

# Installation, Operation and Maintenance Manual

## Commercial Reverse Osmosis Systems

### Series PWR4022

# PURE WATER

**⚠ CAUTION:** Please read the entire manual before proceeding with the installation and startup. Your failure to follow any attached instructions or operating parameters may lead to the product's failure, which can cause property damage and/or personal injury.

- Do not use where the water is microbiologically unsafe.
- Pretreatment must be sufficient to eliminate chemicals that would attack the membrane materials.
- Always turn off the unit, shut off the feed water, and disconnect the electrical power when working on the unit.
- Never allow the pump to run dry.
- Never start the pump with the reject valve closed.
- Never allow the unit to freeze or operate with a feed water temperature above 100°F.

Save manual for future reference.

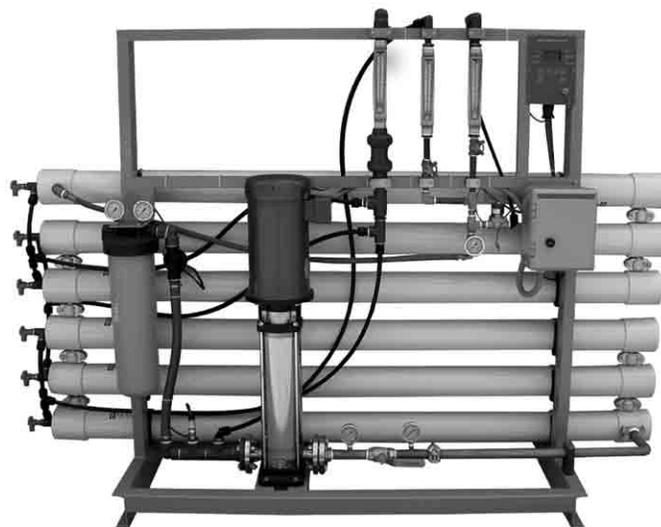
Please refer to Section 6 of this manual for operating parameters according to your specific feed water Silt Density Index (SDI). For all other settings according to your specific feed water quality, please contact your Watts representative. A chemical analysis of the feed water should be conducted prior to the initial sizing and selection of this system.

## Notes

Changes in operating variables are beyond the control of Watts. The end user is responsible for the safe operation of this equipment. The suitability of the product water for any specific application is the responsibility of the end user.

Successful long-term performance of an RO system depends on proper operation and maintenance of the system. This includes the initial system startup and operational startups and shutdowns. Prevention of fouling or scaling of the membranes is not only a matter of system design, but also a matter of proper operation. Record keeping and data normalization are required in order to know the actual system performance and to enable corrective measures when necessary. Complete and accurate records are also required in case of a system performance warranty claim.

Changes in the operating parameters of an RO system can be caused by changes in the feed water or can be a sign of trouble. Maintaining an operation and maintenance log is crucial in diagnosing and preventing system problems. For your reference, a typical log sheet is included in this manual.



Series PWR4022

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**Note:** Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.

# I. Introduction

The separation of dissolved solids and water using RO membranes is a pressure driven temperature dependent process. The membrane material is designed to be as permeable to water as possible while maintaining the ability to reject dissolved solids.

The main system design parameters require the following:

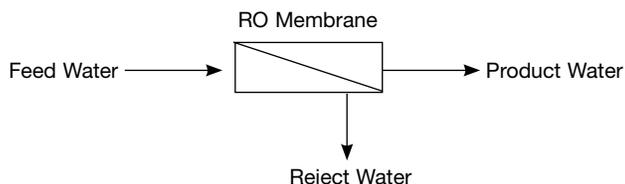
- Internal flows across the membrane surface must be high enough to prevent settling of fine suspended solids on the membrane surface.
- The concentration of each dissolved ionic species must not exceed the limits of solubility anywhere in the system.
- Pre-treatment must be sufficient to eliminate chemicals that would attack the membrane materials.

## A. Specifications

	PWR40223083	PWR40223103	PWR40223123
<b>Maximum Productivity</b> (gallons per day / gallons per minute) Maximum production based on standard membranes and feed water of 25°C, SDI < 3, 1000 ppm TDS, and pH 8. Individual membrane productivity may vary (± 15%). May be operated on other feed waters with reduced capacity.	14,400 / 10	18,000 / 12.5	21,600 / 15
<b>Quality</b> (typical membrane percent rejection) Based on membrane manufactures specifications, overall system percent rejection may be less.	98 %	98 %	98 %
<b>Recovery</b> (without reject recirculation)	59 %	59 %	59 %
<b>Recovery</b> (with reject recirculation, depending on feed water)	75 %	75 %	75 %
<b>Membrane Size</b>	4 x 40	4 x 40	4 x 40
<b>Number Of Membranes Per Vessel</b>	2	2	2
<b>Pressure Vessel Array</b>	2:1:1	2:2:1	3:2:1
<b>Number Of Membranes</b>	8	10	12
<b>Prefilter</b> (system ships with one 5 micron cartridge)	20" BB	20" BB	20" BB
<b>Feed Water Connection</b>	1½" NPT	1½" NPT	1½" NPT
<b>Product Water Connection</b>	1" NPT	1" NPT	1" NPT
<b>Reject Water Connection</b>	¾" NPT	¾" NPT	¾" NPT
<b>Feed Water Required</b> (feed water required will be less if reject recycle is used)	17 gpm	21 gpm	25 gpm
<b>Feed Water Pressure</b> (minimum)	20psi	20psi	20psi
<b>Drain Required</b>	17 gpm	21 gpm	25 gpm
<b>Electrical Requirement</b> 230 VAC, 3-ph, 60 Hz (other voltages available)	15 amps	15 amps	15 amps
<b>TEFC Motor</b> (horse power)	5	5	5
<b>Dimensions L x W x H</b> (ft.)	8 x 3 x 6	8 x 3 x 6	8 x 3 x 6
<b>Shipping Weight</b> (estimated pounds)	1000	1100	1200

## B. RO Overview

Reverse osmosis systems utilize semipermeable membrane elements to separate the feed water into two streams. The pressurized feed water is separated into purified (product) water and concentrate (reject) water. The impurities contained in the feed water are carried to drain by the reject water.



## C. Pretreatment

The RO feed water must be pretreated in order to prevent membrane damage and/or fouling. Proper pretreatment is essential for reliable operation of any RO system.

Pretreatment requirements vary depending on the nature of the feed water. Pretreatment equipment is sold separately. The most common forms of pretreatment are described below.

**Media Filter** - Used to remove large suspended solids (sediment) from the feed water. Backwashing the media removes the trapped particles. Backwash can be initiated by time or differential pressure.

**Water Softener** - Used to remove calcium and magnesium from the feed water in order to prevent hardness scaling. The potential for hardness scaling is predicted by the Langelier Saturation Index (LSI). The LSI should be zero or negative throughout the unit unless approved anti-scalants are used. Softening is the preferred method of controlling hardness scale.

**Carbon Filter** - Used to remove chlorine and organics from the feed water. Free chlorine will cause rapid irreversible damage to the membranes.

*The residual free chlorine present in most municipal water supplies will damage the thin film composite structure of the membranes used in this unit. Carbon filtration or sodium bisulfite injection should be used to completely remove the free chlorine residual.*

**Chemical Injection** - Typically used to feed antiscalant, coagulant, or bisulfite into the feed water or to adjust the feed water pH.

**Prefilter Cartridge** - Used to remove smaller suspended solids and trap any particles that may be generated by the other pretreatment. The cartridge(s) should be replaced when the pressure drop across the housing increases 5 - 10 psig over the clean cartridge pressure drop. The effect of suspended solids is measured by the silt density index (SDI) test. An SDI of five (5) or less is specified by most membrane manufacturers and three (3) or less is recommended.

**Iron & Manganese** - Iron should be removed to less than 0.1 ppm. Manganese should be removed to less than 0.05 ppm. Special media filters and/or chemical treatment is commonly used.

**pH** - The pH is often lowered to reduce the scaling potential.

**Silica:** Reported on the analysis as SiO<sub>2</sub>. Silica forms a coating on membrane surfaces when the concentration exceeds its solubility. Additionally, the solubility is highly pH and temperature dependent. Silica fouling can be prevented with chemical injection and/or reducing the recovery.

## II. Controls, Indicators, and Components (See Figure 1)

### A. General System Component Identification

- (A) Controller - Controls the operation of the system and displays the product water quality. This system uses the micro-electronic based CI-1000 controller.
- (B) Reject Control Valve - Controls the amount of reject flow. A separate reject recycle water control valve is included to regulate waste water recovery.
- (C) Pump Discharge Valve - Used to throttle the pump.
- (D) Prefilter Pressure Gauges - Indicates the inlet and outlet pressure of the prefilter. The difference between these two gauges is the prefilter differential pressure.
- (E) Pump Discharge Pressure Gauge - Indicates the pump discharge pressure.
- (F) Reject Pressure Gauge - Indicates the reject pressure.
- (G) Reject Flow Meter - Indicates the reject flow rate in gallons per minute (gpm). A reject recycle flow meter is also included.
- (H) Product Flow Meter - Indicates the product flow rate in gallons per minute (gpm).
- (I) Prefilter Housing - Contains the RO prefilter.
- (J) Automatic Inlet Valve - Opens when pump is on and closes when the pump is off.
- (K) Low-pressure Switch - Sends a signal to the controller if the pump suction pressure is low.
- (L) RO Feed Pump - Pressurizes the RO feed water.
- (M) RO Membrane Vessels - Contains the RO membranes.
- (N) Permeate water sample port allows the sampling of RO water from each membrane housing.

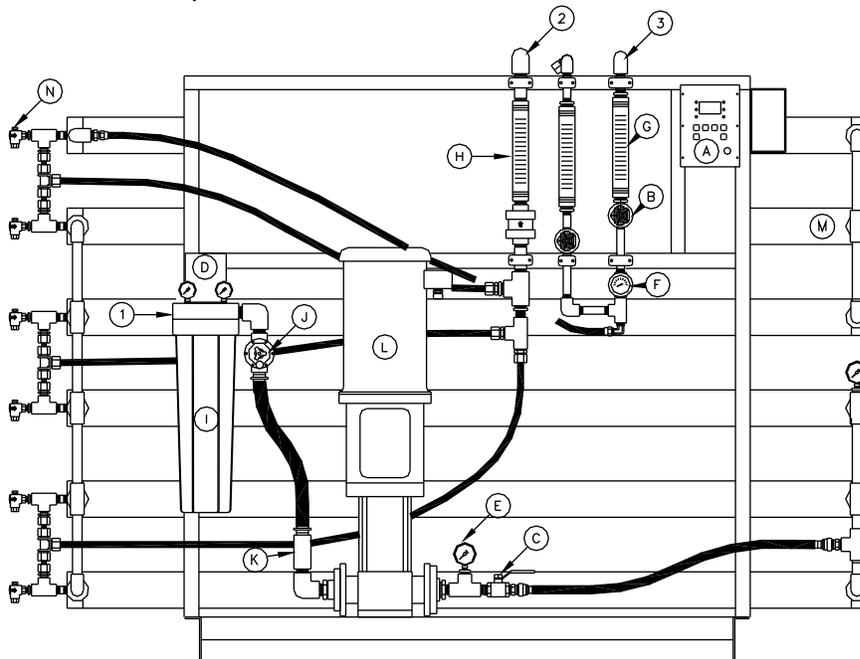


Figure 1

## B. Controller Drawing

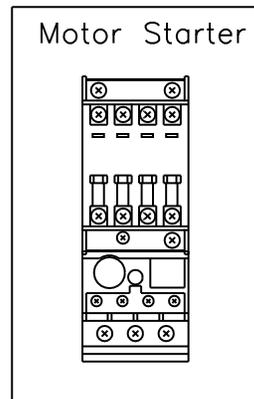
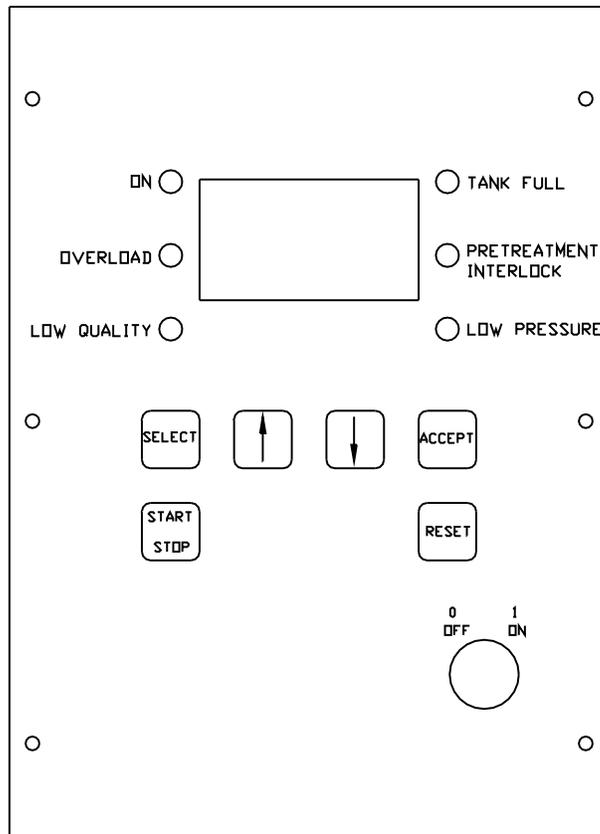


Figure 2

CI-1000 Controller

# III. Operation

## A. Installation

1. The water supply should be sufficient to provide a minimum of 20 psig pressure at the design feed flow.
2. Proper pretreatment must be determined and installed prior to the RO system.
3. A fused high voltage disconnect switch located within 10 feet of the unit is recommended. This disconnect is not provided with the RO system.
4. Responsibility for meeting local electrical and plumbing codes lies with the owner /operator.
5. Install indoors in an area protected from freezing. Space allowances for the removal of the membranes from the pressure vessels should be provided. This system requires 42" minimum clear space on each side.

## B. Plumbing Connections

**Note: It is the responsibility of the end user to ensure that the installation is done according to local codes and regulations.**

1. Connect the pretreated feed water line to the inlet side of the prefilter housing. (Figure # 1 item # 1) A feed water shutoff valve should be located within 10 feet of the system.
2. Temporarily connect the outlet of the product water flow meter to drain. (Figure # 1 item # 2) The product water line should never be restricted. Membrane and/or system damage may occur if the product line is blocked.
3. Connect the outlet of the reject water flow meter to a drain. (Figure # 1 item # 3) The reject drain line should never be restricted. Membrane and/or system damage may occur if the reject drain line is blocked. An air gap must be located between the end of the drain line and the drain. The use of a standpipe or other open drain satisfies most state and local codes and allows for visual inspection and sampling.

## C. Electrical

**Note: It is the responsibility of the end user to ensure that the installation is done according to local codes and regulations.**

1. A safety switch or fused disconnect should be installed within 10 feet of the system.
2. Verify that the disconnect switch is de-energized using a voltmeter.
3. Connect the outlet of the disconnect switch to the terminals on top of the motor starter (Figure # 2). Attach the power supply ground to the chassis ground. It may be necessary to drill a hole in the enclosure and install a water tight strain relief or conduit connector. The hole size and location must be determined by the installer. Check the pump motor nameplate for the amperage draw at various voltages to determine the wire size required.
4. Do not apply power to the RO unit at this time.

## D. Startup

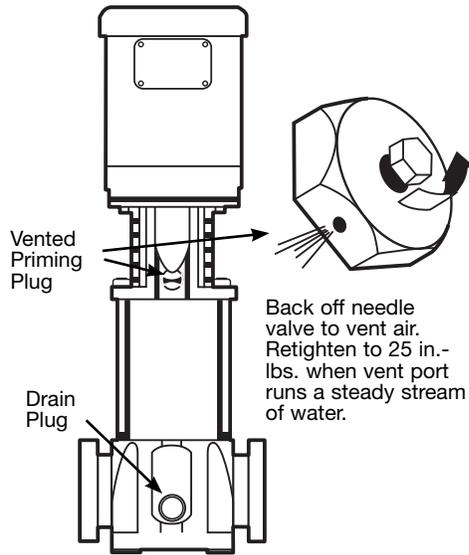
1. Verify that the pretreatment equipment is installed and working properly. Verify that no free chlorine is present in the feed water.
2. Verify that the on/off switch is in the off position.
3. Verify that the pump discharge valve (Figure # 1 item C) is open.
4. Install a 20" five micron filter cartridge in the prefilter housing. (Figure #1 item I)
5. Open the reject control valve completely (Figure # 1 item B) by turning it counterclockwise. Close the reject recycle control valve completely if the reject recycle option is included.
6. Open the feed water shutoff valve installed in step III-B-1 above.
7. Manually open the inlet solenoid valve (Figure #1 item J) by turning the white lever located near the valve outlet.
8. Water will flow through the system and to drain through the reject flow meter (figure # 1 item G).
9. Manually close the inlet solenoid valve after the air has been purged from the system, or after 10 minutes, whichever occurs first.
10. Close the pump discharge valve half way. (Figure # 1 item C)
11. Engage the safety switch or disconnect (installed in step III-C-1 above) to apply electrical power to the RO system.
12. On the CI-1000 controller, put the key switch in the on position and press the start / stop button to turn the pump on. Press the start / stop button again when the pump turns on to turn the pump off and look at the motor fan as the pump stops to determine if the pump rotation is correct. There is a 10 second delay before the pump starts. See the controller section for more details. The fan should rotate in the direction of the rotation arrow located on the pump. Continue with the startup if the pump is rotating in the proper direction. If the pump is rotating backwards, change the rotation by disconnecting the power and reversing any two of the wires on the power inlet. Verify proper pump rotation before continuing.
13. Turn the system on.
14. Adjust the reject control valve(s) (figure # 1 item B) and the pump discharge valve (Figure # 1 item C) until the desired flows are achieved. Closing the reject valve increases the product flow and decreases the reject flow. Opening the pump discharge valve increases both the reject flow and the product flow. See the flow rate guidelines and temperature correction table in the appendix to determine the flow rates for different operating temperatures.
15. Allow the product water to flow to drain for 30 minutes.
16. Turn off the system and connect the product line to the point of use. (Figure # 1 item # 2) The product water line should never be restricted. Membrane and/or system damage may occur if the product line is blocked.
17. Restart the system and record the initial operating data using the log sheet in the next section.

**Note: See the controller section of this manual for more installation and operation information**

**Note: It is very important to vent the mechanical seal during startup. Failure to vent the seal may result in premature seal failure.**

## E. Controllers

The controller for this system is the CI 1000 controller. This is a microprocessor-based controller with a product water conductivity meter. A separate manual for this controller begins on the next page.



# Reverse Osmosis Controller

## Operations and Maintenance Model #CI-1000

### Introduction

The CI-1000 Reverse Osmosis Controller is designed to control and monitor the operating parameters of a reverse osmosis water purification system. Information is displayed on a back-lit liquid crystal display, and on individual light-emitting diodes (LEDs). Functions and controls are operated through snap-dome switches (see Figure 2).

### Features

- Temperature Compensated Conductivity Monitor
- Water Temperature Monitor
- Three Modes of Operation: Stand-by, Tank Feed, and Direct Feed
- Pretreatment Interlock
- Tank Full Shutdown
- Inlet Valve Control
- Pump Control
- Low Feed Pressure Sensing with Automatic Reset
- Autoflush with Adjustable Flush Time
- Diverter Valve Output

### Specifications

**Power Requirements:** The controller can operate with a power source of 115 or 230 VAC single phase. A multi-function power inlet is used to select the proper input voltage.

**Fuse:** 1 amp 250 volt slow blow, located inside the power inlet receptacle.

**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 product water quality and displays this information in micro-mhos/cm. The display is temperature compensated to 25°C (77°F).

### 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.

**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.

**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.

**Auxiliary Output:** A 24 VAC output that energizes under certain conditions, depending upon the mode selected for it in the configuration. This output is intended to power a relay or some other low current device. The maximum current available is one ampere. Two modes are selectable for this output:

**Diverter:** Output energizes when the product quality is below the set point. The diverter valve is not included with the system.

**Alarm:** Output energizes for final detection of low-pressure conditions and low water quality conditions. No alarm hardware is included with the system.

### Inputs

**WARNING: All the inputs described below are dry contacts. Do not apply voltage to these contacts or permanent damage to the controller will result.**

**Conductivity Probe:** There are four inputs for the conductivity probe, two for the thermistor and two for the conductivity. 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 signals 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. The LCD display and a LED will indicate when the system is shut down due to low-pressure. The controller can be programmed to automatically restart. This is described in Section III, Operation.

**Tank Level:** This is a dry contact that signals the system to shut down when the storage tank is full. This contact is normally closed. When a circuit is complete between the two terminals the system will operate. If contact is broken between the two terminals, the system will shut down if it is operating in the tank feed mode. A LED will indicate when the tank is full. The system will restart itself when the contact is closed. The switch for this function is not provided with the controller.

**Pretreatment Interlock:** This is a dry contact that signals the system to shut down when a pretreatment device is not functioning, or regenerating. This could be used on a water softener, multi media filter, chemical feed pump, differential pressure switch, etc. This contact is normally open. When a circuit is not complete between the two terminals the system will operate. If the contact is closed 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 opened.

### 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. When the pump is running, the reject valve and diverter valve outputs are energized.

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 tank level switch (not provided) has an open contact. 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 standby. When the system is flushing, the diverter valve output is energized. 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.

## Controls (see Figure 2)

**NOTE: Refer to Section III, Operation for detailed instructions on operating the controls .**

**Start / Stop Button:** This button turns the system on and off.

**Select Button:** This button is used to select a function or parameter so that it can be reviewed or changed.

**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 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 or overload.

**Key Switch:** This 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 key may be removed.

## Indicators (see Figure 2)

*Multi Function Display: This is a back-lit liquid crystal display. It provides information to the operator regarding water quality, system options, etc.*

There are six individual LED's to indicate the following conditions:

(See Front View drawing)

**On:** Indicates when the system is on.

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

**Low Quality:** Indicates that the quality of the water is below the setpoint.

**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

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

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

## Operation

The key switch must be in the ON position (see Figure 2).

### Contrast Adjustment

Press the up or down arrow when the home screen is displayed to increase or decrease the contrast of the display.

### Operation Screen

When the Start/Stop button is pressed the inlet valve will open. After a 12 second delay the pump will start. The system will operate according to the information stored in memory. The product water conductivity is displayed in the large numbers at the top center of the display. The temperature is displayed as degrees Celsius in the top right corner of the display. The mode of operation is displayed below the product water quality. Flush time information or pump run hours are displayed on the bottom of the display.

## Configuration Screen

Press the SELECT button to view the configuration screen. The software revision level is displayed in the upper right corner of this screen. While the configuration screen is displayed, the SELECT button moves the highlight cursor to the next field. The up and down arrows change the value of the highlighted field. The ACCEPT button saves all of the values and brings up the timer screen. The RESET button discards all changes and brings up the timer screen. If no input is detected for a continuous 30 seconds, the controller will discard all changes and return to the operation screen. An asterisk appears next to a field whenever the value of the field equals the value stored in memory. The configuration screen contains the following field with their options:

**Mode:** (direct feed, tank feed, and standby)

**Low Quality:** (2-200 micromhos) This is the set point for the diverter valve. When the product water conductivity is equal to or greater than value selected, the diverter valve output will be energized and the low quality LED will turn on.

**Autostart:** (on/off) If "on" is selected, the system will automatically restart after a power loss. If "off" is selected, the unit will not restart after a power loss.

**Lowpressure Retry:** (0-10) This is the number of times the system will attempt to restart after a low-pressure shutdown.

**Low-pressure Delay:** (15-90 seconds in 15 second increments) This is the amount of time between attempts to restart after a low-pressure shutdown.

**Autoflush:** (0-10 minutes) This is the length of the flush cycle. The system will flush for this amount of time every hour in tank feed and standby modes.

**Inlet Delay Time:** (10,30,60,120,300,600 seconds) This is the amount of time that the inlet valve stays open after the pump turns off.

**Auxiliary Output Mode:** This selects whether the auxiliary output should be used for a diverter valve (default) or an alarm output. Noted in the configuration menu as "Aux. Out"

**Low Water Quality Alarm Delay:** (0,5,10,30,60, 120,300,600 seconds) This selects the delay between the detection of a low quality water condition and the activation of the auxiliary output. This only applies if the auxiliary output is configured as an alarm output. Noted in the menu as "L/Q Alarm Delay"

## Timer Screen

Pressing either the ACCEPT or the RESET button from the configuration screen brings up the timer screen. The controller has three timers (hour meters). Two are user resetable and one is not. All of these timers count up when the pump is running. The two user resetable meters are labeled PREFILTER and MEMBRANE. Pressing the reset button when either of these timers are highlighted will reset the timer to zero. The SELECT button moves the highlight cursor to the next timer. Press Accept while the membrane meter is highlighted to exit and return to the operation screen.

## Calibration Screen

This screen is used to calibrate the conductivity and temperature. Press ACCEPT and RESET at the same time to bring up this screen. The temperature and conductivity fields on the last two lines of the display can be adjusted using the up and down arrows. Use the arrow keys to input the correct temperature and then press the ACCEPT button. The conductivity will now be highlighted. Use the arrow keys to input the correct conductivity and press the ACCEPT button. Always calibrate the temperature first. (Note: the new values are only saved when the ACCEPT button is pressed while the field is highlighted.) When the desired values are entered press the RESET button to return to the operation screen. You can only enter the calibration screen if the conductivity and temperature readings

## Pop-Up Screens

Under certain circumstances a pop-up screen may be displayed. These look like a window that partially blocks out the screen behind it. The conditions that display pop-up screens are:

Low Inlet Pressure

Pretreatment Interlock

Overload Conditions

Trying to calibrate if the temperature and/or conductivity is not stable.

## Service And Maintenance

The CI-1000 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 the factory.

### Field failures that most frequently occur are:

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

## Troubleshooting

DESCRIPTION OF PROBLEM	POSSIBLE CAUSE OR SOLUTION
System shuts down on low-pressure but pressure is okay.	<ol style="list-style-type: none"> <li>1. Check the pressure switch set point</li> <li>2. Possible short in wiring to pressure switch</li> <li>3. Defective pressure switch</li> <li>4. Orifice in pressure switch may be plugged</li> </ol>
Pressing the Start/Stop button does not turn the system on.	<ol style="list-style-type: none"> <li>1. Verify that the key switch is on</li> <li>2. Verify that the circular connector on the bottom of the controller is attached</li> <li>3. Check the fuse in the power inlet</li> </ol>
Conductivity monitor does not display the proper reading.	<ol style="list-style-type: none"> <li>1. Calibrate the controller</li> <li>2. Check the wiring to the conductivity probe</li> <li>3. Clean the conductivity probe</li> <li>4. Replace the conductivity probe</li> </ol>
Erratic conductivity display	<ol style="list-style-type: none"> <li>1. Conductivity probe wiring may be too close to high voltage lines.</li> <li>2. Check for moisture in the connection between the probe and the lead wire.</li> </ol>



## G. Troubleshooting

### RO Troubleshooting Guide

SYMPTOMS			LOCATION	POSSIBLE CAUSES	VERIFICATION	CORRECTIVE ACTION
SALT PASSAGE	PERMEATE FLOW	PRESSURE DROP				
Normal to increased	Decreased	Normal to increased	Predominantly first stage	Metal oxide	Analysis of metal ions in cleaning solution.	Improved pretreatment to remove metals. Cleaning with acid cleaners.
Normal to increased	Decreased	Normal to increased	Predominantly first stage	Colloidal fouling	SDI measurement of feed/ X-ray diffraction analysis of cleaning sol. residue.	Optimize pretreatment system for colloid removal. Clean with high pH, anionic detergent formulation.
Increased	Decreased	Increased	Predominantly last stage	Scaling (CaSO <sub>4</sub> , CaSO <sub>3</sub> , BaSO <sub>4</sub> , SiO <sub>2</sub> )	Analysis of metal ions in cleaning sol. Check LSI of reject. Calculate maximum solubility for CaSO <sub>4</sub> , BaSO <sub>4</sub> , SiO <sub>2</sub> in reject analysis.	Increase acid addition and scale inhibitor for CaSO <sub>3</sub> and CaSO <sub>4</sub> . Reduce recovery. Clean with an acid formulation for CaCO <sub>3</sub> , CaSO <sub>4</sub> and BaSO <sub>4</sub> .
Normal to moderate increase	Decreased	Normal to moderate increase	Can occur in any stage	Biological fouling	Bacteria count in permeate and reject. Slime in pipes and vessels.	Shock dosage of sodium bisulfite. Continuous feed of low conc. bisulfite at reduced pH. Peracetic acid sterilization. Clean with alkaline anionic surfactant. Chlorine dosage upstream with dechlorination. Replace cartridge filters.
Decreased or moderately increased	Decreased	Normal	All stages	Organic fouling	Destructive testing, e.g. IR reflection analysis.	Optimization of pretreatment system (e.g. coagulation process.) Resin/ activated carbon treatment. Clean with high pH detergent.
Increased	Increased	Decreased	Most severe in the first stage	Chlorine oxidant attack	Chlorine analysis of feed. Destructive element test.	Check chlorine feed equipment and dechlorination equipment.
Increased	Increased	Decreased	Most severe in the first stage	Abrasion of membrane by crystalline material	Microscopic solids analysis of feed. Destructive element test.	Improved pretreatment. Check all filters for media leakage.
Increased	Normal to increased	Decreased	At random	O-ring leaks, End or side seal glue leaks.	Probe test. Vacuum test. Colloidal material passage.	Replace O-rings. Repair or replace elements.
Increased	Normal to low	Decreased	All stages	Conversion too high.	Check flows and pressures against design guidelines	Reduce conversion rate. Calibrate sensors. Increase analysis and data collection.

## Motor Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Motor fails to start	Blown fuses	Replace fuses with proper type and rating
	Overload trips	Check and rest overload in starter.
	Improper power supply	Check to see that power supplied agrees with motor nameplate and load factor.
	Open circuit in winding or control switch	Indicated by humming sound when switch is closed.
	Mechanical failure	Check to see if motor and drive turn freely. Check bearing and lubrication.
	Short circuited stator	Indicated by blown fuses. Motor must be rewound.
	Poor stator coil connection	Remove end bells, locate with test lamp.
	Rotor defective	Look for broken bars or end ring.
Motor may be overloaded	Reduce load.	
Motor Stalls	One phase connection	Check lines for open phase.
	Wrong application	Change type or size. Consult manufacturer.
	Overload motor	Reduce load.
	Low motor voltage	See that nameplate voltage is maintained. Check connection.
	Open circuit	Fuses blown, check overload relay, stator and push buttons.
Motor runs and then dies down	Power failure	Check for loose connections to line, to fuses and to control.
Motor does not come up to speed	Not applied properly	Consult supplier for proper type.
	Voltage too low at motor terminals because of line drop.	Use higher voltage on transformer terminals or reduce load. Check connections. Check conductors for proper size.
	Broken rotor bars or loose rotor.	Look for cracks near the rings. A new rotor may be required as repairs are usually temporary.
Motor takes too long to accelerate	Open primary circuit	Locate fault with testing device and repair.
	Excess loading	Reduce load.
	Poor circuit	Check for high resistance.
	Defective squirrel cage rotor	Replace with new rotor.
	Applied voltage too low	Get power company to increase power tap.
Wrong rotation	Wrong sequence of phases	Reverse connections at motor or at switchboard.
Motor overheats while running under load	Overloaded	Reduce load.
	Frame or bracket vents may be clogged with dirt and prevent proper ventilation of motor.	Open vent holes and check for a continuous stream of air from the motor.
	Motor may have one phase open	Check to make sure that all leads are well connected.
	Grounded could	Locate and repair.
	Unbalanced terminal voltage	Check for faulty leads, connections and transformers.
Motor vibrates after correcting have been made	motor misaligned	Realign
	Weak support	Strengthen base.
	Coupling out of balance	Balance coupling.
	Driven equipment unbalanced	Rebalance driven equipment.
	Defective ball bearing	Replace bearing.
	Bearing not in line	Line properly.
	Balancing weights shifted	Rebalance motor.
	Polyphase motor running single phase	Check for open circuit.
	Excessive end play	Adjust bearing or add washer.
Unbalanced line current on polyphase motors during normal operation	Unequal terminal volts	Check leads and connections
	Single phase operation	Check for open contacts
Scraping noise	Fan rubbing air shield	Remove interference.
	Fan striking insulation	Clear fan.
	Loose on bedplate	Tighten holding bolts.
Noisy operation	Airgap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
Hot bearings general	Bent or sprung shaft	Straighten or replace shaft.
	Excessive belt pull	Decrease belt tension.
	Pulleys too far away	Move pulley closer to motor bearing.
	Pulley diameter too small	Use larger pulleys.
	Misalignment	Correct by realignment of drive.
Hot bearings ball	Insufficient grease	Maintain proper quantity of grease in bearing.
	Deterioration of grease, or lubricant contaminated	Remove old grease, wash bearings thoroughly in kerosene and replace with new grease.
	Excess lubricant	Reduce quantity of grease: bearing should not be more than ½ filled.
	Overloaded bearing	Check alignment, side and end thrust.
	Broken ball or rough races	Replace bearing: first clean housing thoroughly.

These instructions do not cover all details or variations in equipment nor provide for every possible condition to be met in connection with installation, operation or maintenance. Chart courtesy of Marathon Electric.

## RO System Troubleshooting

PROBLEM	CORRECTIVE ACTION
<b>General</b>	
<b>High Product Water TDS</b>	
Membrane expanded.	Replace membrane.
Membrane attack by chlorine	Carbon pre-filter may be exhausted. Replace with a new cartridge.
Clogged pre-filter-creates pressure drop and low reject flow.	Replace pre-filter cartridge.
Feed pressure too low.	Feed pressure must be at least 20psi.
Insufficiently flushed post-filter cartridge.	Flush post-filter with pure water.
Brine seal on membrane leaks.	Determine if seal or o-ring is bad. Replace as needed.
<b>No Product Water or Not Enough Product Water</b>	
Feed water shut off.	Turn on feed water.
Low feed pressure. Feed pressure must be at least 20psi.	Consider booster pump.
Pre-filter cartridge clogged.	Replace pre-filter cartridge.
Membrane fouled.	Determine and correct cause; replace membrane.
Product check valve stuck.	Replace check valve fitting.
Low pump discharge pressure	Open pump discharge valve, replace pump

## IV. Replacement Parts List

A list of common replacement parts is provided below. All of these parts are not used on every system and all of the parts are not listed. Contact your dealer for replacement parts assistance.

ITEM NUMBER	DESCRIPTION
1	Pre filter housing 20" Big Blue
2	RO Membrane Pressure Vessels 4" x 80" FRP
3	Pressure Gauge, 2", 0-100psi, Dry
4	Pressure Gauge, 2½", 0-400psi, LF
5	Flow Meter 1-10 gpm (product)
6	Flow Meter 1-10 gpm (reject)
7	Motor Starter Contactor, 16 amps, 24 volt coil
8	Overload Relay 8 - 14 amps
9	Pump with TEFC 3ph 7.5hp motor
10	Low-pressure Switch, 6.5psi
11	Inlet Solenoid Valve, 1", 24 volt coil
12	Watts Brand 4 x 40 RO Membranes
13	CI 1000 RO Controller
14	Conductivity Probe
15	Autoflush Solenoid Valve, ½", Brass, 24 volt coil.

## V. Membrane Replacement

1. Turn off the system and close the feed water shutoff valve.
2. Disconnect the membrane feed hoses by loosening the brass fittings between the end of the hoses and the pressure vessel end caps.
3. Remove the retaining rings from the pressure vessels.
4. Push the old membrane out of the vessel in the direction of the feed flow. (See flow arrows on the right side of figure #1)
5. Record the serial numbers of the new membranes.
6. Lightly lubricate the brine seals on the new membranes with clean water.
7. Install the new membranes in the direction of flow with the brine seal end going in last.

**Note: Be sure to install the interconnectors between the membranes in each pressure vessel.**

8. Lightly lubricate the end cap internal and external O-rings with glycerin.
9. Install the end caps and secure them with the retaining rings.
10. Install the membrane feed hoses.
11. Verify that all retaining rings are installed.
12. Follow the start up procedure in section III-D.



## VI. Appendix

The following tables are intended as a guide to determining the flow rates for the PWR4022 series RO systems. All flows are in gallons per minute (GPM).

### Nominal flows for systems with reject recycle and a feed water Silt Density Index less than 3.

MODEL NUMBER	PWR40223083	PWR40223103	PWR40223123
Product (max)	10	12.5	15
Reject	3.4	4.2	5
Reject Recycle	3.6	4.5	5.5

### Nominal flows for systems with reject recycle and a feed water Silt Density Index of 3 to less than 5.

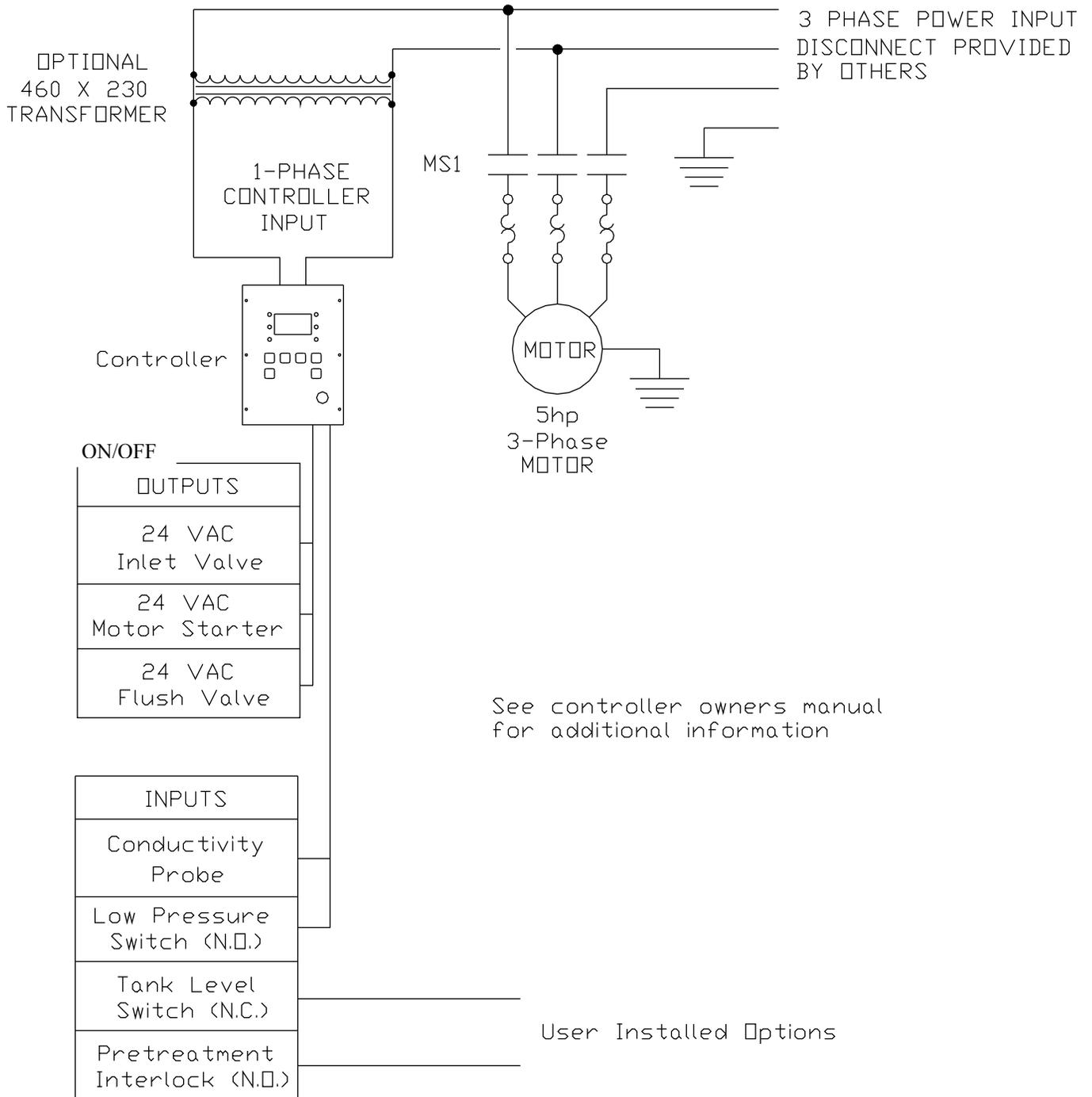
MODEL NUMBER	PWR40223083	PWR40223103	PWR40223123
Product (max)	9	11.5	14
Reject	3	3.8	4.7
Reject Recycle	5	5.2	7.3

## Temperature Correction Factors

°C	°F	CORRECTION FACTOR
30	86	1.16
29	84.2	1.13
28	82.4	1.09
27	80.6	1.06
26	78.8	1.03
25	77	1.00
24	75.2	0.97
23	73.4	0.94
22	71.6	0.92
21	69.8	0.89
20	68	0.86
19	66.2	0.84
18	64.4	0.81
17	62.6	0.79
16	60.8	0.77
15	59	0.74
14	57.2	0.72
13	55.4	0.70
12	53.6	0.68
11	51.8	0.66
10	50	0.64
9	48.2	0.62
8	46.4	0.61
7	44.6	0.59
6	42.8	0.57
5	41	0.55

Multiply the nominal product flow at 25° C by the temperature correction factor to determine the flow at various other temperatures.

# CI-1000 Controller



**CALIFORNIA PROPOSITION 65 WARNING**

**WARNING:** This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. (California law requires this warning to be given to customers in the State of California.)

**For more information:** [www.watts.com/prop65](http://www.watts.com/prop65)

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