Instruction Manual
PN 51-FCLi-54eA rev.B
March 2012

FCLi with 54eA Analyzer

ROSEMOUNT® Analytical

EMERSON. Process Management

ESSENTIAL INSTRUCTIONS

READ THIS PAGE BEFORE PROCEEDING!

Your purchase from Rosemount Analytical, Inc. has resulted in one of the finest instruments available for your particular application. These instruments have been designed, and tested to meet many national and international standards. Experience indicates that its performance is directly related to the quality of the installation and knowledge of the user in operating and maintaining the instrument. To ensure their continued operation to the design specifications, personnel should read this manual thoroughly before proceeding with installation, commissioning, operation, and maintenance of this instrument. If this equipment is used in a manner not specified by the manufacturer, the protection provided by it against hazards may be impaired.

- Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.
- Ensure that you have received the correct model and options from your purchase order. Verify that this manual covers your model and options. If not, call 1-800-854-8257 or 949-757-8500 to request correct manual.
- For clarification of instructions, contact your Rosemount representative.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Use only qualified personnel to install, operate, update, program and maintain the product.
- Educate your personnel in the proper installation, operation, and maintenance of the product.
- Install equipment as specified in the Installation section of this manual. Follow appropriate local and national codes. Only connect the product to electrical and pressure sources specified in this manual.
- Use only factory documented components for repair. Tampering or unauthorized substitution of parts and procedures can affect the performance and cause unsafe operation of your process.
- All equipment doors must be closed and protective covers must be in place unless qualified personnel are performing maintenance.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by it against hazards may be impaired.

⚠WARNING

RISK OF ELECTRICAL SHOCK

⧈ Equipment protected throughout by double insulation.

- Installation of cable connections and servicing of this product require access to shock hazard voltage levels.
- Main power and relay contacts wired to separate power source must be disconnected before servicing.
- Do not operate or energize instrument with case open!
- Signal wiring connected in this box must be rated at least 240 V.
- Non-metallic cable strain reliefs do not provide grounding between conduit connections! Use grounding type bushings and jumper wires.
- Unused cable conduit entries must be securely sealed by non-flammable closures to provide enclosure integrity in compliance with personal safety and environmental protection requirements. Unused conduit openings must be sealed with NEMA 4X or IP65 conduit plugs to maintain the ingress protection rating (NEMA 4X).
- Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.
- Operate only with front and rear panels fastened and in place over terminal area.
- Safety and performance require that this instrument be connected and properly grounded through a three-wire power source.
- Proper relay use and configuration is the responsibility of the user.

⚠ CAUTION

This product generates, uses, and can radiate radio frequency energy and thus can cause radio communication interference. Improper installation, or operation, may increase such interference. As temporarily permitted by regulation, this unit has not been tested for compliance within the limits of Class A computing devices, pursuant to Subpart J of Part 15, of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area may cause interference, in which case the user at his own expense, will be required to take whatever measures may be required to correct the interference.

⚠ WARNING

This product is not intended for use in the light industrial, residential or commercial environments per the instrument's certification to EN50081-2.

Emerson Process Management

2400 Barranca Parkway
Irvine, CA 92606 USA
Tel: (949) 757-8500
Fax: (949) 474-7250

http://www.rosemountanalytical.com

EMERSON
Process Management

About This Document

This manual contains instructions for installation and operation of the FCLi-54eA

The following list provides notes concerning all revisions of this document.

Rev. Level	Date	Notes
A	4/08	This is the initial release of the product manual. The manual has been reformatted to reflect the Emerson documentation style and updated to reflect any changes in the product offering.
B	03/12	Update addresses - mail and web and DNV certification notice

FCLi-54eA

TABLE OF CONTENTS

TABLE OF CONTENTS CONT'D

LIST OF TABLES

LIST OF FIGURES

SECTION 1.0.
DESCRIPTION AND SPECIFICATIONS

- COMPLETE SYSTEM INCLUDES sensor, connecting cable, analyzer, and flow controller
- SENSOR RESPONSE IS PRACTICALLY INDEPENDENT of pH between pH 6 and 10
- NO REAGENTS
- NO AUXILIARY pH ELECTRODE
- VARIOPOL QUICK-DISCONNECT FITTINGS makes sensor replacement easy

1.1 APPLICATIONS AND FEATURES

TheFCL*i* free chlorine system is intended for the determination of free chlorine (hypochlorous acid plus hypochlorite ion) in fresh water. Unlike other free chlorine analyzers, the FCL*i* 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 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 FCL*i* 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 FCL*i* 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 copper 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 FCL*i* 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 is a function of 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 FCL*i* 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.

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.

The FCL*i* includes the easy-to-use Model 54eA analyzer. The analyzer features two fully programmable 4-20 mA analog outputs and three alarm relays. Programming and calibration is simple and intuitive. The large backlit, display allows the user to read chlorine at a single glance.

Valves, rotameters, and pressure regulators to control sample flow are things of the past with the FCL*i*. 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.

1.2 SPECIFICATIONS — GENERAL

Sample requirements:

Pressure: 3 to 65 psig (122 to 549 kPa abs)

A check valve in the inlet opens at 3 psig (122 kPa abs). If the check valve is removed, minimum pressure is 1 psig (108 kpa abs).

Temperature: 32 to 122°F (0 to 50°)

Minimum Flow: 2 gal/hr (7.6 L/hr)

Maximum flow: 80 gal/hr (303 L/hr); high flow causes the overflow tube to back up.

Sample Conductivity: >10 µS/cm

Process connection: 1/4-in OD tubing compression fitting (can be removed and replaced with barbed fitting for soft tubing).

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

Wetted parts:

Overflow sampler: acrylic, polycarbonate, polyester, Kynar[1], nylon, silicone

Chlorine sensor: PVC, Viton[2], silicone, polyethersulfone, polyester, and copper

pH sensor: Tefzel[2], Viton, glass, ceramic

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 FCL*i*-01: 10 lb/13 lb (4.5 kg/6.0 kg)

Model FCL*i*-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 permanganate

Electrolyte life: 3 months (approx.)

[1] Kynar is a registered trademark of Elf Atochem North America.

[2] Viton and Tefzel are registered trademarks of DuPont Performance Eastomers.

SPECIFICATIONS — 54eA ANALYZER

Case: Epoxy-painted cast aluminum, NEMA4X (IP65).

Display: Three-line, back-lit, dot matrix LCD. First line is measurement reading. Second line is temperature and current output. Third line is user-selectable. Character heights: 1st line - 0.6 in. (16 mm) , 2nd and 3rd lines - 0.3 in. (7 mm) .

Ambient Temperature and Humidity: 0 to 50°C (32 to 122°F). 95% (maximum) non-condensing. Analyzer can be operated between -20 and 60°C (-4 to 140°F) with some degradation in display quality.

Power: 100-127 Vac ± 10%, 50/60 Hz ± 6%, 8 W
200-253 Vac ± 10%, 50/60 Hz ± 6%, 8 W

RFI/EMI: EN-61326

LVD: EN-61010-1

CE

Outputs: Two 4-20 mA or 0-20 mA isolated outputs. Continuously adjustable. Output dampening is user-selectable. Maximum load at 115/230 Vac is 600Ω. Maximum load at 100/200 Vac is 550Ω.

Alarms: Three alarm relays for chlorine or temperature. Fully programmable. Fourth relay for analyzer/sensor fault.

Relay: Relays 1-3: Form A, SPST, epoxy sealed
Relay 4: Form C, SPDT, epoxy sealed

	Resistive	Inductive
28 Vdc	5.0	3.0
115 Vac	5.0	3.0
230 Vac	5.0	1.5

1.3 ORDERING INFORMATION

Model FCL*i* Free Chlorine Measuring System. The FCL*i* is a complete system for the determination of free chlorine in aqueous samples. It consists of a sensor, analyzer, and constant head flow controller. All components are mounted on a backplate. Three replacement membranes and enough electrolyte chemicals to fill the sensor three times are shipped with each sensor.

MODEL FCL*i* FREE CHLORINE MEASURING SYSTEM	
CODE	**pH CORRECTION (required selection)**
01	Without pH sensor

CODE	ANALYZER
230	54eA-01
FCL*i*-01 -230	**EXAMPLE**

COMPONENT PARTS

ANALYZER MODEL	DESCRIPTION
54eA-01	54eA analyzer 115/230 Vac

SENSOR MODEL	DESCRIPTION
498CL-01-VP	pH-independent free chlorine sensor with Variopol connector

SENSOR CABLE	DESCRIPTION
23645-13	Interconnecting cable, Variopol for 498CL sensor, 4 ft

ACCESSORIES

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

SPARE PARTS

PART #	DESCRIPTION
33970-00	Fill plug
33968-00	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

This page left blank intentionally

SECTION 2.0. INSTALLATION

2.1 UNPACKING AND INSPECTION

Inspect the shipping container. If it is damaged, contact the shipper immediately for instructions. Save the box. If there is no apparent damage, unpack the container. Be sure all items shown on the packing list are present. If items are missing, notify Rosemount Analytical immediately.

2.1.1 FCLi-01-230 (free chlorine without pH sensor)

Model consists of the following items mounted on a back plate.

1. The 54eA-01 analyzer with sensor cable attached.
2. Constant head overflow sampler with flow cell for chlorine sensor.

The free chlorine sensor (498CL-01-VP) is in a separate package. The sensor is shipped with three membrane assemblies and enough electrolyte chemicals to fill the sensor three times.

2.2 INSTALLATION

2.2.1 General Information

1. Although the system is suitable for outdoor use, do not install it in direct sunlight or in areas of extreme temperature.

⚠ CAUTION

The FCLi free-chlorine analyzer is NOT suitable for use in hazardous areas.

2. To keep the analyzer enclosure watertight, install plugs (provided) in the unused cable openings.
3. Install the system in an area where vibrations and electromagnetic and radio frequency interference are minimized or absent.
4. Be sure there is easy access to the analyzer and sensors.

2.2.2 Sample Requirements

Be sure the sample meets the following requirements:

1. Temperature: 32 to 122ºF (0 to 50ºC)
2. Pressure: 3 to 65 psig (122 to 549 kPa abs)
3. Minimum flow: 2 gal/hr (7.6 L/hr)

2.2.3 Mounting and Making Inlet and Drain Connections

The FCLi is intended for wall mounting only. Refer to Figure 2-2 for details.

A 1/4-inch OD tubing compression fitting is provided for the sample inlet. If desired, the compression fitting can be removed and replaced with a barbed fitting. Do not remove the check valve. The threads are 1/4-inch FNPT.

The sample drains through a 3/4-inch barbed fitting. Attach a piece of soft tubing to the fitting and allow the waste to drain to open atmosphere. **Do not restrict the drain line.**

Remove the foam packing insert between the outer tube and the inner overflow tube. Adjust the sample flow until the water level is even with the central overflow tube and excess water is flowing down the tube. Confirm that sample is flowing through the flow cell.

2.2.4 Electrical Connections

NOTE

Once power has been applied to the analyzer, configure it to measure free chlorine. See section 5.4 for details. Do not connect the sensor to the cable until the analyzer has been properly configured.

Refer to Section 3.0 for wiring details.

2.2.5 Installing the Sensor

1. **The chlorine sensor leaves the factory with a shipping membrane in place. The shipping membrane must be removed and replaced with the chlorine membrane before putting the sensor in service. The chlorine membrane is in a plastic bag attached to the sensor. Do not remove the shipping membrane until you are ready to put the sensor in service.**
   a. Remove the red protective cap from the end of the sensor.
   b. Holding the membrane end pointing up (cable connector end pointing down), unscrew the retainer cap and remove the shipping membrane. See Figure 2.1. It is not necessary to remove the O-ring. **Save the shipping membrane.** It should be reinstalled on the sensor when the sensor is not in use.
   c. Still holding the membrane end pointing up, install the chlorine membrane. The chlorine membrane is in the plastic bag attached to the sensor. Screw the retainer back in place.
2. Install the sensor in the flow cell as shown in Figure 2.2. The chlorine sensor sits in the flow cell and is held in place by the union nut. Be sure to slip the union nut over the sensor before connecting the cable to the sensor.
3. The Model FCLi is provided with sensor cable pre-wired to the analyzer. The terminal end of the sensor is keyed to ensure proper mating with the cable receptacle. Once the key has slid into the mating slot, tighten the connection by turning the knurled ring clockwise.

NOTE

Do not connect the sensor to the cable until the analyzer has been configured to measure free chlorine. See section 5.4 for details.

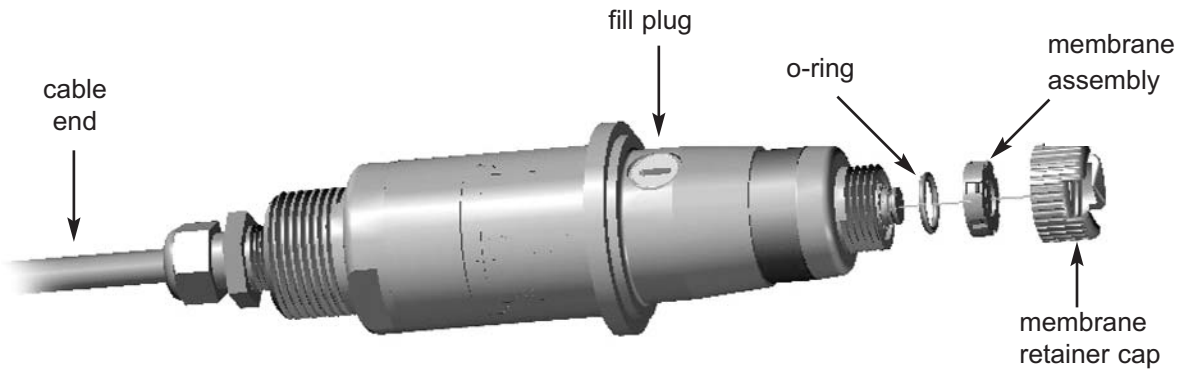


FIGURE 2-1. Chlorine Sensor Parts

NOTE

Once the chlorine sensor has been connected to the analyzer and power applied, the sensor must be placed in the flow cell filled with water.

Generally, the sensor must be in a continously flowing sample. However, the sensor can tolerate loss of sample flow for about four days as long as it remains immersed in water in the flow cell. There is a check valve in the sample inlet to prevent water from draining out of the flow cell.

If the sensor sits too long in a stagnant sample, copper ions from oxidation of the external copper electrode can diffuse into the sensor. Once inside the sensor the copper undergoes an electrochemical reaction that greatly increases the background current and can potentially damage the sensor. See step 2 in Section 7.2 for more information.

Do not store the chlorine sensor in air. The membrane will dry out. If the membrane dries out, it must be replaced.

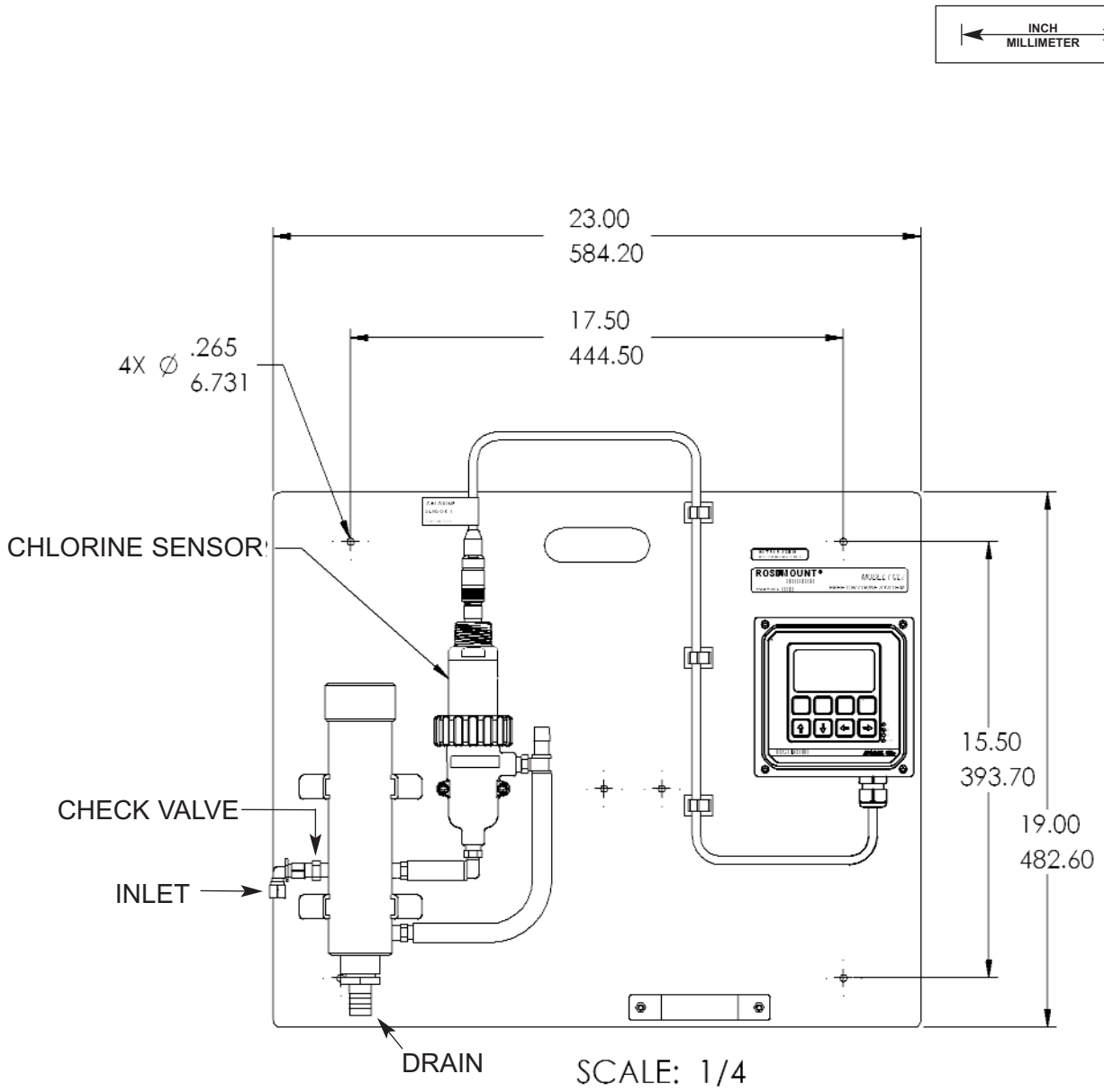


FIGURE 2-2. Model FCLi-01-230

SECTION 3.0.
WIRING

NOTE

The 54eA analyzer leaves the factory configured to measure dissolved oxygen, not free chlorine. Before connecting the sensor to the cable, configure the analyzer to measure free chlorine. See section 5.4

3.1 GENERAL

WARNING

Electrical installation must conform to the National Electrical Code, all state and local codes, and all plant codes and standards for electrical equipment. Electrical installation and wiring must be done by qualified personnel.

The five holes in the bottom of the instrument case accept 1/2-in. strain relief connectors or conduit fittings. The rear openings are for power and alarm relay wiring. The left front opening is for sensor wiring (already installed) and the right front opening is for analog output wiring. Seal unused openings with conduit plugs.

3.2 POWER, ALARM, AND OUTPUT WIRING

Refer to Figure 3-1. Make power and alarm connections on TB3. Make analog output wiring connections on TB2. For access to power and alarm terminals, loosen the screw holding the protective cover in place and remove the cover.

⚠DANGER

Live voltages may be present. Will cause severe injury or death

Alarm contacts are dry (i.e., not powered) and are normally open. Refer to Section 1.0 for relay specifications.

For best EMI/RFI protection, shield the output cable and enclose it in an earth-grounded, rigid, metal conduit. Connect the outer shield of the output cable to the earth ground connection on TB2 (see Figure 3-1).

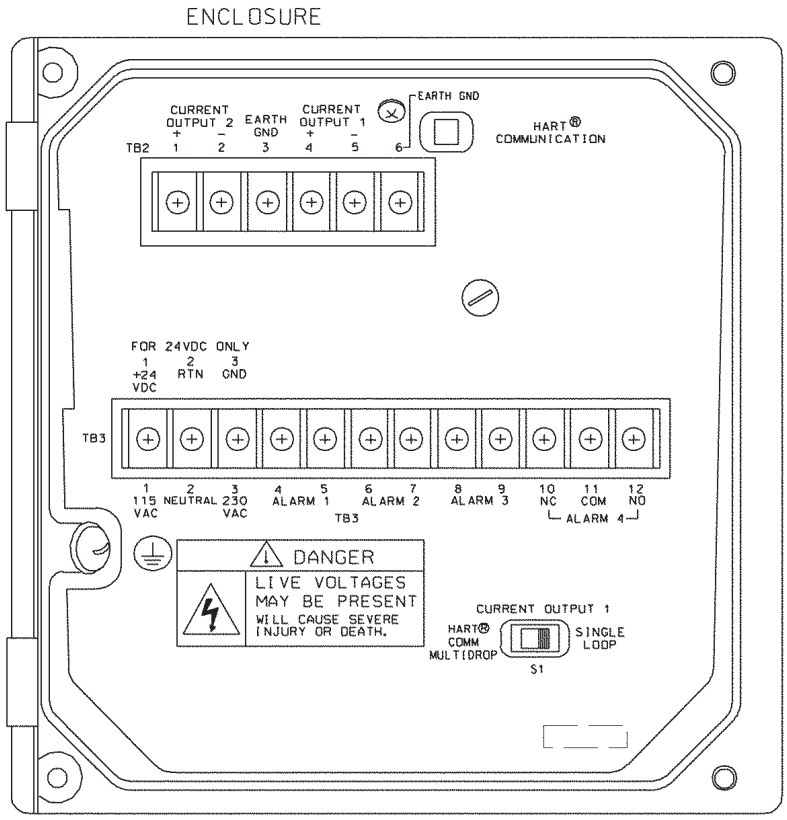
Keep sensor and output signal wiring separate from power wiring. Do not run sensor and power cables in the same conduit or close together in a cable tray.

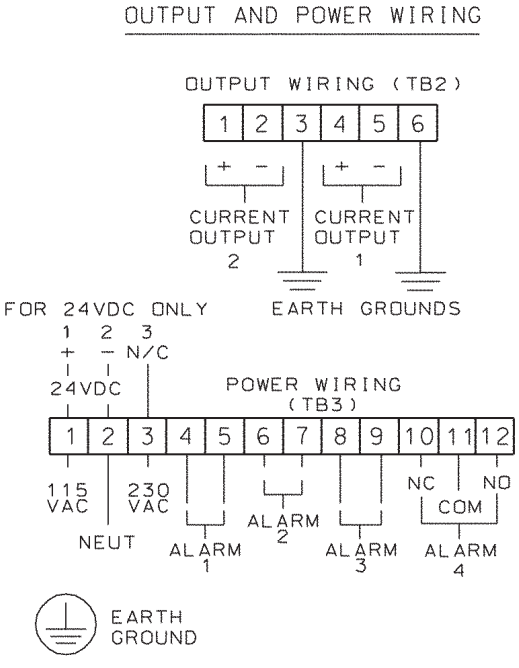
AC wiring must be 14 gauge or greater. Be sure to connect earth ground from the power cable to the nearby ground lug. A good earth ground is necessary for proper operation of the controller. Provide a switch or breaker to disconnect the analyzer from the main power supply. Install the switch or breaker near the analyzer and label it as the disconnecting device.

⚠WARNING

RISK OF ELECTRICAL SHOCK

AC connections and grounding must comply with UL 508 or local electrical code. DO NOT apply power to the analyzer until all electrical connections are verified and secure.





DWG. NO.	REV.
454EPH02	D

FIGURE 3-1. Power Input and Relay Output Wiring for 54eA

3.3 SENSOR WIRING

3.3.1 General

The wiring label is a general purpose label. It has wiring information concerning other sensors, for example, contacting and inductive conductivity sensors, that can be used with the 54e instrument platform. The FCLi is provided with sensor cable pre-wired to the analyzer. If it is necessary to replace the cable, refer to Figures 3-2 (wiring label) and 3-3 (wiring diagram).

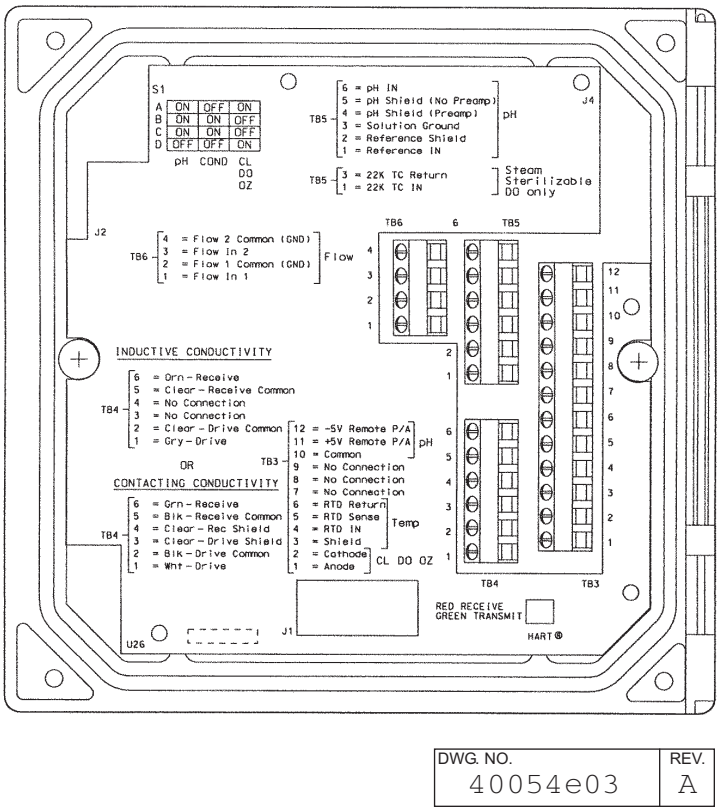


FIGURE 3-2. Wiring Label

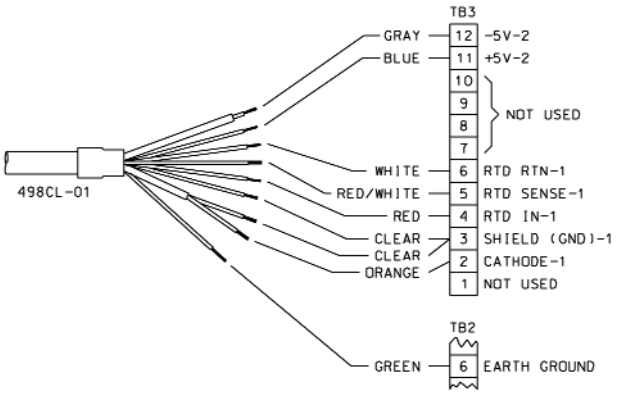


FIGURE 3-3. Wiring Sensor to Model 54eA Analyzer

This page left blank intentionally

SECTION 4.0
DISPLAY AND OPERATION

4.1 GENERAL DESCRIPTION

The 54eA analyzer is a single input, dual output instrument.

4.2 DISPLAY

Figure 4-2 shows the main display.

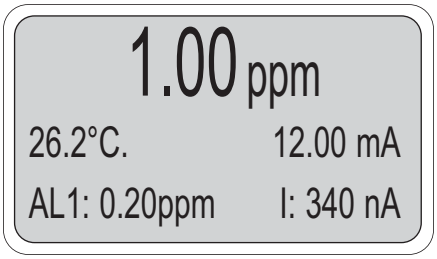


FIGURE 4-1. Main Display Screen

Chlorine is always displayed continuously in large numerals. The temperature and output current are always displayed on the second line of the main display. The third line can be configured by the user. In the example, the third line shows the alarm setpoint and the raw sensor current in nA.

4.3 KEY FUNCTIONS AND CONTROLS

The keys labeled F1, F2, F3, and F4 are multi-function. The function appears in the main display just above the key. For example, F1 is usually labeled Exit and F4 may be labeled Edit, Save, or Enter.

1. To enter the main menu, press any key.
2. Use the ↑ and ↓ keys to move the cursor to the desired sub-menu. The position of the cursor is shown in reverse video.

   NOTE

   When the last item of a menu has been reached, the cursor will be on the third line of the display. If the cursor is on the second line of the display more items remain. Continue pressing the ↓ key.
3. Press Enter (F4) to access a sub-menu or an item in a sub-menu.
4. To change a number or a setting press Edit (F4). The display will change to show the cursor on the first digit or on a + or - sign. Use the ↑ and ↓ keys to increase or decrease a digit or to toggle the + and - signs. Use the ← and → keys to move the cursor left and right.
5. If an entire number or a word is highlighted, use the ↑ and ↓ keys to scroll through the list of choices.
6. To store a number or setting in memory, press Save (F4).
7. To leave without storing changes, press Esc (F3).
8. To leave and return to the previous screen, press Exit (F1).
9. To end a calibration step and leave the previous calibration in place, press Abort (F1).
10. Occasionally, information screens will appear. To leave the information screen and move to the next screen press Cont (F3).

4.4 ALARM STATUS

Green LEDs (labeled 1, 2, and 3) indicate when alarm relays 1, 2, and 3 are energized. The fourth relay indicates a fault condition. When a fault occurs, the red LED (labeled FAIL) lights up, a descriptive error message appears, and the outputs and alarm relays act as described in Section 5.6 under fault value.

The red LED also indicates when the interval timer routine is activated and when the time limit has been reached on a feed limit timer. For more information on these subjects, see Section 5.6.

This page left blank intentionally

SECTION 5.0
PROGRAMMING THE ANALYZER

The 54eA analyzer can be used to measure dissolved oxygen, ozone, total chlorine, and monochloramine in addition to free chlorine. It is configured at the factory to measure dissolved oxygen. Before connecting the sensor to the cable, the analyzer must be configured to measure free chlorine. See section 5.4.

Figure 5-1 is an outline of the analyzer menu structure. Settings that do not apply to the measurement of free chlorine are grayed out. Settings that apply to PID and TPC control and HART digital communications, features not available in the analyzer option provided with the FCLi, are also grayed out.

Table 5-1 list the default settings and the choices available for each setting. Only the choices available for free chlorine are shown.

TABLE 5-1. Program Settings List

ITEMS	CHOICES	FACTORY SETTINGS
A. Alarms setpoints (Section 5.1)		
1. Alarm 1 (low action)		
a. if chlorine	-9999 to 9999 ppm	0 ppm
b. if temperature	-5 to 130°C	0.1°C
2. Alarm 2 (high action)		
a. if chlorine	-9999 to 9999 ppm	20 ppm
b. if temperature	-5 to 130°C	130°C
3. Alarm 3	See alarm 2	See alarm 2
B. Output ranging (Section 5.2)		
1. Output 1 or 2: 4 mA setting		
a. if chlorine	-9999 to 9999 ppm	0 ppm
b. if temperature	-5 to 130°C	0.1°C
2. Output 1 or 2: 20 mA setting		
a. if chlorine	-9999 to 9999 ppm	20 ppm
b. if temperature	-5 to 130°C	130°C
C. Display options (Section 5.4)		
1. Measurement	Oxygen, ozone, free chlorine, total chlorine, monochloramine	Oxygen
2. Temperature units	°C or °F	°C
3. Output 1	mA or % of full scale	mA
4. Output 2	mA or % of full scale	mA
5. Language	English, Français, Español, Deutsch, Italiano	English
6. Main display left	See section 5.4	Sensor current
7. Main display right	See section 5.4	Output 1 current
8. Display contrast	00-99 (darkest)	50
9. Test timeout	On or off	On
10. Timeout value	1 to 60 min	10 min
D Output parameters (Section 5.5)		
1. Output 1 Control		
a. Measurement	Oxygen, chlorine, ozone, pH, or temperature	Oxygen
b. Control	Normal	Normal

Continued on the following page

TABLE 5-1. Program Settings List *(continued)*

ITEMS	CHOICES	FACTORY SETTINGS
D. Outputs (Section 5.5) *(continued)*		
2. Output 1 Setup (normal)		
a. Current	4-20 mA or 0-20 mA*	4-20 mA
b. Dampening	0-299 sec	0 sec
c. Hold mode	Hold last value or go to fixed value	Hold last value
d. Fixed hold value	0-22 mA	21 mA
e. Fault value	0-22 mA	22 mA
3. Output 2	See output 1	See output 1
4. Hold feature	Enable, disable, or 20 min timeout	Disable
E. Alarms parameters (Section 5.6)		
1. Alarm 1 Control		
a. Activation method	Oxygen, chlorine, ozone, temperature, pH	Oxygen
b. Control mode	Normal	Normal
2. Alarm 1 setup (normal)		
a. Configuration	Low, high, or off	High
b. Hysteresis		
if chlorine	-9999 to 9999 ppm	0 ppm
if temperature	0 to 10°C	0.1°C
c. Delay time	0-99 sec	0 sec
d. Relay fault	none, open, closed	None
3. Alarm 2 Control		
a. Activation method	Oxygen, chlorine, monochloramine, ozone, temperature, pH	Oxygen
b. Control mode	Normal	Normal
4. Alarm 2 setup (normal)		
a. Configuration	Low, high, or off	Low
Rest of alarm 2 setup is the same as alarm 1		
5. Alarm 3 control and setup is the same as alarm 1		
6. Alarm 4 control		
Alarm	Fault or off	Fault
7. Feed limit timer		
a. Feed limit	Disable, alarm 1, alarm 2, or alarm 3	Disable
b. Timeout value	0 to 10,800 sec	600 sec
8. Interval timer		
a. Select alarm	Disable, alarm 1, alarm 2, or alarm 3	Disable
b. Interval time	0 to 999.9 hr	24.0 hr
c. Repeats	1 to 60	1
d. On time	0 to 2999 sec	120 sec
e. Off time	0 to 2999 sec	1 sec
f. Recovery time	0 to 999 sec	600 sec
F. Temperature compensation (Section 5.8)		
1. Temperature compensation	Auto or manual	Auto
2. Manual temperature	-15 to 130°C	25°C

Continued on the following page

TABLE 5-1. Program Settings List *(continued)*

ITEMS	CHOICES	FACTORY SETTINGS
G. Noise Reduction (section 5.9)		
Noise rejection	50 or 60 Hz	60 Hz
H. Main sensor calibration (Section 5.10)		
1. Stabilize reading (Chlorine)	0 to 999 ppm	0.05 ppm
2. Stabilize time	0 - 30 sec	10 sec
3. Sensor zero stabilization value		
4. Dual range calibration	Enable or disable	disable
I. Security (Section 5.11)		
1. Lock all	000-999 (000 disables)	000
2. Lock program	000-999 (000 disables)	000
3. Lock configuration	000-999 (000 disables)	000

FIGURE 5-1. Menu Tree for the 54eA Controller

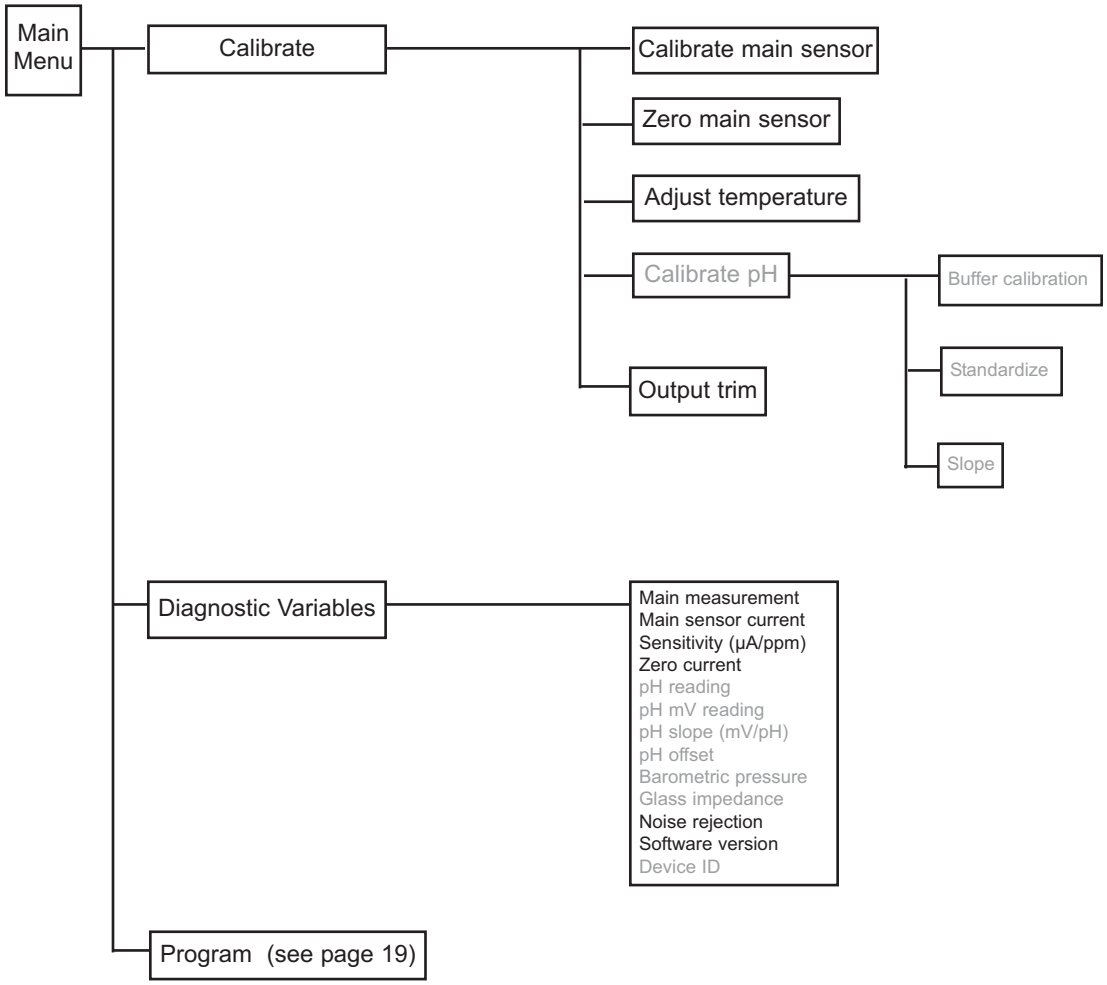
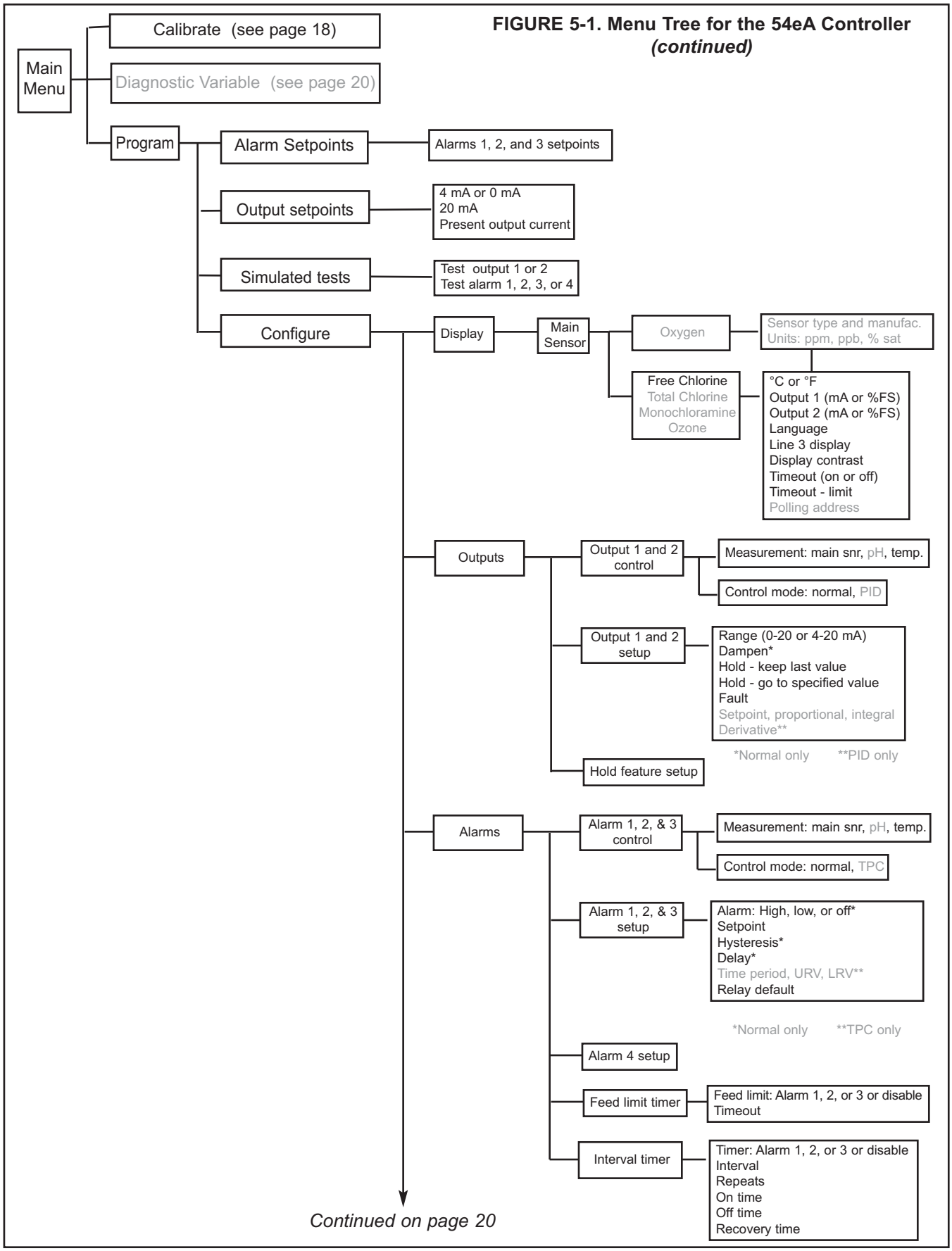
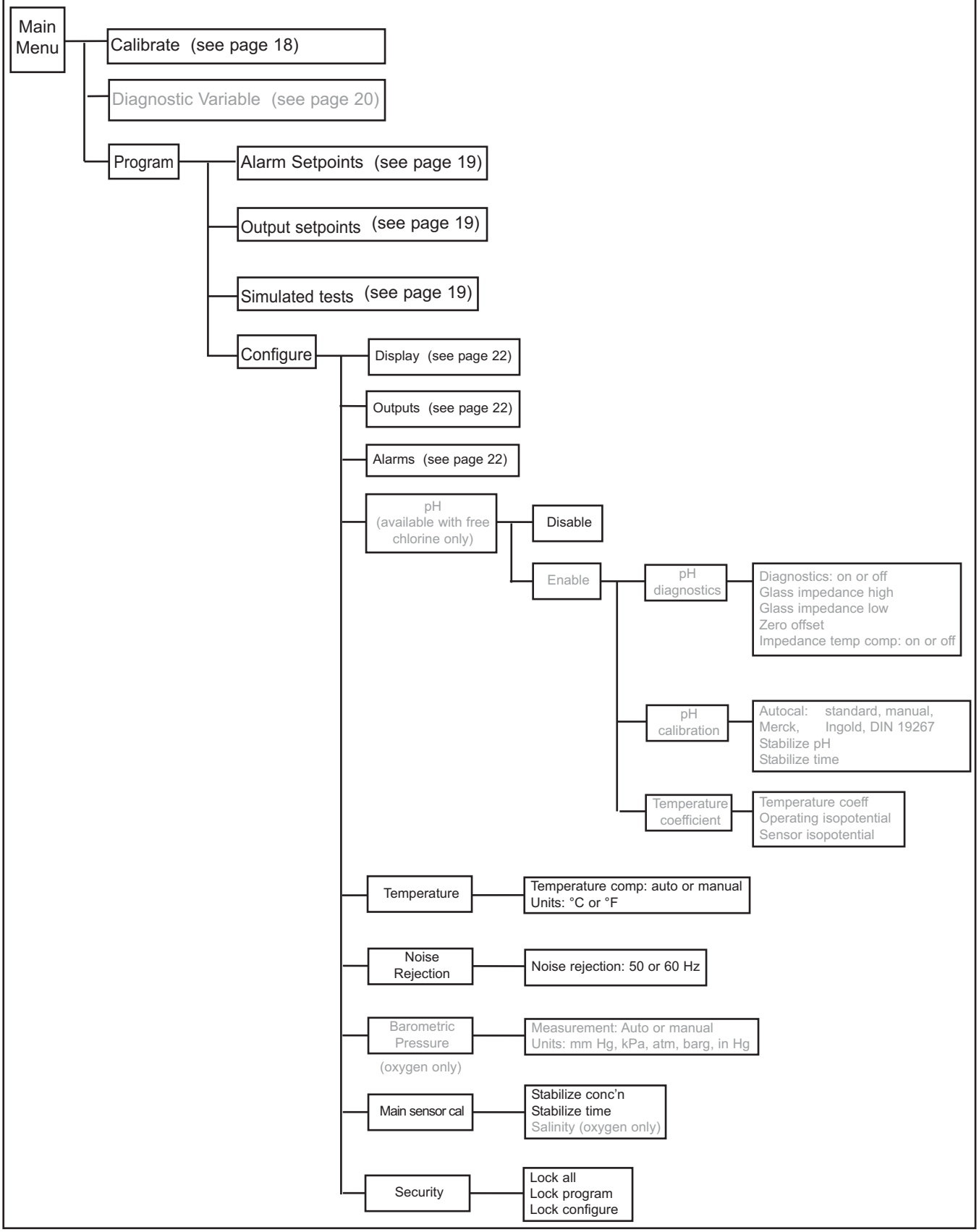


FIGURE 5-1. Menu Tree for the 54eA Controller *(continued)*



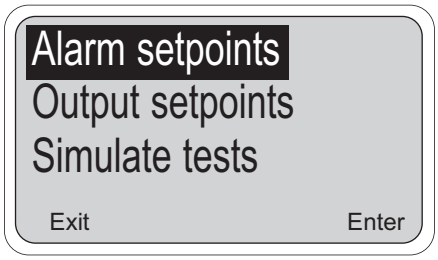
Continued on page 20

FIGURE 5-1. Menu Tree for the 54eA Controller *(continued)*



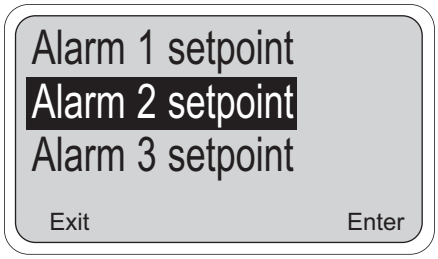
5.1 CHANGING ALARM SETPOINTS

1. **Before changing alarm setpoints, be sure that alarms are properly configured. See Section 5.6.**

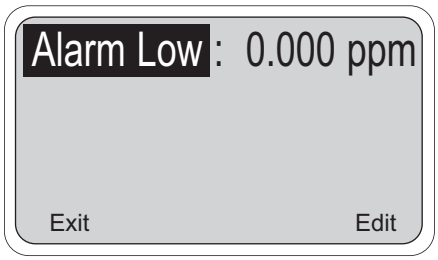


2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Press Enter (F4).



4. Move the cursor to the desired alarm and press Enter (F4).

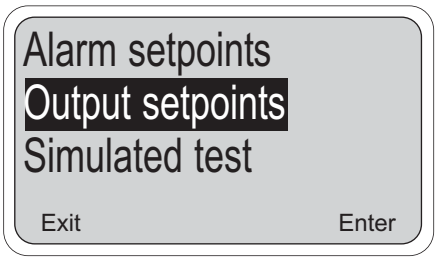


5. A screen like the one shown will appear. The alarm is a low alarm and the setpoint is 0.00 ppm. Press Edit (F4). Use the arrow keys to change the setpoint. Press Save (F4) to store the new value. Press Exit (F1) to return to the screen in step 4. Choose a new alarm.

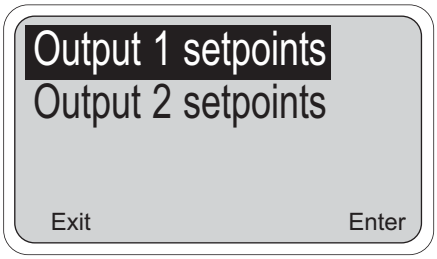
5.2 RANGING THE OUTPUTS

1. Ranging the outputs means assigning values to the low (0 or 4 mA) and high (20 mA) outputs. **Before ranging the outputs, be sure the outputs are properly configured. See Section 5.5.**

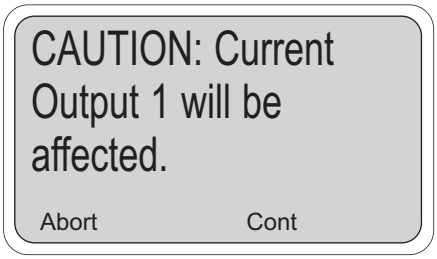
2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).



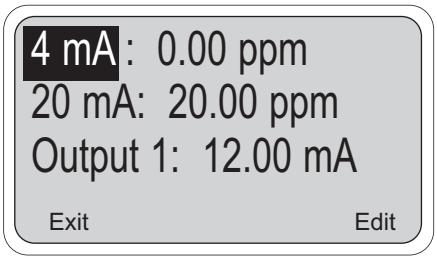
3. Move the cursor to "Output setpoints" and press Enter (F4).



4. Move the cursor to the desired output and press Enter (F4).



5. This screen confirms that changes to output 1 are going to be made. Use caution. Changes may degrade process control. Press Cont (F3) to continue. Otherwise, press Abort (F1).



6. This screen shows the present settings for Output 1. If the output was configured to be 0-20 mA, the first line will show "0mA" instead of "4mA". The live current output is shown on the third line.

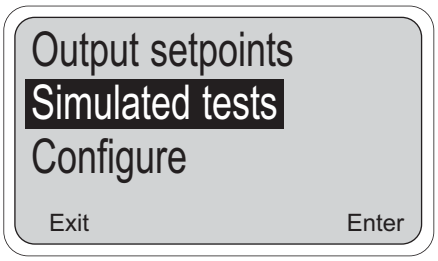
   Move the cursor to the desired line and press Edit (F4). Use the arrow keys to change the setpoint. Press Save (F4) to store the new value.

   Press Exit (F1) to return to the screen in step 4. Choose the other output and continue.

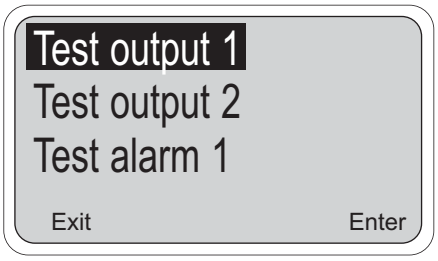
5.3 TESTING OUTPUTS AND ALARMS

1. For testing purposes, the analyzer can be programmed to generate simulated outputs and to activate and deactivate alarms.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

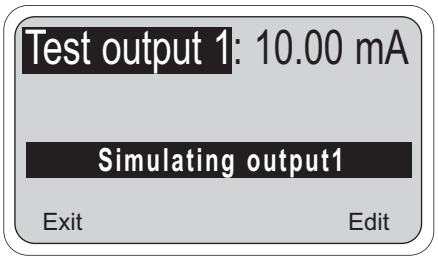


3. Move the cursor to "Simulated tests" and press Enter (F4).



4. Move the cursor to the desired output or alarm. Both outputs and all four alarms can be tested. Press Enter (F4).

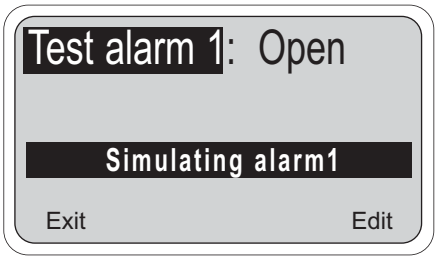
   A screen will appear warning that the output or alarm will change. Press Cont (F3) to continue. Press Abort (F1) to cancel the simulation.



5. This screen appears when an output is being simulated. To change the simulation current, press Edit (F4). Use the arrow keys to change the current to the desired value. Press Test (F4), then Esc (F3).

   The simulated current will be generated for 10 minutes, then the output returns to normal operation. To change the timeout to a different value see Section 5.4.

   To end the simulation at any time, press Exit (F1).



6. This screen appears when an alarm is being simulated. To change the state of the relay, press Edit (F4). Use the ↑ or ↓ keys to change from open to closed. Press Test (F4), then Esc (F3).

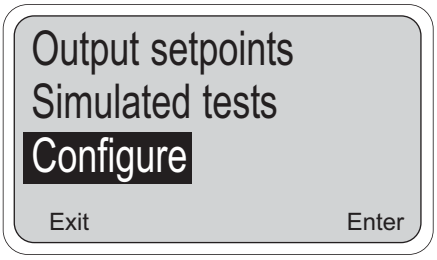
   The alarm will be simulated for 10 minutes, then the alarm returns to normal operation. To change the timeout to a different value, see Section 5.4.

   To end the simulation at any time, press Exit (F1).

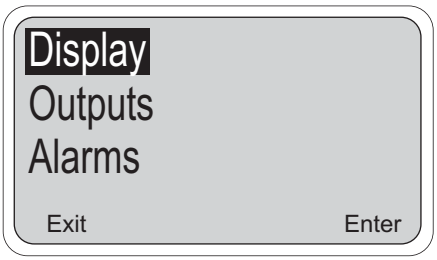
5.4 CHOOSING DISPLAY OPTIONS

1. The Model 54eA analyzer is a versatile instrument that, in addition to free chlorine, can be used to measure oxygen, ozone, and other forms of chlorine. The default measurement is oxygen. Before connecting the sensor to the cable, the analyzer must be configured to measure free chlorine.
2. The display menu also lets the user customize the third line in the display, change timeout values, choose a language other than English, and change the display contrast.

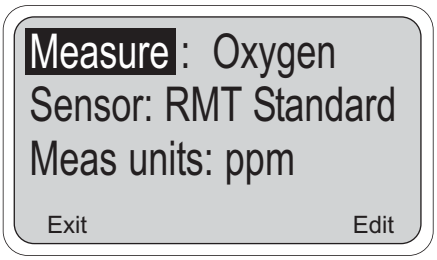
3. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).



4. Move the cursor to "Configure" and press Enter (F4).

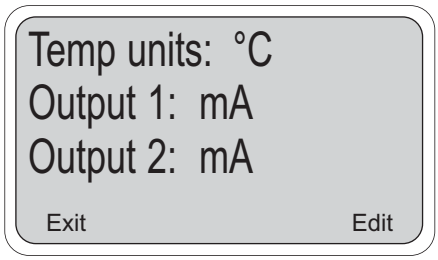


5. With the cursor on "Display", press Enter (F4).



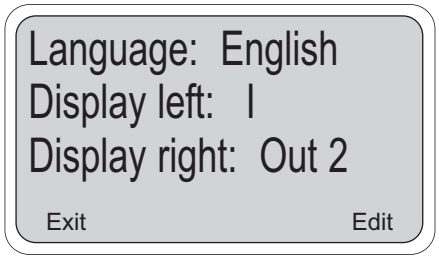
6. A screen showing the present main measurement will appear. To change the measurement from oxygen to free chlorine, press Edit (F4), then use the ↑ key to scroll through the choices until free chlorine is showing. Press Save (F4) to store the setting.

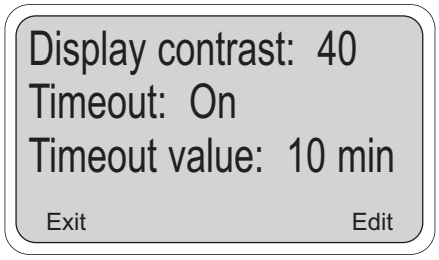
   A screen will appear warning that if the measurement is changed, the analyzer will return to factory default settings. Press Cont (F3) to continue. Press Abort (F1) to cancel the change.



7. Set the remainder of the display parameters. Use the ↑ and ↓ keys to choose the desired parameter. Then press Edit (F4). Use the ↑ key to move the cursor to the desired selection. Press Save (F4) to store.

5.4 CHOOSING DISPLAY OPTIONS (CONTINUED)





Temp units	°C or °F
Output 1	mA or % of full scale
Output 2	mA or % of full scale
Language	English, Français, Español, Deutsch, Italiano
Display left	sensor current (I), alarm 1 setpoint (no units), alarm 3 setpoint (no units), or blank
Display right	sensor current (I), alarm 2 setpoint (no units), alarm 3 setpoint (no units), output 2, or blank
Display Contrast	00 (lightest)-99 (darkest); the display contrast changes as the number changes
Timeout	Timeout returns the display from any other screen to the main display if no key is pressed before the timeout value is exceeded.
Timeout value	

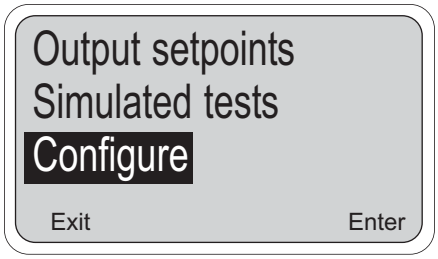
SECURITY CAUTION

The analyzer uses the timeout value to activate security. Once the analyzer is unlocked by entering a security code, security will not re-activate until a display timeout occurs. If timeout has been turned off, security will never reactivate.

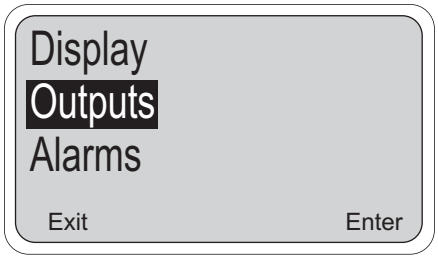
5.5 CHANGING OUTPUT PARAMETERS

1. This section describes how to configure the analyzer outputs. Outputs can be configured to represent chlorine or temperature.

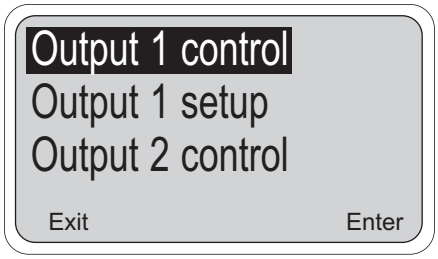
2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).



3. Move the cursor to "Configure" and press Enter (F4).



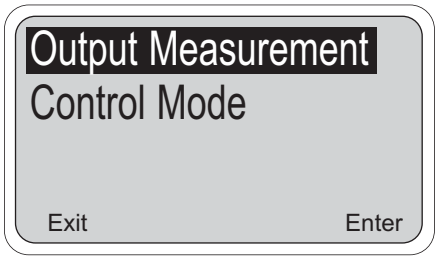
4. Move the cursor to "Outputs" and press Enter (F4).



5. Five menu headers relate to outputs. Each output has a control header and a setup header. The fifth header allows the output hold feature to be configured.

   Always configure the control parameters BEFORE making changes in the output setup.

   To access a header, move the cursor to the desired header and press Enter (F4).

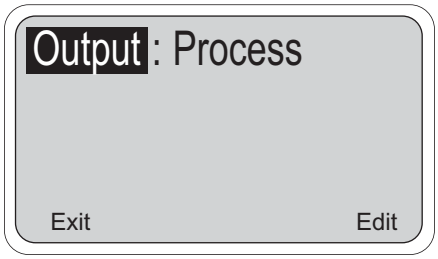


6. **Output Control Settings:**

   NOTE

   There are no settings to make under “Control Mode.” The 54eA analyzer supplied with the FCLi does not have control features.

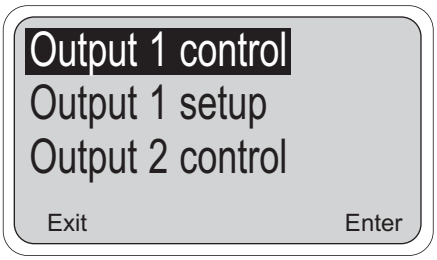
   a. The cursor is on "Output Measurement" press Enter (F4).



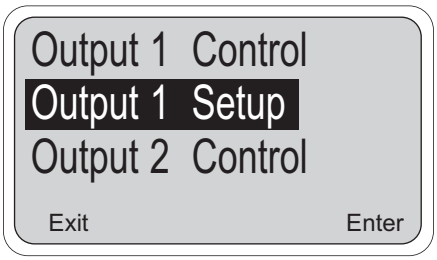
   b. Press Edit (F4).

   c. Use the ↑ key to scroll through the choices: "Process" or "Temperature". "Process" means free chlorine. Press Save (F4) to store the selection.

5.5 CHANGING OUTPUT PARAMETERS (continued)

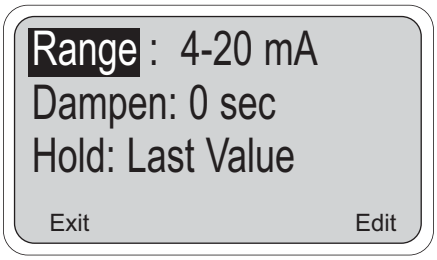


d. The display returns to the “Output: Process” screen. Press Exit (F1) twice. The display returns to the “Control/Setup” screen shown at left.



7. **Output setup for normal outputs:**

a. Move the cursor to the desired output setup and press Enter (F4).



b. Use the ↑ and ↓ arrow keys to move the cursor to the desired parameter. Press Edit (F4). Use the arrow keys to change the setting to the desired value and press Save(F4) to store the value.

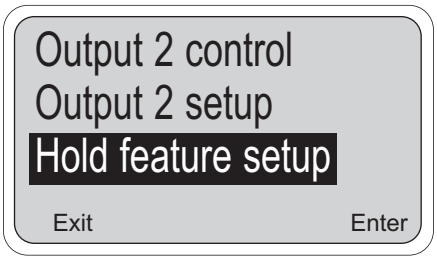
Range: Choose 4-20 mA or 0-20 mA.

Dampen: Dampening averages the output current, thus smoothing out a noisy reading. Higher values provide more smoothing but increase the response time of the output.

Hold and Fixed Hold: If the analyzer is placed in hold, the outputs will either remain at the last value or go to a fixed value selected by the user. The fixed value must be between 0 and 22.00 mA.

Fault: If the analyzer detects a fault, the output will signal the fault by going to a user-selected current between 0 and 22.00 mA.

For allowed values, see Table 5-1.



8. **Hold setup.**

a. Move the cursor to "Hold feature setup" and press Enter (F4).

b. Press Edit (F4). Use the ↑ to scroll through the choices: "Disable feature", "Enable feature", and "20 min timeout". If "20 min timeout" is selected, hold mode will automatically disengage after being on for 20 minutes.

NOTE

Selecting "Enable hold" or "20-min timeout" does not put the analyzer in hold. It only allows the user to put the analyzer in hold when the controller is in calibrate mode.

9. **Using hold.**

If hold was enabled in step 8 above, the hold screen will appear as soon as the user enters the Calibrate menu. To activate Hold, press Edit (F4). Use the ↑ key to change Off to On and press Save (F4). "Hold Mode Activated" will be displayed. Outputs and relays will go to the values programmed in step 7b.

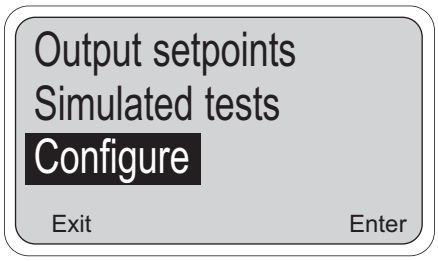
5.5 CHANGING OUTPUT PARAMETERS (continued)

"Hold Mode Activated" will continue to flash in the main display even after the user has left the Calibrate menu. To deactivate hold, enter the Calibrate menu and press Edit (F4). Use the ↑ key to change On to Off and press Save (F4). Press Exit (F1) twice to return to the main display.

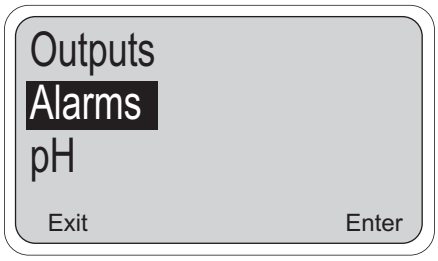
5.6 CHANGING ALARM PARAMETERS

1. This section describes how to configure the analyzer alarms relays. Alarms 1, 2, and 3 can be assigned to chlorine or temperature. In addition, alarm 1, 2, or 3 can be configured as a feed limit timer or as an interval timer (see steps 9 and 10). Alarm 4 is always a fault alarm.

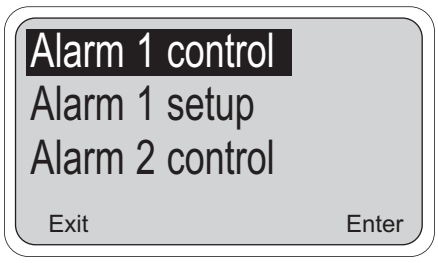
2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).



3. Move the cursor to "Configure" and press Enter (F4).



4. Move the cursor to "Alarms" and press Enter (F4).

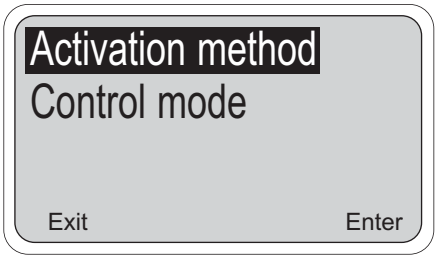


5. Nine menu headers relate to alarms. Alarms 1, 2 and 3, each have a control header and a setup header. Alarm 4 has only a setup header. The eighth menu header is for configuring the feed limit timer, and the ninth menu header is for configuring the interval timer.

   Always configure the control parameters BEFORE making changes in the alarm setup.

   To access a header, move the cursor to the desired header and press Enter (F4).

5.6 CHANGING ALARM PARAMETERS (continued)



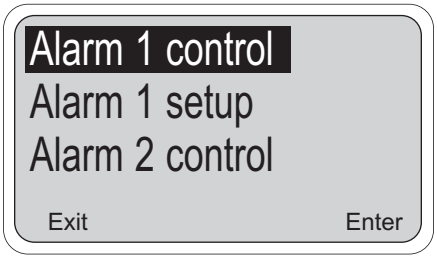
6. **Alarm Control Settings:**

NOTE

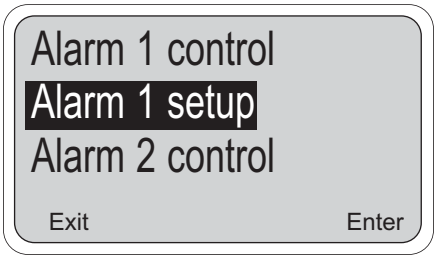
There are no settings to make under “Control Mode.” The 54eA analyzer supplied with the FCLi does not have control features.

a. With the cursor on "Activation method" press Enter (F4).

b. To change the activation method, press Edit (F4). Use the ↑ key to scroll through the choices: "Process" or "Temperature". "Process" means free chlorine. Press Save (F4) to store the selection.

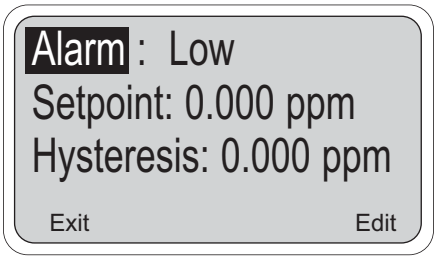


c. The display returns to the "Activate: Process" screen. Press Exit (F1) twice. The display returns to the Control/Setup screen shown at left.



7. **Alarm setup for normal alarms:**

a. Move the cursor to the desired alarm setup and press Enter (F4).



b. Use the ↑ and ↓ keys to move the cursor to the desired parameter. Press Edit (F4). Use the arrow keys to change the setting to the desired value and press Save (F4) to store the value. See the Figures 5-2 and 5-3 for an explanation of terms: **low alarm**, **high alarm**, **hysteresis**, and **delay**. See Table 5-1 for allowed values and limits.

Relay default determines how the relay will operate if there is a fault or the controller is in hold. Alarms can be forced on (Close), off (Open), or remain unchanged (None).

5.6 CHANGING ALARM PARAMETERS (continued)

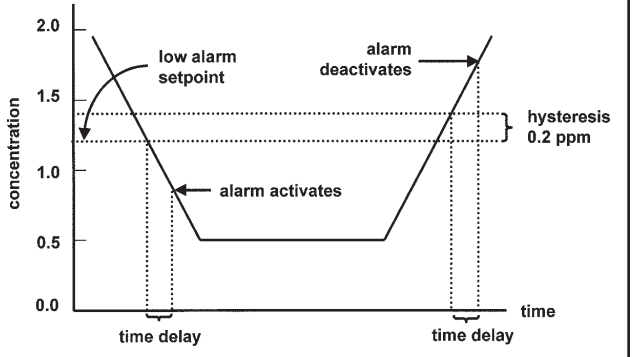


FIGURE 5-2. Low Alarm

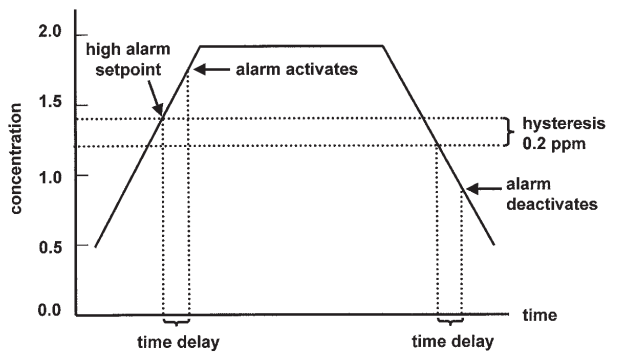
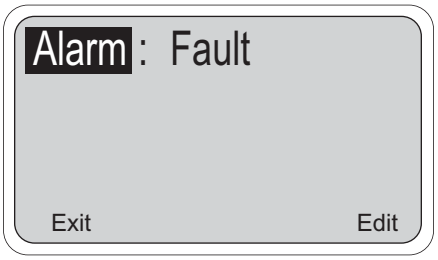


FIGURE 5-3. High Alarm



8. **Alarm 4 setup:**

   Alarm 4 is a dedicated fault alarm. When a fault condition exists, the red LED on the front display will light.

   a. From the menu header screen (step 6) move the cursor to "Alarm 4 setup."

   b. To disable the alarm, press Edit (F4) and use the ↑ key to change the "Fault" to "Off"

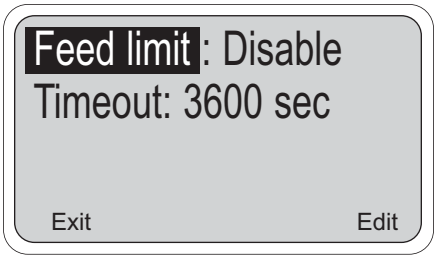
9. **Feed limit timer setup:**

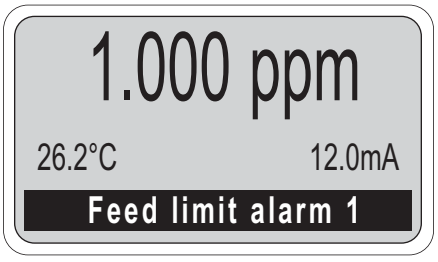
   Alarm 1, 2, or 3 can be configured as a feed limit timer. The feed limit timer prevents overfeeding of treatment chemicals by automatically turning off the relay after a timeout period.

   a. From the menu header screen (step 6) move the cursor to "Feed limit timer." Press Enter (F4).

   b. With the cursor on "Feed limit" press Edit. Use the ↑ key to scroll through the choices: disable, AL 1, AL 2, and AL 3. Press Save (F4) to store the selection.

   c. Move the cursor to "Timeout". Press Edit (F4) and use the arrow keys to change the timeout to the desired value. Press Save (F4) to store the setting.





Operation of the feed limit timer. When a feed limit alarm has timed out, "Feed limit alarm 1" (if alarm 1 was chosen) appears in the display. At the same time the red FAIL LED will light and alarm 4 will close (if not turned off), and the selected feed limit relay (alarm 1) will open (de-energize). All other alarms and current outputs will remain unchanged. The relays remain in the state described until the Ack (F2) key is pressed, at which time the controller returns to normal operation and the feed limit clock starts again.

NOTE

Pressing Ack (F2) acknowledges all conditions that turn on the red LED. If another event occurs after F2 is pressed, F2 must be pressed again to acknowledge the new event.

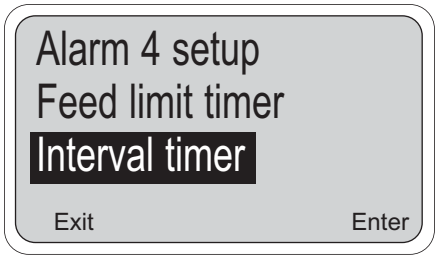
5.6 CHANGING ALARM PARAMETERS (continued)

10. **Interval timer setup:**

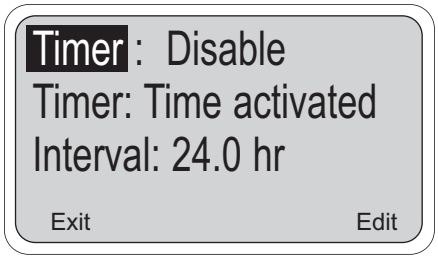
Alarm 1, 2, or 3 can be used as an interval timer. The selected relay will open and close at time intervals programmed by the user. The interval timer is useful for automatic cleaning of sensors.

NOTE

The alarm relay used for the interval timer cannot be used for other purposes. When a timer sequence is occurring, both current outputs are placed in hold (even if hold was not enabled) and the other two alarms will be placed in their default states.



a. From the menu header screen (step 6c) move the cursor to "Interval timer."



b. With the cursor on "Interval timer", press Enter (F4). Use the ↓ key to scroll through the selections. Use the arrow keys to change settings. Press Save (F4) to store.

Refer to the diagram for definition of terms: **interval**, **repeats**, **on time**, **off time**, and **recovery**.

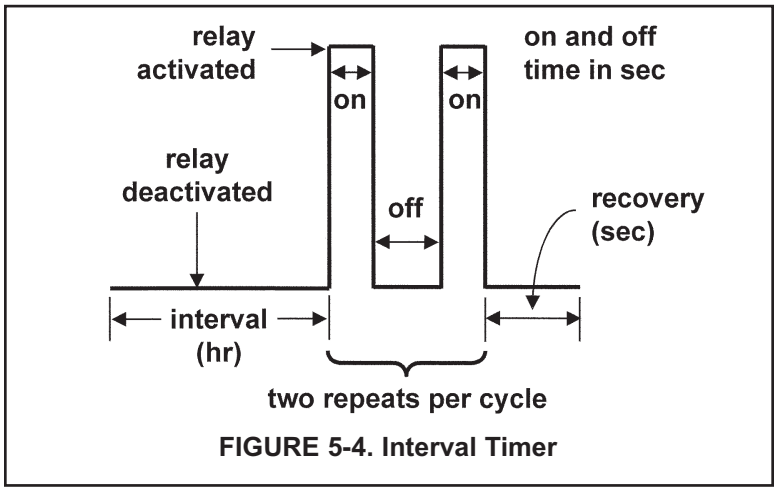


FIGURE 5-4. Interval Timer

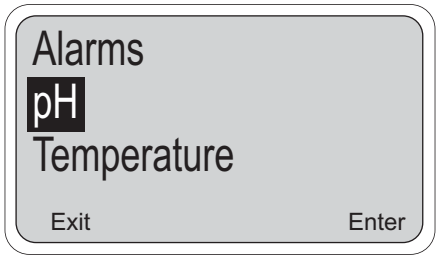
5.7 CONFIGURING THE pH MEASUREMENT

NOTE

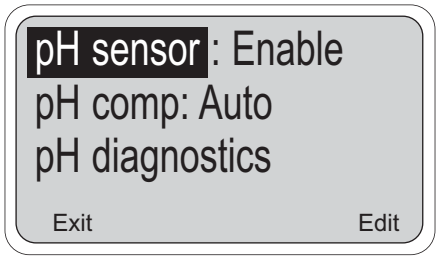
Although the Model 498CL-01 pH-independent free chlorine sensor used in the FCLi requires no pH correction, certain settings must be made in this section to allow the sensor to work properly.

1. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

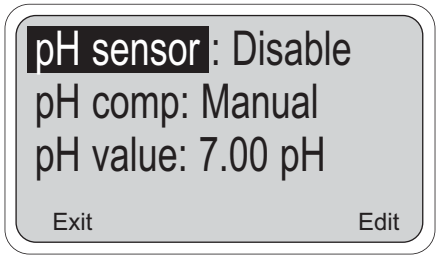
2. Move the cursor to "Configure" and press Enter (F4).



3. Move the cursor to “pH” and press Enter (F4).



4. The screen shows the default settings, which must be changed to allow the sensor to work properly. Press Edit (F4). Use the ↓ key to change “Enable” to “Disable”. Press Save (F4).



5. The screen at left appears. Leave the default settings: pH comp in “Manual” and pH value at “7.00 pH”

6. There are no further settings to make.

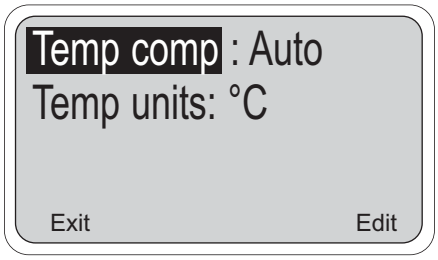
5.8 TEMPERATURE COMPENSATION AND TEMPERATURE UNITS

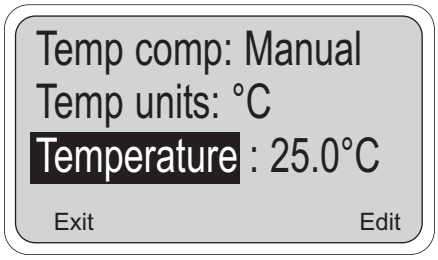
1. Refer to Section 6.1 for a discussion of the ways in which temperature affects the chlorine measurement.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).

4. Move the cursor to "Temperature" and press Enter (F4).





5. Use the ↑ and ↓ keys to move through the list of items. To make a change press Edit (F4). Use the arrow keys to change settings to the desired value. Press Save (F4) to store changes.

   Auto: In automatic temperature compensation, the analyzer measures the temperature using an RTD (resistance temperature device) in the sensor. The analyzer then uses the measured temperature to calculate the membrane permeability correction.

   Manual: In manual temperature compensation, the analyzer uses the temperature entered by the user to calculate membrane permeability correction. It does **NOT** use the actual process temperature. Do **NOT** use manual temperature compensation unless the difference between the calibration and measurement temperatures is less than 2°C.

   Manual temperature compensation is useful if the sensor RTD has failed and a replacement sensor is not available.

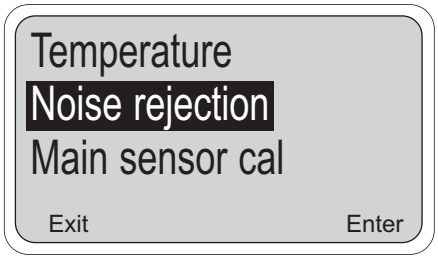
   If Manual temperature compensation is selected, be sure to enter the desired temperature.

5.9 NOISE REDUCTION

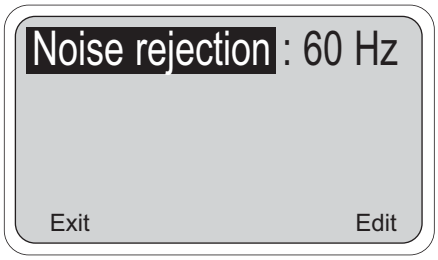
1. For maximum noise reduction the frequency of the ac power must be entered into the analyzer.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).



4. Move the cursor to "Noise rejection" and press Enter (F4).



5. To change the frequency setting, press Edit (F4). Use the ↑ key to toggle between 50 and 60 Hz. Press Save (F4) to store the change.

5.10 MAIN SENSOR CALIBRATION PARAMETERS

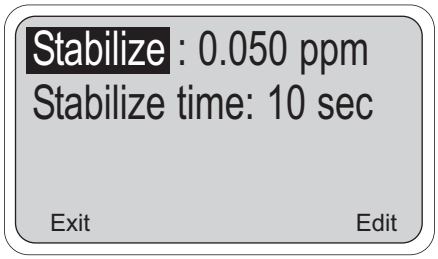
1. Main sensor refers to the chlorine sensor.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).

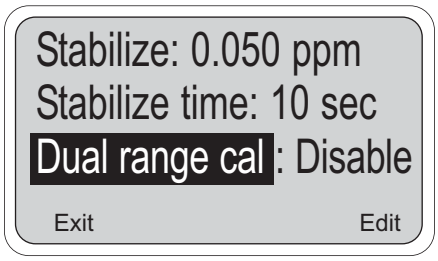
4. Move the cursor to "Main sensor cal" and press Enter (F4).

5. Use the ↑ and ↓ keys to move through the list of items. To make a change press Edit (F4). Use the arrow keys to change settings to the desired value and press Save (F4). For allowed ranges, see Table 5-1.



The choices depend on the measurement being made.

Stabilize and Stabilize time: For the analyzer to accept calibration data, the concentration must remain within a specified range for a specified period of time. The default values are 0.05 ppm and 10 seconds. Using a small stabilize value and a long stabilize time is the best protection against calibration while a reading is still changing.



Dual range cal: The response of pH-independent free chlorine sensor used with the FCLi becomes slightly non-linear at high concentrations of chlorine (>20 ppm). Dual range calibration allows the analyzer to correct for the non-linearity of the sensor. For more information see Section 7.4.

.

5.11 SECURITY

1. The analyzer can be programmed to require a password for access to menus. There are three levels:

   Level 1: A level 1 user can
   1. Zero and calibrate the chlorine sensor
   2. Change temperature compensation from automatic to manual and enter a manual compensation temperature
   3. View diagnostic variables.

   Level 2: A level 2 user can
   1. Do everything a level 1 user can do
   2. Change alarm setpoints
   3. Rerange the 4-20 mA outputs
   4. Manually test both outputs and all four alarm relays.

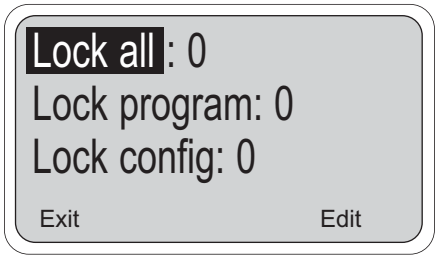
   Level 3: A level 3 user has access to every menu item. Only a level 3 user can change passwords.

   A person with no password can only view the main display.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).

4. Move the cursor to "Security" and press Enter (F4).



5. Use the ↑ and ↓ keys to move through the list of items. To enter a password, press Edit (F4). Use the arrow keys to enter a three-digit password. Press Save (F4) to store the value.

   Lock all: Until the user enters the "lock all" password, all he can do is view the main display. Entering the "lock all" password allows the user access to all Level 1 functions.

   Lock program: Entering the "lock program" password allows the user access to all Level 2 functions.

   Lock config: Entering the "lock config" password allows the user access to all Level 3 functions.

   The controller will accept a higher level security code at a lower level security gate. For example, the controller will accept a level 2 password at a level 1 gate.

NOTES:

a. A code of 000 disables security for that level.
b. The security feature will not activate until after the timeout period has passed with no key presses.
c. A hold condition will indefinitely prolong the timeout period.
d. Security will activate immediately if power is removed and then restored.
e. To recall a forgotten code, press and hold F4 for five seconds when the security screen appears. The code for that level will appear.

5.12 ANALYZER MODE PRIORITY

The Model 54eA analyzer can function in different modes depending on both how it is configured, what process conditions exist, and what actions an operator may have made. To reconcile these possible modes, there is a set priority that determines exactly what will happen to the two (2) current outputs and the four (4) alarm relays in the event of multiple modes occurring at the same time. See Table 5-2 below.

Priority is in the following order (from lowest to highest): normal, fault, timer, hold, feed limit, test. Each output or relay acts as if it is only in the state of highest priority.

NOTE

Some of these features may not be in use in the analyzer.

TABLE 5-2. Controller Mode Priority Chart

Condition	Priority	Current Output 1	Current Output 2	Alarm Relay 1	Alarm Relay 2	Alarm Relay 3	Alarm Relay 4
Normal	**1**	Normal	Normal	Normal	Normal	Normal	Open
Fault	**2**	Default	Default	Default	Default	Default	Closed
Interval Timer	**3**	Hold	Hold	Default/ Normal[1]	Default/ Normal[1]	Default/ Normal[1]	Prior
Hold Mode	**4**	Hold	Hold	Default	Default	Default	Prior
Feed Limit	**5**	Normal	Normal	Open[1]	Open[1]	Open[1]	Closed
Simulate tests	**6**	Test[1]	Test[1]	Test[1]	Test[1]	Test[1]	Test[1]

[1] Indicates the state **IF** that item has been configured or selected (i.e. if it is an interval timer or a feed limit timer or it is the one being tested). Unconfigured or unselected items are not affected by that mode.

Condition Definitions:

1. Normal refers to conditions when no other mode is present.
2. Fault means the instrument has diagnosed a fault condition. A fault message is displayed and the red LED is on.
3. Interval Timer means the timer sequence is occurring.
4. Hold Mode occurs when hold is activated by the operator (i.e. during calibration).
5. Feed Limit occurs when a feed limit timer has reached its limit and is turned off after being on for too long.
6. Simulate tests are described in Section 5.3.

Action Definitions:

1. Normal is determined by process conditions or how the item has been configured (Section 5.6)
2. Open is a deenergized alarm relay (alarm off).
3. Default is the setting configured for each item if there is a fault. (Section 5.6)
4. Closed is an energized alarm relay (alarm on).
5. Hold is the setting for the current output configured in Section 5.5 (fixed mA value or the last normal value).
6. Prior is the state the alarm had before that mode occurred.
7. Test is the value input by the operator (mA for current, on or off for a relay).

This page left blank intentionally

SECTION 6.0
CALIBRATION - TEMPERATURE

6.1 INTRODUCTION

The free chlorine sensor used in the FCLi is a mambrane-covered amperometric sensor. As the sensor operates free chlorine diffuses through the membrane and is consumed at an electrode immediately behind the membrane. The reaction produces a current that depends on the rate at which chlorine diffuses through the membrane. The diffusion rate, in turn, depends on the concentration of chlorine and how easily it passes through the membrane (the membrane permeability). Because the membrane permeability is a function of temperature, the sensor current will change if the temperature changes. To correct for changes in sensor current caused by temperature, the analyzer automatically applies a membrane permeability correction. The correction is about 3%/°C at 25°C, so a 1°C error in temperature produces about a 3% error in the reading.

Without calibration the accuracy of the temperature measurement is about ±0.4°C. Calibrate the analyzer if

1. ±0.4°C accuracy is not acceptable
2. the temperature measurement is suspected of being in error. Calibrate temperature by making the analyzer reading match the temperature measured with a standard thermometer.

6.2 TEMPERATURE CALIBRATION

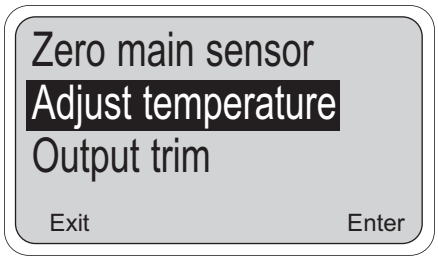
Place the sensor and a standard thermometer in a beaker of water. Allow the system to reach thermal equilibrium.

1. Check the temperature reading (main display) to make sure the sensor has stabilized. Compare the analyzer temperature reading with the standard thermometer. The readings should differ by at most 1°C. If the readings differ by a greater amount, refer to Section 10.3. Go to the next step if the reading requires adjustment.

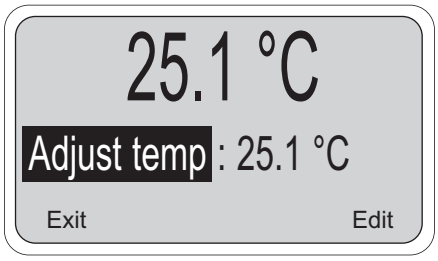
2. From the main display, press any key. With the cursor on “Calibrate,” press Enter (F4).

NOTE

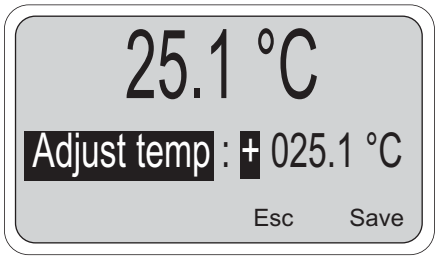
If Hold was enabled in Section 5.5, the hold screen will appear. To activate hold, refer to Section 5.5, step 9.



3. Press the ↓ key twice to move the cursor to “Adjust temperature,” then press Enter (F4).



4. Press Edit (F4) to adjust the temperature. The screen below will then appear. Using the arrow keys, enter the correct temperature and press Save (F4). The controller will enter the value in memory. To abort the change, press Esc (F3). Press Exit (F1) three times for the main display.



NOTE

If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 5.5, step 9.

SECTION 7.0
CALIBRATION - CHLORINE

7.1 INTRODUCTION

As Figure 7-1 shows, a free chlorine sensor generates a current directly proportional to the concentration of free chlorine in the sample. Calibrating the sensor requires exposing it to a solution containing no chlorine (zero standard) and to a solution containing a known amount of chlorine (full-scale standard).

The zero standard is necessary because chlorine sensors, even when no chlorine is in the sample, generate a small current called the residual current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to a chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. Either of the following makes a good zero standard:

- Deionized water.
- Tap water known to contain no chlorine. Expose tap water to bright sunlight for at least 24 hours.

The purpose of the full-scale standard is to establish the slope of the calibration curve. Because stable chlorine standards do not exist, **the sensor must be calibrated against a test run on a grab sample of the process liquid.** Several manufacturers offer portable test kits for this purpose. Observe the following precautions when taking and testing the grab sample.

- Take the grab sample from a point as close to the sensor as possible. Be sure that taking the sample does not alter the flow of the sample to the sensor. It is best to install the sample tap just downstream from the tap for the FCLi.
- Chlorine solutions are unstable. Run the test immediately after taking the sample. Try to calibrate the sensor when the chlorine concentration is at the upper end of the normal operating range.

The Model 498CL-01 free chlorine sensor loses sensitivity at high concentrations of chlorine. The 54eA analyzer has a dual slope feature that allows the user to compensate for the non-linearity of the sensor. However, for the vast majority of applications, dual slope calibration is unnecessary.

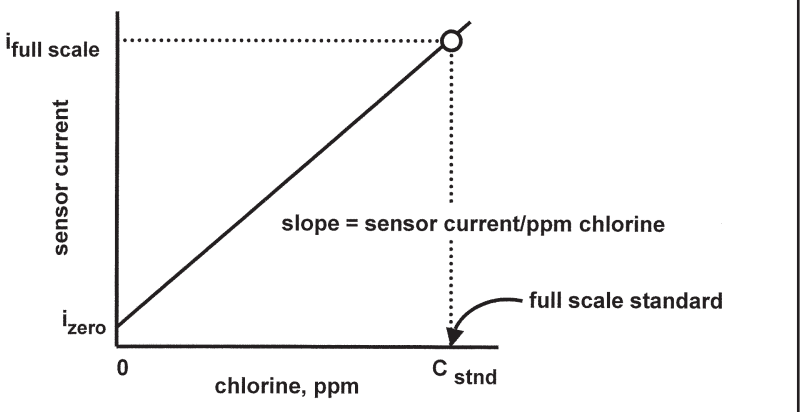


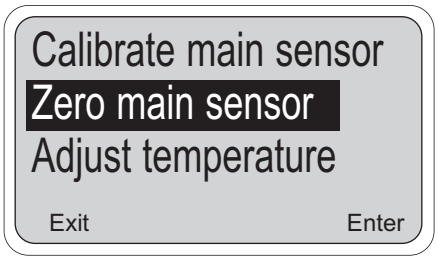
FIGURE 7-1. Sensor Current as a Function of Free Chlorine Concentration

7.2 ZEROING THE SENSOR

1. BEFORE ZEROING THE SENSOR, PLACE IT IN THE FLOW CELL AND ALLOW THE SENSOR TO OPERATE IN A FLOWING CHLORINATED SAMPLE FOR AT LEAST TWO HOURS.
2. After two hours, remove the sensor from the flow cell and place it in the zero standard. See Section 7.1 for suggested zero standards. Be sure no air bubbles are trapped against the membrane. The sensor current will drop rapidly at first and then gradually reach a stable zero value. To monitor the sensor current go to the main display and press any key to obtain the main menu. Press the ↓ key once to highlight "Diagnostic variables.' Press Enter (F4). The sensor current is the second item in the display. Note the units: nA is nanoamps, uA is microamps. To return to the main display, press exit (F1) twice. Typical zero current for the 498CL-01 sensor is between 30 and 80 nA. WHEN ZEROING THE SENSOR, USE A CONTAINER THAT MINIMIZES CONTACT BETWEEN THE AIR AND THE LIQUID SURFACE. DO NOT ALLOW THE SENSOR TO STAND IN THE ZERO SOLUTION FOR LONGER THAN TWO HOURS.

   THE COMBINATION OF DISSOLVED OXYGEN AND THE ACIDIC FILL SOLUTION FROM THE SENSOR CAUSE THE EXTERNAL COPPER ELECTRODE TO CORRODE. CORROSION PRODUCES COPPER IONS, WHICH DIFFUSE INTO THE SENSOR. ONCE INSIDE THE SENSOR, THE COPPER IONS UNDERGO AN ELECTROCHEMICAL REACTION THAT INCREASES THE BACKGROUND CURRENT. THE COPPER ALSO PLATES OUT ON THE CATHODE, AND IF THE CATHODE BECOMES HEAVILY COATED, THE SENSOR WILL BE UNUSABLE UNTIL IT IS CLEANED.

   LIMITING EXPOSURE TO AIR WHILE THE SENSOR IS BEING ZEROED, GREATLY REDUCES THE CORROSION RATE AND THE POTENTIAL FOR DAMAGE.

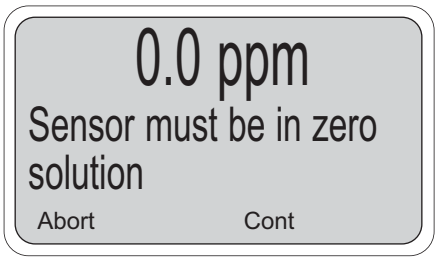


3. From the main display, press any key to obtain the main menu. With the cursor on "Calibrate," press Enter (F4).

   NOTE

   If Hold was enabled in Section 5.5, the hold screen will appear. To activate hold, refer to Section 5.5, step 9.

   Press the ↓ key once to move the cursor to "Zero main sensor." Press Enter (F4).



4. The screen at left appears. Press Cont (F3). "Wait" flashes until the sensor is stabilized. Once the zero step is complete, the message "Sensor zero done" appears.
5. Press Exit (F1) three times to return to the main display.

NOTE

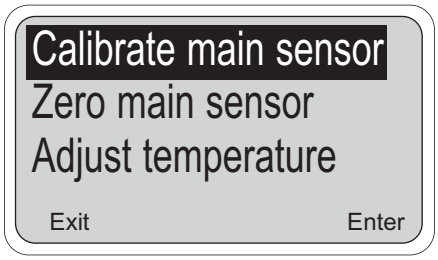
If Hold was activated during calibration, "Hold Mode Activated" will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 5.5, step 9.

NOTE

During calibration, ERROR and WARNING messages may appear. If an ERROR message appears, press Exit (F1) to leave and return to the previous screen. If a WARNING message appears, press Cont (F3) to continue the calibration or press Abort (F1) to leave. Continuing the calibration after a warning message appears may cause substantial errors in the subsequent measurement. Refer to Section 10.4 for assistance.

7.3 FULL SCALE CALIBRATION

1. Place the sensor in the flow cell. Be sure the pH compensation is set to manual and the pH value is 7.00. See Section 5.7. Adjust the sample flow until water overflows the inside tube in the constant head flow controller.
2. Adjust the chlorine concentration until it is near the upper end of the control range. Wait until the analyzer reading is stable before starting the calibration.



3. From the main display, press any key to obtain the main menu. With the cursor on “Calibrate,” press Enter (F4).

NOTE

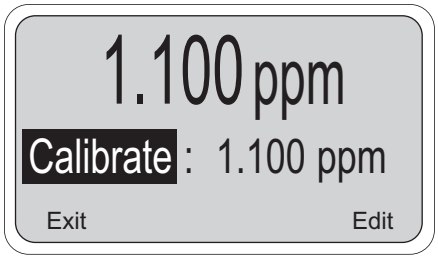
If Hold was enabled in Section 5.5, the hold screen will appear. To activate hold, refer to Section 5.5, step 9.

Press Enter (F4).

4. Press Cont (F3). “Wait” flashes until the sensor is stabilized.

   If the analyzer appears locked, the reading is not stable enough. Wait until the process readings are stable before starting the calibration.

   Alternatively, increase the stability concentration or reduce the stability time. See Section 5.10. Calibrating while readings are unstable may substantially reduce accuracy.



5. Once the reading is stable, the screen at left appears. Sample the process liquid. Make a note of the reading before taking the sample. Immediately determine free chlorine. Note the analyzer reading again. If the present reading (X) differs from the reading when the sample was taken (Y), calculate the value to enter (C) from the following formula:

$$C = (X/Y)\ (A)$$

   where A is the concentration of chlorine measured in the grab sample.

   Press Edit (F4). Use the arrow keys to change the concentration in the second line of the display to the desired value. Press Save (F4) to store the value.

6. Press Exit (F1) four times to return to the main display.

NOTE

If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 5.5, step 9.

7. During the calibration, the analyzer stores the measured current and calculates the sensitivity. Sensitivity is the sensor current in nA divided by the measured concentration. The sensitivity of the 498CL-01 (free chlorine) sensor is 400-1000 nA/ppm.

   To view the sensitivity from the main display, press any key to enter the main menu. Press the ↓ key once. Then press Enter (F4) to display the diagnostic variables. The sensitivity is the third line on the screen. Note the units: nA is nanoamps, μA is microamps.

NOTE

During calibration, ERROR and WARNING messages may appear. If an ERROR message appears, press Exit (F1) to leave and return to the previous screen. If a WARNING message appears, press Cont (F3) to continue the calibration or press Abort (F1) to leave. Continuing the calibration after a warning message appears may cause substantial errors in the subsequent measurement. Refer to Section 10.4 for assistance.

7.4 DUAL SLOPE CALIBRATION

Figure 7-2 shows the principle of dual slope calibration. Between zero and concentration C1, the sensor response is linear. When the concentration of chlorine becomes greater than C1, the response is non-linear. In spite of the non-linearity, the response can be approximated by a straight line between point 1 and point 2.

Dual slope calibration might be needed if the chlorine concentration is greater than 20 ppm.

1. Be sure the analyzer has been configured for dual slope calibration. See Section 5.10.
2. Zero the sensor. See Section 7.2.
3. Place the sensor in the flow cell. Be sure the pH compensation is set to manual and the pH value is 7.00. See Section 5.7. Adjust the sample flow until water overflows the inside tube in the constant head flow controller.

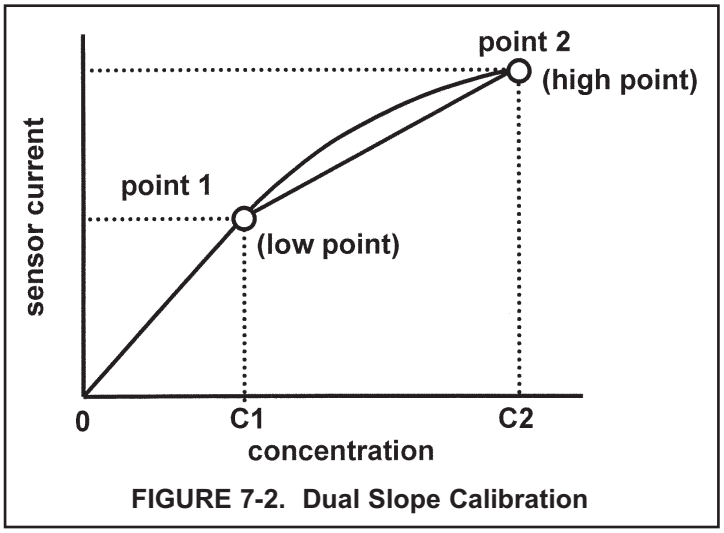
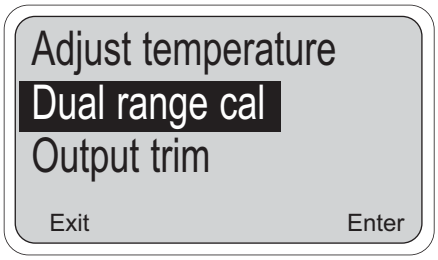


FIGURE 7-2. Dual Slope Calibration

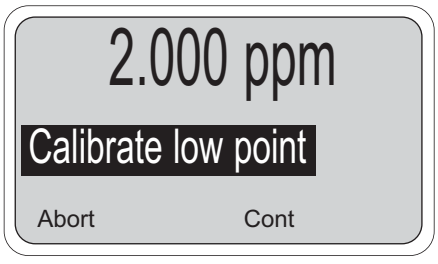


4. From the main display, press any key to obtain the main menu. With the cursor on “Calibrate,” press Enter (F4).

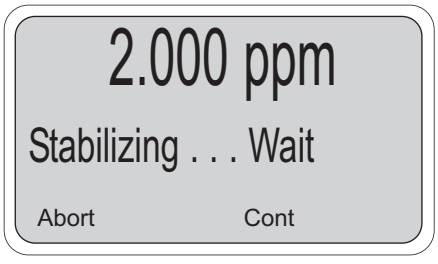
NOTE

If Hold was enabled in Section 5.5, the hold screen will appear. To activate hold, refer to Section 5.5, step 9.

Press the ↓ key three times to move the cursor to “Dual range cal.” Press Enter (F4).

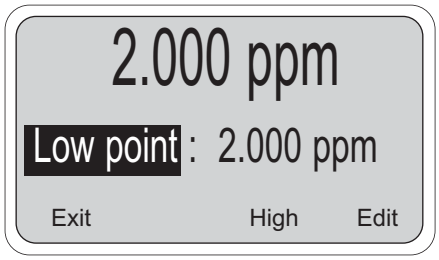


5. Adjust the concentration of chlorine in the process until it is near the upper end of the linear response range of the sensor, i.e., concentration near C1 as shown in Figure 7-2.



6. Press Cont (F3). “Wait” flashes until the sensor is stabilized.

If the controller appears locked, the reading is not stable enough. Wait until the process readings are stable before starting the calibration.



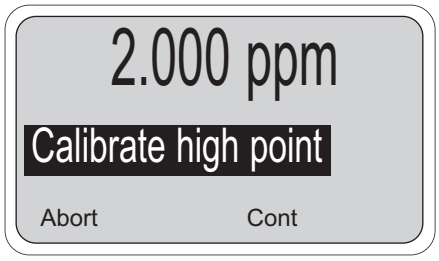
7. Once the reading is stable, the screen at left appears.

   Sample the process liquid. Make a note of the reading before taking the sample. Immediately determine free chlorine. Note the controller reading again. If the present reading (X) differs from the reading when the sample was taken (Y), calculate the value to enter (C) from the following formula:

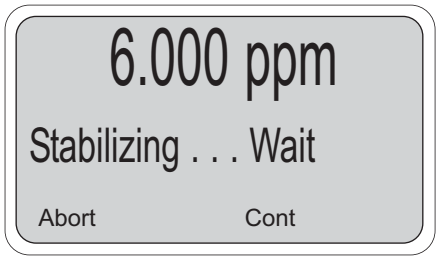
   $$C = (X/Y)\ (A)$$

   where A is the concentration of chlorine measured in the grab sample.

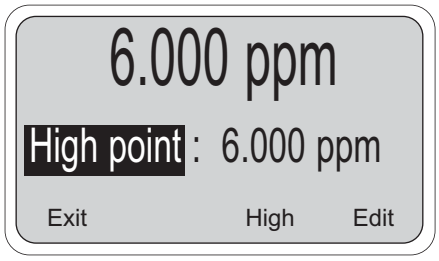
   Press Edit (F4). Use the arrow keys to change the concentration in the second line of the display to the desired value. Press Save (F4) to store the value.



8. Press High (F3). Adjust the concentration of chlorine in the process until it is near the top end of the range, i.e., concentration near C2 as shown in Figure 7-2.



9. Press Cont (F3). “Wait” flashes until the sensor is stabilized.



10. Once the reading is stable, the screen at left appears. Following the procedure in step 7, determine chlorine in a sample of the process liquid.

    Press Edit (F4). Use the arrow keys to change the concentration in the second line of the display to the desired value. Press Save (F4) to store the value.

11. Press Exit (F1) three times to return to the main display.

NOTE

If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 5.5, step 9.

NOTE

During calibration, ERROR and WARNING messages may appear. If an ERROR message appears, press Exit (F1) to leave and return to the previous screen. If a WARNING message appears, press Cont (F3) to continue the calibration or press Abort (F1) to leave. Continuing the calibration after a warning message appears may cause substantial errors in the subsequent measurement. Refer to Section 10.4 for assistance.

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 8.0
CALIBRATION - CURRENT OUTPUTS

8.1 INTRODUCTION

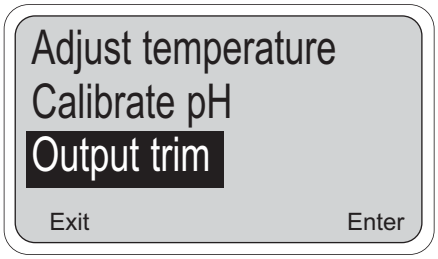
Although the analog outputs are calibrated at the factory, they can be trimmed in the field to match the reading from a standard milliameter. Both the low output (0 or 4 mA) and the high output (20 mA) can be trimmed.

8.2 TRIMMING THE OUTPUTS

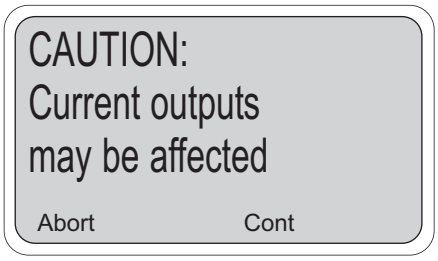
1. From the main display, press any key to obtain the main menu. With the cursor on "Calibrate" press Enter (F4).

NOTE

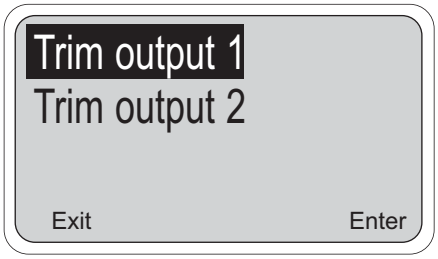
If Hold was enabled in Section 5.5, the hold screen will appear. To activate hold, refer to Section 5.5, step 9.



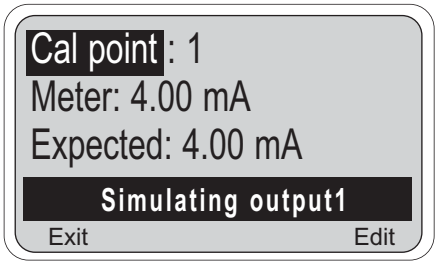
2. Move the cursor to "Output trim" and press Enter (F4).



3. The warning screen reminds the user that the output currents will be affected. Pres Cont (F3) to continue.



4. Use the ↑ or ↓ keys to move the cursor to the desired output and press Enter (F4).



5. Select “Cal point 1” (0 or 4 mA) or “Cal point 2” (20 mA).

6. Move the cursor to “Meter” and press Enter (F4). Measure the output current with a calibrated milliammeter. Use the ↑ or ↓ keys to change the display to match the milliammeter reading and press Save (F4).

7. Move the cursor to the other “Cal point” and select it. Repeat step 6.

NOTE

If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 5.5, step 9.

SECTION 9.0
MAINTENANCE

9.1 ANALYZER

The analyzer used with the FCLi needs little routine maintenance.

Clean the analyzer case and front panel by wiping with a clean soft cloth dampened with water ONLY. Do not use solvents, like alcohol, that might cause a buildup of static charge.

TABLE 9-1. Replacement parts

PART NUMBER	DESCRIPTION
23540-05	Enclosure, Front with Keyboard
23848-00	Power Supply Circuit Board Shield
23849-00	Half Shield, Power Supply
23969-02	PCB, CPU and power supply, calibrated, 115/230 Vac
23969-06	PCB, CPU and power supply, calibrated, 24 Vdc
33281-00	Hinge Pin
33286-00	Gasket, Front Panel
33293-00	Enclosure, Rear
9010377	Back-lit Display, LCD Dot Matrix
9510048	Enclosure Conduit Plug, 1/2 inch

NOTE: Individual printed circuit boards cannot be ordered for Model 54e. Replacement boards for Model 54e are assembled and calibrated as an integrated board stack.

9.2 CHLORINE SENSOR

9.2.1 General.

When used in clean water, the 498CL-01 chlorine sensor requires little maintenance. Generally, the sensor needs maintenance when the response becomes sluggish or noisy or when readings drift following calibration. For a sensor used in potable water, expect to clean the membrane every month and replace the membrane and electrolyte slurry every three months. In water containing large amounts of suspended solids, for example open recirculating cooling water, membrane cleaning or replacement will be more frequent. Actual cleaning frequency can be determined only by experience.

9.2.2 Cleaning the membrane.

Clean the membrane with water sprayed from a wash bottle. **Do not use tissues to clean the membrane.** Pressing on the membrane may damage the mesh cathode.

9.2.3 Replacing the electrolyte solution and membrane.

⚠ CAUTION

Fill solution and solid may cause irritation. Avoid contact with skin and eyes. May be harmful if swallowed. Read and follow manual.

1. Unscrew the membrane retainer and remove the membrane assembly and O-ring. See Figure 9-1.
2. Remove the fill plug.
3. Empty all remaining fill slurry from the sensor. Rinse with deionized water until there is no significant amount of solid left in the sensor.
4. Place a few drops of water in the replacement membrane assembly and place it on the mesh cathode. **DO NOT TOUCH THE MESH CATHODE.** Doing so may bend the mesh and permanently damage the sensor. Screw the membrane retainer into place.
5. Obtain one bottle of saturated succinic acid (PN 9210381, 40 mL) and one bottle of succinic acid crystals (PN 9210379, 40 g) from the electrolyte kit. Remove the red cap from the fill spout on each bottle.
6. Using a razor blade or scissors, cut the fill spout on the bottle of succinic acid crystals just below the line on the spout.
7. Hold the sensor with the membrane end pointed slightly upward. Insert the spout of the bottle of succinic acid solution into the fill port. Squeeze the bottle until half of the solution has been transferred to the electrolyte chamber.
8. Pour the solid succinic acid crystals into the fill port. If the crystals accumulate in the fill hole, shake or tap the sensor gently to unblock the port.
9. Use the remainder of the succinic acid solution to rinse crystals adhering to the threads into the sensor. Keep adding solution until it overflows the fill port. Tap the sensor a few times to be sure no air bubbles are trapped in the sensor.
10. Screw the fill plug back into place until it is flush with the body.
11. Hold the sensor with the membrane end pointing down and give it a few shakes as though shaking down a fever thermometer. Shaking helps clear bubbles that might have become trapped behind the mesh cathode.
12. The sensor may require several hours operating at the polarizing voltage to equilibrate after the electrolye has been replaced. **Be sure to put the sensor in a flowing, chlorinated sample for equilibration.**

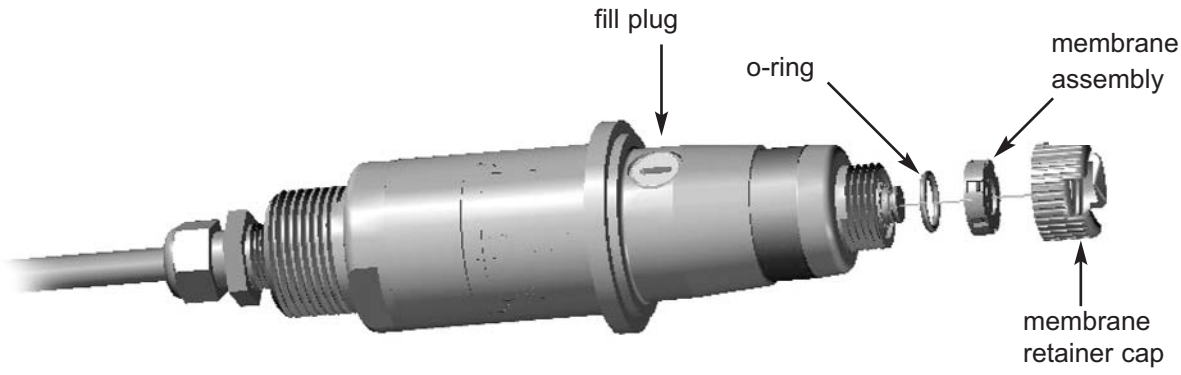


FIGURE 9-1. Chlorine Sensor Parts

SPARE PARTS

33970-00	Fill Plug
33968-00	Membrane retainer cap
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 O-rings
24146-00	pH-independent free chlorine sensor electrolyte kit, includes three bottles of saturated succinic acid solution and three bottles of succinic acid crystals

9.2.4 Storage.

Although the 498CL-01 sensor is designed for use in a continuously flowing sample, the sensor can tolerate loss of flow for up to about four days as long it remains in the low flow cell with as little contact as possible between the sample and air. There is a check valve in the sample inlet to prevent water from draining out of the flow cell. For more information about why the sensor cannot tolerate long term exposure to a stagnant sample, see Section 7.2, step 2.

For long term storage…

1. Turn off power to the analyzer.
2. Remove the sensor from the flow cell.
3. Replace the membrane with the shipping membrane provided with the sensor. For a replacement shipping membrane order PN 23501-00.
4. To protect the sensor from physical damage, store it in the **dry** flow cell.

9.2.5 Rejuvenating a chlorine sensor following improper storage.

If the sensor is stored in a stagnant sample for an extended period, it can become contaminated with copper. Corrosion of the external copper electrode produces copper ions, which diffuse through the membrane into the sensor. If the sensor was powered up during storage, copper will plate out on the cathode. If the sensor was not powered up, the copper will start plating out as soon as the polarizing voltage is applied. As the copper plates out, the zero current increases. Once the copper has coated the cathode the sensitivity drops. The sensor will be unusable until the cathode has been cleaned.

1. If the sensor was not powered up during storage, **DO NOT APPLY POWER.** Empty the fill slurry and thoroughly rinse the sensor with deionized water. Refill the sensor with fresh fill slurry. Let the sensor run in **flowing** chlorinated water overnight. Zero and calibrate the sensor.
2. If the sensor was powered up during storage, the cathode is probably coated with metallic copper. **Disconnect the sensor from the analyzer.** Remove the membrane and clean out the fill slurry. Immerse the mesh cathode in 10% nitric acid solution (10 mL of concentrated nitric acid in 90 mL of water) for about five minutes. Rinse thoroughly with deionized water. Refill the sensor with fresh slurry and install a new membrane. Let the sensor run overnight in **flowing** chlorinated water. Zero and calibrate the sensor.

9.3 CONSTANT HEAD FLOW CONTROLLER

9.3.1 General

After a period of time, deposits may accumulate in the constant head overflow chamber and in the tubing leading to the flow cell(s). Deposits increase the resistance to flow and cause the flow to gradually decrease. Loss of flow may ultimately have an impact on the chlorine sensor performance. The flow controller is designed to provide about 1.2 gal/hr (75 mL/mm) flow. Loss of flow to about 0.5 gal/hr (30 mL/mm) causes about a 5% decrease in chlorine sensor output. Loss of flow has almost no effect on pH sensor performance other than to increase the overall response time of the sensor.

9.3.2 Cleaning the flow controller

The low flow controller can be taken apart completely for cleaning. Use a strong flow of water to flush out the tubing. A pipe cleaner or a small bottlebrush can remove more adherent deposits. To prevent leaks, apply a thin layer of silicone grease (or equivalent) to the two O-rings at the base of overflow chamber and to the O-ring sealing the central overflow tube to the base.

9.3.3 Other Maintenance

Table 9-2 and Figure 9-2 show the replacement parts for the flow controller assembly.

TABLE 9-2. Replacement parts for constant head flow controller assembly

Location in Figure 9-2	PN	Description	Shipping Weight
1	24091-01	Flow cell for chlorine sensor with bubble shedding nozzle	1 lb/0.5 kg
2	24040-00	O-ring kit, two 2-222 and one 2-024 silicone O-rings, with lubricant	1 lb/0.5 kg
3	33812-00	Dust cap for constant head flow controller	1 lb/0.5 kg
4	9322032	Elbow, ¼ in FNPT x ¼ in OD tubing	1 lb/0.5 kg
5	9350029	Check valve, ¼ in FNPT	1 lb/0.5 kg

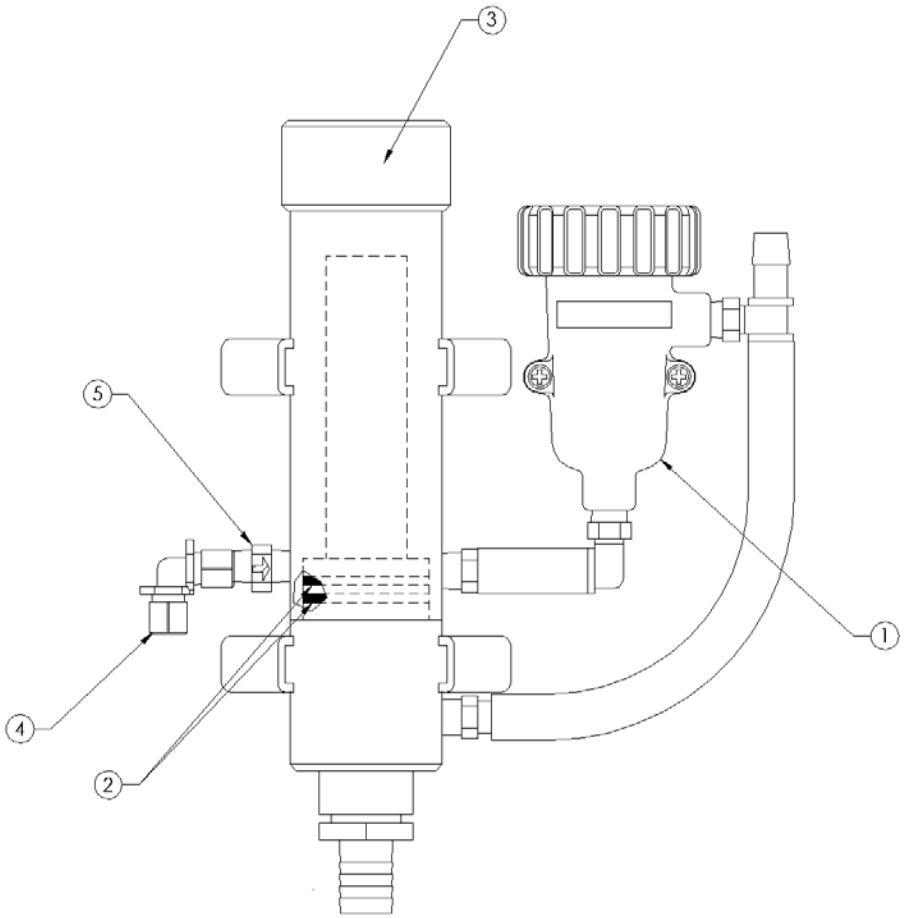


FIGURE 9-2. Replacement Parts for the Flow Controller Assembly.

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 10.0
TROUBLESHOOTING

10.1 OVERVIEW

The 54eA analyzer continuously monitors itself and the sensor for faults. When the analyzer detects a fault in the sensor or in the instrument itself, it displays a **fault message**. If alarm 4 was enabled, the red FAIL LED will also light and relay 4 will activate. The outputs will go to 22.00 mA or to the value programmed in Section 5.6.

See Section 10.2 for an explanation of fault messages and suggested corrective actions.

The analyzer also displays **error** and **warning messages** if a calibration is seriously in error.

To view **diagnostic variables**, go to the main display and press any key. Move the cursor to “Diagnostic variables” and press Enter (F4). Use the ↑ or ↓ key to move up or down the list.

10.2 TROUBLESHOOTING WHEN A FAULT MESSAGE IS SHOWING

Fault message	Explanation	See Section
High input current	input current exceeds 210 uA	10.2.1
Check sensor zero	sensor current was too high when sensor was zeroed	10.2.2
Temp error low	temperature less than -15°C	10.2.3
Temp error high	temperature greater than 130°C	10.2.3
Sense line open	RTD sense line is open	10.2.4
Failure factory	instrument needs factory calibration	10.2.5
Failure eeprom	write verify error has occurred	10.2.5

10.2.1 High input current

Excessive sensor current implies that the sensor is miswired or the sensor has failed. Verify that wiring is correct. See Section 3.3. If wiring is correct, try replacing the sensor.

10.2.2 Check sensor zero

The sensor current was extremely high when the sensor was zeroed. Zeroing the sensor before the zero current has reached a stable minimum value will lead to low results. Allow adequate time, possibly as long as overnight, for the sensor to stabilize before starting the zero routine.

10.2.3 Temperature error low or high

Temperature error usually means the RTD is open or shorted or there is an open or short in the connecting wiring. First, verify all wiring connections. Next, disconnect the RTD IN, SENSE, and RETURN leads at the analyzer. Be sure to note the color of the wire and where it was attached. Measure the resistance between the RTD IN and RETURN leads. The resistance should be close to the value in the table in Section 10.7. If the temperature element is open or shorted, the sensor should be replaced. In the meantime use manual temperature compensation.

10.2.4 Sense line open

The sensor uses a Pt100 in a three-wire configuration (see Figure 10-3). The in and return leads connect the RTD to the measuring circuit in the analyzer. A third wire, called the sense line, is connected to the return lead. The sense line allows the analyzer to correct for the resistance of the in and return leads and to correct for changes in the lead wire resistance caused by changes in ambient temperature. If the sense line is open, check all wiring connections. Next, verify that the sense line is open. Disconnect the sense and return leads and measure the resistance between them. It should be less than 5Ω. If the sense line is open, replace the sensor as soon as possible.

The analyzer can be operated with the sense line open. The measurement will be less accurate because the analyzer can no longer compensate for lead wire resistance. However, if the sensor is to be used at approximately constant ambient temperature, the lead wire resistance error can be eliminated by calibrating the sensor at the measurement temperature. Errors caused by changes in resistance with changes in ambient temperature cannot be eliminated. To make the error message disappear, connect the RTD sense and return terminal with a jumper.

10.2.5 Failure factory and Failure eeprom

Turn the power off, wait about 30 sec, then turn the power back on. If the error message does not clear, call the factory.

10.3 TROUBLESHOOTING WHEN NO FAULT MESSAGE IS SHOWING - TEMPERATURE

10.3.1 Temperature measured by the standard was more than 1°C different from the analyzer.

A. Is the standard thermometer, RTD, or thermistor accurate? General purpose liquid-in-glass thermometers, particularly ones that have been mistreated, can have surprisingly large errors.

B. Is the RTD in the sensor completely submerged in the liquid? The RTD is located behind the cathode.

C. Is the standard temperature sensor submerged to the correct level?

D. Was the RTD allowed adequate time (at least 20 min.) to come to equilibrium?

10.4 TROUBLESHOOTING WHEN NO ERROR MESSAGE IS SHOWING — CHLORINE

Problem	See Section
Zero current was accepted, but the current is substantially greater than 100 nA	10.4.1
Error or warning message appears while zeroing the sensor (zero current is too high)	10.4.1
Zero current is unstable	10.4.2
Sensor can be calibrated, but sensitivity is significantly different from 500 nA/ppm	10.4.3
Process readings are erratic	10.4.4
Readings drift	10.4.5
Sensor does not respond to changes in chlorine level	10.4.6

10.4.1 Zero current is too high

A. Is the sensor properly wired to the analyzer? See Section 3.2.

B. Is the zero solution chlorine-free? Take a sample of the solution and test it for free chlorine. The concentration should be less than 0.02 ppm.

C. Has adequate time been allowed for the sensor to reach a stable zero current? Normally, after a sensor has run in **chlorinated** water for about two hours, it will reach a low stable zero (<100 nA) current after about 30 minutes in **chlorine-free** water. If the zero current is not stable or is still high after 30 minutes, return the sensor to flowing chlorinated water and let it run longer before zeroing.

D. Check the membrane for damage and replace it if necessary.

E. Is the cathode coated with copper? If the 498CL-01 sensor is allowed to operate in a non-flowing sample **exposed to air** for more than about a day, copper from the corrosion of the copper auxiliary electrode can diffuse into the sensor and plate out on the cathode. As the copper plates out, the zero current becomes very high. Once the copper has coated the cathode, the sensitivity drops. Clean the cathode by soaking in dilute nitric acid. See Section 9.2.5 for details

10.4.2 Zero current is unstable

A. Is the sensor properly wired to the analyzer? See Section 3.2. Verify that all wiring connections are tight.

B. Readings are often erratic when a new or rebuilt sensor is first placed in service. Readings usually stabilize after about an hour.

C. Is the space between the membrane and cathode filled with electrolyte solution? The sensor has a gold mesh cathode that allows the fill solution to completely bathe the cathode. Sometimes air bubbles prevent the fill solution from contacting the entire mesh. The air bubbles can usually be cleared by holding the sensor with the membrane end pointing down and sharply shaking the sensor a few times as though shaking down a clinical thermometer.

D. Verify the sensor is filled with electrolyte slurry. Refer to Section 9.2.

10.4.3 Sensor can be calibrated, but the current is too low

A. Is the temperature low? The sensor current decreases about 3% for every °C drop in temperature.
B. Sensor current depends on the rate of sample flow past the sensor tip. If the flow is too low, chlorine readings will be low. Be sure the liquid level in the constant head sampler is level with the central overflow tube and that excess sample is flowing down the tube. If necessary, disassemble and clean the overflow sampler. See Section 9.3.
C. Low current can be caused by lack of electrolyte flow to the cathode and membrane. See step C in Section 10.4.2.
D. Is the membrane fouled or coated? A dirty membrane inhibits diffusion of free chlorine through the membrane, reducing the sensor current and increasing the response time. Clean the membrane by rinsing it with a stream of water from a wash bottle. DO NOT use a tissue to wipe the membrane. Pressing on the membrane may damage the mesh cathode.
E. If cleaning the membrane does not improve the sensor response, replace the membrane and electrolyte solution. See Section 9.2 for details.

10.4.4 Process readings are erratic

A. Readings are often erratic when a new or rebuilt sensor is first placed in service. The current usually stabilizes after a few hours.
B. Is the fill solution making good contact with the cathode? Refer to Section 10.4.2.
C. Verify that wiring is correct. Pay particular attention to shield and ground connections.
D. Is the membrane in good condition and is the sensor filled with electrolyte solution? Replace the fill slurry. Refer to Section 9.2 for details.

10.4.5 Readings drift

A. Is the sample temperature changing? Membrane permeability is a function of temperature. The time constant for the 498CL-01 sensor is about five minutes. Therefore, the reading may drift for a while after a sudden temperature change.
B. Is the membrane clean? For the sensor to work properly, chlorine must diffuse freely through the membrane. A coating on the membrane will interfere with the passage of chlorine, resulting in slow response. Clean the membrane by rinsing it with a stream of water from a wash bottle. **DO NOT** use a membrane or tissue to wipe the membrane.
C. Is the sample flow within the recommended range? Gradual loss of sample flow will cause a downward drift. Be sure the liquid level in the constant head sampler is level with the central overflow tube and that excess sample is flowing down the tube. If necessary, disassemble and clean the overflow sampler. See Section 9.3.
D. Is the sensor new or has it been recently serviced? New or rebuilt sensors may require several hours to stabilize.

10.4.6 Sensor does not respond to changes in chlorine level.

A. Is the grab sample test accurate? Is the grab sample representative of the sample flowing to the sensor?
B. Is sample flowing past the sensor? Be sure the liquid level in the constant head flow controller is level with the central overflow tube and that excess sample is flowing down the tube. If necessary, disassemble and clean the overflow sampler. See Section 9.3.
C. Is the membrane clean? Clean the membrane with a stream of deionized water.DO NOT use a tissue to wipe the membrane. Pressing on the membrane may damage the mesh cathode.
D. Is the fill solution making good contact with the cathode? Hold the sensor with the membrane end pointing down and give it a few sharp shakes to force electrolyte between the cathode and membrane.
E. Replace the electrolyte slurry.
F. Replace the sensor.

10.4.7 Chlorine readings are too low.

A. Was the comparison grab sample tested as soon as it was taken? Chlorine solutions are unstable. Test the sample immediately after collecting it. Avoid exposing the sample to sunlight.

B. Low readings can be caused by zeroing the sensor before the zero current has reached a stable minimum value. Zero current is the current the sensor generates even when no chlorine is in the sample. Because the zero current is subtracted from subsequent measured currents, zeroing before the current is a minimum can lead to low results.
Example: The true zero current for the chlorine sensor is 50 nA, and the sensitivity is 500 nA/ppm. Assume the measured current is 200 nA. The true concentration is (200-50)/500 or 0.30 ppm. If the sensor was zeroed prematurely when the current was 100 nA, the measured concentration will be (200-100)/500 or 0.20 ppm. The error is 33%. Suppose the measured current is 400 nA. The true concentration is 0.70 ppm, and the measured concentration (assuming the sensor was zeroed at 100 nA) is 0.60 ppm. The error is now 14%. The absolute difference between the readings remains the same, 0.10 ppm.

C. Sensor response depends on flow. Verify that the liquid level in the constant head sampler is level with the central overflow tube and that excess sample is flowing down the tube. If necessary, disassemble and clean the overflow sampler. See Section 9.3.

10.5 TROUBLESHOOTING WHEN NO ERROR MESSAGE IS SHOWING — GENERAL

Problem	See Section
Current output is too low	10.5.1
Alarm relays do not operate when setpoint is exceeded	10.5.2

10.5.1 Current Output Too Low.

Load resistance is too high. Maximum load is 550 Ω.

10.5.2 Alarm Relays Do Not Work

Verify the relays are properly wired.

10.6 SIMULATING INPUTS — CHLORINE

The input current of the sensor cannot be simulated.

10.7 SIMULATING INPUTS — TEMPERATURE

10.7.1 General.

The analyzer accepts a Pt100 RTD. The Pt100 RTD is in a three-wire configuration. See Figure 10-3.

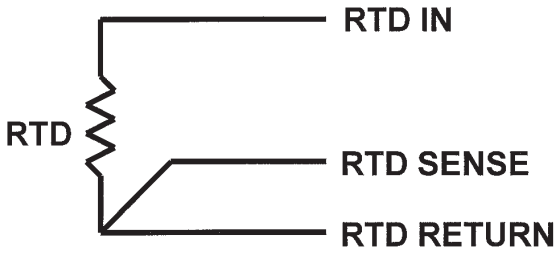


FIGURE 10-3. Three-Wire RTD Configuration.

Although only two wires are required to connect the RTD to the analyzer, using a third (and sometimes fourth) wire allows the analyzer to correct for the resistance of the lead wires and for changes in the lead wire resistance with temperature.

10.7.2 Simulating inputs temperature

To simulate the temperature input, wire a decade box to the analyzer as shown in Figure 10-4.

To check the accuracy of the temperature measurement, set the resistor simulating the RTD to the values in the table and note the temperature readings. The measured temperature might not agree with the value in the table. During sensor calibration an offset might have been applied to make the measured temperature agree with a standard thermometer. The offset is also applied to the simulated resistance. The analyzer is measuring temperature correctly if the difference between measured temperatures equals the difference between the values in the table to within ±0.1°C.

For example, start with a simulated resistance of 103.9 Ω, which corresponds to 10.0°C. Assume the offset from the sensor calibration was -0.3 Ω. Because of the offset, the analyzer calculates temperature using 103.6 Ω. The result is 9.2°C. Now change the resistance to 107.8 Ω, which corresponds to 20.0°C. The analyzer uses 107.5 Ω to calculate the temperature, so the display reads 19.2°C. Because the difference between the displayed temperatures (10.0°C) is the same as the difference between the simulated temperatures, the analyzer is working correctly.

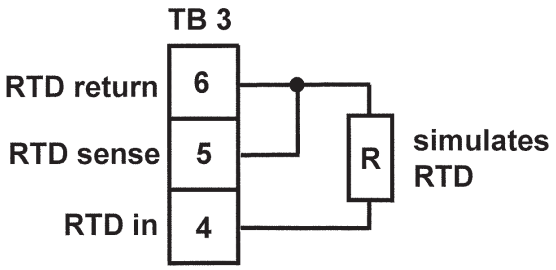


FIGURE 10-4. Simulating RTD Inputs.

Temp. (°C)	Pt 100 (Ω)
0	100.0
10	103.9
20	107.8
25	109.7
30	111.7
40	115.5
50	119.4
60	123.2
70	127.1
80	130.9
85	132.8
90	134.7
100	138.5

Immediate, Reliable Analytical Support

Now there's a way to quickly get the right answers for your liquid analytical instrumentation questions: the Analytical Customer Support Center.

Our staff of trained professionals is ready to provide the information you need. If you are placing an order, verifying delivery, requesting application information, or just want to contact a Rosemount Analytical representative, a call to the Customer Support Center will provide you with the right people, the right answers, right now.

A Worldwide Network of Sales and Service

Emerson Process Management's field sales offices are your source for more information on the fill line of Rosemount Analytical products. Field sales personnel will work closely with you to supply technical data and application information.

For more information, please contact your nearest Emerson Process Management sales office.

THE AMERICAS - HEADQUARTERS

Emerson Process Management
Rosemount Analytical Inc.
Liquid Center of Excellence
2400 Barranca Parkway
Irvine, CA 92606
Phone: +1.949.757.8500
Toll Free: +1.800.854.8257
Fax: +1.949.474.7250

ASIA-PACIFIC

Emerson Process Management
Asia Pacific Private Ltd.
1 Pandan Crescent
Singapore 0512
Republic of Singapore
Phone: 65.777.8211
Fax: 65.777.0947

EUROPE

Emerson Process Management AG
Blegistrasse 21
CH-6341 Baar-Walterswil
Switzerland
T 41.41.768.6111
T 41.41.761.8740

GERMANY

Emerson Process Management Process
Gas Analyzer Center of Excellence
GmbH & Co. OHG
Industriestrasse 1
63594 Hasselroth
Germany
T 49.6055.884.0
F 49.6055.884.20

LATIN AMERICA

Emerson Process Management
Rosemount Analytical
10241 West Little York, Suite #200
Houston, TX 77040 USA
T 713.467.6000
F 713.827.3328

MIDDLE EAST AND AFRICA

Emerson Process Management
EPM Building
P. O. Box 17033
Jebe Ali Free Zone
Dubai, United Arab Emirates
T 971.4.8835235
F 971.4.8835312

VISIT OUR WEBSITE AT
www.rosemountanalytical.com

EMERSON
Process Management

WARRANTY

Seller warrants that the firmware will execute the programming instructions provided by Seller, and that the Goods manufactured or Services provided by Seller will be free from defects in materials or workmanship under normal use and care until the expiration of the applicable warranty period. Goods are warranted for twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller, whichever period expires first. **Consumables, such as glass electrodes, membranes, liquid junctions, electrolyte, o-rings, catalytic beads, etc., and Services are warranted for a period of 90 days from the date of shipment or provision.**

Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Seller has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products.

If Buyer discovers any warranty defects and notifies Seller thereof in writing during the applicable warranty period, Seller shall, at its option, promptly correct any errors that are found by Seller in the firmware or Services, or repair or replace F.O.B. point of manufacture that portion of the Goods or firmware found by Seller to be defective, or refund the purchase price of the defective portion of the Goods/Services.

All replacements or repairs necessitated by inadequate maintenance, normal wear and usage, unsuitable power sources, unsuitable environmental conditions, accident, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense. Seller shall not be obligated to pay any costs or charges incurred by Buyer or any other party except as may be agreed upon in writing in advance by an authorized Seller representative. All costs of dismantling, reinstallation and freight and the time and expenses of Seller's personnel for site travel and diagnosis under this warranty clause shall be borne by Buyer unless accepted in writing by Seller.

Goods repaired and parts replaced during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Seller and can be amended only in a writing signed by an authorized representative of Seller. Except as otherwise expressly provided in the Agreement, THERE ARE NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR ANY OTHER MATTER WITH RESPECT TO ANY OF THE GOODS OR SERVICES.

RETURN OF MATERIAL

Material returned for repair, whether in or out of warranty, should be shipped prepaid to:

Emerson Process Management

2400 Barranca Parkway
Irvine, CA 92606

The shipping container should be marked:

Return for Repair
Model _____

The returned material should be accompanied by a letter of transmittal which should include the following information (make a copy of the "Return of Materials Request" found on the last page of the Manual and provide the following thereon):

1. Location type of service, and length of time of service of the device.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the returned material.
4. Statement as to whether warranty or non-warranty service is requested.
5. Complete shipping instructions for return of the material.

Adherence to these procedures will expedite handling of the returned material and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device.

If the material is returned for out-of-warranty repairs, a purchase order for repairs should be enclosed.

The right people, the right answers, right now.

ON-LINE ORDERING NOW AVAILABLE ON OUR WEB SITE
http://www.rosemountanalytical.com

Specifications subject to change without notice.

PlantWeb™

CERTIFIED QUALITY MANAGEMENT SYSTEM ISO 9001:2008 DNV

Credit Cards for U.S. Purchases Only.

VISA MasterCard AMERICAN EXPRESS Cards

Emerson Process Management

2400 Barranca Parkway
Irvine, CA 92606 USA
Tel: (949) 757-8500
Fax: (949) 474-7250

http://www.rosemountanalytical.com

EMERSON™
Process Management