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Instruction Manual
LIQ-MAN-400
Rev. L
May 2017

Rosemount™ 400 and 400VP

Contacting Conductivity Sensors







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Essential Instructions
Read this page before proceeding!

Emerson designs, manufactures and tests its products to meet many national and international standards. Because these sensors are sophisticated technical products, you MUST properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions MUST be adhered to and integrated into your safety program when installing, using, and maintaining Rosemount products. Failure to follow the proper instructions may cause any one of the following situations to occur: loss of life; personal injury; property damage; damage to this sensor; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product.
- If you do not understand any of the instructions, contact your Emerson representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Emerson. Unauthorized parts and procedures can affect the product's performance, place the safe operation of your process at risk, and VOID YOUR WARRANTY. Third-party substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

The information contained in this document is subject to change without notice.

DANGER

Hazardous Area Installation

Installations near flammable liquids or in hazardous area locations must be carefully evaluated by qualified on site safety personnel.

To secure and maintain an intrinsically safe installation, the certified safety barrier, transmitter, and sensor combination must be used. The installation system must comply with the governing approval agency (FM, CSA or BASEEFA/CENELEC) hazardous area classification requirements. Consult your transmitter instruction manual for more details.

Proper installation, operation and servicing of this sensor in a Hazardous Area Installation is entirely the responsibility of the user.

CAUTION

Sensor/Process Application Compatibility

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

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!

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About This Document

This manual contains instructions for installation and operation of the Rosemount 400 Contacting Conductivity Sensors. The following list provides concerning all revisions of this document.

Rev. Level	Date	Notes
J	10/2016	Updated information with new Emerson Style Guidelines, Added Ordering Information, Added Accessories Information. Added dimensional drawings.
K	11/2016	Updated Ordering Information and Specification.
L	05/2017	Updated the Emerson Address and Logo.

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Section 1: Specifications

1.1 Specifications

Table 1-1 Rosemount 400/400VP contacting conductivity sensor specifications

Wetted materials	
Electrodes	Titanium
Insulator	Glass Filled PEEK
Body	316 Stainless Steel
O-ring	EPDM
Temperature range	
Standard	32 to 221 °F (0 to 105 °C)
With Optional Integral Junction Box	32 to 392 °F (0 to 200 °C)
Maximum pressure	
250 psig (1825 kPa abs)	
Vacuum	
At 1.6 in. Hg air leakage is less than 0.005 SCFM (0.00014 m^3/min)	
Cell constants	
0.01, 0.1, and 1.0/cm	
Process connection	
¾ in. MNPT	
Cable	
10 ft (3.1 m) standard; 50 ft (15.2m) optional; interconnecting VP6 cables sold separately (see Accessories)	

Table 1-2 Flow cell (24092-02) specifications

Wetted materials	
Body and Nut	Polycarbonate and polyester
¼ in. Fittings	316 Stainless Steel
O-ring	Silicone
Process connection	
Compression fitting for ¼ in. OD tubing	
Temperature range	
32 to 158 °F (0 to 70 °C)	
Maximum pressure	
90 psig (722 kPa abs)	

Flow cell sold separately; see Accessories.

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1.2 Ordering Information

Table 1-3 Rosemount 400 Contacting Conductivity Sensor ordering information

Model	Sensor type
400	Contacting Conductivity Sensor
Cell constant	
11	0.01/cm
12	0.1/cm
13	1.0/cm
Temperature compensation	
_	Pt-1000 (1)
54	Pt-100
55	10K Ohm TC
Option 1	
_	No selection
36	Extended insertion length (2)
Option 2	
_	No selection
50	Integral 50 ft (15 m) cable
60	Integral junction box
Typical Model Number: 400-11-_-36-50	

1. *For use with Rosemount transmitter models 56, 1056, 1057, 1066, 5081, and legacy transmitter models 1055, 54C, 54eC, 4081C, 6081-C, and XMT-C.*
2. *5.5 inches from the bottom of threads to tip of sensor.*

Table 1-4 Rosemount 400VP Contacting Conductivity Sensor with Variopol cable connection ordering information

Model	Sensor type
400VP	Contacting Conductivity Sensor
Cell constant	
11	0.01/cm
12	0.1/cm
13	1.0/cm
Temperature compensation	
_	Pt-1000 (1)
54	Pt-100
55	10K Ohm TC
56	100K Ohm TC
Option 1	
_	No selection
36	Extended insertion length (2)
Typical Model Number: 400VP-11-_-36	

1. *For use with Rosemount transmitter models 56, 1056, 1057, 1066, 5081, and legacy transmitter models 1055, 54C, 54eC, 4081C, 6081-C, and XMT-C.*
2. *5.5 inches from the bottom of threads to tip of sensor.*

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Section 2: Installing the sensor

Keep ¼ in. (6 mm) clearance between electrodes and piping. The electrodes must be completely submerged in the process liquid, i.e., to the level of the threaded connection. See Figures 2-1 to Figure 2-6 for recommended orientation and installation. Rosemount 400/40VP Contacting Conductivity Sensors with 0.1 and 1.0/cm cell constants can be installed in ¾-inch pipe tees. Rosemount 400/400VP Contacting Conductivity Sensors can be installed in 1-inch tees with a ¾-inch bushing. If the sensor is installed in a pipe tee or flow cell with the sample draining to open atmosphere, bubbles may accumulate on the electrodes. Trapped bubbles will cause errors. As bubbles accumulate, the conductivity reading normally drifts down. In the plastic flow cell, bubbles are readily visible. To control bubble formation, apply a small amount of back pressure to the flow cell or pipe tee.

Figure 2-1 Sensor orientation

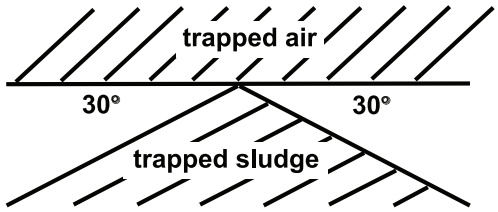


Figure 2-2 Direct insertion in a pipe

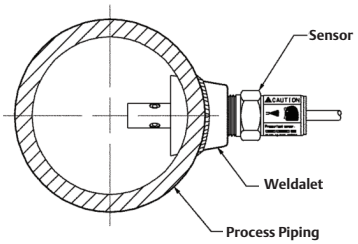


Figure 2-3 Insertion in a pipe Tee

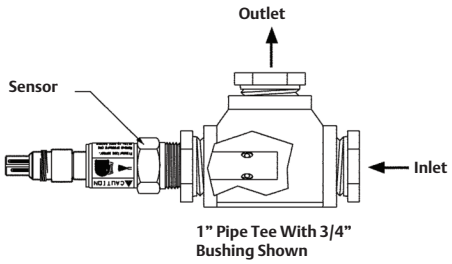


Figure 2-4 Insertion in a pipe Tee

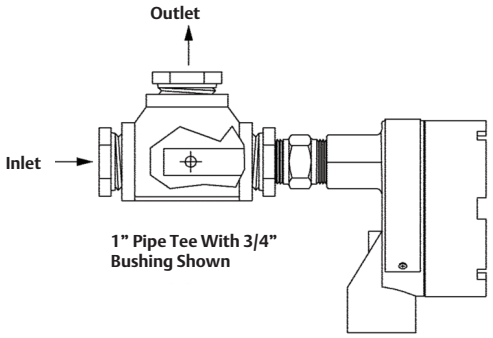


Figure 2-5 Insertion in a pipe Tee

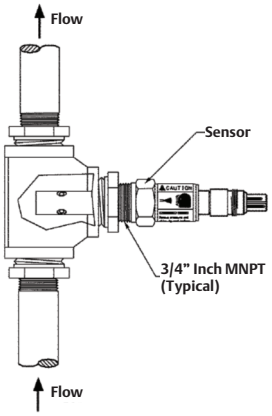
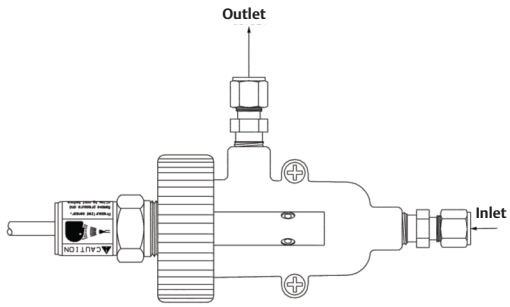
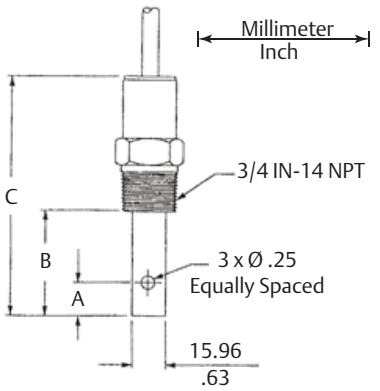


Figure 2-6 Insertion in a flow cell (24091-02)



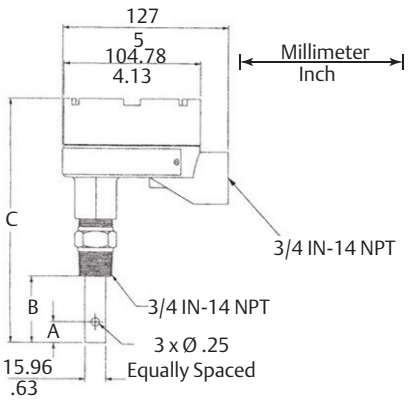
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Figure 2-7 Rosemount 400 with integral cable connection dimensional drawing



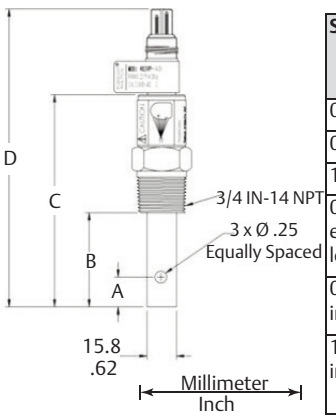
Sensor configuration	A		B		C	
	Inches	mm	Inches	mm	Inches	mm
0.01/cm	1.59	40.39	1.98	50.34	4.52	114.8
0.1/cm	0.687	17.45	1.11	28.15	3.65	92.71
1.0/cm	0.667	16.94	1.13	28.70	3.67	93.22
0.01/cm (with extended insertion length)	1.59	40.39	5.49	139.4	8.00	203.2
0.1/cm (with extended insertion length)	0.687	17.45	5.49	139.4	8.00	203.2
1.0/cm (with extended insertion length)	0.667	16.94	5.49	139.4	8.00	203.2

Figure 2-8 Rosemount 400 with integral junction box dimensional drawing



Sensor configuration	A		B		C	
	Inches	mm	Inches	mm	Inches	mm
0.01/cm	1.59	40.39	1.98	50.34	7.41	188.2
0.1/cm	0.687	17.45	1.11	28.15	6.49	164.9
1.0/cm	0.667	16.94	1.13	28.70	6.51	165.4
0.01/cm (with extended insertion length)	1.59	40.39	5.49	139.4	10.90	276.9
0.1/cm (with extended insertion length)	0.687	17.45	5.49	139.4	10.90	276.9
1.0/cm (with extended insertion length)	0.667	16.94	5.49	139.4	10.90	276.9

Figure 2-9 Rosemount 400VP with Variopol cable connection dimensional drawing



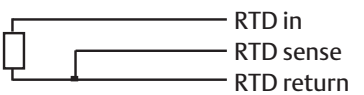
Sensor configuration	A		B		C		D	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.01/cm	1.59	40.39	1.98	50.3	4.43	112.5	6.3	160.0
0.1/cm	0.67	17.0	1.10	27.9	3.47	90.4	5.43	137.9
1.0/cm	0.67	17.0	1.10	27.9	3.58	90.9	5.45	138.4
0.01/cm (with extended insertion length)	1.59	40.4	5.48	139.2	7.91	200.9	9.78	248.4
0.1/cm (with extended insertion length)	0.67	17.0	5.48	139.2	7.91	200.9	9.78	248.4
1.0/cm (with extended insertion length)	0.67	17.0	5.48	139.2	7.91	200.9	9.78	248.4

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2.1 Wiring the sensor

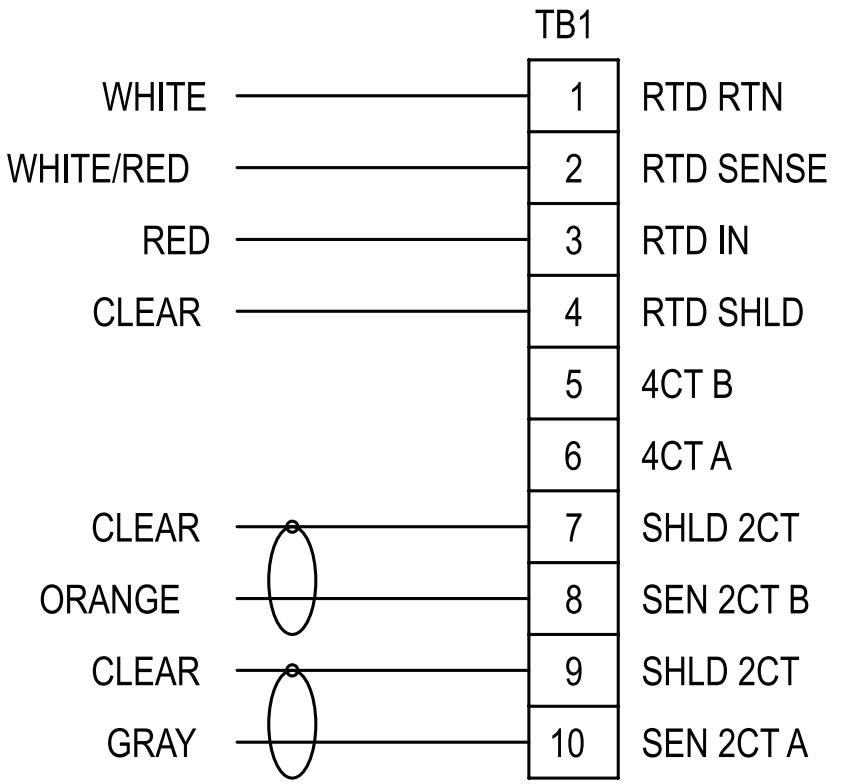
For other wiring diagrams not shown below, please refer to the Liquid Transmitter Wiring Diagrams.

Table 2-1 Wire color and connections in sensor

Color	Function
Gray	Connects to outer electrode
Clear	Coaxial shield for gray wire
Orange	Connects to inner electrode
Clear	Coaxial shield for orange wire
Red	
White with red stripe	
White	
Clear	Shield for all RTD lead wires

2.2 Wiring the sensor to the transmitter

Figure 2-10 Wiring for Rosemount 56, 1056 and 1057 transmitters



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Figure 2-11 Wiring for Rosemount 1066 transmitter

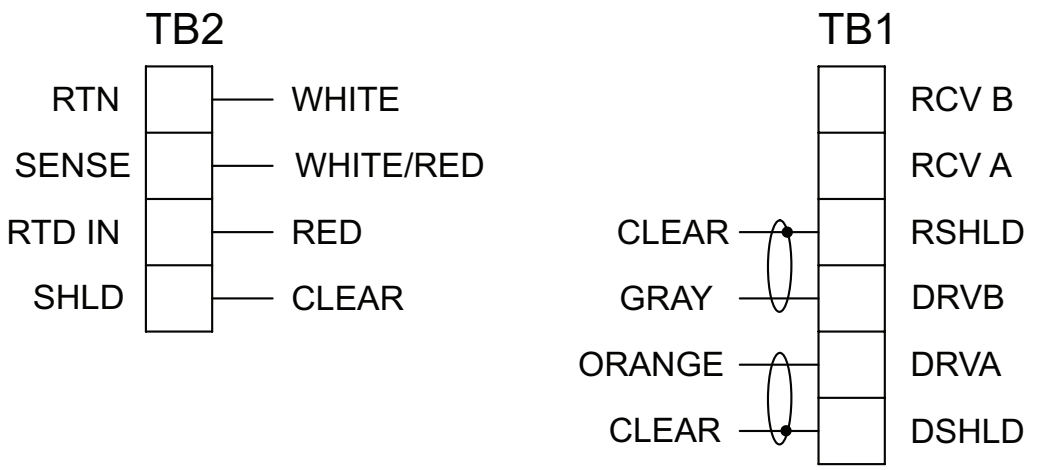
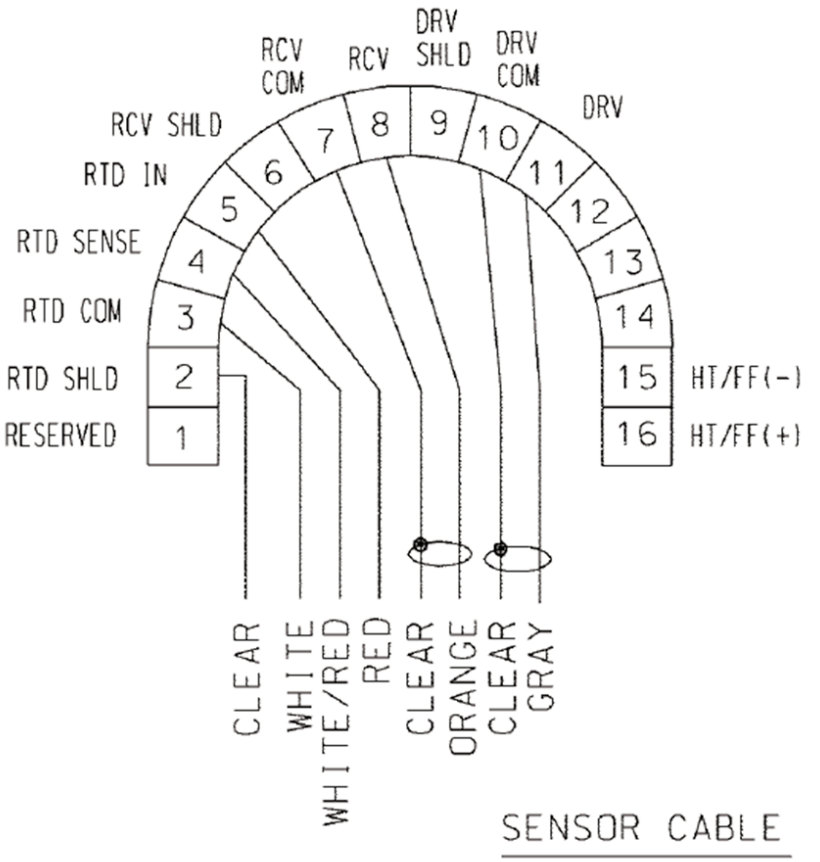


Figure 2-12 Wiring for Rosemount 5081 transmitter



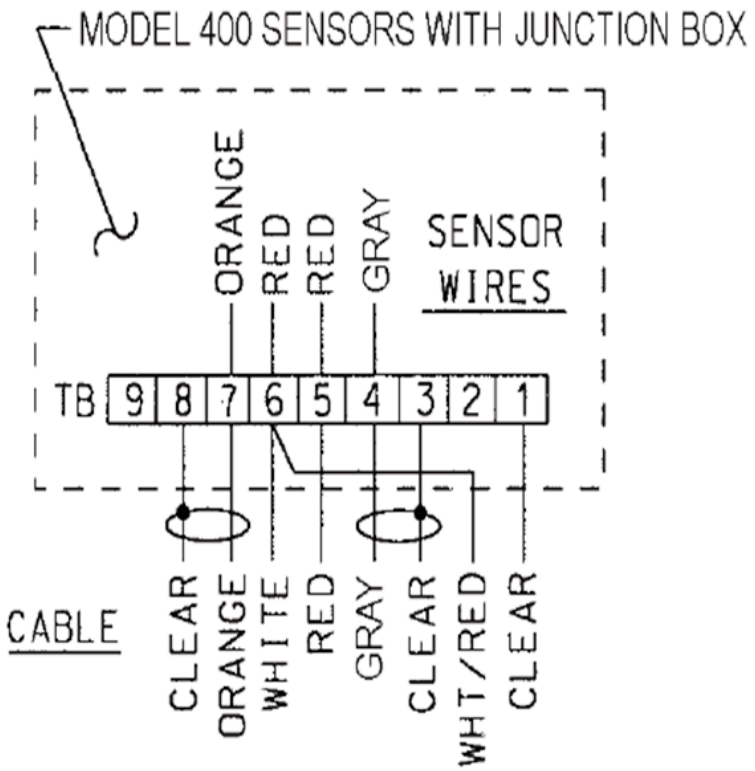
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2.2.1 Wiring through junction box

Rosemount 400 Contacting Conductivity Sensors can have an optional integral junction box mounted on the end of the sensor. See Figure 2-13 for wiring instructions.

If wiring connections are made through a remote junction box (PN 23550-00), wire point-to-point. Use cable 23747-00 (factory-terminated) or 9200275 (raw cable).

Figure 2-13 Sensor-mounted junction box wiring

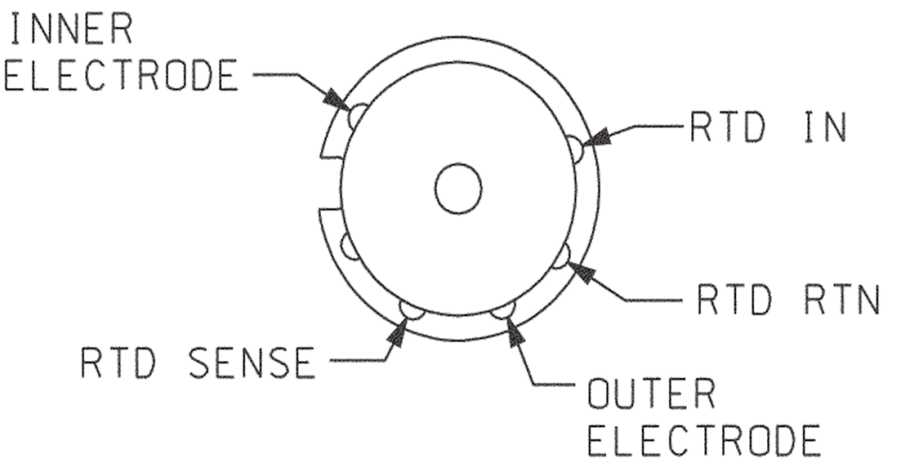


Notes:

1. The gray sensor wire is connected to the junction box, which makes electrical contact with the OUTER electrode.
2. Terminals in junction box are not numbered. Refer to transmitter wiring diagram for connections at transmitter.

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Figure 2-14 Pin out diagram for Rosemount 400VP Contacting Conductivity Sensor with Variopol cable connection



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Section 3: Calibration and maintenance

3.1 Calibrating the sensor

Rosemount 400/400VP Contacting Conductivity Sensors are calibrated at the factory and do not need calibration when first placed in service. Simply enter the cell constant printed on the label into the transmitter. After a period of service, the sensor may require calibration. For more information on calibration, refer to Application Data Sheet.

3.1.1 Calibrating using a standard solution

If using a standard solution, choose one having conductivity in the recommended operating range for the sensor cell constant.

1. Immerse the rinsed sensor in the standard solution and adjust the transmitter reading to match the conductivity of the standard.

2. For an accurate calibration:

   a. Choose a calibration standard near the midpoint of the recommended conductivity range for the sensor.

   b. Do not use calibration standards having conductivity less than 100 µS/cm.

   c. Turn off automatic temperature compensation in the transmitter.

   d. Use a standard for which the conductivity as a function of temperature is known.

   e. Use a good quality calibrated thermometer with an error rate less than ±0.1 °C to measure the temperature of the standard.

   f. Follow good laboratory practice. Rinse the beaker and sensor at least twice with standard. Be sure the rinse solution reaches between the inner and outer electrodes by tapping and swirling the sensor while it is immersed in the standard.

   g. Be sure air bubbles are not trapped between the electrodes. Place the sensor in the standard and tap and swirl to release bubbles. Note the reading and repeat. If readings agree, no trapped bubbles are present. Repeat until two subsequent readings agree.

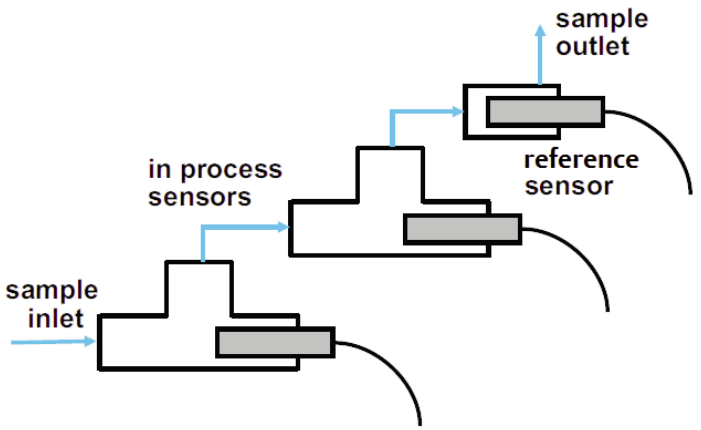
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3.1.2 Calibrating using a reference meter and sensor

1. Connect the process sensors and reference sensor in series and allow the process liquid to flow through all sensors.

2. Calibrate the process sensor by adjusting the process transmitter reading to match the conductivity measured by the reference meter. See Figure 3-1 for the calibration setup.

Figure 3-1 In process calibration setup



NOTICE

The above figure shows two process sensors connected in series with a reference sensor. The horizontal sensor orientation ensures good circulation of the process liquid past the electrodes. The staircase orientatation provides an escape path for bubbles.

3. The method is ideal for calibrating the sensors used in low conductivity water (0.01/cm cell constants) because the calibration system is closed and cannot be contaminated by atmospheric carbon dioxide.

Following precautions are necessary for successful calibration:

1. If the normal conductivity of the process liquid is less than about 1.0 µS/cm, adjust the conductivity so that it is near the upper end of the operating range.

   The difference between the conductivity measured by the process and reference meter usually has both a fixed (constant error) and relative (proportional error) component. Because the cell constant calibration assumes the error is proportional only, calibration at low conductivity allows the fixed component to have an outsized influence on the result.

   For example, assume the only difference between reference meter and process sensor is fixed and the process sensor always reads 0.002 µS/cm high. If the process sensor is calibrated at 0.100 µS/cm, the new cell constant will be changed by 0.100/0.102 or 2%. If the sensor is calibrated at 0.500 µS/cm, the change will be only 0.500/0.502 or 0.4%.

   Calibration at higher conductivity produces a better result because it minimizes the effect of the offset.

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2. Orient the sensors so that air bubbles always have an easy escape path and cannot get trapped between the electrodes.

3. Turn off automatic temperature compensation in the transmitter.

   Almost all process conductivity transmitter feature automatic temperature compensation in which the transmitter applies one of several temperature correction algorithms to convert the measured conductivity to the value at a reference temperature, typically 25 °C.

   Although temperature correction algorithms are useful for routine measurements, they should not be used during calibration.

   There are two following reasons:

   a. No temperature correction is perfect. If the assumptions behind the algorithm do not perfectly fit the solution being measured, the temperature-corrected conductivity will be in error.

   b. If the temperature measurement itself is in error, the corrected conductivity will be in error.

   The purpose of calibrating the sensor is to determine the cell constant. To minimize the error in the cell constant, all sources of avoidable error, e.g., temperature compensation should be eliminated.

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

   If the process temperature is appreciably different from ambient, high flow may not be enough to keep the temperature constant. In this case, pumping sample at room temperature from a reservoir through the sensors might be necessary. Because such a system is likely to be open to atmosphere, saturate the liquid with air to prevent drift caused by absorption of atmospheric carbon dioxide.

5. To prevent contamination of low conductivity (<1 µS/cm) process liquids, use clean tubing to connect the sensors. To prevent drift caused desorption of ionic contaminants from tube walls, keep the sample flow greater than 6 ft/sec (1.8 m/sec).

3.1.3 Calibrating using a grab sample

1. Use the grab sample method when it is impractical to remove the sensor for calibration or to connect a reference sensor to the process line.

2. Take a sample of the process liquid, measuring its conductivity using a reference instrument, and adjusting the reading from the process transmitter to match the measured conductivity.

3. Take the sample from a point as close to the process sensor as possible.

4. Keep temperature compensation turned on. There is likely to be a lag time between sampling and analysis, so temperature is likely to change.

5. Be sure the reference and process instruments are using the same temperature correction algorithm.

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6. Grab sample calibration should be used only when the conductivity is fairly high.

   a. The temperature compensation algorithm will most likely be linear slope.

   b. Confirm that both instruments are using the same temperature coefficient in the linear slope calculation.

   c. If the reference meter does not have automatic temperature correction, calculate the conductivity at 25 °C using the equation:

$$C_{25} = \frac{C_t}{1+\alpha(t-25)}$$

   Where: C25 = the conductivity at 25 °C

   Ct = the conductivity at t °C

   α = the temperature co-efficient expressed as a decimal fraction.

   d. Confirm the temperature measurements in both the process and reference instruments are accurate, ideally to within ±0.5 °C.

   e. Follow good laboratory practice when measuring the conductivity of the grab sample.

   - Rinse the beaker and sensor at least twice with sample. Be sure the rinse solution reaches between the inner and outer electrodes by tapping and swirling the sensor while it is immersed in the sample.

   - Be sure air bubbles are not trapped in the sensor. Place the sensor in the sample and tap and swirl to release bubbles. Note the reading. Then, remove the sensor and return it to the sample. Tap and swirl again and note the reading. If the two readings agree, trapped bubbles are absent. If they do not agree, bubbles are present . Continue the process until two subsequent readings agree.

   - While making the measurement, do not allow the sensor to touch the sides and, particularly, the bottom of the beaker. Keep at least 1/4 inch (6 mm) clearance.

   f. Be sure to compensate for process conductivity changes that might have occurred while the grab sample was being tested. Rosemount conductivity transmitters (Rosemount transmitter models 1056, 1066, and 56) do this automatically. They save the value of the process conductivity at the time the sample was taken and use that value to calculate the new cell constant when the user enters the result of the grab sample test. Older transmitters do not remember the process conductivity value. Therefore, the user must enter a value adjusted by an amount proportional to the change in the process conductivity. For example, suppose the process conductivity is 810 µS/cm when the sample is taken and 815 µS/cm when the test result is entered. If the grab sample conductivity is 819 µS/cm, the user should enter (815/810) × 819 or 824 µS/cm.

3.2 Cleaning the sensor

1. Use a warm detergent solution and a soft brush or pipe cleaner to remove oil and scale.

2. To remove oily films, use Isopropyl alcohol (rubbing alcohol).

3. Do not use strong mineral acids to clean conductivity sensors.

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Section 4: Troubleshooting

4.1 Troubleshooting

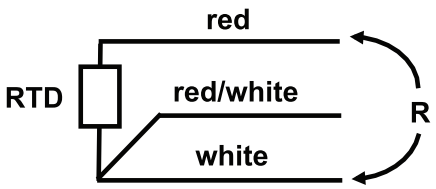
Problem	Probable Cause	Solution
Off-Scale Reading	Wiring is wrong.	Verify wiring.
	Temperature element is open or shorted.	Check temperature element for open or short circuits. See Figure 4-1
	Sensor is not in process stream.	Be sure sensor is completely submerged in process stream.
	Variopol cable is not properly seated.	Loosen connector and reseat.
	Sensor has failed.	Perform isolation checks. See Figure 4-2
Noisy reading	Sensor is improperly installed in process stream.	Be sure sensor is completely submerged in process stream.
	Variopol cable is not properly seated.	Loosen connector and reseat.
Reading seem wrong (lower or higer than expected)	Bubbles trapped in sensor.	Be sure sensor is properly oriented in pipe or flow cell. See Figure 2-1. Apply back pressure to flow cell.
	Wrong temperature correction algorithm.	Check that temperature correction is appropriate for the sample. See transmitter manual for more information.
	Wrong cell constant.	Verify that the correct cell constant has been entered in the transmitter and that the cell constant is appropriate for the conductivity of the sample. See transmitter manual for more information.
Sluggish response	Electrodes are fouled.	Clean electrodes.
	Sensor is installed in dead area in piping.	Move sensor to a location more representative of the process liquid.

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4.1.1 Checking the temperature element

Disconnect leads and measure resistance shown. The measured resistance should be close to the value in the table.

Figure 4-1 Checking the temperature element

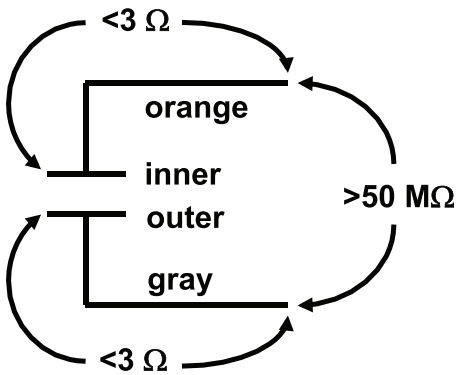


Temperature (°C)	Resistance in ohms	
	Pt 100	Pt 1000
0	100.0	1000
10	103.9	1039
20	107.8	1078
30	111.7	1117
40	115.5	1155
50	119.4	1194

4.1.2 Checking the continuity and leakage

Disconnect electrode leads and measure resistance and continuity as shown. Sensor must be dry when checking resistance between electrode leads.

Figure 4-2 Checking the continuity and leakage



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Section 5: Accessories

5.1 Accessories

Table 5-1 Rosemount 400/400VP Contacting Conductivity Sensor accessories information

Part Number	Description
23550-00	Remote junction box without preamplifier
23747-00	Interconnect cable, prepped (must specify length)
9200275	Extension cable, unprepped (must specify length)
24091-02	Low Flow Cell for Rosemount 400/400VP Sensors
05010781899	Conductivity standard SS-6, 200 µS/cm, 32 oz (0.95 L)
05010797875	Conductivity standard SS-6A, 200 µS/cm, 1 gal (3.78 L)
05010782468	Conductivity standard SS-5, 1000 µS/cm, 32 oz (0.95 L)
05010783002	Conductivity standard SS-5A, 1000 µS/cm, 1 gal (3.78 L)
05000705464	Conductivity standard SS-1, 1409 µS/cm, 32 oz (0.95 L)
05000709672	Conductivity standard SS-1A, 1409 µS/cm, 1 gal (3.78 L)
05010782147	Conductivity standard SS-7, 5000 µS/cm, 32 oz (0.95 L)
05010782026	Conductivity standard SS-7A, 5000 µS/cm, 1 gal (3.78 L)
23747-06	2.5 ft (0.8 m) Interconnecting VP6 Cable
23747-04	6.4 ft (1.2 m) Interconnecting VP6 Cable
23747-02	10 ft (3.0 m) Interconnecting VP6 Cable
23747-07	15 ft (4.6 m) Interconnecting VP6 Cable
23747-08	20 ft (6.1 m) Interconnecting VP6 Cable
23747-09	25 ft (7.6 m) Interconnecting VP6 Cable
23747-10	30 ft (9.1 m) Interconnecting VP6 Cable
23747-03	50 ft (15.2 m) Interconnecting VP6 Cable
23747-11	100 ft (30.5 m) Interconnecting VP6 Cable

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