



Diamond Liberator Control

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

Software Version 1.01

Table of Contents

1. INTRODUCTION	1
1.1 SCOPE.....	8
1.2 DEFINITIONS, ACRONYMS AND ABBREVIATIONS.....	8
1.3 REFERENCES.....	8
2. GENERAL REQUIREMENTS	8
2.1 PRODUCT CHARACTERISTICS.....	8
2.2 USER CHARACTERISTICS.....	9
2.3 GENERAL TRADE-OFFS AND CONSTRAINTS.....	9
3. MAIN OPERATING STATES	9
3.1 POWER ON RESET.....	10
3.2 SELF TEST.....	ERROR! BOOKMARK NOT DEFINED.
3.3 STANDBY POWER.....	10
3.4 SYSTEM SETUP.....	10
3.5 PROGRAM AND DATA DISPLAY.....	10
3.6 IN SERVICE.....	10
3.7 REGENERATING.....	10
4. PROGRAMMING AND DATA DISPLAY	11
4.1 FACTORY PROGRAMMING (NOT PART OF SOFTWARE).....	11
4.2 SYSTEM SETUP.....	12
4.3 LEVEL I PROGRAMMING.....	12
4.4 LEVEL II PROGRAMMING.....	14
4.5 CYCLE TIME PROGRAMMING.....	15
4.6 HISTORY DATA.....	16
4.7 MANUAL REGENERATIONS.....	17
4.7.1 Delayed Manual Backwash.....	17
4.7.2 Immediate Manual Backwash.....	17
4.7.3 Delayed Second Backwash.....	17
4.7.4 Double Immediate Manual Backwash.....	17
5. OPERATING REQUIREMENTS	17
5.1 IN SERVICE.....	17
5.1.1 Model 762 (Demand).....	18
5.1.2 Pump Run Mode.....	19
5.2 REGENERATING.....	20
5.2.1 Motor Control in Regenerating Mode.....	20
5.2.2 Key Control in Regenerating Mode.....	20
5.3 POWER UP.....	21
5.4 POWER DOWN.....	21
5.5 SUPER CAPACITOR POWER.....	21
5.6 SELF TEST.....	ERROR! BOOKMARK NOT DEFINED.
5.7 DISPLAY ERROR.....	23
5.8 INPUTS AND OUTPUTS.....	23
5.8.1 Inputs.....	23

5.8.2	Outputs	23
5.9	FLOW CONVERSION	ERROR! BOOKMARK NOT DEFINED.
	• User Defined K factor (flow sensor select 3)	Error! Bookmark not defined.
	• User Defined Meter Factor (flow sensor select 4).....	Error! Bookmark not defined.
5.10	<i>DATA BASE REQUIREMENTS</i>	ERROR! BOOKMARK NOT DEFINED.
5.10.1	Data and Data Base Format	Error! Bookmark not defined.
5.11	<i>DESIGN CONSTRAINTS</i>	ERROR! BOOKMARK NOT DEFINED.
5.12	<i>HARDWARE LIMITATIONS</i>	ERROR! BOOKMARK NOT DEFINED.
5.13	<i>MAINTAINABILITY</i>	ERROR! BOOKMARK NOT DEFINED.
6.	REVISION HISTORY	ERROR! BOOKMARK NOT DEFINED.

Table of Figures

Figure 1:	762 State Diagram	9
Figure 2:	Key Pad	11
Figure 3:	760/762F Liquid Crystal Display & Overlay Text.....	11

Table of Tables

Table 1:	Valve type defaults	12
Table 2:	Level I programming parameters	13
Table 3:	Level II programming parameters	14
Table 4:	Cycle positions.....	15
Table 5:	History Data.....	16
Table 6:	Self Test Troubleshooting Guide.....	22

1. WATER FILTER SYSTEM

1.1. INTRODUCTION

The Diamond H₂O Filter System produces high quality acid neutral water. Acidic water (less than 7 pH) can have a number of undesirable effects. It can lead to leaching of metal pipes. This can give the water a metallic or sour taste, and can even cause various health problems due to higher concentrations of the metals (copper, lead, and zinc) in the water. Aesthetic problems such as staining to your laundry, sink, and drain are also common from acidic water.

Diamond H₂O Filter Systems utilize calcite to neutralize acidity. Calcite is a crushed and screened white marble media used to neutralize acidic or low pH water. Acidic waters, on contact with calcite, slowly dissolve the calcium carbonate media to raise the pH. The sacrificial media will have to be periodically added as it dissolves. Calcite increases hardness and a water softener may have to be added after the neutralizing filter.

Filters using Calcite work best when the alkalinity is less than 150 PPM and Total Dissolved Solids (TDS) less than 250 PPM. Consult the factory if the influent water alkalinity is higher.

Calcite filters will provide 30 - 40 micron filtration.

1.2 SYSTEM SPECIFICATIONS

MODEL #	LIR-10	LIR-15	LIR-20	LIR-25
Tank Size	10" X 44"	12" x 54"	14" x 65"	16" X 65"
Birm Media	1 cu. Ft.	1.5 cu. Ft.	2 cu. Ft.	2.5 cu. Ft.
KDF Media	8 lbs.	12 lbs.	18 lbs.	22 lbs.
Gravel #20	15 lbs.	20 lbs.	30 lbs.	40 lbs.
Inlet/Outlet	1" NPT	1" NPT	1" NPT	1" NPT
Drain	3/4" NPT	3/4" NPT	3/4" NPT	3/4" NPT
Service Rate Continuous*	3 GPM	4 GPM	6 GPM	8 GPM
Service Rate Peak*	6 GPM	9 GPM	12 GPM	16 GPM
Backwash Rate	9 GPM	13 GPM	18 GPM	24 GPM
Power	120 V, 1 PH	120 V, 1 PH	120 V, 1 PH	120 V, 1 PH

* Continuous Service rate is at 6 PSI pressure drop.
Peak Service rate is at 10 PSI pressure drop.

Diamond H2O

**N1022 Quality Drive / PO Box 170 / Greenville, WI 54942
Ph: (920) 757-5440 / (866) 757-9287 / Fax: (920) 757-5819**

2. GENERAL INSTALLATION INSTRUCTIONS

2.1 LOCATION

1. Select a position near a floor drain that has adequate carrying capacity to handle the filter backwash flow rate. Refer to the Specification Table on page 1 for the backwash flow rate.
2. Erect the filter on a level, firm foundation, preferably concrete. The valve and piping are normally in front.
3. Level the system.

2.2 MECHANICAL

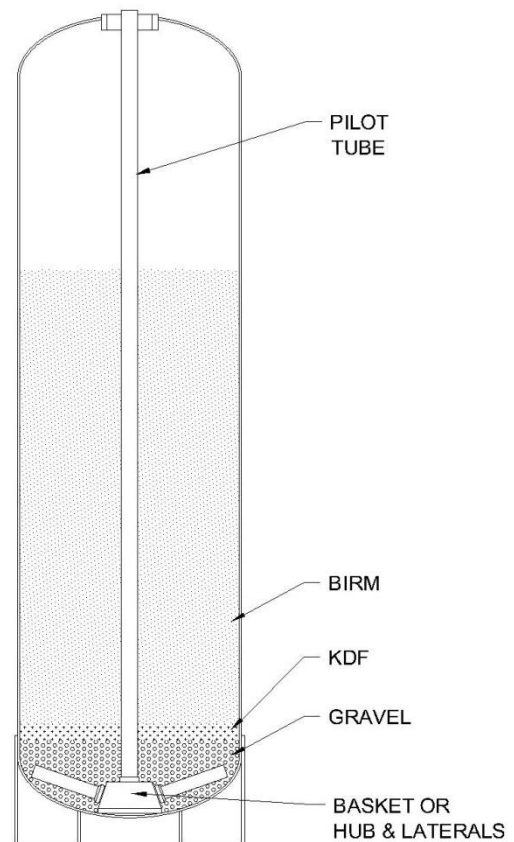
NOTE: Please verify that you have the proper amount of gravel and media on site before proceeding. If the amounts of gravel and media on site differs from what is listed in the Systems Specification table contact Diamond H₂O for the correct amount.

NOTE: The control valve and bypass are designed to accommodate minor plumbing misalignments but are not designed to support the weight of a system or the plumbing.

1. Thoroughly read and comply with the instructions provided in this manual.
2. Thread the control valve onto the fiberglass tank to determine the correct "Front Orientation". Mark the location on the tank with tape.

Note: After the gravel and media are loaded it is very difficult to move or rotate the tank.

3. Remove the control valve and install the PVC distributor system into the tank.
4. Locate the tank, with the proper front orientation, and then fill the tank approximately half full of water.
5. Cover the exposed end of the distributor pipe to prevent any gravel and/or media from falling into the riser.



2.2 MECHANICAL continued

6. SLOWLY pour the support gravel into the tank. See the System Specification on page 1 for the proper amount for your model.

CAUTION: The distributor system is constructed of PVC, which will break if the gravel is poured into the tank too quickly.

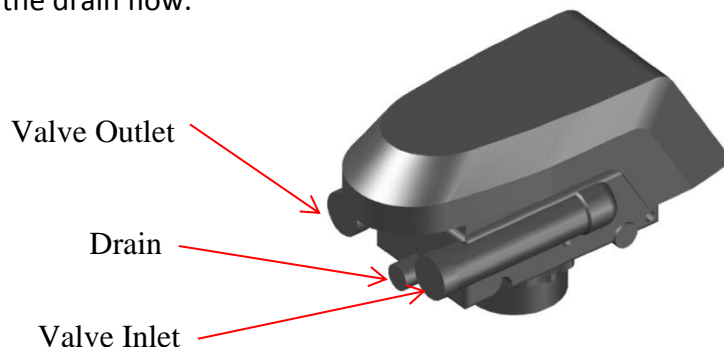
7. When all of the support gravel provided is in the tank, carefully rock the tank back and forth to level the gravel. Confirm that the gravel is covering the distributor basket or radials. If not contact Diamond H₂O.
8. Load the KDF media provided into the tank in the same manner as the gravel. See the System Specification on page 1 for the proper amount for your model.
9. Load the Birm media provided into the tank in the same manner as the gravel. See the System Specification on page 1 for the proper amount for your model
10. Fill the tank with water, if possible.
11. Verify that there is a large tank O-ring on the control valve adapter base.
12. Thread the control valve onto the tank. Make sure that the distributor slides easily into the riser O-ring and does not bind or cut the O-ring.
13. Tighten down the control valve and verify that the orientation is correct to install the plumbing.
14. Connect the facility plumbing to the control valve inlet following all local codes. Temporarily run the control valve outlet to drain at this time.

NOTE: Be sure all piping is free of thread chips and other foreign matter.

15. Pipe a drain line from the backwash flow control assembly to the drain. Use a minimum of elbows and increase or decrease the pipe size to connect to the backwash flow control assembly. Install a union near the backwash flow control assembly to facilitate cleaning, if required.

DO NOT install a valve in this line or use pipe smaller than listed in the Specification Table on page 1.

DO NOT make a direct connection to the drain. Provide an air gap of at least four times the diameter of the drain pipe to conform to sanitation codes and to permit the observation of the drain flow.

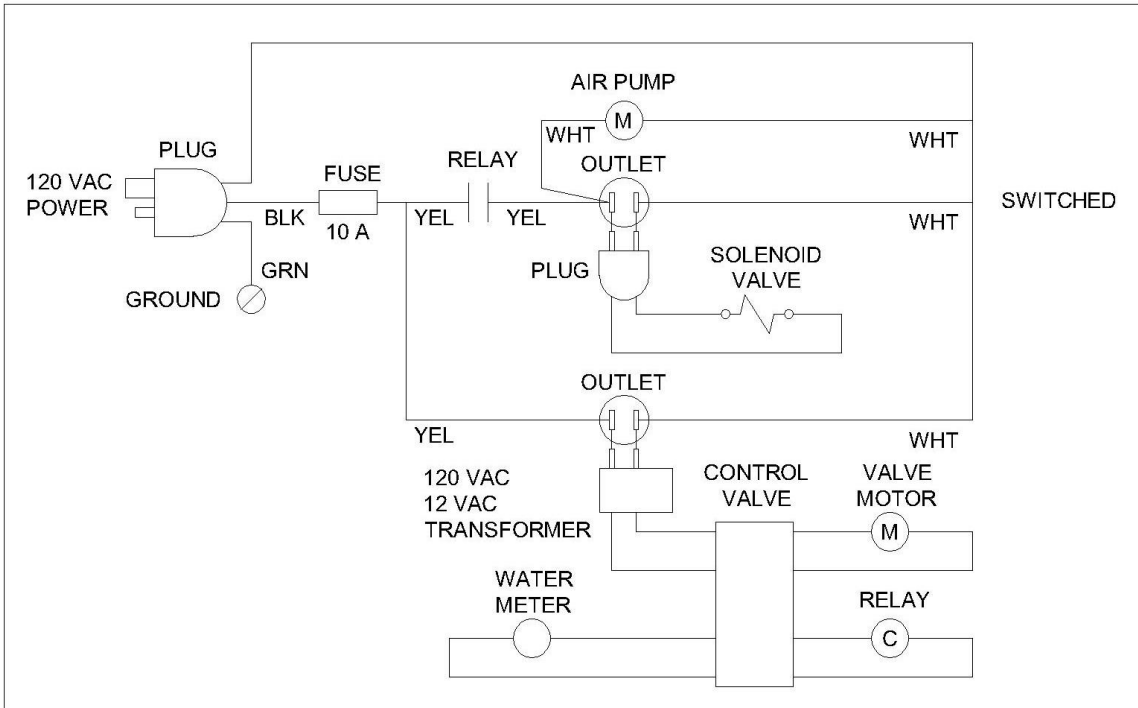


2.3 ELECTRICAL

The Water Filter use requires single-phase 110 volt, 1 phase, 60 hertz, 5 amp service and is equipped with a 10 foot electrical cord and a wall plug-in transformer.

NOTE: We recommend that a licensed electrician install your system in accordance with local and national electrical codes.

WARNING: To reduce the risk of electrical shock, the incoming power supply must include a protective earth ground.



3. GENERAL START-UP INSTRUCTIONS

1. Thoroughly read and comply with the instructions provided in this manual.
2. All plumbing connections to the system must be complete.
3. Note: Start up only one unit at a time and repeat these instructions for multiple units.
4. With the inlet and outlet isolation valves closed and the system bypass open; verify service flow to the facility.
5. Connect power to the unit.
6. Set control valve time and day. Refer to Control Valve Instructions or page 6 for programming and set up.
7. Advance the control to the BACKWASH position by press and holding ▲ and ▼ buttons simultaneously on the valve panel until valve motor starts (typically 3 seconds) and then slowly open the manual inlet valve about 10% open. Water is now being directed into the bottom of the vessel, up through the media and out to the drain. If the vessel was not completely full of water, you will hear air coming out of the drain.

NOTE: The initial backwash water will contain some mineral particles. The media bed should be backwashed until the drain water is clear.

CAUTION: Media should never come out of the drain. If media begins to come out of the drain, close the manual inlet valve until the media is no longer present in the drain flow.

8. Once all of the air has been purged and you have a constant, steady flow of water to the drain, completely open the manual inlet valve. Allow the unit to backwash to the drain for approximately 14 minutes, or until the flow to the drain is clear.
9. The control valve will advance to the FAST RINSE position. The water now flows at a high rate into the top of the tank, down through the media and out to the drain. Allow the unit to automatically fast rinse to the drain for the programmed time, approximately 8 minutes.

3. GENERAL START-UP INSTRUCTIONS continued

10. After the fast rinse time has been completed, the control valve will advance to the SERVICE position.

NOTE: If the drain water is still not clear, initiate another regeneration by press and holding ▲ and ▼ buttons simultaneously until valve motor starts (typically 3 seconds).

11. Test the filtered water for quality.

12. If the Filter is operating properly, close the outlet valve of the control valve. Connect the facility plumbing to the control valve outlet following all local codes.

13. Startup is now complete.

4. PRINCIPLE OF OPERATION

A commonly used water treatment technique for removing iron from water is to add oxygen to the water by utilizing compressed air or an inductor to raise the amount of dissolved oxygen in the water to enhance the oxidation of soluble iron II to insoluble iron III. This addition of air is normally performed during the back wash cycle of the iron filter media in the case of the air pump and whenever water is used for the inductor. The Liberator series valve performs this addition of air based upon the quantity of water that has been treated. When the predetermined amount of water has passed through the Liberator Control Valve the air pump turns on for a predetermined amount of time. Coincident to the air pump running a solenoid valve is opened for the same length of time to allow the air to escape the oxidation tank.

Birm (BM) Birm media is for the reduction of dissolved **iron** and **manganese** compounds from raw water supplies. Birm acts as an insoluble catalyst to enhance the reaction between dissolved oxygen (D.O.) and the iron compounds. When using Birm for iron removal, it is necessary that the water: contain no oil or hydrogen sulfide, organic matter not to exceed 4-5 ppm, the D.O. content equal at least 15% of the iron content with a pH of 6.8 or more.

5. INTRODUCTION

Scope

This SDRS defines the functional capabilities of the software component of the product. The document defines what software capabilities are required, but not how those capabilities are to be implemented in the software design. The information defining how the capabilities are to be implemented is documented in the software design descriptions and source code that are developed after the software design requirements are specified and approved.

This specification focuses on the basic functional requirements, defining these in terms of the inputs to the software, the processing required by the software and the outputs from the software. The specification also defines the operating mode, interface, performance, safety, installation, maintenance and regulatory requirements.

The SDRS forms the basis for the electronic software validation and product validation testing.

Definitions, Acronyms and Abbreviations

Abbreviations

Definitions

FIXED RESERVE - A value, either in gallons or percent of capacity, entered into the unit that is subtracted from the calculated capacity remaining for the unit to determine if regeneration is needed. The same reserve value is used independent of usage pattern.

VARIABLE RESERVE - A value that is based upon the historical usage patterns of the softener. This value is subtracted from the calculated capacity remaining to determine if regeneration is needed. Variable and fixed reserves are mutually exclusive options.

The words regenerate and backwash are used interchangeably. A backwash cycle is a regeneration cycle with the brine draw, slow rinse, and refill cycles reduced to zero minutes.

References

SDRS Diamond Filter ver. 0.3.doc

SDRS EPC 742 & 762 software version 1_07.doc

1. GENERAL REQUIREMENTS

Product Characteristics

This is a standard Logix 762 Control loaded with special customer specific ROM code. It is intended that the control operates much like a standard Logix 762 with exceptions necessary to operate the Diamond Iron Filter System.

User Characteristics

The control and valve will be installed by a technician that has been trained in the special functions of the control. The control will be programmed and functions like a standard Logix 762 Filter control with a few exceptions. The control will energize a customer provided relay using the chlorine generator output. The output will turn on based on water flow and three programmable parameters custom to this control. The parameters custom to the Diamond filter is located at P13, P14, and P15. These parameters are skipped on the standard Logix 762 Filter Control.

General Trade-offs and Constraints

The function of this control will be the same as the Logix 764 Filter control where ever possible to minimize any special training.

2. Main Operating States

Figure 1: 762 State Diagram shows the main operating states for the software and how they interact.

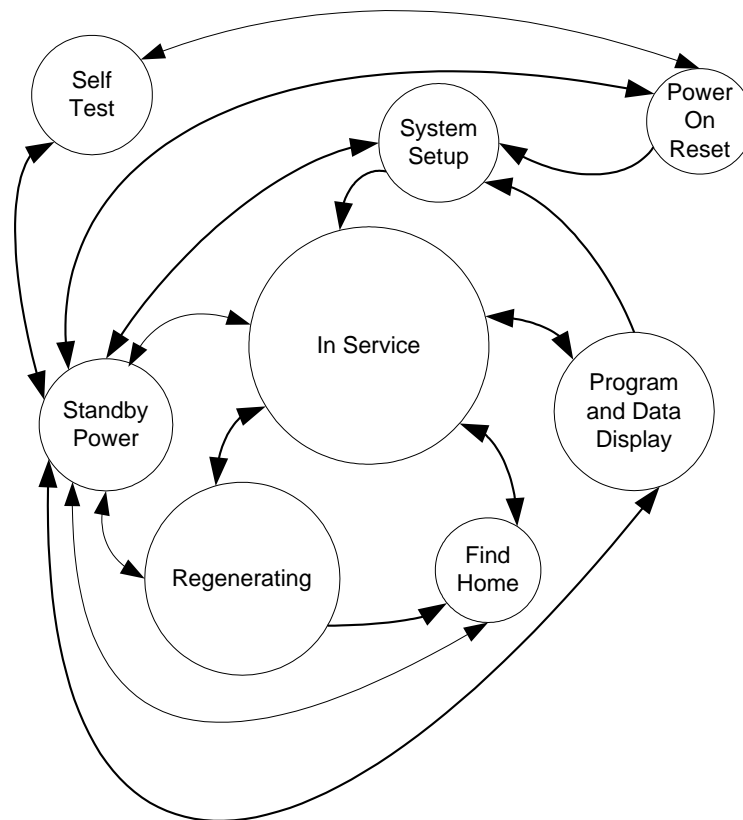


Figure 1: 762 State Diagram

Power On Reset

This will monitor the AC input to determine if the control is operating on 50 or 60 hertz power. Function will pass to the self-test routine if the set key is pressed. The routine initializes all ports and time bases. It reads data from the information memory and checks the validity of the data. The control will set a flag indicating the time of day needs to be set.

Self-Test

The self-test routine will enter from and return to the power on reset routine. The self-test routine will test all inputs and outputs. A simple test fixture will be used to connect to the outputs and inputs.

Standby Power

The standby power routine is called anytime the unregulated voltage falls to a level indicating that AC power has been lost. The microcontroller is placed in a sleep mode waking to maintain the current time of day. Power to operate the microcontroller is supplied by a super capacitor. The display will show the programmed valve number when it wakes from standby power.

System Setup

The initial programming routine is used to load a set of programmable variables based on the resin volume in the softener. The system setup is a two-step process. First the valve is selected, and then the resin volume is selected. The system setup routine is normally entered from the power on reset routine if the initial setting (resin volume) is “no setting”. The initial setting can be cleared in the Program and Data Display State.

Program and Data Display

The program and data display state consists of several routines that allow for setting and displaying programmable values.

In Service

The in service state uses several routines that handle the monitoring and display function while the valve is in service.

Regenerating

The regenerating routine handles the operation of the motor to position the cam in various positions as needed to perform regeneration of the resin bed.

3. Programming and Data Display

The six levels of programming the control are Factory Programming, System Setup, Level I Programming, Level II Programming, Cycle Time Programming, and History Data. Factory programming will use a PC to program the flash ROM and information memory in circuit. All other programming will be performed using the Figure 2: Key Pad, Figure 3: 760/762F Liquid Crystal Display & Overlay Text.

The DOWN key is the down arrow on the far left. The SET key is the square between the down and up arrows. The UP key is the up arrow to the right of the square. The REGENERATION key is the recycle symbol on the far right.

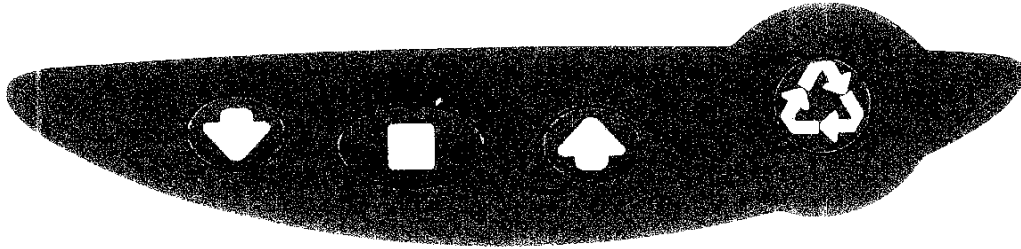


Figure 2: Key Pad

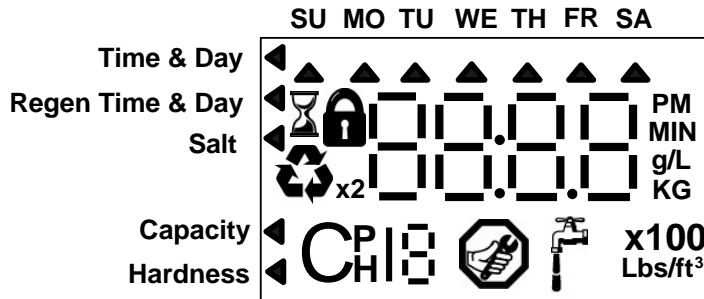


Figure 3: 760/762F Liquid Crystal Display & Overlay Text

Factory Programming (not part of software)

The special Diamond Iron Filter ROM code will be loaded into the control at the factory immediately before valve testing. A label indicating “Diamond Liberator” will be placed on the control immediately after the ROM code is loaded.

System Setup

The control will ship from the factory with US units and 12 hour clock. The control will operate with 50 or 60 Hz power. The customer will select the valve model 263 in the first programming step.

The user will press the SET key when the correct valve selection is displayed. Entering the valve number shall load a set of default values that are dependent on valve selection. Table 1 shows the default values loaded with the valve selection.

Table 1: Valve defaults

Valve	
Turbine Type	1 inch
Backwash 1 Time (min)	14
Fast Rinse Time (min)	10
Re-pressurize Time (min)	1
Backwash-2 Time (min)	1
Fast Rinse-2 Time (min)	1

The resin volume selection shall be limited to “F” for filter if a filter valve is selected.

Level I Programming

Level I programming can be entered by pressing the UP, DOWN, or SET keys. Pressing the UP or DOWN key shall enter the display mode. All parameters available in Level I programming will be displayed with the corresponding icon pointing to the parameter name. The small “P” on the bottom of the display is off indicating Level I. Pressing the UP key will move to the next item up in Tables 5 and 6. Pressing the DOWN key will move to the next item down in the table. Going up while displaying “Time of Day” will loop to “Hardness” for 760 mode. The LOCK icon will turn on if the parameter being viewed is locked out.

Pressing the SET key will enter the change mode at “Time of Day”. The change mode will be entered at the displayed parameter if the control is in data mode when the SET key is pressed. The displayed parameter will flash. Pressing the Up or DOWN key will change the flashing value of the parameter. Holding the UP or DOWN key will scroll the flashing parameter value at a 20 counts per second rate. Pressing the SET key again will enter the flashing value in the appropriate parameter and advance to the next parameter.

Table 2: Level I programming parameters

	Parameter Description	Range of Values	Minimum Increment	Default	Units of Measure	Notes
P1	Time of Day	1:00 - 12:59 AM or PM 0:00 - 23:59	1 minute	12:00 PM	hour minute	Range depends on value selected for P10
P2	Day of Week	N/A	1 day	None	N/A	Uses arrows under days of week on overlay.
P3	Time of Regeneration	1:00 - 12:59 AM or PM 0:00 - 23:59	1 minute	2:00 AM	hour minute	Range depends on value selected for P10
P4	Calendar Override	0-99	1	3	days	0 = no calendar override, 0.5 = regeneration twice a day at time of regeneration and 12 hours later. Calendar Override skipped if at least one Day of Regeneration selected. Can be locked out of changes in Level I programming.
P5	Day of Week Regeneration	N/A	1 day	None	N/A	Uses bars under days of week on overlay.
P6	Backwash Time (3 cycle filter mode)	0-200	1	14		Minutes of backwash in 3 cycle filter mode. Uses the arrow that points to salt amount on control in softener mode.
P7	Capacity of unit (demand only)	0-90,000 0-900	100 1	0	Gallons M ³	Unit of measure depends on value selected for P9.
P8	Backwash 1 Pump On	0-1	1	0	N/A	0 = Auxiliary Output off during Regeneration 1 = Auxiliary Output on during Backwash 1 cycle
Notes:						

Level II Programming

Level II display mode is entered by pressing and holding the UP and DOWN keys for 3 seconds. The display will show the small “P” in the lower portion of the display indicating the control is in Level II programming. Programming in Level II is the same as programming in Level I. Other values in tables 3 and 4 are viewed by pressing the UP or DOWN keys. Items that are locked out of Level I programming will have a flashing LOCK icon. The flashing LOCK is turned on or off by pressing the REGENERATE key.

Pressing the SET key while in Level II display mode will enter Level II programming mode. The displayed parameter will flash. Pressing the Up or DOWN key will change the flashing value of the parameter. Holding the UP or DOWN key will scroll the flashing parameter value at a 20 counts per second rate. Pressing the SET key again will enter the flashing value in the appropriate parameter and advance to the next parameter.

Table 3: Level II programming parameters

	Parameter Description	Range of Values	Minimum Increment	Default	Units of Measure	Notes
P9	Units of measure	0-1	1	0		0 = US 1 = Metric.
P10	Clock mode	0-1	1	0		0 = 12 hour clock 1 = 24 hour clock.
P11	Service Interval	0-250	1	0	Months	Uses 30 days for each month.
P12	Remote regeneration switch delay	3-250	1	60	seconds	Time remote switch must be active to start regeneration on 742 time clock units.
P13	Pump Gallons Set	0 – 250 0.1 – 2.50	1 0.1	10 1	gallons kiloliters	The pump will start at first turbine pulse if “0” is set
P14	Pump Run Time	1 –250	1	10	Seconds	
P15	Pump Run Calendar Override	0-30	1	0	days	0 = no calendar override
P16 (3)	Reserve Type (demand only)	0-3	1	0		0=variable reserve delayed regeneration 1=fixed reserve delayed regeneration 2=variable reserve immediate regeneration 3=fixed reserve immediate regeneration
P17 (3)	Initial average or fixed reserve (demand only)	0-70	1	30	% of Capacity	Depends on value entered in P16
P18 (3)	Flow sensor select (demand only)	0-5	1	(1)		0=internal magnum NHWB, 1=1” Autotrol turbine, 2=2” Autotrol turbine, 3=User define K-Factor, 4=User defined Pulse Equivalent, 5=internal Magnum HWB
P19 (3)	K-factor or Pulse Equivalent	1.00-99.99 1-9999	0.01 1	0.01 1		K-factor P18=3; Pulse Equivalent P18=4

Cycle Time Programming

The cycle times display mode is entered by pressing and holding the UP and SET keys for 3 seconds when the control is in the “in service mode”. The display shall show the small “C” in the lower portion of the display indicating the control is in cycle times programming. Pressing the UP and DOWN keys shall display the programmed time to remain in each cycle. Pressing the REGENERATION key shall exit the cycle times display mode.

Pressing the SET key while a programmed cycle time is displayed shall enter the change cycle time mode. The cycle time in minutes shall flash indicating it can be changed from zero to 200 minutes. Pressing the UP or DOWN keys shall change the flashing time. Pressing the SET key while the cycle time is flashing shall enter the flashing value displayed in the display cycle number. The draw and refill cycle times may be programmed for 3 cycle filters.

Table 4: Cycle positions

Step #	Description
C1	Backwash
C2	Draw & Rinse (1)
C4	Re-pressurize
C5	Fast Rinse
C6	2 nd Backwash
C7	2 nd Fast Rinse
C8	Refill (1)

(1) Draw and Refill times may be programmed in minutes on 3 cycle filter valves.

(*) Wide Gap

History Data

History Data mode is entered by pressing and holding the DOWN and SET keys for three seconds. The stored initial setting will be flashing on the display. The initial setting is reset to the as shipped condition by pressing and holding the SET key for three seconds while it is being displayed. The UP and DOWN keys are used to scroll through the available History Data values as seen in Table 5.

The days Sunday through Saturday in H7 through H13 assume the overlay used has Sunday on the far left and Saturday on the far right.

The average usage for each day of the week will be set to initial average (P17 value) % of the total water the system will treat prior to any usage history being recorded. Averages will also be reset to this initial average % value anytime the hardness value is changed.

Table 5: History Data

	Description	Range	Notes
H0	Initial Setting Value	Cubic Feet or Liters	Resin Volume
H1	Days since last regeneration	0-255	
H2	Current Flow Rate	Depends on Turbine Used	
H3	Water used today in gallons / m ³ since Time of Regeneration	0-131,070 gallons or 0-1,310.70 m ³	
H4	Water used since last regeneration in gallons / m ³	0-131,070 gallons or 0-1,310.70 m ³	
H5	Total water used since reset in 100s	0-999900 gallons or 0-9999 m ³	
H6	Total water used since reset in 1,000,000	4,294 x 10 ⁶ gal or 4264 x 10 ⁴ m ³	
H7	Average usage for Sunday in gallons or m ³	0-131,070 gallons or 0-1,310.70 m ³	
H8	Average usage for Monday in gallons or m ³	0-131,070 gallons or 0-1,310.70 m ³	
H9	Average usage for Tuesday in gallons or m ³	0-131,070 gallons or 0-1,310.70 m ³	
H10	Average usage for Wednesday in gallons or m ³	0-131,070 gallons or 0-1,310.70 m ³	
H11	Average usage for Thursday in gallons or m ³	0-131,070 gallons or 0-1,310.70 m ³	
H12	Average usage for Friday in gallons or m ³	0-131,070 gallons or 0-1,310.70 m ³	
H13	Average usage for Saturday in gallons or m ³	0-131,070 gallons or 0-1,310.70 m ³	
H14	Average service cycle	0-255 days	
H15	Peak Flow Rate	0-200 GPM or 1000 LPM	
H16	Day and Time of Peak Flow Rate	Time and day that peak flow occurred	
H17	Months since service	0 – 2184 months	
H18	Days since last (Auxiliary on) pump run.	0-255	

Manual Regenerations

The REGENERATION key is used to program manual regenerations.

3.1.1 Delayed Manual Backwash

A delayed manual regeneration is programmed by pressing the REGENERATION key. The regeneration icon on the LCD will flash indicating regeneration will start when the time of day reaches the programmed time of regeneration. Pressing the REGENERATION key again will turn off the regeneration icon and cancel the delayed regeneration.

3.1.2 Immediate Manual Backwash

An immediate manual regeneration is programmed by pressing and holding the REGENERATION key for three seconds. The regeneration icon on the LCD will turn on. The control will go to the regenerating mode.

3.1.3 Delayed Second Backwash

A delayed second regeneration is programmed by pressing the REGENERATION key while the control is in the regenerating mode. The x2 icon next to the regeneration icon will flash indicating a second regeneration will start when the time of day reaches the programmed time of regeneration.

3.1.4 Double Immediate Manual Backwash

Back to Back manual regenerations are programmed by pressing and holding the REGENERATION key for three seconds while the control is in the regenerating mode. The x2 icon next to the regeneration icon will turn on indicating a second manual regeneration will start immediately after current regeneration is complete.

4. Operating Requirements

There are five operating modes for the control. The operating modes are In Service, In Regeneration, Standby Power, Self-Test, and Display Error.

In Service

The valve is delivering treated water while the control is in service.
The cam is in the home position.

4.1.1 Model 762 (Demand)

Perform the following functions in the Service operating mode:

- Display the current flow rate and flow icon for 6 seconds alternating with the capacity remaining for 4 seconds. Also display “P18” if the flow sensor select is set to 4 – Meter Factor.
- Display a flashing Regeneration icon, if a regeneration will be performed at the next time of regeneration.
- Display the needs service icon if the days since the control was serviced divided by 30 exceeds the programmed service interval (P11 in months).
- Monitor the status of the photo interrupter. Go to Error Mode if photo interrupter is blocked and Capacity setting is not zero.
- Monitor the four programming keys. Go to programming mode if key is struck.
- Update Time of Day once a minute.
- Update Day of Week at midnight.
- Count pulses from Flow Sensor input and convert to gallons or dekaliters / 5 seconds as described in paragraph **Error! Reference source not found.**
- Turn on flow icon if turbine pulses were detected in the last 5 second sample period.
- Compute the rolling average flow rate using the formula below. Compare the average flow rate to the stored peak flow rate. Store the rolling average flow rate as “peak flow rate” and the current day and time as the “peak flow day and time” if it is higher than the stored peak flow rate.

$$\text{Rolling Average} = ((\text{old average} \times 7) + \text{new 5 second rate}) / 8$$

- Add gallons / dekaliters per 5 seconds to *Today's Usage*.
- Add gallons / dekaliters per 5 seconds to *Water Used Since Last Regeneration*.
- Set Control for a pending regeneration (Regeneration Icon Flashing) if Capacity is not zero and:

$$(\text{Capacity} - \text{Water Used Since Last Regeneration}) < (\text{Reserve})$$

Where: Reserve = 1.2 x the daily average for the current day

Or

Reserve = the water used yesterday if the water used yesterday was twice the average for yesterday.

- Enter pump run mode if the water used since last pump run is more than the value programmed in P13.
- Enter pump run mode when a turbine pulse is detected if P13 is set to zero.
- Enter pump run mode if days since last pump run is equal to the value programmed in P15.

4.1.2 Pump Run Mode

- Suspend the pump run if control is in backwash mode unless P8 (Backwash 1 Pump ON) is set to 1.
- Energize the auxiliary relay coil.
- Display “P-On” on display when the relay is energized.
- Alternate “P-On” with the in regeneration display if the relay is energized while the control is in regeneration.
- Update the pump run seconds once each second.
- Turn off the auxiliary relay coil when the pump run seconds are equal to the value entered in P14.
- Reset the water used since last pump run to zero when the pump run seconds are equal to the value entered in P14.
- Reset the days since last pump run to zero when the pump run seconds are equal to the value entered in P14.

Perform the following functions daily at the programmed time of regeneration:

- Go to Regeneration Mode if programmed for pending regeneration (Regeneration Icon Flashing)
- Skip Regeneration Mode if capacity is set to zero.
- Re-compute the average service cycle (days between regenerations) if a regeneration is needed using the following formula:

$$\text{average service cycle} = ((\text{old average service cycle} \times 3) + \text{days since last regeneration}) / 4$$

- Update Days Since Last Regeneration.
- Update the number of days that have elapsed since the control was serviced. (for service interval)
- Compute average daily usage for that day by the following formula:

If *Today's Usage* is greater than $0.1 \times \text{Old Average for Day } N$

$$\text{New Average for Day } N = (\text{Old Average for Day } N \times 3 + \text{Today's Usage}) / 4$$

If not

$$\text{New Average for Day } N = \text{Old Average for Day } N$$

Where N is the day of the week and has a value of 1 to 7.

Note: Result should be rounded up.

- Set *Water Used Today* to zero.

Regenerating

In the **Regenerating Mode** the following operations are performed

- Calculate the initial value for *Regeneration Time Remaining* by adding all cycle times
- Count pulses from Flow Sensor input and convert to gallons or dekaliters / 5 seconds as described in **Error! Reference source not found.**
- Add gallons / dekaliters per 5 seconds to *Today's Usage*.
- Add gallons / dekaliters per 5 seconds to *Water Used Since Last Regeneration*.
- Display current flow rate and flow icon for 6 seconds alternating with *Regeneration Time Remaining* for four seconds.
- Set *Water Used Since Last Regeneration* to zero at the start of the regeneration.
- Set *Days Since Last Regeneration* to zero at the start of the regeneration cycle.

4.1.3 Motor Control in Regenerating Mode

- Turn on motor output and Wait Icon.
- Wait for photo interrupter to be blocked.
- Turn off motor output and Wait Icon at first cycle position. First cycle stop position is 1 degree past the first 3 degree opening in the photo interrupter cup.
- Increment the elapsed cycle time each 1 minute.
- Turn on motor output and Wait Icon when the elapsed cycle time equals the programmed cycle time and advance to the next cycle position.
- Turn the auxiliary relay coil when cam is stopped in the backwash 1 position if P8 (Backwash 1 Pump ON) is set to 1.
- Go to the service position after the last cycle.
- Go to IN SERVICE mode when the service position is reached.
- Go to ERROR mode if a gap of more than 3 degrees is detected unless the control is in the re-pressurize position. **Note:** This error will occur if the control is programmed for the wrong valve.

4.1.4 Key Control in Regenerating Mode

- Show the minutes remaining for the current cycle when the SET, UP, or DOWN keys are pressed.
- Return to the total *Regeneration Time Remaining* when the set key is released.
- Make the elapsed cycle time equal to the current programmed cycle time if the UP key is pressed while the SET key is held. This will advance the cam to the next cycle.
- Flash the x2 Icon if the REGENRATE key is pressed. Toggle the flashing x2 Icon to off if the REGENERATE key is pressed again.
- Turn on x2 Icon if the REGENERATE key is pressed and held for 3 seconds.

Power Up

When a power up reset interrupt occurs the software will perform the following operations:

- Check the primary location for the 742/762 designation in NOVRAM. Check secondary location for 742/762 designation if data in the first location is corrupt. Copy data from second location to the first location if data in the second location is valid. Go to error mode if both locations are corrupt.
- Default to 762N for 60Hz and 762W for 50Hz and go to error mode if both locations are corrupt.
- Check remaining NOVRAM locations for valid data using a checksum. Check second location if first location is corrupt. Go to error mode if data is invalid in both locations.
- Go to System Setup if the valve type has not been selected.
- Set time of day to 12:00 noon.
- Display “- -: -” indicating *Time of Day* needs to be set if initial setting is non-zero.
- Set control for pending regeneration and flash regeneration icon.

Power Down

The control will perform no special functions at power down.

Super Capacitor Power

The standby power mode is entered when the unregulated voltage drops to 7 volts. The following operations are performed in this mode:

- Turn off all outputs and blank display.
- Update the time of day clock once every 4 seconds.
- Put CPU in low power mode.

Self-Test

Self-test mode will be entered by holding the [SET] key down while powering up. The following tests will be performed:

- Turn on all display segments and icons for 2 seconds.
- Display software version for 4 seconds.
- Check if SET key is still pressed. Continue if SET key is pressed otherwise skip to check keys.
- Check NOVRAM. Write to and read data from all NOVRAM location except the primary and secondary locations for the 740/760 designation.
- Check control outputs and inputs. A functional test fixture must be connected to perform the output and input tests. Change display as each input and output is checked to aid in troubleshooting. Stall the test if a failure occurs. Use Table 6 to determine the cause of the failure. No numbers will be seen if all I/O tests pass.

Table 6: Self-Test Troubleshooting Guide

Displayed Number	Failure
200	HOME01 signal high (> 3.0 VDC) but should be low (< 0.3 VDC).
300	HOME01 signal low but should be high.
400	FLOW signal low but should be high
500	CL-IN signal low but should be high
600	CL-IN signal high but should pulse low.
700	Triac Q2 off but should be on (relay K1 not energized). FLOW signal high but should be low.
800	CL-IN low or pulsing low but should be high.

- Check keys by putting an “8-1” in the display and waiting for the DOWN key to be pressed. Put an “8-2” in the display after the DOWN key is pressed and wait for the SET key to be pressed. Continue with “8-3” for the UP key and “8-4” for the REGENERATE key.

Display Error

The display error mode will be called whenever one of the errors described in the previous sections occurs. The following functions will be performed:

- Display "Err1" if both locations of the 742/762 designation are corrupt. Overwrite the primary and secondary locations for the 742/762 designations with 762N for 60Hz and 762W for 50Hz.
- Display "Err1" if NOVRAM data corrupt. Overwrite all NOVRAM locations except the primary and secondary locations for the 742/762 designation with zeros and re-compute the checksum if any key is pressed.
- Display "Err2" if a "North American" control is being operated with a 50Hz supply.
- Display "Err3" and turn on motor if the photo interrupter is blocked when it should be open in the service position. Run motor until the service position is found.
- Display "Err3" and turn on motor if the control detects the service position before the end of a regeneration cycle. Run motor until the service position is found.

Inputs and Outputs

4.1.5 Inputs

The following items will be input to the software:

- Four push button keys DOWN, SET, UP, REGENERATE requiring software de-bounce (bounce will be less than 12 milliseconds)
- Flow sensor output from Autotrol 1 inch turbine. This input becomes a dry contact closure input when operating in 740 mode.
- Line frequency signal used to determine if the control is operating on 50Hz or 60Hz.
- Signal indicating impending loss of 3.5 volt power. (Must be present at least 25 milliseconds before loss of power).
- A switch shall be provided to discharge the super capacitor. The microcontroller is reset when power is applied after the super capacitor is discharged.
- Photo interrupter open collector input to sense the cam position.

4.1.6 Outputs

The software will control the following items:

- LCD Display (Software must provide duty cycle and inter-digit blanking timing.)
- TRIAC output to run AC motor.
- Output to control current to photo interrupter diode.
- Output for relay coil.