iControls™

ROC-5-UL

Reverse Osmosis System Controller

Documentation

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Document Revised August 2016

Welcome.

Thank you for purchasing an iControls controller.

The ROC-5 is a state-of-the-art RO system controller. The documentation that follows should allow you to successfully install and operate the controller. However, if you have any questions, please contact us at the number below.

As good as our controllers are, there's always room for improvement. If you have an experience, idea or input either positive or negative we'd love to hear from you.

Again, thanks for your purchase. Welcome to the community of iControls users.

David Spears

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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.
Controller Power	110/240 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 Relay Ratings (relays are fused with a 6A fuse)

|	
Feed Solenoid	0.5A. *Voltage is the same as motor/supply voltage.*
Flush Solenoid	0.5A. *Voltage is the same as motor/supply voltage.*
Feed Pump Terminals	0.5A. *Voltage is the same as motor/supply voltage.*
Divert	0.5A. *Voltage is the same as motor/supply voltage or can be dry contact selectable via S1.*
Motor Contactor Coil	0.5A. *Voltage is the same as motor/supply voltage.*

Circuit Protection

Main/Relay Power Fuse	F1	5x20mm	6 Amp	Littelfuse 0234006P
Power Supply/CPU Fuse	F2	5x20mm	0.125 Amp	Littelfuse 0218.125P

Other

Dimensions	11.5" tall, 9.3" wide, 6.7" deep. Nema Type 1 non-metallic (10x8x6)*
	13.5" tall, 11.4" wide, 6.7" deep. Nema Type 1 non-metallic (12x10x6)*
	15.5" tall, 13.3" wide, 7.7" deep. Nema Type 1 non-metallic (14x12x7)*
Weight	4.2 lb. (10x8x6) *(Enclosure, CPU-4 and TB-5 only.)*
	6.0 lb. (12x10x6) *(Enclosure, CPU-4 and TB-5 only.)*
	10.6 lb. (14x12x7) *(Enclosure, CPU-4 and TB-5 only.)*
Environment	0-50°C, 10-90%RH (non-condensing)

*The enclosures are Nema Type 4X, glass reinforced polycarbonate before our modifications. They are reduced to Type 1 because the enclosure has not been tested following the modifications needed to install our components.

Figure 1. Simplified Schematic
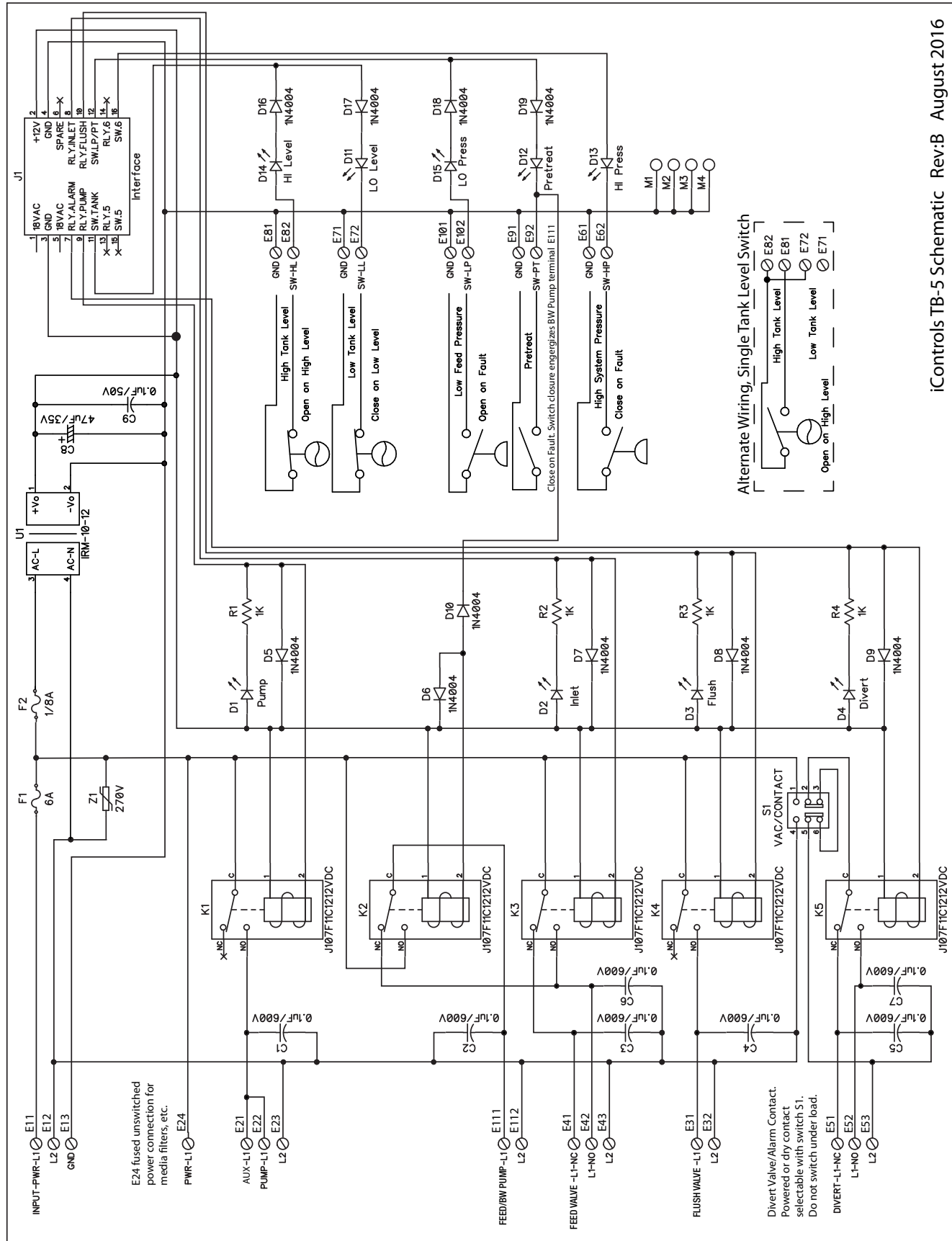
iControls TB-5 Schematic Rev:B August 2016

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Figure 2. Controller Overview

Keypad.

System ON/OFF,

Up Arrow

Down Arrow

Manual Run, Manual Flush

Display. (4 line, 20 character) Clear, concise feedback on the RO's status.

Alarm.
Display backlight flashes along with audible beeper to indicate alarm condition.
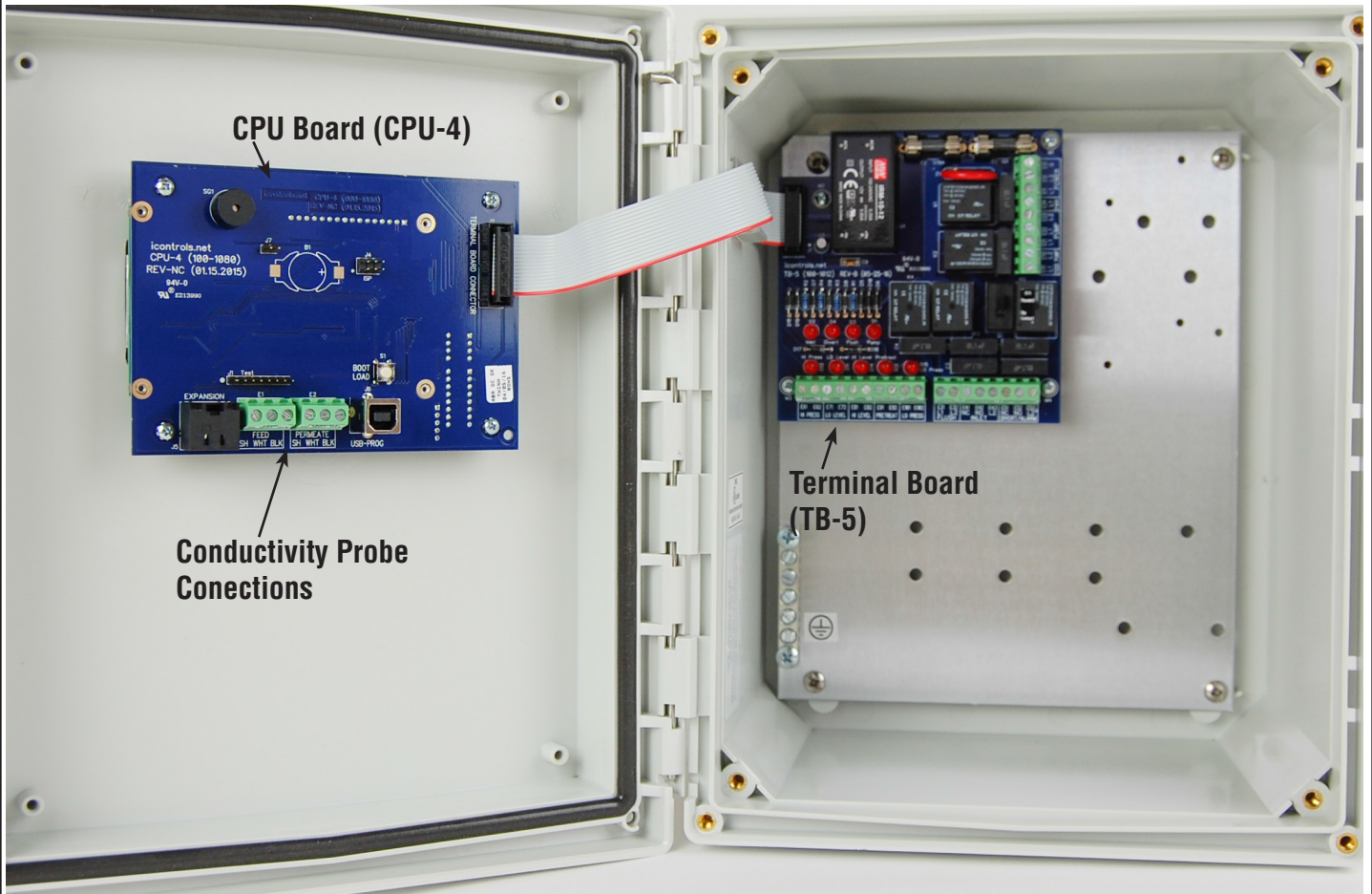
CPU Board (CPU-4)

Conductivity Probe Conections

Terminal Board (TB-5)

Figure 4. Controller Detail: CPU-4

Typical Configuration

Detailed View

Main interface port.
Connects via ribbon cable to Terminal Board.

BootLoad Switch
Used for field updates of CPU-4 firmware

Programming Port
Standard USB printer cable used for programming. See Appendix B for more about the programming interface

(Optional Feed Conductivity Probe)

Permeate Conductivity Probe

![iControls™ logo]
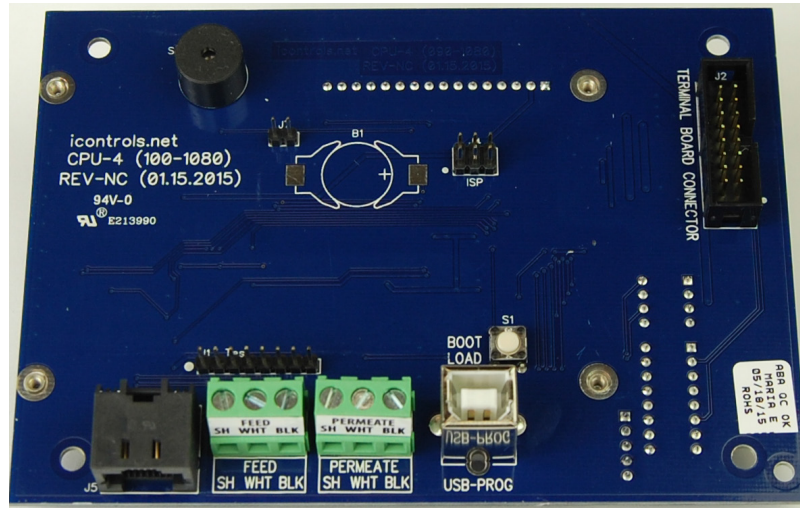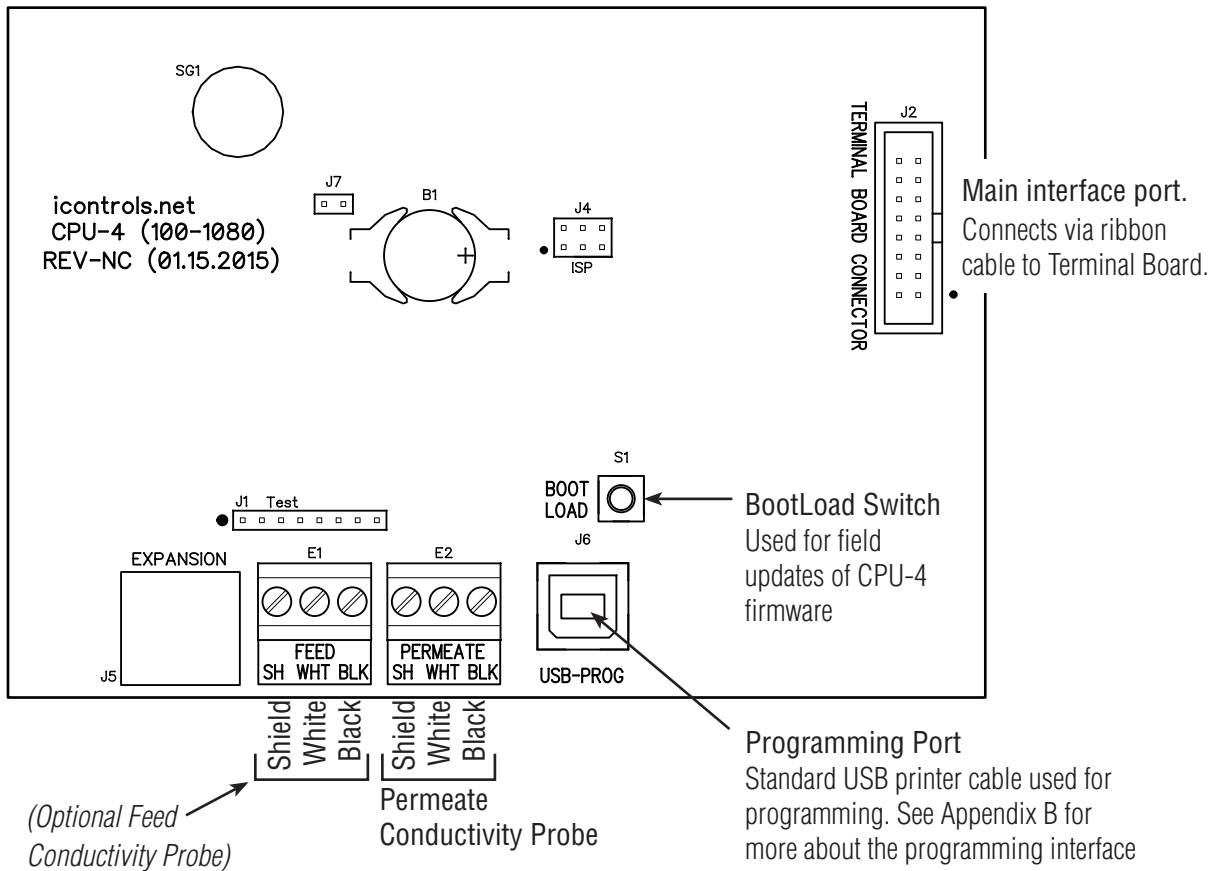
Figure 5. Controller Detail: Terminal Board, TB-5 (See Fig. 1 for schematic)
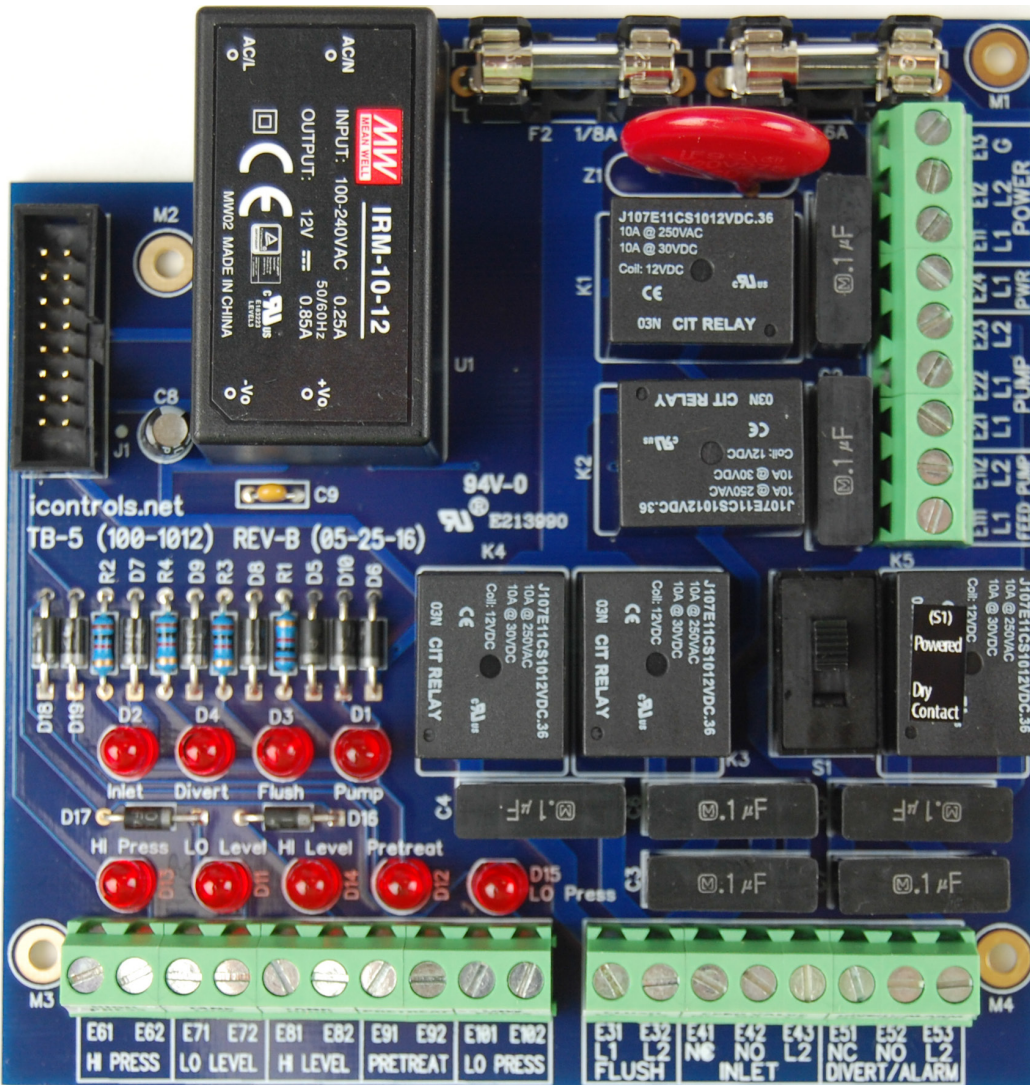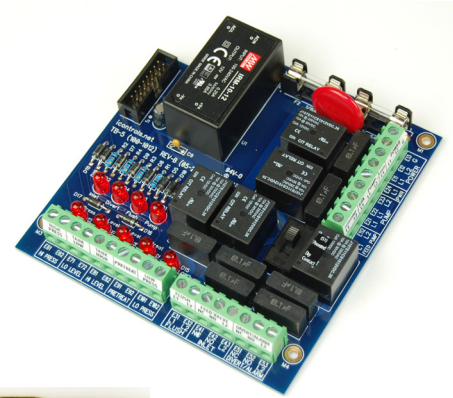
Supply Power
120/240 VAC

Aux Output, unswitched

RO Pump Contactor Coil
120/240 VAC

Aux Output, Switched with pump

Feed/BW Pump Contactor
Coil - 120/240 VAC

S1
Divert/Alarm relay,
Powered or Dry contact
selector
NOTE: Switch only when
not under load.

High Pressure

Tank Low Switch

Tank Hi Switch

Pretreat Switch

Supply Pressure Switch

Flush Valve
120/240 VAC

Inlet Valve
120/240 VAC

Divert/Alarm
Dry Contact
or 120/240 VAC

Tank Low   Tank Hi

Alternate wiring for
single level switch.

Figure 6. Conductivity Probe Installation

Flow
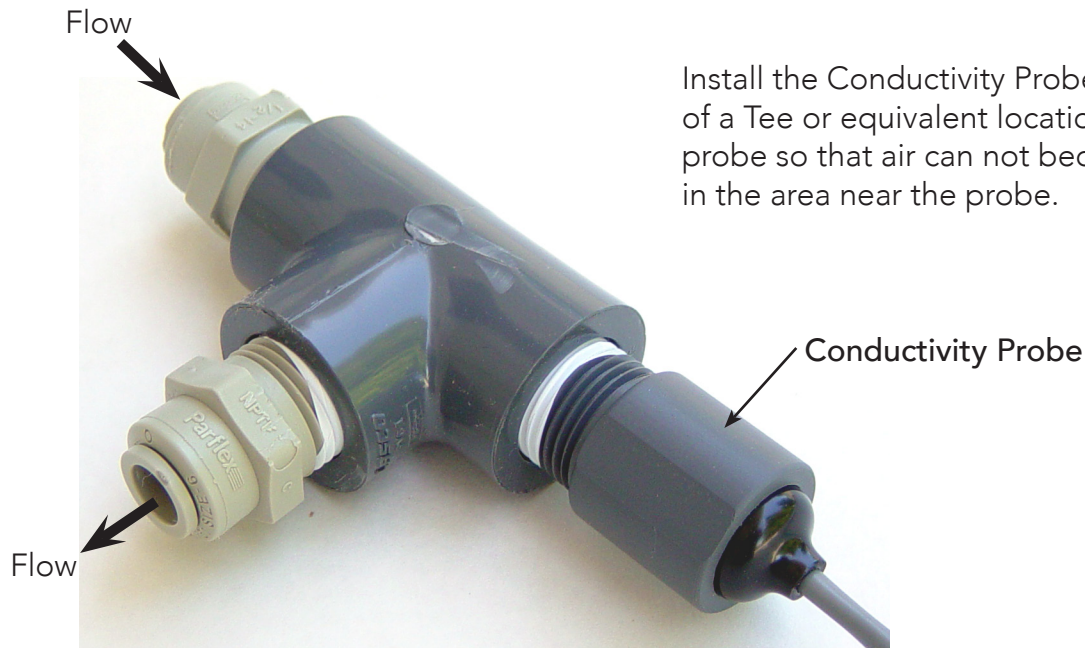
Install the Conductivity Probe in the "Run" of a Tee or equivalent location. Orient the probe so that air can not become trapped in the area near the probe.

Conductivity Probe

Flow

Conductivity Probe Calibration

Because the conductivity measurement is affected by the physical environment in which it operates, it is best to calibrate while installed in the system and operating under normal conditions. This requires an external conductivity measurement device that is known to be accurate to serve as a reference.

1. Operate the RO long enough for the membranes, operating temperature and permeate conductivity reading to stabilize.
2. Take a sample of the permeate and measure it with the reference meter.
3. See Figure 7 for instructions on how to access the Permeate Calibration Menu.
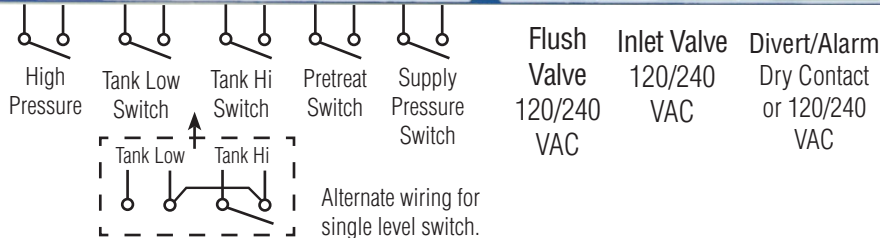4. Enter the Permeate Calibration menu and use the UP or Down arrow until the value on the controller matches the value obtained on the reference meter.
5. Exit and Save the calibration.
6. The same procedure applies to the Feed Probe calibration.

   NOTE: The probe calibration must be performed using solutions with conductivity of less than 900 ppm or µs. The conductivity calibration circuit will behave erratically if you attempt to calibrate using a higher value. When using a standard calibration solution, the NaCl PPM value can be used in place of the µs value if desired.

Installation

1. Drill the enclosure as needed and install liquid-tight fittings for the wiring.

   NOTE: The Controller can be ordered pre-drilled or with fittings installed, or with fittings and wiring istalled. Contact i-controls for details.

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 1,3.4 and 5.)*

4. Install the conductivity cell in the permeate line. *(See Figure 6 for conductivity cell installation instructions.)*

5. Connect the conductivity cell to the terminals on the CPU Board. *(See Figure 3) 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 6 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.

   NOTE: The Program Settings can be customized to suit the specific needs of an OEM and preprogrammed at the factory with your settings. Contact i-controls for details.

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.

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Figure 7. Controller Programming. Accessing the hidden menus.

1. With the System ON, Press and Hold the UP and Down Arrows.

2. With the UP and Down Arrows depressed, press the System On/Off Switch. The menu will switch to the RO Presets menu shown in Figure 7.

```
RO Running
Permeate Temp   74°F
Permeate TDS     0ppm
RO Runtime 00038 HRS
```
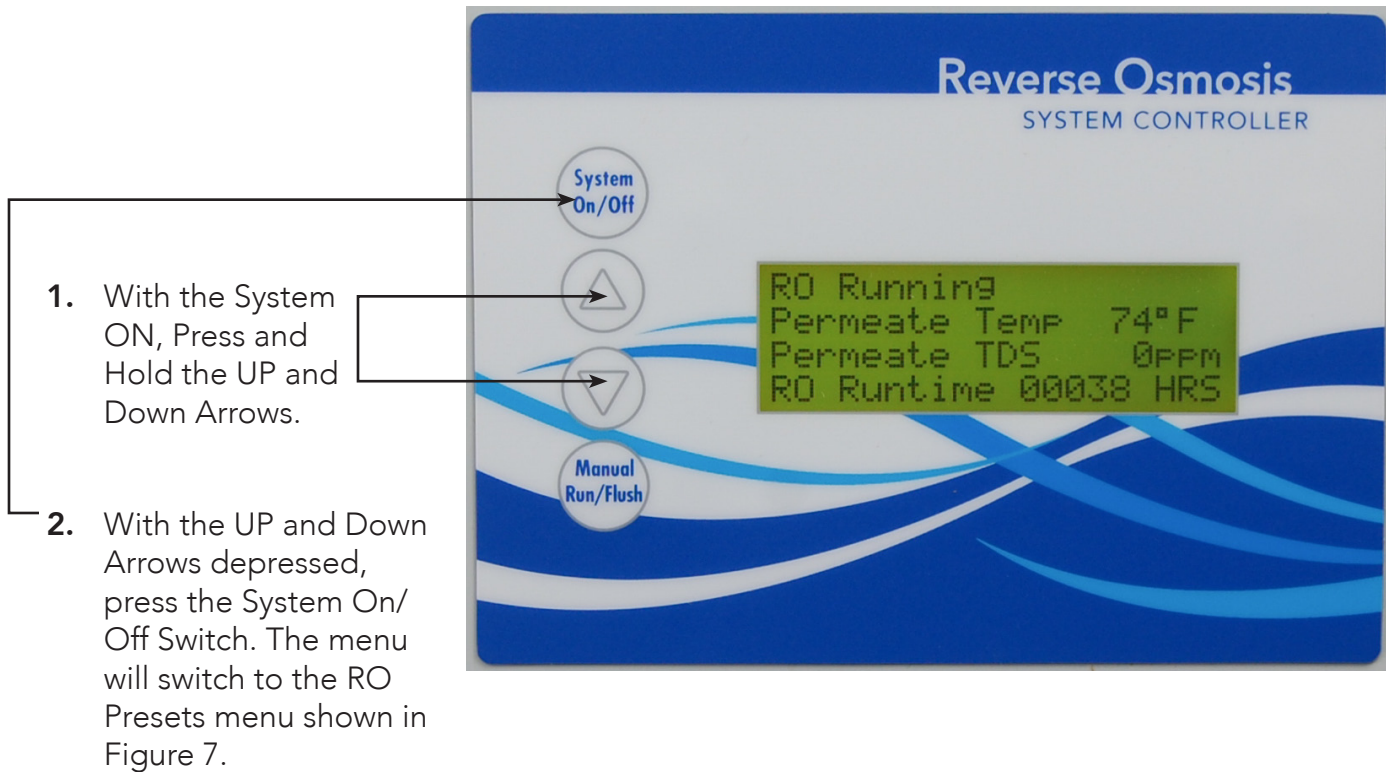
Table 2. Controller Programming: CPU-4 Program Selections

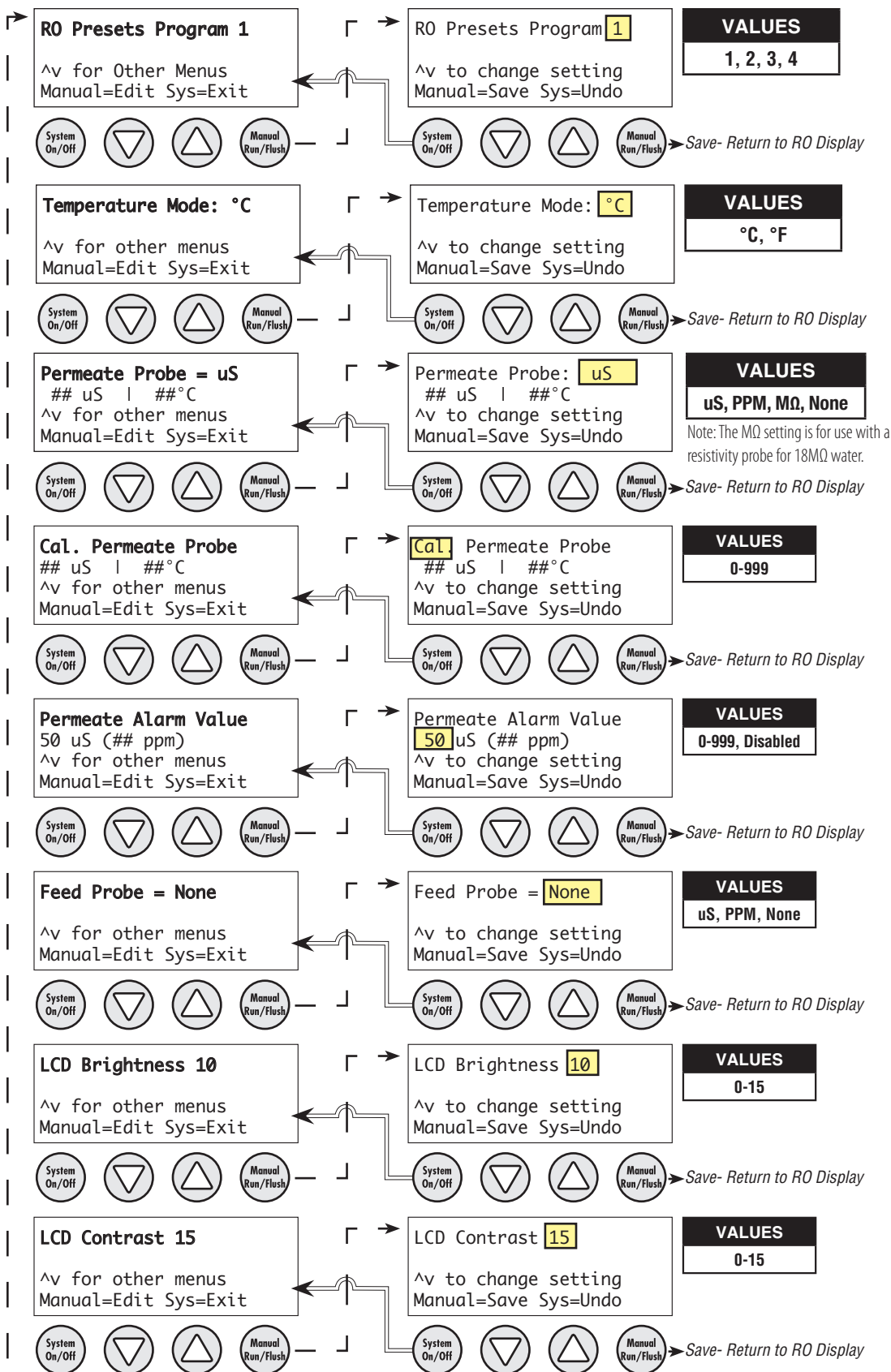The controller has 4 separate, field-selectable sets of settings for configuring the RO. The factThe controller has 4 separate user-selectable sets of settings for configuring the RO. The factory default settings are shown below. The settings are identical except for variations in the flush behavior.

- **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 affect 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 Solenid stop delay	Seconds	1	1	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: Minumum 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 8. Controller Programming: Menu Navigation

RO Presets Program 1

^v for Other Menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

RO Presets Program 1

^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
1, 2, 3, 4

Temperature Mode: °C

^v for other menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

Temperature Mode: °C

^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
°C, °F

Permeate Probe = uS
 ## uS | ##°C
^v for other menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

Permeate Probe: uS
 ## uS | ##°C
^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
uS, PPM, MΩ, None

Note: The MΩ setting is for use with a resistivity probe for 18MΩ water.

Cal. Permeate Probe
uS | ##°C
^v for other menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

Cal. Permeate Probe
 ## uS | ##°C
^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
0-999

Permeate Alarm Value
50 uS (## ppm)
^v for other menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

Permeate Alarm Value
50 uS (## ppm)
^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
0-999, Disabled

Feed Probe = None

^v for other menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

Feed Probe = None

^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
uS, PPM, None

LCD Brightness 10

^v for other menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

LCD Brightness 10

^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
0-15

LCD Contrast 15

^v for other menus
Manual=Edit Sys=Exit

(System On/Off) (▽) (△) (Manual Run/Flush)

LCD Contrast 15

^v to change setting
Manual=Save Sys=Undo

(System On/Off) (▽) (△) (Manual Run/Flush) ➤ *Save- Return to RO Display*

VALUES
0-15

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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. The function is to prevent nuisance tripping of the RO especially in small tanks 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 tanks 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 Solenid stop delay	Seconds		1
This value sets the delay for the inlet solenoid valve to be deenergized following the deenrgizing of the motor on RO shut down. The purpose is to prevent the pump from operating against a closed suction as the pump spins down.			
Low Inlet Pressure Behaviors			
Pump start retry interval (restart delay after LP fault)	Seconds		60
When the inlet pressure swith opens, the controller deenergizes 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 reenergized.			
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			

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Appendix A. Controller Programming: Parameters Explained

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

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Controller Fault Condition Displays

Below are examples and explanations of the displays which accompany the fault conditions possible in the ROC-3. 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 setpoint.)*
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 setpoint.)*
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
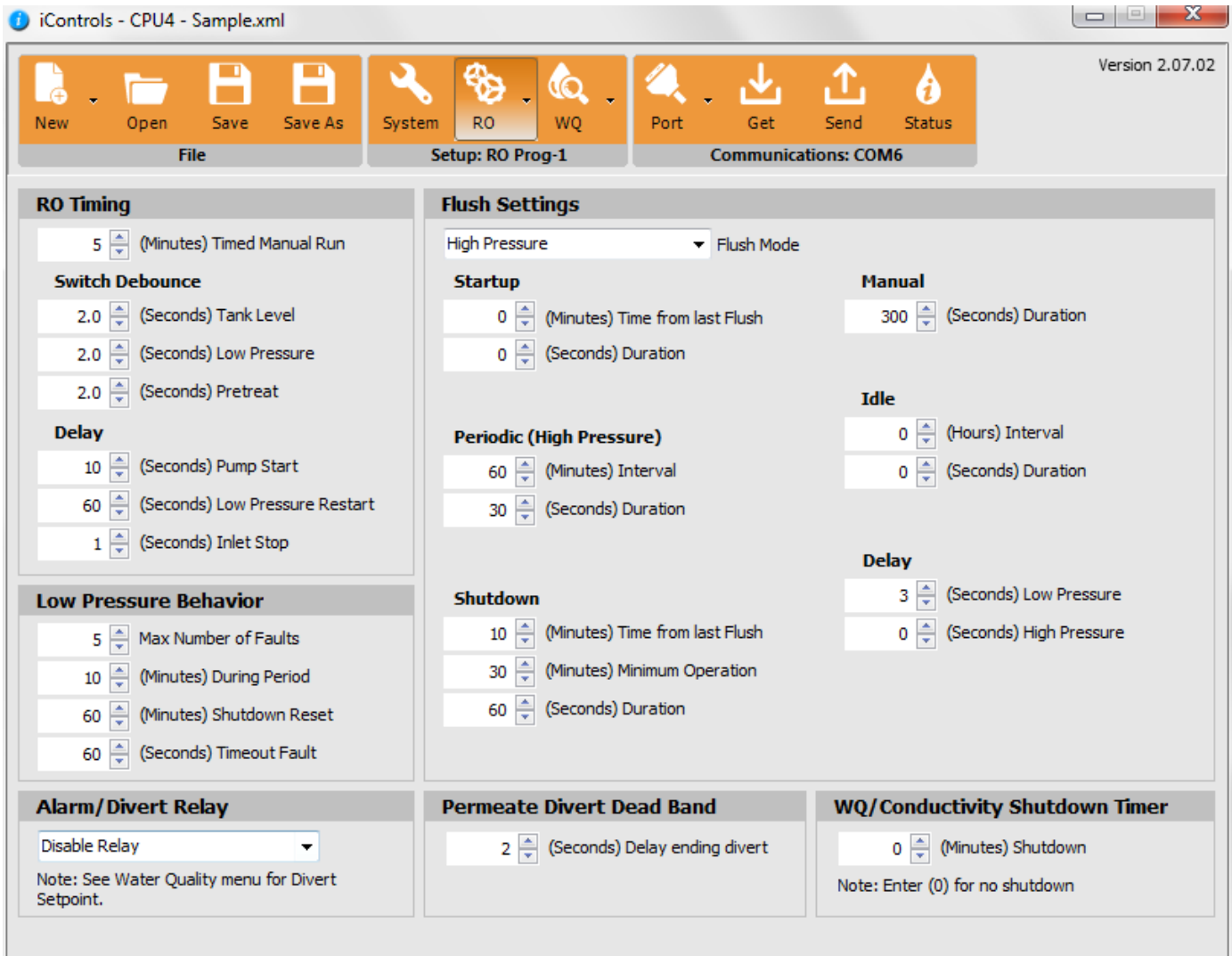
The Programming interface is a Windows-based tool for making changes to the ROC software. This screen shows the RO settings available. There are 4 different sets of settings stored in the CPU-.4

Appendix C. Warranty

I-Controls Limited Warranty

What the warranty covers:
iControls warrants the ROC-5 to be free from defects in materials and workmanship during the warranty period. If a product proves to be defective during the warranty period, *iControls* will at is sole option repair or replace the product with a like product. Replacement product or parts may include remanufactured or refurbished parts or components.

How long the warranty is effective:
The ROC-5 is warranted for one (1) year for parts and labor from the date of the first consumer purchase or 15 months from ship date, whichever comes first.

What the warranty does not cover:
1. Damage, deterioration or malfunction resulting from:
    a. Accident misuse, neglect, fire, water, lightning or other acts of nature, unauthorized product modification or failure to follow instructions supplied with the product.
    b. Repair or attempted repair by anyone not authorized by *iControls*
    c. Any damage of the product due to shipment.
    d. Causes external to the product such as electric power fluctuations.
    e. Use of supplies or parts not meeting *iControls*' specifications.
    f. Normal wear and tear.
    g. Any other cause which does not relate to a product defect.
2. Transportation costs necessary to obtain service under this warranty.
3. Labor other than factory labor.

How to get service:
1. To obtain warranty service, contact *i-controls* for a Return Material Authorization (RMA).
2. You will be required to provide:
    a. Your name and address
    b. A description of the problem
3. Package the controller carefully for shipment and return it to *iControls*, freight prepaid.

Limitation of implied warranties:
There are no warranties, expressed or implied, which extend beyond the description contained herein including the implied warranty of merchantablility and fitness for a particular purpose.

Exclusion of damages:
iControls' liability is limited to the cost of repair or replacement of the product. *i-controls* shall not be liable for:
1. Damage to other property caused by any defects in the product, damages based upon inconvenience, loss of use of the product, loss of time, loss of profits, loss of business opportunity, loss of goodwill, interference with business relationships or other commercial loss, even if advised of the possibility or such damages.
2. Any other damages, whether incidental, consequential or otherwise.
3. Any claim against the customer by any other party.

Effect of state law:
This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. Some states do not allow limitations on implied warranties and/or do not allow the exclusion of incidental or consequential damages, so the above limitations and exclusions may not apply to you.