



# **Binary Solvent Delivery Module**

## **Dual Series-III Pumps with Serial PC and Voltage Control**

### **Operator's Manual**

90-2581 rev B

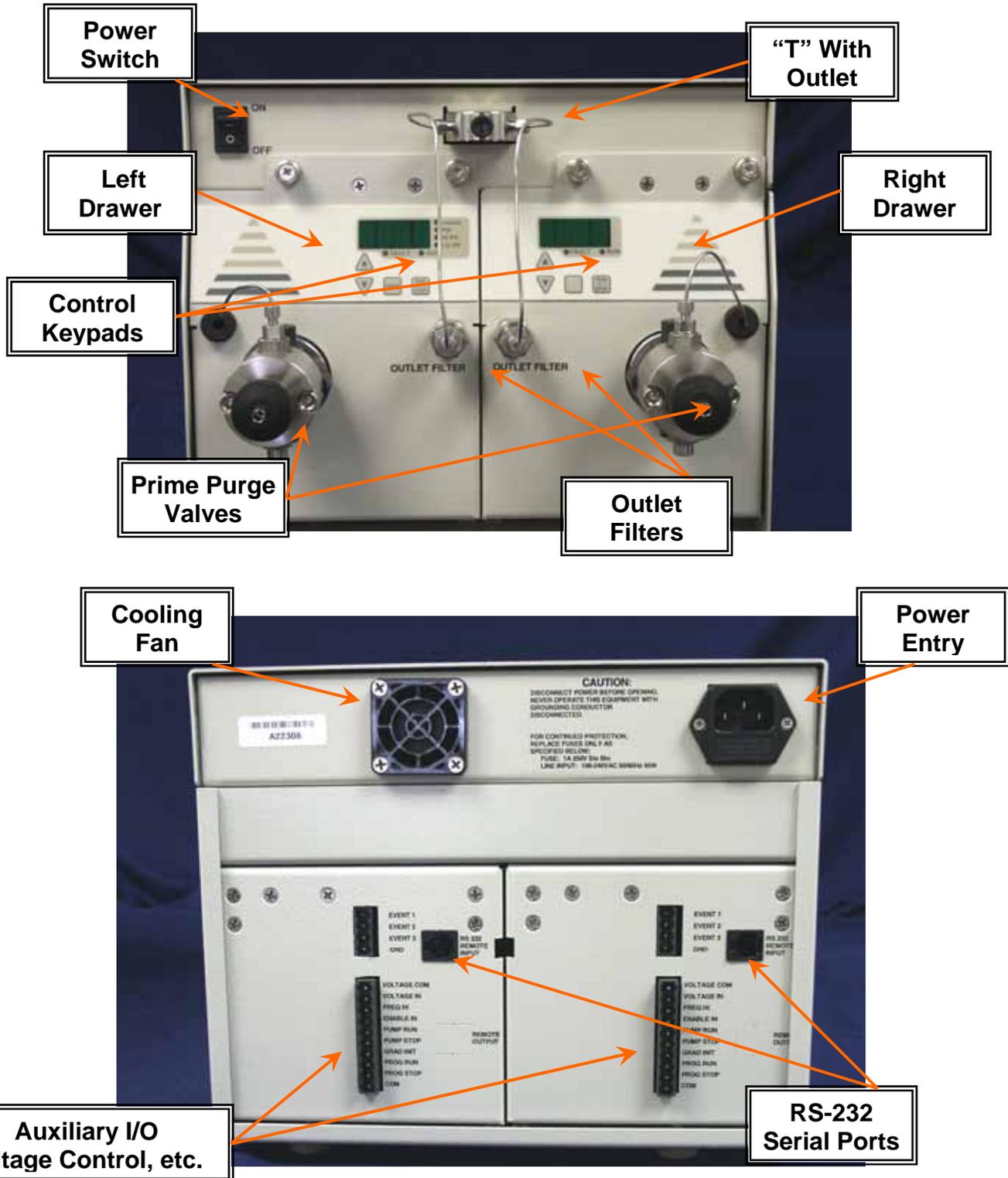


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# 1. INTRODUCTION

This operator's manual contains information needed to install, operate, and perform minor maintenance on the Binary Solvent Delivery Module. The figures below are for reference of items described in the manual.



## 1.1 Description of the Binary Solvent Delivery Module

The system consists of two Series III high performance metering pumps, in a compact package with pulse dampener and an off-line pressure transducer. The pumps use a drawer system for easy access to internal components for troubleshooting & service. These features allow for:

- ▶ Fast & easy setup:
  - Two inlet connection (from solvent reservoirs)
  - One outlet connection (to injector)All connections accessible from front panel
- ▶ Modular:
  - Can be added to any system
- ▶ All Stainless steel or PEEK Fluid path, including pumps, valves and fittings
- ▶ Modular pump bays for easy replacement and maintenance
- ▶ Self flushing pump heads for extended seal life and reduced maintenance
- ▶ Pulse Dampener for reduced pulsation.
- ▶ Very high performance/price ratio
- ▶ Easily user adjustable process set points (flow rate, pressure. etc.) via front key pads
- ▶ Digital readout of process parameters
- ▶ User settable upper/lower pressure and temperature limits
- ▶ RS-232 serial PC interface
- ▶ Compact size—Requires only 11 inches of bench space

The low pulsation flow produced by the reciprocating, single-piston pump is achieved by using an advanced rapid-refill cam design, programmed stepper motor acceleration, and an internal pulse damper.

### 1.1.1 Pump Features

They include:

- Rapid refill mechanism to reduce pulsation
- Stainless Steel or PEEK™ pumps head
- LED front panel readout of flow rate, pressure and upper/lower pressure limits
- Flow adjustment in 0.001 ml increments, from 0.001 to 5.000 ml/min with a precision of 0.2% RSD (5mL/min heads)

Flow adjustment in 0.01 ml increments, from 0.01 to 10.00 ml/min with a precision of 0.2% RSD (10mL/min heads)

- Microprocessor advanced control
- Digital stepper motor design to prevent flow rate drift over time and temperature
- Back panel RS232 serial communications port for complete control and status monitoring
- Remote analog inputs (e.g. voltage) to control flow rate

### 1.1.2 Wetted Pump Materials

Pump heads, check valve bodies, and tubing are made out Stainless Steel or PEEK™. Other materials are synthetic ruby and sapphire (check valve internals and piston).

### 1.1.3 Self-Flushing Pump Head

Self-flushing pump heads provide continuous washing of the piston surface without the inconvenience of a manual flush or gravity feed arrangement. The self-flushing pump head uses a diaphragm and secondary set of check valves to create a continuous and positive flow in the area behind the high pressure pump seal. The flushing solution washes away any buffer salts that have precipitated onto the piston. If not removed, these precipitates can abrade the high pressure seal and cause premature seal failure, leakage, and can possibly damage the pump.

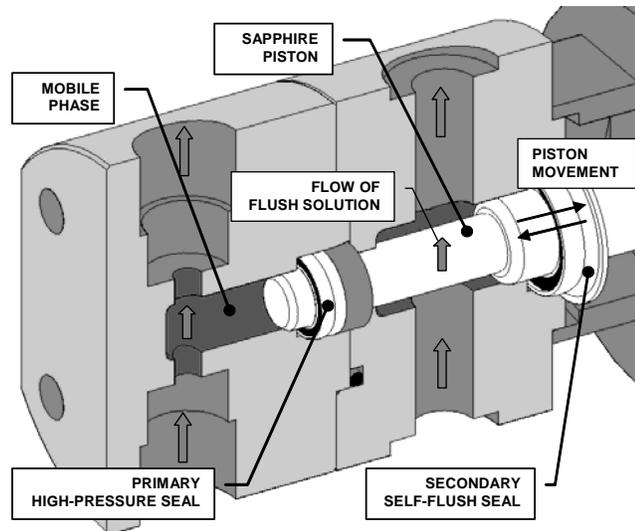


Figure 1-1. Self-Flushing Pump Head

#### *1.1.4 Self-Flush and Seal Life*

It is recommended that the Self Flush feature be used to improve seal life in a number of applications. In particular, (as stated above) if pumping Buffers, Acids/Bases or any inorganic solution near saturation, the pump should utilize the Self Flush feature. With every piston stroke, an extremely thin film of solution is pulled back past the seal. If this zone is dry (without use of Self Flush), then crystals will form with continuous operation, which will ultimately damage the seal.

Another application where Self Flush is highly recommended is when pumping Tetrahydrofuran (a.k.a. THF, Diethylene Oxide) or other volatile solvents such as acetone (Note: THF and most solvents are compatible only with all-Stainless Steel systems. THF will attack PEEK). Volatile solvents will dry rapidly behind the seal (without the use of Self Flush), which will dry and degrade the seal.

IPA, Methanol, 20% IPA/water mix or 20% Methanol/water mix are good choices for the flush solution. Consult the factory for specific recommendations.

## 1.2 Specifications for the Binary Solvent Delivery Modules

Flow Rates ..... 0.000 to 5.000 mL/min for 5mL/min heads  
0.00 to 10.00 mL/min for 10mL/min heads

Pressure ..... 0 to 6,000 p.s.i. for SS pump heads,  
0 to 5,000 p.s.i. for PEEK™ heads,

Pressure Accuracy...  $\pm 1\%$  of full-scale pressure

Pressure Zero Offset.  $\pm 2$  p.s.i.

Flow Accuracy .....  $\pm 2\%$  for a flow rate of 0.20 mL/min and  
above.

Flow Precision ..... 0.2% RSD

Dimensions ..... 9" high x 10.5" wide x 18.5" deep

Weight ..... 34 lb

Power ..... 90-260 VAC, 50-60 Hz, 45W (The main  
voltage supply shall not exceed  $\pm 10\%$ )

Environmental.....Indoor use only

Altitude.....2000 M

Temperature.....10 to 30° C

Humidity.....20 to 90% Relative humidity

Remote Inputs . . . . RS-232, Voltage, Frequency

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## **2. INSTALLATION**

### **2.1 Unpacking and Inspection**

Prior to opening the shipping container, inspect it for damage or evidence of mishandling. If it has been damaged or mishandled, notify the carrier before opening the container. Once the container is opened, inspect the contents for damage. Any damage should be reported to the carrier immediately. Save the shipping container. Check the contents against the packing list.

### **2.2 Location/Environment**

The preferred environment for the Binary Solvent Delivery Module is normal laboratory conditions. The area should be clean and have a stable temperature and humidity. The specific temperature and humidity conditions are 10 to 30 °C and 20% to 90% relative humidity. The instrument should be located on a stable flat surface with surrounding space for ventilation and the necessary electrical and fluid connections.

### **2.3 Fluid Connections & Priming**

There are only four connections to be made.

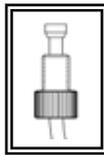
1. Connect left drawer pump solvent line supplied
2. Connect right drawer pump solvent line supplied
3. Connect line to injection valve from outlet “T”
4. Next, install the self flush. Connect the self flush inlet and outlet (opaque) tubing as shown on the the next page.

Details on the proper installation of tubing and priming of the pump and self flush is shown on the next page.

## SELF-FLUSH

Connect wash solution inlet and outlet tubing (opaque) to the flush housing as shown.

Make sure ferrule is in the correct position.



So  
In  
in



## PUMP

Connect pump inlet tubing as shown.

Make sure ferrule is in the correct position.



Ensure inlet line filter is submerged into solvent.

Attach syringe to Prime-Purge valve.

Open Prime-Purge valve by



## 2.4 Electrical Connection

The system utilizes Universal Switching Power Supply, and will accept voltages from 90 – 260 VAC, 50-60 Hz.

**WARNING:** Do not bypass the safety ground connection as a serious shock hazard could result.

## 2.5 Solvent Preparation

Proper solvent preparation will prevent a great number of pumping problems. The most common problem is bubble formation, which may affect the flow rate consistency. Aside from leaky fittings, the problem of bubble formation arises from two sources: solvent out-gassing and cavitation. Filtration of HPLC solvents is also required.

### 2.5.1 Solvent Out-gassing and Sparging

Solvent out-gassing occurs because the mobile phase contains dissolved atmospheric gases, primarily N<sub>2</sub> and O<sub>2</sub>. These dissolved gases may lead to bubble formation and should be removed by degassing the mobile phase before or during use. The best practical technique for degassing is to sparge the solvent with standard laboratory grade (99.9+%) helium. Helium is only sparingly soluble in HPLC solvents, so other gases dissolved in the solvent diffuse into the helium bubbles and are swept from the system. Solvent filtration is not an effective alternative to helium degassing.

It is recommended that you sparge the solvent vigorously for 10 to 15 minutes before using it. Then maintain a trickle sparge during use to keep atmospheric gases from dissolving back into the mobile phase. The sparged solvent must be continually blanketed with helium at 2 to 3 psi. Non- blanketed, sparged solvents will allow atmospheric gases to dissolve back into the mobile phase within four hours.

Solvent mixtures using water and organic solvents (like methanol or acetonitrile) hold less dissolved gas than pure solvents. Sparging to reduce the amount of dissolved gas is therefore particularly important when utilizing solvent mixture.

Even with sparging some out-gassing may occur. A back pressure regulator installed after the detector flow cell will help prevent bubbles from forming and thus limit baseline noise.

**WARNING:** Always release pressure from the pump slowly. A rapid pressure release could cause the pulse damper diaphragm to rupture.

### 2.5.2 Cavitation

Cavitation occurs when inlet conditions restrict the flow of solvent and vapor bubbles are formed during the inlet stroke. The key to preventing cavitation is to reduce inlet restrictions. The most common causes of inlet restrictions are crimped inlet lines and plugged inlet filters. Inlet lines with tubing longer than 48" (120 cm) or with tubing of less than 0.085" (2 mm) ID may also cause cavitation.

Placing the solvent reservoirs below the pump level also promotes cavitation. The optimal location of the reservoirs is slightly above the pump level, but it is adequate to have them on the same level as the pump.

### 2.5.3 Filtration

Solvent filtration is good practice for the reliability of the Binary Solvent Delivery Module and other components in a HPLC system. Solvents should always be filtered with a 0.5 micron filter prior to use. This ensures that no particles will interfere with the reliable operation of the piston seals and check valves. Solvents in which buffers or other salts readily precipitate out will need to be filtered more often. After filtration, the solvents should be stored in a closed, particulate-free bottle.

### 2.5.4 Initial system pressurization (Daily)

**IMPORTANT: To maximize accuracy at all pressures and flows this pump contains a pulse damper for each solvent used. It is important that the pump be brought to pressure with both pumps running to insure that each pulse damper has the correct solvent in it. It is recommended that the flow be set to the operational flow with an equal mixture of the two solvents. Once the system has reached a constant pressure the composition should be set to the initial conditions.**

## 2.6 Instrument Installation

### 2.6.1 Mobile Phase Reservoirs

The mobile phase reservoir should be placed at the same level or slightly higher than the pump, never below the pump, and the inlet tubing should be as short as practical. These steps minimize pressure losses on the inlet side of the pump during refill and help to avoid bubble formation. These steps are particularly important when using high vapor pressure solvents (hexane, methylene chloride, etc.). Mobile phases should be degassed, filtered and covered. (See Section 2.4.)

### *2.6.2 Self-Flush Solution*

Self-flush heads require 250-500 mL of flushing solution. See section 1.1.4 for self-flush solution recommendations. A pH indicator that will indicate the concentration of salts in the solution is recommended as a reminder to change the solution. This flush solution should be replaced with a fresh solution weekly to avoid frequent pump maintenance.

### *2.6.3 Inlet Tubing and Filters*

The table below shows the inlet tubing and filter used in the Binary Solvent Delivery Module. All inlet lines are supplied in a 30" (76 cm) length and are made of a fluoropolymer material.

### *2.6.4 Priming the Pump and the Flushing Lines*

Connect a syringe to the outlet tubing. Run the pump at a flowrate of 3 to 5 ml/min. Prime the pump by pulling mobile phase and any air bubbles through the system and into the syringe (a minimum of 20 ml).

To prime the flush lines for a self-flush head, simply place the inlet line in the flush solution and connect a syringe to the outlet line and apply suction until the line is filled with flush solution. Place the outlet line in the flush solution. Secure both flush lines in the flush solution container so they stay immersed during pump operation.

### *2.6.6 Long Term Pressure Calibration Accuracy*

This note applies if your pump is equipped with an electronic pressure transducer. The transducer has been zeroed and calibrated at the factory. Over the life of the pump, some drift may occur. For example, it is typical for the zero to drift < 10 p.s.i. after about 1 year of operation (i.e., with no back pressure on the pump a reading of 1-9 p.s.i. may be displayed). A similar drift may also occur at higher pressures, and are typically less than 1% (e.g. <50 p.s.i. at 6,000 p.s.i. back pressure).

If pressure calibration and/or drift is a concern, consult the factory. The pump can be shipped back to SSI for recalibration. Alternatively, written calibration and zero-reset procedures are available. Consult the factory to receive these instructions.

## 2.7 Preparation for Storage or Shipping

### 2.7.1 *Isopropanol Flush*

Disconnect the outlet tubing from the pump. Place the inlet filter in isopropanol. Use a syringe to draw a minimum of 50 ml through the pump. Pump a minimum of 5 ml of isopropanol to exit. Leave the inlet tubing connected to the pump. Place the inlet filter in a small plastic bag and attach it to the tubing with a rubber band. Plug the outlet port with the shipping plug or leave a length of outlet tubing on the pump or cover the outlet port with plastic film.

### 2.7.2 *Packaging for Shipping*

**CAUTION:** Reship in the original carton, if possible. If the original carton is not available, wrap the pump in several layers of bubble wrap and cushion the bottom, top, and all four sides with 2" of packaging foam. Although heavy, an HPLC pump is a delicate instrument and must be carefully packaged to withstand the shocks and vibration of shipment.

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## 3. OPERATION

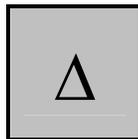
### 3.1 Pump Front Panel Controls and Indicators

#### 3.1.1 Control Panel

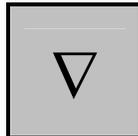
##### 3.1.1.1 Digital Display

The 3-digit display shows the pump flow rate (mL/min), system pressure (psi), or the set upper or lower pressure limit (psi) when operating. Choice of display is selected with the MODE key.

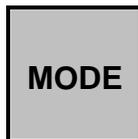
##### 3.1.1.2 Digital Display Pump Keypad



When pressed, this button increases the flow rate.



When pressed, this button decreases the flow rate.



Use this button to cycle through the four display modes: flow rate, pressure, upper pressure limit, or lower pressure limit. A status LED to the right of the digital display indicates which mode is active.



When pressed, this button alternately starts and stops the pump.

Fast And Slow Button Repeat On The Up And Down Arrow Buttons:  
If the UP-ARROW or DOWN-ARROW button is held down for more than approximately one half of a second, the button press will repeat at a slow rate of approximately 10 times a second. Once slow button repeat has begun, fast button repeat can be initiated by using a second finger to press down the second arrow button. During fast button repeat, the button press will repeat at a rate of approximately 100 times a second. Switching back and forth between repeat speeds can be accomplished by pressing and releasing the second arrow button while keeping the first arrow button held down.

### 3.1.1.3 Status LEDs

- **ml/min**      When lit, the digital display shows flow rate in mL/min.
- **PSI**            When lit, the digital display shows system pressure in psi.
- **HI PR**        When lit, the display shows the user-set upper pressure limit in psi.
- **LO PR**        When lit, the display shows the user-set lower pressure limit in psi.
- **RUN**            Lights to indicate that the pump is running.
- **FAULT**        Lights when a fault occurs and stops the pump.

### 3.1.1.2 Power-up Configuration

Non-volatile Memory Reset: If the pump is operating erratically, there is the possibility that the memory has been corrupted. To reset the memory and restore the pump to its default parameters, press and hold the UP-ARROW button when the power is switched on. Release the button when the display reads "rES". The parameters stored in non-volatile memory, i.e., the flowrate, the pressure compensation, the voltage/frequency select, the lower pressure limit, and the upper pressure limit will be set to the factory default values. The head type setting is the only parameter not changed by the non-volatile memory reset function. If the firmware is upgraded to a newer version, a non-volatile memory reset will automatically occur the first time the power is switched on.

### 3.1.1.5 Power-Up Tests

Display Software Version Mode: The software version can be displayed during power-up by pressing and holding the RUN/STOP and the UP-ARROW buttons when the power is switched on. Release the buttons when the display reads "UEr". The decimal point number displayed on the display is the software version. To exit this mode, press the RUN/STOP button.

Align Refill Switch Mode: The signal that initiates the refill phase can be displayed during power-up by pressing and holding the PRIME and the UP-ARROW buttons when the power is switched on. Release the buttons when the display displays "rFL". When the slotted disk allows the light beam to pass from the emitter to the detector on the slotted optical switch a pulse will be generated which signals the beginning of refill. When this pulse occurs the three horizontal segments displayed at the top of the display will turn off and the three horizontal segments at the bottom of the display will turn on. To exit this mode, press the RUN/STOP button.

Serial Port Loopback Test Mode: If an external device will not communicate to the pump via the serial port, the serial port loopback test can be used to verify that the serial port is functioning properly. During power-up press and hold the UP-ARROW and the DOWN-ARROW buttons when the power is switched on and then release the buttons. The display must display "C00" for the first half of the test to pass. Plug in the serial port loop back plug (A modular plug with pins 2 & 5 jumpered together and pins 3 & 4 jumpered together.). The display must read "C11" for the second half of the test to pass. To exit this mode, press the RUN/STOP button.

### 3.5 Rear Panel Remote Input

An RS-232 modular jacks are provided on the back panel. A computer, with appropriate software, can be used as a remote controlling device for pump operation via this connection.

**See Appendix A for details on connection and operation.**

### 3.6 Symbols

The following symbols may appear on back panel of the unit:



**Caution:** To avoid chemical or electrical hazards, always observe safe laboratory practices while operating this equipment.



**Caution:** To avoid electrical shock and possible injury, remove the power cord from the back panel of this equipment before performing any type of service procedures.

**Note:** The user shall be made aware that, if equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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## 4. THEORY OF OPERATION

### 4.1 Pump Mechanical Operation

#### 4.1.1 *Liquid System Flow Path*

The flow path of the Binary Solvent Delivery Module starts at the inlet reservoir filter passes through the inlet check valve, then through the pump head, and finally exits through the outlet check valve.

#### 4.1.2 *Pump Cycle*

The pump cycle consists of two phases, the pumping phase, when fluid is metered out of the pump at high pressure, and the refill phase, when fluid is rapidly drawn into the pump.

During the pumping phase, the pump piston moves forward at a programmed speed; this results in a stable flow from the pump. The piston is driven by a linear rapid refill cam which is belt driven by the motor.

At the end of the pumping phase, the pump enters the refill phase. The piston quickly retracts, refilling the pump head with solvent, and the piston begins to move forward again as the pumping phase begins.

The motor speed is increased during refill to reduce refill time and to pre-compress the solvent at the beginning of the pumping phase. Since the output flow completely stops during refill, an optional, external pulse damper is necessary for applications requiring extremely low pulsation levels.

For optimal operation of the check valves, a back-pressure of at least 25 psi is required. Operating at lower pressures can lead to improper seating of the valves and subsequently inaccurate flow rates.

#### 4.1.3 *Pulse Damping*

The diaphragm-type pulse damper (inside the pump drawer) consists of a compressible fluid (isopropanol) held in an isolated cavity by an inert but flexible diaphragm. During the pumping phase of the pump cycle, the fluid pressure of the mobile phase displaces the diaphragm, compressing the fluid in the cavity and storing energy. During the pump refill phase the pressure on the diaphragm is reduced and the compressed fluid expands, releasing the energy it has stored. This helps to stabilize flow rate and pressure. The amount of mobile phase in contact with the pulse damper is small, only 0.25 mL at 2,500 psi, and the geometry used insures that the flow path is completely swept, so solvent “memory effects” are virtually eliminated.

To be effective, the pulse damper requires a backpressure of approximately 500 psi or greater.

## 4.2 Electronic Control

### 4.2.1 *Microprocessor Control*

The pump is controlled by hybrid microprocessor circuitry which (1) provides control signals to the motor drive circuitry, (2) interfaces with the keyboard/display, (3) receives signals from the refill flag, and (4) provides external input/output (RS-232) interfacing. Firmware programming is stored in an EPROM.

An eccentric cam provides refill in a fraction of the full cam cycle. The remaining revolution of the cam provides piston displacement for outward flow of the mobile phase. In addition to the rapid refill characteristics of the drive, the onset of refill is detected by an infrared optical sensor. The microprocessor changes the refill speed of the motor to an optimum for the set flow rate. At 1ml/min, the refill rate is more than five times faster than if the motor operated at constant speed. The optimum refill rate minimizes the resulting pulsation while avoiding cavitation in the pump head.

The flow rate of any high pressure pump can vary depending on the operating pressure and the compressibility of the fluid being pumped. The Binary Solvent Delivery Module is calibrated at 1000 psi using an 80:20 mixture of water and isopropanol.

### 4.2.2 *DC Power Supply*

Power for the pump is provided by a switching power supply which accepts voltages from 90 – 240 VAC. Output is 24 VDC for the pumps and heater. A switching 5 VDC supply is also provided to power control and display circuits.

### 4.2.3 *Remote Interfacing*

RS-232C modular jacks are provided on the back panel. See Appendix A for information on operation via this connection.

### 4.2.4 *Motor Stall Detector*

The motor can stall and create a loud buzzing sound if the flow path connected to the pump's outlet becomes plugged, if the pressure exceeds the maximum pressure rating of the pump, or if the mechanism jams. If a motor stall occurs, the electrical current being supplied to the motor is turned off and the fault light is turned on.

The Motor Stall Detector is enabled or disabled during power-up by pressing and holding the RUN/STOP and the PRIME buttons while the power is switched on. Release the buttons when the display displays "SFE". To enable the Motor Stall Detector press the UP-ARROW button and the display will display "On". To disable the

Motor Stall Detector press the DOWN-ARROW button and the display will display "OFF". To exit this mode and store the current setting in non-volatile memory, press the RUN/STOP button.

The Motor Stall Detector uses a timer to determine if the camshaft has stopped turning or if the refill switch is defective. The timer begins timing after the pump accelerates or decelerates to its set point flow rate. If the Motor Stall Detector has been enabled, and the camshaft stops turning or the refill switch stops operating, the fault will be detected between the time it takes to complete 1 to 2 pump cycles. One revolution of the camshaft produces a delivery phase and a refill phase.

The fault is canceled by using one of the following methods: (1) by pressing the RUN/STOP button on the front panel, (2) by sending a stop command "ST" via the serial communications port on the back panel, or (3) by connecting the PUMP-STOP input to COM on the back panel, or removing the connection between the PUMP-RUN input and COM if the PUMP-STOP input is permanently jumpered to COM on the back panel. Note: the PUMP-RUN, PUMP-STOP, and COM are an option and do not exist on the standard pump.

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## 5. MAINTENANCE

Cleaning and minor repairs of the Binary pump can be performed as outlined below.

**NOTE:** Lower than normal pressure, pressure variations, or leaks in the pumping system can all indicate possible problems with the piston seal, piston, or check valves. Piston seal replacement could be necessary after 1,000 hours of running time. See Section 5.2.3.

### 5.1 Filter Replacement

#### 5.1.1 Inlet Filters

Inlet filters should be checked periodically to ensure that they are clean and not restricting flow. A restriction could cause cavitation and flow loss in the pump. Two problems that can plug an inlet filter are microbial growth and impure solvents. To prevent microbial growth, use at least 10-20% organic solvent in the mobile phase or add a growth-inhibiting compound. If you pump 100% water or an aqueous solution without any inhibitors, microbes will grow in the inlet filter over time, even if you make fresh solution every day. Always use well filtered, HPLC grade solvents for your mobile phase.

### 5.2 Changing Pump Heads

#### 5.2.1 Removing a Pump Head

**CAUTION:** The sapphire piston is fragile. Twisting the pump head during removal can cause the piston to break. Closely follow instructions during head removal and replacement to avoid breakage.

As a guide to pump head assembly, the standard pump heads are shown in Figures 5-1 through 5-4. All of the Binary pump heads have a similar arrangement.

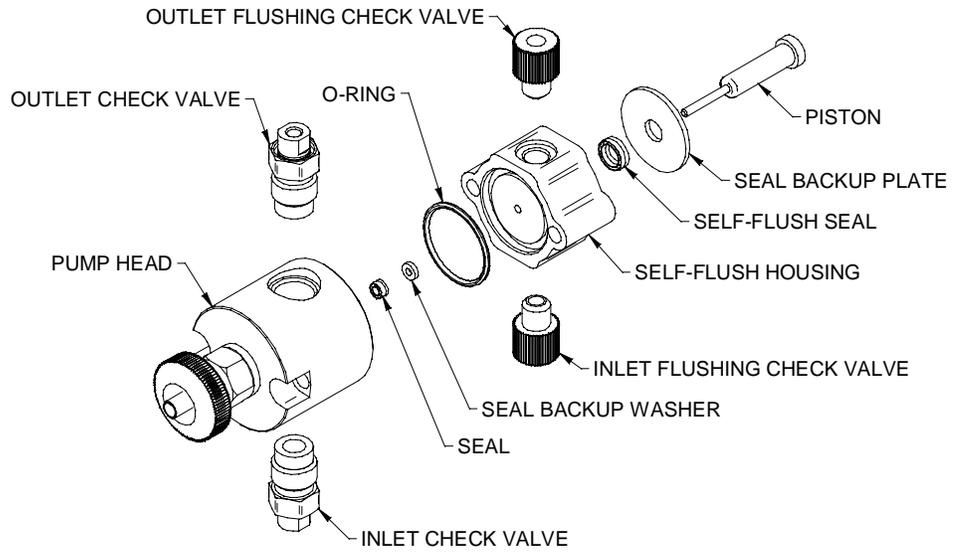
1. Turn OFF the power to the Binary pump.
2. Remove the inlet line and filter from the mobile phase reservoir. Be careful not to damage the inlet filter or crimp the Teflon™ tubing.

**CAUTION:** Check that the Allen nuts at the front of the pump head are secure before removing any tubing from the pump head.

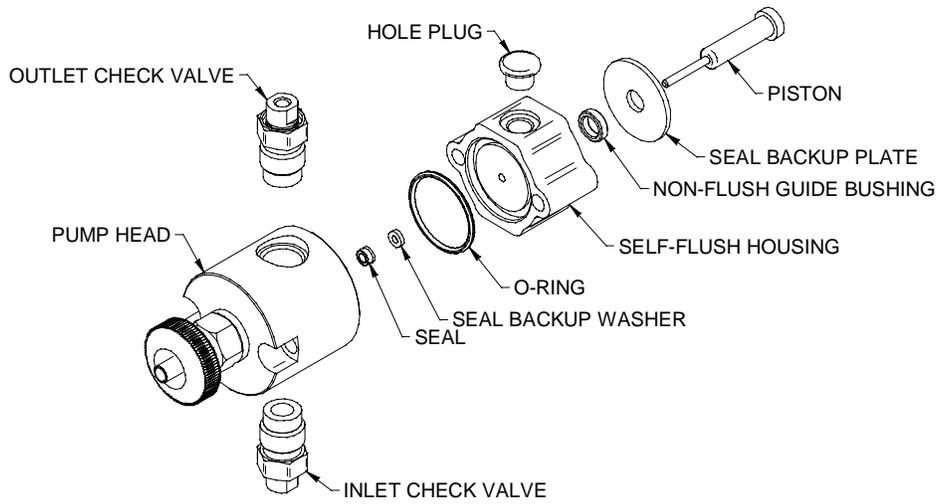
3. Remove the inlet line from the inlet check valve.
4. Remove the outlet line from the outlet check valve.
5. Remove inlet and outlet self-flush check valves.
6. Momentarily turn ON the Binary pump and quickly turn OFF the power upon hearing the refill stroke. This reduces the extension of the piston and decreases the possibility of piston breakage.
7. Unplug the power cord.
8. Carefully remove the two Allen nuts at the front of the pump head.

**CAUTION:** Use care when removing the pump head. Twisting the pump head can cause the piston to break.

9. Carefully separate the pump head from the pump. Move the pump head straight out from the pump and remove it from the piston. Be careful not to break or damage the piston. Also remove the seal and seal backup washer from the piston if they did not stay in the pump head.
10. Carefully separate the flush housing from the pump. Move the flush housing straight out from the pump and remove it from the piston. Be careful not to break or damage the piston. Also remove the self-flush seal from the piston if it did not stay in the flush housing.



*Figure 5-1. Stainless Steel Self-Flushing Pump Head Assembly*



*Figure 5-2. Stainless Steel Non-Self-Flushing Pump Head Assembly*

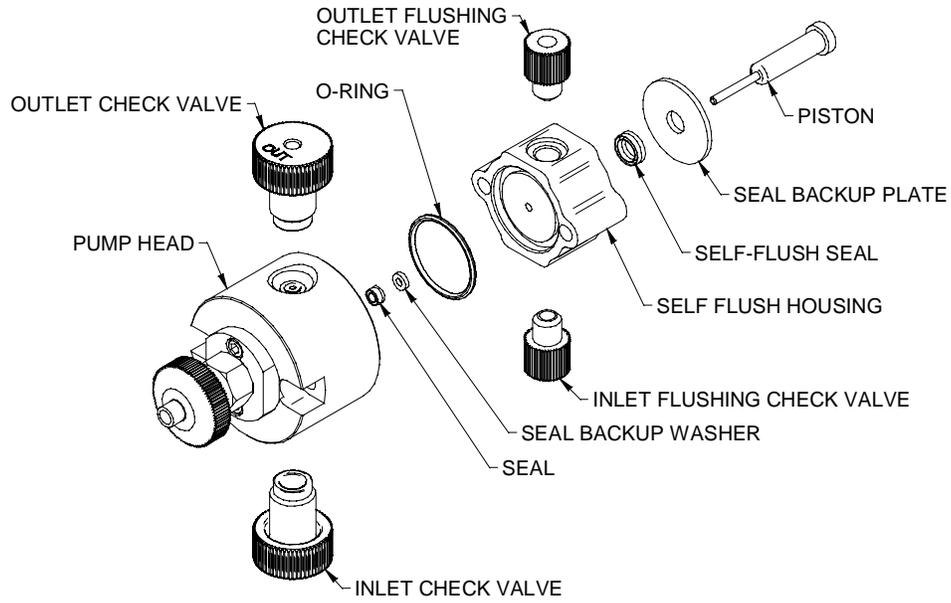


Figure 5-3. Bioclean (PEEK™) Self-Flushing Pump Head Assembly

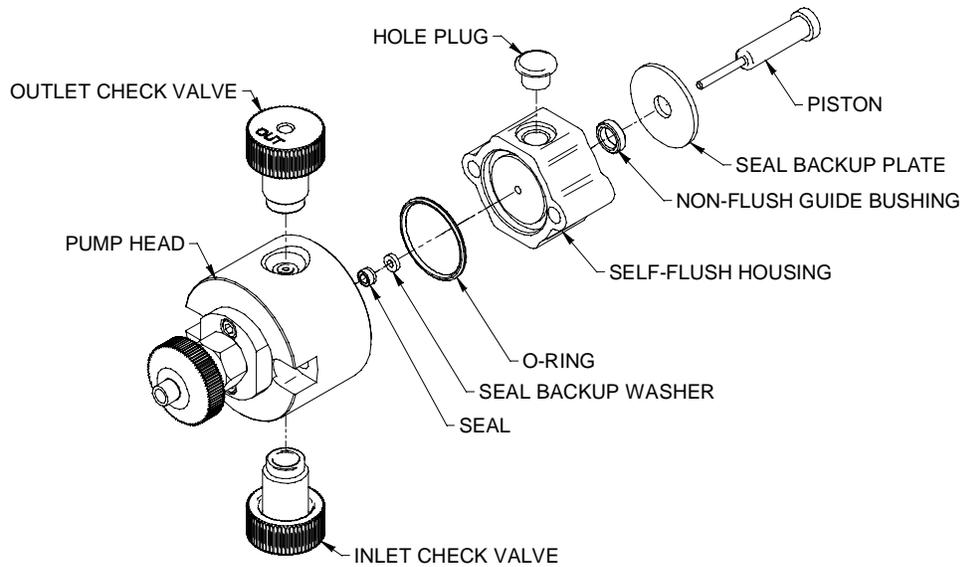


Figure 5-4. Bioclean (PEEK™) Non-Self-Flushing Pump Head Assembly

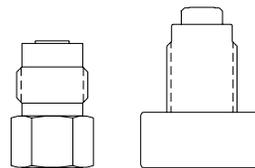
## 5.2.2 Cleaning the Pump Head Assembly

**NOTE:** If you choose to remove the piston seal or self-flush seals, you should have a new set on hand to install after cleaning. It is not recommended that you reinstall used piston or self-flush seals since they are likely to be scratched and damaged during removal and would not provide a reliable seal if reused. If you decide to remove the seals, use only the flanged end of the plastic seal removal tool supplied with the seal replacement kit and avoid scratching the sealing surface in the pump head. See Section 5.2.3 for seal replacement instructions.

1. Inspect the piston seal cavity in the pump head. Remove any foreign material using a cotton swab, or equivalent, and avoid scratching the sealing surfaces. Repeat for the self-flush housing. Be sure no fibers from the cleaning swab remain in the components.
2. The pump head, check valves, and self-flush housing may be further cleaned using a laboratory grade detergent solution in an ultrasonic bath for at least 30 minutes, followed by rinsing for at least 10 minutes in distilled water. Be sure that all particles loosened by the above procedures have been removed from the components before re-assembly.

**CAUTION:** When cleaning check valves, be sure that the ball is not against the seat in the ultrasonic bath. This may destroy the precision matched sealing surface and the valve will not check.

**CAUTION:** If removing the check valves, keep them in the orientation shown below the entire time they are not installed in the pump head. The assemblies may fall apart, parts may be lost, and they may not operate properly when re-assembled.



3. If the check valves have been removed, tighten the check valves on stainless steel pumps to 75 inch-pounds or enough to seal at maximum pressure. Do not exceed maximum torque. For Bioclean (PEEK™) pumps, tighten each check valve firmly by hand. Do not go ¼ turn past finger tight.

NOTE: The inlet check valve has a larger opening (1/4"-28, flat-bottom seat) for the 1/8" inlet tubing; the outlet check valve has a smaller opening (#10-32, cone seat) for the 1/16" outlet tubing. The inlet check valve must be connected at the larger opening in the pump head. See Figure 5-5.

If the piston and flushing seals have been removed, insert new seals as described in Section 5.2.3, then continue with Section 5.2.5 to replace the pump head.

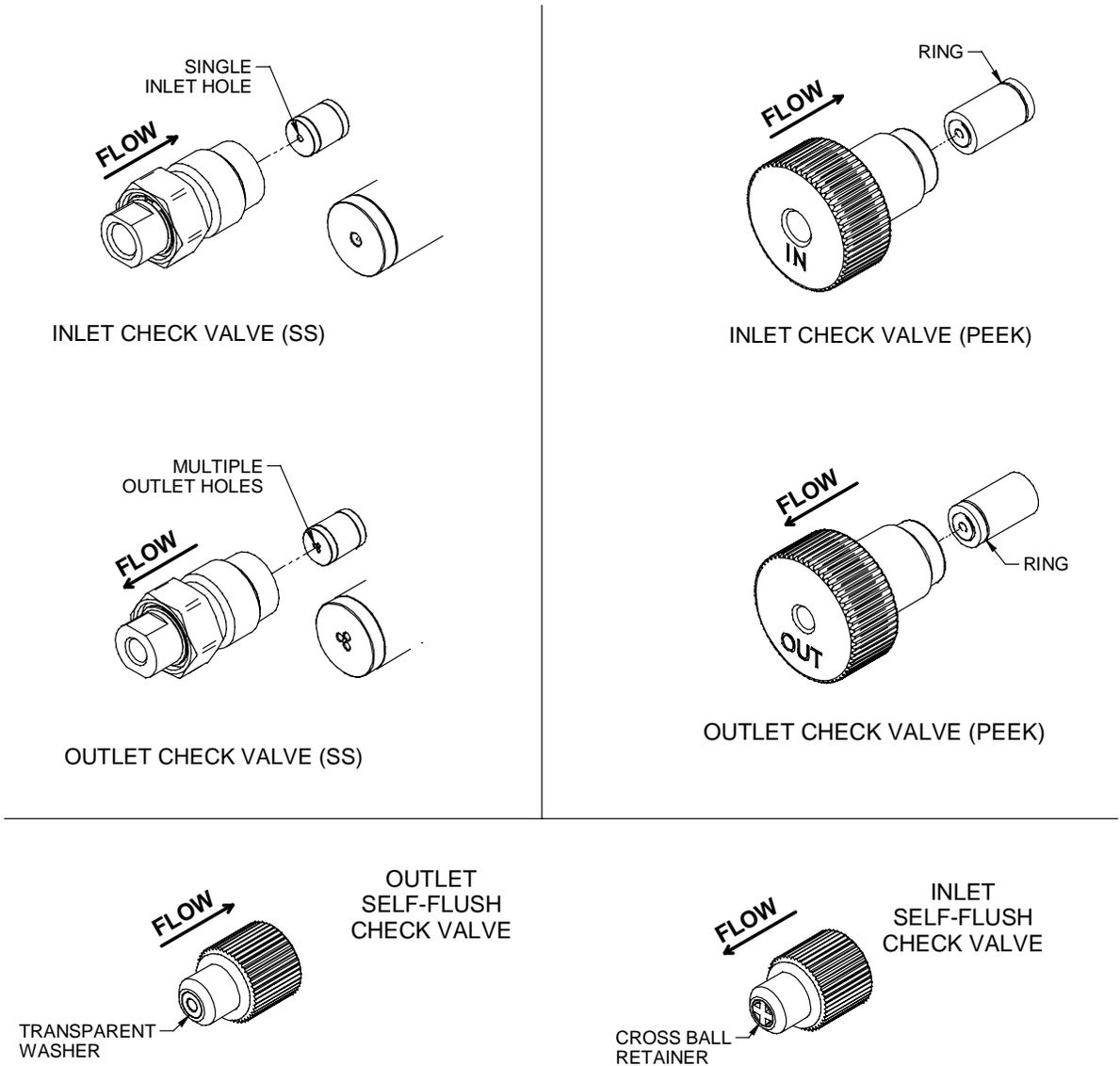


Figure 5-5. Check Valves

### 5.2.3 Replacing Piston Seals

Lower than normal pressure, pressure variations, and leaks in the pumping system can all indicate possible problems with the piston seal. Depending on the fluid or mobile phase used, piston seal replacement is often necessary after 1000 hours of running time.

Each replacement seal kit contains one seal, one backup washer, one self-flush seal, one non-flush guide bushing, two seal insertion/removal tools, and a pad to clean the piston when changing the seal.

#### 5.2.3.1 Removing the Seals

1. Remove the pump head as described in Section 5.2.1. Use caution so as not to damage the sapphire piston.
2. Insert the flanged end of the seal insertion/removal tool into the seal cavity on the pump head. Tilt it slightly so that flange is under the seal and pull out the seal.

**CAUTION:** Using any other “tool” will scratch the finish.

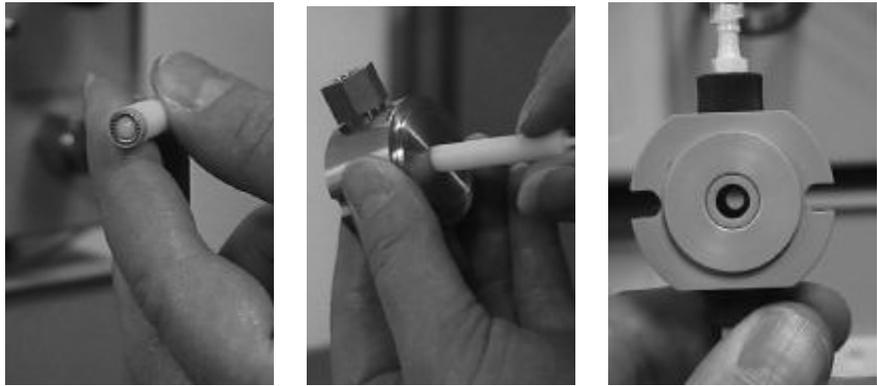
3. Repeat the procedure for the low-pressure seal in the flush housing.
4. Inspect, and if necessary, clean the pump head as described in Section 5.2.2.

#### 5.2.3.2 Cleaning the Piston

1. Once the pump head and self-flush housing are removed, gently remove the seal back-up plate by using either a toothpick or small screwdriver in the slot on top of the pump housing.
2. Grasp the metal base of the piston assembly so that you avoid exerting any side load on the sapphire rod, and remove the piston from the slot in the carrier by sliding it up.
3. Use the scouring pad included in the seal replacement kit to clean the piston. Gently squeeze the piston within a folded section of the pad and rub the pad along the length of the piston. Rotate the piston frequently to assure the entire surface is scrubbed. Do not exert pressure perpendicular to the length of the piston, as this may cause the piston to break. After scouring, use a lint-free cloth, dampened with alcohol, to wipe the piston clean.
4. Grasp the metal base of the piston assembly, and insert it into the slot in the piston carrier until it bottoms in the slot.

#### 5.2.3.3 Replacing the Seals

1. Place a high-pressure replacement seal on the rod-shaped end of the seal insertion/removal tool so that the spring is visible when the seal is fully seated on the tool. Insert the tool into the pump head so that the open side of the seal enters first, facing the high pressure cavity of the pump head. Be careful to line up the seal with the cavity while inserting. Then withdraw the tool, leaving the seal in the pump head. When you look into the pump head cavity, only the polymer portion of the seal should be visible.



2. Place a self-flush replacement seal on the seal insertion/removal tool so that the spring in the seal is visible when the seal is on the tool. As in the previous step, insert the tool and seal into the seal cavity on the flushing housing, taking care to line up the seal with the cavity, and then withdraw the tool. When the seal is fully inserted only the polymer part of the seal will be visible in the seal cavity.
3. Place seal back-up washer over the high-pressure seal. Place seal back-up plate back into pump housing if it was removed. Orientation is not important in these cases.
4. Attach the pump head as described in Section 5.2.5. Use caution so as not to damage the sapphire piston.
5. Condition the new seal as described in Section 5.3.

#### *5.2.4 Changing the Piston*

1. Remove the pump head as described in Section 5.2.1. Use caution so as not to damage the sapphire piston.
2. Grasp the metal base of the piston assembly so that you avoid exerting any side load on the sapphire rod, and remove the piston from the slot in the carrier by sliding it up.
3. Grasp the metal base of the replacement piston assembly, and insert it into the slot in the piston carrier until it bottoms in the slot.
4. Attach the pump head as described in Section 5.2.5. Use caution so as not to damage the sapphire piston.

### 5.2.5 Replacing the Pump Head

**CAUTION:** The sapphire piston is fragile. Twisting the pump head during replacement can cause the piston to break. Closely follow instructions during head removal and replacement to avoid breakage.

1. Make sure that the inlet valve is on the bottom and the outlet valve is on the top. Carefully align the self-flush housing and gently slide it into place on the pump. If misalignment with the piston occurs, gently push up on the piston holder.
2. Line up the pump head and carefully slide it into place. Be sure that the inlet valve is on the bottom and the outlet valve is on the top. Do not force the pump head into place.
3. Finger tighten both knurled nuts into place. To tighten firmly, alternately turn nuts 1/4 turn while gently wiggling the pump head to center it.

**CAUTION:** Use care when replacing the pump head. Twisting the pump head can cause the piston to break.

4. Re-attach the inlet and outlet lines. Reconnect the self-flush lines and fittings to the self-flush check valves. Change the flushing solution.

## 5.3 Conditioning New Seals

**NOTE:** Use only organic solvents to break-in new seals. Buffer solutions and salt solutions should never be used to break-in new seals.

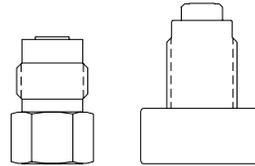
Using a restrictor coil or a suitable column, run the pump with a 50:50 solution of isopropanol (or methanol) and water for 30 minutes at the back pressure and flow rate listed under PHASE 1 below and according to the pump head type. Then run the pump for 15 minutes at a back pressure and flow rate listed under PHASE 2 below.

Pump Head Type	PHASE 1 (30 min.)		PHASE 2 (15 min.)	
	Pressure	Flow Rate	Pressure	Flow Rate
10 mL (SS or PEEK)	1000 psi	< 3 mL/min.	3000-4000 psi	3-4 mL/min.
5 mL (SS or PEEK)	1000 psi	< 2.5 mL/min.	1500 psi	< 5 mL/min.

## 5.4 Check Valve Cleaning and Replacement

Many check valve problems are the result of small particles interfering with the operation of the check valve. As a result, most problems can be solved by pumping a strong solution of liquid, laboratory grade detergent through the check valves at a rate of 1 mL/min for one hour. After washing with detergent, pump distilled water through the pump for fifteen minutes. Always direct the output directly to a waste beaker during cleaning. If this does not work, the check valve should be replaced.

**CAUTION:** When removing the check valves, keep them in the orientation shown below the entire time they are not installed in the pump head. The assemblies may fall apart, parts may be lost, and they may not operate properly when re-assembled.



## 5.5 Pulse Damper Replacement

### 5.5.1 Removing the Pulse Damper

**WARNING:** There are potentially lethal voltages inside the pump case. Disconnect the line cord before removing the cover. Never bypass the power grounds.

1. Make certain that the system has been depressurized. Unplug the power cord and remove the cover.
2. Disconnect the tubing from the pulse damper.
3. Disconnect the transducer from the circuit board.
4. Remove the four screws that secure the pulse damper from the underside of the pump.
5. Remove the pulse damper.

### 5.5.2 Pulse Damper Refurbishing

Refurbishing the pulse damper is a time-consuming procedure. You may want to return the pulse damper to have it

rebuilt. Do not attempt to refill or refurbish the pulse damper until you have a refurbishing kit. Instructions are furnished with the kit.

### 5.5.3 Pulse Damper Installation

1. Position the pulse damper, aligning it with the four mounting holes in the bottom of the cabinet. The pressure transducer should be pointed toward the rear of the cabinet.
2. From the underside of the pump cabinet, tighten the four screws to hold the pulse damper in place.
3. Connect the tubing from the pump head to the port at the rear of the pulse damper (i.e., toward the rear of the cabinet). Connect the line from the prime/purge valve to the other port, toward the front panel.
4. Connect the transducer's wire harness connector to pressure board connector P3.
5. Replace the cover on the pump.

## 5.6 Cleaning the Pump

1. Disconnect the column inlet tube from the column.
2. Direct the column inlet tube (the tube from the injector outlet) to a waste beaker.
3. Set the flow rate to maximum.
4. Turn the injector to the INJECT position.
5. Pump 100% methanol or isopropanol through the pump and injector for 3 minutes.
6. Pump 100% filtered, distilled water through the pump and injector for 3 minutes.

For stainless steel flow paths, proceed to Step 7; For PEEK™ flow paths, skip to step 10.

**WARNING:** Use standard laboratory procedures and extreme care when handling strong acids and bases.

7. Pump a 20% nitric acid/water solution through the pump and injector for 3 minutes.
8. Flush the pump and injector with 100% filtered, distilled water for at least 3 minutes.
9. Pump 100% isopropanol through the pump and injector for 3 minutes. The pump is now prepared for any mobile phase or short- or long-term shutdown.

10. If storing the pump for more than 12 hours fill each pump head with 100% isopropanol then seal the inlets and outlet with the supplied plugs.

## 5.7 Lubrication

The Binary pump has modest lubrication requirements. The bearings in the pump housing and piston carrier are permanently lubricated and require no maintenance. A small dab of light grease such as Lubriplate 630-AA on the cam is the only recommended lubrication. Be sure not to get lubricant on the body of the piston carrier, as this can retard its movement and interfere with proper pumping.

**NOTE:** Keeping the interior of the pump free of dirt and dust will extend the pump's useful life.

## 5.8 Other Pump Maintenance

The internal components of the pump can be accessed by removing the pump drawer. To do so, turn off power at front switch. Unplug power cord. **Ensure there is no power to the system.** Disconnect the inlet line and disconnect pump outlet at the "T" Connector Block above. Unscrew the two thumbscrews on the upper portion of the drawer until fully released (counterclockwise). Pull the drawer out as shown on next page.

Note: Drawer can be removed completely.

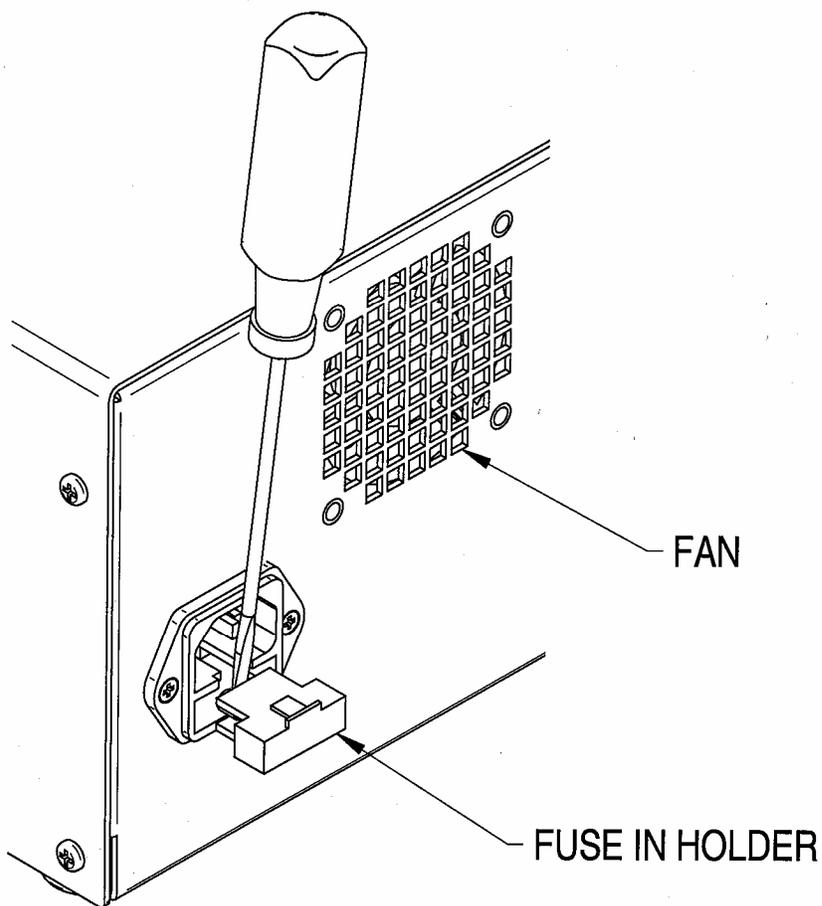


The Pump mechanism, Control Boards, & Pulse Dampener (with Pressure Transducer) are accessible by removing pump drawer.

## 5.9 Fuse Replacement

Three fuses protect the Binary Solvent Delivery Module. Two of the fuses are located in the power entry module at the rear of the cabinet and are in series with the AC input line. The other fuse is located on the circuit board and is in series with the 24 VDC supply.

Troubleshooting the fuses is straightforward. If the power cord is plugged in and the on/off power entry switch is on and the display does not light, check the two fuses in the power entry module. To gain access to these fuses, gently pry off the cover plate with a small flat-bladed screwdriver. Replace with fuses of the correct rating: 2 A slow-blo for 120 VAC systems.



## 5.10 Battery Replacement (If applicable) See attached photo for battery option.

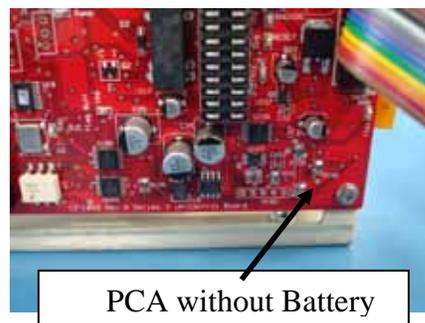
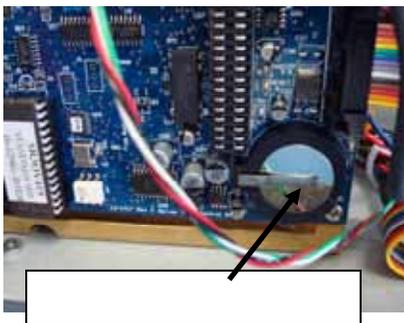
Depending on the version of drive board assembly installed, the board may not have a battery. If the printed circuit board does not have a battery, it is designed with circuitry that does not require a battery backup and you should disregard the following instructions.

The battery provides power for the memory that holds the current pump configuration. If the pump is set at a flowrate and the power is turned off, when the power is turned back on the flowrate should appear as it was set. If this flowrate does not appear the battery will need replaced.

**CAUTION:** Be sure to disconnect power cord before removing cover to insure there is no voltage present.

**CAUTION:** Circuit boards can be damaged by Electro Static Discharge (ESD). Follow standard ESD procedures when handling circuit boards.

1. Unplug the unit.
2. Remove the cover.
3. Turn the unit so that the pump heads are to the right. The battery can be seen in the lower right corner of the circuit board. The battery is circular and has a positive pole mark (+) on the top. Gently pull it from its socket.
4. With the positive mark (+) up, gently slide the new battery into the battery socket. Be sure the battery is all the way into place. It must contact the base of the battery socket.
5. Replace the cover to the unit.
6. Plug the unit back in.



## 6. PROBLEM SOLVING

### Quick Guide to Problem Solving

<b>You Notice</b>	<b>This May Mean</b>	<b>Possible Cause</b>	<b>You Should</b>
<ol style="list-style-type: none"> <li>1. Uneven pressure trace.</li> <li>2. Pressure drops.</li> <li>3. No flow out the outlet check valve.</li> </ol>	<ol style="list-style-type: none"> <li>1. Bubble in check valve.</li> <li>2. Leaks in system.</li> <li>3. Dirty check valve.</li> <li>4. Bad check valve.</li> </ol>	<ol style="list-style-type: none"> <li>1. Solvent not properly degassed.</li> <li>2. Fittings are not tight.</li> <li>3. Mobile phase not properly filtered.</li> <li>4. Particles from worn piston seal caught in check valve.</li> <li>5. Plugged inlet filter.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check to be certain that mobile phase is properly degassed.</li> <li>2. Check connections for leaks by tightening fittings.</li> <li>3. Prime the system directly from the outlet check valve.</li> <li>4. Clean or replace the check valves. See Section 5.4.</li> <li>5. Clean or replace inlet filter. See Section 5.1.1.</li> </ol>
<ol style="list-style-type: none"> <li>1. Uneven pressure trace.</li> <li>2. Pressure drops.</li> <li>3. Fluid between the pump head and the retainer.</li> </ol>	<ol style="list-style-type: none"> <li>1. Leaks in system.</li> <li>2. The piston seal or diaphragm is worn.</li> </ol>	<ol style="list-style-type: none"> <li>1. Fittings not tight.</li> <li>2. Long usage time since last seal / diaphragm change.</li> <li>3. Salt deposits on seal or diaphragm (especially if buffered aqueous mobile phases are used).</li> </ol>	<ol style="list-style-type: none"> <li>1. Check all connections for leaks.</li> <li>2. Replace piston seal &amp; diaphragm. See Sections 5.2 and 5.3.</li> <li>3. Check the piston for salt deposits. Clean as necessary. See Section 5.2.4.</li> </ol>
Pump makes a loud clanging or slapping noise (intermittent contact with cam).	Piston carrier is catching in piston guide.	<ol style="list-style-type: none"> <li>1. Cap nut screws on the pump head are loose.</li> <li>2. Seal(s) are worn.</li> <li>3. Piston guide is worn</li> </ol>	<ol style="list-style-type: none"> <li>1. Check cap nut screws on pump head. Tighten if necessary.</li> <li>2. Replace seals.</li> <li>3. Replace piston guide and seals. See Sections 5.2 and 5.3.</li> </ol>
No power when pump turned ON.	Blown fuses in the power entry module.	<ol style="list-style-type: none"> <li>1. Power surge.</li> <li>2. Internal short.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace only with the appropriate fuses (1A for 100/110 Vac or 1/2A for 220/240 Vac).</li> <li>2. Contact service technician if problem persists.</li> </ol>
Blue dye in mobile phase.	Pulse damper diaphragm has burst.	Sudden pressure drop when purging system.	Replace pulse damper. See Section 5.5.
Pump runs for 50 pump strokes, then shuts down.	Lower pressure limit is activating.	<ol style="list-style-type: none"> <li>1. Mobile phase is not properly filtered.</li> <li>2. Particles from worn seal trapped in the system (e.g., tubing, filters, injection valve, column inlet).</li> </ol>	<ol style="list-style-type: none"> <li>1. Check to be certain the low pressure limit is set to 0 psi.</li> <li>2. Only increase the low pressure limit after the pump attains operating pressure.</li> <li>3. Contact service technician.</li> </ol>
<ol style="list-style-type: none"> <li>1. Pump shuts down after run is called even with no column connected.</li> <li>2. Pump runs to maximum pressure and shuts down.</li> </ol>	Clog in fluid system.		<ol style="list-style-type: none"> <li>1. Remove and clean both the inlet and bulkhead filters. See Section 5.2.</li> <li>2. If the problem persists, remove tubing from system one piece at a time until you find the clogged piece. Most clogs occur outside the pump itself.</li> </ol>
No power when pump turned ON. Fan does not run.	Blown fuses in the power entry module.	<ol style="list-style-type: none"> <li>1. Power surge.</li> <li>2. Internal short.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace only with the appropriate fuses (1A for 100-120 Vac or 1/2A for 220-240 Vac).</li> <li>2. Contact service technician if problem persists.</li> </ol>
Front panel appears OK but pump motor does not run.	Blown fuse on the motor power circuit board.	<ol style="list-style-type: none"> <li>1. Power surge.</li> <li>2. Internal short.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace only with the appropriate fuse .</li> <li>2. Contact service technician if problem persists.</li> </ol>
PEEK fittings or components leak.	You cannot force PEEK parts with interference to seal by brute force tightening.	<ol style="list-style-type: none"> <li>1. Film of fluid between surfaces.</li> <li>2. Salt crystals between surfaces.</li> <li>3. Scratches in mating surfaces.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean and dry mating surfaces.</li> <li>2. If scratched, replace defective part.</li> </ol>

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## 7. LIST OF REPLACEMENT PARTS

### **BINARY, STAINLESS STEEL**

880201	Seal Kit, Aqueous, 5mL
880202	Seal Kit, Organic, 5mL
880203	Seal Kit, Aqueous, 10mL
880204	Seal Kit, Organic, 10mL
880407	Check Valve Kit – Stainless Steel
880721	Replacement Inlet Filter Elements (Package of 2)
880651	Prime Purge Valve Rebuild Kit – Stainless Steel
880353	Series II-IV, Binary Piston, 5mL
880354	Series II-IV, Binary Piston, 10mL
880414	Self-Flush Check Valve Kit
880511	Binary Drive Assembly
880971	Front Panel Assembly
880806	Fuse, 2 Amp, 5x20 mm (10 pack)

### **Specific to Left Hand Pump Drawer (with Pressure)**

880613	Repl. Pulse Damper with Pressure Transducer - Stainless
880144	SMT Board Set with Pressure
880972	Binary Overlay with Pressure
880940	Left hand replacement drawer 5mL SS
880941	Left hand replacement drawer 10mL SS

### **Specific to Right Hand Pump Drawer (without Pressure)**

880615	Repl. Pulse Damper without Pressure Transducer - Stainless
880145	SMT Board Set without Pressure
880979	Binary Overlay without Pressure
880942	Right hand replacement drawer 5mL SS
880943	Right hand replacement drawer 10mL SS

**BINARY, PEEK**

880201 Seal Kit, Aqueous, 5mL  
880202 Seal Kit, Organic, 5mL  
880203 Seal Kit, Aqueous, 10mL  
880204 Seal Kit, Organic, 10mL  
880408 Check Valve Kit - PEEK  
880721 Replacement Inlet Filter Elements (Package of 2)  
880652 Prime Purge Valve Rebuild Kit - PEEK  
880353 Series II-IV, Binary Piston, 5mL  
880354 Series II-IV, Binary Piston, 10mL  
880414 Self-Flush Check Valve Kit  
880511 Binary Drive Assembly  
880124 Front Panel Assembly  
880806 Fuse, 2 Amp, 5x20 mm (10 pack)

**Specific to Left Hand Pump Drawer (with Pressure)**

880614 Repl. Pulse Damper with Pressure Transducer - PEEK  
880144 SMT Board Set with Pressure  
880972 Binary Overlay with Pressure  
880944 Left hand replacement drawer 5mL PEEK  
880945 Left hand replacement drawer 10ml PEEK

**Specific to Right Hand Pump Drawer (without Pressure)**

880616 Repl. Pulse Damper without Pressure Transducer - PEEK  
880145 SMT Board Set without Pressure  
880979 Binary Overlay without Pressure  
880946 Right hand replacement drawer 5mL PEEK  
880947 Right hand replacement drawer 10mL PEEK

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# APPENDIX A

## A.1 Rear Panel Serial Communications Port - Pump

An RS-232C modular jack is provided on the back panel. A computer, with appropriate software, can be used as a remote controlling device for pump operation via this connection.

### A.1.1 Hardware Implementation

The REMOTE INPUT serial communications port is configured for 9600 baud, 8 data bits, 1 stop bit, and no parity. The connector is a standard RJ-11 modular telephone type jack. When looking at the connector on the rear panel of the pump, pin 1 is at the top and pin 6 is at the bottom. The pin-out is:

<u>Pin</u>	<u>Function</u>
1, 6	Ground
2	DSR (Handshaking input to pump)
3	RXD (Serial data input to pump)
4	TXD (Serial data output from pump)
5	DTR (Handshaking output from pump)

Special wiring considerations: Use the following chart for interfacing the pump's serial communications port to either a 25-pin or a 9-pin COM port on an IBM-PC type computer.

<u>Pump (RJ11)</u>	<u>Signal</u>	<u>IBM (DB25)<sup>a</sup></u>	<u>IBM (DB9)<sup>b</sup></u>
1, 6	Ground	7	5
2	DSR	20	4
3	RXD	2	3
4	TXD	3	2
5	DTR	6	6

<sup>a</sup> Jumper pins 4, 5, and 8 on DB25.  
<sup>b</sup> Jumper pins 1, 7, and 8 on DB9.

<b>Part Description</b>	<b>Part Number</b>
Modular Cable	12-0677
Adapter RJ-11 to DB9	12-0672
Adapter RJ-11 to DB-25	12-0671

### A.1.2 Hand-Shaking

The pump uses hardware handshaking. The pump will not transmit on the TXD output if the DSR input is at a low logic level. And, the pump will not receive on the RXD input when the DTR

output is at a low logic level. A low logic level is -3.0 to -15 volts and a high logic level is 3.0 to 15 volts.

### A.1.3 Command Interpreter

The pump's high-level command interpreter receives and responds to command packets. The pump will not send a message except when prompted, and it will send a response to every valid command as described below. The response to an invalid command is "Er/".

Each command is characterized by a unique two-letter command code, and only one command can be issued per line. Case is not important; that is, the command codes "PR" "Pr" "pR" and "pr" are all equivalent. Response strings sent by the pump are terminated by the "/" character.

If the pump's response is "Er/", send a "#" to clear any characters which may be remaining in the command buffer. The pump will automatically clear all characters in the command buffer after one second elapses from the time at which the last character of an incomplete command was sent.

The command packets are as follows:

Command	Response	Comments
RU	OK/	Sets the pump to the RUN state.
ST	OK/	Sets the pump to the STOP state.
FLxxx	OK/	Sets the flow rate to x.xx or xx.x mL/min where the range is fixed for the pump head size, i.e., for 0.01 to 9.99 mL/min xxx = 001 to 999, for 0.1 to 39.9 mL/min xxx = 001 to 399.
FOxxxx	OK/	Sets the flow rate to xx.xx or xxx.x mL/min where the range is fixed for the pump head size, i.e., for 0.01 to 10.00 mL/min xxxx = 0001 to 1000, for 0.1 to 40.0 mL/min xxxx = 0001 to 0400.
FMxxxx	OK/	Sets the flowrate to x.xxx mL/min, i.e., for 0.001 to 9.999mL/min xxxx = 0001 to 9999. for 10.00 to 12.00mL/min xxxx = 1000 to 1200.
PR	OK,x/ (x, xx, xxx, or xxxx)	Reads the pump's current pressure, where: x, xx, xxx, or xxxx = Current pressure in PSI
CC	OK,x,y.yy/  (x, xx, xxx, or xxxx) (y.yyy, y.yy, yy.yy, or yy.y)	Reads the pump's current pressure and flowrate, where: x, xx, xxx, or xxxx = Current pressure in PSI y.yyy, y.yy, yy.yy, or yy.y = Flow rate in mL/min The format is y.yy and yy.yy for a standard pump head, y.yyy for micro pump head or yy.y for a macro pump head.

CS	OK,x.xx,y,z,PSI,w,v,u/ (x.xxx, xx.xx, or xxx.x) (y, yy, yyy, or yyyy) (z, zz, zzz, or zzzz)	Reads the current pump setup, where: x.xxx, xx.xx, or xxx.x = Flow rate in mL/min y, yy, yyy, or yyyy = Upper pressure limit z, zz, zzz, or zzzz = Lower pressure limit PSI = Units (PSI, ATM, MPA, BAR, or KGC) w = Pump head size (0 = standard, 1 = macro) v = Run status (0 = stopped, 1 = running) u = Pressure Board present = 0; otherwise 1
ID	OK,vx.xx SR30 firmware/	Identifies the pump type and EPROM revision x.xx
UPxxxx	OK/	Sets the upper pressure limit in PSI. The maximum value for xxxx is 5000 for the plastic head or 6000 for the steel head; the minimum value is the lower limit plus 100. The value must be expressed as four digits, i.e., for 900 PSI xxxx = 0900.
LPxxxx	OK/	Sets the lower pressure limit in PSI. The maximum value for xxxx is the current upper pressure limit setting minus 100; the minimum value is 0. The value must be expressed as four digits, i.e., for 100 PSI xxxx = 0100.
SF	OK/	Puts the pump in fault mode. Turns on the FAULT LED and stops the pump immediately.
RF	OK,x,y,z/	Reads the fault status, where: x = Motor stall fault (0 = no, 1 = yes) y = Upper pressure limit fault (0 = no, 1 = yes) z = Lower pressure limit fault (0 = no, 1 = yes)
KD	OK/	Disables the keypad. (Default status at power-up is enabled.)
KE	OK/	Enables the keypad.
PCxx	OK/	Sets the pressure compensation value, where xx = the operating pressure (in PSI divided by 100), i.e., for 0 PSI xx = 00, for 5000 PSI xx = 50.
RC	OK,x/ (x or xx)	Reads the pressure compensation value in hundreds of PSI, i.e., for 0 PSI x = 0, for 5000 PSI xx = 50.
HTx	OK/	Sets the pump head type, where: x = 1 for a stainless steel 10 mL/min pump head x = 2 for a plastic 10 mL/min pump head x = 3 for a stainless steel 40 mL/min pump head x = 4 for a plastic 40 mL/min pump head x = 5 for a stainless steel 5 mL/min pump head x = 6 for a plastic 5 mL/min pump head The pump is stopped; and, the pressure compensation and pressure limits are initialized, when the head type is changed.
RH	OK,x/	Reads the pump head type, where: x = 1 for a stainless steel 10 mL/min pump head x = 2 for a plastic 10 mL/min pump head x = 3 for a stainless steel 40 mL/min pump head x = 4 for a plastic 40 mL/min pump head x = 5 for a stainless steel 5mL/min pump head x = 6 for a plastic 5 mL/min pump head

PI	OK,a.aa,b,c,d,e,f,g,h,i,j,k,l, m,n,o,p,q/  (a.aaa, a.aa, aa.aa, or aa.a) (c or cc)	Reads the current pump setup, where: a.aaa, a.aa, aa.aa, or aa.a = Flow rate in mL/min b = Run status (0 = stopped, 1 = running) c or cc = Pressure compensation d = Pump head type (see RH command) e = Pressure Board present = 0; otherwise 1 f = External control mode (0 = frequency, 1 = voltage) g = 1 if pump started and frequency controlled, else 0 h = 1 if pump started and voltage controlled, else 0 i = Upper pressure limit fault (0 = no, 1 = yes) j = Lower pressure limit fault (0 = no, 1 = yes) k = Priming (0 = no, 1 = yes) l = Keypad lockout (0 = no, 1 = yes) m = PUMP-RUN input (0 = inactive, 1 = active) n = PUMP-STOP input (0 = inactive, 1 = active) o = ENABLE IN input(0 = inactive, 1 =active) p = Always 0 q = Motor stall fault (0 = no, 1 = yes)
RE	OK/	Resets the pump configuration to its default power-up state.

## A.2 Pump Rear Panel 4-Pin and 10-Pin Terminal Board Connectors

A 4-pin terminal board connector and a 10-pin terminal board connector are provided on the back panel. Any device capable of providing the proper run/stop logic level, flowrate control frequency, or flowrate control voltage can be used as a remote controlling device for pump operation via this connection. The terminal board connectors can be removed for ease of connecting wires, if desired, by pulling firmly rearward and should be reinserted firmly afterward.

### A.2.1 Pressure Fault and Motor Stall Fault Output

The pump's output is on the 4-pin terminal board connector. The pinout is:

<u>Pin</u>	<u>Function</u>
4	EVENT 1
3	EVENT 2
2	EVENT 3
1	Ground

This output is produced internally by a reed relay which has SPDT contacts with a 0.25 amp maximum, 50 VDC maximum, 0.2 ohm rating. The 4-pin connector allows wires to be connected to the EVENT 1 (Pole), EVENT 2 (NC), and EVENT 3 (NO) terminals. When the pump stops due to the sensed pressure exceeding the set pressure limits or if a motor stall fault occurs, the connection between

the EVENT 1 terminal and the EVENT 2 and EVENT 3 terminals is affected. EVENT 2 is Normally Closed (connected to EVENT 1) until a fault occurs and then opens. EVENT 3 is Normally Open (not connected to EVENT 1) until a fault occurs and then closes.

#### *A.2.1.1 Upper and Lower Pressure Limit Range (pump A only)*

The pressure sensing transducer provides accurate, wide range pressure monitoring. Because of the sensitivity of the transducer, the zero reading may shift up to 0.1% of the full pressure scale over years of operational use. The user should also be aware that the resistance to flow of the fluid being pumped through the tubing and fittings may cause the pressure to vary with the flow rate and the viscosity of the mobile phase employed.

If absolute accuracy is needed for the pressure safety limits:

1. Disconnect the column from pumping system and operate the pump with the mobile phase and flow rate to be used in the analysis. Observe the resulting pressure displayed on the pump readout. The column will cause a pressure reading that adds to this basic reading due to system flow resistance.
2. Set the upper limit shut-off to a pressure equal to the basic reading *plus* the safe operating pressure for the column to be used. For example, if the basic pressure reading (without the column) is 7 PSI and the safe limit for the column is 25 PSI, set the maximum pressure limit to 32 PSI or less.
3. If the mobile phase or flow rate is changed, reset the pressure limit as appropriate.
4. Note that a lower pressure limit is available to prevent continued operation in the event of a leak. For proper operation, this must be set to a pressure higher than the basic pressure or it may not sense the reduced pressure.

#### *A.2.2 General Information on Inputs*

The pump's inputs are on the 10-pin terminal board connector. The pinout is:

<u>Pin</u>	<u>Function</u>
10	VOLTAGE COM
9	VOLTAGE IN
8	FREQ IN
7	ENABLE IN
6	PUMP-RUN
5	PUMP-STOP
4	No connection
3	No connection
2	No connection
1	COM

### *A.2.3 General Information on Run, Stop, and Enable Inputs*

The PUMP-RUN, PUMP-STOP, and ENABLE IN inputs operate from an internal 5 VDC source and each one draws approximately 0.008 amps when connected to COM. To activate either the PUMP-RUN, PUMP-STOP, or ENABLE IN input connect it to COM. Any device capable of switching 0.008 amps can be connected between the PUMP-RUN, PUMP-STOP, or ENABLE IN input and COM, such as: a switch contact, a relay contact, an open collector output, an open drain output, or any output with a high logic level output of 3.8 to 6.0 volts and a low logic level output of 0.0 to 0.5 volts. A switch contact or a relay contact is preferred since this type of connection will provide isolation between the pump and the controlling device. The COM terminal is internally connected to the pump's chassis ground and should be connected to the controlling device's ground or zero volt terminal when the controlling device has an open collector output, an open drain output, or any output with logic level output.

### *A.2.4 Run and Stop Inputs*

The pump's motor can be commanded to run or stop from the back panel inputs when the pump's flowrate is controlled from the front panel or when the pump's flowrate is controlled by the voltage or frequency input. There two modes of operation for the run and stop inputs which are described below:

Dual Signal Pulse: In this mode of operation both the PUMP-RUN and PUMP-STOP inputs are normally at a high logic level. To start the pump, pulse the PUMP-RUN input to a low logic level for a minimum of 500 mS. To stop the pump, pulse the PUMP-STOP input to a low logic level for a minimum of 500 mS.

Single Signal Level: To enable this mode of operation the PUMP-STOP input must be permanently connected to COM with a jumper wire. To start the pump, put a low logic level on the PUMP-RUN input. To stop the pump, put a high logic level on the PUMP-RUN input.

#### *A.2.4 Enable Input*

When activated (ENABLE IN is at a low logic level), the ENABLE IN input disables flowrate control on the front panel and enables flowrate control on the back panel.

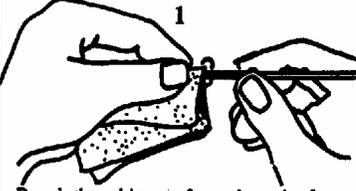
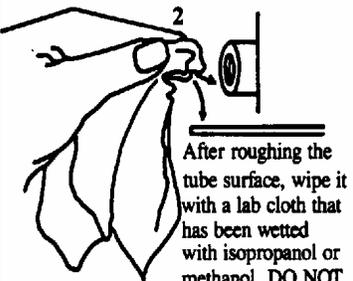
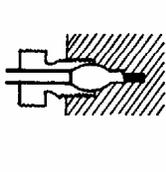
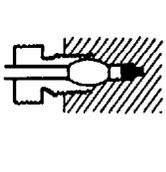
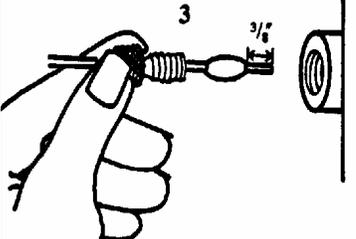
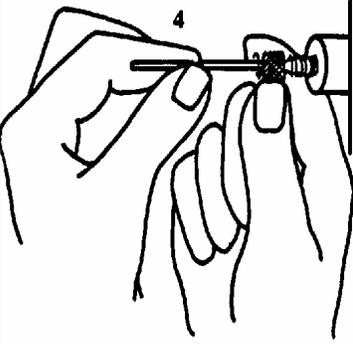
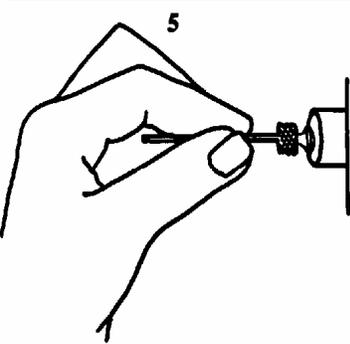
#### *A.2.5 General Information on Voltage and Frequency Inputs*

Special programming and circuitry allows this pump to be operated remotely with the flowrate controlled by voltage or frequency inputs. To select the remote mode of operation:

- a.) With the pump plugged in and the rear panel power switch OFF, press in and hold the "DOWN ARROW" button while turning the power switch ON.
- b.) Release the "DOWN ARROW" button and either a U (closest approximation to V for voltage) or an F (for frequency) will be displayed.
- c.) Select the desired remote operating mode by pressing the "DOWN ARROW" button to toggle between the voltage and frequency mode.
- d.) Press the "RUN/STOP" button to place the pump in normal operating mode.
- e.) To enable the currently selected remote mode (voltage or frequency), connect the rear panel ENABLE IN connection to the COM connection.
- f.) When in the remote mode (ENABLE IN at a low logic level) all front panel buttons remain active except the flow setting increase/decrease capability.

# APPENDIX B

## EZ GRIP FITTING GUIDE

<p>1</p>  <p>Rough the tubing surface where the ferrule will grip with a circular motion. (Sandpaper is included in the kit.) <b>DO NOT PULL THE SANDPAPER ALONG THE AXIS OF THE TUBE AS THIS MAY REDUCE THE HOLDING STRENGTH OF THE FERRULE.</b> Stainless Steel tubing has a very smooth finish and the ferrule will not hold properly unless the surface is rough. This will also help with PEEK tubing.</p>	<p>2</p>  <p>After roughing the tube surface, wipe it with a lab cloth that has been wetted with isopropanol or methanol. <b>DO NOT USE WATER.</b> Also swab out the seat in which the ferrule will sit. If there are any particles or moisture between the ferrule and the surfaces of the seat, the fitting will not seal properly. The low vapor points of methanol or isopropanol make them ideal for cleaning these surfaces.</p>		
		<p>No Salt Crystals or Particles in the Seat</p>	<p>No Moisture in the Seat</p>
			
		<p>Properly Seated</p>	<p>Tubing Not Fully Seated</p>
<p>3</p>  <p>Place the gland nut and then the ferrule on the tubing. The ferrule should be placed about <math>\frac{3}{4}</math>" from the end of the tubing to insure that the tubing length can be fully inserted into the seat. Insert the tube fully so the tubing bottoms against the seat.</p>	<p>4</p>  <p>Maintain firm pressure on tubing and slide the gland nut and ferrule into the seat. Tighten the gland nut as tightly as you can with your fingers. <b>DO NOT USE TOOLS TO TIGHTEN THE GLAND NUT.</b></p>	<p>5</p>  <p>The EZ-Grip™ Gland Nut and EZ-Grip™ Ferrule should now be securely seated in the fitting. Tug on the tubing to double check the fitting.</p>	

# Scientific Systems Inc.

## Warranty Statement

Scientific Systems, Inc. (SSI) warrants that instruments or equipment manufactured by it for a period thirty-six (36) months from date of shipment to customer, against defects in materials and workmanship under normal installation, use and maintenance. Expendable items and physical damage caused by improper handling or damage caused by spillage or exposure to any corrosive environment are excluded from this warranty. The warranty shall be void for Polyetheretherketone (PEEK) components exposed to concentrated Nitric or Sulfuric acids which attack PEEK, or methylene chloride, DMSO or THF which adversely affect UHMWPE seals and PEEK tubing. Any defects covered by this warranty shall be corrected by replacing or repairing, at SSI's option, parts determined by SSI to be defective.

Spare or replacement parts and accessories shall be warranted for a period of 12 months from date of installation at customer against defects in materials and workmanship under normal installation, use and maintenance. Defective Product will be accepted for return only if customer returns them to SSI within thirty (30) days from the time of discovery of the alleged defect, and prior to return, obtains a Return Goods Authorization (RGA) number from SSI, and provides SSI with the serial number of each instrument to be returned. Freight costs for the return of defective Product is the responsibility of SSI. SSI shall specify the freight carrier for returns.

The warranty shall not apply to any Product that has been repaired or altered except by SSI or those specifically authorized by SSI, to the extent that such repair or alteration caused the failure, or to Product that has been subjected to misuse, negligence, accident, excessive wear, or other causes not arising out of a defect in material or workmanship.

The warranty shall not apply to wear items, specifically:

Check Valves	Piston and Wash Seals
Pistons	Pulse-Damper Diaphragms
Inlet Lines	Filter Elements

The following is the exclusive procedure by which to make claims under this warranty. Customer shall obtain SSI's oral or written authorization to return the product and receive a Return Goods Authorization (RGA) number. The Product must be returned with the RGA number plainly visible on the outside of the shipping container to SSI. It must be securely packed in a rigid container with ample cushioning material, preferably the original packaging. All claimed defects must be specified in writing, including the RGA number, with the written claim accompanying the Product. Product shall be shipped to SSI at customer's expense. SSI shall bear the expense of return shipment.

If it appears to SSI that any Product has been subjected to misuse, negligence, accident or excessive wear, or is beyond the warranty period, customer shall be notified promptly. SSI shall notify customer of its finding and provide an estimate to repair such Product at the then current rates for parts and service. SSI shall either repair the product per customer's authorization or shall return such Product not repaired to customer at customer's expense. SSI may invoice customer for the freight costs of any Product shipped back to customer by SSI which is not covered under the warranty.

Limitations of Warranty. THE FOREGOING WARRANTIES AND LIMITATIONS ARE CUSTOMER'S EXCLUSIVE REMEDIES AND ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR

IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.