Operations Manual
FC1N
Digital Free Chlorine Sensor

leadtec
Water Treatment Solution

Table of Content

1.0 Specifications

Specifications are subjected to change without notice.

SPECIFICATIONS	DETAILS
Measuring System	Amperometric Potentiostatic 3-Electrode System
Measuring Range	0.000 – 20.000 ppm
Electronic	Digital Modbus RTU
Slope Drift	Approx. <3% per month
Operating Temperature	0 – 45°C
Temperature Compensation	Automatically by an integrated temperature sensor
Operating Pressure	0.5 bar in the flow cell
Flowrate	Approx. 15 – 30 L/h in flow cell
pH Range	pH 4 – 12, highly reduced dependence on pH value
Run-in Time	First start-up approx. 2 hours
Response Time	T90 approx. 2 minutes
Slope Calibration	DPD-1 Method
Power Supply	9 – 30 VDC
Dimension	Diameter : 25mm Length : 205mm
Material	Microporous Hydrophilic Membrane PVC-U PEEK Stainless Steel 1.4571

2.0 Introduction

2.1. Symbols and Displays

Notice

Indicates essential information regarding operation, calibration or anything which is considered as good practice or handling of the products.

The hazard symbols and signal words listed below are used in these operating instructions. Read the instructions carefully to ensure safe instrument operation.

2.2. Safety Information

	**DANGER!**	Hazard with a high degree of risk which if not avoided will lead to death or serious injury.
	**WARNING!**	Hazard with a medium degree of risk which if not avoided may lead to death or serious injury.
	**CAUTION!**	Hazard with a low degree of risk which if not avoided may lead to minor or moderate injury.
	NOTE	NOTE warns against damage to property.

2.3. Safety Precautions

It is important to take safety precautions during the installation, operation and calibration of sensors and controllers. Safety must not be compromised; some ground rules need to be followed first. The basic guidelines regarding the safe handling of electrical components are documented below will help users while working with electricity.

	General warning symbol that indicate the risks of injury. Take all the actions that are indicated by this warning symbol.

	This symbol indicates tips and helpful information for optimum and economic use of the product.

3.0 Product Overview

3.1. Product Content

Leadtec FC1N Digital Free Chlorine *S*ensor features 3-electrode systems with covering membranes. The applications of FC1N is mainly for clean water applications such as swimming pool, drinking water and municipal water. The sensor is not suitable for checking for the absence of chlorine.

A complete measuring and/or control system normally consists of the following components:

- Sensor
- Electrical leads and connectors
- Flow chambers and connections
- Measuring and controlling device
- Dosing equipment
- Analytical equipment

These operating instructions relate exclusively to the sensor. Comply with the operating instructions accordingly to the respective devices.

3.2. Sensor Measurement

The sensor measures the concentration of free chlorine in the water with the presence of inorganic chlorine compounds; sodium hypochlorite (NaOCl), calcium hypochlorite (Ca(OCl)2), chlorine gas, electrolytically generated chlorine and chlorine compounds based on isocyanuric acid. Therefore, the sensor has a greatly reduced pH dependency.

3.3. Product Completeness

- Keep the all the packaging for the sensor.
- In the event of repair or warranty claim please return the sensor in the original packaging.
- Examine that the delivery is complete and undamaged. If the product is damaged, please contact your supplier promptly.

Component	Quantity
Sensor with membrane cap	1
Electrolyte	1
Special emery paper	1
Operating instructions	1

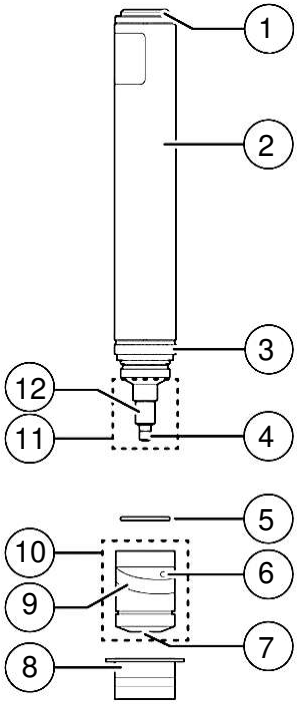


Figure 1 Dimensions of FC1N Digital Free Chlorine Sensor.

1. Electrical connection
2. Sensor body
3. Counter electrode
4. Working electrode
5. O-ring 14 x 1.8
6. Valve opening
7. Membrane Disc
8. Protective cap
9. Hose ring
10. Membrane cap
11. Electrode finger
12. Reference electrode

4.0 Installation and Calibration

This section explains the correct installation of the sensor and how to connect the unit to a power source and auxiliary equipment. The following installation requirements must be satisfied:

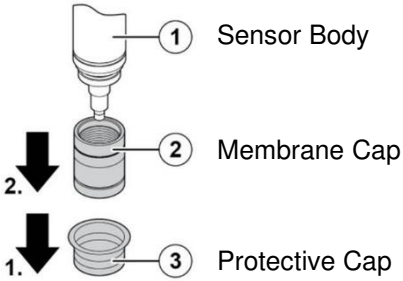
- Continuous power supply and presence of measurement medium
- Flowrate and operating range as specified on the data sheet
- Constant through flowrate
- Presence of free chlorine disinfectants in the water
- Galvanic separation of the electrical connection

⚠	**WARNING!**	The sensor must be securely fastened in its respective flow cell, vibration or pressure may cause sensor leakage of liquid.

4.1. Preparation

Steps:

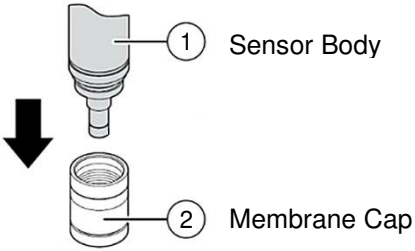
1. Remove the protective cap [3] off from the membrane cap [2].
2. Unscrew the membrane cap [2] from the sensor body [1].



3. Place the membrane cap on a clean surface.

4. Fill the membrane cap with electrolyte to the brim carefully to prevent bubble build up.

5. Place the sensor body [1] upright on the membrane cap [2]. Rotate the sensor body anticlockwise until the thread is felt to engage.



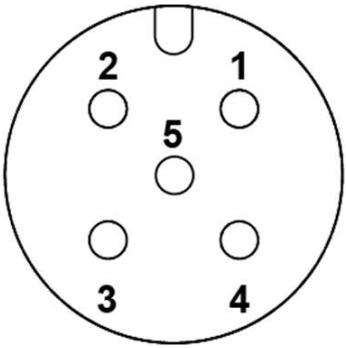
6. Slowly screw the sensor body into the membrane cap.
7. Make sure that the valve opening is not blocked.
8. Screw the cap on further until the gap between the shaft is closed.
9. Once the membrane cap has been fully screwed on, use tap water to rinse off any electrolyte residues adhering to the sensor.
10. The sensor is now prepared for commissioning.

4.1.1. Insertion Into The Flow Chamber

1. Insert the sensor into a flow chamber.
2. Follow the instructions in the operating instructions of the flow chamber.

4.1.2. Connection With Modbus Signal Transmission

The sensor is provided with a 5-pin M12 screwed plug protected against polarity reversal. There are no termination resistors within the sensor. The connection pins are assigned as follows:



1. (not assigned)
2. +9…+30 V
3. GND
4. RS485 B
5. RS485 A

4.1.3. Calibration

The sensor sends output which is a signal proportional to the concentration of the disinfectant in the measured solution. Calibration will improve the accuracy thus correcting the proportion of concentration. For optimum measurement, perform calibration on every week or after changing electrolyte of the sensor / maintenance.

> After completing the first calibration, the sensor requires a certain amount of run-in time as mentioned in datasheet, which in this case is 2 hours, before proceed to the second calibration to get the best possible slope.

1. Ensure the flow chamber is in constants flowrate, temperature, and pH.
2. Let the temperature reading of the sensor stabilized.
3. Avoid presence of oxidant in the measurement medium.
4. Extract 20mL of liquid from the flow chamber as calibration sample.
5. Use DPD method master analyzer to identify the concentration of disinfectant.
6. Adjust the chlorine concentration reading from the sensor closest to the measurement value obtained from the DPD analyzer.

Measured variables	**Recommended Analytical Methods**	
	Method	**Master Analyzer**
Free chlorine	DPD-1 Method	Photometer for chlorine

5.0 Maintenance

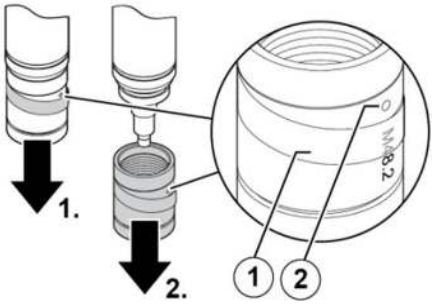
5.1. Overview

Maintenance keeps the condition of the sensor at optimum. In order to achieve excellent performance over extensive period of time, well planned maintenance and calibration are required. Perform the following periodically.

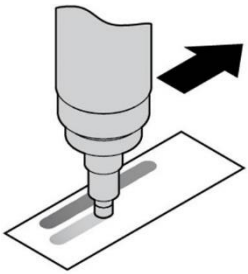
Task	Interval
Electrolyte replacement	3 – 6 months
Membrane cap replacement	Annually
Calibration	• Weekly • After the electrolyte and/or the membrane cap has been changed

5.2. Replacement of Electrolyte & Membrane Cap

- Lift the hose ring [1] sideways off the membrane cap and slide it down.
- The valve opening [2] is now exposed.
- Unscrew the membrane cap.
- Air can now flow through the valve opening.



1. Detach the hose ring.
2. Open the sensor membrane cap.
3. Empty the electrolyte from the membrane cap.
4. Rinse the electrode tip with tap water.
5. Lay a piece of special emery paper on a paper wipe.
6. Hold the sensor upright.
7. Hold the special emery paper in place.
8. Gently rub the tip of the working electrode over it until the gold electrode shines. Make sure to use a fresh area of the emery paper for each rub.
9. Return the hose ring and sensor cap to their original position.



6.0 Troubleshooting

Various factors in the environment can potentially affect the sensor. These are the factors that would cause irregular sensor performance:

- Flowrate
- Measuring cable
- Measuring and controlling device
- Calibration
- Dosing equipment
- Concentration of the disinfectant in the dosing container
- Compatibility of the sensor for measuring the disinfectant that is being dosed
- Concentration of the disinfectant in process water (reference value is determined by analytical methods)
- pH value of measurement medium
- Temperature measurement medium
- Pressure in the flow chamber
- Analytical methods

6.1. Potential Risks

6.1.1. Improper Installation of The Sensor

If the sensor is not securely fastened, vibration or pressure may cause physical damage on the sensor. Please ensure to follow the following guidelines:

- Use suitable size of retaining ring.
- Ensure the sensor is securely fastened.
- Install the sensor in an upright position.

6.1.2. High or Fluctuating Water Pressure

Excess water pressure exceeds the maximum permissible value and frequent pressure fluctuation could cause damage on membrane cap. Please ensure to follow the following guidelines:

- Comply with the permissible pressure stated on the datasheet.
- Stabilize the pressure in flow cell.

6.1.3. Insufficient Disinfectant

Lack of disinfectant in the water for a prolonged period will cause accumulation of biological film on the membrane. Membrane cap replacement may be required if it is damaged. Please ensure to follow the following guidelines:

- Make sure that the period during which there is no disinfectant present is no longer than specified on the data sheet.

6.1.4. Sensor Removal

Removal of sensor during operation will lead to incorrect measurement reading. Always switch off the controller when removing the sensor.

6.1.5. Interferences

Oxidants, reducers, and corrosion inhibitors in the water interfere with measurement. Erratic measurement can be expected. Please ensure to follow the following guidelines:

- Ensuring that there are no oxidants, reducers, corrosion inhibitors and water hardness in the water.
- Comply with the instructions on the data sheet.

6.1.6. pH Value Out of Range

Changes in pH value out of permissible range can cause erratic measurement. Please ensure to follow the following guidelines:

- Ensure that the pH value lies within the permissible range (refer to datasheet).

6.1.7. Temperature Change

Ambient temperature exceeding permissible range may result in electrolyte damage. Please ensure to follow the following guidelines:

- Ensure the sensor is operating or stored within the permissible temperature range as mentioned in the datasheet.
- The sensor might show symptoms such as erratic measurement if the temperature in the process water is fluctuating.

6.1.8. Incorrect Reference Value Used In Calibration

Incorrect measurement of the concentration of the disinfectant will lead to incorrect calibration of the sensor. Please ensure to follow the following guidelines:

- Observe the recommended analysis methods as per the datasheet.
- Perform the current analytical measurement in accordance with the operating instructions of the analytical equipment.

6.2. Fault Overview

Fault	Cause	Corrective Action
Sensor cannot be calibrated / deviation of the measuring value from DPD measurement	Torn membrane	Replace the membrane cap (see Section 5.2).
	Formation of bubbles in electrolyte	Replace the electrolyte (see Section 5.2).
	Insufficient run-in time	Allow more time before performing calibration (see Section 4.1.3).
	Damaged membrane cap	Replace the membrane cap (see Section 5.2).
	Disruptive substances in the water contents	Check the water for disruptive substances (see datasheet). Eliminate or at least dilute the disruptive substances. Consult with the supplier.
	Short circuit / defects in the measuring lead	Locate and eliminate the short circuit / defect.
		Exchange the measuring lead.
	Membrane cap is not fully tightened	Screw the membrane cap on fully to the top.
	The DPD chemicals are past their expiration date	Use new DPD chemicals. Perform calibration (see Section 4.1.3).
	Deposits on the membrane cap	Change the membrane cap (see Section 5.2).

	Gas bubbles forming on membrane	Temporarily increase the flowrate. Check the installation and modify it.
	No electrolyte in the membrane cap	Fill the membrane cap with electrolyte. Prepare the sensor (see Section 4.1).
	The concentration of disinfectant exceeds the maximum measuring limit	Troubleshoot the process line. Repeat the calibration (see Section 4.1.3).
	Lack of galvanic isolation	Create galvanic isolation. Return the sensor to the supplier for checking / reconditioning.
	The sensor is defective	Return the sensor to the supplier for checking / reconditioning.
Unstable measuring value	Gas bubbles in electrolyte	Unscrew membrane cap and empty electrolyte. Repeat the steps in “Preparation” (see Section 4.1).
	Torn membrane	Change the membrane cap (see Section 5.2).
	Gas bubbles forming on the outside of the membrane	Temporarily increase the flowrate. Check the installation and modify it.
	Pressure fluctuations in the measured process water	Check the type of installation and modify it.

	Lack of galvanic isolation	Create galvanic isolation. Return the sensor to the supplier for checking / reconditioning.
	The reference electrode had worn off and/or contaminated[1]	Return the sensor to the supplier for checking / reconditioning.
	Excessive concentration of disinfectant in the measured process water	Check the system. Optimize the chlorine dosing. Calibrate the sensor (see Section 4.1.3).
	Run-in time too short	Allow run-in to complete fully (see Section 4.1.3).
	Damaged membrane cap	Replace the membrane cap (see Section 5.2).
	Flowrate is too high	Check the system. Reduce the flowrate.
	Lack of galvanic isolation	Create a galvanic isolation. Return the sensor to the supplier for checking / reconditioning.
	The sensor is defective	Return the sensor to the supplier for checking / reconditioning.
Underdriving[2]	Insufficient run-in time	Allow run-in to complete fully (see Section 4.1.3).
	The working electrode is contaminated	Perform maintenance on the sensor (see Section 5.2).

[1] The reference electrode has a silvery sheen or is white. The usual colour on the other hand is brown/grey.

[2] The electronics is receiving a signal with the wrong polarity at the input from the electrochemical cell.

	Lack of galvanic isolation	Create galvanic isolation. Return the sensor to the supplier for checking / reconditioning.
	The sensor is defective	Return the sensor to the supplier for checking / reconditioning.
Green LED flickering or failing to light up	Defective Power supply	Provide the correct power supply.
	The sensor is defective	Return the sensor to the supplier for checking / reconditioning.
No signal	The measuring lead is broken	Exchange the measuring lead.
	The sensor is not receiving any power supply	Provide the correct power supply.
	The sensor is defective	Return the sensor to the supplier for checking / reconditioning.
Corrosion / rust on the counter electrode	Lack of galvanic isolation	Provide galvanic isolation.