DOC023.52.03251.Jun05

pHD sc Digital Differential pH/ORP Sensors

User Manual

DOC023.52.03251

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Table of Contents

Section 1 Specifications ... 1

Section 2 General Information ... 3
2.1 Safety Information ... 3
2.1.1 Use of Hazard Information ... 3
2.1.2 Precautionary Labels ... 3
2.2 General Sensor Information ... 4
2.2.1 Sensor Body Styles ... 4
2.3 The Digital Gateway ... 6
2.4 Operating Precaution ... 6

Section 3 Installation ... 7
3.1 Connecting/Wiring the Sensor to the sc Controller ... 7
3.1.1 Attaching a sc Sensor with a Quick-connect Fitting ... 7
3.2 Using the Digital Gateway ... 8
3.2.1 Wiring the Digital Gateway ... 8
3.2.2 Mounting the Digital Gateway ... 10
3.3 Installing the Sensor in the Sample Stream ... 11

Section 4 Operation ... 13
4.1 Using an sc Controller ... 13
4.2 Sensor Setup ... 13
4.3 Sensor Data Logging ... 13
4.4 Sensor Diagnostics Menu for pH and ORP ... 13
4.5 pH Sensor Setup Menu ... 13
4.6 ORP Sensor Setup Menu ... 15
4.7 pH Calibration ... 17
4.7.1 Two Point Automatic Calibration ... 17
4.7.2 One Point Manual Calibration ... 17
4.7.3 Two Point Manual Calibration ... 18
4.8 ORP Calibration ... 19
4.9 Concurrent Calibration of Two Sensors for pH and ORP ... 19
4.10 Adjusting the Temperature ... 20

Section 5 Maintenance ... 21
5.1 Maintenance Schedule ... 21
5.2 Cleaning the Sensor ... 21
5.2.1 Replacing the Standard Cell Solution and Salt Bridge ... 22

Section 6 Troubleshooting ... 23
6.1 Error Codes ... 23
6.2 Warnings ... 23
6.3 Troubleshooting the pH Sensor ... 24
6.3.1 Troubleshooting a pH Sensor without Integral Digital Electronics ... 24
6.3.2 Troubleshooting the pH Sensor with Integral Digital Electronics ... 25
6.4 Checking ORP Sensor Operation ... 26
6.4.1 Troubleshooting the ORP Sensor without Integral Digital Electronics ... 26
6.4.2 Troubleshooting the ORP Sensor with Integral Digital Electronics ... 26

Section 7 Replacement Parts and Accessories ... 27
7.1 Replacement Items, Accessories, and Reagent and Standards ... 27

Table of Contents

Section 8 Warranty, liability and complaints 29
8.1 Compliance Information 30

Section 9 Contact 31

Appendix A General pH Information 32
A.1 pH Measurement Theory 32
A.2 PID Controller Basics 33

Appendix B Modbus Register Information 35

Section 1 Specifications

Specifications are subject to change without notice.

Table 1 Differential pH and ORP Sensor Specifications

Specification Category	pH Sensors[1]	Stainless Steel pH Sensor	ORP Sensors[2]
Wetted Materials	PEEK®[3] or Ryton®[4] (PVDF) body, salt bridge of matching material with Kynar®[5] junction, glass process electrode, titanium ground electrode, and Viton®[6] O-ring seals (pH sensor with optional HF-resistant glass process electrode has 316 stainless steel ground electrode, and perfluoroelastomer wetted O-rings; for other wetted O-ring materials consult the manufacturer)	Immersion mounting only, 316 SS Stainless Steel body with Ryton® (PVDF) ends and salt bridge.	PEEK® or Ryton® (PVDF) body, salt bridge of matching material with Kynar® junction, glass and platinum (or glass and gold) process electrode, titanium ground electrode, and Viton® O-ring seals
Operating Temperature Range	–5 to 70 °C (23 to 158 °F) for sensor with integral digital electronics –5 to 105 °C (23 to 221 °F) for analog sensor with digital gateway	0 to 50 °C (32 to 122 °F) for sensor with integral digital electronics	–5 to 70 °C (23 to 158 °F) for sensor with integral digital electronics –5 to 105 °C (23 to 221 °F) for analog sensor with digital gateway
Pressure/Temperature Limits (without mounting hardware)	6.9 bar at 105 °C (100 psi at 221 °F) for analog with gateway 6.9 bar at 70 °C (100 psi at 158 °F)	N/A (immersion only)	6.9 bar at 70 °C (100 psi at 158 °F) 6.9 bar at 105 °C (100 psi at 221 °F) for analog with gateway
Maximum Flow Rate	3 m (10 ft) per second	3 m (10 ft) per second	3 m (10 ft) per second
Built-in Temperature Element	NTC 300 ohm thermistor for automatic temperature compensation and analyzer temperature readout	NTC 300 ohm thermistor for automatic temperature compensation and analyzer temperature readout	NTC 300 ohm thermistor for analyzer temperature readout only — not for automatic temperature compensation
Stability	0.03 pH per 24 hours, non-cumulative	0.03 pH per 24 hours, non-cumulative	2 mV per 24 hours, non-cumulative
Maximum Transmission Distance	1000 m (3280 ft) with termination box	1000 m (3280 ft) with termination box	1000 m (3280 ft) with termination box
Sensor Cable (integral)	Digital: PUR (polyurethane) 4-conductor with one shield, rated to 105 °C (221 °F), 10 m (33 ft) standard length Analog: Five-conductor (plus two isolated shields) cable with XLPE (cross-linked polyethylene) jacket; rated to 150 °C (302 °F); 6 m (20 ft) standard length	Digital: PUR (polyurethane) 4-conductor with one shield, rated to 105 °C (221 °F), 10 m (33 ft) standard length	Digital: PUR (polyurethane) 4-conductor with one shield, rated to 105 °C (221 °F), 10 m (33 ft) standard length Analog: Five-conductor (plus two isolated shields) cable with XLPE (cross-linked polyethylene) jacket; rated to 150 °C (302 °F); 6 m (20 ft) standard length
Components	Corrosion-resistant materials, fully-immersible probe with 10 m (30 ft) cable	Corrosion-resistant materials, fully-immersible probe with 10 m (30 ft) cable	Corrosion-resistant materials, fully-immersible probe with 10 m (30 ft) cable
Measuring Range	–2.0 to 14.0 pH or –2.00 to 14.00 pH	–2.0 to 14.0 pH or –2.00 to 14.00 pH	–1500 to +1500 mV
Probe Storage Temperature	4 to 70 °C (40 to 158 °F); 0 to 95% relative humidity, non-condensing	4 to 70 °C (40 to 158 °F); 0 to 95% relative humidity, non-condensing	4 to 70 °C (40 to 158 °F); 0 to 95% relative humidity, non-condensing

Table 1 Differential pH and ORP Sensor Specifications (continued)

Specification Category	pH Sensors[1]	Stainless Steel pH Sensor	ORP Sensors[2]
Temperature Compensation	Automatic from –10 to 105 °C (14.0 to 221 °F) with selection for NTC 300 ohm thermistor, Pt 1000 ohm RTD, or Pt 100 ohm RTD temperature element, or manually fixed at a user-entered temperature; additional selectable temperature correction factors (ammonia, morpholine, or user-defined pH/°C linear slope) available for pure water automatic compensation from 0.0 to 50 °C (32 to 122 °F)	Automatic from –10 to 105 °C (14.0 to 221 °F) with selection for NTC 300 ohm thermistor, Pt 1000 ohm RTD, or Pt 100 ohm RTD temperature element, or manually fixed at a user-entered temperature; additional selectable temperature correction factors (ammonia, morpholine, or user-defined pH/°C linear slope) available for pure water automatic compensation from 0.0 to 50 °C (32 to 122 °F)	N/A
Measurement Accuracy	±0.02 pH	±0.02 pH	±5 mV
Temperature Accuracy	±0.5 °C (0.9 °F)	±0.5 °C (0.9 °F)	±0.5 °C (0.9 °F)
Repeatability	±0.05 pH	±0.05 pH	±2mV
Sensitivity	±0.01 pH	±0.01 pH	±0.5 mV
Calibration Methods	Two point automatic, one point automatic, two point manual, one point manual.	Two point automatic, one point automatic, two point manual, one point manual.	one point manual
Maximum Probe Immersion Depth/ Pressure	Submersible to 107 m (350 ft)/1050 kPa (150 psi)	Immersion only	Submersible to 107 m (350 ft)/1050 kPa (150 psi)
Sensor Interface	Modbus	Modbus	Modbus
Probe Cable Length	6 m (20 ft) + 7.7 m (25 ft) interconnect cable extension for analog sensor with digital gateway 10 m (31 ft) for sensor with integral digital electronics	6 m (20 ft) + 7.7 m (25 ft) interconnect cable extension for analog sensor with digital gateway 10 m (31 ft) for sensor with integral digital electronics	6 m (20 ft) + 7.7 m (25 ft) interconnect cable extension for analog sensor with digital gateway 10 m (31 ft) for sensor with integral digital electronics
Probe Weight	316 g (11 oz)	870 g (31 oz)	316 g (11 oz)
Probe Dimensions	See Figure 2 on page 5 through Figure 3 on page 5.	See Figure 4 on page 5.	See Figure 2 on page 5 through Figure 3 on page 5.

[1] Most pH applications are in the 2.5 to 12.5 pH range. The pHD™ Differential pH sensor with the wide-range glass process electrode performs exceptionally well in this range. Some industrial applications require accurate measurement and control below 2 or above 12 pH. In these special cases, please contact the manufacturer for further details.
[2] For best ORP measuring results in solutions containing zinc, cyanide, cadmium or nickel, the manufacturer recommends using the pHD™ ORP sensor equipped with a gold electrode.
[3] PEEK® is a registered trademark of ICI Americas, Inc.
[4] Ryton® is a registered trademark of Phillips 66 Co.
[5] Kynar® is a registered trademark of Pennwalt Corp.
[6] Viton® is a registered trademark of E.I. DuPont de Nemours + Co.

Table 2 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

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.

The electronics of the sensor are encapsulated in a PEEK® or Ryton® body. The pH sensor has an integral NTC 300 ohm thermistor to automatically compensate pH readings for temperature changes. ORP sensors have a fixed temperature value of 25 °C/300 ohm (the ORP measurement is not temperature dependent).

2.2.1 Sensor Body Styles

pHD™ Differential pH and ORP sensors are available in three body styles:

- **Convertible Body Style** — has 1-inch NPT threads at both ends of the body for mounting in any of the following configurations:
  - into a standard 1-inch NPT pipe tee
  - into a pipe adapter for union mounting with a standard 1-½ inch pipe tee
  - onto the end of a pipe for immersion into a vessel

Note: *The convertible style sensor can also be retrofitted into existing installations for 1-½ inch LCP, Ryton, and epoxy sensors.*

- **Insertion Body Style** — similar to the convertible sensor except that its 1-inch NPT threads are only on the cable end for mounting into a flow cell or the pipe adapter of a ball valve hardware assembly. This hardware enables the sensor to be inserted into or retracted from the process without stopping the process flow.
- **Sanitary Body Style** — features a built-in 2-inch flange for mounting into a 2-inch sanitary tee. Included with the sanitary-style sensor is a special cap and EDPM compound gasket for use with the sanitary hardware.

In addition, all probes are available with or without integral digital electronics.
For applications with extreme temperatures, the sensor without integral digital electronics can be combined with the digital gateway.

Figure 1 Convertible Style Sensor Dimensions

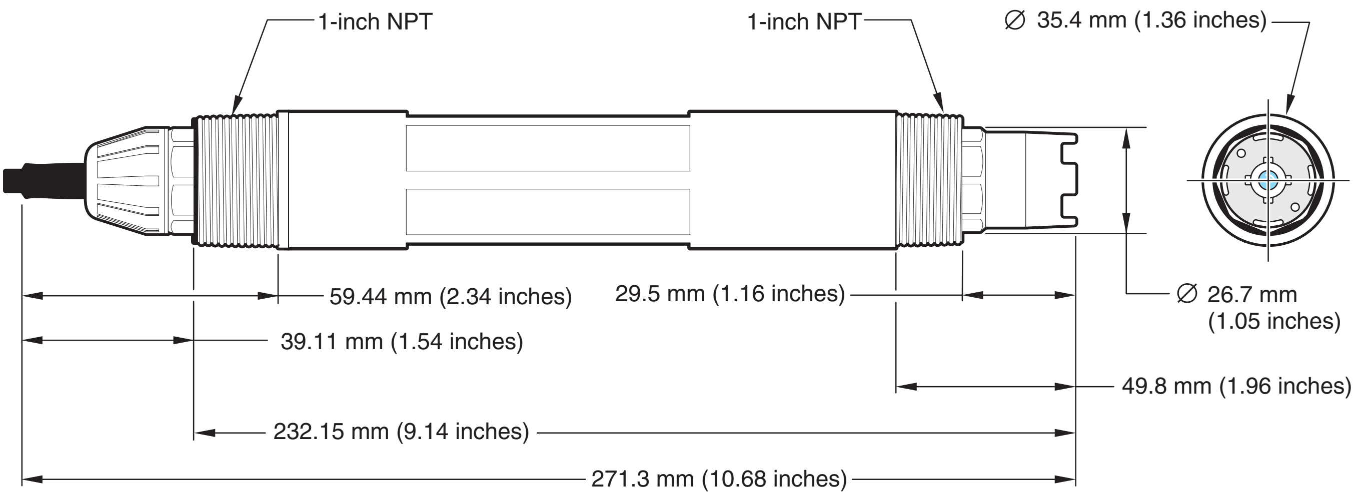


Figure 2 Insertion Style Sensor Dimensions

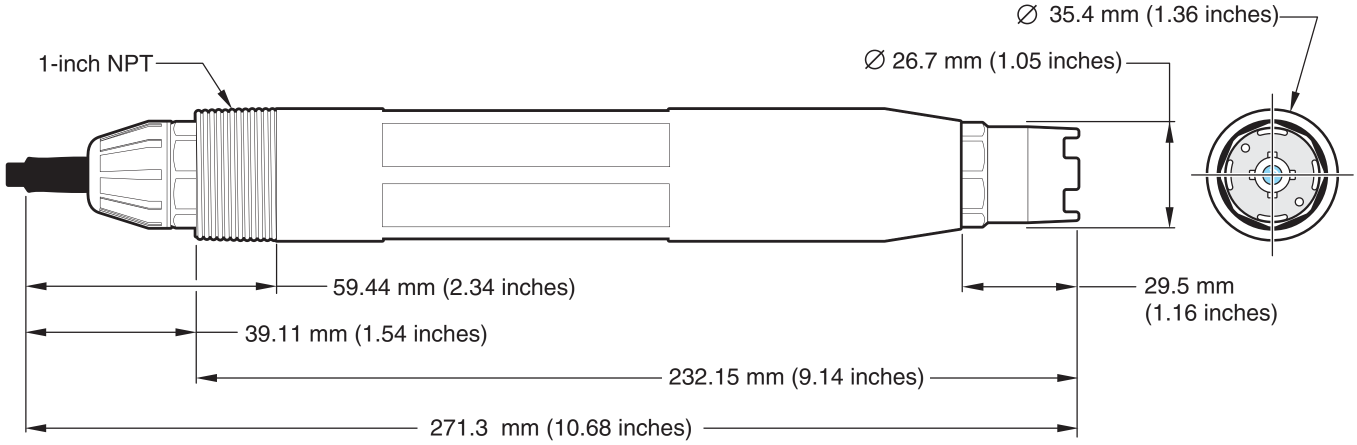


Figure 3 Sanitary Style Sensor Dimensions

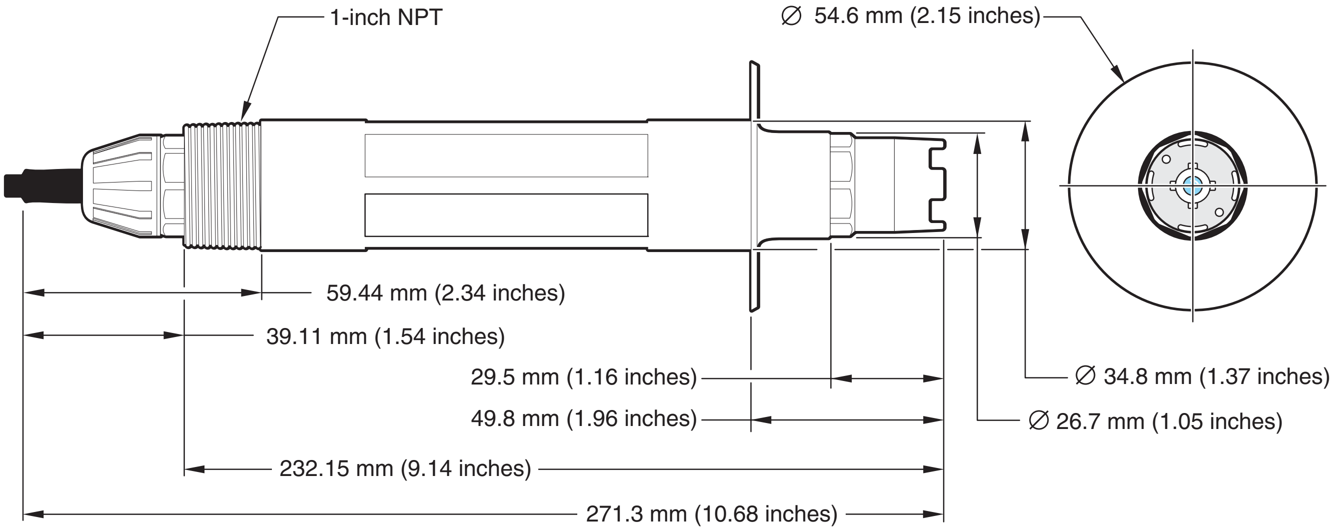
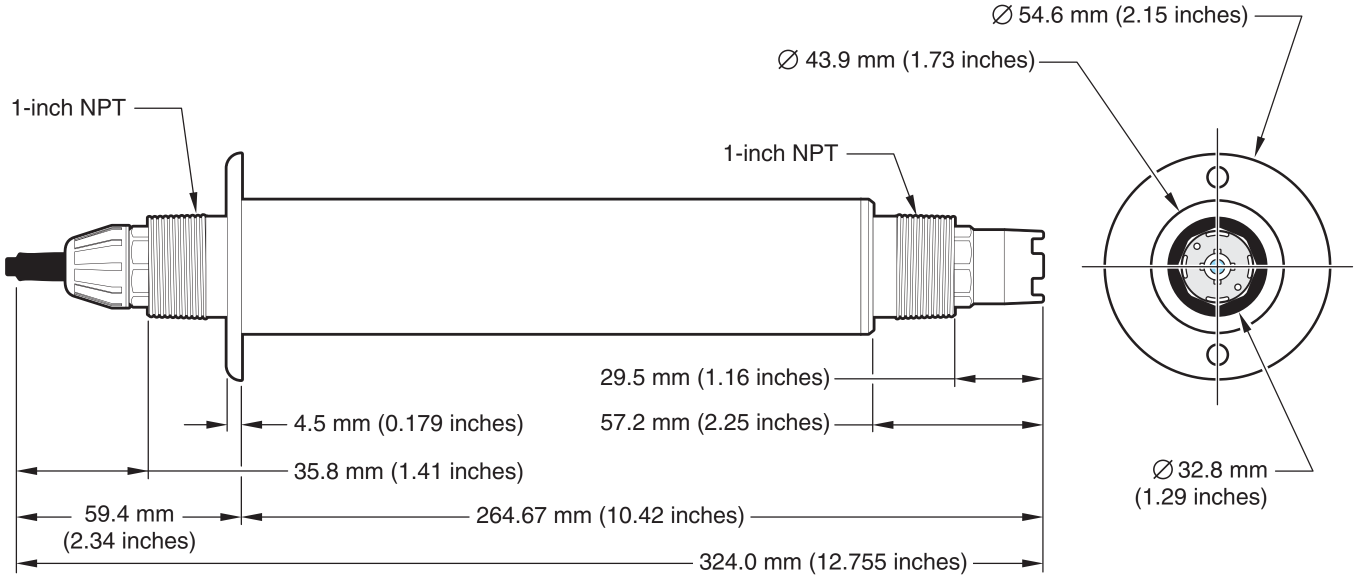


Figure 4 Stainless Steel Style Sensor (DPS1 and DRS5) Dimensions



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 Operating Precaution

CAUTION
If the pH process electrode breaks, handle the sensor very carefully to prevent injury.

Before placing the pH or ORP sensor into operation, remove the protective cap to expose the process electrode and salt bridge. Save the protective cap for future use.

For short-term storage (when sensor is out of the process for more than one hour) fill the protective cap with pH 4 buffer or DI water and place the cap back on the sensor. Keeping the process electrode and salt bridge moist will avoid slow response when the sensor is placed back in operation.

For extended storage, repeat the short-term storage procedure every 2 to 4 weeks, depending on the surrounding environmental conditions. See Specifications on page 1 for temperature storage limits.

The process electrode at the tip of the pH sensor has a glass bulb, which can be broken. Do not subject it to abrupt impact or other mechanical abuse.

The gold or platinum process electrode at the ORP sensor tip has a glass shank (hidden by the salt bridge) which can break. Do not subject this electrode to impact or other mechanical abuse.

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

3.1 Connecting/Wiring the Sensor to the 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 (Figure 5). 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 5 Attaching the Sensor using the Quick-connect Fitting

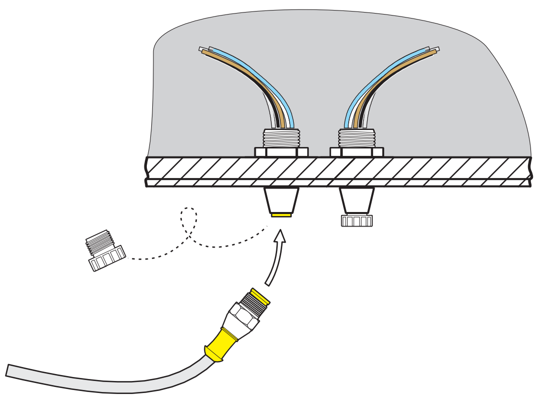
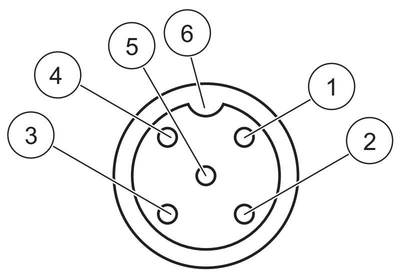


Figure 6 Quick-connect Fitting pin assignment



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.

3.2.1 Wiring the Digital Gateway

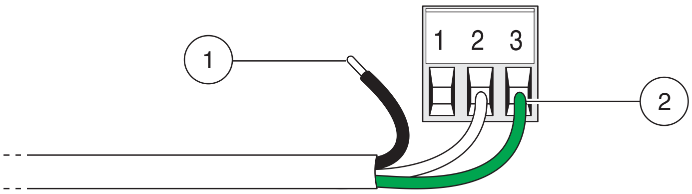
DANGER
Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

1. Route the cable from the sensor through the strain relief in the digital gateway then properly terminate the wire ends (see Figure 7).

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

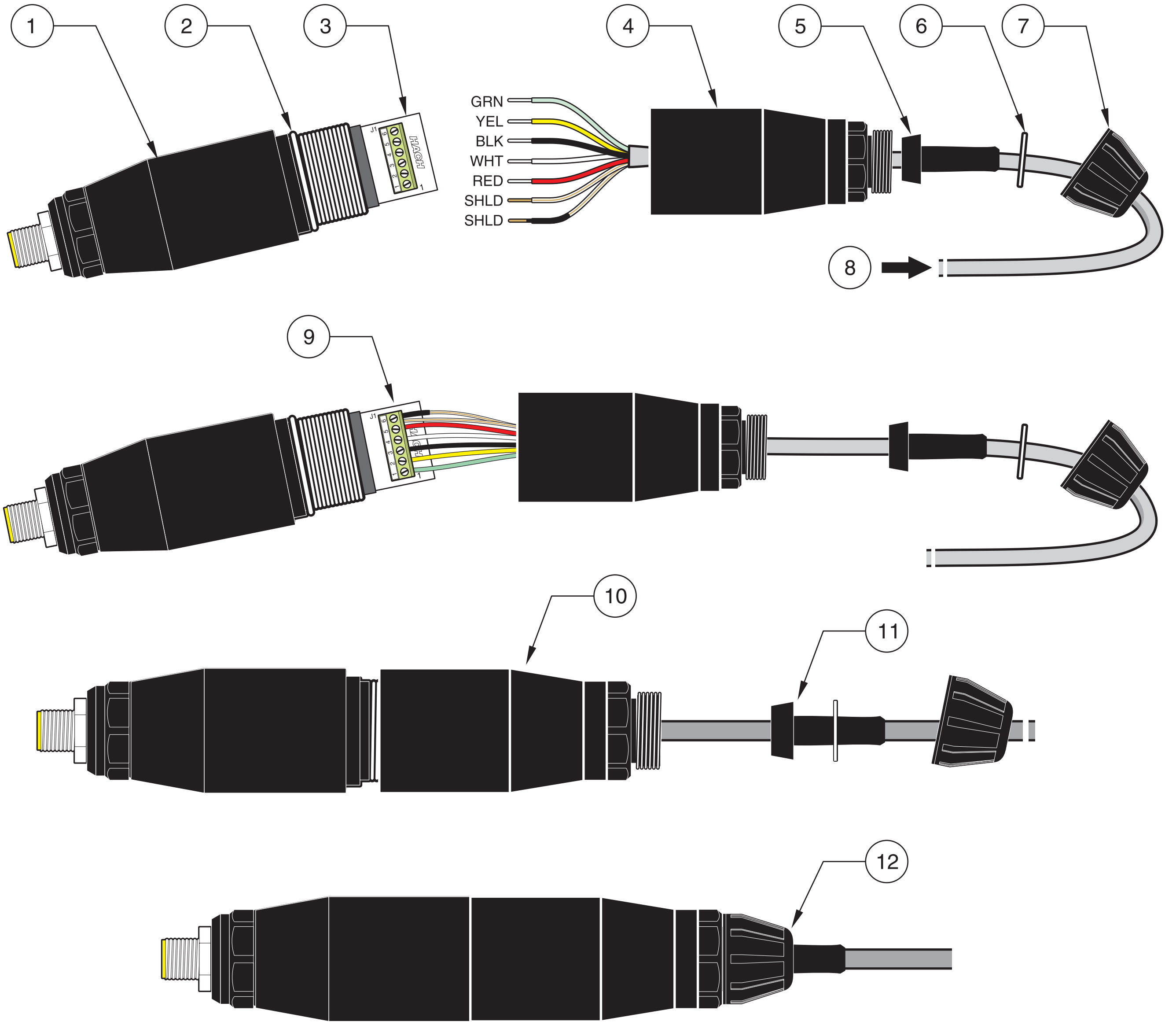
2. Insert the wires as shown in Table 3 and Figure 8.
3. Make sure the O-ring is properly installed between the two halves of the digital gateway and thread the two halves together. Hand tighten.
4. Tighten the strain relief to secure the sensor cable.
5. Connect the digital gateway to the controller.

Figure 7 Proper Wire Preparation and Insertion



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

Figure 8 Wiring and Assembling the Digital Gateway



1. Digital gateway front	**7.** Cord grip
2. O-ring	**8.** From sensor
3. Sensor wire connector	**9.** Insert wires into connector according to Table 3. 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.

Table 3 Wiring the Digital Gateway (Cat. No. 6120500)

Sensor (wire color)	Sensor Signal	Digital Gateway J1
Green	Ref	J1-1
Yellow	Temp +	J1-2
Black	Temp –	J1-3
White	VI	J1-4
Red	Active	J1-5
Clear	Shield	J1-6
Clear w/shrink wrap	Shield	J1-6

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. See Figure 9 for dimensions. Use an appropriate fastener to secure it to the wall, see Figure 10. 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.

Figure 9 Digital Gateway Dimensions

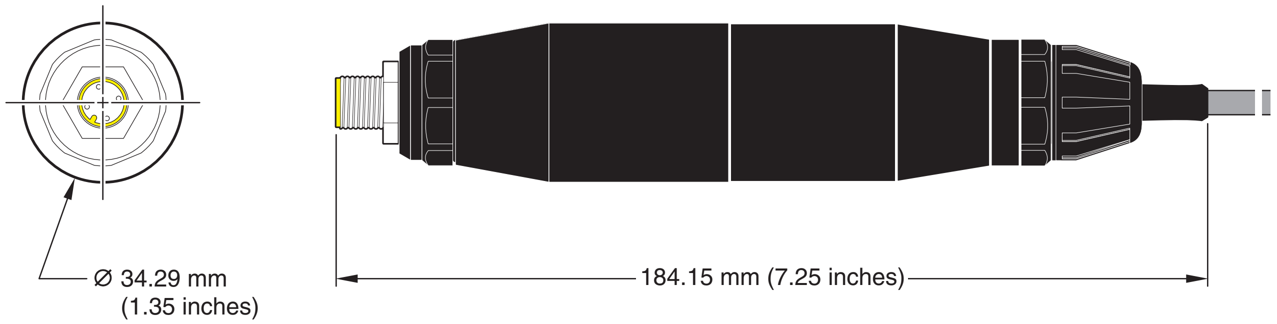
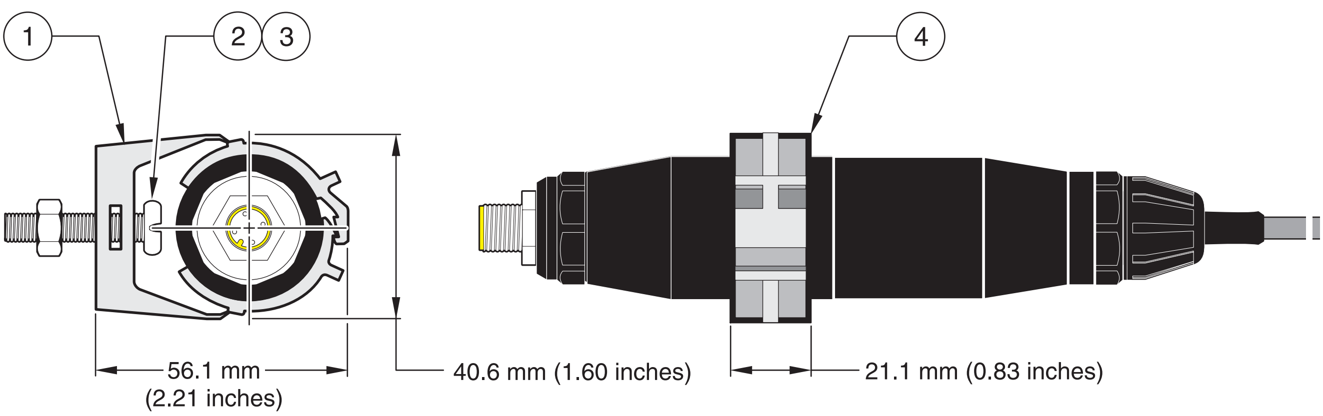


Figure 10 Mounting the Digital Gateway

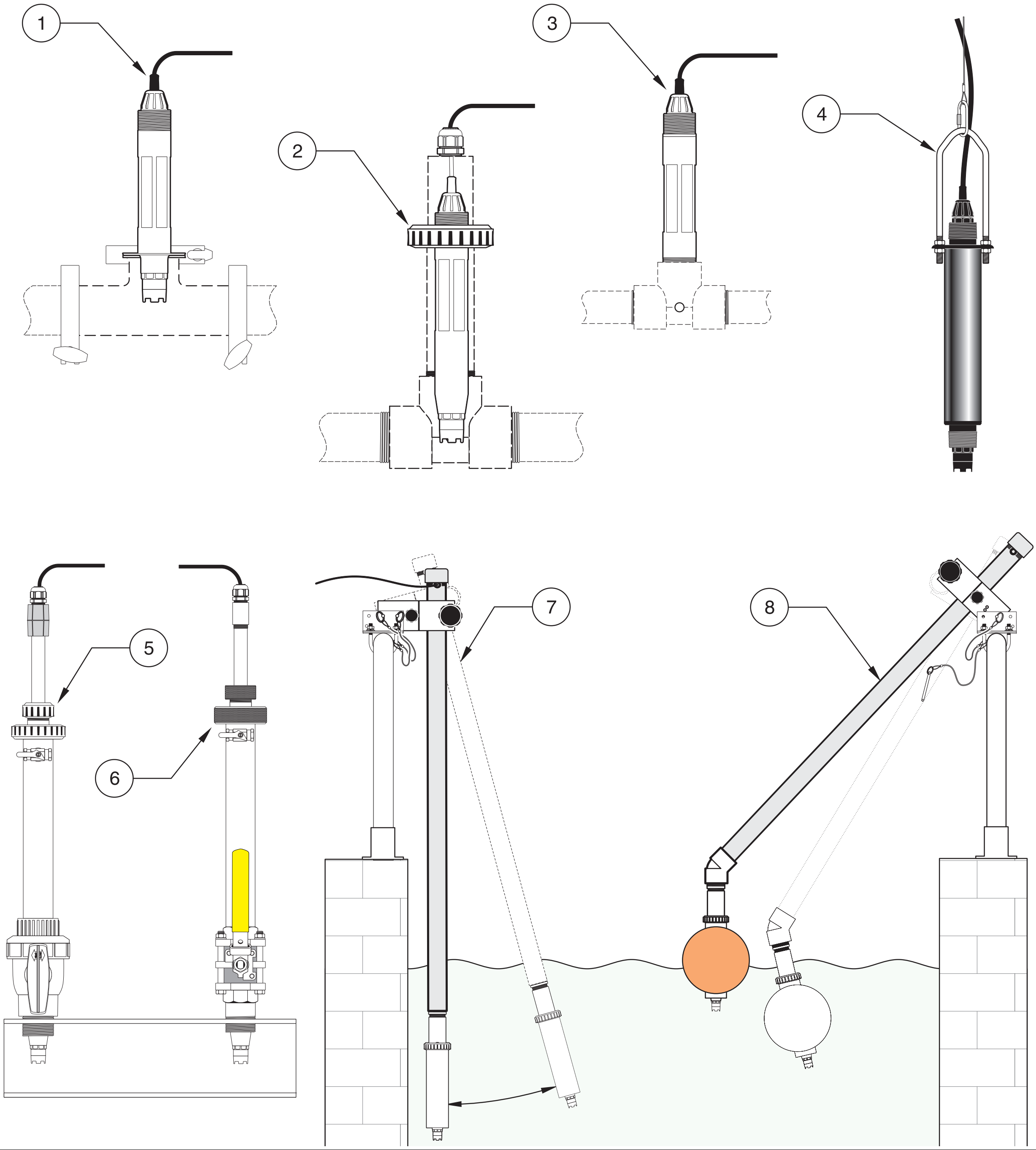


1. Mounting Clip	**3.** Hex Nut, ¼-28
2. Screw, pan head, ¼-28 x 1.25-in.	**4.** Mount clip, insert digital gateway, squeeze clip closed.

3.3 Installing the Sensor in the Sample Stream

- Install the sensor so the sample contacts is representative of the entire process.
- Mount the sensor at least 508 mm (20 in) from the aeration basin wall, and immerse it at least 508 mm (20 in) into the process.
- Install the sensor using the instructions supplied with the installation apparatus. See Figure 11 for suggested mounting configurations.

Figure 11 Sensor Installation Examples



1. Sanitary mount	**5.** PVC Insertion mount
2. Union mount	**6.** Stainless steel insertion mount
3. Flow-through mount	**7.** Immersion mount
4. Hanging stainless steel sensor with the bale	**8.** Immersion mount, ball float

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 Main Menu.
2. From the Main Menu, select SENSOR SETUP and confirm.
3. Highlight 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 Diagnostics Menu for pH and ORP

SELECT SENSOR
ERROR LIST–See section 6.1 on page 23.
WARNING LIST–See section 6.2 on page 23.

4.5 pH Sensor Setup Menu

SELECT SENSOR (if more than one sensor is attached)
CALIBRATE
1 POINT AUTO
Calibration with a single buffer — normally pH 7.
2 POINT AUTO
Calibration with two buffers — normally pH 7 and pH 4 or 10.
1 POINT MANUAL
Calibration against a single known sample.
2 POINT MANUAL
Calibration against two samples, both with a known pH.

4.5 pH Sensor Setup Menu (continued)

	TEMP ADJUST	
		Adjust the displayed temperature by up to ± 15 °C.
	DEFAULT SETUP	
		Restores the system to the original factory calibration.
CONFIGURE		
	EDIT NAME	
		Enter up to a 10-digit name in any combination of symbols and alpha or numeric characters.
	SELECT MEASURE	
		Select the appropriate measurement units to display.
	DISPLAY FORMAT	
		Select the measurement resolution (xx.xx pH or xx.x pH).
	TEMP UNITS	
		Choose from the displayed options (°C or °F).
	LOG SETUP	
		Choose SENSOR INTERVAL to set the sensor log interval or select TEMP INTERVAL to set the temperature log interval.
	REJECT FREQ	
		Choose 50 or 60 Hz depending on the power line frequency for optimal noise rejection. Default is 60 Hz.
	FILTER	
		Select 0–60 second signal averaging time.
	TEMP ELEMENT	
		Select type of temperature element from the displayed choices.
	SELECT BUFFER	
		Select the buffer type (standard 4, 7, 10 or DIN 19267) from the displayed choices.
	PURE H20 COMP	
		Allows the user to specify that ammonia, morpholine, or other user-defined electrolyte is being used in the application, allowing a temperature-dependent linear slope factor to be applied to the measured pH.
	CAL DAYS	
		Number of days since the last calibration. Default notification at 60 days.
	SENSOR DAYS	
		Number of days the sensor has been in operation. Default notification at 365 days.
	DEFAULT SETUP	
		Resets all user-editable options to their factory-defaults.
DIAG/TEST		
	PROBE INFO	
		Display the sensor type, entered name of the sensor (Default: sensor serial number.), the sensor serial number, the software version number, and the sensor driver version number.
	CAL DATA	
		Displays the pH slope and the date of the last calibration.

4.5 pH Sensor Setup Menu (continued)

SIGNALS
SENSOR SIGNAL: Displays the sensor output in mV
SENSOR ADC COUNTS: Displays the sensor ADC counts
TEMP ADC COUNTS: Displays raw data for temperature ADC counts. ADC counts are comparable to A/D counts and are for sensor electronic diagnostic purposes only.
ELECTRODE STATE: Identifies the state of the electrode (good or bad) depending on whether the impedance is within preset limits.
ACTIVE ELECT: Displays the impedance (Mohms) of the active electrode if Imped Status is set to Enabled.
REF. ELECTRODE: Displays the impedance (Mohms) of the reference electrode if Imped Status is set to Enabled.
IMPED STATUS: Sensor diagnostic. Choose Enabled or Disabled.
COUNTERS
SENSOR DAYS: displays the cumulative days the sensor has been in use.
RESET SENSOR: Allows the sensor counter to be reset to zero.
ELECTRODE DAYS: Cumulative days the electrode has been in use.

4.6 ORP Sensor Setup Menu

SELECT SENSOR (if more than one sensor is attached)
CALIBRATE
1 POINT MANUAL
Calibration against a single known sample.
TEMP ADJUST
Adjust the displayed temperature by up to ± 15 °C.
DEFAULT SETUP
Restores the system to the original factory calibration.
CONFIGURE
EDIT NAME
Enter up to a 10-digit name in any combination of symbols and alpha or numeric characters. Press **ENTER** when the entry is complete. The name will be displayed on the status line with the measurement value.
SELECT SENSOR
Choose from the displayed sensor type (pH or ORP).
TEMP UNITS
Choose from the displayed options (°C or °F).
LOG SETUP
Choose SENSOR INTERVAL to set the sensor log interval or select TEMP INTERVAL to set the temperature log interval.
AC FREQUENCY
Choose 50 or 60 Hz depending on the power line frequency for optimal noise rejection. Default is 60 Hz.
CONFIGURE (continued)
FILTER
Select 0–60 second signal averaging time.
TEMP ELEMENT
Select type of temperature element from the displayed choices.

4.6 ORP Sensor Setup Menu (continued)

CAL DAYS	
	Number of days since the last calibration. Default notification at 60 days.
SENSOR DAYS	
	Number of days the sensor has been in operation. Default notification at 365 days.
IMPED LIMITS	
	Set min/max electrode sensor impedance limits.
DEFAULT SETUP	
	Resets all user-editable options to their factory-defaults.
DIAG/TEST	
PROBE INFO	
	Display the sensor type, entered name of the sensor (Default: sensor serial number.), the sensor serial number, the software version number, and the sensor driver version number.
CAL DATA	
	Displays the slope and the date of the last calibration.
SIGNALS	
	SENSOR SIGNAL: displays the sensor output in mV SENSOR ADC COUNTS: displays the sensor ADC counts TEMP ADC COUNTS: shows raw data for temperature ADC counts. ADC counts are comparable to A/D counts and are for sensor electronic diagnostic purposes only. ELECTRODE STATE: Identifies the state of the electrode (good or bad) depending on whether the impedance is within preset limits. ACTIVE ELECT: Shows the impedance (Mohms) of the active electrode if Imped Status is set to Enabled. REF. ELECTRODE: Shows the impedance (Mohms) of the reference electrode if Imped Status is set to Enabled. IMPED STATUS: Sensor diagnostic. Choose Enabled or Disabled.
COUNTERS	
	SENSOR DAYS: displays the cumulative days the sensor has been in use. RESET SENSOR: allows the sensor counter to be reset to zero. ELECTRODE DAYS: Cumulative days the electrode has been in use.

4.7 pH Calibration

The manufacturer offers one and two point automatic and manual calibrations for pH. An automatic calibration identifies the buffer table corresponding to the chosen buffer and automatically calibrates the probe after it stabilizes. A manual calibration is performed by placing the pH sensor in any buffer or sample with a known value and then entering that known value into the controller.

The value of the sample used in the manual calibration may be determined by laboratory analysis or comparison reading.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select 1 POINT AUTO. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.
5. Move the clean probe to buffer and confirm to continue.
6. Confirm when stable. A screen will display 1 Point Auto Complete and the slope (XX.X mV/pH).
7. Return the probe to process.

4.7.1 Two Point Automatic Calibration

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select 2 POINT AUTO. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.
5. Move the clean probe to Buffer 1 and confirm.
6. Confirm when stable.
7. Move the clean probe to Buffer 2 and confirm.
8. Confirm when stable. A screen will display 2 Point Calibration Complete and the slope (XX.X mV/pH).
9. Return the probe to process.

4.7.2 One Point Manual Calibration

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

4. Select 1 POINT MANUAL. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.

5. Move the clean probe to solution and confirm to continue.

6. Confirm when stable. Edit the solution value using the keypad and confirm.

7. Confirm when stable. A screen will display 1 Point Manual Complete and the slope (XX.X mV/pH).

8. Return the probe to process.

4.7.3 Two Point Manual Calibration

1. From the Main Menu, select SENSOR SETUP and confirm.

2. Select the appropriate sensor if more than one is attached and confirm.

3. Select CALIBRATE and confirm.

4. Select 2 POINT MANUAL CAL. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.

5. Move the clean probe to Solution 1 and confirm.

6. Confirm when stable. Edit the solution value using the keypad and confirm.

7. Move probe to solution 1 and confirm.

8. Confirm when stable. Edit the solution value using the keypad and confirm.

9. A screen will display 2 Point Manual Cal Complete and the slope (XX.X mV/pH).

10. Return the probe to process.

4.8 ORP Calibration

The manufacturer offers a one point manual calibration for ORP. The value of the sample used in the manual calibration may be determined by laboratory analysis or comparison reading.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select 1 POINT MANUAL CAL. Select the available Output Mode (Active, Hold, or Transfer) from the list box and confirm.
5. Move the clean probe to Solution and confirm.
6. Confirm when stable. Edit the solution value using the keypad and confirm.
7. A screen will display 1 Point Manual Complete and the slope (XX.X mV).
8. Return the probe to process.

4.9 Concurrent Calibration of Two Sensors for pH and ORP

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. The reading for the sensor currently being calibrated will flash.
3. Begin the calibration for the second sensor and continue until “Wait to Stabilize” is displayed.
4. Select LEAVE and confirm. The display will return to the main measurement screen and the reading for both sensors will flash. The calibration for both sensors are now running in the background.
5. To return to the calibration of either sensor select SENSOR SETUP from the Main Menu and confirm. Select the appropriate sensor and confirm.
6. The calibration in progress will be displayed. Continue with the calibration.

4.10 Adjusting the Temperature

View or change the temperature using the steps below.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select TEMP ADJUST and confirm.
5. Select MEASURED TEMP and confirm.
6. The temperature will be displayed. Tap on the temperature and edit the temperature using the keypad and confirm.

Section 5 Maintenance

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

DANGER
Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

5.1 Maintenance Schedule

Maintenance Task	**90 days**	**Annually**
Clean the sensor[1]	x	
Inspect sensor for damage	x	
Replace Salt Bridge and fill solution[2]		x
Calibrate Sensor (as 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.
[2] Salt bridge replacement frequency is application dependent. More or less frequent replacement will be appropriate in some applications

5.2 Cleaning the Sensor

CAUTION
Before cleaning with acid, determine if the chemical reaction between the acid and the sample will create a hazardous chemical reaction. (For example, do not put a sensor that is used in a cyanide bath directly into a strong acid for cleaning because this chemical combination may produce poisonous cyanide gas.)

1. Clean the exterior of the sensor with a stream of water. If debris remains remove loose contaminate buildup by carefully wiping the entire measuring end of the sensor (process electrode, concentric metal ground electrode, and salt bridge) with a soft clean cloth. Rinse the sensor with clean, warm water.

2. Prepare a mild soap solution of warm water and dish detergent or other non-abrasive soap that does not contain lanolin such as laboratory glass cleaner.

Note: *Lanolin will coat the glass process electrode and can adversely affect sensor performance.*

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

4. Use a small soft bristle brush (such as a toothbrush) and scrub the entire measuring end of the sensor, thoroughly cleaning the electrode and salt bridge surfaces. If surface deposits cannot be removed by detergent solution cleaning, use muriatic acid (or other dilute acid) to dissolve them. The acid should be as dilute as possible. Experience will determine which acid to use and the appropriate dilution ratio. Some stubborn coatings may require a different cleaning agent.

DANGER
Acids are hazardous. Always wear appropriate eye protection and clothing in accordance with material safety data sheet recommendations.

5. Soak the entire measuring end of the sensor in dilute acid for no more than 5 minutes. Rinse the sensor with clean, warm water then place the sensor back into the mild soap solution for 2 to 3 minutes to neutralize any remaining acid.

6. Remove the sensor from the soap solution, and rinse the sensor again in clean, warm water.

7. After cleaning, always calibrate the measurement system.

5.2.1 Replacing the Standard Cell Solution and Salt Bridge

If calibration cannot be attained, rejuvenate the sensor by replacing its standard cell solution and salt bridge as shown in Figure 12. If calibration is still not possible, refer to Section 6 on page 23.

1. To remove the salt bridge, hold the sensor upright (electrode at top), and use pliers or a similar tool to turn it counterclockwise. Take care not to damage the protruding process electrode. Properly discard the old salt bridge.

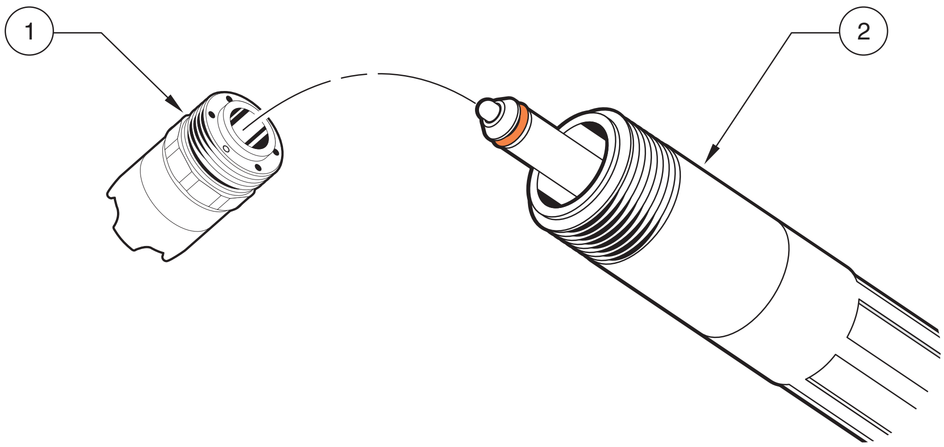
2. Replace the standard cell solution in the sensor reservoir.

   a. Pour out the aged solution, and thoroughly flush the reservoir with distilled water.

   b. Fill the reservoir to the bottom of the salt bridge threads with fresh standard cell solution (Cat. No. 25M1A1025-115).

3. Install a new o-ring then carefully thread the new salt bridge clockwise until it is finger-tight and the bottom surface of the salt bridge is in full contact with the top surface of the sensor body. Do not over tighten.

Figure 12 Replacing Standard Cell Solution and Salt Bridge



1. Salt Bridge	**2.** Sensor

Section 6 Troubleshooting

6.1 Error Codes

Errors are defined in Table 4.

Table 4 Error Codes

Displayed Error	Definition	Resolution
ADC FAILURE	System measurement fails	Contact Technical Consulting Services.

6.2 Warnings

Errors are defined in Table 5.

Table 5 Warning Codes

Displayed Warning	Definition	Resolution
PROBE OUT RANGE	Measured pH/ORP exceeds the expected value range.	Contact Technical Consulting Services.
TEMP OUT RANGE	Measured temperature exceeds the expected value range.	Contact Technical Consulting Services.
FLASH FAILURE	System flash memory write has failed.	Contact Technical Consulting Services.
ACTIVE. ELEC	Standard electrode is not performing within the required specifications.	Contact Technical Consulting Services.
REF. ELECTRODE	Reference electrode is not performing within the required specifications.	Contact Technical Consulting Services.
CAL REQUIRED	60 days has elapsed since the last calibration	Perform a calibration.
REPLACE SENSOR	One year has elapsed since the sensor has been installed.	Replace sensor and restore counter in the SENSOR SETUP>DIAG/TEST>RESET SENSOR menu

6.3 Troubleshooting the pH Sensor

Clean the sensor using the procedure described in section 5.2 on page 21. If the measuring system cannot be calibrated after cleaning, replace the standard cell solution and salt bridge (see section 5.2.1 on page 22) and try calibrating again. If the measuring system still cannot be calibrated, check the sensor operation.

Some simple tests using the sc100 or a multimeter and two pH buffers will determine if the pH sensor is operating properly. The use of pH 7 and pH 4 buffers is preferred but pH 10 can be used in place of pH 4 if it more closely covers the measurement range of interest.

Determine if the sensor has integral digital electronics or uses an external digital gateway. If the sensor uses a digital gateway, it will be hard-wired to the gateway through terminal connections inside the digital gateway enclosure. If the sensor uses the digital gateway and therefore does not have integral digital electronics, proceed with section 6.3.1. If the sensor has integral digital electronics, move to section 6.3.2 on page 25.

6.3.1 Troubleshooting a pH Sensor without Integral Digital Electronics

1. Disconnect the red, green, yellow, and black sensor wires from the digital gateway.
2. Place the sensor in a pH 7 buffer. Before continuing, allow the temperatures of the sensor and buffer to equalize to approximately 25 °C (70 °F).
3. Verify that the sensor temperature element (300 ohm thermistor) is operating properly by measuring the resistance between the yellow and black wires. The reading should be between 250 and 350 ohms at approximately 25 °C (70 °F).
4. Reconnect the yellow and black wires.
5. Connect the multimeter (+) lead to the red wire and (–) lead to the green wire. With the sensor in the pH 7 buffer, measure the dc millivolts. The sensor offset reading should be within the factory-specified limits of –50 and +50 mV. If it is, record the millivolt value reading and continue with step 6. If the reading is outside these limits, discontinue this test and contact Technical Support.
6. With the multimeter still connected, rinse the sensor with water and place it in either pH 4 or pH 10 buffer. Allow the temperatures of the sensor and buffer to equalize to approximately 25 °C (70 °F) then measure the sensor span reading as shown in Table 6 and Table 7 on page 25.

Span Reading in pH 4 Buffer
With the sensor in pH 4 buffer, the sensor span reading should be at least +160 mV more than the offset reading taken in step 5.

Table 6 Typical Span Reading Examples (pH 4 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 4 buffer)
–50 mV	+110 mV
–25 mV	+135 mV
0 mV	+160 mV
+25 mV	+185 mV
+50 mV	+210 mV

Span Reading in pH 10 Buffer
With the sensor in pH 10 buffer, the sensor span reading should be at least –160 mV less than the noted offset reading taken in step 5.

Table 7 Typical Span Reading Examples (pH 10 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 10 buffer)
–50 mV	–210 mV
–25 mV	–185 mV
0 mV	–160 mV
+25 mV	–135 mV
+50 mV	–110 mV

If the span reading is at least +160 mV more than or –160 mV less than the offset reading in pH 4 or pH 10, respectively, the sensor is within factory-specified limits. If not, contact Technical Support.

6.3.2 Troubleshooting the pH Sensor with Integral Digital Electronics

1. Place the sensor in pH 7 buffer and allow the buffer and sensor to reach temperature equilibrium. This can be verified by monitoring the sensor temperature value for a stable temperature measurement. This value is shown on the sc controller display when it is in measurement mode.
2. From the Sensor Setup Menu on the sc controller, select "Diag/Test" and confirm.
3. Select "Sensor Signal" and confirm. This sensor offset reading should be within factory-specified limits of –50 and +50 mV. If it is, write down this millivolt value reading and perform step 4. If the reading is outside these limits, discontinue this test and contact Technical Support.
4. Rinse the sensor and place it in pH 4 or 10 buffer and allow the buffer and sensor to reach temperature equilibrium. This can be verified by monitoring the sensor temperature value for a stable temperature measurement. This value is located on the sc100 display when it is in measurement mode.
5. From the Sensor Setup Menu on the sc controller, select "Diag/Test" and confirm.
6. Select "Sensor Signal" and confirm. Then measure the sensor span value.

Span Reading in pH 4 Buffer
With the sensor in pH 4 buffer, the sensor span reading should be at least +160 mV more than the offset reading as shown in Table 8 and Table 9.

Table 8 Typical Span Reading Examples (pH 4 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 4 buffer)
–50 mV	+110 mV
–25 mV	+135 mV
0 mV	+160 mV
+25 mV	+185 mV
+50 mV	+210 mV

Span Reading in pH 10 Buffer
With the sensor in pH 10 buffer, the sensor span reading should be at least –160 mV less than the noted offset reading taken in step 6. Examples of typical readings:

Table 9 Typical Span Reading Examples (pH 10 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 10 buffer)
–50 mV	–210 mV
–25 mV	–185 mV
0 mV	–160 mV
+25 mV	–135 mV
+50 mV	–110 mV

7. If the span reading is at least +160 mV more than or –160 mV less than the offset reading in pH 4 or pH 10, respectively, the sensor is within factory-specified limits. If not, contact Technical Support.

6.4 Checking ORP Sensor Operation

Simple tests using the sc controller or a multimeter and a 200 mV reference solution can determine if the ORP sensor is operating properly. Determine if the sensor has integral digital electronics or uses an external digital gateway. If the sensor uses a digital gateway, it will be hard-wired to the digital gateway through terminal connections within the digital gateway enclosure. If the sensor uses a digital gateway proceed with section 6.4.1. If the sensor has integral digital electronics, move to section 6.4.2 on page 26.

6.4.1 Troubleshooting the ORP Sensor without Integral Digital Electronics

1. Disconnect the red, green, yellow, and black sensor wires from the digital gateway.
2. Place the sensor in a 200 mV reference solution and allow the temperature of the sensor and reference solution to equalize to approximately 25 °C (70 °F).
3. Verify that the sensor temperature element (300 ohm thermistor) is operating by measuring the resistance between the yellow and black wires. The reading should be between 250 and 350 ohms at approximately 25 °C (70 °F).
4. Reconnect the yellow and black wires.
5. Connect the multimeter (+) lead to the red wire and (–) lead to the green wire. With the sensor in the 200 mV reference solution, measure the dc millivolts. The reading should be between 160 and 240 mV. If the reading is outside these limits, contact Technical Support.

6.4.2 Troubleshooting the ORP Sensor with Integral Digital Electronics

1. Place the sensor in 200 mV reference solution and allow the buffer and sensor to reach temperature equilibrium. This can be verified by monitoring the sensor temperature value for a stable temperature measurement. This value is located on the sc100 display when it is in measurement mode.
2. From the Sensor Setup Menu on the sc controller, select “Diag/Test” and confirm. Select “Sensor Signal” and confirm. The reading should be between 160 and 240 mV. If the reading is outside these limits, contact Customer Service.

Section 7 Replacement Parts and Accessories

7.1 Replacement Items, Accessories, and Reagent and Standards

Item Description	QTY	Catalog Number
Air blast cleaning system, 115 V, includes Kynar® (PVDF) washer head with 7.6 m (25 ft) tubing and quick connect fitting, and a compressor in a NEMA 4X enclosure	each	1000A3335-005
Air blast cleaning system, 230 V, includes Kynar® (PVDF) washer head with 7.6 m (25 ft) tubing and quick connect fitting, and a compressor in a NEMA 4X enclosure	each	1000A3335-006
Air/Water blast cleaning head	each	1000A3335-004
Buffer, pH 7	500 mL (1 pint)	2283549
Buffer, pH 4	500 mL (1 pint)	2283449
Buffer, pH 10	500 mL (1 pint)	2283649
Buffer, pH 7	1 gallon	2283556
Buffer, pH 4	1 gallon	2283456
Buffer, pH 10	1 gallon	2283656
Buffer, pH 7	500 mL (1 pint)	2283549
Cable, interconnect, unterminated ends, specify length in whole feet	each	1W1100
Cable, sensor extension, 1 m (3 ft)	each	6122400
Cable, sensor extension, 7.7 m (25 ft)	each	5796000
Cable, sensor extension, 15 m (50 ft)	each	5796100
Cable, sensor extension, 31 m (100 ft)	each	5796200
Connector Cable	each	6139900
Instruction manual, Differential pH System, English	each	DOC023.52.03251
Plug, sealing, conduit opening	each	5868700
O-ring, Viton	each	5H1304
O-ring, EPDM	each	5H1306
O-ring, Perflouro	each	5H1096-019
ORP Standard Solution, 200 mV	500 mL (1 pint)	25M2A1001-115
ORP Standard Solution, 600 mV	500 mL (1 pint)	25M2A1002-115
ORP Standard Solution, 200 mV	1 gallon	25M2A1001-123
ORP Standard Solution, 600 mV	1 gallon	25M2A1002-123
Salt Bridge, PEEK® Body, PVDF outer junction	each	SB-P1SV
Salt Bridge Ryton® Body, PVDF outer junction	each	SB-R1SV
Standard Cell Solution	each	25M1A1025-115
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

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

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Appendix A General pH Information

A.1 pH Measurement Theory

pH is the negative logarithm of the hydrogen ion activity and a measure of the acidity or alkalinity of a solution.

$$pH = -\log A[H+]$$

pH is normally measured using a glass electrode and a reference electrode.

The glass electrode acts as a transducer, converting chemical energy (the hydrogen ion activity) into an electrical energy (measured in millivolts). The reaction is balanced and the electrical circuit is completed by the flow of ions from the reference solution to the solution under test.

The electrode and reference solution together develop a voltage (emf) whose magnitude depends on the type of reference electrode, the internal construction of the glass electrode, the pH of the solution and the temperature of the solution. This voltage is expressed by the Nernst Equation:

$$E = E_o - (2.3\ RT/F) \times \log A[H+]$$
$$E = E_o - (\text{slope}) \times \log A[H+]$$

where:

E = the emf of the cell

E_o = the zero potential (isopotential) of the system. It depends on the internal construction of the glass and reference electrodes.

R = gas constant

T = temperature in Kelvin

A[H+] = activity of the hydrogen ion (assumed to be equivalent to the concentration of hydrogen ions)

F = Faraday constant

For every unit change in pH (or decade change in ion concentration) the emf of the electrode pair changes by 59.16 mV at 25 °C. This value is known as the Nernstian Slope of the electrode.

The pH electrode pair is calibrated using solutions of known and constant hydrogen ion concentration, called buffer solutions. The buffer solutions are used to calibrate both the electrode isopotential and slope.

A.2 PID Controller Basics

A pH control loop operates as follows: The pH meter measures the value of the pH in the effluent, and, if the pH is different from the setpoint, the controller actuates the reagent pump (or valve) that adds reagent to a mixing tank. The added reagent adjusts the pH value of the process.

The physical layout of the loop, the sizing of the pump (valve), type of mixing tank, and location of the pH electrodes all have a major impact on the ultimate performance of the loop, after the controller is tuned for optimal performance. The largest single performance factor is the delay time around the loop. This includes the response time of the electrode/meter, time required to deliver the reagent to the process water, time required for the reagent to mix with and react with the process water, and the time required to deliver the completely mixed water to the electrode. If the delay times are too long or the mixing is not complete, the control will be poor regardless of how well the controller is tuned.

The Process pH Meter uses a PID (proportional, integral (reset), derivative (rate) control) control algorithm. Each of the instrument settings along with their effects on the control loop, are described below.

Mode
Manual: The manual output is specified in percent of full-scale PID output (4–20 mA) and is commonly used for testing the output device.

Auto: Allows the process to be controlled automatically using information specified in the Phase, Setpoint, Proportional Band, Integral, and Derivative menus as follows:

Phase
Direct: The control output action will cause the process value to increase.

Reverse: The control output action will cause the process value to decrease.

Setpoint
The setpoint is defined as the desired process value in pH

Proportional Band
The proportional band is the range in pH from the setpoint value where the controller provides proportional control. For example, the desired setpoint for the process is pH 7.0 and the process requires that a reagent must be added to the process water to bring it up to pH 7.0. If the proportional band is set to pH 1.0, the controller will provide proportional output control over the range of pH 6.0 to 8.0. When the process is at pH 6.0, the controller will provide a 100% control output level (assuming that Phase is set to Direct). When the process is at pH 7.0, the proportional control will provide a 0% control output level. When the process is at pH 6.5 the proportional control will provide a 50% output. The output action is equal to the difference between the setpoint and the process value, divided by the proportional band value.

Integral

The integral value is used to reduce the steady state error, between the process value and the setpoint, to zero. For example, assume a process can be manually controlled at a level of pH 8.0 by sending a 35% control output level to a reagent pump. Now, say that the system is set up for the controller to provide proportional only control, with the controller setpoint set to pH 8.0 and the proportional band set to pH 1.0. Note that the nearer the process gets to the pH 8.0 setpoint, the lower the control output level is. In fact, when the process is at pH 8.0, the output level will be 0%. Since the process requires that the pump be operated at 35% for the process to reach pH 8.0, its apparent that proportional-only control will never quite reach the desired setpoint of pH 8.0. This is where the integral control comes in.

Integral control can be thought of as adding up the output action from the proportional control over time. For example, the proportional control output reaches a steady state level of 5%. If the integral time is set to five minutes, the integral action of the controller will add an additional 5% to the controller output level over a 5-minute interval. The integral action is additive, so for every 5-minute interval an additional 5% is added to the controller's output level. This will allow the controller to bring the process to the desired setpoint level. Note that the longer the integral time setting, the longer it takes for the integral action to affect the process. The integral control action is disabled by setting it to zero. Note that the integral time is in minutes.

Derivative

Derivative control is used to adjust the control output level based upon the rate at which the process value is approaching or passing the setpoint. Derivative control action would be used in cases where the process value can rapidly ramp up and overshoot the setpoint. The derivative setting is in minutes. The output action of the derivative control is equal to the rate of change of the process (in pH units per minute) times the derivative time, divided by the proportional band, times negative one. For example, if the process pH is changing at a rate of pH 0.20 per minute, the derivative time is set to 3.0 minutes, the proportional band is set to pH 0.80, and the action is “direct” the derivative control output action will be approximately equal to: (–0.20 pH/minute X 3.0 minute) /0.80 pH = –75%.

During calibration, the analog outputs can remain active, be held, or be transferred to a preset mA value.

Appendix B Modbus Register Information

Table 10 Sensor Modbus Registers

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Tags	SensorMeasTag	40001	Integer	1	R	Sensor measurement tag
Measurements	pHMeas	40002	Float	2	R	pH /ORP measurement
Tags	TempMeasTag	40004	Integer	1	R	Temperature measurement tag
Measurements	TempDegCMeas	40005	Float	2	R	Temperature measurement
Configuration	SensorName	40007	String	6	R/W	Sensor name
Tags	FuncCode	40013	Integer	1	R/W	Function code tag
Tags	NextState	40014	Integer	1	R/W	Next state tag
Configuration	MeasType	40015	Integer	1	R/W	Measurement type-pH or ORP
Configuration	TempUnits	40016	Integer	1	R/W	Temperature units-C or F
Configuration	pHFormat	40017	Integer	1	R/W	pH display format
Configuration	TaggedPhFormat	40018	Long	2	R	pH display tagged format
Configuration	Filter	40020	Integer	1	R/W	Sensor filter
Configuration	TempElementType	40021	Integer	1	R/W	Temperature element type
Tags	TempUserValueTag	40022	Integer	1	R	Temperature user value tag
Configuration	TempUserDegCValue	40023	Float	2	R/W	Temperature user value
Configuration	pHBuffer	40025	Integer	1	R/W	pH buffer type
Configuration	PureWaterCompType	40026	Integer	1	R/W	Pure H_2O compensation type
Configuration	PureWaterCompUser	40027	Float	2	R/W	Pure H_2O compensation user val
Calibration	OutputMode	40029	Integer	1	R/W	Output mode
Calibration	CalLeave	40030	Integer	1	R/W	Cal leave mode
Calibration	CalAbort	40031	Integer	1	R/W	Cal abort mode
Tags	CalEditValueTag	40032	Integer	1	R	Cal edit value tag
Calibration	CalEditPhValue	40033	Float	2	R/W	Cal edit value
Diagnostics	pHSlope	40035	Float	2	R	pH slope
Diagnostics	SoftwareVersion	40037	String	6	R	Software version
Diagnostics	SerialNumber	40043	String	6	R	Serial number
Diagnostics	pHOffset	40049	Float	2	R	pH offset
Diagnostics	OrpOffset	40051	Float	2	R	Orp offset
Calibration	CalCode	40053	Integer	1	R	Cal code
Configuration	SensorLogInterval	40054	Integer	1	R/W	Sensor data log interval
Configuration	TempLogInterval	40055	Integer	1	R/W	Temperature data log interval
Diagnostics	pHmV	40056	Float	2	R	pH mV
Diagnostics	ProdDate	40058	Date	2	R/W	Production date
Diagnostics	StdElectrode	40060	Float	2	R	Standard electrode impedance
Diagnostics	RefElectrode	40062	Float	2	R	Reference electrode impedance
Diagnostics	LastCalDate	40064	Date	2	R	Last calibration date
Diagnostics	SensorDays	40066	Integer	1	R	Sensor running days
Diagnostics	ElectrodeDays	40067	Integer	1	R	Electrode running days
Diagnostics	ElectrodeStatus	40068	Integer	1	R	Electrode status

Table 10 Sensor Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Diagnostics	SensorType	40069	Integer	1	R	Sensor type
Configuration	RejectFrequency	40070	Integer	1	R/W	Reject frequency
Diagnostics	DeviceDriver	40071	String	5	R	Device driver
Configuration	CalWarningDays	40076	Integer	1	R/W	Calibration warning days
Configuration	SensorWarningDays	40077	Integer	1	R/W	Sensor warning days

Index

D
Derivative 33
Derivative (Rate) Control 33
E
Error Codes 23
I
Integral 33
Integral (Reset) 33
M
Maintenance Schedule 21
P
Parts
    Replacement 27
PID control
    Proportional 33
Proportional 33
Proportional Band 33
S
Safety Information 3
Sensor Cable
    Connecting 7
    Wiring 7
Specifications 1
W
Warnings 23
Warranty 29