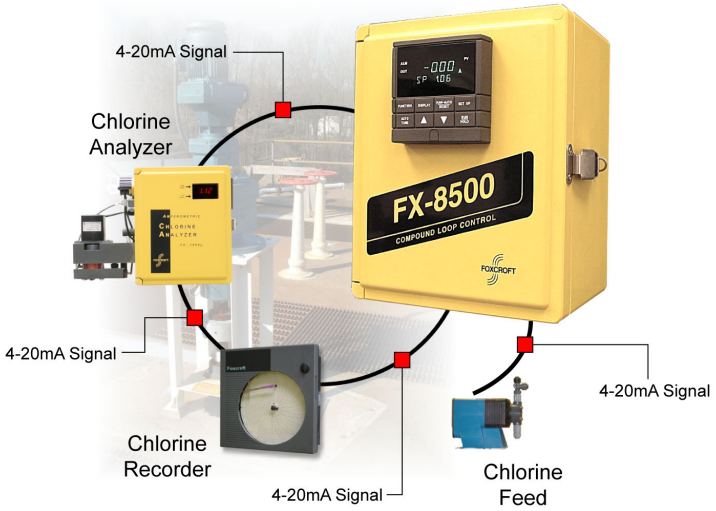
# Model FX-8500

## Compound Loop Controller

Operational Manual




**Warning!**

Please Read Carefully and Save.

The FX-8500 Compound Loop Controller includes a manual and an instructional guide that contain important information about its operation. Purchasers who install this controller for use by others must leave this instruction manual or a copy with the user.



Book #8500-2004A

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# Table of Contents

# Warranty

Foxcroft Equipment and Service Co., Inc. warrants the FX-8500 Compound Loop Controller to be free from defects in material or workmanship for a period of 1 year (12 months) from the date of shipment of this product from our facility. A warranty claim will not be honored if defects are not reported within the warranty period, or if Foxcroft determines that defects or damages are due to normal wear, misapplication, lack of maintenance and or calibration, abuse, improper installation, alteration, or abnormal conditions. Foxcroft obligation under this warranty shall be limited to, at its option, replacement or repair of this product. The product must be returned to Foxcroft, freight prepaid, for examination. The product must be thoroughly cleaned and any process chemicals removed before it will be accepted for replacement or repair. Foxcroft liability shall not exceed the cost of the product. Under no circumstances will Foxcroft be liable for any incidental or consequential damages, whether to person or properly. Foxcroft will not be liable for any other loss, damage or expense of any kind, including loss of profits, resulting from the installation, use, or inability to use this product.

# Unpacking

***Unpacking:***

**After unpacking, it is recommended to save the shipping carton and packing materials if the instrument must be stored or re-shipped. Inspect the equipment and packing materials for signs of shipping damage. If there is any evidence of damage, notify the transit carrier immediately.**

The shipping container consists of the following:

1. FX-8500 Compound Loop Controller
2. Set of mounting feet, 4 ears, 4 screws
3. Operation and Maintenance Manual

***Serial Number:***

The FX-8500 Compound Loop Controller has two serial number labels found on the bottom right side of the enclosure, and on the top of the base plate inside the enclosure. Should technical assistance be required, refer to the serial number to identify your system.

# Important Safety Information

**Warning**

Opening the controller door exposes you to line voltage, if present, at "power" terminal TB-1 at the bottom of the enclosure. This may be hazardous. Always remove line power before entering this area of the enclosure. However, the display board contains only low voltage and is completely safe to handle.

Wiring or repairs should only be performed by qualified personnel and only to an unpowered controller.

Whenever it appears that system safety is questionable, disable the system to ensure against any unintended operation. For example, an unsafe condition is likely when:

1. The system appears visibly damaged.
2. The system fails to operate properly or provide the intended control.
3. The system has been stored for long periods at temperatures above 120° F (49°C).

This control device must be installed by specially trained personnel in accordance with relevant local codes and instructions contained in this operating instruction manual. Observe all technical specifications of the system. If one line of the line power is neutral, use a double-pole main switch to disconnect the controller.

# Introduction

***Introduction:***

The FX-8500 Compound Loop Controller can provide unattended automation for chlorine residual and pH application or virtually any other variable process. The FX-8500 provides the vital link between chlorine analyzer, flowmeter, and chlorine control device in a “closed-loop” chlorine residual control environment. It allows instantaneous chlorine feed changes based on flowrate changes, and overall, time-compensated changes based on residual feed back from the chlorine analyzer. The time compensation reflects the process time interval between chlorine injection and downstream chlorine residual sampling by the residual analyzer. This minimizes overshoot of the desired setpoint. Manual tuning of data parameters is easily done via the built-in keypad and display. Under certain conditions, the Autotune feature can perform self-tuning of the data parameters. Unit has programmable reverse or forward control mode ( into output summator) for chlorine or sulfur dioxide control systems.

# Introduction

***Instructions:*** *continued*

# Introduction

***Instructions:*** *continued*


# Introduction

***Instructions:*** *continued*

This manual is intended to explain the setup and operation of the compound loop controller in layman's terms. For more in-depth detail on the PID controller portion of the unit, please refer to the separate instruction manual that was included with your FX-8500. The FX-8500 Compound Loop Controller consists of three parts; the PID controller, the signal summator, and the enclosure that houses them. For the purposes of this document, and to avoid confusion in terminology, the PID controller will be referred to as the "controller", the signal summator will be referred to as the "summator" and the entire unit will be referred to as the "CLC". "PID" stands for proportional integral derivative, which is the control method, or "algorithm" that the controller uses to change the output signal. The FX-8500 is typically sold for use with chlorine residual control systems, so all references will be for that type of application. However, it is a "universal" controller, and can be used in many other types of applications, such as: pH control, flow control, temperature control, or any other "closed-loop" type of control application. Closed-loop control is where the analytical device is downstream of the controlled device in the process, so that it "sees" the results of its actions. The CLC would be installed in-between the two devices. Single-loop and chart recorder versions of the CLC do not have a summator, and are intended for applications where the flowrate does not change. To keep things simple, this document will only refer to the features that are used in a standard configuration, for chlorine residual control. For other applications, please contact our technical support department.

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# Specifications

***Specifications:***

| | |
|---|---|
| Configuration: | Via keypad and easily understandable prompts with lockout feature. |
| Control Algorithm: | PID-A/ Proportional Band |
| Tuning: | Manual or Automatic |
| Engineering Units | Programmable (typically set to match chlorine analyzer range) |
| Process Time Interval: | (reset) can be set from 0.02 to 50 minutes (however system operation is usually achieved between 1 and 10 minutes of total process time, from injection of chlorine to sample). |
| Setpoint: | 1 or 2, selectable and limitable within input range of chlorine analyzer. |
| Input Filtering: | 0 to 120 seconds plus fuzzy logic filtering mode |
| Proportional Band: | 0.1 to 1000% (determines how “tight” and responsive the control is) Adjustable output control ratio of residual control vs contol (factory set for 50/50). |
| Other Settings: | Many other programmable settings and options too numerous to list, are available on request. |
| Mode Selector Switch: | Flow Control Only (factory set)<br>Residual Control Only<br>Compound Loop Control (flow and residual control only) |

# Specifications

***Specifications:*** *continued*

| | |
|---|---|
| No Flow Mode: | Zeros output in no flow conditions, range 3.0 - 100% adjustable, enable or disable switch (disable - factory set) |
| Flow Signal Input: | 4-20mADC, 220 ohms impedance |
| Residual Signal Input: | 4-20mADC, 250 ohms impedance |
| Control Output Signal: | Powered 4-20mADC into 750 ohms maximum |
| Power Requirements: | 120/ 220 Volts AC, 50/60 Hz., 250 mA |
| Instrument Mounting: | Wall Mount |
| Electronics Enclosure: | NEMA 4X |

# General Information

***General Installation Notes:***

- Do not install the instrumentation near large electrical equipment, computers, radio transmitters, or cellular phones that might provide electrical interference. This includes equipment that might be on the other side of the wall you are working on. Although the FX-8500 is relatively immune to this type of interference, it could be carried into the FX-8500 via electrical connections to it.

- The chlorine sample point in the process should always be down stream of the chlorine injection point. The FX-8500 cannot control chlorine that it cannot "see" the results of.

- The total time between injection and sample should be reasonably short. This means, long enough to ensure good chlorine mix and contact, but short enough to ensure that the system can respond rapidly to changes in chlorine demand. This translates to somewhere between 1 and 10 minutes. Although the controller can go as high as a 50 minute time interval, intervals beyond 20 minutes are not recommended unless the ratio of the summator board is adjusted for mostly flow-based control (70/30 ratios and above), thereby limiting the FX-8500 dependency on chlorine residual returns.

- If the chlorine analyzer operating range is changed from the factory default (0-5.0 PPM on the FX-1000p), be sure to change the IN1 HI setting to match the new analyzer range, or the controller will not pace the chlorine feed correctly.

- Provisions should be made to shut off the chlorine feed at no-flow conditions (recommend using the No Flow selection on the mode switch). Without using the No Flow selection or shutting off the chlorine at no flow, chlorine would continue to increase until it reaches maximum, or until the chlorine residual rises to the setpoint. A simple flow-switch, or a low alarm relay output from the flowmeter or flow chart recorder is recommended. The flow switch or alarm contact can be used to shutoff the AC power to the booster or metering pump. This is especially important in systems that run in a "batch" mode, a daily shift, or any mode that is not continuous.

***General Installation Notes:*** *continued*

- In processes that require chlorine analyzer sample pre-filtering, such as those with suspended solids or fats and grease, provisions should be made to ensure that the filter media gets changed on a regular basis. A clogged filter can stop sample flow to the chlorine analyzer, which would interrupt the closed control loop, or create a chlorine demand within the filter that would send false-low residual samples to the control system.

- Final control device sizing. Is the gas pacing valve or metering pump sized correctly to handle the chlorine demands of the process? For example; in systems where the control device has been sized too small, the chlorine residual usually never reaches the setpoint, or runs the final control device at maximum output for extended time periods after the residual drops below the setpoint. In systems where the final control device is sized too large, the FX-8500 appears to constantly over or undershoot the set point regardless of any system tuning changes. This is seen quite often in new wastewater plant applications, where the entire chlorination system is designed to handle the maximum permitted plant flows, rather than the typical plant flowrates. For example; a chlorination system that is designed for 1 million gallons per day of flow, is probably not going to control residual very well if the more typical flowrates are around 80,000 gallons per day. To put this concept in perspective, it would be like trying to fill a water glass from a fire hose. A properly sized final control device should permit the controller output to run around 50%, when the system is running at or near the desired setpoint level.

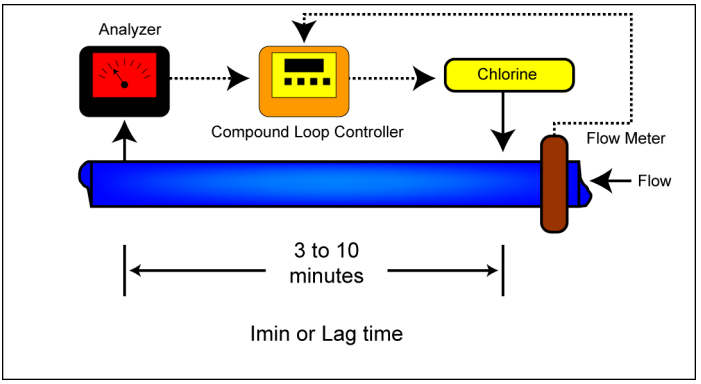
- Chart recorder(s). Although it is not a control system requirement, a circular chart recorder is highly recommended to track the chlorine residual level. It is very helpful in troubleshooting control problems, as it continuously draws a picture of what is happening, and serves as a record of chlorine residual compliance.

# Location and Mounting

***Installation:***

The controller can be installed whereever it is convenient, and easy to access. However, we do not recommend unprotected outdoor, or wash-down locations. Even though the unit is housed in a NEMA 4X enclosure, and would probably work fine in those type of environments, it is a process control instrument, and should be installed in an environment suitable for electronic instrumentation. We have found that locating the FX-8500, and associated instrumentation, in a room that is isolated from the process, yet near enough to ensure short process time sample intervals, is best. This is especially true in poultry processing applications, where wash-down procedures are done with very high pressure, high chlorine residual water sprays, and highly caustic cleaning solutions. The room isolation also serves to keep wandering fingers off of control settings and instrumentation.

***Recommended:*** *Good Control*

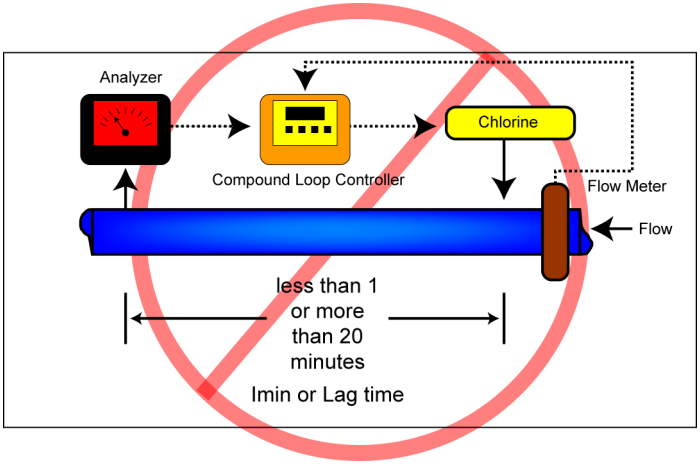



Compound Loop Control

# Location and Mounting

***Installation:*** *continued*

***Not Recommended:*** *Poor Control*




The chlorine sample point in the process should always be downstream of the chlorine injection point. The total time between injection and sample should be reasonably short. This means, long enough to ensure good chlorine mix and contact, but short enough to ensure that the system can respond rapidly to changes in chlorine demand. This translates to somewhere between 1 and 10 minutes. Although the controller can go as high as a 50 minute time interval, intervals beyond 20 minutes are not recommended. Unless the ratio on the summator board is adjusted to mostly flow-based (primary control) 70/30 ratios and above, the FX-8500's dependency on chlorine residual returns will be limited.

# Location and Mounting

***Location:***

Mount the FX-8500 Compound Loop Controller in a location that is:

Protected from the elements, (rain, snow, ice, dust, etc.)

Clean and dry where there is little or no vibration.

Protected from corrosive fluids.

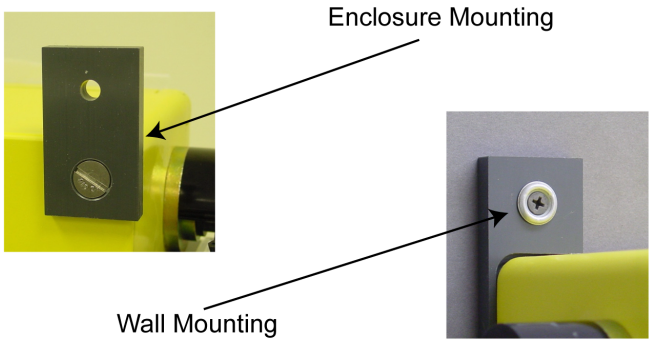
Within ambient temperature limits (32-120°F, 0-49°C).

**Important**

**Mounting the system in direct sunlight may increase the ambient temperature above the maximum limit.**

***Mounting:***

Attach the four mounting ears to the rear of the remote enclosure. Anchor securely to a wall with the conduit holes pointing down. Mount the FX-8500 level and at approximate shoulder height for convenience.



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# Electrical

***Conduit Holes:***

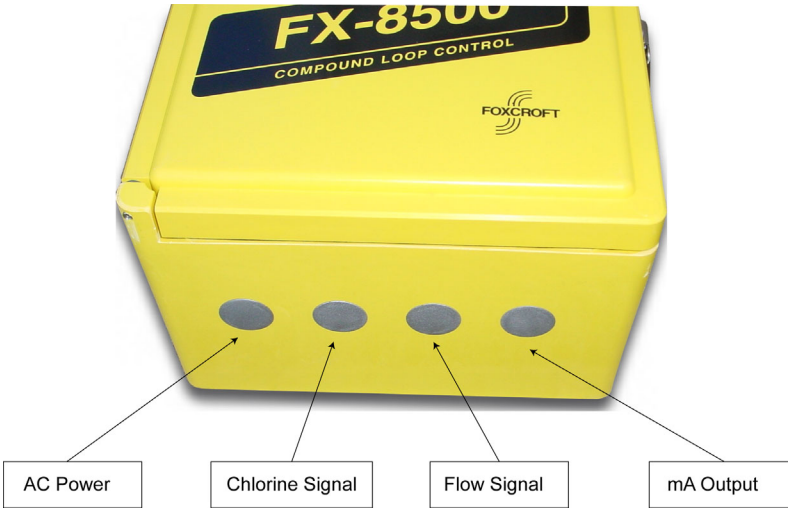
Run all wiring to the FX-8500 in 1/2-inch, grounded metal conduit. If using only shielded cable, appropriate strain reliefs or cable grips are required. Seal unused cable entry holes with appropriate plugs.

**Important**

The electronics enclosure is not a junction box and should not have any other wiring running through it.

**Important**

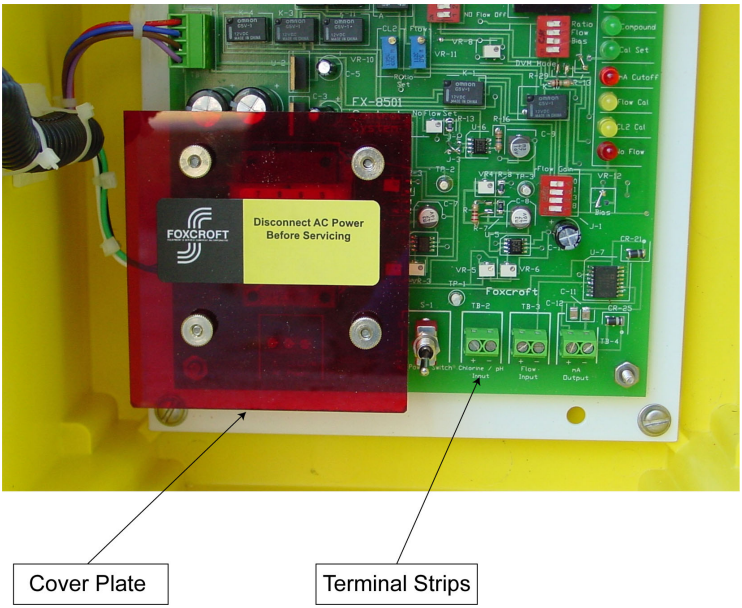
This non-metallic enclosure does not automatically provide grounding between the conduit connections. Grounding must be provided as part of the installation.



# Electrical

***Electrical Connections:***

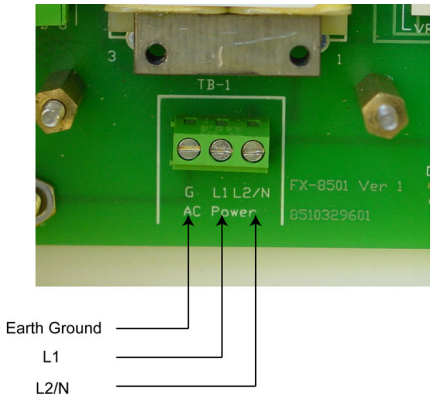
Make electrical connections to the terminal strips located on the circuit board in the enclosure. To access all the terminals, unfasten the retaining nuts on the four threaded standoffs, and carefully remove the cover plate protecting the AC input terminals.



# Electrical

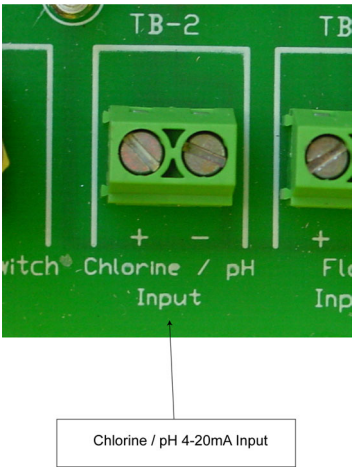
***AC Power:***

TB-1 AC power input terminal is shown below. Use maximum 14 gauge stranded wire only. Do not use solid wire. Always connect to an earth ground. Re-connect the protective cover.




***Chlorine / pH Analog Input:***

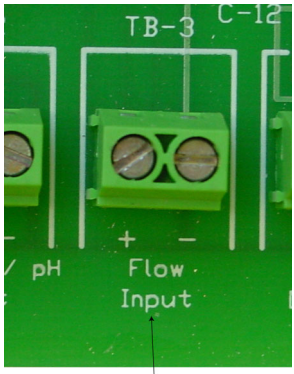
TB-2 will accept the input signal from a chlorine or pH analyzer where input impedance is 220 ohms. Match polarity as indicted.



# Electrical

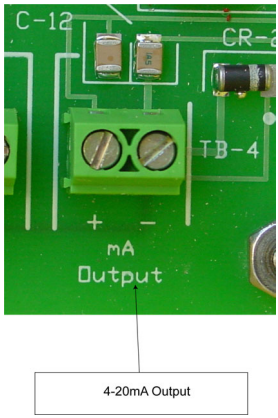
***Flow Meter Analog Input.***

TB-3 will accept the input signal from a flow meter where input impedance is 220 ohms. Match polarity as indicated.



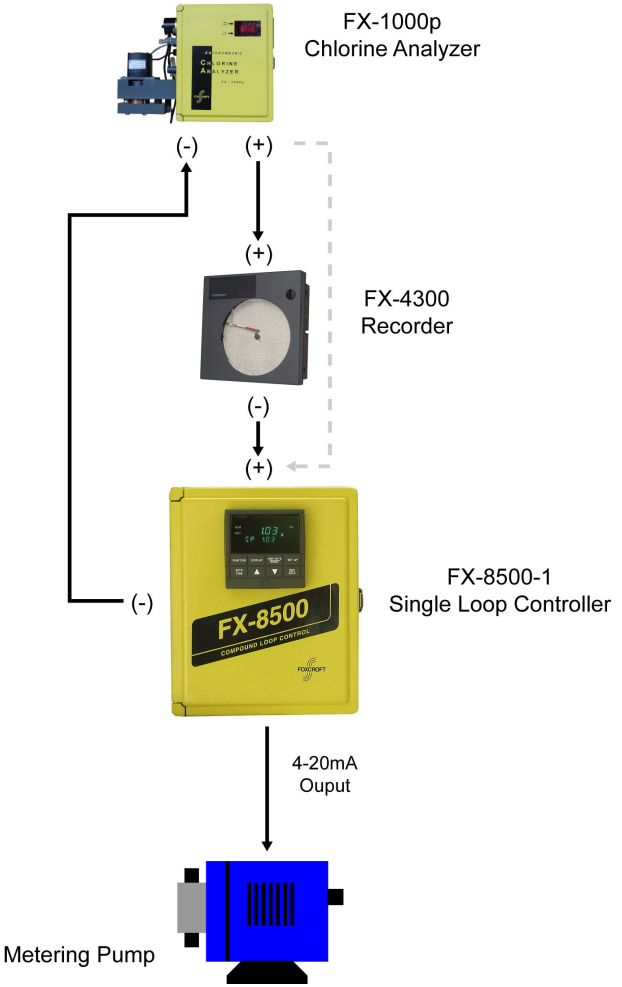

***Analog Output 4-20mA***

The 4-20mA output signal is provided at terminals on TB-4. This output can drive a load of up to 600 ohms. Connect the load device, matching polarity as indicated

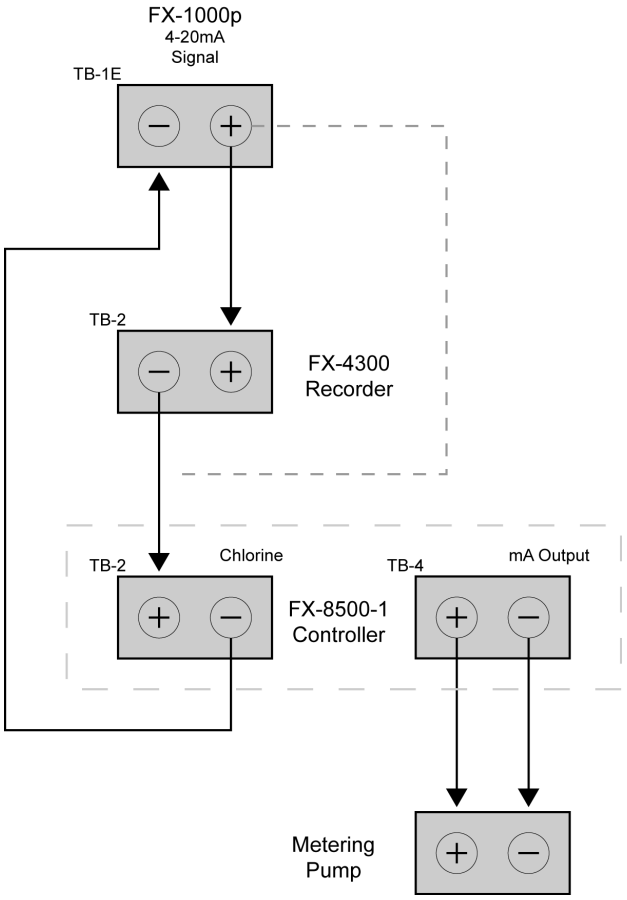


# Electrical

***Connecting a Metering Pump (Single Loop):***

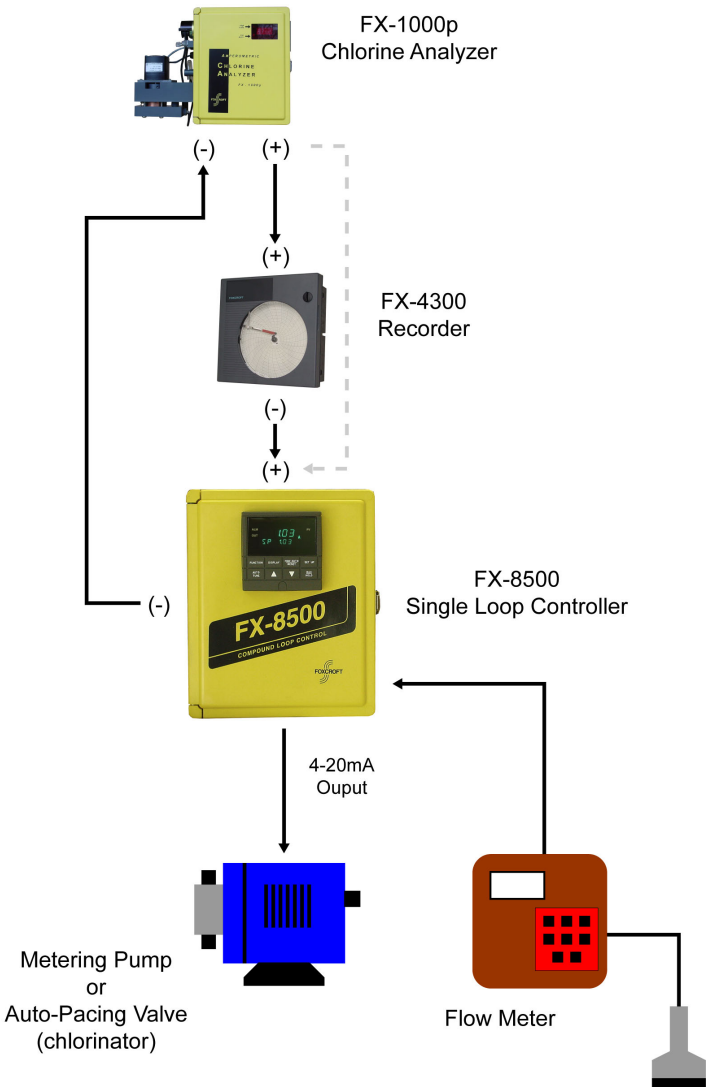


***Connecting a Metering Pump (Single Loop):*** *continued*



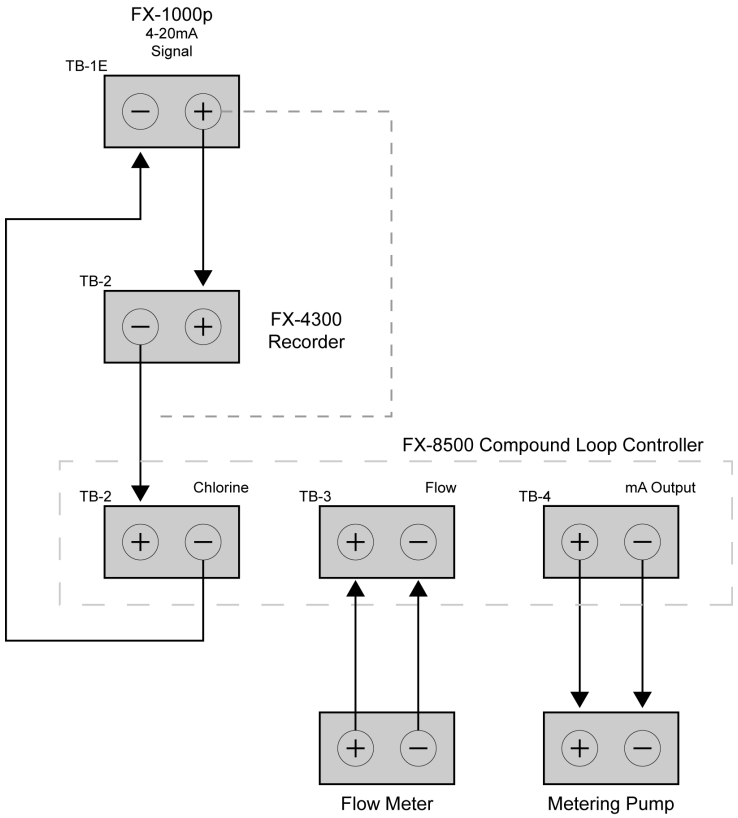
# Electrical

***Connecting a Compound Loop System:***



# Electrical

***Connecting a Compound Loop System:*** *continued*

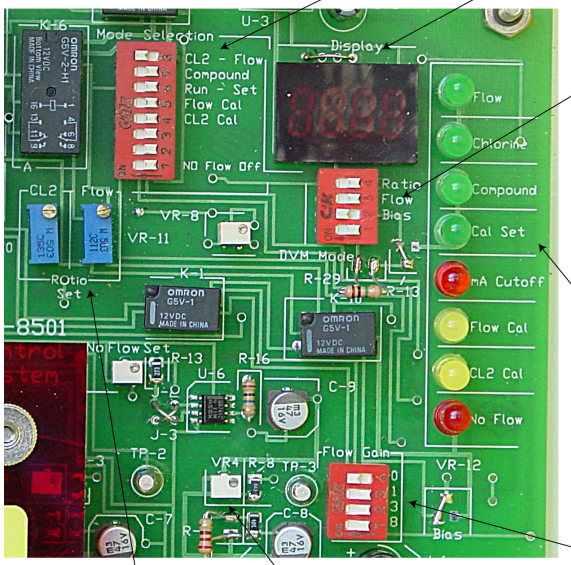


# Getting to Know

**Important**

Before proceeding further, you should familiarize yourself with the following displays and keypad controls.

***Signal Summator:***




Mode Selector Switch

Digital Display

Display Mode Switch

Mode Indicator Panel

Flow Gain Mode Switch

Ratio Control Adjustments

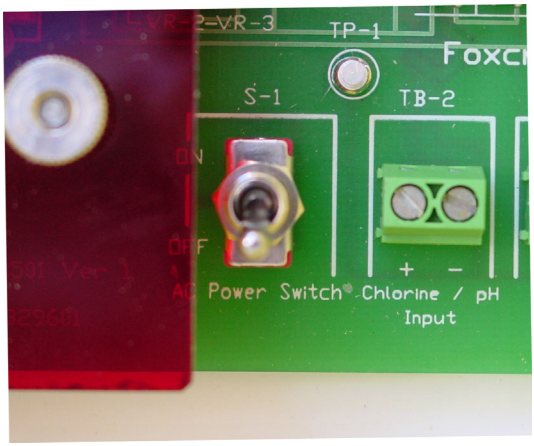
No Flow Cutoff Adjustment

***Signal Summator:*** *continued*

The FX-8500 is equipped with a selector mode switch to give three modes of operation; Flow, Chlorine/ Manual and Compound Loop. The flow mode sends the flowmeter signal only to the chlorine control device, and essentially disables the controller. The chlorine/ manual mode only uses the signal from the chlorine residual analyzer, after it has been processed by the controller. It also allows remote manual operation of the chlorine control device, by allowing you to place the controller in the manual mode. The compound loop mode uses both signals, added together, to control the chlorine control device.

*AC Power Switch:*

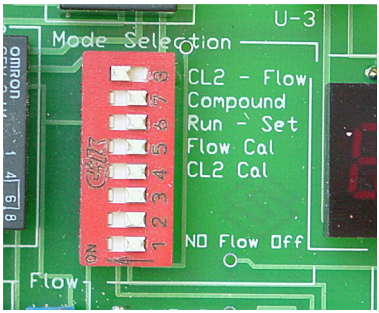
For the master AC power switch, the down position indicates AC power is off, the up position indicates AC power is on.



***Signal Summator:*** *continued*

*Mode Selector Switch:*

This switch selects one of three different modes: Chlorine/ Manual, Flow, or Compound Loop. The Chlorine/ Manual mode controls the chlorine residual using the input from the chlorine analyzer only. The output can be manually controlled in this mode by switching the “DISPLAY” key to the output screen, and pressing the “MAN-AUTO/RESET” key. The “A” on the screen should change to “M”, to indicate manual operation only. The up and down keys then directly change the output signal, and hence the chlorine addition to the process. The Flow mode controls the chlorine residual by the flowmeter output signal only, and essentially disables the controller. The Compound Loop mode uses both the analyzer and flowmeter signals to control the chlorine residual in the process.



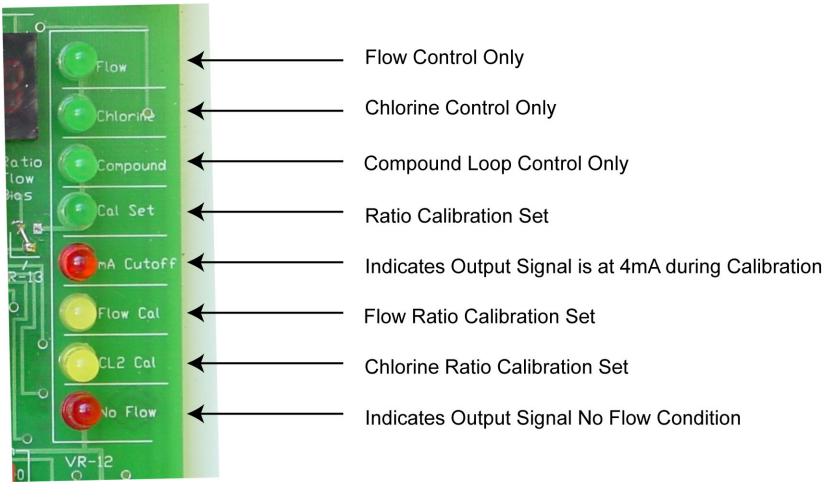

**Switch 8** - Left position “On” Chlorine Control Only, Right position “Off” Flow Control Only.
**Switch 7** - “On” Compound Loop Control Only. Selection will over-ride Chlorine Only or Flow Only
**Switch 6** - “On” position to set Ratio Control Calibration. Selection will cutoff output mA signal (4mA), mA output will return to normal after switch is turn off.
**Switch 5** - Sets Flow Ratio, *Only adjust if primary control, do not adjust if secondary control.*
**Switch 4** - Sets Chlorine Ratio, *Only adjust if primary control, do not adjust if secondary control.*
**Switch 3** and 2 - NOT USED
**Switch 1** - No Flow Cutoff, when the flow signal falls below a pre-set value, the mA output signal will go to 4mA (adjustable range 3-100%).

# Getting to Know

***Signal Summator:*** *continued*

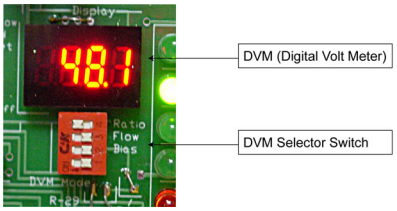
*Mode Selector Indicator Display:*

Indicates position of Mode Selector Switches, also indicates mA output status.




*Digital Display:*

Select three modes of monitoring, **Ratio** (0 - 100% = 4-20mA), **Flow Cutoff** (3 - 100%) and **BIAS** (0% = 4mA output, or no chlorine addition to the process. 100% = 20mA output, or maximum chlorine addition). All can be selected from a DVM Mode selection switch. (Ratio Signal Factory Set) Never select more then one mode of operation.



# Getting to Know

***Controller Display:***

The upper display shows values and the lower display shows selections. This can change depending on the mode the controller is in.

*Upper Display*

**PV:** Process Variable. The chlorine residual reading from an analyzer, typically the 4-20mA output signal from our FX-1000p chlorine residual analyzer. This shows the current value of the input signal to the controller.

**M or A:** Output signal in Manual or Automatic mode. In normal use, this should always be in auto.

*Lower Display*

Press the DISPLAY key to scroll through the operating parameters.

**SP**: Setpoint, sets your desired chlorine residual setpoint

**OT**: Output, value of controller (only) in percent.

**DE**: Deviation, from setpoint (SP).

*Error Messages*

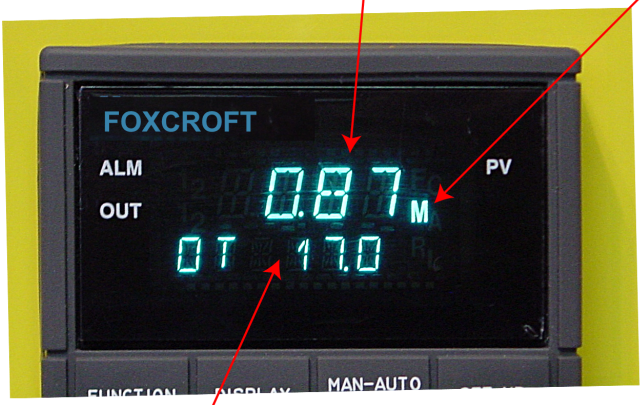
The controller performs background tests to verify data and memory integrity. If there is a malfunction, an error message will be displayed on the lower display.

**IN1 FL:** Input #1 Fail. If this is flashing on the lower display, the input signal is disconnected, shorted, or not powered-up.

**IN1RNG:** Input signal is out-of-range. If this is flashing on the lower display, the input to the controller from the chlorine analyzer is either above 20mA, or below 4mA (chlorine level too high or too low).

# Getting to Know

***Controller Display:*** *continued*




***Upper Display***

PV = Chlorine Residual

**M or A Manual or Auto**

***Lower Display***

SP = Setpoint
DE = Deviation
OT = Output

Error Messages

# Getting to Know

***Controller Keypad:***

**FUNCTION:** Selects sub-menus, when in the setup mode.

**DISPLAY:** Scrolls though informational displays of the Setpoint, Deviation (from the setpoint), and Output. This key also serves as the exit key when the controller is in the setup mode. The setpoint can be changed using the up and down keys. The Deviation display is just informational and cannot be changed. The Output display shows what the controller is doing in the auto mode, in percent. 0 = 4mA output, or no chlorine addition to the process. 100 = 20mA output, or maximum chlorine addition. In the manual mode, the output signal can be manually controlled with the up and down keys, and will stay at whatever value it is set to until the controller is returned to automatic operation.

**MAN-AUTO/RESET:** This switches the controller between Manual and Automatic modes.

**SETUP:** Enters the controller into a configuration mode where preset data can be changed. It is also the primary menu when the controller is in this mode.

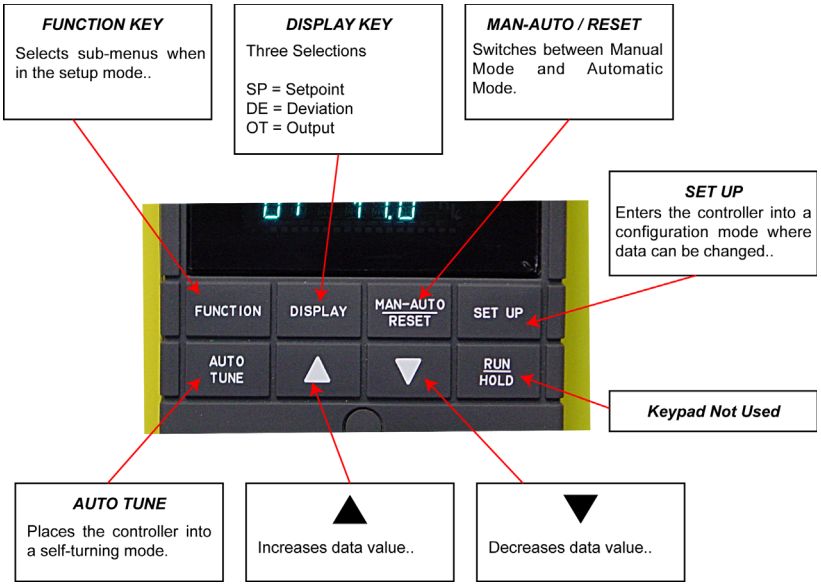
**AUTO TUNE:** This key places the controller into a self-tuning mode where it runs the output to minimum and maximum several times, while it watches the input signal changes. When it has finished this program, it will use what it learned to determine optimum settings for the data parameters in the "Tuning" group of the controller's configuration. Older controllers may not have this option. This mode is best suited to process applications where the time interval from chlorine injection to chlorine sample is relatively short (less than 10 minutes.)

**^ (UP KEY):** Increases a data value. If you press the down key, while holding the up key, the changing number will move up one decimal place for every press of the down key. This is a nice shortcut for making large changes to a number.

**v (DOWN KEY):** Decreases a data value. Operation is the same as the up key.

# Getting to Know

***Controller Keypad:*** *continued*



# Configuration Menus

***Configuration:***

A new FX-8500 should be already configured with default data values. There are only one or two that you may need to change.

Some selections may not appear, depending on settings in other menus. For example; the Proportional Band (PB) setting will not appear in the Tuning group, until the “PB or GN” setting in the Control group is set to PB.

The following list shows the default values for the current version of the controller.

| Setup Key Menu | Function Key Menu | Default Value | Description | Comments |
|---|---|---|---|---|
| Timer | | DIS | Timer function | Not Used |
| Tuning | PB | 100 | Proportional Band | Setpoint Control "Window" |
| | Rate T | 0.00 | Time rate of PV change | |
| | I MIN | 1.00 | Interval Minutes | Process Time |
| | SECUR | 0 | Security Code | |
| | LOCK | CAL | Data Change Lockout | Disables available menus |
| SPRAMP | SPRAMP | DIS | Setpoint Ramp | Not Used |
| | SPRATE | DIS | Setpoint Rate | Not Used |

# Configuration Menus

| Setup Key Menu | Function Key Menu | Default Value | Description | Comments |
|---|---|---|---|---|
| ATUNE | FUZZY | ENAB | Fuzzy Logic | Input Filter |
| | TUNE | ENAB | Tuning Enable | |
| | AT ERR | NONE | Auto Tune Error | Read-Only Field |
| ALGOR | CTRALG | PIDA | Control Algorithm | |
| | OUTALG | CUR | Output Algorithm | 4-20mA Output |
| INPUT1 | DECMAL | 88.88 | Decmical Placement | |
| | UNITS | NONE | Engineering Unit Type | Temperature or None |
| | IN1TYPE | 4-20 | Input Type | |
| | XMITR1 | LIN | Input Type | Set for linear signal input |
| | IN1 HI | 5.00 | Input Span Value | Match to chlorine analyzer range |
| | IN1 LO | 0.00 | Input Zero Value | |
| | RATIO1 | 1.0 | Ratio on Input 1 | |

# Configuration Menus

| Setup Key Menu | Function Key Menu | Default Value | Description | Comments |
|---|---|---|---|---|
| | BIAS | 0.0 | Input Compensation | Offset Value, Normally not used |
| | FILTR1 | 0 | Input Filtering | Can be used to dampen jumpy input |
| | BRNOUT | UP | Burnout setting | Ony used for temperature probes |
| | FREQ | 60 | AC Power Frequency | |
| | LNGUAG | ENGL | Language | |
| CONTRL | PIDSET | ONE | Number of tuning sets | |
| | LSP'S | ONE | Local Setpoints | |
| | SP TRK | NONE | Setpoint Tracking | |
| | PWR UP | ALSP | Setpoint Selection on Power-up | Automatic Local Set Point |
| | SP HI | 5.0 | Setpoint High Limit | Used to limit setpoint selection |
| | SP LO | 0.0 | Setpoint Low | Used to limit setpoint selection |
| | ACTION | REV | Output Action | 4-20 input gives 2--4 output |

# Configuration Menus

| Setup Key Menu | Function Key Menu | Default Value | Decscription | Comments |
|---|---|---|---|---|
| | OUT HI | 100 | Output Span | Used to limit output signal |
| | OUT LO | 0 | Output Zero | Used to limit output signal |
| | FAILSF | 0.0 | Failsafe Value | Temperature probes |
| | FSmode | NO L | Failsafe Mode | |
| | PBorGN | PB | PB or Gain Select | Proportional Band |
| | MINRPM | MIN | Cycle Time Select | Minutes per Repeat |
| COM | ComSTR | DIS | Serial Setup | Not Used |
| ALARMS | A1S1TY | NONE | Alarm1 Setting | Not Used |
| | A1S2TY | NONE | Alarm 1 Setting | Not Used |
| | A2S1TY | NONE | Alarm 2 Setting | Not Used |
| | A2S2TY | NONE | Alarm 2 Setting | Not Used |
| | ALHYST | 0.1 | Alarm Deadband | Not Used |

# Configuration Menus

| Setup Key Menu | Function Key Menu | Default Value | Description | Comments |
|---|---|---|---|---|
| | BLOCK | DIS | Alarm Blocking | Not Used |
| | VERSON | A 106 | Software Version | |
| | FAILSF | NO | Failsafe Mode | |
| | TESTS | PASS | Self Tests | |

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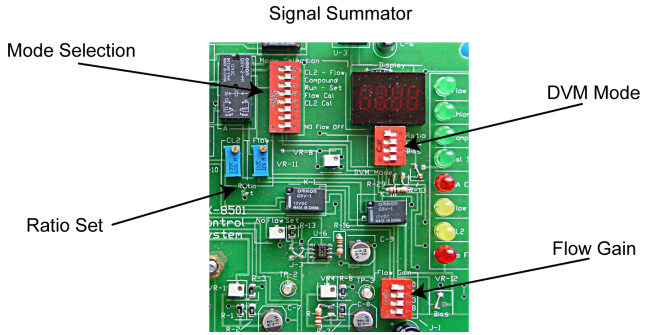
# Factory Default Settings

***Factory Default Settings (Signal Summator):***




The factory default settings are as shown:

*Mode Selection*, position of DIP Switches

#8 - “off” CL2 - Flow
#7 - “off” Compound
#6 - “off” Run - Set
#5 - “off” Flow Cal
#4 - “off” CL2 Cal
#3 - NOT USED
#2 - NOT USED

The *Mode Selection* ONLY requires one selection, do not select more than one switch setting.

#1 - “off” NO Flow off (select as required)

*DVM Mode*, position of DIP Switches

#4 - “on” Ratio
#3 - “off” Flow
#2 - “off” Bias
#1 - NOT USED

The *DVM Mode* ONLY requires one selection, do not select more than one switch setting.

# Factory Default Settings

***Factory Default Settings (Signal Summator); continued***

*Flow Gain*, position of DIP Switches

#4 - “on” 0 minutes
#3 - “off” 1 minute
#2 - “off” 3 minutes
#1 - “off” 8 minutes

The *Flow Gain* requires a least one switch being placed in the “on” position.

*Ratio Set* - Settings are set mid way or 50/50

*No Flow Set* - 3%

# Startup

***Startup:***

At this point you should have all the system instrumentation installed, wired, and fully calibrated. The process being controlled should be up and running in its normal state. The sample should be running through the chlorine analyzer, and the chlorinator should be running in manual mode.

A good practice in system start-up, is to watch how well the system operates in manual mode, and/or in flow-paced only mode. A system that does not respond reasonably well in a simple flow-paced or manual mode, will probably not work well in fully automatic mode. This is the best time to solve problems that the FX-8500 cannot correct for. These type of problems could include one or more of the following:

- Problems with enough vacuum from the injector, in chlorine gas based systems, especially in existing chlorinator systems that have just been retrofitted with new control instrumentation. This might give inconsistent chlorine feed rates that don't respond properly to the FX-8500's output actions. This could be caused by an old booster pump that is not providing the output pressure it originally did, which might put the injector in borderline operation of its performance curve. This type of problem is more common than you might think. In metering pump systems, this could be a metering pump that is not holding its prime, or leaking.

- Problems with an existing chlorine gas pacing valve or servo motor. Does the chlorine gas feed rate on the rotometer respond to changes in the input signal to the servo electronics? If the valve or motor does not respond properly to signal changes, the chlorine residual is not going to respond properly to the new control system. The same goes for a metering pump, does it respond to signal changes proportionally?

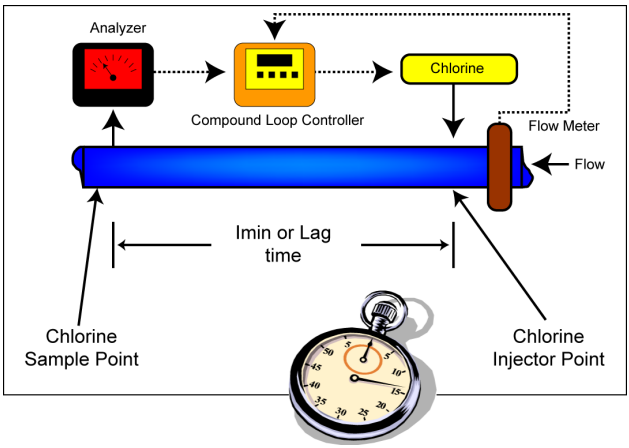
# Startup

***Startup:*** *continued*

- Air leaks in the chlorinator system that draw-in ambient air. This could make it appear that the chlorine gas feed rate is correct on the rotometer, when it is actually half air, and half chlorine gas. Check for proper weight loss on the chlorine cylinder weight scale. Correct any air leaks. Shutting off the chlorine gas cylinder should (eventually) drop the rotometer ball to zero. If it does not, you have an air leak. In metering pump systems using liquid (sodium hypochlorite), this same phenomenon can be caused by old chlorine that has lost some of its strength, especially if it has been stored in elevated temperatures.

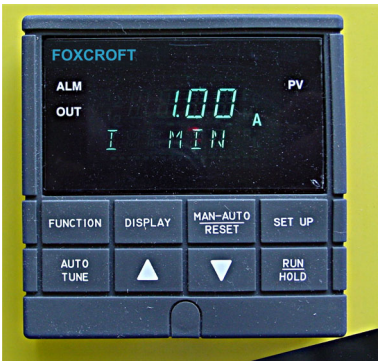
These are just a few examples of problems that are often seen on system start-ups. There are many others. If you are having trouble getting your control system to operate correctly, the problem may be elsewhere in the system. Don't assume that the problem is with the FX-8500 until you check for potential problems elsewhere in the system, or external to the control system. Some basic system troubleshooting can be found in the troubleshooting guide.

While the system is still running in flow-paced or manual mode, you will want to figure-out the process time interval, for the I MIN setting. I MIN should be set for the process time beween the chlorine injection point and the chlorine sample point, during typical flowrates.

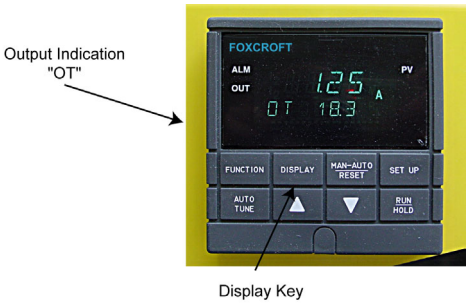


***Startup:*** *continued*

This can be timed with a stopwatch by making a large change to the chlorine feed rate, and waiting until the change residual actually shows on the chlorine analyzer. The I MIN setting is in minutes, and hundredths, not in seconds. So a time interval of 2 minutes and 30 seconds, would be entered as: 2.50.



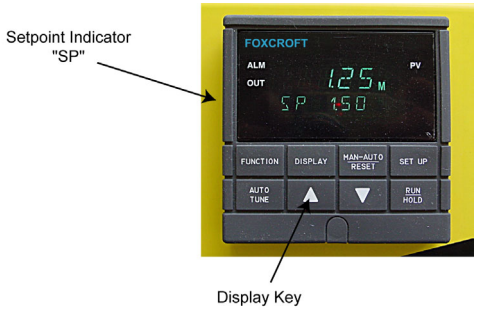

Once you have set the I MIN setting, bring the residual up (or down) to the desired setpoint range using the up and down keys while the display is showing OT, and allow it to stabilize (as much as it is going to). Be sure the FX-8500 is placed in manual mode, a M should be indicated on the display.



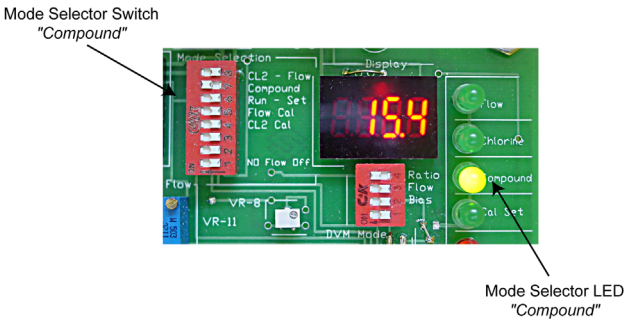
# Startup

***Startup:*** *continued*

While you are waiting for the residual to come up (or down), switch the display to SP, and set your desired chlorine residual setpoint.



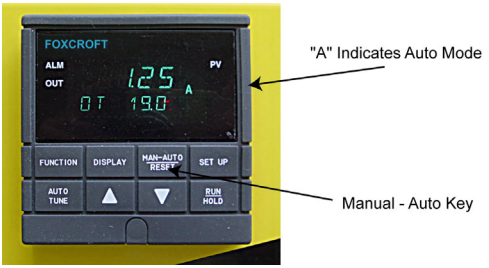

Once the chlorine residual has come up (or down) to the setpoint range, if you have not already done so, open the enclosure, and select compound loop mode (or chlorine/manual mode if there is no flowmeter input) on the Mode Selector Switch. The only indicator on the Mode Selector Indicator Display should be “Compound” or “Chlorine”.



# Startup

***Startup:*** *continued*

Then use the manual/auto key to place the system in fully automatic mode. If all goes well, the system will keep the residual up to your desired setpoint. Just make sure you allow enough time for the system to take control of itself.




If control seems erratic, start manual tuning by making changes to only one parameter at a time. We suggest sticking to just these few; I MIN, PB, and FILTR1. PB is the essentially the width of the output “control window”, or how large a change the controller will apply to the output signal. Smaller sittings give tighter control, but do so with larger changes in the output signal. Larger settings will loosen control, but give smoother response with smaller changes to the output signal. Typically, the best setting is a compromise between the two that follows the process well FILTR1 can be used to “smooth-out” jumpy input signals. If your input signal is not jumpy, do not use the input filtering, you will generally get better response without it.

Some other settings that may prove helpful are: SP HI, SP LO, OUT HI, and OUT LO. These can be used to limit setpoint selection to a specific range, and to limit output action to a specific range.

A good system tuning should give a reasonably flat response as viewed on a chart recorder. It should also keep the final control device working around 50% output, so that the control system has room to work with. If the FX-8500 output is always up around 100%, and there is a sudden additional chlorine demand in the process, the control system will have nowhere to go, and the residual will drop below setpoint.

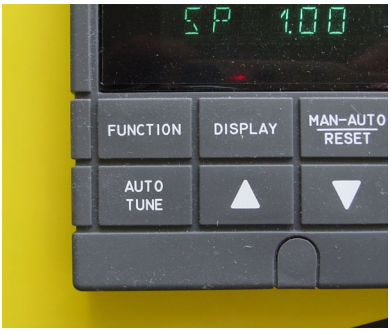
***Startup:*** *continued*

The reverse is also true. If the FX-8500 is always down near 0% output, the control system final control device is either too big or set too high, and the residual will always be over the setpoint.

# Auto-Tune

***Auto-Tune:***

The auto-tune feature is capable of setting the FX-8500 tuning group parameters automatically. It does so by running a program that cycles the final output device fully on, and fully off, several times, while it watches the incoming signal from the analyzer, to see the results. When it has finished, it will use what it learned from the process swings to set the tuning parameters.




This works best in a responsive process control environment. However, if the process is slow to respond to changes, as many chlorination processes can be, you may find that the manual tuning method works better. If you have ran an auto-tune, and response is worse than when you started, you can always reset the tuning group parameters to factory defaults, and start again. The auto-tune feature only changes parameters in the TUNING group.

# Changing Ratio

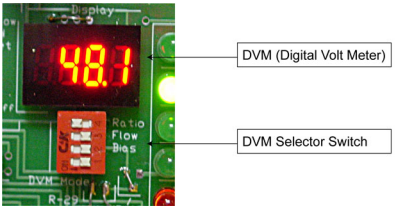
***Changing Ratio:***

The factory default ratio for the FX-8500 is 50-50 (50% flow control and 50% chlorine control), normally this ratio is sufficient but, sometime it is necessary to make changes.

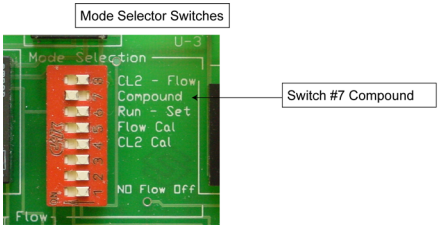
**Never** adjust the chlorine control ratio adjustment more then 70%, but the flow control ratio adjustment can be set as high as 90%.

**Before making any adjustments, place all output devices such as metering pumps and or chlorinators in manual operation.**

Set the display mode switch #4, Ratio to “on” position. Switches #3, #2, and #1 all should be off.




Set the Mode Selector Switch #7 compound to the “on” position. Switches #6, #5, #4, #3, #2, and #1 all should be off. Switch #8 either position.

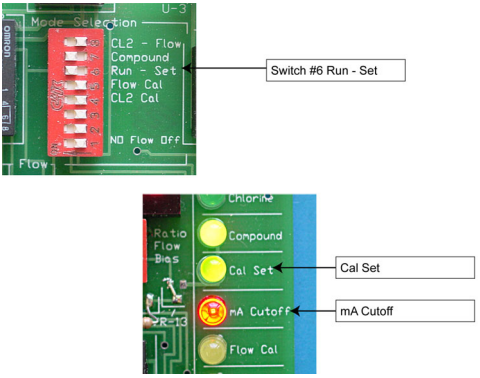



Set the AC Power Switch to the “on” position.

Set the Mode Selector Switch #6 Run - to the “on” position. The Cal Set indicator LED should be blinking and the mA Cutoff red LED should be illuminated.

# Changing Ratio

***Changing Ratio:*** *continued*



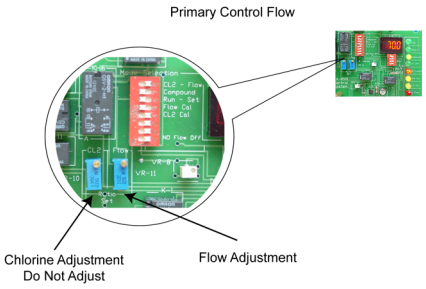

At this time it is only necessary to adjust one control adjustment (flow or chlorine), whichever is the primary control, **ONLY** change the corresponding adjustment. Example, Flow 70% - Chlorine 30%, flow is the primary control, therefore the flow control is the only adjustment required. The total sum of each flow and chlorine must equal 100%. Do not changeboth control adjustments at the same time.

**<u>Set ONLY if the Primary Control is Flow</u>** (example Flow 70%, maximum 90%).

Set the Mode Selector Switch #5 Flow Cal to the “on” position. The Flow Cal indicator LED should illuminate.

Adjust the Flow Ratio set to the primary value (example Flow 70%).
**Do not adjust the chlorine ratio.**

Turn off switch #5 when complete.



# Changing Ratio

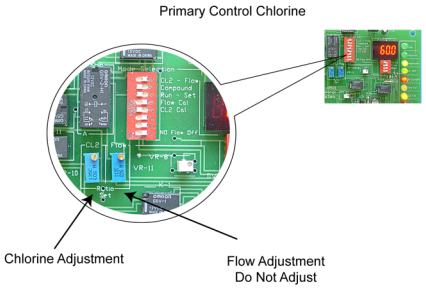
***Changing Ratio:*** *continued*

**<u>Set ONLY if the Primary Control is Chlorine</u>** (example Chlorine 60%, maximum 70%).

Set the Mode Selector Switch #6 CL2 Cal to the “on” position. The CL2 Cal indicator LED should illuminate.

Adjust the CL2 Ratio set to the primary value (example Chlorine 60%). **Do not adjust the flow ratio.**

Turn off switch #6 when complete.




Turn off switch #4 or #5 when complete.

Turn off switch #6.

Ratio adjustment is complete.

# No Flow Cutoff

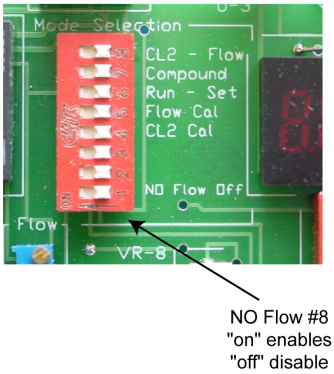
***No Flow Cutoff:***

The No Flow Cutoff zeros the FX-8500 output to 4mA when the flow signal falls and trips a predetermined setpoint. The No Flow Cutoff can be adjusted over a range of 3% (factory default) to 100% and can be enabled (disabled factory default) by turning on #8 Mode Selection switch.

**Adjusting the No Flow Cutoff trip point below 3% will disable the mode.**

To enable the No Flow option turn switch #8 - NO Flow Off to the “on” position located on the Mode Selection switch. When the mode is activated and the flow signal falls below the selected value (3% factory setting) a red blinking LED will illuminate and the output of the FX-8500 will fall to 4mA.

Mode Selection



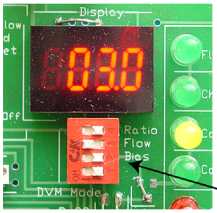

***Setting the No Flow Cutoff:***

The No Flow Cutoff can be adjusted over a range of 3% (factory default) to 100%. Place all the DVM Mode switches in the off position. Set #3 - Flow in the “on” position. Adjust the No Flow Set to the value required (3% minimum - 100% maximum). Adjusting the No Flow Cutoff trip point below 3% will disable the mode. The No Flow cutoff is now set, to be sure drop the flow signal to the value set. When the flow signal drops below the pre-set value the red blinking LED should illuminate. Place the DVM Mode switch #3 - Flow to the “off” position and restore the DVM Mode switch setting to the factory default (#4 - Ratio “on” position).

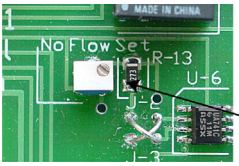
# No Flow Cutoff

***Setting the No Flow Cutoff:*** *continued*

DVM Mode




#3 - "on" position - Flow
(factory default #4 - "on" position)




No Flow Set

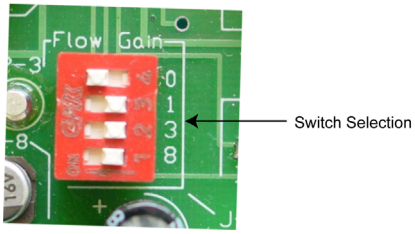
# Flow Gain

***Flow Gain Selections:***

The Flow Gain Mode switch provides dampening of the flow input signal. The dampening can be used to flatten out erratic flow signal, for better control.

**One switch must be selected**, not selecting one switch will disable flow signal available to the compound loop control.

Flow Gain Selection



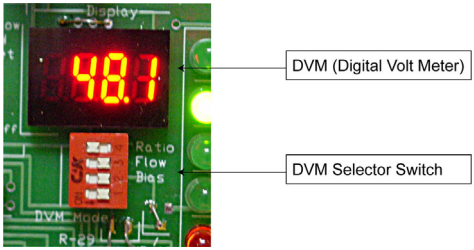

The selections are as followed;

#4 - 0 seconds (factory default)
#3 - 1 second
#2 - 3 seconds
#1 - 8 seconds

# Display

***Display and DVM Mode Selection:***

Select one of any three modes of monitoring, **only select one** mode of operation at any time.




Switch settings:

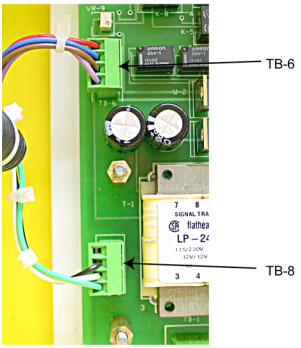
#4 - Ratio - combination of flow and chlorine (factory default).
#3 - Flow - indicates trip point of No Flow cutoff.
#2 - Bias - Output signal of FX-8500 controller.
#1 - Not Used

# Internal Connections

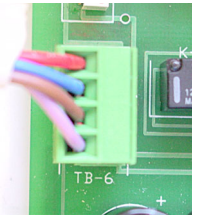
***Internal Connections:***

Do not reverse connectors TB-6 and TB-8, **electrical damage will occur.**

Internal Connections

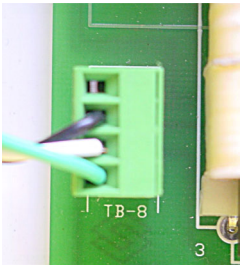



**TB-6**




Pin 1 - Red Wire
Pin 2 - Blue Wire
Pin 3 - Brown Wire
Pin 4 - Violet Wire

**TB-8**




Pin 1 - No Wire
Pin 2 - Black Wire (AC power)
Pin 3 - White Wire (AC power)
Pin 4 - Green Wire (Earth Ground)

# Troubleshooting

***Troubleshooting:***

The following guide lists possible areas to check for problems when initially starting a control system, or troubleshooting an existing system. It is only a general guide for a typical system, and assumes that a proper initial installation was performed.

**The typical compound-loop control system usually involves the following equipment:**

- A gas chlorinator system and Auto-Pacing Valve (FX-8E), or Sodium Hypochlorite liquid and a variable Metering Pump.
- A chlorine injection point to the process that is upstream of sample point.
- A suitable amount of in-line chlorine “contact-time” prior to a downstream sample point.
- A chlorine analyzer, such as the FX-1000p or FX-1000p-TC.
- A flowmeter, for applications that do not have a fixed flowrate.
- A Single or Compound Loop Controller, such as the FX-8500.
- A chart recorder, such as the FX-4301.

**Optional Items:**

- A water solenoid to keep a continuous sample feed to the analyzer, when the process is not running (typical in food processing operations).
- A flow-switch or pump contractor controlled AC power supply to the injector booster pump or chlorine metering pump for process “no-flow” conditions.

Basic System Troubleshooting: (w/Foxcroft Instrumentation)

**FX-1000 Chlorine Analyzer**

- Is there proper sample flow? Check both drains for flow, especially the left drain, which should be around 120 ml/min. On applications that read very low chlorine residuals, or no chlorine residuals most of the time, check for algae growth in the cell, particularly underneath the mixer motor at the back of the cell.

# Troubleshooting

***Troubleshooting:*** *continued*

**FX-1000 Chlorine Analyzer -** continued

- Is there proper vinegar feed? Vinegar use should be about 4.5 days per gallon on a #14 tube.
- Algae in the vinegar. Old or contaminated vinegar can support white algae growth, which will deteriorate the vinegar's effectiveness, and cause erroneous readings. This will get pulled into the peristaltic pump tube, and continue to contaminate new vinegar bottles. So, if you find it, everything that comes in contact with the vinegar should be rinsed-off.
- Cell pH? The vinegar brings the cell pH down to around 4.0. High sample pH and high Total Alkalinity can affect how low the pH can go in the cell. If the pH inside the cell gets above 5.5, the analyzer will read low, or sluggishly. A quick test is to add a drop of vinegar to the inlet weir and watch for increased readings. If the residual reading goes up you have a pH problem. You can also check the pH of the effluent of the left drain with a good pH meter.
- Is the cell clean? Normally, the cell is self-cleaning, but wastewater and food processing applications my require occasional manual cleaning, especially the inside surface of the copper ring. A green Scotch-Brite pad works well for this.
- Has the analyzer been calibrated lately?
- Is the display select switch in "run" mode only? (all others switches off)
- Is the mixer and peristaltic pump on?
- Accuracy of calibration test. How accurate is the test instrument that you are using to calibrate the analyzer?
- Cell connections. Are they loose or corroded?
- Ribbon Cable (bent pins on installation, has someone worked on it lately?) Milliamp output not working?

# Troubleshooting

***Troubleshooting:*** *continued*

**FX-8500 Setpoint Controller**

- Is data setup correct? (refer to configuration tables)
- Is the controller in “PB” Control? (rather than “GAIN”)
- Is the controller in “MIN” Control? (rather than “RPM”)
- Is the controller “PIDA” Algorithm?
- Is the controller in reverse action mode? (“REV”)
- Is the controller in local setpoint? (“1LOC”)
- Has “OUT LO” or “OUT HI” been limited too far? (default: 0% & 100%)
- Is there too much input filtering? (“FILTR 1”, 0-120 seconds)
- Is the Proportional Band too tight or too loose?
- Is the “I-MIN” time too short or too long?
- Have you allowed sufficient time for the system to balance itself?

**FX-8 Series Auto-Pacing Valve**

- Does the unit operate correctly in “manual” mode?
- Does the unit operate correctly in “auto” mode with a milliamp source connected to the input?
- With a 4mA input & 0 “dosage” does the valve close fully?
- When the valve is fully closed does the gas rotameter go to 0?
- With a 20mA input & 0 “dosage” does the valve open 1/2 way? (approx.. 1 1/2” travel from zero”)

**Chlorine Feed Equipment**

- Is there any chlorine gas in the cylinders?
- Are the cylinder header valves open?
- Is there an air or vacuum leak somewhere in the system?
- Is there vacuum? Is it enough?
- Is the booster pump that feeds the injectors providing enough pressure to drive the injector properly?
- Have the rate valves on top of the rotameters (if so equipped) been adjusted?

# Troubleshooting

***Troubleshooting:*** *continued*

**Miscellaneous:**

- Is someone else making unauthorized control changes?
- Are there any interfering factors that the control system cannot compensate for? Such as: additional chlorine injection in the process, that the FX-8500 does not have direct control of.
- Have you correlated the problem to a change noted on the chart recorder?
- Is there an interfering oxidizer in the process that the chlorine analyzer is picking up? Potassium Permanganate, Ozone, and Bromine will all show up as a chlorine reading.

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**Serial Number**

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