Quick Start Guide
00825-0100-3403, Rev AB
January 2020

Rosemount 403/403VP

Contacting Conductivity Sensors

ROSEMOUNT™

EMERSON.

Essential instructions

Read this page before proceeding!

Emerson designs, manufactures, and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use, and maintain them to ensure they continue to operate within their normal specifications. You must adhere to the following instructions and integrate them into your safety program when installing, using, and maintaining Emerson's 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 instrument, 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 Install section of this QSG 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. Look-alike 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 people, to prevent electrical shock and personal injury.

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

⚠ CAUTION

Sensor/process application compatibility

The wetted sensor materials may not be compatible with process composition and operating conditions.

Application compatibility is entirely the operator's responsibility.

⚠ WARNING

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

⚠ WARNING

Physical access

Unauthorized personnel may potentially cause significant damage to and/or misconfiguration of end users' equipment. This could be intentional or unintentional and needs to be protected against.

Physical security is an important part of any security program and fundamental to protecting your system. Restrict physical access by unauthorized personnel to protect end users' assets. This is true for all systems used within the facility.

Contents

1 Specifications

1.1 Specifications

Table 1-1: Rosemount 403/403VP Contacting Conductivity Sensor Specifications

Wetted materials	
Electrodes	Titanium
Insulator	PCTFE (neoflon), compliant to 21CFR 177.1380 and USP Class VI
Sensor tube	316 stainless steel
O-ring	EPDM, compliant to 21CFR 177.1380 and USP Class VI
Temperature range	
32 to 221 °F (0 to 105 °C). Sensors are steam sterilizable to 275 °F (135 °C).	
Maximum pressure	
250 psig (1825 kPa [abs])	
Vacuum	
At 1.6-in. Hg (5.2 kPa), 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	
1½-in. or 2-in. sanitary flange	
Cable length	
10 ft. (3 m) standard; other lengths are optional.	

Table 1-2: Rosemount 403/403VP Weights and Shipping Weights

Rounded up to the nearest 1 lb. or 0,5 kg.

Sensor	Weight	Shipping weight
Rosemount 403 with 10-ft. (3.1 m) cable	2 lb. (1.0 kg)	3 lb. (1.5 kg)
Rosemount 403 with 50-ft. (15.2 m) integral cable	4 lb. (2.0 kg)	5 lb. (2.5 kg)
Rosemount 403VP with Variopol cable connection	1 lb. (0.5 kg)	2 lb. (1.0 kg)

Note
Elastomers and fluorocarbon resisns are compatible with 21CFR177 and meet the requirements of USP Class VI. Stainless steel contains less than five delta ferrite. All surfaces have 16 microinch (0.4 micrometer) Ra finish.

1.2 Rosemount 403 Contacting Conductivity Sensor ordering information

Note
The Endurance™ Rosemount 403 sanitary flange conductivity sensors are supplied with 1½-in. or 2-in. stainless steel sanitary process connections. Rosemount 403 sensors have a maximum temperature rating of 221 °F (105 °C) and are suitable for sterilization up to 275 °F (135 °C). The standard Rosemount 403 sensor has a Pt-1000 resistance temperature device (RTD) and a 10-ft. (3 m) integral cable.

All wetted surfaces in the Rosemount 403 have 16 micro-inch (0.4 micrometer) Ra finish, and all elastomers and plastics in the Rosemount 403 are compliant with 21CFR177 and USP Class VI.

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1.2.1 Model

Code	Description
403	Contacting Conductivity Sensor

1.2.2 Cell constant

Code	Description
11	0.01/cm
12	0.1/cm
13	1.0/cm

1.2.3 Flange size

Code	Description
20	1½-in. stainless steel sanitary fitting
21	2-in. stainless steel sanitary fitting

1.2.4 Temperature compensation

Code	Description
_	Pt-1000 (standard) for Rosemount 1056, 1066-C, 56, and 5081-C
54	Pt-100 for Rosemount 1054; series 2081

1.2.5 Electrode extension insertion length

Code	Description
_	No selection
36	Extended insertion length (6.0-in. [152.4 mm] from inside face of flange to end)

1.2.6 Cable length

Code	Description
_	No selection
50	Integral 50-ft. (15 m) cable
02	Integral 15-ft. (4.6 m) cable
20	Integral 20-ft. (6 m) cable
03	Integral 33-ft. (10 m) cable
06	Integral 100-ft. (30 m) cable

1.2.7 Calibration and conformance certificates - optional level

Code	Description
CC	Certificate of Calibration (no test data given)
LC	Loop Calibration Certificate (sensor and transmitter calibrated together with test data)
EC	Electronic Calibration Certificate (sensor calibrated against factory instrument with test data)

1.2.8 Material traceability certificates - optional level

Code	Description
MC	Material Traceability Certificate

1.3 Rosemount 403VP Contacting Conductivity Sensor ordering information

Note
The standard Rosemount 403VP sensor has an integral six pin Variopol (VP6) connector. A mating VP6 connector cable is required for use with these sensors.

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1.3.1 Model

Code	Description
403VP	Conductivity sensor - sanitary flange Variopol connector

1.3.2 Cell constant

Code	Description
11	0.01/cm
12	0.1/cm
13	1.0/cm

1.3.3 Flange size

Code	Description
20	1½-in. stainless steel sanitary fitting
21	2-in. stainless steel sanitary fitting

1.3.4 Temperature compensation

Code	Description
_	Pt-1000 (standard) for Rosemount 1056, 1066-C, 56, and 5081-C
54	Pt-100 for Rosemount 1054; series 2081

1.3.5 Electrode extension insertion length

Code	Description
_	No selection
36	Extended insertion length (6.0-in. [152.4 mm] from inside face of flange to end)

1.3.6 Calibration and conformance certificates - optional level

Code	Description
CC	Certificate of Calibration (no test data given)
LC	Loop Calibration Certificate (sensor and transmitter calibrated together with test data)
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1.3.7 Material traceability certificates - optional level

Code	Description
MC	Material Traceability Certificate

2 Install

2.1 Unpack and inspect

Procedure

1. Inspect the outside of the carton for any damage. If you detect damage, contact the carrier immediately.
2. Inspect the instrument and hardware. Make sure all items in the packing list are present and in good condition. Notify the factory if any part is missing.

2.2 Install

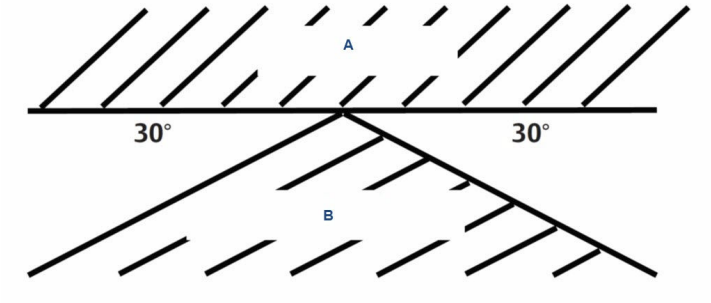
Depending on the option you selected first, you can install the sensor in either a 1½-in. (38.1 mm) or 2-in. (50.8 mm) Tri Clamp tee.

The operator must supply the gasket, clamp, and tee.

Procedure

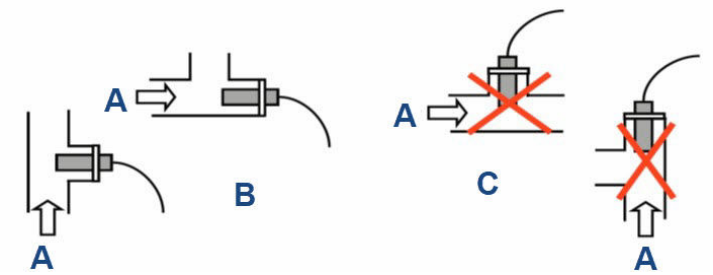
1. Submerge the electrodes completely within the process liquid (i.e., up to the flange's inside surface).
   If you install the sensor in a side stream with sample draining to open atmosphere, bubbles may accumulate on the electrodes. Trapped bubbles will cause errors. Normally, as bubbles accumulate, the conductivity reading drifts down.
2. To control bubble formation, apply a small amount of back pressure to the sensor.

Figure 2-1: Sensor Orientation



A. Trapped air
B. Trapped sludge

Figure 2-2: Recommended Installation



A. Flow
B. Recommended
C. Not recommended

3 Wire

3.1 Wire Rosemount 403/403VP

For additional wiring information on this product, including sensor combinations not shown here, please refer to Emerson.com/RosemountLiquidAnalysisWiring.

Table 3-1: 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	Resistance temperature device (RTD) in
White with red stripe	RTD sense
White	RTD return
Clear	Shield for all RTD lead wires

Figure 3-1: Rosemount 403/403VP Sensor Wiring to Rosemount 56, 1056, and 1057 Transmitters

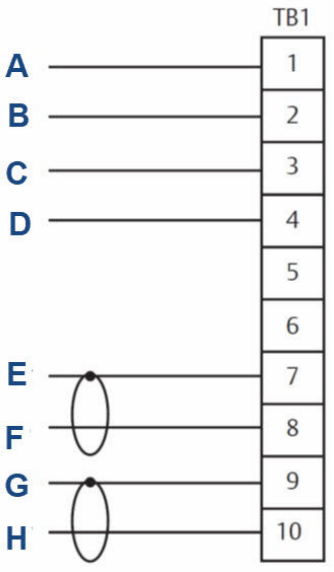


Table 3-2: Rosemount 403/403VP Sensor Wiring to Rosemount 56, 1056, and 1057 Transmitters

Letter	Color	Terminal number	Connects to
A	White	1	RTD return
B	White/red	2	RTD sense
C	Red	3	RTD in
D	Clear	4	RTD shield
N/A	N/A	5	4 count B
N/A	N/A	6	4 count A
E	Clear	7	Shield, 2 count
F	Orange	8	Sensor, 2 count B
G	Clear	9	Shield, 2 count
H	Gray	10	Sensor, 2 count A

Figure 3-2: Rosemount 403/403VP Sensor Wiring to Rosemount 1066 Transmitter

Table 3-3: Rosemount 403/403VP Sensor Wiring to Rosemount 1066 Transmitter

Letter	Wire color	Connects to
A	White	Return
B	White/red	Sense

Table 3-3: Rosemount 403/403VP Sensor Wiring to Rosemount 1066 Transmitter *(continued)*

Letter	Wire color	Connects to
C	Red	RTD in
D	Clear	Shield
E	Clear	R shield
F	Gray	Drive B
G	Orange	Drive A
H	Clear	Drive shield

Figure 3-3: Rosemount 403/403VP Sensor Wiring to Rosemount 5081 Transmitter

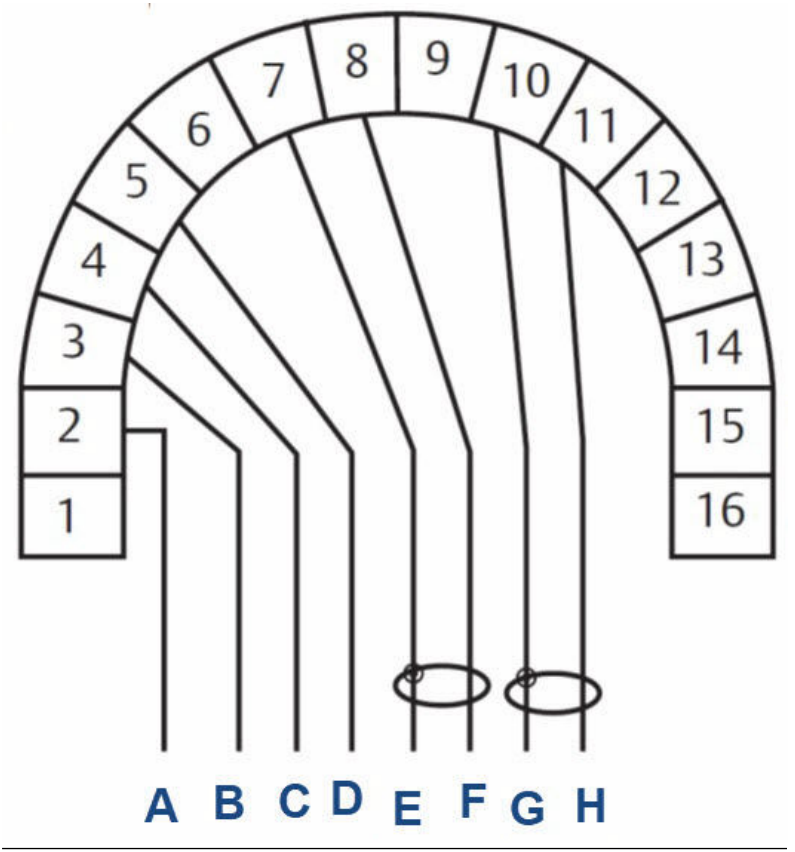


Table 3-4: Rosemount 403/403VP Sensor Wiring to Rosemount 5081 Transmitter

Terminal number	Letter	Wire color	Connects to
1	N/A	N/A	Reserved
2	A	Clear	RTD shield
3	B	White	RTD common
4	C	White/red	RTD sense
5	D	Red	RTD in
6	N/A	N/A	RTD shield
7	E	Clear	RTD common
8	F	Orange	Receive
9	N/A	N/A	Drive shield
10	G	Clear	Drive common
11	H	Gray	Drive
12	N/A	N/A	N/A
13	N/A	N/A	N/A
14	N/A	N/A	N/A
15	NA	N/A	HART®/FOUNDATION™ Fieldbus (-)
16	N/A	N/A	HART/FOUNDATION Fieldbus (+)

3.2 Wire through a junction box

Procedure

If making wiring connections through a remote junction box (PN 23550-00) wire point-to-point. Use cable 23747-00 (factory-terminated) or 9200275 (no termination).

Figure 3-4: Pin out Diagram for Rosemount 403VP Sensor (Viewed from Connector End of Sensor, Looking Down)

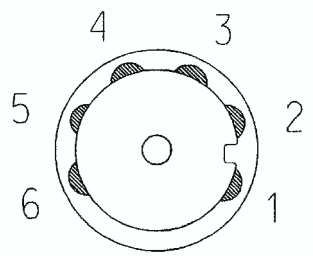


Table 3-5: Pin out Diagram

Number	Connects to
1	Cathode
2	N/A
3	Resistance temperature device (RTD) sense
4	Anode
5	RTD return
6	RTD in

4 Calibrate and maintain

4.1 Clean the sensor

Procedure

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

You can also use isopropyl alcohol to remove oily films. Avoid using strong mineral acids to clean conductivity sensors.

4.2 Calibration

Emerson calibrates PURSense conductivity sensors at the factory; the sensors do not need to be calibrated when first placed in service. Simply enter the cell constant printed on the label into the transmitter. After a period of service, you may need to calibrate the sensor.

You can calibrate the sensor against a solution having a known conductivity or against a referee meter and sensor. If using a standard solution, choose one having conductivity in the recommended operating range for the sensor cell constant. Refer to the transmitter Reference Manual or Product Data Sheet for recommended ranges. Do not use standard solutions having conductivity less than about 100 µS/cm. They are susceptible to contamination by atmospheric carbon dioxide, which can alter the conductivity by a variable amount as great as 1.2 µS/cm (at 77 °F [25 °C]). Because 0.01/cm sensors must be calibrated in low conductivity solutions, it is best to calibrate them against a referee meter and sensor in a closed system.

4.2.1 Calibrate using a standard solution

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

Procedure

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

   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.

4.2.2 Calibrate using a reference meter and sensor

Take the following precautions for a 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 two percent. If the sensor is calibrated at 0.500 µS/cm, the change will be only 0.500/0.502 or 0.4 percent.

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

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 transmitters 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 77 °F (25 °C).

Although temperature correction algorithms are useful for routine measurements, do not use them during calibration for the following two 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, eliminate all sources of avoidable error, e.g., temperature compensation.

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

   If the process temperature is appreciably different from ambient, high flow may not be enough to keep the temperature constant. In this case, you may need to pump sample at room temperature from a reservoir through the sensors. 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.

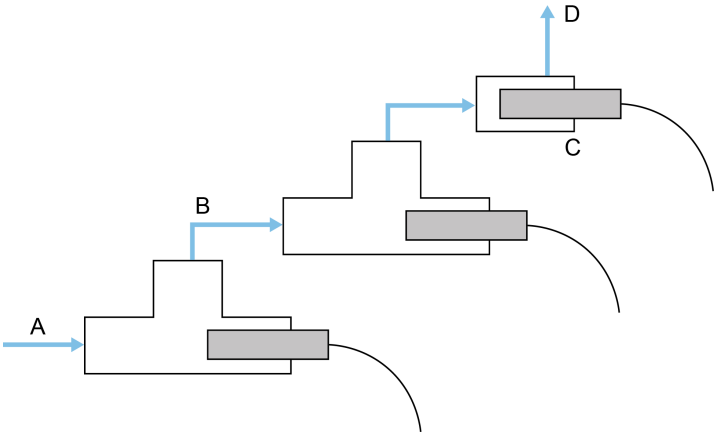
5. To prevent contamination of low conductivity (< 1 µS/cm) process liquids, use clean tubing to connect the sensors. To prevent drift caused desorption of ionic contaminants from tube walls, keep the sample flow greater than 6 ft./sec (1.8 m/sec).

Procedure

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 4-1 for the calibration setup.

Figure 4-1: In Process Calibration Setup



A. Sample inlet
B. In process sensors
C. Reference sensor
D. Sample output

Note

Figure 4-1 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 orientation provides an escape path for bubbles.

This 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.

4.2.3 Calibrate using a grab sample

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.

Procedure

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.

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

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

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

Only use grab sample calibration 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 77 °F (25 °C) using the equation:

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

where: C_{25} = the conductivity at 25 °C
C_t = the conductivity at t °C
α = the temperature coefficient 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, there are no trapped bubbles. If they do not agree, bubbles are present. Continue the process until two subsequent readings agree.
   - While measuring, do not allow the sensor to touch the sides and, particularly, the bottom of the beaker. Keep at least ¼ in. (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 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 you enter the result of the grab sample test. Older transmitters do not remember the process conductivity value.

Therefore, you 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 810 µS/cm, enter (815/810) x 819 or 824 µS/cm.

5 Troubleshoot

Note
For any repair or warranty inquiries, please contact our Customer Care group.

5.1 Off-scale reading

Potential cause

Wiring is incorrect.

Recommended action

Verify and correct wiring.

Potential cause

Resistance temperature device (RTD) is open or shorted.

Recommended actions

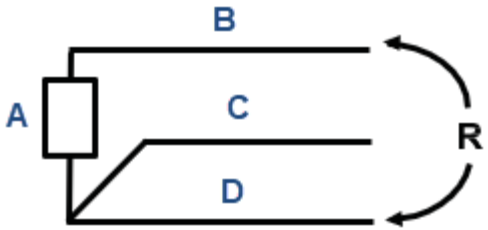
1. Check RTD for open or short circuits.
2. Disconnect leads and measure resistance shown.

   The measured resistance at room temperature should be close to the value in Table 5-1.

Table 5-1: Temperature Resistance

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

Figure 5-1: Checking RTD



A. RTD
B. Red
C. Red/white
D. White

Potential cause

Sensor is not in process stream.

Recommended action

Submerge sensor completely in process stream.

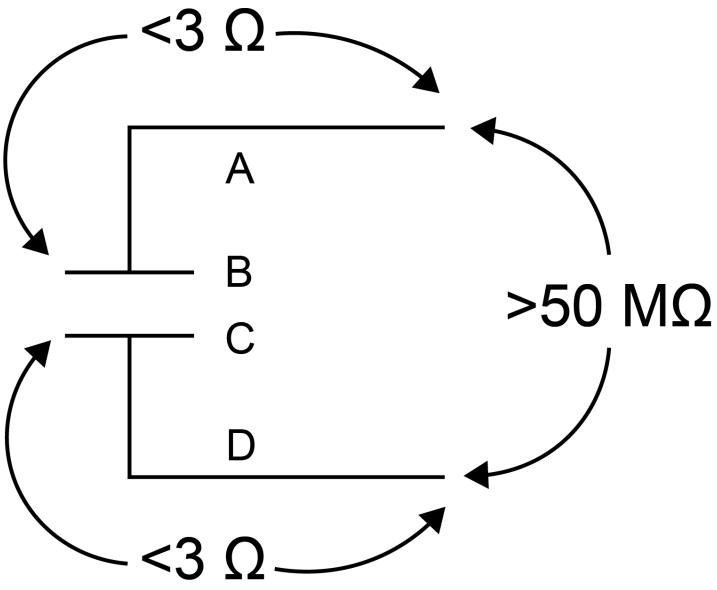
Potential cause

Sensor has failed.

Recommended action

1. Perform isolation checks.
   See Figure 5-2.

Figure 5-2: Checking the Continuity and Leakage



A. Orange
B. Inner
C. Outer
D. Gray

2. Disconnect electrode leads and measure resistance and continuity as shown.

   Sensor must be dry when checkingt resistance between electrode leads.

5.2 Noisy reading

Potential cause

Sensor is improperly installed in process stream.

Recommended action

Submerge sensor completely in process stream.

5.3 Reading seems wrong (lower or higher than expected)

Potential cause

Bubbles trapped in sensor.

Recommended actions

1. Ensure the sensor is properly oriented in pipe or flow cell.
   See Figure 1.
2. Apply back pressure to flow cell.

Potential cause

Wrong temperature correction algorithm is being used.

Recommended action

Check that the temperature correction is appropriate for the sample.
See transmitter manual for more information.

Potential cause

Wrong cell constant.

Recommended action

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.

5.4 Sluggish response

Potential cause

Electrodes are fouled.

Recommended action

Clean electrodes.

Potential cause

Sensor is installed in dead area in piping.

Recommended action

Move sensor to a location more representative of the process liquid.

6 Accessories

Part number	Description
23747-06	Junction box for a remote cable connection
9200275	Connecting cable, unterminated, specify length
23747-00	Connecting cable, terminated, specify length
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)

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