

# Signet 2630-2 Amperometric Chlorine Electrode

English



3-2630.090 Rev. F 06/11 English



## 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.

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## 1. Description

Signet's amperometric chlorine electrode is designed to measure free chlorine in fresh water and waste water treatment applications. The electrode is available with measurement range of 0 to 5 ppm.

This electrode requires the Signet 2650 Amperometric Electronics module to output a digital (S<sup>3</sup>L) 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<sup>®</sup> 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) make for easy electrode replacement without running new cable.

## 2. Electrolyte



**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](http://www.gfsignet.com).

- **Free chlorine** electrodes are pre-filled with electrolyte solution. Simply pull off the protective boot from the end of the electrode and install the electrode into the flow cell fitting.

### Fill and Refill Procedure:

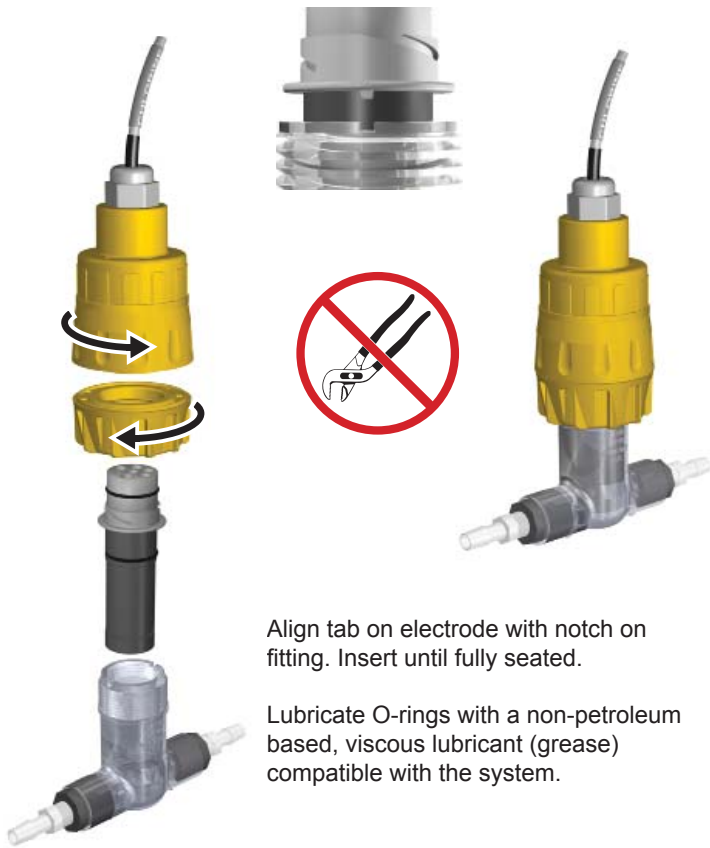
When adding electrolyte, be prepared for an accidental spill.

Working near a sink is recommended.

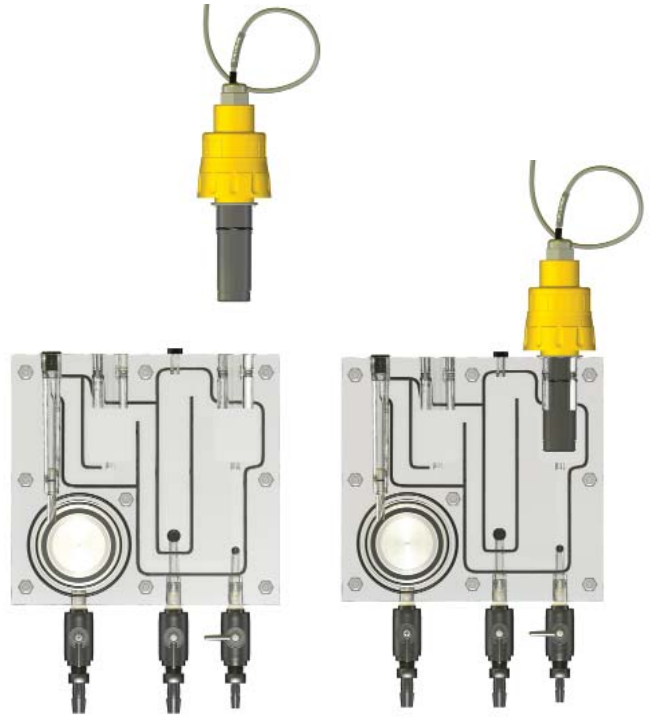
1. Remove the membrane cap from the front of the sensor.
2. Turn the sensor upside down and shake the sensor vigorously to remove the internal electrolyte.
3. Fill supplied syringe with electrolyte solution.
4. Place the electrode on a level surface.
5. Insert syringe needle fully into one of the four electrode holes while injecting with electrolyte solution. The electrode holds approximately 14 milliliters of solution. Insert the needle to the bottom to avoid creating bubbles. Carefully 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.



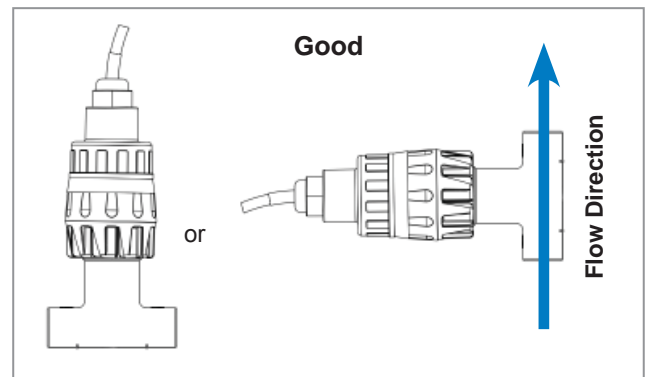
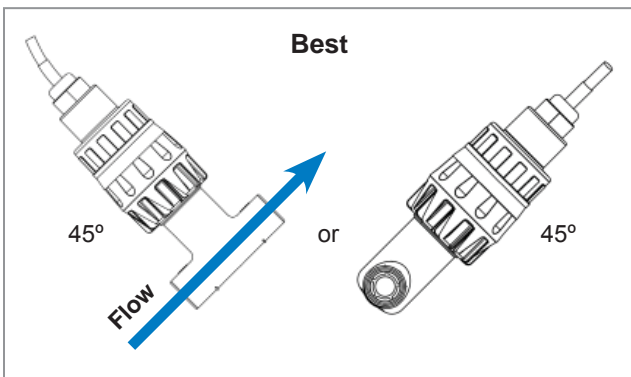
### 3. Installation



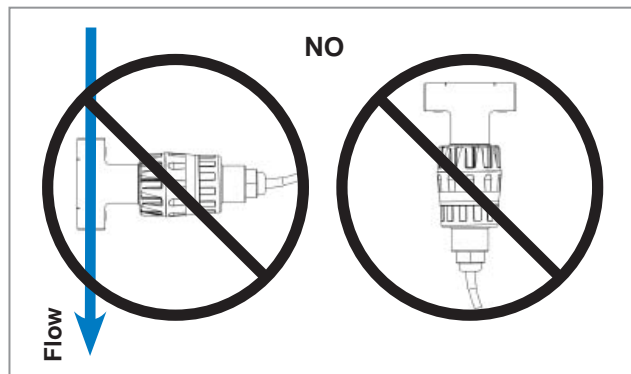
**Do Not Use Lubricant or Sealing Tape on Threads. Do Not Overtighten. Do Not Use Tools.**



### 4. Mounting Position - PVC Tee



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



## 5. 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 g/h).

### 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
3-2630-2	0 to 5 ppm (mg/l)	Free chlorine



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.

## 6. 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.

## 7. Maintenance

The electrolyte fill solution inside the electrode must be refilled periodically. See Sec. 2. The membrane cap also needs to be inspected for contamination. A weekly inspection is recommended. Dirty process water can foul the membrane. If it becomes dirty, rinse with fresh water only. Do not use brushes, detergents or solvents. 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.

## 8. Storage

Store electrode between  $-10$  to  $60$  °C ( $-14$  to  $140$  °F) 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.



Storage Time	Action
$\leq 7$ Days	Store electrode in the flow cell with water to prevent membrane dehydration.
$> 7$ Days	Store electrode with the protective cover for the membrane attached; or immerse the end of the electrode in a small container of water to keep the membrane wet. Do not get the electrical contacts on the DryLoc end of the electrode wet.
$> 1$ month	Unscrew the membrane cap and store it fully immersed in tap water. Remove the electrolyte from the electrode by holding it over a container and shaking it or use a syringe and needle to withdraw the solution.

## 9. Disposal

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

## 10. 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 ( $\text{Cl}_2$ ), hypochlorous acid ( $\text{HOCl}$ ) and hypochlorite ( $\text{OCl}^-$ ). Above pH 4.0 all of the molecular chlorine is converted to  $\text{HOCl}$  and  $\text{OCl}^-$ . Hypochlorous acid is a more potent disinfectant than hypochlorite and exists in a pH dependent equilibrium as shown in Figure 1.

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 ( $\text{NH}_2\text{Cl}$ ), dichloramine ( $\text{NHCl}_2$ ) and trichloramine ( $\text{NCl}_3$ ). 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 ( $\text{Cl}_2$ ,  $\text{HOCl}$  and  $\text{OCl}^-$ ) and combined chlorine ( $\text{NH}_2\text{Cl}$ ,  $\text{NHCl}_2$ ,  $\text{NCl}_3$ ).

### 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 1, 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.

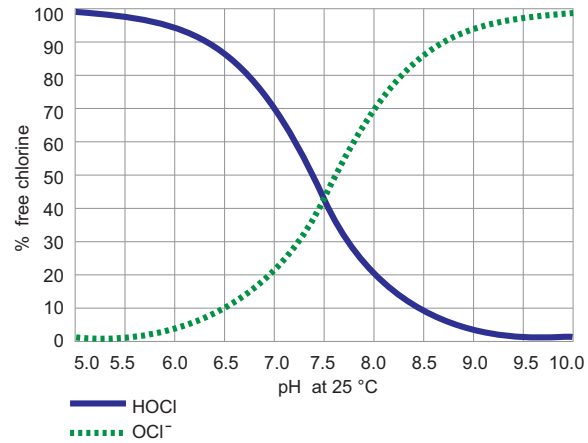


FIG.1

### Automatic pH Compensation and Free Chlorine

In many applications, the process pH does not significantly fluctuate and only a sensor and instrument is 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 2 for pH variation recommendations.

Example:

If the pH nominal value is 7.5 and the pH variation is  $\pm 0.2$  then automatic pH compensation is recommended.

If the pH nominal value is 7.0 and the pH variation is  $\pm 0.2$  then automatic pH compensation is not required.

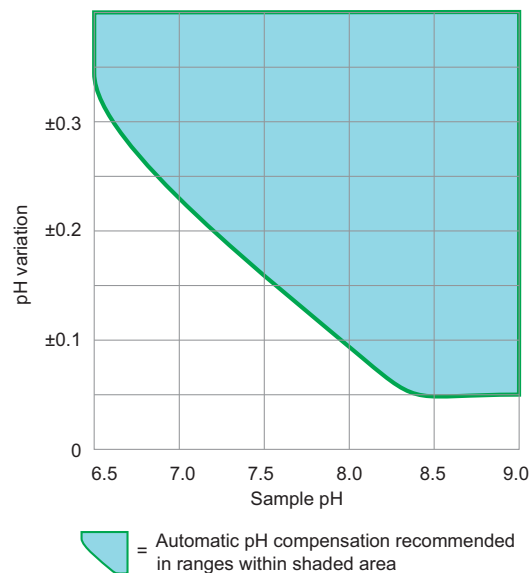



FIG.2

 = Automatic pH compensation recommended in ranges within shaded area

## 11. 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.

## 12. Ordering Information

Mfr. Part No.	Code	Description
3-2630-2	159 001 662	Free Chlorine electrode, 0 to 5 ppm (mg/l)

### Accessories and Replacement Parts

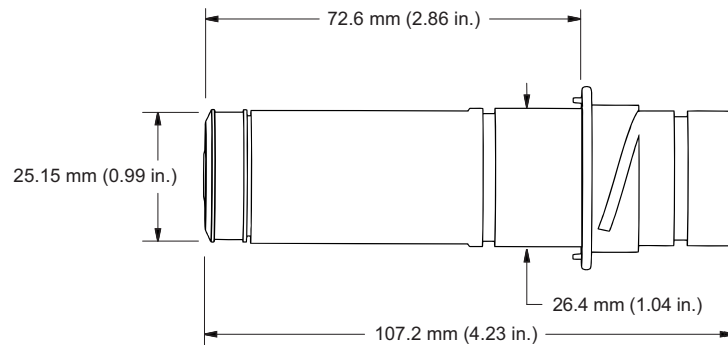
Mfr. Part No.	Code	Description
3-2630.391	159 001 674	Free Chlorine electrolyte, 30 ml
3-2630.392	159 001 675	Free Chlorine replacement membrane (1)
3-2630.396	159 001 676	Free Chlorine replacement kit - (2) electrolyte and (2) membranes
3-0700.390	198 864 403	pH Buffer Kit (1 each 4, 7, 10 pH buffer in powder form, makes 50 mL)
3822-7004	159 001 581	pH 4.01 buffer solution, 1 pint (473 ml)
3822-7007	159 001 582	pH 7.00 buffer solution, 1 pint (473 ml)
3822-7010	159 001 583	pH 10.00 buffer solution, 1 pint (473 ml)
3-2700.395	159 001 605	Calibration kit: included 3 polypropylene cups, box used as cup stand, 1 pint pH 4.01, 1 pint pH 7.00

Notes:

## 13. Technical Data

## Signet 2630-2 Amperometric Chlorine Electrode

### 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:

Membrane material: PVDF

O-ring material: FPM

Working electrode: Gold

Counter reference electrode: Silver halide

#### Wetted Materials:

PVC, PVDF, FPM

### Performance

#### Electrode:

Repeatability:  $\pm 0.08$  ppm (mg/l) or 3% of selected range whichever is less

Slope: 10 to 60 nA/ppm (mg/l)

Response time, T90: < 2 minutes

#### System: (including electronics and instrument)

Accuracy: <  $\pm 3\%$  of electrode signal after calibration

Resolution:  $\leq 0.5\%$  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:

0 to 5 ppm (mg/l)

#### Free Chlorine pH Operating Range:

5.5 to 9.0 pH

#### Operating Temperature:

0 to 45 °C (32 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:

ClO<sub>2</sub>, ozone, bromine

#### Chemical Compatibility:

< 50% ethanol/water, < 50% glycerol/water

### Environmental Requirements

#### Storage Temperature (dry):

-10 to 60 °C (-4 to 140 °F)

#### Operating Temperature:

0 to 45 °C (32 to 113 °F)

#### Relative Humidity:

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

### Standards and Approvals

CE

Manufactured under ISO 9001

 China RoHS (Go to [www.gfsignet.com](http://www.gfsignet.com) for details)



Georg Fischer Signet LLC, 3401 Aerojet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057  
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