

Chlorine Dioxide Amperometric 4-20mA Sensors

Product Instructions

Section 1.0 Theory of Operation

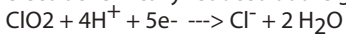
1.0 Chlorine Dioxide Introduction

Chlorine dioxide is considered one of the most powerful biocides available today.

It is so effective that it was used to disinfect sites infected with the SARS virus and is used to disinfect areas know to be contaminated with *Legionella sp.* One of the most important properties of ClO₂ that sets it apart from chlorine is its behavior when placed in water. Not only is ClO₂ 10 times more soluble in water than chlorine (3.01 grams/Liter at 25 degrees C), it does not hydrolyze when placed in solution. It remains as a "true" dissolved gas that retains its useful oxidative and biocidal properties throughout the entire 2 to 10 pH range.

1.1 Sensor Operating Principle

Chlorine dioxide gas diffuses across the sensor's membrane between the cathode and electrolyte solution. At the applied potential, it is electrochemically reduced at the gold cathode as:



At the same time, the silver anode is oxidized to form silver chloride (AgCl) as: $\text{Cl}^- + \text{Ag} \rightarrow \text{AgCl} + \text{e}^-$

The release of electrons at the cathode and acceptance at the anode creates a current flow, which under constant conditions, is proportional to the chlorine dioxide concentration in the medium outside the sensor. The resulting low current output is then conditioned to 4-20mA current by the sensor's onboard electronic circuitry.

Section 2.0 Factors Influencing the Sensor

2.0 pH

As dicussed in Section 1, there is no significant pH dependence when measuring ClO₂.

2.1 Chemical Interferences

The sensor should not be used in water containing surfactants. Monochloramine and ozone are interferences.

2.2 Flow

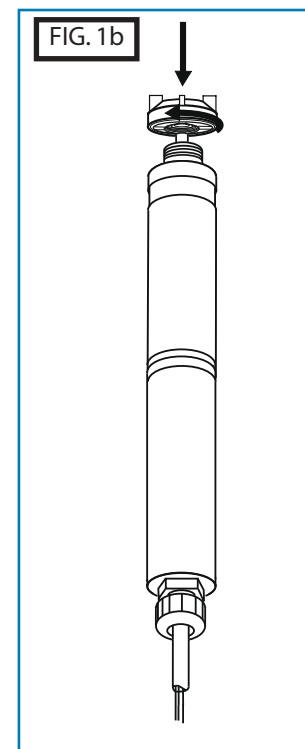
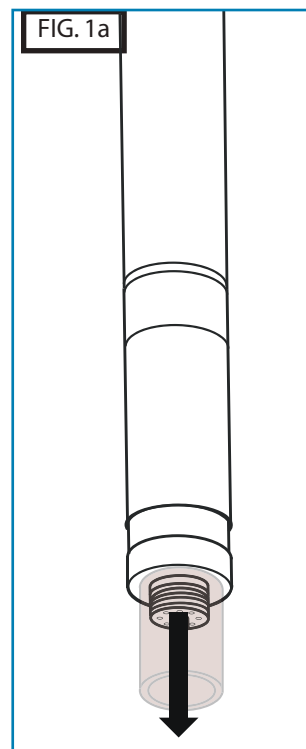
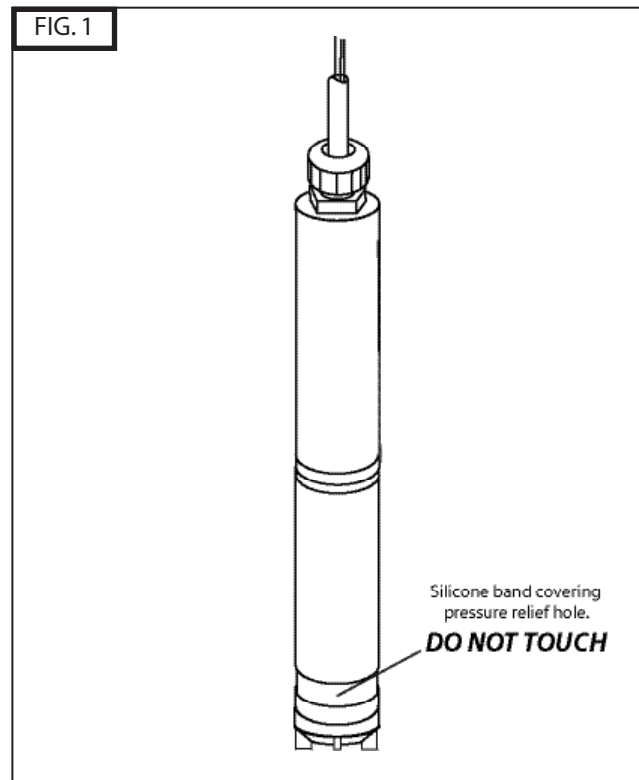
To acheive reproducibile measurements, the (CLD) chlorine dioxide sensors require a specified constant flow rate. To avoid complications (such as bubbles), it is best to operate the sensors at a flow rate of 0.2 - 0.6 gpm if using flow cell FC72 or FC70 (old version). Use of a flowmeter is recommended (FM001- See Section 4.1)

2.2 Pressure

Pressure is relieved via a small vent hole covered with a silicone sleeve (FIG1). DO NOT REMOVE THE SLEEVE, even when refilling the sensor.

Parts covered by this product data sheet include:

CLD502, CLD510, FC72, CLDA-5015, CLDA-5016, CLDA-5017, CLDA-5018



SECTION 3.0 Sensor Preparation

3.0 Chlorine Dioxide Sensor Assembly

Your Chlorine Dioxide Sensor is shipped with a protective tube covering the cathode. Remove the tube per FIG. 1A. It is also shipped with 2 membrane cap assemblies, 1 replacement pressure relief band, 3 sheets of polishing paper and 2 bottles of electrolyte. First, fill the sensor with electrolyte using the provided needle and syringe (FIG. 8). **Use gloves when handling the electrolyte.** Next attached the membrane cap assembly (FIG. 1B). Next install sensor into flow cell per SECTION 5.0. **NOTE: If sensor will be stored out of flow cell, the internal fill solution should be removed. Since the refill solution's pH is <1.5, caution should be taken when removing the refill solution. Gloves should be worn and the refill solution should be removed with the provided syringe into a container for acid waste neutralization. Take the membrane cap and immerse in a cup of tap water until ready to reuse. See Section 10. Replace cap and electrolyte before installing into flow cell (See section 10 for cap and electrolyte change and see section 5 for sensor installation into flow cell).**

SECTION 4.0 Flow Cell/Flow Meter Installation

4.0 Flow Cell

To obtain accurate Chlorine dioxide readings, the Sensor must be installed into the Flow Cell to prevent air bubbles formation on the membrane while maintaining proper spacing between the sensor and the installation wall, and laminar flow across the membrane. *Make sure sensor and flow cell are oriented vertically or no more than 45 degrees below vertical (SEE FIG 2B).*

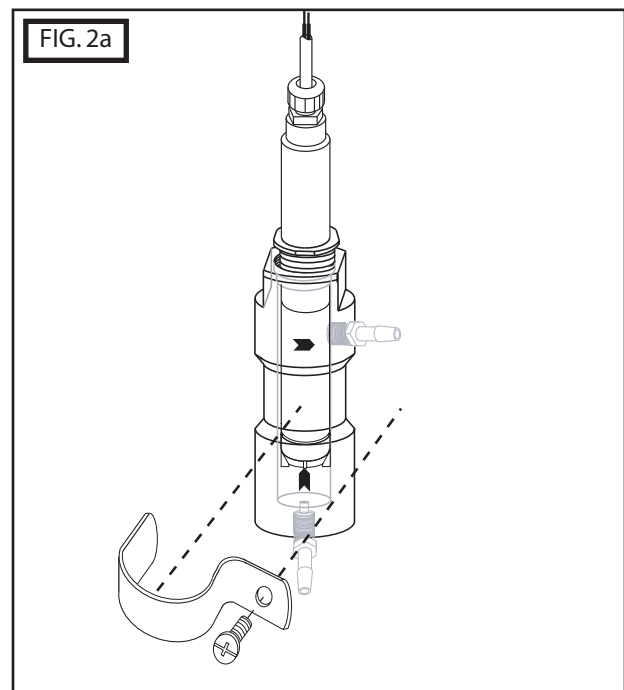
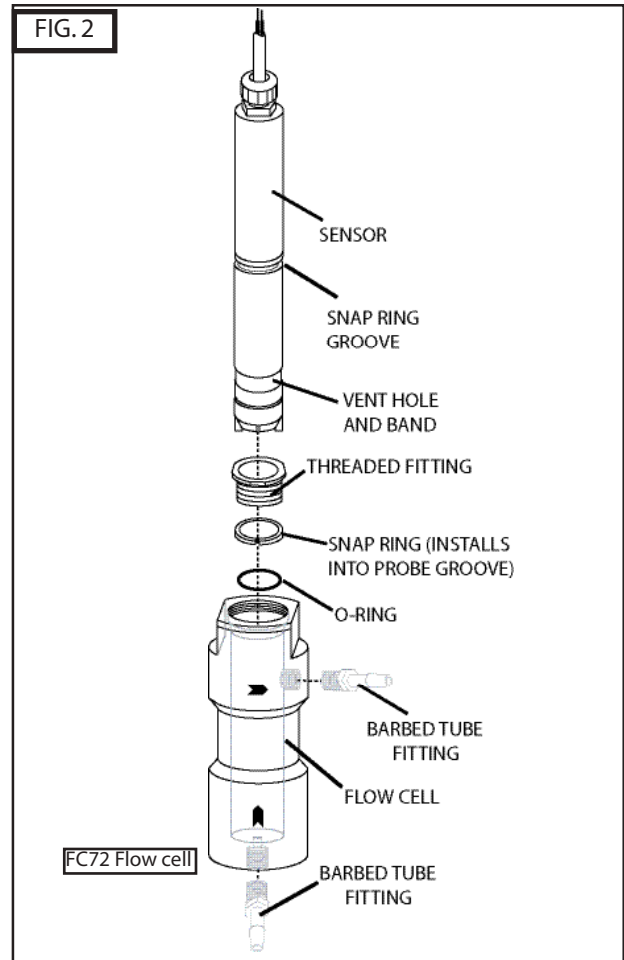
- 4.0a Using two 1/4" NPT Tube fittings, connect the FC72 Flow Cell into your system, noting the inlet (bottom) and outlet (side) orientation (SEE FIG 2).
- 4.0b Install clamp with rubber backing as shown in FIG 2A.
- 4.0c Drill 3/8" diameter hole on the panel.
- 4.0d Insert bolt as shown in FIG 2A.
- 4.0e On back of panel attach lock washer and nut to secure clamp and flow cell to panel.

Ensure flow cell is mounted at 45 deg or higher above horizontal as shown in FIG 2B.

4.1 Flow Meter

To control flow to the flow cell, a flow meter is recommended. Sensorex supplies model FM001 for this purpose. The FM001 provides flow control from 0.1 to 1.0 GPM (0.5 to 4.0 LPM) with 94% accuracy.

4.1.1 Install the flow meter and flow cell as shown in FIG 2C. Follow the diagram so that the incoming water is attached to the bottom of the flow meter (where flow adjustment knob is located).



SECTION 5.0 Sensor Installation

5.0 Sensor Installation into Flow Cell

- First install threaded fitting onto sensor body (remove fitting if pre-installed in flow cell)
- Install snap-ring into groove on sensor body
- Next, slide o-ring onto body of sensor until it reaches bottom of threaded fitting.
- Thread sensor assembly into top of flow cell as shown in FIG 2.
- Turn on flow and verify the flow through the Flow Cell is at least 0.2 gpm (45 liters/hour and no more than 0.6gpm (135 liters/hour).

SECTION 6.0 Electrical Installation

6.0 Electrical Installation

The sensor produces an approximate output of 4 mA in air and 20 mA at the top range of chlorine dioxide output (0-2ppm, 0-5ppm and 0-10ppm).

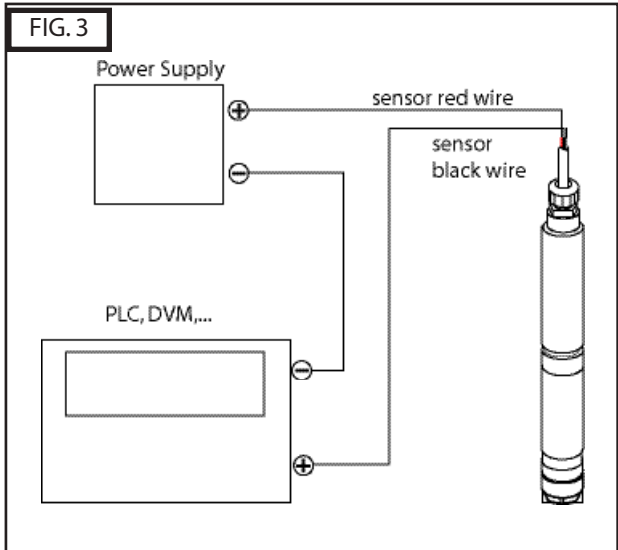
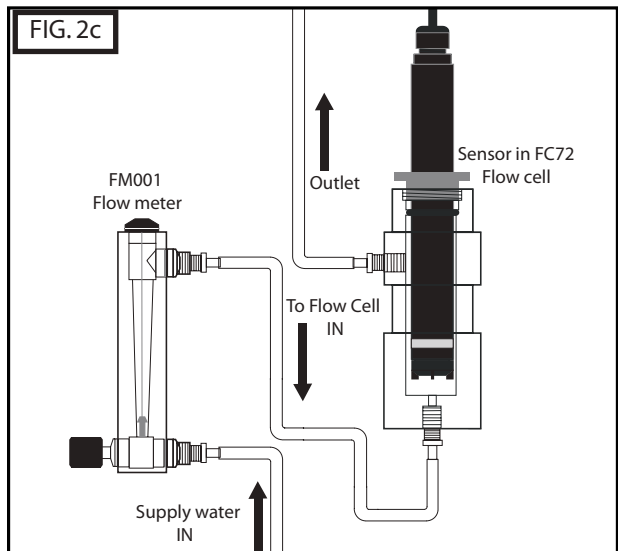
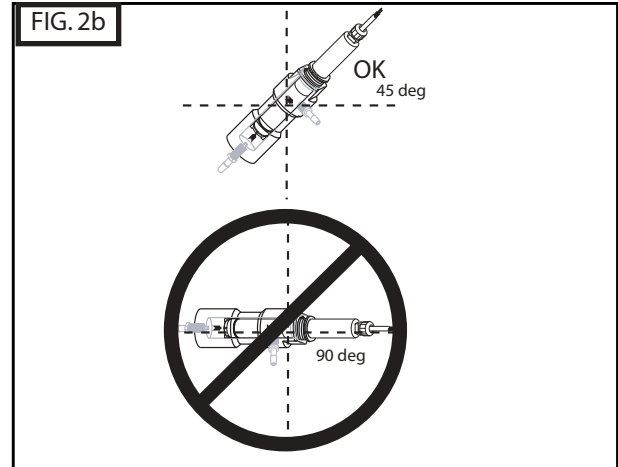
NOTE: The supply voltage to the Sensor must be 12-24 V DC with minimum of 250 mA. Maximum load is 1 Watt. The sensor has 2 wires, red (+), black (-). Attach the red wire to the power supply positive terminal (+) and the black wire to the PLC or DVM positive (+) terminal. Connect a wire (customer supplied) from the power supply negative (-) and the PLC or DVM (-). See FIG 3. The Sensor will require several minutes to stabilize after power is supplied to it.

SECTION 7.0 Sensor Conditioning

7.0 Sensor Conditioning

The sensor requires conditioning prior to generating stable values.

- For new Sensors, connect the sensor to power and allow to run overnight (at least 12 hours) before calibration.
- If the Sensor will be un-powered for two hours or more, run for two hours prior to use.
- If the Sensor's flow will be off for one hour or less, run the sensor for at least one hour prior to recalibration.
- After membrane/electrolyte replacement, allow the Sensor to run powered overnight (at least 12 hours before calibration.



Section 8.0 Calibration

NOTE: Sensors are supplied factory calibrated with a 4-20mA signal output corresponding to their specific range (0-2, OR 0-10ppm). Any span/range calibration can be done at your PLC or other 4-20mA input device. Fine span calibration can be done at the sensor if required. The zero-point calibration is not necessary since the zero setting is very stable. Check calibration about once per week. No need to calibrate if it has not changed much. This is useful in tracking sensor failures as well. This calibration should also be done at the PLC or other 4-20mA input device.

8.0 Span/Slope Calibration

- Determine the chlorine dioxide content using a diethyl-p-phenylenediamine (DPD) colorimeter test kit (SEE FIG 4) not included with chlorine dioxide sensor and flow cell.
- Measure chlorine dioxide content with sensor. Make sure that calibration flow rate matches flow rate when measuring sample since probe output is flow rate dependent. Make sure pH is within 4.0-11 range.
- Adjust span/slope at PLC/4-20mA device.
- Repeat this slope calibration one day after sensor is initially installed.
- Repeat the slope calibration monthly.

Section 9.0 Sensor Storage

9.0 Storage

Store sensor at 5° C - 50° C *only* and maximum humidity of 95% non-condensing.

- Short Term Storage* (one week or less): Store in Flow cell with water to prevent the probe from drying out.
- Intermediate Term* (one week to one month): Store in cap, bottle, or beaker with water to keep membrane wet.
- Long Term* (one month or longer): Remove Membrane Cap and store cap completely immersed in tap water. Remove fill solution safely by using **cautions in Section 3**

Note: Electrolyte shelf life is one year from date of mfg (see bottle).

Section 10.0 Sensor Maintenance/Reconditioning

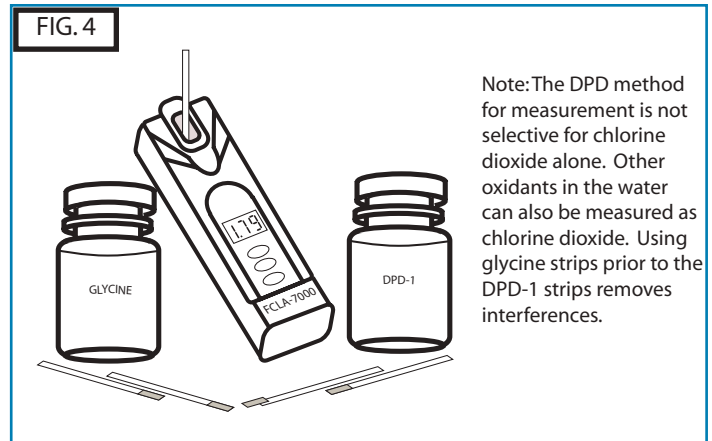
10.0 Membrane Cap Replacement

If membrane replacement is required, a new cap with preinstalled membrane must be used. One cap and refill solution is shipped with each sensor. Additional caps are ordered as CLDA-5016, and refill solution as CLDA-5015 or order complete kit CLDA-5018.

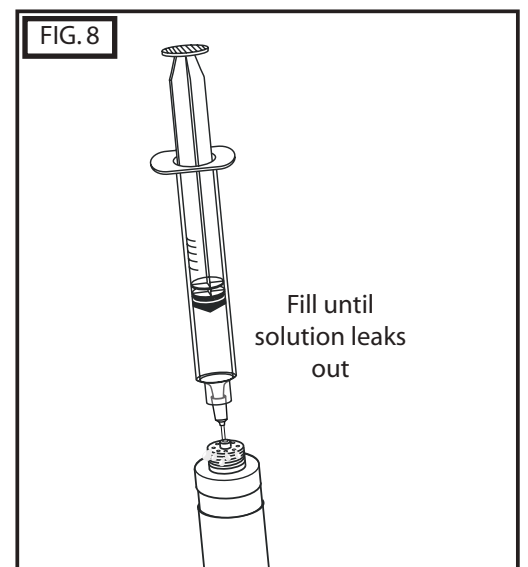
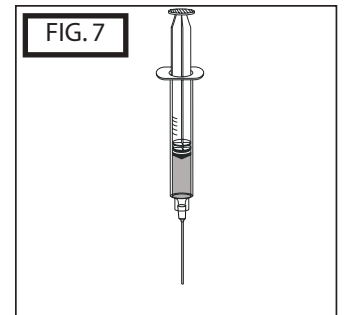
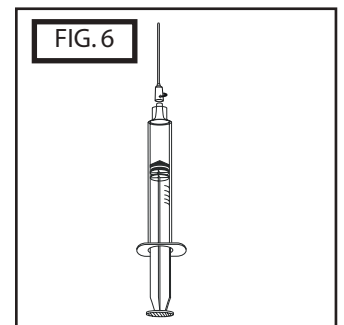
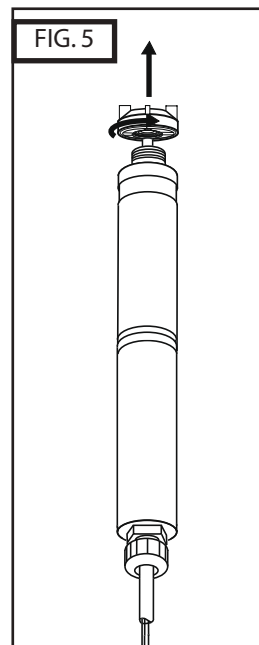
To change membrane cap:

WEAR GLOVES WHEN HANDLING THE REFILL SOLUTION!

- Turn sensor upside down with cap facing upward.
- Rotate cap counter-clockwise to remove (SEE FIG 5).
- Place needle tip on syringe as shown in FIG 6
- Remove solution from bottle with needle and syringe as shown in FIG 7
- Fill sensor body with electrolyte using needle and bottle of refill solution (SEE FIG 8).
- Install new membrane cap by threading cap onto sensor rotating cap clockwise (FIG 1B).



Note: The DPD method for measurement is not selective for chlorine dioxide alone. Other oxidants in the water can also be measured as chlorine dioxide. Using glycine strips prior to the DPD-1 strips removes interferences.



SECTION 11

Sensor Maintenance/Reconditioning

11.0 Electrolyte Solution Replacement

WEAR GLOVES WHEN HANDLING THE REFILL SOLUTION!

Drain old refill solution into an acid waste neutralization container. Refill the sensor approximately every two months.

11.1 Membrane Replacement

If membrane replacement is required (**change at least every 6 months**), a new cap with preinstalled membrane must be used. One cap and fill solution is shipped with each sensor. Additional caps are ordered as CLDA-5016, and refill solution as CLDA-5015. To change membrane cap :

WEAR GLOVES WHEN HANDLING THE REFILL SOLUTION!

- a) Turn sensor upside down with cap facing upward.
- b) Rotate cap counter-clockwise to remove (SEE FIG 5).
- c) Attached supplied needle to syringe and remove fill solution as shown in FIG 6 & FIG 7. **Put old refill solution into an acid waste container for neutralization.**
- d) Fill sensor body with electrolyte using needle and syringe of refill solution (SEE FIG 8).
- e) Install a new membrane cap by threading cap onto sensor rotating cap clockwise (Opposite of FIG 5).

11.2 Membrane Cap/Sensor Cleaning

Rinse cap with water only. If cap does not clean, replace with new one.

11.3 Cathode Polishing

If the sensor cannot calibrate, then the gold cathode could be coated. Follow instruction in cathode polishing addendum to this instruction manual. Then fill the sensor and replace membrane cap assembly and attempt calibration again.

SECTION 12

Sensor Troubleshooting

12.0 Calibration Problems

- a) Sensor output *higher* than DPD test
 - 1) Run in time too short
 - 2) Membrane cap damaged
 - 3) Interference from water contaminants (see Specifications, "Cross Sensitivity")
 - 4) Cable short circuit or damage
 - 5) pH value less than pH 4.0
- b) Sensor output *lower* than DPD test
 - 1) Run in time too short
 - 2) Deposits on Membrane cap
 - 3) Flow rate too low
 - 4) Air bubbles on membrane
 - 5) Surfactants in water
 - 6) pH value more than pH 11.0
 - 7) No electrolyte in membrane cap
 - 8) Gold cathode coated
- c) Sensor output is 4mA (zero ppm)
 - 1) Run in time too short
 - 2) Only bound chlorine present
 - 3) Chlorine dioxide content below detection limit
 - 4) Sensor not wired correctly (See section 6.0 of this manual)
 - 5) Defective sensor
- d) Sensor output *unstable*
 - 1) Air bubbles on membrane
 - 2) Membrane damage
 - 3) Non-sensor problem

TROUBLESHOOTING CHART

Symptom	Possible Cause	Solution/Remedy
The sensor cannot be calibrated- output is <i>HIGHER</i> than	<ol style="list-style-type: none"> 1) Run in time too short 2) Membrane cap damaged 3) Interference from contaminants 4) DPD chemicals bad 5) Temperature increased since cal 	<ol style="list-style-type: none"> 1) See Sec 7.0 -CONDITIONING 2) Replace cap - See Sec 11.0 3) See SPECIFICATIONS 4) Use new DPD kit 5) Match calibration temp.
The sensor cannot be calibrated- output is <i>LOWER</i> than DPD Test	<ol style="list-style-type: none"> 1) Run in time too short 2) Deposits on membrane cap 3) Flow rate too low 4) Air bubbles on membrane 5) Surfactants in water 6) No electrolyte in cap 8) Temperature decreased since cal 9) Cathode coated 	<ol style="list-style-type: none"> 1) See Sec 7.0 -CONDITIONING 2) Remove deposits or replace cap if cleaning ineffective. 3) increase flow - See SPECIFICATIONS 4) Remove and re-install sensor to remove bubbles. 5) Remove surfactants and replace cap. See SEC 11.0 6) Add new electrolyte, run in sensor and re-calibrate 8) Increase temp to match cal 9) Polish cathode per Sensorex instructions. This should only be done if electrolyte refill and membrane cap change have not improved sensor performance./can't calibrate.
Sensor output is 4mA (0ppm)	<ol style="list-style-type: none"> 1) NO ClO2 present 2) Run in time too short 3) Chlorine dioxide too low 4) No electrolyte in cap 5) Sensor electrical connection wrong 	<ol style="list-style-type: none"> 1) Check system. 2) See Sec 7.0 -CONDITIONING 3) Add ClO2 and repeat calibration 4) Refill electrolyte 5) See SECTION 6.0
Unstable output from sensor	<ol style="list-style-type: none"> 1) Air bubbles on sensor membrane 2) Membrane damaged 3) Non-sensor problem 	<ol style="list-style-type: none"> 1) Tap to remove bubbles 2) Replace membrane, run in sensor and recalibrate. 3) check PLC or I/O device

SECTION 13 Sensor Specification

13.0 Operating Specifications

Follow all operating specifications, especially for pH and flow rate as noted in the specification tables below.

TECHNICAL SPECIFICATIONS

SENSOR

Dimensions:	8.2"L x 1" dia
Body Material:	Black PVC
Membrane Material:	Proprietary
O-ring material:	Viton®
Cathode:	Gold
Anode:	Silver chloride (AgCl)
Cable:	2-conductor shielded, 10ft (3mtr) tinned wire leads

FLOW CELL

Dimensions:	5.58"H x 2.25"DIA
Material:	Acrylic
Connections:	1/4" NPT inlet and outlet

OPERATING SPECIFICATIONS

Operating temperature range:	0-45 degC
Maximum operating pressure:	1 bar/14.7 psi/1atm
Flow rate minimum:	0.2 gpm (0.75Lpm)
Flow rate maximum:	0.6 ppm (2.25Lpm)
pH range:	4-11
Output signal:	4.0+/- 0.4mA in air (zero) 21mA +/- 0.5 mA at high range (2 or 10ppm)
Power Requirement:	12-24 VDC, 250 mA minimum
Cross-Sensitivity:	Ozone, monochloramine
Chemical Compatibility:	up to 50% ethanol/water or up to 50% glycerol/water

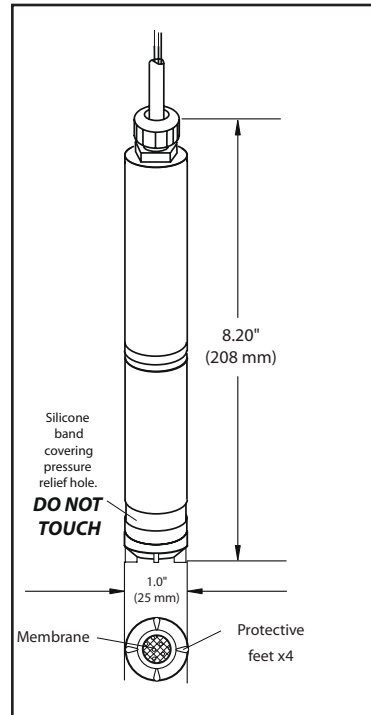
MAINTENANCE/REPLACEMENT PARTS

CLDA-5015	Chlorine dioxide sensor fill solution, 30mL, 2 each
CLDA-5016	Chlorine dioxide replacement premembraned cap, 1 each + pressure relief band, 1 each
CLDA-5017	Polishing squares for gold cathode, 3 each
CLDA-5018	Complete maintenance kit, CLD5 Series includes: 2 each 30mL bottles of electrolyte, 1 membrane cap assembly, 1 pressure relief band, 3 polishing squares for gold cathode

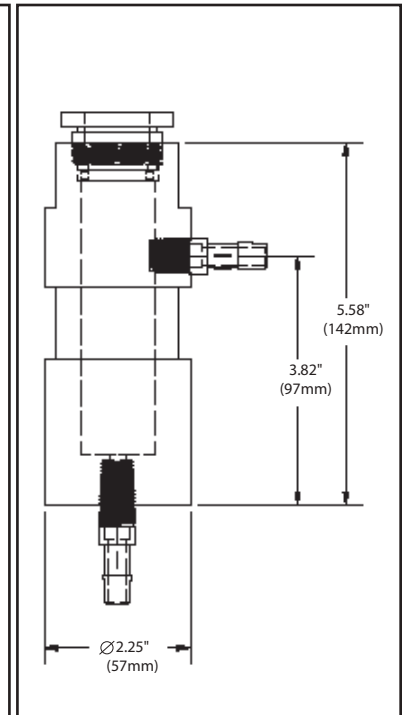
ACCESSORIES

FM001	Flow Meter, 0.1 to 1.0 gpm (0.5 to 4.0 Lpm) 1/2 inch MNPT & 1/4 inch FNPT inlet and outlet, includes: 2 each 1/4" barbed tube fittings(3/8" tube)
FC72C	Flow Cell, 1/4 inch FNPT inlet and outlet, includes: 2 each 1/4" barbed tube (3/8" tube) fittings, clamp, threaded flow cell installation fitting
FCLA-7000	Free Chlorine /Chlorine Dioxide Colorimeter-eXact 7+, requires CLDA-7001 strips
CLDA-7001	Glycine strips for Chlorine dioxide testing with FCLA-7000

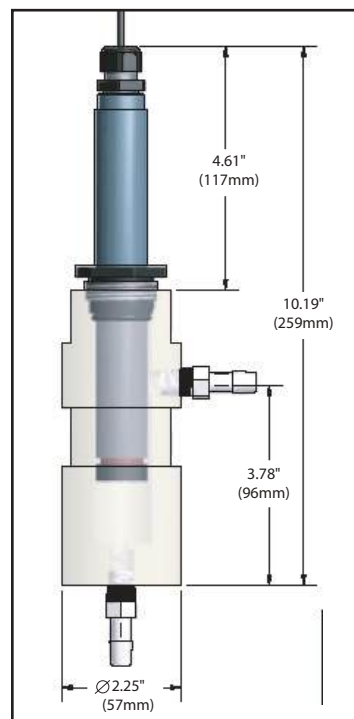
SENSOR DIMENSIONS



FC72 FLOW CELL DIMENSIONS



SENSOR AND FLOW CELL INSTALLATION DIMENSIONS



FM001 - FLOW METER DIMENSIONS

