Signet 3-2630-X Amperometric Free Chlorine Electrode
Signet 3-2632-X Amperometric Chlorine Dioxide Electrode

English

3-2630.090 Rev. N 05/17

CAUTION!

1. Follow instructions carefully to avoid personal injury or damage to electrode.
2. Prior to installation or removal:
   a. Disconnect flow through system.
   b. Drain below sensor level.
3. Confirm chemical compatibility before use.
4. Do not exceed the maximum pressure or temperature specifications.
5. Do not alter product construction.

1. Description

The Signet Amperometric Chlorine Electrodes are designed to measure chlorine in fresh, clean water treatment applications. Free Chlorine electrodes are available in measurement ranges of 0.02 to 2 ppm, 0.05 to 5 ppm or 0.1 to 20 ppm. Chlorine Dioxide electrodes are available in measurement ranges of 0.02 to 2 ppm.
Electrodes require the Signet 2650 Amperometric Electronics to output a digital (S^3L) signal to the Signet 8630 Chlorine Transmitter

Features:

- Utilizing smart-sensor technology, this electrode incorporates a unique embedded memory chip within the electrode to communicate a wide variety of information to the Signet 2650 electronics and Signet 8630 transmitter. Electrode type, factory calibration data, service time, chlorine range, high and low pH (with optional Signet pH electrode), temperature limits and more are stored on the chip. This information is accessible via the Signet 8630 transmitter.
- Signet's patented DryLoc® connector provides quick assembly and a secure connection. Gold-plated contacts and an O-ring seal ensure a waterproof and reliable interconnect to the Signet 2650 Amperometric Electronics.
- Integrated temperature element for automatic temperature compensation.
- Separate drive electronics (Signet 2650) allow easy electrode replacement without running new cable.

2. Sensor Preparation

- Chlorine sensors are shipped without internal electrolyte solution.
- Prior to installation and supplying power, Chlorine sensors must be filled with the appropriate internal electrolyte solution.
- Verify the correct electrolyte solution is utilized with the corresponding sensor.
- Free Chlorine and Chlorine Dioxide sensor require different electrolyte solutions.

Avoid skin or eye contact with electrolyte solution.
Wear rubber gloves and goggles.
* Material Safety Data Sheets (MSDS) are available online at www.gfsignet.com.

CAUTION: DO NOT touch the gold tip or the membrane of the sensor.

Initial Fill Procedure:
When adding electrolyte, be prepared for an accidental spill.
Working near a sink is recommended.

1. Remove the protective bottle from the end of the electrode
2. Remove the membrane cap from the front of the sensor.
   Note: When new sensors are shipped, the membrane cap is not tightened to the sensor
3. Fill supplied syringe with electrolyte solution.
4. Place the electrode on a level surface.
5. Insert syringe needle fully into one of the eight electrode holes while injecting with electrolyte solution. Slowly injecting the electrolyte solution into the sensor to avoid introducing air bubbles. The electrode holds approximately 14 milliliters of solution. Slowly fill until solution begins to flow out of holes. Do not allow the solution to run down the electrode and wet the electrical contacts in the DryLoc connector.
6. Slowly screw on the membrane cap finger tight. Do not use tools.
   To avoid damage and contamination, do not touch the white membrane surface on the membrane cap.

3. Operation

Electrode Range: The electrode must match the type and range of chlorine concentration to be measured.

Flow Rate:
The electrode must have a stable and constant flow of water past its membrane for accurate measurement. When the sensor is installed in the Tee flow cell 3-3610-2 (159 001 684), the flow rate must range from 37.8 to 75.7 LPH (10 to 20 US g/h).

When the sensor is installed in the Flow Cell Block 3-4630.392 (159 001 690), the flow rate range should be 30.24 to 45.36 LPH (8 to 12 US gph).

Sensor Conditioning: 4 hours
A new electrode requires conditioning of 4 hours with the electrode powered on and water flowing past the head to generate a stable reading.

Subsequent start-ups can require an electrode conditioning of up to two hours.

Part Number	Chlorine Range	Chlorine Type
3-2630-1	0.02 to 2 ppm (mg/L)	Free chlorine
3-2630-2	0.05 to 5 ppm (mg/L)	
3-2630-3	0.1 to 20 ppm (mg/L)	
3-2632-1	0.02 to 2 ppm (mg/L)	Chlorine Dioxide

The electrode should not be used in water containing surfactants, oils, organic chlorine or stabilizers such as cyanuric acid.

The maximum allowable operating pressure must be less than 0.48 bar (7 psi). Higher pressures will damage the electrode.

4. Calibration

A new chlorine electrode or one that has had the membrane cap changed must be calibrated. Refer to the Signet 8630 Chlorine Transmitter manual for electrode and instrument calibration information. A diethyl-p-phenylenediamine (DPD) colorimeter test kit (not included) is required for sensor calibration. A sample is taken and analyzed with the DPD test kit, then this value is entered into the Signet 8630 transmitter.

- Calibrate after a membrane cap change.
- Check calibration one day after sensor is placed in service.
- Check calibration weekly to monthly depending on process requirements.

5. Maintenance

Verifying the sensors accuracy using the DPD method should be performed to determine if the sensor requires maintenance.

1. Inspect the membrane for dirt or damage. Replace the membrane if its torn or if the gold cathode is visible.
2. If the membrane is dirty clean the membrane by soaking it in 1 - 5% HCL and gently washed with a stream of DI water. (do not use any mechanical device on the membrane)

Diluted HCl can irritate the eyes and skin, use proper safety equipment.
Do not use surface tension reducing chemicals, detergents or solvents on the membrane.

If a fresh water rinse does not clean the membrane, it will need to be replaced. Keep spare membrane caps available. Membrane caps carry no warranty.

Avoid skin or eye contact with electrolyte solution.
Wear rubber gloves and goggles.
* Material Safety Data Sheets (MSDS) are available online at www.gfsignet.com.

Additional caution should be taken when handling the Chlorine Dioxide electrolyte solution.

Refill Procedure:
When adding electrolyte, be prepared for an accidental spill. Working near a sink is recommended.

1. Remove the membrane cap from the front of the sensor.
2. Turn the sensor upside down and shake the sensor vigorously to remove the internal electrolyte.
3. Fill supplied syringe with electrolyte solution.
4. Place the electrode on a level surface.
5. Insert syringe needle fully into one of the eight electrode holes while injecting with electrolyte solution. Slowly injecting the electrolyte solution into the sensor to avoid introducing air bubbles. The electrode holds approximately 14 milliliters of solution. Slowly fill until solution begins to flow out of holes. Do not allow the solution to run down the electrode and wet the electrical contacts in the DryLoc connector.
6. Slowly screw on the membrane cap finger tight. Do not use tools. To avoid damage and contamination, do not touch the white membrane surface on the membrane cap.

6. Storage and Disposal

Store electrode between –10 ºC to 60 ºC (–14 ºF to 140 ºF) at a relative humidity that does not exceed 95%.
The primary concerns when storing the electrode is membrane dehydration and freezing in extremely cold environments.

6.1. Storage of the Sensor

If the sensor or panel assembly is to be removed from service for a period of time the sensor must be properly prepared for storage and may need to be recommissioned.

Storage periods of 1 week or less:

- Close the drain valve, then close the inlet valve of the flow cell, to maintain water inside the flow cell to keep the membrane wet.
- If draining the flow cell is required, remove the sensor from the cell and the 2650 electronics and store in the shipping bottle with tap water added.

Storage periods greater than 1 week, but less than 2 months:

- Remove the membrane cap and internal electrolyte solution.
- Rinse the sensor internal chamber with DI water or cold tap water; drain and allow to dry.
- Place the membrane cap back onto the sensor. INSTALL LOOSE, DO NOT COMPLETELY TIGHTEN THE CAP. WHEN STORED DRY, THE MEMBRANE CAP MUST BE STORED RELAXED AND UNSTRESSED.
- Store sensor DRY in the shipping bottle, DO NOT ADD WATER.

Recommissioning Procedure:

1. Fill the sensor with the electrolyte as outlined in Maintenance, Section 3, and install the membrane cap.
2. The sensor will have to be polarized in the flow cell with flowing Chlorinated water before being used.
   Note: This may take 30 to 120 minutes before calibration can be performed.
3. If the sensor does not recover after recommission, follow steps 1-10 outlined under "Storage periods greater than 2 months."
4. If the sensor still fails to work properly, continue with steps 11-17.

Storage periods greater than 2 months:

- If the sensor has been in storage for a long period of time, or used in a chlorine free environment, the sensor may develop a low slope (output), which may cause the sensor to have a slow response time.
- In this case, the sensor must be reconditioned.

Required to recondition a sensor:

- DI Water
- Beaker (any size available)
- Polishing Sheets (Included in sensor maintenance kit)
- Free Chlorine: Chlorine Bleach (13% concentration)
- Chlorine Dioxide: Aqueous Chlorine Dioxide solution

CAUTION!
Bleach and Chlorine Dioxide solutions are very corrosive and may release dangerous gases if it comes in contact with acids.

- Wear proper protective clothing (gloves and eye protection)
- Avoid contact with skin and eyes
- Observe all warnings on safety data sheets
- Avoid spilling bleach and possible contact with acids

Reconditioning Procedure:

1. Remove the sensor from the 2750-7 electronics.
2. Remove the membrane cap.
3. Place the sensor on a firm flat surface with the gold cathode pointing upward.
4. Apply a small amount of water to the Blue (Course) polishing paper (dull side).
5. Polish the gold electrode by moving the paper in a circular pattern for 30 seconds. DO NOT go back and forth in a single direction. See Figure 1.
6. Rinse the sensor tip with DI water.
7. Apply a small amount of DI water to the White (Fine) polishing paper (dull side) and polish the gold electrode by moving the paper in a circular pattern for 30 seconds. DO NOT go back and forth in a single direction. See figure 1.
8. Rinse the sensor tip with DI water.
9. Top off the sensor with electrolyte and inspect membrane for dirt or damage. Replace if necessary.
10. Insert the sensor into the 2650 electronics and apply power.

(Steps 11-17, See Next Page)

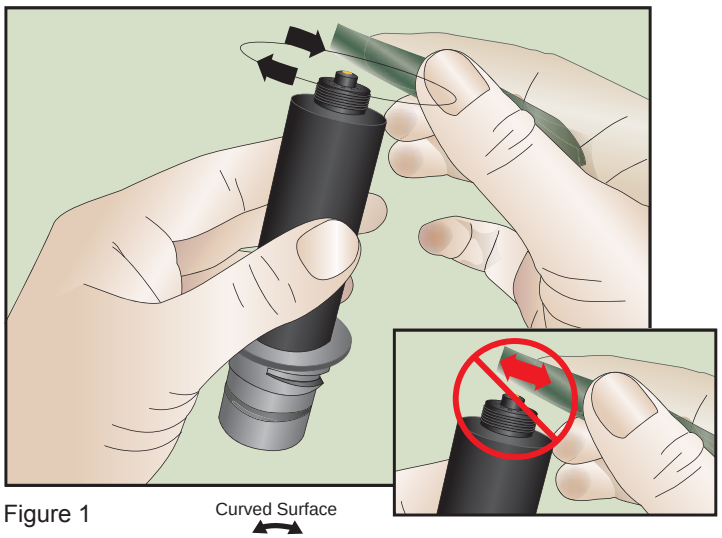
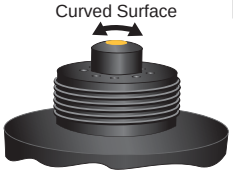


Figure 1

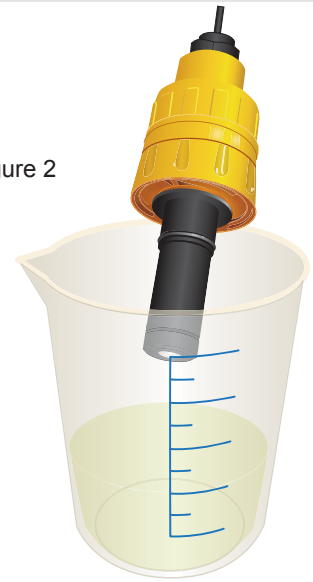


6.1. Storage of the Sensor continued

Reconditioning Procedure Continued:
(Steps 1-10, See Previous Page)

11. Fill beaker with a 12 mm (½ inch) of the appropriate solution.
12. Position or suspend the sensor 0.2 mm to 12 mm (¼ in. to ½ in.) above the appropriate solution. DO NOT SUBMERGE THE SENSOR. See Figure 2.
13. Apply power to the system.
14. Monitor the nA of the sensor (press the down arrow once on the 8630 transmitter). The nA reading should start to rise. Response time and nA reading will depend upon the temperature of the bleach.
15. Once the sensor's nA reading reaches approximately 300-360 nA allow the sensor to remain in the beaker, suspended over the appropriate solution, for an additional 20 minutes.
    - If sensor does not recover quickly, cover the beaker to avoid air contamination.
    - Contact the factory for assistance (www.gfsignet.com).
16. After 20 minutes, remove the sensor and install it into the flow cell and restore flow to the system.
17. Calibrate the sensor after the system has become stable.

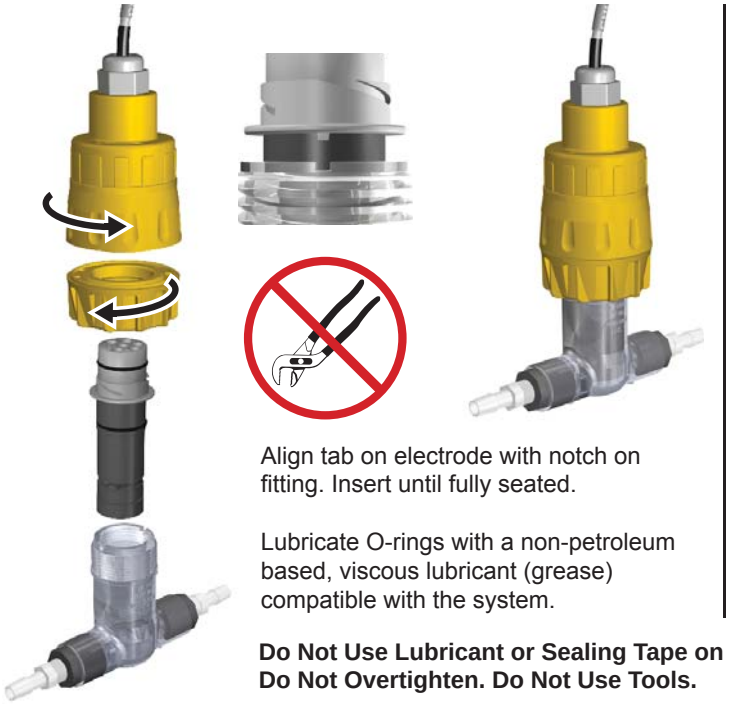
Figure 2



6.2. Disposal

The electrode is not recyclable. Dispose of properly according to local, state and federal guidelines.

7. Installation

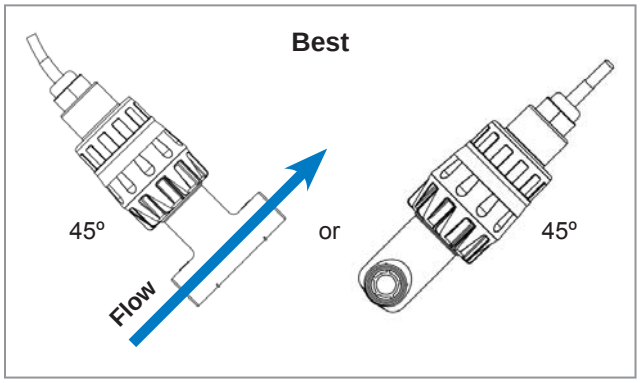


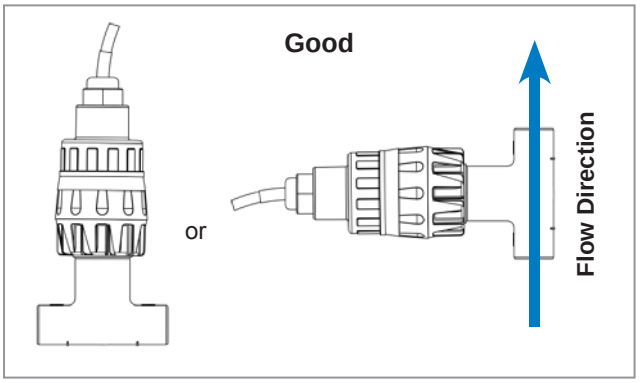
Align tab on electrode with notch on fitting. Insert until fully seated.

Lubricate O-rings with a non-petroleum based, viscous lubricant (grease) compatible with the system.

Do Not Use Lubricant or Sealing Tape on Threads.
Do Not Overtighten. Do Not Use Tools.

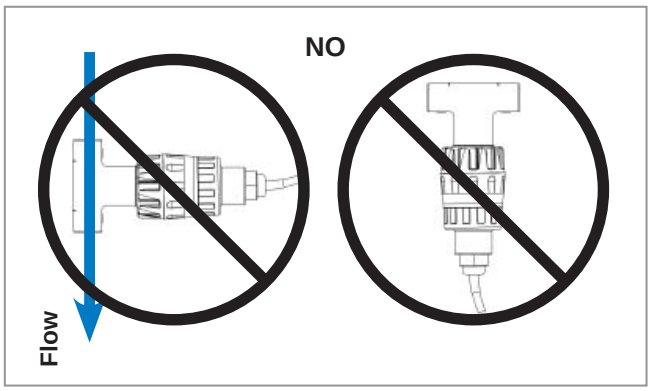
8. Mounting Position - PVC Tee





8. Mounting Position continued

Mount the flow cell where the sensor will be easily accessible.
To avoid air bubble entrapment, do not mount with downward flow.



9. Overview

Chlorine in Water

Various forms of chlorine are used to disinfect water. Each form of chlorine has benefits and limitations which help determine the specific application. The predominant categories used in disinfection are Free Chlorine, Total Chlorine and Chlorine Dioxide. Free Chlorine is the sum of chlorine gas (Cl_2), hypochlorous acid (HOCl) and hypochlorite (OCl^-). Above pH 4.0 all of the molecular chlorine is converted to HOCl and OCl^-. Hypochlorous acid is a more potent disinfectant than hypochlorite and exists in a pH dependent equilibrium as shown in Figure 3.

Free chlorine also combines with naturally occurring or human-introduced nitrogen compounds in the water to form chloramines, also known as combined chlorine. Treatment operators introduce ammonia into the water to form monochloramine (NH_2Cl), dichloramine ($NHCl_2$) and trichloramine (NCl_3). Chloramines are a less effective disinfectant but have a longer residence time than the free chlorine species. Total chlorine is the sum of free chlorine (Cl_2, HOCl and OCl^-) and combined chlorine (NH_2Cl, $NHCl_2$, NCl_3).

Chlorine Measurement by Amperometric Sensors

Signet chlorine sensors are membrane-covered amperometric 2-electrode sensors. A gold or platinum cathode acts as the working electrode with a silver halide acting as the counter electrode. Depending on the species to be analyzed, a polarization voltage is applied between the two electrodes. When placed into service, the chlorine species of interest diffuses across the membrane and is reduced at the cathode surface. For the case of total chlorine, the analyte reacts with the fill solution to produce an intermediate, which is subsequently reduced at the cathode surface. At the same time, the silver anode is oxidized to form a silver halide. The current generated at the cathode is proportional to the rate of diffusion through the membrane and the concentration of chlorine in the sample. The current from the cathode to the anode is conditioned, digitized and transmitted by the associated electronics.

pH Compensation for Free Chlorine

Amperometric free chlorine sensors measure only hypochlorous acid. As noted in the text above and in Figure 3, the ratio of hypochlorous acid and hypochlorite is pH dependent. In many applications the process pH is relatively stable and no correction is needed. However, where the pH of the water changes significantly, accurate free chlorine measurement requires pH compensation. With the addition of a pH sensor, the Signet 8630 transmitter will automatically compensate the free chlorine reading for changes in pH.

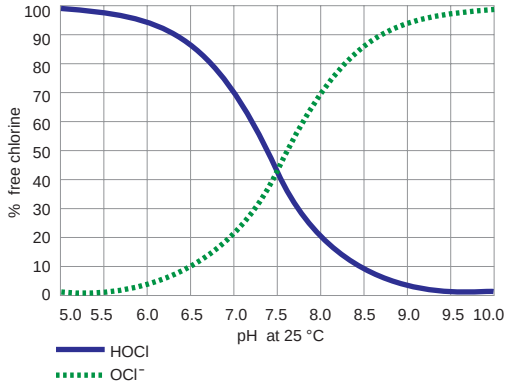


Figure 3

Automatic pH Compensation and Free Chlorine

In many applications, the process pH does not significantly fluctuate and only a chlorine sensor and instrument are necessary for accurate chlorine measurement.
It is when the pH varies that free chlorine concentration can not accurately be determined without the use of automatic pH compensation.

The addition of the Signet 3-2724-00 (159 001 545) pH electrode along with its 3-2750-7 (159 001 671) preamplifier to the system makes pH compensation extremely easy and automatic even with wide fluctuations or high pH.

See Figure 4 for pH variation recommendations.
Example:
If the pH nominal value is 7.5 and the pH variation is ±0.2 then automatic pH compensation is recommended.
If the pH nominal value is 7.0 and the pH variation is ±0.2 then automatic pH compensation is not required.

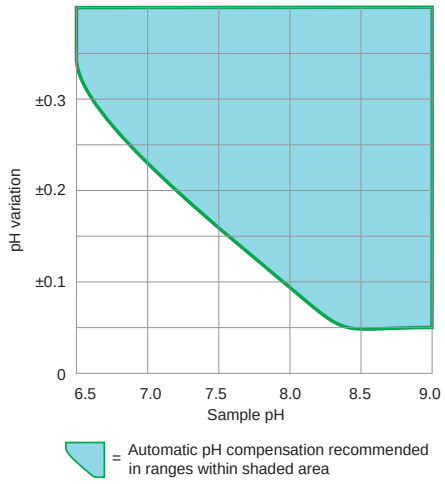


Figure 4

10. Troubleshooting

Transmitter error messages related to calibration are detailed in the Signet 8630 Chlorine Transmitter operation manual.

Problem	Possible Causes	Remedies
Sensor cannot be calibrated. Output is higher than DPD test (out of range).	Sensor conditioning time too short	Condition for 4 hours minimum prior to initial calibration
	Interference from contaminants	See technical data
	Membrane cap damaged	Replace cap and recondition
	DPD chemicals bad	Use fresh reagents
	pH outside of working range	See technical data
Sensor cannot be calibrated. Output is lower than DPD test.	Sensor conditioning time too short	Condition for 4 hours minimum prior to initial calibration
	Chlorine content too low	DPD value must be greater than 0.5 ppm to calibrate
	Low flow rate	Check to make sure flow rate is sufficient
	Air bubbles on electrode membrane	Inspect visually. Tap to remove bubbles. Mount at an angle.
	Low or no electrolyte in electrode	Fill electrode with electrolyte
	Organic chlorination agents present in water	See technical data
	Surfactants in water	Remove surfactants and replace cap
	Membrane cap coated	Clean or replace membrane cap
	Membrane cap loose	Tighten or replace membrane cap
	pH outside working range.	See technical data
Sensor output very low	Sensor conditioning time too short	Condition for 4 hours minimum prior to initial calibration
	Chlorine content too low	Add chlorine to validate
	Only bound chlorine present. No free chlorine	Check for chloramine with appropriate DPD test
	Electrode not making good contact with electronics	Inspect and reconnect
Unstable output from sensor	Air bubbles on electrode membrane	Inspect visually. Tap to remove bubbles. Mount at an angle.
	Membrane damaged	Replace membrane. Condition sensor for at least 2 hours and recalibrate.
	Electrode not making good contact with electronics	Inspect and reconnect
	Non-sensor problem	Check 3-2650 Electronics connection to electrode (see 3-2650 manual for instructions). Make sure connections are dry. Check instrument hookup.

11. Ordering Information

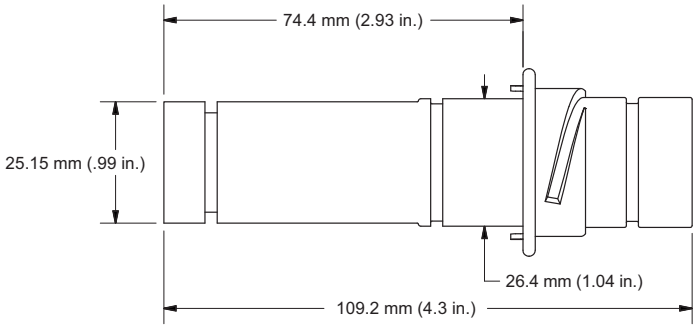
Mfr. Part No.	Code	Description
3-2630-1	159 001 746	Free Chlorine electrode, 0.02 to 2 ppm (mg/L)
3-2630-2	159 001 662	Free Chlorine electrode, 0.05 to 5 ppm (mg/L)
3-2630-3	159 001 747	Free Chlorine electrode, 0.1 to 20 ppm (mg/L)
3-2632-1	159 001 767	Chlorine Dioxide electrode, 0.02 to 2 ppm (mg/L)

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
3-2630.391	159 001 674	Free Chlorine electrolyte, 30 mL
3-2632.391	159 310 160	Chlorine Dioxide electrolyte solution, 30 mL
3-2630.394	159 310 164	Free Chlorine and Chlorine Dioxide Replacement PTFE membrane (1)
3-2630.398	159 310 166	Free Chlorine Sensor maintenance kit - (2) electrolyte, (2) PTFE membranes, (2) Silicone Bands, and Polishing Paper
3-2632.398	159 310 165	Chlorine Dioxide maintenance kit - (2) electrolyte, (2) PTFE membranes, (2) Silicone Bands, and Polishing Paper
3-2600.510	159 500 422	Silicone Band, Chlorine electrode

12. Technical Data

Dimensions



General

Polarization Source:
Signet 2650 Amperometric Electronics

Compatible Flow Cells:
Signet 3-3610-1 (159 001 683)
Signet 3-3610-2 (159 001 684)
Signet 3-4630.392 (159 001 690)

Mounting:
Signet DryLoc connection

Materials:
CPVC

Free Chlorine and Chlorine Dioxide:
Membrane material: PTFE

Free Chlorine and Chlorine Dioxide:
O-ring material: FPM
Working electrode: Gold
Counter reference electrode: Silver halide

Wetted Materials:
PVC or PTFE, FPM, Nylon, Silicone

Performance

Electrode:
Repeatability: ± 0.08 ppm (mg/l) or 3% of selected range whichever is less
Free Chlorine Slope: 15 to 60 nA/ppm (mg/l) @ 25 ºC
Chlorine Dioxide Slope: 40 to 200 nA/ppm (mg/l) @ 17 ºC
Response time, T90: < 2 minutes

System: (including electronics and instrument)
Accuracy: < ±3% of electrode signal after calibration
Resolution: ≤ 0.5% of electrode range

Sensor Conditioning:
New, first start-up: 4 hours maximum before calibration
Subsequent start-ups: 2 hours maximum

Temperature Element:
PT1000

Operational Ranges and Limits

Free Chlorine:
Range: 3-2630-1: 0.02 to 2 ppm (mg/L)
3-2630-2: 0.05 to 5 ppm (mg/L)
3-2630-3: 0.1 to 20 ppm (mg/L)
pH Operating Range: 5.5 pH to 8.5 pH

Chlorine Dioxide:
Range: 3-2632-1: 0.02 to 2 ppm (mg/L)
pH Operating Range: 4.0 pH to 11 pH

Maximum Operating Temperature:
0 °C to 45 °C (32 °F to 113 °F)

Maximum Operating Pressure:
Membrane: 0.48 bar @ 25 °C (7 psi @ 77 °F)

Flow Velocity Across Membrane Surface:
Minimum: 15 cm/s (0.49 ft/s)
Maximum: 30 cm/s (0.98 ft/s)

Free Chlorine Cross Sensitivity:
Chlorine Dioxide, ozone, bromine

Chlorine Dioxide Cross Sensitivity:
Free Chlorine, ozone

Chemical Compatibility:
< 50% ethanol/water, < 50% glycerol/water

Environmental Requirements

Storage Temperature (dry):
-10 ºC to 60 ºC (-4 ºF to 140 ºF)

System Temperature:
-10 ºC to 60 ºC (-4 ºF to 140 ºF)

Relative Humidity:
0 to 95% indoor/outdoor non-condensing to rated ambient

Standards and Approvals
CE, WEEE
Manufactured under ISO 9001
RoHS Compliant
China RoHS (Go to www.gfsignet.com for details)
Declaration of Conformity according to FCC Part 15
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.

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