Inductive Conductivity Sensors

04/2022, Edition 8

User Manual

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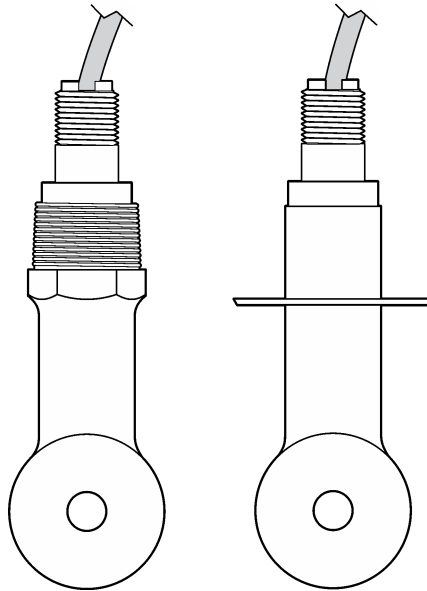
Section 1 Specifications

Specifications are subject to change without notice.

1.1 Inductive conductivity sensor

NOTICE
Sensitive measurement equipment. High levels of electrical interference can make measurements less accurate. Keep electrical interference away from the power sources, probes and cables of measurement equipment.

Specification	Details
Dimensions	Refer to Figure 1 on page 5.
Temperature element	PT1000
Sensor cable	5-conductor (plus two isolated shields), 6 m (20 ft); rated at 150 °C (302 °F)—polypropylene
Wetted materials	Polypropylene, PVDF, PEEK® or PTFE
Temperature/pressure limit	Polypropylene: 100 °C at 6.9 bar (212 °F at 100 psi); PVDF: 120 °C at 6.9 bar (248 °F at 100 psi); PEEK and PTFE: 200 °C at 13.8 bar (392 °F at 200 psi)
Operating temperature	–10 to 200 °C (14 to 392 °F); limited only by sensor body material and mounting hardware
Conductivity range	0.0 to 200.0 µS/cm; 0 to 2,000,000 µS/cm
Temperature range	–10 to 200.0 °C (14 to 392 °F) limited by sensor body material
Maximum flow rate	3 m/s (10 ft/s)
Warranty	1 year; 2 years (EU)

1.2 Inductive conductivity digital gateway

Specification	Details
Dimensions (L x ∅)	17.5 x 3.4 cm (7 x 1.4 in.)
Weight	145 g (5 oz)
Operating temperature	–20 to 60 °C (–4 to 140 °F)
Humidity	95% humidity, non-condensing
Certifications	cETLus, CE, 3-A Sanitary Standard

1.3 sc200 conductivity module

Specification	Details
Linearity	≥ 1.5 mS/cm: ±1% of reading; < 1.5 mS/cm: ±15 µS/cm
Measuring range	0–2000 mS/cm
Response time	0.5 seconds
Precision	> 500 µS/cm: ±0.5% of reading; < 500 µS/cm: ±5 µS/cm
Maximum cable length	200 to 2000 µS/cm: 61 m (200 ft); 2000 to 2,000,000 µS/cm: 91 m (300 ft)
Warranty	1 year; 2 years (EU)

Section 2 General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

2.1 Safety information

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is soley responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

2.1.1 Use of hazard information

⚠ D A N G E R

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ W A R N I N G

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ C A U T I O N

Indicates a potentially hazardous situation that may result in minor or moderate injury.

N O T I C E

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

2.1.2 Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

⚠	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
⚡	This symbol indicates that a risk of electrical shock and/or electrocution exists.
🖐	This symbol indicates the presence of devices sensitive to Electro-static Discharge (ESD) and indicates that care must be taken to prevent damage with the equipment.
🗑	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.

2.2 Product overview

> **⚠ DANGER**
>
> Chemical or biological hazards. If this instrument is used to monitor a treatment process and/or chemical feed system for which there are regulatory limits and monitoring requirements related to public health, public safety, food or beverage manufacture or processing, it is the responsibility of the user of this instrument to know and abide by any applicable regulation and to have sufficient and appropriate mechanisms in place for compliance with applicable regulations in the event of malfunction of the instrument.

> **N O T I C E**
>
> Use of this sensor may lead to fissures of the coating, exposing the underlying substrate to the environment in which the sensor is immersed. Therefore, this sensor has not been developed for, and is not meant for use in applications where the liquid is expected to conform to certain purity or cleanliness parameters and in which contamination could result in substantial damages. These applications typically include semiconductor manufacturing applications and may include other applications in which the user must assess risk of contamination and subsequent impact on product quality. The manufacturer advises against the use of the sensor in these applications and assumes no responsibility for any claims or damages arising as a result of the sensor being used in or in relation to these applications.

The 3700 series inductive conductivity sensors are analog sensors that are used with a controller for data collection and operation. This document assumes sensor installation and use with an sc controller (sc100, sc200 or sc1000). To use the sensor with other controllers, refer to the user manual for the controller that is used and the wiring information in this document.

Refer to Figure 1 for the sensor dimensions.

Figure 1 Dimensions
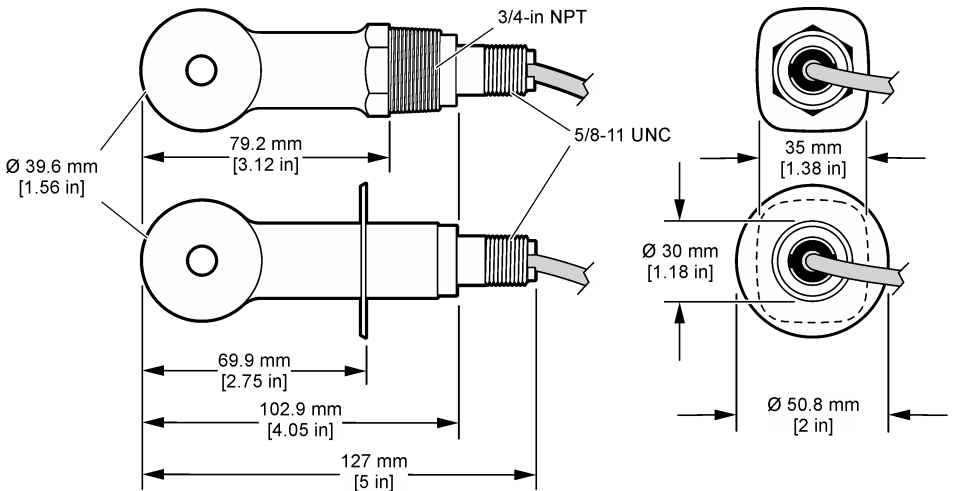
2.3 Product components

Make sure that all components have been received. Refer to Figure 2 and Figure 3[1]. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

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[1] The sensor can be ordered without the digital gateway.

Figure 2 Sensor components
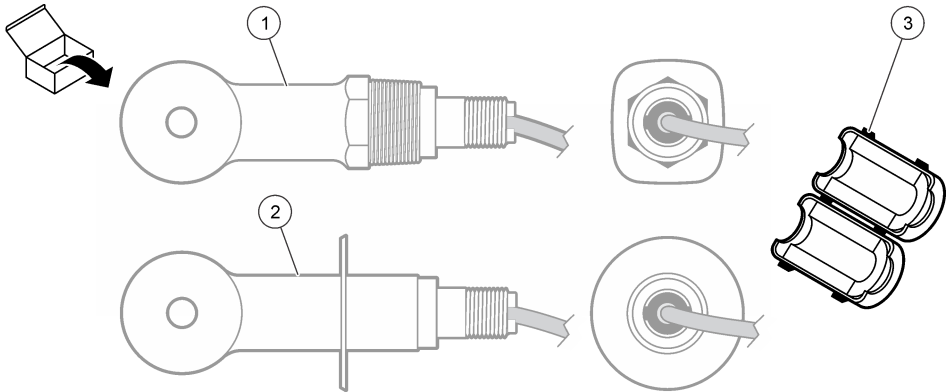
1	Convertible-style sensor—for installation in a pipe tee or an open vessel with applicable mounting hardware	3	Ferrite
2	Sanitary-style sensor—for installation in a 2-inch sanitary tee		

Figure 3 Digital gateway components
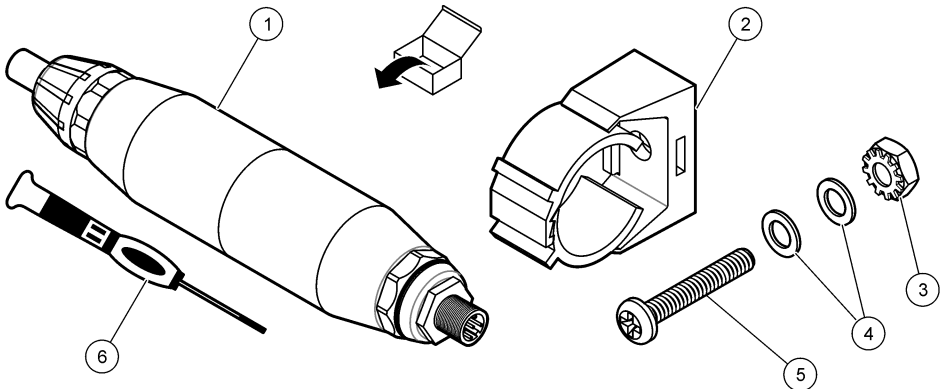
1	Digital gateway	4	Flat washer, #8 (2x)
2	Mounting bracket	5	Screw, cross-slot, #8-32 x 1.25 in.
3	Nut with lock washer, #8-32	6	Screwdriver (for the terminal block)

Section 3 Installation

⚠ **W A R N I N G**

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

3.1 Install the sensor in the sample stream

⚠ W A R N I N G

Personal injury hazard. Removal of a sensor from a pressurized vessel can be dangerous. Installation and removal of these sensors should be done by individuals trained in proper high pressure and temperature installation. Always use industry approved hardware and safety procedures when dealing with high pressure and/or temperature fluid transport systems.

Refer to Figure 4 for installation of the sensor in different applications. The sensor must be calibrated before use. Refer to Calibrate the sensor on page 16.

Make sure that the routing of the sensor cable prevents exposure to high electromagnetic fields (e.g., transmitters, motors and switching equipment). Exposure to these fields can cause inaccurate results.

Figure 4 Mounting examples
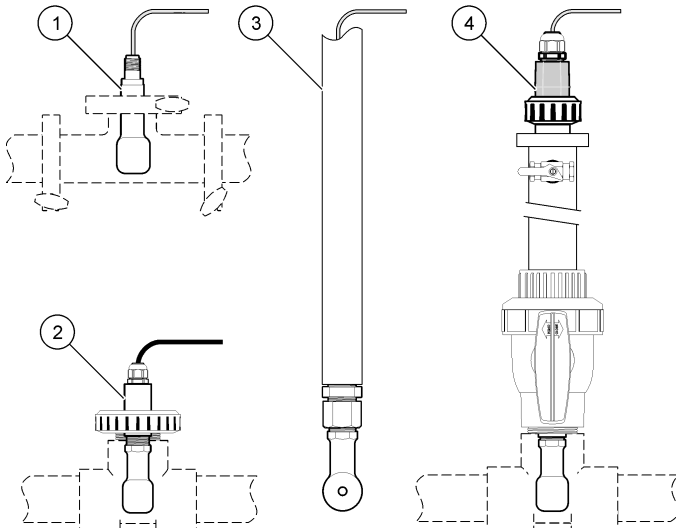
1	Sanitary (CIP) flange mount	**3**	End of pipe immersion
2	Union T-mount	**4**	Ball valve insertion

3.2 Electrical installation

3.2.1 Prepare the sensor wires

If the sensor cable length is changed, prepare the wires as shown in Figure 5.

Figure 5 Wire preparation
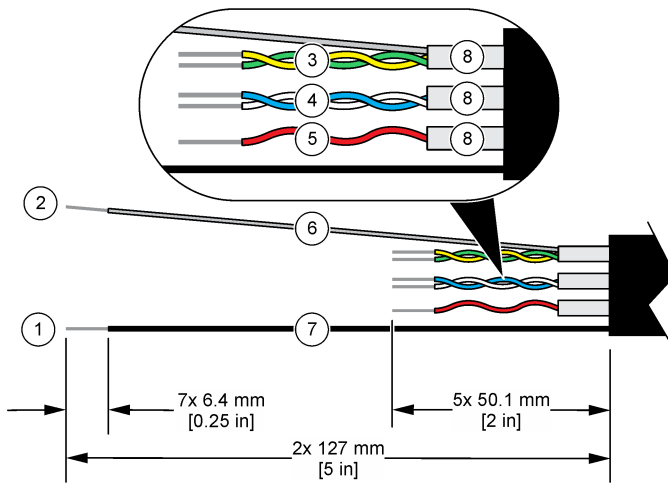
1	Outer shield wire[2]	5	Red wire
2	Inner shield wire[3]	6	Clear heat-shrink tubing[4]
3	Twisted pair, yellow wire and green wire	7	Black heat-shrink tubing[4]
4	Twisted pair, white wire and blue wire	8	Inner conductor shields[5]

3.2.2 Electrostatic discharge (ESD) considerations

NOTICE

Potential Instrument Damage. Delicate internal electronic components can be damaged by static electricity, resulting in degraded performance or eventual failure.

Refer to the steps in this procedure to prevent ESD damage to the instrument:

• Touch an earth-grounded metal surface such as the chassis of an instrument, a metal conduit or pipe to discharge static electricity from the body.
• Avoid excessive movement. Transport static-sensitive components in anti-static containers or packages.
• Wear a wrist strap connected by a wire to earth ground.
• Work in a static-safe area with anti-static floor pads and work bench pads.

3.2.3 sc controller

Connect the sensor to an sc controller with an inductive conductivity digital gateway. The digital gateway converts the analog signal from the sensor to a digital signal.

As an alternative, connect the sensor to an sc200 controller with an sc200 conductivity module. Refer to Connect the sensor with a module on page 10.

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[2] The shield wire for the sensor cable
[3] The shield wire for the green and yellow twisted pair
[4] User supplied
[5] The inner conductor shields are foil tubes with a conductive interior side and a nonconductive exterior side. Make sure to keep the electrical isolation between the interior side of the inner conductor shields. Make sure that the interior side of the inner conductive shields is not exposed.

3.2.3.1 Connect the sensor to the digital gateway

Connect the sensor to the digital gateway. Refer to the documentation supplied with the digital gateway (DOC273.99.80624).

3.2.3.2 Connect the digital gateway to the controller

Item to collect: Digital extension cable[6]

Use only a digital extension cable that is supplied by the instrument manufacturer. The digital extension cable is sold separately.

Note: If the length of the digital extension cable is more than 100 m (300 ft), install a termination box. As an alternative, add an analog extension cable from the sensor to the digital gateway.

1. Remove power from the sc controller.
2. Connect one end of the digital extension cable to the digital gateway.
3. Connect the other end of the digital extension cable to a quick-connect fitting on the sc controller. Refer to Figure 6.

   Note: Keep the cap for the quick-connect fitting for use later.
4. For Class 1, Division 2 Hazardous Location installations, install a connector safety lock on each end of the digital extension cable. The connector safety locks prevent the cable from being accidentally disconnected from the digital gateway fitting or the sc controller quick-connect fitting while the power is on. Refer to Figure 7.
5. Supply power to the sc controller.

Figure 6 Quick-connect fitting

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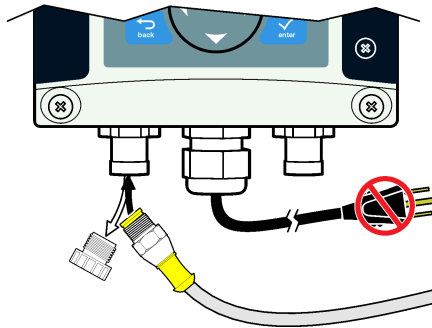
[6] For Class 1, Division 2 Hazardous Location installations, use a digital extension cable with two connector safety locks. Refer to Replacement parts and accessories on page 26.

Figure 7 Install the connector safety lock
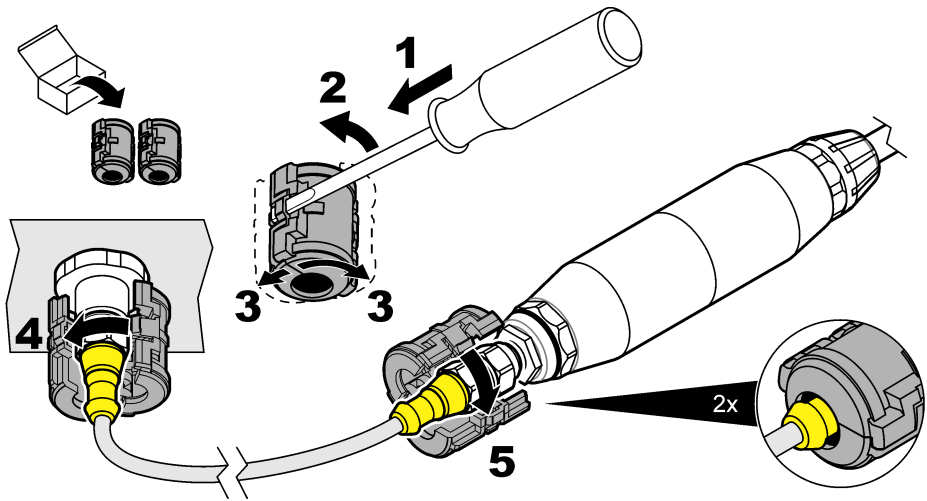
3.2.3.3 Attach the digital gateway to a wall (optional)

Attach the supplied mounting bracket to a wall or other flat surface. Refer to the documentation supplied with the digital gateway (DOC273.99.80624).

3.2.3.4 Connect the sensor with a module

<table>
<tr><td colspan="2" align="center">⚠ **D A N G E R**</td></tr>
<tr><td>⚡</td><td>Electrocution hazard. Always remove power to the instrument before making electrical connections.</td></tr>
</table>

<table>
<tr><td colspan="2" align="center">⚠ **D A N G E R**</td></tr>
<tr><td>⚡</td><td>Electrocution hazard. High voltage wiring for the controller is connected behind the high voltage barrier in the controller enclosure. The barrier must remain in place except when installing modules, or when a qualified installation technician is wiring for power, relays or analog and network cards.</td></tr>
</table>

As an alternative, connect the sensor to an sc200 controller with an sc200 conductivity module. Refer to the illustrated steps that follow and Table 1.

5

6

MODULE 1

MODULE 2

NETWORK

FIELD WIRING
INSULATION MUST
BE RATED TO
80° C MINIMUM

DO NOT CONNECT/
DISCONNECT MODULE WHEN
CONTROLLER POWER IS ON

7

6.4mm
[0.25 in]

8

MODULE 1

NETWORK

MODULE 2

DO NOT CONNECT/
DISCONNECT MODULE WHEN
CONTROLLER POWER IS ON

6   7

3

5   4
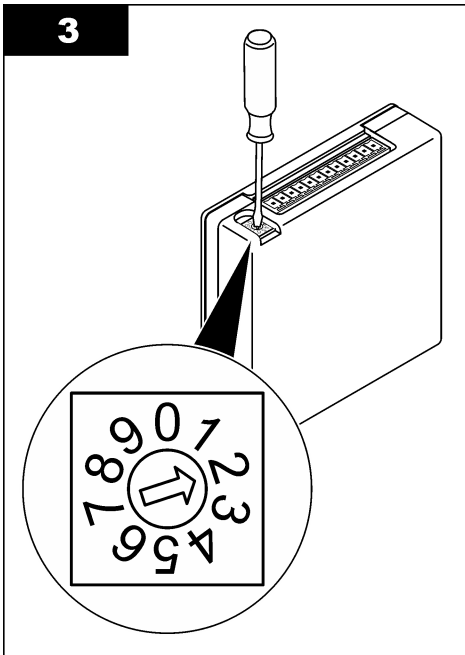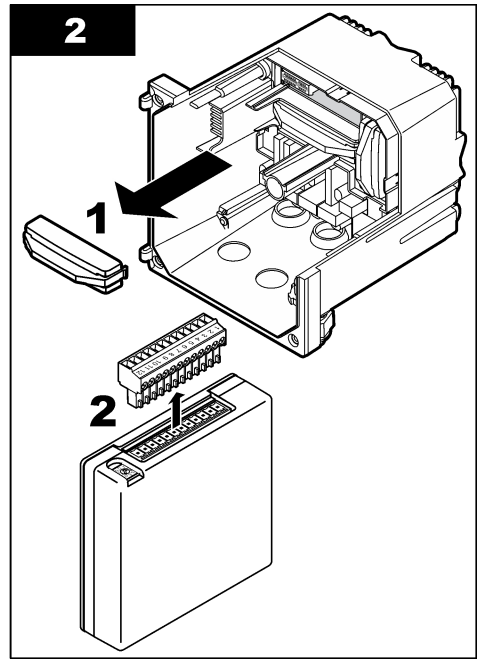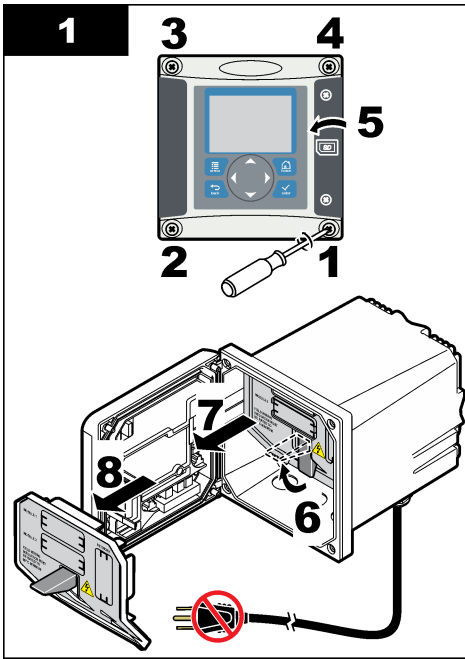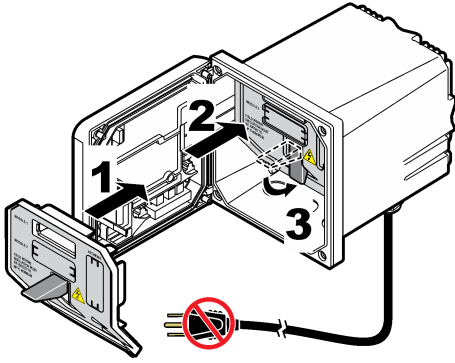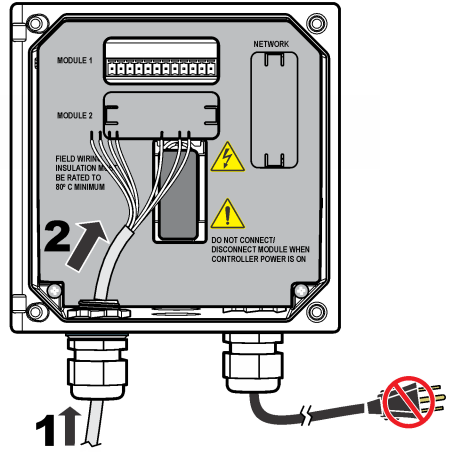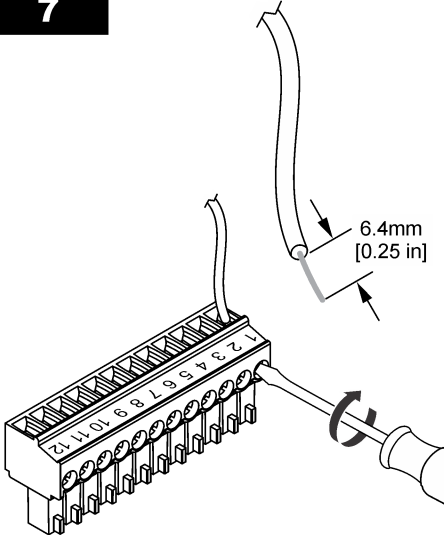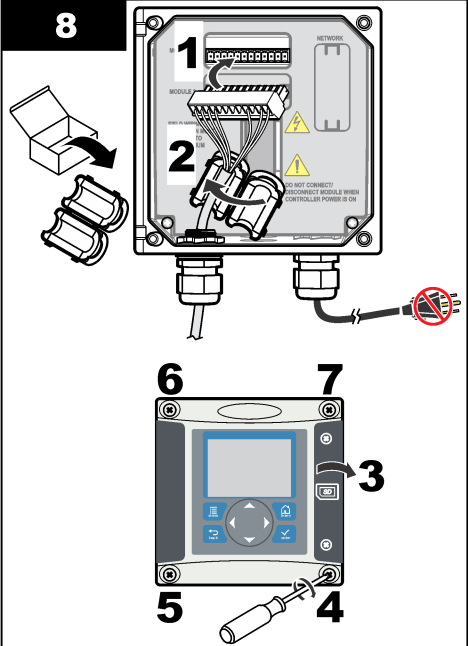
Table 1 Sensor wiring information

Terminal	Wire	Signal	Terminal	Wire	Signal
1	Green	Inner electrode	7	—	—
2	Yellow	Signal ground/ Temperature	8	—	—
3	—	—	9	Clear	Shield
4	Black	Shield	10	Red	Temperature
5	—	—	11	White	Outer electrode/ Receive high
6	—	—	12	Blue	Receive low

3.2.4 PRO-series Model E3 electrodeless conductivity transmitter

To connect the sensor to a PRO-series Model E3 electrodeless conductivity transmitter, remove power to the transmitter and refer to Figure 8 and Table 2.

Figure 8 Connect the sensor to the transmitter
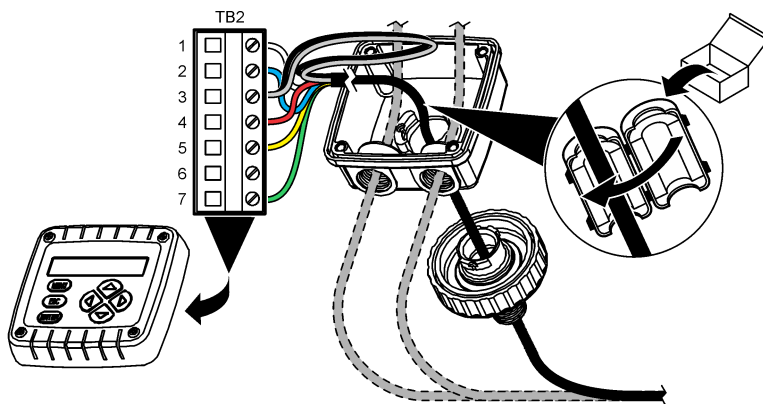
Table 2 Sensor wiring information

Terminal (TB2)	Wire	Terminal (TB2)	Wire
1	White	4	Red
2	Blue	5	Yellow
3	Clear (inner shield)[7]	6	—
3	Black (outer shield)[7]	7	Green

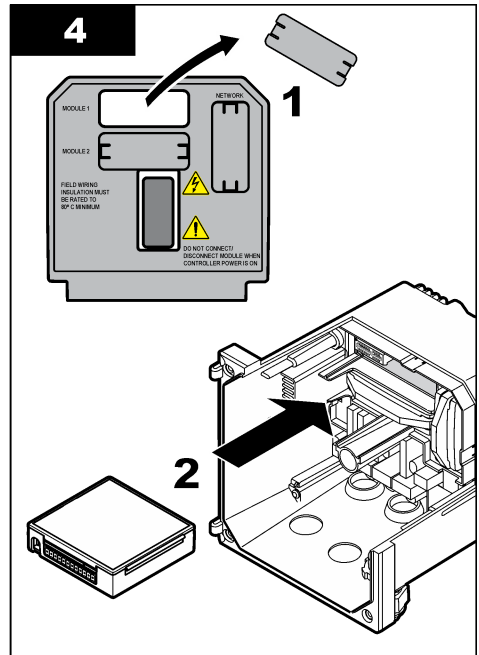### 3.2.5 Model E33 electrodeless conductivity analyzer

⚠ **D A N G E R**
Electrocution hazard. Always remove power to the instrument before making electrical connections.

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[7] For the best immunity to electrical noise, connect the inner shield wire and the outer shield wire together with solder before they are put in the terminal block.

To connect the sensor to a Model E33 electrodeless conductivity transmitter, refer to Figure 9 and Table 3.

Figure 9 Connect the sensor to the analyzer
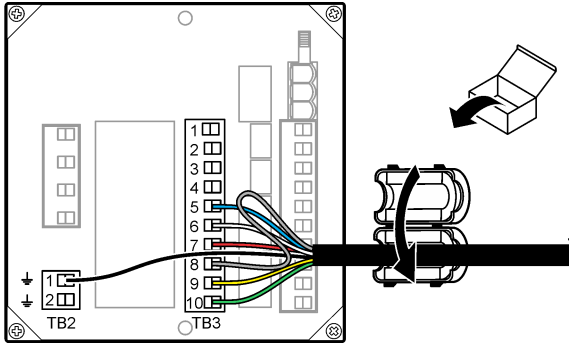
Table 3 Sensor wiring information

Connector	Terminal	Wire	Connector	Terminal	Wire
TB3	5	Blue	TB3	9	Yellow
TB3	6	White	TB3	10	Green
TB3	7	Red	TB2	1	Black (outer shield)
TB3	8	Clear (inner shield)			

Section 4 User navigation

Refer to the controller documentation for keypad description and navigation information.

Push the **RIGHT** arrow key on the controller multiple times to show more information on the home screen and to show a graphical display.

Section 5 Operation

5.1 User navigation

Refer to the controller documentation for keypad description and navigation information.

Push the **RIGHT** arrow key on the controller multiple times to show more information on the home screen and to show a graphical display.

5.2 Configure the sensor

Use the Configure menu of the sc controller to enter identification information for the sensor and to change options for data handling and storage.

1. Push the **MENU** key and select Sensor Setup, [Select Sensor], Configure.
2. Select an option. Use the arrow keys to select an option.

   *Note: For the sc100 and sc200 controller, push and hold the **UP** or **DOWN** arrow keys to enter numbers, characters or punctuation. Push the **RIGHT** arrow key to advance to the next space.*

Option	Description
EDIT NAME	Changes the name that corresponds to the sensor on the top of the measure screen. The name is limited to 10 characters in any combination of letters, numbers, spaces or punctuation.

Option	Description
SENSOR S/N[8]	Allows the user to enter the serial number of the sensor, limited to 16 characters in any combination of letters, numbers, spaces or punctuation.
SELECT MEASURE	Changes the measured parameter to conductivity (default), TDS (total dissolved solids), salinity or % concentration. When the parameter is changed, all other configured settings are reset to the default values. **sc100**—When Concentration is selected, the CONFIG CONC option is added to the menu. Refer to the CONFIG CONC description that follows.
DISPLAY FORMAT[8]	Changes the number of decimal places that are shown on the measure screen to auto (default), X.XXX, XX.XX, XXX.X or XXXX. When set to auto, the number of decimal places changes automatically with changes in the measured value.
COND UNITS	Changes the conductivity units—µS/cm (default), mS/cm, S/cm or auto[8]. When set to auto, the units change automatically with changes in the measured value. For concentration measurements, changes the units for calibration and user conductivity-concentration table—µS/cm, mS/cm (default) or S/cm.
TEMP UNITS	Sets the temperature units to °C (default) or °F
T-COMPENSATION	Adds a temperature-dependent correction to the measured value—linear (default: 2.0%/°C, 25 °C), natural water, temp table (enter x,y points in ascending order) or none. For special applications, a user-defined linear compensation can be entered (0–4%/°C, 0–200 °C). Natural water is not available for TDS or concentration.
CONFIG TDS	TDS only—changes the factor that is used to convert conductivity to TDS: NaCl (default, 0.49 ppm/µS) or custom (enter factor between 0.01 and 99.99 ppm/µS). *Note: This menu option shows after SELECT MEASURE>TDS is selected.*
CONFIG CONC	Concentration (%) only—sets the type of concentration table to use: built-in (default) or user table (user defined). When built-in is selected, the user can select the chemical that is measured. If user table is selected, the user can enter up to 10 x,y (conductivity, %) points in ascending order. Refer to Table 4. **sc100**—This menu option shows after SELECT MEASURE>CONCENTRATION is selected.
TEMP ELEMENT	Sets the temperature element for automatic temperature compensation to PT100 or PT1000 (default). After selection, the user should enter the certified T-factor from the label on the sensor cable for best accuracy. If no element is used, the type can be set to manual and a value for temperature compensation can be entered (manual default: 25 °C). *Note: If a sensor with a PT100 or PT1000 element is set to manual and the sensor is replaced or the sensor days are reset, the TEMP ELEMENT automatically changes to the default setting.*
CELL CONSTANT	Changes the cell constant to the actual certified K value from the label on the sensor cable. When the certified K value is entered, the calibration curve is defined.
FILTER	Sets a time constant to increase signal stability. The time constant calculates the average value during a specified time—0 (no effect, default) to 60 seconds (average of signal value for 60 seconds). The filter increases the time for the sensor signal to respond to actual changes in the process.
LOG SETUP	Sets the time interval for data storage in the data log—5, 30 seconds, 1, 2, 5, 10, 15 (default), 30, 60 minutes.
RESET DEFAULTS (or DEFAULT SETUP)	Sets the configuration menu to the default settings. All sensor information is lost.

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[8] Not applicable to the sc100 controller

Table 4 Built-in concentration tables

Solution	Concentration	Solution	Concentration
H_3PO_4	0–40%	NaCl	0–26%
HCl	0–18% or 22–36%	HF	0–30%
NaOH	0–16%	HNO_3	0–28%, 36–96%
$CaCl_2$	0–22%	H_2SO_4	40–80%, 93–99% or 0–30%

5.3 Adjust the T-factor for non-standard cable lengths

When the sensor cable is extended or shortened from the standard 6 m (20 ft), the resistance of the cable changes. This change reduces the accuracy of temperature measurements. To correct for this difference, calculate a new T-factor.
Note: This procedure applies only to sensors with a PT1000 temperature element. Sensors with a PT100 temperature element are less accurate.

1. Measure the temperature of a solution with the sensor and with an independent, reliable instrument such as a thermometer.
2. Record the difference between the temperature measured from the sensor and from the independent source (actual).
   For example, if the actual temperature is 50 °C and the sensor reading is 53 °C, the difference is 3 °C.
3. Multiply this difference by 3.85 to get an adjustment value.
   Example: 3 x 3.85 = 11.55.
4. Calculate a new T-factor:

   • Sensor temperature > actual—add the adjustment value to the T-factor on the sensor cable
   • Sensor temperature < actual—subtract the adjustment value from the T-factor on the sensor cable
5. Enter the new T-factor in the Configure, Temp Element menu.

5.4 Calibrate the sensor

⚠ **W A R N I N G**

Explosion hazard. Removal of a sensor from a pressurized vessel can be dangerous. Reduce the process pressure to below 10 psi before removal. If this is not possible, use extreme caution. Refer to the documentation supplied with the mounting hardware for more information.

⚠ **W A R N I N G**

Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

⚠ **C A U T I O N**

Chemical exposure hazard. Dispose of chemicals and wastes in accordance with local, regional and national regulations.

5.4.1 About sensor calibration

The wet cal method should be used to calibrate the conductivity sensor:

• **Wet cal**—use air (Zero Cal) and a reference solution or process sample of known value to define a calibration curve. A reference solution calibration is recommended for best accuracy. When the process sample is used, the reference value must be determined with a secondary verification

instrument. Be sure to enter the T-factor in the Configure menu for accurate temperature compensation.

During calibration, data is not sent to the datalog. Thus, the datalog can have areas where the data is intermittent.

5.4.2 Zero calibration procedure

Use the zero calibration procedure to define the unique zero point of the conductivity sensor. The zero point must be defined before the sensor is calibrated for the first time with a reference solution or process sample.

1. Remove the sensor from the process. Wipe the sensor with a clean towel or use compressed air to make sure the sensor is clean and dry.
2. Push the **MENU** key and select Sensor Setup, [Select Sensor], Calibrate.
3. Push **ENTER** to select Zero Cal.
4. If the passcode is enabled in the security menu for the controller, enter the passcode.
5. Select the option for the output signal during calibration:

Option	Description
Active	The instrument sends the current measured output value during the calibration procedure.
Hold	The sensor output value is held at the current measured value during the calibration procedure.
Transfer	A preset output value is sent during calibration. Refer to the controller user manual to change the preset value.

6. Hold the dry sensor in the air and push **ENTER**.
7. Review the calibration result:

   - Pass—the zero point is set.
   - Fail—the value is outside of accepted limits. Make sure the sensor is dry and repeat the zero calibration procedure. Make sure that the cause is not the digital extension cable or a lot of electronic noise.

8. If the calibration passed, push **ENTER** to continue.
9. For the sc100 controller, go to step 12.
10. If the option for operator ID is set to Yes in the Calibration Options menu, enter an operator ID. Refer to Change calibration options on page 20.
11. On the New Sensor screen, select whether the sensor is new:

Option	Description
Yes	The sensor was not calibrated previously with this controller. The days of operation and previous calibration curves for the sensor are reset.
No	The sensor was calibrated previously with this controller.

12. Proceed to the calibration with a reference solution or process sample.

5.4.3 Calibration with a reference solution

Calibration adjusts the sensor reading to match the value of a reference solution. Use a reference solution that is at the same value or higher than the expected measurement readings.
Note: If the sensor is being calibrated for the first time, be sure to complete the zero calibration first.

1. Thoroughly rinse the clean sensor in deionized water.
2. Put the sensor in the reference solution. Support the sensor so that it does not touch the container. Make sure that there is at least 2 inches of space between the sensor and the sides of the container (Figure 10). Stir the sensor to remove bubbles.

Figure 10 Sensor in reference solution
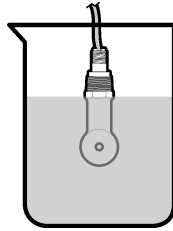
3. Wait for the sensor and solution temperature to equalize. This can take 30 minutes or more if the temperature difference between the process and reference solution is significant.
4. Push the **MENU** key and select Sensor Setup, [Select Sensor], Calibrate.
5. Select Sample Cal and push **ENTER**.
6. For the sc200 or sc1000 controller, select the calibration for the specified parameter and push **ENTER**:

   • Conductivity—Cond Cal
   • TDS—TDS Cal
   • Salinity—Cond Cal
   • Concentration—Conc Cal or Cond Cal

   Note: Refer to the sensor configuration menu if the option that is necessary is not shown.
7. If the passcode is enabled in the security menu for the controller, enter the passcode.
8. Select the option for the output signal during calibration:

Option	Description
Active	The instrument sends the current measured output value during the calibration procedure.
Hold	The sensor output value is held at the current measured value during the calibration procedure.
Transfer	A preset output value is sent during calibration. Refer to the controller user manual to change the preset value.

9. With the sensor in the reference solution, push **ENTER**.
10. For the sc100 controller, go to step 13.
11. Enter the reference temperature of the reference solution and push **ENTER**.
12. Enter the slope of the reference solution and push **ENTER**.
13. Wait for the value to stabilize and push **ENTER**.
    Note: The screen may advance to the next step automatically.
14. Enter the value of the reference solution and push **ENTER**.
15. Review the calibration result:

    • Passed—the sensor is calibrated and ready to measure samples. The slope and/or offset values are shown.

    • Failed—the calibration slope or offset is outside of accepted limits. Repeat the calibration with fresh reference solutions. Refer to and Troubleshooting on page 22 for more information.
16. For the sc100 controller, go to step 20.
17. If the calibration passed, push **ENTER** to continue.
18. If the option for operator ID is set to Yes in the Calibration Options menu, enter an operator ID. Refer to Change calibration options on page 20.

19. On the New Sensor screen, select whether the sensor is new:

Option	Description
Yes	The sensor was not calibrated previously with this controller. The days of operation and previous calibration curves for the sensor are reset.
No	The sensor was calibrated previously with this controller.

20. Return the sensor to the process and push **ENTER**.
The output signal returns to the active state and the measured sample value is shown on the measure screen.
Note: If the output mode is set to hold or transfer, select the delay time when the outputs return to the active state.

5.4.4 Calibration with the process sample

The sensor can remain in the process sample, or a portion of the process sample can be removed for calibration. The reference value must be determined with a secondary verification instrument.
Note: If the sensor is calibrated for the first time, be sure to complete the zero calibration first.

1. Push the **MENU** key and select Sensor Setup, [Select Sensor], Calibrate.
2. Select Sample Cal and push **ENTER**.
3. For the sc200 and sc1000 controller, select the type of calibration and push **ENTER**:

   • Conductivity—Sample Cal
   • TDS—TDS Cal
   • Salinity—Sample Cal
   • Concentration—Conc Cal

4. If the passcode is enabled in the security menu for the controller, enter the passcode.
5. Select the option for the output signal during calibration:

Option	Description
Active	The instrument sends the current measured output value during the calibration procedure.
Hold	The sensor output value is held at the current measured value during the calibration procedure.
Transfer	A preset output value is sent during calibration. Refer to the controller user manual to change the preset value.

6. With the sensor in the process sample, push **ENTER**.
The measured value is shown.
7. Wait for the value to stabilize and push **ENTER**.
8. Measure the conductivity (or other parameter) value with a secondary verification instrument. Use the arrow keys to enter the measured value and push **ENTER**.
9. Review the calibration result:

   • Passed—the sensor is calibrated and ready to measure samples. The slope and/or offset values are shown.

   • Failed—the calibration slope or offset is outside of accepted limits. Repeat the calibration with fresh reference solutions. Refer to and Troubleshooting on page 22 for more information.

10. For the sc100 controller, go to step 14.
11. If the calibration passed, push **ENTER** to continue.
12. If the option for operator ID is set to Yes in the Calibration Options menu, enter an operator ID. Refer to Change calibration options on page 20.

13. On the New Sensor screen, select whether the sensor is new:

Option	Description
Yes	The sensor was not calibrated previously with this controller. The days of operation and previous calibration curves for the sensor are reset.
No	The sensor was calibrated previously with this controller.

14. Return the sensor to the process and push **ENTER**.
The output signal returns to the active state and the measured sample value is shown on the measure screen.
Note: If the output mode is set to hold or transfer, select the delay time when the outputs return to the active state.

5.4.5 Temperature calibration

The instrument is calibrated at the factory for accurate temperature measurement. The temperature can be calibrated to increase accuracy.

1. Put the sensor in a container of water.
2. Measure the temperature of the water with an accurate thermometer or independent instrument.
3. Push the **MENU** key and select Sensor Setup, [Select Sensor], Calibrate.
4. Select 1 PT Temp Cal (or Temp Adjust) and push **ENTER**.
5. For the sc100 controller, select Measured Temp and push **ENTER**. The measured temperature show.
6. For the sc100 controller, if the measured value shown is not the same as the value shown on the thermometer, adjust the temperature value shown. Select Edit Temp and push **ENTER**.
7. For the sc100 controller, go to step 10.
8. Wait for the value to stabilize and push **ENTER**.
9. Enter the exact value and push **ENTER**.
10. Return the sensor to the process and push **ENTER**.

5.4.6 Exit calibration procedure

1. To exit a calibration, push **back**.
2. Select an option.

Option	Description
ABORT	Stop the calibration. A new calibration must start from the beginning.
BACK TO CAL	Return to the calibration.
LEAVE	Exit the calibration temporarily. Access to other menus is allowed. A calibration for a second sensor (if present) can be started. To return to the calibration, push **menu** and select SENSOR SETUP > [Select Sensor].

5.4.7 Change calibration options

The user can set a reminder or include an operator ID with calibration data from the CAL OPTIONS menu.

Note: This procedure is not applicable to the sc100 controller.

1. Push the **MENU** key and select Sensor Setup, [Select Sensor], Calibrate, Cal Options.
2. Use the arrow keys to select an option and push **ENTER**.

Option	Description
CAL REMINDER	Sets a reminder for the next calibration in days, months or years—Off (default), 1 day, 7, 30, 60, or 90 days, 6 or 9 months, 1 or 2 years
OP ID on CAL	Includes an operator ID with calibration data—Yes or No (default). The ID is entered during the calibration.

5.4.8 Reset calibration options

The calibration options can be reset to the factory default options.

Note: This procedure is not applicable to the sc100 controller.

1. Push the **MENU** key and select Sensor Setup, [Select Sensor], Calibrate, Reset Default Cal.
2. If the passcode is enabled in the security menu for the controller, enter the passcode.
3. Push **ENTER**. The Reset Cal? screen is shown.
4. Push **ENTER**. All calibration options are set to the default values.
5. If the option for operator ID is set to Yes in the Calibration Options menu, enter an operator ID. Refer to Change calibration options on page 20.
6. On the New Sensor screen, select whether the sensor is new:

Option	Description
Yes	The sensor was not calibrated previously with this controller. The days of operation and previous calibration curves for the sensor are reset.
No	The sensor was calibrated previously with this controller.

7. Push the **BACK** key to return to the measure screen.

5.5 Modbus registers

A list of Modbus registers is available for network communication. Refer to the manufacturer's website for more information.

Section 6 Maintenance

⚠ D A N G E R

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

6.1 Clean the sensor

⚠ W A R N I N G

Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

⚠ W A R N I N G

Personal injury hazard. Removal of a sensor from a pressurized vessel can be dangerous. Installation and removal of these sensors should be done by individuals trained in proper high pressure and temperature installation. Always use industry approved hardware and safety procedures when dealing with high pressure and/or temperature fluid transport systems.

Pre-requisite: Prepare a mild soap solution with warm water and dishwashing detergent, Borax hand soap or a similar soap.

Examine the sensor periodically for debris and deposits. Clean the sensor when there is a buildup of deposits or when performance has degraded.

1. Use a clean, soft cloth to remove loose debris from the end of the sensor. Rinse the sensor with clean, warm water.
2. Soak the sensor for 2 to 3 minutes in the soap solution.
3. Use a soft bristle brush to scrub the entire measuring end of the sensor. Scrub the inside of the toroid.
4. If debris remains, soak the measuring end of the sensor in a dilute acid solution such as < 5% HCl for a maximum of 5 minutes.
5. Rinse the sensor with water and then return to the soap solution for 2 to 3 minutes.
6. Rinse the sensor with clean water.

Always calibrate the sensor after maintenance procedures are done.

Section 7 Troubleshooting

7.1 Intermittent data

During calibration, data is not sent to the datalog. Thus, the datalog can have areas where the data is intermittent.

7.2 Test the conductivity sensor

If a calibration fails, first complete the maintenance procedures in .

1. Disconnect the sensor wires.
2. Use an ohmmeter to test the resistance between the sensor wires as shown in Table 5.

   Note: Be sure that the ohmmeter is set to its highest range for all infinite (open circuit) resistance readings.

Table 5 Conductivity resistance measurements

Measurement points	Resistance
Between red and yellow wires	1090–1105 ohms at 23–27 °C[9]
Between blue and white wires	Less than 5 ohms
Between green and yellow wires	Less than 5 ohms
Between white and shield wires	Infinite (open circuit)

If one or more of the measurements is incorrect, call technical support. Supply technical support with the serial number of the sensor and the resistance values measured.

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[9] An infinite value (open circuit) or 0 ohms (short circuit) identifies a failure.

7.3 Sensor diagnostic and test menu

The sensor diagnostic and test menu shows current and historical information about the instrument. Refer to Table 6. To access the sensor diagnostic and test menu, push the **MENU** key and select Sensor Setup, [Select Sensor], DIAG/TEST.

Table 6 Sensor DIAG/TEST menu

Option	Description
SENSOR INFORMATION	Shows the name and serial number that was entered by the user.
CARD INFORMATION[10]	Shows the version and the serial number for the sensor module.
CAL DATA	sc100 controller only—Shows the number of days since the last calibration and sets the offset value.
CAL DAYS[10]	Shows the number of days since the last calibration.
CAL HISTORY[10]	Shows a list of the calibrations and the details for each calibration.
RESET CAL HISTORY[10]	Service use only. Resets the calibration history for the sensor. All previous calibration data is lost.
SENSOR SIGNALS	Shows the current sensor signal and span in µS/cm. *Note: For the sc100 controller, select SIGNALS>SENSOR SIGNAL.*
SENSOR DAYS	Shows the number of days that the sensor has been in operation. *Note: For the sc100 controller, select COUNTERS>SENSOR DAYS.*
RESET SENSOR DAYS	Resets the Sensor Days counter. *Note: For the sc100 controller, select COUNTERS>RESET SENSOR.*

7.4 Error list

When an error occurs, the reading on the measurement screen flashes and all outputs are held when specified in the controller menu. To show the sensor errors, press the **MENU** key and select Sensor Diag, [Select Sensor], Error List. A list of possible errors is shown in Table 7.

Table 7 Error list for conductivity sensors

Error	Description	Resolution
MEAS TOO HIGH	The measured value is > 2 S/cm, 1,000,000 ppm, 200% or 20,000 ppt	Make sure that the display format is set for the correct measurement range.
MEAS TOO LOW	The measured value is < 0 µS/cm, 0 ppm, 0% or 0 ppt or the sensor cell constant is not correct	Make sure that the sensor is configured for the correct cell constant.
ZERO TOO HIGH	The zero calibration value is > 500,000 counts	Make sure that the sensor is held in air during zero calibration and is not located near radio frequency or electromagnetic interference. Make sure that the cable is shielded by metal conduit.
ZERO TOO LOW	The zero calibration value is < –500,000 counts	Examine the wiring. If possible, connect the sensor wires to the controller with no extension cable.
TEMP TOO HIGH	The measured temperature is > 130 °C	Make sure that the sensor is configured for the correct temperature element. Refer to Test the conductivity sensor on page 22.
TEMP TOO LOW	The measured temperature is < –10 °C	Examine the wiring. If possible, connect the sensor wires to the controller with no extension cable.
ADC FAILURE	The analog to digital conversion failed	Make sure that the sensor module is fully inserted into the controller connector. Replace the sensor module.

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[10] Not applicable to the sc100 controller

Table 7 Error list for conductivity sensors (continued)

Error	Description	Resolution
SENSOR MISSING	The sensor is missing or disconnected	Examine the wiring and connections for the sensor and for the module. Make sure that the terminal block is fully inserted into the module.
SENS OUT RANGE	The sensor signal is outside of the accepted limits (2 S/cm)	Make sure that the display format is set for the correct measurement range. Examine the wiring. If possible, connect the sensor wires to the controller with no extension cable.

7.5 Warning list for sensors

A warning does not affect the operation of menus, relays and outputs. A warning icon flashes and a message is shown on the bottom of the measurement screen. To show the sensor warnings, press the **MENU** key and select Sensor Diag, [Select Sensor], Warning List. A list of possible warnings is shown in Table 8.

Table 8 Warning list for conductivity sensors

Warning	Description	Resolution
ZERO TOO HIGH	The zero calibration value is >300,000 counts	Make sure that the sensor is held in air during zero calibration and is not located near radio frequency or electromagnetic interference. Make sure that the cable is shielded by metal conduit.
ZERO TOO LOW	The zero calibration value is < –300,000 counts	Examine the wiring. If possible, connect the sensor wires to the controller with no extension cable.
TEMP TOO HIGH	The measured temperature is > 100 °C	Make sure that the sensor is configured for the correct temperature element.
TEMP TOO LOW	The measured temperature is < 0 °C	Examine the wiring. If possible, connect the sensor wires to the controller with no extension cable.
CAL OVERDUE	The Cal Reminder time has expired	Calibrate the sensor.
NOT CALIBRATED	The sensor has not been calibrated	Calibrate the sensor.
REPLACE SENSOR	The sensor has been in operation > 365 days	Calibrate the sensor with a reference solution and reset the sensor days counter. Refer to Sensor diagnostic and test menu on page 23. If the calibration fails, replace the sensor. If the problem continues, call technical support.
CAL IN PROGRESS	A calibration was started but not completed	Return to calibration. As an alternative, remove and then supply power to the controller.
OUTPUTS ON HOLD	During calibration, the outputs were set to hold for a selected time.	The outputs will become active after the selected time period. As an alternative, remove and then supply power to the controller.
WRONG LINEAR TC	The user-defined linear temperature compensation is out of range	The value must be between 0 and 4%/°C; 0 to 200 °C.
WRONG TC TABLE	The user-defined temperature compensation table is out of range	The temperature is above or below the temperature range defined by the table.
WRNG USER CONC TABLE	The concentration measurement is outside of the range of the user table	Make sure that the user table is set for the correct measurement range.

Table 8 Warning list for conductivity sensors (continued)

Warning	Description	Resolution
WRNG BLT-IN TEMP TABLE	The measured temperature is outside of the range of the built-in temperature compensation table	Make sure that the temperature compensation is configured correctly.
WRNG BLT-IN CONC TABLE	The concentration measurement is outside of the range of the built-in concentration table	Make sure that the concentration measurement is configured for the correct chemical and range.

7.6 Event list for sensors

The event list shows current activities such as configuration changes, alarms, warning conditions, etc. To show the events, press the **MENU** key and select Sensor Diag, [Select Sensor], Event List. A list of possible events is shown in Table 9. Previous events are recorded in the event log, which can be downloaded from the controller. Refer to the controller documentation for data retrieval options.

Table 9 Event list for conductivity sensors

Event	Description
CAL READY	The sensor is ready for calibration
CAL OK	The current calibration is good
TIME EXPIRED	The stabilization time during calibration expired
CAL FAIL	The calibration failed
CAL HIGH	The calibration value is above the upper limit
K OUTRANGE	The cell constant K is out of range for the current calibration
UNSTABLE	The reading during calibration was unstable
CHANGE IN CONFIG float	The configuration was changed—floating point type
CHANGE IN CONFIG text	The configuration was changed—text type
CHANGE IN CONFIG int	The configuration was changed—integer value type
RESET CONFIG	The configuration was reset to the default options
POWER ON EVENT	The power was turned on
ADC FAILURE	The ADC conversion failed (hardware failure)
FLASH ERASE	The external serial flash memory erase occurred
TEMPERATURE	The temperature is out of range (-20 to 200 °C)
SAMPLE CAL START	Start of calibration for conductivity
SAMPLE CAL END	End of calibration for conductivity
ZERO CAL START	Start of zero calibration
ZERO CAL END	End of zero calibration
COND SOLN START	Start of reference solution calibration for conductivity
COND SOLN END	End of reference solution calibration for conductivity
TDS CAL START	Start of calibration for TDS
TDS CAL END	End of calibration for TDS
CONC CAL START	Start of calibration for concentration
CONC CAL END	End of calibration for concentration

Table 9 Event list for conductivity sensors (continued)

Event	Description
SALIN CAL START	Start of calibration for salinity
SALIN CAL END	End of calibration for salinity

Section 8 Replacement parts and accessories

⚠ W A R N I N G

Personal injury hazard. Use of non-approved parts may cause personal injury, damage to the instrument or equipment malfunction. The replacement parts in this section are approved by the manufacturer.

Note: Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.

8.1 Inductive conductivity sensor

Consumables

Description	Quantity	Item no.
Conductivity reference solution, 100–1000 µS/cm[11]	1 L	25M3A2000-119
Conductivity reference solution, 1000–2000 µS/cm[11]	1 L	25M3A2050-119
Conductivity reference solution, 2000–150,000 µS/cm[11]	1 L	25M3A2100-119
Conductivity reference solution, 200,000–300,000 µS/cm[11]	1 L	25M3A2200-119

Replacement parts and accessories

Description	Item no.
Gasket, EDPM, 2-in. sanitary-type sensors	9H1327
Junction box, aluminum	60A2053
Junction box, NEMA-4X	76A4010-001
Sanitary clamp, 2-in. heavy duty	9H1132
Cap, 2-in., sanitary-type sensors	70F1037-003

8.2 Inductive conductivity digital gateway

Replacement parts

Description	Quantity	Item no.
Mounting bracket	1	5989800
Nut, 8-32 hex, KEPS, stainless steel	1	3153100
Screw, Phillips, 8-32 x 1.25 PAN, stainless steel	1	560211
Screwdriver, slotted, 2.0 mm blade	1	6134300
Washer, #8 flat, regular, stainless steel	2	695712

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[11] A concentration within this range must be selected when ordered.

Accessories

Description	Item no.
Digital extension cable, 1 m (3.2 ft)	6122400
Digital extension cable, 7.7 m (25 ft)	5796000
Digital extension cable, 15 m (50 ft)	5796100
Digital extension cable, 31 m (100 ft)	5796200

Accessories for C1D2 locations

Description	Item no.
Digital extension cable with two connector safety locks, 1 m (3.2 ft)	6122401
Digital extension cable with two connector safety locks, 7.7 m (25 ft)	5796001
Digital extension cable with two connector safety locks, 15 m (50 ft)	5796101
Digital extension cable with two connector safety locks, 31 m (100 ft)	5796201
Connector safety lock	6139900

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