Altair Equipment Company

Containerized Reverse Osmosis Unit

Operation & Maintenance Manual

Prepared for:

Customer: Blue Marble
Indianapolis, Ill

Model: Dual 125 GPM Container

Job Number: 239442

Container Series - Table of Contents

Section I.

GENERAL INFORMATION

I. GENERAL INFORMATION

I.A. The Manual

This manual has been prepared to provide the operator with information regarding the installation, use, maintenance, and troubleshooting of the Altair Containerized Reverse Osmosis (RO) System.

The manual has been written in narrative form supplemented with schematics and drawings for clarification. Most procedures mentioned in this manual can be performed by the operator. Any exceptions will be clearly identified by a qualifying statement.

Words of **ENHANCED CAPITAL** letters are used to identify labels on the unit or components, and are key safety or qualifying statements.

I.B. Safety Summary

This safety summary does not contain all of the safety statements in the manual. Other safety statements are included within the manual text and are enhanced and defined as follows:

NOTE: Statements that require further clarification.

CAUTION: Statements that identify conditions or practices that could result in equipment or other property damage.

WARNING: Statements that identify conditions or practices that could result in injury or loss of life.

READ THIS MANUAL: Prior to operating or servicing this unit, this manual must be read and understood. If anything is not clear, call for assistance before proceeding. Keep this, and other associated manuals for future reference and for new operators or qualified service personnel.

USE PROPER POWER CONNECTIONS: Use proper wiring and connection methods to satisfy local electrical codes.

DO NOT REMOVE COVERS OR PANELS: To avoid electrical shock hazard, do not remove covers or panels when power is supplied to the unit. Do not operate the unit when covers or panels are removed.

SHOCK HAZARD: Connect this unit to a properly grounded connection in accordance with the National Electric Code. **DO NOT**, under any circumstances, remove the ground wire or ground prong from any power plug. Do not use extension cords or an adapter without proper consideration.

UNIT COMPONENT LABELING: Do not, under any circumstances, remove any Caution, Warning, or other descriptive labels from the unit or components until the conditions warranting the labels are eliminated.

DO NOT OPERATE IN FLAMMABLE ATMOSPHERES: To avoid fire, or explosion, do not operate this unit in an explosive environment.

I.C. Applications

The Altair Containerized RO System is designed to purify water by forcing water through a semi-permeable membrane. Water purified by reverse osmosis has had often greater than 95% of dissolved ions, and 99% of most other contaminants removed. The quality of the purified water, referred to as product water (or permeate), depends on the quality of the feed water, and normally exceeds ASTM type III or IV. Such water is suitable for applications as glassware, rinsing, beverage reconstitution, solution preparation, and numerous other scientific, commercial, and industrial applications.

I.D. Contraindications

Altair Containerized RO Systems are not designed, sold, or intended for use in producing water for injection (WFI) or other sterile solutions.

Furthermore, Altair Containerized RO Systems are not intended to be used outside of the unit's specifications or limitations. Also, the system must not be used in an explosive environment.

I.E. Environmental Considerations

Prior to the installation of the Containerized RO System, it will be necessary to provide utilities and create an environment suitable for the trouble free operation of the Containerized RO System and its accessories.

1. Power All 120 volts and 220 volts components operate on single phase power. 220/380/460 volt systems operate on 3 phase power. Histories of power failure, power surges, and low line voltages should be noted and reported to the manufacturer or their agent as they may create adverse conditions for the operation of equipment. **This system maybe equipped with a voltage monitor that will shut down the system due to phase loss, unbalance or phase reversal.**

2. Water Reverse osmosis systems require a reliable water source. The Altair RO needs a minimum of 50 psi inlet pressure. It is important to run water at the design flow rate when testing water pressure rather than reading static pressure.

3. Drain A drain outlet is required by the Containerized RO System. The drain must have a capacity equal to the designed concentrate flow rate as long as and as often as the RO is operating.

4. Temperature The Altair RO unit is normally connected to a cold water supply. The membrane performance specifications of the RO are based on 77º F (25º C) feed temperature. For each degree Fahrenheit the feed water temperature falls, the RO product flow decreases approximately 1.5%. In climates where the winter water temperature significantly below 77º F (25º C), it may be advisable to heat the water or increase the number of membranes in the RO unit. Refer to the inlet water specifications for the maximum operating temperature for your unit. It is also necessary to keep the unit from freezing to prevent serious damage to the RO.

5. Noise The RO unit does not generate significant noise levels. Hard walls absorb noise poorly and will make the unit appear more noisy.

6. Water Purity Plumbing materials can significantly contribute to the contamination of water. Metallic (non-stainless steel) pipes must be eliminated once the purification process has begun. Schedule 40 or 80 PVC pipes are suitable for most grades of purified water. Care must also be exercised over the choice of thread sealant. Teflon tape is suitable for all threaded connections in this system. Pipe dope must be avoided since it leaches objectionable impurities into the water.

I.F. Theory of Operation

The Altair RO is a family of frame mounted units with a variety of optional features. The unit includes prefiltration to remove particles capable of fouling membranes and damaging the high pressure pump. The RO pump provides the pressure required to drive water through the membranes at economical flow rates and improves the membrane rejection performance. The fluid controls provide a means of managing required flowrates and pressures.

For process feed water having low levels of chlorine present, optional activated carbon vessel(s) should be used to remove all chlorine prior to RO prefiltration. Feed water having high levels of chlorine present may require optional chemical injection methods for chlorine removal prior to RO prefiltration.

Section II.

FEATURES & COMPONENTS

II. FEATURES & COMPONENTS OF THE CIB SERIES RO

II.A. Available Features

The following presents a listing of standard components and features for the Altair Containerized RO Series:

II.B. Components of the Altair Containerized RO System

The system supplied is a double pass 125 GPM nominal unit that may be operated as a 250 GPM nominal single pass unit.

The **electronically operated inlet valve** is located at the inlet of all RO's and serves to access and shut off the water supply to the system. It is actuated when the system is placed into an operational mode.

The fluid path then flows into the **5-micron prefilter** located in a filter housing, frame mounted to the RO. It is a cartridge type filter with nominal rating of 5 microns. The purpose of the filter is to collect any particles larger than 5 microns which may be detrimental to the output water quality and subsequent components in the system.

A **high-pressure pump** provides boost of the inlet water pressure to the reverse osmosis membrane assembly. There is one (1) 0-300 psi **liquid filled pressure gauge,** mounted on the inlet to the first membrane. And one 0-100 psi **liquid filled pressure gauge** mounted on the feed inlet. Some systems have other gauges as options.

A **low-pressure switch** is mounted at the inlet of the system. The **low-pressure switch** sends a signal to the pump to disengage, should the inlet suction pressure to the unit be insufficient for safe operation. A **high-pressure switch** is mounted to the output of the pump to the membranes. It disengages the pump if the pressure exceeds a preset pressure.

All **low-pressure piping** is of pvc or polypropylene. And **high-pressure piping** is of SS and nylon material.

Flow meters, as mounted on the product and concentrate lines are used to monitor associated flow rates of the RO membranes.

The reverse osmosis membranes are housed in FRP or SS vessels.

In the optional **auto flush** mode, the feed line valve stays open for a set time after shut down enabling a low pressure flow of water to pass across the RO membranes, flushing out residual contaminants, supporting longer RO membrane life and greater overall performance.

All equipment is skid mounted on a **epoxy coated welded steel frame.**

The system may have a **automatic permeate** sample system. This allows you to take a sample from any vessel and get a reading on a separate quality meter by using a selector switch.

II.C. Specific Standard Components Available on the Altair Containerized RO Systems*

Descrition	Manufacturer	Part #
High press. Pump	Grundfos/Goulds	CRN/SV
Press. Vessel	ProTec	
Membranes	Lanxess/LG	400 LP
Conductivity / Flow meter	Signet	2537
Feed Valve	Max-Air	3" BF Elec.
High Press. sw.	United Electric	100 Series
Low Press. Sw	United Electric	100 series
RO Motor starter	Allen Bradley	
Motor Overload	Allen Bradley	
Flow Control valve 3" SS	Powell (Globe)	
Press. Gauge 100 PSI	Ametek	
Press. Gauge 300 PSI	Ametek	
Filter Housing	Shelco	

Section III.

SPECIFICATIONS

III. SPECIFICATIONS

The specifications for the Altair Containerized RO Systems are different for each system. The
Following information is specific to your model.

Altair Series 60:

III.A. Inlet Water Requirements

Feed pressure:................................ 40 - 60 PSI
Feed temperature:........................... 55 - 85 deg. F.
Feed flow:.. 333 gpm

III.B. Electrical Requirements

Input power:.................................... 460 VAC 60hz 3ph 80 amps min

NOTE: Connect the system to a fused disconnect.

III.C. Inlet / Outlet Connections

Feed:.. 3" FNPT
Concentrate:.................................... 2" FNPT
Permeate:.. 3" FNPT

Section IV.

SERVICE ASSISTANCE

IV. SERVICE ASSISTANCE

If service assistance is required, take the following steps:

1. Consult the "Trouble Shooting" section of this manual. If the problem cannot be identified and corrected by any of the procedures found in that section, then contact Altair Equipment Technical Service Personnel for Assistance.

Altair Equipment Company

Section V.

INSTALLATION

V. INSTALLATION

V.A. Altair Reverse Osmosis (RO) System Installation

1.] Select a location for the Containerized RO System with adequate clearance from the walls and other equipment to enable servicing of the pump / motor assemblies, membranes, cartridge prefilters, and other serviceable components.

2.] Run three (3) PVC or stainless-steel water lines (pipes) to the system connection points as follows:

Line 1: Inlet raw water supply to the inlet. The line size is to be the same or larger than the inlet line to the feed valve.

Line 2: Drain line to the concentrate line. If other lines are connecting to the concentrate to drain line, installation of a check valve is recommended on each line to prevent back flow through the main concentration line.

Line 3: Connect a line from the permeate line to the storage tank (or downstream equipment). Connection of the product line to a storage tank or other downstream equipment is to be in such a manner to prevent static head pressure in the product line. A check valve should be installed to prevent product back flow to the Containerized RO System membranes. The product line is to have no restrictions or air gaps at the discharge.

3.] Make all connections of the specified voltage. Insure the switch is in the "OFF" position before connecting the system's power supply. Connect 3 phase power to fuse block. Connect a good ground to bottom screw on sub-panel in control box (green wires).

4.] If your system is set up to work with floats install them at this time. Refer to the electrical diagram for wiring points. Floats should be installed so that the float switches are in the open position when the tank is full.

Section VI.

SYSTEM START – UP, OPERATION

& SHUT - DOWN

VI. SYSTEM START-UP, OPERATIONS AND SHUTDOWN

VI.A. Initial System Start-Up

1.] Upon replacement of membranes, draining of the system or clean in place start the system up as an initial start-up.

2.] Lock out the two pumps and the chemical injection pumps.

CAUTION: Direct permeate flow to drain for the first 30 minutes to remove preservative.

3.] Turn ON the water supply to the unit. Ensure that the feed flow from the water source or any pretreatment is capable of supplying the system pump with the minimum gallons / min. requirement on page 13 of this manual. Inadequate feed flow will damage the system pump and void warrantees.

4.] Check installation for water leaks and make fitting adjustments, as required, to eliminate leaks.

5.] Open the concentrate valve and recycle valve (if your system has one) full open (counter clockwise). Open the pump control valve on the pump output.

Check the rotation on all 3 phase pumps before turning on the system. Rotation is clearly marked on the side of the pump with red arrow.

6.] Turn the power switch to the manual or auto position. The feed valve will open and water will flow into the system. In the auto position the system works off the signal from the floats in your storage tank, if the tank is full the system won't run till it reaches the lower float. In manual mode it overrides these floats.

7.] The system pump will come on after the preset time has expired.

8.] The RO unit is now ready for operation. The RO pump will start. Use the recycle valve (if your system has one), control valve and the pump control valve to set recommended system flows and recovery.

CAUTION: DO NOT EXCEED RECOMMENDED RECOVERY.
DO NOT EXCEED 170 PSI ON SYSTEM PRESSURE GAUGE

9.] Redirect the permeate to the purified water storage tank after the initial 30 minute start-up period has been completed. The system is now in use and ready for full operation.

10.] The TDS monitor should stabilize within 2 minutes of start-up time. The TDS of the product water may be higher than normal during the initial start-up time.

11.] Regularly record system performance data on the daily log sheet.

VI.B. Normal System Operation

1.] Once the Initial System Start-Up is complete the system will start and stop based upon remote signals supplied to the unit (level/ pressure or other) by the Owner's operations. SYSTEM MUST BE IN AUTOMATIC OPERATION. Double Pass and Single Pass operations are MANUAL VALVE SETTINGS on the inlet side of each pass.

2.] The "First Pass Recycle Valve" should be fully open during start-up then adjusted to balance the recycle. All manual valves around the filters, pump feed and concentrate should also be fully open.

3.] Dual Unit Single Pass Operation – For double pass RO operation set the inlet valves as follows:

a. OPEN "Pass 1 Inlet Valve" manual valve to allow feedwater to flow to the first pass.
b. OPEN "Pass 2 Inlet Valve" manual valve to allow feedwater to flow to the second pass.
c. CLOSE "First Pass Feed to Second Pass" manual valve which feeds permeate from the first pass to the second pass.
d. OPEN "Pass 1 Single Pass Permeate Valve" manual valve which feeds permeate to the "Permeate Outlet" when running in single pass.
e. OPEN "Pass 2 Raw Water Inlet" Valve manual valve which feeds raw water to the Second Pass when running in single pass.
f. OPEN both the Pass1 Concentrate Back Pressure Valve and the Pass 2 Concentrate Back Pressure Valve 100%.
g. At Control Panel press START RO SYSTEM and system will start automatically. Inlet solenoids will open to flush the system, Pumps will ramp to pressure. Out of specification water is flushed to drain.
h. Adjust Pass 1 Concentrate Back Pressure Valve until the RO ONE Product Flow : Concentrate Flow is at 3:1.
i. Pass 2 Booster Pump will start automatically. Adjust the Pass 2 Booster Pump Pressure Adjustment Valve until RO TWO Product plus Concentrate Flow equal the RO ONE Product Flow.
j. Adjust the Pass 2 Concentrate Back Pressure Valve until the RO TWO Product Flow : Concentrate Flow is at 3:1.

5.] The system will start and stop based upon level signals from the downstream storage tank.

.

VI.C. Normal System Shut-down

1.] Turn OFF the switch.

2.] The feed valve will stay open during the flush cycle (optional).

3.] At the end of the flush cycle the feed valve will close.

4.] If the unit is to be left stagnant (not in operation) for an extended period of time, the unit membranes should be treated with an approved disinfectant.

WARNING: Do not store the Containerized RO System in freezing conditions to avoid irreparable membrane damage.

Section VII.

ROUTINE MAINTENANCE

VII. ROUTINE MAINTENANCE

Altair Containerized RO Systems have been designed to operate with a minimum of operator attention. As with all mechanical systems, longer operation and fewer problems will result, when operator maintenance is performed regularly. Operator maintenance on a Altair Containerized RO System is limited to maintaining performance logs, cleaning, proper disinfection, periodic lubrication, and timely prefilter cartridge replacement. The maintenance procedures have been categorized by their frequency of action and are as follows: (Specific instructions follow the maintenance schedule.)

VII.A. Daily Requirements

1.] Observe and record the water hardness level in the pretreatment log (for systems with a water softener as part of the pretreatment).

2.] Observe and record the salt level in the brine tank (for systems with a water softener as part of the pretreatment).

3.] Observe and record chlorine / chloramine concentrations in the pretreatment log. (For systems incorporating activated carbon vessels or chemical injection as part of the pretreatment, chlorine / chloramine concentrations must be noted both before and after this pretreatment step).

NOTE: Take corrective action, or contact Altair Equipment if any pretreatment equipment fails to provide adequate feed water treatment.

4.] Check the condition of the 5 micron prefilter cartridges. If the pretreatment cartridges appear dirty or plugged, change all the prefilter cartridges. To check or change the prefilter cartridges, the Containerized RO System must be turned OFF. All pressure gauges should read zero psi. Remove the old filter cartridges, then install new filter cartridges.

5.] Observe and record the pump pressure on the daily operational log sheet.

6.] Observe and record the conductivity of the product water.

7.] Check water treatment chemical levels and chemical injection pump operation.

VII.B. Weekly Requirements

1.] Observe or measure, and record the concentrate, recycle and product flow rates on the daily operational log sheet. Allow water temperatures to stabilize before attempting to record results to prevent errors due to fluctuating temperatures.

2.] Observe or measure, and record the feed water temperature. A hand held thermometer is satisfactory if a temperature gauge is not present. The water temperature has a significant effect on the product flow rate of the RO membranes and on the evaluation of the membranes' need to be cleaned.

3.] Record all pressures on the pressure gauges.

Section VIII.

SPECIFIC INSTRUCTIONS

VIII. SPECIFIC INSTRUCTIONS

VIII.A. Prefilter Cartridges

1.] Visually check the prefilter cartridges at least weekly. When inspecting the white prefilter cartridges, the inside of the filter cores should be inspected for signs of discoloration. If the inside is discolored, then the filters have been on-line too long and a more frequent filter change out cycle should be considered. If prefilter servicing becomes too excessive, greater pre-filtration capacity or additional equipment is recommended to extend intervals between filter maintenance.

NOTE: This procedure should be followed every 7 days, or more often as deemed necessary.

a. Turn the system OFF and allow pressures to drop to zero on the gauges.

b. Remove the filter sump by loosening the band at the top. Drain the water from the filter housing.

c. Carefully remove the used prefilter cartridge(s) from the housing to prevent excess spillage and shedding of particles. Inspect the filter to see if change out is warranted, if it is then discard the used pre-filters. Otherwise, carefully reinstall the inspected filter(s) back into housing.

NOTE: All pre-filters in the housing are recommended to be changed at the same time (do not mix new filters and used filters in the same housing).

d. Reinstall the prefilter cartridges into the housing and perform the preceding procedure in reverse, to bring the RO prefilter back on-line.

VIII.B. Long Term System Storage

It is not recommended that Altair Containerized RO Systems be left stagnant for greater than 24 hours. Should your system not be operated for extended periods, please contact Altair Equipment for long term storage instructions (refer to Section IV).

WARNING: Do not store the Containerized RO System in freezing conditions to avoid irreparable membrane damage.

VIII.C. Membrane Replacement

1.] Turn OFF the Containerized RO System.

2.] Follow the pressure vessel manual from the manufacture which is included with this manual.

3.] Remove the end plugs per the instruction manual. Pull out the end adapter and the old membrane(s).

NOTE: It may be necessary to remove the end plug assembly from the concentrate end of the pressure vessels (steps 2-5), in order to push the membrane(s) out of the vessel end.

7.] Install the new membranes from the feed end, insuring that each brine seal is orientated at the feed end and is sealing properly within the vessel, and that the end adapters, membrane interconnecters and associated O-rings are in good condition and positioned correctly.

8.] Replace the end plugs using glycerin as a lubricant on all O-rings, and reconnect all lines, prior to checking the reinstallation.

9.] Direct permeate flow to drain for 30 minutes whenever using new membranes the first time.

VIII.D. Control Time Delays

Altair Containerized RO Systems are equipped with a logic controller. There are 4 time delays programmed in it for the system, Auto Flush Timer, Low Pressure delay, high pressure delay and Pump Start delay. To change these follow the steps listed. A list of the program is provided with this manual.

1.] With the logo in the run mode, push the ESC & OK buttons at the same time.

2.] Use the down arrow button to move the cursor to the Set Param. Press OK after this.

3.] The 1st timer will appear in the display. Use the up/down arrow buttons to select the timer to change.

4.] When you have the timer you need, push the OK button.

5.] Use the left/right arrow buttons to move the cursor over the position you wish to change.

6.] Use the up/down arrows to set the new time. When done push the OK button.

7.] Push the ESC button 2 times to set the new time and to return the LOGO to its normal display.

Following is a table of the only 4 timers that should be changed. **DO NOT CHANGE ANY OTHER TIMERS.**

B05:T - Auto Flush Timer - Normally 2 min.
B19:T - Pump delay - Normally 10 Sec.
B11:T - Low Pressure delay - Normally 4 Sec. **Do not exceed 5 Sec**.
B16:T –High pressure delay- Normally 4 Sec. **Do not exceed 4 Sec**.

Cleaning: If your RO has an automatic built in cleaning system, follow the procedures below.

1. Turn the system switch to the off position. Put cleaning compound in the tank.

2. Open the manual ball valve on the bottom of the tank to fill it. When the tank is full close the valve.

3. Turn the cleaning switch on. The valves will switch and the pump will come on. When the 45 min. cycle is complete the valves will switch again and the cleaning solution will go down the drain. At this time open the manual valve on the bottom of the cleaning tank to start filling it up(adjust this to keep the tank full but not overfill. Let this run like this till the Containerized RO System is flushed to drain, then close the manual vale and let the tank empty.

4. Turn the clean switch to the off position. The valves will return to the stand by mode and the system is ready to run again.

5. Turn the system switch to the run position. When the pump starts check the flows and pressures, you may have to adjust the valves after cleaning.

6. Flush the cleaning tank with fresh water and let drain for the next time.

Section IX.

TROUBLE SHOOTING

IX. TROUBLE SHOOTING GUIDE FOR ALTAIR CONTAINERIZED RO SYSTEMS

IX.A. Unit Fails to Run

1.] Power off.
   a. Check position of switches.
   b. Check power cord (connected to source).
   c. Check outlet and circuit breaker / fuse panel with power voltmeter.
   d. Check fuses in unit.

2.] Improper line voltage.
   a. Verify that the line and equipment voltages are compatible.

3.] Loose electrical connections.
   a. Check all wiring connections to verify solid connections.

4.] Power switch inoperative.
   a. Replace power switch.

5.] Pump motor inoperative.
   a. Verify that the voltage supply is correct and the motor is wired for correct voltage. Correct as necessary.
   b. Motor thermal overload switch tripped (most motors have automatic internal reset). Motor will restart when it cools, approximately 10-15 minutes. Correct reason for overload.
   c. Replace motor.

6.] Pump inoperative.
   a. Inspect pump and motor coupling for wear.
   b. Clean any debris or liquid from connection area.
   c. Replace pump assembly.

IX.B. Unit Runs Intermittently

1.] Loose electrical connection.
   a. Verify that all wiring connections are solid and secure.

2.] Pump pressure too high.
   a. Adjust pressure at pump head.

3.] Thermal overload trips.
   a. Verify line voltage and motor amperage draw.
   b. Disassemble the pump / motor at clamp, inspect coupler for wear.
   c. Pump pressure too high (See section IX.B.2.).

IX.C. Motor Runs Hot

1.] Voltage too low.
   a. Check voltage against serial label, correct condition.

2.] Excessive current draw.
   a. Verify that the flow rates and pressures are within unit specifications.
   b. Confirm amperage draw with meter.
   c. Motor insulation shorted, replace motor.
   d. Check motor / pump coupling for proper alignment.

IX.D. Water Produced While Unit is Off

1.] Faulty inlet water valve.
   a. Check electrical connections, check valve for obstruction.
   b. Replace valve.

IX.E. Low Pump Pressure

1.] No pressure develops above level of feed pressure.
   a. Verify motor operation.
   b. Replace pump.

2.] Pressure develops, but does not achieve normal operating pressure.
   a. Concentrate or product flow too high.
      1. Check water temperature and flow rate.
   b. Faulty control valve.
      1. Replace valve.
   c. Pump adjusted improperly.
      1. Adjust pump at pump head.
   d. Pump worn out or damaged.
      1. Replace pump.

IX.F. Pressure Gauge Vibrates Wildly

1.] Air in gauge tubing.
  a. Loosen tube fitting at gauge to bleed air.

2.] Obstruction in pressure gauge orifice.
  a. Remove obstruction.

3.] Faulty gauge.
  a. Replace gauge.

IX.G. Product Flow Too Low

1.] Pump pressure too low.
  a. See section IX.E.

2.] Low feed water temperature.
  a. Upgrade unit size with additional membranes.
  b. Install or adjust temperature blending value.

3.] Membrane fouled or scaled.
  a. See test report for original flow rate.
  b. Clean membrane for fouling or scaling problem indicated.
  c. Replace membrane.

4.] Center tube of membrane collapsed from operating at high temperatures.
  a. Correct temperature problem.
  b. Replace membrane.

5.] Check pretreatment for brackish water quality.
  a. Check inlet water for high TDS.
  b. Check water softener for proper function.

IX.H. Product Flow Too High

A. Rejection Satisfactory.
1.] Pump pressure too high.
  a. Adjust control valves on RO panel.

2.] Temperature too high.
  a. Install or adjust temperature blending value.
  b. Correct plumbing error that allows the cold water to be heated.

B. Rejection Unsatisfactory.

1.] Membrane / vessel internal seals damaged, dirty, or dislodged.
  a. Remove membranes from vessel, clean and inspect O-rings and brine seals.

2.] Membrane hydrolyzed (exposed to oxidant).
  a. Verify condition of pretreatment equipment.
  b. Replace membrane.

3.] Concentrate flow too low.
  a. Check concentration flow rate.
  b. Check for blockage or kink in concentration line.

4.] Membrane damaged (or ruptured).
  a. Check for high product pressure.
  b. Check for product line back pressure.
  c. Correct problem source.
  d. Replace membrane.

IX.I. Low Percent Rejection

1.] Concentrate flow too low.
  a. Disinfectant or cleaner not rinsed from the unit.
  b. Check concentrate flow control.
  c. Check for obstruction or kink in concentrate line.

2.] Pump pressure too low.
  a. Adjust control valves.
  b. Adjust pump head pressure valve.

3.] Product flow too high.
  a. See section IX.I.

4.] Membrane scaled or fouled.
  a. Verify condition of pretreatment equipment.
  b. See membrane cleaning procedure.

5.] Erroneous meter readout.
  a. Verify water quality with independent meter.
  b. Calibrate meter.
  c. Replace product water sensor probe.
  d. Replace monitor.

6.] Membrane failure.
- a. Replace membrane.

7.] Change in feed water TDS.
- a. Verify feed and product water quality with independent meter.

IX.J. TDS Value High

1.] Concentrate flow too low.
- a. Measure and compare to original data. Correct as necessary.

2.] Concentrate pressure too high.
- a. Adjust control valve.

3.] Product flow too high.
- a. See section IX.I.

4.] Membrane scaled or fouled.
- a. Verify operation of pretreatment equipment.
- b. See membrane cleaning procedure.

5.] Erroneous meter readout.
- a. Verify water quality with independent meter.
- b. TDS water probe wire disconnected or loose.
- c. Replace TDS sensor probe.
- d. Calibrate monitor.
- e. Replace monitor.

6.] Membrane failure.
- a. Replace membrane.

7.] Change in feed water TDS.
- a. Verify water quality with independent meter.

IX.K. RO Pump Leaks

1.] Connection leaking.
- a. Tighten or reconnect fitting.
- b. Check fitting for damage.

2.] Mechanical seat failure.
- a. Replace pump.

Section X.

GLOSSARY OF TERMS

GLOSSARY OF TERMS (C & I)

Adsorption: Adsorption is the binding of a molecule to a surface (solid or liquid) by non-specific physical forces. For example, the removal of free chlorine and chloramines by activated carbon through the mechanism of adsorption.

Algae: A group of single-celled plants which include both seawater and fresh water varieties.

Alkalinity: A measurement of the quantity of chemicals present in water which can neutralize acids. These include carbon dioxide, bicarbonate, carbonate and hydroxides. See also titratable alkalinity.

Aluminum Sulfate: An aluminum salt commonly used as a flocculant by municipal water treatment facilities.

Anions: A negatively charged ion (see ion).

Array: A group of one or more pressure vessels, each containing one or multiple membranes, within an ultrafiltration or reverse osmosis system design. Typical system arrays might be 2:1, or 3:2, or 4:2:1, or 1:1:1 (there are many other possible combinations). The array defines the system design which determines water quantity, quality, and efficiency for a given process application.

Asymmetric Membranes: See membranes.

Cations: A positively charged ion (see ion).

Cellulose Acetate: A synthetic polymer derived from naturally occurring cellulose and widely used in the fabrication of reverse osmosis membranes. The polymers used for water purification membranes may be diacetate, tricetate, or blends of these materials.

Chloramines: Chemicals used to disinfect municipal water. They are formed by reacting ammonia and free chlorine and may occur naturally when free chlorine combines with ammonia arising from the breakdown of vegetation. Chloramines are strong oxidants which can react with trace organic materials in water to form trialomethanes (THMs). THMs have been linked to being carcinogenic precursors.

Chlorine: A chemical widely used to disinfect municipal water.

Coagulation: A practice common in municipal water treatment in which a chemical (coagulant), most commonly alum, is added to the water in order to destabilize colloidal particles by neutralization of their electrical charges. Coagulation is used, together with flocculation, as an economical process for colloid removal.

Compaction: The undesirable physical compression of a reverse osmosis or ultrafiltration membrane which results in reduced flux rates. The phenomenon is accelerated at higher temperatures and pressures. Cellulose acetate membranes are especially susceptible to compaction.

Conductivity: The ability of an aqueous solution to carry electric current depends on the presence of ions in the solution. Conductivity is a quantitative measure which describes this ability. Solutions of inorganic ions are relatively good conductors (and exhibit high conductivity), whereas solutions of organic molecules are rather poor conductors (and exhibit low conductivity). Highly purified water is also a poor conductor. Conductivity is expressed in units of Siemens/cm (also known as mhos/cm). Conductivity is temperature dependent and should be measured with temperature-compensated water. The usual reference temperature is 25 degrees C (77 degrees F). Conductivity measurements are sometimes used to eliminate total dissolved solids in water. While convenient, this practice is imprecise. (See also resistivity).

Deionization: Removal of ions from water by exchange with other ions associated with fixed charges on ion exchange or softening resin.

Empty Bed Contact Time: The empty bed contact time (EBCT) is used as a measure of how much contact occurs between particles, such as activated carbon, and water flow through the bed of particles. As the EBCT increases, the time available for the particles to adsorb solutes from the water also increases, as does the amount of solute removed from the water during its transit through the bed. EBCT is calculated from:

$$EBCT = Vm/Q$$

where Vm is the volume of particles in the bed and Q is the volumetric flow rate. A consistent set of units must be used when calculating EBCT with this equation. For example, if Vm is given in ft cubed, then Q must be expressed in ft cubed / min for the EBCT to have units of minutes. Values of Q can be converted from other units, such as U.S. gpm, to ft cubed / min using appropriate conversion factors.

Flocculation: A practice common in municipal water treatment in which destabilized colloidal particles are formed into larger particles (flocs), usually by stirring. The flocs are removed from the water by settling or filtration. The process may also incorporate the addition of such compounds as synthetic polyelectrolytes, which increase the size of the flocs, thereby making them more easily removed by settling or filtration. Removal of colloids by flocculation is typically done in combination with coagulation.

Flow Velocity: The flow of fluid at any point in a water treatment system may be expressed quantitatively in two ways, either in terms of the volume of fluid passing the point at a given time (volumetric flow rate) or in terms of the velocity with which fluid passes a given point (flow velocity). The flow velocity (V) depends on the geometry of the conduit through which the fluid flows and is related to volumetric flow (Q) by

$$V = Q / A$$

where A is the cross-sectional area of the conduit. As an example, the following table shows the volumetric flow rate as the function of flow velocity in PVC Schedule 80 pipes of different diameters. (The values in the Table are based on actual, rather than normal pipe diameters.). Note that for such calculations, it is essential that consistent units be employed. Thus, the term Q would be expressed as ft cubed / sec and A as ft squared, to yield as ft / sec.

where A is the cross-sectional area of the conduit. As an example, the following table shows the volumetric flow rate as the function of flow velocity in PVC Schedule 80 pipes of different diameters. (The values in the Table are based on actual, rather than normal pipe diameters.). Note that for such calculations, it is essential that consistent units be employed. Thus, the term Q would be expressed as ft cubed / sec and A as ft squared, to yield as ft / sec.

PVC Schedule 80 Nominal Pipe Size	**Volumetric Flow Rate (U.S. gpm*) At Specialized Flow Velocities**		
(Inches)	**1.5 ft/sec**	**3.0 ft/sec**	**5.0 ft/sec**
1/4	0.33	0.67	1.12
3/8	0.66	1.31	2.19
1/2	1.09	2.19	3.65
3/4	2.02	4.04	6.74
1	3.36	6.73	11.21

*gpm = gallons / minute

Flux Rate: The rate per unit of area at which water passes through a semi-permeable membrane, such as those used for ultrafiltration or reverse osmosis.

Fouling: The deposition of insoluble materials, such as bacteria, colloids, oxides and water-borne debris, onto the surface of reverse osmosis or ultrafiltration membrane. Fouling is associated with decreased flux rates and may also reduce the rejection rates of reverse osmosis membranes.

Grains of Hardness: Although the theoretical hardness of water is the sum of concentrations of all metallic ions, other than the alkali metals, it is commonly expressed as the equivalent concentration of calcium carbonate in grains. Ionic concentrations can be expressed in terms of their combining potential (Eq / L), the number of moles present (mol / L), or their masses in any of several conventional units. In the American English system, masses are expressed in terms of pounds (avoirdupois) which contain 7000 grains each. Although considered outdated in most of the world, the U.S. water purification industry continues to express hardness in units of grains / gallon (grains / gal) expressed as calcium carbonate. Grains / gal expressed as calcium carbonate can be converted into metric units (mg / L) by multiplying the former by 17.1. Grains / gal expressed as calcium carbonate can also be converted into mEq / L of a univalent ion, such as sodium (Na^+) by multiplying by 0.342. Care must be taken in using these conversion factors to size equipment based on ion exchange principles, since the ionic content of water will depend on the type of ions present as well as their total mass.

Hardness: Hardness was originally defined as a measure of the ability to precipitate soaps made from fatty carboxylic acids. These "soaps" precipitated in the presence of calcium and/or magnesium ions. Today, hardness is used to describe the total concentration of calcium and magnesium, expressed as mg / L of calcium carbonate. It is generally calculated from measurement of calcium and magnesium ion concentrations, using:

Hardness (mg CaCOcubed / L) = 2.497 x Ca (mg /L) + 4.118 x Mg (mg / L)

Ion: An atom or molecule having either a positive or negative charge. Positively charged ions are referred to as cautions and ions having a negative charge are termed anions.

Ion Exchange: Ion exchange is based on the principle of electroneutrality, that is, charged ions are stable only when they exist as balanced pairs of positive and negative charges. Ion exchange resins, the materials used to carry out the process of ion exchange, are particles which contain a fixed charges on their surface. To maintain electroneutrality, each of these charges has an ion of equal and opposite charge held to it; these ions are called counter ions. The counter ions are mobile and can leave the fixed charge if some other counter ion is available to replace it. The replacement ion must be of the same charge as the initial counter ion, in order to maintain electroneutrality. The initial counter ion is established by washing the resin with a concentrated solution of the desired counter ion. For example, softener resins are caution exchangers containing carboxylic acids on their surfaces. If these resins are washed with strong NaCl solutions, the predominant caution in the solution is Na+ and it will become the counter ion. In use, the feed water will provide the competing counter ions, such as Ca2+. Because of the preference of carboxylic acids for Ca2+ over Na+ in dilute solutions, the water will be depleted of Ca+ in exchange for the Na+ initially present.

Langelier Saturation Index: The precipitation of calcium and magnesium carbonates in water purification systems is a serious cause of system failure. The insolubility of these compounds are a complex function of the pH of the water, the dissolved carbon dioxide content, the carbonate content, the presence of other salts, and the water temperature. The Langeglier Saturation Index is complex, but it provides an important determination of the proper functioning of the water treatment system. Reverse osmosis vendors may use the index in determining the maximum recovery and rejection rates that can be obtained from a reverse osmosis system before carbonate deposits on the membrane surface, resulting in a serious reduction in water quality and recovery. It should be noted that the utility of such determinations is limited to those situations in which softener is not used as part of the pre-treatment scheme for reverse osmosis.

Membranes: Membranes are thin films made with structures designed to provide selective transport of solutes. In general, the selectivity of a membrane is based on its ability to pass or exclude ionic species according to their size. Membrane structures may either be homogenous or asymmetric. Homogenous membranes have structures which are uniform in cross-section, at least at a magnification of up to 100 x. Most homogenous membranes have been developed for microfiltration and hemodialysis applications. Membranes reduce not only the flow of undesirable solutes (contaminants), but also the flow of solvent (product/purified water). In order to minimize the reduction in product flow, asymmetric cross-sections, that is, they consist if two or more parallel layers of materials. The resistance to the flow of the skin layer (top layer), which gives the membrane its filtration selectivity, is minimized by reducing its thickness. The resistance to the flow of the thicker support layer, which provides structural strength, is minimized because of its open pore structure. These different layers may be made from the same material, as in asymmetric cellulose acetate membranes, or from different materials, as in thin-film composite membranes.

Membranes used in water treatment equipment are fabricated in two forms, as flat sheets or as hollow fibers.

Nitrate: An anion comprised of one nitrogen atom and three oxygen atoms. Nitrates often enter the water supply as a result of agricultural runoff and have been found to be harmful to infants when consumed orally.

Osmotic Pressure: When a solution, such as salt water, is separated from pure water by a membrane which is impermeable to salt, a flow of water will occur from the pure water solution to the salt solution. The driving force for this flow is called the osmotic pressure and its magnitude depends on the number of salt particles in the solution. Note that the osmotic pressure and its magnitude depends on the number of particles and not on the total mass of particles. For example, 1 g/l of a small solute, such as sodium chloride, will exert a greater osmotic pressure than 1 g/l of a large solute, such as a protein. For water to flow from the salt solution to the pure water, the solution must be exposed to a hydrostatic pressure greater than its osmotic pressure. This is the principle of reverse osmosis.

Oxidants (oxidizing agents): Chemicals which provide oxygen and accept an electron in an oxidation-reduction reaction. Free chlorine and chloramines are oxidants which are widely used for municipal water disinfection.

Ozone: An extremely active oxidizing agent which consists of three unstable oxygen atoms. It is formed by the action of a high voltage electrical field on an oxygen source or on oxygen present in air. Care must be taken when using ozone for water system disinfection/sanitation to ensure that all materials of construction coming into contact with ozonated water are compatible for the ozone concentration used. Conventional reverse osmosis membranes must never be exposed to ozone (irreparable damage will occur).

Permeate: See product water.

pH: Water (H_20) can dissociate into two ions: hydrogen (H+) and hydroxyl (OH-). These ions can also be added to water in combination with other oppositely charges ions. Thus, a solution of hydrochloric acid added to water provides both H+ and the chloride anion, Cl-. The concentration of H+ in the water is a measure of the water acidity and the concentration of OH-, a measure of its alkalinity. To simplify quantification of H+ differences, where numbers with a wide range of exponents are encountered, sCIBntists devised a logarithmic scale called pH. The pH values range from 1 to 14. The pH value of 7 is considered neutral. Lower values of pH indicate acidic conditions and higher pH values indicate alkaline conditions. Because pH is a logarithmic scale, an increase of 1 pH unit corresponds to a ten-fold change in acidity.

Pressure Drop: A certain amount of energy is required for a fluid to flow through any channel, such as a pipe, particle bed, cartridge filter or membrane. The pressure at any point is a measure of the energy content of the fluid at that point. Since some of this energy is spent in flowing to a second point downstream, the pressure at the downstream point will be less than at the original point. The amount of energy spent, and hence the decrease in pressure (or pressure drop), is dependent on the flow rate and viscosity of the fluid, and the size and shape of the channel. Pressure drops are usually expressed in terms of lbs / in squared or PSI, or in the SI system, kPa (kipopascals) or kg / cm squared. Pressure drop is sometimes commonly referred to as "delta P".

Product Water: The purified water stream produced by reverse osmosis equipment or ultrafilters.

Recovery (percent recovery): A measurement applied to reverse osmosis and ultrafiltration equipment which characterizes the ratio of product water to feed water flow rates. The measurement is descriptive of reverse osmosis or ultrafiltration equipment as a system and not as individual membranes. Expressed as a percentage, recovery is defined as:

% Recovery = (Product flow rate / Feed flow rate) x 100

Rejection (percent rejection): A measurement of the ability of a reverse osmosis membrane to remove salts. Expressed as a percentage, rejection is defined as:

% Rejection = (1 - Product concentration / Feed concentration) x 100

Resistivity: Resistivity is a measure of the current-resisting characteristics of a substance when an electrical charge is applied (and the reciprocal of conductivity). The standard unit of resistance is the Ohm. Because of the variable nature of water, the distance between measuring probes must be maintained if accurate measures are desired. The almost universal standard for this measurement is the centimeter, hence the "Ohm-cm". Resistivity measurements, like conductivity measurements, can be used in many ways to improve the management of a water purification system, and are commonly used to assess the quality of water produced by deionizers. Because temperature effects resistivity of water, temperature compensating devices are frequently used. These adjust the resistance meter to indicate what the water resistance would be at one standard temperature, usually 25° C (77° F).

Salt Passage Rate: A measurement of the passage of salts through a reverse osmosis membrane. Salt passage is related to rejection by:

% Salt passage = 100 - % Rejection

Scaling: In reference to reverse osmosis equipment, scaling is the precipitation of sparingly soluble salts, such as calcium carbonate, onto the surface of a membrane. Scaling is associated with decreased flux and reduced reverse osmosis rejection rates.

Semi-permeable: Description of a material, such as reverse osmosis or ultrafiltration membrane, which allows the passage of some molecules and prevents the passage of others.

Silt Density Index: The silt density index (SDI) is a measure of the ability of water to foul a membrane or plug a filter. SDI is measured using an apparatus which typically consists of an inlet pressure regulator and pressure gauge followed by a filter holder containing a 0.45 micron microporus membrane filter. Commercial test kits, complete with instructions on how to calculate the index, are available.

Total Dissolved Solids (TDS): The sum of all organic, inorganic and ionic contents in a solution (excluding all dissolved gasses). Since a TDS meter cannot measure organic content of water, most TDS readings are an approximation. TDS measurements are widely used in the water and waste water industries to monitor final water quality. The TDS meter derives its values from resistivity and conductivity measurements of the product water.

Total Organic Carbon: Organic compounds dissolved in water are characterized by their carbon content. Total organic carbon (TOC) is the mass of carbon present in a water sample, excluding the carbon present in a water sample, excluding the carbon present as CO_2 and/or other carbonates. The values are determined by catalytically oxidizing (burning) all dissolved carbon (after CO_2 / CO_3- removal by acidification) to CO_2. The resulting CO_2 may be measured directly by infa-red absorption, or it may be reduced in a furnace with hydrogen to form methane, which is measured by flame ionization detectors. Because of how it is measured, TOC is also commonly referred to as "total oxidizable carbon."

Turbidity: Turbidity is a relative measurement of the presence of a colloidial matter in the water that remains suspended. Suspended matter in a water sample, such as clay, silt, or finely divided organic and/or inorganic material will scatter the light from an incident light beam. The extent of scattering is expressed in Jackson or Nephelometirc turbidity units (JTU and NTU, respectively).

Ultrafilters: A membrane based filtration system in which the pore sizes range from 0.001 to 0.1 microns. This pore size distribution is highly controlled to enhance membrane performance in specialty separation applications.

Section XI.

SUPPORT LITERATURE & DRAWINGS

Table 1. Temperature Correction Factors For Thin Film RO Membranes

Temperature		Correction Factor
Degrees F	Degrees C	TCF
32	0.0	0.27
35	1.7	0.31
40	4.4	0.37
45	7.2	0.45
50	10.0	0.53
55	12.8	0.61
60	15.6	0.69
65	18.3	0.79
70	21.1	0.89
77	25.0	1.00
80	26.7	1.07
85	29.7	1.18

Example: If the Containerized RO System, with thin film composite membranes, is rated at 2000 gpd, and the inlet water temperature is 55º F, it would produce (2000 x 0.61) or 1220 gpd of product water.

XI.A. Recommended System Settings

Note: These settings are recommended to aid in system safety and are not published as the most efficient setting for running your system, they are approximate settings only. Flows and Recovery are dependent on Feed Water quality and Temperature.

Hydraulic Settings

Permeate flow:	125 GPM
Concentrate flow:	50 GPM
System Pressure:	240 PSI
Feed Pressure:	40-60 PSI

Timer Settings: See page 25 .

XI.D. RO Operator Log Sample

Operations Log RO ____________________ CIB Ser. # _______________

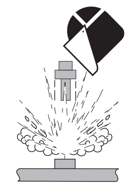
Date	Operator	System Pressure	Feed Pressure	Feed Temp.	Permeate Flow	Concentrate Flow	Recycle Flow	Conductivity	Comments

XI.E. Notes

Signet 2537 Paddlewheel Flowmeter

3-2537.090 Rev A 5/06 English

SAFETY INSTRUCTIONS
1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.



Description

The new 2537 Paddlewheel Flowmeter Series offer low flow, low power and high resolution with various output options such as a flow switch, pulse divider, Digital (S^3L), or 4-20mA. This unit can be configured on-site directly through the built-in user interface.

- The Digital model provides the digital (S^3L) output for use with the Signet 8900 Multi-Parameter Controller.
- The 4-20 mA model provides a blind current loop output.
- The Flow Switch Model uses a single relay (mechanical or solid state) for Hi or Lo alarm operation.
- The Pulse model uses a single relay (select mechanical or solid state) and has two selectable operating modes:
  - The Divider mode scales the paddlewheel frequency down to accomodate low frequency input devices.
  - In Total mode, the Pulse Model becomes a traditional pump pulser, able to output one pulse per a set volume of fluid.

A small LCD enables the 2537 to be programmed without any external equipment. During normal operation the display is not visible.

Specifications

General

Wetted materials:

	Body	Rotor	Pin	O-ring
-P0, -P1:	PP	Blk. PVDF	Titanium	FPM
-T0:	PVDF	PVDF	PVDF	FPM

Case: PBT, Yellow

Power Requirements

Pulse, Flow Switch
With dry-contact relay: 24 VDC nominal
(21.6 VDC min. to 26.4 VDC max.)
30 mA max current
With solid-state relay: 5 to 24 VDC nominal
(5.0 VDC min to 26.4 VDC max.)
30 mA max current
Digital (S^3L): 5 VDC nominal
(5.0 VDC min to 6.5 VDC max.)
3 mA max current
4-20 mA: 12 VDC to 32 VDC nominal
(10.8 VDC min to 35.2 VDC max.)
21 mA max current
Reverse Polarity and short circuit protected: Up to 40V, 1 hour
Over-voltage protection: > 40 VDC over 1 hour

Performance Specifications

Input Frequency Range: 1 Hz to 1000 Hz
Operating Range: 0.1 m/s to 6 m/s (0.3 ft/s to 20 ft/s)
Linearity: ±1% of max. range @ 25°C (77°F)
Repeatability ±0.5% of max. range @ 25°C (77°F)
System Response: 100 ms update rate nominal
Operating Range: 0.3 to 20 ft/s

Output Specifications

Signal Averaging: Programmable 0 to 100 seconds
Sensitivity Response: Programmable 0 to 9 scale

Pulse Divider/Total Pulse

Pulse Divider Setting: 1.0000 to 99999
Maximum pulse rate: 300 Hz
Maximum pulse width: 50 ms

Flow Switch Output

Relay Modes: Low, High
Time Delay: 0.0 to 6400.0 seconds
Hysteresis: Adjustable in Engineering Units

Relay Specifications

Mechanical SPDT: 5A @ 30 VDC, 5A @ 250VAC
Solid-State Relay: 100mA @ 40VDC

Digital (S^3L) Output

Type: Serial ASCII, TTL level 9600 bps
Maximum cable length: See S^3L specifications

Current Output (Passive 4 to 20 mA)

Loop Accuracy: ±32 µA (@ 25°C @ 24 VDC)
Loop resolution: 5 µA
Temp. drift: ±1 µA per °C max.
Power supply rejection: ±1 uA per V
Maximum cable: 300 m (1000 ft.)
Maximum Loop Resistance:
600Ω @ 24 VDC
1KΩ @ 32 VDC

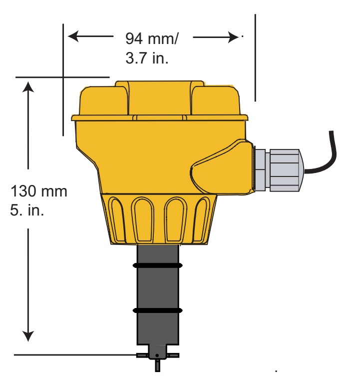
Environmental Requirements

Enclosure rating: NEMA 4X/IP65
Storage Temperature: -10°C to 75°C
Operating Temperature: 0°C to 65°C
Relative Humidity: 0 to 90% RH, non-condensing

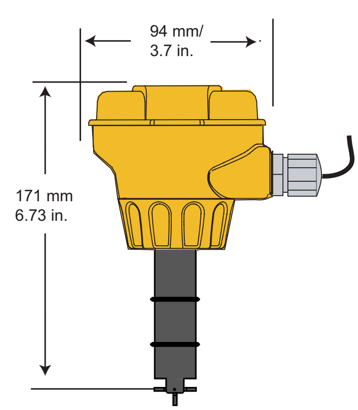
Standards & Approvals

CE
UL pending
EN61326: Immunity and Emissions for Control Equipment
EN61010: Safety requirements for electrical equipment..
Manufactured under ISO 9001 and ISO 14001

Dimensions



2537 Paddlewheel Flowmeter
for ½ in. to 4 in. pipe

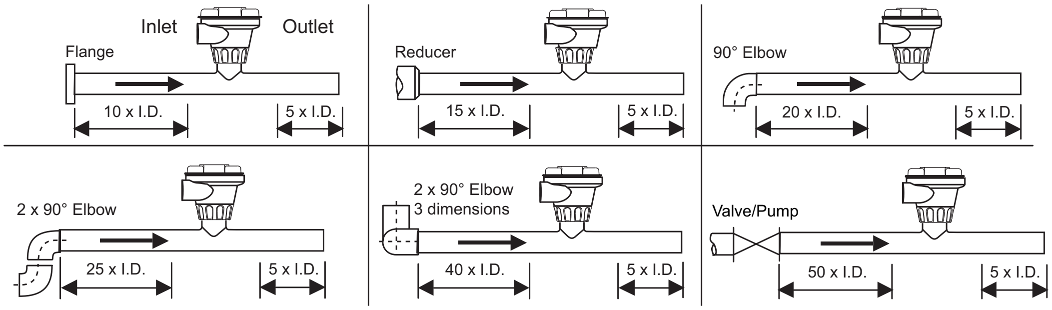


2537 Paddlewheel Flowmeter
for 5 to 8 in. pipe

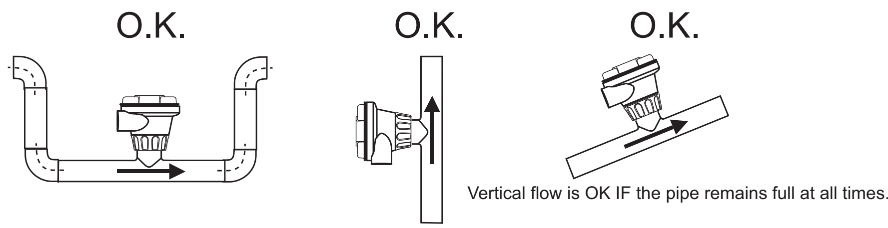
Location of Fitting

Recommended sensor upstream/downstream mounting requirements

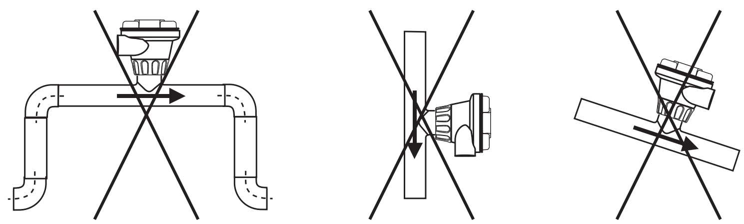
Select a location with sufficient distance of straight pipe immediately upstream of the sensor.



Locating the sensor in a trap or where the flow is upward helps to protect the sensor from exposure to air bubbles when the system is in operation.

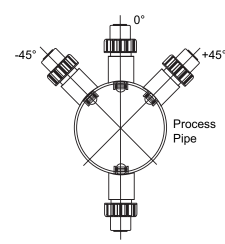


These configurations are not recommended because it is difficult to keep the pipe full.



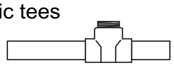
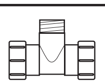
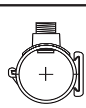
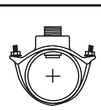
Sensor Mounting Position

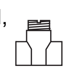
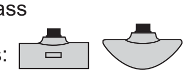
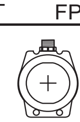
- Horizontal pipe runs: Mount sensor in the upright (0°) position for best performance. Mount at a maximum of 45° when air bubbles are present (pipe must be full). Do not mount on the bottom of the pipe when sediments are present.
- Vertical pipe runs: Mount sensor in any orientation, however, downward flow is not recomended. Upward flow is preferred to ensure full pipe.



Installation: Pipe fittings

George Fischer Signet offers a wide selection of installation fittings that control the position of the paddlewheel in relation to the dimensions of the pipe.

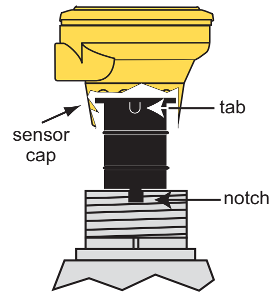
Type	Description
Plastic tees 	• 0.5 to 4 inch versions • PVC or CPVC
Metric Union Fitting 	• For pipes from DN 15 to 50 mm • PP or PVDF
PVC Saddles 	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • 6 to 8 inch, cut 2-1/8 inch hole in pipe
Iron Strap-on saddles 	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe

Type	Description
Iron, Carbon Steel, 316 SS Threaded tees 	• 0.5 to 2 inch versions • Mounts on threaded pipe ends
Carbon steel & stainless steel Weld-on Weldolets 	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe
Fiberglass tees & saddles:  FPT FPS	• 1.5 inch to 8 in. PVDF insert • > 8 inch PVC insert
Metric Wafer Fitting 	• For pipes DN 65 to 200 mm • PP or PVDF

3. Installation

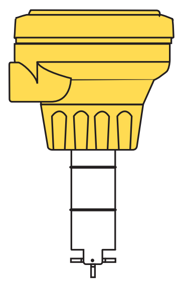
3.3 Plastic sensor installation tips

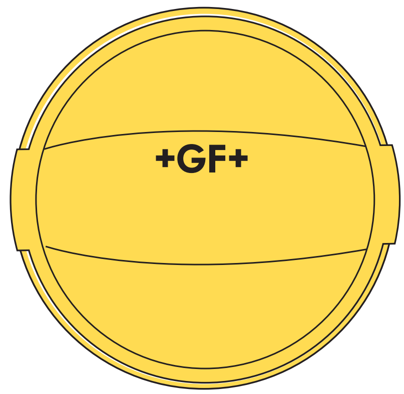
- Lubricate the sensor O-rings with a suitable lubricant.
  Do not use any petroleum based lubricant, which can attack the O-rings.
- Using an alternating/twisting motion, lower the sensor into the fitting, making sure the conduit ports on the yellow housing are pointing in the direction of flow.
- Engage one thread of the sensor cap then turn the sensor until the alignment tab is seated in the fitting notch. Hand tighten the sensor cap.
  DO NOT USE ANY TOOLS ON THE SENSOR CAP.



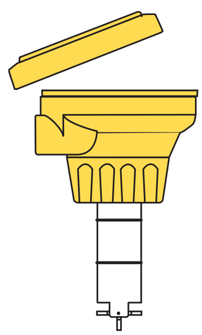
Access to Wiring and Setup hardware

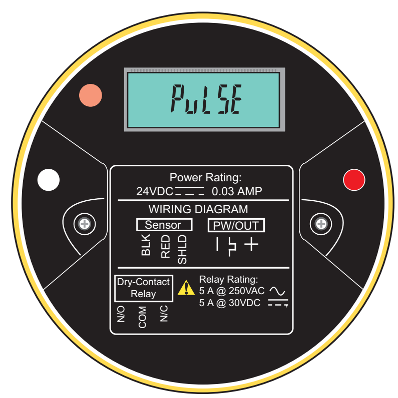
Turn yellow cap ¼ turn counterclockwise to remove it.





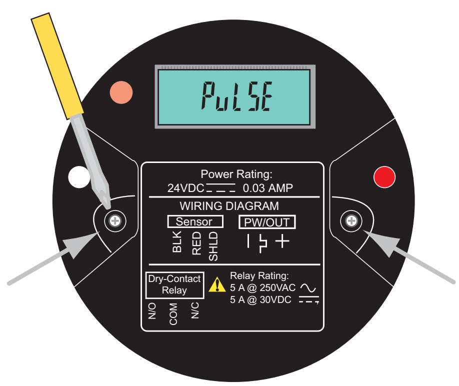
The WHITE and RED pushbuttons are accessible through the black cover.

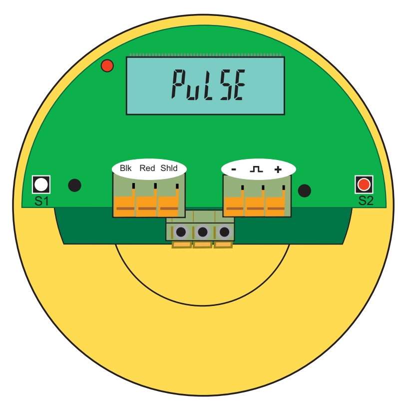




Remove the two retaining screws and remove the black cover.

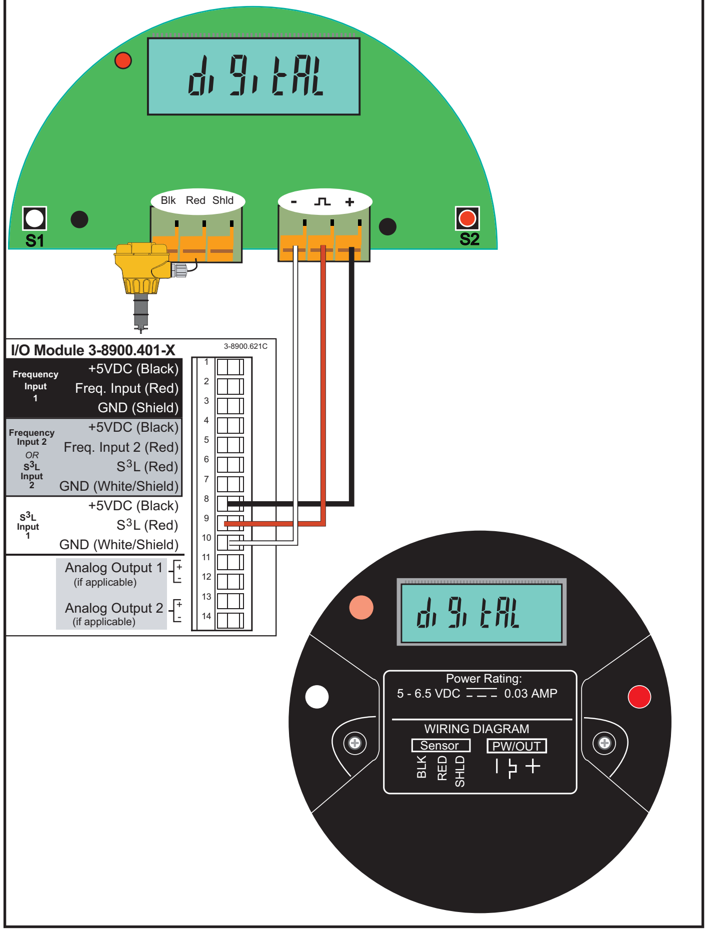
The wiring terminals are accessible inside the yellow housing.



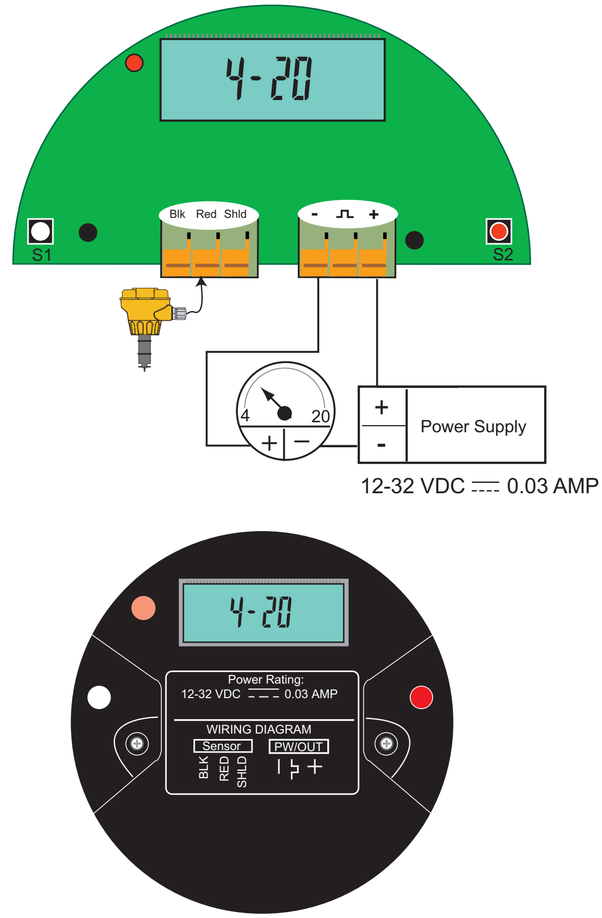


Wiring

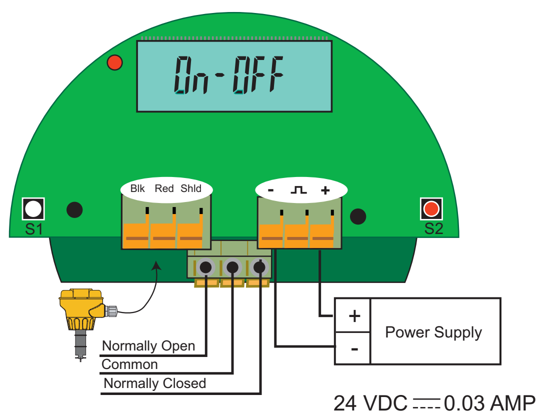
The Digital (S^3L) output is compatible with the 3-8900 Multi-Parameter Controller.



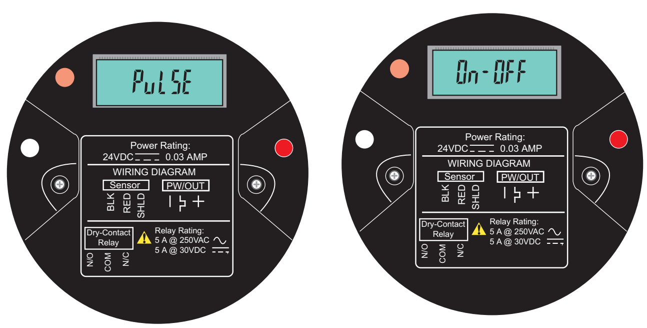
The 4-20 mA output can be connected to Chart Recorders, PLCs or any device that requires a 4-20 mA signal.



The On-OFF/PuLSE versions provide a single dry-contact relay output that can be programmed as a HIGH alarm or a LOW alarm.

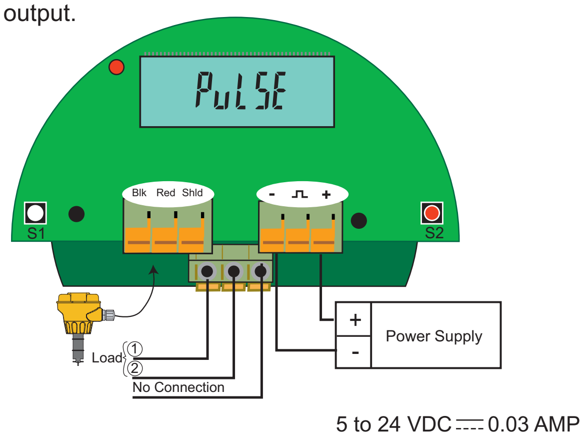


Wiring is the same for both PuLSE and On-OFF versions.

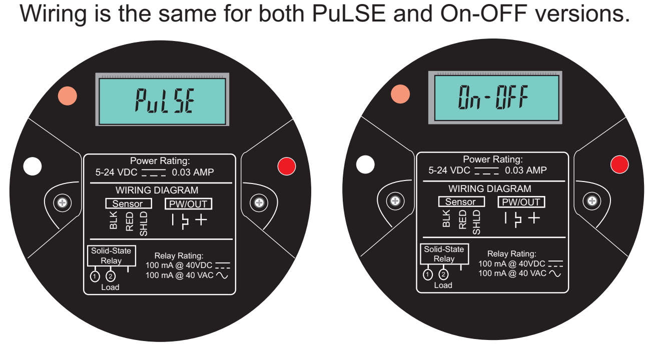


Dry-Contact Relay Model

The PuLSE/On-OFF versions provide a single solid-state relay output that repersents a volumetric pulse or pulse divided output.



Wiring is the same for both PuLSE and On-OFF versions.

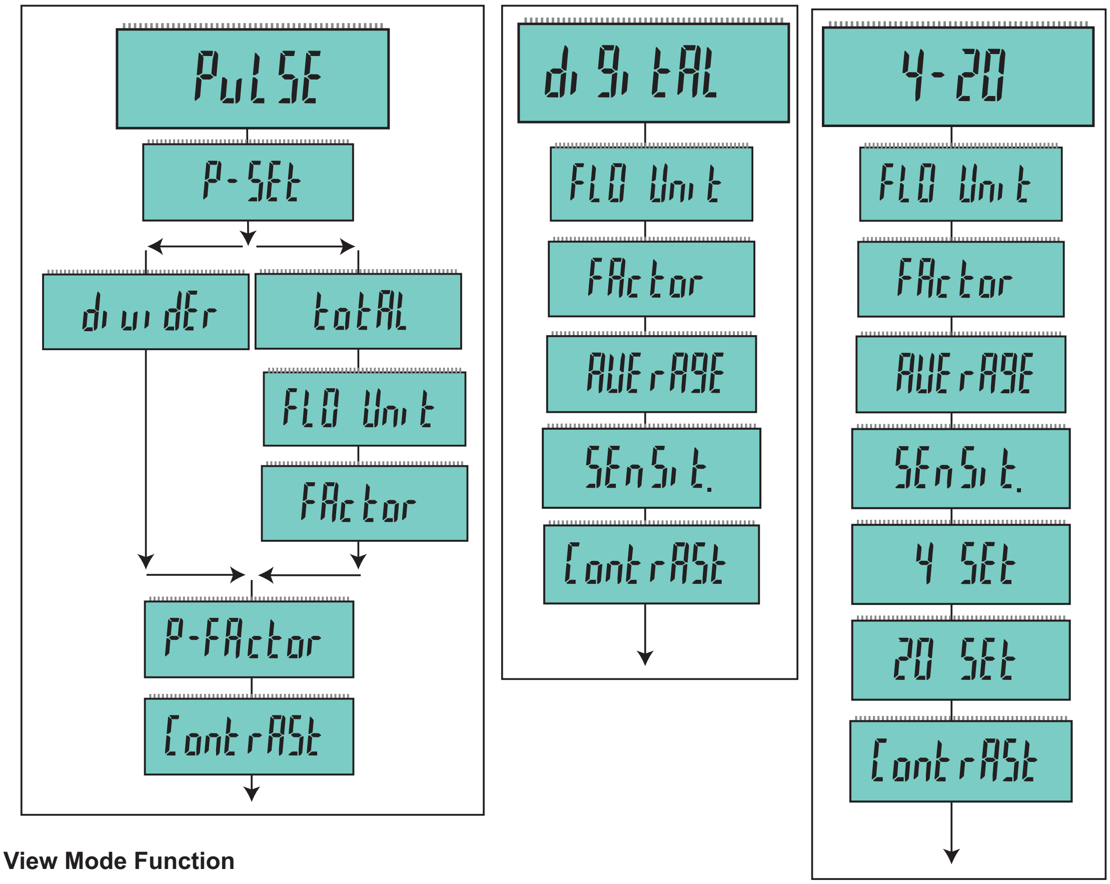


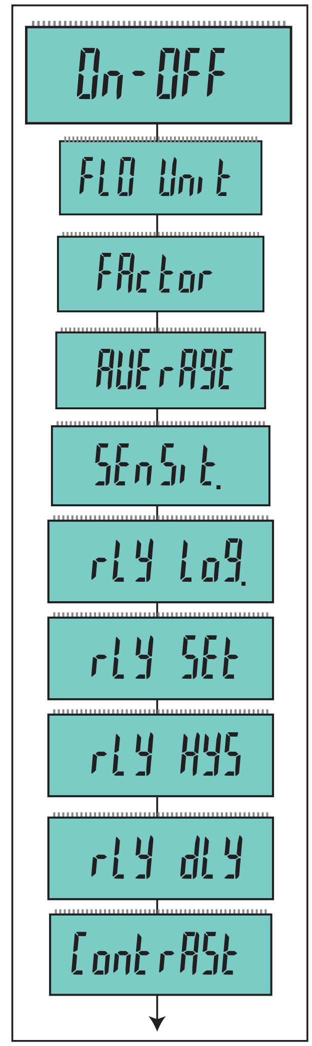
Solid-State Relay Model

Operation

The 2537 Flowmeter is available in 4 different models. The programming menus vary significantly from one model to another. The illustration below shows the sequence and content of each model.

The bottom table shows the definition of each menu function, the setting parameters and the page where detailed instructions can be located.





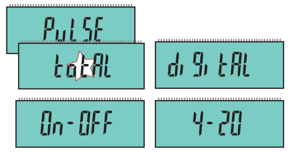
View Mode Function

- All models display the model name: PulSE, digital, 4-20, or On-OFF.
- If the white key is held down for 3 three seconds, the flow rate is displayed for 10 minutes, in user units, before reverting back to the model name.
  - In the PulSE Model, if the “P-Set” menu item is set to “divider”, then the divided pulse output will be displayed in pulses/seconds, (p/s).

Menu Function	Definition	Setting Parameters	More Information On
Flow Unit	Liters or Gallons per sec, min, hour or day	See list on page 6	page 6
(K)Factor	Set PULSES per VOLUME UNIT	0.0001 to 999999	page 6
Average	Smooths out erratic flow conditions	0 to 100 seconds	page 7
Sensitivity	Overrides Average for large rate changes	0 to 9	page 7
P-Set	Select the mode for the PULSE OUT	Total or Divider	page 8
P-Factor	As PULSE **DIVIDER**, divides input freq.	1.0000 to 99999	page 8
P-Factor	As PULSE **TOTAL**, multiplies K-Factor	1.0000 to 99999	page 8
Relay Logic	Select Hi alarm or Lo alarm mode	Hi or Lo	page 9
Relay Set	Set Relay Setpoint	0.0000 to 99999	page 9
Relay Hysteresis	Rate inside Setpoint to DEENERGIZE relay	0.0000 to 99999	page 9
Relay Delay	Time delay before relay is ENERGIZED	0000.0 to 6400.0	page 9
4 Set	Set flow RATE to be represented by 4 mA	0.0000 to 99999	page 6
20 Set	Set flow RATE to be represented by 20 mA	0.0000 to 99999	page 6
Contrast	Adjust visibility of liquid crystal display	1 to 3	page 6

Flow Units

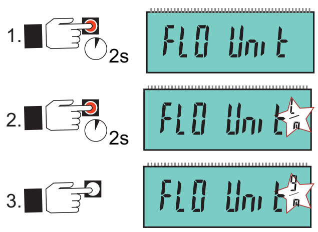
This function is available on these versions of the 2537.



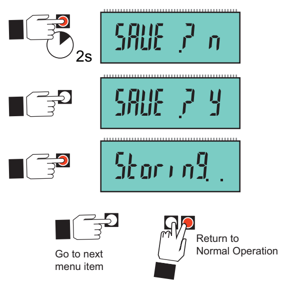
Select the volumetric units for the flow measurement.

L/S	Liters/second	g/S	Gallons/second
L/m	Liters/minute (Factory setting)	g/m	Gallons/minute
L/h	Liters/hour	g/h	Gallons/hour
L/d	Liters/day	g/d	Gallons/day

Example: Set the Flow Units to Gallons per minute:

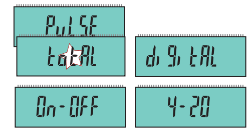


Save the new setting:



K-Factor

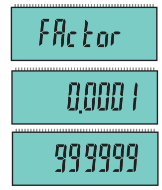
This function is available on these versions of the 2537.



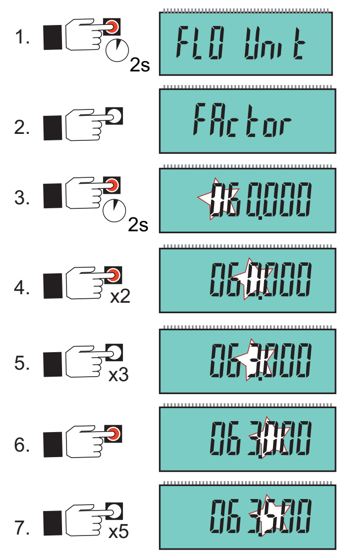
The factory setting is 60.0000.
Locate the K-factor in the tables on page 10.

Minimum value

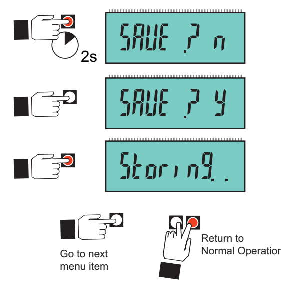
Maximum value



Example: Set the K-Factor to 63.5 Pulses per Gallon:

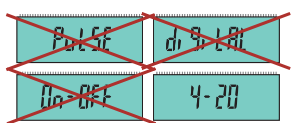


Save the new setting:



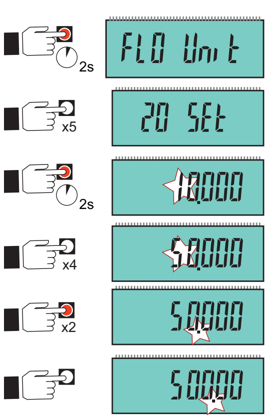
Set 4 and Set 20

This function is available on these versions of the 2537.

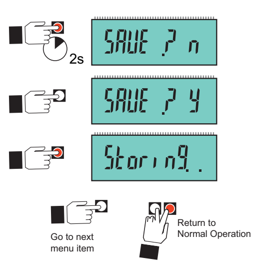


These two functions are used to span the 4-20 mA output signal to the required range.
The factory setting is 4-20 mA = 0 to 10.000

Only the 20 mA span is illustrated here.
Example: Set 20 mA = 500 GPM.

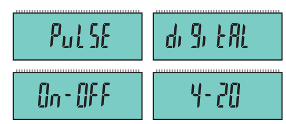


Save the new setting:

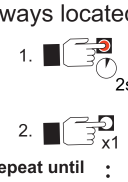


Set Contrast

This function is available on these versions of the 2537.



All models of the 2537 have the CONTRAST adjustment. It is always located at the end of the menu.

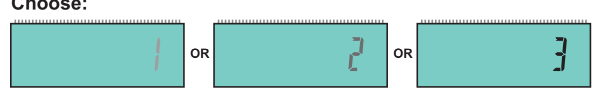


To access the adjustment, enter the menu and scroll until the Contrast display appears.

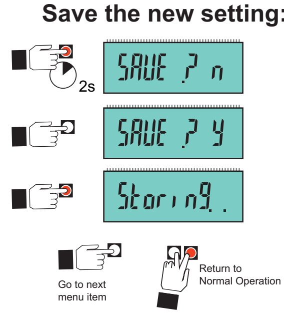
Repeat until

There are three levels of adjustment. The factory setting of 3 is the highest contrast setting.

Choose:



Save the new setting:



Averaging and Sensitivity Settings

- Because ideal flow conditions are often impossible to achieve, the flow rate is often erratic, which causes any control features (ie; relays, 4-20 mA loops, etc.) that are associated with the flow rate to be erratic.
- The best solution to these problems is to correct any piping deficiency that causes the instability. This may involve longer straight runs upstream, reducing the pipe size to maintain a full pipe at all times, and other installation changes. But in many situations these measures are simply not possible.
- The 2537 meter provides two tools that are designed to "work around" these deficiencies. The Averaging and the Sensitivity features should be studied before making adjustments.

Averaging Time in Seconds (Factory set: 0 seconds)

- Set the time the meter will use as the averaging period. The range is from 0 (no average applied to input) to 100 (seconds of averaging applied to input).
  Use higher averaging times to smooth the display and current output where the flow in the pipe is erratic.

Quick Response Sensitivity (Factory set: 0)

- Set the relative degree of change in the flow rate required to allow the 2537 to disable the AVERAGING and jump to a new flow rate immediately. The scale is from 0 (Least sensitive, averaging is never disabled.) to 9 (a very small change in flow rate will disable the averaging).

No AVERAGING, no SENSITIVITY

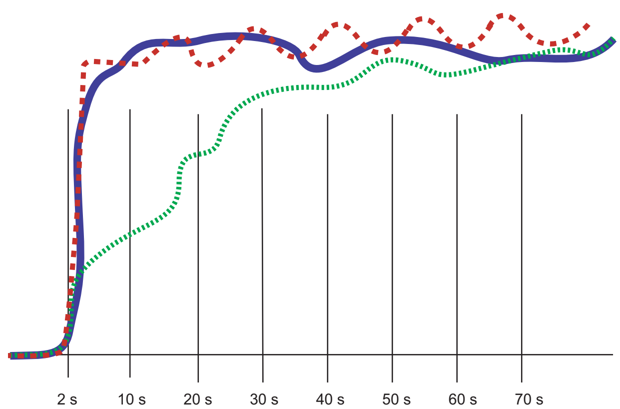
With AVERAGING set to 0 (zero) and with SENSITIVITY set to zero, the 2537 responds to every unstable shift in the flow. The dashed red line represents the actual output of the flow sensor in unstable flow conditions.

AVERAGING only

With AVERAGING set to 5 seconds and SENSITIVITY still set to zero the flow rate is stabilized, but a sharp change in flow rate is not represented for 50 seconds or longer. (dotted green line).

AVERAGING and SENSITIVITY

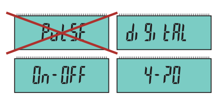
With AVERAGING at 50 seconds and SENSITIVITY set to 4 OR 5, the flow rate is stabilized, while the sudden shift in flow is reflected very quickly. (Solid blue line)



NOTE: The SENSITIVITY function is ineffective if the AVERAGING function is set to zero (seconds).

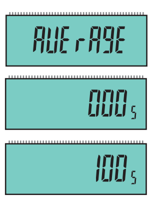
Set Averaging

This function is available on these versions of the 2537:



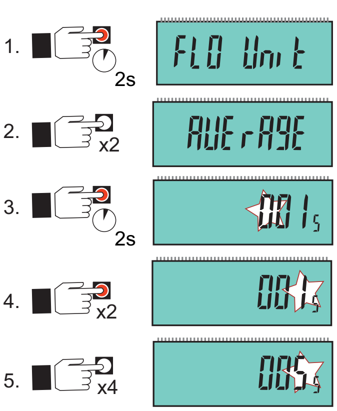
Minimum value

Maximum value

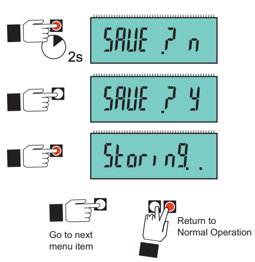


The factory setting is 0 (zero).

Example: Set the Averaging for 5 seconds.

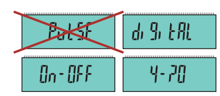


Save the new setting:



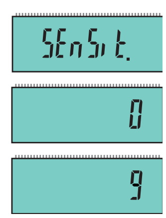
Set Sensitivity

This function is available on these versions of the 2537:



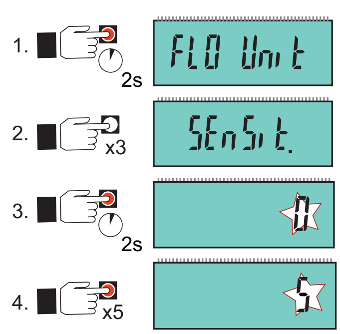
Minimum value

Maximum value

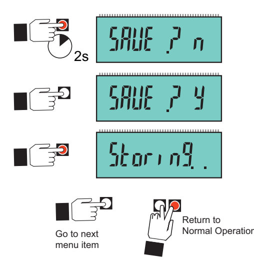


The factory setting is 0 (zero).

Example: Set the Sensitivity to 5.

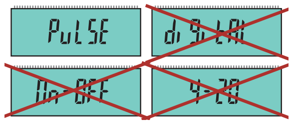


Save the new setting:



P-Set

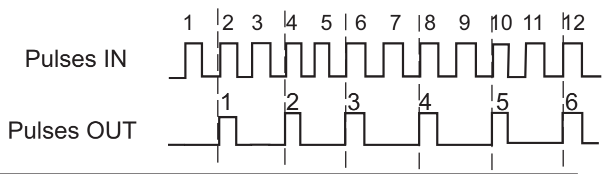
This function is available on these versions of the 2537:



Select DIVIDER or TOTAL operation.
The factory setting is TOTAL.

PULSE DIVIDER Output = Input pulses ÷ (P-Factor)
DIVIDER allows you to set a scaling value (P-Factor) from 1.0000 to 99999.

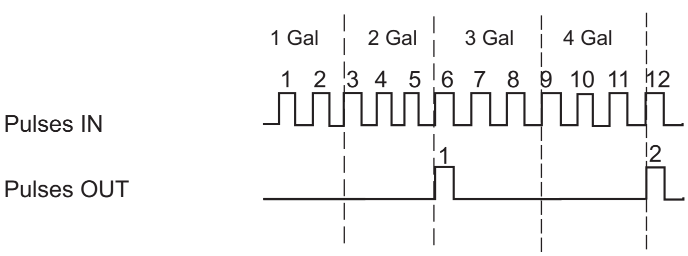
Example: If the P-Factor is set for 2, then the 2537 will output one pulse for every 2 pulses received from the sensor.
This selection enables the output frequency to be scaled down to match associated equipment capabilities.

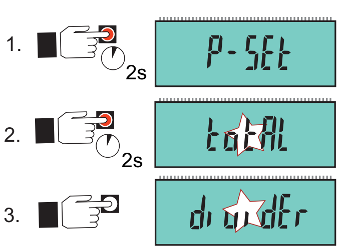


PULSE TOTAL Output = Input pulses ÷ (K-Factor • P-Factor)
TOTAL is a traditional pump pulser function. This selection will allow the entry of a K-Factor to define a volumetric unit, then set a P-Factor to define the number of volumetric units required to pass to generate one pulse out.

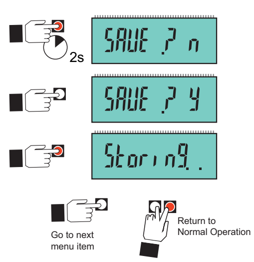
Example:
Set the Total Pulse output so there is one pulse out for each 2 gallons that passes the sensor if the K-factor is 3.0.

1. (K) Factor = 3.0 (pulses in per gallon)
2. P- Factor = 2 (gallons out per pulse)



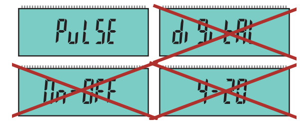


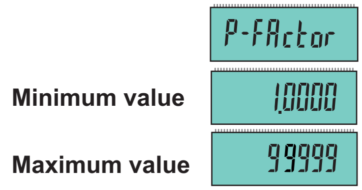
Save the new setting:



P-Factor

This function is available on these versions of the 2537:

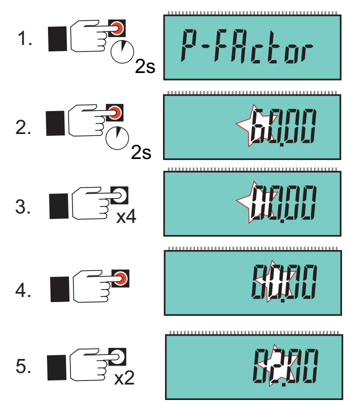




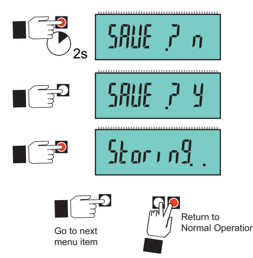
The factory setting is 1.0000

In PULSE DIVIDER mode the P-Factor divides:
The pulse stream from the paddlewheel sensor will be divided by the P-Factor. The resulting frequency is output through a relay.

In PULSE TOTAL mode the P-Factor multiplies:
The pulse stream from the paddlewheel sensor is divided by the K-Factor MULTIPLIED by the P-factor. The resulting frequency is output through a relay.

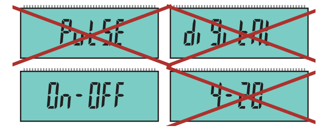


Save the new setting:



Set Relay operation

The Flow Switch has one relay (SPDT or solid-state) that can be programmed as a HIGH (Hi) alarm or a LOW (Lo) alarm.



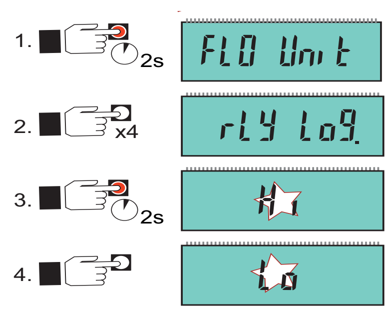
1. Select HI or LO Relay Alarm logic

A HI alarm will be activated when the flow rate rises ABOVE the setpoint.

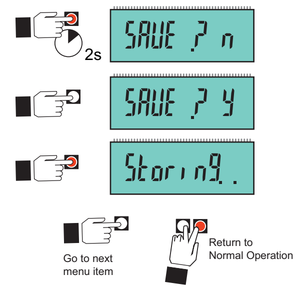
A LO alarm will be activated when the flow rate falls BELOW the setpoint.

The factory setting is Hi(gh).

Example: Change the Relay Logic to Low:



Save the new setting:



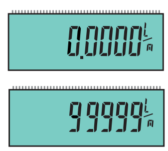
2. Program the SETPOINT.

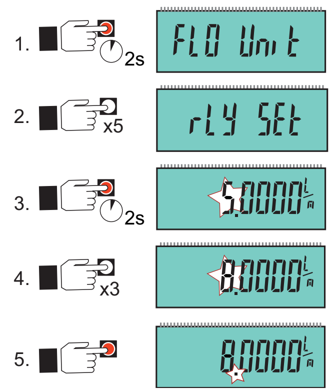
The SETPOINT is the flow rate where the relay will be energized.
The factory setting is 5.0000.

Example: Change the Setpoint to 8.0000:

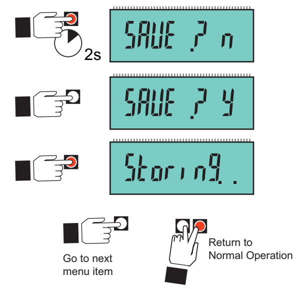
Minimum value

Maximum value





Save the new setting:



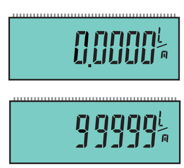
3. Program the HYSTERESIS.

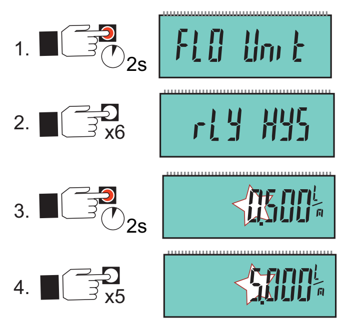
Hysteresis holds a relayenergized until the flow rate moves this amount past the setpoint.
The factory setting is 0.5000

Example: Change the Hysteresis to 5.0000:

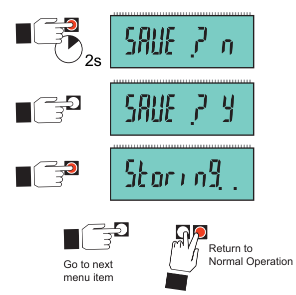
Minimum value

Maximum value





Save the new setting:



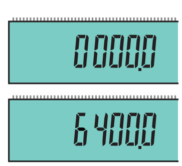
4. Program the DELAY.

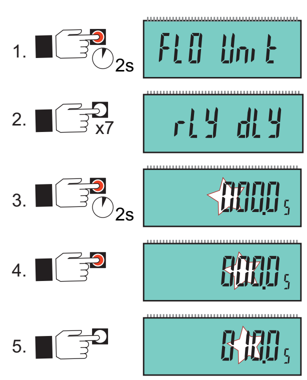
When the flow rate reaches the setpoint, the 2537 will wait this long (in seconds) before triggering the alarm.
The factory setting is 0000.0 seconds.

Example: Change the Delay to 10.0:

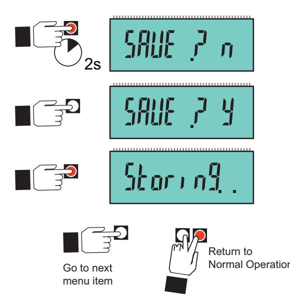
Minimum value

Maximum value

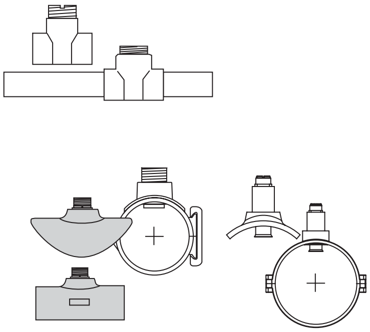




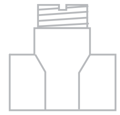
Save the new setting:



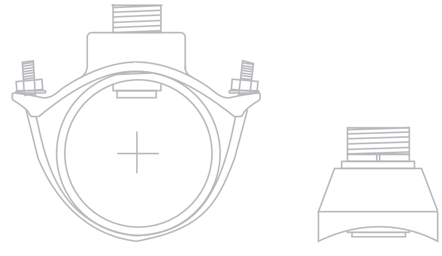
K-Factors



PIPE SIZE (IN.)	FITTING	2536/8512-XX U.S. GAL	2536/8512-XX LITERS
SCH 80 PVC TEES FOR SCH 80 PVC PIPE			
1/2	PV8T005	991.71	262.01
3/4	PV8T007	545.14	144.03
1	PV8T010	352.44	93.114
1-1/4	PV8T012	177.18	46.812
1-1/2	PV8T015	117.85	31.137
2	PV8T020	66.739	17.633
2-1/2	PV8T025	42.994	11.359
3	PV8T030	26.652	7.0414
4	PV8T040	15.006	3.9645
SCH 80 CPVC TEES FOR SCH 80 CPVC PIPE			
1/2	CPV8T005	991.71	262.01
3/4	CPV8T007	545.14	144.03
1	CPV8T010	352.44	93.114
1-1/4	CPV8T012	177.18	46.812
1-1/2	CPV8T015	117.85	31.137
SCH 80 PVC SADDLES FOR SCH 80 PVC PIPE			
2	PV8S020	66.739	17.633
2-1/2	PV8S025	42.994	11.359
3	PV8S030	26.652	7.0414
4	PV8S040	15.006	3.9645
6	PV8S060	8.3246	2.1994
8	PV8S080	5.0164	1.3253
SCH 80 PVC SADDLE ON SCH 40 PVC PIPE			
2	PV8S020	54.700	14.452
2-1/2	PV8S025	37.159	9.8175
3	PV8S030	23.697	6.2608
4	PV8S040	13.456	3.5552
6	PV8S060	7.4594	1.9708
8	PV8S080	4.5292	1.1966



PIPE SIZE (IN.)	FITTING	2536/8512-XX U.S. GAL	2536/8512-XX LITERS
CARBON STEEL TEES ON SCH 40 PIPE			
1/2	CS4T005	756.00	199.74
3/4	CS4T007	438.69	115.90
1	CS4T010	286.78	75.768
1-1/4	CS4T012	121.22	32.026
1-1/2	CS4T015	91.139	24.079
2	CS4T020	54.468	14.391
STAINLESS STEEL TEES ON SCH 40 PIPE			
1/2	CR4T005	734.20	193.98
3/4	CR4T007	412.10	108.88
1	CR4T010	252.70	66.764
1-1/4	CR4T012	128.12	33.849
1-1/2	CR4T015	77.320	20.428
2	CR4T020	45.780	12.095
GALVANIZED IRON TEES ON SCH 40 PIPE			
1	IR4T010	213.01	56.277
1-1/4	IR4T012	127.75	33.751
1 1/2	IR4T015	94.401	24.941
2	IR4T020	59.420	15.699
BRONZE TEES ON SCH 40 PIPE			
1	BR4T010	213.01	56.277
1-1/4	BR4T012	127.75	33.751
1-1/2	BR4T015	94.401	24.941
2	BR4T020	59.420	15.699
COPPER TEE FITTINGS ON COPPER PIPE SCH K			
1/2	CUKT005	917.84	242.50
3/4	CUKT007	428.27	113.15
1	CUKT010	256.43	67.749
1-1/4	CUKT012	176.44	46.615
1-1/2	CUKT015	115.69	30.565
2	CUKT020	63.385	16.746
COPPER TEE FITTINGS ON COPPER PIPE SCH L			
1/2	CUKT005	858.22	226.74
3/4	CUKT007	385.74	101.91
1	CUKT010	241.64	63.841
1-1/4	CUKT012	170.90	45.152
1-1/2	CUKT015	112.03	29.598
2	CUKT020	61.74	16.310

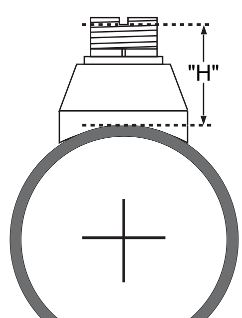


PIPE SIZE (IN.)	FITTING	2536/8512-XX U.S. GAL	2536/8512-XX LITERS
STAINLESS STEEL WELDOLETS ON SCH 40 PIPE			
2-1/2	CR4W025	37.600	9.9339
3	CR4W030	24.340	6.4306
4	CR4W040	13.920	3.6777
5	CR4W050	10.860	2.8692
6	CR4W060	7.5200	1.9868
8	CR4W080	4.3400	1.1466
CARBON STEEL WELDOLETS ON SCH 40 PIPE			
2-1/2	CS4W025	37.600	9.9339
3	CS4W030	24.340	6.4306
4	CS4W040	13.920	3.6777
5	CS4W050	10.860	2.8692
6	CS4W060	7.5200	1.9868
8	CS4W080	4.3400	1.1466
COPPER/BRONZE BRAZOLETS ON SCH 40 PIPE			
2-1/2	BR4B025	37.600	9.934
3	BR4B030	24.340	6.431
4	BR4B040	13.920	3.678
5	BR4B050	10.860	2.869
6	BR4B060	7.5200	1.987
8	BR4B080	4.3400	1.147
SCH 80 IRON SADDLES ON SCH 80 PIPE			
2	IR8S020	64.720	17.099
2-1/2	IR8S025	42.480	11.223
3	IR8S030	26.420	6.980
4	IR8S040	14.700	3.884
5	IR8S050	12.180	3.218
6	IR8S060	8.4400	2.230
8	IR8S080	4.9000	1.295
SCH 80 IRON SADDLE ON SCH 40 PIPE			
2	IR8S020	53.640	14.172
2-1/2	IR8S025	37.600	9.934
3	IR8S030	23.220	6.135
4	IR8S040	13.260	3.503
5	IR8S050	11.040	2.917
6	IR8S060	7.2400	1.913
8	IR8S080	4.4000	1.162

H-Dimensions

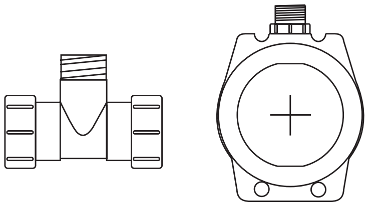
The plastic insert in Weldolet fittings MUST be removed during the welding process. When reinstalled, it is important that the insert be threaded to the proper height ("H" dimension).

Weldolet part number	"H" dimension inches	"H" dimension mm
CS4W020	2.38	60.45
CS4W025	2.33	59.18
CS4W030	2.32	58.92
CS4W040	2.30	58.42
CS4W050	3.09	78.48
CS4W060	2.96	75.18
CS4W080	2.73	69.34



Weldolet part number	"H" dimension inches	"H" dimension mm
CR4W020	2.38	60.45
CR4W025	2.33	59.18
CR4W030	2.32	58.92
CR4W040	2.30	58.42
CR4W050	3.09	78.48
CR4W060	2.96	75.18
CR4W080	2.73	69.34

K-Factors



PIPE SIZE	FITTING	2536/8512-XX	
		U.S. GAL	LITERS
POLYPROPYLENE FITTINGS (DIN/ISO AND BS AND ANSI)			
DN 15	PPMT005	952.87	251.75
DN 20	PPMT007	563.10	148.77
DN 25	PPMT010	291.60	77.042
DN 32	PPMT012	169.22	44.709
DN 40	PPMT015	103.90	27.450
DN 50	PPMT020	60.789	16.060
DN 65	PPMT025	41.498	10.964
DN 80	PPMT030	26.786	7.0769
DN 100	PPMT040	17.415	4.6011
DN 125	PPMT050	10.168	2.6864
DN 150	PPMT060	7.3119	1.9318
DN 200	PPMT080	3.9946	1.0554
PVDF FITTINGS (DIN/ISO AND BS AND ANSI)			
DN 15	SFMT005	827.26	218.56
DN 20	SFMT007	489.87	129.42
DN 25	SFMT010	283.55	74.915
DN 32	SFMT012	158.59	41.899
DN 40	SFMT015	86.980	22.980
DN 50	SFMT020	50.385	13.312
DN 65	SFMT025	36.133	9.5465
DN 80	SFMT030	24.715	6.5297
DN 100	SFMT040	16.120	4.2589
DN 125	SFMT050	8.8624	2.3415
DN 150	SFMT060	6.4543	1.7052
DN 200	SFMT080	4.0720	1.0758
PVC FITTINGS (DIN/ISO) - EUROPE ONLY			
DN 15	PVMT005	972.37	256.90
DN 20	PVMT007	485.69	128.32
DN 25	PVMT010	297.27	78.540
DN 32	PVMT012	170.25	44.980
DN 40	PVMT015	103.71	27.400
DN 50	PVMT020	59.500	15.720
DN 65	PVMT025	34.973	9.2400
DN 80	PVMT030	24.981	6.6000
DN 100	PVMT040	16.275	4.3000
DN 150	PVMT060	8.1756	2.1600
DN 200	PVMT080	4.0878	1.0800

Ordering Information

Mfr. Part No.	Code	Description
2537 system for 0.5 in. to 4 in. pipes, with polypropylene body, Black PVDF rotor, Titanium pin, FPM O-rings		
3-2537-1C-P0	159 001 291	Pulse Divider via Dry-Contact Relay, Integral Mount
3-2537-2C-P0	159 001 292	Pulse Divider via Solid-State Relay, Integral Mount
3-2537-3C-P0	159 001 293	Flow Switch via Dry-Contact Relay, Integral Mount
3-2537-4C-P0	159 001 294	Flow Switch via Solid-State Relay, Integral Mount
3-2537-5C-P0	159 001 295	Digital (S^3L), Integral Mount
3-2537-6C-P0	159 001 296	4-20mA, Integral Mount
2537 system for 5 in. to 8 in. pipes, with polypropylene body, Black PVDF rotor, Titanium pin, FPM O-rings		
3-2537-1C-P1	159 001 303	Pulse Divider via Dry-Contact Relay, Integral Mount
3-2537-2C-P1	159 001 304	Pulse Divider via Solid-State Relay, Integral Mount
3-2537-3C-P1	159 001 305	Flow Switch via Dry-Contact Relay, Integral Mount
3-2537-4C-P1	159 001 306	Flow Switch via Solid-State Relay, Integral Mount
3-2537-5C-P1	159 001 307	Digital (S^3L), Integral Mount
3-2537-6C-P1	159 001 308	4-20mA, Integral Mount
2537 system for 0.5 in. to 4 in. pipes, with natural PVDF body, rotor and pin, FPM O-rings		
3-2537-1C-T0	159 001 315	Pulse Divider via Dry-Contact Relay, Integral Mount
3-2537-2C-T0	159 001 316	Pulse Divider via Solid-State Relay, Integral Mount
3-2537-3C-T0	159 001 317	Flow Switch via Dry-Contact Relay, Integral Mount
3-2537-4C-T0	159 001 318	Flow Switch via Solid-State Relay, Integral Mount
3-2537-5C-T0	159 001 319	Digital (S^3L), Integral Mount
3-2537-6C-T0	159 001 320	4-20mA, Integral Mount

Accessories

Mfr. Part No.	Code	Description
3-2536.320-1	198 820 052	Rotor, PVDF Black
3-2536.320-2	159 000 272	Rotor, PVDF Natural
3-2536.320-3	159 000 273	Rotor, Tefzel®
3-2536.321	198 820 054	Rotor and Pin, PVDF Natural
3-2536.322-1	198 820 056	Sleeved Rotor, PVDF Black
3-2536.322-2	198 820 057	Sleeved Rotor, PVDF Natural
3-2536.322-3	198 820 058	Sleeved Rotor, Tefzel®
M1546-1	198 801 182	Rotor Pin, Titanium
M1546-2	198 801 183	Rotor Pin, Hastelloy-C
M1546-3	198 820 014	Rotor Pin, Tantalum
M1546-4	198 820 015	Rotor Pin, Stainless Steel
P51545	198 820 016	Rotor Pin, Ceramic
1220-0021	198 801 186	O-Ring, FPM
1224-0021	198 820 006	O-Ring, EPDM
1228-0021	198 820 007	O-Ring, FFKM
P31536	198 840 201	Sensor Plug, Polypro
P31536-1	198 840 202	Sensor Plug, PVDF Metric
P31536-2	159 000 649	Sensor Plug, PVDF
3-8050.396	159 000 617	RC Filter kit (for relay use)
3-9000.392-1	159 000 839	Liquid tight connector kit, NPT (1 piece)
3-9000.392-2	159 000 841	Liquid tight connector kit, PG13.5 (1 piece)
7300-7524	159 000 687	24 VDC Power Supply 7.5 W, 300mA
7300-1524	159 000 688	24 VDC Power Supply 15 W, 600mA
7300-3024	159 000 689	24 VDC Power Supply 30 W, 1.3 A
7300-5024	159 000 690	24 VDC Power Supply 50 W, 2.1 A
7300-1024	159 000 691	24 VDC Power Supply 100 W, 4.2 A

Intended Use: This product is intended for use in industrial water treatment and waste water treatment applications where the chemical content and the fluid temperatures are consistent with the specifications listed herein.

+GF+

George Fischer Signet Inc., 3401 Aerojet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057
For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090

Printed in U.S.A. on recycled paper

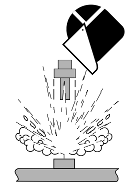
Signet 2850 Conductivity/Resistivity Sensor Electronics

English

3-2850.090-1 Rev. H 06/12 English

SAFETY PRECAUTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.
6. When using chemicals or solvents, care should be taken and appropriate eye, face, hand, body, and/or respiratory protection should be used.



Contents

1. Description

- Signet 2850 Conductivity/Resistivity Sensor Electronics provides either a two-wire 4 to 20 mA output or Digital (S^{3}L) format.
- The 4 to 20 mA output models provide eight ranges for each electrode cell constant, plus the ability to invert each range.
- The EasyCal feature allows the devices to automatically recognize standard conductivity test solution values for simple field calibration.
- The Conductivity sensor provided with integral systems will have its custom cell constant information programmed into the electronics at the factory to provide a 1% sensor accuracy. See Section 8 for details.

2. Specifications

General

Compatible Electrodes:	Any Signet Conductivity/ Resisitivity electrode (2818-2823, 2839-2842)
Temperature Compensation:	PT-1000 RTD (2% per °C)
Pure Water Compensation:	Auto-switching when using 0.01 cell and raw conductivity value < 0.5 µS

EasyCal:
Automatic recognition of the following conductivity values:
- 146.93 µS, 1408.8 µS, 12856 µS (@ 25 °C) (Test solutions per ASTM D1125-95)
- 10 µS, 100 µS, 200 µS, 500 µS, 1000 µS, 5000 µS, 10,000 µS, 50,000 µS, 100,000 µS (@ 25 °C)

Electrical

Power:	12 to 24 VDC (4 to 20 mA output) 5 VDC ±5% regulated, 3.0 mA max. for Digital (S^{3}L) output (Reverse polarity and short circuit protected)
Digital (S^{3}L) Output:	Serial ASCII, TTL level 9600 bps
• Accuracy:	Conductivity: ±2% of reading Temperature: ±0.5 °C
• Resolution:	Conductivity: 0.1% of reading Temperature: < 0.2 °C
• Update Rate:	Single input models: < 600 ms Dual input models: < 1.2 s

Current Output:
- Field-selectable ranges
- Factory set span:

0.01 cell (2818, 2819, 2839):	4 to 20 mA = 0 to 100 µS
0.10 cell (2820, 2840):	4 to 20 mA = 0 to 1000 µS
1.0 cell (2821, 2841):	4 to 20 mA = 0 to 10,000 µS
10.0 cell (2822, 2842):	4 to 20 mA = 0 to 200,000 µS
20.0 cell (2823):	4 to 20 mA = 0 to 400,000 µS
• Max. Loop Resistance:	50 Ω @ 12 VDC 325 Ω @ 18 VDC 600 Ω @ 24 VDC
• Accuracy:	±2% of output span
• Resolution:	7 µA
• Update Rate:	<600 ms
• Error Indication:	22 mA

Available data via Digital (S^{3}L) Output:
- Raw conductivity
- Calibrated conductivity
- Calibrated temperature-compensated conductivity
- Temp. Error Indication: Open input and out-of-range diagnostics for temperature or internal electronic error.

Environmental

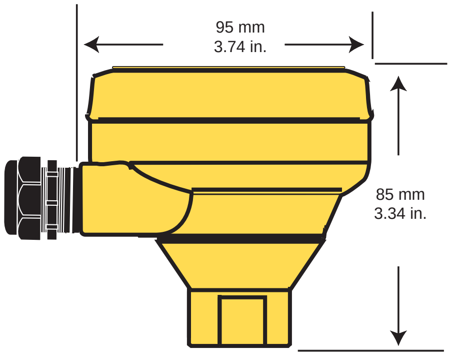
Material:	PBT
Enclosure Rating:	NEMA 4X/IP65
Operating Temperature:	-10 to 85 °C (14 to 185 °F)
Storage Temperature:	-20 to 85 °C (-4 to 185 °F)
Relative Humidity:	0 to 95%, non-condensing
Shipping Weight:	0.75 kg (1.75 lb.)

Standards and Approvals
- CE
- Manufactured under ISO 9001 and ISO 14001

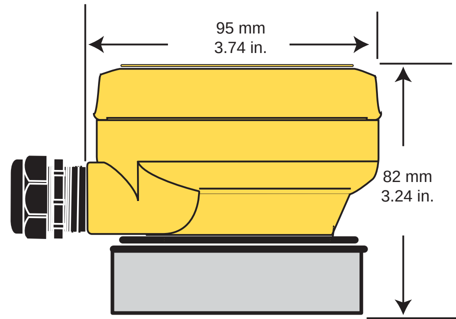
China RoHS (Go to www.gfsignet.com for details)

Dimensions

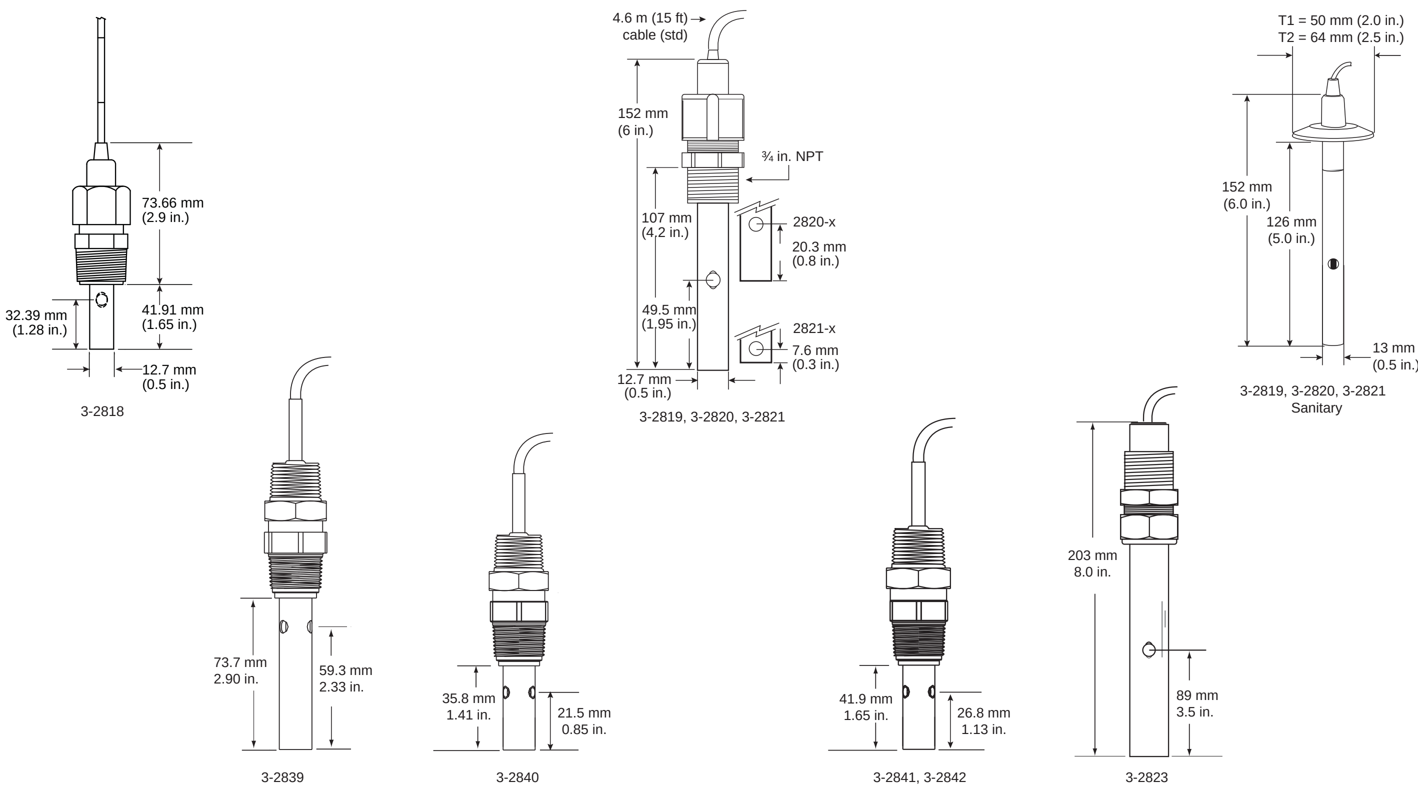
2850-51, -52 Integral mount



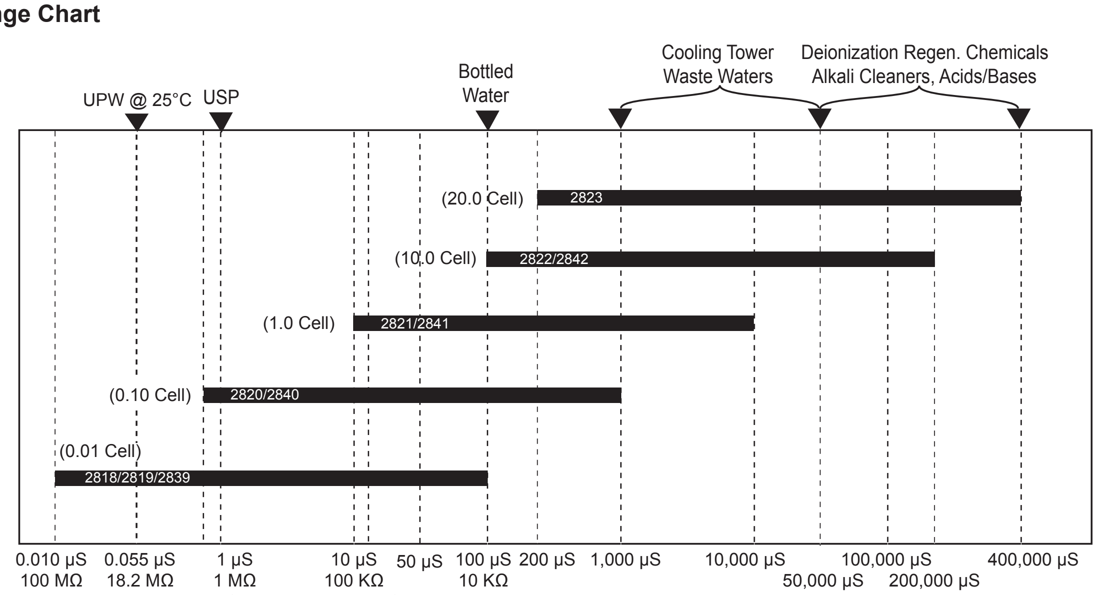
2850-61, -62, -63 Universal mount



Conductivity Sensor Dimensions



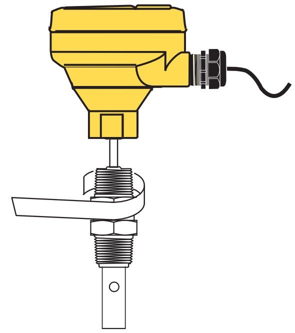
Operating Range Chart



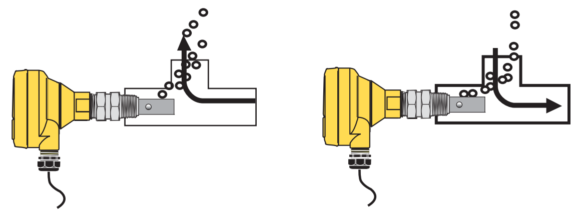
3. In-Line Installations

Most of the Conductivity/Resistivity electrodes used with the 2850 can be installed into standard $^3/_4$ in. (NPT or ISO 7-R$^3/_4$) fittings.

The 2850-5X models are designed for integral systems, where the electronics are attached directly to the sensor.

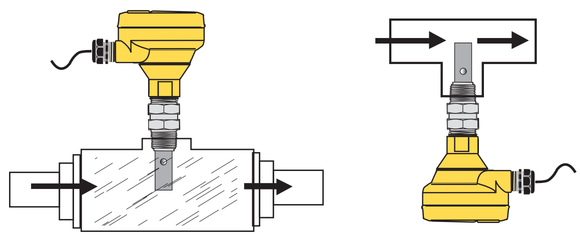


The preferred installation for in-line applications directs flow straight into the electrode. This configuration reduces the probability of entrapped air bubbles, and provides the best continuous sampling of the fluid content.

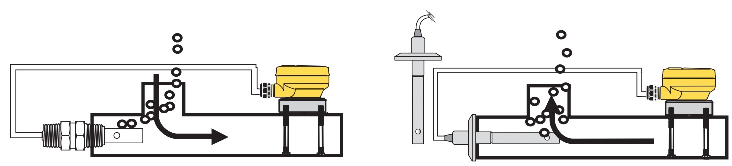


If the electrode is mounted vertically in a tee, do not recess the electrode orifices inside the tee. Mounting upside down may help prevent air entrapment.

An oversized tee or flow cell may be helpful for inline installations. At least 4 threads (ANSI B1.20.1) must be engaged to meet the pressure rating as published in the specifications.



Use the 2850-6X models for in-line installations where the electronics must be separated from the electrode. Conductivity electrodes with sanitary flange fittings must be installed using this option.



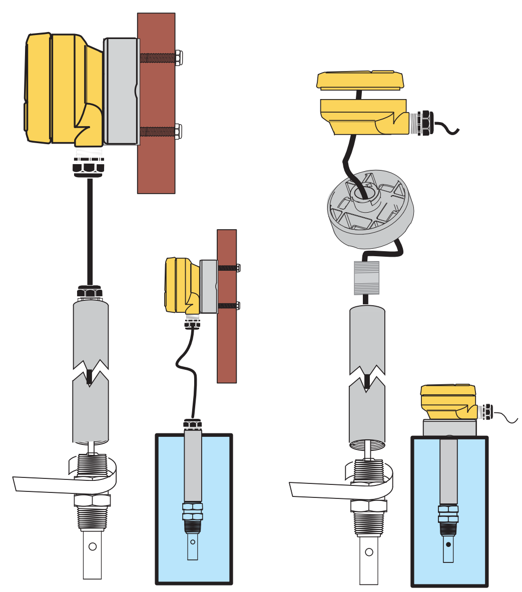
4. Tank Installations

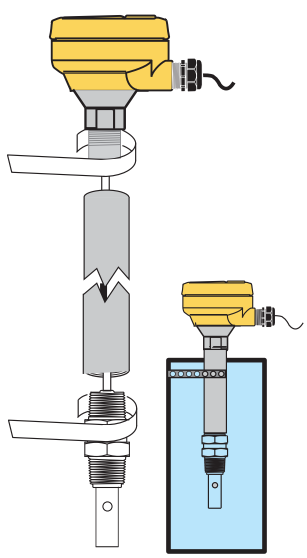
While the 2850-5X and -6X electronics cannot be submerged, either model will accomodate tank installation.

Select any electrode with a 5 m (15 ft) cable. The cable may be cut to length, but it CANNOT BE EXTENDED.

The universal adapter included with 2850-6X models can be attached to the top of a tank or mounted to a surface near the tank.

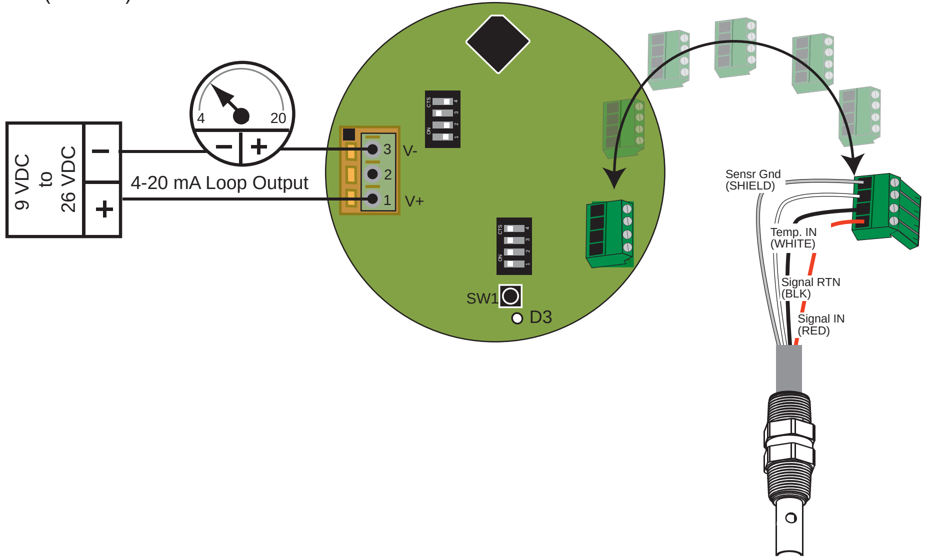
Adapt the 2850-5X models to tank installations by attaching a clamp to the conduit.





5. Wiring 4 to 20 mA Output Version

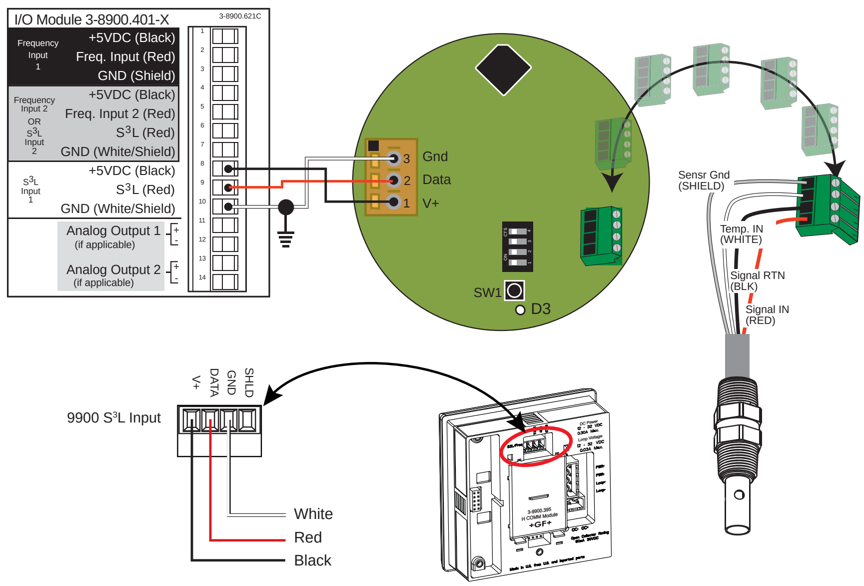
- Maximum length of 4 to 20 mA loop is 300 meters (1000 ft)



6. Wiring Digital (S³L) Output Version

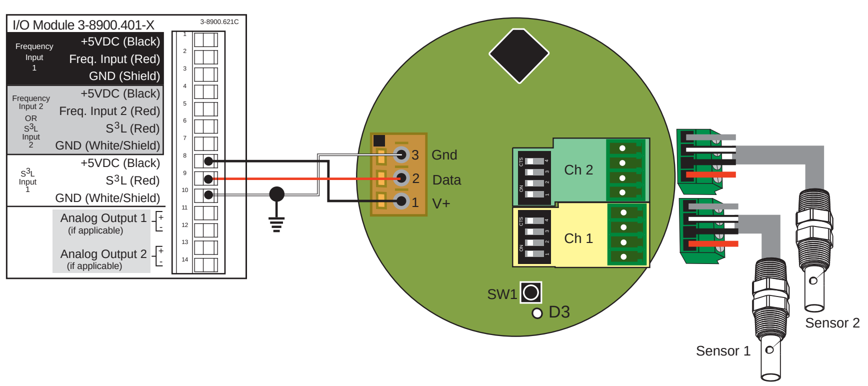
- The digital output is compatible with the Signet 8900 Multi-Parameter Controller and the Signet 9900 Transmitter.
- Refer to the wiring sections of the 8900 or 9900 manual to determine cable length limitations.
- IMPORTANT: Provide Earth Ground as indicated by ⏚ symbol.

Note: The 2819-2823 and 2839-2842 sensors can connect directly to the 9900 via the 9900's optional Direct Conductivity/Resistivity Module 3-9900.394 (159 001 699).



7. Wiring Dual Input Digital (S³L) Output Version

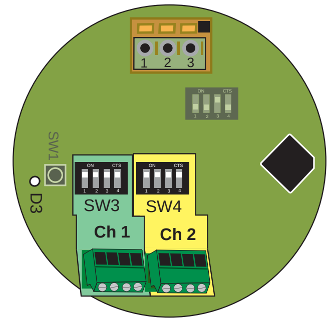
- Dual input is available on Digital S³L output model 3-2850-63 only, for use with the Signet 8900 Multi-Parameter Controller.
- Sensors may be the same or different cell constants.
- If the dual input model is used with a single sensor, connect the sensor to channel 1 and set all of the channel 2 switches to OFF.
- IMPORTANT: Provide Earth Ground as indicated by ⏚ symbol.

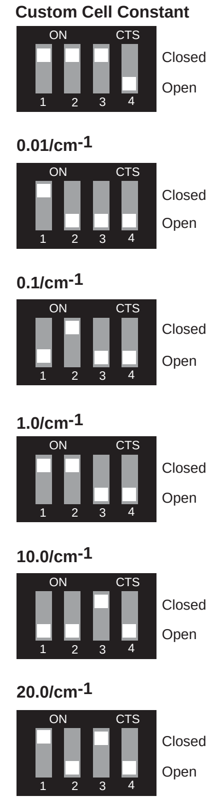


8. Cell Constant Selection

Cell Constant Selection

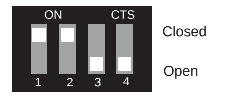
- The 2850 is shipped from the factory with the custom cell constant and temperature offset programmed into the single-input electronics. SW3 will be preset to "Custom cell constant".
- Switch banks SW3 and SW4 are used to select the cell constant of the electrode. The Dual Input model is illustrated. Single input models use only SW3.
- Make all switch settings before connecting power. Switch changes made with the power ON will take 15 to 20 seconds before becoming effective.
- Use SW3 #1-3 to select the cell constant for the first sensor.
- Use SW3 #4 to disable the PT1000 Temp Compensation function in the 2850 (as required for USP applications.) This disables the function for BOTH INPUTS.
- Use SW4 #1-3 to select the cell constant for the second sensor.
- Set SW4 #4 to OPEN to disable the second input.



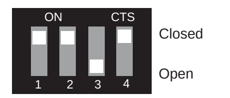


SW3 Cell Constant and Temp Compensation				
#1	**#2**	**#3**	**#4**	**For Cell Constant**
C	C	C	O	Custom
C	O	O	O	0.01 cm^{-1}
O	C	O	O	0.1 cm^{-1}
C	C	O	O	1.0 cm^{-1}
O	O	C	O	10.0 cm^{-1}
C	O	C	O	20.0 cm^{-1}
#4:	Open = Temp Comp ON Closed = Temp Comp OFF			
SW4:	#1, #2 and #3 operate the same as SW3. #4 turns input 2 OFF when set to OPEN. (Open = Off, Closed = On)			

Example: 1.0 cell constant, temp comp ON



Example: 1.0 cell constant, temp comp OFF



NOTE: To work correctly with the 9900, the 2850 must be set for the custom cell constant or the actual probe cell constant and the 9900 set for a 1.0 cell constant.

9. Range Selection for 4 to 20 mA Output

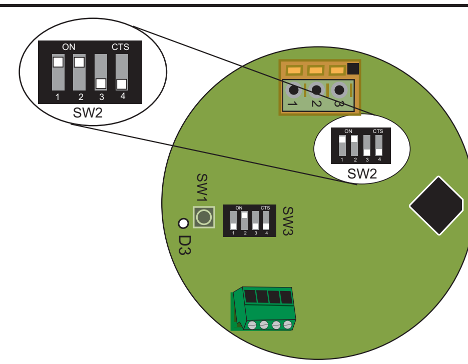
- The Range selection switch bank (SW2) provides eight range selections for each cell constant. Each range can be inverted, making a total of 16 range options.
- Select a range from the table below and set SW2 as indicated.

Example (refer to shaded selections of chart):

- The electrode installed is the 3-2840-1, with a 0.10 cell constant.
- The required output is 4 to 20 mA = 0 to 100 µS.
- Set SW2 switch bank to C-C-O-O.
- To invert range (4 to 20 mA = 100 to 0 µS), close switch #4.

C = Closed

O = Open



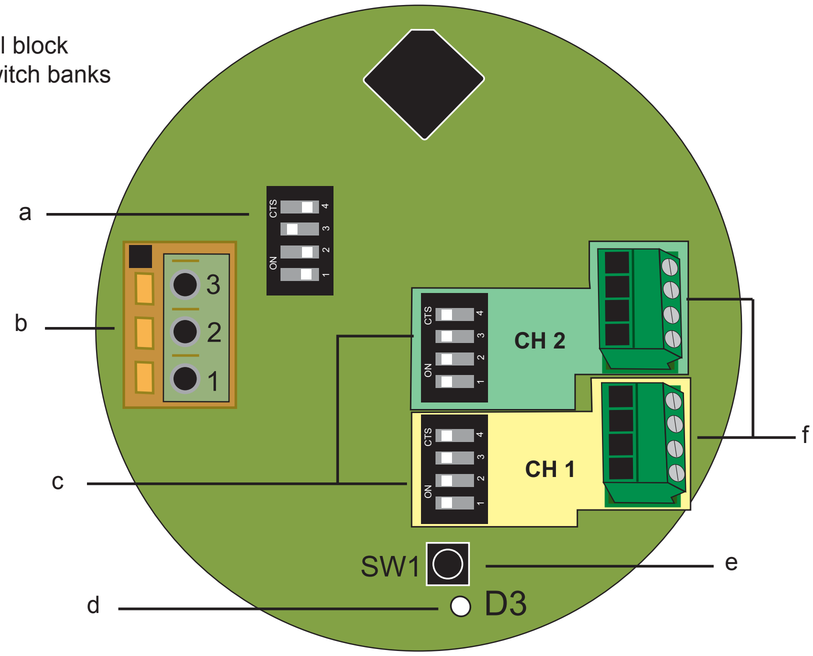
SW2 Switch Setting				0.01 Cell	0.10 Cell	1.0 Cell	10.0 Cell	20.0 Cell
#1	#2	#3	#4	Resistivity Ranges in **BOLD**				
C	C	C	O	**10 to 20 MΩ**	0 to 2 µS	0 to 20 µS	0 to 200 µS	0 to 400 µS
C	C	C	C	**20 to 10 MΩ**	2 to 0 µS	20 to 0 µS	200 to 0 µS	400 to 0 µS
O	C	C	O	**2 to 10 MΩ**	0 to 5 µS	0 to 50 µS	0 to 500 µS	0 to 1000 µS
O	C	C	C	**10 to 2 MΩ**	5 to 0 µS	50 to 0 µS	500 to 0 µS	1 000 to 0 µS
C	O	C	O	**0 to 2 MΩ**	0 to 10 µS	0 to 100 µS	0 to 1 000 µS	0 to 2 000 µS
C	O	C	C	**2 to 0 MΩ**	10 to 0 µS	100 to 0 µS	1 000 to 0 µS	2 000 to 0 µS
O	O	C	O	0 to 1 µS	0 to 50 µS	0 to 5 000 µS	0 to 5 000 µS	0 to 10 000 µS
O	O	C	C	1 to 0 µS	50 to 0 µS	500 to 0 µS	5 000 to 0 µS	10 000 to 0 µS
C	C	O	O	0 to 5 µS	0 to 100 µS	0 to 1 000 µS	0 to 10 000 µS	0 to 20 000 µS
C	C	O	C	5 to 0 µS	100 to 0 µS	1 000 to 0 µS	10 000 to 0 µS	20 000 to 0 µS
O	C	O	O	0 to 10 µS	0 to 200 µS	0 to 2 000 µS	0 to 50 000 µS	0 to 100 000 µS
O	C	O	C	10 to 0 µS	200 to 0 µS	2 000 to 0 µS	50 000 to 0 µS	100 000 to 0 µS
C	O	O	O	0 to 50 µS	0 to 500 µS	0 to 5 000 µS	0 to 100 000 µS	0 to 200 000 µS
C	O	O	C	50 to 0 µS	500 to 0 µS	5 000 to 0 µS	100 000 to 0 µS	200 000 to 0 µS
O	O	O	O	0 to 100 µS	0 to 1 000 µS	0 to 10 000 µS	0 to 200 000 µS	0 to 400 000 µS
O	O	O	C	100 to 0 µS	1000 to 0 µS	10 000 to 0 µS	200 000 to 0 µS	400 000 to 0 µS
C = CLOSED O = OPEN				Switch #4 inverts the output: OPEN = 4 to 20 mA, CLOSED = 20 to 4 mA				

10. Calibration

- All 2850 Conductivity/Resistivity Sensor Electronics are factory calibrated for maximum out-of-the-box accuracy.
- The EasyCal feature allows calibration to be performed at the sensor.

The 2839-2842 Conductivity sensors come with a certificate of calibration. This certificate provides information regarding the actual cell constant and temperature offset as tested and verified according to NIST standards. This information has been programmed into the 2850 electronics as its default factory value. If required, the sensor can be recertified by contacting the GF Signet repair department.

a. SW2: 4 to 20 mA output range selection switch bank
b. Power and 4 to 20 mA or Digital (S³L) output terminal block
c. SW3 and SW4: Electrode Cell Constant selection switch banks
d. D3: LED indicator
e. SW1: EasyCal Push-button
f. Conductivity Electrode connections



10.1 EasyCal

EasyCal is a single-point calibration system. During this procedure, if the measured value is within ±10% of any of the test values listed below, the 2850 will automatically recognize the test value and calibrate the output to that value.

Note:
The first step (Reset) is recommended each time an electrode is replaced, but is NOT necessary upon initial installation or periodic calibration.

1. **Reset** the 2850 Sensor to factory calibration: Set all switches on SW3 (and SW4 for dual input) to OPEN. Apply power, wait at least 3 seconds, then press and hold SW1 until the LED (D3) comes on steady then goes off again (approx. 10 seconds). When the LED goes off, release SW1; reset is complete. Reset SW3 and SW4 to the proper settings.

2. **Place** the electrode/sensor assembly into the conductivity test solution appropriate to your operating range. Shake the electrode to dislodge any air bubbles visible on the surface of the electrode.

   - 146.93 µS, 1408.8 µS, 12856 µS (per ASTM D1125-95)

   - 10 µS, 100 µS, 200 µS, 500 µS, 1000 µS, 5000 µS, 10,000 µS, 50,000 µS, 100,000 µS.

- Allow at least 2 minutes for the electrode response to stabilize.

3. **Press** and hold SW1 for approximately 8 to 10 seconds. During this time, the LED will come on steady then go back off. (If the LED blinks several times rapidly, the calibration was not successful. See the troubleshooting section).

Calibration is complete. Return the system to service.

Calibrating the Dual-Input model 3-2850-63
- The 2850-63 can only be calibrated if both inputs are used, or if input 2 is disabled.
  - To disable input 2: Set SW4, #4 to OPEN.
- Place each sensor into a test solution that represents the operating range of that sensor. When SW1 is pressed, the 2850 will calibrate both inputs simultaneously.
- Dual input applications usually include one sensor with a smaller cell constant and one sensor with a larger cell constant. **Place the larger cell constant on input 1**. This allows periodic recalibration of the larger cell by simply turning input 2 OFF.

11. Maintenance

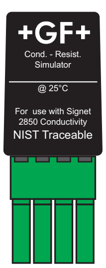
- The 2850 requires no periodic maintenance.
- Coatings on the electrode may cause slow response or drift.
  Clean metallic surfaces with a mild detergent and a non-abrasive brush or cotton swab.

11.1 Troubleshooting

LED and Output Condition	Possible Causes	Suggested Solutions
Current Out: **LED off, current output is 22 mA** **(S^3L) out: "Check Sensor"**	• SW3 and SW4 set to all OPEN (factory setting). • No electrode installed. • SW3 (and SW4) not set correctly. • System not ready.	• Normal for new system. • Install electrode. • Set SW3 and SW4 correctly. • Retry (recycle power).
During EasyCal, the LED blinks rapidly for 4 seconds.	• Measured value of the test solution is outside the ±10% tolerance. • The electronics or the electrode is defective.	• Use fresh test solutions and restart the calibration. • Replace the electronics or the electrode.
After completing calibration procedure, the output values are inaccurate.	• Insufficient time allowed for electrode stabilization during calibration procedure. • Test solutions are contaminated. • EasyCal performed with temp comp OFF, then temp comp turned ON for measurement. (or vice versa)	• Recalibrate and wait at least 2 minutes after placing electrode in solution before pressing SW1. • Use fresh test solutions and restart the calibration.
The output of the 2850 indicates a value that is off by a factor of 10 (e.g. 10x, 100x the correct value)	• The cell constant selection on the 2850 (SW3 or SW4) does not match the actual input.	• Match the 2850 switch settings to agree with the sensor being used.

Electronic Certification

Signet offers conductivity simulators in five different values. These tools enable the user to validate the performance of the electronics independently of the electrode. This requirement is defined by ASTM D 1125-95 (Standard Test Methods for Electrical Conductivity and Resistivity of Water) which is commonly used for USP 24 applications.



3-2850.101-1 (159 001 392)	1.0 μS ±0.1%	3-2850.101-2 (159 001 393)	2.5 μS ±0.1%
3-2850.101-3 (159 001 394)	10.0 μS ±0.1%	3-2850.101-4 (159 001 395)	18.2 MΩ ±0.1%
3-2850.101-5 (159 001 396)	10.0 MΩ ±0.1%		

Before using the Simulator:

Before using the simulators, disconnect all electrodes and reset the 2850 Electronics to factory calibration:

1. Set all switches on SW3 (and SW4 for dual input) to OPEN. Turn the power on, wait at least 3 seconds
2. Press and hold SW1 until the LED (D3) comes on steady then goes off again (approx. 10 seconds).
3. When the LED goes off, release SW1. Reset is complete.

To validate input 1:

1. Turn the power off.
2. Set SW3 to accept a 0.01 cell constant. Leave SW4 in the all-OPEN position.
3. Install the simulator into the 2850 at the input 1 conductivity electrode terminals.
4. Connect the 2850 output terminals to the appropriate display instrument. Turn the power on.
   - The display should indicate a conductivity value within ±2% of the simulator value.
   - If the output is x10 or x100 of the correct value, recheck step 2. The 2850 is not set to accept a 0.01 cell constant.
   - If the correct value is displayed, the electronics are calibrated to ASTM D 1125 specifications. Remove the simulator and reset SW3 to the correct cell constant before reinstalling the electrode.
   - If the correct value is not displayed, contact the factory.

To validate input 2:

1. Turn the power off.
2. Set SW4 to accept a 0.01 cell constant.
3. Install the simulator into the 2850 at the input 2 conductivity electrode terminals.
4. Set SW3 switches to the all-OPEN position.
5. Turn the power on and repeat step 4.

Remember to reset all switches to their correct position before resuming normal operation.

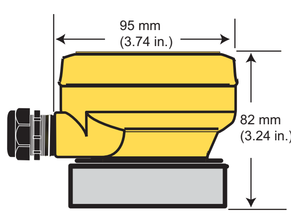
12. Ordering Information

Mfr. Part No.	Code	Description
3-2850-51	159 001 398	2850 Sensor Electronics w/ Digital Output and ¾ inch adapter
3-2850-52	159 001 399	2850 Sensor Electronics w/ 4 to 20 mA Output and ¾ inch adapter
3-2850-61	159 001 400	2850 Sensor Electronics w/ Digital Output and Universal adapter
3-2850-62	159 001 401	2850 Sensor Electronics w/ 4 to 20 mA Output and Universal adapter
3-2850-63	159 001 402	2850 Sensor Electronics w/ Dual Inputs, Digital Outputs and Universal adapter (see **NOTE**)
3-2850-51-39	159 001 339	Integral 2850 system, Digital (S^3L) output, 0.01 cell, NPT threads
3-2850-51-40	159 001 340	Integral 2850 system, Digital (S^3L) output, 0.1 cell, NPT threads
3-2850-51-41	159 001 341	Integral 2850 system, Digital (S^3L) output, 1.0 cell, NPT threads
3-2850-51-42	159 001 342	Integral 2850 system, Digital (S^3L) output, 10.0 cell, NPT threads
3-2850-51-39D	159 001 343	Integral 2850 system, Digital (S^3L) output, 0.01 cell, ISO threads
3-2850-51-40D	159 001 344	Integral 2850 system, Digital (S^3L) output, 0.1 cell, ISO threads
3-2850-51-41D	159 001 345	Integral 2850 system, Digital (S^3L) output, 1.0 cell, ISO threads
3-2850-51-42D	159 001 346	Integral 2850 system, Digital (S^3L) output, 10.0 cell, ISO threads
3-2850-52-39	159 001 347	Integral 2850 system, 4 to 20 mA output, 0.01 cell, NPT threads
3-2850-52-40	159 001 348	Integral 2850 system, 4 to 20 mA output, 0.1 cell, NPT threads
3-2850-52-41	159 001 349	Integral 2850 system, 4 to 20 mA output, 1.0 cell, NPT threads
3-2850-52-42	159 001 350	Integral 2850 system, 4 to 20 mA output, 10.0 cell, NPT threads
3-2850-52-39D	159 001 351	Integral 2850 system, 4 to 20 mA output, 0.01 cell, ISO threads
3-2850-52-40D	159 001 352	Integral 2850 system, 4 to 20 mA output, 0.1 cell, ISO threads
3-2850-52-41D	159 001 353	Integral 2850 system, 4 to 20 mA output, 1.0 cell, ISO threads
3-2850-52-42D	159 001 354	Integral 2850 system, 4 to 20 mA output, 10.0 cell, ISO threads

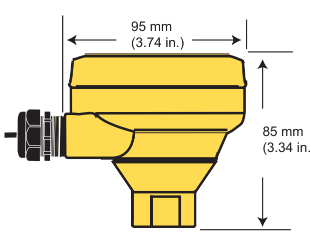
Parts and Accessories

Mfr. Part No.	Code	Description
3-9000.392-1	159 000 839	Liquid-tight connector kit, 1 set, ½ in. NPT
3-9000.392-2	159 000 841	Liquid-tight connector kit, 1 set, PG 13.5
3-2850.101-1	159 001 392	Plug-in NIST-traceable recertification tool, 1.0 μS
3-2850.101-2	159 001 393	Plug-in NIST-traceable recertification tool, 2.5 μS
3-2850.101-3	159 001 394	Plug-in NIST-traceable recertification tool, 10.0 μS
3-2850.101-4	159 001 395	Plug-in NIST-traceable recertification tool, 18.2 MΩ
3-2850.101-5	159 001 396	Plug-in NIST-traceable recertification tool, 10.0 MΩ

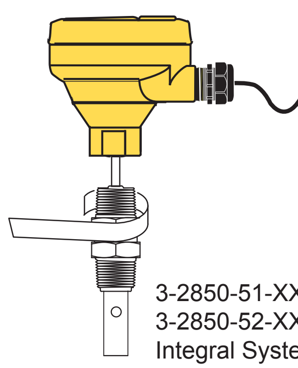
NOTE: Dual-input unit (3-2850-63) is available only in the universal adapter configuration with Digital S^3L output for use with the 8900 Controller.



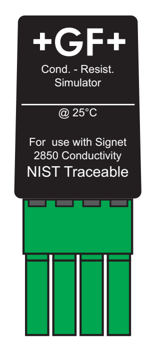
3-2850-61
3-2850-62
3-2850-63
Electronics w/Universal adapter



3-2850-51
3-2850-52
Electronics w/ ¾-in. adapter



3-2850-51-XX
3-2850-52-XX
Integral System



3-2850.101-X
NIST-traceable
recertification tool

+GF+

Georg Fischer Signet LLC, 3401 Aerojet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057
For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090
For the most up-to-date information, please refer to our website at www.gfsignet.com

Initialization for Slot 4 - 1746-NI8 - Analog 8 Channel Input - Class 1

First Pass

S:1

0000

15

COP
Copy File
Source #N9:
Dest #O:4.
Length 8

Initialization for Slot 5 - 1746-NI8 - Analog 8 Channel Input - Class 1

First Pass

S:1

0001

15

COP
Copy File
Source #N9:
Dest #O:5.
Length 8

0002

JSR
Jump To Subroutine
SBR File Number U:3

0003

JSR
Jump To Subroutine
SBR File Number U:4

0004

JSR
Jump To Subroutine
SBR File Number U:5

0005

JSR
Jump To Subroutine
SBR File Number U:6

0006

END

0000 T12:0 DN

TON
Timer On Delay
Timer T12:
Time Base 0.0
Preset 10(<
Accum 27<

EN
DN

RO1 In
Cond

0001 T12:0 DN

SCP
Scale w/Parameters
Input I:4.(
0<
Input Min. 4000.
4000.<
Input Max. 20000.
20000.<
Scaled Min. 0.(
0.(<
Scaled Max. 1000.
1000.<
Output F8:(
-250.(<

RO1 Out
Cond

0002 T12:0 DN

SCP
Scale w/Parameters
Input I:4.
0<
Input Min. 4000.
4000.<
Input Max. 20000.
20000.<
Scaled Min. 0.(
0.(<
Scaled Max. 100.(
100.(<
Output F8:
-25.(<

RO1 Perm
Flow

0003

SCP
Scale w/Parameters
Input I:4.
0<
Input Min. 400(
400(<
Input Max. 2000
2000<
Scaled Min. 0
0<
Scaled Max. 17
17<
Output N7:
-4<

0004

RO1 Conc Flow

SCP
Scale w/Parameters
Input I:4.3 0<
Input Min. 4000 4000<
Input Max. 20000 20000<
Scaled Min. 0 0<
Scaled Max. 50 50<
Output N7:3 -13<

0005

ADD
Add
Source A N7:2 -44<
Source B N7:3 -13<
Dest N7:10 -57<

0006

T12:0 DN

RO2 In Cond

SCP
Scale w/Parameters
Input I:4.4 0<
Input Min. 4000.0 4000.0<
Input Max. 20000. 20000.<
Scaled Min. 0.0 0.0<
Scaled Max. 1000.0 1000.0<
Output F8:1 -250.0<

0007

T12:0 DN

RO2 Out Cond

SCP
Scale w/Parameters
Input I:4.5 0<
Input Min. 4000.0 4000.0<
Input Max. 20000. 20000.<
Scaled Min. 0.0 0.0<
Scaled Max. 100.0 100.0<
Output F8:3 -25.0<

0008

RO2 Perm
Flow

SCP
Scale w/Parameters

Input	I:4.(	0<
Input Min.	400(	400(<
Input Max.	2000(	2000(<
Scaled Min.	0	0<
Scaled Max.	17:	17:<
Output	N7:(	-44<

0009

RO2 Conc
Flow

SCP
Scale w/Parameters

Input	I:4.:	0<
Input Min.	400(	400(<
Input Max.	2000(	2000(<
Scaled Min.	0	0<
Scaled Max.	5(	5(<
Output	N7::	-1:<

0010

ADD
Add

Source A	N7:(	-44<
Source B	N7::	-1:<
Dest	N7:1'	-57<

0011

Cust Tnk
Lvl

SCP
Scale w/Parameters

Input	I:5.(	0<
Input Min.	400(	400(<
Input Max.	2000(	2000(<
Scaled Min.	0	0<
Scaled Max.	10(	10(<
Output	N7:1.	-2:<

0012

Cust Tnk Lvl

LEQ
Less Than or Eql (A<=B)
Source A N7:1
-2<
Source B N7:2
(<

Req 4 H2O
B3:0
1

0013

Cust Tnk Lvl

LEQ
Less Than or Eql (A<=B)
Source A N7:1
-2<
Source B N7:2
1<

B3:0
3

0014

Cust Tnk Lvl

GEQ
Grtr Than or Eql (A>=B)
Source A N7:1
-2<
Source B N7:1
0<

Tank Full
B3:0
2

0015

ADD
Add
Source A N7:1
-57<
Source B N7:1
-57<
Dest N7:2
-11<

0016

DIV
Divide
Source A N7:2
-11<
Source B 60
60<
Dest N7:2
-2<

0017

DIV
Divide
Source A N7:
-44<
Source B 60.
60.<
Dest F13:
-0.73333<

0018
DIV
Divide
Source A N7:3
-13<
Source B 60.0
60.0<
Dest F13:
-0.216666<

RO1 State
0019
EQU
Equal
Source A N7:8
0<
Source B 3
3<
T12:0
DN
ADD
Add
Source A F8:0
0.0<
Source B F13:9
-0.733333<
Dest F8:0
0.0<

RO2 State
0020
B3:4
7
EQU
Equal
Source A N7:9
0<
Source B 3
3<
T12:0
DN
ADD
Add
Source A F8:0
0.0<
Source B F13:
-0.216666<
Dest F8:0
0.0<

0021
CTU
Count Up
Counter C5:9
Preset 1440<
Accum 611<
CU
DN

0022
C5:9
DN
TON
Timer On Delay
Timer T12:
Time Base 1.0
Preset 10<
Accum 0<
EN
DN

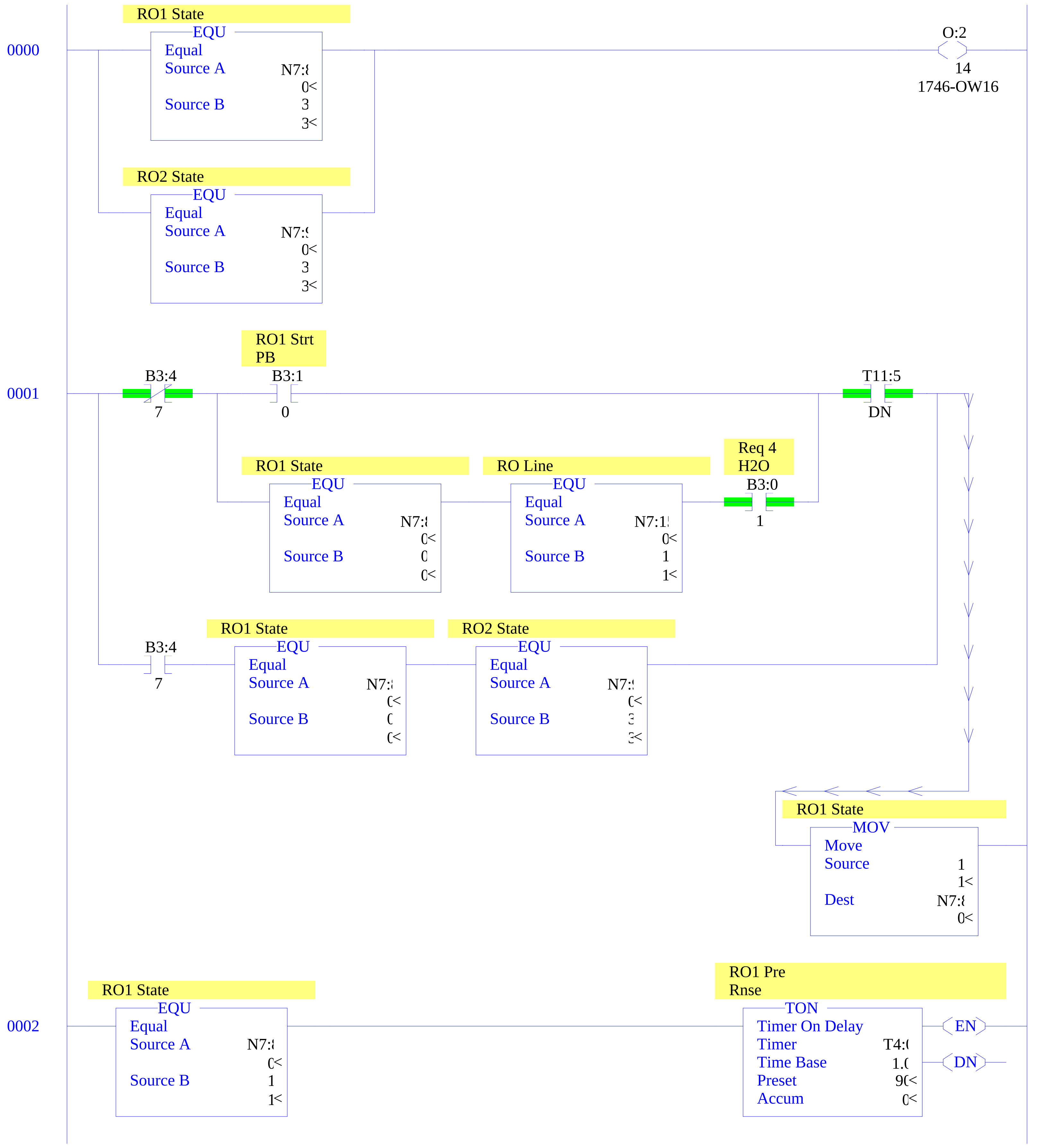
0023
T12:1
TT
MOV
Move
Source F8:0
0.0<
Dest F8:
51290.4<

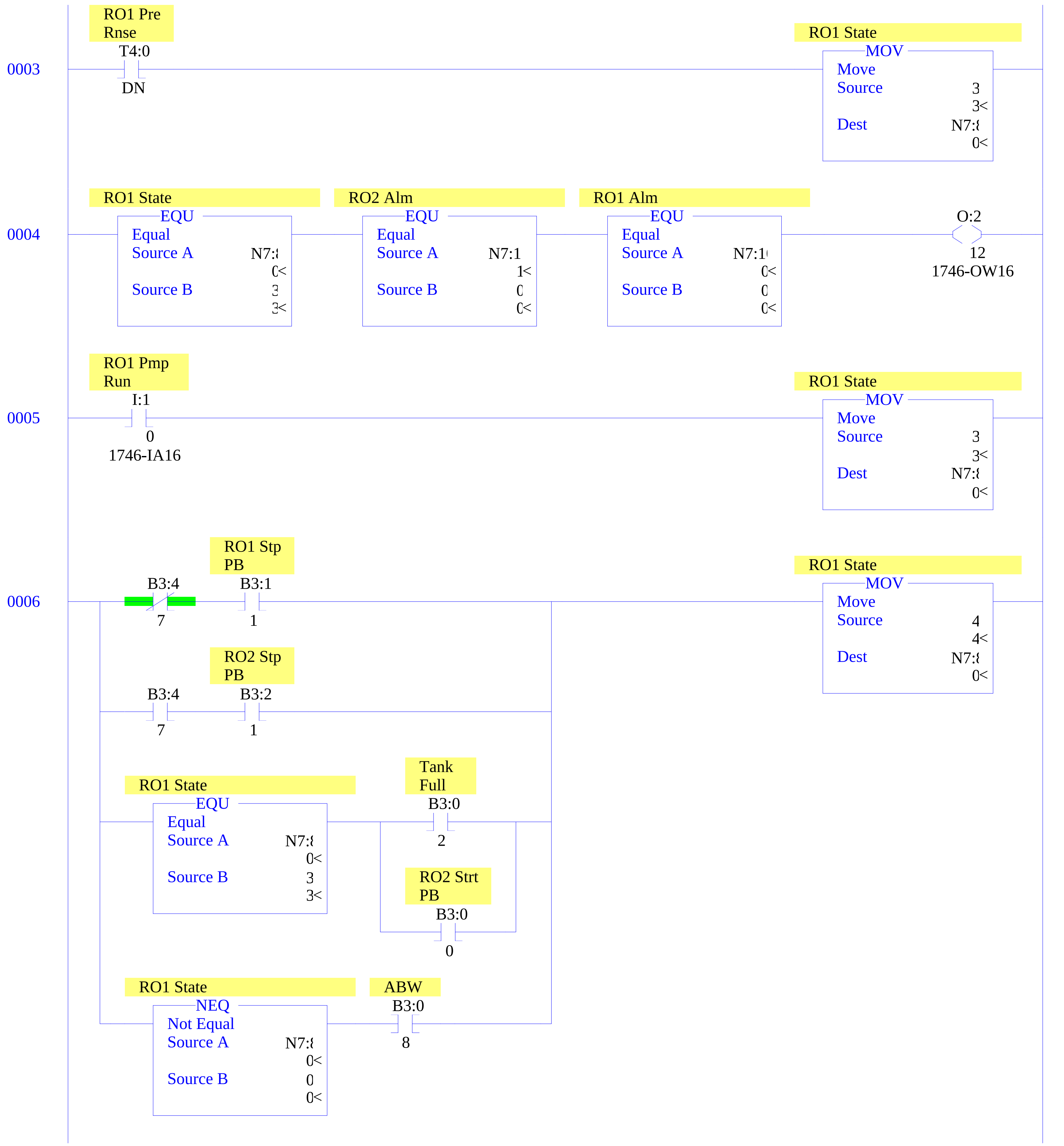
0024
T12:1
DN
MOV
Move
Source 0.0
0.0<
Dest F8:0
0.0<
C5:9
RES

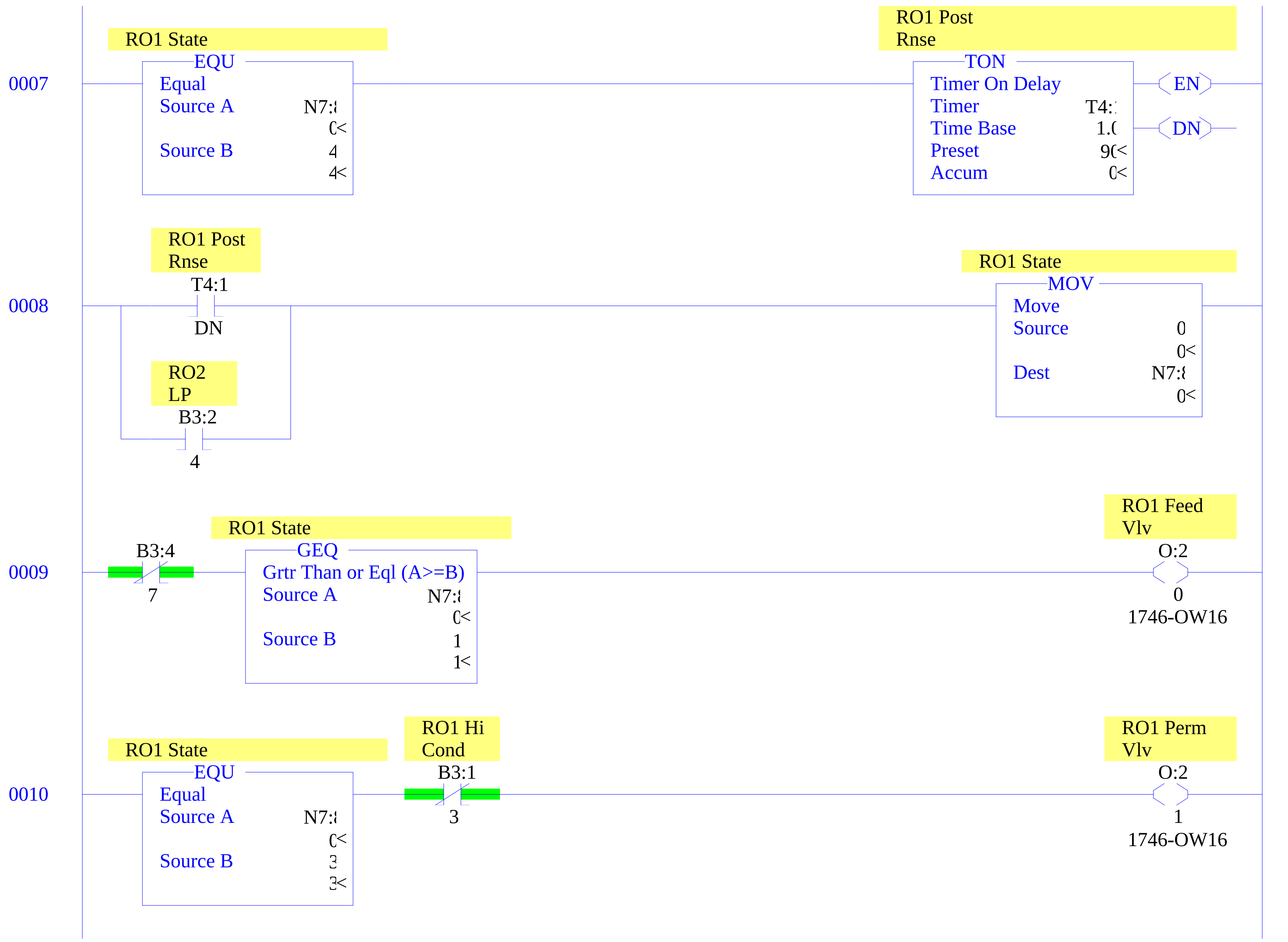
RO1 In
Cond

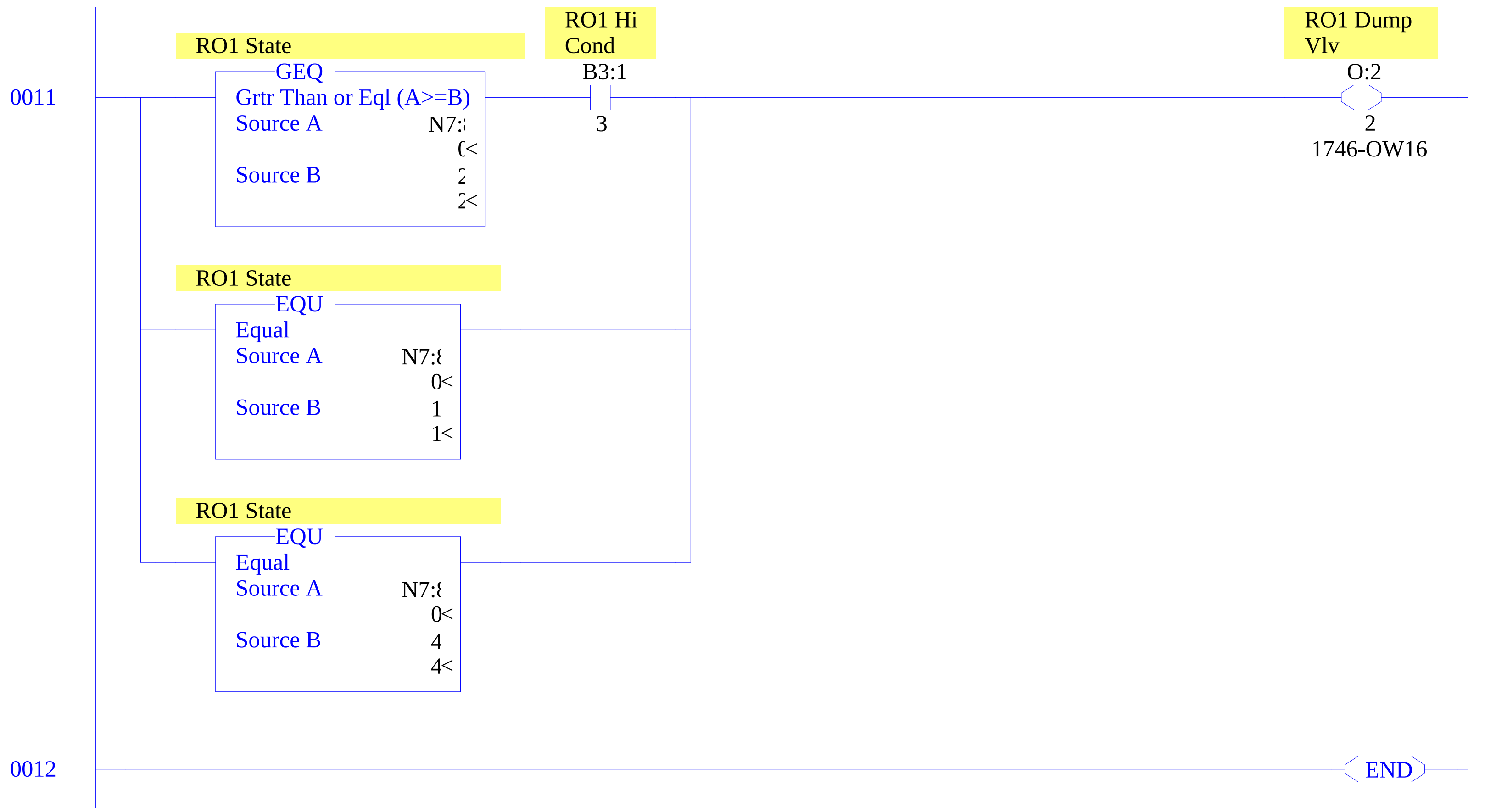
0025 SCP
Scale w/Parameters
Input I:5.2
0<
Input Min. 4000
4000<
Input Max. 20000
20000<
Scaled Min. 0
0<
Scaled Max. 15
15<
Output N7:0
-4<

0026 END

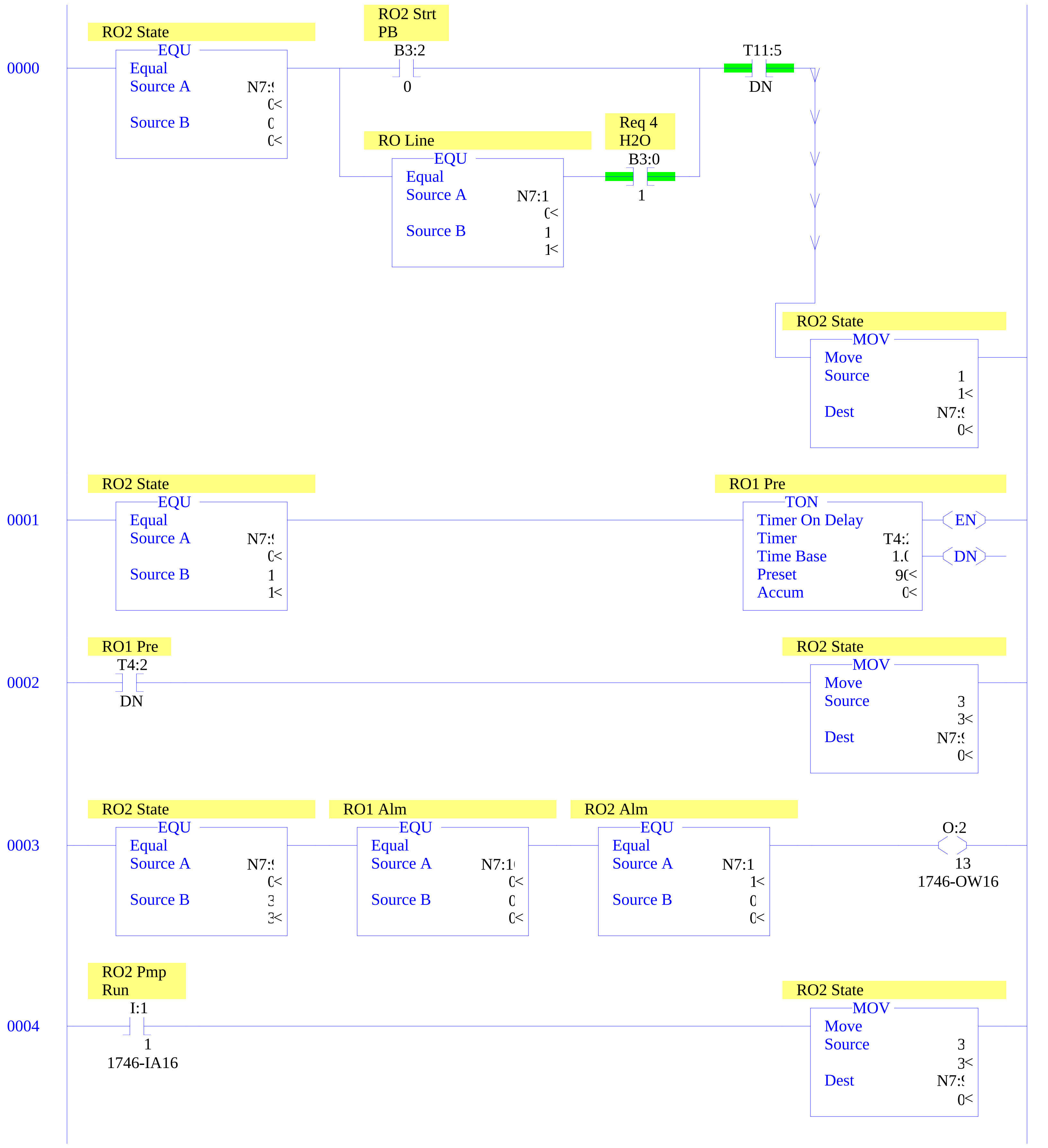

0000
RO1 State
EQU
Equal
Source A N7:8
0<
Source B 3
3<
RO2 State
EQU
Equal
Source A N7:9
0<
Source B 3
3<
O:2
14
1746-OW16
0001
B3:4
7
RO1 Strt
PB
B3:1
0
T11:5
DN
RO1 State
EQU
Equal
Source A N7:8
0<
Source B 0
0<
RO Line
EQU
Equal
Source A N7:15
0<
Source B 1
1<
Req 4
H2O
B3:0
1
B3:4
7
RO1 State
EQU
Equal
Source A N7:8
0<
Source B 0
0<
RO2 State
EQU
Equal
Source A N7:9
0<
Source B 3
3<
RO1 State
MOV
Move
Source 1
1<
Dest N7:8
0<
0002
RO1 State
EQU
Equal
Source A N7:8
0<
Source B 1
1<
RO1 Pre
Rnse
TON
Timer On Delay
Timer T4:0
Time Base 1.0
Preset 90<
Accum 0<
EN
DN


0003
RO1 Pre
Rnse
T4:0
DN
RO1 State
MOV
Move
Source 3
3<
Dest N7:
0<
0004
RO1 State
EQU
Equal
Source A N7:
0<
Source B 3
3<
RO2 Alm
EQU
Equal
Source A N7:1
1<
Source B 0
0<
RO1 Alm
EQU
Equal
Source A N7:1
0<
Source B 0
0<
O:2
12
1746-OW16
0005
RO1 Pmp
Run
I:1
0
1746-IA16
RO1 State
MOV
Move
Source 3
3<
Dest N7:
0<
0006
B3:4
7
RO1 Stp
PB
B3:1
1
RO2 Stp
PB
B3:4
7
B3:2
1
RO1 State
EQU
Equal
Source A N7:
0<
Source B 3
3<
Tank
Full
B3:0
2
RO2 Strt
PB
B3:0
0
RO1 State
NEQ
Not Equal
Source A N7:
0<
Source B 0
0<
ABW
B3:0
8
RO1 State
MOV
Move
Source 4
4<
Dest N7:
0<


0007
RO1 State
EQU
Equal
Source A
N7:
0<
Source B
4
4<
RO1 Post Rnse
TON
Timer On Delay
Timer
T4:
Time Base
1.
Preset
9<
Accum
0<
EN
DN
0008
RO1 Post Rnse
T4:1
DN
RO2 LP
B3:2
4
RO1 State
MOV
Move
Source
0
0<
Dest
N7:
0<
0009
B3:4
7
RO1 State
GEQ
Grtr Than or Eql (A>=B)
Source A
N7:
0<
Source B
1
1<
RO1 Feed Vlv
O:2
0
1746-OW16
0010
RO1 State
EQU
Equal
Source A
N7:
0<
Source B
3
3<
RO1 Hi Cond
B3:1
3
RO1 Perm Vlv
O:2
1
1746-OW16

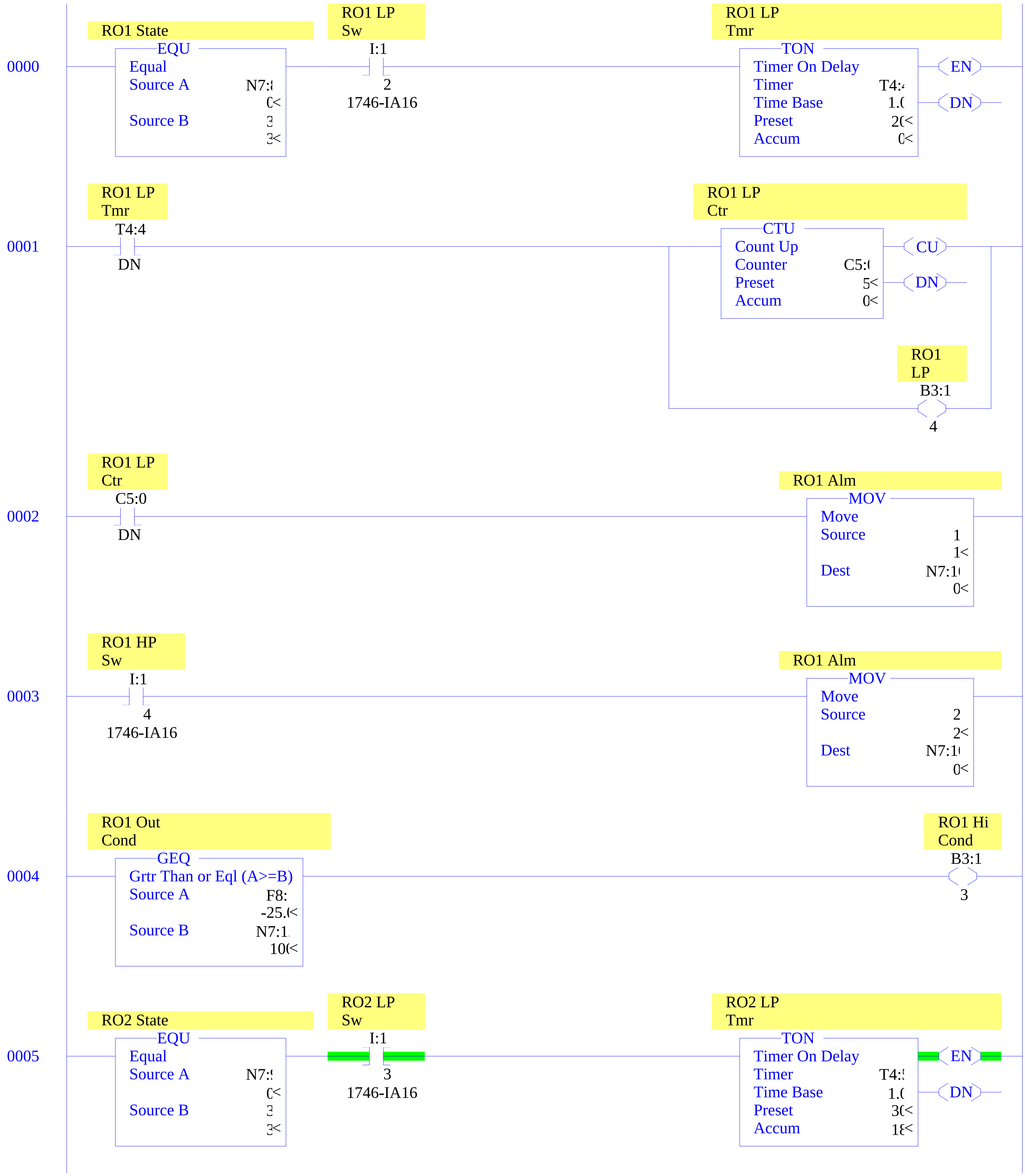

0011
RO1 State
GEQ
Grtr Than or Eql (A>=B)
Source A
N7:
0<
Source B
2
2<
RO1 Hi
Cond
B3:1
3
RO1 Dump
Vlv
O:2
2
1746-OW16
RO1 State
EQU
Equal
Source A
N7:
0<
Source B
1
1<
RO1 State
EQU
Equal
Source A
N7:
0<
Source B
4
4<
0012
END

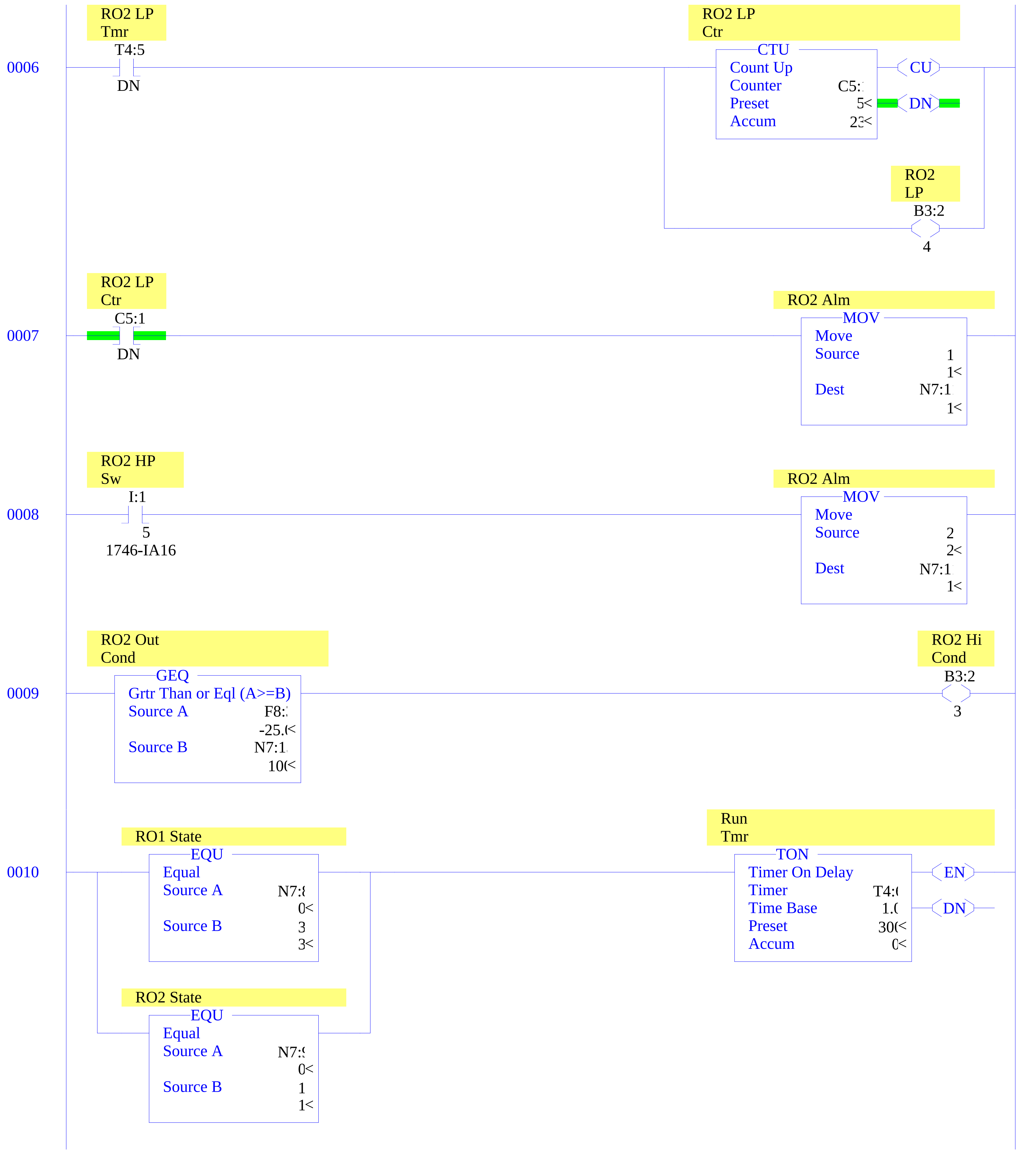
LAD 5 - RO TWO --- Total Rungs in File = 13



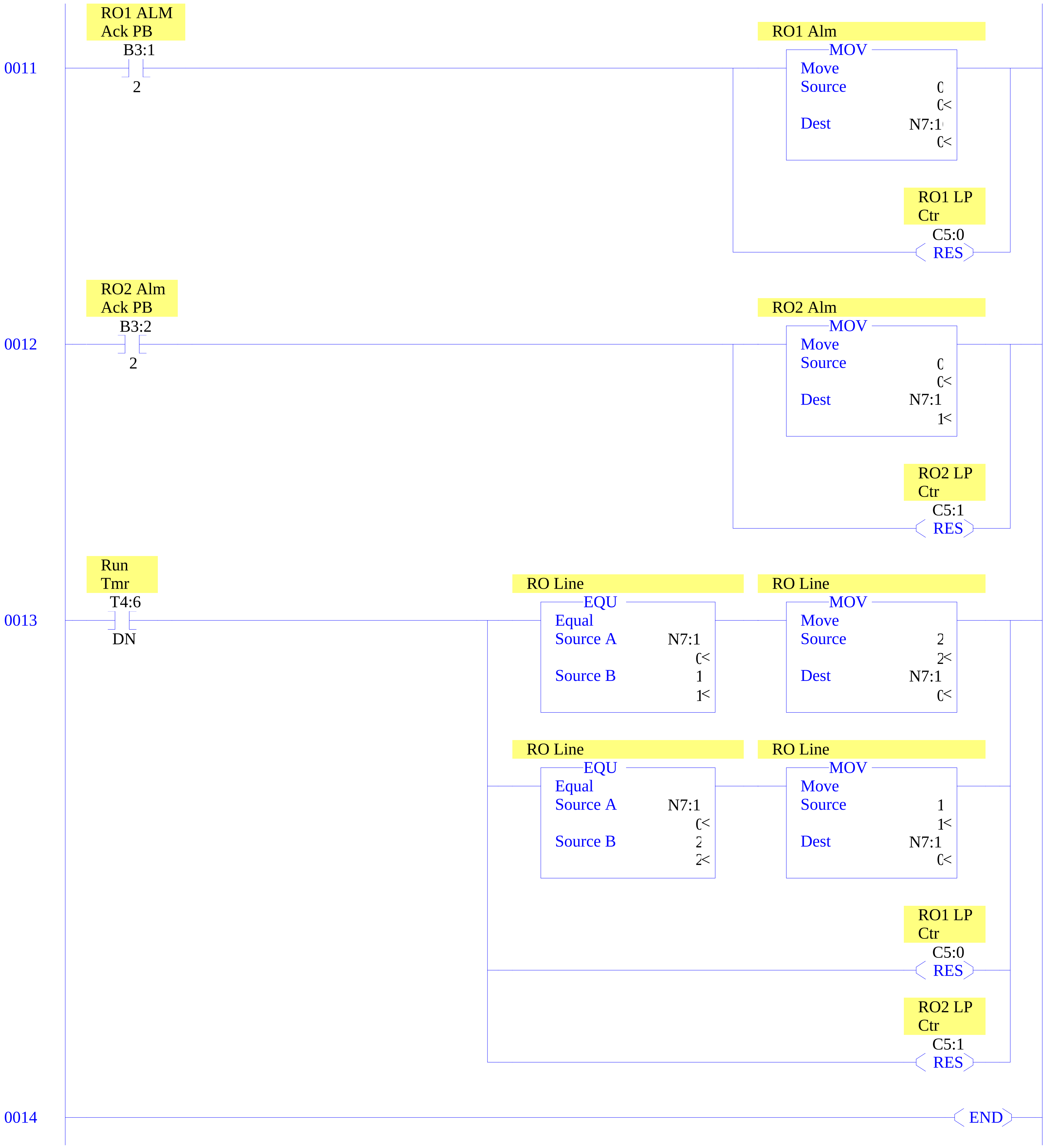

0005
RO2 Stp PB
B3:2
1
RO2 State
MOV
Move
Source 4
4<
Dest N7:9
0<
RO2 State
EQU
Equal
Source A N7:9
0<
Source B 3
3<
Tank Full
B3:0
2
RO2 Strt PB
B3:0
0
RO2 State
NEQ
Not Equal
Source A N7:9
0<
Source B 0
0<
ABW
B3:0
8
0006
RO2 State
EQU
Equal
Source A N7:9
0<
Source B 4
4<
RO2 Post
TON
Timer On Delay
Timer T4:3
Time Base 1.0
Preset 90<
Accum 0<
EN
DN
0007
RO2 Post
T4:3
DN
RO2 LP
B3:2
4
RO2 State
MOV
Move
Source 0
0<
Dest N7:9
0<
0008
RO2 State
GEQ
Grtr Than or Eql (A>=B)
Source A N7:9
0<
Source B 1
1<
RO2 Feed Vlv
O:2
3
1746-OW16
0009
B3:4
7
RO2 State
EQU
Equal
Source A N7:9
0<
Source B 3
3<
RO2 Hi Cond
B3:2
3
RO2 Perm Vlv
O:2
4
1746-OW16


0010
B3:4
7
RO2 State
GEQ
Grtr Than or Eql (A>=B)
Source A
N7:9
0<
Source B
2
2<
RO2 Hi Cond
B3:2
3
RO2 Dump Vlv
O:2
5
1746-OW16
RO2 State
EQU
Equal
Source A
N7:9
0<
Source B
1
1<
RO2 State
EQU
Equal
Source A
N7:9
0<
Source B
4
4<
0011
B3:4
7
O:2
6
1746-OW16
0012
END


0000
RO1 State
EQU
Equal
Source A
N7:
Source B
RO1 LP Sw
I:1
2
1746-IA16
RO1 LP Tmr
TON
Timer On Delay
Timer
T4:
Time Base
1.
Preset
Accum
EN
DN
0001
RO1 LP Tmr
T4:4
DN
RO1 LP Ctr
CTU
Count Up
Counter
C5:
Preset
5<
Accum
0<
CU
DN
RO1 LP
B3:1
4
0002
RO1 LP Ctr
C5:0
DN
RO1 Alm
MOV
Move
Source
1
1<
Dest
N7:1
0<
0003
RO1 HP Sw
I:1
4
1746-IA16
RO1 Alm
MOV
Move
Source
2
2<
Dest
N7:1
0<
0004
RO1 Out Cond
GEQ
Grtr Than or Eql (A>=B)
Source A
F8:
Source B
N7:1
RO1 Hi Cond
B3:1
3
0005
RO2 State
EQU
Equal
Source A
N7:
Source B
RO2 LP Sw
I:1
3
1746-IA16
RO2 LP Tmr
TON
Timer On Delay
Timer
T4:
Time Base
1.
Preset
Accum
EN
DN


0006
RO2 LP Tmr
T4:5
DN
RO2 LP Ctr
CTU
Count Up
Counter C5:
Preset 5<
Accum 2<
CU
DN
RO2 LP
B3:2
4
0007
RO2 LP Ctr
C5:1
DN
RO2 Alm
MOV
Move
Source 1
1<
Dest N7:1
1<
0008
RO2 HP Sw
I:1
5
1746-IA16
RO2 Alm
MOV
Move
Source 2
2<
Dest N7:1
1<
0009
RO2 Out Cond
GEQ
Grtr Than or Eql (A>=B)
Source A F8:
-25.<
Source B N7:1
10<
RO2 Hi Cond
B3:2
3
0010
RO1 State
EQU
Equal
Source A N7:
0<
Source B 3
3<
RO2 State
EQU
Equal
Source A N7:
0<
Source B 1
1<
Run Tmr
TON
Timer On Delay
Timer T4:
Time Base 1.
Preset 30<
Accum 0<
EN
DN

LAD 6 - ALARM --- Total Rungs in File = 15



Address/Symbol Database

Address	Symbol	Scope	Description	Sym Group	Dev. Code	ABV	BLW
B3:0/0			RO2 Strt PB				
B3:0/1			Req 4 H2O				
B3:0/2			Tank Full				
B3:0/3							
B3:0/5			CF2 ABW				
B3:0/6			CF1 ABW				
B3:0/7			Hld				
B3:0/8			ABW				
B3:1/0			RO1 Strt PB				
B3:1/1			RO1 Stp PB				
B3:1/2			RO1 ALM Ack PB				
B3:1/3			RO1 Hi Cond				
B3:1/4			RO1 LP				
B3:2/0			RO2 Strt PB				
B3:2/1			RO2 Stp PB				
B3:2/2			RO2 Alm Ack PB				
B3:2/3			RO2 Hi Cond				
B3:2/4			RO2 LP				
B3:3			Stp Adv PB				
B3:3/0			CF1 Strt PB				
B3:3/1			CF1 Stp PB				
B3:3/2			CF1 BW PB				
B3:3/3			CF2 Strt PB				
B3:3/4			CF2 Stp PB				
B3:3/5			CF2 BW PB				
B3:3/6			CF Regn Rly				
B3:3/7			Stp Adv PB				
B3:3/8			Stp Hld PB				
B3:3/9			Plse Rly				
B3:3/10			Reset				
B3:5/0			REM				
B3:6							
C5:0			RO1 LP Ctr				
C5:1			RO2 LP Ctr				
C5:2			CF Stp Cntr				
C5:3			CF Stp One Cntr				
C5:3/DN			CF Stp One				
C5:4			CF Stp Two Cntr				
C5:4/DN			CF Stp Two				
C5:5			CF Stp Three Cntr				
C5:5/DN			CF Stp Three				
C5:6			CF Stp Four Cntr				
C5:6/DN			CF Step Four				
C5:8			CF2 Min Cntr				
F8:0			RO1 In Cond				
F8:1			RO1 Out Cond				
F8:2			RO2 In Cond				
F8:3			RO2 Out Cond				
I:1/0			RO1 Pmp Run				
I:1/1			RO2 Pmp Run				
I:1/2			RO1 LP Sw				
I:1/3			RO2 LP Sw				
I:1/4			RO1 HP Sw				
I:1/5			RO2 HP Sw				
I:4.3							
N7:0			RO1 In Cond				
N7:1			RO1 Out Cond				
N7:2			RO1 Perm Flow				
N7:3			RO1 Conc Flow				
N7:4			RO2 In Cond				
N7:5			RO2 Out Cond				
N7:6			RO2 Perm Flow				
N7:7			RO2 Conc Flow				
N7:8			RO1 State				
N7:9			RO2 State				
N7:10			RO1 Alm				
N7:11			RO2 Alm				
N7:14			Cust Tnk Lvl				
N7:15			RO Line				
N10:0			CF1 State				
N10:1			CF2 State				
N10:2			Stp Dsply				
N10:3			Stp Tm Dsply				
O:2/0			RO1 Feed Vlv				
O:2/1			RO1 Perm Vlv				
O:2/2			RO1 Dump Vlv				
O:2/3			RO2 Feed Vlv				
O:2/4			RO2 Perm Vlv				
O:2/5			RO2 Dump Vlv				
O:3/0			CF-11 Serv In				
O:3/1			CF-12 Serv Out				
O:3/2			CF-13 BW In				
O:3/3			CF-14 BW Out				
O:3/4			CF-15 Rnse Out				

Address	Symbol	Scope	Description	Sym Group	Dev. Code	ABV	BLW
O:3/5			CF-21 Serv In				
O:3/6			CF-22 Serv Out				
O:3/7			CF-23 BW In				
O:3/8			CF-24 BW Out				
O:3/9			CF-25 Rnse Out				
O:3/11			Fwd Pmp				
O:3/12			RO1 Pmp				
O:3/13			RO2 Pmp				
S:0			Arithmetic Flags				
S:0/0			Processor Arithmetic Carry Flag				
S:0/1			Processor Arithmetic Underflow/ Overflow Flag				
S:0/2			Processor Arithmetic Zero Flag				
S:0/3			Processor Arithmetic Sign Flag				
S:1			Processor Mode Status/ Control				
S:1/0			Processor Mode Bit 0				
S:1/1			Processor Mode Bit 1				
S:1/2			Processor Mode Bit 2				
S:1/3			Processor Mode Bit 3				
S:1/4			Processor Mode Bit 4				
S:1/5			Forces Enabled				
S:1/6			Forces Present				
S:1/7			Comms Active				
S:1/8			Fault Override at Powerup				
S:1/9			Startup Protection Fault				
S:1/10			Load Memory Module on Memory Error				
S:1/11			Load Memory Module Always				
S:1/12			Load Memory Module and RUN				
S:1/13			Major Error Halted				
S:1/14			Access Denied				
S:1/15			First Pass				
S:2/0			STI Pending				
S:2/1			STI Enabled				
S:2/2			STI Executing				
S:2/3			Index Addressing File Range				
S:2/4			Saved with Debug Single Step				
S:2/5			DH-485 Incoming Command Pending				
S:2/6			DH-485 Message Reply Pending				
S:2/7			DH-485 Outgoing Message Command Pending				
S:2/15			Comms Servicing Selection				
S:3			Current Scan Time/ Watchdog Scan Time				
S:4			Time Base				
S:5/0			Overflow Trap				
S:5/2			Control Register Error				
S:5/3			Major Err Detected Executing UserFault Routine				
S:5/4			M0-M1 Referenced on Disabled Slot				
S:5/8			Memory Module Boot				
S:5/9			Memory Module Password Mismatch				
S:5/10			STI Overflow				
S:5/11			Battery Low				
S:6			Major Error Fault Code				
S:7			Suspend Code				
S:8			Suspend File				
S:9			Active Nodes				
S:10			Active Nodes				
S:11			I/O Slot Enables				
S:12			I/O Slot Enables				
S:13			Math Register				
S:14			Math Register				
S:15			Node Address/ Baud Rate				
S:16			Debug Single Step Rung				
S:17			Debug Single Step File				
S:18			Debug Single Step Breakpoint Rung				
S:19			Debug Single Step Breakpoint File				
S:20			Debug Fault/ Powerdown Rung				
S:21			Debug Fault/ Powerdown File				
S:22			Maximum Observed Scan Time				
S:23			Average Scan Time				
S:24			Index Register				
S:25			I/O Interrupt Pending				
S:26			I/O Interrupt Pending				
S:27			I/O Interrupt Enabled				
S:28			I/O Interrupt Enabled				
S:29			User Fault Routine File Number				
S:30			STI Setpoint				
S:31			STI File Number				
S:32			I/O Interrupt Executing				
S:33			Extended Proc Status Control Word				
S:33/0			Incoming Command Pending				
S:33/1			Message Reply Pending				
S:33/2			Outgoing Message Command Pending				
S:33/3			Selection Status User/DF1				
S:33/4			Communicat Active				
S:33/5			Communicat Servicing Selection				
S:33/6			Message Servicing Selection Channel 0				

Address	Symbol	Scope	Description	Sym Group	Dev. Code	ABV	BLW
S:33/7			Message Servicing Selection Channel 1				
S:33/8			Interrupt Latency Control Flag				
S:33/9			Scan Toggle Flag				
S:33/10			Discrete Input Interrupt Reconfigur Flag				
S:33/11			Online Edit Status				
S:33/12			Online Edit Status				
S:33/13			Scan Time Timebase Selection				
S:33/14			DTR Control Bit				
S:33/15			DTR Force Bit				
S:34			Pass-thru Disabled				
S:34/0			Pass-Thru Disabled Flag				
S:34/1			DH+ Active Node Table Enable Flag				
S:34/2			Floating Point Math Flag Disable,Fl				
S:35			Last 1 ms Scan Time				
S:36			Extended Minor Error Bits				
S:36/8			DII Lost				
S:36/9			STI Lost				
S:36/10			Memory Module Data File Overwrite Protection				
S:37			Clock Calendar Year				
S:38			Clock Calendar Month				
S:39			Clock Calendar Day				
S:40			Clock Calendar Hours				
S:41			Clock Calendar Minutes				
S:42			Clock Calendar Seconds				
S:43			STI Interrupt Time				
S:44			I/O Event Interrupt Time				
S:45			DII Interrupt Time				
S:46			Discrete Input Interrupt- File Number				
S:47			Discrete Input Interrupt- Slot Number				
S:48			Discrete Input Interrupt- Bit Mask				
S:49			Discrete Input Interrupt- Compare Value				
S:50			Processor Catalog Number				
S:51			Discrete Input Interrupt- Return Number				
S:52			Discrete Input Interrupt- Accumulat				
S:53			Reserved/ Clock Calendar Day of the Week				
S:55			Last DII Scan Time				
S:56			Maximum Observed DII Scan Time				
S:57			Operating System Catalog Number				
S:58			Operating System Series				
S:59			Operating System FRN				
S:61			Processor Series				
S:62			Processor Revision				
S:63			User Program Type				
S:64			User Program Functional Index				
S:65			User RAM Size				
S:66			Flash EEPROM Size				
S:67			Channel 0 Active Nodes				
S:68			Channel 0 Active Nodes				
S:69			Channel 0 Active Nodes				
S:70			Channel 0 Active Nodes				
S:71			Channel 0 Active Nodes				
S:72			Channel 0 Active Nodes				
S:73			Channel 0 Active Nodes				
S:74			Channel 0 Active Nodes				
S:75			Channel 0 Active Nodes				
S:76			Channel 0 Active Nodes				
S:77			Channel 0 Active Nodes				
S:78			Channel 0 Active Nodes				
S:79			Channel 0 Active Nodes				
S:80			Channel 0 Active Nodes				
S:81			Channel 0 Active Nodes				
S:82			Channel 0 Active Nodes				
S:83			DH+ Active Nodes				
S:84			DH+ Active Nodes				
S:85			DH+ Active Nodes				
S:86			DH+ Active Nodes				
T4:0			RO1 Pre Rnse				
T4:1			RO1 Post Rnse				
T4:2			RO1 Pre				
T4:3			RO2 Post				
T4:4			RO1 LP Tmr				
T4:5			RO2 LP Tmr				
T4:6			Run Tmr				
T4:7			CF Mint Tmr				
T4:8			Rst Tmr				
T11:0			CF1 Pre Tmr				
T11:1			CF2 Pre Tmr				
U:3							

Address	Instruction	Description

Group_Name	Description