Catalog Number DOC023.54.00051

9184sc Chlorine
9185sc Ozone and
9187sc Chlorine Dioxide Analyzer

USER MANUAL

February 2006, Edition 4

te/dk

Table of Contents

Section 1 Specifications

Specifications are subject to change without notice

General			
Mounting	Flat, vertical surface such as a wall, panel, stand, etc.		
Analyzer Dimensions	10.63 x 9.84 in. (270 x 250 mm)		
Analyzer Weight	6.5 kg (14.3 lb)		
Materials	Electrode: gold cathode/silver anode; probe body: PVC; measuring cell: acrylic		
Sample Requirements			
Sample Flow Rate to Analyzer	Flow rate should allow for 14 L/hr minimum		
Minimum Inlet Pressure to Instrument	0.1–2 bar (1.4–28 psi)		
Minimum Flow Rate	14 L/hr auto-regulated by flow thru cell		
Pressure Range	0.1–2 bar (1.4–28 psi) influent; flow cell pressure will be the atmospheric pressure		
Sample Temperature Range	+2–45 °C (35.6–113 °F)		
Temperature Compensation	Automatic over the sample Temperature Range		
Sample pH	4 to 8 (acidification unit available for >8 pH)		
Sample Inlet Tubing: at instrument	¼ in. OD		
Drain Fitting	½ in. ID (supplied)		
Application Sample	Clean water		
Electrical			
Power Consumption	12V, 1.5 Watts provided by sc100/sc1000		
Performance			
	9184sc	**9185sc**	**9187sc**
Measurement Range	0–20 ppm (0–20 mg/L) HOCl	0–2 ppm (0–2 mg/L) O_3	0–2 ppm (0–2 mg/L) ClO_2
Detection Limit	5 ppb (0.005 mg/L) HOCl	5 ppb (0.005 mg/L) O_3	10 ppb (0.01 mg/L) ClO_2
Accuracy	TFC—2% at pH < 7.5, 5% at pH 7.5 to 7.7, 10% at pH 7.7 to 8.0 HOCl—2% at pH < 8	3% or ±10 ppb O_3, whichever is greater	5% or ±10 ppb ClO_2, whichever is greater
Standard Deviation	0.7%	1.0%	1.5%
Interference	No interference from chloramines. Ozone and chlorine dioxide interfere with measurement.	No interference from chlorine, chloramines, hydrogen peroxide, bromine, or chlorine dioxide.	None
Response Time	90% <T=90 seconds		
Measurement Interval	Continuous		
Measurement Technology	Amperometric/Membrane (electrode, membrane, electrolyte)		
Calibration	Electrical zero or chemical zero with dechlorinated or deozoned water; calibration of the slope by comparison with a laboratory instrument; pH calibration (9184sc only) with Single or Two Point using standards or comparison with lab method with the process sample.		
Calibration Interval	2 months for typical application		
Maintenance			
Maintenance Interval, Measurement Cell	6 months for the membrane and electrolyte for typical operation (3 to 12 month range)		
Maintenance Interval, pH	1 to 1.5 years for typical operation		

Specifications

Environmental (sc Analyzer)	
Enclosure	IP66/NEMA 4X
Storage Temperature Range	–20 to 60 °C (–4 to 140 °F)
Operating Temperature Range	0 to 45 °C (32 to 113 °F)
Relative Humidity	10 to 90% non-condensing
Operating Humidity	0 to 90% non-condensing
Compliance	
The sc analyzer and sensor combination are: CE marked and declared by Hach Company to the applicable EU Safety and EMC Directives. Listed to UL61010A-1 by OSHA accredited 3rd party NRTL's. Certified CSA C22.2 No. 1010.1 by SCC accredited Test Laboratories.	

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.
	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.*
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists.
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.
	This symbol, when noted on the product, indicates that the marked item can be hot and should not be touched without care.
	This symbol, when noted on the product, indicates the presence of devices sensitive to Electro-Static Discharge and indicates that care must be taken to prevent damage to them.
	This symbol, when noted on the product, identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment.
	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).

2.2 General Sensor Information

DANGER
Although the sc100 controller is certified for Class 1, Division 2 Hazardous Locations, it is only certified when installed with sensors listed in Control Drawings 5860078. The sc100 controller and this sensor are NOT suitable for use in Class 1, Division 2 Hazardous Locations.

The system consists of a controller with an integrated display, and a sensor (Figure 2). The choice can be made to use this instrument with the specifications and processes of the 9184sc, 9185sc, or 9187sc sensor. This is determined by selecting the parameter during the initial sensor setup and the type of sensor being used. See section 4.1 on page 23.

2.3 Theory of Operation

Refer to the following Appendices.

- Appendix A 9184sc Theory of Operation on page 59
- Appendix B 9185sc Theory of Operation on page 61
- Appendix C 9187sc Theory of Operation on page 53

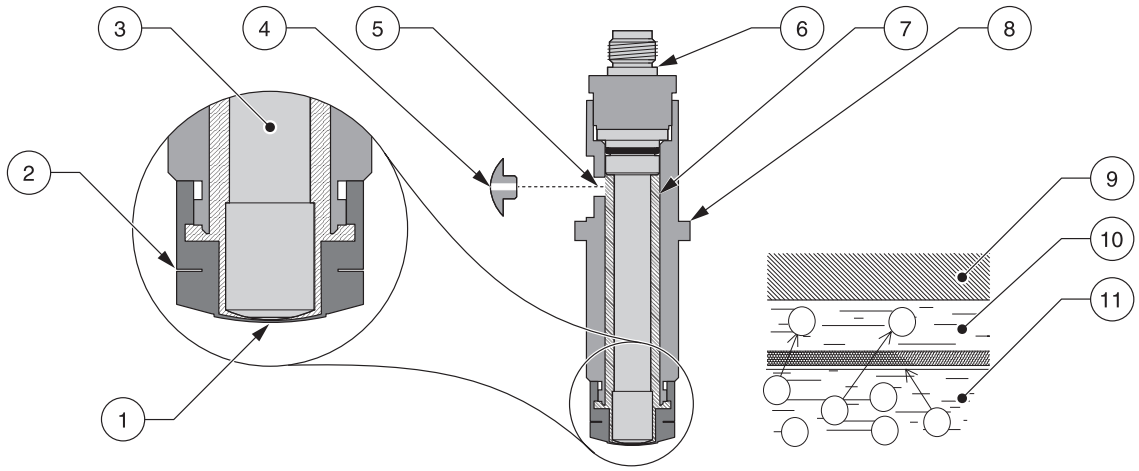


Figure 1 Sensor Cell Operation

1	Membrane	**7**	Electrolyte
2	Membrane Holder	**8**	Probe Body
3	Anode	**9**	Cathode
4	Electrolyte Filling Plug[1]	**10**	Membrane/Interface Sample
5	Electrolyte Filling Hole	**11**	Sample
6	Assembled Electrode		

[1] See Replacement Parts and Accessories on page 51.

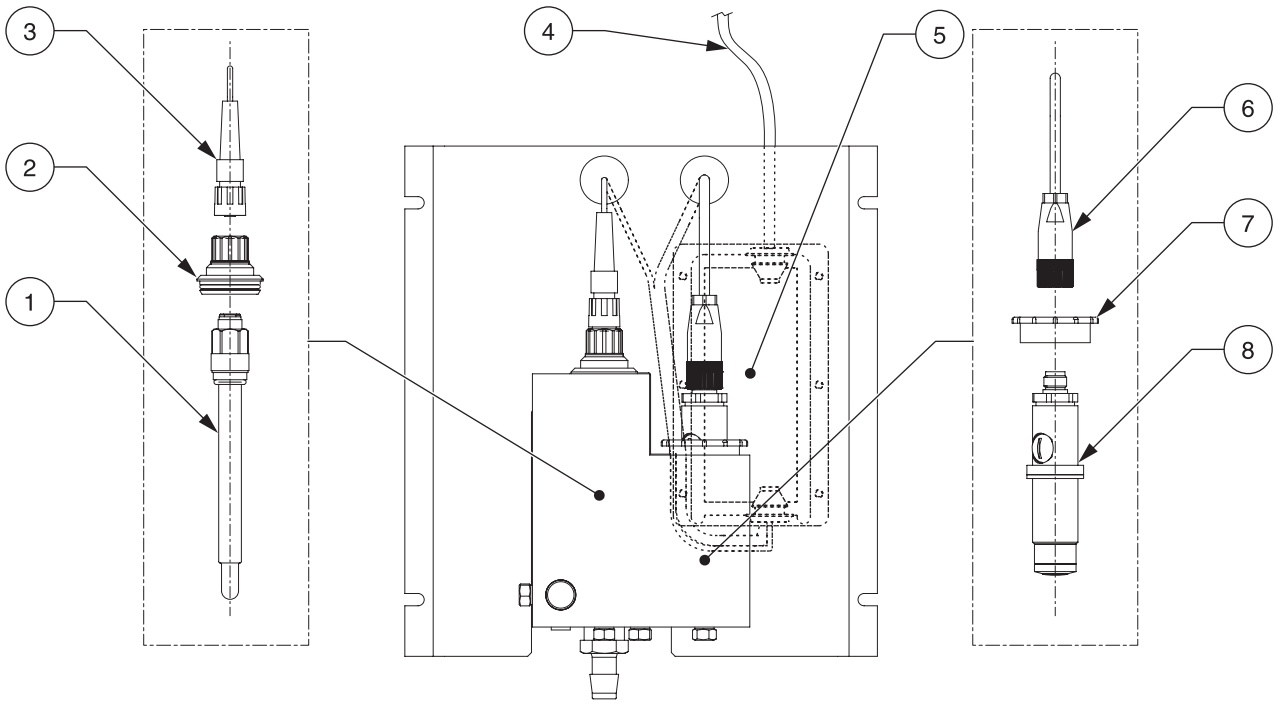


Figure 2 General Instrument Schematic[1]

1	pH Probe (9184sc only)	**5**	Gateway (behind Mounting Plate)
2	pH Cell Cap (9184sc only)	**6**	Connector
3	Connector	**7**	Cell Cap
4	Cable to Controller	**8**	Probe Body

[1] See Replacement Parts and Accessories on page 51

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

3.1 Mounting the Analyzer

The analyzer is designed to be mounted on a flat, vertical surface such as a wall, panel, stand, etc. The instrument must be level.

Locate the sensor as close to the sampling point as possible. The shorter the distance traveled by the sample, the faster the instrument can respond and indicate changes in sample concentration. The 6-inch clearance at the bottom of the instrument is not necessary if using the accessories. Refer to section 3.3 on page 13 for sample stream connection instructions.

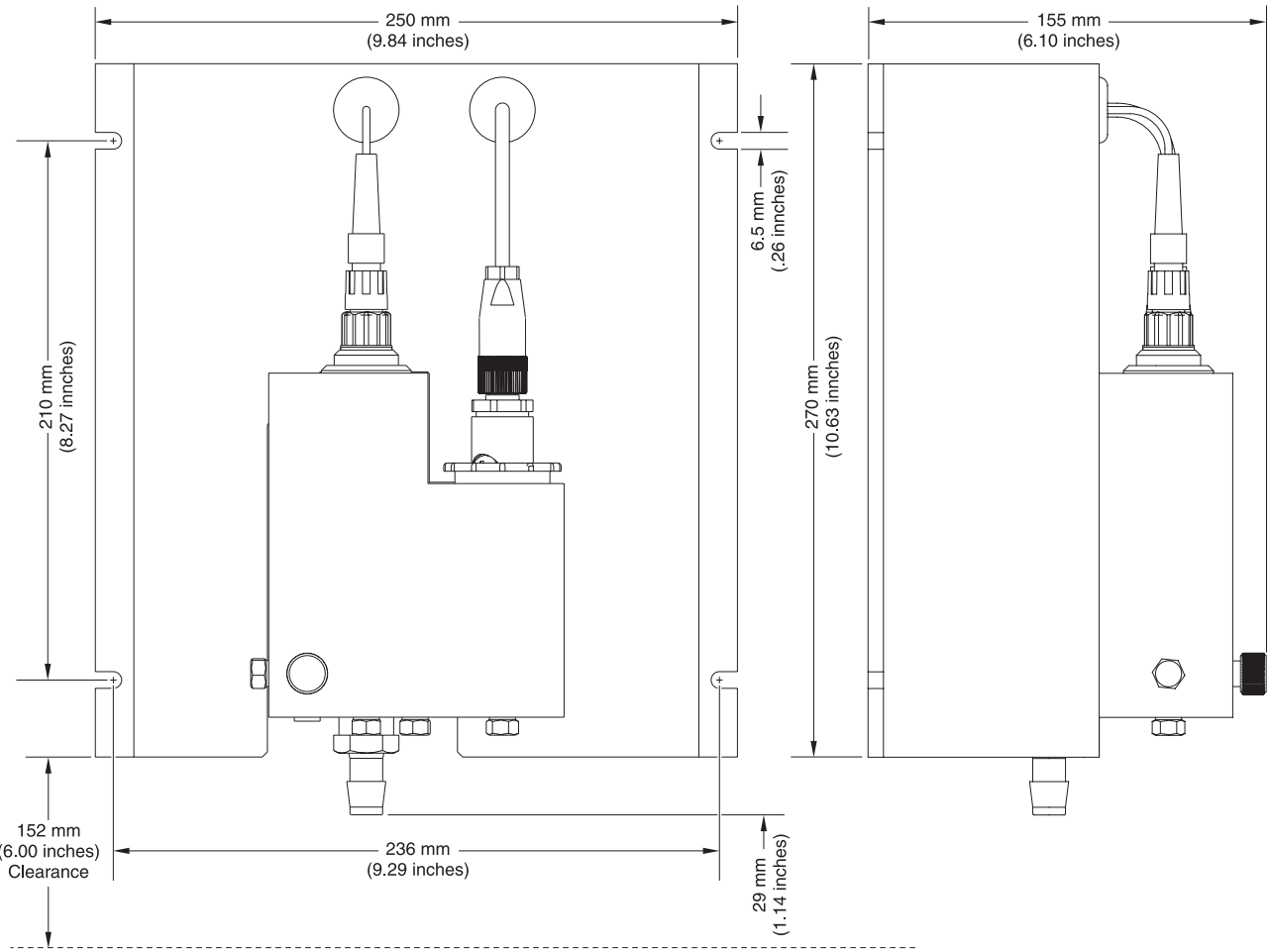


Figure 3 Dimensions

Note: *The optional pH probe is used for the 9184sc TFC only.*

3.1.1 Environmental Considerations

The instrument enclosure is IP66/NEMA 4X with an ambient temperature between 0 and 45 °C (32 to 113 °F), see Specifications on page 5 for more information.

3.1.2 General Installation Considerations

- Place the analyzer in an accessible location.
- Keep the sample tubing as short as possible to minimize lag time.
- Do not place the probe next to a heat source.
- Ensure that there is no air intrusion into the sample supply line.
- Sample pressure must be sufficient to ensure a continuous supply to the probe. A minimum pressure of approximately 0.1–2 bar (1.4–28 psi) is sufficient to provide the correct flow rate. A stable flow rate of 200–250 mL/min is critical. Erratic flow rates will create erratic measurements.

3.2 Choosing the Sample Line Location

Note: *Erratic readings will occur if a sample is drawn from a location that is too close to points of chemical additions to the process stream, if mixing is inadequate, or if the chemical reaction is incomplete.*

Selecting a good, representative sampling point is important for optimum instrument performance (). The sample analyzed must be representative of the condition of the entire system.

Install sample line taps into the side of larger process pipes to minimize the chance of ingesting sediment from the pipe line bottom or air bubbles from the top. A tap projecting into the horizontal center of the pipe is ideal.

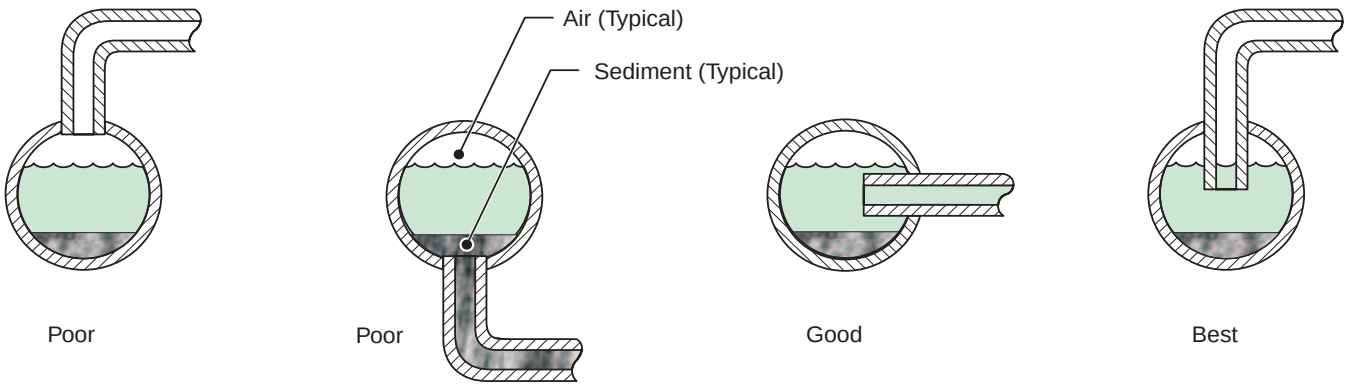


Figure 4 Sample Line Location in the Process Stream

3.3 Connecting the Sample Stream

Sample inlet and drain connections are made on the Analyzer Flow Cell. Refer to Specifications on page 5 for flow rates.

The sample inlet requires ¼ in. OD tubing. The connections are made with a quick connect fitting. Use the ¼ in. supplied tubing adapter in the electrode kit. Cut all tubing so the ends are squarely cut and not angled.

1. Push the tubing into the influent of the flow analyzer (Figure 5).
2. Push the supplied drain tubing onto the nipple beside the influent.
3. Ensure there are no bends in the tubing to prevent back pressure.

3.4 Connecting the Waste Stream

Connect the waste stream using the supplied ½-inch ID tubing. Be sure the drain is free flowing (free of obstructions) so that the waste stream does not cause unnecessary back-pressure or overflow.

Note: *Waste from this instrument must go to the drain.*

3.5 Assembling and Placing the Probe

Refer to Figure 5 for a detailed description of the probe components.

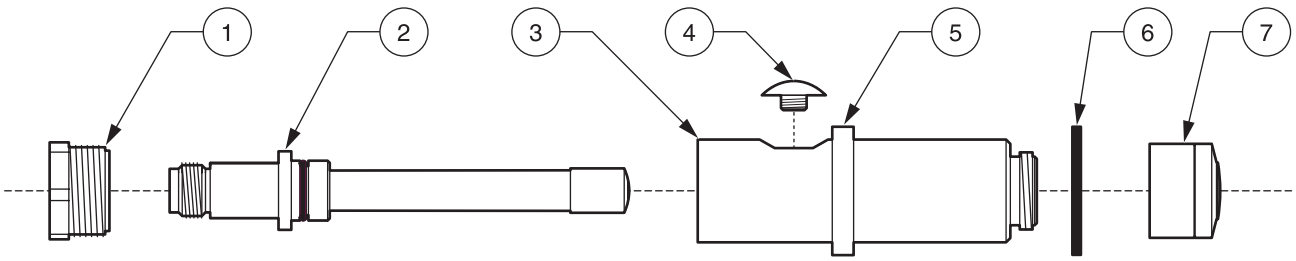


Figure 5 Probe Components[1]

1	Electrode Retaining Ring
2	Measurement Electrode
3	Probe Body
4	Filling Screw
5	A small hole exists in the plug to allow the instrument to maintain a consistent pressure regardless of changes in atmopsheric pressure.
6	Flange
7	Probe Body Washer
8	Pre-Mounted Membrane (set of four); Ensure the properly marked membrane is chosen (e.g. CL will appear on the side for a Chlorine membrane).

[1] See Replacement Parts and Accessories on page 51.

3.5.1 Probe Assembly

CAUTION
To familiarize yourself with handling precautions, dangers and emergency procedures, always review the Material Safety Data Sheets prior to handling containers, reservoirs, and delivery systems that contain chemical reagents and standards. Protective eye wear is always recommended when contact with chemicals is possible.

1. Screw the membrane cap onto the probe body (Figure 6 and Figure 7). Be careful not to touch or damage the membrane surface.
2. Remove the filling screw from the probe body.
3. Visually inspect the electrolyte to ensure that there are no particles or other
impurities present.
4. Using the supplied syringe, fill the probe body with ~7 mL of electrolyte.
5. Slowly insert the electrode into the probe body. Do not use force when inserting into the probe body.
6. Tap the side of the probe to make sure that no air bubbles are trapped in the probe body when inserting the electrode.
7. Screw on the retaining ring. Some electrolyte may spill out the top of the body.
8. Insert the filling screw.
9. Wash hands and rinse sensor to remove excess electrolyte.
10. Place the probe into the Flow Thru Assembly.

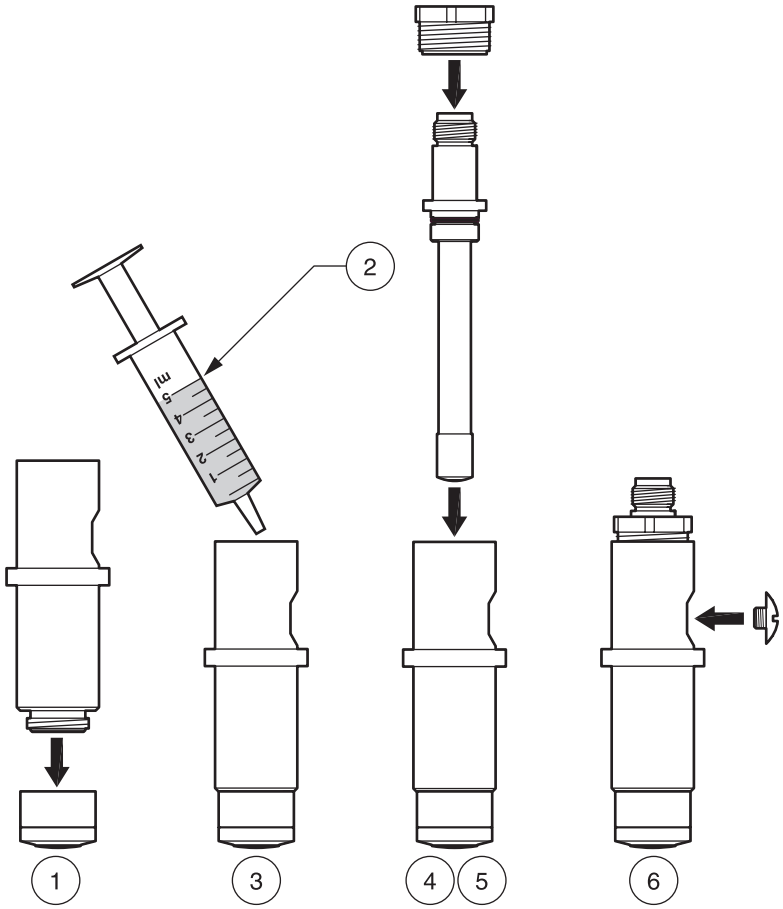


Figure 6 Probe Assembly

1	Membrane Cap to Probe Body	**4**	Seat Electrode into Probe Body.
2	Syringe Filled with 5 mL Electrolyte	**5**	Secure Electrode with Retaining Ring.
3	Inject Electrolyte into Electrode Body.	**6**	Insert Filling Screw[1].

[1] A small hole is in the plug so the instrument can maintain consistent pressure regardless of atmospheric pressure changes.

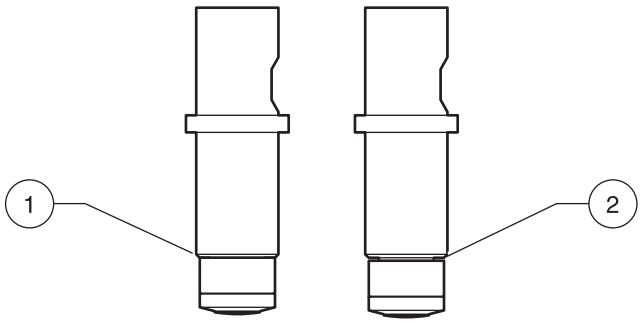


Figure 7 Tightening the Membrane

1	Displays the correct way to tighten the membrane. It is snug but not overtightened.	**2**	Displays the incorrect way to tighten the membrane. It is too loose and the internal electrolyte could leak.

3.5.1.1 Placing the Probe Into the Flow Thru Assembly

1. Remove the probe retaining nut (item 2, Figure 8).
2. Insert the newly assembled probe into the right chamber of the flow cell.
3. Gently screw the retaining nut back on, ensuring it is snug but do not overtighten.
4. Attach the keyed electrode.

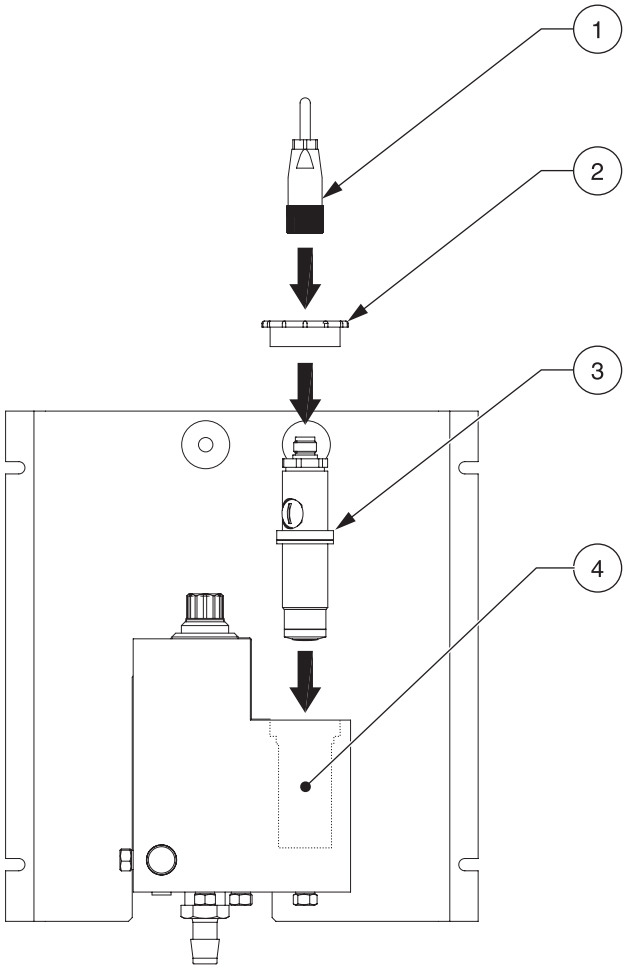


Figure 8 Placing the Probe Into the Flow Thru Assembly[1]

1	Electrode Cable Connector	**3**	Probe Assembly
2	Probe Retaining Nut	**4**	Flow Thru Assembly

[1] See Replacement Parts and Accessories on page 51.

3.5.1.2 Using the Optional pH (9184sc TFC only)

The optional pH (Figure 2 on page 9) is used when analysis is needed for measuring all of the free available chlorine (both HOCl and OCl^-). See section 4.1 on page 23 and section 5.2 on page 38 for selecting this option using the controller during initial sensor parameter selection.

1. Remove the red cap from the left side of the flow cell.
2. Remove the O-ring from the white blank.
3. Gently remove the cover from the pH probe.
4. Put the O-ring from Step 2 onto the pH probe, sliding it gently over the glass end and up the probe until it is flush against the red connection.
5. Insert the newly assembled probe into the left chamber of the flow cell.
6. Attach the keyed electrode cable.

3.6 Connecting/Wiring the Sensor with the sc100

DANGER
Although the sc100 controller is certified for Class 1, Division 2 Hazardous Locations, it is only certified when installed with sensors listed in Control Drawings 5860078. The sc100 controller and this sensor are NOT suitable for use in Class 1, Division 2 Hazardous Locations.

The quick-connect process for connecting the sensor to the controller is the most common connection used section 3.6.2. There is also the option to hard-wire the sensor to the controller at the user's discretion section 3.6.3.

3.6.1 Wiring Safety Information

When making any wiring connections to the instrument, the following warnings and notes must be adhered to, as well as, any warnings and notes found throughout the individual installation sections. For more safety information refer to section 2.1 on page 7.

DANGER
Always disconnect power to the instrument when any making electrical connections.

3.6.2 Attaching the Sensor with Quick-Connect Fittings

The sensor cable is supplied with a keyed quick-connect fitting for easy attachment to the controller (Figure 9). Retain the connector cap to seal the connector opening in case the sensor must be removed. Extension cables may be purchased in 7.7, 15, and 31 m (25, 50, and 100 ft) lengths. The maximum cable length should not exceed 310 m (1000 ft). A load termination box must be installed for installations with more than 31 m (100 ft) of cable between the controller and sensor. See Replacement Parts and Accessories on page 41.

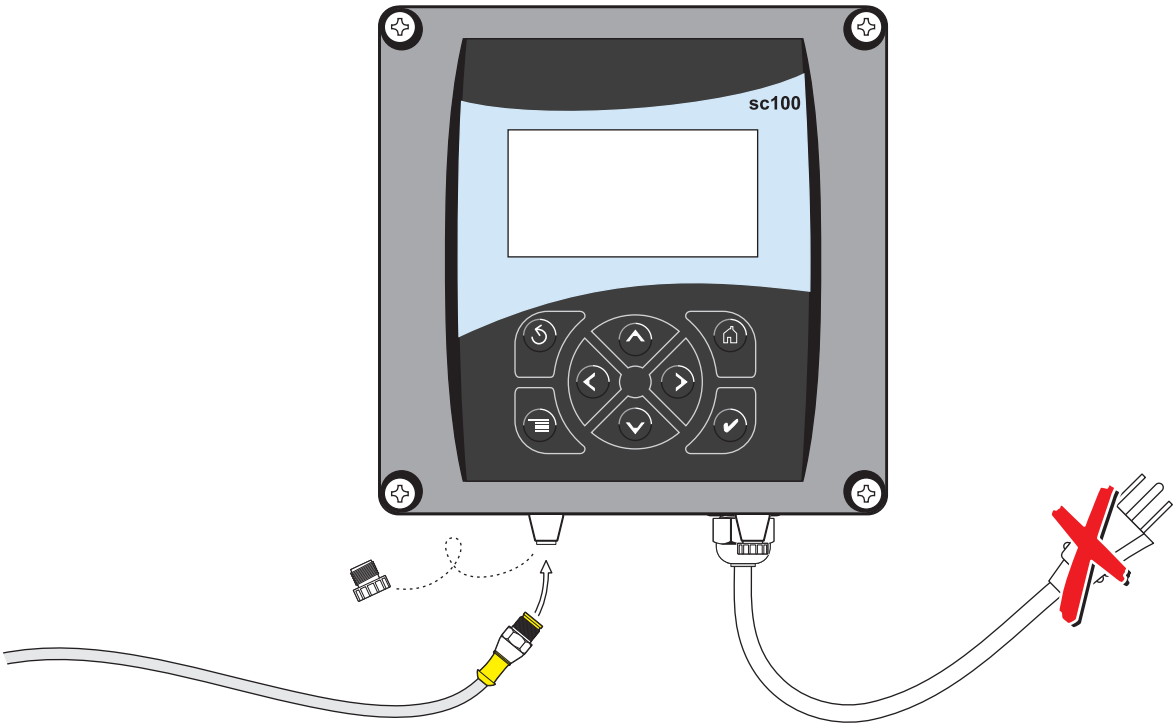


Figure 9 Attaching the Sensor with Quick-Connect Fittings

3.6.3 Hard-wiring the Sensor with the sc100 Controller

1. Open the controller cover.
2. Disconnect and remove the existing wires between the quick connect and terminal strip J5, see Figure 10 on page 19.
3. Remove the quick connect fitting and wires and install the threaded plug on the opening to maintain the environmental rating.
4. Cut the connector from the sensor cable.
5. Strip the insulation on the cable back 1-inch. Strip ¼-inch of each individual wire end (Figure 11 on page 19)
6. Pass the cable through conduit and a conduit hub or a strain relief fitting (Figure 12 on page 20) and an available access hole in the controller enclosure. Tighten the fitting.
7. Reinstall the plug on the sensor access opening to maintain the environmental rating.
8. Wire as shown in Table 1 on page 19.
9. Close and secure the cover.

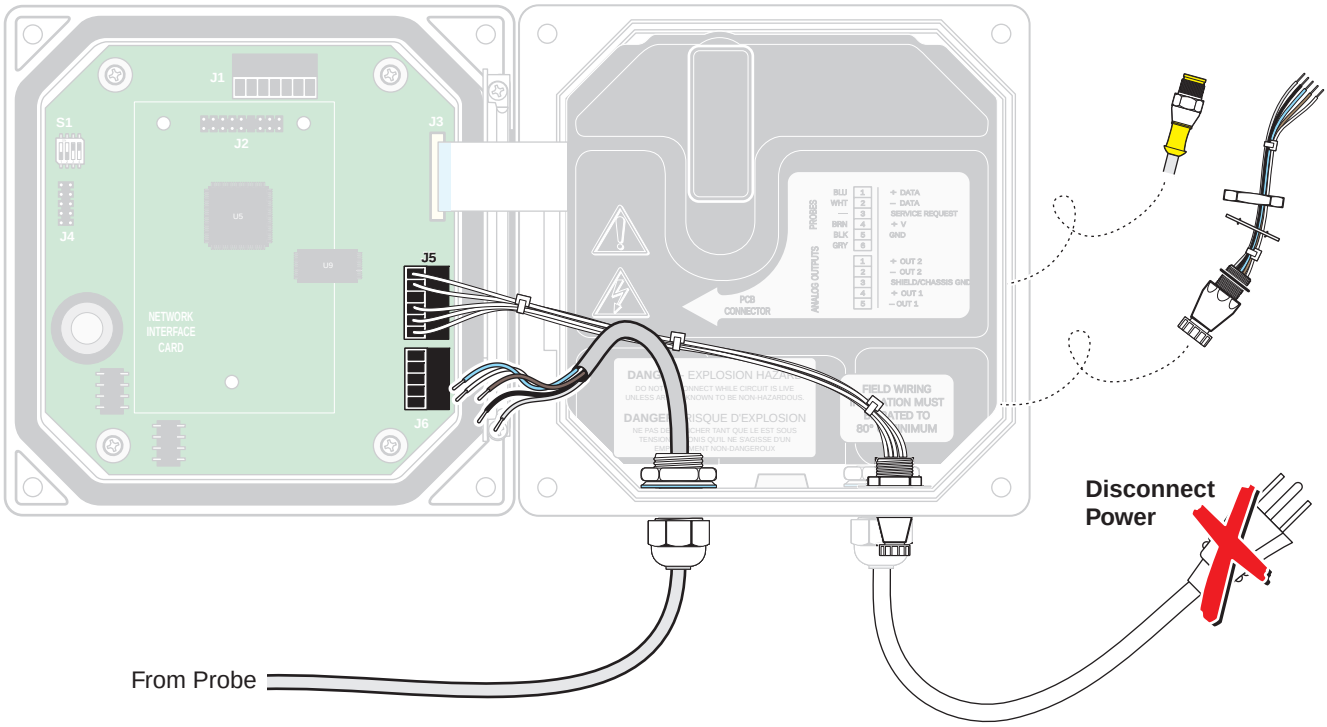


Figure 10 Hard-wiring the Sensor

Table 1 Wiring at Terminal Block J5 on the sc100

Terminal Number	Terminal Designation	Wire Color
1	Data (+)	Blue
2	Data (–)	White
3	Service Request	No Connection
4	+12 VDC	Brown
5	Circuit Common	Black
6	Shield	Shield (grey wire in existing quick-disconnect fitting)

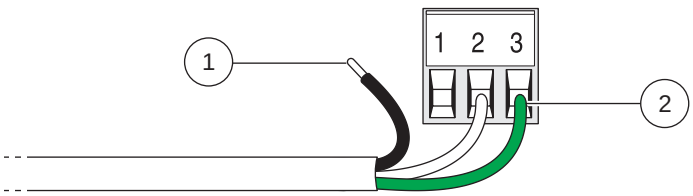


Figure 11 Wire Preparation and Insertion

1	Strip ¼-inch of insulation.	**2**	Seat insulation against connector with no bare wire exposed.

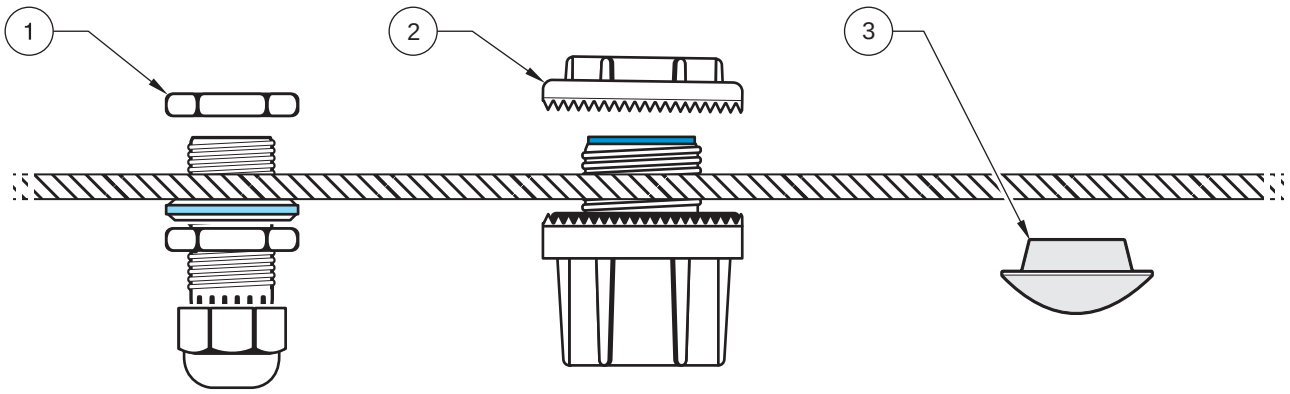


Figure 12 Using the Optional Strain Relief and Conduit Hole Sealing Plug

1	Power cord strain relief	**2**	Conduit strain relief	**3**	Conduit hole sealing plug

3.7 Connecting the Sensor to the sc1000

3.7.1 Connecting the Sensor using the Quick-connect Fittings

1. Unscrew the connector cap from the controller. Retain the connector cap to seal the connector opening in case the sensor must be removed.
2. Push the connector into the socket.
3. Hand-tighten the union nut.

Important Note: *Do not use the middle connection for the sensors as this is reserved for the display module.*

3.8 Instrument and Controller Startup

1. Ensure the flow regulator is threaded (clockwise) all the way and is snug but not overtightened.
2. Turn on the sample stream.
3. Slowly open the flow regulator (Figure 13) counterclockwise until consistent flow is achieved at a rate in which the flow cell can be flushed out for about two minutes. Check for leaks at this time. If leaks occur, fix by ensuring all connections are snug but not overtightened.
4. Adjust the flow regulator on the flow cell until the water begins to drain out the left drain port. This results in a constant 14 L/hour (200–250 mL/min) flow rate.
5. Supply power to the controller and it will automatically power on.
6. Allow the instrument to stabilize before proceeding. This usually takes between 2–48 hours.

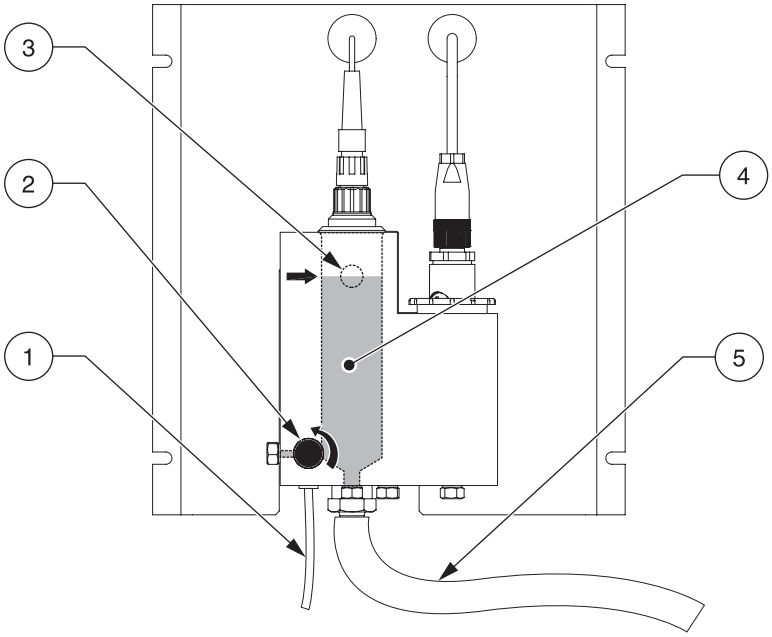


Figure 13 Setting the Flow Rate

1	Sample inlet tubing	**4**	Sample
2	Flow meter adjustment knob	**5**	Drain tubing
3	Sample level overflow (indicates the correct water level)		

Section 4 User Interface and Navigation

4.1 Using the sc100 Controller

The front of the controller is shown in . The keypad consists of the eight keys described in Table 2.

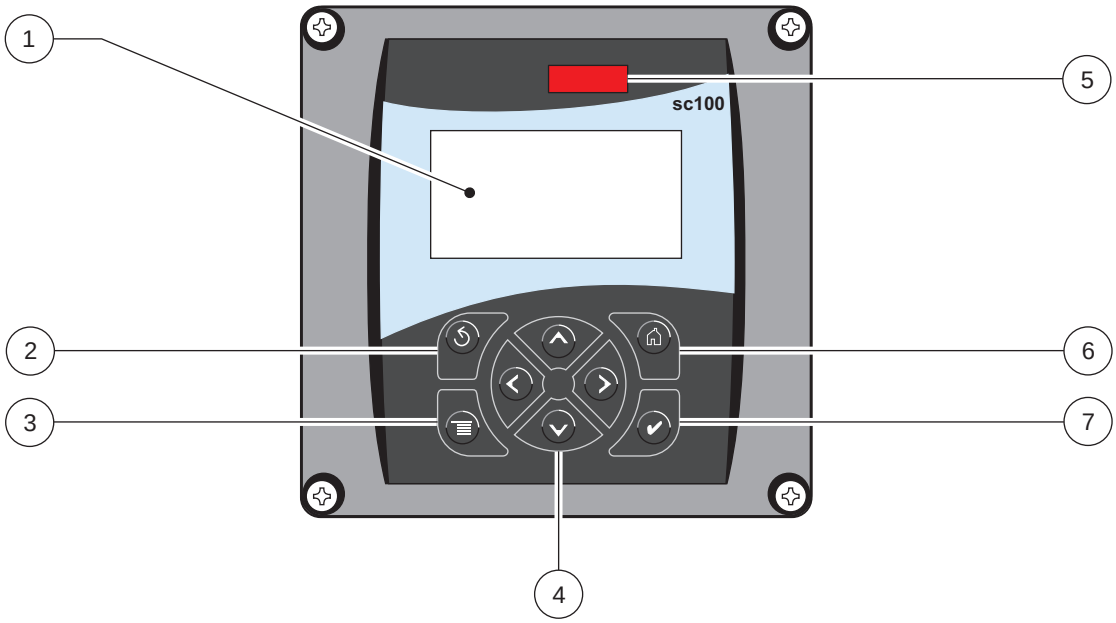


Figure 14 Front of the Controller

1	Instrument display	**5**	IrDA window
2	**BACK** key	**6**	**HOME** key
3	**MENU** key	**7**	**ENTER** key
4	**RIGHT**, **LEFT**, **UP**, and **DOWN** keys		

Table 2 Controller Key Functions/Features

Number	Key	Function
2	back	Moves back one level in the menu structure.
3	menu	Moves to the main menu from other menus. This key is not active in menus where a selection or other input must be made.
4		Navigates through the menus, changes settings, and increments and decrements digits.
5	home	Moves to the Main Measurement screen from any other screen. This key is not active in menus where a selection or other input must be made.
6	enter	Accepts an input value, updates, or accepts displayed menu options.

4.1.1 Controller Display Features

When a sensor is connected and the controller is in measurement mode, the controller automatically identifies the connected sensors and displays associated measurements.

The display will flash on startup, when a sensor error has occurred, and when a sensor is being calibrated.

An active system warning will cause the warning icon (a triangle with an exclamation point inside) to be displayed on the right side of the display. See Figure 15.

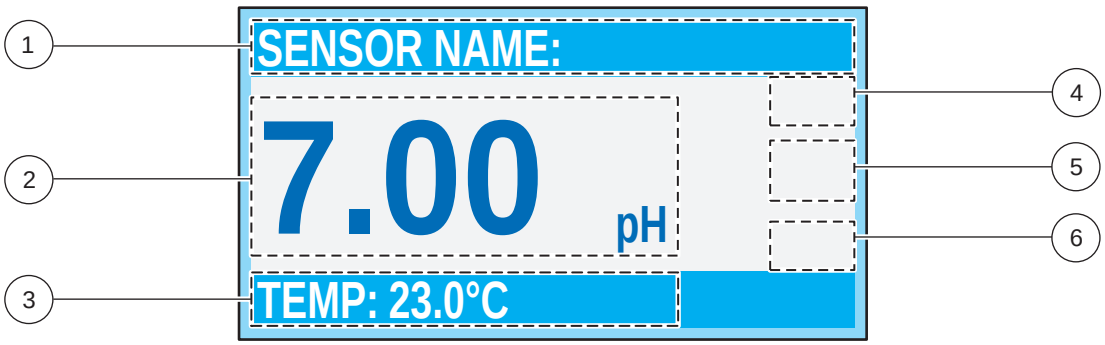
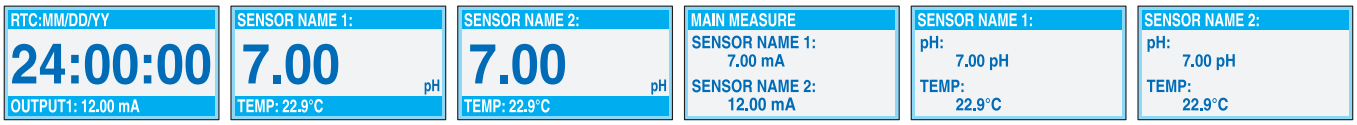


Figure 15 Display

1	Status bar. Indicates the sensor name and status of relays. The relay letter is displayed when the relay is energized.	**4**	Parameter
2	Main measurement	**5**	Warning icon area
3	Secondary measurement (if applicable)	**6**	Measurement units

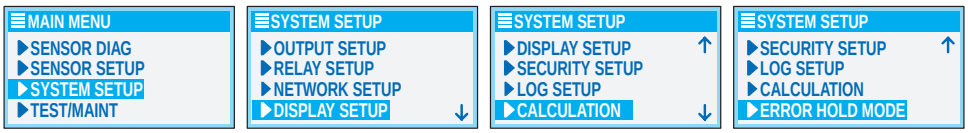
4.1.2 Important Key Presses

- Press **HOME** then the **RIGHT** or **LEFT** key to display two readings when two sensors are connected. Continue to press the **RIGHT** or **LEFT** key to toggle through the available display options as shown below.



- Press the **UP** and **DOWN** keys to toggle the status bar at the bottom of the measurement display to display the secondary measurement (temperature) and output information.

- When in Menu mode, an arrow may appear on the right side of the display to indicate that more menus are available. Press the **UP** or **DOWN** key (corresponding to the arrow direction) to display additional menus.



4.2 Using the sc1000 Controller

The sc1000 is a touch screen application. Use your finger to touch keys and menu commands. In normal operation the touch screen displays the measured values for the sensors selected.

4.2.1 Display Features

4.2.1.1 Using the Pop-up Toolbar

The pop-up toolbar provides access to the controller and sensor settings. The toolbar is normally hidden from view. To view the toolbar, touch the bottom-left of the screen.

Figure 16 Pop-up Toolbar Functions

	**MAIN MENU**–displays the Main Menu Structure
	**UP** Arrow–scrolls up to the previous displayed value.
	Displays one value.
	Displays two values at the same time.
	Displays four values at the same time.
	**LIST**–displays the list of connected devices and sensors.
	**DOWN** Arrow–scrolls down to the next displayed value.

4.2.1.2 Using the Menu Windows

If the Menu button (from the pop-up toolbar) is selected, the Main Menu screen is opened. The Main Menu screen allows the user to view the sensor status, configure the sensor setup, system setup, and perform diagnostics.

The menu structure may vary depending on the configuration of the system.

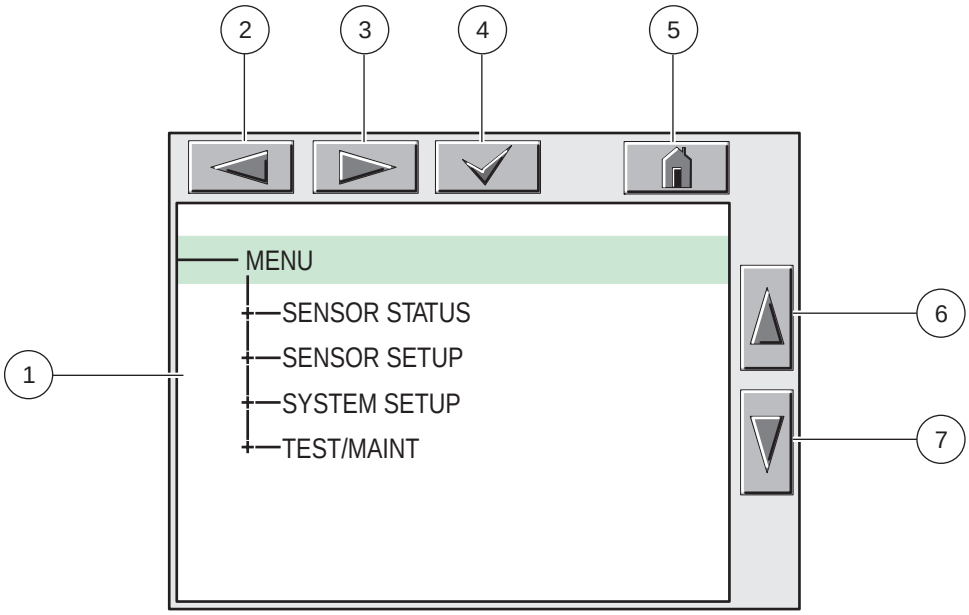


Figure 17 Main Menu

1	Display Area
2	BACK
3	FORWARD
4	**ENTER**–confirms the entry or selection.
5	**HOME**–changes to the display of measured values. The pop-up toolbar cannot open from the menu window. To view the Main Menu from this display, touch the Home button and then the bottom of the screen.
6	**UP**–scrolls up
7	**DOWN**–scrolls down

4.2.1.3 Navigating the Menu Windows

To view a menu item, touch the menu item or use the **UP** and **DOWN** keys to highlight the item. The menu item remains highlighted for approximately 4 seconds after it is selected. To view the highlighted command, select the area to the left of the menu item or select the **ENTER** button.

A "**+**" next to a menu command indicates there is a submenu. Touch the "+" to view the submenu. An "**i**" next to a menu command indicates it is information only.

If a menu item is editable, highlight the item and touch the far-left part of the menu item until it is highlighted and press **ENTER** or double-tap the highlighted item. A keypad will be displayed to change an entry (Figure 19 on page 27) or a list box will be displayed (Figure 20 on page 28).

Messages are displayed in the message window (Figure 21 on page 28).

If an entry is incorrect, repeat the entry with the correct values. If the entry is outside the working range, a correction to the entry is made automatically.

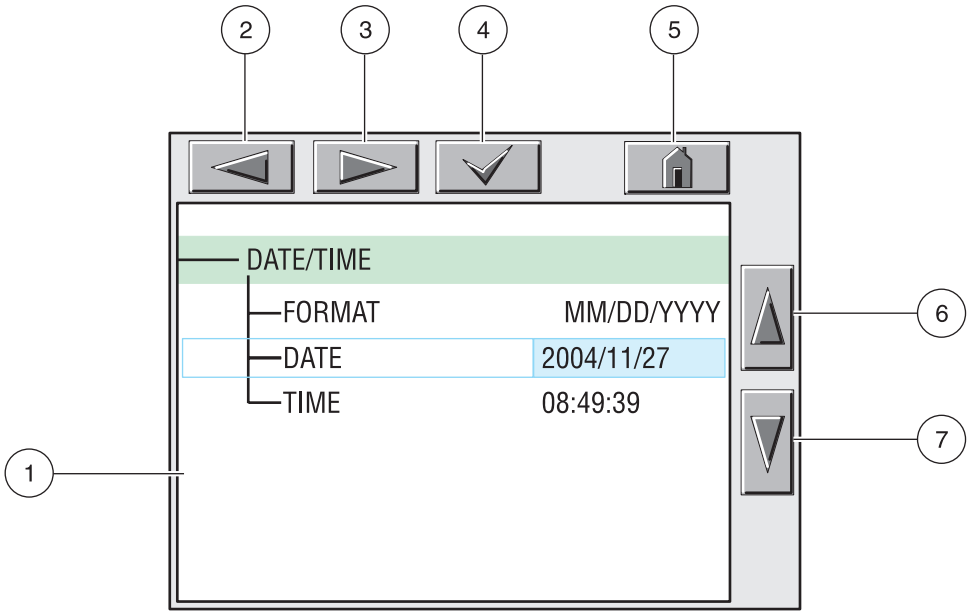


Figure 18 Changing a Menu Item

1	Display Area	**5**	**HOME**–changes to the display of measured values.
2	BACK	**6**	**UP**–scrolls up
3	FORWARD	**7**	**DOWN**–scrolls down
4	**ENTER**–confirms the entry or selection.		

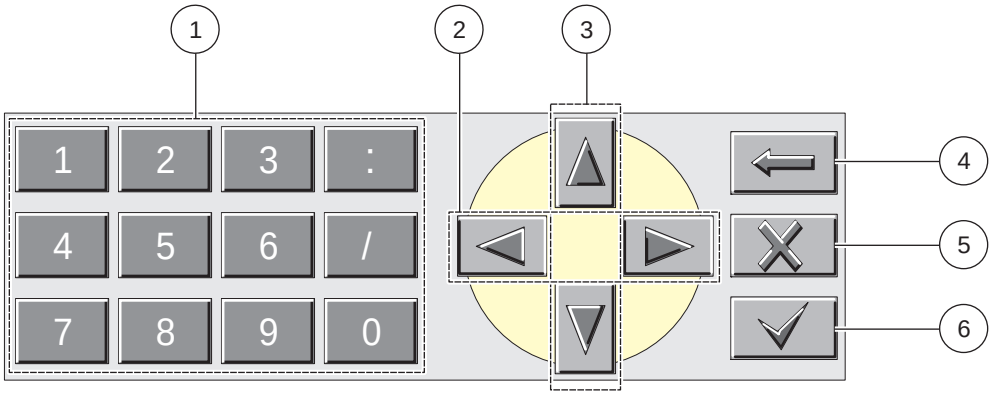


Figure 19 Keypad

1	Enters numbers or the character as shown on the button.
2	Moves the cursor one position to the left or to the right.
3	Increase/Decrease a number or letter at the cursor position. Keep the button pressed to change the numbers/characters continuously.
4	Deletes the character to the left of the cursor.
5	**CANCEL**–cancels the entry.
6	**ENTER**–confirms the entry or selection.

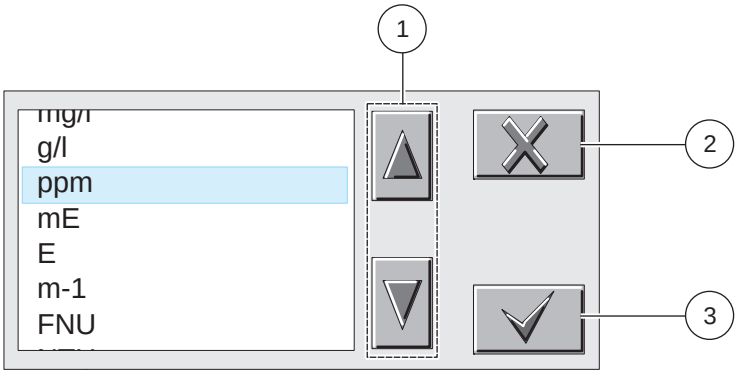


Figure 20 List Box

1	Scrolls up or down
2	**CANCEL**–cancels and entry.
3	**ENTER**–confirms a selection.

Figure 21Message window

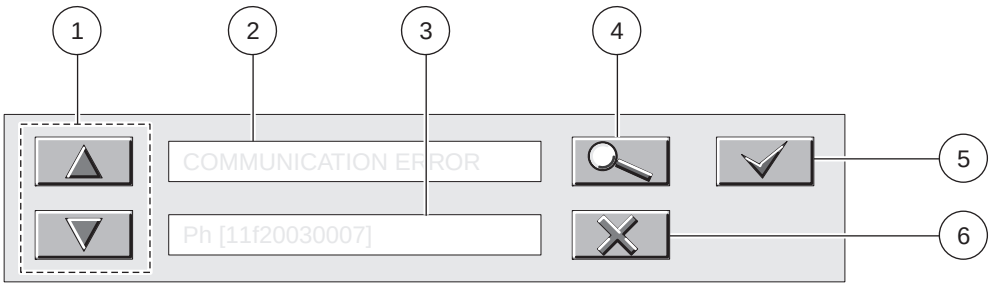


Figure 22 Message Window

1	Scrolls up or down.
2	Displays the messages or warnings.
3	Displays details on the selected entry.
4	This button changes back to the previous display.
5	**ENTER**–confirms an entry.
6	**CANCEL**–cancels an entry.

Section 5 Operation

5.1 Sensor Setup

Select the parameter during the initial sensor setup for the parameter that corresponds to the instrument that has been purchased. Parameter choices, depending on the instrument, are:

- Chlorine HOCL, does not include pH measurement
- Chlorine + Acid which is HOCL plus the acid verification accessory, does not include pH measurement
- Total Free Chlorine (TFC), includes pH measurement
- Ozone, does not include pH measurement
- Chlorine Dioxide, does not include pH measurement

5.1.1 Changing the Sensor Name and Parameter Selection

When a sensor is initially installed, the sensor name will be displayed.

To change the sensor name:

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one sensor is attached and confirm.
3. Select CONFIGURE and confirm.
4. Select EDIT NAME and edit the name. Confirm or cancel to return to SENSOR SETUP.
5. Select PARAMETER and confirm.
6. Choose the parameter that the purchased instrument corresponds to and confirm.

5.2 Sensor Data Logging

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one sensor is attached and confirm.
3. Select CONFIGURE and confirm.
4. Select LOG SETUP and confirm.
5. Select from the logging interval options and confirm

5.3 Sensor Diagnostics Menu

SELECT SENSOR	
ERROR LIST	See section 7.1 on page 39.
WARNING LIST	See section 7.2 on page 39.

5.4 Sensor Setup Menu

SELECT SENSOR (if more than one sensor is attached)		
CALIBRATE		
	ZERO CAL	See section 5.5.5 on page 34.
	PROCESS CONC	Use to adjust concentration which requires accurate pH; and TFC in ppb. See section 5.5.3 on page 33.
	PROCESS TEMP	Use to adjust the TEMPERATURE for a °C value. See section 5.5.1.1 on page 31.
	PROCESS PH (9184sc only)	Use to adjust for a 1 or 2 Point Process pH Sample. See section 5.5.2.1 on page 32 and section 5.5.2.2 on page 32.
	CAL CONFIG	Select OUTPUT MODE, CAL ZERO, or CAL DELAY.
	OUTPUT MODE	Select ACTIVE, HOLD, TRANSFER, or CHOICE ACTIVE—Outputs the value currently measured by the sensor HOLD—Holds the last value stored before going into calibration mode TRANSFER—Sensor transfers a value set by the user (refer to the sc controller manual) CHOICE—User is prompted to enter a transfer value when entering calibration mode
	CAL ZERO	Select ELECTRICAL or CHEMICAL. For CHEMICAL use a sample that does not contain any oxidants. Ensure that the sample source has a sufficient flow rate and that the sample is adequately mixed. ELECTRICAL—For most users, the manufacturer recommends using the Electrical Zero Calibration. This is a completely automated method of setting the zero calibration point. No user input is required, although it can be manually triggered. CHEMICAL—In low range applications (< 50 ppb) and applications with strong oxidants such as Ozone, the Chemical Zero Method is recommended. The Chemical Zero Method requires a sample that is completely free of any oxidants. An oxidant free reference sample may be produced by leaving water in an open container for 24 hours. For best results use actual process water. Bubble the water, if possible, to speed up the oxidant evaporation.
	CAL DELAY	Adjust the number of days between calibration and alarm signal. The default is 90 days. See section 5.5.4 on page 34
	SET CAL DEFLT	Resets the sensor configuration to default settings. See section 5.5.6 on page 35.
CONFIGURE		
	EDIT NAME	Enter up to a 10-digit name in any combination of symbols and alpha or numeric characters.
	SELECT PARAMETER	Select CHLORINE HOCL, CHLORINE + ACID, T.F.C., OZONE, or CHLORINE DIOX.
	CONC UNITS	Select ppb–ppm or µg/L–mg/L to allow the sensor to automatically select the most appropriate measurement range. Select ppb, ppm, ug/L, or mg/L to override the autoranging feature and force the reading to a particular unit of measure.
	T-SENSOR	The sensor has a factory-set internal temperature. Select AUTOMATIC or MANUAL setting. The preferred setting is AUTOMATIC.
	TEMP UNITS	Select °C or °F.
	SELECT PH MEAS	AUTOMATIC or MANUAL setting and pH compensation. Use the AUTOMATIC setting when using supplied pH.
	DISP PH FORMAT (9184sc only)	Choose either XX.XX pH or XX.X pH.
	LOG SETUP	Allows user to select data logging interval for the sensor and temperature.
	FILTER	Adjust for + s. This averages the signal over the specified time interval.
	MAINS FREQ	Choose 50 or 60 Hz.
	DEFAULT SETUP	Resets the sensor configuration to default settings.

5.4 Sensor Setup Menu (continued)

DIAG/TEST	
PROBE INFO	Displays the driver and software versions and the serial number.
CAL DATA	Displays OFFSET: °C, SLOPE: in A/mg and OFFSET: uA, SLOPE: %
SIGNALS	Displays INT, TEMP RAW, MV RAW and PH RAW.
COUNTERS	Displays sensor total time and humidity suppressor.
SERVICE	Displays the Enter Passcode screen.

5.5 Calibration

5.5.1 Temperature Sensor Calibration

The probe contains a temperature sensor which is factory pre-set. If there are setting questions, the data can be validated using a high precision thermometer using Table 3 and performing the steps in section 5.5.1.1 on page 31.

Temperature Conversion
Conversion from Celsius to Fahrenheit: °F = 1.8 x °C + 32
Conversion from Celsius to Kelvin: K = °C + 273.15

Table 3 Temperature Conversions

°C	°F	K	°C	°F	K	°C	°F	K
0	32	273.15	16	60.8	289.15	32	89.6	305.15
1	33.8	274.15	17	62.6	290.15	33	91.4	306.15
2	35.6	275.15	18	64.4	291.15	34	93.2	307.15
3	37.4	276.15	19	66.2	292.15	35	95	308.15
4	39.2	277.15	20	68	293.15	36	96.8	309.15
5	41	278.15	21	69.8	294.15	37	98.6	310.15
6	42.8	279.15	22	71.6	295.15	38	100.4	311.15
7	44.6	280.15	23	73.4	296.15	39	102.2	312.15
8	46.4	281.15	24	75.2	297.15	40	104	313.15
9	48.2	282.15	25	77	298.15	41	105.8	314.15
10	50	283.15	26	78.8	299.15	42	107.6	315.15
11	51.8	284.15	27	80.6	300.15	43	109.4	316.15
12	53.6	285.15	28	82.4	301.15	44	111.2	317.15
13	55.4	286.15	29	84.2	302.15	45	113	318.15
14	57.2	287.15	30	86	303.15			
15	59	288.15	31	87.8	304.15			

5.5.1.1 Adjusting the Temperature

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one sensor is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select PROCESS TEMP and confirm.

5. Confirm when stable. TEMP: XX.X will be displayed. Confirm to continue.
6. Adjust the Reading XX.X °C and confirm.
7. A screen will display CAL COMPLETE, OFFSET: X.X °C, confirm to continue.
8. Move the probe to the process and confirm.

5.5.2 pH Calibration (9184sc only)

The manufacturer recommends calibrating the pH probe with a pH 4 and pH 7 buffer solution, regardless of sample pH.

5.5.2.1 Process pH 1 Point Sample

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select PROCESS PH and confirm.
5. Select 1 POINT SAMPLE. Select the available Output Mode (Active, Hold, or Transfer) and confirm.
6. Move the clean probe to the sample and confirm to continue.
7. VALUE: X.XX pH, TEMP: XX.X °C is displayed. Confirm to continue.
8. Adjust the SAMPLE VALUE: X.XX pH and confirm.
9. COMPLETE, OFFSET: X.XX pH, SLOPE: XX.X% is displayed. Confirm to continue.
10. Return the probe to the process and confirm.

5.5.2.2 Process pH 2 Point Sample

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select PROCESS PH and confirm.
5. Select 2 POINT SAMPLE. Select the available Output Mode (Active, Hold, or Transfer) and confirm.
6. Move the clean probe to Sample 1 and confirm.
7. VALUE: X.XX pH, TEMP: XX.X °C is displayed. Confirm to continue.
8. Adjust the SAMPLE VALUE: X.XX pH to the known pH and confirm.
9. Move the clean probe to Sample 2 and confirm.
10. The VALUE: XX.XX pH, TEMP: XXX °C is displayed. Confirm to continue.
11. Adjust the second SAMPLE VALUE: X.XX pH to the known pH and confirm.

12. The VALUE: XX.XX pH, TEMP: XXX °C IS displayed. Confirm to continue.
13. COMPLETE, SLOPE: XXX.X%, OFFSET: X.XX pH is displayed. Confirm to continue.
14. Return the probe to the process and confirm.

5.5.3 Concentration Calibration

9184sc
To test for Total Free Chlorine, use the Total Free Chlorine Calibration Method, with the manufacturer DPD test kits (Cat. No. 2105545) for the DR/4000 and DR/2500 spectrophotometers and the DR/800 colorimeter.

Use the Pocket Colorimeter II™ for measuring free chlorine concentrations with the DPD method that is available from the manufacturer (Cat. No. 5870023) for all other 9184sc uses.

9185sc
To test for Ozone, use the Indigo Method, Ozone HR AccuVac test (Cat. No. 25180-25) for the DR/4000, DR/2500, DR/890, and the Pocket Colorimeter II.

9187sc
Table 4 lists methods available for Chlorine Dioxide testing (listed in order of preference). Check the Procedures Manual to verify program availability for specific spectrophotometers and colorimeters.

Table 4 Chlorine Dioxide Tests

Reagent	Method	Range	Catalog Number
Chlorine Dioxide Reagent A	Amaranth Method	20–500 µg/L	LYW240
Chlorine Dioxide Tool Set for LYW240	NA	NA	LZC140
Chlorine DIoxide Reagent	Chlorophenol Red	0.01–1.00 mg/L	22423-00
Chlorine Dioxide DPD/Glycine Reagent	DPD/Glycine	0.04–5.00 mg/L	27709-00

5.5.3.1 Process Calibration

For the 9184sc, calibrate the pH and record the number for reference. To ensure accuracy, the pH calibration buffers must be at the same temperature as the chlorine sensor.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one sensor is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select PROCESS CONC and confirm.
5. Move the clean probe to the sample and confirm.
6. Confirm when Stable, VALUE: X.X nA, TEMP: XX.X °C will be displayed.
7. (9184sc only) Adjust the pH VALUE: +X.XXpH (this is an actual value) and confirm.

8. Adjust the TFC or CONCENTRATION VALUE (depending on instrument): XXX.X ppb (this is an actual value) and confirm.
9. Refer to section 5.5.3 on page 33. If adjusting the TFC value, use the Total Free Chlorine Method.
10. COMPLETE, SLOPE: nA/MG, OFFSET: uA is displayed. Confirm to continue.
11. Return the probe to the process and confirm.

5.5.4 Calibration Configuration

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one sensor is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select CAL CONFIG and confirm.
5. Select the Output mode (ACTIVE, HOLD, TRANSFER, or CHOICE) and confirm.
6. Select CAL CONFIG and confirm.
7. Select CAL ZERO and confirm.
8. Choose either ELECTRICAL or CHEMICAL and confirm.
9. Select CAL CONFIG and confirm.
10. Select CAL Delay and confirm.
11. Adjust the Day XX and confirm.

5.5.5 Zero Calibration

The Zero Calibration can be performed in two different ways: chemically (recommended for low range applications) or electrically (recommended by the manufacturer for standard applications). To perform a Zero Calibration, refer to section 5.5.4 on page 34.

The electrical zero calibration uses an automatic means of setting the zero calibration point. Electrical zero can be done at any time regardless of where the sensor is located (sample, air, etc.). The 9184sc will auto-zero when the power is cycled, or upon demand.

In low range applications (< 50 ppb), the manufacturer recommends using the Chemical Zero Calibration (section 5.5.5.1 on page 35). The Chemical Zero Calibration requires a sample that is free of oxidants. An oxidant-free reference sample may be produced by leaving water in an open container for 24 hours. For best results use actual process water. Bubble the water to speed up the oxidant evaporation.

The Upper Level Calibration point is obtained by reference to a laboratory method (process calibration).

5.5.5.1 Chemical Zero Calibration

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select ZERO and confirm. Select the available Output Mode (Active, Hold, or Transfer) and confirm to confirm.
5. Move the clean probe to the sample and confirm.
6. The VALUE: XX.X µg/L, TEMP: XX.X °C is displayed. Confirm to continue.
7. Complete OFFSET: 0.0 uA is displayed. Confirm to continue.
8. Return the probe to the process and confirm.

5.5.6 Set Calibration Defaults

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Highlight the appropriate sensor if more than one sensor is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select DEFAULT SETUP and confirm.
5. ARE YOU SURE? is displayed. Confirm to continue.
6. Complete is displayed. Confirm to return to the CALIBRATE.

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

6.1 Maintenance Schedule

The following schedule shows the minimum maintenance requirements for typical operation.

Maintenance Task	2 Months	3 Months	6 Months	Annually
Membrane			X	
Electrolyte			X	
pH (9184sc only)				X
Cleaning[1]		X		
Tubing				X
Calibration	X			

[1] Maintenance frequency is application dependent. Additional or less maintenance will be appropriate in some applications. The sensor must be cleaned before liquid standard verification or calibration.

6.2 Scheduled Maintenance

CAUTION
To familiarize yourself with handling precautions, dangers and emergency procedures, always review the Material Safety Data Sheets prior to handling containers, reservoirs, and delivery systems that contain chemical reagents and standards. Protective eye wear is always recommended when contact with chemicals is possible.

6.2.1 Replacing the Membrane

When removing the probe from the sample, th emanufacturer recommends keeping the probe vertical with the membrane facing down. Avoid touching the active part of the membrane.

Replace the membrane every 6 months under typical operating conditions, or more frequently as experience dictates.

1. Shut off the sample supply. Remove the probe cable.
2. Unscrew the probe retaining ring. Remove the sensor.

   Note: *Removing the sensor may activate alarms. Ensure that removing the sensor will not affect plant operation by switching to maintenance mode.*

3. Unscrew the electrode retaining ring and filling screw. Never pull sharply on the electrode when the filling screw is in place.
4. Remove the electrode. Pour out the electrolyte.
5. Unscrew the membrane.

Note: *Do not re-install a used membrane. After changing the membrane, allow the probe to stabilize for at least three hours; recalibrate the sensor.*

For re-assembly, see section 3.5.1 on page 14.

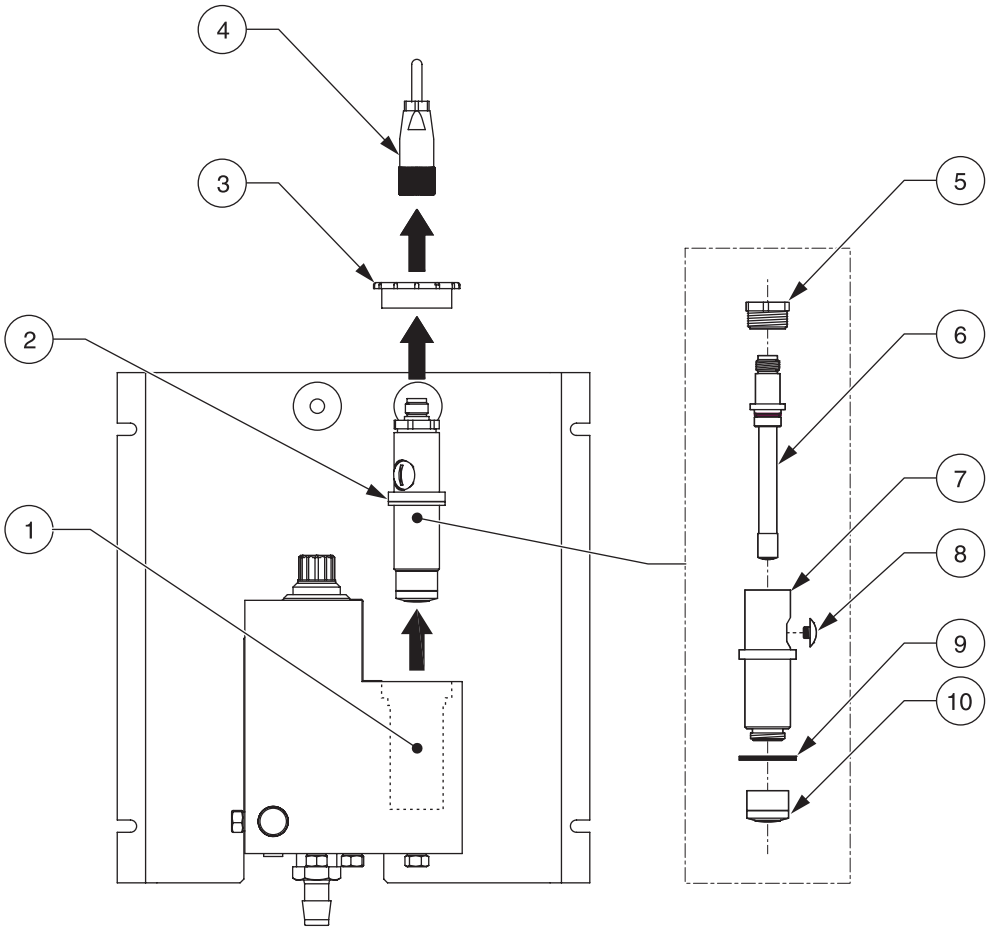


Figure 23 Disassembling the Sensor

1	Probe Chamber	**6**	Measurement Electrode
2	Probe Assembly	**7**	Probe Body
3	Probe Retaining Nut	**8**	Filling Screw
4	Electrode Cable Connector	**9**	Probe Body Washer
5	Electrode Retaining Ring	**10**	Pre-mounted Membrane

6.2.2 Replacing the Electrolyte

Replace the electrolyte when changing the membrane. Refer to section 3.5.1 on page 14 to replace the electrolyte.

6.2.3 Replacing the pH Electrode (9184sc only)

Replace the electrode 12 to 18 months depending on the application.

Section 7 Troubleshooting

7.1 Error Messages

Note: *When an error occurs, the measurement values are replaced by dashes, (- - -).*

Message Type	Error Message	Solution
Measurement-related Error Messages	CONC TOO HIGH	Check the current value, along with the calibration parameters. Check electrode.
	CONC TOO LOW	Check the current value, along with the calibration parameters. Check electrode.
	TEMPERATURE ERROR	Check for short-circuit or open circuit.
	CURRENT TOO LOW	Negative current. Check the electrode (electrolyte and membrane).
	CURRENT TOO HIGH	Ensure that there are no short-circuits on the measurement chain. Check the polarizing voltage.
	***** on the main display	No communication. Verify the connection and the cable. Test the 12V power supply.
	(At Connection time:) SENSOR MISSING FFFFFFFFFFFF displays	No communication. Verify the sensor is properly connected to the transmitter. Verify that the cable is not damaged. Test the 12V power supply. Open the sensor and change the board.
	COMMUNICATION ERROR	Open the sensor and verify that there is no humidity.
	TEMP TOO LOW	Temperature measurement is below –2°C. Verify that the actual temperature is not below –2°C. Verify the internal resistance of the NTC/K, which must be around 10 K. Connect the sensor simulator and verify the RAW value.
	TEMP TOO HIGH	Verify the actual temperature is not higher than 45 °C. Connect the sensor simulator and verify the RAW value.
	RAW MEASURMENT	Change the preamplifier.
	PH TOO LOW (9184sc only)	PH electrode is clogged, broken or too old. Calibrate the pH electrode. Clean the electrode. Replace the electrode.
	PH TOO HIGH (9184sc only)	PH electrode is clogged, broken or too old. Calibrate the pH electrode. Clean the electrode. Replace the electrode.
Calibration-related Error Messages	ΔT OUT OF LIMITS	The temperature difference between calibration and the theoretical sensor response is greater than the allowed limit. Limits: ±20 °C. Check temperature calibration (see section 4.5 on page 25),
	OUT OF 4/20 mA	The measured value is out of the programmed scale range for analog outputs 1 and 2.

7.2 Warning Messages

Warning Display	Problem	Resolution
CAL FAIL SLOPE LOW	Slope is outside the limits.	Check zero calibration, especially if chemical zero calibration procedure was performed. Change calibration to default settings (if necessary) and repeat concentration calibration. Ensure proper flow rate and cleanliness of probe before performing any calibrations.
SLOPE HIGH		
CAL TOO OLD	Time to chemical calibration has exceeded the CAL Delay time period.	Perform chemical calibration and/or adjust default delay time (section 4.5.5 on page 29).

Section 8 Replacement Parts and Accessories

8.1 Replacement Parts, Sensor Only

Description	Catalog Number
9184sc HOCl Chlorine Sensor	LXV430.99.00001
9184sc TFC Chlorine Sensor With pH	LXV432.99.00001
9185sc Ozone Sensor	LXV433.99.00001
9187sc Chlorine Dioxide Sensor	LXV434.99.00001

8.2 Replacement Parts

Description	Catalog Number
Cable, electrode	09184=A=4300
Cable, pH probe	09184=A=4400
Cable, transmitter	LZY105
Electrode, pH	368416,00000
Electrode, replacement, 9184sc	09184=A=1001
Electrode, replacement, 9185sc	09185=A=1000
Electrode, replacement, 9187sc	09184=A=1001
Electrode Spare Parts Kit	LZY061
Electrolyte for the 9184sc	09184=A=3600
Electrolyte for the 9185sc	09185=A=3600
Electrolyte for the 9187sc	09187=A=3600
Filling Screw	09184=C=1030
Flow Cell, pre-assembled	LZY053
Flow Cell Maintenance Kit	LZY297
Gateway Circuit Board	LZX823
Manual, English	DOC023.54.00051
Membranes, 9184sc, set of 4 pre-mounted	09184=A=3500
Membranes, 9185sc, set of 4 pre-mounted	09185=A=3500
Membranes, 9187sc, set of 4 pre-mounted	09187=A=3500
Mounting Panel	LZY059
Probe Body	09184=C=4100
Syringe	560150,21957
Tubing Adapter, ¼-inch	09184=A=4020
Tubing Kit, Acidification	LZY300

8.3 Optional Accessories

Description	Catalog Number
9180sc Acidification Unit	LZY051
9180sc Intermittent Flow Unit	LZY052
Versa Stand	5743200
125V Power Cord w/ Strain Relief	5448800
230V Power Cord w/ Strain Relief	5448900
Chlorine Free, Pocket Colorimeter II, with SwifTest DPD Reagent Dispenser	5870023
Chlorine, Free, DPD Test 'N-Tube, 10 mL sample, 50/test	2105545

8.3 Optional Accessories (continued)

Description	Catalog Number
Ozone HR AccuVac	2518025
Chlorine Dioxide Reagent Set	2770900
Manual—French	DOC023.91.00051
Manual—Portuguese	DOC023.90.00051
Manual—Spanish	DOC023.92.00051

8.4 Extension Cables

Description	Catalog Number
1 m (3.3ft)	6122400
7.6 m (25ft)	5796000
15.2 m (50ft)	5796100
30.5 m (100ft)	5796200
Digital termination box, required for total cable lengths greater than 100m (328ft)	5867000
Service cable	LXV887

Section 9 How to Order

U.S.A. Customers

By Telephone:

6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH (800-227-4224)

By Fax:

(970) 669-2932

By Mail:

Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.

Ordering information by e-mail: orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send an e-mail to: intl@hach.com or contact:

Hach Company World Headquarters; Loveland, Colorado, U.S.A.
Telephone: (00) (1) (970) 669-3050; Fax: (00) (1) (970) 669-2932

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you.

Call 1-800-227-4224 or e-mail techhelp@hach.com.

Section 10 Repair Service

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Service Center serving your location.

In the United States:

Hach Company
Ames Service
100 Dayton Avenue
Ames, Iowa 50010

(800) 227-4224 (U.S.A. only)
FAX: (515) 232-3835

In Canada:

Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4

(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

In Latin America, the Caribbean, the Far East,
Indian Subcontinent, Africa, Europe, or the Middle East:

Hach Company World Headquarters,
P.O. Box 389
Loveland, Colorado, 80539-0389 U.S.A.

Telephone: (00) (1) (970) 669-3050
FAX: (00) (1) (970) 669-2932
E-mail: intl@hach.com

Section 11 Limited Warranty

Hach Company warrants its products to the original purchaser against any defects that are due to faulty material or workmanship for a period of one year from date of shipment unless otherwise noted in the product manual.

In the event that a defect is discovered during the warranty period, Hach Company agrees that, at its option, it will repair or replace the defective product or refund the purchase price excluding original shipping and handling charges. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products such as chemical reagents; or consumable components of a product, such as, but not limited to, lamps and tubing.

Contact Hach Company or your distributor to initiate warranty support. Products may not be returned without authorization from Hach Company.

Limitations

This warranty does not cover:

- Damage caused by acts of God, natural disaster, labor unrest, acts of war (declared or undeclared), terrorism, civil strife or acts of any governmental jurisdiction
- Damage caused by misuse, neglect, accident or improper application or installation
- Damage caused by any repair or attempted repair not authorized by Hach Company
- Any product not used in accordance with the instructions furnished by Hach Company
- Freight charges to return merchandise to Hach Company
- Freight charges on expedited or express shipment of warranted parts or product
- Travel fees associated with on-site warranty repair

This warranty contains the sole express warranty made by Hach Company in connection with its products. All implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.

Some states within the United States do not allow the disclaimer of implied warranties and if this is true in your state the above limitation may not apply to you. This warranty gives you specific rights, and you may also have other rights that vary from state to state.

This warranty constitutes the final, complete, and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Hach Company.

Limitation of Remedies

The remedies of repair, replacement or refund of purchase price as stated above are the exclusive remedies for the breach of this warranty. On the basis of strict liability or under any other legal theory, in no event shall Hach Company be liable for any incidental or consequential damages of any kind for breach of warranty or negligence.

Section 12 Compliance Information

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.
The **9184sc, 9185sc, 9187sc sensor and sc series controllers** have been tested and is certified as indicated to the following instrumentation standards:

Product Safety

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

Immunity

The 9184sc, 9185sc, 9187sc sensor and sc series controllers were 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) Electro-Static Discharge
Immunity (Criteria B)
IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electro-Magnetic 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 Electro-Magnetic Field from Digital Telephones (Criteria A)

Emissions

The 9184sc, 9185sc, 9187sc sensor and sc series controllers were 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 with 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

CANADIAN INTERFERENCE-CAUSING EQUIPMENT REGULATION, IECS-003, Class A

Supporting test records with Hach Company.
This Class A digital apparatus meets all requirements of the Canadian Interference- Causing Equipment Regulations.
Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

FCC PART 15, Class "A" Limits

Supporting test records with Hach Company.
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Disconnect the Controller from it’s power source to verify that it is or is not the source of the interference.
2. If the Controller is connected into the same outlet as the device with which it is interfering, try another outlet.
3. Move the Controller away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Appendix A 9184sc Theory of Operation

A.1 Theory of Operation

The 9184sc Chlorine Analyzer is an on-line, single-channel industrial analyzer that measures free chlorine in drinking water treatment plants, distribution networks, and other applications that require monitoring free chlorine at the ppb and ppm levels.

This instrument uses an amperometric method to measure HOCl concentration. A membrane allows the selective diffusion of HOCl molecules to the amperometric sensor (section 2.3 on page 8). The measurement is compensated for pH and temperature.

A.1.1 Principle of Operation

Specific terms exist to mention the different species of chlorine:

- Active Chlorine HOCl (hypochlorous acid)

  It is the most powerful disinfectant, up to 100 times more efficient than hypochlorite

- Total Free Chlorine (TFC): HOCl + ClO^-:

  It is composed of dissolved chlorine (at low pH values), hypochlorous acid gas and hypochlorite ion. These species coexist, their relative proportion is depending on pH and temperature (see curve below for a dissociation at 25°C).

- Total Combinated Chlorine (TCC):

  It results from the addition of total free chlorine and chloramines (mono-, di- and trichloramine). The 9184 sc does not measure this parameter.

Fraction of Cl_2, HOCl and ClO^- react as a function of pH (Figure 24).

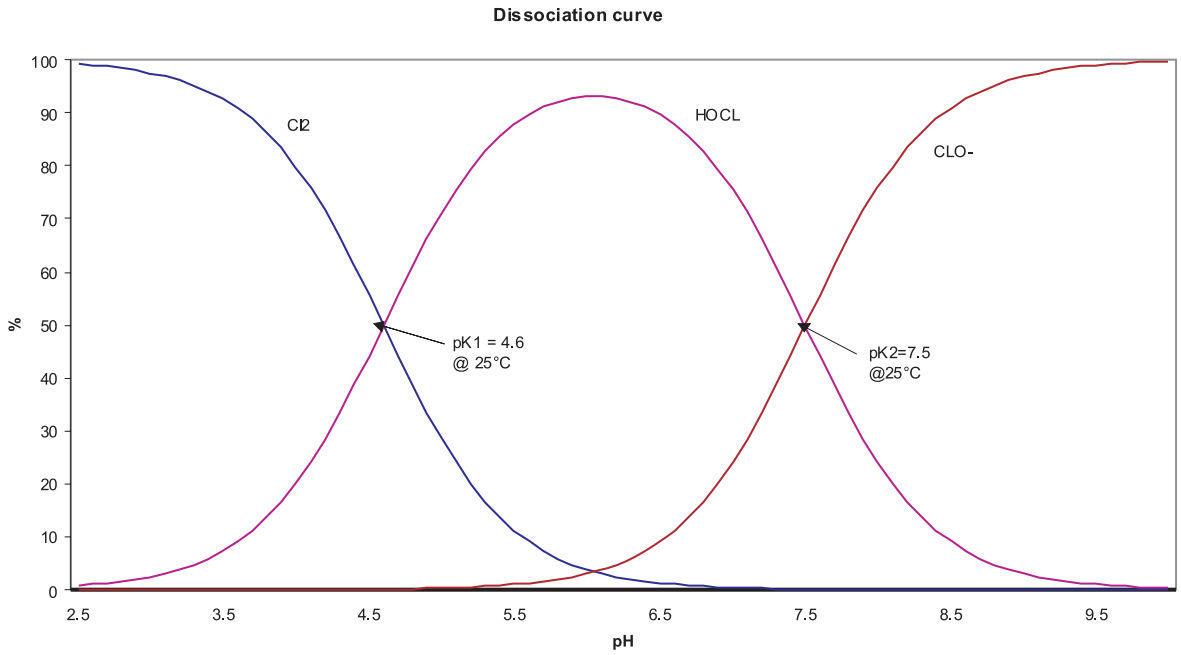


Figure 24 Dissociation Curve

The dissociation reactions are as follow:

$$Cl_2 + H_2O \rightarrow H^+ + Cl^- + HOCl \qquad pK1 = 4.6 \text{ at } 25\ ^\circ C$$

$$HOCl \rightarrow H^+ + ClO^- \qquad pK2 = 7.5 \text{ at } 25\ ^\circ C$$

It is also important to notice that the dissociation constants are temperature-dependent (the equipment takes into account this element).

The amperometric sensor consists of:

- a gold working electrode (cathode) where the main reaction occurs
- a silver counter-reference electrode (anode)
- KCl electrolyte
- a microporous membrane selective to HOCl

The HOCl molecules in the sample diffuse through the membrane to a thin region between the membrane and the cathode that contains the electrolyte.

A constant potential is applied to the working electrode where HOCl is reduced according to the reaction:

$$HOCl + H^+ + 2e^- \rightarrow Cl^- + H_2O$$

At the silver electrode (anode) the silver is oxidized to Ag^+:

$$2Cl^- + 2Ag^+ \rightarrow 2AgCl + 2e^-$$

The reduction in HOCl at the cathode generates a current that is directly proportional to its partial pressure in the sample.

The electrochemical reaction and diffusion through the membrane are dependent upon temperature. Consequently, the measurement cell contains a temperature sensor that allows for automatic temperature compensation.

The 9184sc Chlorine Sensors measure HOCl, the concentration of which is pH dependant. Therefore it is necessary to control the sample pH in certain circumstances for optimal performance. For the HOCl Sensor, accuracy is maintained at 2% until pH exceeds 8, at which point the accuracy diminishes quickly. For the TFC Sensor, accuracy is maintained at 2% until pH exceeds 7.5, at which point accuracy diminishes quickly. For this reason, it is recommended to add the 9180sc Acidification Unit to the HOCl Sensor for sample pH at values that exceed 8 and to the TFC Sensor for sample pH at values that exceed 7.5 (see Specifications on page 5). With the acidification unit, sample pH is kept constant between 5.5 and 6.5 by continuously adding acid solution. At such pH levels, all ClO^- ions turn into HOCl, thus enabling the sensor to measure TFC.

Appendix B 9185sc Theory of Operation

B.1 Theory of Operation

The 9185sc Ozone Analyzer is an on-line, single-channel industrial analyzer that measures ozone in drinking water treatment plants, distribution networks, and other applications that require monitoring ozone at the ppb and ppm levels.

This instrument uses an amperometric method to measure O_3 concentration. A membrane allows the selective diffusion of O_3 molecules to the amperometric sensor (section 2.3 on page 8). The measurement is compensated for pH and temperature.

B.1.1 Principle of Operation

Ozone is a gas that is highly soluble in water (13 times more than oxygen). It is unstable when dissolved in water.

Effects on solubility:

- Some parameters e.g. temperature and pH can influence the stability of the measurement. The solubility of ozone in water decreases rapidly with temperature.

Effects of pH: Ozone reacting with OH^- hydroxide ions: the greater the number of these ions (high pH), the greater the degree of breakdown. Conversely, at a low pH, breakdown will be slower.

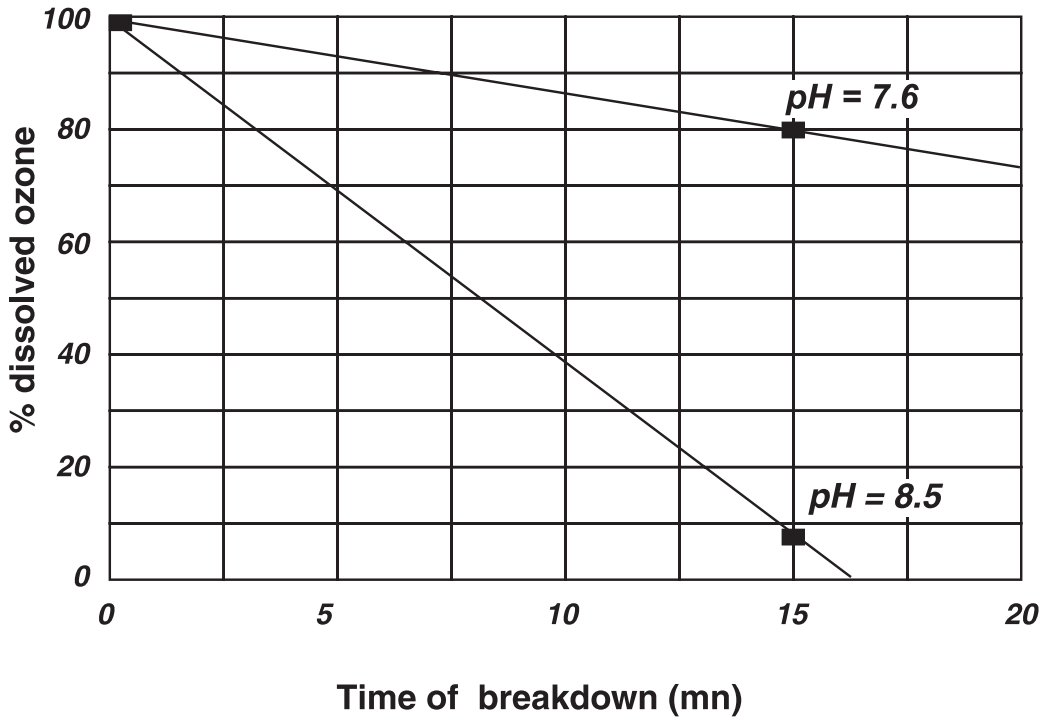


Figure 25 TIme of Breakdown of Dissolved Ozone

Finally, it is worth noting that, as the OH^- ion is a by-product of ozone breakdown in water, the reaction between OH^- and O_3 can be sustained until complete disappearance of the ozone. This is more pronounced if air is mixed with the water sample.

The exposure to free air of ozone water results in significant degassing: as the ozone content of ambient air is very low compared to that of the sample, exchange therefore occurs, with rapid loss of ozone in the sample.

This problem is even more pronounced if air/water mixing occurs. All of these phenomena, therefore, require that certain precautions be taken concerning the sampling line (section 3.2 on page 12 and section 3.3 on page 13).

Appendix C 9187sc Theory of Operation

C.1 Theory of Operation

The 9187sc Chlorine Dioxide Analyzer is an on-line, single-channel industrial analyzer that measures chlorine dioxide in drinking water treatment plants, distribution networks, and other applications that require monitoring chlorine dioxide at the ppb and ppm levels.

This instrument uses an amperometric method to measure chlorine dioxide concentration. A membrane allows the selective diffusion of ClO2 molecules to the amperometric sensor (section 2.3 on page 8). The measurement is compensated for temperature.

C.1.1 Principle of Operation

Measurement is carried out using an amperometric method after diffusion of the chlorine dioxide molecules through a membrane. The molecules of chlorine dioxide contained in the sample diffuse through the membrane and are then found in an electrolyte zone of very slight thickness between the membrane and the cathode. A constant work potential is applied to the work electrode (cathode) where ClO2 is reduced according to the reaction:

$$ClO_2 + 5e^- + 4H^+ \rightarrow Cl^- + 2H_2O$$

At the silver electrode (anode) the silver is oxidized to:

$$Ag^+ : Cl^- + Ag \rightarrow AgCl + e^-$$

The reduction in chlorine dioxide at the cathode generates a current which is directly proportional to the partial pressure of it in the sample. The electrochemical reaction and diffusion through the membrane are dependent upon temperature, consequently the measurement cell is fitted with a temperature sensor which enables the automatic compensation of measurement variations according to temperature.

Appendix D Modbus Register Information

Table 5 Sensor Modbus Registers

Tag Name	Register #	Data Type	Length	R/W	Description
Main Measurement Parameter in mg/L	40001	Float	2	R	Concentration Measurement Tag in mg/L
pH Measurement Param.	40003	Float	2	R	pH Measurement Tag
Temperature measurement	40005	Float	2	R	Temperature measurement
Current Measurement Parameter in µA	40007	Float	2	R	Current measurement in µA
Main Measurement Parameter in ppm	40009	Float	2	R	Concentration Measurement Tag in ppm
Main Measurement Parameter in ppb	40011	Float	2	R	Concentration Measurement Tag in ppb
Main Measurement Parameter in µg/L	40013	Float	2	R	Concentration Measurement Tag in µg/L
Current Measurement Parameter in nA	40015	Float	2	R	Current measurement in nA
Raw pH measurement	40017	Float	2	R	Raw pH measurement
mV Raw measurement	40019	Float	2	R	Raw ORP measurement
Raw Temperature measurement	40021	Float	2	R	Raw Temperature measurement
AutoRange Concentration in ppX	40023	Integer	1	R	Auto Ranging Tag in ppX
AutoRange Concentration in Xg/L	40024	Integer	1	R	Auto Ranging Tag in xg/L
AutoRange Current	40025	Integer	1	R	Auto Ranging redirection of nA-µA units
Concentration Tag-based	40026	Integer	1	R	Redirection tag for concentration ppm-mg/L units
Temperature Tag-based	40027	Integer	1	R/W	Redirection tag for temperature unit (°C-°F)
Sensor Name[0]	40028	Integer	1	R/W	Sensor Name[0]
Sensor Name[1]	40029	Integer	1	R/W	Sensor Name[1]
Sensor Name[2]	40030	Integer	1	R/W	Sensor Name[2]
Sensor Name[3]	40031	Integer	1	R/W	Sensor Name[3]
Sensor Name[4]	40032	Integer	1	R/W	Sensor Name[4]
Sensor Name[5]	40033	Integer	1	R/W	Sensor Name[5]
Function code	40034	Integer	1		Function code
Next Step	40035	Integer	1		Next Step
Password	40036	Pass	1	R/W	Password
Serial Number[0]	40037	Integer	1	R/W	Serial Number[0]
Serial Number[1]	40038	Integer	1	R/W	Serial Number[1]
Serial Number[2]	40039	Integer	1	R/W	Serial Number[2]
Application toogle	40040	Integer	1	R/W	9184...9187 applications
Active Concentration unit	40041	Integer	1	R/W	Active concentration unit (ppm or mg/L)
Concentration unit toogle	40042	Bit	1	R/W	Concentration unit toogle (ppm-mg/L)
Temperature unit toogle	40043	Bit	1	R/W	Temperature unit toogle (°C-°F)
Concentration offset unit	40044	Integer	1	R	Concentration offset unit (na-µA)
Compensation pH toogle	40045	Integer	1	R/W	Compensation pH toogle (manual-auto)
pH display format toogle	40046	Bit	1	R/W	pH display format XX.X or XX.XX
---	40047	Integer	1	R/W	Internal use
---	40048	Integer	1	R/W	Internal use
Averaging	40049	Integer	1	R/W	Averaging
Automatic/Manual temperature toogle	40050	Bit	1	R/W	Automatic/Manual temperature toogle
Manual Temperature unit	40051	Integer	1	R/W	Manual Temperature unit
Manual Temperature	40052	Float	2	R/W	Manual Temperature
Manual pH	40054	Float	2	R/W	Manual pH

Table 5 Sensor Modbus Registers (continued)

Tag Name	Register #	Data Type	Length	R/W	Description
50/60 Hz toogle	40056	Bit	1	R/W	50/60 Hz toogle
Output Mode	40057	Integer	1	R	Internal use
---	40058	Integer	1	R	Internal use
---	40059	Integer	1	R	Internal use
---	40060	Integer	1	R	Internal use
---	40061	Integer	1	R	Internal use
---	40062	Integer	1	R	Internal use
---	40063	Integer	1	R	Internal use
---	40064	Integer	1	R	Internal use
---	40065	Float	2	R	Internal use
---	40067	Float	2	R	Internal use
---	40069	Float	2	R	Internal use
Temperature Offset	40071	Float	2	R/W	Temperature Offset
Temperature Offset unit	40073	Integer	1	R	Internal use
pH Buffer 1 Measurement	40074	Float	2	R	Internal use
pH Buffer 2 Measurement	40076	Float	2	R	Internal use
Cal Conc Measurement	40078	Float	2	R	Internal use
Cal TFC Measurement	40080	Float	2	R	Internal use
Output Mode	40082	Integer	1	R	Internal use
Software version	40083	Float	2	R	Software version
Serial Number String[0]	40085	Integer	1	R/W	Internal use
Serial Number String[2]	40086	Integer	1	R/W	Internal use
Serial Number String[4]	40087	Integer	1	R/W	Internal use
Serial Number String[6]	40088	Integer	1	R/W	Internal use
Serial Number String[8]	40089	Integer	1	R/W	Internal use
Serial Number String[10	40090	Integer	1	R/W	Internal use
pH Offset	40091	Float	2	R	pH Calibration Offset
pH Slope	40093	Float	2	R	pH Calibration slope
Concentration Offset	40095	Float	2	R	Concentration Offset
Concentration Slope	40097	Float	2	R	Concentration Slope
Calibration Return Status	40099	Integer	1	R	Calibration Return Status
Time between two calibrations	40100	Integer	1	R/W	Time between two calibrations
Concentration zero toogle	40101	Integer	1	R/W	Concentration zero toogle (electrical-chemical)
Time from start up	40102	Integer	1	R	Time the system is running
Time to exchange Humidity bag	40103	Integer	1	R	Time the humidity bag has been used
DriverVersion_float	40104	Float	2	R	Driver version
---	40106	Float	2	R	Internal use
Measurement Logging Interval	40108	Integer	1	R/W	Sensor Data logging interval
Temperature Logging Interval	40109	Integer	1	R/W	Temperature logging interval