DOC023.52.03249

3400 sc Digital Conductivity Analysis Sensors

User Manual

01/2019, Edition 3

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Section 1 Specifications

Specifications are subject to change without notice.

Table 1: 3400sc-series Conductivity Probe Specifications

Components	Corrosion-resistant materials, fully-immersible probe with 10 m (30 ft) cable
Measuring Range (Conductivity)	See Table 3: " Sensor Cell Constants and Measuring Ranges" on page 5
Measuring Range (Resistivity)	See Table 3: " Sensor Cell Constants and Measuring Ranges" on page 5
Measuring Range (TDS)	See Table 3: " Sensor Cell Constants and Measuring Ranges" on page 5
Measuring Range (Temperature)	–20.0 to 200.0 °C (–4.0 to 392.0 °F)
Operating Temperature/Humidity	–20 to 60 °C (–4 to 140 °F); 0–95% relative humidity, non-condensing
Storage Temperature/Humidity	–30 to 70 °C (–22 to 158 °F); 0–95% relative humidity, non-condensing
Response Time	90% of reading within 30 seconds of step change
Measurement Accuracy	±2% of reading
Temperature Accuracy	±0.1 °C
Repeatability	±0.5% of reading
Sensitivity	±0.5% of reading
Calibration/Verification	Comparison to standard
Sensor Interface	Modbus
Standard Probe Cable Length	Analog probe: 6 m (20 ft); Digital probe: 10 m (32.8 ft)
Probe Weight	0.3 to 0.4 kg (approximately one pound) dependent on probe type
Probe Dimensions	Dependent on probe type, see Figure 1: "Compression-style Sensor, 0.5-in. Diameter" on page 8 through Figure 7: "Boiler/Condensate Sensor" on page 10.

Table 2: Specific Conductivity Probe Specifications

Model 3422-series Conductivity/resistivity Sensors	Model 3433-series Conductivity/resistivity Sensors	Model 3444-series Conductivity/resistivity Sensors	Model 3455-series Conductivity/resistivity Sensors
Wetted Materials			
Titanium electrodes (316 stainless steel outer electrode for extended sensor body style used with ball valve assembly), PTFE Teflon insulator, and treated Viton® O-ring seals	Graphite electrodes, Ryton® body, and Viton® O-ring seals	316 stainless steel and titanium electrodes, PEEK insulator, and fluoroelastomer O-ring seals	316 stainless steel electrodes, PTFE Teflon insulator, and pufluoro-elastomer O-ring seals
Maximum Temperature/Pressure			
Sensor with integral digital electronics: limited to 70 °C (160 °F). Analog sensor with Kynar (PVDF) compression fitting: 150 °C at 1.7 bar (302 °F at 25 psi) or 36 °C at 10.3 bar (97 °F at 150 psi) Analog sensor with manufacturer-supplied 316 stainless steel compression fitting: 150 °C at 13.7 bar (302 °F at 200 psi) Analog sensor with 316 stainless steel ball valve hardware assemblies: 125 °C at 10.3 bar (302 °F at 150 psi)	Analog sensor only: 150 °C at 6.8 bar (302 °F at 100 psi) or 20 °C at 13.7 bar (68 °F at 200 psi) Analog sensor with hardware: A lower rated mounting hardware or piping material may limit the temperature and pressure ratings listed above.	Analog sensor with integral cord grip: 100 °C at 20.7 bar (212 °F at 300 psi) Analog with integral analog polypropylene J-box Head: 92 °C at 20.7 bar (198 °F at 300 psi) Analog sensor with integral aluminum or 316 SS J-box head: 200 °C at 20.7 bar (392 °F at 300 psi)	Analog sensor with manufacturer-supplied sanitary mount hardware assemblies: 150 °C at 10.3 bar (302 °F at 150 psi) or 20 °C at 13.7 bar (68 °F at 200 psi)[1]
Flow Rate			
0–3 m (0–10 ft) per second (fully immersed)	0–3 m (0–10 ft) per second (fully immersed)	0–3 m (0–10 ft) per second (fully immersed)	0–3 m (0–10 ft) per second (fully immersed)
Temperature Compensator			
Pt 1000 RTD	Pt 1000 RTD	Pt 1000 RTD	Pt 1000 RTD
Sensor Cable:			
Digital: PUR (polyethylene) 5-conductor, shielded, rated to 105 °C (221 °F); 10 m (33 ft) standard length Analog: 6-wire cable (four conductors and two isolated shield wires); rated at 150 °C (302 °F); 6 m (20 ft) long	Analog: 6-wire cable (four conductors and two isolated shield wires); rated at 150 °C (302 °F); 6 m (20 ft) long	Analog: 6-wire cable (four conductors and two isolated shield wires); rated at 150 °C (302 °F); 6 m (20 ft) long	Analog: 6-wire cable (four conductors and two isolated shield wires); rated at 150 °C (302 °F); 6 m (20 ft) long

[1] Other brands of mounting hardware assemblies and sanitary clamps may reduce the listed rating.

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Table 3: Sensor Cell Constants and Measuring Ranges

Sensor Cell Constant	Inherent Measuring Range			
	Conductivity (µS/cm)	Resistivity (Mohm)	TDS	Salinity (PPT)
0.05	0–100	0.002–20	See Note[1]	not applicable
0.5	0–1000	0.001-20	See Note1	< 1
1	0–2000	not applicable	See Note1	< 2
5	0–10000	not applicable	See Note1	< 15
10	0–200000	not applicable	See Note1	< 500[2]

[1] To determine which cell constant to use, convert the full-scale TDS value to its equivalent conductivity value at 25 °C by multiplying the TDS value by 2. Find that value in the conductivity column and use the cell constant that corresponds to that value.

[2] Practical upper limit is 280.

Table 4: Digital Gateway Specifications

Weight	145 g (5 oz)
Dimensions	17.5 x 3.4 cm (7 x 1 3/8 in.)
Operating Temperature	–20 to 60 °C (–4 to 140 °F)

Section 2 General Information

2.1 Safety Information

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.

To ensure 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

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

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

Important Note: *Information that requires special emphasis.*

Note: *Information that supplements points in the main text.*

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

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists.
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground).
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of life equipment to the Producer for disposal at no charge to the user. ***Note:*** *For all electrical products (marked or unmarked) which are supplied or produced by Hach-Lange, please contact the local Hach-Lange sales office for instructions for proper disposal.*

2.2 General Sensor Information

The Contacting Conductivity Sensor allows aqueous samples to be easily and accurately analyzed for conductivity. Sensor models are available for applications with temperatures up to 200 °C (392 °F). Refer to Figure 1: and Figure 6: for sensor options.

Optional equipment, such as mounting hardware for the probe, is supplied with instructions for all user installation tasks. Several mounting options are available, allowing the probe to be adapted for use in many different applications.

Figure 1: Compression-style Sensor, 0.5-in. Diameter

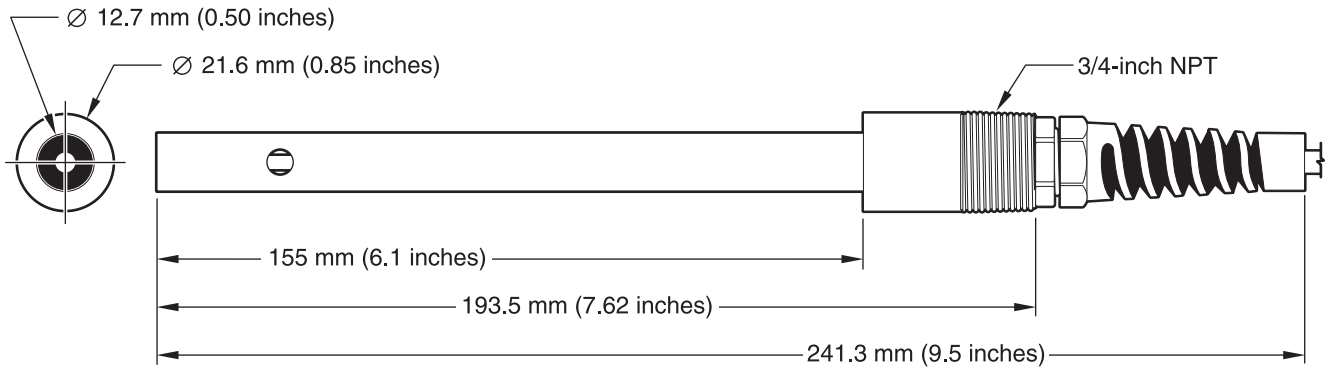


Figure 2: Compression-style Sensor, 0.75-in Diameter

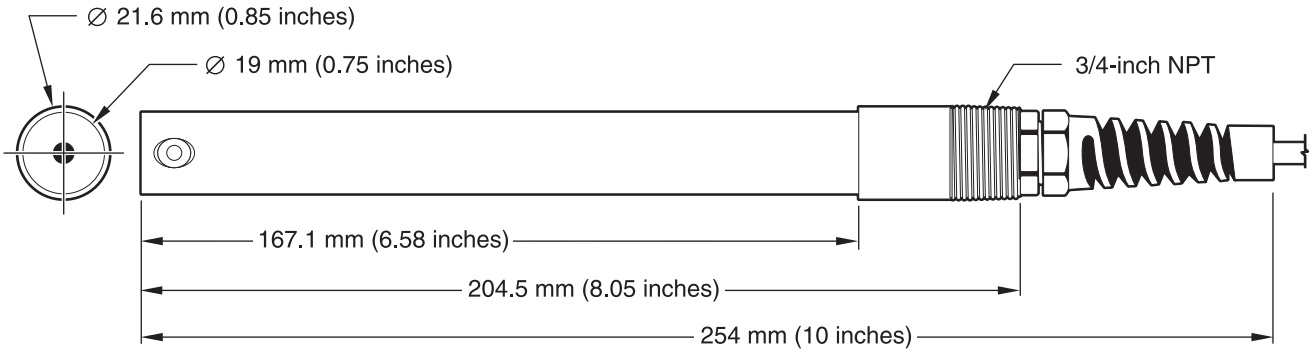


Figure 3: Compression-style Sensor with Teflon® Tip

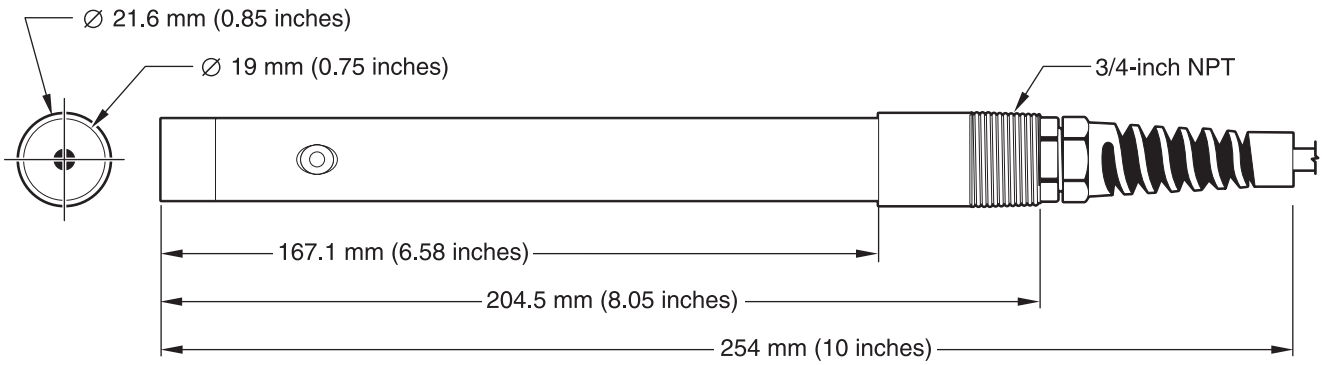


Figure 4: Compression-style Sensor (with integral junction box)

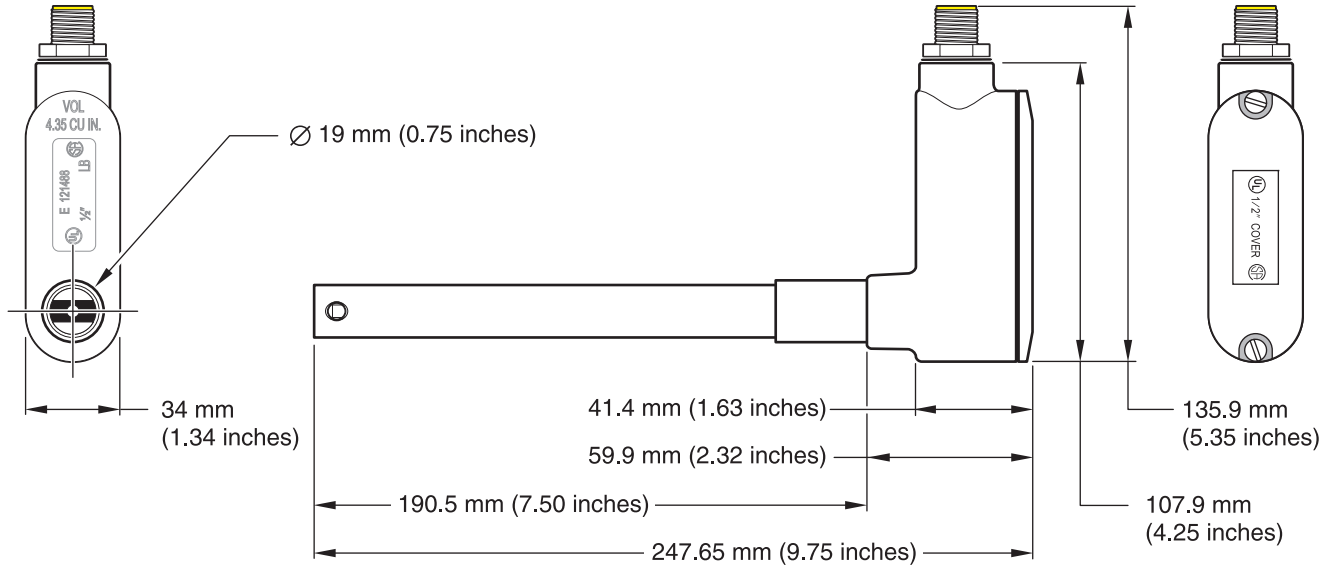


Figure 5: Sanitary (CIP)-style Sensor

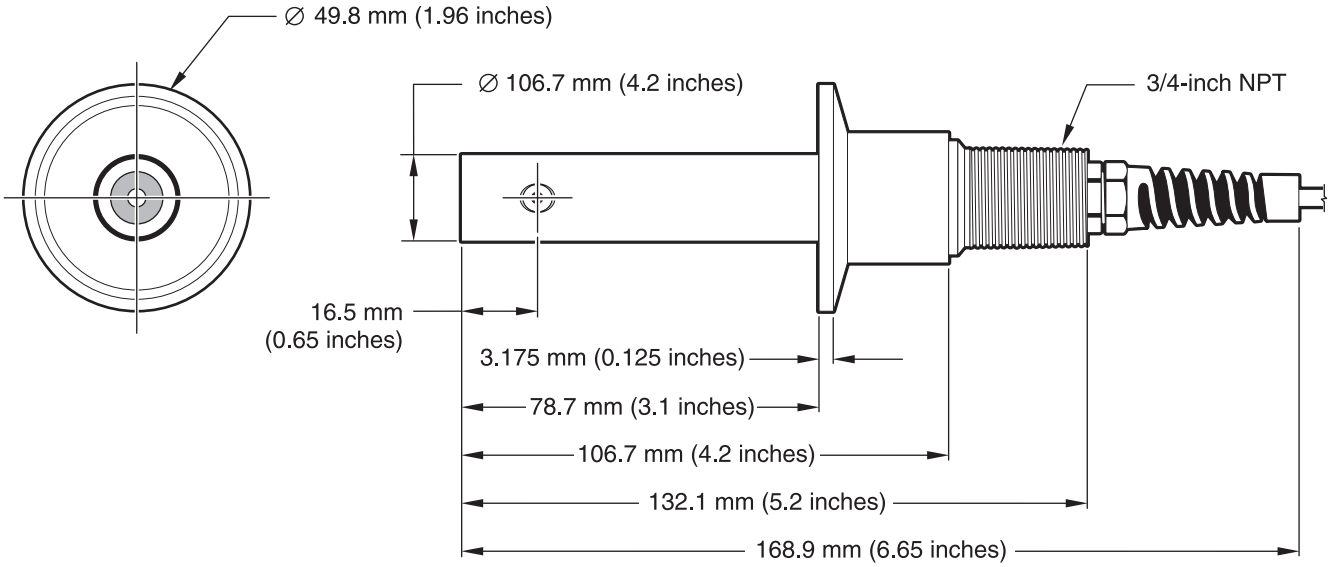


Figure 6: Non-metallic General Purpose Sensor

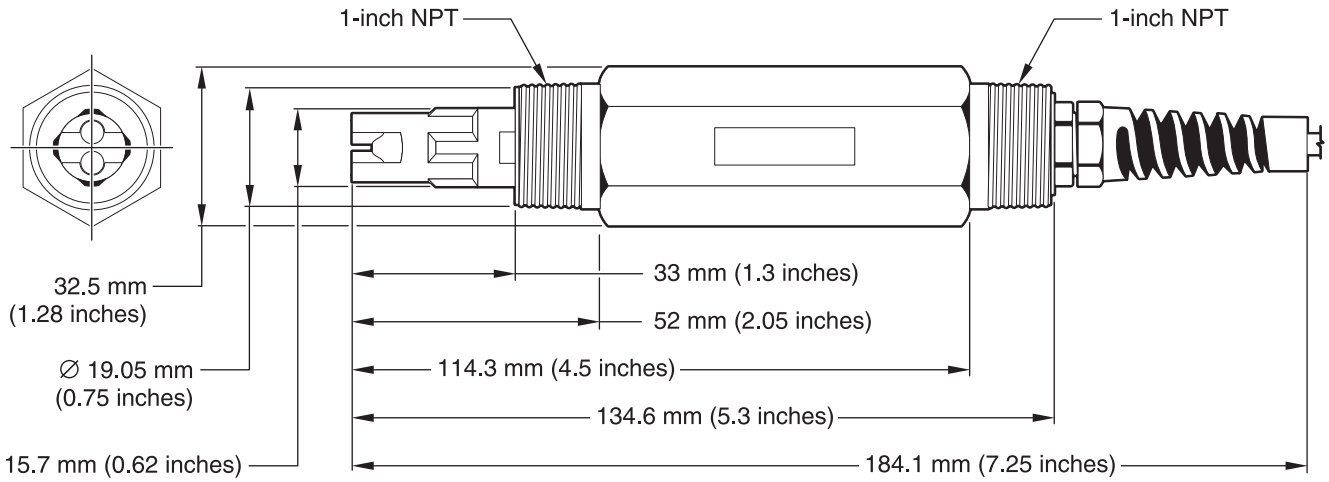
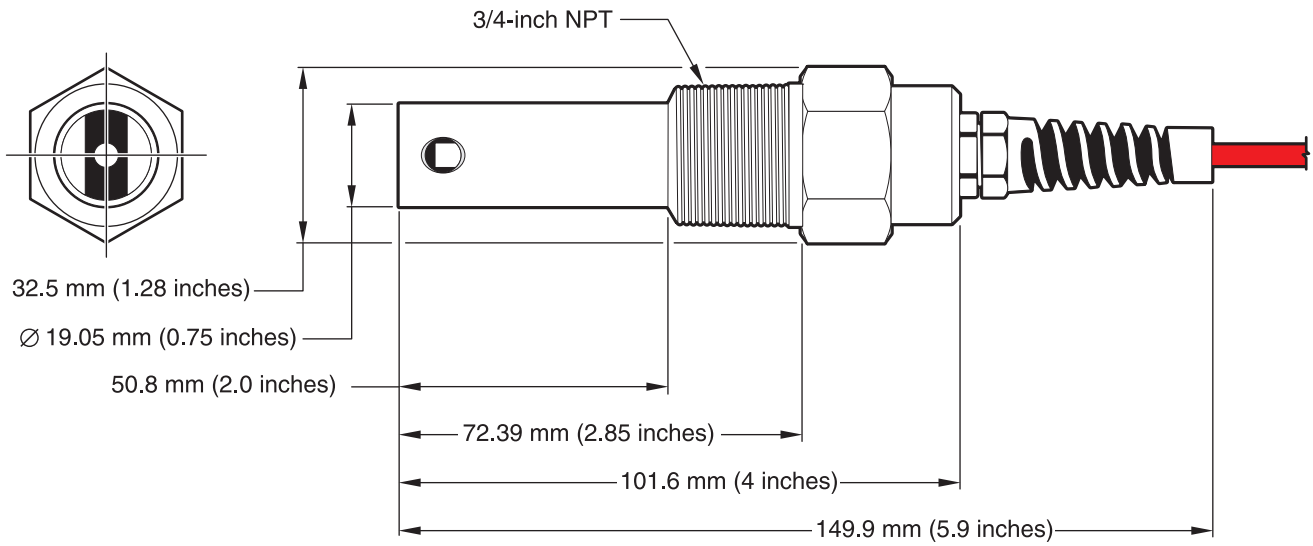


Figure 7: Boiler/Condensate Sensor



2.3 The Digital Gateway

The Digital Gateway was developed to provide a means to use existing analog sensors with the new digital controllers. The gateway contains all the necessary software and hardware to interface with the controller and output a digital signal.

2.4 Theory of Operation

The Contacting Conductivity Sensors are designed to accurately measure conductivity/resistivity/TDS/salinity from ultrapure water (0.056 µS/cm) to 200,000 µS/cm in clear fluids. Conductivity is a measure of the ability of a solution to conduct an electric current and resistivity is the measure of the ability of a solution to resist an electric current. Total Dissolved Solids (TDS) is a measure that reflects the amount of solids dissolved in a water sample and salinity is a measure of the dissolved salts in a solution.

Each sensor is available in a variety of precisely measured cell constants and different materials to meet many measurement needs and are ideal for deionization, reverse osmosis, electro-deionization, desalination, chemical purity, and other clear fluid applications.

Each sensor is individually tested to determine its absolute cell constant (shown on its label as K =X) and temperature element value (to the nearest 0.1 ohm). The cell constant (K) and temperature factor (T) are entered during instrument configuration or calibration to ensure the highest possible measurement accuracy.

Available cell constants include: 0.05, 0.5, 1.0, 5.0, and 10. The temperature element was designed to provide fast response to changes in temperature and ensure high measurement accuracy.

DANGER
Only qualified personnel should conduct the tasks described in this section of the manual.

The system can be used with any sc controller. Refer to the controller manual for installation instructions.

The Contacting Conductivity sensor may be ordered with an internal or external digital gateway. If you received an external digital gateway, refer to 3.2 "Using the Digital Gateway" on page 12 for digital gateway connecting/wiring and mounting instructions.

3.1 Connecting the Sensor to an sc Controller

3.1.1 Attaching a sc Sensor with a Quick-connect Fitting

The sensor cable is supplied with a keyed quick-connect fitting for easy attachment to the controller (see Figure 8: "Attaching the Sensor using the Quick-connect Fitting"). Retain the connector cap to seal the connector opening in case the sensor must be removed. Optional extension cables may be purchased to extend the sensor cable length. If the total cable length exceeds 100 m (300 ft), a termination box must be installed.

Note: *Use of a load termination box other than Cat. No. 5867000 may result in a hazard.*

Figure 8: Attaching the Sensor using the Quick-connect Fitting

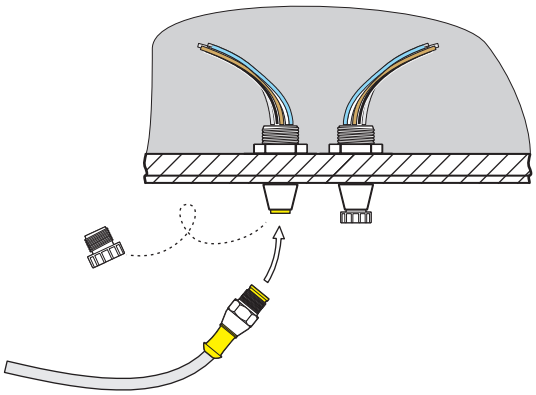
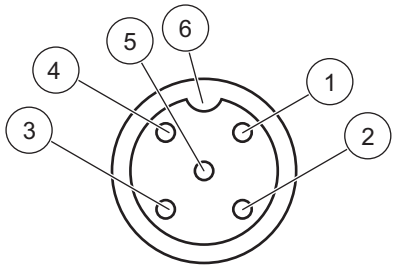


Figure 9: Quick-connect Fitting pin assignment



Number	Designation	Wire Color
1	+12 VDC	Brown
2	Circuit Common	Black
3	Data (+)	Blue
4	Data (–)	White
5	Shield	Shield (grey wire in existing quick-disconnect fitting)
6	Groove	

3.2 Using the Digital Gateway

The digital gateway is designed to provide a digital interface to the controller. The non-sensor end is wired to the controller as shown in "Connecting the Sensor to an sc Controller" on page 11.

3.2.1 Wiring the sc Sensor to the Digital Gateway

1. Route the cable from the sensor through the strain relief in the digital gateway then properly terminate the wire ends.

Note: *Do not tighten the strain relief until the digital gateway is wired and the two halves are threaded securely together.*

2. Insert the wires as shown in Table 5: "Wiring the Digital Gateway" and Figure 10: "Wiring and Assembling the Digital Gateway".

3. Make sure the O-ring is properly installed between the two halves of the digital gateway and thread the two halves together. Hand tighten.

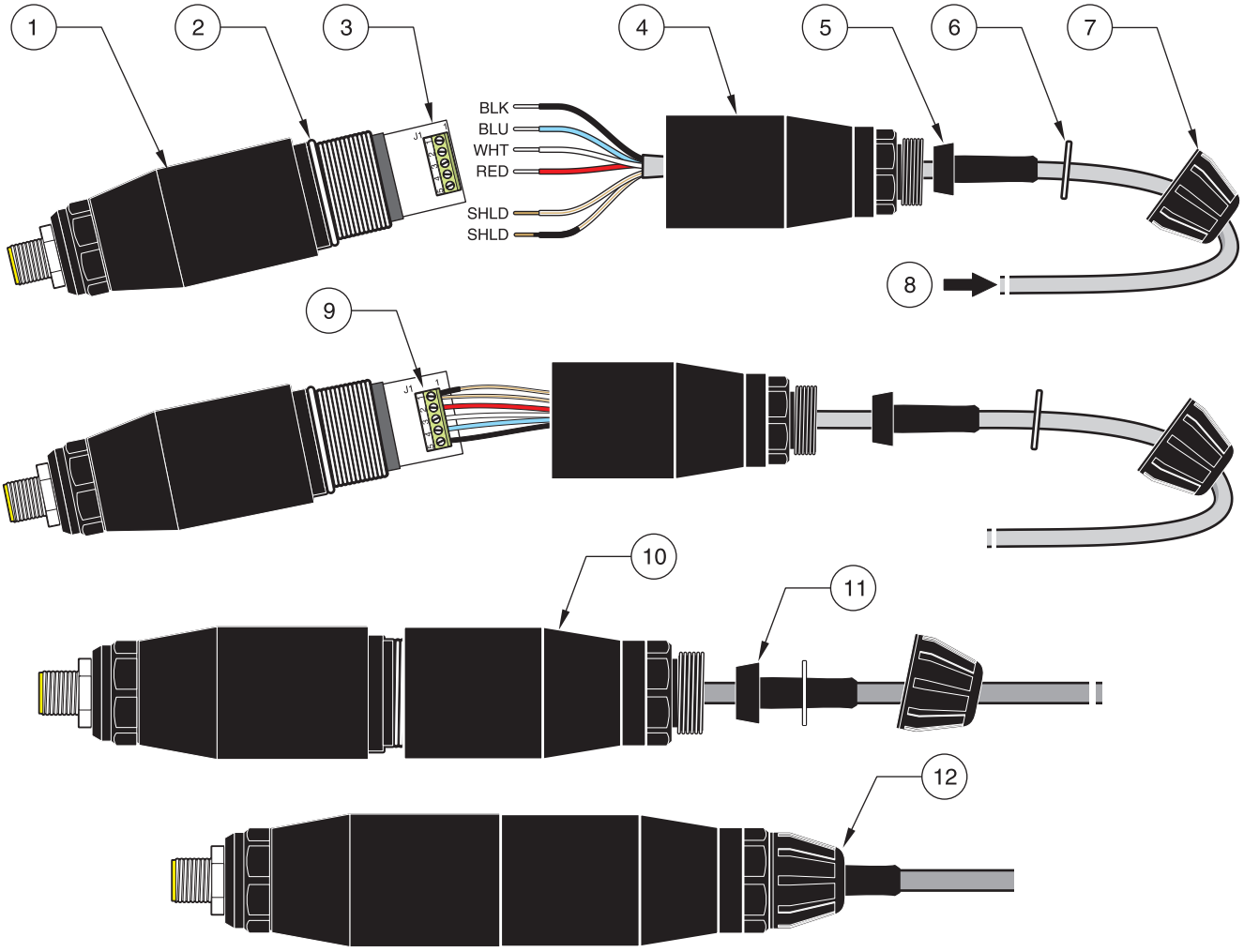
4. Tighten the strain relief to secure the sensor cable.

5. Connect the digital gateway to the controller.

Table 5: Wiring the Digital Gateway

Sensor (wire color)	Sensor Signal	Digital Gateway Sensor Wire connector
Clear	Shield	J1-1
Clear w/shrink wrap	Shield	J1-1
Red	Drive	J1-2
White	Temp –	J1-3
Blue	Temp +	J1-4
Black	Sense	J1-5

Figure 10: Wiring and Assembling the Digital Gateway



1. Digital gateway front	**7.** Nut, strain relief
2. O-ring	**8.** From sensor
3. Sensor wire connector	**9.** Insert wires into connector according to Table 5:. Use the included 2 mm screwdriver (Cat. No. 6134300) to secure connections.
4. Digital gateway back	**10.** Screw back of digital gateway onto front
5. Cable bushing	**11.** Push cable bushing and anti-rotation washer into back.
6. Anti-rotation washer	**12.** Fasten cord grip securely. Assembly is complete.

3.2.2 Mounting the Digital Gateway

The digital gateway is supplied with a mounting clip for mounting to a wall or other flat surface. Use an appropriate fastener to secure it to the wall. After the sensor is wired to the digital gateway and the two halves are threaded together, place the mounting clip over the center of the digital gateway and squeeze the clip together to secure. See Figure 12: "Mounting the Digital Gateway".

Figure 11: Digital Gateway Dimensions

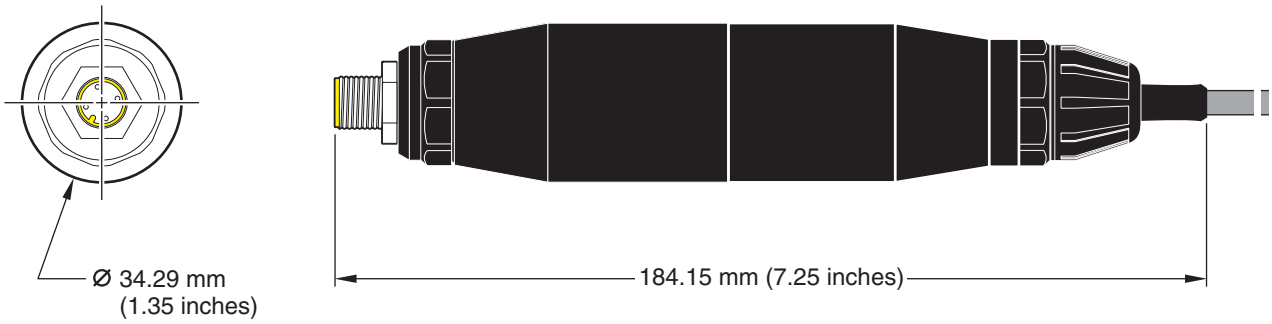
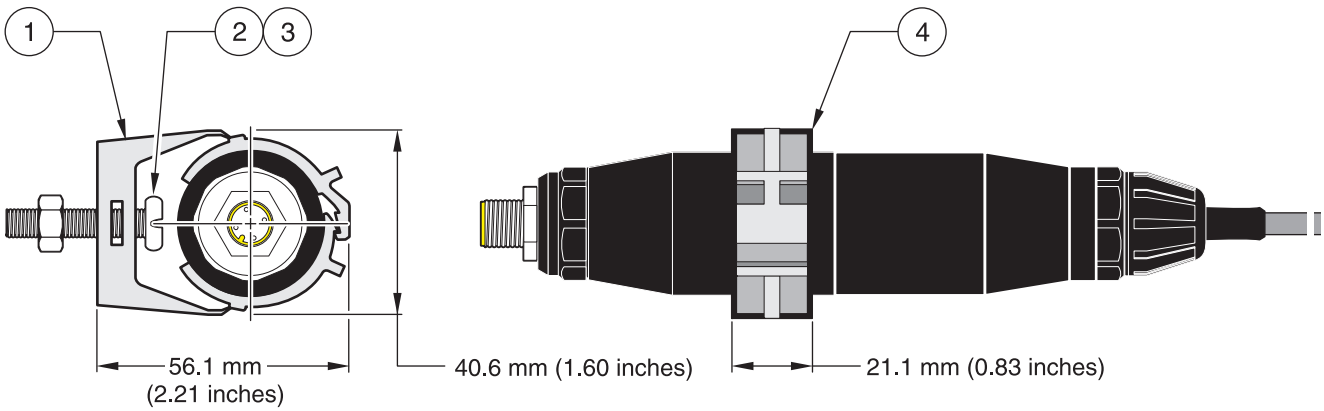


Figure 12: Mounting the Digital Gateway



1.	Mounting clip	**3.**	Hex nut, ¼-28
2.	Screw, pan head, ¼-28 x 1.25-in.es	**4.**	Mount clip, insert digital gateway, squeeze clip closed.

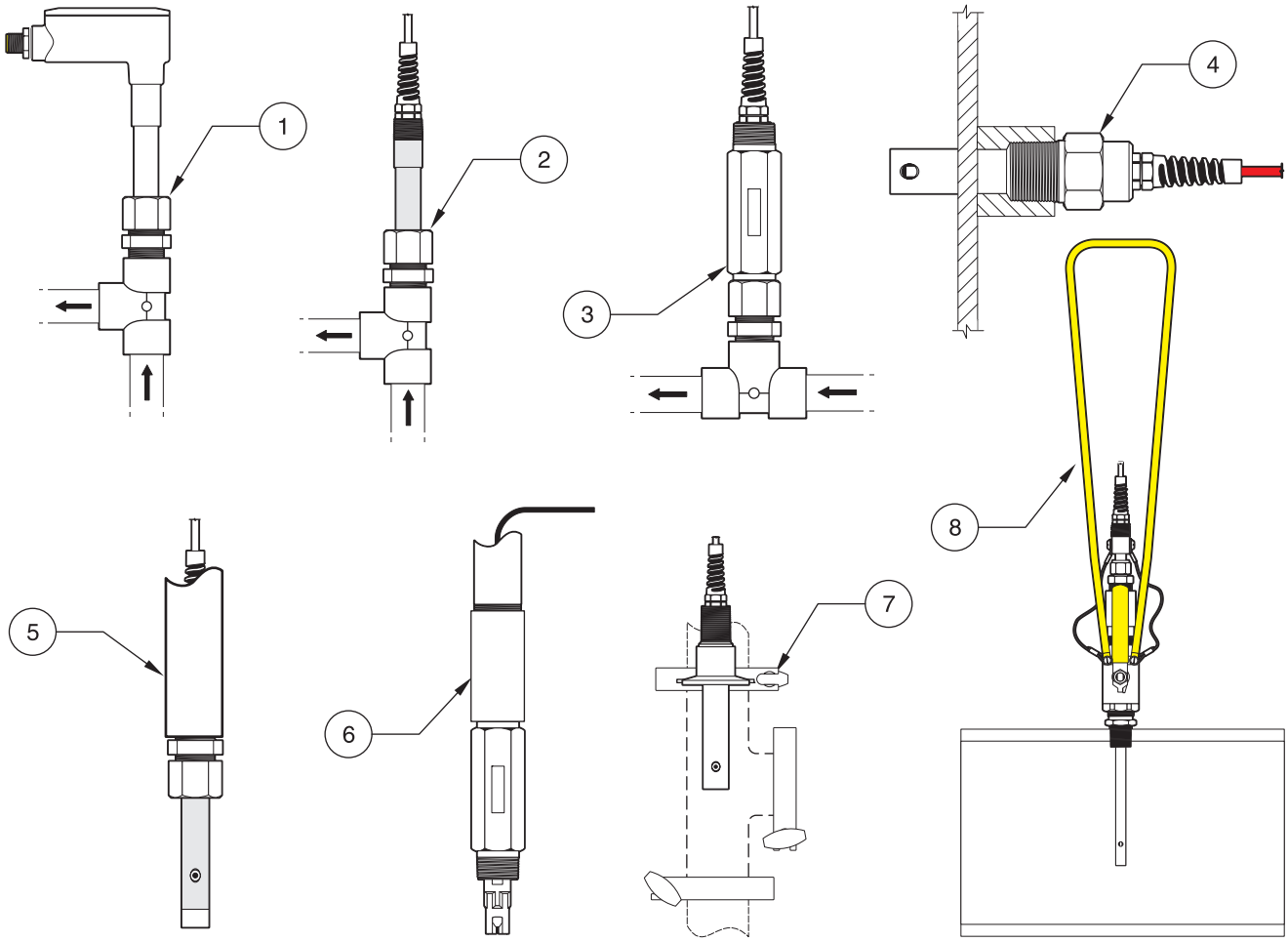
3.3 Installing the Sensor in the Sample Stream

Two compression-style installation schemes are available. For sensors with a 0.05 cell constant, use ½-in or ¾-in male NPT compression fittings made of Kynar (PVDF) or 316 stainless steel. For sensors with any other cell constant, use a ¾-in. male NPT compression fitting made of Kynar or 316 stainless steel. In all cases, the fitting enables the sensor to be insertion mounted, up to 102 mm (4 in.) deep, into a pipe tee or vessel. Reversing the fitting enables the sensor to be fastened onto the end of a pipe for immersion mounting.

A longer version of the sensor can be installed into a 316 stainless steel ball valve assembly to insert/retract the sensor without stopping the process flow. Maximum insertion depth is 178 mm (7 in.).

Examples of common sensor installations are shown in Figure 13: "Sensor Installation Examples" and dimension drawings are shown in Figure 1: "Compression-style Sensor, 0.5-in. Diameter" on page 8 through Figure 7: "Boiler/Condensate Sensor" on page 10. Refer to the instructions supplied with the mounting hardware for installation specifics.

Figure 13: Sensor Installation Examples



1.	Insertion mounting	**5.**	End of pipe immersion
2.	Insertion mounting	**6.**	Non-metallic sensor, end of pipe immersion
3.	Non-metallic sensor, insertion mounting	**7.**	Sanitary (CIP) flange mounting
4.	Boiler wall insertion mounting	**8.**	Ball valve insertion for compression-style sensor with extended sensor body

Section 4 Operation

4.1 Using an sc Controller

Before using the sensor in combination with an sc controller make yourself familiar with the operating mode of the controller. Refer to the controller user manual and learn how to use and navigate the menu functions.

4.2 Sensor Setup

When a sensor is initially installed, the serial number of the sensor will be displayed as the sensor name. To change the sensor name refer to the following instructions:

1. Select the Main Menu.
2. From the Main Menu, select SENSOR SETUP and confirm.
3. Select the appropriate sensor if more than one sensor is attached and confirm.
4. Select CONFIGURE and confirm.
5. Select EDIT NAME and edit the name. Confirm or cancel to return to the Sensor Setup menu.

4.3 Sensor Data Logging

The sc controller provides one data log and one event log for each sensor. The data log stores the measurement data at selected intervals. The event log stores a variety of events that occur on the devices such as configuration changes, alarms, warning conditions, etc. The data log and the event log can be read out in a CSV format. For downloading the logs please refer to the controller user manual.

4.4 SENSOR STATUS Menu

SELECT SENSOR	
ERROR LIST	See 6.1 "Error Codes" on page 25.
WARNING LIST	See 6.2 "Warnings" on page 25.

4.5 SENSOR SETUP Menu

SELECT SENSOR (if more than one sensor is attached)	
CALIBRATE	
ZERO	Perform a zero cal to remove sensor offset (4.6.1 "Zero Cal" on page 19).
1 POINT SAMPLE	Perform a single point calibration (4.6.2 "One Point Sample Calibration" on page 20).
TEMP ADJUST	Displays the measured temperature and allows the user to edit the displayed temperature by ± 5 °C.
DEFAULT SETUP	Return the instrument to the default calibration settings.

4.5 SENSOR SETUP Menu

SELECT SENSOR (if more than one sensor is attached)	
CONFIGURE	
EDIT_NAME	Enter a 10-digit name in any combination of symbols and alpha or numeric characters.
SELECT MEASURE	Choose from Conductivity, Resistivity, TDS, or Salinity. Default: Conductivity
MEAS UNITS	Choose from the displayed units (dependent on the parameter selected in the Set Parameter menu)
TEMP UNITS	Select Celsius or Fahrenheit. Default: Celsius
DISPLAY FORMAT	Choose from the presented options to set the display resolution.
FILTER	Average the measurement over time by entering a number between 0–60. Default is 0.
LOG SETUP	Choose from Sensor Interval or Temp Interval. If the interval is enabled, choose from the displayed options to specify the frequency to log the sensor or temperature reading. Default is Disabled.
CONFIG TDS This menu appears only if the selected parameter is TDS.	This menu appears only if the selected parameter is TDS. Set TDS factor. Default is 0.49 ppm/µS.
CELL CONSTANT	Choose Select Cell K to choose a nominal cell constant value from the displayed options that is close to the “K” value provided with the sensor. Then choose Set Cell K to enter the specific “K” value supplied with the sensor. Entering the “K” value eliminates the need for calibration until the sensor is replaced and sets the analyzer measurement range to correspond to the specified cell constant.
T–COMPENSATION	The factory default for temperature compensation is linear with a 2.00% per °C slope and a 25 °C reference temperature. The default settings are appropriate for most aqueous solutions. To enter different slope and reference temperature values for an uncommon solution, access the menu options described below. LINEAR: Recommended for most applications. Confirm to change the slope or reference temperature. AMMONIA: Not available for TDS. Contact Technical Support for application specific information and assistance. NATURAL WATER: Unavailable for TDS. Contact Technical Support for application specific information and assistance. USER TABLE: Use to configure a temperature compensation table by entering up to 10 x-axis parameters and 10 y-axis parameters. Contact Technical Consulting Services for additional information and assistance.
TEMP ELEMENT	Select the temperature element type (100PT, 1000PT (default), or manual) then choose Select Factor to enter the specific “T” Factor supplied with the sensor.
AC FREQUENCY	Choose 50 or 60 Hz depending on the power line frequency for optimal noise rejection. Default is 60 Hz.
DEFAULT SETUP	Reset the configure settings to the factory defaults.

4.5 SENSOR SETUP Menu

SELECT SENSOR (if more than one sensor is attached)	
DIAG/TEST	
PROBE INFO	Display the probe device driver version number, software version number, or probe 12-digit serial number using this menu.
SIGNALS	Display the conductivity A/D counts or the temperature output in Ohms
CAL DATA	Display the CELL K: 1.00000 (current cell constant), TEMP ADJ: current temperature offset correction, ZERO 1: Zero counts for gain 1, ZERO 2: Zero counts for gain 2, ZERO 3: Zero counts for gain 3

4.6 Calibration

Each contacting conductivity sensor has a unique zero point and offset. Always zero the sensor when calibrating it for the first time. Zeroing provides the best possible measurement accuracy and eliminates discrepancies between sensor measurements on two different channels. Zeroing should always be followed by a calibration.

4.6.1 Zero Cal

Zero the sensor if it is being calibrated for the first time. Make sure the sensor is dry before zeroing.

1. Select the Main Menu.
2. From the Main Menu, select SENSOR SETUP and confirm.
3. Select the appropriate sensor if more than one sensor is attached and confirm.
4. Select CALIBRATE and confirm.
5. Select ZERO and confirm.
6. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.
7. Move the sensor to air and confirm to continue.
8. The zero calibration procedure will begin and “WAIT TO STABILIZE” will be displayed.
9. Confirm, when the current value and temperature will be displayed.
10. Return the sensor to the process.

4.6.2 One Point Sample Calibration

The wet calibration requires that the sensor be immersed into a properly prepared conductivity reference solution or if installed in the process sample, the process value must be determined by laboratory analysis or comparison reading.

Remove the probe from the process and clean it. Obtain a sample solution with a known value and proceed as follows:

1. Select the Main Menu.
2. From the Main Menu, select SENSOR SETUP and confirm.
3. Select the appropriate sensor if more than one sensor is attached and confirm.
4. Select CALIBRATE and confirm.
5. Select ZERO and confirm.
6. Select 1 POINT SAMPLE and confirm.
7. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.
8. Move the sensor to the sample and confirm to continue.
9. Confirm when stable.
10. Edit the value and temperature using the keypad and confirm.
11. Return the sensor to the process.

4.6.3 Concurrent Calibration of Two Sensors

1. Begin a calibration on the first sensor and continue until “WAIT TO STABILIZE” is displayed.
2. Select Leave and confirm.

The display will return to the Main Measurement screen and the reading for both sensors will be flashing.

3. Begin the calibration for the second sensor and continue until “WAIT TO STABILIZE” is displayed.
4. Select LEAVE.

The display will return to the Main Measurement screen and the reading for both sensors will be flashing. The calibration for both sensors are now running in the background.

5. To return to the calibration of either sensor, select the Main Menu
6. Select SENSOR SETUP and confirm.
7. Select the appropriate sensor and confirm.
8. The calibration in progress will be displayed. Continue with the calibration.

4.6.3.1 Preparing Conductivity Reference Solutions

Use Table 6: "Conductivity Reference Solutions" on page 21 to prepare a conductivity reference solution with a value between 200 and 100,000 µS/cm. The value prepared should be near the typical measured process value for best accuracy. Add the listed grams of pure, dried NaCl to one liter of high-purity, deionized, CO_2-free water at 25 °C to obtain the stated conductivity.

Table 6: Conductivity Reference Solutions

Desired Solution Value			Grams NaCl to be added
µS/cm	mS/cm	ppm (NaCl)[1]	
100	0.10	50	0.05
200	0.20	100	0.10
500	0.50	250	0.25
1000	1.00	500	0.50
2000	2.00	1010	1.01
3000	3.00	1530	1.53
4000	4.00	2060	2.06
5000	5.00	2610	2.61
8000	8.00	4340	4.34
10000	10.00	5560	5.56
20000	20.00	11590	11.59

[1] When using the ppm measuring scale for compounds other than NaCl, refer to the appropriate chemistry handbook for reference solution for formulation.

4.7 Adjusting the Temperature

View or change the temperature using the steps below.

1. Select the Main Menu.
2. From the Main Menu, select SENSOR SETUP and confirm.
3. Select the appropriate sensor if more than one sensor is attached and confirm.
4. Select DIAG/TEST and confirm.
5. Select TEMP ADJUST and confirm.

The temperature will be displayed.

6. Edit the temperature and confirm.

Section 5 Maintenance

DANGER
Only qualified personnel should conduct the tasks described in this section of the manual.

5.1 Maintenance Schedule

Maintenance Task	90 days	Annually
Clean the sensor[1]	**x**	
Calibrate Sensor (if required by regulatory agency)	**Per the schedule mandated by your regulatory agency.**	

[1] Cleaning frequency is application dependent. More or less frequent cleaning will be appropriate in some applications.

5.2 Cleaning the Sensor

CAUTION
Before cleaning with acid, determine if any hazardous reaction products could form. (For example, a sensor used in a cyanide bath should not be put directly into a strong acid for cleaning because poisonous cyanide gas could be produced.) Acids are hazardous. Wear appropriate eye protection and clothing in accordance with Material Safety Data Sheet recommendations.

Keep the sensor clean to maintain measurement accuracy. The time between cleaning (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience.

1. Clean the exterior of the sensor with a stream of water. If debris remains, wipe with a soft, wet cloth.

2. Remove most contaminate buildup by carefully wiping the inner electrode rod, and the concentric outer electrode tube (inner and outer surfaces) with a soft clean cloth. Then rinse the sensor with clean, warm water.

3. Prepare a mild soap solution using warm water and dishwashing detergent or similar.

4. Soak the sensor for 2 to 3 minutes in the soap solution.

5. Use a soft brush, cotton swab, or pipe cleaner to scrub the entire measuring end of the sensor, thoroughly cleaning the electrode surfaces.

6. If detergent solution cleaning cannot remove surface deposits, use muriatic acid (or another dilute acid) to dissolve the deposits. Soak the sensor in dilute acid **no more than 5 minutes**.

Note: *The acid should be as dilute as possible, but yet strong enough to clean. Experience will help determine which acid to use and how dilute it can be. Some stubborn coatings may require a different cleaning agent. For assistance in these difficult cases, contact Technical Consulting Services.*

7. Rinse the sensor with clean, warm water and then place the sensor back into the mild soap solution for 2 to 3 minutes to neutralize any remaining acid.

8. Rinse the sensor in clean, warm water.

9. Calibrate the analyzer using the procedure in the analyzer instruction manual. If calibration cannot be attained, check the sensor using the procedure in the troubleshooting section.

Section 6 Troubleshooting

6.1 Error Codes

When a sensor is experiencing an error condition, the sensor reading on the measurement screen will flash and all relays and analog outputs associated with this sensor will be held. The following conditions will cause the sensor reading to flash:

- Sensor calibration
- Relay timer washing cycle
- Loss of communication

Select the SENSOR STATUS menu and confirm. Select ERRORS and confirm to determine the cause of the error. Errors are defined in Table 7: "Error Codes".

Table 7: Error Codes

Displayed Error	Definition	Resolution
ADC FAIL	ADC reading bad	Contact Customer Service
SENSOR FAIL	Sensor ADC reading bad	Contact Customer Service
FLASH FAIL	Failed operation on Flash Memory	Contact Customer Service

6.2 Warnings

A Sensor Warning will leave all menus, relays, and outputs functioning normally, but will cause a warning icon to flash on the right side of the display. Select WARNINGS and confirm to determine the cause of the warning.

A warning may be used to trigger a relay and users can set warning levels to define the severity of the warning. Warnings are defined in Table 8: "Warning Codes".

Table 8: Warning Codes

Displayed Warning	Definition	Resolution
TEMP < –20 °C	The sensed temperature is below –20 °C (–4 °F).	Temperature out of Range: Increase process temperature or discontinue use until the process temperature is above –20 °C (–4 °F). Bad Temperature Sensor: Check temperature of the sample stream with an independent temperature measuring device. If the temperature is within range, contact the Technical Consulting Services Department.
TEMP > 200 °C	The sensed temperature is above 200 °C (392 °F).	Temperature out of Range: Decrease process temperature or discontinue use until the process temperature is below 200 °C (392 °F). Bad Temperature Sensor: Check temperature of the sample stream with an independent temperature measuring device. If the temperature is within range, contact the Technical Consulting Services Department.

6.3 General Troubleshooting

Problem	Resolution
Reading is unstable	Clean and calibrate sensor

6.4 Checking Sensor Operation

6.4.1 Sensors without the Integral Junction Box

Use the following troubleshooting steps for sensors without the integrated integral junction box (Model: D3422, D3433, D3444, and D3455).

1. Disconnect the sensor from the analyzer or junction box.
2. Clean the sensor using the procedure in 5.2 "Cleaning the Sensor" on page 23.
3. Using an ohmmeter, check all of the measurement point resistance readings shown in Table 9: " Sensor Operations (Resistance) Checks for Models 3422 and 3455", Table 10: " Sensor Operations (Resistance) Checks for Models 3433", and Table 11: " Sensor Operations (Resistance) Checks for Models 3422 and 3455". Make sure that the ohmmeter is set to its highest range for all infinite (open circuit) resistance readings.
4. If you cannot get the required readings for one or more of the resistance check or if the sensor still does not operate when the resistance checks are okay, contact Technical Support for more troubleshooting options.

Table 9: Sensor Operations (Resistance) Checks for Models 3422 and 3455

Measurement Points	Correct Resistance Readings
Between blue and white wires	1089–1106 ohms at 23–27 °C
Between red wire and sensor body	Less than 5 ohms
Between black wire and inner electrode	Less than 5 ohms
Between black and red wires	Infinite (open circuit)
Between black and white wires	Infinite (open circuit)
Between red and white wires	Infinite (open circuit)
Between red and inner shield wires	Infinite (open circuit)
Between black and inner shield wires	Infinite (open circuit)
Between white and inner shield wires	Infinite (open circuit)
Between outer and inner shield wires	Infinite (open circuit)

Table 10: Sensor Operations (Resistance) Checks for Models 3433

Measurement Points	Correct Resistance Readings
Between blue and white wires	1089–1106 ohms at 23–27 °C
Between black and red wires	Infinite (open circuit)
Between black and white wires	Infinite (open circuit)
Between red and white wires	Infinite (open circuit)
Between red and inner shield wires	Infinite (open circuit)
Between black and inner shield wires	Infinite (open circuit)
Between white and inner shield wires	Infinite (open circuit)
Between outer and inner shield wires	Infinite (open circuit)

Table 11: Sensor Operations (Resistance) Checks for Models 3422 and 3455

Measurement Points	Correct Resistance Readings
Between blue and white wires	1089–1106 ohms at 23–27 °C
Between red wire and sensor body	Less than 5 ohms
Between black wire and inner electrode	Less than 5 ohms
Between black and red wires	Infinite (open circuit)
Between black and white wires	Infinite (open circuit)
Between red and white wires	Infinite (open circuit)
Between red and outer shield wires	Infinite (open circuit)
Between black and outer shield wires	Infinite (open circuit)
Between white and outer shield wires	Infinite (open circuit)
Between outer and outer shield wires	Infinite (open circuit)

6.4.2 Analog or External Digital Gateway Sensors

1. Disconnect the sensor from the analyzer or junction box.
2. Clean the sensor using the procedure in "Cleaning the Sensor" on page 23.
3. Obtain a known standard (NIST-traceable is preferred for many applications) and take a measurement.
4. Reconnect the sensor to the controller or junction box.
5. If the resulting measurement is out of specification (different from the value stated on the label ± the stated standard error), contact Technical Consulting Services.

6.4.3 Sensor Linearity Check

1. Obtain two standards, one close to the maximum for the range of interest (high standard) and another with a value half way between the high standard and 0 (mid-range standard).

2. Prepare 50 mL high and mid-range standards in 100 mL beakers and add 50 mL of deionized water to another 100 mL beaker.

3. Insert the sensor into the beaker containing deionized water. Record the stable reading.

4. Remove the sensor from the deionized water and shake it gently to remove excess water.

5. Place the sensor into the high standard and record the stable reading.

6. Remove the sensor from the high standard, rinse with deionized water and shake gently to remove excess water.

7. Place the sensor in the mid-range standard and record the stable reading.

The mid-range standard reading should fall half way between the reading obtained for the deionized water and the high standard. If it does not, the sensor may be defective. Call Customer Service for assistance.

Section 7 Replacement Parts

7.1 Replacement Items and Accessories

Item	QTY	Catalog Number
Cable, sensor extension, 0,35 m	each	LZX847
Cable, sensor extension, 5 m	each	LZX848
Cable, sensor extension, 10 m	each	LZX849
Cable, sensor extension, 15 m	each	LZX850
Cable, sensor extension, 20 m	each	LZX851
Cable, sensor extension, 30 m	each	LZX852
Cable, sensor extension, 50 m	each	LZX853
Load termination box, required for total cable lengths greater than 100m (328ft)	each	58670-00
Conductivity Reference Solution, 100–1000 µs/cm	1L	25M3A2000-119
Conductivity Reference Solution, 100–1000 µs/cm	1L	25M3A2050-119
Conductivity Reference Solution, 2000–100000 µs/cm	1L	25M3A2100-119
Conductivity Reference Solution, 200000–300000 µs/cm	1L	25M3A2200-119
Connector Safety Lock	each	6139900
Digital termination box	each	5867000
user manual, sc100 Controller, English	each	DOC023.52.00032
user manual, sc1000 Controller, English	each	DOC023.52.03260
user manual, Conductivity System, English	each	DOC023.52.03249
Mount Hardware, Insertion (Ball Valve), 3422 series, SS, 0.05 cell constant	each	MH113M2C
Mount Hardware, Insertion (Ball Valve), 3422 series, SS for all other cell constants	each	MH114M2C
Mounting hardware kit, pipe	each	5794400
Mounting hardware kit, ball float	each	5794300
Plug, sealing, conduit opening	each	5868700
Strain relief, Heyco	each	16664

Section 8 Warranty, liability and complaints

HACH LANGE GmbH warrants that the product supplied is free of material and manufacturing defects and undertakes the obligation to repair or replace any defective parts at zero cost.

The warranty period for instruments is 24 months. If a service contract is taken out within 6 months of purchase, the warranty period is extended to 60 months.

With the exclusion of the further claims, the supplier is liable for defects including the lack of assured properties as follows: all those parts that can be demonstrated to have become unusable or that can only be used with significant limitations due to a situation present prior to the transfer of risk, in particular due to incorrect design, poor materials or inadequate finish will be improved or replaced, at the supplier's discretion. The identification of such defects must be notified to the supplier in writing without delay, however at the latest 7 days after the identification of the fault. If the customer fails to notify the supplier, the product is considered approved despite the defect. Further liability for any direct or indirect damages is not accepted.

If instrument-specific maintenance and servicing work defined by the supplier is to be performed within the warranty period by the customer (maintenance) or by the supplier (servicing) and these requirements are not met, claims for damages due to the failure to comply with the requirements are rendered void.

Any further claims, in particular claims for consequential damages cannot be made.

Consumables and damage caused by improper handling, poor installation or incorrect use are excluded from this clause.

HACH LANGE GmbH process instruments are of proven reliability in many applications and are therefore often used in automatic control loops to provide the most economical possible operation of the related process.

To avoid or limit consequential damage, it is therefore recommended to design the control loop such that a malfunction in an instrument results in an automatic change over to the backup control system; this is the safest operating state for the environment and the process.

8.1 Compliance Information

Hach Co. certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The **Model sc100 Controller/sc1000 Controller with Contacting Conductivity Probe** has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

UL 61010A-1 (ETL Listing # 65454)
CSA C22.2 No. 1010.1 (ETLc Certification # 65454)
Certified by Hach Co. to EN 61010-1 Amds. 1 & 2 (IEC1010-1) per 73/23/EEC, supporting test records by Intertek Testing Services.

Immunity

This equipment was tested for industrial level EMC per:

EN 61326 (EMC Requirements for Electrical Equipment for Measurement, Control and Laboratory Use) **per 89/336/EEC EMC:** Supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:

IEC 1000-4-2:1995 (EN 61000-4-2:1995) Electrostatic Discharge Immunity (Criteria B)
IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electromagnetic Field Immunity (Criteria A)
IEC 1000-4-4:1995 (EN 61000-4-4:1995) Electrical Fast Transients/Burst (Criteria B)
IEC 1000-4-5:1995 (EN 61000-4-5:1995) Surge (Criteria B)
IEC 1000-4-6:1996 (EN 61000-4-6:1996) Conducted Disturbances Induced by RF Fields (Criteria A)
IEC 1000-4-11:1994 (EN 61000-4-11:1994) Voltage Dip/Short Interruptions (Criteria B)

Additional Immunity Standard/s include:

ENV 50204:1996 Radiated Electromagnetic Field from Digital Telephones (Criteria A)

Emissions

This equipment was tested for Radio Frequency Emissions as follows:

Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use—EMC requirements) Class “A” emission limits. Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

Standards include:

EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment
EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

Additional Emissions Standard/s include:

EN 55011 (CISPR 11), Class “A” emission limits

Appendix A Additional information for series 34xx sensors

A.1 Additional information for series 3410 ... 3412 sensors

This additional information is only applicable for sensors of types

- 3410,
- 3411 and
- 3412.

For all other information necessary for the operation of the sensors, please see the operating instructions for the analysis systems installed.

A.1.1 Technical data for the 43410 ... 3412 sensors

Series	**3410/3411**	**3412**
Maximum sample temperature	125 °C at 10 bar	
Maximum sample pressure	10 bar at 125 °C	
Cell constant K * 0.01 cm $^{-1}$ 0.1 cm $^{-1}$ 1 cm $^{-1}$	 0 µS/cm ... 20 µS/cm 0 µS/cm ... 200 µS/cm 0 µS/cm ... 2000 µS/cm	
* The cell constant has a precision of ± 2 %.		
Materials		
Top part of housing Inner electrode Outer electrode Isolator Connector	Black polyester SST316L, stainless SST316L, stainless PES Glass-fibre reinforced polyester / IP 65	Black polyester Graphite Graphite PES Glass-fibre reinforced polyester / IP 65
Connection thread	External thread 3/4” NPT	

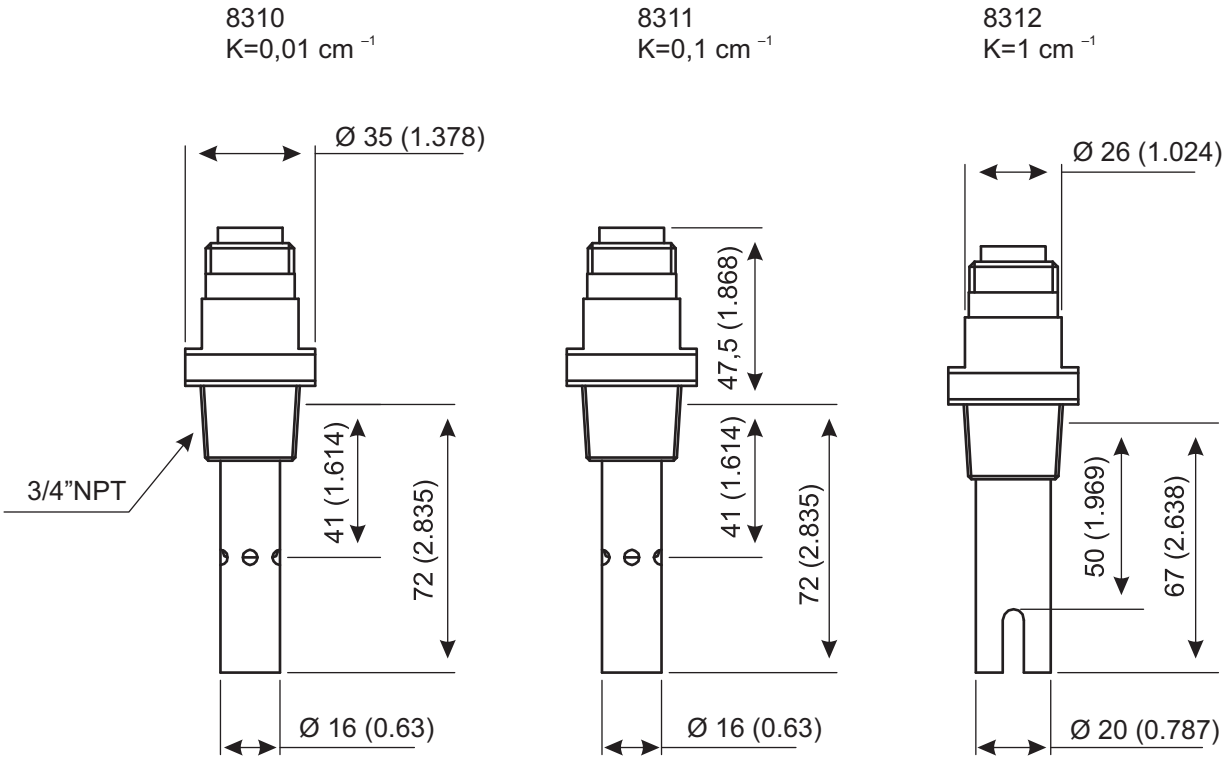
A.1.2 Installation of the sensors

For the necessary information please see the operating instructions for the gateway.

A.1.3 Installation of the sensor in the flow of sample

For the necessary information please see the operating instructions for the gateway.

Figure 14: Dimensions of the 8310 ... 8312 sensors



A.2 Additional information for series 3415 ... 3417 sensors

This additional information is only applicable for sensors of types

- 3415,
- 3416 and
- 3417.

For all other information necessary for the operation of the sensors, please see the operating instructions for the analysis systems installed.

A.2.1 Technical data for the 3415 ... 3417 sensors

Series	**3415/3416**	**3417**
Maximum sample temperature	150 °C (at 25 bar)	
Maximum sample pressure	25 bar (at 150 °C)	
Cell constant K * 0.01 cm^{-1} 0.1 cm^{-1} 1 cm^{-1}	 0 µS/cm ... 20 µS/cm 0 µS/cm ... 200 µS/cm 0 µS/cm ... 2000 µS/cm	
* The cell constant has a precision of ± 2 %.		
Materials		
Body (top part) Inner electrode * Outer electrode * Isolator * O-rings * Connector	Stainless steel 316 L Stainless steel 316 L Stainless steel 316 L PES VITON Glass-fibre reinforced polyester / IP 65	Stainless steel 316 L Graphite Graphite PES VITON Glass-fibre reinforced polyester / IP 65
* In contact with the liquid medium VITON is a registered trademark of DUPONT DE NEMOURS		
Connection thread	External thread 3/4” NPT	

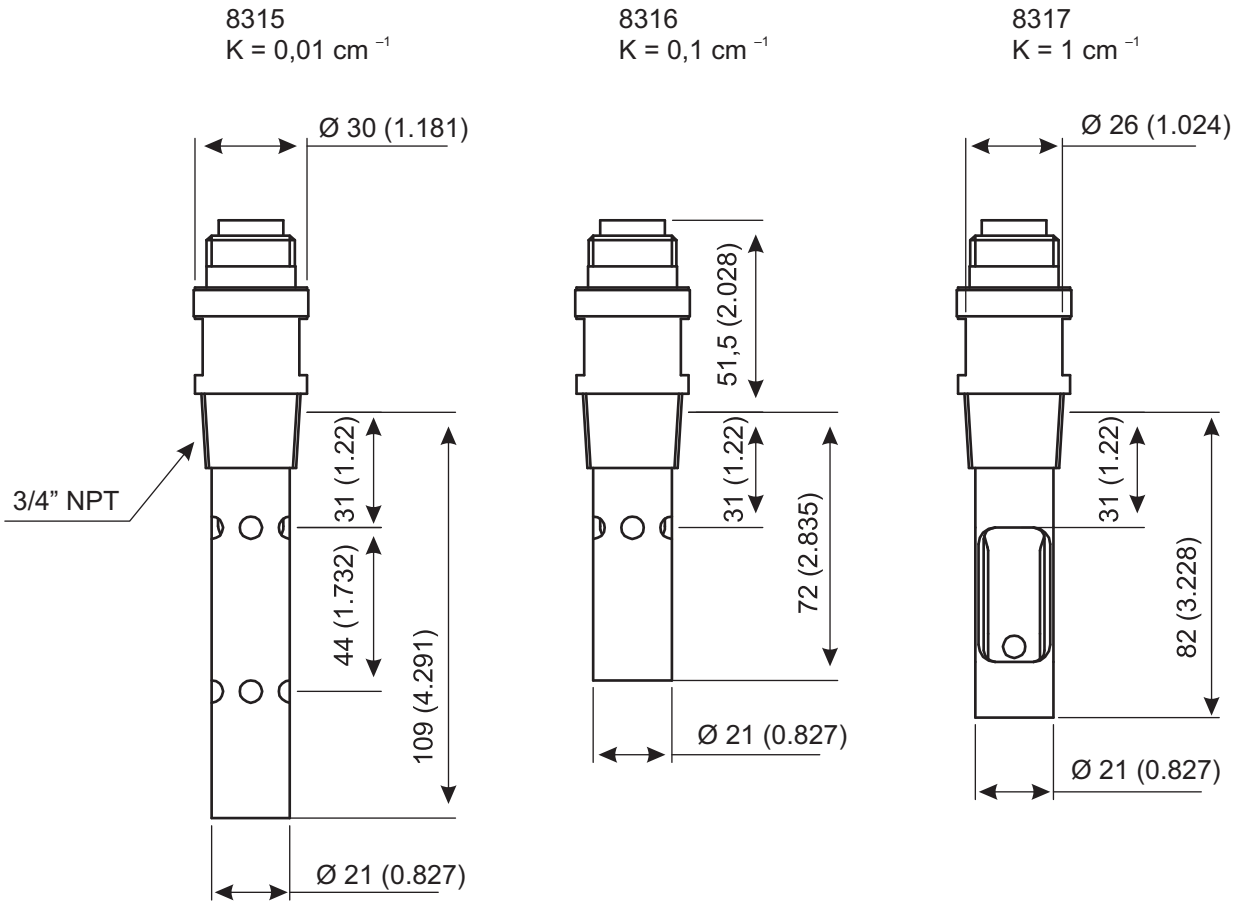
A.2.2 Installation of the sensors

For the necessary information please see the operating instructions for the gateway.

A.2.3 Installation of the sensor in the flow of sample

For the necessary information please see the operating instructions for the gateway.

Figure 15: Dimensions of the 8315 ... 8317



A.3 Additional information for series 3494 sensors

This additional information is only applicable for sensors of type 3494.

For all other information necessary for the operation of the sensors, please see the operating instructions for the analysis systems installed.

A.3.1 Technical data for the 3494 sensors

Series	**3494**
Maximum sample temperature	150 °C (at 10 bar)
Maximum sample pressure	25 bar (at 100 °C)
Cell constant K Temperature sensor	0.01 cm $^{-1}$, ± 2 % 0 µS/cm ...20 µS/cm, ±1 % ± 0.15 °C
Materials	
Body (top part) Inner electrode Outer electrode Isolator Sealing ring Connector	Stainless steel 316 L, (Ra < 0.4 µm) Stainless steel 316 L, (Ra < 0.4 µm) Stainless steel 316 L, (Ra < 0.4 µm) PEEK * (FDA approved) EPDM *(FDA approved) Glass-fibre reinforced polyester / IP 65
* In contact with the liquid medium	

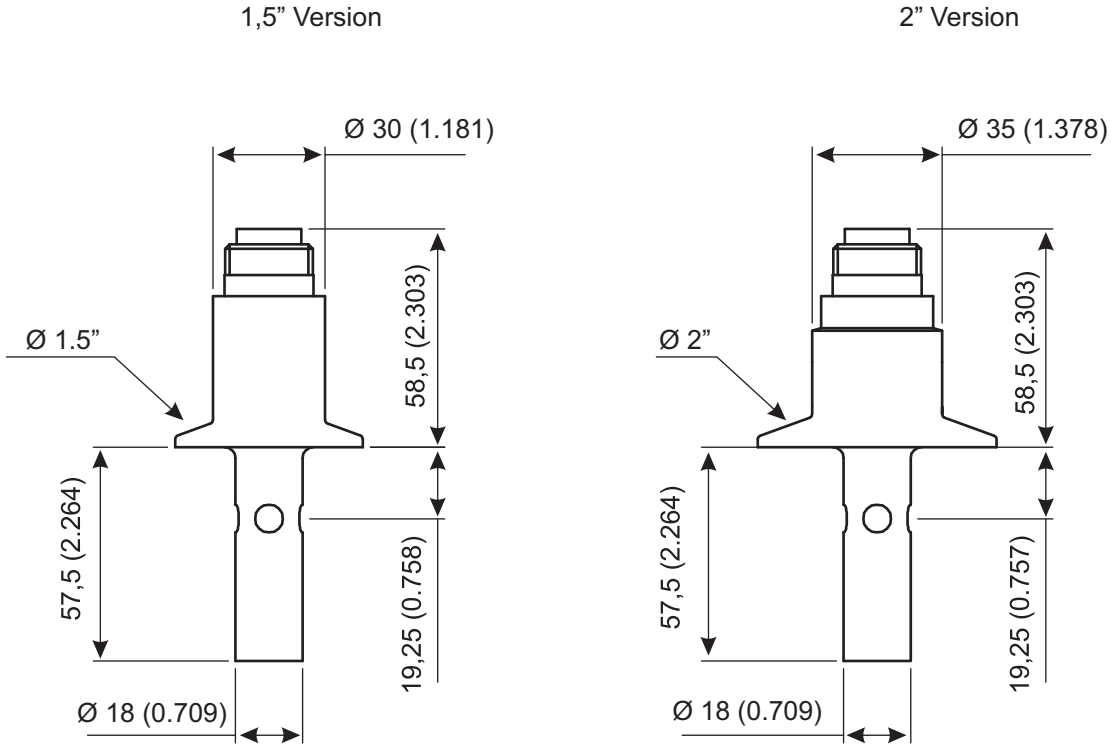
A.3.2 Installation of the sensors

For the necessary information please see the operating instructions for the gateway.

A.3.3 Installation of the sensor in the flow of sample

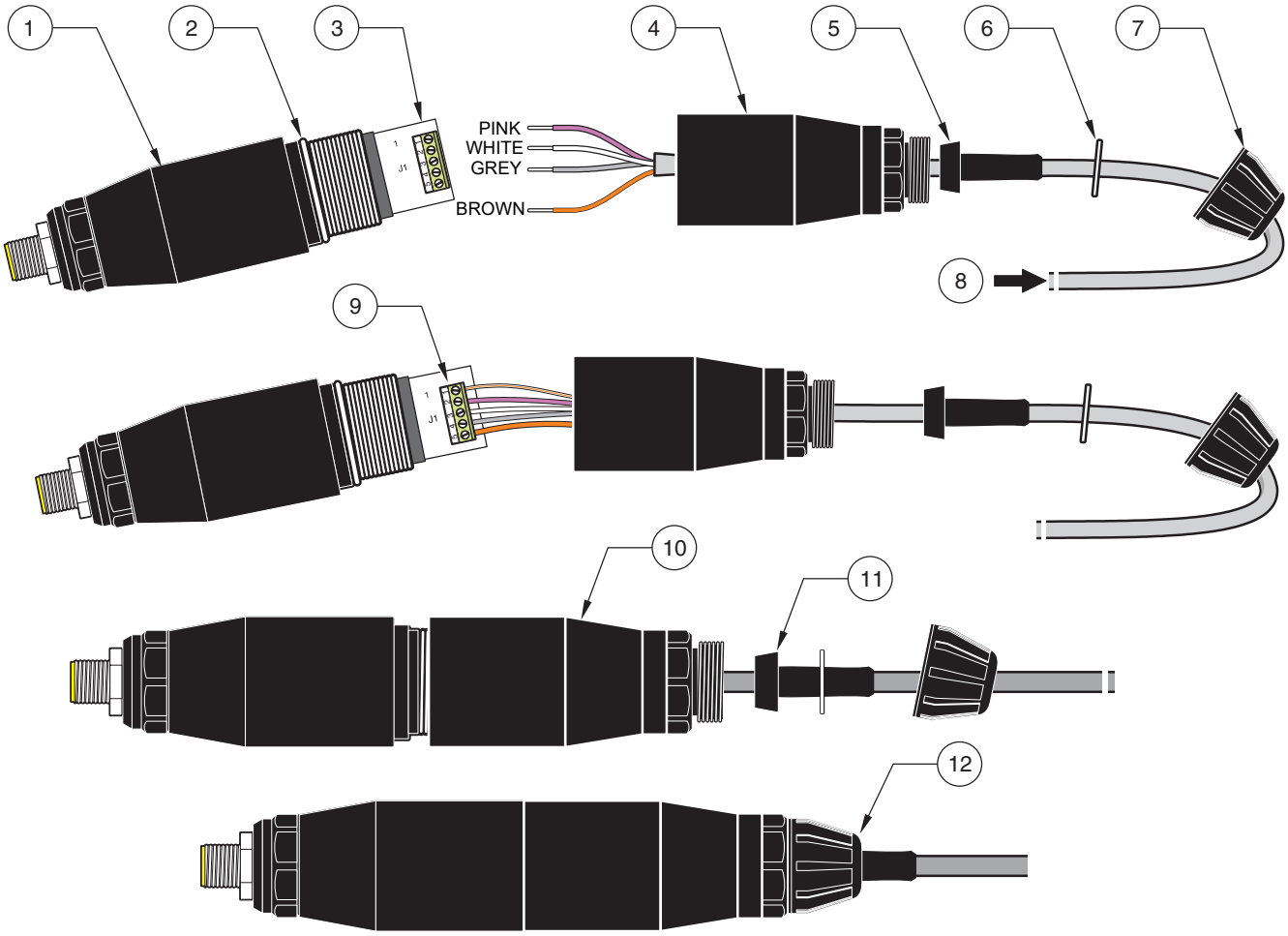
For the necessary information please see the operating instructions for the gateway.

Figure 16: Dimensions of the 8394 sensors



A.4 Digital gateway

Figure 17: Connection digital gateway / 83xx



1. Front of housing	**7.** Union nut
2. O-ring	**8.** From the sensor
3. Sensor wire connections	**9.** Cable assignment as per Table 12: "Cable assignment, digital gateway / 83xx" on page 42.
4. Rear of housing	**10.** Bolt together the housing for the digital gateway.
5. Cable sleeve	**11.** Slide back the cable sleeve and the washer.
6. Washer	**12.** Tighten the union nut.

A.5 Accessories

A.5.1 Technical data for the bypass chambers

Bypass chamber	for series 831x sensors	for series 8394 sensors
Maximum sample temperature	150 °C at 25 bar	150 °C at 10 bar
Maximum sample pressure	10 bar at 125 °C	25 bar at 100 °C
Connection thread	Bypass: internal thread 1/4” NPT Sensor: internal thread 3/4" NPT	Bypass: internal thread 1/4" NPT
Material	SST316L, stainless	

Figure 18: Bypass chambers for series 8394 sensors

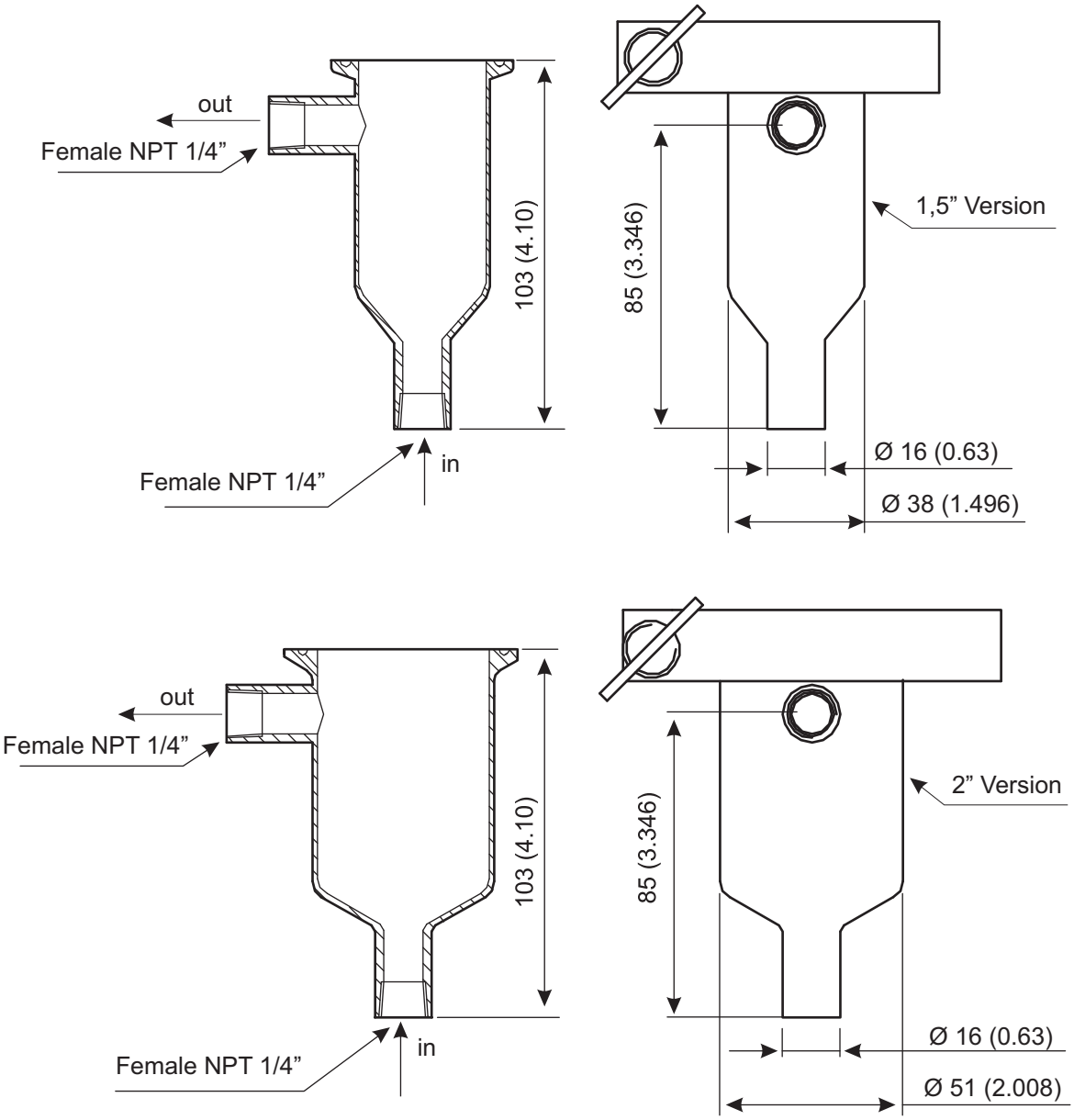


Figure 19: Bypass chambers for series 831x sensors

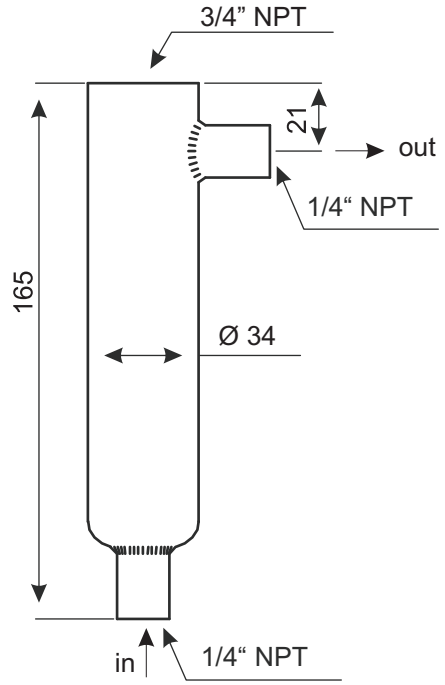


Figure 20: Welded fittings for series 8394 sensors

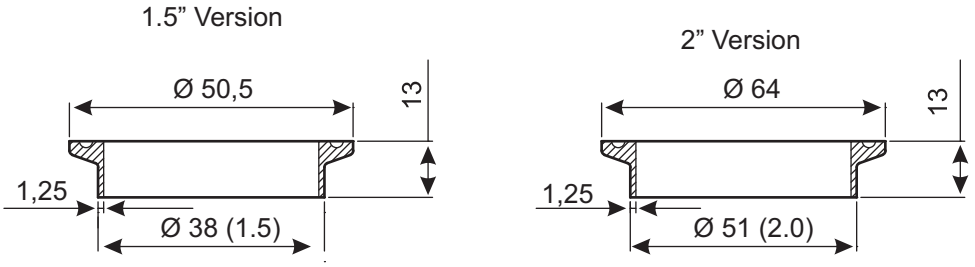


Figure 21: Gateway

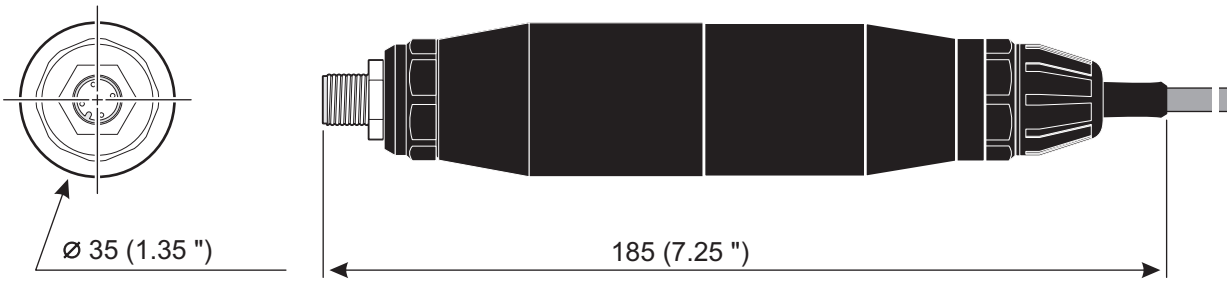


Figure 22: Connection cable sensor / gateway

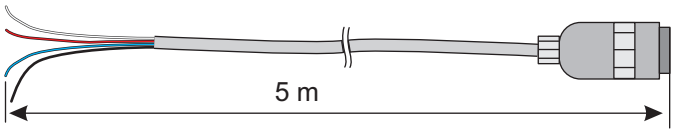


Table 12: Cable assignment, digital gateway / 83xx

Sensor (cable colour)	Sensor signal	Controller connection sc100 digital gateway
–	–	J1-1
Pink	Outer electrode	J1-2
White	Temp –	J1-3
Grey	Temp +	J1-4
Brown	Inner electrode	J1-5

A.6 Spare parts and accessories

Sensor 8310	Z08310=A=0000
Sensor 8311	Z08311=A=0000
Sensor 8312	Z08312=A=0000
Sensor 8315	Z08315=A=0000
Sensor 8316	Z08316=A=0000
Sensor 8317	Z08317=A=0000
Sensor 8394, 1.5 " clamp	Z08394=A=1500
Sensor 8394, 1.5 " clamp, with material and surface finish certificates	Z08394=A=1511
Sensor 8394, 2 " clamp	Z08394=A=2000
Sensor 8394, 2 " clamp, with material and surface finish certificates	Z08394=A=2011
Connection cable sensor-gateway, 5 m/16 ft	Z08319=A=1115
Bypass chamber, stainless steel, for sensor 8310 ... 8317	Z08318=A=0001
Bypass chamber, stainless steel, for sensor 8394, 1.5 "	Z08394=A=8150
Bypass chamber, stainless steel, for sensor 8394, 2 "	Z08394=A=8200
Welded fitting, stainless steel, for sensor 8394, 1.5 "	Z08394=A=0380
Welded fitting, stainless steel, for sensor 8394, 2"	Z08394=A=0510

Appendix B Modbus Register Information

Table 13 Sensor Modbus Registers

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Tags	Conductivity	40001	Unsigned Integer	1	R/W	Sensor meas tag index
Tags	Temperature	40002	Unsigned Integer	1	R/W	Temperature tag index
Measurements	Conductivity	40003	Float	2	R	Sensor measurement
Measurements	Temperature	40005	Float	2	R	Temperature measurement
Settings	MeasMin	40007	Float	2	R	Minimum meas. value
Settings	MeasMax	40009	Float	2	R	Maximum meas. value
Settings	MeasFormat	40011	Unsigned Integer	2	R	Display format
Settings	MeasUnitsCond	40013	Unsigned Integer	1	R/W	Siemens units
Settings	MeasUnitsResist	40014	Unsigned Integer	1	R/W	Ohm units
Settings	MeasUnitsTDS	40015	Unsigned Integer	1	R/W	TDS units
Settings	MeasUnitsSalinity	40016	Unsigned Integer	1	R/W	Salinity units
Settings	TempUnits	40017	Unsigned Integer	1	R/W	Temperature units
Settings	Parameter	40018	Unsigned Integer	1	R/W	Selected primary parameter
Settings	DisplayFormat	40019	Unsigned Integer	1	R/W	User selected display format
Settings	Filter	40020	Unsigned Integer	1	R/W	Number of samples to average
Settings	TDSConfig	40021	Unsigned Integer	1	R/W	TDS configuration
Settings	TDS Factor	40022	Float	2	R/W	TDS multiplier
Settings	Cell Constant	40024	Float	2	R/W	Cell constant value
Settings	Cell Constant Min	40026	Float	2	R/W	Minimum cell constant value
Settings	Cell Constant Max	40028	Float	2	R/W	Maximum cell constant value
Settings	CellConstSel	40030	Unsigned Integer	1	R/W	Cell constant selection: 0.01, 0.05, 0.1, 0.5, 1.0, 5.0, 10.0
Settings	TCompSlope	40033	Float	2	R/W	Temp. comp. slope
Settings	TCompRefTemp	40035	Float	2	R/W	Temp. comp. ref. temp
Settings	TElementType	40041	Unsigned Integer	1	R/W	Temp. element: Manual, Pt100, Pt1000 = 0/1/2
Settings	TElementFactor	40042	Float	2	R/W	Temp. element offset
Settings	TElementManual	40048	Float	2	R/W	Temp. manual temperature
Settings	OutPutMode	40050	Unsigned Integer	1	R/W	Output mode during calibration: Active/Hold/Transfer = 0/1/2
Calibration	Cal Value	40052	Float	2	R	Calib. value
Settings	Sensor Name	40054	String	6	R/W	Name of sensor
Diagnostics	Driver Version	40060	String	8	R/W	Version of driver
Diagnostics	Serial Number	40068	String	6	R/W	Sensor serial number

Table 13 Sensor Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Tags	Function Code	40074	Unsigned Integer	1	R/W	Function code tag
Tags	Next State	40075	Unsigned Integer	1	R/W	Next state tag
Diagnostics	FactoryCalValue	40076	Float	2	R/W	Factory diagnostic
Diagnostics	FactoryCalCmd	40078	Unsigned Integer	1	R/W	Factory diagnostic
Diagnostics	Sensor Log Interval	40079	Unsigned Integer	1	R/W	Enable/disable sensor log interval
Diagnostics	Tempr Log Interval	40080	Unsigned Integer	1	R/W	Enable/disable temperature log interval
Diagnostics	Temp Counts	40081	Float	2	R	A/D counts for temperature
Diagnostics	Cond Counts	40083	Float	2	R	A/D counts for sensor
Diagnostics	Tohms	40085	Float	2	R	Calculated ohms of temp. sensor
Diagnostics	AutoRange	40087	Unsigned Integer	1	R/W	Autorange if set to 0
Diagnostics	Range	40088	Unsigned Integer	1	R/W	Current gain setting of sensor — 0/1/2
Diagnostics	Zero Counts 0	40089	Float	2	R	A/D counts for gain level 0
Diagnostics	Zero Counts 1	40091	Float	2	R	A/D counts for gain level 1
Diagnostics	Zero Counts 2	40093	Float	2	R	A/D counts for gain level 2
Settings	Freq Reject	40146	Unsigned Integer	1	R/W	Set 50/60 Hz rejection on A/D
Diagnostics	Driver Version	40147	Unsigned Integer	6	R	Device driver version
Diagnostics	Edit Temp	40153	Float	2	R/W	Edit temperature +/- 5 degrees celsius

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