Quick Start Guide
LIQ-QSG-228, Rev S
January 2017

Rosemount™ 228 Toroidal Conductivity Sensors

ROSEMOUNT™

EMERSON™

Safety Information

⚠ WARNING!

Before removing the sensor, be absolutely certain that the process pressure is reduced to 0 psig and the process temperature is lowered to a safe level.

⚠ CAUTION!

EQUIPMENT DAMAGE

The wetted sensor materials may not be compatible with process composition and operating conditions. Application compatibility is entirely your responsibility.

Contents

1 Description and Specifications

1.1 Unpacking and Inspection

1. Inspect the shipping container. If it is damaged, contact the shipper immediately for instructions.
2. If there is no apparent damage, remove the sensor.
3. Ensure that all items shown on the packing list are present. If items are missing, notify Rosemount immediately.
4. Save the shipping container and packaging.

   They can be reused to return the sensor to the factory in case of damage.

1.2 Sensor Specifications

Table 1-1: Sensor specifications

Wetted materials	Body materials either glass-filled PEEK, glass-filled Tefzel, or unfilled Tefzel. Option -20 has EPDM gasket
Process connection	-20: 5/8 in. 11 UNC, -21: 3/4 in. MNPT
Cable length	20 ft (6.1 m)
Maximum cable length	200 ft (61.0 m)
Weight/shipping weight	2 lb / 3 lb (1.0 kg / 1.5 kg)

Table 1-2: Maximum operating temperature and pressure

Body material option	Maximum temperature	Maximum pressure	Maximum pressure (for CRN registration only)
-02	248 °F (120 °C)	295 psig (2135 kPa)	220 psig (1618 kPa [abs])
-03	392 °F (200 °C)	295 psig (2135 kPa)	220 psig (1618 kPa [abs])
-04	248 °F (120 °C)	200 psig (1480 kPa)	150 psig (1135 kPa [abs])
-05	248 °F (120 °C)	200 psig (1480 kPa)	150 psig (1135 kPa [abs])

Table 1-3: Insertion adapter specifications

Adapter part number	Sensor compatibility	Process connection	Wetted materials	Maximum temperature	Maximum pressure	Maximum pressure (for CRN registration only)	Weight / shipping weight
23242-02	For use with option -21	1-1/2 in. MNPT	316 stainless steel, glass-filled PEEK, Viton	392 ° F (200 °C)	295 psig (2135 kPa)	220 psig (1618 kPa [abs])	3 lb / 4 lb (1.5 kg / 2.0 kg)
23242-03	For use with option -20	1-1/2 in. MNPT	316 stainless steel, glass-filled PEEK, Viton	392 °F (200 °C)	295 psig (2135 kPa)	220 psig (1618 kPa [abs])	3 lb / 4 lb (1.5 kg / 2.0 kg)
2001990	For use with option -21	2 in. MNPT	CPVC Viton	100 °F (38 °C)	100 psig (791 kPa [abs])	N/A	1 lb / 2 lb (0.5 kg / 1.0 kg)
				185 °F (85 ° C)	45 psig (412 kPa [abs])		

Table 1-4: Retraction assembly specfications

Sensor compatibility	The retraction assemblies are used with 228 - [ ]-20-54-62 only
Wetted materials	315 stainless steel, ethylene polypropylene (EP), unfilled Teflon, carbon-filled Teflon
Process connection	1 - 1/2 in. MNPT
Maximum operating condition	392 °F (200 °C), 295 psig (2135 kPa [abs])

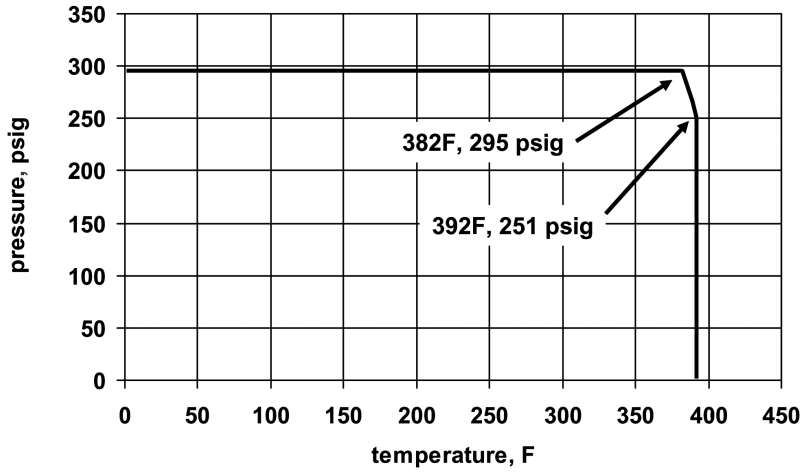
Table 1-5: Maximum retraction/insertion conditions

Description	Temperature	Pressure	Maximum insertion travel	Weight / shipping weight
23311-00, mechanical retraction assembly	392 °F (200 °C)	295 psig (2135 kPa [abs])	10.5 in. (267 mm)	12 lb / 15 lb (5.5 kg / 7.0 kg)
23311-01, manual retraction assembly	266 °F (130 °C)	35 psig (343 kPa [abs])	12.0 in. (305 mm)	9 lb / 12 lb (4.5 kg / 5.5 kg)

Table 1-6: Ball valve specifications (sold separately)

Part number	9340065
Wetted materials	316 stainless steel, Teflon TFE
Process connection	1-1/2 in. FNPT
Weight / shipping weight	4 lb / 5 lb (2.0 kg / 2.5 kg)

Ball valve pressure and temperature



1.3 Ordering Information

Table 1-7: Rosemount 228 Toroidal Conductivity Sensor Ordering Information

Model	Sensor type
228	Toroidal Conductivity Sensor
Materials of construction	
02	Glass-filled PEEK (standard temperature)
03	Glass-filled PEEK (high temperature)
04	Glass-filled Tefzel(1)
05	Unfilled Tefzel(2)
Process connection	
20	5/8 in. 11 UNC(3)
21	3/4 in. MNPT(4)

Table 1-7: Rosemount 228 Toroidal Conductivity Sensor Ordering Information *(continued)*

Cable type[5]	
54	Unshielded cable[6]
56	Unshielded cable[7]
Cable length	
61	20 ft (6.1 m)
62	18 in. (457 mm)[8]

(1) Not available with options -50-62 and -54-62.

(2) Not available with option -54-62.

(3) This option requires a mounting adapter. This option comes standard with an EPDM gsket (Viton and Kalrez gaskets are also available).

(4) Not available with option -62.

(5) Cable may be extended using the remote junction box PN 235500-00 (sold separately) and extension cables..

(6) Recommended for use with transmitter models 1054 and 2054. May be used with transmitter models 1055, 1056, 1066, 54C, 54eC, 81T, 2081T, 3081T, 4081T, 5081, and XMT, but not recommended.

(7) Recommended for use with transmitter models 1055, 1056, 1066, 56, 54C, 54eC, 5081, and XMT.

(8) For use with option -54 only. Connects sensor used in valve insertion assembly to junction box. Requires interconnecting cable to connect junction box to transmitter. Use either cable 23294-00 (unshielded) or 23294-05 (shielded).

2 Install

2.1 Installing the Sensor

The sensor may be installed in either a tank or pipe using a customer-supplied Tri-Clamp and tee assembly. Keep at least 1 in. (25 cm) between the sensor and the pipe wall. If clearance is too small, calibrate the sensor in place.

Figure 2-1: Rosemount 228 dimensional drawing

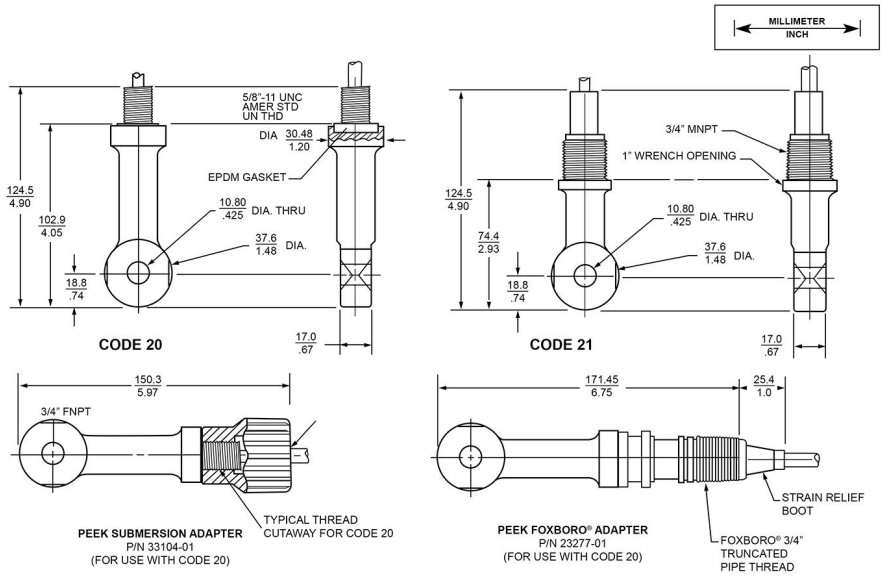


Figure 2-2: Insertion adapter 23242-02 for use with 3/4 in. MNPT threaded process connection (-21 option)

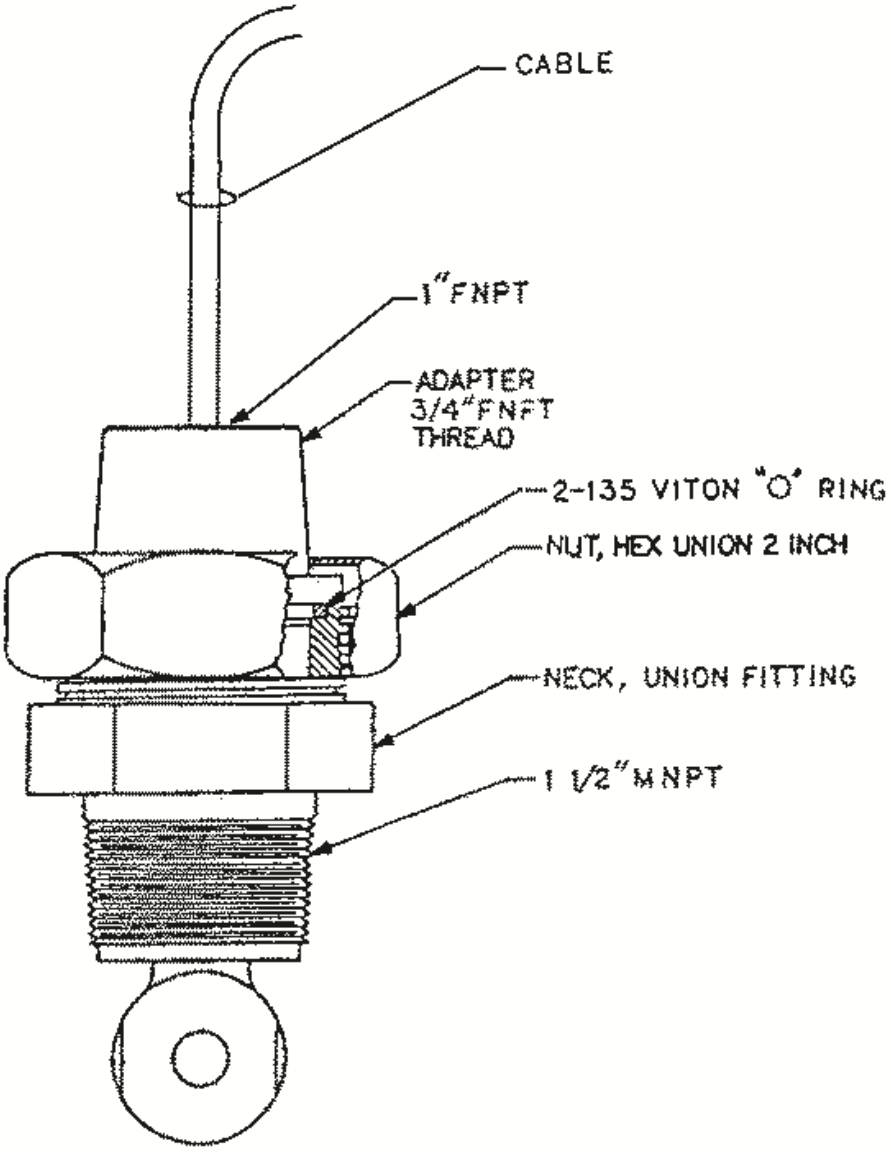


Figure 2-3: Insertion adapter 23242-03 for use with 5/8 in. 11 UNC threaded process connection (-20 option)

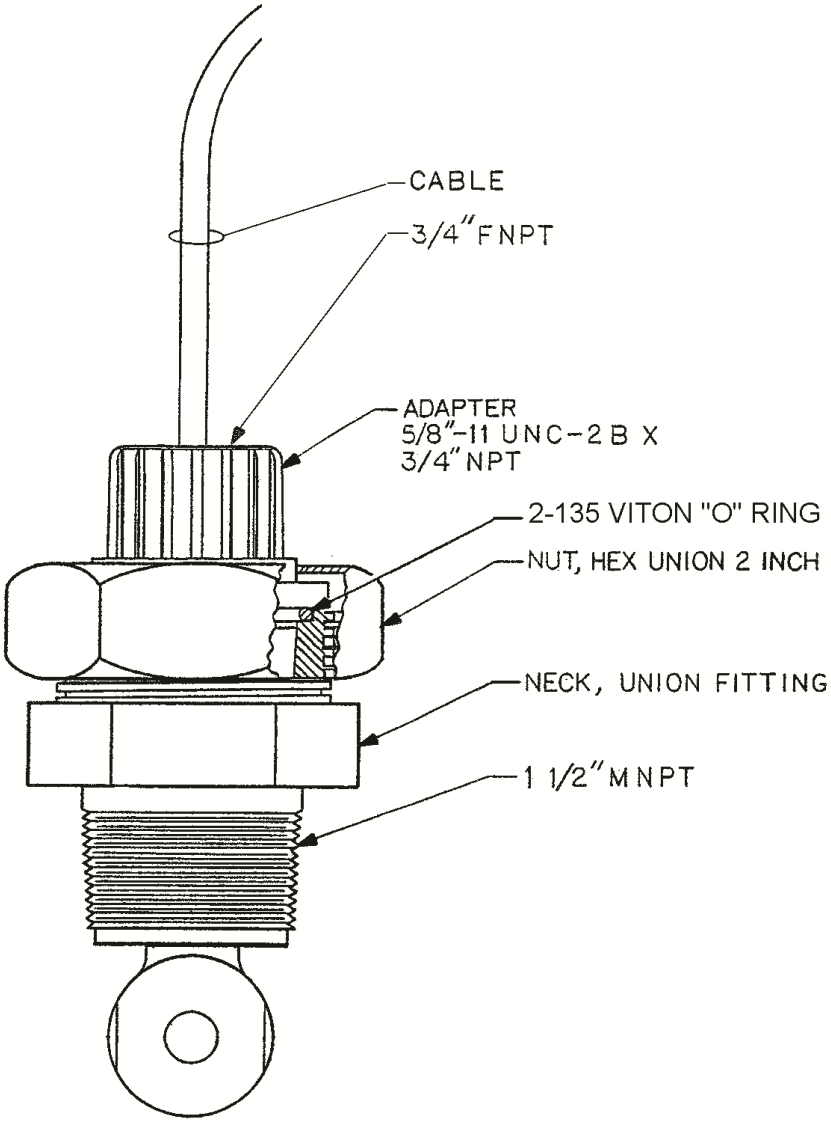
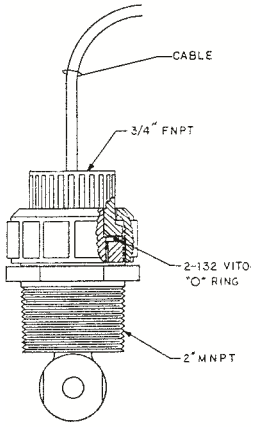


Figure 2-4: Insertion adapter 2001990 for use with 3/4 in. MNPT threaded process connection (-21 option)



Procedure

1. Mount the sensor in the pipe.

   Keep at least 1 in. (2.5 cm) between the sensor and pipe walls. If the clearance is too small, calibrate the sensor in place. Mounting the sensor in a vertical pipe run with the flow from top to bottom is best. If the sensor must be mounted in a horizontal pipe run, orient the sensor in the 3 o'clock or 9 o'clock position.
2. Ensure that the sensor is completely submerged in liquid.

2.2 Insertion/Retraction Assembly Installation Requirements

1. Process connection: 1-1/2 in. Larger openings may keep the sensor from inserting far enough into the process liquid.
2. Line size: 3 in.; 2 in. line requires in-place calibration.
3. Valve: 1-1/2 in. NPT full port valve (PN 9340065).
4. Retraction clearnace: 2 ft (0.6 m)
5. Provide mechanical support if excess vibration is expected.
6. Flush water: provide 1/8 in. valves in inlet and outlet flush ports. Position flush ports so that retraction chamber can be drained.

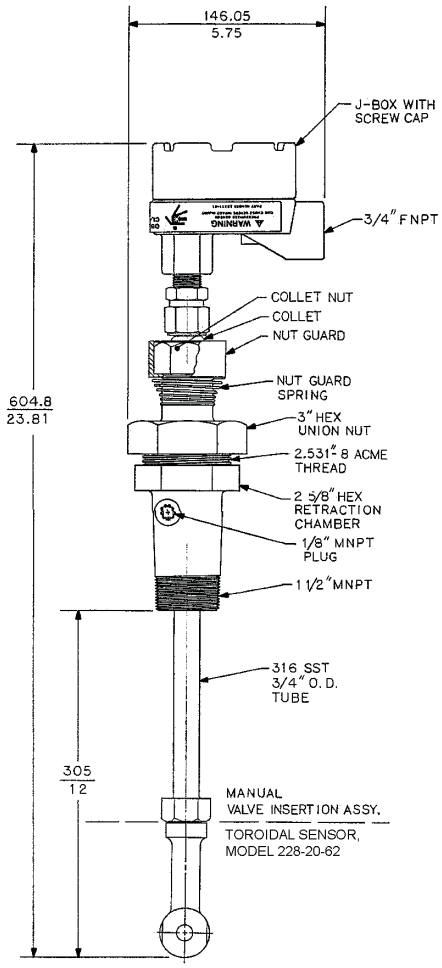
2.2.1 Manual Retraction Assembly

Installing a Manual Retraction Assembly

1. Loosen the collet nut and retract the sensor tube into the retraction chamber.

See *Figure 2-5*.

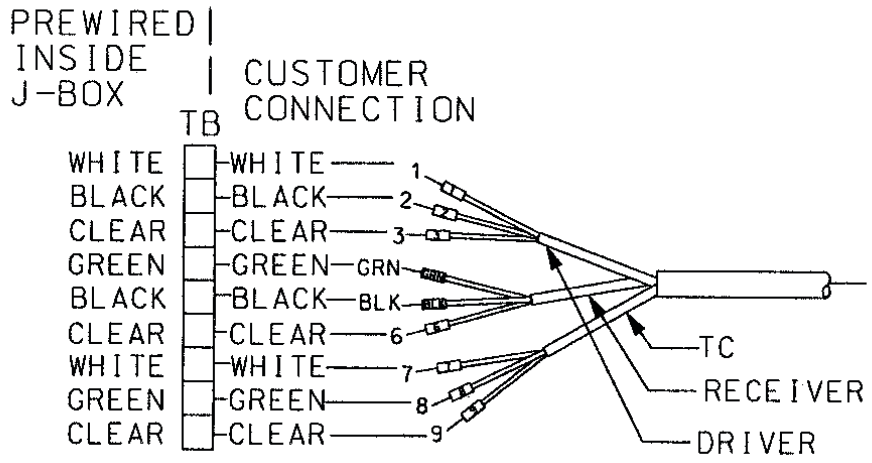
Figure 2-5: Manual retraction assembly dimensional drawing



2. Loosen the union nut and separate the retraction chamber from the assembly.
3. Install the retraction chamber on the 1-1/2 in. NPT full port valve mounted on the process line or vessel.
4. Thread the sensor cable through the tube into the junction box. Screw the sensor into the tube. Hand-tighten the sensor an additional half turn once the gasket is seated.
5. Connect the sensor and interconnecting cable leads to the terminal strip in the junction box.

See *Figure 2-6*.

Figure 2-6: Sensor-mounted junction box wiring



The wiring diagram shown is for the cable PN 23294-00, which has three RTD (TC) leads. If you are useing cable PN 23294-05, which has four RTD (TC) leads, connect the green, white, and clear wires in the RTD bundle as shown in the drawing. Do not dconnect the black wire. When you reconnect the RTD wires in PN 23294-05 to the transmitter, make the connections as described in step 6 (this section) or step 3 (Section 2.2.2).

6. Connect the other end of the cable to the transmitter. See the wiring diagrams in *Figure 3-2*, *Figure 3-3*, and *Figure 3-4*. For cable PN 23294-00, follow the wiring for the 228-54 sensor. For cable PN 23294-05, follow the wiring for the 228-56 sensor with the following exception:

   Refer to the wire function diagram for the 228-56 option in *Figure 3-1* and identify the RTD wire bundle. Connect the RTD wires to the transmitter as follows:

   - Green - RTD in
   - Black - No connection
   - Clear - RTD common or RTD return
   - White - RTD sense

   Wrap the bare end of the black wire to prevent accidental connections.
7. Insert the sensor and tube assembly into the retraction chamber.
8. Tighten the union nut.
9. Open the ball valve, check for leaks, and manually insert the sensor into the process.
10. Position the sensor at least 1/2 in. (13 mm) away from any wall of the vessel or pipe.
11. Tighten the collet nut.

Retracting the Manual Retraction Assembly

Prerequisites

Make certain that the system pressure is less than 35 psig (342 kPa [abs]).

Procedure

1. Push in on the sensor using the top of the junction box. Slowly loosen the collet nut.

⚠ WARNING!

Severe impact injury can occur if the collet nut is loosened under pressure.

2. When the collet nut is loose enough, slowly ease the sensor back so that it clears the ball valve. Close the valve to the process line.
3. Drain the retraction chamber contents using the 1/8 in. flush ports.
4. Loosen the 3 in. hex union nut. Removt the sensor and tube assembly.
5. Replace the 3 in. hex nut O-ring. Place the sensor and tube assembly back in the retraction assembly. Tighten the 3 in. hex union nut. Verify that the 1/8 in. flush ports are closed.

NOTICE

With the ball valve closed and the retraction chamber 1/8 in. flush ports open, some residual process fluid may leak from the 3 in. hex union nut female ACME threads. This leakage is normal and to be expected.

6. Before opening the ball valve, make sure that the process pressure is less than 35 psig (342 kPa [abs]). Open the ball valve and check for leaks. Insert the sensor into the process. Tighten the collet nut.

⚠ WARNING!

Retraction chamber contents may be under pressure.

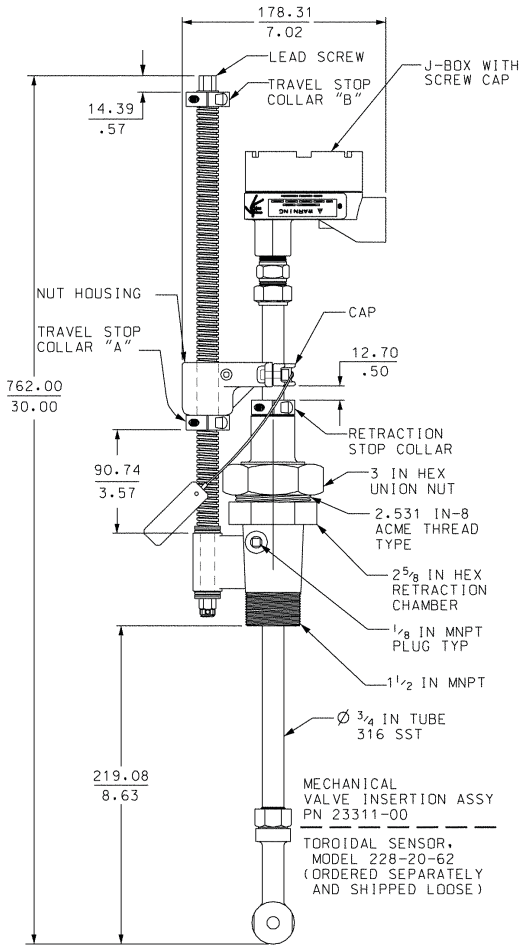
2.2.2 Mechanical Retraction Assembly (PN 23311-00)

Installing the Mechanical Retraction Assembly

1. Tighten the sensor cable through the tube into the junction box. Screw the sensor into the tube. Hand-tighten the sensor an additional half turn once the gasket is seated.

   See *Figure 2-7*.

Figure 2-7: Mechanical retraction assembly



2. Terminate the sensor wiring in the junction box.

   See *Figure 2-6* for wiring details.

3. Connect the other end of the cable to the transmitter.

   See the wiring diagrams in *Figure 3-2*, *Figure 3-3*, and *Figure 3-4*. For cable PN 23294-00, follow the wiring for the 228-54 sensor. For cable PN 23294-05, follow the wiring for the 228-56 sensor with the following exception:

Refer to the wire function diagram for the 228-56 option in *Figure 3-1* and identify the RTD wire bundle. Connect the RTD wires to the transmitter as follows:

- Green - RTD in
- Black - no connection
- Clear - RTD common or RTD return
- White - RTD sense

Wrap the bare end of the black wire to prevent accidental connections.

4. Using a 1/2 in. (13 mm) socket wrench, retract the sensor into the retraction chamber.
5. Install the assembly on the 1-1/2 in. NPT full port ball valve mounted in the process line or vessel.
6. Tighten the union nut.
7. Open the ball valve and check for leaks.
8. Using a 1/2 in. (13 mm) socket wrench, inser the sensor into the process line or vessel.
9. Position the sensor at least 1/2 in. (13 mm) away from any wall of the vessel or pipe. Set the travel stop collar *A* net to the nut housing.

⚠ WARNING!

Do not loosen cap screws or collar when pressurized.

Retracting a Mechanical Retraction Assembly

Prerequisites

Make sure that the system pressure is less than 295 psig (2135 kPa [abs]) before retracting the sensor.

Procedure

1. Retract the sensor using a 1/2 in. (13 mm) socket wrench. When the sensor clears the ball valve, close the valve.

⚠ WARNING!

Retraction chamber contents may be under pressure.

2. Drain the retraction chamber using 1/8 in. flush ports.
3. Loosen the 3 in. hex union nut and remove the retraction stop collar and orange clamp top. Remove the sensor and tube assembly.
4. Replace the 3 in. hex nut O-ring. Place the sensor and tube assembly back in the retraction assembly. Replace the retraction stop collar about 1/2 in. in front of the clamp. Tighten the clamp screws, retraction stop collar, and 3 in. hex union nut. Verify that the 1/8 in. flush ports are closed.

NOTICE

With the ball valve fully closed and the retraciton chamber 1/8 in. flush ports open, some residual process fluid maay leak from the 3 in. hex union female ACME threads. This leakage is normal and to be expected.

5. Before opening the ball valve, make sure that the process pressure is less than 295 psig (3135 kPa [abs]). Open the valve, check for leaks, and insert the sensor into the process.

2.2.3 Replacing Seals in Manual and Mechanical Retraction Assemblies

1. Retract the sensor into the retraction chamber and fully close the ball valve.
2. Drain the reaction chamber contents using the 1/8 in. flush ports.

⚠ WARNING!

Retraction chamber contents may be under pressure.

3. For mechanical retraction assemblies, mark the location of the nut housing cap and retraction collar on the sensor tube. Remove both socket head cup screws from the nut housing and loosent the retraction stop collar.
4. Remove the 3 in. hex union nut.
5. Withdraw the sensor from the retraction chamber.
6. Open the junction box and disconnect the sensor wires from the terminal block.
7. Remove the compression fitting just below the junction box and remove the junction box from the sensor tube.
8. For manual retraction assemblies, pull down the nut guard and remove the collet nut from the bushing housing.
9. Slide all hardware, including the bushing housing, off the sensor tube.
10. Remove the retaining ring from the bottom of the bushing housing.
11. Remove the Teflon guard.
12. From the top of the bushing housing, press out the Teflon bushing.

    This will also push out the Teflon cup seal.
13. Replace all damaged parts with replacement parts from *Figure 2-8* or *Figure 2-9*. Replace the sensor tube if the surface is damaged.

    A rough or uneven surface will prevent the Teflon cup from sealing.

Figure 2-8: Mechanical retraction assembly replacement parts

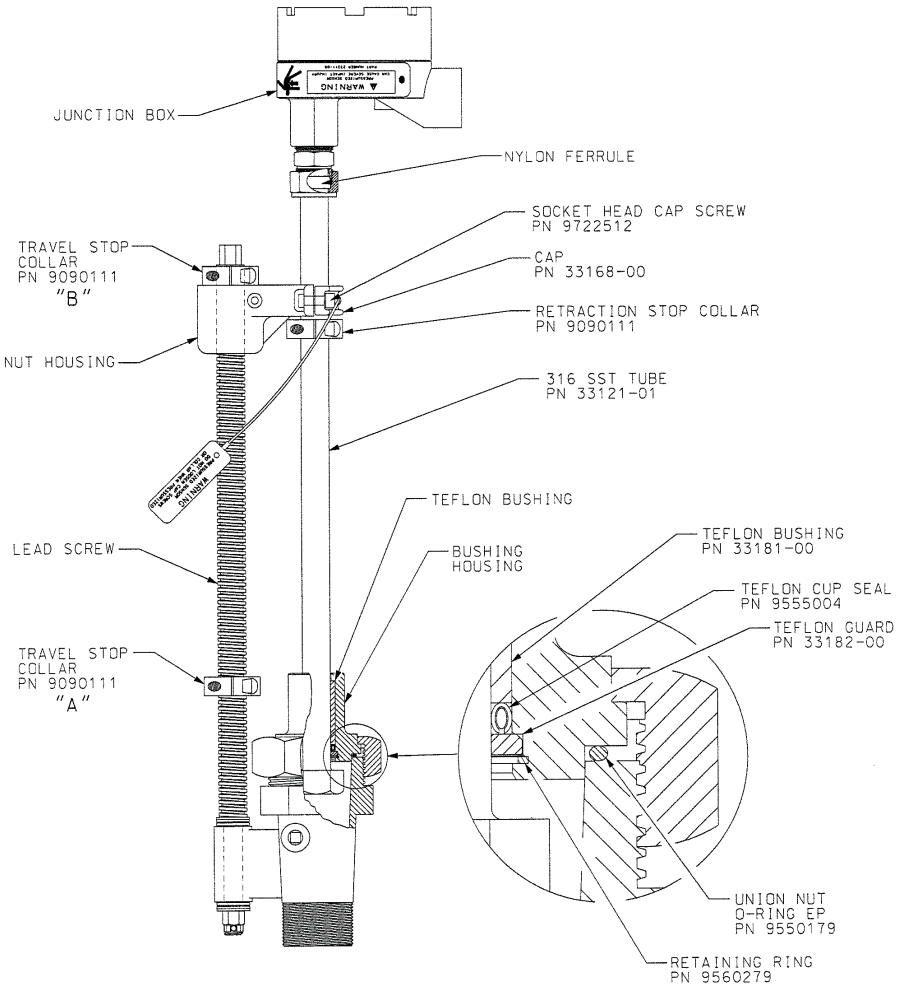
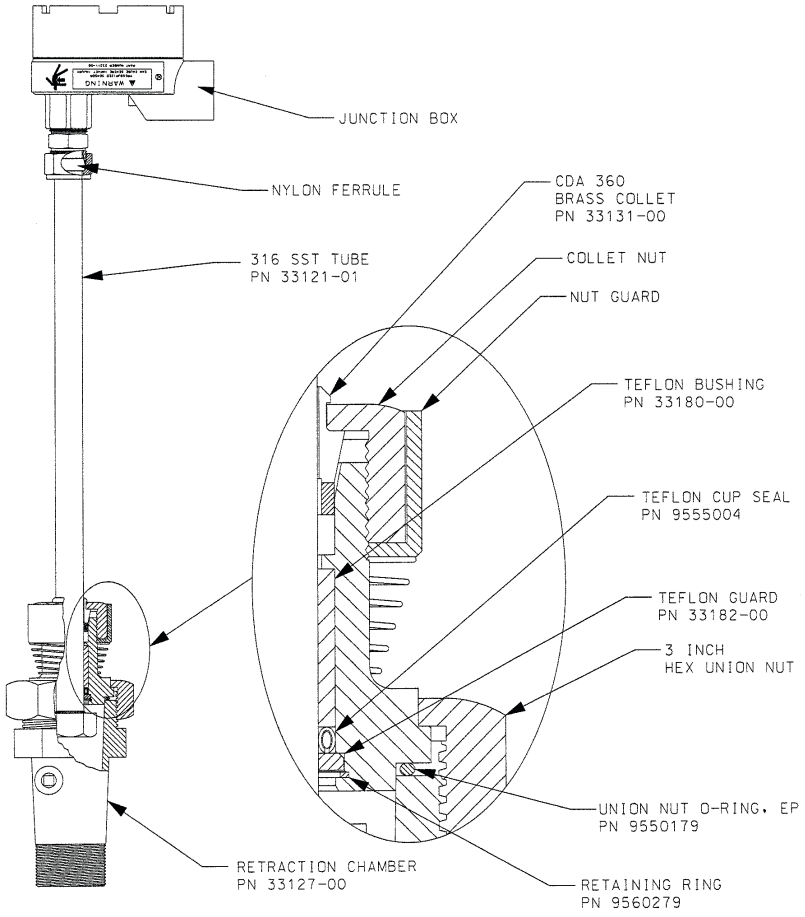


Figure 2-9: Manual retraction assembly replacement parts



14. Rebuild the bushing housing.

    The open end of the cup seal (spring visible) faces the process.

15. Carefully slide the bushing housing onto the sensor tube.

    Do not damage the Teflon bushing or the Teflon cup seal.

16. For manual retraction assemblies, slide the 3 in. hex union nut, collet nut with nut guard, junction box compression nut, and plastic ferrules onto the sensor tubee.

17. For mechanical retraction assemblies, slide the 3 in. hex union nut, retraction stop collar, junction box compression nut, and plastic ferrules onto the sensor tube.

18. Connect the junction box to the sensor tube and wire the sensor leads to the appropriate terminals.

19. For mechanical retraction assemblies, lock the retraction stop collar into position.

    See *Figure 2-8* or previously marked position for proper location.

20. Place the union nut O-ring at the bottom of the bushing housing. Insert the sensor assembly into the retraction chamber and tighten the 3 in. hex union nut.

21. For mechanical retraction assemblies, install the nut housing cap.

    See *Figure 2-8* or previously marked position for proper location.

3 Wiring

3.1 Wiring the Sensor

Keep sensor wiring away from ac conductors and high current demanding equipment. Do not cut the cable.

NOTICE

For additional wiring information on this product, please refer to the Liquid Transmitter Wiring Diagrams:
http://www2.emersonprocess.com/en-US/brands/rosemountanalytical/Liquid/Wiring-Diagrams/Pages/analyzer-wiring-diagrams.aspx

Figure 3-1: Wire functions

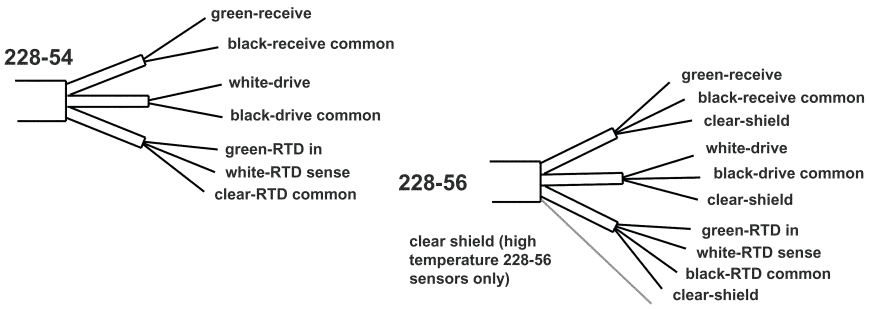


Figure 3-2: Wiring diagram for Rosemount 1056 and 56 Transmitters

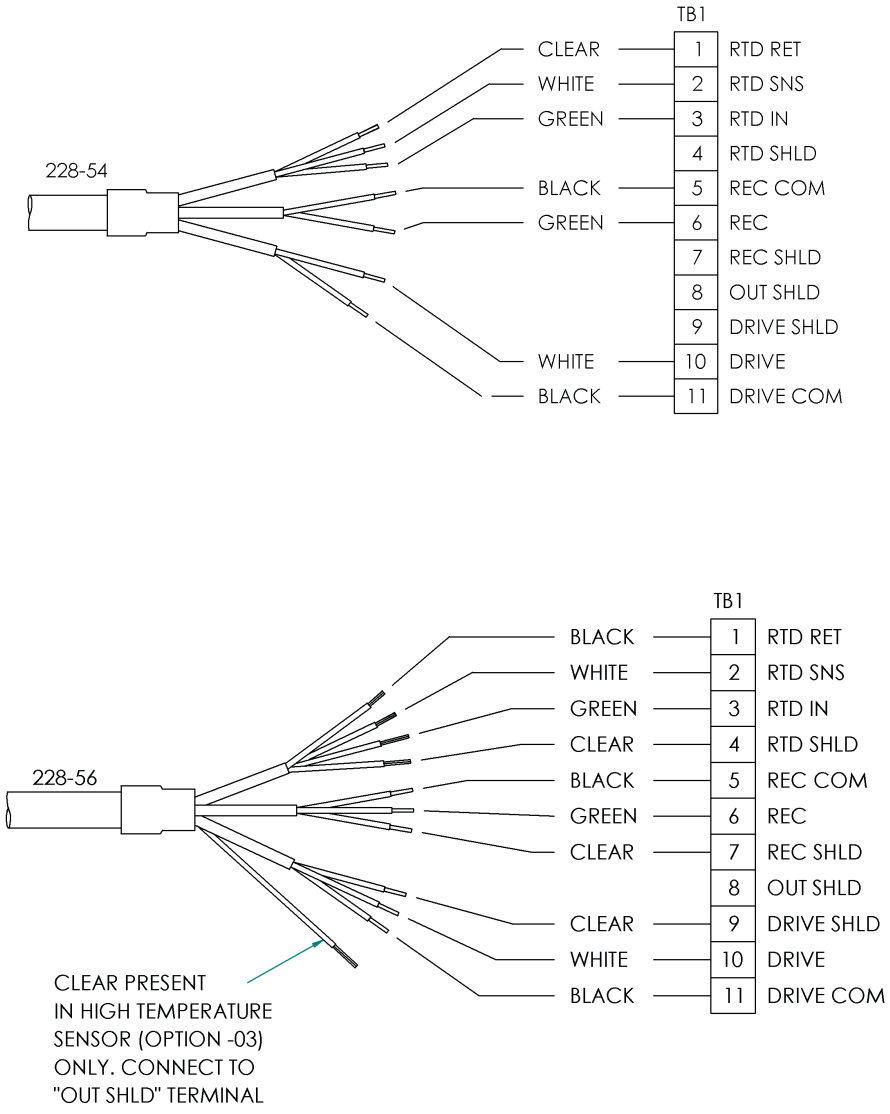


Figure 3-3: Wiring diagram for Rosemount 1066 Transmitters

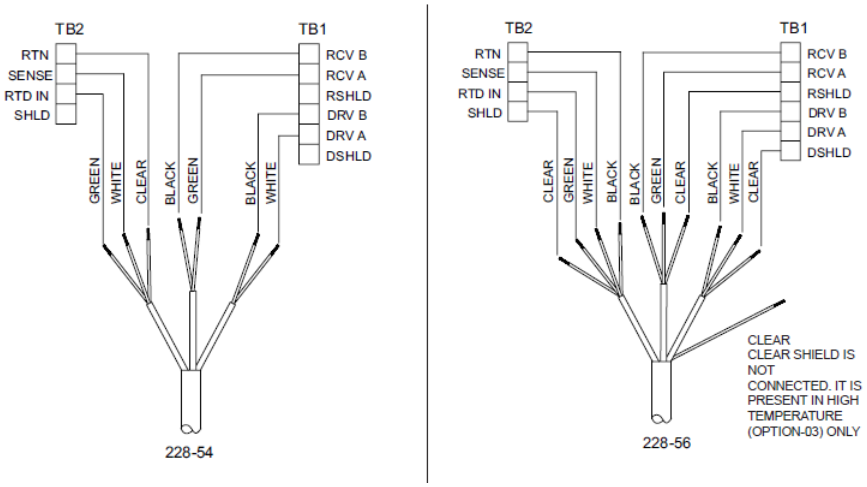


Figure 3-4: Wiring diagram for Rosemount 5081 Transmitters

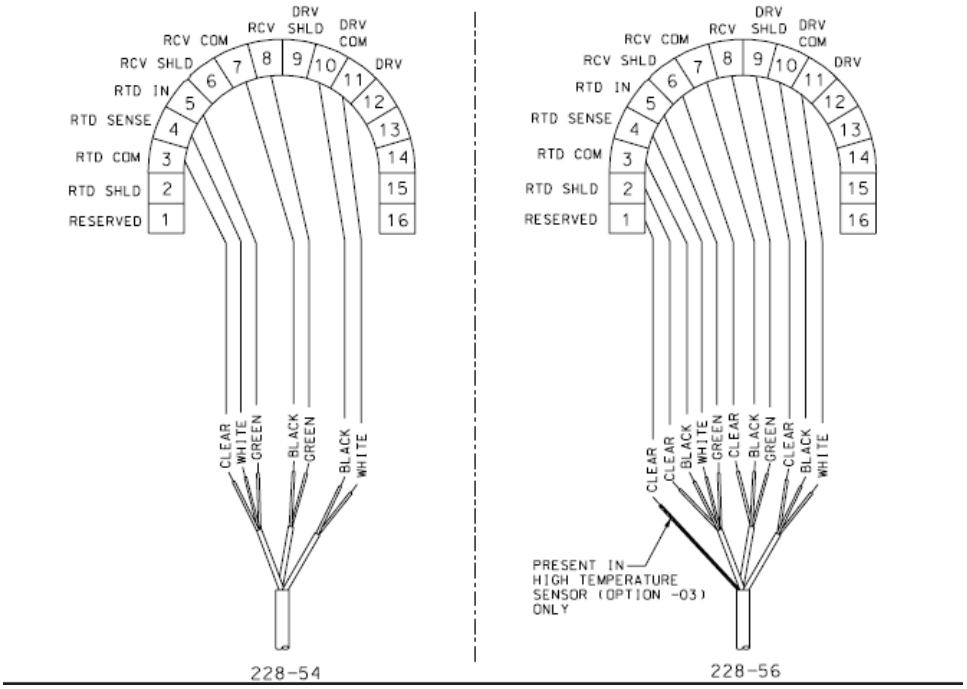
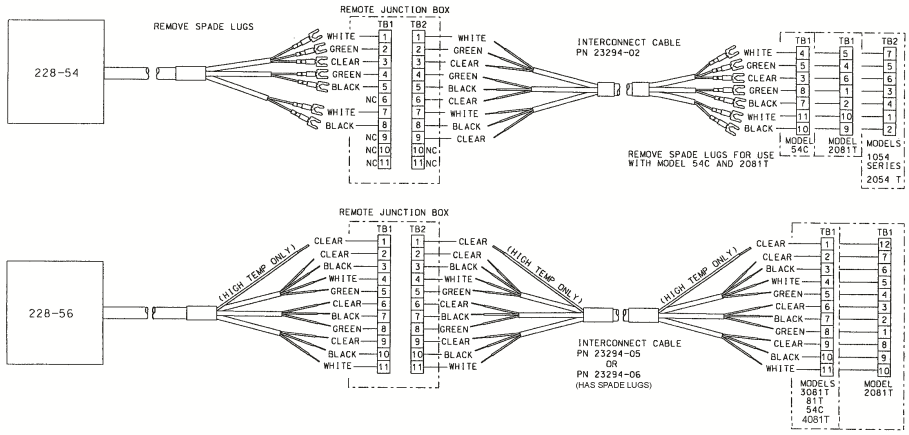
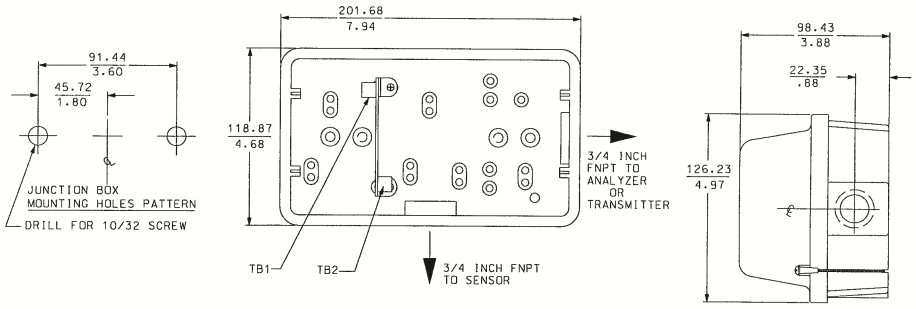


Figure 3-5: Wiring sensors through a remote junction box



Wire sensors point to point. For wiring at the transmitter end, refer to the appropriate transmitter wiring diagram. For interconnecting cable 23294-00, use the 228-54 wiring diagram. For interconnecting cable 23294-04 and 23294-05, use the 228-54 wiring diagram.

Figure 3-6: Remote Junction Box (PN 23550-00) dimensions



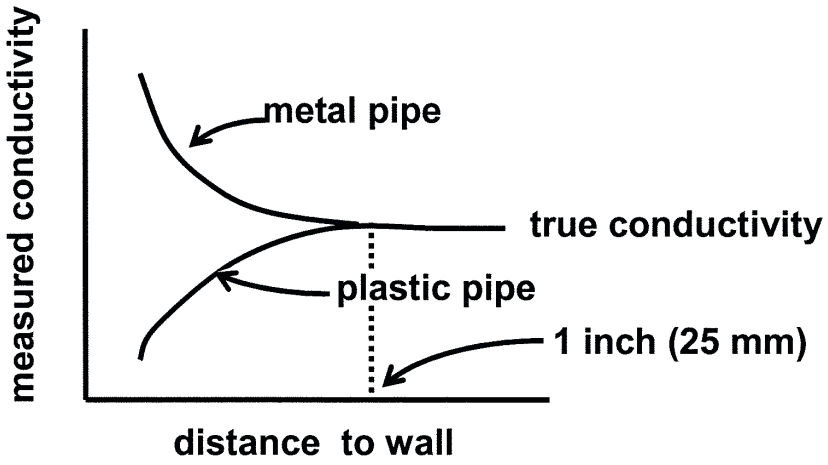
4 Calibration

4.1 Sensor calibration

The nominal cell constant of the Rosemount 228 sensor is 2.7/cm. The error in cell constant is about ±10%, so conductivity readings made the using the nominal cell constant will have an error of at least ±10%. Wall effects,as shown in *Figure 4-1*, will likely make the error greater.

For more detailed information on calibration methods, please reference application data sheet ADS-43-025 available on the *Emerson Liquid Analysis website*.

Figure 4-1: Measured Conductivity as a Function of Clearance between Sensor and Walls



4.2 Calibrating against a Standard Solution

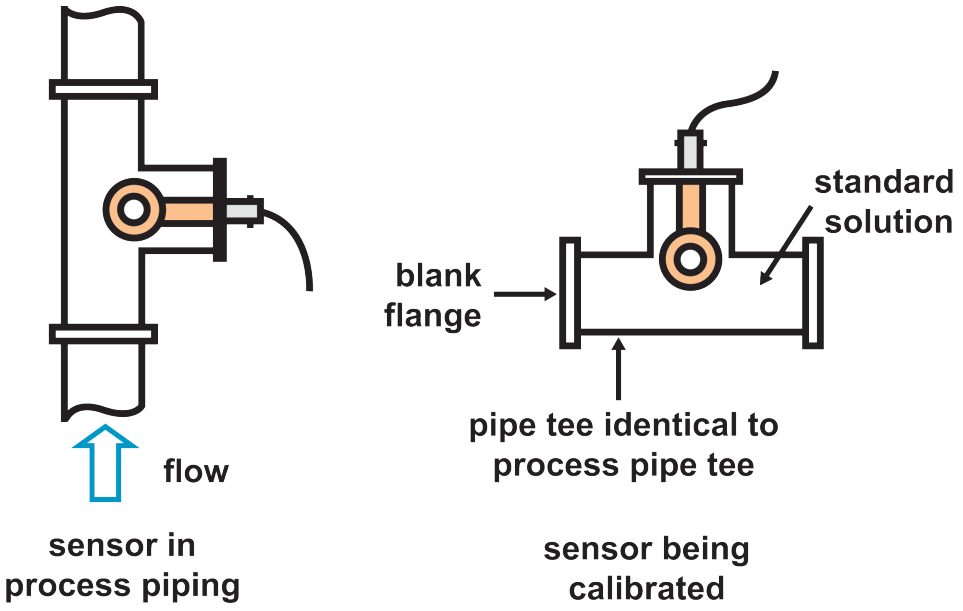
Calibration against a standard solution requires removing the sensor from process piping. This calibration method is practical only if wall effects are absent or if the sensor can be calibrated in a container identical to the process piping. Ideally, the conductivity of the standard used should be close to the middle of the range that the sensor will be used in. Generally, toroidal conductivity sensors have good linearity, and so standards greater than 5000 µS/cm at 77 °F (25 °C) may also be used.

1. Remove the sensor from the pipe.
2. Fill a container with the standard solution.

If wall effects are absent in the process installation, use a sufficiently large container for calibration to ensure that wall effects are absent. To check for wall effects, fill the container with solution and place the sensor in the center, submerged at least 3/4 of the way up the stem. Note the reading. Then move the sensor small distances from the center and note the reading in each position. The readings should not change.

If wall effects are present, be sure the vessel used for calibration has exactly the same dimensions as the process piping. Also ensure that the orientation of the sensor with respect to the piping is exactly the same in the process and calibration vessels. See *Figure 4-2*.

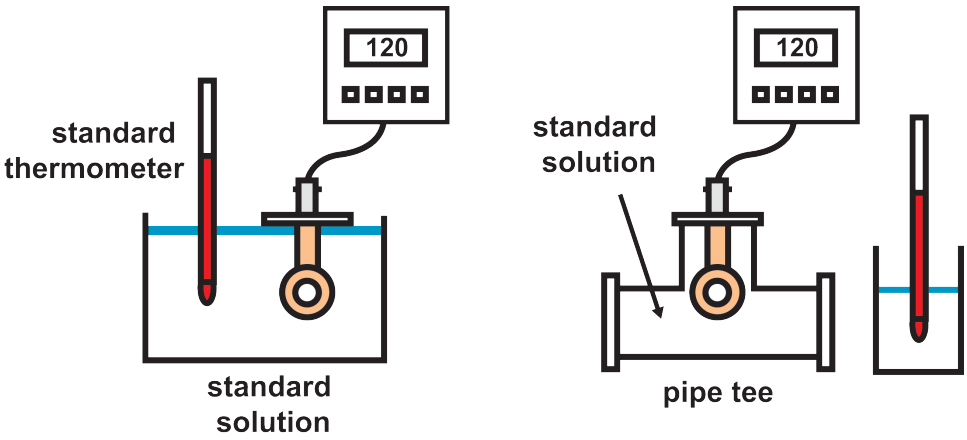
Figure 4-2: Calibration installation orientation



3. Rinse the sensor with water.
4. Immerse the rinsed sensor in the standard solution.

   Use a good quality calibrated thermometer to measure the temperature of the standard solution. The thermometer error should be less than ±1 °C. Allow adequate time for the solution and sensor to reach thermal equilibrium. If the sensor is being calibrated in an open beaker, keep the thermometer far enough away from the sensor so it does not introduce wall effects. If the sensor is being calibrated in a pipe tee or similar vessel, it is impractical to place the thermometer in the standard solution. Instead, put the thermometer in a beaker of water placed next to the callibration vessel. Let both come to thermal equilibrium with the ambient air before continuing calibration. See *Figure 4-3*.

Figure 4-3: Measuring standard temperature



Be sure air bubbles are not adhering to the sensor. An air bubble trapped in the toroid opening has a particularly severe effect on the reading.

5. Turn off automatic temperature compensation in the transmitter.

   This eliminates error in the cell constant.

6. Adjust the transmitter reading to match the conductivity of the standard.

4.3 Calibrating against a Referee - in-Process

Prerequisites

If possible, adjust the conductivity of the process liquid so that it is near the midpoint of the operating range. If this is not possible, adjust the conductivity so that it is at least 5000 µS/cm.

Turn off automatic temperature compensation in the transmitter. This eliminates error in the cell constant.

Procedure

1. Connect the process and referee sensors in a series.

   Keep tubing runs between the sensors short and adjust the sample flow to as high a rate as possible. Short tubing runs and high flow ensure that the temperature of the liquid does not change as it flows from one sensor to another.

2. Allow the process liquid to flow through both sensors.

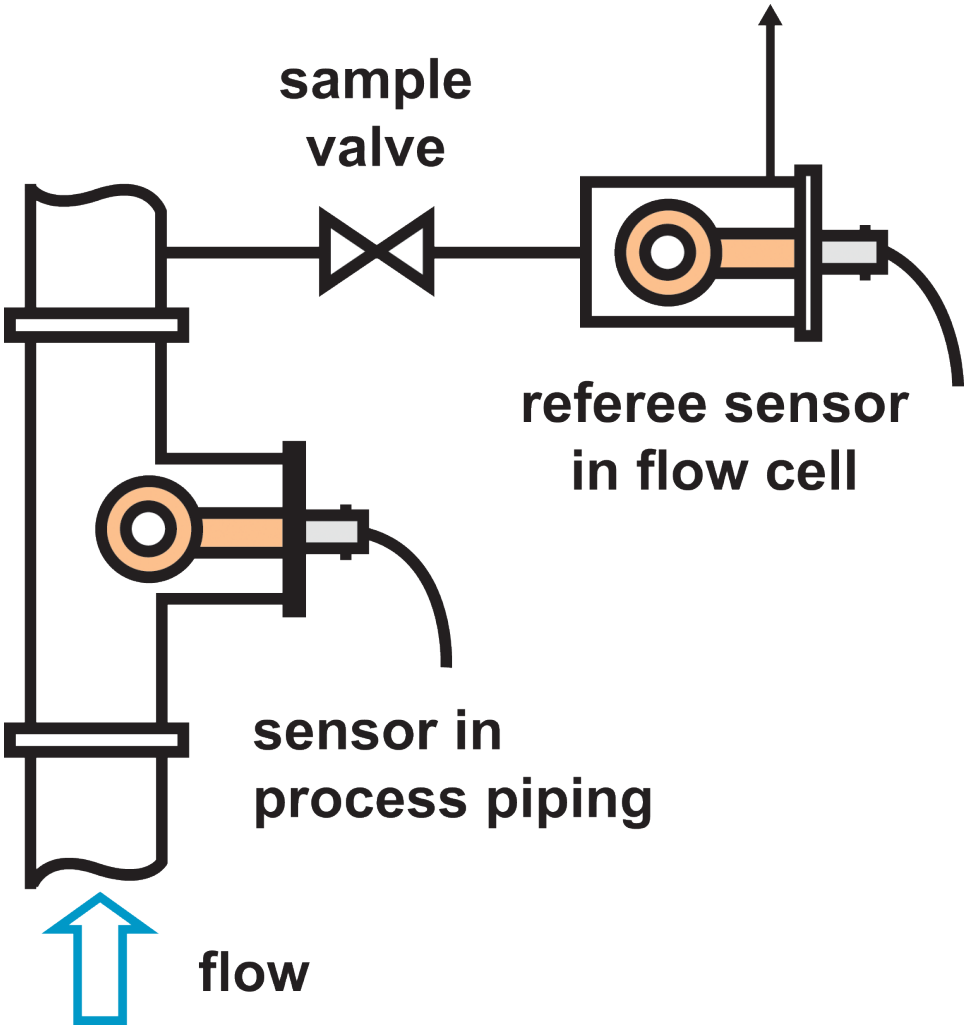
   Orient the referee sensor so that the air bubbles always have an easy escape path and cannot get trapped. Tap and hold the flow cell in different positions to allow bubbles to escape.

   Wait for readings to stabilize before starting the calibration.

3. Adjust the process sensor to match the conductivity measured by the referee instrument.

Figure 4-4 shows the arrangement.

Figure 4-4: Calibration with a referee instrument example



4.4 Calibrating against a Referee - Grab Sample

This method is useful when calibration against a standard is impractical or when in-process calibration is not feasible, because the sample is hot, corrosive, or dirty, making handling the waste stream from the referee sensor difficult.

1. Take a sample of the process liquid.

Take the sample from a point as close to the process sensor as possible. Be sure the sample is representative of what the sensor is measuring. If possible, adjust the conductivity of the process liquid so that it is near the midpoint of the operating range. If that is not possible, adjust the conductivity so that it is at least 5000 µS/cm.

2. Connect the process and referee sensors.

   Keep temperature compensation with the transmitter turned on. Confirm that the temperature measurements in both process and referee instruments are accurate, ideally to within ±0.5 °C.

3. Place the sensors in the grab sample.

   Wait until the readings are stable before starting the calibration.

4. Adjust the reading from the process analyzer to match the conductivity measured by the referee sensor.

5 Maintenance and Troubleshooting

5.1 Maintaining the sensor

⚠ WARNING!

Retraction chamber contents may be under pressure.

⚠ CAUTION!

Be sure the sensor has been cleaned of process liquid before handling.

Generally, the only maintenance required is to keep the opening of the sensor clear of deposits. Cleaning frequency is best determined by experience.

5.2 Troubleshooting

Table 5-1: Resistance vs. Temperature for Temperature Compensation (PT-100 RTD)

Temperature	Resistance
10 °C (50 °F)	103.9 Ω
20 °C (68 °F)	107.8 Ω
25 °C (77 °F)	109.7 Ω
30 °C (86 °F)	111.7 Ω
40 °C (104 °F)	115.5 Ω
50 °C (122 °F)	119.4 Ω

6 Accessories

Part number	Description
23550-00	Remote junction box
23294-00	Interconnecting extension cable, unshielded, prepped (for use with remote junction box)
23294-05	Interconnecting extension cable, shielded, prepped (for use with remote junction box)
23311-00	Mechanical valve insertion assembly
23311-01	Manual valve insertion assembly
2001990	Mounting adapter, 2 in. MNPT, CPVC
9550179	O-ring, EP rubber, for 20011990
23242-02	Mounting adapter, 1-1/2 in. MNPT insertion, 1 in. FNPT conduit connection, PEEK
33081-00-99SQ7091A	Adapter insert, Tefzel, for 23242-02
33081-00	Adapter insert, PEED, for 23242-02
23242-03	Mounting adapter, 1-1/2 in. MNPT insertion, 3/4 in. FNPT conduit connection, PEEK
33080-01-99SQ7091B	Adapter insert, Tefzel, for 23242-03
23277-01	Mounting adapter, Foxboro, PEEK, 5/8 11 UNC
23277-01-99SQ7182	Mounting adapter, Foxboro, Tefzel, 5/8 11 UNC
33075-00	Viton gasket for option 20
33075-03	Kalrez gasket for option 20
9200276	Interconnecting extension cable, shielded, unprepped
9340065	1-1/2 in. FNPT full port ball valve for use with retraction assemblies

7 Return of Materials

For repair and warranty inquiries, please contact the factory.

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