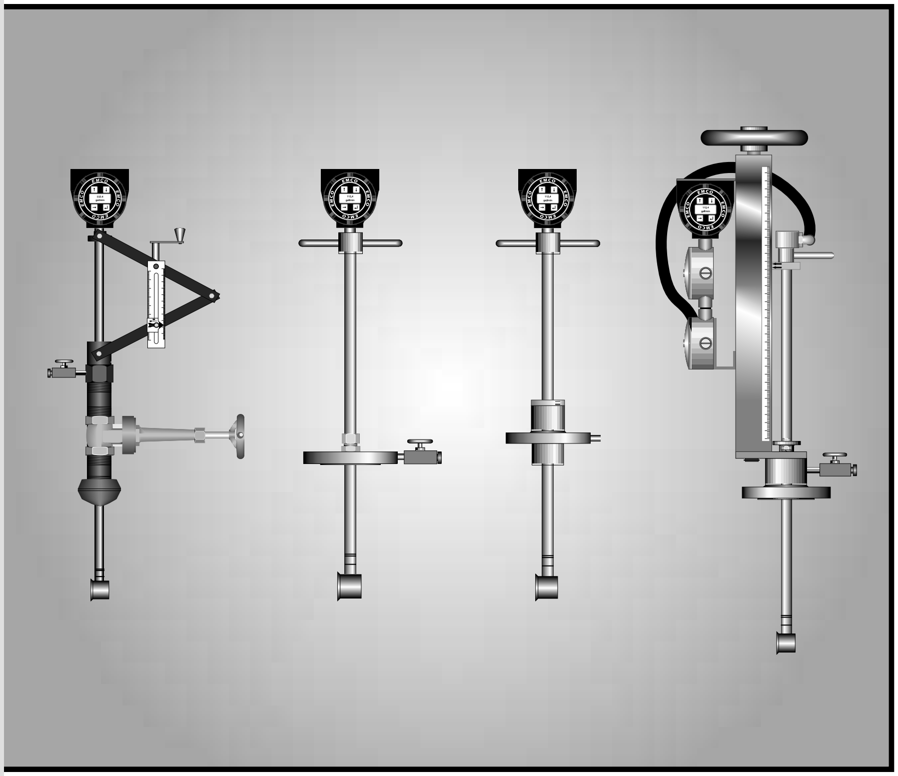
insertion
vortex
flowmeter

Model V-Bar General Specification

V-Bar-600/60S
V-Bar-700
V-Bar-800/80S
V-Bar-910/960

Features

- **Fluid types: liquid, gas or steam**
- **Pipe sizes: 3 to 80 in. (80 to 2000 mm)**
- **Negligible head loss**
- **Rugged construction**
- **Reliability: no moving parts**
- **Process pressure up to 2000 psig (138 barg)**
- **Process temperatures up to 500 °F (260 °C)**
- **Industry standard frequency and/or 4–20 mA output signals**
- **Optional integral pressure and/or temperature measurement**
- **Compatible with HART® protocol**
- **EZ-Logic™ menu-driven user interface (microprocessor-based)**
- **Local programming via EZ-Logic keypad or magnet wand through explosion-proof enclosure**



EMCO's model V-Bar™ Insertion Vortex Flowmeters measure flow rates for a wide variety of fluids and pipe sizes. Unlike an inline flowmeter, which replaces a section of pipe, an insertion meter is "tapped" into the flow line and can be mounted virtually anywhere.

EMCO's V-Bar insertion flowmeters have three main components: the retractor, the sensor, and the electronics. The retractor serves to position the sensor within the pipe. The sensor detects the pattern of vortices as a frequency signal. The "Smart," microprocessor-based EZ-Logic electronics conditions the signal and provides a frequency output, a scaled pulse output, or a 4–20 mA dc signal proportional to the average pipe flow rate.

Most V-Bar flowmeters can be installed on an isolation valve, which permits installation and removal without process shutdown. Integral pressure and/or temperature measurement may be combined with the V-Bar to provide mass flow measurement from a single pipe tap. In addition, a flow processor may be used to increase the accuracy and functionality of the metering system.

EMCO

Engineering Measurements Company
303.651.0550 • 303.678.7152 Fax
sales@emcoflow.com

Performance Specifications

Accuracy (linear ranges)

Liquid .... ±1.0% of flow rate
Test conditions: Water at 60 °F (15 °C), 50 psig (3.4 barg) with a flow rectifier and 10 pipe diameters upstream.
Gas and Steam .... ±1.5% of flow rate
Test conditions: Air at 68 °F (20 °C), 2 psia (2 bara) with a flow rectifier and 10 pipe diameters upstream.
Analog Output....................................... add ±0.1% of full scale

Repeatability

±0.15% of flow rate

Response Time

Adjustable from 1 to 100 seconds

Operating Specifications

Applied Pipeline Sizes

3 to 80 in. (80 to 2000 mm)
For larger pipe sizes, a one or two foot stem extension may be required.

Fluid Types

V-Bar-600 .... Liquid or gas
V-Bar-60S .... Steam
V-Bar-700 .... Liquid, gas, or steam
V-Bar-800 .... Liquid or gas
V-Bar-80S .... Steam
V-Bar-910/960 .... Liquid, gas, or steam

Linear Range

Reynolds number from 20,000 to 7,000,000

Measurable Flow Velocities

Liquid Flow...................................... 1.5 to 32 ft/s (0.5 to 9 m/s)
For liquids, use the following equations to calculate the average flow velocity:

Velocity in ft/s = $0.4085(Q_1/D^2)$
where Q = volumetric flow (gpm)
D = pipe inside diameter (in.)

Velocity in m/s = $353.7(Q_1/D^2)$
where Q = volumetric flow (m^3/h)
D = pipe inside diameter (mm)

Gas and Steam Flow .... $\sqrt{\frac{50}{\rho}}$ to 300 ft/s ($\sqrt{\frac{74}{\rho}}$ to 91 m/s)

where ρ = density (lb/ft^3) (ρ = density (kg/m^3))

For gases, use the following equations to calculate the average flow velocity:

Velocity in ft/s = $3.056(Q_g/D^2)$
where Q = volumetric flow (ft^3/min)
D = pipe inside diameter (in.)

Velocity in m/s = $353.7(Q_g/D^2)$
where Q = volumetric flow (m^3/h)
D = pipe inside diameter (mm)

For steam, use the following equations to calculate the average flow velocity:

Velocity in ft/s = $0.051 \frac{M}{\rho \bullet D^2}$

where M = mass flow (lbs/hr)
D = pipe inside diameter (in)
ρ = fluid density (lbs/ft^3)

Velocity in m/s = $353.7 \frac{M}{\rho \bullet D^2}$

where
M = mass flow (kg/h)
D = pipe inside diameter (mm)
r = fluid density (kg/m^3)

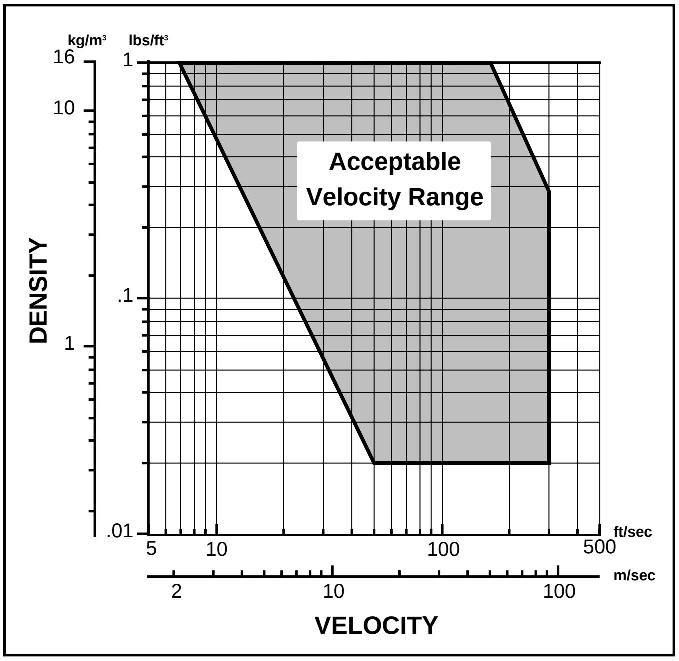


Figure A-1. Density vs. velocity

Process Viscosity
Reynolds number must be > 20,000. The Figure below translates the minimum Reynolds number, 20,000, to the minimum measurable pipe velocity.

$$\text{Kinematic Viscosity } \upsilon = \frac{\mu\,(cP)}{S.G.}$$

$$Re = \frac{124\rho VD}{\mu}$$

where ρ = fluid density
V = average velocity (lb/ft³)
D = pipe inside diameter (in.)
μ = fluid viscosity (cP)
S.G. = specific gravity

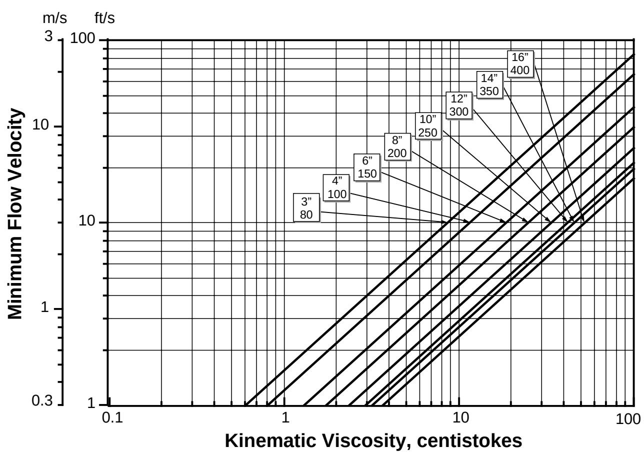


Figure A-2. Viscosity vs. velocity

Process Temperature Limit
V-Bar-600/60S, V-Bar-800/80S, and V-Bar-910
–40 to 400 °F (–40 to 204 °C)
V-Bar-700 and V-Bar-960
–40 to 500 °F (–40 to 260 °C)

Ambient Temperature Limit
32 to 140 °F (0 to 60 °C)

Ambient Humidity Limit
5 to 100% relative humidity non-condensing

Process Pressure Limit
V-Bar-600/60S
125 psi (8.62 bar)
V-Bar-700 with NPT connection
2000 psi (138 bar)
V-Bar-700 with flanged connection
According to flange rating, up to 900 psi
V-Bar-800/80S
50 psi (3.45 bar)
V-Bar-910/960
According to flange rating, up to 900 psi

Power Requirements
Standard
Isolated 18–40 VAC, 35 mA maximum.

Note: Maximum voltage with pressure transmitter option is 30 volts.

Optional
110/220 VAC

NOTE: All power wiring must be enclosed in rigid conduit and a watertight and/or explosion proof seal applied at the condulet entry.

Output Signals
Analog
4–20 mA, 2-wire system, digitally adjusted span
Frequency
Voltage pulses, 3-wire system, 0 to 3000 Hz square wave, 50% duty cycle. The pulse output can be scaled so that 1 pulse indicates a specific quantity of fluid passing through the pipe.
- Low Level: 0 to 1 volts
- High Level: power supply voltage-load

Hart® communications protocol

Display (LOC-TOT)
2-line by 8-character LCD digital display alternately show flow rate and totalized flow in user-selectable engineering units.

Four buttons (up, down, right, enter) operable either directly on the display panel or with a hand-held magnetic wand through the explosion-proof enclosure enable local programming. Local programming follows the EZ-Logic menu-driven user interface, which is the standard interface for EMCO flowmeter instrumentation.

Zero & Span Setting (analog output only)
Zero and span calibration can be performed without a frequency source by programming the flow rate using the EZ-Logic interface.

Physical Specifications

Materials

Wetted Parts
316L stainless steel or the cast equivalent, CF3M (bronze & carbon steel on V-Bar-600/60S)

External Parts
Aluminum, 316 stainless steel, carbon steel (bronze & carbon steel on V-Bar-600/60S)

Electrical Enclosure
383 Aluminum. Approved for NEMA 4X watertight and dusttight requirements.

Retractor Type

V-Bar-600/60S .... Screw thread, rising stem
V-Bar-700 .... Not retractable
V-Bar-800/80S .... Manual rising stem
V-Bar-910/960 .... Acme thread, non-rising

Seal Type

V-Bar-600 .... Viton™ O-ring
V-Bar-60S .... Ethylene propylene O-ring
V-Bar-700 .... Swagelok™
V-Bar-800 .... Viton™ O-ring
V-Bar-80S .... Ethylene propylene O-ring
V-Bar-910 .... Teflon™ packing rings
V-Bar-960 .... Grafoil™ packing rings Carbide)

Process Connection

V-Bar-600/60S .... 2" NPT
V-Bar-700 .... 2" NPT or 2" 150#, 300#, 600# or 900# ANSI raised face flange
V-Bar-800/80S .... 2" NPT or 2" 150# ANSI raised face flange
V-Bar-910/960 .... 2" 150#, 300#, 600# or 900# ANSI raised face flange

Isolation Valve (V-Bar-600/60S only)

2" full port bronze gate valve, 125 psi (8.62 bar) maximum. For V-Bar-800/80S and V-Bar-910/960, see Accessories.

Pressure Tap and Bleed Valve

Standard ¼" NPT pipe nipple with ¼" stainless steel bleed valve (bleed valve is bronze for V-Bar-600/60S only). Provides connections for mounting optional pressure transmitter (Model PT).

Model PT Pressure Transmitter (Optional)

A pressure transmitter can be mounted using the ¼" NPT connection on the bleed valve supplied with the meter, eliminating the need for a separate pressure tap. A 4–20 mA output, scaled to the desired pressure range, is provided. All pressure transmitters include a siphon tube, bleed valve, plug, nipple, and tee. A pressure transmitter is not available with 110/220 VAC power. See the PT General Specifications for complete details.

Temperature Sensor (RTD Option)

A 1000 Ω, 3-wire, platinum RTD can be mounted inside the stem of the flowmeter probe, eliminating the need for a separate temperature tap.

Temperature Transmitter (TXX Option)

Includes the RTD option with an additional 4–20 mA output, scaled to the desired temperature range. A temperature transmitter is not available with 110/220 VAC power.

Remote Mount Electronics (RMT Option)

30 ft (9.144 m) signal cable and U-bolts are provided with remote mount electronics. Cable must be run in conduit (conduit not supplied). Conduit connection is 3/4" NPT (PG 13.5).

Approvals

FM Approval (FM Option)
Certified by FM for Class I, Division 2, Groups A, B, C and D; Class II, III, Division 2, Groups F and G.

FM option is not available when using a 4-20 mA temperature transmitter or a 110/220 VAC power supply option. Use the RTD option only for temperature selection, if FM is required.

CSA Approval (CSA Option)
Certified by CSA for Hazardous Locations Class I, Division 2, Groups A, B, C and D; Class II, Division 2, Groups F and G; Class III.

CSA option is not available when using a 4-20 mA temperature transmitter or a 110/220 VAC power supply option. Use the RTD option only for temperature selection, if CSA is required.

Accessories

Gate Valve (Model 2GV) (For use with V-Bar-800/80S and V-Bar-910/960 only)
Installation with a 2" double flanged, raised-face, full port gate valve enables the flow sensor to be inserted and removed from the pipe under full flow conditions. Both the valve and pipe tap must have a minimum 1.875 in. (48 mm) internal diameter clearance.

Flow Rectifier (Model EFR)
A flow rectifier (EFR) is recommended when there is insufficient straight pipe run or flow disturbance. When using an EFR, the straight pipe run can be a combination of 5 pipe diameters upstream and 2 pipe diameters downstream, instead of the standard 10 and 5.

Flow Processors (Models FP-93 and FP-100)
A microprocessor-based flow processor can be used to significantly increase the accuracy and functionality of any flowmetering application. See the FP-93 or FP-100 General Specifications for complete details.

Measurable Flow Rates

Water Minimum and Maximum Flow Rates[1]							
in. (mm)	**3 (80)**	**4 (100)**	**6 (150)**	**8 (200)**	**12 (300)**	**16 (400)**	**24 (600)**
gpm	35 737	60 1,270	135 2,882	234 4,990	523 11,164	826 17,625	1,879 40,096
m^3/h	2 46	2 80	9 182	15 315	33 704	52 1,112	119 2,530

Table A-1. Water Minimum and Maximum Flow Rates.

Note:
1. Standard conditions of 60 °F (15 °C) and 14.7 psia (1.013 bar) in schedule 40 pipe.

Air Minimum and Maximum Flow Rates (SCFM[1])							
Pressure[2] (Density)[3]	**3"**	**4"**	**6"**	**8"**	**12"**	**16"**	**24"**
0 (0.0764)	79 924	136 1,591	308 3,611	533 6,253	1,193 13,991	1,883 22,089	4,284 50,250
50 (0.3368)	165 4,073	285 7,015	646 15,916	1,119 27,561	2,504 61,665	3,954 97,355	8,995 221,469
100 (0.5979)	220 7,229	380 12,452	861 28,253	1,491 48,923	3,337 109,461	5,268 172,814	11,984 393,129
150 (0.8600)	264 9,449	455 16,272	1,033 36,927	1,789 63,943	4,002 143,067	6,318 225,869	14,373 513,823
200 (1.1219)	302 10,792	520 18,589	1,180 42,175	2,043 73,030	4,571 163,400	7,216 257,971	16,415 586,851
300 (1.6480)	366 13,080	630 22,530	1,430 51,117	2,476 88,514	5,540 198,044	8,746 312,667	19,896 711,276
400 (2.1760)	420 15,030	724 25,889	1,643 58,736	2,845 101,709	6,365 227,567	10,050 359,276	22,862 817,305
500 (2.7054)	469 16,759	807 28,866	1,832 65,493	3,172 113,408	7,098 253,742	11,206 400,602	25,491 911,316
Air Minimum and Maximum Flow Rates (NCMM[4])							
Pressure[5] (Density)[6]	**80mm**	**100mm**	**150mm**	**200mm**	**300mm**	**400mm**	**600mm**
0 (1.2238)	2 25	4 47	8 97	14 167	32 374	50 591	115 1,345
3.4 (5.3950)	4 109	8 204	17 426	30 738	67 1,650	106 2,605	241 5,926
6.9 (9.5774)	6 193	11 366	23 756	40 1,309	89 2,929	141 4,624	321 10,520
11.0 (14.6089)	7 260	14 492	28 1,018	49 1,762	110 3,942	174 6,224	396 14,159
13.8 (17.9711)	8 289	15 546	32 1,129	55 1,954	122 4,372	193 6,903	439 15,704
20.7 (26.3985)	10 350	19 662	38 1,368	66 2,369	148 5,299	234 8,367	532 19,033
27.6 (34.8562)	11 402	21 761	44 1,572	76 2,722	170 6,089	269 9,614	612 21,870
34.5 (43.3364)	13 448	24 848	49 1,753	85 3,035	190 6,790	300 10,720	682 24,386

Table A-2. Air Minimum and Maximum Flow Rates.

Notes:
1. Standard conditions of 60 °F and 14.7 psia in schedule 40 pipe.
2. psig
3. lb/ft^3
4. Standard conditions of 15 °C and 1.013 bar in schedule 40 pipe.
5. bar
6. kg/m^3

Measurable Flow Rates

Saturated Steam Minimum and Maximum Flow Rates (lb/h[1])							
Pressure[2] (Density)[3]	**3**	**4**	**6**	**8**	**12**	**16**	**24**
0 (0.0373)	252 2,069	435 3,563	987 8,087	1,709 14,004	3,823 31,333	6,035 49,468	13,729 112,534
50 (0.1496)	506 8,297	871 14,287	1,976 32,425	3,421 56,148	7,654 125,627	12,085 198,336	27,491 451,189
100 (0.2570)	663 14,250	1,141 24,538	2,589 55,688	4,483 96,431	10,031 215,758	15,837 340,632	36,027 774,893
150 (0.3630)	787 20,116	1,356 34,640	3,076 78,613	5,327 136,129	11,919 304,577	18,817 480,858	42,805 1,093,889
200 (0.4682)	894 25,957	1,540 44,698	3,494 101,439	6,051 175,654	13,539 393,013	21,374 620,477	48,624 1,411,504
300 (0.6794)	1,077 37,667	1,855 64,862	4,209 147,200	7,289 25,895	16,309 507,308	25,748 900,386	58,574 2,048,260
400 (0.8930)	1,235 44,149	2,127 76,024	4,826 172,531	8,357 298,759	18,698 668,452	29,520 1,055,332	67,154 2,400,742
500 (1.1102)	1,377 49,228	2,371 84,770	5,381 192,380	9,318 333,129	20,849 745,351	32,916 1,176,739	74,879 2,676,927
Saturated Steam Minimum and Maximum Flow Rates (kg/h[4])							
Pressure[5] (Density)[6]	**80**	**100**	**150**	**200**	**300**	**400**	**600**
0 (0.5980)	114 938	216 1,773	448 3,668	775 6,352	1,734 14,212	2,737 22,438	6,227 51,045
3.4 (2.3730)	230 3,763	431 7,037	896 14,708	1,552 25,468	3,472 56,983	5,482 89,964	12,470 204,656
6.9 (4.1190)	301 6,464	568 12,216	1,174 25,260	2,033 43,740	4,550 97,866	7,184 154,508	16,342 351,485
11.0 (6.1340)	367 9,655	693 18,191	1,435 37,731	2,486 65,336	5,561 146,186	8,780 230,793	19,973 525,024
13.8 (7.5040)	406 11,774	766 22,254	1,585 46,012	2,745 79,675	6,141 178,268	9,695 281,444	22,055 640,247
20.7 (10.8900)	489 17,085	923 32,294	1,909 66,769	3,306 115,618	7,398 258,687	11,679 408,408	26,569 929,075
27.6 (14.3100)	560 20,026	1,058 37,839	2,189 78,259	3,791 135,515	8,481 303,205	13,390 478,690	30,461 1,088,958
34.5 (17.8000)	625 22,329	1,180 42,193	2,441 87,262	4,227 151,105	9,457 338,085	14,930 533,760	33,965 1,214,233

Table A-3. Saturated Steam Minimum and Maximum Flow Rates.

Notes:
1. Standard conditions of 60 °F and 14.7 psia in schedule 40 pipe.
2. psig
3. lb/ft³
4. Standard conditions of 15 °C and 1.013 bar in schedule 40 pipe.
5. bar
6. kg/m³

Natural Gas Minimum and Maximum Flow Rates (SCFM[1])							
Pressure[2] (Density)[3]	**3"**	**4"**	**6"**	**8"**	**12"**	**16"**	**24"**
0 (0.0457)	102 924	175 1,588	398 3,611	690 6,253	1,543 13,991	2,437 22,089	5,543 50,250
50 (0.2067)	217 4,184	368 7,044	848 16,352	1,468 28,315	3,284 63,352	5,185 100,019	11,795 227,529
100 (0.3695)	290 7,478	492 12,588	1,133 29,223	1,962 50,603	4,390 113,221	6,931 178,750	15,768 406,634
150 (0.5350)	341 10,590	588 18,236	1,334 41,384	2,309 71,662	5,166 160,338	8,157 253,137	18,555 575,854
200 (0.7030)	400 14,227	679 23,945	1,563 55,600	2,707 96,279	6,056 215,417	9,561 340,094	21,749 773,669
300 (1.475)	488 17,455	829 29,623	1,908 68,212	3,304 118,117	7,392 264,278	11,671 417,235	26,550 949,156
400 (1.4036)	565 20,204	959 34,286	2,209 78,958	3,824 136,725	8,557 305,912	13,510 482,965	30,732 1,098,683
500 (1.7715)	635 22,698	1,077 38,513	2,481 88,705	4,297 153,603	9,613 343,676	15,177 542,586	34,526 1,234,312
Natural Gas Minimum and Maximum Flow Rates (NCMM[4])							
Pressure[5] (Density)[6]	**80mm**	**100mm**	**150mm**	**200mm**	**300mm**	**400mm**	**600mm**
0 (0.7320)	3 25	5 47	11 97	18 167	14 374	65 591	148 1,345
3.4 (3.3110)	6 112	11 205	23 438	39 758	88 1,695	139 2,676	316 6,088
6.9 (5.9188)	8 200	14 371	30 782	53 1,354	117 3,030	185 4,783	422 10,881
11.0 (9.1033)	10 308	18 569	38 1,203	65 2,083	146 4,660	230 7,357	523 16,735
13.8 (11.2610)	11 381	20 706	42 1,488	72 2,576	162 5,764	256 9,101	582 20,703
20.7 (16.7794)	13 467	24 873	51 1,825	88 3,161	198 7,072	312 11,165	710 25,399
27.6 (22.4835)	15 541	28 1,010	59 2,113	102 3,659	229 8,186	362 12,924	822 29,400
34.5 (28.3767)	17 607	32 1,135	66 2,374	115 4,110	257 9,196	406 14,519	924 33,029

Table A-4. Natural Gas Minimum and Maximum Flow Rates.

Notes:
1. Standard conditions of 60 °F and 14.7 psia in schedule 40 pipe.
2. psig
3. lb/ft³
4. Standard conditions of 15 °C and 1.013 bar in schedule 40 pipe.
5. bar
6. kg/m³
7. Approximate specific gravity of natural gas = 0.61 and 0.8% N_2.

Model and Suffix Codes

Category	Description	Suffix Codes					
Model	Liquid or gas service, 400 °F (204 °C)	600	. . .	. . .	. . .	. . .	. . .
	Steam service, 400 °F (204 °C)	60S	. . .	. . .	. . .	. . .	. . .
	Liquid, gas, or steam service, 500 °F (260 °C)	700	. . .	. . .	. . .	. . .	. . .
	Liquid or gas service, 400 °F (204 °C)	800	. . .	. . .	. . .	. . .	. . .
	Steam service, 400 °F (204 °C)	80S	. . .	. . .	. . .	. . .	. . .
	Liquid, gas, or steam service, 400 °F (204 °C)	910	. . .	. . .	. . .	. . .	. . .
	Liquid, gas, or steam service, 500 °F (260 °C)	960	. . .	. . .	. . .	. . .	. . .
Connection	2", male NPT (model 700, 800, 80S)	. . .	2NPT	. . .	. . .	. . .	. . .
	2", 150# flange (model 700, 800, 80S, 910, 960)	. . .	2F150	. . .	. . .	. . .	. . .
	2", 300# flange (model 700, 910, 960)	. . .	2F300	. . .	. . .	. . .	. . .
	2", 600# flange (model 700, 910, 960)	. . .	2F600	. . .	. . .	. . .	. . .
	2", 900# flange (model 700, 910, 960)	. . .	2F900	. . .	. . .	. . .	. . .
	Thread-o-let, xx = 03-80 inches (models 600, 60S) includes 2" isolation valve	. . .	VXX	. . .	. . .	. . .	. . .
Pressure Transmitter	No pressure transmitter	. . .	. . .	XX	. . .	. . .	. . .
	PT for pressure range 0-50 psig (0-3.44 barg)	. . .	. . .	50	. . .	. . .	. . .
	0-100 psig (0-6.89 barg)	. . .	. . .	100	. . .	. . .	. . .
	0-150 psig (0-10.34 barg)	. . .	. . .	150	. . .	. . .	. . .
	0-200 psig (0-13.79 barg)	. . .	. . .	200	. . .	. . .	. . .
	0-250 psig (0-17.24 barg)	. . .	. . .	250	. . .	. . .	. . .
	0-500 psig (0-34.47 barg)	. . .	. . .	500	. . .	. . .	. . .
	0-1000 psig (0-68.95 barg)	. . .	. . .	1000	. . .	. . .	. . .
	Special scaling requests[1]	. . .	. . .	PXX	. . .	. . .	. . .
Temperature Sensor or Transmitter	No temperature transmitter	. . .	. . .	. . .	XXX	. . .	. . .
	Temperature sensor without preamplifier (RTD only) Teflon RTD internal wires –40 to 400 °F (–40 to 204 °C)	. . .	. . .	. . .	RTD-T	. . .	. . .
	Temperature sensor without preamplifier (RTD only) Fiberglass RTD internal wires 150 to 800 °F (65 to 427 °C) (models 700 and 960 only)	. . .	. . .	. . .	RTD-F	. . .	. . .
	Temperature sensor with preamplifier scaled from 32 to 68 °F (liquid/gas)	. . .	. . .	. . .	T09	. . .	. . .
	0 to 250 °F (liquid/gas)	. . .	. . .	. . .	T10	. . .	. . .
	–40 to 150 °F (liquid/gas)	. . .	. . .	. . .	T11	. . .	. . .
	212 to 400 °F (liquid/gas)	. . .	. . .	. . .	T12	. . .	. . .
	212 to 500 °F (steam) (model 700, 910, 960 only)	. . .	. . .	. . .	T14	. . .	. . .
	–17.7 to 121.1 °C (liquid/gas)	. . .	. . .	. . .	T20	. . .	. . .
	–40 to 65 °C (liquid/gas)	. . .	. . .	. . .	T21	. . .	. . .
	100 to 204 °C (steam)	. . .	. . .	. . .	T22	. . .	. . .
	100 to 260 °C (liquid/gas) (model 700, 910, 960 only)	. . .	. . .	. . .	T24	. . .	. . .
	Special scaling requests[1]	. . .	. . .	. . .	TXX	. . .	. . .
Electronics	EZ-Logic with local rate and total [2]	. . .	. . .	. . .	. . .	. . .	LOC-TOT
	Remote mount electronics [3]	. . .	. . .	. . .	. . .	. . .	RMT
	FM Approval[6]	. . .	. . .	. . .	. . .	. . .	FM
	CSA Approval[7]	. . .	. . .	. . .	. . .	. . .	CSA
	Integral 110 V ac input [4,5]	. . .	. . .	. . .	. . .	. . .	110
	Integral 220 V ac input [4,5]	. . .	. . .	. . .	. . .	. . .	220

Table A-5. V-Bar Model and Suffix Codes.

Notes:
1. Special transmitter scaling is available. Please note scaling range below model code when ordering. If no special scaling is indicated, transmitter will be scaled per model code.
2. Unidirectional only. Unit has 4-20 mA and frequency output.
3. The standard remote option comes with 30 feet of cable.
4. Not available for use with pressure and temperature transmitters.
5. Not available with European CE Mark.
6. Certified by FM and CSA for Class I, Division 2, Groups A, B, C, D; Class II, III, Div. 2, Groups F, G. Not approved by FM and CSA when using a 4-20 mA temperature transmitter or a 110/220 VAC power supply option. If FM or CSA is required, use RTD option only for temperature selection.

Please specify the following information with your order:
- Fluid type or composition
- Maximum, minimum, and normal operating flow rate
- Maximum, minimum, and normal operating temperatures
- Maximum, minimum, and normal operating pressures
- Specific weight and viscosity at normal operating conditions

industrial

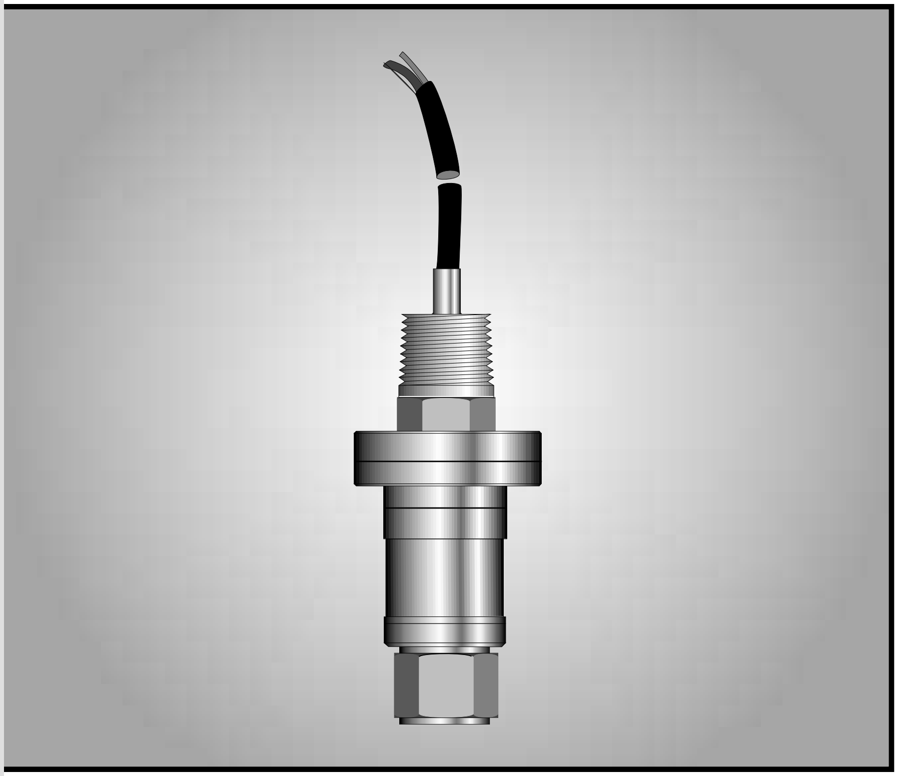
pressure

transmitter

Model PT General Specification

Features

- **Process pressure range: 1.5 to 1,000 psi (0.1 to 69 bar)**
- **Accuracy of ± 0.25% of full scale**
- **Process temperature range: −40 to 250 °F (−40 to 121 °C)**
- **2-wire, 4 to 20 mA output**
- **CE Approved**
- **FM Approved for Class I, Division 2, Groups A, B, C, D; Class II & III, Division 2, Groups F, G**



The PT combines micro-machined silicon diaphragms with fully welded stainless steel and hastelloy pressure ports to provide a highly accurate, stable pressure transmitter. It is constructed with the materials and environmental protection required for industrial applications.

The silicon sensors incorporate developments derived from aerospace applications and use them to decrease output noise, non–linearity, and hysteresis and to improve long term stability.

A detachable industrial electrical connector provides access to the independent zero and span trim controls. If any on-site configuration changes to the electrical or pressure connections are required, replacement parts and screw in pressure adaptors are available.

Each transmitter incorporates RFI/EMC and electrical spike protection.

Performance Specifications

Accuracy
0.25% of full scale (the best straight line–determined from the combined effects of non-linearity, hysteresis, and repeatability).

Ambient Temperature Effects
For ranges of 5 psi and above, the output will not deviate from room temperature calibration by more than:
2.0% full scale over 15 to 122 °F (–9.4 to 50 °C)
3.0% full scale over –5 to 175 °F (–20.6 to 79.4 °C)
Typically:
1.0% full scale over 15 to 122 °F (–9.4 to 50 °C)
2.0% full scale over –5 to 175 °F (–20.6 to 79.4 °C)
For ranges below 5 psi these values will increase pro–rata with calibrated span.

Operating Specifications

Service
Liquid, gas, and steam

Operating Pressure Range
See Table B-1.

Proof Pressure
The rated pressure can be exceeded by 2× without degrading performance.

Operating Temperature Range
Ambient ....–40 to 175 °F (–40 to 80°C)
Process Media ....–40 to 250 °F (–40 to 121°C)
Storage–40 to 250 °F (–40 to 121°C)

Power Supply Requirements
9 to 30 VAC, across red wire (positive) and blue wire (negative). This voltage must appear across the transmitter terminals.

Output
4 to 20 mA (2–wire configuration) proportional for zero to full scale pressure

Part Number	Pressure Range	
	psig	barg
011115-1	0 to 50	0 to 3.4
011115-2	0 to 100	0 to 6.9
011115-3	0 to 150	0 to 10.3
011115-4	0 to 200	0 to 13.8
011115-5	0 to 250	0 to 17.2
011115-6	0 to 500	0 to 34.5
011117-2	0 to 1000	0 to 69.0
011117-1	Customer specified.	

Table B-1. Operating Pressure Range.

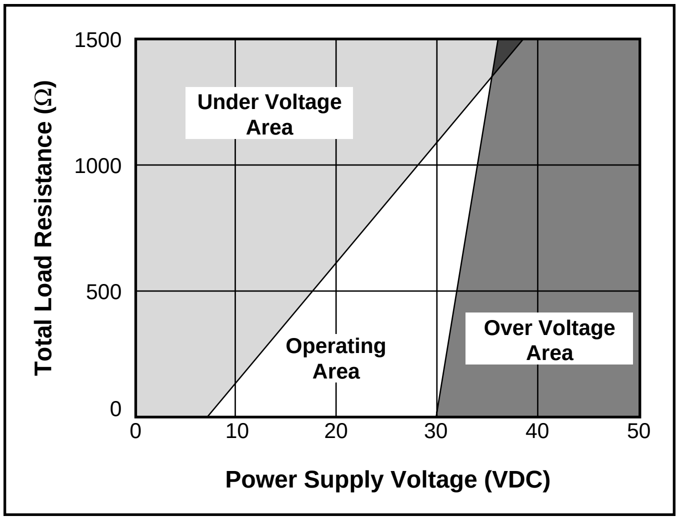


Figure B-1. Operating Pressure Range.

Physical Specifications

Materials of Construction
Isolating Diaphragm .... Hastelloy C®–276
Transducer Body.. 316 stainless steel

Pressure Connection
¼" NPT female

Electrical Connection
Two 22 AWG wires
See Figure B-2.

Weight
14 oz nominal

Calibration Standards
Transmitters are calibrated against precision pressure calibration equipment traceable to NIST.

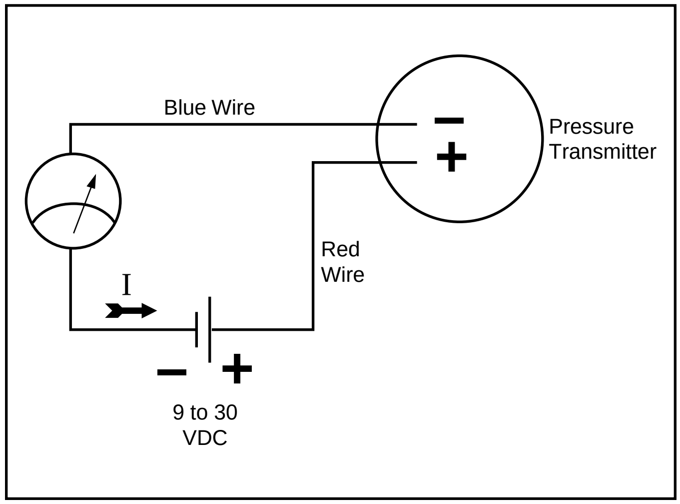


Figure B-2. PT Electrical Connection.

Dimensions

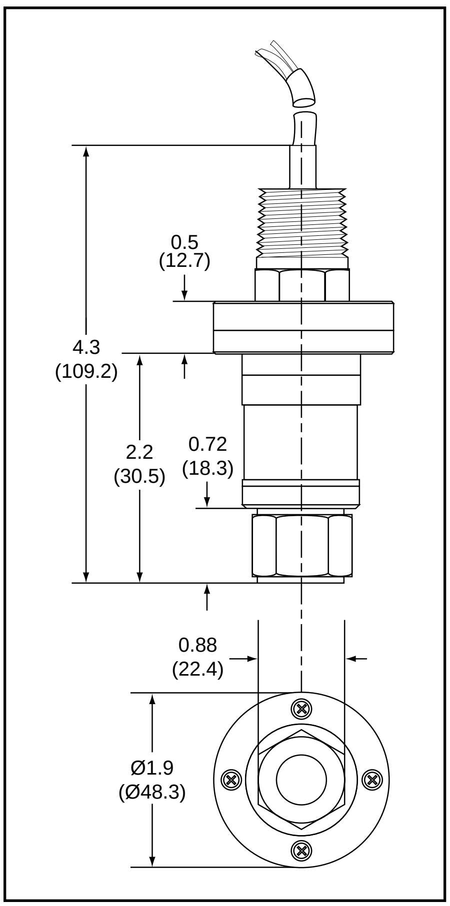


Figure B-3. PT Dimensions.

Zero and Span Adjustments

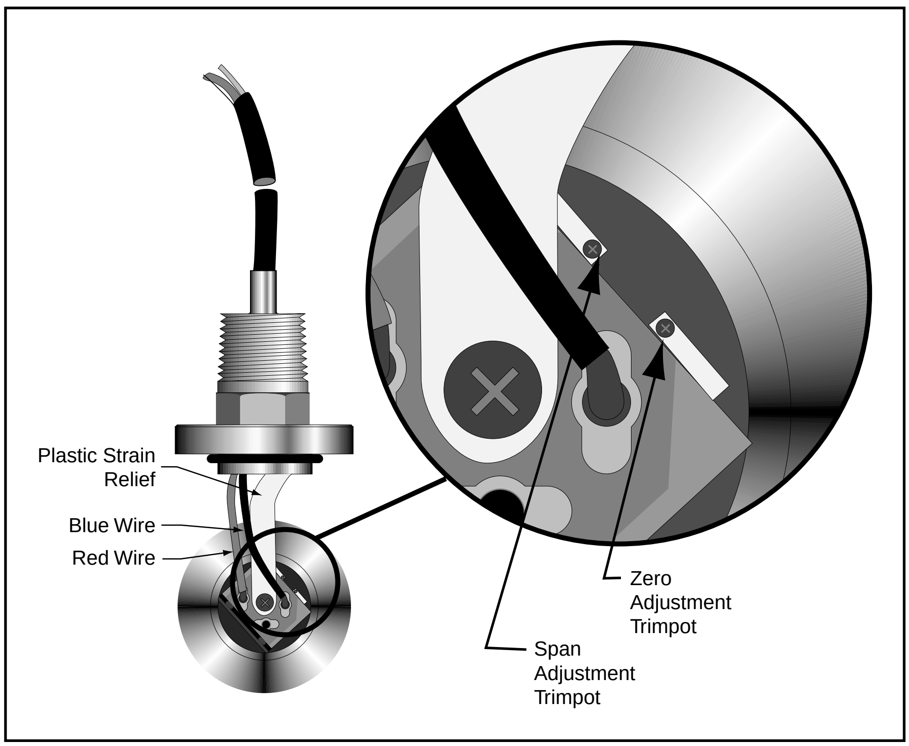


Figure B-4. PT Zero Span Adjustments.

Zero and span adjustments are made using the trimpots. To gain access to trimpots, disassemble the PT as follows:

a. Remove the four screws
b. Gently separate two halves
c. Adjust zero and span as needed
d. Replace the connection plate back on the housing

Mounting Kit

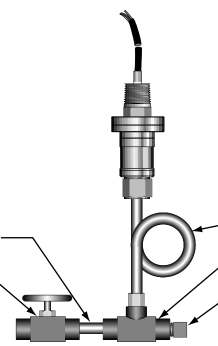


Figure B-5.

Model and Suffix Codes

Description	Part No.
PT for pressure range 0–50 psig (0–3.44 barg)	011115-1
PT for pressure range 0–100 psig (0–6.99 barg)	011115-2
PT for pressure range 0–150 psig (0–10.34 barg)	011115-3
PT for pressure range 0–200 psig (0–13.79 barg)	011115-4
PT for pressure range 0–250 psig (0–17.24 barg)	011115-5
PT for pressure range 0–500 psig (0–34.47 barg)	011115-6
PT for pressure range 0–1000 psig (0–68.95 barg)	011117-2
PT to accommodate special requests and bar scaling.[1]	011117-1
Mounting Kit includes bleed valve, siphon tube, plug, nipple, and tee. Must be used with PT if process temperature is above 250°F (121° C)	010589-4

Table B-2. PT Model and Suffix Codes.

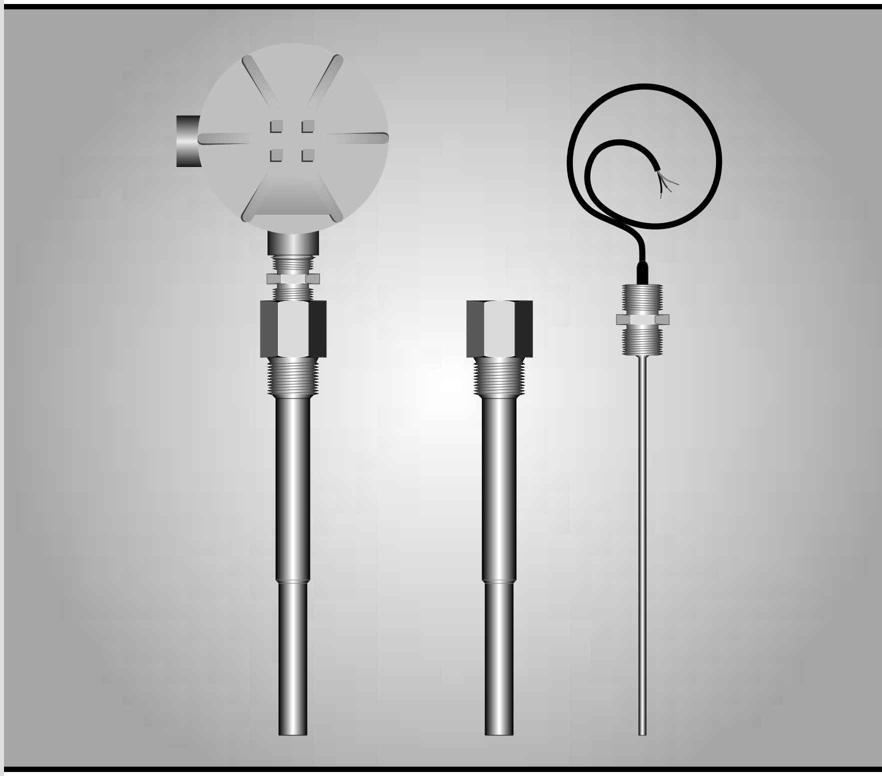
Notes:
1. Determine the pressure range that is the most appropriate for your application. Contact your EMCO representative for details.
2. Specify the typical service conditions. A siphon tube on the PT is required for all applications above 250 °F (121 °C).

precision
temperature
sensor/transmitter

Model TEM General Specification

Features

- RTD or 4-20 mA current output (linear)
- Factory calibrated over selected range
- Rugged design
- Thermowell included



EMCO's TEM platinum resistance temperature sensors measure process fluid temperature for most applications. The TEM uses a resistance temperature device (RTD) to measure process temperature. RTDs operate on the principle that the resistance of the sensing device is proportional to the temperature, producing a highly repeatable and exceptionally stable resistance versus temperature relationship.

The TEM may be selected with either a direct RTD output or with an industry standard 4-20 mA current output. The current output includes a preamplifier that is factory scaled and calibrated to one of several standard temperature ranges in either degrees Fahrenheit or Celsius.

The TEM is thermowell mounted to allow installation and removal without process shutdown. Several immersion lengths are available to accommodate a wide range of pipe sizes.

EMCO

Engineering Measurements Company
303.651.0550 • 303.678.7152 Fax
sales@emcoflow.com

Performance Specifications

RTD Sensor

Accuracy (Ice Point)
± 0.12% (1000 ± 1.2 Ω)

Interchangeability
Accuracy .... ± 0.9 °F or 0.8% (± 0.5 °C)

Stability
Better than ± 0.45 °F (± 0.25 °C) per year

Sensing Element Coefficient
0.00385 Ω/Ω/°C

Preamplifier

Accuracy
± 0.1% of span

Ambient Temperature Effect
Zero....................................... 0.03 + 0.005% of span per °C
Span .... 0.02 + 0.003% of span per °C

Operating Specifications

Temperature Ranges

Ambient Temperature Limit
–30 to 160 °F (–34 to 71 °C)

Storage Temperature Limit
–60 to 185 °F (–51 to 85 °C)

Ambient Humidity Limit
0 to 100% relative humidity

Thermowell Pressure Limit
3500 psig (241 barg) at 1140 °F (615 °C)

RTD Sensor

Output
3-wire RTD

Current
1 mA recommended, 2 mA maximum

Insulation Resistance
100 mΩ minimum at 300 VAC at 75 °F

Optional Preamplifier

Output
4 to 20 mA, 2-wire

Power Supply
24 Vdc nominal, operable from 12 to 40 VAC

Load Resistance
600 Ω at 24 VAC; depends upon power supply voltage

Output	Preamplifier Model Suffix Code	Temperature Range
RTD Sensor	RTD	–40 to 800 °F (–40 to 426 °C)
Transmitter (4 to 20 mA)	T09	32 to 68 °F
	T10	0 to 250 °F
	T11	–40 to 150 °F
	T12	212 to 400 °F
	T14	212 to 500 °F
	T13	212 to 800 °F
	T20	–17.7 to 121.1 °C
	T21	–40 to 65 °C
	T22	100 to 204 °C
	T24	100 to 260 °C
	T23	100 to 426 °C

Table C-1. Temperature Range.

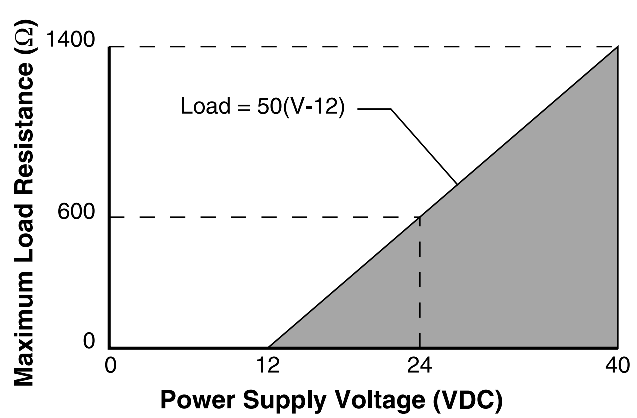


Figure C-1. Permissible Load Resistance Range.

Physical Specifications

Materials

Sensing Element
1000 Ω thin film platinum

RTD Sheath
316 stainless steel

Junction Box
Aluminum

Thermowell
316 stainless steel

Process Connection (Thermowell)
½" NPT

Electrical Connection
Junction box with terminal block for external wiring.
¾" NPT female connection for conduit.

Weight (with 6" Thermowell)
3 lb (1.4 kg)

Dimensions

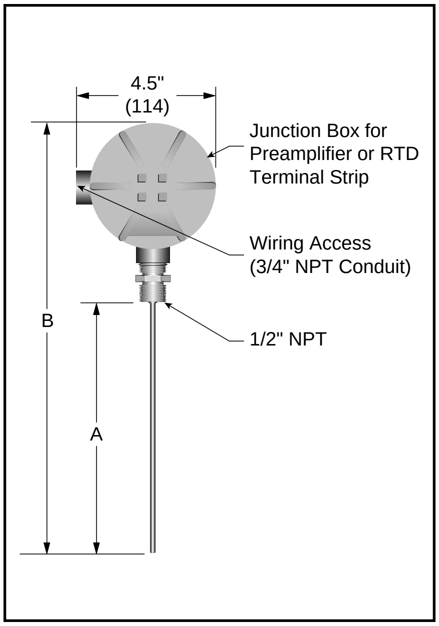


Figure C-2. TEM Probe.

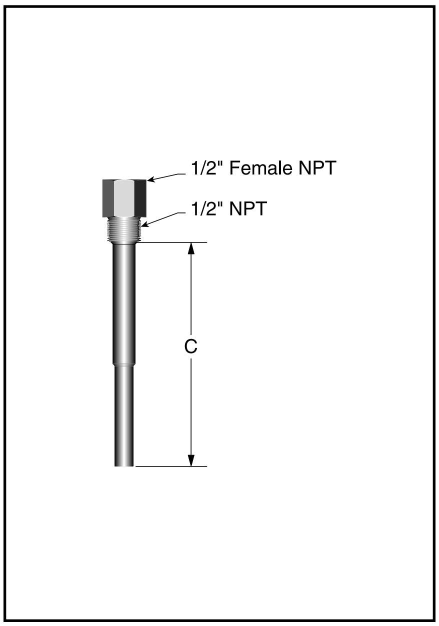


Figure C-3. Thermowell.

Thermowell Length Model Suffix Code	A in. (mm)	B in. (mm)	C in. (mm)
2"	2.5 (64)	9.5 (241)	2 (51)
2.5"	3 (76)	10 (254)	2.5 (64)
3"	3.5 (89)	10.5 (268)	3 (76)
4"	4.5 (114)	11.5 (292)	4 (102)
6"	6.5 (165)	13.5 (343)	6 (152)
8"	8.5 (216)	15.5 (394)	8 (203)
10"	10.5 (268)	17.5 (444)	10 (254)
12"	12.5 (318)	19.5 (495)	12 (305)

Table C-2. Thermowell Dimensions

Note:
Dimensions are in inches (millimeters).

Model and Suffix Codes

Category	Description	Suffix Codes			
Model	Precision RTD with thermowell	TEM-30	. . .	. . .	. . .
Preamplifier (Temperature Range)	None (RTD output only)	. . .	RTD	. . .	. . .
	Preamplifier scaled from: 32 to 68 °F (liquid or gas)	. . .	T09	. . .	. . .
	Preamplifier scaled from: 0 to 250 °F (liquid or gas)	. . .	T10	. . .	. . .
	Preamplifier scaled from: –40 to 150 °F (liquid or gas)	. . .	T11	. . .	. . .
	Preamplifier scaled from: 212 to 400 °F (liquid or gas)	. . .	T12	. . .	. . .
	Preamplifier scaled from: 212 to 500 °F (steam)	. . .	T14	. . .	. . .
	Preamplifier scaled from: 212 to 800 °F (steam)	. . .	T13	. . .	. . .
	Preamplifier scaled from: –17.7 to 121.1 °C (liquid or gas)	. . .	T20	. . .	. . .
	Preamplifier scaled from: –40 to 65 °C (liquid or gas)	. . .	T21	. . .	. . .
	Preamplifier scaled from: 100 to 204 °C (steam)	. . .	T22	. . .	. . .
	Preamplifier scaled from: 100 to 260 °C (liquid or gas)	. . .	T24	. . .	. . .
	Preamplifier scaled from: 100 to 426 °C (steam)	. . .	T23	. . .	. . .
	Transmitters can be scaled to accommodate special requests and bar scaling	. . .	TXX	. . .	. . .
Thermowell Length	2" thermowell length	. . .	. . .	2	. . .
	2.5" thermowell length	. . .	. . .	25	. . .
	3" thermowell length	. . .	. . .	3	. . .
	4" thermowell length	. . .	. . .	4	. . .
	6" thermowell length	. . .	. . .	6	. . .
	8" thermowell length	. . .	. . .	8	. . .
	10" thermowell length	. . .	. . .	10	. . .
	12" thermowell length	. . .	. . .	12	. . .
RTD wires (internal)	Teflon, –40 to 400 °F (–40 to 204 °C)	. . .	. . .	. . .	T
	Fiberglass, 150 to 800 °F (65 to 427 °C)	. . .	. . .	. . .	F
Example		**TEM-30-**	**T13-**	**6-**	**F**

Table C-3. PT Model and Suffix Codes.

Appendix D: List of Figures and Tables

Appendix E: How to Contact Us

Quality Statement
Customer satisfaction is the ultimate measure of quality.

Contact
- Phone: (303) 651-0550
- Fax: (303) 678-7152
- E-mail: sales@emcoflow.com
- For technical support, ask for an Applications Engineer.
- To place an order, ask for Customer Service.

Returns
- Call or fax Customer Service for a Return Material Authorization (RMA) number before returning equipment.
- Put the RMA number on the shipping label, and also on a written description of the problem.
- A restocking charge of 25% of the net price is charged for all standard units returned to stock within 6 months.

Glossary

ac Alternating current; an electric current that reverses direction at regular intervals.

ambient temperature the average or mean temperature of the surrounding air which comes in contact with the equipment and instruments in use.

analog output a voltage or current signal that is a continuous function of the measured parameter (i.e. flow, pressure, temperature).

ANSI American National Standards Institute, the primary organization for fostering the development of technology standards in the United States.

AWG American Wire Gauge; A standard of the dimensional characteristics of wire used to conduct electrical current or signals.

bbl Barrel

°C Degrees Celsius

CE A manufacturer's mark that demonstrates compliance with European Union (EU) laws governing products sold in Europe.

cm centimeter

cm³ cubic centimeter

CMOS Complementary Metal Oxide Semiconductor; A kind of integrated circuit used in processors and memories.

cold tap See tap.

conduit A channel or pipe for carrying fluids or a tube or trough for protecting electrical wires.

cP Centipoise.

dc Direct current; an electric current of constant magnitude flowing in one direction only.

density Mass per unit of volume of a substance.
(i.e. g/cm^3, lb/ft^3).

downstream In flowmetering, the piping from the point of flow measurement that is in the direction of flow.

ESD Electrostatic discharge

°F Degrees Fahrenheit

FM Factory Mutual Research Corporation; An organization which sets industrial safety standards.

frequency output An oscillating or varying current, where frequency is the number of complete cycles per second in alternating current direction. The standard unit of frequency is the hertz, abbreviated Hz. If a current completes one cycle per second, then the frequency is 1 Hz; 60 cycles per second equals 60 Hz (the standard alternating-current utility frequency). Larger units of frequency include the kilohertz (kHz) representing thousands (1,000's) of cycles per second, the megahertz (MHz) representing millions (1,000,000's) of cycles per second.

ft Foot

ft² Square foot

ft³ Cubic foot

g Gram

gal Gallon

h Hour

hot tap See tap

Hz Hertz

impedance The total opposition to electrical flow (resistive plus reactive).

in. Inch.

insertion depth the measured length that positions the sensor into the pipe.

ISO International Standards Organization

jumper A pair of prongs that are electrical contact points set into an electronic board. When you set a jumper, you place a plug on the prongs that completes a contact. The jumper settings tell the microprocessor how it is configured and what operations can be performed.

kg Kilogram

kHz Kilohertz

lb pound

m Meter

m³ Cubic meter

mA Milliamp

max. Maximum

min Minute

min. Minimum

mm Millimeter

mΩ Megohm

ms Millisecond

NEMA 4X A standard from the National Electrical Manufacturer's Association) which defines enclosures intended for indoor or outdoor use, primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water.

NIST National Institute of Standards & Technology

NPT National Pipe Thread

Ω ohm

output The electrical signal measured at the output terminals which is produced by an applied input to a transducer.

upstream In flowmetering, the piping from the point of flowmeter that is against the direction of flow.

resistance A measure of the extent to which a substance opposes the movement of electrons among atoms. The more easily the atoms give up and/or accept electrons, the lower the resistance. It is always a positive real-number quantity. Resistance is observed with ac and dc voltage. The standard unit of resistance is the ohm, sometimes written out as a word, and sometimes symbolized by the uppercase Greek letter omega. When an electric current of one ampere passes through a component across which a potential difference (voltage) of one volt exists, then the resistance of that component is one ohm.

Reynolds Number The ratio of inertial and viscous forces in a fluid defined by the formula $Re = \rho VD/\mu$, where: ρ = Density of fluid, μ = Viscosity in centipoise (cP), V = Velocity, and D = Inside diameter of pipe.

RTD Resistance Temperature Detector

s Second

tap To cut a hole in a pipe. A hot tap is performed while there is flow and/or pressure in the pipe being cut. A cold tap is performed when there is no flow or pressure in the pipe.

terminal An input/output device used to enter data into a computer and record the output.

terminal block A group of terminals mounted as one unit.

thread-o-let A threaded steel fitting that is welded to a pipe to provide a mounting for a flowmeter with an NPT connection.

transmitter A device that coverts a physical phenomenon (i.e. flow, pressure, temperature) and converts it to a 4-20 mA 2-wire output.

V Volt

velocity The time rate of change of displacement; dx/dt.

viscosity The inherent resistance of a substance to flow.

weld-o-let A steel fitting that is welded to a pipe to provide a mounting for equipment which does not have threads and may require welding.

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R

S

Providing innovative flowmeter products and services for over three decades . . .

Engineering Measurements Company (EMCO) is a long established manufacturer of precision flowmeters for liquid, gas, and steam applications for commerce and industry. Manufacturing under an ISO 9001 certified quality system, which includes extensive flow calibration capability, engineering, applications, and service, underpins a world-wide sales and service organization totally focused on providing the best flowmeters and customer service in the industry.

- Manufacturing is housed in a modern plant located in Longmont, Colorado
- Modern clean-room, mechanized assembly equipment, and computer based testing ensure the highest quality product
- Trained professional flow specialists and technicians offer timely customer assistance
- Factory trained and certified field technicians provide product support services


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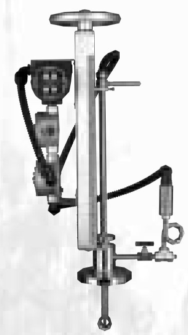
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