Free Chlorine Measuring System

- Complete system includes sensor, connecting cable, transmitter, and flow controller
- Sensor response is practically independent of pH between pH 6.5 and 10
- No reagents
- No auxiliary pH electrode
- Variopol quick-disconnect fittings makes sensor replacement easy

Applications and Features

The Model FCLi free chlorine system is intended for the determination of free chlorine (hypochlorous acid plus hypochlorite ion) in fresh water. Unlike other free chlorine transmitters, the Model FCLi does not use expensive sample conditioning systems or messy reagents to control pH. Nor, does it require an auxiliary pH sensor for pH correction. Instead, the pH adjustment takes place inside the sensor, producing a signal that changes less than 4% per unit change in pH between pH 6.5 and 10. Below pH 6.5 the change is less than 1%. The linear range of the sensor is 0 to 20 ppm (mg/L).

The Model FCLi is not intended for the determination of total or combined chlorine (like monochloramine). Nor, can the FCLi be used for the determination of chlorine in seawater.

The Model FCLi uses a three electrode, membrane-covered amperometric sensor. The sensor consists of a hydrophilic membrane stretched over a gold mesh cathode. A silver/silver chloride reference electrode and an external auxiliary electrode complete the circuit. The fill solution is saturated succinic acid slurry. During operation, an electrochemical reaction, driven by the polarizing voltage, consumes free chlorine at the cathode surface. The auxiliary electrode provides the electrons for the cathode reaction, and a current proportional to the reaction rate flows between the electrodes. Because the concentration of chlorine at the cathode is zero, free chlorine in the sample continuously diffuses through the membrane and is destroyed at the cathode. Thus, the cathode current is proportional to the diffusion rate, which is proportional to the concentration of free chlorine in the sample.

The FCLi sensor requires neither sample pretreatment nor pH correction. All amperometric free chlorine sensors generate a raw current that depends primarily on the concentration of hypochlorous acid. Because the fraction of free chlorine present as hypochlorous acid depends on pH, readings will be in error if the sample pH changes from the value it had during calibration. To correct for pH changes, some manufacturers treat the sample with acid to convert hypochlorite to hypochlorous acid. Others continuously measure the pH and use the pH value to correct the chlorine sensor reading. The Model FCLi is different. The sensor uses a highly buffered acidic fill solution for internal pH adjustment. The fill solution converts all the free chlorine entering the sensor as well as much of the free chlorine at the outside surface of the membrane into hypochlorous acid. Thus, the sensor response is practically independent of pH.

For customers who wish to measure pH, an option that includes a pH sensor and flow cell is available.

Maintenance is fast and easy. Replacing a membrane requires no special tools or fixtures. A screw cap holds the pre-tensioned membrane in place. Replacing the membrane and fill slurry takes only a few minutes.

Applications and Features cont.

The FCLi is available with the Model 1056 or 56 transmitter. Both instruments are easy to use, with simple and intuitive pro- gramming and calibration. Both have fully programmable analog outputs and fully programmable alarm relays.

Valves, rotameters, and pressure regulators to control sample flow are things of the past with the the Model FCLi. A constant head overflow sampler ensures the correct flow to the sensor no matter how much the sample flow or pressure changes. To eliminate wiring hassles, quick disconnect Variopol cable is standard.

Stable free chlorine standards do not exist. The chlorine sensor must be calibrated using the results of a laboratory test on a grab sample.

Specifications — General

Sample requirements:

Pressure: 3 to 65 psig (122 to 549 kPa abs) Inlet check valve opens at 3 psig (122 kPa abs). Without check valve pressure is 1 psig (108 kpa abs).

Temperature: 32 to 122°F (0 to 50°)

Flow: 2-80 gal/hr (7.6-303 L/hr)

Sample Conductivity: >10 µS/cm

Process connection: 1/4-in OD tubing compression fitting.

Drain connection: 3/4-in barbed fitting. Sample must drain to open atmosphere.

Wetted parts: acrylic, polycarbonate, polyester, Kynar(1), nylon, silicone, PVC, Viton(2), polyethersulfone, copper, (316 stainless steel in some versions), Tefzel(2), glass

Response time to step change in chlorine concentration: <120 sec to 90% of final reading for inlet sample flow of 2 gph (7.6 L/hr).

Weight/shipping weight:

Model FCLi-01: 10 lb/13 lb (4.5 kg/6.0 kg)

Model FCLi-02: 11 lb/14 lb (5.0 kg/6.5 kg)

[rounded to the nearest 1 lb. (0.5 kg)]

Specifications — Sensor

Free chlorine range: 0 to 20 ppm as Cl_2. For higher ranges; consult the factory.

Accuracy: Accuracy depends on the accuracy of the chemical test used to calibrate the sensor

Linearity (0-20 ppm): 1% per IEC 60746

Linearity (0-2 ppm): ±0.05 ppm following calibration at 2 ppm

Sensitivity to pH: Between pH 6.5 and 10, sensor signal changes <4% per unit change in pH. Below pH 6.5 the change is <1%. per unit change in pH.

Interferences: Monochloramine, dichloramine, and permaganate

Electrolyte life: 3 months (approx.)

Specifications — Model 1056 Transmitter

Case: Polycarbonate NEMA 4X/CSA 4 (IP65).

Conduit openings: Accepts PG13.5 or 1/2 in. conduit fittings

Display: Monochromatic back-lit LCD. Main character height 0.6 in (15mm). Display is user-programmable

Languages: English, French, German, Italian, Spanish, Portuguese, and Chinese.

Ambient temperature and humidity: 32 to 131°F (0 to 55°C); RH 5 to 95% (con-condensing)

Storage temperature: -4 to 140°F (-20°C and 60°C)

Power: 84-265 Vac, 47.5 to 65.0 Hz, switching, 15 W

⧈ Equipment protected by double insulation

RFI/EMI: EN-61326

LVD: EN-61010-1

CE

Outputs: Two 4-20 mA or 0-20 mA isolated outputs. Continuously adjustable. Linear or logarithmic. Maximum load 550 Ω. Output dampening is user-adjustable.

Alarms: Four alarm relays. Any relay can be configured as a fault alarm instead of a process alarm. Each relay can be configured independently and each can be programmed with interval timer settings.

Relays: Form C, SPDT, epoxy sealed

Relay Contact ratings:

5 A at 28 VDC or 300 VAC (resistive)
1/8 HP at 120/240 VAC.

Terminal Connections Rating: Power connector (3-leads): 18-12 AWG wire size. Current output connectors (2-leads): 24-16 AWG wire size. Alarm relay terminal blocks: 18-16 AWG wire size

Hazardous Location Approvals: For more information refer to the Model 1056 product data sheet 71-1056. Approvals apply to the transmitter only. The FCLi is not suitable for use in hazardous areas.

(1) Kynar is a registered trademark of Elf Atochem North America.

(2) Viton and Tefzel are registered trademarks of DuPont Performance Eastomers.

Specifications — Model 56 Transmitter

Case:
Polycarbonate

Display: Full color LCD, 3.75 x 2.20 in. (95 x 56 mm); display can be customized by the user.

Languages: English, French, German, Italian, Spanish, Portuguese, Chinese, Russian, and Polish.

Ambient Temperature and Humidity: 14 to 140°F (-10 to 60°C); RH 5 to 95% (non-condensing). Between 23 and 131°F (-5 to 55°C) there is no visible degradation in display response or performance.

Storage temperature: -4 to 140°F (-20 to 60°C)

Power: 85 to 265 VAC, 47.5 to 65.0 Hz, 20 W

RFI/EMI: EN-61326

LVD: EN-6101-01

Outputs: Four 4-20 or 0-20 mA isolated current outputs; assignable to measurement or temperature; fully scalable; maximum load 550 Ω. HART digital signal is superimposed on output 1.

Alarms and Timers: Four relays, fully configurable as a setpoint alarm, interval timer, TPC, bleed and feed timer, delay timer, date and time timer, and fault alarm.

Relays: Form C, SPDT, epoxy sealed.

Relay Contact ratings:

5 A at 28 VDC or 300 VAC (resistive)
1/8 HP at 120/240 VAC

Control features: PID control (analog output) and time proportional control or TPC (relays) are standard.

Data logger: Data automatically stored every 30 seconds for 30 days; older data removed to make room for new data. The following data are automatically stored:

Chlorine: date and time, ppm, temperature, raw sensor current

pH: date and time, pH, temperature, mV, glass impedance, and reference impedance (if available)

Event logger: Stores up to 300 events with data and time stamp: faults, warnings, calibration data, calibration results (pass or fail), power on/off cycles, and hold on/off. Alarm relay activation and deactivation can also be stored. Older events are automatically removed to make room for new events.

Data and event downloading: through USB port on front panel.

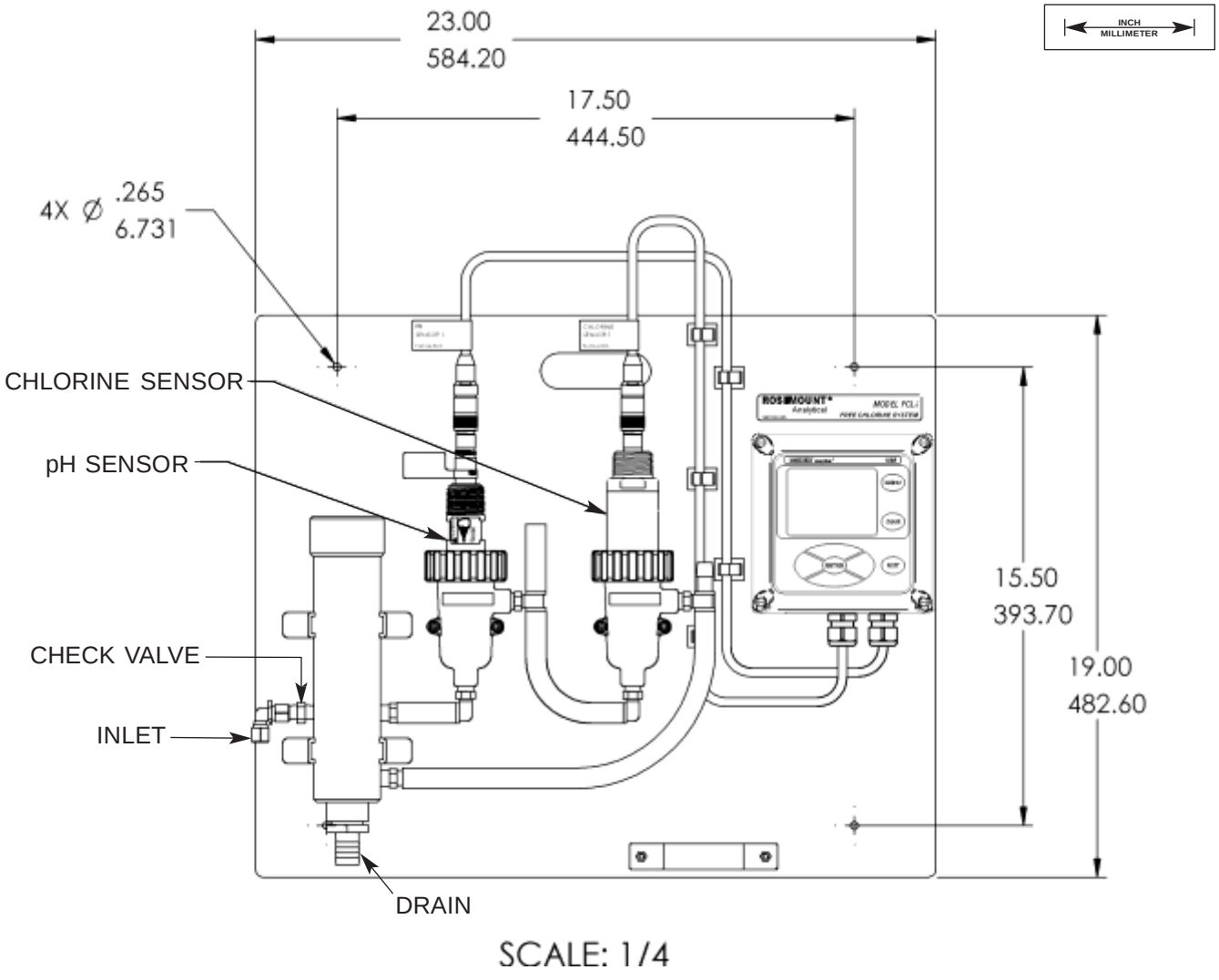
Graphical display: Dual graphical display shows measurement data on the y-axis and time on the x-axis. Y-axis is fully assignable and scalable. X-axis can be set to one hour, one day, seven days, or 30 days.

Digital communications: HART digital communications is standard.

Hazardous Location Approvals: For more information refer to the Model 56 product data sheet 71-56. Approvals apply to the transmitter only. The FCLi is not suitable for use in hazardous areas.

FCLi-02-221 shown.

Both versions of the FCLi have the same overall dimensions. The FCLi-01 has a single flow cell for the chlorine sensor.



Model FCLi —1056 Engineering Specification

1. The system shall be suitable for the determination of free chlorine in water without sample conditioning reagents or an auxiliary pH sensor. Systems that use sample conditioning or require a pH sensor for pH correction are not acceptable.
2. The system shall consist of an transmitter, a free chlorine sensor, a flow cell for the sensor, and a flow controller. The components shall be mounted on a back plate. Sensor cables shall be pre-wired to the transmitter. Sensors shall plug into the cables using Variopol quick disconnect fittings. The flow cell shall be clear plastic to allow the sensor to be easily inspected for fouling. The inlet shall be fitted with a check valve to ensure the sensors remain wet in the event sample flow is lost.
3. Although a pH measurement is not required for correcting the raw chlorine signal, a system incorporating a pH sensor shall be available as an option.
4. The system shall use no mechanical devices, such as pressure regulators, valves, or rotameters, to control flow. Instead, flow shall be regulated using a constant head flow controller. Minimum sample flow shall be no more than about 3 gallons per hour (11 liters per hour). Maximum flow can be as high as 80 gallons per hour (303 liters per hour). The flow controller shall be able to handle inlet pressure between 3 and 65 psig (122 to 549 kPa abs) and temperature between 32 and 122°F (0 and 50°C).
5. The free chlorine sensor shall be a three-electrode membrane-covered sensor with a silver/silver chloride reference, gold mesh cathode, and external auxiliary electrode. The fill solution shall be saturated succinic acid. The free chlorine sensor shall be fitted with an RTD to allow continuous correction for changes in membrane permeability caused by temperature.
6. The change in chlorine signal shall be less than 4% per unit change in pH between pH 6 and 10.
7. The linear range of the free chlorine sensor shall be at least 0 to 20 ppm as Cl_2.
8. The linearity between 0 and 20 ppm shall be 1% (IEC 60746).
9. The optional pH sensor shall be a combination electrode having a glass sensing membrane and a double junction reference electrode.
10. The transmitter shall have optional dual input, one for the free chlorine sensor and the other for the optional pH sensor. The transmitter shall receive the raw signal from the free chlorine sensor and automatically correct it for temperature effects. Results shall be displayed as ppm Cl_2.
11. The transmitter shall require single point calibration if the expected chlorine level is within the linear range of the sensor. A correction for the sensor zero current shall also be available.
12. The transmitter shall have automatic buffer recognition for pH sensor calibration.
13. The transmitter shall have a four line, back lit display. The display shall show ppm chlorine, pH (if measured), and temperature in one screen. The user shall be able to customize the main display to show additional information such as raw sensor current.
14. The transmitter shall be capable of operating between 32 and131°F (0 and 55°C) and between 5 and 95% relative humidity (non-condensing).
15. The transmitter shall have dual 0/4-20 mA isolated outputs. Outputs shall be fully scalable and assignable independently to chlorine, pH (if measured), or temperature.
16. The transmitter shall have four optional alarm relays fully programmable for logic (high or low operation), dead band, and set point. Any relay can also be configured to energize when the transmitter detects a fault with the sensor or the transmitter.
17. All transmitter programming shall be through a front panel membrane keypad. The language (English, Spanish, Italian, Portuguese, German, or French) used in the menu screens shall be selectable by the user.
18. The transmitter shall have a security feature to prevent unauthorized tampering with calibration and configuration settings.
19. The analyzer shall be Rosemount Model FCLi-01-220 (free chlorine only) or Model FCLi-02-221 (free chlorine with optional pH sensor) or approved equal.

Model FCLi —56 Engineering Specification

1. The system shall be suitable for the determination of free chlorine in water without sample conditioning reagents or an auxiliary pH sensor. Systems that use sample conditioning or require a pH sensor for pH-correction are not acceptable.
2. The system shall consist of an transmitter, a free chlorine sensor, a flow cell, and a flow controller. The components shall be mounted on a back plate. Sensor cable shall be pre-wired to the transmitter. The sensor shall plug into the cable using a Variopol quick disconnect fitting. The flow cell shall be clear plastic to allow the sensor to be easily inspected for fouling. The inlet shall be fitted with a check valve to ensure the sensor remains wet in the event sample flow is lost.
3. Although a pH measurement is not required for correcting the raw chlorine signal, a system incorporating a pH sensor shall be available as an option.
4. The system shall use no mechanical devices, such as pressure regulators, valves, or rotameters, to control flow. Instead, flow shall be regulated using a constant head flow controller. Minimum sample flow shall be no more than about 3 gallons per hour (11 liters per hour). Maximum flow can be as high as 80 gallons per hour (303 liters per hour). The flow controller shall be able to handle inlet pressure between 3 and 65 psig (122 to 549 kPa abs) and temperature between 32 and 122°F (0 and 50°C).
5. The free chlorine sensor shall be a three-electrode membrane-covered sensor with a silver/silver chloride reference, gold mesh cathode, and external auxiliary electrode. The fill solution shall be saturated succinic acid. The free chlorine sensor shall be fitted with an RTD to allow continuous correction for changes in membrane permeability caused by temperature.
6. The change in chlorine signal shall be less than 4% per unit change in pH between pH 6 and 10.
7. The linear range of the free chlorine sensor shall be at least 0 to 20 ppm as Cl_2.
8. The linearity between 0 and 20 ppm shall be 1% (IEC 60746).
9. The optional pH sensor shall be a combination electrode having a glass sensing membrane and a double junction reference electrode.
10. The transmitter shall receive the raw signal from the free chlorine sensor and automatically correct it for temperature effects. Results shall be displayed as ppm Cl_2. For systems having an optional pH sensor, the transmitter shall have dual input, one for the free chlorine sensor and the other for the pH sensor.
11. The transmitter shall require single point calibration. A correction for the sensor zero current shall also be available.
12. The transmitter shall have automatic buffer recognition for pH sensor calibration.
13. The transmitter shall have a four line, full color display. The display shall show ppm chlorine, pH (if required), and temperature on one screen. The display shall be programmable to show additional information such as raw sensor current.
14. The transmitter shall be capable of operating between 14 and140°F (-10 and 60°C) and between 5 and 95% relative humidity (non-condensing).
15. The transmitter shall have four 0/4-20 mA isolated outputs and HART digital communications. Outputs shall be fully scalable and assignable independently to chlorine, pH, or temperature. PID control shall be available as a standard feature.
16. The transmitter shall have four alarm relays fully programmable as a high/low alarm with adjustable deadband or as a timer. Timer functions shall include an interval timer, bleed and feed timer, delay timer, and date and time timer. Time-proportional control shall also be available. In addition relays shall be configurable to energize when the transmitter detects a fault with itself or the sensor.
17. All transmitter programming shall be through a front panel membrane keypad. The language (English, Spanish, Italian, Portuguese, German, French, Russian, Polish, or Chinese) shall be selectable by the user.
18. The transmitter shall have a data logger that automatically stores data every thirty seconds for thirty days with older data being discarded to make room for newer data. In addition to storing date and time, chlorine concentration, pH, and temperature, the transmitter will store raw sensor current (chlorine sensor) and mV reading and glass and reference impedance (pH sensor). Stored data shall be downloadable through a USB port.
19. The transmitter shall have a dual graphical display that allows stored data to be viewed over one hour, one day, seven days, and one month intervals.
20. The transmitter shall have a data logger that stores up to 300 events.
21. The transmitter shall have help screens, available at the touch of a button, that provide information about configuration, calibration, and troubleshooting.
22. The transmitter shall have a security feature to prevent unauthorized tampering with calibration and configuration settings.
23. The analyzer shall be Rosemount Model FCLi-01-240 (free chlorine only) or Model FCLi-02-241 (free chlorine with optional pH sensor) or approved equal.

Ordering Information

Model FCLi Free Chlorine Measuring System. The FCLi is a complete system for the determination of free chlorine in aqueous samples. It consists of the sensor, transmitter, and constant head flow controller. All components are mounted on a backplate. Model option
-02 includes a pH sensor for customers who wish to measure pH in addition to free chlorine. Three replacement membranes and enough electrolyte chemicals for three refills are shipped with each chlorine sensor.

Model FCLi	Free Chlorine Measuring System
CODE	pH Correction (required selection)
01	Without pH sensor
02	With pH sensor

CODE	Transmitter (required selection)
220	1056-03-24-38-AN transmitter, single input (chlorine) (option -01 only)
221	1056-03-24-32-AN transmitter, dual input (pH and chlorine) (option -02 only)
240	56-03-24-38-HT transmitter, single input (chlorine) (option -01 only)
241	56-03-24-32-HT transmitter, dual input (pH and chlorine) (option -02 only)

FCLi -02 -241 EXAMPLE

Component Parts

Transmitter Model	Description
1056-03-24-38-AN	1056 transmitter, single input (chlorine), 85-265 Vac, 47.5-65.0Hz
1056-03-24-32-AN	1056 transmitter, dual input (chlorine and pH), 85-265 Vac, 47.5-65.0Hz
56-03-24-38-HT	56 transmitter, single input (chlorine), 85-265 Vac, 47.5-65.0Hz
56-03-24-32-HT	56 transmitter, dual input (pH and chlorine), 85-265 Vac, 47.5-65.0Hz

Sensor Model	Description
498CL-01-VP	pH-independent free chlorine sensor with Variopol connector
3900VP-02-10	pH sensor with Variopol connector

Sensor Cable	Description
24150-00	Interconnecting cable, Variopol for 498ACL -01-VP sensor, 4 ft
24281-05	Interconnecting cable, Variopol for 3900VP sensor, blue 4 ft (1.2m)

Accessories

PART #	Description
9240048-00	Tag, stainless steel (specify marking)

Spare Parts

PART #	Description
33970-00	Fill plug
33521-03	Membrane retainer
9550094	O-ring, 2-014, Viton®
23501-10	pH-independent free chlorine membrane assembly, includes one membrane assembly and O-ring
23502-10	pH-independent free chlorine membrane assembly, includes three membrane assemblies and three O-rings
24146-00	pH-independent free chlorine sensor electrolyte kit, includes three bottles of saturated succinic acid and three bottles of succinic acid crystals

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