PULSE INSTRUMENTS®
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Disinfection Sensors Instruction Manual

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1.0 Introduction

The Pulse Instruments disinfection sensors consist of an amperometric sensor assembly and a flow cell and/or manifold. Assembly of these parts is required, so please read these instructions carefully. The sensor is capable of measuring the disinfectant in clean water or in water contaminated with debris thanks to our unique flow cell design.

The sensors are not compatible with water containing surfactants!

Sensor

The sensor assembly includes the sensor body with 6 meters (20 feet) of cable, a replaceable membrane cap, a 100-ml bottle of electrolyte fill solution, and special abrasive paper. Make sure that all parts are included.

The oxidizer molecules diffuse through the membrane and in the acidic environment of the electrolyte fill solution, a redox reaction occurs at the electrodes in the sensor. The current generated by this reaction is converted to a robust voltage signal that is linear with the concentration of the oxidizer.

Flow Cell

The flow cell consists of a translucent flow cell body, lid and o-ring, and a compression fitting to hold the sensor in place. Make sure that all of the parts are included.

The flow cell is required to prevent bubble formation on the membrane and to provide proper flow velocity across the face of the membrane, and allows debris or organic matter to pass through without clogging the flow cell.. The sensor will not read accurately if it is not installed in the flow cell, with a constant flow rate between 1 to 2 gallons per minute. It must not be exposed to a pressure above 14.7 psi or the membrane will be permanently destroyed, so it is recommended to discharge the sample water into atmospheric pressure and that the inlet pressure is throttled.

2.0 Installation

Assembling the Sensor

CAUTION: Wear gloves and safety glasses during assembly of the sensor since the electrolyte is a STRONG ACID. It is recommended to perform this operation over a sink with running water available. After using, re-cap any remaining electrolyte and store the bottle until the next use.

PPM Sensors

1. Clean just the **tip** of the working electrode with the special abrasive paper supplied. Avoid touching the electrodes! Place the special abrasive paper on top of a clean paper towel and rub the electrode tip over the abrasive paper, holding the electrode at a slight angle. Repeat several times at different angles. Never touch or clean the brown electrode shaft.

2. Fill the membrane cap to the top with the electrolyte fill solution. **Never shake the electrolyte bottle, it must stay free of bubbles!**

3. Hold the sensor body vertically with the tip pointing down and SLOWLY screw on the membrane cap until it is hand tight. **Be prepared for some electrolyte solution to squeeze out from the vent hole in the cap.**

4. Rinse your hands, the sensor, and all surfaces contaminated with electrolyte solution with running water. Check the sensor for leaks, especially at the membrane and the membrane cap threads. If any leaks are detected, tighten the membrane cap or replace it. Move the rubber band back into the groove. **Never remove the membrane cap with the rubber band covering the vent hole, or the membrane will be damaged!**

5. Push the cable onto the end of the sensor, aligning the pins with the holes. Turn the connector until hand tight to seal the cable connection.

Other Sensors

1. Remove the black protective tube from the electrode tip, and clean just the **tip** of the working electrode with the special abrasive paper supplied. Avoid touching the electrodes! Place the special abrasive paper on top of a clean paper towel and rub the electrode tip over the abrasive paper, holding the electrode at a slight angle Repeat several times at different angles. Never touch or clean the brown electrode shaft.

2. Open the vial containing the membrane cap. Empty out the water. Make sure that only one grey rubber band is in the groove covering the vent hole in the membrane cap. Fill the membrane cap to the top with the electrolyte fill solution.

3. Hold the sensor body vertically with the tip pointing down and SLOWLY screw on the membrane cap until it is hand tight. **Be prepared for some electrolyte solution to squeeze out from the vent hole in the cap.**

4. Push the second grey band into the groove in the cap, making sure that the bands are smooth and flush.

5. Rinse your hands, the sensor, and all surfaces contaminated with electrolyte solution with running water. Check the sensor for leaks, especially at the membrane and the membrane cap threads. If any leaks are detected, tighten the membrane cap or replace it.

6. Push the cable onto the end of the sensor, aligning the pins with the holes. Turn the connector until hand tight to seal the cable connection.

Flow Cell Placement

Instructions for mounting the sensor into the process can vary greatly with the circumstances that are encountered in your application. Here are some general guidelines to assist you. Refer also to the typical installation drawings.

The sensor should be mounted such that the measuring surfaces will always stay wet. If the membrane dries out, it will respond slowly to changing disinfectant values for 24 hours, and if dried out repeatedly, will fail prematurely. **If the sensor is left dry for longer than 24 hours, the membrane cap must be replaced!**

The flow cell should be placed on the discharge side of a circulation pump or downhill from a gravity feed. Flow into the cell must come from the bottom side of the flow cell and discharge out of the top of the flow cell.

A “U” trap should be installed so that if the flow stops, the sensor is still immersed in the water. The outlet of the flow cell must be plumbed to open atmosphere unless the system pressure is at or below 1 atmosphere. If the flow through the line cannot be stopped to allow for cleaning and calibration of the sensor, then it should be placed in a by-pass line with isolation valves to allow for sensor removal. Install the sensor vertically, with the measuring surface pointing down, at least 5 degrees above horizontal. (Refer to Installation drawings)

Flow rate regulation must be done upstream from the sensor, because any flow restriction downstream can increase the pressure above atmospheric and damage the membrane cap!

The sensor should be installed in an area where there is good solution movement and where it will respond rapidly to chemical additions. The placement of the sensor relative to the placement of chemical replenishment, along with the quality of the mixing, and the replenishment chemical flow rate are critical to accurate process control.

To avoid biological growth on the membrane, which can block measurement, never leave the sensor in water without oxidant for longer than 24 hours.

Installing Sensor into Flow Cell

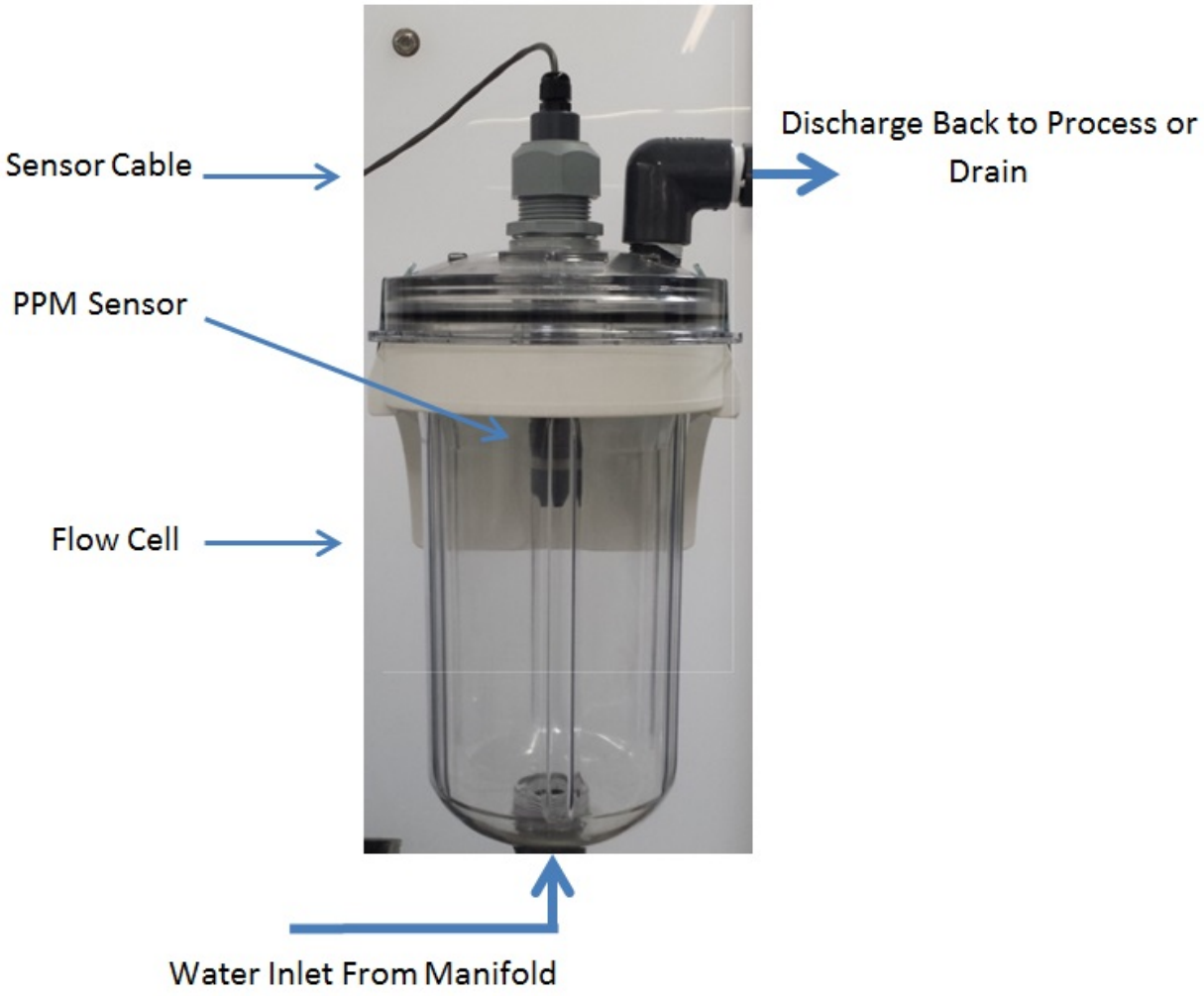
1. Assemble the sensor based on the instructions above. Do not yet attach the sensor cable.

2. Remove the lid of the flow cell by opening the two latches and gently lifting the lid from the flow cell. Remove the grey nut from the compression fitting on the top of the flow cell.

3. Insert the top of the sensor through the bottom of the lid, through the bottom of the flow cell lid until ~1" of the sensor is sticking above the . Place the grey nut and screw it on slightly to secure the sensor in place.

4. Immediately fill the manifold/ flow cell with water so that the membrane does not dry out. At this point the cable can be connected to the sensor and the controller can be powered on.

Typical Installation

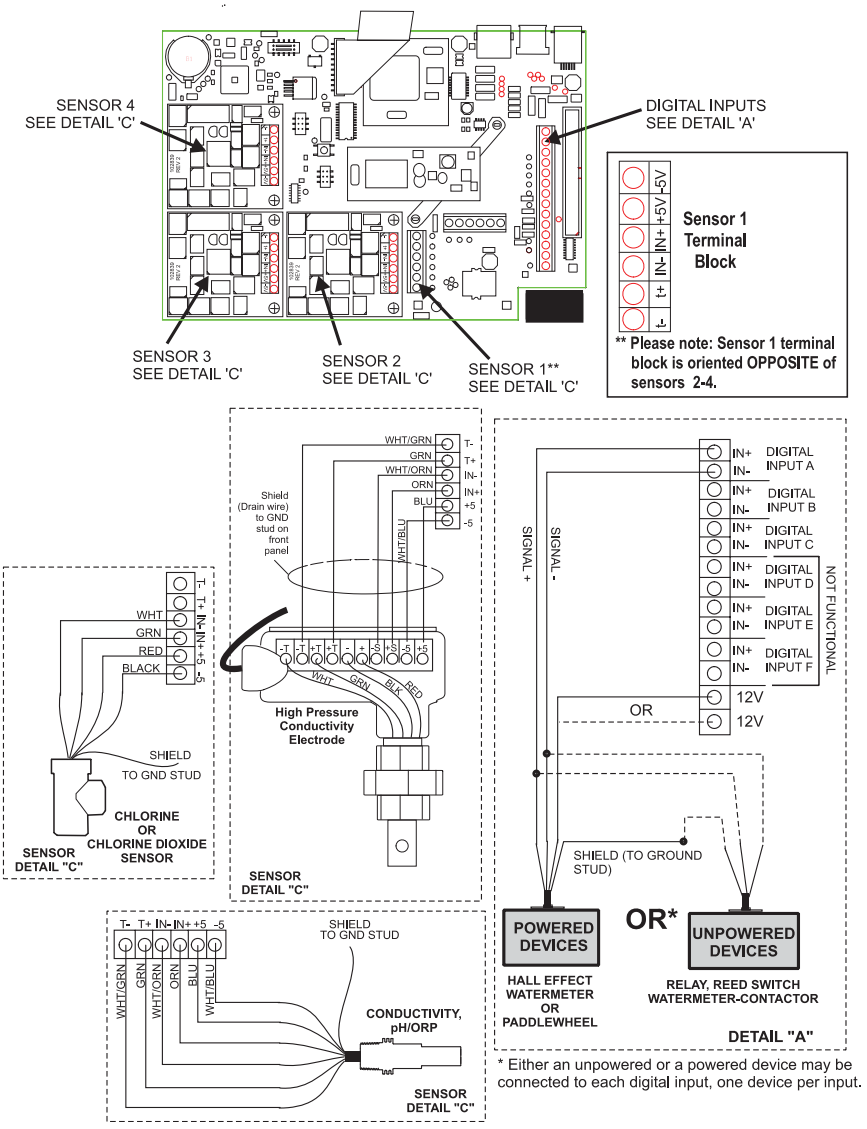


Wiring Instructions

The sensor is provided with a 2-twisted pair, shielded, 24 AWG, 35 pF/foot capacitance cable. The wiring to the controller is as follows:

Shield Drain:	Earth Ground
GRN:	IN+
WHT:	IN-
RED:	+5 V
BLK:	- 5 V

If the required cable length exceeds the 6 meters (20 feet) that is supplied, it can be extended using 4-conductor shielded cable. Maximum cable length must not exceed 1000' feet.



3.0 Operation

This section describes how to prepare the sensor for use.

Conditioning

The sensor requires conditioning to acclimate the electrodes prior to generating stable readings. Conditioning consists of installing the sensor in the flow cell, ensuring that the sensor remains wet at all times with water containing the disinfectant to be measured, and supplying power to the sensor.

The following conditioning times are recommended:

New Sensor	12 – 24 hours
After membrane or electrolyte replacement	1-3 hours (see specifications in section 6.0)

Calibration

The frequency of calibration is a function of many factors. These factors include:

1. The accuracy required by the application.
2. The value of the off-specification product versus the cost of calibration.
3. The coating or abrasive nature of the application.
4. The stability of the sensor and controller as a system.

The frequency of calibration is really determined by experience. At a new installation, calibration might initially be checked every day by comparing the controller reading to a DPD test or other manual analysis and logging the results. If the reading drifts off significantly in one direction you should consider calibrating. Resist the temptation to calibrate to correct for small errors that may be a result of normal variations in the test methods.

A calibration MUST be performed on initial installation, or after cleaning or replacing the membrane or electrolyte. A sensor installed in clean water can hold its calibration for several months.

DO NOT attempt to perform a calibration until the following conditions have been met:

1. The sensor has been conditioned as described above.
2. The sensor has equilibrated to the temperature of the water (for the zero calibration) or the sample (for the 1 point process calibration).

Zero Calibration

1. Remove the sensor from the flow cell and place it in a beaker of clean, oxidizer-free water.
2. Allow the sensor 15 minutes to equilibrate to the water temperature.
3. Go to the Zero Calibration menu of the controller. Refer to the controller instructions.
4. Stir the water with the sensor until the mV reading is stable for at least 5 minutes.
5. When the reading is stable, continue to the final steps of the calibration.
6. Return the sensor to the flow cell and check for leaks.

One Point Process Calibration

1. Ensure that the sensor is conditioned and equilibrated to the temperature of the sample.
2. Ensure that the sample flow rate is between 30 and 100 liters/hour.
3. Perform a DPD test or other manual analysis on the sample water.
4. Go to the One Point Process Calibration menu of the controller. Refer to the controller instructions.
5. When the reading is stable, continue to the final steps of the calibration.

NOTE: Disinfectant concentration can change rapidly in the sample! Minimize the time between performing the DPD test or manual analysis and finishing the calibration!

4.0 Troubleshooting

The disinfectant reading is much lower than the manual analysis

Possible Causes	Corrective Actions
Insufficient conditioning	Wait for the appropriate amount of time before attempting a calibration.
Insufficient sample flow	Increase flow rate to between 30 and 100 liter per hour.
Air bubbles on membrane	Dislodge bubbles. Adjust flow rate higher if necessary.
Dirty membrane	Clean membrane
Loose membrane cap	Tighten membrane cap.
Faulty membrane	Replace membrane cap.
High Pressure	Reduce pressure to below 1 atmosphere and refill cap with electrolyte
No electrolyte fill solution in membrane cap	Fill membrane cap with electrolyte. Replace membrane cap if it will not hold solution.
Faulty sensor	Replace sensor
Faulty analysis equipment or reagents	Consult test equipment instructions

The disinfectant reading is much higher than the manual analysis

Possible Causes	Corrective Actions
Insufficient conditioning	Wait for the appropriate amount of time before attempting a calibration.
Faulty membrane	Replace membrane cap.
Faulty sensor	Replace sensor
Faulty analysis equipment or reagents	Consult test equipment instructions
Sample contaminated with interfering molecule (refer to Sensitivity specification in Section 6)	Remove source of contamination

Sensor Error

This error message appears if the signal from the sensor is outside the range of the controller.

Possible Causes	Corrective Actions
Faulty wiring	Check wiring
Faulty sensor	Replace sensor
Faulty controller sensor input	Go to the Sensor Input menu and perform a self test. If this passes, then the problem is with the sensor or its wiring. If it fails, then disconnect the sensor from the circuit board and try the self test again. If it still fails, replace the circuit board.

Disinfectant Reading is Unstable

Possible Causes	Corrective Actions
Air bubbles on membrane	Dislodge bubbles. Adjust flow rate higher if necessary.
Air bubbles in electrolyte	Refill membrane cap with electrolyte.
Faulty membrane	Replace membrane cap.
Faulty wiring	Check wiring
Faulty controller sensor input	Go to the Sensor Input menu and perform a self test. If this passes, then the problem is with the sensor or its wiring. If it fails, then disconnect the sensor from the circuit board and try the self test again. If it still fails, replace the circuit board.

Calibration Failure

The controller will display a calibration failure if the offset calculated in the Zero Calibration is outside of the range –20 to 40 mV or the slope (mV/ppm) calculated in the One Point Process Calibration is outside of the range of the nominal mV per 0.1 to 2.0 ppm.

For W100:

The acceptable range for the slope (mV/ppm) is the nominal mV per 0.5 to 2.0 ppm. The range of mV for a Zero Calibration is –100 mV to 100 mV.

To calculate the nominal slope for your sensor, divide the high end of the nominal range by -2000. For example, for a 0-20 ppm sensor, the nominal slope is -2000/20 = -100 mV/ppm.

Possible Causes	Corrective Actions
Insufficient conditioning	Wait for the appropriate amount of time before attempting a calibration.
Insufficient sample flow	Increase flow rate to between 30 and 100 liters per hour
Air bubbles on membrane	Dislodge bubbles. Adjust flow rate higher if necessary.
Dirty membrane	Clean membrane
Faulty membrane	Replace membrane cap.
High Pressure	Reduce pressure to below 1 atmosphere and refill cap with electrolyte
No electrolyte fill solution in membrane cap	Fill membrane cap with electrolyte. Replace membrane cap if it will not hold solution.
Faulty sensor	Replace sensor
Faulty analysis equipment or reagents	Consult test equipment instructions
Sample contaminated with interefering molecule (refer to Sensitivity specification in section 6.0)	Remove source of contamination
Faulty wiring	Check wiring
Faulty controller sensor input	Go to the Sensor Input Page and perform a self test. If this passes, then the problem is with the sensor or its wiring. If it fails, then disconnect the sensor from the circuit board and try the self test again. If it still fails, replace the circuit board.

5.0 Maintenance

The sections below describe how to clean and replace the membrane cap and electrolyte solution, and also how to store the sensor when not in use.

See section 4.0 Troubleshooting for assistance in determining when maintenance may be required.

Cleaning the Membrane

Instructions for cleaning the membrane vary depending upon the type of contamination. Follow the directions for replacing the membrane shown below, replacing step 3 with one of these cleaning methods:

For general deposits:
Rinse in clear cold water.

For calcium scale:
Soak in dilute (1% by volume) hydrochloric acid, then rinse in clear cold water.

For oils:
Rinse in isopropyl alcohol.
DO NOT use cleaners or detergents containing surfactants on the membrane, as these will reduce the life of the membrane.

If the sensor still cannot be calibrated after cleaning, replace the membrane cap as described below.

Replacing the Membrane

CAUTION: Wear gloves and safety glasses during assembly of the sensor since the electrolyte is a STRONG ACID. It is recommended to perform this operation over a sink with running water available. After using, re-cap any remaining electrolyte until the next use.

1. **Always move the gray band(s) to uncover the vent hole before removing the membrane cap, or else the membrane will be destroyed!** Hold the sensor vertically with the membrane facing down and carefully unscrew the membrane cap.
2. Rinse the electrolyte fill solution off the cap and electrodes with cold water.
3. Discard the old membrane cap.

4. Unpack the new membrane cap, taking care not to touch the membrane or get it dirty.
5. Fill the membrane cap to the top with the electrolyte fill solution.
6. Hold the sensor body vertically with the tip pointing down and SLOWLY screw on the membrane cap until it is hand tight. **Be prepared for some electrolyte solution to squeeze out from the cap.**
7. Rinse your hands, the sensor, and all surfaces contaminated with electrolyte solution with running water.
8. Check the sensor for leaks, especially at the membrane and the membrane cap threads. If any leaks are detected, tighten the membrane cap or replace it. Move the rubber band(s) back into the groove.

Sensor Storage

The sensor may be stored for up to one month in the flow cell assuming that the membrane is always kept submerged in water.

For long term storage, up to 3 years, follow this procedure:
CAUTION: Wear gloves and safety glasses during assembly of the sensor since the electrolyte is a STRONG ACID. It is recommended to perform this operation over a sink with running water available. After using, re-cap any remaining electrolyte until the next use.

1. Hold the sensor vertically with the membrane facing down and carefully unscrew the membrane cap. Always move the gray bands to uncover the vent hole before removing the cap!

2. Rinse the electrolyte fill solution off the cap and electrodes with cold water.

3. Allow the parts to air dry.

4. Loosely screw the membrane cap back on and store the sensor in a clean dry place. The electrode tip must not touch the membrane.

5. The old membrane cap used to protect the sensor during storage must be discarded and replaced when the sensor is put back into service.

6.0 Specifications

Calibration	Weekly
Change electrolyte	3-6 months
Change membrane cap	1 year

Electrical

Power requirements	±5 VDC, 5 mA maximum
Signal	0 to -2000 mVDC
Max cable length	1000 feet (305 meters)
Extension cable	2 twisted pair, 22 AWG, shielded, 35 pF/ft

Mechanical

Operating Temperature	Free Chlorine/Bromine Free Chlorine/Bromine (Extended pH Range) Total Chlorine	0 to 45°C (32 to 113°F)
	Chlorine Dioxide	0 to 50°C (32 to 122 °F)
	Peracetic Acid	0 to 55°C (32 to 131 °F)
	Ozone	0 to 50°C (32 to 122 °F)
	Hydrogen Peroxide	0 to 45°C (32 to 113 °F)

Operating Pressure	0 to 1 atmosphere (0 to 14.7 psi)
Storage temperature	0 to 50°C (32 to 122 °F)
Shelf life	3 years
Flow cell inlet	¼" NPTF
Flow cell outlet	¾" NPTF

Wetted materials of construction

Sensor	Free Chlorine/Bromine	PVC, Polycarbonate, Silicone rubber
	Free Chlorine/Bromine (Extended pH Range) Total Chlorine Chlorine Dioxide Peracetic Acid Ozone Hydrogen Peroxide	PVC, Polycarbonate, Silicone rubber, Stainless Steel
Flow cell body	Isoplast	
O-Ring	FKM	

Free Chlorine/Bromine

Range (Nominal)	Range (WDIS)	Range (WM1, WIND)	Resolution
0-2 mg/l	0-1.33 mg/l	0-0.8 mg/l	0.001 mg/l
0-20 mg/l	0-13.25 mg/l	0-8 mg/l	0.01 mg/l
0-200 mg/l	0-132.5 mg/l	0-80 mg/l	0.1 mg/l

Sensitivity	HOCl (100%) HOBr (100%) Ozone ClO_2 (900%)
Sample Flow rate	30 to 100 liters/hour (0.13 to 0.44 gal/min)
pH Range	6.8 – 8.0 (pH must be stable within ± 0.10)
Conductivity Range	Up to 4% NaCl
Response time	30 sec
Conditioning time	60 min

Free Chlorine/Bromine- Extended pH Range

Range (Nominal)	Range (WDIS)	Range (WM1, WIND)	Resolution
0-20 mg/l	0-12.5 mg/l	0-7.5 mg/l	0.01 mg/l

Sensitivity	HOCl (100%) HOBr (100%) Ozone ClO_2 (100%) HOCl with isocyanuric acid
Sample Flow rate	30 to 100 liters/hour (0.13 to 0.44 gal/min)
pH Range	4.0 – 12.0
Conductivity Range	50 to 10,000 µS/cm
Response time	2 min
Conditioning time	120 min

Total Chlorine

Range (Nominal)	Range (WDIS)	Range (WM1, WIND)	Resolution
0-20 mg/l	0-16.75 mg/l	0-10 mg/l	0.01 mg/l

Sensitivity	ClO_2 (100%) Ozone (130%)
Sample Flow rate	30 to 100 liters/hour (0.13 to 0.44 gal/min)
pH Range	4.0 – 12.0
Conductivity Range	50 to 10,000 µS/cm
Response time	2 min
Conditioning time	120 min

Chlorine Dioxide

Range (Nominal)	Range (WDIS)	Range (WM1, WIND)	Resolution
0-2 mg/l	0-1.67 mg/l	0-1.0 mg/l	0.001 mg/l
0-20 mg/l	0-16.75 mg/l	0-10 mg/l	0.01 mg/l
0-200 mg/l	0-167.5 mg/l	0-100 mg/l	0.1 mg/l

Sensitivity	Free Chlorine (5%) Ozone (2500%)
Sample Flow rate	30 to 100 liters/hour (0.13 to 0.44 gal/min)
pH Range	1.0 – 11.0
Conductivity Range	50 to 10,000 µS/cm
Response time	30 sec
Conditioning time	60 min

Peracetic Acid

Range (Nominal)	Range (WDIS)	Range (WM1, WIND)	Resolution
0-200 mg/l	0-167.5 mg/l	0-100 mg/l	0.1 mg/l
0-2,000 mg/l	0-1,675 mg/l	0-1000 mg/l	1 mg/l
0-20,000 mg/l	0-16,750 mg/l	0-10,000 mg/l	10 mg/l

Sensitivity	Ozone (250%) ClO_2 (100%) H_2O_2 (0.5%)
Sample Flow rate	30 to 100 liters/hour (0.13 to 0.44 gal/min)
pH Range	1.0 – 7.0
Conductivity Range	50 to 10,000 µS/cm
Response time	3 min
Conditioning time	60 min

Ozone

Range (Nominal)	Range (WDIS)	Range (WM1, WIND)	Resolution
0-20 mg/l	0-16.75 mg/l	0-10 mg/l	0.01 mg/l

Sensitivity	ClO_2 (6%)
Sample Flow rate	30 to 100 liters/hour (0.13 to 0.44 gal/min)
pH Range	2.0 – 11.0
Conductivity Range	50 to 10,000 µS/cm
Response time	50 sec
Conditioning time	60 min

Hydrogen Peroxide

Range (Nominal)	Range (WDIS)	Range (WM1, WIND)	Resolution
0-200 mg/l	0-167.5 mg/l	0-100 mg/l	0.1 mg/l
0-2,000 mg/l	0-1,675 mg/l	0-1000 mg/l	1 mg/l
0-20,000 mg/l	0-16,750 mg/l	0-10,000 mg/l	10 mg/l

Sensitivity	Chlorine (none may be present) PAA (none may be present) Ozone (none may be present)
Sample Flow rate	30 to 100 liters/hour (0.13 to 0.44 gal/min)
pH Range	2.0-11.0
Conductivity Range	50 to 10,000 μS/cm
Response time	5-10 min
Conditioning time	180 min