USFilter

Operation and Maintenance Manual
Reverse Osmosis Controller

Model CW-2000

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I. INTRODUCTION

The CW-2000 Reverse Osmosis Controller is designed to control and monitor the operating parameters of a single pump reverse osmosis water purification system. Information is displayed on a back-lit liquid crystal display, and on individual light-emitting diodes (LED). Functions and controls are operated through snap-dome switches.

A. Features

Temperature Compensated Conductivity Monitor with Percent Rejection and Adjustable Alarm Setpoint

Water Temperature Monitor with Adjustable High Temperature Shutdown

Three Modes of Operation: Stand-by, Tank Feed, and Direct Feed

Pretreatment Interlock

High Tank Shutdown

Mid Tank Restart

Inlet Valve Control

Pump Control

Low Feed Pressure Sensing with Automatic Reset

High Pressure Sensing

Autoflush with Adjustable Flush Time

Diverter Valve Output

Alarm Output

Sanitization Lockout

B. Specifications

Power Requirements: The controller can operate with a power source of 110, 208, or 230 VAC single phase. A voltage plug is used to select the proper voltage option.

Environment: The controller can operate at a temperature from 0° to 60° C (32° to 140° F). Relative humidity must not exceed 95 percent.

Conductivity Monitor: The conductivity monitor measures the feed and product water quality and displays this information in micro-mho/cm. The display is temperature compensated to 25° C (77° F). The controller calculates and displays the percent rejection of the system, and has an adjustable alarm.

C. Outputs

Inlet Solenoid: A 24 VAC output is provided to power the inlet solenoid. This output always energizes 12 seconds before the pump turns on, and de-energizes 12 seconds after the pump turns off. All water systems equipped with this controller are also equipped with a compatible inlet solenoid valve. If the valve must be replaced it must function on 24 VAC and have a current load less than one ampere.

Flush Valve: A 24 VAC output is provided to power the optional reject solenoid valve. This output will energize during the flush cycle. This is an optional accessory. All water systems ordered with the autoflush option will include a compatible valve. If autoflush is added, or the valve is replaced, the new valve must function on 24 VAC and have a current load less than one ampere.

Motor Starter: A 24 VAC output is included to provide controlled pump operation. This output powers the coil of the magnetic starter relay. This output is energized depending on other operating parameters. This output also has a maximum current rating of one ampere.

Diverter Valve: This is also a 24 VAC output. When the percent rejection of the system is below the setpoint, this output will be energized. This valve is not included with the system. This output is intended to power a relay or some other low current device. The maximum current available is one ampere.

Alarm: This is a 12 Volt D.C. output. This output is energized when the following conditions are present:

Low Pressure Shutdown

High Pressure Shutdown

High Temperature Shutdown

When Percent Rejection is Below Setpoint

The percent rejection alarm can be inhibited. Inhibiting the percent rejection alarm does not inhibit the other alarms. This output is intended for an audible and/or visual indicator. The maximum current available is 100 milliamps.

All outputs are protected by positive temperature coefficient resistors. This eliminates all fuses and prevents damage caused by the incorrect fuse being installed.

D. Inputs

Conductivity Probes: There are four inputs for each conductivity probe, two for the thermistor and two for the conductivity. Inputs are available for both the feed and product probes. Only probes with a cell constant of 1.0 and a thermistor with a nominal resistance value of 20K at 25° C will work with this controller.

Low Pressure Switch: This is a dry contact that tells the system to shut down if the pump suction pressure falls below the desired value. This is a normally open contact. When a circuit is not complete between the two terminals, the system will operate. If contact is made between the two terminals, the system will shut down. A LED will indicate when the system is in a state of low pressure shut down. If the contacts open (pressure returns) within 30 seconds of a shutdown, the system will attempt to restart. The system will make up to five attempts at restarting. The system must be able to run continuously for thirty seconds without seeing low pressure. If the controller senses low pressure after the fifth restart, it will lock out and the alarm reset button must be pressed to resume operation.

High Pressure Switch: This is a dry contact that tells the system to shut down if the pump discharge or membrane pressure exceeds the desired value. This is a normally open contact. When a circuit is not complete between the two terminals, the system will operate. If contact is made between the two terminals, the system will shut down. A LED will indicate when the system is in a state of high pressure shut down. The alarm reset button must be pressed to resume operation after a shutdown due to high pressure.

Tank Level: The controller has two inputs that accept the dry contacts for the high level and mid level switches. These switches read the water level in the RO product storage tank and turn the pump ON or OFF depending on the level.

Install each switch in the tank so that the contacts close when the water level falls below that particular switch. If the controller is in the "Tank Feed" mode, the pump will turn off when the water level reaches the high level switch. The pump will remain off until the water level drops to the mid level switch.

NOTE: *There is an option to use only one (1) level switch, depending on the system setup and customer preference. When using one, be sure to select the high level switch*

NOTE: *Also, if only a high tank level switch is used, select a switch with a built in "dead band" in order to prevent the RO pump from cycling. A switch without a "dead band" could cause the motor starter to fail and can contribute to low product water quality.*

For more information on connecting the tank level switches, see the section titled Tank Level Switches on page 7 of this manual.

Pretreatment Interlock: This is a dry contact that tells the system to shut down when a pretreatment device is not functioning or regenerating. This could be used on a water softener, multimedia filter, chemical feed pump, pressure differential switch on prefilters, etc. This contact is normally closed. When a circuit is complete between the two terminals the system will operate. If contact is broken the system will shut down. A LED will indicate when the system is shut down due to pretreatment interlock. The system will restart itself when the contact is closed.

WARNING **All the inputs described above are dry contacts. Do not apply voltage to these contacts or permanent damage may result.**

E. Mode Descriptions

The stand-by mode is intended to place the system in a temporary non-operational mode. When the system is placed in this mode it will operate for the amount of time set for the flush cycle. If the flush time is set for zero the system will operate for one minute. After this cycle is complete the pump will turn off and the inlet valve will close. The system will repeat this cycle once every hour. When the system is flushing, the amount of time remaining in the flush cycle will be indicated on the last line of the display. When the system is idle, the amount of time remaining until the next flush will be indicated.

The tank feed mode is intended to be used when the system is feeding a storage tank. When in this mode the system will shut down when the high tank level switch (not provided) has an open contact. The system will restart when the mid level switch closes. The flush cycle is also enabled in this mode. If the autoflush option has been included on the system, the controller will activate the flush cycle when the system is turned on and once every hour. When the system is flushing, the amount of time remaining in the flush cycle will be indicated on the last line of the display. When the system is not flushing the amount of time until the next flush will be indicated. The system will still flush every hour even if the tank is full. During a full tank condition the system is essentially in stand-by. *If the flush time is set for zero, the system will not flush when the tank is full.*

The direct feed mode is intended to be used when the system is feeding a distribution loop or another piece of equipment. In this mode the system will not flush and the tank level switch is disregarded. When the system is in this mode, the total number of hours the system has been operated will be indicated on the last line of the display.

F. Controls

Power Button: This button turns the system on and off.

Select Button: This button changes the top line of the display. Each time this button is pressed the display changes to the next parameter. This button is used to select a function or parameter so that it can be changed. The following information is displayed on the top line; Percent rejection and alarm setpoint, flush time, percent rejection alarm inhibit/enable, high temperature limit, and mode of operation.

Up Arrow: This button increases the value of, or advances to the next option of, the function selected.

Down Arrow: This button decreases the value of, or advances to the next option of, the function selected.

Accept Button: Pressing this button causes the controller to store all current values or options in memory.

Alarm Reset Button: This button is used to reset the system after a shut down due to; low pressure, high pressure, high temperature, or overload.

Sanitization Lock Out: This is a key switch which serves as a master power switch. When the system is turned on the key may not be removed. If the system is turned off the sanitization lock out LED will light and the key may be removed.

G. Indicators

Multi Function Display: This is a back-lit liquid crystal display. This display consists of four lines. The top line normally displays the current percent rejection and the percent rejection alarm setpoint. This line changes when the select button is pressed but will return to the percent rejection display after ten seconds if no input is given from the key pad. The second line always displays the feed water conductivity and temperature. The third line always displays the product water conductivity and temperature. The last line displays the flush time remaining or time remaining until the next flush when the tank feed mode or stand by mode is selected. This line displays the total hours of operation when the direct feed mode is selected. If an overload occurs on one of the outputs, the bottom line will read "PRESS ALARM RESET".

There are individual LED's to indicate the following conditions: (See Front View drawing)

Flush On: Indicates when the system is flushing.

Pretreatment Interlock: Indicates when the system is shut down due to external pretreatment equipment.

Tank Full: Indicates when the system is shut down due to a full storage tank. The system will only shut down in the tank feed mode. The light will turn on if the system is in direct feed mode but the system will not shut down.

Below Setpoint: Indicates that the percent rejection is below the alarm setpoint. When the alarm is inhibited this will still turn on.

Low Pressure: Indicates that the system has shut down due to low pump feed pressure.

High Pressure: Indicates that the system has shut down due to high pump or membrane pressure.

High Temperature: Indicates that the system has shut down due to high feed or product water temperature.

Overload Condition: Indicates that the system has shut down due to an overload condition on one of the outputs.

There is also an LED to indicate that the system is turned on, and a sanitization lockout LED to indicate when the key switch is turned off.

II. INSTALLATION

A. Installing a New System

If the controller is purchased as part of a water system, the following procedures should be followed:

Verify that the voltage plug matches the power source that you are using. The plugs are labeled. If the water system is powered by 460 VAC, there should be a step down transformer to provide 230 volts to the controller.

Make any required accessory connections. See Front View drawing for the locations of the appropriate terminal connection, and review output and input specifications on pages 2 through 3 before proceeding.

Tank Level Switches: This controller can accommodate 1 or 2 tank level switches. They are the high-level, and the mid-level switches. If installing only one tank level switch, install the high-level switch. The system, however, will accommodate both and installing the mid-level switch will save wear and tear on the pump motor.

Instructions to Install 2 Tank Level Switches

1. Attach the mid-level tank switch to the left terminal, numbers 6 & 7.
2. Attach the high tank level switch to the middle terminal, numbers 5 & 6.
3. Wire both tank level switches normally closed.
4. Make sure that the controller is set in the 'tank feed mode'.

Instructions to Install 1 Tank Level Switch

1. Jumper the mid level tank switch input to the first terminal 1, numbers 6 & 7.

   Note: If this is not done, the RO controller will remain in the 'tank full mode.'
2. Attach the high tank level switch to the middle terminal, numbers 5 & 6.
3. Wire the high-level switch input normally closed.
4. Make sure that the controller is set for 'tank feed mode'.

NOTE: *If only a high tank level switch is used, a switch should be selected with a built in "dead band" in order to prevent the RO pump from cycling. Using a switch without a "dead band" could cause the motor starter to fail and can contribute to low product water quality.*

Pretreatment Interlock: Remove the shorting wire from terminals 7 and 8 on the middle terminal strip and attach the pretreatment device to these terminals. The system will shut down when the circuit between these terminals is broken.

Several pieces of pretreatment equipment can be wired in series; contacts are normally closed during the service mode.

CAUTION **# 1 and # 2 above are dry contacts; putting voltage to these terminals will cause permanent damage to the controller.**

Diverter Valve: Attach a solenoid or relay to terminals 1 and 2 on the right terminal strip. This output will be energized when the percent rejection is below the setpoint. This output is 24 VAC with a current rating of one amp.

Alarm: Attach an audible and/or visual signaling device to terminals 7 and 8 on the right terminal strip. This is a 12 volt DC output with a current rating of 100 milliamps. Terminal 7 is negative and terminal 8 is positive.

B. Replacing a CW-1000 RO Controller

If this controller is replacing a CW-1000 Reverse Osmosis Controller, the following procedures should be performed:

NOTE: *This controller can only be used with the latest transformer revision. The transformer must be wired to use the voltage plug to select the appropriate voltage. If an old style transformer is installed it must be rewired to use a voltage plug or be replaced with a new style transformer.*

1. Disconnect the power supply from the system.
2. Remove the controller and conductivity modules.
3. Remove the mother board.
4. Remove the two large male terminal connectors from the wires coming from the bottom of the enclosure and replace them with the new connectors provided with the CW-2000 Reverse Osmosis Controller. The new connectors should be wired exactly like the old ones. It is not necessary to rewire the small connector used on the red and white thermistor wires.
5. Be sure that the appropriate voltage plug is installed on the CW-2000 Reverse Osmosis Controller. (See Back View drawing)
6. Plug the transformer on to the back of the CW-2000 Reverse Osmosis Controller. Be sure that the wires coming from the transformer plug point down towards the voltage plug. (See Back View drawing)
7. Install the CW-2000 Reverse Osmosis Controller into the chassis of the controller housing using the thumb screws from the old controller to hold it in place.
8. Plug the male terminal connectors into the new controller.

II. OPERATION

When the power switch is turned on the inlet valve will open. After a 12 second delay the pump will start. The system will operate according to the information stored in the memory.

To turn the system off, press the power button and wait ten seconds before turning the key switch off.

The contrast of the display can be adjusted by turning the adjustment screw. See Front View drawing for the location of this screw.

A. Settings

To set the *flush time* press the select button until "FLUSH TIME" appears on the top line of the display. Press the up or down arrow buttons to select the amount of time for the flush. Press the accept button. The available flush times are: 0, 1, 2, 4, and 6 minutes.

To enable or disable the *percent rejection alarm* press the select button until "REJECTION ALARM" appears on the top line of the display. Press either the up or down arrow buttons to enable or disable the alarm. Press the accept button.

To set the *high temperature limit* press the select button until "HI TEMP LIMIT" appears on the top line of the display. Press the up or down arrow buttons to select the shut down temperature. Press the accept button. The temperature range is from 35 to 50° C.

B. Modes

To change the mode of operation press the select button until "MODE" appears on the top line of the display. Press the up or down arrow buttons to select the desired mode. Press the accept button.

C. Percent Rejection Alarm Setpoint

To adjust the percent rejection alarm setpoint press the select button until the percent rejection appears on the top line of the display. This is the default display and will automatically return to the top line after ten seconds if no inputs are made. Press the up or down arrows to select the alarm setpoint. Press the accept button. The range for the percent rejection alarm is from 80 to 99 percent.

In all cases if the accept button is not pressed the function will remain unchanged and the display will return to the prior value the next time that function is displayed.

D. Conductivity and Temperature Display Calibrations

The first time the system is used, it may be necessary to calibrate the conductivity and temperature displays. See Front View drawing for the location of the calibration screws. Always calibrate the temperature first then the conductivity. When calibrating the conductivity and temperature displays, make small adjustments and wait 10 seconds between adjustments. The controller updates the display once a second and the value displayed is an average of the values from the previous ten seconds. This smoothes out the display and helps prevent large variances between each update.

III. SERVICE AND MAINTENANCE

The CW-2000 Reverse Osmosis Controller is designed for ease of maintenance and minimum service. Since the highest quality of electronic semiconductor components are used in this design, it is not likely that circuit malfunctions or failures will occur. It is our recommendation that service be limited to identifying malfunctions at the board level and that component level troubleshooting be referred to ***USFilter***'s Technical Service Department (see the phone number listed on the cover of this manual.)

It is our experience that field failures which most frequently occur are:

- Improper or broken wiring connections
- Incorrect wiring of magnetic starter
- Improper grounding
- Cable run is too long
- Water in connectors
- Dirty cell electrodes
- Defective probes

A. Troubleshooting

	Type of Problem		Possible Cause or Solution
1.	Motor draws too much current and trips magnetic starter.	1.	Motor overloaded, pump not rotating freely.
		2.	Bearing defective.
		3.	Power distribution not even, check voltages and current drawn on each leg.
		4.	Check pin connectors.
		5.	Current imbalance (3-phase)
		6.	Loss of power on 1 leg (3-phase)
2.	Controller shuts down on low pressure, but pressure in line is okay.	1.	Check setting of pressure switch.
		2.	Check wiring, must be wired normally closed.
		3.	Defective switch, contacts can be corroded or diaphragm could be defective.
		4.	Make sure wiring from controller to pressure switch are shielded wires. Also route wire away from any AC lines or motor windings.
		5.	Inlet to pressure switch is obstructed.

	Type of Problem		Possible Cause or Solution
3.	Magnetic starter keeps cutting out.	1.	Verify wiring to and from coil and controller.
		2.	Verify that the overload relay is set according to rating specified on motor nameplate.
		3.	Check the secondary voltage on the transformer (should be 24 VAC ± 2 volts).
4.	Pressing start/reset button does not show any response and system continues to be off.	1.	Verify wiring.
		2.	Check circuit breakers in front of RO controller.
		3.	Check pin connectors.
		4.	Check that the key switch is installed and turned on.
5.	RO Controller shuts off and does not restart and no alarm indication is present.	1.	Possible brown out, or power outage could unlatch circuit enable mechanism.
		2.	Check for feedback.
6.	RO Controller shuts down on high temperature even though the temperature is below setpoint.	1.	Replace conductivity probes and recalibrate.
		2.	Check for feedback.
7.	Conductivity monitor not displaying proper reading.	1.	Conductivity monitor must be calibrated to match each conductivity probe.
		2.	Check for defective cell or defective connection at cell end.
		3.	Check cable connection; must be tight and free from interference.
		4.	Check for feedback.
8.	RO System is shutting down on high temperature even though temperature is okay.	1.	Check calibration of feed and product conductivity cells.
		2.	Check for defective conductivity cell.
		3.	Replace conductivity module.
		4.	Check for feedback.

	Type of Problem		Possible Cause or Solution
9.	Conductivity monitor shows reading to be higher than known solution.	1.	Check calibration of each cell.
		2.	Sensor electrode not fully immersed.
		3.	Air bubbles in sensing area.
		4.	Fouled sensor.
		5.	Defective sensor wiring.
		6.	Relocate sensor.
		7.	Clean sensor electrode.
		8.	Check sensor wiring.
10.	Conductivity monitor does not respond to known solution.	1.	Calibrate sensors. (See section III. Operation, C. How to Calibrate Conductivity and Temperature Displays.
		2.	Replace sensors.
		3.	Replace leads to sensors.
11.	Conductivity monitor shows low reading for known conductivity changes.	1.	Sensor electrode obstructed.
		2.	Inadequate solution circulation.
		3.	Clean or relocate sensor.
12.	Conductivity reading is erratic.	1.	Faulty sensor.
		2.	Faulty power wiring.
		3.	Moisture in cables.
		4.	Dry or replace cables.
		5.	Check for feedback.

B. Checking for AC Feedback

Using a volt meter that reads alternating current, you will be checking for AC feedback from the 2000 Series controller to the RO frame or piping. AC "Feedback" is caused when one of the "load" contacts used for actuating the inlet solenoid, magnetic starter coil, flush solenoid, and diverter solenoid is grounding out.

The primary symptom of this condition is:

Feed conductivity readings are erratic (the display will show constant variances of 20-100 μmhos).

Set the volt meter in the AC mode (low range) and locate the green conductivity thermistor terminal strip on the left hand side of the circuit board. Use terminal #5 (from the left) as a grounding source for the circuit board. Turn on the RO. With the volt meter set on AC, apply the black lead to the # 5 terminal screw on the circuit board. With the red lead from the volt meter, make a good contact with the metal plumbing on the RO or the surrounding frame. Try to find an area where there is no paint, a metal pipe is the best place. If there is 24 volts AC or more existing, there is a good possibility that one of the 24 volt outputs is grounding. Each 24 volt output will have to be manually checked one at a time by disconnecting the wires at the controller terminal strip. (When disconnecting the inlet solenoid wires, you will need to by-pass the solenoid so the unit has water going to the pump. Plastic valves would require loosening the bleed-off screw and with brass valves the coil will have to be removed and the plunger taken out, then re-assemble the coil to the valve.)

WARNING **Do not energize the coil with the plunger removed. After the ground has been located, repair and re-check the system for AC feedback. Normally there should be less than 0.5 volts AC present.**

C. Checking for DC Feedback

Using a volt meter that reads in direct current, you will be checking for DC feedback from the 2000 Series controller to the RO frame or piping. DC "Feedback" is caused when one of the "dry" contacts used for sensing Low Pressure, High Pressure, Tank Level and Pretreatment Interlocks comes in contact with the water or frame. The primary symptoms of this condition are:

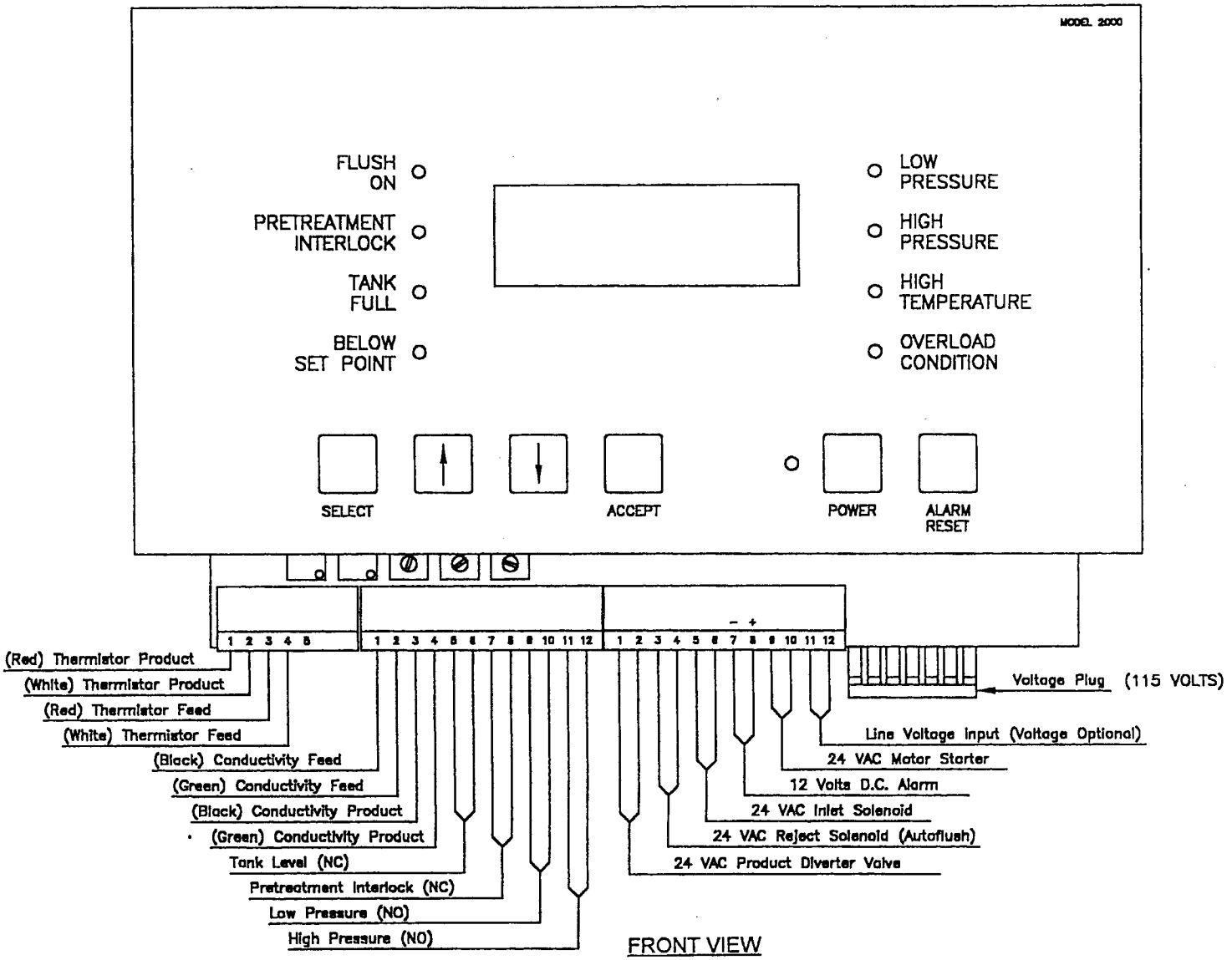
1. Not being able to adjust the product conductivity below 12-15 μmho.
2. High temperature shutdown when temperature is not above the setpoint.
3. Erratic alarm indication.

A tank level switch with a leak in the housing is a common cause of this problem.

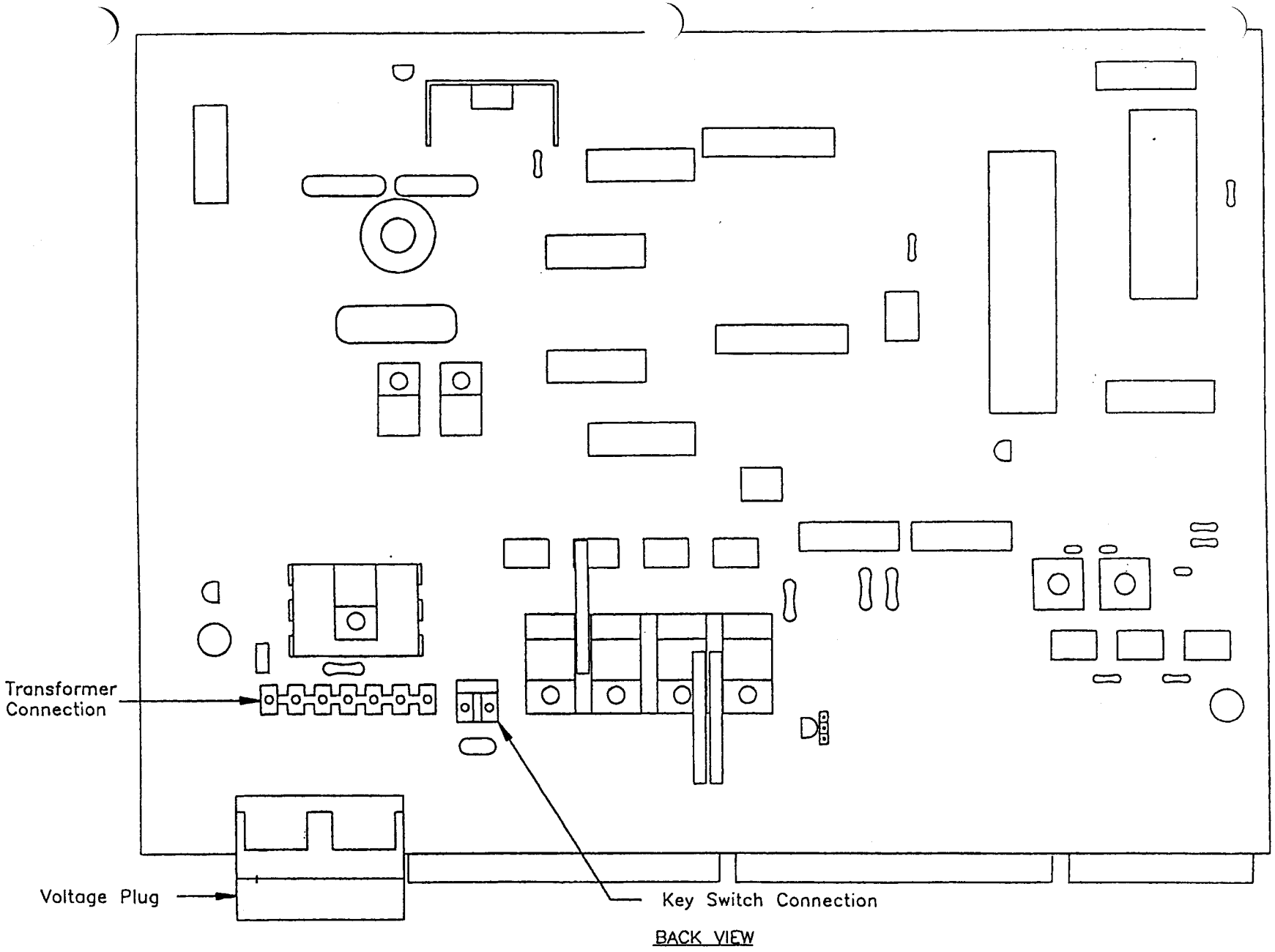
Set the volt meter in the DC mode and locate the green conductivity thermistor terminal strip on the left hand side of the circuit board. Use terminal #5 (from the left) as a grounding source for the circuit board. Turn on the RO. With the voltmeter set on DC, apply the black lead to the #5 terminal screw on the circuit board. With the red lead from the voltmeter, make a good contact with the metal plumbing on the RO or the surrounding frame. Try to find an area where there is no paint, a metal pipe is the best place. If voltage is present (12 VDC ± 3 volts) it is probably caused by one of the sensor from the controller coming into contact with ground. Each output will have to manually be checked. Sensors that could cause problems would normally be pressure switches, tank level switches, wiring to interlocks, etc. Normally there should be less than 1.0 volt DC present.

D. Replacing the Microprocessor

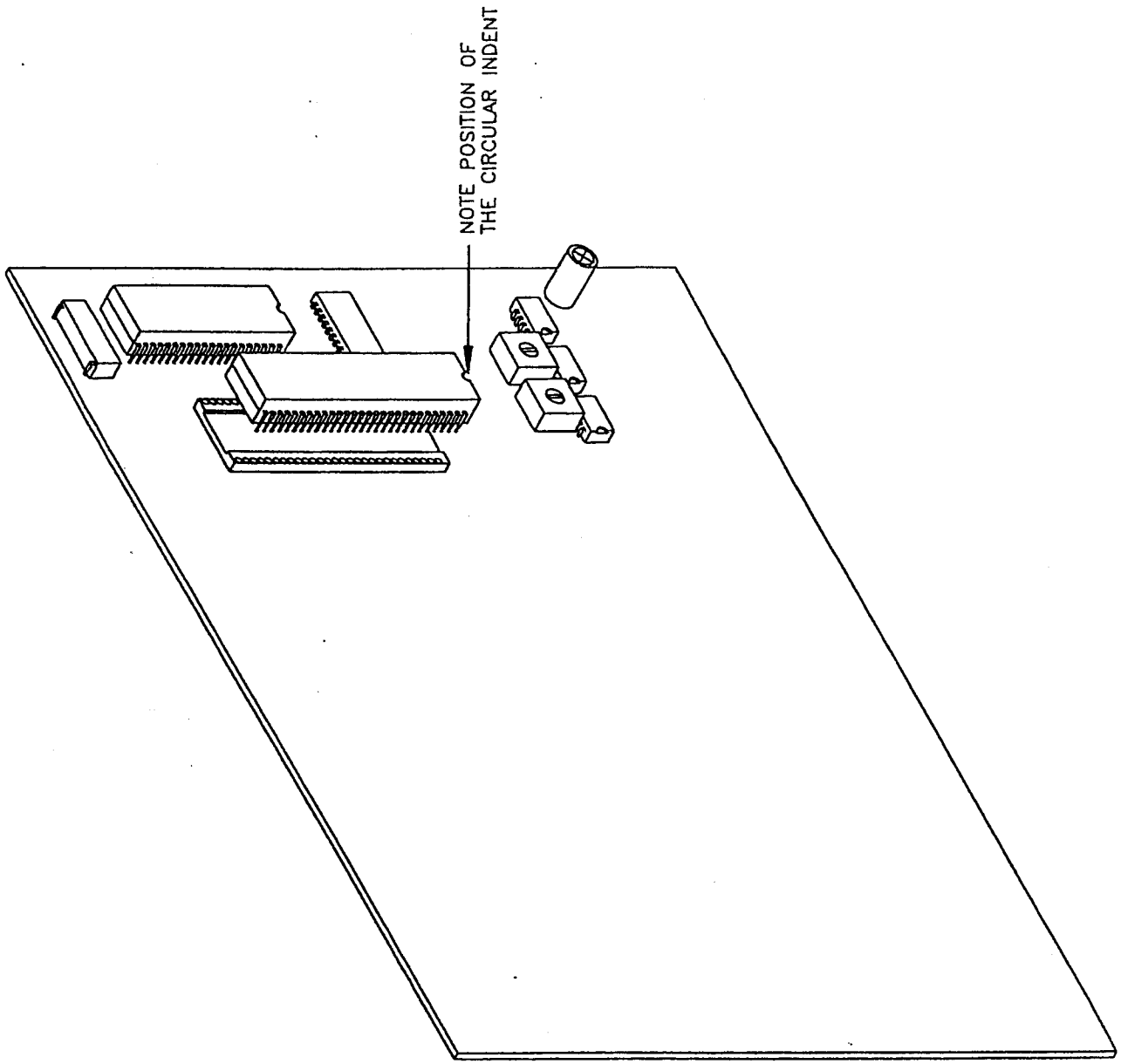
1. Turn the system off and disconnect the power supply.
2. Remove the control board from the system.
3. **Note the position of the circular indent on the end of the chip.** Use a screwdriver and carefully pry the microprocessor chip from its socket.
4. Install the replacement microprocessor in the same socket.
   a. Be sure that the circular indent is on the end of the chip that is closest to the center of the circuit board. (See attached sketch.)
   b. Line all the pins up and press the chip firmly into place.
5. Reinstall the control board in the system.
6. Reconnect the power supply and turn on the system.



FRONT VIEW



BACK VIEW



Microprocessor Placement

General Limited Warranty

United States Filter Corporation ("USF") warrants the products manufactured by it against defects in materials and workmanship when used in accordance with the applicable instructions for a period of one year from the date of shipment of the products. USF MAKES NO OTHER WARRANTY, EXPRESSED OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. The warranty provided herein and the data, specifications and descriptions of USF products appearing in USF's published catalogs and product literature may not be altered except by express written agreement signed by an officer of USF. Representations, oral or written, which are inconsistent with this warranty or such publications are not authorized and if given, should not be relied upon.

In the event of a breach of the foregoing warranty, USF's sole obligation shall be to repair or replace, at its option, any product or part thereof that proves defective in materials or workmanship within the warranty period, provided the customer notifies USF promptly of any such defect. The exclusive remedy provided herein shall not be deemed to have failed of its essential purpose so long as USF is willing and able to repair or replace any nonconforming USF product or part. USF shall not be liable for consequential damages resulting from economic loss or property damages sustained by a customer from the use of its products.

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