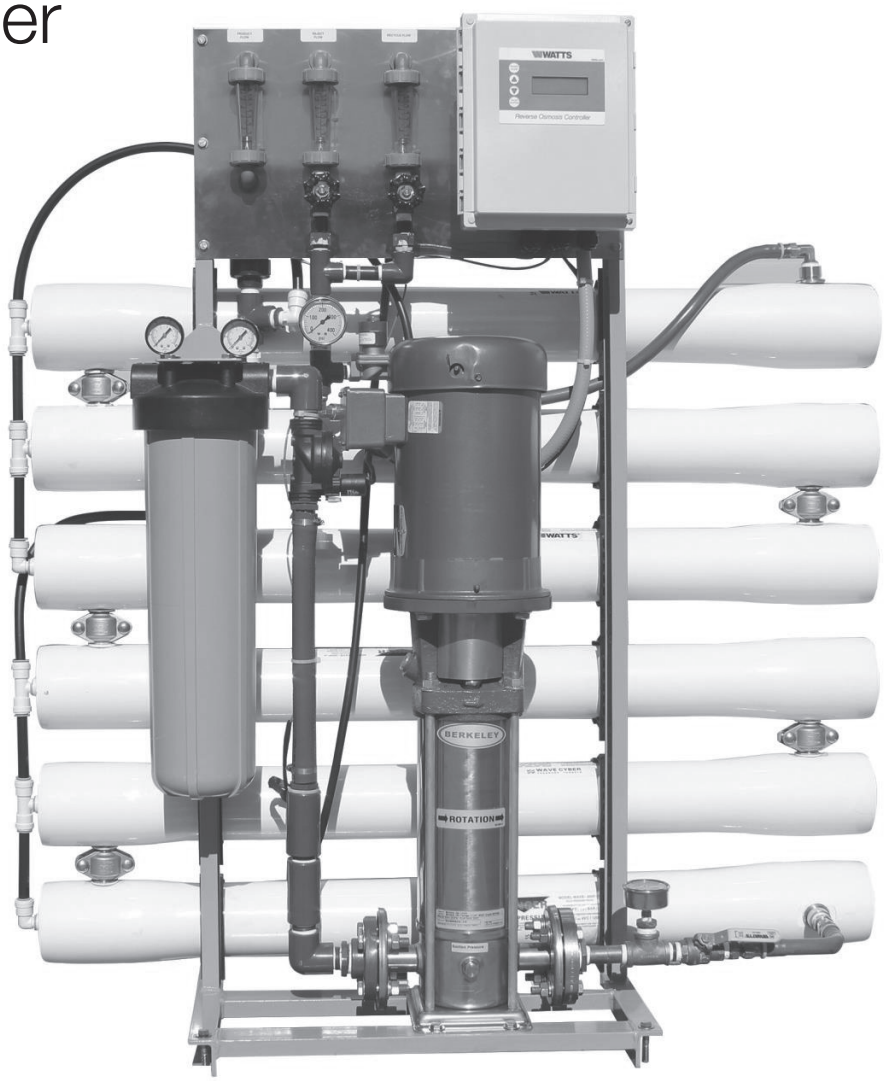
Installation, Operation and Maintenance Manual

Commercial Reverse Osmosis Systems

Series PWR4021

WATTS® pure water



Series PWR4021

⚠ WARNING

Please read carefully before proceeding with installation. Your failure to follow any attached instructions or operating parameters may lead to the product's failure.
Keep this Manual for future reference.

THINK SAFETY FIRST

WATTS®

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⚠ WARNING

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

- **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.

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:

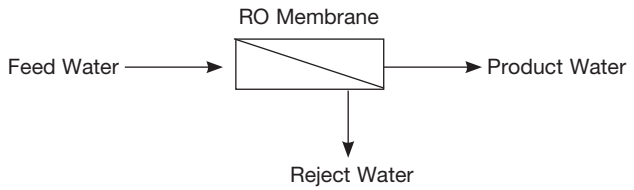
- Internal flows across the membrane surface must be high enough to prevent settling of fine suspended solids on the membrane surface.
- The concentration of each dissolved ionic species must not exceed the limits of solubility anywhere in the system.
- Pre-treatment must be sufficient to eliminate chemicals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

A. Specifications

	PWR40213023	PWR40213033	PWR40213043	PWR40213053	PWR40213063
Productivity (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%).	3600 / 2.5	5400 / 3.75	7200 / 5.0	9000 / 6.25	10800 / 7.5
Quality (typical membrane percent rejection) Based on membrane manufacturer's specifications, overall system percent rejection may be less.	98 %	98 %	98 %	98 %	98 %
Recovery without reject recycle	29 %	39 %	50 %	57 %	62 %
Recovery with reject recycle (adjustable)	50 %	50 %	75 %	75 %	75 %
Membrane Size	4 x 40	4 x 40	4 x 40	4 x 40	4 x 40
Number Of Membranes Per Vessel	1	1	1	1	1
Pressure Vessel Array	1:1	1:1:1	1:1:1:1	1:1:1:1:1	1:1:1:1:1:1
Number Of Membranes	2	3	4	5	6
Prefilter (system ships with one 5 micron cartridge)	20" BB	20" BB	20" BB	20" BB	20" BB
Feed Water Connection	1" NPT	1" NPT	1" NPT	1" NPT	1" NPT
Product Water Connection	¾" NPT	¾" NPT	¾" NPT	¾" NPT	¾" NPT
Reject Water Connection	¾" NPT	¾" NPT	¾" NPT	¾" NPT	¾" NPT
Feed Water Required (feed water required will be less if reject recycle is used)	9 gpm	10 gpm	10 gpm	12 gpm	13 gpm
Feed Water Pressure (minimum)	20psi	20psi	20psi	20psi	20psi
Drain Required	9 gpm	10 gpm	10 gpm	12 gpm	12 gpm
Electrical Requirement 230 VAC, 3-ph, 60 Hz (other voltages available)	15 amps	15 amps	15 amps	15 amps	15 amps
TEFC Motor (horse power)	5	5	5	5	5
Dimensions L x W x H (inches)	60 x 18 x 56	60 x 18 x 56	60 x 18 x 56	60 x 18 x 56	60 x 18 x 56
Shipping Weight (estimated pounds)	400	500	600	700	800

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. It is critical to maintain adequate reject flow in order to prevent membrane scaling and/or fouling.



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 antiscalants 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 antiscalants, 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 SiO2. 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. Controller - Controls the operation of the system and displays the product water quality.

B. Reject Control Valve - Controls the amount of reject flow.

C. Reject Recycle Control Valve – Controls the amount of reject recycle flow.

D. Pump Discharge Valve - Used to throttle the pump.

E. Prefilter Pressure Gauges - Indicates the inlet and outlet pressure of the prefilter. The difference between these two gauges is the prefilter differential pressure.

F. Pump Discharge Pressure Gauge - Indicates the pump discharge pressure.

G. Reject Pressure Gauge - Indicates the reject pressure.

H. Reject Flow Meter - Indicates the reject flow rate in gallons per minute (gpm).

I. Product Flow Meter - Indicates the product flow rate in gallons per minute (gpm).

J. Reject Recycle Flow Meter – Indicates the reject recycle flow rate in gallons per minute (gpm).

K. Prefilter Housing - Contains the RO prefilter.

L. Automatic Inlet Valve - Opens when pump is on and closes when the pump is off.

M. Low Pressure Switch - Sends a signal to the controller if the pump suction pressure is low.

N. RO Feed Pump - Pressurizes the RO feed water.

O. RO Membrane Vessels - Contains the RO membranes.

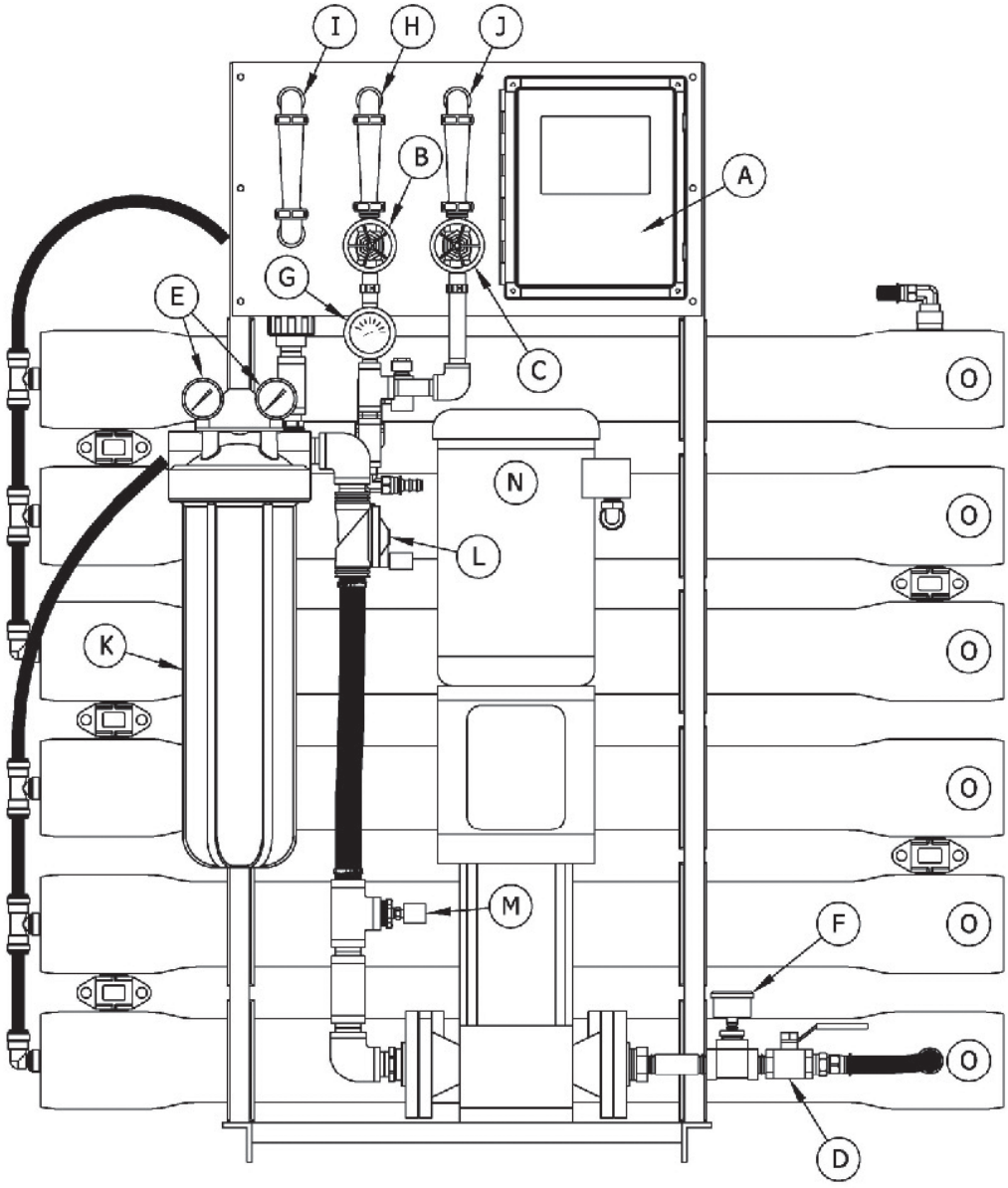


Figure 1. General System Component Identification

B. Controller Drawing

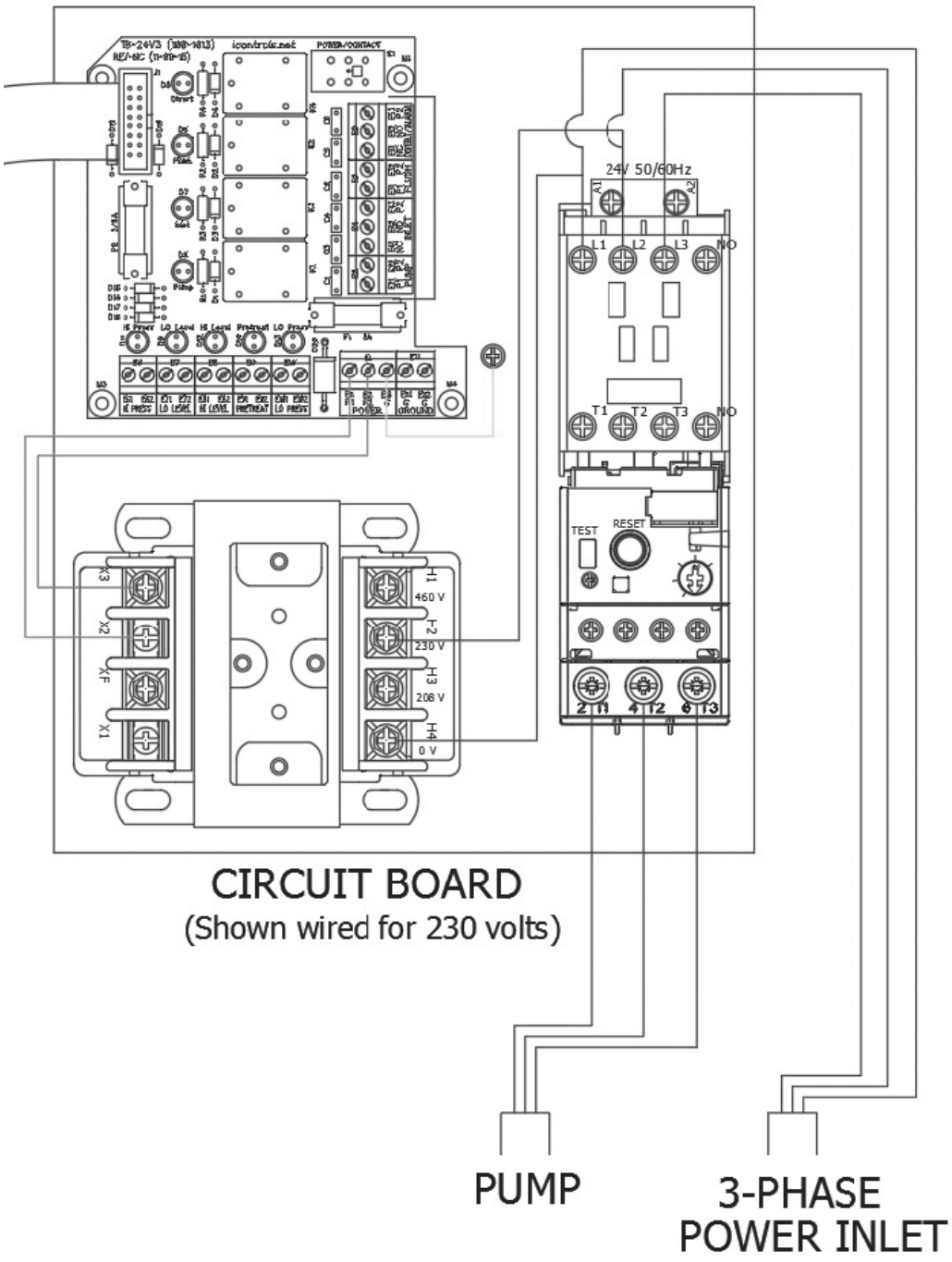


Figure 2

B. Controller Drawing (continued)

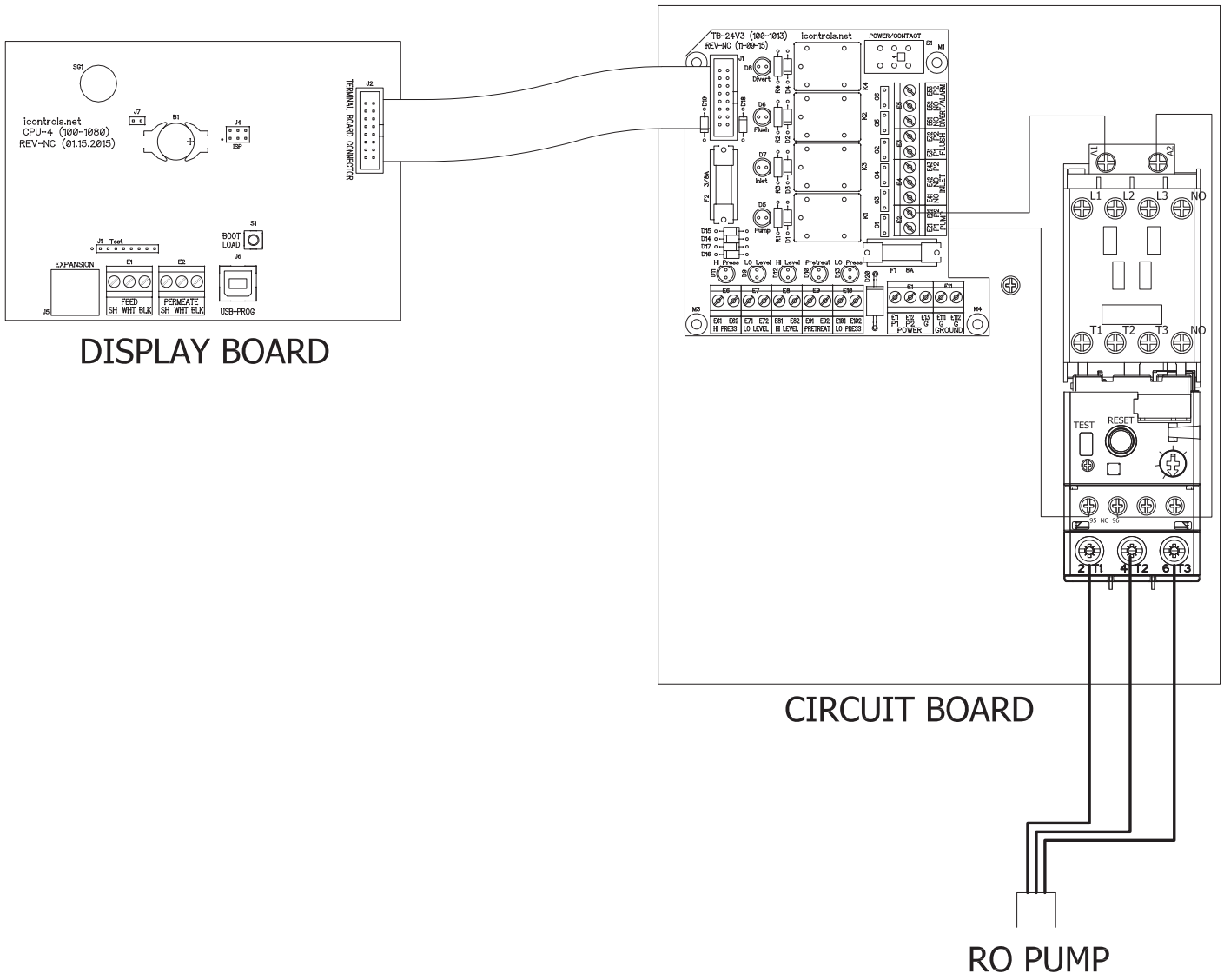


Figure 3

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

NOTICE

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 Connections

NOTICE

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 pump discharge valve (Figure # 1 item D) is open.
3. Install a 20" five micron filter cartridge in the prefilter housing. (Figure #1 item K)
4. Open the reject control valve completely (Figure # 1 item B) by turning it counterclockwise. Close the reject recycle control valve completely (Figure # 1 item C) by turning it clockwise.
5. Open the feed water shutoff valve installed in step III-B-1 above.
6. Manually open the inlet solenoid valve (figure #1 item L) by turning the white lever located near the valve outlet.
7. Water will flow through the system and to drain through the reject flow meter (figure # 1 item H).
8. Manually close the inlet solenoid valve after the air has been purged from the system, or after 10 minutes, whichever occurs first.
9. Close the pump discharge valve half way. (Figure # 1 item D)
10. Engage the safety switch or disconnect (installed in step III-C-1 above) to apply electrical power to the RO system.
11. Press the on/off button on the controller. When the pump starts, press and hold the on/off button to turn off the pump and look at the motor fan as the pump stops to determine if the pump rotation is correct. 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.

12.Turn the system on.

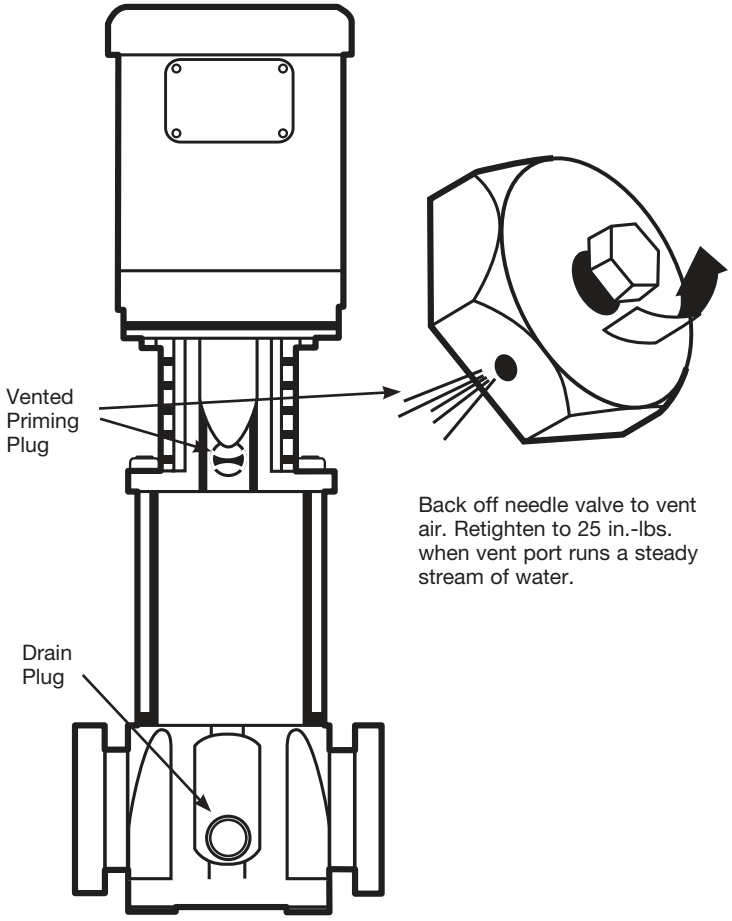
13. Adjust the reject control valve(s) (figure # 1 items B & C) and the pump discharge valve (Figure # 1 item D) until the desired flows are achieved. Closing the reject valve increases the product flow and decreases the reject flow. Opening the pump discharge valve increases both the reject flow and the product flow. See the flow rate guidelines and temperature correction table in the appendix to determine the flow rates for different operating temperatures.
14. Allow the product water to flow to drain for 30 minutes.
15. Turn off the system and connect the product line to the point of use. (Figure # 1 item # I) The product water line should never be restricted. Membrane and/or system damage may occur if the product line is blocked.
16. Restart the system and record the initial operating data using the log sheet in the next section.

NOTICE

See the controller section of this manual for more installation and operation information.

NOTICE

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 ROC-4 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 #R23-ROC-4

TABLE 1. SPECIFICATIONS	
Inputs	
Tank level switches	(2) Normally-Closed. Can be used with a single level switch.
Inlet pressure switch	Normally-Open.
Pretreat lockout switch	Normally-Open.
High pressure switch	Normally-Open.
(opt) Controller Power	24 VAC, 60/50Hz
Permeate Conductivity	0-3000 PPM, 0-6000 µs (standard sensor, CP-1, K=.75)
Feed Conductivity (opt)	0-3000 PPM, 0-6000 µs (standard sensor, CP-1, K=.75)
Output Ratings	
Feed Solenoid	24 VAC – 1 amp
Flush Solenoid	24 VAC – 1 amp
Divert (opt)	24 VAC – 1 amp
Motor Contactor Coil	24 VAC – 1 amp
Circuit Protection	
Main Power Fuse	F1 5 x 20 mm 2 Amp
Relay/XFMR Fuse	F2 5 x 20 mm 0.125 Amp
Other	
Dimensions	11.5" tall, 9.3" wide, 6.7" deep. Nema 4X non-metallic (10 x 8 x 6) 13.5" tall, 11.4" wide, 6.7" deep. Nema 4X non-metallic (12 x 10 x 6) 15.5" tall, 13.3" wide, 7.7" deep. Nema 4X non-metallic (14 x 12 x 7)
Weight	4.2 lb. (10 x 8 x 6) (Enclosure, CPU-4 and TB-3 only.) 6.0 lb. (12 x 10 x 6) (Enclosure, CPU-4 and TB-3 only.) 10.6 lb. (14 x 12 x 7) (Enclosure, CPU-4 and TB-3 only.)
Environment	0-50°C, 10-90%RH (non-condensing)

Figure 4. Simplified Schematic

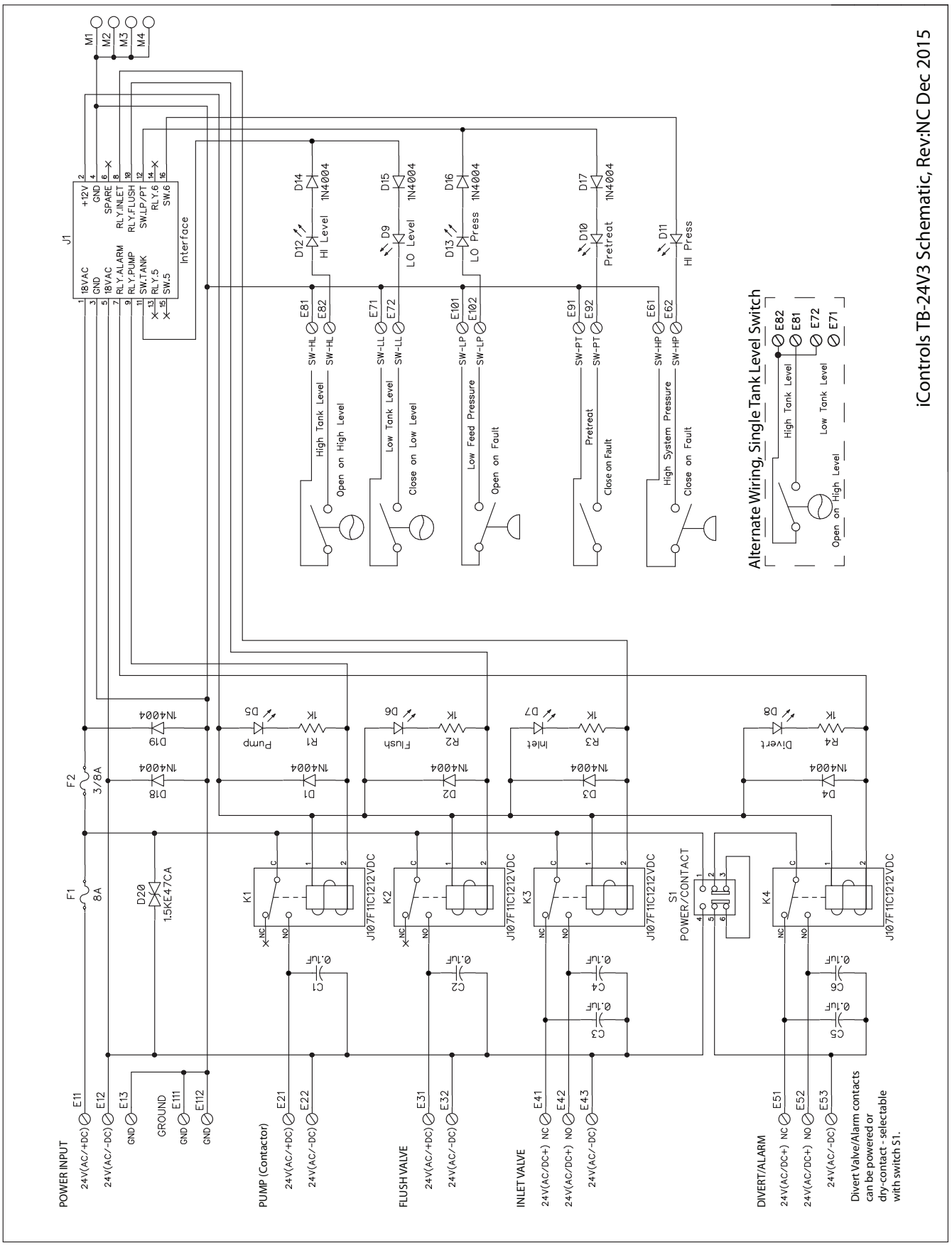
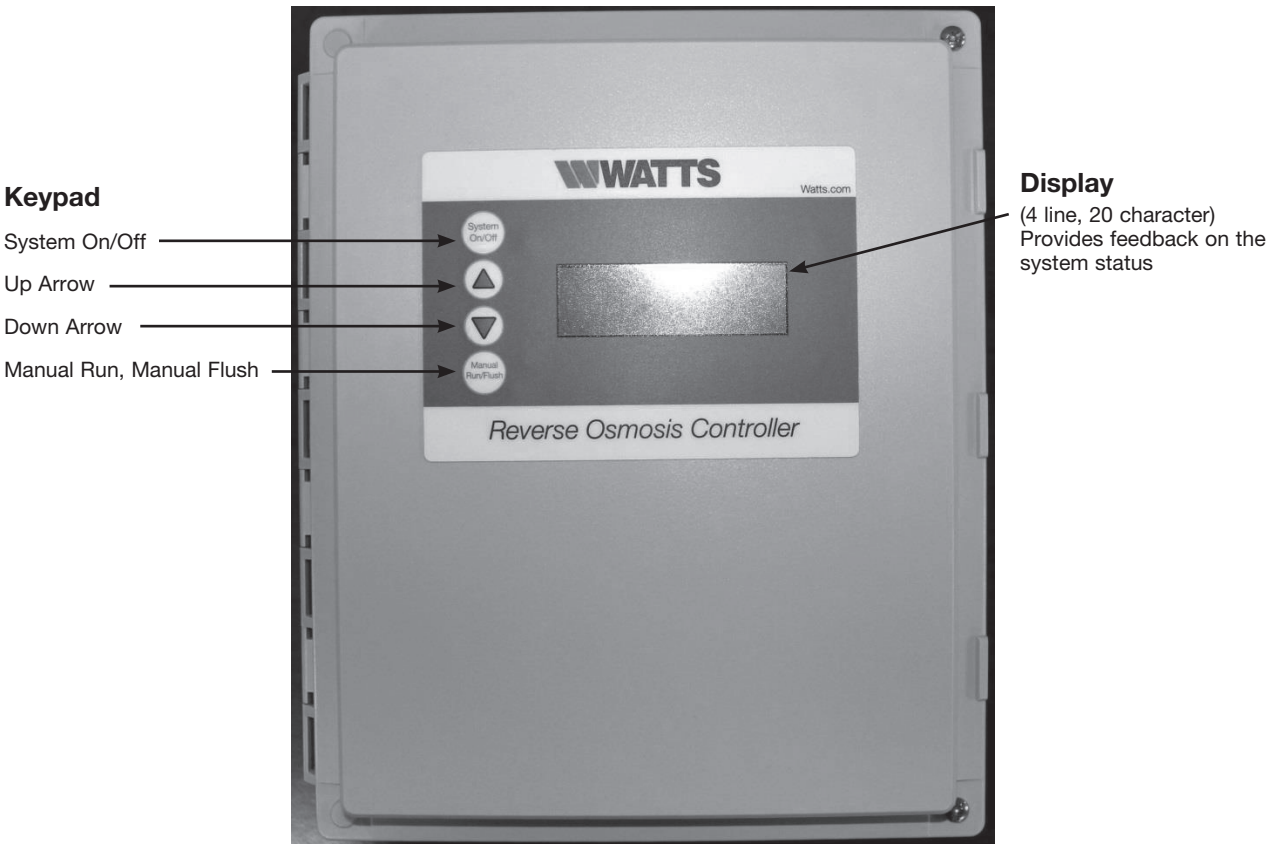


Figure 5. Controller Overview



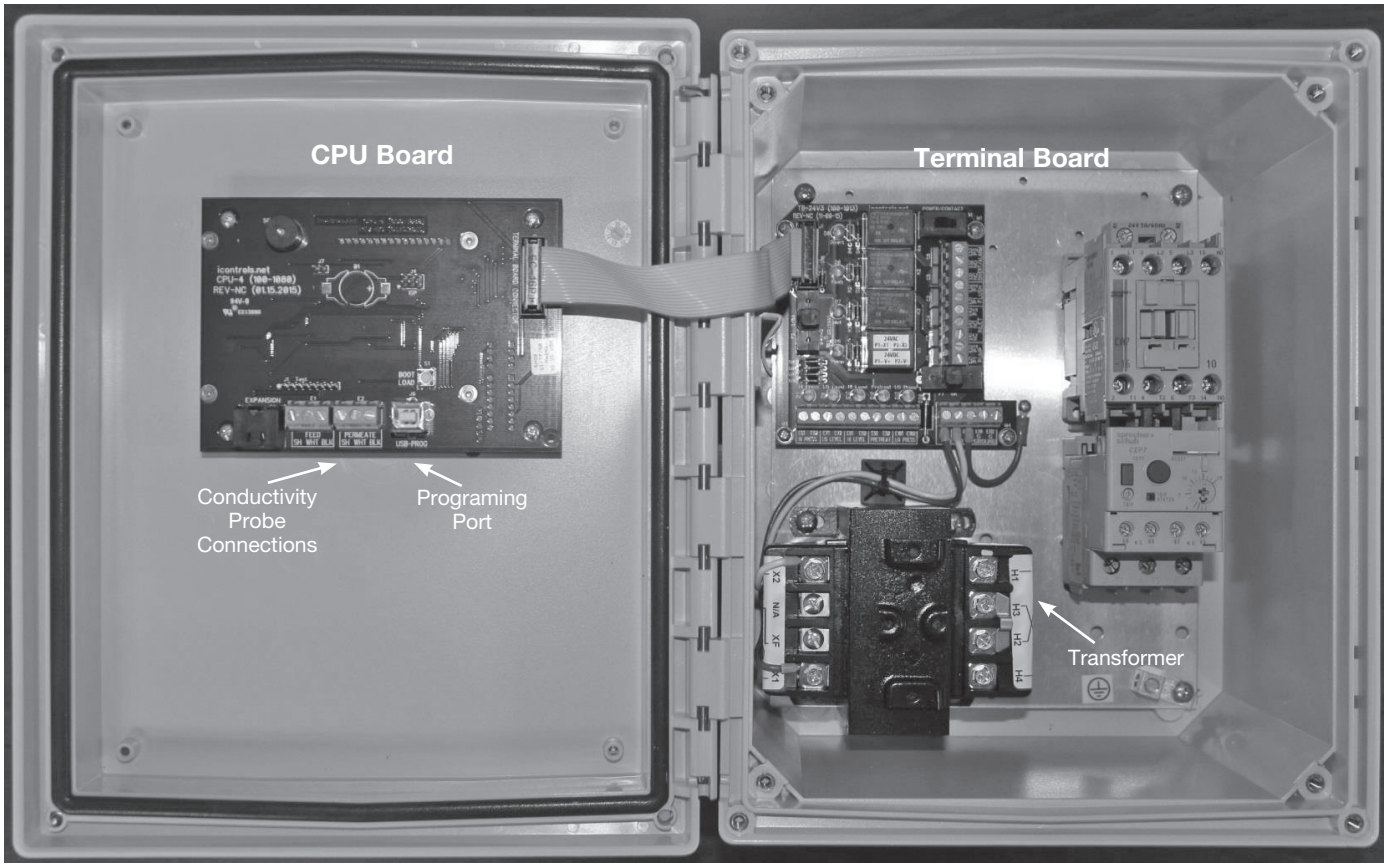


Figure 6. Wiring Diagram

Pictorial Schematic of a Typical ROC-4 System

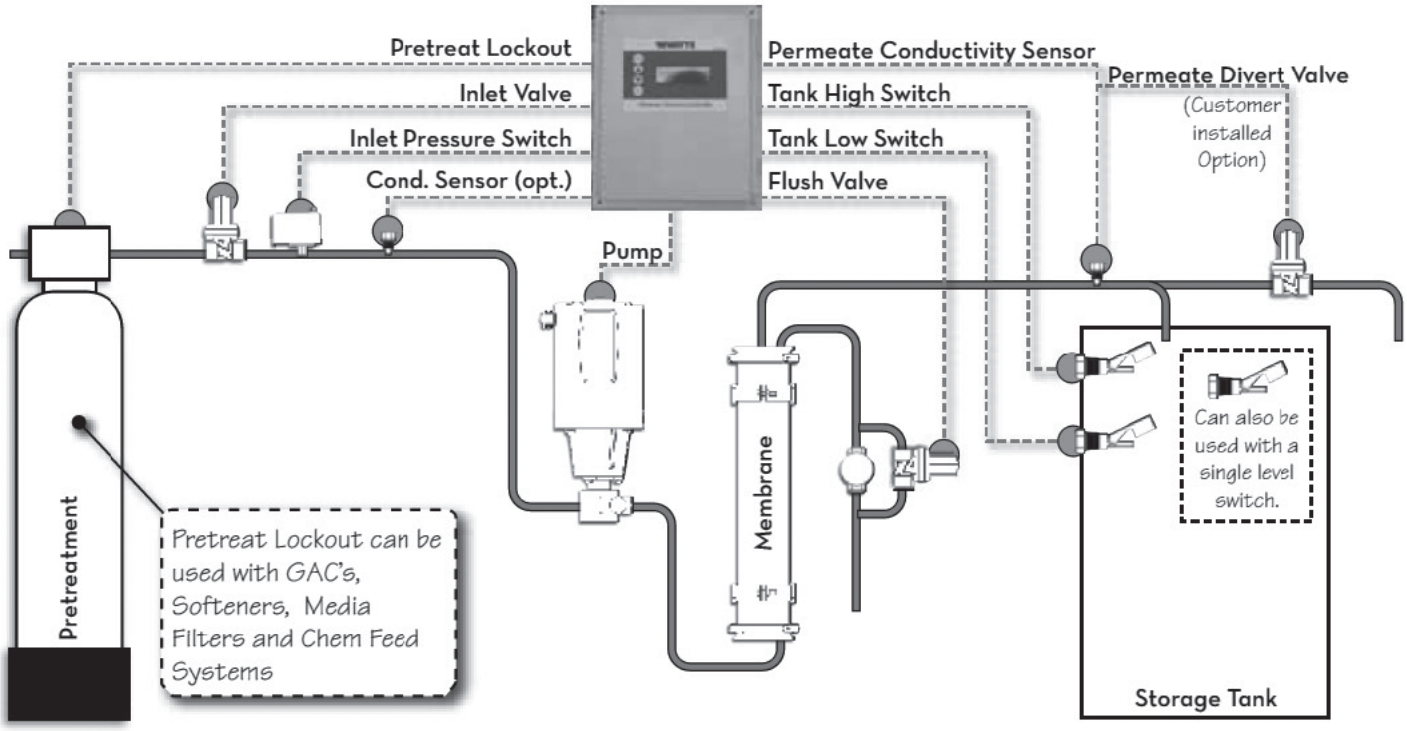
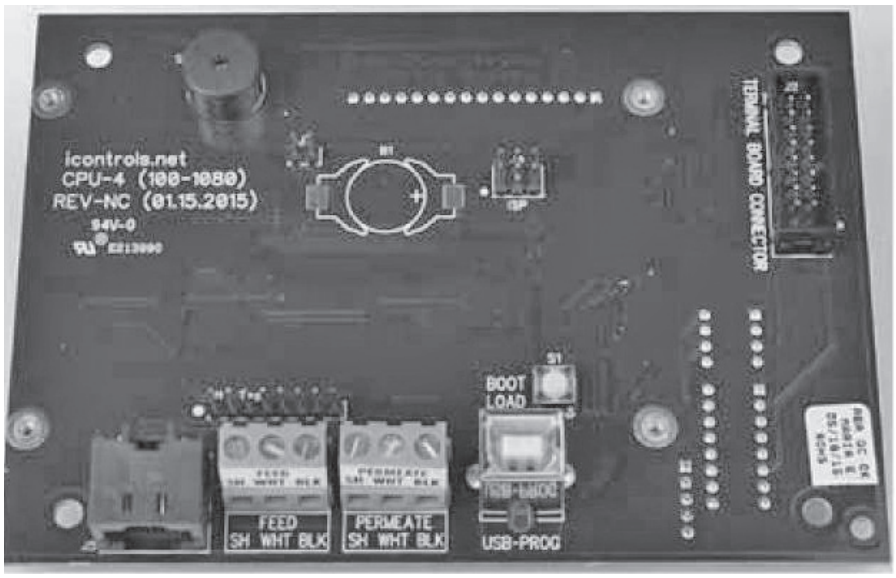


Figure 7. Controller Detail: CPU-4

Typical Configuration



Detailed View

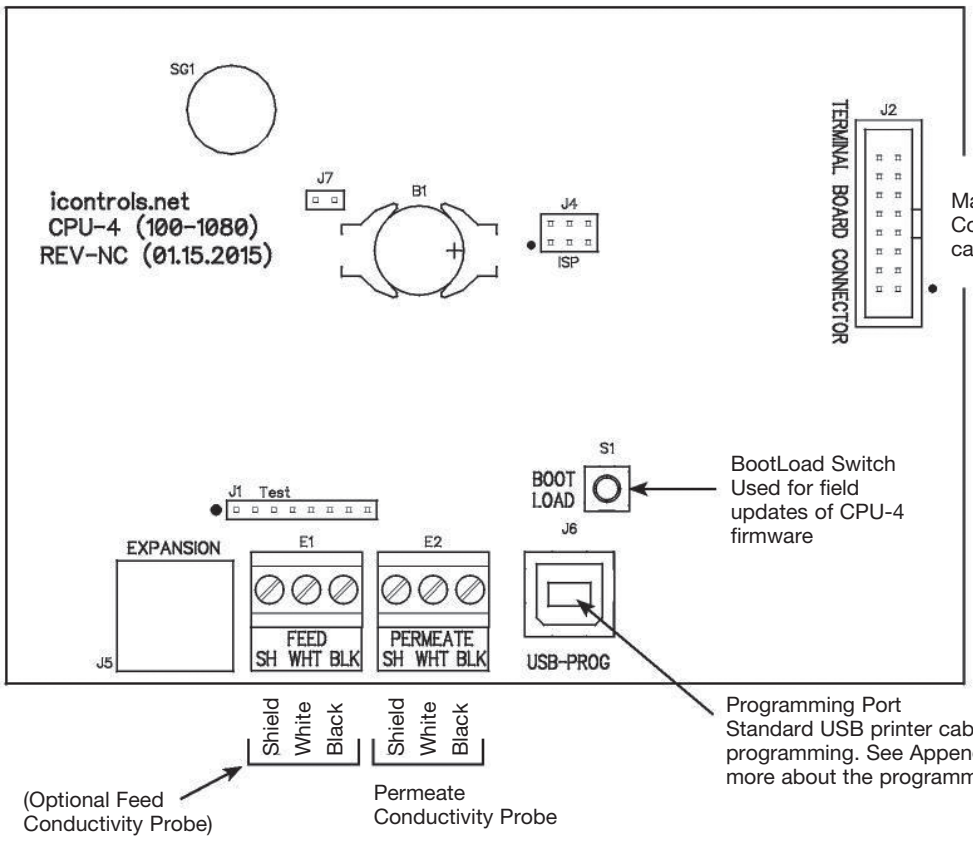
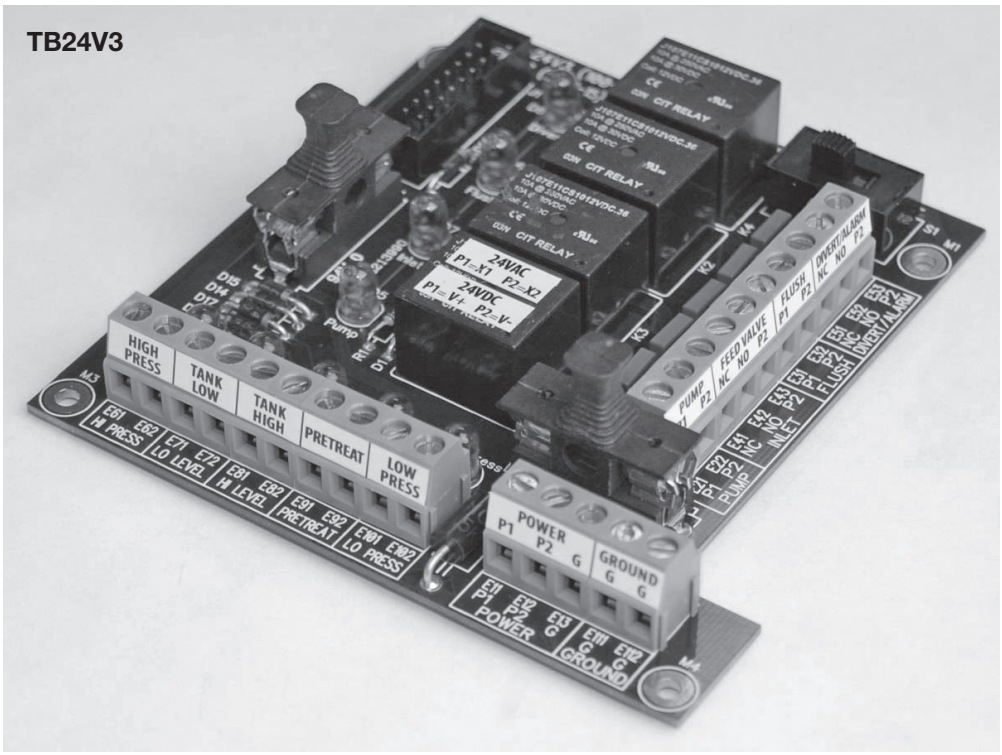


Figure 8. Controller Detail: Terminal Board, TB-3 (See Fig. 3 for schematic)



TB-24V3 Layout

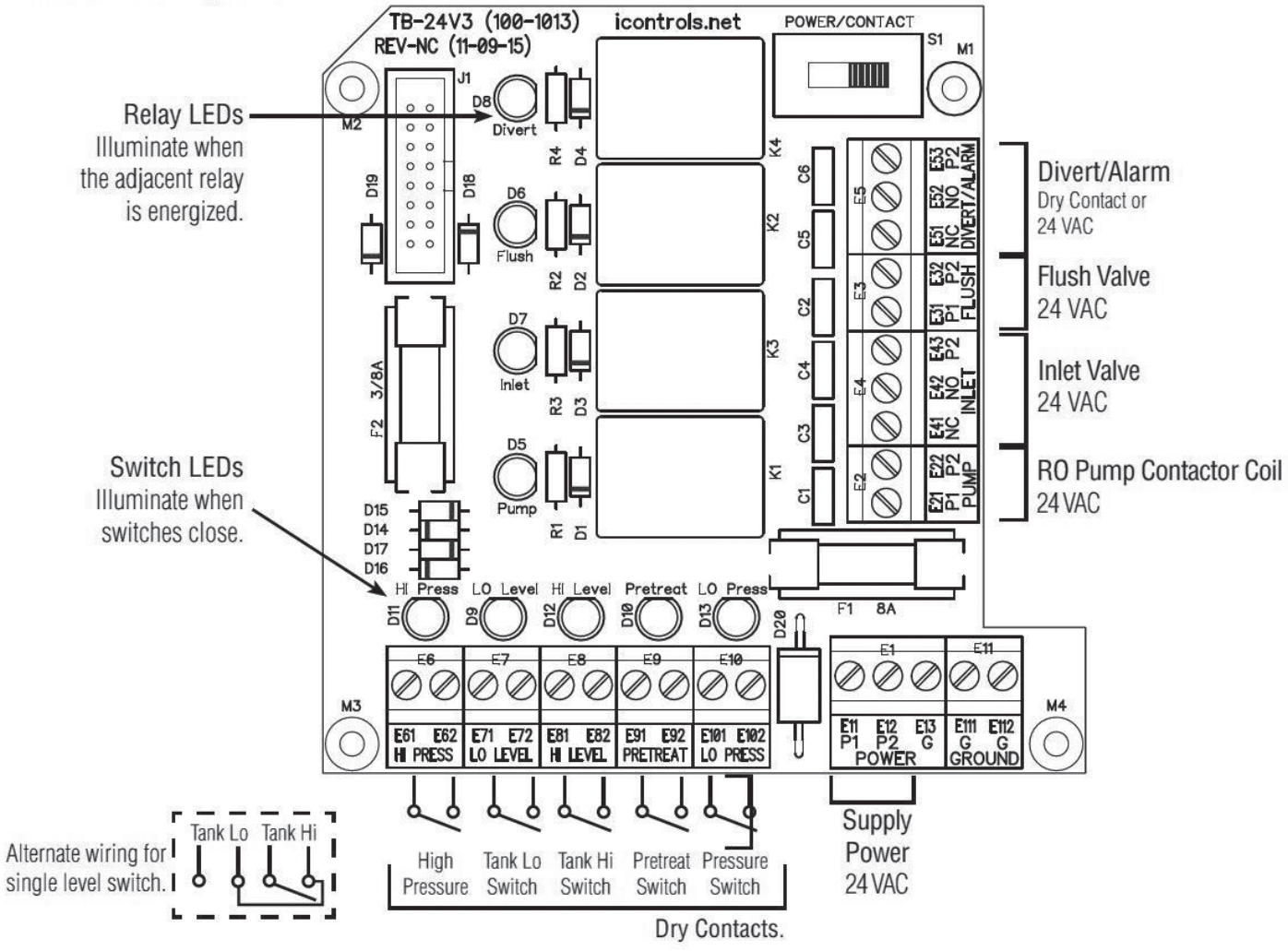
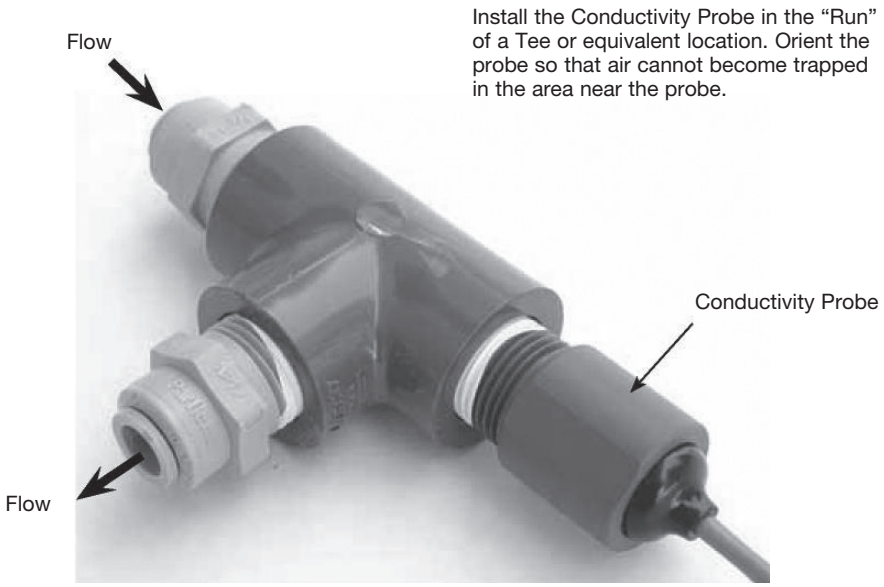
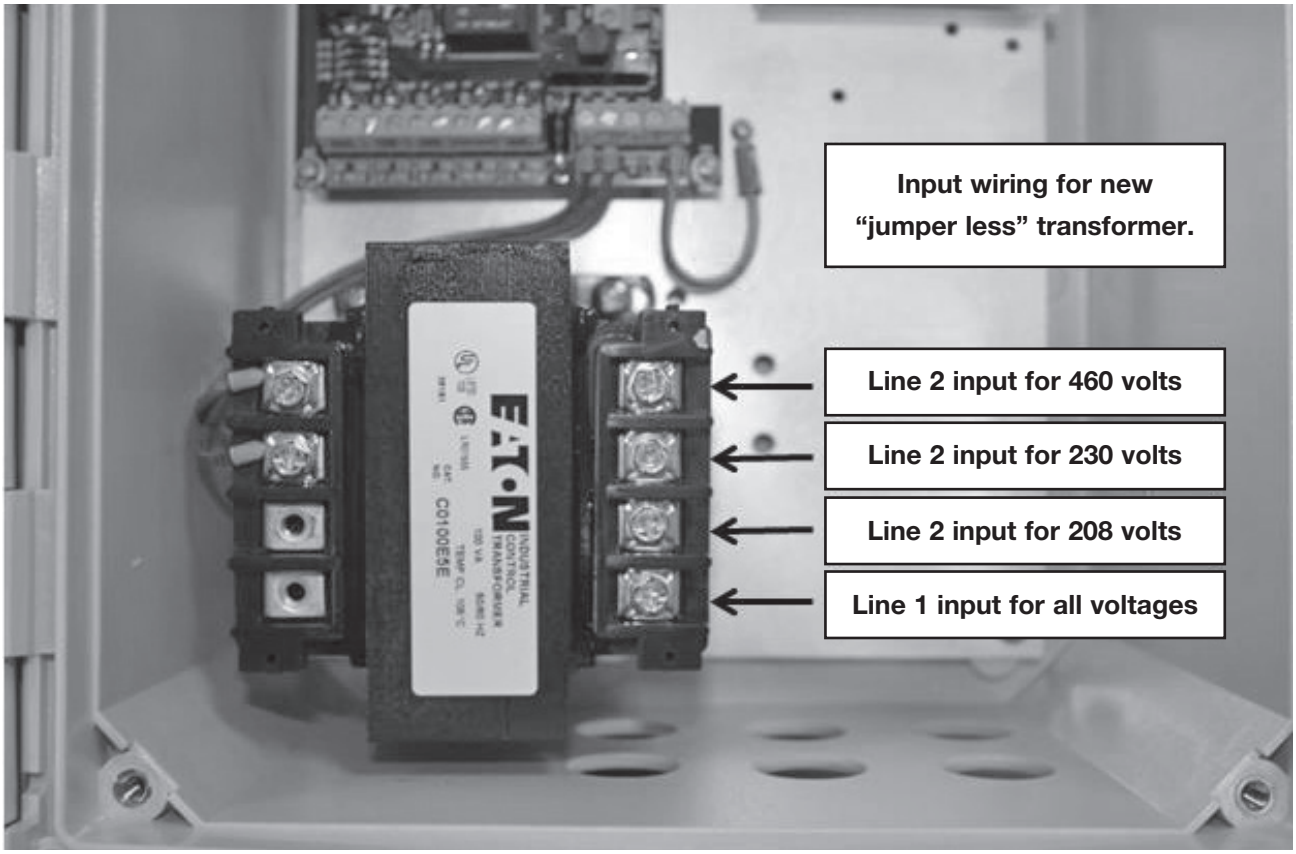


Figure 9. Conductivity Probe Installation





Installation

1. Drill the enclosure as needed and install liquid-tight fittings for the wiring.
2. Mount the enclosure in the desired location on the RO system.
3. Bring the wires from the peripheral devices into the enclosure and connect them to the appropriate terminals. (See Figures 3,6,7 and 8.)
4. Install the conductivity cell in the permeate line. (See Figure 9 for conductivity cell installation instructions.)
5. Connect the conductivity cell to the terminals on the CPU Board. (See Figure 6) Repeat Steps 6 & 7 for the Feed Conductivity cell if your system will utilize both feed and permeate conductivity measurement.
6. Provide power to the RO system.
7. Press the System On/Off switch to turn the system ON.
8. Select the Program Mode (See Figure 9 and Table 2). The default is Program 1 which is a general purpose setting. Use Program 2 if your system is not equipped with a flush valve.
9. Make any other changes you want to the settings. Press System On/Off to save your changes.
10. The controller is now ready for service.

NOTICE

The above information is provided in case the controller is purchased as a standalone product.

Figure 10. Controller Programming. Accessing the hidden menus.

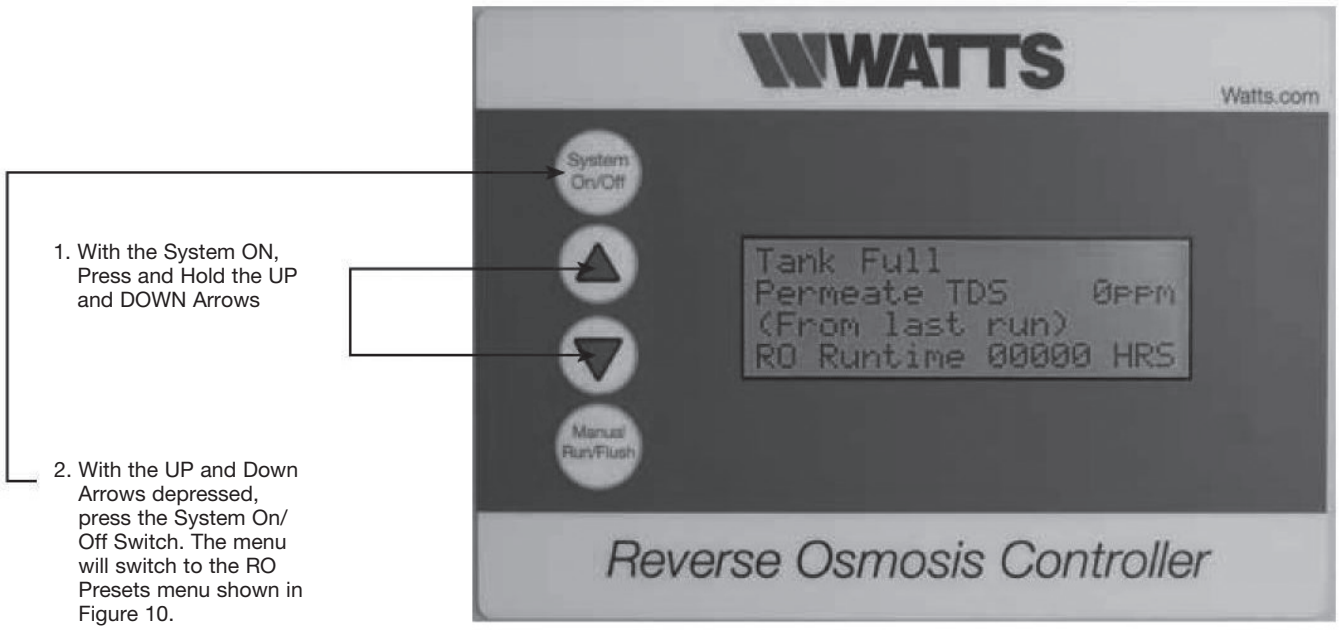


TABLE 2. CONTROLLER PROGRAMMING: ROC-4 PROGRAM SELECTIONS

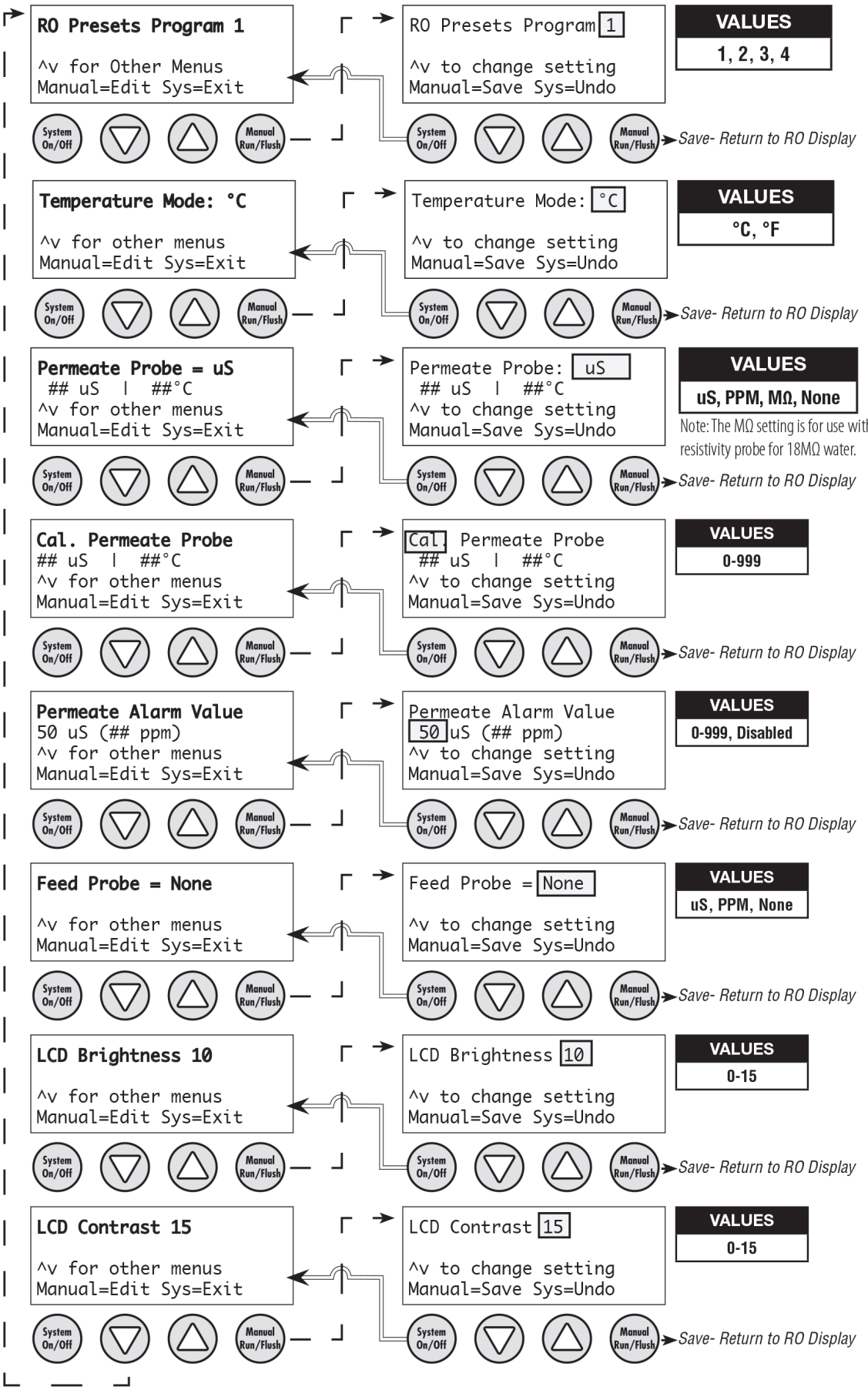
The controller has 4 separate user-selectable sets of settings for configuring the RO. The factory default settings are shown below. The settings are identical except for variations in the flush behavior.

- Program 1, High Pressure flush.
- Program 2, No Flush
- Program 3, Permeate Flush, (low pressure, inlet valve closed)
- Program 4, Low Pressure, feed water flush
- See the previous page for instructions on how to access the menu for selecting these programs.
- See Appendix A for a detailed explanation of the Parameters and their effect on the RO's operation

Parameter	Value	Program 1	Program 2	Program 3	Program 4
Tank Level Switch delay (actuation and de-actuation)	Seconds	2	2	2	2
Pressure Switch delay (actuation and de-actuation)	Seconds	2	2	2	2
Pretreat Switch delay (actuation and de-actuation)	Seconds	2	2	2	2
Pump start delay	Seconds	10	10	10	10
Inlet Solenoid stop delay	Seconds	5	5	1	1
Pump start retry interval (restart delay after LP fault)	Seconds	60	60	60	60
Low pressure fault shutdown, # of faults	Faults	5	5	5	5
Low pressure fault shutdown, time period to count faults	Minutes	10	10	10	10
Low pressure fault shutdown, reset after shutdown	Minutes	60	60	60	60
Low pressure timeout fault	Seconds	60	60	60	60
Flush Behavior		High Pressure	No Flush	Permeate Flush	Low Pressure Flush
Startup Flush: Minutes from last flush	Minutes	0	0	0	0
Startup Flush: Duration	Seconds	0	0	0	30
Periodic Flush: Interval	Minutes	60	0	0	0
Periodic Flush: Duration	Seconds	30	0	0	0
Shutdown Flush: Time from last flush	Minutes	10	0	0	0
Shutdown Flush: Minimum operation	Minutes	30	0	0	0
Shutdown Flush: Duration	Seconds	60	0	60	60
Idle Flush: Interval *	Minutes	0	0	0	0
Idle Flush: Duration *	Seconds	0	0	0	0
Timed Manual Run	Minutes	5	5	5	5
Timed Manual Flush	Minutes	5	0	5	5

* These features are disabled by default due to the potential for confusion on the part of end-users in the field. They can be enabled when needed via the OEM PC programming interface which allows changes to all of the values shown above.

Figure 11. Controller Programming: Menu Navigation



APPENDIX A. CONTROLLER PROGRAMMING: PARAMETERS EXPLAINED			
Parameter	Value	Range	Example
Input Switch Behaviors			
Tank Level Switch de-Bounce	Seconds		2.0
This specifies the time that the tank switch must be closed or open before the controller accepts it as a valid condition. This helps to prevent nuisance tripping of the RO especially in small or turbulent tanks			
Pressure Switch de-Bounce	Seconds		2
Pretreat Switch de-Bounce	Seconds		2
This is the time that the pretreat switch must be OPEN before the controller accepts it as a valid condition. The function is to prevent nuisance tripping of the RO especially in small or turbulent tanks			
Pump/Inlet Solenoid Behaviors			
Pump start delay	Seconds		10
On RO start-up, after the tank switch opens, the inlet solenoid valve is energized. When the inlet pressure switch closes this begins the “Pump start delay”. If the pressure switch remains closed, the pump will start after 10 seconds.			
Inlet Solenoid stop delay	Seconds		1
This value sets the delay for the inlet solenoid valve to be de-energized following the de-energizing of the motor on Tank Full RO shut down. This prevents the pump from operating against a closed suction as the pump spins down. Time values greater than 1 or 2 seconds may require an inlet valve that will operate with 0psi differential pressure.			
Low Inlet Pressure Behaviors			
Pump start retry interval (restart delay after LP fault)	Seconds		60
When the inlet pressure switch opens, the controller de-energizes the motor and the inlet solenoid valve remains open. The controller will continue to monitor the inlet pressure switch. After the switch is closed for the duration of the “Pump start retry interval” the motor is re-energized.			
Low pressure fault shutdown, # of faults	Faults		5
Low pressure fault shutdown, time period to count faults	Minutes		10
Low pressure fault shutdown, reset after shutdown (0 value = no restart)	Minutes		60
These three values work together to determine how the RO handles Low Pressure conditions. The first two values, “# of faults” and “time period to count faults”, sets the limit for the number of low fault conditions over time that are required to place the RO in “Low Pressure Fault Shutdown”. The third value sets the duration of the “Low Pressure Fault Shutdown” which is the period that the RO will remain idle before trying to restart. The purpose of the Low Pressure Fault Shutdown is to prevent an RO from turning OFF/ON repeatedly without any limit.			
Low pressure timeout fault	Seconds		60
If the inlet valve is open, but the pressure isn’t sufficient to close the inlet pressure switch, the RO would run indefinitely on line pressure. This value sets the time limit for the RO to operate with the inlet valve open with Low Pressure as indicated by an Open inlet pressure switch before a Low Pressure Fault is added to the counter above.			
Flush Behavior			
Time from last flush before Flush on Shutdown	Minutes		15
Minimum operation before Flush on Shutdown	Minutes		60
Flush duration on Shutdown	Seconds		60
Periodic Flush interval	Minutes		60
Periodic Flush duration	Seconds		30
Unit Idle Flush interval	Minutes		0
The Unit Idle Flush Interval sets a time after which the RO will start-up and run in the flush mode. This is disabled by default because of the danger of over-flowing a tank if not properly implemented. It is intended for environments where leaving the RO idle for long periods would invite bio-fouling. (0)=disabled			
Unit Idle Flush duration	Seconds		0
Sets the duration of the Idle Flush. (0)=disabled			
Timed Manual Run - Duration of Manual Run	Minutes		5
Timed Manual Flush - Duration of Manual Flush	Minutes		5
Conductivity Probe Sample Rate	Seconds		2
Conductivity Shutdown (0)=disabled	Minutes		0

Controller Fault Condition Displays

Below are examples and explanations of the displays which accompany the fault conditions possible in the ROC-4. Fault conditions always indicated a problem of some sort which requires corrective action. The displays provide sufficient information to recognize the source of the fault and the required corrective action.

High Pressure Fault: *(Occurs when High Pressure Switch Closes)*

Line 1 “Service Fault”

Line 2 “High System Pressure”

Line 3

Line 4 “To Reset Push OFF/ON”

Low Pressure Fault: *(System is responding to low pressure condition per system settings)*

Line 1 “Service Fault”

Line 2 “Low Feed Pressure”

Line 3

Line 4 “Restart in MM:SS”

Pre Treat Fault: *(Pretreat Switch is closed indicating problem with pretreat system).*

Line 1 “Service Fault”

Line 2 “Pretreat”

Line 3

Line 4 “Check Pretreat Sys.”

Permeate Conductivity Fault: *(Permeate conductivity is higher than the alarm set point.)*

Line 1 “Service Fault”

Line 2 “Permeate TDS xxx ppm” or “Permeate Cond xxx uS”

Line 3 “Alarm SP xxx ppm” or “Alarm SP xxx uS”

Line 4 “To Reset Push OFF/ON”

Feed Conductivity Fault: *(Feed conductivity is higher than the alarm set point.)*

Line 1 “Service Fault”

Line 2 “Feed TDS xxx ppm” or “Feed Cond xxx uS”

Line 3 “Alarm SP xxx ppm” or “Alarm SP xxx uS”

Line 4 “To Reset Push OFF/ON”

Conductivity Probe Error messages:

Line 2 “Over-range” - Measurement is out of range for the circuit, probe may also be shorted

Line 2 “Probe shorted” - Short circuit detected on temperature sensor in probe

Line 2 “Probe not detected” - Open circuit detected on temperature sensor in probe

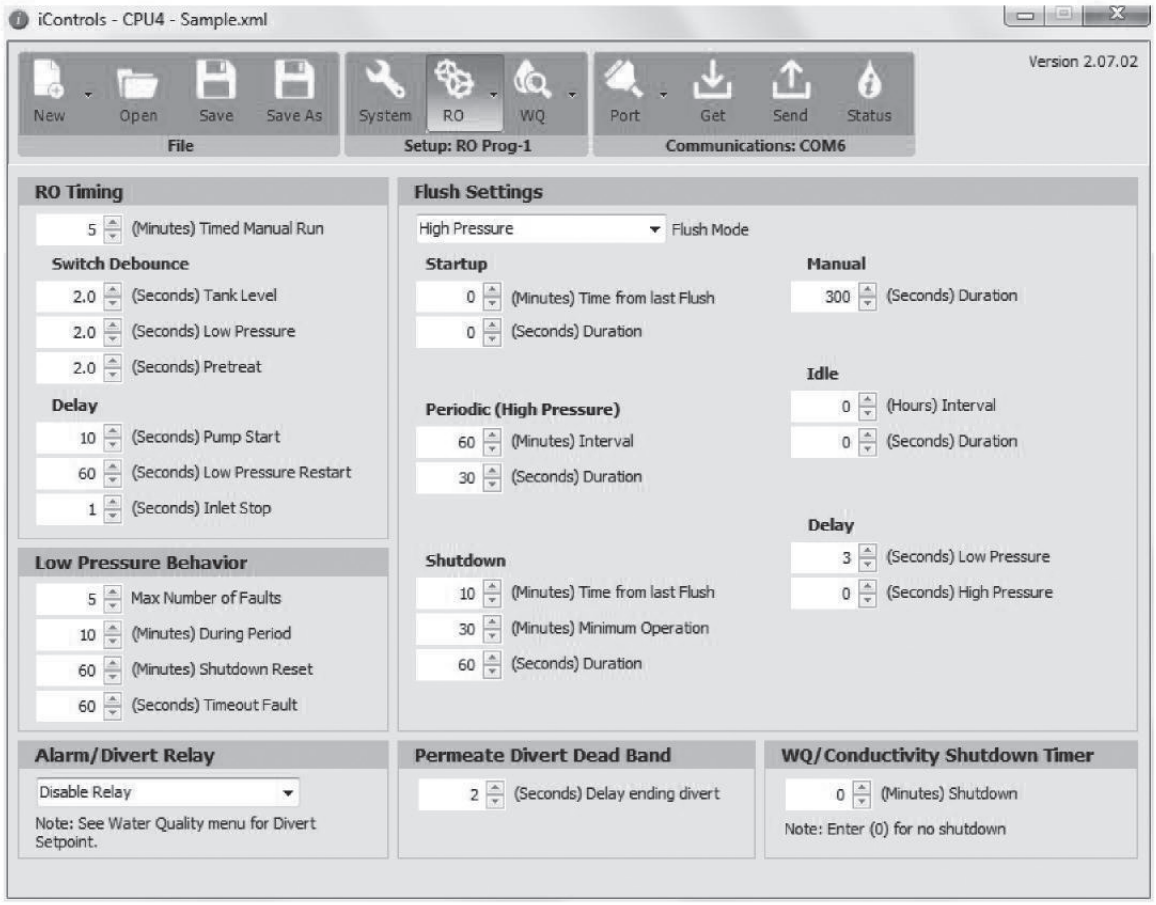
Line 2 “Probe Startup 1” - Internal reference voltage too high to make valid measurement

Line 2 “Probe Startup 2” - Internal reference voltage too low to make valid measurement

Line 2 “Probe Startup 3” - Internal excitation voltage too high to make valid measurement

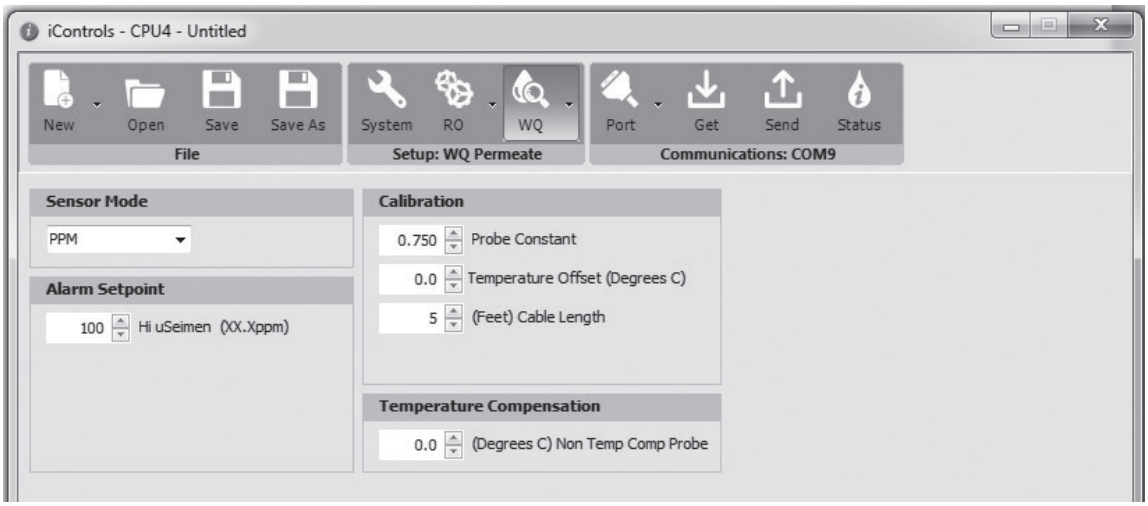
Line 2 “Probe Startup 4”, - Internal excitation voltage too low to make valid measurement

Appendix B. Controller Programming: Programming Interface Overview

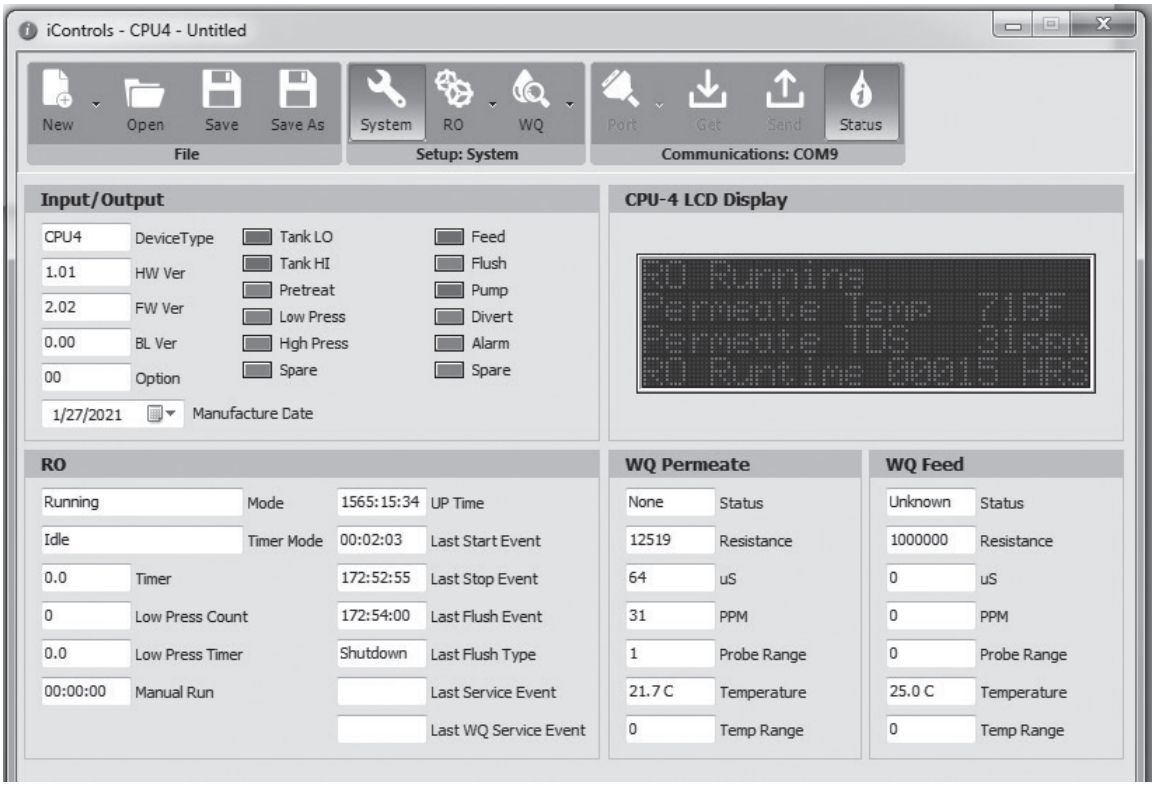


The Programming interface is a Windows-based tool for making changes to the ROC software. This screen shows the RO settings available. There are 4 field-selectable sets of settings stored in the CPU-4

Appendix B. Controller Programming: Programming Interface Overview



The WQ screen allows the configuration of the conductivity probes.



The status screen shows the input and output status and other operational information.

F. PWR4021 Operation and Maintenance Log

DATE	PRODUCT GPM	REJECT GPM	PUMP DISCHARGE PRESSURE	REJECT PRESSURE	FEED TDS PPM	PRODUCT TDS PPM	FEED WATER TEMP	FEED WATER HARDNESS	FEED WATER CHLORINE LEVEL	PRE FILTER INLET PRESSURE	PRE FILTER OUTLET PRESSURE	REMARKS

Note: Change the prefilter when the differential pressure increases by 5 - 10psi over the clean differential pressure.
Clean the RO membrane(s) when the product flow drops by 15% or more. (See appendix)

Troubleshooting

RO TROUBLE SHOOTING GUIDE						
	SYMPTOMS					
Salt Passage	*Permeate Flow*	*Pressure Drop*	*Location*	*Possible Causes*	*Verification*	*Corrective Action*
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 colloidal removal. Clean with high pH, anionic detergent formulation.
Increased	Decreased	Increased	Predominantly last stage	Scaling (CaSO4, CaSO3, BaSO4, SiO2)	Analysis of metal ions in cleaning sol. Check LSI of reject. Calculate maximum solubility for CaSO4, BaSO4, SiO2 in reject analysis.	Increase acid addition and scale inhibitor for CaSO3 and CaSO4. Reduce recovery. Clean with an acid formulation for CaCO3, CaSO4 and BaSO4.
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. Of bisulfite at reduced pH. Formaldehyde sterilization. Clean with alkaline anionic surfactant. Chlorine dosage up-stream with subs. 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 TROUBLE SHOOTING CHART		
TROUBLE	CAUSE	WHAT TO DO
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.
	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.

MOTOR TROUBLE SHOOTING CHART (CONTINUED)		
TROUBLE	CAUSE	WHAT TO DO
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 TROUBLE SHOOTING	
PROBLEM	REMEDY
General	
High Product Water TDS	
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.
No Product Water or Not Enough Product Water	
Feed water shut off.	Turn on feed water.
Low feed pressure.	Consider booster pump.
Feed pressure must be at least 20psi.	Replace pre-filter cartridge.
Pre-filter cartridge clogged.	Determine and correct cause; replace membrane.
Membrane fouled. Product check valve stuck.	Replace check valve fitting.
Low pump discharge pressure	Open pump discharge valve, replace pump

ORDERING CODE #	DESCRIPTION
68107603	Pre-Filter housing 20" Full Flow
68107310	RO Membrane Pressure Vessels 4" x 40" FRP
68107309	RO Membrane Pressure Vessel 4" x 40" FRP (bottom)
7300452	Pressure Gauge, 2", 0 - 100psi, Dry
68107029	Pressure Gauge, 2.5", 0 - 400psi, LF
7300464	Flow Meter 1 - 10 gpm (product)
7300468	Flow Meter 1 - 10 gpm (reject)
7300924	Motor Starter Contactor, 16 amps, 24 volt coil
7300925	Overload Relay 3.2 - 16 amps
68107195	Pump and Motor BVMI 3-21 5 HP, 3-Phase
7300444	Low-Pressure Switch, 4psi for package II Controller
7300390	Inlet Solenoid Valve, 1", 24 volt coil
7300817	Watts 4" x 40" RO Membranes
7300923	Package II Controller ROC-4
68106950	Conductivity Probe
7300446	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 loosing the brass fittings between the end of the hoses and the pressure vessel end caps.
3. Remove the retaining plates the pressure vessel end caps.
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.
8. Lightly lubricate the end cap internal and external o-rings with glycerin.
9. Install the end caps and secure them with the retaining plates.
10. Install the membrane feed hoses.
11. Verify that all retaining plates are installed.
12. Follow the startup procedure in section III-D.

VI. Appendix

The following tables are intended as a guide to determining the flow rates for the PWR4021 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	PWR40213023	PWR40213033	PWR40213043	PWR40213053	PWR40213063
Product	2.5	3.75	5	6.25	7.5
Reject	2.5	3.75	1.7	2.1	2.5
Reject Recycle	3.6	2.2	3.3	2.6	2.1

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

MODEL NUMBER	PWR40213023	PWR40213033	PWR40213043	PWR40213053	PWR40213063
Product	2.3	3.5	4.3	5.2	6.3
Reject	2.3	3.5	1.4	1.7	2.1
Reject Recycle	4.3	3	3.9	3.1	2.3

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.

Notes

LIMITED WARRANTY: Certain Watts Pure Water products come with a limited warranty from Watts Regulator Co. Other products may have no warranty or are covered by the original manufacturer's warranty only. For specific product warranty information, please visit www.watts.com or the published literature that comes with your product. Any remedies stated in such warranties are exclusive and are the only remedies for breach of warranty. **EXCEPT FOR THE APPLICABLE PRODUCT WARRANTY, IF ANY, WATTS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED. TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, WATTS HEREBY SPECIFICALLY DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND IN NO EVENT SHALL WATTS BE LIABLE, IN CONTRACT, TORT, STRICT LIABILITY OR UNDER ANY OTHER LEGAL THEORY, FOR INCIDENTAL, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR PROPERTY DAMAGE, REGARDLESS OF WHETHER IT WAS INFORMED ABOUT THE POSSIBILITY OF SUCH DAMAGES.**

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