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:
$ClO2 + 4H^+ + 5e- \text{ ---> } Cl^- + 2\ H_2O$
At the same time, the silver anode is oxidized to form silver chloride (AgCl) as: $Cl^- + Ag \text{ ---> } AgCl + e-$

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.

2.2 Flow

To acheive reproducible 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)

Parts covered by this product data sheet include:
CLD402, CLD405, CLD410, FC72, CLDA-4015, CLDA-4016, CLDA-4026

SECTION 3.0
Sensor Preparation

3.0 Chlorine Dioxide Sensor Assembly

The Chlorine Dioxide Sensor is shipped with the membrane cap (CLDA-4016) pre-installed and covered with a cap which has water inside to keep the membrane wet. Make sure to keep sensor cap, anode and cathode away from oily or greasy materials. Contact with oil or grease will result in inaccurate measurements. The sensor is also supplied with a 3 oz bottle of refill solution, a syringe and needle tip.

NOTE: ***If sensor will be stored dry out of flow cell, shake body downward into a sink to remove the fill solution. Take the membrane cap and immerse in a cup of tap water untill 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 Free Chlorine reading, the Sensor must be installed into the Flow Cell to prevent air bubbles formation on the membrane, 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 F001 provides flow control from 0.1 to 1.0 GPM (0.5 to 4.0 LPM) with 6% 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).

FIG. 2

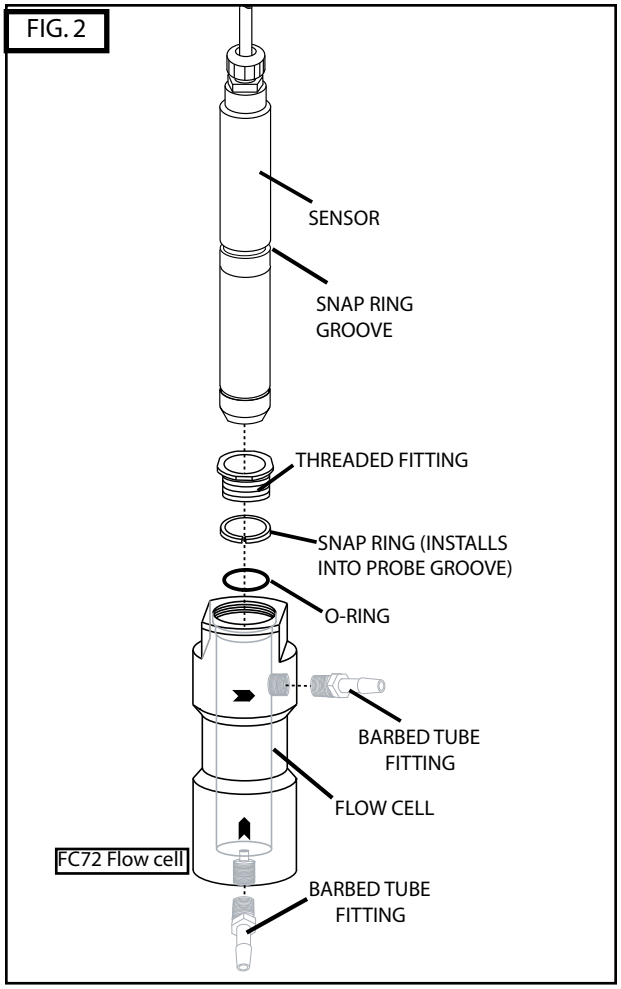
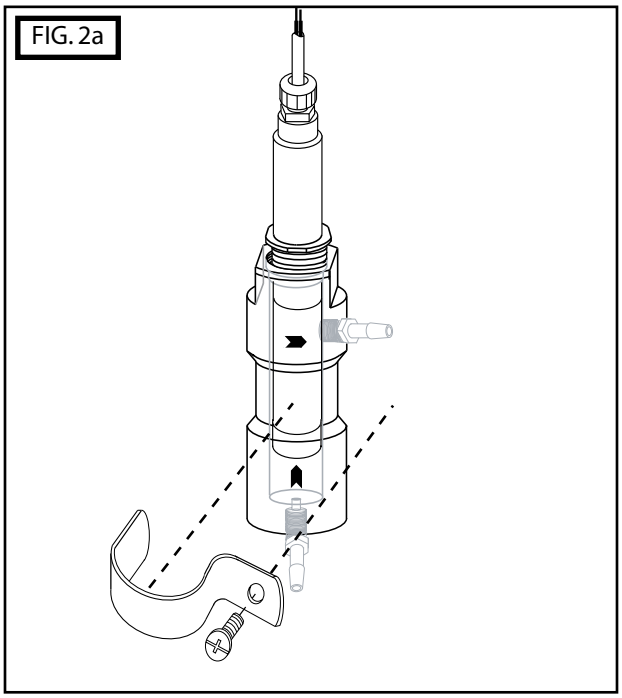


FIG. 2a



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SECTION 5.0
Sensor Installation

5.0 Sensor Installation into Flow Cell

a) First install threaded fitting onto sensor body (remove fitting if pre-installed in flow cell)
b) Install snap-ring into groove on sensor body
c) Next, slide o-ring onto body of sensor until it reaches bottom of threaded fitting.
d) Thread sensor assembly into top of flow cell as shown in FIG 2.
e) 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 (0-1ppm, 0-2ppm, 0-5ppm).

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 three wires, red (+), black (-) and clear (shield). Twist together or solder black and clear if instrument does not have separate ground. If a separate ground is available such as for PLC's connect clear (shield) to it. 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 suppy 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.

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

FIG. 2b

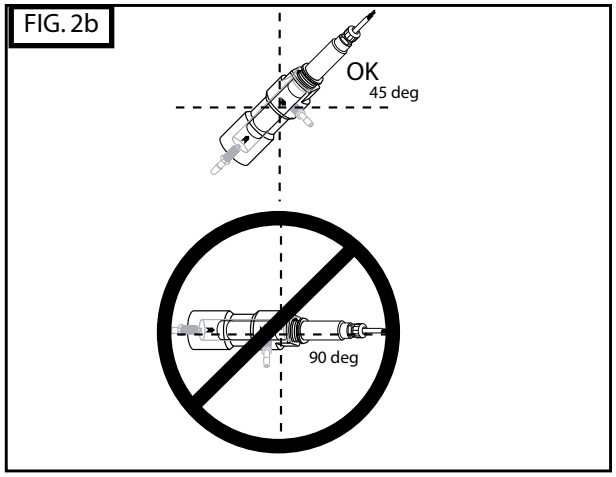


FIG. 2c

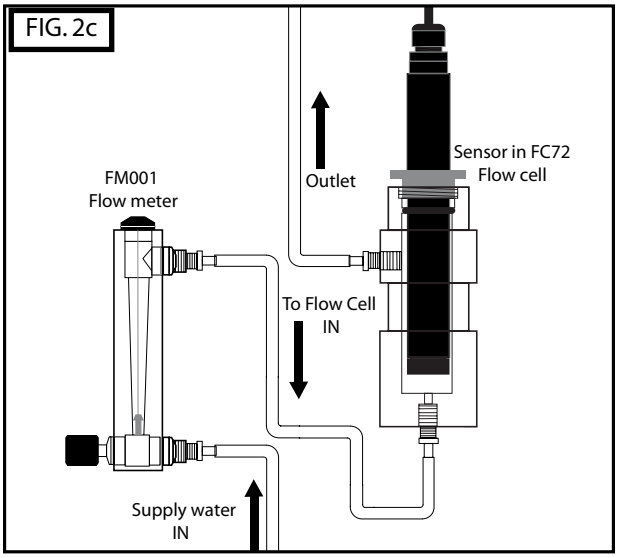
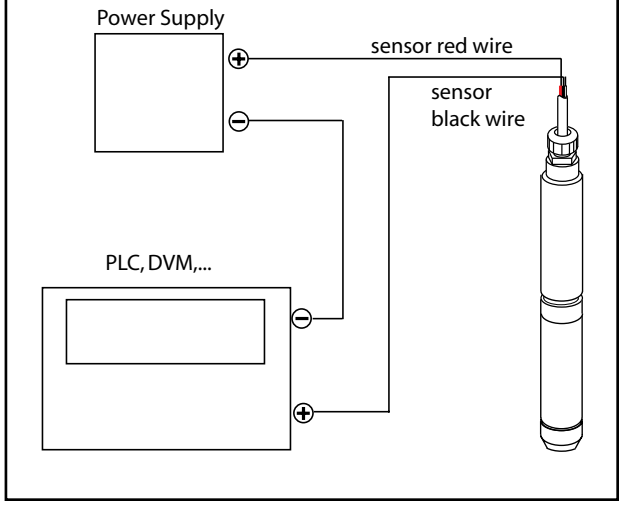


FIG. 3



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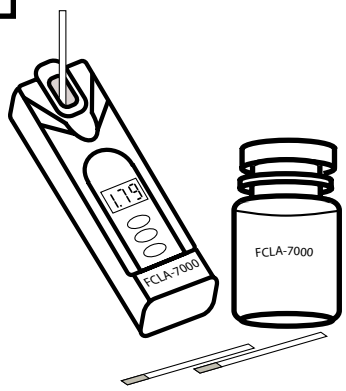
Section 8.0
Calibration

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. Periodic calibration (about once per week) is recommended. 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

a) 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.
b) Measure chlorine dioxide content with sensor. Make sure that calibration flow rate and pH matches flow rate when measuring sample since probe output is flow rate dependent. Make sure pH is within 4.0-11 range.
c) Adjust span/slope at PLC/4-20mA device.
d) Repeat this slope calibration one day after sensor is initially installed.
e) Repeat the slope calibration monthly.

FIG. 4



Note: The DPD method for Free chlorine measurement is not selective for free chlorine alone. Other oxidants in the water can also be measured as free chlorine.

Section 9.0
Sensor Storage

9.0 Storage

Store sensor at 5^{O} C - 50^{O} C *only* and maximum humidity of 95% non-condensing.

a) *Short Term Storage* (one week or less): Store in Flow cell with water to prevent the probe from drying out.
b) *Intermediate Term* (one week to one month): Store in cap, bottle, or beaker with water to keep membrane wet.
c) *Long Term* (one month or longer): Remove Membrane Cap and store cap completely immersed in tap water. Turn sensor upright and shake it to remove fill solution from inside the sensor.

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

FIG. 5

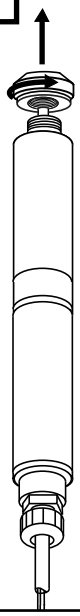


FIG. 6

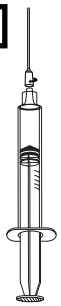
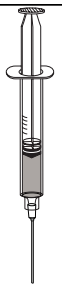


FIG. 7



Section 10.0
Sensor Maintenance/Reconditioning

10.0 Mebrane Cap Replacement

If membrane replacement is required, a new cap with preinstalled membrane must be used. Order CLD-4016 (See Section 11) cap/membrane replacement.

To change membrane cap:

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

FIG. 8

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SECTION 11
Sensor Maintenance/Reconditioning

11.0 Electrolyte Solution Replacement

Drain and refill the sensor approximately every two months.

11.1 Membrane Replacement

If membrane replacement is required, a new cap with preinstalled membrane must be used. Order CLDA-4016 replacement membrane cap and CLDA-4015 refill solution. To change membrane cap (do the following over a sink or washbasin):

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.
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 50).

11.2 Membrane Cap/Sensor Cleaning

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

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 watercontaminants (see Specifications, "Cross Sensitivity")
4) Cable short circuit or damage
5) pH value less than pH 5.5

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 8.5
7) No electrolyte in membrane cap

c) Sensor ouput is 4mA (zero ppm)
1) Run in time too short
2) Only bound chlorine present
3) Chlorine content below detectionlimit
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- ouput is *HIGHER than*	1) Run in time too short	1) See Sec 7.0 -CONDITIONING
	2) Membrane cap damaged	2) Replace cap - See Sec 11.0
	3) Interference from contaminants	3) See SPECIFICATIONS
	4) DPD chemicals bad	4) Use new DPD kit
	5)Temperatue increased since cal	5) Match calibration temp.
The sensor cannot be calibrated- output is *LOWER than* DPD Test	1) Run in time too short	1) See Sec 7.0 -CONDITIONING
	2) Deposits on membrane cap	2) Remove deposits or replace cap if cleaning ineffective.
	3) Flow rate too low	3) increase flow - See SPECIFICATIONS
	4) Air bubbles on membrane	4) Remove and re-install sensor to remove bubbles.
	5) Surfactants in water	5) Remove surfactants and replace cap. See SEC 11.0
	6) No electrolyte in cap	6) Add new electrolyte, run in sensor and re-calibrate
	8) Temperature decreased since cal	8) Increase temp to match cal
Sensor output	1) NO ClO2 present	1) Check system.
	2) Run in time too short	2) See Sec 7.0 -CONDITIONING
	3) Chlorine dioxide too low	3) Add CLO2 and repeat calibration
	4) No electrolyte in cap	4) Refill electrolyte
	5) Sensor electrical connection wrong	5) See SECTION 6.0
Unstable output from sensor	1) Air bubbles on sensor membrane	1) Tap to remove bubbles
	2) Membrane damaged	2) Replace membrane, run in sensor and recalibrate.
	3) Non-sensor problem	3) check PLC or I/O device

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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:	polyethersulfone
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+/- 0.2mA in air (zero) 20mA +/- 0.2mA at high range (2, 5 or 10ppm)
Power Requirement:	12-24 VDC, *250* mA minimum
Cross-Sensitivity:	N/A
Chemical Compatibility:	up to 50% ethanol/water or up to 50% glycerol/water

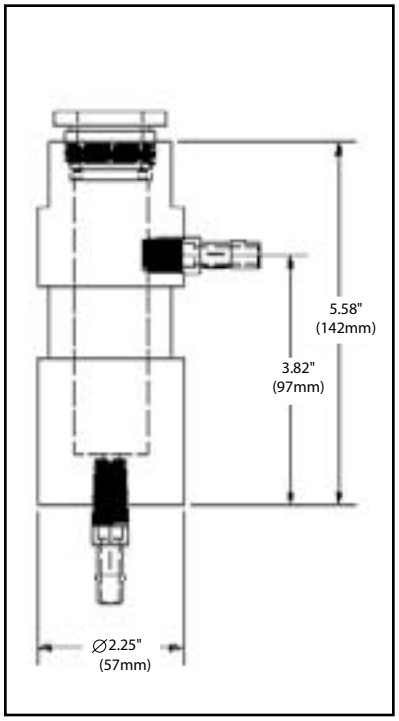
MAINTENANCE/REPLACEMENT PARTS

CLDA-4015	Chlorine Dioxide sensor fill solution, 30mL, 1 each
CLDA-4016	Chlorine Dioxide Replacement premembraned cap, 1 each

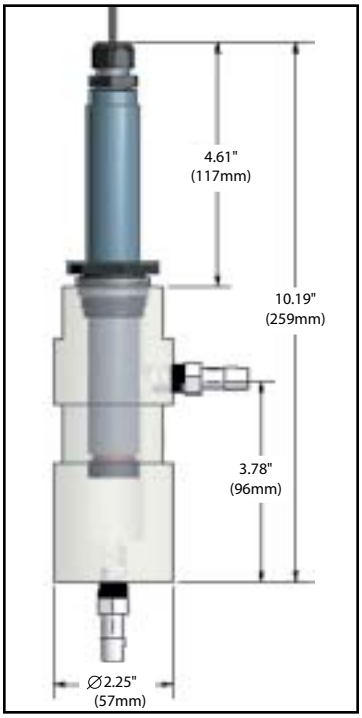
ACCESSORIES

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 Chrlorine /Chlorine Dioxide Colorimeter-eXact 7+, requires CLDA-7001 strips
CLDA-7001	Glydine strips for Chlorine dioxide testing with FCLA-7000

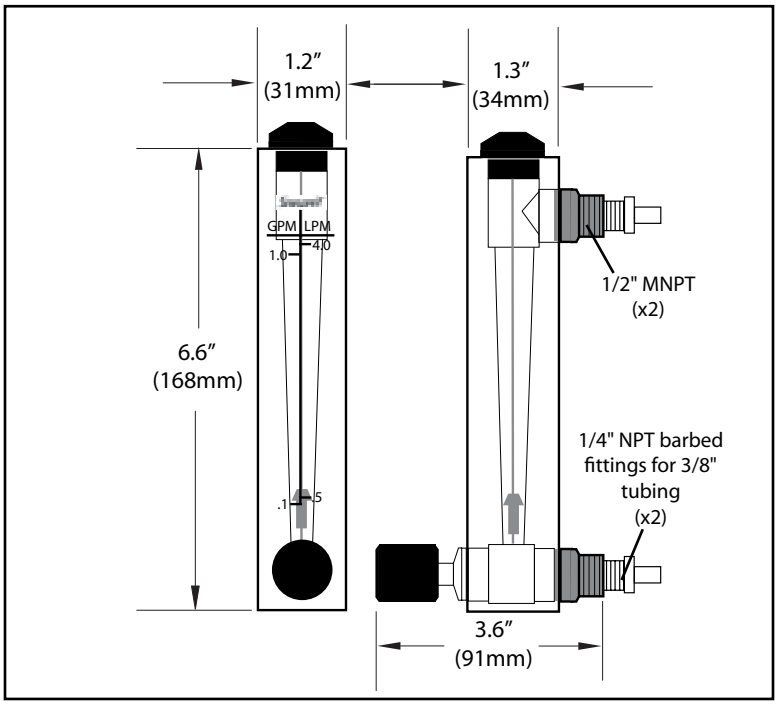
FC72 FLOW CELL DIMENSIONS



SENSOR AND FLOW CELL INSTALLATION DIMENSIONS



FM001 - FLOW METER INSTALLATION



Form: InstrCLD4 [Rev: 2011-06-27]