User Guide For Free Chlorine Sensor with Analog output A420-FCL

A420-FCL-01	JUN-2021

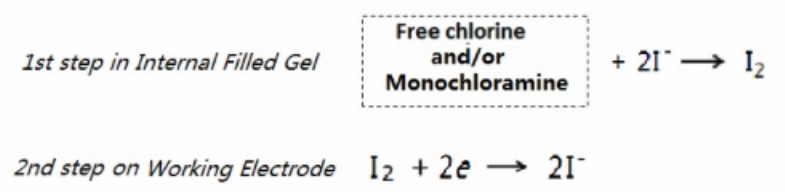
This document is applied for the following products

1. Introduction

Free Chlorine Sensor with Analog output A420-FCL

The Chlorine Electrode is an amperometric (or polarographic) electrode (or “probe”) used for continuous measurement of chlorine in drinking water, swimming pools, spas, industrial applications, or dirty/colored samples where colorimetric methods are inadequate. A 3-electrode system is employed for ensuring good linearity between the output and the chlorine concentration (up to 50 ppm). The bound membrane sensor cap provides good stability and durability for this product. In addition, our proprietary Internal Filled Gel (IFG) significantly reduces the electrode measurement’s pH dependence.

In principle, the chlorine electrode measures the total chlorine of the water sample via the measurement mechanism described below. However, free chlorine measurement is also feasible when the chloramine concentration is negligible or constant and calibrated for free chlorine.



2. Specification

Sensing Technology	Two-electrode amperometric technology with gas permeable membranes (replaceable)
Measuring range	0-10mg/L or 0-20mg/L
Accuracy & Resolution	+/- 0.1 mg/L
Repeatability	+/- 0.05 mg/L (25 oC)
Response Time	T90 < 90s (25 oC)
Working Condition	0 .. 50 oC with pH = 5 .. 9
Working Pressure	0 .. 15 psig
Flow range	30 .. 60 L/h or 0.6 .. 1.3 cm/s
Output	4-20mA
Power supply	6..12VDC, avg. < 200mA
Conditioning	New, first start-up: at least 4hours Restart-up: < 30 min.
Calibration	One Point - Manual with DPD
Interferences	ClO2, Ozone, Bromine Cyanuric Acid compatible
Process connection	1/2" NPT
Wetted parts	PVC, Silicone, ABS, PES Silver-Silver Halide/Platinum
Sensor Cable	6m with BNC connector
Rating	IP68
Sensor Dimension	D21.3 x 219 (mm)
Sensor net weight	< 200 grams
Warranty	1 year for probe, membrane for 03 months

3. Installation

⚠ IMPORTANT NOTES:

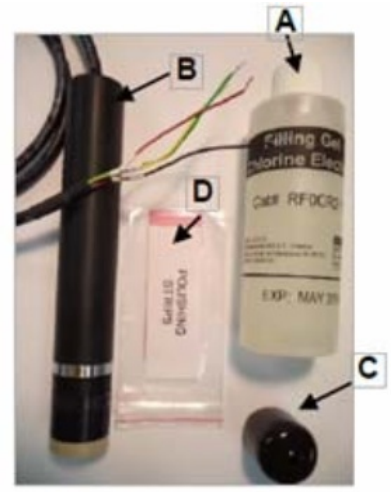
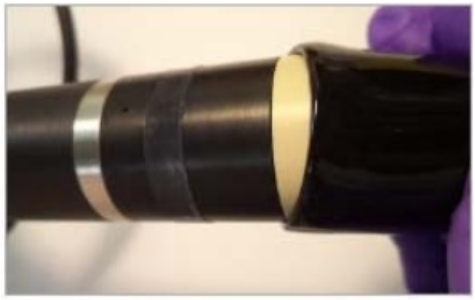
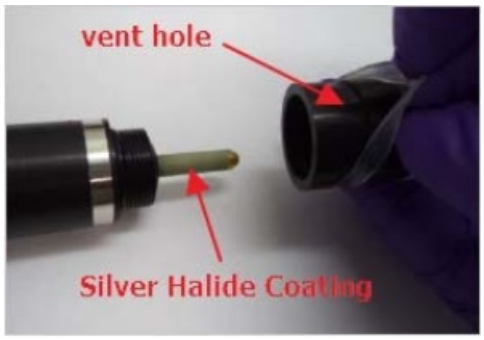
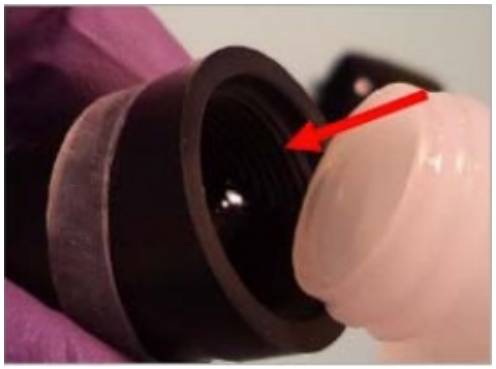
The Chlorine Electrode is designed to operate with 9-24 VDC power. Connecting the electrode to any power outside the normal range may result in electrode damage and void the warranty.

In addition to complying with the instructions included in this manual, be sure to follow the applicable analyzer/controller/meter instructions regarding electrode wiring.

The membrane cap needs to be filled with Internal Filled Gel(IFG) before using the electrode.

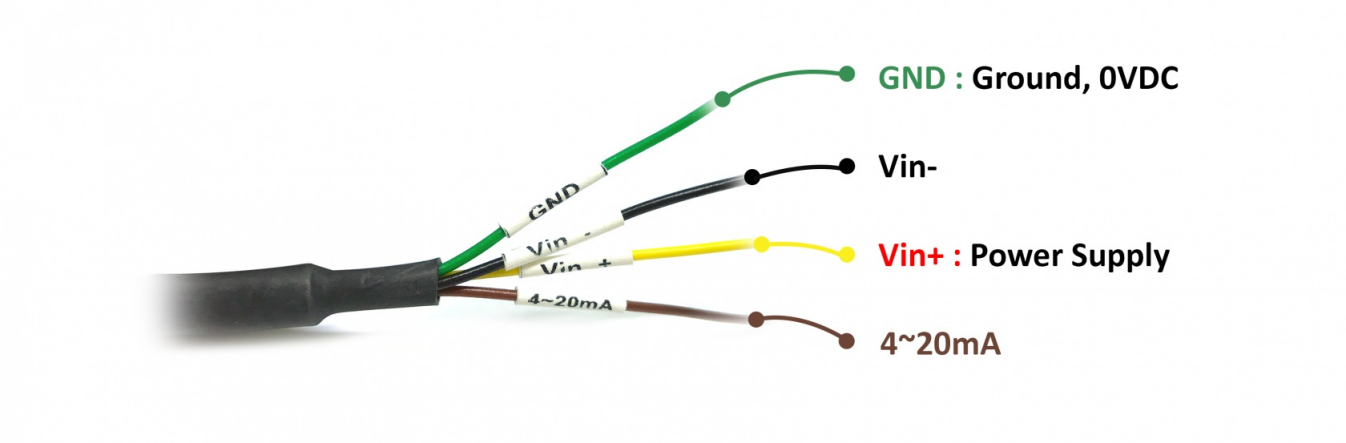
Safety Data Sheets (SDS) for information on safe handling of chemicals for operating the electrode should be made available to all personnel involved in installation, testing, and ongoing use, as needed.

3.1. Electrode Assembly steps 1-8

	1. Ensure you have the necessary components to assemble the electrode ● Internal Filled Gel (IFG) ● Electrode & Membrane Cap ● Protection Boot ● Electrode polishing strips
	2. Remove the protection boot from the electrode or membrane cap
	3. Lift the silicone band covering the vent hole. Make sure the vent hole (see arrow in image) is open to air. Avoid using any sharp tools for this step. Set the membrane cap aside. ► Note:Avoid damaging the Silver Halide Coating(gray portion)
	4. Polish the working electrode (WE) surface (see arrow) with the polishing strip until it is shiny in appearance. ● Polish the gold tip in one direction. ● Do not over-polish – this should just take a few strokes on the polishing strip ● Avoid touching the silver halide coating ● Rinse the electrode with DI water after polishing
	5. Fill the membrane cap with Internal Filled Gel (IFG) to the upper threads (red arrow). ► Note:DoNOTshaketheInternalFilledGel(IFG) before filling – this may introduce problematic air bubbles.

	6. Make sure the silicone band is not covering the vent hole and screw the membrane cap on the electrode until it is finger tight. The vent hole will allow excess IFG to escape. ► Note:Do this step over a sink with running water to rinse away excess IFG.
	7. Push the silicone vent hole band back into the recess and rinse the electrode thoroughly before using.
	8. Wipe water off the electrode gently. Avoid touching the membrane after assembly. The electrode is now ready for polarization and conditioning steps.

3.2. Electrode wiring



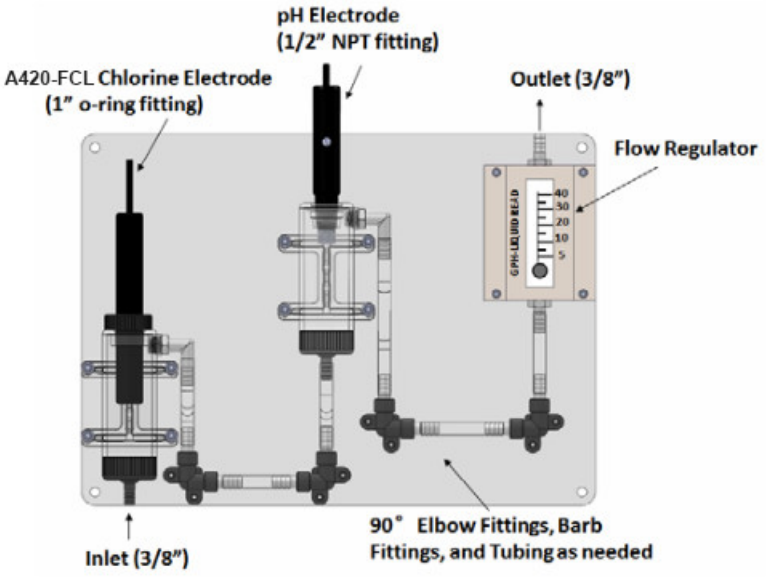
- **Yellow:** Vin+
- **Black:** Vin-
- **Red:** 4-20mA Input
- **Green:** Ground, 0VDC

⚠ NOTE:

1. The standard cable length is 3 feet. If another cable length is needed, contact your supplier or manufacturer. The maximum length should be no more than 30 feet to avoid signal loss.
2. The output current of power source should be more than 100 mA.
3. The A420-FCL output can be measured by multimeter or other devices which allow the analogue input and measurement. The maximum loop resistance of the devices should be less than 400Ω for testing the current output of A420-FCL (4-20mA version).

3.3. Installation into a flow cell or similar system

To achieve accurate measurements, an appropriate flow rate in the range of 30 to 60 L/hr is required to reach equilibrium between the electrochemical consumption and the diffusion of chlorine. A beaker with magnetic stirrer can be used for electrode evaluation or polarization in a lab environment, but for real continuous measurement applications, a flow cell system is required. A diagram of a flow cell system for the A420-FCL electrode, a pH electrode, and a flow regulator is shown in picture below.



⚠ NOTE:

- Make sure the stainless-steel ring on the A420-FCL chlorine electrode is completely submersed in the water (above the stainless-steel counter electrode).
- The flow regulator and 90o elbow tubing is important for the devices to maintain a constant flow rate. An unstable flow rate will lead to an inaccurate chlorine measurement.
- The flow regulator can be installed at INLET side as well.
- Avoid bubbles adhering to the center hole of membrane cap. Bubbles in other areas of membrane cap are acceptable.
- Make sure to maintain a clear space of ~25mm (about 1") between the tip of the sensor cap and the bottom of the flow cell tube.

4. Calibration

The output of A420-FCL is linear with chlorine concentration. As a result, a 2-point calibration determine the final calculation equation. Usually, the zero and the half-scale points are recommended for calibrating A420-FCL.

For the zero point (1st point), it can be obtained in zero chlorine water during the conditioning processing. Generally, the zero point of A420-FCL should be within the specification ranges provided in Tables 1 and 2. The zero point drift is very slow and negligible in most cases. If the zero point of A420-FCL is not within the specification ranges, please change the internal filled gel, clean the working electrode and polarize the probe in the zero-chlorine water again. Please check the zero point every quarter or half a year at least for more precision.

For the half-scale point (2nd point), it is usually around the middle point of the measurement range and it is the most important point for the accuracy of A420-FCL. In most cases, the calibration of A420-FCL is actually a 1-point calibration while zero point drift can be ignored. Thus, the colorimetric DPD method (colorimeter, photometer or spectrophotometer) is strongly recommended to standardize the exact concentration of chlorine at this point. There are primarily two types of DPD Reagents commercially available:

1. DPD Free Chlorine Reagent (DPD Method #1) for measuring free chlorine.
2. DPD Total Chlorine Reagent (DPD Method #4) for measuring total chlorine.

Calibration Preparation and Procedure

- The operator should review and familiarize themselves with the DPD method, reagents, and devices to make sure knowing how to perform this important calibration measurement.
- PreparetheequipmentandDPDreagentsforafastandefficientmeasurement.
- MakesuretheA420-FCLchlorineelectrodeisfullypolarizedandconditionedinzero-chlorinewaterand record the output of zero point (the 1st point).
- Make sure the electrode is installed properly inthe measurement system with a constant flowrate ranging from 30 L/hr to 60 L/hr (0.6 cm/s to 1.3 cm/s).
- Add chlorine to the system, and preliminarily measure the chlorine concentration by DPDmethod.

Approximately adjust the chlorine concentration to the middle point of the measurement range by adding water or chlorine if necessary.
- Let the probe output be stable, and then take water samples from the measurement system for DPD standardization. This sample should be close to the A420-FCL electrode location for best accuracy.
- Record the output of A420-FCL (the 2nd point) as well as the chlorine reading from DPD test.
- Calculate the slope as follows:

$$\text{Slope} = \frac{\text{Output of 2nd point (mV or mA)} - \text{Output of 1st point (mV or mA)}}{\text{DPD reading (mg/L or ppm)}}$$

Once the slope is obtained, the electrode output including voltage (0-5V) or current (4-20 mA) can be converted into “mg/L” or “ppm” in customers’ analyzer/controller/meter. The conversion equation for any of A420-FCL output is below:

$$\text{Chlorine (mg/L or ppm)} = \frac{\text{Output of A420-FCL (mV or mA)} - \text{Output of zero point (mV or mA)}}{\text{Slope}}$$

5. Maintenance

5.1. Electrode re-polarization

When the zero point of A420-FCL is not within specifications or there is no significant change in the measurement environment, but the electrode reading is continuously increasing or decreasing (not fluctuating) within an hour, re-polarization is probably needed. The root cause is that some interfering substances probably were brought to the working electrode again, such as unsuccessfully polishing the surface of working electrode, changing the IFG, replacing the membrane or soaking the electrode with the power off (unconnected) in chlorine or other strong oxidant solution for a long time. The re- polarization process is mandatory until the electrode presents a stable output. If the zero point of A420-FCL still can not meet the specifications after a reasonable amount of polarization time, changing the IFG or polishing the working electrode again may be necessary, or adding tiny sodium thiosulfate in testing water for removing the potential oxidizers.

5.2. Changing the Internal Filled Gel (IFG)

If the zero point of the A420-FCL does not meet the listed specifications it may be necessary to change the IFG. The IFG also needs be changed if the stainless-steel ring (counter electrode) is not submersed in the water when the electrode is powered for more than 5 minutes. Also, when the slope is lower than 50% of the nominal value, changing the IFG may correct this situation. It is important to disconnect/power off the electrode before removing it from the water. Instructions for changing the IFG are as follows:

1. Lift the vent hole band up and move it to the lower part of the membrane cap.
2. Unscrew the membrane cap from the electrode body.
3. Dump any residual IFG remaining in the cap or on the electrode body.
4. Rinse the membrane cap with DI water, then with 1-2 mL of new IFG.
5. Complete the IFG change as described in the section Electrode Assembly, from step 5 to step 8.

5.3. Cleaning the Membrane Cap (De-iodine)

It is recommended to clean the membrane, when the center pore of the membrane cap is discolored (usually yellow or brown) or if the slope is lower than 50 % of the nominal value after changing the IFG. This is not actually “cleaning” the membrane, but rather the removal of extra iodine precipitates by Na2S, Na2S2O3 solution or Ethanol. The recommended process is as follows:

1. Disconnect the electrode and unscrew the membrane cap , discard the IFG, and rinse the membrane cap and the electrode with clean water.
2. Cover the working electrode (WE) and reference electrode (RE) parts with a paper towel and avoid exposure to sunlight.
3. Prepare ~ 0.1 M Na2S2O3 or 95% Ethanol and pour ~150 ml in an appropriately sized beaker to allow the membrane to be submerged.
4. Submerge the membrane cap in the solution completely for overnight. Use parafilm to cover the open of the beaker during soaking.
5. Clear the cap by DI water and paper, refill IFG and screw onto electrode.

5.4. Replacing the Membrane Cap

If the membrane cap gets damaged, the electrode reading is fluctuating, or the slope is lower than 30% of the nominal value after changing the IFG and cleaning the membrane, the membrane cap may need to be replaced. Please make sure the electrode is not powered during assembly and then follow the instruction below for replacement.

1. Unpack the membrane cap replacement kit and prepare the new membrane cap on a clean surface.
2. Unscrew the old membrane cap and discard it.
3. Rinse the new membrane cap with clean water, then rinse it with 1-2 mL of the IFG.
4. Follow the instructions from step 5 to step 8 as described in the Electrode Assembly section.

5.5. Polishing the Working Electrode (WE)

If the A420-FCL electrode reading is abnormal or the zero point is not within specifications after a reasonable polarization time, the working electrode (WE) may not be able to completely polarize. Try to polish the WE again with the polishing strip. In addition, if a stain or discoloration is visible on the surface of the WE, it should be polished until the stain is less visible or removed completely. Please refer to Step 4 of Electrode Assembly section to brush the gold reference electrode (RE) a few times in one direction, and then follow the next steps for electrode assembly.

5.6. Storing the Electrode

The A420-FCL electrode can be stored in clean water or stored dry, preferably at normal room temperatures, while not in use. It is recommended to:

1. Soak the electrode in clean water (IFG in cap) if it will be used within 1 week.
2. Store the electrode dry (IFG in cap) if it will be used within 1 month.
3. Store the electrode dry (without IFG in cap) for longer than 1-month storage.

> NOTE: The reference electrode is light sensitive and should be capped or covered during storage

6. Troubleshooting

Problem	Possible Cause	Solution
No reading (1)	Insufficient conditioning.	Reading should appear within 10 mins.
No reading (2)	Electrode connection or power supply.	Check connection/wiring.
No reading and electrode feels warm	PCB shorted or corrupted.	Replace electrode
Zero point out of specification	1. Water sample is not chlorine free 2. Insufficient polarization/conditioning 3. Interfering substances cannot be cleaned electrochemically.	1. Replace the zero chlorine water. 2. Continue polarizing andconditioning electrode. 3. Brush WE with polishing strip.
Reading instable or fluctuation	1. Membrane cap fouled or damaged. 2. Air bubbles on outside of membranecap – especially at center pore 3. Air bubbles inside the membrane cap.	1. Clean or change membrane cap. 2. Shake the electrode to remove theair bubbles from the center pore. 3. Shake electrode or inspect the cap for air bubbles
Slope too low	1. Membrane cap fouled. 2. IFG deterioration. 3. Insufficient conditioning 4. Flow rate too low. 5. Erroneous DPD standardization.	1. Clean or change membrane cap. 2. Refill IFG. 3. Recondition the electrode. 4. Adjust flow rate into working range. 5. Check the measurement range of the DPD and recalibrate.
Reading out of range	1. Chlorine content > maximum measuring range. 2. Electrode and membrane cap are unmatched or improperly attached.	1. Confirm actual sample or electrode range specification 2. Reinstall the membrane cap looser or slightly tighter. Replace the membrane cap.

7. Package Include:

8. Support contacts:

Manufacturer

Daviteq Technologies Inc
No.11 Street 2G, Nam Hung Vuong Res., An Lac Ward, Binh Tan Dist., Ho Chi Minh City, Vietnam.
Tel: +84-28-6268.2523/4 (ext.122)
Email: info@daviteq.com | www.daviteq.com

Distributor in **Australia** and **New Zealand**

Templogger Pty Ltd
Tel: 1800 LOGGER
Email: contact@templogger.net

Revision #23
Created Fri, Jun 18, 2021 6:41 PM by Vũ Hoàng Anh Tài
Updated Wed, Jul 21, 2021 9:08 AM by Kiệt Anh Nguyễn