

**871FT Series  
Toroidal Flow-Through Conductivity Sensors**

**Installation, Calibration, and Troubleshooting**



FLANGED INDUSTRIAL VERSION

TRI-CLAMP SANITARY VERSION  
3-A Compliant

(NPT INDUSTRIAL VERSION NOT SHOWN)



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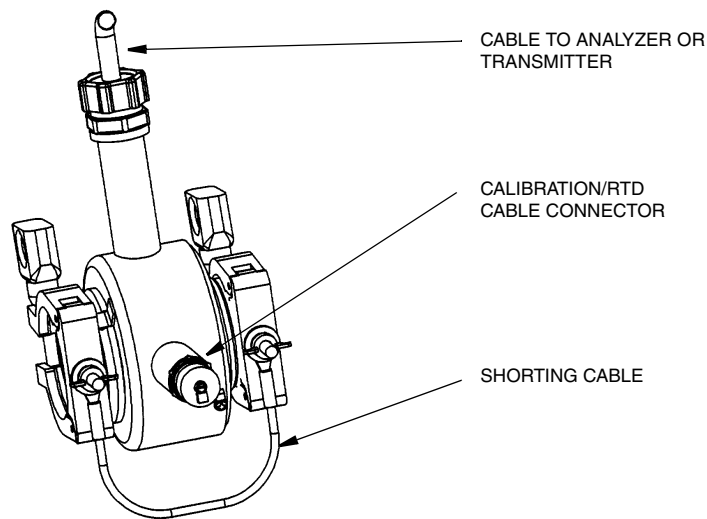




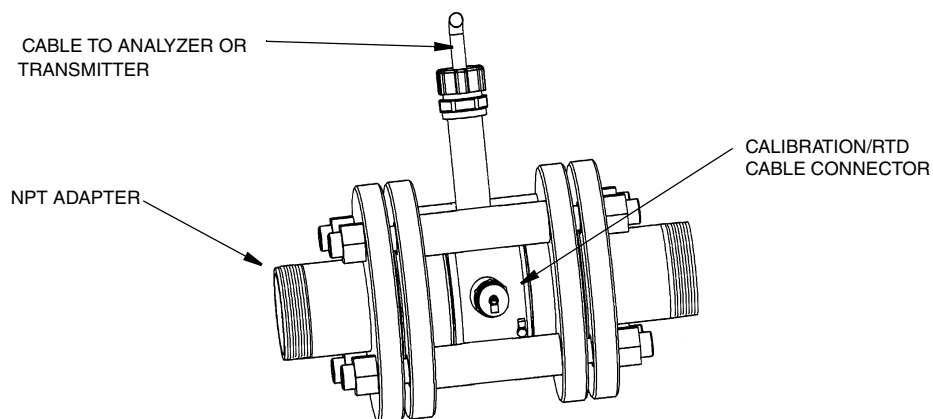
# 1. Introduction

The 871FT Toroidal Flow-Through Conductivity Sensors are a family of in-line, noninvasive, sensors that measure conductivity of virtually any conductive liquid. These sensors are available in many common line sizes and materials of construction to accommodate a wide range of sanitary and industrial applications. The sanitary virgin PEEK version uses Tri-Clamp® Flange mounting (Figure 1) and materials to comply with 3-A and FDA standards. Industrial versions use ANSI Class 150 flanges (Figure 2), ANSI Class 300 flanges or NPT (Figure ) mounting.

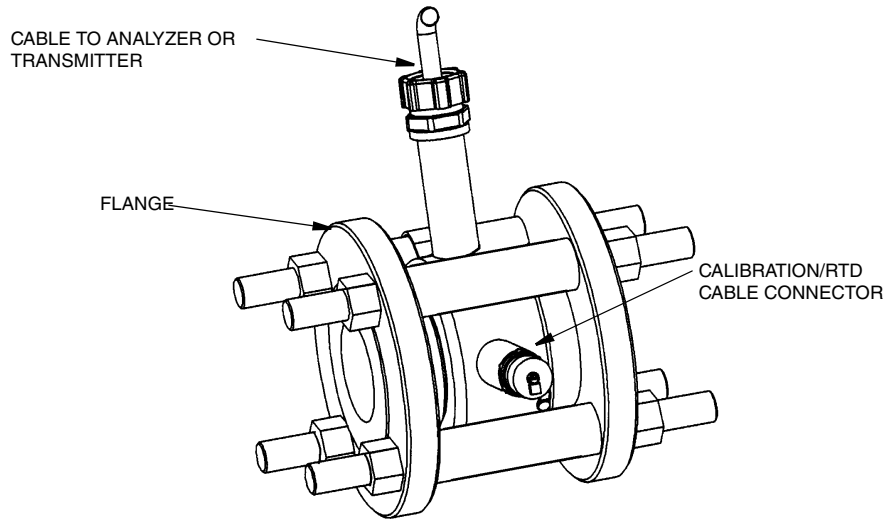
*Figure 1. 871FT Conductivity Sensor – Sanitary Version (3-A Compliant)*



*Figure 2. 871FT Conductivity Sensor – Industrial Version (Flanged)*



*Figure 3. 871FT Conductivity Sensor – Industrial Version (NPT)*

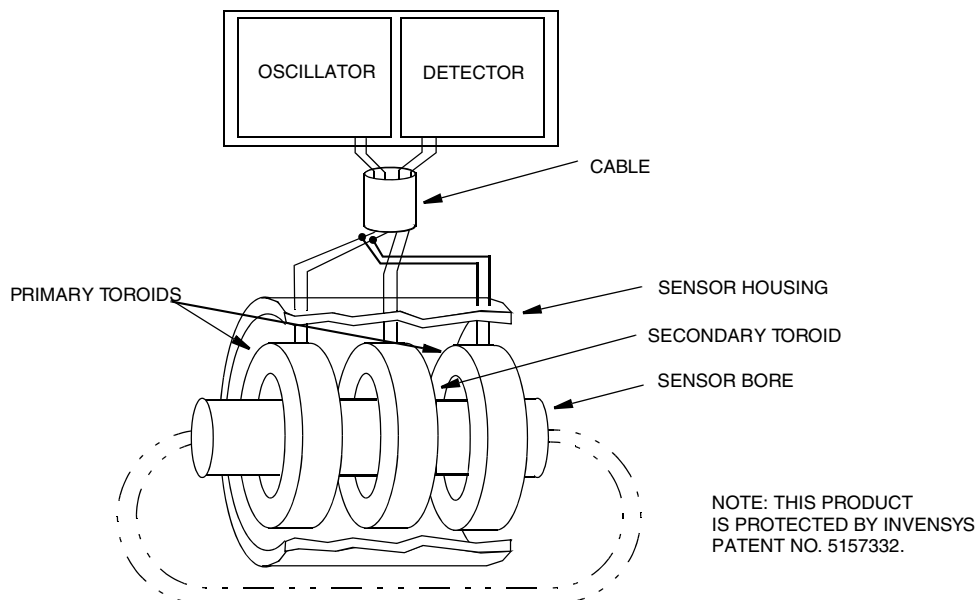


## Principle of Operation

As illustrated in Figure 4, an 871FT sensor consists of inductive toroids mounted on an electrically nonconductive (insulator) section coaxial with the piping system. The primary toroids induce an electric current in the process fluid as it passes through the insulator. The voltage created, which varies with process fluid conductivity, is detected by a secondary toroid and converted to a conductivity measurement. Because of the smooth bore, the 871FT sensor provides a totally noninvasive measurement of conductivity and significantly reduces the influence of coatings and deposits on conductivity measurement.

An RTD is available to measure process temperature. This measurement is used for automatic temperature compensation of the conductivity measurement. The RTD also provides an indication of process temperature at the analyzer instrument.

*Figure 4. Principle of Operation*



## Reference Documents

| Document   | Description  |
|------------|--|
| DP 611-150 | Dimensional Print – 871FT Flow-Through Conductivity Sensors with ANSI Class 150 Flanged End Connections        |
| DP 611-151 | Dimensional Print – 871FT Flow-Through Conductivity Sensors with Industrial-Rated NPT Threaded End Connections |
| DP 611-152 | Dimensional Print – 871FT Flow-Through Conductivity Sensors with Sanitary End Connections                      |
| DP 611-153 | Dimensional Print – 871FT Flow-Through Conductivity Sensors with ANSI Class 300 Flanged End Connections        |
| MI 611-150 | Master Instruction – 871EC Electrodeless Conductivity Sensors and Accessories                                  |
| MI 611-167 | Master Instruction – 873EC Series Electrochemical Analyzers  |
| MI 611-193 | Master Instruction – 873AEC Series Electrochemical Analyzers   |
| MI 611-212 | Master Instruction – 870ITEC Intelligent Electrochemical Transmitters  |
| MI 611-220 | Master Instruction – System Calibration Examples   |
| MI 611-224 | Master Instruction – 875EC Intelligent Electrochemical Analyzer  |
| PL 611-017 | Parts List – 871FT Flow-Through Conductivity Sensors   |
| TI 612-005 | Electrodeless Conductivity, Toroidal Magnets and the Procedure of Degaussing                                   |

## Electrical Safety Specifications

*Table 1. Electrical Safety Specifications*

| Testing Laboratory, Type of Protection, and Area Classification  | Application Conditions   | Electrical Safety Design Code |
|--|--|-------------------------------|
| <b>ATEX</b> intrinsically safe for II 1 GD EEx ia IIC, Zone 0.   | Temperature Class T4 - T6. T110°C - T260°C. Connect per MI 611-208.  | CS-E/AAA                      |
| <b>ATEX</b> Type n energy limited for II 3 GD EEx nL IIC, Zone 2.  | Temperature Class T4 - T6. T110°C - T235°C. Connect per MI 611-208.  | CS-E/ANN                      |
| <b>CSA</b> intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1. | Connect to certified 870ITEC per MI 611-206. Temperature Class T6.   | CS-E/CAA                      |
| <b>CSA</b> Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.                            | Connect to certified 870ITEC Transmitter or 873EC, 873AEC, or 875EC Analyzer per MI 611-206. Temperature Class T6. | CS-E/CNZ                      |
| <b>FM</b> intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1.  | Connect to approved 870ITEC per MI 611-206. Temperature Class T6.  | CS-E/FAA                      |
| <b>FM</b> nonincendive Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2.                | Connect to approved 870ITEC Transmitter or 873EC, 873AEC, or 875EC Analyzer per MI 611-206. Temperature Class T6.  | CS-E/FNZ                      |

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**NOTE**

These sensors have been designed to meet the electrical safety descriptions noted in the table above. For detailed information or status of testing laboratory approvals and certifications, contact Invensys.

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## Sanitary Certifications

Models 871FT-1 and 871FT-2 sensors with Tri-Clamp end Connections and Virgin PEEK Insulator material are FDA compliant for food use and comply with 3-A Standard 74-xx.

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### — NOTE

Sanitary sensor with Virgin PEEK insulator complies with 3-A Sanitary Standard 74-xx. Sanitary sensor with 2-inch line size and Virgin PEEK insulator is certified by EHEDG (European Hygienic Engineering and Design Group) for in-place cleanability according to EHEDG Document 2. Additionally, the Virgin PEEK insulator used in these sensors is FDA compliant. The Virgin PEEK insulator has a crevice-free design, interior bore surface finish <16 micro inch, and provides quick-disconnect construction.

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## Pressure Equipment Directive (PED) Compliance

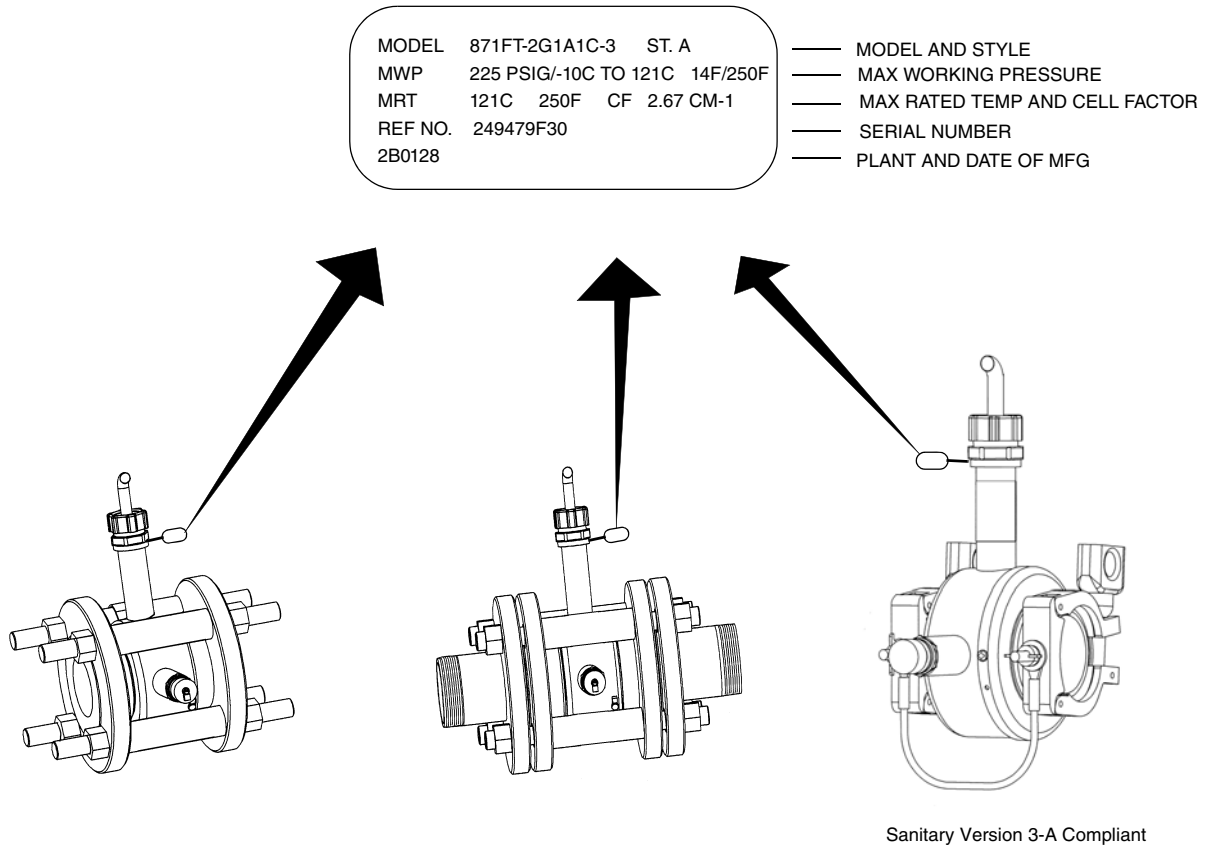
With the exception of the model codes listed in Table 2, the 871FT Sensors are in compliance with the Pressure Equipment Directive 97/23/EC as Sound Engineering Practice (SEP). For those models listed in Table 2, please contact Invensys.

*Table 2. Exceptions to PED Compliance*

| Model Code                 | Description   |
|----------------------------|---|
| 871FT-1J1A1<br>871FT-2J1A1 | 4-inch Sanitary Type with Virgin PEEK Insulator Material and Tri-Clamp Flange End Connections.      |
| 871FT-3H.D4<br>871FT-4H.D4 | 3-inch Industrial Type with Glass Filled PEEK Insulator Material and ANSI Class 300 End Connections |
| 871FT-3J.D3<br>871FT-4J.D3 | 4-inch Industrial Type with Glass Filled PEEK Insulator Material and ANSI Class 150 End Connections |
| 871FT-3J.D4<br>871FT-4J.D4 | 4-inch Industrial Type with Glass Filled PEEK Insulator Material and ANSI Class 300 End Connections |

# Flow-Through Conductivity Sensor Identification

*Figure 5. 871FT Toroidal Flow-Through Conductivity Sensor Data Label*



## Standard Specifications

*Table 3. Standard Specifications*

| Item   | Description  |
|--|--|
| <b>Ambient Temperature Normal Operating Condition Limits</b> | -10 and +50°C (14 and 120°F)   |
| <b>Process Temperature</b>                                   | Listed for various situations below  |
| <b>Wetted Parts</b>  |  |
| Sanitary Versions  | Virgin PEEK (PolyEtherEtherKetone) or PolyChloroTriFluorEthylene Insulators (PCTFE)  |
| Industrial Versions  | KYNAR (PolyVinylideneDiFluoride [PVDF]), PCTFE, or Glass Filled “PEEK” Insulators and 316 Stainless Steel, Nickel Alloy (a), or Carpenter 20-CB3 End Connections. Industrial versions have EPDM O-rings, with Viton or Chemraz optional. |
| <b>Cable</b>   |  |
| Standard   | 6 m (20 ft) PVC Jacketed Cable terminated in numbered tinned spadeless leads or spade lugs. This cable should be selected for use in conduit wiring applications.  |

Table 3. Standard Specifications (Continued)

| Item   | Description  |
|--|--|
| Optional   | 6 m (20 ft) Teflon <sup>®</sup> Jacketed Cable terminated in numbered tinned spadeless or spade lugs. This cable provides RFI/EMI shielding and therefore does not normally require a conduit.   |
| <b>Maximum Recommended Cable Length (b):</b>                           | 30 m (100 ft).   |
| <b>Nominal Line Sizes</b>  | Available line sizes in Sanitary and Industrial Sensors are determined by industry standard mounting sizes for sanitary tubing with Tri-Clamp flanges or Invensys Schedule 40 pipe dimensions with ANSI Class 150 or 300 flanges, respectively. NPT terminated models use Industrial Sensors with Flange/NPT adapters and have corresponding bore dimensions. These dimensions are shown in Table 4. Also shown in Table 4 are the part numbers for the Flange/NPT adapters that convert Flanged Industrial Sensors to NPT end fittings. |
| <b>Temperature and Pressure Limits (Also see Appendix A)</b>           |  |
| <b>Sanitary Sensors with Tri-Clamp Type Fittings (c)</b>               |  |
| Virgin PEEK<br>1/2, 3/4, and 2 in<br>1, 1 1/2, and 3 in<br>4 in        | 225 psi, -10 to +121°C (14 to 250°F) (d)<br>150 psi, -10 to +121°C (14 to 250°F) (d)<br>100 psi, -10 to +121°C (14 to 250°F) (d)   |
| PCTFE  | 60 psi, -10 to +60°C (14 to 140°F) linearly derated to 10 psi at 121°C (250°F) (e)   |
| <b>Industrial Sensors with ANSI Class 150 Flanges or NPT Mounting</b>  |  |
| Glass Filled PEEK  | 275 psi, -10 to +60°C (14 to 140°F) linearly derated to 190 psi at 210°C (411°F)   |
| PVDF: 2 in   | 150 psi, -10 to 100°C (14 to 212°F) no derating  |
| PCTFE  | 100 psi, -10 to +60°C (14 to 140°F) linearly derated to 10 psi at 121°C (250°F)  |
| <b>Industrial Sensors with ANSI Class 300 Stainless Steel Flanges:</b> |  |
| Glass Filled PEEK:<br>1/2, 1, 1 1/2, 2, 3, 4 in                        | 400 psi, -10 to +210°C (14 to 411°F)   |
| <b>Industrial Sensors with ANSI Class 300 Nickel Alloy (a) Flanges</b> |  |
| PVDF: 1/2 in   | 400 psi, -25 to +66°C (-13 to 150°F) linearly derated to 60 psi at 121°C (250°F)   |
| PVDF: 1 in   | 400 psi, -10 to +66°C (14 to 150°F) linearly derated to 60 psi at 121°C (250°F)  |
| PVDF: 1 1/2 in   | 400 psi, -10 to +66°C (14 to 150°F) linearly derated to 60 psi at 121°C (250°F)  |

- a. Equivalent to Hastelloy<sup>®</sup> C-276. Hastelloy is a registered trademark of Haynes International, Inc.
- b. Maximum recommended overall length.
- c. Tri-Clamp wing nut tightened to 25 lb•in (2.8 N•m) torque.
- d. Applications to 140°C (284°F) - contact Global Customer Support.
- e. Pressure of 15.3 psi at 250°F can be used for a short period of time (2 hours) for hot water or steam sterilization. For longer periods, contact Global Customer Support.

*Table 4. Standard Bore Dimensions for Sanitary and Industrial Sensors and Part Numbers of Flange/NPT Adapters*

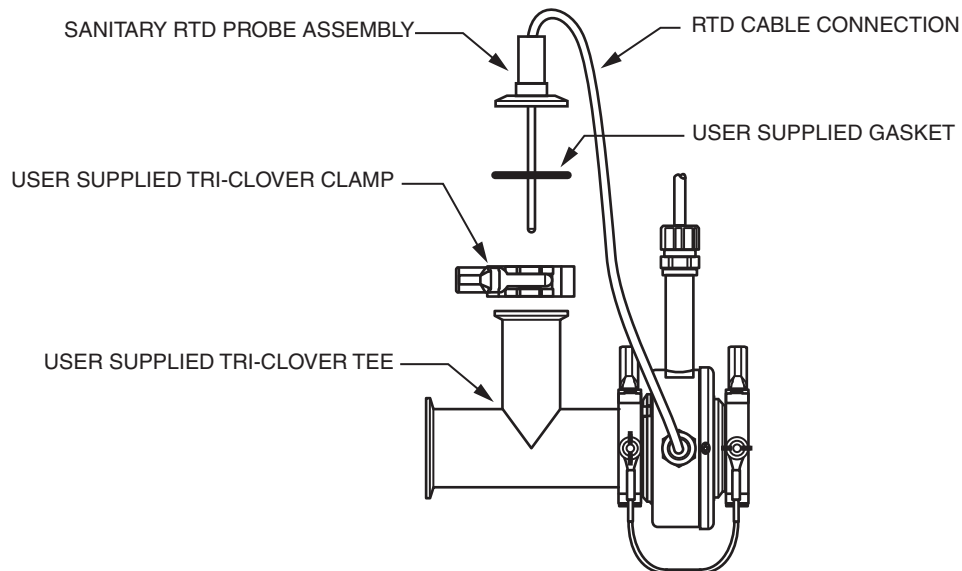
| Line Size (in) | Sanitary Bore (in) | Industrial Bore (in) | Flange/NPT Adapter Part Number (Industrial)                       |
|----------------|--------------------|----------------------|---|
| 1/2            | 0.375              | 0.622                | N/A   |
| 3/4            | 0.625              | N/A                  | N/A   |
| 1              | 0.870              | 1.049                | BS807GR (316 ss)<br>BS807HB Nickel Alloy (a)<br>BS807GW (C20-Cb3) |
| 1-1/2          | 1.370              | 1.610                | BS807GS (316 ss)<br>BS807HC Nickel Alloy (a)<br>BS807GX (C20-Cb3) |
| 2              | 1.870              | 2.067                | BS807GT (316 ss)<br>BS807HD Nickel Alloy (a)<br>BS807GY (C20-Cb3) |
| 3              | 2.870              | 3.068                | N/A   |
| 4              | 3.830              | 4.026                | N/A   |

a. Equivalent to Hastelloy® C.

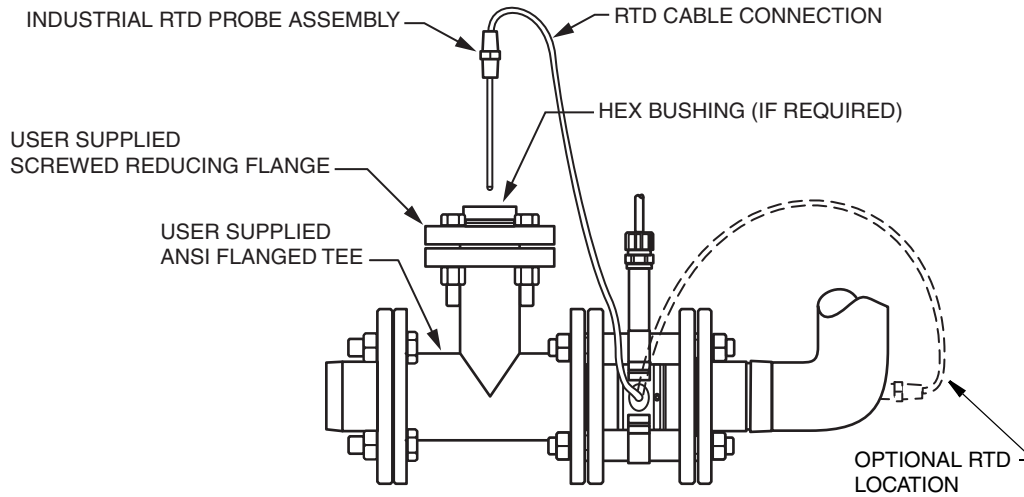
## Temperature Compensation

Solution temperature measurement is obtained by using nonintegral RTD Probe Assemblies available in both sanitary and industrial versions with 100  $\Omega$  or 1000  $\Omega$  RTDs. Typical installations are shown in Figures 6 and 7.

*Figure 6. Temperature Compensation Assembly with 3-A Compliant Sanitary Sensor*



**Figure 7. Temperature Compensation Assembly With Industrial SensorS**



Sanitary RTD Probe Assemblies are available in 316L Stainless Steel with 3/4-, 2-, and 4-inch Tri-Clover flanges for use with user-supplied sanitary tees. Industrial RTD Probe Assemblies are available in 316 Stainless Steel, Carpenter 20-Cb3, and Hastelloy-C276. These probes all use a 1/2-inch pipe nipple for mounting in a user-supplied flanged process tee using a reducing screwed flange. Industrial RTD sensors can also be mounted directly into the process line (for example, at an elbow). Avoid excess flow against the sheath if mounted vertically. Avoid accumulation of fouling material. Tables 5 and 6, list Foxboro part numbers for these probes plus potential source and vendor part numbers for the associated hardware items required for each type and line size of sensor.

**Table 5. Parts List for Addition of Temperature Measurement to Sanitary Sensor**

| Size       | RTD Ohms    | RTD Assembly       | Tri-Clover Tee* Part No.                                  | Tri-Clover Clamp (a) Part No. |
|------------|-------------|--------------------|---|-------------------------------|
| 1/2 inch   | 100<br>1000 | BS807VR<br>BS807VS | 1/2 inch Full Tee<br>7MP-1/2-316L                         | 13MHHS 3/4-S                  |
| 3/4 inch   | 100<br>1000 | BS807VR<br>BS807VS | 3/4 inch Full Tee<br>7MP-3/4-316L                         | 13MHHS 3/4-S                  |
| 1 inch     | 100<br>1000 | BS807VR<br>BS807VS | Reducing Tee<br>1 in to 1/2 in<br>7RMP-1x1/2-316L         | 13MHHS 3/4-S                  |
| 1-1/2 inch | 100<br>1000 | BS807VR<br>BS807VS | Reducing Tee<br>1-1/2 in to 1/2 in<br>7RMP-1-1/2x1/2-316L | 13MHHS 3/4-S                  |
| 2 inch     | 100<br>1000 | BS807VT<br>BS807VU | 2 inch Full Tee<br>7MP-2-316L                             | 13MHHS 2-S                    |
| 3 inch     | 100<br>1000 | BS807VT<br>BS807VU | Reducing Tee<br>3 in to 2 in<br>7RMP-3x2-316L             | 13MHHS 2-S                    |
| 4 inch     | 100<br>1000 | BS807VV<br>BS807VW | 4 in Full Tee<br>7MP-4-316L                               | 13MHHS 4-S                    |

a. Typical Vendor Source: Tri-Clover, Inc., 9201 Wilmot Road, Kenosha WI 52141-1413



*Table 6. Parts List for Addition of Temperature Measurement to Industrial Sensors*

| Size       | Material  | RTD Ohms | RTD Assembly | Commercial Tee (a)              | Reducing Screwed Flange*             | Hex Bushing (a) |
|------------|-----------|----------|--------------|---------------------------------|--------------------------------------|-----------------|
| 1/2 inch   | 316       | 100      | BS807WR      | ---                             | ---                                  | ---             |
|            |           | 100      | BS807WS      |                                 |                                      |                 |
|            | Hast C276 | 100      | BS807WP      |                                 |                                      |                 |
|            |           | 100      | BS807WQ      |                                 |                                      |                 |
| 1-inch     | 316       | 100      | BS807WR      | 1-in ANSI<br>300 lb Flanged     | 1-in ANSI 300 lb<br>x 1/2 NPT        | Not Required    |
|            |           | 100 (b)  | BS811EU      |                                 |                                      |                 |
|            | 1000      | BS807WS  |              |                                 |                                      |                 |
|            | C20-Cb3   | 100      | BS807WR      | 1-in ANSI<br>150 lb Flanged     | 1-in ANSI 150 lb<br>x<br>1/2 NPT     | Not Required    |
| 1000       |           | BS807WS  |              |                                 |                                      |                 |
| Hast-C276  | 100       | BS807WT  | 1000         | BS807WU                         |                                      |                 |
|            | 1000      | BS807WQ  |              |                                 |                                      |                 |
| 1-1/2 inch | 316       | 100      | BS807WB      | 1-1/2 in ANSI 300 lb<br>Flanged | 1-1/2 ANSI 300 lb<br>x 1-1/4 NPT     | 1-1/4 x 1/2 NPT |
|            |           | 100 (b)  | BS811EV      |                                 |                                      |                 |
|            | 1000      | BS807WC  |              |                                 |                                      |                 |
|            | 316       | 100      | BS807VX      | 1-1/2-in ANSI 150 lb<br>Flanged | 1-1/2-in ANSI 150 lb<br>x<br>1/2 NPT | Not Required    |
| 1000       |           | BS807VY  |              |                                 |                                      |                 |
| C20 -Cb3   | 100       | BS807WF  | 1000         | BS807WG                         |                                      |                 |
|            | 1000      | BS807VH  |              |                                 |                                      |                 |
| Hast-C276  | 100       | BS807VJ  |              |                                 |                                      |                 |
|            | 1000      | BS807VJ  |              |                                 |                                      |                 |
| 2-inch     | 316       | 100      | BS807WB      | 2 in ANSI<br>300 lb Flanged     | 2 ANSI 300 lb<br>x 1-1/4 NPT         | 1-1/4 x 1/2 NPT |
|            |           | 100 (b)  | BS811EV      |                                 |                                      |                 |
|            | 1000      | BS807WC  |              |                                 |                                      |                 |
|            | 316       | 100      | BS807VX      | 2-in ANSI 150 lb<br>Flanged     | 2-in ANSI 150 lb<br>x<br>1-1/4 NPT   | 1-1/4 x 1/2 NPT |
| 1000       |           | BS807VY  |              |                                 |                                      |                 |
| C20-Cb3    | 100       | BS807WF  | 1000         | BS807WG                         |                                      |                 |
|            | 1000      | BS807VH  |              |                                 |                                      |                 |
| Hast-C276  | 100       | BS807VJ  |              |                                 |                                      |                 |
|            | 1000      | BS807VJ  |              |                                 |                                      |                 |
| 3-inch     | 316       | 100      | BS808EG      | 3 in ANSI<br>300 lb Flanged     | 3 ANSI 300 lb<br>x 1-1/4 NPT         | 1-1/4 x 1/2 NPT |
|            |           | 100 (b)  | BS811EW      |                                 |                                      |                 |
|            | 1000      | BS808EH  |              |                                 |                                      |                 |
|            | 316       | 100      | BS807WB      | 3-in ANSI 150 lb<br>Flanged     | 3-in ANSI 150 lb<br>x<br>1-1/4 NPT   | 1-1/4 x 1/2 NPT |
| 1000       |           | BS807WC  |              |                                 |                                      |                 |
| C20-Cb3    | 100       | BS807WK  | 1000         | BS807WL                         |                                      |                 |
|            | 1000      | BS807VM  |              |                                 |                                      |                 |
| Hast-C276  | 100       | BS807VN  |              |                                 |                                      |                 |
|            | 1000      | BS807VN  |              |                                 |                                      |                 |

**Table 6. Parts List for Addition of Temperature Measurement to Industrial Sensors (Continued)**

| Size   | Material  | RTD Ohms               | RTD Assembly                  | Commercial Tee (a)          | Reducing Screwed Flange*     | Hex Bushing (a) |
|--------|-----------|------------------------|-------------------------------|-----------------------------|------------------------------|-----------------|
| 4-inch | 316       | 100<br>100 (b)<br>1000 | BS808EG<br>BS811EW<br>BS808EH | 4 in ANSI<br>300 lb Flanged | 4 ANSI 300 lb<br>x 1-1/4 NPT | 1-1/4 x 1/2 NPT |
|        | 316       | 100<br>1000            | BS807WB<br>BS807WC            |                             |                              |                 |
|        | C20-Cb3   | 100<br>1000            | BS807WK<br>BS807WL            |                             |                              |                 |
|        | Hast-C276 | 100<br>1000            | BS807VM<br>BS807VN            |                             |                              |                 |

a. Typical Vendor Source: All Stainless, Inc., 75 Research Road, Hingham MA 02043.

b. Per MIL-T-24388C (SH).

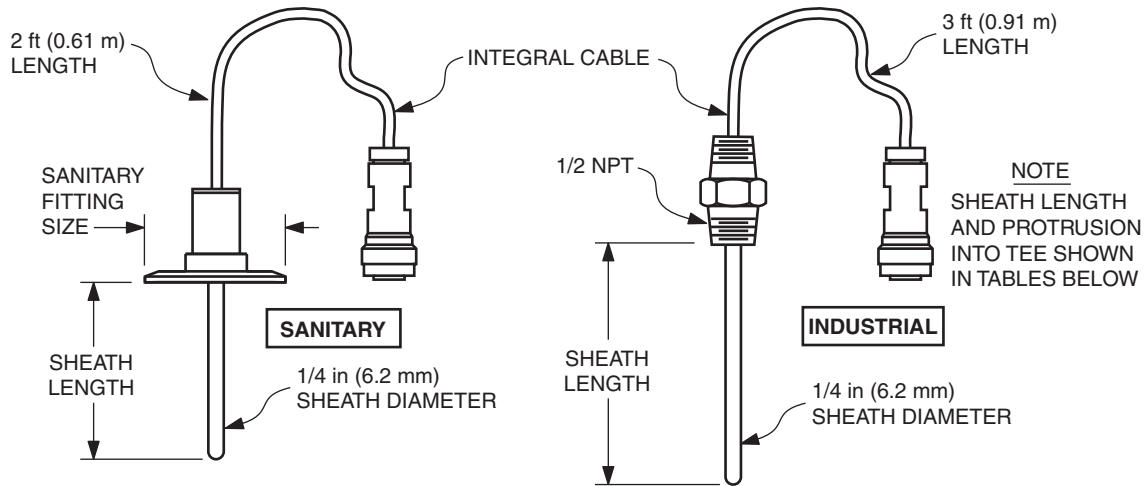
The 100 and 1000  $\Omega$  Platinum RTDs have temperature functions per DIN 43760 or IEC 751-1983. The 100  $\Omega$  MIL SPEC RTD is per MIL-T-24388C (SH). This function, at various temperatures, is shown in Table 7.

*Table 7. Temperature vs. RTD Resistance*

| Temperature |     | 100 Ohm RTD | 100 Ohm RTD (MIL SPEC) | 1000 Ohm RTD |
|-------------|-----|-------------|------------------------|--------------|
| °C          | °F  | Ohms        | Ohms                   | Ohms         |
| -5          | +20 | 98.04       | 98.01                  | 980.4        |
| 0           | 32  | 100.00      | 100.00                 | 1000.0       |
| 10          | 50  | 103.90      | 103.98                 | 1039.0       |
| 20          | 68  | 107.79      | 107.94                 | 1077.9       |
| 25          | 77  | 109.73      | 109.92                 | 1097.3       |
| 30          | 86  | 111.67      | 111.89                 | 1116.7       |
| 40          | 104 | 115.54      | 115.83                 | 1155.4       |
| 50          | 122 | 119.40      | 119.77                 | 1194.0       |
| 60          | 140 | 123.24      | 123.69                 | 1232.4       |
| 70          | 158 | 127.07      | 127.60                 | 1270.7       |
| 80          | 176 | 130.89      | 131.49                 | 1308.9       |
| 90          | 194 | 134.70      | 135.37                 | 1347.0       |
| 100         | 212 | 138.50      | 139.24                 | 1385.0       |
| 105         | 225 | 140.39      | 141.17                 | 1403.9       |
| 110         | 230 | 142.28      | 143.10                 | 1422.8       |
| 120         | 248 | 146.06      | 146.95                 | 1460.6       |
| 130         | 266 | 149.82      | 150.79                 | 1498.2       |
| 140         | 284 | 153.58      | 154.61                 | 1535.8       |
| 150         | 302 | 157.32      | 158.42                 | 1573.2       |
| 160         | 320 | 161.04      | 162.22                 | 1610.4       |
| 170         | 338 | 164.76      | 166.01                 | 1674.6       |
| 180         | 356 | 168.47      | 169.79                 | 1684.7       |
| 190         | 374 | 172.16      | 173.42                 | 1721.6       |
| 200         | 392 | 175.84      | 177.23                 | 1758.4       |
| 210         | 410 | 179.51      | 181.05                 | 1795.1       |

Temperature compensation sensor elements (RTDs) are shown in Figure 8. Cable lengths are 2 ft (0.6 m) long for sanitary sensors and 3 ft (0.9 m) for industrial sensors. Patch Cables are available for RTD assemblies. Cable BS809UN is 10 ft (3 m) long. Cable BS809UP is for special lengths per sales order. RTD sheath length (Figure 8) and protrusion into the pipe (Figure 9) is shown in Table 8.

**Figure 8. Temperature Compensation Sensor Elements (RTDs)**

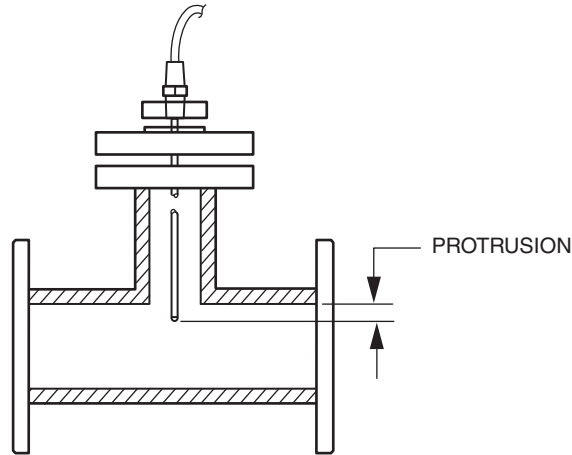


**Table 8. RTD Sheath Length and Protrusion**

| Sensor Type          | Size                  | Sheath Length | Protrusion (a) | Sanitary Fitting Size |
|----------------------|-----------------------|---------------|----------------|-----------------------|
| Sanitary             | 1/2, 3/4, 1, 1 1/2 in | 2.5 in        | 0.13 in        | 0.98 in               |
|                      | 2 in                  | 3.25 in       | 0.25 in        | 2.5 in                |
|                      | 3 in                  | 3.25 in       | 0.19 in        | 2.5 in                |
|                      | 4 in                  | 4.5 in        | center of pipe | 4.7 in                |
| Industrial Class 150 | 1/2 and 1 in          | 3.38 in       | 0.56 in        |                       |
|                      | 1 1/2                 | 3.38 in       | 0.56 in        |                       |
|                      | 2 in                  | 3.38 in       | 0.19 in        |                       |
|                      | 3 in                  | 5.44 in       | 0.65 in        |                       |
|                      | 4 in                  | 5.44 in       | 0.25 in        |                       |
| Industrial Class 300 | 1/2 and 1 in          | 3.38 in       |                |                       |
|                      | 1 1/2 and 2 in        | 5.44 in       |                |                       |
|                      | 3 and 4 in            | 6.62 in       |                |                       |

a. The amount of protrusion into the pipe may vary with gasket thickness.

*Figure 9. Protrusion Into Pipe*



## Sensor Weights

Table 9 lists approximate gross weights for various sizes of sensors.

*Table 9. Approximate Sensor Weights*

| Nominal Size Per Model Code | Weight (lb) |                |                |      |
|-----------------------------|-------------|----------------|----------------|------|
|                             | Sanitary    | ANSI Class 150 | ANSI Class 300 | NPT  |
| C = 1/2                     | 2.5         | 11             | 15             | 14   |
| D = 3/4                     | 2.5         | N/A            | N/A            | N/A  |
| E = 1                       | 7.5         | 10             | 14             | 18.5 |
| F = 1-1/2                   | 7.0         | 12             | 15             | 17.5 |
| G = 2                       | 6.5         | 17             | 20             | 28.5 |
| H = 3                       | 9.3         | 32             | 40             | N/A  |
| J = 4                       | 8.8         | 41             | 60             | N/A  |



## 2. Installation

### Selecting the Location for the Sensor

---

**! CAUTION**

---

Prior to shipment, Invensys routinely tests all sensors at 1.5 times the maximum rated pressure for each model as shown in Table 3, “Standard Specifications,” on page 13. For sanitary sensors, this test ensures integrity of the insulator only. For industrial sensors, this test ensures integrity of the insulator and the two sets of O-rings captured within the assembly. Since the threaded rods that hold the industrial sensor together must be removed to allow installation in the process line, the sensor as installed no longer represents the pressure tested assembly. It is recommended that the user pressure test the assembly after installation, preferably with water, prior to placing the line back in service.

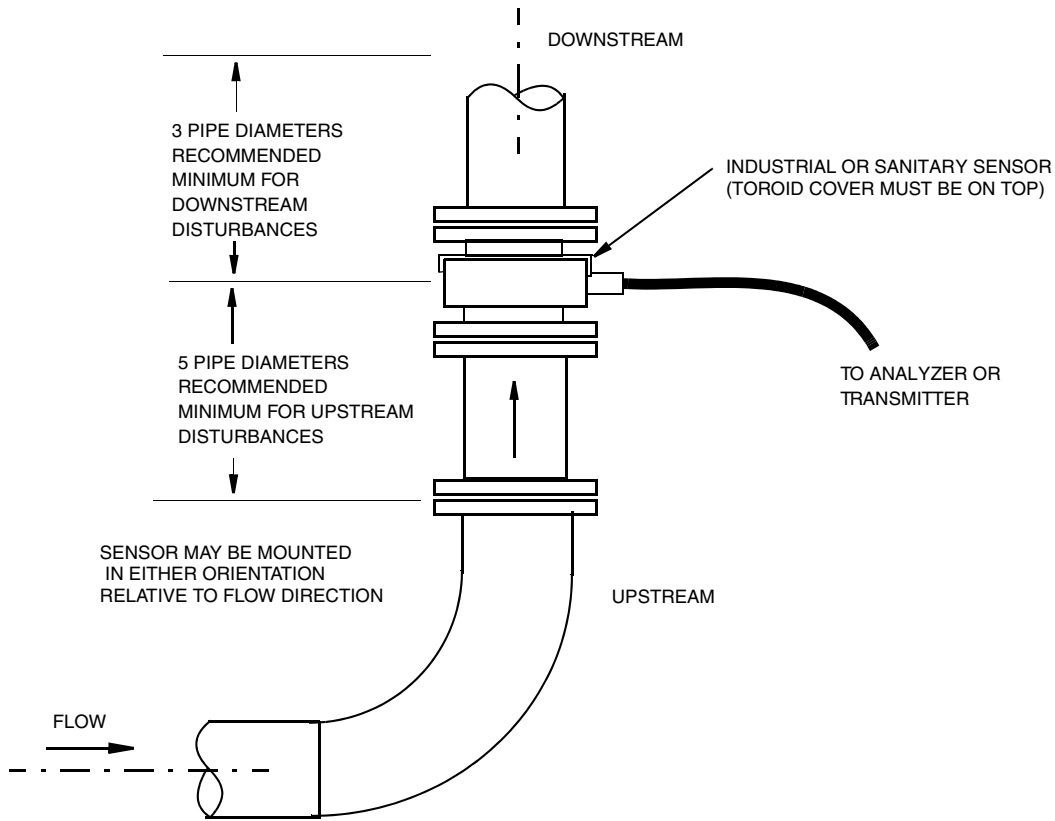
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The sensor can be installed in plastic or nonmagnetic metal piping to avoid the remote possibility of magnetizing the sensor assembly (see “Flange Types and Materials” on page 25) and can usually be placed at any convenient location in the pipeline. To ensure good performance, however, the location should be analyzed relative to the factors listed below:

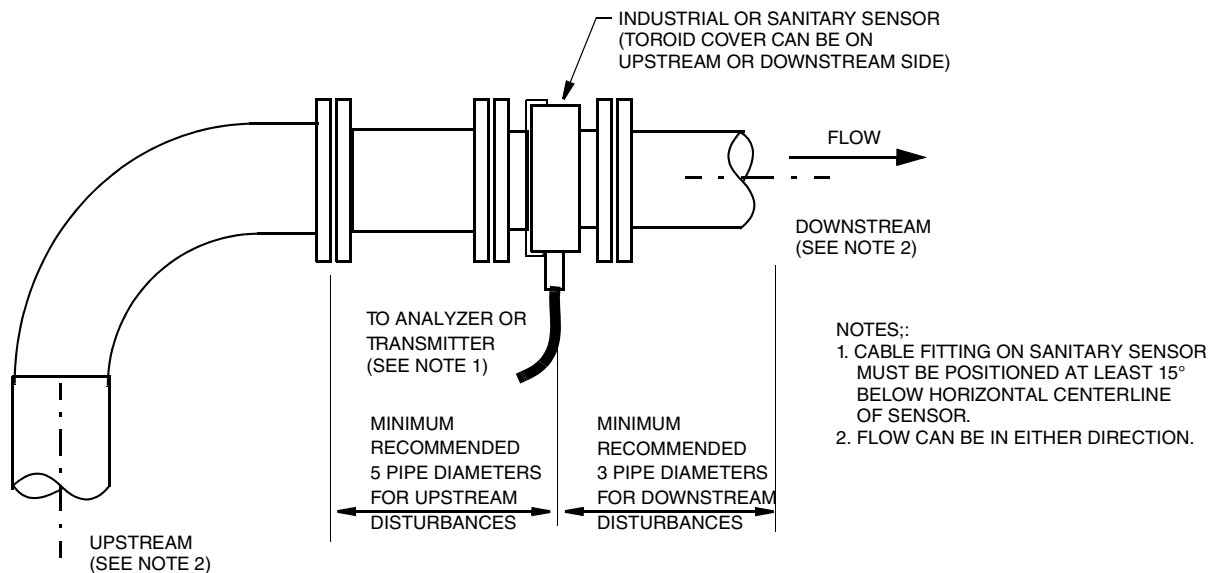
- ◆ Flow through the sensor can be in either direction, but upstream/downstream disturbances must be within the guidelines shown in Figure 10 and Figure 11.
- ◆ For accuracy, it is essential that the tube be completely full during operation. Horizontal, vertical, or sloping positions are acceptable, but some positions require special attention to ensure that the tube remains full. In addition to obvious problem locations such as down flowing vertical runs, consider areas where air pockets may form and where siphoning action or low pressure areas could create voids.
- ◆ Effects of upstream disturbances, such as valves, elbows, etc., are difficult to predict, but in nearly all cases, standard accuracy will be realized if there are at least five pipe diameters of straight pipe upstream of the sensor. Downstream disturbances that are three or more pipe diameters from the end of the sensor will not affect performance. The inside diameter of the piping should be the same as or larger than the nominal size of the sensor bore. Sensors can be placed in larger nominal size pipelines by using tapered conical reducers. The small end of the reducers can be directly coupled to the sensor and can have an included angle of 16° maximum.
- ◆ Buildup of sedimentary deposits within the sensor or on the metallic terminations may change the cell factor, proportionate to the thickness of the deposit, and may therefore affect accuracy and require in-line recalibration at intervals dependent on the magnitude of the fouling condition in the application.
- ◆ The presence of entrained air or bubbles within the insulator may lead to errors in measurement proportional to the volume of fluid they displace.

- ◆ The mounting orientation of the sensor must be horizontal to vertically “up” with the toroid cover on the top to prevent access of contamination. This is mandatory for sanitary sensors and strongly recommended for industrial sensors. See Figure 10.
- ◆ User supplied EHEDG approved seals, i.e. SS/Kalrez, are required to maintain EHEDG certification for use with Tri-Clamp Connector.

*Figure 10. Vertical Mounting of Sensor*



*Figure 11. Horizontal Mounting of Sensor*





# Pipeline Preparation

## Flow-Through Sensor Dimensions

Refer to the dimensional prints listed in “Reference Documents” on page 11 for complete information. Note that the dimensions noted for the Industrial sensors should be increased to accommodate the two required flange gaskets (supplied by user).

## Flange Types and Materials

Process piping and flanges must not be magnetized. Sanitary sensors must be installed in nonmagnetic metal piping systems or, if placed in nonmetallic systems, a nonmagnetic metal spoolpiece (user supplied or contact Invensys) with a length of at least one tube diameter must be installed on each end of the sensor. Industrial models with integral metal flanges may be installed into nonmagnetic metal or nonmetallic pipe and flange systems.

## Pipeline Support and Alignment

Adequately support the pipeline to carry its weight when full and to control pipeline motions such as may be caused by water hammer or other disturbances within the piping system.

In cases where temperature differences will occur, make provisions to allow for thermal expansions in a manner that will preserve the initial alignment of the piping at the sensor.

The pipeline must provide support for the sensor and the alignment must be accurate enough to allow sealing at the flanges or Tri-Clamp type joints with normal clamp tightening forces. Cantilever or bending loads on the sensor must be minimized. Use through-bolting wafer style mounting for all line sizes.

## Pre-Startup Cleaning

It is recommended that a flanged “spool piece” (user-supplied) the same length as the sensor be installed. Insert it in the line before startup. On startup, any foreign objects in the line such as pieces of wood or metal, should be located and removed before the sensor is installed. This greatly lessens the possibility of accidental damage to the sensor.

## Unpacking and Handling Procedures

Before removing the sensor from its shipping carton, move it as close as possible to its installation point. Flanged-body sensors are shipped with end covers to protect the sensor lining. If the covers must be removed for receiving inspection, *reinstall the end covers after inspection*.

To lift a flanged-body sensor out of its carton, use a rope fall, chain hoist, or similar tool as shown in Figure 12. In some instances, it may be more convenient to insert bolts into the flange bolt holes and use hooks around the bolts for lifting (rather than tying slings around the sensor).

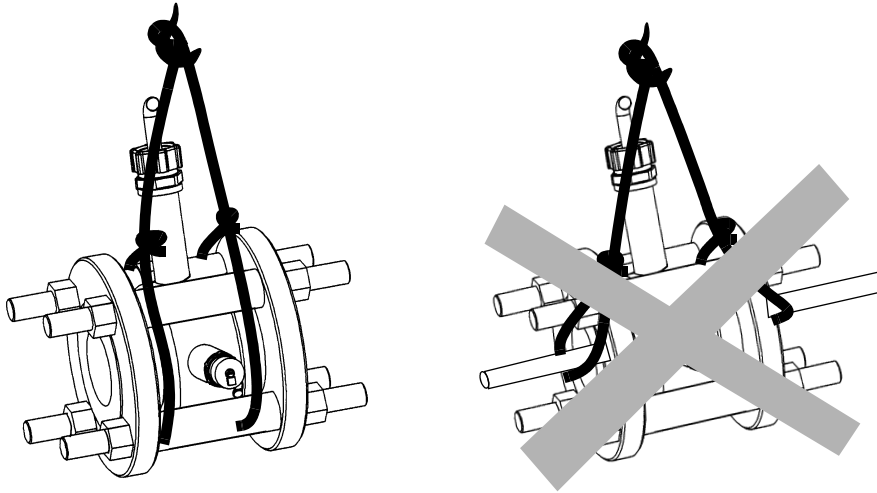
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 **CAUTION**

Never put anything through the sensor to lift it.

---

*Figure 12. Handling Flanged-Body Sensor*



After removing the sensor from its shipping cartons, inspect it for visible damage. If any damage is observed, notify the carrier immediately and request an inspection report. Obtain a signed copy of the report from the carrier.

## Sensor Mounting

1. Position sensor in pipeline. Note that the sensor can be installed in either direction relative to direction of flow. Select the orientation that provides best access for routing of cables.
2. Verify that the desired gasket is in place (user supplied). User supplied EHEDG approved seals, i.e. SS/Kalrez, are required to maintain EHEDG certification for use with Tri-Clamp Connector.
3. For sanitary sensors, install Tri-Clamp assembly provided with sensor and tighten to 25 lb·in torque (Tri-Clamp fitting) or 20 lb·ft torque (high pressure fitting)
4. For industrial sensors with flange fittings as shown in Figure 2, loosely install mounting bolts as required. Begin tightening the flanges to the sensor. Initially, this should be done by carefully tightening the nuts in an order that will bring the flanges flat against the sensor gaskets. Through-bolt mounting wafer-style is recommended for all line size industrial models.
5. Tightening of flange nuts requires special care – first, to create a uniform clamping load on the sensor, and second, to avoid overcompressing the gaskets. Begin by bringing the flanges into full face contact with the gaskets, using minimum possible torque. This should be done by tightening the nuts adjacent to the largest flange-to-gasket gaps until full circle contact is made. Then, with all nuts at least finger-tight, proceed to tighten the nuts following a diametrically opposite pattern. Turn the first nut 1/6 of a turn, then move to the next nut and tighten it 1/6 of a turn. Continue this sequence until the maximum torque spec for each nut, shown in the following table for the various flange sizes, has been reached.

*Table 10. Maximum Mounting Nut Torques for Flanged Sensors*

| Flange |             | Bolt Size | Maximum Mounting Nut Torque |       |
|--------|-------------|-----------|-----------------------------|-------|
| Class  | Size (in)   |           | kg-m                        | lb-ft |
| 150    | 1, 1-1/2    | 1/2-13    | 5.8                         | 42    |
|        | 2, 3, 4     | 5/8-11    | 13.8                        | 100   |
| 300    | 1/2, 1, 2   | 5/8-11    | 13.8                        | 100   |
|        | 1-1/2, 3, 4 | 3/4-10    | 17.8                        | 130   |

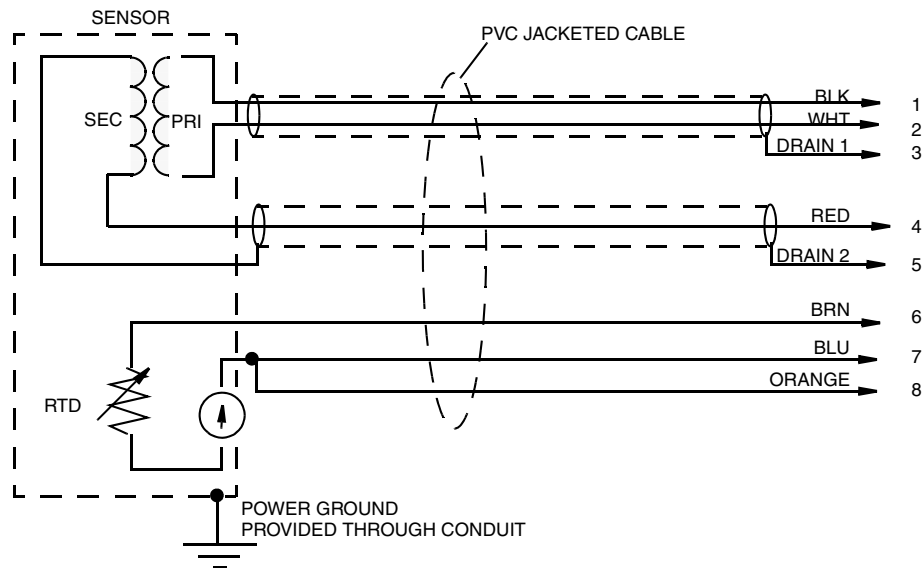
**! CAUTION**

The torque values in this table are for 316 SS bolts and flanges per ANSI B.16.5-1977. If plastic flanges are used, consult specifications supplied with the plastic flanges.

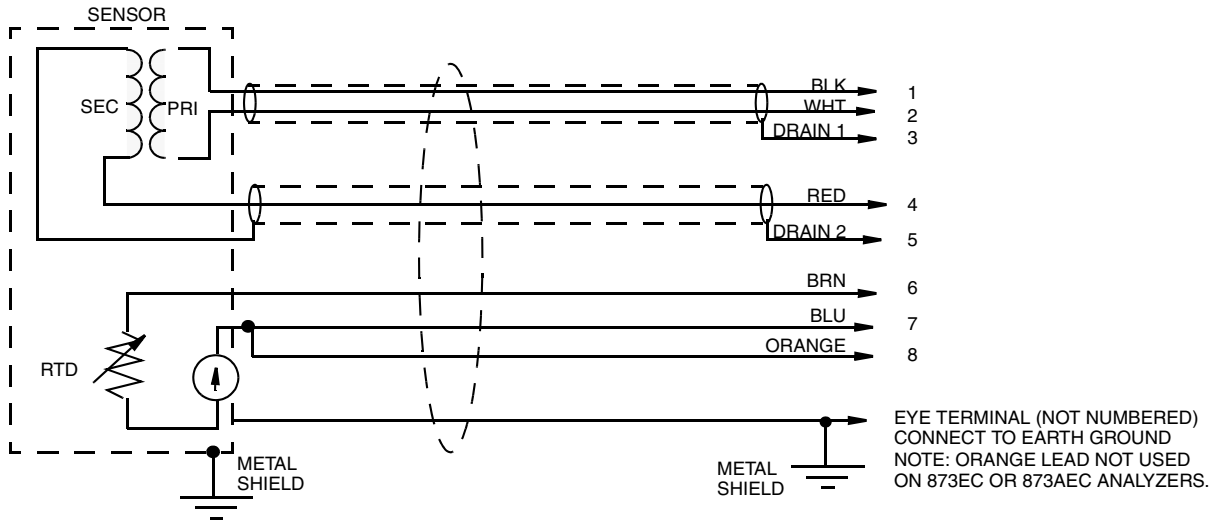
## System Wiring

The two cable types available with the sensor are terminated in numbered, tinned, spadeless leads or leads with spade lugs. Spadeless terminations are used with 873EC or 873AEC Analyzers and spade lug types for wiring to junction boxes or to 875EC Analyzers or 870ITEC Transmitters. The standard cable is PVC-jacketed and has eight conductors (see Figure 13). The PVC cable is selected for use in conduit wiring applications where the conduit provides RFI/EMI shielding and electrically interconnects the metal shield on the sensor with power ground on the analyzer. The optional cable is Teflon-jacketed, has integral RFI/EMI shielding, and has nine conductors (see Figure 14). A low smoke cable is also available. It has eight conductors (see Figure 13).

*Figure 13. Flow-Through Sensor with PVC-Jacketed 8-Conductor Cable*



*Figure 14. Flow-Through Sensor with Teflon-Jacketed 9-Conductor Cable*

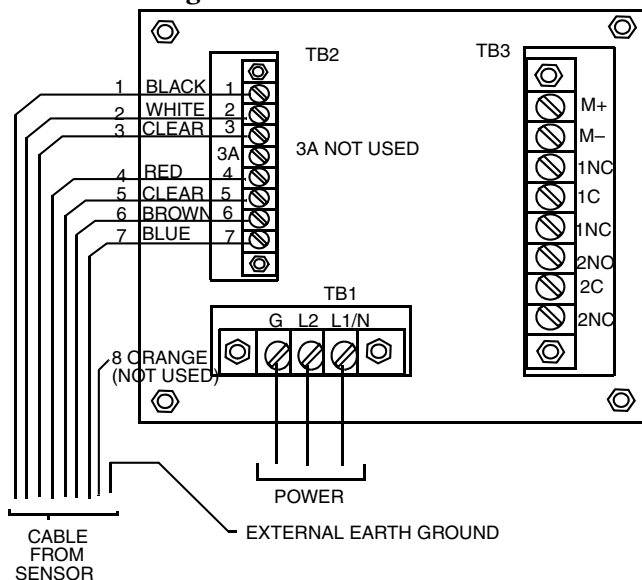


## Wiring to 873EC and 873AEC Analyzers

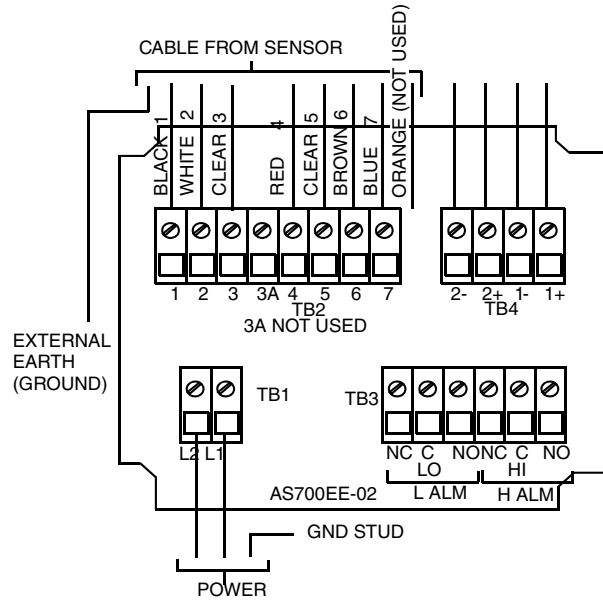
Sensor wiring to the plastic NEMA 1 and metal NEMA 4X analyzer are shown in Figure 15 and Figure 16, respectively. In each case, Leads 1 through 7 are connected to the corresponding numbered terminals on the back of the analyzer.

For the metal NEMA 4X Analyzer and Teflon-jacketed cable, the orange lead No. 8 from the sensor is not used. The ground lead (with the eye terminal) is connected to the grounding stud on the inside of the analyzer case. When using the metal NEMA 4X Analyzer with PVC-jacketed cable, the wires are connected as numbered and should be installed in conduit to provide shielding between the analyzer and the metal case on the sensor.

*Figure 15. Sensor Wiring to Plastic 873EC or 873AEC NEMA 1 Analyzer*



*Figure 16. Sensor Wiring to Metal 873EC and 873AEC NEMA 4X Analyzer*

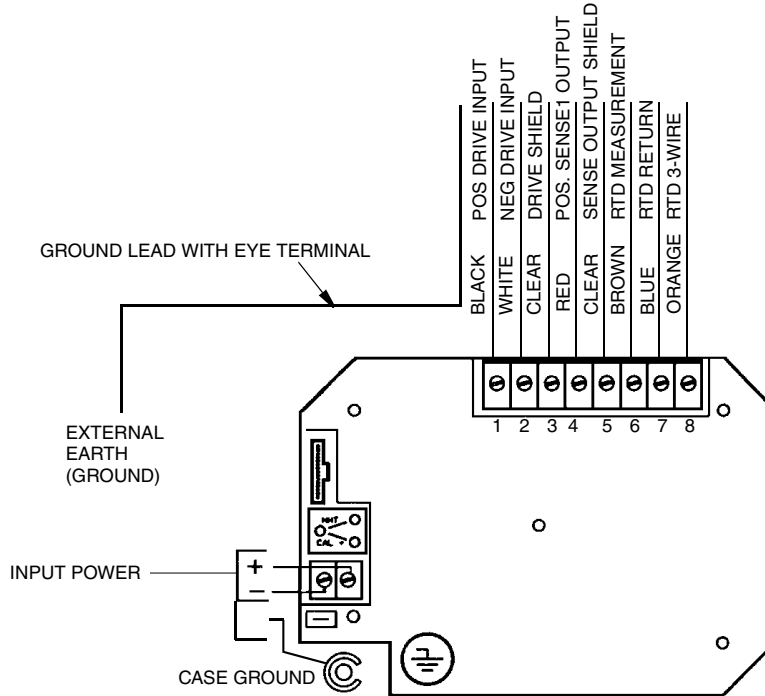


The plastic NEMA 1 Analyzer should be used only with the Teflon-jacketed cable, since provision is not otherwise made for metal conduit connection to this instrument. The orange lead No. 8 from the sensor is not used and the ground lead with the eye terminal is connected to the green wire power ground terminal on the back of the analyzer.

## Wiring to 870ITEC Analyzers

When wiring sensors to 870ITEC Transmitters using standard PVC jacketed cable, Leads 1 through 8 are connected to the corresponding numbered terminals on the back of the analyzer. This cable is normally run in conduit, which provides earth ground between sensor and transmitter. When wiring with Teflon jacketed cable, the lead with the eye terminal is provided for grounding and is connected to the case earth ground on the transmitter (see Figure 17).

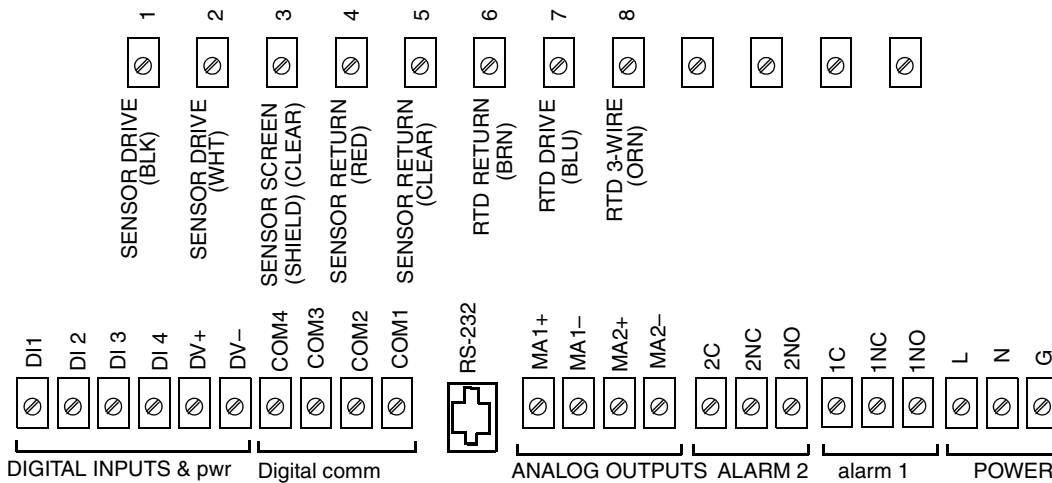
Figure 17. Sensor Wiring to 870ITEC Analyzer



## Wiring to 875EC Analyzers

Wiring connections on 875EC panel-mounted analyzers are located on the rear of the housing. Those on pipe- or surface-mounted analyzers are located in the lower compartment of the housing. Connect sensor leads 1 through 8 per Figure 18. To meet CE requirements, the ac cable must be routed away from all other I/O wiring, especially the sensor cable.

Figure 18. Sensor Wiring to 875EC Analyzer



## Junction Box Installation

The maximum recommended cable length between the sensor and the analyzer or transmitter is 30 m (100 ft). Where possible, the sensor should be supplied with the appropriate length of cable for the intended installation. To minimize inaccuracies that may result from use of a junction box, the analyzer/sensor system should be calibrated as a system after installation, using the appropriate procedure as described in “Bench Calibration” on page 34.

Four extension cables are available for wiring between junction box Part No. BS807DY and the analyzer or transmitter. These cables are ordered with customer-specified lengths.

---

### NOTE

Cables used with an 873EC or 873AEC Analyzer are terminated with stripped and tinned wires; cables used with an 870ITEC Transmitter or 875EC Analyzer are terminated with spade lugs, as listed in the following table.

---

The two PVC-jacketed shielded cables can also be used with junction box Part No. BS807NS and the analyzer or transmitter.

| Part No. | Jacket | No. of Conductors | Use between junction box and ...                  |
|----------|--------|-------------------|---|
| BS807PB  | Teflon | 8, plus ground    | 873EC or 873AEC Analyzer (lugs/lugless)           |
| BS807PA  | Teflon | 8, plus ground    | 870ITEC Transmitter or 875EC Analyzer (lugs/lugs) |
| BS807PD  | PVC    | 8, no ground      | 873EC or 873AEC Analyzer (lugs/lugless)           |
| BS807PC  | PVC    | 8, no ground      | 870ITEC Transmitter or 875EC Analyzer (lugs/lugs) |

## Junction Box Mounting

The junction box (Foxboro Part No. BS807DY (used with Teflon- or PVC-jacketed cable) or BS807NS (only used with PVC-jacketed cable) is used when the distance between sensor and monitor or transmitter is more than the cable length on the sensor. Note that the maximum recommended separation between sensor and analyzer or transmitter is 30 m (100 ft).

---

### ! CAUTION

Cable length must be considered so that connections can be made without exposing cable to damage.

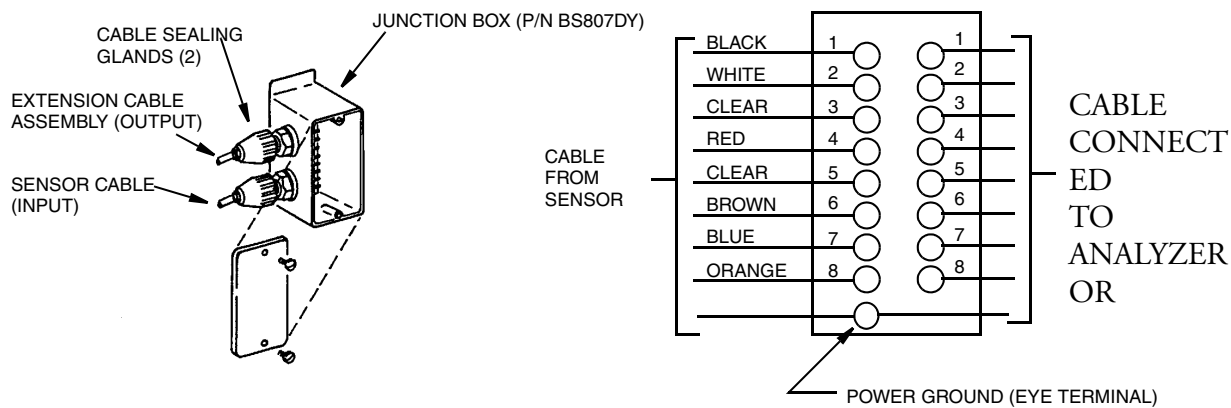
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1. Select a rigid surface and a location protected from damage or exposure to excessive moisture and corrosive fumes.
2. Position the junction box against the mounting surface and mark the location of the mounting holes.
3. Drill the mounting holes on the marked centers.
4. Mount the junction box with appropriate hardware (user-supplied).

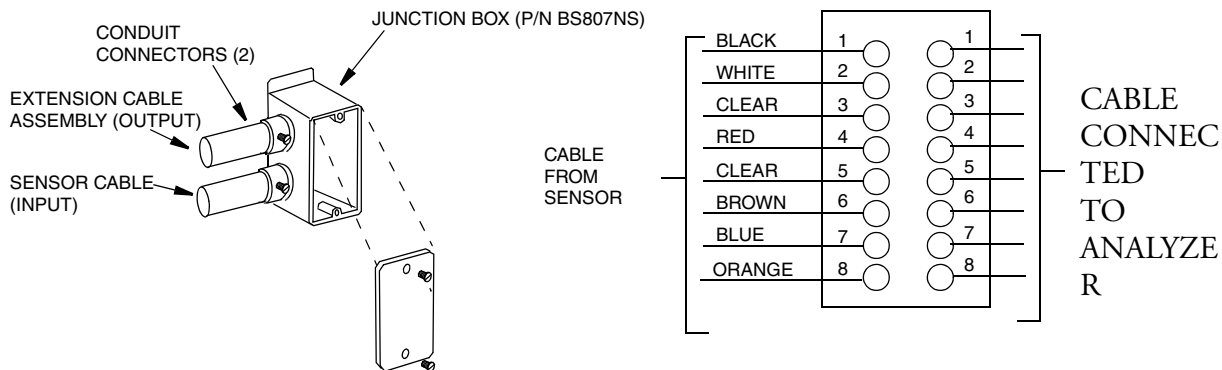
## Junction Box Wiring

1. Remove the junction box cover, loosen nuts on cable sealing glands and slide sensor and extension cables through seals. (See Figure 19.)

**Figure 19. Junction Box Wiring With 9-Conductor Teflon-Jacketed Cable**



**Figure 20. Junction Box Wiring with 8-Conductor PVC-Jacketed Cable**



2. Fasten the numbered wires on the sensor cable to the corresponding numbered terminals on the terminal strip (wires 1-8). The ground wire on the Teflon-jacketed cable has an eyelet and is attached to one of the terminal strip mounting studs (see Figure 19). If PVC cable is used, since there is no ground wire, the user must supply conduit connectors to replace the sealing glands supplied with the junction box so as to insure required EMI/RFI electrical shielding between analyzer/transmitter and sensor. (See Figure 20.)
3. Fasten the numbered wires on the extension cable assembly to the corresponding numbered terminals on the terminal strip. For the Teflon-jacketed cable, the ground wire on the cable is attached to the terminal stud with the ground wire from the sensor. For the PVC-jacketed cable, this ground connection is made through the conduit connections (see Figure 20).



# 3. System Calibration

The 871FT Flow-Through Conductivity Sensor, when connected to an 875EC Analyzer, 870ITEC Transmitter, or 873EC Analyzer is calibrated as a system, using either of two procedures; a “Bench Calibration” using resistances or a “Solution Calibration” using solutions.

---

— **NOTE** —

Conductivity conversions are given at the end of this chapter for your convenience.

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## Bench Calibration

Since the analyzer or transmitter measures conductance (in S, mS, or  $\mu$ S) and the quantity desired is conductivity (in S/cm, mS/cm, or  $\mu$ S/cm), it is necessary to introduce the cell factor (l/cm) into the calibration procedure. These cell factors are indicated by the Model Code and are tabulated in Table 11. This procedure is found in “Bench Calibration” on page 34. The cell factors shown in Table 11 are accurate to  $\pm 2\%$ . If desired, the cell factors may be checked using the procedure “Determination of Geometric Cell Factors” on page 42.

## Solution Calibration

When a system calibration using solutions is employed, specific knowledge of the cell factor is not required. A standard solution of known conductivity or a sample of process with independently measured conductivity is used for this procedure, as outlined in “Solution Calibration” on page 40.

---

—  **CAUTION** —

All electrodeless sensors can become magnetized if they come in close proximity to magnetic sources such as motors or electrical lines carrying high current. If this occurs, the measurement values obtained may be in error, particularly at low conductivity ranges (such as less than 500  $\mu$ S/cm). For this reason, Invensys recommends that any sensor to be used in a low conductivity application first be degaussed to eliminate any possibility that the sensor has been magnetized either during shipping or on-site. For information on degaussing a magnetized sensor, see TI 612-005. Invensys routinely degausses all electrodeless sensors prior to shipment.

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— **NOTE** —

For step-by-step examples of calibration procedures for 871FT Sensors with 875EC Analyzers, 870ITEC Transmitters, or 873EC Analyzers, refer to MI 611-220.

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## Bench Calibration

To perform a bench calibration, you must:

1. Enter data into your analyzer or transmitter
2. Perform a calibration at the low value
3. Calculate a resistance value
4. Perform a calibration at the full scale value.

## Entering Data Into Analyzer or Transmitter

1. Check the model code for the sensor being calibrated. The 871FT-1 and -3 are high range conductivity sensors and the 871FT-2 and -4 are low range conductivity sensors.

2. Enter the appropriate cell factor information.

For the 873EC Analyzer, enter the appropriate  $C_T$  from Table 11 for the sensor being used in the configuration menu.

For the 870ITEC Transmitter, enter the appropriate  $C_{f(\text{elec})}$  from Table 11 for the sensor being used in the configuration menu.

For the 875EC Analyzer, by entering the sensor type, the  $C_{f(\text{elec})}$  is automatically set.

3. Refer to Table 12 to determine the minimum and maximum full scale conductivity range desired for the system being calibrated.

Enter the desired full scale conductivity range in the 873EC Analyzer, 870ITEC Transmitter, or 875EC Analyzer using the appropriate configuration menu.

*Table 11. Geometric and Electrical Cell Factors of Flow-Through Sensors*

| Sanitary Sensors    |                  |                               |                              |                                |                              |
|---------------------|------------------|-------------------------------|------------------------------|--------------------------------|------------------------------|
| Line Size           | Cf (geom) (a)    | Cf (elec) (b)                 |                              | C <sub>T</sub> (c)             |                              |
|                     | cm <sup>-1</sup> | High Range<br>* <sub>=1</sub> | Low Range<br>* <sub>=2</sub> | High Range<br>* <sub>= 1</sub> | Low Range<br>* <sub>=2</sub> |
| 871FT-*C (1/2 in)   | 11.6             | 5.80                          | 2.27                         | 8                              | 5                            |
| 871FT-*D (3/4 in)   | 4.14             | 2.07                          | 0.81                         | 7                              | 13                           |
| 871FT-*E (1 in)     | 2.67             | 1.34                          | 0.52                         | 10                             | 3                            |
| 871FT-*F (1-1/2 in) | 1.11             | 0.56                          | 0.22                         | 3                              | 1                            |
| 871FT-*G (2 in)     | 0.62             | 0.31                          | 0.12                         | 2                              | 11                           |
| 871FT-*H (3 in)     | 0.38             | 0.19                          | 0.07                         | 9                              | 11                           |
| 871FT-*J (4 in)     | 0.21             | 0.10                          | 0.04                         | 1                              | 12                           |
| Industrial Sensors  |                  |                               |                              |                                |                              |
| Line Size           | Cf (geom) (a)    | Cf (elec) (b)                 |                              | C <sub>T</sub> (c)             |                              |
|                     | cm <sup>-1</sup> | High Range<br>* <sub>=3</sub> | Low Range<br>* <sub>=4</sub> | High Range<br>* <sub>=3</sub>  | Low Range<br>* <sub>=4</sub> |
| 871FT-*C (1/2 in)   | 3.02             | 3.02                          | 0.59                         | 7                              | 9                            |
| 871FT-*E (1 in)     | 1.06             | 1.06                          | 0.21                         | 15                             | 1                            |
| 871FT-*F (1-1/2 in) | 0.49             | 0.49                          | 0.09                         | 14                             | 11                           |
| 871FT-*G (2 in)     | 0.49             | 0.49                          | 0.09                         | 14                             | 11                           |
| 871FT-*H (3 in)     | 0.25             | 0.25                          | 0.05                         | 3                              | 12                           |
| 871FT-*J (4 in)     | 0.15             | 0.15                          | 0.03                         | 16                             | 12                           |

- a. Cf<sub>(geom)</sub> is used to calculate the loop resistance value for full scale calibration (or for nonzero low end calibration value).  
b. Cf<sub>(elec)</sub>, is used in the configuration of the 870ITEC Transmitter.  
c. C<sub>T</sub> is used in the configuration of the 873EC Analyzer.

*Table 12. Minimum and Maximum Full Scale Conductivity Ranges*

| Sanitary Sensors    |                          |                        |                          |                        |
|---------------------|--------------------------|------------------------|--------------------------|------------------------|
| Line Size           | High Range *=1           |                        | Low Range *=2            |                        |
|                     | Minimum $\mu\text{S/cm}$ | Maximum $\text{mS/cm}$ | Minimum $\mu\text{S/cm}$ | Maximum $\text{mS/cm}$ |
| 871FT-*C (1/2 in)   | 1000                     | 2000                   | 500                      | 2000                   |
| 871FT-*D (3/4 in)   | 500                      | 2000                   | 500                      | 1000                   |
| 871FT-*E (1 in)     | 500                      | 2000                   | 200                      | 500                    |
| 871FT-*F (1-1/2 in) | 100                      | 1000                   | 50                       | 200                    |
| 871FT-*G (2 in)     | 100                      | 1000                   | 50                       | 100                    |
| 871FT-*H (3 in)     | 100                      | 1000                   | 50                       | 100                    |
| 871FT-*J (4 in)     | 50                       | 500                    | 50                       | 50                     |
| Industrial Sensors  |                          |                        |                          |                        |
| Line Size           | High Range *=3           |                        | Low Range *=4            |                        |
|                     | Minimum $\mu\text{S/cm}$ | Maximum $\text{mS/cm}$ | Minimum $\mu\text{S/cm}$ | Maximum $\text{mS/cm}$ |
| 871FT-*C (1/2 in)   | 500                      | 2000                   | 100                      | 500                    |
| 871FT-*E (1 in)     | 1000                     | 2000                   | 50                       | 200                    |
| 871FT-*F (1-1/2 in) | 1000                     | 2000                   | 50                       | 100                    |
| 871FT-*G (2 in)     | 1000                     | 2000                   | 50                       | 100                    |
| 871FT-*H (3 in)     | 200                      | 1000                   | 50                       | 50                     |
| 871FT-*J (4 in)     | 200                      | 500                    | 50                       | 50                     |

## Calibration at Low Value

1. Connect the sensor to the analyzer or transmitter.

**NOTE**

For in-line calibration of industrial sensors, the sensor must be empty or filled with a solution having a conductivity at least 1000-fold less than the full scale range for which the system will be calibrated. If this is not possible, the sensor **must** be removed from the piping system, emptied, cleaned, and dried before proceeding.

2. For sanitary sensors mounted in nonconductive piping systems (See “Flange Types and Materials” on page 25), disconnect one end of the grounding strap between the Tri-Clamp fittings by disconnecting its wing nut. This allows in-line calibration irrespective of the solution conductivity within the sensor. Do **not** remove the Tri-Clamp fitting.
3. If using a Foxboro calibration plug (EP485A) or Foxboro calibration cable, remove the RTD connector.

4. With infinite resistance (no calibration plug or calibration cable connected to the sensor), and using the procedure in the applicable instruction for the analyzer or transmitter being used (MI 611-224 for 875EC, MI 611-212 for 870ITEC, or MI 611-167 for 873EC), calibrate the low value at 0.0  $\mu\text{S}/\text{cm}$ , 0.0  $\text{mS}/\text{cm}$  or 0.0  $\text{S}/\text{cm}$ , depending on the desired range (or at a nonzero low value, if desired). Also see MI 611-220, System Calibration Examples.

## Calculating the Resistance Value

The resistance required to calibrate your system at full scale value is dependent upon when your sensor was manufactured and if you are using a Foxboro calibration cable. The date of manufacture is determined from the last four digits of the Origin Date Code found on the sensor data plate. A code of 2B0149 means the sensor was manufactured in week 49 of 2001,

Use formula “a” to calculate full scale loop resistance:

- ◆ If using a user-supplied calibration wire looped through the sensor **or**
- ◆ If using a Foxboro calibration cable **and** your sensor has an Origin Date code earlier than 2B9710.

**Formula “a”:**  $(Cf_{(\text{geom})} \cdot 1000 \cdot 1) / (\text{FS in mS/cm}) = \text{Loop R in ohms}$

where

$Cf_{(\text{geom})}$  = geometric cell factor for the sensor being calibrated, found in Tables 11.

FS = Full Scale conductivity value expressed in  $\text{mS}/\text{cm}$

R = Resistance value, in ohms, to set on the decade resistance box.

Use formula “b” to calculate full scale loop resistance:

- ◆ If using a Foxboro calibration cable **and** your sensor has an Origin Date code of 2B9710 or later.

**Formula “b”:**  $(Cf_{(\text{geom})} \cdot 1000 \cdot 25) / (\text{FS in mS/cm}) = \text{Loop R in ohms}$

where

$Cf_{(\text{geom})}$  = geometric cell factor for the sensor being calibrated, found in Tables 11.

FS = Full Scale conductivity value expressed in  $\text{mS}/\text{cm}$

R = Resistance value, in ohms, to set on the decade resistance box.

### Example:

Calibrate an 871FT-1F Sanitary Flow-Thru Sensor with Full Scale Conductivity = 500  $\mu\text{S}/\text{cm}$  using a Foxboro calibration cable.

From Table 11,  $Cf_{(\text{geom})} = 1.11 \text{ cm}^{-1}$ .

From Formula “a”,

$R = (1.11 \cdot 1000 \cdot 1) / (0.5) = 2220 \text{ ohms}$  for a sensor with a pre-2B9710 Origin Code.

From Formula “b”,

$$R = (1.11 \cdot 1000 \cdot 25) / (0.5) = 55,500 \text{ ohms for a sensor with an Origin Code of 2B9710 or later.}$$

The resistance value calculated in these formulas assume a Foxboro calibration cable assembly is used or a user supplied calibration wire is used with a single loop or turn through the sensor as shown in the third setup of Figure 21. When the value of the resistance calculated is very small (less than 10 ohms), the resistance of the wire could affect the accuracy of the calibration. To avoid this, use multiple loops of user-supplied calibration wire through the sensor as shown in the fourth setup of Figure 21. The resistance calculated is then multiplied by the square of the number of turns.

**Example:**

Calibrate an 871FT-3G Industrial Flow-Thru Sensor with a full scale conductivity = 500 mS/cm.

From Table 11,  $Cf_{(gcom)} = 0.49 \text{ cm}^{-1}$ .

From Formula “a”,

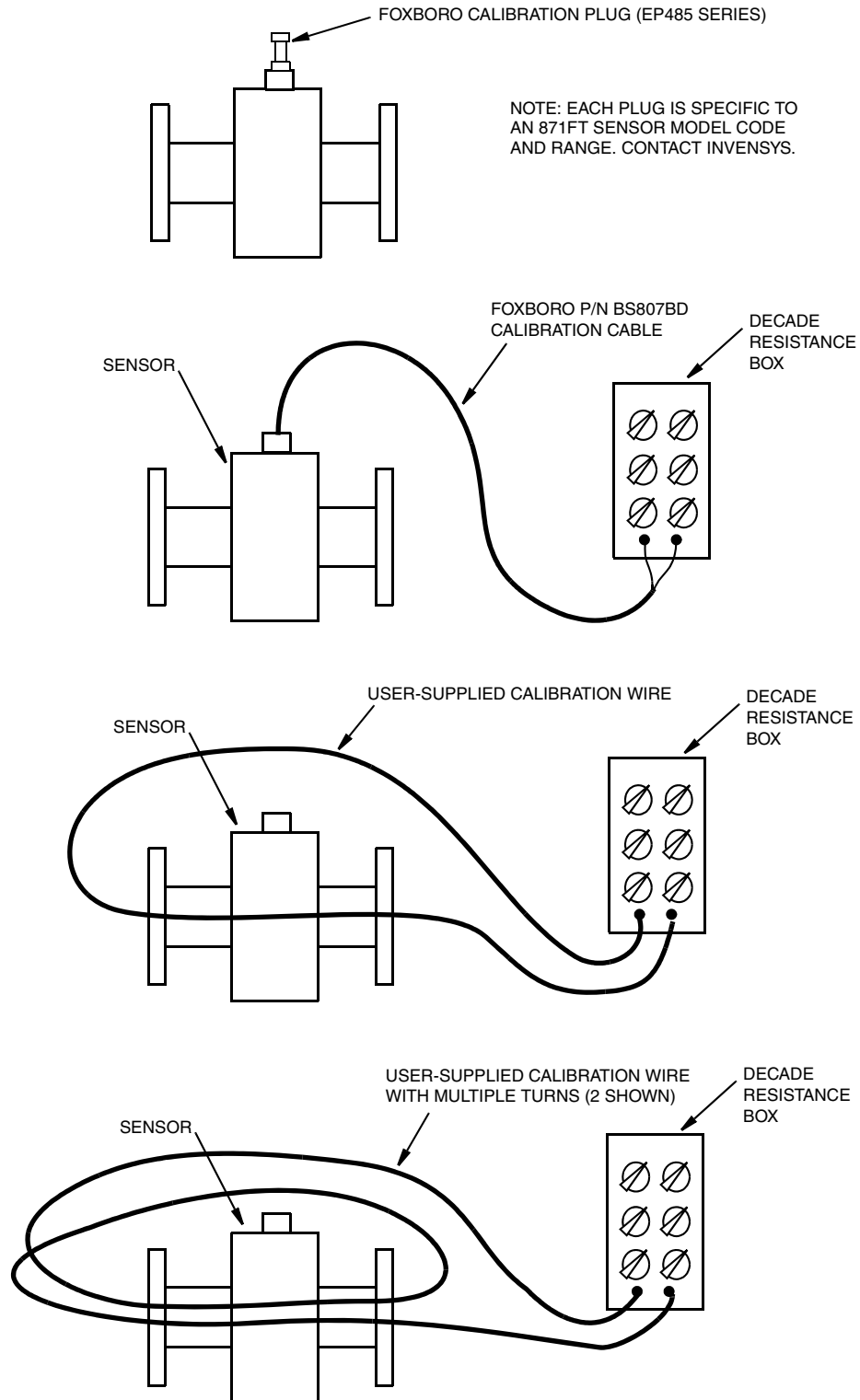
$$R = (0.49 \cdot 1000 \cdot 1) / (500) = 0.98 \text{ ohms for a sensor with a pre-2B9710 Origin Code.}$$

From Formula “b”,

$$R = (0.49 \cdot 1000 \cdot 25) / (500) = 24.5 \text{ ohms for a sensor with an Origin Code of 2B9710 or later.}$$

The resistance calculated in Formula “a” is less than 10 ohms. Therefore, you may decide to use 10 turns of wire. With 10 turns of wire, multiply the resistance value by  $10^2$  or 100 and use a resistance of 98 ohms to calibrate the full scale value to 500 mS/cm.

**Figure 21. Flow-Through Sensor Cell Factor Calibration**



## Calibration at Full Scale Value

1. If using a Foxboro calibration plug, connect the plug to the RTD connection.

If using a Foxboro calibration cable assembly or user-supplied calibration wire, connect it to a decade resistance box as shown in Figure 21 and set to the resistance calculated above.

On sanitary sensors, if you disconnected the grounding strap in the “Calibration at Low Value” procedure on page 36, reinstall the strap.

2. Using the procedure in the appropriate instruction manual for the analyzer being used (MI 611-224 for 875EC, MI 611-212 for 870ITEC, or MI 611-167 for 873EC), calibrate at the full scale value. Also see MI 611-220, System Calibration Examples.
3. Disconnect the calibration plug or calibration cable/wire and reinstall RTD Cable (if used).
4. Reinstall the sensor into the process if previously removed.

## Solution Calibration

This calibration may be performed using:

- ◆ NIST Standard KCl Solutions available from NIST or commercial suppliers (contact Invensys for additional information),
- ◆ Equivalent solutions that may be prepared by the user, or
- ◆ A grab sample obtained by analyzing the process solution by means of an independent conductivity measurement.

---

### NOTE

For highest accuracy, this calibration may be performed using NIST Standard KCl Solutions or equivalent solutions that may be prepared by the user.

---

## Preparation of Solutions

For preparation of solutions, use deionized or distilled water with a conductivity less than 2  $\mu\text{S}/\text{cm}$ .

*Table 13. Conductivity of Calibrating Solutions*

| Measuring Range                  | Solution | Conductivity (a)            |                             |                             |
|----------------------------------|----------|-----------------------------|-----------------------------|-----------------------------|
|                                  |          | at 0 °C                     | at 18 °C                    | at 25 °C                    |
| 100-1300 $\mu\text{S}/\text{cm}$ | A        |                             |                             | 147 $\mu\text{S}/\text{cm}$ |
|                                  | B        | 540 $\mu\text{S}/\text{cm}$ | 873 $\mu\text{S}/\text{cm}$ | 1.01 mS/cm                  |
|                                  | C        | 774 $\mu\text{S}/\text{cm}$ | 1.22 mS/cm                  | 1.41 mS/cm                  |
| 1.00-13.0 mS/cm                  | D        | 7.14 mS/cm                  | 11.2 mS/cm                  | 12.9 mS/cm                  |
| 10.0-130.0 mS/cm                 | E        | 65.2 mS/cm                  | 97.8 mS/cm                  | 111.3 mS/cm                 |
| 100-1300 mS/cm                   | F        |                             |                             | 251 mS/cm                   |
|                                  | G        |                             |                             | 826 mS/cm                   |

- a. For solutions A, B and C, the conductivity of the water used for preparation of solutions should be added to the values specified.



---

**NOTE**

---

Solution conductivity is a strong function of temperature. For intermediate temperatures or temperatures outside the range shown in Table 13, sufficient accuracy may be obtained by linear interpolation or extrapolation using the values shown.

---

- Solution A: Dilute 100 ml of Solution C to 1000 ml at 20°C (68°F).  
 Solution B: Weigh 500 mg dry NaCl and add water to give 1 kg solution (0.05 wt percent NaCl).  
 Solution C: Weigh 0.7440 g dry KCl and dilute to 1000 ml at 20 °C (68°F).  
 Solution D: Weigh 7.4365 g dry KCl and dilute to 1000 ml at 20 °C (68°F).  
 Solution E: Weigh 74.2640 g dry KCl and dilute to 1000 ml at 20 °C (68°F).  
 Solution F: Saturate water with NaCl at 20 °C (68°F).  
 Solution G: This conductivity level requires use of an acid solution. For information, contact Invensys.

## Enter Data Into Analyzer or Transmitter

1. Check the model code for the sensor being calibrated. The 871FT-1 and -3 are high range conductivity sensors and the 871FT-2 and -4 are low range conductivity sensors.

For the 873EC Analyzer, enter the appropriate  $C_T$  from Table 11 for the sensor being used in the configuration menu.

For the 870ITEC Transmitter, enter the appropriate  $C_{f(\text{elec})}$  from Table 11 for the sensor being used in the configuration menu.

For the 875EC Analyzer, by entering the sensor type, the  $C_{f(\text{elec})}$  is automatically set.

2. Refer to Table 12 to determine the minimum and maximum full scale conductivity range for the system being calibrated.

Enter the desired full scale conductivity range in the 873EC Analyzer, 870ITEC Transmitter, or 875EC Analyzer using the appropriate configuration menu.

---

**! CAUTION**

---

When calibrating analyzer/sensor systems using solutions or when calibrating cell factors using solutions, it is important to account for the effect of temperature in the procedure.

---

## Calibration Procedure

1. Prepare a calibration solution having a known conductivity in the required measuring range (see Table 13 and “Preparation of Solutions” on page 40).
2. Connect the sensor to the analyzer or transmitter.

---

**NOTE**

---

For in-line calibration of industrial sensors, the sensor **must** be empty or filled with a solution having a conductivity at least 1000-fold less than the full scale range for which the system will be calibrated. If this is not possible, the sensor **must** be removed from the piping system, emptied, cleaned, and dried before proceeding.

---

3. For sanitary versions mounted in nonconductive piping systems (See “Flange Types and Materials” on page 25), disconnect one end of the grounding strap between the Tri-Clamp fittings by disconnecting its wing nut. This allows in-line calibration irrespective of the solution conductivity within the sensor. Do **not** remove the Tri-Clamp fitting.
4. Using the procedure in the applicable instruction for the analyzer or transmitter being used (MI 611-224 for 875EC, MI 611-212 for 870ITEC, or MI 611-167 for 873EC), calibrate the low value at 0.0  $\mu\text{S}/\text{cm}$ , 0.0  $\text{mS}/\text{cm}$  or 0.0  $\text{S}/\text{cm}$ , depending on the desired range (or at a nonzero low value, if desired). Also see MI 611-220, System Calibration Examples.
5. On sanitary sensors, reinstall the grounding strap removed in Step 3.
6. Fill the sensor with the appropriate calibrating solution selected from Table 13 or measure the conductivity of the solution in the sensor using an independent conductivity system. (Note effects of temperature on conductivity. Typically conductivity increases with temperature.)

---

**NOTE**

Assure that bore of sensor is completely full.

---

7. Using the procedure in the applicable instruction for the analyzer or transmitter being used (MI 611-224 for 875EC, MI 611-212 for 870ITEC, or MI 611-167 for 873EC), calibrate for the conductivity of the known solution. Also see MI 611-220, System Calibration Examples.

---

**NOTE**

Solution conductivity is a strong function of temperature. For intermediate temperatures or temperatures outside the range shown in Table 13, sufficient accuracy can possibly be obtained by linear interpolation or extrapolation using the values shown.

---

## Determination of Geometric Cell Factors

Cell Factors are determined by the geometries of the sensors and will remain constant as long as the length and diameter of the insulating bore pieces within the sensor do not change. Nominal Cell Factors for the available sensor geometries are shown in Table 11. This procedure can be used to more accurately determine these cell factors.

In performing this procedure, you must:

1. Perform a solution calibration of the sensor and record the resulting conductivity
2. Determine the resistance necessary to reproduce this conductivity value
3. Calculate the geometric cell factor.

## Performing a Solution Calibration

1. Follow the procedure “Solution Calibration” on page 40.

---

**— NOTE**

This calibration cannot be an in-line calibration.

---

2. Record the conductivity value.

## Determining the Resistance Value

1. Remove the solution from the sensor. Rinse and dry the sensor.
2. Remove the RTD connector from the sensor and connect a Foxboro calibration cable or loop a user-supplied calibration wire through the sensor (see Figure 21).
3. Connect the calibration cable/wire to a decade resistance box. Dial in the value of resistance necessary to reproduce the conductivity value recorded in Step 2 of the previous section.

---

**— NOTE**

If the value of resistance necessary to reproduce the desired conductivity reading is smaller than 10 ohms, the resistance of the wire could affect accuracy. In such a situation, pass several turns of your user-supplied calibration wire through the sensor (see the fourth setup of Figure 21) and then connect to the decade resistance box. The resistance required to reproduce the conductivity noted in Step 3 is now larger by a factor of the square of the number of turns of wire through the sensor. Thus, if 10 turns of wire are used and the resistance on the decade box is 500 ohms, the resistance used in the cell factor equation in the next section is  $500/10^2$  or 5 ohms.

---

## Calculation of Cell Factor

1. Calculate the cell factor using the appropriate formula, which depends on your conductivity range:

$$Cf_{(\text{geom})} = (\text{Conductivity, } \mu\text{S/cm})(\text{Resistance, } \Omega/10^6) = \text{cm}^{-1}$$

$$Cf_{(\text{geom})} = (\text{Conductivity, mS/cm})(\text{Resistance, } \Omega/10^3) = \text{cm}^{-1}$$

$$Cf_{(\text{geom})} = (\text{Conductivity, S/cm})(\text{Resistance, } \Omega) = \text{cm}^{-1}$$

where:

Conductivity is that recorded in Step 2 of “Performing a Solution Calibration” above.

Resistance is that determined in Step 3 of “Determining the Resistance Value” above.

## Example 1

Calibrate the cell factor of an 871FT-1F Sanitary Flow-Through Sensor using Solution D from Table 13. Conductivity = 11.2 mS/cm at 18 °C.

### Using an 873EC Analyzer

1. Configure  $C_t = 3$ . This value comes from Table 11.
2. Configure the Full Scale Range = 20 mS/cm. 0 to 20 mS/cm is the range above the 11.2 mS/cm value given in the example.
3. Configure TEMP to 18.0. °C.
4. Perform a solution calibration per “Calibration Procedure” on page 41. Record the conductivity.
5. Determine the resistance value by performing the procedure in “Determining the Resistance Value” above. If the value of resistance necessary to display the conductivity (which should be 11.2 mS/cm) is 99.1 ohms, then calculate the cell factor.

$$Cf_{(\text{geom})} = (11.2)(99.1/10^3) = 1.11 \text{ cm}^{-1}$$

### Using an 870ITEC Transmitter

1. Configure  $Cf_{(\text{elec})} = 0.56 \text{ cm}^{-1}$  This value comes from Table 11.
2. Configure the Full Scale Range = 20 mS/cm. 0 to 20 mS/cm is the range above the 11.2 mS/cm value given in the example.
3. Configure TEMP to 18.0.°C.
4. Perform a solution calibration per “Calibration Procedure” on page 41. Record the conductivity.
5. Determine the resistance value by performing the procedure in “Determining the Resistance Value” above. If the value of resistance necessary to display the conductivity (which should be 11.2 mS/cm) is 99.1 ohms, then calculate the cell factor.

$$Cf_{(\text{geom})} = (11.2)(99.1/10^3) = 1.11 \text{ cm}^{-1}$$

### Using an 875EC Analyzer

1. Configure the Full Scale Range = 20 mS/cm. 0 to 20 mS/cm is the range above the 11.2 mS/cm value given in the example.
2. Configure TEMP to 18.0.°C.
3. Perform a solution calibration per “Calibration Procedure” on page 41. Record the conductivity.
4. Determine the resistance value by performing the procedure in “Determining the Resistance Value” above. If the value of resistance necessary to display the conductivity (which should be 11.2 mS/cm) is 99.1 ohms, then calculate the cell factor.

$$Cf_{(\text{geom})} = (11.2)(99.1/10^3) = 1.11 \text{ cm}^{-1}$$

## Example 2

Calibrate cell factor of 871FT-2G sensor using Solution E from Table 13.

Conductivity = 111.3 mS/cm at 25 °C. However the temperature in the lab is 21.5°C.

### Using an 873EC Analyzer

1. Configure Ct = 11 (Table 11). This value comes from Table 11.
2. Configure the Full Scale Range = 200 mS/cm. 0 to 200 mS/cm is the range above the 111.3 mS/cm value given in the example.
3. Configure TEMP to 21.5 °C.
4. Perform a solution calibration per “Calibration Procedure” on page 41. Record the conductivity.

---

#### — NOTE

Because the calibration was done at 21.5°C, the conductivity should have been close to the value calculated as follows:

$$97.8 \text{ mS/cm} + (0.02/\text{°C})(3.5\text{°C})(97.8 \text{ mS/cm}) = 104.6 \text{ mS/cm}$$

where:

97.8 mS/cm is the conductivity at 18°C per Table 13

2%/°C is the approximate temperature coefficient in the range of 18 to 25°C

3.5°C is the difference of 21.5 - 18°C

---

5. Determine the resistance value by performing the procedure in “Determining the Resistance Value” on page 43.

---

#### — NOTE

Because the resistance value is less than 10 ohms, use multiple loops of user-supplied calibration cable as explained in the note in that section.

---

If the value of resistance necessary to display the conductivity (which should be 104.6 mS/cm) is 5.88 ohms, then calculate the cell factor.

$$Cf_{(\text{geom})} = (104.6)(5.88/10^3) = 0.615 \text{ cm}^{-1}$$

The value of resistance necessary to display 104.6 mS/cm should be 5.88 ohms within the accuracies of the solution and the analyzer/sensor system. If the actual resistance necessary to display 104.6 mS/cm is 5.74 ohms, then the calculation is:

$$Cf_{(\text{geom})} = (104.6)(5.74/10^3) = 0.60 \text{ cm}^{-1}$$

### Using an 870ITEC Transmitter

1. Configure Cf<sub>(elec)</sub> = 0.12). This value comes from Table 11.
2. Configure the Full Scale Range = 200 mS/cm. 0 to 200 mS/cm is the range above the 111.3 mS/cm value given in the example.
3. Configure TEMP to 21.5.0. °C.
4. Perform a solution calibration per “Calibration Procedure” on page 41. Record the conductivity.

---

**NOTE**

---

Because the calibration was done at 21.5°C, the conductivity should have been close to the value calculated as follows:

$$97.8 \text{ mS/cm} + (0.02/\text{°C})(3.5\text{°C})(97.8 \text{ mS/cm}) = 104.6 \text{ mS/cm}$$

where:

97.8 mS/cm is the conductivity at 18°C per Table 13

2%/°C is the approximate temperature coefficient in the range of 18 to 25°C

3.5°C is the difference of 21.5 - 18°C

---

- Determine the resistance value by performing the procedure in “Determining the Resistance Value” on page 43.

---

**NOTE**

---

Because the resistance value was less than 10 ohms, use multiple loops of user-supplied calibration cable as explained in the note in that section.

---

If the value of resistance necessary to display the conductivity (which should be 104.6 mS/cm) is 5.88 ohms, then calculate the cell factor.

$$Cf_{(\text{geom})} = (104.6)(5.88/10^3) = 0.615 \text{ cm}^{-1}$$

The value of resistance necessary to display 104.6 mS/cm should be 5.88 ohms within the accuracies of the solution and the analyzer/sensor system. If the actual resistance necessary to display 104.6 mS/cm is 5.74 ohms, then the calculation is:

$$Cf_{(\text{geom})} = (104.6)(5.74/10^3) = 0.60 \text{ cm}^{-1}$$

### *Using an 875EC Analyzer*

- Configure the Full Scale Range = 200 mS/cm. 0 to 200 mS/cm is the range above the 111.3 mS/cm value given in the example.
- Configure TEMP to 18.0.°C.
- Perform a solution calibration per “Calibration Procedure” on page 41. Record the conductivity.

---

**NOTE**

---

Because the calibration was done at 21.5°C, the conductivity should have been close to the value calculated as follows:

$$97.8 \text{ mS/cm} + (0.02/\text{°C})(3.5\text{°C})(97.8 \text{ mS/cm}) = 104.6 \text{ mS/cm}$$

where:

97.8 mS/cm is the conductivity at 18°C per Table 13

2%/°C is the approximate temperature coefficient in the range of 18 to 25°C

3.5°C is the difference of 21.5 - 18°C

---

- Determine the resistance value by performing the procedure in “Determining the Resistance Value” on page 43.

---

**NOTE**

---

Because the resistance value was less than 10 ohms, use multiple loops of user-supplied calibration cable as explained in the note in that section.

---

If the value of resistance necessary to display the conductivity (which should be 104.6 mS/cm) is 5.88 ohms, then calculate the cell factor.

$$Cf_{(\text{geom})} = (104.6)(5.88/10^3) = 0.615 \text{ cm}^{-1}$$

The value of resistance necessary to display 104.6 mS/cm should be 5.88 ohms within the accuracies of the solution and the analyzer/sensor system. If the actual resistance necessary to display 104.6 mS/cm is 5.74 ohms, then the calculation is:

$$Cf_{(\text{geom})} = (104.6)(5.74/10^3) = 0.60 \text{ cm}^{-1}$$

## Conversion Factors

$$1 \text{ S} = 1000 \text{ mS}$$

$$1 \text{ S} = 1,000,000 \text{ } \mu\text{S}$$

$$1 \text{ mS} = 1000 \text{ } \mu\text{S}$$

-----

$$1 \text{ S/m} = 0.01 \text{ S/cm}$$

$$1 \text{ mS/m} = 0.01 \text{ mS/cm}$$

$$1 \text{ } \mu\text{S/m} = 0.01 \text{ } \mu\text{S/cm}$$

-----

$$1 \text{ S/m} = 1 \text{ mho/m}$$

$$1 \text{ S/m} = 0.01 \text{ mho/cm}$$

$$1 \text{ S/cm} = 1 \text{ mho/cm}$$

$$1 \text{ mS/cm} = 0.001 \text{ mho/cm}$$





# 4. Troubleshooting

*Table 14. Symptoms, Possible Causes, and Remedies*

| Symptom                        | Possible Cause  | Remedy   |
|--------------------------------|---|--|
| Noisy signal                   | 1. Improper grounding.<br>2. Cavitation or bubbles trapped in sensor. | See "System Wiring" on page 27.  |
| No signal                      | 1. Open toroid.<br>2. Loose connection in wiring to sensor.           | See Table 15.<br>Replace.  |
| Reduced sensitivity            | 1. One of drive toroids electrically open.                            | Replace toroid assembly.<br>Remove sensor and clean. See Warning.        |
| Temperature reads incorrectly  | 1. Short/open RTD.<br>2. Temperature setup incorrect.                 | Replace RTD Assembly.<br>Check configuration of analyzer or transmitter. |
| Accuracy/change of cell factor | 1. Deposits within sensor.<br>2. Magnetization.                       | Clean sensor. See Warning.<br>Demagnetize.                               |

 **WARNING**

Use protective clothing and extra care when removing any industrial sensor for cleaning. Process fluid may be trapped in O-ring grooves.

## Sensor Resistance Check

Cable resistances to facilitate problem isolation are shown in the following table.

*Table 15. Cable Resistance*

| Connection          | Resistance             |
|---------------------|------------------------|
| 1 to 2              | 0 (short)              |
| 1 or 2 to 3         | infinite               |
| 1 or 2 to 4 or 5    | infinite               |
| 4 to 5              | 0 (short)              |
| 4 or 5 to 6, 7 or 8 | infinite               |
| 6 to 7              | see Table 7 on page 19 |
| 7 to 8              | 0 (short)              |



# 5. Maintenance

There are six O-rings in the 871FT Sensor. Their life is dependent on the chemical, concentration, and temperature of the solution being monitored. Therefore, eventually, they need to be replaced. You may also want to change the O-rings if you decide to use the sensor in a different application that requires a different O-ring material. O-ring kits are available in EPDM (standard), Viton, and Chemraz. The O-rings should always be replaced as a set. Refer to PL 611-017 to ascertain the part numbers for 1/2 to 4 inch line size sensors.

The replacement of the O-rings requires that the sensor be removed from the line and disassembled. The following procedure is illustrated with views of an industrial sensor.

1. Remove the hex nuts from the threaded rods. For sensors installed in a process line, two wrenches may be required to remove the nuts. Then remove the rods. The sensor can now be removed from the process line for further disassembly.

*Figure 22. Removing the Hex Nuts*



2. Loosen the set screws on the edge of one flange so the flange can be removed from the spacers.
3. Remove the flanges and spacers leaving the toroid assembly with the toroid sleeves.

---

**NOTE**

The O-rings may become dislodged from the O-ring grooves in the end of the toroid sleeve during removal of the flanges. In Figure 23 note that one O-ring remained in the O-ring groove and the other is on the flange.

---

*Figure 23. Separation of Flanges from the Toroid Assembly*



4. Carefully remove one toroid sleeve from the toroid assembly.

*Figure 24. Removal of First Toroid Sleeve from the Toroid Assembly*



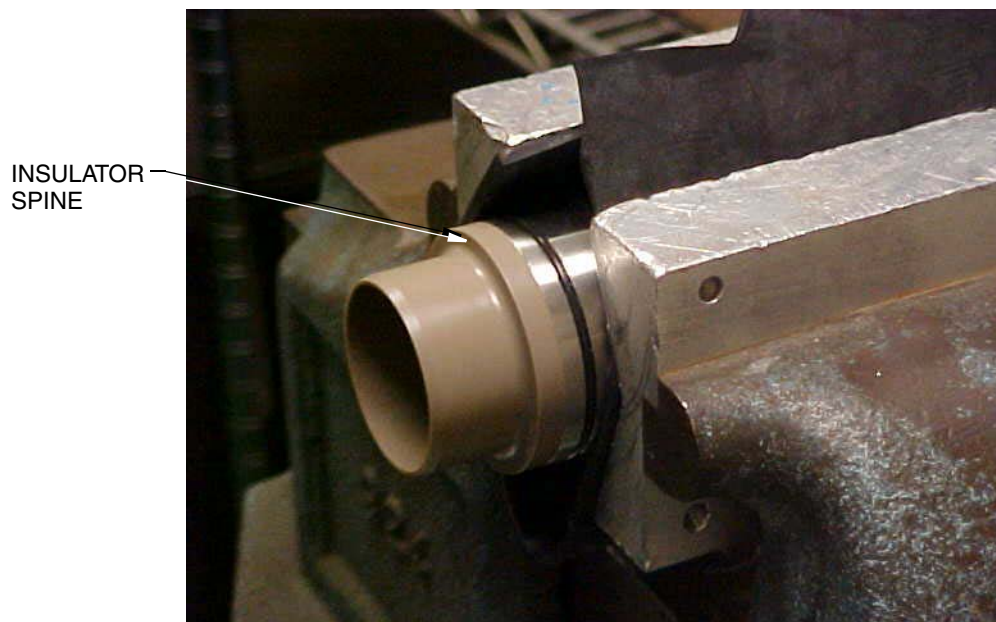
- After removal of one toroid sleeve, the other sleeve and the insulator (bore piece) can easily be removed from the toroid assembly. You can now see the inner and outer toroid sleeve O-rings.

*Figure 25. Removal of Second Toroid Sleeve and Insulator from Toroid Assembly*



- Grab the toroid sleeve, either by hand or by some mechanical means (as shown) and carefully remove the insulator using a twisting motion. Even though the toroid sleeve is well lubricated with silicone grease, sometimes it is necessary to use a strap wrench on the spine of the insulator to start the rotation of the insulator in the sleeve.

*Figure 26. Removal of Insulator from Second Toroid Sleeve*



- Lubricate the new O-rings with the silicone grease supplied in the O-ring kit.

8. Replace the flange to toroid O-rings in the end of the toroid sleeve. Assure that the O-rings are not twisted or nicked.
9. Replace the inner and outer toroid sleeve O-rings. Assure that the O-rings are not twisted or nicked.
10. Using care not to damage the new O-rings, reassemble the sensor by reversing Steps 1 through 6.

# Appendix A. Pressure/Temperature Derating Tables

Table 16. Sanitary Type, PCTFE

| If Maximum Pressure (psi) | Then, Maximum Temp (°F) |
|---------------------------|-------------------------|
| 60                        | 140                     |
| 55                        | 150                     |
| 50.5                      | 160                     |
| 46                        | 170                     |
| 41.5                      | 180                     |
| 37                        | 190                     |
| 32.5                      | 200                     |
| 28                        | 210                     |
| 23.5                      | 220                     |
| 19                        | 230                     |
| 14.5                      | 240                     |
| 10                        | 250                     |

**NOTE**

Pressure of 15.3 psi at 250°F can be used for a short period of time (2 hours) for hot water or steam sterilization. For longer periods, contact Invensys.

Table 17. Industrial Type, ANSI Class 150, PVDF (a)

| If Maximum Pressure (psi) | Then, Maximum Temp (°F) |
|---------------------------|-------------------------|
| 100                       | 140                     |
| 96                        | 150                     |
| 93                        | 160                     |
| 89                        | 170                     |
| 85                        | 180                     |
| 82                        | 190                     |
| 78                        | 200                     |
| 74                        | 210                     |
| 71                        | 220                     |
| 67                        | 230                     |
| 63                        | 240                     |
| 60                        | 250                     |

a. The 2-in version with ANSI flange is rated to 150 psig (1034 kPag) from 14 to 212 °F (-10 to 100 °C).

*Table 18. Industrial Type, ANSI Class 150, Glass Filled PEEK*

| If Maximum Pressure (psi) | Then, Maximum Temp (°F) |
|---------------------------|-------------------------|
| 275                       | 140                     |
| 271                       | 150                     |
| 268                       | 160                     |
| 265                       | 170                     |
| 262                       | 180                     |
| 259                       | 190                     |
| 256                       | 200                     |
| 253                       | 210                     |
| 249                       | 220                     |
| 246                       | 230                     |
| 243                       | 240                     |
| 240                       | 250                     |
| 237                       | 260                     |
| 234                       | 270                     |
| 231                       | 280                     |
| 227                       | 290                     |
| 224                       | 300                     |
| 221                       | 310                     |
| 218                       | 320                     |
| 215                       | 330                     |
| 212                       | 340                     |
| 209                       | 350                     |
| 205                       | 360                     |
| 202                       | 370                     |
| 199                       | 380                     |
| 196                       | 390                     |
| 193                       | 400                     |
| 190                       | 410                     |

*Table 19. Industrial Type, ANSI Class 150, PCTFE*

| If Maximum Pressure (psi) | Then, Maximum Temp (°F) |
|---------------------------|-------------------------|
| 100                       | 140                     |
| 90                        | 150                     |
| 82                        | 160                     |
| 74                        | 170                     |
| 66                        | 180                     |
| 58                        | 190                     |
| 50                        | 200                     |
| 42                        | 210                     |
| 34                        | 220                     |
| 26                        | 230                     |



*Table 19. Industrial Type, ANSI Class 150, PCTFE (Continued)*

| If Maximum Pressure (psi) | Then, Maximum Temp (°F) |
|---------------------------|-------------------------|
| 18                        | 240                     |
| 10                        | 250                     |

*Table 20. Industrial Type, ANSI Class 300, PVDF (a)*

| If Maximum Pressure (psi) | Then, Maximum Temp (°F) |
|---------------------------|-------------------------|
| 365                       | 150                     |
| 334.5                     | 160                     |
| 304                       | 170                     |
| 273.5                     | 180                     |
| 243                       | 190                     |
| 212.5                     | 200                     |
| 182                       | 210                     |
| 151.5                     | 220                     |
| 121                       | 230                     |
| 90.5                      | 240                     |
| 60                        | 250                     |

a. Applies to 2-, 3-, and 4- inch line sizes.

*Table 21. Industrial Type, ANSI Class 300, PVDF (a)*

| If Maximum Pressure (psi) | Then, Maximum Temp (°F) |
|---------------------------|-------------------------|
| 400                       | 150                     |
| 366                       | 160                     |
| 332                       | 170                     |
| 298                       | 180                     |
| 264                       | 190                     |
| 230                       | 200                     |
| 196                       | 210                     |
| 162                       | 220                     |
| 128                       | 230                     |
| 94                        | 240                     |
| 60                        | 250                     |

a. Applies to 1/2-, 1-, and 1 1/2- inch line sizes.

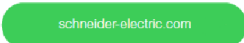
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