Instruction Manual
PN 51-FCLi-56 rev.C
June 2013

FCL*i* with 56 Analyzer

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.

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QUICK START GUIDE
FOR FCL*i* ANALYZER

1. Refer to Section 2.0 for installation instructions and Section 3.0 for wiring instructions.
2. Once connections are secure and verified, apply power to the analyzer.
3. When the analyzer is powered up for the first time Quick Start screens appear.
4. The first quick start screen has two control boxes, one for language and the other for temperature units.
    a. The cursor, shown by dark blue backlighting, will be on the language control box. To change the language, press the ENTER/MENU key. A list of available languages, shown two at a time, will appear. Using the up and down keys, scroll (see section 4.2) to display the choices. Press ENTER/MENU to select the desired language. Press the down key to move to the cursor to the temperature control box. To change units, press ENTER/MENU and scroll to either °F or °C. Press ENTER/MENU to store the selection.
    b. To move to the next screen, use the navigation keys to move the cursor to NEXT and press ENTER/MENU.
5. The next screen lists navigation rules. Press ENTER/MENU for the next screen.
6. The next step is to configure sensor 1. Sensor 1 is the free chlorine sensor. The screen has three control boxes.
    a. For measurement choose pH-independent free chlorine.
    b. Choose the desired units, mg/L or ppm
7. If you have an FCLi-02 (with pH sensor), the next step is to configure sensor 2 (the pH sensor). The screen has two control boxes.
    a. For measurement choose pH.
    b. For pre-amplifier location choose analyzer.
    c. Move the cursor to NEXT and press ENTER/MENU. The display will change to show some basic keypad operation guidelines. Press ENTER/MENU to show the main display.
8. The outputs, alarms, display configuration, and data logging are all assigned to default values. The default value for data logging is disabled. To change the settings refer to Sections 4.5, 5.0, and 8.0.

About This Document

This manual contains instructions for installation and operation of the FCLi-56

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

Rev. Level	Date	Notes
A	7/11	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 - maill and web
C	06/13	Correct PN 33521-03, page 37

FCLi-56

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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

The FCL*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 Model 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.

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

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

The FCL*i* includes the easy-to-use Model 56 analyzer. The analyzer features four fully programmable 4-20 mA outputs and four fully programmable relays. The large, full color display allows the user to read sample pH and chlorine concentration at a glance. A data logger, graphical display, and HART digital communications are standard.

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, gold, and copper (or 316 stainless steel)

pH sensor (3900VP) : Stainless steel, glass, Teflon®[2], polyphenylene sulfide, EPDM, and silicone

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, peroxides

Electrolyte life: 3 months (approx.)

SPECIFICATIONS — ANALYZER

Case: Polycarbonate

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

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

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

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

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

RFI/EMI: EN-61326

LVD: EN-6101-01 CE

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

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

Relays: Form C, SPDT, epoxy sealed.

Relay Contact ratings:

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

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

Data logger: Data automatically stored every 30 seconds for 30 days; older data removed to make room for new data. The following data are automatically stored:
Chlorine: date and time, ppm, temperature, raw sensor current
pH: date and time, pH, temperature, mV, glass impedance, and reference impedance (if available)

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

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

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

Digital communications: HART digital communications is standard.

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

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

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 the sensor(s), analyzer, and constant head flow controller. All components are mounted on a backplate. Model option -02 includes a pH sensor for customers who wish to measure pH in addition to free chlorine. Three replacement membranes and enough electrolyte chemicals to fill the sensor three times are shipped with each sensor.

FCLi FREE CHLORINE MEASURING SYSTEM	
CODE	**pH CORRECTION (required selection)**
01	Without pH sensor
02	With pH sensor

CODE	pH CORRECTION (required selection)
240	56-03-24-38-HT, 85–265 VAC, 47.5/65.0 Hz, chlorine only (option -01 only)
241	56-03-24-32-HT, 85–265 VAC, 47.5/65.0 Hz, chlorine and pH (option -02 only)

FCLi-02 -241 EXAMPLE

COMPONENT PARTS

ANALYZER MODEL	DESCRIPTION
56-03-24-38-HT	56-03-24-38-HT, 85–265 VAC, 47.5/65.0 Hz, chlorine only
56-03-24-32-HT	56-03-24-32-HT, 85–265 VAC, 47.5/65.0 Hz, chlorine and pH

SENSOR MODEL	DESCRIPTION
498CL-01-VP	pH Independent free chlorine sensor with Variopol connector
3900VP-02-10	pH sensor with Variopol connector

SENSOR CABLE	DESCRIPTION
24150-00	Interconnecting cable, Variopol for 498ACL sensor, 4 ft
23645-08	Interconnecting cable, Variopol for 3900VP 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

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-01-240 (free chlorine without pH sensor)

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

1. Model 56-03-24-38-HT analyzer with sensor cable attached.
2. Constant head overflow sampler with flow cell for chlorine sensor.

The free chlorine sensor (Model 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.

2.1.1 FCLi-02-241 (free chlorine with pH sensor)

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

1. The 56-03-24-32-HT analyzer with sensor cables attached.
2. Constant head overflow sampler with flow cells for chlorine and pH sensors.
3. Stand to hold buffer solution during calibration.

The free chlorine sensor (498CL-01-VP), and the Model 3900VP-02-10 pH sensor, which replaces the older 399VP-09 sensor, are in separate packages. The free chlorine 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 system 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 or 2-3 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 cells.

2.2.4 Electrical Connections

Refer to Section 3.1 for details.

2.2.5 Installing the Sensor(s)

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.

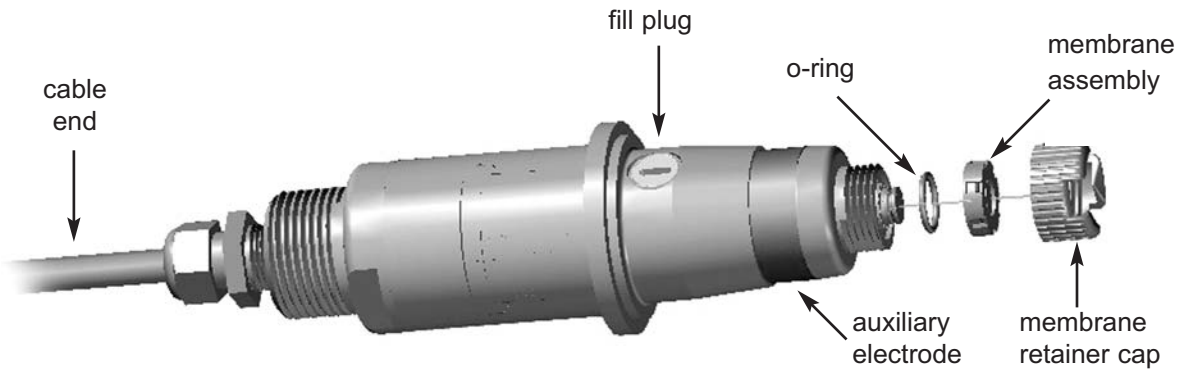

FIGURE 2-1. Chlorine Sensor Parts

2. If you are using a pH sensor, remove the protective cap on the sensor.
3. Install the sensors in the flow cells as shown in Figures 2.2 and 2.3. For Model FCLi-02-241, the pH sensor must be installed as shown in Figure 2.3. The chlorine sensor sits in the flow cell and is held in place by the union nut. The pH sensor screws into a plastic fitting, which the union nut holds in the flow cell. Be sure to slip the union nut over the sensor before connecting the cable to the sensor.
4. The Model FCLi is provided with sensor cables pre-wired to the analyzer. Connect the chlorine sensor to the cable labeled Chlorine Sensor. Connect the pH sensor to the cable labeled pH Sensor. 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

The chlorine sensor is available in two styles. One has a copper auxiliary electrode; the other has a stainless steel auxiliary electrode. The auxiliary electrode is the metal band visible at the bottom of the sensor. The copper electrode is gradually being phased out and replaced by a stainless steel electrode.

***If the sensor has a copper electrode*…Generally, it is best to keep the sensor in a continuously flowing sample. The sensor can tolerate loss of sample flow for about four days as long as it remains immersed in water <u>in the flow cell</u>. A check valve in the sample inlet prevents water from draining out of the flow cell. If the sensor sits too long in a stagnant sample, copper ions from the air oxidation of the 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.**

***If the sensor has a stainless steel electrode…*The stainless steel electrode is not susceptible to air oxidation. Therefore, loss of sample flow does not normally present a problem.**

Do not expose the chlorine sensor to air for any longer than an hour. Prolonged exposure to air will cause the membrane to dry out. Once this happens, the membrane must be replaced.

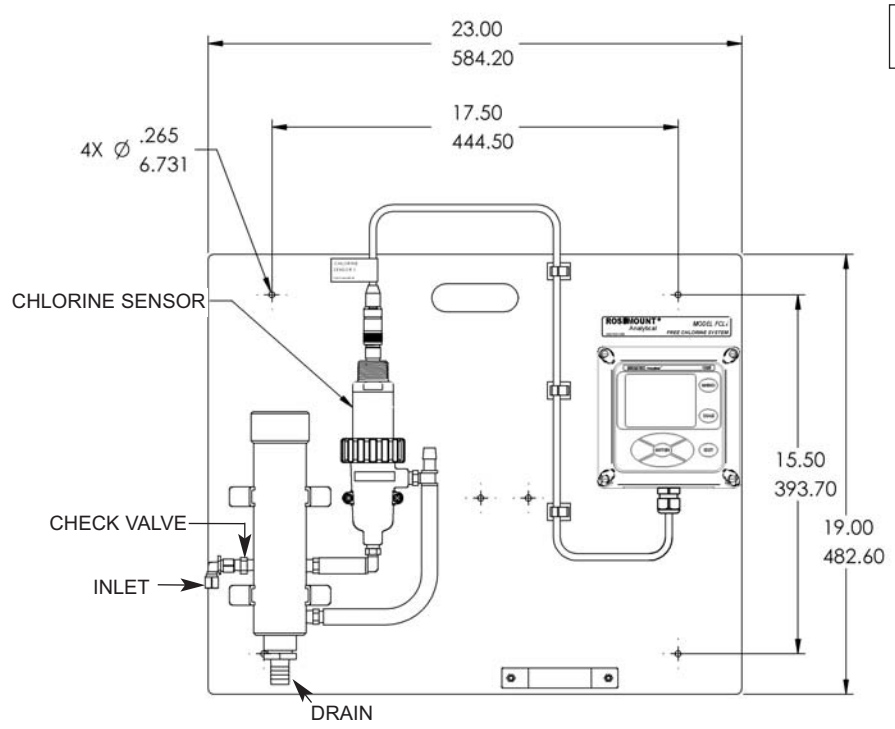

FIGURE 2-2. Model FCLi-01-220

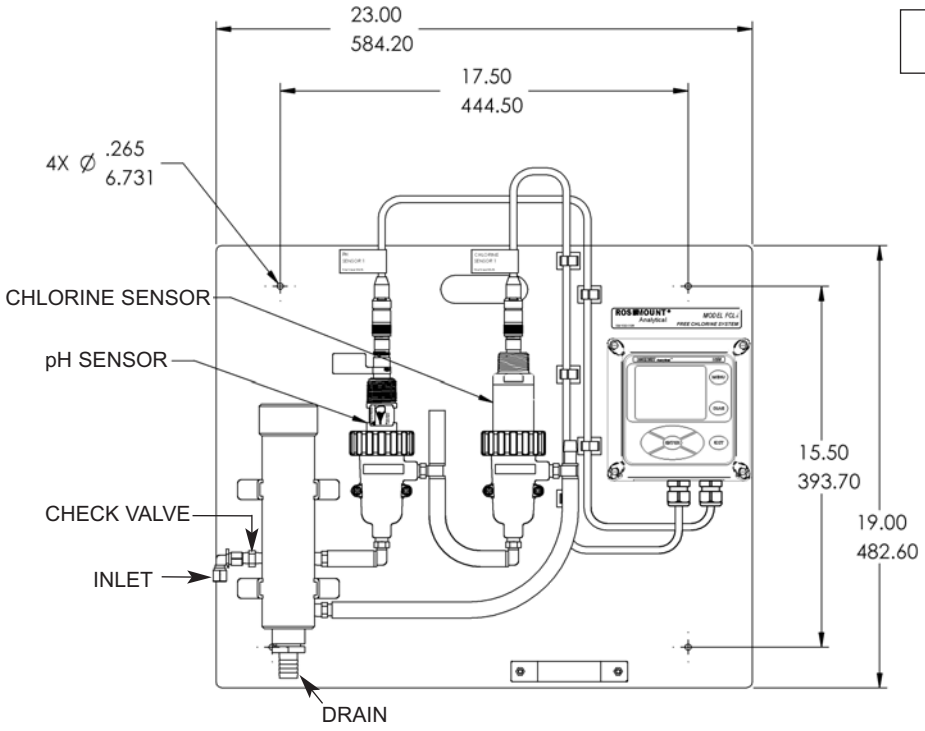

FIGURE 2-3. Model FCLi-02-221

SECTION 3.0.
WIRING

3.1 POWER, ALARM, AND OUTPUT WIRING

⚠WARNING

RISK OF ELECTRICAL SHOCK

Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.

3.1.1 Power

Wire AC mains power to the power supply board, which is mounted vertically on the left hand side of the analyzer enclosure. The power connector is at the top of the board. Unplug the connector from the board and wire the power cable to it. Lead connections are marked on the connector. (L is live or hot; N is neutral, the ground connection has the standard symbol.)

AC power wiring should be 14 gauge or greater. Run the power wiring through the conduit opening nearest the power terminal. 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 for the analyzer.

3.1.2 Analog output wiring

Four analog current outputs are located on the main circuit board, which is attached to the inside of the enclosure door. Figure 3-1 shows the location of the terminals, the outputs they are assigned to, and the polarity.

For best EMI/RFI protection, use shielded output signal cable enclosed in earth-grounded metal conduit.

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

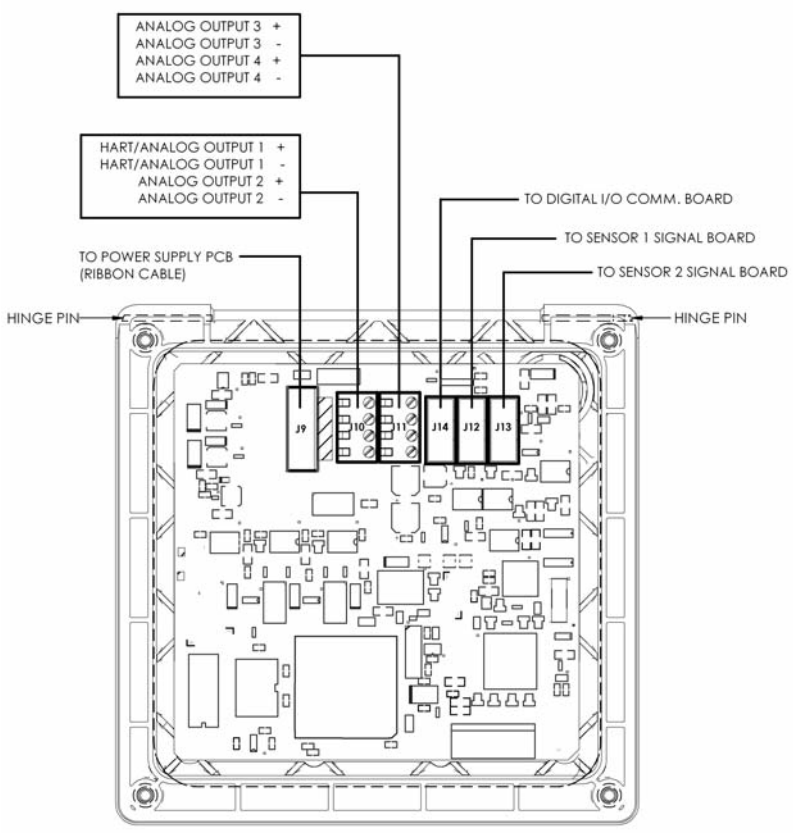

FIGURE 3-1. Analog output connections.
The analog outputs are on the main board near the hinged end of the enclosure door.

TITLE	WIRING DIAGRAM MAIN BOARD, 1056	
B SIZE	DWG NO 40005603	REV A

3.1.3 Alarm wiring.

⚠WARNING

Exposure to some chemicals may degrade the sealing properties used in the following devices: Zettler Relays (K1-K4) PN AZ8-1CH12DSEA

The alarm relay terminal strip is located just above the power connector on the power supply board. See Figure 3-2.

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

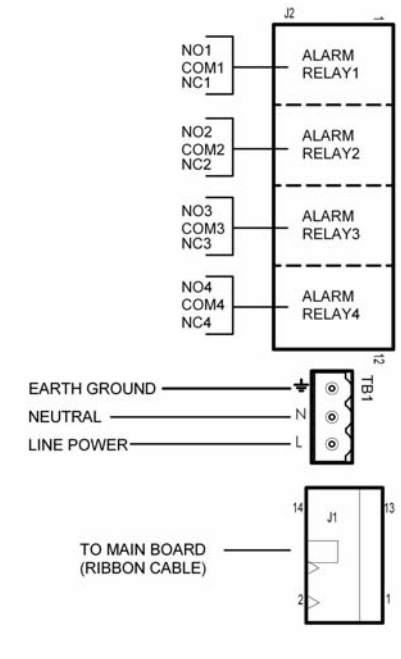

FIGURE 3-2. Alarm relay connections.

3.2 SENSOR WIRING

The Model FCLi is provided with sensor cables pre-wired to the analyzer. If it is necessary to replace the sensor cable, refer to the instructions below.

1. Shut off power to the analyzer.
2. Loosen the four screws holding the front panel in place and let it drop down.
3. Locate the appropriate signal board.

Slot 1 (left)	Slot 2 (center)	Slot 3 (right)
communication	input 1 (chlorine)	input 2 (pH)

4. Loosen the gland fitting and carefully push the sensor cable up through the fitting as you pull the board forward to gain access to the wires and terminal screws. Disconnect the wires and remove the cable.
5. Insert the new cable through the gland and pull the cable through the cable slot.
6. Wire the sensor to the signal board. Refer to the wiring diagrams in Figures 3-3 through 3-6.
7. Once the cable has been connected to the board, slide the board fully into the enclosure while taking up the excess cable through the cable gland. Tighten the gland nut to secure the cable and ensure a sealed enclosure.

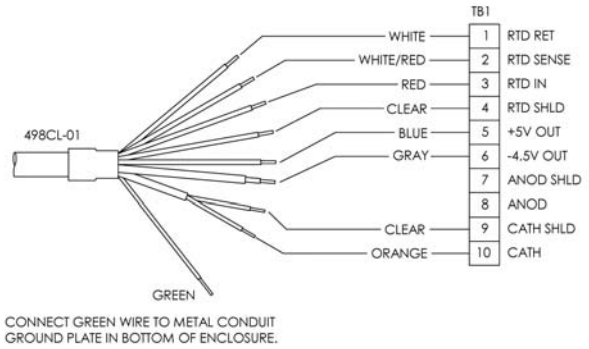

Figure 3-3. Wiring Diagram for Free Chlorine Sensor

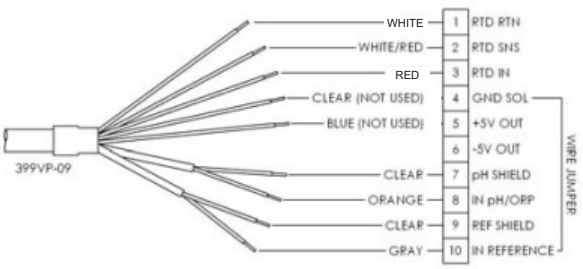

Figure 3-4. Wiring Diagram for 399VP-09 pH Sensor

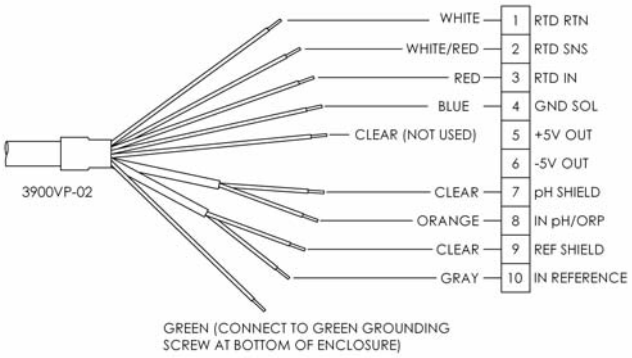

Figure 3-5. Wiring Diagram for 3900VP-10 pH sensor (gray cable)

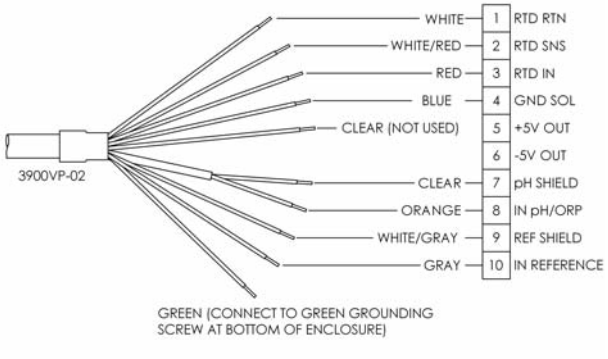

Figure 3-6. Wiring Diagram for 3900VP-10 pH sensor (blue cable)

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SECTION 4.0
DISPLAY AND OPERATION

4.1. MAIN DISPLAY

The analyzer has a four line display. See Figure 4-1. The display can be customized to meet user requirements. See Section 4.5. Fault or warning messages, if appropriate, appear at the bottom of the screen. See Section 11.1.

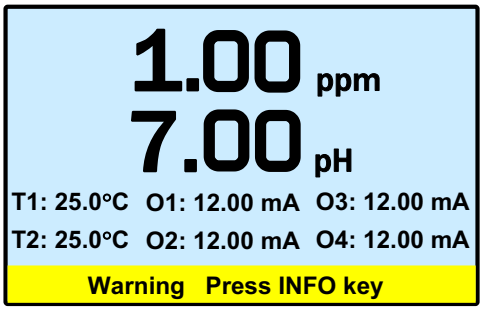


FIGURE 4-1. Main Display

The following abbreviations are used in the lower two lines of the display. The number following the abbreviation refers to the sensor, alarm relay, or output.

O	output
T	temperature (live)
Tm	temperature (manual)
M	measurement
AL	alarm relay

I	sensor current (chlorine)
mV	mV input (pH)
Slp	slope (pH)
R.Z	reference impedance (pH)
Gl.Z	glass impedance (pH)

4.2. KEYPAD

Local communication with the analyzer is through the membrane keypad. See Figure 4-2.

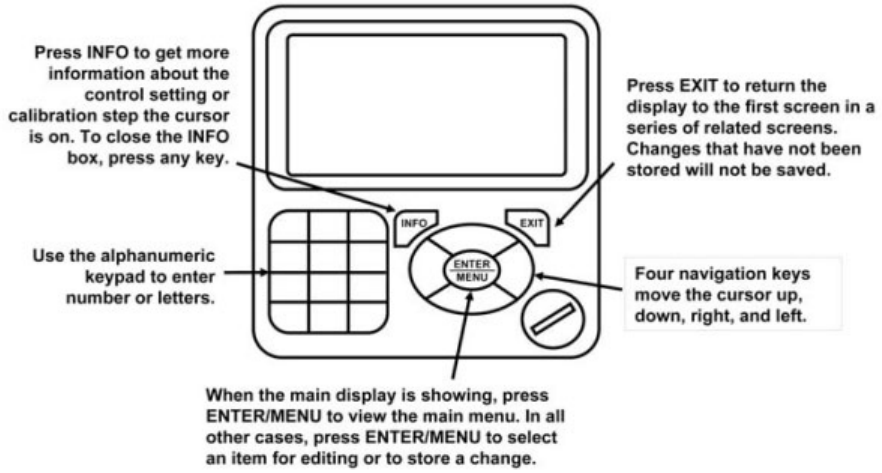
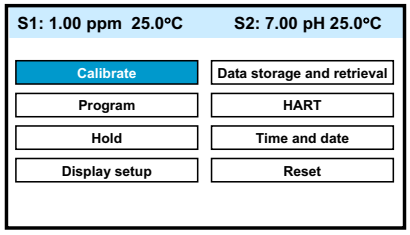


FIGURE 4-2. Analyzer keypad.

4.3 OPERATION

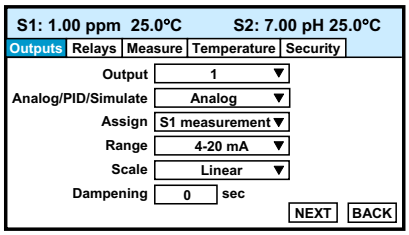
The operation of the Model 56 can best be understood from the following example.



1. With the main display showing (Figure 4-1), press the ENTER/MENU key. The main menu, shown at left, will appear. **Pressing the ENTER/MENU key will bring up the main menu only if the main display is showing.**

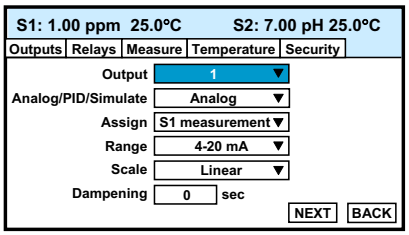
   Note that the current reading and temperature for sensor 1 (S1) and sensor (S2), if applicable, always appear at the top of the screen.

   The cursor (dark blue backlit field) is on the Calibrate button. Press the down key to move the cursor to the Program button.

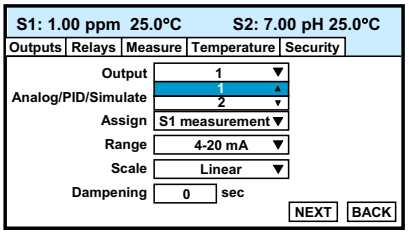


2. Press the ENTER/MENU key. The cursor is on the outputs tab and the first screen in the outputs sub-menu is showing.

   To select a different program submenu use the right key to move the cursor to the desired tab and press ENTER/MENU.

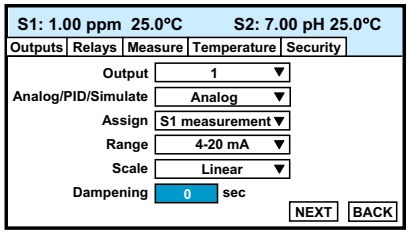


3. To enter the outputs submenu, press the down key. The cursor moves to the first control box, Output. The Model 56 has four analog outputs, and this control lets the user select which output to configure.

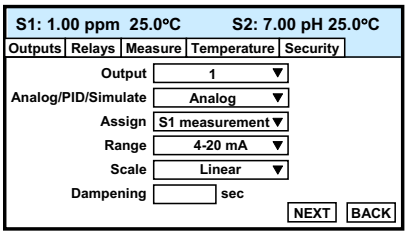


4. The default is output 1. To select a different output, press the ENTER/MENU key. A list of the available outputs, shown **two at a time**, appears. To view the list, press or press and hold the up or down key. To select and store the highlighted selection, press ENTER/MENU.

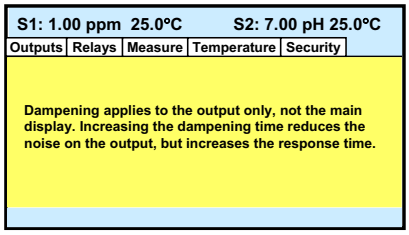
5. To move from one control box to another, press the up or down key.



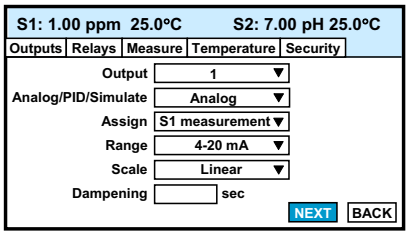
6. Some controls require the user to select an item from a list. Others, like the dampening control, require the user to enter a number. Move the cursor to Dampening at the bottom of the screen.



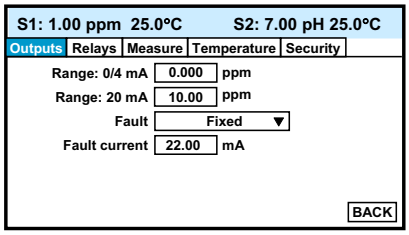
7. The default dampening value is 0 seconds. To change the value, press ENTER/MENU. The dark blue back-lighting will disappear indicating that a number can be entered. Use the numeric keypad to enter the desired number. If you make an error, press the left key to erase the digit last entered. To store the number, press ENTER/MENU.



8. Every control box has an information or help screen associated with it. To view the information screen for the control box the cursor is on, press the INFO key. The information screen for the Dampening control is shown at left. To close the information screen, press any key.



9. A NEXT and BACK button are at the bottom of the screen. The NEXT button means that additional control boxes are available on at least one more screen. To view the next screen, use the navigation keys (either down or right) to move the cursor to NEXT and press ENTER/MENU.



10. The next screen in the Outputs sub-menu appears. The cursor is on the outputs tab. To enter the screen, press the down navigation key.

11. To return to the previous screen, move the cursor to BACK and press ENTER/MENU.

12. To return to the main menu, press EXIT.

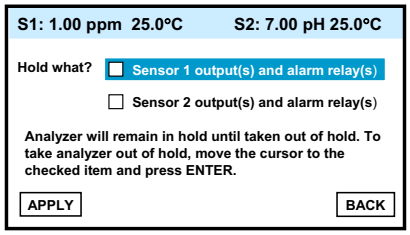
4.4 HOLD

4.4.1 Purpose

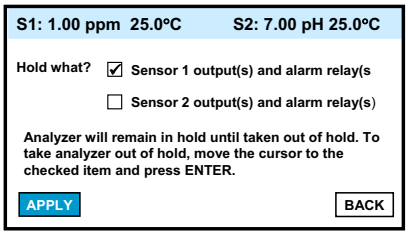
To prevent unwanted alarms and improper operation of control systems or dosing pumps, place the alarm relays and outputs assigned to the sensor in hold before removing the sensor for maintenance. Hold is also useful if calibration, for example, buffering a pH sensor, will cause an out of limits condition. During hold, outputs assigned to the sensor remain at the last value, and alarms assigned to the sensor remain in their present state.

4.4.2 Using the Hold Function.

The hold function uses certain programming features not discussed in Section 4.3.

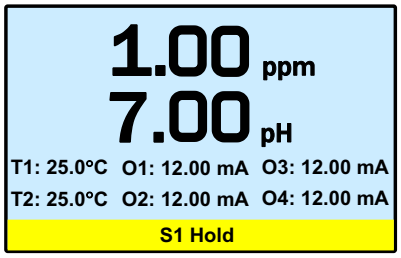


1. With the main display showing, press ENTER/MENU. The main menu will appear. Choose Hold. The screen shown at left appears. The cursor is on the first check box. To hold outputs and relays associated with sensor 1, press ENTER/MENU. A check will appear in the check box. To put sensor 2 on hold also, move the cursor to the sensor 2 line and press ENTER/MENU to check the sensor 2 hold box.



2. To activate Hold, move the cursor to the APPLY button at the bottom left of the screen and press ENTER/MENU. The selected sensor outputs and alarm relays will remain on hold until taken out of hold. However, if power is lost then restored, hold will automatically be turned off.

3. The screen describes how to take the analyzer out of hold. **Be sure to press APPLY once the box has been unchecked.**

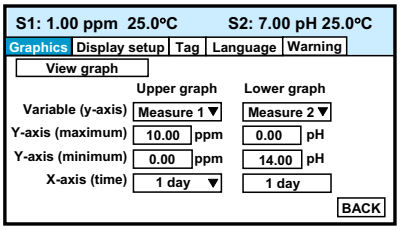


4. A message stating which sensors are in hold will appear in the fault/warning banner at the bottom of the main display.

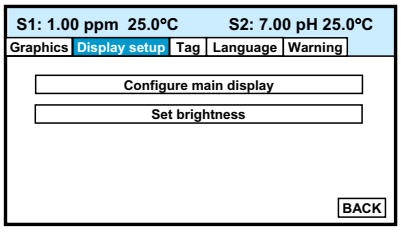
4.5 MAIN DISPLAY

4.5.1 Configuring the main display

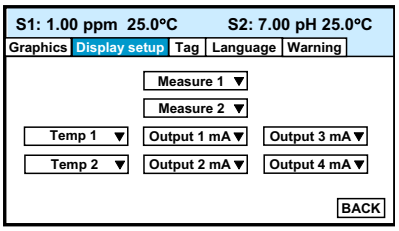
The main display can be configured to meet specific user requirements.



1. With the main display showing, press ENTER/MENU. The main menu will appear. Choose Display Setup. The screen shown at left appears.



2. Move the cursor the Display setup tab and press ENTER/MENU. The screen shown at left appears.



3. Choose Configure main display. The screen at left appears. The position of each control box corresponds to the position of the variable in the main display. Move the cursor to the control box and press ENTER/MENU. Use the up and down keys to scroll through the list of variables and press ENTER/MENU to select the desired variable for display.

4.5.2 Setting brightness

Move the cursor to the Set brightness button in the screen shown in step 2 in Section 4.5.1 and press ENTER/MENU. Then, move the cursor to the Display brightness control and select the desired brightness. The information screen gives recommendations about setting the brightness level especially in areas where the ambient temperature exceeds 121°F (50°C).

4.6 SECURITY

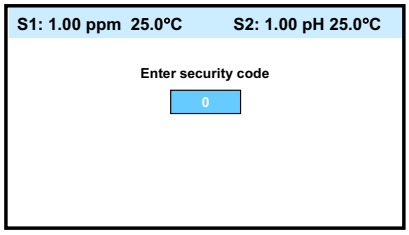
4.6.1 How the Security Code Works

Security codes prevent accidental or unwanted changes to program settings or calibrations. There are three levels of security.

a. A user can view the main display and diagnostic screens only.

b. A user has access to the calibration and hold menus only.

c. A user has access to all menus.



1. If a security code has been programmed, pressing a sub-menu button (See section 4.3) will cause the security screen shown at left to appear.

2. Enter the three digit security code.

3. If the entry is correct, the requested sub-menu will appear and the user has access to all the sub-menus the code entitles him to.

4. If the entry is wrong, the invalid code screen appears.

4.6.1 Assigning Security Codes

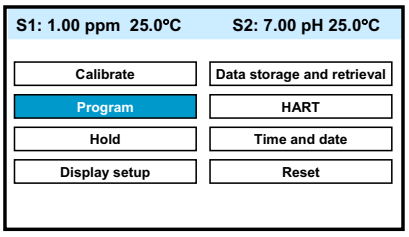
See Section 5.7.

4.6.2 Bypassing Security Codes

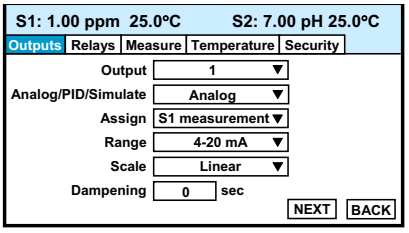
Call the factory.

SECTION 5.0
PROGRAMMING THE ANALYZER

5.1 ENTERING THE PROGRAM MENUS



1. With the main display showing, press ENTER/MENU to display the main menu. Move the cursor to Program and press ENTER/MENU.



2. Move the cursor to the tab showing the desired sub menu and press ENTER/MENU. A fifth tab, not shown, labeled pH diagnostics setup, will be present if one of the sensors is a pH sensor.

5.2 OUTPUTS

5.2.1 Menu Tree

Figure 5-1 is the Outputs menu tree.

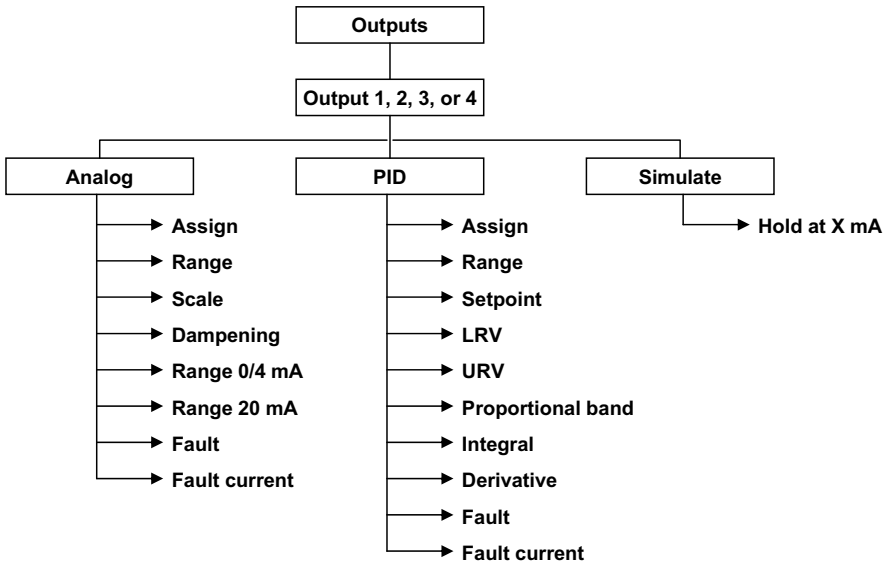


FIGURE 5-1. Menu tree for the Outputs sub menu.

5.2.2. Settings

Move the cursor to the appropriate control box and make the desired setting. For more information about the control box the cursor is on press INFO. To close the information screen, press any key.

5.3 RELAYS

5.3.1 Menu Tree

Figure 5-2 is the Relays menu tree.

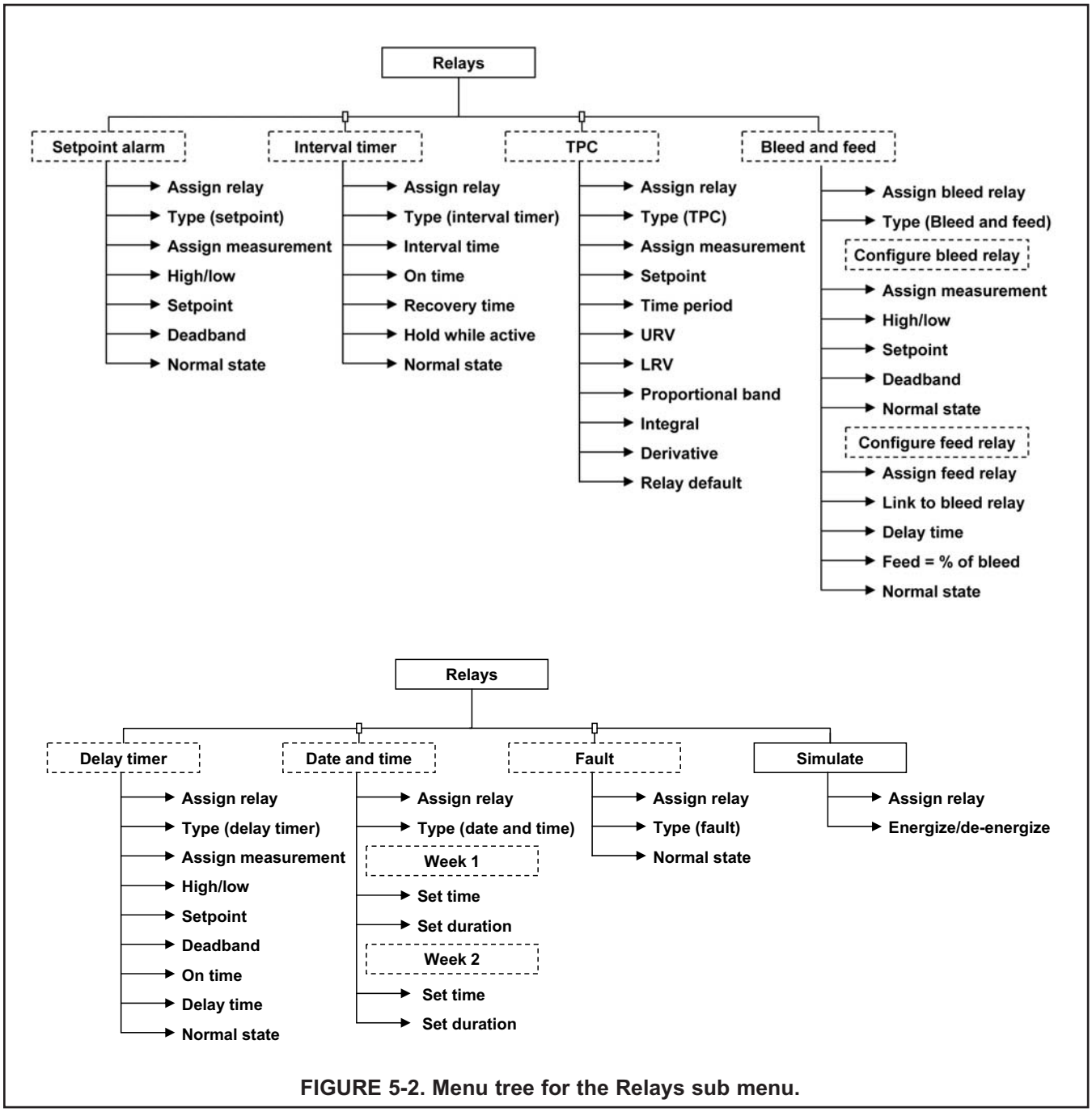
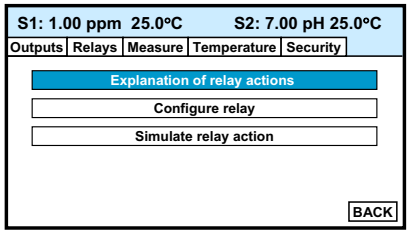
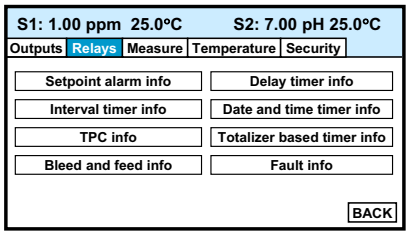


FIGURE 5-2. Menu tree for the Relays sub menu.

5.3.2. Settings



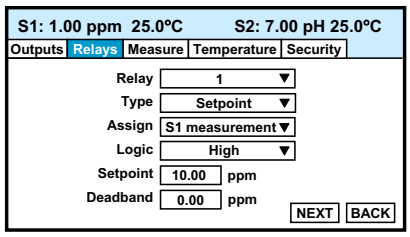
1. A large number of relay actions are available in the Model 56. For more information about a relay action, move the cursor the Explanation of relay actions button and press ENTER/MENU.



2. The screen at left appears. Select the desired relay action and press INFO to display the information screen. To close the information screen, press any key.

   The totalizer-based relay timer is not available in the FCL. It is available only if one of the measurements is flow.

   To configure a relay, press EXIT to return to the screen in step 1.



3. Move the cursor to the Configure relay button and press ENTER/MENU. A screen similar to the one at left will appear.

4. Move the cursor to the appropriate control box and make the desired setting. For more information about the control the cursor is on press INFO. To close the information screen, press any key.

5.4 MEASUREMENT

5.4.1 Menu Tree

Figure 5-3 is the Measurements menu tree.

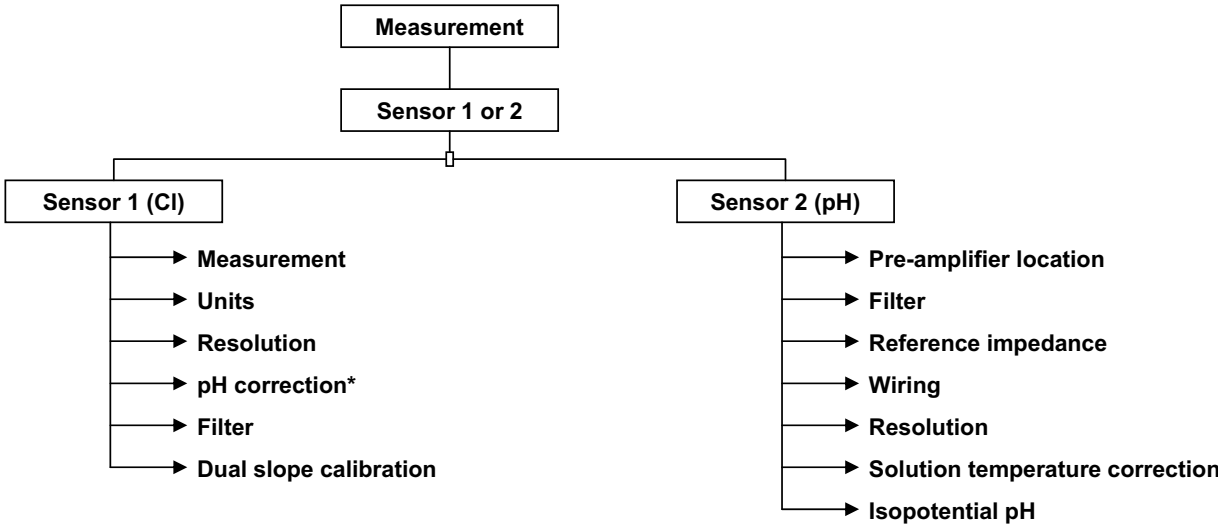


FIGURE 5-3. Menu tree for the Measurements sub menu.

5.4.2. Settings

Move the cursor to the appropriate control box and make the desired setting. For more information about the control the cursor is on press INFO. To close the information screen, press any key.

5.5 TEMPERATURE

5.5.1 Menu Tree

Figure 5-4 is the Temperature menu tree.

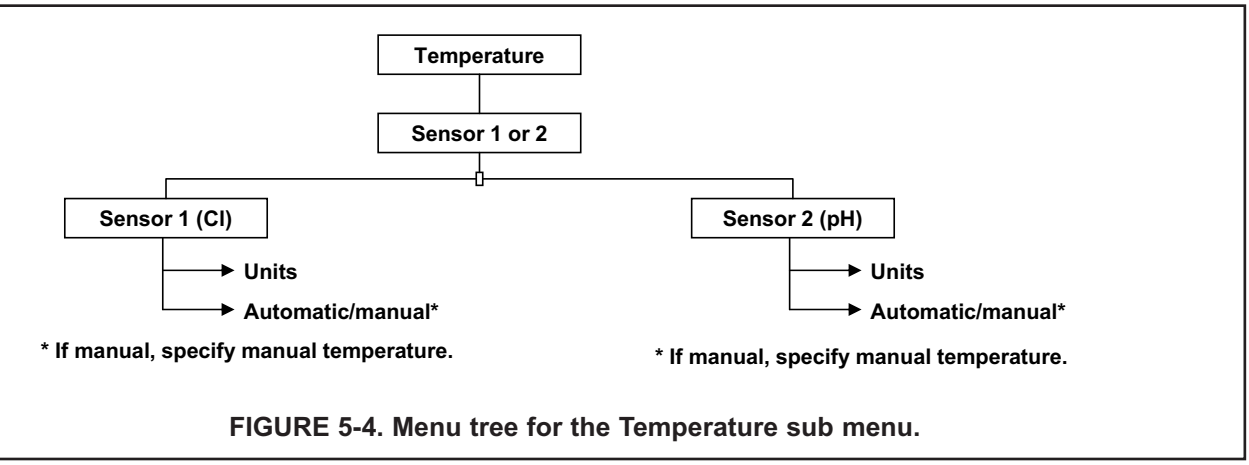


FIGURE 5-4. Menu tree for the Temperature sub menu.

5.5.2. Settings

Move the cursor to the appropriate control box and make the desired setting. For more information about the control the cursor is on press INFO. To close the information screen, press any key.

5.6 pH DIAGNOSTIC SETUP

5.6.1 Menu Tree

Figure 5-5 is the pH diagnostic setup menu tree.

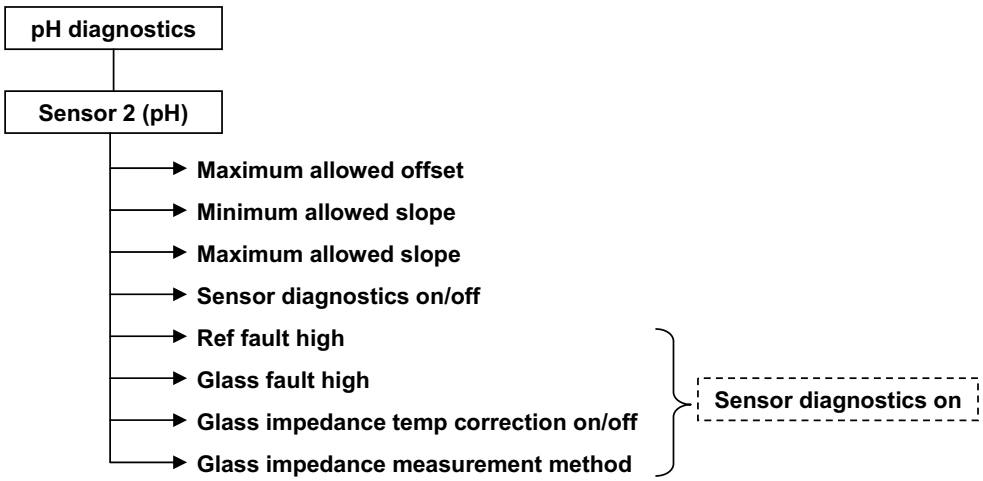


FIGURE 5-5. Menu tree for the pH diagnostic setup sub menu.

5.6.2. Settings

Move the cursor to the appropriate control box and make the desired setting. For more information about the control the cursor is on press INFO. To close the information screen, press any key.

5.7 SECURITY

5.7.1 Menu Tree

Figure 5-6 is the security setup menu tree.

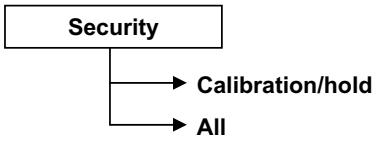


FIGURE 5-6. Menu tree for the security setup sub menu.

5.7.2. Settings

Move the cursor to the appropriate control box and make the desired setting. For more information about the control the cursor is on press INFO. To close the information screen, press any key.

5.8 RESTORING DEFAULT SETTINGS

See section 6.7.

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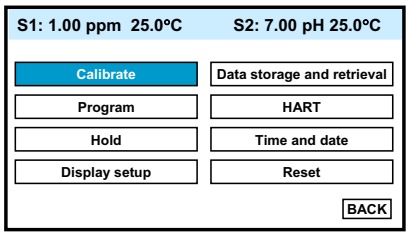
SECTION 6.0
CALIBRATION

6.1 INTRODUCTION

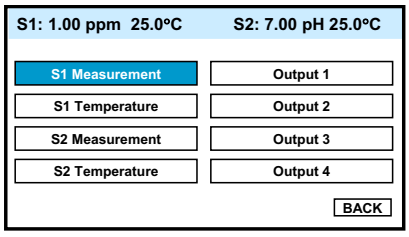
The calibrate menu allows the user to do the following:

1. Calibrate the RTD (temperature sensing element) in the chlorine and pH sensors.
2. Calibrate the chlorine sensor.
3. Calibrate the pH sensor. Four methods are available.
   a. Two-point automatic buffer calibration
   b. Manual two-point buffer calibration
   c. Standardization (one-point calibration) against either a grab sample or an in-process measurement
   d. Manual entry of pH sensor slope and offset if they are already known
4. Calibrate the analog outputs.

6.2 ENTERING THE CALIBRATION MENUS



1. With the main display showing, press ENTER/MENU to display the main menu. The cursor will be on Calibrate. Press ENTER/MENU.

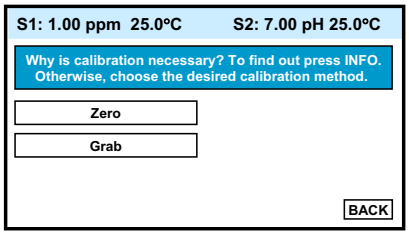


2. Choose the sensor (measurement or temperature) or output to be calibrated. Sensor 1 (S1) is the free chlorine sensor; sensor 2 (S2) is the pH sensor (if present).

6.3 CALIBRATING TEMPERATURE

To calibrate the temperature device in the sensor, choose S1 temperature or S2 temperature and follow the prompts. If you want more information about a calibration step, press the INFO key. Once the calibration is complete, the screen will show the results of the calibration. The screen will also show some acceptance criteria to help you determine whether to accept the calibration. Press the INFO key for an information screen to aid with troubleshooting if the calibration results are not acceptable.

6.4 CALIBRATING THE FREE CHLORINE SENSOR



1. Choosing sensor 1 (free chlorine) in section 6.2 causes the screen shown at left to appear. There are two steps to calibrating a free chlorine sensor, measuring the zero current (zero) and determining the slope of the calibration curve (grab). Because stable free chlorine standards in the ppm range do not exist, the sensor must be calibrated against the results of a laboratory test run on a grab sample.

2. To zero the sensor, select Zero and follow the prompts. For more information about preparing the zero solution and measuring the zero current, press the INFO key when prompted.

   NOTE:

   The information screen refers to a copper auxiliary electrode (see Figure 10.1) that can corrode, producing copper ions that, in the absence of flow, diffuse into the sensor, potentially harming it. Not all versions of the chlorine sensor have the copper electrode. Some have a stainless steel electrode, which is unaffected by prolonged exposure to non-flowing aerated water.

   If the zero step is successful, the analyzer will display the zero complete screen and the measured zero current. The screen will also show the typical zero current for the sensor and the recommended acceptance criterion. You will be asked to accept the zero current. Press the INFO key for an information screen to aid with troubleshooting if the results are not acceptable.

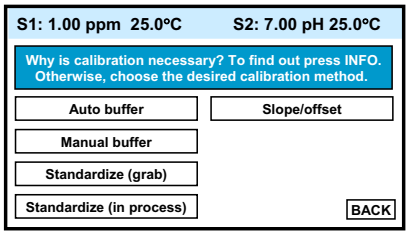
   If the zero current is badly in error, the analyzer will display the zero failed screen. Press the INFO key for troubleshooting.

3. To calibrate the sensor response in chlorinated water, select Grab and follow the prompts. Be sure the sensor is installed in the flow cell in the FCLi and the sample is overflowing the inside tube in the overflow sampler.

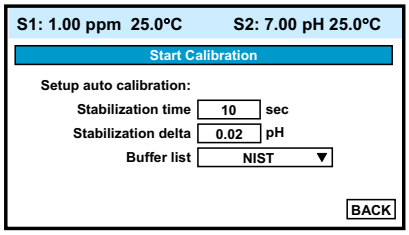
   If the calibration is successful, the analyzer will display the calibration complete screen and the sensitivity (nA/ppm). The screen will also show the typical sensitivity range for the sensor and the recommended acceptance criterion. You will be asked to accept the calibration. Press the INFO key for an information screen to aid with troubleshooting if the calibration is not acceptable.

   If the sensitivity is badly in error, the analyzer will display the calibration failed screen. Press the INFO key for troubleshooting.

6.5 CALIBRATING THE pH SENSOR



1. Choosing sensor 2 (pH) in section 6.2 causes the screen shown at left to appear. There are five possible ways to calibrate the pH sensor. Select the desired calibration method (auto buffer is recommended) and follow the prompts. For more information about calibration methods, press the INFO key



2. If you choose auto buffer calibration, the screen at left will appear to allow you to setup auto buffer calibration parameters. The default values are recommended.

3. If the calibration is successful, the analyzer will display the calibration results (slope and offset for automatic and manual buffer calibration and offset for standardize calibration).

   If there is a possible calibration error, the analyzer will display the calibration results and the nature of the error. You will be asked to accept the calibration. Press the INFO key for an information screen to aid with troubleshooting if the calibration is not acceptable.

   If there is a serious calibration error, the analyzer will display the calibration results and the error. Press the INFO key for an information screen to aid with troubleshooting and repeat the calibration.

6.6 CALIBRATING THE ANALOG OUTPUTS

Choose the appropriate output in section 6.2 and follow the prompts to trim the selected output. If the calibration is successful the trim complete screen will appear. If the entered value is more than 1.0 mA different from the simulated output current, the analyzer will display the possible error screen, and you will be asked to accept the calibration. Press the INFO key for an information screen to aid with troubleshooting if the calibration is not acceptable.

6.7 RESET

6.7.1 Purpose

There are three resets.

1. Reset all user settings, including calibration and program settings, to the factory default values. The analyzer will return to Quick Start. **The event logger and data logger (See section 8.0) will be unaffected.**
2. Reset sensor calibration to the default value. The analyzer will clear all user-entered calibration data for the selected sensor. It will leave all other user-entered data unaffected.
3. Reset the analog output calibration for the selected output to the default value. The analyzer will leave all other user-entered settings unchanged.

6.7.2 Procedure

1. With the main display showing, press ENTER/MENU to display the main menu. Move the cursor to Reset and press ENTER/MENU.
2. Check the desired boxes and press APPLY.

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SECTION 7.0
DIGITAL COMMUNICATIONS

The Model 56 analyzer supplied with the FCL has HART communications as a standard feature. For more information refer to the Model 56 HART Addendum Manual.

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SECTION 8.0
DATA AND EVENT LOGGING AND RETRIEVAL

8.1. OVERVIEW

Data and event logging is a standard feature in the Model 56 analyzer. However, the feature must be enabled.

When data/event logging is enabled, the Model 56 analyzer will automatically store the following **events** with date and time stamp: faults, warnings, calibration data, calibration results (pass or fail), power on/off cycles, hold on/off, and new sensor board detected. At the user's discretion the analyzer will also store alarm activation and deactivation as events. The event logger holds 300 events. When the capacity of the logger is reached, the oldest events are removed to make room for new events.

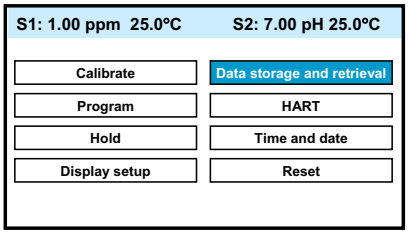
When data/event logging is enabled, the analyzer will automatically store the following measurement **data**.

Free chlorine: date and time, ppm chlorine, temperature, and sensor current.

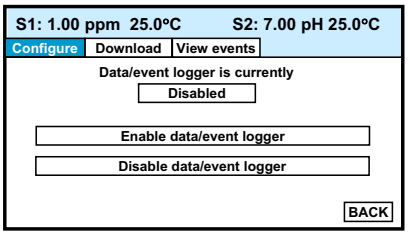
pH: date and time, pH, temperature, mV, glass impedance, reference impedance, and raw pH (if displayed pH has a solution temperature correction applied).

The analyzer can store up to 30 days of data. When the capacity of the logger is reached, the oldest data are removed to make room for new data. Data storage frequency is once every 30 seconds.

8.2. CONFIGURATION



1. With the main display showing, press MENU/ENTER. Choose Data storage and retrieval



2. The screen shown at left appears. The data logger is currently disabled (default). To enable the data logger, move the cursor to the Enable data/event logger button and press ENTER/MENU.

3. Make the appropriate date and time settings and choose which alarm relay activations and deactivations to record as events.

NOTE

Setting the date or time to an earlier value than the one currently showing will cause data to be lost from the data/event logger. Download data before resetting time or date. See section 8.3.

8.3. DOWNLOADING DATA AND EVENTS

To download data or events, move the cursor to the download tab and press ENTER/MENU. Unscrew the USB port cover in the lower right hand corner of the front panel and insert a USB flash drive in the port. Press the appropriate button to download data or events. Downloading may take as long as 20 minutes. During download, the display and keypad are frozen, but all other analyzer functions continue.

Downloaded data and events are stored in a spreadsheet. There is a separate spreadsheet for every day of data. The filename for downloaded data is **dl mmddyy** *or* **dl ddmmyy**, depending on the date and time format selected by the user. The filename for downloaded events is **el mmddyy or el ddmmyy**.

8.4. VIEWING EVENTS

The event log can be viewed on the Model 56 display. Move the cursor the View events tab and press ENTER/MENU. Move the cursor to the View Events button and press ENTER/MENU.

To scroll through the list of events move the cursor to the DOWN or UP key at the bottom of the screen and press and hold ENTER/MENU.

8.5. DATE AND TIME

The date and time can also be reset from the main menu by pressing the Time and Date button.

NOTE

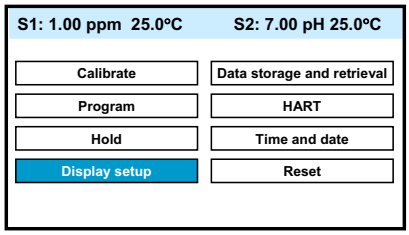
Setting the date or time to an earlier value than the one showing will cause data to be lost from the data/event logger. Download data before resetting time or date. See section 8.3.

SECTION 9.0
GRAPHICAL DISPLAY

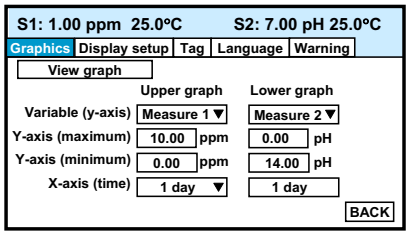
9.1. OVERVIEW

The Model 56 has a dual graphical display. Each graph can be configured to meet user requirements, although the time axis on both graphs must be the same. The time scale can be one hour, one day, seven days, or 30 days.

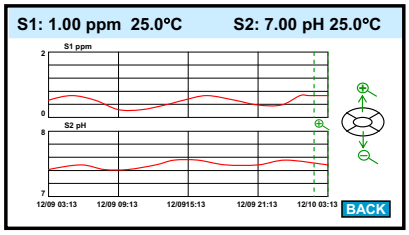
9.2. CONFIGURATION



1. With the main display showing, press MENU/ENTER. Choose Display setup.



2. The screen shown at left appears. Configure the displayed variable, the maximum and minimum values for the y-axis, and the time scale. To view the graphs, move the cursor to the View graph button and press ENTER/MENU.



3. The time axis can be expanded or shrunk. To expand the time scale, use the left or right navigation keys to move the pair of dotted green lines to the area of interest. Press the up navigation key to expand the graph. To shrink the time axis, press the down navigation key.

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SECTION 10.0
MAINTENANCE

10.1 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.

Sensor circuit boards are replaceable.

PN	
24207-00	pH/ORP/ISE sensor board
24203-01	chlorine sensor board

To replace a board

⚠WARNING

RISK OF ELECTRICAL SHOCK

Disconnect main power and relay contacts wired to separate power source before servicing

1. Turn off power to the analyzer.
2. Loosen the four screws holding the front panel in place and let the front panel drop down.
3. Loosen the gland fitting and carefully push the sensor cable up through the fitting as you pull out the circuit board.
4. Once you have access to the terminal strip, disconnect the sensor.
5. Unplug the sensor board from the main board. See Figure 3-2.
6. Slide the replacement board partially into the board slot. Plug the sensor board into the main board and reattach the sensor wires.
7. Carefully pull the sensor cable through the gland fitting as you push the sensor board back into the enclosure. Tighten the table glands.
8. Close the front panel.
9. Turn on power.

10.2 CHLORINE SENSOR

10.2.1 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.

10.2.2 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.

10.2.3 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 10-1.
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 electrolyte has been replaced. **Be sure to put the sensor in a flowing, chlorinated sample for equilibration.**

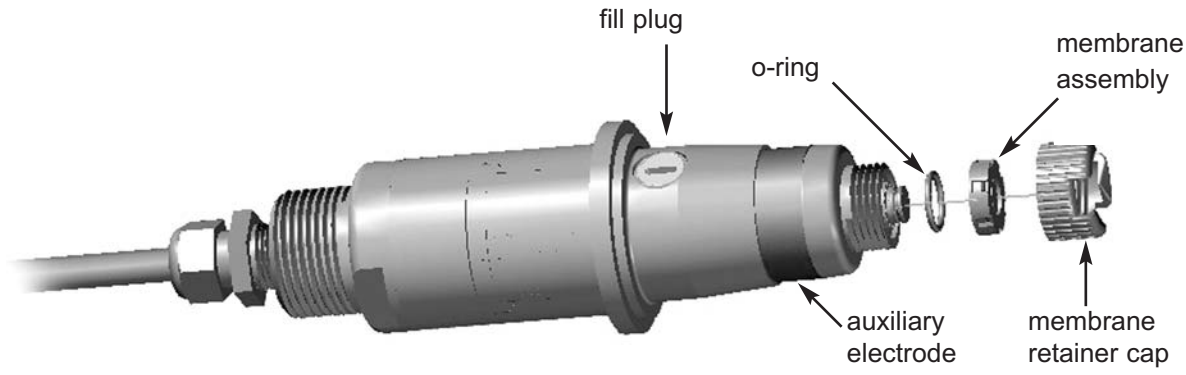


FIGURE 10-1. Chlorine Sensor Parts

SPARE PARTS

33970-00	Fill Plug
33521-03	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

10.2.4 Storage.

The chlorine sensor is available in two styles. One has a copper auxiliary electrode; the other has a stainless steel auxiliary electrode. The auxiliary electrode is the metal band visible at the bottom of the sensor. The copper electrode is gradually being phased out and replaced by the stainless steel electrode.

The *copper-electrode sensor* can be damaged by long term exposure to a non-flowing sample. See the note at the end of section 2.2.5. However, it can tolerate loss of flow for up to four days as long as it remains in liquid in the flow cell with as little contact as possible between the liquid and air. There is a check valve in the sample inlet to prevent sample from draining out of the chlorine flow cell.

The *stainless steel-electrode sensor* can be kept for weeks or longer in a non-flowing sample as long as the sensor is not allowed to dry out.

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.

10.2.5 Rejuvenating a copper-electrode chlorine sensor following improper storage.

If the copper electrode 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.

10.3 pH SENSOR

10.3.1 General.

When used in clean water, the pH sensor requires little maintenance. Generally, the sensor needs maintenance when the response becomes sluggish or noisy. In clean water the typical cleaning frequency is once a month. In water containing large amounts of suspended solids, for example open recirculating cooling water, cleaning frequency will be substantially greater.

10.3.2 Cleaning the Sensor

Remove soft deposits by rinsing with a stream of water from a wash bottle. If the sensor becomes coated with rust, dissolve the rust by soaking the sensor in dilute citric acid (dissolve 5 grams of citric acid crystals in 100 mL of water) for no longer than 30 minutes at room temperature. Rinse the sensor thoroughly with water and soak in pH 4 buffer for several hours. Recalibrate the sensor in buffers before returning it to service.

10.3.3 Other Maintenance

The 3900VP-02-10 pH sensor supplied with the Model FCLi-02 is disposable. It has no replaceable parts.

10.4 CONSTANT HEAD FLOW CONTROLLER

10.4.1 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.

10.4.2 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.

10.4.3 Other Maintenance

Table 10-2 and Figure 10-2 show the replacement parts for the flow controller assembly used in Model FCLi-01. Table 10-3 and Figure 10-3 show replacement parts for the flow controller assembly used in Model FCLi-02.

TABLE 10-2. Replacement parts for constant head flow controller assembly (Model FCLi-01)

Location in Figure 10-2	PN	Description	Shipping Weight
1	24039-00	Flow cell for chlorine sensor with bubble shedding nozzle[1]	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
6	33823-00	Outside tube for constant head device	1 lb/0.5 kg

[1]The replacement flow cell (item 1) is used in other products. It includes a clear plastic adapter with 1-inch FPT. The adapter is not used in the FCLi.

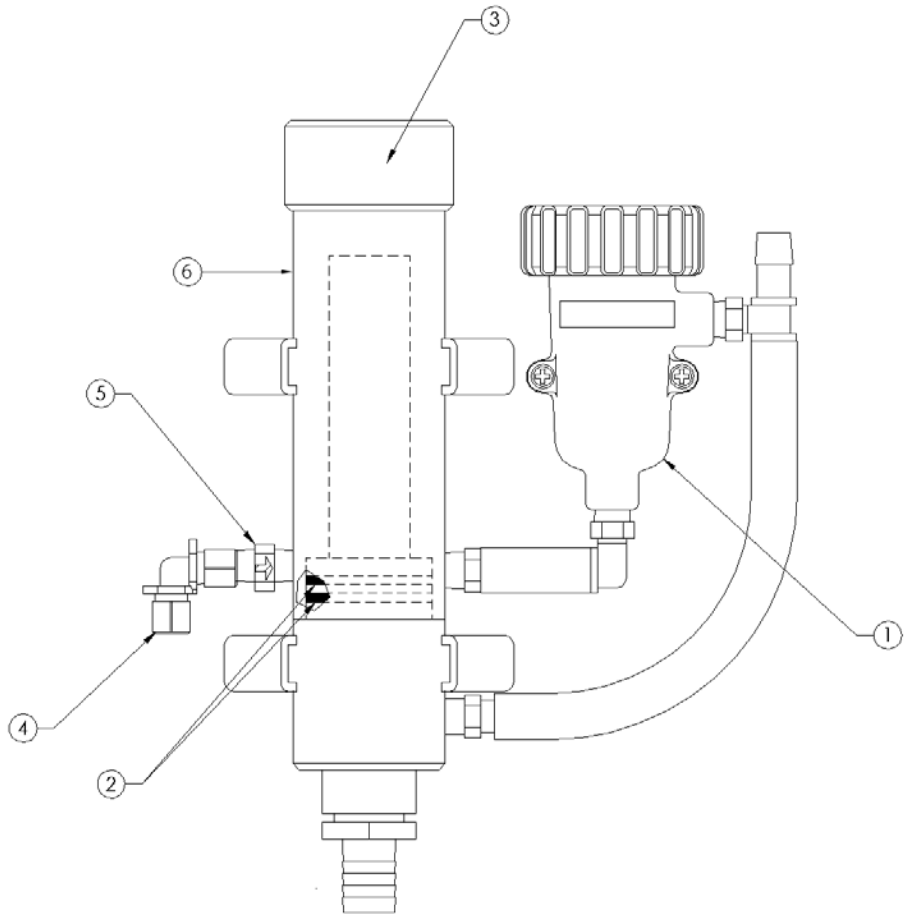


FIGURE 10-2. Replacement Parts for the Flow Controller Assembly used in Model FCLi-01.

TABLE 10-3. Replacement parts for constant head flow controller assembly (Model FCLi-02)

Location in Figure 8-3	PN	Description	Shipping Weight
1	24039-00	Flow cell for chlorine sensor with bubble shedding nozzle[1]	1 lb/0.5 kg
2	24039-01	Flow cell for pH sensor	1 lb/0.5 kg
3	24040-00	O-ring kit, two 2-222 and one 2-024 silicone O-rings, with lubricant	1 lb/0.5 kg
4	33812-00	Dust cap for constant head flow controller	1 lb/0.5 kg
5	9322032	Elbow, ¼ in FNPT x ¼ in OD tubing	1 lb/0.5 kg
6	9350029	Check valve, ¼ in FNPT	1 lb/0.5 kg
7	33823-00	Outside tube for constant head device	1 lb/0.5 kg

[1]The replacement flow cell (item 1) is used in other products. It includes a clear plastic adapter with 1-inch FPT. The adapter is not used in the FCLi.

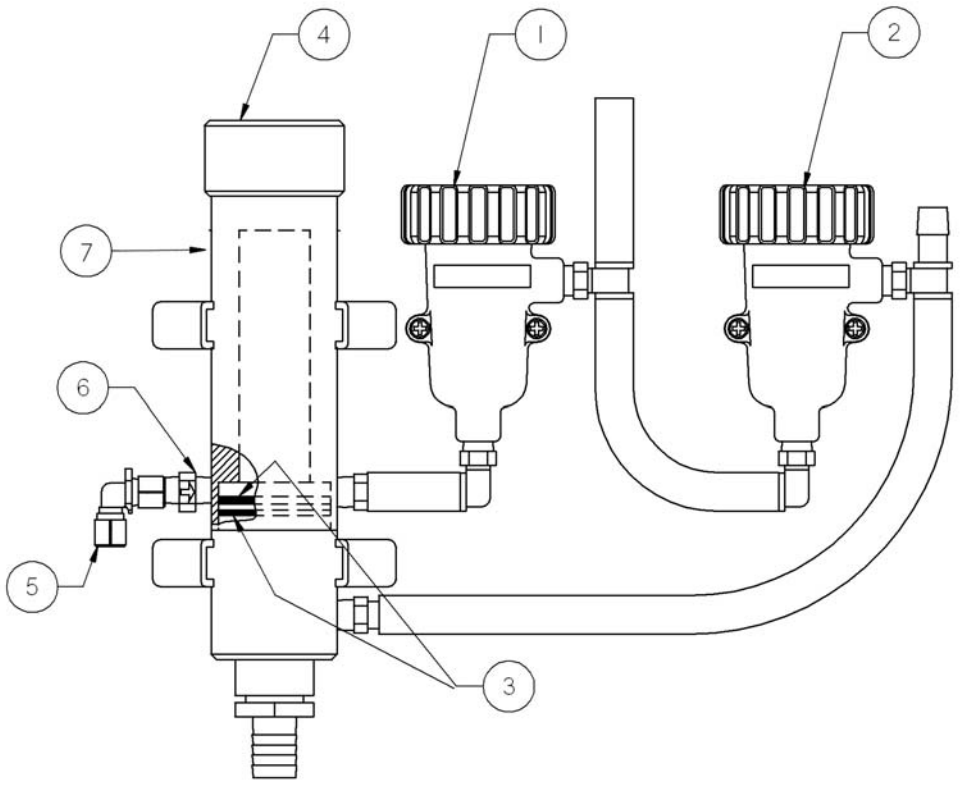


FIGURE 10-3. Replacement Parts for the Flow Controller Assembly used in Model FCLi-02.

SECTION 11.0
TROUBLESHOOTING

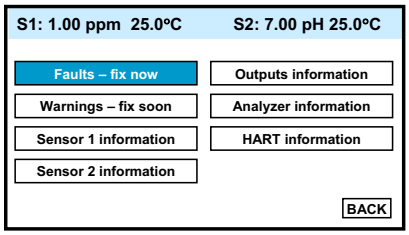
11.1 OVERVIEW

The analyzer continuously monitors itself and the sensor(s) for problems. When the analyzer identifies a problem, the word **warning** or **fault** appears intermittently at the bottom of the display. To read the fault or warning message and troubleshooting information, press INFO. See section 11.2.

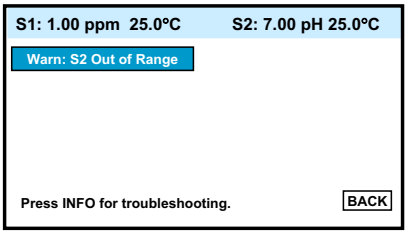
A **warning** means the instrument or sensor is usable, but steps should be taken as soon as possible to correct the condition causing the warning. Warning messages can be turned off. To turn off warning messages, go to the main menu and choose Display setup. Scroll to the Warning tab and turn off warning messages.

A **fault** means the measurement is seriously in error and is not to be trusted. A fault condition might also mean that the analyzer has failed. Fault conditions should be corrected immediately. When a fault occurs, the analog output goes to 22.00 mA or to the value programmed in Section 5.2. Fault messages cannot be turned off.

11.2 READING AND TROUBLESHOOTING FAULT AND WARNING MESSAGES



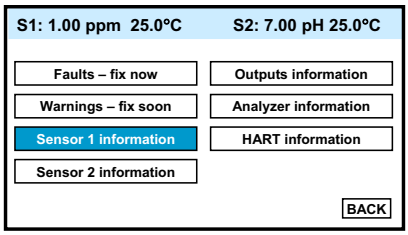
1. With the main display showing, press the INFO key. The screen at left appears. Move the cursor to the appropriate button and press ENTER/MENU.



2. A screen like the one at left will appear showing all the warning or fault messages. For troubleshooting information press the INFO key

11.3 SENSOR DIAGNOSTICS

Sensor diagnostic readings are often useful in troubleshooting measurement problems.



1. With the main display showing, press the INFO key. Move the cursor to the Sensor 1 or Sensor 2 information button and press ENTER/MENU.

2. A list of sensor diagnostics will appear. For more information about a specific diagnostic measurement, move the cursor to the diagnostic of interest and press the INFO key.

11.4 TROUBLESHOOTING CALIBRATION PROBLEMS

If a calibration attempt results in an error or a likely error, the analyzer will display the appropriate warning screen. For troubleshooting suggestions, press the INFO key.

11.5 OTHER TROUBLESHOOTING — CHLORINE

Although calibration troubleshooting information is available in the analyzer by pressing the INFO key, troubleshooting information for process measurement problems is not.

Problem	See Section
Process readings are erratic	11.5.1
Readings drift	11.5.2
Sensor does not respond to changes in chlorine level	11.5.3
Chlorine readings are to low	11.5.4

11.5.1 Process readings are erratic

1. Readings are often erratic when a new or rebuilt sensor is first placed in service. The current usually stabilizes after a few hours.
2. Is the fill solution making good contact with the cathode? The sensor has a gold mesh cathode that allows the fill solution to completely bathe the cathode. Sometimes air bubbles prevent the fill solution for 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.
3. Verify that wiring is correct. Pay particular attention to the shield and ground connections.
4. Is the membrane in good condition and is the sensor filled with electrolyte solution? Replace the fill slurry, if necessary. See section 10.2.3.

11.5.2 Readings drift

1. Is the sample temperature changing? The analyzer automatically corrects for changes in sensor current caused by temperature changes. The time constant for the temperature measurement is about five minutes. Therefore, the reading may drift for a while after a sudden temperature change.
2. 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 tissue to wipe the membrane.
3. 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 10.4.
4. Is the sensor new or has it been recently serviced? New or rebuilt sensors may require several hours to stabilize.
5. Is a bubble trapped against the membrane? For the sensor to work properly, the chlorine must continuously diffuse through the membrane. Bubbles block the chlorine in the sample from reaching the membrane, so readings drift downward as bubbles form and grow. The nozzle at the bottom of the flow cell pushes bubbles to the edges of the membrane where they do no harm. In cold samples the nozzle may not be as effective.
   a. If bubbles are visible, confirm that they are blocking the membrane by removing the sensor from the flow cell and replacing it. Removing the sensor breaks the bubbles, so when the sensor is replaced, readings return to normal.
   b. Confirm that the nozzle is properly positioned in the flow cell. Line up your eye with the bottom of the membrane retainer. No gap should be visible between the end of the nozzle and membrane retainer.

11.5.3 Sensor does not respond to changes in chlorine level.

1. Is the grab sample test accurate? Is the grab sample representative of the sample flowing to the sensor?
2. Is sample flowing past the sensor? 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 over flow sampler. See Section 10.4.
3. 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.
4. 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 solution between the cathode and membrane.
5. Replace the electrolyte slurry.
6. Replace the sensor.

11.5.4 Chlorine readings spike following sudden changes in pH (automatic pH correction).

1. 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.
2. 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.
3. Sensor response depends on flow. Verify that the chlorine sensor is installed in the correct flow cell. See Figures 2-2 and 2-3. 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 8.4.

11.6 OTHER TROUBLESHOOTING — pH

Problem	See Section
Sensor does not respond to known pH changes	11.6.1
Calibration was successful, but process pH is slightly different from expected value	11.6.2
Calibration was successful, but process pH is grossly wrong or noisy	11.6.3
pH readings are moderately noisy and tend to wander	11.6.4

Although calibration troubleshooting information is available in the analyzer by pressing the INFO key, troubleshooting information for process measurement problems is not.

11.6.1 Sensor Does Not Respond to Known pH Changes.

1. Is the pH sensor responsive to buffers? Check sensor response in two buffers at least two pH units apart.
2. Did the expected pH change really occur? Use a second pH meter to verify the change.
3. Is sample flowing past the sensor? 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 over flow sampler. See Section 10.4.
4. Is the sensor properly wired to the analyzer? See Section 3.2.
5. Is the glass bulb cracked or broken? Go to sensor diagnostics and check the glass electrode impedance. See Section 11.3.
6. Is the analyzer working properly? Check the analyzer by simulating the pH input. See Section 11.9.

11.6.2 Buffer Calibration Is Acceptable, Process pH Is Slightly Different from Expected Value.
Differences between pH readings made with an on-line instrument and a laboratory or portable instrument are normal. The on-line instrument is subject to process variables, for example ground potentials, stray voltages, and orientation effects that may not affect the laboratory or portable instrument. To make the process reading agree with a referee instrument, standardize the sensor. See Section 6.5.

11.6.3 Calibration Was Successful, but Process pH Is Grossly Wrong and/or Noisy.
Grossly wrong or noisy readings suggest a ground loop (measurement system connected to earth ground at more than one point), a floating system (no earth ground), or noise being brought into the analyzer by the sensor cable. The problem arises from the process or installation. It is not a fault of the analyzer. The problem should disappear once the sensor is taken out of the system. Check the following:

1. Is a ground loop present?
   a. Verify that the system works properly in buffers. Be sure there is no direct electrical connection between the buffer containers and the process liquid or piping.
   b. Strip back the ends of a heavy gauge wire. Connect one end of the wire to the process piping or place it in the process liquid. Place the other end of the wire in the container of buffer with the sensor. The wire makes an electrical connection between the process and sensor.
   c. If offsets and noise appear after making the connection, a ground loop exists.
2. Is the process grounded?
   a. The measurement system needs one path to ground: through the process liquid and piping. Plastic piping, fiberglass tanks, and ungrounded or poorly grounded vessels do not provide a path. A floating system can pick up stray voltages from other electrical equipment.
   b. Ground the piping or tank to a local earth ground.
   c. If noise still persists, simple grounding is not the problem. Noise is probably being carried into the instrument through the sensor wiring.
3. Simplify the sensor wiring.
   a. Disconnect all sensor wires at the analyzer except, IN REFERENCE, IN pH, RTD IN and RTD RETURN. See the wiring diagrams in Section 3.2.
   b. Tape back the ends of the disconnected wires to keep them from making accidental connections with other wires or terminals.
   c. Connect a jumper wire between the RTD RETURN and RTD SENSE terminals (see wiring diagrams in Section 3.2).
   d. If noise and/or offsets disappear, the interference was coming into the analyzer through one of the sensor wires. The system can be operated permanently with the simplified wiring.
4. Check for extra ground connections or induced noise.
   a. To avoid induced noise in the sensor cable, keep the unit as far away as possible from power cables, relays, and electric motors.
   b. If ground loops persist, consult the factory. A visit from an experienced technician may be required to solve the problem.

11.6.4 pH Readings Are Moderately Noisy and Tend to Wander.
pH readings that are moderately noisy (±0.1 pH) and tend to wander are probably caused by bubbles getting trapped against the pH sensor. Although the overflow sampler is designed to allow bubbles to escape before they reach the pH sensor and the sensor itself is designed so trapped air bubbles don't interfere with the measurement, bubbles may occasionally be a problem. Shaking the sensor will dislodge the bubbles. If bubbles remain a problem, call the factory.

11.7 OTHER TROUBLESHOOTING — GENERAL

Problem	See Section
Current output is too low	11.7.1
Alarm relays do not operate properly	11.7.2

11.7.1 Current Output Is Too Low.
Load resistance is too high. Maximum is 550Ω.

11.7.2 Alarm Relays Do Not Operate Properly
1. Verify the relays are properly wired.
2. Verify the relays are properly configured.

11.8 SIMULATING INPUTS — CHLORINE

The input current from the sensor cannot be simmulated.

11.9 SIMULATING INPUTS — pH

11.9.1 General

This section describes how to simulate a pH input into the analyzer. To simulate a pH measurement, connect a standard millivolt source to the analyzer. If the analyzer is working properly, it will accurately measure the input voltage and convert it to pH.

11.9.2 Simulating pH input.

1. Set automatic temperature correction to manual and set manual temperature to 25°C. See Section 5.5
2. Disconnect the sensor and connect a jumper wire between the IN REFERENCE and IN pH terminals.
3. Press INFO and choose sensor 2 information (pH). The input voltage should be 0 mV and the pH should be 7.00. Because calibration data stored in the analyzer may be offsetting the input voltage, the displayed pH may not be exactly 7.00.
4. If a standard millivolt source is available, disconnect the jumper wire between IN REFERENCE and IN pH and connect the voltage source as shown in Figure 11-1. Be sure to jumper the IN REFERENCE and GND SOL terminals.
5. Calibrate the analyzer using the manual buffer procedure. Use 0.0 mV for Buffer 1 (pH 7.00) and -177.4 mV for Buffer 2 (pH 10.00). If the analyzer is working properly it should accept the calibration. The slope should be 59.16 mV/pH and the offset should be zero.
6. To check linearity, set the voltage source to the values shown in the table and verify that the pH and millivolt readings match the values in the table.

Voltage (mV)	pH (at 25°)
295.8	2.00
177.5	4.00
59.2	6.00
-59.2	8.00
-177.5	10.00
-295.8	12.00

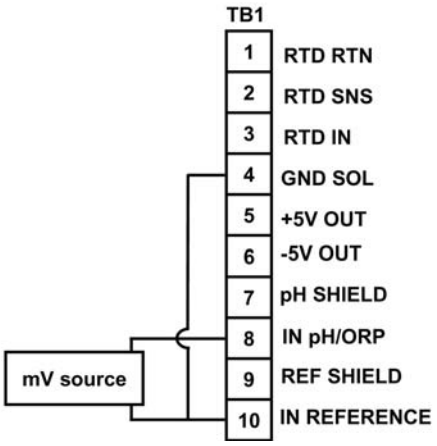


FIGURE 11-1. Simulating pH Input.

11.10 SIMULATING INPUTS — TEMPERATURE

11.10.1 General.

The analyzer accepts a Pt100 RTD (for pH and chlorine sensors). The Pt100 RTD is in a three-wire configuration. See Figure 11-2.

11.10.2 Simulating temperature

To simulate the temperature input, wire a decade box to the analyzer as shown in Figure 11-3.

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.

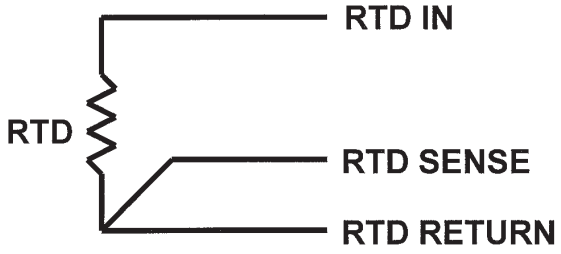


FIGURE 11-2. Three-Wire RTD Configuration.

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 caused by changes in ambient temperature.

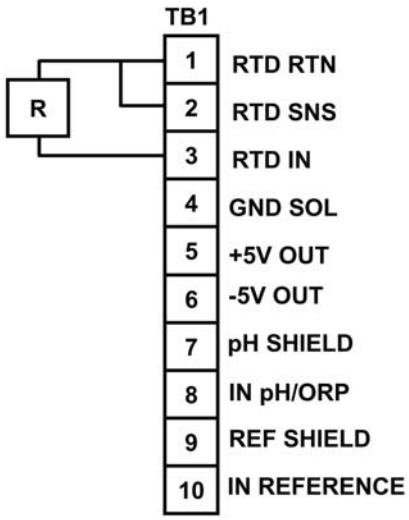


FIGURE 11-3. Simulating RTD Inputs.

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

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Emerson Process Management
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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.

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