

# 499 ACL-01

## Free Chlorine Sensor

The 499ACL-01 sensor is intended for the continuous determination of free chlorine (hypochlorous acid plus hypochlorite ion) in water.

- Measure free chlorine without sample pretreatment. No messy and expensive reagents needed.
- Automatic correction to at least pH 9.5.
- Easily replaceable membrane; no special tools required.
- Automatic compensation for changes in membrane permeability with temperature.
- Automatic pressure equalization maintains correct membrane tension.
- Variopool connector option allows the sensor to be replaced without running new cable.

## Features and Applications

The primary application is measuring chlorine in drinking water. The sensor requires no acid pretreatment and can measure free chlorine in samples having pH as high as 9.5. In some cases, samples having pH as great as 10.0 can be measured. For high pH applications, consult the factory. The linear range of the sensor is 0 to 10 ppm. For determination of higher levels of chlorine, consult the factory.

The 499ACL-01 is a membrane-covered amperometric sensor. The sensor consists of a hydrophilic membrane stretched tightly over a platinum cathode. A silver anode and an electrolyte solution complete the internal circuit. During operation, chlorine diffuses from the sample through the membrane. A polarizing voltage applied to the cathode completely reduces chlorine to chloride. The reduction produces a current, which the analyzer measures. The current is directly proportional to the rate at which chlorine diffuses through the membrane, which is ultimately proportional to the concentration of chlorine in the sample



The 499ACL-01 sensor needs no pretreatment. Instead, the analyzer automatically applies a pH correction factor to the chlorine reading. If the sample pH varies more than 0.2 pH (peak-to-peak), an auxiliary pH sensor is required to provide the continuous pH correction.

Because the rate of diffusion of free chlorine through the membrane depends on temperature, sensor response must be corrected for temperature changes. A Pt 100 RTD in the sensor measures the temperature, and the analyzer automatically performs the correction.

Stable, dilute chlorine standards do not exist, so the sensor must be calibrated against the results of a laboratory test run on a grab sample of the process liquid. Portable test kits are available from other manufacturers.

All amperometric free chlorine sensors respond to changes in pH. Although free chlorine is a mixture of hypochlorous acid and

hypochlorite ion, hypochlorous acid alone is responsible for the sensor current. Because the relative amounts of hypochlorous acid and hypochlorite depend on pH, a pH change will cause the current and the apparent free chlorine concentration to change, even though the true concentration remained constant. To compensate for variable pH, most competing sensors require the sample to be treated with acid. Acid converts the free chlorine completely to hypochlorous acid and eliminates the interference.

Maintenance is fast and easy. Replacing the membrane requires no special tools or fixtures. Simply place a few drops of electrolyte solution in the membrane assembly, place it on the cathode, and screw the retainer in place. To replenish the

electrolyte solution, unscrew the fill plug, add the reagent from a squeeze bottle, and replace the plug.

Pressure changes have little influence on sensor response. A flexible bladder in the sensor prevents distortion of the membrane by keeping the pressure inside the sensor equal to the sample pressure.

The 499ACL-01 sensor is available with a Variopol (VP) watertight connector. Wire the interconnecting cable to the analyzer and run the cable to the sensor. The sensor plugs into the cable receptacle. To replace the sensor, simply disconnect the Variopol fitting and plug in a new sensor.

## Specifications

Table 1 - Sensor specifications

Free Chlorine Sensor	
Range	0 to 10 ppm (mg/L) as Cl <sub>2</sub> . For higher ranges, consult the factory
Wetted parts	Noryl <sup>(1)</sup> , Viton <sup>(2)</sup> , silicone, platinum, and polyethersulfone
Accuracy	Accuracy depends on the accuracy of the chemical test used to calibrate the sensor.
pH range	6.0 to 9.5. For samples having pH between 9.5 and 10.0, consult the factory. Samples with ranges below 6.0 require no pH correction.
pH correction	Use continuous pH correction (requires an auxiliary pH sensor) if sample pH varies more than 0.2 pH (peak to peak). If pH variability is less or seasonal, the pH sensor is generally not required.
Interferences	Peroxides, permanganate, and chloramines
Sample conductivity	>50 µS/cm
Response time	22 sec to 95% of final reading at 25 °C (77 °F)
Pressure	0 to 65 psig (0 to 549 kPa abs)
Temperature	0 °C to 50 °C (32 °F to 122 °F)
Process connection	1 inch MNPT
Electrolyte volume	25 mL (approx.)
Electrolyte life	3 months (approx.); for best results, replace electrolyte monthly
Cable length (standard integral cable)	25 ft (7.6 m)
Cable length (maximum)	300 ft (91 m)
Weight/shipping weight	1 lb/3 lb (0.5 kg/1.5 kg)
Sample Flow	
Flow through	2 to 5 gpm (3.8 to 19 L/min)
Open channel	1 ft/sec (0.3 m/sec)
Low flow cell (PN 24091-00)	8 to 15 gph (30 to 57 L/hr)
Low flow cell (PN 24091-01)	2 to 5 gph (8 to 19 L/hr)

(1) Noryl is a registered trademark of General Electric

(2) Viton is a registered trademark of E.I. duPont de Nemours & Co.

**Table 2 - Low flow cell specifications**

<b>N 24091-00 and 24091-01. PN 24091-01 contains a bubble sweeping nozzle to keep bubbles from accumulating against the membrane. It is intended for samples where high flows are not available. See flow specifications above.</b>	
<b>Wetted parts</b>	Polycarbonate, polyester, 316 stainless steel, silicone
<b>Process connection</b>	¼ inch OD tubing compression fitting or ¼ inch FNPT
<b>Maximum pressure</b>	90 psig (722 kPa abs)
<b>Maximum temperature</b>	70 °C (158 °F)

**Note:**The temperature and pressure specifications for the low flow cell exceed the specifications for the sensor.

**Table 3 - Flow-Through Tee Specifications**

<b>1-½ inch body, PN 23567-00</b>	
<b>Wetted parts</b>	CPVC and Buna N; body is schedule 80 CPVC
<b>Process connection</b>	1-½ inch socket
<b>Maximum pressure</b>	65 psig (549 kPa abs)
<b>Maximum temperature</b>	50 °C (122 °F)
<b>2 inch body, PN 915240-03, 04, 05</b>	
<b>Wetted parts</b>	PVC and Buna N; body is schedule 80 PVC
<b>Process connection</b>	¾ inch NFPT, 1 inch NFPT, or 1-½ inch NFPT
<b>Maximum pressure</b>	60 psig (515 kPa abs)
<b>Maximum temperature</b>	49 °C (120 °F)

**Table 4 - Valved Rotameter Specifications**

<b>PN 196-898754 for use with low flow cell PN 24091-00</b>	
<b>Flow</b>	2 to 10 gph (7.6 to 76 L/hr)
<b>Wetted parts</b>	Polycarbonate, 316 stainless steel, brass, Buna N
<b>Process connection</b>	⅝ inch NFPT (brass)
<b>Maximum pressure</b>	100 psig (858 kPa abs)
<b>Maximum temperature</b>	54 °C (130 °F)
<b>PN 939004 for use with low flow cell PN 24091-01</b>	
<b>Flow</b>	0.4 to 5 gph (1.4 to 19 L/hr)
<b>Wetted parts</b>	Acrylic, 316 stainless steel, Viton
<b>Process connection</b>	¼ inch NFPT (316 SS)
<b>Maximum pressure</b>	100 psig (858 kPa abs)
<b>Maximum temperature</b>	65 °C (150 °F)

## Recommended Analyzers

Use the 499 ACL-01 with models 1056, 56, 5081-A, and 1066

Figure 1 - Standard sensor with integral cable

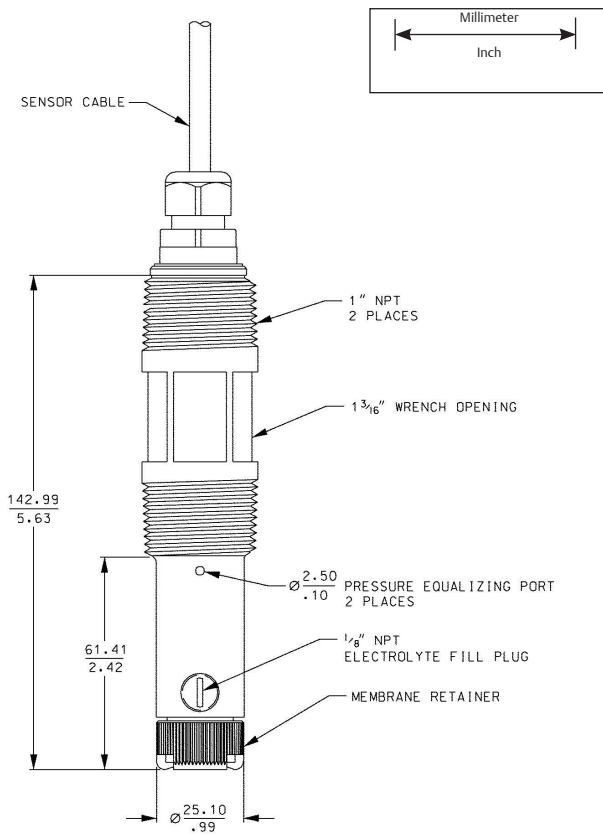
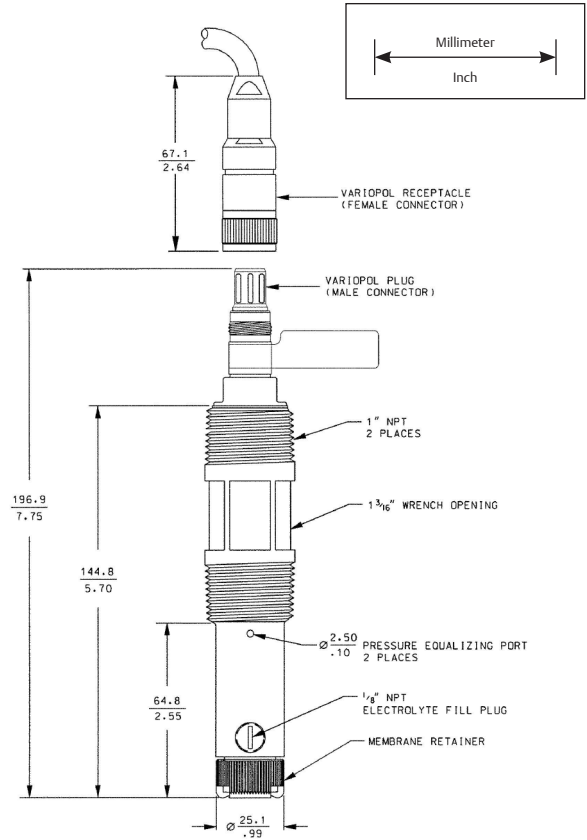
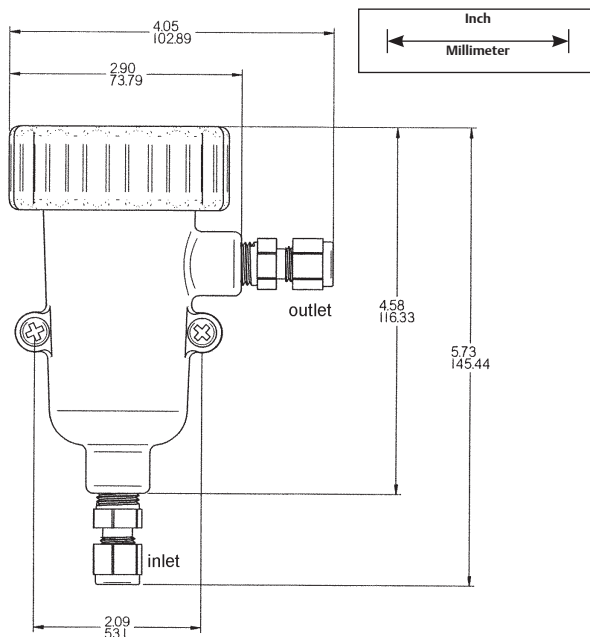


Figure 2 - Sensor with Variopool connector



Length of assembled sensor is 9.3 in. (236 mm).

Figure 3 - Low flow cell (PN 24091-00 and 24091-01)



The bubble sweeping nozzle in the inlet of PN 24091-01 is not shown.

Figure 4 - Flow-through tee (1-1/2 inch) (PN 23567-00)

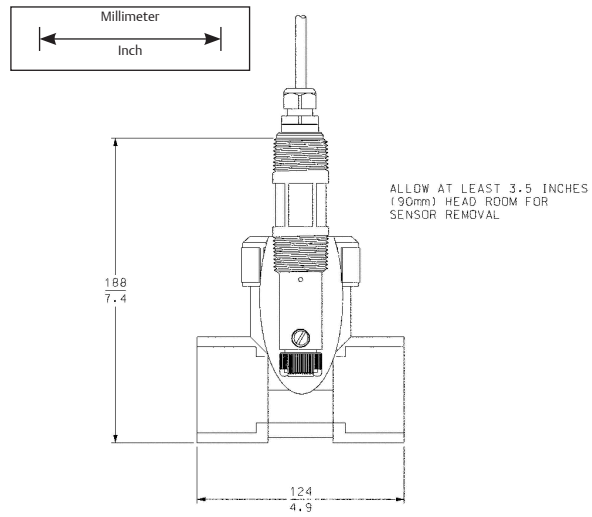
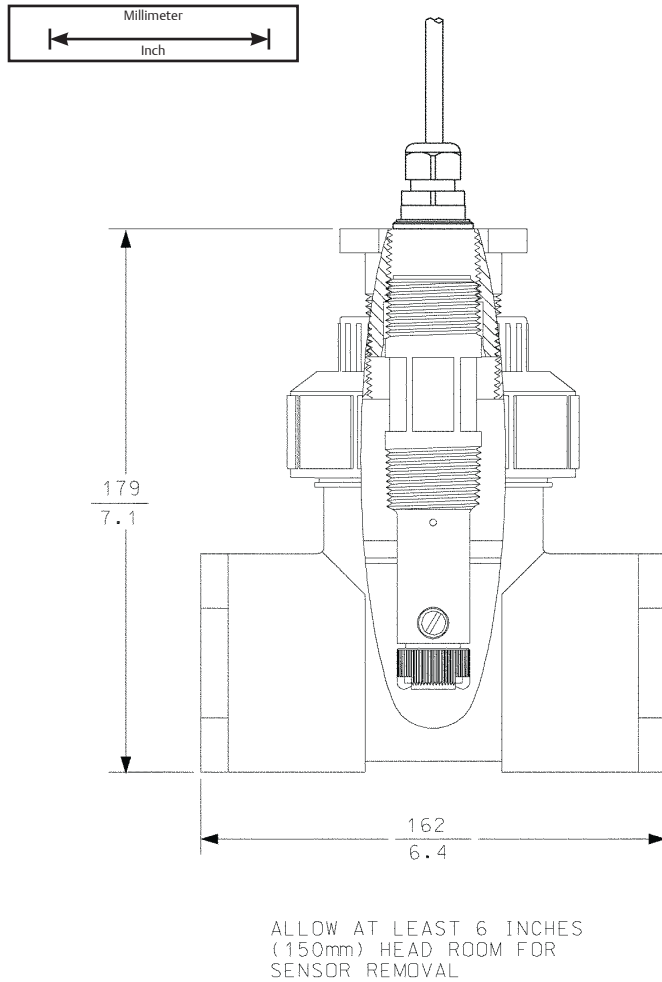


Figure 5 - Flow-through tee (2 inch) (PN 915240-03, -04, -05)



## Ordering Information

The 499ACL-01 sensor is intended for the determination of free chlorine in water. The sensor is generally intended for mounting in a flow cell installed in a sidestream sample. The sensor is available with either an integral cable or a VP 6.0 quick disconnect fitting. Three replacement membrane assemblies with O-rings, five O-rings for the electrolyte fill plug, and a 4 oz (125 ml) bottle of electrolyte solution are provided with each sensor.

**Table 5 - 499 ACL-01 Free Chlorine Sensor**

Code	Required selection
54	For use with models 1056, 56, 5081, and 1066 analyzers
Code	Optional selection
60	Optimum EMI/RFI cable (not available with - VP option)
VP	Sensor with Variopol 6 connector (interconnecting cable must be ordered separately)

**Table 6 - For First Time Variopol Installations**

Part #	Description
23747-06	Interconnecting cable, VP 6, 2.5 ft (0.8 m)
23747-04	Interconnecting cable, VP 6, 4 ft (1.2 m)
23747-02	Interconnecting cable, VP 6, 10 ft (3.0 m)
23747-07	Interconnecting cable, VP 6, 15 ft (4.6 m)
23747-08	Interconnecting cable, VP 6, 20 ft (6.1 m)
23747-09	Interconnecting cable, VP 6, 25 ft (7.6 m)
23747-10	Interconnecting cable, VP 6, 30 ft (9.1 m)
23747-03	Interconnecting cable, VP 6, 50 ft (15.2 m)
23747-11	Interconnecting cable, VP 6, 100 ft (30.5 m)

**Table 7 - Accessories**

Part #	Description
23567-00	1–½inch flow through tee with 1–½ socket connections
914240-03	2 inch flow through tee with ¾ inch FNPT connections
915240-04	2 inch flow through tee with 1 inch FNPT connections
915240-05	2 inch flow through tee with 1 ½ inch FNPT connections
24091-00	Low flow cell for 8–15 gph
24091-01	Low flow cell with bubble sweeping nozzle for 2–5 gph
96-898754	Rotameter: 2.0–20.0 gph
23550-00	Junction box, 12 terminals
9200266	Extension cable (standard), unterminated (specify length)
9200275	Extension cable (optimum EMI/RFI) unterminated (specify length)
23747-00	Extension cable (optimum EMI/RFI), terminated (specify length)
2001492	Stainless steel tag
24552-00	Electrolyte fill plug and O-ring kit
24555-00	O-rings for electrolyte fill plug, 5 each
23502-08	Free chlorine membrane assembly: includes 3 membrane assemblies and 3 O-rings
9210356	#4 free chlorine sensor fill solution, 4 oz (125 mL)

**Table 8 - Recommended pH Sensors**

Model	Description
3900-02-10	3900 sensor with 15 ft (4.7 m) cable, no pre-amplifier
3900-01-10	3900 sensor with 32 ft (10 m) cable, with integral preamplifier
3900VP-02-10	3900 sensor with VP connector (consult 3900/3900VP product data sheet for cable).

## 499ACL-01 Engineering Specification

1. The sensor shall be suitable for the determination of free chlorine in water without the use of sample conditioning reagents. Sensors that require sample conditioning are not acceptable.
2. An auxiliary pH sensor to compensate for the effect of pH on the chlorine sensor response shall be required if the pH variability is more than 0.2 units (peak-to-peak). Otherwise, a pH sensor shall not be required.
3. The sensor shall be a two-electrode membrane-covered sensor with a silver/silver chloride anode and a platinum cathode. The fill solution shall be potassium chloride.
4. Flow cells designed for the sensor shall be available. A low flow cell requiring no more than about 2 gal/hour (8 L/hr) of sample shall be available.
5. The response time to a step change in free chlorine concentration shall be about 22 seconds to 95 % of final value.
6. Sensor maintenance shall require no special tools or fixtures.
7. The sensor fill solution shall require replacing no more often than once a month.
8. The sensor shall be available with either integral cable or a VP 6 quick disconnect fitting.
9. The sensor shall be Rosemount Analytical Model 499ACL-01-54 (standard integral cable), 499ACL-01-54-60 (optimum EMI/RFI resistant cable), 499ACL-01-54-VP (VP 6 connection), or approved equivalent.

## Free Chlorine Measurement System

Instead of ordering and assembling individual components, choose the FCL free chlorine system. The FCL consists of the free chlorine sensor, a pH sensor (if required), the analyzer, VP quick-disconnect cable(s) prewired to the analyzer, flow cell(s), and a constant head flow controller. The flow controller automatically provides the correct sample flow and eliminates the need for pressure regulators, valves, and rotameters. Commissioning the FCL is simple. The analyzer, flow controller, and flow cells are all mounted on a back plate. Simply mount the FCL on a wall, bring in power and sample, provide a drain, and connect the sensors to the cables.



## Compatible Analyzers and Transmitters

The 1056 dual input analyzer offers the choice of single or dual sensor inputs in any combination of pH/ORP, contacting and toroidal conductivity (or resistivity), chlorine, oxygen, and ozone. When used with the 499ACL-01 sensor, the most common dual-channel configuration is chlorine and pH, where the pH measurement is used to compensate the chlorine reading for pH effects. The 1056 analyzer features a large, easy-to-read back lit display, which can be customized to fit user requirements. The analyzer has two fully programmable analog outputs, and digital communication, either HART® or Profibus DP, is available as an option. Four fully programmable alarm relays are also optional. Diagnostic variables to aid in troubleshooting are displayed at the touch of a button. Menu prompts can be displayed in one of seven user-selectable languages. Programming and calibrating is so simple that a manual is almost not necessary.



The 56 Dual Input Analyzer offers the choice of single or dual sensor inputs in any combination of pH/ORP, contacting or toroidal conductivity, chlorine, oxygen, or ozone. When used with the 499ACL-01 sensor, the most common dual-channel configuration is chlorine and pH, where the pH measurement is used to compensate the chlorine reading for pH effects. The analyzer has four fully programmable analog outputs and four fully programmable alarm relays, including PID and TPC control. The high contrast, full color display shows measurement results in large, easy-to-read digits. Menu screens for programming and calibration are simple and intuitive. Information screens, offering detailed explanation of programming features and calibration methods as well as troubleshooting assistance, are available at the touch of a button. An event and data logger and a dual graphical display are also standard. HART® and Profibus DP digital communication are optional.



The 5081 conductivity transmitter is compatible with any Rosemount Analytical amperometric sensor (chlorine, oxygen, or ozone). Although the 5081-A is a single input and single output device, a second input channel for pH is available if the instrument is configured to measure free chlorine. The pH channel is used to correct the chlorine reading for pH effects. The analog output is dedicated to chlorine, but it can be freely scaled to any range. Two digital communication protocols, HART® and FOUNDATION™ Fieldbus, are available as options. The 5081-A has a large, easy-to-read display. Local communication with the transmitter is through an infrared remote controller. The analyzer enclosure is NEMA 7B (explosion-proof).



The loop-powered 1066 analyzer serves industrial, commercial, and municipal applications with the widest range of liquid measurement inputs available for a two-wire liquid transmitter. The 1066 SMART transmitter supports continuous measurement of one liquid analytical input. The design supports easy internal access and wiring connections. The large display gives excellent visibility for live measurements and displayed parameters. Conveniently, live process values are always displayed during programming and calibration routines.



The 1066 HART® communications can be switched between HART® version 7 and HART® version 5 at the transmitter. This makes it possible to take advantage of the new features of HART® 7, or maintain compatibility with older HART® 5 hosts.

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